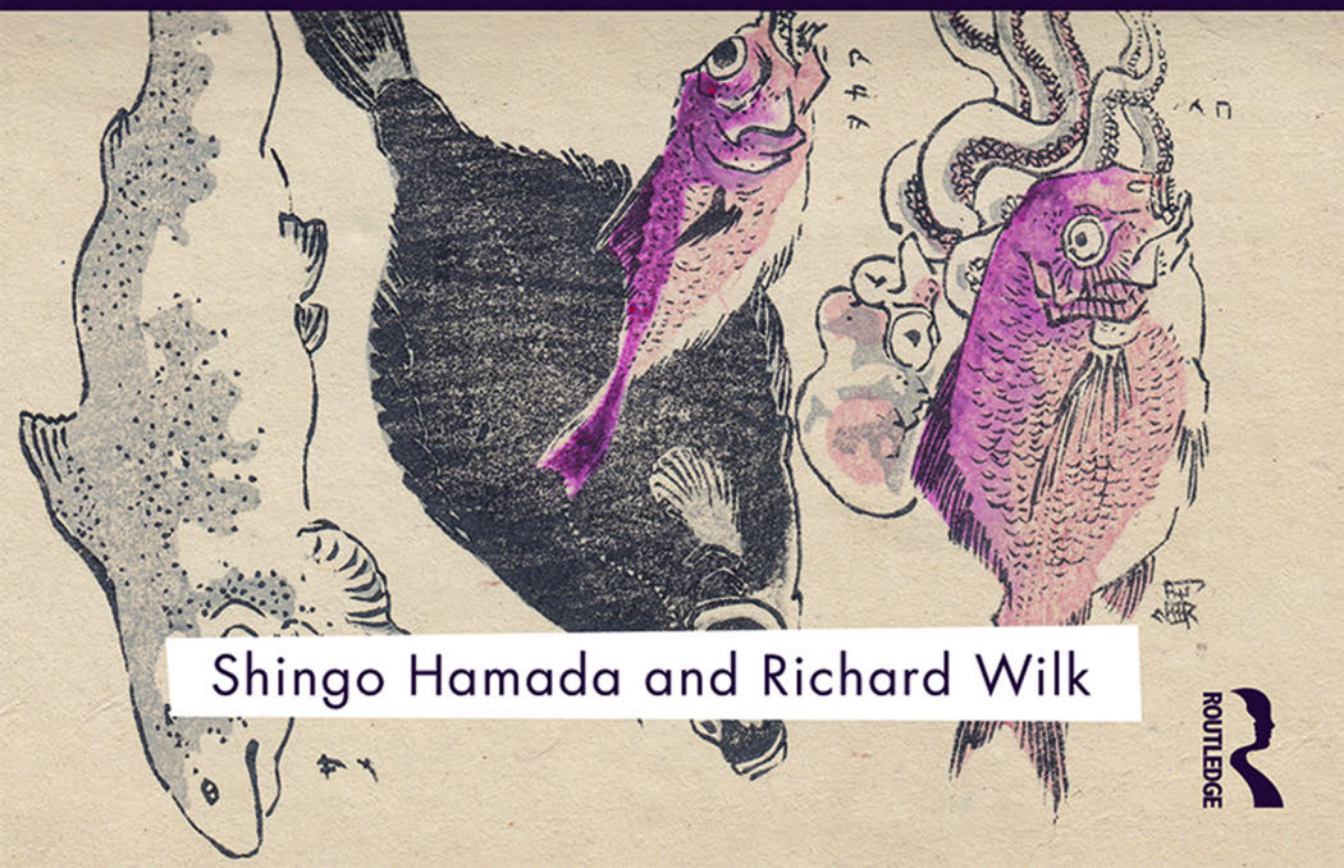
ROUTLEDGE SERIES FOR CREATIVE TEACHING AND LEARNING IN ANTHROPOLOGY

SEAFOOD

Ocean to the Plate



Shingo Hamada and Richard Wilk

ROUTLEDGE

SEAFOOD

Seafood draws on controversial themes in the interdisciplinary field of food studies, with case studies from different eras and geographic regions. Using familiar commodities, this accessible book will help students understand cutting-edge issues in sustainability and ask readers to think about the future of an industry that has lain waste to its own resources. Examining the practical aspects of fisheries and seafood leads the reader through discussions of the core elements of anthropological method and theory, and the book concludes with discussions of sustainable seafood and current efforts to save what is left of marine ecosystems. Students will be encouraged to think about their own seafood consumption through project assignments that challenge them to trace the commodity chains of the seafood on their own plates.

Seafood is an ideal book for courses on food and culture, economic anthropology, and the environment.

Shingo Hamada is Associate Professor of Food Studies at the Faculty of Liberal Arts, Osaka Shoin Women's University. His research revolves around the environmental history and cultural politics of seafood in coastal Japan, with a special focus on fermented seafoods and commoners' fish such as herring. He is the author of "The Future of Food Studies" in *Food, Culture & Society*, and "Gone with the Herring: Ainu Geographic Names and a Multiethnic History of Coastal Hokkaido" in *Canadian Journal of Native Studies*.

Richard Wilk is a Distinguished Professor and Provost's Professor Emeritus at Indiana University, and former president of the Society for Economic Anthropology. His publications include more than 160 papers and book chapters, and monographs including *Home Cooking in the Global Village: Caribbean Food from Buccaneers to Ecotourists*, which was the winner of the Society for Economic Anthropology Annual Book Prize 2008. He has collaborated with both domestic and international scholars for several edited volumes, such as *Fast Food/Slow Food: The Cultural Economy of the Global Food System* and *Rice and Beans: A Unique Dish in a Hundred Places* (co-edited with Livia Barbosa). He is also co-editing with Josiah Heyman the Globalization and the Environment book series from Altamira Press, and with Frank Trentmann the Consumption and Public Life series from Palgrave/Macmillan, and he has co-edited several textbooks and readers, including *The Environment in Anthropology: A Reader in Ecology, Culture, and Sustainable Living* (co-edited with Nora Haenn), and *The Anthropology of Media: A Reader* (co-edited with Kelly Askew). His textbook co-written with Lisa Cliggett, *Economies and Cultures*, is in its second edition and has been translated into six languages.

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Editors: Richard H. Robbins, SUNY Plattsburgh and
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This series is dedicated to innovative, unconventional ways to connect undergraduate students and their lived concerns about our social world to the power of social science ideas and evidence. We seek to publish titles that use anthropology to help students understand how they benefit from exposing their own lives and activities to the power of anthropological thought and analysis. Our goal is to help spark social science imaginations and, in doing so, open new avenues for meaningful thought and action.

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SEAFOOD

Ocean to the Plate

Shingo Hamada and Richard Wilk

Routledge
Taylor & Francis Group
NEW YORK AND LONDON

First published 2019
by Routledge
711 Third Avenue, New York, NY 10017

and by Routledge
2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

Routledge is an imprint of the Taylor & Francis Group, an informa business

Library of Congress Cataloging-in-Publication Data
Names: Wilk, Richard R., author. | Hamada, Shingo, author.
Title: Seafood : ocean to the plate / Richard Wilk and Shingo Hamada.
Description: New York : Routledge, 2018. | Includes bibliographical references and index.
Identifiers: LCCN 2018015291 (print) | LCCN 2018029401 (ebook) | ISBN 9781315640259 (Master ebook) | ISBN 9781317276463 (Web pdf) | ISBN 9781317276456 (ePub) | ISBN 9781317276449 (Mobipocket) | ISBN 9781138191860 (hardback) | ISBN 9781138191877 (pbk.)
Subjects: LCSH: Fish as food. | Seafood—Health aspects. | Environmental protection—Moral and ethical aspects.
Classification: LCC TX385 (ebook) | LCC TX385 .W55 2018 (print) | DDC 641.3/92—dc23
LC record available at https://lccn.loc.gov/2018015291

ISBN: 978-1-138-19186-0 (hbk)
ISBN: 978-1-138-19187-7 (pbk)
ISBN: 978-1-315-64025-9 (ebk)

Typeset in New Baskerville
by Apex CoVantage, LLC

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SERIES FOREWORD

The premise of these short books on the *Anthropology of Stuff* is that stuff talks, that written into the biographies of everyday items of our lives—coffee, T-shirts, computers, iPods, flowers, drugs, and so forth—are the stories that make us who we are and that make the world the way it is. From their beginnings, each item bears the signature of the people who extracted, manufactured, picked, caught, assembled, packaged, delivered, purchased, and disposed of it. And in our modern market-driven societies, our lives are dominated by the pursuit of stuff.

Examining stuff is also an excellent way to teach and learn about what is exciting and insightful about anthropological and sociological ways of knowing. Students, as with virtually all of us, can relate to stuff, while at the same time discovering through these books that it can provide new and fascinating ways of looking at the world.

Stuff, or commodities and things, are central, of course, to all societies, to one extent or another. Whether it is yams, necklaces, horses, cattle, or shells, the acquisition, accumulation, and exchange of things is central to the identities and relationships that tie people together and drive their behavior. But never, before now, has the craving for stuff reached the level it has, and never before have so many people been trying to convince each other that acquiring more stuff is what they most want to do. As a consequence, the creation, consumption, and disposal of stuff now threaten the planet itself. Yet to stop or even slow down the manufacture and accumulation of stuff would threaten the viability of our economy, on which our society is built.

This raises various questions. For example, what impact does the compulsion to acquire stuff have on our economic, social, and political well-being, as well as on our environment? How do we come to believe that there are certain things that we must have? How do we come to value some commodities or form of commodities above others? How have we managed to create commodity chains that link peasant farmers in Colombia or gold miners in Angola to wealthy residents of New York or teenagers in Nebraska? Who comes up with the ideas for stuff and how do they translate those ideas into things for people to buy? Why do we sometimes consume stuff that is not very good for us? These short books examine such questions and more.

ACKNOWLEDGMENTS

This book could not have come about without invaluable help from many people. First of all, we appreciate the patience, trust, and the editorial professionalism of Erik Zimmerman, Athena Bryan, and Samantha Barbaro at Routledge over a period that extended further than they expected.

We thank students in the class "Fish and Ships: An Anthropology of Seafood," which Hamada designed and taught in 2013 at Indiana University (IU). The fact that Hamada could not find an accessible textbook that overviews the history, politics, and culture of seafood led directly to his getting this book underway and recruiting Wilk as a co-author. And here we have it, thanks to the creativity and vision of Richard Robbins and Luis Vivanco, editors for the Routledge Series for Creative Teaching and Learning in Anthropology.

At Indiana, Lillian Brown helped us start this book project, and Dr. Leigh Bush gave invaluable help with research at a crucial time. Hamada appreciates the IU Department of Anthropology for giving him access to library resources while he lives and works in Japan. We both cannot thank Kendra Obermaier enough for her superb editorial work and research in finalizing the manuscript. Ryo Nakamura generously provided us with his research, the story of Kilwa seafood culture, and his pictures. Patricia Clay helped keep us up with marine resource management, although she cannot be blamed for what we did with her help.

Hamada also wants to express gratitude to Al Wilson, Harvey Kitka, and the Sitka Tlingit people who shared their herring stories, and for their sensible practice of stewardship, showing us how environmental, social, and culinary sustainability can be achieved across the North Pacific. Many thanks also go to Masami Yoshigaura, Sei'ichi Hamano, Seiji Takada, Masahiro Katsuragawa, Yuji Ikeda, and Norio Shirafuji for their support for Hamada's fieldwork in eastern Hokkaido. Hamada also wants to express special thanks to Soichiro Kusaka, Takanori Oishi, and Mari Takehara for their encouragement during his time at the Research Institute for Humanity and Nature.

A generous Fulbright grant and funding from Indiana University allowed Wilk to pursue his seafood interests in Singapore in 2017. At Tembusu College of the National University of Singapore, Dr. Liz Chee Pui Yee provided invaluable help and inspiration for Wilk's research while co-teaching a memorable class on seafood consumption in Singapore. Wilk is also grateful to Professors Tommy Koh and Gregory Clancey for facilitating his research in Singapore, and to Foo Junhong for handling endless paperwork with such cheerful competence. He finds it impossible to thank most of the people he has been fishing, clamming, and oyster picking with over sixty years, but he does want to give special mention to Orvar Löfgren, Stewart Krohn, Paul Jamison, Robert Price, and the late Kim Kennedy for many hours of shared research on what was hiding under the water. The residents of Crooked Tree Village in Belize deserve a shout-out too, especially Glenn Crawford who kept taking Wilk out until they finally caught that tarpon. He also appreciates his late parents, Max and Barbara Wilk, and the love of his life Anne Pyburn, for tolerating and indulging his obsession with fishing over many years.

Support from Wilk's and Hamada's families were the foundation upon which this book was designed and built. Anne, Elvia, and Natsuyo have shared a lot of seafood—and talk about seafood—with us in the United States, Japan, Singapore, France, Sweden, Belize, and many other places.

Finally, this book is dedicated to the memory of Archie, a more-than-human friend who taught us that seafood is not just for humans.

PROLOGUE

Why Study Seafood?

This book is based on the idea that there is something special about foods that come from the sea. As land animals we often forget that about 71 percent of the Earth's surface is covered by water, which makes aquatic life invisible to most of us. Yet there is something very attractive about the shore: about half of the global population lives within 3 km of a body of water, and in the United States, about 39 percent of the population lives near a coast (USDC n.d.; Kummu et al. 2011). When our ancestors first began to spread across the planet about 200,000 to 300,000 years ago, water proved no obstacle, as we colonized oceans full of islands, some of them separated by thousands of kilometers of open sea. Seafood has been a significant part of the human diet for a very long time.

Food is not the only ocean product that was crucial in human history. We need salt in our diet in order to survive, and the ocean was the only source of salt in many parts of the world. Long-distance trading of salt was one of the earliest forms of commerce. Seashells were the very first jewelry. Shell necklaces were buried with the dead 80,000–100,000 years ago by the earliest *Homo sapiens* and our close relatives the Neanderthals. Cowrie shells from the Indian Ocean were the first widely accepted money, enabling the first long-distance trade. The products of the ocean also provided necessary trace elements like iodine that we must have in our diets.

The amount of seafood eaten in different parts of the world varies widely over time and space. In the United States, annual seafood consumption has very slowly grown from 13 kg to 22 kg per person during the last fifty years. Still, today most Americans cannot name more than three or four kinds of fish that they often eat (Menon 2009). Most of what they do eat comes out of a can or is hidden beneath a deep fried crust. In contrast, the average Chinese eats 34 kg, preferring fresh whole fish on their plates. The Japanese eat about 49 kg per year of more than 100 different species of fish and shellfish, as well as a good deal of seaweed. Iceland, surrounded by water and unable to grow any crops on land, is impressive at about 92 kg of seafood, so each person is eating more than their weight of ocean products every year. The average annual consumption

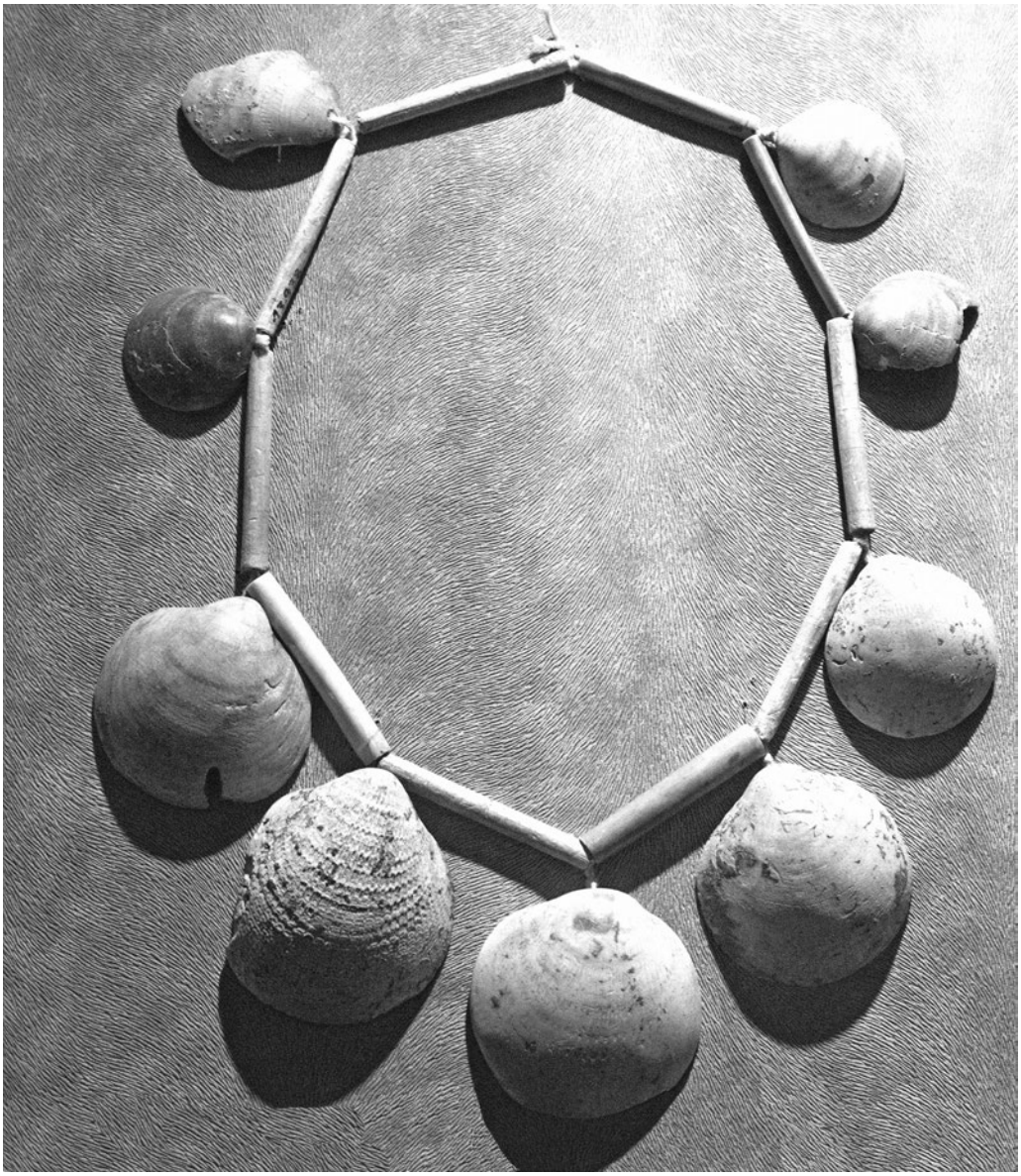

Figure 0.1 **Prehistoric shell necklace made of river mussels from the Czech Republic, about 4000 BC** (Photo: Zde/Prehistor, from the City of Prague Museum)

in the tiny Maldives Islands reaches 185 kg! (all data for 2013, https://ourworldindata.org). In each place, seafood has a different place in culinary traditions, so they can be prepared in a dazzling variety of recipes.

It is not hard to find seafood cookbooks, or work in the new and rapidly growing world of interdisciplinary food studies that discusses fish and seafood. There is also a huge amount of writing and research on fishing, the biology of fish, and the aquatic environment. But we have found very little that makes a

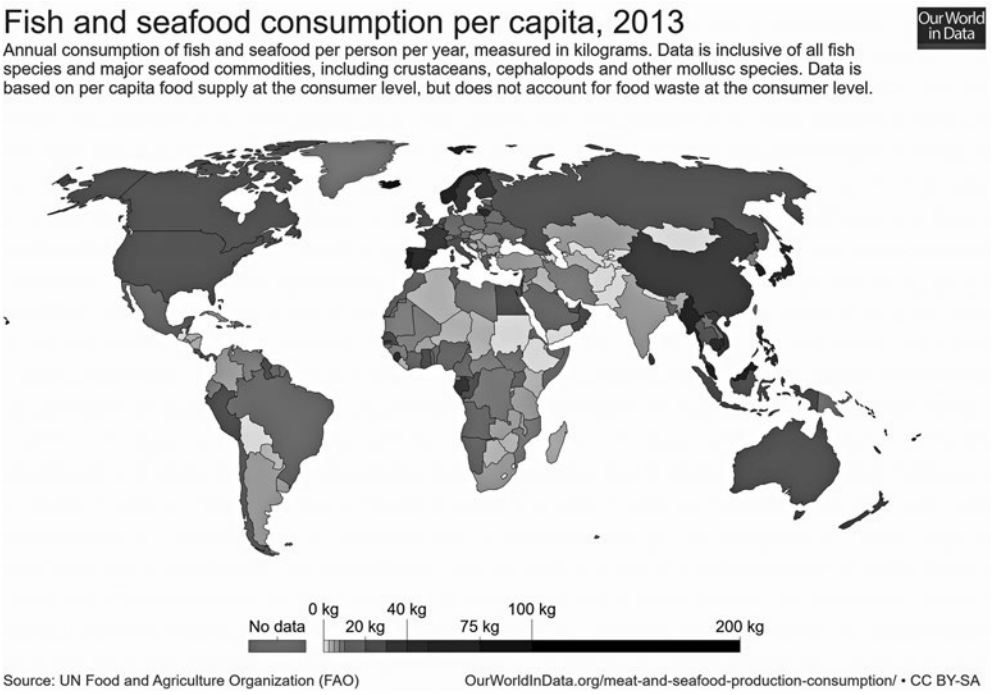

Figure 0.2 **Map showing fish and seafood consumption per capita** (Source: With permission from http://ourworldindata.org)

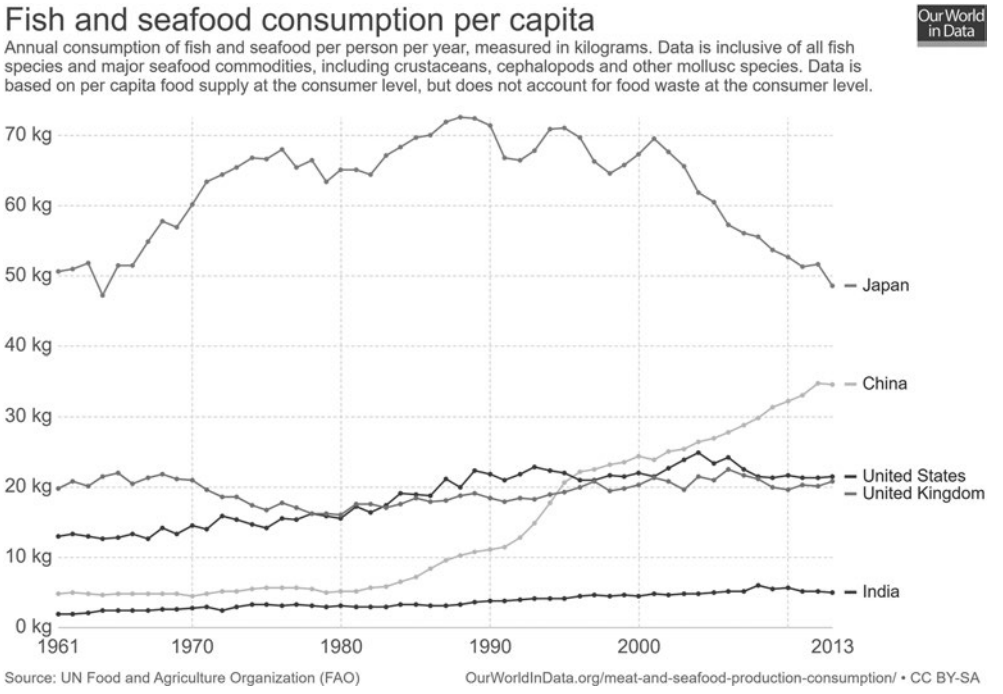

Figure 0.3 **Chart showing fish and seafood consumption per capita for five major countries** (Source: With permission from http://ourworldindata.org)

clear connection between the seafood we eat, the way it is produced, and how it gets there. That is our goal in this book, with a breadth and scope that draws on disciplines as diverse as microbiology and religious studies. We focus most broadly on the history of human relationships with the sea, the connection of seafood with human cultures and beliefs, and the difficult task of taking food from the oceans without destroying their source. With examples from past and present, we uncover the complex commodity chains that connect the marine environment, fishing communities, and the global economy with your dinner table.

Our goals are shared with the other volumes in this book series, the *Anthropology of Stuff*, edited by Richard Robbins and Luis A. Vivanco. The series is in turn a part of a broader project, the Routledge Series for Creative Teaching and Learning in Anthropology, which aims to develop new ways to teach the relevance of anthropology to the issues that shape our lives today. We join a group of innovative short texts with topics ranging from Lycra to milk. Each uses an example of the material stuff that furnishes everyday life as an entry into understanding serious problems that threaten our increasingly interconnected world.

Sometimes we can see a whole world in a single glass of milk, a chocolate bar, or a heaping plate of fried shrimp. And sometimes also, we can find good examples of the kinds of strategies and actions that minimize or solve problems, while we also explain how and why those problems got started. This is the power of anthropology: to cross the boundaries of contemporary disciplines in order to draw connections through time, across oceans and continents to find innovative solutions to serious problems.

This book series is definitely not the stereotypical twentieth-century anthropology, which was so preoccupied with tribal and traditional cultures, watching tiny bits of the world like a voyeur through a window. Today we recognize that all forms of research and learning have a form of politics, just in the choice of what to study and how to communicate what we learn. Anthropology today also recognizes that we are material people living in a material world, that all our cultures are consumer cultures in that while we design and make artifacts, those artifacts also make us who we are. And like all the books in this series, we are devoted to the craft of explaining a complex world without using complex language, avoiding the specialized jargon that anthropologists and other scientists use to converse with each other. Like the other authors in this series, we follow the dictum of the writer George Orwell, who said that clear writing comes from clear thinking, and that there is nothing so difficult or complicated that it cannot be explained with clear language.

Scope of the Work

Humans get food from all kinds of waters, from tiny alpine lakes to the vastness of the open ocean. Many fish migrate long distances, and during their lives they may move through brackish, salty, and fresh waters; some even live in the permanent darkness of deep caves or walk across dry land. This makes it hard to find firm boundaries around the concept of *seafood*. In this book we use the term very loosely to mean "anything humans eat that comes from any kind of water." Most of the book, however, is about fish, the most abundant and widely consumed form of seafood. We take our examples from all over the world, but our choice also reflects on the fact that one of us (Hamada) works mainly in Japan, and the other (Wilk) in the United States and Caribbean. We also bring different skills and interests to this work: Hamada has done field research in fishing communities and studies fisheries management and conservation; Wilk, besides being a lifelong fisherman, brings his experience researching and writing about globalization and the anthropology of food.

We have made every effort to make this text readable without requiring a lot of prior knowledge about seafood, nutrition, or fishing. For this reason we use the common names for marine organisms, but give the scientific names in a separate glossary. We have given bibliographic information for the most important and specific resources we have drawn upon, but have not referenced every general statement, fact, and figure; they are based on verified information publicly available online.

Chapter 1 overviews the nutritional benefits and risks of seafood consumption, while Chapter 2 explores the prehistory and environmental history of seafood, looking at how fishing and other uses have shaped the oceans we see today. Large-scale industrial fisheries have had a major impact on sea life, and Chapter 3 discusses the ways that small and artisanal fishing communities have found to manage communal seafood resources in a sustainable way. Chapter 4 discusses how technologies and techniques of seafood production have developed, and the expansion and globalization of the seafood industry. In Chapter 5, we examine the relationship between production and consumption, the growth of aquaculture, and the ways that taste and culture shape and are shaped by the local marine environments. Chapter 6 covers the importance of taste and culture in the demand for different kinds of seafood and ocean products, showing how taste is closely related to problems of sustainability. Chapter 7 questions the ethical issues related to consuming sea life and discusses some of the ways that religious beliefs affect the things people eat. Chapter 8 discusses the prospects and limitations of using eco-labeling for making seafood production and consumption more sustainable. We include a short postscript

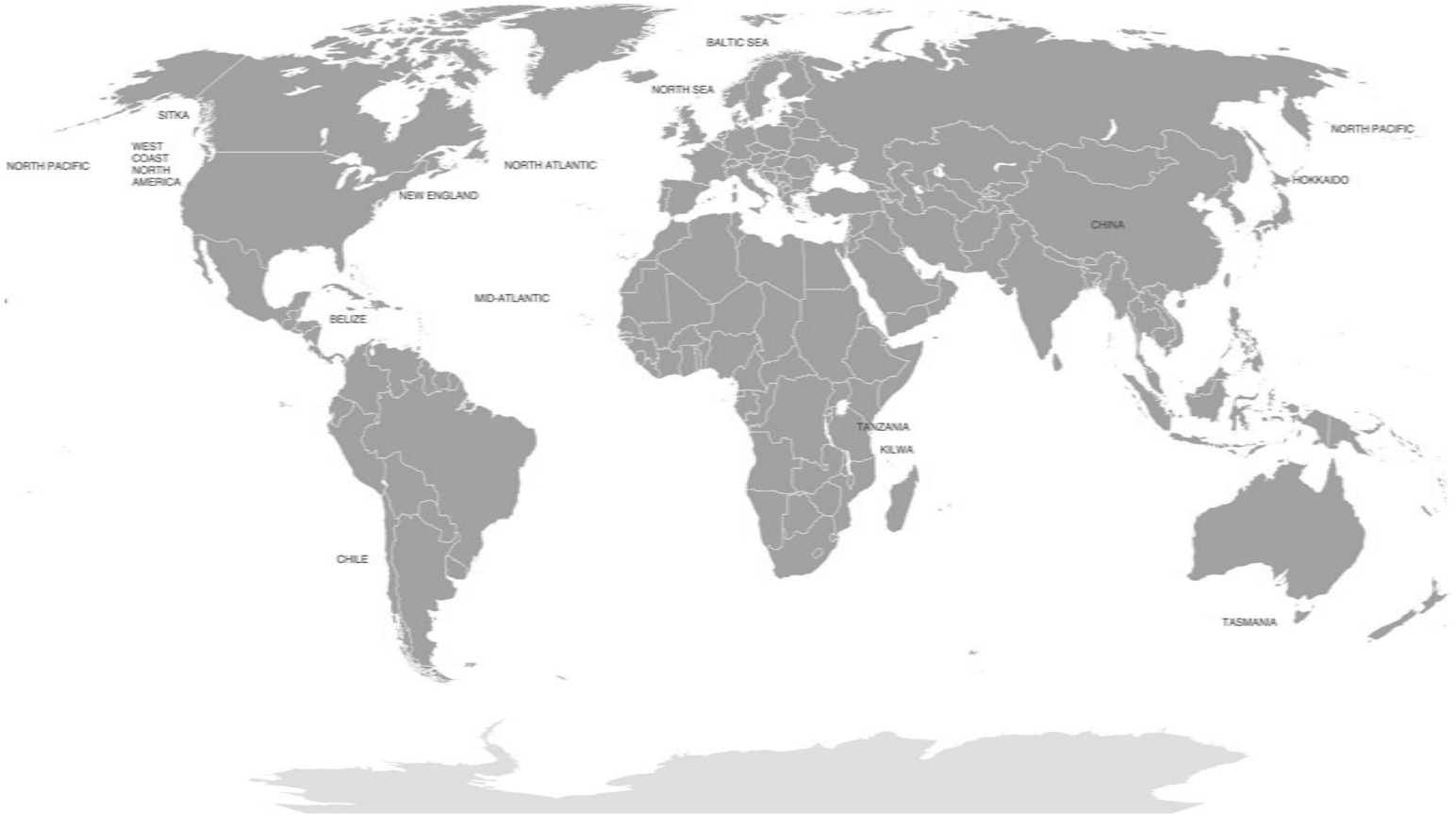

Figure 0.4 **World Map showing locations mentioned in the text** (Source: Wikimedia commons)

with some advice about cooking and preparing fish, followed by a glossary of fish names.

There is still a great deal that we don't know about seafood and sea life, although new technologies and techniques are providing new information at an accelerating rate. We do know that our species has had a poor record as a steward of nature, and we are destroying aquatic environments even more quickly than we are learning new things about them. Overfishing is just one problem; the oceans are suffering from oil and mineral exploration, pollution with a long list of chemicals and plastics, and abuses connected with warfare and conflict. Global climate change is perhaps the greatest danger both to sea life and the people who depend upon it for a living, and we are only now beginning to understand how rapidly and drastically the oceans are changing. We hope this book will spur readers to seek more information and find out how to help move the world toward a more sustainable relationship with sea life, not just by changing their own consumption, but also through the public and political actions that constitute positive citizenship.

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1

FISH AS FOOD

Health and Danger

Is seafood good for you? Most people have heard that countries where they eat a lot of fish, like Japan, have much lower rates of heart disease, and many of us have heard that seafood is rich in omega-3 fatty acids, which promotes health. Hamada and his family usually eat slow-cooked sardines once a week because of their health benefits and their reasonable price. The health benefits of seafood are well-known, but on the other hand, we also hear health warnings about the dangers of consuming too much tuna or other fish that can contain dangerous amounts of mercury or other pollutants. In some parts of the world, but particularly the tropics, some species of fish and shellfish can accumulate natural toxins and become dangerously poisonous.

In Indiana, where Wilk lives, when you buy a fishing license you also get a pamphlet that lists polluted rivers and lakes, the species that have unsafe levels of polychlorinated biphenyls (PCBs) and/or mercury, and suggested limits on how many fish can be eaten safely each month by children, pregnant women, and other adults. This hardly inspires confidence, and it begs the question of whether the benefits of eating fish are outweighed by the hazards. The fear inspired by health warnings like this explain why so many people seem to prefer taking fish oil capsules instead of eating more fish.

Scientifically speaking, each fish species has a different set of nutritional values: some are high in fat, others provide more trace elements like iodine and selenium, and they vary widely in their caloric value. In general, filter feeders and small fish low on the food chain—those that eat algae and tiny plankton—have less fat containing pollutants. Larger, predatory fish are more likely to contain pollutants that they accumulate from the many smaller fish they eat. However, the actual nutrient and pollutant content of any particular fish depends on its age and specific life history, the environments it lives in and moves between, the season, and how the fish is treated after it is caught and before it is eaten.

Regardless of benefits or dangers, billions of people rely on fish and other seafood as an essential part of their daily diet, and for many of them, catching and selling seafood is their livelihood. Fish accounts for approximately

17 percent of animal protein intake globally (Thilsted et al. 2014), and it is a regular part of the diet of more than one billion people (Tacon and Metian 2009). The importance of fish as a vital source of nutrition tends to be higher in developing countries than in industrialized nations.

