

AQUACULTURE LANDSCAPES

Fish Farms and the Public Realm

Michael Ezban

foreword by Charles Waldheim



Aquaculture Landscapes

Aquaculture Landscapes explores the landscape architecture of farms, reefs, parks, and cities that are designed to entwine the lives of fish and humans.

In the twenty-first century, aquaculture's contribution to the supply of fish for human consumption exceeds that of wild-caught fish for the first time in history. Aquaculture has emerged as the fastest growing food production sector in the world, but aquaculture has agency beyond simply converting fish to food. *Aquaculture Landscapes* recovers aquaculture as a practice with a deep history of constructing extraordinary landscapes. These landscapes are characterized and enriched by multispecies interdependency, performative ecologies, collaborative practices, and aesthetic experiences between humans and fish. *Aquaculture Landscapes* presents over thirty contemporary and historical landscapes, spanning six continents, with incisive diagrams and vivid photographs. Within this expansive scope is a focus on urban aquaculture projects by leading designers—including Turenscape, James Corner Field Operations, and SCAPE—that employ mutually beneficial strategies for fish and humans to address urban coastal resiliency, wastewater management, and other contemporary urban challenges. Michael Ezban delivers a compelling account of the coalitions of fish and humans that shape the form, function, and identity of cities, and he offers a forward-thinking theorization of landscape as the preeminent medium for the design of ichthyological urbanism in the Anthropocene.

With over two hundred evocative images, including ninety original drawings by the author, *Aquaculture Landscapes* is a richly illustrated portrayal of aquaculture seen through the disciplinary lens of landscape architecture. As the first book devoted to this topic, *Aquaculture Landscapes* is an original and essential resource for landscape architects, urbanists, animal geographers, aquaculturists, and all who seek and value multispecies cohabitation of a shared public realm.

Michael Ezban is an architect, landscape designer, and scholar. His work explores landscapes and buildings designed to mediate relations between humans and other animals. Published and exhibited internationally, Ezban's writing and design focus on aquaculture landscapes, waterfowl hunting grounds, and equestrian facilities. He is a recipient of the Maeder-York Family Fellowship in Landscape Architecture from the Isabella Stewart Gardner Museum and the Charles Eliot Traveling Fellowship from the Harvard University Graduate School of Design. Ezban is an Assistant Professor in Landscape Architecture at the University of Virginia, and a cofounder of VanderGoot Ezban Studio, a research-based practice.

Aquaculture Landscapes is a breath-taking book—full of historical drawings, ingenious diagrams, and superb photography—that demonstrates how we can revolutionize our relationships with aquatic life. Grounded in multispecies urban theory and dreams of coexistence instead of exploitation, Ezban offers both concrete examples and speculative designs from around the world that will transform landscape architecture practice. His book is the first to not only argue for a post-human urbanism, but to demonstrate how landscape architects can go about creating a zoöpolitan urbanism for the future. *Aquaculture Landscapes* is a must-read for all landscape architecture students, faculty, and professionals.

—Jennifer Wolch

Dean, College of Environmental Design, UC Berkeley, USA

Michael Ezban presents an original and informative book on an extremely intriguing subject: aquaculture landscapes—fish farms as seen through the lens of contemporary landscape architecture. His work opens and invites us all into vast and exciting new territory for landscape architecture practice. Through examination of public landscapes where nutrient cycling, biological conservation, remediation, and vernacular farming practices combine to inspire a sense of wonder and pleasure, *Aquaculture Landscapes* illustrates both the art of survival and the art beyond survival.

—Kongjian Yu

Dean and Professor, Graduate School of Landscape Architecture, Peking University, China
President, Turenscape

Aquaculture Landscapes is a thoughtful, articulate, forward-thinking contribution to a deeply problematic yet still-growing sector of food production. Combining intelligent prose with illuminating illustrations, Michael Ezban presents an alluring vision for how new, ecologically and ethically sensitive systems can—indeed, must—be designed for a livable future. With what I've seen of the state of contemporary industrial aquaculture, this is a much-needed blueprint.

—Jonathan Balcombe, author of *What a Fish Knows*

We are all born of water, and our primordial relationship with aquatic ecologies endures. In this lush volume, Michael Ezban both plumbs the depths and surfaces common currents to reveal an aqueous terrain worthy of navigation for the Anthropocene. Through rigorous historical research and insightful contemporary precedents from aquaculture to angling, *Aquaculture Landscapes* offers fresh thinking and timely designs for a richer, more biodiverse world. Ezban's design research intelligently articulates how we might materially and metaphorically cohabit with our oldest of relatives—the fish—and other species beyond the human.

—Nina-Marie E. Lister

Graduate Program Director, School of Urban + Regional Planning, Ryerson University, Canada

Aquaculture Landscapes is an incredible achievement! Michael Ezban's beautiful maps, diagrams, and renderings unpack the diverse and integrated worlds that humans and fish inhabit. This book is a celebration of our ingenious and resourceful history as humans guiding and cultivating the aquatic landscape.

—James Prosek, author of *Eels*

We are ecological beings. We interact with our fellow humans as well as with other species and our environments. But our interactions with other species tend to be one-sided; we take much more than we give. In *Aquaculture Landscapes*, Michael Ezban takes compelling deep dives into cohabited landscapes from around the world, and he offers a hopeful vision for how we might rebalance and reconfigure our relationships with fish and other aquatic life through design.

—Frederick Steiner

Dean, Stuart Weitzman School of Design, University of Pennsylvania, USA

AQUACULTURE LANDSCAPES

Fish Farms and the Public Realm

Michael Ezban

 **Routledge**
Taylor & Francis Group
LONDON AND NEW YORK

First published 2020
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

and by Routledge
52 Vanderbilt Avenue, New York, NY 10017

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

© 2020 Michael Ezban

The right of Michael Ezban to be identified as author of this work has been asserted by him in accordance with sections 77 and 78 of the Copyright, Designs and Patents Act 1988.

