Bonus Episode: Bloom Goes the Dinoflagellate! Understanding ...

Tue, 9/28 4:13PM 50:47

SUMMARY KEYWORDS

blooms, toxins, neurotoxins, harmful algal blooms, lakes, florida, people, nutrients, biomass, species, important, terms, consequence, typically, algae, red tide, human, shellfish, area, cyanobacteria

SPEAKERS

Betty Staugler, Michaela Kandzer, Ed Phlips, Phillip Stokes

P **Phillip Stokes** 00:08

Hello, everyone, I'm Phillip Stokes, and this is a bonus episode from Science by the Slice on the topic of harmful algal blooms. Hopefully you enjoyed the episode bloom goes the Dinoflagellate. And for those that want to hear more from our speakers, we put together some of the clips from the interviews that didn't make the main show into this bonus episode. When we recorded the three interviews, there was so much really good content from the conversations, but not all of it could fit into one episode. So we thought, let's make a bonus feature. Keep in mind that this is not a polished podcast episode, but a bonus. Think of it like the deleted scenes from a show or an audio resource. So the clips don't necessarily transition like they would in a regular episode. And for this bonus episode, you'll hear from Betty Staugler, the harmful algal bloom liaison with the National Oceanic and Atmospheric Administration, and Florida Sea Grant, as well as Ed Phlips, professor of algal physiology and ecology at the University of Florida. And we'll start with me asking a question to Dr. Phlips. So, you know, moving right along, of course, we're talking about Harmful Algal Blooms today, how do you take an organism that is so important to life? And then it becomes harmful, right? You know, where where does that switch happen?

E **Ed Phlips** 01:41

Yeah, well, I think the place to start maybe to first to define what what is a bloom because we're talking about harmful algae blooms, but they're also blooms that are relatively benign. And so a bloom is actually just an exceedance of the normal range of biomass within the system. So you have a system that normally ranges let's say, use chlorophyll as an indicator of biomass, I'll use that just for ease. So that might range from five micrograms of chlorophyll per liter to about 10. And then our exceptional cases, you might get beyond that, and that would be considered a bloom. So when you're defining a bloom, a lot of people try to form exceedance criteria. So in other words, for a system that you know a lot about over time, what percentage, let's say 10% of the highest values would be considered a bloom, and that would be an exceedance criteria. So the blooms are actually the cases where biomass levels reach beyond the normal range you would expect for that system. And one system, that range may be narrower than another system. So in a eutrophic lake that has a lot of nutrients in Florida, the range may be quite large. Whereas in lakes like Lake Tahoe, the range may be because it's very oligotrophic, very nutrient poor, the range might be very narrow. So that's a bloom. So what's a harmful algae bloom? Well, harmful. algae bloom is basically a bloom that creates a distortion or a, a disruption of an ecosystem structure and function. And so that can

happen in many different ways that can be a toxic blooms that cause mass mortalities of animals. And that would be disrupting the ecosystem by causing large losses of important parts of the food web, an important part of the biological community, it could be low oxygen conditions, which cause mortality, it could also be situation where you have a change in the character of what's available for the primary consumers that eat the algae. And all of a sudden that that's no longer there, because they can't eat that algae. And as a consequence, that disrupts the ecosystem. So it's really harmful means disruptive, right, the stable, stable structure and function of the system.

P Phillip Stokes 04:08

It's disrupting kind of the normal, the normal function of of that have that system and like you said, every system is going to be different. And so I mean, blooms are going to look different, you know, whether you're talking about the Gulf of Florida, the Atlantic side, or any, like freshwater lakes. So I guess what are some of the precursors to a blooms to blooms? Like, what kind of what things happen before a bloom might might occur?

