Can the long-lost abalone make a comeback in California?

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Hunched over a tank inside the Bodega Marine Laboratory, alongside bubbling vats of seaweed and greenhouses filled with algae, Kristin Aquilino coaxed a baby white abalone onto her hand.

She held out the endangered sea snail—no larger than a bottle cap—like a delicate jewel. After years of fretting over their health, cleaning tanks and filtering the saltwater just right, one tiny oops could undo it all.

"They're like human hemophiliacs," Aquilino said, using a plastic ruler to measure the stubborn gastropod as it twisted and squirmed. "Even a small cut, they can bleed to death."

To the untrained eye, they appear pretty drab. But in this humming lab, home to more white abalone than in the wild, these invertebrates have captured minds and even hearts. They're the unsung canary in the coal mine—their vanishing numbers sounding the alarm of human greed and the perils we face as the land and oceans burn.

Abalone once were to California what lobster is to Maine and blue crab to Maryland, so plentiful they stacked one on top of another like colorful paving stones. Californians held abalone bakes, spun abalone folk tales, sang abalone love songs. They grew large and hardy and fetched extraordinary prices. One diver once said it was like pulling $100 bills from the seafloor.

But we loved them almost to death.

The oft-told story of over-fishing goes something like this: Fishermen organize to defend their livelihoods, environmentalists protest, wildlife officials create rules to keep the population and the trade alive. But in this case, bans came too late, and the abalone fisherman is already a generation gone.

The white abalone—one of seven species along the California coast—once numbered in the millions, but in 2001 it became the first marine invertebrate to be listed as a federal endangered species.

How to save the white abalone has become a scientific puzzle. No one had thought to study them when they were abundant: What do they eat? How often do they reproduce? By the time this information was crucial to their survival, there were few left to study.

Scientists, aquarists, abalone farmers and retired divers have spent years trading notes, searching for wild abalone, and getting them to reproduce. Anchoring the effort is Aquilino's lab, which breeds them by the thousands in hopes of one day planting them in the ocean where they belong.

Aquilino has bathed and fed and pampered these snails with studious care. She's known them longer—five years—than her own children, and on this day in August, the mother of abalone was saying goodbye as the team packed them up for their journey into the wild.

If all these years of effort and love do pay off and Aquilino's abalone thrive, maybe, just maybe, they might even revive a special heritage that also has been dying in California with each passing year.

Aquilino held up the abalone and looked square into its beady-eyed face.

"You," she said, "are the future of your species."

The story of the abalone begins with the native people of the land, who say the strength of the ocean is in the abalone. Like the buffalo in the plains, the abalone in California were used for food, for tools, for adornment. Their shells, brilliant and pearlescent on the inside, were cherished and traded as far as New Mexico, where just one could buy a horse.

The California coast once teemed with the greatest number of abalone species in the world—black, white, red, green, pink, flat and pinto.

Linguists trace the word back to the indigenous Rumsen people in Monterey Bay, where they had gathered red abalone, aulun, for thousands of years. Spanish settlers adopted this word into abulon.

In the early 1900s, "Pop" Ernest Doelter, a German restaurateur who landed in Monterey, was frustrated that his oysters from San Francisco didn't always arrive fresh. Looking for a local product, he took a red abalone into his kitchen to experiment.

He figured out how to tenderize it just right—five whacks with a wooden mallet. He ran it through an egg wash, added cracker crumbs and cooked it up in butter, just like wiener schnitzel.

Sweet and salty with the slightest crunch, abalone steaks became a seafood sensation. Many professed their love in song and rhyme, jotting down verses in Pop's guest book, according to historian Tim Thomas, author of "The Abalone King of Monterey."

Oh! Some like jam, and some like ham,

And some like macaroni;

But bring to me a pail of gin

And a tub of abalone.

Millions of pounds were harvested by commercial fishermen, and diving for abalone became a favorite pastime.

"My dad was Dr. Ab. He once got five abalone in one breath," said Jenny Hofmeister, who is now trying to save the species with the California Department of Fish and Wildlife. "We'd have a big abalone feast. ... All the families come together and it's a full day of slicing and

pounding and frying."

When there were no more abalone on the rocks, divers went after species in deeper water. Whites, whose range stretched from Point Conception to Baja California, were the last to be fished, and in time more than 99% of the population vanished.

The state in 1997 finally banned both commercial and sport diving south of the Golden Gate Bridge.

