

# a balancing act



**A leading UMaine marine scientist says better management is needed to save the world's oceans that are drastically out of sync**



**I**N 1982, THEY WERE EVERYWHERE. Thousands of mushy, globular bodies attached to tens of thousands of tiny, tubular feet, each slowly pulling its burden across the ocean floor with a clear and instinctual determination. Driven by the urge to eat and defended by a dome of stubby, green spikes, Maine's population of green sea urchins, *Strongylocentrotus droebachiensis*, were the miniature versions of so many punk-rock buffalo, grazing their way across the Gulf of Maine in seemingly endless, insatiable herds. Fast forward to 2002. In less than 20 years, the Gulf's vast, prickly carpet of urchins was reduced by hundreds of millions of animals by over fishing, the survivors sprinkled far and wide along Maine's ragged coast. But the urchins' story is not as simple as it might seem. Like so many other organisms that have been harvested from the waters of the Northeast, the urchin is just another character in a very long and complicated story — a story marked by intricate plot twists, shocking irony and a conclusion that is shaping up to be downright terrifying.

**WITH MORE THAN** a quarter-century on the front lines of marine research, Bob Steneck is a man who knows when to fish and when to cut bait. The University of Maine Department of Marine Sciences researcher has spent his career unraveling the intricacies of

the world's marine ecosystems, and his "big picture" approach to conservation and fisheries management has helped to tie together the oceans' many divergent plot lines into a single, unified tale of global turmoil and anthropological excess. From searching for fish

bones in 2,000-year-old trash heaps to studying Caribbean corals with the help of high-tech diving gear, Steneck has gathered considerable evidence that suggests that the coming years may be the final chapter for many marine ecosystems as they exist today.

**Invasive species like the green crab are just one of many problems facing the health of marine ecosystems and the sustainability of marine fisheries. By feeding on native shellfish and other organisms, and competing with native crabs and lobsters for food and shelter, green crabs and their imported brethren have been a scourge along both coasts of North America.**

Underwater images courtesy of Bob Steneck

### Lost World

MORE THAN 20 years ago, in an attempt to assess the ecological impacts of the cod's disappearance in the Gulf of Maine, Steneck spent months monitoring predator-prey interactions along an under-sea mountain known as Cashes Ledge. Free of the groundfish draggers that had hauled off millions of pounds of cod elsewhere in the gulf, the area was home to a relic population of big cod that dominated the ecosystem.

Like the hapless goat in Jurassic Park, tethered lobsters along Cashes Ledge met their end almost instantly. In this lost world, the pressure of predation kept the number of smaller lobsters down, leaving only the fittest grow large enough, and smart enough, to avoid being eaten. The large predators kept the populations of smaller species in check and the system in balance.

Steneck used the data he gathered at Cashes Ledge as a springboard for his current archeological research. By sifting through fish remains in an ancient midden discovered on an island just off the Maine coast, he has discovered evidence that suggests that changes in the marine ecosystem caused by humans may have begun to have an effect on cod populations much earlier than previously thought. Taken together, the two projects offer dramatic insights into just how much the Gulf of Maine ecosystem may have changes since humans first began hauling fish from its waters.

Bones collected from the midden show a dramatic change in the early inhabitants' eating habits, switching from a diet that consisted almost exclusively of cod to one that included smaller species like flounder and sculpin. The change could reflect a localized impact on the marine ecosystem caused by humans nearly 2,000 years ago.



From kelp forests to coral reefs, University of Maine Darling Center marine scientist Bob Steneck has studied the factors that lead to population collapse, identifying the nature of the ecological thresholds that determine a population's breaking point. Urchins are one of the main consumers of kelp and other algae in the Gulf of Maine, making changes in urchin populations critically important to



the health of kelp forests. By helping to better understand the complex scenarios that lead to population collapse, Steneck hopes to find ways to protect other organisms from the same fate. The photos below, left to right, show healthy algae and kelp beds, as well as an urchin barren on the ocean floor. All three marine habitats are found WHERE?

The story is still being written, but Steneck, for one, is bent on creating a happy ending.

"I'm generally an optimist at heart, but there are some serious threats to the world's oceans," Steneck says. "We tend to look at the planet, and in particular the oceans, as this stable, permanent, nurturing source of life, but as science peels back the layers,

what we see is a global ocean in trouble."

**POINTING TO A** growing list of health threats to the world's oceans, Steneck describes a common pattern of slow, incremental overload and sudden collapse, suggesting that the Blue Planet's ability to absorb the insults of human misuse have clear limits. The notion of ecological thresholds is at the core of Steneck's assessment of the seas. As pressure on the marine environment continues to grow, these thresholds are being met — and surpassed.

A classic example of the threshold phenomenon can

be found in the sad tale of the green sea urchin. Prolific and plentiful across the Gulf of Maine, green sea urchins spent decades quietly munching at the Atlantic's undersea salad bar, unaware of the socioeconomic tsunami on the horizon.