The Good News

In the 1970s, Danish scientists found that the Greenlandic Inuit, who consumed large amounts of seal, whale, and fish, had extremely low rates of death from heart diseases (Bang et al. 1980). Similar studies of countries with high levels of seafood consumption followed, affecting scientists and policymakers in the US and other countries where heart disease had become the number one cause of death among adults. The 1977 McGovern Report recommended that US citizens decrease their consumption of meat, particularly fatty red meats, and increase their consumption of poultry and fish. Seafood consumption supplies us with animal proteins, essential fats, minerals, and vitamins.

Indigenous people who have lived in the same environment for thousands of years have developed techniques to maximize the nutrition they get from their catch. The Ainu, the indigenous people of northern Japan, use every part of a salmon from head to tail. *Citatap*, one of their traditional foods, is a chopped mixture of the head, intestines, gills, and milt (sperm), seasoned and preserved with salt (Iwasaki-Goodman et al. 2009). The head, skin, bones, viscera, and even scales of fish, although they are considered waste and thrown away in much of the developed world, are actually the parts that are highest in micronutrients such as iodine, selenium, zinc, calcium, potassium, and vitamins (FAO 2011). Some kinds of cooking, fermentation, and pickling can make these nutrients more available and digestible, or reduce the content dramatically.

According to the US National Institutes of Health (NIH), "seafood consumption is associated with potential health benefits, including neurologic development during gestation and infancy and reduced risk of heart disease" (Iwamoto et al. 2010). The United Nations Food and Agriculture Organization (FAO 2016b) calls fish "nature's super food" for its nutritional components. In the 1950s Ralph T. Holman, a researcher at the Hormel Institute, a research division of the Hormel Food Corporation, coined the terms *omega-3s* and *omega-6s* for the essential fatty acids in foods (Holman 1998). Fish oil is widely available in many forms as a dietary supplement. Long-chain omega-3 fatty acids—*docosahexaenoic acid* (DHA) and *eicosapentaenoic acid* (EPA)—are particularly valued as nutrients essential for optimal neurodevelopment in infants and young children. Fatty dark-fleshed fish like herring and mackerel have much higher content of omega-3 fatty acids, while lean white-fleshed fish like mahi-mahi or barracuda have much less. Paradoxically however, fish with a lot of body fat are also the

most likely to accumulate toxins and heavy metals, and diners are often warned to remove all the fat from fish caught in polluted waters. Dietary guidelines from the US Food and Drug Administration (FDA) suggest eating two or three fish meals per week, preferably fatty fish, to improve cardiovascular health and reduce the risk of coronary heart disease (Gebauer et al. 2006).

It is worth remembering the limits of nutritional science. Traditional folklore in Europe recommended fish as "brain food," and similar recommendations can be found in many other cultures. Over the last few decades, nutritionists and public health advocates have claimed to find many different positive effects of fish consumption in human diets, creating a long list of diseases and ailments that can be prevented by eating more fish, including Alzheimer's disease and other dementias, strokes, metabolic syndrome, obesity, diabetes, asthma, and deteriorating vision. Some even claim that eating more fish can cure your acne, help you avoid arthritis, lower the risk of cancer, speed up your metabolism, increase your concentration and attention span, improve your sleep, keep you from getting depressed, and make you a generally happier person (Morris et al. 2003; Baik et al. 2010).

We should remember, however, that most of the studies that these recommendations are based upon are weak and are at best indicative rather than conclusive. They generally measure the fish consumption of a sample of people, and then compare this with the incidence of different diseases. This is the standard method in nutritional epidemiology, and it is full of potential flaws, so it can be very misleading.

First, they rarely directly measure how much fish or seafood a person is eating; instead they depend on self-reporting, which can be very unreliable. Most people cannot recall everything they ate during the past week or even month with any accuracy, and they are notoriously unreliable in reporting how much they eat.

Second, the actual group of people being studied is often small and/or biased. A study may enroll people who are quite unusual and atypical, and they are rarely representative of the ethnic and gender diversity of an entire population.

Third, most nutritional studies report only correlations, meaning that when you see one thing you also tend to see something else more often than you would find by chance. One of the most basic flaws in all social science research is confusing correlation and causation; just because two things co-occur does not mean that one causes the other. For example, people who live near the ocean could be richer than average, and while they eat more fish than people living inland, they may be healthier because they have better access to medical care, less strenuous work, or any number of other factors. They eat more fish,

but they probably also drink more red wine and fresh fruits and vegetables and have time to go to the gym and exercise.

While this science about nutrition and seafood is complicated, the actual claims in reliable studies are modest, and the results are carefully stated and qualified, but when those scientific results make their way into the popular press they are often distorted and exaggerated to a ridiculous degree. For example, the US Agency for Healthcare Research and Quality (AHRQ) put together a panel of scientists to review many studies of the effects of ingesting omega-3 fatty acids on diseases of the eyes (Hodge et al. 2005). They conclude that there is no clear evidence one way or the other, because while some studies showed positive effects, others were neutral or negative, and all the studies had flaws that made their results questionable.

Yet, the "Eat This, Not That" website, in an article called "20 Reasons You Should Be Eating More Fish," cites this very study as saying "*omega-3 fatty acids are beneficial to improving vision and eye health. This is because the brain and eyes are heavily concentrated in omega-3 fatty acids and need them to maintain their health and function, according to the AHRQ's findings*" (Hussein 2017, emphasis added). Besides the straightforward falsehood about the results of the study, the explanation makes no sense at all—just because you have a lot of fatty acids in your brain and eyes does not mean that eating fatty acids is good for your brain and eyes! You also have tiny hairs in your ears—does that mean eating hair is good for your hearing? This is perfectly ordinary and straightforward magical thinking, but it is not science or logic. It is not the kind of evidence you would want in order to start an expensive habit—and Americans spend more than $1 billion a year on fish oil.

Recently several studies have shown the negative side of omega-3 and fish oil supplements. Some research connects high levels of omega-3 in the blood with the most aggressive forms of prostate cancer, although there was also a small reduction in the total incidence of prostate cancer (Brasky et al. 2013). Doctors do prescribe fish oil supplements for people with high blood triglyceride levels, but if you do not have that condition, you could be much better off spending money on something else.

Remember also that there is a huge difference between *preventative* and *curative* medicine. When you have a specific illness and get a prescription remedy, you are being cured. But when you take vitamin D so you will grow up with strong bones and avoid osteoporosis in your elder years, this is a preventative. As you can imagine, it is easy to track the results of a cure, but it is often very difficult to tell whether or not preventative medicine is working unless you are testing vaccines in the midst of an epidemic. It is hard to tell if you got osteoporosis at sixty because you did not drink enough milk when you

were five. The disease could be caused by something else, and who accurately remembers what they consumed as a child? This is why you should always ask questions when you are told to buy and consume some supplement or food because it will prevent an illness, keep you trim, or give you muscles of steel and the eyesight of an eagle.

The Bad News

Knowing exactly when and where seafood is caught is important. Polluted or damaged environments can turn healthy seafood into something untouchable. The disaster of Fukushima Daiichi Nuclear Power Plant caused by the huge Japanese tsunami in 2011 led to widespread contamination of fish with radionuclides. This is information any Japanese food shopper would want to know. US nuclear bomb testing in the Marshall Islands in the 1950s continues to make many local fish there dangerous to eat (Johnston and Barker 2008).

Just like people, every fish is really an ecosystem populated by microbes, viruses, and often parasites. And just like people, fish can get sick: it is not unusual to catch fish infested with sea lice and worms, with various deformities, or with fins and eyes damaged by fungal infections.

Table 1.1 **List of common diseases from eating fish and shellfish**

Category and Common Name	*Cause or toxin*	*Region*	*Common carrying commercial species*
MARINE TOXINS			
CIGUATERA FISH POISONING (CFP)	Dinoflagellates (*Gambierdiscus toxicus*) attached to algae blooming	Warmer (tropical and subtropical reef) waters	Older, larger fish (grouper, barracudas, snapper, jack, mackerel, triggerfish, shark, etc.)
SCOMBROID	High levels of histamine released from fish infected by bacteria when not properly and timely refrigerated	Temperate and tropical waters	Tuna, mahi-mahi, mackerel, marlin, bluefish, amberjack, and abalone
SHELLFISH POISONING	Dinoflagellates in algal blooms	Temperate waters	Filter-feeding bivalve mollusks, gastropod mollusks (abalone, whelks, and moon snails), crustaceans (crabs, shrimp, and lobsters)

(*Continued*)

Table 1.1 **Continued**

Category and Common Name	*Cause or toxin*	*Region*	*Common carrying commercial species*
-Paralytic shellfish poisoning (PSP)	Dinoflagellates, diatoms, cyanobacteria (*Alexandrium catenella, A. tamarense, A. fundyense*)	Subarctic, temperate (the Pacific and Atlantic coasts of North America), tropical	Bivalve mollusks (mussels, clams, oysters, scallops)
-Neurotoxic shellfish poisoning (NSP)	Dinoflagellate *K. brevis*	Southeastern coast of the United States, the Gulf of Mexico, the Caribbean, and New Zealand	Shellfish
-Diarrheic shellfish poisoning	Okadaic acid	Worldwide (China, Japan, Scandinavia, France, Belgium, Spain, Chile, Uruguay, Ireland, the United States, and Canada	Shellfish
AMNESIC SHELLFISH POISONING (ASP)	Domoic acid (diatom *Pseudonitzchia* spp.)	Canada, Scotland, Ireland, France, Belgium, Spain, Portugal, New Zealand, Australia, and Chile	Mussels, scallops, razor clams, crustaceans
FUGU (PUFFER FISH) POISONING	Tetrodotoxin	Indo-Pacific Ocean, also the Atlantic Ocean, Gulf of Mexico, and Gulf of California	Gonads, intestines, liver, and skin of approximately eighty species of puffer
PARASITES		Habitat	
Anisakiasis roundworm infection (herring worms, cod worms)	Nematode worms	All saltwater	Marine fish (herring, cod, plaice, halibut, rockfish, pollock, sea bass, flounder, Pacific saury)
Tapeworm infection	*Diphyllobothrium*	Freshwater and anadromous fish	Trout, salmon, pike, perch, some others

Category and Common Name	*Cause or toxin*	*Region*	*Common carrying commercial species*
MICROBES AND FOODBORNE ILLNESSES			
Hepatitis	Hepatitis A virus	Food and water contaminated with human feces, resistant to most processing	Fish, shellfish
Noroviruses	Viral gastroenteritis, winter diarrhea, acute non-bacterial gastroenteritis	Contaminated water, contaminated processing place	Shellfish
Vibrio infection	*V. parahaemolyticus*, *V. vulnificus*	Warm contaminated water	Undercooked or raw fish and shellfish (especially oysters)
E. coli infection	*Escherichia coli*	Contaminated water, contaminated processing place and materials	Fish and shellfish
E. coli infection	*E. coli O157:H7*	Contaminated water, contaminated processing place and materials	Fish and shellfish
Typhoid fever	*Salmonella typhi*	Water contaminated with human feces	Shellfish, polluted water used for washing
MAN-MADE POLLUTANTS			
PCBs	Polychlorinated biphenyls (PCBs) and dioxins	Accumulate in fat of predatory fish	Fish and shellfish from contaminated water
Pesticide	Various	Can accumulate in predatory fish	Fish and shellfish from contaminated water
Microplastic pollution	Toothpastes and cleansing creams with micro plastic beads, breakdown of other plastics	Worldwide	Have been found in many species including marine mammals
Mercury poisoning	Naturally and artificially produced mercury, often from coal-burning	Accumulates in predatory fish	Fish and shellfish from contaminated water

Source: US Food and Drug Administration, Japan Ministry of Health, Labor and Welfare, and seafoodhealthfacts.org

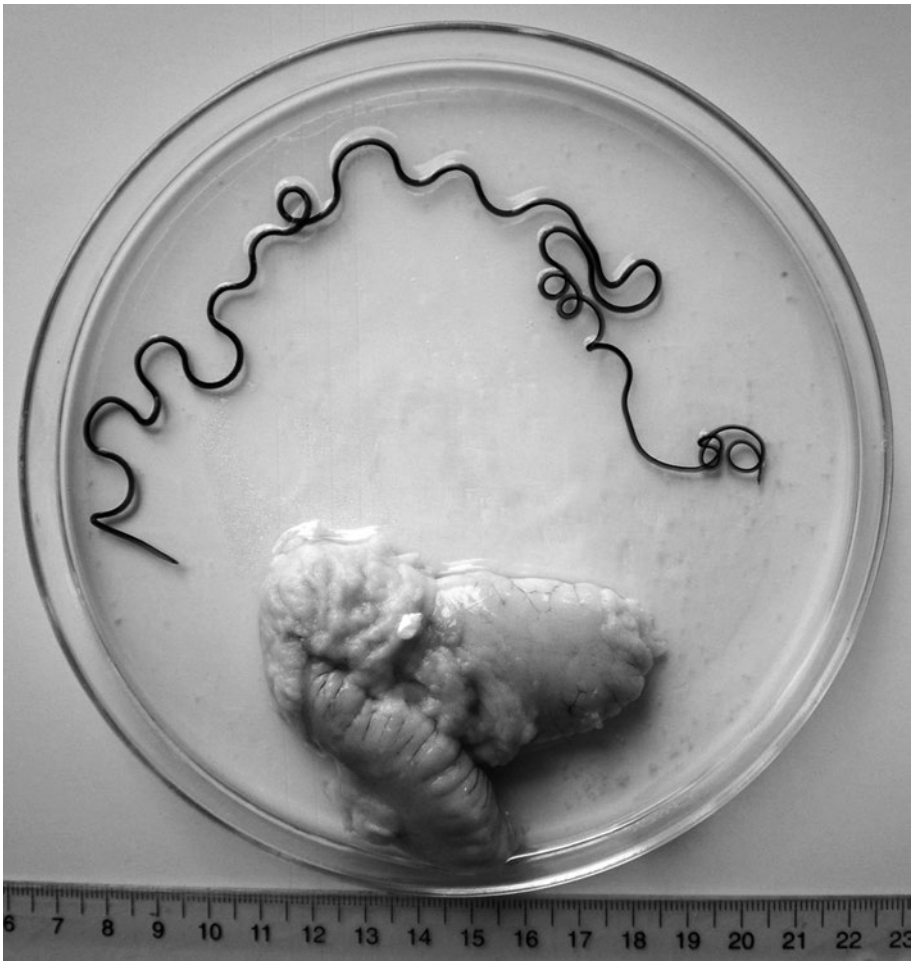

Figure 1.1 **Nematode worm (*Philometra fasciata*) parasite from the ovary of a Blacktip Grouper, scale in centimeters** (Source: www.wikiwand.com/en/Blacktip_grouper, Creative Commons License 2.0; Photo: Jean-Lou Justine)

Fish can be infected with tuberculosis as well as herpesvirus, and they have passed them on to humans through wounds and cuts. You can also get potentially deadly infections from *Vibrio* viruses, salmonella, "fish handlers disease" (a skin infection), and "mad fish disease" caused by *Streptococcus* bacteria, but these dangers are mainly a hazard for people who keep aquaria or regularly handle and clean live fish.

Fish harbor many parasites as well, sometimes as an intermediate stage in the life cycle of the parasite. A parasitic worm that grows in the ovary of female blacktip groupers can reach 40 cm long (almost 16 inches). Most internal and external fish parasites are killed by the heat of cooking, and while they may be

shocking to the rare diner who recognizes one, they do no harm. Raw fish and shellfish are also generally safe for people with healthy immune systems, and even the most common infections (anisakiasis or herring worm and *Vibrio*) are relatively rare and usually nonfatal.

The most dangerous and common foodborne illness carried by fish is ciguatera, often called fish poisoning. It is caused by a toxin secreted by tiny plankton that builds up in filter-feeding shellfish and the flesh of fish, becoming more concentrated as it moves up the food chain. The plankton are usually rare, but sometimes (because of phosphate pollution) they grow in huge numbers causing what is called an algal bloom, or *red tide*. Large predatory fish are generally the most dangerous because they are higher on the food chain, but the prevalence of ciguatera varies from place to place. In Florida, for example, most people avoid eating large barracuda, grouper, and amberjack, but in Belize the disease is rare and all these species are enthusiastically eaten. Numbness and tingling are the telltale symptoms, which can progress to general paralysis, but while as many as 50,000 people get very sick every year, very few actually die from ciguatera.

More insidious and common is the accumulation of toxic substances, such as methylmercury, other heavy metals and polychlorinated biphenyls (PCBs) in the flesh of the fish we eat. The hideous poisoning of the Japanese town of Minamata in the 1950s by mercury from a chemical factory that accumulated in fish is still one of the worst environmental disasters of recent times (see George 2001). In the United States, women are advised to limit the amount of seafood consumption, especially during pregnancy, to 340 g weekly because of the dangers posed by these and other pollutants (Hibbeln et al. 2007). The major sources of mercury in fish today are coal-fired power plants (because coal contains tiny amounts of mercury), hydroelectric dams (mercury is emitted by vegetation rotting underwater), and illegal gold mining (where mercury is used as a solvent for gold).

Bivalves like oysters and mussels are good indicators of water pollution because they filter large amounts of water as they feed. In the crowded conditions of modern aquaculture there are also many opportunities for disease and pollution, but because the level of contamination differs so much by location and season, predicting toxic levels is challenging (Rehnstam-Holm and Hernroth 2005). In developed countries like the United States and Japan, public authorities try to monitor water quality and then close fishing and shellfish gathering if dangerous levels of pollutants are found, or if they recur on a seasonal basis.

The Japanese eat a lot of uncooked fish—which poses a higher risk of parasites and disease. But in Japan chefs are careful in preparing sushi and sashimi,

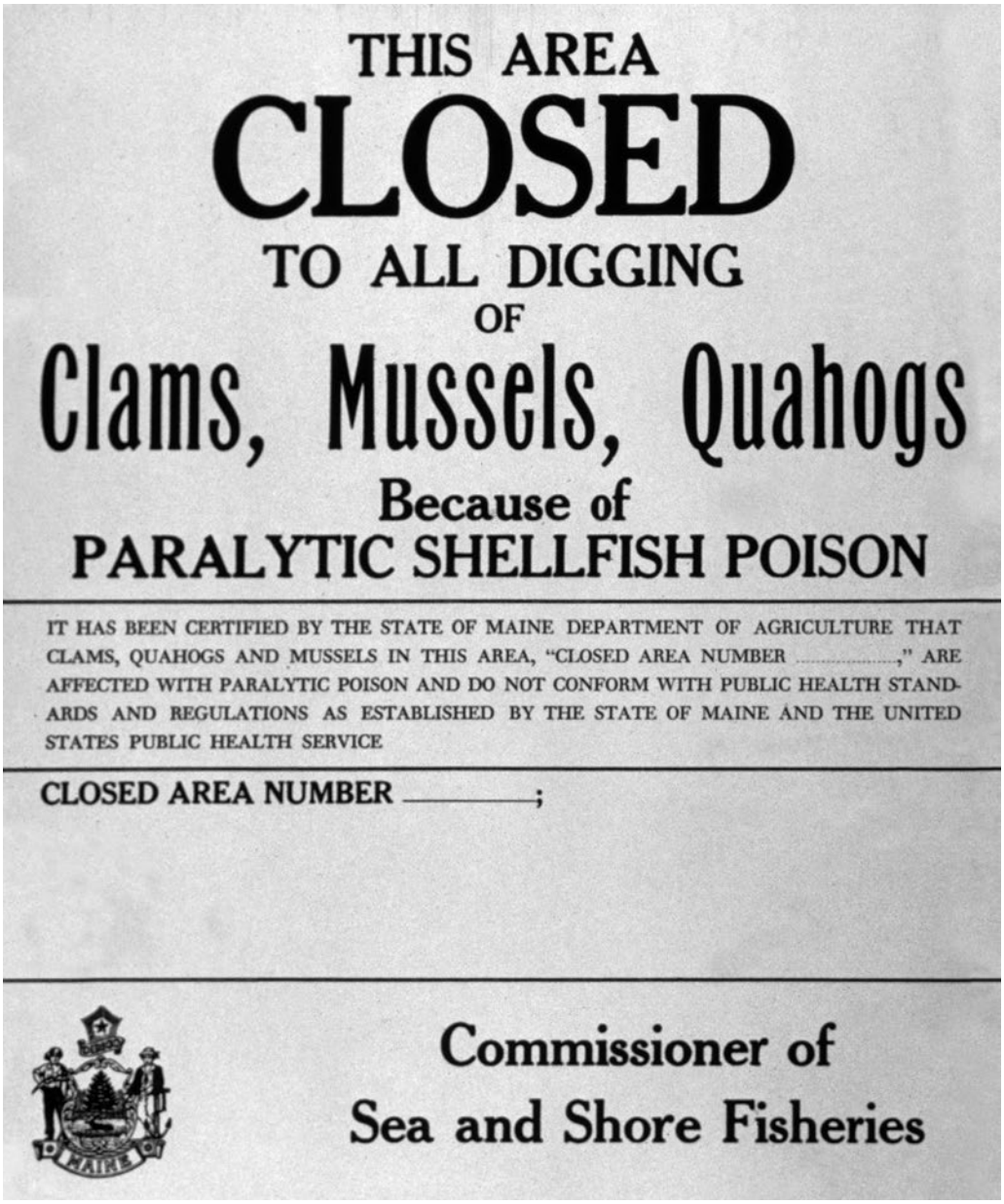

Figure 1.2 **Warning sign posted during the 1926 Typhoid fever epidemic caused by contaminated shellfish** (Source: Food and Drug Administration)

constantly checking its quality while slicing and insisting on freshness. Many kinds of fish are frozen before they are sliced and served, a process that kills most parasites or their eggs. Some sashimi is also served after being aged or marinated to increase its umami flavor and texture. In many places, shellfish

such as oysters are eaten alive, fresh, and raw out of shells. In northern Europe raw herring is often pickled in vinegar without heat, and in South America lime juice is used in various kinds of ceviche to season fresh seafood and eliminate the smells of fishiness. Poke salads, originally from Hawaii, marinate fish in soy sauce and sesame oil. This kind of preparation is a form of cooking, but not using heat, which dramatically changes the flavor and texture of most seafoods.

The worst aspect of foodborne biohazards from seafood is that individual consumers often have to make decisions about what is safe with limited information, even though pollution is an economic, environmental, and political problem. The US Environmental Protection Agency (EPA) warns people to "Choose Fish and Shellfish Wisely," and they have been tracking the mercury content of sixty-six different fish species for decades, but how many citizens actually take the time to look up the local, state, and national lists of recommended 4 oz. servings for each species? (www.epa.gov/fish-tech/2017-epa-fda-advice-about-eating-fish-and-shellfish). The 2017 guidelines issued by the agency sort sixty fish into three categories of "Best Choices," "Good Choices," and "Choices to Avoid" and recommend two servings a week (4 oz. each—a little bit more than a McDonald's fish sandwich).[1] However, how many people carry around or regularly use an information table like this one? And in the sushi bar, how do you know if you are eating yellowfin tuna (good choice) or bigeye tuna (choice to avoid)?

After the first FDA advisory warning about mercury in 2001, some people significantly reduced the amount of seafood they were eating (Oken et al. 2003), but the warning proved a blunt instrument. Some of the most vulnerable people (especially pregnant women) did not change their habits, and some people who were already eating a safe amount of fish reduced their consumption even further (Shimshack et al. 2007). And changing tastes and ideas about healthy living have proven more powerful than government warnings in the United States at least: average annual fish consumption jumped by more than a pound between 2014 and 2015 (www.st.nmfs.noaa.gov/commercial-fisheries/fus/fus15/index). In the balance, government advisories on seafood consumption do have a small effect, but they are inefficient and they may sometimes scare people away from perfectly healthy options (Shimshack and Ward 2010).

Deciding what is healthy food is complicated, and most people do not have the information they would need to make an accurate assessment of the dangers of the seafood (or anything else) they eat. Beyond the complexities of chemistry and marine ecology, seafood is often mislabeled or important information is left off the package (and of course fresh fish are not labeled at all). Salmon fillets labeled as being from China are actually raised in Chile, Tasmania, or elsewhere, but are processed into fillets in China where labor is cheaper.

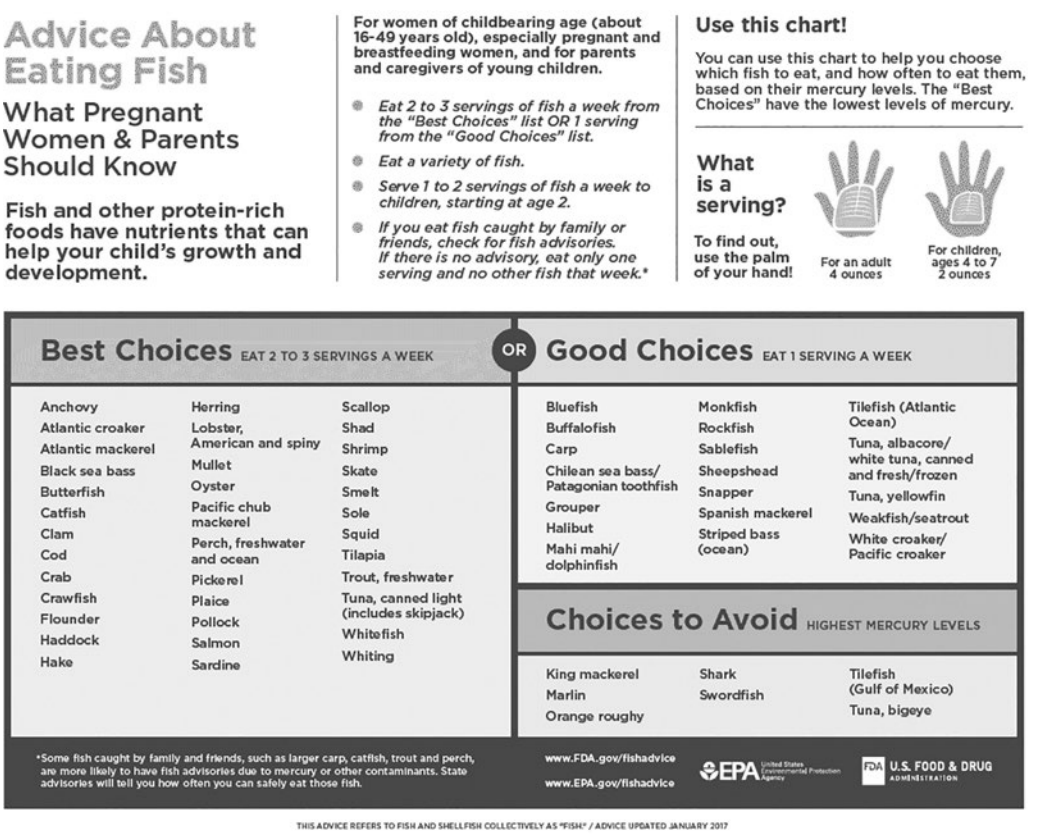

Figure 1.3 **Public notice about safe levels of fish consumption issued by the FDA and the EPA** (Source: Food and Drug Administration)

Low-value fish are often switched for higher-priced species—one survey found that 69 percent of salmon mislabeled and sold as "wild caught" in US markets is actually much cheaper farmed fish (Warner et al. 2015).

Finding a Balance?

Should governments warn consumers about the dangers of eating fish? Most restaurant menus in the United States now carry warnings about the dangers of eating raw fish and shellfish, although they do not seem to have a major effect on what people order. Therefore, maximizing health benefits of seafood is a conundrum. Salmon, trout, shrimp, and tilapia are high in omega-3 fatty acids and low in mercury, but there are other species that *may* contain high levels of both mercury and omega-3s, such tuna, shark, halibut, swordfish, mackerel, cod, catfish, and sea bass (Smith and Guentzel 2010; see also Mahaffey 2004).

So what is the best answer to the simple question: is seafood good to eat? The unpleasant answer is, "it depends on how much and what kinds of seafood."

Experts tell us that if we choose seafood carefully, the health benefits exceed the potential risks (Mozaffarian and Rimm 2007). Cooking also matters, because high temperatures can kill most dangerous bacteria and viruses. A good rule of thumb is to play it safe. If you belong to an at-risk group, you should probably limit the amount of mercury-containing fish species, but otherwise a varied diet including a lot of different kinds of seafood is very unlikely to harm you.

Aquaculture presents specific risks to seafood consumers. Many people fear that farmed shrimp and fish contain high levels of fertilizers, pesticides, and antibiotics. Another more complex issue is the advent of genetically modified fish; in 2017 the first genetically engineered salmon were marketed by a company called AquaBounty Technologies after a twenty-five-year wait for regulatory approval (Waltz 2017, also see Chapter 5). They grow to almost twice the size of unmodified salmon in the same time. Dozens of environmental and consumer-protection organizations have opposed the introduction of GMOs (genetically modified organisms) into the food chain in the United States and many other countries. Some countries have banned them while others require them to be labeled; the US FDA allows many to be sold without a label.

While there are no scientifically verified examples of damages to human health from eating GMO foods, they have not been proven to be completely safe either. The best we can do is to try to make up a balance sheet of the advantages and dangers of allowing transgenic fish into our environment and our bodies (Maclean and Laight 2000). While seafood may be a healthy food choice for human diet, we need to think about what we mean by *healthy consumption.* Jose Granziano Da Silva, the director-general of FAO, states "The health of our planet as well as our own health and future food security all hinge on how we treat the blue world" (2016: 2). What happens when thousands of GMO salmon escape from the farm and interbreed with wild salmon, as happened in Puget Sound in 2017? (O'Neill 2017). How many pounds of meal made from other species of wild fish are used to grow a single pound of domesticated tuna? Whether or not seafood is "good to eat" is a question that needs a broader environmental, economic, and geopolitical context.

The same caveats apply to taking omega-3 supplements. A number of studies show that taking supplements does not confer the same protection as eating fish, and other studies find quality problems with many popular fish oil capsules. The industrial process that reduces fish into oil supplements can be wasteful, damaging to the environment, and difficult to track—in other words, it is no magic bullet. We also need to recognize the degree to which the food industry constantly drives new fads and fashions, trendy diets, and magic superfoods. We can do better by focusing on what tastes good, what makes us feel healthy, rather than by listening to the advice of this year's most famous health guru.

Most of all, it is to remember that we eat food for many reasons beyond nutritional value or specific health benefits. Eating a favorite dish or sharing a special meal can make us feel good in ways no pill can accomplish. If we define "good food" more broadly, we can recognize that nutrition requires far more than specific chemicals or nutrients (Guthman 2014).

Note

1. www.fda.gov/Food/ResourcesForYou/Consumers/ucm393070.htm.

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2

THE ENVIRONMENTAL HISTORY OF THE SEA AND SEAFOOD

Introduction

Do we really know the exact area and volume of the ocean? Consider that seawater supports many complex, dynamic ecosystems at multiple scales. Its volume changes as water evaporates, it increases when rain falls and glaciers melt, and it expands and contracts as temperature goes up and down (Eakins and Sharman 2010). Acidity, salinity, and temperature are uneven and unstable because of global climate change, which also affects storms and rainfall. The area of the oceans constantly changes because of tidal ebbs and flows—and then consider the ambiguity of estuaries and rivers where fresh and saltwater meet and mix. Coastlines lengthen at low tide, tides that vary from a few centimeters in the Caribbean Sea to 14.5 meters in Newfoundland. If you could manage to push your way through a dense coastal mangrove forest, you would be baffled about where land ends and sea begins; erosion, currents, and tides constantly remodel every coastline, giving in some places and taking away elsewhere.

Adding to this uncertainty, much of the ocean is still unexplored and unknown to science: we have better maps of the moon and Mars than of the earth's oceans. Biologists estimate that there are still tens of thousands of plant and animal species in the ocean yet to be seen, collected, and described. The deepest parts of the ocean have only been visited a few times, for short periods of time. Another strange paradox about fresh and saltwater habitats is that they can be seen as deserts, mostly huge volumes of water entirely devoid of life, but we can also perceive them as stews teeming with organisms from tiny single cells all the way up to the largest animals now living on the planet. This depends as much on your point of view, the scale of your observation, and what you are looking for, as it does on the actual density of living organisms. The oceans are so vast and alien, they do not easily fit into the human imagination. We are used to thinking about the environment as what we can see, but sight just does not work in understanding the underwater world. Visible light only penetrates 200 meters—a tiny fraction of the seas, a thin skin on a huge, dark body compressed by its own weight into extreme density that would crush any

land animal into a small dot in seconds. A final enigma about the ocean is that it contains vast quantities of precious minerals like gold, magnesium, thorium, and silver, diluted so much they are not recoverable.

Archeologists suggest that our species modified coastal seascapes long before industrial fishing. Toward the end of the last ice age, when people finally colonized the new world, they may have driven a number of marine mammals into extinction, at the same time that they were helping to eliminate mammoths, giant sloths, and wild horses. As the huge continental glaciers started to melt away, the sea level rose almost 200 meters, covering up all of the evidence of the earliest colonists and their diets, destroying old habitats with giant floods, and creating an entirely new coastline. Our species flourished during rapid changes in vegetation and animal life during this time period, but we did not start to settle down and develop permanent communities until the climate became relatively stable about 10,000 years ago.

The evidence that humans dined well in coastal zones appears in the form of giant shell mounds, hundreds of meters long, stuffed with the bones of fish, crocodilians, seals, and other marine mammals. On the coast of western Mexico, ancient people even built a pyramid 25 meters high from about 300 million seashells (Sirkin 1985; INAH 2008), and in southwest Florida the prehistoric Calusa Kingdom created islands now called Mound Key and Pine Island (Thompson et al. 2016). In the North Sea off modern-day Denmark, people ate vast amounts of oysters between 4,000 and 6,000 years ago, until the oysters got smaller and smaller and fewer until finally people switched to eating small bivalves called cockles (Milner 2013). Historical ecologists now tell us that the muddy North Sea in northern Europe was once clear. The water was filtered by billions of oysters and other shellfish in gigantic beds. Once people had dredged up the oysters over thousands of years, the bottom of the North Sea was dominated by mud and silt that keeps the oysters from reestablishing themselves (Monbiot 2014: 239).

