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STUDENT POLICY REPORT SERIES • APRIL 2024

Blue Foods for Indonesia: A Human & Planetary Health Action Lab

Supplemental Information [All Reports]

This report was produced by a team of students participating in a ten-week Action Lab offered by the Stanford Center for Ocean Solutions and the Human & Planetary Health Initiative, of the Stanford Doerr School of Sustainability, and Stanford Law School. The course was taught by Jim Leape, Janet Martinez, Richard Nyiawung, and Eric Hartge, with support from Colette Wabnitz, Zach Koehn, Josheena Naggea, and Liz Selig. The Action Lab experience was supported by staff from the Stanford Human & Planetary Health Initiative: Kathy Burke, Allison Phillips, Erika Veidis, and Katie Vogelheim. An editing and formatting review was completed by Molly Glickman.

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1. Small-Scale Fisheries Report

1a. Interview List

Through expert interviews (Table 5), we have delved into the specific contexts of the selected countries, enriching our analysis with interviews from various stakeholders including authors, NGOs, and community representatives. This process allows for a deep understanding of the practical applications and outcomes of different co-management strategies, providing valuable insights into the complexities and dynamics of SSF management.

Table 5: Interview Reference Guide

Interviewee Name	Country of Expertise	Organization	Contact
Elena Finkbeiner	Mexico	Associate Adjunct Faculty at University of California, Santa Cruz Coastal Community Fisheries Director at Conservation International	efinkbei@ucsc.edu
Xavier Basurto	Mexico	Bass Chair for Excellence in Teaching and Research Associate Professor of Sustainability Science at the Nicholas School of the Environment and director of the Coasts and Commons Co-Laboratory at Duke University	xavier.basurto@duke.edu
Ratana Chuenpagdee	Southeast Asia	Professor in Geography at Memorial University of Newfoundland	ratanac@mun.ca
Stuart Campbell	Indonesia	Senior Director Fisheries, Gender & Financial Inclusion, Rare Indonesia	scampbell@rare.org
Brian Crawford	Southeast Asia and Africa	Senior Coastal Manager, Coastal Resources Center, Univ. Rhode Island	bcrawford@uri.edu
Annisya Rosdiana	Indonesia	Project Leader at Fisheries Resource Center of Indonesia	a.rosdiana@rekam.org
Belva Widyaprasetia	Indonesia	Blue Economy Consultant at Indonesia Ministry of Development and Planning	jbelva.w@gmail.com
Edison D. Macusi	Philippines	Associate Professor III at Davao Oriental State University (DOrSU)	edison.macusi@dorsu.edu.ph

1b. Most Landed Marine Resources in Chile's Artisanal Sector

Table 6: Most Landed Marine Resources in Chile's Artisanal Sector (2011)

Spanish name	**English name**	**Scientific name**	**Landings (metric tons)**
Sardina común	South American pilchard	*Strangomera bentincki*	648,531
Anchoveta	Anchovy	*Engraulis ringens*	279,402
Huiro negro o chascón	Kelp	*Lessonia nigrescens*	241,633
Bacaladillo o mote	Mote sculpin	*Normanichthys crockeri*	173,004
Jibia o calamar rojo	Jumbo squid	*Dosidicus gigas*	138,708
Huiro palo	Kelp	*Lessonia trabeculata*	46,239
Pelillo	Seaweed	*Gracilaria chilensis*	42,224
Erizo	Chilean sea urchin	*Loxechinus albus*	31,901
Luga negra o crespa	Seaweed	*Sarcothalia crispata*	29,559
Reineta	Southern rays bream	*Brama australis*	25,761
Jurel	Chilean jack mackerel	*Trachurus murphyi*	21,282
Almeja	Clam	*Venus antiqua*	20,359
Huiro (pito o canutillo/flotador)	Kelp	*Macrocystis spp./M. integrifolia*	19,400
Sardina austral	Falkland sprat	*Sprattus fuegensis*	17,822
Merluza común	South Pacific hake	*Merluccius gayi gayi*	16,858

2. Aquaculture Report

2a. Policy Pathways for Silvofishery Implementation and Expansion

The following three tables present several policy pathways for the implementation and expansion of silvofishery in Indonesia. Table 1 outlines existing regulatory policies in Indonesia that, as they stand or with revisions, may facilitate the expansion of silvofishery. Table 2 describes additional policies in Indonesia with relevance to the implementation of silvofishery and is categorized based on its relevance to the categories of water quality, environment, and food safety and quality. Table 3 lists certification programs that have been implemented in Indonesia.

Table 1. Existing Indonesian policies that may impact silvofishery implementation.

Date and Decision	**Implication**	**Potential Policy Pathway**
Sulawesi - Regional Regulation No. 8 of 1999	Prohibition of logging in mangrove areas of society Regulation was hard to roll out due to conflicts of interest between communities and local government	Establishing a payment for ecosystem services (PES) scheme for the prohibition of logging could help alleviate conflicts of interests between communities and local governments - May be applicable to future regulations surrounding logging in areas of society
Presidential Decree No. 62/2013	REDD+ (Reduced Emissions from Deforestation and Forest Degradation) schemes	Primarily targeted towards Indonesia's big national parks, REDD+ schemes could be expanded to include extensive farming communities/cooperatives to engage in mangrove reforestation. - Could potentially aid in circumventing conflicts of interest especially surrounding incomes
Farmer Protection and Empowerment Act, or FPE Act (Law No. 19/2013)	Obligates national and local governments to protect farming activities, including through the provision of agricultural insurance, and gives state insurance company PT Asuransi Jasa Indonesia (Jasindo) the **exclusive right** to implement subsidized crop, livestock, and aquaculture insurance in the country.	Continuation of 100% subsidized insurance premiums will be necessary for extensive farmers to switch or adopt silvofishery extensively
Law No.16 concerning Animal, Fish	Export of such aquatic species,	Only law on disease is surrounding

Date and Decision	Implication	Potential Policy Pathway
and Plant Quarantine (1992)	unlike the export of other animals, is only subject to quarantine measures upon request of the importing country.	the export of aquatic species. As IndoGAP gets rolled out, it's crucial that practices on disease control are also standardized (as illustrated in ASEAN good shrimp farming practices) (*see section in Appendix on ASEAN good shrimp farming practices - Animal Health & Welfare + Food Safety & Quality)*
IndoGAP (Indonesia Good Aquaculture Practices)	End-to-end certification scheme for the whole Indonesia shrimp value chain Currently, only large shrimp producers, hatcheries, and feed suppliers currently comply with MMAF's framework for Indonesian Good Aquaculture Practices (INDOGAP).	IndoGAP could be expanded to also ensure that integrated-mangrove shrimp farming practices could enroll in certification programs. With over 82% of total shrimp production land area attributed to extensive farming, certification programs could aid in overall greater export values for small and large shrimp farmers.
Pengelolaan Irigasi Tambak Partisipatif (PITAP)	Indonesian multi-level governmental program focused on supporting small-scale and traditional aquaculture farmers in repairing tertiary irrigation canals	Programs focused on supporting small-scale and traditional aquaculture farming communities could prioritize building and supporting aquaculture cooperatives as farmers tend to have greater trust in cooperatives
The 2004 Fisheries Law - **Decree of the Minister of Agriculture No.466/Kpts/TN.206/V/99**.	Manual for Prime Method of animal drugs manufacturing (CPOHB) (1999) establishes a certification system for animal drugs production No specific provisions are made with regard to the use of drugs in aquaculture	Could incorporate ASEAN Good Shrimp Farming Practices in IndoGAP, specifically the paragraph pertaining to: 1. Control of diseases with authorized veterinary drugs should be carried out only on the basis of a proper diagnosis

