ENVIRONMENTAL LAW INSTITUTE

FISH FORWARD:

Best Practices For Sustainable Land-Based Aquaculture In Maine

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Acronyms & Abbreviations

AAQS	Ambient Air Quality Standards
AAR	Aquaculture Activities Regulations
AFEL	Aquaculture Farm Establishment License
APA	Federal Administrative Procedure Act
APHIS	USDA Animal and Plant Health Inspection Service
ASC	Aquaculture Stewardship Council
BAP	Best Aquaculture Practices
BCARP	British Columbia Aquaculture Regulatory Program
BEP	Board of Environmental Protection
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
CAAPs	Concentrated Aquatic Animal Production facilities
CARB	California Air Resources Board
CCC	California Coastal Commission
CDP	Coastal Development Permit
CEAA	Canadian Environmental Assessment Act (inactive)
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CFIA	Canadian Food Inspection Agency
CIWMA	California Integrated Waste Management Act
CNWA	Canadian Navigable Waters Act
CO_2	Carbon dioxide
CUP	Conditional Use Permit
CWA	Clean Water Act
CWS	Canadian Wildlife Service
DATCP	Wisconsin Department of Agriculture, Trade and Consumer Protection
DEP	Maine Department of Environmental Protection
DFO	Fisheries and Oceans Canada
DFW	Department of Fish and Wildlife
DMR	Maine Department of Marine Resources
DNR	Wisconsin Department of Natural Resources
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EAB	Environmental Appeals Board
EEA	European Economic Agreement
EEC	Department of Environment and Climate Change (BC)
EECA	Environment, Energy and Climate Action (PEI)
EEEC	Environment and Climate Change Canada
EFH	Essential Fish Habitat
EFTA	European Free Trade Association
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ELGs	Effluent Limitation Guidelines

EPA	Environmental Protection Agency
ERP	Environmental Resource Permit
ESA	Endangered Species Act
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FCR	Feed Conversion Rate
FDA	Food and Drug Administration
FDACS	Florida Department of Agriculture and Consumer Services
FDCA	Food Drug and Cosmetic Act
FDEP	Florida Department of Environmental Protection
FIFRA	Federal Insecticide Fungicide and Rodenticide Act
FONSI	Finding of No Significant Impact
FSMA	Food Safety Modernization Act
FWC	Fish and Wildlife Conservation Commission
G.A.P.	Global Animal Partnership
GHG	Greenhouse gas
GM	Genetically Modified
GPD	Gallons Per Day
GPM	Gallons Per Minute
GSA	Global Seafood Alliance
GSSI	Global Sustainable Seafood Initiative
HMP	Health Management Plan
IAA	Impact Assessment Act
IFA	Integrated Farm Assurance
ISLEAL	International Social and Environmental Accreditation and Labeling Alliance
ITC	Introductions and Transfers Committee
ITP	Incidental Take Permits
LBA	Land-based aquaculture
LCP	Local Coastal Program
MAB	Maximum Allowable Biomass
MBBR	Moving Bed Biofilm Reactor
MEL	Marine Eco-Label
MOCCAE	Ministry of Climate Change and Environment
MRP	Monitoring and Reporting Program
MRR	Mandatory Reporting of Greenhouse Gas Emissions
MSC	Marine Stewardship Council
NAAHP	National Aquatic Animal Health Program
NAAQS	National Ambient Air Quality Standards
NAHP&S	National Aquaculture Health Plan and Standards
NASCO	North Atlantic Salmon Conservation Organization
NEPA	National Environment Policy Act
NOAA	National Oceanic and Atmospheric Administration
NOC	No Objection Certificate
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System

NRPA	Natural Resources Protection Act
NSDFA	Nova Scotia Department of Fisheries and Aquaculture
NSR	New Source Review
OECD	Organisation for the Economic Co-Operation and Development
PCA	Parks Canada Agency
PCAF	Preventive Controls for Animal Food
PEI	Prince Edward Island
pH	Potential/power of hydrogen (scale used to indicate acidity or basicity)
RAMO	Regional Aquaculture Management Office
RAS	Recirculating aquaculture system
RDG	Regional Director General
RGGI	Regional Greenhouse Gas Initiative
RPS	Renewable Portfolio Standards
RWQCB	Regional Water Quality Control Boards
SARA	Species at Risk Act
SLODA	Site Location Development Act
SOC	Standards Oversight Committee
SOP	Standard Operating Procedures
SWDA	Safe Water Drinking Act
TC	Transport Canada
TMDLs	Total Maximum Daily Loads
TSCA	Toxic Substances Control Act
TSS	Total Suspended Solids
UAE	United Arab Emirates
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S, Fish and Wildlife Service
UV	Ultraviolet
VHS	Viral Hemorrhagic Septicemia
WDL	Waste Discharge License
WEPA	Wisconsin Environmental Policy Act
WMD	Regional Water Management District
WOAH	World Organisation of Animal Health
WPDES	Wisconsin Pollutant Discharge Elimination System
WTO	World Trade Organization
WWF	World Wildlife Fund

Executive Summary

The nascent state of the land-based aquaculture (LBA) sector makes this an opportune moment to assess the regulatory framework governing LBA in the United States. ***Fish Forward*** *seeks to accomplish this through rigorous analysis that identifies regulatory gaps in—and opportunities for—addressing and mitigating the industry's environmental impacts, particularly in finfish production.*

AQUACULTURE, the commercial production of finfish, shellfish, and seaweed, is today the fastest-growing food production sector globally. Aquaculture is credited as a comparatively sustainable protein source, but nevertheless imposes costs on the environment. Marine-based aquaculture is associated with the eutrophication of water bodies, outbreaks of sea lice and disease, and disruption of sensitive habitat when farmed fish escape their net pens. Efforts to respond to these challenges have resulted in today's growing land-based aquaculture (LBA) industry.

Proponents of LBA—of recirculating aquaculture system (RAS) technology in particular—point out that these facilities can avoid or mitigate many of the environmental impacts associated with marine-based finfish aquaculture. They point out that RAS facilities (which treat and recirculate water, distinguished from flow-through systems, which continually divert and discharge water) can discharge fewer contaminants, such as carbon dioxide, nitrogen, and phosphorus, and can be highly efficient, recycling upwards of 90% of the water consumed. Waste is more easily controlled on land and risk of escapement is significantly reduced. Advocates also highlight economic advantages. For example, flexibility in

RAS Facilities in the United States

Existing Facilities

Superior Fresh
- Located in Wisconsin
- Aquaponics system (RAS + hydroponics)
- 99.9% recirculation
- .02m^3 of water per kilogram of fish produced annually (super intensive RAS)

Atlantic Sapphire
- Located in Florida
- Over 99% recirculation
- 0.76m^3 of water per kilogram of fish produced annually (intensive RAS)

Ideal Fish
- Located in Connecticut
- 95% recirculation
- 0.26m^3 of water per kilogram of fish produced annually (super intensive RAS)

AquaBounty
- Located in Indiana
- 95% recirculation
- 0.58 m^3 of water per kilogram of fish produced annually (intensive RAS)

LocalCoho
- Located in New York
- 90-95% recirculation
- Water consumption data unavailable

Freshwater Institute
- Located in West Virginia
- Research-focused facility
- Over 99% recirculation

Proposed Facilities

KingFish
- Located in Maine
- Recirculation rate unknown
- .007m^3 of water per kilogram of fish produced annually (super intensive RAS)

Whole Oceans
- Located in Maine
- 95-99% recirculation
- 1.29m^3 of water per kilogram of fish produced annually (low-level RAS)

Nordic Aquafarms
- Located in California
- 99% recirculation
- 0.64 m^3 of water per kilogram of fish produced (intensive RAS)

siting LBA facilities means more communities benefit from job growth and local investment.

Critics note this technology introduces its own set of environmental challenges, related to land use and siting, water quality and supply, animal welfare, air pollution, energy consumption, and both upstream and downstream greenhouse gas emissions. Water recycling rates vary and resulting effluent can still carry contaminants to marine and other environments. Federal and state laws governing aquaculture were originally designed for marine/offshore facilities, and so may be inadequate to address these concerns. Currently, there are very few efforts underway to update the legal framework, as land-based aquaculture is still an emerging industry in the United States.

Fish Forward presents best practices for regulating LBA that are robust yet practicable, addressing the environmental impacts while recognizing the economic benefits LBA can bring to local communities. The focus is on three categories of pragmatic solutions, particularly those that can be implemented in Maine, where the state's abundant natural resources, economic potential, and longstanding maritime tradition is attracting the interest of the LBA industry.

Category 1: Avoiding or mitigating environmental impacts.

Air Pollution

- Improve mobile air emissions by managing vehicle miles traveled.

Biodiversity and Habitat

- Avoid situating facilities in or near sensitive habitats and mitigate impacts to endangered or threatened species potentially impacted by development or operation.
- Prevent introduction of invasive species into local ecosystem through chemical, biological, and physical barriers to prevent escapement.

Energy Consumption and Carbon Footprint

- Mitigate greenhouse gas emissions by maximizing renewable energy sources and implementing benchmarking and reporting programs.
- Reduce energy consumption with energy efficiency measures, benchmarking, and reporting guidelines.

Governance, Equity and Accountability

- Mandate compliance with all applicable state and local environmental standards by incorporating them into permit conditions.
- Recognize environmental justice as part of permitting review.
- Undertake an environmental impact assessment early in the project proposal stage.

Land Use and Siting

- Require a bond or similar financial assurance instrument to ensure the site is restored for future uses when the facility is decommissioned or ceases operations for any other reason.
- Site facilities in areas currently zoned industrial and in compliance with the local land use plan.

- When possible, locate facilities on brownfield sites as an opportunity to remediate preexisting contamination.

Solid Waste and Hazardous Substances

- Meet mandatory or voluntary landfill diversion requirements and find secondary uses for ensilage and other bioproducts to reduce solid waste.

Water Use and Quality

- Control disease through inspections, biosecurity controls, and leveraging recirculating systems as a barrier to pathogens.
- Control water consumption via diversion thresholds, stringent reuse goals, water supply assessments, and incorporation of water-efficient technologies.
- Establish and implement numerical, science-based standards for biological oxygen demand, suspended solids, and nitrogen.
- Implement a rigorous chemical and drug management plan.

Category 2: Promoting transparency, public engagement, and expert and stakeholder input.

- Circulate and otherwise make available environmental review documents, meeting agendas, and other materials well in advance of an agency decision.
- Establish a public comment period of at least 30 days and hold at least one oral hearing at a time and location determined to be most accessible to the public.
- Respond in writing to all significant comments and incorporate suggestions as reasonable and feasible.
- Provide a streamlined appeals process with low barriers to standing for both interested parties and those acting on behalf of the public interest.
- Create effective communication channels, such as web portals and e-newsletters to inform the public of important developments before, during, and after the permitting process.
- Solicit stakeholder feedback through committees with diverse representation, as well as other avenues for feedback.

- Engage in government-to-government consultation with affected Tribal nations, with the goal of a mutual agreement on mitigation steps, including a mitigation, monitoring, and reporting program co-produced and collaboratively implemented with the Tribe.

Category 3: Supporting measures to ensure regulation keeps pace with technological innovation while providing certainty to the industry.

- Define key terminology, such as *aquaculture*, *land-based aquaculture*, *RAS aquaculture*, and *Community of Concern/Disadvantaged Community/Environmental Justice Community*.
- Adopt a centralized permitting system with a comprehensive process and easily accessible information.
- Issue licenses for carrying out RAS aquaculture customized to the needs and impacts of RAS facilities and consistent with the abilities of regulatory agencies to monitor compliance with license conditions.
- Regularly update standards and guidelines with public input.

Fish Forward offers this white paper for the consideration of state and local policymakers in both Maine and jurisdictions across the United States. Many of the best practices detailed can be tailored to each jurisdiction's priorities and available resources. Above all, this white paper demonstrates that state and local governments can work within their existing regulatory frameworks to develop standards for land-based aquaculture that promote both environmental sustainability and economic growth.

Guide to *Fish Forward*

- ***Introduction to LBA*** and its environmental impacts
- ***Overview of the legal frameworks governing RAS facilities*** in the United States at both the federal and state level, focusing on Maine, California, Wisconsin, and Florida, each presenting different approaches to regulating the industry
- ***Comparative review of three foreign jurisdictions*** which have a robust LBA industry – Norway, Canada, and the United Arab Emirates – focusing on strengths and weaknesses of the legal frameworks, lessons learned, and sustainability measures that could potentially be duplicated in the United States
- ***Case studies of three aquaculture facilities*** and their individual approaches to mitigating environmental impacts
- ***A set of best practices*** derived from this analysis as well as from a survey of international certification standard-setting bodies

Introduction

Aquaculture, the commercial production of finfish, shellfish, and seaweed is a rapidly growing industry worldwide. Land-based aquaculture, however, is an emerging industry in the United States. Currently, only a handful of land-based Recirculating Aquaculture System (RAS) facilities are operational in the country.

But the rapid evolution of land-based aquaculture technologies is driving expansion in the production capacity of these facilities. This brings new environmental challenges involving land use and siting, water and air quality, water and energy consumption, and wildlife and habitat, and exposes regulatory gaps in addressing and mitigating these impacts.

This white paper aims **to inform state and local policymakers in Maine and other jurisdictions** about different approaches to regulating land-based RAS aquaculture in the United States and around the world and describe best practices in developing and enforcing policies at the state and local level that effectively protect the environment while allowing economic growth.

The report guides readers through the following:

- Introduction to land-based RAS aquaculture and its environmental benefits and impacts
- Overview of the leading RAS certification and sustainability ranking systems
- Regulatory frameworks governing RAS facilities in the United States at the federal level, in Maine, and in three key states for comparison, as well as a review of three foreign jurisdictions with a robust aquaculture industry
- Case studies of three aquaculture facilities in the United States and their approaches to mitigating environmental impacts
- Best practices across a cross-referenced set of standards, policies, and practices across multiple jurisdictions, RAS facilities, and international certification standard-setting bodies

This white paper was developed to inform Maine policymakers but is relevant for state and local governments across the United States witnessing the growth of this industry.

A RAPIDLY GROWING INDUSTRY

Aquaculture was responsible for **49% of the 178 million metric tons of marine animals produced** worldwide in 2020.

The **United States produced 658 million pounds** of freshwater and marine species in 2019.

Atlantic Salmon was the leading species produced for marine aquaculture at 31.9 million pounds.

The **few land-based RAS facilities operating in the U.S.** include Atlantic Sapphire in Florida, Superior Fresh in Wisconsin, AquaBounty in Indiana, and LocalCoho in New York.

Facilities are proposed for Belfast, Jonesport, and Bucksport in Maine, Humboldt County in California, and in many other sites across the country.

Sources: FAO State of World Fisheries and Aquaculture: Towards a Blue Transformation (2022); NOAA-NMFS, 2020 Fisheries of the United States p. 16 (May 2022).

Overview of Industrial Land-Based Aquaculture (LBA)

*Defined by the Food and Agriculture Organization of the United Nations (FAO) as **"the farming of aquatic organisms... impl[ying] some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc.,"**[1] aquaculture has become the fastest growing food production sector globally.*[2]

Traditional fishing and marine based aquaculture result in long-recognized environmental impacts like overfishing, eutrophication of water bodies, sea lice, and introduction of disease. These environmental challenges—plus increased LBA technological and operational capacities—have driven greater investment in and conversation around LBA.[3] Many have turned to LBA as a potential solution to bring fish production closer to key, inland markets. This is especially the case in the United States, the leading importer of fish and fishery products in the world.[4] As of January 2021, at least 14 land-based facilities in the U.S. were operating or in construction, each producing more than 400 metric tons of salmon a year. More operate under the 400 metric ton threshold.[5]

This paper will primarily consider Recirculating Aquaculture Systems (RAS). There are several options for LBA production systems, but the most prevalent is RAS technology. RAS is distinguished by the reuse of water in the system—often over 90% reuse and sometimes reaching 99%. This high level of reuse is made possible by mechanical and biological treatments developed to eliminate ammonia, as well as treating pH, controlling temperature, removing solids, aerating, adding oxygen, and degassing. The most critical components of an RAS system are the mechanical filter, biofilter, reoxygenation, and UV disinfection. Other land-based systems include flow-through systems and ponds. Flow-through systems typically use raceways, with a one-time use of water and continual flow. Ponds are earthen or lined ponds, using traditional ecological methods to manage the fish and water.[6]

Within RAS, there is also differentiation, mostly due to individual system water consumption practices.

A note on water consumption and RAS designation

While decreased water consumption is one potential sustainability benefit of RAS, not all RAS operations live up to the promise of reducing water 100 times the usage level of traditional land-based aquaculture. As such, standardized water consumption metrics are imperative for industry assessment.

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[1] *Definitions*, Food and Agriculture Organization of the United Nations, https://www.fao.org/3/x6941e/x6941e04.htm (last visited Oct. 3, 2022).
[2] The State of World Fisheries and Aquaculture: Meeting Sustainable Development Goals (Food and Agriculture Organization of the United Nations 2018)
[3] Trip O'Shea et al., Towards a Blue Revolution: Catalyzing Private Investment in Sustainable Aquaculture Production Systems (The Nature Conservancy and Encourage Capital 2019).
[4] University of Michigan Center for Sustainable Systems, Food Product Environmental Footprint Literature Summary: Land-Based Aquaculture (State of Oregon Department of Environmental Quality 2017).
[5] *A Partial List of Recent Land Based Salmonid Farms Globally,* Newfoundland and Labrador Coalition for Aquaculture Reform, http://www.nlcar.ca/uploads/1/0/3/2/103263934/global_list_land_based_-_jan16_2021.pdf (last visited Oct. 3, 2022).
[6] Id.

Intensity is a quantitative and comparative figure corresponding to the level of water used in a RAS operation. It measures the amount of water used by a facility per kilogram of fish produced, over a year-long timeframe. According to the FAO, a typical land-based, flow-through system (not recirculating) will use 30m^3 of water per kilogram of fish produced annually. The least water consumptive RAS, designated super intensive, uses as little as 0.3m^3 per kilogram of fish produced annually. An intensive RAS uses 1m^3 and a low-level RAS uses 3m^3.[7] For example, an operation producing 500 tons of fish each year is designated super intensive (the most efficient) if it uses 17 cubic meters of water per hour (m^3/h), intensive if it uses 57 m^3/h, low-level system if it uses 171 m^3/h, and flow-through (the least efficient) if it uses 1,712 m^3/h.[8]

Throughout this paper, recirculating systems will be categorized and understood based on their intensity. While colloquially people may refer to certain RAS as "hybrid" or "flow-through" (notably the flow-through moniker can be used for non-RAS, flow-through systems), the only accepted standard to categorizing RAS in terms of water usage is this intensity metric, with super intensive using the least water, intensive using the second least amount of water, and low-level using the most. There are some RAS facilities whose water consumption intensity is almost that of a flow-through system, even with high levels of recirculation. In these cases, the system is still recirculating, but this designation indicates that *despite recirculation, the given facility uses as much water per kilogram of fish produced as a flow-through system.* Calculating the intensity of a given system can help policy makers better understand whether promised recirculation rates actually entail lower water consumption. See *Table 1* for a breakdown of the intensity of each facility considered in this report.

Table 1. Intensity Figures

Facility Name	Reported water usage	Reported fish output	Converted water usage (cubic meters/year)	Converted fish output (kg)	Numeric intensity	Intensity designation
Superior Fresh	8 gallons per minute (upper estimate)[9]	1.5 million lbs[10]	15768	680388.555	0.023175	Super intensive
Atlantic Sapphire	133.7 million gallons + 1.6 billion gallons (in a year)[11]	9,500 tons[12]	6562768.41	8618255	0.7614962	Intensive

[7] Jacob Bregnballe, *A Guide to Recirculation Aquaculture An introduction to the new environmentally friendly and highly productive closed fish farming systems*, Food and Agriculture Organization of the United Nations (2015)
[8] Id.
[9] Barry Adams, *Tank Salmon Disrupt Food Chain,* Agri-View, https://agupdate.com/agriview/news/business/tank-salmon-disrupt-food-chain/article_e89a6279-c875-5f83-9c44-841b958606dc.html (last visited June 27, 2023).
[10] Erich Luenig, *Superior Fresh expanding salmon farm in Wisconsin, looking at additional locations,* https://www.seafoodsource.com/news/aquaculture/superior-fresh-expanding-salmon-farm-in-wisconsin-looking-at-additional-locations (last visited June 27, 2023).
[11] *Annual Report 2022*, Atlantic Sapphire, https://atlanticsapphire.com/wp-content/uploads/2023/04/20230420-Atlantic-Sapphire-ASA-Integrated-Annual-Report-for-2022.pdf (2022).
[12] *Annual Report 2021,* Atlantic Sapphire, https://atlanticsapphire.com/wp-content/uploads/2022/04/20220421-Atlantic-Sapphire-ASA-Integrated-Annual-Report-for-2021.pdf (2021).

Ideal Fish	23,000 gallons per day[13]	120 metric tons[14]	31778.53	120000	0.2648211	Super intensive
AquaBounty	350 gallons per minute (upper estimate)[15]	1,200 metric tons[16]	696826.43	1200000	0.5806887	Intensive
KingFish	43,200 gpd[17]	8,000 metric tons (upper estimate)[18]	59727.98	8000000	0.007466	Super intensive
Whole Oceans	18.6 MGD[19]	20,000 metric tons (upper estimate)[20]	25716058.68	20000000	1.2858029	Low-level
Nordic (Humboldt)	12.5 MGD[21]	27,000 metric tons (upper estimate)[22]	17282297.5	27000000	0.6400851	Intensive
Nordic (Belfast)	7.7 MGD[23]	30,000 metric tons[24]	10645895.26	30000000	0.3548632	Intensive
Fifax	80 m3/h[25]	3,200 tons[26]	700800	2902991	0.2414062	Super intensive

Those systems closest to true 100% recirculation, sometimes called a "closed loop" system, are traditionally aquaponics systems. In these operations, recirculating aquaculture technology is used in tandem with an agriculture operation, and water recirculates between both the plant and fish production.

[13] *Great American Aquaculture LLC, dba Ideal Fish,* B Corporation, https://www.bcorporation.net/en-us/find-a-b-corp/company/great-american-aquaculture-l-l-c-dba-ideal-fish (last visited June 27, 2023).
[14] Id.
[15] *Significant Water Withdrawal Facility Data,* Indiana Department of Natural Resources Division of Water, https://www.in.gov/dnr/water/files/18-SWWF.zip (last visited Jan. 5, 2023).
[16] Our Farms, https://aquabounty.com/our-farms (last visited Dec. 27, 2022).
[17] *Kingfish Maine, Inc.,* State of Maine Department of Environmental Protection, https://www.maine.gov/dep/ftp/projects/kingfish/applications/SITE/Kingfish%20Maine,%20Inc.%20L28995anbncndnen%20Order.pdf (last visited June 27, 2023).
[18] Kingfish Maine Maine Pollutant Discharge Elimination System (MEPDES) Permit #ME0037559 Maine Waste Discharge License (WDL) Application #W009238-6F-A-N Finalized MEPDES Permit https://www3.epa.gov/region1/npdes/permits/2021/finalme0037559permit.pdf
[19] Whole Oceans Maine Pollutant Discharge Elimination System (MEPDES) Permit #ME0037478 Maine Waste Discharge License (WDL) #W009190-6F-A-N Proposed Draft Permit https://www.epa.gov/sites/default/files/2018-10/documents/draftme0037478permit.pdf
[20] Id.
[21] Final EIR, at 302-1 Cont.
[22] Id.
[23] Nordic Aquafarms General Application for Waste Discharge License (WDL) / Maine Pollutant Discharge Elimination System (MEPDES) Permit https://www.maine.gov/dep/ftp/projects/nordic/applications/MEPDES%20Permit%20Application_Final_Oct%2019,%202018.pdf
[24] Id.
[25] Audit Announcement, Aquaculture Stewardship Council (2021).
[26] *Financial Statements Release 1.1.2021-31.12.2021,* Fifax (Feb. 2022), https://fifax.ax/wp-content/uploads/2022/02/financial-statements-release-2021.pdf.

Benefits of LBA

Fish, having traditionally better feed conversion ratios than terrestrial livestock, are an effective starting point for environmentally friendly protein production.[27] Additionally, when operated with a sustainability mindset, salmon-rearing releases fewer greenhouse gases (GHG) into the atmosphere and requires less intensive land use and lower levels of freshwater consumption than beef production.[28] LBA, in particular, has several environmental benefits:

- **Waste:** Effective treatment of accumulating nutrient waste is important to the future sustainability of RAS.[29] Water filtration consolidates the waste from RAS systems into a sludge, and the use or disposal of this sludge strongly influences the overall sustainability of the operation. *Treatment of sludge is more manageable than waste disposal mechanisms in marine aquaculture*, making LBA more sustainable in this area.
- **Other land and water discharges:** In general, *RAS discharges fewer contaminants than does traditional aquaculture via effluent and air emissions into nearby ecosystems*, including carbon dioxide, nitrogen, and phosphorus.[30]
- **Water consumption:** Water use for RAS systems can be up to 100 times lower than traditional aquaculture,[31] making it a more feasible option for producing finfish and other aquaculture products in sites with limited water availability.
- **Ecosystem impacts:** *LBA technology decouples aquaculture from the marine environment,* thereby reducing the risk of sea lice and other diseases that pose large challenges for traditional aquaculture. This also reduces the need to vaccinate fish or use antibodies and pesticides.[32]

Economic and social co-benefits

Aquaculture, in general, is also one of few industries attracting investment during economic recessions.[33] Until recently, marine aquaculture was more economical than LBA. However, cost increases

FAST FACTS AND FIGURES

The aquaculture industry is expected to be worth **$262 billion** by the end of 2026 (International Trade Administration).

Fish consumption has increased 122% from 1980 to 2018 (Nasdaq).

The **United States imports more fish than any other country** (FAO).

Salmon, and related species, comprise about **20% of the global fish trade** (Shike, University of Illinois at Urbana-Champaign).

Salmon has a **14% share of the U.S. seafood market**, contrasted to 3-10% in European countries (DNB).

Each kilogram of salmon produced represents a **reduction of 27 kg of CO_2** discharged into the environment relative to the production of beef (Boyd et al.).

[27] University of Michigan Center for Sustainable Systems, Food Product Environmental Footprint Literature Summary: Land-Based Aquaculture (State of Oregon Department of1 Environmental Quality 2017).
[28] Claude E. Boyd et al., *Achieving sustainable aquaculture: Historical and current perspectives and future needs and challenges*, 51 J WORLD AQUACULT SOC. 578, 633 (2020).
[29] Yossi Tal et al., *Environmentally sustainable land-based marine aquaculture*, 286 AQUACULTURE 28, 35 (2009).
[30] John Colt et al., *Energy and resource consumption of land-based Atlantic salmon smolt hatcheries in the Pacific Northwest (USA)*, 280 Aquaculture 94, 108 (2008).
[31] J. P. Blancheton et al., *Intensification of land based aquaculture production in single pass and reuse systems*, Aquacultural Eng. and Env. 21, 47 (2007).
[32] Trond Bjørndal & Amalie Tusvik, *Economic analysis of land-based farming of salmon*, 23 AQUACULTURE ECONOMICS & MANAGEMENT 1, 27 (2019).
[33] T.V.R. Pillay, *Economic and social dimensions of aquaculture management*, 1 AQUACULTURE ECONOMICS & MANAGEMENT 3, 11 (1997).

associated with the adoption of more stringent regulations for marine aquaculture in the late 2010s gave LBA a competitive edge.[34] Finally, LBA's increased siting flexibility allows operations to be placed in communities that previously would not reap the economic benefits of the fish farming industry. The social benefits may include high-wage jobs for community members and infusing small-town economies.[35]

Negative Impacts of LBA

Both LBA (and aquaculture more generally) can also adversely impact the environment:

- **Feed:** The energy associated with producing feed is the highest point of energy consumption for most aquaculture systems.[36] Nutrient-rich and species-appropriate feed sources traditionally rely on fishmeal and fish oil, the production of which uses one-fifth of the world's wild caught fish, and *links LBA with unsustainable wild fishing operations associated with overfishing*.[37]
- **Energy**: There are two interrelated considerations for energy in the aquaculture sector: how much energy is consumed and whether the source of that energy is fossil fuels or renewables. *LBA and RAS have much higher energy demands than do other forms of aquaculture*,[38] with RAS sometimes reported as requiring more than double the energy of a closed net system.[39]
- **Water quality discharges:** There is a *risk of metals being introduced into RAS filtration systems,* including aluminum, due to the nitrification water treatment options, *resulting in these being discharged as contaminants in the facility's effluent*.[40]
- **Greenhouse Gases:** RAS releases *more respiratory carbon dioxide* due to water treatment mechanisms than other forms of aquaculture. Beyond RAS, power generation and feeding comprise the largest components of GHG emissions in all aquaculture systems.[41]
- **Ecosystem impacts:** The risk of fish escaping is significantly reduced in LBA, but not entirely diminished. Of highest concern are *natural disasters (such as hurricanes, earthquakes, and tsunamis), which could damage or destroy LBA facilities and allow for genetic mixing of domesticated and wild fish, as well as competition for the same food resources*.[42]
- **Land use:** RAS requires land that is flat, easily drainable, and close to a water source. This water source can be fresh or saltwater, depending on the species farmed at the facility. Atlantic salmon

[34] Seafood – Special Report: Deep dive into land-based farming (DNB Markets 2017).
[35] *Land Based Aquaculture,* Maine Department of Economic and Community Development, https://www.maine.gov/decd/businessdevelopment/landbasedaquaculture (last visited Oct. 3, 2022).
[36] M. Troell et al., *Aquaculture and Energy Use,* ENCYCLOPEDIA OF ENERGY. 97, 108 (2004)
[37] Claude E. Boyd et al., *Achieving sustainable aquaculture: Historical and current perspectives and future needs and challenges*, 51 J World Aquacult Soc. 578, 633 (2020).
[38] John Colt et al., *Energy and resource consumption of land-based Atlantic salmon smolt hatcheries in the Pacific Northwest (USA)*, 280 Aquaculture 94, 108 (2008).
[39] Trip O'Shea et al., *Towards a Blue Revolution: Catalyzing Private Investment in Sustainable Aquaculture Production Systems* (The Nature Conservancy and Encourage Capital 2019).
[40] J. P. Blancheton et al., *Intensification of land based aquaculture production in single pass and reuse systems*, AQUACULTURAL ENG. AND ENV. 21, 47 (2007).
[41] University of Michigan Center for Sustainable Systems, *Food Product Environmental Footprint Literature Summary: Land-Based Aquaculture* (State of Oregon Department of Environmental Quality 2017).
[42] Trip O'Shea et al., *Towards a Blue Revolution: Catalyzing Private Investment in Sustainable Aquaculture Production Systems* (The Nature Conservancy and Encourage Capital 2019).

are rare in their ability to thrive in both water types. This type of flat land is also often desired for other uses like urbanization and wetland conservation.[43]

Socio-economic impacts

LBA requires high up-front costs to build large-scale facilities and knowledgeable professionals.[44] Additionally, most RAS projects are owned by nonlocal companies, creating a sense that products and profits are not being reinvested in local areas.[45] Local communities are also concerned about water consumption. Even though RAS consumes less water than other LBA systems, there are still significant inflows and outflows, causing concerns about water availability for other purposes, such as for drinking water, the ecosystem, and recreation.

State of the Industry

Other forms of LBA face a scaling problem: the amount of water required to meet a growing global food demand would exceed that which is available in most countries, especially as water resources grow scarcer in the face of climate change. Additionally, marine aquaculture has earned a poor reputation for its impacts on the natural environment.[46] While RAS can offer a solution in terms of water usage and environmental impacts, it increases energy demand. This high demand for energy and rising energy costs have halted RAS projects around the world.[47] RAS also incurs higher operational costs and requires more consistent monitoring, leaving facilities prone to accidents when strict standards are not upheld.[48] Moving forward, economic viability for RAS will rely on maximized fish growth, efficient feed conversion, maximized density, early maturation, quality taste, and low levels of mortality; all elements better controlled in LBA than in a marine facility.[49]

One area of sustainable innovation is *raising two species on the same farm*, whether that be two fish species or one fish species and a plant species. Most identified studies agree that this can reduce overall water usage, feed, land usage, and waste as well as spread the economic risk.[50] RAS technology innovators are also *continually improving its recirculation loop*.

In 2021, Norway funded RAS 4.0, a research project that aims to use "novel sensor technology, data integration, and smart algorithms for optimal control of main water quality parameters, feeding management, and energy usage."[51] Energy impacts can also be reduced using *renewable energy and siting*

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[43] Yoram Avnimelech et al., *Sustainable Land-based Aquaculture: Rational Utilization of Water, Land and Feed Resources*, 1 MEDITERRANEAN AQUACULTURE 45, 55 (2008).
[44] Trip O'Shea et al., *Towards a Blue Revolution: Catalyzing Private Investment in Sustainable Aquaculture Production Systems* (The Nature Conservancy and Encourage Capital 2019).
[45] T.V.R. Pillay, *Economic and social dimensions of aquaculture management*, 1 Aquaculture Economics & Management 3, 11 (1997).
[46] Yossi Tal et al., *Environmentally sustainable land-based marine aquaculture*, 286 Aquaculture 28, 35 (2009).
[47] Aslak Berge, Land-based fish farm boom grinds to halt, SALMON BUSINESS, Sept. 9, 2022, https://salmonbusiness.com/land-based-fish-farm-boom-grinds-to-halt/.
[48] University of Michigan Center for Sustainable Systems, *Food Product Environmental Footprint Literature Summary: Land-Based Aquaculture* (State of Oregon Department of Environmental Quality 2017).
[49] Trond Bjørndal & Amalie Tusvik, *Economic analysis of land-based farming of salmon*, 23 AQUACULTURE ECONOMICS & MANAGEMENT 1, 27 (2019).
[50] Claude E. Boyd et al., *Achieving sustainable aquaculture: Historical and current perspectives and future needs and challenges*, 51 J World Aquacult Soc. 578, 633 (2020).
[51] Jelena Kolarevic, *Recirculating aquaculture systems: Improving Atlantic salmon performance*, Innovation News Network, (May 18, 2022), https://www.innovationnewsnetwork.com/recirculating-aquaculture-systems-improving-atlantic-salmon-performance/21554/

projects where impacts to the electricity grid will be minimal. Continuing to invest in *alternative feed sources* that require less energy and do not interfere with wild fishing could also help improve the environmental footprint of RAS. Finally, *increased aeration and drainage of water into sediment ponds* can improve water quality in LBA.[52]

As this industry grows and its practices and technologies change, regulatory systems around the world are facing new challenges.

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[52] J. P. Blancheton et al., *Intensification of land based aquaculture production in single pass and reuse systems*, Aquacultural Eng. and Env. 21, 47 (2007).

Summary of sustainability ranking systems

Ecolabels

An ecolabel is a mark "placed on product packaging or in e-catalogs that can help consumers and institutional purchasers quickly and easily identify those products that meet specific environmental performance criteria and are therefore deemed 'environmentally preferable."

Third party certification organizations have become a form of hybrid governance in the global aquaculture industry. Originally designed to enable retailers to communicate with suppliers and consumers, third party certification labels have also become important marketing tools in the food sector. Proponents claim these third-party assessments rectify the shortcomings of government and promote sustainability in the production cycle. However, certification has important drawbacks. Since certification can only be applied to products, a facility in the planning stage cannot be certified. This means that certification is of no utility to a planned development or its opponents, and decisions concerning siting and facility design are not reviewed by third party certifiers.

The following discussion first describes a third-party aquaculture certification systems model proposed in a previous ELI report, *Gold Standard for Sustainable Aquaculture Ecolabel Design.* With that as context, this section then profiles the four dominant certification systems for Recirculating Aquaculture Systems (RAS), as well as one consumer recommendation program geared towards guiding consumer choice. We also present a compilation of common sustainable best practices, drawn from these certification criteria and several state, national, and international regimes.

The entire Gold Standard is available at https://www.eli.org/research-report/gold-standard-sustainable-aquaculture-ecolabel-design-summary-report

Gold Standard for Sustainable Aquaculture Ecolabel Design

ELI designed the Gold Standard to aid aquaculture ecolabels in meeting certain environmental and social sustainability goals while also providing long term benefits to producers. The Gold Standard establishes a framework for designing an aquaculture certification system for ensuring rigorous standards, and guides the scope, governance structures, standard-setting, and implementation of ecolabel design.[53]

An aquaculture ecolabel should include:

☑ ***Statement of principles*** — identification of impacts and affected stakeholder groups, definitions of sustainability and other key terms, key principles for ecolabel operation (participation, transparency, and accountability) that address all relevant social and environmental effects of aquaculture production.

[53] Environmental Law Institute & The Ocean Foundation, Gold Standard for Sustainable Aquaculture Ecolabel Design: Summary Report (2008).

☑ **Consultation with a broad, diverse array of stakeholders** from both developed *and* developing countries,[54] including large- and small-scale producers, supply chains, environmental NGOs, community/social NGOs, consumer groups, wild-capture fishery representatives, academics, multilateral organizations.[55]

☑ **Clear stringency** based on environmental, social, and economic sustainability, determined on the best available science.[56]

☑ **Governance structure** given credibility through the consensus of a diverse stakeholder group, and which includes a General Assembly (stakeholder engagement), Board of Directors (oversight, key decision-making), Secretariat (day-to-day management), Technical Advisory Board (independent expertise), and Objection Panel (reviews grievances).

☑ **Standards** rooted in science and encompassing overarching principles, criteria determining the relationship between principles and impacts, and indicators measuring compliance with each criterion.[57]

An ecolabel can be implemented at the production facility or processor level. An independent certification body carries out conformity assessments.[58]

The certification process itself includes preassessment, assessment, and review to encourage producer participation at each step. *Preassessment* should confidentially and inexpensively provide producers a basic understanding of their standing. *Assessment* should be fully transparent, involving on-site consultation and engagement with local communities. Public comment periods occur before and after the issuance of the initial audit report. Final reports are subject to review. The Gold Standard recommends annually auditing producers and processors to ensure ongoing facility compliance,"[59] and compiling performance data for use in an annual report.[60]

Certification Systems for RAS and Consumer Recommendation Program

Best Aquaculture Practices (BAP) Certification Program and Farm Standards

Best Aquaculture Practices (BAP) is a division of Global Seafood Alliance (GSA) spanning 39 countries and is among the most widely known aquaculture certification programs.[61] BAP is the only aquaculture certification program certifying every step in the production cycle, including processing plants, farms, hatcheries, and feed mills.

[54] Gold Standard, p. 4
[55] Gold Standard, p. 3
[56] Gold Standard, p. 4
[57] Gold Standard, p. 9
[58] Gold Standard, p. 11
[59] Gold Standard, p. 12
[60] Gold Standard, p. 13
[61] *Why You Should Look for the BAP Label*, YouTube, https://www.youtube.com/watch?v=O33qCr2ok3g (last visited August 8, 2022).

BAP standards employ a "star-based" ranking system. Each star corresponds to a facility in the chain of custody: Feed, Hatchery, Farm, and Processor Plant. A four-star certification signifies every facility in an operation's chain of production is BAP certified.[62]

The certification timeline for BAP is typically between 150-180 days and contains four phases.

> Phase One: A farm may submit the initial BAP application once it has been in operation for at least three months.
>
> Phase Two: A third-party certifier begins the audit. The audit consists of an opening meeting, a site assessment, collection of samples, necessary interviews with employees and community members, review of management records and procedures, and a closing meeting. Any non-conformity discovered in the audit will be recorded as major, minor, or critical.
>
> Phase Three: Operations are granted 28 days to correct major and minor deviations, while critical non-conformities can prompt immediate temporary suspension.
>
> Phase Four: A certifying body conducts a technical review and issues the certification decision. Non-compliance from BAP standards is never permitted.

The Standards Oversight Committee (SOC) sets BAP farm standards. SOC is composed of members with broad stakeholder representation, equal parts conservation, academia, and industry.[63] Since its inception in 2002, BAP farm standards have been constantly updated to reflect the evolving aquaculture industry. The SOC first introduced standards for RAS in March 2021, as part of the BAP farm standard's third iteration. Drafts for new program standards are released to the public, with a 60-day period to submit comments. The standards are modified in response to this feedback, and finally approved by both the SOC and GSA Board of Directors before being published.

BAP's Farm Standards 3.0 (March 2021) offer detailed certification standards, requirements, and implementation guidelines for the aquaculture industry.[64] These standards apply to finfish, crustaceans, and other aquatic invertebrate farming. They cover all production methods, including RAS. Net pen salmonoid farms, bivalve mollusks, and hatcheries each are reviewed under a separate set of standards. BAP standards are built on four pillars of sustainability: environmental responsibility, animal health and welfare, food safety, and social accountability — all underpinned by traceability. They have fifteen audit clauses specifically related to traceability, ensuring the certifying body obtains proper documentation and evidence of compliance for each standard.