Even in classical antiquity, the times of the Greeks and Romans, people noted that the abundance of sea life was declining due to overfishing. Long before this, people had begun to develop new technologies in order to catch more fish, starting a cycle that we see throughout history. Better technology reduces the fish population, requiring improved technology that then continues to pressure the fish, as we will discuss in the next chapter. Another response was to control access to a fishery with religious prohibitions, or for groups to claim ownership of a resource and keep others out, by force if necessary. When Europeans arrived on the coast of what is now Washington State, they found that every bed of clams, each fishing station on a salmon stream, and even patches of wild blueberry bushes belonged to somebody, and poaching could lead to the

Figure 2.1 **Old Postcard of a prehistoric shell mound in St. Petersburg, Florida** (Source: Author Photo)

offender being killed or enslaved. People built weirs and dams and modified the landscape in ways that enhanced seafood production, but even the strongest human constructions were always temporary, subject to the force of storms and floods.

Culture, Cuisine, and Seafood

Economists explain human diets with cost-benefit analysis: people will eat the things that give them the highest payoff in calories for a given amount of work. This works sometimes, and indeed the consumption of many foods goes up when prices go down and vice versa. But this analytic framework of calculation cannot explain why people are willing to work harder for things that taste good, while they reject other foods that are perfectly nutritious, like duck heads or fish livers.[1]

The growth of regional, natural, and local cuisine has a strong effect on the kinds of foods that people value. While in Southeast Asia and most of China the head is considered the tastiest part of a fish (because it has large amounts of fat and gelatin), in most of Europe and North America this part of the fish is not considered edible at all and is thrown away. In Singapore, the skin, bones, and even the scales of larger fish are deep fried delicacies. In different parts of Asia people relish starfish, moray eels, barnacles, marine worms, and jellyfish, while

Figure 2.2 **A package of fried catfish skins, from a store in Singapore, where they are a popular crunchy snack** (Source: Richard Wilk)

there are parts of the United States where people cannot even name more than four or five edible fish.

It is very common to find that a fish rejected as inedible "trash" is considered choice and especially tasty among other nearby people. A good example is the species called jack crevalle: in Florida where they are common, most fishermen throw them back because, they say, the meat is bloody and doesn't taste good. Just move to the nearby island of Cuba and they are eaten with enthusiasm, or go a bit further south in Belize where they are considered among the very best fish in the sea. Thousands of tons are caught in the Atlantic by commercial fishers every year, but in the United States they are turned into fishmeal to be fed to animals.

An archeological mystery gives us another example of how culture and taste are more important than practicality when it comes to the choice of food. The aboriginal inhabitants of Tasmania, an island off the south coast of Australia that has very few land mammals, ate fish enthusiastically for thousands of years, judging from the amount of fish bones in archeological sites. But then around 1800 BC we find no fish bones at all; it appears that the entire population stopped eating fish, even though there were not a lot of alternative sources

of meat. They still avoided fish when the first Europeans arrived in 1642. The Tasmanians did not necessarily avoid the seashore, because they continue to eat shellfish and crustaceans, just not fish (Bowdler 1982; Bassett 2004). We can surmise that a powerful taboo was operating, but the reason is clearly cultural, not something determined by the environment.

Culture also affects the amount of seafood eaten in different parts of the world, and often dramatic changes in preferences and taste. Japan is surrounded by seas, and complex coastal seascapes are productive fishing sites for a variety of species, and even inland communities consume fish as the primary source of protein in their diet, including many freshwater fish. Nevertheless Japanese fish consumption is declining rapidly to the point where they are now exporting fish that would otherwise go unsold in Japan.[2] People are also eating a lot less fish in England, where fish and chips was once the national dish and jellied eel shops were on every high street. This is hard to explain; some scholars blame higher prices, fast food, or a growing concern about a toxic ocean and sharp bones (Verbeke et al. 2005).

The tools and methods people use to preserve and process seafood also affect the amount people eat, particularly because fish spoil quickly once killed. For many thousands of years, the only ways to preserve fish were through salting, drying, smoking or fermenting, all of which can be done with very little technology (see Chapter 5).[3] Fish and crustaceans can also be ground up into a paste mixed with salt, dried over a fire and crushed into powder, or submerged in small containers of fat or honey, both of which retard spoilage by keeping oxygen out. All of these food technologies can be scaled up to an industrial level, which was certainly the case for the ancient Romans who shipped huge quantities of a salty fish sauce (garum or liquamen) in large clay amphoras thousands of miles in sailing ships. Later, anchovy paste was a common relish spread on toast throughout the British Empire, packed in small ceramic jars.

By the nineteenth century, new technologies and methods for food preservation began to appear, including canning, refrigeration, and then freezing. At one time fishing boats had no option other than stuffing their catch into casks of brine, landing them quickly to be dried in the sun on racks or smoked over fires, or trying to keep them alive in a tank of seawater. Once ice-making machinery was widely available in the 1870s, fishing boats had many more options. Fish can last up to twelve days if packed in ice right after they are caught, and they will last even longer if they are gutted and filleted. In the early twentieth century, the giant fish processing ship was invented where the catch could be completely processed, frozen, and packaged on board. Very rapid "flash" freezing at very low temperatures preserves the texture of fish better than earlier methods

Figure 2.3 **Anchovy paste in a ceramic jar, produce in London and shipped all over the British Empire** (Photo: Susan Blatt)

of freezing. Along with cheap bulk freight moved in containers on giant ships, this technology has allowed food processors to ship fish long distances for processing and then to market. The cost of air freight has continued to decline, creating a global marketplace where fish from anywhere can be sold fresh from Patagonia to Dubai. Because of container systems and new giant ships that can carry thousands, the cost of all kinds of global freight has gone down. Fish caught in one place can be frozen and then shipped somewhere with cheaper labor for processing, and then re-frozen and shipped onwards to the United States and other markets (Greenberg 2014). There are press reports that some of the fish eaten in the United States and Japan has been cleaned and processed on ships by North Koreans who are forced to give up most of their wages to their cash-strapped government (Sullivan et al. 2017).

Seafood in Prehistory

We do not know precisely what the oceans were like before human beings started to harvest them. Some anthropologists think that our species evolved on seashores, or ecologically diverse shallow water areas with rich resources available year-round, but there is not much evidence for or against the idea (Morgan 1982; Wrangham et al. 1999). Global sea levels have risen and fallen over 150 meters at least three times since *Homo sapiens* appeared on the planet about 300,000 years ago, so old seashores—the logical place to look for evidence—are long gone. As the earth has warmed and cooled, oceans and coastlines have changed so much that the idea of "untouched" oceans is fairly meaningless. At least for the last 20,000 years humans have been hunting and gathering sea creatures, not just for food but also for useful materials like sea mammal hides, sharp teeth and bones for tools, feed for land animals, fertilizer, and medicines. When did our human ancestors start to eat seafood? Most anthropologists who study human origins believe that our ancestors evolved on relatively dry savanna environments in Africa, which would give them very few opportunities to eat seafood. It is difficult to trace exactly when human ancestors like *H. habilis* and *H. erectus* invented cooking. Based on fossils from Kenya, *H. erectus* ate aquatic animals, such as turtles and crocodiles, and fish including catfish more than a million years ago (Braun et al. 2010). Even earlier hominids and modern chimpanzees certainly knew how to crack nuts using stones, a skill easily transferred to opening shellfish, turtles, and crabs, and by the time of *H. erectus* our ancestors made sophisticated stone tools for cutting, chopping, and mashing.

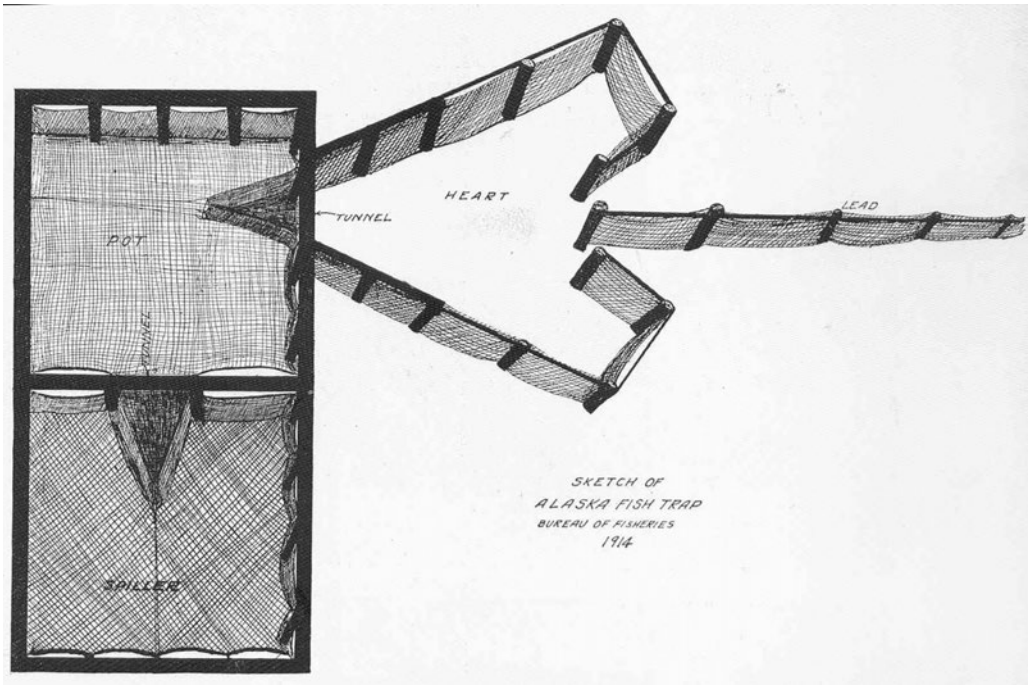
We can learn how to get the most possible nutrition from a small animal by watching the way Australian aborigines prepare goanna lizards (which are full of small bones just like fish). They put the lizard in a fire to burn off the scales from the skin, cover it with coals for a while, and then they put the carcass on a large flat rock and pound it with another rock until it becomes a paste, so you can eat every bit including the bones. This may sound unappetizing to us, but it is as efficient and quick as a microwave pizza, and probably more nutritious. Nobody in Australia eats this way anymore. Although aboriginal food, what they now call "bush tucker" is becoming very popular among educated people in Australia cities, and many people are willing to try goanna lizards, the aborigines have learned that city people think the old ways of doing things are disgusting. As we see in many other places, when old and traditional local foods are revived and modernized, a lot of things are edited out, mostly ingredients and practices that do not fit in the worldview of contemporary gourmets. Some things, like homemade pickles, get revived and become gourmet treats, while others like the fried ribs of the US Midwestern buffalo fish, once the staple of community fish fries, are left behind.

Preindustrial people found many ingenious ways to catch fish and gather shellfish, activities that also require a good deal of knowledge about the environment, and highly specific skills. Over thousands of years they accumulated knowledge about when and where to find hundreds of different species of marine life, their spawning places and times, the best ways to catch them, and amazingly accurate methods of navigating the open ocean. Most of this intricate traditional knowledge is being lost as people enter a money economy and start getting their food from stores instead of nature, although some scholars are trying to record it for future generations. Many species of clams, for instance, don't just sit there waiting to be caught. You have to be very quick to grab razor clams or giant geoducks, because they can quickly dig deeper and deeper into the mud. As fans of recent fishing US television shows know, in many places it is possible to catch fish including catfish and trout with bare hands, a practice called noodling. In most areas there are also toxic plants that can be used to stun or poison fish in a small body of water. This was usually done by a large group, because it produces enough to feed a crowd. You can also wait for the tide to come in and then build a barrier to keep the fish from following the tide out, or build small dams or traps from stone, wood, or fiber. In many places today, traps continue to be an effective way of catching large amounts of fish with very little work, and some fisheries depend on them entirely.

We do not know very much about prehistoric weaving or fiber crafts, so it's not possible to know when fishnets were invented, but humans and their ancestors have probably used cord and carrying bags for a million years or more. This allowed people to carry much larger loads back from their foraging expeditions. They do not need to be elaborate: in Hawaii, fishers used a string of large leaves tied together to frighten and drive fish into a small area where they can be easily speared. In many places, archeologists find small pieces of rock or clay used as weights, to make sure the bottom of the net hangs down. Nets could also be used to catch turtles, frogs and even seabirds.

The first known harpoons made specifically for catching fish appear in the upper Paleolithic era, about 40,000 years ago, and later Stone Age peoples produced fishing arrows and a whole range of fishhooks made from thorns, ground shells, wood, and/or fiber. The gorge is an even simpler device: a stick sharpened at both ends with a hole in the middle attached to a line. This is embedded in a piece of bait, and once it is swallowed, pulling on the line drives it sideways and jams it into the throat of the fish. In China, cormorant fishing was once common, using well-trained aquatic birds with rings around their necks to keep them from swallowing the catch.

One of the most elaborate and ingenious ways of fishing was developed by Polynesian islanders, who trained sharks and barracuda to come to



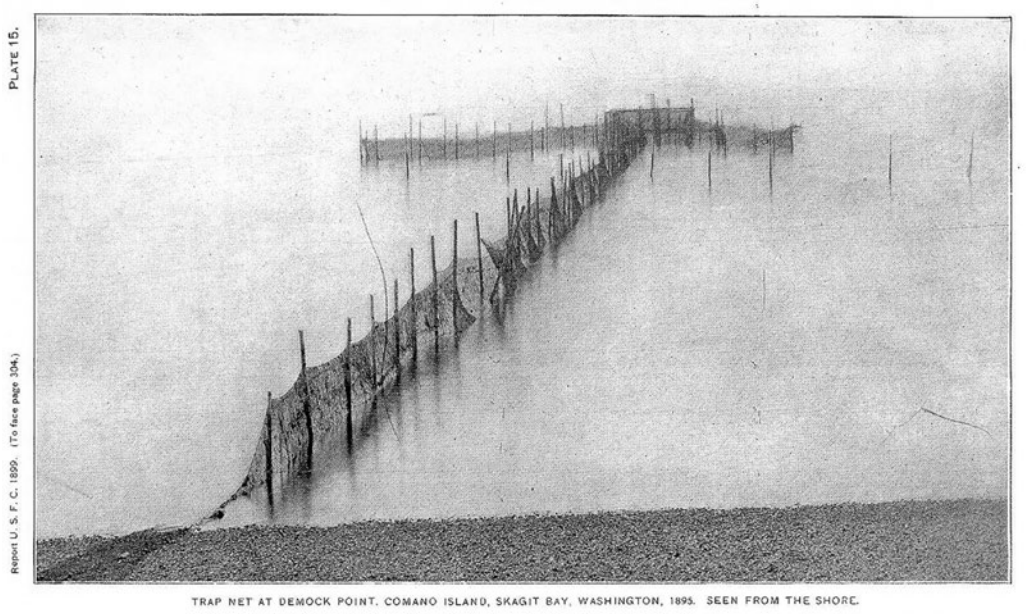


Figure 2.4 **Traditional forms of fish trap from the Pacific Northwest of the USA; fish travel along shore until they hit the lead, which diverts them into the heart** (Sources: Top by Richard Rathbun, bottom by Lester E. Jones, both in the Freshwater and Marine Image Bank at the University of Washington)

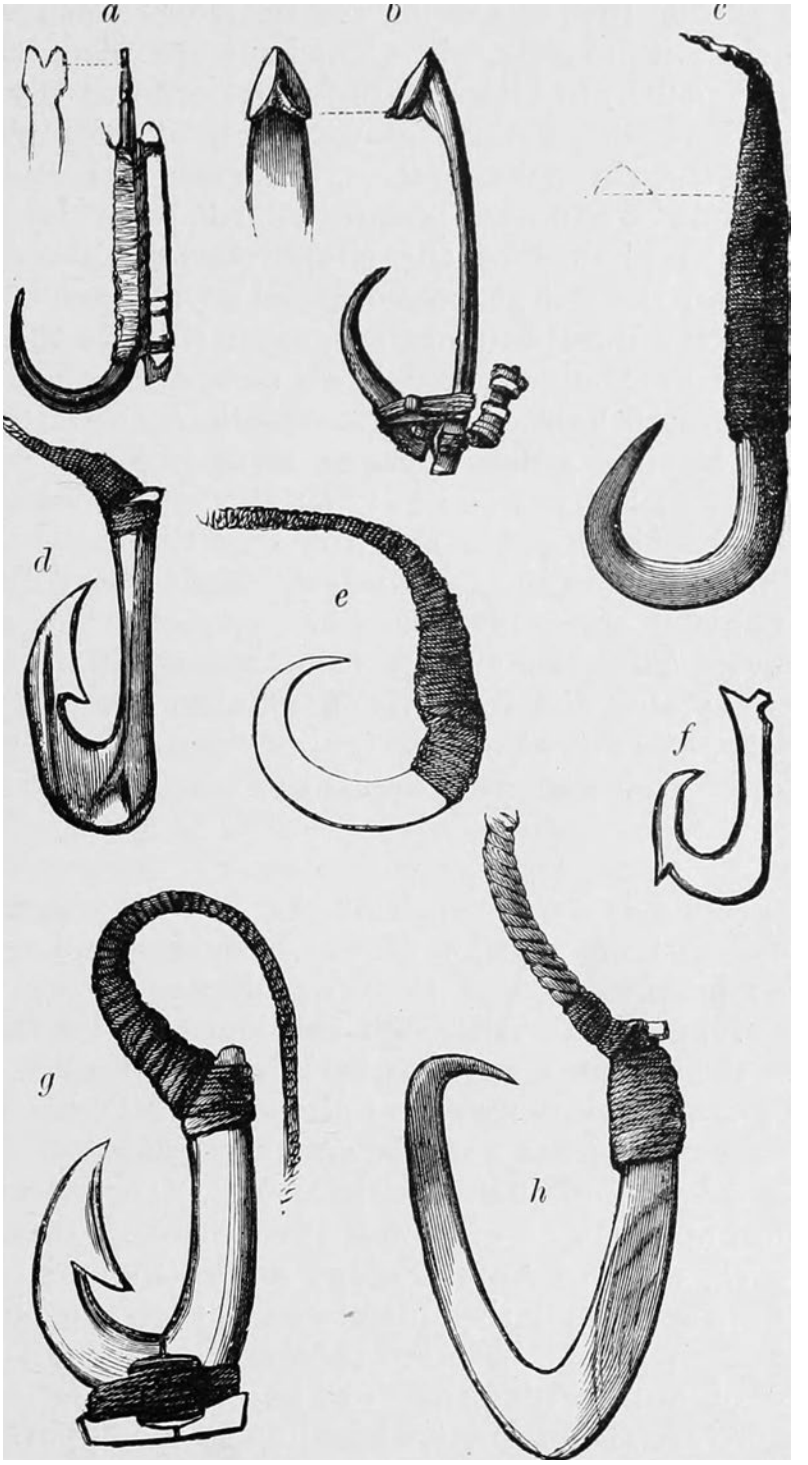


Figure 2.5 **Fish hooks made by Pacific islanders in Hawaii, the Solomons and Tahiti** (Source: British Museum)

particular sounds made by banging a paddle against the side of a wooden canoe. Then the fish they have called surround a school of smaller fish and bring them under the fisherman's ready net. They are rewarded with part of the catch. All of these early fishing methods entailed some risk, particularly in environments where people mostly went barefoot among sharp, spiny, and sometimes poisonous sea life, or swimming with hungry sharks, and using flimsy rafts or boats on large lakes or in the open ocean. Because of their intimate knowledge of the environment and understanding of animal populations, many coastal peoples found find effective ways to monitor populations and prevent overfishing.

The biologist R. E. Johannes wrote a remarkable book about the detailed knowledge of the sea among the people living on the island nation of Palau, located between the Philippines and New Guinea. The fishermen knew the names of more than 300 different species of fish and used methods as diverse as spears, lures (some made from spiderweb), wood and shell fishhooks, nets made from leaves, poisons, and a variety of fish traps. They trolled lures behind sailing canoes, use torches to attract fish at night, and used kites made from leaves to carry their baited hooks up to 300 feet out to sea. To catch sharks, fisherman held a flying fish in their hand underwater as bait while holding a loop of line in the other hand; when the shark ate the fish, the fisherman tightened the noose and held it long enough to kill the shark with a spear. Those brave enough to undertake this task had a special tattoo on the wrist, and they were "not supposed to let go of the bait until the tip of the sharks snout reached the tattoo" (Johannes 1981: 14). They closely followed tides, currents, the weather, and the phases of the moon, and examined the stomachs of the fish they caught to understand their diets. Until the twentieth century they had their own laws regulating open and closed seasons, recognized exclusive fishing territories, and mandated that fish be allowed to spawn before they were caught.

Cultivating the Seascape

Today when we think about cultivation, we tend to have a vision of a giant farm laid out in nice rows of flourishing plants. But long before people began to depend on crops and domestic animals, they were modifying the environment in significant ways, sometimes on purpose and sometimes by accident. For example, when Europeans arrived in the Midwestern United States, they saw primeval forests untouched by humans. But Native Americans had been carefully manipulating and tending the forests for thousands of years, thinning out unwanted trees, carefully burning undergrowth to maximize food for deer and elk. In Central and South America, prehistoric peoples practiced agroforestry, tending, and cultivating forest trees they valued for food and medicine. They dug thousands

of kilometers of irrigation and drainage ditches, changed the courses of rivers, and found ways to create environments that attracted desired fish and game.

Many people think that the ocean is so vast that it is still very much "natural" or "wild." Just in the last decades with the invention of the field called historical ecology, we have discovered that people have modified and manipulated seascapes in many ways for thousands of years. A good example is the "Ricefield fishery" in the Upper Mekong River watershed, where people combine wet rice cultivation and raising fish with techniques for fermenting fish in containers of rice and rice bran (Ishige and Ruddle 1985). We have already mentioned early carp aquaculture in China and saltwater fishponds in Hawaii. Indigenous peoples on the Pacific Northwest coast also constructed "clam gardens," using rocks to create the kinds of environment where clams flourish (Williams 2006; Groesbeck et al. 2014), and clams may have been transplanted from other shores (Grier 2015). In both ancient China and the Roman Empire, fish and oysters were kept alive in barrels and transplanted to distant areas, so in many places what people consider the local oysters are actually invasive transplants (Kurlansky 2007). We discuss aquaculture at greater length in Chapter 6.

People also have completely unanticipated impacts on sea life, especially when they do not understand the complexity of marine ecology. The result is sometimes what is called a "trophic cascade." In every ecological system there are "keystone" species; removing them causes widespread changes because they are such a crucial part of the system. Sharks are a good example. Off the East Coast of the United States, the shark population has declined by more than 90 percent due to shark fishing and being caught inadvertently in nets and on longlines set for other species. Without the sharks, the population of rays, skates, and smaller bottom-dwelling sharks grew rapidly, and all of these animals consume shellfish. Take away the sharks and you drive the fishers who depend upon scallop, clam, and oyster beds out of business (Monbiot 2014). There are many other examples of unintended effects: when divers in Maine started to make money by gathering sea urchins for the Japanese sushi market, the kelp that had been grazed by sea urchins started to grow dramatically, which in turn provided shelter for baby lobsters. The decline of the cod fishery also helped baby lobsters survive, because cod were one of their major predators. The result has been a continued boom in the lobster industry, and although the connection is unclear (given the steady rise in ocean temperature), shrimp have almost disappeared from the Gulf of Maine.

Fish and Status

While European medieval farmers and manual laborers ate heavily salted cod and herring and the occasional fresh carp, landowners, merchants, and the

nobility ate eels, salmon, pike, and bream. Trout fishing was considered the leisure occupation of gentlemen, and in England salmon and trout streams continue to be mostly owned by descendants of the nobility, who collect rent for particular fishing spots. Even today, people who catch a sturgeon in England must ask the Queen if they can eat it, because she officially owns all the sturgeon (and swans) in the rivers. In much of Europe, certain fish like Dover sole and turbot are considered the finest flavored delicacies, and they are consequently expensive (US$40–50 for a single fish).[4] Taste and status have a dramatic environmental impact, but they can also be changed fairly rapidly, as we see with the rise of sushi as a global cuisine, and the way it has fallen quickly from a rare treat to a supermarket staple. On the other hand, that other sushi staple, the bluefin

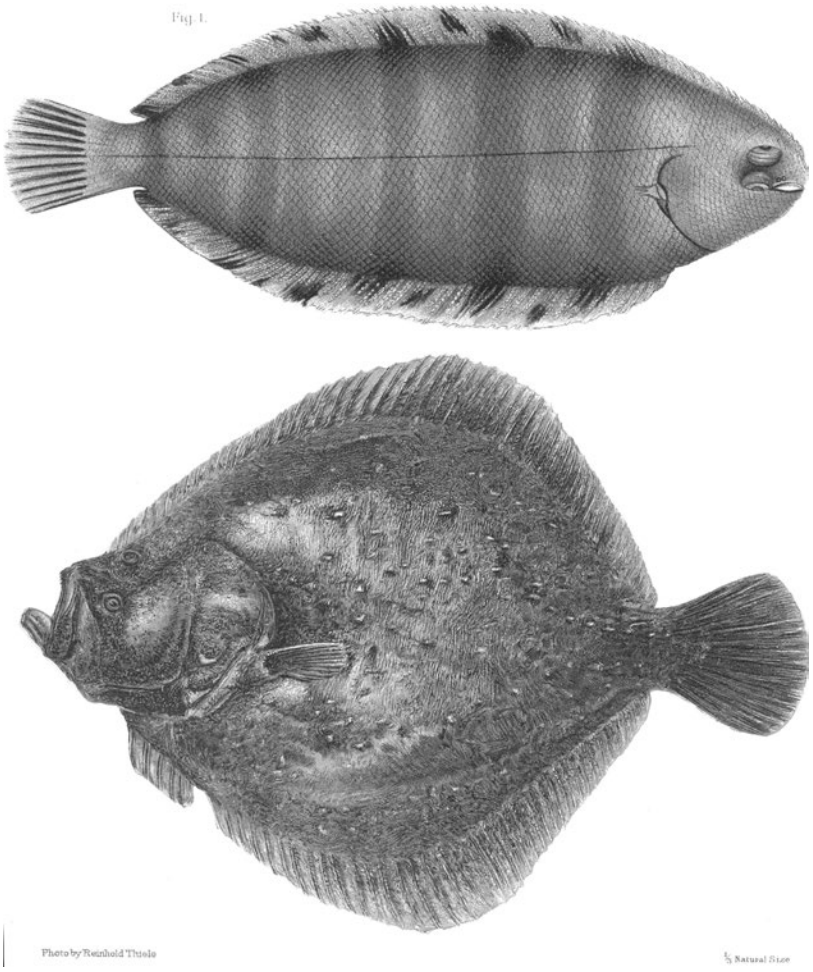


Figure 2.6 **Dover Sole (Solea variegate), drawing 1890 by Joseph T. Cunningham, and Turbot (*Scophthalmus maximus*), drawing 1904 by Reinhold Thiele** (Source: Freshwater and Marine Image Bank)

Figure 2.7 **Auction of frozen Tuna at Narita wholesale market in Japan, 2009** (Photo: Sin Imai)

tuna, has steadily risen in status; once sold for cat food in the United States, extraordinary prices—up to $1.8 million—are now paid for the first fish of the year at Tsukiji market in Tokyo, and it is rumored that some large corporations are buying up flash frozen tuna as an investment, betting that the species will soon be extinct.

The native nobility in Hawaii were also enthusiastic fish farmers, raising species in many different kinds of ponds, including some for the king's family that were taboo for common people (Costa-Pierce 1987; Farber 1997). Indigenous people on the northwest coast of North America also had a hierarchical society with nobility and slaves, where only those of high rank were entitled to eat the appropriately named king salmon (Shoffner 2007).

China is probably where the first fish farming took place, and it also has a very long tradition of status-oriented consumption of seafood. These include specialties like shark fin soup, sea cucumber, and various parts of highly valued fish. Today diners can spend up to $20,000 for the lips and eyes of Napoleon wrasse fish caught in the South China Sea and transported live to Hong Kong (Safina 1998). No official Chinese banquet would be complete without some exotic or expensive seafood. Crabs from Sri Lanka are exported all over Southeast Asia because discriminating diners consider them the tastiest.

Spreading west from Russia, smoked fish and caviar have become universal signs of wealth and luxury. The price of caviar has reached astronomical levels because populations of the beluga sturgeon, from the Caspian and Black Seas, and other large sturgeon are spiraling downward toward extinction due to overfishing, poaching, and habitat destruction. It seems especially wasteful to eat the eggs of a fish with a plummeting population, but conspicuous waste is as much a part of our consumer culture as is conspicuous spending on expensive luxury goods like Hermés Birkin bags and Lamborghinis. Over time, luxury foods tend to percolate downward in status, because the high prices stimulate greater production and the use of more expensive technology. But in the case of caviar, new technology has not saved the species despite attempts at substitution with artificial caviar and the eggs from other species of fish.

As they become cheaper and more accessible, these "populuxe" products still retain a tinge of status and luxury. As late as the 1980s only wild shrimp were available, and they were expensive, so in the United States they were mostly eaten in upscale restaurants as an appetizer in the form of shrimp cocktail. Now farmed shrimp have become the most popular seafood in the United States. New England lobster and Alaskan king crab are global luxuries eaten by rich people all over the world. Japanese fish and shellfish used in sushi have also become globally popular, and frozen sea urchin roe (*uni*), yellowtail, and grilled eel can be found almost anywhere (and are increasingly fished in all the seas). The irony is that many of the "Japanese" eels served in sushi bars were originally caught as tiny transparent elvers in the United States, and then shipped to China and Southeast Asia where they are grown to maturity on farms before being processed and frozen and shipped back to the United States. Because eels do not reproduce in captivity, elvers are very valuable (up to $2,000 a pound), creating a kind of gold rush that has endangered the source. Maine, the last US state to allow substantial elver fishing, has set quotas and instituted a lottery system for fishing permits in 2018 (Whittle 2017), but there is a considerable illegal market (Weiner 2017).

Salmon has seen the greatest fall in status of any seafood in modern times. Up until the very end of the twentieth century, smoked salmon was a relatively expensive delicacy, ranked with Scottish and Irish salmon at the top, followed by less expensive Canadian Atlantic salmon called "Nova Scotia." Pacific salmon barely registered on the scale because it was mostly sold in cans as a food with about the same status as canned tuna. Fresh salmon was expensive and uncommon, rarely served outside high-end restaurants and fancy dinner parties. When large-scale salmon farming started in the 1980s and '90s, it brought the price of salmon down rapidly and the status of salmon started to slide. Today it is the default option at large dinners and banquets, replacing the "rubber chicken"

served at thousands of conventions and conferences. Cultivated salmon has also become a staple in innumerable sushi bars, available in almost every supermarket in the developed world. It has grown in popularity worldwide, available year-round at a reasonable price, in standard-sized portions, with a mild flavor that can fit into many cuisines.

Seafood and the Economy

Salmon farming has been an extraordinarily successful way of bringing down the cost of seafood for the public, but it has environmental costs that are invisible to almost all consumers (Lien 2015). Between 2 and 4 kilograms of other fish are required to feed 1 kilogram of growth in domestic salmon, who now also consume about half the world's production of fish oil. Domestic salmon attract huge numbers of parasites ("sea lice"), which then attack wild fish; escaped domestics interbreed with and dilute the gene pool of wild fish too. Salmon farms also pollute nearby waters with huge plumes of fish waste.

Economists and environmentalists use the term "externalities" to describe costs that are not borne by those who produce and sell goods. When a company dumps pollutants into a river, forcing people downstream to install expensive filters in order to drink water from the river, the company has displaced the cost of filtering that wastewater onto others. When a farmer sucks groundwater up with a pump from an aquifer below the surface and uses it for irrigating crops, it may lower the groundwater level for everyone else, making them spend more money pumping. For many years people thought the ocean, like the atmosphere, was an infinite resource (Roberts 2007). But now we know that the pollutants that come from factory smokestacks can kill people and forests far away, essentially dumping a private problem onto the public.

The same is true with ocean resources. When population and technology were limited, people thought they could catch an endless amount of fish because the ocean was so vast and bottomless. Now we recognize that giant schools of fish are gone, huge rafts of plastic are accumulating on the ocean surface, and "dead zones" form in the ocean caused by the fertilizer and pesticide runoff from farms thousands of miles away.

Our ability to pollute and overexploit the oceans has grown with our population, our technology, and the huge growth in consumer culture in the last 200 years. For example, when fishers in Europe invented the trawl net in the fourteenth century (Fagan 2007), the heavy net towed behind a sailing ship caught a lot more fish, but it also dragged across the seabed destroying reefs and many other kinds of life. The invention of steam engines in the nineteenth century allowed both more catch to feed a growing population and more destruction

and disturbance of the ocean. Steam transportation also increased the global trade in fish products to new consumers and colonial cultures that defined particular kinds of fish products as luxuries and staples. The global transportation of fish was part of the system that brought African slaves to the Americas to work on sugar plantations, bringing the price of sugar down to the point where it became a daily necessity for European factory workers (Mintz 1985). On many of the sugar islands the slaves were fed with salted fish from the North Sea and the North Atlantic, and after slavery it continued to be an important source of protein and eventually became part of the national dish in Jamaica (Higman 2008). Because of the collapse of the North Atlantic cod fishery, salted cod (or bacalao as it is known in southern Europe) is now quite expensive, a hardship for those who consider it an essential part of their cuisine.

When fishing was predominantly local, with thousands of individual boats, there were hundreds of wholesalers, middlemen, and retailers who got the product to customers. The largest companies were those involved in cleaning and canning major commodities like salmon, anchovies, sardines, and tuna. They employed thousands of workers on a seasonal basis, including mostly women and members of minority groups in what was considered a dirty and dangerous job.

As more of the population lived in cities, new systems of transportation and marketing made it possible to carry fresh and frozen produce, and supermarket chains became the dominant form of food retailing. Fishing became organized more as an industrial business rather than a craft, and more fishing vessels were owned by companies rather than individuals. Outfitting a boat with sophisticated electronics and multiple sets of gear requires financing, and governments often encouraged this "rationalization of the fishery" by providing cheap credit to build bigger boats. Today's fishers can go thousands of miles to find new fishing grounds, and the food industry treats fish as a raw material that can be chopped, liquefied, and molded into new products for new consumers. We have to ask if the same technologies can be used to monitor and preserve fisheries and find ways of fishing sustainably. The question of how fish became an industrial food is taken up in the next chapter.

