KMI International Journal of Maritime Affairs and Fisheries

KMI International Journal of Maritime Affairs and Fisheries (www.kmij.org) is a peer-review international journal of ocean policy studies and marine data analytics. It offers researchers, analysts and policy makers a unique combination of legal, political, social and economic analyses. The journal covers international, regional and national marine policies; management and regulation of marine activities including fisheries, ports and logistics; marine affairs, which encompass the topics of marine pollution and conservation as well as use of marine resources. This journal is published biannually in June and December by the Korea Maritime Institute.

Editorial Board

Editor-in-Chief
Jungho Nam, Korea Maritime Institute, Korea
Tel: +82-51-797-4712, E-mail: jhnam@kmi.re.kr

Editor
Venus Lun, Korea Maritime Institute, Korea and Logistics and Supply Chain MultiTech R&D Center, Hong Kong

Managing Editor
Jin-Young Hong, Inha University, Korea

Members
Meifeng Luo, Hong Kong Polytechnic University, Hong Kong
Sang Yoon Lee, Inha University, Korea
Francesco Parola, University of Genoa, Italy
Jihong Chen, Shanghai Maritime University, China
Michele Acciaro, Kühne Logistics University, Germany
Jong Sung Ryu, Anyang University, Korea
Kum Fai Yuen, Nanyang Technological University, Singapore
Do Hoon Kim, Pukyong National University, Korea
Frank Asche, University of Florida, USA
Adolf K. Y. NG, University of Manitoba, Canada
Xiwen Bai, Tsinghua University, China
Young-Je Park, Korea Institute of Ocean Science and Technology, Korea
Joon ho Kwon, Pusan National University, Korea
Stephen Jay, University of Liverpool, United Kingdom
Hwa Joong Kim, Inha University, Korea
Gi-Tae Yeo, Incheon National University, Korea
Kyoung-Suk Choi, Jeonbuk National University, Korea
Young-Tae Chang, Inha University, Korea
Geun-sub Kim, Korea Maritime Institute, Korea
Keonwoo Chio, Korea Maritime Institute, Korea
DongHun Go, Korea Maritime Institute, Korea
Deukhoon Han, Korea Maritime Institute, Korea
Young-Kil Park, Korea Maritime Institute, Korea
Sung-Jin Cho, Korea Maritime Institute, Korea
Yong An Park, Busan University of Foreign Studies, Korea
Fabia Ballini, World Maritime University, Sweden
Stefano Ricci, University of Rome La Sapienza, Italy
Leonardo Santiago, Copenhagen Business School, Denmark
Dakshina G. De Silva, Department of Economics, Lancaster University Management School, UK
Luca Cocconcelli, London Stock Exchange, UK
Zhi-Hua Hu, Shanghai Maritime University, China
Kamal Ranatunga, University of Sri Jayewardenepura, Srilanka
Hokey Min, Bowling Green State University, USA
Seong-Jong Joo, Air Force Institute of Technology, USA
Hong-Oanh Nguyen, University of Tasmania, Australia

Administration
Da-eun Lee, Staff, Korea Maritime Institute, Korea
Tel: +82-51-797-4385, E-mail: journal@kmi.re.kr

Copyright

© Copyright 2025 Korea Maritime Institute.
This is an Open-Access journal distributed under the terms of the Creative Commons Attribution Non-Commercial License (http://creativecommons.org/licenses/by-nc/4.0/) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Publisher

Jung-hee Cho
President of the Korea Maritime Institute
26, Haeyang-ro 301beon-gil, Yeongdo-gu, Busan, 49111, Korea
Telephone: +82-51-797-4800, Facsimile: +82-51-797-4810
Website: www.kmi.re.kr; www.kmij.org

The publisher, the institute and the editor cannot be held responsible for errors or any consequences arising from the use of information contained in this journal.

Printed and bound by Guhmok Publishing Co./Guhmok Info Inc.
Published December 31, 2025

KMI International Journal of Maritime Affairs and Fisheries

CONTENTS

Forecasting Supply and Demand for Farmed Abalone in Korea:
A Simultaneous Model Approach
MyungJoon Moon · HongSeok Seo ····· *17*

What Should a Sustainable and Inclusive Fisheries Value Chain Entail?
Perspectives from Coastal Fishing Communities in Yunlin, Taiwan
Baker Matovu ····· *47*

KMI International Journal of Maritime Affairs and Fisheries • Volume 17 Issue 2 December 2025 pp. 17-46 •
https://doi.org/10.54007/ijmaf.2025.e2

Forecasting Supply and Demand for Farmed Abalone in Korea: A Simultaneous Model Approach

MyungJoon Moon* · HongSeok Seo**

ABSTRACT

Despite the rapid growth of Korea's abalone aquaculture industry, stagnant domestic demand has led to persistent oversupply, placing downward pressure on prices and underscoring the need for effective supply-demand forecasting. In response to increasing mortality risks, farmers have shortened the grow-out period, inadvertently exacerbating the oversupply problem. This study develops a simultaneous equation model to capture the dynamic interactions between abalone supply and demand. To address potential structural changes in the time-series data, multiple breakpoint tests were conducted. Most variables in the behavioral equations were statistically significant at the 1% level. However, the coefficient for shipment volume in the grow-out stock equation for abalone over one year was not statistically significant, although it remained economically plausible. The model incorporates both in-sample and out-of-sample forecast evaluations, along with a policy simulation module to enhance practical applicability. Except for export-related equations, the model exhibits strong predictive accuracy. These results suggest that the proposed framework is a valuable tool for forecasting and policy planning in Korea's abalone industry.

Key words : abalone aquaculture, simultaneous model, forecasting, policy simulation

* Master's Degree Student, Department of Agricultural Economics, Chungbuk National University, Cheongju, Korea, ansaudwns9@chungbuk.ac.kr
** Corresponding author, Assistant Professor, Department of Agricultural Economics, Chungbuk National University, Cheongju, Korea, hongseok@chungbuk.ac.kr

Received July 19, 2025; Received in revised form October 16, 2025; Accepted November 17, 2025

1. Introduction

Since the 2000s, Korea's abalone aquaculture industry has rapidly expanded (Ock, 2015). Prior to the 1990s, abalone production was predominantly small-scale and heavily reliant on wild stocks harvested from natural habitats. The development of aquaculture technologies, along with the expansion of offshore cage farming facilities in the 2000s, enabled large-scale farmed abalone production feasible (Oh, Lee, and Kim, 2020). In Korea, farmed abalone production increased more than fiftyfold, rising sharply from 20 metric tons in 2000 to 1,065 metric tons in 2003 (Statistics Korea, 2025). During the same period, the share of marine aquaculture in total abalone production increased from 20.8% to 93.6%. By 2023, this share had reached 99.7%, indicating a near-complete transition to an aquaculture-dominated production structure.[1] The mechanization of feeding systems has further enhanced production efficiency and contributed to the sustained growth of farmed abalone output (Lee and Park, 2010). As a result, Korea is now recognized as one of the world's leading abalone producers, second only to China (Cook, 2016).

