Fish and Shellfish Program NEWSLETTER

December 2018
EPA 823-N-18-012

In This Issue

https://www.epa.gov/fish-tech

Recent Advisory News

Oregon Health Authority Expands Health Advisory For Lower Willamette River

On April 11, 2018, the Oregon Health Authority (OHA) updated an existing health advisory issued June 2004 for resident fish in the Portland Harbor area of the Lower Willamette River.

The new advisory expands the 2004 advisory for two reasons:

- Fish and shellfish tissue data made available to OHA show that the level of polychlorinated biphenyls (PCBs) found in resident species of the Lower Willamette River warranted updating meal recommendations.
- Additional fish tissue data collected outside the Portland Harbor study area warranted expanding the boundary of the fish advisory.

The boundary now encompasses the Lower Willamette River from the Sellwood Bridge to its confluence with the Columbia to include Multnomah Channel from its confluence with the Willamette to the Sauvie Island Bridge. The original advisory covered only the Portland Harbor study area from the mouth of the Columbia River to the Fremont Bridge.

The advisory affects bass, carp, brown bullhead, black crappie, and all other resident fish, as well as crayfish, clams, and mussels found within the Lower Willamette River. It is illegal for non-tribal members to harvest or possess any freshwater mussels or clams, according to the Oregon Department of Fish and Wildlife, and non-tribal members who do so can be subject to a fine by the Oregon State Police. Meal recommendations in this advisory for clams and mussels are provided for tribal use, and in the event these shellfish are harvested or possessed illegally.

“Our iconic salmon, steelhead, and other migratory fish are fine,” said David Farrer, Ph.D., public health toxicologist at the OHA Public Health Division’s Environmental Public Health Section. “People still need to eat at least two meals of fish per week. We want people to know which fish are the healthiest to eat and which fish they need to be careful about.”

Resident fish live in the same area their entire life. Some, like bass, are long-lived top predators, eating other PCB-contaminated fish within the river. The longer they live, the more PCBs they accumulate. Other fish such as carp are bottom-feeders. PCBs can accumulate in these types of fish because they live and eat in areas where PCB concentrations tend to be elevated.

This advisory does not apply to migratory fish like salmon, steelhead, and shad that spend most of their lives in other places beyond the Lower Willamette River, including the ocean. These and other migratory fish are considered a healthy choice when deciding what fish to eat.

Advisories are issued when fish or shellfish tissue data collected and analyzed verify that the level of a contaminant — in this case, PCBs — is above Oregon's established health-based screening value for that contaminant. Meal recommendations are then calculated using this data to help people better understand the amount of resident fish and shellfish they can safely eat in any one month. These meal recommendations are only for the portion of the Lower Willamette River described above.

Meal Recommendations for Resident Fish and Shellfish in the Lower Willamette River			
Fish Species	**Meals[a] per Month**	**Invertebrate Species**	**Meals[a] per Month**
Bass	0	Crayfish	2
Carp	0	Clams[c]	0
Brown bullhead	0	Mussels[c]	7
Black crappie	2[b]		
All other resident fish	0		

It is illegal to harvest or possess any freshwater mussels or clams and fines could be charged.

a A meal is about the size and thickness of your or your child's hand, or 1 ounce of uncooked fish for every 20 pounds of body weight.

b This number is for whole body consumption. If only the fillet is eaten the meal recommendation is four.

c Meal recommendations for clams and mussels are provided in the event these shellfish are harvested or possessed illegally, and for tribal member information. Tribes have reserved treaty rights to harvest.

People who eat too much resident fish and shellfish contaminated with PCBs can suffer negative health effects over time, such as damage to organs, the nervous system, and the brain, leading to potential learning and behavior problems. Mothers can pass PCBs to their babies during pregnancy or in breast milk. Fetuses, babies, and small children are most vulnerable to the health effects of PCBs. OHA recommends that pregnant and nursing women, and women of childbearing age (18 to 45) follow these meal recommendations closely. Anglers also should not give resident fish or shellfish to others unless the recipients are aware of the PCB contamination issue and understand the recommendations in this and other fish and shellfish advisories.

While it is important for people to know about contaminants in fish and shellfish to protect themselves and their families, it is equally important for everyone to eat a variety of fish from a variety of sources to gain important health benefits. Fish are an important part of a healthy diet, especially migratory fish like salmon, steelhead, and shad that are low in contaminants. Fish are high in protein, low in fat, and rich in nutrients like omega-3 fatty acids. Omega-3s provide protection from heart disease and are an important brain food for adults, children, and fetuses.

Consistent with other sediment clean-up sites like Portland Harbor, the U.S. Environmental Protection Agency (EPA) and the Oregon Department of Environmental Quality anticipate a temporary increase in contaminant concentrations in fish tissue once clean-up activities begin, and for some duration immediately following the clean-up phase. This is due to disturbance of contaminated sediment in the river. At that time, and until new resident fish and shellfish tissue data are available, advisory meal recommendations will be updated to zero meals per month for all resident fish and shellfish species. This update will ensure the public, especially the most vulnerable populations, are protected as much as possible, when spikes in the amount of contaminants that fish and shellfish are exposed to, are predicted.

