EXPLORING EELGRASS

SHALLOW-WATER BEDS CAPTURE CO2

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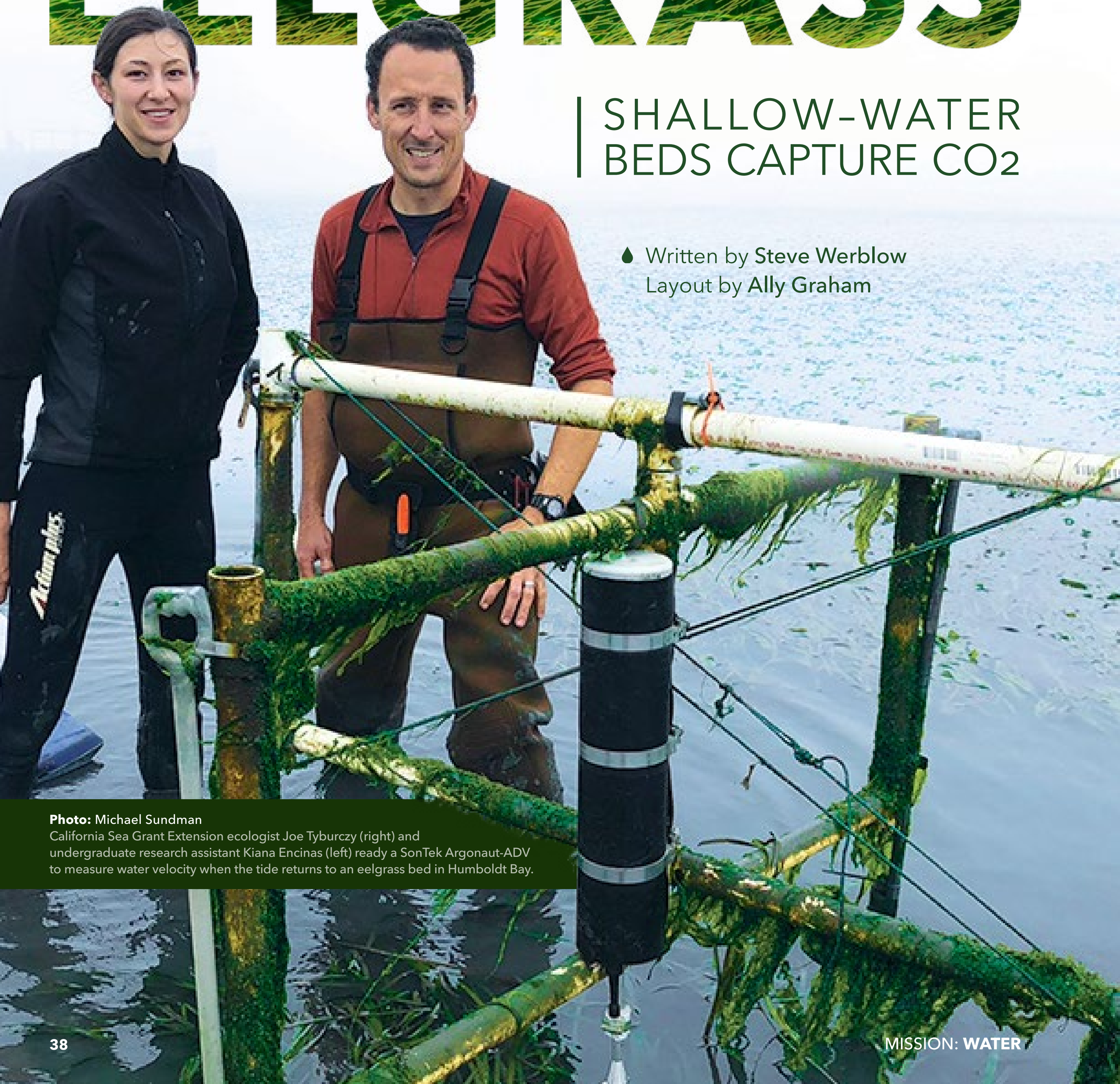


Photo: Michael Sundman
California Sea Grant Extension ecologist Joe Tyburczy (right) and undergraduate research assistant Kiana Encinas (left) ready a SonTek Argonaut-ADV to measure water velocity when the tide returns to an eelgrass bed in Humboldt Bay.