Table 2. Additional policies relevant for silvofishery

Category of Policy	**Implications**
WATER QUALITY Law No.7/2004 on Water Resources (2004) - regulates the sustainable use of inland fresh and salt waters, without making any specific provision on aquaculture.	A license is required for the use of water beyond personal needs or for activities other than small-scale farming within an existing irrigation system. A license is also required to carry out construction works affecting water resources. Local example of regulations on water use for aquaculture purposes: Regional Regulation of the Special Capital Province of Jakarta No.1/2004 - Taxes on the extraction and use of groundwater and surface water (2004), which exempts small fish pond owners from the payment of water charges.
WATER QUALITY Decree of the Minister of Marine Affairs and Fisheries No.Kep.17/MEN/2004 on Indonesian Shellfish Sanitation System (2004).	Regular monitoring is carried out to ensure compliance with health requirements The discharge of effluents and waste into marine waters is covered by **Government Regulation No.19/1999 re Control over marine contamination and/or damage (1999)** **Decree of the State Minister for Environmental affairs No.110/2003** on the guidelines on stipulation of accommodating capacity of load of water pollution in water sources (2003) proposes two mathematical models for the assessment of pollution capacity of water bodies and watercourses.
ENVIRONMENT *Environmental Management Act No.23 (1997)*	An EIA is required to engage in any business or activity likely to have a major and significant impact on the environment. The conduct of aquaculture is subject to the EIA procedure, as established by **Decree of the State Minister of the Environmental Affairs No.3/2000** on the types of businesses and/or activities for which an **Environment Impact Analysis is compulsory (2000).** An EIA is required for the cultivation of shrimp/fish-breeding ponds, with or without a processing unit, exceeding 50 ha in size.
ENVIRONMENT *Fisheries Law No. 31/2004 (2004):* highlights the importance of sustainable use of aquatic resources in the development of fisheries.	A specific license called SIUP to engage in fishery business, including aquaculture Small fishermen and small fish breeders are exempt from such requirement Companies being granted a SIUP and using foreign vessels in the Indonesian EEZ must apply for a foreign vessel use permit (PPKA), which lasts three years. PPKA holders must submit a quarterly activity report to the responsible authority
ENVIRONMENT Pengelolaan Irigasi Tambak Partisipatif (PITAP)	Supports small-scale and traditional aquaculture farmers in repairing tertiary irrigation canals by enhancing community participation with labor-intensive and simple tools (KKP, 2020).

ENVIRONMENT
 	
The 2004 Fisheries Law
	Use of chemical or biological substances which may harm aquatic resources or the environment is forbidden in both fisheries and aquaculture.
	- prohibits the use of additives that may endanger human health.
	- **Decree of the Minister of Agriculture No.466/Kpts/TN.206/V/99** re Manual for Prime Method of animal drugs manufacturing (CPOHB) (1999) establishes a certification system for animal drugs production.
	  - Applications of complying producers must be lodged with the Director General of Animal Husbandry of the Ministry of Agriculture.
	  - CPOHB certification holders are entitled to mention it on the product's label.
	
	- No specific provisions are made with regard to the use of drugs in aquaculture.

FOOD SAFETY AND QUALITY ASEAN Good Shrimp Farm Management Practices	<u>Food Safety and Quality</u> Banned/non-approved antibacterials, veterinary drugs and/or chemicals should not be used in any stage of shrimp production. Authorized veterinary drugs, chemicals and hazardous materials used in shrimp production should be manufactured, distributed, labeled and stored properly. Probiotics and biological agent inputs should be registered with, and approved by, the relevant/competent authorities Water used for shrimp farming should be of a quality suitable for the production of food which is safe for human consumption. Source of broodstock and seed for shrimp farming (larvae, post larvae, fry and the fingerlings, etc.) should be such to reduce the risk of carryover of potential human health hazards into the growing stocks. Feeds and feed ingredients should not contain unsafe levels of pesticides, biological, chemical (e.g. antibiotics) and physical contaminants Shrimp farming facilities should be designed and operated in ways that prevent shrimp contamination by workers, sewage/toilets, domestic animals, machinery oil/fuel and other possible sources. <u>Animal Health and Welfare</u> Routine monitoring of shrimp health should be performed and records of health and corrective actions should be maintained On occurrence or an outbreak of any disease of shrimp, farmers should notify and seek advice from the relevant authority or other available expertise. Control of diseases with authorized veterinary drugs should be carried out only on the basis of a proper diagnosis. <u>Environmental Integrity</u> Location of shrimp farms should be in accordance with local and national

	plans and regulations on environmental protection. Farm site selection and infrastructure construction should take into consideration the conservation of natural habitat and minimization of disturbance to the surrounding environment. Shrimp farms should be operated in economically viable ways that make efficient use of fuel/energy, feeds and water. Damage caused by previous shrimp farming operations should be rehabilitated on or close to the farm site. On-farm and off-farm environmental quality indicators should be monitored routinely including with community participation. Records of use of inputs, management of effluents, habitat rehabilitation, and environmental monitoring should be kept and maintained
FOOD SAFETY AND QUALITY IndoGAP (Indonesia Good Aquaculture Practices)	Encompasses: 1. Cara Pembuatan Pakan Ikan yang Baik (CPPIB) / Good Management Practices for Aquaculture Feed 2. Cara Pembenihan Ikan yang Baik (CPIB) / Good Hatchery Practices 3. Cara Pembuatan Obat Ikan yang Baik (CPOIB) / Good Management Practices for Fish Medicines 4. Cara Budidaya Ikan yang Baik (CBIB) / Good Aquaculture Practices 5. Cara Penanganan Ikan yang Baik (CPIB) / Good Management Practices for Handling Aquaculture Product 6. Surat Kelayakan Pengolahan (SKP) / Processing Eligibility Certificate The intention of IndoGAP is to comply with FAO and ASEAN standards and open up farms to be assessed by third-party certification.
FOOD SAFETY AND QUALITY Law No.16 concerning Animal, Fish and Plant Quarantine (1992) - the import, export and transfer of animals and plants, including aquatic species. - Specific provisions concerning live fish are provided by **Decree No.265 of the Ministry of Agriculture concerning Quarantine Requirements for the Importation of Live Fish** into the Territory of the Republic of Indonesia (1986) and **Decree No.245/Kpts/LB.730/4/90**	Export of such aquatic species, unlike the export of other animals, is only subject to quarantine measures upon request of the importing country. Quarantine measures include the following steps: 1. Inspection to check the required documentation and detect the presence of pests and diseases. 2. Isolation and observation, if the disease requires specific action to be identified. 3. Detention, if inspection and observation reveal that import or transit requirements are not met. 4. Treatment of disease, when possible. 5. Refusal of import or transit of infected specimens and their destruction; or 6. Release of specimens meeting import, transit or export requirements. The quarantine authority shall then issue a certificate of release for imports or a health certificate for exports.

re Quarantine Measures taken on Live Fish Exported from the Territory of the Republic of Indonesia (1990). - only mandatory for the import and transport of fish species and plants susceptible to quarantine diseases, as identified by the competent Minister.	

Table 3. Certification programs in Indonesia

Certification Programs	Implications
Global Aquaculture Alliance's Best Aquaculture Practices (GAA-BAP)	• Relatively comprehensive range of issues – including food safety, social accountability, environmental responsibility and traceability • Encompasses the whole production chain, including feed mill, hatchery, farm and processing plant. • All certified sites are required to have detailed records in their supply chains.
Aquaculture Stewardship Council (ASC)	• Focused more on the producers' side; places a heavy emphasis on environmental sustainability, biosecurity, and community and workers protection. • Utilizes the Chain of Custody (CoC) standard from the Marine Stewardship Council (MSC) to track the ASC certified products along the supply chain
GLOBAL GAP	• Covers the whole production chain and applies its standard for food safety, workers' rights, animal welfare and environmental protection • CoC Standard which contains strict requirements for handling and segregation of the certified and uncertified products throughout the supply chain to ensure traceability
The Monterey Bay Aquarium Seafood Watch	• Provides seafood recommendations and rating criteria but offers no certification programme. • Benchmarked other eco-certifications standards against their own to provide MBASW ratings of those certified products
Asian Seafood Improvement Collaborative (ASIC) - ASIC Shrimp Initiative	• Developed an improvement programme to help small-scale shrimp producers in Southeast Asia to improve their farming practices and gain recognition for their efforts but without the barriers of the certification schemes • Currently working with NSF International to give assurance to global buyers and consumers
NaturLand - EU/Germany	• Fish farming requirements for a wide range of species. In addition to the general standards for organic aquaculture, there are also additional species- and system-specific farming requirements that apply to each species. • Mangrove destruction is not permitted in organic aquaculture and the former mangrove area in parts of the shrimp farm shall be reforested to at least 50% during a period of maximum 5 years according to Naturland organic aquaculture standards.

