Chesapeake Quarterly

Maryland Sea Grant College • Volume 18, Number 1

Handling a Changing Seafood Economy

contents

Volume 18, Number 1

CHESAPEAKE QUARTERLY *May 2019*

Chesapeake Quarterly explores scientific, environmental, and cultural issues relevant to the Chesapeake Bay and its watershed. The magazine is produced and funded by the Maryland Sea Grant College. The college receives support from the National Oceanic and Atmospheric Administration and the state of Maryland.

Maryland Sea Grant College staff: Director, Fredrika Moser; Managing Editor/ Writer, Rona Kobell; Production Editor/Designer, Nicole Lehming; Guest Editor, Don Schiller; Guest Copy Editor, Alison Kahn

Send items for the magazine to

Maryland Sea Grant College
4321 Hartwick Road, Suite 300
University System of Maryland
College Park, Maryland 20740
email: mdsg@mdsg.umd.edu

www.mdsg.umd.edu
www.chesapeakequarterly.net

Cover: *Crab pickers at Lindy's Seafood in Woolford, Maryland.* PHOTO, JAY FLEMING

Sea Changes in Seafood Markets

Rona Kobell, Chesapeake Quarterly's *editor, inquires about crabs at D.C.'s Maine Avenue Fish Market at the Wharf.* PHOTO, NICOLE LEHMING / MDSG

It wasn't that long ago that we got up close and personal with our fish. We knew the names of the men — and some women — who caught them, cut them, and sold them. At local open-air fish markets from Boston to Baltimore, on wharves crowded with incoming vessels from the Chesapeake and Atlantic, the seafood economy was on full display.

Today, most of us who buy fish find it under plastic at the grocery store. And it usually comes from far away: Atlantic salmon farmed in Norway, halibut caught wild in Alaska.

No doubt today's seafood is safer. But the distance we've put between us and our fish has also created a dissonance between the health of our bay and that of ourselves. It's healthy for us to eat more fish, but isn't it also a sign of a healthy Chesapeake if the fish come from here?

For this issue of *Chesapeake Quarterly,* Baltimore writer Brennen Jensen dives into the history of Baltimore's famous seafood market — and its future, as an "eat-and-catch local" movement gains a foothold. We also look at the essential role that Sea Grant plays, nationally, in keeping seafood safe. Here in Maryland, Sea Grant's Cathy Liu has helped many seafood processors reduce their contamination risks; you can read all about her contributions in this issue. Farther afield, there is Constantinos Mylonas, who used funding from Maryland Sea Grant at a crucial point in his studies to help him develop brood stock management techniques in blue fin tuna. He is applying those ideas in Greece in hopes of growing that country's aquaculture industry.

We also introduce readers to our new Knauss fellows, who have studied marine science and will now spend a year in the offices of the executives who help set the agendas for coastal and oceans policy. You'll get to meet our science management and policy intern, Eva May, as well. And we'll reconnect with Emily Liljestrand, a former Maryland Sea Grant fellow, who is using new models to interpret historical data and learn where menhaden traveled in the 1960s, how many died on the way, and what those statistics can tell us about the way we fish now.

— *Rona Kobell*

A Different Fish Story

Buying seafood used to mean picking up fresh catch from local fishermen. With the push for verified sustainable seafood, will the personal connection between customers return?

by Brennen Jensen

It's 2 a.m. Do you know where your seafood is? If you live in the Mid-Atlantic, there's a good chance it's in Jessup, an unincorporated industrial transportation hub some 12 miles southwest of Baltimore, near the neat townhouses of suburban Columbia. The snapper, or scallops, or shrimp you'll select later from your grocer's seafood counter or a restaurant menu is likely being processed there in an anonymous warehouse, within earshot of Interstate 95, in the Chesapeake Bay watershed — but far from the source where most of those fish were caught or even a waterway where they would survive.

Capital Seaboard runs one such facility, a 160,000-square-foot building opened in 2017 to distribute fresh and frozen seafood from Richmond, Virginia, to central Pennsylvania. Seafood orders can come in as late as midnight, perhaps from a chef creating a menu that will appear on Capital's phone app — a sign of how technology has driven major market changes. After 2 a.m., when most chefs have nodded off, the action begins. In a ballet of pallet jacks, workers whisk around boxes of seafood, most of it shipped in from far shores, on the self-propelled devices: squid from China, shrimp from India, orange roughy from New Zealand, ahi tuna from Indonesia. The Chesapeake contributes rockfish and pasteurized crab, as well as raw oysters from Maryland.

With the exception of the company's administrative offices, the entire facility — a complex of vast, white-washed spaces — is refrigerated, allowing for an unbroken "cold chain." The term, used commonly by seafood safety professionals, refers to a major safety protocol, which requires that all seafood be kept at

***Dave Webb** of Wild Seafood mans the last surviving retail shop at Jessup's wholesale seafood market.* PHOTO, RONA KOBELL.

an optimal low temperature during the entire time that it remains in the Capital facility. A cavernous freezer is set at a steady minus-eight degrees Fahrenheit. (The floors are heated to prevent ice from forming and workers from hydroplaning.) Warm dress is a must for employees, and regulations also mandate hair and beard nets, rubber gloves, and safety boots. All of these changes reflect a decades-long effort to keep seafood safe — and they have paid off by drastically reducing the number of people who have become ill or died from food-borne illnesses in fish and shellfish.

In one frigid room, fish cutters slice and clean whole rockfish, salmon, and mahi-mahi. (The latter is what's called a histamine fish, a biological classification that includes tuna, mackerel, and herring — all species capable of emitting potentially harmful secretions. To avoid food safety risks, workers process these fish at separate color-coded cutting stations.) Watching over the knife-wielding workers is one of Capital's clipboard-wielding food safety inspectors; any waste that hits the gray floor does not stay long, as other workers wielding hoses and long-handled squeegees quickly wash it away.

By 3 a.m., workers load the first delivery trucks. As the fleet fans out, a computerized GPS system tracks each vehicle on a giant map while monitoring the cargo area's temperature. It's not the way your grandparents bought seafood. But is that a good thing?

The answer is, it may be a mixed bag. On one hand, seafood is safer. Robust science and technical protocols have determined how quickly and for how long fish needs to be iced, and federal and state inspection teams monitor carefully to make sure that processors follow the rules. No one wants to break them: a single outbreak of a food-borne pathogen that sends diners to the hospital can cripple the industry, potentially turning diners off for the long term.

