WEST END NATURAL RESOURCES NEWS

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SPECIAL SCIENCE ISSUE

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Getting the Scoop on Scat: River Otter Diets in Makah Bay

By Bobbie Buzzell, Western Washington University

A European green crab caught during the 2019 trapping season.
Photo: Bobbie Buzzell

I remember the first European green crab I saw, beautiful and distinctive, but also intimidating – its reputation preceded it. It was hard to believe this single species of crab could be the reason for such concern within natural resource departments across Washington state. The European green crab is an invasive shore crab (native to Europe as the name suggests), and its arrival into our state's waters over the last few decades poses a serious threat to native flora and fauna along the outer coast and inland waters.

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Teaching During the Pandemic (Covid-19)

By Alice Ryan, Quileute Tribal School

I was asked to write about teaching during this crazy pandemic year. The following is a disjointed mess of emotions, situations, and regular daily experience to...pretty accurately, sum it all up.

River otter swimming.
Photo: Courtesy of CuriOdyssey Science Playground and Zoo

01.

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Getting the Scoop on Scat: River Otter Diets in Makah Bay

By Bobbie Buzzell, Western Washington University

When green crab establish and reproduce, they can severely harm local habitats, which is why the sight of even a single green crab is cause for concern.

On the Makah Indian Reservation, more than 3,700 green crabs have been trapped on the Wa'atch and Tsoo-Yess river estuaries over the last few years. Adrianne Akmajian, marine ecologist for the Makah Tribe, believes green crab are here to stay "…we are already seeing the young 2021 brood and have hand caught over 80 crabs… I suspect that in addition to the larvae that may come from other areas, they are reproducing locally here in Makah Bay." In high numbers, this voracious crab damages coastal eelgrass beds, and can cause declines in shellfish and native crab populations as seen in places on the East Coast. For the locals in Washington, shellfish lovers are worried about what this might do to the beloved (and valuable) Dungeness crab.

Currently, early detection and removal through trapping are the only forms of control for green crab. A lack of control options, coupled with a knowledge gap on how green crab could influence coastal ecosystems, leaves natural resource managers looking for answers. Some of those answers might include identifying the predators of green crab, which is what happened in 2018 when trapping efforts led to the discovery of a river otter latrine along the lower Wa'atch River. River otter latrines are communication hubs where this aquatic mammal routinely defecates, urinates, and leaves their scent. Adrianne describes coming across the latrine, "I had not planned for it, I immediately converted bags that were going to be used for green crab and began collecting river otter scats, just in case."

Alas, my master's thesis was born! Around the same time the latrine was found, I was looking to return to school to pursue a master's degree. I had previously studied river otter diet in the San Juan Islands, so I was already familiar with the fare of river otters in marine-coastal habitats and methods in scatology (the study of feces). My advisor at Western Washington University (WWU) connected me with Adrianne. One thing led to the next, and in early 2019 I was hired by the Makah Tribe and received approval from the Tribal Council to begin field

Bobbie Buzzell identifies crustacean remains with a dissecting microscope during the stay-at-home order.
Photo: Edward Hayes

European green crab trapping at the mouth of the Tsoo-Yess River.
Photo: Bobbie Buzzell

work collecting scats at several latrines on the lower Wa'atch and Tsoo-Yess rivers. My objective was to document river otter diet in the area of where green crab trapping takes place, with the hope of understanding the role of green crab in river otter diet.

From April through September 2019, I collected scats and prepared the leftover hard parts for identification. Collecting scat and identifying undigested remains (e.g., fish bones, crab shells) is a no-harm way to document diet. One piece of prey at a time, this method has been used for decades to understand connections between organisms. Identifying prey from leftover hard parts is like a jigsaw puzzle with a lot of missing pieces. A jawbone here, a crab claw there… With enough fragments, a full fish or crab can be identified.

It wasn't just me working on this puzzle though. I had help from other technicians and high school interns with the Makah Tribe that summer, and later undergraduate assistants at WWU. Could there be a more fun way to introduce students to ecology than teaching them about poop puzzles? Chaya Gaberria, one of my undergraduate assistants at WWU, wanted to learn more about mammals. She said the project " allowed [her] the opportunity to delve into the prey patterns of river otters and gain a deeper understanding of their diet." She also developed technical skills with microscopes and learned how to identify fish and crustaceans.

Then in March of 2020 the pandemic hit, and labs were either shut down or heavy restrictions were put in place, making the lab where I worked inaccessible. Due to the restrictions, I was unable to keep my assistants. Thankfully, scats and a microscope are fairly portable, so I brought scatology back to my humble abode. As summer approached, continued closures on campus meant my home would be my new lab. Despite these changes, funding from NPC MRC allowed me to finish crustacean identifications before the next school year started. Although I had enough experience to identify crabs and crayfish, I brought in an expert to identify the fish prey. But even he could be stumped! William "Bill" Walker has spent decades identifying prey remains from animal stomach contents and feces but

Bobbie unrolls a beach seine to look for fish specimens at the mouth of the Wa'atch River.
Photo: Elizabeth Allyn

described river otter diet as "an elaborate forensic exercise." He told me that part of the challenge with river otter diet is that they thoroughly chew their food into bits prior to ingestion. Despite how broken up the prey were, bones and shells were in good condition, which speaks to how quickly river otters digest their food.

