Ask A Biologist Vol 099 (Guest: Greg Asner)

High Flying Science

For hundreds of years scientist have explored life on Earth with their feet firmly planted on the ground. Doing research was either in the laboratory, or out in the field. But in recent years exploring our planet has taken to the air. Dr. Biology gets to spend some time with ecologist Greg Asner to learn about his flying laboratory that is giving us a new view of our planet and new insights into many of our biomes.

Transcript

Dr. Biology: This is Ask A Biologist a program about the living world and I'm Dr. Biology. We've talked about the marine biome and coral reefs on the show before. My guest at the time was Diana Lipscomb and we had a conversation about the challenges the coral reefs are facing now. That was about 10 years ago for part of this show. We're going to go back to those coral reefs to dive into this amazing ecosystem, but instead of grabbing our scuba gear, we're going to take off and an airborne laboratory that is moving the study of coral reefs from the ocean floor to the sky above.

Dr. Biology: My guest today is Greg Asner, the director of Arizona State University's Center for Global Discovery and Conservation Science. He's also a faculty member in the School of Geographical Sciences and Urban Planning as well as the School of Earth and Space Exploration. In 2017 he was the recipient of the Heinz award, which if you're not familiar with that recognizes outstanding individuals for their innovation and contributions in five areas of which one of them was the environment, which is his specialty. His research into the health of many of our ecosystems, which includes the coral reefs, has taken him into the air on his custom airplane outfitted with special instruments that give us a whole new picture of our planet. Welcome to the show, Greg. I appreciate you taking the time to sit down and talk about your high-flying research.

Greg Asner: It's a pleasure to be here.

Dr. Biology: Let's start with that. My research I have done for many years is in the laboratory and I'm usually looking through a microscope - pretty stereotypical. I'm kind of jealous. Let's learn about this laboratory that you have.

Greg Asner: Yeah. The airborne lab is the outcome of two plus decades of development and the development has been around the idea that we need to understand ecosystems at a larger scale than we can understand by doing laboratory work alone or field work alone. We needed another scale of understanding. And so the airborne lab gives us this ability to fly over any ecosystem. And today we can measure not just the location of that ecosystem, but its composition, its health, what species are there and we can put it together like assembling a puzzle piece from the air.

Dr. Biology: So let's take the coral reefs. This is the topic for today. I know you'd do a lot of different ecosystems.

Greg Asner: Yup.

New Speaker: Let's talk about what you're learning from the laboratory and how it's different from when you go do the traditional scuba diving.

Greg Asner: In the Marine environment, we are limited basically by the scuba tank on your back. That's one major limitation. An experienced diver gets an hour on the sea floor and it's a frenzied hour to collect some data. You might collect a couple of square meters of data or you could swim across a reef and get 30 meters of information and you're done. With the airborne lab today we can fly over hundreds of thousands of acres of reef per day. And through our technology development that we've achieved from the airborne lab, we're able to peel back the seawater digitally back in the lab and see those organisms, primarily the corals that create the habitat for other species. And we're able to do that at this brand new level that lets us see what's really happening over the broader ecological scales that we're interested in.

Dr. Biology: You're a flying at. What kind of an altitude? How high are you?

Greg Asner: It depends on the project, but our standard altitude would be about 8,000 feet. Sometimes we're higher. We can easily go up to 20,000 feet and collect from there or go lower and skim the ocean surface. And the difference in those altitudes leads to the difference in the resolution of the information that we get from the sea floor - from anywhere from just four centimeters of resolution for the low altitude flights to maybe a meter or two meters resolution from the high altitude.

Dr. Biology: You're reading my mind because that was my question is what kind of detail can you get? And you're saying a couple of inches maybe on up to feet.

Greg Asner: Yeah.

Dr. Biology: So we have some amazing detail.

Greg Asner: Right.

Dr. Biology: It's also, if I recall, it's not just like a normal photograph in some cases. Now I don't know if you can do it with the corals, but with the-land based ones you're able to get 3Dimensions, is that correct?

