



WRACKLINES

Volume 16, Number 2, Fall/Winter 2016

Exciting efforts are underway—in wetlands, in the Sound, in labs, in gardens too!

HEALTHY HABITATS RESILIENT RESOURCES



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From the EDITOR

OUR VISION FOR THE FUTURE

Greetings as we all prepare for the fall and winter season as 2016 winds up and 2017 approaches with alacrity. We've decided that for this issue of *Wrack Lines*, we'd have a theme that resonates with resilient coastal ecosystems and healthy living resources. With this idea comes the overused but uber-important words "resiliency" and "sustainability" for our vision of the future. There are exciting things happening!

In these pages, you will learn about some new research on the ability of salt marshes to adapt to rising sea levels, and some insights on native fish stocks. Marine scientist Sylvia Earle once said, "The concept of 'peak oil' has penetrated the hearts and minds of people concerned about energy for the future-- [but] 'Peak fish' occurred around the end of the 1980s." Don't despair; we have good news about Atlantic sturgeon, and insights for better management of our tautog, or blackfish.

You've heard the adage, "What is old is new again" – and that is a good way to describe Rachel Carson's little-noticed early observation about the trend of rising seas and threat of climate change, made back when your unsuspecting editor was in diapers. We celebrate this amazing and innovative scientist who talked about those rising seas in a story by another Rachel, from the millennial generation's perspective. Who knew that Carson's first at-sea voyage was likely in Long Island Sound?

It's also a time to celebrate Sea Grant's 50th anniversary. Nationally this year marks a half century of Sea Grant bringing science to serve America's shores. We hope you'll watch the video on our home page, <http://seagrant.uconn.edu> to find out what Sea Grant does for you around the nation. In October, Connecticut Sea Grant was honored to receive, with our partner programs in Maine and New Hampshire, the Sea Grant Association's Research to Application Award for our efforts to develop the sea vegetable industry in Connecticut and New England.

We celebrated yet another landmark event, the Connecticut Shellfish Initiative's launch on October 20, bringing appreciation of our valuable shellfish resources to light. Check out our photo gallery on page 13.

Yours,

Peg Van Patten

Wrack Lines editor

About our cover:

UConn grad student April Doroski samples wetland sediments to quantify characteristics for experiments. See page 10



Sea Grant
50
YEARS

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Dick Harris has always loved the water and the creatures in it, and he now connects people to Long Island Sound.





Angler Nick Sandone has landed a tautog, also known as blackfish. Photo: Sean Outlaw

Throw the big ones back!

by Eric Schultz, Jason Vokoun, Jason McNamee, and Jacob Kasper

Tautog (*Tautoga onitis*), also known as blackfish, have a lifestyle that promotes a long life: they eat crabs and shellfish, sleep all winter, and in the summer they rest every night and have sex every day. But not all is well with blackfish. Long Island Sound (LIS) anglers with long memories know that our waters now have fewer of these wonderful fish. What do we know about the biology of this fish species, the anglers that seek it, and the way the resource is managed? What can be done to restore the population in our area? The answers may lie in protecting the bigger older fish that make an especially large contribution to the next generation.

Biology

Tautog is an expatriot species. It is a wrasse, one in a family of thousands of species mostly living in tropical habitats such as coral reefs. But tautog and the related cunner (*Tautoglabrus adspersus*) live entirely in the coastal waters of eastern North America, mostly between Cape Cod and Chesapeake Bay. Like their tropical relatives, they remain close to the seafloor in shallow water, and are active during the day, while at night they take shelter and remain quite still. Unlike the tropical wrasses, they also rest all winter, perhaps having inherited a dislike for cold from their coral reef-dwelling ancestors.

Tautog take most things slowly. Their growth is gradual and they need a few years to become sexually mature. If they are lucky they live a long time: their lifespan can extend beyond 30 years. One aspect of life they are not so chill about is making babies. Former



Blackfish larvae collected in a plankton sample at the Millstone Nuclear Power Station. The largest larva is about 8 mm long. Photo: Shannon Nardi

UConn graduate student Lori Laplante, now a professor at St. Anselm College in New Hampshire, found that most mature females expel a fresh batch of eggs every day during the summer, from May into September. Their output adds up to an amazingly large number. A big female weighing six pounds can produce about 50 million eggs in a season! The eggs are tiny and planktonic, drifting away from the spawning pair with water currents and eventually hatching into planktonic larvae.

With such prodigious output of eggs, why aren't we up to our necks in blackfish? We could ask this question about almost any coastal fish species, because they all broadcast numerous eggs. The price for making many tiny eggs is shockingly high offspring mortality. Here's the math: if a female and male make an average of 20 million fertilized eggs each year, reproduce for an average of ten years, and just replace themselves, then 99.99999% of the offspring die before spawning. Nearly all mortality occurs in the first few weeks of life. But predators continue to be interested in our little fish. Indeed, when they get big enough, humans like to catch and eat them.

Fishing for Tautog and how the fishery is managed

Large coastal fishes are often targeted by the fishing trade for sale in fish markets, as well as by those who fish for fun and their own dinner table. Most tautog are caught by recreational fishers: for every one fish that is commercially harvested, four are kept by recreational anglers who prize blackfish for their mild flavor, firm texture and their habit of living close to shore. Most are captured by rod and reel during spring and fall seasons. Some adventure-seeking fishers target blackfish by spearfishing.

Just as with people, where you live determines what laws you live by. Most adult blackfish live within state

continued on next page



Jacob Kasper and Lazer Kasper with Lazer's first tautog, caught in RI. The fish was undersized and released. Photo: Roy Shakun

waters up to three miles from shore. Just how often and how far blackfish move have been measured in relatively few locations. We have enlisted enthusiastic anglers to help place tags on blackfish in Long Island Sound so that we can learn more about their movements in that environment. Of course, fish don't read maps and adhere to political boundaries. If different states share the same fish, they should coordinate

enough? Are enough fish evading capture each year? By these indicators, the ASMFC determined that tautog are, using fisheries terminology, 'overfished' (less abundant than is desirable) and in some places are subjected to 'overfishing' (fishery-based mortality is higher than is desirable).

The remedy for a situation like this is 'take fewer fish.' The ASMFC sets a general target for a sustainable fishery,

fishery into three regions: a Southern New England region combining Massachusetts and Rhode Island, a middle region with Connecticut, New York, and New Jersey, and a southernmost region with Delaware, Maryland and Virginia. An alternate scenario under consideration was to put Connecticut together with Massachusetts and Rhode Island, and New York together with New Jersey, thus awkwardly splitting LIS between two management regions. Both regional divisions were problematic for those concerned with managing tautog in Long Island Sound, because there are clear differences in fish growth patterns and fishing practices between LIS and waters off New Jersey. Dave Simpson, who is an ASMFC Commissioner and a now-retired biologist with the Connecticut Department of Energy and Environmental Protection (CT DEEP) characterized this situation as "trying to fill a bucket full of holes... We're going to keep losing fish to a southern region that won't be reflected in their stock assessments; and we'll be perpetually cutting our catch to no avail." Fortunately, we had just received a research grant from Connecticut Sea Grant to prepare a Long Island Sound-specific assessment. With this news, the management board deferred consideration of regional stock assessments until this year.

Our team, including fisheries biologists from CT DEEP, New York and New Jersey, prepared a new set of separate assessments for LIS and the New York Bight (the waters off the south shore of Long Island and off the New Jersey coast). In August 2016, the management board approved this new regional division for management use. This was an exciting development for us, because we saw how our research could be useful to managers who are responsible for conserving the fish population.

