confluence

Promoting discovery, understanding, and resilience for Oregon coastal communities and ecosystems

Oregon Sea Grant | Fall/Winter 2015

Preparedness, Not Panic: Readying the Pacific Northwest for "The Big One"

When a *New Yorker* feature that suggested a major Cascadia Subduction Zone earthquake would make "toast" of everything in Oregon west of Interstate 5 hit social media recently, it certainly drew attention to the seismic reality of life in the Pacific Northwest.

But Oregon Sea Grant's Pat Corcoran says focusing only on extreme scenarios can lead to a fatalistic sense that nothing can be done. And that's the challenge of earthquake and tsunami preparedness in the U.S., says Corcoran, who works to prepare coastal communities, residents, and visitors for just such disasters.

"The Cascadia Subduction Zone has shifted from a science project to a social studies project," Corcoran says. "We need to find a sweet spot between fear and action. What I try to do is temper the tendency of people to toggle between the poles of 'it won't happen here' and 'it will be so bad that there's no use worrying about it.' Both responses are a form of denial. The fact is, they do happen here. And, there are lots of things we can do to prepare."

It's been more than a quarter century since Oregon State University researchers—some working under Sea Grant funding—began warning that the Cascadia Subduction Zone, where a deep-sea tectonic plate is inexorably slipping under the North American continent, will likely trigger an earthquake ranging from magnitude 8.0 (comparable to the 2010 quake in Chile) to 9.0 or greater, like Japan's 2011 Tohoku quake. The geologic record and current seismic research indicates a 37 percent chance such a quake will occur in the next 50 years.

Tsunami hazard and evacuation zone signs are a common sight along Oregon's 370-mile coastland, all of which is vulnerable to a Cascadia Subduction Zone earthquake.

Ever since, Oregon Sea Grant has been working with state and local officials, scientists, and engineers to increase the region's resilience to a major offshore earthquake and the tsunami that will likely follow.

Corcoran acknowledges that a magnitude 9.0 earthquake and tsunami—what he calls "the largest of the large"—could devastate coastal communities and destroy infrastructure throughout western Oregon and Washington, including roads, bridges, water

Continued on next page

confluence: *The junction of two or more rivers; an act or process of merging; from the Latin word "confluere," meaning "flow together." We chose the name Confluence to reflect the merging, or flowing together, of Oregon Sea Grant's three "rivers": research, education, and engagement. Integrating the three supports our mission of promoting discovery, understanding, and resilience for Oregon coastal communities and ecosystems.*

Oregon Sea Grant's Pat Corcoran saw for himself what a powerful tsunami can do when he visited Japan a year after the devastating 2011 Tohoku quake. (Photo courtesy of Pat Corcoran)

and sewer lines, and the power grid.

But he adds that a more probable scenario is an earthquake on "the average side of large"—and the best response isn't to move away or pretend it's not going to happen, but to prepare now for disaster.

"The best approach is to do something," Corcoran says. "Don't let fear about the potential worst-case scenario prevent you from taking action that will help you in the more likely scenario."

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Corcoran suggests that people start by preparing for the "most likely next event"—and that doesn't necessarily mean the destruction of western Oregon as we know it.

"We don't insist on the worst-case scenario with driving vehicles," Corcoran says. "We don't have a zero-tolerance for car fatalities. We try to do our best to identify and mitigate the risks, but we assume a great deal of risk. We don't require that all cars be able to hit a brick wall at 100 miles per hour and have passengers unharmed. That's impractical. We need to consider a similar approach with earthquakes."

For additional Oregon Sea Grant earthquake and tsunami preparedness resources, visit http://bit.ly/1LGbfWA

Hitching a Ride

Recovering drift bottles takes time and sometimes detours, as in the case of T-8, a transponder in a plastic bottle dropped with 11 others off the Pacific Coast of Tohoku, Japan, in January 2012 by scientists from Japan's Tottori University for Environmental Studies and Sam Chan of [Oregon] Sea Grant Extension. Seeking to track patterns and rates of transoceanic debris travel following the March 11, 2011, earthquake and tsunami, Chan monitored T-8 as it drifted for three and a half years across the Pacific to the rugged coast of northwest Vancouver Island, British Columbia.