In recent years, growth in domestic consumption and international demand has failed to keep pace with the continued increase in production, resulting in persistent market oversupply and a decline in producer prices (Han et al., 2020). The producer price of abalone, standardized at 10 pieces per kilogram, declined from Korean Won (KRW) 48,780 in 2012 to KRW 23,222 in 2024, corresponding an average annual decrease of approximately 4%. While the shipment volume in 2024 reached 23,347 metric tons, marking a 1.2% increase compared to 23,061 metric tons in 2021, the total production value declined by approximately 30%, from KRW 694 billion to KRW 486 billion over the same period (Statistics Korea, 2025). This indicates a substantial decrease in total income for abalone producers due to falling prices, signaling deteriorating profitability and growing management uncertainty amid ongoing overproduction.

The rapid expansion of Korea's abalone industry has brought forth several challenges that threaten its long-term sustainability, including disease outbreaks associated with high stocking densities and increased mortality rates driven by rising sea temperatures (Kim, 2020). In response to these heightened mortality risks, abalone farmers have shortened the grow-out period, which previously averaged 36 months (Nam and Sim, 2014). More recently, an increasing number of farms have further reduced the grow-out period to approximately 18 months prior to harvest (Seong, 2021). Although this strategy aims to mitigate mortality

1 Abalone production statistics are published by both Statistics Korea and the Fisheries Outlook Center of the Korea Maritime Institute (KMI). Although discrepancies arise between the two institutions due to differences in sampling methodologies, the production data from 2008 to 2024 exhibit a very strong positive correlation, with a correlation coefficient of 0.99.

risks, it has also led to accelerated shipments, exacerbating market oversupply and placing additional downward pressure on prices.

The abalone industry is vulnerable to biological constraints and environmental fluctuations on the supply side (Morash and Alter, 2016). In addition, institutional inefficiencies in the distribution system reinforce market imbalances and increase price instability. Abalone is frequently distributed through informal channels, characterized by a high proportion of non-systematic sales and side payments, and transactions conducted via unofficial wholesale markets.[2] These practices undermine price transparency in distribution processes at the production level (Cho and Lee, 2024). Accordingly, there is an increasing need to develop a supply and demand model that systematically captures the unique structural and behavioral characteristics of the abalone industry to improve forecasting accuracy and support evidence-based policy responses to market volatility.

Reliable information on the supply and price outlook for abalone is essential not only for producers and industry stakeholders but also for government policymakers (Choi and Cho, 2018). In response to the growing demand for economically and statistically robust forecasting models, Kim et al. (2014) developed the first supply-demand forecasting model specifically for the abalone industry. This model employed a partial equilibrium framework and was specified as a Recursive Model (RM), in which market equilibrium prices were determined sequentially based on projected domestic consumption. While the model enabled quarterly mid- to long-term supply forecasts, it exhibited limited model fit and low forecasting reliability. Specifically, it did not adequately capture the time lags and interdependencies among key structural components of abalone supply—namely, juvenile abalone input volume, grow-out stock, and shipment volume—which critically influence expected prices.

Cho, Choi, and Kim (2016) improved upon the previous model by incorporating the biological growth stages of farmed abalone and its supply structure, modifying the model to capture the dynamic monthly relationships among production, shipment, and pricing. To improve short-term forecasting accuracy, the original quarterly model was revised to operate on a monthly basis. Furthermore, since juvenile abalone input and grow-out volumes are measured in numbers of individuals while shipment volumes are reported in metric tons, a conversion formula was applied to standardize the units of measurement. These enhancements improved the model's performance in forecasting short-term shipment volumes and wholesale market prices. Nevertheless, certain explanatory variables included in the model lacked strong theoretical justification, indicating limitations in the model's overall validity.

2 Lee and Park (2010) highlighted that, unlike manufactured goods, agri-fishery products are highly perishable and vulnerable to damage during distribution, rendering quality recovery difficult once deterioration occurs. Due to variations in moisture content and other product-specific characteristics, it is common practice in actual trade settings to provide additional quantities as bonuses or to apply weight allowances as loss adjustments to compensate for shrinkage and mortality losses incurred during handling.

Han and Jang (2019) identified potential uncertainties and inaccuracies in the quantity-to-weight conversion formulas used in earlier models to standardize juvenile abalone input, grow-out volume, and shipment volume. To address these issues, they developed a model that retains the original measurement units. Shipment data were converted into age-based estimates, and behavioral equations were specified within a dynamic ecological framework reflecting the biological growth cycle and harvest timing of abalone. The observed short-term fluctuations in the abalone market, driven predominantly by supply-side variations rather than demand, imply that a Simultaneous Model (SM) is theoretically preferable. However, due to limited availability of monthly data, the model was structured as a RM. Although the conversion from size-based to age-based figures may have introduced measurement errors—constituting a limitation—the model's significance lies in its ability to reduce supply-side modeling errors.

The purpose of this study is to develop a SM that quantitatively captures the characteristics and dynamic behavior of Korea's abalone market. The proposed model incorporates biological production cycles, endogenous interactions between supply and demand, and structural shifts identified in time-series data. To improve the predictive accuracy and policy relevance beyond existing models, key behavioral equations are re-estimated and refined. Forecast performance is assessed using both in-sample and out-of-sample error metrics. The proposed SM is intended to serve as a practical tool for supply-demand forecasting and policy formulation within the abalone industry.

This study offers several distinctive contributions. First, the model derives the equilibrium price under the market equilibrium condition in which total supply equals total demand. Second, the grow-out stock is classified into two categories based on recent age distribution patterns. Third, juvenile abalone input from November to April is estimated in aggregate, applying recent monthly proportions to capture seasonal patterns. Fourth, export volume equations are disaggregated into exports to Japan and other countries excluding China, and export unit price equations are newly introduced.

2. Overview of the Korean Abalone Aquaculture Industry

Juvenile seeding represents the initial stage of abalone aquaculture. Since 2021, the previously rising trend in juvenile input volumes has reversed, shifting toward a declining pattern. Wando county serves as the leading production area for farmed abalone in Korea (Ock, 2015). Between 2008 and 2023, it accounted for approximately 77% of the nation's total juvenile seeding. The seeding period can be broadly categorized by hatching time: early-hatched juveniles are typically seeded from October to November, whereas late-hatched juveniles are seeded from

March to April of the following year. Although early-hatched juveniles generally command higher prices, they exhibit superior growth performance, enabling a shorter grow-out period and greater economic efficiency (National Fisheries Research and Development Institute, 2008).

Juvenile seeding historically took place from October through the following May. However, since 2011, seeding in October has been discontinued, and from 2021 onward, the overall seeding window has gradually narrowed to the period between November and April. In Wando, the main production region, seeding has been predominantly concentrated between November and the following January. Regional variation was evident in 2006; over time, the Jindo, Shinan, and Haenam regions have increasingly aligned with the Wando pattern, with the proportion of seeding occurring between November and January increasing significantly—from approximately 37% in 2011 to 86% by 2023. Monthly and regional seeding trends are summarized in Table 1.

After reaching a certain size, juvenile abalone are typically transferred to offshore cage systems for grow-out, where the cultivation period varies according to biological growth rates (Choi and Cho, 2018). Grow-out stocks are generally classified into four age groups: under one year, one year, two years, and three years or older. Abalone aged one year or older are considered marketable and are shipped accordingly. As shown in Figure 1, while total grow-out volume has been increasing since 2008, growth has stagnated since 2017, suggesting a saturation of farm capacity and a strategic shift in production planning.