2b. Relevant Tables and Figures

Table 4. Main provincial policies in Ca Mau related to mangrove forest management and shrimp aquaculture (T. T. P. Ha, van Dijk, and Visser 2014).

Date and Decision	Title of Regulations	Implication	Notes
6/3/1985 57/QD.UB 8/11/1988 389/QD.UB	Temporary regulations about mangrove management, protection with relation to aquaculture technical management in Forestry-Fisheries Enterprises and households. Temporary regulations on allocation of mangrove land to households for production and protection.	Households were allocated mangrove land for re-plantation and protection from destruction. Farmers have to cover at least 80% with mangroves and limit area to 20% for pond aquaculture. Mangroves must be planted at a density of 20,000 trees/hectare.	
28/3/1991 64/QD.UB	Decision on implementing methods for management, protection, and uses of forest, forestry land and water surface in forest land. Replaced Decision 389/QD.UB	Households that have less than 20 hectares of mangrove forest or 10 hectares of empty mangrove maintain at least 80% of mangroves. Farmers are allowed to open ponds by hand and have to plant 20,000 trees per hectare. Renewable land-use rights were granted for 20 years to individual HHs or under contract with Forest Enterprises.	The provincial government proposed changes to these guidelines to increase the proportion of land used for agriculture, housing, and other domestic purposes to 40%, which was later passed in Decision 10/QD.DB in 2010. This proposal is in line with provincial goals to increase provincial aquaculture exports from US $145 million in 1999 to US $500 million in 2005.
Decree No. 2/CP on January 15 1994		Decentralizes forest management to the private sector and to organizations. Allows individuals to hold forest lands under a 50-year lease.	The structure of the 50-year lease which would allow for farmers to have multiple 20-year cycle mangrove harvests is inaccessible to farmers. Enterprises are instead granted 50-year leases who issue 20-year leases to individual farmers.
No. 351 November 1995		Total ban on cutting mangroves in Ngoc Hien District 1996 (removed 1999)	

12/9/2002 24/QD.UB	Decision on reforming structure and management regimes of forest and forestry lands in Ca Mau province	Converts the use-right contracts from green to red certificates. Allows farmers to gain more benefits from timber marketing, to dredge or excavate the ponds using machines. Mangroves should cover 70% of the area; for households, mangroves could cover 50%, 60%, or 70% of the total area of farms with less than 3 hectares, 3-5 hectares, or more than 5 hectares, respectively.	
14/8/2006 186/QD.TTg	Decision on promulgating the regulation of forest management	Requires a ratio of 40:60 pond to forest for farms smaller than 3 hectares.	
22/9/2010 10/QD.UB	Decision on the implementation of policies on forest development and protection in Ca Mau province. To replace Decision 24/QD.UB	To encourage all economic and private sectors involved in forest protection, development, production, and market. Mangroves should cover at least 60% of the total allocated area to farmers.	
22/1/2016 111/QD.UBND		Implements PES for mangrove cover in shrimp farming.	

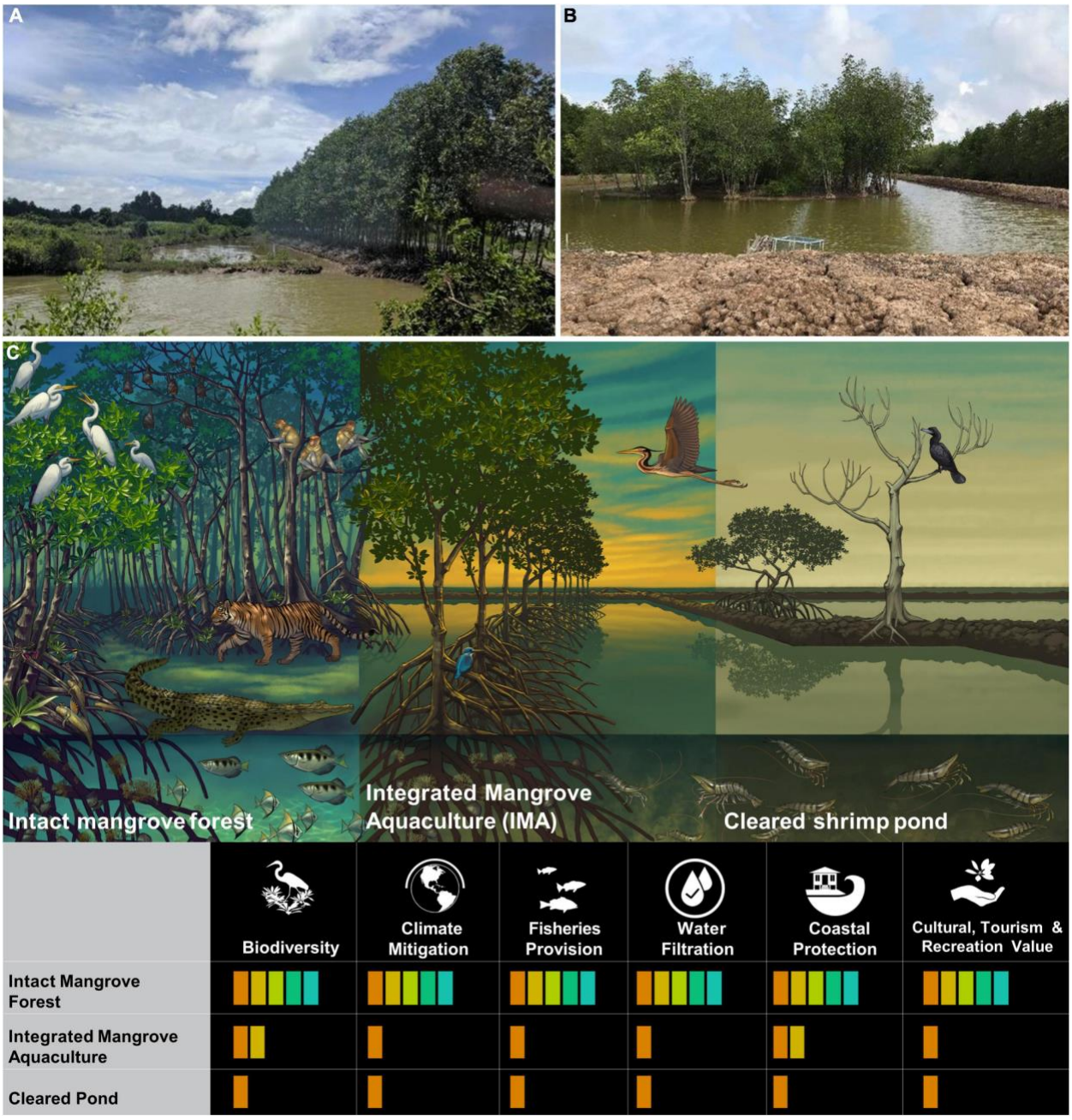
Table 5. Mangrove governing institutions and mandates (Mursyid et al. 2021).

Legal Basis	Task and Responsibility	Institution
Law No. 5/1990; Law No. 41/1999; Law No. 32/2009	Protect and manage mangroves in state forest zones.	Ministry of Environment and Forestry (MoEF)
Law No. 27/2007	Manage mangroves in coastal and small island areas.	Minister of Marine Affairs and Fisheries (MoMAF)
Decree of the National Development Planning Agency No. 89/2020	Prepare the national strategy for mangrove ecosystem management.	Ministry of National Development Planning (MoNDP)
Presidential Regulation No. 120/2020	Coordinate stakeholders at varying levels associated with the implementation of mangrove restoration.	Peatland and Mangrove Restoration Board (BRGM)
Law No. 23/2014	Manage mangroves at the site level.	Local Governments

Table 6. Main relevant policies in Indonesia related to mangrove forest management (Mursyid et al. 2021; Arifanti et al. 2022).

