Science Studio Vol 022 (Guest: Leah Gerber)

Of Whales, Fish and Men: Managing Marine Reserves

With 90% of the world's fisheries in a state of collapse, the questions around establishing marine reserves, monitoring, and species/stock recovery take on critical dimensions. But how do decision-makers, stakeholders, and the public formulate effective conservation policies; ones right for their community? Associate professor and ASU Exemplar Leah Gerber research helps bridge the gap between science and policy, addresses how reserves are established and assessed, and investigates whether we can shift the balance from bust to bounty.

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Peggy Coulombe: Hi, this is Peggy Coulombe and welcome to Science Studio. Today, we're sitting down to talk with Leah Gerber, an associate professor in the School of Life Sciences, selected as ASU Exemplar by President Crow. Leah is a conservation biologist whose work integrates research with policy development around endangered species recovery and marine reserve management and design. Welcome, Leah and congratulations on your tenure and your recognition by President Crow.

Leah Gerber: Thank you, Peggy.

Peggy: I notice that your work largely centers around large marine mammals: sea lions and whales. Is this an outgrowth of your early doctoral training at the University of Washington and your work as a wildlife biologist with the National Marine Mammal Laboratory or something that you've always dreamed of doing since you were a kid?

Leah: Thanks, Peggy. I think the former, actually. As an undergraduate at a small liberal arts college, I was interested broadly in environmental issues, which is fairly typical of undergraduates when you graduate: "Hmm, what am I going to do with my life?" So, I thought, let's delay reality a little more and I applied to a Master's program at the University of Washington.

And the program that I pursued was interdisciplinary, it focused on science and policy and economics. I think at that stage in my career I saw conservation biology and environmental studies as broadly including educational components, scientific components and also policy, and I liked this program because it included all of these aspects. But another reason for going to graduate school was that I didn't know what else to do. So, it was there in the School of Marine Affairs that I developed a little bit of focus on what areas within that broad context I might pursue for my future.

And it was more or less serendipitous that the previous summer I had spent in Alaska and got very interested the stellar sea lion, ground fish issue... basically stellar sea lions are an endangered species that live in habitats that are very productive fisheries. In fact, the most lucrative fishery in the U.S. is in the Gulf of Alaska. And so, I was very interested in the intersection of the science and the policy from spending time in the field to collecting data on sea lions and then entering this graduate program that was a little bit more interdisciplinary.

I was really interested in how the laws that were developed to protect endangered species like the Endangered Species Act intersected with laws that were intended to promote sustainable fisheries like the Magnuson Fishery Conservation and Management Act, and then we have this other law for marine mammals because they're so cute and everyone loves them.

Peggy: [laughs]

Leah: We have our own law called the Marine Mammal Protection Act. So, I sort of was interested with... this is a case study where these three laws are kind of conflicting. How does it play out? How do we make decisions that promote the recovery of the species and also promote fisheries? So, I would say that largely the path that I pursued in my career developed out of that serendipitous experience of spending time in Alaska and then focusing in on that marine mammal fishery interaction as a graduate student.

Peggy: So, tell me how does one go about establishing a marine reserve?

Leah: Well, there are three components to that. I think it makes working on marine reserves very challenging and also interdisciplinary. One side is the science of marine reserves and that tends to be what I focus on, and the students in my lab focus on, and that entails going out and monitoring, so you do transects underwater to assess the abundance or diversity of fish or other organisms. Another component is working with local communities to understand what is the use of these resources and if we are going to set a reserve whether there are some economic alternatives that might make the idea of a reserve appealing to local communities.

So, for example we're working in Loreto Bay Marine Park in the southern Gulf of California and it turns out that the local fishermen are the ones that are using the areas for fishing. But when you set a reserve, it's the tourist sector, so that's Americans who go down there for scuba diving who are going to benefit. So, we're working on some approaches to look at how you might transfer some of the benefits from the tourist industry back to local communities.