But diners and cooks are losing their connection to the Chesapeake, and possibly as a consequence their impetus to restore the Bay.

"I think when people talk about the health of the Bay, it's always been very much linked to the health of iconic species, like the blue crab. It's hard to just say, 'Let's restore the Bay ecosystem,' because most people don't know what a healthy ecosystem would really look like," said Douglas Lipton, a longtime seafood economist for Maryland Sea Grant and now a senior scientist at the National Oceanic and Atmospheric Administration (NOAA). "But they would know what having abundant crabs, oysters, and striped bass looks like — that's an easier sell."

Consumers are buying fish, both from aquaculture and wild sources. According to NOAA's most recent data presented in its 2017 Fisheries of the United States report, the estimated per capita consumption of fish and shellfish was 16 pounds. Fish comes to the table from both domestic and imported sources. In 2017, edible fish products from imports were valued at $21.5 billion, and domestic products at about half that amount, just $11 billion. In 2016, U.S. aquaculture production contributed $1.45 billion in edible fish products.

Those in the wholesale fish business

SEAFOOD SAFETY

These photos show how far seafood safety has come in the decades.

At the old market, men wore jeans and flannels, produce sat on the floor at times, and rubbish shared space with seafood about to be picked. *PHOTOS, COURTESY OF RELIANT FISH CO.*

will always find a sizable market among consumers who simply want their seafood to be safe and cheap. But sellers are responding to a new buy-local movement. Steve Vilnit, Capital Seaboard's vice president of marketing, promotes local seafood, even in this era when exotic fish ordered from New Zealand can be delivered in 48 hours. "If we're about getting the best quality products, of course it's going to be fresher sourcing something from the waters of our own Bay, as opposed to the other side the world," he said. "It makes business sense to carry it."

He also has seen a trend at local restaurants and upscale chains where a fish dinner will come with a tail — and a tale. "Menus are adding descriptions," he said. "Now you [see] things like 'hook-and-line-caught eastern Chesapeake Bay striped bass.' People want a story — [it's] almost a romance of being connected with their food."

Fishmongering 3.0

One constant in the wholesale seafood business is the flurry of early morning activity. But just about every other aspect of the industry has changed substantially over the years: what and how fish are sold, and to whom. And the pace of change is accelerating.

For the bulk of the last century, the region's wholesale fish trade operated out of a brick building in downtown Baltimore, two blocks from the Inner Harbor. But 35 years ago, fishmongers decamped to Jessup and the large, purpose-built Maryland Wholesale Fish Market. They had outgrown a facility built for horse carts and clashed with leaders in an urban area that was tilting more towards tourism than trade. While some cities managed to preserve the vitality of their downtown fish markets, most, like Baltimore, have seen their markets move out to industrial fringes or suburbs, where many have merged with produce markets. (Washington, D.C., still has its wharf, though it's being squeezed by new luxury condos, a nightclub, and an oyster bar.) This invisible warehouse model is long on efficiency but short on charm and pedestrian traffic.

Over the past decade, even wholesale markets like Jessup's couldn't manage the burgeoning fish trade. Many companies have built their own facilities in the shadow of the wholesale market to accommodate swelling inventory needs and the growing battery of quality-control requirements from grocery stores. They have become contemporary nodes in a 21st-century global seafood supply chain, where products often come from the other side of the world rather than from the Chesapeake, fewer than 20 miles away.

"Very fishy smelling"

The building that housed Baltimore's downtown fish market still stands, but the signs on the arched entryways now say "Port Discovery," identifying the children's museum that took up residence there. The original market cost $101,000 to build in 1907; it replaced an earlier structure that had burned down in the 1904 Baltimore fire, continuing the tradition of a downtown seafood marketplace that began before the Revolutionary War.

In the new facilities at Jessup and next to it, workers wear oilskin overalls, head coverings, and gloves. They cut fish on sanitized surfaces with clean knives. Boxes are organized on palettes for shipping, and inspectors from the company and government agencies routinely check to ensure that everything is sanitary and clean. *PHOTOS, BRENNEN JENSEN*

George McManus was a teenager in the mid-1970s. He worked weekends and summers icing fish in the old market.

"Our day started around 5 a.m., when we'd roll up our big, rusted metal doors and let the air from the city flow through the building, even if it was a 90-degree summer day," said McManus, who now owns J. J. McDonnell Seafood, one of the Baltimore (and then Jessup) stalwarts. He, like others, has now left the Jessup market for a 62,000-square -foot stand-alone facility near it. "A truck would come in at the back of the market and unload ice into these big 50-gallon metal barrels, which you would literally roll into market to get ice to your fish." The market's aged cement floor was riven with cracks and fissures. "You could never have that now," he added. "The health department would shut you down."

Pat Welsh of Reliant Fish Co. remembers that floor, too. "There was not a smooth piece of concrete down there," said the third-generation president of his family-run company, now also on its way to becoming a stand-alone facility. "As a kid learning to use a hand truck, I dumped a lot of boxes of product."

The stalls of competing fish merchants lined both sides of the rectangular building; each merchant had an office upstairs. Fish and shellfish sat on ice-filled wooden boxes and bushel baskets along a center concourse, where customers wandered through. Today, nearly all of the product is delivered via trucks. But 40 years ago, most customers took their seafood purchases with them — crabs, lobsters, oysters, rockfish, yellow perch, whiting, monkfish, hake, spot, ling, croakers. Buyers included the public, chefs, and small-scale resellers who came in pickup trucks or horse-drawn carts. Larger wholesalers from Virginia and Pennsylvania took away truckloads of seafood for resale.

"People came in because they wanted to see the fish they bought," Welsh said.

"It's hard to just say, 'Let's restore the Bay ecosystem,' because most people don't know what a healthy ecosystem would really look like. . . . But they would know what having abundant crabs, oysters, and striped bass looks like — that's an easier sell."

— Doug Lipton, NOAA

Most seafood was caught domestically, he added, from the Mid-Atlantic up to New England and down to Florida. "And of course, back in the really old days, product came up the harbor by boat."

