

A report on the conference

Seafood – Balancing Benefits and Risks

November 9, 2007



“We need to educate people about the value of seafood and provide research-based information to help them make wise decisions.”

-Rollie Barnaby, NH Sea Grant Extension Educator

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Concord, NH



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If you wish to access each speaker's PowerPoint presentation, please visit the UNH Cooperative Extension website at: <http://extension.unh.edu/Marine/Seafood.htm>.

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Introduction

In March 2004, the U.S. Food and Drug Administration (FDA) issued an advisory concerning mercury levels in fish. The advisory specifically addressed potential risks to pregnant, nursing and soon-to-be pregnant women and young children. It warned that high levels of mercury could impair an unborn or young child's development; it also made clear that the nutritional benefits of eating seafood are substantial. The FDA advised those women to eat fish that are known to have lower mercury levels, but in limited amounts. The advisory offered three recommendations: avoid certain species of fish, particularly shark, swordfish, king mackerel and tilefish, due to high mercury levels; eat up to 12 ounces a week of a variety of fish that are lower in mercury; and check local advisories before eating local recreationally caught freshwater fish, because their mercury levels vary. The FDA advised this

group of women to limit their intake of albacore tuna to six ounces per week, because it contains more mercury than canned light tuna and it offered suggestions for other fish low in mercury. These recommendations were also applied to young children.

The advisory confused the general public. Many people were under the impression that it applied to the general population, and media reports often misrepresented the information, sensationalizing the issue in headlines and failing to report both the risks and benefits of fish consumption. The event spurred an American preoccupation with seafood safety and may have led some consumers to stop eating fish altogether.

In addition to the advisory, a 2004 report was published in the journal *Science* comparing toxin levels in wild-caught and farm-raised fish. The report concluded that farmed salmon had significantly higher levels

of methylmercury, and based on the Environmental Protection Agency's (EPA) determined toxicity levels, the study advised consumers to limit their intake of the farm-raised products. While the report concluded that farmed salmon had far higher levels of the toxins than wild salmon, it also said the benefits of omega-3 fatty acids must be weighed against the risks. This report had visible impacts on public perception of fish safety. The sales of imported farmed salmon dropped after the release of the report, as consumers became concerned about cancer risks. Conflicting information regarding seafood risks and benefits helped to fuel public confusion. The study also gave environmental groups a stronger argument against aquaculture, which was already being targeted because of pollution concerns.

The Nov. 9 conference "Seafood – Exploring Benefits and Risks" examined, from several scientific perspectives, key aspects of seafood safety: the global need for seafood as a protein source, the current research on the risks and benefits of eating wild harvested or farmed seafood, what went wrong in getting the messages on mercury and toxins out to the public, how the media portrayed the two reports, public response and knowledge on seafood and whether the reports are still affecting them today, and how to better communicate the complex issue to the public in the future. The forum was hosted by NH Sea Grant and UNH Cooperative Extension.



Balancing the Risks and Benefits of Fish for Sensitive Populations

Charles Santerre, Ph.D., Professor of Food Toxicology,
Department of Foods and Nutrition, Purdue University

Santerre defined “sensitive populations” as pregnant or nursing women, women that will become pregnant, and young children. What, he asked, are the benefits and risks of eating seafood for these populations? Heart health was cited as the main benefit, while methylmercury and polychlorinated biphenyls (PCBs) were the main concerns. “What we’re talking about during this conference,” he said, “can pose minimal risks to health if consumers make informed decisions.” He said these risks are predictable and preventable. He would later conclude that the benefits of eating seafood far outweigh the risks.

Santerre discussed the origins of health concerns linked with fish consumption. He first discussed Minamata disease in Japan in 1956. Victims of Minamata disease suffered from severe toxicity that included: speech and hearing impairment, loss of muscle coordination, tremors, death and congenital effects that included delays in development. The cause was determined to be industrial discharge of mercury that was contaminating the fish and shellfish being consumed by the indigenous population.

Today, fish that contain mercury remains a top concern of experts and the public alike. On the one hand, if sensitive populations ignore fish consumption advisories, they can put their babies at risk. On the other hand, if sensitive populations are afraid to eat fish then their babies may also be at risk. So, excluding fish from the diet as a result of these concerns can lead sensitive populations to miss out on the many benefits of eating seafood.

Reports by the Institute of Medicine suggest that eating fish during pregnancy may help lead to

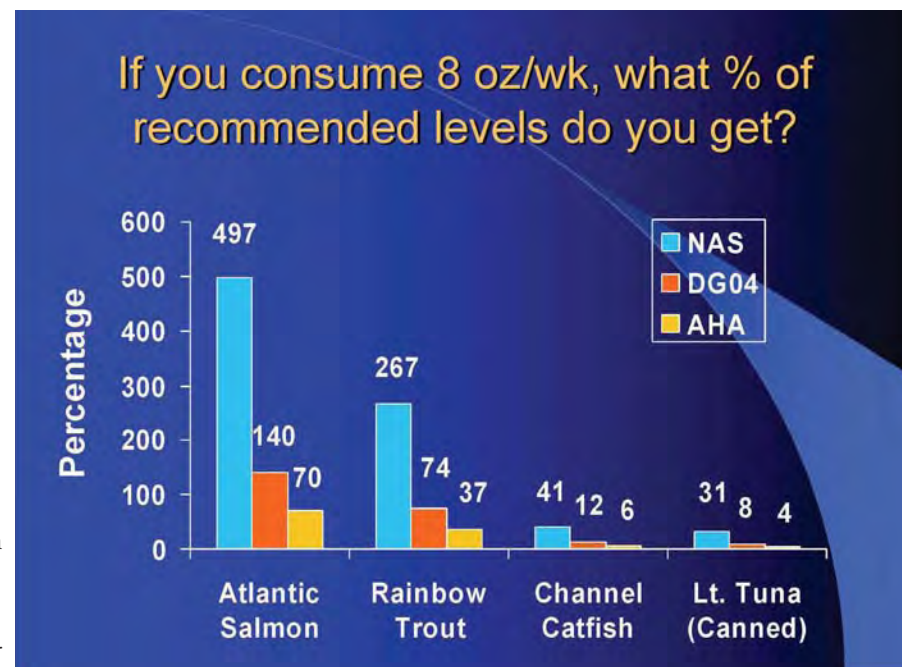
full gestation and full-term weight of newborns. In children eating fish and in breastfeeding infants whose mothers eat seafood, benefits include improved visual acuity, sensory motor development and cognitive development. Many other potential benefits are being explored.

Fish contain omega-3 fatty acids, which can reduce the risk of sudden cardiac death. A study by Mozafarian and Rimm at the Harvard School of Public Health¹ found that “modest fish consumption (e.g., 1-2 servings per wk), especially species higher in omega-3 fatty acids (particularly docosahexaenoic acid, or DHA, and eicosapentaenoic acid, or EPA), reduces the risk of sudden cardiac death by 36% and total mortality by 17%. Intake of 250 (mg/day) of EPA and DHA appears sufficient for primary protection.” Therefore, one or two servings of fish a week can save 120,000 of the lives lost each year from sudden cardiac death.

According to one study, fish consumption by seniors can delay cognitive decline.² In 3,718 subjects age 65 and above, a six-year follow-up found that those who had eaten one serving of fish per week in that time

experienced 10% less cognitive decline than those who ate less than one serving per week, while those who ate two or more servings of fish per week experienced 13% less decline in cognitive loss. These benefits were due to fish consumption, but further study is needed to determine whether it was the healthy fats that were providing the benefits.

Santerre pointed out what he called a “great range in what people are recommending for fish intake by



Percentage of recommended omega-3 fatty acid levels found in four fish species. Recommendations shown are from the National Academy of Science (NAS), the Dietary Guidelines Advisory Committee (DG04) and the American Heart Association (AHA).

Dietary Recommendations

National Academy of Sciences:

- 140 mg/day of Omega-3s (EPA and DHA) for nursing/pregnant women

Dietary Guidelines Advisory Committee Report (2004)

- 500 mg/day of EPA and DHA, or about 8 oz. fish/week for general population

American Heart Association

- 1,000 mg/day of EPA and DHA, or two servings (2-3 oz. per serving) of fatty fish/week for heart disease patients



Ignoring fish advisories can put sensitive populations at risk, while excluding fish from the diet means missing out on the benefits of eating seafood.

pregnant and nursing women.” Dietary advice from the National Academy of Sciences (NAS), the Dietary Guidelines Advisory Committee (DGAC) and the American Heart Association (AHA) vary for both new/soon-to-be mothers and the general population, leading to confusion among the public. The NAS recommends that pregnant or nursing women consume about 140 milligrams per day of EPA and DHA; the DGAC recommends eight ounces of fish per week with the goal of consuming 500 mg/day of EPA and DHA; and the AHA says two servings per week (two to three ounces per serving) of fatty fish is recommended for healthy adults, and 1,000 mg/day for heart disease patients. Santerre warned that when the intake of healthy fats was intended to treat a disease, the food (fish or fish oil in this case) transitions to being a drug. Some have tried to look at fish as a drug but we should remember that it is not.

The recommended levels for the fatty acids EPA and DHA are different for various fish species. Atlantic salmon, rainbow trout and mackerel exceed the dietary recommendations while channel catfish and canned light tuna do not provide much EPA and DHA. Canned Albacore or white tuna are higher in EPA and DHA; however, sensitive populations should limit their consumption to four ounces per week.

The risks of eating fish include the ingestion of mercury and PCBs. Santerre explained the pollution process, where mercury is released in the effluent from coal-fired power plants. Some mercury is produced naturally. Mercury is transported through the atmosphere and returns to earth in rainfall where it is then

“...an estimated 120,000 lives per year, or seven million-plus lives over 70 years, could be saved by reducing sudden cardiac death if consumers ate more salmon.”

converted from elemental mercury to methylmercury by small organisms. Methylmercury moves more easily up the food chain and accounts for more than 90% of all mercury found in fish.

In a study conducted at the California Pacific Medical Center in San Francisco,³ 89 patients at the center, mostly female, were tested for blood mercury levels. A “substantial fraction” of the patients ate fish that contained higher amounts of mercury (swordfish, shark and fresh tuna) regularly and many of them had blood mercury levels that exceeded the safe limits set by the EPA. Their symptoms included fatigue, headaches, decreased memory and concentration, and pain in muscles and joints. When they changed their diets and stopped eating the higher mercury fish, their blood mercury levels declined and their symptoms disappeared.

A report by the Centers for Disease Control and Prevention surveyed blood mercury levels in women of childbearing age.⁴ The survey, conducted from 1999 to 2002, found that 5.7% of those women had blood mercury levels beyond the EPA’s reference dose of 5.8 micrograms per liter. A Reference Dose, or

One to two servings per week of species higher in omega-3 fatty acids may reduce the risk of sudden cardiac death by 30% and total mortality by 17%.

RfD, is a safety limit. If you’re below the RfD, your risk is low; if you cross it, your risk is increasing

toward toxicity. The RfD is often misunderstood as a “line in the sand” and some people think that once you have crossed the RfD, you are in severe danger. However, the calculation of the RfD includes an uncertainty factor that accounts for species to species variation and the limitations of toxicity testing. In this case, the RfD has a tenfold uncertainty factor that is

expected to help protect all individuals. This creates a buffer, so if consumers aim for the RfD, they won't be at risk of toxicity if they go slightly above. "Toxicology," he said, "is as much an art as it is a science."

The EPA estimated in 2005⁵ that 10%, or approximately 400,000, of the four million babies born in the U.S. every

year may be born to mothers whose blood mercury levels are equal to or exceed 3.5 milligrams/liter. Santerre said this should be a cause for concern, "but we shouldn't be running around yelling 'the sky is falling.'" What healthcare professionals and government officials should be doing instead is encouraging consumers to make better choices.

The differences in mercury limit recommendations across North America will likely lead to controversy because the agencies "can't agree on what's safe," he said. The FDA's action level for fish tissue is 1,000 parts per billion; the Canadian limit for fish tissue at 500 ppb; and the EPA's RfD (which is a dosage and not a fish tissue concentration) is about equal to 200 to 250 ppb – about one-fourth the FDA's limit.

So what levels of omega-3 fatty acids and mercury found in fish are accessible to consumers? A 2005 study evaluated fish sandwiches from six fast food restaurant chains for mercury and omega-3 fatty acids.⁶ The tests found ranges of 5 to 132 ppb of mercury and an average of 92 mg of omega-3 fatty acids EPA and DHA per sandwich. The sandwiches were low in mercury, but they were also lower in long chain omega-3 fatty acids. A similar study in 2004⁷ tested mercury levels in several types of commercially available canned fish products, including tuna (188 ppb in all types, including canned and chunk light), salmon (45 ppb), and mackerel (55 ppb). As expected, light tuna was low in mercury, at 54 ppb, but it was also

According to the NAS, beef is the primary source of PCBs in the U.S. diet at 63%, while fish provide 22% of dietary PCBs.

low in the omega-3 fatty acids EPA and DHA.

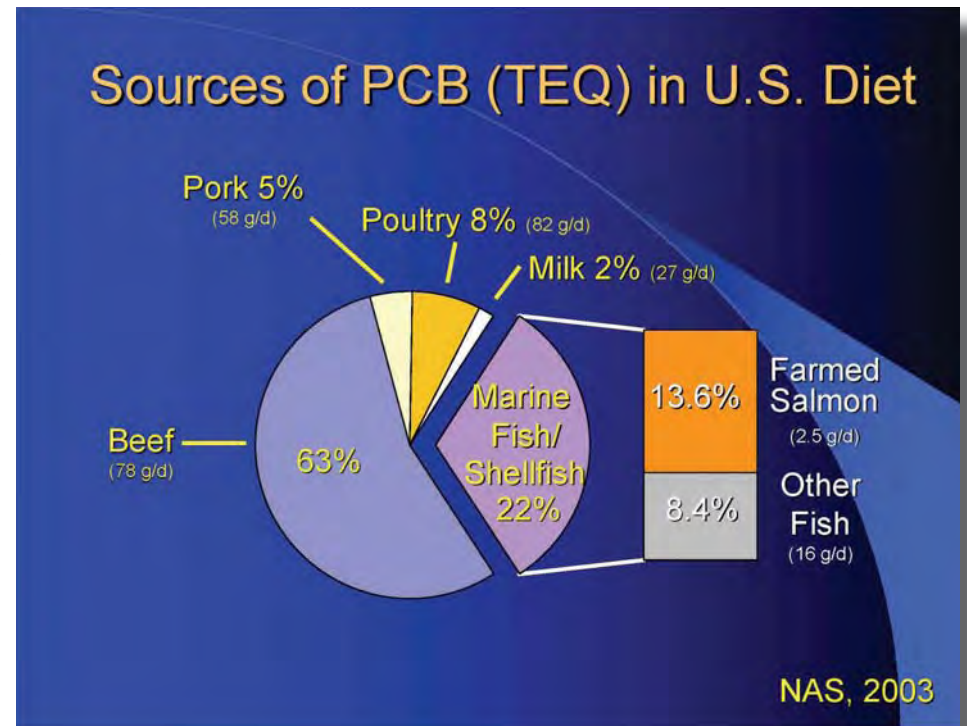
Canned tuna accounts for 34% of all dietary mercury. It is affordable and nutritious, and it "encourages people to eat stronger-tasting fish," he said. Scientists are trying to help the tuna industry out of the mercury controversy, suggesting a "Kid Healthy" label for low-mercury products (below 80 ppb)

and suggesting that these lower mercury products be fortified by adding 300 mg/ounce of DHA, thereby increasing its nutritional value for sensitive populations. These added-value products could be provided to school lunch programs and to WIC Clinics for lactating women.