All rights reserved. No part of this book may be reprinted or reproduced or utilised in any form or by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying and recording, or in any information storage or retrieval system, without permission in writing from the publishers. Printed in Canada

Trademark notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data
A catalog record has been requested for this book

ISBN: 978-1-138-21835-2 (hbk)
ISBN: 978-1-315-40478-3 (ebk)

Publisher's Note
This book has been prepared from camera-ready copy provided by the author.

Typeset in Avenir.

For my father, Morris, who loved to go to the sea.



01 View to cascading raceways at Posto Aquícola Ribeiro Frio, the state-run fish farm located within Laurisilva of Madeira, Portugal, a UNESCO World Heritage Site. The centuries-old system of *levadas* (irrigation canals) supply the farm with fresh water. Rainbow Trout (*Oncorhynchus mykiss*) are farmed here to stock the *levadas* and other waterways of Madeira.

Contents

Foreword	viii
Imagining Aquaculture, by Charles Waldheim	
Acknowledgements	x
Introduction	01
Aquacultures	
PART ONE	
Situating Aquaculture Landscapes	
Designing Ichthyological Urbanism	15
Resilient Aquaculture Coastlines	19
Catalytic Polycultures	27
Post-Aquaculture Adaptations	35
PART TWO	
Surveying Aquaculture Landscapes	
Overview of Aquaculture Landscapes Case Studies	45
01 Fishponds of the Třeboň Basin, Czech Republic	53
02 Esteros in the Bay of Cádiz, Spain	63
03 Wetland Basins in the Doñana Nature Reserve, Spain	73
04 Valli of Comacchio, Italy	83
05 Piscina of Sperlonga, Italy	93
06 Piscifatoire of Huningue, France	103
07 Grotto Aquarium in Paris, France	113
08 Acadjas at Lake Nokoué, Benin	123
09 Bheries of the East Kolkata Wetlands, India	133
10 Dike-Pond System of the Pearl River Delta, China	143
11 Rice-Fish Terraces of Longxian Village, China	153
12 Gei Wai in the Mai Po Marshes, Hong Kong	163
13 Savanna Weirs of Baures, Bolivia	173
14 Tailwater Fisheries at Wolf Creek Dam, United States	183
15 Ahupua'a of the Hawaiian Islands, United States	193
PART THREE	
Depicting Aquaculture Landscapes	
Representations of Aquaculture Landscapes	205
Afterword	241
Notes	242
Image Credits	246
Index	248

Foreword

Imagining Aquaculture

We have been eating fish since long before we were human.¹ Fish have been as fundamental and formative to our development as any terrestrial species. Fishing and eating fish, either raw or cooked, predate our emergence as *Homo sapiens*. Yet, fish farming is a decidedly human invention, deeply associated with our species. The terrestrial cultivation of fish for human consumption is found across cultures and climates as diverse as human habitation itself.

This fascinating book presents the astonishing diversity of these aquaculture practices and the landscapes they construct. *Aquaculture Landscapes* assembles essential knowledge on both ancient and contemporary human practices for readers across the design disciplines. The case studies curated in this volume present a compelling, comparative account of these cultural practices as well as ample evidence of the variable relations between the humans and non-humans that cohabit these landscapes. These cases offer thick readings of constructed, species-specific ecological systems, and they augment contemporary interest in the design of mutualistic relationships between species across complex webs of ecological feedback. This study is particularly timely, as ecological performance has emerged as a lens for understanding urbanism and species-driven projects in contemporary design practice.

Michael Ezban's rigorous original research illustrates not only our relationship with fish and farming, but it also describes the broad range of societal and cultural conditions that aquaculture supports. Ezban rightly reads the material practices of aquaculture and their social economies as forms of landscape. By claiming these sites as landscape, Ezban invokes the social construction and cultural complexity that the term originally invoked in its European origins, yet he extends that frame to describe constructed landscapes found across nearly every human culture. Ezban posits aquaculture as an ancient form of socially constructed landscape with significant import for contemporary design discourse on urbanism, a claim that is resonant with the current disciplinary interest in agricultural production and its implications for landscape architecture and the shape of the city.

Ezban's reading of farms, reefs, hatcheries, and associated aquaria as socially constructed landscapes is reinforced through his attentiveness to the complexity with which multiple species are ordered, in various relationships to one another, at these sites. His evocative account of these multispecies entanglements draws on contemporary posthuman discourse that examines the status and meaning of non-humans in the social construction of culture. Ezban's drawings, diagrams, and texts conspire to produce an exemplary portrayal of aquaculture landscapes, and the species they assemble, as extraordinary cultural constructs. This book has much to teach us about human relations with the non-human world, as well as the roles of landscape in mediating those relations and imagining that world.

Charles Waldheim, Harvard University, USA



01 Louis-Joseph Yoerman, *La pêche au Vivier*, raised wall mural, Palais des Papes, Avignon, France, 1910. Copy after original from 1343-1344.

Acknowledgements

This project on aquaculture landscapes has been six years in development. Before it was a book, it was a series of travels and experiences with people, fish, and landscapes—an embodied practice of research that I initiated to get a feel for what aquaculture is, what it has been, and what it can be. My journeys included visits to extant sixteenth-century carp ponds in the Czech Republic; the 36 ft diameter fiberglass tanks in a nondescript warehouse in Massachusetts that house thousands of barramundi, a fish native to Australian billabongs; interdependent and intertwined Andalusian salt and fish farms; the ruins of a *piscina* on the Italian coast where a Roman emperor and his guests would relax alongside eels; and the alluvial forest of a nineteenth-century hatchery landscape in France. In my travels I savored the taste of lightly seasoned Common Carp; I spied egrets stalking Northern Pike from a bird blind; I joined six men who harvested a group of Grey Mulletts from a drained pond with a seine and then witnessed the slow death of those fish on ice; I tossed feed pellets to thrashing Rainbow Trout in concrete raceways; I observed sinuous European Eels swimming in a coastal lagoon and watched their long bodies being threaded on skewers and fired; and I sketched anglers effortlessly pulling Brown Trout out of a tailwater on a Tuesday morning.

