The Natural Laboratory Podcast Transcript:
Acid Ocean: Where will all the seashells go?

Introduction
This is the Natural Laboratory, a podcast exploring science for Bay Area National Parks. I’m Cassandra Brooks.

More than a hundred thousand marine species built their bodies using calcium carbonate, including snails, oysters, sea stars, coral, and plenty of planktonic animals.

This incredible diversity of life evolved over millions of years as animals figured out ways to pull calcium and carbonate ions from the water to build shells and skeletons so robust that they remain intact long after the animals perish.

But all of this is changing. Our addiction to fossil fuels and the billions of tons of carbon dioxide \([\text{CO}_2]\) we’re pumping into the atmosphere each year may be undoing millions of years of evolution in a geological blink of time.

Ann Russell
Interview
Ann Russell: Geochemists and oceanographers have known for a long time that when \(\text{CO}_2\) dissolves in water, it forms an acid.

Cassandra Brooks: That’s Ann Russell, an ocean geochemist at the University of California, Davis who studies ocean acidification in Tomales Bay, just east of Point Reyes National Seashore.

Almost one third of the world’s carbon dioxide is absorbed by the oceans, says Ann. This excess \(\text{CO}_2\) reacts with seawater, freeing hydrogen ions, which lowers the pH and makes the water more acidic.

Living in more acidic waters is bad enough for shell-building animals, but \(\text{CO}_2\) adds another problem. Animals need both calcium and carbonate to build their skeletons. But the extra hydrogen ions in the high \(\text{CO}_2\) water bind carbonate, reducing the amount available for animals to build their shells. So, what might this mean for the future of calcifying organisms?

[ somber music and a video of a sand dollar dissolving in acidic water with a pH of 4.7 ]

AR: Just to bring in some of the geologic perspective on this, 18,000 years ago during the last glacial maximum, atmospheric \text{CO}_2 was 200 ... 200 parts per million. Then it rose at the end of the glacial period.

CB: But it only rose to 280, Ann says. And the increase happened over an 8,000-year period.

Since the industrial revolution, atmospheric carbon dioxide has now spiked to more than 390 parts per million. That's an increase of 110 ppm in only 250 years.

AR: So, they’re faced with much more rapid change than has ever been seen in the geologic record... ever. We don’t have a geologic analogue for the rate of change going on right now.

Terry Swyer
Interview
CB: Given how fast the ocean’s chemistry is changing, it’s no surprise that we’re beginning to see widespread effects in many calcifying animals, including those we like to eat. Oyster hatcheries in the Pacific Northwest have recently experienced massive larval die offs. When scientists measured local seawater, they found that during certain times of the year, the waters were corrosive enough to be the culprit.

Terry Sawyer: It's fairly insidious, as far as the effects, if you’re talking about degradation of shell because of the lack of ability to bind the calcium carbonate, which is what our bivalves use to build their homes.

CB: That’s Terry Sawyer, one of the owners of Hog Island Oyster Company in Marshall, California. Terry said that young oysters are particularly vulnerable to ocean acidification. Their thin shells dissolve much faster and they struggle to make their transition from planktonic larvae to settling out on the sea floor. In general, more acidic waters simply stress the animals out.
Conclusion

It’s hard to imagine that humans are burning so much fossil fuel that we’ve altered our atmosphere—and now our oceans—faster than has ever happened in the history of the Earth. And it’s easy to feel hopeless. But I walked away from my conversations feeling that our fate—and the fate of our oceans—were not yet sealed.

We live in an ever-connected world, which affords incredible power to educate and be educated. We have the power to learn about the world around us and to listen to the scientists who are continuously deciphering our impact on it. We have the power to teach our children, to inspire change in our communities, and to support policies that are in favor of a healthy planet. We have the power to make a choice—every day—about how we live our lives.

With the Pacific Coast Science and Learning Center, I’m Cassandra Brooks.

Andrew Dickson Interview

CB: These strategies might work in the short term, but they would prove ever more difficult as atmospheric CO₂ levels continue to rise. And they’re sure to continue rising. Even if we stopped all CO₂ emissions tomorrow, the oceans won’t quickly return to pre-industrial levels.

Andrew Dickson: That’s one of the biggest concerns—if we add CO₂ to the oceans, and then we just stopped, how long would it take.

CB: That’s Andrew Dickson, a chemical oceanographer with the Scripps Institution of Oceanography.

AD: One picture is that it would keep going up a little bit, because the CO₂ in the atmosphere has not all yet dissolved in the ocean. But after a while, it would start coming down. Unfortunately, “after a while” is tens of thousands of years. We’re putting it in over a few hundred years, and if we leave it to purely natural processes of our planet to take us back to where it would— I don’t like to use the word—perhaps, “prefer” to be, the general chemistry, it’s going to take tens of thousands of years.

CB: Do you have any visions in your mind of what the future ocean’s going to look like in light of these changes? [pause] Visions, nightmares, dreams…?

AD: Visions, nightmares, dreams, I don’t know. [pause] Clearly, it’s going to change the possibility for a variety of calcium carbonate organisms in certain environments.

The coral reefs—if they grow more slowly, they are always being hit by waves and broken up. So, you have to keep growing where we go into the OA.

CB: OA or ocean acidification.

Hatcheries and oyster growers are actively discussing mitigation strategies, like only pumping in seawater during low CO₂ periods or installing seawater treatment systems.

TS: So, what is the...what are we seeing, you ask. Let’s say, in the past five years—let’s go even ten years—we’re seeing disease, a lot of disease issues. Why are they becoming more, uh, susceptible to disease? So, one, maybe there’s an introduction of that disease from another shellfish growing region. You know, maybe there’s transport going on. Maybe there is stress. And that’s...