Regarding pesticides and their potential effects on fish and the people that consume them, comparisons were made between farm-raised and wild-caught fish. Based on Santerre's research from 1999 and 2000, channel catfish, rainbow trout and red swamp crayfish had significantly lower levels of pesticides and toxic metals than those caught in the wild. He said that through aquaculture "you control the fish's environment," including what they're eating and any contaminants to which they are exposed. Since fish obtain pollutants through their diet as humans do, if you control

the feed you can minimize their exposure to pollutants.

Polychlorinated biphenyls, or PCBs, have raised public concern because they are developmental toxicants similar to mercury. They are man-made organic compounds that do not easily break down in the environment. In the past, they have polluted rivers and streams by leeching from landfills and it may take up to six years for PCBs to clear themselves from the human body (as opposed to mercury, which takes about one year). Pregnant or nursing women can pass PCBs through the placenta or through their milk. Infants exposed to high levels of PCBs can have poor short-term memory and delayed postnatal development. The FDA and Health Canada have established a limit for PCBs in commercial fish at two parts per million, or 2,000 ppb.



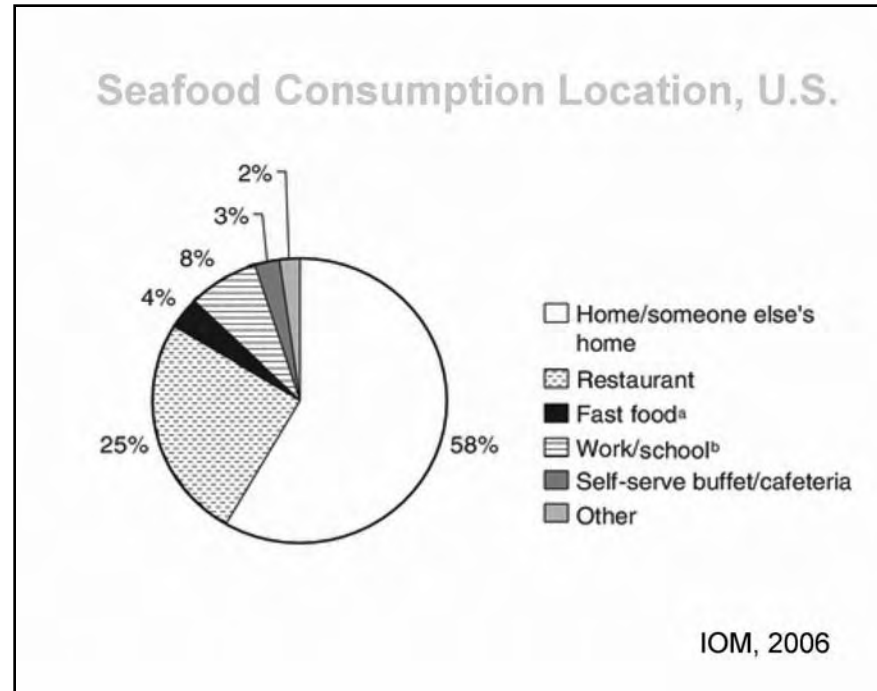
In a 2004 Pew Charitable Trust report,⁸ higher levels of PCBs were found in farmed salmon than in wild salmon: The mean amount in farmed salmon was 36.6 ppb; in wild salmon, the mean was 4.75 ppb. Based on the EPA's cancer risk parameters in association with PCBs, the study's authors suggested consumers eat no more than one meal of farmed salmon per month. Some might suggest that consumers stop eating farmed salmon but Santerre said he has a different interpretation of the studies' results.

Based on the above numbers, if consumers ate eight ounces of farmed salmon every week over the course of their lives (estimated to be 70 years using current models), the PCBs that they would ingest would increase their risk of cancer by only a minimal amount. The current cancer rate is 25,000 in 100,000 (i.e., 25,000 of every 100,000 people living in the U.S. will get cancer during their 70 year life span); eating salmon twice a week would increase that number to 25,004 in 100,000. That works out to be 12,000 more cancer cases for 300 million Americans over a 70-year life-span. On the other hand, an estimated 120,000 lives per year, or seven million-plus lives over 70 years, could be saved by reducing sudden cardiac death if consumers ate more salmon. That is 120,000 lives saved every year as compared to an estimated 12,000 lives lost over 70 years.

The Pew study also ignored the reductions in PCBs that occurs when fish is cooked, where levels can be decreased by 30 to 50%. Another study⁹ that noted lower levels of PCBs in Canadian samples of farmed salmon "could reflect efforts by industry to reduce contaminant loads in salmon feed," Santerre said. Re-

garding farm-raised fish, he said "Whatever you feed to the fish is what's going to end up in the fish."

PCBs aren't limited to seafood, as they are also found in the biomass of terrestrial agriculture. According to the NAS, beef is the number one source of PCBs in the U.S. diet, at 63%. PCBs are also present in pork, poultry and milk. Fish provide 22% of



dietary PCBs – farmed salmon account for 13.6%, while other fish species account for the remaining 8.4%.

A 2004 advisory put out by the FDA and the EPA made recommendations for pregnant and nursing women. It recommends that sensitive populations not eat certain types of fish (swordfish, shark, King mackerel and tilefish); that they consume up to 12 ounces of fish and shellfish that are low in mercury; that they check local advisories before eating recreationally

caught fish; and that they consume up to six ounces of Albacore or white tuna per week.

Consumers have been confused by the advisory since there is no comparable advice for the general population. However, it is clear that consumer health is benefited when people eat fish. Even sensitive populations are encouraged to eat fish for its nutritional benefits. The Harvard School of Public Health's Center for Risk Analysis stated¹⁰: "If pregnant women were to . . . replace fish high in mercury with fish low in mercury, cognitive development benefits . . . could be achieved with virtually no nutritional losses."

More effective education is needed to encourage pregnant and nursing women to consume fish. In 2006, 721 women between the ages of 10 and 49 enrolled in the Expanded Food and Nutrition Education Program for low-income families in Indiana. Thirty-five percent of them were pregnant and 5% were nursing mothers. The women were given a pre-test, one hour of face-to-face training on fish consumption, and a post-test. Thirty-nine percent of them hadn't eaten fish in the past 30 days, and 10% had eaten high-mercury fish. One-third of the women knew before the training that omega-3 fatty acids were important for the health of their fetuses or infants, but after the training 87% understood this concept. Before the training only 6 or 7% had used Indiana's fish consumption advisory, which relates to recreationally caught fish; after the training 69 to 79% planned to use the advisory in the future.

However, there is a simpler way to teach new and soon-to-be mothers about the benefits and risks of fish consumption. The Indiana State Department of Health already promotes a wallet-sized pamphlet that consumers can carry with them that lists fish of high,

moderate and low mercury amounts and how much they should consume each week.

Diet has a significant effect on mercury absorption and release from the body. In a study conducted in the Brazilian Amazon, 26 women consumed the same amount of fish.¹¹ Those whose diets included tropical fruits had lower levels of mercury in their hair compared to those lacking a tropical fruit diet. Laboratory tests on mice showed adding fiber to the diet helped their bodies to eliminate methyl mercury; a diet high in protein lowered mercury concentrations in the blood and kidneys; and mercury accumulation could be lessened in certain organs with an increase in garlic consumption.

Inspired by the Amazon study, Santerre and his colleagues set out to determine how certain foods affect mercury in the human body. They used an *in vitro* (in glassware) digestion model. Porcine pepsin was added to model the gastric stage of digestion; pancreatin, lipase and porcine bile extract were used to model the digestion stage in the small intestine. The experiment included several foods: green and black tea powder, three sources of dietary fiber (wheat bran, oat bran and psyllium), soy protein and grapefruit juice.

Both teas seemed to bind to mercury, which may suggest that they would end up in the stool rather than be absorbed by the body. Compounds in the tea may bind to metals, including mercury, thus preventing them from being absorbed in the gut. Black tea was two to three times better at reducing bioaccessibility than green tea, when low levels were used; at higher levels, the effectiveness of the black and green teas evened out. Of the types of dietary fiber, wheat bran, oat bran and psyllium, wheat bran proved to have the greatest reduction effect. At higher doses, oat bran was also successful at reducing bioaccessibility. It is important to keep in mind that these studies are

preliminary and more work needs to be conducted using animals to verify the findings, Santerre explained. “We are a long way from recommending dietary changes to reduce a person’s exposure to mercury in fish,” he added.

Several conference attendees wanted to know more about fish oil supplements and Santerre’s opinion on their effectiveness. He said supplements offer options beyond eating fish, but it’s generally better (with a few exceptions) to get our nutrients from

Fish oil supplements offer options beyond eating fish, but it’s generally better to get nutrients from whole foods.

whole foods rather than take dietary supplements. Omega-3-enhanced eggs and orange juice might also be promising products. He voiced subtle concern for the oversight of supplements, saying that the industry is improving but has a ways to go in terms of quality assurance. Contaminants in supplement products have been higher than expected, and there are no “robust” studies examining the quality of fish oil supplements. In the meantime, eating fish provides not only the essential omega-3 EPAs and DHAs, but also other nutrients that supplements don’t offer. Those nutrients are closely linked to the health of pre-term infants. So the whole fish, he said, is simply “a better package.”

In response to a question about turning to plant sources for omega-3s, Santerre explained that plants can only produce alpha-linolenic acids, or ALAs. This fatty acid must then be converted to EPA and DHA in the body. The process of converting the essential fatty acid ALA to EPA and DHA is very slow. Thus, it’s important that EPA and DHA be included in the diet, especially for women who are pregnant or nursing.

The Role of Aquaculture in Meeting the Future Demand for Protein

Richard Langan, Ph.D., Director, Atlantic Marine Aquaculture Center, University of New Hampshire

Since his time as a first mate on a fishing boat, Langan has seen firsthand how the fishing industry's practices and management strategies have led to a decline in commercially important fish. One night in 1980, as he was at the wheel of a bottom trawler busy catching 1,000 pounds of fish an hour, he saw the lights of approximately 50 other boats strung out across the horizon, each probably catching the same amount of fish. He knew that harvesting at this rate would deplete ocean fisheries and he knew something had to change. "My days in fishing," Langan said, "are what led me to aquaculture." Now, there are huge developments in the industry, as well as a number of challenges it must overcome in order to be a signifi-

cant source of the domestic seafood supply.

Production from aquaculture, the farming of fish and shellfish, has risen dramatically in the past 30 years. In 2004, aquaculture supplied half of the fish and shellfish that humans consumed. The role of aquaculture in meeting the demand for seafood over the next two decades is likely to increase. If aquaculture continues to grow at the current rate of approximately 10% per year, by 2030 aquaculture will contribute 100 million metric tons to the global seafood supply. However, this will

not meet the growing global demand – it will leave a supply gap of 40 million metric tons. That gap may be filled by exploring new methods of production.

The pros and cons of growing seafood versus wild harvest were explored. Farming can be costly – a permit to farm seafood can cost more than a fishing boat. But aquaculture provides a much greater potential for growth, and it is a better way to ensure product safety. "You're going to get out of the fish whatever you put into it," Langan said. Diversification is also a benefit from aquaculture – as many as 350 products have the potential to be grown using aquaculture, and farming can also help to stabilize the market prices of seafood.

As far as environmental costs are concerned, both farming and fishing can have environmental effects, though farming gets a

better grade than catching fish in the wild. Fish from the top of the food chain make up the consumer market, but removing a top predator from an ocean fishery can have devastating effects on the ecosystem. Farming is more energy efficient, because it uses less fuel than current commercial fishing practices. Fishermen, he said, are "spending more time distance fishing, because we have depleted fisheries near the coast."

In many ways, current agricultural practices on land are not sustainable. Twenty-four percent of the earth's land is already cultivated, the

top soil is eroding, and global climate change could reduce the land's productivity. "There's not much more we can produce on land," he said. We are also taking away from the global food supply by turning to agricultural sources to make biofuels. "Does that make sense?" he asked.

The challenges to land-based agriculture and open-water fishing will affect the future supply of animal protein. Between the problems with on-land farming and open-ocean fishing, and with new omega-3 fatty acid supplements available, he said many people are asking, "Why don't we just eat something else and take a pill?" Aquaculture can provide some answers.

When comparing the food input required to raise animals on land and in the water, he said farm-raised fish is the most efficient. To produce one kilogram of salmon requires only 1.1 kg of food, while it takes nearly eight times that to raise 1 kg of cattle. Producing one kilogram of pork requires 3 kg of food, and chickens require 2 kg. Using one acre to farm mussels

As many as 350 products have the potential to be grown using aquaculture.



Projected supply gap created by the difference between global supply and demand for fish.

can produce 1,000 times the meat that is produced on one acre of grazing land for cattle.

For marine species, there are three aquaculture options: land-based aquaculture, near-shore farming in protected waters and open-ocean systems. Land-based farming uses a lot of energy to pump, filter, heat and cool water. Langan said it is limited in the number of species that can be tank-grown. Near-shore aquaculture can be very efficient, and he said its success is the reason more people are eating salmon and shellfish.

But there are several things holding it back, including space limitations, conflicts with recreational activities, and the “not-in-my-backyard” factor – owners of waterfront homes don’t want fish farms obstructing their ocean views.

Fishermen are “spending more time distance fishing because we have depleted fisheries near the coast.”