BAP is currently developing a Recirculating Aquaculture Systems (RAS) Vanguard Standard.[65] This initiative intends to incentivize leading-edge innovations and enable rapid development of aquaculture—including RAS—standards. Eventually, to apply for Vanguard certification, producers must be BAP Farm Standard 3.0 certified. Companies with the Vanguard Standard will be listed on the BAP Vanguard webpage and will

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[62] *BAP Star System*, Best Aquaculture Practices, https://www.bapcertification.org/OurLogo, (last visited August 8, 2022).
[63] *Program Standards*, Best Aquaculture Practices, https://www.bapcertification.org/Standards (last visited August 8, 2022).
[64] *Aquaculture Facility Certification: BAP Farm Standard*, Best Aquaculture Practices, https://www.bapcertification.org/Downloadables/pdf/PI%20-%20Standard%20-%20Farm%20Standard%20-%20Issue%203.0%20-%2001-March-2021-GSA.pdf (last visited August 8, 2022).
[65] *Recirculating Aquaculture Systems Vanguard Standard*, Best Aquaculture Practices, https://www.bapcertification.org/Downloadables/pdf/Public%20Comment%20-%20RAS.pdf (last visited August 8, 2022).

be authorized to publicize their special status to stakeholders. Vanguard Standard elements will be progressively adopted into mainstream BAP standards to help drive industry-wide improvements. The RAS Vanguard Standard will address several categories of resource use and impacts, including water use efficiency, waste management and circular economies, energy use efficiency and use of renewable energy, and animal welfare.[66]

BAP meets the Gold Standard for ecolabel design through its broad stakeholder representation, its governance structure, and its detailed certification standards and implementation guidelines. Furthermore, BAP standards were built on pillars of sustainability addressing the social and environmental impacts of aquaculture production.

Aquaculture Stewardship Council (ASC) Certification

The Aquaculture Stewardship Council (ASC) was established in 2009 to create a set of certifications specific to aquaculture, with the goal of complementing the Marine Stewardship Council's (MSC) certification for wild-caught fish. The ASC emerged from a series of aquaculture dialogues coordinated by the World Wildlife Fund (WWF) and the Dutch Sustainable Trade Initiative.[67] These dialogues led to the development of eight standards covering 12 species groups.[68] ASC has since expanded to 11 standards covering 17 species groups including abalone, bivalve, finfish, freshwater trout, pangasius, and salmon.[69]

The organization is currently consolidating these eight standards into a single standard with three core principles applicable to all current and future species. This consolidation effort, known as the Alignment Project, began in 2021 with the intention to harmonize the existing species standards into one comprehensive Farm Standard.[70] The three core principles are known as the Legal, Environmental, and Social pillars. ASC released the adapted standards on April 25, 2022, and they went into effect on October 25, 2022. This project also entails adapting the existing Farm Standard for Recirculating Aquaculture Systems. Land-based RAS farms will need to comply with species-specific standards, as well as be graded against a list of indicators covering water resource use, water discharge, waste disposal, and energy use. Water Resource indicators encompass proper permitting and annually tested well depths, as well as ensuring the maximum amount of water diverted from a natural flowing water body is no more than 50% of the natural water body's flow, with the amount of diverted water returned greater than 90%. Waste disposal requirements include implementing biosolids' best management practices and evidencing specific chlorine concentration values in the sludge as not in excess of chlorine concentration values in soil in the disposal area. Energy use indicators include records of GHG consumption during the farm's production cycle, emissions amassed during off site feed production, annual GHG assessments, and evidence of a documented strategy to reduce GHG emissions within three years of the initial audit.[71]

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[66] *Recirculating Aquaculture Systems Vanguard Standard*, Best Aquaculture Practices, https://www.bapcertification.org/Downloadables/pdf/Public%20Comment%20-%20RAS.pdf (last visited August 8, 2022).
[67] *Environmental Certifications*, Salmon Facts, https://salmonfacts.com/salmon-and-environment/environmental-certifications-for-farmed-salmon/ (last visited August 9, 2022).
[68] Joanna Vince & Marcus Haward, Hybrid governance in aquaculture: Certification schemes and third-party accreditation, 507 Aquaculture 322–328 (2019).
[69] *Our standards*, ASC-AQUA.ORG, https://www.asc-aqua.org/what-we-do/our-standards/ (last visited August 9, 2022).
[70] *Alignment: ASC Farm Standard*, ASC-Aqua.org, https://www.asc-aqua.org/programme-improvements/aligned-standard/ (last visited August 9, 2022).
[71] *RAS Module Development*, ASC-Aqua.org, https://www.asc-aqua.org/programme-improvements/ras/ (last visited August 9, 2022).

The ASC certification label can only be applied to products meeting ASC certification standards for each stage of production.[72] ASC certification is considered difficult to obtain and this difficulty adds to its credibility. This certification is more popular in other parts of the world than the U.S. For example, 66% of Australia's farmed salmon production is ASC certified, as is 29% of Canada's and 29% of Chile's. No farmed salmon production in the U.S. is ASC certified.[73]

As of 2022, ASC remained the only aquaculture certification scheme in the world recognized as a full member of the International Social and Environmental Accreditation and Labeling Alliance (ISEAL), an organization recognized for providing credibility to sustainability standards and certification systems.[74]

ASC certification aligns with the Gold Standard because of basis on environmental and social standards, recognition as a full member by ISEAL, and identification of several indicators, such as water resource use, water discharge, waste disposal and energy use. Furthermore, it establishes the stringency of the certification through establishing ASC standards can only be applied to products meeting standards at every stage of the process.

GlobalG.A.P. Certification

The GlobalG.A.P. certification and its associated standard—Integrated Farm Assurance (IFA)—take a holistic approach to responsible agriculture, animal husbandry, and aquaculture. Introduced in 1997, the certification schema aimed to address consumer concerns about sustainable development. Previously known as EUREPG.A.P., GlobalG.A.P. rebranded as standards were adopted by a wider set of producers.[75]

GlobalG.A.P. focuses on "food safety, minimized environmental impact, animal health and welfare, health safety and welfare of workers,"[76] and encompasses the entire production chain.[77] The sixth version of the IFA standard, which was launched in April 2022, includes new sustainability criteria on plastics, waste, carbon neutrality, deforestation, and animal welfare.[78] Unlike other certifications, applicants may apply for GlobalG.A.P. certification as either an individual producer or as a group of producers.[79] GlobalG.A.P.'s aquaculture standard covers finfish, crustaceans, and mollusks for all types of farming systems.[80]

GlobalG.A.P. has eight main criteria for aquaculture certification: food safety, health and animal welfare, occupational health and safety, social practices, environment, biosecurity, traceability, and integrity. The

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[72] Joanna Vince & Marcus Haward, Hybrid governance in aquaculture: Certification schemes and third-party accreditation, 507 Aquaculture 322–328 (2019).
[73] *ASC Global Review*, Seachoice, https://www.seachoice.org/asc-global-review/ (last visited August 9, 2022).
[74] *Who we are*, ISEAL Alliance, https://www.isealalliance.org/about-iseal/who-we-are#:~:text=ISEAL%20supports%20ambitious%20sustainability%20systems,markets%20a%20force%20for%20good., (last visited August 9, 2022).
[75] Yeong Sheng Tey et al., A review of an International Sustainability Standard (GlobalG.A.P.) and its local replica (MyGap), 45 Outlook on Agriculture 67–72 (2016).
[76] Yeong Sheng Tey et al., A review of an International Sustainability Standard (GlobalG.A.P.) and its local replica (MyGap), 45 Outlook on Agriculture 67–72 (2016).
[77] *Environmental Certifications*, Salmon Facts, https://salmonfacts.com/salmon-and-environment/environmental-certifications-for-farmed-salmon/ (last visited August 9, 2022).
[78] *Integrated Farm Assurance (IFA) V6 at a Glance*, GLOBALG.A.P., https://www.globalgap.org/uk_en/for-producers/globalg.a.p./integrated-farm-assurance-ifa/IFA-V6/, (last visited August 8, 2022).
[79] Yeong Sheng Tey et al., A review of an International Sustainability Standard (GlobalG.A.P.) and its local replica (MyGap), 45 Outlook on Agriculture 67–72 (2016).
[80] *Aquaculture Certification Systems*, GLOBALG.A.P., https://www.globalgap.org/.content/.galleries/ASC_Vergleich/index.html, (last visited August 8, 2022).

criteria most relevant to sustainability are social practices, environment, biosecurity, and traceability. Social practices ensure farming activities do not prevent local community access to drinking water. Environmental criteria include: energy efficiency, an Environmental Impact Assessment, waste and pollution management, recycling and reuse, incoming water and wastewater monitoring and treatment, escapes prevention management, protected areas, chemicals transport, usage and storage, adequate process to properly manage empty containers, sanitary sewage disposal, and feeding levels monitoring. Biosecurity requires a biosecurity plan, an area management plan, and a pest control plan. Finally, the traceability requires broodstock be obtained through a breeding program with no genetic modification. It also requires all traceability from feed use and seedlings through packing/processing.[81]

Global G.A.P. is the only certification standard recognized by both Global Food Safety Initiative and Global Sustainable Seafood Initiative.[82]

Global G.A.P. meets the Gold Standard because of strong roots in sustainability criteria and clear definitions of these criteria. Global G.A.P. also meets the Gold Standard through its broad inclusion of stakeholders and its prioritization of transparency throughout the standard-setting process.

Marine Eco-Label (MEL) Japan Certification

The Marine Eco-Label (MEL) Japan certification program was launched in 2016 and rewards producers who engage in sustainable use of marine resources and conservation efforts,[83] with three types of certifications: Fisheries certification, Aquaculture certification, and Chain of Custody (CoC) certification.[84]

MEL's aquaculture standards are built to promote sustainable and responsible aquaculture production, such as the protection of natural stocks, the conservation of environment, and the improvement of consumer's trust. [85]

In 2019, the Marine Eco-Label (MEL) Japan certification was recognized by The Global Sustainable Seafood Initiative (GSSI), a benchmarking agency for international certification labels. MEL's recognition marked the first time an Asian eco-label marine certification has received recognition, propelling MEL standards to an international level.

Not much information is available about the governance, standard-setting, and implementation of the Marine Eco-Label (MEL) Japan certification. However, MEL demonstrates a clear commitment to sustainable and responsible aquaculture and is reputable since its certification standards and regulations are based on strong international standards.

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[81] *Aquaculture Certification Systems*, GLOBALG.A.P., https://www.globalgap.org/.content/.galleries/ASC_Vergleich/index.html, (last visited August 8, 2022).
[82] *Aquaculture Certification Systems*, GLOBALG.A.P., https://www.globalgap.org/.content/.galleries/ASC_Vergleich/index.html, (last visited August 8, 2022).
[83] *Aquaculture certification*, Azuma, https://www.azuma.or.jp/en/authentication-en/ (last visited August 8, 2022).
[84] *Marine Eco-Labels*, Nissui Disclosure Site, https://nissui.disclosure.site/en/themes/170 (last visited August 8, 2022).
[85] *Aquaculture Management Standard*, Marine Eco-Label Japan, http://melj.jp/eng/wp-content/uploads/2018/07/%E3%80%90Standard%E3%80%91-Aquaculture-FINAL.180730.pdf, (last visited August 8, 2022).

Global Animal Partnership (G.A.P.) Certification and Salmon Welfare Standards

The Global Animal Partnership (G.A.P.) Salmon Welfare Standards offer a set of parameters for animal welfare within the aquaculture industry.[86] Although the G.A.P. certification program is related primarily to animal welfare, G.A.P. recognizes animal welfare and environmental sustainability are linked,[87] and requires specific measures for environmental compliance.

G.A.P. offers multi-tiered standards designed to assess animal welfare and uses third party certifiers to administer the program. To remain certified, farms undergo re-auditing every 15 months. G.A.P. certification consists of six step levels: (1) Basic Certification, (2) Enriched Environment, (3) Outdoor Access, (4) Pasture Raised, (5) Animal Centered, and (5+) Entire Life on Farm. The higher the step level, the more the animals' environment on the farm mimics a natural environment. Step levels for salmon farms are simplified to Animal Welfare Certified (1), Enhanced Habitat (3), and Fish Centered (5+). Each increased step level requires additional and more stringent standards for certification. These standards include but are not limited to: Fish source; Fish health; Fish care and management; Smoltification; Feed; Sea Lice; Cleaner fish welfare; Transport; Plans; and Protocols, procedures, training, records, and documents.[88]

Global Animal Partnership (G.A.P.) Salmon Welfare Standards meets Gold Standard recommendations for its commitment to environmental sustainability over the entire lifecycle of the animal. Furthermore, it has defined the scope and stringency of its multi-tiered standards. G.A.P. may or may not follow governance structure and implementation guidelines recommended by the Gold Standard. It has no requirements for site selection or community engagement.

Monterey Bay Seafood Watch Ranking System

While certification systems offer individual producers sustainability certification, Seafood Watch provides categorical recommendations for seafood. This guide is intended to help consumers make responsible buying decisions. Seafood items are divided into three descending categories: best choices, good alternatives, and items to avoid. The National list often indicates whether a species is farmed or wild-caught (and, if wild-caught, how a species is caught) and the specific regions where the species is harvested.[89] Rather than offering certifications for individual facilities or producers, the Seafood Watch system focuses on species-based, operation-specific, and geographic categories. For example, "Catfish (US)" is a Best Choice while "Shrimp (Canada & US wild, Ecuador, Honduras, & Thailand farmed)" is on the Good Alternatives list.

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[86] *Our Standards*, Global Animal Partnership, https://globalanimalpartnership.org/standards/?gclid=Cj0KCQjwz96WBhC8ARIsAATR251MFoLtbGHTo7KedpUnmZ_k7fijkTRw6szAM0KWODyiWfKhXMvzokcaAhU6EALw_wcB, (last visited August 8, 2022).

[87] *5-Step Animal Welfare Program for Farmed Atlantic Salmon*, Global Animal Partnership, https://globalanimalpartnership.org/wp-content/uploads/2022/06/G.A.P.Animal-Welfare-Standards-for-Farmed-Atlantic-Salmon-v1.0.20220615.pdf (last visited August 8, 2022).

[88] *5-Step Animal Welfare Program for Farmed Atlantic Salmon*, Global Animal Partnership, https://globalanimalpartnership.org/wp-content/uploads/2022/06/G.A.P.Animal-Welfare-Standards-for-Farmed-Atlantic-Salmon-v1.0.20220615.pdf (last visited August 8, 2022).

[89] Seafood Watch National Consumer Guide January-August 2022, (2022).

The overall rankings are based on aggregated analysis of individual facilities using Monterey Bay's Standards document.[90] This rating criteria includes data, effluent, habitat, chemical use, feed, escapes, disease/pathogen/parasite interactions, source of stock, predator and wildlife mortalities, and escape of secondary species. Each criterion is evaluated, the fishery is given a sub score, the fishery is rated as green, yellow, red, or critical, and finally, when combined with other fisheries in its species, operation, and geographic category, is given a Seafood Watch recommendation.

In 2014, Seafood Watch published a specific rating for Recirculating Aquaculture Systems, where it compiled global RAS technology data for all species (except for eels) raised in these systems. The rating criteria for evaluating RAS technology are the same as the overall aquaculture criteria categories. Wastewater treatment also has a separate criterion. RAS is then rated as green, yellow, red, or critical, and finally given a Seafood Watch recommendation: "Best Choice," "Good Alternative," or "Avoid." The final ranking for global RAS production of all species (minus eels), and with wastewater treatment, is "Best Choice."

Though The Monterey Bay Seafood Watch System follows the Gold Standard through clearly outlined environmental and sustainability indicators, it differs from the Gold Standard in not offering certifications for individual facilities or producers. The certification may or may not align with the governance and implementation guidelines recommended.

[90] *Standard for aquaculture*, Monterey Bay Aquarium Seafood Watch, https://www.seafoodwatch.org/recommendations/our-standards/standard-for-aquaculture, (last visited August 8, 2022).

Compilation of Most Relevant Best Practices for Land-Based Finfish (salmon) Aquaculture facilities

The following best practices represented the most noted categories across different certification standards and ranking systems described above. Only standards for farm-raised salmon have been included in the table:

Table 2. Certification Systems Sustainability Best Practices

Criteria	BAP	ASC	Global G.A.P.	MEL	GAP	Monterey Bay
Site Selection	✓	✓	✓	✓	✗	✓
Community Engagement	✓	✓	✓	✗	✗	✗
Fish Source	✓	✓	✓	✓	✓	✓
Disease, Biosecurity, and Chemical & Drug Management	✓	✓	✓	✓	✓	✓
Energy Consumption	✓	✓	✓	✗	✓	✓
Water Management	✗	✓	✓	✓	✓	✗
Feed Management	✓	✓	✓	✓	✓	✓
Effluent Discharge Management	✓	✓	✓	✗	✗	✓
Solids and Liquids Management and Disposal	✓	✓	✓	✓	✗	✓
Facility Operation and Maintenance	✓	✗	✓	✓	✓	✗
Environmental Management Plan	✓	✗	✓	✗	✓	✓

Legend

✓ Comprehensive; considers multiple sustainability elements

✓ Few requirements and/or describes only one or two elements of sustainability

✗ No best practice guidance for this criterion

How federal, state, and foreign jurisdictions regulate land-based aquaculture

This section provides an in-depth analysis of the regulatory framework for land-based aquaculture in the United States and three foreign jurisdictions. The federal government's level of regulatory authority and oversight regarding land-based facilities in the U.S. is examined, as well as the regulatory landscape for land-based RAS in the states of Maine, Wisconsin, Florida, and California. The inclusion of the latter three states was based on the existence of current land-based RAS facilities (Wisconsin and Florida,) or proposed facilities (California).

Finally, the legal framework for aquaculture in Canada, United Arab Emirates, and Norway is reviewed, with a focus on the strengths, weaknesses, and sustainability measures that could be applied in the United States.

United States Federal Jurisdiction

Industrial land-based aquaculture in the United States is largely regulated at the state, Tribal, and local level. States issue permits, impose standards, which are equally stringent or more stringent than federal standards, and conduct enforcement actions.

Although Congress has enacted a National Aquaculture Act, it is primarily policy oriented and does not confer regulatory authority on either the federal government or the states. The Clean Water Act and the Clean Air Act, together with other federal statutes and regulations related to food safety, animal health, endangered species, and safe drinking water, provide the backbone of federal authority regarding land-based aquaculture in the United States.

States submitted plans to the Environmental Protection Agency (EPA) to implement federal programs under the Federal Water Pollution Control Act (Clean Water Act or "CWA"), the Clean Air Act (CAA) and other major federal environmental statutes. While states take "the lead in implementation and enforcement subject to minimum national standards set by the federal government,"[91] this does not grant the federal government direct authority to implement federal environmental laws in the

NATIONAL AQUACULTURE ACT

The National Aquaculture Act of 1980 (NAA), established aquaculture as a national policy priority in the U.S. It defines aquaculture as:

"the propagation and rearing of aquatic species in controlled or selected environments, including but not limited to, ocean ranching." 16 U.S.C. § 2802(1).

An aquaculture facility is defined as:

"any land, structure, or other appurtenance that is used for aquaculture and is in any State."

The term includes but it is not limited to "any laboratory, hatchery, rearing pond, raceway, pen, incubator, or other equipment used in aquaculture." 16 U.S.C. § 2802(2).

The NAA provided for the creation of an interagency coordinating body, the Subcommittee on Aquaculture, to advance the effectiveness and productivity of federal aquaculture research, regulation, technology transfer, and assistance programs.

[91] Environmental Law Institute, Law of Environmental Protection, Chapter 7(2022) at p.331.

states, rather the federal government oversees "the adequacy of the state effort."[92]

Cooperative Federalism

None of the federal environmental statues delegate any federal power to the states.

The federal government relies on the states' own inherent powers to implement federal environmental laws.

A withdrawal from federal "authorization" does not mean that a state lacks power to make and enforce laws dealing with the subject matter of the authorization (e.g., water pollution).

Lack of "authorization" in a state solely means that the federal government must engage in an extra effort in a state in addition to the independent efforts states might take.

Environmental Law Institute, Law of Environmental Protection, Chapter 7: State Environmental Law Programs (2022) at p.331.

The EPA may withdraw a state's authorization if it is not adequately complying with program obligations under the Clean Water Act's National Pollutant Elimination Discharge System (NPDES) program, the Safe Drinking Water Act, Resource Conservation and Recovery Act (RCRA), and the Underground Storage Tank program.[93] In the NPDES context, citizens can petition EPA to withdraw a state's authority to administer the program. However, program withdrawals by the EPA are rare. Upon receiving a petition, EPA typically works with the state and the petitioner(s) to strengthen the state's NPDES program.[94]

Land-based regulation and oversight

The EPA and the U.S. Army Corps of Engineers (USACE) provide oversight and in some rare circumstances could issue permits to land-based aquaculture operations if a state or a Tribal government lacks permitting authority under the CWA, CAA or other major federal statutes. This authority is very limited and is not the case in any of the jurisdictions referenced in this report. Other federal agencies providing a measure of oversight include the National Oceanic and Atmospheric Administration (NOAA), the U.S, Fish and Wildlife Service (USFWS), the Food and Drug Administration (FDA), and the U.S. Department of Agriculture (USDA).

Environmental Impact Review

The National Environmental Policy Act (NEPA) requires federal agencies to evaluate the impacts of major federal actions[95] with potential to significantly affect the environment.[96] This includes developing detailed documents assessing the environmental impacts of the proposed federal action, alternative actions, and mitigation measures.[97] Agencies first prepare an Environmental Assessment (EA),[98] determining if the

[92] Environmental Law Institute, Law of Environmental Protection, Chapter 7 (2022) at p.331.
[93] Environmental Law Institute, Law of Environmental Protection, Chapter 7: State Environmental Law Programs (2022) at p.331.
[94]Environmental Protection Agency, NPDES State Program Withdrawal Petitions, https://www.epa.gov/npdes/npdes-state-program-withdrawal-petitions
[95] As defined, it 40 C.F.R. § 1508.1(q).
[96] National Environmental Policy Act (NEPA) of 1969 42 U.S.C. §§ 4321-4370e.
[97] NEPA section 102, 42 U.S.C. § 4322.
[98]40 C.F. R. § 1508.1(h). "The purpose of the EA is to determine the significance of the environmental effects and to look at alternative means to achieve the agency's objective . . . [it] (1) briefly provides sufficient evidence and analysis for determining whether to prepare an EIS; (2) aids an agency's compliance with NEPA when no environmental impact statement is necessary; and (3) facilitates preparation of an Environmental Impact Statement when one is necessary." Council on Environmental Quality, A Citizen's Guide to the NEPA: Having your voice heard p. 11 (2007). https://ceq.doe.gov/docs/get-involved/Citizens_Guide_Dec07.pdf.

action will require an Environmental Impact Statement (EIS).[99] The EIS evaluates impacts of major actions proposed by the federal government, including related to environmental, social, and cultural effects. The review ensures environmental concerns are examined and alternatives considered prior to making the final decision on a project or action. Land based industrial aquaculture generally does not require a review under NEPA at the federal agency level because they are not considered major federal actions, but many states impose their own EIS requirements.[100]

Water Quality and Habitat Protection

Effluent Discharge: NDPES Permit

Land-based aquaculture facilities that contain, grow, or hold cold water fish or animals (e.g., Atlantic salmon) in ponds, raceways, or other similar structures that annually discharge effluent at least 30 days and produce 20,000 or more pounds of aquatic animals are classified as Concentrated Aquatic Animal Production facilities (CAAPs).[101] CAAPs qualify as "point sources" under the Clean Water Act.[102] Section 402 of the Clean Water Act requires point sources to obtain from the EPA a National Pollutant Discharge Elimination System (NPDES) permit to discharge pollutants into waters of the U.S. (states and tribes can broaden the definition of regulated waters under the NPDES program). States or Tribes with an approved NPDES program can issue permits for discharges into regulated waters within their respective jurisdictions. EPA has set standards for what a state or tribe must have in its permit program in order to be approved. Maine, along with 46 other states, has been approved by EPA to issue such permits. EPA may, on a case-by-case-basis, require smaller land-based aquaculture facilities that otherwise do not meet the requirements to qualify as CAAPs to obtain a NPDES permit.

NPDES permits contain industry-specific technology-based effluent limitations and/or water-quality based limits, establish pollutant monitoring and reporting requirements, and impose record-keeping requirements, among other special and standard conditions aimed at protecting water quality. CAAP facilities that produce 100,000 pounds or more of fish are covered under the CAAP Effluent Limitation Guidelines (CAAP ELGs).[103] The CAAP ELGs contain narrative rather than numeric effluent limitation requirements and stipulate a series of management practices designed to decrease pollutant discharges from CAAP facilities.[104]

Other EPA authorizations that may be required for land-based aquaculture facilities include those under the Clean Air Act (CAA) (minor source permits, for facilities with diesel fuel back-up generators),[105] the Safe Water Drinking Act (SWDA) (for land-based aquaculture facilities with underground injection wells to dispose of fluids on site),[106] the Toxic Substances Control Act (TSCA) (for certain chemical substances or mixtures used by, manufactured, or processed as part of a land-based aquaculture operation), and the

[99] NEPA section 102(2)(c), 42 U.S.C. § 4322(2)(c). 40 C.F.R. § 1508.1(j).
[100] Approximately 20 states have enacted NEPA-like laws. The State of Maine has not enacted an environmental review law requiring an EIS for state actions.
[101] Concentrated Aquatic Animal Production Facilities 40 C.F.R. § 122.24(b). Appendix C. 40 C.F.R. § 122.24(b).
[102] Clean Water Act § 502 (14), 33 U.S.C. § 1362 (14).
[103] 40 C.F.R. § 451.
[104] EPA, *Concentrated Aquatic Animal Production Effluent Guidelines*, (n.d.). Available at: https://www.epa.gov/eg/concentrated-aquatic-animal-production-effluent-guidelines. *See* Appendix section for more discussion on the CAAP ELGS.
[105] New Source Review Permit (for construction) or Title V Permit (for operation of major sources and some minor sources).
[106] The SWDA regulates EPA's Underground Injection Control Program. EPA, Underground Injection Control Program, https://www.epa.gov/uic.

Federal Insecticide Fungicide and Rodenticide Act (FIFRA) and Food Drug and Cosmetic Act (FDCA) (for pesticides used in aquaculture facilities and in food products, respectively).

Excavation/Dredge and Fill: USACE

Authorization from the USACE could be required under Section 10 of the Rivers and Harbors Act of 1892 and under CWA Section 404. Section 10 of the Rivers and Harbors Act requires obtaining from USACE a permit for construction of any structure in, over, or under any navigable water of the United States,[107] the excavating or dredging from or depositing of material in such waters, or the accomplishment of any other work affecting the course, location, condition, or capacity of such waters.[108] Furthermore, authorization from USACE is also required under CWA Section 404 for the discharge of dredged or fill material and certain discharges associated with the excavation into waters of the United States, including wetlands.[109] These permits are typically required in the land-based aquaculture context for the construction of intake/outfall pipes that impact waters of the U.S.

Other Federal Authorizations

The Endangered Species Act (ESA), the Magnuson-Stevens Conservation and Management Act, and the Fish and Wildlife Coordination Act require that action agencies—like EPA or USACE—consult NOAA National Marine Fisheries Service (NMFS) and USFWS prior to issuing a permit for aquaculture operations that will have an impact on Essential Fish Habitat (EFH) and endangered or threatened wildlife species, or their critical habitat. The ESA allows citizens to sue "any person" which includes the United States government and other agencies and instrumentalities for failure to comply with any of its provisions or implementing regulations.[110] For example, citizen could sue federal action agencies for failing to consult USFWS and NMFS prior taking an action that might impact an endangered species or its critical habitat.[111]

Under the Lacey Act,[112] USFWS is tasked with preventing the movement of potentially harmful live or dead Salmonoid fishes that may carry pathogens into the waters of the U.S.[113] All shipments of live Salmonoid fish and their eggs, as well as dead whole eviscerated Salmonoid imports, must be inspected by an USFWS agent and certified as free of disease.[114]

Other agencies that regulate some aspect of the operations of land-based aquaculture facilities, particularly the harvesting and processing of fish products, are the Food and Drug Administration (FDA) and USDA. Under the Food Safety Modernization Act (FSMA),[115] aquaculture operations that manufacture, process, pack, or hold human or animal food must register as "food facilities."[116] As food facilities, aquaculture operations must comply with the Preventive Controls for Animal Food (PCAF) regulations.[117] Additionally, processors of fish and fishery products for human food are subject to FDA's Procedures for

[107] 33 C.F.R. § 328.3, 40 C.F.R. § 120.2.
[108] 33 U.S.C § 403. *See also* 33 C.F.R. § 322 (1995).
[109] 33 C.F.R. § 323.
[110] 16 U.S.CA. § 1540(a)(3), ESA section 11(a)(3).
[111] Section 7 consultation is only triggered by a proposed federal action. It does not apply to state or local actions. 16 U.S.C.A. § 1536, ESA Section 7.
[112] 16 U.S.C §§ 3371-3378 and 18 U.S.C. §42.
[113]. 50 C.F.R § 16.13.
[114] 18 U.S.C. §42., 50 C.F.R § 16.13.
[115] 21 U.S.C § 301 *et seq*. The FSMA amended the Federal Food, Drug and Cosmetic Act (FDCA).
[116] 21 C.F.R § 1, subpart H.
[117] 21 C.F.R. § 507.

the Safe and Sanitary Processing and Importing of Fish and Fishery Products (known as the seafood Hazard Analysis and Critical Control Point, or "HACCP").[118] This regulation requires both domestic and foreign processors of fish and fishery products to be aware of, prevent, and mitigate the food safety hazards associated with their processes and products.[119]

Additional requirements under FDA regulations applicable to aquaculture operations include the misbranding and adulteration provisions under the FDCA and both the Good Manufacturing Practice for Medicated Feed and Veterinary Feed Directive regulations for medicated feed and food additive regulations.[120] Moreover, FDA approval is required for drugs intended for use in food-producing animals; this includes drugs used in animal feed.[121]

Under both the Animal Health Protection Act and the Virus Serum Toxin Act, and their implementing regulations,[122] the USDA Animal and Plant Health Inspection Service (APHIS) provides a wide range of services to aquaculture businesses. This includes laboratory diagnostic and testing capacity, vaccine development, epidemiology and risk assessment expertise, and disease surveillance.[123]

The USDA is increasingly playing a role in overseeing aquatic animal and aquaculture health, most recently by developing the National Aquaculture Health Plan and Standards (NAHP&S). The NAHP&S establish guidance for aquaculture operations in terms of national disease reporting, laboratory and testing standardization, surveillance, response, biosecurity, data management, and education and training for personnel involved in aquaculture operations.[124]

Public Participation

The federal regulatory framework provides several opportunities for the public to provide input at various stages in the permitting process.

National Environment Policy Act (NEPA) review

The public participation process during the NEPA review conducted by federal agencies will depend on the type of review process. If during the preparation of the Environmental Assessment (EA), the agency determines that the action will require an Environmental Impact Statement (EIS), NEPA requires the agency to issue a Notice of Intent (NOI) to prepare an EIS and hold a scoping process to gather public input on the impacts of its action(s). Then, the agency publishes the draft environmental impact statement (EIS) and opens a comment period to members of the public and all relevant federal, state, Indian Tribes, and

[118] 21 C.F.R §§ 123, 1240.
[119] NOAA, *Guide for Permitting*, *supra,* note 7 at 23-25.
[120] 21 U.S.C §§ 321(s), 331, 342, 343, § 348(a)(2), 360b and 360ccc, 40 C.F R. § 501, 21 C.F.R. §§ 225. § 558.6, 570.30 and 570.35.
[121] 21 U.S.C §§ 321(s), 331, 342, 343, § 348(a)(2), 360b and 360ccc, 40 C.F R. § 501, 21 C.F.R. §§ 225. § 558.6, 570.30 and 570.35.
[122] Congress enacted the Animal Health protection Act to prevent, detect, control or eradicate diseases from farmed animals including aquaculture species and promoting species specific best management practices. 7 U.S.C §§ 8301-8322. The Virus Serum Toxin Act was enacted to ensure that pure, safe, potent, and effective biologic products are available for sale and distribution on the U.S. for use in animals. 21 U.S.C §§ 151-159. Implementing regulations: 9 C.F.R. §§ 53.10, 71.2, 71.3, 91, 93.900-906, 161-162.
[123] USDA, *Animal and Plant Health Inspection Service*, (n.d.) p. 1 available at: https://www.ars.usda.gov/SCA/Fact%20Sheets/USDA%20APHIS%20Profile%20for%20AA%2012.pdf
[124] NOAA, *Guide for Permitting*, *supra,* note 7 at 22-23.

local agencies.[125] The agency may also hold a public hearing. The final EIS incorporates all the comments received, including responses and recommendations.

If the agency issues a Finding of No Significant Impact (FONSI), the public participation process during the development of a FONSI will be subject to the action agency's discretion. Some agencies "mirror the scoping process and public comment periods that are found in the EIS process" while others "make the EA and a draft FONSI available to interested members of the public."[126] Parties with a particular interest may challenge the final EIS and FONSI in federal district court after any required administrative appeals put in place by the action agency.[127]

NPDES permits

In the rare circumstance that EPA issues the NPDES permit instead of a state or Tribal program, it will issue public notice of the draft NPDES permit under agency review and invite public comment on the draft. The agency may hold a public hearing. The agency must consider all comments submitted in making its final decision and will incorporate the responses with the final NPDES permit.[128] After a final permit is issued, a person who filed comments or participated in a public hearing on the draft permit may file a petition for review with the Environmental Appeals Board (EAB). The EAB's final decision is subject to judicial review in federal district court under the proceedings set forth in the Federal Administrative Procedure Act (APA).

USACE permits

USACE similarly invites written comments from interested parties after receiving a completed permit application and it incorporates the respective answers to the comments in the final permit. USACE may also hold a public hearing as part of the public participation process. Parties with a particularized interest (e.g., adjacent property owners) may challenge the final permit decision in federal district court.

[125] 40 C.F.R §§ 1502.19, 1506.6.
[126] Council on Environmental Quality, A Citizen's Guide to the NEPA: Having your voice heard p. 12 (2007). https://ceq.doe.gov/docs/get-involved/Citizens_Guide_Dec07.pdf.
[127] A Citizen's Guide to the NEPA: Having your voice heard p. 30 (2007). https://ceq.doe.gov/docs/get-involved/Citizens_Guide_Dec07.pdf.
[128] 40 C.F.R. § 124.17 and §124.18.

Table 3. Overview of the U.S. Federal Regulatory Framework for Land-Based Aquaculture

Regulated area	Permit/ Report Name	Impacts Addressed	Lead Agency	Permit Allows	Permit Requires	Public Partici-pation	Key Laws/ Regulations
Envtl. Assessment	EIS	Significant environmental impacts of a federal action	Lead federal agency that approves, funds, or executes a project. (e.g., EPA, USACE)	Aids in the informed decision-making of federal agencies	Identifies significant adverse environmental impacts of a project, alternatives, and mitigation measures	Notice and opport-unity to comment. Agency must respond to comments in final EIS	NEPA and Council on Environmen-tal Quality (CEQ) implementing regulations
Land use: Coastal Zone	Coastal Zone Management Act	Impacts of Federal activities to States' coastal areas	Lead federal agency that approves, funds, or executes a project	Determi-nation that the activities are consistent with States' enforceable coastal program policies	Federal Agency's consistency determination that is then reviewed by the impacted State.	Oppor-tunity to submit written comments .	Coastal Zone Management Act and implementing regulations
Habitat	Consultation	MSA: Impacts to EFH. ESA: Impacts to endangered or threatened species or designated critical habitat. FWCA: impacts to fish and wildlife resources	Lead federal agency that approves, funds, or executes a project. Consulted agencies: NOAA-NMFS and USFWS	Considera-tions of impacts of a federal action to EFH, endangered or threatened species and/or their critical habitats, and harms to fish and wildlife resources	If formal consultation required, consulted agencies issue a biological opinion with recommendations. If consultation is required under MSA, NOAA will issue an EFH assessment	N/A	Magnuson-Stevens Conservation and Management Act, ESA, Fish and Wildlife Coordination Act and implementing regulations
Water quality (effluent)	NPDES (construction and operation)	Discharge of pollutants (e.g., BOD5, TSS, total nitrogen, drugs, and pesticides).	EPA or authorized State/ Tribes	Discharges of pollutants into waters of the United States	Effluent limitations, monitoring, record-keeping, reporting, mitigation measures, and proper operation and maintenance	Public notice and comment period. Public hearing may also be held if requested	CWA and implementing regulations
Water quality (dredge & fill)	CWA Section 404 and Section 10 of Rivers and Harbors Act of 1899 permits	Discharge of dredge and fill material and construction in navigable waters	USACE or State/Tribal 404 Programs	Discharge of dredge and fill material, and construction in, over, or under navigable waters of the United States	Conditions to prevent and mitigate the project's impact to wildlife, wetlands, and land rights	Public notice and comment period. Public hearing may also be held if requested	CWA and Rivers and Harbors Act of 1899 and implementing regulations

Water quality (groundwater)	Underground Injection Control Permit	Contami-nation of underground sources of drinking water caused by aquaculture injection wells	EPA Regional Office or State/Tribal authorities	Disposal of wastewater and sludge from aquaculture operations in a waste disposal well	Recordkeeping, monitoring, and reporting	Same as for NPDES permit	Safe Drinking Water Act and implementing regulations
Air	New Source Review (NSR) Preconstruc-tion permits	Emissions of any regulated pollutants (e.g., lead, carbon monoxide, and other hazardous air pollutants)	EPA/ State local/ Tribal air pollution control agencies	Aggregate non-fugitive emissions of regulated pollutants generated by the construction of new sources	Emissions limitations that prevent the interference with National Ambient Air Quality Standards (NAAQS) or the control strategies in a SIP, TIP or FIP	Public notice of permit applic-ation and opportu-nity for public comment. Public hearing may be held if requested	CAA and implementing regulations
Toxic/hazardous chemicals	Conformance with TSCA provisions	Chemical substances used in aquaculture operations	EPA	Use of regulated chemicals in aquaculture operations	Registration in TSCA Inventory, reporting, recordkeeping, testing requirements, and worker protection standards	N/A	TSCA and implementing regulations. Occupational Safety Hazard Act
Pesticides	Pesticide registration and use, tolerance levels for fish and fishery products, and workplace protection standards	Use of pesticides in aquaculture operations	EPA	Use of registered pesticides in land-based aquaculture operations	Commercial pesticide applicator certification, use of only registered pesticides according to the label, meet worker protection standards, and comply with tolerance levels for pesticides in fish and fishery products	N/A	FIFRA. FDCA, Occupational Safety Hazard Act and regulations

Case Study: Nordic Aquafarms

Location: Belfast, Maine
Capacity: 30,000, at full capacity[1]

Belfast, Maine | Getty Images/iStockphoto

The proposed project will be developed on a 54-acre wooded site in the valley of the Little River, emptying into Penobscot Bay, entailing 196,030 square feet of permanent and temporary alterations to freshwater wetlands and 2,037 linear feet of alterations to nearby streams. The site will also require 127,000 square feet of temporary alterations to tidal waterfowl and wading bird habitat. Nordic is required by Maine DEP to contribute to the In-Lieu Fee program monetarily for the loss of wetland functioning.