Part of the Portland Harbor clean-up plan includes ongoing fish tissue sampling to monitor the recovery of the river. As the data from this monitoring becomes available, OHA will evaluate them and update the advisory meal allowances as warranted.

For a list of other areas and water bodies with existing fish advisories and recommended meal allowances, and to learn more about fish consumption and other fish-related topics, visit HealthOregon.org/fishadv.

For more information contact OHA: https://www.oregon.gov/oha/Pages/Contact-Us.aspx.

Source:
https://www.oregon.gov/oha/ERD/Pages/OHAExpandsLowerWillametteRiverResidentFishHealthAdvisory.aspx

EPA News

EPA announces action plan to combat harmful algal blooms in Lake Erie

On March 7, 2018, EPA announced the release of the U.S.' domestic action plan for reducing phosphorus, a major contributor to harmful algal blooms, in Lake Erie. The plan outlines federal and state efforts to achieve the binational phosphorus reduction targets adopted by the U.S. and Canada in 2016 under the Great Lakes Water Quality Agreement.

The U.S. has committed to reduce phosphorus nutrient sources by 40%, a reduction of 7.3 million pounds. The March 2018 plan summarizes the actions federal agencies and states are taking across the Lake Erie basin and provides a mechanism for tracking progress.

While the bulk of the phosphorus reductions will come from sources in Ohio, Indiana, and Michigan, all five states in the basin are committed to reducing nutrient loadings and minimizing problems of excessive algal growth. The U.S. plan presents a coordinated approach to link and expand the efforts across the states to achieve the nutrient goals in the basin. Additionally, the states of Michigan, Ohio, Indiana, and Pennsylvania each submitted individual action plans that describe specific phosphorus reduction measures in more detail.

Excessive algal growth poses substantial threats to both Lake Erie's ecosystem and human health. More than 10 million people rely on the lake for clean drinking water, swimming, and fishing opportunities. In the last decade, harmful and nuisance algal growth in the lake has increased significantly due to storms that deliver high levels of nutrients from major rivers. Recurring algal blooms and associated "dead zones" (oxygen-depleted areas created when algae die and decompose) threaten drinking water quality and Lake Erie's critical $12.9 billion tourism industry and world class fishery.

EPA engaged stakeholders in the development of the domestic action plan in August and September 2017 through in-person engagement sessions with targeted stakeholder groups.

The U.S. Action Plan can be accessed here: www.epa.gov/glwqa/.

The full suite of U.S., state, and Canada-Ontario domestic action plans can be accessed here: https://binational.net/annexes/a4/.

For more information, contact Allison Lippert at 312-353-0967 or Lippert.allison@epa.gov.

Source: https://www.epa.gov/newsreleases/epa-announces-action-plan-combat-harmful-algal-blooms-lake-erie

Other News

What is Killing the Coho?

Researchers are trying to determine which chemicals in stormwater are contributing to the deaths of large numbers of coho salmon in Puget Sound. This has prompted a larger question: What exactly is in stormwater?


Coho salmon. *(Image courtesy of NOAA)*

Stormwater may be Puget Sound's most well-known pollutant, and at the same time its least known. While the state has called stormwater Puget Sound's largest source of toxic contaminants, scientists are still having a tough time answering two basic questions about it: What is stormwater, exactly, and what does it do?

Let It Rain

Every year, the Puget Sound region receives up to 40 inches of precipitation, most of it as rain. In the past, which is to say before the Interstate-5 corridor became the bustling urban matrix it is today, much of that rain seeped into the soil or collected on leaves and grass and then evaporated back into the atmosphere; less than 1% was thereafter left to trickle into the Sound as surface runoff. But as humans altered the drainage basin of Puget Sound, so, too, did we alter the fate of the rains. Now, with more than 350,000 acres of impervious surfaces—streets, roads, highways, parking lots, building roofs, and so on—between 20 and 30% of precipitation turns into surface runoff. This translates into more than 370 billion gallons of stormwater per year pouring into Puget Sound.

As modern stormwater sluices downhill, it gathers whatever is in its path. By the time it is in the Sound, it is a formidable toxic stew. According to a 2015 report from the Washington Department of Ecology, at least 33 pollutants have a 50% or greater detection frequency in stormwater, meaning that they are found in at least half of samples. The list includes almost everything from fecal coliform to polycyclic aromatic hydrocarbons, which are known carcinogens. On top of those pollutants, 16 others are found in at least 20% of samples, and hundreds of other chemicals also are present.