So what about the open ocean? The seas make up nearly 70% of our planet and therefore provide us with vast farming opportunities. Open-ocean aquaculture can have fewer impacts on the environment than other forms of fish farming because of its higher assimilative capacity: A more stable environment means healthier conditions for the species being farmed. But new technology is required, because the open ocean is a “totally different environment” from near-shore areas, he said. It means breaking new ground, because no one has ever done it before. And because there is no precedent, the economic risks are not fully known.

In an effort to assess the potential, Langan has led a demonstration project at UNH for the last nine years that has explored open ocean aquaculture. He and his colleagues set out to find a site in which to perform the study, and surveyed a 10-square-kilometer area in the Gulf of Maine before choosing a 30-acre site for research and demonstration. This required taking into account a number of factors, including depth, water and sediment chemistry, the benthic community and

currents. The site is 10 km from shore and the water is 52 meters deep. One of the most significant aspects of the site is the wave height, which he said can reach 30 feet in storm conditions. They also had to account for other uses, such as commercial, military and recreation, as well as the potential for impacts on endangered species and essential fish habitat.

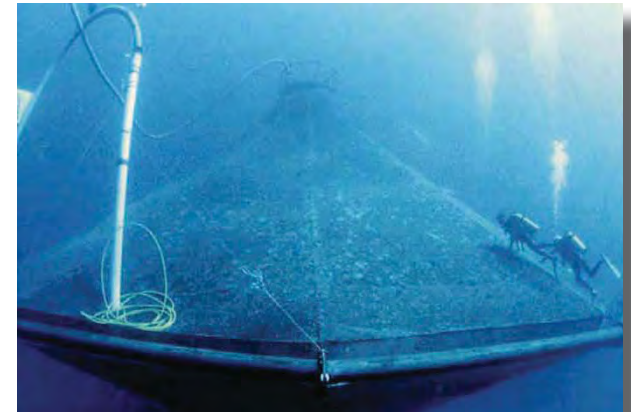
After numerical modeling and scaled model testing at UNH, as well as field tests using “load cells” to measure the forces that would be acting on the system at the site, the researchers designed and deployed

infrastructure at the site that included fish cages, automated feeding systems, supporting technologies and submerged longlines for shellfish farming. The team uses wireless technology to communicate with

instrumentation at the site, so from shore they can observe fish activity and feed the fish as needed. Several fish in the cages were tracked using transmitters for 40 days at a time, so they could learn more about their physiology and behavior as environmental conditions in the cages changed. This provided information on conditions that were stressful for the fish, an important consideration for maintaining good health.

One of the potential impacts of fish farming is the alteration of benthic ecosystems beneath the cages from deposition of organic wastes. Feeding fish means adding carbon, nitrogen and phosphorous to the ocean system. To reduce or eliminate the localized nutrient loads, the researchers used “integrated multi-trophic aquaculture” placing filter-feeding bivalves, such as mussels, in close proximity to the fish cages to extract nutrients from the water. The open ocean demonstration site has found mussel farming to be economi-

To produce 1 kg of salmon requires only 1.1 kg of food, while it takes nearly eight times that to raise 1 kg of cattle.



An underwater view of the UNH offshore aquaculture facility.

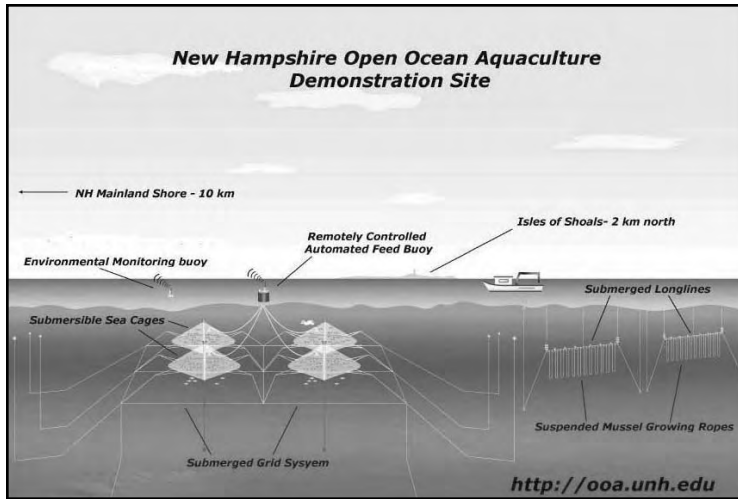
cally viable, and there is now a commercial producer in the Gulf of Maine.

Langan said there is a “tremendous anti-farming campaign out there that claims that it’s environmentally unsound.” A frequent concern is the use of chemicals and antibiotics in fish farms, and the UNH system, as well as most commercial aquaculture farms, use few to no chemicals at all. The research team vaccinates its fish but does not use antibiotics. Whale entanglement and other negative interactions with endangered species can be avoided altogether by proper design and placement of the cages – the UNH project,

for example, was placed at a site where there would be a low risk of interaction with whales.

The risk of farmed species escaping is a moot point at the site because the fish being farmed were the offspring of

wild fish – so if they did escape, they would only be replenishing the population. Having a containment management plan is the key to preventing escapement: “This is something that requires vigilance and putting the right type of equipment out there,” he added.



tuna; in California, striped bass, yellowtail and halibut might be farmed in the future.

The UNH study has accomplished several things that will aid in future fish farming in the Gulf of Maine. It demonstrated that fish and shellfish farming systems can be installed and built to last in the rough, cold seas of New England, and that several native species are well-suited for open

ocean farming – particularly mussels, which can be a tremendous business opportunity for fishermen. Technology will drive this industry, not manual labor. The

The UNH study demonstrated that fish and shellfish farming systems can be installed and built to last in the rough, cold seas of New England.

Another common concern is the amount of fish waste produced by aquaculture and its effects on the sea floor. The waste is sometimes compared to human sewage, but the two are nothing alike. “Fish waste (produced by farming) is no different than wild fish waste,” he said. “The key is, don’t put too much in the same place.” The UNH project took into account where currents would take the waste from the cages, using a hydrodynamic model to predict the “zones” that the waste might affect. A monitoring program was implemented to closely examine the impacts on those zones. In the nine years of farming fish at the site, they have been unable to detect any impact on the sediments or benthic communities of the area.

Researchers have been unable to detect impact on sediments or benthic communities of the OOA demonstration site.

Several open ocean aquaculture projects are currently either under way or developing in the U.S. Fish species being farmed in Hawaii and Puerto Rico include Pacific threadfin, amberjack and cobia (a species that is not well known but is fast-growing and therefore highly efficient for farming). Potential farming projects in the Gulf of Mexico could grow redfish and

environmental impacts of aquaculture can be negligible. A concern for filling the oceans with fish cages is unfounded: By Langan’s calculations, the use of only 0.003% of the U.S. Exclusive Economic Zone would produce enough fish to close the supply gap in the country.

Open-ocean farming does require some maintenance on site, including inspecting and cleaning the fish cages, refilling feeding systems and harvesting fish and shellfish. New technologies are needed, such as “autonomous, intelligent feeding systems” and affordable remote communication of data at the site.

There are biological challenges as well, such as the need for sustainable feed, more knowledge about the health and nutrition needs of fish being farmed, and a better plan to handle “bio-fouling,” the unwanted accumulation of organisms on equipment.

But there are bigger social and political hurdles to overcome. Aquaculture, he said, “is not acknowl-

edged” as important to seafood production in the U.S., so it is not accepted as a legitimate use of our oceans. There is currently no policy or regulatory framework for aquaculture in federal waters. Consumers are inundated by what he called the “anti-farming misinformation machine,” so there is too little knowledge and therefore not enough support for aquaculture practices. Public and private funding for research and development is lacking, and there is a need for

greater cooperation from members of the commercial fishing industry.

Despite all this, Langan foresees development happening outside the U.S. in the near future,

as well as the possible expansion of existing domestic farms. He predicts some new farms will be established in state waters, and mussel farming will take off, perhaps leading to the establishment of mussel cooperatives. “I think we’re at the very beginning of what we can do off-shore in terms of the efficiency of production,” he added.

Fish and Omega-3 Consumption and Cardiovascular Health: Risks and Benefits

Dariusz Mozaffarian, M.D., Dr. P.H., Harvard School of Public Health

Mozaffarian, a cardiologist, approaches research relating to fish consumption “from a health point of view.” He spoke about the pros and cons of fish consumption for the general population as opposed to the sensitive population of pregnant or nursing mothers. A key point was that benefits and risks must be considered together rather than separately because performing separate investigations can result in confusion about the relative evidence for benefits versus risks. “It’s also important to be quantitative,” he said, in order to understand the relative magnitudes of the risks and benefits, so that decisions can be made based upon valid comparisons.

A study in 1995 examined the correlation between consumption of omega-3 fatty acids from seafood and risk of sudden cardiac death (SCD).¹² The study investigated 295 cases of SCD (a disorder caused by an electrical disturbance of the heart) and the amount of seafood the victims had eaten in the month prior to their deaths, compared with 398 controls and accounting for other risk factors such as age, physical activity and family history. After weighing all the risk factors, the study demonstrated that the consumption of polyunsaturated fatty acids found in seafood was inversely related to the risk of SCD – the higher the intake of the omega-3s, the smaller the risk. Blood samples of a subset of the study participants showed those with highest red blood levels (the top 25%) of

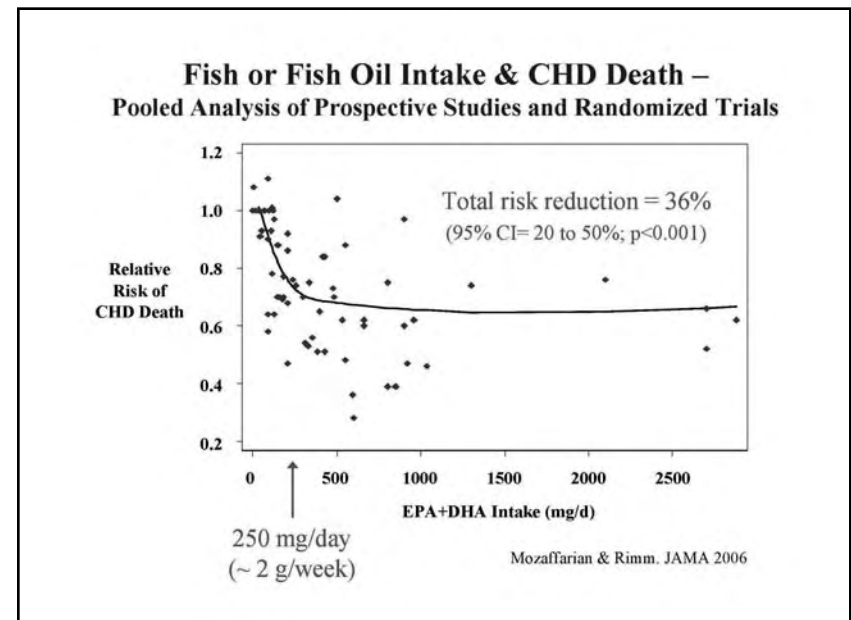
The higher the intake of the omega-3 fatty acids found in seafood, the smaller the risk for sudden cardiac death.

EPA and DHA, the marine omega-3 fatty acids found in fish, had a 90% lower risk of SCD than those with the lowest levels (the bottom 25%) of these fatty acids in the blood. Therefore, the relative risk of SCD for those with the lower omega-3 levels was 10. “There are very few things in science,” he said, “that give one a ten-fold difference in relative risk.”

Numerous studies since 1995 have confirmed these findings, demonstrating that individuals at low-, moderate or high risk are at greater risk of cardiac death when eating fewer omega-3 fatty acids, compared to those who consume modest levels. A threshold appears to be present at 250 milligrams per day, or approximately 2 grams per week, of EPA and DHA. Most of the reduction in risk of cardiac death occurs when individuals consume this quantity or higher of omega-3 fatty acids. This is the equivalent of a remarkably low 2.25 calories of EPA and DHA per day. Compared to no seafood intake, the total risk reduction in cardiac death at this threshold level is 36 percent.¹ Other potential benefits linked with fish consumption, backed by what Mozaffarian called “good but not yet conclusive

evidence” include reduced risks of ischemic stroke, nonfatal coronary events, depression, asthma and cognitive decline.

Mozaffarian examined the potential risks of seafood consumption in adults, beginning with the most well-studied: mercury. He and his colleagues looked at the five reported studies that have evaluated exposure to mercury and risk of heart disease. For higher mercury levels, two studies found relative risk to be above the reference risk of 1; two found relative risk below the



Consumption of 250 mg/day (about 2 g/week) of omega-3 fatty acids EPA and DHA may result in a total risk reduction in cardiac death by 36%.

reference factor; and one study found neutral results that couldn't suggest a higher or lower risk. Overall, a combined analysis of the studies suggested no statistically significant difference in risk of heart disease with higher mercury exposure. However, there were several limitations that may have affected the results. "While there may be a modestly higher risk," he said, "based on current evidence this cannot be concluded."

Even in the two studies that found higher cardiac risk with higher mercury levels, the overall effect of fish consumption was still beneficial. For example, in a 2000 study of mercury levels and omega-3 fatty acids, men who had higher levels of mercury, as measured in their hair, had a higher risk of heart disease than men who had lower levels of mercury.¹³ However, overall, the men at highest risk were those who had the fewest omega-3 fatty acids in their systems: as seafood consumption increased, the risk of heart disease declined,

but the slope of this decline was similar among the men with higher mercury levels. The findings suggest that mercury diminishes the cardiac benefits of fish consumption, rather than actually increasing absolute cardiac risk. These results are "very important from a public health perspective," he said. "It's a very different message for the individual consumer who's trying to buy fish – these findings suggest that eating fish results in cardiac benefit; the benefit may simply be less if one eats fish with higher mercury."

When it comes to mercury's impacts on cognitive function in adults, clinical tests on regular consumption levels due to fish intake have found no evidence of clinically apparent effects. In some studies, specialized neurologic testing has found evidence for subtle, subclinical effects of higher mercury levels, but these findings are inconsistent and require further study. In contrast, the evidence for such potential subclinical neurologic risks is far outweighed by evidence for clinical neurological benefits, supported by studies suggesting lower risks of clinical depression, stroke and dementia with greater fish consumption.