As I worked through each scat, the optimism I had for river otters eating a lot of green crab slowly faded. There was a decent bit of Dungeness crab and crayfish, but only a handful of the 447 scats from latrines on the Wa'atch River contained green crab. No green crab were found in the 227 scats collected from latrines on the Tsoo-Yess River. This was disappointing, but since I could look at the whole diet of these river otters, the other jigsaw pieces would help me understand why so few green crab had been eaten.

If river otters aren't eating green crab, then what are they eating? The results were a bit overwhelming! While only a handful of prey items were found in more than 10% of scats, there were at least 50 different fish, crustaceans, and other miscellaneous prey groups discovered in river otter diet. Bill expressed his take on the complexity of river otter prey, "they will eat just about anything they encounter in their immediate environment."

Fish were the dominant prey type, and the most frequently found species was the saddleback gunnel, a small eel-like fish (maximum size about 10 inches) that commonly inhabits estuaries, tidepools, and eelgrass beds of the coast. What was most interesting about this fish though, was river otters frequently consumed it with many other gunnels. Some scats contained as many as 200-300 individuals! Similarly, other small fish prey like various sculpins (bottom-dwelling fish), starry flounder (flatfish), bay pipefish (cousin to the sea horse), shiner perch and three-spine stickleback (schooling fish) were frequently consumed in large quantities. "From an energetic cost standpoint, I believe it unlikely these fish were consumed individually", said Bill, "I suspect that individual otters are engaging in some form of feeding strategy that involves herding these

Bobbie collects river otter scats at one of the Tsoo-Yess River latrine sites.
Photo: Tom Moore

small fish into concentrations where they can consume multiple fish at a time."

Of crustacean prey, "young" (sub-adult) Dungeness crab were consumed more frequently on the Wa'atch River while signal crayfish were more commonly consumed on the Tsoo-Yess River. It was surprising that no green crab were eaten on the Tsoo-Yess despite there being more green crab trapped there than on the Wa'atch. Differences in green crab abundance between the two rivers were dwarfed by the overall abundance of Dungeness crab. In other words, Dungeness crab were overwhelmingly more common than green crab. I believe this was one reason why fewer green crab were eaten by river otters. Given what is known about river otter diet in other coastal studies, this is reasonable since otters choose prey opportunistically, consuming the most abundant and accessible of slow-moving prey.

When it comes to hunting, the river otters that made a "contribution" to this study are in a unique living situation. Not only can they forage in the lower and upper sections of the rivers, they also have access to the surrounding wetlands and shallow areas of Makah Bay. The range in their hunting grounds shows through in the vast array of fish and crustaceans they consumed. In human terms, it's comparable to the variety of cuisines one might find at a mall food court. You have Asian, Italian, sandwiches and subs – you name it!

However, if the green crab numbers continue to increase in Makah Bay, I predict green crab will be like the McDonald's of the 1940s, bound to be a staple at every food court in the future.

It's important to note though, green crab behavior might also be a reason why they are not frequent fare of river otters. Green crab are especially aggressive and river otters probably don't have the easiest time wrangling this feisty prey. From experience, I know green crab are good at hiding in the main river channels where river otters mainly forage. One of the best tricks for hand catching this crustacean is to probe and disturb areas around logs and driftwood on the bottom of the rivers, scaring green

A curious river otter forages among the kelp at Tatoosh Island.
Photo: Bobbie Buzzell

A prickly sculpin, a popular item on river otter menus.
Photo: Bobbie Buzzell

crab out of hiding. Perhaps river otters haven't caught on to this trick yet?

Very few river otter diet studies have been able to document diet in as extensive detail as this one has, and this information provides a lot of context for not only why green crab have a limited role in river otter diet but also what the role of river otters are in Makah Bay. Understanding the big picture of ecosystems starts with knowing how both prey and predators influence each other. Given the quantity of small crabs and fish river otters eat on a daily basis in Makah Bay, it's safe to assume they might provide balance to food webs in the estuaries, keeping prey populations "in check", and in turn may allow other animals to thrive.

River otters aren't the only ones consuming green crab though. Predators like shore birds, fish, and other crabs may be a cumulative defense against the growing threat. In fact, the red rock crab, a native crustacean to rocky intertidal zones on the west coast, has already proven to provide some resistance against this invasive crab. Supporting these predators and their homes could be key to reducing green crab. It's unlikely river otters on their own will end the impending invasion, but a robust community of predators will maximize chances to buffer impacts of green crab.

02. *(Continued from Page 1...)*

Teaching During the Pandemic (Covid-19)

By Alice Ryan, Quileute Tribal School

- It's early March 2020: China is experiencing this *Covid* thing; it is an epidemic. My students and I are playing a board game called "Pandemic" as a way of talking about this event going on across the sea…

- People are contracting it in the U.S. now… California has its first case of unknown origin that my students noticed. Washington state starts getting cases, a lot of cases. Seattle is a scary place to go, and where many of my students need to go for medical appointments. Each time they were nervous, and even more so coming back to the tribe.

