Marine Conservation & Ecological Interactions
in Dr. Steve Rumrill's Webinar 'Calamity in the Kelp'

Photo Credit: Ingrid Lam

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December 1st, 2020

On the southern Oregon Coast, Dr. Steve Rumrill studies ecological relationships, ecosystem stability, resilience, and disruptions among rocky intertidal organisms. His work adeptly illustrates the impact of global climate change on coastal ecosystem dynamics from global climate change (GCC) to Sea Star Wasting Disease (SSWD). In his webinar, hosted by CoastWatch and titled "Calamity in the Kelp", Dr. Rumrill explained the effects of these changes and how they influence each other. Anthropogenic global climate change impacts not only terrestrial ecosystems, but also marine biota. With the rising nearshore–temperatures, organisms face physiological stress and shifts in their geographic distribution. For example, in the California Current, concerns surrounding the timing and intensity of upwelling arose with uncertainty. Coastal upwelling supports the organisms in an ecosystem because the deeper, cold, oxygen-rich water rising to the surface is often filled with nutrients, providing vital food for marine life. In addition, the increasing effects of ocean acidification in the Pacific Northwest negatively impact the growth and development of crab embryos and larvae, causing unpredictable fluctuations in pre-existing food webs. The combined consequences of warming temperatures and acidification ultimately causes an upheaval in overall ecosystem structure, altering stability, and affecting species composition. The increasing oceanic temperatures create a domino effect of continuous harm to marine ecosystems. In 2016, fishermen and scientists encountered more exotic or non-native fish. By 2018, more warm water fish were spotted. By 2019, subtropical fish were found in the warmer temperatures of seawater on the Oregon Coast. Rumrill tells us that these issues continue to weaken the ecological integrity of marine habitats, and urges listeners like myself to maintain its balance. The shift in the ecosystem thus far demonstrates the further change to come.

Sea Star Wasting Disease (SSWD) contributes to major decline in sea star populations throughout the West Coast. Ochre sea stars (*Pisaster ochraceus*), essential predators that control species composition in rocky intertidal zones, are susceptible to this disease. When infected, sea stars' bodies decay, resulting in lesions on their body and eventual death. Although first detected as early as 1970, the resulting losses from SSWD are catastrophic. In 2018, around 60-98% of Ochre sea stars in Oregon were wiped out, and Sea Star Wasting Disease was named one of the largest mortality events from a marine disease (Miner et. al, 2020). Initially identified in the Pacific Northwest in 2013, the disease quickly spread throughout California and Washington, eventually reaching the state of Oregon in 2014. In addition, sea star populations in both Alaska and Baja, California face infection. These diverse effects illustrate the question, stated by Dr. Rumrill in his research: "how do ecological dynamics of echinoderms differ along their biogeographic range?" In addition to Ochre sea stars, the Sunflower Star (*Pycnopodia helianthoides*) is severely affected by SSWD, making the species now rare to find. In Oregon and California, the species faced an almost 100% decline and 99% decline in Washington. Sunflower stars are a main predator of sea urchins. As a result of this loss, populations of sea urchins multiplied. Despite the high death rates, scientists are working to secure a promising recovery of some species in Oregon and in Northern California. Through the removal of a top trophic level predator in the rocky intertidal zone, the Ochre sea star, the previously diverse ecosystem experiences a striking trophic downgrade, the consequences of altering food web relationships. The major changes catalyzed by this new hierarchy include growth in the population of mussels, limpets, and barnacles. Scientists predict, after the removal of the Ochre sea star, intertidal ecosystems may exhibit significantly less species diversity and an over-representation of mussels as the dominant species within the rocky intertidal zone. Yet, the upheaval of ecosystems is diffuse, complex, and heterogeneous in nature. For example, mussel populations in Monterey, California experience little to no change in ecosystem dynamics despite the loss of sea stars, whereas in Port Orford, Oregon, mussels are colonizing rocks 1.5 meters lower in rocky intertidal zones. With the scarcity of sea stars, the dynamics of the marine ecosystem become further impacted, affecting all species in diverse and dynamic ways.