But for all these years of caps and restrictions, the species has not recovered. With El Ninos and red tides and rising temperatures, the ocean has become a much trickier place to live.

That's how so many white abalone ended up hundreds of miles north of their native habitat, in Aquilino's Bodega Bay lab, where the water's still cold.

Here in the facility run by the University of California, Davis, they get the best food, the cleanest water. The lights are synced to sunrise and sunset in Santa Barbara. More than 80,000 gallons of seawater pump in daily, and an intricate network of pipes and contraptions zaps away bacteria with UV radiation and filters everything down to 5 microns. The water is chilled to exactly 57.2 degrees Fahrenheit.

A huge threat to survival is withering syndrome—a disease, scientists discovered, that proliferates in warmer water and paralyzes the abalone's esophagus. The abalone stops eating, eventually digesting its own muscle to death like a starving human would their own fat.

Lucky for Aquilino, the state shellfish health expert (yes, that's a real job) works next door. His team developed an antibiotic bath that keeps the bacteria at bay. They also developed a protective shell waxing

treatment, coating the abalone with organic coconut oil and beeswax twice a year.

"We're like the Sonoma County spa retreat for white abalone," Aquilino said.

They deserve to be pampered. The future, after all, rests on the sexual whims of the 10 special mama and papa abalone that scientists were able to recover from the wild.

To get them in the mood to release eggs and sperm within the same hour, Aquilino dims the lights and uses a "love potion" of just the right amount of hydrogen peroxide. She learned some tricks from Doug Bush, an abalone farmer in Goleta who has successfully bred red abalone for chefs and markets.

She finally got 20 babies that made it past the first year. The following year, 120. Then it was a few thousand. She's now at about 30,000 a year, but to truly keep the population going, she needs 100,000 new abalone each year.

"If we can make enough of these animals," she said, "we will be able to save the species."

Eight months before the white abalone were packed up in Bodega Bay, Heather Burdick and her team were on a research boat off the coast of Palos Verdes, tending to the other half of the operation: Learning and practicing how to put abalone deep into the ocean.

On this cold January day, they were checking on 1,200 farm-raised red abalone they had left in 20 makeshift homes built out of milk-crate-like boxes anchored to concrete slabs. Burdick and her team at the Bay Foundation had tucked them along a reef about 70 feet deep. Like easing

fish from the pet store into an aquarium, these so-called SAFEs (Short-term Abalone Fixed Enclosures) help reduce the shock of a new habitat.

It had been two weeks, and Burdick was anxious to see if even a few of the abalone were still alive.

She crouched over a mock-up of the SAFE, fumbling with zip ties and PVC pipes as she showed the other divers how to open the contraption just a crack—enough for the abalone to crawl out if they feel ready, but still enclosed enough to fend off any predators.

Diving at that far depth, they would have only 55 minutes to open all 20 SAFEs. Better to practice on deck before heading underwater.

"Make your mistakes now," she said. "You don't run out of air up here."

These red abalone missions will ultimately determine what's best for the whites. The two species match up closest in how deep they tend to live. The team first tried green abalone in 2015—much easier, their habitats only 12 feet deep—and saw that planting animals out in the ocean did indeed work.

"All right, let's do this," said Tom Ford, the Bay Foundation's executive director.

They dove off the boat with four other divers. Anticipation charged the silence. Will the abalone, they wondered, embrace the deep ocean?

The visibility was so clear Burdick and Ford could see the SAFEs almost 50 feet before they reached them. They opened the first one like they practiced on deck, and Burdick gurgled in surprise. Four abalone crawled out without hesitation, their tentacles tickling their new surroundings.

Ford gurgled and bubbled back. They watched with giddiness, losing precious minutes of air.

When they resurfaced, the rest of the team was already on deck.

"We had four crawl out immediately! It was so cool," Burdick said. "They booked it."

"Oh, wow, ours just wanted to hang on," said Adri Sparks, who was counting the shells she had collected from all the abalone that didn't make it.

Burdick added eight more to the growing pile. "There was an octopus underneath one of the SAFEs. I think he made it his personal buffet."

They traded more notes on what they saw so many feet underwater. Whites are special because they're the only abalone species that live more than 200 feet deep. They're the Zambonis of the seafloor, the ones who help keep the whole ecosystem stable—especially as climate change throws the entire ocean out of whack.