T-8 beached near Lawn Point Provincial Park in late June 2015, where a collector of marine debris spotted the unusual-looking orange bottle from afar and recovered it after nearly a two-hour hike. Chan and his colleagues were puzzled by the signals that followed, which came not from the coastline but from steep upland forests. "We honestly thought it might have been moved by a bear," says Chan, but then T-8 took a turn and traveled seven hours via logging roads to Campbell River on the eastern side of the island. With assistance from the British Columbia Ministry of Environment, as well as citizens and the media, Chan's investigative work led to the recovery of T-8 several days later. "That whole time, T-8 was still 'talking' to us," he says. "Believe it or not, we think this is the first trans-Pacific bottle that's been continuously monitored."

—Rebecca Lawton, "Getting the Drift," *Hakai Magazine*, 14 August 2015 [accessed 17 August 2015]; http://bit.ly/1gxIC1N

Improving Coastal Communities' Disaster Resilience

Oregon Sea Grant is helping to improve Cascadia communities' and the USA's disaster resilience through the Cascadia EarthScope Earthquake and Tsunami Education Program (CEETEP). CEETEP offers coastal science educators a four-day workshop to learn about earth science and disaster preparedness.

The Cascadia Subduction Zone (CSZ) is a fault line stretching from northern California to Vancouver Island, Canada, where two of the Earth's tectonic plates meet. One plate is steadily sliding underneath—subducting—the other, and the resulting force can produce large earthquake events across the region. The last large CSZ earthquake struck in the year 1700, and experts say the next event—the "Big One"—could happen in the coming century.

CEETEP provides coastal educators in the Pacific Northwest with background knowledge, strategies, and materials to engage students and visitors on the science of, and preparedness for, earthquakes and tsunamis along the CSZ. Few middle-school earth-science teachers, park interpreters, or emergency-management educators have a background in geology or geophysics, or the opportunity to expand their knowledge base in these topics. Through CEETEP, these educators learn meaningful science and connections to daily life.

"This is not just about doing a workshop and moving on, but to invest in the people who have leverage and are caretaking hundreds of thousands of people per year in the inundation zone," says Nancee Hunter, CEETEP coordinator and education specialist for Oregon Sea Grant.

CEETEP has brought together formal and informal educators from coastal Cascadia into professional development workshops to improve teaching of the science and preparedness of Cascadia's tsunami and earthquake hazard, and to leverage the educational capabilities of the National Science Foundation's EarthScope project.

"The workshop presented not only the scientific evidence for the causes and effects of Cascadia Subduction Zone earthquakes and tsunamis, but also very tangible individual and community preparedness measures," says Doug Lownsbery, a Graduate Research Fellow in science education at OSU who participated in a CEETEP workshop offered in 2013.

Each workshop offers three days of classroom activities, followed by a fourth day of field trips to Cascadia earthquake and tsunami sites, where participants witness seismic monitoring and carry out a tsunami evacuation drill. These experiences expose participants to evidence of past Cascadia disasters to inspire preparedness for future events.

"The value of Sea Grant is to make the physical science relevant for human safety," Hunter says. She adds that participants in CEETEP come away with a newfound appreciation of the landscape and an understanding of how to prepare for a large tsunami event. Additionally, CEETEP has assisted science educators in developing educational materials that will carry the value of EarthScope science and tsunami preparedness strategies to novice learners of all ages.

Feedback from the course revealed that workshop participants made notable im-

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"The workshop presented not only the scientific evidence for the causes and effects of Cascadia Subduction Zone earthquakes and tsunamis, but also very tangible individual and community preparedness measures."

Workshop participants learn about sedimentary layers associated with Cascadia massive earthquakes and tsunami from US Geological Survey researcher Brian Atwater. (Photo by Beth Pratt-Sitaula, CWU and UNAVCO)

provement in science content knowledge, teaching confidence, and optimism about preparedness. CEETEP participants also continue to collaborate beyond the course and have translated their new knowledge into award-winning results and exchange opportunities between formal and informal coastal educators.

Helping Resource Managers Improve Data-Poor Nearshore Fisheries Stock Assessments

Research funded by Oregon Sea Grant is evaluating new assessment methods for managing Oregon's data-poor nearshore fisheries. The results of this research could greatly improve how fishery managers set catch limits and assess fish stocks along the Oregon Coast.

Stocks of 10 "data poor" species considered for alternative assessment methods included rockfish like this one. (Photo by Claire Fackler, NOAA)

Scientifically sound, transparent evaluation of Oregon's nearshore fisheries resources is essential for effective management. The Oregon Department of Fish and Wildlife (ODFW) relies on federal stock assessments to set fishing limits. However, these assessments may not adequately capture the population dynamics of nearshore species that do not frequent federal waters. When management plans do exist, they tend to be homogeneous for the entire coastline, and are not representative of changes in habitat and fishing intensity.