E Ed Phlips 04:39

Okay, well, I guess to understand a bloom. And of course, we talk about harmful. We'll talk about that in a second. But basically, it's a pretty simple thing. Yeah, I mean, it's very complex when you get down to the nitty gritty of it, but it's actually quite simple to to have a bloom form. You need some basic elements. You need nutrients. Typically the ones that are most limiting in aquatic environments are either nitrogen or phosphorus. And the reason they're limiting is because they are available at lower levels, relative to the requirement for the organisms that are growing. So for example, calcium is is abundant in most systems. So calcium is typically not limiting for algae growth. But nitrogen and phosphorus can be limiting, therefore, they limit algae growth. Some algae require silica, that would also be considered a potential limiting nutrient then for some systems, iron a micronutrient can be limiting. So you need nutrients. And then you need light. And so light is available, you know, in most areas, and it's vary seasonally and how much light is available. And depending on the depth of the system, more or less light can be available in the water column. So that affects it. But so you got nutrients and light, both of which are required for photosynthesis, that's really all you need. And the essential driving element will be carbon. And that's CO2. But CO2 is very seldom limiting. So we don't really look at as limiting nutrient we look at it more as a nutrient that is there. And it can be used if the nutrients other nutrients and the light is there. And so that's the ingredients for growth. So what happens what, how do you get bloom development, but then you need time. And that's the third element and there's fourth element. So time, you need the time for the algae to be able to expand its biomass. And so that can happen fairly quickly at high temperatures, particularly as temperatures get cold, that can happen slower. And so that's because growth rates are slower at low temperatures than they are at high temperatures. So as a consequence, when you have seasonality up north in polar latitudes, or temperate latitudes, as temperatures get really cold in the water, boom formation is slower. Whereas here in the subtopics, it's a less little less of a factor in terms of temperature. And so then the final element is loss. So what is as a biomass is accumulating, if can be lost, and how does that happen? organisms can be grazing the biomass down as it's going, it can be flushed out of a system, by rainfall or discharged from rivers can be flushed out. Or sediments can be sedimented out. In other words, cells can fall out of the water column where they no longer have light. And so those are the three major loss factors flushing, glazing and sedimentation. So those elements all combined to define whether bloom is possible or not. But the primary ones are nutrients, light and time. And then the lost rates come into play. Does that make sense?

P Phillip Stokes 07:49

I guess kind of my next thought is, you know, why? I don't know, if you can maybe kind of break down Bloom's from a historical approach. Right? So have blooms been occurring for years, you know, centuries, you know? Well, before, you know, humans were really modifying systems to some extent, and how how has human activity changed that? I

mean, I mean, just kind of what's the historical perspective of blooms? Because we know that all of these factors, right, light and CO2 and these nutrients they've, they've always been around, but maybe not in all the exact same concentrations? So like, what is kind of a historical approach of that?

E Ed Phlips 08:42

Right? Yeah, I think the the maybe the easiest way to understand that is to look at, for example, lakes in Florida would be good example. lakes in Florida, reside in different geological formations. And so for example, in the near Tampa, Orlando area, the sediments in that area tend to be very high in phosphorus. And so lakes in the that region of Florida tend to be more productive because they have a higher nutrient concentrations in them. And so historically, many of those lakes have probably been subject to periodic blooms of algae. Given the right combination of water residence time, and other factors come into play. And so blooms may have been a regular feature in many of those lakes, whereas in other parts of Florida, where the sediments are less rich in phosphorus, those lakes may be more oligotrophic. In other words, they don't have that base of nutrients in the sediments that are feeding into the lakes. So they are less productive, less prone to blooms in terms of what we think of as a bloom. Now we added the human dimension to that basically As development happens, you're adding additional nutrients to those lakes. And so you're elevating the nutrient status of all those lakes where human development is impacting the lakes. And so as a consequence, the more oligotrophic Lakes which had low nutrient content, you're adding nutrients, so they're going to be more prone to to blooms. And then the lakes that are already somewhat prone to blooms are going to have more extreme blooms because more nutrients are being put in by human activity. So that's an example of how historically there may have been in blooms in the naturally rich lakes. But now there's more blooms more intense, more harmful.

M Michaela Kandzer 10:42

What exactly causes these algaes to be so harmful?

B Betty Staugler 10:46

Um, so it really depends on the species that we're talking about. In the case of K arenia brevis, which is the organism that causes red tide, it produces a neurotoxin called brevetoxin. And that brevetoxin can be released into the air, it becomes aerosolized is what we say. And that can cause respiratory distress in humans, particularly those with underlying respiratory conditions. It can also cause respiratory distress in in animals such as manatees, birds, dolphins, anything that needs to breathe air, and the neurotoxins can almost paralyze the gills of fish and cause them not to be able to breathe essentially or respirate. And that results in fish kills in the case of the the picoplankton over in the Indian River Lagoon or the brown tide, that one because it is such a tiny organism, it it just shades the the anything underneath. And so they've it's resulted in significant seagrass mortality. And right now in the news, you may have heard that a lot of manatees are dying because they don't have enough food to eat. So there's just a whole host of issues associated with these these different organisms.