Though heavy lifting and harsh aromas were part of the merchant's experience, some aspects still evoke wistfulness. "Oh, it was very fishy smelling — there was no mistaking that," Welsh said. "But the market had a lot of character. You could see your competition, you could see your customers. There was always a buzz in the old market. It was alive."

Market Corrections

City leaders first threatened the fish market's downtown location in 1963 with proposed plans for a new women's prison. Then it was to be razed for a new highway project. The brick edifice dodged both of those perils. But by the early 80s, the fishy-smelling, bustling market was at odds with Inner Harbor development and the area's transition to tourism. The city was on the move; the fish market was in the way. One proposal that drew support from some fish sellers incorporated the market into a hybrid trade-tourism attraction, where fish mongering would flourish alongside restaurants and shops in the style of San Francisco's Fisherman's Wharf. But that plan depended on federal relocation dollars for a highway expansion — which never occurred.

The market's fate played out in the pages of the *Baltimore Sun*. "The dank, smelly old building is a treasure," ran one impassioned letter to the editor. "The fish market is a remembrance of a simple city life . . . close to the heart of older Baltimoreans." Meanwhile, the merchants grew exasperated with the less than optimal working conditions in the undersized building that lacked heat, air conditioning, and hot water, and with the talk of increasing regulations to refrigerate seafood more consistently. Shipping bays where horse carts had once parked were already catering to refrigerated tractor trailers — or trying to. "I'd watch the poor truck drivers work like an hour just to back into the market," McManus recalled.

In 1981, the merchants voted unanimously to move out. They began discussions with the Maryland Food Center Authority about a new home in the emerging food hub of Jessup, where the Maryland Wholesale Produce Market had set up shop in 1976. The market closed for good on January 14, 1984; two days later, the new suburban facility opened. Among the 10 proposals for converting the old market, one called for development of an entertainment complex affiliated with the flamboyant pianist Liberace. Ultimately, Baltimore's old fish market became a nightclub called the Fish Market; it was dead in the water by 1989.

Meanwhile, some seafood companies that had relocated to Jessup struggled to adapt to the ways of the new business model — deals made over the phone instead of with a handshake, and fish that was flown in or farmed. (The most popular fish and shellfish consumed in the United States are shrimp, tuna, salmon, and tilapia — none of which comes from the Chesapeake Bay or from local rivers. Tilapia, for example, is farmed, mostly in Mississippi and other southern states.)

Consolidations ensued as corporate big fish gobbled little ones.

The ever bigger firms sold to ever bigger regions, and the Bay and adjacent Atlantic waters became a diminishing component of a far-flung piscatory protein chain, with familiar local names adopted by national and regional chains.

Mild vs. wild?

"Maybe about 20 or 25 years ago, we went to the sexy fish," said John Shields, co-owner of Gertrude's restaurant at the Baltimore Museum of Art and a vocal local seafood evangelist. His latest cookbook, *The New Chesapeake Kitchen,* came out last fall. By that, he's referring to fish like salmon, which comes from elsewhere but features on menus of most area restaurants. "People forgot about fish that is native and local here."

These popular nonlocal fish varieties are mild in flavor, sourced or farmed globally, and not subject to seasonality or supply disruptions — whereas a patch of bad weather can keep Bay watermen onshore and local fish off dinner plates. They have become so ubiquitous that they hardly seem special anymore.

Shields recalls visiting the downtown fish market — "It was gritty and real, with people shouting" — and spending time at his great-uncle's seafood packing house on Tilghman Island. He opened Gertrude's in 1999 to reconnect with the seasonal rhythms of the Bay's bounty.

The Baltimore native promotes cooking and eating species like yellow perch and rockfish. Younger chefs, including Thomas Zippelli, owner of Columbia's Turn House, have gotten the message. The previous generation of diners "kind of grew up eating a lot of packaged foods," he said. "But now you see a lot of the younger guys, like me, starting to really shift that mentality." Zippelli honed his skills as a chef in New England where he developed relationships with Rhode Island fishermen. He loves serving regional seafood, including snakeheads from the Potomac and bluefish from Ocean City. "There's really excellent fish here if you look for it," he said.

Regional chefs gather around *oyster farmer Johnny Shockley (in red shirt) at Chesapeake Gold, his oyster farm on Hooper's Island, where he shows them his oyster nursery. Steve Vilnit, formerly with Department of Natural Resources and now with Capital Seafood, organizes trips so chefs can meet watermen.* PHOTO COURTESY OF STEVE VILNIT

During a four-year stint as director of fisheries marketing for the Maryland Department of Natural Resources, Vilnit connected chefs with seafood by getting them out of the kitchen and out on the water, where they met Chesapeake watermen and oyster farmers. Capital Seaboard runs similar chef tours for its customers. For chefs too harried to take time out to tour, Vilnit videotapes his visits with suppliers. "In a minute and a half of viewing, a chef can see where the food is coming from," he said. "They get the story."

J. J. McDonnell, where Vilnit worked previously, also conducts tours under the name School of Fish.

Might this renewed interest in the Chesapeake Bay as a seafood source bolster consumer commitment to improving its water quality?

"It certainly helps reinforce the need," said Doug Lipton of NOAA.

Some years ago, the Environmental Protection Agency's Chesapeake Bay Program launched a campaign to get people to connect a love for seafood with Bay restoration. Many conservation groups adapted slogans like "Save the crabs, then eat them" and "The lunch you save may be your own." The campaign urged diners to fertilize their lawns less and plant native trees.

There's still plenty of work to be done to hook consumers on seafood, now that the buying and selling of fish no longer happens under the public eye. But modern-day fish sellers, like Stephanie Pazzaglia, McDonnell's business development manager, are not giving up.

"Just the other day, someone asked me for halibut — but only from the Chesapeake Bay," she said of the popular fish that usually is sourced from deep northern waters off Alaska. "I didn't criticize them: it was just another opportunity for someone to be educated."

— *mdsg@mdsg.umd.edu*

From Astronauts to Aquaculture

How Sea Grant played a role in keeping seafood safe

by Rona Kobell

For several decades, the National Sea Grant network has been leading the nation's efforts to keep seafood safe. Its food safety scientists have trained more than 45,000 seafood inspectors, plant managers, and quality-assurance personnel in the United States and dozens of other countries that sell American seafood. Regulators from the Food and Drug Administration (FDA) to the Centers for Disease Control have praised the efforts, noting that illnesses from seafood have dropped in recent years and crediting the network's efforts for that change.