And then, the final component of establishing a reserve is of course working not just with local communities started from the grassroots level but also with policy makers and decision makers, Mexican government officials and actually getting the science into practice. For example, our diving surveys may indicate, oh well after five years of an experimental no-take reserve we're seeing demonstrated increases in biomass and diversity in size of this reef fish.

The next step will be to get that established as a permanent reserve. So, we provide the data and we work with policy makers to make the best use of the scientific data to make these policy decisions. So, in a nutshell, I see there are three components: science, working with local communities and policy makers. And I think our strength is in the science, but I don't think that just doing science would be enough to establish a reserve.

Peggy: You've written a booklet to assist in the "adoptive monitoring and management of marine protected areas" entitled "Navigating Uncertain Seas." If a country knows enough to establish a reserve, what uncertainties could still be involved?

Leah: I would say that's... and let me just give the same example of Loreto Bay Marine Park in the Gulf of California, there's a consortium of researchers and non-governmental organizations that have compiled and shared data for the entire Gulf of California to basically say: "OK, where are the biodiversity hot spots?" And then from that, we can actually look at a map and say: "OK, these are the important areas for biodiversity."

But then the next question is: "OK, well what do we do?" And once we have prioritized these areas, how do we go about establishing the reserves? Should we just choose the area that has the highest biodiversity or do we need to consider economic and social factors as well? And then another component of that is: how do we go about monitoring these areas?

So, say we identified these biodiversity hot spots, we then begin to monitor to say: "OK, which are going to be the best suited for setting reserves with respect to their efficacy?" Some areas are going to be much more effective as marine protected areas and others won't. And then the second aspect of the monitoring is: once you start monitoring, how is that linked to management?

And so, for example, we might be monitoring and in a lot of cases one of the issues with reserves throughout the world is that you set up a reserve and then we monitor. But there's no... what's the use of the monitoring data? And so, part of what we're trying to accomplish is to make a more clear link between the data that we're collecting and management decisions.

So, for example, if we monitor for a decade and see a demonstrated increase in populations, perhaps at some point we might be able to open that area to fishing again. Basically, we could use the data for monitoring to constantly adapt management and then test the effects of those management decisions. So, this general approach is known as adaptive management.

Peggy: Now, I went to your website, and your exemplar statement and your CV and a bunch of proposals you've written and besides the breadth of your expertise, the one thing that strikes me most is the human factor and when I say that, I'm referring to the fact that you've involved a lot of students and stakeholders and members of communities fully in the process of research and the policy development. Tell me something about having this sort of philosophy and approach.

Leah: Well, I think the first component is maybe that I just like people.

Peggy: [laughs]

Leah: I think a lot of scientists like to just work solo and I'm very much a people person. So, I really enjoy working as a team and that's why I involve students in my research and I would say that there are sort of three components to your question. One is that I think involving students in research not only provides hands-on training to students but also educates future generations who are going to contribute to conservation and sustainable solutions to environmental problems.

And then the other aspect is that working in a vacuum where one is fully doing scientific

research is less likely to have profound impact on the real world. So, I think because I'm interested in applying the science, I've embraced working with local communities and also working with policy makers to make my science available. So, I think I had a juncture early in my career where I decided: “Am I going to be a policy person or a scientist?” And I chose, “I'm a scientist” and so I often... sort of walking a tight rope between science and policy, and I try to stay on the science side and not advocate any particular opinion, but rather to make the data and the information available in a way that a policy maker could use it.

Peggy Coulombe: I'm struck by a project that you are doing, developing marine reserves and conservation policy in the Gulf of Mexico. The project touches on a host of people, undergraduates, graduates, your postdoctoral fellows, Mexican students, conservation groups, natural resource agencies, and communities in Mexico. That's a lot of people to be trying to balance needs and understanding with, and how do you go about calculating and balancing the needs of all these individuals and aspects like economics and ecotourism, and a system that's protected?

Leah: That's an interesting question and kind of relates to our previous discussion. I think that the way that maybe I attempt to handle this or manage and balance all of this is... well first, to spend a lot of time in the field to understand both the biology and the human communities, but more specifically in terms of the approaches that I develop in the lab and scientifically are to use novel and cutting edge quantitative approaches from the field of conservation biology to address these complex problems. So I think that what happens, and what has happened for many decades is that... environmental problems are so complicated and so as a result the decisions or the solutions that we come up with are not necessarily objective, but they're the result of laborious negotiation and people's values and whether the person had a good day or bad day.