Notes

1. In this chapter we can only briefly discuss the way human beings have had an effect on the marine environment. For more details on topics such as overfishing (Jackson et al. 2001) and ocean acidification caused by climate change, see Roberts (2012) and Breitburg et al. (2018). Although environmental outcomes of exploitation of marine species cannot be left behind in the discussion of food and environmental history, this chapter focuses on distribution and consumption of seafood.
2. www.undercurrentnews.com/2015/09/15/as-seafood-consumption-declines-japan-exporting-more/.

3. There are many examples of fermented fish products, with many recipes for making fish and shrimp sauces, fermenting whole fish in jars full of rice bran, or wrapped in leaves and stored underground. Most North Americans have unwittingly consumed fermented anchovies, a fundamental ingredient in Worcestershire sauce (Ruddle and Ishige 2010).
4. One website explains that "turbot and Dover sole are remarkable for the resilience of their tender flesh and its high content of gelatin, which imbues it with a light, pleasant stickiness similar to that of sauces made with highly reduced veal stock. Both fish have a similarly elegant, lightly sweet flavor without the slightest 'fishy' taste." www(.washingtonian.com/2007/02/07/kings-of-the-sea/).

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3

TRAGEDY OR TREASURY?

Managing Fisheries

When we think of the "natural" life in the sea, we need to remember that human beings have been affecting the oceans for a long time, intentionally and unintentionally. Ecological anthropologists have argued that the way people live is shaped by the environment that they live in, meaning that a culture is a systematic way to adapt to a given environment. However, the relationship works both ways: cultures manipulate and change the physical world to suit their culturally defined needs (Netting 1986: 101). Furthermore, historical ecologists, such as William Balée (2010) and Carole Crumley (1994), show how indigenous peoples have used their traditional knowledge to not only adapt to their natural environments but have, over thousands of years, actually created the areas we call wild, pristine, and natural. Maintaining a way of life is contingent upon the interaction between local human societies and environmental "nonhuman" communities, all of which compose a dynamic and ever-changing ecosystem (Balée 2010).

Humans have changed along with the sea, and like other sea creatures, we have fit into the ocean food chain in many different ways. On the other hand, there is no question that as we human beings have grown in numbers, spread all over the planet and developed our technology to astounding levels, we have changed the seas in ways we are only beginning to understand. The sorry irony is that our ability to change things has outpaced our understanding of the world we are changing. We focus so much on our own location, our limited life span, immediate needs, and appetites, we only see the larger scale and the longer term in hindsight, after the damage has been done. Unfortunately, nature does not allow U-turns—you can never simply turn back the clock and return to a previous state. The ecosystem has a past, but it only moves forward. Once fished into oblivion, like the huge schools of sardines that were the staple of Monterey's Cannery Row, the fish may never come back.

A useful way to think of the way people interact with the world around them is the concept of "ecosystemic channelling" (Hackenberg 1974). When people focus on intensifying their use of a particular resource, for example by

introducing a new species into rivers and lakes, this usually has the effect of eliminating some of the options they may have had. So, for example, the streams of North America were full of many different kinds of indigenous fish, and Native Americans used many of them in different seasons, from little madtom catfish and smelt to giant sturgeon over 6.5 meters (20 feet) long. Early European colonists and settlers enjoyed this bounty, but over time they built water mills, drained swamps, and built dams and levees that dramatically changed the aquatic environment. Then in the middle of the nineteenth century, the US government fisheries department decided that European carp would be a more familiar and abundant source of food for European immigrants, and they also planted European species of trout (Ireland 2017). Carp are herbivores that root through the mud in shallow waters, and this reduced the ability of many native fish to spawn, killing off a multimillion-dollar freshwater commercial fishery and putting thousands of rural people out of jobs. Like turning a forest into a cow pasture, human interference narrowed down the diversity of species and eliminated food options like gathering chestnuts and shooting squirrels.

In this chapter we will discuss the most important ways human intelligence—and ignorance—have worked with and affected ocean life. We begin with the tools and technologies that have expanded the scope of our powers, and we draw on the anthropology of fishing communities to find out how people can find a degree of balance, a relatively stable relationship with neighboring communities and with their environment.

Fish for All: Fish as a Common Resource

In a famous article titled "Tragedy of the Commons," Garrett Hardin (1968) suggests that communities are not capable of conserving resources they hold in common, like a village green or a mountain pasture, because each person will try to get the most before someone else takes it, so only private property systems can protect natural resources. The argument has been refuted again and again, and social scientists have detailed literally hundreds of counter-examples where groups of people have managed sustainable use of common resources for hundreds and even thousands of years (see Schlager and Ostrom 1992). Under the right circumstances, people can successfully restrict access to the common-pool resource and establish rules among themselves for its use. Now it has become clear that any kind of property can be managed well; everything depends on who makes and enforces the rules, and the nature of the resource being governed (Feeny et al. 1990). A regime that works well for a small lake full of bass and bluegill is going to be very different from one that protects and maintains bluefin tuna schools that migrate for thousands of miles.

Even though the tragedy of the commons has been proven simplistic and over-generalizing, it is still true that common-pool resources (CPRs), particularly in the open ocean, are difficult to use sustainably, requiring good traditional and scientific knowledge and effective formal and informal institutions. Controlling large bodies of water is costly: someone must be watching all the time, and there must be a way to catch and punish people who break the rules. "Free-riders," people who take resources but pay none of the costs of management, are a constant problem. Even if users A, B, and C observe the institutional arrangement to limit their catch, the agreement can be undercut if user D takes more than their share. With enough free riders, everyone decides to "defect" and get whatever they can before it is all gone. A common response is to break up the commons and turn it into private property, but this has proven challenging with mobile sea life, and it always creates other problems. Privatization gives an advantage to those who are already wealthy, who can afford to buy out struggling poorer owners, and the result is often a single person or company with a monopoly, and once independent producers who are now impoverished workers (more on this topic below).

Many technicians and biologists, as well as economists and political policymakers, have no understanding of how CPRs work. They typically make three false assumptions: first, that resource users are only interested in maximizing their own personal gain; second, that government regulations and laws alone can effectively manage resources; and third, that a single kind of regulation will fit all situations and resources. These assumptions often lead to ineffective top-down resource management policies coming from officials who may know or care little about local people and culture. Ignoring local knowledge and customary rules is a recipe for failure (Brockington 2002). Corruption and granting special favors to privileged people or corporations is another way to undercut CPR systems, promoting defection and collapse.

In the past, policymakers tended to think that unless there was government regulation, all marine natural resources were open access, meaning that anyone could take them. Anthropologists and social scientists began to question this assumption in the 1970s and '80s. The anthropologist Bonnie McCay studied the history of oystering and clamming in New Jersey, and found that these important sources of food had never been open access to anyone, that communities had rules about who could use them, when, and how much, for hundreds of years before the state began to write laws and make rules. The very idea of open access is in her words "unnatural" (1998). Instead the idea of open access was constructed by people promoting the industrial development of resources that they saw as being "wasted" by inefficient local communities. These ideas were promoted by powerful images and stories depicting the oceans as the

last frontier, where human population density is low and natural resources are abundant, ripe for conquest and development (Roberts 2008), something forgotten or lost that could be gathered or mined like gold or oil: "natural wealth." The nasty fact was that many of these resources were actually being used, managed, and even controlled and promoted by communities and groups who had no voice, often minorities who were considered undesirable. Their knowledge and experience, skills, and management systems were ignored by those who wanted to commercialize and "rationalize" natural resources.

Limited Entry Systems, Tradable Quotas, and Total Allowable Catch

Governmental organizations and agencies have developed a number of ways to regulate the use of common-pool resources. For example, limited entry systems restrict the number of fishing permits for a specific fishery; a permit can be revoked if a fisher breaks the rules, for example by staying at home and renting the permit to someone else. Sometimes entry privileges may be given out to individual boats, or they can be allocated by fishing port, or to organizations like Native American tribes with historical fishing rights.

TAC (total allowed catch) is a method of regulation that sets the rules on how much of a fish or shellfish species can be landed and sold in a season, in each fishing port, or for a particular designated fishing area. Once the quota has been landed, the fishery is closed. This helps fishers and wholesalers maintain the price of their catch, because everyone knows how much will be available in advance. Otherwise, fishers are competing with each other and the one who gets to port first gets the best price, an incentive for sloppy fishing and taking unnecessary risks with gear or the weather.

While TAC does not specify how many fishers can participate, the individual fishing quota (IFQ) gives each fishing boat a permit to catch a particular quantity of fish, usually a percentage of the TAC. Sometimes a fishing boat or company is allowed to buy or sell their permit (called an individual transferable quota or ITQ), which creates a market for permits. A large company, for example, could buy up most of the permits and then manipulate the price using their monopoly power. They could also rent or lease the permits to individual fishers for a profit requiring no effort. An ITQ does offer flexibility to each fisher, who can decide when and where to fill their quota, and some fisheries have a share cap, which prevents any fisher from accumulating more than a specified percentage of the total quota.

Another way of managing a fishery is to regulate the kinds of gear or boats the fishers are allowed to use. A good example is the fishery for oysters in Chesapeake Bay in the Eastern United States, which was limited by state law

to sailboats of a certain design, called skipjacks, for many years. Unfortunately, declining water quality in the bay caused a steady decline in oyster beds, and today only a few skipjacks are still fishing; now they are allowed to use a motor two days a week (Livie 2015). With a small fleet and a limited area, fishers can effectively police each other's behavior, but on some open ocean fisheries with large ships, a regulating agency may put an observer aboard who is responsible for monitoring the catch and gear (which can be a very lonely, and sometimes dangerous job).

Co-management

We have only recently begun to understand traditional systems of common property management, and the principles behind them, largely due to the work of Elinor Ostrom (1990, 2005). Case studies of successful CPR management range from indigenous systems to "modern" high-tech fishing. James Acheson's *The Lobster Gangs of Maine* is a classic ethnographic case study that recounts how "harbor gangs"—lobstermen in the same communities working the same territories—fish sustainably through networking, local institutions, and individual strategies. Skills and information are shared in the lobster gang networks, while newcomers and outsiders are excluded. Belonging to the social network of a gang enables lobster fishers to negotiate better prices with lobster dealers and middlemen, while they share information on lobstering, new technologies, and skills (Acheson 1988).

For a long time fishery scientists tended to ignore the practical knowledge and local culture of fishing communities; they figured that they knew better, and that unschooled local folks were ignorant bumpkins operating on old wives' tales, myths, and misconceptions. Fisherfolk tended to stereotype the scientists as lacking in any experience or real knowledge, trusting their models and instruments instead of their senses, ignoring what anyone could see with their bare eyes. And both tended to be powerless before powerful companies, who argued that resources should be privatized and sold to the highest bidder, because they (in theory at least) would then have a motive to manage the resource sustainably.

Co-management is a relatively new approach, still unevenly practiced and mistrusted by many. It developed partially through the efforts of social scientists who argued that no system of regulation could work if the fishing communities had no stake in them, if their voices, needs, and knowledge were ignored. The discovery of effectively managed CPRs also made a difference. Co-management means that fisheries scientists and government agencies work along with communities to develop rules and regulations, and ways to enforce them (Townsend et al. 2008). Usually this means that fishing communities will define who is

allowed to fish, set quotas or limits, and specify what kind of gear can be used at what time of year. The community may also agree on closed seasons or areas that become marine sanctuaries, especially areas where fish spawn, or where the young grow to a commercial size. Co-management can also be applied in communities that are making a transition from fishing to tourism, although case studies show that there are often conflicts between the two very different and sometimes incompatible uses of the sea, especially when sport fishing is a major part of the tourism mix. A working commercial fishing port is messy and smelly—not the ideal place for eco-tourism.

In the following section we present three short case studies, which illustrate how sustainable fishing works in traditional communities and in modern commercial fishing. We do not intend to depict any fishing community as following a static and unchanging traditional way of life, nor simply lament the passing of another time. Our goal is to show how it is feasible to develop better systems of management, and more stable and sustainable relationships with the ocean, in very different fisheries and economic situations.

Case Study: Kilwa Island, Tanzania

Kilwa Island is one of the Swahili-speaking islands off the southern coast of Tanzania, facing the Indian Ocean. In the late twelfth to the middle fifteenth centuries, the *island* town, which was founded by Persians, was the home of the Kilwa Sultanate, a powerful state that controlled a large area of coast and prospered as a vital connection in the largest trade network of the time. Kilwa traders connected the wealth of Africa with the burgeoning Islamic Indian Ocean trade, which extended as far as Indonesia and China.

Today Kilwa Island is surrounded by an "inland sea" of mangroves and tidal marsh on one side, and coral reefs and open sea on the other, which offer abundant and diverse fish and shellfish. Kilwa is a small community of less than a thousand, divided among thirteen ethnic groups, some of which are grouped as "Bantu" because of their language and mainland origin. Still predominately Muslim, they have a mixed economy based on farming and fishing. While farming is mainly for subsistence, fishing generates cash income (Nakamura 2011a, 2012).

Residents of Kilwa Island believe that the ocean is a property of Allah, and thus fishing grounds should be available to all. However, Bantu peoples and Arab/Persian descendants live and utilize different aquatic resources, in three distinct ecological zones. The Bantu are about 80 percent of the community, while those residents of Arab descent are about 14 percent (Nakamura 2011b).

Bantu peoples engage in small-scale subsistence fishing in mangrove areas with brackish water and many seagrass beds. These mangroves are important

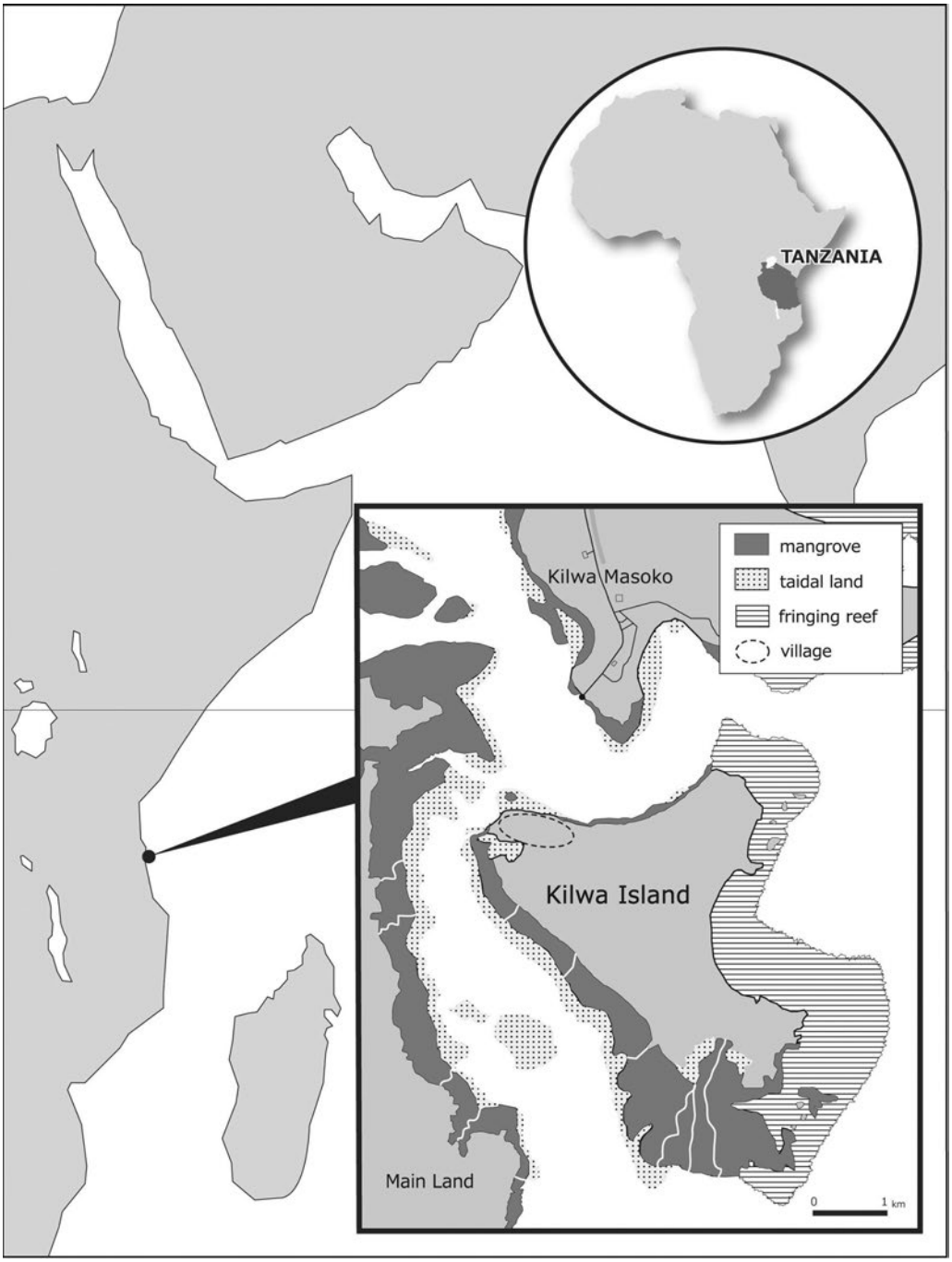

Figure 3.1 **Map of East Africa showing Kilwa** (Source: Ryo Nakamura)

to everyone because they are breeding areas for ocean fish, and they shelter juvenile fish until they are big enough to move offshore. The Bantu fishers use small wooden dugout canoes and flat-bottom boats suited to calm shallow inshore waters. They gather mud crabs, shellfish, prawns, and shrimp among the mangroves; they also harvest five kinds of sea cucumbers by diving, and they use fences, baskets, and nets to catch fish along the mainland coast (Nakamura 2011a).

While the Bantu peoples engage in subsistence fishing and agriculture, Arab descendant fishers own larger boats that they also use for shipping cargo, particularly salt. Using these large plank-bottom boats, Arab descendants catch octopus, spiny lobsters, and larger fish in the coral reefs, venturing into deep water and the open sea for coral grouper, bullhead parrotfish, yellowfin tuna and cobia.

Both groups of fishers on Kilwa sell part of their catch. Because they do not have any refrigeration, they have to consume or sell the catch quickly before it spoils. They make salted and dried fish for their own use and for the local market. Crabs, lobster, shark fins, and dried sea cucumber are too valuable to

Figures 3.2 **Dried fish from Kilwa** (Source: Ryo Nakamura)

consume locally, and they are sold in mainland markets for eventual export. They also sell dried, fried, and fresh fish on Kilwa and neighboring islands. In their own homes, fish are a highly valued part of the everyday diet. Fresh fish are deep fried or made into soup, and after scraping off the salt, dried fish are grilled or added to soup.

Nakamura reports forty-one different fishing methods on Kilwa Island, with many variations of gathering tools, fishhooks, and nets. Bantu fishers with small boats use the widest variety, while the Arab descendants focus on gillnets and other more expensive gear. Because the two groups are using different territories and resources, and using different methods, and each has specialized skills and gear, there is little conflict between them, often a problem when different ethnic groups share the same resource (Nakamura 2011b).

Although the community has worked out sustainable ways of managing their fishing, and they are also restrained by their relatively simple technologies, they now face a lot of external stress because of changes in Tanzanian food and economic policies, in the physical environment due to climate change, and well-meaning conservation nongovernmental organizations (NGOs). These groups are focused on the protection of mangroves, a crucial zone for marine life that has suffered great destruction all around the world (for wood, coastal construction, and aquaculture). They have formulated policies restricting fishing activities in the mangroves, which undercuts the livelihood and food security of Bantu families. Because the Arab fishers continue to fish as they like on the reef and open ocean, there is now an increasing economic gap between the two ethnicities on the same island (Nakamura 2013).

In this case, as in many others around the world, conservation organizations and national governments seem to be focused on the wrong people. The Bantu fishers are not the ones destroying mangroves; on the contrary they have a very strong interest in keeping those zones healthy. The worldwide destruction of mangrove zones is usually a product of large developments by rich individuals and large corporations, groups over which that the conservation organizations have little power. Corruption and political connections often make it possible to get around regulations and displace locals, often with the rationale of providing them with jobs and improving their lives.

Taking the mangrove zones out of the control of local fishers, effectively giving oversight to foreign organizations and distant government bureaucrats, leaves the local fishers with no motivation to protect the mangroves. Instead they have a very strong motive to get as much as they can as quickly as possible, before some powerful person or group decides to build a shrimp farm or resort there. The paradox is that the best efforts of conservationists and resource managers to save a valuable environment or eco-zone often ends up pushing out

the very people who have been sustaining that environment for many years. The result is often the decline or destruction of that environment. When large NGOs, big businesses, and government agencies step in, they often pay little attention to the local people and the way they make a living (e.g., Kamat 2014). The practice of preserving a place by erecting walls around it and keeping people out—called "fortress conservation"—has a very poor record (Chapin 2004; Brockington 2002).

Hokkai shrimp in northern Japan

Hokkai shrimp are a regional specialty in Hokkaido that brings a high price in the market because when they are boiled, they turn red and white, a color combination that has a high symbolic value in Japan. For this reason, they are mostly sold cooked rather than fresh, unlike most other shrimp in Japanese markets.

Local fishing cooperatives (LFCs) operate most coastal fisheries in Japan. In Japan the government officially owns all fisheries as public property. They delegate those rights to LFCs who are responsible for issuing fishing permits and managing the fisheries. In the town of Akkeshi, on the eastern side of the northernmost island of Japan, Hokkaido, the shrimp fishery is managed by a cooperative that practices limited entry to maintain the shrimp stocks. You have to live in the village and work for a specific number of years as an associate member before you get full membership, and only some members have access to the shrimp fishery. These rules create a tight social environment for monitoring and enforcing fishery management, a form of a limited entry system. However, not all LFCs are successful in sustainably managing their local stocks;

Figure 3.3 **Map showing location of Hokkaido and Akkeshi** (Source: http://freemap.jp)

success depends on the characteristics of local communities and the nature of the targeted species. As sociopolitical and environmental contexts are diverse in time and space, there is no panacea for common-pool resource management (Ostrom 2007; Brondizio et al. 2009).

Nevertheless, community-based management has been shown to have great potential for enforcing sustainable fishing practices. In Akkeshi the once depleted and destroyed Hokkai shrimp fishery was successfully restored to commercial viability. Today the local cooperative only allows twenty fishers to catch shrimp, and their yield and treatment of the catch ashore are standardized and monitored at multi-levels by wholesale buyers, market staff, and the shrimp fishing group. Beyond the limited entry approach, the co-op also sets TAE (total allowed effort) and gathers information on the abundance and market price of the catch.

For many years the shrimp fishery was not managed carefully, and the catch in traps and trawl nets kept falling. In 1993 they stopped using trawls towed behind boats because the price of the shrimp could not cover their operating costs, and after that only traps were used. The co-op limited fishing to

Figure 3.4 **Trap used to catch Hokkai shrimp in Akkeshi** (Source: Author photo)

six months and allowed each member to use no more than 250 traps. As the catch continued to decline, many fishers gave up, and the number of active fishers dropped from seventy to twenty-five. Then in 2007, the members of the co-op decided to close the fishery for a year, to give the shrimp population a chance to recover.

Figure 3.5 **Hokkai shrimp being boiled in Akkeshi** (Source: Author photo)

Many of the fishers were initially reluctant to stop fishing for a year, but they were convinced by improved scientific knowledge about the shrimp species. The leader of the shrimp fishers' group visited researchers at the government's regional fisheries extension office and learned that the Hokkai shrimp is a hermaphroditic species. That is, Hokkai shrimp are transsexual, so male shrimps become females when they mature. This means if you take away most of the younger shrimp, in the following generations you have very few females. If you wait for the shrimp to mature, you will get much higher egg production and the population can rebound.

The new shrimp fishing season opened in June of 2008 with a series of new self-imposed regulations. The fishing period was shortened from six to two months to avoid the spawning season. The number of traps used by each harvester was reduced from 250 to 50, and the mesh size of the trap was widened so that smaller, younger shrimps escape and grow to maturity, raising the rate of reproduction. They started with eighteen fishers, and then issued two additional permits as the shrimp resource began to recover. With only fifty traps, they had to work shorter hours and had lower expenses, while their yields

Figure 3.6 **Hokkai shrimp from Akkeshi packaged for sale** (Source: Author photo)

Figure 3.7 **Author Hamada with a shrimp fisherman holding branded Hokkai shrimp** (Source: Author photo)

and the value of the shrimp have increased because now they sell only larger shrimp. In changing the Hokkai shrimp regulations, the cooperative had the active support of local buyers. They helped the co-op with advice on cooking and packaging, and then supported a new brand and label that told buyers where the shrimp came from, and that they had been fished sustainably. The result was a higher income for both fishers and merchants, and the creation of an Akkeshi brand helped all the fishers in the community get higher prices for their catch (Hamada 2016).

Tilefish in the North Atlantic

The golden tilefish lives close to the bottom of the sea, between 100 to 400 meters deep off the mid-Atlantic and New England coasts. Its white flesh and firm texture makes it a favorite in the marketplace. In the early twentieth century, tilefish were caught mainly using giant trawl nets dragged across the seabed, but in the early 1970s fishers began to use longlines, fishing lines many kilometers long, with 4,000 to 4,500 baited hooks anchored to the bottom and

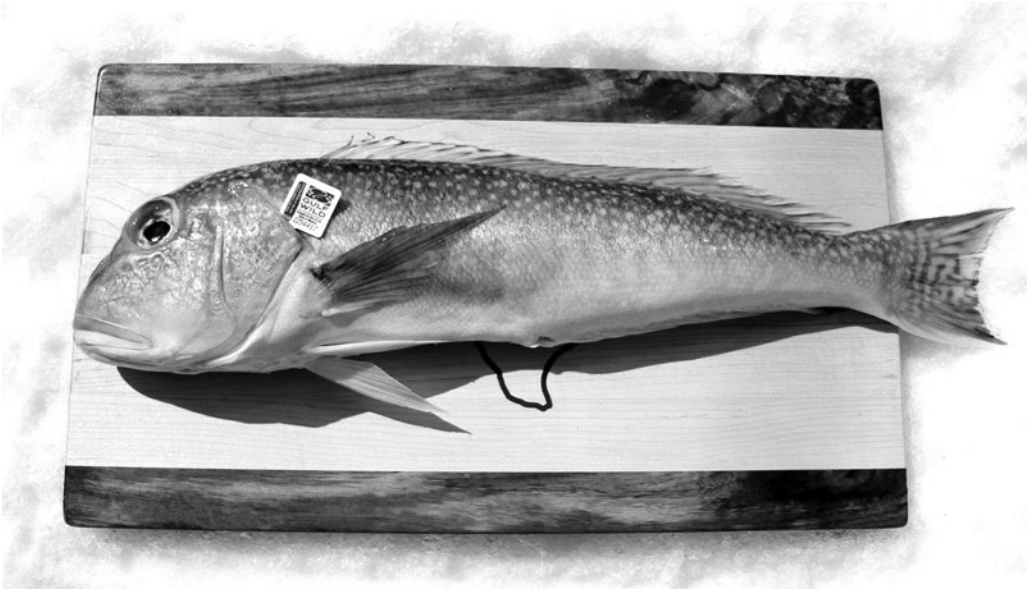

Figure 3.8 **Golden tilefish (*Lopholatilus chamaeleonticeps*)** (Source: Katie's Seafood Market)

checked every day. By the 1990s, larger and newer steel-hulled vessels were introduced that enabled longliners to navigate further offshore even in bad weather (Rountree et al. 2008).

After tilefish are landed, most are gutted, iced, and quickly trucked to fish markets where they are sold fresh. The price depends on the quantity of the catch every day, so oversupply can easily drop the price. Better technology led to larger catches, but with a limited market, prices continued to fall and squeeze fishers' financial bottom line. The tilefish fishery was open access up until 2001, so there was no limit on how much a vessel could catch or how long they could stay out. To try to keep up, fishing crews worked up to 22 hours a day, 330 days a year, and gradually the population of tilefish began to suffer until it was clearly overfished and in decline.

In this dire situation, fishing boat owners and scientists worked closely with the National Marine Fisheries Service to develop a cooperative Tilefish Fishery Management Plan (FMP), based on a categorized permit system, with permits allocated to individual vessels. This plan set a goal of rebuilding the stock over ten years by limiting entry to new vessels. The plan set an annual total quota of 905 tons of live weight, reducing the total catch by half compared to previous years.

The FMP issued permits for fifty-one vessels, with different sized quotas based on historical participation in the tilefish fishery. There are two different sized

quotas, one for full-time fishers and one for those who only fish tilefish part-time. There is no license fee, but permit holding vessels have to pay "restoring fees" based on the amount they catch, and this covers the cost of managing and enforcing the rules (Rountree et al. 2008; NOAA 2016).

The key to turning resource management around in this case was social capital, the informal social glue that keeps groups working together (Kitts et al. 2007). The larger quota full-time fishers formed a non-profit association well before the plan started, because they all lived in the same area and used the same docks for their boats. Through this association they built a more trusting relationship with the NMFS and the marine scientists who worked with them. Consulting closely with the fishers who had the larger stake, the NMFS management plan incorporated their concerns from the beginning, distributing the permits and quotas according to a scale that all participants agreed with. This allowed all of the fishers the flexibility to shift to catching other fish when they wished without losing their quotas. This allowed them in turn to coordinate their catches of tilefish so they did not flood the market, keeping sale prices relatively constant and reliable. While the total catch was lower, this system allowed the fishers to reduce pressure on the resource without losing the income they needed to pay for their boats, gear, fuel, and crew. It also allowed the tilefish population to bounce back and reach a stable equilibrium (Rountree et al. 2008).

Conclusion

Everywhere that human beings have hunted and gathered, on land and in the sea, we have used our intelligence to change the ecosystem to make it better serve our purposes, killing predators that take the fish we want to eat, moving earth and rocks to make it easier to confine and catch animals, and gradually managing the reproduction of plants and animals for our own convenience. Agriculture, pastoralism, and aquaculture were not suddenly invented—they are just the most recent stage of a very long history of using and manipulating the earth and its biota, the supreme talent of our species. But let us not take too much credit: the earth is still much bigger than our own logic and imagination, and the control we may claim over the earth is still tenuous and partial. All it takes is a tsunami, eruption, or hurricane to remind us that it is hubris to imagine we are in charge.

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4

INDUSTRIALIZATION, MARKETS, AND GLOBALIZATION

In his recent book, *Fishing*, archeologist Brian Fagan argues that fishing was the first real industry. At the end of the last ice age, our hunting-gathering ancestors found seafood to be a reliable source of protein, with seasonal bursts of great abundance at salmon runs up rivers, low tides exposing shellfish beds, and sea fish gathering to spawn. Depending on seafood required planning, highly specialized technology, group cooperation, and new ways to preserve and store food, and this in turn was a stimulus for the growth of the first permanent towns and villages (2017).

In another book, Fagan draws on historical sources to show that dried and salted fish were among the very earliest foods traded over long distances around the globe (2007). In the Mediterranean and in China, well before the time of Christ, fishing industries utilized mass production, centralized processing and packaging, systems of transportation, and economic competition that drove many technological innovations to make fishing more efficient and reliable. Many ancient civilizations in Asia, Africa, and Europe developed fishing into a highly organized process that fed large numbers of people on a regular basis with relatively cheap protein.

Right up until the advent of steam power, fishing in the sea and large lakes was constrained by the wind and the capacity of human muscles, because boats had to navigate using either sales or paddles. Although sailing ships can be slow, they are generally cheap, reliable, and efficient. By the end of the age of sail in the late 1800s, giant iron clipper ships were each carrying up to 1 million pounds (454,000 kg) of cargo from China around Africa to England in 80–100 days (Jefferson 2014). Dried and salted codfish from the abundant fisheries of the north Atlantic coast of North America became a standard global commodity, neatly separated into different grades, and traded in standardized packages, feeding hundreds of thousands in markets from Stockholm to Calcutta (Kurlansky 1997).

Fish as Commodity

The 1870s saw a huge leap in the technology of fishing with the advent of steam power, followed shortly by large-scale steam packing of canned food and machinery to produce cheap ice for refrigeration (Longo et al. 2015). Seafood was on the way to becoming a mass commodity, a kind of nameless and uniform product identified with a corporation, a brand, and sometimes a region. The Romans discovered this

in their garum and liquamen industries: the market requires you to produce the same high-quality distinctive product year after year, so customers will know what they're getting when they buy a sealed clay amphora of a unique shape full of the precious sauce, made from fermented fish guts (Corcoran 1963; Ellis 2011).

Figure 4.1 **An assortment of ancient Roman amphorae from different ports and time periods in the Museu Nacional Arqueològic de Tarragona in Spain** (Source: Á. M. Felicísimo)

When any foodstuff becomes a standardized commodity, it is more easily traded because people know exactly what they're getting. Buying whole fish by the dockside or in a street market is a completely different experience because it requires a good deal of knowledge on the part of both the buyer and the seller. The buyer can look at the fish: are its eyes still bulging, or are they clouded and slightly shrunk? Are the gills still bright red, or have they faded? Was this fish caught in the polluted waters around the city, or out in the open ocean? All of these distinctions and signs of quality disappear in the world of commodities, and instead of buying a fish, you buy a can of tuna, a box of catfish fillets of a uniform size, or vacuum-packed breaded "fish sticks."

There are many tricks in the trade of fish when they become a commodity. A fish may be frozen and thawed two or even three times before it is sold, and labels do not have to tell you if the fish has been preserved with carbon monoxide, sodium tripolyphosphate, metabisulphate, or other common chemicals that "extend the life" of perishable foods. And who knows what gets into the mix when fish are ground up to make artificial crab? (See Chapter 5).

Supermarket fish departments know that when the fish starts to get old, it is time to cover them with bread crumbs, fry them and freeze them as "fish nuggets," marinate them in spices and sauces, or pass them along to the delicatessen counter. As prepared foods, none of these products needs to be labeled under current US laws. Retailers have often been accused of a kind of "recycling" by soaking spoiled meat and fish in bleach to kill the bad odor before putting them out to sell again. You can play speculative markets when you have commodity fish, holding them off the market to raise prices or gambling on what will happen to supply and demand the following year by trading commodity futures. Commodities can travel the world, while a gorgeously fresh trout caught that very morning can only be served close to the river.