My experiences were enriched by conversations with farmers, hatchery managers, and biologists who provided me with insight into the world of fish culture. My deepest thanks to J. Miguel Medialdea, the Quality and Environment manager of the Veta la Palma fish farm in Spain, for walking with me across the productive landscape that he has stewarded for many years. Witnessing, experiencing, and discussing the intricate workings of that constructed ecology was crucially formative to my thinking and made me feel hopeful for a future of ecological aquaculture. My forays into aquaculture landscapes across Europe and North America would not have been possible without financial support from the Charles Eliot Traveling Fellowship from the Harvard University Graduate School of Design, a prize I am truly grateful to have received.

For all my travels, there were many landscapes I did not visit. In these instances, I am so thankful for the scholars who agreed to dig back into their slide libraries to unearth photographs from their own time spent at aquaculture landscapes. Thank you, Peter Edwards, Luohui Liang, Kenneth Ruddle, and Clark Erickson for your willingness to share your beautiful images with me.

The Isabella Stewart Gardner Museum in Boston was a wonderful place to live and work for three months in 2014 as I explored these topics. I am grateful to museum director Anne Hawley for conversation and perspective on how my work resonates with the museums' previous artists in residence. Thanks to all members of the museum staff who offered comments, questions, and support as I shared my work, and especially to JoAnn Robinson for extending generous hospitality throughout my stay. I am so appreciative that the Maeder-York Family Fellowship Selection Committee, including Anita Berrizbeitia, Julia Czerniak, Teresa Galí-Izard, Charles Waldheim, and Richard Weller, saw potential in my research proposal. Special thanks to Alan Berger, who proposed that I consider shifting focus from the Boston Harbor to the Quabbin Reservoir and the waterways that form the metropolitan water system; I'm so glad I took your advice!

I am indebted to Charles Waldheim, my mentor since 2011, who has helped me hone this project and shaped my larger sense of landscape architecture as well. I am so grateful for our many conversations in recent years on angling and waterfowl hunting over meals and in front of audiences—such unexpected topics! Thank you, Charles, for your thoughts at the front of this book, they mean so much to me. I am also so appreciative of the guidance, encouragement, and perspectives from several of the faculty at the Harvard University Graduate School of Design during my time in the Master in Landscape program, especially Pierre Belanger, Chris Reed, John Dixon Hunt, and Mark Laird.

I appreciate the contributions that various designers, colleagues, research assistants, and editors brought to this book. Thank you to Siena Scarff for the thoughtfulness and creativity you conveyed to the cover design; you created an evocative threshold for the book. I can't thank my colleague David Bayer enough for bringing rigor, dedication, and patience to the project of beautifully rendering the fifteen case study transects in this book. Thank you, David, for the many hours, and for always being up for one more round of edits. I am also grateful for my research assistants who traveled far to capture aquaculture landscapes through photography, especially Jason Manongdo who exhibited excellent drone-piloting skills in Hawaii and Kentucky, and Boyu Li for her beautiful photographs and travel in China. Finally, I appreciate the guidance of Amy Johnston and Hannah Ferguson at Routledge, and I have been so very well-served by the editorial acumen of Jake Starmer, who went extra rounds with my near-final drafts.

Exhibitions and public lectures were wonderful opportunities to share and advance this work during its development. I am grateful to Brian Kelly and Ronit Eisenbach for the gracious invitation to mount an exhibition of this work at the Kibel Gallery at the University of Maryland School of Architecture, Planning & Preservation in 2016. I am also grateful to David Hill and Rob Holmes for extending an offer to exhibit this work and lecture at Auburn University School of Architecture, Planning and Landscape Architecture in 2017. I appreciate the opportunity to share and discuss my aquaculture research along with other emerging landscape academics at the Landscape Dialogues Symposium at the University of Pennsylvania School of Design in 2017. Finally, I am grateful for the invitation to deliver a public lecture at the Isabella Stewart Gardner Museum in 2014, a first opportunity for me to draw the lines that connect my work on aquaculture landscapes, waterfowl hunting grounds, and equestrian facilities that has spanned my career.

A special thank you to my colleagues at the Virginia Tech Washington-Alexandria Architecture Center, especially Laurel McSherry, Paul Kelsh, and Nathan Heavers for inviting me to collaborate in an environment and community that I found stimulating and formative. I appreciate the trust, guidance, support, and friendship you all have offered me over the past several years.

Finally, Jana, I could not have done this without your help and your love. I am so grateful that you lent your discerning eye to the project, and I truly appreciate that you offered just the right edits at just the right time. Thank you for believing in me. I love that my kids were drawing alongside me over the last few years; thank you Peter, for your vivid and creative drawings of fish and farms, and Anna, for your loose and imaginative explorations. Thank you Luiza, for the unending love you have offered in so many ways, and Al, for slaughtering commas, reshaping sentences, and other helpful edits. And finally, thank you Henry and Mary VanderGoot, for your generosity in always being willing to engage and support my creative works.



01 The diversity of historical and contemporary fish farms across the globe has produced a rich, transcultural heritage of aquaculture landscapes.

Introduction

Aquacultures

Most fish never left the primordial waters. They stayed submerged in marine and freshwater environments and evolved over millions of years alongside molluscs and crustaceans. They diversified into tens of thousands of species, weathered waves of extinction and proliferation, and developed an extraordinary range of behaviors, migration strategies, specializations, and morphologies. And the fish that left the sea? Consensus among paleontologists, evolutionary biologists, and marine scientists affirms evidence that some primeval fish emerged on land about 375 million years ago¹, and that these pioneers from the Age of Fishes are the ancestors of almost all vertebrates alive today, including humans.²

Paleontologist Neil Shubin suggests that our human bodies offer clues about the origins we share with fish. He describes our "inner fish," noting the resemblance in the bone structure of human arms and hands to ancient fins and the similarities between the organization of our heads and those of our aquatic forebearers.³ Building on the long lineage of work in evolutionary biology, paleontology, and genetics, Shubin's anatomical observations add dimension to the relationship between humans and fish.