Greg Asner: Yes, and we are getting 3Dimensions in the corals as well. So we have designed and implemented technology that allows us to do two things that are unique and they're done together. One is to image an ecosystem in 3D and that works on land and it works on coral reefs down to about 70 feet of water depth. Below 70 we lose the signal and we can't see the in 3D anymore. And so the 3D mapping is generated by a unique set of instruments that we can talk about. And then we have complimentary to that 3D look an ability to see the chemical composition of the organisms that we're flying over. It could be trees. We see their chemistry if we're flying over a forest. It can be corals if we're flying over a coral reef. And the chemistry not only tells us the health of the corals, kind of like getting a blood test, go to the doctor, get a blood test, here's how you're doing, here's your health. The chemistry of these corals do tell us about their health, but nowadays we're converting these chemical signals into information about the biological diversity, which is a fancy way of saying what species are actually there.

Dr. Biology: I've done 3Dimensional imaging of cells. That was a big thing and we started doing quite a long time ago and use lasers. Your scale is a little bit different. What kind of scale are you talking about?

Greg Asner: Yeah, a, if you're doing on a microscope slide in the lab or whatever it is that you're doing, that laboratory 3D imaging, just take that in microscope slide and take it up to the size of a football field and that's what we're doing every second of flight. So it's a really big step up in scale. We're getting many football fields per minute per hour, and those are being strung together in a grand map of whatever we're looking at. Lately we've been mapping the Hawaiian islands that's a vast area of islands that stretch over something like 500 miles worth of ocean distance and there's a huge amount of coral reef to cover. You know, our approach allows us to see all of those coral reefs over the course of a few, you know, days of flying.

Dr. Biology: Let's talk a little bit more about your flying laboratory.

Greg Asner: Sure.

Dr. Biology: What are these instruments that are in there?

Greg Asner: There are four instruments on board our lab and really important to understand that these four instruments, each one is unique, but it's the integration of them all that gives us this super detailed, comprehensive understanding of whatever we're flying over. The primary instrument on board is called an imaging spectrometer. It's a very fancy camera. An imaging spectrometer has in some ways similarities to a standard camera in that with a standard camera you're seeing basically in combinations of red, green, and blue. The camera on your phone or your SLR camera, they're all designed to do that. An imaging spectrometer allows us to see not just red, green and blue, but in our case hundreds and hundreds of spectral channels, both in the visible part of the electromagnetic spectrum that would be the red, green and blue, but also in what's invisible to the naked eye, what's called the near-infrared and the short wave infrared.

Greg Asner: These are parts of the spectrum that we don't see with our eyes that give us much more detailed information on the chemistry of different organisms that we fly over. That's the imaging spectrometer and that's kind of our core system. We matched that with another system called a LIDAR, which is a acronym for light detection and ranging LIDAR. It's a fancy system for firing laser beams out of the bottom of the plane. Every time the laser fires that ball of photons or light hits, whatever we are shooting the laser at, for example, over a tree canopy, it'll pass through the foliage down to the ground. As that interaction occurs as the laser beam touches the foliage, some of the photons are sent back to the sensor and that digitization of where the laser light touched each leaf, the tree STEM and the ground is like getting an MRI.

Greg Asner: If you go to the doctor, it gives us this 3D understanding of whatever we flew over. That laser is shooting at 500,000 times per second as we fly over, because we're flying fast and so you have to shoot these lasers fast in order to do the 3D imaging and to get this 3D perspective. The third instrument is another imaging spectrometer, kind of like the first one I talked about. It gives us similar information to the first one, but super high resolution. Think of it this way. If you fly over a tree canopy and you see the tree and its foliage, the super high resolution spectrometer might allow us to see an animal in the tree canopy, something that's occupying the tree canopy. And then the fourth is an even more high resolution. We call it ultra resolution camera. It's more like a standard camera that you might own it or your SLR, but it's very high resolution. It allows us to see even smaller organisms from way up high in the sky. All of these instruments are what are called boresight aligned. It's a fancy term for making them all line up so that the pixels from one instrument line up with the pixels from the other and so forth. And that gives us this deep, deep understanding in each pixel of what we flew over. And that's the airborne observatories imaging system.

Dr. Biology: You put this together.