This remarkable progress was made possible in part through a set of procedures known as Hazard Analysis and Critical Control Points — HACCP for short. HACCP lays out steps that a processor must take to ensure that seafood is stored at the right temperature, that utensils are washed frequently, and that surfaces are sterilized at critical stages in the process to reduce the risk of contamination. HACCP training includes classroom time, with a manual developed by Sea Grant scientists and communicators, and plant time with equipment demonstrations and instruction. Many Sea Grant offices, including Maryland's, have robust programs to help processors turn fresh seafood safely into consumer products.

What drove the whole effort, though, was a request that had nothing to do with fresh seafood. It had to do with astronauts.

In 1959, NASA teamed up with Pillsbury to make food that would prevent astronauts in zero-gravity conditions from getting stomach ailments. Thirteen years later, an outbreak of botulism in canned potato soup prompted the FDA to promulgate regulations for low-acid canned foods. Again, the government turned to Pillsbury. Scientists from the company presented their guidelines to the FDA:

"Food Safety through the Hazard Analysis and Critical Control Point System." It was the first time that the acronym HACCP would be used.

Regulatory and science agencies continued to discuss the concept. A 1980 World Health Organization commission on food safety recommended the use of HACCP. In 1985, the National Academy of Sciences endorsed it over the practice of random food testing, another concept touted at the time. The 1993 *E. coli* outbreak at 73 Jack-in-the-Box restaurants killed four children and sickened hundreds, forcing urgent action across the meat industry. But for seafood, it wasn't so much an outbreak as it was a shifting reliance on foreign- and farm-raised sources, said Steve Otwell, the former seafood safety specialist at Florida Sea Grant who helped start the program. As wild stocks became depleted, the supply and demand cycle for seafood endured historical changes, and with them came many unanswered questions.

"There was a new public concern about seafood safety, and it paralleled concerns about food safety," Otwell said. "The federal government decided to do something about seafood safety, because the public was screaming for it and the politicians were screaming for it."

Anticipating new regulations, Otwell and a few Sea Grant colleagues approached the Association of Food and Drug Officials of the Southern States to see if they had an interest in a partnership, with Sea Grant leading the training. That group included state and federal regulators from the U.S. Department of Agriculture, the FDA, and the National Marine Fisheries Service. Armed with the association's endorsement, Otwell said he and other Sea Grant food safety specialists received $80,000 from the National Sea Grant Office to develop a program, including funds for traveling to meetings and production of a training manual. The Sea Grant colleagues and the regulators formed the Seafood HACCP Alliance. HACCP training for the seafood industry became mandatory in 1997, with Sea Grant in the lead role.

Two other Sea Grant experts were involved, Doris Hicks of Delaware and Ron Kinnunen of Michigan. "We were familiar with the industry. Many of us did our master's thesis or Ph.D. in the areas of seafood processing," Hicks said. "We worked with FDA to develop the [HACCP] curriculum."

Hicks and Otwell are retired — Kinnunen will retire this spring — but with their colleagues, they continue to refine the curriculum. They are updating HACCP materials for aquaculture, Otwell said, because it's a growing source for seafood. Sea Grant specialists update HACCP procedures as the FDA updates its requirements. Training is voluntary, but following HACCP procedures is not — and FDA officers do come around to inspect.

"My phone starts ringing" when FDA regulators visit commercial processors, said Kinnunen, who estimates he visits dozens of processors each year to help them comply with regulations. Sometimes the processors have questions that he can handle over the phone; other times, he schedules a return visit.

Recently, he said, regulators wanted to require fish processors to use expensive magnetometers, because they were concerned about metal fragments shedding during processing and potentially contaminating the fish. Kinnunen said he'd never seen metal fragments in fish. "We didn't want metal detectors or magnetometers," he said. "We developed some safety procedures [to address concerns]."

Last month, he said, a processor he works with was going to buy a sanitation device for a specialized whitefish product; Kinnunen recommended alternatively a three-basin sink and high pressure and high heat for optimal sanitation. "I walked out, and he said, 'You just saved me $10,000,'" Kinnunen recalled.

Many in the industry say they appreciate the training. "Processors like us wouldn't know what the handling process is [without HACCP training]," said Bill Cox, co-owner of the Honga Oyster Company on Maryland's Eastern Shore. "When you go through the training, you understand how important it is." He learned, for example, how to ensure that oysters are refrigerated by 10 a.m. in the summer, and also how to keep a cooler clean, how to write a disaster plan, and how to follow it.

Michigan Sea Grant Extension Agent
Ron Kinnunen (above) holding a whitefish on a trap-netting vessel in Lake Michigan. Fish on ice (opposite page) at the last seafood market in Jessup, Maryland. PHOTO (ABOVE) COURTESY OF RON KINNUNEN; (OPPOSITE PAGE) RONA KOBELL

Dorothy Zimmerman, who came to Florida Sea Grant in 2000 and now works for the Institute of Food and Agricultural Sciences at the University of Florida (UF), is still the publications coordinator for the training manuals that Sea Grant colleagues created in the 1990s — and which they regularly update. They were by far the best selling of the many Sea Grant Extension publications, she said. "We still sell several thousand a year." While UF stores the publications, Cornell University maintains the online training databases, and Virginia Tech still trains many seafood safety scientists, some of whom work for Sea Grant. It is a system, Zimmerman said, that relies on commitment and communication.

"They were way ahead of their time [on food safety]," Zimmerman said of the HACCP pioneers. "It was such a remarkable assemblage of Sea Grant talent."

HACCP and seafood safety continue to be important to Sea Grant. Tom Rippen started the Maryland Seafood Quality Assurance Program to ensure that crab processors follow safety procedures, from the time the crabs leave the dock until the time they are shipped. Cathy Liu runs that program now (see story, page 11).

Mike Ciaramella, New York's Sea Grant specialist, joined the program three years ago, after finishing his Ph.D. in food science, with a concentration in aquaculture, at Mississippi State University. At 32, he wasn't yet born when Kinnunen started at Michigan Sea Grant, or when Hicks ran her first consumer safety programs. Ciaramella is dealing with new seafood questions, and he and his colleagues are trying to come up with answers.