As urchin populations in other parts of the world were rapidly depleted by overfishing through the 1970s and '80s, a seemingly insatiable Asian market turned its hungry eyes toward Maine, creating a boom-and-bust fishery that crashed a multi-million urchin population in less than 20 years. Steneck used the urchin story to illustrate the effects of roving bandits

in a paper he, UMaine Marine Science professor Jim Wilson and others recently published in the journal *Science*.

"The urchin story is classic overfishing. Because of the globalization of fisheries, the Japanese were able to deplete the global stock. They could afford to pay top dollar in places like Maine, but they had no stake in the health of the ecosystem. Harvesters who move into a fishery and deplete the resource without any kind of investment in the ecosystem's long-term health are the definition of the roving bandit," Steneck says.

"The collapse of the urchin fishery was marked by a cascade

of ecological and socioeconomic effects. We can see the effects of surpassing the economic thresholds in the fishery: processors and distributors pull out, harvesters go out of business, but the effects of surpassing the ecological threshold are unknown. We don't know the implications of targeting the Gulf of Maine's most significant herbivore. But we do know that there is more seaweed sprouting in the Gulf of Maine than there's been in decades."

**THE PREQUEL** to the urchin story adds yet another twist to the tale: the urchin's pre-harvest heyday itself was due, at least in

part, to yet another case of overfishing. For millennia, the Gulf of Maine was ruled by the mighty cod. The powerful predator's mustached mouth gobbled up untold thousands of crabs, lobsters, shrimp and, of course, urchins during the fish's tenure as dominant predator, but the cod proved to be too tasty for its own good, quickly becoming the target of an international race to capture the most fish. Human-kind's appetite for salted cod, dried cod, boiled cod, cod chowder and finhaddie inspired a race for more traps, bigger nets, more powerful boats and so on. The technological onslaught proved too much for the cod, putting it

### Dynamics of Diversity

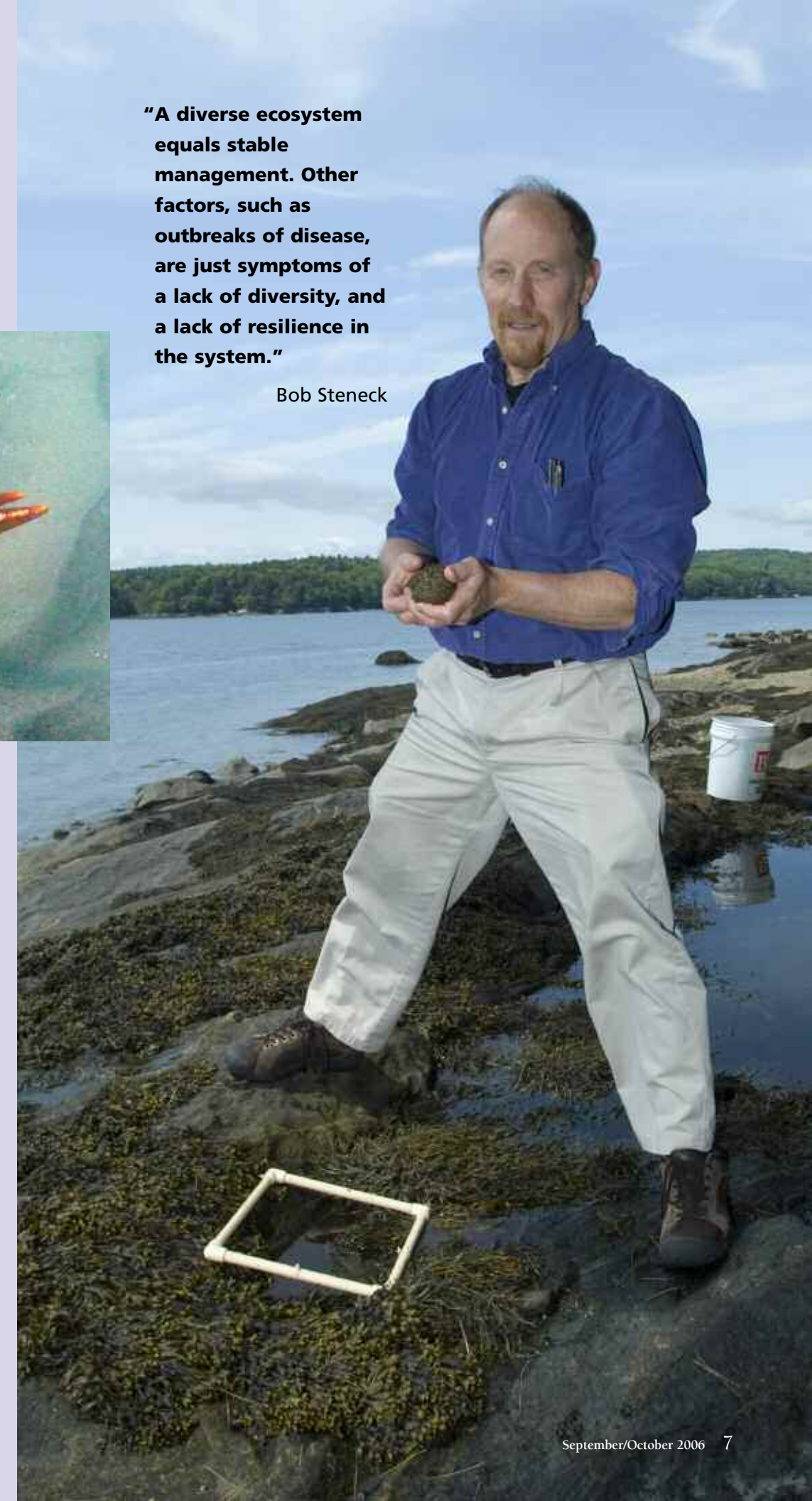
FROM MICROSCOPIC mud worms to 1,000-pound tuna, all marine organisms are part of a complex web of interdependence that forms the foundation for the system's overall health. As an ecosystem loses its biodiversity, it loses its resilience as well, making the organisms that depend in it more susceptible to disease, pollution, invasive species, over fishing, environmental changes and other threats. Professor of Marine Sciences Bob Steneck hopes to find new ways to preserve and restore biodiversity in the marine environment, an effort he hopes will not only strengthen damaged ecosystems, but stabilize fisheries a well.