"...these findings suggest that eating fish results in cardiac benefit; the benefit may simply be less if one eats fish with higher mercury."

risks include the intake of PCBs and dioxins. For example, in 2005, a study that estimated the potential cancer risks due to PCBs and dioxins in wild versus farmed salmon received a lot of media attention.¹⁴ The

study included hundreds of samples of wild and farmed salmon. Based on the measured levels of PCBs and dioxins, the authors estimated that

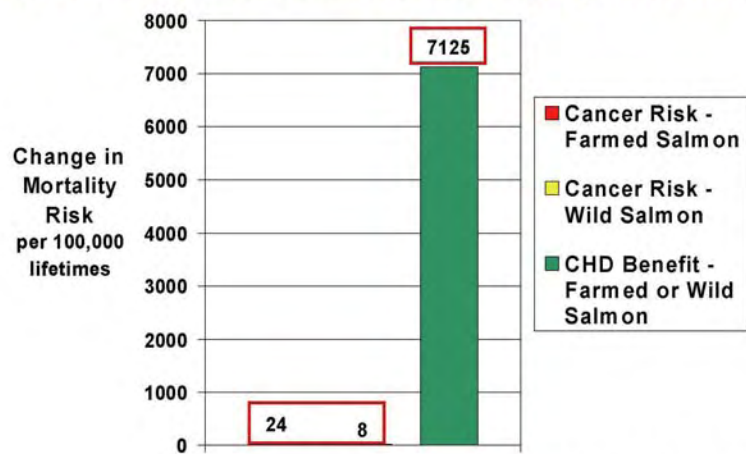
eating enough farmed salmon to achieve an intake of one gram of EPA and DHA per day over a 70-year lifetime increased the risk of cancer mortality by 24 per 100,000 lifetimes, whereas eating enough wild salmon to achieve the same EPA and DHA intake over a 70-year lifetime increased the risk of cancer mortality by 8 per 100,000 lifetimes. This study was part of the Monterey Bay Aquarium's basis for recommending against eating farmed salmon, because the risk of cancer deaths due to PCB and dioxin ingestion was seen as threefold the risk created by eating wild salmon.

However, the study didn't highlight the well-established cardiac benefits of fish consumption as compared to these hypothesized cancer risks, he said.

"Modest consumption of fish, particularly fish richer in omega-3 fatty acids EPA and DHA, provides a simple means to prevent cardiac death."

When the benefits of preventing coronary heart disease were considered by the same authors, the estimated cancer risk was miniscule in comparison: The same quantity of EPA and DHA consumption, from either wild or farmed salmon, would lead to 7,125 fewer cardiac deaths for every 100,000 lifetimes. The many thousand-fold difference between the cardiac benefits versus cancer risks was the most important result of

Estimated Lifetime Cancer Risks and Heart Benefits with Salmon Intake (intake to achieve 1 g/day EPA+DHA)



Foran et al., J Nutr 2005

Other hypothesized seafood consumption

the study and should have been emphasized, not the threefold difference between 24 and 8 estimated cancer deaths. “Compared to 7,125 deaths prevented, the difference between 24 and 8 possible cancer deaths is sort of a rounding error,” Mozaffarian said.

The PCB levels in freshwater and ocean fish were then discussed. A 2004 study estimated that consumption of 75 grams, or about three ounces, of freshwater fish every day would put a consumer at the recommended toxicity limit of PCBs.¹⁵ However, the limit is based on a tenfold safety factor, giving consumers a wide buffer – to reach the actual estimated toxic level of intake, one would have to eat 10 times this amount of freshwater fish. Furthermore, the three ounces per day estimate was based on assuming that any fish in which toxins were not detected would have toxin levels at exactly the limit of detection of the assay. For example, if the assay only detected PCB levels at or above 10 parts per billion, any fish in which toxins were not detected was assumed to have a PCB level of 10 ppb. This is a conservative (and unlikely) assumption. If instead one were to assume that fish in which PCBs could not be detected contained, on average, toxin levels that were lower than the limit of detection, the amount of freshwater fish that could be eaten before crossing the recommended limit would be higher. When ocean fish were evaluated, the study concluded that even with consumption of two, 3-oz. servings every day, one would not reach the recommended toxicity limit, even including the 10-fold safety factor and the conservative assumption that any fish in which toxins were not detected contained the maximum possible toxin levels. “If a person eats a lot of freshwater fish, such as sports-caught fish from local lakes, then one should probably check the local fish

PCB levels in beef, pork, chicken, eggs, butter and farmed salmon are all far below the FDA’s action level of 2,000 ppb, but only seafood also has significant amounts of omega-3 fatty acids.

advisories for recommended intakes,” he said. “In contrast, commercially caught ocean fish, the main type of fish purchased and consumed by the vast majority of people, could be eaten up to two servings per day without reaching the PCB and dioxin limit.”

The well-established cardiac benefits of fish consumption were compared to the hypothesized risks associated with PCBs with a focus on the amount of omega-3 fatty acids versus PCBs in different species¹. For example, catfish contain 25 ppb of the toxin; farmed salmon contain anywhere from 15 to 40 ppb, depending on the study and whether it included the

“Based on cost and EPA and DHA content, salmon, tuna, anchovies and sardines are some of the most cost-effective options.”

skin; and wild salmon contain 5 ppb. Each of these fish also contain EPA and DHA – “and remember,” he said, “the evidence suggests that a person only needs about 250 milligrams of EPA and DHA per day to lower the risk of cardiac death.” Catfish contain 253 milligrams of these fatty acids per serving; farmed salmon contain 4,713 mg; and wild salmon contain 1,606 mg. Toxin levels were also compared to other protein sources: Beef, pork, chicken, eggs and butter all contain similar amounts of PCBs as farmed salmon – from 18 to 70 ppb. “So, all these major protein sources have some PCBs and dioxins in them, but only seafood also has significant amounts of

the beneficial EPA and DHA.”

Then why are the media attention and public concern for PCBs in fish so high, while the concerns for the same or higher levels of toxins in these other protein sources are small to nonexistent? “Shouldn’t we post signs in grocery stores warning people about PCB or dioxin levels in beef, chicken, pork or butter?” Mozaffarian asked hypothetically. “Some people suggest that’s what we should do for fish.” The reason alerts should not be placed for any of these food, Mozaffarian continued, is that the PCB levels in all of these foods are far below the FDA’s action level of 2,000 ppb.

The main sources of PCBs in our food supply were put into perspective. In the U.S.,¹⁶ fish and shellfish together account for only 9% of the PCBs in the food supply. Beef, chicken and pork make up 34%, dairy products 30%, vegetables 22% and eggs 5%.

Mozaffarian noted that, in contrast to effects in adults, potential effects of PCBs on infant neurological development are concerning; there is “pretty consistent evidence” that high levels of PCBs and dioxins can have subtle negative neurodevelopmental effects. So women who are or might become pregnant should be aware of the potential PCBs and dioxins in the foods that they eat, particularly “sports-caught, freshwater fish from local lakes that might be more highly contaminated,” he said. But for the general public, “the numbers just don’t support a lot of the concern.” Except for women who are or might become pregnant or are nursing, concern over PCBs and dioxins should not affect consumers’ choices to eat fish.

Mozaffarian’s research has led him to some conclusions: Just one or two servings of fish per week, par-

“For the general populations, to prevent confusion, the message can be simple: ‘Eat a variety of seafood once or twice per week and don’t worry about mercury and other toxins.’”

ticularly oily fish like herring or farmed salmon, will significantly benefit cardiac health; there is currently no consistent evidence that low levels of mercury from such levels of fish consumption pose a health risk in adults; and heart health benefits of eating fish far outweigh the hypothesized cancer risks posed by PCBs and dioxins.

Nearly 300,000 people die of sudden cardiac death in the U.S. every year. Certain subgroups of patients at highest risk have the highest percentage of sudden death, but the general population produces the highest number of total events each year because it is so large. “The great majority of sudden deaths occur in the general population,” he said. Because nearly all cardiac arrests are deadly, primary prevention should be the treatment of choice. Modest consumption of fish, particularly fish richer in omega-3 fatty acids EPA and DHA, provides a simple means to prevent cardiac death. Based on cost and EPA and DHA content, salmon, tuna, anchovies and sardines are some of the most cost-effective options. For example, pound for pound, salmon can be more expensive than some other types of fish, but given the high EPA and DHA content one does not have to consume large amounts (only 3-6 oz. per week) to achieve the recommended minimum intake of omega-3 fatty acids.

In response to an audience member’s question about the challenge consumers face in understanding the relative dangers of mercury and PCBs versus the benefits of omega-3 fatty acids, Mozaffarian said that the levels of PCBs and dioxins are very low in seafood and pose an insignificant risk to the general population. Therefore, they shouldn’t concern the general consumer (only women who are or might become pregnant should consult local advisories for freshwater fish). Of the studies of mercury and cardiovascular risk, three did not show higher risk and two studies suggested only that mercury might decrease the overall benefits of fish consumption, not increase the

absolute risk. “For the general populations, to prevent confusion, the message can be simple: ‘Eat a variety of seafood once or twice per week, and don’t worry about mercury or other toxins.’”

Influence on Media Reporting on U.S. Demand for Farmed Salmon

Cathy Roheim, Ph.D., Professor, Department of Environmental and Natural Resource Economics, Coastal Institute, University of Rhode Island

Roheim said her studies have focused on the media's response to scientific reports and advisories on the risks and benefits of consuming fish. "We know how the press can react to things," she said. "They don't always tell us all the information we need, and if they do, they don't always tell it to us accurately." What she wanted to know is how the media reported one particular study on PCBs and how both the report on PCBs and the subsequent media reporting on it influenced the public's consumption of farmed salmon.

In 2004, a study was released on PCB levels in farm-raised salmon.⁸ It generated a large amount of interest from the media and has prevailed as a story since then. The study tested 459 farmed salmon from six countries, 145 wild salmon and salmon fillets purchased from markets in 16 cities. The study's authors concluded that farmed salmon, particularly from Northern Europe, had far higher levels of PCBs and other toxins than wild salmon, and that consumers should limit their consumption of farmed salmon to no more than one meal per month due to risks of cancer based on EPA limits, which are far more strict than FDA limits.

When the report came out, the story was front-page news in several papers. Several of the headlines were misleading. For example, a story in the *Washington Post* was headlined, "Toxins cited in farmed salmon: Cancer risk is lower in wild fish, study reports." However, the words "lower in wild fish" did not clarify

whether the risk was for all other wild fish species or just wild salmon. A headline in the *St. Paul Pioneer Press* announced, "Limit on eating salmon urged," but failed to make the distinction between farmed and wild salmon. A headline in *USA Today* stated, "Some salmon are highly toxic," which seems vague and sensational. "Gosh, if I were a consumer – what do you do?" Roheim asked.

In response, medical professionals came out with counterarguments to the original study. They said the original study did not sufficiently weigh the risks of cancer in context with the health benefits from eating salmon; one response said the study and subsequent media reports "likely caused substantial numbers of premature deaths," alluding to the many members of the public who may have read the report and stopped eating farmed salmon or fish altogether.

Several of the things the media failed to clarify included the differences in recommended limits by the EPA and the FDA, which shows that farmed salmon are quite safe according to the FDA; that the farmed salmon were tested three years earlier, when the methods being used in salmon farming and fish feed were

different; and that the tests were on raw fish (cooking can lower the levels of toxins). Since then, the media has treated the PCB study as fact instead of including any changes in salmon farming practices or new research that shows health risks from PCBs in either wild or farmed salmon are low, particularly compared to health benefits. Newspapers still recommend wild salmon. In September 2007, a doctor on the "Today" show recommended eating wild over farmed. "So it continues, even today," Roheim added.

U.S. salmon consumption is now dominated by farmed imported salmon. According to her figures, the demand for salmon grew fivefold from 1989 to 2004. "Salmon's very important to our consumption, but most of that is farmed," she said. If the public

The media failed to clarify several things about a 2004 study on PCB levels on farmed salmon, and since then has treated it as fact without including the changes that occurred.

Newspaper Headlines

"Study cites toxins in farmed salmon" – *Chicago Tribune*

"Study says farmed salmon dangerous" – *Detroit Free Press*

"Toxic risks in farmed salmon – consumers told to be wary. Study finds PCBs, dioxins, pesticides, probably from diet" – *San Francisco Chronicle*

"Toxins cited in farmed salmon. Cancer risk is lower in wild fish, study reports" – *Washington Post*

"Limit on eating salmon urged" – *St. Paul Pioneer Press*

"Some salmon are highly toxic" – *USA Today*

followed the media's reports and switched to wild salmon, it would force the U.S. to stop exporting much of its Alaskan salmon and still couldn't fully meet demand. She said our exports are "predominantly of the lower-quality species."

"So the big question is, what was the impact of that story?" she asked. A graph illustrated a large decrease in the imports of farmed salmon right after the PCB study came out. She wanted to know what other factors might have been involved in that drop, such as economic drivers and whether imports were affected in the long term – would the number of imports have been greater in the following months had that report not been published and widely broadcast by the media?

To answer these questions, Roheim conducted a statistical regression analysis of the amounts of salmon imported by month from January 1998 through

December 2005, to examine the trends before and after the release of the report. She analyzed the economic influences of the time period and created a "media index," utilizing those articles to determine the impact of the information the general public was getting. The index aimed to "capture the pervasiveness of news and the strength of the impact of the news on imports, holding all economic effects constant." The resulting analysis was "statistically significant." With the index, she predicted what imports would have been had the PCB report not been released.

The prediction shows that imports would have been higher through the spring of 2005. "Price impacts (and) economic impacts would still have caused a downturn in farmed-salmon imports at the end of 2005," she said,

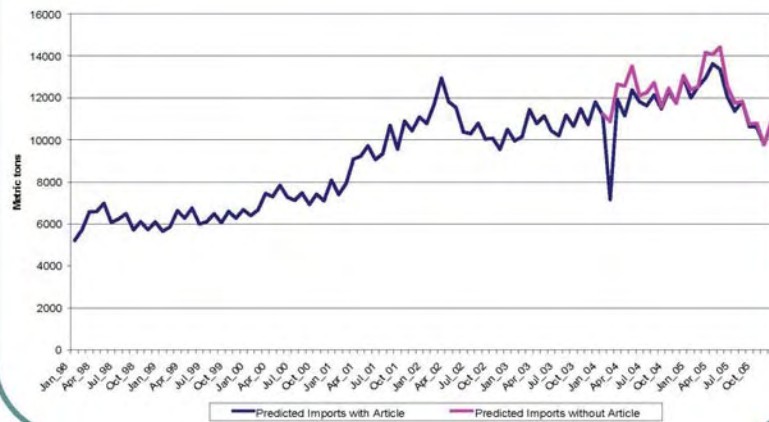
The report caused a temporary dip in farmed salmon imports, but the long-term effects may have tapered off.

