Researcher discusses climate-related perils facing migratory fish and the changes needed

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Persistent drought in the West has helped bring climate change to the forefront of the public consciousness. Indicia of a warming planet—relentless heatwaves, drained reservoirs, and raging forest fires—have applied pressure to humans and their environment,

prompting discussions about the long-term sustainability of a fossil fuel-based economy.

What may be forgotten in these discussions is how climate change affects fish and aquatic ecosystems. Warming rivers and streams, water storage and diversion practices, and other impacts have led to a decades-long decline that threatens the survival of many Western fish populations.

Water in the West visiting researcher Eric Palkovacs is writing a book that explores the challenges associated with balancing water needs of fish and people, and how the West can move toward a more sustainable water future. Below, the University of California Santa Cruz professor of ecology and evolutionary biology discusses existential threats facing migratory fishes and why it's important to save them from extinction.

Can you describe your research interests?

My work focuses on the intersection between people, ecological changes in populations, the evolutionary responses of populations, and how we can use our understanding of ecological and evolutionary theory to help us manage and conserve populations. I study coastal freshwater and estuary systems, particularly anadromous fishes—migratory fishes that spawn in freshwater habitats, migrate to the ocean to mature, and then return to freshwater to spawn. I've worked on salmonids, sturgeon, and other migratory fishes.

How is climate change affecting freshwater ecosystems?

Drought and wildfire have significant effects on anadromous fishes, and both are increasing in the West due to climate change. Salmon in

California are at the southern end of their distribution, so they're already challenged by a warm, dry climate relative to what they experience in the Pacific Northwest or Alaska. They're living at the edge in terms of their thermal tolerances. Climate change is threatening to tip these populations over the edge toward extinction.

How does fire impact freshwater habitat?

Fire can remove the canopy—the upper layer of vegetation formed by tree crowns—and this allows more solar radiation to reach streams and warm the water. For fish, there's a balance between temperature, metabolism, and food intake. When water warms, fish need to eat more to keep up metabolically.

Fire increases stream sedimentation, which reduces populations of smaller creatures fish depend on for food. These fish may be facing a feedback loop in which wildfire raises stream temperatures, fishes' metabolic demand increases, and their food supply simultaneously declines due to sedimentation.

We know that wildfire releases heavy metals into streams, including copper and mercury. These metals are known olfactory toxins for fish. Fish use their sense of smell to detect prey and predators, and migratory fish use their sense of smell to imprint on and find their way back to their natal streams when they return from the ocean to spawn.

Can you observe a nexus between climate change, drought, and the evolution of aquatic species?

We would expect that drought will select for certain traits. We're interested in whether thermal tolerances are evolving as temperatures changes. We need to know how quickly those tolerances can evolve.

Contemporary global evolution is a mechanism of biological resilience. If populations can adapt to changing conditions in real time, they may be able to persist. If the rate of environmental change is too fast, then evolution can't necessarily keep up.

To mitigate the effects of the West's persistent drought, cities are being asked to reduce their water consumption and farmers are taking land out of production. How do you make the case that more water should be left in streams to protect aquatic ecosystems?

These fish have been culturally important for thousands of years. They are a food resource for people and, in some cases, are commercially harvested. California still has a commercial salmon fishery, and we want that to continue. Recreational fishing is also valued by society. We don't want to lose these things. Outside of fishes, freshwater biodiversity is poorly understood. If we were to explore streams in California, it's conceivable that we would discover new species. We need to understand and conserve aquatic biodiversity for the knowledge that it potentially represents.

What are the most significant challenges to sustainable fisheries in the West?

One challenge is figuring out how we can provide water for human needs and also maintain enough flow—and the timing and patterns of flow variation—to support fishes and the food web they depend on.

What concerns me most is whether we can change our regulatory and policy environments fast enough to keep up with the rapid pace of

climate change. We have populations that are hanging on by a thread. In a changing climate, we either have to bring these populations back, or they will go extinct. In many cases, we know what needs to be done, but we're adapting too slowly. Rather than managing these populations from one crisis to the next, we need to be proactive and put more resources into getting them on the road to recovery.

How should Western water management change to accommodate sustainable fisheries?

We need to bring together people who are interested in aquatic biodiversity and those who would prioritize water resources for agriculture or urban uses. We need to align our interests, coordinate our uses, and work toward the same goals. Everyone's needs can be met if we're smarter about when and how we use water.

What gives you hope?

I'm hopeful because I see an increase in community engagement. Watershed groups, resource conservation districts, and local governments are really invested in protecting aquatic ecosystems. We need to support these groups, bring them together, and facilitate communication to ensure that everybody is working from the same playbook. If we do that, we can start to make better progress. If we also solve some of the regulatory challenges and provide more flexibility with permitting requirements, we can increase the pace at which habitat is restored, and water resources are managed more sustainably.

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