M Michaela Kandzer 12:19

Yeah, so it seems like this is a really huge issue. And it's connected to so many other things that affects the wildlife affects waterways, it affects humans. Can you talk more about how these different effects are connected?

B Betty Staugler 12:32

Yeah, so when we have, for instance, a harmful algal bloom event and and I'll use 2018 as an example, because we had a really significant red tide, that red tide resulted in very significant fish kills. And those fish kills occurred at a time when a lot of our recreational sport fish species were in the near shore waters, aggregating to spawn. And so not only did we lose the reproducing females and males, but we also lost an entire year class of fish that should have been the small fry that were growing up in the estuaries. And so as a result, the state of Florida actually had to close three fish species to recreational harvest, and some of those species are still closed in all of the affected area, including like from Sarasota County, south down through Collier County, and a little bit north of there, there's one fish species that is, now you're allowed to keep. But that's two years later, and we're still you know, dealing with these lingering effects from from that one event. And, of course, you know, Florida is driven by tourism, a lot of that is around recreationally recreational angling, and guiding activities. So when we have these types of closures or catch and release only events, that impacts their ability to make a living out on the water. Another concern that we've had, since the significant bloom in 2018, which actually started in 2017, and ended in 2019. Is that the, the shellfish in our aquaculture leases became very toxic. And so for some of those shellfish growers, they were out of work for well over a year between the actual red title event and then waiting for the toxins to purge from those animals. We've also had significant die offs of sea grasses. And of course, that impacts a large part of the economy as well both boating fishing and and then that trickles into some of those water dependent businesses that support those activities like Bait and Tackle shops. And so it's just becomes this, this huge issue that is far reaching.

P Phillip Stokes 15:09

So real quickly, can you just describe the term eutrophic? I know you've used that a few times. And yeah, I think it just might be a good term to understand in the context of harmful algal blooms.

E Ed Phlips 15:22

Well, I guess eutrophic is kind of, in a way somewhat obscure term to a lot of people. Eutrophic actually means highly productive. But typically, people associate that with nutrient levels. So a lot of people think, well, eutrophic means high nutrient, and in a way it does. But the actual term means highly productive. And but the relationship typically assumes that with high nutrients, you have high productivity. And so eutrophic is actually it's actually a process. So eutrophication is a process. And an interesting way of thinking about it is, if you have a lake that's just formed through some geological activity, originally, it probably doesn't have a lot of nutrients in it. So it would be called oligotrophic, not eutrophic, meaning low nutrient low productivity. So oligotrophic actually means low productivity but is associated with low nutrient content. Over time, as surface water runs into the system, you have sediment organic matter learning into the lake. So over long periods of time, that lake becomes more nutrient rich, because of the inputs from the surrounding watershed. So over time, it'll it a lot of these lakes will transition from oligotrophic to mesotrophic, in other words, more productivity, more nutrients to eutrophic, meaning high nutrients, high productivity, and all the way up to hypertrophic which would be you know, the at the extreme other end of the or in a range, we have very high nutrients, very high productivity, very high potential for massive algae blooms. In terms of consequences, probably the most common in freshwater systems. And because of freshwater, let me start with freshwater systems. In the 1980s, we did some work with several hundred Lakes here in Florida collaboration would Lake Watch, and came up with a relationship between chlorophyll levels in the lake, which is biomass basically. And the percentage of composition of the of the algae in the lake. And what we found is when we get to a high levels of chlorophyll, high levels of biomass, the lakes were almost consistently dominated by cyanobacteria. And cyanobacteria are an issue because many cyanobacteria produce toxins, not all, but many do. And as a consequence, it's an important group, and we'll talk about the toxins later. But when you get a large accumulation of biomass in in freshwater lakes, then there's a potential for high BOD, biological oxygen demand. And you can end up with periodic regional hypoxia or anoxia. And that's one of the most common ways that you see fish kills is because of an excessive biomass associated with large blooms. And then overnight, typically, that biological oxygen demand

