OSU Marine Ecologist Mark Hixon:

Citizen and Scientist

Mark Hixon has been studying marine life in the world's oceans for over thirty years. In that time he's seen significant degradation of marine ecosystems and fisheries from Oregon to the Bahamas — degradation that continues unabated. Can the world's oceans wait until science is able to provide absolutes upon which policy can be made? Mark Hixon doesn' t think so and he's doing something about it.

Mark Hixon in his office at OSU

It's often been said that change is the only constant in life. Indeed, it is the imperative of life itself; ecosystems undergo change, species change and adapt, even the fixed stars in our night sky are playing out their own long-term scheme of change. And, in the past, dominant forms of life on earth have had their day, then stepped aside as change worked its ceaseless endeavors.

Clearly, it would be hard not to recognize that today's dominant species on the planet, *Homo sapiens*, by way of its ever-growing numbers and the consequences of those numbers, is causing change, the likes of which we are only beginning to comprehend.

For over 30 years, Mark Hixon has been witnessing those changes in the world's oceans and seas. Hixon, a professor of marine ecology at OSU, has worked in marine ecosystems around the world, from the deep waters off the Oregon coast, to his current research in a remote part of the Bahamas. The changes he has seen over the course of those years provide a cautionary tale about the effects of unintended consequences and the difficult decisions that lie ahead.

A lifetime in the water

Stepping into Mark Hixon's office is like stepping into a mini-library of marine ecological history. Shelves are neatly stacked with journals; books and reference materials run from floor to ceiling. A large desk is lined with works in progress, current scientific journals, and a wealth of material that speak of Hixon's passion for his work.

To understand what this marine ecologist can tell us about the state of the world's oceans, it helps to understand a bit about Hixon's research. One of his primary focuses has been fish population dynamics. A decade ago, Hixon and colleagues studied the types and numbers of fish living on the continental shelf off the Oregon coast. Descending the immense depths in submarines, Hixon and his fellow researchers catalogued the numbers and species of fish there at the time. Ten years later, they returned to this same area to reassess it. Their findings were not encouraging. Up and down the West Coast the story was the same—fisheries were in dramatic decline.

Hixon's work in the Bahamas has revealed other disturbing trends. There, Hixon and his fellow researchers have been studying fish population dynamics on coral reefs as a guide for trying to understand fish population dynamics in the larger ocean. "My current NSF (National Science Foundation) work in the Bahamas is on highly isolated coral reefs that are very far from any direct human impact," he said. "And these reefs are dying." Hixon and many in the scientific community believe that the explanation may lie in global warming. "Colleagues who study coral reefs and those who study global warming are drawing linkages between the global warming being caused by the burning of fossil fuels, and the death of corals and coral reefs worldwide."

Both of these fisheries, far from each other, are troubling examples of the kinds of unforeseen consequences human activity can have on the ecosystems upon which we depend. "What I've seen in the last two decades is widespread degradation of marine ecosystems," said Hixon. "In the Bahamas where I've studied fish populations on coral reefs, I've watched the system deteriorate over time. With the submersible work we're doing off the Oregon coast, going down and counting the fish distributions on rocky reefs on the outer edge of the continental shelf, what we've seen is the collapse of what's called the 'groundfish' fishery."

Hixon tagging kelp forest fish using SCUBA

Hixon says that this severe depletion of most groundfish is what prompted regulators to close the continental shelf off the West Coast to commercial fishing. "Some of these stocks are below 10 percent of their virgin biomass," he said. The official federal definition of an overfished species is when the biomass drops below 25 percent of its virgin value.

Hixon explains that there are essentially two causes at the heart of this decline: overfishing, which is fairly easy to understand, and changes in ocean climate, which, he admits, is a good deal more difficult to understand.

The science of marine reserves

These disturbing trends have led researchers and policy makers to develop an underutilized approach in marine ecosystem management: the marine reserve. The idea of marine reserves has garnered much scientific press recently, and Hixon says many scientists think marine reserves hold much promise for helping to stem the tide of fisheries' decline.

