

Introduction: "The time has come," the Walrus said, "to talk of other things!"

Stephanie Otts: This is a podcast not about shoes, and ships, and sealing wax, but about the who, what, where, why, and how of shellfish aquaculture, including the many different legal challenges that can arise. We're the National Sea Grant Law Center, and we invite you to sit down, and get ready for a wave of knowledge. Hi, I'm Stephanie. I'm the director of the National Sea Grant Law Center.

Cathy Janasie: Hi, I'm Cathy. I'm a Senior Research Counsel at the National Sea Grant Law Center.

Amanda Nichols: I'm Amanda. I'm the Ocean and Coastal Law Fellow with the National Sea Grant Law Center.

Stephanie Otts: You're listening to Law On the Half Shell. On today's episode, we're going to talk about the impact of invasive species on shellfish aquaculture. Do you guys remember that song from Sesame Street? One of those things is not like the others? Thought we could start by playing a round of that. I'm going to name four species found in the Gulf of Mexico, and you tell me which one doesn't belong. Ready?

Cathy Janasie: Ready.

Amanda Nichols: Ready.

Stephanie Otts: Red snapper, grouper, lionfish, and marlin.

Cathy Janasie: I'm going to guess lionfish.

Stephanie Otts: Why doesn't lionfish belong?

Amanda Nichols: Is it because they aren't native to the Gulf of Mexico? I think lionfish are actually native to the warm tropical waters of the South Pacific, and the Indian Oceans, right?

Stephanie Otts: That's correct.

Cathy Janasie: Wait, so if lionfish are from the South Pacific, how did they get all the way over here to the Gulf of Mexico?

Stephanie Otts: Yeah, no one really knows. It's one of those great mysteries, but the leading theory is that they escaped from a Florida aquarium that was destroyed during a hurricane. So, the wind must've come in, and blew all the tanks over, and allowed the fish to escape. Since being introduced to the waters around Florida, lionfish populations have exploded throughout the Southeast, Caribbean, and into the Gulf of Mexico. With few predators outside their native ranges lionfish

can easily take over a reef by preying on native species, or out-competing them for food. Not so fun fact, a single lionfish residing on a coral reef can reduce recruitment of native reef fishes by 79%. Because of their ability to thrive in their new environment and the ecosystem damage they inflict, lionfish are referred to as invasive species.

Amanda Nichols: Invasive species can be plants, animals, and other organisms such as microbes. Species can travel to new geographic areas through a variety of routes known as pathways. Pathways can be natural, or manmade. Natural pathways include wind and currents that might sweep animals, and plants into new territory. Most of the time, however, species are moved by humans. Invasive species can be introduced by humans intentionally. For instance, when someone releases a pet snake into the woods behind their backyard, when they don't want it anymore, or by accident.

Stephanie Otts: We asked Sam Chan, a professor at Oregon State University, and statewide aquatic invasive species specialist with Oregon Sea Grant about a natural pathway that can cause accidental introductions that we don't think much about, tsunamis.

Sam Chan: This is a species that recently has become a concern. It happened when the Japanese tsunami of 2011 occurred. What happened was is that, in Japan, after the major earthquake, the tsunami actually swept debris from much of the Japanese coastal infrastructure. That debris ended up on a Pacific trek that went through the Pacific islands, like Hawaii, and then it actually trekked, some trekked north towards Alaska, and then some into Canada, and the United States, and then others actually trekked from the south and headed north, and impacted California. So, one the species that came with that debris, which was evidenced by a large dock, a concrete dock that actually moved a entire community of organisms from a Japanese fishing point of Masala, and to the main island in northern Japan. It actually carried with it, a huge amount, I think several tons of wakame, and so that was one that species that we continue to monitor for, because if it establishes here, we see it as a major threat to our kelp forests, and that it can overgrow, and shade out our kelp forest.

Cathy Janasie: I bet by now, you're probably thinking, "What does all this have to do with shellfish aquaculture?" Well, aquaculture farms, just like the natural environment, can be significantly affected by invasive species. Take the oyster drill, for example. Oyster drills are small predatory sea snails that live on rocks, and shell beds and low tidal areas up to a depth of 25 feet. Have you ever found a shell on the beach with a perfectly round hole in it? They are very convenient for making necklaces, right? Just put them on a string, and you're ready to go. Ever wonder what made that hole? Most likely, it was made by a predatory snail. Moon snails, for instance, attach to clams with their huge foot, and then bore into the shell with a sandpaper-like tongue, called a radula, until it can reach the tissue, and eat the clam alive. In the Gulf of Mexico, the Atlantic

oyster drill does the same thing to oysters. Infestations can have major impacts on oyster populations including farmed oysters.

Stephanie Otts: That sounds like the start of a very bad horror movie. To be eaten alive by a snail. While Atlantic oyster drills are native to the Atlantic coast of North America, from Nova Scotia to Florida's Nassau sound, they have been accidentally introduced with baby oysters, or spat, to Northern Europe, and the west coast of North America, from California to Washington. Their feeding habits can cause millions of dollars worth of damage every year, especially in the shellfish aquaculture industry. They can also cause significant environmental damage with some reports, noting that the snails can consume as much as 70% of one-year-old oysters on an oyster bed. Controlling oyster drills can be tough. For example, there have been many attempts over the years to control populations of the snails in the Pacific Northwest. Aquatic pesticides are largely ruled out, due to their toxicity to non-target organisms, or all the other animals in the ocean besides the snails.