from the biomass of the bloom itself and the bacteria associated with the compositional processes cause low oxygen and cause fish kills. And so that's one of the main main factors. And then the other factor would be another factor would be light attenuation. And so when a bloom gets really dense, it extinguishes light through the water column very rapidly. And so as a consequence of benthic algae or benthic plants that require light, are no longer seeing enough light to be able to survive. And so for example, in the Indian River Lagoon, where we've been working for a long time, there have been persistent, massive blooms of algae over the last 10-11 years. And this the depths of light penetration within the system during those blooms are limited to maybe the first half a foot of the water column. So that means plants which normally living at one meter depth or 1.5 meter and they're not seeing any light, and that causes losses of sea grasses, losses of benthic plants and algae. So light attenuation can be a severe factor in terms of limiting production of plants and benthic algae which are an important habitat for for many species within ecosystems, in other words, which they destabilize ecosystems or changes their their structure and function. Another thing is food web alteration. So if you have a bloom It's typically dominated by one or two species, typically one species becomes dominant. If that species is not very attracted to secondary consumers or primary consumers, that means that they run out of things that they like to eat. And as a consequence, and then ends up changing the whole structure of the food web. And very often, some of these bloom formers are very small cell species. So it accentuates the micro, they call the microbial loop. In other words, all that's available to eat is very small celled, bloom forming species. And what that does is actually limits the amount of biomass for carbon that's flowing up the food web. And so you have less fish, different kinds of fish different structure the system because of persistent blooms. So then the final element, and there's other, you know, details to this. But the final element, of course, is algae toxins. And I'm not really sure if you want to specifically get into that right now. But we can talk about algae toxins.

P Phillip Stokes 21:05

Well, I guess an important thing to say is, you mentioned cyanobacteria can produce toxins, but not all of them do. So yeah, maybe let's break that down just a little bit. Which cyanobacteria produce toxins? Or you know, which, which are the ones that we hear about here in with blooms? What are the toxins? And what are the organisms that are you know associated with those toxins?

E Ed Phlips 21:34

Yeah, so in the case of cyanobacteria, and then we'll talk about marine toxins a little bit. But in terms of cyanobacterial toxins, there's there's really two major categories. There's a lot of different toxins, which I won't get into the excruciating details, but the two major forms are hepatotoxins and neurotoxins, so hepatotoxins are toxins that affected digestive systems, particularly the liver. Prolonged exposure by animals, for animals and humans, to hepatotoxins can cause liver, liver necrosis can naturally actually cause if the, if the exposure is very prolonged can actually cause death. And in in, in many parts of the world, the dominant producers of the hepatotoxins are cyanobacteria that are fairly common here in Florida called microcystis. And microcystis, is probably the most common toxin producing organism in Florida. It's also one of the most common toxin producing species around the world. And in some cases, these toxins can be very high levels in lakes, like Lake Okeechobee has very high microcystis blooms, many lakes in Florida have microcystis blooms, and the toxin levels can be very high. Fortunately, from the human perspective, the toxins typically aren't a problem because we don't typically drink water out of lakes directly. We did a project in Africa, in villages in Africa, where they do consume water out of regional lakes from these villages will boil the water but the boiling the water doesn't get rid of the toxin. They can filter the water, but some of the toxin gets solubilized in the water column, so that doesn't totally eliminate the toxin. So these villages were actually consuming this water over long periods of time, and they were having problems with human health. In the United States, typically, potable water is treated with either ozone or chlorine, chlorine being the most common, and chlorine does destroy the toxin. So so long as the water treatment levels are adequate in terms of the top, you know, the chlorine concentrations, the problems with human health should be minimal. And so so in in the case of the United States has very little significant problems with potable water, and toxins, although there's always