The facility will withdraw 5.6 MGD seawater from Penobscot Bay through two pipes extending "approximately 6,400 linear feet into the coastal wetland." It will also require 2.1 MGD of freshwater. It will discharge 7.7 million GPD of treated wastewater into Belfast Bay that is "5° to 33° warmer than the ambient water temperatures and contains a multitude of known and unknown contaminants regardless of weather conditions."[2]

In terms of solid waste, Nordic estimates operations will produce 5,000 and 12,000 metric tons per year (mt/yr) of cut-off and fish trimmings, respectively, during the first two phases of production. The company is considering innovative sustainability options for using by-products such as use as lobster bait, composting, biogas, and biotech.[3]

Energy will be provided by the local utility, Central Maine Power Company (CMPC). While CMPC is "looking at [renewable] technology," it remains reliant on fossil fuels.[3] Nordic will install diesel generators for periods of high energy demand on the state's power grid, planned maintenance, and power outages. These generators could become notable sources of air pollution to the area. Still, an independent review of the project's potential air emissions found the operation "would not cause or contribute to a violation of applicable ambient air quality and emissions standards." Beyond the generators, the other source of air emissions is the on-site boiler, used for heating the facility. [4]

Nordic has been approved for a Maine Pollutant Discharge Elimination System Permit/Waste Discharge License,[5] Site Location of Development Act,[6] Submerged Lands Permit,[7] Chapter 115 Minor Air Emission License, [8] Land Based Aquaculture License: State of Maine Department of Agriculture, Conservation, and Forestry,[9] and municipal permits: Chapter 90 (site plan application), Chapter 102 (Zoning, use permit), and Chapter 82 (Shoreland Permit).[10]

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[1] https://www.maine.gov/dep/ftp/projects/nordic/applications/MEPDES%20Permit%20Application_Final_Oct%2019,%202018.pdf; [2] https://www.maine.gov/dep/ftp/projects/nordic/final-signed-orders/MEPDES-WDL%20signed%20order%2011-19-2020.pdf.; [3] https://www.maine.gov/dep/ftp/projects/nordic/applications/MEPDES%20Permit%20Application_Final_Oct%2019,%202018.pdf; [4] https://www.cmpco.com/wps/portal/cmp/home/!ut/p/z0/Zc5Ra8IwFIbh3-JFL-Wka93m5RBXKXZjTKXmRrJ4lh6NSU2zqP9-EQeKuzzw8nwHONTAjQikhCdrhI73kj-usrQaT_IRe3uu8iH7yLPpvCgW7HWYQgn8Nnj_LLMY5OPZJC2ytHw6Cw-uGlUKeCt80yfzbaHuREA06NTpXvg_EQXa7Pf8Bbi0xuPRQy13rVBudf01YQ2KNbqEdTvh_MVOGBljw1_Q6h8V51Gj9I5kwIakxi5hh-ZEXRTJBKsDrqHd8q-BVr1fRtVWvA!!/; [5] https://www.maine.gov/dep/ftp/projects/nordic/final-signed-orders/MEPDES-WDL%20signed%20order%2011-19-2020.pdf; [6] https://www.maine.gov/dep/ftp/projects/nordic/final-signed-orders/MEPDES-WDL%20signed%20order%2011-19-2020.pdf; [7] https://www.maine.gov/dep/ftp/projects/nordic/final-signed-orders/MEPDES-WDL%20signed%20order%2011-19-2020.pdf; [8] https://www.maine.gov/dep/ftp/projects/nordic/final-signed-orders/Air%20signed%20order%2011-19-20.pdf; [9] https://www.cityofbelfast.org/DocumentCenter/View/3030/Permit-List?bidId=; [10] https://www.cityofbelfast.org/DocumentCenter/View/3695/Draft-3---PB-FOF---Nordic-Updated---July-8-2020-Mtg?bidId=

Maine

Industrial aquaculture in Maine began in the late 1970s with the legislature's adoption of the state's first leasing law.[129] However, historical records document some form of commercial aquaculture activity in the state since the 1800s.[130] The aquaculture industry in Maine today contributes significantly to the state's economy: in 2014, aquaculture businesses generated an economic contribution of $137.6 million. Since then, the sector has experienced a steady growth.[131] By 2025, Maine's aquaculture exports are expected to net $230-$800 million.[132] Land-based fin fish aquaculture remains nascent, but there are at several permitted industrial-scale facilities in Maine, though none are yet operational.

Table 4. Proposed Aquaculture Facilities in Maine

Company	Location	Fish/year (MT)	Effluent (MGD)	Nitrogen (lbs/day)	CO2 (MT/yr.)	Technology used
Nordic Aquafarms[133]	Belfast	33,000	7.7	1,484	594,000	RAS
Whole Oceans[134]	Bucksport	20,000	18.6	7,460	360,000	RAS
American Aquafarms[135]	Frenchman Bay	33,000	4,000	2,338	594,000	FLOAT RAS
Kingfish Maine[136]	Jonesport	8,000	28.7	1,580	144,000	RAS
Aquabanq *(Permitting applications not yet submitted)*	Millinocket	10,000	N/A	N/A	180,000	RAS
Totals	–	104,000	4,055	13,082	1,870,000	–

[129] *Maine Aquaculture Roadmap 2022-2032,* Maine Sea Grant, (2022), https://seagrant.umaine.edu/wp-content/uploads/sites/467/2022/01/Maine-Aquaculture-Roadmap-2022.pdf.
[130] *Maine Aquaculture Timeline*, Maine Aquaculture Industry Innovation Center, https://www.maineaquaculture.org/industry/#:~:text=Maine%27s%20aquaculture%20industry%20dates%20back,Craig%20Brook%20on%20Alamoosook%20Lake (last visited Jan. 5, 2023).
[131] *Maine Aquaculture Roadmap 2022-2032,* Maine Sea Grant, (2022), https://seagrant.umaine.edu/wp-content/uploads/sites/467/2022/01/Maine-Aquaculture-Roadmap-2022.pdf.
[132] *Maine Aquaculture Roadmap 2022-2032,* Maine Sea Grant, (2022), https://seagrant.umaine.edu/wp-content/uploads/sites/467/2022/01/Maine-Aquaculture-Roadmap-2022.pdf.
[133] *Nordic Aquafarms General Application for Waste Discharge License (WDL) / Maine Pollutant Discharge Elimination System Permit (MPDES)* https://www.maine.gov/dep/ftp/projects/nordic/applications/MEPDES%20Permit%20Application_Final_Oct%2019,%202018.pdf.
[134] *Whole Oceans Maine Pollutant Discharge Elimination System (MEPDES) Permit #ME0037478 Maine Waste Discharge License (WDL) #W009190-6F-A-N Proposed Draft Permit* https://www.epa.gov/sites/default/files/2018-10/documents/draftme0037478permit.pdf.
[135] *American Aquafarms General Application for Waste Discharge License (WDL) / Maine Pollutant Discharge Elimination System (MEPDES) Permit*, https://www.maine.gov/dep/ftp/projects/american-aquafarms/applications/mepdes/FB01%20Long%20Porcupine%20General%20Application%20for%20Waste%20Discharge%20Permit%20with%20Attachments.pdf.
[136] *Kingfish Maine Maine Pollutant Discharge Elimination System (MEPDES) Permit #ME0037559 Maine Waste Discharge License (WDL) Application #W009238-6F-A-N Finalized MEPDES Permit* https://www3.epa.gov/region1/npdes/permits/2021/finalme0037559permit.pdf.

Environmental Impact Review

Maine does not have a requirement for environmental impact review of state actions.

State Authorizations

Land-based aquaculture in Maine is primarily regulated by two agencies: the Department of Marine Resources (DMR) (aquaculture activities in the state not located in coastal waters, importation of marine organisms) and the Department of Environmental Protection (DEP) (facility effluent discharge, site location development, impacts to marine and coastal habitats, facility air emissions).

DMR issues the Marine Aquaculture License for aquaculture activities that, like land-based aquaculture, are not located in the State's coastal waters. The permit requires facilities to issue periodic reports and allow DMR to conduct site inspections. Until 2019, this license was granted by the Department of Agriculture Conservation and Forestry and currently, DMR has not initiated rulemaking for this permit. DMR requires that any person who (1) plans to introduce or holds non-native and native species of marine organisms with the purpose of introducing them into coastal waters; or (2) holds such species in a place where direct or indirect discharges into coastal waters occurs, obtain a Permit Application for Marine Organisms. This permit ensures the control of invasive species, non-native species, and diseases in coastal waters that can be harmful to local species and habitats.

DEP or the Board of Environmental Protection (BEP) issues other authorizations required for land-based aquaculture in Maine, including:

- *Maine Pollutant Discharge Elimination System (MEPDES) /Waste Discharge License (WDL*) (in conjunction permit) – Regulates effluent discharges from the operation of a land-based facility and sets both numeric technology-based and water quality-based limitations for the effluent produced during operation. Technology-based standards are set on pollution control technologies available for each contaminant identified. es.
- *Maine Construction General Permit* – for discharges of stormwater associated with the construction of a land-based aquaculture facility.
- *Natural Resources Protection Act (NRPA) permit* – Required when the construction of the land-based facilities (including structures such as discharge pipes) will impact coastal and freshwater wetlands, which are declared as protected resources by the state.
- *Site Location Development Act (SLODA) permit* — The Site Law obligates DEP to undertake a detailed review of development that will have a substantial effect upon the environment. State policy requires DEP to consider erosion and sedimentation, surface and ground water quality, solid waste management, impact to climate (which not includes climate change) and noise in determining if a development will have an adverse environmental effect.
- *Air Emissions License* — Land-based operations must obtain this license, which establishes emissions limitations for construction of the facility and the subsequent operation (e.g., diesel fuel generators that are used continuously).

DEP also provides oversight in other areas of land-based facility operations, such as hazardous waste and solid waste management. Other state agencies that provide oversight to land-based facilities during construction and/or operation include:

- Board of Pesticides Control—pesticides used in LBA operations.
- Bureau of Parks and Lands—facility intake/outfall pipes placed in submerged or intertidal state lands.
- Department of Public Health and Safety—building and energy efficiency codes.

Maine Pollutant Discharge Elimination System (MEPDES) /Waste Discharge License (WDL) Permit:

The MEPDES/WDL permit addresses the unlawful discharge[137] of pollutants such as BOD5, TSS, thermal discharges, pH, fecal coliform, stormwater, pesticides, and drugs into state waters.[138] The discharge either by itself or in combination with other discharges cannot lower the quality of any classified water below such classification and will not lower the quality of any unclassified body of water below the classification which the DEP expects to adopt that meet the required effluent limitation standards imposed in the permit/license.

If the DEP determines that the discharge will lower the existing quality of any body of water, it can issue a permit only if following an opportunity for public participation, it finds the discharge is necessary to achieve important economic or social benefits to the State and when the discharge is in conformance with section 464 of Title 38 (Maine's water and navigation statute).[139]

According to DEP's guidance, when considering the economic and social benefit resulting from the lowering of the water quality, DEP analyzes the increases in employment, increases in local or regional income or purchasing power, increases in the community tax base, correction of an environmental or public health problem or nuisance situation, and improved community stability.[140] In the case of a lowering of water quality due to community growth, the benefits that DEP analyzes include an assessment of the economic and social consequences that would result if the new or increased discharge and the resulting lowering of water quality were not approved. Additionally, DEP analyzes the technical availability, economic feasibility, and environmental effectiveness of alternatives that could reduce or eliminate the lowering of the water quality. These alternatives may include, but are not limited to, alternative discharge locations, non-discharging alternatives, alternate methods of production, improved process controls, wastewater minimization technologies, improved wastewater treatment facility

[137] Discharge is defined as "any spilling, leaking, pumping, pouring, emptying, dumping, disposing, or other addition of any pollutants to water of the State. 38 MRSA § 361-A (1).
[138] Waters of the state are defined as " any and all surface and subsurface waters that are contained within, flow through, or under or border upon the State or any portion of the State, including marginal and high seas, except such waters as are confined and retained completely upon the property of one person and do not drain into or connect with any other waters of the State, but not excluding waters susceptible to use in interstate or foreign commerce, or whose use, degradation or destruction would affect interstate or foreign commerce. 38 MRSA § 361-A(7).
[139] 38 M.R.S.A. § 414-A (1)(C). This finding must be made following procedures established by the Board of Environmental Protection pursuant to section 464 subsection 4 parr F. 38 M.R.S.A. § 414-A (1)(C).
[140] Department of Environmental Protection, Memorandum to Board of Environmental protection regarding Nordic Aquafarms, Inc. – Application for a Maine Pollutant Discharge Elimination
System (MEPDES) Permit, https://www.maine.gov/dep/bep/2020/05-20-20/BEP%20Memo%20-%20Nordic%20Deliberative%20Session%20-%20Bureau%20of%20Water%20Quality.pdf.

operation and maintenance, alternative wastewater treatment methodologies, and advanced treatment beyond applicable technology requirements.[141]

The MEPDES/WDL permit requires effluent limitations based on the best practicable treatment, monitoring, recordkeeping, and sampling. Specific conditions applicable to land-based aquaculture facilities include: monitoring effluents of specific pollutants such as ammonia, total phosphorous and nitrogen, conducting a dye study to more accurately determine the mixing characteristics of the treated effluent discharge from the facility with the receiving water, conducting seasonal ambient water quality monitoring, developing and maintaining an operations and maintenance plan for the production facility and the wastewater treatment facility, requirements to limit the use of antibiotics, fungicides, bactericides, parasiticides and other chemical compounds and requirements for the facility to develop and maintain a containment management system to prevent escape of fish from the facility. Other specific permit conditions include compliance with disease control requirements as established in state fish health laws[142], using FDA approved drugs and implementation of containment and management systems to prevent accidental fish or consequential fish escapes from the facility.

Local Authorizations

Maine's Constitution delegates broad home rule authority to cities and towns.[143] Home rule authorizes municipalities to legislate on local matters that are not preempted by or conflict with state law. In Maine, the scope of local authority with regards to permitting land-based aquaculture facilities is limited to land use and development. This includes the siting and construction of land-based facilities. Maine's municipalities do not play a role in the permitting of other environmental impacts such as air emissions or a water quality.

Permits required by local government could encompass land use (or zoning use permits), shoreland zoning (for facilities impacting the state's shoreland),[144] site plan review permit (for major developments) and building permits. Other local permits may include the significant water intake/discharge permit, and the significant groundwater well permits, which address impacts to local surface water and ground water resources.

Planning Boards approve these permits after reviewing multiple potential impacts, including to the natural environment (including habitat of local plant and species, vegetation, air, and water pollution), property values, and enjoyment of property and public health. In issuing a final determination on the permits, the Planning Board considers the concerns raised by the public during public hearings. The Planning Board's final decision can be appealed to the Zoning Board of Appeals.

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[141] Department of Environmental Protection, Memorandum to Board of Environmental protection regarding Nordic Aquafarms, Inc. – Application for a Maine Pollutant Discharge Elimination.
System (MEPDES) Permit.
[142] 12 M.R.S.A. §§ 6071 and 12 MRSA §§ 10051, 10105, 12507, and 12509.
[143] Constitution of Maine, Article VIII, Part Second, section 1.
[144] City of Belfast Ordinances §82-1.

Public Participation and Review of Agency Decisions

There are multiple opportunities for public participation during land-based aquaculture permitting at the state and local levels.

State

The DEP or the BEP is required to give public notice of the drafts of the Site Location Development Act permit, the Air Emissions License and the MEPDES and WDL permit and provide an opportunity for public comments. Public hearings may be held if they are requested by the public.

The Bureau of Parks and Public Lands provides public notice and an opportunity to comment on final dredging lease applications and the DMR is required to hold a public hearing prior granting a license for the transfer or importation of species not previously authorized to be transferred and imported into the state. DMR also provides public notice and an opportunity to comment when issuing a Coastal Zone Consistency Determination.

Local

When reviewing a Site Plan application and after approving a Shoreland Zoning permit, the Planning Board holds a public hearing. Zoning Permits and Building Permits are reviewed during the Board's bimonthly meetings which are open to the public.

Interested parties[145] may seek administrative and judicial review of state agency permitting decisions following the review process established by the agencies.[146] At the local level, the Zoning Board of Appeals reviews the permits issued by the Planning Board.

[145] The "specific person whose legal rights, duties or privileges are being determined in the proceeding." 375 M.R.S.A. § 8002(8).
[146] *See* DEP/BEP 38 M.R.S.A. §§ 341-D(4) and 346, Bureau of Parks and Public Lands 01-670 CODE ME. REG. § 53, DMR 12 M.R.S.A. §§ 6301-6312.

Case Study: Whole Oceans Facility

Location: Bucksport, Maine
Capacity: 20,000 metric tons, at full capacity[1]

Bucksport, Maine | Joe Hardenbrook/Flickr

The proposed project will be developed over 10 years on a 103.89-acre site encompassing 21.69 acres of buildings, 31.50 acres of impervious surfaces, and 32.83 acres of developed area. The project does not require any significant removal of existing vegetation, and the facility has no plans to "propose new vegetative buffer areas along the River."[2]

At full build-out, the facility is expected to withdraw 4 million GDP of freshwater from Silver Lake, and 14.6 million GDP of saltwater, which will be sourced from the Penobscot River. The diverted water will support the RAS units as well as HVAC systems.[3] The facility will discharge a monthly average of 18.6 million gallons per day (MGD) of treated wastewater Penobscot River.[4] This is equivalent to 1.29 cubic meters of water per kilogram of fish produced. This level of water consumption designates Whole Oceans somewhere between an intensive RAS (1 m^3 per kg of fish) and low-level RAS (3m^3 per kg of fish).

The facility also expects to produce 35 mega tons per day of sludge, with an additional 25 mega tons of waste per week from salmon processing. There will be 400 mega tons of carcasses due to salmon mortality per year, and two cubic yards per week of "Universal Waste." Whole Oceans established a partnership with Agri-Cycle Energy to use generated organic waste for biofuels and electricity.

Whole Oceans intends to construct a power generation facility utilizing existing energy infrastructure and power supply lines from an adjacent Central Maine Power Co. Substation. In times where the power grid is cut off from the facility, Whole Oceans will rely on onsite diesel generators. The company plans to obtain air emissions licenses for use of diesel-powered generators.

Other sources of burning fossil fuels include boilers, systems to control temperature of RAS units, and facility buildings. The firm stated it will release an inventory of units included in an Air Emissions License when "construction design plans are further along."[5]

So far, Whole Oceans is approved for a Maine Pollutant Discharge Elimination System Permit/Waste Discharge License,[6] Site Location of Development Act,[7] Land Use Permit Application: Level 2 Review,[8] and municipal permits: Sewer and Public Works/ Entrance Permit Application.[10]

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[1] https://www.epa.gov/sites/default/files/2018-10/documents/draftme0037478permit.pdf; [2] https://www.bucksportmaine.gov/vertical/sites/%7B1700581E-144E-4C5D-B026-79CCA6D1E656%7D/uploads/2019-08-16_FINAL_12340.002_SITE_PLAN_REVIEW_APPLICATION.pdf; [3] https://www.bucksportmaine.gov/vertical/sites/%7B1700581E-144E-4C5D-B026-79CCA6D1E656%7D/uploads/2019-08-16_FINAL_12340.002_SITE_PLAN_REVIEW_APPLICATION.pdf; [4] https://www.epa.gov/sites/default/files/2018-10/documents/draftme0037478permit.pdf; [5] https://www.bucksportmaine.gov/vertical/sites/%7B1700581E-144E-4C5D-B026-79CCA6D1E656%7D/uploads/2019-08-16_FINAL_12340.002_SITE_PLAN_REVIEW_APPLICATION.pdf; [6] https://www.epa.gov/sites/default/files/2018-10/documents/draftme0037478permit.pdf; [7] https://drive.google.com/file/d/0BwX4t-nQWwo5dkNUMlE4ZmZVM1J6Si1Fek5HcE96aklTOHJF/view?resourcekey=0-XiDZzAC6Nk0Jx9LQfjOgRw; [8] https://www.bucksportmaine.gov/vertical/sites/%7B1700581E-144E-4C5D-B026-79CCA6D1E656%7D/uploads/2019-08-16_FINAL_12340.002_SITE_PLAN_REVIEW_APPLICATION.pdf; [9] https://www.bucksportmaine.gov/vertical/sites/%7B1700581E-144E-4C5D-B026-79CCA6D1E656%7D/uploads/2019-08-16_FINAL_12340.002_SITE_PLAN_REVIEW_APPLICATION.pdf

Table 5. Overview of Maine's Regulatory Framework for Land-Based Aquaculture

Regulated area	Permit/ Report Name	Impacts Addressed	Lead Agency	Level of Govt.	Permit Allows	Permit Requires	Public Participation	Key Laws/ Regulations
Land-Use (1)	SLODA Permit	Impacts to surface and ground water, wetlands, air, soil, erosion public health, and welfare, caused by construction of facility and associated infrastructure	DE/BEP	State	Development	Monitoring, sampling, and analysis of sediment, emergency response and facility closure plan, site inspections	Public notice of and comment on permit application. A hearing may be held if requested	Site Location of Development Act and implementing regulations
Land-Use (2)	Site Plan Permit	Environmental impacts of major developments	Planning Board	Local	Development	Solid waste management plan, storm water management plan, noise control measures, site inspections	Public notice of permit application and hearing	Local ordinances
Land-Use (3)	Shoreland Permit	Impacts of developments in the shoreland	Planning Board	Local	Development	Conditions to minimize impacts to water bodies, aquatic life, wildlife habitats	Public notice of permit application and hearing	Local Ordinances
Land-Use (4)	Zoning use/land use and building permits	Construction, alteration, or modification of structures	Planning Board	Local	Development	Conditions to minimize impacts of development	Planning Board meeting is advertised and open to the public for comments	Local Ordinances
Public Lands Lease	Dredging Lease	Impacts of discharge / intake pipes on state-owned submerged lands	Bureau of Parks and Public Lands	State	Dredging, filling, or erecting intake and outfall pipes on state submerged and intertidal lands.	Pay the annual rental fee determined by the Bureau, special conditions to safeguard traditional and customary public use of public resources, site inspection	Public notice of lease application and a period to submit written comments	12 M.R.S.A §§ 1801, 1802 and 1862 and implementing regulations

Coastal Zone ***See also* discussion of the Federal regulatory framework**	Coastal Zone Consistency Determin-ation	Impacts of federal activities (e.g., permitting) on State's land or water resources	DMR	State	Determin-ation that federal activity is consistent with the State's coastal program	Federal Agency's consistency determinati on that is then reviewed by the state	Public notice and comment period	38 M.R.S.A. §§ 1801-1805. Federal Coastal Zone Protection Act
Habitat	Natural Resources Protection Act (NRPA) Permit	Alteration of freshwater or coastal wetlands that impact plant habitat, aquatic habitat, freshwater, estuarine or marine fisheries, or other aquatic life	DEP/ BEP	State	Development in or in adjacent natural protected areas	Demar-cation or designation of the dredging area, spoils disposal and transport-ation route, testing dredge spoils if the disposal is to a coastal wetland. Conduct surveys, monitoring of impacted resources, sampling, and compliance monitoring and mitigation	*See* public participation process in the Site Location Development Permit. Disposal route: Permittee required to issue public notice in area adjacent to the disposal route. Public hearing held in the location of the discharge, if any	Natural Resources Protection Act (NRPA) and implement-ing regulations
Land-Based Aquaculture	Marine Organism Aquaculture License	Possession of marine organisms raised by means of aquaculture activities not located in coastal waters	DMR	State	Aquaculture of marine organisms in facilities not located in coastal waters	Periodic reports regarding aquaculture practices and the production of the facility, site inspections	N/A.	12 M.R.S.A. § 6085(1). (DMR has not initiated rulemaking for this permit)
Introduction of Marine Organisms	Transfer and/or Importation of Marine Organisms	Impacts from introduction of invasive non-native species into coastal waters	DMR	State	Any importation of indigenous or non-indigenous marine organisms to waters of the State, including facilities that produce direct or indirect discharges	Compliance with permit conditions, which include quarantine of bloodstock and adequate effluent treatment of waters used to hold organisms	Public notice and hearing when proposed introduction of a non-indigenous organism that has not been previously introduced under a prior permit	12 M.R.S.A. § 6071.
Water Consumption (1)	Significant Water Intake/	Impacts to soil, vegetation,	Plan-ning Board	Local	Placing a water intake/discha	Soil and Erosion control	*See* Shoreland	Local Ordinances

	Discharge Pipe Permit	erosion, coastal resources (e.g., fishing and recreation)			rge pipe to service 54,400 gallons/week and 36,000 gallons on any day	measures, revegetation of upland areas, inspection, monitoring	and Zoning use permits	
Water Consumption (2)	Significant Groundwater Well	Lowering of water table beyond property lines, saltwater intrusion	Plan-ning Board	Local	Placing a well to withdraw large amounts of water (75,000-216,000/day and 50,000-144,000/day) from coastal or freshwater wetlands	Monitoring, reporting, record-keeping, water extraction rates	*See Shoreland and Zoning use permits*	Local Ordinances
Water Quality (1)	MEPDES/ Water Discharge License	Discharges of pollutants (e.g., BOD5, TSS, thermal discharges, total nitrogen)	DEP/ BEP	State	Effluent discharge into waters of the state and waters of the U.S.	Effluent limitations based on the best practicable treatment, monitoring, sampling, operations, and mainten-ance plan	Public notice of permit application and an opportunity for comment. Public hearing may be held if requested	Pollution Control Act, Water Classification program and Federal Water Pollution Control Act and implement-ing regulations
Water Quality (2) / Stormwater	Maine Construction General Permit	Stormwater discharges into State waters and waters of the U.S.	DEP/ BEP	State	Direct or indirect discharges of storm water caused by construction activities associated with an LBA facility	Sampling and testing of effluents, monitoring, develop-ment of an erosion and sedimentati on control plan, and mainten-ance	N/A	Pollution Control Act, Water Classification program and the Federal Clean Water Act and implement-ing regulations
Water Quality (3)	Water Quality Certification	Discharge of pollutants to navigable waters, permitted by federal agencies and which could affect state waters	DEP/ BEP	State	Certifies that the discharge of pollutants into navigable waters complies with State water quality standards	Determinati on that that the federal permitted activities will not impair the water quality of the impacted waters within the state's borders	*See* NARPA permit	CWA Section 401, Maine Pollution Control Act
Energy Consumption	Maine Uniform Building and Energy Code	Construction and operation of LBA facilities	Code Enforce-ment Office (Local)	State, Local	Construction of LBA facilities	Construction and energy efficiency require-ments	N/A	38 MRSA § 9722

			and Department of Public Safety (State)					
Air	Air Emissions License	Pollutants emitted during both construction and operation (e.g., diesel generator)	DEP/ BEP	State	Construction and operation of LBA facility[147]	Emissions control at a level considered by DEP to be Best Practical Treatment, monitoring, record-keeping, operation, and maintenance requirements	Public notice of intent to file application and public notice of draft license and period for comments. Public hearings may be held within proposed project region	38 M.R.S.A. §§ 344 and 590 and implementing regulations
Greenhouse Gases	Regional Greenhouse Gas Initiative (RGGI) (ME, NH, NJ, NY, MD, MA, RI, and VT)	GHG emissions	DEP/ BEP	State	Electric generation	Mandatory participation in carbon dioxide cap-and-trade program. Fossil fuel plants with capacity greater than 25 megawatts to obtain allowance for each ton of carbon dioxide emitted per year	N/A	38 MRSA § 576-A and implementing regulations
Solid Waste	Site Law (Under the SLODA permit)	Adverse effects from wastes produced during construction (e.g., debris and dredge spoils) and operation (e.g., salmon processing solids and grease)	DEP/ BEP	State	Disposal of solid wastes produced by a LBA facility in a manner that does not interfere with the natural environment, public health, and welfare	Construction: Mark area where spoil will be discharged, notice to local fishermen of dredging operations. Operation: Solid waste management plan, groundwater monitoring site inspection,	*See* SLODA permit	Site Law and implementing regulations.

[147] 06-096-100 CODE ME. REG. §125.

						emergency response and facility closure plan		
Toxic/ Hazardous Chemicals	Hazardous waste program	Impacts from hazardous waste use and produced in aquaculture operations (e.g., pesticides)	DEP	State	Disposal of hazardous wastes from LBA facilities	Obtain hazardous waste identifi-cation number, hazardous waste transporter license or use licensed transporter, disposal in licensed hazardous waste facilities, adequate waste packaging and labeling, fill hazardous waste manifest form, report discharges	N/A	Waste manage-ment provisions 38 M.R.S.A. §§ 1301-1319-Y and 38 M.R.S.A §§ 1601-1614
Pesticides	Control of pesticides used in aquaculture operations	Impacts of pesticides used in LBA operations	Board of Pesti-cides Control	State	Use, purchase, distribution, and possession of restricted use pesticides	Registration of all pesticides distributed within the State, Board Certification as a pesticide applicator, proper use, storage and disposal, record-keeping, monitoring, reporting	N/A	Maine Pesticide Control Act of 1975, Maine Board of Pesticides Control Law and implement-ing regs *See also* Federal section
Noise	Site Law (under SLODA permit)	Noise from construction and operation	DEP/ BEP	State, Local	Construction and operations of LBA facilities	Limitations in the hourly equivalent sound level (construct-ion and operation) according to limits established in DEP rules and local zoning ordinances	*See* SLODA permit	Site Law and Local Ordinances

Case Study: Kingfish Maine

Jonesport, Maine | Copyright: Dean Tyler Photography

Location: Jonesport, Maine
Capacity: 6,000 - 8,000 metric tons, at full capacity[1]

Producing Yellowtail Kingfish, the proposed project will occupy a 93-acre parcel of land, resulting in 28.1 acres of developed area and 21.9 acres of impervious surfaces. Construction would adversely impact 7,136 square feet of coastal wetlands and 261,196 square feet of freshwater wetlands.[2] Kingfish Maine must pay a fee to compensate for the unavoidable impacts to wetlands. The facility will also impact 37,230 square feet of essential fish habitat, an effect the District Engineer ruled as insubstantial.[3]

The facility will withdraw water through two intake pipes sited in Chandler Bay and from onsite wells. Anticipated to use 43,200 GPD, equivalent to .0006 m^3/h, the facility is firmly within the parameters for super intensive RAS, using only 0.007m^3 per kilogram of fish produced annually. The facility has received a permit to discharge up to 28.7 million gallons per day (MGD) of treated wastewater to Chandler Bay.

At full capacity, the facility is expected to produce 183 tons of general solid waste annually, disposed at the Penobscot Energy Recovery Company. The facility will generate an additional 25 tons/day of waste from process water that will be disposed of at Juniper Ridge Landfill. Daily generation of fish processing byproducts is anticipated at 5 tons, which will be disposed at the Coast of Maine compost facility.[4]

Kingfish's website claims the "operation runs on 100% renewable energy, sourced from wind, solar and biogas."[5] However this refers to the Kingfish Company's facility in the Netherlands. The energy supply for the facility in Maine has not yet been identified. The facility in Maine plans to install six 2,500 kW emergency generators, and Kingfish has obtained air emissions license from the Department accordingly.[6]

Kingfish is approved for a Maine Pollutant Discharge Elimination System Permit/Waste Discharge License,[7] Site Location of Development Act and Natural Resources Protection Act,[8] Chapter 115 Minor Air Emission License,[9] and Land Based Aquaculture License.[10]

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[1]https://www.maine.gov/dep/ftp/projects/kingfish/applications/SITE/Kingfish%20Maine,%20Inc.%20L28995anbncndnen%20Order.pdf; [2] https://www.maine.gov/dep/ftp/projects/kingfish/applications/SITE/Kingfish%20Maine,%20Inc.%20L28995anbncndnen%20Order.pdf; [3] https://www.nae.usace.army.mil/Portals/74/docs/regulatory/PublicNotices/2021/NAE-2020-01651-PN.pdf; [4] https://www.maine.gov/dep/ftp/projects/kingfish/applications/SITE/Kingfish%20Maine,%20Inc.%20L28995anbncndnen%20Order.pdf; [5] https://www.kingfish-maine.com/about; [6] https://www.maine.gov/dep/ftp/AIR/licenses/ch115/A1157AN.pdf; [7] https://www.maine.gov/dep/ftp/projects/kingfish/ME0037559_2021%20FINAL%20with%20attachments.pdf; [8] https://www.maine.gov/dep/ftp/projects/kingfish/applications/SITE/Kingfish%20Maine,%20Inc.%20L28995anbncndnen%20Order.pdf; [9] https://www.maine.gov/dep/ftp/AIR/licenses/ch115/A1157AN.pdf; [10] https://www.maine.gov/dep/projects/kingfish/index.html

California

Industrial-scale finfish aquaculture is a new arrival in California, a state recognized for adopting a stringent and extensive environmental protection framework. One industrial-scale RAS yellowtail facility, Nordic Aquafarms California, LLC, is currently proposed to be constructed in Humboldt County, and is setting the stage for establishing how environmental protections and sustainability requirements will apply to later proposed RAS operations.

Siting approval and environmental review

Local governments have primary authority over land use decisions, including whether to approve the siting and building of a proposed land-based aquaculture facility.

A Conditional Use Permit (CUP) is generally required to develop a site with a RAS facility and associated infrastructure, even if aquaculture is a permitted land use in that zone. The county or city with land use authority over the proposed site issues the CUP and any needed building permits.

Aquaculture facilities often are sited within the coastal zone. Developments within the coastal zone must obtain a Coastal Development Permit (CDP) under the California Coastal Act. Counties and cities with a certified local coastal program (LCP) make determinations on issuing CDPs, subject to appeal to the California Coastal Commission (CCC). The governing body will approve a CDP for facilities that conform with the LCP and the statute's public access and public recreation policies. The CCC, an independent, quasi-judicial state agency overseeing the use of and planning for land and water in the coastal zone, separately issues permits for developments or activities, such as outfall pipes, proposed for tidelands, submerged lands, or on public trust lands.

Prior to issuing the CUP and CDP, the county or city carries out an environmental review as the designated lead agency principally responsible for approving the project. The California Environmental Quality Act (CEQA) and the CEQA Guidelines govern the environmental review process in California and are recognized for their detailed and robust requirements. The lead agency consults with other agencies responsible for approving the project and trustee agencies with jurisdiction over potentially impacted natural resources. The regional water quality control board and the Department of Fish and Wildlife are key responsible and trustee agencies, respectively, for CEQA review of RAS facilities. The lead agency determines whether an activity could potentially have a significant effect on the environment, including cumulative impacts, and adopts any necessary mitigation measures prior to certifying the environmental document.

State permits

Land-based aquaculture in California is regulated primarily by the Department of Fish and Wildlife (DFW) (registration, importation, and incidental take) and the Regional Water Quality Control Boards (RWQCB) (effluent discharge).

DFW registers aquaculture facilities, issues importation permits for live fish, shellfish, and aquatic plants, and takes action to detect and address disease in aquaculture facilities. DFW also issues incidental take

permits (ITP) for endangered and threatened species that could be adversely impacted. This includes potential impingement or entrainment of aquatic species in water intake pipes.

The nine RWQCBs, located in the major watersheds, prepare basin plans and regulate discharges to the waters of the state under State Water Resource Control Board (SWRCBP) oversight. The RWQCBs issue National Pollution Discharge Elimination System (NPDES) permits for discharges to waters of the United States and California. A permit for discharges from a land-based aquaculture facility generally will require discharge and technology-based effluent limitations and a Monitoring and Reporting Program (MRP). Receiving water bodies listed as impaired under Clean Water Action (CWA) § 303(d) trigger Total Maximum Daily Loads ("TMDLs," or the maximum amount of a pollutant permitted to enter a waterbody in order to meet the applicable water quality standards) and obligations pertaining to disinfection authorized drugs for fish treatment, best management practices, materials storage, structure maintenance, recordkeeping, training, pollution minimization, and sludge handling and disposal.

Public Participation

California law mandates opportunities for the public to provide input at several junctures and establishes processes for appealing final agency decisions.

If a project does not qualify for an exemption under CEQA, the Lead Agency carries out an Initial Study to determine whether it should prepare an *Environmental Impact Report* (EIR), *Mitigated Negative Declaration* (MND), or *Negative Declaration* (ND), or to rely on an EIR/ND prepared previously. An EIR determines whether an activity could potentially have a significant effect on the environment, discusses all significant effects the proposed project may have on the environment, including cumulative impacts, lists feasible alternatives, and proposes methods for minimizing or altogether avoiding those effects. CEQA intends agencies to consider the environmental impacts treated in these documents to inform their decisions as well as hold themselves accountable to the wider public by justifying their ultimate action. An LBA facility will likely require preparation of an EIR. As an example, the two lead agencies responsible for approving Nordic Aquafarms' CUP and CDP, Humboldt County Planning and Building Department and the California Coastal Commission, initially drafted a MND and decided to prepare an EIR after receiving a substantial number of comments expressing concerns related to energy usage, effluent discharge and related monitoring, transportation and traffic, alternative fish species, and potential biological impacts related to the water intake.

Lead agencies must solicit public comments on the draft environmental impact report (EIR) and provide a written response to every public comment that raises significant environmental issues, as well as to comments supplied by any public agency. The final EIR incorporates the comments and recommendations. Persons who can identify either a beneficial or public interest may challenge in superior court the lead agency's decision on grounds of noncompliance with CEQA.

Public notification and hearing requirements apply also to CUPs and CDPs, which are appealable from the planning body to the city council or board of supervisors. A CDP is ultimately appealable to the California

Coastal Commission. The RWQCB similarly must disseminate public notice of applications for waste discharge permits, open a public comment period, and make a public hearing opportunity available.

Notable practices

Special considerations include statewide policy to reduce greenhouse gas emissions, incorporation of environmental justice into land use planning, robust worker protection, and energy efficiency standards.

Major sources, including industrial facilities, are those that emit more than 10,000 MT CO_2e and must report their GHG emissions under California's Regulation for the Mandatory Reporting of Greenhouse Gas Emissions (MRR). The state's Cap-and-Trade Program applies to major GHG-emitting sources and large stationary sources that emit more than 25,000 metric tons of CO_2e. Land-based aquaculture facilities will rarely be regulated as a major source under either the Mandatory Reporting of Greenhouse Gas Emissions (MRR) Regulation or the state Cap-and-Trade Program, if Nordic Aquafarms is a representative example. The facility's projected constructions emissions (13,706.1 MT CO_2e total or 458.67 MT CO_2e annually) and operational emissions (4,098.23 MT CO_2e annually) do not meet the threshold for mandatory state reporting nor for inclusion in California's cap-and-trade program.[148]

California policy will substantially mitigate greenhouse gas emissions generated by land-based facilities, especially those operational after 2030. This is due to the Renewable Portfolio Standards (RPS) requirement that 60% of all energy procured by local publicly owned electric utilities and retail sellers derive from zero-carbon or renewable sources by 2030, with a set policy of achieving 100% by 2045. Mobile emissions generated by employee commutes and delivery/supply trucks associated with RAS facilities will also be mitigated. The California Air Resources Board (CARB) recently approved the Advanced Clean Cars II Regulations, which would effectively ban sales of gasoline vehicles in the state by 2035. The regulations require 100% of passenger cars and light-duty trucks sold in California produce zero emissions by 2035, with increasing interim targets starting at 35% in 2026.

[148] Draft EIR, at 3.7-8.