So I realize that there are many variables that go into these decisions, but I think that using mathematical models and quantitative approaches at least allows us to make our values and our assumptions explicit, so that we know what the factors going into the decisions are based on. So, I think that that has been a really useful tool and one that I apply across all of the different projects in my lab and that my students generally adopt in their research as well.

Peggy: The Hawaiian Islands just established a marine reserve and I can imagine how it might impact the flora and fauna locally and create spillover, which is improved fish numbers and biodiversity in areas surrounding the reserve itself. But how can a marine reserve, which is obviously limited in size, possibly have any effect when a fish, like a cod for example, is distributed widely or is migratory or its life stages are dispersed, or are there just many players in the international borders that are involved?

Leah: Interesting question and that really cuts to the heart of some of the research that we're currently engaged in. I think the short answer to your question is in some cases maybe a reserve would not be effective, so it's not always effective and that's precisely the basis for some of our research to explore, under what circumstances and for what types of species are reserves effective?

To date most of the reserves have focused on marine fish and invertebrates, with little

application for wide-ranging marine species like marine mammals, turtles, seabirds, but with a number of colleagues and over the past few years that is something that I've been exploring is: for these wide-ranging species, can this tool be applied? For example, it might be useful if we understand the lifecycle of the organisms and particular the distinct habitats that are being used throughout the lifecycle. For example, say for Baleen whales, they tend to migrate between northern areas for feeding and southern latitudes for reproducing and those are pretty predictable in space and time.

So the idea of a reserve might apply if we can focus it in conjunction with the movements of these large whales. For example: set a reserve and feeding area in the summer and then breeding areas in the winter. So, understanding the life stages is really important. For example: there are some organisms that disperse as larvae and some disperse as adults and which of those life stages is most important in the population biology. In population biology, there's something known as sensitivity analysis that lets you look at which life stage contributes most to population growth.

For example, for long-lived mammals it tends to be the juvenile and adult stages that are most important, whereas the younger are less important. But for small fish that are dispersing large quantities of larvae, it could be the younger stages that are important. So the life history strategies has a really significant impact on the relative importance of the life stages, which then has an impact on the potential efficacy of reserves with respect to where and when they may be placed. But the bottom line is-- that some species will benefit and some won't.

A recent review that we did for the International Whaling Commission is currently considering the idea of applying some of the lessons that we've learned in the field of marine protected areas to conserving large whales. In fact, there are several huge protected areas throughout the world, one is the Southern Ocean Sanctuary. A couple of years ago, some colleagues and I went to the IWC meeting in Italy as external reviewers for: "Is the Sanctuary Program Effective?"

Peggy: The "IWC" is the International Whaling Commission?

Leah: Right, the International Whaling Commission.

Peggy: OK.

Leah: We were charged with examining how effective this protected area was, and we basically concluded that it was not effective, mainly because within this sanctuary there has very little restriction, it was just simply called a sanctuary. There were no clear objectives for why the sanctuary was set, or even though it was a sanctuary, there were still illegal and unregulated whaling occurring. So that was one problem, and the other problem is that the whales migrate in and out of that area. So, we might want to consider more closely designed protected areas that correspond with those movement rates.

Peggy: So, say a fish is over-fished. What would it take for a stock to recover?

Leah: Well, there are a couple strategies. The one that's traditionally been used in fisheries management is to basically set a quota, so we understand through assessments

from both biological assessments and data that are implied from fisheries, the data that are collected when we catch fish, get an assessment of how the population is doing. Then from that assessment we can say, "OK. How many fish can we catch the next year?"

The problem with that, and I think maybe the criticism of a traditional fishery management and maybe part of the rationale for why new approaches are needed, is that there's always a lot of uncertainty in, "What's the population size?" Typically the burden of proof has been on regulating agencies to show that the fish can't sustain more harvest and, "If the data aren't there, then let's just keep harvesting." In other words, we need a shift in the burden of proof.