More notably, the age distribution of grow-out stock has shifted significantly. The shares of abalone under one year and one year old rose from 39.2% and 33.1% in 2008 to 49.5% and 41.0% in 2023, respectively. Conversely, the shares of two-year-old and three-years-and-older abalone declined from 21.8% and 5.9% to just 8.5% and 0.9%. Such compositional changes indicate a clear industry-wide transition toward shorter production cycles, which reflects a broader strategy to mitigate high mortality risks (Nam and Sim, 2014).

Abalone are shipped according to size classifications: 8 pieces per kilogram, 9–11 pieces, 12–15 pieces, 16–20 pieces, and more than 21 pieces. In recent years, there has been a marked increase in the shipment of smaller-sized abalone (Kim, 2020). Historically, consumer preferences leaned toward larger abalone, owing to their perceived nutritional benefits and higher market value, which encouraged producers to prioritize the cultivation of larger individuals (Ock, 2013). However, a recent shift in consumer demand toward smaller, more affordable abalone has resulted in increased shipment and production of smaller size categories (Choi, 2017).

Abalone survival and growth rates are influenced by environmental conditions (Kim, 2020). In particular, feeding activity decreases when the water temperature falls below 7°C, while mass mortality can occur if the temperature rises above 28°C due to feed spoilage (National Institute of Fisheries Science, 2008). To improve survival rates, abalone farms have shorten the cultivation period

Table 1. Regional and monthly distribution patterns of juvenile abalone seeding volume

(units: 10,000 individuals)

Month	2006/2007		2011/2012		2016/2017		2021/2022		2022/2023		2023/2024	
	Wando (%)	Others (%)	Wando (%)	Others (%)	Wando (%)	Others (%)	Wando (%)	Others (%)	Wando (%)	Others (%)	Wando (%)	Others (%)
Oct	1,076 (4)	318 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Nov	9,093 (53)	1,205 (17)	30,452 (70)	2,050 (16)	33,100 (59)	3,200 (18)	35,000 (60)	4,897 (27)	42,151 (75)	4,196 (24)	38,783 (72)	4,674 (28)
Dec	800 (5)	1,066 (15)	3,785 (9)	2,556 (20)	6,700 (12)	5,100 (28)	14,603 (25)	4,370 (24)	9,571 (17)	6,806 (38)	10,491 (20)	5,874 (35)
Jan	409 (2)	295 (4)	1,789 (4)	164 (1)	2,800 (5)	2,600 (15)	3,869 (7)	5,125 (29)	2,619 (5)	3,892 (22)	3,012 (6)	3,771 (23)
Feb	212 (1)	68 (1)	1,194 (3)	0 (0)	4,600 (8)	800 (4)	3,192 (5)	2,491 (14)	1,096 (2)	2,214 (12)	761 (1)	2,189 (13)
Mar	4,090 (24)	3,060 (43)	3,931 (9)	4,942 (39)	5,400 (10)	3,000 (17)	944 (2)	591 (3)	663 (1)	395 (2)	233 (0)	62 (0)
Apr	1,678 (10)	962 (13)	2,461 (6)	2,581 (20)	1,600 (3)	1,300 (7)	437 (1)	382 (2)	210 (0)	230 (1)	397 (1)	189 (1)
May	0 (0)	156 (2)	0 (0)	313 (2)	2,100 (4)	1,900 (11)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Total	24,170		56,218		74,200		75,901		74,043		70,436	

Note: "Others" comprises Jindo, Shinan, and Haenam; values in parentheses indicate each region's share (%) of total monthly juvenile seeding volume.

so that abalone experience the high-temperature summer season only once (Seong, 2021) (Table 2).

Most abalone imported into Korea is frozen or processed, differing in usage from domestically produced live abalone (Shin, Jang, and Kim, 2008). Korean abalone exports are primarily directed to Japan, and shipments to Vietnam, Taiwan, and the United States have also increased in recent years. Exports to Japan have grown by an average of 16% annually since 2008, reaching 2,223 metric tons in 2023. Exports to Vietnam, Taiwan, and the United States rose from just 3 metric tons in 2009 to 403 metric tons in 2023, reflecting notable market expansion. China, in particular, experienced a temporary spike in demand for Korean abalone due to its domestic supply and rising prices (Korea Maritime Institute, 2016). Consequently, Korea exported 589 metric tons to China in 2016 and 386 metric tons in 2018, but volumes remained minimal in other years.

Figure 1. Annual trends in abalone grow-out stock by age group and production cycle.

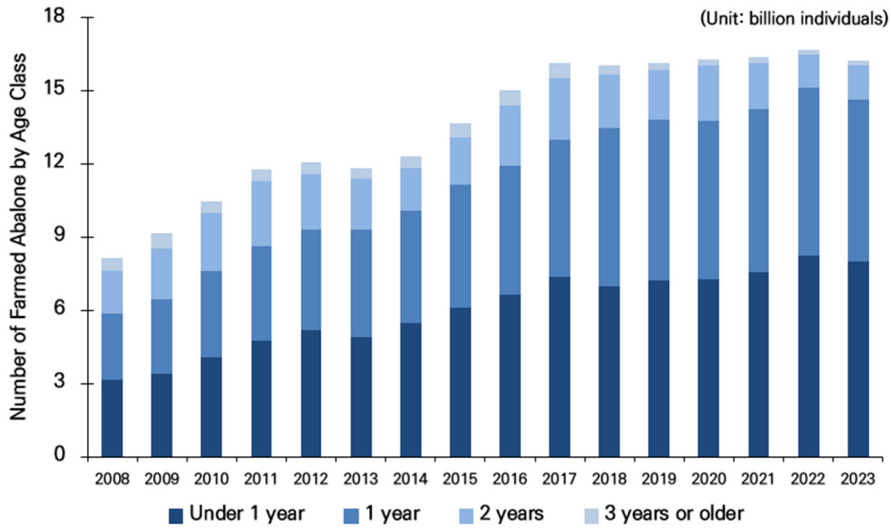


Table 2. Trends in abalone shipment volume by size and year

(units: 1,000 metric tons)

Category	2008 (%)	2012 (%)	2016 (%)	2020 (%)	2021 (%)	2022 (%)	2023 (%)
8 or fewer	740 (12.4)	198 (2.2)	554 (4.1)	834 (4.2)	1,216 (5.3)	542 (2.5)	833 (3.5)
9–11	1,373 (23.0)	1,077 (12.2)	1,757 (13.0)	2,696 (13.5)	3,231 (14.0)	2,418 (11.0)	3,407 (14.2)
12–15	1,803 (30.2)	1,855 (21.0)	2,939 (21.8)	4,597 (23.1)	4,687 (20.3)	4,764 (21.7)	5,795 (24.2)
16–20	1,486 (24.9)	2,155 (24.4)	3,660 (27.1)	5,234 (26.3)	6,191 (26.8)	6,229 (28.4)	6,339 (26.5)
Over 21	562 (9.4)	3,534 (40.1)	4,599 (34.0)	6,557 (32.9)	7,736 (33.5)	7,964 (36.3)	7,551 (31.6)
Total	5,964	8,819	13,509	19,918	23,061	21,917	23,925

Note: Percentages indicate the proportion of each size category in the total annual shipment volume. Category is classified by weight (per kg).

