

Books and Other Reviews

MERCURY AND THE EVERGLADES. A SYNTHESIS AND MODEL FOR COMPLEX ECOSYSTEM RESTORATION

Volume I—The evolution of the Everglades as a perturbed ecosystem and the role of atmospheric mercury

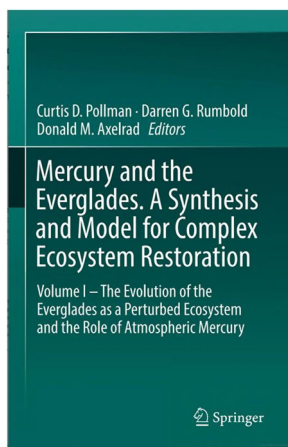
edited by Curtis D Pollman, Darren G Rumbold, and Donald M Axelrad

Volume II—Aquatic mercury cycling and bioaccumulation in the Everglades

edited by Darren G Rumbold, Curtis D Pollman, and Donald M Axelrad

Volume III—Temporal trends of mercury in the Everglades, synthesis and management implications

edited by Curtis D Pollman, Darren G Rumbold, and Donald M Axelrad



Some environmental assessments are exceptional in their geographic scope, temporal duration, public and ecological significance, research and monitoring effort, number of individuals and institutions involved, and implications for environmental management. The assessment of risks from Hg to humans and nonhuman populations in the Everglades of South Florida, USA, is an important example of such mega assessments. The editors of these 3 volumes have done a great service in providing this review and synthesis of field and laboratory studies, modeling, and assessment of Hg in the Everglades. In addition to editing, they are the principal authors of the 25 total chapters.

The 3 volumes follow a logical sequence. Volume I is background, beginning with the geophysics, ecology, and history of the Everglades and followed by sources, transport, deposition, and fate of Hg. Volume II begins with 6 chapters summarizing the biogeochemistry of Everglades Hg. No other chemical's environmental risks depend so

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much on complex inorganic and organic biogeochemistry. The next 6 chapters are devoted to bioaccumulation, ecological risks, and human health risks. Volume III is primarily devoted to 5 chapters addressing temporal trends in Everglades Hg. The last 2 chapters include a structural equation model (SEM) of the system and a discussion of “mitigation management strategies and likely outcomes,” which uses results from the SEM.

Most of the work is in the form of conventional scientific reviews in which 1 study found this, another study found that, a third study found another thing, and the authors conclude something from their synthesis. Nothing wrong with that. Even the chapter on the “Regional-Scale Ecological Risk Assessment of Mercury in the Everglades and South Florida” synthesized 21 prior ecological assessments, none of which were so inclusive.

Unlike the narrative approach of other review and synthesis chapters, Volume II Chapter 3 takes a formal weight of evidence approach to determining the cause of the extreme geographic and temporal variability in Hg biomagnification. To do that, they adapted the United States Environmental Protection Agency's (USEPA's) Causal Analysis/Diagnosis Decision Information System (CADDIS), which was developed for determining causes of biological impairments. The adaptation CADDIS causes of Hg speciation and accumulation makes the evidence review clearer and the inferences more transparent than the narrative reviews elsewhere. Note that this opinion is biased by the fact that I was one of the 3 leads in the development of CADDIS.

In the end, this review and synthesis concludes that the only management practice that promises to reduce the toxic levels of exposure is reduced sulfate input. Mercury input is primarily from global sources that are not realistically controllable. Nutrient enrichment is likely to have negative effects without reducing Hg methylation and accumulation. The primary source of sulfate is surface water due to agricultural fertilization, not atmospheric deposition. A model of sulfate control suggests that it could reduce Hg bioaccumulation, but toxic Hg levels will persist for decades.

This synthesis is particularly important because it brings together approximately 30 y of work on the Everglades Hg problem. During that time, the research effort has been immense, but without an assessment framework the results were incoherent. One wonders what might have been accomplished with a coordinated assessment plan. Examples that come to mind are the US National Acid Precipitation

Program (NAPAP) in the 1980s and currently the US National Climate Assessment and Intergovernmental Panel on Climate Change (IPCC). The editors and authors of this set of books have done a real service to Everglades management, to environmental science, and particularly to those who deal with risks from Hg.

Volume I. 2019. 107 p. Hardcover. ISBN 978-3-030-20069-5. \$170. Springer Nature, Cham, Switzerland.