- The arrangements are all made, finally: A major field trip planned for March 19th to our new school site. Grades 6 through 12 are all going. We're building the school to get our classes out of harm's way in case of a tsunami, and the field trip there is about watershed restoration. We have about seventy plants named and ready to plant; we're going to pull invasive weeds and do "Bonds Across the Water" (https://depts.washington.edu/i2sea/index.php?page=batw) activities including water quality testing and biodiversity data collection.

- March 14th. We are told to get Google Classrooms ready, and we teach our students how to access them while we were learning how to make them at the same time. CRASH COURSE IN ONLINE LEARNING!!!

- It's Monday, March 17th. The entire school is closing. Three students join me that night to plant all of our plants as the sun starts to set, so that they won't die while we wait for the school to reopen. Perhaps it will be just a week or two, but we do not want to chance it. We get about one hour of warning that we are not coming back to school tomorrow, so I take what I might need to teach. I might not be allowed back to campus. The reservation is closing too.

- Reaching out to students is an "all approaches on deck" sort of situation. Some teachers try Snapchat. It doesn't work for me. Facebook Messenger, texting, calling, voice chatting. I even learned about TikTok. Anything and everything that we could do to meet our students in their spaces we tried. Still some stopped connecting. Many students' voices just fall off into the nothingness, and I worry about them.

- Students who are doing their schoolwork do not need to follow the classic school schedule… I am getting calls at 9 pm, 11 pm, and even one at 2:30 am from students that are trying. That 2:30 am one was from a student I had been trying to get in touch with, so you know I took that call.

- Getting students their supplies is a whole different kind of mess. I mask up and drive into the reservation. I call students up on the phone and then throw their lab to them from a few feet away. We talk in loud voices, and I treasure these strange interactions because I miss them so much.

- Sometimes I teach from my kitchen (most productive), sometimes the couch (more comfortable), and my favorite is from the back yard. Giving students tours and talking about the strange things that I am doing and asking them about how they are doing.

- I gave up calling some parents because they sound just as lost and frustrated as I am. They're feeling overwhelmed and like they were failing at keeping their kids working, keeping their own jobs going, keeping the house clean, and all of the other expectations and now… they needed to help teach??? Especially difficult are the families with kids spanning a wide age range. Elementary aged students need more support from parents. 7-12th grade students in these families had to pitch in as teachers/parents themselves and, because of this, fall behind in their own schoolwork.

SUMMER IS FINALLY HERE!!! In all my years of teaching never has March – June lasted so very, very long…. Am still checking in with students often.

This fall things changed. Teachers are all AT SCHOOL while students are AT HOME. Sitting at my desk, staring at the laptop screen. Zoom is up and running. A full class now means almost half of my students, which makes five of them. Five black squares with white letters spelling out their names. Cameras are off – I can't see them. Five mics are turned off. I am speaking though; Is anyone home? I smile, I laugh, I act goofy, bring in Star Wars toys to interact with… I FAKE being upbeat. Nothing… Silence… I ask questions. Wait. Wait Wait… A lengthy wait time doesn't work when a period is only thirty minutes long and the students are all more than ten minutes late, if they show up at all. I try not to cry till classes are over.

Students are missing – are they ok? I reach out to them without response, I can't just go to their houses, they are on the reservation. I am ONLY allowed to go to work and back. I call, I text, a FB message here, a Snap there, even a Tik-Tok… ARE my STUDENTS DOING OK? Am I doing OK? NO, I AM NOT.

SELF CHECK: How do I fix this…. What am I not getting that would help? I'd like to see their faces at least.

Illustration by Quileute Tribal School teacher Alice Ryan.

Teaching is *so much more* than a job, or a paycheck.

It is the daily interactions, the good and bad, happy, and sad ones. Students give me something… let's call it energy and it is tangible.

Without it, I fall into darkness.

- Another day of Darkness, one-way conversations to little black boxes with white names. The silence…. So quiet, I must talk faster, talk more… fill the gap. It's all a gap! It's all worth it to just to hear someone.

- How do I fix this? OK. I need their videos on…. How How How… TOYS?!? I will bribe them. I bought a bunch of toys – $$$ well spent. For every five classes that they're visible online through class, they got a toy. We would drive over to their house and throw the toys to them.

- It WORKED. !!! Their faces helped pull me out of the darkness a little bit more. Further from the edge, I was going to make it through this, now I had at least one student in all but one class who would turn their camera on for me.

- It's March 2021, and we're back in person with a seriously modified schedule. Still only three days a week, still only from 8am-2pm. BUT, we now had 70-minute classroom periods which I love, and then a day of all 30-minute periods. There are worries and concerns even now we are remote for the rest of the week because we had two Covid cases in the school. I am taking it in stride.

- Two weeks of Cohorts. That is, students stay in their advisory groups. I am with my seniors as we work on a 7-12th grade focus on digital citizenship. We are also preparing for graduation, helping them get caught up with their classes.

CONCLUSIONS, or so I think. Teaching is SO MUCH MORE than a job, or a paycheck. It is the daily interactions, the good and bad, happy, and sad ones. Students give me something… let's call it energy and it is tangible. Without it, I fall into darkness. This is SOOO obvious now, and I share that with my students. Labs, activities, students are getting caught up, most of my students are present.