this issue always comes up. And it's also very important to have it monitored to make sure you're using the right chlorine concentrations and so forth. And then there are a couple other species that produce hepatotoxins. cylindrospermopsis being another bloom, former here in Florida, but much, much more rare in terms of its prominence. And I think one of the reasons is that the strains of some of cylindrospermopsis we have in Florida, probably do not have the genes to produce the toxin. And so as a consequence, cylindrospermopsis levels are typically not that high. So then the other toxin that we're concerned about is the neurotoxins and neurotoxins affects the nervous system. And their effect can be quite rapid and profound. You can actually from a neurotoxin exposure, you could actually die within minutes or hours. And that's because you can get a shutdown of the respiratory system, you can paralyze the respiratory system. So what what's the cut what's in terms of cyanobacteria there ar ae number of species that can produce neurotoxins, the two principal ones are saxitoxin and anatoxin. However, the production rates of these toxins in Florida systems are relatively small. And the Florida Department of Environmental Protection monitors around the state for these toxins saxitoxin anatoxin microsystis and they have readily find fairly high levels of microsystin. But they seldom find high levels of saxitoxin and anatoxin. So the rates of production of these toxins, neurotoxins are much more limited. And so as a consequence, the probably the risk for human health and animal health is, is less for neurotoxins, even though their consequences are more rapid in terms of the way they act. So so so that's good. Now since we bring up neurotoxin in the coastal environment, it's a different story. Many of the coastal blooms are either Dinoflagellates, which are like red tides, commonly called red tides. very prominent in the Gulf. The karenia blooms in the Gulf are very prominent, and they produce saxitoxin or brevetoxin, both of which are are neurotoxins. And the problem for human health in the case of neurooxins is, shellfish can bioaccumulate neurotoxins, and if you're consuming shellfish that's contaminated with neurotoxins that can cause respiratory problems can even cause death. And parts of the world where neurotoxins and toxic algae are not monitored well. For example, in Southeast Asia, and the islands in Southeast Asia every year, people die from eating contaminated shellfish in the US, Europe and other parts of the world where they're regulated, that's very rare. Because the when when you see blooms happen, the monitoring activities you know, expose this and and then shellfish harvesting is closed down. In terms of a more general effect for red tides pretty much people on the West Coast are probably familiar with it. The toxins associated with like Karenia in the red tides can be aerosolized into the air. And then people can get eye irritation or respiratory irritation because they're breathing in or get exposed to toxins because of wave activity that aerosolized the toxins. So in terms of the aquatic animals, hepatotoxins tend to not be lethal for aquatic animals in general. Although we don't know we don't have very detailed information yet on whether the long term sub lethal consequences for aquatic animals or hepatotoxins, what those actually are involved with. And so that that that area is not well and as well understood as neurotoxins. Now, brevetoxin associated with red tides on the West Coast can cause mass mortalities of shellfish, fish and marine mammals. And that's been well documented on the west coast. There's a couple other neurotoxins that are worth mentioning. There are some diatom species, which is another common thing in marine environments, which produce the toxin, domoic acid. And domoic acid is more commonly referred to as amnesiac shellfish poisoning, because it leads to a memory loss. And that's a real problem in the North Pacific. And the North Atlantic where these diatom blooms of toxin producing species are quite common, and they can cause problems with marine mammals because of memory loss and they can cause disorientation and sometimes death. In in Florida we have some of the same species, but they're much rarer in terms of forming major blooms. And so it's not as big an issue in Florida but the because of the awareness of this they're actually in the North Pacific North Atlantic, these levels of domoic acid and these diatoms are well monitored. So it's not a huge human health risk, but it is a is a animal risk for aquatic animals. And then lastly, I mean there are many, many different kinds of toxin but the other one that's often mentioned is BMAA. BMAA is actually a subsidiary of alanine, which is actually an amino acid. It was reported to have potential linkages to Alzheimer's, ALS and Parkinson's disease. However, the actual link between BMAA and those diseases is very uncertain. And there's a lot of controversy over whether there's actually sufficient BMAA concentrations in the natural environment to actually be important in terms of human health, or for that amount of animal health. And so that's really an issue that a lot of people are worried about, because it always comes up whenever you have a big bloom. Someone always asked the question, what about BMAA but there's such tremendous uncertainty about its distribution, what's producing it, and its effects on human health, or animal health. That really the the the information isn't sufficient to really make a definitive statement about whether it's really a health risk, or just just an ancillary issue, that's of minor consequence.

P Phillip Stokes 30:55

Thank you for that very thorough explanation. And it's apparent that there are a lot of different toxins, which, of course, is is a different consequence to some of the other things you laid out before, which just kind of, you know, throw off the ecosystem services and, you know, kind of the status quo. And so I guess, hearing all of that information, I guess my next thought is what should people know about those toxins and those blooms and, and what people can do to, I don't know, stay safe, or excuse me, or monitor those. And just under what can kind of humans do to kind of keep themselves safe? You know, maybe during a bloom?