All of these pollutants and toxins can have profoundly negative effects on Puget Sound's biota, such as aquatic insects and especially salmon runs, several of which are federally listed as threatened. Nathaniel Scholz, a biologist with the National Ocean and Atmospheric Administration (NOAA), and colleagues from several government agencies showed in 2011 that between 60 to 100% of coho salmon returning to some lowland urban streams in Puget Sound die before spawning. More recent work found that juvenile and adult coho salmon die within hours of exposure to untreated runoff from the State Route (SR) 520 bridge between Seattle and the eastside of Lake Washington. In a recent paper in *Ecological Applications*, biologists from NOAA and the Washington Department of Fish and Wildlife found that across 40% of coho's Puget Sound range, returning spawners are being especially hard-hit in urban areas, primarily due to stormwater.

A Complex Mixture

So which of the potentially thousands of chemical compounds found in stormwater might be killing the coho? That question is behind Jenifer McIntyre's research at the Washington Stormwater Center in Puyallup, and it is why she has waited so eagerly for a bag of tire shavings. McIntyre, an aquatic ecotoxicologist with Washington State University (WSU), is part of a broad coalition of scientists from groups including WSU, NOAA Fisheries, the U.S. Fish and Wildlife Service, and the University of Washington (UW), working together to solve this longstanding mystery. McIntyre is using the ground-up tires in an upcoming study to see what chemicals might leach out of them during a rainstorm, as rain turns into urban stormwater. The results might help clarify what is killing large numbers of coho salmon in the waters of Puget Sound, a condition known as "pre-spawn mortality."

Among the biggest suspects, not surprisingly, are the millions of cars that pass nearby, shedding potentially toxic substances such as synthetic rubber from tires, motor oil, windshield washer fluid, transmission fluid, brake dust, and automobile exhaust. Those and other substances are being tested at the lab.

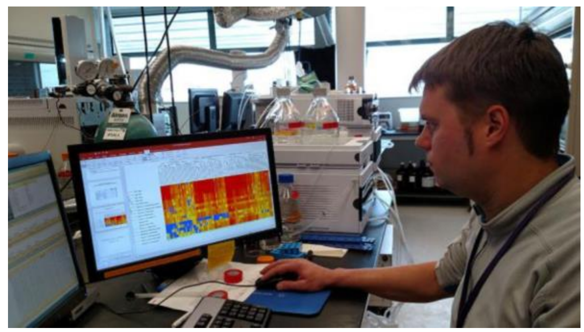
If, in fact, the problem is cars, McIntyre wonders: "Could we find a vehicle pollutant source that is responsible for most of the toxicity?" And if so, could that help regulators deal with the issue?

For the study of the ground up tires, McIntyre will run water through the grounds — a process not unlike making a cup of coffee — and see whether the contaminants that leach out match the toxicity of urban stormwater runoff. Early results have been intriguing. Coho salmon have died when exposed to the leached chemicals, but other chemicals may have similar results and it's too early to say what role automobile tires might have in pre-spawn mortality of coho in the wild.

"Stormwater is a complex mixture," McIntyre says. It can vary by location (urban, rural), habitat type (forest, farmland), and season (winter, summer). As to its exact chemical makeup, she demurs. "That's probably a better question for someone like Ed Kolodziej [a collaborator on the project]," she says.

New Analysis

While McIntyre is doing the biology — by researching how salmon react to certain chemicals — Ed Kolodziej is looking deep into the chemistry of stormwater. A backroom in the Department of Civil and Environmental Engineering serves as his makeshift office on the UW Seattle campus. He is just here for the day; he spends most of his time at the UW Tacoma Center for Urban Waters where he works with a series of specialized instruments that can measure the presence of molecules in a water sample in the parts per billion.



Dr. Ed Kolodziej analyzes mass spectrometry data in his lab at the Center for Urban Waters. *(Image courtesy of Kris Symer)*

Kolodziej is using a process known as high-resolution mass spectrometry to understand stormwater's convoluted chemical makeup. If a particular chemical is in the water, the instruments at the lab are likely to find it. The proverbial needle in a haystack? No problem. But what if you don't know exactly what you are looking for? That's more difficult, and it's where Kolodziej's work may differ from that of other researchers.

Conventional diagnostic methods are best at finding known chemicals. Typically, when facing a sample, a researcher will come up with a list of toxicants they think they're likely to find, called targets, and then test for those substances.

What Kolodziej is helping to develop is a method for testing urban stormwater that uses liquid chromatography coupled to high-resolution quadrupole time-of-flight mass spectrometry. He and his co-authors described the process last August in a paper in *Environmental Sciences: Processes & Impacts*. "Basically, I think of it as someone going fishing for a specific kind of fish, versus a trawler that pulls everything in and then sorts through the catch," says Kathy Peter, Kolodziej's postdoctoral scientist and one of the study's co-authors. "When you run a stormwater sample, you might see 1,000 or 2,000 features, and each feature is a chemical. Some of them will be natural, but some will be synthetic compounds that you need to test."