- Here we go again! May… almost to summer and now, LOCK DOWN! I'm sent home with a partial day's notice, with the hopes of coming back on June 3rd. What to grab, what will I need to teach from home?

- We were starting the dissections this week. I had one parent beg me to still let her daughter do her dissection… got permission, set up special permission slips, and brought her a frog… Everyone else wants to wait – much to the relief of parents… but what will we do until then? The physics class is right in the middle of making Triboelectric Nano-Generators… A whole giant box of supplies is involved for each student, and very few of the boxes are labelled, so a bit of a guessing game. They all need to get to the kids. Set up their bags, eggs go in, copper, marbles, bouncy balls, can't forget the lights…what else can I throw in… I call my husband (who also works at the school) and ask him to drive them out to the kids so that they have their lab supplies.

- Almost 4pm almost ready to leave. OH NO! My Earth Science class just started a lab about the effects of CO_2 on muscles. I carefully pull out each student group's beakers, grab any notes that they left on their containers just in case they did not write them down, and weigh each shell, recording it all on a scrap of paper.

- I am so tired, ready to head out. Grabbing the project, I am working on for seniors, the supplies, anything I can think of that I might need.

- Teaching From Home Again! First day of online. A few students show up. Black squares with white names, black squares white names… again.

- Paper dissection time. I know I will buy the paper fog dissection kits with my own money, but its worth the cost, and there is no way to go through the school fast enough. Downloading …now print. I have enough ink, yay. And I didn't run out of paper. A call out for help with delivery, math teacher to the rescue. Phew… I got them all passed out.

- Black screens, white names… silence. Bribe with toys again… it helps. The teamwork I saw in class, gone, I beg, I ask them to help each other out, put the cameras back on. One girl does, and her mom jumps on excitement infectious as her daughter's. TEN boxes light up with laughter. Another video feed pops on, and another. I remind them of their teamwork in class, and now they all have videos on, and they are mostly talking and sharing. PHEW…

- The next period black screens, white names… Silence.

Please NOTE: I am lucky that I teach at the Quileute Tribal School; there are so many ways in which the school bent over backwards to support teachers and students. This article reflects upon my own unique experience. – A.R.

Low-elevation marine terrace at Rialto Beach in Olympic National Park looking toward Hole-in-the-Wall from the top of the terrace.
Photo: Kathy Troost

03.

A Challenging Puzzle: Terraces, Landslides, and Earthquakes at Rialto Beach

By Dr. Kathy Goetz Troost, University of Washington – Seattle

View south from on top of the terrace showing beach gravel thrown up onto the terrace by high energy winter waves.
Photo: Kathy Troost

The low-elevation terrace at Rialto Beach is a geologic enigma. My team of graduate students and I are trying to unravel a complicated puzzle there. What is that puzzle; why is it so complicated; and why do we care? We want to know the origin of a low-elevation marine terrace that lines Rialto Beach and the northwest coast of Washington. The answer is complicated because of the intermingling of landslides, earthquakes, erosion, large windstorms, and sea level change. And the origin could tell us about a previously unknown history of uplift and landslides, related to earthquakes, on the coast.

As a geologist and faculty member, it is hard to find a better place to conduct research and teach than the outer coast

This shows the oxidized color of the older beach deposits in contrast to the gray color of the modern beach gravels. Chelsea Bush, Elizabeth Davis (partly hidden), and Mary Alice Benson all helped with research on Rialto Beach terrace. ***Photo: Kathy Troost***

of Washington. Besides the breath-taking beauty and diverse ecosystems, the geology is amazing with ample evidence of multiple glaciations, active erosion and deposition, deformed bedrock, and many geologic hazards. My team has been fortunate to have the support of the North Pacific Coast Marine Resources Committee, the U.S. Geological Survey, the 10,000 Years Institute, Olympic National Park, Sea Grant, and the University of Washington (UW) to work out here for four years now, mostly focusing on the origin of the terrace and the geologic story it holds. The terrace is an enigma: why does it exist? It is of variable height (3 to 6 feet) and variable width (100 to 200 feet) and contains deposits that tell of many changes in the environment. At the base of the terrace, we see a layer of older beach deposits that is over 400 years old. That layer is buried by organic-rich layers and multiple landslide deposits ranging in age from 200 to 700 years old. Pollen in the landslide deposits hints at variations in the climate and shows that a slightly different assemblage of trees once grew on the slope above the terrace.

Many landslides, originating on the slopes that are currently above the back of the terrace, have spread across the beach in the past. What we see today is the truncated toes of these landslides because the terrace is being eroded by waves. The landslide deposits contain angular clasts of sandstone bedrock and so are distinctive from the rounded and ovate gravels in the beach deposits. We also find a bounty of carbon-rich material to date in the landslide deposits: sections of trees, limbs, stems, leaves, and Sitka spruce cones. We have obtained several radiocarbon dates on wood and cones in the landslide deposits and have learned that at one location, a landslide dates to about 300 years before present. This location coincides with the most actively eroding section of the terrace and is also the tallest section because of the greater thickness of landslide deposits there. We plan to refine the date of that landslide because, with an age of ~300 years, it could have happened because of shaking during the 1700 AD Cascadia Subduction Zone (CSZ) earthquake. Our next step is precision dating using tree-ring

We see beach gravel migrating onto and off of the base of the terrace. A large spruce tree was toppled during a period of erosion. *Photo: Kathy Troost*

Besides the breath-taking beauty and diverse ecosystems, the geology is amazing . . . .