"The agency has limited time and money for fishery-independent surveys," says Oregon State University fisheries professor Selina Heppell, the study's lead researcher. "This was an experiment to see if you can apply different methods that rely on catch information and life history at a smaller spatial scale, such as Oregon, or parts of Oregon."

Alternative methods rely on life-history characteristics such as birthrate and catch information to set harvest caps that reflect a true local assessment process.

Researchers used a method called a "gap analysis" to identify existing data and data needs. They found that many nearshore species are considered "data poor" in that they lack important biological information such as age at maturity.

Stocks of 10 "data poor" species were selected for alternative assessment methods, including black rockfish, kelp greenling, cabezon, lingcod, china rockfish, copper

rockfish, red Irish lord, buffalo sculpin, quillback rockfish, and redtail surfperch.

Researchers conducted a Productivity-Sensitivity Analysis (PSA) to determine stock vulnerability at coastal intervals. Four local management regions were considered for the Oregon Coast, and stock assessments (productivity) and overfishing limits (sensitivity) within each region were compared with statewide assessments currently used to determine whether local information was lost when managing for the entire coastline.

"What you get out of PSA is which species are more vulnerable and which ones you need to pay more attention to than others," Heppell says. "We also think the PSA can be very good for detecting regional differences that can give you a head start for planning your surveys."

Analysis provided relative abundance and susceptibility for the 10 species in different coastal areas, but PSA cannot yet provide quantitative results for direct regulation or allocation such as setting catch limits.

Researchers also tested other simple assessment methods relying on catch data to compare overfishing estimates, but found that local differences and changes in fishing effort and gear-types need to be considered in the interpretation of results.

"It is critical to continue to evaluate and work to improve methods for species assessments, particularly for species where we have very little information," says Alison Whitman, a marine fisheries analyst with ODFW.

The research team concluded that PSA is a useful management tool for considering local factors under ODFW's Nearshore Strategy, which is currently nearing the end of a 10-year evaluation process. State and regional managers will continue to review and comment on final synthesis of these methods for inclusion in future fisheries plans.

Scientifically sound and transparent evaluation of Oregon's nearshore fisheries resources is essential for effective management.

Oregon Sea Grant Researchers Develop New Sensor Package to Detect CO_2 in Shallow Waters

Oregon Sea Grant-sponsored researchers have developed a new, less-expensive way to measure carbon dioxide (CO_2) in shallow waters. The tool will help investigate the benefits of native seagrass in protecting oysters from an increasingly acidic environment.

The coastal waters of Oregon are particularly prone to high acidity levels, which threaten the state's multimillion-dollar commercial and recreational shellfish industry. The ocean reacts with CO_2 from the atmosphere to form carbonic acid, through a process called ocean acidification. High acidity levels have been shown to limit oyster growth, but new research suggests that seagrasses may mitigate local increases in coastal CO_2.

"There is a lot of interest in whether seagrasses and microalgae can be used to offset CO_2 in the coastal zone," says Oregon State University (OSU) ocean ecology professor George Waldbusser, lead researcher for the project. "We want to understand the dynamics of the seagrasses and how they could help oyster growers."

Faced with equipment failures, the researchers designed and constructed their own experimental CO_2 sensors. The new sensor package, which at under $2,000 is less than half the initial estimate and substantially less than commercially available products, was developed with the help of Waldbusser's collaborator at OSU, Burke Hales.

To determine the possible benefit of seagrasses to shellfish, researchers have deployed several CO_2 sensors within and outside seagrass beds at four reference sites in Oregon's Netarts Bay. Seagrass beds with

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"We want to understand the dynamics of the sea grasses and how they could help oyster growers."

Oregon Sea Grant researchers are using CO_2 sensors in seagrass beds to determine the role of seagrass as a refugium from rising ocean acidification levels. Here, graduate student Stephanie Smith changes a battery pack. In the background are bags containing oyster spat "outplants." (Photo by Iria Gimenez)

both native seagrass *(Zostera marina)* and non-native grass *(Zostera japonica)* were selected to test the hypothesis that native grasses are more beneficial due to a slower decay rate; a process that produces CO_2.

The oysters are frequently cycled out of the study sites so researchers can study how growth progresses in early development, a stage in which previous research has shown them to be most vulnerable. This process also mirrors practices used by the shellfish industry to provide useful results for coastal stakeholders.

