Intro: "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.

Stephanie Otts: Hi, I'm Stephanie. I'm the director of the National Sea Grant Law Center.

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

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

Stephanie Otts: You are listening to Law on the Half Shell. In this episode we are going to be talking about shellfish biology and the role that shellfish play in the ecosystem. So let's start by talking about what exactly our shellfish. For one thing, they're not actually fish. So they're not swimming around. They don't have backbones, scales, or fins. What they have is a shell. And so the general reference is to an aquatic animal that has a shell or a shell like outer skeleton.

Stephanie Otts: In the culinary world, there are two major groups of seafood that are referred to as shellfish. Mollusks, which include clams, oysters, mussels, snails, scallops, that large group. But then there's also crustaceans that include shrimp, crabs, lobsters, and crayfish. One group of mollusks that includes snails and whelks have a single, usually coiled shell and a large muscular foot and distinct head with eyes and little antennas or feelers. We're going to be focusing on the mollusks that have a shell consisting of two hinged valves. And because of this structure, they're also called bivalves.

Cathy Janasie: So are all bivalves the same? Besides having these shells with two hinged valves, bivalves also reproduce in the same way. So they do this seasonally inside the water. And what they do is they just released their eggs and sperm out into the water where they mingle to fertilize the egg. Bivalves do this when their food source is abundant. And so there'll be plenty to feed on. And this is generally in the late spring or the mid summer. Once the water is warm and the plaktonic food source for them is abundant. Once the egg is fertilized and grows into a larvae that eventually becomes tiny shellfish, that's at all on the water bottom. For instance, mussels actually float around for one to six months in the water before they go through this growing process that allows them to set on the water bottom to live out the rest of their life as an adult mussel. While they have certain biological characteristics all bivalves look or act the same in the water.

Amanda Nichols: That's true. For instance, oysters are grayish in shell color and they're often shaped like a teardrop, whereas mussels are deep purple, brown, or green and

are elongated and roughly triangular in shape. Hard clams can have thick shells that also resemble a triangle and are usually grayish or brownish in color, but razor clams average in size between five to nine inches. Their length is about six times their width and they can range from a yellowish to a dark brown color. Then scallops of deeply grooved shells that are usually quite colorful and they're hues range from purple to an orange or yellow-like color. They are the most circular bivalve with two ear-like growths near their hinges. And these are most easily recognized by the Shell company's symbol if any of you have ever been to one of those fueling stations before.

Cathy Janasie: So all bivalves don't go through the same life cycle process the same. Some bivalves have a gland that produces a thread-like material, which is called byssus. This thread-like material is used by the tiny shellfish to anchor themselves to hard substances on the water bottom, such as rocks. Oysters and mussels have this structure. So they attach themselves to hard surfaces in this way and they hang out for the rest of their lives in this one location.

Amanda Nichols: Other types lack this thread-like structure and use their foot to burrow deep into the seabed. While these shellfish can move, they still spend most of their life in a small area.

Stephanie Otts: Did you know that scallops can get seasick?

Amanda Nichols: Wow.

Stephanie Otts: This is the craziest thing I found. So if scallops are subject to a lot of wave action, say like on a farm where they're being held in baskets, they can get very agitated and they start swimming around fighting each other and they can actually cause internal damage to each other. And farms have suffered massive mortality because of this. And so farmers have to take precautions to minimize the wave action affecting the scallops. So placing the baskets further down in the water column where there is less wave action.

Amanda Nichols: Neat.

Cathy Janasie: Neat.

Amanda Nichols: When they swim around are they galloping scallops?

Stephanie Otts: Well I guess it's because scallops are one of the few shellfish that actually can swim by pushing water through their systems.

Amanda Nichols: Be on the lookout next time I go to the beach. Agitated scallops.

Amanda Nichols: Scallops are the most mobile. They can swim by rapidly closing their shells and forcing water out of valves in their shells. Much like spitting water out between

your two lips. This propels them forward in the water. Razor clams are found in the sand and mud and are usually dug for by hand, but they are hard to catch because of the speed at which they can burrow into the bay bottom. In fact, because of its streamline shell and strong foot, razor clams can burrow in wet sand very quickly and also have the ability to swim.