3. Methodology

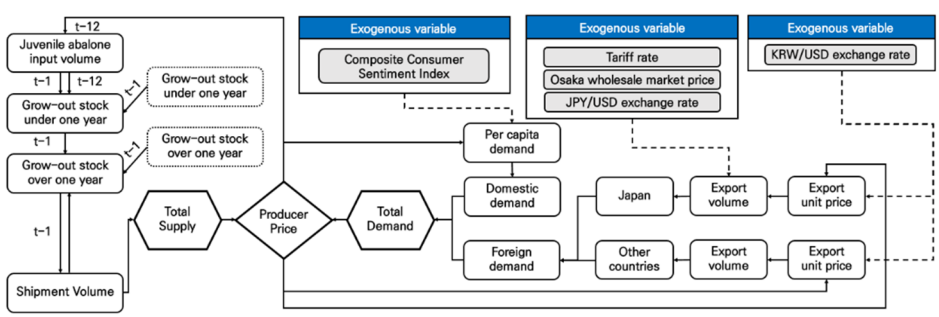
3.1 Data Description and Model Design

This study utilizes monthly data spanning from July 2008 to May 2024, which was provided by the Korea Maritime Institute (KMI) for analysis. Data prior

to July 2008 were excluded from the analysis to enhance the explanatory power of the model. The model is constructed based on a Dynamic Ecological Equation Model (DEEM) framework, reflecting the biological characteristics of abalone, thus sharing a common foundation with prior studies (Cho, Choi, and Kim, 2016; Han et al., 2020). However, unlike previous research that primarily employed a RM, this study adopts a SM, in which supply and demand interact bidirectionally to determine equilibrium prices.[3]

The abalone supply and demand model comprises three components: supply, demand, and price. The model's structural framework is presented in Figure 2. The supply component is defined as the total volume of domestic abalone shipments. The demand component consists of the sum of domestic consumption and foreign demand. In Korea, most abalone imports are in frozen or processed form, which differ significantly in terms of consumption purpose from domestically produced live abalone (Shin et al., 2008). Therefore, imports are not considered to have a meaningful impact on the equilibrium price and are excluded from the supply side of the model. Regarding exports, Japan remains the primary destination for Korean abalone, but the share of exports to other countries such as Vietnam, Taiwan, and the United States has recently increased. In contrast, exports to China tend to be irregular due to fluctuations in its domestic supply and demand conditions. Accordingly, this study categorizes abalone exports into two segments: Japan and other countries (excluding China), and formulates separate behavioral equations for each.[4]

Figure 2. Schematic framework of the abalone supply and demand model.



3 Thurman (1986) empirically demonstrated that the coefficient estimates derived from the demand function—where the dependent variable is quantity consumed—exhibited greater consistency and were asymptotically more efficient than those from the inverse demand function, where the dependent variable is price.

4 As of 2023, Korea exported 2,223 metric tons of abalone to Japan, accounting for 83.4% of its total abalone exports. In contrast, the share of exports to other countries—such as Vietnam, Taiwan, and the United States—was only 0.1% in 2008 but increased to 15.1% by 2023. Exports to China, meanwhile, have shown high volatility. Although volumes reached 589 metric tons in 2016 and 386 metric tons in 2018, in most other years they remained below 10 metric tons annually.

In Korea's abalone distribution system, official auction prices are not established in wholesale markets (Lee, Choi, and Kang, 2016). Therefore, it is not appropriate to define the market equilibrium price based on wholesale prices. In practice, most abalone is traded directly at the production sites or through intermediaries, making the production stage the primary point of supply-demand equilibrium. Consequently, the producer price is regarded as the market equilibrium price. In this study, the representative producer price, defined as the price for a standard size of 10 pieces per kilogram, is adopted as the market equilibrium price for the purposes of analysis.[5]

3.2 Functional Specification of the Abalone Supply and Demand Model

Abalone shipment volume is determined by the production intentions of abalone farms. The volume of juvenile abalone input is used as a proxy variable to reflect these intentions. Juvenile seeding marks the initial stage of abalone aquaculture and serves as a key determinant of future shipments. Abalone seed is typically stocked in February and cultivated for 8 to 9 months before being seeded, primarily in Wando, starting in November (Han et al., 2020). Given this biological time lag, juvenile abalone input volume is assumed to be influenced by the average producer price observed from the previous November to the following April.

Once juveniles reach a certain size, they are transferred to offshore cage farms, entering the main grow-out phase (Kim et al., 2016). Recently, in response to high mortality rates, there has been a growing trend toward shortening the grow-out period, leading to a decreasing proportion of abalone aged two years or older (Nam and Sim, 2014). Therefore, this study classifies grow-out stock into two groups: under one year and one year or older.

The monthly volume of abalone under one year of age is influenced by the previous month's juvenile abalone input, the previous month's volume of abalone under one year of age, and the juvenile input from the same month in the previous year. In contrast, abalone aged one year or older are subject to market shipments and therefore require the inclusion of shipment-related factors. Specifically, the volume of abalone aged one year or older is affected by the portion of the previous month's under-one-year abalone that has grown to one year or older, the previous month's volume of abalone aged one year or older, and the shipment volume for the current month.

Total demand for abalone is composed of domestic consumption and foreign demand. In the domestic market, per capita abalone demand is assumed to be determined by the equilibrium price and the Composite Consumer Sentiment

5 The producer price of abalone responds promptly to changes in supply and demand factors such as production volume, climatic conditions, and consumer preferences. In contrast, the wholesale price may reflect these changes in a delayed or distorted manner. Therefore, this study selects the producer price as the market equilibrium price. As the Korea Maritime Institute (KMI) provides forecasts based on the producer price for 10-piece-per-kilogram abalone, this price is used as the representative equilibrium price.

Index (CCSI).[6] To control for price level fluctuations, the producer price is deflated using the Consumer Price Index (CPI). Theoretically, disposable income would be the most appropriate variable to reflect income effects; however, it is published on a quarterly basis, making it unsuitable for use in a monthly model. Therefore, this study employs the monthly CCSI as a proxy variable to capture consumers' expectations and perceptions of economic conditions.

In modeling foreign demand, exports are classified into two categories: Japan and other countries (including Vietnam, Taiwan, and the United States). Export volume to Japan is specified using the demand function of Japanese importers. A 7% tariff is currently imposed on Korean abalone exports to Japan, and this cost is reflected in the export unit price. Abalone distributed in the Osaka wholesale market, produced domestically in Japan, may function as a substitute for Korean abalone. An increase in the Osaka market price can raise the demand for Korean abalone. The export unit price and the Osaka market price are used as explanatory variables for exports to Japan.

The exchange rate, defined as the Japanese Yen/United States Dollar (JPY/USD) exchange rate, is treated as an exogenous variable from the perspective of Japanese importers, as it determines the relative price of imports. A stronger yen (lower exchange rate) enhances the price competitiveness of Korean abalone in Japan, whereas a weaker yen (higher exchange rate) reduces it. The export unit price to Japan is modeled as a function of both the domestic equilibrium price and the exchange rate.

For exports to other countries, including Vietnam, Taiwan, and the United States, export volume is assumed to be determined solely by the export unit price. A tariff rate is not applied, as doing so would not accurately reflect the heterogeneous import conditions of these countries and may introduce bias in the estimation process. Due to data limitations regarding country-specific export prices, these destinations are grouped into a single category labeled "other countries," for which a unified behavioral equation is specified (Table 3).

