



California Department of Fish and Wildlife
Marine Region

“Perfect Storm” Decimates Northern California Kelp Forests

by Cynthia Catton, CDFW Marine Environmental Scientist, Laura Rogers-Bennett, CDFW Senior Environmental Scientist Specialist, and Alisan Amrhein, California Sea Grant Fellow

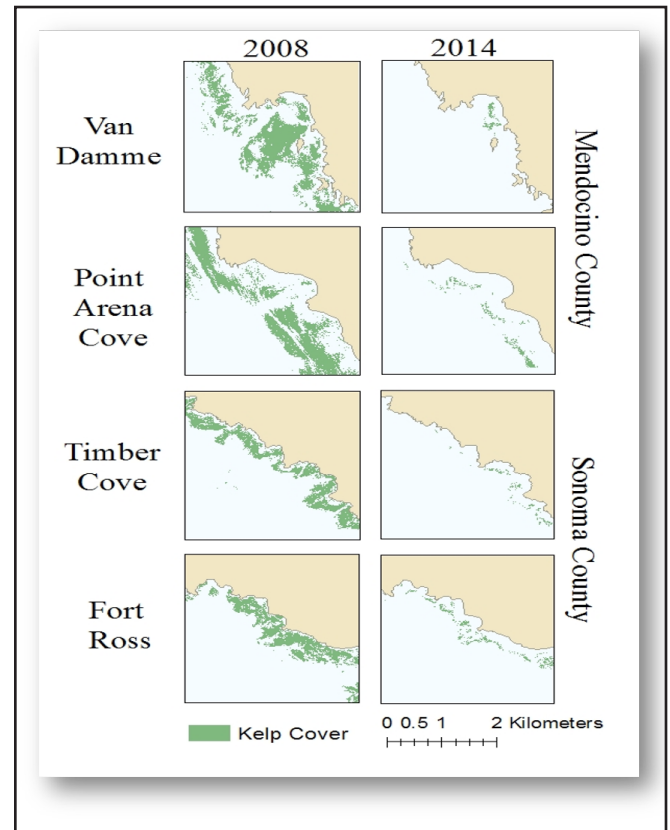
Northern California kelp forests have been reduced to an all-time low due to a “perfect storm” of large-scale ecological impacts. The California Department of Fish and Wildlife (CDFW) marine invertebrate management team has conducted annual ecosystem surveys of kelp forests in Sonoma and Mendocino counties since the late 1990s, and recent observations have caused concern about the state of the kelp forests. The severe reduction in kelp has already impacted the recreational red abalone fishery and commercial red urchin fishery, two economically important fisheries in northern California.

Abalone and Urchins Starving

Bull kelp (*Nereocystis luetkeana*), usually common on the northern California coast, has declined dramatically since 2014. Kelp forests are now 93 percent smaller compared to previous years, creating starvation conditions for herbivores.

Abalone and sea urchins are both herbivores that depend on healthy kelp forest ecosystems for food and habitat. With the recent loss of kelp and the ensuing starvation conditions, researchers have documented unusual behavior for both abalone and urchins. Large abalone are now more commonly observed climbing stalks in search of kelp blades, and small abalone have abandoned the protection of rocky crevices in search of food. Other

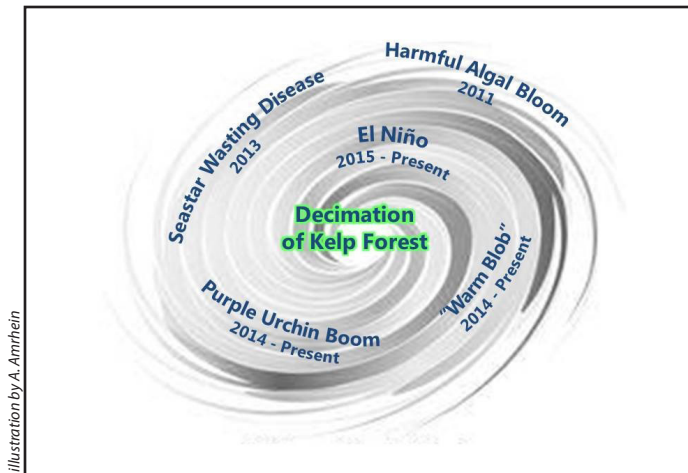
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Comparison of kelp cover at four important abalone fishery sites in 2008 and 2014. Green color indicates kelp canopy observed.