Cathy Janasie: Hard clams are also somewhat mobile. So I grew up clamming in a bay in New Jersey for hard clams, which are also known as northern quahogs. And so my parents would take us out in the boat and make us put on our old shoes or rain boots and we'd wade out into the water that was a few feet deep and my family would be hopping around in the water with other people in our area where we would be feeling with our feet for hard substances on the bay floor. And when you found something hard, you would just keep your foot on it and then dip your hand down below the water to grab what it was. And it usually was one of two things, a clam which made you happy or a crab which made you really sad. So if you were lucky, it was a clam, so they can't move quick and so you can go down and grab it pretty easily. But when you were unlucky, it was a crab. And why I'm telling you this is you know, crabs, unfortunately would usually bite you when you went to grab them. And you would move your foot and they could swim away really easily.

Cathy Janasie: So while clams can move as well as you know, scallops and razor clams, they're not super mobile like other types of shellfish such as crabs or lobsters that can really quickly float away from you in the water.

Amanda Nichols: Jonathan Smith who wrote the classic book Gulliver's Travels once said, "He was a bold man that first eat an oyster." No one is quite sure how people came to eat shellfish, but they play an important role in our culinary history. That said, shellfish have more importance than just food for people.

Stephanie Otts: In addition to their importance to the economy. Shellfish can offer a number of important ecosystem services. Ecosystem services are the benefits humans obtained from ecosystems such as marine ecosystems. For example, fish can provide an important ecosystem service in that humans can catch and eat them. Though many people only think about shellfish when they're sitting in front of them on the dinner plate. Shellfish offer many more ecosystem services than those just related to food.

Stephanie Otts: The United Nations has designated four broad categories of ecosystem services. That could be the products that the ecosystem provides. There may be benefits that come from the species regulating processes within the ecosystem. They may be supporting other features of the ecosystem, and there can also be cultural benefits from that. Interestingly enough, shellfish can provide ecosystem services within each of these four categories.

Amanda Nichols: So we can actually do more with shellfish than just harvest or grow them and then eat them in terms of the UN's first category, which is provisioning. So they

provide food for predator animals that humans may consume. For example, sponges, aquatic snails like the oyster drill, crabs, lobsters, sea stars in fish, all eat oysters. Sometimes we land lovers can see evidence of this when we watch seagulls dropping shellfish on roofs or dropping rocks from high up in order to break the shell and get to the meat inside. Otters also break open clams with rocks and starfish use their powerful arms to pry them open.

Amanda Nichols: Some shellfish are also valued for their non-meat provisions such as pearls and their shells. So pearls and shells can be made into jewelry and other decoration. And then shells can also be utilized as fertilizer and building materials due to their lime content. Provisioning services are also closely tied with cultural services in many instances. So for example, some native American tribes historically used shells as currency and the city of Biloxi, Mississippi has been termed the seafood capital of the world by some due to its deep rooted seafood traditions. The cultural services that shellfish can offer can also be seen on the small scale, such as when Stephanie's aunt made oyster stuffing every Christmas.

Cathy Janasie: So in addition to these provisioning services, shellfish offer numerous regulating and supporting services as well. One of the largest of which involves the way in which they eat. So shellfish are prodigious filter feeders, meaning they get their food out of the water that they take in and then filter out their nutrients. So some species are capable of actually filtering as much as 55 gallons of seawater in one day. In addition to giving them their nutrients this also cleans the water by removing human-added nutrients. This has caused scientists to explore the role of shellfish as potential bioremediators. So we could use them to consume and break down environmental pollutants that humans have sadly put into the environment.

Cathy Janasie: So a project in Bud Inlet, which is located in the southern part of Puget sound and the Pacific Northwest used native mussels to successfully removed 42 pounds of nitrogen from the polluted water, which is an impressive amount of pollutants to be taken out. The presence of shellfish shells can also create an environment that provide habitat to other marine and estuary organisms such as barnacles, mussels, and anemones. Further, some fish use dead oyster shells to lay their eggs in and the nooks and crannies of oyster reefs offer habitat to different species of worms, mollusks, fish, and mud crabs.