"but imports would have been higher without the *Science* report and subsequent press related to its release." She concluded that the PCB report caused "considerable controversy and media attention," and the information strengthened the anti-aquaculture campaign. A more interesting question is whether that has changed consumer demand for farmed salmon, and whether the sales of salmon are still being affected. The report caused a tempo-

rary dip in farmed salmon imports, but the long-term effects "may have tapered off," she said. If they have, that means consumers are eating farmed salmon and gaining its health benefits. But if the report's effects haven't diminished, consumers may not be balancing the risks and benefits of eating farmed salmon appropriately. The analysis doesn't provide information on whether consumers might be switching to different kinds of fish, such as wild salmon, as a result of the report. Research is under way to examine the impacts the report may have had beyond 2005.

In response to an audience member's question about whether the "perfect storm" of media misinformation was organized or random, Roheim said she was "unimpressed" with the presentation on the PCB study by one of its authors. She said she believed he was biased against farmed salmon, illustrated by his presentation of cartoons that she called "anti-farmed salmon." As for whether it was meant to happen this way, she said she couldn't say.

Predictions of U.S. Farmed Salmon Imports with and without *Science* Article



Shellfish Pathogens: Incidence, Risk and Prevention

Ken La Valley, Ph.D., Assistant Professor, Department of Zoology,
NH Sea Grant/UNH Cooperative Extension

La Valley examined the bacteria species and viruses that can live in seafood and cause illness in humans who ingest them. He began by listing a pathogen “most wanted” list that was divided into bacteria, viruses and biotoxins. Regarding bacteria that are associated with shellfish consumption-related illnesses, he named *Salmonella*, *Yersinia* and *E. coli* bacteria, as well as the *Vibrio* species, as resulting in various pathological conditions. Raw shellfish aficionados are particularly susceptible to the harm of *Vibrio* species when eating raw shellfish, and one species of concern, *Vibrio vulnificus*, is associated with a high morbidity rate in members of certain at-risk groups. On the viral end, Hepatitis A and noroviruses were identified as potential pathological agents. Several biological toxins, including paralytic, diarrhetic, neurotoxic and amnesic shellfish poisoning, are the results of dinoflagellate blooms in estuarine and coastal waters, the typical environments where shellfish grow and are harvested.

Shellfish are more likely than other seafood to contain pathogens that are harmful to human consumers because they are filter feeders and thus concentrate particles (potentially toxic or pathogenic compounds) from the water into their systems. “This is a very non-selective approach to feeding,” La Valley said, “so whatever is in the water at that time is being concentrated within their digestive system or soft tissues.” If pathogens

or toxins are present in the water, they will become concentrated in the shellfish. Biotoxins in particular can be absorbed by shellfish tissues and become highly concentrated, while many of the pathogens, such as *E. coli* and other bacteria, are regularly discharged from shellfish systems during the process of digestion. But despite this, many organisms can utilize the shell surfaces of mollusks as a habitat or “microenvironment” – the existing biofilms and waste products produced by shellfish provide localized concentrations of nutri-

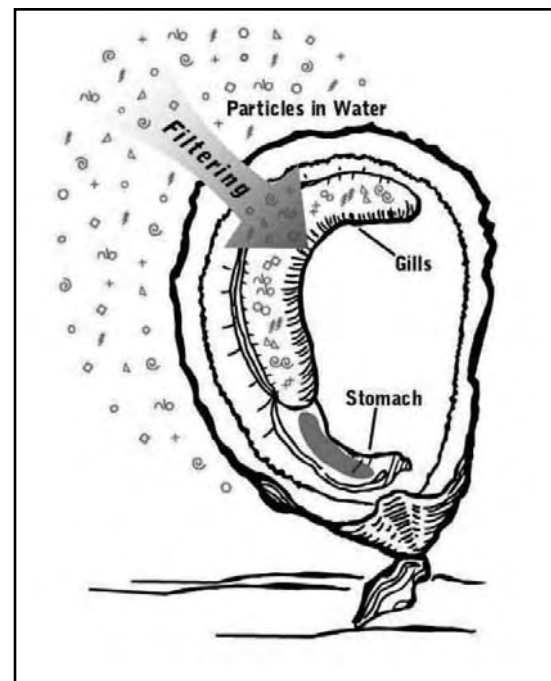
Shellfish are more likely than other seafood to contain harmful pathogens.

ents providing the right conditions for microorganisms to grow. Shellfish typically live and grow in estuarine habitats, areas that have a high potential to be impacted by run-off pollution. This includes point sources, such as toxins being dumped, industrial facilities being housed nearby and sewage treatment plants discharging waste, and nonpoint sources, including urban and agricultural runoff. In addition to directly adding fecal bacteria, viral particles and a host of other microorganisms to the surrounding estuaries, these pollutants provide nitrogen and other nutrients to the water, thus allowing microorganisms to proliferate. Because shellfish are non-selective feeders, the particles that end up in coastal and estuarine waters are filtered through their systems and may become concentrated.

La Valley focused on the *Vibrio* bacterial species.

According to a 2005 report by the Centers for Disease Control and Prevention, *Vibrio* bacteria is the cause of 8,000 foodborne illnesses in the U.S. each year. More than half are caused by the species *Vibrio parahaemolyticus*, and more than a third are due to raw oyster consumption. Sixty-two percent of *Vibrio parahaemolyticus* infections can be attributed to raw oysters.

There is a seasonal effect from specific species of



Shellfish are filter feeders that concentrate toxins or pathogens from the surrounding water. Foodborne illnesses, such as *Vibrio* bacteria, are often caused by raw oyster consumption.

People who consume raw shellfish are susceptible to the bacteria *Vibrio vulnificus*, which is associated with a high morbidity rate in members of certain at-risk groups.

Vibrio, including *V. parahaemolyticus*. A report by the U.S. Department of Agriculture noted that 52% of *V. parahaemolyticus* incidences occur during the summer months. This is due to greater tourism – beachgoers, for example, visiting seafood establishments – and the environmental conditions of the summertime, when bacteria can bloom. *Vibrio vulnificus*, the species with the highest morbidity rate, is most often lethal in people who suffer from liver sclerosis, such as recovering alcoholics, or those who have immune deficiencies, such as HIV-positive individuals and cancer patients undergoing chemotherapy. The majority of *V. vulnificus* cases occur in the southeastern states. When it occurs in the Northeast, emergency rooms may not recognize the illness and may not necessarily be equipped to test for the bacteria. Because of this, statistics that show few to no cases of the illness in this area may be due to the fact that incidences were not specifically diagnosed, or people who suffered

effects of the bacteria didn't seek medical attention. From 1998 to 2004, 44% of those who contracted *V. vulnificus* died – but the chance of becoming infected is very low unless you're a part of the at-risk community.

How can we prevent infection by *Vibrio* bacteria? The consumption of oysters puts people at the highest risk of any seafood, because there's no way to detect whether they contain the bacteria. Cooking shellfish thoroughly will destroy the bacteria – so raw oysters pose the greatest danger of infection. Proper seafood maintenance, such as keeping shellfish stored at 40 degrees Fahrenheit or below, is also key to shellfish safety. It is important that consumers know where their fish is coming from – where and when it was harvested and who is handling it – so they can make smart choices about the shellfish they eat.

The risks of harmful algal blooms were broken down by geographic region. In the Southeast, the most widely spread concern is for neurotoxic shellfish poisoning, while in the Northeast, the biggest concern is paralytic shellfish poisoning. Very few paralytic poisonings have occurred in the past 20 years because states have tight regulations on testing biotoxins,

keeping a sharp eye out for algal blooms, such as red tide. If a bloom is detected, states will determine toxicity levels and make a judgment call on whether to close a particular harvest area and stop harvesting shellfish at that time. "Given the current surveillance

for harmful algal blooms and the tight overseeing of the harvest and sale of shellfish, the likelihood of getting toxic shellfish poisoning is very low," he said.

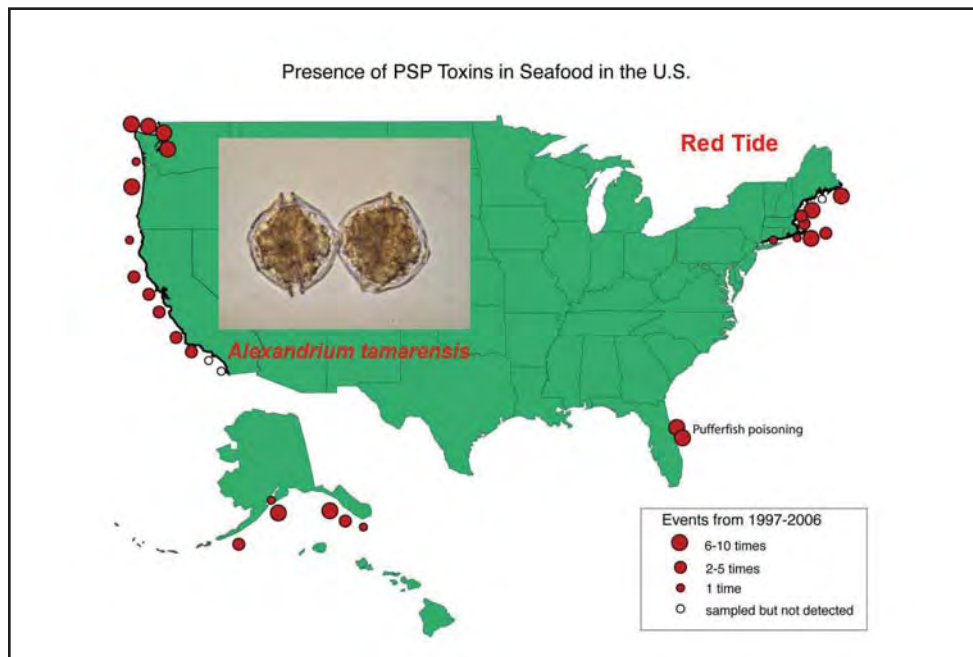
The risk that shellfish available to consumers in mainstream forms of sale, such as grocery stores, are contaminated with biotoxins is low also due to the comprehensive regulation of shellfish harvest and sale. For shellfish that are harvested recreationally, the risk is moderate to high, because those who harvest may not be informed of the levels of biotoxins in the water. Recreational fishermen can check state advisories to learn more before collecting shellfish. He said the risk is moderate when purchasing shellfish from a "dock-side" harvester, because there is a potential that the

"Given the current surveillance for harmful algal blooms and the tight overseeing of the harvest and sale of shellfish, the likelihood of getting toxic shellfish poisoning is very low."

There are several safety frameworks in place to prevent biotoxins and pathogens in the shellfish available to consumers.

seller is unlicensed and uninformed about the status of the waters. And in the case of biotoxins, cooking will not make the fish safe – it will kill bacteria, but not biotoxins.

Noroviruses are a group of viruses that cause gastrointestinal illness and are the cause of the vast majority of foodborne illness in the U.S. High levels of fecal coliform in water bodies where shellfish grow can lead to high incidences of noroviruses, but there



are currently no strong methods for detecting the viruses in the water. “That’s what we’re looking for in the future,” he said. In the meantime, cooking shellfish thoroughly will destroy the virus.

After all this talk of the risks of eating shellfish, La Valley explained

measures that have been put in place to ensure shellfish safety. There are several safety

Regulatory agencies can determine where the outbreak originated from, determine if a recall is appropriate and diagnose the source of the problem.

frameworks to prevent biotoxins and pathogens in the shellfish available to consumers. The Interstate Shellfish Sanitation Conference (ISSC) aims to control the diseases that can be contracted by eating raw shellfish. It began as the National Shellfish Sanitation Program (NSSP) in 1925, and it included participation from state regulatory agencies, the FDA and the shellfish industry. The conference manages the NSSP guidebook, the *Guide for the Control of Molluscan Shellfish*, that controls shellfish harvesting, identification, storage temperatures and marketing. In 1998, the countries and states participating in the conference passed an ordinance, agreeing to follow the guidelines. The ordinance is under continual review and controls harvesting, processing and sales of shellfish in participating ISSC entities.

In addition, there is the industry-mandated Hazard Analysis of Critical Control Points, or HACCP plan that each shellfish dealer or purveyor must provide for their particular business. It is important that members of the shellfish industry follow the same guidelines for processing. These guidelines include establishing procedures for monitoring, corrective actions and record-keeping. “Now you can rest assured,” La Valley said, “that when you buy shellfish from a reputable source, there’s going to be a stream of documentation you can

follow to the exact bed where the shellfish were harvested. So whenever there is an outbreak, regulatory agencies can determine where the outbreak originated from, determine if a recall is appropriate and hopefully diagnose the source of the problem.”

A member of the audience asked how consumers can determine who is a reputable shellfish dealer. La Valley gave his advice for knowing who to trust: If the seller knows the harvest date and product origin, he said, “I would be fairly confident that they have a good

HACCP program in place.” If you’re buying from a grocery chain, he said, there have been so many required steps taken before the shellfish reached that

Cooking shellfish will kill bacteria but not biotoxins.

store that you can be sure it’s safe. La Valley was also quick to point out that no system is “fool proof” and contaminated or mishandled shellfish products do make it into the consumer stream.

In regards to cooking shellfish, La Valley clarified that steaming shellfish such as mussels does not mean they are considered thoroughly cooked, according to the FDA. However, he said the steaming process will significantly reduce bacteria levels.

A Quantitative Risk-Benefit Analysis of Changes in Population Fish Consumption

Joshua T. Cohen, Ph.D., Research Associate Professor of Medicine, Tufts-New England Medical Center

Cohen was interested in two impacts of the 2004 advisory on mercury in fish: If members of the sensitive population, for whom the advisory was issued, followed its recommendations, would there be unintended consequences, such as missing out on the benefits of fish; and how might the health of the general population be affected, depending on how they react to the advisory? His task was to analyze the risks and benefits resulting from shifts in population fish consumption. He and his colleagues analyzed existing studies, synthesizing the information to get an overall picture of the risks and benefits.