6 The Composite Consumer Sentiment Index (CCSI) is derived from the Consumer Survey (Approval No. 301020) and is widely used as a research indicator for economic sentiment, private consumption, and overall economic conditions. The index is calculated by standardizing and aggregating six key components: current living conditions, expected living conditions, expected household income, expected household consumption expenditures, current economic conditions, and future economic outlook. A CCSI value above 100 indicates that consumers view the current economy more positively than the historical average, while a value below 100 suggests that consumers perceive the current economic conditions as worse than average.

Table 3. Key explanatory variables in the behavioral equations for supply and demand

Category	Behavioral equation	Key explanatory variables
Supply	Juvenile abalone input volume	$lnI_t = f(\ln FP10_{t-1})$
	Grow-out stock under one year	$S_t^0 = f(S_{t-1}^0, I_{t-1}, I_{t-12})$
	Grow-out stock over one year	$S_t^{123} = f(S_{t-1}^0, S_{t-1}^{123}, Q_t)$
	Shipment volume	$\ln Q_t = f(\ln S_{t-1}^{123})$
Demand	Per capita demand	$\ln(Demand_t/POP_t) = f(\ln(FP10_t/CPI_t), \ln CCSI_t)$
	Japan export volume	$\ln(X_t^{JP}) = f(\ln(XP_t^{JP} \times (1 + TARIFF_t), \ln(OMJP_t/EXCH_t^{JPY/USD}))$
	Japan export unit price	$\ln(XP_t^{JP}) = f(\ln FP10_t, \ln(EXCH_t^{KRW/USD}))$
	Other countries export volume	$\ln(X_t^{ETC}) = f(\ln(XP_t^{ETC}))$
	Other countries export unit price	$\ln(XP_t^{ETC}) = f(\ln FP10_t, \ln(EXCH_t^{KRW/USD}))$
Market clearing condition		Total supply = Total demand

Note: 1) I denotes the seed stocking volume; $FP10$ refers to the producer price for 10-piece abalone; S^0 indicates the grow-out stock under one year, while S^{123} refers to the grow-out stock over one year. Q represents the shipment volume. $DEMAND$ denotes domestic demand; POP is the estimated population; CPI represents the consumer price index; $CCSI$ refers to the composite consumer sentiment index. X^{JP} denotes the export volume to Japan, and XP^{JP} the corresponding export unit price. $TARIFF$ indicates the applicable tariff rate, $OMJP$ is the Osaka wholesale market price, and $EXCH^{JPY/USD}$ and $EXCH^{KRW/USD}$ represent the JPY/USD and KRW/USD exchange rates, respectively. X^{ETC} refers to the export volume to other countries (excluding China), and XP^{ETC} indicates the corresponding export unit price.
2) KRW, Korean Won; JPY, Japanese Yen; USD, United States Dollar.

4. Analysis Result

This study adopts a SM that satisfies the market-clearing condition and endogenously determines the equilibrium price through simultaneously specified supply and demand equations. Although simultaneity bias—arising from the correlation between explanatory variables and the error term—remains a theoretical concern in such systems (Rhew, 2017), the structural form specified in this study does not exhibit endogeneity among the behavioral equations. Consequently, all equations are estimated using the ordinary least squares method.

The behavioral equations of the abalone supply and demand model were estimated using EViews 8. The Breusch–Godfrey Lagrange Multiplier (LM) test was applied to detect autocorrelation in the residuals, as the model includes lagged dependent variables among the explanatory variables (Godfrey, 1978). The presence of autocorrelation was also assessed using the Durbin–Watson statistic. In

cases where autocorrelation was detected, the Newey–West estimator was used to obtain robust standard errors (Newey and West, 1994).

To account for potential structural changes in the time-series data, a multiple breakpoint test was conducted. While the traditional Chow test identifies a single breakpoint by comparing two predefined sub-periods (Chow, 1960), the Bai–Perron test enables the simultaneous detection of multiple structural breaks within the series (Bai and Perron, 1998). In this study, the Bai–Perron test was applied, with only those breakpoints deemed statistically significant at the 5% level or below retained to enhance the robustness and reliability of the analysis.[7]

4.1 Supply-Side Behavioral Equation

The estimation results for juvenile abalone input volume are presented in Table 4. The average producer price of 10-piece abalone from November to the following April has a statistically significant effect on seed stocking volume at the 5% significance level. Given that seeding activities are concentrated during this period, the volume is influenced by the average abalone price observed over the same months in the previous year. The estimation results indicate that a 1% increase in the 10-piece abalone price leads to a 0.1% increase in seed stocking volume. This finding implies that abalone farmers respond to price signals when

Table 4. Estimation results of juvenile abalone input volume (log–log)

Variables	Coefficient	*t*-value
C	9.202***	20.366
ln(FP10(−1))	0.103**	2.484
TREND	0.172***	17.529
$TREND^2$	−0.006***	−12.211
SD12	−0.232***	−7.635
SD17	−0.182***	−7.607
Sample range	2007Y–2023Y	
Adjusted R-squared	0.99	
Durbin-Watson stat	2.23	

Note: 1) *, **, *** Indicate statistical significance at the 10%, 5%, 1% levels, respectively.
2) As the number of observations used in the analysis is relatively small, the Newey-West estimator was applied to obtain robust standard errors.
3) FP10 refers to the average producer price from November of year t−1 to April of year t; TREND denotes a time trend variable; SD12 is a structural dummy for 2012 (0 for years prior to 2012, 1 for 2012 and onwards); and SD17 is a structural dummy for 2017 (0 for years prior to 2017, 1 for 2017 and onwards).

7 Structural changes within the time-series data were identified using multiple breakpoint tests, and the underlying causes of the detected breakpoints were thoroughly investigated and discussed in the analysis.

making production decisions, although the relatively low price elasticity observed may be attributed to biological or infrastructural constraints limiting short-term adjustments in seeding volumes.

Although seed stocking volume had exhibited a steady upward trend, a decline was observed beginning in 2021. To capture this shift, both linear and quadratic time trend variables were incorporated into the equation. The estimation results suggest that seed stocking volume increased at an average annual rate of 17.2%, with the growth rate decelerating by 0.6%p per year. The abalone industry in Korea is characterized by a lack of standardized facility materials and construction practices, rendering it structurally vulnerable to natural disasters such as typhoons (Kim et al., 2013). In late August and mid-September of 2012, typhoons Bolaven, Tembin, and Sanba caused substantial damage to offshore abalone cages and hatcheries (Korea Maritime Institute, 2012). To reflect the structural impact of this event, a structural dummy variable was introduced for the post-2012 period. In addition, the year 2017 was identified as another structural breakpoint, associated with sluggish growth in seed abalone and an excessive accumulation of grow-out stock. The estimation results show that seed stocking volume declined by 23.2% following the 2012 typhoon events and by an additional 18.2% after 2017. These findings indicate that changes in the seed production and stocking environment have exerted a structural impact on the medium- to long-term dynamics of abalone supply.

The estimation results for the grow-out stock of abalone under one year of age are presented in Table 5. Reflecting the dynamic biological growth process of abalone, the monthly stock of individuals under one year is influenced by several key factors. These include the stock remaining from the previous month, which captures the natural survival and retention; the seed stocking volume in the previous month, representing the immediate inflow of new juveniles; and the stocking volume in the same month in the previous year, which accounts for biological growth transitions, specifically the maturation of abalone beyond the under-one-year classification.