"People don't know, really, what goes into the production of their seafood and how safe it really is," Ciaramella said. "A lot of times, the Extension folks are the ones who get the questions about whether something is safe."

— *kobell@mdsg.umd.edu*

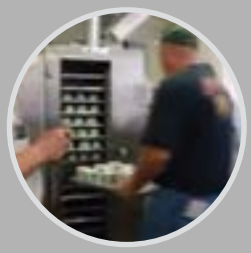
Our Extension seafood technology specialist is a member of the Seafood HACCP Alliance (www.afdo.org).

MDSG seafood specialist *Cathy Liu works with processors on safety procedures.*
PHOTO, DANIEL PENDICK / MDSG

Maryland Sea Grant provides HACCP training periodically throughout the year. Visit www.mdsg.umd.edu/seafood for more information.

BEYOND HACCP

Maryland Sea Grant trains hundreds of seafood processors each year in safe handling of seafood. But the seafood specialists do much more. Over the years, they have helped crab processors develop protocols for pasteurization, sterilization, freezing, and shipping. Here are a few highlights:



Flash freezing of crab meat

Our Extension staff helped several crab processing companies across Maryland to take advantage of new flash freezing technology for preserving crabmeat. Freezers keep crabmeat fresh for months, allowing processors to sell their jumbo lump and other products through the winter — without sacrificing flavor. We helped these companies obtain grants to buy the freezers. We also conducted scientific testing to determine temperatures at which crabmeat should be cooled and for how long. To learn more about this project, read "Crab Processors Get High Tech," a feature article in *Chesapeake Quarterly,* (www.chesapeakequarterly.net/V11N2) or visit our YouTube channel (www.youtube.com/user/MDSeaGrant/videos) to watch "Flash Freezing Crab Meat."

Maryland Crabmeat Quality Assurance Program (MCQAP)

Crabmeat processors who join the voluntary MCQAP agree to meet food safety standards and undergo safety inspections and testing. Companies receive an extra level of sanitary inspection and education through Maryland Sea Grant Extension. Participation in MCQAP helps processors remain competitive in a global market. Almost two thirds of Maryland crabmeat processors participate in this unique program. The economic benefit was estimated to be $728,000. For information, visit www.mdsg.umd.edu/topics/seafood-safety/seafood-safety.

Crab soup and products

When Maryland's Beach to Bay Seafood Company in Somerset County needed help figuring out how to produce and sell their famed crab soup commercially, Sea Grant Extension stepped up. Tom Rippen, a longtime Sea Grant specialist who retired and now consults with industry, developed protocols for pasteurizing and packaging the company's recipe. Eventually, owner Richard Evanusa hopes to sell the soup to supermarkets. This spring, Evanusa said, the restaurant will have 10 products ready for market, including marinades, breading, and seasonings.

NETWORKING NATIONWIDE FOR SEAFOOD SAFETY

From halibut in Alaska to oysters in the Chesapeake Bay, the Sea Grant network is invested in seafood safety, education, training, and communications. In some programs, Sea Grant Extension agents are interpreters, working with Vietnamese shrimpers in Louisiana or native Spanish speakers in Texas. In others, such as in Alaska and Michigan, agents work with members of tribal nations in remote areas. Aquaculture has recently become a focus for NOAA and the network to ensure that the same safety procedures for wild catch apply in ponds and nets. For more information, visit seagrant.noaa.gov/Our-Work/SFA.

Meet the Extension Specialist

CATHY LIU

by Rona Kobell

Five years ago, Maryland Sea Grant's Extension Program hired Cathy Liu as its seafood technology specialist. And ever since, she has been helping seafood processors maintain the safety of domestic seafood through training and certification updates to minimize the risks of contamination.

Liu grew up in an inland city in China's Sichuan Province. She studied soil science and agrochemistry in college in her home country, then went on to receive her doctorate in food science in Japan. Eventually the multilingual Liu found herself living halfway around the world, focusing her research on crabs and fish in the Chesapeake Bay.

"Even though I was in an inland city, we had freshwater fish," Liu said.

In Chinese culture, the fish is considered a lucky symbol. The Mandarin word for fish — *yu* — shares a similar pronunciation with another character that means surplus or abundance. Due to the homophony, the Chinese tend to equate fish with auspicious traits. During the Lunar New Year, the most important cultural festival, fish is an indispensable dish at the table, as celebrants gather to welcome a year of abundance.

Liu feels lucky to be working in the Chesapeake Bay — where she's on a first-name basis with many seafood processors. Every year, dozens of them attend her trainings to learn about hazard analysis and critical control point (HACCP) to ensure that seafood is kept at the proper temperature during processing and is stored properly (see p. 8). She also runs the Maryland Crabmeat Quality Assurance Program, providing support and oversight. Nearly two-thirds of Maryland processors participate in the program.

Her current research involves the development of effective post-harvest processes to reduce *vibrio* pathogens in shellfish. Food-borne illnesses from these bacteria, which live in marine environments and thrive in warm temperatures, can cause turmoil in an entire market. Almost every state now has a *vibrio* control plan, including Maryland. This work builds on Liu's previous research combining ultra-low flash-freezing at -95.5°C for 12 minutes, followed by storage at -21°C for five months, which can reduce *vibrio* in half-shell oysters to nondetectable levels.

Liu earned a master's degree in food science from the Southwest Agricultural University in Chongqing, China, in 1992, and a Ph.D. in food science from Ehime University in Matsuyama, Japan, in 2000. She directed the Laboratory of Marine Bioresources Utilization at the Shanghai Ocean University from 2004 to 2013, after which she came to the United States — first as a visiting professor at the FDA's Gulf Coast Seafood Lab in Alabama and then at Oregon State University Seafood Research and Education Center.

She works out of two offices — at the College of Agriculture and Natural Resources in College Park and at the Center for Food Science and Technology at the University of Maryland, Eastern Shore, where she conducts collaborative research.

Liu may not always be near the water, but fish are never far from her mind — or her plate. It's all about *yu,* that Chinese character with the dual message: "If you have fish," she said, "then you are also rich."