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Bull kelp, or *Nereocystis*, inhabits much of the Oregon Coast, extending to depths of 40 meters. This subtidal marine plant is a vital part of the ecosystem and serves as an integral source of food for many species including the purple sea urchin, crabs, and abalone, as well as a natural barricade that protects coastlines from large waves. Unfortunately, scientists like Dr. Rumrill recently noticed a decline in bull kelp prevalence along the Oregon Coast. In 2015, Northern California experienced warmer seawater temperatures resulting in an unprecedented loss of kelp. Fluctuating amounts of kelp due to anthropogenic global climate change among other variables persists across the coast. On Orford reef on the southern Oregon coast, kelp populations experienced decline, however, on Aras, Redfish and Rogue Reef, also of the southern Oregon coast, kelp exhibited overall growth. While recording these changes, scientists also noticed reefs like those in Depoe Bay showed little to no change. Yet, with an overall increasing water temperature, local kelp forests experience significant decline in species abundance and great forests are replaced by carpets of algae. Without a healthy balanced kelp population, many organisms lose a key food source. As a keystone species along the West Coast, this loss of bull kelp may catastrophically impact coastal ecosystems.

Red and purple sea urchins (*Echinoidea*) inhabit much of the rocky subtitle zones along the Oregon coast. Harvested by fishermen, the urchin crop annually reaches 500,000 pounds, providing a vital bounty both to human and wildlife. At sushi restaurants, tourists and residents enjoy “uni”, the urchin gonads. In 2014, urchin numbers plummeted to an all-time low, however in 2016, the numbers grew again. Since the decline in sea stars, a noticeable surge of urchins multiply across the West Coast. In 2019, there were over 350 million urchins, with a dramatic growth in places such as Orford Reef, an area affected by kelp loss. Urchins represent a main source of food for sea stars, but with the recent scarcity of sea stars and increase in urchins, the question remains: Is ecological release from predators by sea stars responsible for the dramatic increase in purple urchins? Without a predator to keep numbers in check, species diversity among the tidepools is overwhelmed with a monoculture of urchins. The new explosion of urchins allows this species to colonize deeper habitats, from intertidal zones to 16,000 feet down. Due to key life history characteristics including the fast reproduction rate of the species, efforts to reduce urchins may be ineffective despite our best efforts. With a sudden shift in the ecosystem, changes are inevitable.

Red abalone (*Haliotis rufescens*) and flat abalone (*Haliotis walallensis*) represent two salient species along the coast and provide an important ecosystem service to humans, supplying decorative jewelry, and meat. With a desirably large shell, abalone holds the world record for largest shell, and in the past were hunted for sport or trophy on the Oregon and California coasts. Methods for hunting include SCUBA free diving and shore picking (Groth and Rumrill, 2018). Red Abalone face a number of challenges from dwindling habitat to over fishing as a coveted food item. With sea waters rising in temperature and increasing frequency of sport harvest, abalone become less prevalent throughout the Oregon Coast. In addition to traveling and living in groups, abalone occur in low densities, resulting in poor reproductive success and making them an easy target for fishermen or hunters. They generally feast upon kelp and algae, but with the dwindling of healthy kelp beds, abalone are left with food shortages. Without the sea star as a predator to purple urchins, the remaining kelp beds are ravaged, leaving a barren sea floor. In the face of these challenges, red abalone populations have decimated. In an effort to protect abalone, the Oregon Fish and Wildlife Commission suspended sport abalone harvest from 2018-2020. In addition, scientists are working to develop an Oregon Abalone Conservation and Fishery Management Plan. Through these efforts, the abalone population may recover over time.