Our next step is to use our assessment of the LIS blackfish population to evaluate alternative management approaches. We will project from the LIS stock



A tagged blackfish. Photo: John Swenarton

their management of those fish. This is the reason for the Atlantic State Marine Fisheries Commission (ASMFC), formed in an interstate compact approved by Congress in 1942. The ASMFC coordinates 26 management boards, each focusing on a coastal species of fish or crustacean. Management boards are informed by technical committees, advisory panels, and plan review teams, which in combination strive to provide boards with timely information on the fishery.

The ASMFC is worried about tautog. There have been numerous management efforts since the mid-1990s, but the stock has fallen to low levels and is not rebuilding. The situation is laid out in an analysis called a stock assessment. A stock assessment is like a medical chart: the stock (meaning a managed population) is the patient, and the assessment is a report on the stock's condition: it might include data on changes in abundance and vital signs such as birth rate, growth rate, and mortality rate. The patient's condition is judged in comparing these data to sustainable values: is it abundant

such as a level of mortality or abundance of fish. The states then propose ways to restrict the catch. For a primarily recreational fishery such as that for tautog, this is mostly done by increasing the minimum legal size, capping the legal number of fish allowed per fishing trip, and restricting the fishing season. Over the years, fishing for tautog in Connecticut has become more restrictive, from a minimum size of 12" and no restriction on the season or number of fish that can be kept, to current regulations with a minimum size of 16", seven months in which fishing is prohibited, and a limit of two or four fish depending on the month.

The ASMFC is also improving management by regionally tailoring its tautog stock assessments, and we have assisted in that effort. The stock has historically been assessed as a single coastwide management unit despite evidence that aspects of the species' biology such as growth rate vary along its range. Improvements to data collection and modeling methods permitted ASMFC to develop region-specific stock assessments. Last year, the Tautog Technical Committee presented a stock assessment to the management board that divided the

assessment how many fish should be harvested each year over the next five years in order to maintain the stock at a sustainable level. With these projections, we can test for the effect of changes in the legal size, the legal limit of fish allowed per fishing trip, and the fishing season. We are particularly interested in alternative management approaches because of our high regard for the big old blackfish, for reasons we will now explain.

Respecting the elders in fisheries management

We should always respect elders (says the ‘senior author’), but we should especially do this for fishes. In contrast to humans and other mammals, in which reproduction declines after a certain age and may cease altogether, fishes keep breeding as they keep growing. We have recently learned from studies of tautog and other species that the continued reproduction of older individuals is especially valuable for the population, for two reasons. One reason is that larger females of many species make more eggs. We found that a large (six pounds) female tautog will make 20 to 80 times as many eggs per unit of body weight than a small (one pound) mature female. Surprisingly, they do not necessarily sacrifice quality for quantity: large females of many species make larger eggs as well. So, a second reason that large females are especially valuable is that their offspring are especially likely to survive because of this head start on the young that hatch from smaller eggs.

Unfortunately, fisheries do not show elder fishes much respect. Larger and older fish are scarcer in populations that are fished, mostly because they have been ‘at risk’ for longer: an old fish has been tempted by baited hooks or has seen more nets go by than a younger fish. This decline in the abundance of elders could impair our efforts to rescue overfished stocks.

With the help of Connecticut Sea Grant, we are working to restore the Tautog stock in Long Island Sound to its former abundance.

Short of stopping fishing altogether, what can be done to bring the elders back? We suggest that we can better respect the elders by throwing them back in the water! In recreational fisheries, we could use a slot limit that sets not only a minimum size that a fish must reach to be legally kept for the oven, grill or frying pan, but also a maximum size above which a fish must be released. In this way, the lucky fish that avoided the hook for several years will continue to enjoy an active sex life for years to come. We are scientifically testing this idea via stock assessment projections that compare the effectiveness of managing by a slot limit relative to other management approaches. We hypothesize that an especially effective way to help the population recover will be for anglers to throw the big ones back. Whether this is an approach that the anglers will accept will be the subject of a future study.

Bringing back the blackfish

Harvesting wild organisms in a sustainable way is no easy matter. We humans are quite clever at getting to our quarry, are well-equipped to catch them, and there are many of us to feed. These impacts are especially evident in a populous region such as ours. Fortunately, we have also learned how to maintain a close watch on the population health of the quarry and how to enable fishery managers to restrict the harvest. Prospects are improving for some stocks in the northeast. With the help of Connecticut Sea Grant, we are working to restore the tautog stock in Long Island Sound to its former abundance.

ABOUT THE AUTHORS:

Eric Schultz and Jason Vokoun are faculty members at the University of Connecticut, in the Department of Ecology and Evolutionary Biology, and the Department of Natural Resources and the Environment respectively. Jacob Kasper is a graduate student in the Schultz lab. Jason McNamee is with the Rhode Island Department of Environmental Management, and current chair of the ASMFC Tautog Technical Committee.

Endangered Atlantic sturgeon find a new nursery in the Connecticut River

by Judy Benson, Day staff writer

Reprinted from *The Day Publishing Co.*, July 19, 2016

Old Lyme — Though facing extinction after 70 million years of existence, Atlantic sturgeon apparently aren't done looking for new ways to adapt and survive. "They're really amazing fish," Isaac Wirgin, associate professor in the Department of Environmental Medicine at New York University's School of Medicine, said Monday. "This was really an unexpected result."

The result he was referring to was the outcome of genetic tests he completed last fall on tissue samples from some 6-inch, 1-year-old Atlantic sturgeon caught in the lower Connecticut River in 2014. Tom Savoy, a fisheries biologist with the state Department of Energy and Environmental Protection who's been researching Atlantic sturgeon in Long Island Sound for more than 20 years, caught the small fish while sampling with nets in the river for a related species—the short-nosed sturgeon—and knew right away he'd found something unique. Based on their size, they had to have been born in the river.

"Prior to that, we assumed the breeding population had been extirpated in Connecticut," said Savoy, who works out of DEEP's Marine Headquarters on Ferry Road. "But the great news is, evidently they are spawning in the Connecticut River," he said. "Now, because they're a federally protected species, the state is obligated to learn more. We need to know where they are, and how many there are."

The ancient species, which supplied the caviar that became one of the first exports from the colonies, was declared a federally endangered species in 2012. Living up to 70 years and growing up to 400 pounds, adult Atlantic sturgeon were popular fish for Native Americans and the European settlers who came after them.

"By the 1800s, about 75 percent of the stocks on the East Coast were wiped out," Savoy said. Since receiving endangered species status, more

researchers have been looking for—and finding—Atlantic sturgeon in rivers and estuaries along the Atlantic coast, with the Hudson River population standing out as the most robust, Wirgin said. The fish spawn and live the first few years of their lives in rivers, then swim into the ocean to spend the next 20 years until they reach sexual maturity and return to the rivers to lay eggs. In the intervening years, sturgeon travel a wide area, usually swimming south in the winter and north in the summer.

In the Thames River in Groton, a juvenile Atlantic sturgeon found in 2015 swimming offshore from the Naval Submarine Base had a transmitter that showed he had come from the south shore of Long Island. Savoy concluded that fish was probably a summer visitor that found his way into the Sound, then into the Thames River in search of food.