Abalone thrive on kelp. But the kelp forests have been dying as the ocean gets hotter and clouded with more pollution. And what little kelp is left keeps getting devoured by aggressive purple urchins that have pushed out all other life, carpeting the seafloor.

"If there's no forest, you wouldn't expect any birds perching in the trees," Ford said. "In our ocean, there is no abalone without the kelp."

Divers in Southern California have spent years smashing purple urchins. They're monitoring the decimated forests and helping them heal. All this work leading up to the white abalone's homecoming—the kelp, the green abalone, now the red—just might bring back the whole ecosystem.

On a warm day in July, 20 scientists gathered for one of their final missions: Finding just the right spot in the ocean for the white abalone.

David Witting, a NOAA Fisheries biologist, had spent years gathering local knowledge from retired fishermen and divers to identify areas where white abalone once thrived.

A good hint that you've found a primo location is if you come across a white, he said.

It's a rare sight, but Witting's been lucky a few times. He still remembers a fateful day in 2016 when he came face-to-face with a full-grown female clinging to a large rock. Careful not to disturb her, he lugged the 10-pound boulder back up to the boat. That abalone spewed millions of eggs this April, mobilizing an entire network of aquariums, labs and farms across California as Team White Abalone scrambled to house 7 million new larvae.

Now they just need a home in the ocean. Witting and the team gathered around a map marked with points and lines. They discussed what to look for: Macrocystis kelp. Foliose red algae. A nice mix of boulders and bedrock, cobble and sand.

Ian Taniguchi, a 27-year veteran at the California Department of Fish and Wildlife, was ready to channel his inner abalone—crevices, nooks, good places to hide. His colleagues say he has a particularly good "abalone tingle."

Taniguchi sank slowly to the bottom, skimming 3 feet above the seafloor. He pushed through the kelp and admired the nice ridges along the reef. Another diver suddenly heard his muffled yell and rushed over to see a large white abalone.

When the divers hoisted themselves back onto the boat, Burdick asked, "See anything interesting?"

Taniguchi grinned. "Only a live white abalone."

"Shut up! Really?

"We found one too!" Sparks, from the Bay Foundation, called out across the deck. Her dive partner, Armand Barilotti, had spotted one moments before they had to swim up for air.

"We did a little dance," she said. "We did a lot of dances."

Witting, the NOAA biologist, popped out of the water: "I found one!"

He joined the deck full of jubilant scientists and savored the moment. Each diver had spent years solving their piece of the abalone puzzle: Burdick and her team practicing different methods with red abalone. Another team, led by the Paua Marine Research Group, doing the same in San Diego. A dozen more at NOAA, Fish and Wildlife and the Aquarium of the Pacific studying how abalone breed, the food they eat, and the predators that eat them.

"Abalone historically brought people together," Witting said. "You get together to dive, get together to cook, get together to celebrate. ... We lost all that when we lost the abalone."

Saving this species, he realized, had brought people together again.

In August, back at the lab in Bodega Bay, it was time to say goodbye. Another gathering of people, 30 this time, for the white abalone and Aquilino, the mother who raised them all.

Some wiped away tears. One woman held roses. L. Frank stepped forward to sing to the abalone in Tongva as they began their journey south to their ancient homeland.

Don't be afraid.

"Like the abalone, we are also fighting extinction," said Frank, who is Tongva and Ajachmem. "We understand the loneliness of the comeback. But there is also strength in that comeback."

Aquilino nodded, filled with all the anxiety and joy a parent feels when their kids go off to college. She had spent days preparing the first 3,000 abalone to brave a new world. Now they were all tucked into coolers, cushioned with ice packs and foam soaked in sterilized sea water. Burdick promised to check their temperatures during the 10-hour drive to Southern California.

After giving the abalone two months to acclimate to Los Angeles seawater, the team reunited in October. It was just past 7 a.m., and messages were flooding in from fellow scientists who have worked for years leading up to this day—the day the abalone go into the ocean:

"Happy white ab day!"

"Make me proud!"

Aquilino and Burdick hugged and boarded the boat.

"I woke up this morning shaking," Aquilino said, "with excitement, I think."

"I woke up seven times last night thinking we forgot something," Burdick said.

Burdick and three scientists dove off the boat, geared up like they had practiced so many times before. Aquilino, standing watch on deck, hugged the bag of white abalone one last time before gently handing them overboard.

To her surprise, tears came. Aquilino wiped them away as the divers went under. The day will come, she hopes, when she'll see her abalone again in the wild.