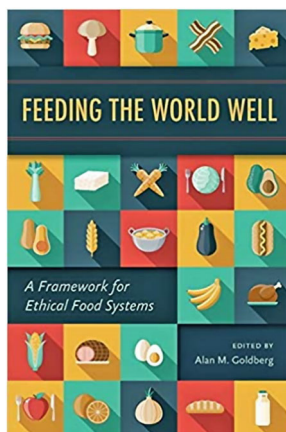
Volume II. 2019. 273 p. Hardcover. ISBN 978-3-030-32056-0. \$130. Springer Nature, Cham, Switzerland.

Volume III. 2020. 164 p. Hardcover. ISBN 978-3-030-55634-1. \$155. Springer Nature, Cham, Switzerland.

Glenn Suter
SETAC Reviews Editor

FEEDING THE WORLD WELL: A FRAMEWORK FOR ETHICAL FOOD SYSTEMS

edited by Alan M Goldberg



It is among the great dilemmas of our time. How shall the world provide plentiful, healthy, and nutritious food for all, and do so in an environmentally sustainable and safe manner? The challenge is dire, indeed, and much like the climate crisis, the time to act is now if we are to avert a global catastrophe.

At first glance this might appear to be yet another book addressing the question of how best to feed the 10 billion or more people anticipated on Earth by 2050. The book follows the well-worn belief that current food production practices are fragile, lacking in diversity of crops and animals, unsustainable, oftentimes inhumane to animals, and in violation of human rights in the work force. And by the way, we are not growing enough food to feed the current population. No surprises. In fact, the International Rescue Committee's (<https://www.rescue.org>) 2021 Emergency Watchlist identifies food shortages, famine, and high food prices among key factors that are contributing to the unprecedented humanitarian emergencies facing the world right now.

The book, *Feeding the World Well: A Framework for Ethical Food Systems*, calls for reinvention of the most complex supply chain in all of human history. But rather than focus strictly on technological solutions, the book introduces ethical arguments to persuade the reader of the urgency for change. What makes this book different from others is that the collection of writings from experts focuses on the moral imperative and ethical considerations underlying the urgent need to adopt new technologies and farming practices to feed the world sustainably and responsibly. The underlying premise of the book is that eating involves moral decisions rooted in the context of culture, tradition, and social structures. Food choices are intertwined with personal beliefs and values, our relationship to where food comes from, and our physiological drive toward certain foods, traditions, and habits.

Although the book, in some chapters, portrays a catastrophic view of imminent widespread starvation, experts guided by the book's editor, Alan M Goldberg, convey optimism that changes to current farming practices and food distribution networks will lead to more effective use of available land and water resources, improved farming efficiencies, less food waste, and even encourage the transformation of our diets. These experts collectively argue that new plant, animal, and seafood farming practices can produce healthy, nutritious foods in volumes sufficient to feed the world.

Goldberg is well qualified to guide the reader on this topic. His work 10 y ago on the Pew Commission on Industrial Farm Animal Production inspired creation of the Global Food Ethics and Policy Program and the Choose Food Project at John Hopkins Berman Institute of Bioethics, Baltimore, Maryland. This book is the culmination of Goldberg's several decades of work to bring together food system experts to discuss the ethical challenges inherent in several facets of food production: environment, crops and horticulture, water, animal welfare, public health, food safety, and labor.

Book chapters are written by leaders from food companies and nonprofit organizations, researchers, policy makers, and regulators, each discussing practices and technologies that foster the changes needed to feed the world. The book is presented in 5 parts. The first part is a series of chapters describing the challenges and moral imperative for feeding the world. The second part describes the social, environmental, and economic forces that influence how the world produces food. The third part explores the ethical challenges. And the fourth and fifth parts of the book deliver the solution envisioned by Goldberg: a framework for ethical food systems defined by a set of core ethical commitments. Case studies presented at the end of the book illustrate the wisdom of adopting new farming and food distribution practices. The final 2 chapters are dedicated to explaining why these commitments are essential for preparing the food production industry for a world in which "ethical" or "sustainable" production practices are commonplace.

The book is conceived as a textbook for university-level food studies courses. It will also appeal to agriculture and

seafood professionals who seek a more philosophical argument for why the world's food production and distribution supply chain needs to change. Ecologists and environmental scientists may find interesting the chapters dedicated to discussing the use of chemicals in farming and the need to adopt genetic modification to support higher food production volumes. Several chapters that discuss new approaches for improving efficiencies in the use of water, soil, and other natural resources should sound familiar to conservationists and opponents of current industrial-type farming practices. The technical and ethical arguments put forth in the book—the need for new farming practices, embracing genetic diversity, promoting animal welfare, and encouraging sustainability—are quite persuasive, and the reader may find it difficult to disagree.