A juvenile sturgeon caught in 2014 in lower Connecticut River by Tom Savoy, fisheries biologist with the state Department of Energy and Environmental Protection, is seen in this photo. Photo: Tom Savoy



“Atlantic sturgeon go everywhere,” Wirgin said, noting that a population in the Baltic Sea was found through genetic analysis to have originated in North America. Still, when he began analyzing the Connecticut River tissue samples, he said, he expected to find that the young fish were genetically related to sturgeon from the Hudson River or the Kennebunk River in Maine, since adults from both waterways had been tracked swimming into Long Island Sound with transmitters implanted by researchers.

Or, he thought, perhaps they were a remnant native population that had survived in the Connecticut River after researchers thought they had all disappeared. “But these fish look very different from Hudson River fish,” he said, and bore no similarities that would mark them as remnant Connecticut River fish.

Instead, he said, “they look most like fish from the Chesapeake Bay, South Carolina and Georgia.” Atlantic sturgeon are divided into five “distinct population segments” or subspecies—each with unique genetic characteristics found in a specific geographic area. Perhaps, he said, some “colonizers” from these southern areas swam into the Sound, then found appealing spawning habitat in the Connecticut River. “It could keep happening,” he said. “We should monitor to see if there are future colonization events in the Connecticut River.”

“It’s a very important finding,” said Wirgin, who is making final revisions to an academic journal article that soon will be published about the results. “Number one, it shows that there is successful reproduction going on in the Connecticut River. Sometimes you think a fish is gone from a river because you don’t know where to look,” he said.

Jennifer Goebel, spokeswoman for the Greater Atlantic Fisheries Office of the National Oceanic and Atmospheric Administration, said the discovery of spawning Atlantic sturgeon in the Connecticut River is significant for the survival prospects of the endangered fish. “We are very excited about the potential to be spawning there, since we didn’t know they were there,” she said. “It will need some more research, but it is great news.” She said her agency is developing a proposal to establish “critical habitat” areas to enhance protection of the fish.

The Connecticut River is one of the areas that would receive the designation. “What that would mean is

Let’s celebrate the first time the Connecticut River has had an independently spawning Atlantic sturgeon population in a century! As a result of this research funded by Connecticut Sea Grant, the management strategy for this population may be reconsidered with the knowledge that it is distinct from its neighbors.

that, if someone wanted to do a dredging or construction project on the river, they would have to figure out how to minimize impacts,” she said. The plan is slated to be completed in 2017, she said. The issue of impacts on sturgeon arose during the construction of the new Tappan Zee Bridge over the Hudson River in New York. Last year, the environmental group Riverkeeper petitioned the National Marine Fisheries Service, a branch of NOAA, to examine whether the bridge work had caused the deaths of 122 sturgeon since construction began in 2012.

For his part, Savoy is eager to continue searching for young sturgeon in the Connecticut River, hoping to discern whether the fish he found in 2014 were a small, isolated population from a one-time, out-of-state visitor or part of a larger migration trend. With bony plates like swordfish and fang-like sensory barbules on the lower jaw to help find worms, mollusks and ghost shrimp in the sediment, Atlantic sturgeon are a unique species he doesn’t want to see go extinct.

“They have mouths like vacuum cleaners that pull worms and ghost shrimp out of long burrows,” he said. “Since we’ve found they’re spawning here, we need to consider that anytime there’s construction or dredging at marinas.”

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"Our analyses suggest that salinity significantly suppresses rates of denitrification; and that this may be mediated by interactions between salinity, organic matter content, and manganese concentrations."

– Ashley Helton

Urban wetlands on the edge – a salty conversation

by Peg Van Patten

Coastal wetlands are literally at the edge of sea level rise, as the changing interface between land and sea. As sea level continues to rise, it is more important than ever to have resilient wetlands that will serve not only in providing essential productive wildlife habitat, but also in buffering storms from inland communities, removing water contaminants, storing carbon, and other important functions. However, those peaceful looking grassy wetlands and their inhabitants are in an epic struggle to maintain stability and survive. The formidable, even inexorable, opponents are sea level rise, coastal flooding and erosion from storms, and the effects of adjacent land development.

Some marshes are able to migrate landward, depending on elevation, development, and other factors. Globally, some researchers estimate that as much as four-fifths of the world's wetlands are at risk of disappearing. Sea-level rise is predicted to threaten 50 to 97% of high marsh habitat in Connecticut by the year 2100.

Ashley Helton, assistant professor of Natural Resources and Environment at University of Connecticut (UConn), asked how we can identify which wetlands are capable of performing the most critical functions, and which are most susceptible to increased salinity. Little is known how wetland ecosystem functions are changing under the conditions of both urban development and saltwater intrusion from sea level rise. Finding answers would make it easier to identify target wetlands for restoration. Partnering with Timothy Vadas, assistant professor of UConn Civil and Environmental Engineering, she was successful in getting Sea Grant to support a research project initiated in 2014.

With the help of April Doroski, an enthusiastic UConn graduate student (featured on our cover), Mary Zawatski, an undergraduate student in Environmental Science at UConn, and two high school students in community

projects for the Natural Resources Conservation Academy, they set out to find out answers. The approach uses geospatial information, field surveys, and lab experiments to investigate restored and reference tidal wetlands across a salinity gradient. In 2015 they sampled soil in 32 coastal wetlands (restored and reference) in Connecticut with varying salinity and levels of contaminants from nearby urban areas.

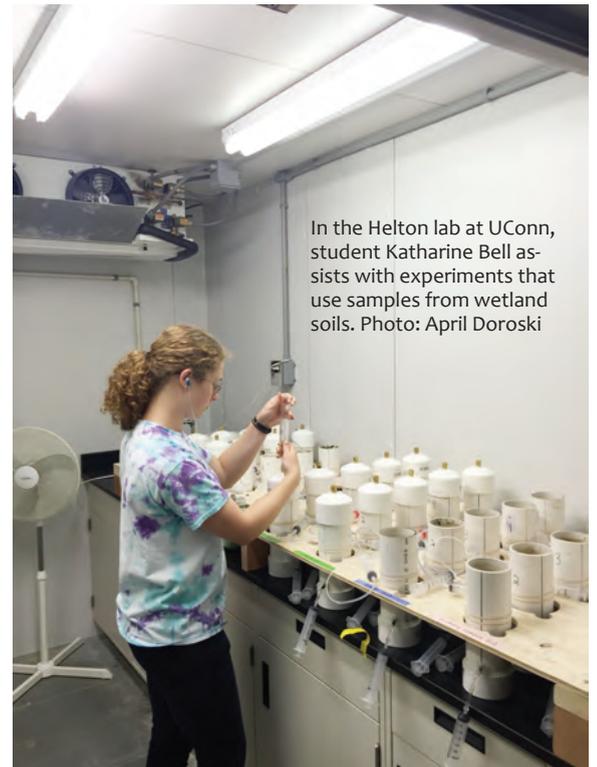
Naturally, each wetland is unique, and each has its own set of conditions, characteristics, and challenges. The team focused on the wetlands' ability to convert reactive nitrogen and retain certain common urban metal contaminants (copper, lead, and zinc) as primary ecosystem functions.

"When wetlands have the capacity to retain these metals and nutrients, downstream water quality will likely improve," said Helton, "At the same time, these wetlands may be particularly sensitive to saltwater inundation in urban landscapes, and we need to know how that works."

The team took the samples back to the lab, and analyzed them for denitrification (a process in which microbes convert reactive nitrogen to atmospheric gas), soil nitrogen content, salinity, metal content, and chemical properties that indicate the measure of a soil's capacity to retain metals and nutrients. They measured several other parameters such as pH, carbon mineralization, and organic matter content, Doroski said.

"Our analyses suggest that salinity significantly suppresses rates of denitrification; and that this may be mediated by interactions between salinity, organic matter content, and manganese concentrations." Helton said.