Legal Basis	Implication/Relevance
Law No. 5/1990 on the Conservation of Biological Natural Resources and their Ecosystems	Basis for implementing area and species conservation in Indonesia.
Law No. 41/1999 on Forestry, revised in Law No. 19/2004	Management of mangrove ecosystems in forest areas, such as regulations on the prohibition of logging and forest encroachment.
Law No. 27/2007 Amended to Law No.1/2014 on the Management of the Coastal Zone and Small Islands	Sustainable management of coastal areas and small islands. Allows logging practices in mangrove areas that adhere to the sustainability of coastal ecological functions.
Government Regulation No. 26/2008 on National Spatial Planning	Timber use violations of mangroves and activity bans that can change, reduce the area, and/or pollute mangrove ecosystems in the mangrove zoning system.
Law No. 32/2009PrRecognizes two different categories of environmental management schemes: Payments for Ecosystem Services (PES) and Compensation for environmental services (CES).esidential Regulation No. 73/2012 of Mangrove Ecosystem Management	Conservation activities and ecosystem rehabilitation of mangroves in protected and cultivation areas, as well as the improvement of public wellbeing. Established National Coordinating Team for Mangrove Ecosystem Management, consisting of a coordinating/steering team and an implementation team. Institutional arrangement and structure became irrelevant to the next presidential cabinet.
Law No. 23/2014 on the Regional Government	Significant authority given to regional heads in the management of natural resources. The environment is linked to the existence of mangroves as coastal borders with the status of local protected areas.
Presidential Decree No. 73/2015 on the Implementation of Coordination for the Management of Coastal Regions and Small Islands at the National Level	Sustainable management of coastal areas and small islands.
Regulation No. 7/2017	Targeted the restoration of 3.49 million hectares of mangroves by 2045. Established *Norma Standar Prosedur Kriteria* (NSPK) which regulates mechanisms for mangrove conservation.

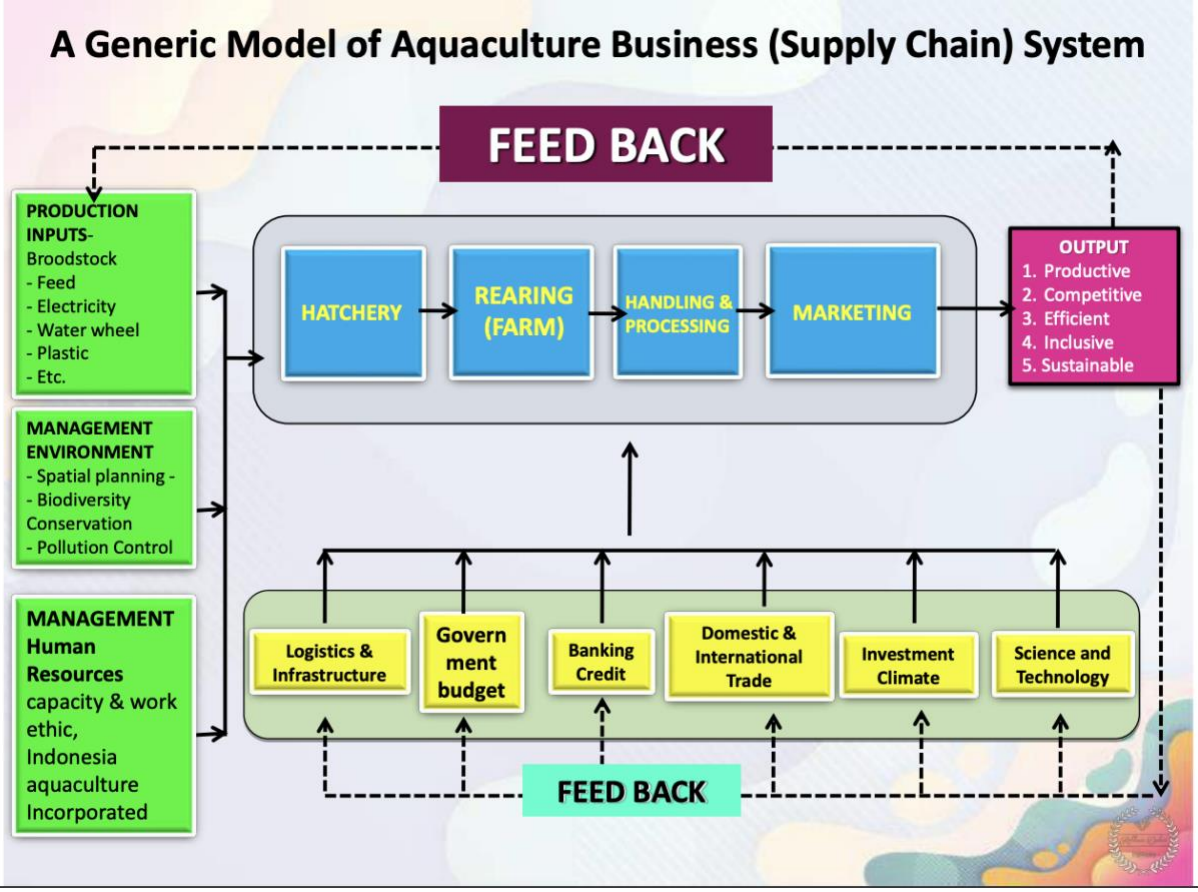
Regulation No.1/2018	Guides spatial utilization distribution, specifying the Strategic Enviromental Assessment (Kajian Lingkugan Hidup Strategis/KLHS) Land uses are not fine-scale enough and lead to inconsistencies and overlapping land use.
Regulation No. 17/2018	Intact mangrove forests are included as land gazetted for agrarian reform (Tanah Objeck Reforma Agraria) and can be cultivated by local communities for non-conservation uses.
Regulation No. 25/2019 Regulation No. 27/2021	Stipulate that development activities can be conducted in conservation areas where mangroves lie.
Job Creation/Omnibus Law No.11/2020	Fosters economic investments by simplifying procedures in obtaining business permits. Prohibits the harvest of mangroves, exempts mangrove uses for fisheries as long as they meet conservation rules without clear operationalization. Encourages the further expansion of commercial shrimp and fish ponds.
No. 31/2020	Does not list mangroves as a protected ecosystem/habitat. Regulation specifies "wise utilization activities" in conservation without prescribing detailed conservation norms and principles.
Regulation No.82/2020, revised to Presidential Regulation 108/2020	Annulled Presidential Regulation No. 73/2012. Aimed to simplify the bureaucracies governing mangrove utilization, dissolution of the National Coordinating Team for Mangrove Ecosystem Management.
Minister Decree No. 89/2020	Mandated the establishment of a new strategic coordinating team for wetland management. Regulation will be active in 10 years.



Supplementary Figure 1: Comparison table showing intact mangrove forest, integrated mangrove aquaculture and cleared shrimp pond. Integrated mangrove aquaculture shrimp systems showing: (A) Mangroves directly adjacent to the pond on the pond walls, and (B) mangroves within the pond as a central mass. (C) Stylized differences between intact mangrove forests, integrated mangrove aquaculture, and cleared shrimp ponds and their value for biodiversity and ecosystem service provision. *(From McSherry et al., 2023)*

Specific management regime	Food	Raw materials	Carbon storage and sequestration	Coastal protection	Water purification	Nursery service	Recreation
Natural mangroves							
Protection	○○	●●●	●●●	○○○	●●●	○○○	○○○
Conservation	○○	●●	●●●	○○○	●●●	○○○	●●●
Low intensity use mangroves							
Production	○	●●	○○	○○	●●	○○	○○
Unprotected	○	○○	○○	○○	○○○	○○	○
High intensity use mangroves							
Plantation	●	●●	●●	○○	●●●	○○	○○
Silvo-fishery	●●	○	○	○	○○	○○	○○
Mangroves converted for aquaculture							
Eco-certified aquaculture	○○○	○	-	◇	◇◇◇	-	○
Extensive aquaculture	●●	○	◇◇	◇◇	◇◇	-	-
Semi-intensive aquaculture	●●	-	◇◇	◇◇	◇◇	-	-
Intensive aquaculture	●●●	-	◇◇	◇◇	◆◆◆	-	-
Abandoned aquaculture							
Abandoned aquaculture	-	-	◇	◇◇	◇◇	-	-

Supplementary Figure 2: Comparison Table of Mangroves in Natural Ecosystems and in Aquaculture Systems.