Unusual foraging behavior near Elk in Mendocino County: a large red abalone climbing a bare kelp stalk trying to reach fronds that are not there.



The “perfect storm” of ecological impacts

invertebrates and fish species, such as rockfish, also depend on the shrinking kelp forest ecosystem for food and protection from predation.

The Perfect Storm

A series of large-scale catastrophic events recently combined into a “perfect storm” of ecological impacts that triggered dramatic shifts in the kelp forest ecosystem on the north coast. Environmental stressors included impacts from a toxic algae bloom off the Sonoma coast in 2011, a widespread sea star disease in 2013 that was followed by an explosion in the sea urchin population, and the warm water conditions that have persisted offshore since 2014.

Harmful Algal Bloom

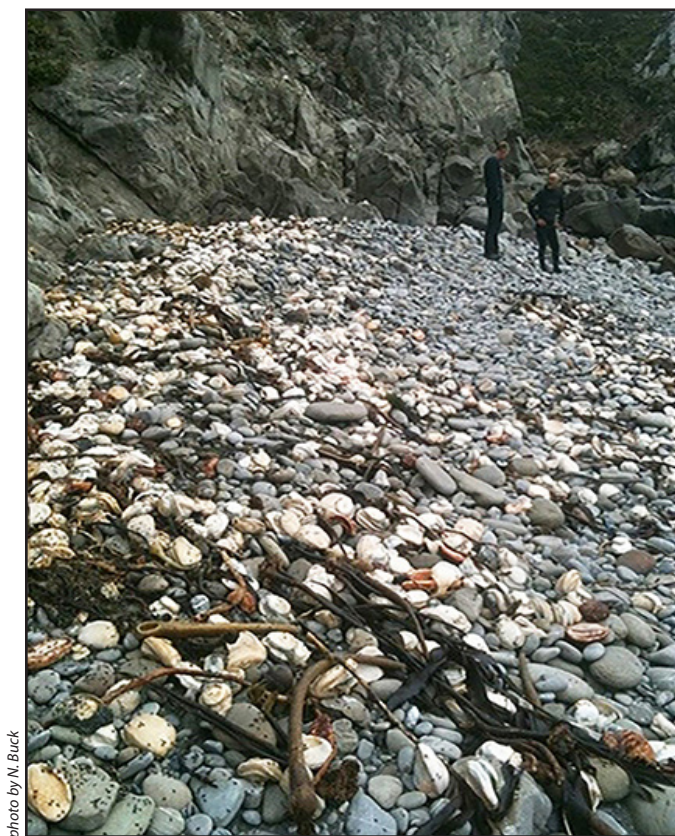
The first major impact to the region occurred in August 2011 when a harmful algal bloom released a toxin into Sonoma County waters, killing large numbers of marine invertebrates. The California Fish and Game Commission responded to this unprecedented event by instituting a temporary emergency closure of the abalone fishery in Sonoma County, followed by reductions in the annual abalone catch limits starting in 2014. This event marked the beginning of a set of ecological stressors that would impact multiple invertebrate fisheries on California’s north coast.

Sea Star Wasting Disease

Two years later, in 2013, Sea Star Wasting Disease killed large numbers of sea stars on the West Coast of North America, from Mexico to Alaska. Sea stars are important predators of invertebrates that live in the kelp forests. The loss of these predators added another stressor that would later contribute to a sea urchin population expansion.

Purple Sea Urchin Population Boom

CDFW researchers have discovered that purple sea urchin densities are now greater than 60 times their historic density in northern California. This unprecedented expansion of urchin populations spans hundreds of miles of coastline. Purple sea urchins are voracious consumers of kelp. In large numbers, these small but hardy herbivores can easily wipe out vast expanses of kelp and other algae, changing the landscape from a lush and diverse kelp forest ecosystem to what is known as an “urchin barren”.