Throughout an ecosystem, relative stability depends on the frequency and severity of disturbance events, including human influences, from global climate change to ocean acidification. With warming waters, bull kelp has become scarce throughout the Oregon coast. Sea Star Wasting Disease razes sea star colonies and leads to a burgeon of sea urchins. With this imbalance in trophic levels, ecosystems along the rocky subtidal zones are overwhelmed. The shortage of abalone results from the boom of urchins, who compete with the abalone for the ever declining kelp. Thus, a clear pattern appears: The Marina Heat Wave affects the bull kelp and increases SSWD mortality, the decimation of sea stars causes the sudden growth of purple urchins, catalyzing the initial decline in kelp and red abalone. Although the exact beginning of this complex cyclical relationship remains unknown, the effect of shifting population in rocky intertidal zones demonstrates the interconnectivity of each species in an ecosystem. In an effort to help rebalance coastal marine ecosystems, scientists have suggested introducing sea otters to the Oregon coast. A new top trophic level predator of urchins, crab, abalone, and clams, this reintroduction could enhance ecological stability of marine ecosystems. In communities with otters, kelp is generally more prominent due to the otter’s consumption of kelp grazers. As keystone species, otters are vital to sustaining the ecosystem of a kelp forest. As a keystone species, they prey upon sea urchins and maintain kelp forests. When sea otters are present, marine environments are more diverse and robust. Understanding the ecological communities with complex trophic relationships within closed ecosystems is key to helping this coastal community thrive. Scientists all around the coast are conducting long-term research and designing effective ways to manage changes to a biome.

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These powerful biotic interactions and their dynamic effects throughout marine ecosystems are prevalent among the rocky intertidal zones and tide pools. During a recent visit to Indian Beach (Clatsop County, Oregon) the tide receded at 0.5 feet, leaving a visibly dense cluster of mussels and limpets observable along the rocks (see photos throughout my article). Closer to the ocean, a few Ochre sea stars lay tucked tightly between the crevices of the large rocks. As I walked the beach, I remembered what I learned from Dr. Rumrill's words during the webinar; I recognized the true cost of rising sea temperatures and unstable ecosystems. I remember visiting the beach as a young child and seeing whole colonies of sea stars among the tide pools, demonstrating the catastrophic effects of Sea Star Wasting Disease and how it affects the ecosystem, once heterogeneous and dynamic, now more fragile and recovering. It reminded me of the Mary Oliver poem, I Go Down to the Shore (2012).

I Go Down to the Shore
By Mary Oliver (2012)

I go down to the shore in the morning
And depending on the hour the waves
Are rolling in or moving out

And I say, oh, I am miserable,
What shall–
What should I do? And the sea says
In its lovely voice
Excuse me, I have work to do

Poet Mary Oliver recognizes the importance of supporting the environment for the well-being of both humans and the animals around us. Oliver discusses a person going down to the sea to lament, asking for advice. However, they forget the sea is not meant to only be experienced passively, but that it also works to supply habitat, food, and resources for its inhabitants. The sea is responsible for much of life on earth and keeping it healthy represents a global environmental goal. Scientists spend their entire lives studying the environment and the organisms that inhabit it. However, scientists are not the only ones who can get involved. A variety of opportunities exist that are available to high school students with diverse organizations such as CoastWatch, internships at marine biology stations, Sea Grant, LiMPETS, and many others. Learning more about science fields like marine biology and oceanology connect students to the world around them and allow them to foster a conservation ethic. Attending webinars, reading scientific studies, and participating in internships and local science programs shed the much needed light upon ways to improve marine conservation. As a community, we need to preserve our oceans by being environmentally conscious and aware of the organisms living there. We must always remember the voice of the sea: “Excuse me, I have work to do."

Ways to Get Involved

Oregon
Elakha Alliance Elakhaalliance.org
CoastWatch https://oregonshores.org/coastwatch
Oregon Sea Grant https://seagrant.oregonstate.edu/

Washington
Washington Coast Savers https://www.coastsavers.org/

California
LiMPETS https://limpets.org/

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