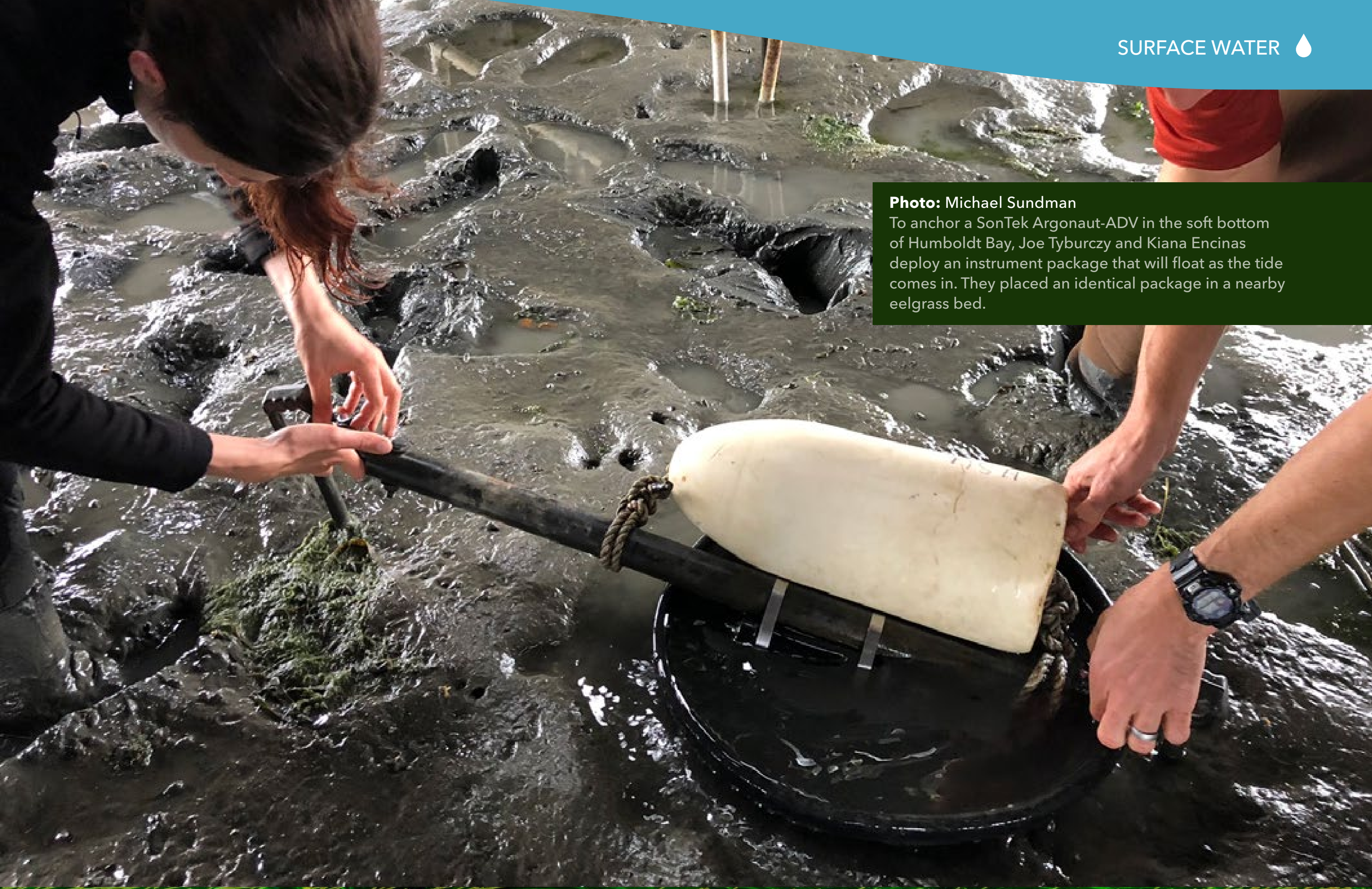


Photo: Michael Sundman
To anchor a SonTek Argonaut-ADV in the soft bottom of Humboldt Bay, Joe Tyburczy and Kiana Encinas deploy an instrument package that will float as the tide comes in. They placed an identical package in a nearby eelgrass bed.

Waving gently in the shallows of California's Humboldt Bay, meadows of eelgrass glow green in the tides.

The long, fluttering leaves of the eelgrass do more than shelter and nourish fish and crustaceans in the estuary. Like trees in the tropical rainforest, eelgrass captures carbon dioxide (CO_2) as it photosynthesizes.

That ability could make eelgrass more important than ever as CO_2 levels climb in the ocean, acidifying the water and threatening the survival of shellfish and plankton at the bottom of the food chain.

"Like many green plants, eelgrass grows faster as carbon dioxide levels increase," notes California Sea Grant Extension ecologist Joe Tyburczy at Humboldt State University in Eureka, California. "But unlike green plants that grow on land, eelgrass takes up CO_2 directly from the seawater."