The estimation results reveal that an increase of 10,000 individuals in the under-one-year stock from the previous month leads to an increases of approximately 9,845 individuals in the current month's stock. Similarly, a 10,000-unit increase in the previous month's seed stocking volume results in a 5,417-unit increase in the current stock under one year, indicating the transition of sufficiently grown seed abalone into the grow-out stage. Conversely, a 10,000-unit increase in the seed stocking volume from the same month in the previous year results in a 5,464-unit decrease in the current under-one-year stock, reflecting the biological progression of one-year-old abalone into the over-one-year category. These results confirm that short-term variations in juvenile input and carry-over stocks are key determinants of the monthly grow-out stock of abalone under one year of age.

In terms of seasonal stocking patterns, the proportion of seed abalone stocked in March averaged approximately 17% prior to 2018 but declined sharply

Table 5. Estimation results of grow-out stock volume for abalone under one year of age (level-level)

Variables	Coefficient	*t*-value
C	359.815	0.387
S0(-1)	0.985***	60.926
I(-1)	0.542***	20.552
I(-12)	-0.546***	-19.817
DUMBF18Y03M	12,134.775***	11.442
DUM08Y12M+DUM14Y11M+DUM17Y11M	-12,772.911***	-6.688
DUM19Y12M+DUM20Y12M+DUM23Y11M	8,736.975***	4.387
Sample range	2008Y07M-2024Y05M	
Adjusted R-squared	0.96	
Durbin-Watson stat	2.10	
B-G LM test	1.363 (0.506)	

Note: 1) *, **, *** indicate statistical significance at the 10%, 5%, 1% levels, respectively.
2) B-G LM test refers to the Breusch-Godfrey test for autocorrelation, with *p*-values shown in parentheses.
3) S0 denotes the grow-out stock volume of abalone under one year of age; I represents the juvenile abalone stocking volume; and DUMBF18Y03M is a dummy variable for the month of March in each year up to 2018.
4) B-G LM, Breusch-Godfrey Lagrange Multiplier.

to around 3% after 2019. This trend can be interpreted as a response to the increasing use of early-hatched juveniles, which, although more expensive, offer superior growth performance and reduce the overall grow-out period, thus enhancing economic efficiency (National Fisheries Research and Development Institute, 2008). To account for this structural change, a dummy variable was included for the month of March up to 2018. The estimation results indicate that the grow-out stock under one year in March before 2018 was higher by approximately 12,135 individuals compared to the same month after 2019.

The estimation results for the grow-out stock over one year are presented in Table 6. Abalone that are shipped to market have reached the grow-out stage of over one year (Han et al., 2020). Accordingly, the monthly stock of abalone over one year can be calculated by summing the previous month's stock under one year and over one year, and then subtracting the current month's shipment volume.

The results show that a 10,000-unit increase in the grow-out stock over one year in the previous month leads to a 6,112-unit increase in the current stock. This suggests a relatively high mortality rate among older stock, potentially due to age-related vulnerability or environmental stressors. In addition, a 10,000-unit increase in the previous month's stock under one year results in a 2,268-unit increase in the current stock over one year, which reflects the biological transition from under-one-year to over-one-year stock through natural growth.

Conversely, a one-metric ton increase in shipment volume leads to a

Table 6. Estimation results of grow-out stock volume for abalone aged one year or older (level-level)

Variables	Coefficient	*t*-value
C	18,728.398***	5.943
S123(-1)	0.611***	12.321
S0(-1)	0.227***	6.370
Q	-1.464	-1.587
DUM01M	126.779	0.101
DUM02M	-1,612.474	-1.233
DUM03M	-2,912.961**	-2.105
DUM04M	-6,104.401***	-3.731
DUM05M	-8,133.573***	-4.118
DUM06M	-7,016.661***	-3.591
DUM07M	-9,114.457***	-4.425
DUM08M	-11,049.313***	-4.779
DUM09M	-12,231.951***	-4.730
DUM10M	-12,999.052***	-5.610
DUM11M	14,521.755***	4.653
DUM11×SD16Y01M	30,070.062***	8.493
DUM11×SD22Y01M	-19,501.657***	-7.233
Sample range	2008Y07M-2024Y05M	
Adjusted R-squared	0.96	
Durbin-Watson stat	1.70	
B-G LM test	0.006 (0.004)	

Note: 1) *, **, *** Indicate statistical significance at the 10%, 5%, 1% levels, respectively.
2) B-G LM test refers to the Breusch-Godfrey test for autocorrelation, with *p*-values shown in parentheses. The Newey-West estimator was applied to obtain robust standard errors.
3) S123 denotes the grow-out stock volume of abalone aged one year or older; S0 refers to the grow-out stock volume of abalone under one year of age; Q represents the shipment volume. SD16Y01M is a structural dummy variable that equals 1 from January 2016 onward (0 prior to January 2016), and SD22Y01M is a structural change variable that equals 1 from January 2022 onward (0 prior to January 2022).
4) B-G LM, Breusch-Godfrey Lagrange Multiplier.

14,638-unit decrease in the over-one-year stock. Han et al. (2020) adjusted for the mismatch between shipment volume (recorded by size category) and grow-out stock (classified by age group) by applying region- and age-specific shipment proportions derived from size-based survey data. However, their estimates were based on outdated samples and did not fully account for recent changes in market structure and consumer preferences, potentially resulting in measurement errors. Therefore, the present study integrated total shipment volume without conversion to age-based units.

Based on average shipment ratios by size category during the analysis period (8-piece: 4.6%, 9–11-piece: 14.4%, 12–15-piece: 23.1%, 16–20-piece: 25.7%, over 21-piece: 32.1%) and average weight per size group, the number of abalone shipped per metric ton was estimated at approximately 16,435 individuals. Although the coefficient for shipment volume was not statistically significant, the estimated reduction of 14,638 individuals was similar to the computed conversion value, suggesting that the coefficient is economically reliable.

The stock of abalone over one year also exhibited a seasonal pattern, typically increasing sharply in November and gradually declining thereafter. To reflect this seasonality, seasonal dummy variables were included. In addition, changes in the data collection methodology for grow-out stock in November 2016 and 2022 were addressed by introducing structural dummy variables. As a result, the model estimates an increase of 30,070 individuals in November after 2016, and a decrease of 19,502 individuals in November after 2022.

The estimation results for shipment volume are presented in Table 7. A 1% increase in the grow-out stock over one year in the previous month leads to a 0.39% increase in the current month's shipment volume. Additionally, shipment volume shows a monthly growth rate of 3%. Following the restoration and expansion of offshore cage facilities in typhoon-affected areas between 2012 and 2014, abalone that had been grown for 2–3 years began to be shipped in earnest starting in July 2016. The analysis estimates that from this point onward, the monthly shipment volume increased by an additional 3%p.

Abalone farmers tend to concentrate shipments during the summer months due to increased mortality risks associated with rising seawater temperatures. Furthermore, abalone is considered a high-demand gift product during the Chuseok holiday season, which further amplifies shipment activity in the preceding months (Korea Maritime Institute, 2017). As a result of these factors, abalone shipments exhibit a distinct seasonal pattern, particularly concentrated in the summer. To account for this, seasonal dummy variables were included in the model. The results show that, compared to December, shipment volume increases by 50% in July, 40% in August, and 44% in September.