Stephanie Otts: Some mechanical removal methods such as using studded tile traps, have been successful in the past. However, mechanical removal methods are often expensive, and labor intensive, because it takes people to go out there, and to try to individually remove the snails leaving aquaculture farmers with few viable management options. In Oregon, shellfish farmers are facing challenges from the presence of invasive tunicate species, also known as sea squirts. Tunicates are rather weird creatures. They are invertebrates that spend most of their lives attached to rocks, docks, and other hard surfaces. Sometimes they just look like slimy blobs of goo. Here's Sam again talking about their impact on shellfish farms.

Sam Chan: The tunicates foul our shellfish, and what the oyster farmers have to do is that when they harvest the oysters, they actually have to go through a washing system, because one is, it's mainly for marketability. People don't want to buy oysters with shells that are coated with this slimy organism. So, they actually wash those tunicates off, but oftentimes, that ends up with discharge problems, in that, right now the state is concerned about permits for discharge, of this wash water, are now being regulated, and that the actually have to filter, and screen, that wash before it actually goes back out.

Amanda Nichols: Plants and animals aren't the only invaders shellfish farmers have to be worried about. Diseases such as Vibrio can also have far reaching negative impacts. There are about a dozen species of Vibrio bacteria that can cause human illness called vibriosis, but only a couple of those species are commonly associated with shellfish. Different strains, or types of Vibrio, can be found throughout the country. According to the Center for Disease Control, or CDC, vibriosis causes an estimated 80,000 illnesses, and 100 deaths in the United States every year. People with vibriosis become infected by consuming raw, or undercooked seafood, or exposing a wound to seawater. Vibrio bacteria are impossible to detect by sight, smell, or even taste, so many people who are infected, do not

suspect that they could have been until symptoms such as stomach, cramping, fever, and vomiting start to show. While most people with a mild case recover after about three days with no lasting effects, severe cases may require intensive care or even limb amputation. About one in five people with this type of severe infection die, sometimes only within a day or two of becoming ill.

Stephanie Otts: Fun fact, have you ever heard the saying that you should only eat shellfish in months that end in R? So September, October, November, December.

Amanda Nichols: Sure. Every oyster lover knows that.

Stephanie Otts: Well, this phrase likely comes from the fact that red tides are more common in summer as well as Vibrio. People probably observed that there were more illnesses from eating shellfish in the summer, than in winter months, leading them to create the rhyme.

Amanda Nichols: Well, hey, that's pretty neat.

Stephanie Otts: Luckily for shellfish farmers, there are ways to reduce the risk of Vibrio, because Vibrio bacteria are temperature dependent, limiting harvest during the warmer summer months, properly cooling the shellfish after harvest, or moving them to waters where the bacteria aren't present for a period of time, to enable the shellfish to remove the bacteria from their systems can reduce the risk. However, because of the contamination risks, the CDC recommends that individuals with compromised immune systems avoid eating raw, or uncooked shellfish.

Stephanie Otts: While some Vibrio species are native, some are not. As we mentioned earlier, there are different types of Vibrio bacteria that are found in different parts of the country, and the world. Cholera isn't something we think about much here in the United States anymore, but since 1973, 91 cases of cholera have occurred in the United States that were unrelated to international travel. Meaning they weren't people coming back from overseas trips that happened to be exposed during their trip. Most of these followed consumption of raw, or undercooked seafood harvested from the Gulf coast that was contaminated with a native strain of Vibrio cholerae, the bacteria that causes cholera.

Amanda Nichols: But in 1991 oysters in Mobile Bay, tested positive for a different Latin American strain of Vibrio cholerae. This introduction may have been linked to discharge of ballast water from freighter vessels, which is a notorious pathway for the introduction of non-native species into new environments. Ballast water discharges have also been responsible for the introduction of other harmful species such as the zebra mussel in the Great Lakes.

Stephanie Otts: Here's Sam again with some thoughts on the movement of diseases in light of changing ocean conditions.

Sam Chan: But the reality is that with our ocean water conditions changing, that creates more stresses, and therefore diseases, Vibrio being one of them, is one of those that is of great concern for commercial shellfish, but also in terms of our conservation shellfish programs, because we actually are trying to restore native oysters, but Vibrio is one of those that have been accentuated by, we think, changing ocean conditions. And as we find that there are more strains of Vibrio, it could be from Europe, from France, could be from Australia, it could be exchanged from our different coast systems. So, we just have to be a much more careful in our movement of shellfish seed for aquaculture. The thing is, is that unless we actually have good protection tools early on, you can't tell by looking at an oyster, or a seed that has been infested in, so until the symptoms actually show up.