Joni Gore (top) and Mary Alice Benson (bottom) collecting high resolution GPS measurements at the top of the landslide deposits on the terrace. *Photo: Kathy Troost*

chronology and wiggle matching on some of the bigger logs in the landslide to see if death of the trees coincides with the exact year of that earthquake.

In addition to detailed sedimentology, surveying elevations of the tops of the layers in the terrace will help us determine if uplift created the terrace. Nowhere on the Washington coast has uplift been documented from a CSZ earthquake. Subsidence has been documented and correlated to the 1700 AD CSZ earthquake, but that evidence is well south of Rialto Beach. Deformation models now suggest that uplift could be possible. Finding uplift would change current expectations for land-level change during the next earthquake, with implications for hazard mitigation.

Did earthquake shaking trigger landsliding and uplift of a former beach surface forming the terrace at Rialto Beach? We need to know what kind of land level changes could occur in the next CSZ earthquake. And we need to know if such an earthquake would trigger landslides along the coast. Those are the goals of our research. To get at those questions, we must deal with more parts of the puzzle - sea level rise and rapid erosion. We know from residents and scientists like Jill Silver (10,000 Years Institute) that the terrace once extended tens of meters further seaward. In the short time that we

Photograph of ~300-year old landslide deposits with wood (black areas), resting on top of oxidized older beach gravels. From left to right, Elise Freeman, Elizabeth Davis, Chelsea Bush, Mary Alice Benson, and Suzanna Doak, current and former graduate students in the Earth and Space Sciences Department at the UW-Seattle. *Photo: Kathy Troost*

. . . . with ample evidence of multiple glaciations, active erosion and deposition, deformed bedrock, and many geologic hazards.

have been studying the terrace, we have seen nine meters of erosion. This is a very dynamic beach! Dying Sitka spruce trees are falling onto the beach from the edge of the terrace and then being moved down beach joining other drift logs.

So, stay tuned for future updates on our research as we refine our dating and mapping to determine the origin of the low-elevation marine terrace at Rialto Beach. We hope to answer our questions so that we can contribute to our collective understanding of the geologic hazards on the Washington coast, recurrence intervals of those hazards, and risks of damage from earthquakes.

The base of the terrace is exposed here. In the background, the upper extent of the spruce on page 12 is visible. ***Photo: Kathy Troost***

A razor clam digging back into the sand after being sampled for a stock assessment.
Photo: Steve Fradkin

04.

Searching for NIX, a Gill Disease of Razor Clams

By Maya Groner, U.S. Geological Survey and Prince William Sound Science Center

Maya Groner.
Photo: Maya Groner

Walking the beach in the early morning fog, I almost run into the researchers before I see them. A crew of field technicians is busy at 6 a.m., moving a long hose into the saltwater in order to pump it into small, carefully located plastic cylinders twisted into the sand. The crew is doing a survey of razor clams along the outer coast of Washington state. These surveys are conducted during low tide series by the Washington Department of Fish and Wildlife, the Quinault Indian Nation, Hoh Tribe and Olympic National Park. They occur every summer and cover every mile of beach where the clams occur. The water hosed into the sand liquifies it, and the razor clams float to the top, where they can be counted, measured, and returned to the sand. The measurements feed into the annual stock assessments that are used to set the recreational and commercial limits on this prized fishery.

In a good year, razor clams are open to harvest all up and down the coast, including fishing by tribal members of the