Supplementary Figure 3: Systems map for Indonesian Shrimp Farming

Table 7. List of region-specific Indonesia silvofishery studies used

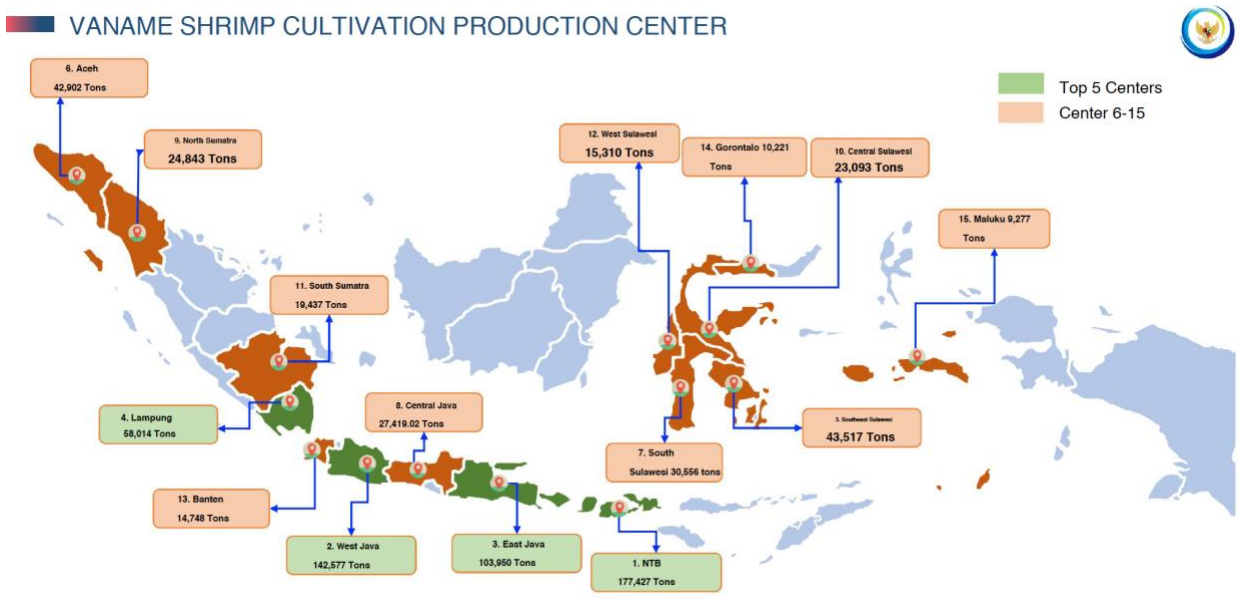
Region	Papers
Lombok	Paramita, Adiska Octa, Stefan Partelow, Achim Schlüter, and Nurliah Buhari. "Can the Indonesian collective action norm of Gotong-Royong be strengthened with economic incentives? Comparing the implementation of an aquaculture irrigation policy program." *International Journal of the Commons* 17, no. 1 (2023): 462-480.
North Sumatra	Basyuni, M., H. Sagami, S. Baba, and H. Oku. "IOP Conf. ser: Earth Environ." *Sci* 130 (2018): 012039. Siswoyo, Bambang Hendra, Siti Mardiana, and Sabrina Sabrina. "SILVOFISHERY DEVELOPMENT TO INCREASE FISHERIES PRODUCTION AND MANGROVE ECOSYSTEM RECOVERY ON THE EAST COAST OF NORTH SUMATERA." *PROSIDING UNIVERSITAS DHARMAWANGSA* 3, no. 1 (2023): 157-162. Basyuni, M., K. S. Nasution, B. Slamet, N. Sulistiyono, Y. Bimantara, L. A. P. Putri, E. Yusraini, R. Hayati, and I. Lesmana. "Introducing of a silvofishery pond on sapling and seedling density based

	in Lubuk Kertang Village, North Sumatera." In *IOP Conference Series: Earth and Environmental Science*, vol. 260, no. 1, p. 012115. IOP Publishing, 2019. Harefa, Meilinda Suriani, Zulkifli Nasution, Miswar Budi Mulya, and Azhar Maksum. "Silvofishery: In What Mangrove Coverage Condition Can this System Provide Benefits for the Community?." *Universal Journal of Agricultural Research* 10, no. 3 (2022): 249-265.
Situbondo	Musa, Muhammad, Mohammad Mahmudi, Sulastri Arsad, and Nanik Retno Buwono. "Feasibility study and potential of pond as silvofishery in coastal area: Local case study in Situbondo Indonesia." *Regional Studies in Marine Science* 33 (2020): 100971.
Semarang City	Budihastuti, Rini, Sutrisno Anggoro, and Suradi W. Saputra. "The application of silvofishery on Tilapia (Oreochromis niloticus) and Milkfish (Chanos chanos) fattening within mangrove ecosystem of the northern coastal area of Semarang City." *Journal of Coastal Development* 16, no. 1 (2012): 89-93.
South Sulawesi	Fitzgerald Jr, William. "Integrated mangrove forest and aquaculture systems in Indonesia." (2000).
East Kalimantan	Hardi, E. H., H. R. Susmiyati, R. Diana, N. P. Palupi, M. Agriandini, G. Saptiani, and A. N. Asikin. "Traditional polyculture as a mangrove restoration solution in Delta Mahakam, East Kalimantan Indonesia." In *IOP Conference Series: Earth and Environmental Science*, vol. 1208, no. 1, p. 012056. IOP Publishing, 2023. Hardi, Esti Handayani, Haris Retno Susmiyati, Rita Diana, Nurul P. Palupi, Maulina Agriandini, Gina Saptiani, Andi N. Asikin, Myrna Asnawati Safitri, and Dermawati Sihite. "A Comparison of the Silvofishery Models for Mangrove Restoration in East Kalimantan." In *Brawijaya International Conference (BIC 2022)*, pp. 614-626. Atlantis Press, 2023. Susilo, Heru, Yoshifumi Takahashi, Goshi Sato, Hisako Nomura, and Mitsuyasu Yabe. "The adoption of silvofishery system to restore mangrove ecosystems and its impact on farmers' income in Mahakam Delta, Indonesia." (2018): 433-442.
East Java	Musa, Muhammad, Evellin Dewi Lusiana, Nanik Retno Buwono, Sulastri Arsad, and Mohammad Mahmudi. "The effectiveness of silvofishery system in water treatment in intensive whiteleg shrimp (Litopenaeus vannamei) ponds, probolinggo district, East Java, Indonesia." *Biodiversitas Journal of Biological Diversity* 21, no. 10 (2020).
West Java	Perwitasari, Woro Kusumaningtyas, Fuad Muhammad, and Jaffran Wasiq Hidayat. "Silvofishery as an alternative system of sustainable aquaculture in mororejo village, kendal regency." In *E3S Web of Conferences*, vol. 202, p. 06043. EDP Sciences, 2020.

2c. Background and Current Status of Indonesia Shrimp Aquaculture

Shrimp Farming - Current Status and Intensive Method

Shrimp aquaculture is a significant component of Indonesia's blue economy. In 2021, shrimp production was 707,951 tons and had a total value of Rp43 trillion (Lawira 2024). In 2018, Indonesian shrimp represented 7.1% of the total global market and was the 4th largest exporter of shrimp by trade value (Fisheries and Others 2016). 90% of these exports go to either the United States (US), Japan, and the European Union (EU) (Klinger 2024). Indonesia is thus uniquely situated as a global player in the shrimp aquaculture trade.



Supplementary Figure 4. Geographical comparison of the shrimp cultivation centers across Indonesia (Klinger 2024)

In Indonesia, approximately 804,018 hectares are being used for shrimp farming. This current farm area can be further subdivided into non-shrimp pond usage and shrimp pond usage. 504,517 ha, or 62.6% fall in the non-shrimp category (eg. tilapia, milkfish, crabs), while 300,501 ha, or 37.4%, are stocked with shrimp (Klinger 2024). In these ponds, two different species of shrimp are used. The main species is whiteleg shrimp (*Litopenaeus vannamei*). 80% of the large companies and 50% of the smallholders use whiteleg shrimp as their main stock. The second species farmed is the tiger shrimp (*Penaeus Mondon) (Lawira 2024).* Tiger shrimp is primarily cultivated by smallholders.