Aftermath of the harmful algal bloom: dead abalone and other invertebrates washed up on shore at Fort Ross in 2011.



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More sunlight reaches the sea floor in urchin barrens, because the light is no longer filtered through thick fronds of kelp canopy and sub-canopy – similar to the way sunlight is filtered through a rain forest canopy on land. Fish and other species that normally hide in the shade of these fronds are no longer protected from the hungry eyes of larger predators.

In urchin barrens, the sea floor is dominated by the purple and red spines of urchins as they scour the rocks for food. Only the hard, calcified, pink crustose algae can withstand the high-impact grazing pressure currently observed in northern California. The urchin barren conditions may persist until the presence of sufficient predators, disease, or storms reduce the exploding urchin population.

Unprecedented Warm Water

The kelp forest ecosystem suffered another series of shocks in 2014 and 2015, when coastal water temperatures along the West Coast rocketed upwards due to a combination of oceanographic features: the “Warm Blob” in 2014, combined with a strong El Niño that began in 2015. Kelp and many other marine species are very sensitive to changes in water temperature, and warm water holds few of the nutrients required for kelp growth.

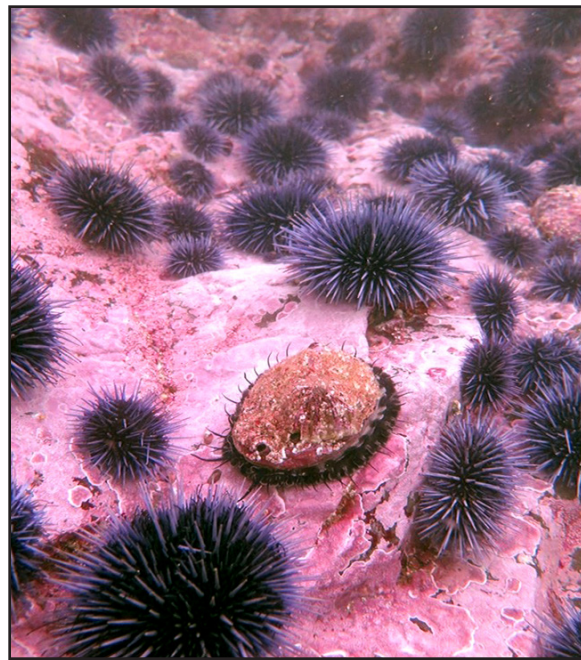
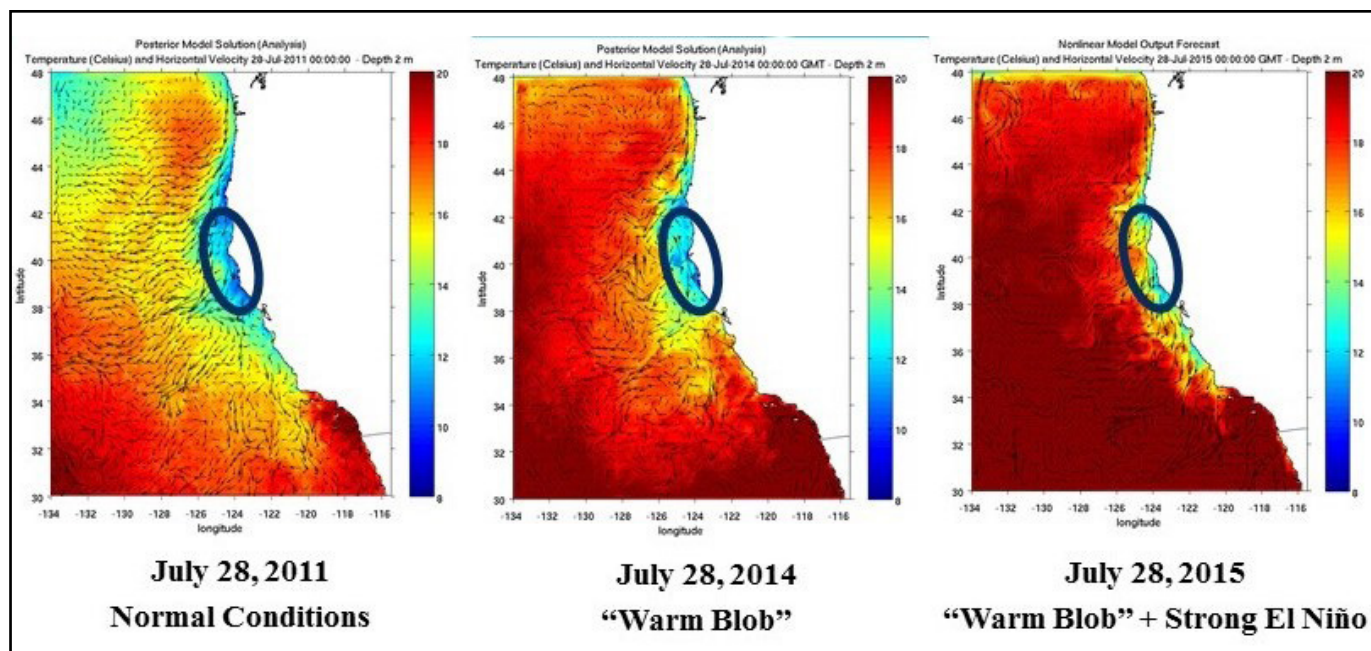