That's actually a concept that was proposed I think in the mid '90s by Paul Dayton from Scripps, that we need to shift the burden of proof in fishery management so that we're erring on the side of caution when there's uncertainty. But, as you probably know over 90% of the world's fisheries have collapsed. So, we really have been doing something wrong. As a result one of the approaches that has been proposed, that we have talked about today, is the use of marine protected areas, because they leave less room for error. If you just say, "Don't take anything in this area!", then it's not a matter of how much we can take.

It also has some benefits associated with... when you set an area aside, it allows the habitat structures to recover. Because when a lot of these large scale fisheries are trolling, in other words they're dragging a net across the bottom of the ocean floor that is destroying the structures that are important to support marine biodiversity. So, it has this additional benefit of allowing recovery of these organisms.

So to your question, "What does it take for a stock to recover?" Well, either reduce the amount that's being taken or set a marine protected area. One of my graduate students, Jennifer Rupnow, she works on these long-lived reef fish in the Northern Gulf of California, and she's studying the reproductive biology, and their spawning aggregation. So, they go to very specific places geographically to spawn. The fishermen have caught on to that, so they know where to go to find them.

What she's learning, and actually it's been suggested for other examples in the literature, is that when you over-exploit or you deplete the populations that are returning to these spawning aggregations below a certain level, they don't appear to recover. So, in some cases if we deplete a population to be so low, beyond a certain threshold that may depend on a particular case, there is no potential for recovery.

In population conservation biology there is a term known as the “Allee effect,” and that might apply in these marine systems as well, where basically, beyond the certain threshold there is sort of social dysfunction where the organisms are unable to find each other, and they are basically extinct even if they are still there.

Peggy Coulombe: The Japanese government recently proposed that whales are the culprits in the loss of fish stocks, so called 'Whales Eat Fish' campaign. You have recently been awarded a grant by the Pew Charitable Trusts, to study the effect of whales on fisheries in the Caribbean, North Africa, and tropical South Pacific. So why are

governments pointing fingers at marine mammals when we know plenty of stocks have been over-fished?

Leah: That's a very good question, and I think it's essentially the basis for this project, to basically evaluate what is the evidence for the assertion that whales are depleting fisheries. I think from a scientific standpoint, many scientists would view that assertion as bogus, because marine ecosystems are much more complex. It's not that there are just two trophic levels where you remove one and the fish increase. In fact, whales tend to focus on lower trophic levels like krill and other zooplankton, whereas fisheries... we tend to focus on "We want the bigger fish". So there is that disjunct between the trophic levels and also...

For example, one of our focal areas is... we are working in three geographic areas and one of those areas is the Caribbean and whales do not eat in the Caribbean. They are breeding in the Caribbean. Yet there has been a sort of a campaign about this in the Caribbean to basically propose that there is this conflict. So we are going to just answer the question looking at using ecosystem models to basically simulate. “OK, let's construct an ecosystem with all of the different links between a food web, a model, and then we can look at the dynamics that are going on and then simulate the removal of whales and different species of whales” and see what happens to the fisheries that are commercially important.

It is a little bit of a political issue because, intuitively, I think I know the answer. However, there hasn't been a scientific study to provide this answer. While many scientists would think: "Well, I know the answer!", it's still a huge focus at a lot of these International Whaling Commission meetings that occupies a lot of time and energy, because it's an issue that is brought up regularly. So we just want to put it to bed and say: "Well, here is the answer," one way or another. Maybe there is some legitimacy to the claim in certain areas or time, but our approach is to really construct these models based on the best available data that include biomass consumption rates, trophic interactions for all organisms within each ecosystem. The other two ecosystems being North-West Africa and tropical South Pacific, and then explore this explicitly.

This last phase of the project will be to convene, in collaboration with Pew, these educational workshops in each of the local communities to basically disseminate the results, to say: "OK, well, here is what you have been told, here is our study, and here is what it means." So to actually try to get some of the results out there to the local community, so they can perhaps make more informed decisions on how they are going to vote with respect to whaling at an international scale.