Shrimp farming production is split among smallholders and big companies, each holding 70% and 30% of production respectively (Lawira 2024). A farmer is defined as a smallholder if they farm a total area of 2 hectares in freshwater or in less than 5 hectares in brackish water and use simple technology (Lawira 2024). Beyond the smallholder and big company classification, shrimp farming can be further categorized into two groups: extensive and intensive. Extensive farming encompasses both semi-intensive and traditional farming methods. In Indonesia, intensive farms use 9,055 hectares or 3% of the total shrimp production land area ("Investment Guideline for Sustainable Aquaculture in Indonesia" 2018). Semi-intensive farms take up 43,643 hectares or 15% ("Investment Guideline for Sustainable Aquaculture in Indonesia" 2018). Traditional farms represent 247,803 hectares or 82% ("Investment Guideline for Sustainable Aquaculture in Indonesia" 2018).

Intensive farming, while represented by 3% of the production land area, is the most productive method on a short-term, pre-hectare basis. Intensive farms produce 30 ton/ha/year ("Investment Guideline for Sustainable Aquaculture in Indonesia" 2018). Intensive farms tend to have man-made pond structures that are packed densely with shrimp. Water flows in from the sea and is supplied to the ponds. Artificial feed is used and ponds can deploy water aeration systems to circulate the water in the pond. Water is then pumped out to the discharge channel and is released from the system (Taw 2017)

Intensive farms are the most productive system but also require significant inputs to be successful. Intensive farms require easy access to large amounts of capital. Additionally, these farms require greater construction of management infrastructure and higher energy requirements to operate the pond. Finally, due to the usage of more complicated technologies, intensive farms require higher skilled labor than other farming systems (Taw 2017)

Extensive Farms - Semi-Intensive & Traditional

Extensive farms can be distinguished as semi-intensive or traditional. Traditional systems are more common than semi-intensive farms in Indonesia because of easier setup, simpler management, and lower costs. However, semi-intensive farms are usually the more productive of the two systems producing ~10 ton/ha/year (Lawira 2024). Semi-intensive farms are a balance between the intensive system or the completely natural system. Semi-intensive farms still construct pond structures but the stocking density of shrimp is lower than that of an intensive

farm. Semi-intensive farms use man-made infrastructure for feed mills and channels to feed and move water throughout the system. Semi-intensive systems, like intensive systems, require land cover change for production.

Semi-intensive farms still suffer from many of the same challenges that intensive systems do. Disease outbreaks and poor genetic diversity in broodstock can cause entire crops to fail (Lawira 2024). For farmers, capital can be hard to access ("Investment Guideline for Sustainable Aquaculture in Indonesia" 2018). The lack of capital flows means that it is increasingly difficult for farmers to build semi-intensive farms. Semi-intensive also require mangrove land conversion for the farms to be set up. On the flip side, semi-intensive, due to the nature of their smaller footprint, can be more sustainable. The decrease in shrimp density results in fewer disease outbreaks (Fitriani 2020). Since semi-intensive systems require less sophisticated technology, the labor force working the farm can be less skilled (Fitriani 2020). For these reasons, semi-intensive farms have been noted by some observers as the best type of farm for Indonesia.

Traditional systems are the least productive out of the three methods, producing 0.6 ton/ha/year ("Investment Guideline for Sustainable Aquaculture in Indonesia" 2018). Traditional shrimp farms are defined by their lower stocking densities compared to semi-intensive and intensive methods. Because of the lower stocking density, traditional can rely on natural food sources such as plankton. Additionally, the lower stocking densities mean that traditional farms can rely on natural seawater flow for water filtration and do not require water pumping/reservoir systems that are often deployed in more intensive farms.

The more barebones structure of traditional farms translates to lower costs for farmers. Farmers do not need to spend capital on feed or water management systems. The labor requirements are also reduced. The smaller footprint means that traditional farms have reduced disease risk (Fitriani 2020). Yet, the small stocking density means that productivity decreases, and it is more difficult to make profit without assistance (Fitriani 2020).

3. Blue Foods Technology Report

3a. Elaboration on technical innovations

Biotechnology for more resilient seaweed

Dodon Yamin, founder and CEO of Indonesian seaweed social enterprise Banyu, observes that seedlings supplied by the government, which most farmers rely on, are identical nationwide and thus not optimized for varying environmental conditions across the archipelago. The limited funding and institutional capacity for seedling R&D also means that farmers go for many cycles before using enhanced seedlings, cutting the same seaweed for seedlings for up to five years despite rapid changes in the climate.

Amid a conspicuous absence of commercial entities dedicated to selling seedlings directly to farmers, seaweed seedling innovation may be a critical frontier in making the most of Indonesia's seaweed potential. Potato Productions, a Singapore-based holding company investing in social impact startups, identifies a pressing demand for the development of genetically superior seedlings that are tailored to endure the rigors of climate change, such as temperature fluctuations, salinity shifts, and diseases. However, Natalie Longmire-Kulis, an investment analyst at Potato Productions focused on seaweed startup investments, observes that the seedling innovation space is presently "lacking focus, funding, and understanding." Banyu's Dodon confirms this sentiment, stating that he is not aware of anyone in Indonesia other than himself actively working on seedling research to improve seaweed cultivation productivity. There is also a low level of awareness among seaweed farmers that seedlings can be improved, and seaweed traders (e.g. middlemen distributors) appear complacent with the industry status quo. The potential for gains is huge; Dodon's testing indicates a 40-60% increase in yield from improved seedlings Banyu has piloted in Sulawesi.

Biotechnology for diverse seaweed use cases

Indonesia's seaweed industry will thus stand to capture more economic value by producing seaweed for uses beyond carrageenan production, which tends to fetch lower prices and currently accounts for almost all of Indonesia's seaweed cultivation. However, much of the research about

seaweed use is focused mostly on northern hemisphere seaweed species, reflecting a relative void in R&D into broader use bases for tropical seaweeds such as those native to Indonesia (Azalea Ayuningyas). Although there have been some startups seeking to close this innovation gap in the region—such as SEADLING from Sabah, Malaysia and Jakarta-based Evoware which makes plastic wrappings using seaweed sourced from Sulawesi[1] – these are the exceptions rather than the rule, and Indonesia's seaweed farmers still produce almost exclusively for lower-value carrageenan use.

Genetic engineering and sustainable feed

Traditionally, aquaculture feed for both fish and shrimp has been heavily dependent on fish meal or fish oil obtained from wild fish, including "trash" fish – but this source is becoming more expensive and less healthy for farmed blue foods. The price of fish meal and fish oil has more than tripled since the mid-90s[2] as the demand for fish-based feeds has grown with the aquaculture boom, even as the annual catch of wild fish used to make FM/FO declined from 23 million tonnes to 16 million tonnes between 1997-2017. Against this backdrop, feed formulations have evolved over the past two decades, with fishmeal and fish oil increasingly replaced by plant and animal proteins and oils.[3]

This shift has been enabled by technology. Rosamund Naylor, co-chair of the Blue Foods Assessment initiative, observes that genetic advances in fish breeding can help fish adapt better to plant-based diets, while genetic engineering has enabled the isolation of genes responsible for Omega-3 production in microalgae and subsequent insertion into crop plants like canola. More recently, a new wave of innovation in sustainable feed is emerging, focused on sourcing feed with high nutritional content and low environmental footprint. These include obtaining feed from insects, algae, bacteria, yeasts as well as synthetic proteins and fats. For instance, INSEACT, a Singapore-based startup, produces aquafeed from black soldier flies which in turn feed on palm oil waste.

[1] This edible packaging will make you reconsider seaweed | GreenBiz
[2] Hamidoghli, A., Yun, H., Won, S. *et al.* Evaluation of a single-cell protein as a dietary fish meal substitute for whiteleg shrimp *Litopenaeus vannamei*. *Fish Sci* **85**, 147–155 (2019). https://doi.org/10.1007/s12562-018-1275-5
[3] Roz Naylor, lecture on 23 January 2024.

Precision farming

The aquaculture space is currently experiencing a significant transformation, propelled by the integration of Internet of Things (IoT) technologies, cloud computing and advancements in artificial intelligence (AI).