On a global basis, the largest volume industrial seafood products are domesticated shrimp and fish grown through aquaculture, farms often owned and managed at a large scale by corporations that also process and sell the products. You can go into a supermarket anywhere in the world and find frozen farmed shrimp and salmon. Because aquaculture is efficient, you can find its products even in countries that have their own fishing industries. For example, in Belize, located on the Caribbean Sea with a long tradition of fishing and its own shrimp farms, supermarkets have freezers full of Norwegian salmon and Vietnamese pangasius (a kind of catfish, now the tenth most popular seafood in the United States), as well as wild-caught squid from Thailand. There are still some wild ocean seafoods that are marketed

	1980	% of total	2015	% of total
Capture: Freshwater	5.1	7.1	11.5	6.9
Capture: Oceans	62.1	86.4	81.2	48.5
Total Capture	67.2	93.5	92.6	55.4
Aquaculture: Freshwater	2.4	3.3	48.8	29.2
Aquaculture: Oceans	2.4	3.3	27.8	16.6
Total Aquaculture	4.7	6.5	76.6	45.8

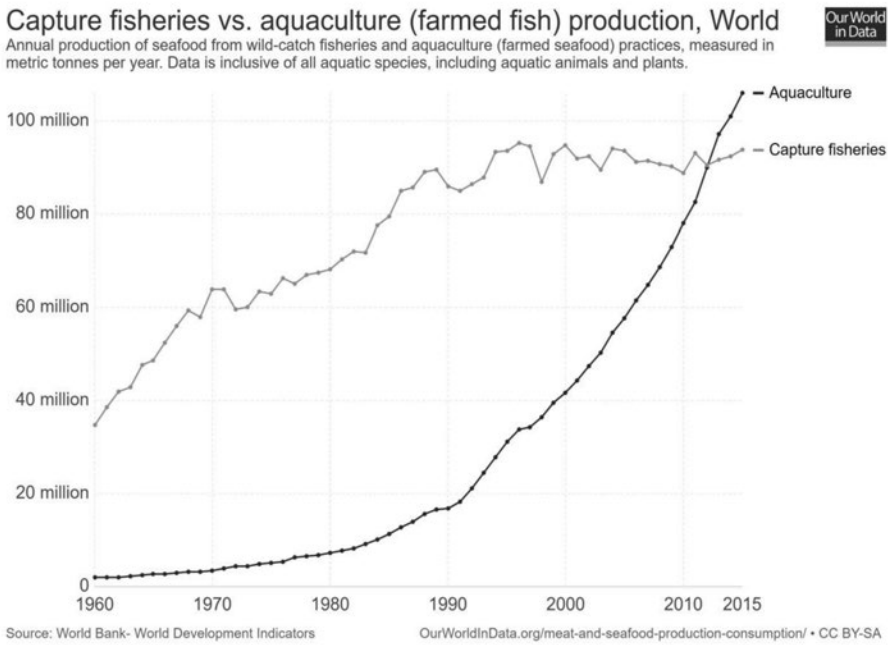

Figure 4.1 World Fish Production in millions of metric tons. Source: FAO 2017:xxii, chart by Ourworldindata.org

Figure 4.2 **World aquaculture production over time** (Sources: ourworldindata.org and the FAO)

competitively all around the world: key species are albacore tuna, squid, pollock, and mackerel.

Bioscience is helping companies domesticate and farm many new kinds of seafood, from cobia, striped bass, and tuna to clams and crabs. Some are grown from eggs and milt stripped from mature fish, while others, like tuna and eels, are caught as juveniles in the wild and then grown to market weight. Fish farms range from tiny ponds in a farmer's yard or a flooded rice paddy up to mega-sized salmon farms in huge net-enclosures fed by machines and constantly monitored by computerized instruments and fish veterinarians. The latest trends

in aquaculture include "offshore" fish farms enclosed by nets tethered in the open ocean, recirculating aquaculture systems (RAS) on dry land where water in large tanks is continuously cleaned and reused, and closed-loop systems that combine RAS with aquaponic farming, using the fish manure to fertilize crops, some of which can then be fed to the fish. Recirculating systems are still a relatively new technology, but they can be placed almost anywhere with a water supply and reliable electricity and they should have far less environmental impact than ocean-based farms. Soon you may be eating truly local seafood grown in a barn or factory in your town or city.

It is ironic that standardized commodities create a market niche for their very opposites, the local, the individual, fresh real fish produced and treated by individuals with faces and names. Your everyday sushi eater is happy with a slice of nice red maguro (tuna) in their maki roll bought at the supermarket. The rich do not want to eat Chicken of the Sea tuna fish in their salade niçoise; they want small slices of bluefin tuna from a tiny fishing village in Sardinia, hand-packed in freshly squeezed olive oil, garnished with a certain kind of small lemon that is only available for two months a year.

The real sushi connoisseur wants to know the exact species of tuna, where and when the fish was caught, how fat the flesh, and even who sliced it. Delicacies like sea limpets are eaten only by poor and local people who are willing to scavenge along the seashore, or by those educated well-traveled eaters who consider it a rare and expensive (and in many places illegal) delicacy, procured through personal connections. In contrast, most people in the middle classes are happy to eat frozen breaded fish sticks from the supermarket, which are assuredly normal and unremarkable, and send no message about poverty or elitism. Rising interest in ecology among some consumers helps explain the recent proliferation of programs like Community Supported Fisheries (CSF), where a small group of fishers deliver their fresh catches directly to a list of subscribers (Campbell 2008; NOAA 2012).

Technology and the Global Market

In many countries people have a choice between locally caught fresh fish and shellfish from a small shop or public market, or the standardized fillets they find in the supermarket either fresh or frozen. The processed supermarket item is usually quite a bit more expensive, and when you ask a buyer why they are willing to pay this extra price, they are most likely to say that they prefer it because it is cleaner, and they feel assured that it is not going to make them sick or have hidden bones. Processed food in general has attracted customers for generations because people are worried about their own and their families' health, and they are willing to pay more for food that they believe is safer because it is

more sanitary and better handled. This in turn has attracted the attention of large corporations, who have gradually taken a growing share of the seafood market, crowding out smaller firms and independent boat owners. Bigger companies want to have regular deliveries, so they can keep their processing plants running at a constant pace. They need to find huge schools of fish of the same species, which they can cheaply vacuum up from the ocean with the most efficient technology.

Today the fishing industry meets these demands in three different ways. First, companies may buy their own boats and hire captains and crews who are paid a regular salary when they catch their quota. Second, they can shoulder the expense of a huge factory ship, which has its own processing and packaging equipment and freezers, and complex machines that can skin and fillet the catch. This takes the factory to the fish rather than the fish to the factory. Third, a company can expand into the retail and restaurant trade or have long-term contracts with chain restaurants and franchises, so they always have a steady market. At an industrial scale, the fishing industry has a long history of exploiting a very low-paid workforce, at sea and in the processing factory, which is hired and fired as needed. Because they are driven by volume, and need a constant supply, industrial fishers tend to keep fishing, even when the schools of fish are in a steep decline. Their response is often to buy bigger boats and to use higher technology. Larger industries also have a lot more political clout and can lobby governments and regulators to maintain or increase their fishing quotas and territories. They can swing huge loans from banks in order to invest in high-tech equipment, and they can hire their own scientists who can dispute and challenge the science done by universities, conservation organizations, and government-sponsored researchers.

Governments often provide subsidies, cheap loans, and help with insurance to expand and "modernize" fishing fleets, encouraging ever larger and more expensive boats. In the meantime, older, less powerful, and more dangerous fishing boats get passed along to poorer areas, for less lucrative fisheries, and they may even end up in the shadowy world of illegal "outlaw" fishing (Couper et al. 2015; NY Times 2015). Today's large commercial fishing boats have powerful engines, radar, sonar, and global positioning system (GPS) navigation. They use satellite imagery and direct communication with forecasters to predict sea temperature, wind, and weather; they may use spotter airplanes or even drones to find aggregations of fish; and nets can now carry cameras and thermal sensors to directly monitor the catch. One of the latest developments is "pulse trawling," used by Dutch fishermen to catch Dover sole and other flatfish; a large net is towed behind the boat just above the sea bottom while electrodes on the net stun the fish, which then rise into the net. They claim this is

Figure 4.3 **Modern fishing boat—M.V.Northern Osprey, a Factory/Freezer Shrimp and Ground fish Trawler. Overall Length: 66.6 meters. Crew Accommodation: 36. Speed: 15 Knots** (Source: Dennis Jarvis)

environmentally friendly because they are not dragging a heavy trawl net across the bottom, which destroys much sea life. Conservation organizations and fishers and other nations are calling for a ban on this method (Stokstad 2018).

What is remarkable about the global fishing industry is that so many small boats and independent fishers have managed to survive centuries of pressure from governments and competition from large corporations. Remember that seafood is a wild resource, the only one that has remained an important part of the modern diet. Fish are elusive, unpredictable, and difficult to manage at a large scale.[1] Small boats and fishing companies have survived because there are still people who want fresh local fish, and because local fishers have a deep knowledge of the local ecosystem, they can find and exploit smaller and more variable stocks of seafood. They can also emphasize the quality and uniqueness of their product, but at the best of times they still have to remain flexible and may have to move to different fisheries or change their equipment and methods several times a year in order to remain productive. And let us not forget the millions of people who fish for recreation as well as the table, who help feed their families and communities.

We should also remember that commercial fishing of all kinds is a dangerous business. Even the most modern, well-equipped vessels, in waters where

rescue organizations operate, are regularly lost to unexpected weather and mechanical breakdowns. Statistics regularly show that fishing is high on the list of the most dangerous jobs, and every fishing community must deal with the possibility that boats will not return safely to port. Artisanal fisheries in poor countries are especially accident-prone because people use poor equipment and illegal methods like dynamite fishing and fish poisoning. In the lobster fishery on the Atlantic coast of Honduras, for example, men use old scuba tanks with just a plastic hose to their mouth and stones for weights, and because they do not use diving tables, many end up crippled or dead from "the bends," caused by nitrogen bubbling in their blood because of pressure changes (Izdepski 1994).

Globalization

The term globalization has many meanings in both academia and the popular press. At one extreme globalization means the total integration of all the world's cultures and countries into a single system. Used this way, globalization implies that the world is becoming a uniform place where local differences are gradually disappearing. People have suggested many different causes for this global integration, including mass media, the growth of the internet and social media, migration, financial markets, and increases in trade. This could be seen as a bright, democratic, and enlightened future, where everyone benefits and the reasons for conflict disappear, a kind of utopia (e.g., Friedman 2007). Others are horrified at the prospect that everyone will become alike, and predict that such a world will be dictatorial and oppressive, leaving everyone powerless and under the control of large corporations or a single world government. The film *The Matrix* expresses this dystopian future quite convincingly.

At the other extreme, globalization just brings cultures and countries into contact, and allows each one to develop in its own direction. The utopian version of this idea about globalization has everyone living in their own relatively self-sufficient communities but connected with each other in a way that allows the free flow of creative energy and scientific advances. There are two dystopian versions of this globalized future: in one, the persistence of basic differences between peoples and religions leads to unending conflict, a "clash of civilizations" (Huntington 1996). In the other, all differences become elaborate fakes, produced to attract tourists, sell "ethnic" artifacts, and delude people into thinking that they are distinct individuals when they are really just cogs in a giant machine (Ritzer 2000). It follows that culture will be like a fish stick—nothing more than another commodity.

What does globalization mean for the future of seafood? For many fishing communities, globalization means that large corporations take over a fishery;

standardize and regulate it in the name of science, efficiency and health, and concentrate on producing a standardized commodity. The interests of artisanal fishers, communities, and their culture are superseded by the need for economic growth, often in an effort to increase export earnings for the country as a whole. Nobody is interested in the unique histories of fishing villages and close emotional and social relationships with the sea. Those large corporations may justify their actions by stressing their accountability, and their concern for the health and safety of customers. In the meantime, local fishing communities are often told to turn their skills to tourism and eco-tourism and to get involved in environmental projects financed by foundations or international conservation organizations.

Another vision of globalization is based on newer concepts of sustainable economics, grounded in the ownership and stewardship of nature by communities that want to protect their way of life. This is still a form of globalization, because often the impetus comes from global organizations and educators inspired by models in other parts of the world. But in this case globalization means a growing consensus among many groups and peoples that a sustainable future for the worlds' oceans depends on fair trade, locally managed environmental conservation, and the value of unique flavors and specialties in a diverse world (Jacques 2006).

You may recognize the themes here are closely related to the centuries-long political struggle between those favoring free trade and protectionists who want to develop local production through regulations, tariffs, and tax policies (Trentmann 2009). The same dichotomy appears in the world of food policy, with neoliberal economists favoring free trade of food so that every country can specialize in the things that it produces most efficiently. They say that everyone should import their food if they can buy it more cheaply abroad than they can produce it at home. The other side rallies under the banners of food sovereignty and food security; that each country or region should control its own food economy, so they are not over-dependent on other countries.

Imagine a small country with unfertile farmland, inefficient farms, and old and inefficient fishing fleets, but lots of copper and oil. Food produced in this country is therefore expensive, especially because they have to import fertilizer, fishing equipment and machinery, and bring in teachers and experts to train their people. The free traders say this country is better off selling its copper and oil, and buying food from other countries that can produce it much more cheaply.[2]

Those in favor of food sovereignty argue that free trade destroys the local productive economy: it favors the rich who can buy imported food and ruins the livelihoods of small-scale farmers and fishers who cannot compete with imported products (Madeley 2000). We are also today seeing what happens when many countries pursue comparative advantage by producing oil, coffee, and frozen chicken.

When competition drags down prices in the world market, a country may not have enough money to buy food, and it no longer has the farmers and fisherfolk or the food industry they would need to go back to producing their own.

This has caused great hardship in countries like Nigeria and Haiti, which once produced enough surplus food to feed their country and export the rest (Andrae and Beckman 1985). When the World Bank and other institutions forced them to adopt neoliberal policies, food production plummeted and both countries had to import the bulk of their food. When economic hard times struck, neither country could go back to producing enough to feed themselves. The same thing happened in Mexico after the North American Free Trade Agreement (NAFTA) was signed in 1994. It was cheaper for Mexico to buy corn from the United States, which dropped huge numbers of rural Mexicans into poverty, driving a wave of migration to the United States (where many found work picking crops) and providing an opening for other cash crops like marijuana and opium poppies. It was also cheaper to import frozen squid from Thailand than to support a diverse but often inefficient Mexican fishing industry that produced fresh fish for the local market. The fishers who survived had to borrow huge amounts of money for larger boats and better technology, and they concentrated on fish like tuna and sardines that they could sell in the global market. Artisanal small-scale fishers have to operate in the margins, fishing high-value specialties like conch and sea cucumber or operating beyond the law (Salas et al. 2011).

It is important to recognize that culture and cuisine, as well as government and trade laws and policies, stand in the way of free trade and open markets for food. If fresh local seafood is a basic part of a local food culture, part of people's identity and heritage, they are going to resist blocks of frozen Thai squid or cans of mackerel, even if they are cheap. When people develop an elaborate local cuisine based on indigenous ingredients, they are also more likely to build a restaurant culture and attract culinary tourists in search of something local and authentic. This is why the food sovereignty movement is so closely tied to organizations like Slow Food who work to revive food economies that are part of local identity and history (Petrini 2015). The fast food burger (beef or fish) is a symbol of globalization: the local farmers market or the CSF organization is a statement of resistance to globalization.

Case Study: Commercial Fishing and Globalization

There are two important kinds of herring: Pacific and Atlantic. Both are migratory, pelagic fish, and many rely on them including whales, halibut, salmon, and humans. They spawn in coastal waters, often in huge numbers, but their migratory routes are capricious, changing unexpectedly. For reasons we still do not

understand, whole populations can disappear for decades or even hundreds of years. Although they appear in vast schools, they can be overfished to the point of local extinction. Because of their abundance, and because they are fatty and highly nutritious, they were early targets for commercial development.

Until the invention of a method for preserving herring, they were used only for fertilizer, or they could be pressed or boiled for lamp oil (which was smoky and smelly, but cheap). The Hanseatic League developed in the twelfth century as a group of traders and merchants on the Baltic and North Sea on the northern coasts of Europe (now the Netherlands, Germany, and Poland). Around 1400 AD they developed a method for preserving herring using salt and brine and packing them in barrels, using different recipes as the fish changed from lean to fat with the season. They had already developed a form of stable and reliable wooden sailing ship called a cog, between 15 and 25 meters long, and carrying up to 200 metric tons (Gardiner and Unger 1994). With political changes and new herring migration routes, the Netherlands became the dominant producer of salted herring in the sixteenth century, a major source of wealth that fueled Dutch expansion into a world power.

Consumption of fish was deeply embedded in the Catholic Church calendar of medieval and early modern Europe: meat consumption was banned during the Lenten fast, on Fridays throughout the year, and over time on an

Figure 4.4 **Author Wilk demonstrating the Dutch technique for eating a whole, lightly salted "green" herring in 1993** (Source: Anne Pyburn)

expanding list of saints' days and other holidays (Fagan 2007). This raised the demand for fish, met with salted fish for the common people, while those better off could afford fresh carp, pike, and other fish from the burgeoning fish farms along European rivers (many of which were managed by Catholic monks). Salted and pickled herring continues to be a favorite food in northern Europe, although more as a delicacy and holiday food than an everyday meal.

The story of herring in the northwestern Pacific embracing Japanese and Russian islands is similar. Large-scale herring fishing with new technologies like pound-trap nets contributed to the colonization and settlement of the Hokkaido and Sakhalin Islands in the eighteenth to nineteenth centuries. Herring fisheries expanded their operations to produce and export fishmeal fertilizers for distant farmers in North America and Europe. In the late half of the twentieth century, the main objective of herring fisheries shifted from the production of fishmeal fertilizers to the harvest of pre-spawning herring roe sacks, called kazunoko in Japan. This is a crunchy seasonal delicacy that is popular in Japanese sushi bars.

Because overfishing gradually destroyed the native stocks of herring in Japanese waters, today most kazunoko comes from the Pacific coast of Canada and southern Alaska. In order to preserve these stocks, the modern herring fishery on the Pacific coast is highly regulated: each fishing area has a quota. A limited number of fishing boats are allowed to compete for the quota in a rush triggered by the ripeness of the roe. The wild scene at the opening of the fishery was dramatized on National Geographic TV in the series "Alaskan Fish Wars" and "Combat Fishing." This system aims to ensure that every year enough fish are allowed to spawn, maintaining the total population. In the meantime, Japanese herring is still unregulated, so they have not recovered to the level of the late nineteenth and early twentieth centuries (Hamada 2014; Howell 1995; Thornton et al. 2010).

The herring fishery developed into one of the largest industries in late-nineteenth-century Japan. While approximately 75,000 metric tons of herring were harvested annually in the 1830s, the figure increased to 150,000 tons in the 1850s and peaked in 1897, when 975,000 tons of herring were taken. Instead of mechanization, the modern Japanese herring fishery used numerous set nets along the coastlines; these project out from the shore and channel the fish schools into pens from which they cannot escape. Unfortunately, they caught large schools of fish migrating before they could spawn, so the population declined rapidly and collapsed in 1956 in western Hokkaido and then in 1968 on the eastern coast. Beyond overfishing, the destruction of spawning grounds through coastal development and a rise in sea temperature contributed to this collapse (Hamada 2014; Kobayashi 2002).

Figure 4.5 **Different sizes, grades and forms of Kazunoko (herring roe) on display at Tsukiji market in Tokyo** (Source: Author Photo)

Today, Japan annually imports approximately between 50,000 and 80,000 metric tons of herring from Russia, the United States, Canada, and European nations. The fish is served as sashimi, and it is also grilled, boiled, dried, smoked, salted, flaked, and pickled using the bran left over from polishing rice. The high price of herring roe makes it very profitable for merchants and retailers, and it is reflected in the high prices paid to the fishing communities. Today, approximately 20,000 to 25,000 metric tons of herring roe are imported to Japan yearly (Burke and Phyne 2008; Thornton et al. 2010).

The state of Alaska and the province of British Columbia on the west coast of Canada developed their herring fisheries for export after Japan's domestic herring fishery collapsed. The limited entry fishery for herring is regulated using the computer models of population dynamics used by marine biologists to predict the maximum sustainable yield—the most that can be taken in a year without damaging the stock. They set the total amount of catch prior to the fishing season in the spring, and then carefully monitor the fishing boats to make sure they don't exceed their quota. However, because the boats use purse

seine nets to surround whole schools, many First Nations and Native Alaskan communities, which have a historical claim to the herring, are concerned about the long-term impacts.

These indigenous communities have long depended on herring as a source of food, but the herring are also part of their spiritual and cultural connection with the natural landscape (Thornton et al. 2010). They harvest the herring eggs in a very different way from the industrial purse seine nets. Coastal indigenous people, such as the Tlingit people of Sitka in southeast Alaska, set hemlock tree branches in shallow water as the herring spawning season approaches. Herring eggs naturally stick to fronds of seaweed until they hatch, so the Tlingit method creates an artificial spawning bed that catches only a fraction of the total. Gifts of herring eggs circulate between households, a good deal going to elders and to community members who have relocated to inland parts of the region (Sill and Lemons 2015). The bounty of herring and many other seafoods are an essential aspect of food security in indigenous communities, and the circulation of gifts ties communities together (Fabinyi et al. 2017).

The Tlingit way of harvesting herring eggs is sustainable because they do not kill the spawning herring and they harvest only the fraction of eggs they catch with branches. Like other coastal indigenous nations, they are concerned that the government's scientific management regime allows boats to haul in shoals of mature herring before they spawn. The high cash value of kazunoko as a delicacy in Japan has endangered an essential part of their food system, essentially displacing an important and nutritious part of the indigenous diet with a profitable luxury treat.

While imported herring fish and roe still play a major part of herring business in Japan, government-sponsored hatchery projects started to restore regional herring stocks in 1996. The set nets are rarely used any longer because shoals of spawning herring returning to shore are now too sparse. Inshore household fishers use gillnets, usually with a wider to allow small-size herring through the net. With the stable artificial production and release of hatchery-bred herring and community-based fishing management, there have been modest increases in herring harvests in recent years, although the catch is still very low from an historical perspective (Hamada 2014).

Globalization and the Fishing Industry

There is no question that modern industrial-scale fishing and aquaculture is providing relatively inexpensive and palatable food for billions of people. Shrimp, the most popular seafood in the United States (taking inflation into account), is cheaper today than it was thirty years ago even as consumption has continued to grow (Indexmundi). But is this level of production sustainable?

Can we continue to produce this much seafood without doing permanent harm to the natural environment? There are no easy answers, and there are strong arguments on both sides, but we know of a whole series of calamitous collapses of important fisheries, some species driven to the edge of extinction, and many fisheries scientists report that the majority of wild ocean seafood is already *at or over* the maximum sustainable yield (Probyn 2016; Greenberg 2011; Clover 2006). Many fisherfolk have watched as even well-protected coral reefs have died, and once fertile fisheries have become zones dominated by large, inedible jellyfish (Richardson et al. 2009; Lynam et al. 2006).

While aquaculture has grown dramatically, analysis shows that there has been a high price for this growth, particularly in poor countries where the natural environment has been devastated, rural communities have been displaced, and many workers have been exploited to the point that they have been called "sea slaves" (Marschke and Vandergeest 2016; Islam 2014). We have yet to see the consequences of releasing genetically modified fish and other organisms into nature, but already many damaging invasive species have escaped from fish farms.

Critics of globalization and the industrialization of food production have pointed to a general problem of extending the logic of the market, that everything should become property and be given a cash value, to the natural world: *externalities* (McCormack 2017). Corporations and producers will always seek to minimize their expenses, and if possible, make nature or someone else bear some of those costs. Instead of paying to safely dispose of their wastes, they will dump it into the ocean or dump it near poor communities. Instead of paying a living wage to their workers or provide pensions and healthcare, they will find powerless workers who are desperate for any kind of jobs. The result is that the price of their products does not reflect the *true cost* of making them. Those costs may be borne by future generations, who will have to deal with messes we made in our rush for discounts and bargains.

A particular kind of externality often found in food production is called *distancing* (Conca et al. 2002). Foods can pass through so many hands on their way to our plate, mixed and blended and cooked together with so many ingredients, that we end up with no connection back to its origin; we cannot ever know where it came from. Names and labels can be deceptive—they may convince us that the tuna in our sandwich comes from a company, a country, or a snappy mascot like Charlie the tuna, all of which are easier to visualize than a flapping, living 5 kg albacore fish caught in a net far away by overworked men in a rusty old boat. Everything in the food chain pushes us to a distance from the real people, the real oceans and farms where our food begins its journey. It is often impossible, even for experts, to figure out where a particular piece of fish, bag of mussels, or can of clam chowder actually came from, despite (or sometimes

because of) the weak and faulty laws that allows a company to label it "product of USA" when the bulk of the ingredients come from somewhere else.

Proponents of ethical and local food, researchers, and seafood certification organizations can be seen as attempting to shrink or bridge the distance between consumers and producers by demanding to know who produces their food, where and how it is produced (see Chapter 8). This means counteracting the efforts of marketers and advertisers who are constantly highlighting the benefits of eating seafood, while never mentioning the costs to the environment, health risks to consumers, or the suffering of workers.

One recent and shocking example of distancing reported by international news media in 2014, concerning labor abuses on offshore shrimp and tuna boats in Thailand. Many consumers in the United States and elsewhere in were shocked, and a social movement to boycott imported shrimps spread through social media (Pramod et al. 2014). This demonstrates that globalization can help solve conservation and social justice problems, because it makes it possible to connect people in different parts of the world who share ethical values, and motivate action. Seafood activists are now able to organize and publicize to challenge wrongdoing in production, distribution, consumption, and waste (Marschke and Vandergeest 2016; Chantavanich et al. 2016; Pramod et al. 2014). Nevertheless, labor abuses continue in many fisheries, and the mistreatment of workers in the Thai fishing industry has not been stopped by the publicity.

Globalization also spreads information about successes in co-management, and new methods and technologies for monitoring fish populations and testing the safety of seafoods. Satellite imagery and drones are now being used by governments and NGOs (like Sea Shepherds and Greenpeace) to track illegal fishing and bring violators to justice. Cheaper DNA testing has made it possible to identify the species and sources of some seafoods, even after they have been ground into paste. Globalization itself is neither good nor bad—the outcomes depend on what people do with new tools, markets, and resources.

Notes

1. The beef industry in contrast has become highly concentrated and dominated by only three large corporations; meat production, slaughter, processing, packaging, and distribution can be managed like any other factory system, where production and profits can be fairly regular and predictable (Horowitz 2005).
2. Economists are usually in favor of free trade because of what they call "comparative advantage." Rather than compete on a global market with more efficient producers in other countries, each country should concentrate on what it can produce most efficiently. Any basic macro economic textbook can explain this in much more detail, but remember that comparative advantage is a model based on an ideal world, rather than one riven with ideology, politics, nationalism, and religious oppression.

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5

FISH TRANSFORMERS

The Rise of the Krabmeat

Human have developed many technologies and techniques to acquire seafood, but methods for processing and preserving the bounty of the ocean have accumulated slowly through time. Only recently have we begun to understand the important role of fire in the evolution of human beings. Modifying foods to make them edible, tasty, and to last longer without spoiling allowed early humans to adapt to a wide range of new environments, expand their families and clans, and reduce the feast-or-famine rhythm of the year. A store of dried or smoked food meant security and gave people time for other pursuits; it allowed tribes and bands to spend longer periods in more permanent camps. Processed food is now taken for granted, but without diverse processing techniques, our food supplies would have been limited.

One of the characteristics that make seafood different from plant and meat foods is that most consumers do not usually know what the thing they are eating actually looked like in nature. We can easily envision cows, pigs, and the vegetables in our salads, but how do we connect a slice of smoked salmon or a tuna fish salad with a particular kind of fish? Unless you like fishing or live in or near coastal areas where fishmongers sell whole fishes, most seafood in the supermarket has been thoroughly processed to make its source unrecognizable. This makes it easy to mislabel food products, or to substitute a cheap product for one that is more expensive. More seriously, it raises questions about food safety and the presence of pollutants and contaminants that are becoming more common as our diet becomes distanced from its source, and filled with anonymous ingredients (Jacquet and Pauly 2008).

As discussed in Chapter 4, "distancing" is a concept developed in the growing field of sustainable consumption to describe the process of obscuring the origins of commodities (Princen et al. 2002). Distancing strips goods of their environmental and ethical information, and makes it difficult or impossible for people to connect the things they consume with their origins. In seafood commodity chains, products are often distanced by renaming them, or substituting a new ingredient for a familiar one. While the renaming of fish is well-known

and understood, there are more subtle forms of geographic distancing through the use of indefinite terminology like "Pacific," "freshwater," "and "oceanic." Using these generic terms breaks the connection between increasingly apocalyptic stories about the oceans in the press and on TV, and the denatured white frozen slabs people actually buy in the supermarket.

This chapter explores the cultural biography of *surimi*, a highly processed fish food product, illustrating some of the issues raised when fish is transformed from its natural state by industry. In Japan where the term surimi originates, a wide array of surimi products are common, but in the United States and other countries where surimi products were introduced more recently, they are often seen as imitations and cheap substitutes for "real" seafood (Mansfield 2003a). This raises the general question of how something fake becomes authentic, but it also exposes the way that concepts of authenticity are closely connected with legitimate fears about food safety and purity, and our concern that we are not getting what we pay for in the grocery store or the restaurant. Surimi is more than fish, but less than seafood. Just as a breaking wave blurs a boundary between land and sea, surimi circulates in the seafood system as a transforming, intermediary food that makes it difficult for us to determine its authenticity.

What Is Surimi?

Surimi, broadly defined, is both a processed ingredient and finished product. Generally, fish are processed and then frozen raw; then they are packed, and shipped to factories where surimi pastes are made, and then this is often repacked and shipped to other companies which cook the final product and package it for retail sale. Artificial crab, lobster, and other seafood products bought in the supermarket are like many sausages, already cooked and ready to eat.

Surimi is minced fish mixed with other substances to change its color, texture, and flavor. Fresh or thawed fish are first washed, gutted, de-headed and skinned, before chopping and grinding transforms them into a paste. A chemical leaching process removes flavor and odor components from raw surimi, which makes it more versatile as a protein-rich base. This is mixed with salt, sugar, anti-freezing (cryoprotectant) sugar compounds like sucrose and sorbitol, water, starch derived from grains or tubers, and then artificial and/or natural colorants and flavorings. Cryoprotectant additives prevent the fish cells and tissues from turning into unappetizing slush after being frozen and thawed—until they were invented, surimi could not become a genuinely global convenience food (Sonu 2002).

Raw surimi has almost no flavor of its own, but the texture is very important and is carefully controlled. The most important rheological property of surimi

is elasticity, or what Japanese food scientists and engineers call *ashi*. When you bite into the surimi, it should give some resistance and then snap (Shimizu and Shimizu 1960).

The industrialized surimi-making process was refined in 1969 by Nishitani Yōsuke of Japan's Hokkaidō Fisheries Experiment Institute to utilize a surplus of fish, to revitalize Japan's fish industry, and to make use of unwanted species, which used to be called "fodder fish." The surimi seafood that we see and consume today became globalized when on-vessel cleaning and freezing technology developed in the 1960s. Having the processing machinery on board the fishing vessel made it possible to utilize everything that came up in the nets. The automated system accelerated mass production to meet with increasing demands (Nishioka 2009).

Two to three million tons of fish from around the world, amounting to 2–3 percent of the world fisheries' supply, are used for the production of surimi and surimi-based products. The United States and Japan are major producers. Thailand has become an important producer, and China is also a major player. Many newcomers to the surimi industry have emerged, including Lithuania, Vietnam, Chile, the Faroe Islands, France, and Malaysia. While surimi was originally made from local fish in each part of Japan, as production increased to an industrial scale, the dominant ingredient became the Alaska pollock (Bailey 2013).

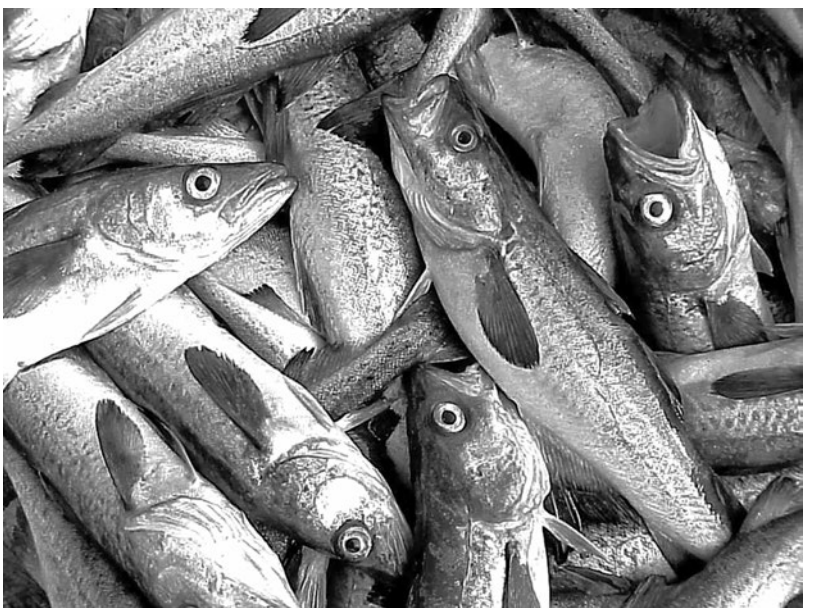

Figure 5.1 **Alaska (Walleye) Pollock (Theragra chalcogramma), each about 14 inches (36 cm) long** (Source: Alaska Fisheries Science Center, NOAA Fisheries)

This fish, a member of the cod family, with similar white flesh, was relatively unexploited until the 1970s, and as the stocks of Atlantic cod crashed during that decade because of overfishing and environmental change, the Alaska pollock quickly replaced it, and it remains the largest single fishery for deep ocean white-fleshed fish. Today if you have a fast food fish sandwich, fish sticks, or fish tacos, you are likely to be eating Alaska pollock. Catches peaked at about 7 million metric tons in the late 1980s, and they continue today at a level between 3 and 4 million tons a year. While some authorities deem the fishery an example of good management and sustainability, others point to signs of impending collapse and call for a dramatic reduction in the catch. As climate change warms the water in the North Pacific, we are also seeing dramatic changes in the location and abundance of the schools of pollock (Reed et al. 2011; Bailey 2013).