photo by A. Maguire

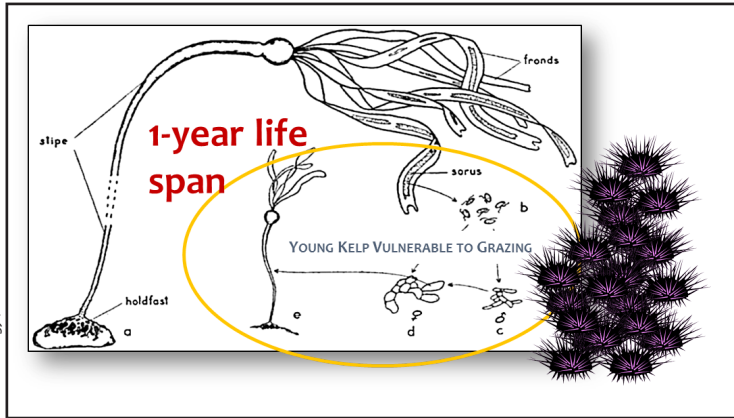
Large aggregations of purple urchins are wiping out kelp forests, creating pink barrens and out-competing other species, such as abalone, for food.



Summer water temperatures. The impacted area on California's north coast is circled.



diagram from "The Oceans, Their Physics, Chemistry, and General Biology", 1942



Challenges to Kelp Recovery

The recovery of canopy-forming bull kelp is a critical concern for many of the nearshore commercial fisheries in California. The lack of kelp and associated loss of species diversity may also reduce recreational fishery enjoyment in affected areas. Bull kelp, common on the north coast, is very sensitive to warm water, and can die in water temperatures above 63°F (17°C). Bull kelp recovery may be limited even if ocean temperatures cool because kelp spores are vulnerable to intense urchin grazing, which can prevent the re-establishment of kelp beds. Successful re-establishment of new kelp every year is critical, because bull kelp is an annual species that lives for only one year. Without successful reproduction every year, the kelp forest may be unable to grow back to its full potential.

Consequences for Local Fisheries

Coastal communities are already experiencing socio-economic impacts from this environmental disaster. The recreational red abalone fishery and the commercial red sea urchin fishery are economically very important to the north coast region. The recreational abalone fishery was recently assessed at a value of \$44 million to the fishermen (non-market value). The north coast sea urchin fishery, which mainly targets urchin roe for export, has been valued at \$3 million (ex-vessel value) per year.

In 2015, the commercial red urchin fishery experienced a 66 percent drop in catch and economic value due to the poor quality of the urchin roe. Red urchins are the primary target of the fishery (not purple urchins) since they are larger and more marketable.

Recreational divers and rock pickers reported shrunken and weakened abalone in fall 2015, which may also decrease the red abalone catch. Recreational abalone fishing on the north coast is a time-honored tradition, but people are less inclined to search for abalone if the meat is not worth the effort, or if people choose not to pursue abalone fishing due to concerns about the health of the resource.