Aquabyte, a US-based aquaculture tech provider with operations in Norway and Chile, installs cameras that collect reliable and precise data about fish growth, welfare, performance, and the environment. This data is visualized in a user-friendly web platform, which uses AI to provide valuable information to optimize the timing of harvest (e.g. average weight and weight distribution, growth rate).[4]

Indonesia's aquaculture unicorn eFishery's flagship product is the eFeeder, an automatic fish and shrimp feeder device that can be controlled and customized through a mobile phone. Although eFishery does not apply advanced AI engineering like Aquabyte or Tidal, their eFeeder has been proven effective in accelerating harvests, maintaining water quality, optimizing FCR (Feed Conversion Ratio), and producing even harvests. eFishery also makes use of its mobile app to connect farmers to relevant ancillary services, such as materials on disease prevention, consultation with experts and a purchasing platform for medications and vitamins. It has also built an online marketplace for customers to buy directly from farmers.

Another Indonesian startup, Banyu, is working on developing an IoT-based solution for seaweed farmers to automate the tedious task of adjusting the depth and tightness of seaweed lines. Seaweed growth is highly sensitive to optimal sunlight exposure and movement at sea, so farmers typically take a *sampan* out to manually calibrate the depth and tightness of the lines by adjusting water levels in the plastic bottles used as floaters for the lines. Banyu's innovation uses sensor-activated adjustments to environmental conditions, optimizing yield.

Traceability

Traceable and sustainable blue foods are typically premium products for a niche market, given the increased costs that are borne either by the suppliers or buyers. According to the Seafood

[4] https://aquabyte.ai/

Certification and Ratings Collaboration, only 2% of blue foods production is certified as sustainable.

However, Mark Kaplan, founder of blockchain-based, commodity-neutral traceability solution Wholechain, observes a growing consumer sentiment that the seafood industry needs to operate more ethically for environmental sustainability and without labor abuse.

Amid this, policy momentum from governments and certification bodies are now catching up. For example, FDA's Food Traceability Final Rule establishes new recordkeeping requirements for persons who manufacture, process, pack or hold listed foods, which include finfish, shrimp and molluscs (but not seaweed). Effective January 2026. FDA sets out key data elements (KDEs) required at critical tracking events (CTEs) such as harvesting, cooling, shipping, transformation.

Wholechain was founded to meet this growing demand for digital visibility and connectivity throughout the value chain. Solutions like these enable farmers to be rewarded and incentivized for adopting more sustainable practices. While there are many solution providers within this space, a key problem is the lack of interoperability across them: there are still too many companies selling buyers and suppliers proprietary tracing solutions that require every company to use and pay for that one solution in order to comply with policies or gain visibility into their supply chains. Mark Kaplan thus points out the importance of adherence to global data standards such as GS1 EPCIS and those set by the Global Dialogue on Seafood Traceability, to facilitate transparency and harmonize reporting.

By moving fast in being able to demonstrate traceability, Indonesia’s blue foods sector may gain a competitive advantage in reaching markets demanding high transparency such as the US.

3b. Elaboration on non-technical innovations

Management practices

A common theme among Indonesian blue foods startups is that they often help producers improve production management. For example, eFishery and JALA offer customers digital dashboards to monitor key indicators of pond conditions and company finances, along with tips

on best practices. In many cases, such data was previously only manually collected, or not recorded at all. Standards were rarely set, much less applied consistently by workers. The adoption of simple management practices can thus help significantly improve fish health, productivity as well as financial management.

An anecdote from DelosAqua, a VC-backed saltwater shrimp operator with ambitions for global expansion, is particularly revealing. Through the adoption of SOPs and some basic tech, DelosAqua managed to improve efficiency and become a top 99th percentile performer in Indonesia. Despite this, it continues to struggle with enforcing basic hygiene protocols as recently as February 2024, when the CEO discovered that workers were not washing their hands and feet before entering the shrimp pools.

New business models

The examples below illustrate not only new business models which have emerged in recent years, but also the types of basic industry gaps which remain in Indonesia's blue foods sector.

A general sentiment among SMEs is that working capital financing is difficult to obtain through debt, which is why startups are heavily reliant on raising capital by giving up equity to investors. It is this challenge which eFishery, now a celebrated Indonesian aquaculture unicorn, initially sought to address. Small and medium sized aquaculture farmers lacked cash flow to afford feed, given the 90-120 days for each farming cycle. The solution was to sell feed to these farmers on credit, which they would recoup when they bought the harvested fish from these farmers at a discounted price.[5] This was a fundamentally novel type of business, combining roles of financier, feed supplier, and middleman. The automatic feeder hardware was simply a way to enhance what was already an innovative solution to aquaculture farmers.

DelosAqua, which has raised over US$13 million from venture capital, began with a value proposition of relieving saltwater shrimp farm owners from the burden of managing their farms, which are harder to operate compared to freshwater fish farming.[6] Specifically, DelosAqua

[5] Mallarangeng, Guntur. Interview 13 Feb 2024
[6] Mallarangeng, Guntur. Interview 13 Feb 2024

targeted distant smallholder farm owners who lived in big cities far away from their inefficient (and typically inherited) rural farms.[7] DelosAqua copied the "Hilton model" of hotel management to lease and operate the farms, thus achieving economies of scale through 'horizontal integration' in an otherwise highly fragmented sector with many inefficient small farms.[8]

The problem of fragmentation and inefficiency also applies in other sectors within aquaculture and fisheries, such as seaweed.[9] In fact, the current fragmented and relatively informal nature of the Indonesian seaweed market deters venture capitalists.[10]

Moreover, the fragmentation problem is not limited to the production stage alone. Distribution chains remain largely fragmented and inefficient,[11] with up to 8-9 middlemen being customary in the seaweed and caught fish industry.[12] Moreover, many processing plants operate well below capacity, at around 50% utilization for shrimp[13] and 25% for carrageenan.[14] Most blue foods producers, and even processing factories, in Indonesia lack direct access to foreign consumers, especially in high-value Western markets. Most of this value is currently captured by importers from those nations, but Indonesian producers can increase margins by several multiples if they distribute and sell Indonesian brands in Western markets. Compared to selling by producer at farmgate, selling from processor to importer makes 2X margin and selling to consumer 5X margin.[15] Given this context, DelosAqua is overcoming these inefficiencies by scaling through horizontal expansion via leasing in order to contract directly with partner distributors and processing factories which can in turn operate at close to full capacity. DelosAqua is also seeking to build a brand to sell directly to retailers in the West to achieve full vertical integration and capture value all along the value chain from supplier to end consumer.

[7] Mallarangeng, Guntur. Interview 13 Feb 2024
[8] Mallarangeng, Guntur. Interview 13 Feb 2024
[9] Yamin, Dodon. Interview 9 Feb 2024
[10] Longmire-Kulis, Natalie. Interview 29 Feb 2024
[11] Mallarangeng, Guntur. Interview 13 Feb 2024
[12] Yamin, Dodon. Interview 9 Feb 2024
[13] Mallarangeng, Guntur. Interview 13 Feb 2024
[14] Azalea, Ayu. Interview 11 Feb 2024
[15] Mallarangeng, Guntur. Interview 13 Feb 2024

Carbon markets

The market for carbon credits is projected to grow to up to US$50 billion[16] ~ US$100 billion[17] by 2030. Within this, blue carbon, which refers to carbon sequestration from ocean and coastal ecosystems, is gaining attention as an effective nature-based solution for carbon abatement.

While blue economy strategies tend to consider blue carbon and blue foods separately, there is potential for synergies between the two.[18] UMITRON, an aquaculture technology provider based in Singapore and Japan, believes that an active voluntary carbon market in Indonesia would open up opportunities for aquaculture farmers to capture new revenue streams by selling carbon credits. Kristin Veriga, a senior executive at Indonesian aquaculture tech unicorn eFishery, shares this optimism and expressed that eFishery would be keen on using their tech solutions to calculate blue carbon credits.