Table 6. Overview of California's Regulatory Framework for Land-Based Aquaculture

Regulated area	Permit/ Report	Impacts Addressed	Lead Agency	Level of Govt.	Permit Allows	Permit Requires	Public Partici-pation	Key Laws/ Regulations
Envtl. Assessment	EIR, MND, ND	Significant effects on the environment	Agency responsible for carrying out/approving project	State, local	Certification to approve project	Analysis of potential impacts, alterna-tives, mitigation measures	Notice, comment, response to comments raising significant issues	CEQA, CEQA Guidelines
Envtl. Justice	Consider-ation when issuing CDP; General Plan element	Impacts on disadvantaged communities	CCC, counties/ cities with LCP	State, local	Incorpor-ation of equity into land use planning and decisions	Consider EJ in issuing CDP, include EJ element in General Plan	Same require-ments as for issuing CDP, General Plan adoption	California Coastal Act, Govern-ment Code
Land use: General	Conditional Use Permit	Consistency with zoning	County, city	Local	Develop-ment	Conditions to minimize adverse impacts	Public notifica-tion and hearing	Govern-ment Code
Land use: Coastal Zone	Coastal Develop-ment Permit	Public access, recreational use, marine environment (including water quality), environment-ally sensitive habitat, agricultural and timberlands, archeological and paleonto-logical resources	County, Harbor, and Special Districts with certified LCP or PMP; CCC (in some circum-stances)	Local, state	Develop-ment within coastal zone	Conditions, conformity with LCP or PMP, conformity with public access, public recreation policy	Notice, comment	California Coastal Act
Habitat	Conform-ance with statutory provisions	Endangered/ threatened species, impingement/ entrainment	DFW, CCC, SWRCB	State	Develop-ment subject to mitigation measures	Avoid impacts detrimental to native wildlife, significant degradation	N/A	California Coastal Act, Fish and Game Code (including California Endangered Species Act), California Ocean Plan, California Thermal Plan
Disease control	Importation Permit	Pathogen transmission	DFW, Aquaculture Disease Committee	State	Importation of eggs, live fish	Inspection, health certificate, quarantine	N/A	Fish and Game Code
Invasive species	Blanket prohibition *or* approval to import	Escape	DFW, Fish and Game Commission	State	Importation and cultivation	No release	N/A	Fish and Game Code

Water consump-tion	WSA, will-serve letter	Water supply availability	City, County, public water system	Local	Consider-ation of impacts as part of CEQA review	Confirm-ation system can meet projected water demand	N/A	Water Code (Senate Bill 610)
Water quality	NPDES, CWA § 401 certification, stormwater permit (construc-tion and operation)	Contami-nants (ammonia, salinity, temper-ature)	SWRCB, RWQCBs	State	Effluent discharge to Water of the United States, Waters of the State. Runoff	Discharge and effluent limitations, monitoring, sampling, reporting	Notice, comment, and hearing	Water Code (Porter-Cologne Water Quality Control Act), California Coastal Act
Energy consump-tion	Building Energy Efficiency Standards	Energy efficiency, GHGs	CEC, City, County	State (adopts standards) local (ensure developers comply)	Building permit approval	Comply with energy efficiency measures	Notice, comment, and hearing (adoption of standards)	California Code of Regulations
Air	Stationary source permit (exemption may apply for emergency standby generators)	NAAQS and CAAQS (NOx) associated with generators	Air pollution control agencies	State	Installation and use of generators	Comply with standards (e.g., maximum annual hours of operation)	*See Federal Regula-tory Frame-work section*	Federal Clean Air Act, California Air Pollution Control District rules
Greenhouse Gases	RPS, MRR, Cap-and-Trade Program	Emissions	PUC, CARB, local public utilities	State	Procure and sell electricity, emissions	60% renewable/ zero-carbon source by 2030; 100% goal by 2045. Report GHG emissions (10,000 CO_2e), coverage under Cap-and-Trade (25,000 CO_2e)	Notice, comment, public work-shops	California Global Warming Solutions Act of 2006 (AB 32). The 100 Percent Clean Energy Act of 2018 (Senate Bill 100). Regulation for the Mandatory Reporting of Greenhouse Gas Emissions (MRR)
Solid waste	Statewide diversion target	Construction debris, aquaculture byproducts	CalRecycle	State	N/A	Reduce organic waste disposal from 2014 levels by 50% by 2020 and 75% by 2025	N/A	California Integrated Waste Manage-ment Act (CIWMA)

Hazardous materials	*See Federal Regulatory Framework section*	Hazardous materials and chemicals for wastewater treatment, fish processing, operations	DTSC, Cal/OSHA	State	Handling of hazardous materials	*See Federal Regulatory Framework section.* Provide warnings on certain chemicals	N/A	Hazardous Waste Control Law, Labor Code, California Occupational Safety and Health Act, HazCom Regulation, Safety Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65)
Pesticides	Worker protection standards	Worker safety, water quality and habitat protection	DPR, County Commissioner of Agriculture	State	Application of pesticides	Worker safety measures (warnings, PPE, training, medical care)	N/A.	Food and Agriculture Code, California Code of Regulations
Noise	Noise compatibility standards	Ventilation units and backup generators; harassment to marine mammals	County, city	Local	Facility construc-tion, operation	Limitations and conditions (noise level, day/time)	Public hearing for excep-tions	General Plan Noise Element, Municipal Code/Noise Ordinance

Florida

Florida's long coastline—8,436 statute miles—makes the state attractive for offshore aquaculture.[149] Indeed, the state's aquaculture industry ranks ninth nationally in annual farm gate sales as of 2018.[150] The state is home to approximately 1,000 certified aquaculture farms, producing roughly 1,500 varieties of marine species.[151] The food fish sector, however, is comparatively small, and introduction of land-based aquaculture is recent, with no specific reference made in Florida's Aquaculture Policy Act.[152] The state's only land-based aquaculture facility in operation, as of time of publication, is Atlantic Sapphire. The facility produces salmon and has stated an ambitious goal to meet 41% of current U.S. annual salmon consumption by 2031.[153]

Local Government Role: Land Use and Environmental Review

City and county governments make land use decisions, including whether to approve the siting and building of a proposed land-based aquaculture facility. Project proponents must obtain a Special Exception Permit where the proposed use is not consistent with the designated land use, but still generally compatible with the other uses permitted in the applicable zone. While the state Department of Environmental Protection oversees permitting of air pollution sources, six district offices and a number of local air programs process applications for air general permits and both construction and operating permits. Eight counties are approved to lead monitoring, compliance, and enforcement efforts in their jurisdictions; six may issue permits to most types of air pollution sources.[154] This includes Miami-Dade County, where Atlantic Sapphire is located.[155]

State Role: Water Quality and Supply, Air Quality, and Energy Efficiency

Three state agencies regulate key environmental impacts associated with land-based aquaculture:

- **Department of Environmental Protection (FDEP):** is charged with oversight of water quality permitting, including effluent discharge and injection of water into underground wells. FDEP issues NPDES permits for discharges into the waters of the U.S. and the state.[156] A permit for discharges from a land-based aquaculture facility generally requires discharge and technology-based effluent limitations, discharge, and monitoring reports. Discharges into underground wells require an underground injection control permit. FDEP also oversees air emissions permitting, though the agency delegates certain programs to eight counties.

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[149] *Shoreline Mileage of the United States*, NOAA Office for Coastal Management, https://coast.noaa.gov/data/docs/states/shorelines.pdf (last visited Nov. 20, 2022).
[150] *Florida Aquaculture Industry Overview*, FDACS, https://www.fdacs.gov/content/download/91723/file/FDACS-P-02145-2020FLAquacultureIndustryOverview.pdf (last visited Nov. 15, 2022).
[151] *Shoreline Mileage of the United States, NOAA Office for Coastal Management, https://coast.noaa.gov/data/docs/states/shorelines.pdf (last visited Nov. 20, 2022).*
[152] *See* Florida Statutes, Title XXXV, Chapter 597.
[153] Dan Gibson, *The Salmon You Buy in the Future May be Farmed on Land*, BBC, Apr. 26, 2021, https://www.bbc.com/news/business-56829129.
[154] *Local Air Program Contacts*, Florida Department of Environmental Protection, https://floridadep.gov/air/air-director/content/local-program-air-contacts (last visited Nov. 20, 2022).
[155] *Air Quality Protection*, Miami-Dade County, https://www.miamidade.gov/environment/air-quality.asp (last visited Nov. 20, 2022).
[156] *See Federal Regulatory Framework Section.*

- **Fish and Wildlife Conservation Commission (FWC) and the regional Water Management Districts (WMD):** lead efforts on water use and disease control. FWC leads the state's programs for imperiled and imported species, operating under federal legislation and regulation, and working in conjunction with the Department of Agriculture and Consumer Services. FWC monitors species entering the state to prevent the risk of dangerous pathogens. The five WMDs oversee and enforce various water-related permits. One such permit, the groundwater use permit, authorizes land-based aquaculture facilities to draw fresh water from aquifers.[157] This is key, as Florida's natural waters are salt water, and the salmon being cultivated at Atlantic Sapphire are grown in fresh and salt water.
- **Department of Agriculture and Consumer Services (FDACS):** regulates pesticides, disease control, and energy consumption. FDACS ensures that agricultural products and pesticides comply with health regulations and safety standards. This includes overseeing aquaculture operations. The Division of Aquaculture oversees the Aquaculture Certificate of Registration (required to engage in commercial aquaculture in the state), establishes the Aquaculture Best Management Practices,[158] promotes aquaculture development, and ensures safety. FDACS has also developed the Efficiency and Renewable Improvements in Commercial Aquaculture (ERICA), which provides grant reimbursement for technologies that significantly increase energy efficiency and renewable energy for eligible commercial aquaculture facilities and farms located in Florida. This program was created to increase energy efficiency, reduce energy usage, and lower operating costs at commercial aquaculture facilities in Florida.[159]

Water Resources Best Management Practices for RAS facilities:[160]

- Design the system for no direct off-site discharge of production water. Effluents must be treated and retained on site or discharged to a permitted sanitary sewer system. Treatment techniques include, but are not limited to percolation ponds, irrigation systems for filter strips. These techniques may be utilized individually or in combination with other approved treatment methods. Please note that discharging production water to a sanitary sewer system will require authorization/permitting from the local municipal wastewater treatment plant authority.
- Design a waste treatment system to accommodate the semi solid waste stream and non-recycled production effluent from filters and solids separators. Dispose of waste solids in a legal manner that will not cause environmental degradation. Potential options for solids treatment and disposal include composting followed by appropriate land application as a soil amendment or disposal at a sanitary landfill.

[157] *See* Florida Statutes Title XXVIII, Chapter 373; Water Use Individual Permit, South Florida Water Management District, Permit No. 13-06295-W Atlantic Sapphire (Dec. 1, 2019).
[158] The BMPs were established by FDACS trough the Florida Aquaculture Policy Act, Title XXV, Chapter 597 of the Florida Statutes. All aquaculture facilities Aquaculture Certificate of Registration must abide by the Aquaculture BMPs appropriate for the size, production, system design, location and species for their farm. Florida Department of Agriculture and Consumer Services, Division of Aquaculture, Aquaculture Certificate of Registration https://www.fdacs.gov/Agriculture-Industry/Aquaculture/Aquaculture-Certificate-of-Registration.
[159] Florida Department of Agriculture and Consumer Services, Office of Energy Annual Report (2019), https://www.fdacs.gov/ezs3download/download/90056/2572665/Media/Files/Energy-Files/2019-OOE-Annual-Report.pdf.
[160] Florida Department of Agriculture and Consumer Services, Aquaculture Best Practices Manual 2022, at 7 https://www.fdacs.gov/content/download/64045/file/aquaculture-bmp-manual.pdf.

Public Participation

Florida law obligates state and local agencies to solicit public input when approving the NPDES, underground injection control, land-use and zoning, Environmental Resource, and air emissions permits.

For example, FDEP must solicit public comments for draft permits for Class V Underground Injection Control Permits, and any interested person may request a public meeting. The FDEP shall consider the comments and hold a public meeting after public notice whenever a significant degree of public interest in a draft permit is expressed. It can also hold a public meeting whenever it might clarify one or more issues involved in the permit decision.

The public may also participate in local land use decisions. Most municipal codes allow aggrieved persons—those who suffer an adverse effect because of a city council decision—who oppose special exemptions to land use changes to seek a review of a decision if they had opposed the exception at a public hearing.

Notable Practices

Florida developed state best management practices for aquaculture to ensure that aquaculture operations withing the state have minimal environmental impact. However, the effectiveness the best management practices and their enforcement in the context of RAS in the state has yet to be ascertained.

On the other hand, greenhouse gas mitigation remains a significant gap in Florida's regulatory framework, following the state's repeal of its greenhouse gas reduction and cap-and-trade program, initially adopted in 2008 and 2012, respectively. Indirect mitigation is possible through FDACS, which oversees an incentive program providing grant reimbursement for technologies that increase energy efficiency and renewable energy for commercial aquaculture facilities and farms. The state's lack of an environmental review regime is also notable.

Table 7. Overview of Florida's Regulatory Framework for Land-Based Aquaculture

Regulated area	Permit/ Report	Impacts Addressed	Lead Agency	Level of Govt.	Instrument Allows/Intends	Permit Requires	Public Participation	Key Laws / Regulations
Envtl. Justice	Consideration in public participation for brownfield management programs	Health impacts on disadvantaged communities	N/A	State	Consideration of equity in brownfield redevelopment	N/A	N/A	Florida Administrative Code
Land use	Special Exception Permit	Consistency with underlying zoning requirements	County, city	Local	Development and use of premises	Conditions to minimize "unreasonable disruption" to nearby landowners	Public notification and hearing; aggrieved persons to seek a review of a decision	Municipal Codes
Registration	Aquaculture Certificate of Registration	Raising aquatic species for commercial sale	Florida Department of Agriculture and Consumer Services	State	Authorizes the production, harvest, and sale of aquaculture products. Aquaculture activities considered agriculture and benefit from the same state programs as other agricultural producers	Abide by the Aquaculture BMPs, facility inspections. Certificate renewed yearly	N/A	Title XXXV, Chapter 597 of the Florida Statutes and implementing regulations
Invasive species	Importation of non-native species	Escape from facility into natural habitat with adverse impacts to native species (e.g., cross-breeding, competition for resources)	Florida Fish and Wildlife Conservation Committee	State	Importation and possession of non-native eggs, live fish, and their taxonomic successors or subspecies for business	Safe, proper, and secure enclosure of eggs and live fish.	N/A	FAC 68-5
Water consumption	Water Use Individual Permit	Pumping and use of groundwater	Regional Water Management District	Regional	Extraction of groundwater at annual and monthly maximums	Compliance with the permit, and no withdrawals over the allocated quantity	N/A	Florida Statutes Title XXVIII, Chapter 373, Part II; FAC 40E-1.603 and 40E-2

Water quality	ERP, NPDES, Class V dewatering and under-ground injection control permits	Contami-nants such as metals, nitrates, sodium; state water quality and flow	FDEP, District, County	State/ county	Effluent discharge to WOTUS, state waters, alteration to surface waters, injection into waters	Discharge and effluent limitations, monitoring, sampling, reporting	Notice, comment, and hearing	Florida Statutes, Chapters 120; 253, 258; 373; 403. FAC 62-330; 62-340; 62-528; 403; Code of Miami Dade County, 24-44 (among other counties)
Energy consump-tion	Efficiency and Renewable Improve-ments in Commercial Aquaculture	Energy efficiency, lower operating costs	FDACS	State	Grant reimbursement	Technology must increase energy efficiency	N/A	2019 Office of Energy Annual Report, Florida Aquaculture Plan 2021
Air	Air general permit, air construction permit, air operations permit	Emissions of air pollution from construct-ion and operation	FDEP	State, District, Local	Air emissions from stationary sources	Comply with standards	*See* discussion of the Federal Regulatory Framework	Federal Clean Air Act, FAC 62
Green-house Gases	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Solid waste	Aquaculture waste, state recycling goals	Introduction of aquatic nuisance species	FDEP	District	Aquaculture operations	Recycling 75% of solid waste	N/A	RCRA, FAC 62 and Florida Statute Chapter 403
Hazardous materials	*See* discussion of the Federal Regulatory Framework	Hazardous materials and chemicals from operation and construction of land-based aquaculture facilities	FDEP	State	Handling of hazardous materials	*See* discussion of the Federal Regulatory Framework Authori-zation to operate or build a facility	N/A	FAC 62-730
Pesticides	Worker protection standards, impacts on the environ-ment	Worker safety, water quality, and environ-mental protection	FDACS	State	Distribution, sale, and use of pesticides	Worker access to information about materials they are working with, no harmful disposal of pesticides	N/A	Worker Protection Standard, FIFRA, Florida Pesticide Law, Florida Agricultural Worker Safety Act
Noise	Noise ordinance	Un-reasonably loud, excessive, un-necessary, or unusual noise	County, city	Local	Facility construction, power tools	Limitations on time of day	N/A	Municipal Code/Noise Ordinance

Case Study: Atlantic Sapphire

Miami, Florida | Art Wager/iStock

Location: Miami, Florida
Capacity: 9,500 tons

Located in Miami, Florida, Norwegian-based corporation Atlantic Sapphire operates Florida's land-based RAS aquaculture facility, producing salmon claiming to recycle up to 99% of the water used in the production.[1] Given the Florida heat, and salmon's preference for cool water, the state may seem an unusual choice for an operation on such a large scale. The company attributes the decision to base its U.S. facility in Florida to the accessibility of two groundwater aquifers—one saltwater, and one freshwater—which allow the facility to provide the salmon with the water they need.[2] Facility construction on the facility began in 2017, following the issuance of NPDES permits, and it has been operational since 2020. In addition to locally issued permits authorizing Atlantic Sapphire to extract water from these aquifers, the facility is also permitted by FDEP to inject its wastewater into the ground below the two aquifers.[3] FDEP also granted the facility air permits to operate on-site generators, and issued it a dewatering permit, necessary for construction of electrical lines that were needed to reach the facility.

The facility has faced multiple stumbling blocks since it began operations. In July 2020, identified risk of a massive mortality event prompted Atlantic Sapphire to harvest 200,000 fish before they reached maturity.[4] In March 2021, the company reported a problem with its filtration system that impacted the water in the tanks. This caused abnormal fish behavior, including gathering at the bottom of the tanks and blocking the flow of new water, which resulted in mortalities.[5] A gas release the subsequent month resulted in the hospitalization of three workers. The cause of the leak was not identified.[6] The company reported more mortality events in October 2023 and revised its revenue expectations.[7] Despite these setbacks, the company hopes to meet its stated goal of producing sufficient salmon to meet 41% of current U.S. annual salmon consumption by 2031.[8]

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[1] Dan Gibson, *The Salmon You Buy in the Future May be Farmed on Land*, BBC, Apr. 26, 2021, https://www.bbc.com/news/business-56829129.
[2] *Id.*
[3] Class V Underground Injection Well Permit, Florida Department of Environmental Protection, Permit No. 034483-002-UO/5X (May 20, 2022).
[4] Dan Gibson, *The Salmon You Buy in the Future May be Farmed on Land*, BBC, Apr. 26, 2021, https://www.bbc.com/news/business-56829129.
[5] Press Release, Atlantic Sapphire, Atlantic Sapphire ASA: Incident in Atlantic Sapphire's US facility (Mar. 23, 2021), https://newsweb.oslobors.no/message/528571.
[6] Dan Gibson, *The Salmon You Buy in the Future May be Farmed on Land*, BBC, Apr. 26, 2021, https://www.bbc.com/news/business-56829129.
[7] Chris Chase, *Atlantic Sapphire Expects Delays, But Hasn't Stopped Production of Second Phase of RAS Expansion*, SEAFOOD SOURCE, Oct. 19, 2022, https://www.seafoodsource.com/news/business-finance/atlantic-sapphire-reportedly-delaying-phase-2-development-after-revenue-shortfalls.
[8] Dan Gibson, *The Salmon You Buy in the Future May be Farmed on Land*, BBC, Apr. 26, 2021, https://www.bbc.com/news/business-56829129.

Wisconsin

Finfish aquaculture in Wisconsin, or "fish farming" as it is commonly known in the state, has existed since 1856.[161] Notwithstanding, the aquaculture industry in Wisconsin is relatively small compared to other states in the Atlantic and Pacific regions of the United States.[162] For example, in 2019, most commercial aquaculture farms in the state were small operations that produced less than 20,000 pounds of finfish. [163]

> **Fish farm is defined as "a facility at which a person hatches fish eggs or rears fish for the purpose of introduction into the waters of the state, human or animal consumption, permitting fishing, use as bait or fertilizer, or any other purpose specified by the [DATCP]"**
>
> Wis. Stat. § 95.001(1)(aj).

Pond aquaculture is the most common form of land-based aquaculture in Wisconsin, followed by flowthrough systems and aquaponics.[164] There are only a few RAS farms in the state, making it the least common land-based aquaculture method.[165] The largest commercial RAS farm is Superior Fresh, LLC, located in the Village of Hixton. Superior Fresh is featured on p. 110.

State Authorizations

The Department of Agriculture, Trade and Consumer Protection (DATCP) and the Department of Natural Resources (DNR) are the primary regulators of land-based aquaculture in Wisconsin.

DATCP's primary role is ensuring that fish farmed in the state meet determined health standards developed to prevent infectious disease, in particular viral hemorrhagic septicemia (VHS), discharged to the state's natural water bodies.

DATCP maintains a registry of fin-fish aquaculture farms. Commercial land-based fin-fish aquaculture farms must register as either a Type 2 farm (for farms that distribute or sell live fish or fish eggs) or Type 3 (if the farm obtains its live fish or fish eggs from a wild source of species susceptible to VHS and intends to sell or distribute any live fish or fish eggs). Fish farms must renew their registration on an annual basis.

For a land-based aquaculture farm to be registered:

- DATCP first issues a **fish health certificate** stating that the fish in the farm are free from contagious and infectious diseases, including VHS and whirling disease if the farmed fish are salmonoids. Fish health certificates are renewed annually.
- Farms must also obtain a **livestock premises registration** intended to track where an animal disease originated in case of an outbreak.

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[161] University of Wisconsin at Stevens Point, *What is Wisconsin Aquaculture,* (n.d). Available at: https://www3.uwsp.edu/cols-ap/nadf/Pages/What-is-WI-Aquaculture.aspx.

[162] NOAA, Fisheries of the United States (2020) https://www.fisheries.noaa.gov/national/sustainable-fisheries/fisheries-united-states.

[163] Shiyu Yang, et al., Aquaculture in Wisconsin: Results from a Statewide Survey of Fish Farmers (2019) https://fyi.extension.wisc.edu/localfoodmarketing/files/2019/10/AquacultureProducerReport-10-3-2019.pdf.

[164] Aquaculture in Wisconsin, p. 12.

[165] Aquaculture in Wisconsin, p. 14.

DATCP also issues a food processing plant license, for operations that process fish for human consumption.

DNR issues other authorizations related to the farm's impact to state water resources:

- The **Wisconsin Pollutant Discharge Elimination System (WPDES) permit** regulates effluent discharges and sets both numeric technology-based and water quality-based limitations. Standards for open-loop and/or closed-loop facilities are the same; technology-based standards are based on pollution control technologies available for each contaminant identified.
- **Construction Site WPDES general permit** for discharges of stormwater associated with the construction.
- The **High Capacity Well permit** regulates use of water well or wells in land-based aquaculture facilities that have a combined capacity of 70 gallons per minute (approx. 100,000 gallons per day) and imposes certain requirements for the design, construction, operation, and maintenance of high-capacity wells.
- The **Non-native species import permit** regulates the introduction of fish and eggs of non-native species (Atlantic Salmon) into the waters of the state.

Local Authorizations

Wisconsin villages, cities, and counties (for unincorporated areas) have home rule authority to legislate over local matters not preempted by or in direct conflict with state law. The scope of local authority over land-based aquaculture is limited to land use and development, solid waste management, and regulation of noise.

Environmental Impact Statement

The Wisconsin Environmental Policy Act (WEPA), enacted in 1972, directs all state agencies to analyze, consider, and disclose the anticipated environmental impacts of certain proposed actions, along with reasonable alternatives.[166] DNR would oversee development of an Environmental Impact Statement (EIS) for a proposed land-based RAS facility if required. However, land-based RAS is typically qualified as a minor action under DNR rules, and therefore is exempt from EIS requirements.[167] Exceptions could apply on a permit-by-permit basis.[168]

Public Participation and Review of Agency Decisions

Opportunities for public participation in the land-based aquaculture permitting process are somewhat limited in Wisconsin. WPDES permit regulations mandate the draft permit be published for public comment and require the agency to address public comments in the final permit. However, it is the only permit required for land-based aquaculture with explicit public participation mechanisms during the approval process. There are opportunities for public participation in the preparation of an EIS, but those are seldom required for land-based aquaculture facilities.

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[166] Wisconsin Environmental Policy Act | Environmental Impact Analysis | Wisconsin DNR.
[167] Wis. Admin. Code NR § 150.03(15).
[168] For example, DNR regulations require the development of an Environmental Assessment when granting a permit for a high capacity well(s) if they are in areas determined by DNR to groundwater protection areas or if the well(s) will have significant environmental impacts on a spring. Wis. Admin. Code NR § 820.30.

A person aggrieved by a decision , (e.g., issuance of a license or permit)[169] made by the DNR or the DATCP may request administrative review and judicial review of that decision following the review process established by the agencies.[170]

Table 8. Overview of Wisconsin's Regulatory Framework for Land-Based Aquaculture

Regulated area	Instrument Name	Impacts Addressed	Lead Agency	Level of Govt.	Instrument Allows	Instrument Requires	Public Partici-pation	Key Laws/ Regulations
Envtl. Assessment ***Not typically applicable but could apply on a permit-by-permit basis.***	EIS	Significant effects on human environment	DNR	State	Informed decision-making prior to approving major actions significantly affecting human environment	Analysis of environmental effects, alternatives, resource consumption, economic effects	Notice, comments, response to comments, public hearing	Wis. Stat. § 1.11 and implementing regulations
Registration	Fish farm registration	Introduction of diseases to waters of the state	DATCP	State	Operation of fish farms including sale, distribution, and processing fish for use of human or animal food	Annual recertification, inspection, recordkeeping, health certificate and registration of farm as a livestock premise	N/A	Wis. Stat. §§ 95.60 and 95.51 and implementing regulations
Land use	Building permit (cities or villages) or land use/zoning permit (un-incorporated territories)	Impacts to public health, property use, floodplain, and the introduction of sediment into the waters of the state	Zoning Depart-ments (Counties) /Zoning Board of Appeals (City or Villages)	Local	Construction of structures greater than 125 ft^2	Standards to ensure that developments do not affect the floodplain and introduce sediment into the waters of the state, buildings are not unsafe, unsanitary, or unfit for human consumption, inspection after construction	N/A	Jackson County, Wis., Code of Ordinance § 17.17 Village of Hixton Code of Ordinance §§ 193 and 208
Non-Native Species	Fish importation permit	Introduction of non-native fish species into the waters of the state	DNR	State	Introduction of non-native fish species, including Atlantic Salmon, to land-based farms in the state	Inspection of fish, eggs, and spawn to be introduced	N/A	Wis. Stat. § 29.735, and 23.22; and implementing regulations
Fish Health	Fish health certificate	Introduction of contagious	DATCP	State	Registration of fish farms and	Inspection of the fish held at the farm for	N/A	Statutes: Wis. Stat. § 95.60 and

[169] Person aggrieved is defined under Wisconsin administrative law as a person whose substantial interests have been adversely affected by an agency determination. Wis. Stat. §227.01. (9).
[170] *See* Wis. Admin. Code NR § 2.01-2.20 and Wis. Admin. Code ATCP §§ 1.01-1.42.

		and infectious disease into the waters of the state			importation of non-native live fish and eggs into the state	visible signs of infections and contagious diseases including whirling disease and VHS for salmonoids species and reporting of disease outbreak		implementing regulations
Food Safety	Food processing plant license	Public health impacts	DATCP	State	Preparation of fish for human consumption	Standards for safe handling fish for human consumption, operation, worker standards, pest control, cleaning and sanitation, storage packaging and labelling	N/A	Wis. Stat. § 95.60; and implementing regulations
Water consump-tion	High-Capacity Well permit	Impacts to ground and surface waters, public health, fish, aquatic life, scenic, and ecological values	DNR	State	Use of water well or wells in land-based aquaculture facilities with a capacity of 70 GPM (approx. 100,000 GPD)	Design, construction, operation, and maintenance standards for well or wells in the property	N/A	Wis. Stat. §§ 281.17, 281.34, 281.35; and implementing regulations
Water quality	WPDES permit and Construction Site WPDES General Permit	Discharges of pollutants including but not limited to chloride, total nitrogen, BOD5, total suspended solids (TSS), ammonia, phos-phorous, pH, thermal discharges, and stormwater	DNR	State	Discharge of wastewater into the waters of the state	Fish farms required to use the best practicable control technology currently available to manage the discharge of accumulated solids, effluent limitations and standards, recordkeeping, monitoring, sampling, and operation standards	Notice, public comments, public hearing on request	Wis. Stat. § 283.01-95 and implementing regulations
Solid waste	General require-ments for municipal industrial or commercial waste	Solid waste from land-based aquaculture operations such as aquaculture byproducts, sludge, and	Local solid Waste Depart-ment with oversight from DNR	Local	Safe handling of solid waste from land-based aquaculture facilities	Land-based aquaculture farms to follow minimum standards for the storage, collection, transport, processing,	N/A	Wis. Stat. §§ 289.00 et and implementing regulations; Village of Hixton Code of Ordinance §§ 407-1-407-9.

		animal waste				reparation, recovery, and disposal of solid waste		
Noise	Local Noise Ordinances	Noise pollution stemming from the construction and operation of land-based aquaculture farms	Code enforce-ment office	Local	Noise from construction and operation of land-based farms	Time and sound level limits for construction and operation noises	N/A	Village of Hixton Code of Ordinance §§ 3344-1-334-4.

Canada Federal Jurisdiction

Introduction

Overview: Economic impact and industry

Canada is a net exporter of seafood. The Organisation for the Economic Co-Operation and Development (OECD) reported that in 2020, Canada ranked 23rd in aquaculture production worldwide, by value.[171] FAO estimated Canada's aquaculture sector produced 171,000 tons in 2020, a number projected to increase 42.5% to 244,000 tons by 2030.[172] The Canadian government calculated total *finfish* aquaculture production at 143,820 tons, valued at $1.1143 billion (Canadian dollars).[173]

The aquaculture sector is heavily consolidated with a few large players; more than 260 aquaculture businesses reported operations in 2019, with small facilities comprising the majority. Coastal net-pen production is the most common category,[174] and Atlantic salmon is the predominant farmed finfish species.[175] The industry directly employs 3,700 Canadians as of 2019.[176]

Overview: Regulatory framework

Regulation of the aquaculture sector is largely shared between the federal and provincial/territorial governments, with local governments maintaining authority over land use and development decisions. Three distinct regulatory frameworks, applied to British Columbia, Prince Edward Island, and the rest of the nation, respectively, produce a fragmented system of oversight.

Table 9. Managing Aquaculture in Canada

Management area	Environmental review	Site Approval	Day to Day Operations and Oversight	Introductions and Transfers of live eggs and fish	Drug and Pesticide Approvals	Food Safety	Habitat/Species Protection	Other Impacts*
British Columbia	Provincial	Shared	Federal	Shared	Shared	Federal	Shared	Provincial
Rest of Canada	Provincial	Provincial	Shared	Shared	Shared	Federal	Shared	Provincial
Prince Edward Island	Provincial	Shared	Federal	Shared	Shared	Federal	Shared	Provincial

**Water quality and consumption, air quality, GHG, solid waste, pesticide application*
Based on: Daniele Lafrance. Library of Parliament. Background Paper. Canada's Aquaculture Industry table. 3 10 February 2021.

[171] OECD (2023), Aquaculture production (indicator). doi: 10.1787/d00923d8-en (Accessed on 16 February 2023) *available at* https://data.oecd.org/fish/aquaculture-production.htm. OECD calculated the value at $780,941,531. *But see* Daniele Lafrance. Library of Parliament. Background Paper. Canada's Aquaculture Industry 2 (2021) (hereinafter Lafrance) (In 2019, 187,026 tonnes of seafood were produced by Canada's aquaculture sector, valued at more than $1.2 billion).
[172] FAO. The State of World Fisheries and Aquaculture: Towards Blue Transformation 213 tbl. 18 (2022) https://www.fao.org/3/cc0461en/cc0461en.pdf.
[173] Lafrance at 2 at tbl. 1.
[174] Lafrance at 1, 3.
[175] Megan Sidey. Aquaculture Regulation in Canada: A Case for Modernization, Standardization and Collaboration. A major report submitted to the School of Graduate Studies in Partial fulfilment of the requirements for the degree of Master of Marine Studies Fisheries Resource Management 37 (2019) (hereinafter Sidey).
[176] Lafrance.

Federal government role: Generally

Federal government jurisdiction is, across most of Canada, centered on aquaculture *operations* through issuing and enforcing licences. Federal requirements set a floor rather than a ceiling, with provincial/territorial governments free to regulate environmental impacts more stringently.

Statutes, Regulations, and Agency Roles

The primary federal statute governing aquaculture operations is ***The Fisheries Act***, last amended in 2019, and implemented by Fisheries and Oceans Canada (DFO).[177] Parliament enacted the statute intending for it to regulate the wild capture fisheries, but several provisions are directly applied to the aquaculture industry and serve as the basis for sector-specific regulations.[178]

The Act sets forth provisions on pollution prevention, licensing, management, and habitat protection.[179] Habitat protection encompasses unauthorized discharge of any "deleterious substance" likely to harm fish or fish habitat.[180] DFO may issue permits authorizing a "designated project"—defined as activities it "considers likely to result in the death of fish or the harmful alteration, disruption or destruction of fish habitat"[181]—and make a permit subject to conditions, such as mitigation measures and monitoring requirements.[182]

The Aquaculture Activities Regulations (AAR), promulgated under *The Fisheries Act*, establish baseline requirements and conditions for aquaculture operators regarding facility management, treatment of fish for disease and parasites, effluent discharge, and recordkeeping and reporting.[183] The AAR limit owners/operators to drugs approved for use in Canada, require annual reporting on drug and pest control product type and use, and mandate owners/operators consider both the implications of using a selected drug or pest control product and the availability of alternatives.[184] The regulations also impose specific environmental monitoring and sampling requirements, and obligations to minimize effluent and effluent-caused harm to fish and fish habitat.[185] Owners/operators submit annual reports on their activities to the Regional Aquaculture Management Office (RAMO).[186]

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[177] Lafrance at 5.
[178] Case in point, the statute does not define aquaculture. *The Fisheries Act*, R.S.C. 1985, c. F-14 § 2(1) (setting forth definitions). The statute does include a section on "Culture of Fish," authorizing DFO to set water bodies apart for propagating fish and to issue licences and leases for oyster cultivation, but that is the extent to which the Act directly addresses aquaculture. *Id.* at § 59.
[179] *See generally* Lafrance at 5 (overview of *The Fisheries Act*, as applied to aquaculture). DFO's authority to issue and suspend or cancel leases and licences is encoded at §§ 7(1) and 9(1), respectively.
[180] See *The Fisheries Act* § 34(1) (defining "deleterious substance"); and § 36(3) (prohibiting nonauthorized discharges).
[181] *Id.* at § 35.1(2).
[182] *Id.* at § 35.1(3). See also Canada's Fisheries Act. The Habitat Prevention and Pollution Prevention Provisions of the Fisheries Act.
[183] *See generally* Lafrance at 5; *see also* Aquaculture Activities Regulations § 14 (2010) (hereinafter AAR).
[184] AAR §§ 5(c), 6(c); *and* § 2 (specifying as deleterious substances drugs permitted under the Food and Drugs Act, pest control products authorized under the Pest Control Products Act, and biochemical oxygen demanding matter (BOD)). *See also* Sidey at 30, 49-50.
[185] AAR §7(1-2). *See, e.g.*, Environmental Impact Statement of the Placentia Bay Atlantic Salmon Aquaculture Project (May 2018).
[186] *See* DFO, Regional aquaculture management offices – contact information, https://www.dfo-mpo.gc.ca/aquaculture/management-gestion/contact-eng.htm (last visited Feb. 20, 2023).

The ***Impact Assessment Act*** **(IAA)** merits discussion for its *in*applicability to aquaculture facilities. The IAA succeeded the *Canadian Environmental Assessment Act* (CEAA) in 2019.[187] Prior to 2012, when Parliament amended the CEAA, DFO carried out environmental assessments of some proposed aquaculture sites, as triggered by regulations promulgated under that statute.[188] Regulation promulgated under the 2012 CEAA, and which listed project categories triggering environmental assessments, did not include aquaculture.[189]

News reporters and observers at the time doubted the provincial/territorial governments would assume responsibility for carrying out environmental assessments for aquaculture projects.[190] A brief survey of land-based aquaculture facilities approved since 2012, however, yielded several examples of those governments requiring environmental assessment under their own, preexisting environmental statutes and regulations.[191] Regulations and orders promulgated under the present IAA contain a trigger only for aquaculture facilities proposed for national parks and other protected areas.[192]

Unlike in the United States, *the proponent and not the lead agency* is responsible for developing the environmental assessment (also referred to as an environmental impact study) and holding a related public information session. However, as is common at the state level in the U.S., typically a consultant will carry out the technical work. The lead agency issues to the proponent a set of tailored guidelines or terms of reference the environmental assessment must adhere to. Usually this includes a description of baseline environmental conditions, potential adverse effects, alternatives, monitoring program, and the proponent's compliance history. The environmental assessment may also explain the proponent's decommissioning approach.[193]

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[187] *See generally* Impact Assessment Act, S.C. 2019 (hereinafter IAA).

[188] This included whether a project required a *Navigable Waters Protection Act* (precursor to the *Canadian Navigable Waters Act*) permit. *See, e.g.*, Erica Butler. No More Environmental Impact Assessments for Salmon Farms in Nova Scotia: Navigable Waters Act omnibus cut leaves gap in federal assessments; province won't pick up the slack. Halifax Media (Feb. 22, 2013).

[189] *See* Regulations Designating Physical Activities (SOR/2012-147) at app'x A (SCHEDULE – Physical Activities) *available at* https://laws-lois.justice.gc.ca/eng/regulations/SOR-2012-147/index.html.

[190] *See, e.g.*, Darren Perrett. No more EIAs for aquaculture projects? Mastereia (Apr. 9, 2013), https://mastereia.wordpress.com/2013/05/04/no-more-eias-for-aquaculture-projects/ (reporting that "[p]rovincial authorities are now expected to pick up where federal authorities left off" and there were "no immediate plans to update Nova Scotia's Environmental Act to compensate") *and* Erica Butler. No More Environmental Impact Assessments for Salmon Farms in Nova Scotia: Navigable Waters Act omnibus cut leaves gap in federal assessments; province won't pick up the slack. Halifax Media (Feb. 22, 2013).

[191] Two such provinces are Nova Scotia and Newfoundland and Labrador, discussed later in this section.

[192] *See* IAA § 2 (defining "designated project" as "one or more physical activities that (a) are carried out in Canada or on federal lands; and (b) are designated by regulations made under 109(b) or designated in an order made by the Minister under subsection 9(1)") *and* Physical Activities Regulations SOR/2019-285 *available at* https://laws.justice.gc.ca/eng/regulations/SOR-2019-285/page-2.html#h-1194153 (Under Schedule 1(1), National Parks and Protected Areas—encompassing construction, operation, decommission, and abandonment in a wildlife area, migratory bird sanctuary, or marine protected area—of certain projects, including (l) "a new aquaculture facility").

[193] *C.f.* most environmental impact reports and studies in the U.S., which cover construction and operation phases, but not decommissioning. *See, e.g.*, The Newfoundland and Labrador Dept. of Muni. Affairs and Envt. Environmental Impact Statement Guidelines for the Placentia Bay Atlantic Salmon Aquaculture Project 13 (2018) (requiring EIS to describe applicant's approach to project decommission and potential options to closure and/or reuse of the hatchery facility).

Other relevant federal statutes and licences/permits include:

- **Health of Animals Act** – Imposes responsibility on owners/operators to notify a veterinary inspector about the presence, or potential presence, of a reportable disease or toxic substance, and provides for federal inspection of imported animals. Implemented by the Canadian Food Inspection Agency (CFIA).[194]
- **Migratory Birds Convention Act** – Prohibits depositing substances harmful to migratory birds to water bodies or areas such birds frequent and authorizes granting of permits to "take" migratory birds.[195] Issued by Environment and Climate Change Canada (EEEC), Canadian Wildlife Service (CWS).
- **Species at Risk Act (SARA)** – Provides for issuance of "Section 73" permits for activities affecting listed species or protected habitat, including for "incidental take."[196] Issued by DFO (aquatic species), Parks Canada Agency (PCA) (on federal lands), and ECCC (all other listed species).
- **Canadian Navigable Waters Act (CNWA)** – Regulates works and obstructions on navigable rivers; more generally applicable to marine aquaculture. Implemented by Transport Canada (TC).[197]
- **Feeds Act** – Regulates and controls the sale of feed, including packaging, labelling, and manufacturing.[198] Measures provide for inspection of feed moving between provinces,[199] and prohibition on manufacture, sale, and import/export of feed with potential of harming human or animal health or the environment.[200] As of 2022, proposed regulations would require traceability protocols.[201] Implemented by CFIA.
- **Aquatic Animal Health Import Permit** – Includes import of fish eggs. Issued by CFIA under the National Aquatic Animal Health Program (NAAHP).

Consultation with First Nations and Public Transparency

The Fisheries Act requires DFO to consider adverse impacts of its decisions on the constitutionally recognized and affirmed rights of Indigenous peoples.[202] The Aboriginal Aquaculture in Canada Initiative strove between 2013 and 2018 to increase First Nations' participation in the aquaculture industry.[203] The Northern Integrated Commercial Initiative later provided funding and other support to developing Indigenous-owned aquaculture enterprise.[204]

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[194] Health of Animals Act, S.C. 1990, c.21, §§ 5(1), 16(1) *available at* https://www.canlii.org/en/ca/laws/stat/sc-1990-c-21/latest/sc-1990-c-21.html#:~:text=every%20person%20in%20that%20area,entry%20without%20the%20person%27s%20permission.

[195] Migratory Birds Convention Act, 1994, S.C. 1994, c.22 §§ 5.1(1), 12(1) *available at* https://laws-lois.justice.gc.ca/eng/acts/m-7.01/.

[196] Species at Risk Act, S.C. 2002, c.29 § 73 *available at* https://laws.justice.gc.ca/eng/acts/s-15.3/.

[197] Transport Canada. About the Canadian Navigable Waters Act, https://tc.canada.ca/en/marine/about-canadian-navigable-waters-act (last visited Feb. 16, 2023).