This sort of non-target analysis is good at uncovering what Kolodziej calls the unknown-unknowns of stormwater. "What are the emerging contaminants?" he says. "We're good at building analytical methods for things we know about, but there's tons of stuff we don't know about." To help assemble a wide array of urban runoff samples, he has enlisted citizen scientists. If someone sees a salmon die in a stream, they can take water and tissue samples. Kolodziej can then analyze the water that salmon was swimming in and try to figure out what killed it.

Even as Kolodziej and his colleagues have identified possible toxins, their precise origin remains as murky as the stormwater itself, at least in the published literature. "But," he says, "cars and trucks seem to be the biggest culprits." Motor vehicles are always shedding little bits of themselves as they whiz down roads and highways: flakes of brake, tire dust, droplets of motor oil, antifreeze, and gasoline. All of it adds up. The question is how might these different substances interact with one another. Can they become greater than the sum of their parts?

Possible Solutions

As for what to do about stormwater, McIntyre and her colleagues at the Washington Stormwater Center are testing a variety of possible solutions. With coho and the lethal stormwater cocktail streaming off the SR-520 bridge, McIntyre was able to reduce the runoff's toxicity simply by running it through a vertical soil treatment column: essentially, a barrel full of sand, shredded bark, and compost. After that, the coho were basically fine. (An interesting quirk is that chum salmon — or, as McIntyre calls them, "zombie fish" — were essentially untroubled by what killed the coho. "They just swam right through it like nothing," she says.) In a greenhouse down the road, Ben Leonard, one of her graduate students, is testing different lengths of swale for the extra removal of metals, running gallons of stormwater over a mix of Dutch clover and red fescue. His goal is to learn what a minimum effective length of swale might be, so Washington Department of Transportation engineers know how much to plant next to roads.

SR-520 bridge traffic in Seattle. Drain pipes visible at each column allow contaminated stormwater to flow directly from the roadway into Portage Bay, Union Bay, and Lake Washington. *(Image courtesy of Kathy Peter)*

"It's an issue of horizontal versus vertical, and how long stormwater stays in contact with the media," Leonard says. "Horizontal is better for roadways, but vertical is good for, say, a road next to a steel refinery next to a river where salmon spawn."

All of these fixes may one day solve what at present seems like an intractable problem. Once everyone has a better idea of the contaminants in stormwater, people can start to recommend changes in a policy sphere. Source control is always better than treatment after the fact, as Kathy Peter points out. "You don't want to be managing a problem like this in perpetuity," she says.

This article was posted on December 5, 2017, by the *Encyclopedia of Puget Sound*, a publication of the Puget Sound Institute. For more information, contact the article author, Eric Wagner, at erlwagne@gmail.com.

Study Assesses Fish Otoliths for Metal Exposure after *Deepwater Horizon*

On May 4, 2018, the Gulf of Mexico Research Initiative reported that researchers have examined metal exposure patterns in otoliths from six offshore fish species with varying health status to identify changes corresponding with the *Deepwater Horizon* incident. Otoliths are metabolically inert stones located within fish's teleost ears that incorporate trace elements from surrounding water and diet and, in this study, serve as oil biomarkers that would not degrade over time. Many fish with external lesions exhibited elevated concentrations of nickel and zinc before, during, and after the spill. These findings suggest that lesioned fish had long-term exposure to a persistent source of trace metals in the Gulf of Mexico, which may have had health implications during and after the spill. This study is the first to use the time-keeping properties of fish otoliths for baseline and post-spill comparisons of metal concentrations. The researchers published their findings in *Marine Pollution Bulletin*: Associations between metal exposure and lesion formation in offshore Gulf of Mexico fishes collected after the *Deepwater Horizon* oil spill.

Previous studies that detected oil exposure biomarkers in several fish species collected near the spill site documented an elevated prevalence of external skin lesions and hydrocarbon concentrations, suggesting exposure from an episodic event. However, a lack of baseline data and the rapid metabolization of hydrocarbons (and, therefore, biomarkers) made it difficult to connect the spill and sublethal effects on fish.

Researchers analyzed otolith sections from 222 fish collected near the spill site (Louisiana Shelf and Desoto Canyon) and the West Florida Shelf from 2011 to 2013. Their collections specifically included Red Grouper, Red Porgy, Red Snapper, Southern Hake, Tilefish, and Yellowedge Grouper because these fish have overlapping distributions with the spill site and diverse life history patterns. The team used an inductively coupled plasma-mass spectrometer to identify metal isotopes and assess annual (2009 to 2011) microchemistry for metal concentration changes concurrent with the spill.

