Are You Eating What You Think You’re Eating?

Steve Palumbi’s molecular forensics exposes the seedy side of seafood.

By [Eric Wagner](http://www.slate.com/authors.eric_wagner.html), Slate.com (January 29, 2013)

Steve Palumbi, business casual

Photo courtesy of Dan Griffin

Steve Palumbi has a few rules when it comes to sushi. If something is labeled tuna, then it probably is, but stay away from the salmon, because it probably isn’t. More likely, it’s steelhead trout—a close relative of salmon, both of which start life in freshwater, migrate to the sea, and return to their natal stream to breed and die. But still: a trout. Shrimp is shrimp and crab is crab, unless it’s pollock. And don’t trust the white fish. That could be anything: tilapia, something else, who knows.

Palumbi is a marine biologist at Stanford University and the director of the Hopkins Marine Station in Pacific Grove, Calif. He has tested the veracity of seafood labels at venues ranging from huge, upscale grocery stores to small fish markets. As a practitioner of what might be called molecular forensics, he uses DNA “to see whether the things we assume are true really are,” and it’s time, he says, for the scales to fall from our eyes.

Palumbi grew up in Maryland, where he enjoyed what he calls the marine biologist’s standard origin story: lots of aquariums when he was a kid, trips to the beach with his family, an innate curiosity about the sea and its meanings, the goofy joy that comes with the discovery that a person could actually get paid to study it. He majored in biology in college and did his graduate work at the University of Washington on sponges. When he finished his Ph.D. in 1984, he started teaching at the University of Hawaii, turning his attention to the population structure of local humpback whales. In 1992, after he got a call from a man named Don White, he became interested in the discrepancies between what people think they are eating and what they are actually eating.

White was a co-founder of Greenpeace who had gone on to become the director of Earthtrust, and he was worried about whale meat being sold at Japanese markets. The International Whaling Commission banned commercial whaling in 1986 save for a few subsistence hunts and, more problematically, whaling for research. Under that research clause, Japanese whalers were allowed to kill a few hundred minke whales each year (although, as Palumbi points out, that form of research is generally understood to be nothing more than an excuse to whale). Once science had supposedly been done on the whales, vendors could sell the meat.

White had heard rumors that the legal sale of minke whale meat served as a cover for the illegal sale of other kinds of whale meat, possibly from endangered species. The problem was that he didn’t know how to prove it. Palumbi knew he could sequence DNA from whale meat to see what species it came from, but he also knew that, given what he was looking for, Japanese officials would not let him take meat out of the country. Smuggling wasn’t an option, though. Marketplace monitoring using molecular evidence was a new field, subject to intense scrutiny by both scientists and those who found themselves in the crosshairs of such monitoring. And molecular forensics of the type Palumbi practiced hadn’t been used in a fishery before.

“We had to be completely squeaky clean,” Palumbi says, which meant he had to go to Japan. He and [Scott Baker](http://mmi.oregonstate.edu/c-scott-baker), now at Oregon State University, helped develop a sort of suitcase PCR lab to take with them. (PCR—polymerase chain reaction—is a technique that allows researchers to make millions of copies of a segment of DNA that they can then sequence. When the Japanese Whaling Association later challenged Palumbi and Baker over the legality of their methods, he argued that since they were taking synthetic copies of whale DNA assembled from a stew of nucleotides rather than DNA from actual whale flesh, they [weren’t running afoul of CITES](http://www.cites.org/), the trade agreement that regulates the transport of endangered species across international boundaries.)

Once in Tokyo, he and Baker enlisted agents to go to markets and buy pieces of “kujira”—the generic term for whale—because “two white guys asking to buy whale would have attracted a lot of unwanted attention.” The agents brought 16 hunks of whale meat back to a small hotel room where Palumbi and Baker were holed up with their mobile genetics lab. The two extracted segments of DNA from the meat, copied them using PCR, and returned to their labs with vials of synthetic whale DNA. When they analyzed the data, they found that less than half of the whale meat was from minke whales. The rest of the meat was from a mix of large, protected baleen whales, including fin and humpback whales, and smaller, toothed whales, such as dolphins and porpoises.

When Palumbi and Baker [published their results in *Science*](http://www.soest.hawaii.edu/oceanography/courses_html/OCN331/Baker%26Palumbi.pdf)in 1994, it caused a sensation. The Japanese Whaling Association denounced the researchers for having an agenda and for their supposedly shoddy and incomplete science. But the data were irrefutable.

A few years later, Palumbi saw darker implications, and not just for whales. He sent his agents shopping for whale meat in Japan again. When he tested the samples, Palumbi again found a grab bag of species. But there was something else: Meat from the toothed whales—dolphins and porpoises—had much [higher concentrations of mercury and other pollutants](http://palumbi.stanford.edu/manuscripts/Simmonds%20et%20al%202002.pdf) in their flesh. These species eat prey at higher trophic levels than do minke whales, which eat mostly krill and plankton and are much less contaminated. “We were seeing levels that [no pregnant woman should even touch](http://articles.latimes.com/1999/oct/30/news/mn-27832),” he says.