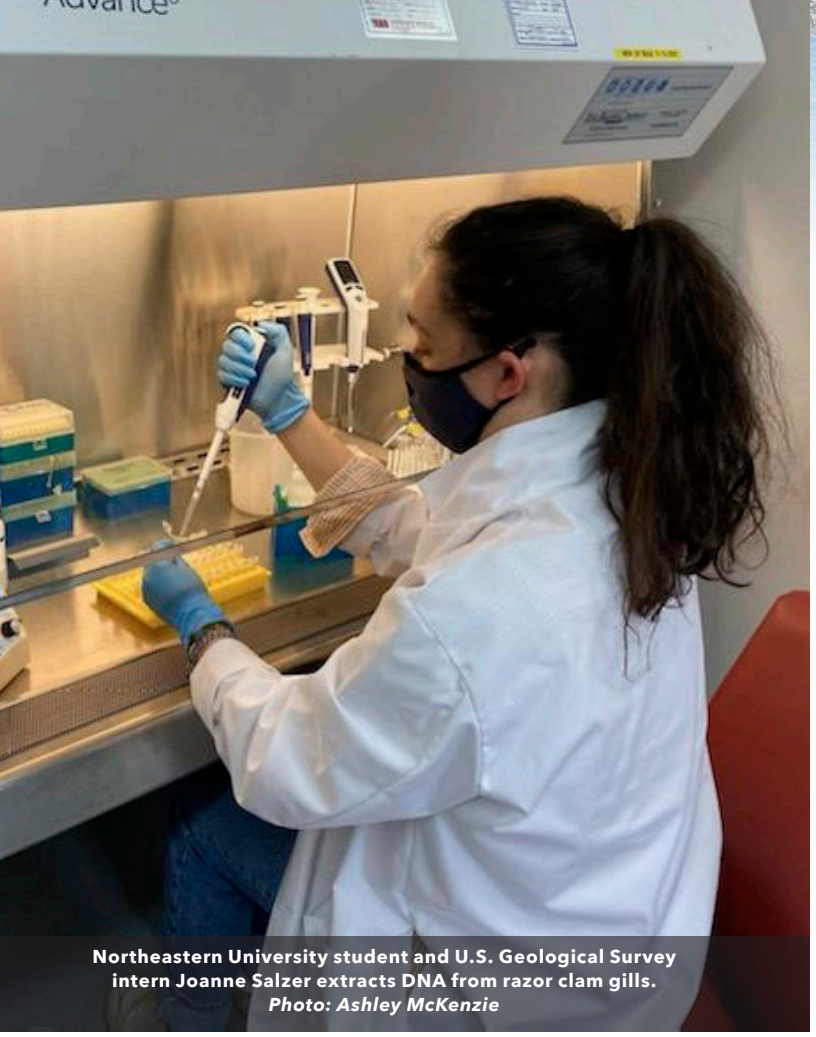
Dead razor clams and razor clam shells on the beach at low tide in 2017.
Photo: Steve Fradkin

Hoh and Quileute Tribes and the Quinault Indian Nation, and to recreational fishing by the general public. The razor clam fishery brings in tourists to small coastal towns and their visits are valued in the millions annually. However, the fishery has not been opened at all locations in all years. Kalaloch Beach has been partially or fully closed in most of the last twenty years due to various combinations of high levels of domoic acid in the clam tissue, which can make humans sick, or a lack of older, harvestable clams. While large numbers of clams are recruiting to Kalaloch Beach, they are not surviving past their second year, by which time they normally approach a size that humans like to collect.

Between the summer of 1983 and the winter of 1984, razor clam populations in Washington state beaches declined by an estimated 95%, from about twenty million clams, to less than one million clams. A year later, microbiologist and pathologist Ralph Elston identified the likely culprit: a bacterial pathogen that he called nuclear inclusion X (NIX), which was infecting gill tissue of the clams.

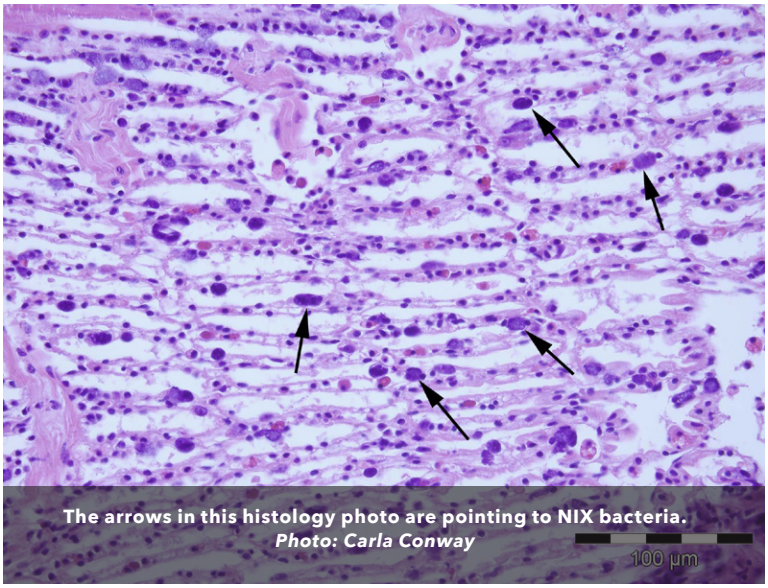
The pathogen gets inside of the nuclei of the cells making up the gills and enlarges them, thereby disrupting the flow of seawater and potentially causing clams to suffocate. Many of the dead clams that were found in 1983 had large amounts of mucus in the gills, possibly a response to the infection. Surveys conducted by Dr. Elston and colleagues revealed that the pathogen was prevalent in most razor clams in state beaches throughout Washington and was not detected in clams from northern British Columbia or Cook inlet, AK. Recently, the possible associations between NIX infections and clam mortality resurfaced because of the poor survival in adult razor clams in Washington coastal beaches.

Olympic National Park coastal ecologist, Dr. Steve Fradkin, has raised the question as to whether disease may be killing these clams after their second year. Thanks to funding from the North



Northeastern University student and U.S. Geological Survey intern Joanne Salzer extracts DNA from razor clam gills.
Photo: Ashley McKenzie

A WDFW technician pumps seawater into the sand during a stock assessment survey. Positively buoyant clams will float to the top.
Photo: Maya Groner



The arrows in this histology photo are pointing to NIX bacteria.
Photo: Carla Conway

Pacific Coast Marine Resources Committee, colleagues at the USGS Western Fisheries Research Center were able to help answer this question by first developing two new molecular NIX identification tests.[1] The first test uses an assay called quantitative "polymerase chain reaction" (PCR) to quantify how much DNA of NIX is contained in a tissue sample. The second test uses a molecular probe that binds to NIX DNA in tissue and can be seen under the microscope.