If it could capture enough CO_2, eelgrass could be recognized as a vital resource in the protected bays where it thrives, and spur efforts to integrate it into shellfish production where it has long been viewed as a competitor for space by oyster growers.

Rising Carbon, Falling pH

Carbon dioxide levels in the atmosphere have increased by about one-third since the start of the Industrial Revolution, from about 300 parts per million (ppm) to about 400 ppm. About one-third of the atmosphere's carbon dioxide dissolves into the ocean, says Tyburczy. As dissolved carbon dioxide levels have increased, the earth's seawater has become about 30 percent more acidic.

For creatures that use carbonate from ocean water to build protective shells—including shellfish like oysters and snails, urchins, crabs, coccolithophores (plankton) and pteropods (tiny "sea butterflies" that are an important food for wild salmon)—acidic water poses two grave threats, Tyburczy notes. Most dramatically, acidic water can corrode shells.

But even before the pH falls low enough to be corrosive, acidified seawater reduces the rate at which carbonate precipitates out of solution. Precipitated carbonate is the fundamental ingredient used by shell-building organisms to make their protective armor.

If the carbonate saturation state of the water is low because of excess CO_2, fragile larval oysters and other bivalves and shellfish are forced to expend too much energy to build their shells.

"It takes more energy than they have," Tyburczy says. "They don't have yolk sacs—they get their energy from feeding on plankton. If they can't make ends meet with their energy budget, then they'll die or become so weakened that they can't fight off even low levels of parasites or bacteria." It's not hard to see why Tyburczy is so anxious to find out how underwater plants could combat acidification.

Joe Tyburczy and Kiana Encinas set up a SonTek Argonaut-ADV on a PVC rig to measure the flow of water across a bed of eelgrass. **Photo:** Michael Sundman

National Treasure

Tyburczy's current research is in Humboldt Bay, a shallow, highly protected estuary that is home to a $10 million oyster fishery, a wild salmon industry and at least one-third of California's eelgrass. In fact, 4,700 acres (19 km^2) of the bay's 15,400 acres (62.4 km^2) are covered with eelgrass beds. Humboldt Bay looks like a pair of lungs, with a windpipe poking through a thick sandbar into the Pacific Ocean.

It's a sheltered estuary with broad shallows—a perfect place to be an oyster or an eelgrass plant. In turn, eelgrass is a great indicator of changes in healthy but sensitive environments. The list of changes that can cause eelgrass to die off is a long one.

There's the movement of sediment that can clog tidal channels or change the elevation of the intertidal zone. Excess nutrients. Turbid water. Rising temperatures. Falling oxygen levels.

"Because it is such a sensitive species, it's an indicator species, a canary in a coal mine, a good species to keep an eye on in terms of monitoring the health of the bay," Tyburczy says.

PROVE IT YOURSELF

One of the most compelling reasons to study eelgrass is to learn how natural systems may help mitigate rising acidification in the oceans, according to Joe Tyburczy, a marine ecologist with California Sea Grant Extension. And one of the most striking things about understanding the link between dissolved carbon dioxide and acidification is that you can prove this relationship to yourself in your own kitchen.

1. **Coarsely chop half a head of red cabbage and put it in a pot with just enough water to cover the leaves.**
2. **Bring the water to a boil, cover the pot, turn off the heat and let it cool.**
3. **Meanwhile, pour fresh water into a pair of clear glasses.**
4. **Insert a drinking straw into one of the glasses and blow into the straw for a minute or two to inject carbon dioxide into the water.**
5. **Place the glasses on a piece of white paper and strain some cabbage water into each one.**
6. **The water that contains the higher level of CO2 will turn pinker—an indication of higher acidity—than the undisturbed water.**

"This demonstration is really fundamental," Tyburczy emphasizes. "This is a real, undeniable chemical change that is happening in our oceans and it is caused directly by carbon dioxide. It doesn't require you to believe fancy climate models. It just requires you to believe chemistry you can demonstrate in your kitchen at home."

Principal Effort

Tyburczy and his colleagues have been studying eelgrass beds and plan to start experimenting with removing cobble and shell riprap laid in the shallows years ago by oyster farmers. For decades, California's farmed oysters were grown directly on the mudflats and eelgrass beds and harvested by dredge.

Eelgrass, which grows in soft sediment, was disrupted by the dredging, as well as by the cobble and shell laid by shellfish producers to prevent the oysters from sinking into the mud and being smothered. Today, oysters are farmed on long lines festooned with groups of the growing bivalves in clusters or cages instead. Though far less damaging than dredging, these lines can pose other kinds of challenges for eelgrass, like shading eelgrass plants or abrading their leaves.