The first material evidence of encounters between humans and fish include the recent discovery in northern Kenya of catfish bones marked with cuts from stone tools. This find dates early hominin consumption of fish to nearly two million years ago and factors into discussions of how fish provided human ancestors with essential nutrients for expanding their brain size.⁴ The earliest record of *Homo sapiens*' systematic harvesting of shellfish dates back 164,000 years and was discovered in a coastal cave in South Africa.⁵ Around 25,000 years ago in ancient France, a human carved the earliest known representation of a fish into limestone. The fish is depicted in such remarkable detail that experts identified it as a spawning Atlantic Salmon (*Salmo salar*).⁶

Only in the past several millennia did humans begin to construct landscapes for the capture and culture of fish. With the advent of this practice, fish flourished in new homes that had been built precisely with them in mind, and material evidence reveals that humans thrived with fish in these landscapes.

The oldest known examples date to the Neolithic era. The Guditjmarra people at Lake Condah in south-western Victoria, Australia, constructed an extensive system of interconnected traps, ponds and habitats for Shortfin Eels (*Anguilla australis*). These have been dated to 6,600 years ago.⁷ Excavated into a rugged lava-flow terrain, this landscape includes 35 km of channels that once steered migrating eels into traps. The traps were connected to a constructed wetland eel habitat that increased the fish's availability to humans beyond the migration season. The management of the eel habitat as a component of this landscape has led some scholars to consider the Lake Condah site to be one of the first and largest eel farms.⁸ Archaeologists also believe they have found the remains of numerous circular stone huts near the excavated eel channels. In addition to the huts, interspersed hollowed trees, which are thought to have been used for smoking and cooking eels, serve as probable traces of a culinary culture.⁹

A remarkable diversity of terrestrial fish farms has emerged across the globe since the Neolithic era. These farms form a rich, transcultural heritage of *aquaculture landscapes*. Aquaculture landscapes shape, and are shaped by, a range of encounters between fish and humans. The production of these landscapes is informed by the variable relations between the species that cohabit them, as well as the dynamic economies and cultures in which they are embedded. Aquaculture landscapes are geographically located sites that are subject to shifts in climate, species populations, and migration patterns. These landscapes range in scale from ponds to watersheds, and their management has regional and global ecological and economic implications.

Examples of aquaculture landscapes are found in China, where estuaries and mountainsides alike have been transformed through the construction of ponds and terraces to generate polycultures of carp, rice, vegetables, and fruit (see Case Studies 10 and 11). In the twenty-first century, China produces two-thirds of the world's freshwater aquaculture output, and a detailed treatise on carp culture published in China in 475 BCE, speaks to the longevity of the country's aquaculture traditions. In the pre-Columbian savanna of Baures, Bolivia, thousands of kilometers of weirs were constructed by the people of Baure to channel seasonal floods and turn the savanna into a fishery (see Case Study 13). In the Třeboň Basin, Czech Republic, a regional-scale system of fishponds, dams, and canals that was constructed in the sixteenth century continues to produce tremendous quantities of carp for European markets. The landscape also provides recreational opportunities, flood protection, and biodiverse habitat (see Case Study 01).

Exemplary aquaculture landscapes can be characterized as sites where fish have agency and freedom to express species-specific behaviors in biodiverse habitats, novel aesthetic experiences and recreational activities are enabled, colocated programming and infrastructural functions produce diversified economies, and mutualistic relations between humans, fish and plants are constructed. As such, aquaculture landscapes have significant cultural and ecological importance, and they are also particularly relevant to contemporary discourses in landscape architecture and related design disciplines.

Intensive Fish Monocultures

Despite the deep history of wide-ranging aquaculture practices and the multifunctional landscapes they produce, aquaculture in the twenty-first century is largely framed and practiced in narrow terms. The Food and Agriculture Organization (FAO) of the United Nations, for example, defines aquaculture simply as the farming of aquatic organisms, including vertebrates, invertebrates, and plants. According to the FAO, aquaculture involves both an intervention to enhance production of fish, through feeding or breeding practices for instance, as well as ownership of the stock being cultivated.¹⁰

The growth of global aquaculture surged in the last fifty years. In 2019, the production of fish for human consumption is the fastest growing food production sector in the world.¹¹ Growth has been fueled by "intensive" aquaculture, high-density monocultures that rely on industrially manufactured feed pellets and hormonally induced breeding. In many cases, these fish feedlots have supplanted more resilient ecological practices.¹² They also reduced the range of activities that traditionally took place in aquaculture landscapes to the singular program of transforming fish into food.

In addition to the production of fish for human consumption, aquaculture also produces fish to stock waters for recreational fishing and to restore populations of

imperiled species. In service of this function, the US Federal and State fish hatcheries have for nearly 150 years enacted the controversial practice of introducing non-native fish species, such as Rainbow Trout (*Oncorhynchus mykiss*), into rivers and streams across the country (see Part Three). In 2004, hatcheries in the United States stocked 1.7 billion fish, a population that constitutes the largest total weight of fish stocked in the country in any given year, since adequate records have been kept.¹³

These modes of fish farming have an intellectual precursor in the French aquaculture revolution of the nineteenth century. That era saw the construction of state-operated hatcheries, such as the *piscifactory* (fish factory) in France, to produce salmonoids for stocking blighted rivers to satisfy the growing interest in recreational fishing among elites (see Case Study 06). Technologies and knowledge, along with fish and eggs, were exported to countries eager to institute their own programs.

Characterized by environmental historian Darin Kinsey as efforts to manipulate aquatic species to fit human cultural expectations, the French aquaculture revolution was linked to the contemporaneous Western ideology of improving nature, as well as acclimatization practices, such as the global distribution of non-native species, that emerged during the period of European colonialism.¹⁴ Kinsey writes that policies and programs of the revolution "promoted the imperial conquest of water, and its diffusion of aquatic species had profound global consequences."¹⁵ The legacy of the nineteenth-century revolution continues to reverberate in contemporary intensive aquaculture, where anthropocentric and productivist narratives frame fish farming in terms of yields, and species are genetically modified for economic gain. These paradigms and practices are exemplified in the contemporary farming of Atlantic Salmon, the same species of fish carved in limestone by human hands in ancient France.