Palumbi and his colleagues were faced with a dilemma. Illegal dolphin meat had the potential to be not only an ecological problem but also a public health concern. Due to that urgency, they bypassed the traditional scientific publishing process and instead went directly to the press. Again there was a sensation. Again, Japanese officials disparaged the results. Palumbi didn’t care. “We thought people had a right to know exactly what they were eating and what it might be doing to them,” he says. Consumption of whale meat in Japan has since [declined markedly](http://www.guardian.co.uk/environment/2012/jun/14/japan-appetite-whale-meat-wanes); last year, the Institute for Cetacean Research [failed to sell](http://ika-net.jp/en/our-actions/whaling-issue/251-whale-meat-does-not-sell)three-quarters of its product.

The problem of mislabeled seafood, be it whales or fish, is not a new one. As far back as the 1930s, mackerel was being canned and sold as salmon, and anecdotes have always floated around of more exotic substitutions—of shark being shopped as swordfish, say, or skate wings for scallops. These days, thanks in part to the work Palumbi helped spearhead, the fish-eating public is used to a steady flow of sophisticated, DNA-based studies and exposés. A 2004 paper by Peter Marko, then of the University of North Carolina, found that 77 percent of red snapper bought in the United States was [actually a cheaper, smaller](http://www.clemson.edu/biosci/faculty/marko/lab/papers/Marko_et_al_04.pdf) species. In 2008, Palumbi found something similar with [Pacific red snapper](http://palumbi.stanford.edu/manuscripts/an%20impediment%20to%20consumer%20choice.pdf)—the market name for a suite of species called rockfishes. In December, the conservation group Oceana released a report showing that nearly 40 percent of [fish in New York restaurants was mislabeled](http://oceana.org/sites/default/files/reports/Oceana_NYC_Seafood_Fraud_Report_FINAL.pdf), which followed a [similar investigation in Los Angeles](http://oceana.org/sites/default/files/LA_Seafood_Testing_Report_FINAL.pdf). In 2011, the *Boston* *Globe* found [widespread fraud](http://www.boston.com/business/specials/fish_testing/) at area eateries, and a follow-up in 2012 showed that little had changed. And [on](http://www.consumerreports.org/cro/magazine-archive/2011/december/food/fake-fish/overview/index.htm) and [on](http://oceana.org/sites/default/files/reports/Bait_and_Switch_report_2011.pdf).

Such studies empower the consumer only by showing them just how much they’re being disempowered. “This story isn’t about information anymore,” says Jennifer Jacquet, an environmental studies professor at NYU. “It’s gone way past that, to something deeper.” What’s most insidious, she says, is how mislabeling undercuts even the most conscientious consumer, giving them the illusion of choice. Even seafood that is labeled sustainable at the store sometimes [turns out not to be](http://www.clemson.edu/biosci/faculty/marko/lab/papers/MarkoCB_2011.pdf), as [Marko showed](http://www.clemson.edu/biosci/faculty/marko/lab/research_PISS.html) in a paper from 2011, and Jacquet has argued that such sustainable sanctioning schemes are [potentially unreliable](http://jenniferjacquet.files.wordpress.com/2010/05/jacquetetal2010_nature1.pdf). What’s the good of carrying a little card around in your wallet listing the most sustainable species if you have no idea what you’re actually buying?

For his part, Palumbi has since turned his molecular eye to other things, as is his wont. “Once you’ve trained someone and they leave your lab, you immediately turn into competitors,” he says, and he’s happy to let them continue the research while he seeks out new topics. He doesn’t exactly face a shortage of issues to investigate, what with ocean acidification, overfishing, and the like. He compares problems with the health of the ocean to “the flashing lights in your rearview mirror that you’d maybe rather ignore.” Of late he is working in American Samoa on corals that show a surprising capacity to [withstand temperature fluctuations](http://www.pnas.org/content/early/2013/01/02/1210224110.full.pdf) that normally kill corals—except these corals mysteriously do not die. It is another way for him to use molecular forensics as he searches throughout the South Pacific for hardy corals and reefs.

Still, he keeps tabs on fish labels. So pervasive is the problem that he can send students from his university biology courses out to test the offerings of local stores every year, confident that something strange will turn up. “It’s a terrific teaching tool,” he says. “The data themselves are boring. It’s what you add to the data. What does it tell you about what is going on?” Just a couple of years ago, he tested the aquatic wares at his local Whole Foods grocery. “I’m usually reluctant to test food at my favorite places, but they were pretty good,” he says. “All but one of the fish was labeled correctly.” The one that wasn’t, and within sight of Monterey Bay’s famed [Cannery Row](http://www.canneryrowsardineco.com/)? A sardine.

*Eric Wagner writes about science and the environment from his home in Seattle, where he lives with his wife and daughter. His writing has appeared in*Smithsonian*,*Orion*, and*High Country News*, among other places.*