In some ways the Alaska pollock has become the marine equivalent of corn, a product ubiquitous in the industrial diet but rarely eaten in its raw form. Instead the pollock is a generic fish that appears in many guises in products without any specific identification, such as where it came from, how it was caught and by whom, and where it was processed. It is most often sold in the form of frozen blocks of fillets; whole fillets that have only been frozen once are used in more expensive products and surimi, while crushed or partial fillets and trim pieces that have been frozen, thawed, and frozen again are used for breaded and battered fish sticks and cakes.

Other Highly Processed Fish Products

Outside of Japan, Norwegian fish pudding (*fiskegrot*) and fish cake are similar products made from processed fish and starch as well as other ingredients. Like Japanese surimi-based products, whitefish such as haddock is used, and shark is often mixed as an ingredient as well, but the Norwegians prefer a softer and smoother texture than the Japanese, and they use additives derived from milk. The variety served in the Faroe Islands (*knettir*) includes mutton fat as a binder.

All through Asia chopped fish and other seafood are processed into many forms including fish balls, fish sausages, and dried fish snacks. In each country there are specific recipes and preferences for particular kinds of fish species, and the processed fish products are prepared and cooked in many different ways including marinating, smoking, drying, salting, grilling, steaming, frying, baking, boiling, and cooking at the table in a hot pot. Many different kinds of flavorings and additives are used to change the texture, color, and taste of manufactured fish products. Most were originally developed as a means of preserving fish in the absence of refrigeration, but those earlier forms have tended to become rare luxuries as modern forms of packaging and freezing grew common.

China is home to the largest variety of highly processed fish products in the world, and many cities and provinces have their own preferences and signature products distinguished by their ingredients, taste, color, and texture. Mostly featured in soups, they range from the size of peas up to the fist-sized golden fish ball called Cheung Chau. Fish balls are especially popular in the Philippines as a street food, often served with a sweet and spicy sauce.

Another category of processed seafood is created by fermentation; throughout East and Southeast Asia there is a bewildering variety of liquid fermented sauces that appear in jars and bottles, and in more solid forms as blocks and pastes. Malaysian cooking would lose much of its character without the use of belacan, with or without added chili. Other fermented fish and seafood products include the infamous Swedish Surströmming, a fermented herring product usually sold in cans, which bulge out from gas pressure when the product is ready to eat (buyers are generally warned to open the cans outdoors). It has a strong ammonia smell that puts off foreigners, much like Kæstur hákarl, which is fermented and dried Greenland shark that is considered a national dish in Iceland. In Japan, *funazushi* (fermented carp) is an expensive luxury. The raw fish are salted for one year, dried, and then packed in rice for three years—like many fermented foods funazushi contains lactic acids and a small amount of alcohol and it has a strong aroma that some Western people liken to blue cheese. Fermented fish is also featured in traditional cuisines in Egypt, India, and Korea. Most North Americans have unwittingly consumed fermented anchovies, a fundamental ingredient in Worcestershire sauce (Ruddle and Ishige 2010; Shephard 2006).

The original surimi-like seafood in Japan is called *kamaboko*, with the earliest recorded production in 1115, from a drawing that shows kamaboko on a tray at a feast (Shimizu 1982; Okada 1983). Although the name kamaboko was once specific to a single recipe, it is now produced in various shapes and types, and they are consumed in a variety of ways at both everyday meals and special occasions.

Kamaboko manufacturers use low value fish species that are considered not suitable for fresh consumption. Raw fish materials used for kamaboko differ from one region of Japan to another. In Osaka, where Hamada now works, croakers (*guchi*) and conger pikes (*hamo*) used to be the main ingredients for kamaboko. However, croakers became scarce and conger pikes became a highly prized delicacy, so today golden threadfin bream (*itoyori*) and Alaska pollock are mainly used. There are also regional differences in processing and cooking methods. For at least 300 years steaming was preferred in the Tokyo area, while baking is still predominant in Osaka and Kyoto.

Figure 5.2 **(Above) Belacan (Blachen) shrimp paste products for sale in Seattle; (Below) Unwrapped Belacan (Terasi) shrimp paste from Bangka Island, Indonesia** (Source: (Above) Tim Mansfield; (Below) Taman Renyah)

Figure 5.3 **A plate of sliced Japanese Kamaboko** (Source: Author Photo)

While fish pastes like kamaboko and fish balls are available in many Asian countries, Japanese fish sausage has a unique cultural biography. It is not smoked like pork and beef sausages, but added smoke flavoring make it taste like a Western smoked sausage. It is usually packed in plastic film, not the intestines of animals like traditional Western sausage. Europeans might see it as fake sausage, but they were inexpensive and popular in Japan when ham and pork sausages were still considered exotic and expensive. However, fish sausage did play an important role by introducing the form of the sausage, which made it easier for Japanese consumers to make the transition to a more meat-based diet in Japan (Hatanaka 2013: 48–49).

The development of fish sausage production and consumption was partially a by-product of the postwar expansion of US international agribusiness and nuclear geopolitics in the Pacific. Fish sausage became a popular school meal item in Japan when the country was trying to overcome food shortages after World War II. They imported surplus American wheat, because of demands by the bureaucrats in the US Army of occupation. The wheat was used to manufacture bread to replace the rice in traditional school meals, and the fish sausage was a convenient and cheap side dish, which had a Western form but Japanese content.

The biography of fish sausage was also shaped by Cold War politics. In 1954, a Japanese tuna fishing vessel, *No. 5 Fukuryu Maru*, was contaminated with radiation after the United States conducted a nuclear test on Bikini Atoll in the Marshall Islands, a US territory. The news of this radioactive exposure spread quickly and the market price of tuna in Japan plummeted. Companies bought up the surplus at a low price and turned it into fish sausage, a form of distancing that deceived consumers into thinking they were eating something other than the radioactive fish. When the reputation and price of tuna eventually recovered, they began to use other common and inexpensive fish such as dogfish, jack mackerel, and squid, which changed the taste and texture in ways that consumers found less appetizing (Okada 1987).

Is Surimi Real Seafood?

For the food processing and marketing industry, surimi is an ideal product; it can be made from the cheapest available raw materials, kept virtually forever in frozen storage, and processed with different colors and flavors to imitate more expensive products that fit into local and national cuisines. From the point of view of the consumer, surimi is relatively cheap compared to other fresh seafood, it is easy to prepare and serve because it has no bones or skin, and it tastes sweet rather than fishy. It is an easy way to add what appears to be healthy seafood to a diet without learning a lot about seafood and how to cook it.

From an environmental perspective surimi has pluses and minuses. On one hand it reduces the waste of bycatch, and takes some of the pressure off of heavily fished high-value species like crabs and sea bass. On the other hand, it may increase the total amount of wild seafood eaten at a time when we may be reaching the limits of what can be taken from the ocean. Surimi products have also made it economical to build and operate huge factory ships that may drive the Alaskan pollock fishery into the same oblivion that overtook Atlantic cod.

One unexpected environmental benefit of surimi is that it can substitute for higher status foods from depleted fisheries. Shark fin soup is a well-known delicacy in Chinese and other East Asian cuisines; the shark fin lends a thick chewy and sinewy texture to the soup rather than a strong flavor. The soup is also reputed to boost sexual potency, improve the skin, lower cholesterol, and increase energy. The demand for shark fins, however has been driving many species into extinction through the noxious practice of "finning," where the fins are cut off and the shark is thrown back to die in the water. More recently studies have found that shark fins can contain dangerous amounts of cadmium and mercury. The fake fins are made from collagens extracted and restructured from shark skins and bones with additional ingredients including ham, pigskin, mushrooms, seaweeds, and *konyaku* (indigestible starch made from a Japanese

lily root); they are at least partially responsible for what appears to be a decrease in the shark fin trade (Nishioka 2009: 70; CNN 2011). Today you can even buy instant imitation shark fin ramen (Galbraith 2017).

When surimi was first introduced into the United States, many gourmets and chefs derided it as fake food with little taste and a boring uniform texture. But over time surimi products have gained acceptance and lost their stigma as fake or imitation food, and many consumers now expect to see it in low-priced fish salads, soups, stews, and even traditional dishes like chowders and jambalaya. Like all heavily processed foods, however, surimi raises questions about the sources and safety of ingredients. Food safety has become a major concern for people all over the world, with particularly intense controversy in East Asia and Western Europe where there have been highly publicized incidents of contamination, poisoning, and food counterfeiting (Wertheim-Heck 2015; Merrifield 2017).

While a whole fish lying on ice in the fish market may have undetectable amounts of heavy metals or pesticide residue, at least the buyer can assess the freshness of the fish and ask where it came from. Packaged frozen surimi, on the other hand, has a "scientific" list of ingredients, but some of the contents are unknown to the average shopper, and if they mistrust the manufacturer, the package is no more credible than an unknown butcher behind the fish counter. While in the US most shoppers seem to be satisfied with the assurances of the label, in many other parts of the world the fish sold in a supermarket has less credibility than that found in traditional wet markets and neighborhood fish stores, where the buyer knows the seller and can examine the merchandise.

Industrialized fish products like surimi also lack the kind of local identity that lends flavor to home cooking and connects people with the particulars of a local environment. The homogenization of surimi offers convenience and economy, but its bland flavor is a form of what Ritzer calls "McDonaldization" and the "globalization of nothing" (Ritzer 2003). The uniformity of all industrial food has provoked backlash in many parts of the world in forms like Slow Food, the revitalization of local farm and fishing economies, and an increased focus on cuisines that have deep historical and cultural roots (Mansfield 2003a, 2003b; Weiss 2012; Trubek 2008). Globalization often goes hand in hand with the revitalization of local food, even though they may appear to be opposites (Wilk 2007). In this indirect way, the advancement of fisheries technologies and the standardization of fish products promotes the revaluing of wild and fresh fish products, while farm-raised and hatchery-bred and stocked fish tend to occupy the middle ground (e.g., Takahashi 2014).

So is surimi fake or real? Authenticity turns out to be complex and very subjective, and it has many different meanings. Authentic recipe, authentic

ingredients, authentic tools, authentic settings—there are many ways a sense of authenticity can be created and reproduced in a modern marketplace (Bruner 1994). Surimi can be considered authentic seafood in Japan, where it has a historical connection to traditionally crafted kamaboko. The very same package can be denigrated as fake crab in a high-end seafood restaurant in the United States, while it is perfectly acceptable in a Subway seafood salad sandwich. Nobody in the United States thinks of canned tuna as "fake" although it is also homogenized, anonymous, and industrially produced.

The seafood industry certainly wants to avoid the perception that surimi is fake seafood. In Canada the labels of surimi products can now say "crab-flavored fish" and "lobster-flavored fish" instead of "imitation." The "imitation" label was also removed in the United States in 2006, and labels now promote Krab's nutritional and functional value as "crab-flavored seafood, made with surimi, a fully cooked fish protein." Surimi seafood consumption in the United States did increase slightly after the labels were changed, but the industry may have overestimated the importance of authenticity to consumers. Convenience and a reasonable price, plus a mild flavor and a familiar texture may make artificially shaped, colored, flavored, and textured fish products more popular than any fillet, fish steak or whole fish.

Concluding—No Easy Answers

Can such a difficult balancing issue between cultural and environmental sustainability be solved with technological fix? Eel populations are in a rapid decline all over the world. In Japan, a university research team developed a technology and technique to use catfish as a substitute for *kabayaki*-style grilled eels (Noda-Terazima and Hagiuda 2014). Catfish is certainly nutritious, and it is relatively cheap because it is now farmed successfully in so many countries. But like many technological solutions to environmental problems, this substitution is imperfect. Real kabayaki lovers know that the fat from cooking eels is an essential part of the sauce, and the best sauces have been created through generations of cooking and mixing. Without eels, the kabayaki loses its flavor, and the thousands of artisans and chefs in small restaurants and bars lose their jobs. Instead of switching to catfish, most Japanese producers have switched to using eels imported from Southeast Asia, Australia, and even Africa.

The lesson seems to be that free markets and large corporations are not always the best qualified institutions to manage a fragile wild resource. Large-scale commercialization is always caught in a bind between maintaining or increasing profits and a resource that has natural limits. While small communities and artisanal producers are capable of managing resources in sustainable ways, their products are always going to be expensive, and they will not feed a mass-market looking

for cheap protein. In practice, fisheries are pressured by both high demand for large amounts of cheap food, and by high-end specialty production for a voracious luxury market. Simply setting aside reserves, marine parks and protected areas cannot address this squeeze created by markets and demand.

The tools that small communities use to maintain their marine resources are vulnerable to free riders, corruption, and invasions by outside fishers and industries, so those very artisans and communities can become agents of destruction. At the same time, government regulation of fisheries, even with the best possible scientific advice, is a blunt and imperfect tool that has had some spectacular failures. Government bureaus and fishery managers are in many places corruptible, and even in developed countries they often give in to pressure from industry, even when they know there will be bad consequences. And in the vast oceans it can be very difficult and expensive to try to catch those who violate laws, regulations that often cannot be enforced outside the coastal zone.

The best hope we have is for the emergence of co-management by coalitions of fishers, marine scientists, conservation organizations and government agencies. We can also find some optimism in the new tools for monitoring fishing provided by satellites and drones, and by the continuing work of conservation organizations like Greenpeace and Sea Shepherds. Concerned citizens have the power to organize buycotts, raise public awareness, lobby politicians, and call attention to local environmental problems and issues.

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6

FEEDING OUR APPETITES AND TASTES

In 2014 the fishing industry caught 93.4 million tons of wild fish and shellfish, at a time when about one-third of fisheries stocks are considered overfished and are clearly unsustainable. At the same time ocean pollution, mostly from farming, has created many "dead zones" without enough oxygen to support any sea life, while climate change has reduced the oxygen content of the entire ocean, also increasing its acidity. Others are sounding the alarm about plastic pollution in the ocean and the possibility that micro-particles of plastic are in much of the food we eat (facts still in dispute). Nevertheless a growing population and increasing levels of prosperity tend to increase the demand for fish, which cannot be met entirely by aquaculture (see Chapter 4).

People have been using aquatic resources for nonfood purposes for thousands of years as well, in fertilizer, animal feed, medicine, lubricating oil, and hundreds of other products. Anything from pudding to pastry is likely to contain agar, alginate, and carrageenan from seaweed as thickening agents, while other seaweed products turn up in cosmetics, plastics, and even dog food. This chapter focuses on some of the connections between culture, aquaculture, and industry, and we use the concept of "taste" to show how cultures are bound together with ecosystems, so that the fate of the ocean is connected to our bodies and our perceptions of the world. While there is clearly a biological substrate for taste—even newborn babies make a face when they taste something bitter—a lot depends on the particular flavors favored by each culture. You may have grown up eating a variety of cheese (fermented milk), but you would probably find fermented fish disgusting, or vice versa. As we point out in Chapter 2, taste is also instructed by class and status, and it reflects gendered identities as well. In turn, these tastes affect how we use resources from the sea, and increasingly the kinds of things we produce through aquaculture.

Aquaculture and Food Security

Human populations have grown rapidly over the last century, and anthropologists use the word "intensification" to explain how technologies change and

develop to increase production under the pressure of a growing population (Boserup 1965). The development of large-scale fish farming, often glossed as the *blue revolution*, is a good example of intensification, maintaining seafood consumption for a growing population that could no longer be fed from wild resources (e.g., Bisbee 1993).

Another way to think about the relationship between population and consumption is with the concept of *food security*. According to the Food and Agriculture Organization (FAO), food security is "when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life." Article 2 on the FAO Code of Conduct for Responsible Fisheries promotes the contribution of fisheries to enhance food security and food quality, giving priority to the nutritional needs of local communities. Article 11.9 also declares, "States should encourage the use of fish for human consumption and promote consumption of fish whenever appropriate" (Tacon and Metian 2009a: 300). According to this definition, accepted by most of the world's nations, a just and ethical world must supply adequate fish and seafood to everyone.

Earlier generations of population scientists, drawing on the work of the eighteenth-century English cleric Thomas Malthus, thought that mortality would create a balance between food production and population growth. In other words, population would always grow faster than food production, until people began to starve and die, so their numbers would level off. This kind of population pressure on local resources has certainly happened in some places, but the causes of famine and starvation are overwhelmingly political and economic rather than being caused by climate or crop failures (Sen 1982; Wilk n.d.). Instead, a combination of social and economic pressures has enabled a continuing advance in production to keep up with population, although some people are still a lot better fed than others. As many critics have pointed out, this has depended not just on improved technology, but on using up large amounts of fossil fuel as a source of energy, a sort of *subsidy from nature*, and there are limits on how much fossil fuel we can pump out of the ground to keep this going.

As it has turned out, long before we have run out of fossil fuel, burning it has changed the atmosphere in dramatic ways that are transforming the climate and raising sea levels. The sea and the forests have provided another kind of subsidy, a support that has allowed us to feed and house people cheaply; modern civilization is as much based on cheap paper products as it is on cheap food. Long before we have pumped all the oil, it looks like we have run into natural limits on many forest and marine resources.

Seafood is a luxury for most of the world, even some of those who live close to bodies of water. At the same time more than a billion people have risen out of

poverty in the last twenty-five years, becoming middle-income consumers who can afford much more meat and seafood in their diets. The poor continue to eat a mostly vegetarian diet, but demand for seafood is growing rapidly because of dramatic increases in income and standards of living in South Asia, China, and significant parts of Latin America. It turns out that taste, the desire for meat and seafood, is a more powerful force in driving aquaculture than simple population growth. If people in the United States will pay more for a lobster tail from Honduras, then people in Honduras are out of luck when they want a lobster dinner. Domestic and wild seafood, in this age of cheap transportation, gravitates toward the place where it has the most value. Later in this chapter we will survey some of the new methods for seafood production that create new hazards and have often unexpected consequences.

Non-food Use of Aquatic Resources

Aquaculture has benefits and costs, opportunities, and risks. Supporters say aquaculture is the only way to keep seafood cheap enough to be part of the daily diet for billions. They argue that aquaculture is less wasteful, uses less fossil fuel, and does less damage to the natural environment while it eases pressure on wild fisheries. Aquaculture also offers a relatively stable supply of animal proteins compared to the booms and crashes common in wild fisheries. As a business, aquaculture provides employment in poor areas, and a business opportunity for ambitious entrepreneurs in developed countries. Furthermore it can be much more easily policed and controlled than ocean fisheries, and it is an efficient way to use land and water resources that would otherwise be wasted.

Of course there is inevitably another, darker side of the story. If we look at world of fishing production statistics by nation, countries like Chile and Peru appear among the top of the list. However, the domestic consumption of seafood in those South American nations is not as high as we would expect because their largest catch is destined to become fishmeal for aquaculture, pig, and chicken feed or pet food. Peruvian anchovies are the largest single fishery in the world (between 4.2 and 8.3 million metric tons per year), but not because people eat a lot of anchovies (less than 1 percent are eaten by humans); instead they become industrial raw material. The anchovy harvest is called a *reduction fishery* because a whole fish is processed and broken down into fish protein concentrate, dry meal and oil.

Besides its use as a food supplement, fish oil is used for leather tanning, soapmaking, and glycerol production. Glycerol in turn is used in food as a humectant, solvent, and sweetener, and a filler in low-fat foods. Glycerol also finds its way into cosmetics, toothpaste, skin, and hair care products and even the liquid used in e-cigarettes and sex lubricants. Oil from anchovies can turn up

in dynamite and TNT explosives and nitroglycerin pills for relieving the pain of angina in the heart. The development of commercial reduction fisheries dates back to the nineteenth century, but they rapidly increased in scale after the 1950s. While only 8 percent of the total world fishery landings was reduced to fishmeal and fish oil back then, the proportion is well over 30 percent today (Watson et al. 2006).

Aquaculture as we know it today could never have developed without the large-scale operation of reduction fishery. Because the Peruvian anchovy harvest has peaked, waste from fish processing and other low value fish have ended up in the grinder to meet the increased demand for fish feed. One nongovernmental organization (NGO) reports that tropical reef fish, including clownfish (the famous Nemo of the animated film of the same name), are now being reduced to fishmeal for fish and shrimp farming in Southeast Asia (Gillis 2012).

Environmentalists and fishing communities raise other important questions about fish farming as a sustainable source of food. Domestic fish escape from their pens and spread disease among wild populations. Effluent (mostly feces) from fish and shrimp farms often ends up in nearby bodies of water, where they spur the growth of algae, bacteria, and phytoplankton, consuming oxygen and killing fish. Fish and shrimp farms also turned out to be great breeding grounds for parasites, bacteria, and viruses that can spread to wild populations. In some places, for example coastal Belize, shrimp farmers just buy another piece of land and dig new ponds when their farm gets infected and the shrimp die, but elsewhere they use antibiotics, which may leave residue in the product. Recently the US government has refused entry to a number of shipments of shrimp from China and Vietnam because of high levels of antibiotic residue. In response, new methods of green fish farming are being developed that use recycled filtered water and recycle their effluent as fertilizer.

Skeptics of the development of industrial aquaculture also worried that the abundance of cheap farmed fish, such as Atlantic salmon, will lull shoppers into thinking that ocean resources are in good shape, and keep them from recognizing the endangered status of wild salmon. How could salmon be in trouble when there is so much of it for sale in the supermarket? If farming salmon promotes public apathy among consumers, people will pay less attention to incidents like the recent approval of a giant copper and gold mine adjacent to the Bristol Bay in Alaska, which poses great danger to some of the largest remaining populations of wild salmon (Mordant 2018; Save 2018). Nor does aquaculture help preserve indigenous and small-scale local fisheries and the communities that depend upon them, often the poorest people with the most need for food and income. Finally, as a form of mass production aquaculture too readily becomes a symbol of the human conquest of nature, promoting a kind of intoxication

with technology and the belief that every problem can be solved by some bright entrepreneurs and a killer app. This kind of hubris has led to major catastrophes in the past, reminding us that human powers have limits.

Resistance in the Name of Taste

In 1996, Croatians borrowed techniques developed in Australia for feeding captive bluefin tuna and opened the first "tuna ranch" in the Adriatic Sea. In this system, a net is used to capture a large school of young tuna, which is then transferred to giant floating sea cages, where for months—and even years—they are fed oily fish such as anchovies or sardines to give their flesh the high fat content so prized in Japan (Montagne 2007). This makes economic sense because of the high price of bluefin tuna flesh. The question is, will this save endangered wild tuna stocks from extinction, while allowing gourmets to continue to enjoy eating them? Is this finally a win-win solution for the environment?

Once again there are some unexpected problems. Producing cheaper bluefin tuna meat does not displace the wild fish, just as the availability of cheaper salmon from farms did not diminish the demand for wild salmon, and may have actually increased it. Now people with money treat wild salmon and wild bluefin tuna as superior choices, tasting better and probably better for you. This is how luxury markets work: having a cheaper version actually raises demand for the higher-priced variety. You end up expanding the market for tuna, not limiting it. You are enabling larger numbers of people to develop taste for something they may not have tried before, people who might then want to "move up" to the more expensive wild fish. Furthermore bluefin tuna, like eels, are farmed by catching wild fish at a point in their lifecycle when they are very fragile and easily killed, and before they can spawn. Research teams in Japan have been working for more than thirty years to raise tuna from eggs and spawn, but still only one percent of hatched eggs survive to adulthood (Ito 2016). Despite their marketing efforts, consumers still much prefer the wild bluefin, which is in deep trouble all around the world due to overfishing and the failure of international regulation.

While people often seem set in their ways, sticking to the tastes of their childhood, we also know that people can pick up new tastes very quickly, and we live in a consumer culture where fads and fashions extend throughout the supermarket and restaurant industries. People want familiarity and comfort food, but they also enjoy the adventure and challenge of finding new flavors and exotic venues. The practice of renaming provides many examples of how fluid and changeable tastes can be. Marketers know that it is easier to sell something that sounds good; "bubble tea" sells much better than "very sweet tea with little chewy balls of tapioca."

There is a long history of changing the names of fish to make them more salable on the market. The Patagonian toothfish, an ugly black deep-water fish from the southern Pacific, was renamed "Chilean sea bass" in the 1970s and quickly became a favorite of restaurant chefs for its firm texture and mild flavor. Unfortunately, most of the populations were fished into oblivion, and more recently the even uglier snake mackerel, sold as "butterfish" or "white tuna," has taken its place. One major problem is that if you eat too much of it, its wax ester content can cause stomach cramps and diarrhea.

Some other famous sleight of hand with fish names are the branding of spiny dogfish as "rock salmon," of carp as "lake salmon," and the tail of the very ugly bottom dwelling goosefish has become monkfish, or in French, *gigot de mer*, which means "leg of lamb of the sea" (Shulman 2015). Puffer fish, famous in Japan (as *fugu*) because parts of the fish are so poisonous that chefs need training and a license to prepare it, used to be very popular in the eastern US as "sea squab," and more recently the slime head became "orange roughy." Aware of the danger of overfishing popular species, a group in the United States called the Chefs Collaborative has begun to sponsor what they call "trash fish dinners," where skilled chefs prepare fish that are normally thrown away as trash or bycatch, to get people to broaden their taste and thereby reduce pressure on the popular species. Once again, we see that taste and fashion have direct effects on the marine environment.

Fresh or Frozen

Why do we want to keep food fresh? It turns out that freshness is a very complex idea, with very different meanings for different groups of people, and applied to diverse kinds of food (Freidberg 2009: 4). We may want fresh foods to connect ourselves closer to nature, which we imagine as pure, clean, "uncivilized" space far from toxic industry and human civilization. Freshness also implies a short connection between the producer and the consumer. However, as much as we want things fresh, we also want foods to be convenient, attractive, safe and cheap. Sometimes freshness is no more than a marketing device, as meaningless as the word "natural."

The preoccupation with freshness in food culture and economy emerged during the rise of mass consumer culture in the nineteenth century, as both proof of and an antidote to modernity and progress. In her book, *Fresh*, Suzanne Friedberg discusses the advent of refrigeration at the end of the nineteenth century, when it was just as controversial as genetically modified foods are today. Consumers blamed cold storage for high prices and rotten eggs, and doctors and health gurus claimed that refrigeration destroyed all nutritive value in food. However, aggressive marketing, advances in technology, and new ideas

about health and hygiene ultimately overcame this distrust (Freidberg 2009). In the case of fish, people have gradually come to accept that something can be fresh and frozen at the same time.

A preoccupation with freshness, although it is dear to advocates of local food, may be bad for the environment. *National Geographic*, for example, report that choosing frozen rather than fresh could reduce the environmental impact of eating fish (2010). Remember that live or very fresh fish require very fast transportation, often by air freight. Frozen and processed products can move more slowly on more efficient ships, railways, and trucks. Frozen food is also less likely to spoil quickly and end up thrown away, wasted, and it also makes portion control much easier (Martindale 2014).

What is good for the consumer is not always good for the producer, however. Cheap farm-raised frozen fish is convenient, but it may cut into the business of professional ocean fishers by undercutting market price, or it could encourage them to cut corners on safety or even break rules and regulations. Some also argue that frozen farmed seafood distances people from the experience of nature, particularly the sense and knowledge of seasonality and ecological cycles in natural populations. Fish is a natural product after all, and when it appears in uniform six-ounce rectangular portions with no skin or bones, it looks more like an industrial substance, the kind we get from giant factory ships that may stay at sea for months at a time, vacuuming up sea life and turning it into anonymous slices of flesh. A strong market for diverse fresh fish supports small producers who can emphasize quality over price (Griffith et al. 2013).

The global trade of fresh and frozen seafood began to increase rapidly around 1985, the beginning of a trading system where prosperous countries both import and export seafood in what has been called "The Great Fish Swap" (Fresh Air 2014). At about the same time, consumers in both the United States and Japan began to accept frozen seafood as a substitute for fresh. In Japan shrimp, octopus, and squid were the first frozen seafood accepted, perhaps because there is not much difference in taste or texture between frozen and fresh. But it took a while for other frozen fish to be generally accepted as more than a sign of poverty, and Japanese consumers still demand and eat much more fresh unfrozen seafood than those in the United States or Europe. The increased quality of frozen products, the switch from small fishmongers to supermarkets, and the depletion of fish stocks in Japanese waters all contributed to the trend. Also, freezing made it possible to import new kinds of fish to the Japanese market, with new tastes to explore. Today you can find fish from all over the world in supermarkets all over the world.

In the United States, where the seafood industry was much more centralized, and historically centered on canned and frozen products, the market for

high-quality, high-end fresh fish has only recently grown, driven partially by the globalization of sushi and growing perception of Japanese food as a healthy option (Bestor 2001; Issenberg 2007). Nations like Spain, Italy, Norway, and Portugal tend to follow the same pattern as Japan, starting out with fresh and salted fish and then gradually moving to accept more frozen and processed product. Larger continental and landlocked countries tend to follow the US model more closely. Most recently, the world seafood system has become polarized between fresh and frozen, with fresh still in the hands of smaller producers and frozen by large international companies (Miyake 1991: 12).

Frankenfish?

Genetically modified food has been controversial and under public scrutiny, and in Europe many countries still refuse to allow genetically modified food into their marketplaces. Genetically modified organisms (GMOs) have become a symbol of ecological disruption, unsafe food, and the corporate dominance and control of food production and marketing. Besides growing faster, fish could be genetically modified to have resistance to cold, polluted water and disease, and even their taste and texture could be tailored to particular markets.

At the same time, genetically modified fish farms present many of the same kinds of pollution, water use and destruction of coastal environments as other forms of aquaculture. Like other kinds of genetically modified foods, while the industry promises to feed the hungry and poor, most of the fish is going to be consumed by the wealthier middle class, as a substitute for declining ocean stocks. Most GMO products have only been tested in animals for short time periods—we know very little about the long term effects of eating them. Those concerned with food ethics wonder if humans should be manipulating different species and redesigning natural animals for the sake of their own gastronomic delight, and they worry that human meddling with nature will have a bad long-term effect. The more general issues of food ethics will be taken up in the next chapter.

To a large extent, the issue of GMO fish is a distraction from the increasing number of species being grown in fish farms, as bioscience provides new forms of reproduction by cloning and the use of stem cells. Trout have been farmed for generations with relatively low technology, but now we are farming steelhead trout, cod, sturgeon, red drum, Pacific threadfin, and cobia, crayfish, and varieties of shrimp, and that is just in the United States. Experiments are underway around the world with hundreds of other species. Many proponents have a vision of integrated systems that grow fish food, recycle fish waste, and use only solar or wind energy, so there is no pollution or burning of fossil fuel (Costa-Pierce 2002).

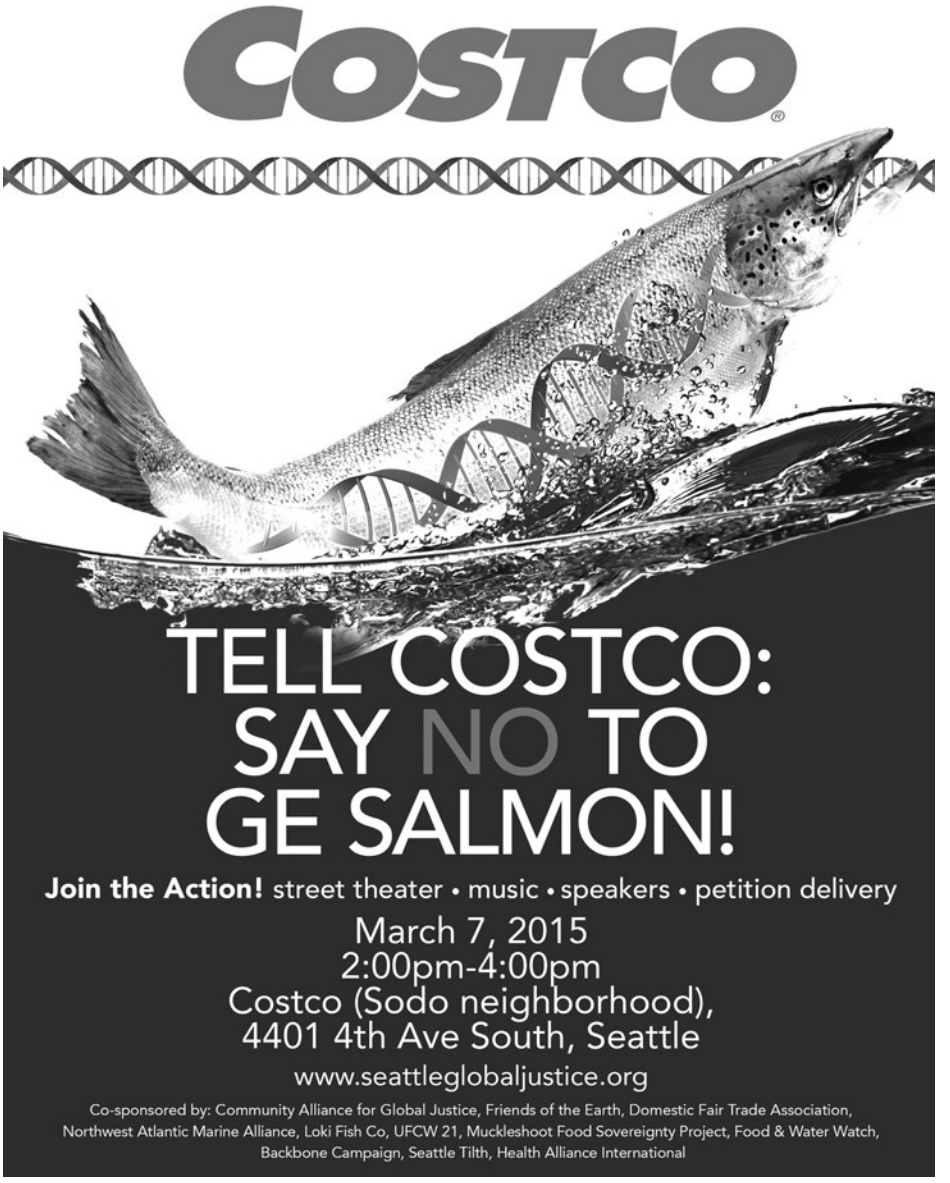

Figure 6.1 **Poster for a demonstration against the sale of genetically modified salmon at a Costco store in Seattle, WA in 2015** (Source: Community Alliance for Global Justice)

Conclusion

Sustainability has been the key concept for thinking about the present and future of seafood in the world, but sustainability is a notoriously slippery concept. To a businessperson, sustainability means that profits keep growing, while a radical environmentalist might see sustainability as reducing human populations to

the point where most of the earth is given over to the wild. So far in this book we have been using the term loosely to mean something like "using nature in a way that does not deplete or destroy it." We follow in the spirit of the original Brundtland Report, which defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." But how far into the future, and how will needs change in future generations?