Blue carbon encompasses a range of solutions, with different levels of proven efficacy and commercial viability, ranging between established, emerging and nascent stages.[19] In Indonesia, mangrove affiliated carbon credits are more established, while seaweed affiliated carbon credits are still in the nascent stages. However, given Indonesia's status as an archipelagic nation, Indonesia may seek to pilot seaweed-based carbon credits given the large scale of seaweed production across islands.[20]

Social engagement:

From the several examples of success we came across, we found that it is critical to have close proximity to the target users in order to identify their needs and establish trust before introducing a new solution. In the case of eFishery, farmer Gibran Huzaifah had the benefit of being an aquaculture farmer himself who already established trust with his community and understood their perspectives. Fishers and farmers also live in tightly knit communities and are protective of

[16] Claes, et al., "Blue carbon: The potential of coastal and oceanic climate action"
[17] Morgan Stanley, "Where the Carbon Offset Market Is Poised to Surge"
[18] Kelly, Emily. Interview 28 Feb 2024
[19] Claes, et al., "Blue carbon: The potential of coastal and oceanic climate action"
[20] Kelly, Emily. Interview 28 Feb 2024

their family techniques or legacies.[21] As such, it is important that the introduction of technological advancements complements rather than replaces traditional farming practices.[22]

Dodon Yamin of Banyu, who has worked closely with coastal communities in Sulawesi and NTB, also emphasizes the importance of social capital to ensure grassroot-level adoption. For instance, he did not directly and simply offer farmers more resilient seedlings, but rather he first worked among them to set up cooperatives to fund their purchase of inputs for seaweed farming. This in turn gave him access to the farmers which opened doors to pilot and eventually adopt new seedlings and optimized farming practices.

On the other side of the world, ABALOBI is a South African social enterprise that targets different key elements of a small-scale fisher's business operations and livelihood through catch and expense logging, digital marketplace access, communication, vessel tracking, and more. Furthermore, ABALOBI's Fisher with a Story platform cooperative is a fully traceable platform that allows a consumer to see the full journey of the fish they purchase, which allows ABALOBI fishers to market their fish as a premium product. Most importantly, ABALOBI is able to create this value through a co-design process with the communities it serves. ABALOBI is able to work with the community in 1) understanding their needs and where technology can assist them and 2) introducing new technologies gradually and through a trusted venue while assisting the community in all the steps in between. ABALOBI, and similar social enterprises, can serve as a bridge between communities and technology innovators, thus directing the benefits of blue food technology directly to those who need it the most.

3c. Interview Protocol

Our interview questions template is summarized below. Given that we used a semi-structured interview approach, we customized the individual list of questions based on the background and experience of the interviewee.

[21] Shang, Bryton. Interview 23 Feb 2024
[22] Longmire-Kulis, Natalie. Interview 29 Feb 2024

Topics	*Questions + Notes*
Background (Organization and role)	Please briefly walk us through what [your organization] does, and your role.
Issues and obstacles	**What are the biggest obstacles your organization is faced with?** What about the industry do you find frustrating, cumbersome, outdated?
Unlocks and enabling factors	If you had the **ability to change one thing** about your industry - what would it be? Let's say that change did happen. What would it look like? What would it enable? What would the next hurdle be?
Shifts and disruptions	**How are things different** now than they were two years ago? Do you think these changes will stick? What shifts in the industry or greater ecosystem are you excited about? Which ones are concerning?
Introduction to other resources	Is there any person or resource that you would recommend me engage with?

3d. List of experts interviewed

A big thank you to the following interviewees whose insights were invaluable throughout the course of our research. We'd also like to thank the interviewees who wished to remain anonymous; their insights shaped our research direction tremendously.

Name	**Affiliation**
Azalea Ayuningyas	Co-founder & CEO, Krealogi
Belva Widyaprasetia	Blue Economy Consultant, BAPPENAS
Bryton Shang	CEO, Aquabyte
Chairul Irawan	Co-founder & CEO, SeaTech Consulting
Christopher Amhoff	Business Development Manager, UMITRON
Dane Klinger	Senior Director of Blue Foods, Conservation International
Dodon Yamin	CEO, Banyu Farms
Emily Kelly	Blue Carbon Lead, World Economic Forum
Gracie White	Lead of Global Ocean Investments, Conservation International Ventures
Guntur Mallarangeng	Founder & CEO, Delos Aqua
Jennifer Bushman	Founder, Fed by Blue
Karlotta Rieve	Project Manager, Hatch Blue
Kristin Veriga	Senior Vice President, eFishery
Chaula Tedja	Manager, Capacity Building Programs for mFarmer
Mark Kaplan	Co-founder & Partner, Wholechain CEO of Tone Mobile (affiliated with mFish)
Mike Lin	Partner, Dangerous Ventures
Natalie Longmire-Kulis	Investment Analyst, Potato Productions
Stephanie Quah	Managing Director, Cargill
Steven Fox	Partner, Propeller Ventures
Steven Herman	Author, Phyconomy
Wayne Murphy	CEO, Hatch Blue

We'd also like to thank the teaching team and Dr. Josheena Naggea for their guidance and help.

4. Justice & Inclusion Report

4a: Key informant interviews

Table 1. List of interviews conducted with key informants.

Key Informant	Institution/Programs	Experience/Interview Focus
Brian Crawford	University of Rhode Island, Coastal Resources Center	Case studies regarding women harvesters in Gambia and Ghana
Sarah Harper	University of Victoria	Illuminating Hidden Harvests Project and enabling factors for gender transformative approaches
Dian "Tita" Rositawati	Judicial Reform Working Group at the Supreme Court of Republic Indonesia	Discussion on current findings and application to Indonesia context
Elin Torell	University of Rhode Island, Coastal Resources Center	Case studies regarding women gleaners in Calamianes, Philippines and Tanzania
Sangeeta Mangubhai	Talanoa Consulting, Fiji Island	Progress of gender equity in the Pacific and the need for gender language in policy
Karen Kent	University of Rhode Island, Coastal Resources Center	Case studies in Ghana and Gambia and challenges in the blue foods sector facing gender equity and inclusion
Belva Widyaprasetia	BAPPENAS	BAPPENAS feedback on progress
David Cohen	Stanford, Center for Human Rights and International Justice	Justice sector reform initiatives and legal context of Indonesia
Joan Regina L. Castro	PATH Foundation Philippines, Inc.	Legal process and lessons learned from supporting women harvesters in Calamianes, Philippines
Cephas Asare	Environmental Justice Foundation	Work in empowering women through case studies in Ghana and Liberia
Pip Cohen	James Cook University, Independent Researcher	Gender-transformative approaches across the world
Annisya Rosdiana and Heidi Retnoningtyas	Fisheries Resource Center of Indonesia	Key barriers and opportunities for empowering Indonesian women in the fisheries and aquaculture sector

4b: Partnerships table

Table 2. List of local, national, international, and private sector partnerships with women in small-scale fishing communities amongst case studies.

Case Study	Women Harvesters' Organization	NGOs L = Local N = National I = International	Government, Local Authorities, and National Agencies	Universities/ Academic Institutions	International Development Agencies	Private Sector
The Gambia	TRY Association	World Wildlife Fund for Nature - West Africa Marine Ecoregion (I)	Department of Fisheries Department of Parks and Wildlife Management Department of Forestry National Environment Agency	University of Rhode Island, Coastal Resources Center	United States Agency for International Development (USAID)	N/A
Ghana	Densu Oyster Pickers Association	Development Action Association (L)	Fisheries Commission Ministry of Fisheries and Aquaculture Development Ga South Municipal Assembly Ghana Water Company Limited Wildlife Division of the Forestry Commission of Ghana	University of Rhode Island, Coastal Resources Center University of Cape Coast	United States Agency for International Development	Panbros Salt Industry Bojo Beach Resort
Philippines	N/A	PATH Foundation Philippines Inc. (N) C3 Philippines (L)	Local governments of Busuanga, Coron, Linapacan, and Culion	University of Rhode Island, Coastal Resources Center	United States Agency for International Development	BDO Foundation

Liberia	VSLA groups (various women actors involved; not limited to harvesters) Fishmongers' and fish sellers' associations (informal)	Environmental Justice Foundation (I)	Liberia National Fisheries and Aquaculture Authority Liberia Artisanal Fishers' Association Collaborative Management Associations (various) Sea Chiefs Council of Elders Town Chiefs	N/A	European Union	N/A

4c: Summary of key learnings by category

Table 3. Key identified learnings, sorted into the categories of Foundational, Actualizing, and Strengthening

Foundational	**Actualizing**	**Strengthening**
Learning 1: Putting gender language into policy **Learning 2:** Enacting gender mainstreaming **Learning 3:** Incorporating gender analysis into planning and decision-making	**Learning 4:** Securing avenues for meaningful participation	**Learning 5:** Establishing equitable and balanced collaborations with a diversity of partners **Learning 6:** Incorporating local capacity-building and strengthening programs **Learning 7:** Ensuring sustainable financing, interventions, and structures