The results from the 2015 field survey aided in planning the ensuing experiment this year in which Doroski applied variations of



In the Helton lab at UConn, student Katharine Bell assists with experiments that use samples from wetland soils. Photo: April Doroski

saltwater and runoff treatments to soil cores collected from a freshwater wetland.

"The goal of our experiment was to disentangle the effects of both runoff and saltwater intrusion on freshwater wetland ecosystem functions like greenhouse gas emissions," Doroski explains. Preliminary results indicate increasing nitrous oxide emissions in soil cores receiving saltwater treatments. This suggests saltwater intrusion may increase greenhouse gas emission of nitrous oxide, which has a global warming potential 298 times that of carbon dioxide.

With field survey and experimental data combined, Doroski and Helton hope to better identify how coastal wetlands will respond to rising sea level, especially in urban landscapes. This information can be useful for land managers and agencies interested restoring or protecting wetlands to improve downstream water quality or balance greenhouse gas emissions, while also taking into account effects of sea level rise.

Sea Grant celebrates its 50th anniversary



NOAA Sea Grant is a federal-state partnership that turns science into action to ensure that our coastal communities remain engines of economic growth in a rapidly changing world. There are now 33 Sea Grant programs in every coastal and Great Lakes state, plus Puerto Rico and Guam. This year, through March 2017, Sea Grant celebrates its 50th anniversary of putting science to work for America's coastal communities. In the next 50 years, Sea Grant's expertise and place-based support will become even more vital as America's coasts face new environmental challenges.

Over the past 50 years, Sea Grant's research, education, and outreach activities have encompassed diverse issues relevant to local, regional, and national priorities, such as healthy coastal ecosystems, resilient communities and economies, sustainable fisheries and aquaculture, and environmental literacy and workforce development. In Connecticut, the state program has only been around for 30 years; it's a small but very strong program.

Sea Grant is unique in its ability to quickly transfer research to application. Nationwide, 350 extension agents share science and tools that have improved the environment and economy of coastal and Great Lakes communities.

Over the last 50 years, the U.S. coastal population doubled in size. In 2010, 123.3 million people, or 39 percent, of the nation's population lived in counties directly on the shoreline. Since its inception 50 years

ago, Sea Grant has been on the ground in coastal communities across every coastal and Great Lakes state and Guam, the Marshall Islands, Micronesia, American Samoa, Puerto Rico, Korea, Japan, and the U.S. Virgin Islands to listen to needs, respond with science, and transfer new information into products people can use.

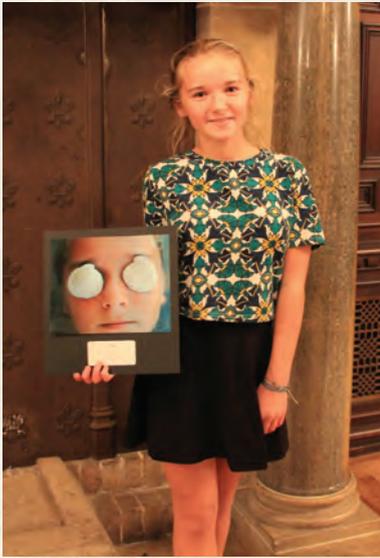
Coastal economies are a driving force for the economy of the nation as a whole, and Sea Grant is an important part of that. Sea Grant creates or sustains an average of 9,300 jobs and 2,825 businesses each year in growing and innovative industries including aquaculture, recreation and tourism.

Sea Grant has provided fellowships to more than 1,000 John A. Knauss Marine Policy Fellows since the fellowship began.

Sea Grant programs draw on more than 3,000 scientists, engineers, law and policy specialists, public outreach experts, communication professionals, and educators from more than 300 institutions across the country.

To watch a video about what Sea Grant does for the nation, see <http://s.uconn.edu/sg50>





Lili Kane, age 13, holds her entry for the youth shellfish art contest.



Informative table displays were appreciated at the event.



UConn Vice President for Research Jeff Seemann talked about the new shellfish plan.



Mary McKenzie's painting, "Clams" was the winning art contest entry.

The Connecticut Shellfish Initiative launched its implementation phase with a celebration on October 20, at UConn Avery Point's Branford House.

Here are a few photos of the occasion.



Jim Bloom, of Norm Bloom and Son, talks about his family's multi-generational business.



“For the first time in history, gardening has taken on a role that transcends the needs of the gardener.”

Doug Tallamy, *The Backyard Revolution*

“Ecosystem services are goods and services of direct or indirect benefit to humans that are produced by nature: clean water, clean air, crop pollination, climate regulation are just a few. These natural assets are traditionally absent from society’s balance sheet.”

Wikipedia, USFS



“Unlike buildings that typically depreciate over time, high-performance landscapes appreciate in value by continuing to provide a variety of benefits to a community such as conserving resources, managing stormwater, cleaning air, reducing urban heat islands, and improving human health and well-being. Sustainable landscapes can create ecologically resilient places better able to withstand and recover from episodic floods, droughts, wildfires, and other catastrophic events.”

Danielle Pieranunzi, Director, Sustainable SITES Initiative

Native plants can satisfy our need for beauty, while also growing sustainably with few inputs, once established. This group of asters, joe-pye weed and sneezeweed grow wild on the banks of the Salmon River in East Haddam. Photo: Judy Preston



Native plants and coastal resilience

This is not your Grandmother's Garden

By Judy Preston

More than a pastime, today's gardens have the potential to fulfill a wide array of societal needs and can be a tangible way to address environmental degradation and climate change in our own backyard. Particularly in coastal communities where the prospect of rising seas, more frequent and intensive storm events, and changing precipitation patterns has added greater urgency to the need for coastal resiliency planning, engaging residential homeowners in viable solutions is needed more than ever.

In addition to providing curb appeal, residential gardens and landscaping can be key tools to reduce the damaging impacts of floodwaters. How they are maintained can not only stem the misuse of vital resources such as water but can protect water quality, store carbon as a hedge against climate change, provide critical

urban wildlife habitat, and even improve our mental health.

While plants are the backbone of these collective benefits not all plants provide equal services, particularly relative to wildlife habitat and the resources necessary to sustain important insect pollinators. Native plants are key to providing the type of food and resources that wildlife and insects need when they need them. When plants and animals have evolved together over long periods of time they establish time-honored interdependencies that can be lost when one or the other is subtracted from the landscape. Rick Darke and Doug Tallamy, a horticulturist and entomologist who joined forces to write *The Living Landscape*, define native as: "a plant or animal that has evolved in a given place over a period of time sufficient to develop complex and essential relationships with the



Low impact design includes the use of porous pavement that permits rain water to infiltrate into the ground. Photo Judy Preston

physical environment and other organisms in a given ecological community." As urban gardens take on increasing roles as stepping stones for both residential and migratory animals, the type of plant material available makes a difference. This is especially true as human landscapes continue to be impacted by non-native invasive plant species that can significantly diminish wildlife habitat.

Rain as a Resource

Our build-out landscapes containing roads, rooftops and parking lots have been designed to whisk away rainfall as quickly and expediently as possible. Gutters and downspouts connect to driveways and streets where curbs channel these streams of water to the nearest storm drain, after which most of us no longer consider its

collective endpoint: Long Island Sound. While the management of stormwater is a public safety issue, particularly in our increasingly urbanizing state, it has disconnected many of us from the values of rainfall.