The intensive farming of Atlantic Salmon began roughly forty years ago. In 2014, this species was globally the most economically valuable cultured fish and in 2016, more than 99% of all salmon consumed globally were farmed.¹⁶ Intensive farming of Atlantic Salmon is characterized by high densities of fish, penned in open water. These salmon are prone to parasites and disease, and the application of vaccines and antibiotics is routine.

The weight gain of wild salmon is tied to their migratory patterns. Their growth surges prior to their summer spawning run, and slows in winter. Farmed salmon, on the other hand, are genetically modified to be hungry and gain weight year-round.¹⁷ Pelleted feed that satisfies the intensified growth pattern of farmed salmon is produced from wild stocks of fish. Around 2.5 kg of forage fish are required for every kilogram a farmed salmon gains.¹⁸ Salmon void most of the nutrients from the consumed pellets, creating nutrient overloads and eutrophication in the water near the farms.¹⁹

Another issue is that salmon that escape from farms differ from native populations of wild salmon in terms of their genetics, behavior, and physiology. There are concerns that the mingling of farmed and wild salmon will lead to reduced productivity of the overall salmon population and decreased resiliency of wild salmon.²⁰ Despite the many negative impacts, intensive practices such as Atlantic Salmon monocultures persist. As the rising global human population becomes more urban and fish consumption increases, the expectation is that intensive aquaculture practices will continue to fuel the growth of global aquaculture.²¹ In 2014, a long-expected but astonishing milestone was met. For the first time in history, the contribution of aquaculture to the supply of fish for human consumption exceeded that of wild-caught fish.²²

Landscapes for Multispecies Coalitions

It is in the context of these trends and histories that *Aquaculture Landscapes* delves deeper into theories and practices of mutualism, polyculture, species interdependency, and urban cohabitation, offering alternatives to intensive monocultures in an attempt to realign aquaculture with landscape and humans with fish.

This introductory essay discusses aquaculture from three disciplinary perspectives: 1) landscape architecture (the primary lens through which this book is written), 2) human-animal studies, and 3) science of aquaculture and ecology. One recurrent theme found in all three disciplines concerns "multispecies coalitions," alliances between humans and non-humans that inspire collaborative patterns of interaction between species, challenge the typical power relations found in conventional animal agriculture, and enable animal agency in the coproduction of shared landscapes.

Contemporary practitioners and academics in the field of landscape architecture have shown leadership by envisioning, theorizing, and enacting progressive forms of aquaculture. These works illustrate many roles that landscape can play in the contemporary, cohabited public realm. Landscape architect Kate Orff, whose widely-recognized work includes a multifunctional oyster and human habitat in New York Harbor in the United States, urges her audience to think "beyond a built environment conceived exclusively for human consumption and comfort" in order to "address the wider global ecosystem as a shared space for all species."²³

The field of human-animal studies includes geographers, anthropologists, ethnographers, and scientists who explore more-than-human perspectives and places of multispecies entanglements. Works in this field are premised on an understanding of relations between humans and non-humans as simultaneously biological, cultural, economic, ethical, geographical, and political.²⁴ Ethologist Jonathan Balcombe, for example, examines breakthroughs in sociobiology, neurobiology, and other fields that explore fish sentience, as well as their diverse social and emotional lives.²⁵ Balcombe illuminates a perspective of fish as beings with intrinsic value, and he calls for their inclusion in what bioethicist Peter Singer calls the "expanding circle of moral concern."²⁶

A regrounding of aquaculture in the wisdom of sustainable indigenous practices is advocated in many quarters of the marine and freshwater sciences. Prominent aquaculture scholar Barry Costa-Pierce argues, "Aquaculture must become less short-term and less production oriented, and become more ecologically, community, and culturally based."²⁷ The FAO has also attempted to encourage more "ecological approaches" to aquaculture in their literature and programs.²⁸

Aquaculture Landscapes joins the forward-thinking, multidisciplinary discourse outlined above. This book brings together many examples of farms, reefs, parks, aquaria, and cities, where the lives of fish and humans are inexorably entwined. The aquaculture landscapes in this book are charged spaces that enable vivid encounters, socialization, and collaboration between species. The stakeholders, stewards, and fish at these sites form a constellation of relationships that underlie the social construction of aquaculture landscapes. These relations are foundational in making twenty-first century aquaculture into a phenomenon characterized by practices, attitudes, and landscapes that can only be cocreated by multispecies coalitions.

Geographers Jody Emel, Connie Johnston, and Elisabeth Stoddard suggest that we "hold ourselves accountable to [animals] in changing, exploratory, respectful, and

collectively oriented relationships—relationships rife with contradictions, vulnerabilities, violence, and uncertainties.²⁹ The landscapes examined in this book enable such relationships in part because they resist easy categorization and embody contradictions. They are habitats, but they are not wild. They yield less fish than intensive practices, but they provide a range of invaluable ecosystem services that can be difficult to quantify. They are spaces of power imbalances between species, yet they can also be environments where fish have agency. They offer humans opportunities to marvel, empathize, and collaborate with fish while at the same time bringing an end to their lives through harvest. In short, the aquaculture landscapes described here are thorny territory. They are open-ended experiments in the social construction of a cohabited public realm.

