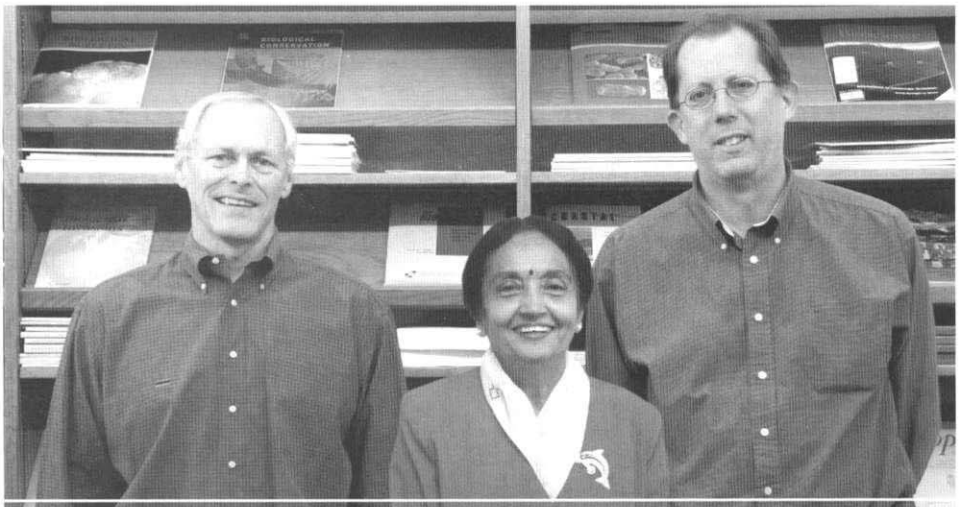
The Seafood "Dilemma"—A Way Forward



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Increasing seafood consumption will improve health and save lives. A study by the Harvard Center for Risk Analysis suggested that if every adult in the United States consumed 8 ounces of salmon per week, each year there would be 20,000 fewer deaths due to heart attack and 8,000 fewer strokes and stroke-related deaths. A Harvard meta-analysis of previous studies also concluded that the benefits of increased seafood consumption outweighed the added risks from contamination by two to three orders of magnitude (Mozaffarian and Rimm 2006). Another recent report from the National Institutes of Medicine (2007) provides further evidence for the numerous benefits associated with eating seafood, but also points out that certain fish and shellfish in specific locations can contain a variety of substances that pose health risks to various sub-populations. The nature of our seafood supply is changing. To meet the growing demand for seafood, there are more cultured products available and imports of seafood from foreign sources are increasing. Surveillance of these products is minimal, especially for compounds that are difficult or expensive to monitor. At the same time, risks, or perceptions of risk, are also changing because many coastal areas are subject to habitat degradation and contamination by chemicals and biological agents. People well versed in these issues realize that benefits and risks vary among types and sources of seafood; however, this complexity still results in considerable confusion on the part of the public about which seafood choices are appropriate given various risk factors. This confusion, which we call a "seafood dilemma," is believed to lead to less seafood consumption than is otherwise advisable and consistent with a healthy diet. Working in the field for over three decades, we feel compelled to offer suggestions to assuage this dilemma. In this commentary, we propose that a U.S. nationwide program is needed to analyze and evaluate seafood for beneficial properties, as well as harmful chemicals and pathogens, and to provide standardized and user-friendly information on the quality and safety of our nation's seafood supply. Such information will improve public understanding and confidence in the safety and quality of seafood, which will enhance human health and well being.