Though delayed by having to produce a new sensor package, researchers collected a number of measurements of oyster and seagrass biomass, pore-water chemistry (pore water is water filling the spaces between grains of sediment), and oyster growth. Preliminary results show that oyster biomass is consistently higher in beds of native seagrass than in non-native seagrass. Combined with the high-resolution CO_2 data currently being collected by the sensors, these observations will help determine the role of seagrass as a refugium from rising ocean acidification levels.

"We know seagrass provides structure and hideouts from predators, but we want to address the possibility that seagrass habitats may be beneficial to shellfish from an ocean chemistry perspective," says Stephanie Smith, a graduate student working on the project.

CO_2 levels fluctuate naturally in coastal bays by season, and even by time of day. However, the added input from increasingly acidic ocean water threatens shellfish development in local hatcheries and bays.

"Coastal systems are variable by nature," Waldbusser says. "Adding atmospheric CO_2 makes those extreme events more extreme. Ocean acidification makes instances with natural variability worse than they would be otherwise."

A similar CO_2 monitoring project is underway at both the Davis and Santa Cruz campuses of the University of California. Replicating the study in different locations will produce robust results to help the struggling shellfish industry recover, and potentially protect coastal ecosystems from rapidly acidifying waters.

New Smartphone Apps Enhance Visitor Experience and Add Economic Value to Working Waterfronts

"Our goal is to expand how people look at seafood."

Oregon Sea Grant is developing smartphone apps that provide visitors to the Oregon Coast with a self-guided tour of two working waterfronts and facilitates direct marketing of local seafood to consumers.

The project is intended to help both visitors and residents explore the local waterfront industry through interactive materials. Recent work by Oregon Sea Grant and partners revealed that Oregon Coast residents and visitors have limited knowledge of local business, lack understanding of natural processes, and need information on accessing local seafood. Increasing awareness of these topics could help support local economies and create a better visitor experience.

Oregon Sea Grant Extension Fisheries Specialist Ruby Moon (right) leads coastal visitors on a "dock walk" along a working waterfront in Newport, Oregon.

Oregon Sea Grant developed two smartphone apps to respond to these issues: a self-guided tour, and a tool for direct marketing of seafood.

The "Working Waterfronts" tour app is focused on Coos Bay, North Bend, and Charleston and includes a series of "stops" for users to follow for a richer coastal experience. Each stop highlights current waterfront activities and offers a "behind the scenes" look at dredging operations, processing plants, oyster growing, and more. Through video clips (online at http://bit.ly/1FX5K5A), photos, and short stories, participants learn about the people who work in these local industries, giving a personal face to the working waterfront.

"For tourists, I hope they learn something, stay a little longer, and have a greater appreciation for the Coos Bay area," says Jamie Doyle, Oregon Sea Grant coastal community development specialist. "For locals, I hope they have pride and support for the waterfront industry, and it gives a human face to people in their neighborhood they might not know about."

In addition to the app, a hard-copy Working Waterfronts map was produced with the same "stops." Local businesses and other attractions will carry both hard-copy maps and a QR code for visitors to scan and download the app.

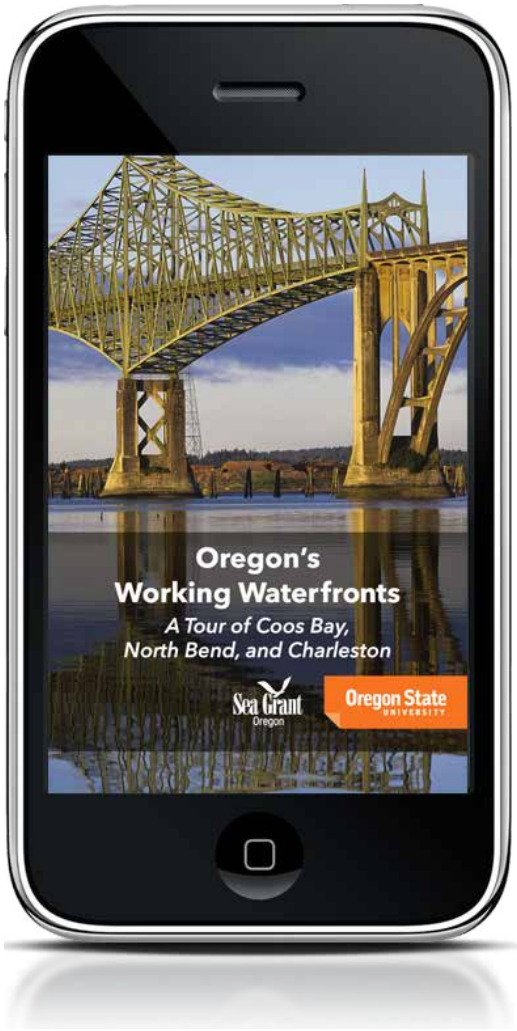
The second app, called "Oregon's Catch," allows individuals to connect with vendors of local seafood along the entire coast via their smartphones or tablets. Residents and tourists can identify nearby locations to purchase quality seafood—much of which is frozen—caught by Oregon fishermen.