Aquacultures in the Discipline of Landscape Architecture

Western traditions and philosophies of landscape architecture have origins in the design of landscape parks at seventeenth- and eighteenth-century English estates, where multispecies cohabitation was integral to function and aesthetics. Actively managed fishponds figured in these landscapes, joining deer parks, waterfowl decoys, pheasantries, livestock paddocks, dovecotes, and rabbit warrens. The management of animals and their habitat was directly tied to the varied economies and recreational programs of the estate, and management practices informed the evolving aesthetics of the landscape park.³⁰ As landscape historian Tom Williamson notes, "These diverse activities were not simply fitted round or hidden away from the dominant aesthetic. They lay at the very heart of the landscape park . . . forming the very essence of its structure."³¹

Prior to the seventeenth century, the construction of fishponds by the Norman aristocracy in England was common. Fishponds remained as one of the principal status features at estates in Medieval England. Two types of fishponds were typically constructed at medieval estates: *vivaria*, which were large breeding ponds constructed by damming and flooding low ground, and *servatoria*, which were small holding ponds adjacent to the residence for temporary storage of fish transferred from the *vivaria*. Freshwater fish were still considered status objects in the early eighteenth century when formal garden design had come into fashion. As a result, the ponds of the medieval era were often adapted to include ornamental fountains, cascades, and defined sidewalls. Garden archaeologist Christopher Currie finds that estate accounts from the era indicate that despite aesthetic modifications, the aquaculture function of these ponds was still treated "very seriously."³²

Dyrham Park in Avon is a prime example of such a transformation. Five medieval fishponds at the estate underwent radical aesthetic transformation and were incorporated into an elaborate formal garden in 1704. Following these changes, the ponds continued to be used for rearing and breeding fish. An account from 1710 of the fish kept in Dyrham Park's ponds includes notes on aquaculture practices with projections of up to ten years out for when fish would be ready for harvest.³³ Observing trout, perch, and carp at Dyrham Park garden, the theorist Stephen Switzer noted that the "scaley residents" were not disturbed by the frequent visitation of people.³⁴

A more pastoral landscape aesthetic was pursued by landscape designers, gardeners, and homeowners later in eighteenth century England. The design of water features shifted from formal geometries toward the "naturalized" shapes of ponds that followed existing contours of the land. Currie notes the resonance in both shape and construction between these informal ponds and the *vivaria* fish breeding ponds of the

medieval period.³⁵ As farming of carp and perch for the table fell out of favor at English estates in the eighteenth century, the new picturesque ponds supported a burgeoning interest in the sport of angling among elites. It is the aesthetics and philosophies of pastoral landscape design—which, in England, were infused with histories of multispecies cohabitation, aquaculture, and angling—that influential landscape architects like Fredrick Law Olmsted sought for inspiration while developing public landscapes and parks in the United States, in the nineteenth century.

Landscape architects in the twenty-first century are once again designing for multispecies cohabitation. A system-based understanding of ecology, advanced by biologist Eugene Odum in the twentieth century, informs contemporary urban design theory.³⁶ Charles Waldheim, James Corner, Kongjian Yu, and other influential thinkers in the field of landscape architecture theorize urbanism as dynamic and interconnected social and biophysical systems where landscape is both a model and medium for urbanism.³⁷ Landscape architect Kate Orff poses important questions for the project of designing urban ecologies for a multispecies public realm: Can the notion of working for “clients” also include attending to “perceived human and animal needs?”³⁸ Can “new mutualistic systems be introduced that encourage the success of both human and non-human inhabitants?”³⁹

Contemporary landscape architects affirm these possibilities through the design of infrastructural systems and landscapes that function as habitats. Latz+Partner created a significant new habitat for migratory neotropical birds at the once barren Hiriya Landfill in Israel, by designing a lush wadi at the foot of the landfill and a vegetated “oasis” at the top. In the Netherlands, West 8 transformed the landscape of Amsterdam Airport Schiphol into a birch forest and pollinator habitat, making it among the first projects in a contemporary global movement toward airport apiaries. Designers create migratory wildlife crossings like the ARC Wildlife Bridge in Colorado, United States, by Michael Van Valkenburgh Associates, which was designed to span an interstate highway with striated woodland ecologies and provide safe crossings for black bear, elk, and other species.

Increasingly, designers are also crossing fish habitats and farms with infrastructure and public space to create multifunctional aquaculture landscapes. In urban contexts, these landscapes employ mutually beneficial strategies for fish and humans to address coastal resiliency, revitalization of urban ecologies, municipal waste and stormwater management, and other pressing urban challenges that are central to contemporary landscape practice. For example, as part of the larger redesign of the Seattle waterfront by James Corner Field Operations, the Elliott Bay seawall is remade as a biodiverse salmon migration corridor and public promenade. Another example is found in China, where Turenscape’s design for Yunhe Park in Yichang transforms a derelict fish farm into a stormwater management park and urban wildlife habitat (see Part One).

Landscape theorist Elizabeth Meyer has enriched the discourse on infrastructural landscapes as habitat by probing their aesthetic dimensions. She posits that human experiences of emotion, reflection, and even pleasure are intensified through “prolonged, vivid, and strange encounters with constructed nature,” and these aesthetic experiences differ from those that arise in the wild.⁴⁰ As part of her argument, Meyer suggests that “numerous, simultaneous individual experiences in a public space comprise an aesthetic collectivity and create new ways of living in and thinking about the environment.”⁴¹ Extending upon Meyer’s thinking, and Orff’s queries, other questions arise. If urban

infrastructure is designed to serve as loci of encounters between species in the city, can our intensified, decentering experiences at these "constructed natures" foster recognition of sentient fish and other animals as contributors to the "numerous, simultaneous, individual experiences" that comprise collectivity? Can granting fish and other animals subjectivity, recognizing our kinship with them, and planning for their success and ours, seed the emergence of "new ways of living" in multispecies societies?

More-Than-Human Perspectives on Aquaculture and Angling

Contemporary discourse in the field of human-animal studies has been fueled by, among other things, the theoretical shift to a more-than-human framework that recognizes animals as social subjects and actors in the world.⁴² Work in this field, and the allied field of multispecies ethnography, examines animal agency, collaboration and interdependency between species, and the implications of cohabitation. These works provide useful frameworks to explore varied relations between fish and humans at aquaculture landscapes.