Greg Asner: Yup. My engineers and I hope the first one in 2005 with two instruments that were less capable than the four I just described, far less capable, and worked that combination. And then by 2009 I added a third and repackaged the other two and so forth and so on up to 2019 and we have this ultra-premiere instrument suite that we fly on board the plane that is, not found anywhere else. We are the sole operators of such technology.

Dr. Biology: I think some people might be experiencing LIDAR because I believe that technology is being used in some of the self-driving cars and some of them that are having the cruise control that's doing some adjustment as well. So it's interesting because we have it around us and a lot of people don't realize it.

Greg Asner: Right?

Dr. Biology: Certainly not to the resolution and the detail that you have, but it is pretty impressive.

Greg Asner: Yeah, people will say, well, there were LIDARs elsewhere and that is true. There are LIDARs all over the place using lasers to measure distances to things. That's what a LIDAR really is in the commercial world or in other sectors. For us, we built these unique LIDARs that can do this kind of 3D environmental imaging from the air as we fly at, you know, 200 knots above the Earth's surface. It's a very unique LIDAR. However, it's, it's integration in the larger suite of instruments that makes the entire contraption, so to speak, unique.

Dr. Biology: So we have moved the laboratory into a plane flying over the Earth mapping in a way we've never mapped before.

Greg Asner: Right.

Dr. Biology: Looking at ecosystems a way we've never looked at ecosystems before. What are we learning?

Greg Asner: [Laughter] There's a lot to say on that. The first one is that I've been a practicing ecologist for 25 years and I come from a long line of ecologists that understand the functioning of ecosystems at certain scales. When you do this kind of work at the scale that we're working, it gives us not only a new perspective and integrated view, but actually it has changed some of our understanding of actually how ecosystems work fundamentally. And we've been extremely biased through our field and laboratory work, which we still do quite a lot. Those interested out there want to do field and laboratory work. We need more of you too, because the airborne studies need interpretation and that brings us back to the field in the lab. But we're doing lab or field work alone is inherently biased in a field that's focused on the functioning of an entire ecosystem. And it's easy to see that you just can't walk through the woods, or take a dive with a scuba tank and get an understanding of what that ecosystem is really doing. How it's assembled biologically. What it's health is under the current massive environmental changes that we're undergoing now or anything else about it without getting that zoomed out view. The zoomed out view though is hamstrung by the fact that it is zoomed out. So you still need to couple that with the field and the laboratory work.

Dr. Biology: When I was asking about what we're learning, a lot of people don't realize they hear the word carbon, but they really don't understand how it works and why it's so important to us.

Greg Asner: Carbon is everywhere.

Dr. Biology: Right? I mean it's in us.

Greg Asner: Yeah.

Dr. Biology: In every plant.

Greg Asner: Yeah.

Greg Asner: I always think it's interesting that we kind of inherently non-experts inherently know what water is H2O, but water is needed because carbon requires it. So there's this coupling between water and carbon that it happens at all scales from cellular all the way up to, you know, the entire world population and all the animals. And all the plants and everything that's alive on the planet has carbon and water and its basis to even exist. And so carbon is a basic building block. It's an element. It's interesting because it has become more of a known element because of some problems we're having where we're emitting a lot of this carbon into our atmosphere. If you think of geohistorically the history of the planet, most of the carbon has been tied up in the, what we call the bias sphere.

Greg Asner: That's all of the living organisms combined. Whether there's, microbes all the way up to elephants and whales and everything in between, or the carbon has been buried deep in the Earth's surface. A lot of that carbon is buried as fossil carbon, which is oil and that we burn. And so you know, the carbon is the carbon. It gets from that gas form to the organic form via the biosphere and a large amount of stored beneath the Earth's surface. And so it's essential. It's everywhere. It fuels our economy currently. It is what we are and it flows through us. It's what we eat. It's everything.

Dr. Biology: And today we're talking about how carbon can be released back into the atmosphere. You're talking about the fossil fuels. We're also talking a fair amount about the rainforest.

Greg Asner: Yup, yup.

Dr. Biology: And tied to this is climate change.

Greg Asner: Right?

