Salmon Ear Bones Shed Light on Fishery
by Dominic Horath

I was 14 when I caught my first salmon. My dad convinced his boss to let me tag along on their Saturday fishing expedition. It was spring, and a crisp offshore breeze made my face sting as we gently motored out of the harbor. The sun was barely visible on the horizon, bleeding deep reds and purples across the dawn sky. My eyes itched from the early morning awakening. “Get up,” my dad had said. “It’s time to go fishing.”

When the boat stopped and I dropped my line in, I hooked a fish almost immediately. “Beginner’s luck,” I heard my dad chuckle. Getting the fish from the depths to the boat wasn’t easy. As I reeled it in, my forearms began to ache, sweat dripped down my forehead, and I thought I would lose the pole overboard.

When I finally managed to haul it to the deck I stared at it, mesmerized. “It’s beautiful,” I thought. It was a Chinook—I’d never seen one up close. “First one of many more to come!” my dad yelled. And there were.

Now, the bountiful days of California’s Chinook salmon are a memory. The population has been declining for decades, but in 2008 commercial fishing was closed for the season. It’s remained closed ever since. I spoke to one fisherman, Pietro Perravano from Half Moon Bay, about the closure. “Here we are in 2010, and our most important stock has collapsed,” he says. “How could we let this happen?”

Others wonder the same thing, and some are searching for answers. They include Rachel Barnett-Johnson, a UCSC-affiliated researcher who works in Sacramento for the US Bureau of Reclamation. Barnett-Johnson finds crucial clues in a surprising place: the rear of fish brains. Otoliths, small stone-like structures nestled securely in the back of all fish heads, have proven instrumental for studying Chinook. Her discoveries may reopen the struggling fishery—or keep it closed for good.

Every spring, commercial and recreational fishermen ply Northern Californian waters, hoping to land some of the hundreds of thousands of fish from the fall run of the Sacramento River, the biggest along the state’s coast. “The Chinook are a fisherman’s bread and butter—their cash crop,” Perravano says. “They have really been a backbone of many coastal communities.”

To ensure that the Chinook population would remain strong, hatcheries have supplemented the natural wild population with hatched fish to keep overall numbers high. This has proven controversial because hatched fish can make it hard for biologists to track the natural population. However, it’s been tricky to validate these

concerns; it's hard to tell wild and hatched fish apart. Coded wire tags—small strips of metal marked with an I.D. number—have succeeded modestly in states like Washington and Alaska, but spotty use of the tags in California hasn't given scientists enough to go on.

An alternative became clear to Barnett-Johnson while she worked as an intern for NMFS. She learned that otoliths, much like tree rings, could provide information about the age and growth rates of a fish. Biologists had used otoliths in previous studies to tell wild fish apart from hatched ones, but the method was still relatively new and it had never been used in California.

Barnett-Johnson's excited voice zips along at a million miles a minute as she describes the details of her work. To examine how the wild population was faring, she needed otoliths. To get those, she needed fish heads first. "One of the biggest problems we encountered was simply obtaining the heads," she says. "Getting plugged into the network of who was collecting fish was tough. I ended up going on a lot of recreational fishing boats, trying to convince people to let me cut into the heads of the fish they just caught."

People weren't always happy about having the head of a trophy fish cut open, she recalls, laughing. Her boss suggested that she use a dremmel, a small drill-like tool, to drill into the back of the fish heads to get the penny-sized bones. "I thought the problem required more of a woman's touch," she says. "So, I went to the local home appliance store and bought an apple corer. Only a woman would think of using a kitchen tool for something like that!" The device not only worked, but it worked well enough for the California Department of Fish and Game to adopt the strategy.

Another invaluable resource was Perravano—a hard-working, politically active fisherman who was enthused to help Barnett-Johnson in any way possible. "When I first met Rachel," he reminisced, "I thought, 'now here's someone who is going to affect the future of salmon in a positive way.'" To help, Perravano would bring dozens of fish heads every week to his local farmer's market, where he sold fresh fillets. Barnett-Johnson would meet him there with a big cooler. "I'd buy my fruit, then go get my fish heads," she recalls. "It was a great system."

With the otoliths in hand, Barnett-Johnson used simple microscopy to distinguish wild from hatched salmon by examining banding patterns in the tiny bones. Much like tree rings, otoliths form light and dark bands when they grow. The bands arise from alternating deposits of calcium carbonate and organic matter. The wider the band, the faster the rate of growth. In a hatchery, food is abundant so the fish have a high growth rate, which shows up as wide bands. In the wild, the newborn fish hide in gravel and use their yolk sac for food. After that's depleted, it takes them some

time to learn how to catch aquatic insects. This lag in nutrition produces a distinctly narrower pattern. These growths act as natural signatures to identify where the fish grew up.

After Barnett-Johnson analyzed all of her otolith data, the results were a bit shocking: only one out of every ten salmon were wild. Initial theories were correct; the supplemented hatched fish were indeed masking the vitality of the wild population. “At first, I thought ‘Aha! People were being overly optimistic about the wild fish,’” she recalls. “Then my attitude switched to ‘Whoa. Bad things are happening.’”

Her published results coincided with the worst fishing season in history. In previous years, hundreds of thousands of adults had returned to the Sacramento River to spawn. In 2008, only 60,000 adults were predicted. According to Barnett-Johnson’s research, only 6,000 of those returning fish would be wild—a drastic reduction from years past.

The 2008 collapse was the result of two things: environmental degradation of spawning habitats and a food shortage in the ocean. Both factors coincided when the 2008 adults were juveniles, decimating the numbers of fish. Federal agencies like NMFS have taken note. The Chinook are currently listed as a “species of concern,” which means the data isn’t solid enough to place them under the Endangered Species Act. With results like those from Barnett-Johnson and colleagues, that soon may change. “We now have a tool to continuously monitor how the wild population doing,” she says. “It’s really powerful.”

The connection between Barnett-Johnson and fishermen fostered this research, and Perravano realizes the irony. Her results may give Chinook federal protection, which in turn would invoke a permanent moratorium on commercial fishing. This would leave Perravano, and others like him, out of business.

“Fishermen understand the need for better data,” he says. “Better data allows for sustainable fishing. That’s what we want: fish to be around in the future.” Signs hidden securely in the back of their brains may reveal whether the bounty of the Chinook will return once again.

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