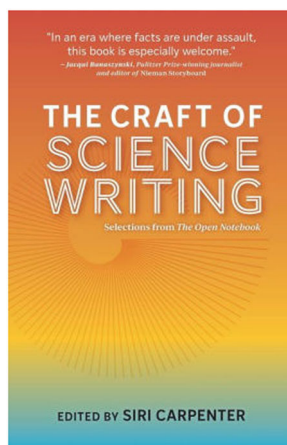
Goldberg and the collection of experts provide plenty of food for thought on the duties and responsibilities of different stakeholders in the world's food system, including consumers, governments, and food and agriculture industry. The book serves to remind us that the current food system is neither environmentally nor economically sustainable, dependent as it is on fossil fuels and monoculture farming and routinely resulting in environmental damage. Changes are sorely needed. And yet, are the changes proposed in the book only temporary measures that delay inevitable catastrophe? There simply is not sufficient land, water, or raw materials to feed an ever-increasing human population. What then?

2020. 392 p. Hardcover. ISBN-10: 1421439344; ISBN-13: 978-1421439341. Johns Hopkins University Press, Baltimore, Maryland.

Richard Wenning
IEAM Editor in Chief

THE CRAFT OF SCIENCE WRITING

edited by Siri Carpenter



The Craft of Science Writing is a collection of interviews and articles from The Open Notebook (TON; <https://www.theopennotebook.com>), a nonprofit organization dedi-

icated to supporting science journalists and aspiring science writers. The book's editor, Siri Carpenter, is a cofounder and editor in chief at TON, an award-winning science journalist, and immediate past president of the National Association of Science Writers. Carpenter has collected her favorite articles from TON's online archive, written by science writers and journalists who confess their struggles and challenges, as well as their personal habits and solutions, for reporting science news stories, interviewing experts, conducting background research, and (most difficult of all) composing the compelling narrative science stories that readers find riveting and relevant to our world.

The book is touted as a must-read for English majors and journalism students, and hailed as an indispensable guide for journalists, media professionals, researchers, and educators charged with communicating difficult science topics to nonscientists. This could be enormously helpful to Society of Environmental Toxicology and Chemistry (SETAC) members and readers of *Integrated Environmental Assessment and Management* (IEAM) who enjoy the challenge of writing about science for the public. The book discusses how to get published in popular media, how to pitch stories to magazine editors or literary agents, how to frame an interesting story, how to collect research and interview experts, and how to read and dissect the contents of a technical paper.

The opening set of articles in the first 50 pages describes the virtues of science journalism. The heart and purpose of the book begins thereafter with a focus on the mechanics of science writing with tips and suggestions from experienced writers on the process for collecting facts and writing a story that can be understood by nonscientists. The book delves into the delicate challenges of communicating risk, recognizing shady facts and statistics, and spotting bias in both the scientific research and the writing process itself. The chapter written by freelance science journalist Rodrigo Perez Ortega on how to get the most out of attending science conferences should be required reading for students and young professionals for whom the excitement of a paid business trip can interfere with the intended learning experience. Science stories published during the past decade in newspapers and magazines are discussed throughout the book as examples of both good and poor science storytelling.

Carpenter's goal, she writes, is to provide a glimpse behind the curtain of successful writers and to reveal the toil, self-doubts, and the many dead ends, false starts, and crumpled pages of rejected text. I confess that I took some comfort reading how much even the most successful writers struggle and fail. I have often mused how my environmental career has followed the evolution of environmental awareness in business and governments around the world. I have often wondered if the many environmental investigations, cleanups, research, and new

technologies that I have witnessed during my career would interest others. But, how to begin? Which stories would be interesting to the public or useful to students? Who can I confide in and not feel embarrassed by my inexperience writing for the public? For these and other questions, I found the book provided some answers and plenty of encouraging tips and insights.