Stephanie Otts: So here in Mississippi, one of the most talked about shellfish is oysters and how oyster reefs are formed. As you might've guessed by now, oysters are one of the best ecosystem helpers around. This distinction has led them to being classified as a keystone species, which means a species on which other species in an ecosystem largely depend. Or in other words, if we lost oysters from the ecosystem, that ecosystem would change dramatically.

Amanda Nichols: James, an environmental toxicology graduate student at the University of Mississippi has more to say about oysters' important role as a keystone species.

James Gledhill: I mean, just to start off, oysters are just so important to ecosystems. They provide several ecosystem services. Their reefs form these big 3D structures in the water and they provide habitat for other fish, other organisms, other crabs that live in the water. So they're important in that sense where they provide habitat. They filter water, so they're filtering contamination. They're cleaning up the water from harmful algal blooms like we've had a lot recently down in Mississippi coast. They provide a buffer for wave energy. So their 3D structures of these reefs actually block wave energy preventing erosion on our shorelines.

Amanda Nichols: And oyster reefs are actually important to restoration in many ways. So for example, oyster reefs can protect shorelines from storm surges or waves and can help stabilize the land. Furthermore, by adding structure to what might otherwise be bare mud flat, they increase an area's habitat complexity, potentially making it more inviting to juvenile fish in search of refuge from predators or as a haven for other intertidal invertebrates. And as mentioned earlier, oyster reefs can also provide other important restoration related ecosystem services such as water filtration. And however, despite their importance and the services they can offer, oyster reefs are currently facing a number of challenges in some areas.

Cathy Janasie: Yeah. So while oyster reefs are so important to our environment, sadly they have faced so many challenges throughout time. To paint a picture of this in 1607 when Captain John Smith explored the Chesapeake Bay on our East Coast of the United States, there were oyster reefs so prominent that it made the waters hazardous for ships to navigate through. Likewise, when Henry Hudson arrived in New York in 1609 the harbor's oyster reefs were the largest source of oysters nationwide. If you've been to New York City recently, you wouldn't see those oyster reefs or people out there harvesting. It's a much different landscape today.

Cathy Janasie: So oysters have been challenged by a lot of different stressors in the environment. Today erosion from development, wetland loss, and excessive nutrient pollution have proved devastating for oysters, increasing the likelihood of disease and bringing wild oyster populations to historic lows. Also, outdated harvest methods and overfishing have destroyed or damaged reef structures.

Cathy Janasie: Additionally, unsustainable harvesting habits and a steady decline in water quality has led to greatly diminished oyster reef habitat on all the nation's coast.

Cathy Janasie: Dredges and tong harvesting in particular, which scrape living oysters off the reef can destroy the reefs' height and structure, harming the reef in a way that can take decades to recover. Such harvesting methods are actually counterproductive as oysters grow faster and larger high in the water column on top of the reef structures.

Amanda Nichols: So James, how do you think the oysters are doing?

James Gledhill: I mean I guess the short answer is not very good, as to what I'm seeing. But there's a paper that when you look through literature that's talking about this subject that a lot of people tend to reference. It's a paper in the journal BioScience. It's actually by a man named Michael Beck and he does this study where he looks at oyster populations in probably about 140 to 250 bays throughout the entire world that actually. He's using data from fisheries, using data from regulating agencies, and commercial commercial harvest data. And he actually estimates that there's been an 85% reduction total worldwide in oyster reefs. So it's pretty grim. 85% so a pretty big number.

Amanda Nichols: Runoff and erosion from industry, farming, and development can also adversely affect water quality and oyster reef health by leading to lower salinity, low oxygen levels, and silt overload. So when waste toxins and excess nutrients from runoff end up in the water, it actually weakens oysters and increases the spread of disease. Furthermore, over sedimentation reduces the available nutrition and pollutes the hard bottom habitat that oysters need to survive. So as oyster reefs decline in health and numbers, their ecosystem services also diminish. This is a problem that many people are trying to fix before the consequences become too dire.

Stephanie Otts: Join us next time as we discuss the leasing and permitting process for shellfish aquaculture operations.

Stephanie Otts: 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.