The popularity of rain barrels has drawn attention to the passive reuse of rainwater. Sustainable landscaping can help emphasize not only the reuse of water, but also the ability of vegetation to slow down, infiltrate, and even help clean floodwaters. What storm waters pick up from the residential landscape – fertilizers, pesticides, petroleum byproducts, and animal waste among them – can be trapped, consumed, modified, even volatilized, by plants.

As future storms become more intensive, landscaping plants and streamside buffers can provide a “first responder” resource to help mitigate the impacts of excess, and polluted, water.

As we have recently experienced in the Northeast, and other parts of the country have come to know all too well: a changing climate can make drought and water shortages a potentially too common occurrence. By using plants – in gardens, vegetated roadside swales, and even green roofs, as well as other “low impact design” tools, rain water can be allowed to recharge groundwater and aquifers, maintain the base flow of our local streams and rivers, and help offset the dry conditions brought about by drought.

Gardens and the Birds and Bees

A bird’s eye view of our developed shoreline would quickly reveal the extent to which the natural landscape has been altered by development over time. To residents, these are neighborhoods, to birds, particularly migrants, these are too often ecological deserts. How our landscapes – our gardens, lawns and public spaces – are planted and maintained can make a huge difference to resident and migratory animals.

Chances are, you have never thought of your garden – indeed, of all of the space on your property – as a wildlife preserve that represents the last chance we have for sustaining plants and animals that were once common throughout the U.S. But that is exactly the role our suburban landscapes are now playing and will play even more in the near future.

– Doug Tallamy,
Gardening for Life



This ferocious looking insect (right) is actually a ladybug larvae that preys on aphids (left), helping to keep the balance in a natural garden. Photo: Judy Preston

Doug Tallamy, the icon of sustainable gardening with insects in mind, believes that we are at the cusp of a revolutionary way of thinking about our gardens: suburban and urban yards and landscapes CAN make a difference. At the heart of his advice is planting the native plants that are essential to insect lifecycles that in turn fuel many food webs.

The extent of land converted to housing developments may

also provide the opportunity for neighborhoods to create the very linkages that animals – and plants – need to support viable populations, or assist migrants on their journey to or from their nesting grounds. Suburbia could become the connectors between dedicated open spaces.

You need only put “wildlife gardening” into your computer’s web browser to see the heartening array of initiatives that have come to light espousing the virtues of gardening with native plants to sustain wildlife. Who hasn’t delighted in seeing spring Cedar Waxwings descending on the remains of last year’s cranberry bush fruits, or Monarch butterflies drifting between clusters of planted milkweed plants in the fall? Although the general public has a simplified ideal of acceptable insect life – hence the success of nationwide efforts to plant milkweeds for Monarchs, most gardeners are tacitly aware of the importance of insects to productive gardens.

More than a Pretty Face; an evolving garden aesthetic

Making the shift from our “Grandmother’s Garden” to the resilient, diverse and ecologically meaningful garden needed for an uncertain climate future is not an easy challenge. Despite faith in the average citizen’s willingness to “do the right thing” for the planet, one of the greatest challenges will be letting go of a diehard aesthetic that is antithetical to wildlife habitat. Truly native plants – local genotypes – are unlikely to satisfy what the average gardener has come to expect: big color and lots of it, robust and consistent growth, and predictability.

But beyond this, the home landscape can take on elements of a more sustainable natural plant community. Sustainable gardens can include a greater diversity of plants, planted in drifts and in numbers that more closely replicate how nature colonizes natural landscapes. Adding layers to our gardens – small trees, shrubs,

ground covers that replace wood chips with a “living mulch”, and even vines – can attract wildlife, particularly birds that often make use of separate zones in natural communities. Using shredded leaves as garden mulch feeds soil life (the backbone of sustainable gardens) and provides habitat for overwintering insects; it can also reduce the labor (and leaf-blower noise) of removal. In nature, plants move around through the time-honored process of cross pollination and seed distribution by birds, small mammals and multitudes of ants, among other things. When flower stalks are allowed to overwinter in place they provide the infrastructure for insects such as praying mantis egg cases, and nascent seeds for overwintering birds and small mammals.



On the High Line in New York City, native plants provide refuge for people – as well as insect pollinators. Photo: Judy Preston

Is Nature Optional?

According to the United Nations, 54 percent of the world’s population lives in urban areas, and that number is expected to increase to 66 percent by 2050. There is a large and growing body of information that points to the importance of nature to people: everything from visual to physical access to nature has been shown to dampen anxiety, anger and

depression as well as elevate feeling of satisfaction and pleasure. Exercise outdoors in nature is not only popular, but has been shown to have greater benefits to mental well-being compared with exercising indoors.

The tremendous appeal of the High Line, New York City’s elevated freight rail line that was transformed into a public park in 2014, is in part due to the attraction of its naturalized plantings (inspired by the landscape that grew on the abandoned tracks), as well as the views of the Hudson River. The more urbanized our landscape becomes, the greater role our local gardens and residential landscapes can play in providing benefits to human health and well-being.

What’s at Stake: resilient gardens and Long Island Sound

We know a lot more today than we ever have about the extent to which our gardens and home landscapes are using, abusing and losing fertilizers, pesticides and water. More land in the United States is planted in turf than in irrigated corn, our largest crop, and the maintenance of those lawns uses extraordinary amounts of nitrogen-rich fertilizers, herbicides, pesticides, and water (most of it potable). Even the equipment that is used to mow and blow our lawns consumes fossil fuels that are known to contribute to climate change.

The water that leaves our suburban and urban landscapes laden with the products used to keep our flowers blooming and lawns emerald green contribute to the same problems that plague estuaries worldwide: hypoxia, or too little oxygen in the water. Nitrogen that arrives via storm water into Long Island Sound fuels a short-lived cycle of algal growth and, when the nutrient concentration dissipates, death. In addition to the nuisance growths of these algae, the decomposition of their unsustainable

***Mycobacterium vaccae*, a microbe that lives in soil, has been found to activate the release of brain serotonin, a known mood elevator.**

numbers is what ultimately robs oxygen from the bottom waters of the Sound. The result – out of sight from our backyards – is a shifting and sometimes massive area in Long Island Sound (particularly the western end) where marine life is stressed. Add to this the increasing pressures from a changing climate and it’s not hard to see that the cost of traditional landscaping practices may not be ultimately affordable.

“Sustainability” and “resilience” are the catch phrases of our evolving understanding of what it means to be prepared for change in a time of uncertainty. What greater model could we seek than the natural resiliency of native plants and natural communities that have learned to adapt to the vagaries of changing conditions over the long haul of geologic time? Nature-based solutions are right in our backyards.



Fruits that are not consumed from the American Cranberry bush in the fall will overwinter and provide a coveted source of energy for migrating birds in spring. Photo: Judy Preston

ABOUT THE AUTHOR:

Judy Preston is outreach coordinator for the EPA Long Island Sound Study.

How we maintain our backyard landscapes can be a tangible way to stem the tide of environmental degradation that impacts Long Island Sound. Photo: Judy Preston



In Connecticut, we are all in the Long Island Sound watershed. That means that practices in our own backyards are directly tied to the well-being of Long Island Sound. Even our winter gardens, if left intact until spring, provide important habitat for insects and wildlife. Resist the urge to “clean” what the growing season has produced. Overwintering insects can provide critical resources for birds, in particular. Photo: Judy Preston



RACHEL CARSON'S RISING SEA

by Rachel Earnhardt

At dusk, as sky and sea became one shade, I sat re-reading one of my favorite books with my back against the Mystic Seaport lighthouse. For a visual, picture your stereotypical eco-conscious millennial: well-worn jeans and second-hand sweater, green sandals, reusable water bottle. I got stuck on the line: “We live in an age of rising seas.”