In sustainable fisheries management, the focus is on the mid-size, leaving the smallest and largest of the population in the sea. It's been a successful strategy for the lobster industry, and may help bring back important predators like Atlantic cod and other groundfish. Below, left to right: a large rock crab and baby lobster.



**"A diverse ecosystem equals stable management. Other factors, such as outbreaks of disease, are just symptoms of a lack of diversity, and a lack of resilience in the system."**

Bob Steneck



and its fellow groundfish on Maine's long list of collapsed fisheries.

As the cod population dwindled, the urchin population grew, just as kelp and other algae are now taking advantage of their freedom from the urchin's hungry herbivory.

With their big-brained ability to find new ways to exploit marine resources, humans have proven again and again their knack for surpassing ecological thresholds and upsetting the natural balance beneath the waves. Steneck hopes to stabilize our relationship with the sea by finding new ways to fish that work more harmoniously

with natural processes.

"Following the evidence drawn from marine research over the years is like watching an episode of *CSI*: the science is very good at telling us what made the victim die," says Steneck. "What we are learning is that the role of consumers, or predators, in marine ecosystems is much more significant than it had been considered in the past. Loss of large predators from the system has a much greater impact than nutrient run-off or invasive species or any of the other factors threatening ecosystem health. One could argue it is the biggest issue facing fisheries management."

STENECK MAINTAINS that marine ecosystems are structured by their large predators, and that the lack of large predators due to overfishing can cause the populations of other organisms within the system to fluctuate uncontrollably. In the gulf, where the Cod Wars raged for nearly 400 years, declines in the cod population led to increases in the number of shrimp, lobster, urchins and other prey species. While some might argue that an increase in lobsters or other species humans find tasty is a good thing, the population swings of prey species represent a system out of balance, and it is that



Bob Steneck's interests in global biogeography, the study of why populations of different species inhabit some areas and not others, has led him beneath the waves in locations around the world. With the looming threat of global climate change largely beyond the ability of humans to control, conservation efforts and changes in fisheries management techniques may be our last best hope to preserve the health of the world's oceans.



balance that is so important to maintaining healthy ecosystems and sustainable fisheries.

Worldwide, many marine species once abundant are now rare, and dramatic increases in populations are often the precursor to disease outbreaks. In Maine, where fishermen once split their efforts between several different species throughout the year, fully 80 percent of the state's fisheries income now comes from a single species: the American lobster.

To put that into perspective, there are more than 50 other marine species that split the remaining 20 percent of Maine's

commercial fisheries income. The harvest of bloodworms for use as fish bait currently brings in more money to the state than cod.

"We need to manage our fisheries in a way that will bring back the dominant predators in order to restore diversity. A diversified ecosystem can support diversified fisheries, and that is the only way to maintain sustainable harvests," he says.

With 80 percent of the fishing economy riding on lobster, an outbreak of disease like what happened in Long Island Sound could devastate the socioeconomic fabric of the

state. Fishermen know the danger of depending too much on one species, says Steneck, who advocates broad changes in how fisheries are managed.

"When I first began doing research and working with fishermen, there was open hostility between managers, fishermen and scientists. Just in the past five years, fishermen have gone from being in denial to openly admitting there's a problem."

Steneck hopes to reinvent fishing by changing the way we look at harvest and management. Almost all fishing has been aimed at capturing the biggest individuals of the target species, leaving behind smaller,

younger animals to replenish the species. But to increase a fishery population, Steneck contends that mesh sizes or minimum lengths must be adjusted to leave a larger pool of small animals.

This is the antithesis to how natural predators work. As part of the natural process, predators take the bite-sized and the injured, but the biggest, healthiest, reproductive animals are relatively immune.

"If we could change our focus to target the intermediate-size animals, our fisheries would be more sustainable and the ecosystem would benefit," says Steneck. ■