Otoliths from all species showed a consistent pattern of short- and long-term metal exposure that varied according to species-specific life history patterns. There was long-term exposure for at least half of the offshore fishes to nickel, zinc, copper, and vanadium before, during, and after the spill. Three distinct groups emerged within most species – those with comparatively low metal concentrations, relatively high copper concentrations, and relatively high nickel and zinc concentrations. The copper group was relatively small compared to the other groups and exhibited no patterns in location, sex, or other metrics that would explain the copper concentration levels. The nickel-zinc group exhibited a much higher number of lesioned fish than anticipated, suggesting a possible greater bioavailability of nickel and zinc resulting from the spill.

Offshore oil platforms in the Gulf of Mexico *(Image courtesy of the Bureau of Safety and Environmental Enforcement, U.S. Department of the Interior)*

The team suspects that lesioned fish may have been immunosuppressed before the spill (nickel and zinc can alter immunoregulatory functions) making them vulnerable to polycyclic aromatic hydrocarbon impacts. Several metals appeared in higher concentrations in fish living near oil platforms and associated with oil production processes (drilling mud, pipelines). Other quantifiable metal sources include natural oil seeps, oil combustion byproducts, transportation activities, and oil and gas extraction activities.

However, there are many additional potential sources for these metals – atmospheric deposition, river discharge, inputs from sediments near highly populated areas, industrial or military installations, agricultural watersheds, and the Mississippi River. The researchers suggest that the elevated concentrations may have resulted from or been bolstered by the 2010 Mississippi River diversion and sediment burrowing or manipulating by the study's deeper-dwelling species.

Data are publicly available through the Gulf of Mexico Research Initiative Information & Data Cooperative at doi:10.7266/N7XS5SFZ and doi:10.7266/N79021PB.

For more information, contact the study's authors: Jennifer E. Granneman at jgranneman@mail.usf.edu, David L. Jones at djones14@mail.usf.edu, and Ernst B. Peebles at epeebles@mail.usf.edu.

Source: http://gulfresearchinitiative.org/study-assesses-fish-otoliths-metal-exposure-deepwater-horizon/

Recently Awarded Research

Louisiana Trustees Release Funds to Support Monitoring of Fish and Marine Mammal Research

In July 2018, the Louisiana Trustee Implementation Group approved funding for three important activities to inform restoration planning and projects in the Gulf of Mexico.

Coastwide Fish and Shellfish Monitoring

With this activity, data will be gathered to assess fish, shellfish, and their associated habitats in Louisiana's basins over time.

- The first year of a five-year fisheries-independent monitoring plan will result in valuable data for nearshore habitats and resources targeted for restoration, including coastal wetlands, oysters, fish, and prey for threatened or endangered species such as gulf sturgeon, sea turtles, and marine mammals. The data will be used to enhance monitoring efforts within Louisiana, assessing changes in fish, shellfish, and their habitats over time. These activities will support assessment of restoration projects at a coastwide or regional scale. Estimated costs of these activities are $2,120,000.

Near-term Marine Mammal Data Collection for Future Restoration Planning

With this activity, two marine mammal near-term data collection efforts will be funded:

- Monitoring and adaptive management funds will be used to further refine the understanding of current bottlenose dolphin abundance and distribution in the Barataria Basin and may be used to evaluate the effects of implementing *Deepwater Horizon* trustee-led and other restoration projects across coastal Louisiana. The estimated costs of these activities are $402,183.

Bottlenose dolphin. *(Image courtesy of NOAA)*

- A marine mammal project will support restoration decisions through the compilation and synthesis of existing data regarding the physiological effects of fresh water exposure on marine mammals. The estimated costs of these activities are $249,272.

The approved resolution and scopes of work for the activities can be viewed here.

Contact information for the Deepwater Horizon Natural Resource Damage Assessment Trustees can be found here: https://www.gulfspillrestoration.noaa.gov/about-us/contact-us.

Source: https://www.gulfspillrestoration.noaa.gov/2018/09/louisiana-trustees-release-funds-support-monitoring-fish-and-marine-mammal-research?utm_medium=email&utm_source=govdelivery

Tech and Tools

Innovative Technology Promises Fast, Cost-Efficient Age Data for Fisheries Management