One of the themes of a more-than-human perspective is that embodied and recurrent experiences with non-humans are vehicles for decentering and connecting to their worlds. Urbanist and geographer Jennifer Wolch writes that cohabitation with other animals provides the "local, situated, everyday knowledge of animal life required to grasp animal standpoints or ways of being in the world, to interact with them accordingly in particular contexts, and to motivate political action necessary to protect their autonomy as subjects and their life spaces."⁴³ Geographer Catherine Johnston, building on anthropologist Tim Ingold's philosophy of dwelling, advocates "day-to-day living and working" relationships with other animals as "a way of knowing about and knowing with animals."⁴⁴ She notes that these experiences are "by their nature noisier, smellier, messier and, in some cases, bloodier than we might like to think," but they open paths to empathic relationships with non-humans.⁴⁵

In "Livelier Livelihoods: Animal and Human Collaboration on the Farm," Emel, Johnston, and Stoddard advocate animal agriculture characterized by "flatter hierarchies," where farming practices are aligned with animals' known behavioral tendencies to create "a partnership type of on-farm relationship."⁴⁶ While the authors explore pigs in permaculture systems, their paradigms can be applied to reconsider humans and fish in aquaculture as "co-workers." Humans provide food, shelter, and healthcare while fish "work as foragers, fertilizers, seed spreaders, mothers, caregivers, and food providers."⁴⁷ Ecofeminist scholar Donna Haraway, exploring the ethics of animal labor, writes, "To be in relation of use to each other is not the definition of unfreedom and violation."⁴⁸ Framing and constructing farms as habitat, where fish have agency and can make choices relative to feeding, socializing, and exploring, is one form of acknowledging that fish are "working subjects, not just worked objects."⁴⁹

Angling landscapes are also sites where embodied experiences foster complex connections with non-human worlds. Through fieldwork conducted in rivers in Yorkshire, United Kingdom, geographers Christopher Bear and Sally Eden find that anglers "do not see the cold blood or scaly bodies of fish as alien or as a barrier to attempting to understand and, to an extent, empathize with them."⁵⁰ The geographers describe what they see as the everyday attempts of anglers "to think like fish."⁵¹ Anglers adapt their behavior to share the rhythms of fish communities, as well as individual

fish. Likewise, fish seem to adapt to the practices of anglers, by changing where, when, and what they feed on over time. Thus, for Bear and Eden, angling is a coproduced and reciprocal activity—a “transformative practice whereby anglers and fish adapt through their coconstitutive encounters.”⁵² New streams built specifically for both spawning and angling exemplify that the complex, coconstitutive encounters between fish and humans also produce landscapes (see Case Study 14).

At both the farm and the stream, humans kill fish. The ethical implications of killing fish for food and sport are contentious and debate on the subject is perennial. Haraway observes that the act of killing can itself create opportunities for mindful reflection. She writes that killing is an inevitable act, since “eating means also killing, directly or indirectly,” but she adds that “killing well is an obligation akin to eating well.”⁵³ Humans, she writes, should resist killing with a sense of self-certainty or ethical resolution. We should “learn to live responsibly within the multiplicitous necessity and labor of killing,” always, “yearning for the capacity to respond and recognize with response, always with reasons but knowing there will never be sufficient reason.”⁵⁴

Day to day encounters with fish, working alongside fish at farms, thinking like them in streams, and mindfully killing them, are some of the decentering activities enabled at aquaculture landscapes. Embodied experiences like these can foster empathic responses to fish, which in turn can fuel critical examinations of the practices, coalitions, and ethics that shape aquaculture and angling in a more-than-human world.

Implementing Ecological Approaches to Aquaculture

Recent years have seen calls for ecological and system-based approaches to sustainable fish farming by institutions like the FAO as well as communities of aquaculture scholars. The FAO convened a discussion with international aquaculture experts in 2007 to explore an “ecosystem approach to aquaculture” (EAA) that the group defined as “a strategy for the integration of [aquaculture] within the wider ecosystem in such a way that it promotes sustainable development, equity, and resilience of interlinked social and ecological systems.”⁵⁵ In 2018, a critical review of EAAs effectiveness in joining aquaculture with local socio-economic development found that this strategy had been impactful.⁵⁶

The Veta la Palma fish farm in Spain is a remarkable example of an EAA. The farm is a public-private partnership in which a commercial fishery leases land from the Doñana Nature Reserve and adheres to strict environmental regulations (see Case Study 03). At the farm, constructed wetland basins are flooded with water from the Guadalquivir River and the fish raised in this polyculture environment freely forage for shrimp and microalgae that proliferate in the basins. The wetlands cleanse the water contaminated from upland agriculture—the farm’s discharge is cleaner than the water that enters it. Over 250 species of migratory birds routinely visit the site, and visiting birders augment the farm’s revenues.

An EAA can also inform urban aquaculture that is multifunctional and linked to social networks. In the edited volume *Urban Aquaculture*, scholar Costa-Pierce positions urban aquaculture as “a vital, functional, and necessary component of urban ecosystems.”⁵⁷ He recommends redirecting flows of municipal wastewater toward aquaculture wetlands to fuel fish production and vitalize habitats in the city. An extraordinary model for such a system is the East Kolkata Wetlands in India (see Case Study 09). Other aquaculture scholars describe the need to cultivate social and aesthetic experiences around aquaculture in urban ecosystems, to educate and inspire the next

generation of urban aquaculturists. They point to successes in integrating aquaculture in urban school curricula as well as visceral community events like clam bakes and fish fries.

Costa-Pierce advocates that we encourage the "art of aquaculture in urban areas and plan creatively for its beauty and utility in revitalized cities."⁵⁸ He and others who call for urban aquaculture with ecological infrastructural, social, and aesthetic dimensions also recommend an integration of aquaculture and urban planning processes as a means to achieve it. Such a shift could increase collaboration between aquaculturists and landscape architects—a natural partnership, given landscape architecture's disciplinary expertise in envisioning and designing multifunctional, multispecies public infrastructure.