Stephanie Otts: In addition to Vibrio, shellfish farms can also suffer from E.coli contamination, but those pathogens typically invade marine environments through a different sort of pathway, upland runoff. Everyone's probably familiar with beach closures that happen after heavy rains. Beaches are closed due to concerns over contamination from all that water running off the land, which can carry E.coli bacteria from farm fields, overflows from wastewater treatment plants, or failing septic tanks. E.coli bacteria naturally live in mammals colons, but the bacteria present in raw shellfish is directly related to fecal contamination, due in part, to this upland runoff.

Amanda Nichols: Because of the severe risks to human health associated with E.coli contamination, and seafood, it's important for upland landowners to be aware of how their actions can impact our nation's coastal waters. One of the most common causes of E.coli carrying pollution, are septic systems. When septic systems fall into disrepair, or reach capacity, sewage can leak into nearby waterways, eventually flowing into marine environments. Because of this, septic tank absorption fields, or the areas over which discharged sewage is dispersed into the ground, should be located away from waterways, and wells. Septic tank owners should also regularly inspect, pump, and maintain their septic tank systems, redirect surface water flow away from their septic systems, avoid driving vehicles, or have the equipment over their septic systems, and consider planting a green belt between their septic systems, and the shoreline. Green belts are grassy strips of small short-rooted vegetation that can help absorb any sewage that is discharged onto a system's absorption field, before it has a chance to reach, and contaminate nearby water resources.

Stephanie Otts: In addition to harming human health, contamination from Vibrio and E.coli bacteria can have other negative impacts on the shellfish industry. As we talked about a moment ago, heavy rainfall can result in beach closures due to concerns over upland runoff. As one might expect, beach closures generally mean water closures as well, meaning that both wild harvesters and shellfish farmers have no way to bring their catch to market, and sell it for a profit. So, they are being restricted from harvest because of the concerns over the water contamination. The Federal Clean Water Act and other laws are responsible for these closures.

If shellfish are being grown in contaminated waters, also referred to as impaired waters, they often can't be eaten. Although, as we mentioned in a previous episode, they can help mitigate water impairment by filter feeding. The Clean Water Act's water quality standards help shellfish farmers know when waters are unsafe for harvesting shellfish meant for human consumption, and aim to prevent those situations from occurring.

Stephanie Otts: Generally, water quality standards protect the public health, and welfare, enhancing the quality of the target water body, and serve the purposes of the act. States must establish these water quality standards through a two-step process. First, the state must designate a specific use for the water, which becomes the goal use to be attained for the water body. For example, the use of the water body could be designated for a range of activities. Maybe it's used as a drinking water reservoir, or for agricultural irrigation. Some are wildlife habitat, and others might be for recreational swimming, or fishing.

Stephanie Otts: Second, the state must set water quality criteria, which are the levels of individual pollutants, or water quality characteristics, or descriptions of conditions of a water body that, if met, will generally protect that designated use of the water. So, a water body might not need as much protection, and if it is used for agricultural irrigation as opposed to being used for drinking water supply. These criteria can be numeric, such as the maximum pollutant concentration levels permitted in a water body, or a narrative. For instance, a state may require that a water body be free from certain negative conditions. States, territories, and authorized tribes typically adopt both numeric, and narrative criteria

Amanda Nichols: In bodies of water where contaminant levels are unsafe, fish, and shellfish advisories are issue to help people make informed decisions about where to fish, or harvest shellfish. Advisories recommend that people limit, or avoid eating certain species of fish, and shellfish caught in certain places. Fish, and shellfish advisories can be issued either for the general public, or for specific groups of people at risk, such as the elderly, pregnant women, and children. All 50 States, and some US territories, and tribes, issue advisories to protect people from potential health risks of eating contaminated aquatic organisms caught in local waters. The EPA also encourages those states, territories, and tribes to issue safe eating guidelines that tell people which fish they can eat safely. However, these fish, and shellfish advisories or just recommendations, not laws,

Stephanie Otts: So, sometimes poor water conditions do force fisheries closures, which are mandatory, and these happen when contaminant levels reach high enough levels that the certain toxins, or bacteria, found in the water would make it unsafe for humans to eat the shellfish harvested there. When a contaminated area has been closed, it is both illegal, and unsafe, to harvest and consume shellfish from there. States generally maintain online databases of closed areas so that harvesters, and aquaculturalists, can know ahead of time that they won't be able to enter, and harvest shellfish. Fisheries can only be reopened once the

state tests, and verifies, that the contaminants have decreased to safe levels in the closed area. While these closures are important for human health, they can hurt the people who rely on shellfish resources. For example, shellfish farmers, who lease submerged state lands, may miss out on potential profits when closures happen during peak demand times.

Stephanie Otts: Join us next time, for our final episode, where we will examine shellfish aquaculture at the local level, and explore the impact of local land use decisions. This podcast is a production of the National Sea Grant Law Center, at the University of Mississippi School of Law. It is made possible in part by funding from the NOAA National Sea Grant College Program. The statements, findings, conclusions, and recommendations are those of the speakers, and do not necessarily reflect the views of NOAA, or the US Department of Commerce. Editing and production assistance was provided by Kerrigan Herrett, a senior journalism student at the University of Mississippi. Thanks for listening.