[198] Feeds Act, R.S.C., 1985, c. F-9 §2 (fish included in definition of "livestock") *available at* https://laws-lois.justice.gc.ca/eng/acts/f-9/.

[199] Sidey at 59.

[200] Feeds Act § 3(3).

[201] CFIA, Fact sheet – Traceability, https://inspection.canada.ca/animal-health/livestock-feeds/regulatory-modernization/traceability/eng/1617040726269/1617040726644 (last visited Feb. 21, 2023).

[202] *Fisheries Act* § 2.4 (referencing Constitution Act of 1982 § 35).

[203] Lafrance at 11.

[204] *Id*.

DFO makes information reported by aquaculture facility owners/operators available on its **National Aquaculture Public Reporting Data** portal.[205] This includes information on antibiotics and pesticides.[206]

Provincial application

Generally

The relationship between the federal government and Canada's provinces/territories, and their regulatory frameworks governing land-based aquaculture, is as follows. Nova Scotia, British Columbia, and Price Eduard Island are provided as generally representative examples, with Labrador and Newfoundland illustrating other variations.

Federal jurisdiction

As discussed above, the federal government role focuses on issuing operational licences (DFO) and managing disease risks in aquatic animals (CFIA - NAAHP). The categories of aquatic animal diseases are: reportable, immediately notifiable, and annually notifiable.[207] Other agencies playing regulatory roles include: Health Canada – Veterinary Drugs Directorate (VDD) (aquaculture feed, vaccines, and drugs),[208] the Pest Management Regulatory Agency (pesticides), and Transport Canada (navigable waters).

The Introductions and Transfers Committee (ITC) is a joint federal/provincial body with a significant role. The ITC issues licences permitting the importation, transfer, and movement of aquatic species within Canada after considering the potential ecological, disease, and genetic risks.[209] Membership comprises provincial/territorial representation, also consisting of federal (DFO, CFIA) aquaculture specialists, scientists, and policy experts.[210] Each regional ITC conducts risk assessments on whether to transfer non-native species into that province's/territory's waters, using the risk management framework set out in the National Code on Introductions and Transfers of Aquatic Organisms.[211] The Regional Director General (RDG) or designated provincial/territorial official considers the ITC's recommendation and, in turn, makes a recommendation to the DFO minister, the final decision-making authority.[212] The National ITC comprises representation from the provincial/territorial ITCs.[213]

Provincial/territorial government jurisdiction, generally

Provincial/territorial governments typically license aquaculture **operations** subject to **an environmental assessment**. Separate statutory/regulatory measures require authorization for effluent discharge (water

[205] DFO. National Aquaculture Public Reporting Data, https://open.canada.ca/data/en/dataset/288b6dc4-16dc-43cc-80a4-2a45b1f93383 (last visited Feb. 16, 2023).
[206] Lafrance at 5.
[207] CFIA, Aquatic animal diseases, https://inspection.canada.ca/animal-health/aquatic-animals/diseases/eng/1299156296625/1320599059508 (last visited Feb. 21, 2023).
[208] Health Canada, Veterinary Drugs Directorate (VDD), https://www.canada.ca/en/health-canada/corporate/about-health-canada/branches-agencies/health-products-food-branch/veterinary-drugs-directorate.html (last visited Feb. 21, 2023).
[209] National Code on Introductions and Transfers of Aquatic Organisms i (hereinafter Nat'l Code).
[210] DFO provides diagnostic/laboratory support. Nat'l Code 4.1, 7.2.1.
[211] Nat'l Code at app'x 7. Risks are classified as high, medium, or low. Nat'l Code 6.3.10.
[212] Nat'l Code 6.2.1, 6.2.2, 6.3.14.
[213] Nat'l Code i.

quality) and diversion (water consumption) and govern other environmental impacts including animal welfare and fish health, biosecurity, and pesticide use. Provinces/territories also issue a Crown Land Lease permitting aquacultural operations up to the high tide mark, though this is inapplicable to land-based facilities operating on private land.

The municipal government role is primarily in making land use and zoning decisions and permitting development. For example, Newfoundland and Labrador's Urban and Rural Planning Act establishes that municipal governments are bound by their municipal plan and development regulations, which set out a scheme of "permitted, prohibited, and discretionary" land uses. Developments must conform to that plan and regulations.[214] Permit applications require public notice.[215] Persons "aggrieved" by a land use decision—including new development—may appeal to the local appeal board. The appeal board is similarly bound by the municipal plan and regulations, but it may not overrule a discretionary decision.[216] Appeals board decisions may also be appealed to the court within 10 days, on a question of "law or jurisdiction."[217]

Nova Scotia: Aquaculture licence for production operations

The Ministry of Fisheries and Aquaculture licenses and manages land-based aquaculture under the Fisheries and Coastal Resources Act and the associated Aquaculture Licence and Lease Regulations and Aquaculture Management Regulations.[218]

Nova Scotia's Fisheries and Coastal Resources Act §3(1) defines aquaculture as "the farming for commercial purposes of aquatic plants and animals over which the Minister exercises control but does not include raising or breeding in tanks, nets, pens or cages of aquatic plants and animals either as aquarium species, in laboratory experiments or by individuals on their own property as food for their own use"

The Aquaculture Licence and Lease Regulations establish a two-tier licensing system.[219] Land-based facilities undergo the less onerous administrative process, limited to activities deemed as posing less environmental risk, rather than the adjudicative approval process. The administrative process encompasses three phases: pre-application, review, and decision.[220]

In the *pre-application phase*, the proponent drafts a Development Plan, containing relevant biophysical,

[214] Newfoundland and Labrador. Urban and Rural Planning Act, 2000, SNL2000 Chapter U-8. §§12, 29(2), 35(1) *available at* https://www.assembly.nl.ca/legislation/sr/statutes/u08.htm.
[215] *Id.* at § 35(1)(i).
[216] *Id.* at § 42.
[217] *Id.* at § 46.
[218] Fisheries and Coastal Resources Act S.N.S. 1996, c. 25 O.I.C. 2015-338 (October 26, 2015) (hereinafter FCRA). Section 58(1)(a) authorizes the Administrator—an appointed Department official—to issue aquaculture licenses for land-based aquaculture sites. Section 64 provides authority for both regulations. Aquaculture Licence and Lease Regulations O.I.C. 2015-338 (October 26, 2015), N.S. Reg. 347/2015 amended to O.I.C. 2019-322 (effective November 12, 2019), N.S. Reg. 186/2019, *available at* https://novascotia.ca/just/regulations/regs/fcraqualiclease.htm (hereinafter ALLR); Aquaculture Management Regulations S.N.S. 1996, c. 25 O.I.C. 2015-339 (effective October 26, 2015), N.S. Reg. 348/2015 amended to O.I.C. 2019-218 (effective August 13, 2019), N.S. Reg. 118/2019 *available at* https://novascotia.ca/just/regulations/regs/fcraquamgmt.htm (hereinafter AMR).
[219] *See generally* East Coast Environmental Law. Aquaculture and Public Engagement in Nova Scotia 5-7 (2021).
[220] ALLR §§ 39-42 (Prescribed process for administrative decisions which, under § 38(1)(b), applies to aquaculture licenses for land-based aquaculture sites).

technical, and/or social data.[221] The Development Plan includes information on technical viability (e.g., production plan, data on biomass, species, stock source, maximum feed, tank density, tank volume, FCR, location, water source, maximum flow, water withdrawal or diversion activities), effluent treatment, infrastructure, escapement, compliance history, and impacts to conservation areas and to other users.[222]

During the *review phase*, agency staff assess the proponent's development plan;[223] consultation with First Nations may be necessary at this point.[224]

In the *decision phase*, the Administrator evaluates the application against the three "Section 43" factors (named for the regulatory provision). These are: (1) financial viability of the proponent and proposed operation (including proponent's history and future projections); (2) adherence to the statute, regulations, guidelines, and policies (including impact to other users, the ecosystem, and public right of navigation); (3) technical viability (infrastructure, water source and discharge, escapement, management team, and compliance history); and (4) any additional, relevant factors.[225] The Administrator consults with federal and provincial/territorial agencies as required under other laws, and with any other parties, as needed.[226] Members of the public may submit written comments, limited to the Section 43 factors, within a 30-day comment period.[227] The Administrator will finally issue a written decision, accompanied by the rationale, on whether to issue the licence.[228]

The Administrator's decision may be appealed, first to the Minister, and then ultimately to the Supreme Court of Nova Scotia.[229] The initial licence and subsequent renewals are limited to a 10-year term, and facilities undergo a performance review, both following the first production cycle and on application to renew.[230]

Licence holders must prepare both a *Farm Management Plan* and a *mitigation plan.* Farm management plans for land-based facilities span fish health management (antibiotics, reporting disease and mortality events), environmental monitoring, and farm operations (feed, chemical and fuel storage, waste removal and disposal, wildlife interactions, and noise).[231] The *Aquaculture Management Regulations* detail the information licence holders must include in each section.[232] Farm Management Plans for land-based facilities also describe stocking and production plans, facility design, specific procedures for fish

[221] Administrative Process for Aquaculture License and Lease Applications 1.
[222] Guide for Land-based Aquaculture Development Plans 3-8.
[223] ALLR § 44.
[224] Administrative Process for Aquaculture License and Lease Applications 2.
[225] ALLR § 43.
[226] ALLR § 40.
[227] ALLR §§ 41(1), 41(4-5).
[228] ALLR § 42(1).
[229] FCRA §§ 118(1)(A), 119(1) (A person "aggrieved by a decision or order" of the Department may appeal to the Minister within 30 days. If aggrieved by a decision of the Minister, a person may then appeal within 30 days – on a question of law, fact, or both – to the Supreme Court of Nova Scotia). Similarly, in Newfoundland and Labrador, under the Environmental Protection Act § 108, aggrieved persons may appeal to the court a minister's order or decision, including respecting the terms or conditions of an approval, within 30 days, and may appeal a decision of the Trial Division—on a point of law—to the Court of Appeal.
[230] ALLR §§ 52(1), 72(a, c).
[231] AMR §§ 2, 5-6, 14, 20(a), 21.
[232] AMR §§ 9-15.

health management, information on environmental monitoring, and reporting protocols.[233] Mitigation plans correct for inadequate environmental performance through monitoring activities.[234]

Nova Scotia: Environmental assessment

Certain "undertakings" trigger the provincial Department of Environment and Climate Change (ECC) to require environmental assessment, as required by *Nova Scotia's Environment Act*. The *Activities Designation Regulations* prescribe these undertakings.[235] Notably, activities requiring environmental assessments may also require one or more operational approvals—categorized as water, pesticides, waste, dangerous goods, and industrial activities. For example, one designated activity is diversion of more than 23,000 L/day from a surface or ground water source.[236]

The environmental assessment process is as follows under the statute and regulations:
First, the proponent publishes notice of and registers the undertaking.[237] The submission must lay out the steps the proponent followed to identify the public and Indigenous people's concerns about environmental impacts, a list of those concerns, and measures taken to address them.[238] The Minister makes an initial determination whether to: (1) require the proponent to prepare either a full environmental assessment or a focus report (for a limited range of adverse impacts); (2) request the proponent provide additional information; or (3) reject the undertaking outright.[239]

Second, if an environmental assessment is required, ECC proposes terms of reference for both the public and proponent to comment on.[240] The terms of reference will require a description of: alternatives to the undertaking, the potentially affected environment, environmental effects, how the project will benefit and/or be a detriment to the environment, mitigation measures, adverse effects or significant environmental effects that are unavoidable, an environmental monitoring program, and a public information program. Also incorporated is consideration of feedback from the public, municipalities in the vicinity, and affected Indigenous peoples.[241] The public may submit comments within a 30-day period.[242]

Third, the proponent prepares the environmental assessment, which is made available to interested persons and the public. ECC must refer environmental assessments for Class II undertakings to a review

[233] Land-based Farm Management Plan Minimum Compliance Requirements §§ 2.1, 5.0, 6.0, 8.0—10.0).
[234] AMR §2.
[235] Environment Act §§ 31(1), 66 *available at* https://nslegislature.ca/sites/default/files/legc/statutes/environment.pdf. Activities Designation Regulations promulgated under Section 66 of the Environment Act (2022) (hereinafter ARD).
[236] ADR § 5A(1)(a). *See also* § 14(2)(d, j, k) ("Construction, operation, or reclamation of…an inland fish processing plant in which fish is processed and wastewater is discharged to a watercourse, land or an on-site sewage disposal system; a fish meal plant in which fish meal is processed from fish wastes, with or without oil recovery; and a fish silage operation in which ground up fish waste is digested").
[237] Environment Act § 33.
[238] Environmental Assessment Regulations made under Section 49 of the Environment Act (hereinafter EAR) §9(1)(b)(xiii, xiv, xv).
[239] Environment Act § 34. Class II undertakings require environmental assessment. EAR § 11(2).
[240] Environmental Act § 36.
[241] Other jurisdictions require inclusion of similar in environmental assessments/environmental impact studies. *See, e.g.*, Newfoundland and Labrador Environmental Protection Act §§ 57-59.
[242] EAR § 19A(2).

panel; this is a discretionary step for Class I undertakings.[243] Class II undertakings are generally larger in scale and hold greater potential to result in significant environmental impacts.[244] The review panel solicits public input, typically via a hearing or through written comment, and makes a recommendation to the Minister.[245]

The Minister ultimately approves, rejects, or approves the proposal with conditions.[246] The Minister must consider: the location and the surrounding area's nature and sensitivity, concerns expressed by the public and Indigenous people about the proposed undertaking's effects, steps the proponent took to address those concerns, the sufficiency of environmental baseline information provided, and any known or potential adverse or environmental effects.[247] Approval obliges the proponent to carry out environmental monitoring and remediation activities.[248] ECC may impose more stringent terms and conditions on undertakings in environmentally sensitive areas.[249]

Aggrieved persons may appeal a decision or order of the ECC within a 30-day period.[250] Persons aggrieved by a decision of the Minister – including on whether to grant or refuse an appeal or approval and on the terms and conditions of an approval – may appeal that decision to a judge of the Supreme Court. However, the option to appeal to the Supreme Court does *not* extend to a Minister's decision to approve or reject an undertaking.[251]

The Environment Act empowers the public to report suspected offenses under the statute to ECC, which will investigate and report on progress and any proposed action to the applicant (complainant) within a 90-day period.[252] The statute also provides a measure of transparency: an online Environmental Registry gives access to information on licence approvals and enforcement actions.[253]

Other jurisdictions follow a similar process. For example, in Newfoundland and Labrador, all "undertakings" not exempted or "released" require an environmental impact study.[254] The Environment and Climate Change minister determines whether either an environmental preview report or a full impact statement is required, or to "release" the undertaking from both.[255] Applicants carry out an environmental assessment, which results in a report, the environmental impact statement. An

[243] Environmental Act § 38(1).
[244] A Guide to the Environment Act 4 (February 2006). Class I Undertakings include both facilities that produce fish meal and undertakings that disrupt 2 ha or more of wetland. EAR Schedule A.
[245] Environment Act §§ 39(1), 40, 44(1). *See also* EAR § 23 *and* Environmental Assessment Review Panel Regulations, S.N.S. 1994-95, c. 1, O.I.C. 2013-19 (January 22, 2013), N.S. Reg. 19/2013, *available at* https://novascotia.ca/just/regulations/regs/envreviewpanel.htm. Similarly in Newfoundland and Labrador, an environmental assessment board may be appointed to conduct public hearings on the environmental assessment. Environmental Protection Act, SNL2002 Chapter E-14.2, §63(1).
[246] Environment Act § 39(2).
[247] EAR § 12.
[248] Environment Act § 41.
[249] A Guide to the Environment Act 9 (February 2006).
[250] Environment Act § 137(1).
[251] Environment Act § 138 (1-2).
[252] Environment Act §§ 115-16
[253] Environmental Protection Act § 10(1); Nova Scotia Environment and Climate Change, Environmental Registry, https://novascotia.ca/nse/dept/envregistry.asp (last visited Feb. 17, 2023).
[254] Environmental Protection Act, SNL2002 Chapter E-14.2 §§ 47-48.
[255] *Id.* at § 51.

appointed committee prepares guidelines (similar to the terms of reference required of applicants in Nova Scotia) for the required document.[256]

Nova Scotia: Other environmental impacts

- **Water Quality** – Releasing contaminants into the environment requires authorization.[257]
- **Water Use** – "Watercourse[s]" – encompassing bed, shore, surface water, and groundwater – fall under provincial jurisdiction.[258] Withdrawal or diversion of more than 23,000 L/day requires a license issued by ECCC.[259] Newfoundland and Labrador's Water Resources Act similarly incorporates groundwater into any reference to surface water.[260] The province requires a license for diverting or using water, including for agricultural and industrial purposes.[261] The statute includes provisions for citizens to initiate enforcement of license terms or conditions by submitting a complaint about noncompliance.[262] It also provides for aggrieved persons to appeal a decision or order under the statute within a 60-day period.[263] Decisions pertaining to a license's or permit's terms or conditions may be further appealed to the court (Trial Division) within 30 days of the decision on the original appeal.[264]
- **Pesticides** – Use, application, and storage of pesticides must comply with the regulations and label instructions.[265] Pesticide applicators must be certified.[266] Newfoundland and Labrador's Environmental Protection Act does permit holders of applicator licences to employ unlicenced assistants, but the holder remains responsible for the assistants' actions. The unlicenced assistants must also comply with statutory and regulatory safety measures.[267]
- **Solid waste** – Nova Scotia has adopted a 50% solid-waste diversion goal.[268]
- **Greenhouse gases** – Nova Scotia adopted a cap-and-trade program,[269] which applies to emitters unless otherwise exempted under the regulations.[270] However, the program appears inapplicable to aquaculture facilities.[271] As of publication, the province was considering an emissions-reduction plan to replace the cap-and-trade system.[272]
- **Air pollution[273]** – Provincial/territorial air quality regulations generally are not directly applicable to land-based aquaculture facilities as not meeting the threshold of a new/modified emission

[256] *Id.* at §§ 53(1), 55(1).
[257] Environment Act § 67.
[258] Environment Act §§ 2(be).
[259] Nova Scotia Environment and Climate Change, Water Approval, Water Allocation (Storage, Diversion or Withdrawal), https://novascotia.ca/sns/paal/nse/paal182.asp (last visited Feb. 17, 2023).
[260] Newfoundland and Labrador, Water Resources Act, SNL2002 Chapter W-4.01 § 6.
[261] *Id.* at § 14.
[262] *Id.* § 23(1).
[263] *Id.* at § 86(1).
[264] *Id.* at § 87(1)(a).
[265] Environment Act § 79(3); *see also id.* at § 75 (Handling of pesticides must not cause adverse environmental effects).
[266] A Guide to the Environment Act 9 (February 2006).
[267] Newfoundland & Labrador Environmental Protection Act § 35(1-3).
[268] Environment Act § 93(1).
[269] Environment Act § 112C.
[270] Environment Act § 112D(1).
[271] Climate Change Nova Scotia, Program Details, https://climatechange.novascotia.ca/cap-trade-regulations (last visited Feb. 17, 2023).
[272] Keith Doucette, Nova Scotia legislation to replace cap and trade system for greenhouse gas emitters, GLOBALNEWS.CA, https://globalnews.ca/news/9207253/ns-legislation-greenhouse-gas-emitters/ (Oct. 18, 2022).
[273] ECC, Air – Regulations, https://novascotia.ca/nse/air/regulations.asp (last visited Feb. 23, 2023).

source. Backup generators, however, must comply with the relevant air pollution controls. For example, in Labrador and Newfoundland, air quality is regulated under the Air Pollution Control Regulations, and emergency backup generators must comply with the Ambient Air Quality Standards (AAQS).[274]

SPOTLIGHT ON NOVA SCOTIA
Kelly Cove Salmon, Ltd.

As of 2020, Nova Scotia hosted 234 licensed aquaculture sites, including 32 land-based sites.[1] Kelly Cove Salmon, Ltd., a subsidiary of Cooke Aquaculture, Inc., owns and operates one such facility in Centreville on Digby Neck.

The RAS facility will include four modules (egg incubation, first feeding, parr, smolt, all freshwater stages of production) that will annually produce three million Atlantic salmon. The firm estimated the facility will generate 453 FTE construction jobs, 82 indirect jobs, and 101 induced jobs.[2]

The $45.5 million (U.S.) facility obtained its water withdrawal permit on May 11, 2020, and its Nova Scotia Department of Fisheries and Aquaculture (NSDFA) licence March 15, 2021, with a three-year construction period commencing in 2022.[3] The 14 public comments submitted during the NSDFA notice period include concerns about a scant lack of detail provided, water intake, and effluent. Additional approvals likely include a DFO Introductions and Transfer permit, authorization for placing pipelines and associated structures (Dept. Lands and Forestry; now Department of Natural Resources and Renewables, Transport Canada), and a new construction permit (County of Digby).[4]

[1] East Coast Environmental Law. Aquaculture and Public Engagement in Nova Scotia 1 (2021).;
[2] Request to the Municipality of Shelburne to write a letter of support on Kelly Cove Salmon Ltd.'s application for a new Land-based Aquaculture License (AQ#1436) in Centreville, Digby County. Letter from Warden Penny Smith and Municipal County, the Municipality of Shelburne (Jan. 25, 2021).;
[3] Chris Chase, Cooke subsidiary receives provincial approval for Nova Scotia land-based RAS hatchery, SeafoodSource, https://www.seafoodsource.com/news/aquaculture/cooke-subsidiary-receives-provincial-approval-for-nova-scotia-land-based-ras-hatchery (Mar. 15, 2021).;
[4] Findings and Decision – New Application of Kelly Cove Salmon Ltd. For AO#1436 (Aug. 30, 2019).

[274] Newfoundland and Labrador Regulation 11/22 § 3, Schedule A (2022) *available at* https://www.assembly.nl.ca/Legislation/sr/regulations/rc220011.htm.

British Columbia

British Columbia: History

The federal government is the primary regulator of aquaculture in British Columbia, following the 2009 *Morton* Decision of British Columbia's Supreme Court. The Court categorized "aquaculture" as a "fishery." Fisheries fall under federal jurisdiction according to the Constitution Act of 1867, and by that logic, so do aquaculture facilities.[275] Both governments signed in 2010 a memorandum of understanding, the *Canada-British Columbia Agreement on Aquaculture Management*, which defined each party's roles and responsibilities. DFO later promulgated the *Pacific Aquaculture Regulations*, pertaining specifically to British Columbia, and established the British Columbia Aquaculture Regulatory Program (BCARP). The *Pacific Aquaculture Regulations* lay out several requirements for aquaculture facilities, including: permitted fish feeds; measures to control and monitor pathogens and pests, minimize and mitigate escapement, and minimize impacts on fish and fish habitat; as well as monitoring and recordkeeping requirements.[276]

> **British Columbia is Canada's leading finfish producer, primarily of salmon. In 2019, the province's output totaled 90,595 tons for a $681.7 million value.**
>
> Lafrance at ii

British Columbia: Federal role

The federal government holds primary authority for granting operational licences for aquaculture facilities, issuing land tenures for Crown lands, protecting fish and conserving fish habitat, pollution control, reporting on the industry, and conducting scientific research. **DFO** is responsible for monitoring and enforcing all licences in British Columbia for aquaculture operations, including for land-based facilities, and regulating environmental impacts.[277] **CFIA** oversees fish processing.

British Columbia: Provincial role

British Columbia retains jurisdiction over land use and siting, certain environmental impacts (e.g., effluent discharge, water diversion), worker health and safety, and fish processing. Notably, while the provincial government issues tenures for Provincial Crown and Aquatic Crown land,[278] this applies generally only to marine and freshwater aquaculture facilities accessing submerged land. Land-based facilities, typically

> **British Columbia's Finfish Aquaculture Waste Control Regulations §1 defines a "land-based finfish facility" as "a fish hatchery, rearing point, or other similar facility where finfish are fed, nurtured, held, maintained or reared in fresh water to reach a size for release or for market sale."**

[275] Lafrance at 4; Constitution Act of 1867 § 91(12); Morton v. British Columbia (Agriculture and Lands) 2009 BCSC 136.
[276] Pacific Aquaculture Regulations SOR/2010-270 § 4 (2010) (hereinafter PAR) *available at* https://laws-lois.justice.gc.ca/eng/Regulations/SOR-2010-270/index.html.
[277] PAR § 2 (2010) (applies to aquaculture and prescribed activities in Canada's territorial sea and internal waters off British Columbia's coast, the internal waters of Canada in British Columbia, and "any facility in British Columbia from which fish may escape into Canadian fisheries water"); PAR § 3(1) Authorizes DFO Minister to issue aquaculture license; Pacific Region Freshwater/Land-Based Integrated Management of Aquaculture Plan 14 (July 2016).
[278] British Columbia issues tenures under the *Land Act for Aquaculture Operations in B.C.* DFO. Aquaculture licensing in British Columbia, https://www.pac.dfo-mpo.gc.ca/aquaculture/licence-permis/index-eng.html (last visited Feb. 21, 2023).

operating on private land, need not apply for tenure and instead are primarily subject to local land use and zoning requirements.[279]

The **Ministry of Environment and Climate Change Strategy** is the key provincial regulatory body. The Ministry issues permits for effluent discharge and pesticide use; regulates waste and disposal activities; and protects habitats.[280] The *Environmental Management Act* mandates a permit to discharge effluent into the environment and authorizes the agency to require an environmental impact assessment be provided for proposed undertakings that could result in a detrimental impact to the environment.[281] The *Finfish Aquaculture Waste Control Regulations*, promulgated under the statute, mandates concentration limitations in effluent, based on the dilution ratio, of non-filterable residue, phosphorus, and detectable chlorine, and prohibits the discharge of certain treatment-related debris and untreated cleaning wastes.[282] Activities may be exempted from needing a permit if certain conditions are met, such as submitting a preoperational report, registering, and complying with regulatory requirements. The *Water Sustainability Act* and *Water Sustainability Regulations* establish conditions for diverting water from a stream or aquifer. Aquaculture is a designated water use under the regulations.[283] Licence applicants (or the agency) must give notice to listed categories of parties whose right might be affected by license approval.[284] The Ministry must consider several environmental factors, including the stream's flow needs, and may require the applicant mitigate significant adverse impacts to water quality, water supply, and/or the aquatic ecosystem.[285]

Other relevant regulatory agencies include:

- **Ministry of Water, Land, and Natural Resource Stewardship** – Issues tenures and licenses aquaculture sites.[286]
- **Ministry of Agriculture** – Supports the aquaculture sector; issues licenses for processing, receiving fish.[287]
- **Local governments** – Zoning and land use decisions consistent with the official community plan.[288]

[279] DFO. Pacific Region Freshwater/Land-Based Integrated Management of Aquaculture Plan 5 (July 2016).
[280] DFO. Pacific Region Freshwater/Land-Based Integrated Management of Aquaculture Plan 11 (July 2016); British Columbia, Ministry of Environment and Climate Change Strategy, https://www2.gov.bc.ca/gov/content/governments/organizational-structure/ministries-organizations/ministries/environment-climate-change#:~:text=The%20Ministry%20of%20Environment%20and,land%2C%20air%20and%20living%20resources (last visited Feb. 21, 2023).
[281] Environmental Management Act [SBC 2003] Chapter 53 § 6 (2,5), 14(1), 78.
[282] Land Based Finfish Waste Control Regulation (under Environmental Management Act) B.C. Reg. 68/94. Last Amended October 1, 2018 by B.C. Reg. 191/2018 §§ 6-7 (hereinafter LBFWCR).
[283] Water Sustainability Regulations (Under Water Sustainability Act), B.C. Reg. 36/2016 Schedule A §14 (2022) (hereinafter WSR) ("Industrial Water Use Purposes" includes "Pond and aquaculture," clarified as including fish farming and not fish hatcheries).
[284] Water Sustainability Act [SBC 2014] Chapter 15 §§ 6(1), 13(1, 3-4) (2022) (hereinafter WSA); WSR §14(1) (2022).
[285] WSA §§ 15(1), 16 (1-2).
[286] British Columbia, Land use – aquaculture, https://www2.gov.bc.ca/gov/content/industry/crown-land-water/crown-land/crown-land-uses/aquaculture (last visited Feb. 21, 2023).
[287] Authority derived from the Fish and Seafood Act and Fish and Seafood Licensing Regulation. *See* British Columbia, Land use – aquaculture, https://www2.gov.bc.ca/gov/content/industry/crown-land-water/crown-land/crown-land-uses/aquaculture (last visited Feb. 18, 2023).
[288] DFO and British Columbia, Guide to the Pacific Freshwater/Landbased Aquaculture Application 22 (2017).

British Columbia: Joint approach to licensing

The federal and provincial apply a harmonized approach to the application process for proponents seeking the requisite authorizations at both levels of government. Front Counter British Columbia coordinates the review process by DFO (aquaculture license), TC (Navigation Protection Program approval), and the province (land tenure; may not be applicable to land-based facilities). Proponents may need to seek additional authorizations, such as to divert water under the Water Sustainability Act, registration under the Land Based Finfish Waste Control Regulation, an ITC permit, and/or a Seafood Industry Licence.[289]

Proponents of land-based facilities must submit documentation, including a Health Management Plan (HMP) and associated Standard Operating Procedures (SOP) for implementing it; an Escape Prevention and Response Plan; a debris management; and an Official Band Council Resolution if a proposed tenure boundary is located with one kilometer of a First Nation Reserve (First Nations proposing facilities operating entirely on Reserve land need not apply for provincial authorization). DFO's assessment includes review of environmental factors.[290]

General conditions of an aquaculture licence for land-based facilities address: the introduction or transfer of finfish, fish health and mortalities, escapement, reporting, and recordkeeping.[291] Members of the public can access information on the industry's compliance online,[292] as well as information on DFO applications and decisions.[293]

Prince Edward Island

Prince Edward Island: History and overview

Prince Edward Island (P.E.I.) and DFO entered into *The Canada-Prince Edward Island Memorandum of Understanding for Commercial Aquaculture Development* in 1928, renewing the agreement in 1987. The

Prince Edward Island leads Canadian shellfish production; finfish production is comparatively much less, with a 2019 output of 429 tons at a $4.1 million value.[1] As of 2014, five finfish operations—all land-based—operated in the province.[2]

[1] Lafrance at ii. [2] East Coast Environmental Law. Comparative Analysis of Five Aquaculture Regulatory Frameworks

[289] Pacific Region Freshwater/Land-Based Integrated Management of Aquaculture Plan 20 (July 2016); British Columbia, Land use – aquaculture, https://alpha.gov.bc.ca/gov/content/industry/crown-land-water/crown-land/crown-land-uses/aquaculture (last visited Feb. 18, 2023).
[290] Canada and British Columbia. Guide to the Pacific Freshwater / Landbased Aquaculture Application 9, 22-23, 31-32 (2017); British Columbia, Land use – aquaculture, https://www2.gov.bc.ca/gov/content/industry/crown-land-water/crown-land/crown-land-uses/aquaculture (last visited Feb. 18, 2023).
[291] Pacific Region Freshwater/Land-Based Integrated Management of Aquaculture Plan 22 (July 2016).
[292] DFO, Environmental management reports for aquaculture in British Columbia, https://www.pac.dfo-mpo.gc.ca/aquaculture/reporting-rapports/index-eng.html (last visited Feb. 18, 2023).
[293] DFO, Aquaculture licensing in British Columbia, https://www.pac.dfo-mpo.gc.ca/aquaculture/licence-permis/index-eng.html (last visited Feb. 18, 2023). A map of all freshwater *and* land-based facilities, as of 2020, is available at: DFO, 2020 Freshwater/Land-based Aquaculture in British Columbia https://www.dfo-mpo.gc.ca/aquaculture/bc-cb/docs/maps-cartes/fresh-douce-eng.pdf (last visited Feb. 18, 2023).

MOU established the P.E.I. Aquaculture Leasing and Management Board, with federal, provincial, and industry representation. DFO maintains jurisdiction over aquaculture licences (operations)[294] and leases (land tenure) through its P.E.I. Aquaculture Leasing Division, with the Board serving in an advisory capacity.[295]

Prince Edward Island: Provincial role

P.E.I.'s *Environmental Protection Act* requires Environment, Energy and Climate Action (EECA) Department approval prior to a proponent initiating an "undertaking," which is inclusive of aquaculture facilities as well as any activity that may discharge a contaminant, significantly impact the environment, or cause public concern. EECA may obligate proponents to carry out an environmental impact assessment, subject to public notice and comment.[296] Often the proponent must produce both an Environmental Protection Plan (mitigation measures during construction) and Environmental Management Plan (long-term and periodically updated mitigation over project lifespan). An Environmental Management Committee may be established to oversee implementation of the Environmental Management Plan. Level II public consultation requires proponents hold at least one public information session, with members of the public able to submit comments within a minimum 10-day period. The Minister makes the determination whether to approve or reject the project, approve the project with terms and conditions, or request more information; there is no mechanism to appeal the decision.[297]

Additional authorizations needed may include development and groundwater extraction permits.

Current Developments: Proposal for a federal Aquaculture Act

Canadian policymakers recognize the fractured, tripart regulatory scheme creates inconsistency and confusion, and that the *Fisheries Act* was never intended to regulate the aquaculture industry. A 2016 Standing Senate Committee on Fisheries and Oceans report recommended DFO introduce a federal statute establishing a unified framework,[298] followed by a 2017 Advisory Council on Economic Growth report calling for legislative reform,[299] and a 2018 meeting of the Canadian Council of Fisheries and Aquaculture Ministers that resulted in support for such a measure. In 2019, the Prime Minister instructed DFO and Canadian Coast Guard to begin developing a federal Aquaculture Act.

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[294] Fisheries Act § 7. Unlike British Columbia, no P.E.I.-specific federal regulations exist.
[295] Lafrance at 4; East Coast Environmental Law. Comparative Analysis of Five Aquaculture Regulatory Frameworks in Canada 22 (2014) *available at* https://www.ecelaw.ca/images/PDFs/Aquaculture_Regulation_Comparative_Analysis_for_Website.pdf.
[296] Environmental Protection Act § 1 (defining "undertaking"); *id.* at § 9 (Minister's authority to require environmental impact assessment); *id.* at § 20 (prohibition on effluent discharge without approval); Prince Edward Island. Environment, Labour and Justice. Environmental Impact Assessment Guidelines app'x A (rev. January 2010) (lists "Aquaculture facilities" as a listed project qualifying as an "undertaking"). Projects not screened out as undertakings are "referral" projects, subject to interdepartmental technical review. *Id.* ch. 4.
[297] Prince Edward Island. Environment, Labour and Justice. Environmental Impact Assessment Guidelines ch. 9 (rev. January 2010).
[298] 2016 Standing Senate Committee on Fisheries and Oceans, An Ocean of Opportunities: Aquaculture in Canada (2016) available at https://sencanada.ca/en/content/sen/committee/412/pofo/rms/12jul15/report-e#StartofContent.
[299] Advisory Council on Economic Growth. Unleashing the Growth Potential of Key Sectors 12 (2017) ("Increase global market share…by adopting a new, forward-looking Canadian Aquaculture Act") *available at* https://www.budget.canada.ca/aceg-ccce/pdf/key-sectors-secteurs-cles-eng.pdf.

DFO undertook this effort, carrying out a public engagement campaign in 2019 and making its discussion paper available for public comment in 2020 and 2021 (undertaking separate engagement with First Nations/Indigenous peoples in 2022), and issuing a Discussion Paper. The goals of a new, unified framework are: (1) Establish national consistency; (2) clarify division of powers/jurisdictional roles; (3) simplify/streamline regulation; and (4) enhance environmental protection.[300] The proposed legislation would be partially based on the *Fisheries Act* and establish a licensing and enforcement system, specialized advisory panels, environmental protection standards, and a public registry.[301]

SPOTLIGHT ON PRINCE EDWARD ISLAND
Snow Island's Atlantic Sea Smolt Ltd. Facility

AquaBounty Canada, Inc. in 2016 acquired a previously licenced aquaculture facility located in Rollo Bay West, Kings County. The firm proposed renovations, including two new 3,700 m^2 RAS structures, to replace the original flow-through structure. The facility would have capacity to produce 250 metric tons per year of 4.5-5 kg AquAdvantage (sterile GMO) Salmon. Authorizations were needed for development, groundwater extraction, and watercourse alteration, as well as a compartmentalization permit.

The environmental impact statement concluded there would be no significant impacts with implementation of mitigation and monitoring measures, such as for effluent treatment. Sustainability-focused practices included: 99.7% RAS, two pre-engineered steel buildings, biosecurity measures, and addressing, as needed, impacts to an adjacent stream with discharge water replenishment. P.E.I. required AquaBounty to sample both influent and effluent for certain contaminants for a minimum of two years. Key public concerns spanned AquAdvantage Salmon escapes; release of parasites, disease-causing organisms, and pharmaceutical products; groundwater impacts; and wastewater management.

P.E.I. approved the project, which was completed in 2019. AquaBounty decided in 2022 to pull back on AquAdvantage production, continuing to rear salmon broodstock and produce eggs, but refocusing on marketing conventional eggs to other salmon farmers.

* Sources: Final Amended Environmental Impact Statement Proposed Redevelopment of Snow Island's Atlantic Sea Smolt Ltd. Facility 1300 Route No. 2 (Parcel Nos. 849505 and 1022300) Rollo Bay West, Kings County, P.E.I. Joose Environmental Project No. JE0219 i-ii, I-2, 4, 9, 11, 17, 19, 21-22, 30-31, 37 Table F-1 (2017); The Province of Prince Edward Island. Proposed Redevelopment of Snow Island's Atlantic Sea Smolt Ltd. Facility (AquaBounty) in Rollo Bay. Public Submissions (2017); Prince Edward Island. Environment, Labour and Justice. Environmental Impact Assessment Guidelines (rev. January 2010); and Barb Dean-Simmons. Aquaculture company AquaBounty ditching genetically modified fish in favour of salmon eggs at P.E.I. facility. SaltWire,

[300] DFO. What we heard report: Proposed federal Aquaculture Act – 2020 general engagement (2021) https://www.dfo-mpo.gc.ca/aquaculture/publications/report-potential-act-rapport-eventuelle-loi-eng.htm; DFO. Discussion Paper: A Canadian Aquaculture Act (2020) https://www.dfo-mpo.gc.ca/aquaculture/act-loi/discussion-eng.html.
[301] DFO. Considerations for a New Act, https://www.dfo-mpo.gc.ca/aquaculture/act-loi/considerations-eng.html (last visited Jun. 21, 2023).

Norway Federal Jurisdiction

Introduction

This section describes the regulatory framework of land-based aquaculture in Norway as derived from secondary sources.[302] It focuses on the different permit programs and includes an overview of the newly proposed resource rent tax.

Multiple licencing schemes in Norway often leave industry, administration, and academia confused.[303]

Background

Norway primarily regulates the aquaculture industry in the Act no. 79 relating to aquaculture,[304] adopted in 2005 and last amended in 2019. "Aquaculture" is herein defined as

> *… the production of aquatic organisms (aquaculture). Aquatic organisms are aquatic animals and plants. Any measure to affect the weight, size, number, characteristics or quality of living aquatic organisms is considered production.*[305]

The Act applies broadly to all kinds of aquaculture in Norway, including land-based facilities.[306] "Land-based" aquaculture is not explicitly defined in the Aquaculture Act nor elsewhere.

The Ministry of Trade, Industry and Fisheries implements and enforces the Aquaculture Act through its Directorate of Fisheries, whose main tasks include regulation, guidance, supervision, resource management and quality control. Relevant regulations, promulgated by predecessors to the current Ministry, include Decree No. 1798 of 2004[307] relating to authorizations for the breeding of salmon, trout and rainbow trout,[308] and Decree No. 822 of 2008[309] relating to the operation of aquaculture installations and fish welfare.[310] The Directorate's regional offices are authorized to issue aquaculture permits.

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[302] The Ministry of Trade, Industry and Fisheries published a comprehensive report on Norway's aquaculture industry and the Ministry's strategy for development in that sector ("An Ocean of Possibilities") in June 2021. However, the report is available only in Norwegian. The detailed and comprehensive overview by the Food and Agriculture Organization of the United Nations (FAO) was published prior to 2007 and is therefore not incorporated.

[303] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 1-11, 2022, p. 1.

[304] Lov om akvakultur (akvakulturloven) (Aquaculture Act, Act no. 79) https://lovdata.no/dokument/NL/lov/2005-06-17-79.

[305] § 2 Aquaculture Act. The definition is repeated in § 4(a) Decree No. 1798 of 2004 relating to authorizations for the breeding of salmon, trout and rainbow trout. https://www.fao.org/faolex/results/details/en/c/LEX-FAOC066429/.

[306] *Cf.* the geographical scope in § 3(a): "This Act applies on land territory (…).".