The advisory, which was issued by the EPA and the FDA to protect women of childbearing age and young children, is based on the EPA's mercury reference dose (RfD) of 0.1 micrograms of mercury per kilogram body weight per day. The EPA developed its mercury RfD from epidemiologic data describing the relationship between cognitive maternal exposure to mercury during pregnancy and subsequent childhood cognitive development. The agency effectively deems exposure to mercury below the RfD as "safe" and exposures above this level as unacceptable. The division line between safe and unacceptable implied by the RfD is artificial because there is no evidence of a threshold below which mercury exposure is associated with no harm. There is also no evidence that within any normal range of exposure, mercury

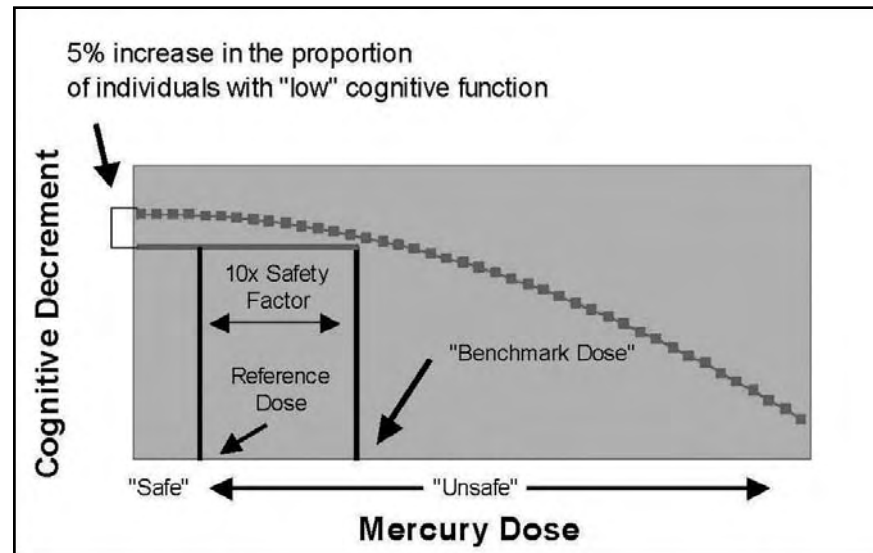
intake above a certain level is associated with notably more severe effects, although it must be emphasized that at exposures common in the U.S. population, these effects are "sub-clinical," meaning that they can only be detected as statistical shifts in the average cognitive performance of large populations.

Some media coverage and scientific reports have made strong statements about the consequences of exposures exceeding EPA's RfD. For example, the

National Research Council at the National Academies of Science said, "Over 60,000 children each year are born at risk for adverse neurodevelopment." The "60,000" statistic corresponds to the estimated number of infants born to mothers whose blood mercury levels indicate exposure to mercury in excess of the reference dose. "But I think that's kind of strong wording," Cohen said. The Environmental Working Group said, "An average woman following the FDA's

advice of eating two servings of fish per week would exceed a safe dose of mercury by 30%." Now, Cohen said, "you have the word 'safe' attached to 'reference dose.'" The preoccupation with the RfD has confused the issue, preventing a fair assessment of the benefits of seafood. The benefits are directly related to the amount of seafood intake – the more you eat, the more benefits you get. But the RfD designates a line that some consumers don't want to cross, despite the benefits that doing so might confer.

Cohen and his colleagues approached the problem by first analyzing the advisory's effects on the sensitive population: women of childbearing age and infants. Hypothetically, the advisory might lead women to either change the type of fish or the amount of fish they consumed. Both choices



The FDA's basis for the 2004 fish advisory regarding mercury is based on epidemiology data. It sets a "benchmark dose" where the smallest level of mercury exposure is associated with an "important" cognitive decrement. This dose is divided by a safety factor of 10 to provide a reference dose, or RfD, of mercury levels.

would decrease their methylmercury exposure and influence their intake of omega-3 fatty acids, changes that would affect the benefits and risks associated with cognitive development. But comprehensive data quantifying such changes are lacking. Cohen's study considered several ways the advisory might have affected behavior. The researchers explored two scenarios: Their optimistic scenario assumed that women would eat fish that are lower in mercury but would not decrease the amount of seafood they consume; the pessimistic scenario assumed women would decrease their fish intake by 17%, a number based on a study published in 2003 by Emily Oken that found fish consumption among women in one medical practice decreased by that amount after promulgation of the federal government's 2001 mercury advisory.

For members of the sensitive populations: "Continue to eat fish, but eat species that are lower in mercury content."

Cohen and his colleagues estimated the impact of mercury on cognitive development using the findings of the three major epidemiological studies conducted in the Faroe Islands, the Seychelles Islands and in New Zealand. They used reported impacts for several cognitive development domains, including language, memory, attention and intelligence, and combined these effects to develop an overall estimated impact for mercury on cognition measured in terms of IQ. The domains were assigned weights that reflected their relevance to IQ, and the studies were assigned weights that reflected their sample size, the quality of their methodology, and their applicability to the U.S. populations. The two biggest studies on mercury and cognitive development (Faroe Islands and Seychelles Islands) came to opposite conclusions. The Faroe Islands study concluded that mercury exposure during pregnancy found no association between

mercury exposure and cognitive development. Using a high end estimate of mercury's effects from the Faroe Islands study, Cohen and his colleagues estimated that mercury exposure during pregnancy sufficient to increase the concentration of this metal in maternal hair by one part per million (ppm) would decrease IQ in the offspring by 0.7 IQ points. An EPA analysis estimated a much smaller impact of 0.13 IQ points per ppm mercury in maternal hair. Cohen noted that his result was heavily influenced by his interpretation of the Faroe Island results. A more central estimate of mercury's impact from that study, taken together with the Seychelles Islands and New Zealand studies, produced an estimate of 0.2 IQ

"The preoccupation with the [mercury] reference dose (RfD) has confused the issue, preventing a fair assessment of the benefits of seafood."

points lost per ppm mercury in maternal hair.

Cohen and his colleagues developed estimates for the beneficial impact of omega-3 fatty acid consumption on cognitive development in a similar manner based on a set of small randomized trials. By estimating how changes in fish consumption (envisioned in their pessimistic and optimistic scenarios), and how these changes would influence mercury exposure and omega-3 fatty acid intake, Cohen and his colleagues were able to sum the adverse cognitive effects of mercury and the positive contribution of the omega-3 fatty acids to come up with an overall impact on cognitive development. In the optimistic scenario, in which women changed the type of fish they consume but not the amount of fish, average

The 2004 advisory on mercury in fish could have unintended consequences such as sensitive populations missing out on the benefits of eating fish.

child IQ increased by 0.1 IQ points. In the pessimistic scenario, in which women decreased their fish intake by one-sixth, child IQ still increased but by a considerably smaller 0.02 IQ points.

Cohen and his colleagues also quantified the effects an advisory would have on the general adult population. "For a whole bunch of reasons we could dream up," he said, "this advisory could influence the (fish) consumption of people who were not even targeted by the advisory." Some members of the public might think, "If it's not good for babies, it's not good for me"; and if pregnant or nursing mothers were buying the food for their families and they were conscious of decreasing their fish intake, it would affect the whole family. The scenarios developed for the general population were similar to those developed for women of childbearing age. An optimistic scenario assumed the advisory would not influence fish consumption among adults that the advisory did not target. In this scenario, the advisory has no impact on the health of other adults. The pessimistic scenario assumed that the advisory caused other adults to decrease their fish consumption by approximately one-sixth. This reduction increased the risk of coronary heart disease and stroke.

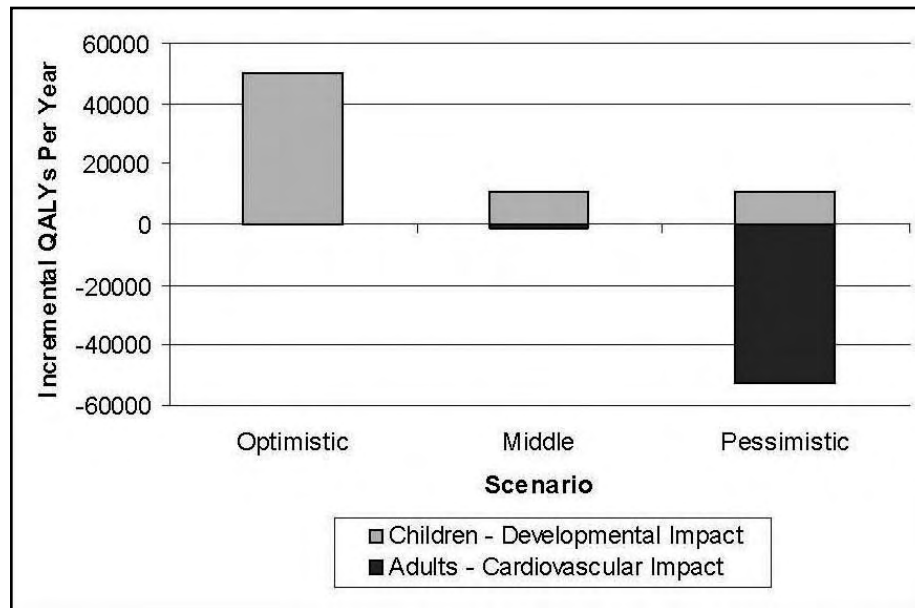
Because the baseline risk for coronary heart disease and stroke are so high, even modest changes in these risks can have substantial impacts on public health.

For example, Cohen and his colleagues estimated that the decreased fish consumption envisioned in the pessimistic scenario would result in an additional 7,900 deaths and 1,500 non-fatal strokes annually. Although there is no direct way to quantitatively compare this increase in risk to the cognitive development benefits associated

with fish consumption shifts, health economists have developed a common measure to compare disparate health effects. That measure, called a ‘quality adjusted life year’ (QALY) takes into account changes in both the length of life and quality of life. Measured in this way, the increased coronary heart disease and stroke risks swamp the value of the benefits associated with improved cognitive development.

The study concluded that it would be beneficial to members of the sensitive population to follow the 2004 advisory as it was intended: Continue to eat fish, but eat species that are lower in mercury content. Even if they decrease their fish consumption, rather than shifting to lower mercury fish, the sensitive population can still benefit, although the benefits will be substantially smaller. If this benefit comes at the cost of scar-

ing other adults from consuming as much fish as they might otherwise consume, it is likely that the overall public health impact of an advisory will be negative. The coronary heart disease and stroke risk impacts are too large to be outweighed by cognitive benefits. Moreover, depending on how the Faroe Islands study findings are interpreted, it may turn out that there is a negative impact on cognitive development associated with the fish consumption changes envisioned in these studies. For that reason, the findings of the Faroe Islands studies must be regarded as “a key source of uncertainty.” Even more importantly, nobody knows for sure how the public’s behavior changes in response to these advisories. Without this information, it is difficult to evaluate the risks and benefits associated with the federal advisory on mercury in fish.



The number of quality adjusted life years (QALY) impacted by changes in fish consumption by children and adults. Three scenarios, including optimistic, middle and pessimistic reflect the change in the number of QALYs per year for each population.

Consumer Perceptions about Seafood: An Internet Survey

Lori Pivarnik, Ph.D., Coordinator, Food Safety Education/Research Program,
Nutrition and Food Sciences Department, University of Rhode Island

The public is faced with a lot of conflicting information: Health and medical groups tout the benefits of fish consumption and say people should eat more, while concerns loom for mercury and other contaminants. Pivarnik and collaborators Doris Hicks and Ryan McDermott (University of Delaware) conducted an online survey to assess consumer knowledge and attitudes about seafood and its risks and benefits. An Internet survey program, Zoomerang, was used that allowed for the creation, deployment and analysis of surveys.

The survey was administered between July 27 and Aug. 7, 2006, and 1,062 adults completed the online questionnaire. The survey results compared well to the 2005 census of the U.S. population in several ways, including age, income, education, ethnicity and geographic location. The survey asked participants questions about their households and how long they had lived in their towns; it asked females if they were pregnant or nursing at the time of the survey – 5% of whom said they were – and it asked all responders whether they were the primary food shoppers. About 60% of survey participants were the ones who shopped most for their families' food, and about 30% said they shared the duty with someone else in the household. Pivarnik said there was "a slightly higher educated group in our sample. I think these surveys are sort of self-selecting, that some people who are slightly more interested in the topic would answer."

The first few questions divided the survey respond-

ers into three groups: current seafood eaters, non-seafood eaters and former seafood eaters, with a subset group of childbearing aged women, about 30% of the participants. All respondents were asked if they were aware of the 2004 advisory on fish consumption, and if they were, what they considered to be their level of knowledge on the subject. Participants who said they were not aware of it were given the advisory to read before answering additional questions. All participants were asked to read Pivarnik's definition of seafood "to try and get them all on the same page."

Eighty-eight percent of the responders classified

"...education really played a role in whether they (survey participants) were eating seafood frequently or not. Those people with some college education or beyond took to seafood more often than others."

themselves as currently eating seafood, ranging from very frequently to just once a month. About 85% of the women of childbearing age said they were current seafood eaters. The survey showed that 22% of the current seafood eaters were consuming fish at least two times per week, and 24% were consuming fish at least once a week. Pivarnik said she was surprised to see 44% of the population eating seafood regularly.

Next, she looked at the education levels of the respondents who said they were eating fish twice a week, and therefore following the advisory as it was intended. "It was clear that education really played a role in whether they were eating seafood frequently or not," she said. "Those people with some college or

beyond took to seafood more often than others." The group was then broken down by income to determine if the cost of seafood might hinder fish consumption. People who ate seafood twice a week or more came from all income groups. "I think that decision may be made separate from income," she said. Age was unevenly distributed among this group, although it appeared that higher consumption rates may be found in the middle-aged group.

Fifty one percent of the seafood-eaters most often prepared it at home. The survey found that 42% ate most of their fish in restaurants; the rest usually got take-out or fast food. Pivarnik noted a connection between the frequency that people ate fish and where they ate it: "The people who were eating it more often were preparing it at home more often, and the people who were eating it

less often were the ones who were going out and getting it at a restaurant," she said. This may have been because those who eat it less often are less familiar with how it's prepared and "don't want to mess it up," so they eat it when someone else prepares it for them.

For former and non-seafood eaters, the survey asked why they weren't eating it. Taste was the number one response. Other, less common reasons included allergies, being vegetarian and having a bad experience with seafood in the past.

Participants were asked whether they'd heard good or bad things about seafood. Most (85%) had heard positive things, and many (61%) had heard negative things. The survey asked for an open response to the

Positive	Negative
Old wives tale turns out to be true - fish is brain food.	Can be high in mercury. Overfishing is a big problem. Farmed salmon is evil.
Will help me maintain my low-fat, high-protein diet.	Certain fish are not good for kids/pregnant women
Eating certain seafood is good for your heart and cholesterol	Fish carry diseases
After heart surgery my cardiologist recommended less red meat. Fish was a good alternative.	Lack of inspection could lead to higher rate of bacteria and other organisms.
Even with the risks, it is a good addition for my diet to lose or maintain weight.	Red Tide

Positive and negative messages the public says it is receiving about fish consumption.

question, “What have you heard and where did you hear it?” The responses showed that almost half of the people who had heard good things were aware that fatty acids, fish oils or “healthy fats” were beneficial, and more than half of those who had heard bad things mentioned mercury. Many of the women of childbearing age listed several pros to eating seafood: It’s low in fat and calories, it’s healthier than other types of meat, it’s nutritious, the omega-3s are good for your heart and it tastes good. They also had negative things to say: There could be too much mercury, raw oysters pose risks, improper handling can lead to illness, and it may be bad for pregnant women.

