[CRICKETS]

[CYMBAL PLAYS]

[MUSIC PLAYING]

[POWER:] I've always had a deep wonder and fascination about the natural world. And I'm especially intrigued with how species interact with each other and also with their environments. My scientific research focuses on rivers and the food webs they contain. Rivers are extremely dynamic habitats. They can change dramatically from season to season and from year to year with the amount of water that's flowing through them. Yet rivers are also habitats with clear boundaries. With a little work you can follow the key river food web members as they go through their daily lives, and watch their numbers and their interactions change over time. One question that drives my work is- how does the amount of water flowing through a river affect its food web and the state of the river ecosystem as a whole?

[MUSIC PLAYING]

[POWER:] To answer this question I've been studying the Eel River in northern California year after year for the past 25 years.

[MUSIC PLAYING]

[POWER:] Our "Eyes on the Eel survey" is 10 Berkeley students and me, and we go out three times a summer. We focus on three groups of organisms to get a picture of the river's food web- the fish, the aquatic invertebrates, and the algae. Now, algae are the base of the food web. They're at the lowest trophic level. The amount of algae and that type of algae both determine the health and diversity of the insects that eat it, and in turn, they determine the food supply for the fish that eat them. And then there are bigger fish that feed on the little fish. So all of this energy is flowing up the food web. We always start with the big fish. That's because the big fish in the pool spook most easily. So we need to count them first or we'll scare them off when we're taking our other measurements.

[ROSSI:] When we snorkel the tributaries, one thing that is true for most tributaries in this part of world is they're cold. So, I put on a big dry suit, I zip it up. I have a dive slate on my arm. I typically know the type of organisms I'm going to run into in the tributaries, and I have different size classes which relate to different ages that we're interested in. You need to move very quietly, very slowly. And you don't want to be spooking fish. It's such a neat experience to get to put your head underwater and join this aquatic world that you never get to be a part of otherwise.

[ROSSI:] I'm going to to snorkel the upper pools, we can start bugs and algae down here, right now. If you want to get going on that.

[POWER:] Once the larger fish in the pools have been counted, we count the juvenile fish from the shore. We take counts in three minute increments, carefully noting the species and size class of the

fish. When we finish counting the fish, the team moves on to measuring the second component in the food web, the amount of algae that's there. Or what we call the algal standing crop.

[POWER:] The quickest way to get a picture of what the river habitat looks like at the moment is to throw a measuring tape across the stream, so there's a cross section. A river is essentially a collection of pools connected by shallow riffles. We measure our cross sections in both pools and riffles.

[POWER:] And then you make a measurement from the water surface down on the stream bed at even intervals. The depth is 19.

[POWER:] And you can quantify the texture of the substrate. Is it cobble-y, boulder-y, is it sand, is it mud? What are the major algae that are growing there? That's enough information to draw a picture of what the algal standing crop is doing and how it's changing seasonally.

[POWER:] When we're done surveying the habitat in the algae, we move on to the aquatic invertebrates. The riffle's where a lot of the bugs grow. We take a aquarium net, and you sneak up on a rock and you pick up this rock skillfully and quickly, and then you invert it over a white plastic tray. You're looking at these tiny things but they are so diverse. And some of them are so brave. They're little predators walking around trying to pinch the ruler that you're trying to measure them with, and we just get so fascinated.

[POWER:] Victoria, let's take a sample of this home, because it might be something unusual.

[POWER:] When we are keeping track of the species, we can follow their densities from year to year. When I started studying the Eel 25 years ago, I had no idea of what controlled the river food web. What we have discovered is that water flow in the river over the entire year determines the state of the summer food web. We have identified three main states that can develop during any given summer. The first state is what you get in a typical year. A typical year here has a wet winter and a drier summer that still has enough flow to support the algae, the invertebrates, and the fish.

[POWER:] You don't see the algae or the bugs accumulate. You see the fish accumulate. That's a ecosystem that we tend to like for the clean water benefit, and the biodiversity in the fisheries. The second state occurs when we have a drier winter, so we don't get scouring winter floods. And one insect in particular, an armored caddisfly larvae, can take over.

[POWER:] And it's heavily armored, as you can see from the rocks.

[POWER:] So we can think of this second food web as having only two trophic levels. Algae goes straight into these armored grazers, but the energy isn't transferred to the predators. Still, if there is adequate river flow the water stays clean even if the fish aren't growing that well. Then recently we're learning about a third state, which is the cyanobacterial state. So with the extreme California drought that we've had, drying up our rivers to the point where the flow gets stagnant. So if the flows get stagnant and warm, then the good algae start dying and what proliferate, living off of their rotting releasing nutrients, are cyanobacteria.

[POWER:] Not all cyanobacteria are harmful but some can be toxic to mammals.

[POWER:] The ones in the Eel and in the Russian, so far, look like they're neurotoxic. Because if the dog runs into these proliferations of cyanobacteria and licks it's fur, it dies in convulsions within 20 or 30 minutes. Extreme summer drought can allow cyanobacteria to accumulate. If on the other hand, there's enough winter and summer water food webs sustain algae and invertebrates that support fish and this clearly benefits humans. But there are more pieces of this puzzle than just fish and humans. For example, what fish need for flows and cold water is not particularly good for the river-breeding frog. River-breeding frog needs areas where the little egg masses won't get washed away. So if you had a dry year, it might be a good year for frogs.

[ROSSI:] Once we're all done with bankside counts, we'll split into two groups--

[POWER:] If observing and measuring the rhythm of this river system for 25 years has taught me one thing, it's this-- there is no single, optimum state. Complex natural systems require a lot of variation. And if we're ever going to sustain these wonderful natural systems, we really need to map out the depth and breadth of this variation to understand why it matters and to learn to live with it.