[307] Decree No. 1798 of 2004 relative to authorizations for breeding of salmon, trout and rainbow trout.

[308] § 3: "Aquaculture of food fish on land is regulated in Chapters 1, 2, 5a and 7, as well as §§ 29, 30, 31, 35, 36." This Decree makes provision for the authorization of commercial fish breeding installations in saltwater and freshwater. It defines conditions for authorization and criteria for the operation of aquaculture and mariculture of salmon, trout and rainbow trout. The Decree applies to the Norwegian territory and the continental shelf and the EEZ of Norway. *Cf*. https://www.fao.org/faolex/results/details/en/c/LEX-FAOC066429/ (last updated June 04, 2018).

[309] Decree No. 822 of 2008 relative to the operation of aquaculture installations https://leap.unep.org/countries/no/national-legislation/decree-no-822-2008-relative-operation-aquaculture-installations.

[310] For example, the operation of aquaculture facilities must be "technically, biologically, and environmentally sound" (§ 5) and include regular infection prevention and hygiene measures (§ 11). "Particular care" is required to prevent fish from escaping; land-based facilities must install a double safety or equivalent escape protection mechanism (§ 37). The Decree is generally focused on animal welfare, *cf*. § 20: "Methods, installations and equipment used for fish…must be suitable from the point of view of fish welfare." § 22: "The amount of water, water quality, water flow and current speed must be such that the fish have good living conditions." Environmental monitoring is only required for aquaculture facilities in sea water (§ 35).

Norway is a member state of the European Free Trade Association (EFTA) and is bound by certain laws of the European Union (EU) on food safety and animal welfare through the Agreement on the European Economic Area (EEA). Norway is also member of the World Trade Organization (WTO), the North Atlantic Salmon Conservation Organization (NASCO), the World Organisation of Animal Health (WOAH), and the Codex Alimentarius Commission.

In 1973, only one aquaculture licensing system existed in Norway. Today, there are ten different licensing schemes, including commercial licences, licences for special purposes (i.e., brood stock, education, research, display and development), and licences for new forms of farming (e.g., land-based and post-smolt production). Norway's aquaculture industry since experienced immense growth and today is the country's third largest export industry, with large parts of production activity concentrated in only a few large companies.[311] Norway's regulatory framework and policies lately focus on biological sustainability and environmental protection.[312] Municipalities and counties until recently historically profited the least from the lucrative aquaculture industry, when aquaculture licences were issued free of cost.[313] This changed when the government introduced a fee for sea-based commercial aquaculture licenses.

Sea-based aquaculture

Salmon farmers must obtain a *production licence* and a *site licence* to operate an aquaculture facility. The site licence regulates certain technical and operational requirements whereas the production licence regulates aspects of the actual fish production, e.g., weight and biomass.

The main types of production licences are as follows:

- **Commercial licence**—Granted for commercially producing food fish. The aquaculture facility must be environmentally sound, meet the requirements of the Aquaculture Act regarding land use (§§ 15, 16), and have obtained permits required by the Food Safety Act,[314] the Pollution Control Act,[315] the Harbor and Fairways Act,[316] and the Water Resources Act.[317] The Ministry can provide further provisions on the granting of aquaculture permits. The application procedure is *centralized*: The Directorate's regional office receives and forwards the application to the other relevant authorities, which process their own part of the application, and obtains their licences for the applicant, as shown in *Figure 1*. The regional office ensures that statements and decisions are obtained from the local municipality and other authorities.[318] It is also *decentralized* because the respective regional office of the Directorate of Fisheries processes the application.

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[311] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 1.
[312] Hersoug, *The greening of Norwegian salmon production*, Maritime Studies (14)16, 2015, 1-19, p. 14.
[313] This may change with the resource rent tax, *see below*. Municipalities and counties today also receive an annual production fee as well as 40% of the payments for the Aquaculture Fund.
[314] Act No. 124 of 2003 relative to food production and food safety. https://www.fao.org/faolex/results/details/en/c/LEX-FAOC066883.
[315] Pollution Act (No. 6 of 1981) https://www.fao.org/faolex/results/details/en/c/LEX-FAOC013923.
[316]Lov om havner og farvann (havne- og farvannsloven) (Harbor and Fairways Act of 2019) https://lovdata.no/dokument/NL/lov/2019-06-21-70.
[317] § 6(a)-(d) Aquaculture Act.
[318] *See* the brochure on the (then new) Aquaculture Act by the (former) Ministry of Fisheries and Coastal Affairs, downloadable at https://www.regjeringen.no/no/dokumenter/the-norwegian-aquaculture-act/id430160/ (August 9, 2005), at 13. [. *The brochure has not been updated since the Act's amendments entered into force (the latest on January 1, 2020).*].

The commercial licence establishes a maximum allowable biomass (MAB) for production[319] The determination of a site's carrying capacity and the appropriate MAB is subject to "an extensive and complicated process where a number of factors are assessed and finally a figure is given."[320]

Permits are no longer issued free of The Directorate of Fisheries in 2018 estimated the total value of commercial licences at NOK 150 million.[321]

The commercial licence system relies on the ***traffic light system***, implemented in 2017 to remedy concerns about the then-existing process being discretionary, random, and unpredictable. This system divides the country's shoreline into 13 regions, each designated green, yellow, or red for a two-year period. The number of sea lice on salmon in the respective region determine the color.[322] Green regions may increase their production by 6%, yellow regions maintain their production rate, and red regions must decrease production by 6%. If the region's color changes within that two-year period, facilities undergo a more comprehensive assessment that also considers socio-economic conditions.[323]

As of December 31, 2022, 1,135 commercial licences are in operation, with a total MAB of 917,679 tons.[324] 989 sites are currently operated in sea water for commercial and brood stock production.[325] In 2019, it was reported no new commercial permits for sea-based facilities would be issued until sea lice problems are brought under control and critical environmental conditions have been alleviated. Entry into the sea-based aquaculture market is therefore currently only possible by purchasing an existing permit.[326]

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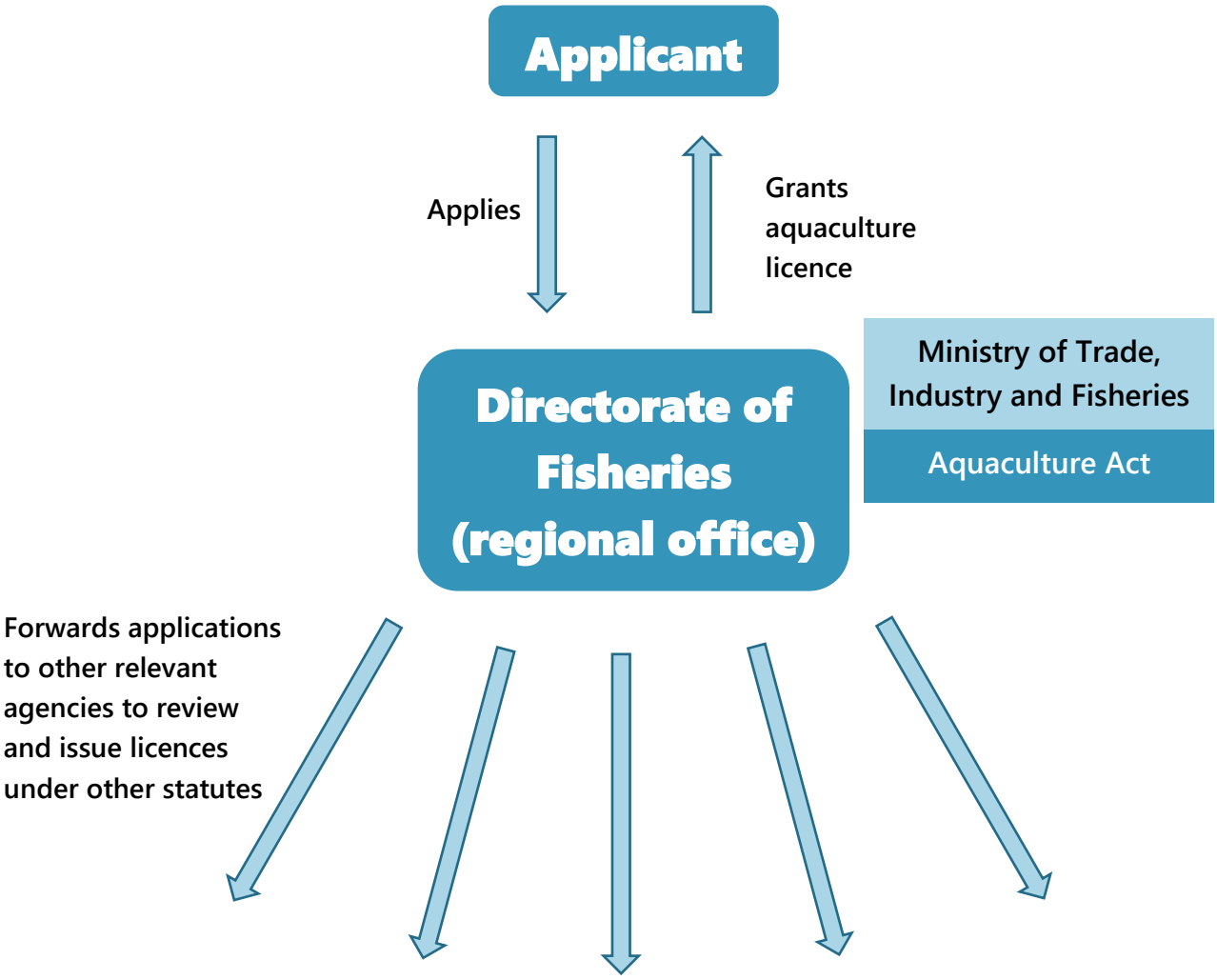
[319] *See* Hersoug, *Why and how to regulate Norwegian salmon production? – The history of Maximum Allowable Biomass (MAB)*, Aquaculture545(737144), 2021.
[320] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 8.
[321] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 6.
[322] Sea lice prevalence is the only environmental indicator so far. Theoretically, there is room for other environmental indicators like "fish mortality, escapes, local pollution, use of medical substances." *See* Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 5. The legal lice infection thresholds between 2000 and 2013 were set to 0.5 adult female lice per fish in the period Jan 1–Aug 31, and 1 adult female louse per fish in the period Sep 1– Dec 31. Abolofia et al., *The Cost of Lice: Quantifying the Impacts of Parasitic Sea Lice on Farmed Salmon*, Marine Resource Economics32(3), 2017, 329-349, p. 333.
[323] https://www.regjeringen.no/no/dokumenter/havbruksstrategien-et-hav-av-muligheter/id2864482/?ch=8 (last accessed February 5, 2023).
[324] Directorate of Fisheries, *Atlantic salmon, rainbow trout and trout grow out production in Norway* (Excel Spreadsheet) https://www.fiskeridir.no/English/Aquaculture/Statistics/Atlantic-salmon-and-rainbow-trout. Excel sheet downloadable here: https://www.fiskeridir.no/English/Aquaculture/Statistics/Atlantic-salmon-and-rainbow-trout/_/attachment/download/3250e1f9-e4f3-4438-b3bd-f9c96660dfb8:777d45e564bf820d149a6f9625465a33cc8e9e27/sta-laks-mat-01-tillatelser.xlsx. This includes licenses for salmon, rainbow trout and trout.
[325] Directorate of Fisheries, *Atlantic salmon, rainbow trout and trout grow out production in Norway* (Excel Spreadsheet) https://www.fiskeridir.no/English/Aquaculture/Statistics/Atlantic-salmon-and-rainbow-trout/_/attachment/download/a643fd7a-2300-499a-869d-f11ef8d53619:46a7d44841c45d73c18a5680e3a8db0b25cc4cfa/sta-laks-mat-02-lokaliteter.xlsx. For an explanation of brood stock purpose license, *see below* (special purpose licenses).
[326] Bjørndal, Tusvik, *Economic analysis of land based farming of salmon*, Aquaculture Economics & Management(23)4, 2019, 449-475, p. 453.

Figure 2. Process of Aquaculture Licence Applications



Coastal Administration (regional office)	Food Safety Authority (regional office)	Environment Agency, County Governor	Water Resources and Energy Directorate (regional office)	County Council, County Governor
Ministry of Transport and Communications	Ministry of Food and Agriculture	Ministry of Climate and Environment	Ministry of Oil and Energy	Ministry of Municipalities and Modernisation
Harbor and Fairways Act	Food Safety Act, Animal Welfare Act	Pollution Control Act, Nature Diversity Act	Water Resources Act	Planning and Building Act

- **Special purpose licence** – issued for brood stock, education, research, display and development purposes. There is no limit on how many licences a single entity may obtain. These licences are typically limited in time and issued free of charge.[327] Whereas the commercial licence scheme intends to reduce environmental pollution and diseases, the special purpose licence scheme aims at generating and sharing knowledge, identifying best practices, and promoting innovation throughout the aquaculture industry.[328]

  205 special purpose licences were active as of time of publication, comprising 15.3% of the total number of licences.[329] Many fish farming companies that produce salmon under commercial licenses operate additional stocks under special purpose licences.[330] They are subject to the same inspections, but most special purpose licences are not bound by the traffic light system restrictions.[331]

  Critics argue that the special purpose licencing scheme undermines the commercial licencing scheme and provides a cheap detour to larger total production.[332] The special purpose licence system is also disputed for lacking efficient control mechanisms. For example, the research results from research licence aquaculture, have not been transparent.

  In March 2021, the Ministry of Trade, Industry and Fisheries temporarily halted its processing of new applications for special purpose permits.[333] The Directorate of Fisheries stated that special purpose permits are still needed, but the regulations would benefit from an. The agency

[327] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 5.
[328] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 2.
[329] Brood stock (44), research (109), display (31), development (21). Directorate of Fisheries, *Atlantic salmon, rainbow trout and trout grow out production in Norway* (Excel Spreadsheet) https://www.fiskeridir.no/English/Aquaculture/Statistics/Atlantic-salmon-and-rainbow-trout. Excel sheet downloadable here: https://www.fiskeridir.no/English/Aquaculture/Statistics/Atlantic-salmon-and-rainbow-trout/_/attachment/download/3250e1f9-e4f3-4438-b3bd-f9c96660dfb8:777d45e564bf820d149a6f9625465a33cc8e9e27/sta-laks-mat-01-tillatelser.xlsx.
In 2020, special licenses comprised 21% of the total number of licenses, and 17% of the total MAB capacity. https://www.fiskeridir.no/Akvakultur/Registre-og-skjema/Akvakulturregisteret (last accessed Feb. 1, 2023). Another government website speaks of 20% of the industry's total MAB, https://www.regjeringen.no/no/dokumenter/havbruksstrategien-et-hav-av-muligheter/id2864482/?ch=8 (last accessed February 5, 2023) under 8.4.
[330] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 5.
[331] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 8. Even if the special purpose license was granted in a red area, the facility would not be obliged to reduce its production MAB should the environmental conditions worsen.
[332] Hersoug et al., *Serving the industry or undermining the regulatory system? The use of special purpose licenses in Norwegian salmon aquaculture*, Aquaculture(543)736918, 2021, p. 9: because it avoids the cost and restrictions of a commercial license; Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 8.
[333] Ministry of Trade, Industry and Fisheries, *The aquaculture strategy - A sea of opportunities*, https://www.regjeringen.no/no/dokumenter/havbruksstrategien-et-hav-av-muligheter/id2864482/?ch=8 (last accessed February 9, 2023) under 8.4.

recommended closer evaluation of the special purpose licence schemes, streamlining application processes, and including special purpose permits in the traffic light system.[334]

- **Development licence** program was established in 2015, within the special purpose licence scheme. This temporary program granted a time-limited licence free of cost to projects that promised to address environmental challenges through significant investments in innovative technologies.[335] The program "bolstered a lot of investment into mechanical innovation."[336] There was no limit on the number of licences per project but an MAB of 780 tons for each licence. The development licence owner may apply to convert the development permit into a commercial license at a fixed price of NOK 10 million. The Directorate of Fisheries eventually reduced the MAB on the finding that the fish producers can test the technology sufficiently with less biomass.[337]

  The goal behind development licences – to reduce the risk of innovation for companies in order to develop new technologies and best practices that will eventually benefit the entire industry – was not met. The use of development licences consolidated two large producers that "are today affiliated with large foreign-owned genetics companies."[338] Also, the Directorate of Fisheries has freely interpreted what *significant investments* means and has changed its interpretation over time.[339] To alleviate these concerns, the special purpose licences require a more carefully delimited scope and close monitoring.[340]

Land-based aquaculture

The same regulatory framework applied to both land-based and sea-based aquaculture facilities until 2016.[341] The Directorate of Fisheries now issues licences for land-based aquaculture on a continuous basis and. there is no limit to the number of licences that may be granted to any individual facility.[342] Applicants

[334] Ministry of Trade, Industry and Fisheries, The aquaculture strategy - A sea of opportunities, under 8.4.
[335] Anders Furuset, *Norway hopes to jump-start closed-containment salmon farming with new incentive program* https://www.intrafish.com/technology/norway-hopes-to-jump-start-closed-containment-salmon-farming-with-new-incentive-program/2-1-1057555 (August 31, 2021).; Afewerki et al., *Innovation in the Norwegian aquaculture industry*, Reviews in Aquaculture, 2022, 1-13, p. 8; Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 5.
[336] Bjørnar Skjæran, *The road ahead to a sustainable aquaculture industry in Norway* https://www.innovationnewsnetwork.com/the-road-ahead-to-a-sustainable-aquaculture-industry-in-norway/24698/ (August 22, 2022).
[337] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 6.
[338] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 7.
[339] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 9.
[340] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 10.
[341] *New rules for land-based farming*, https://www.regjeringen.no/no/dokumentarkiv/regjeringen-solberg/aktuelt-regjeringen-solberg/nfd/pressemeldinger/2016/nye-regler-for-landbasert-oppdrett/id2502424/ (June 1, 2016).
[342] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 6.

must only pay a small administrative fee but no licence fee.[343] Land-based aquaculture permits do not establish an MAB.[344] The government's goal was to promote the competitiveness of the industry by lowering barriers to market.[345] Yet, land-based aquaculture facilities must still meet many of the same requirements applicable to any land-based development project, such as effluent limitations.[346] Land-based aquaculture facilities must also install at least a double safety or other equivalent escape protection mechanism to prevent salmon from escaping through the drain or otherwise.[347]

The application process parallels that for a sea-based licence is the same for the land-based aquaculture licence.

Current developments and state of the industry

As of December 31, 2022, there were 58 sites in operation on land, 29 in fresh water and 29 in salt water.[348] The number seems to have increased extraordinarily quickly, as for the end of 2020, only "one small facility" was reported to be in operation on land.[349]

Aquaculture companies increasingly grow larger smolt (young salmon) in land-based tanks before releasing them into a sea-based facility. This was also facilitated by the new regulations that apply to both land-based aquaculture and smolt production on land. Formerly, the land-grown smolt could only weigh up to 200g. The weight restriction for smolt is now eliminated so that producers have started to grow large smolt of up to 1kg before releasing them into the sea. This reduces the time the fish spend at sea, hence reducing the exposure to sea lice and the need for biochemical treatment. The producers also benefit by using their (sea-based) MAB-capacity more efficiently: since they (only) pay a licence fee for the sea-based facility and must not exceed the MAB, bringing in large fish that only stay for a shorter time period increases the total amount that can be grown at reduced expense. The land-based or smolt

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[343] Bjørndal, Tusvik, *Economic analysis of land based farming of salmon*, Aquaculture Economics & Management(23)4, 2019, 449-475, p. 453. The government is therefore missing out on billions in revenue. https://ilaks.no/rush-etter-landbaserte-lakseanlegg-myndighetene-gar-glipp-av-milliardinntekter/ (January 4, 2021).

[344] Solheim, Trovatn, *The Economic Attractiveness of Land-based Salmon Farming in Norway*, Master thesis, 2019, p. 16. For example: a land-based facility for the production of 792,000 tons of salmon was planned in 2021 in Norway. If this volume was to be produced in sea-based facilities, it would have required 660 new licenses that would have cost a total of NOK 99-132 billion (NOK 150-200 million per license). https://ilaks.no/rush-etter-landbaserte-lakseanlegg-myndighetene-gar-glipp-av-milliardinntekter/ (January 4, 2021).

[345] The Norwegian government is also hoping to export the technologies developed and the knowledge generated in its land-based aquaculture industry. Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 6; *cf*. Solheim, Trovatn, *The Economic Attractiveness of Land-based Salmon Farming in Norway*, Master thesis, 2019, p. 16.

[346] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 6.

[347] § 37 of the Decree No. 822 of 2008.

[348]Directorate of Fisheries, Atlantic salmon, rainbow trout and trout grow out production in Norway (Excel Spreadsheet) https://www.fiskeridir.no/English/Aquaculture/Statistics/Atlantic-salmon-and-rainbow-trout. Excel sheet downloadable here: https://www.fiskeridir.no/English/Aquaculture/Statistics/Atlantic-salmon-and-rainbow-trout/_/attachment/download/a643fd7a-2300-499a-869d-f11ef8d53619:46a7d44841c45d73c18a5680e3a8db0b25cc4cfa/sta-laks-mat-02-lokaliteter.xlsx.

[349] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 6.

production volume in tons of MAB is largely based on tank capacity, rather than environmental considerations. Smolt production on land must still comply with effluent limitations.[350]

There is now a six-month minimum moratorium on accepting applications for land-based aquaculture permits are no longer accepted, as of December 20, 2022, until the Ministry of Trade, Fisheries and Industry promulgates new regulations. The decision is in recognition that projects permitted as "land-based" increasingly have a closer connection to the sea (flow-through). This blurs the distinction between sea-based and land-based aquaculture with implications for water quality.[351]

Applications already submitted will continue to be processed, as well as applications for extensions or changes to existing permits.[352]

Criticism and reform ideas

The government has acknowledged that the regulations and laws governing the salmon aquaculture industry are "too expensive, too detailed, too time-consuming and difficult to control."[353] The permitting process entails a "veto-right" of at least four agencies that may deny a licence if they find contravening objectives in the sector laws they govern.[354] Despite realizing the need for simplification, the government authorities want to retain their power and authority.[355]

The current licensing system "largely excludes newcomers and thus has a limiting effect on innovation."[356] This may disincentivize companies to compete for environmental and sustainable solutions.

In 2020, the government proposed to abolish the permit requirement under the Pollution Control Act for aquaculture within one nautical mile from the shoreline. Applicants would be subjected to a set of standard requirements for pollution prevention and mitigation rather than to conditions specific to each, individual permit.[357]

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[350] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 6.
[351] Pål Mugaas Jensen, *430,000 tonnes of on-land salmonid production in Norway's planning pipeline* https://www.fishfarmingexpert.com/landbased-salmon-norway/430000-tonnes-of-on-land-salmonid-production-in-norways-planning-pipeline/1475151 (January 11, 2023); Pål Mugaas Jensen, Se oversikt: Disse selskapene har søkt om tillatelser på land (See overview: These companies have applied for permits on land). https://www.landbasedaq.no/tillatelser/se-oversikt-disse-selskapene-har-sokt-om-tillatelser-pa-land/1473125 (January 6, 2023); Vince McDonagh, *Norway puts land farm expansion on hold,* https://www.fishfarmermagazine.com/news/norway-puts-land-farm-expansion-on-hold/ (December 21, 2022).
[352]. Pål Mugaas Jensen, *430,000 tonnes of on-land salmonid production in Norway's planning pipeline.*
[353] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 9.
[354] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 6.
[355] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 9; *cf.* https://www.regjeringen.no/no/dokumenter/havbruksstrategien-et-hav-av-muligheter/id2864482/?ch=8 (last accessed February 5, 2023).
[356] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 7.
[357] Ministry of Trade, Industry and Fisheries, *The aquaculture strategy - A sea of opportunities*, under 8.1.

Reform ideas proposed, primarily by academics and researchers, include following:

- Establish a standalone aquaculture directorate with broad authority for a centralized, simplified permitting regime. One argument against is that this agency may need to meet potentially competing objectives, such as safety, animal welfare, economic growth, and environmental protection.[358]
- Resume the development licence scheme. Target closed or semi-closed cage technology, considering that the biggest problems are related to lice, escapes and discharges.[359]
- Impose time limits on the licences, introduce specific environmental requirements such as fish mortality, local pollution by medical substances or fish excrement, and increase cooperation between farmers in the same area.[360] Some caution that determining environmental requirements area-specifically may result in a race to the bottom.

Resource rent tax[361]

In September 2022, the Norwegian government proposed a 40% resource rent tax[362] (currently reduced to 25%)[363] on sea-based production of salmon, trout, and rainbow trout. It reasoned that the aquaculture industry was using public resources like the Norwegian fjords and sea areas – areas "that belong to society … It is therefore reasonable for society to receive a share of the extraordinary return generated through the exploitation of these resources."[364] The goal is to support the local communities in the coastal regions – those regions whose public resources are being exploited by the aquaculture industry.[365]Arguably land-based facilities (and production under development licences) would not be affected by the tax.[366]

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[358] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 9.
[359] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 9.
[360] Hersoug, *"One country, ten systems" – The use of different licensing systems in Norwegian aquaculture*, Marine Policy137(104902), 2022, 1-11, p. 10.
[361] For an overview of the taxation of aquaculture in different countries, *see* https://assets.kpmg/content/dam/kpmg/no/pdf/2022/10/KPMG%20Law%20Norway%20-%20Taxation%20of%20Aquaculture%202022.pdf.
[362] Also called "ground rent tax". The concept basically means "rental fee for the use of natural resources." https://sciencenorway.no/agriculture-fisheries-economics-finance/ground-rent-norways-new-salmon-tax-turns-economic-textbook-models-into-reality/2107405 (November 20, 2022). Both hydropower and the oil industry and, if the proposal is adopted, wind power, are taxed in the same way. *Ibid*. The cited article provides a background on the economics of the tax and how the proposal was perceived among economists.
[363] Chris Chase, *Political agreement lowers Norway's proposed salmon tax to 25 percent*, https://www.seafoodsource.com/news/aquaculture/norway-close-to-agreement-on-salmon-tax-rate-of-25-percent-norway-salmon-company-stocks-soar (May 25, 2023).
[364] Ministry of Finance, *Resource rent tax on aquaculture,* https://www.regjeringen.no/en/aktuelt/resource-rent-tax-on-aquaculture/id2929113/ (September 28, 2022). The government also proposed to introduce a resource rent tax on onshore wind energy, with the same rationale, *cf.* https://www.regjeringen.no/en/aktuelt/resource-rent-tax-on-onshore-wind-energy/id2929117/.
[365] Ministry of Finance, *Resource rent tax on aquaculture* (September 28, 2022).
[366] *Cf.* EY Norway, *Resource rent tax on aquaculture,* https://www.ey.com/en_no/tax/resource-rent-tax-on-aquaculture (October 16, 2022); Vince McDonagh, Norway puts land farm expansion on hold, (December 21, 2022). Surprisingly, the government's press report does not explicitly mention the non-applicability to land-based aquaculture, Ministry of Finance, Resource rent tax on aquaculture (September 28, 2022): "The resource rent tax applies to all licenses within the geographical scope of the Aquaculture Act (out to the continental shelf)."

The government proposed the following procedure:

- Calculate revenues from salmon based on prices for salmon on a public exchange (commodity prices for salmon). The estimated tax revenue is NOK 3,65-3,8 billion annually (USD 347-361 million).
- Tax income and investments on an ongoing basis in the year in which they are earned/incurred.
- Distribute half to the municipal sector.

The proposal includes a tax-free allowance of between 4,000 and 5,000 tons of biomass. Smaller businesses (approx. 65-70% of aquaculture companies that account for only 15-17% of the total biomass produced) are therefore exempt.[367] "The tax-free allowance is considered a flat-rate deduction for historical purchases of licences for fish for consumption. The tax-free allowance is granted at corporate group level. Tax-free allowances are granted in the form of estimated average profit per ton of biomass and can be deducted from positive resource rent income. Corporate tax is calculated before resource rent tax on aquaculture, and resource rent-related corporate tax is deducted from the basis for resource rent tax (as for petroleum and hydropower). An effective resource rent tax rate of 40 per cent therefore means that the formal resource rent tax rate is set at 51.3 per cent. Including corporate tax, the total effective marginal tax is 62 per cent. Negative calculated resource rent income can be carried forward with interest and deducted from positive calculated resource rent income in subsequent years."[368]

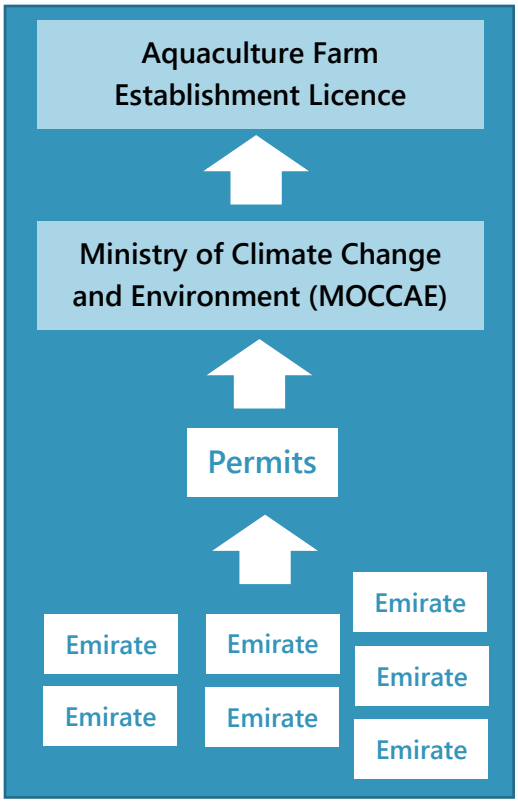
The aquaculture industry is vehemently opposed to the government's plans. All publicly traded salmon farming firms' stock prices fell significantly on the day of the publication of the proposal.[369] Some companies are already cutting employment due to expected redundancy.[370] Economists caution the new tax could backfire, with the government losing tax revenues if the industry starts to decline, instead of continuing to grow. "A thriving aquaculture industry will likely be more positive for the long-term Norwegian government budget."[371] The proposal remains highly disputed and in flux.

[367] *Cf. EY Norway, Resource rent tax on aquaculture* (October 16, 2022).
[368] Ministry of Finance, Resource rent tax on aquaculture (September 28, 2022).
[369] Jason Holland, Norway proposes 40 percent resource tax on aquaculture operations, https://www.seafoodsource.com/news/business-finance/norway-proposes-40-percent-resource-tax-on-aquaculture-operations (September 28, 2022).
[370] Andy Coyne, *SalMar blames Norway aquaculture tax plan for mass redundancies,* https://www.just-food.com/news/salmar-blames-norway-aquaculture-tax-plan-as-mass-redundancies-announced/ (November 15, 2022).
[371] Rob Fletcher, *Why Norway's salmon tax could dramatically backfire,* https://thefishsite.com/articles/why-norways-salmon-tax-could-dramatically-backfire-rabobank-gorjan-nikolik?utm_medium=email&utm_campaign=South%20America%20could%20be%20set%20for%20a%20few%20fruitful%20years%20-%2016th%20November%202022&utm_content=South%20America%20could%20be%20set%20for%20a%20few%20fruitful%20years%20-%2016th%20November%202022+CID_452bc083fccb28c9a8193203c39e537c&utm_source=Email%20marketing%20software&utm_term=Why%20Norways%20salmon%20tax%20could%20dramatically%20backfire (November 11, 2022), citing Rabobank's chief seafood analyst, Gorjan Nikolik. The article includes further background analyses on economic considerations.

UAE Federal Jurisdiction

Aquaculture in the United Arab Emirates (UAE) is regulated at the national and local levels through Federal Laws, Executive issuances,[372] and local standards set by the seven emirates. The Ministry of Climate Change and Environment (MOCCAE)[373] is the lead federal regulatory agency in UAE, authorized to issue the required Aquaculture Farm Establishment Licence (AFEL).[374] The regulatory system of aquaculture in UAE takes a "bottom-up" approach, requiring emirate involvement in the early stages of the permitting process: MOCCAE requires proponents to first obtain the necessary permits from the emirates in order for the agency to issue the AFEL. Licence proponents then submit all approved permits and other required items through the agency's online portal. The result is a streamlined regulatory process that promotes close coordination between the federal government and the emirates.

Figure 3. UAE Regulatory Framework



The UAE regulatory process adopting a bottom-up approach beginning with its seven emirates which issue permits in their respective jurisdictions. The permits are made part of the reportorial requirements of the MOCCAE in issuing an Aquaculture Farm Establishment Licence and are submitted in its online portal.

Overview of key federal statutes

UAE regulates aquaculture under the following statutes:

- ***Federal Law No. 23 of 1999*** (*"concerning Exploitation, Protection and Development of the Living Aquatic Resources in the State of the United Arab Emirates"*) — licensing of aquaculture farms. This law is implemented by *Ministerial Resolution No. 21 of 2018*, repealing *Ministerial Resolution 302 of 2001.* The MOCCAE and its counterpart environmental agencies in the emirates also issue Aquaculture Guides outlining the administrative procedure of UAE's licensing system.

- ***Federal Law No. 24 of 1999*** (*"for the Protection and Development of the Environment"*)– a comprehensive environmental regulatory scheme governing development projects, subject to more specific federal regulations, such as the *Regulation concerning Environmental Impact*

[372] Executive issuances mentioned in this material refer to issuances of UAE's Cabinet. These usually take the form of Ministerial or Cabinet Resolutions and Decrees which serve as implementing rules and regulations of Federal Laws mentioned. The term "executive issuances" are referred to interchangeably in English translation as executive orders, implementing rules and regulations, and bylaws.

[373] The UAE's Cabinet, consisting of Federal Ministries and Agencies, have undergone continuous administrative structuring over time. As of 2016, the jurisdiction of the newly renamed Ministry of Climate Change and Environment incorporates certain authorities previously under the jurisdiction of the Ministry of Environment and Water and the Ministry of Agriculture and Fisheries. MOCCAE's purview also now includes green development, environmental affairs, fisheries, biodiversity, marine sector, food safety, and agriculture.

[374] Name of license appearing on the official application form of the MOCCAE.

Assessment Projects,[375] *Regulation Concerning Protection of Air from Pollution,*[376] and *Regulation for Handling Hazardous Materials, Hazardous Wastes and Medical Wastes*.[377]

The MOCCAE enforces both statutes but closely coordinates with the emirates in implementing Federal Law No. 24 of 1999. The agency enforces other relevant legislation in aquaculture regulation encompassing veterinary products, animal feed, food safety, and waste management. The Ministry of Energy and Industry implements federal regulations governing electricity and water under Federal Law No. 31 of 1999 ("*concerning The Establishment Of The Federal Department Of Electricity And Water*")[378] but is generally limited to regulating prices, due to separate development of energy and water authorities of the emirates. The emirates consequently issue their own regulations governing water and electricity matters within their respective jurisdictions.[379]

The restructuring of UAE's administrative agencies, combined with the streamlined licensing system and introduction of an online portal for processing licence applications, promotes coherence and transparency in the regulation of aquaculture in UAE. The UAE is considered one of the leading countries in aquaculture industry development and, relatedly, recently adopted policies aimed at achieving food security.[380] The country consistently attracts investments into the Gulf region and approved an organic salmon-producing RAS facility,[381] despite the challenges presented by an arid and desert climate.[382]

Legislation relevant to land-based aquaculture regulation

Aquaculture Licence and Regulation of Aquatic Resources under Federal Law No. 23 of 1999 and other related laws

Federal Law No. 23 of 1999 is the primary law governing aquaculture licensing and regulation of living aquatic resources in UAE. It defines *aquaculture* as a production project in an industrial or natural environment for farming and breeding fish, crustaceans, mollusks, and aquatic plants.[383] The MOCCAE oversees the Aquaculture Farm Establishment Licence program under the statute, and issues permits for export, re-export , import, and transit of living aquatic resources fished outside the state (including eggs,

[375] Executive Order issued by Council of Ministers Decree No. 37 of 2001.
[376] Ministerial Order No. 12 of 2006.
[377] Executive Order issued by Council of Ministers Decree No. 37 of 2001.
[378] Implements other laws such as Federal Law No. 12 of 1982: Concerning Empowering the Minister of Electricity and Water to Issue Rules regarding organization/determination of the prices of Electricity and Water/Fees imposed on Beneficiaries/Financial Penalties and exemption instances, and Federal Law No. 21 of 1981: Concerning The Establishment Of The General Department For Water Resources Management In The United Arab Emirates.
[379] The emirates of Dubai and Abu Dhabi regulate water and electricity regulates through the Dubai Electricity & Water Authority (DEWA) and the Abu Dhabi Water and Electricity Authority, respectively.
[380] *See* The UAE National Framework Statement for Sustainable Fisheries(2019-2030), *available at* https://www.moccae.gov.ae/assets/download/749e9268/UAE%20National%20Framework%20Statement%20for%20Sustainable%20Fisheries%20(2019-2030)%20English.pdf.aspx.
[381] See company profile of Fish Farm LLC at http://www.fishfarm.ae/our-story.html.
[382] Implements other laws such as Federal Law No. 12 of 1982: Concerning Empowering the Minister of Electricity and Water to Issue Rules regarding organization/determination of the prices of Electricity and Water/Fees imposed on Beneficiaries/Financial Penalties and exemption instances, and Federal Law No. 21 of 1981: Concerning The Establishment Of The General Department For Water Resources Management In The United Arab Emirates.
[383] Article 25, Federal Law No. 24 of 1999.

larvae, fingerlings, and broodstocks).[384] Aquaculture farms licencees must keep records of their activities and submit annual reports to the MOCCAE, subject to routine inspection. The Ministerial Resolution 302 of 2001 and Ministerial Resolution No. 21 of 2018 implement Federal Law No. 23 of 1999; the latter establishes conditions and controls in granting licences for aquaculture.

Environmental Protection under Federal Law No. 24 of 1999 and other related laws

Federal and emirate-level licensing and permitting

Federal Law No. 24 of 1999 establishes a comprehensive legal framework covering environmental protection, control of all forms of pollution, and prevention of long-term harmful effects of developments. This general framework is subject to further refinement by the minimum standards set under federal regulations as well as those set forth under more specific local regulations. Importantly, the law creates requirements for the development of projects or establishments, including aquaculture farms. The MOCCAE enforces the statute, in close coordination with its counterpart agencies in the emirates. The latter play an active role in the permitting process for the construction and operation of projects or establishments within their respective jurisdictions.

The law requires any project or establishment to obtain a permit before undertaking an activity (e.g., developing a Land Based Aquaculture [LBA] facility).[385] This is colloquially referred to as an "environmental permit," with various technical names in the emirates (e.g., No Objection Certificate (NOC)[386] or Environmental Clearance).[387] Proponents must obtain an environmental permit during the initial planning stage and prior to construction. An operational permit from the emirate's environmental agency may also be required, depending on the emirate, to operate the establishment or project. These emirate-level permits are subject to the general requirements of Federal Law No. 24 of 1999, its implementing regulations, and specific or sometimes even more stringent local standards of the emirates. These local standards mostly concern discharge of effluent to water bodies. The law also requires aquaculture farms to prepare and submit an environmental impact assessment to the relevant emirate's environmental agency. Moreover, some emirates designate specific sites for aquaculture development as part of their land use planning; a proposed facility may require an initial project site approval.[388]

Federal Law No. 24 of 1999 prescribes a national system of environmental monitoring networks, administered by the MOCCAE in close coordination with the emirates. This system reports violations and submits periodic reports.

Applicants submit the NOC, environmental impact assessment, project site approval, and any additional items required by each emirate to the MOCCAE for review (through the online portal) as part of the aquaculture licensing system.

[384] Articles 49 and 50, Federal Law No. 24 of 1999, as amended, and implementing rules.
[385] Article 4, Federal 24 of 1999.
[386] Term used in Abu Dhabi.
[387] Term used in Dubai.
[388] Abu Dhabi delineates areas for aquaculture projects within its jurisdiction.

Water Environment.[389] Under Federal Law No. 24 of 1999, subject to the Regulation concerning Environmental Impact Assessment Projects, aquaculture facilities and other establishments must treat substances, wastes, or liquid prior to discharging the effluent into the water or marine environment. Effluent must not exceed the allowable limits prescribed under federal regulations.[390] Also prohibited are discharge of certain non-degradable contaminants prescribed in the regulations,[391] and discharge from establishments located near the coastline.