Though the circular scars from past dredge harvesting have largely filled in with eelgrass, many areas covered in shell and cobble remain mostly bare. By removing the hard material and restoring the soft sediment, Tyburczy and his colleagues are confident that eelgrass can be restored to those cleared areas.

Tyburczy's study of the ability of eelgrass to capture CO_2 from the water and reduce acidity could help illustrate the importance of the coexistence of oyster farms and eelgrass beds. One idea was that if the carbon-capturing effect were great enough, oyster hatcheries could site their water intakes near eelgrass beds and draw in water after it had sat over the eelgrass and some of its CO_2 had been extracted—and its pH had increased.

Tyburczy and his team use two key instruments for the research: a Burke-o-lator designed by Oregon State University oceanographer Burke Hales to measure carbonate chemistry in the water in real time, and a SonTek Argonaut-ADV (Acoustic Doppler Velocimeter) to measure the movement of water in the shallow beds.

Eelgrass research is not just interesting to SonTek:

Tyburczy's project is funded by the Ocean Protection Council. It involves collaboration among California Sea Grant, Humboldt State University, Oregon State University, the Wiyot Tribe, the California Department of Fish and Wildlife and the Hog Island Oyster Company—a wide range of stakeholders illustrating the broad impact of ocean acidification.

"Velocity is a key covariate," he explains. "If velocity is high and chemical change is high, the eelgrass is doing a lot. If there's not a lot of change in the chemistry and not a lot of motion in the water, then the eelgrass is not doing much. Instead of just the magnitude of the difference in the chemistry, having data on the flow tells you about the flux."

Because the Argonaut-ADV uses acoustic signals to measure flow at a single, small point just a few centimeters from its transmitter, it is highly effective in the shallow water that favors eelgrass growth and extremely accurate at measuring the highly variable flows that are common in Humboldt Bay, he adds.

Dr. Xue Fan, an application engineer for SonTek, points out that Tyburczy's use of an Argonaut ADV underscores the importance of accurate flow measurement in a wide range of water chemistry research.

"The data from the Argonaut can provide the vital context for changes in chemistry that we observe," she notes. "We are very excited to see Dr. Tyburczy using the Argonaut-ADV to shed light on one of today's most pressing issues: how underwater communities are operating as the pH of the oceans continues to fall."

Tyburczy also measures temperature, salinity, dissolved oxygen and pH both inside and outside the eelgrass beds, tracking the diurnal and seasonal cycles in water chemistry and comparing water quality inside and outside the beds under various conditions.