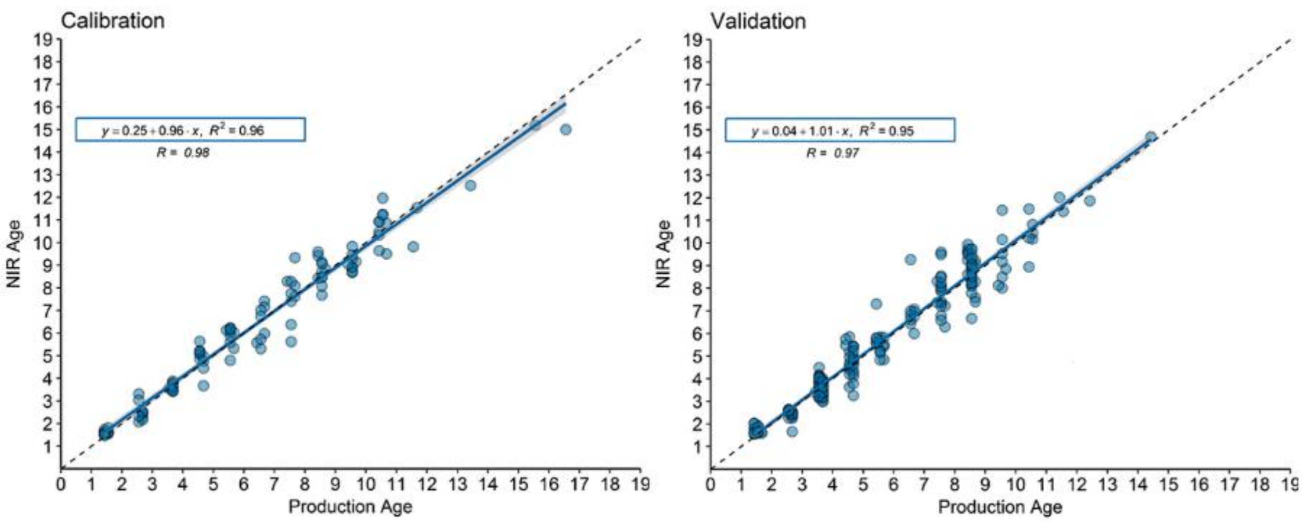
Knowing how long fish live and the number of different age groups in a fish population is essential to sustainably manage Alaska's valuable fisheries. Reported on July 30, 2018, NOAA Fisheries scientists are evaluating the use of machine-based technology – Fourier Transform-Near Infrared Spectroscopy (FT-NIRS) of otoliths – to determine fish age. Initial results on Bering Sea walleye pollock otoliths suggest with this technology NOAA Fisheries will be able to determine the age of fish more quickly and cost-effectively. Efficiency is likely to vary by species; however, for pollock, preliminary estimates suggest that efficiency could improve by 600% to 800%.

This digitally enhanced Otolith is one of the ways technology is helping scientists more accurately determine the age of fish. *(Image courtesy of NOAA Fisheries)*

"This could transform, even revolutionize, the way we collect age data," says Dr. Thomas Helser of the Alaska Fisheries Science Center Age and Growth Program, who is spearheading the effort. "FT-NIRS analysis is rapid and repeatable, and our preliminary analysis for eastern Bering Sea walleye pollock is highly promising."

Age data are critical for understanding population dynamics of commercially fished species and providing management advice. Assessing populations of the Nation's biggest fisheries is complex, and requires a lot of age data.

Conventional ageing methods estimate the age of each fish by visually counting annual growth rings on its otoliths, or ear bones, under a microscope. Handling time per otolith is three to five minutes, plus additional time for quality control readings. With over 60,000 age requests coming in each year to NOAA's Alaska Fisheries Science Center Age and Growth Program, this means a big investment in time, effort, and money.



Data output examples from an FT-NIRS analysis. *(Image courtesy of NOAA Fisheries)*

"The demand for fish ageing has increased steadily, but production capacity has not. With conventional methods and limited budgets, there is no way to keep up," says Helser. "We are looking to new technology to bridge the gap."

An Age Spectrum

FT-NIRS first gained prominence in the pharmaceutical, chemical, and agricultural industries as an efficient and accurate way to measure chemical formulations for product quality and in-process monitoring of factory operations. For example, in the dairy industry, FT-NIRS is used to determine the strictly regulated butterfat content of milk and other dairy products.

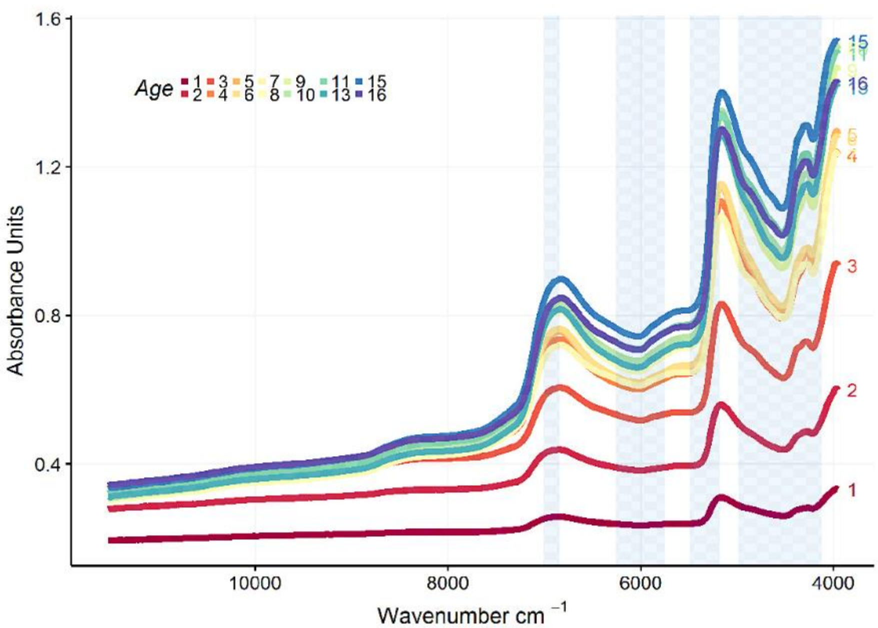
"We are working on understanding the exact molecular constituents in otoliths that give the relationship between spectral data measured by FT-NIRS and fish age. However, based on the most informative O-H, N-H and C-H regions in the near-infrared wavelength range we believe it is the organic content, including proteins, in otoliths that determine the age of fish," Helser explains. "As a fish grows, its otoliths accrete layers of calcium carbonate, including a protein matrix within. The otoliths of a one-year-old pollock will have less protein than those of a 10-year-old. If we can measure the difference with FT-NIRS, we will have an efficient method to age large numbers of fish."