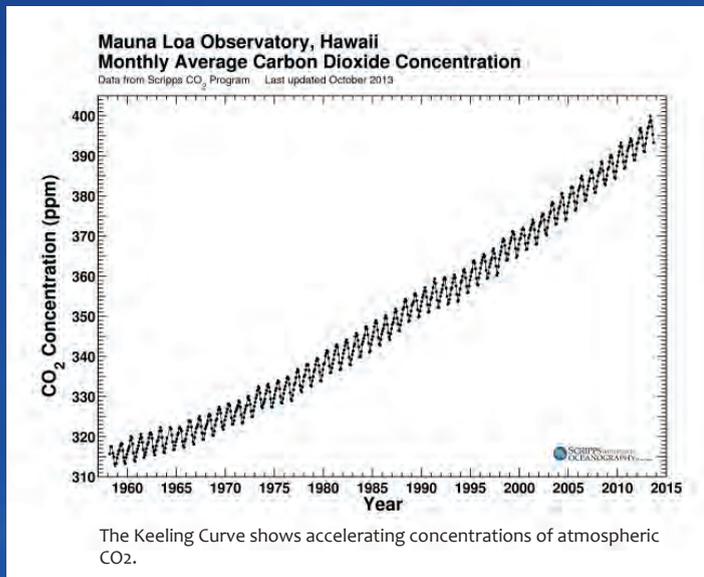
In 2016, this sentence is a matter-of-fact, albeit concerning, observation about a defining consequence of anthropogenic climate change. Coastal communities all around the country are taking action to respond to the reality of rising seas. Scientists, like those at Connecticut Sea Grant, are measuring and monitoring the impacts of encroaching sea water on ecosystems. Educators and communicators are working to translate the science and urgency of climate change for the public.

It might be surprising that the book in my hands was not a recent publication, but rather Rachel Carson's *The Sea Around Us*. Published in 1951, the book came out several years before there was scientific consensus or public awareness about anthropogenic climate change. Reading it now, this line, which opens Carson's “The Shape of Ancient Seas” chapter, seems ominously prophetic.

I am a 21-year-old environmentalist in the 21st century. In my lifetime, the scientific and environmentalist communities have largely taken anthropogenic climate change as a given. And thus, I cannot help but read Carson's discussion of rising seas through a modern lens. With her sea trilogy, Carson took readers below the water's surface and inspired a generation to care about the 70 percent of the world that is blue. Then with her monumental *Silent Spring* (1962), she articulated the dangers of indiscriminate applications of pesticides and helped to catalyze the modern environmental movement. In addition to all this, was Rachel Carson also prescient about anthropogenic climate change as the driver of sea level rise?

Rachel Carson in front of the fishing vessel Bernice in Woods Hole, 1951.
Photo: Yale University

continued on next page



The short answer is no. What might be surprising and significant, however, is that Carson, in her final years, likely did have contact with early research about connections between fossil fuels, atmospheric CO₂ and global climate change. Carson was a contemporary of scientists Roger Revelle and Charles Keeling, who had begun to document concentrations of atmospheric CO₂ and explore its climate implications. Just as any discussion of environmentalism today cannot occur without mention of climate change, no history of the environmental movement could exist without the contributions of Rachel Carson. Ultimately, this article seeks to put Rachel Carson into context within the broader history of anthropogenic climate change science and awareness. But before that, let us begin with some context for the woman herself.

The Woman with a Sense of Wonder

Given her land-locked origins, Carson was an unlikely ocean hero. Born in 1907 on a farm in Springdale, Pennsylvania,



A steamboat similar to the one Rachel Carson would have taken for her first trip at sea, traveling through Long Island Sound to Woods Hole.

she did not meet the sea formally until after she had graduated from Pennsylvania College for Women (now Chatham University) in 1929. We know from her letters that in late July, while traveling to a research position at Woods Hole, she boarded an evening passenger ship at New York Harbor, bound for New Bedford. At the time, nearly all of these passenger ships traveled up the East River and through Long Island Sound, so Carson's first experience at sea was almost certainly in the Sound.

By this time in her life, she had already developed a deep curiosity and appreciation for the sea through her study of marine science and early exploration of maritime literature. After receiving a master's degree in zoology from Johns Hopkins University for her thesis on catfish, Carson worked for 15 years at the U.S. Bureau of Fisheries. As a staff writer and eventual chief editor of publications, she wrote science communication articles of a similar nature to those produced in *Wrack Lines*.

Carson began her elegant sea trilogy with *Under the Sea Wind* (1941). In the late 1940s, she transitioned away from the Bureau of Fisheries into her own writing full time, and penned *The Sea Around Us* and *The Edge of the Sea*. This year marks the 75th anniversary of Carson's first book, *Under the Sea Wind*, which follows the lives of different species: a sanderling, a mackerel, and an eel. Although *Under the Sea Wind* animates a diverse array of sea life, the ocean ultimately proves the principal character and the last voice. In the final sentence, Carson writes: "For once more the mountains would be worn away by the endless erosion and carried in silt to the sea, and once more all the towns would belong to the sea." This powerful evocation serves as a reminder of the enduring power and patience of the ocean.

Her next book, *The Sea Around Us* (1951), translates the geological, biological, and chemical processes of the ocean for a popular audience. It catapulted to the bestseller list, where it remained for an unprecedented 86 weeks. In the wake of *The Sea Around Us*, *Under the Sea Wind* too experienced a prominence unknown after its initial publication. In December 1941, national attention had turned suddenly to the Second World War in the wake of the surprise Japanese attack on Pearl Harbor, leaving *Under the Sea Wind* to favorable critical reviews, but slim readership. Carson completed her sea trilogy in 1955 with *The Edge of the Sea*. Carson captivated her audience with her lyrical writing and crisp scientific explanations.

Climate Change and Carson

While her writing is still as informative and transcendent as ever, we return to her work here specifically because her commentary on the rising sea and warming climate is particularly relevant for twenty-first-century readers. Connecticut Sea Grant extension educator Juliana



Rachel Carson with Bob Hines in the Florida Keys, gathering information for *The Edge of the Sea*, 1955. Photo: Rex Gary Schmidt, Rachel Carson Council

Barrett emphasizes that contemporary “changes due to climate impacts reinforce how connected our ecosystems are,” demonstrating that the ecological interconnectedness that Carson so championed remains essential. Although Carson did not have the same data or insights we do today about anthropogenic climate change, she reports clearly and precisely about rising sea levels and warming trends. In *The Sea Around Us*, Rachel Carson explains: “Along all the coasts of the United States a continuing rise of sea level has been perceptible.” In a 1953 paper entitled “The Edge of the Sea” that she presented at the American Association for the Advancement of Science Symposium, Carson announced a warming climate: “Now our climate is changing and we are moving into a warming cycle of unknown duration.” Carson certainly did understand and write about natural cycles of change over the preceding millennia, but her observations of real-time changes are now understood to be unique. Only in recent decades have the warming temperatures of the past century and rising seas been unequivocally attributed to the burning of fossil fuels. But scientists now believe the rising seas and warming climate Carson described were likely part of undiagnosed anthropogenic climate change.