Peggy: So you are doing both the assessment and then providing the tools to policy makers to make a more informed decision?

Leah: Exactly. So one of the final products that we plan to produce is an actual user-friendly tool. So we will take our ecosystem models and sort of distill it into a pretty glossy model that a manager or policy decision maker could actually use and say: "OK, well, what do I want to do? What if I take the whales out, what is that going to do?" And the effect may vary depending on the ecosystem.

Peggy: What role does the media play in conservation and policy, in and around these issues?

Leah: The media plays a very significant role and I think with respect to the media, I suppose it's not something that I have a lot of expertise in working with, and for that reason this is coming back to the issue of “Am I scientist” or “Am I a policy maker” with this project. It is right sort of at that intersection between science and policy. In negotiating and setting up this project with Pew, they were very supportive and very clear about: "We want you to do the science and we will work with you in disseminating that." And so I am sort of leaving that to them because that's their expertise but I am looking forward to learning more about disseminating the results at this type of scale.

Peggy: What is the most challenging aspect of the work that you do?

Leah: I would say that it’s -- and this may be relevant to some of the students that I teach, who are conservation biology majors -- is that I think the reason we do what we do is because we have a passion for the environment and for biodiversity, and we have some kind of ethical or moral feeling or obligation to contribute. I think some people decide in their life they are going to do something that contributes to the world in some way. So that's based on a desire to improve something that we care about.

I think what's tricky is accomplishing that in a world of human population growth, human consumption and also human needs. I think that we can't naively say we are going to set aside the city of Phoenix as a protected area, and so developing solutions involves a lot of compromise and sometimes it's hard to know how much compromise is appropriate. An example of that is the recent workshop in Mexico, we're discussing these protected areas and saying: "OK, well, where should we set them up and how big and how do we take into account all these priorities between the local communities and recovering reef fishing?"

I was later that evening out to dinner with some of the folks from the various non-governmental organizations, and a guy from a grassroots organization said: "You know what? I really do not care about human communities. These reef fish are going extinct and we do not have room for negotiating. We need to set a reserve or they are going to be gone." So it's hard to know, when to say: "We cannot think about humans, we need to set aside a reserve or do something that might not benefit humans." At the same time, it is challenging to say: "Well, in this case there's not really any intervention strategy or any recovery mechanism that we can implement that's going to result in the recovery of a population, when those spawning aggregations are over-exploited."

What can we do? We just watch them go extinct. And so, I think it's making those... I would not say they are my decisions, but trying to balance those priorities between human communities and conservation. I think one of the important components of that is recognizing that the world is not what it once was and that we need to be strategic in how we preserve remaining biodiversity while allowing sustainable human communities.

Peggy: You have an adorable daughter. What legacy would you like to leave for her?

Leah: OK, I won't mention the terrible twos [laughter].

Peggy: Yeah, we had this discussion about the terrible twos [laughter].

Leah: So I guess, I do not know... Thinking about this, it's hard to think much ahead of where we are right now. But I would say that I would hope that -- Gabriela is growing up in an urban environment -- and I hope that she has the opportunity to appreciate the natural world, and to have some understanding of where things come from; that when we go to the grocery store and we buy vegetables, that those are grown from the earth.

And related to that, that resources are finite, that we cannot just have more and more and more. That there is an end to the resources and we should reuse and recycle these things that we are buying, because she likes to buy lots of things. [laughter]. So I do not know how one would instill that in a two year old, but the concept of “less is more.” And I think there is a lot more to life than things. So I hope she appreciates that and has the chance to enjoy the natural world.

Peggy: Leah, I want to thank you for coming in, taking the time to talk with us today.

Leah: Thanks, Peggy.

Peggy: This is Peggy Coulombe, and you have been listening to Science Studio. Our theme music is by Yongen, and is provided by Magnatunes. Science Studio is produced by the School of Life Sciences and is in the College of Liberal Arts and Sciences, on the Tampa campus of Arizona State University.

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