Toward Entwining

Aquaculture Landscapes gathers contemporary discourses, historical accounts, and evocative visual representations, and views this assemblage through the disciplinary lens of landscape architecture. This approach informs a critical reading of aquaculture as landscape. This book recovers aquaculture as a practice with a deep history of constructing extraordinary landscapes, and posits landscape as the preeminent medium for the future integration of aquaculture and urbanism. In so doing, *Aquaculture Landscapes* aspires to support and expand the roles that landscape architects play in assembling the multispecies coalitions that coshape aquacultures for resilient coastlines, biodiverse urban ecologies, and a cohabited public realm.

In 2019, the *Catalog of Fishes*, the authoritative global reference for taxonomic fish names, lists over 35,000 known fish species.⁵⁹ Of those thousands, only six hundred species have ever been farmed.⁶⁰ The relatively small number of fish species selected for cultivation belies the likely trillions of individual fish that humans have encountered in aquaculture landscapes. For millennia, a lineage of landscapes shaped a myriad of experiences—and fluid, ever-changing relationships—between humans and these countless sentient beings. Our common histories bind humans and fish together. These bonds form a basis from which we can imagine and build the shared landscapes that further entwine our lives.

Organization of the Book

Aquaculture Landscapes features essays, case studies, and representations that are organized into three parts.

Part One: *Situating Aquaculture Landscapes* explores projects by leading designers working at the nexus of aquaculture and urbanism. Six projects in Asia, North America, and Europe are situated relative to historical and contemporary aquaculture practices as well as contemporary landscape design and theory.

Part Two: *Surveying Aquaculture Landscapes* presents fifteen aquaculture landscape case studies that describe a broad range of forms and practices of aquaculture located across five continents and ten countries. Each case study features key data, written descriptions, images, and a range of original analytical drawings.

Part Three: *Depicting Aquaculture Landscapes* is an image essay that places evocative contemporary drawings, models, maps, and paintings into a long, transcultural tradition of aquaculture landscape representation. These depictions of real and imagined aquaculture landscapes reveal drawing and modeling as ongoing, fertile processes through which humans discover relationships to farmed fish.

"*Aquaculture Landscapes* is a breath-taking book—full of historical drawings, ingenious diagrams, and superb photography—that demonstrates how we can revolutionize our relationships with aquatic life. Grounded in multispecies urban theory and dreams of coexistence instead of exploitation, Ezban offers both concrete examples and speculative designs from around the world that will transform landscape architecture practice. His book is the first to not only argue for a post-human urbanism, but to demonstrate how landscape architects can go about creating a zoöpolitan urbanism for the future."

— **Jennifer Wolch**, Dean, College of Environmental Design, UC Berkeley, USA

"Michael Ezban presents an original and informative book on an extremely intriguing subject: aquaculture landscapes—fish farms as seen through the lens of contemporary landscape architecture. His work opens and invites us all into vast and exciting new territory for landscape architecture practice."

— **Kongjian Yu**, Dean and Professor, Graduate School of Landscape Architecture, Peking University, China, President, Turenscape

"We are all born of water, and our primordial relationship with aquatic ecologies endures. In this lush volume, Michael Ezban both plumbs the depths and surfaces common currents to reveal an aqueous terrain worthy of navigation for the Anthropocene. Through rigorous historical research and insightful contemporary precedents from aquaculture to angling, *Aquaculture Landscapes* offers fresh thinking and timely designs for a richer, more biodiverse world. Ezban's design research intelligently articulates how we might materially and metaphorically cohabit with our oldest of relatives—the fish—and other species beyond the human."

— **Nina-Marie E. Lister**, Graduate Program Director, School of Urban + Regional Planning, Ryerson University, Canada

Aquaculture Landscapes explores the landscape architecture of farms, reefs, parks, and cities that are designed to entwine the lives of fish and humans.

In the twenty-first century, aquaculture's contribution to the supply of fish for human consumption exceeds that of wild-caught fish for the first time in history. Aquaculture has emerged as the fastest growing food production sector in the world, but aquaculture has agency beyond simply converting fish to food. *Aquaculture Landscapes* recovers aquaculture as a practice with a deep history of constructing extraordinary landscapes. These landscapes are characterized and enriched by multispecies interdependency, performative ecologies, collaborative practices, and aesthetic experiences between humans and fish. *Aquaculture Landscapes* presents over thirty contemporary and historical landscapes, spanning six continents, with incisive diagrams and vivid photographs. Within this expansive scope is a focus on urban aquaculture projects by leading designers—including Turenscape, James Corner Field Operations, and SCAPE—that employ mutually beneficial strategies for fish and humans to address urban coastal resiliency, wastewater management, and other contemporary urban challenges. Michael Ezban delivers a compelling account of the coalitions of fish and humans that shape the form, function, and identity of cities, and he offers a forward-thinking theorization of landscape as the preeminent medium for the design of ichthyological urbanism in the Anthropocene.

With over two hundred evocative images, including ninety original drawings by the author, *Aquaculture Landscapes* is a richly illustrated portrayal of aquaculture seen through the disciplinary lens of landscape architecture. As the first book devoted to this topic, *Aquaculture Landscapes* is an original and essential resource for landscape architects, urbanists, animal geographers, aquaculturists, and all who seek and value multispecies cohabitation of a shared public realm.

Michael Ezban is an architect, landscape designer, and scholar. His work explores landscapes and buildings designed to mediate relations between humans and other animals. Published and exhibited internationally, Ezban's writing and design focus on aquaculture landscapes, waterfowl hunting grounds, and equestrian facilities. He is a recipient of the Maeder-York Family Fellowship in Landscape Architecture from the Isabella Stewart Gardner Museum and the Charles Eliot Traveling Fellowship from the Harvard University Graduate School of Design. Ezban is an Assistant Professor in Landscape Architecture at the University of Virginia, and a cofounder of VanderGoot Ezban Studio, a research-based practice.

Cover design by Siena Scarff Design. Image courtesy of Bibliothèque nationale de France.

LANDSCAPE ARCHITECTURE | ENVIRONMENT | AQUACULTURE

 **Routledge**
Taylor & Francis Group
www.routledge.com

Routledge titles are available as eBook editions in a range of digital formats

an informa business
ISBN 978-1-138-21835-2

9 781138 218352