4.2 Demand-Side Behavioral Equation

The estimation results for per capita demand for abalone are presented in Table 8. Per capita demand is determined by the equilibrium price, the CCSI, and seasonal factors. The 10-piece producer price was converted to a real price using the CPI to eliminate the effects of inflation. The estimation indicates that a 1% increase in the real 10-piece producer price leads to a 0.4% decrease in per capita demand, yielding a price elasticity of –0.4. This suggests that abalone demand is price-inelastic, meaning demand does not significantly change in response to price fluctuations. In contrast, a 1% improvement in the CCSI leads to a 0.3% increase in per capita demand, implying an income elasticity of 0.3. This finding suggests

Table 7. Estimation results of shipment volume (log-log)

Variables	Coefficient	*t*-value
C	2.038**	2.183
ln(S123(-1))	0.391***	4.584
TREND	0.003***	5.259
TREND×SD16Y07M	0.003***	7.931
DUM01M	0.039	1.432
DUM02M	-0.175***	-5.037
DUM03M	-0.002	-0.072
DUM04M	0.129***	4.033
DUM05M	0.235***	6.314
DUM06M	0.252***	5.799
DUM07M	0.498***	11.533
DUM08M	0.398***	8.670
DUM09M	0.444***	7.178
DUM10M	0.152***	2.603
DUM11M	0.177***	3.340
DUM08Y07M+DUM11Y09M+DUM22Y09M	-0.306***	-7.765
DUM09Y09M+DUM11Y01M+DUM18Y06M	0.320***	10.292
Sample range	2008Y07M-2024Y05M	
Adjusted R-squared	0.94	
Durbin-Watson stat	1.34	
Multiple Breakpoint test	2016Y07M	

Note: 1) *, **, *** Indicate statistical significance at the 10%, 5%, 1% levels, respectively.
2) A Durbin-Watson value of 1.34 suggested autocorrelation, prompting the use of the Newey-West estimator.
3) S123 denotes the grow-out stock volume of abalone aged one year or older; TREND represents the time trend variable; and SD16Y07M is a structural dummy that equals 1 from July 2016 onward (0 prior to July 2016).

that consumers tend to increase their abalone consumption when they perceive economic conditions more positively.

Per capita demand had been increasing at a rate of approximately 1% per month; however, following a typhoon in June 2012 that reduced shipment volumes, the growth rate declined by 0.5 percentage points. After a temporary spike in exports to China in July 2016, the growth rate increased by 0.2%p, but it declined again by 0.2%p after September 2022, when exports expanded to countries such as Vietnam and Taiwan. As a result, the current monthly growth rate of per capita demand is approximately 0.5%. Similar to shipment patterns, abalone consumption is concentrated in the summer. This is mainly due to increased demand as a health food and a traditional Chuseok gift (Lee and Park, 2010). Per capita demand in July, August, and September is estimated to be 39%, 25%, and 30% higher,

Table 8. Estimation results of per capita demand (log–log)

Variables	Coefficient	*t*–value
C	–10.751***	–24.578
ln(FP10/CPI)	–0.396***	–5.569
ln(CCSI)	0.343***	4.581
TREND	0.010***	10.111
TREND×SD12Y06M	–0.005***	–6.567
TREND×SD16Y07M	0.002***	8.467
TREND×SD22Y09M	–0.002***	–6.494
DUM01M	0.136***	3.761
DUM02M	–0.173***	–3.819
DUM03M	–0.034	–0.872
DUM04M	0.052	1.362
DUM05M	0.144***	3.936
DUM06M	0.164***	3.585
DUM07M	0.387***	11.035
DUM08M	0.255***	5.609
DUM09M	0.300***	5.822
DUM10M	0.007	0.155
DUM11M	–0.004	–0.148
DUM08Y09M+DUM09Y09M	0.327***	5.161
DUM10Y10M+DUM11Y09M+DUM15Y06M	–0.301***	–10.266
Sample range	2008Y07M–2024Y05M	
Adjusted R–squared	0.94	
Durbin–Watson stat	1.51	
Multiple Breakpoint test	2012Y06M, 2016Y07M, 2022Y09M	

Note: 1) *, **, *** Indicate statistical significance at the 10%, 5%, 1% levels, respectively.
2) A Durbin–Watson value of 1.51 suggested autocorrelation, prompting the use of the Newey–West estimator.
3) FP10 denotes the farm–gate price for abalone based on 10 pieces; CPI represents the Consumer Price Index; CCSI stands for the Composite Consumer Sentiment Index; and TREND is the time trend variable. SD12Y06M is a structural dummy that equals 1 from June 2012 onward (0 prior to June 2012); SD16Y07M is a structural dummy for July 2016 onward; and SD22Y09M is a structural dummy for September 2022 onward.

respectively, than in December.

The estimation results for export volume to Japan are presented in Table 9. The results indicate that a 1% increase in the export unit price leads to a 0.5% decrease in the volume of exports to Japan. Conversely, a 1% increase in the Osaka wholesale market price or a 1% depreciation of the Japanese yen against the U.S. dollar leads to a 0.4% increase in export volume to Japan. This implies that rising domestic abalone prices in Japan improve the relative competitiveness of Korean abalone in the Japanese market, subsequently stimulating demand through a

Table 9. Estimation results of export volume to Japan (log–log)

Variables	Coefficient	*t*–value
C	–4.871***	–8.685
ln(XP^{JP}(1+TARIFF))	–0.500***	–4.678
ln(OMJP/$EXCH^{JPY/USD}$)	0.383***	4.601
TREND	0.009***	7.630
TREND × SD14Y04M	–0.005***	–5.487
TREND × SD20Y03M	–0.001***	–3.755
DUM01M	–0.843***	–19.953
DUM02M	–0.702***	–13.624
DUM03M	–0.471***	–10.108
DUM04M	–0.311***	–6.600
DUM05M	–0.540***	–10.740
DUM06M	–0.444***	–11.116
DUM07M	–0.358***	–7.885
DUM08M	–0.252***	–5.136
DUM09M	–0.491***	–10.353
DUM10M	–0.442***	–11.521
DUM11M	–0.426***	–11.154
DUM08Y07M+DUM20Y05M+DUM21Y05M	–0.503***	–4.691
DUM20Y04M+DUM21Y01M	–0.872***	–4.760
DUM09Y03M+DUM16Y05M+DUM21Y11M	0.376***	13.256
Sample range	2008Y07M–2024Y05M	
Adjusted R–squared	0.88	
Durbin–Watson stat	1.61	
Multiple Breakpoint test	2014Y04M, 2020Y03M	

Note: 1) *, **, *** Indicate statistical significance at the 10%, 5%, 1% levels, respectively.
2) A Durbin–Watson value of 1.61 suggested autocorrelation, prompting the use of the Newey–West estimator.
3) XP^{JP} denotes the export unit price to Japan; Tariff represents the tariff rate; OMJP refers to the wholesale market price in Osaka; $EXCH^{JPY/USD}$ is the yen–U.S. dollar exchange rate; and TREND indicates the time trend variable. SD14Y04M is a structural dummy that equals 1 from April 2014 onward (0 prior to April 2014), and SD20Y03M is a structural dummy that equals 1 from March 2020 onward (0 prior to March 2020).
4) JPY, Japanese Yen; USD, United States Dollar.

substitution effect.