The concept of sustainability is an uncomfortable fit with what we know about globalization. Benefits accrue in one place, while people far away may pay the costs, and the long distances make any kind of accounting difficult. The United States today imports 91 percent (by value) of its seafood, which means that the costs and potential environmental damage is spread over thousands of individual sites and fisheries around the world, affecting millions who will never see the USA.

It is much easier to define unsustainable systems, and it is clear that the way we are using the ocean cannot continue for many reasons. Aquaculture is often presented as a more sustainable option, with the potential to feed a growing population with less damage to the natural environment. Agriculture may have been sold to long-ago generations as a similar way of getting around the limits of production of wild nature, perhaps something like "it is much more reliable to keep your own animals than to depend on wild herds that come and go." As always with innovations, something is gained, but other things are lost and the full picture only emerges long after the important choices are taken.

Whatever the future of aquaculture and seafood, the issues of equity and justice will not go away. We have to ask how we distribute the benefits we humans reap from fisheries resources, from ethical and humanistic points of view. The culprit behind overfishing is not fishers per se; rather, it is the operating system and engine of our global economy, capitalism. We have created a system that needs to continuously grow by exploiting people and nature in order to survive, driven by a consumer culture of ever-increasing needs (Wilk 2014).

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7

SEAFOOD ETHICS

Eating and Entertainment

Do fish have souls? Emotions? Are some of them intelligent and self-aware? Does the lobster feel pain when dunked in boiling water? Does a tarpon remember the last time it was caught and released?

The ethics of eating has been a preoccupation of humans for millennia—there can be no ethical issue more fundamental than who gets to eat the best meals and who goes hungry. For centuries individuals, and even whole nations have become vegetarians because they considered eating the flesh of animals to be sinful and unethical. Animal rights activists point out that *2 billion* cattle, chickens, ducks, hogs, sheep, lambs, and turkeys were killed for food in the United States in 2015, and this does not include many more billions of fish and wild animals (Lin 2016). The global slaughter could be as high as 60 billion land animals each year. You may have very little sympathy for chickens or ducks, but we know pigs are at least as intelligent as dogs, which begs the question of why it is a crime to kill one, and a great pleasure to eat the other.

People who fish have known for many years that fish can be remarkably smart, but when it comes to ethics, many people feel that fish and other sea life have such tiny brains they are really no more sentient than worms or insects. Even some vegetarians are willing to eat fish on these grounds. Recently, however, animal behaviorists have begun to study the senses and intelligence of fish, with some remarkable results.

First, fish have extremely sensitive and complex senses, including some we mammals don't have. Some use sonar, can sense electric fields, hear over long distances and a wide range of frequencies, have built-in compasses, and can remember for years a scent we can barely detect with our best instruments. Some of them can communicate with sounds, body gestures or postures, and even flashing lights and farts. They cooperate with each other, even across species, seem to enjoy each other's company, recognize individuals, and can learn to use simple tools (Balcombe 2016).

Many scientists believe that because fish brains are structured so differently from those of mammals, they cannot be conscious, so while their body reacts

to stimulus, they can't be said to *feel* anything (Rose et al. 2014). Others say that while fish brains are different, they can still support consciousness; they just work a different way (Braithwaite 2010). Fish can certainly learn. Experiments show fish can remember things for long periods of time, learn from the experience of being caught or injured, and recognize individual people. In an experiment, trout and even crustaceans like lobster given a painful stimulus calmed down quickly when given morphine, a painkiller (Elwood et al. 2009). They learn to avoid areas and experiences they associate with pain, often more quickly than small mammals like rats and mice.

Experiments like this have convinced many scientists that fish are conscious and feel pain. Many also believe they have emotions, feel stress, enjoy playing, and have individual personalities (Byrnes 2016; Brown 2016). Even lowly mollusks like octopi have acute senses of time, direction, and memory, and they can make logical decisions, recognize individual humans, and have proven devious in finding ways to escape from their tanks (Montgomery 2016). Some scientists who study fish and mollusks say they can see clear evidence that these

Figure 7.1 **Bluefin tuna head on display in Tsukiji market, Tokyo** (Source: Author Photo)

animals have emotions, including anger, fear, and even affection, although others argue that researchers are merely projecting human emotions onto unfeeling animals (Brown et al. 2006). Evidence that crustaceans feel pain has led the government of Switzerland to ban killing lobsters and crabs by dunking them into boiling water, a death that can take more than a minute. The legislators assume that using a knife to pierce their brain or stunning them with electricity is more humane because it is quicker (Weintraub 2018; Wallace 2004). In Japan, fish and crustaceans are killed by pushing a wire through their spinal cord, a method called *ikejime*. Many chefs say that fish killed this way taste better and stay fresh longer (Secci and Parisi 2016). More importantly, ikejime is considered the most humane way to kill fish because it destroys the brain before the rest of the body.

What about eating seafood while it is still alive? Many people around the world enjoy eating live raw oysters. In parts of East Asia, live octopus, shrimp, and squid are a delicacy, and it is not unusual to throw a fish into hot oil while it is still moving. Does it seem more ethical when the diner kills the animal, or when it is done by a chef or a factory worker on a fish-cleaning line? The result is certainly the same.

We can also ask if it is ethical to eat the eggs (roe) of fish, which are sometimes valued much more highly than the fish itself, as in the caviar and kazunoko industries. What if this is helping to push a species toward extinction? (Saffron 2002). By eating fish eggs, consumers may be destroying countless generations of future fish while undercutting environmental sustainability, for the sake of a salty hors d'oeuvre. Your ethical stance in each case reflects your culture and your beliefs about the status of animal life in relation to human beings. Do humans share a world with fellow animals, or do we control inferior beasts put on the planet to feed and serve us? Is every person a responsible steward of the natural world, or is that an issue better left to experts and authorities? Do other animals have souls, and can humans be reincarnated in animal form?

Fish Culture?

Animal ethologist Jonathan Balcombe argues that fish also have *culture*, meaning that they learn important behavior from each other as humans do, rather than through instinct or intelligence. He argues that they can even learn new things so their culture changes (2016). Balcombe cites a study in Panama, which showed that a fish called the bluehead wrasse learns about the best places to meet and mate from other fish, and if you remove all the fish and bring in new ones, they choose completely different places. Balcombe also describes studies of cleaner fish, species that get their food by eating the parasites and damaged skin from other fish. They have cleaning stations where fish remain calm

and hover while the smaller cleaner fish enters its mouth and gills. Individual cleaner fish (and there are many different species) have long-term relationships, recognizing fish that have come to them many times. In the intricacy of these relationships, Balcombe finds "trust, crime and punishment, choosiness, audience awareness, reputation, and brownnosing. These social dynamics support a degree of awareness and social sophistication quite out of keeping with our cultural impression of fishes."

If we accept that fish are cultural, knowledgeable, and intelligent, should this keep us from eating them? If they can feel pain, isn't it cruel, even sadistic to catch them, fight them on the end of a line and throw them back, merely for our own amusement? We certainly would resist the idea of eating the pet fish in a home aquarium, fish that we name, train, and communicate with. So why is it okay to eat the same kind of fish when it is caught in the ocean?

Most Americans who are perfectly willing to eat fish would balk at eating a whale, seal, porpoise, or other marine mammal. But isn't it hypocritical to refuse to eat marine mammals, but be perfectly willing to eat land mammals like cows and pigs? The international controversy over whaling is ostensibly about conservation because whale species and other marine mammals are in danger of extinction. The popular view in many countries is that whales are intelligent mammals that deserve protection because killing them is inhumane and unethical. Some indigenous groups argue that whaling is part of their history and culture, and countries like Japan, Iceland, and Norway also see whales as another form of seafood, part of their national cuisine and unproblematic from an environmental point of view because they avoid eating any endangered species. Would you be able to eat whale sushi if you knew the whale was sustainably caught and processed? What makes the difference between an edible and an inedible animal? Why show favor to mammals over birds or fish?

The relationship between humans and whales has varied widely over time and from place to place. The United States was the center of global whaling for more than 100 years, driving many species to the brink of destruction for the sake of the fine oil, often used for lubricating machines, that was rendered from their fat. On the other hands, Japan, a country that continues whaling despite criticism from many nations, has a history of taking whales for food, arguably a much less wasteful practice than just boiling their blubber for oil.

Indigenous people like the Makah in the western US state of Washington also have a very long history of hunting whales for food and valuable materials like teeth and bones. They treat whales with great respect and acknowledged that they have a spirit, and whaling is an important ritual event that inspires songs,

dances, and art; the right to take whales was guaranteed in a treaty with the US government in 1855. The Makah are strongly opposed by advocates for animal rights and conservationists, and those who benefit from the many tourists who want to go whale watching. In this dispute, both sides claim to speak on behalf of nature, and both speak out of respect for the intelligence of the animals. From an anthropological point of view, the different parties are debating the location of the boundary between humans and animals, but we need to ask how and why some animals like pets are given quasi-human status while others that are equally smart, but perhaps less cute, are edible and delicious. In India, dolphins have recently been legally deemed "non-human persons," for the purposes of protection, although they still do not have "human rights," a category that activists in the United States want to apply to chimpanzees, gorillas, and orangutans (Coelho 2013). When activists call for an end to all whaling, are they just expressing a very Euro-American taboo on particular species because of their iconic and symbolic value? (Lien 2004).

Confronted with a real live flesh-and-blood animal, many people find they cannot go ahead and eat parts of that animal, much less kill it and butcher it themselves. In *Portrait of a Burger as a Young Calf*, Peter Lovenheim describes his revelation that most people do not really want to know where their food comes from, to protect themselves from the ethical dangers of knowledge (2002). Many people who eat fish would be disgusted by the details of how fish are caught, gutted, and frozen, often while still alive. The people and corporations who produce and process our food have a shared interest in cutting the connection between production and consumption, because this also silences inconvenient facts.

A Japanese Alternative: Kuyo

The Japanese practice of *kuyo* is a kind of memorial service that expresses appreciation for nonhuman sacrifice. Kuyo as a verb is "to give/perform a memorial service," to pay for the repose of the souls. It is also a state of feeling and consciousness, embracing all life and therefore being individually responsible for taking another's being's life, human or nonhuman. In Japanese Buddhist and Shinto temples there are many monuments for nonhuman beings that sacrifice their lives for the well-being of humans. If you are cynical, you could argue that this sacrifice is just a form of self-justification, an excuse for killing while continuing to feel ethical. But it is part of a Japanese ethical system that recognizes nonhuman beings have souls just like humans that deserve respect. Even those engaged in industrial-scale fishing and meat production take time to visit temples and raise monuments for the repose of nonhuman souls (Nagano 2015).

Figure 7.2 **Kuyo monument in shrine at Tsukiji fish market, Tokyo** (Source: Author photo)

Seafood and Religion

Food taboos of a religious or semi-religious nature were once universal throughout Micronesia, and common among indigenous people around the world. The most well-known in the Pacific islands were those connected with the clan totems, normally a species or animate object that was identified with the clan's origins, which all members were expected to treat with respect. The totems in Pohnpei, for instance, included turtle, shark, eel, several kinds of fish, the owl, a species of banana, and one type of yam. Clan members were forbidden to eat the plant or animal associated with their totem, although they were allowed to kill them (O'Riordan 2013). As Christian missions spread through the area, most of these taboos disappeared, but many people still avoid certain foods for moral reasons.

There are no easy answers for the ethical problems of eating animals, including fish and other sea life. In every culture religion and law provide guidelines for how ethical principles should be applied to the practice of daily life including preparing and eating food. At one extreme we have religions like the Jains, which forbid killing or consuming any kind of animal, even noxious insects. But even Jains argue about whether or not it is an ethical duty to feed all animals, as well as avoiding harming them. They cannot eat any food that was produced in a violent way, and even vegetables are treated gingerly. At the other extreme are modern forms of Buddhism and Christianity that do not stop followers from eating any kind of animal, assuming that they are either inferior forms of life, or that they are bound on a wheel of Dharma and will be reincarnated as something else.

As mentioned earlier, one way that religions define an orderly and ethical world is to place boundaries around consumption, including rules about what can be eaten or avoided. The consensus in anthropology is that food taboos are really about creating boundaries between people, emphasizing ethnicity, age, gender, and other forms of status. By projecting human differences onto nature, we make our social and cultural lives seem "natural," even though these differences vary so much from culture to culture.

In many cultures the connections between human diets and nature are explained and rationalized in myths, lore, folk stories, proverbs, and histories that recount the origin of human beings, or the events that led humans to become separate from nature. Many religious traditions say that spirits or deities inhabit animals, or that powerful ancestor spirits were part human and part animal (Houlberg 1996). The spirits of fish and other sea life can be powerful, malevolent, and dangerous, or guides and protectors. For example, historical Japanese people said that earthquakes were caused by the motions of a giant catfish far underground.

Spirits or deities may also have put particular animals on earth for the sustenance of people, and require people to purify themselves or ask permission from those spirits or gods before they go hunting or fishing. Because of their power, spirits and ancestors may forbid consuming particular creatures entirely or seasonally, for everyone or just for a specific category of people such as menstruating women. Food taboos sometimes operate to protect parts of the environment, but they also express empathy, respect, and culturally based ideas about health and well-being (e.g., Asi and Teri 2016).

Many coastal and island cultures have legends and myths where fish turned into humans and vice versa, half-human mermaids and mermen, sirens, and shark-men. In the Marshall Islands of Polynesia, the fierce and dangerous half-human/half-fish Kujinmödo could be seen at night in a "fiery sea" (Erdland 1914). These creatures often had special powers to communicate between humans and the spirit world, but this is also why they were so often seen as dangerous.

Predatory fish like sharks and spearfish were used as symbols of power by leaders, nobles, and royalty in many parts of the world (and they continue as the totems of innumerable teams in sports like football and basketball) (Helms 1988). Shark teeth and stingray spines were set in masks, swords, and the regalia of warriors. Here is a description of the gear used by warriors in the islands of Kiribati in the Pacific Ocean:

> Along with a sword and/or dagger, a warrior wore a complete set of armour, made from thickly woven coconut fibre and a belt of stingray skin, or *Tekatibana*, and a helmet created from a hollowed out and dried puffer fish, known as *Tebarantauti*. These helmets were created by an individual hunting a puffer fish while it was fully inflated, and then burying it in the sand until it was completely dried out. Helmets would then be reinforced with coconut wood and lined with plaited pandanus strips around the edges. . . . Further ferocity in these warrior suits comes from yet another use of sharks teeth, this time sewn into woven husk and palm leaf hand covers, sometimes with human hair, and clearly used as knuckle dusters to anyone who got past the swords.
>
> (O'Riordan 2013)

In many cultures fish have magical powers to curse or to heal, and they may be forbidden to young people or a gender on the grounds that this power can hurt them. People also use magic before going fishing to improve their chances and increase the catch. In places where fishing is a dangerous occupation, magic may be used to influence deities or powers to keep the fishing expeditions safe.

Figure 7.3 **Statue of Behanzin, the last king of Dahomey (Benin) as an armored sea creature, about 3 feet tall; he promised to fight French invaders "like a shark"** (Source: Musée du quai Branly, Paris)

Even desert-dwelling people who may rarely see water may believe that fish have magical power (Radcliffe-Brown 1926). This is reasonable when you consider remarkable behaviors that are difficult to explain even for science. Fish can kill with an electric shock, swim up inside a person and lodge in their urethra, survive for days buried in mud, move over dry ground for kilometers, shoot a stream of water three meters to knock a bug off a plant, and tear all the flesh from a living animal in minutes. Then there are the very real dangers of being eaten by a shark, bitten and disfigured by predatory fish, or punctured and poisoned by sharp spines. Even with the best equipment of modern science, the underwater world is a mysterious unknown place where legendary and fantastic monsters and creatures may dwell. Fish even live in the perpetual darkness of caves, far underground, and in tiny springs in the middle of deserts.

Fish may also have powerful symbolic meaning, as in the Christian tradition of using a fish as a symbol of Christ.[1] Ritual and religious calendars may be synchronized to the appearance or disappearance of particular fish, and the arrival of spawning salmon, shad, herring, mackerel, and other fish often triggers celebrations and feasts. Fish may also be taken as symbols of particular strengths or virtues. The carp, for example, is a symbol of persistence and strength in many parts of China where people see them fighting strong currents and surviving in stagnant water that kills other fish. Among the Nuer people of what is now South Sudan, fish symbolized water and rain, the particular powers controlled by a single clan (Evans-Pritchard 1956). The association between rain, water, and fish is clear, and this led many cultures to offer sacrifices of fish and other marine life to spirits or deities responsible for bringing rain.

Given their symbolic power, it is no surprise to find fish depicted in some of the earliest cave paintings and engravings found in Europe, Africa, and parts of Australia. We don't know what these paintings meant at the time, but surely they reflect the importance of fish in supernatural and religious beliefs about nature and the world, not just their importance in the everyday diet. The classical Dutch and Flemish painters of the seventeenth century included fish, lobsters, and shellfish in many of their still life paintings often sold to decorate the houses of prosperous fish merchants, where they symbolized vitality, prosperity, abundance, and wealth (Helmus 2004). Eels were the favorite fish of the classical Greeks, and because of their exorbitant price in the marketplace, eels came to stand for both luxury and overindulgence, because the passion for eels and expensive wine led to financial ruin for many prosperous families (Davidson 1997).

Mass Mediated Seafood

Fish and people who make their lives through the harvest of sea life continue to have symbolic importance in contemporary mass media and popular culture.

How can we explain the popularity of reality TV shows about commercial fishing? *The Deadliest Catch* was an instant and unexpected hit when it opened in 2005. Its success spawned other shows on US television like *Wicked Tuna* and *Cold River Cash, Ice Men, Tougher in Alaska*, and *Alaska Fish Wars*, among others, and there are equivalents in several other countries. These new genres fit in with other new forms of outdoor reality TV where men take on dangerous and difficult jobs, or hunt for treasure, a kind of validation of old-fashioned masculine courage and tenacity.

The older genre of fishing program, giving practical advice on recreational fishing, usually had endless footage of the guide, host, and celebrity guest hauling huge fish into the boat in exotic places, started in the 1960s with "Gadabout Gaddis" and is still flourishing today. These "going fishing" programs still dominate the US programming of the Outdoor Channel, Animal Planet, the World Fishing Network, the Sportsman's Channel, National Geographic, the Discovery Channel, Going Fishing TV, and more in many other countries. The World Fishing Network lists twenty-one different fishing programs on its website, most sponsored by fishing gear companies and the manufacturers of outdoor equipment and off-road vehicles. The dirty secret of most of these programs is that they are also sponsored by the hotels or resorts and sometimes the guides that are featured on the program. The producers and actors in the programs rarely pay for their own food, lodging, gear, or fishing time, and they are quite willing to edit and fake film to make it look like every jaunt was successful. That is why you rarely see a fishing program where the trip is disappointing or unproductive, where gear malfunctions, boats break down, meals are awful or drunk fishermen argue and fight. The internet has provided another new outlet for fishing media, some of which are also commercially sponsored, and the variety of genres and programs available is bewildering (see www.angling.tv or the YouTube fishing channel).[2]

Even this tame genre has been updated in shows like *Monster Fish* and *River Monsters*, adventure shows that feature a heroic fisherman traveling the world to find exotic, huge, and/or dangerous fish ostensibly for the purpose of education and conservation. The traditional fishing program was completely about men, and if there was any advice about how to prepare and cook the catch, it mostly involved grilling or frying in a pan over an open fire. By the 1990s feminism had an effect on even the masculine sinecure of fishing programs, and TV fishermen started to pay a lot more attention to cooking, while other programs featured women (e.g., *What a Catch, Girls Gone Fishing, Fly Gal*) who fished and sometimes cooked as well. Nevertheless, the venerable genre of "women in tiny bikinis holding fish" (or draped over a new boat) as a kind of outdoor titillation is still alive and well.[3] The internet has also been an outlet for fishing

pornography, inventing new genres like "naked fishing," which are related to the spate of naked survival, dating, and shopping reality programs popular in US television.

As in recreational fishing itself, there is a class divide in television. Fly fishing is generally polite and restrained and the fisherfolk are well dressed, emphasizing their knowledge and skill, rather than their exotic gear. Fly fishing became the preferred sport of elite men in England and the United States in the mid-nineteenth century, and it has retained that ambience (for example, see Kaminsky 2008, also Washabaugh 2000). At the other end of the class scale, you have programs where working-class guys in the Southern US go fishing for giant catfish using only their hands, which they thrust into the fish's mouth. The TV show *Hillbilly Handfishing* is a good example of this genre, where the fishermen are happy to call themselves "rednecks" (see also *Fishin' With the Good Ol' Boys*). For the intellectual (perhaps hipster) crowd, we also have ironic fishing shows like *Robson's Extreme Fishing Challenge* in the United States and *Fishing with the Stars* in Australia. Robson, for example, often catches nothing, or something different from the intended, and the challenges that he makes up are usually silly or impractical.

While elite flyfishing for trout is depicted as peaceful and solitary, almost a form of meditation, further down the status scale, fishing can be a competitive sport. Fishing tournaments in the United States and Caribbean islands, first held at private yacht clubs by "big game" (billfish) fishermen, started to become more popular and lucrative as boating and outdoor sports grew into major industries in the 1960s and '70s. Like NASCAR motor racing, competitive fishing is masculine and appeals mostly to working people (what used to be called blue collar). In the United States there is now a well-populated circuit of professional fishing, with both individual and team competitions and tournaments, many with huge cash prizes. Just like NASCAR racers, competitive fishers are covered with the patches of their sponsors. Today there are hundreds of competitions in the United States at professional, college, high school and junior levels, team events, and annual championship rankings, not to mention fantasy fishing (see www.bassmaster.com). Fishing tournaments and competitions have spread around the planet (often to promote tourism), and the International Game Fishing Association keeps global records, a detailed rule book, issues certificates and trophies, and record holders are immortalized in an annual book.

There are many national variations of competitive fishing. In the UK, carp fishing is by far the most popular, and some of the larger and more famous fish have names and have been caught dozens of times. While competitive fishing is promoted by tourism and boat businesses, the manufacture and sale of fishing gear is now a multibillion dollar enterprise, selling an almost infinite variety

Figure 7.4 **Indiana University angler Jesse Schultz shows off a big largemouth bass** (Source: Photo by Zack Wojtowicz/Fishing League Worldwide)

of rods, reels, line, and tackle ranging from a few dollars to $12,000 rods and $5,000 reels, not to mention the collectors who will pay tens of thousands of dollars for rare antique gear.

This recreational corner of the fishing world, just like every other sport, has slowly moved from being an everyday fun activity that also fed families to being a spectator sport. As life has become more and more sedentary and competitive, it makes sense that people who could not go fishing for lack of money or

time can now get entertainment from watching others fish. This might explain the small genre of fishing computer games. As a lifelong fisherman, one of the authors of this book (Wilk) states flatly that the games are no substitute for the actual experience of being out on the water. The motives of the millions of recreational fishers are complicated and diverse, patterned by gender and class, but for most it is an important way to make contact with the natural world (Toth and Brown 1997).

Zoos, Aquaria, and Other Spectator Sports

The popularity of fishing as a recreation and spectator sport raises a number of wider issues connected to the relationship between humans and animals. In the European and American Judeo-Christian traditions, animals are completely separated from and subject to humanity, so the ethics of human relationships cannot be extended to them. Animals were put on the earth for the use of humans. This radical separation is why the Romans were able to enjoy watching hundreds of wild animals slaughtered in the arena, and why dogfighting, bearbaiting, cockfighting, bullfighting, and other violence toward and between animals were legitimate entertainments in Europe right up to the twentieth century. Nobles hunted animals for recreation, and the hunt was an established form of elite social life supported by gamekeepers and game farmers. Even at the dawn of civilization we find rulers and kings accumulating zoos of exotic animals, not for pets but as a display of their power. It is almost impossible to feel empathy toward something that has no soul and feels no pain.

It is always difficult to avoid anthropomorphism, projecting human attributes and actions onto animals, as in children's stories. For a long time this made any discussion of animal consciousness seem unscientific, and many scientists did not even ask questions about how animals think and feel. In popular culture the circle of empathy has broadened to include pets of many species, and it is now illegal in many places to mistreat pets. At the same time we perceive rats or fish or cockroaches as lower animals that are as essentially unfeeling and inanimate or even harmful, not as something that poses an ethical problem. Many cultures and nations resist this change, and see it as an imposition of Western values, so there are still a lot of places in the world where it is perfectly legal to harm and kill animals for fun. On the other hand, there is no particular scientific reason for considering humans and other species to be separate orders of life, and many of the things that anthropologists once thought of as uniquely human characteristics have now been found elsewhere in the animal world (including tool use, homosexuality, self-consciousness, culture, and language).

Today zoos are also making a shift from places of entertainment to promoting empathy and knowledge about nature, with the goal of conservation and

rescue in the midst of a mass extinction where species are disappearing before they have even been named. Public aquariums have the same kind of historical origins, and they have become more popular as people become more aware of the fragility of ocean life. They are also still a source of entertainment, for the pleasure of seeing animals so unlike us safely on the other side of a sheet of glass. Outdoor marine parks or "oceanariums" with performing animals began in the United States with the opening of Marineland of the Pacific in 1954 (before Disneyland). Training marine mammals to perform is another step removed from science and conservation, and many marine parks are facing mounting dissatisfaction with the way their animals are treated (Davis 1997). The same questions arise in response to the recent spate of "porpoise encounter" attractions, where people pay to swim with, feed, and pet the animals.

Personal contact is a very potent way to expand the circle of human empathy. When scuba diving and snorkeling became popular in the 1980s and '90s, guides started feeding fish to attract them to snorkeling sites. Over time, fish and other sea life proved quite docile when conditioned to feeding, so resorts and dive shops began to stage shark and stingray encounters where people could stroke, pet, and feed wild animals that are generally considered dangerous and scary, especially after sharks themselves achieved a kind of celebrity on wildlife television.[4] Aquaria are also giving people opportunities to touch and hold living sharks and rays, and the home aquarium is now a celebrity plaything instead of an intricate hobby.[5]

Figure 7.5 **Petting sharks and rays in Moorea, French Polynesia** (Source: Photo by Mary Solio/ The World is a Book)

It is hard to tell if this kind of intimacy actually affects people's relationship with nature, helping them to recognize ethical and conservation issues raised by the plunder and destruction of the oceans. You can also argue that these activities really create distance, distracting people from serious environmental issues by turning sea life into just another form of entertainment. There is now a whole field of study devoted to human-animal interactions that takes these issues seriously, but there is no consensus (e.g., Davis 1997; DeMello 2012; Fagan 2015). It is quite possible that a close encounter with a giant manta ray will turn someone into a lifelong environmentalist or a marine biologist, while also entertaining them and bringing groups and families together through a shared experience.

The book titled *The Others: How Animals Made Us Human* (Shepard 1995) reflects on the long mutual engagement of human culture with nature. From the earliest history, people have reflected on the differences and similarities between humans and other animals. All religions mandate rules for human-animal relationships, some imbuing natural animals with supernatural powers. The rules may be different between cultures, but there is always a relationship between the ethical rules for treating other people, and those for treating animals. Part of the way humans make order in the world and understand their place in the cosmos is by finding meaning in nature. This is why marine life always has ethical significance above and beyond its value as food or entertainment.

Case Study: The Ethics of Catch and Release

Recreational fishing has become so popular in the United States that the 56 million active fishers generate more than $40 billion a year in business, employing millions of workers.[6] This gives recreational fisherfolk a voice in the management of resources that had previously been the sole province of commercial fishing. In the United States and many other places around the world, commercial fishing has been banned or tightly regulated so recreational fishers will have something to catch. Specialists estimate that sport fishing is responsible for about 12 percent of all fish caught (Cooke and Cowx 2004). Why is fishing so entertaining that some people will travel around the world and happily spend days and dollars for just a chance to catch something? Many people find fishing or gathering shellfish to be incredibly boring, and they they often point out that it would be much cheaper to buy fish in the market (in many places there is a whole genre of jokes about fishing).

This misses the point of fishing. While many plan to eat the fish they catch, others just catch fish for fun. Their pleasure comes from the intricate challenge of finding where to fish, from choosing from an amazing panoply of tackle and costume, fighting the fish, and being out in nature, often in the company

of like-minded friends. In many ways fishing is a test of skill and knowledge. Stories about fishing often say that while a person began fishing because they wanted something to eat, over time they begin to realize that the experience is more important than the meal and they find fishing is a spiritual connection, a Zen-like engagement with the natural world.

In many parts of the world large billfish like marlin, spearfish, and sailfish are rarely eaten, and because of the importance of the recreational fishery they are often banned in the commercial market (Miyake 1991: 90). These fish are renowned for fighting long and hard, leaping, and even attacking the boat at times. A trip to catch one can cost many thousands of dollars in travel, the cost of a boat charter, and an expert guide. Until recently the giant fish were strung up by the tail on the dockside at the end of the day, marked with their weight and the name of the fisher for a triumphal photograph, while parts of the dead animal were sent off to be mounted as a trophy for the office or home wall. The fish itself was not eaten by the fisher, but was sold off by the boat owner or guide on the local market (in the United States most of these fish were sold for pennies a pound for animal food). As commercial fishing began to reduce populations of large fish, a conservation ethic became common in the sport fishing industry, which supported bans on the commercial fishing of billfish. A policy of catch and release has spread rapidly and is now predominant in many recreational fisheries, recognizing that fish in the water are worth a lot more than one in a can or on the plate. Countries like Belize have made it illegal to catch and kill the species that form part of the popular "grand slam," achieved by catching a tarpon, a bonefish, and a permit on the same day.

Striped marlin are enthusiastically eaten in Hawaii and much of Asia, where the color and fat content of its flesh is more important than its fighting qualities. Even the name of a fish reflects its status as a game fish or seafood fish. For example, *Istiophorus indica* is called "black" marlin in the United States because its body is so dark when caught. The very same species is called "white skin" marlin (*shirokawakajiki*) in Japan because the skin of the fish fades to white when it arrives at auction houses and wholesale markets. Asian markets generally name the fish for the color of its flesh, while English, Spanish, and French names refer to the color and shape of the live fish. Just to make things more complicated, many places use different names for the same fish, and the names used by fishers and scientists and wholesale and retail vendors can be different too (Miyake 1991: 163–164). But even in parts of Asia, those who profit from recreational fishing are working to ban the commercial sale of marlin and sailfish.

But what does it mean to fish for recreation? People who fish commercially often say that the working conditions are terrible and the pay is low and unreliable, but they continue fishing because they love it, that they still get excited

every time a net or line comes up from the deep. It is one of very few professions where people can be free to make their own choices, so it offers a kind of freedom and independence, which is one reason why they often despise regulations and fisheries scientists. With satellite tracking, underwater video, spotter planes, and on-board observers, they can be tracked and monitored, and many of them feel like the profession is dying from these restrictions.

Alongside recreational and commercial fishing there is another type that is often ignored: subsistence fishing. In many parts of the world, poor people get a substantial part of their diet from fish caught by members of their own family or community. Subsistence fishing is continued by many Native Americans and indigenous peoples who see it as an essential part of their culture, a set of rights to relate to nature in ways established long before the arrival of European colonists. But because fishing policy is dominated by commercial and recreational interests, subsistence fishers are often pushed aside, with drastic cultural and nutritional consequences. This demonstrates once again how the ethics of dealing with other people are closely intertwined with the ethics of our relations with the natural world.

A final conundrum can be found in the practice of catch and release fishing. Many see this as a huge improvement over commercial fishing and take pride in their conservationist ethic. Of course these are usually people who can afford to buy a fish dinner in a fine restaurant, perhaps eating a fish caught in a faraway place by commercial fishers. Furthermore, if fish feel pain, then how is it ethical to cause such misery to a large, beautiful, and knowledgeable fellow being? Catch and release, from the point of view of the fish, is a form of pointless torture, not to mention that many of the fish that are released are too weak or damaged to survive for long. In some ethical systems, it would make much more sense to honor the fish and its struggle by eating it!

Notes

1. In the Christian tradition, the fish refers to the miracle of the loaves and the fishes as described in the New Testament, but it got its popular meaning from an acrostic for the Greek letters spelling the word fish, and the words describing the character of Christ.
2. Odd fishing programs include *Fishing Musicians, Hawaii: Strange Fish*, and New Zealand's *Big Angry Fish*.
3. www.saltwatersportsman.com/gallery/photo-galleries/2013/06/fifty-top-fishing-girls?image=3.
4. "Shark Week" has been an annual event on the Discovery Channel in the United States since 1987, and there are hundreds of other programs and films featuring fierce sharks, shading into the fantastic in films like *Sharknado* (now with five sequels and a video game), *Sharktopus*, and *Dinoshark*. See www.homes.com/real-estate/disaster-prep/sharknado/.
5. The aquarium trade is enormously lucrative and has been held responsible for the near extinction of many species, as well as the spread of invasive species like the lionfish.

6. www.statista.com/topics/1163/recreational-fishing/, accessed July 29, 2016. www.asla.org/uploadedFiles/CMS/Government_Affairs/Federal_Government_Affairs/OIA_OutdoorRecEconomyReport2012.pdf.

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8

ECO-LABELED SEAFOOD

Social Justice or Co-optation?