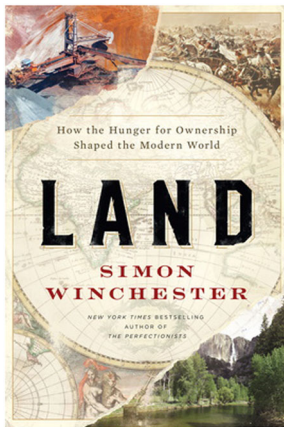
Carpenter has captured in 300 pages an inspirational reference guide for the budding science writer. The introduction to the book reveals her enthusiasm for the science writing process and deep admiration for successful writers. When we read work that we admire, Carpenter reminds us that we often do not appreciate the writer's hard work and discipline. Writing is a chore, a craft honed by time and practice. Inspired by this book, I intend to keep practicing.

2020. 306 p. Softcover. ISBN-13: 978-1734028003. \$24.95. The Open Notebook Press, Madison, Wisconsin.

Richard Wenning
IEAM Editor in Chief

LAND: HOW THE HUNGER FOR OWNERSHIP SHAPED THE MODERN WORLD

by Simon Winchester



The journalist and successful nonfiction author Simon Winchester became fascinated by the concept of land ownership when he bought land in the United States. The resulting book intrigued me because land ownership is central to environmental management. It determines who manages the land and how terrestrial biotic communities are treated. Rather than a coherent narrative or argument, this book presents a series of vignettes describing historical events that relate to land ownership. They range from broad trends such as the introduction of tilled agriculture, the development of cartography, and the colonial occupations of the Americas, Africa, and Australia, to more specific events such as the destruction of land-owning Ukrainian peasants by Stalin, and extremely specific events such as the theft of a Japanese-American strawberry farm by the farmer's neighbor.

The narratives are all well written, and even when familiar, they are presented with engaging facts and anecdotes. My favorite is Jomo Kenyatta's account of colonialism. "When the missionaries came to Africa, they had the Bible, and we had the land. They said, 'Let us pray.' We closed our eyes. When we opened them, we had the Bible, and they had the land."

To the extent that there is a theme, it is that common occupation and use of the land is preferable to private ownership. Winchester speaks admiringly about cultures with no land ownership and of institutions like land trusts that bring private property back into community ownership. However, he does not suggest how large-scale sharing of the land might be accomplished and what sort of culture might allow it. As the example of Stalin suggests, it would take force for a government to impose it. Most of Winchester's examples of people without land parceling are hunter-gatherers or pastoralists. Even in those cultures that had no idea of private property, tribes or bands fought over territory. Even chimpanzee troops patrol their borders and attack intruders. Without private property, there are still evils from collective landholding.

Winchester praises the spiritual attachment of traditional cultures to the land and admires their superior land management. In particular, he criticizes conservation movements that protect ecosystems and he admires the land-burning practices of Indigenous Australians and North Americans. It is certainly true that if you regularly burn a landscape, large wildfires are less likely. It also results in grasslands or park-like savannahs that many people prefer. However, that results in depauperate ecosystems. I read in the visitor's center for Kakadu National Park, Australia, that a purpose of burning in the park is to sustain traditional practices, but the purposes of those practices was to drive game to hunters, kill snakes, and clean the land. Under Indigenous management, Yosemite Valley, California, USA, was an oak savannah due to burning that provided acorns and aided their collection. Now, it is returning to its natural conifer forest. Which is better? Naturally caused fires are rare in California because lightning is rare and occurs in the wet season. Should we give up on protecting natural vegetation through fire prevention and control and burn California regularly? This did not seem at first to be an issue of land ownership but on second thought, it is. Massive, controlled burning might be practical on government-owned land, but would landowners agree to the government deliberately or accidentally burning their land every few years? How about vacationers finding that the park where they came to camp was recently burned? These questions are complicated by climate change and increasing drought in California and much of Australia. This is an interesting issue for environmental policy, assessment, and management. Neither current nor traditional Indigenous practices will work as a standard practice.

The issue of common ownership is more directly addressed in Winchester's attack on Garrett Hardin and his theory of the tragedy of the commons. Hardin assumed, as economists do, that people will maximize their utilities. If pasture lands are held in common, each person will put as

many animals on the commons as possible because he or she gets all the benefit of each animal, but the damage to the pasture from overgrazing is shared by all members of the community. Hardin concludes that private ownership is necessary to prevent damage to the land by rationally selfish individuals. This logic can be applied to utilization of any natural resources (fisheries, forests, irrigation water, etc.). The resulting argument between commons and individual ownership neglects a third way, regulation of resource use by the community. Surely, the British farmers who shared common pastures would ostracize or otherwise control those who engaged in selfish behavior of the sort that Hardin said was inevitable. More relevantly, resource management agencies function to prevent overgrazing, overfishing, and otherwise overexploiting common resources.