Moreover, an aquaculture farm must comply with the emirate-level environmental standards and guidelines that prescribe allowable limits of pollutant levels in effluent. These levels are usually expressed in numerical valuations. Examples of different local standards observed in the emirates include:

1) **Abu Dhabi Water Quality Regulations of 2021** - provides drinking water quality Guidelines, among others.[392]
2) **Dubai Environmental Standards and Allowable Limits of Pollutants on Land, Water and Air Environment** – specifies wastewater discharge limits, marine quality objectives, and land contamination indicator levels.[393]
3) **Ras Al Khaimah Environmental Standards and Allowable Limits –** sets out appropriate ambient water (tank, drinking, industrial effluent, sewage, ground etc.), soil, pesticide, and sediment quality specifications.[394]

Federal Law No. 24 of 1999 also protects drinking water and preserves underground water resources via prescribed safety rules for water tanks and water connections. These are both subject to periodic examination.

Soil protection. Federal Law No. 24 of 1999 prohibits any activity from contributing directly or indirectly to damaging, disturbing the natural properties of, or polluting the soil in any way that may affect its productivity.[395] The law protects natural reserves (especially those situated in the desert environment), prohibits activities from affecting the quantity and quality of flora and fauna, includes measures against

[389] Technically defined under Federal Law No. 24, 1999 as marine environment and inland waters including ground, spring and valleys waters and their natural resources, plants, fishes and other living organisms as well as the above atmosphere, fixed and movable installations and projects established on such waters.
[390] Article 35, 21 and 22 of Federal Law No. 24 of 1999.
[391] Article 21 and 22 of the Regulation for the Protection of Marine Environment.
[392] ABU DHABI DEPARTMENT OF ENERGY, WATER REGULATIONS 2021 (2021), available at https://www.doe.gov.ae/-/media/Project/DOE/Department-Of-Energy/Media-Center-Publications/Regulations/English/Water-Quality-Regulations-2021-Edition-5.pdf.
[393] DUBAI ENVIRONMENT DEPARTMENT, DUBAI ENVIRONMENTAL STANDARDS AND ALLOWABLE LIMITS OF POLLUTANTS ON LAND, WATER, AND AIR ENVIRONMENT (2003), available at https://www.researchgate.net/profile/Anoop_Srivastava7/post/What_is_the_permissible_level_of_Heavy_metals_in_Marine_water_and_Port_waters/attachment/59d6517a79197b80779a9fad/AS%3A507599269629952%401498032504605/download/allowablepollutants.pdf.
[394] RAS AL KHAIMAH, ENVIRONMENTAL PROTECTION AND DEVELOPMENT AUTHORITY, RAS AL KHAIMA ENVIRONMENTAL STANDARDS AND ALLOWABLE LIMITS (2020), available at https://epda.rak.ae/Documents/EPDA%20Standard%20Limits.pdf.
[395] Article 43, Federal Law No. 24 of 1999.

desertification and deformation, and recommends use of modern technologies for agriculture development, such as recycling and reuse of water.

Air Pollution.[396] Operational establishments or projects must not exceed permissible limits for air pollutants, as specified under implementing regulations.[397] The use of machines, engines, or vehicles producing exhaust gases similarly may not exceed permissible limits.[398] Establishments are prohibited from discarding, treating, or burning garbage and solid wastes, except at designated sites located a certain distance away from residential, industrial, and agricultural areas, as well as from the water environment.[399]

The Cabinet Decree No. 12 of 2006 (pertaining to the Regulation concerning Protection of Air from Pollution) implements relevant provisions of Federal Law No. 24 of 1999. The Decree prescribes the maximum allowable air pollutant emission limits for stationary sources, stationary combustion sources using hydrocarbon fuel, allowable limits of pollutants in the working areas (such as dust and chemicals), and ambient air quality standards.

Noise. Parties and individuals undertaking production, service, or other activities—and especially when operating machines, equipment, warning devices and loud-speakers– may not exceed the permissible limits for noise levels set for different types of areas.[400]

Pesticides. MOCCAE registers pesticides and issues permits for release of imported pesticides, under Federal Law No. 10 of 2020 (regulating pesticides) and Ministerial Decree No. 849 of 2010 (amending Ministerial Decision No. 554 of 2009 concerning the prohibited and restricted use of pesticides).

Hazardous wastes. Export, import, transit, and disposal of hazardous wastes requires a permit from MOCCAE and adherence to the Regulation for Handling Hazardous Materials, Hazardous Wastes and Medical Waste.[401] The latter sets forth requirements for handling and disposal of hazardous materials, hazardous wastes, and medical wastes.

Other relevant federal laws regulating land-based aquaculture

- Federal Law No. 9 of 2017 on Veterinary Products—registration and licensing of veterinary products (administered by MOCCAE)
- Ministerial Decree No. 163 of 2012 (on tracking and recalling of food and feed) and Ministerial decree No. 369 of 2008—setting the requirements for registration of non-pharmaceutical veterinary products and animal food (administered by MOCCAE)
- *Federal Law No. 12 of 2018* (integrated Waste Management)—promoting reuse, recycling and safe disposal of industrial waste (administered by MOCCAE)

[396] Articles 43, 48, 49, 50, 52, 56 of Federal Law No. 24 of 1999.
[397] Article 48, Federal Law No. 24 of 1999.
[398] Article 49, Federal Law No. 24 of 1999.
[399] Article 50, Federal Law No. 24 of 1999.
[400] Article 54, Federal Law No. 24 of 1999.
[401] Article 59, Federal Law No. 24 of 1999.

- *Federal Law No. 5 of 2009 on Organic Inputs and Products*—production, manufacturing, processing, circulation, import, and export of organic inputs and products (administered by MOCCAE)

Public participation

Environmental review. The Environmental Impact Assessment (EIA) process in some emirates incorporates elements of public participation via feedback mechanisms. For example, in Dubai,[402] the initial stage of conducting an EIA is guided by the EIA Principles and Factors.[403] These facilitate consultation with stakeholders, in order to assess the overall impacts of a project prior to the environmental agency making a decision on the application for environmental permits (Environmental Clearance). The goal is inclusion of environmental protection, mitigation, and enhancement measures. *Stakeholders* in this context refers to individuals, communities, government agencies, private organizations, non-governmental organizations, or others who may directly or indirectly be affected by or may have interest in the Project or activity. Dubai's procedure also recognizes traditional and Indigenous knowledge as the basis for local-level decision-making in many rural communities and integrates this information into impact assessment to provide a complete and reliable overview of issues specific to a community.

The applicant is required to attend site progress meetings as necessary and attend other meetings with concerned stakeholders regarding the environmental concerns or issues they may raise. Measures to mitigate identified social impacts of projects are usually incorporated into environmental management and monitoring requirements included in the environmental impact assessment.

Environmental Permits and Operational Permits. After issuance of environmental permits, the emirate-level environmental agencies will monitor regulatory compliance. The agencies carry out inspection, gather information on environmental damage, accept public complaints for investigation, and issue a Notice of Violation to permit holders in the case of non-compliance.[404]

Aquaculture Farm Establishment Licence. The UAE's aquaculture regulatory framework remains in its infancy. The country very recently adopted the UAE National Framework Statement for Sustainable Fisheries (2019-2030), which recognizes the vital role played of stakeholders, such as commercial fishers, recreational fishers, fishermen's cooperative, societies, aquaculture producers, and the public.[405] This framework aims to involve stakeholders in decision making for future policy and legal developments in the coming years.

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[402] Stakeholder participation is incorporated in environmental impact assessment in Dubai as stated in its Guidance on the Environmental Clearance (EC) Requirements for Development, Infrastructure and Industrial Projects in the Emirate of Dubai. Abu Dhabi's Standard Operating Procedure for Permitting of Development and Infrastructure Project also recognize that stakeholders must be informed of projects.

[403] Dubai Municipality, Guidance on the Environmental Clearance (EC) Requirements for Development, Infrastructure and Industrial Projects in the Emirate of Dubai p 19, https://www.dm.gov.ae/wp-content/uploads/2021/09/.

[404] Dubai Municipality, Guidance on the Environmental Clearance (EC) Requirements for Development, Infrastructure and Industrial Projects in the Emirate of Dubai p 45, https://www.dm.gov.ae/wp-content/uploads/2021/09/.

[405] Ministry of Climate Change and the Environment, The UAE National Framework Statement for Sustainable Fisheries (2019-2030), p.6.

In addition, MOCCAE administers a Digital Participation portal.[406] This empowers the public to participate in the agency's decision-making process via soliciting suggestions, proposals, and opinions submitted through linked social media platforms, polls, communication channels, surveys, and digital consultations. The public may also submit and request data under an Open Data portal.

Table 10. Overview of the U.A.E Regulatory Framework for Land-Based Aquaculture

Regulated area	Permit/ Report Name	Impacts Addressed	Lead Agency	Permit Allows	Permit Requires	Public Participa-tion	Key Laws/ Regulations
Environ-mental Assessment	Environmental Impact Assessment (EIA)	Significant environmental impacts, such as air quality; noise and vibration; land uses, soil, and groundwater; water uses, water and sediment quality; aquatic ecology and nature conservation; terrestrial ecology and nature conservation	Emirate-level environmental agency	Serves as require-ment for permit (e.g., No Objection Certificate or Environ-mental Clearance) and the aquaculture farm license	Identifica-tion of significant impacts, their magnitude, mitigation & enhance-ment measures	Consultation with stakeholders who may be affected by the aquaculture farm	Federal Law No. 24 of 1999, its regulations, and local standards of the emirates.
Land use	Permit from environmental agencies of emirates (e.g., Project Site Approval, No Objection Certificate, Environmental Clearance) as required in aquaculture farm license	Pollution of soil and moderation of development	Emirate-level environmental agency	Construc-tion in areas designated for aquaculture and carrying out other activities which may affect soil, subject to limitations	Conformity with local land use planning and federal regulations for soil protection	Public complaints regarding violations of a permit holder may be submitted to the environ-mental agency	Federal Law No. 24 of 1999, its regulations and local standards of the emirates
Habitat	Permit from environmental agencies of emirates (e.g., No Objection Certificate, Environmental Clearance) as required in aquaculture farm license	Impact on natural reserves, habitat of wild and marine animals including endangered species	MOCCAE and Emirate-level environmental and planning agencies	Establish-ment and activities on natural reserves and near habitats of wildlife and marine animals subject to limitations	Compliance with federal regulations protecting natural reserves, wild and marine animals & endangered species	Public complaints regarding violations of a permit holder may be submitted to the environ-mental agency	Federal Law No. 24 of 1999, its regulations, and Federal Law No. 11 of 2002
Invasive species	Import Permit from the MOCCAE	Infiltration of species to local aquatic resources	MOCCAE	Importation of brood stock, permission	Maximum precaution to prevent infiltration	N/A	Federal Law No. 23 of 1999 and its regulations

[406] Available at www.moccae.gov.ae/en/e-participation/social-media.aspx.

				to rear non-native species	to local aquatic environment. Quarantine facilities and measures for at least three weeks		
Water quality (effluent)	Permit from environmental agencies of emirates (e.g. No Objection Certificate, Environmental Clearance and or operational permit) as required in aquaculture farm license	Discharge of pollutants from LBA facilities into the water environment	MOCCAE and Emirate-level environmental agency	Discharge of pollutants into the water environment	Treatment facilities, compliance with effluent limitations, and prohibits some non-degradable discharge	Public complaints regarding violations of a holder of a permit approving water quality may be submitted to the environmental agency	Federal Law No. 24 of 1999, its regulations and local standards of the emirates
Water quality (ground-water)	Permit from environmental agencies of emirates (e.g. No Objection Certificate, Environmental Clearance and or operational permit) as required in aquaculture farm license	Pollution of groundwater and drinking water	MOCCAE and Emirate-level environmental agency	Discharge of wastewater from aquaculture farms	Compliance with federal regulations on safety rules for tanks and water connections and local regulations	Public complaints regarding violations of a holder of a permit approving water quality may be submitted to the environmental agency	Federal Law No. 24 of 1999, its regulations and local standards of the emirates
Pesticides	Certificate of Registration or Release Permits in case of importation of pesticides	Pollution of soil environment, health, and safety of aquaculture products	MOCCAE	Use of pesticides in LBA farms	Registration of pesticides, recording and included in the annual reporting	N/A	Federal Law No. 24 of 1999, Federal Law No. 10 of 2020, Ministerial Decree No. 849 of 2010 and Ministerial Decision No. 554
Aquaculture	Aquaculture Farm Establishment License	Species (e.g. fish, crustaceans, mollusks, and aquatic plants), which may be produced through aquaculture and different aquaculture systems which may be used in the Aquaculture Farm Establishment (e.g., RAS)	MOCCAE	Farming and breeding fish, crustaceans, mollusks, and aquatic plants. Use of aquaculture systems	Permits from the respective environmental agencies and environmental impact assessment	Request and submission of data. Digital participation in polls, surveys, consultation etc.	Federal Law No. 23 of 1999 and its regulations

Case Studies of Land-Based RAS facilities

This segment examines three distinct land-based aquaculture facilities and thoroughly analyzes how they have approached and resolved environmental concerns. Each case study provides a comprehensive overview of the facility, including its history, geographical location, and ownership. Additionally, the assessment will encompass the environmental impact of each facility, any relevant permits and certifications and it explores the community response to these facilities. Lastly the study identifies essential insights and best practices that may be employed by similar operations.

AquaBounty Facility in Albany, Indiana

Overview

AquaBounty raises and harvests genetically modified (GM) AquAdvantage Salmon at its Land-based aquaculture (LBA) facility in Albany, Indiana ("Indiana farm").[407] The company uses Recirculating Aquaculture Systems (RAS) technology.

In 1989, researchers at Memorial University of Newfoundland developed a genetically modified Atlantic Salmon that grows to market size (4-6kg) in about two years, as opposed to three years. This GM salmon is farmed today at the AquaBounty facility in Indiana, and in 2015, became the first genetically engineered animal approved for human consumption by the FDA in the U.S. and Canada.[408]

AquaBounty purchased the Indiana farm from Bell Aquaculture in 2017 and started operations in 2019, producing the first batch of salmon in 2020.[409] The facility is capable of producing 1,200 metric tons of salmon annually, and consists of a hatchery, nursery, grow-out facility, and purge–harvest area.[410]

AquaBounty also operates a facility in Prince Edward Island, Canada ("Canadian farm") and is constructing another in Pioneer, Ohio ("Ohio farm"). The company operated a grow-out facility in Panama that was fined for water use and discharge violations by the Panamanian National Environmental Authority in 2014; that facility ceased operations in 2019. Its closure was unrelated to the water fines. [411]

In October 2022, former AquaBounty employee at the Indiana farm, Braydon Humphrey, released a report entitled "AquaBounty Exposed Report" alongside #BlockCorporateSalmon campaign, a national Black, Indigenous, People of Color-led campaign, detailing myriad ways the company has failed to meet their environmental and worker safety promises.[412] The report includes text messages, photos, and videos as proof.[413]

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[407] About Us, https://aquabounty.com/about-us (last visited Dec. 27, 2022).
[408] NADA 141-454 dated Nov. 19, 2015.
[409] About Us, https://aquabounty.com/about-us (last visited Dec. 27, 2022).
[410] Our Farms, https://aquabounty.com/our-farms (last visited Dec. 27, 2022).
[411] Christine Blank, *AquaBounty defends its Panama salmon operations,* Seafood Source (Oct. 29, 2014), https://www.seafoodsource.com/news/aquaculture/aquabounty-defends-its-panama-salmon-operations.
[412] *AquaBounty Exposed Report*, Black Corporate Salmon Campaign (Oct. 25, 2022), https://docs.google.com/document/d/1FysnUssU4IvPQljNl3nWnWEVkN4Yj1CYQgu3f9YXIAo/edit#heading=h.v5ne2qst1c56.
[413] *Photo & Video Evidence of AquaBounty Former Worker Testimony*, Black Corporate Salmon Campaign (Oct. 25, 2022), https://docs.google.com/document/d/1R17Vfr5A-rTEKuMBfRd7YqS0mu67kLVrKeBWEKuyI6s/edit.

Environmental Impacts

The Indiana farm uses water at a rate of between 300 and 350 gallons per minute (GPM) when fully operational,[414] and recirculates more than 95% of the freshwater it consumes.[415] Water is degassed and filtered onsite, both when entering the system and before being recirculated. Even with this recirculation, the Indiana farm is classified as a Significant Water Withdrawal Facility by the Indiana Department of Natural Resources. This designation requires AquaBounty to report annual water consumption within three months after the end of each calendar year. Although the facility is permitted to use 1.33 million gallons of water per day (MGD), it consistently consumes less than half that allotment.[416] The facility used approximately 0.52 MGD in 2021, equivalent to about 82 m3/h. Since the facility produces 1200 metric tons of fish annually, that level of water consumption per kilogram of fish produced is 0.58 m^3, using the upper estimate of 350 GPM. This figure means AquaBounty's water usage is less efficient than an average super intensive RAS, but more efficient than an average intensive RAS. A super intensive RAS uses approximately .3m^3 per kilogram of fish produced and intensive RAS uses 1m^3 per kilogram of fish produced.[417]

Table 11. NPDES Permit Daily and Average Maximum Limits

	BOD	Ammonia	Phosphorous	TSS	pH
Summer Daily Maximum	30 mg/l	3.8 milligrams per liter (mg/L)	0	36 mg/L	6.0
Winter Daily Maximum	50 mg/l	7.7 mg/L	0	60 mg/L	9.0
Summer Monthly Average Maximum	15 mg/L	1.7 mg/L	0	18 mg/L	6.0
Winter Monthly Average Maximum	25 mg/L	3.3 mg/L	0	30 mg/L	9.0

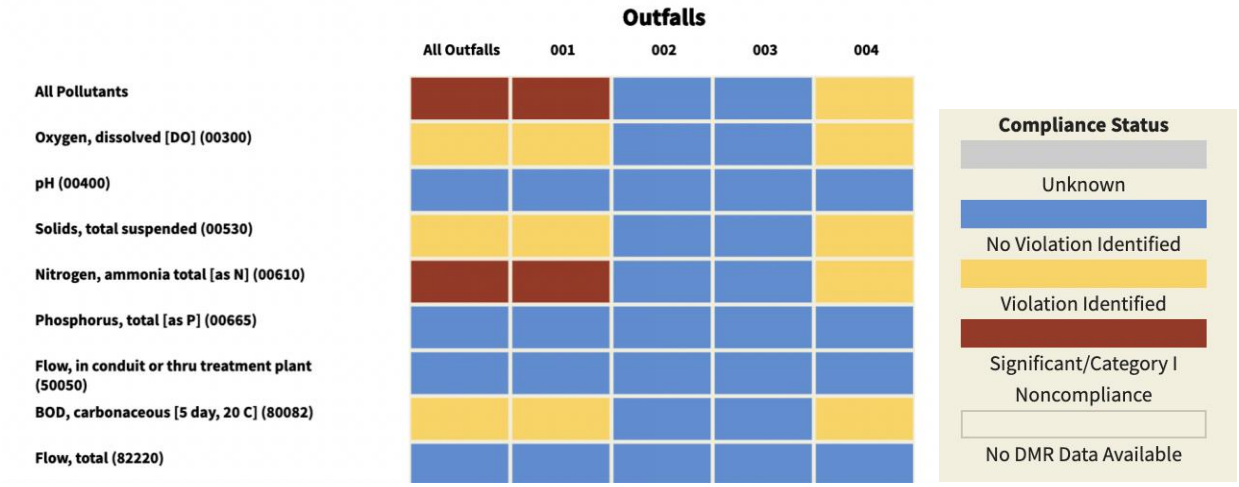
The Indiana farm treats water for reuse with a Moving Bed Biofilm Reactor (MBBR) technology and an aerated wastewater treatment tower.[418] This biofiltration process claims to remove suspended solids, ammonia, and carbon dioxide, creating "sludge" which is then applied as agricultural fertilizer. The Indiana farm produces about one ton of sludge per day. The remaining water that is not reused is treated and discharged into a series of 12 wetlands ponds. This effluent then flows into the Riley Stafford Ditch and

[414] *Significant Water Withdrawal Facility Data,* Indiana Department of Natural Resources Division of Water, https://www.in.gov/dnr/water/files/18-SWWF.zip (last visited Jan. 5, 2023).
[415] About Us, https://aquabounty.com/about-us (last visited Dec. 27, 2022).
[416] *AquaBounty Pollutant Loading Report (DMR)*, EPA Enforcement and Compliance History Online (2020), https://echo.epa.gov/trends/loading-tool/reports/dmr-pollutant-loading?permit_id=IN0062669&year=2020; *AquaBounty Pollutant Loading Report (DMR)*, EPA Enforcement and Compliance History Online (2021), https://echo.epa.gov/trends/loading-tool/reports/dmr-pollutant-loading?permit_id=IN0062669&year=2021.
[417] Jacob Bregnballe, *A Guide to Recirculation Aquaculture An introduction to the new environmentally friendly and highly productive closed fish farming systems*, Food and Agriculture Organization of the United Nations (2015).
[418] Section 327 IAC 2-1-6.

then the Mississinewa River.[419] Former employee, Humphrey, reported that despite these cleaning procedures, AquaBounty did not replace the aging infrastructure inherited from Bell Aquaculture, leading to "delamination of the fiberglass tanks," and resulting in pieces of fiberglass floating around and polluting the fish tank water.[420]

The facility's National Pollutant Discharge Elimination System (NPDES) permit limits the amount of Biochemical Oxygen Demand (BOD), Ammonia, phosphorous, total suspended solids (TSS), and pH discharged into Indiana waters (Figure 1).[421] As of publication, AquaBounty has exceeded effluent limits for eight out of twelve quarters since being issued its NPDES permit (Figure 2).[422] Most notably, on July 8, 2020, AquaBounty voluntarily reported noncompliance with the permit limits for ammonia without providing a cause.

Figure 4: AquaBounty Effluent Compliance Outfalls since 2019



Courtesy of EPA's Enforcement and Compliance history online Effluent Chart tracker.

Other hazardous materials have also been found onsite. In the AquaBounty Exposed Report, video evidence captured by Humphrey shows a "severe instance of plumes of hydrochloric acid fumes leaking from a barrel,"[423] a chemical which is known to cause asphyxiation in humans.[424] The same report noted

[419] FDA, AquAdvantage Salmon Environmental Assessment: Supplement to NADA 141-454 (Apr. 20, 2018).
[420] *AquaBounty Exposed Report*, Black Corporate Salmon Campaign (Oct. 25, 2022), https://docs.google.com/document/d/1FysnUssU4IvPQljNl3nWnWEVkN4Yj1CYQgu3f9YXIAo/edit#heading=h.v5ne2qst1c56.
[421] NPDES permit #IN0062669.
[422] *AquaBounty Detailed Facility Report,* EPA Enforcement and Compliance History Online, https://echo.epa.gov/detailed-facility-report?fid=110028093186 (last visited Jan. 5, 2022).
[423] *AquaBounty Exposed Report*, Black Corporate Salmon Campaign (Oct. 25, 2022), https://docs.google.com/document/d/1FysnUssU4IvPQljNl3nWnWEVkN4Yj1CYQgu3f9YXIAo/edit#heading=h.v5ne2qst1c56.
[424] *Medical Management Guidelines for Hydrogen Chloride,* Agency for Toxic Substances and Disease Registry, https://wwwn.cdc.gov/TSP/MMG/MMGDetails.aspx?mmgid=758&toxid=147 (last visited Jan. 5, 2023).

AquaBounty was consistently using barrels used to transport hazardous materials for other purposes, even though they are required, by law, not to be reused. The employee offered evidence of "mislabeling and improper handling and storage of chemicals such as hydrochloric acid, virocid containers without lids, barrels full of mystery chemicals (and people joking about it), and a spray bottle labeled as alcohol that was actually full of paint thinner."[425]

The Indiana Department of Environmental Management air permits branch has not received an application from AquaBounty for an air emissions permit. In an interview conversation with a representative from the Department's air permits branch, they described it as a "chicken and egg problem." Unless AquaBounty applied for an air emissions permit, the department would not have reason to access the facility's air emission data. If there was suspected infringement of local air laws, the department would act.[426]

The Indiana farm is not on the EPA's list of large emitting GHG facilities.[427] While the EPA's Greenhouse Gas Reporting Program (GHGRP) captures only 80–90% of U.S. total emissions data at a facility level, AquaBounty's exclusion from the list of large emitters that self-report their emissions suggest the facility's emissions fall below the 25,000 metric tons of CO2e/Year threshold.[428] The Indiana farm is not currently pursuing renewable energy efforts or strategies to reduce energy consumption, despite high levels of energy usage, with energy bills consistently exceeding $10,000 a month.[429]

One element particular to the Indiana farm is its production of GM salmon exclusively. According to AquaBounty, the primary benefit of producing GM salmon is that these fish are modified to mature more quickly than their non-modified counterparts. While they consume more food daily, they also reach maturity in about two-thirds the time of an unmodified salmon. Consequently, AquaBounty salmon require less food over a lifetime, approximately 25% less than salmon bred in a sea-cage operation.[430] As feed containing fishmeal and fish oil most strongly connects LBA with unsustainable wild fishing operations, this substantial reduction in the amount of food required to bring salmon to harvest could be seen as a sustainability initiative. Additionally, AquaBounty sources only 100% GlobalG.A.P. Certified feed.[431]

GM fish have the potential to cause harm to local ecosystems, should they escape. GM salmon that breed with unmodified fish could pass on their modified gene, allowing offspring to grow to much larger sizes. Such offspring would impact the natural ecosystem through competition for the same prey.[432]

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[425] *AquaBounty Exposed Report*, Black Corporate Salmon Campaign (Oct. 25, 2022), https://docs.google.com/document/d/1FysnUssU4IvPQljNl3nWnWEVkN4Yj1CYQgu3f9YXIAo/edit#heading=h.v5ne2qst1c56.
[426] Telephone interview with Indiana Dept. of Env. Mgmt. (Aug. 30, 2022).
[427] *GHGRP State and Tribal Fact Sheet,* EPA Greenhouse Gas Reporting Program, https://www.epa.gov/ghgreporting/ghgrp-state-and-tribal-fact-sheet (last visited Jan. 5, 2023).
[428] *Using GHG Inventory and GHGRP Data,* EPA, https://cfpub.epa.gov/ghgdata/inventoryexplorer/data_explorer_flight.html (last visited Jan. 5, 2023).
[429] *AquaBounty Exposed Report*, Black Corporate Salmon Campaign (Oct. 25, 2022), https://docs.google.com/document/d/1FysnUssU4IvPQljNl3nWnWEVkN4Yj1CYQgu3f9YXIAo/edit#heading=h.v5ne2qst1c56.
[430] Casey Smith, *In a first-of-its-kind endeavor, AquaBounty farms country's bio-engineered salmon in Indiana,* IndyStar (July 28, 2019), https://www.indystar.com/story/news/environment/2019/07/28/aquabounty-farms-united-states-first-bio-engineered-salmon-indiana/1528588001/.
[431] *See* Summary of sustainability ranking systems.
[432] Rebecca Morelle, *GM Salmon can breed with wild fish and pass on genes,* BBC News (May 29, 2013), https://www.bbc.com/news/science-environment-22694239.

AquaBounty addresses this challenge with a three-pronged approach to preventing fish escapes in its facilities: biological, environmental, and physical. Biologically, AquaBounty produces triploid fish, meaning they are incapable of breeding. The facility also breeds only female fish.[433] Environmentally, the surrounding habitat serves as a de facto barrier as it is not suitable for Atlantic salmon.[434] Neither Atlantic salmon nor other salmonids are endemic to the receiving water bodies adjacent to the Indiana farm's outfall pipe. Finally, physical containment methods include onsite security personnel, cameras, and a chain link fence installed on top of nets, screens, and filters. Chemical barriers include chlorine applied in drainage areas to kill any eggs that may escape. These barriers serve a dual purpose by eliminating any need for the facility to use medicines, chemicals, or antibiotics for disease prevention, and instead the Indiana farm relies on biosecurity methods to prevent the introduction of pathogens.[435]

Despite these stated biosecurity practices, Humphrey recounts multiple instances of improper biosecurity measures including using duct tape to repair nets, pests like frogs and rats present in the facility, "excessive" use of toxins and antibiotics, fish corpses decomposing and recirculating in the system, live fish feeding on fish corpses, clogged drains, floating fiberglass, a fungal outbreak covering gills in "a sticky gray mucus," disposal of dead fish in outside dumpsters where other animals in the ecosystem may consume them, and sometimes disposal of live fish in outside dumpster.[436]

Permits and Certifications

AquaBounty has an aquaculture permit issued by the Indiana Department of Natural Resources (DNR). This permit is conditioned on the farm periodically publishing reports on the "health status of broodstock housed at the [Canadian] facility" which supplies the Indiana farm.[437]

The Indiana farm is not GlobalG.A.P. Certified. AquaBounty recently initiated the BAP certification process after a 2019 determination by the certification company to make facilities producing GM fish eligible.[438] The Aquaculture Stewardship Council continues to consider operations producing GM fish ineligible for its certification.

Still, the AquaBounty Exposed Report details procedures undertaken in the lead up to visits from permitting agencies. The report claims employees were instructed to "stop feeding the fish 24 hours before on-site visits, as well as to introduce extra fresh water into the tanks in order to make the water look clearer than it normally was." There was also evidence in text messages of high-level management instructing employees to obscure the amount of fish mortalities. One text message from an employee reads "the drum filter being off will cause it to overflow and go to the sump. This is a SERIOUS violation of

[433] Anastasia Bodnar, *Preventing Escape of GM Salmon,* Biology Fortified (Nov. 20, 2015), https://biofortified.org/2015/11/gmo-salmon/.
[434] *Q&A on FDA's Approval of AquAdvantage Salmon,* FDA, https://www.fda.gov/animal-veterinary/aquadvantage-salmon/qa-fdas-approval-aquadvantage-salmon (last visited Jan. 5, 2023).
[435] FDA, AquAdvantage Salmon Environmental Assessment: Supplement to NADA 141-454 (Apr. 20, 2018).
[436] *AquaBounty Exposed Report*, Black Corporate Salmon Campaign (Oct. 25, 2022), https://docs.google.com/document/d/1FysnUssU4IvPQljNl3nWnWEVkN4Yj1CYQgu3f9YXIAo/edit#heading=h.v5ne2qst1c56.
[437] FDA, AquAdvantage Salmon Environmental Assessment: Supplement to NADA 141-454 (Apr. 20, 2018).
[438] Chris Chase, *AquaBounty GE salmon eligible for BAP certification; company plans to pursue*, Seafood Source (Mar. 13, 2019) https://www.seafoodsource.com/news/aquaculture/aquabounty-ge-salmon-eligible-for-bap-certification.

our containment procedures. This point is NOT for discussion. If the FDA came tomorrow, this would be a serious finding."[439]

Community Response

AquaBounty has faced difficulties convincing U.S. grocery brands to carry its products. Aramark, Walmart, Kroger, Albertsons, and Ahold Delhaize have decided not to sell genetically modified salmon as of 2021.[440]

While there has not been a strong community opposition to the Indiana facility, members of the public raised significant concerns about the farm in Ohio that is under development, particularly pertaining to granting a water withdrawal permit.[441] Additionally, when American AquaFarms announced they were considering using AquAdvantage eggs (from the Canadian facility) at their farm in Maine, their application was terminated by the Maine Department of Natural Resources over "genetic questions."[442]

Alaska Senator Lisa Murkowski has opposed the FDA's decision to approve AquAdvantage Salmon, alongside environmental NGOs including The Center for Food Safety, Earthjustice and Friends of the Earth.[443] Senator Murkowski raised concerns about clear, transparent labeling of genetically modified salmon by reintroducing the S. 282 - Genetically Engineered Salmon Labeling Act (2019) within the 116th and 117th Congress.[444] Members of the public have also raised concerns about the FDA approval implicitly giving AquaBounty ownership rights over chinook salmon DNA used in the genetic modification process as it holds spiritual significance for the Mi'kma'ki people.[445]

A 2016 lawsuit centered on concerns over potential escapes, FDA agency authority, and labeling requirements, claiming that the FDA failed "to consider all environmental risks" under the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA), when granting approval to AquAdvantage salmon.[446] In response to this lawsuit and a 2020 requirement from a judge to perform an additional review of the GM salmon, the FDA released an amended Environmental Assessment in November 2020. As of the writing of this report, that draft is still open to public comment, and it is unclear the consequences it could hold for the company.[447]

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[439] *Photo & Video Evidence of AquaBounty Former Worker Testimony*, Black Corporate Salmon Campaign (Oct. 25, 2022), https://docs.google.com/document/d/1R17Vfr5A-rTEKuMBfRd7YqS0mu67kLVrKeBWEKuyI6s/edit.
[440] Sam Bloch, *America's biggest retailers and foodservice companies have already agreed not to sell GMO salmon,* The Counter (Feb. 11, 2021), https://thecounter.org/americas-biggest-retailers-foodservice-companies-gmo-salmon-aquabounty/.
[441] Tom Henry, *Salmon-faming project gets Ohio DNR permit to proceed,* Toledo Blade (Mar. 14, 2022), https://www.toledoblade.com/local/environment/2022/03/14/controversial-aquabounty-project-gets-ohio-dnr-permit-proceed/stories/20220314117.
[442] Cliff White, *AquaBounty salmon eggs cited as reason for Maine's rejection of American Aquafarms permit,* Seafood Source (Apr. 22, 2022), https://www.seafoodsource.com/news/aquaculture/aquabounty-salmon-eggs-cited-as-reason-for-maine-s-rejection-of-american-aquafarms-permit.
[443] Matthew Gonzales, *The World's First GMO Fish is Stranded in Albany, Indiana*, Indianapolis Monthly (Nov. 6, 2018), https://www.indianapolismonthly.com/news-and-opinion/news/the-worlds-first-gmo-fish-is-stranded-in-albany-indiana-2.
[444] Press Release, Lisa Murkowski, Murkowski and Colleagues Stand Up for Wild-Caught Salmon (Jun. 4, 2021), https://www.murkowski.senate.gov/press/release/murkowski-and-colleagues-stand-up-for-wild-caught-salmon.
[445] FDA public comment meeting, 12/15/2022 (Comments by Mark Butler from Nature Canada).
[446] NEPA: 42 U.S.C. § 4332(2)(C); ESA: 16 U.S.C. § 1536(a)(2); 50 C.F.R. § 402.14.
[447] *FDA Releases Draft Amended Environmental Assessment for AquAdvantage Salmon and Announces Virtual Public Meeting*, FDA (Nov. 16, 2022), https://www.fda.gov/animal-veterinary/cvm-updates/fda-releases-draft-amended-environmental-assessment-aquadvantage-salmon-and-announces-virtual-public.

Key Takeaways

AquaBounty is a prime example of a company promising sustainability practices on paper: high levels of water recirculation, extensive biosecurity practices, no antibiotic use, and high-end water cleaning procedures, to name a few. However, it is clear from the AquaBounty Exposed Report that the situation is far from the idealized picture they are portraying to investors, the public, and regulatory agencies. Excessive documentation of improper handling of chemicals, fish escapes, gruesome fish mortalities, poor employee training, elevated levels of contaminates, and a culture of lying and cover ups prove that AquaBounty is far from the paragon of sustainable land-based fish farming they claim to be. In fact, the only area where the company continues to demonstrate best sustainability practices is in the lower level of water required in the facility, a feature implicit to all RAS.

Sustainability Highlight: Superior Fresh and Aquaponics

Photo by Sara Stathas; Copyright: Kylie Gappa (kylie@superiorfresh.com)

Location: Hixton, Wisconsin
Capacity: 1.5 million pounds annually (after expansion)[1]

Superior Fresh is a BAP certified, Monterey Bay Seafood Watch "Best Choice" certified, non-GMO, Salmon Welfare certified, RAS facility producing Atlantic Salmon.[2] The company operates an aquaculture and a hydroponics facility symbiotically (termed "aquaponics"). The fish live in water ultimately watering the greens, and the greens purify the water to be returned to the fish. The fish waste also provides nutrients to the plants. This innovation means Superior Fresh can produce 1.5 million pounds of fish as well as 1.5 million pounds of organic vegetables annually, through their onsite grow houses.[3] Using 1,100 LED grow lights, Sustainable Blue mimics growing conditions of the Salinas Valley for their leafy greens while a well provides water to the next-door RAS facility. The company has plans to grow their current facility and establish more throughout the United States.

Sustainable Blue may be the most famous and largest example of an aquaponic system, but it is not the only one. Nearby, also in Wisconsin, Clean Fresh Foods uses a similar strategy with tilapia and leafy greens.[4] ECF Farm in Berlin raises perch and basil symbiotically,[5] and Upward Farms in Brooklyn, New York grows hybrid striped bass and microgreens.[6] Some aquaponics farms, like Ouroboros Farms in California, use fish to provide nutrients to the crops, but do not raise the fish themselves for consumption.[7]

While there remains concern about ensuring proper nutrient levels flow between fish tanks and fields in these types of systems,[8] the technology could be a way forward in reducing the amount of water required for both fish farming and greenhouse farming, both of which aim to respond to a growing global population's greater food consumption.

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[1] https://www.seafoodsource.com/news/aquaculture/superior-fresh-expanding-salmon-farm-in-wisconsin-looking-at-additional-locations;
[2] https://www.superiorfresh.com/fish; [3] https://apnews.com/article/ad5cd86ed7844916ae1f36b73710097a;
[4] https://www.cleanfreshfood.com/?fbclid=IwAR1eO9UdYrgC-k7EjxZtLmCx5zSMnFby7yNQeIQl0ZMSuNEW8qC4qONlBio; [5] https://www.ecf-farm.de/en;
[6] https://upwardfarms.com/products; [7] Proksch et al., Aquaponics in the Built Environment, https://link.springer.com/chapter/10.1007/978-3-030-15943-6_21;
[8] https://www.ouroborosfarms.com/try-it

Fifax Facility in Eckerö, Åland

Overview

Founded in 2012, Fifax produces rainbow trout for local consumption at an LBA facility in Eckerö, Åland, an autonomous region in Finland. It uses Ultra-intensive RAS technology.

Construction of the land-based facility began in 2014, and in 2020 it reached full technical capacity.[448] The Eckerö facility can produce 3,200 tons of rainbow trout annually,[449] containing 36 basins in three basin areas, and occupying approximately 15,000 m^2 of land.[450] Water is pumped from the Baltic Sea and filtered through three water treatment plants before being used, purified, and recycled.[451]

The Eckerö facility handles each step of the rainbow production process, including hatching, raising, cleaning, and processing rainbow trout. However, the company relies on third party partners to distribute, sell, and market its products. An outbreak of the Infectious Hematopoietic Necrosis (IHN) virus in 2022 required all fish at the facility to be either harvested or culled.[452]

Environmental Impacts

Fifax leases 34 hectares of land from Eckerö City for its operation. The facility is in an industrial zone where no natural protected areas and wetlands are present.[453] Fifax chose to operate its facility in Eckerö in order to source water from the Baltic Sea, which is located 1.5 km from the site.[454] The location also places the facility near Finnish and Swedish consumer markets.[455]

While rainbow trout production requires less feed than salmon,[456] Fifax notes feed remains the largest part of its carbon footprint.[457] Feed reduction is an area where Fifax seeks to improve, by attempting to implement more efficient feeding practices. Feeding regimens at the facility are calibrated to the fish size within each tank, ensuring smaller fish are not being provided excess food. Despite these practices, Fifax is has not reached its feed conversion ratio goal of 1.0, meaning the amount of feed consumed exceeds the net production of fish meat.

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[448] *Fifax: Better fish for the world (presentation to investors)*, Fifax (Oct. 2021), https://fifax.ax/wp-content/uploads/2021/10/fifax-company-presentation-for-investors-october-2021-english.pdf.
[449] *Financial Statements Release 1.1.2021-31.12.2021,* Fifax (Feb. 2022), https://fifax.ax/wp-content/uploads/2022/02/financial-statements-release-2021.pdf.
[450] *Weholite yields savings and smoother implementation, Eckerö, Finland*, Uponor, https://www.uponor.com/en-en/r/dry-land-fish-farm-facility-in-the-aland-islands (last visited Jan. 5, 2022).
[451] *Weholite yields savings and smoother implementation, Eckerö, Finland*, Uponor, https://www.uponor.com/en-en/r/dry-land-fish-farm-facility-in-the-aland-islands (last visited Jan. 5, 2022).
[452] Tiedotteet, *Fifax: The Finnish Food Authority has ordered the harvesting of symptom-free fish and the culling of remaining fish at the Eckerö facility due to the IHN virus outbreak*, Inderes (Nov. 7, 2022), https://www.inderes.fi/en/tiedotteet/fifax-finnish-food-authority-has-ordered-harvesting-symptom-free-fish-and-culling.
[453] *Audit Announcement*, Aquaculture Stewardship Council (2021).
[454] *Fifax: Better fish for the world (presentation to investors)*, Fifax (Oct. 2021), https://fifax.ax/wp-content/uploads/2021/10/fifax-company-presentation-for-investors-october-2021-english.pdf.
[455] *Fifax: Better fish for the world (presentation to investors)*, Fifax (Oct. 2021), https://fifax.ax/wp-content/uploads/2021/10/fifax-company-presentation-for-investors-october-2021-english.pdf.
[456] *Offering Circular: Listing on the First North Growth Market Finland marketplace, offering of approximately EUR 15 million, subscription Price of EUR 2.55 per Offer Share,* Fifax 32 (Sept. 28, 2021), https://fifax.ax/wp-content/uploads/2021/09/fifax-plc-offering-circular-28-september-2021.pdf.
[457] Interview with Sampaa Rouhtula, CEO and Linda Lindroos, CFO, Fifax (Oct. 13, 2022).