E Ed Phlips 31:43

Yeah. Well, I guess again, it goes back to what kind of toxin you're dealing with. So let's just go down the list of some of the major ones that are associated with potential human exposure. So the hepatotoxins, the hepatotoxins because it's a very commonly found in freshwater systems in in Florida, and around the world, and also can actually entered into a coastal systems, for example, in St. Lucie estuary periodically gets hit with cyanobacteria blooms from Lake Okeechobee. And very often they include microcystis, which means they're going to be high in the toxin microsystin. In terms of recreational exposure, there are guidelines from the EPA about recreational exposure. And typically, the the concentrations found in most samples don't necessarily reach that level, which typically is around 30 micrograms per liter of the microsystin. But they can exceed that. So what are people concerned about? And and so it's a complex question. So a short term exposure to hepatotoxin, probably, unless you're drinking it, in large quantities would probably not necessarily be either lethal or that dangerous as long as you're not, you know, doing it over prolonged periods of time. And then in terms of your pets, or animals try to keep them away from it. Because if, if you're living on a lake, and you have a dog, and you have persistent blooms of on the lake, try to keep the dog away from the lake, because if they're regularly going to be consuming water in a lake that have blooms of microsystin, they could conceivably cause liver problems for that animal. And you want to avoid that if possible. The broader issue of potable water, which is an important issue, because if you're consuming water from a lake, and some parts of Florida, they do take water out of lakes for human consumption. You want to make sure that it's treated well with chlorine to avoid exposure to microsystin over prolonged periods of time, because that's where the risk really lies. Is is in consuming either, you know, water for prolonged periods of time, which then over time can cause liver damage. And so that's a microsystin. In terms of the neurotoxins, coastal environments, there's really no way of getting away from it. If there's a red tide on the near the shoreline, your chances if the winds blowing pretty pretty strongly you're going to be exposed to some neurotoxin. Typically, it's more of an irritant than it is a long term problem. neurotoxins, while they can have short term really serious consequences, including dying from consuming contaminated shellfish, they don't have prolonged chronic issues unless you're eating small amounts of toxin over long periods of time. But the more the more relevant risk is by consuming a large amount of it in one dose and then having respiratory failure. And so if you're if you're alergic or you're very sensitive or you have a lung condition, you probably want to stay away from beaches when there's a red tide going on, because you could getting into trouble in terms of your exposure to, to an irritant. So then there's a couple other toxins which, which I didn't mention before, but like ciguatoxin, which is common in South Florida and the Caribbean, is produced by Dinoflagellate, it can also cause health problems which are persistent. And so that's, that's usually related to eating fish that are contaminated with seguatoxin, and are certain fish like Barracuda amberjack, so forth, that have larger levels of that toxin, assuming they're in areas where that toxin exists. And so you want to be careful about what kind of fish you eat in large quantities, particularly, because that can cause health problems, typically not lethal. But the health problems associated with siguatoxin can be very persistent, and take a long time to recover from.

P Phillip Stokes 36:10

So I guess my one of my last questions is, what needs to be done? Right? What can people do and what needs to be done to just help reduce maybe the prevalence of some of these blooms?

done to just help reduce maybe the prevalence of some of these blooms?

E Ed Phlips 36:24

Yeah, well, that's, that's a that's a really interesting question, which I don't normally think about that much myself, per se. Although we are involved in you know, IFAS, and so forth with a lot of different activities to try to help bring down nutrient loads to aquatic ecosystems to reduce the potential for blooms. And that's, that's often the the focal point is how do we reduce excess nutrient loads to systems to reduce the potential for algae blooms, because, because that's one of the ways that we can remediate or mitigate bloom activity. But I think, you know, from a broader perspective, more generic sense, I think it's really important for the for the public to become well educated on these issues, from multiple reputable sources, not just one source of information, because a lot of times people get siloed into loops, and they don't really look at multiple sources of information, then they can get misinformed. And so I think that's really important. So education is critical. And I think that's one thing that IFAS we try to focus on is to try to through our extension programs into other programs, through your program, to try to educate people on what the issues are, and and then help and have helped him to support you know, sensible regulation. And so that from their local communities to statewide, a sensible regulation, I think, is really important. And and that needs to be supported by the general public. And that that can be supported by how you who you vote for, or other activities that you do within the community. And I think from an individual level, of course, you can always try to focus on reducing your carbon and nutrient footprint, as much as you can. And as an individual that's a little can be a little difficult, but like for example, your nutrient footprint. You know, one small example would be don't over fertilize your yard. And that's a minor example of something an individual can do to help prevent excessive nutrient loading to aquatic ecosystems and there are many other things like that. And for example I'm working with some people who are trying to figure out how to best develop new housing developments to minimize their their nutrient output from the system or waste or carbon in general, and I think that's really critical to in a broader perspective say, how do we develop in more reasonable ways more, more meaningful ways in terms of limiting carbon and nutrients?