Dr. Biology: So how do we prepare? Because climate is changing, how do we prepare for climate change?

Greg Asner: So the climate is changing. The principal driver, there are multiple drivers, but the principle driver is carbon dioxide in our atmosphere. It is a greenhouse gas. We have radically increased its concentration in the atmosphere, especially over the last 100 years, but also 200 plus years, but especially the last hundred years. It's causing disruptions in our climate system. It's not just global warming. We used to call that the thing. It's climate change or climate disruption. That's what I say to people. What it means is that the climate is getting more variable and unpredictable. Those who do climate modeling, I'm not a climatologist, but I hang out with them. Those who do climate modeling, the disruption and the variation that this is causing is even pressing their ability with their models. Okay, so it's a tough one. We know some solutions that are no brainers in a lot of ways.

Greg Asner: One is to get the carbon back into the biosphere. I just said carbon originates in the biosphere or below ground and that below ground was in the biosphere in the geologic record. So all of that carbon comes from the biosphere. Well, the way to get the climate system, our atmosphere has settled down is to pull it back into the biosphere. And that's where forests are really important. They're a major, what we call wedge in the kind of the pie of solutions. It's not the only solution, but it's a critical contributor. That wedge of finding a solution, that puzzle piece, looks like this. We have an opportunity to slow deforestation, which causes a lot of this carbon to go into the atmosphere in the first place, but also to do forest restoration to bring the carbon back into forests. And a lot of our airborne program and our satellite program is focused on that process on understanding where to put the carbon and how well it's going back in for those projects. You know, government projects, international projects that are trying to do that kind of work. So we measure that stuff. Where is the carbon for these organizations? We often do that. And it's a process that has to continue and it has to accelerate. It's not just for us. There are other carbon capture technologies that are out there that are coming online. So getting the carbon out of the atmosphere back onto the land surface one way or another is a major goal.

Dr. Biology: On an earlier show, I had Klaus Lachner on here.

Greg Asner: Ah, perfect,

Dr. Biology: He's an engineer that's doing some pretty amazing stuff where he basically, I think the name of the show is called Hacking Nature.

Greg Asner: Yeah, exactly.

Dr. Biology: So how do we make our mechanisms that actually suck that carbon back out that we've been releasing into the atmosphere?

Greg Asner: Yeah.

Dr. Biology: So we've had this great journey. I love learning about the laboratory. Amazed at the images that I've been seeing, and I'm courageous anyone to go out and do some Google searching to look at them. Some of them are actually rather, you know, painterly, almost.

Greg Asner: They're artistic in a way. Yeah, yeah.

Dr. Biology: Yeah. But back to our coral reefs. Yeah. Let's get back to our coral reefs. What's going on with those? Because 10 years ago we were worried because it was the story of the coral reefs are dying. So now where are we today?

Greg Asner: So my core training is in biology and I have a worldview of biology that's long-term. And right now we're going through a very tough time with coral reefs. It's a bottleneck, so to speak. And who's going to pop out on the other side of that bottleneck in terms of the stress we're putting on reefs is hanging in the balance today. We don't know of all the coral reefs and the species that occupy those reefs who are going to survive and win and who are gonna lose and disappear, go extinct. We don't know that answer today. And so a lot of our airborne work is to figure out what I call the good, the bad and the ugly. Where are the survivors, where are the places where coral reefs and the corals themselves are surviving? And then to ask why, and we can talk about that.

Greg Asner: The second one is to find out where are the areas that are degraded. Some of it's climate driven, a lot of its coastal development driven. Bad, you know, sedimentation, bad management of coastlines. There's a lot of direct impacts on coral reefs and that's the bad that can be restored. And then there's the ugly, the good, the bad. And then the ugly and the ugly or coral reef areas that are so far gone that all practical means for bringing them back are overpriced and cannot really be made actionable. And so that's what we're doing is a geography of what's going on out there with our airborne program, and with our satellite program. Ten years ago, we said coral reefs were dying and kind of universally we're going to disappear. Ten years later because of the airborne work that I do. I do not believe that. I think the coral reefs are changing radically.