Based on these answers, Pivarnik broke down the positive and negative messages the public is receiving. Generally, members of the public know that seafood is good for your heart and your brain, can help maintain a low-fat diet and can aid in weight control. They also believe that fish can carry disease, can pose risks due to high mercury levels, and certain species are not good

the middle. The survey also asked if medical experts are going to put the information out there, where is the best place for consumers to get the information? The responses were nearly identical to where they were getting the information already: Media was at the top of the list, followed by the Internet, magazines and doctors. When asked where they were getting positive

“They (survey participants) are so much more concerned about mercury than how to handle and prepare fish and make sure it’s safe to eat. That message is not getting out.”

and negative information, respondents said very similar things: The media was number one on both lists, followed by family and friends. On the Internet, 27% said they were seeing positive things, while 16% said they saw negative things. “What are they supposed to believe?” Pivarnik asked. “They want to get their

for pregnant women. The survey asked where participants were getting their information from, and the most popular response was the media. Family and friends, the Internet, and health magazines were also high on the list. “Environmental groups and consumer advocacy groups – they’re way at the bottom,” Pivarnik said. “The public is not getting the messages from them.” Physicians and nutritional experts were somewhere in

messages from the media, there’s positive information from the media, there’s negative.” She pointed out that environmental groups got a poor rating: Eleven percent of survey respondents said they were receiving negative information from those groups.

To analyze consumer knowledge, the survey asked participants to select “yes,” “no” or “not sure” for several statements about seafood. The good news was that 70% knew deep-frying fish is not healthy, and

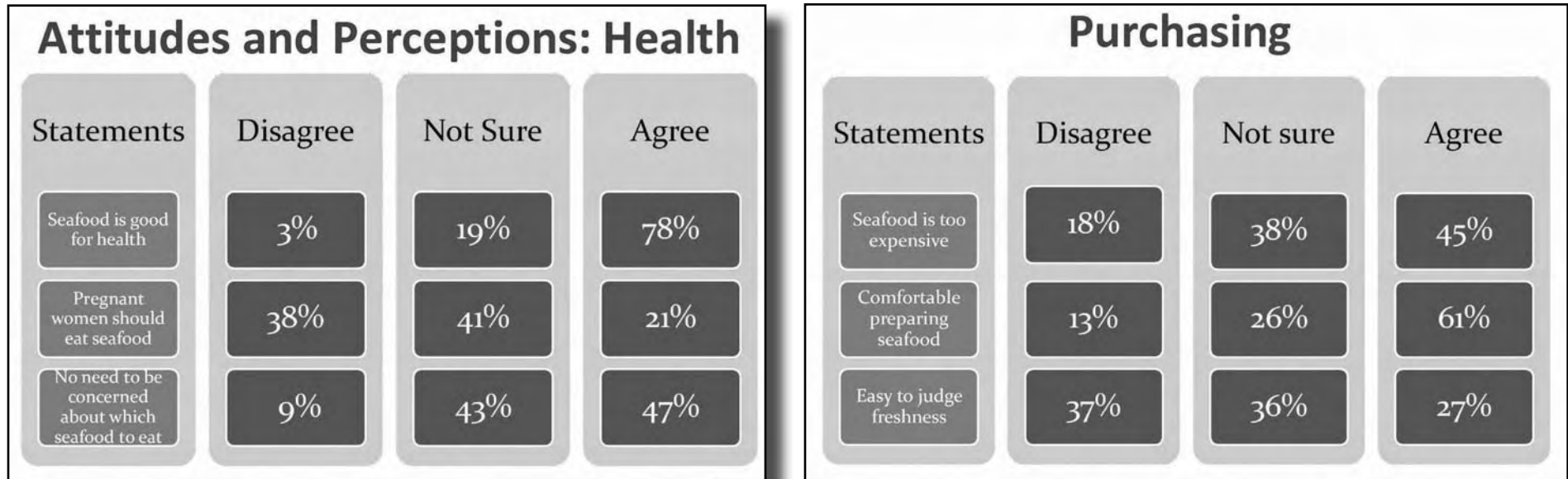
Survey participants noted that they get most of their positive and negative information from the media regarding seafood consumption.

66% knew the omega-3s are found in oily fish. But only 30% knew that the biggest safety risks of eating seafood are pathogens and allergens. “They’re so much more concerned about mercury than how to handle and prepare fish and make sure that it’s safe to eat,” she said. “That message is not getting out.” And most participants (72%) didn’t know whether their state posts an advisory on locally caught fish.

Three-quarters of the respondents said seafood quality affected their decisions to purchase fish. Most participants also said safe handling, preparation,

storage, health benefits and contaminants had an impact on their choices. To find out more about their attitudes, the survey asked whether they agreed with several statements. Forty-five percent said they agreed that seafood is too expensive,

which Pivarnik said was not unexpected; but she was surprised to see that 61% said they were comfortable preparing seafood. However, only 27% said seafood freshness is easy to judge. “They want quality, but they don’t know how to judge it,” she said. Their responses showed a general lack of trust in the media



Results of an Internet survey regarding the attitudes and perceptions of the health of seafood consumption (left) and seafood purchasing (right).

and consumer groups, but about half trusted in the government’s advice on which seafood to eat. Nearly 80% agreed that seafood is good for your health, but most either disagreed or were unsure that pregnant women should eat fish.

Twenty-nine percent of the participants said they would buy farmed salmon, and 22% said they would buy wild salmon. Some had no preference, while others said it depends on species or price. Ten percent said they don’t buy salmon at all. “It just shows the confusion that’s out there,” Pivarnik added.

The survey asked about organic labels and whether consumers had seen them on seafood. Most said no; 25% said they weren’t sure, and 10% answered yes – “which is really surprising,” she said, “because the United States has no organic labeling on seafood.” That may be due to fish coming from Europe, where organic labels are used. About half of the respondents said they would buy organic seafood, but only half of

those said they would pay more for it. The people who had higher levels of education were more willing to pay for organic seafood than those with lower levels.

Finally, the survey asked about the 2004 FDA advisory. Seventy-five percent of respondents said they were aware of it, and 34% said they considered themselves knowledgeable. Seventy percent of the women of childbearing age were aware of the advisory, and 30% said they were knowledgeable. Those who said they did not know of the advisory or knew little about it were given a chance to read the advisory before answering several questions. The results were discouraging: “Forty percent of them got it wrong – they said the advisory was for everyone. Something isn’t getting to them,” she said. Only 60% of those who said they were knowledgeable about the advisory understood that it wasn’t intended for the general population.

The survey has led Pivarnik to come to several conclusions: Most of the U.S. population is eating

fish, but not enough; most people recognize the health benefits of seafood, but most have heard negative things as well; the advisory is poorly understood; and consumers prefer to get their information about seafood from the media and the Internet.

Putting Risk in Perspective: Effective Risk Communication

Kimberly Thompson, Sc.D., Associate Professor of Risk Analysis and Decision Science and Director of the Kids Risk Project, Harvard School of Public Health

Questions to Consider when Regarding Health Information

- What is the message?
- Is the source reliable?
- How strong is the evidence overall?
- Does this information matter?
- What do the numbers mean?
- How does this risk compare to others?
- What actions can be taken to reduce risk?
- What are the trade-offs?
- What else do I need to know?
- Where can I get more information?

<http://www.health-insight.harvard.edu>

Thompson called this the “Age of Risk Management” saying that we live in a time when science data plays a key role in the tough choices we make, both individually and collectively, and the advancements in technology mean new opportunities, so we’re benefiting from high-quality information and the ability to better understand problems and solutions. This is all true when it comes to our food. She mentioned the nationwide recall of spinach in 2006 due to product contaminated with *E. coli* as an example of how technology has changed how we eat: “We are in a global supply chain when it comes to food, and many of us are getting farther and farther away from the sources of our food. As a result we often know very little about where our food is coming from,” she said.

People are living longer today, but citizens’ outlooks are not so positive – it’s easy to live in the future and not the present, and it’s hard to keep perspective when there’s so much information out there. She suggested that maybe it has something to do with the media and the reality that many people are overwhelmed by the information presented to them. “It’s set up so that every time there’s a big study the news media gets ready to spread the word with their huge machine,” she said.

On top of that, the newspaper headlines often highlight risks and they can seem “very scary” because they are often sensational and lacking content. And there’s the Web – “You can find great information on the Internet, but you can also find incredibly misleading information on the Internet,” she said. “And in some cases, the misleading information can be made

to look just as authoritative, and actually sometimes even prettier.” Entertainment may also play up natural disasters in ways that can scare people.

One of the goals is to empower consumers – to give them the tools so that they can find out what they really need to know. When talking to consumers, many of them feel “paralyzed” – overwhelmed by the many sources they encounter and not able to digest the information. Americans are not really taught how to do that in high school or in college. “We need to do a much better job educating consumers about risk,” she said. This can be accomplished by giving consumers the tools to ask the right questions and sort out the vast and often conflicting information.

To accomplish this, Thompson has made a guide available to the public online. The guide, called “Health Insight: Taking Charge of Health Information” and found at www.health-insight.harvard.edu, gives 10 questions for consumers to use when deciphering information. The first question: What is the message? News stories will draw readers in with an “emotional hook,” and consumers need to look past this to get to the real message of the story. Often, the presentation of a story can be distracting as well. Consumers should be able to put all this aside.

The second question: Is the source reliable? Members of the public should be able to identify the source and look closely at its motivation for putting the information out. Consumers should also consider factors such as whether the research has been published or repeated. The media reports on findings that are new, but those results might not necessarily have been

supported by repeated studies, so drawing conclusions from the results would be premature. In contrast, she noted that many important risks are not “newsworthy.” “That’s why it’s so hard in public health,” she said. “Because most of the stuff we want to tell people is not new, it’s stuff they need to do every day.”

The third question advises consumers to look at the strength of the evidence overall by examining the level of scientific agreement and the consistency of the message. The uncertainty of the evidence must be weighed accordingly – if the information is not certain, it

very well may change. Many news reporters have a very difficult time when they’re

dealing with uncertainty because they’re trying to sort out what scientists are saying from all different directions. They tend to represent the polar opposites, which are easy to understand – but it can only confuse the issue further, because it represents the information as if there is no consensus on the evidence at all and ignores the weight of the evidence. It is important that consumers understand that “uncertainty is reality,” but Thompson acknowledged that uncertainty can be very uncomfortable. “It’s something we have to be somewhat empowered by, because it does mean that our choices matter,” she said.

The fourth question is: Does this information really matter to me? And if it does, how does it help

me to manage risk? The fifth: What do the numbers mean? Stories often include some of the numbers, but not all, and they confuse absolute and relative risks. “One thing that news people like to do is take the biggest number, or the scariest number,” she said. “So you really have to watch out for that.” Question six asks

Consumers need to actively monitor their health, ask questions, keep risks in perspective, and get help from the experts.

how the risk compares to others, which ties into the numbers as well – they have to be compared correctly. Other important factors need to be weighed against the risk, such as the benefits – they may prove to be more important than the risks.

The seventh question, considering the actions that can be taken to reduce risk, empowers consumers to act on their own behalf. The success of their actions depends on creativity and practicality, and consumers must consider how well the solutions will work before acting. Question eight asks consumers to think

about what impacts the actions will have beforehand, and to consider whether the tradeoffs are worthwhile. Actions can have unintended consequences, and people should consider this possibility before acting. The ninth question encourages the consumer to be empowered by uncertainty and think about what else he or she needs to know, and the tenth question encourages consumers to think about the next step in finding more information.

Thompson has received many calls recently regarding food risks, such as choking, allergens and toxins, and she’s been working on a project to address these concerns. A guide on managing the risks of eating that offers 10 simple actions can be found at www.viola.harvard.edu. The actions include enjoying food healthfully,

“We need to do a much better job of educating consumers about risk.”

as it provides nutrients and benefits to health; recognizing eating-related risks; reducing those risks; and balancing energy intake and output by exercising and counting calories. Consumers should understand food labels and the information they provide but they should also go beyond the labels, because they’re not enough – con-

sumers need to take responsibility for their own food intake. They should actively monitor their health, ask questions, keep risks in perspective, and get help from the experts.

Often when reporting on medical studies, the media promote the idea that one food can provide a cure to something. Thompson said this is the wrong message: Medical experts want the public to know the benefits of certain foods, but not think that they are “miracle cures.”

Panel Discussion

Moderated by **Kimberly Thompson**

Panel: **Sebastian Belle**, Executive Director, Maine Aquaculture Association, joined by **Ken La Valley**, **Joshua T. Cohen**, **Charles Santerre** and **Richard Langan**

During the conference, members of the audience were given the opportunity to write down questions to ask this panel. The questions addressed fish feed, fish oil supplements, cholesterol, saturated fat and sending the right messages to the public. Thompson facilitated the panel discussion, asking the questions provided by conference attendees.

The first question sought information about the modification of fish color: “From the media, I heard that fish feed can change the color of fish flesh, for example making salmon more vibrant. Three questions here: Is that true? If yes, then tell us more about this; and if yes, then is it a health hazard?” Belle said aquaculture farmers in his state add two compounds to salmon feed that the fish can’t synthesize naturally.



He said the compounds are needed nutritionally, and in the wild the fish get them from eating crustacean larvae. He said some farmers use the shells of shrimp in their feed, others use a product that comes from a yeast compound, and still others use both synthetic and natural sources. “The popularly held myth” that fish have gray flesh without the added compound is inaccurate, he said. “If you don’t feed your fish (the compounds), it’s a lighter color of pink.” He said the compound additives are the only thing that requires labeling in fish cases in the U.S. “From a grower’s perspective, I believe very strongly that consumers should know what they’re eating,” he said. But he said the additives have been widely misrepresented, and the media has portrayed the process as injecting salmon with dye using hypodermic needles.

