Episode 4: Fitting the Gulf of Mexico inside a computer: how to build an ecosystem model

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Levin: You're listening to The Loop, an audio series about the mud, microbes, and mammals in the Gulf of Mexico. I'm David Levin.

Ainsworth: My role is to basically pull together all the information that's coming in from laboratory work, from fieldwork, and try to integrate it into one comprehensive overview of what's happening in the ecosystem.

Levin: This is Cameron Ainsworth, from the University of South Florida. He's building a virtual version of the entire Gulf ecosystem inside a computer. Why?

Stay tuned.

<music out>

Levin: It's been more than three years since the Deepwater Horizon spill hit the Gulf of Mexico, dumping more than 5 million barrels of oil into the ocean. Since then, researchers have been unraveling the impact it's had on the Gulf as a whole. How the oil moved in the water. How that oil degraded. And how it affected marine animals along the way.

But every spill is different, and studying one doesn't guarantee that scientists can tell how the next one will play out.

According to Jason Lenes, predicting *that* involves serious math.

Lenes: You don't truly understand something unless you can describe it mathematically. What we try to do is use math to describe ecosystems and biology.

Levin: Lenes is a researcher at the University of South Florida. He's one of a small group of people using complex equations to build a computer model of the Gulf—a kind of digital reproduction of the entire Gulf ecosystem.

Inside that virtual world, they'll be able simulate future oil spills, and anticipate how they'll affect fish and other organisms.

But getting the model to work – well, that's the hard part.

Lenes: It's such a large picture, and there's so many questions, in terms of just the ecology itself, let alone the physics. It's so much information.

Levin: First, the scientists need data on all the key species in the Gulf, from tiny plankton to huge whales. They have to know roughly how many are out there. Where they live. How often they reproduce. How quickly they grow. And most importantly, what they eat. Without understanding the food chain, or who eats who, it's almost impossible to build an ecosystem model.

Ainsworth: If you want to make predictions about predators, about fisheries, about recovery time, that information on the food web is really not negotiable.

Levin: Cameron Ainsworth works with the modeling team at USF, and he's trying to simulate the life cycle of *fish* in the Gulf. He says getting data on what they eat is actually pretty tricky. Most of the fish studies in the Gulf focus on commercial species, like red snapper or grouper, and there's a lot less information on species fishermen can't sell.

Ainsworth 14:40 There's no end to the holes. [Laughs] You know, just the nature of ecosystem modeling is that you're bound to run into data deficiencies. And, you know, in a lot of cases those can't be swept under the rug.

Sometimes, he says, his team has to fill in the missing data themselves, by studying fish collected by other researchers.

Ainsworth: 18:10 What my laboratory did in particular was just survey the gut contents of fish. So we would take fish, bring it into the lab // and then dissect it, and try to determine what the species has been eating…

Levin: For a group that works with computers most of the time, being elbow-deep in fish guts is kind of unusual. But it's something that Michelle Masi does all the time. She's Ainsworth's PhD student. When the fish come in, she spends hours cutting open their stomachs and recording what's inside.

Masi: So you'd look in there for anything that looks like it might be a little prey item. A claw perhaps, or some bones or scales. If there are scales in there, you know that it's eating fish.

Levin: But looking for scales and claws inside fish bellies can only tell you so much about who's eating who. To build an accurate model of the Gulf ecosystem, you also have to factor in the tiny stuff, like plankton and bacteria. That's where Jason Lenes comes in.

Lenes: 2:39 The stuff that we're trying to model are at the base of the food chain. we're interested in the bacteria, we're interested in algae, we're interested in the zooplankton, which are the little guys that eat the algae. So we want to see what is the baseline, what is the standard that goes on in the gulf, and then when you add oil // how that would impact // the algae and the zooplankton.

Levin: It's a big job. For every one fish in the Gulf, there are huge numbers of those little critters. And they're growing, reproducing, and being eaten every minute of every day, so the population can change dramatically in a short time. To keep track of that many organisms, the model Lenes is creating needs some heavy computer power.

[AMBI: footsteps in a hallway; door opening]

Smith: Hi, Dave,
Levin: Hey, nice to meet you.
Smith: Good to meet you. So we're going up to the 3rd floor where the data center is at…

Levin: Brian Smith oversees the University of South Florida's research computing center, the place where Lenes runs his models. He leads me into a squat brick office building, through a maze of cubicles, to a glass security door.

[AMBI: swipe card beeps, door opens, and a whoosh of fan noise fills the air]

Inside is the heart of the system. It's a huge white room filled with racks of powerful computers. The fan noise is deafening.

Smith: It's high performance computing. Lots of processors, lots of memory, very fast network. So // we can actually take one simulation and run it on all these machines simultaneously in order to harness all of their power.

Levin: Even with all that computing power, the millions of calculations that Jason *Lenes* needs for his model can still take up to a week to run. And that's just his latest version, which covers only a small fraction of the Gulf.

At the moment, he's working on expanding and perfecting the model. Next, he plans to combine it with Ainsworth's *fish* model, and together, they'll create a simulation of life in the Gulf that covers everything—from the tiniest microbe to the biggest whale.

Ainsworth: Yeah, that's our hope.

Levin: Again, Cameron Ainsworth. He says that once the full ecosystem model is up and running, it'll be incredibly useful for studying future spills, and testing how they might affect marine life.

Ainsworth: For a given level of oil concentration, how do we expect fish to be impacted? // how long would it take populations to bounce back to where they were before the spill; What's the impact on growth, on longevity, on their ability to reproduce and things like that. // So I think what we hope to get is a little bit of a better perspective on // what to do in the case of the next oil spill which is surely coming.

Levin: In other words, with more than eight thousand oil wells in the Gulf, it's only a matter of time until another disaster.

In the past, scientists have had to react to those spills *after* they happen—but using these models, they might be able to predict how they'll play out ahead of time. They'll know which fishing grounds should close first. Which species will be hardest hit. And ultimately, what the impact will be on *people* in the Gulf.

For The Loop, I'm David Levin.

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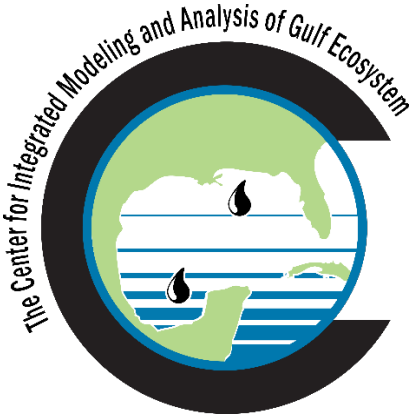


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