Greg Asner: There's a lot of problems with them. There will be winners and there will be losers. If we want more winners, we have to make some major changes. They start with two things. One is, and this is all gleaned from our airborne observatory, we need to reduce our carbon emissions and get some of this heat out of the atmosphere. And that is absolute. And two, we need to generate incentives for better coastal uses of coastlines. We need to generate incentives that reduce pollution is a big one, nutrient pollution and other pollutants into reef ecosystems. It's a major area that we have mapped and, and understand. The third one is sedimentation. That's literally our actions on land are causing erosion and all kinds of problems from land to sea and our smothering these reefs. We need to work there. And then the final one is our fisheries, coastal fishing practices. A lot of people don't realize that fish need corals and corals need fish. And there's a whole story to unpack there. But if we don't get our fishing industries under control, our coral reefs are going to continue to be degraded.

Dr. Biology: So with your imagery, basically it's using almost a medical term or it is a medical term of triage. In other words, you go out and you're looking at what are the conditions of the different corals and decide which ones are the ones that we can save or actually ones that are doing well and why.

Greg Asner: Sometimes we find corals are doing well and the news media typically will focus on the corals that are doing poorly because it's more newsworthy in the moment. However, there's an emerging understanding, and I'm actually writing what I think is the document that says, well you know, what's the new geography of coral reefs? And there is this area, these areas all strewn across the planet that are doing well. And those are areas that are largely protected by distance currently from these bad coastal development actions I just described coastal processes. And or are evolved to handle some of this hotter water that the climate change issue is generating and we're trying to understand genetically why those corals can handle the heat. And we have developed a method from our aircraft that can pick out the corals genetically that can handle the heat better than the other ones. So using the technology I described, but interpreting it in a new way that's highly genetically focused. And so we're seeing that and people know me as pretty positive about the environment. Even given all of the challenges and it's because I see the full picture or a fuller picture from our technologies, it doesn't mean everything's going to be okay. No, it means that it's a much more complex and interesting problem than just saying it's all dying

Dr. Biology: For someone who wants to help.

Greg Asner: Yep.

Dr. Biology: We've talked about reduce your carbon footprint. We have stuff on Ask A Biologist on how to reduce your carbon footprint. Are there other things that people could do that they're not aware of that would make a difference for, in particular coral reefs?

Greg Asner: Yeah. It's interesting because as we speak today, the state of Hawaii is going through its second big coral bleaching event and the coral bleaching event is being caused by what we call a Marine heatwave. It's hot water that's passing through the region, and that's a climate change driver. We know its linkage extremely well to climate change. So do people say, I can't do anything. Actually, we have issued with our partners in the state of Hawaii, who are state government partners, requests to the public there, both the residents of Hawaii and the visitors are going to Hawaii, which there are many all the time, every day. We're asking them to do six specific actions to help reduce what we call secondary stress on these reefs. Because we have this primary stress, this heat wave, just like when we have a heat wave in Phoenix or we have a heat wave anywhere. In the cities, we understand that we have to take care of ourselves and reduce some of the stress, right?

Greg Asner: Well we have to do that for corals and the other inhabitants of these reefs. And one is reduce fishing pressure immediately. And there's a reason. We know that the more fish we have on the reef, they tend to be the groomers of the coral and keep the algal blooms from happening, which smothered and killed the coral during these hot water events, reduce pollutants to the reefs immediately. There are certain sunscreens that have emerged as huge problems for corals. I've been involved in that as well. I can name some of the chemicals. One of the biggest culprits is called oxybenzone. Do not put that on the use a rash guard or something that doesn't have those chemicals in it. And that's pretty easy to find on the internet. What's good and what's bad. There are others in this list of six that we've provided and they're available. The six are available on our websites and in the public now. So if people are interested, it's not hard to find these six things they can do.

Dr. Biology: Perfect. So on Ask A Biologist before any of my scientists get out of here. I always have three questions.

Greg Asner: Got it.

Dr. Biology: Okay. So you're ready. Okay. The first question, this one's probably going to be an easy one. When did you first know you wanted to be a scientist?