The next question was also about fish feed, asking about the specific contents and how they “help or hinder the growth” of farmed fish. Belle said it depends on the species. “Worldwide, we’re culturing about 630 species of aquatic animals,” he said. “Many of the

There are approximately 630 species of aquatic animals cultured worldwide and their feed formulations are evolving rapidly.

species we’re culturing, we’re only just learning what their nutritional needs are, and so feed formulations are evolving very rapidly.” The balance of lipids and proteins is changing as they learn more, and he said many feeds contain higher ratios of lipids initially and then reduce them as they learn more about the nutritional needs of the species they are growing. He said from a cost-benefit perspective, many organizations urge farmers to use more vegetable proteins than marine proteins or lipids. “That’s going to impact the relative concentrations of omega-3s and omega-6s in the seafood that we produce,” he said. “Those are not benign choices.” He said those decisions have environmental impacts as well, because they can increase the demand on terrestrial plant production, such as soy beans. “Those are the kinds of choices we have to make, and they’re not simple ones.”

Marine ecosystems are based on phytoplankton and sequential carnivory as opposed to terrestrial ecosystems based on seed and grain.

Langan said the controversy over fish meal seems to be centered around aquaculture, when fish have been fed to terrestrial livestock for more than 50 years. “So the issue is really not aquaculture; the issue is really the use of these industrial fish,” he said. Some species are also used as bait for catching fish in the wild.

“We’re using an awful lot of these species for purposes other than feeding to aquacultured fish.” So the conversation, he said, should focus on more than just aquaculture.

Belle said many of the people opposed to the farming of fish call the fish carnivores, claiming that it’s an inefficient way to produce food. “Marine ecosystems are fundamentally different from terrestrial ecosystems – they are not based on seeds and grain; they are based on phytoplankton and then sequential carnivory,” he said. So the portrayal of fish as carnivores, likening aquaculture to farming tigers on land, is very misleading. But it’s gotten a lot of press, because “it’s a very catchy sound bite.” Of all fish meal globally, only 19 percent goes to salmon; most goes to farming in China.

The next question was in reference to Roheim’s presentation on the impacts of the 2004 report in the journal *Science* that detailed PCB levels in farm-raised versus wild salmon. Roheim explained that salmon farmed in northern Europe had some of the highest levels of PCBs. Most of the farmed salmon consumed in the United States is imported. The question to the panelists was, “Since the *Science* study, have fish farmers in northern Europe changed their fish feed?” Belle said they have. He said the salmon industry has been “horrible” at communicating to the public about how fish farming works, but the study caused farmers to re-examine how they were feeding their fish. Farmers have changed what they put in the feed and the methods of testing for contaminants, putting new accepted limits into feed contracts. He said a \$4.5 million contract in 2006 was voided because one of the ingredients went “over the threshold” that was stated in the contract.

The benefits of eating seafood such as salmon high in omega-3 fatty acids outweighs the negligible risks from an increase in saturated fats.

The questions turned to fatty acids. Thompson asked the panel whether there is a higher level of saturated fat in farm-raised fish because they are less active than those in the wild, and whether that matters for cardiac health. Santerre responded, saying that our understanding concerning the risks and benefits

of saturated fats “has gone through a revolution.”

Scientists have gone from believing that all fat is bad for you to eschewing just saturated fats, he said, and

now, they believe that some saturated fats may be less healthy while some others may be more neutral. But the benefits of eating both farm-raised and wild-caught salmon, particularly since they are excellent

“I think the enjoyment of seafood is still very, very important. We shouldn’t ignore the nutrition, we shouldn’t ignore the should still enjoy what we eat.”

sources of long-chain omega-3 fatty acids, outweighs the “negligible risks” from an increase in the saturated fats.

Thompson read a question concerning the cholesterol levels in fish and shellfish, whether they should be taken into account when assessing dietary value and whether certain fish varieties should be selected over others.

Santerre said, “First and foremost, people eat fish because they enjoy it, and that will always be the case.” He admitted loving the deep-fried shellfish of the New England coast, and he said it can be enjoyed as part of a balanced diet, while providing the benefits that seafood offers. “One food does not make the whole diet,”

In the future, more row crops like soybeans and corn will be produced that contain long-chain omega-3 fatty acids.

he said. While he doesn’t subscribe to the term “junk food,” many enjoyable foods can be a part of a healthy diet – “which is why I believe I can still eat my deep fried shellfish and still have a healthy diet. I think the enjoyment of seafood is still very, very important. We shouldn’t ignore the nutrition, we shouldn’t ignore the safety, but we should still enjoy what we eat.”

The next question concerned fish oil capsules: Can they be low in or free of mercury, and how can consumers assure they’re buying quality products? Santerre said mercury in fish oils is a negligible concern, because mercury is not a ‘fat-loving’ chemical – it binds to proteins. For that reason, fish oil capsules, he said, have “almost no measurable mercury.” In regards to quality assurance, Cohen said he had heard about a company (Martek Biosciences) producing omega-3 fatty acids that were not fish derived. Santerre expanded on that, saying that algae are being used to produce a supplement that contains the omega-3 fatty acid DHA. These supplements do not contain EPA. “I don’t believe that there are any health concerns from only obtaining

DHA since most of the studies look at EPA and DHA together,” he said. But he predicted that in the next 15 years, more row crops will be grown in our fields that produce long-chain omega-3s. “I think that’s a good thing when we can eat corn or soybeans and get these

healthy fats.” He also foresees higher levels of regulation of fish oil supplements in the near future. “The FDA is implementing Good Manufacturing Practices for dietary supplements,

which will improve the quality and consistency of these products.”

One question asked about the safety issues related to importing seafood from abroad and environmental issues related to “factory fishing.” Belle said his experi-

ence has allowed him to learn quite a bit about food safety law. “I can tell you firsthand, on the farming end of things, a lot of the stuff that goes on overseas is the bad stuff you hear. They’re not regulated on the same level as we are in the U.S.,” he said. Between 1 and 3% of the fish that enter the country is inspected by the FDA. He said importing any animal that has been exposed to compounds not allowed in the U.S. would be illegal. “I can tell you firsthand,” he said, “with a great deal of confidence, that there are literally hundreds of thousands of tons of animals being imported into this country that are grown or harvested in other places of the world that are repeatedly exposed to chemicals that are illegal to use in the U.S.” They’re not often tested, and suppliers can sometimes be tricky about working around the specified thresholds. He said it’s particularly concerning from a domestic supplier’s standpoint, because when the story hits the newsstands, domestic fish will be highly affected. He said domestic suppliers are working hard to help the FDA improve import inspections, and in the next two years, 600 new inspectors will be hired. But even then, the portion of imports being tested will probably be less than 20%.

The last question posed to the panelists was how educators could send the right messages to the public on “complex health and environmental issues.”

Thompson responded by saying that the mantra “keep it simple, stupid” is simply not working. The issues are complicated, she said, and those in outreach positions should try to enable the public to understand that. The messages should be as simple as they can be, and focusing on target groups and knowing the audience is essential. She said it is important to learn from the past,

If the public is given information in a way that makes sense to them, they will be more likely to understand its implications.

citing the FDA advisory: “That message was not a very good one. I think we’ve seen plenty of evidence that it didn’t do what we hoped it would do, and it actually may have caused more damage.” Testing the messages before releasing them could avoid this, and she suggested that some staff at the FDA who tested the mercury message and predicted its failure were apparently not heard or were overruled. “I think we have to start thinking of people as smart instead of stupid,” she said. “And I think we have to start empowering them with good information, but really understanding where they are.” Messages should be consumer-specific, targeting different groups with information in different ways – the media in particu-

Even with the addition of new inspectors in the near future, the portion of imported food being tested will probably be less than 20%.

lar, addressing where consumers might get confused and helping them take action.

La Valley said understanding your clientele is the most important part of getting a message out effectively. Experts should understand the target group’s knowledge base, and ask them how they want their information. “In terms of getting the message out,” he said, “you really have to understand who you’re giving the message to, and then ask that very real question, how do you want that information delivered to you?” If they’re given the information in a way that makes sense to them, they’re more likely to accept it, absorb it and understand its implications.

Cohen added that journalists might need to be better educated as well, saying there should be “an ongoing effort” to get members of the media to better

understand risk. He said it’s important to convey the message that everything is a tradeoff – there are risks, but they have to be weighed against the benefits. “If journalists can start to understand that nuance,” he

said, “then I think it will get to a better and, quite frankly,

Medical experts, nutritionists and other officials should reach out to the media to communicate their message proactively,

more realistic discussion of the issues.”

After all of the previously submitted questions were answered, additional questions from the floor were invited. One last question came directly from an audience member: “Is it better for the message to be ‘eat fish that are low in mercury,’ or is it better to say ‘avoid fish that are high in mercury?’” Thompson said the choice of words can make all the difference, and if the messages are framed positively, telling the population what to do instead of what not to do, it will help people to feel better about it. But before dispersing that information, she said, the method should always be tested on a target population first to ensure that the theories about its effects are correct. Having direct relationships with members of the media can have a strong impact as well – she said having contact early can give scientists the time to apply context to the message in a way journalists can better understand before reporting it to the public. Belle expanded on this, saying experts should go to the reporters instead of waiting for the reporters to come to them. Journalists have a tough job – communicating complicated issues to the general public is “wicked, wicked hard,” he said. If medical experts, nutritionists, scientists and other officials “reach out to that (media) community and begin to communicate proactively, I think it does a tremendous service to the public.”

Closing and Summary

Catherine Violette from UNH Cooperative Extension thanked the speakers for their participation in the conference and “for so generously sharing their research and expertise on these topics.” She thanked Rollie Barnaby and La Valley, her co-planners for the conference. She acknowledged Deb Stevens in the Rockingham County office and Jonathan Arnold for videotaping the conference. She announced that all the presenters had agreed to write a manuscript on the conference for a supplement in the March edition of the *Journal of Food Science*. She thanked members of the audience for attending.

The speakers who participated in “Seafood – Exploring Benefits and Risks” seemed to have one dominant message: Eat fish. Their studies show that

the health benefits exceed the risks by far, and for all Americans, including sensitive populations such as pregnant women, fish is an essential part of a healthy diet. But the seafood industry faces many challenges

Fish is an essential part of a healthy diet but there are many challenges in getting that message out to the public.

in getting that message out to the public effectively: Misguided information in the media and on the Internet, inadequate education on handling and preparing seafood, campaigns against aquaculture and confusion

and fear among the general population are all hindering the task of setting the record straight.

Researchers, health care providers and extension agents are faced with overcoming these obstacles. This means reaching out in new ways, trying new things and learning from past mistakes. It means closely considering how advisories and study reports in the future will be interpreted and what consequences they may have. It means

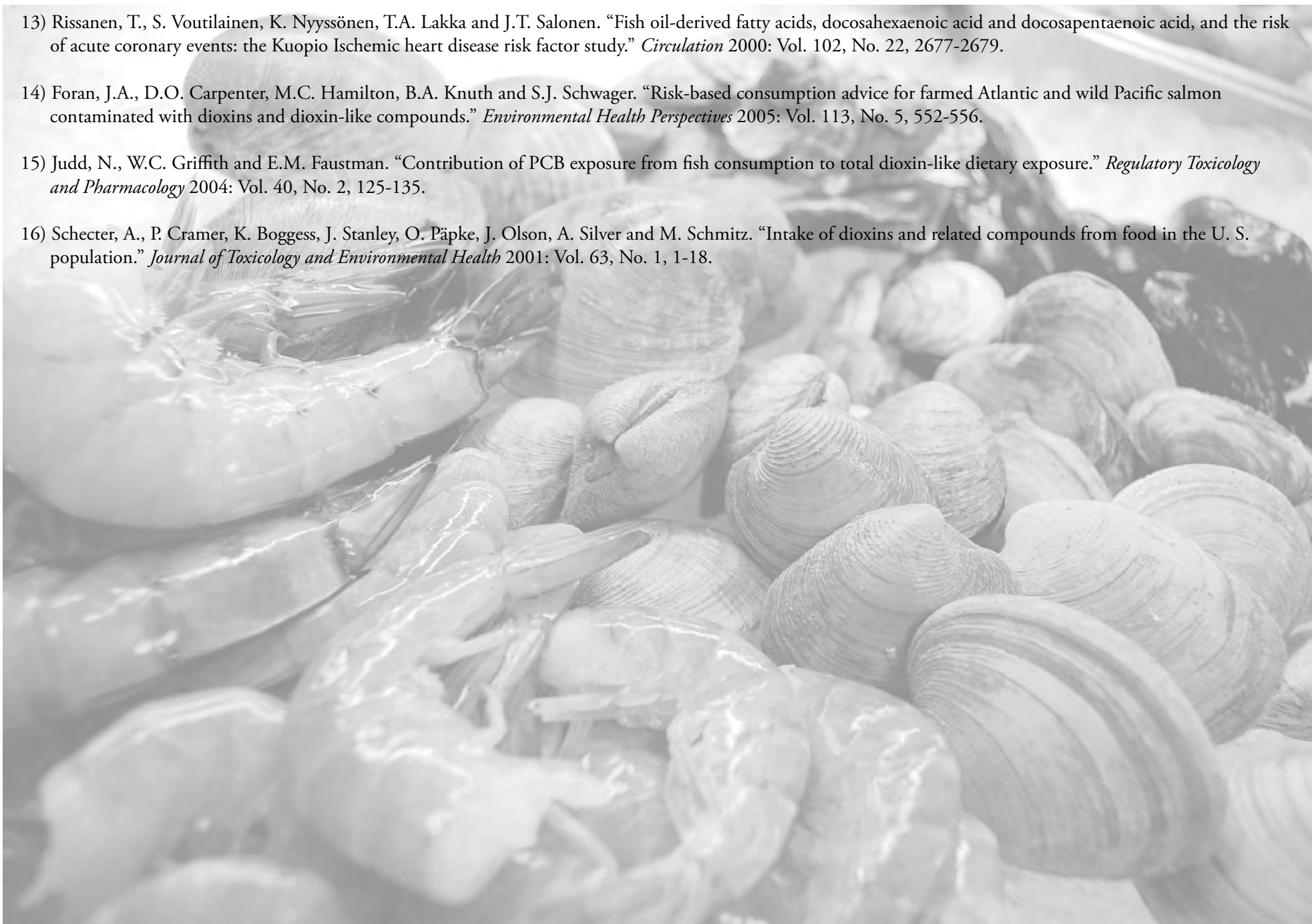
empowering journalists, so they understand the issues and can deliver them accurately and completely to the public. And it means empowering consumers, who need the tools to understand these complex issues and to weed through the vast amounts of biased or misconstrued information. The ultimate hope is that Americans will truly understand how eating fish can benefit their health – an achievement that would improve the quality of living in the U.S. and even save countless lives.



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Notes