While in agreement that climate change is a tangible problem now, many scientists and scholars are

understandably reticent to assign an exact date to the start of anthropogenic climate change or the moment of consensus in the scientific community. While it may not be necessary to pinpoint such a date, it is important to understand that climate scientists had been making observations and testing predictions about atmospheric carbon well before the twenty-first century. Even nineteenth-century scientists were exploring the influence of carbon on the atmosphere and its relationship to global temperatures. In 1896, Swedish scientist Svante Arrhenius made predictions of warming as a result of increasing CO₂. In 1958, Charles Keeling began monitoring levels of atmospheric CO₂ from Mauna Loa Observatory in Hawaii. Over the next decades, he plotted the results on the now famous “Keeling curve,” which shows an accelerating increase in atmospheric CO₂ concentration and is often cited as one of the first confirmations of a changing atmosphere. Keeling’s colleague, Roger Revelle, director of the Scripps Institution of Oceanography, was part of a team that released the seminal Conservation Foundation report in March 1963 that posited a connection between the accelerating levels of carbon dioxide and the amplified greenhouse effect. The report made grave (and ultimately accurate) predictions that such warming would result in melting glaciers, rising seas and flooding of low-lying areas.

According to the president of the Rachel Carson Council, Robert K. Musil, Carson worked with and was aware of reports from the Conservation Foundation and the work of Revelle and Keeling. Carson lost a battle against breast cancer

in 1964, before she could join the early discussions about the significance of rising CO₂ concentrations and the role of fossil fuels.

Reading Carson in Today’s Climate

In her high school senior thesis, titled “Intellectual Dissipation,” Carson writes what can only be described as a love letter to books: “None of us can be wholly indifferent to the power of books. All that is great and worthwhile in the noblest minds of the ages is stored up in their covers. Thru them we can make the acquaintance of wise men and philosophers, of kings and emperors. Is there something you wish to know[...]Then turn to your bookshelf.”

Carson has, of course, established herself as one of those noble minds, proving that we should make acquaintance with wise men *and* women. When we turn to our bookshelves and turn the pages of her books, we find observations of a changing climate and rising seas from the mid-twentieth century perspective. As a student of history, I hesitate to superimpose contemporary knowledge onto thinkers of the past. Certainly, it would not be precise or productive to assume that Rachel Carson possessed a prescient insight into anthropogenic causes behind the climate change she observed. Her comments on the rising seas and warming atmosphere do at least highlight that anthropogenic climate changes were perceptible even before it was connected to the burning of fossil fuels.

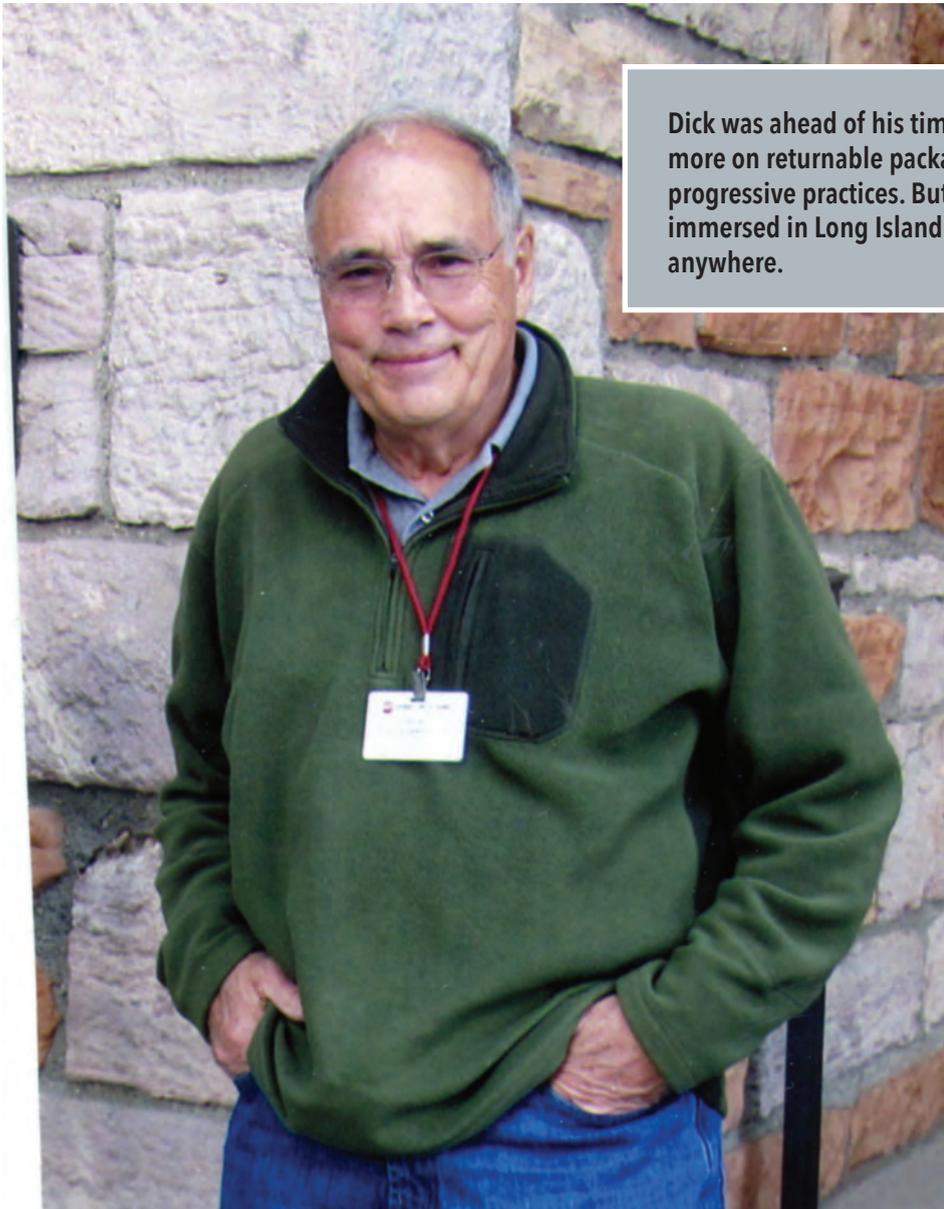
Although the challenges plaguing the earth and ocean continue to change, Carson’s voice and work remains constant, like a well-tended lighthouse, offering both warning and hope.



ABOUT THE AUTHOR:

Rachel Earnhardt is a senior history and environmental studies major at Wesleyan University and Spring 2016 graduate of the Williams-Mystic Maritime Studies

Program. Her parents tell her she was named after Rachel Carson.



Dick was ahead of his time, trying to convince Shell to do more on returnable packaging and other environmentally progressive practices. But by then Dick had his feet firmly immersed in Long Island Sound and he wasn't going anywhere.

district manager in the early eighties. With Long Island Sound as his backyard, Dick began volunteering on weekends for an organization that was the forerunner to Save the Sound. Soon he was doing beach walks and giving talks. He taught classes for Cooperative Education Services to high school kids on the marine environment during the summer. He continued to expand his teaching assignments and at one point contacted Norwalk Connecticut oysterman Hillard Bloom to ask about taking students out on the oyster boats. Dick's whole teaching approach revolved around the interactive...very hands on. Instead of reading about how sewage treatment plants work, his students would visit one. Instead of just hearing about oysters in Long Island Sound, Dick's classes would actually go out on an oyster boat.

In 1992 Dick left Shell, turning down yet another promotion, this time on the environmental management side of the business in Houston. To the last, Dick was ahead of his time, trying to convince Shell to do more on returnable packaging and other environmentally-progressive practices. But by then Dick had his feet firmly immersed in Long Island Sound and he wasn't going anywhere. In 1986, along with a partner, he started Harbor Watch, a citizen-led, all volunteer water quality monitoring group. Harbor Watch is now part of Earthplace, a well-known, grass-roots environmental advocacy, educational, land conservancy group based in Westport, Connecticut.