— *kobell@mdsg.umd.edu*

Maryland Sea Grant Extension Agent *Cathy Liu with a wet storage system used to control* vibrio. PHOTO, DANIEL PENDICK / MDSG

Seeding the Future

Maryland Sea Grant helps Greek aquaculture

by Rona Kobell

Tourists to Crete flock to the island's aquarium, CretAquarium, in the seaside town of Heraklion to gaze at purple anemones, sinewy octopi, and a 10-legged lobster. Bilingual guides point out the glory under the glass and explain how long the creatures live, where they go, and even how they organize their social lives.

But behind closed doors, scientists are working on something less colorful and perhaps even more fascinating: how to propagate a species in aquaculture to boost the future of Greek seafood in European markets.

Greece is revered for its pristine blue waters and fresh wild fish. Over the last three decades, the country has focused increasingly on aquaculture, growing fish such as gilthead seabream *(Sparus aurata)* and European seabass *(Dicentrarchus labrax)*, mostly in outdoor cages and some in recirculating aquaculture systems. Marine aquaculture is the third most important agricultural export industry in Greece, which exports 80 percent of its total output. (Aquaculture is considered a subset of agriculture.) Before its financial crisis in 2008, Greece was the leading European producer and exporter of fish, according to the Food and Aquaculture Organization of the United Nations (FAO), and it is still a significant producer as its economy struggles to recover. It is now the 12th major finfish producer in the world, far behind China and Norway, but well ahead of the United States, reports the FAO. The hope is to boost Greece's struggling economy with a steady supply of fish that can feed Europe and the rest of the world.

Among the leaders in this effort is Constantinos "Dinos" Mylonas, director of research for the Institute of Marine Biology, Biotechnology, and Aquaculture at the Hellenic Center for Marine Research, located at the aquarium. Recently, he was the lead author on several scientific papers that presented ways to enhance reproduction in certain marine fishes using reproductive hormones — the same hormones used to assist human reproduction. One of the papers looked at striped bass *(Morone saxatilis)*, meagre *(Argyrosomus regius)*, and Atlantic halibut *(Hippoglossus hippoglossus)*, focusing on gonadal hormone manipulations and on pheromones to increase sperm secretions

Constantinos "Dinos" Mylonas *(left) with his longtime friend and mentor, Yonathan Zohar, of IMET in Baltimore.* PHOTO COURTESY OF DINOS MYLONAS; MAP, GOOGLE MAPS

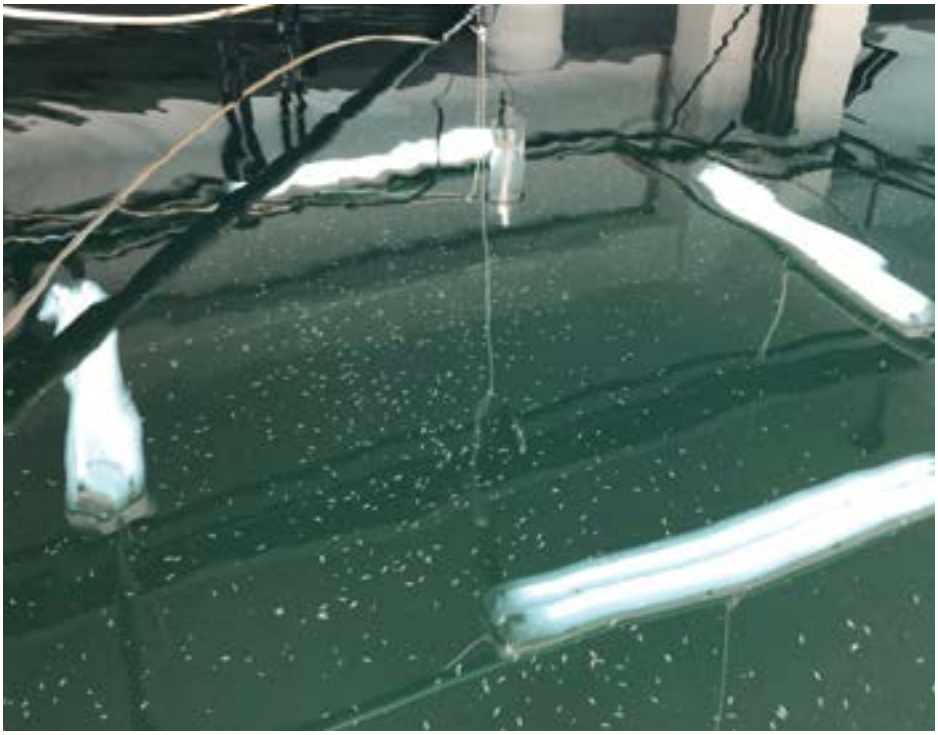
and egg production. Sometimes referred to as the "spawning bottleneck," it refers to the challenge of getting fish to reproduce in captivity. Mylonas also cowrote a paper on reproduction of Atlantic bluefin tuna in captivity.

Mylonas headed an EU research project involving the aquaculture of new fish species. That project, titled DIVERSIFY, consists of 38 partners from 12 countries (www.diversifyfish.eu). His lab received a $1.8 million grant to explore reproduction in captivity of two fish species—meagre, a cousin of the red drum, and greater amberjack, also known as "kanpachi" in sushi bars—for aquaculture. Results of the project, completed in November 2018, showed how to maximize efficiency in the spawning and reproductive processes.

Mylonas started his Ph.D. studies in 1991 in the lab of Yonathan Zohar, an aquaculture endocrinologist at the University of Maryland Biotechnology Institute — now the Institute of Marine and Environmental Technology — located at the city's Inner Harbor. Zohar, who had come to the University of Maryland from a lab in Eilat, Israel, only a few months prior, applied for funding from Maryland Sea Grant just four days after he arrived. With it he hoped to bring in Mylonas, the young doctoral student who had sought him out while he was working in the Israeli lab. Zohar received two years of funding from Maryland Sea Grant, and he brought Mylonas to Maryland. Together the pair collected striped bass from Maryland rivers and tried to spawn the fish in captivity. They honed breeding techniques that are still used today.

"It was instrumental," Mylonas said of the Sea Grant funding. "Without it, I wouldn't have been able to do it. I wouldn't have had any other means of support."

In 1996, Mylonas received his Ph.D. from the Marine Estuarine Environmental Sciences Graduate Program at the University of Maryland, College Park. He returned to his native Cyprus for a couple of years to manage a finfish aquaculture operation. In 1999, he moved to Greece, where he is now the research director at the Crete facility.