M Michaela Kandzer 39:08

So what are some of the ways that speaking on that topic more? How what are some of the way that our listeners can learn more about HABs in their area?

B Betty Staugler 39:15

Yeah so um, excuse me. Um, usually, I think the way that most people find out about a harmful algal bloom in their area is probably through the news, I they tend to, to be the first ones to put it out there. But then I always encourage people to take it a step further, you know, you know, you will be providing these links to these state agencies so they can get additional information from from them. Local governments are tend to be very connected to their state partners as do Extension agents. So if somebody is, you know, in a particular county and they want to know more about harmful algal blooms, sometimes the easiest place to go is to the source that's closest to them, and that's their local government or extension office.

M Michaela Kandzer 40:06

Okay, interesting. So what if they just overall want to learn more about harmful algal blooms and what these harmful blooms look like? Or how to know if they're toxic? Where can they find that information?

B Betty Staugler 40:16

That's probably your those state agencies. But the University of Florida IFAS also has a really nice harmful algal bloom web web page, as does Florida Sea Grant. So I would absolutely say trusted sources, like your state agencies, Mote Marine Laboratory has a really nice website, where the public can can learn more, there are frequently programs put on by extension agents on harmful algal blooms, particularly during those seasons. And so I would encourage people to just kind of reach out and find out what's happening in their area to be part of that.

M Michaela Kandzer 40:59

Okay, so what is the season for harmful algal blooms?

B Betty Staugler 41:02

So again, it depends on the species. For blue green algae, it usually starts in the late spring and will occur through the summer, and once it gets cold, that or the rain start and it doesn't get enough sunlight, that's when we start seeing the decline of the bloom for Karenia brevis, that red tide that is usually late summer into the fall. But any of these blooms can occur any month of the year, and you know, at any time and it lasts longer or shorter. So there's, there's, you know, kind of a season, but that doesn't mean that that's when things are going to happen.

M Michaela Kandzer 41:43

Okay, okay. So, um, if there is a HAB event in the location or in the area of our listeners, what are some of the things that they should do? Or is there anything that they should be they can do or should do?

B Betty Staugler 41:56

Yeah, so you know, I guess it really depends on the types of activities that somebody is wanting to engage in or you know, whether it's in their backyard, those types of things. But I think the best thing that people can do is arm themselves with information and go to those trusted sources. So for instance, you know, let's say you wanted to go to the beach and the the news said that there was a red tide bloom, you know, in the area that you wanted to go to the beach. I would then go to the state resources, the the Florida Department, or excuse me, the Florida Fish and Wildlife Conservation Commission, I would look to see what what those cell counts looks like. There's also some real time information from Mote Marine Laboratory from their beach conditions reporting system, that's an app, you can actually download from your app store, just put in bcrs. And it'll take you to that app. And that's where the Sentinels will stand out on the beach and give you these real time conditions. There's, there's some experimental programs such as hab scope, and that is on the the GCOOS website. So GCOOS.org And that is actually a respiratory forecast. So volunteers collect a water sample, they put it under a microscope, take a video, and machine learning actually counts the cells, and then it's combined with wind speed and direction. And that produces a forecast that's updated every three hours for many of the beaches in Florida. So you can get a feel for you know, which beach is more favorable to go to and when, because when we're talking about red tide, red tide is not it doesn't it comes on shore in patches. And so conditions can be very different, even a mile a part along the shoreline. Ever, you know, as we're talking about people in safety, let's say you go to the beach and you start experiencing respiratory irritation. The first thing I would do is leave the beach, get into some air conditioning, maybe you're going to look for another location, maybe you're going to go home or do a different activity. Some people who can go in the water and have no issues in these red tide areas other people will have skin irritation, so you want to wash off. Certainly when we're talking about blue green algae, if you see scums or any signs of a visible bloom, you just want to avoid those waters because

they can cause some some bad skin irritation and the activities in the water can cause some aerosolization and then that can be can be harmful and it can cause some some gastrointestinal issues and, and we want to avoid that. So yeah, just I mean, use common sense. But I again, I always say arm yourself with as much information as you can to make those those decisions.