Marine reserves are exactly what they sound like—a specific marine area closed off to commercial activity of any kind—fishing, mining, drilling, etc. There are two general goals at the heart of marine reserves, says Hixon. The first goal is to promote biodiversity and ecosystem protection. This, he says, is fairly uncontroversial. "It's just like taking our most beautiful and biologically diverse land areas like Yellowstone and Yosemite and protecting them from human exploitation," he said.

Then, there is another, more controversial aspect of marine reserves that has generated much debate. That, he says, is whether or not marine reserves conclusively benefit fisheries.

Commercial fishermen who are most affected by marine reserves often raise the obvious question—'How can an area closed to fishing be good for fishing?' Hixon agrees that it's a valid question. "The fishing community looks at that and rightfully says, 'Are you crazy? How's that going to benefit us?'" said Hixon.

And unfortunately, the reality, says Hixon, is that science currently can't provide a definitive answer to that question.

There are three ways scientists believe such reserves will ultimately benefit fisheries. First, is the very simple notion, that by restricting fishing, stocks that have become dangerously low will have a better chance to regenerate. This is the "no brainer" part of the reserve idea. Leave it alone until it can replenish itself.

A second, more controversial part of the marine reserve concept, is what is known as the "spillover effect." In theory, the idea makes sense. Fish larvae settle and grow in the reserve unimpeded by human activity. Eventually, as the reserve grows more crowded, fish will swim out of the reserve into areas still open to fishing. In the Bahamas, Hixon and his colleagues are using acoustic tags to track the movements of the two main species of food fish—snapper and grouper—to learn more about the spillover effect and if it indeed could help replenish depleted fishing areas. "It makes sense theoretically," says Hixon, "But I can't go to a fisherman and say I have 100 percent certainty."

Lastly, there is the "seeding effect." This is a variation on the spillover effect in that, instead of *fish* leaving the reserve, it's their eggs and larvae that drift out of the reserve, thus "seeding" areas still open to fishing. This is even more controversial, says Hixon, because tracing the path of larvae and eggs is currently impossible. While some genetic tools and other methods are being developed that could help in this process, for now, there's really no way to conclusively document if eggs and larvae drift out of reserves to provide any significant seeding.

Like many scientists who support the idea of the marine reserve, Hixon likes to see them as analogous to a financial investment. The initial capital can be seen as the fish protected in the reserve. The "interest" that fishermen would draw on this "account" would be the fish, eggs and larvae that eventually leave the reserve through the spillover and seeding effects.

Even if universally implemented though, marine reserves, says Hixon, are not a panacea. "Marine reserves are a tool in the toolbox for marine conservation and sustaining fisheries, but they can't do it alone," he said. First, conventional fisheries management must continue outside reserves. Second, marine reserves can't do anything about global warming. "All marine reserves can do is regulate and restrict local human activity," said Hixon. "These coral reefs I'm studying in the Bahamas are dying in an area far from humans, and it doesn't matter if they're in a marine reserve. These reefs will still die if global warming is killing them."

Being on the front lines, Hixon understands the scope of the problem and recognizes the many challenges ahead. He is especially aware of how hard a sell this is going to be for the fishing industry. "Let's say I'm a fisherman and I'm not making a whole bunch of money and I've got children to feed and rent to pay. I'm going to catch as many fish as I can," Hixon said. "As a fisherman, I can't afford to think long-term, about grandchildren and future generations."

Hixon surveys deepsea fish from a submersible

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The citizen scientist

So here's the situation: marine ecosystems are deteriorating faster than science can provide absolute certainty as to the cause. It's a scenario that evokes the arguments made by those who oppose regulations to reduce the emissions of greenhouse gases that contribute to global warming: "Show me the connection with absolute scientific certainty and then we'll do something about it." In both cases, potentially beneficial policy action is stymied by the inability of science to provide absolute certainties right now.

So what should science and scientists do in the meantime? Continue trying to find the absolute certainty that policy makers can't dismiss? Some think this is a little like fiddling while Rome burns. Then should scientists step up in other ways? Mark Hixon thinks so. He sees the stakes as being so high that science needs to contribute to the debate based on the *best knowledge available*. For him, this means helping policy makers follow what is called, the "precautionary principle." That is, when it comes to making decisions with such long-term consequences, err on the side of caution.