"Our goal is to expand how people look at seafood," Doyle says. "There is a long-standing perception of frozen seafood being poor quality, but freezing technology has really improved, and frozen can actually be much better quality than fresh."

The apps will enter focus groups this fall, and will likely be available to the public early next year. Both the Working Waterfronts tour and Oregon's Catch will be free and available for Android and Apple devices. Signage is being created to promote the materials in the local community, and the videos will also be accessible online.

Although Coos Bay, North Bend, and Charleston currently are the only featured waterfronts, the developers plan to use feedback from the app to incorporate additional tours of other waterfronts, such as Astoria or Newport, in the future. For now, the two apps will be connected in a way that seamlessly allows individuals to transition from a tour to purchasing local seafood—benefiting consumers as well as the coastal economy.

Through video clips, photos, and short stories, participants learn about the people who work in these local industries, giving a personal face to the working waterfront.



Courtesy of Mark Farley, cyberlab manager, Oregon Sea Grant

SCHOLARS CORNER

Applying Principles of Resilience

Edited from a blog post by Sea Grant Scholar Sarah Allison

Back in December [2014], I posted a blog about how I think about and apply resilience to my research on hazards and the business community. From the high-level questions of "resilience of what" and "resilience to what," this post will drill down into specific principles of resilience, and how they are applied to this topic.

Graphic of the "seven resilience principles": 1. Maintain diversity and redundancy; 2. Manage connectivity; 3. Manage slow variables and feedbacks; 4. Foster complex adaptive systems thinking; 5. Encourage learning; 6. Broaden participation; and 7. Promote polycentric governance systems. (From Applying Resilience Thinking, *by the Stockholm Resilience Centre)*

The Stockholm Resilience Centre has developed seven resilience principles, which form the basis of my evaluation of economic resilience to hazards. Economic resilience to hazards is the ability of the local business community to handle natural hazards. By focusing in on how resilience principles can be applied to that specific intersection of stress and system, we can identify targeted ways to increase resilience and therefore reduce the vulnerability of the business community. This post will look at the first three resilience principles, and how they apply to the more narrow focus of economic resilience to hazards.

The first principle is "maintain diversity and redundancy." Diversity helps because not all things are impacted in the same way by the same disruption when they have different qualities. Redundancy helps because functions are covered by multiple elements. If one system fails, the function is not completely lost; there are backups. From an "economic resilience to hazards" perspective, this becomes "support multiple types of businesses and back-up resources." A community with different industries, locations, and sizes of businesses can withstand hazards better. A community with multiple sources of power, water, and transportation options can get back on its feet sooner.

The second principle is "manage connectivity." Connectivity is tricky, because you want enough connectivity for mutual support, but not such tight connections that breakdowns spill over. For economic resilience to hazards, this principle became "strengthen supportive networks." By thinking about the networks that provide resources and support to businesses, we can focus on the connections that will serve businesses around hazards.

The third principle is "manage slow variables and feedbacks." When systems change slowly, it can be hard to notice it happening, and even harder to determine the point at which the change is irreversible. Declining populations of fish or the pollution levels in a river are examples of this type of change. Another challenge is that there are infinite systems in our communities, and we cannot track all of them. This principle, when applied to economic resilience to hazards, became "identify and track areas of vulnerability." By focusing on areas of vulnerability, the particular systems that businesses rely on, we are more likely to catch shifts that will have significant impact.

These three principles focus on the outcomes that resilience planning seeks to accomplish. The principles in my next post will focus on the process of pursuing those outcomes. Both are important in creating resilience.

Ms. Allison is a graduate of the University of Oregon. See part 2 of her blog post, which discusses principles 4 through 7, at http://bit.ly/1Rcmh73

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