Juvenile fish *(above) grow in Mylonas's lab. Mylonas (right) trying to hold on to one of the lab's more mature residents.* PHOTOS, RONA KOBELL / MDSG

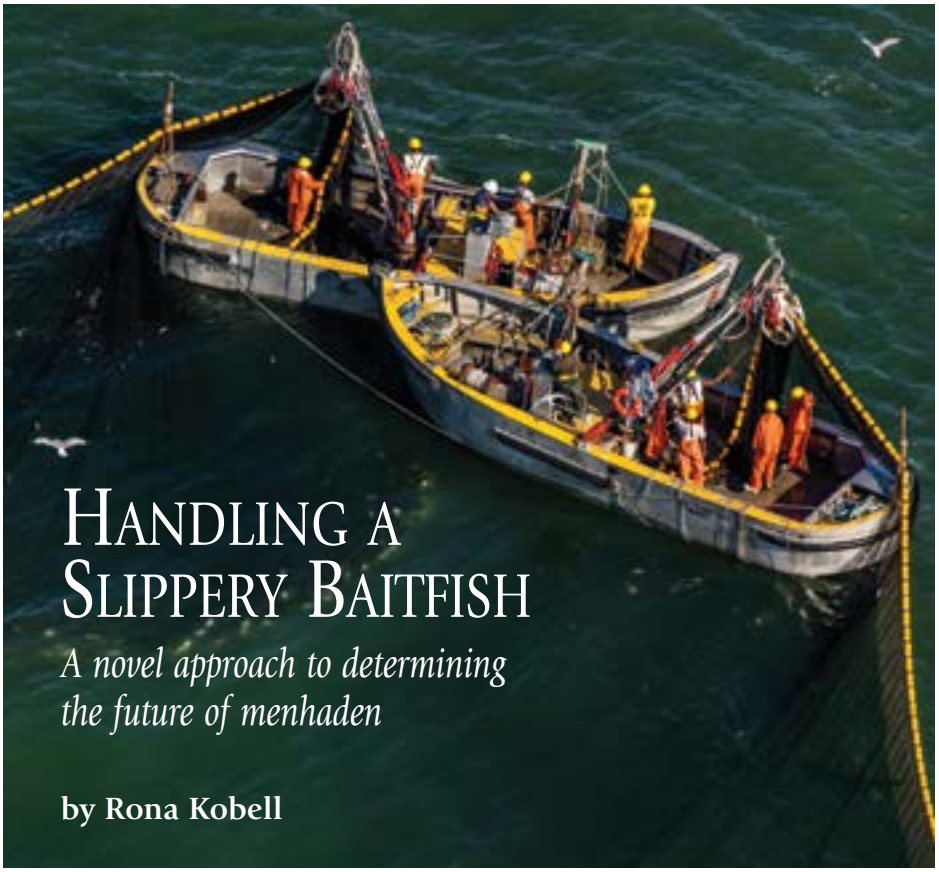
Many days find Mylonas in his lab in front of a warren of tanks, wrangling a meagre or an amberjack to inject a hormone that will induce maturation and spawning. The fish he works with — silver, thick, and wily — are already eight years old. In the wild, they mate at five years, but in captivity they do not spawn unless treated with reproductive hormones. Mylonas and his team tackle this "reproduction dysfunction," by helping the fish through this maturation so that they will produce large numbers of fertilized eggs. Next to the lab are small pools filled with tiny fry, the product of successful spawns. Those fish will grow and become products in the burgeoning aquaculture industry.

"We know we can control reproduction," Mylonas said, "but is it possible to do it whenever we want, regardless of the species of fish or the rearing conditions?"

Zohar said that Mylonas, like his other international graduate students from those early days, became like a member of the family — and he still is.

"He contributed a huge amount to the Mediterranean marine aquaculture industry," Zohar said, "overcoming that first reproduction spawning bottleneck that is so common in almost all culture fishes."

— *kobell@mdsg.umd.edu*



Handling a Slippery Baitfish

A novel approach to determining the future of menhaden

by Rona Kobell

If you want to know how many fish of a particular species you can safely take out of the sea, it's useful to know how many of those fish are in the sea. How many die annually of natural causes? How many migrate? Where and when do they go?

Those were questions facing Emily Liljestrand when she was a Maryland Sea Grant fellow and a master's student at the Chesapeake Biological Laboratory at the University of Maryland Center for Environmental Science (UMCES) a couple of years ago. Now working on her doctorate at Michigan State University, Liljestrand has answered some of those questions with regard to one key species: Atlantic menhaden *(Brevoortia tyrannus)*. In collaboration with Michael Wilberg, her UMCES advisor, and Amy M. Schueller, research biologist at the NOAA Fisheries Service, Liljestrand has published two papers on mendaden population models and mortality in Fisheries Research.

Atlantic menhaden, an oily baitfish not consumed directly by humans but a food staple for striped bass, are processed into dietary supplements, fertilizer, and animal feed. Watermen can make a living catching menhaden, which come from the Chesapeake Bay and the Atlantic Ocean, but the bulk are harvested by Omega Protein Company in Reedville, Virginia.

In the late 1960s, researchers from the NOAA Beaufort Laboratory in North Carolina injected menhaden with individualized magnetic tags — usually placed under the dorsal fin — that recorded the current length and age of the fish. These tagged menhaden were released along the Atlantic coast. Processing boats later caught the fish and took them back to the plants, where workers extracted the tags along with the recorded information. The fish were subsequently ground and converted into various products. Over the decades, some of the information recorded by the tags was lost, and it was mostly forgotten — that is, until Liljestrand and a team rediscovered the information and digitized it at the Chesapeake Biological Laboratory. Equipped with new statistical techniques and computer models, they wanted to see if they could make any determinations about the menhaden population with the recovered data.

The range of Atlantic menhaden extends from Nova Scotia to North Carolina. Scientists had assumed that in the spring, most of them moved north — and in the winter, most headed south toward the Chesapeake Bay. Liljestrand's modeling, however, showed that only about half of the population moved south. Many overwintered in the northern part of the range, north of the Chesapeake Bay. The data analysis also indicated that natural mortality was 2.3 times greater than previous estimates. That conclusion challenged assumptions that much of the mortality was the result of fishing pressure; instead, it was influenced by temperature and predation and factors not connected to fishing.