Helser notes that scientists in Australia began exploring the use of FT-NIRS technology to age fish about three years ago. “We are not the first to try this technology, but so far it has been in the exploratory phase. If we are able to develop it for use on a large scale, we will be the first to use FT-NIRS to age fish for stock assessments.”

Helser’s team is now working with scientists at Bruker Optics, the instrumentation's manufacturer, to perfect it for ageing large numbers of fish.

Using FT-NIRS technology, light from a special near-infrared source is focused on the otolith, which absorbs some of this light at characteristic wavelengths or frequencies. The amount of light that is absorbed is measured and recorded by an instrument known as a spectrometer. This record of the light absorbance by the otolith is called a near-infrared spectrum. The process takes about 30 to 50 seconds per otolith -- more than 10x faster than traditional methods.

“Once spectral data on a number of samples is collected, it is correlated (using special statistical software) with recorded visual estimate of age to create models for age predictions,” explains Helser. “Matches for pollock calibration models so far have been on the order of 92 to 95%.” The calibration model is then validated with unobserved spectra from another set of otoliths to evaluate the robustness of the predictions.



The amount of light absorbed by walleye pollock otoliths of different ages at each specific frequency (wavenumber) across the NIR spectral range.
(Image courtesy of NOAA Fisheries)

Future Ages

Helser points out that there is still a lot to learn about how organic constituents in otoliths relate to the measurement of age fish. “We are not sure how protein gets incorporated in otoliths, so we don’t know if it varies by location, or prey type, or climate conditions. Do we need different calibrations for different locations and years? We need to nail that down.”

But once the method is fine-tuned, increased efficiency and reduced costs are only the beginning of the potential benefits of using FT-NIRS technology in fisheries research and management.

"We haven't even begun to explore all the fisheries applications of the technology," says Helser. "Can we differentiate species? Is it sensitive enough to measure age at monthly or weekly intervals in larval or juvenile fish, and determine actual birthdates? We might use it to look at effects of climate on growth. Moreover, we have begun to explore this technology to the rapid interrogation of other biological structures, such as female ovary tissue for maturity status and fecundity, and predator stomach contents for diet analysis. We envision the use of FT-NIRS for the rapid assessment of fish biological structures, either in the laboratory or ship-board research surveys, which could be transformative for providing a key data source for stock assessments and ultimately management advice. And with the machine doing the mundane stuff, people will have scope to do more interesting projects. We're excited to be realizing something that may transform our field of work."

Additional Resources

- Age and Growth Otolith Collections Ageing Methods
- Fish Otolith Chronologies
- Fish Otolith Collection Database

For more information, contact Dr. Thomas Helser at Thomas.Helser@noaa.gov.

Source: https://www.fisheries.noaa.gov/feature-story/innovative-technology-promises-fast-cost-efficient-age-data-fisheries-management

Recent Publications

Journal Articles

The list below provides a selection of research articles:

- **Subcellular distributions of trace elements (Cd, Pb, As, Hg, Se) in the livers of Alaskan yelloweye rockfish (*Sebastes ruberrimus*)**
  Barst, B.D., M. Rosabal, P.E. Drevnick, P.G.C. Campbell, and N. Basu. 2018. Subcellular distributions of trace elements (Cd, Pb, As, Hg, Se) in the livers of Alaskan yelloweye rockfish (*Sebastes ruberrimus*). *Environmental Pollution* 242:63-72.

- **Experimental evidence of dietary ciguatoxin accumulation in an herbivorous coral reef fish**
  Clausing, R.J., B. Losen, F.R. Oberhaensli, H.T. Darius, et al. 2018. Experimental evidence of dietary ciguatoxin accumulation in an herbivorous coral reef fish. *Aquatic Toxicology* 200:257-265.