The issue of land ownership is part of the issue of maldistribution of resources. Just as a few individuals control a large fraction of monetary wealth, a few individuals own large land areas, and many individuals own none. Winchester suggests that land barons might be induced to share, particularly given the loss of coastal land with sea-level rise. Although we are accustomed to using taxes to redistribute wealth, I have difficulty imagining that US landowners would agree to land redistribution.

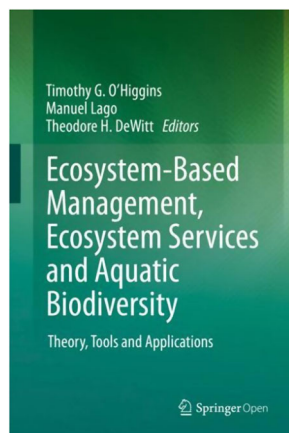
While I was reading this book, Joe Biden was inaugurated as US president. The ceremony included a performance of Woody Guthrie's *This Land is Your Land* by Jennifer Lopez. Guthrie was a socialist and really believed that the land belongs to everyone. Hence, the performance got the usual blowback from conservatives. However, criticism also came from some Indigenous groups who objected that the land, by rights, belongs to them. The themes of this book are unavoidable.

2021. 446 p. Hard cover. ISBN 978-0-06-293833-6. \$30. HarperCollins, New York, New York.

Glenn Suter
SETAC Reviews Editor

ECOSYSTEM-BASED MANAGEMENT, ECOSYSTEM SERVICES AND AQUATIC BIODIVERSITY: THEORY, TOOLS AND APPLICATIONS

edited by Timothy G O'Higgins, Manuel Lago, and Theodore H DeWitt



While fighting the global pandemic, we have shortened distances, reexplored our surroundings, reevaluated local food chains, and rediscovered new as well as forgotten dimensions of human well-being (e.g., cycling). It is the right time to revamp the discussion about the management of nature's goods and services, get up to date with the evolution of ecosystem-based management (EBM), and start thinking how we could contribute to further progress.

The book offers 24 chapters arranged into 5 parts. Following a general introductory chapter stressing the challenge posed by managing our environment as a dynamic socio-ecological system, Part II reviews EBM's conceptual basis starting from its multiple definitions and links to a multitude of collateral disciplines, such as ecosystem services (ES) evaluation, Driver–Pressure–State–Impact–Response (DPSIR) and its evolutions, environmental risk assessment (ERA), environmental impact assessment, and ecosystem-based adaptation (...among others). The conceptual subtleties and the amount of detail risks discouraging readers who may not feel passionate about the ecosystem assessment and management (not a concern for IEAM readers, of course!). The general impression is that we are at (an advanced) brainstorming phase and that O'Higgins et al. make a commendable effort in trying to assemble a systemic view out of a potpourri of ideas that tend to continuously generate new jargon. As recently observed by Nathalie Doswald (UN Environment): “every year... [they] come up with a new definition about how Nature is helping us”; currently the most popular phrase is “nature-based solutions” (briefly addressed in the third chapter by Delacámara et al.), which refers to urban ecological engineering, but it is also interpreted on a broader scale.

Part III illustrates EBM tools and techniques; it stresses that we need to go beyond ES quantification and place greater emphasis on strategies that can actually feed outputs of assessments and evaluations (including ERA, ES, etc.) into recommendations to decision makers that can be incorporated in science-policy processes. It includes a comparative review of natural capital accounting frameworks such as the System of Environmental Economic Accounting (SEEA) developed by the United Nations and partners, the USEPA's National Ecosystem Services Classification System (NESCS), and the Common International Classification of Ecosystem Services (CICES) developed by the European Environment Agency.