M Michaela Kandzer 45:04

Yeah, no, that's really great advice. And I appreciate you emphasizing that need for arming yourself with education and for giving, you know, giving me and us and some of our listeners a good place to go to get some of that information and some good ideas for some places to start as far as as far as finding trusted sources on these topics. So you mentioned a couple of times about these volunteer sentinels. So is there a way that any of our listeners could get in on that they wanted, they were passionate about this topic and that they wanted to become volunteers?

B Betty Staugler 45:30

Yes, there is. So yeah, Mote Marine Laboratory is actually wanting to expand their beach conditions reporting system. Right now they have fairly good coverage on the Gulf Coast up to maybe a little bit north of Tampa. But they're hoping to expand to the entire Gulf of Mexico and the east coast of Florida. So there's lots of opportunities there. And, you know, and I will say that the beach conditions reporting systems, it's its basis, I guess, I would say is in Harmful Algal Blooms or, or red tide. But there's a lot of other information that the Sentinels collect that are really of interest to beach goers such as how many how crowded is the beach, Riptide conditions and wave conditions, those types of things. So just you know, if you don't have red tide on a regular basis, don't count yourself out as as a sentinel for the beach conditions reporting system. And likewise, with hab scope, they are also expanding that program. So So yes, there are opportunities there as well. And and I can provide you with those, those resources that you can also put in the links.

M Michaela Kandzer 46:46

Perfect. That's awesome. So are there just any other initiatives that the public can support to work on how it's collaboratively?

B Betty Staugler 46:54

Yeah, I'm actually on a lot of different levels. So you know, we talked about some of the very HAB specific monitoring programs. Another one that I will mention, which is just getting going in Florida is the phytoplankton monitoring network. And a lot of the Sea Grant agents with the University of Florida are starting to develop a monitoring network of volunteers where they go out and they pull a small trawl and, and then there, they have a microscope that they actually identify the different phytoplankton species. And this is a partnership with with NOAA, another branch of NOAA that oversees that program. There's a variety of water quality monitoring programs that use volunteers in within the University of Florida Lake Watch and Waterwatch are two. And then Sea Grant has a eyes on seagrass monitoring program that uses volunteers to help monitor seagrass. So you can check with your local extension offices to see what kind of volunteer opportunities exist.

P Phillip Stokes 48:05

You know, one thing about blooms and harmful algal blooms. You know, it's something that I feel like pretty much

everyone comes together on that. We don't like them when they're disruptive, right when they when they're harmful to our health, or to our recreation, or whatever. But I also like your point of making sure you are getting your information from different sources and kind of doing some of that just kind of that background reading and not becoming siloed. And so I do want to ask you, because you mentioned there are some resources from IFAS. So where would you direct people maybe for some of those IFAS resources or other resources if they want to learn more?

E Ed Phlips 48:52

Yeah, I think because the issues associated with HABs can be regionally different. I think the the access to the local Extension people in different parts of the state, I think is an incredibly valuable resource and probably a resource that a lot of people aren't even aware of. And so Extension services are a really important part of gaining information about your particular area, about important issues that you're dealing with them in different parts of the state. I think the other the other thing is to the water management districts typically have what websites which have environmental issues associated with their websites and they are a good source of information. And typically the information is quite good. And that would just be looking at your Water Management District whether it be South Florida Water Management District or Suwannee River Water Management District wherever you are, you can look at their website and there's always an environmental, a source of environmental information for that region that can be very valuable. Florida Department of Environmental Protection. They have a website where you can find out information on environmental issues. And for the Department of Health is a good source of information about health risks from things from algae blooms, or from other things associated with the water. And so I think those those sources are probably underused by the general public because I think a lot of people aren't even aware that that they're there. And of course you can always if you find the references to some faculty member who knows something about something particular. But I think the important thing is that those are, there's a lot of those resources available and I frequently talk to people and they are totally unaware of the fact that they even exist.