- **Developmental exposure to low concentrations of two brominated flame retardants, BDE-47 and BDE-99, causes life-long behavioral alterations in zebrafish**
  Glazer, L., Wells, C. N., Drastal, M., Odamah, K. A., Galat, R. E., Behl, M., and Levin, E. D. 2018. Developmental exposure to low concentrations of two brominated flame retardants, BDE-47 and BDE-99, causes life-long behavioral alterations in zebrafish. *Neurotoxicology* 66:221-232.

- **Relation of contaminants to fish intersex in riverine sport fishes**
  Grieshaber, C.A., T.N. Penland, T.J. Kwak, W.G. Cope, R.J. Heise, J.M. Law, D. Shea, D.D. Aday, J.A. Rice, and S.W. Kullman. 2018. Relation of contaminants to fish intersex in riverine sport fishes. *Science of The Total Environment* 643:73-89.

- **Microwave calcination of waste oyster shells for CO2 capture**
  Huang, Y., Y. Lee, P. Chiueh, and S. Lo. 2018. Microwave calcination of waste oyster shells for CO2 capture. *Energy Procedia* 152:1242-247.

- **Mercury levels in fish for human consumption from the Southeast Gulf of California: Tissue distribution and health risk assessment**
  Martinez-Salcido, A.I., J. Ruelas-Inzunza, B. Gil-Manrique, O. Nateras-Ramirez, and F. Amezcua. 2018. Mercury levels in fish for human consumption from the Southeast Gulf of California: Tissue distribution and health risk assessment. *Archives of Environmental Contamination and Toxicology* 74(2):273-283.

- **Inducible variation in anaerobic energy metabolism reflects hypoxia tolerance across the intertidal and subtidal distribution of the Pacific oyster (*Crassostrea gigas*)**
  Meng, Jie, T. Wang, L. Li, and G. Zhang. 2018. Inducible variation in anaerobic energy metabolism reflects hypoxia tolerance across the intertidal and subtidal distribution of the Pacific Oyster (*Crassostrea Gigas*). *Marine Environmental Research* 138:135-43.

- **Presenting information on regulation values improves the public's sense of safety: Perceived mercury risk in fish and shellfish and its effects on consumption intention**
  Murakami, N., M. Suzuki, and T. Yamaguchi. 2017. Presenting information on regulation values improves the public's sense of safety: Perceived mercury risk in fish and shellfish and its effects on consumption intention. *PLoS One* 12(2):e0188758.

- **Developmental exposure to an organophosphate flame retardant alters later behavioral responses to dopamine antagonism in zebrafish larvae**
  Oliveri, A. N., E. Ortiz, and E.D. Levin. 2018. Developmental exposure to an organophosphate flame retardant alters later behavioral responses to dopamine antagonism in zebrafish larvae. *Neurotoxicology and teratology* 67:25-30.

- **Maternal transfer of nanoplastics to offspring in zebrafish (*Danio rerio*): A case study with nanopolystyrene**
  Pitt, J. A., R. Trevisan, A. Massarsky, J.S. Kozal, E.D. Levin, and R.T. Di Giulio. 2018. Maternal transfer of nanoplastics to offspring in zebrafish (*Danio rerio*): A case study with nanopolystyrene. *Science of The Total Environment* 643:324-334.

- **Potentially harmful cyanobacteria in oyster banks of Términos lagoon, southeastern Gulf of Mexico**
  Poot-Delgado, C.A., Y.B. Okolodkov, J.A. Aké-Castillo, and J.R. von Osten. 2018. Potentially harmful cyanobacteria in oyster banks of Términos lagoon, southeastern Gulf of Mexico. *Acta Biológica Colombiana* 23(1):51-58.

- **Climate change alters fish community size-structure, requiring adaptive policy targets**
  Queirós, A.M., J. Fernandes, L. Genevier, and C.P. Lynam. 2018. Climate change alters fish community size-structure, requiring adaptive policy targets. *Fish and Fisheries* 19(4):613-21.

- **Tracking pollutants in dietary fish oil: From ocean to table**
  Sun, S., X. Hua, Y. Deng, Y. Zhang, J. Li, Z. Wu, S.M. Limbu, D. Lu, H. Yin, G. Wang, R. Waagbø, L. Frøyland, M. Zhang, and Z. Du. 2018. Tracking pollutants in dietary fish oil: From ocean to table. *Environmental Pollution* 240:733-44.

Upcoming Meetings and Conferences

Aquaculture 2019
March 7-11, 2019
New Orleans, Louisiana

11th International Conference on Toxic Cyanobacteria
May 5-10, 2019
Kraków, Poland

National Shellfisheries Association 111th Annual Meeting
March 7-11, 2019
New Orleans, Louisiana

Additional Information

This monthly newsletter highlights current information about fish and shellfish.

For more information about specific advisories within the state, territory, or tribe, contact the appropriate state agency listed on EPA's National Listing of Fish Advisories website at https://fishadvisoryonline.epa.gov/Contacts.aspx.

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