Harbor Watch had humble roots. Dick started doing basic water quality tests up and down the Norwalk River: dissolved oxygen, salinity,

Meet Dick Harris

by Steve Plant

Dick Harris has always had a love of water and the animals that live in it. He grew up on a lake in Indiana and watched the progression of the plants and animals as the seasons came and went. Oddly enough, his first job was with an oil company... Shell Oil. But Shell also paid for Dick to receive a degree in Marine Sciences at Stonybrook University on Long Island.

Dick stayed with Shell through a couple of moves, ending up in Stamford Connecticut, working as a chemical sales

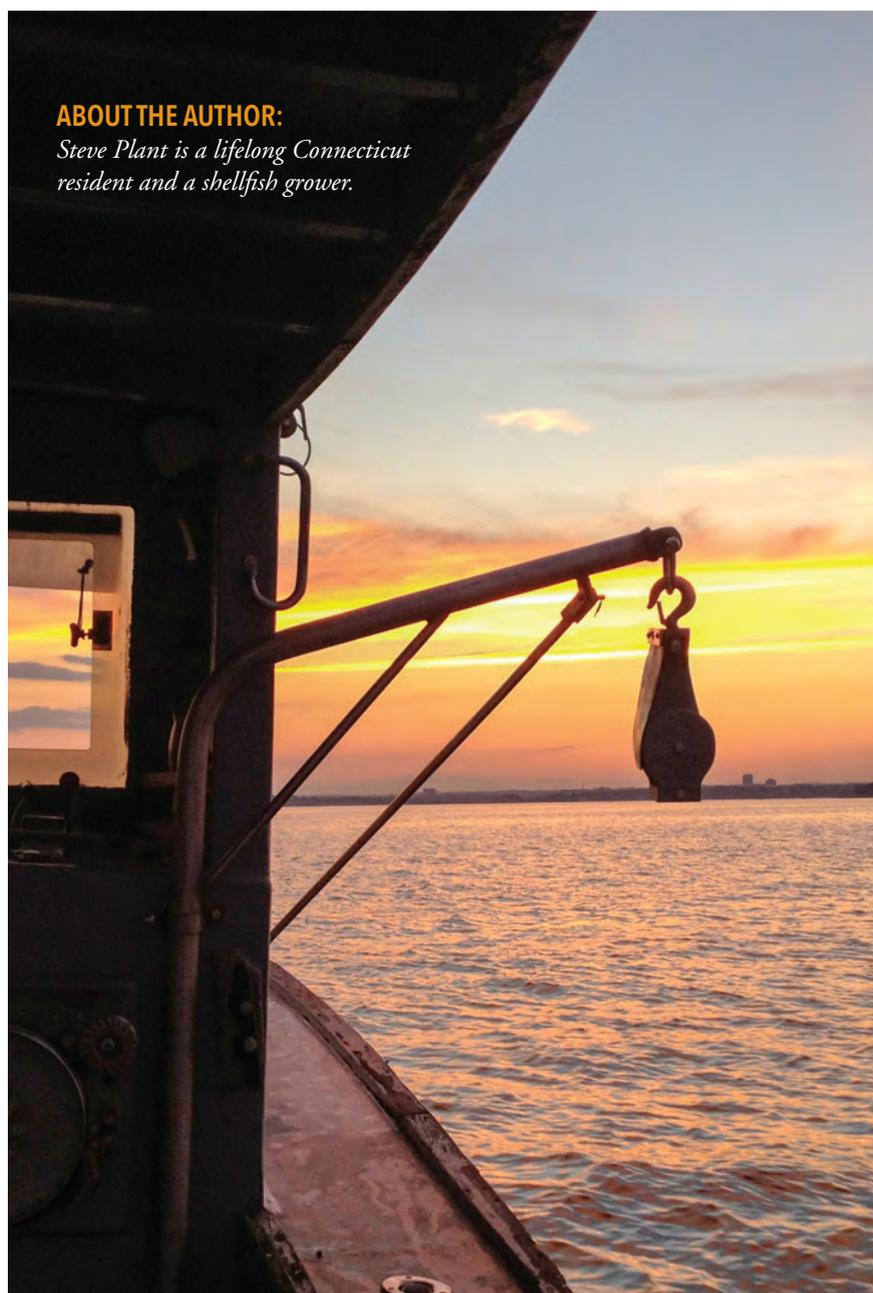
temperature...all with borrowed meters out of a 16' wood dory. With some grant funding (from Shell in fact) he was able to buy his own instruments. He expanded testing to include the Saugatuck River. Dick also began a long collaboration with state agencies and local public works departments. The Connecticut Department of Environmental Protection, which was also monitoring the Norwalk River, turned the job wholly over to Harbor Watch. They began to share data and results. Dick enlisted half a dozen volunteers through advertising in the paper, a couple who have been with Harbor Watch to this day! With his dedicated crew, Dick ran his tests once a week all summer long. Connecticut DEP continued to draw on Harbor Watch's enthusiasm, adding Sasco Brook in Westport to their testing program, and adding bacteria to the list of sample parameters.

As the workload grew, Dick realized they needed a fixed location to process the increasing volume of water samples. They set up a certified lab at the Nature Center in Westport, and added yet another watershed, the Five Mile River, to their list of collection sites. Doing bacteria samples opened up a whole new world of involvement for Harbor Watch. Unlike temperature or salinity, bacteria are an introduced factor. Bacteria come from human or animal waste, and are responsible for excess nutrients in the estuary. Excess nutrients can cause harmful algal blooms which can overwhelm the marine environment and seriously degrade water quality. Testing various sites along these multiple watersheds allowed Dick and his crew to identify specific sources of pollution, whether they were leaking septic systems, broken sewer pipes or storm drains. As it turned out, a handful of the storm drains ran water all the time because of underground springs and seeps. Many of these had a regular flow of sewage from adjacent broken sewer lines. They began to pass this information on the various town public works departments who could then get the problems fixed. Working with the towns, Harbor Watch was able to track these bacteria "plumes" back up the storm drain to the original source. The town could then use their camera truck to find the exact point of the problem. Ralph Kolb at Norwalk Public Works was instrumental in facilitating the follow-up and repair work. All of this effort began to have a cumulative positive impact on water quality in Norwalk Harbor. Dick has even worked with the U.S. EPA to confirm through pharmaceutical testing that bacteria sources they were detecting had human origins.

In 2014 Dick left Harbor Watch in good hands. By then they were surveying about 250 sites in 10 watersheds that drain into Long Island Sound, and they were looking to expand their operations to include other towns along the Connecticut shoreline.

He has since joined up with Norm Bloom and Son to continue his work, monitoring water quality, trying to figure out how each of the river and estuary systems work in processing nutrient loads and contaminants. He is currently in the process of expanding his laboratory capacity at the Bloom facility in East Norwalk.

At 77 years old Dick still has the enthusiasm of a school kid when he talks about his most recent discoveries. Over the past 30 years he single handedly has done more to improve southwestern Long Island Sound water quality than anyone... all through a bottom-up approach of grass-roots, community based activism. With little fanfare he has helped form a unique partnership between municipalities, concerned citizens and the shellfish industry, to improve Long Island Sound water quality and the quality of life for the people of southwestern Connecticut.



ABOUT THE AUTHOR:

Steve Plant is a lifelong Connecticut resident and a shellfish grower.

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