Although ES approaches developed supply-side models that predict ecosystem productivity, most authors in this book place greater emphasis on stakeholder perception, on linkages to metrics integrating changes in livelihoods and in well-being (chapter by Flood et al.), on the dynamic relationship between supply and demand, and finally converge toward the definition of Final Ecosystem Goods & Services (chapter by DeWitt et al.) for a more robust management of socioecological systems. Proposals that promote stakeholder engagement include stakeholder analysis and classification (chapter by Sharpe et al.), strategic communication (chapter

by Harwell et al.), translational science (chapter by Gobble et al.), engagement indicator tools (chapter by Bousquin et al.), participatory adaptive management, and several decision-support models that emphasize demand-side approaches. Few authors mention cultural services, the relevance of psychological health, and the inclusion of equity in ES evaluation, issues that are likely to rise to the forefront as a result of the current pandemic. Numerous examples address continental as well as coastal ecosystems. Modeling approaches are particularly advanced, with emphasis on issues of scale, uncertainty, data validation, comprehensiveness, relevance, examples of application, and multimodel frameworks in which the output from 1 model becomes input for another. Biodiversity is not prominent, despite its inclusion in the book title.

Part IV offers an overview of legal and policy aspects, stressing that ES and EBM have a weak connection with legal frameworks in Europe, in the United States, and internationally, despite the frequent mention of the “ecosystem approach” found in many policy documents issued during the last 20 y. Administrative sectorial “silos” seem increasingly confused by the flurry of concepts and sophisticated models proposed by academics. As a result, there is a lack of policy intervention across development sectors, administrative boundaries, and levels of government, and a failure to generate action at the most efficient scale of implementation.

Part V offers 8 case studies that illustrate EBM in aquatic ecosystems (the category that, according to Costanza and De Groot, conveys the greatest ES benefits) in Europe and North America. The cases underrepresent the Global South, with the notable exception of the Lower Mekong Basin addressed in the chapter by Johnston et al., where EBM is applied under the perspective of climate change.

The writing style is technical, informative, and less formal than in a scientific article, leaving more space for reporting about ongoing projects and for illustrating new approaches. Detailed reference lists provide links to resources for practitioners who would like to move to the hands-on stage. Given the large number of authors, the style is not entirely harmonized, and there are repetitions of concepts, duplications of definitions, and descriptions of tools with overlapping objectives. Fortunately, at the beginning of each chapter there is an abstract and 2 useful bullet-point sections, “Lessons learned” and “Needs to advance EBM,” that nicely summarize key teachings.

2020. 580 p. Softcover. ISBN 978-3-030-45842-3. €41.59. eBook. ISBN 978-3-030-45843-0. Free at <https://doi.org/10.1007/978-3-030-45843-0>. Springer Nature, Cham, Switzerland.

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GROWING OUR FUTURE: SCALING REGENERATIVE AGRICULTURE IN THE UNITED STATES OF AMERICA

by Mary McCarthy, Elizabeth Rich, Samuel Smith, Lesley Mitchell, and Sally Uren



To understand this publication, it is necessary to understand something about Forum for the Future, the organization that published it. Forum for the Future describes itself as an international nonprofit that helps organizations develop sustainable business strategies. The research was supported by the Walmart Foundation and focused on the food and apparel sectors in the United States, so one could think of the document as a project report on developing sustainable business strategies to improve the livelihoods of people working in US food and apparel supply chains.

The report identifies 3 key elements (one could call them “objectives”) of Forum for the Future’s strategy to scale up what it calls “regenerative agricultural practices” in the United States:

- Improve supply chain resiliency.
- Restore soil health, water quality, and biodiversity.
- Create political and economic conditions that allow farmers and other agribusinesses to thrive.

The report starts by briefly juxtaposing the structure of the current agricultural sector on Forum for the Future’s 3 strategic objectives pertaining to this project. This is helpful because it provides a way to map out the changes that would have to come to meaningfully improve supply chain resiliency, restore ecosystem services, and allow regenerative agribusinesses to thrive. The rest of the report suggests diverse ways to make those changes happen.

I liked this report. It could inspire people to become more optimistic about our collective ability to bring about deliberate, large-scale social changes, such as scaled-up regenerative agriculture. It is well organized. It talks about how to bring about change, but it is not a how-to manual. It is more manifesto than manual. It will help stakeholders see the changes they want to bring about through a different lens. It uses leverage as a metaphor for small stakeholders being able to drive big changes. It identifies 4 “levers” that a

savvy small stakeholder can use. It identifies several stakeholder roles and which role players are best suited to use which levers. It spotlights farmers, citizens, scientists and engineers, policy makers, businesspeople, philanthropists. It spotlights all of us, collectively, as consumers of food and apparel products. It tells stories of small stakeholders who have had leveraging success. It tells stories of small stakeholders who are doing the painstaking preparations to have leveraging success in the future.