As the fog begins to burn off, I see wildlife feeding on clams. Gulls, migratory birds, raccoons and coyotes are some of the animals that take advantage of these low tides to harvest a delectable meal. We collect and preserve gill tissue in ethanol

1 *https://www.sciencedirect.com/science/article/abs/pii/S0022201120302251*

A WDFW technician samples razor clams in the lower intertidal.
Photo: Maya Groner

so that we can quantify the level of infection in these clams. Nearly all the clams we have tested so far are infected, so the highly sensitive quantitative PCR test we use can help us distinguish between highly and lightly infected clams. Disease is a part of all food webs, and the mere presence of a pathogen does not tell us whether or not it is contributing to mortality. We are setting up a baseline monitoring program so that we can quantify infection levels and see if there are correlations between high levels of infection and subsequent population reductions. In the next phase of our research, we will construct spatial and temporal maps of infection and investigate how this pathogen contributes to the survival of these charismatic clams.

Razor clams surveys are timed around the low tides and can occur early in the morning as seen here.
Photo: Maya Groner

05.

Olympic Coast ROV School Program Navigates Challenging Waters During Pandemic

by Nicole Harris, National Marine Sanctuary Foundation

MATE, the Marine Advanced Technology and Education organization, is leading the way in preparing the next generation ocean work force. The hook is using remotely operated vehicle (ROV) technology to inspire and challenge students to learn and creatively apply science, technology, engineering, and math (STEM) to solve real-world problems in a way that strengthens critical thinking, collaboration, entrepreneurship, and innovation. Pre-pandemic, this was achieved through the hard work of teachers, mentors and students building teams, solving problems and telling their stories at regional competitions around the world, including the Olympic Coast MATE ROV Competition.

The realities of the Covic-19 pandemic changed the way students engaged with learning. Face to face interactions and opportunities to work closely in teams to solve problems and engineer solutions weren't allowed. The uncertainty of being around anyone in those early days of understanding Covid-19 were strange and surreal and the 4th annual MATE Olympic Coast ROV competition in spring of 2020 was cancelled, as were all MATE regional competitions. Then, we all waited to see what the next academic year would bring.

And the next academic school year seemed to bring, well, more of the same. To reference Google Maps, we were constantly "recalculating" our next turn, as restrictions related to Covid-19 never quite allowed for opportunities that could support the efforts needed to build a competing team. They also never quite allowed for the return to an indoor, organized event the size of our competition. And yet, we persevered.

With the continued support of our funders and the commitment of the amazing mentors and teachers supporting their students, the Olympic Coast At-Home STEM Challenge was born. Funds were re-allocated to support kits that would be distributed to participating students and all activities could be accomplished at their home.

The kit might look like a mish-mash of junk drawer "treasures" – string, paperclips, electrical tape, PVC, tongue depressors, shrimp nets, craft wire, zip ties, wooden dowels – but to a robotics student, it was the makings of a manipulator that could retrieve an object. And retrieving an object was the goal they set out to accomplish when entering this challenge.

The Olympic Coast At-Home STEM Challenge provided kits to 28 students. Students could submit entries to all three challenges: the States of Buoyancy Challenge, the Manipulator Design Challenge, and the Object Retrieval Challenge. All students who submitted an entry received a "participation prize" for overcoming the Covid-19 blues and rising to the challenge of STEM at home. Additionally, three $50 and four $25 cash prizes were provided by the Surfrider Foundation Olympic Peninsula Chapter to the following students based upon their entries: Kevin Ryan, Damian Colfax, Mica McCarter, Xavier Johnson, Thalia Black, Denise Ward Bender, and David Ward.

The challenging waters of the Covid-19 pandemic may have knocked us back as a community committed to STEM engagement for coastal youth, but it didn't take us down. The future looks bright for MATE ROV on the Olympic Peninsula, with new projects on the horizon and a rising group of students to bring into the world of underwater robots, marine technology and teamwork.

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Quileute Tribal School student Joe Ward doing the Buoyancy Challenge portion of the Stay-At-Home Challenge where he needs to create eggs that are able to just barely float (positive buoyancy), just barely sink (negative buoyancy) and maintain neutral buoyancy for 60 seconds.
Photo: Alice Ryan

Clean Swell's data application graphics.
Image: Courtesy Ocean Conservancy.

06.