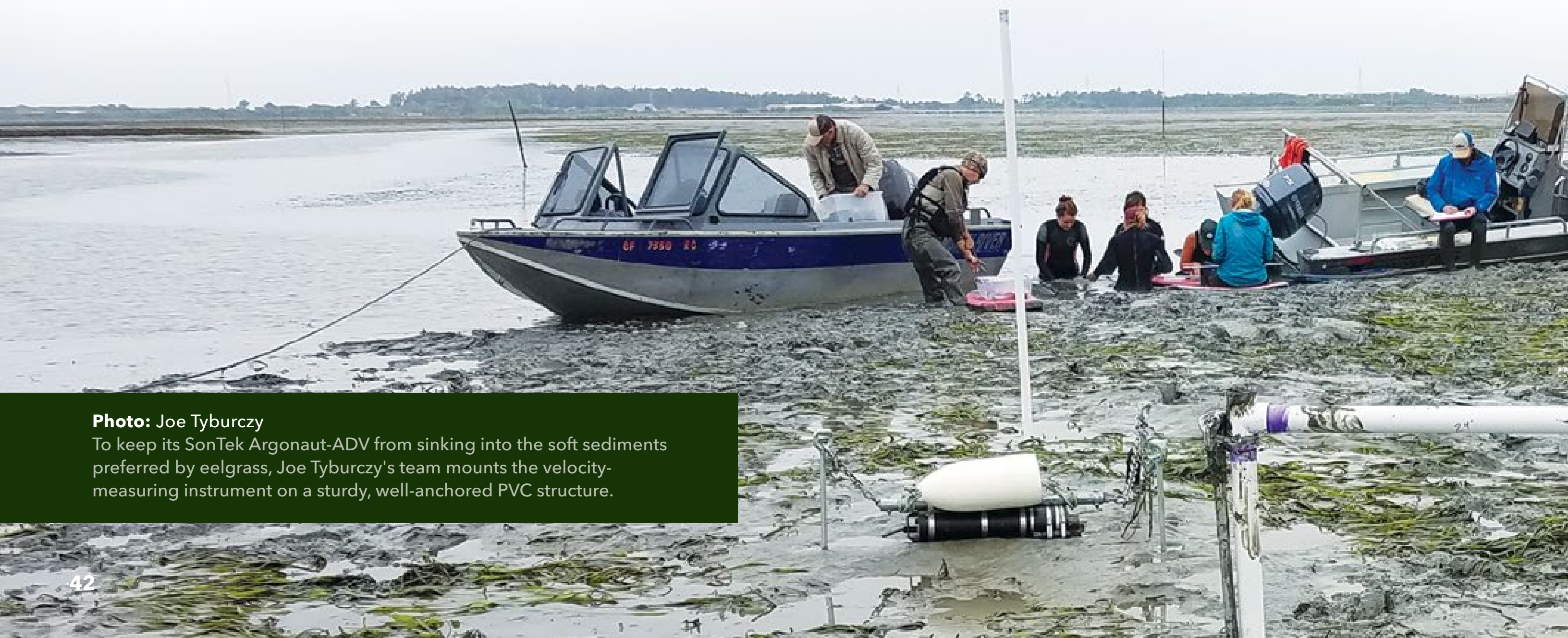


Photo: Joe Tyburczy
To keep its SonTek Argonaut-ADV from sinking into the soft sediments preferred by eelgrass, Joe Tyburczy's team mounts the velocity-measuring instrument on a sturdy, well-anchored PVC structure.

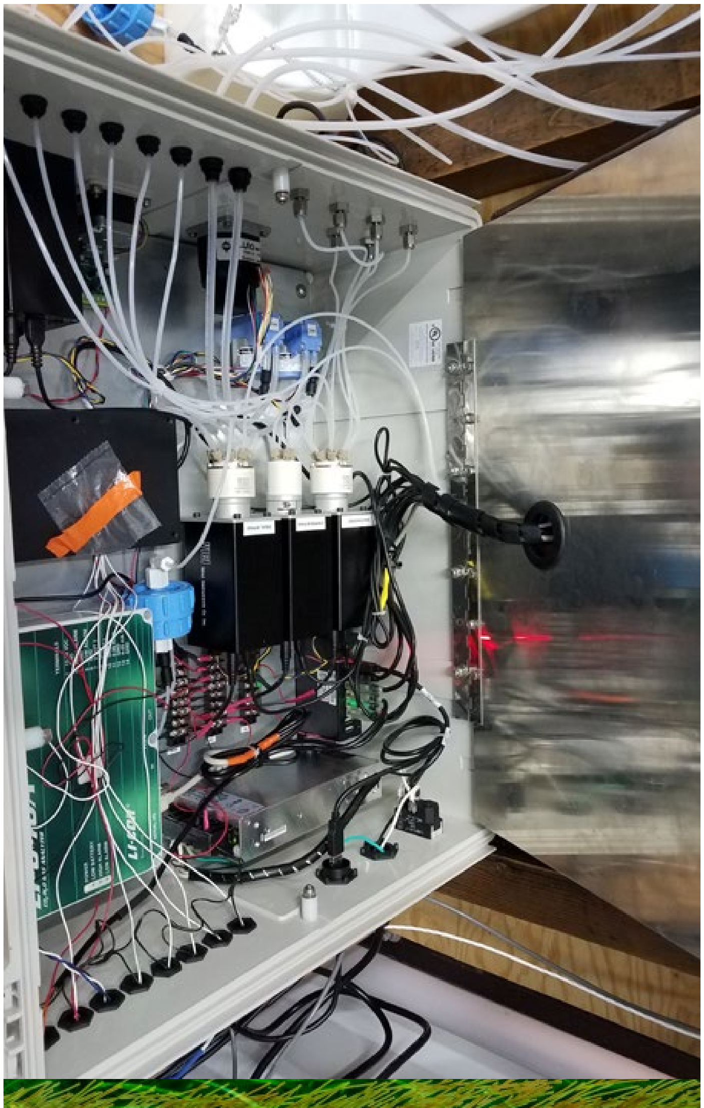
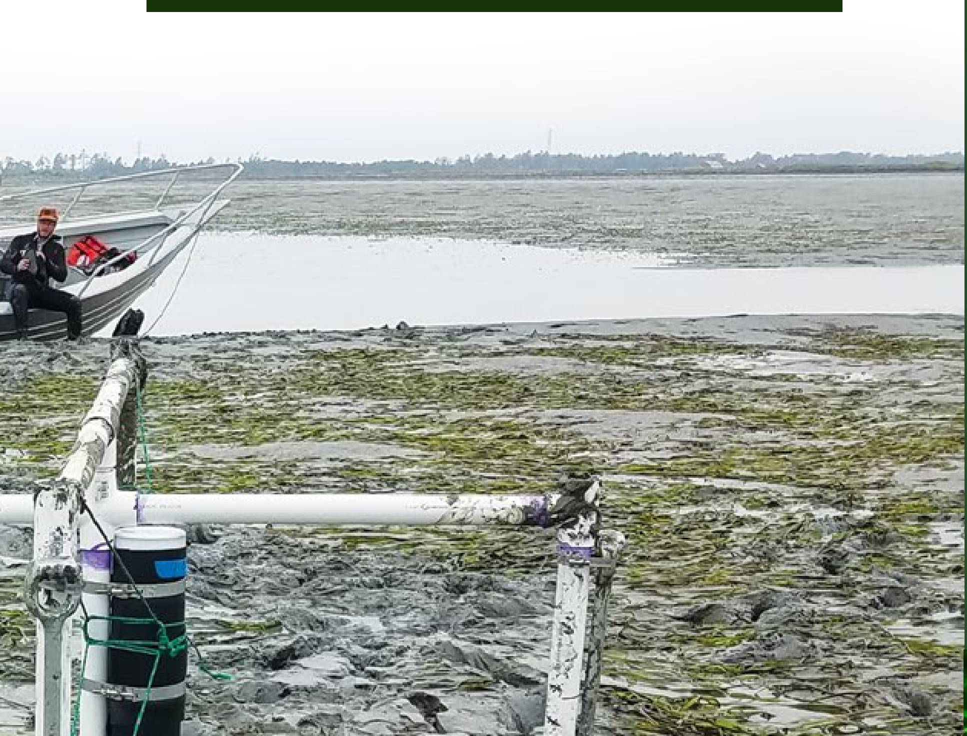