The report closes on a high note, by imploring us to engage in “ongoing collaboration among uncommon partners.” Sage advice for our times. An encore follows, in which 16 barriers to scaling regenerative agriculture are documented. Better the devil you know.

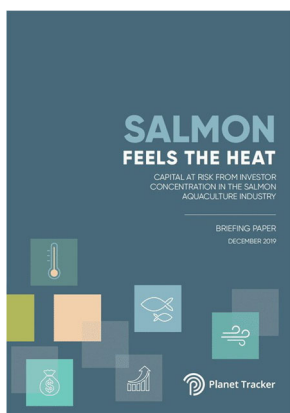
“Growing Our Future” is 1 of 44 reports available on Forum for the Future's website, covering complex global challenges under 4 broad topics: climate change, food, supply chains, and circular economy. I am glad that I learned about Forum for the Future and look forward to exploring more of its publications.

2020. 37 p. Free at <https://www.forumforthefuture.org/Pages/Category/publication-library?Take=44>. Forum for the Future, Brooklyn, New York.

John Toll
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SALMON FEELS THE HEAT: CAPITAL AT RISK FROM INVESTOR CONCENTRATION IN THE SALMON AQUACULTURE INDUSTRY—BRIEFING PAPER 2019

by Planet Tracker



The white paper, “Salmon Feels the Heat” was published by Seafood Tracker, a derivative subsidiary of Planet Tracker. These organizations align capital markets with ecological limits and sustainable management practices. Personally, this was a highly informative read. The white paper demonstrates the relationship between a multibillion

dollar industry (salmon aquaculture), capital markets, environmental constraints, and sustainability practices. For the average consumer who debates to purchase farm-raised salmon, this white paper looks at the big picture.

As an initial topic, the paper contrasts the wild-caught fisheries industry with the aquaculture industry. Global wild-catch fisheries production has plateaued during the past 15 years at about 90 million tons/yr. The causes of this flat-line growth are many: overfished stocks, inconsistent jurisdiction regulations, and contested fishing rights (latest example, the battle between China and the Philippines for fisheries rights in the South China Sea). Taking a fisheries biology course as a young graduate student, our first assignment was to read the classic paper by Garrett Hardin (1968), on the “Tragedy of the Commons.” This theory was realized time and time again as valuable fisheries stocks around the world were depleted in the absence of enforceable governmental quotas.

As opposed to wild-caught fisheries production, aquaculture production (all species included) is expected to double from 10 million tons/yr (2010) to 140 million tons/yr (2050), due to an increasing global demand of seafood-source protein. Some organizations, however, predict less of an increase.

The white paper then focuses on the Atlantic salmon fishery, which is the 2nd most financially valuable farmed species in the world, with over 2.4 tons of farmed products produced in 2018 representing a market value of \$18 billion, based on industry estimates.

Based on data from 2016, Atlantic salmon aquaculture production in two countries (Norway and Chile) represents about 75% of total global salmon production. In these countries, there is a concentrated ownership of the aquaculture industry (i.e., a few companies control a majority of the aquaculture industry). Since 2000, global production of Atlantic salmon (all countries combined) has increased by about 155%.

But there are concerns about the viability of future growth. The white paper identifies 4 environmental factors (“environmental shocks”) that are causing consternation for investors. These factors are: 1) algal blooms, caused by watershed runoff of nitrates and phosphorus; 2) diseases, notably infectious salmon anaemia (ISA), which are directly correlated to the environmental quality of the aquaculture pens and stocking rates; 3) parasites, notably sea lice, whose infestations have cause millions of dollars in losses of salmon production and threaten the health of wild salmon populations; and 4) water temperature increases. In Norway, monitoring studies have indicated that near-shore water temperatures, on occasion, are higher than Atlantic salmon upper preferred water temperatures in summer months. This observation, obviously, represents just 1 of several concerns about potential effects of long-term climate change.

How can investors and ownership companies respond to these threats to the growth of the salmon aquaculture

industry? The Seafood Tracker report summarizes this quite concisely:

It is imperative that institutional and other investors demand long-term sustainable industry growth through the implementation of effective environmental and financial risk management policies within a sustainable business model. As part of their decision-making investors should be addressing disease resilience, genetics, site selection, technology type and operational resilience to climate change.

Simply put, those companies that are committed to growth in the salmon aquaculture industry will need to evaluate ways to adapt to environmental constraints through sustainable practices. And, it should be recognized that there are other food industries that will need to do the same.

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