Do you know the difference between a chinook salmon and a chum salmon? Could you identify a pangasius or a tilapia swimming in an aquarium? The diversity of the seafood we eat far outnumbers the few species of poultry and mammals that end up on our plates. The source of most seafood is invisible; unless you go fishing or diving, you may never come face-to-face (or face-to-shell) with the animals you eat, particularly if they are from a foreign country you have never been to. Naming and branding of seafood, and the marketing of chains like Red Lobster and Long John Silver's further cloud the issues, because restaurants rarely give much information on where their seafood comes from. This chapter discusses how the identities and origins of seafood become blurred and distanced in the global seafood economy, and how various organizations are trying to fill the gap with information to help us make better choices.

The Power of Consumers in the Marketplace

If we go back 150 years, governments did very little to make sure that food was safe, check to see if merchants were honest, or verify that a product really did come from the place and people on the label. This made sense in a world where most food was local, and the buyer knew the seller. But in the early twentieth century when food was becoming a large industry, there were a spate of cases where food was counterfeited or adulterated, and large numbers of people were sickened or killed by what they ate. Governments responded by setting up systems of laws and agencies to test and guarantee the safety of food and drink and monitor their contents. As more food was traded internationally, governments also collaborated through organizations like the United Nations Food and Agriculture Organization to set agreed standards for quality and permitted chemicals. The result is the ingredients and nutrition labels on every package of food, although the requirements for labels continue to vary from place to place.

By the end of the twentieth century, the volume of food moving around the world was so great that governments fell far behind in their ability to monitor

what people were eating. At the same time, people were becoming much more concerned with the health implications of food, frightened by some of the substances allowed in processed and packaged foodstuff, and worried about the environmental and ethical problems resulting from food production and marketing. Even in the richest countries, with the most comprehensive food safety legislation, there were many instances of polluted and counterfeited products, other kinds of food fraud, and periodic problems with contamination by chemicals, microorganisms, and viruses. Distrust of food was furthered by incidents like the outbreak of "mad cow disease" (bovine spongiform encephalopathy) in the UK and parts of Europe in the 1980s, and the 2008 Chinese milk scandal, where melamine-tainted foods killed and sickened hundreds of thousands in China (and thousands of dogs in the United States). In the United States, many people continue to die every year from foods contaminated with salmonella and E. coli, and food recalls have generally been too little and too late.

While the global food trade was becoming incredibly complex, governments, and international agencies began to adopt policies that are now called *neoliberalism*. The central ideas driving neoliberalism are that smaller government is better, private enterprises are more efficient than government agencies, and markets should be freed of regulation to the greatest possible extent. One major consequence is that many functions of government, from feeding the homeless to saving elephants have now been taken over by voluntary, religious and charitable organizations (called nongovernmental organizations [NGOs] and Private Voluntary Organizations [PVOs]) that have stepped into the gaps left by shrinking government funding and responsibility. While there are still international agencies negotiating trade treaties and regulations, to a large extent these organizations have taken over many issues of human rights, conservation and environmental quality, and the investigation and publishing of information about industries like fishing and oil drilling.

Sometimes these organizations work along with governments and international agencies, but they also conflict with them and challenge their programs. For example, in the United States the invention and then certification of organic farming was originally in the hands of farmer-led organizations, and was only later taken up by the US Department of Agriculture. Now many farmers and groups reject the organic standards as cumbersome, inflexible, and bureaucratic, favoring large producers over small. The idea of an eco-label is closely linked with the concept of certification, and both are usually voluntary standards meant to assure consumers of the quality, content, and origin of what they are buying. Instead of making each shopper responsible for investigating the ethics and practices of the companies making their food, eco-labeling gives them a shortcut, with a certifying agency overseeing the process and attesting to

its veracity. Because seafood tends to be widely scattered and hard to monitor, certification, and regulation tend to rely heavily on the integrity of producers, and the trust they have established with consumers, NGOs, and government agencies.

The ultimate goal of an eco-labeling scheme is to use the power of the marketplace to change the behavior of producers and make commodity chains more environmentally sound. In other words, purchasing is like voting, and the vote consists of paying more for a better and more sustainable product. From an economic standpoint, the eco-label is trying to make the seafood industry pay for its externalities and be more transparent about the way it treats workers and the environment. They mainly target consumers in rich countries who have more disposable income and can pay for higher quality and more ethical products. But the effects of eco-labeling extend far outside of those selected markets. For example, the Earth Island Institute operates the "dolphin safe" program, the oldest eco-labeling program, which certifies tuna fisheries that minimize the bycatch dolphins in all of the oceans, including

Figure 8.1 **A variety of seafood eco-labels and certifications on display at Seafood Expo 2018** (Source: Author photo)

those of poor countries. Seafood eco-labeling programs have long focused on wild captive fisheries, but more recently we have witnessed new initiatives for certifying aquaculture producers that minimize their environmental impact, among them the Aquaculture Stewardship Council and the RSPCA's (Royal Society for the Prevention of Cruelty to Animals) Freedom Food label.

There are three kinds of eco-labels and certification schemes for seafood (Ecolabel Index 2018). First, there are self-declaration labeling programs established by producers, resellers, or retailers based on their own rules and principles. In Japan the best examples are "Pride Fish!" and "Fast Fish!," while in Europe several programs put a photo of the fisher on fish packages to show that there are real people behind the product. Second, producers' associations and cooperatives have created labeling schemes for their members' products, often sponsoring annual awards, and voluntary standards; in the UK they have "National Fish & Chip Awards" and "Young Seafood Chef of the Year." The third type of labeling schemes are operated by non-profit, non-governmental organizations external to the industry, with independent means of certifying and monitoring seafood production (Ward and Phillips 2008).

The Marine Stewardship Council (MSC) based in London is the best-known non-profit organization that researches fishing practices and certifies fisheries as sustainable. To get certification from the MSC, a fishery is scored on thirty-one different criteria, with an accurate catch history and scientific information on the target species (Froese and Proelss 2012). This is not a cheap, quick, or simple process, and the fishers and processors have to bear most of the cost. For some small and very sustainable fisheries the cost is out of reach, particularly in poor countries where fishers may not be literate or numerate. For example, it took two years and US$250,000 for an Alaska wild salmon fishery to qualify for MSC certification (Hedlund 2007). On the other hand, getting MSC-certified can immediately and dramatically boost the value of a fishery. Under pressure from retailers and processors, the pollock fishers in the Russian Sea of Okhotsk worked for years to get the MSC label on their product, succeeding in 2013 despite many objections. In 2015 news reports that a Russian pollock trawler had sunk killing sixty-nine crewmembers, including illegal foreign workers, led to demands that MSC rescind the certification (Murphy 2015). This case was still unsettled at the time of writing, but it does pose a challenge to the value of MSC certification,

To make an effective eco-label, the certifying organization has to publicize its label and convince consumers that it is worth paying more for their "green" product, which can take a good deal of time and money. Consumers in rich countries are often quite skeptical of eco-labels, and it can be difficult to gain their trust, especially with the proliferation of greenwashing and practices of

manipulative and deceptive marketing using general terms like *real, natural,* and *authentic*. Even the best intended shoppers have trouble making consistently "green" choices for any number of reasons, including the amount of time it takes to get relevant information (Carrier and Wilk 2012).

Producers and companies have very diverse attitudes toward eco-certification—some find them intrusive and impractical, while others are enthusiastic participants because the labels mirror their own values. The concept of "corporate social responsibility" is being taken seriously by many in the business world, and a growing number of individual and institutional investors will not put their money into companies that violate principles of sustainability or exploit their workers. In the United States, college student groups have pursued a strategy of pressuring their schools to divest their endowment of shares in companies that violate human rights or damage the environment.

Confusion: vCOOL and mCOOL

No policies are perfect, especially when the regulations are applied to something invisible and highly mobile. Hypothetically, if a US flagged offshore fishing boat catches migratory tuna off the northern coast of Japan, fish that have been feeding near the nuclear disaster site of Fukushima, the fish they bring back will be labeled a product of the USA, even though they have been swimming in polluted Japanese waters. Given the migratory range of many tuna, it is even possible that a fish caught in Mexico has spent part of its life near Fukushima. The problem is even worse in parts of the world where illegal, unreported, and unregulated (IUU) or pirate fishing is common, and ships are registered in countries they have never even seen. The vast amounts of seafood being traded around the world, and the tiny fraction that is inspected by customs agencies make it easy to change labels and falsify sources. Corruption and bribery make the problem even worse. For this reason, an estimated one third of the seafood sold at in the United States is mislabeled in some way, according to the US National Seafood Inspection Laboratory (Jacquet and Pauly 2008).

There have been many debates about whether or not governments should require industries to specify the country of origin on all seafood labels, and regulations vary from country to country. And what do we mean by "origin?" What is the identity of a fish that grew up in Mexico, matured off California, and was then caught by a Chinese boat in international waters? How much of a frozen breaded fish stick is American, given that the wheat could come from Canada and the fish from China, and only the cooking and freezing takes place in the United States? How do you know if the lobsters on the menu are really from Maine, or the shrimp from Louisiana? If you order "Boston scrod" in a fancy restaurant, the name is really just telling you that the fish has been cooked in a

way vaguely reminiscent of the way they cook it in Boston, not that the fish itself comes from Boston or anywhere nearby (or even that it is really cod). New York or New England clam chowder is a just a vague style of preparation, not even following a specific recipe, and the place names are just conventions. It is even possible to find "clam chowder" on restaurant menus that is entirely free of clams.

Mislabeling and renaming were already an issue in the 1930s in the United States, when what was sold as canned salmon turned out to be much cheaper and more abundant mackerel (Kallet and Schlink 1933). Mislabeling often occurs because merchants want to sell fish caught illegally, or over quota. In many coastal areas fishers will sell their legal catch to a wholesaler or a dockside buyer, and then they will take the undersized or out of season fish to a restaurant or private customers. Wilk has been on charter fishing boats in Alaska where all of the illegal undersized halibut were dropped into the captain's cooler instead of being thrown back. In Belize he was offered bags of tiny undersized spiny lobster tails out of the trunk of a car.

Renaming allows the fisher or merchant to sell a cheap fish for much more than it is worth. Once cleaned and filleted, fish is difficult for consumers to identify, because differences in taste and texture are subtle. Most of the fish sold as "red snapper" in the United States is lavender jobfish, slender pinjalo, farmed Nile perch, or tilapia (Wong and Hanner 2008). Throughout the Caribbean, the "grouper" on restaurant menus is much more likely to be parrotfish or another colorful reef fish. Oceana's research shows that 59 percent of the "tuna" American public consume is not actually tuna (Warner et al. 2013). Sushi bars are even less reliable than supermarkets, because the fish is unlabeled and even in Japan the cheaper sushi bars have been caught renaming cheap fish—or "substituting," to use their friendlier term.

If we could know the origin of aquatic products, we could at least decide what we really want to eat. In the United States, Country-Of-Origin Labeling (COOL) has been mandatory (mCOOL) since April 2005. By the US federal regulations, retailers, and suppliers have to disclose the country of origins for all farm-raised and wild fish and seafood including fillets, steaks, nuggets, and any other flesh.[1] However, if fish is processed, meaning breaded, sauced, cooked, canned, cured, or "restructured," the COOL is not mandatory—it becomes vCOOL (voluntarily COOL). Fish sticks, clam chowder, steamed lobster tails, maki sushi, and canned salmon do not have to be labeled and can remain anonymous.

New Methods for Tracing Origins

As stated earlier, there are many assumptions built into an eco-label. We have to assume that companies or fishers are susceptible to pressure, and will change their behavior in response to market demand. We also assume that the best

way to improve fisheries and make the more sustainable is through changing individuals' choices in the marketplace; that people really do want more environmental information when they buy seafood, and given that information they will change what they buy. Finally we are also assuming that the information given to consumers is accurate and worthy of their trust. Any of these assumptions can and should be questioned; here we focus on the last one—how reliable is the information behind eco-labeling?

Organizations like the Global Ocean Commission are developing satellite and artificial intelligence (AI) technology to identify, track and monitor fishing boats to make sure they are fishing legally. Drones could also monitor catches of individual boats. Another recent innovation is the use of DNA analysis to securely identify species, and even their local origin. This technology can help stop the practice of mixing illegal fish with those that have been eco-labeled (Marko et al. 2011). Soon DNA fingerprinting test kits will be cheap enough for any restaurant or supermarket to use, but as long as it is easy to substitute a cheap farmed salmon for expensive wild salmon, and buyers can't tell the difference, it will be hard for fish sellers to resist the temptation to double their profits. The shopping guides issued by conservation organizations and aquaria are useful, particularly by identifying the kinds of fish that are likely to be illegally sourced or unreliably identified, but in a rapidly changing market it is hard to keep them up to date.[2] An additional complexity is that many species are caught or grown in multiple places by different methods, some sustainable and others quite destructive. Good and honest merchants should have this information available to shoppers, but they will not bother unless buyers demand it.

Overall, it is a monumental task to educate more than three billion individual shoppers in more than 100 countries about which seafood is healthy to eat and sustainably sourced. Certifications are meaningless if consumers don't understand the hazards to themselves and the environment. This illustrates a fundamental contradiction in neoliberalism: government regulation is often heavy-handed, inflexible and corrupt, but leaving everything up to the marketplace and individual choice puts unreasonable demands on the shoulders of shoppers who already have busy and complicated lives, and small scale producers who operate on a narrow profit margin. Independent NGOs have stepped into the gap, but their funding is precarious and they have no particular power to make or enforce rules—compliance is always voluntary. The best hope at this time seems to hinge on international organizations, independent from but funded by governments, which have their own enforcement power based on international agreements and treaties. The International Whaling Commission, founded in 1946 through an international convention is a good model,

but there is also a good case for aggressive NGOs like Sea Shepherd, and the Plastic Oceans Foundation to act as independent watchdogs and investigators.

Maximum Sustainable Yield?

Eco-labeling schemes are supposed to give consumers and retailers an opportunity to support fisheries that practice environmentally friendly production and to be a part of efforts to avoid overfishing. A study shows that MSC-certified seafood is three to five times less likely to be produced by unsustainably practicing fisheries than non-certified seafood (Gutiérrez et al. 2012). However, overfishing is not easy to define in practice because it includes fish landings, discards, inadvertent damage to underwater life, and the pollution and destruction of breeding areas and other habitats.

The formal definition of overfishing is when mortality from all sources is higher than recruitment, defined as reproduction and growth of breeding aged stocks, so the total biomass is declining. Biomass is the total weight of wild animals in the water, rather than the total number of fish or their size. Sustainable fishery management generally follows this single species approach; like a supermarket it measures how much fish is stocked, how much is sold, and how much is restocked. The goal is to reach something called maximum sustainable yield (MSY), the point at which the most fish can be harvested without causing the decline of fish biomass.

This approach is widely criticized as an unrealistic and simplified view of ocean ecosystems and population dynamics. Fisherfolk and marine scientists often disagree about the best way to measure biomass, and therefore the condition of the stock. Fishing one species sustainably may cause a rapid decline in another species that feeds on it or depends on it in other ways. Catching only the biggest and oldest fish may sustain yield, but also change the population structure of the fish and push evolution toward smaller individuals and earlier spawning. What counts as a sustainable yield at one time of the year might be much lower in a different season, or when fished with different gear. Two small young fish might weigh the same as one large spawning female, but the assessment of sustainability is complicated when we add the potential recruitment from the roe that the spawning fish carries, and try to estimate how much of that is eaten by other species. In some places it is possible to use another measure called multi-species maximum sustainable yield (mMSY), defined as "the highest average catch (by weight) of all target species in a region that could be caught over time without causing a decline in any single species." (Ocean Health Index 2018).

MSY is useful as a way to set short-term goals, but it is an unreliable way to measure long-term sustainability, particularly in a rapidly changing climate and an oceanic environment affected by many non-fishing activities like oil spills and dredging. A particular problem is establishing the level of healthy biomass that

must be sustained. As previously mentioned, fishing for Pacific herring on the Northwest coast of Canada and Alaska has been tightly regulated and managed by the Department of Fish and Game in the US and Department of Fisheries and Oceans in Canada. Each year they set the TAC (total allowable catch) based on measures of the historic biomass of herring. However, archeological studies show that herring was much more abundant, and therefore had much greater biomass before large-scale industrial fishing began (McKechnie et al. 2013). This is a problem in many fisheries; the baseline biomass being maintained is much lower than the level before monitoring and scientific data gathering began.[3]

Eco-certification based on the MSY is a reasonable starting place for building sustainability standards, but it needs to be adaptable to diverse marine and coastal ecosystems. Storms, tsunamis, and earthquakes, the El Niño oscillation, and climate change can all lead to drastic changes in the environment that cause both booms and busts in populations of sea life. Enormous shoals of herring appear and disappear in places and times that are still unpredictable, and we do not know much about how fishing interacts with environmental changes. Events on land, including damming streams, hunting beavers, logging forests and paving parking lots can have a dramatic effect on nearshore environments, mangrove swamps and riverine spawning areas. When we focus on the sustainability of a single species or fishery, we miss vital information on species interactions, part of what is now called ecosystem-based fisheries management. Returning to the nutrition and food safety theme of Chapter 1, all of these sustainability issues and certification systems need to be balanced with our knowledge of what is good for our health, so knowing what to eat is never an easy task. It becomes even more complex when we add in the social and cultural issues introduced in Chapters 3 and 7.

Discussion

Reaction to eco-labels varies widely among different countries (Johnston et al. 2001). In many places, particularly Eastern Europe and East Asia, people remain highly skeptical of all claims made by food sellers, even those backed by national laws and standards. Eco-labels depend on a degree of trust, just like the fair trade labels on coffee and clothing, or the Forest Stewardship Council certificates on wood. This makes them vulnerable to widely publicized cases of fraud, particularly when the fraud puts human health in danger. Investigations of fraud create a conflict of interest for the certifying authority—which may try to hush up bad news or keep reporters away from their facilities in order to maintain their credibility, particularly when the organization gets most of its funding from the industry it is supposed to be supervising. Some certifying organizations may attack the credibility of others. A good example is the campaign by Naturskyddsföreningen,

the Swedish Society for Nature Conservation (which has its own eco-label), which investigated organic shrimp farms in Ecuador certified by Naturland and found them destroying mangrove swamps and using armed guards to dispossess local fishing communities (Naturskyddsföreningen 2011).

The international consensus of governments in the mid-twentieth century favored using national and local laws to regulate food safety, and to keep dangerous goods from reaching the marketplace. Toward the end of the century however, under the influence of neoliberalism, governments pulled back from regulating at just the same time that globalization and trade were introducing many new dangers into the marketplace. This late twentieth century was also the time when more people and organizations began to worry about the ultimate sustainability of fossil-fuel-driven consumer culture, and scientists began to campaign against global climate change and the ongoing mass extinction that is threatening biodiversity. Initially eco-certification by neutral non-political organizations seemed like an ideal solution to many of these problems. Educated green consumers would shop their way to a better world. Unfortunately things have not worked out as planned, and we are now saturated with conflicting information about what to buy, while a vast majority pays no attention at all to the environmental consequences of their own consumption because they are focused on affordability.

Governing eco-labeling standards is as important as governing fisheries or forestry, but there is no overarching authority behind most of these standards. People rarely go to prison for needlessly destroying mangrove forests, or treating supposedly organic catfish with pesticides and growth hormones. Why should difficult scientific and ethical problems related to sustainability be thrust into the hands of consumers? Nobody can ever trace the origins of everything they eat, unless they retreat to an isolated farm and grow everything themselves (and even then they will ingest pollutants dissolved in rain). It took more than a year for Steve Ettlinger to track down the origins of the ingredients in a single Twinkie pastry, and even then some proved untraceable (2007).

Advocates of neoliberalism claim that when consumers question ethical issues about their food, merchants will respond and clean up their labor and environmental practices. We can find many positive examples, and a lot of large corporations are being proactive in greening and cleaning their production and transportation. Food activists often see this as corporate greenwashing, a token effort to satisfy the questioning public rather than a real change in the way businesses behave. Governments are also subject to local and international pressure concerning unfair labor practices, the use of dangerous chemicals, and drastic damage to the natural environment. Improving technology is helping governments stop the flow of questionable food products into international trade, although there is still a great deal to be done. A journey that starts with questions

about what is in your McDonald's fish sandwich, can eventually reach all the way around the world and enter into the lives of people you will never meet.

Some reports claim that sales of eco-labeled seafood are rising rapidly, and consumers are becoming more aware of the issues, but we are still unclear on the overall effects of marine eco-labeling (Ethical Consumer 2016). There is no question that it will make a real difference if shoppers change their buying habits, particularly if they choose small pelagic fish, "foragers" like sardines, herring, sprats, smelt, capelin, and halfbeaks, instead of apex predators like tuna and salmon (e.g., Grescoe 2008). Consumers' oceanic ecoliteracy, including understanding the meaning of seafood sustainability is the key (Gutierrez and Thornton 2014; see also Uchida et al. 2014).

A switch to new foods like grilled eel-flavored catfish, farmed tuna, and artificial krabmeat could also ease some of the pressure on wild stocks. A company founded by students and faculty at Purdue University is now marketing a raw-tuna substitute made from tomatoes! We can also find hope in movements to involve fishing communities in co-management, encourage local fish production and direct marketing, and preserve and build upon traditional knowledge about the marine environment. But there is always going to be a need for well-funded and independent science, and enlightened fisheries management involving internationally regulations and laws that extend to the high seas. Each one of these steps is an opening for those who value marine life and love to eat good fish, to get involved and build a more humane and sustainable future.

Notes

1. Electronic Code of Federal Regulations. PART 60 Country of Origin Labeling for Fish and Shellfish. The Agricultural Marketing Service, US Department of Agriculture.
2. The most comprehensive online and printable shopping guide and smartphone app for the United States can be found at www.montereybayaquarium.org/conservation-and-science/our-programs/seafood-watch. Other good sites are www.fishchoice.com and for the UK, the Marine Conservation Society at www.mcsuk.org; the World Wildlife Federation has seafood guides for twenty-four countries in Europe and Asia.
3. For a discussion of Shifting Baseline Syndrome, see (Papworth et al. 2009; Pauly 1995; Roberts 2007).

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POSTSCRIPT

Preparing and Eating Seafood

If you have gotten this far in the book, you've read a lot about seafood, but to really appreciate the subject you need to experience seafood with your other senses, by preparing and eating it. Many people believe that cooking seafood is challenging, requiring some special skill or expertise. Nothing could be further from the truth. Any kind of cooking method used for meat or vegetables can be used with seafoods. But every cuisine has its own special ways of cooking and serving particular kinds of seafood—ranging from the indigenous Alaskan practice of burying fish underground to ferment, to the French practice of lightly poaching fish in a delicate courtbouillon. Seafood considered a delicacy in one place can be thrown out as inedible trash in another.

Many kinds of seafood are also challenging to the eater. A rural Midwesterner faced with a whole boiled Maine lobster needs some instructions, and probably a bib. People who are used to getting their fish in a fillet sandwich or from a can are often afraid of choking on the bones in a whole fish. But none of these eating skills are difficult to learn, and sampling new flavors usually provides a delicious incentive.

What parts are good to eat? Of course the shells of bivalves like clams and crustaceans like crabs and lobster are not usually eaten, although the soft shells of crustaceans right after they molt are quite edible, and some people grind the shells of crabs as an ingredient for sauces. The broth that remains after steaming clams or oysters is also worth trying. You can boil shells of shrimp and other crustaceans to make broth, or to flavor butter and oil. Almost every part of marine animals and plants can be eaten, so waste is minimized.

There are very few parts of any sea life that are actually poisonous, although of course jellyfish and some anemones can inflict painful and even mortal stings, certain corals can cut, burn or irritate the skin, and a variety of fish, cuttlefish, squid, sea snakes, and cone shells have toxic venom or other secretions. A few fish like the freshwater alligator gar have highly toxic roe, and puffer fish, the notorious fugu, have deadly toxin in their internal organs, enough in one individual to kill thirty people, according to *National Geographic*. Large predatory

fish like barracuda in some places, as mentioned in Chapter 1, can accumulate toxins in their bodies that causes ciguatera poisoning. Tiny nudibranchs, unattractive slug-like, free-swimming mollusks, may accumulate dangerous toxins. Otherwise there are entire categories of sea life that are perfectly healthy to eat. For example, there are no known toxic seaweeds, although some of them are too tough to chew and don't taste very good.

Many kinds of seafood actually require no cooking at all. Besides the many kinds of sashimi eaten in Japan, Korea and parts of China, clams and oysters are eaten raw and alive in Europe and North America. In parts of central and South America it is common to marinate fresh fish and shellfish in acidic lemon juice (or sometimes vinegar) in a dish called ceviche, a practice that is very much like pickling. Dried and salted fish can be eaten as is—tiny dried fish and strips of dried squid, for example, are a common snack in much of East Asia. Salted fish can also be soaked to remove the salt and then prepared just like fresh fish, grilled, fried, or stewed.

Smoking is another way to preserve fish and mollusks, with or without additional salt. In many European and East European countries smoked fish is now considered a delicacy, but in the past, in the form of smoked herring and mackerel, it was a relatively cheap food. There are actually two basic forms of smoking, one using heat and the other is cold smoking without heating: both change the flavor and texture of the fish, and help preserve it. In parts of West Africa small fish are traditionally hot smoked until completely dry in ovens on or close to the beach, which preserves them in an otherwise humid climate.

There is an almost infinite number of ways to cook fish, and different parts of the fish are preferred in different places. In East and Southeast Asia where food texture is often more important than flavor, the chewy and soft fat and ligaments in the fish's head are considered better than the boring flesh. Texture is also most important in eating shark fin, fish maw (swim bladder), and sea cucumber, among many others. In Europe and North America, the muscle tissue composing fish flesh is the only part usually eaten, often fried in hot oil to make the outside crisp. There are actually two kinds of muscles in fish; the red muscles in a strip along the side of the fish are used for slow and steady swimming, while the white muscle is used for short bursts of energy in feeding or fleeing. Salmon and some other related fish appear pink or orange because they absorb pigment from the crustaceans they eat—the pigment is provided artificially for farm-raised salmon. Red muscle tends to be more strongly flavored because it is full of hemoglobin, and commercial fish handlers in the USA and Europe often strip off this "bloodline" and throw it away.

Fish also accumulate fat, in thin streaks between the muscles, in and just below the skin, inside the head and sometimes in the liver. This fat is where the

omega-3 fatty acids accumulate Nutritionists generally divide fish into categories based on the amount of fat in their flesh. Lean fish like the Pacific pollock, flounder, catfish, tilapia, and mahi-mahi store most of their fat in their liver instead of their muscles, so their white flesh is firm and generally has a mild flavor. Fatty fish like eel, herring, mackerel, and anchovies are more than 5 percent fat by weight, and their flesh is usually darker and a bit softer than lean fish. There are also many fish that occupy an intermediate zone between the fatty and the lean.

In general, small fish are cooked whole, and large fish are cut into either fillets (lengthwise) or steaks (crossways), but the practices of butchering and cleaning fish vary tremendously from place to place. In international trade the fish are usually sold as fillets because these are regarded as the most valuable parts. In small and local markets, however, most fish are sold whole, and in many places the skin, eyes, head, fins, organs, eggs or milt, and even scales are also prepared and eaten. The ratio of the weight of a fillet to the weight of the whole fish varies quite a bit. The fillet is only one-third of the weight of a wild striped bass; all the rest is called the "frame," which is used for bait, for making soup, or thrown away. On the other hand, on salmon and tuna the fillet with skin is about three-quarters of the weight of the whole fish (Hovey 2010). These figures make a real difference when a fishseller buys whole fish and sells fillet.

For the traveling chef or diner, it is useful to know the difference between cosmopolitan species and local ones. The first are found in all of the world's oceans, or transplanted into most of the world's freshwater, while the second tends to be limited to a particular local environment. A diner almost anywhere in the ocean world can expect to find familiar tuna and sharks, king, and Spanish mackerel, mahi-mahi, and some variety of squid on the menu or in the market. North American black bass, rainbow trout, Nile perch, and tilapia (and increasingly snakehead) have been transplanted into much of the world's freshwater, often to the detriment of local fish. Farmed salmon and shrimp and wild squid and crab legs have become true global commodities, and can be found frozen in shops and markets from India to Patagonia.

Unless it is frozen or alive, most seafood spoils in less than a week, even when kept on ice. Truly fresh fish and live crustaceans have very little of what is often called a "fishy" smell. You should avoid buying mushy fish that has been frozen and thawed a few times, even if it smells fine. Do not buy dead mollusks with open shells. A whole fish should have bright red gills and the eyes should be rounded out from the head, not flat or sunken. Beware of anything that smells even a little bit like ammonia, generally a sign that the fish is decaying. Just like any other food, if you let a cooked or raw fish sit around too long, it will become a breeding ground for salmonella, E. coli and other nasty bacteria. Wilk says

his worst-ever case of food poisoning was caused by a lukewarm fish soup in Morocco, and it is possible to get nastier and even fatal diseases, from tuberculosis to cholera, from poorly prepared food cooked or handled by people with active infections.

Bad as this may sound, almost anyone with even the barest kitchen skills can successfully prepare perfectly healthy and delicious fish, shellfish or crustaceans for a meal. A few of minutes in boiling water or a microwave is enough for most seafood. There are wonderful seafood cookbooks from all over the world, and each cuisine has its own special way of presenting these gifts from nature. Enjoy!

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GLOSSARY OF SEA LIFE MENTIONED IN THE TEXT

In some cases there are multiple species with a single common name, so we give the genera (always capitalized) followed by spp. In other cases multiple species from different genera are given a single common name, in which case we give their common class, family, or subfamily, not italicized.

For details see www.fishbase.org, www.sealifebase.org, and www.theoutdoorlodge.com/fishing.

A

Alaska pollock (*Gadus chalkogrammus*)
Alligator gar (*Atractosteus spatula*)
Amberjack (*Seriola*)
Atlantic cod (*Gadus morhua*)
Atlantic golden tilefish (*Lopholatilus chamaeleonticeps*)
Atlantic herring (*Clupea harengus*)
Atlantic mackerel (*Scomber scombrus*)
Atlantic salmon (*Salmo salar*)

B

Barnacle (Cirripedia)
Barracuda (*Sphyraena barracuda*)
Bigeye croaker, aka Japanese bluefish (*Micropogonias megalops*)
Black marlin (*Istiophorus indica*) (JPN: shirokawa-kajiki)
Blacktip grouper (*Epinephelus fasciatus*)
Blue drum (*Pogonias cromis*)
Blue marlin (*Makaira mazara*)
Bluefin tuna (*Thunnus thynnus*)
Bluehead wrasse (*Thalassoma bifasciatus*)
Bullhead parrotfish (*Scarus sordidus*)

C

Chinook salmon (*Oncorhynchus tshawytscha*)
Chub mackerel (*Scomber scombrus* and *S. japonicaus*)

Chum salmon (*Oncorhynchus keta*)
Clownfish (*Amphiprion* spp.)
Cobia (*Rachycentron canadum*)
Cockles (*Cerastoderma edule*)
Cod (Atlantic) (*Gadus morhua*)
Conger pike (*Muraenesox bagio*)
Coral grouper (*Cephalophlis miniata*)
Croaker (Sciaenidae)

D
Dolphinfish, aka mahi-mahi (*Coryphaena hippurus*)
Dover sole (*Solea solea*)

E
European eel (*Anguilla anguilla*)

G
Geoduck (*Panopea generosa*)
Golden threadfin bream (*Nemipterus virgatus*)
Golden tilefish (*Lopholatilus chamaeleonticeps*)
Goosefish, aka monkfish (*Lophius americanus*)
Greenland shark (*Somniosus antarcticus*)
Grouper (Epinephelinae)

H
Haddock (*Melanogrammus aeglefinus*)
Herring (Atlantic) (*Clupea harengus*)
Herring (Pacific) (*Clupea pallasii*)
Hokkai shrimp (*Pandalus latristris*)

I
Indo-Pacific blue marlin (*Makaira mazara*)

J
Jack crevalle (*Caranx hippos*)
Japanese eel (*Anguilla japonica*)

K
King crab (Lithodidae)

L
Lavender jobfish (*Pristipomoides sieboldii*)

Limpet (Patellidae)
Lobster (Kilwa) (*Panulirus ornatus*)
Lobster (Maine) (*Homarus americanus*)

M
Mackerel (Atlantic) (*Scomber scombrus*)
Mahi-mahi, aka dolphinfish (*Coryphaena hippurus*)
Malabar blood snapper, aka scarlet snapper (*Lutjanus malabaricus*)
Moray eel (Muraenidae)
Mud crab (*Scylla* spp.)

N
Nile perch (*Lates niloticus*)

O
Octopus (Kilwa) (*Octopus cyanea*)
Oyster (Ostreoidea)

P
Pacific anchovy (*Stolephorus pacificus*)
Pacific herring (*Clupea pallasii*)
Pangasius, aka basa fish, swai, river cobbler (*Pangasius bocourti*)
Parrotfish (Scaridae)
Patagonian toothfish, aka Chilean sea bass (*Dissostichus eleginoides*)
Puffer fish (Genera: *Takifugu, Lagocephalus*, and *Sphoeroides*)

R
Red snapper (*Lutjanus* spp.)

S
Sailfish (*Istiophorus platypterus*)
Salmon (Atlantic) (*Salmo salar*)
Sea cucumber (Holothuroidea)
Skipjack tuna (*Katsuwonus pelamis*)
Slender pinjalo (*Pinjalo lewisi*)
Slimehead, aka orange roughy (*Hoplostethus atlanticus*)
Snake mackerel, aka butterfish, white tuna (*Lepidocybium flavobrunneum*)
Sockeye salmon (*Oncorhynchus nerka*)
South African hake, aka scarlet snapper (*Merluccius* spp.)
Spiny dogfish, aka mudshark, rock salmon, huss (*Squalus acanthias*)
Starfish (Asteroidea)
Striped bass (*Morone saxatilis*)

T

Tarpon (*Megalops atlanticus*)
Threadfin bream (Nemipteridae)
Tilapia (*Tilapia* spp., *Oreochromis* spp., and *Sarotherodon* spp.)
Turbot (*Scophthalmus maximus*)

W

Witch, aka Torbay sole (*Glyptocephalus cynoglossus*)

Y

Yellowfin tuna (*Thunnus albacares*)

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