Benefits of seafood consumption

Fish are an important source of high quality protein and other essential nutrients, including omega-3 fatty acids that have a variety of benefits. Dozens of epidemiological studies show that consumption of fish, especially fatty cold-water species such as salmon, mackerel, sardines, and herring, protects against cardiovascular disease and promotes human brain development (Mozaffarian and Rimm 2006; Institute of Medicine 2007). Other studies suggest that eating fish can protect against some cancers, asthma, diabetes, rheumatoid arthritis and other inflammatory diseases, Alzheimer's disease, depression, and macular degeneration (Rose and Connolly 1999; Calder 2006; Hodge et al. 2006). The American Heart Association recommends that adults consume fish at least twice per week to protect against cardiovascular disease. The U.S. Department of Agriculture (USDA) recommends consuming fish (as well as nuts and vegetable oils) to maximize mono- and polyunsaturated fats in our diets (http://www.health.gov/dietaryguidelines/dga2005/document/). Our research center has been a pioneer in the identification of fish oils and their health benefits (Stansby 1967, 1990). We have first-hand experience in the challenges of communicating scientific information in the area of seafood safety (Brown et al. 1999, Hom et al. 1999). Despite the growing list of reports on the health benefits of seafood, there is a clear need to better predict and understand the pathways that lead to the health benefits from fish consumption. For example, there has been speculation that cultured fish, especially those raised on non marine-derived feedstocks, are markedly lower in beneficial fatty acids. We also do not know if consumption of shellfish confers similar health benefits as the consumption of fatty fish. It is also not certain which specific active components in seafood protect against various diseases. A great deal of evidence shows that the omega-3 fatty acids and eicosapentaenoic and docosahexaenoic acids (EPA; 20:5n-3, and DHA; 22:6n-3) are important in protecting us from cardiovascular disease, but supplements of these substances extracted from seafood may confer fewer health benefits than comparable levels contained in intact seafood rich in high quality protein. There is no federal guidance on the use of supplements, and it is believed that consumption of fish in the diet is the preferred recommendation.

Real and perceived risks of seafood consumption

In contrast to the benefits of fish consumption, there are also risks associated with the presence of chemical and biological contaminants in seafood. Depending on the species and area of capture, wild fish contain variable levels of chemical contaminants (e.g., mercury and organic compounds such as polychlorinated biphenyls [PCBs],

such as polychlorinated biphenyls [PCBs], dioxins, and polybrominated diphenyl ethers [PBDEs]). Mercury is arguably the most worrisome of the many chemical contaminants that can be found in fish. Mercury, and its biologically active form, methylmercury, are thought to be injurious to the developing human nervous system. Thus, while the Food and Drug Administration (FDA) and Environmental Protection Agency (EPA) acknowledge the importance of fish in the diet, these agencies also currently recommend limiting consumption of certain types of fish (shark, swordfish, king mackerel, tilefish) for women who are or might become pregnant, nursing mothers, and young children. In addition to its effect on the nervous system, methylmercury may also counteract the protective effects of omega-3 fatty acids on cardiovascular disease. There are also currently over 2,000 localized fish consumption advisories in the United States based on mercury contamination. Most of these are in fresh waters and thus are probably not significant contributors to the commercial seafood supply. However, even in these cases there is concern for populations who consume fish as subsistence or as part of recreational activities. There are half as many fish consumption advisories based on organic chemical contaminants.

Balancing Risks and Rewards

The meta-analysis conducted by Mozaffarian and Rimm (2006) concludes that for the many fish consumption studies they reviewed, the human health benefits for the population as a whole (measured as numbers of premature mortalities) exceeded the health risks (all factors combined) by two to three orders of magnitude. While these results are generally reassuring, there remain a number of risk factors related to particular species, locations, and human sub-populations (pregnant and nursing women, young children, and subsistence consumers).

Other potential risks associated with seafood consumption are the presence of pathogens (bacteria, viruses) or marine-derived algal toxins, especially in shellfish. Contamination of shellfish with pathogens and algal toxins is a continuing national problem that every year results in closures of beaches to harvesting and recalls or warnings about shellfish consumption. Although pathogens in shellfish can be neutralized by cooking, raw shellfish are a delicacy to many consumers, and are a culturally important part of the diet of many Native American tribal members. Moreover, algal toxins remain injurious even after cooking. The shellfish industry is well aware of these issues, and researchers are working on new technologies to reduce risks in both raw and cooked seafood.

In addition to contamination concerns, consumer confidence in the marketplace is being eroded by mislabeling or substitution of fish species (product fraud). The extent to which species substitution is occurring is unknown, but is feared to be widespread. New techniques of DNA-based species identification are promising avenues for truth in marketing and restoring consumer confidence (Marko et al. 2005).