Greg Asner: My mom says I wanted to be a scientist when I was about four or five years old and demanded monkey covered wallpaper. I don't remember that, but I believe her. But I remember when I was finishing my undergrad degree in radiation physics, which is what my undergrad degree was in. I sort of had this awakening that ecosystems were interesting, complex and we're likely to be changing. And it came from the physics of the atmosphere and kind of thinking about the atmosphere. And then I kind of went down into the biosphere from there and that's when real interest was born - my professional interest.

Dr. Biology: So now I'm going to take it all away because you've got the high-flying laboratory, you're doing all these wonderful things. I'm going to take it away. What would you be or what would you do if you weren't a scientist or lecturer and teacher?

Greg Asner: That's a tough one. Yeah. You know, science, let me just say something about this. Science is not a job. It's a lifestyle. It's a profession you have to make your money to feed yourself and your family. Yes. But it's a way of life being a scientist. And so to think that there's some other way of life would be hard for me to fathom at this point - 25 years into this career. Um, I guess the only thing I can think of, but I don't think anyone would fund it, is to be a naturalist and a science communicator of some sort. But that's still science. So I don't know. I wouldn't be a politician and I wouldn't be a banker. And I wouldn't be a medical doctor, so I'd know what I wouldn't be. But science is a lifestyle. It's a way of life and it's hard to break out of it because it's not like you work nine to five, your brain is working 24 seven on it and it becomes part of who you are. So to think otherwise is pretty tough.

Dr. Biology: Everyone struggles with that question. Sometimes there's the hidden actor or the hidden baseball player and things like that. There's always been some fun things like that that come out once in a while though. Yeah, I would have been...

Both: [Laughter]

Greg Asner: I don't have an actor or a baseball player in me. [Laughter]

Dr. Biology: Oh okay, that's fine.

Greg Asner: All right.

Dr. Biology: All right, and the third question, what advice would you have for a young scientist or perhaps someone who's thinking about a career change into the sciences?

Greg Asner: Do it. Take the risk. Believe in yourself. Those are the cliché ones, but they're real here and get involved in science project. To sit in a classroom and go through hardcore physics classes, chemistry classes, mathematics classes are all needed. Biology classes are all needed, but to be able to put those into perspective a little bit as you go, whether you're, you know, in high school, or an undergrad in college or doing a career change, doing it in the context of trying out some of the science endeavors through internships, through involvement, through volunteer, whatever it takes to get your feet in the door. That's I think the most important step. That's what I did. And it paid off.

Dr. Biology: You are actually new to ASU and you're starting a new center for global discovery and conservation science. What brought you here?

Greg Asner: So, yeah, I've been a practicing scientist faculty member for about 20 years prior to coming here and I just got here in 2019. So I'm in my first year here at ASU and I have had a very successful program at my last organization. No organizations that I know of, at least within the United States, are pursuing the goal and role of solutions oriented science and social science and all of the factors that need to come into play to generate a more sustainable future. ASU is leading in that space and they are understandably, for lack of words, stealing the, people from around the planet that want to do this work are getting them. And they got me because I wanted to do more of what I do at the next level up. So I founded and I'm building this center for global discovery and conservation science. And it sounds lofty, but those words were very carefully chosen by me because in my, with stakeholders, whether they're international government, local, whatever they are, the process of conserving something or managing the earth system better requires new discoveries at the same time. So to pair the words, discovery and conservation together were essential. And so the center is one of the new arms of solutions oriented science at ASU in a portfolio of centers and institutes that are really working together to try to generate a more sustainable future. Not just in Arizona but worldwide.

Dr. Biology: Well Greg, I want to thank you for visiting with me today.

Greg Asner: My pleasure. It was great talking to you.

Dr. Biology: You've been listening to Ask A Biologist, and my guest has been Greg Asner, the director of Arizona State University Center for Global Discovery and Conservation Science. The Ask A Biologist podcast is produced on the campus of Arizona State University and is recorded in the Grassroots Studio housed in the School of Life Sciences, which is an academic unit of The College of Liberal Arts and Sciences. And remember, even though our program is not broadcast live, you can still send us your questions about biology using our companion website. The address is ask askabiologist.asu.edu or you can just Google the words, ask a biologist. I'm Dr. Biology.