Our Ocean Backyard — *Santa Cruz Sentinel* columns by Gary Griggs, Director, Institute of Marine Sciences, UC Santa Cruz.

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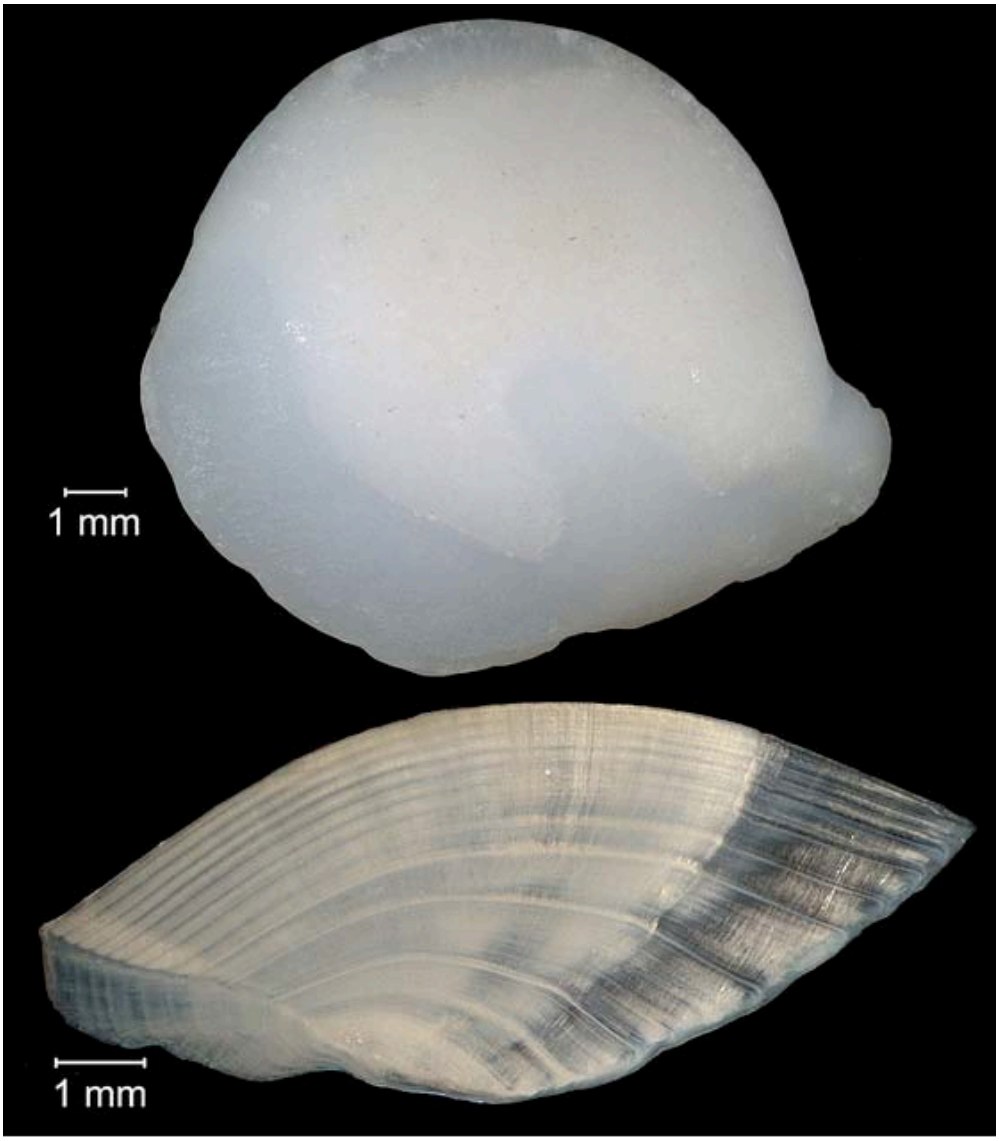
Reading a salmon's ear bone



Magnified image of the otolith (earbone) of a Hardhead Catfish.

Fish, like humans, have ear bones, which are called otoliths. They're used by fish as sensory organs, and play a role in hearing and also balance. These small structures are made up of concentric layers of calcium carbonate and a protein material and grow throughout a fish's life. The accretion rate varies with growth of the fish - often slower in winter and faster in summer- resulting in the appearance

of rings that resemble tree rings. By counting the rings, it is possible to determine the age of the fish in years, exactly like we would do with the rings in a log or tree stump. In most fish species, the accretion of calcium carbonate and the protein also alternates on a daily cycle, which makes it possible to determine fish age in days. Knowing the age of a fish and how fast it grows are important for understanding questions like how long fish spend as juveniles, and what the population structure is. All of this information is in turn important for designing appropriate fisheries management policies.

The composition or chemistry of the individual layers of a fish otolith is also now proving extremely useful in providing us with information about the lives of fish such as salmon- questions like where they are born, how long they live in fresh water before they migrate out to sea, and how fast they grow. Much like the rings of a tree, otolith layers are deposited as a fish grows, with each layer recording the components of the chemical environment in which the fish was swimming. Analyzing the composition or the trace elements within an ear bone would allow us to figure out where a fish had spent its life and how long it lived in each neighborhood.

What we need is a tool that can precisely analyze the composition of these very, very thin daily layers in a fish's ear bone. The instrument has now been developed to do just that, and has a name you will probably not soon forget, a laser ablation inductively coupled plasma mass spectrometer. One of the most useful trace elements being analyzed is strontium, simply because it is chemically similar to calcium so is easily taken up in the calcium carbonate of individual layers. Strontium comes in two different isotopes or forms, strontium-87 and strontium-86, and the ratio of these two isotopes in the waters of a stream is related to the rocks the streams flow through. Strontium ratios, therefore, are unique to individual watersheds, and their signature in a fish ear bone acts as a natural population marker, sort of a geographic birth certificate for a fish.

The Central Valley Chinook salmon make up 90%- or about $60 million worth- of California's ocean harvested salmon, but the populations have gone through a disastrous decline in the last several years, which has forced the closure of the commercial salmon season. Knowing something about the life histories of these fish and where they come from may help us resolve some of the problems with their declining populations.

By measuring the strontium-87 and strontium-86 ratios in the ear bones from salmon in the rivers of the Central Valley, and also from fish caught offshore in the

adjacent ocean, scientists can tell with 95% accuracy not only where the fish was hatched, but also how long it lived in fresh water before it reached San Francisco Bay, and then when it entered the ocean. With this information we can determine how many of the ocean salmon had their origins in specific rivers (or hatcheries) in the Central Valley.

What came as a surprise when the data from the fish ear bones were first evaluated was that only 10% of the fall-run Chinook salmon were wild fish and the other 90% were hatchery fish. The role of hatcheries in the management of salmon populations has been a controversial issue and this high tech research indicates that the decline in the natural salmon population has been masked by the larger numbers of artificially propagated or hatchery fish. Salmon have been a major fishery for California for many decades but for a complex combination of reasons, some natural and many human, the populations are in very serious decline and only occupy a small portion of their original range. Deciphering the tape recorders of their lives embedded in their ear bones may help us bring these fish back from the edge.