CDFW Tracks Ecosystem Impacts

These rapid and dramatic changes over a large area of the coast are a primary concern for marine resource

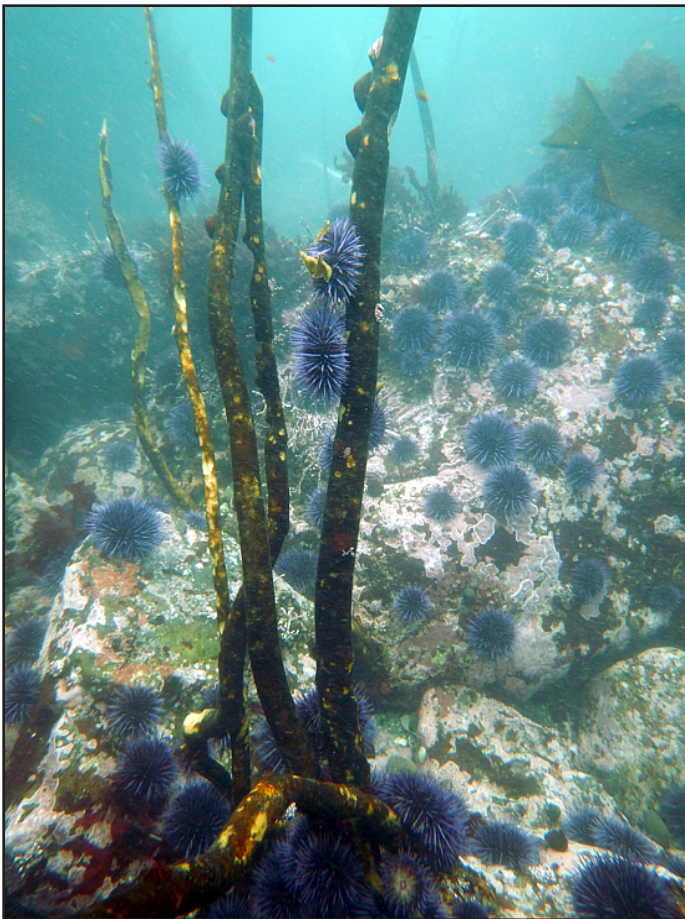


photo by A. Weltz

Purple urchins grazing a desolate kelp forest, Fort Ross, 2015.



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managers in California. Alerting the public, policymakers, scientific community and other stakeholders to these issues is a high priority for CDFW.

CDFW will prioritize research and monitoring of the situation to improve our understanding of the impacts hitting the affected fisheries, and to find methods that may help the kelp forest ecosystem recover. CDFW's marine invertebrate management team is partnering with the fishing industry and the scientific community to identify opportunities to assess kelp forest recovery potential under various conditions. CDFW researchers will also continue the long-term ecosystem monitoring program that will track changes in ocean conditions, and hopefully the progress of kelp forest recovery.

Continued assessments of abalone health and reproduction on the fishing grounds will also improve researchers' understanding of the magnitude of impacts to our fisheries. The CDFW Marine Region website and Marine Management News blog will be updated periodically with results and developments from these efforts as they occur.

What Can You Do?

Here are a few ways to become involved:

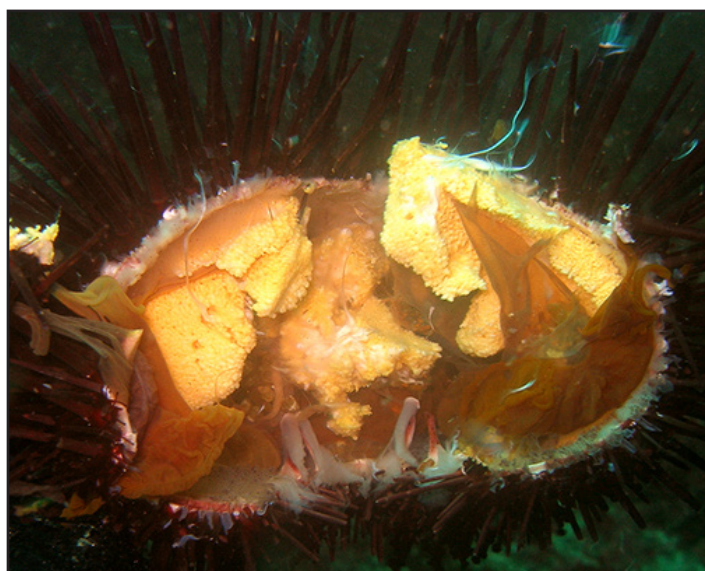
- Share this information on your social media accounts. This is an important message. Please help spread the word!
- Visit the Noyo Center for Marine Science's "[Help the Kelp](#)" [web page](#) for the latest information about recovery plans and activities.
- Report Observations: If you have observed related events, and would like to share your observations and photos, please contact CDFW's [marine invertebrate team](#). The most helpful information for research will include the date, location, and depth of your observations.

Learn More

CDFW Marine Region Invertebrate Project website: www.wildlife.ca.gov/Conservation/Marine/Invertebrates

CDFW Marine Region website: www.wildlife.ca.gov/Regions/Marine

continued



Healthy urchin roe

photo by D. Rudie



Shrunken abalone due to lack of food, October 2015. The foot (meat) of the abalone should be roughly the same size as its shell.

photo by S. Holmes



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Watch Dr. Laura Rogers-Bennett's presentation "The Perfect Storm: Multiple Climate Stressors Push Kelp Forest Beyond Tipping Point in Northern California" (<https://www.wildlife.ca.gov/Conservation/Lectures/Archive#CLIMATEJULY18>) (7/18/2019)

Fish and Game Commission Adopts Emergency Regulations to Increase Purple Sea Urchin Bag Limit in Sonoma and Mendocino Counties (<https://cdfgnews.wordpress.com/2018/05/15/fish-and-game-commission-adopts-emergency-regulations-to-increase-purple-sea-urchin-bag-limit-in-sonoma-and-mendocino-counties/>) CDFW Press Release (5/15/2018)

Listen to Dr. Cynthia Catton's interview about the closure of the north coast red abalone fishery on KZYX Mendocino Public Radio (<http://www.kzyx.org/post/north-coast-red-abalone-fishery-closes-first-time-history#stream/0>) (12/21/2017)

California Recreational Red Abalone Fishery to be Closed in 2018 (<https://cdfgnews.wordpress.com/2017/12/08/california-recreational-abalone-fishery-to-be-closed-in-2018/>) CDFW Press Release (12/08/2017)

Northern California Abalone Numbers Crashing, Recreational Season May Shutter (<http://www.santacruzsentinel.com/article/NE/20171205/NEWS/171209832>) by Santa Cruz Sentinel journalist Alex Fox (12/05/2017)

Listen to Dr. Cynthia Catton and sport diver Josh Russo's interview on KRCB's World Cafe program (<http://radio.krcb.org/post/struggle-survival-ocean-floor#stream/0>) (11/7/2016)

North Coast Kelp Beds "Like a Desert" This Year (<https://www.pressdemocrat.com/lifestyle/5815868-181/north-coast-kelp-beds-like>) by Santa Rosa Press Democrat journalist Mary Callahan

Collapse of Kelp Forest Imperils North Coast Ocean Ecosystem (<https://www.pressdemocrat.com/news/5487602-181/collapse-of-kelp-forest-imperils>) by Santa Rosa Press Democrat journalist Mary Callahan (4/16/2016)

Watch Dr. Cynthia Catton's presentation to the California Fish and Game Commission (<https://www.youtube.com/watch?v=P42Gm1AiWQw>) on this topic (4/6/2016)

Listen to Dr. Laura Rogers-Bennett describe the environmental factors that caused the "perfect storm" on KCBS News Radio (<https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=122457&inline>)

Scientists now link massive starfish die-off, warming ocean (<https://www.seattletimes.com/seattle-news/environment/scientists-now-link-massive-starfish-die-off-warming-ocean/>) Seattle Times, 2/21/2016

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More information is available online at this web address.