Photo: Joe Tyburczy
The Burke-o-lator, designed by Oregon State University oceanographer Burke Hales, provides real-time measurements of the carbonate status of seawater. Carbonate is the main ingredient in crustacean shells.



X MARKS THE SPOT

On pirate maps in movies and kids' books, X has always marked the site of buried treasure. For California Sea Grant Extension ecologist **Joe Tyburczy**, a four-foot (1.21 meter) X marks the location of his SonTek **Argonaut-ADV** (Acoustic Doppler Velocimeter).

Tyburczy uses the Argonaut to measure water flow in the shallow eelgrass beds of **Humboldt Bay** in northern California, where he is studying eelgrass' ability to capture carbon and reduce acidity levels in bay water.

Eelgrass thrives in soft sediment—so soft that getting to the study sites at low tide is a grueling slog through knee-deep mud or a trudge on snowshoe-like mudders. It's the sort of bottom that can quickly suck in a pole-mounted instrument.

Tyburczy deploys his Argonaut-ADV on a cross-shaped PVC rig that is augered deep into the mud at all four corners—a pair of stacked, horizontal Xs held together by two-foot lengths of pipe at the end of each arm and the crossing point at the center.

The Argonaut-ADV is strapped to the center pipe, its acoustic transmitter and receivers aimed just above the bed to measure the velocity and direction of water flow using the Doppler effect. It's stable, unsinkable, and clever—and it provides vital context for the water chemistry data Tyburczy is generating nearby. Treasure indeed.

Findings To Date

Tyburczy is blunt about his findings so far. "The chemical benefits, the extent to which eelgrass counteracts the ocean's acidity seem to be more modest—not as robust—as we had hoped," he says. "At least in North Humboldt Bay, it doesn't extract enough carbon to meet the needs of the hatchery."

Eelgrass does raise water pH, he explains, but not enough to modify water chemistry as much as oyster producers had hoped. On Oregon's Netarts Bay, the staff of the Whiskey Creek oyster hatchery have found it necessary to raise the pH and carbonate saturation of intake water with sodium carbonate. Based on the results of Tyburczy's work with the Burke-o-lator, the Hog Island Oyster Company hatchery on Humboldt Bay has begun buffering its seawater, too.

That's science, says Janice Yasui, SonTek product manager. It's a journey. "Sometimes a single study will produce a revelatory result," she notes, "but often science is a longer process of building up the literature and performing the critical task of adding to the body of knowledge, step by step. Scientists are the unsung heroes of our generation's efforts to address climate change.

"These problems don't solve themselves," Yasui adds. "But it's not a hope-and-pray situation, because science is a method above all, and scientists are doing the research that needs to be done to find the connections that work—and, by definition, also finding the ones that don't—to create legitimate hope and solutions."