"I used to be a pure basic marine ecologist," said Hixon. "I studied marine ecological systems because I loved them and wanted to understand them. I didn't think so much about the broader social implications of my work." Today, he sees the world and his role differently.

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Early in his career, Hixon thought that by teaching ecology and marine biology courses at OSU he would make a difference. "I used to teach ecological concepts to people and they would keep those in mind as they went about living their lives," he said. "I've come to realize that teaching may not be enough."

Now, Hixon says he's come to a point in his career where he feels the need to be more engaged in using his science to help influence policy. He's become involved with various advisory panels and organizations. He was appointed by the Clinton administration and now the Bush administration to a federal advisory committee on marine protected areas. He's also involved with many other organizations working to help influence policy regarding marine resources.

It's a new way for scientists to see their role in the larger society. Hixon calls this "scientific advocacy," and acknowledges that it is not without personal and professional risk to those who embrace it.

"What I mean by scientific advocacy," says Hixon, "is where a scientist expresses and defends a policy alternative that's based on science." It's a break with tradition and some scientists are not comfortable with it. "There's been this traditional role of scientists," said Hixon. "We provide data and information to society, then sit back and let society decide what to do with that information." Hixon refers to it as the "Wall of Science."

Hixon notes that a growing number of scientists believe that the issues facing society are so pressing and there's such a sense of urgency, that the Wall of Science may need to be breached. "This new movement says that we should be right there in the debates, arguing for policy alternatives based on what we know to be the best science," he said. "We *do* have to step up and based on what we *do* know, point a direction that science tells us."

Hixon recognizes the hazards yet remains steadfast. "It's a very controversial issue right now because some people believe that advocacy automatically reduces scientists' credibility," he said. "My belief is that there *are* risks in being an advocate, but the risk of inaction is *greater* than the risk of advocacy. That's really the bottom line for me."

Since scientific advocacy can carry a price in perceived credibility, Hixon says scientists need to be up front about their own values and doubly rigorous in how they conduct their research. "I have to really know within myself what my personal bias is and what my personal values are, and I have to be honest about those up front," said Hixon. "I also have to be the best possible scientist I can be—in fact, more rigorous than average."

In doing so, Hixon says he has to acknowledge and incorporate contrary data that may not fit his worldview. "I need to acknowledge that those data exist and not be data-selective," he said.

The reality, says Hixon, is that scientists have to begin to recognize that they do have another reality, and that is as a citizen. Hixon makes it very clear when he is speaking to various groups whether he's speaking as a scientist or a citizen, but believes scientists need to acknowledge that they are both. "I believe scientists need to hold the paradox of the citizen/scientist because we are both," he said. "When I became a scientist, I did not abdicate my citizenship."

Down the road

In the long haul, Hixon knows that the best hope for reversing fisheries' decline is to engage all the various constituencies in working out solutions. "It's time to bring all the stakeholders together with scientists to try to hash things out despite the uncertainty," said Hixon. "We'll have to use our best available data because that's all we've got right now and time is short."

As he enters this bold new arena, Hixon will continue with his research off the Oregon coast and in the Bahamas—work that he hopes will yield more answers to the pressing questions in front of us. And he'll continue as he has for the past thirty years, teaching others to go forth and learn as much as they can about the marine environment. In this way, Hixon is also planting seeds for the future. For instance, one of his former students is now Director of Marine Fisheries for the California Department of Fish and Game. "She came up to me at a recent conference and said, 'You were my inspiration,'" Hixon recalls. "That's clearly the most satisfying thing I get from this job."

Still, Hixon knows that change is outpacing our ability to adequately respond to it and the next generation of scientists will have a much different role in the world. "The luxury of studying nature simply for the sake of understanding nature is passing rapidly because there are serious threats out there and many systems are in trouble." Future scientists, he said, will still be doing basic research, but will have greater need to recognize the connection between their work and their roles as citizens. And, thankfully, leaders like Mark Hixon will be there to help this next generation navigate their way into the unknown territory that lies ahead.

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Right, Hixon prepares for Congressional testimony