15th Annual Washington Coast Cleanup Makes for a Healthier Coast during Pandemic

By James Roubal, Washington CoastSavers

During Washington CoastSavers' 15th annual Washington Coast Cleanup (WCC) on April 17th, over 500 volunteers from around the region hauled away over 12,000 pounds of plastic water bottles, household trash, lost fishing gear, and other types of washed-up debris that can kill or poison coastal wildlife and spoil the natural beauty of our shorelines. This outcome is especially impressive given the fact that twenty Olympic National Park, Olympic Coast National Marine Sanctuary, and Makah, Quinault, Quileute, and Hoh tribal beaches, normally a part of the annual cleanup, were closed during this time to help prevent the spread Covid-19. For these areas, CoastSavers put out a call to action to local communities in proximity to some of these beaches to help reduce local waste streams and other sources of marine debris. The Washington Clean Coast Alliance, the network of federal and state agencies and NGOs that runs the CoastSavers program, also partnered with Olympic National Park to distribute cleanup toolkits to encourage solo cleanups throughout the month of April 2021. These toolkits included garbage bags, gloves, datasheets, instructions how to use Ocean Conservancy's free Clean Swell data app (available through app stores), as well as Surfrider Foundation's pamphlet 'Break Free from Plastic,' and instructions on where to dispose of the debris.

CoastSavers' Beach Clean Up volunteers at Twin Harbors State Park categorize marine debris. *Photo: Courtesy of Net Your Problem LLC*

ANNOUNCEMENTS

YOUR INPUT IS REQUESTED
DRAFT Middle Hoh River Resiliency Plan
Available July 19th
Please review and comment

A portion of the Middle Hoh Reach.
Photo: Raena Anderson

A non-regulatory plan for improving resiliency for people and fish within the Middle Hoh River Reach (ONP boundary to Hwy 101 Bridge) will be available for download at: https://www.co.jefferson.wa.us/1427/Hoh-River-Resiliency-Plan. Developed by Jefferson County in partnership with consultant Natural Systems Design, Hoh Tribe Natural Resources, and a diverse steering committee of agency and NGO representatives and volunteers, the plan describes how conditions within the reach have changed, incorporates flood projections through 2080, identifies existing desired future conditions, delineates a "resiliency corridor" to support natural processes, and discusses opportunities to enhance sustainability and improve employment opportunities in restoration-related fields.

For more information, contact:
Tami Pokorny at tpokorny@co.jefferson.wa.us
or call 360/379-4498.

COAST SALMON
PARTNERSHIP

Please join us! The Coast Salmon Partnership is hosting a Coast Region Symposium at the Ocean Shores Convention Center on October 27, 2021. Speakers will be subject matter experts on climate science, salmon biology, freshwater ecology, and restoration techniques. Come and learn what climate change means for our rivers, our fish, and the work to restore them in the Washington Coast Region. The one-day event is open to the public and will be held in-person with virtual access also available. Registration is free but required (open in July). For more information: mara@coastsalmonpartnership.org.

Riley Person of Clallam Bay sorts through a table of debris.
Photo: Nancy Messmer

07.

Beach Cleanups: Why Do We Collect, Sort, Count and Report?

By Roy Morris and Nancy Mesmer, Volunteers

As part of the springtime coast cleanup this year, 33 volunteers (sponsored by Clallam Bay Sekiu Lions, Clallam Bay Chamber of Commerce, and CoastSavers.org) collected marine debris from the beaches on the northwest Strait of Juan de Fuca. They removed 770 pounds of debris that could negatively impact habitats and wildlife. Bravo!

Several volunteers added another job to their day. Many people would be happy to sort the recyclables into one bin, dump the rest in a landfill and go home. Citizen scientists do more. One group of high school students and a Mom brought in 295 pounds of debris and dumped the huge piles of rope, net, awkward shaped debris and full bags onto the ground. They sorted it into categories: plastic beverage bottles (60), foam and plastic packaging (218), straws/stirrers (41), food wrappers (60), and much more. The sorting of large items went quickly, the final counting of tiny trash took the longest time. Data was recorded on data sheets, and entered into the Ocean Conservancy interactive database and real-time global map (https://www.coastalcleanupdata.org).

Why go to the trouble to sort and count and report? The information generated by citizen scientists (students, families, senior citizens, community groups, a couple of friends) around the world provides a snapshot of the global ocean trash problem and influences long term solutions. Throughout the year, small scale cleanups can be conducted along Washington waterways. Plastic pollution and trash in the seas are big problems. Local citizen scientists are part of the solution.

Lions Club member Roy Morris loads his pickup with piles of marine debris removed from Strait beaches during the 2021 Earth Day Cleanup.
Photo: Nancy Messmer

Four students from PAHS and one Mom sorted, counted and recorded the debris they brought in.
Photo: Nancy Messmer

Tanner Price, Kellen Garcelon, and Zane Glassock sort debris into categories.
Photo: Nancy Messmer

Kevin Ryan of Quileute Tribal School is holding his "grabber" for the Stay-At-Home Challenge. Students needed to retrieve three objects from a bucket of water, one at the top of the water, one in the middle of the water column, and one at the bottom *(see article #5 on page 18).*
Photo: Alice Ryan

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"NATURAL RESOURCES TUESDAYS"

West End community stakeholder meetings on water, salmon and marine resources.

1pm – 3pm
North Pacific Coast Lead Entity for salmon recovery
4pm – 6pm
North Pacific Coast Marine Resources Committee

Meetings currently held online and by phone. Contact Tami Pokorny (Phone: 360-379-4498; Email: tpokorny@co.jefferson.wa.us) for meeting access information.