To that end, Tyburczy is still exploring the factors that make bays like Humboldt less acidic than the oceans that feed into them. As part of that research, he is working to differentiate the carbon-capturing effects of eelgrass and phytoplankton, which may be masking each other's effects. "That's too important a nexus not to investigate," he says.

Meanwhile, Tyburczy points out that even if eelgrass can't overcome the effects of climate change on its own, research like his is helping scientists appreciate how strong an indicator it is of ecosystems that are functioning in spite of the challenges around them. "If you're going to find refugia from ocean acidification, a bay with a lot of eelgrass is a good place to look for that," he notes. That's good news for oysters, and important for the rest of us to recognize—and protect.

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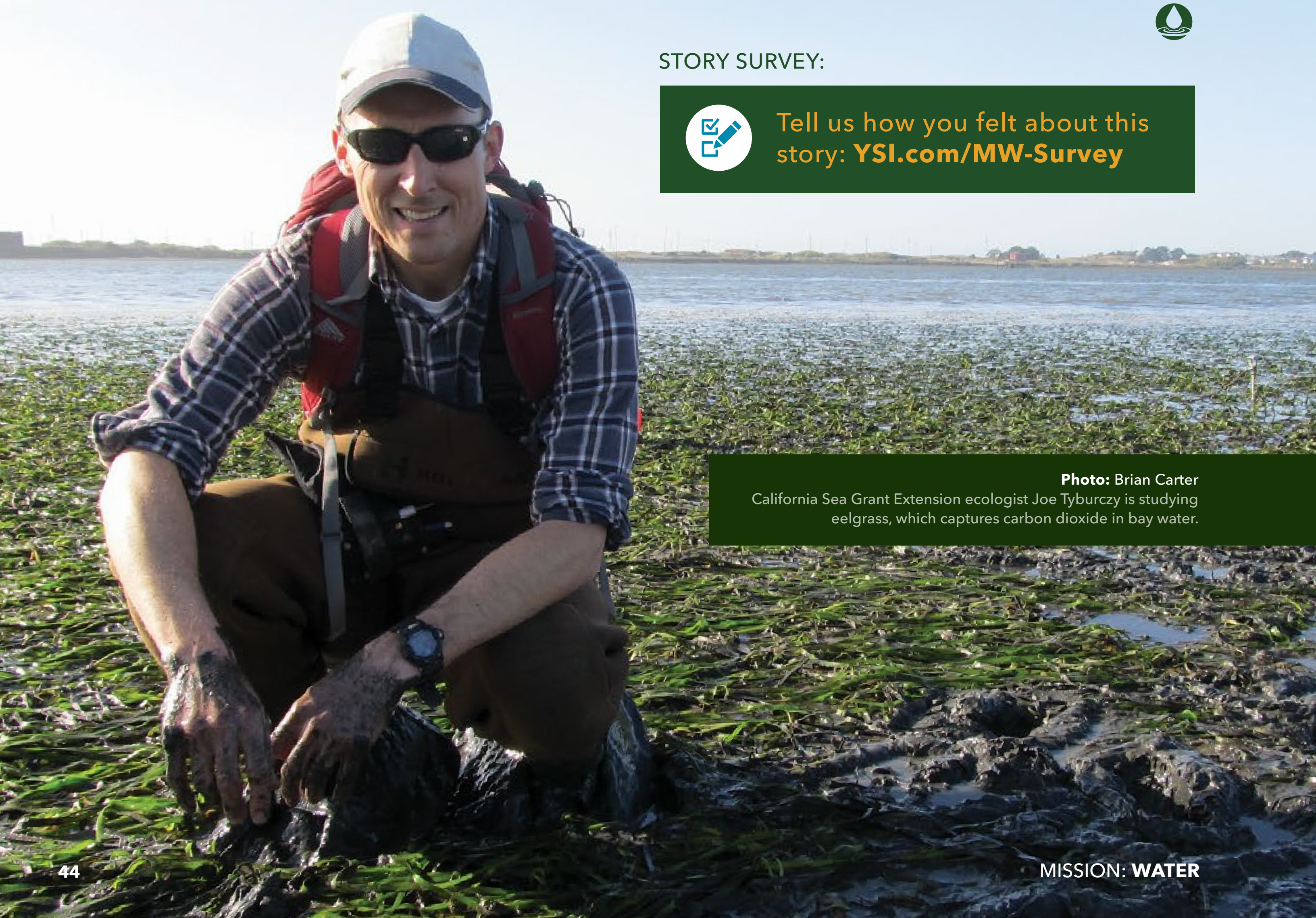

Photo: Brian Carter
California Sea Grant Extension ecologist Joe Tyburczy is studying eelgrass, which captures carbon dioxide in bay water.