During the 1960s, 18 companies took massive amounts of menhaden. Today, only one company, Omega, is still operating — but natural mortality rates basically have stayed the same. Knowing where menhaden migrate and at what rate they die can help inform management decisions. The Atlantic States Marine Fisheries Commission regulates the stock, except in Virginia; the only state that still has a reduction fishery, it regulates menhaden through the state legislature.

Recreational anglers long have contended that Omega takes too many menhaden and is harming the striped bass population, while scientists have said that menhaden are not overfished. Liljestrand said her team's findings could "open the possibility to fishing at certain areas and at certain times" that, historically, were believed to be unproductive. North Carolina's fall fishery, according to the study, is one such area that could support higher catches.

— *kobell@mdsg.umd.edu*

Menhaden seine nets. PHOTO, GORDON CAMPBELL / AT ALTITUDE GALLERY

Maryland's 2019 Knauss Fellows

Established in 1979, the Knauss Fellowship matches highly qualified graduate students in marine science with "hosts" in Congress or the Executive Branch for a one-year paid fellowship focused on resource management policy. Meet our 2019 fellows:

Maureen Brooks is the interagency and international policy liaison at the Office of the United States Navy's Oceanographer of the Navy. Her work will focus on oceanography, marine weather, and navigation. Brooks defended her doctoral dissertation for the Marine Estuarine Environmental Sciences Graduate Program at the University of Maryland Center for Environmental Science (UMCES), where she studied the interactions between ocean physics and seaweed biology. As an undergraduate at McDaniel College and a master's student at the University of Maryland, she applied her love of science and math to develop computer models to understand the effects of nutrient pollution in the Chesapeake Bay. Brooks was also a Blue Waters Fellow with the National Center for Supercomputing Applications. She enjoys kayaking, creative writing, and crafting sea creatures from yarn.

Zoraida P. Pérez Delgado is special assistant to the assistant administrator at NOAA's Office of Oceanic and Atmospheric Research, where she will concentrate on issues relating to climate, oceans, weather, and coasts. She earned her bachelor's degree in environmental science at the School of Science and Technology at Universidad Metropolitana in San Juan, Puerto Rico. As a master's student in the Marine Estuarine and Environmental Science Program at the UMCES Chesapeake Biology Laboratory, Delgado is studying paleoclimatology. For her thesis, she analyzed coral geochemical records from the Atlantic, Indian, and Pacific oceans to explore how volcanic eruptions over the last 400 years affected temperature and precipitation patterns. Delgado enjoys traveling, dancing, and working on do-it-yourself and interior design projects.

Melanie Jackson is an executive fellow in NOAA's Office of Legislative and Intergovernmental Affairs, where she will serve as the official liaison between NOAA and Congress. Jackson received her undergraduate degree in 2012 in marine science and biology from the University of Miami's Rosenstiel School of Marine and Atmospheric Science. After graduation, she served a term in AmeriCorps as watershed ambassador for the Hackensack River in New Jersey. In 2013, Jackson began her master's at the UMCES Horn Point Laboratory in Cambridge, focusing on algae blooms and nitrogen. She defended her dissertation for her doctorate, specializing in oyster restoration and aquaculture and how oysters remove nitrogen pollution. Jackson enjoys hiking and singing science parody songs for the UMCES Integration and Application Network.

Emily Russ is working with the Engineer Research and Development Center, part of the United States Army Corps of Engineers, as an advisor to the technical director. She focuses on topics ranging from marine transportation to hurricane resilience. Russ holds two degrees from North Carolina State University: a bachelor's in marine and coastal resources and a master's in earth science, with a focus on coastal geomorphology. She also has a certificate in geographic information systems. Russ recently defended her doctoral thesis at the UMCES Horn Point Laboratory, where she researched sediment transport between the lower Susquehanna River and upper Chesapeake Bay — and discovered a passion for promoting coastal resilience through outreach education. She enjoys baking, hiking, and playing ultimate frisbee.

The Knauss Marine Policy Fellowships run from February 1 to January 31 and pay a stipend plus allowances for health insurance, moving expenses, and travel. Students can apply through their state's Sea Grant program.

Maryland Sea Grant Program
www.mdsg.umd.edu/education/knauss

National Sea Grant Program
www.seagrant.noaa.gov/knauss

Maryland Sea Grant College
4321 Hartwick Road, Suite 300
University System of Maryland
College Park, Maryland 20740

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Maryland Sea Grant Welcomes EVA MAY

Eva May *by the Anacostia River in Bladensburg Waterfront Park.* PHOTO, NICOLE LEHMING / MDSG

It's a long way from the waters of Ban Nam Khem to the campus of College Park. But Eva May has traveled that road — with stops at many places in between. May is Maryland Sea Grant's new Science Management and Policy intern.

As a student at Duke University, the Atlanta native traveled to Thailand to rehabilitate and research her favorite animal — sea turtles. In addition, she built and analyzed nanoparticle aquatic microcosms, investigated marine worms, and conducted independent research on trophic dynamics. May also studied marine bioacoustics at the University of South Carolina, Beaufort.

When she graduated from Duke in 2017, May received a bachelor's degree in environmental sciences, with a minor in biology, as well as a certificate in marine science and conservation leadership. Her time at Duke taught her what a career in marine science could look like. While she enjoyed rehabilitating and researching sea turtles and parrotfish hatchlings, she also learned the ways in which her research could facilitate changes in fisheries management and in ecosystems as a whole.

"I knew if I wanted to do conservation management, I couldn't only do research," she said.

May's course work exposed her to several marine coastal areas, including the Chesapeake Bay. Her knowledge of the region, combined with her broad interest in marine sciences, made her a great fit for Maryland Sea Grant.

Here, no two days are alike. May has enjoyed juggling many special projects, from event planning to Capitol Hill visits to microplastics research at Baltimore's Inner Harbor. She also has continued to pursue her hobbies, yoga and hiking, and she appreciates having access to Washington's many free museums. "I have my hands in so many pots," she said.

This won't be the end of May's travels: When her internship is over, she plans to apply to graduate schools in several places, including as far as Australia. Hers is a road with many exciting stops to come.

— *Alexandra Grayson*

Alexandra Grayson, a first-year student at Howard University, is a Maryland Sea Grant intern with the communications department.