Fifax's feed supplier is the Danish company BioMar, which is GlobalG.A.P. certified and independently audited.[458] BioMar's feed sources are all either Global Standard for Responsible Supply (IFFO RS) or Marine Stewardship Council certified. IFFO RS is the leading independent business-to-business certification program for the production of marine ingredients,[459] and Marine Stewardship Council is a global nonprofit organization that works to end overfishing around the world.[460] According to Fifax, IFFO RS or MSC (Marine Stewardship Council) certification ensures traceability in the feed supply chain with strict regulations regarding wild fish use for feed.

Eggs constitute another important element of Fifax's carbon footprint. The company sources eggs from South Africa,[461] resulting in transportation associated GHG emissions. However, Fifax's proximity to key markets reduces transportation emissions associated with consumer delivery. Fifax does not monitor GHG emissions onsite, but claims they are negligible.[462] While Fifax's target carbon footprint is 6.1 kg annually,[463] putting it on a competitive level with protein sources like chicken (with a carbon footprint of 6.2 kg),[464] these levels remain only targets and have not been independently confirmed (Figure 1).

Fifax optimizes water consumption through: (1) ensuring a water consumption ratio of 50 l/kg, and (2) reusing more than 99.7% of water through an almost completely closed loop RAS technology.[465] The facility discharges the remaining treated effluent back into the ocean at a volume of approximately 10 m^3/h. In that same hour, on average, Fifax is inputting 80 m^3/h of water into the system.[466] That which is not accounted for in the discharge evaporates in the system. Since the facility produces 3200 metric tons of fish annually, the amount of water used per kilogram of fish is 0.24m^3. Super intensive RAS uses an average of 0.3m^3 per kilogram of fish produced. Fifax is super intensive.

The facility's water treatment process includes removing solids, disinfection, pH adjustment, biological filtering, and oxygenation.[467] The "ultra-intensive" system, as the company describes, filters microplastics and other solids before treating for nitrogen and phosphorus.[468] Information regarding the specifics of the treatment system could not be verified independently. Water undergoes treatment during intake, between reuses, and prior to discharge back into the Baltic Ocean as effluent.[469] Fifax's oxygenation

[458] GGN #4050373897437.
[459] *IFFO RS,* Global Marine Commodities, https://globalmarinecommodities.org/en/iffo-rs/ (last visited Jan. 5, 2023).
[460] *What is the MSC?,* Marine Stewardship Council, https://www.msc.org/en-us/about-the-msc (last visited Jan. 5, 2023).
[461] Interview with Sampaa Rouhtula, CEO and Linda Lindroos, CFO, Fifax (Oct. 13, 2022).
[462] Interview with Sampaa Rouhtula, CEO and Linda Lindroos, CFO, Fifax (Oct. 13, 2022).
[463] *Fifax: Better fish for the world (presentation to investors)*, Fifax (Oct. 2021), https://fifax.ax/wp-content/uploads/2021/10/fifax-company-presentation-for-investors-october-2021-english.pdf.
[464] *Fifax: Better fish for the world (presentation to investors)*, Fifax (Oct. 2021), https://fifax.ax/wp-content/uploads/2021/10/fifax-company-presentation-for-investors-october-2021-english.pdf.
[465] *Fifax: Better fish for the world (presentation to investors)*, Fifax (Oct. 2021), https://fifax.ax/wp-content/uploads/2021/10/fifax-company-presentation-for-investors-october-2021-english.pdf.
[466] *Audit Announcement*, Aquaculture Stewardship Council (2021).
[467] *Fifax: Better fish for the world (presentation to investors)*, Fifax (Oct. 2021), https://fifax.ax/wp-content/uploads/2021/10/fifax-company-presentation-for-investors-october-2021-english.pdf.
[468] Interview with Sampaa Rouhtula, CEO and Linda Lindroos, CFO, Fifax (Oct. 13, 2022).
[469] Interview with Sampaa Rouhtula, CEO and Linda Lindroos, CFO, Fifax (Oct. 13, 2022).

system reduces the company's oxygen use and manufacturing footprint by allowing similar oxygen levels to be reached in the water with less oxygen fed into the system.[470]

The Åland autonomous region does not require fish farms to obtain an environmental permit if they can demonstrate annual nitrogen and phosphorus levels do not exceed standards. While Fifax reports a rigorous water purification system, in 2017, the Eckerö facility faced criminal liability for high concentrations of nitrogen and phosphorus in grow-out water. This water overflowed from a runoff water pool used for temporary water purification during the construction phase of the facility. Fifax was fined EUR 5,000 in December 2020 for impairment of the environment after prosecutors pressed charges against Fifax and former CEO Kimmo Jalo in 2019. Kimmo Jalo remains on staff for Fifax, but no longer serves as CEO.[471] Åland Environmental and Health Protection Authority (AMHM) engages the independent firm Ålands Vatten and Miljoprovtagn to monitor Fifax's water quality on a semimonthly basis. Collected water samples are sent to SGS Analytics Sweden.[472]

The water treatment processes and closed system approach both limit the introduction of contaminants and pathogens to the facility, allowing reduced use of antibiotics.[473] However, the facility's Aquaculture Stewardship Council certification audit indicated a lack of detail in the facility's biosecurity practices and identified other health hazards.[474] For example, the facility had no written hygiene practices. In fact, the Eckerö facility experienced an IHN outbreak in 2022, indicating a gap in its biosecurity and health measures.[475] This outbreak has stalled production at the facility while the Finnish government completes a 10-week sanitization plan.[476] In a subsequent report to investors, Fifax stated it plans to increase its biosecurity measures by further segmenting fish to prevent any future outbreak from affecting the entire facility.[477]

The ASC's initial evaluation also cited concerns over Fifax's handling of onsite chemicals. Most chemicals used at Fifax's facility are for water treatment and facility cleaning. The evaluation confirmed the company's compliance with the Finnish Act on the Safety Handling of Hazardous Chemicals and

[470] *Offering Circular: Listing on the First North Growth Market Finland marketplace, offering of approximately EUR 15 million, subscription Price of EUR 2.55 per Offer Share,* Fifax 34 (Sept. 28, 2021), https://fifax.ax/wp-content/uploads/2021/09/fifax-plc-offering-circular-28-september-2021.pdf.
[471] *Offering Circular: Listing on the First North Growth Market Finland marketplace, offering of approximately EUR 15 million, subscription Price of EUR 2.55 per Offer Share,* Fifax 128 (Sept. 28, 2021), https://fifax.ax/wp-content/uploads/2021/09/fifax-plc-offering-circular-28-september-2021.pdf.
[472] *Audit Announcement*, Aquaculture Stewardship Council (2021).
[473] *Offering Circular: Listing on the First North Growth Market Finland marketplace, offering of approximately EUR 15 million, subscription Price of EUR 2.55 per Offer Share,* Fifax 22 (Sept. 28, 2021), https://fifax.ax/wp-content/uploads/2021/09/fifax-plc-offering-circular-28-september-2021.pdf.
[474] *Audit Announcement*, Aquaculture Stewardship Council (2021).
[475] Press Release, Fifax, The Finnish Food Authority has ordered the harvesting of symptom-free fish and the culling of remaining fish at the Eckerö facility due to the IHN virus outbreak (July 11, 2022), https://fifax.ax/en/item?slug=fifax-the-finnish-food-authority-has-ordered-the-harvesting-of-symptom-free-fish-and-the-culling-of-remaining-fish-at-the-eckero-facility-due-to-the-ihn-virus-outbreak.
[476] Press Release, Fifax, Agreement on sanitation work at the Eckerö facility signed with the Finnish Food Authority – sanitation work according to the sanitation plan starts immediately (Oct. 13, 2022), https://fifax.ax/en/item?slug=fifax-agreement-on-sanitation-work-at-the-eckero-facility-signed-with-the-finnish-food-authority-sanitation-work-according-to-the-sanitation-plan-starts-immediately.
[477] *Fifax Abp's half-year report January - June 2022*, Fifax (Aug. 22, 2022), https://view.news.eu.nasdaq.com/view?id=b8fcf7c0b58638a8bae0e1536db6759ff&lang=en.

Explosives,[478] but noted it failed to appropriately separate the chemicals, therefore posing a hazardous risk.[479] Fifax subsequently invested in and installed new chemical cabins to separately store the chemicals and dispose of chemicals.

Fifax closely monitors energy usage, calculated at 10-11 gigawatts of power each year.[480] The facility relies exclusively on renewable wind energy, purchased from a plant on the Åland islands. The company is considering the following steps to increase energy efficiency: (1) investments to produce wind and solar energy onsite; (2) constructing biogas plants in conjunction with efforts to capture carbon dioxide released in the bioprocess of production and to minimize its carbon footprint; [481] and (3) capturing the heat that fish produce for energy use (at full capacity, Fifax's fish produce 500 kw of heat and power).[482] In terms of solid waste production, the Eckerö facility removes water from sludge, producing about 7,000 cubic meters of dried fish waste annually.[483] Sludge is currently used as fertilizer and feed, but Fifax is exploring side streams, use as biogas, and increased fertilization as alternative uses.

Fifax has encountered waste disposal challenges. Overflows from a "large circular tank used for denitrification" resulted in spillovers of plastic-ball shaped biomedia onto nearby land.[484] Fifax responded by increasing the height of the fence around the tank so that it would no longer overflow and building an additional buffer tank. Additionally, an oxygen issue in May 2021 led to a mass mortality event where 262 tons of trout were lost. While most of the dead trout were removed by compost company Albiocom Ab on June 27, 2021, some remains were improperly stored in 10 Intermediate Bulk Containers for six months. Generally, mortalities are disposed of using formic acid after the dead fish are ground up.[485]

Permits and Certifications

Fifax holds an Aquaculture Stewardship Council (ASC) Certificate for Sustainable Aquaculture, awarded in February 2022 and valid until February 2025. [486] The company is the first farm in Finland and the northern Baltic Sea area to receive an ASC certification.[487]

BioMar Denmark, the company that supplies Fifax fish feed, is currently Global G.A.P. certified until August 3, 2023.[488]

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[478] *Offering Circular: Listing on the First North Growth Market Finland marketplace, offering of approximately EUR 15 million, subscription Price of EUR 2.55 per Offer Share,* Fifax 47 (Sept. 28, 2021), https://fifax.ax/wp-content/uploads/2021/09/fifax-plc-offering-circular-28-september-2021.pdf.
[479] *Audit Announcement*, Aquaculture Stewardship Council (2021).
[480] Interview with Sampaa Rouhtula, CEO and Linda Lindroos, CFO, Fifax (Oct. 13, 2022).
[481] *Offering Circular: Listing on the First North Growth Market Finland marketplace, offering of approximately EUR 15 million, subscription Price of EUR 2.55 per Offer Share,* Fifax 34 (Sept. 28, 2021), https://fifax.ax/wp-content/uploads/2021/09/fifax-plc-offering-circular-28-september-2021.pdf.
[482] Interview with Sampaa Rouhtula, CEO and Linda Lindroos, CFO, Fifax (Oct. 13, 2022).
[483] Interview with Sampaa Rouhtula, CEO and Linda Lindroos, CFO, Fifax (Oct. 13, 2022).
[484] *Audit Announcement*, Aquaculture Stewardship Council (2021).
[485] *Audit Announcement*, Aquaculture Stewardship Council (2021).
[486] See Sustainability Ranking Systems Section.
[487] ASC Certificate #ASC01851.
[488] GGN #4050373897437.

Community Response

Fifax pledged in its initial ASC assessment to hold semiannual open community meetings. However, the company has not complied with that commitment, because of the IHN outbreak.[489] Fifax, in an interview, stated it is conducting narrowly focused stakeholder conversations with community members about the disease outbreak.[490]

Key Takeaways

Fifax implements sustainability measures in some areas, including siting its facility near key target markets, developing more efficient oxygenation methods, sourcing renewable wind energy to power its operations, and decoupling its feed from harmful wild fishing operations. It is also an industry leader in water usage, using even less water than the defined level for a super intensive Recirculating Aquaculture System.

The company also has notable areas for improvement, including increasing biosecurity measures and managing waste properly. It has taken recent steps to bring chemical contamination into compliance and respond to challenges, such as the IHN outbreak.

[489] *Audit Announcement*, Aquaculture Stewardship Council (2021).
[490] Interview with Sampaa Rouhtula, CEO and Linda Lindroos, CFO, Fifax (Oct. 13, 2022).

Sustainability Highlight: Ideal Fish and B Corporation's Best for the World Environment List

Photo and design by Steve Habersang Design (stevehabersangdesign.com)

Location: Waterbury, Connecticut
Capacity: 120 metric tons[1]

Ideal Fish in Waterbury, Connecticut where it raises Branzino (Mediterranean Sea Bass) for the United States East Coast market.[2] The operation, founded in 2013, is BAP certified and has been on the B-Corporation's Best for the World Environment List for the past two years (in both 2021 and 2022).[3] B Corporation designation entails high social and environmental performance based on an impact assessment considering risk and baseline requirements.[4] Ideal Fish is committed to sustainable water consumption, decreased wastewater discharge, and ethical harvesting. Each of these practices, along with BAP certification, earned it a spot on the B-Corp list, the only aquaculture facility in the world to receive this designation.

Ideal Fish consumes 23,000 gallons per day (GPD) which is equivalent to 0.26m^3 per kilogram of fish produced annually. This places the company's water usage lower than even super intensive RAS, as defined by the FAO at 0.3 m^3 for each kilogram of fish produced. The company continues its efforts to decrease water consumption to 12,000 GPD. Further, with the wastewater this is produced, the company has paired the typical RAS disposal mechanism with a vacuum drum filter to decrease the amount of water dispelled from the system on a daily basis from 20% to 3%.[5] Finally, the operation uses the "chill kill" method for fish, which is designated by the state of Connecticut as the most humane way to kill fish.

While Ideal Fish's accolades prove a commitment to sustainability, its processes exist on a much smaller scale than some of the other facilities this paper considers. For example, it produces over 200 times fewer fish than the proposed Nordic facility in California and over 26 times fewer than the smaller Fifax facility in Norway. Scalability is a concern for the scalability of these sustainable best practices.

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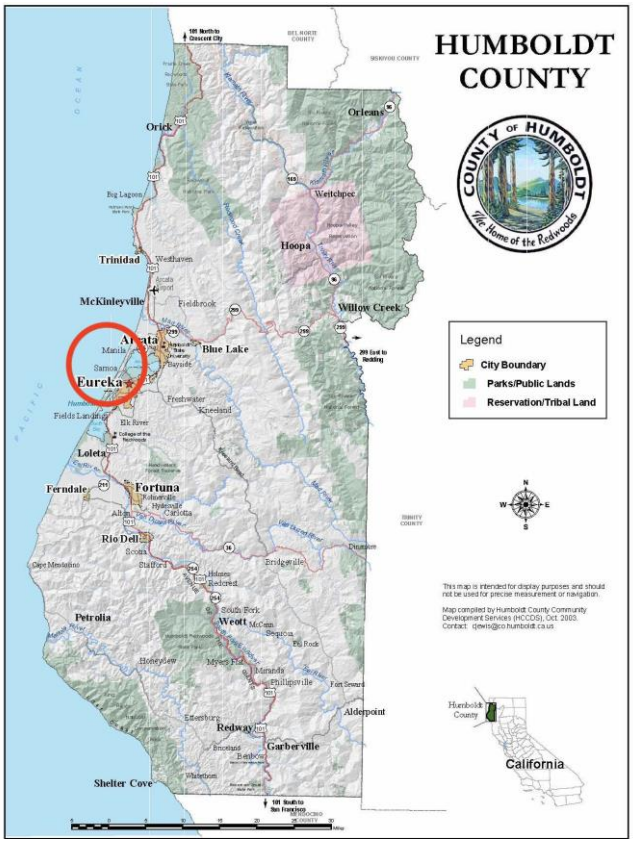
[1] B-Corporation Transparent Materials, *Ideal Fish*, https://www.bcorporation.net/en-us/find-a-b-corp/company/great-american-aquaculture-l-l-c-dba-ideal-fish (last visited Dec. 29, 2022).; [2] https://www.linkedin.com/company/ideal-fish/about/; [3] https://idealfish.com/; [4] https://www.bcorporation.net/en-us/certification/; [5] B-Corporation Transparent Materials

Nordic Facility in Humboldt County, California

Overview



Nordic Aquafarms California, LLC is planning to build and operate a land-based aquaculture facility on a former brownfield site on the Samoa Peninsula in Humboldt County, CA.[491] Originally intended to produce approximately 25,000-27,000 metric tons of Atlantic salmon.[492] However, the company switched to Yellowtail kingfish with a Phase 1 capacity between 2,000-3,000 metric tons annually.[493] Subject to obtaining all necessary permits and approvals, Nordic anticipates completing site remediation and two build-out phases by 2030.

Nordic Aquafarms was established in 2015 to produce land-based seafood near consumer markets in Norway, Denmark, and the United States.[494] The current U.S. strategy includes future LBA facilities in Belfast, Maine and Samoa, California.[495]

The planned 36-acre California facility includes a hatchery, grow-out modules, fish processing facility, an oxygen generation plant and liquid oxygen storage, water intake treatment system, and wastewater treatment plant.[496] Nordic will install its patented RAS technology, a Moving Bed Biofilm Reactor (MBBR), a membrane bioreactor (MBR), UV-C disinfection, and a 4.8 MW solar panel array.[497]

Environmental Impacts

The location Nordic selected for the California facility is the former site of the Freshwater Tissue Samoa Pulp Mill facility.[498] The location is a brownfield, and the company will need to perform asbestos remediation. This location nevertheless has many benefits for Nordic. In addition to being situated close to key California markets, Nordic will be able to utilize existing infrastructure, including the industrial

[491] Chris Chase, Nordic Aquafarms gets key permit for California RAS salmon farm, SeafoodSource (Apr. 15, 2022), https://www.seafoodsource.com/news/aquaculture/nordic-aquafarms-gets-key-permit-approval-for-california-ras.
[492] Final EIR, at 302-1 Cont.
[493] Sage Alexander, Nordic Aquafarms' reduced plan won't affect job projections, company says, TIMES STANDARD (apr. 28, 2023), https://www.times-standard.com/2023/04/28/nordic-aquafarms-reduced-plan-wont-affect-job-projections-company-says/.
[494] Investor Relations, https://www.nordicaquafarms.com/investor-relations-2/ (last visited Jan. 5, 2023).
[495] Our Company, https://www.nordicaquafarms.com/our-company/ (last visited Jan. 5, 2023).
[496] Final EIR, at Attachment F - Fact Sheet p. 5.
[497] Final EIR, at Attachment F - Fact Sheet p. 5.
[498] NCRWQCB case no. 1NHU892.

water supply line, sea water intakes, and outflow pipe.[499] The site is zoned as both Coastal Dependent Industrial (MC) and Industrial General (MG) use.[500]

Despite the existing infrastructure, necessary additional construction is anticipated to impact the marine ecosystem and aquatic species, such as Longfin Smelt larvae. Nordic's co-applicant, the Humboldt Bay Harbor, Recreation and Conservation District (Harbor District), must mitigate for impacts to the smelt by upgrading water intake screens, and carrying out 1:1 compensatory mitigation through creation of suitable nursery habitat.[501]

Facility construction will result in demolition and construction waste,[502] and operation will produce between 8,000 to 12,000 metric tons of processing byproduct annually, including dewatered sludge, processing co-products, and dead fish. Nordic has set a goal of repurposing and recycling all construction materials and byproduct resources.[503]

Effluent contaminants of concern include ammonia, salinity, temperature, total suspended solids (TSS), biochemical oxygen demand (BOD), phosphorus, nitrogen, detergents, and disinfectants/sanitizers; any antibiotics used will be metabolized in the fish.[504] Nordic plans to treat water discharge through a Moving Bed Biofilm Reactor (MBBR), 0.04-micron Ultrafiltration Membrane Bioreactor systems (MBR), a UV-C disinfection process designed for 99.9% virus removal, and filtrate collection, dewatering, and storage system.[505] The facility must also adhere to temperature regulations stated in the State Thermal Plan and the California Ocean Plan.[506]

The total energy usage of the facility at full capacity is estimated at 195 GWh. After installing a 4.8 MW solar array, the company hopes to meet this electricity requirement through 189.5 GWh of grid electricity and 5.5 GWh of onsite solar electricity.[507] Nordic is also amenable to powering the facility with wind energy, if a proposed wind facility off Humboldt Bay is realized.[508] Either way, approximately 94% of facility energy will be sourced from the two primary electricity providers in the region, Redwood Coast Energy Authority (RCEA) and the Pacific Gas & Electric Company (PG&E), both relying primarily on fossil fuel sources.[509] However, by 2030, California's Senate Bill 100 will require California utilities to purchase at least 60% of its power from renewable resources. RCEA also has a goal of reaching 100% net-zero-carbon-

[499] Humboldt Facility FAQ, https://nafnewsdesk.com/humboldt-faq/ (last visited Jan. 5, 2023).
[500] Draft EIR, at 2-5.
[501] Final EIR, at 2-52—2-54. The lead agency added this mitigation measure in response to concerns of the California Department of Fish and Wildlife. See Letter from Craig Shuman, Marine Regional Manager, Tina Bartlett, Northern Region Regional Manager & Jay Rowan, Fisheries Branch Chief, CA Dept. of Fish & Wildlife, to Cade McNamara, Planner II, Humboldt County Planning & Bldg. Dep't 4 (Feb. 28, 2022).
[502] Draft EIR, at 3.13-8.
[503] Draft EIR, at 3.13-8.
[504] Draft EIR, at 3.9-23.
[505] Draft EIR, at 2-13, 2-24, 3.3-26; NCRWQB Draft permit, Fact sheet § 2.1. The Draft NPDES permit requires Nordic to demonstrate its compliance with the UV dose and routinely inspect and maintain the UV equipment. National Pollutant Discharge Elimination System (NPDES) Draft Order (NCRWQCB 2021) § 4.4.1.
[506] NCRWQB Draft permit, Fact sheet at 3.3.2, 3.3.3.
[507] Draft EIR, at 3.5-5.
[508] Draft EIR, at 2-19.
[509] Draft EIR, at 2-31, 3.5-1—3.5-2, 3.5-5.

emission renewable sources by 2030.[510] To reduce energy demand onsite, the facility plans to maximize water-heat exchangers and heat pumps.

Total operational emissions (incorporating annualized construction emissions) will total 4,098.23 CO_2e metric tons per year, excluding Scope 3 emissions.[511] The facility does not meet the threshold for mandatory reporting of GHGs nor must the facility obtain a Stationary Source Air Quality Permit,[512]because its anticipated emissions fall below the North Coast Unified Air Quality Management District's (NCUAQMD) stationary sources emission threshold.[513] Motor vehicle emissions associated with transportation to and from the facility will release particulate matter; Nordic is developing an Operation and Construction Transportation Plan to reduce mobile emissions from vehicles,[514] and the California Air Resources Board's (CARB) recent regulatory decision to effectively ban sales of gasoline vehicles in the state by 2035 may further mitigate these impacts. Additionally, the emergency onsite backup power system, which could be operated for up to 500 hours annually (in the case of planned safety power shutdowns, maintenance, etc.) operates using natural gas or diesel. NCUAQMD is currently preparing an engineering evaluation of the proposed generators, and expects the generators will fall well below threshold, therefore requiring only a minor source permit.[515]

Other environmental considerations include stormwater runoff (addressed through a Stormwater Pollution Prevention Plan and bioretention and infiltration ponds),[516] risk of pollutant release in the event of a tsunami (addressed through infrastructure improvements and safeguards),[517] and fish escapement (addressed through physical barriers and an Escape Response and Reporting Plan).[518] A Spill, Prevention, Control, and Countermeasure (SPCC) plan and a Hazardous Materials Business Plan will mitigate hazardous materials.[519]

Planned water consumption is 12.5 MGD, or approximately 1972 m3/h, including 10 MGD seawater from Humboldt Bay and 2 MGD from Mad River.[520] The RAS facility will recirculate up to 99% of the water consumed. The reviewing agency confirmed the availability of the water. Using the upper end of the facility's expected capacity (27,000 tons of fish annually), this level of water usage translates to 0.64m^3 per kilogram of fish produced annually. The least efficient of the three facilities, this figure still places the Nordic facility in between a super intensive RAS facility (with a water consumption per kg of fish at 0.3m^3) and an intensive facility (with a water consumption per kg of fish at 1m^3).

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[510] Draft EIR, at 3.5-10.
[511] Draft EIR, at 3.7-13 (parameters are: area, energy, off road, emergency generators, waste, water, mobile, and construction).
[512] Draft EIR, at 3.7-8.
[513] Draft EIR, at 3.2-10.
[514] Draft EIR, at 2-20—2-21; Final EIR, at 2-277, 2-441, Errata at 4.
[515] Draft EIR, at 2-33.
[516] Draft EIR, at 2-22, 3.9-32, 3.9-34 (the requirement for post-development stormwater flow is the 85th percentile, 24-hour storm event (heavy rainfall event) and retaining stormwater from a storm event up to the 100-year event, or 6.19 inches in a 24 hour period).
[517] County of Humboldt Planning and Building Department Current Planning Division, Nordic Aquafarms California, LLC, Coastal Development Permit and Special Permit 25, 89 (Aug. 4, 2022) available at https://humboldt.legistar.com/LegislationDetail.aspx?ID=5558840&GUID=F4A16E60-1F2D-4B9D-80B0-0DD7289BDCB5&Options=&Search= [hereafter Nordic Staff Report].
[518] Draft EIR, at 2-40—2-45, 3.3-25.
[519] Draft EIR, at 3.8-9.
[520] Final EIR, at 302-1 Cont.

Permits and Certifications

There are two lead agencies responsible for completing environmental review—and subsequently deciding whether to approve—each component of the project: the Humboldt County Planning and Building Department for the terrestrial development;[521] and the California Coastal Commission for modifying the ocean outfall (opening additional ports) and modernizing the two existing saltwater intakes and distribution infrastructure.

The Humboldt County Planning Commission certified the Environmental Impact Report (EIR) and approved the Coastal Development Permit (CDP) on August 4, 2022.[522] The County Board of Supervisors unanimously denied an appeal on September 28, 2022.[523] The project is currently facing litigation and appeals to the California Coastal Commission.

Nordic will also need to obtain the following permits to begin site remediation and facility construction:

- Coastal Development Permit (CDP) from the California Coastal Commission for the discharge to comply with the Coastal Act[524]
- National Pollutant Discharge Elimination System (NPDES) permit issued by the North Coast Regional Water Control Board[525]
- Air quality permit from the North Coast Unified Air Quality Management[526]
- Water quality permits for intake pipe construction[527] and stormwater discharge[528]
- Incidental Take Permit (ITP) for the potential take of Longfin Smelt issued by the California Department of Fish and Wildlife (CDFW)[529]
- Egg importation permit and Aquaculture Registration issued by the CDFW[530]

Community Response

Proponents of Nordic's project focus on how facility construction will catalyze job creation. Operating Engineers Local 3 members expressed support for the proposed facility during the Planning Commission CDP hearing, as it would stimulate construction-related jobs.[531] Similarly, the California Aquaculture Association (CAA), and the College of the Redwoods conveyed approval of the facility after expressing

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[521] Draft EIR, at 1-2, 2-7.
[522] *Nordic Aquafarms Lays out Next Steps After Planning Commission Gives the Thumbs-Up to Their Samoa Fish Farm Plans*, LOCAL COAST OUTPOST (Aug. 5, 2022), https://lostcoastoutpost.com/2022/aug/5/nordic-aquafarms-lays-out-next-steps-after-plannin/.
[523] Ryan Burns, *Supervisors Deny Appeal of Nordic Aquafarms Project*, LOCAL COAST OUTPOST (Sept. 28, 2022), https://lostcoastoutpost.com/2022/sep/28/supervisors-deny-appeal-nordic-aquafarms-project/ [hereinafter Burns].
[524] Humboldt Land-Based Salmon Facility FAQ - Nordic Aquafarms US News (nafnewsdesk.com).
[525] Draft NPDES Permit (discharge classified by EPA and NCRWQCB as "minor".).
[526] Humboldt Land-Based Salmon Facility FAQ - Nordic Aquafarms US News (nafnewsdesk.com).
[527] Clean Water Act Section 10 permit issued by the U.S. Army Corps of Engineers and Clean Water Act Section 401 Water Quality Certification from the North Coast Regional Water Quality Control Board (Draft EIR, at 2-10).
[528] Stormwater discharge permits for both construction and operations, issued by the North Coast Regional Water Quality Control Board (Draft EIR, at 2-7, 2-22, 2-32).
[529] Draft EIR, at 2-8, 2-10.
[530] Draft EIR, at 2-8.
[531] *See* Combined Opposed and Supporting Comments, County of Humboldt Planning Commission Meeting of August 4, 2022, https://humboldt.legistar.com/MeetingDetail.aspx?ID=990953&GUID=3CA9A411-B6BC-415B-B943-B4C8B66BA634&Options=info%7C&Search= (last visited Aug. 8, 2021).

interest in developing education programs focused on aquaculture industry training during the same hearing.[532]

Individual opponents and nongovernmental organizations, such as 350 Humboldt Grassroots Climate Action and Redwood Region Audubon Society, cited concerns regarding energy consumption, greenhouse gas emissions, feed, tsunami and earthquake hazards, escapement, pesticide and drug use, effluent and water quality, and water consumption.[533]

Most recently, a group of residents, Citizens Protecting Humboldt Bay, filed a lawsuit against the county and Board of Supervisors in November 2022 alleging the EIR failed to sufficiently account for project impacts and therefore is noncompliant with CEQA. At least five appeals were filed with the California Coastal Commission as of November 2022.[534]

Key Takeaways

Some sustainability-related measures derived from Nordic Aquafarms' proposed LBA facility include: 1) locating the facility where it could leverage existing infrastructure, and 2) improving a brownfield site through site remediation, removal of spent pulping liquors and other hazardous chemicals, and asbestos abatement.[535]

[532] Ibid.

[533] Ibid.

[534] Ryan Burns, Lawsuit Challenges Humboldt County's Environmental Impact Report for Nordic Aquafarms Project; Five Appeals Filed With Coastal Commission, LOCAL COAST OUTPOST (Nov. 9, 2022), https://lostcoastoutpost.com/2022/nov/9/lawsuit-challenges-humboldt-countys-environmental/.

Recommended Best Practices on Sustainable Land-Based Aquaculture

The following set of best practice were identified as representing the most robust, yet practicable environmental protection measures adopted by RAS facilities, third-party certification programs, and government agencies at the federal, state, and local levels. These best practices can be categorized as those:

- ***Directly avoiding or mitigating environmental impacts***;
- ***Promoting transparency, public engagement, and expert and stakeholder input***; and
- ***Supporting measures*** to ensure regulation keeps pace with technological innovation while providing clarity and certainty the regulated industry can rely on to continue maturing in an environmentally responsible manner.

Environmental Impacts

- **Environmental impact assessment carried out early in the project proposal stage.** Environmental review ensures decision-makers weigh and consider all potential significant adverse environmental impacts associated with an activity, along with adopting mitigation measures. Such review also reassures the public a decision to approve a project is based on the best available information. Jurisdictions presently without an environmental review statute, such as Maine, may consider adopting in the short-term statutory requirements for a form of environmental impact assessment specific to RAS facilities and associated environmental impacts, with costs recoverable from project applicants. Findings from the environmental impact assessment process may be used to determine appropriate conditions to be included in permits issued for the proposed facility. The baseline environmental conditions considered in the EIA may also be used in determining how to reclaim the facility at the end of its life. A bond or similar financial assurance instrument may be useful in ensuring the site is reclaimed when the facility Is shut down for whatever reason.
- **Siting facilities in areas currently zoned industrial** and in compliance with the local land use plan, subject to final approval by the elected governing body.
- **Avoiding siting facilities in or near sensitive habitats and mitigating impacts to endangered or threatened species potentially impacted by development or operation.** Some species are especially sensitive to construction activities or to impingement/entrainment associated with water intake. Jurisdictions may require RAS facility operators to obtain an incidental take permit for potential impacts to endangered and threatened species and to undertake compensatory habitat restoration activities.[536]

[536] Incidental Take Permits (ITPs) are required for any "take" of an endangered or threatened species under the Endangered Species Act § 10(a)(1)(B) ("The Secretary may permit, under such terms and conditions as he shall prescribe…any taking otherwise prohibited by section 9(a)(1)(B) if such taking is incidental to, and not the purpose of, the carrying out of an otherwise

- **Control disease through inspections, biosecurity controls, and leveraging recirculating systems as a barrier to pathogens.** Jurisdictions may condition egg importation permits on inspection and health certification by a qualified professional. Both state agencies and RAS facilities can also carry out regular inspections for potential disease and parasite infections, imposing a quarantine if necessary. Other measures include leveraging recirculating systems to minimize inputs.
- **Implement a rigorous chemical and drug management plan**, including applying only approved products, inventorying use, and following strict recordkeeping and storage procedures.
- **Prevent introduction of invasive species into local ecosystem through chemical, biological, and physical barriers to prevent escapement.** Jurisdictions can require agency approval to import non-native species. Some facilities produce only fish genetically modified to be infertile.
- **Control water consumption via diversion thresholds, stringent reuse goals, water supply assessments, and incorporation of water-efficient technologies.** Current technologies permit maximum water recycling at greater than 99%. Jurisdictions may establish an annual water consumption threshold by facility size or production capacity. Local public water systems can also carry out a water supply assessment to ensure sufficient supply exists for a proposed RAS facility's projected water demand.
- **Establish and implement numerical, science-based standards for biological oxygen demand, suspended solids, and nitrogen.** NPDES permits or their state equivalents may be conditioned on robust discharge and technology-based effluent limitations with a rigorous monitoring and reporting program. This is achievable through filtration technology, such as Moving Bed Biofilter Reactor (MMBR) filters.
- **Reduce energy consumption with energy efficiency measures, benchmarking and reporting guidelines,**
- **Improve air quality through permit conditions and managing vehicle miles traveled.** Generators and vehicles associated with operational trips are the primary emitters of RAS facility-related air pollutants. Permanent generators typically require obtaining synthetic minor permit, and emergency standby generators may require an air quality permit, depending on its emissions levels and hours of operation under rules set by the state and local air pollution control authorities. RAS facilities can implement a transportation demand program to reduce the number of miles generated by employee commuting and short- and long-hauling of supply and delivery trucks.
- **Mitigate greenhouse gas emissions by maximizing renewable energy sources and implementing benchmarking and reporting programs.** RAS facilities can maximize renewable sources of energy in several ways, such as siting in jurisdictions with renewable portfolio standards and producing renewable energy on-site. GHG reduction strategies include locating facilities near market destinations to limit emissions generated by transporting products. Jurisdictions may also subject RAS facilities to GHG reporting requirements and any regional emissions-trading program. Other effective strategies include benchmarking and reporting annual energy use and GHG emissions (Scope 1 and 2, and Scope 3 insofar as feasible) and procuring feed from sustainable sources.

lawful activity."). State agencies may also authorize the take of such species under state law. *See, e.g.*, CA FISH & GAME CODE § 2081(b).

- **Meet mandatory or voluntary landfill diversion requirements and find secondary uses for ensilage and other bioproducts** to reduce solid waste. One option is recycling wastes into agricultural fertilizer, but chemical and salt content may limit their utility.
- **Recognize environmental justice as part of permitting review.** State and local agencies can avoid adverse impacts to fence-line communities through appropriate zoning, adopting incentives to site facilities in existing brownfields and disincentives to greenfield development, and carrying out an analysis of whether benefits and burdens would be equitably distributed to the impacted communities.
- **Comply with state and local noise standards.** Many municipalities adopt a noise ordinance and may establish maximum sound levels and other short- and long-term noise standards for RAS facilities.

Engagement and Public Participation

Public Participation

The most effective public participation mechanisms promote meaningful engagement by **prioritizing access to information, transparency, opportunity to provide comments, and agency consideration of feedback.** Specific measures include:

- Circulating and otherwise making available environmental review documents, meeting agendas, and other materials well in advance of an agency decision. This includes providing versions in multiple languages and Braille.
- Establishing a public comment period of at least 30 days and holding at least one oral hearing at a time and location determined to be most accessible to the public. Holding hearings in hybrid format, with live translation and ASL interpretation services and support, and making recording available within 24-48 hours, expands public participation and awareness.
- Responding in writing to all significant comments and incorporating suggestions as reasonable and feasible.
- Providing a streamlined appeals process with low barriers to standing for both interested parties and those acting on behalf of the public interest.

Creating effective communication channels, such as web portals and e-newsletters to inform the public of important developments before, during and after the permitting process.

Stakeholder Input

Stakeholders to a proposed RAS facility include industry, academia, fishermen, community and economic leaders, and others who bring to the table substantial knowledge and expertise. Establishing stakeholder committees with diverse representation, as well as other avenues for feedback, can provide valuable input into developing state or local government regulation and/or approval of RAS facilities.

Tribal Consultation

There are 574 federally recognized sovereign Tribes in the United States, located in 36 states, in addition to hundreds more unrecognized and/or state-recognized Indian Nations. Many of these Tribes have reserved hunting, fishing, gathering, and other rights under various treaties. All Tribes are associated with traditional or aboriginal lands currently under federal, state, or local jurisdiction.

The siting or operation of RAS facilities may adversely impact traditional tribal cultural places or critical tribal cultural resources. For example, land-disturbing activity during construction can destroy important sites or artifacts. Effluent produced during operation can impact subsistence fisheries and aquatic plants.

Lead agencies, working with RAS project proponents, can avoid or mitigate these impacts, while building positive relations with affected Tribes by **engaging in government-to-government consultation**. Some states have adopted strong consultation requirements by statute or policy, and many state and even local governments designate a Tribal Liaison to lead these efforts. Effective consultation is respectful, substantive, and carried out early in the project planning stages. The goal is a mutual agreement on mitigation steps, often including a mitigation, monitoring, and reporting program co-produced and collaboratively implemented with the Tribe.

Supporting measures

The following actions by a state reinforce the best practices discussed above and provide overall clarity and efficiency to both regulatory and regulated parties:

- **Defining key terminology**, such as *aquaculture*, *land-based aquaculture*, *RAS aquaculture*, and *Community of Concern/Disadvantaged Community/Environmental Justice Community*.
- **Adopting a centralized permitting system** with a comprehensive process and easily accessible information.
- **Issuing licenses for carrying out RAS aquaculture** customized to the needs and impacts of RAS facilities.
- **Regularly updating standards and guidelines**, such as every three to five years, with public input.
- RAS facilities can consider **applying for third-party certification programs.**

These best practices represent a cross-referenced set of standards, policies, and practices across multiple jurisdictions, RAS facilities, and international certification standard-setting bodies. We present them as a set of measures for the consideration of both governing bodies and RAS facilities intent on meeting a high bar for environmental protection while ensuring sustainable growth that brings social and economic benefits over the long term.

Conclusion

As the land-based RAS aquaculture industry in the United States continues to grow, so will its environmental impacts. Policymakers know they must act proactively on behalf of their constituents to ensure the industry's expansion is sustainable.

This white paper demonstrates that **state and local governments can work within their existing regulatory frameworks to develop standards** for land-based finfish RAS based on the best-available science and recognized sustainable practices. Multiple jurisdictions at the national, state, and local level have adopted or are now exploring policies that promote sustainable land-based finfish RAS. **Policymakers can draw from best practices** recognized by international standard-setting bodies and existing land-based finfish RAS facilities to address and mitigate the detrimental environmental and social impacts of land-based finfish RAS aquaculture.

Maine could become a nationwide leader in setting standards that promote sustainable land-based aquaculture practices. Policy can be enacted under a precautionary approach, looking to mitigate present and future environmental impacts of the growing land-based RAS aquaculture industry within the state. This could be more easily accomplished with a statewide environmental review requirement. However, even the best laws and regulations will not provide sustainable results if they are not followed.