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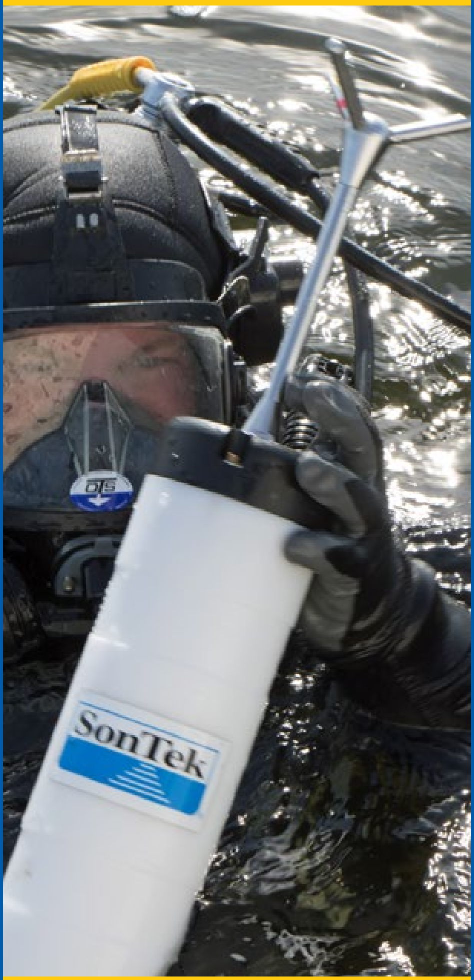
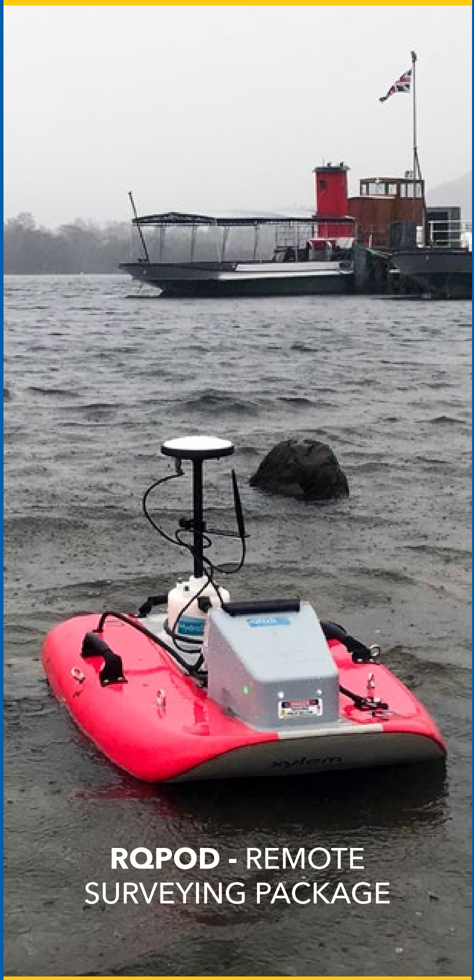


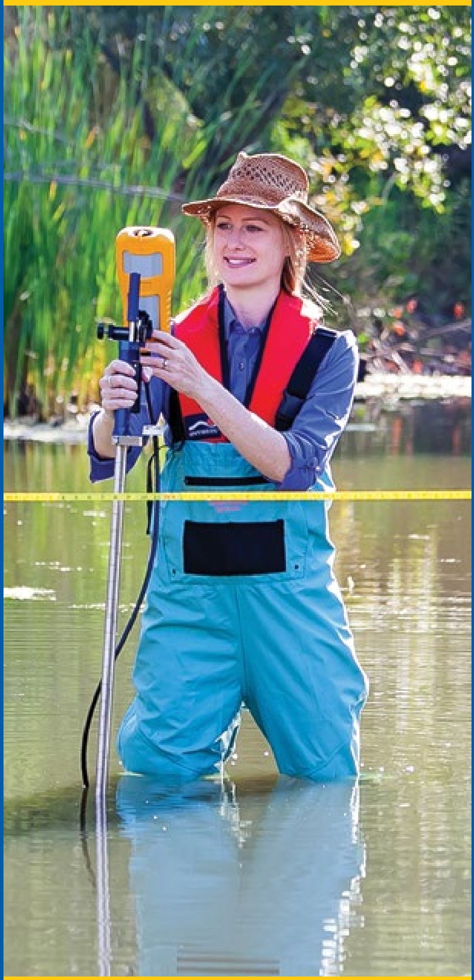
Argonaut-ADV

Maps and Surveys



HydroSurveyor-M9

Discharge Data



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