Challenges and the need for a seafood safety assessment program

A crucial element that would help better educate the public is the provision of additional objective information on both benefits and risks of seafood in ways that consumers can easily understand. The United States currently lacks a systematic effort to collect and report such information in a user-friendly manner. This was evident following Hurricane Katrina when there was great concern about potential contamination of seafood from the northern Gulf of Mexico as a result of the pumping of floodwaters from the submerged city of New Orleans and the ebbing of the storm surge along the coasts of Louisiana, Mississippi, and Alabama. While there was unprecedented coordination among state and federal agencies in mounting a response and conducting analyses, three issues impaired the ability to clearly communicate information on seafood safety to the public once sampling and analyses were underway. The first of these was the lack of baseline, or pre-storm data. Levels of chemical contaminants in seafood from the affected region (Krahn et al. 2006) could only be compared to sparse, decade-old information from a now discontinued national fish surveillance project, described in McCain et al. (2000), and there were no pre-storm data on levels of pathogens. Secondly, there were disparities in methods, instrumentation, and quality assurance procedures among laboratories and agencies. Third, in some cases different agencies had widely different guidance or regulatory criteria.

Overall, we believe that the seafood dilemma faced by U.S. consumers of wild, imported, and domestically-cultured seafood is derived from the following gaps in data and policies:

1. The levels of beneficial substances in seafood are not well quantified across regions and across seafood sources (e.g., cultured vs. wild). Moreover, the mechanisms by which seafood confers health benefits and the specific attributes of seafood that are involved are not well understood.
2. There is insufficient current information on the levels of chemical contaminants and pathogens in seafood, and differences in sampling protocols and analytical methods make it difficult and sometimes impossible to make comparisons among the data that do exist.
3. Not all contaminants, even within a well-studied class such as PCBs, are equally toxic, and not all strains of a microbial species are equally pathogenic. Although there are recent advances in molecular techniques to differentiate pathogenic vs. nonpathogenic microbes, standard methods for analyses of both toxins and pathogens with the necessary detail are lacking. Moreover, new contaminants and pathogens are appearing in our marine waters, and methods to detect and report these substances are in many cases undeveloped. Accurate methods using cutting-edge technology will prevent unnecessary fishery closures and reduce the temporal and spatial extent of closures.
4. Regulatory criteria on allowable limits for consumption of contaminated seafood have not been developed for many substances, and when such criteria do exist they may be inconsistent among various federal and state environmental and health agencies.

Recommendations

We propose that a U.S. national seafood assessment program is needed that could provide better and more timely information to consumers and regulators. This program would directly address the seafood dilemma faced by U.S. consumers and should enhance the health benefits derived from increased seafood consumption, as well as public confidence in the seafood supply. This program would:

- Conduct a sustained monitoring effort that systematically collects representative samples of commercially and recreationally harvested fish and shellfish from the waters of the U.S., domestically cultured seafood, and imported wild and cultured seafood. The frequency of market surveillance should be increased to improve detection of banned and harmful substances and species substitutions.
- Develop consistent regulatory criteria among federal (e.g., EPA, FDA, USDA, and NOAA), state, and local regulatory agencies.
- Increase analytical capacity for pathogens, algal toxins, and chemical contaminants, both for known risks as well as emerging threats. Support more DNA-based species identification for detection

of this analytical capacity would be dedicated to ongoing analyses of substances and pathogens of concern, while some capacity would be used for methods development, standardization (including interlaboratory comparisons), and quality assurance.

- Develop analytical capacity to identify and quantify nutritionally beneficial components of fish and shellfish, including the omega-3 fatty acids. Most of this capacity would be dedicated to ongoing analyses of beneficial components of seafood, with some attention given to methods development and standardization. Close coordination with the public health community to better understand beneficial aspects of seafood consumption would greatly enhance this effort.
- Provide publicly available user-friendly data on the health benefits and risks associated with different species and sources of seafood. This database should also link to more technical syntheses of this information for health care providers, public health agencies, and regional environmental managers.
- Develop a seafood tracking system that would identify the source of seafood from catch waters to the end consumer (on the East Coast such a system is in place to track interstate movement of hard clams and other species).
- Routinely convene an external advisory panel constituted of representatives from the seafood and aquaculture industries, environmental interest groups, and the public health community to help set priorities, monitor progress and coordination among federal agencies with seafood safety programs, and communicate results.

A program such as this to deal with the complexities of the seafood dilemma will not be a trivial task. The potential benefit to public health and well-being, however, makes such an effort well worthwhile. ♋

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