Export volume to Japan exhibited a general upward trend during the analysis period, and a trend variable was included to capture this pattern. To examine potential structural changes over time, a multiple breakpoint test was conducted on the trend variable. The results indicate that, following the depreciation of the Japanese yen starting in April 2014, the monthly growth rate of exports to

Japan weakened by 0.4%. Furthermore, after the outbreak of COVID-19 in March 2020, adverse export conditions led to an additional monthly decline of 0.1%p in the export growth rate.

The estimation results for the export unit price to Japan are presented in Table 10. The analysis shows that a 1% increase in the domestic 10-piece producer price of abalone leads to a 0.8% increase in the export unit price to Japan, suggesting that changes in domestic prices are proportionally reflected in export prices. Conversely, a 1% increase in the exchange rate (KRW/USD) results in a 0.7% decrease in the export unit price to Japan, indicating the impact of currency appreciation on price competitiveness.

To detect structural changes, a multiple breakpoint test was conducted on the intercept term. The test identified significant structural breaks in January 2009, September 2020, and November 2022. Specifically, following January 2009, the export unit price declined by 14.1%. Due to reduced export demand stemming from the COVID-19 pandemic, an additional decline of 17.4% was observed after September 2020. In contrast, beginning in November 2022, the export unit price rose by 11%, which is presumed to reflect adjustments associated with a drop in the domestic producer price.

The estimation results for export volume to other countries (excluding China) are presented in Table 11. A 1% increase in the export unit price to these countries is estimated to reduce export volume by 1.25%, indicating a price elasticity

Table 10. Estimation results of export unit price to Japan (log–log)

Variables	Coefficient	*t*-value
C	−0.067	−0.098
ln(FP10)	0.807***	33.446
ln($EXCH^{KRW/USD}$)	−0.701***	−8.023
SD09M01	−0.141***	−9.063
SD20M09	−0.174***	−9.514
SD22M11	0.110***	4.624
Sample range	2008Y07M–2024Y05M	
Adjusted R-squared	0.97	
Durbin-Watson stat	0.53	
Multiple Breakpoint test	2009Y01M, 2020Y09M, 2022Y11M	

Note: 1) *, **, *** Indicate statistical significance at the 10%, 5%, 1% levels, respectively.
2) A Durbin–Watson value of 0.53 suggested autocorrelation, prompting the use of the Newey–West estimator.
3) FP10 denotes the producer price for abalone based on 10 pieces; $EXCH^{KRW/USD}$ represents the Korean won–U.S. dollar exchange rate. SD09Y01M is a structural dummy that equals 1 from January 2009 onward (0 prior to January 2009); SD20Y09M is a structural dummy for September 2020 onward; and SD22Y11M is a structural dummy for November 2022 onward.
4) KRW, Korean Won; USD, United States Dollar.

Table 11. Estimation results of export volume to countries other than China (log-log)

Variables	Coefficient	*t*-value
C	2.309	1.643
ln(XP^{ETC})	−1.246***	−3.481
TREND	0.024***	5.770
TREND×SD16M06	0.024***	16.204
TREND×SD17M01	−0.015***	−10.671
TREND×SD22M08	−0.005***	−4.199
Sample range	2012Y04M–2024Y05M	
Adjusted R-squared	0.96	
Durbin-Watson stat	0.97	
Multiple Breakpoint test	2016Y06M, 2017Y01M, 2022Y08M	

Note: 1) *, **, *** Indicate statistical significance at the 10%, 5%, 1% levels, respectively.
2) A Durbin-Watson value of 0.97 suggested autocorrelation, prompting the use of the Newey-West estimator.
3) XP^{ETC} denotes the export unit price to countries other than China; TREND represents the time trend variable. SD16Y06M is a structural dummy that equals 1 from June 2016 onward (0 prior to June 2016); SD17Y01M is a structural dummy for January 2017 onward; and SD22Y08M is a structural dummy for August 2022 onward.

greater than one and suggesting that export volume is highly sensitive to changes in export unit price. The export volume to other countries has shown a monthly growth rate of approximately 2.4%.

To detect potential structural shifts over time, a multiple breakpoint test was conducted, identifying structural changes in June 2016, January 2017, and August 2022. Following June 2016, when exports to countries such as Vietnam, Taiwan, and the United States surged, export volume to other countries increased by an additional 2.4 percentage points. However, the growth rate weakened after the breakpoints in January 2017 and August 2022. As a result, the export volume returned to a stabilized monthly growth rate of approximately 2.8%.

The estimation results for the export unit price to other countries (excluding China) are presented in Table 12. A 1% increase in the domestic 10-piece producer price of abalone is associated with a 0.17% increase in the export unit price to these countries. In contrast, a 1% increase in the exchange rate (KRW/USD) is estimated to decrease the export unit price by 0.58%.

A multiple breakpoint test identified structural changes in June 2016, January 2017, and August 2022. Following the surge in export volume to countries such as Vietnam, Taiwan, and the United States in June 2016, the export unit price to other countries fell by 33.2%. After January 2017, the export unit price increased by 19.8%, but declined again by 16.6% after August 2022.

Table 12. Estimation results of export unit price to countries other than China (log-log)

Variables	Coefficient	*t*-value
C	5.915***	4.475
ln(FP10)	0.172***	3.622
ln($EXCH^{KRW/USD}$)	−0.582***	−3.426
SD16M06	−0.332***	−9.346
SD17M01	0.198***	5.868
SD22M08	−0.166***	−5.131
Sample range	2012Y04M–2024Y05M	
Adjusted R-squared	0.80	
Durbin-Watson stat	1.52	
Multiple Breakpoint test	2016Y06M, 2017Y01M, 2022Y08M	

Note: 1) *, **, *** Indicate statistical significance at the 10%, 5%, 1% levels, respectively.
2) A Durbin-Watson value of 1.52 suggested autocorrelation, prompting the use of the Newey-West estimator.
3) FP10 denotes the producer price for abalone based on 10 pieces; $EXCH^{KRW/USD}$ represents the Korean won-U.S. dollar exchange rate. SD06Y06M is a structural dummy variable that equals 1 from June 2006 onward (0 prior to June 2006); SD17Y01M is a structural dummy for January 2017 onward; and SD22Y08M is a structural dummy for August 2022 onward.
4) KRW, Korean Won; USD, United States Dollar.

4.3 Assessment of Model Predictive Accuracy

To evaluate the predictive performance of the model, several commonly used indicators were considered, including the Mean Absolute Percent Error (MAPE), Mean Squared Percentage Error (MSPE), Mean Squared Error (MSE), Root Mean Square Percent Error (RMSPE), and Theil's Inequality Coefficient (Theil's U). Among these, MAPE, RMSPE, and Theil's U are frequently used to measure the relative size of prediction errors against actual values because they are not affected by the scale of the variables (Kim et al., 2018). This study employed MAPE, RMSPE, and Theil's U as the primary criteria to assess the forecasting accuracy of the abalone supply-demand model.[8]

$$\text{MAPE} = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{\widehat{Y_t} - Y_t}{Y_t}\right| \times 100$$

8 MAPE and RMSPE represent the percentage error between the model's forecasts and actual observed values; smaller values indicate higher predictive accuracy. Theil's U ranges between 0 and 1, with a value of 0 indicating a perfect match between predicted and actual values. In general, lower values of Theil's U suggest superior forecasting performance of the model.

$$\text{RMSPE} = \sqrt{\frac{1}{n}\sum_{t=1}^{n}\left(\frac{\hat{Y}_t - Y_t}{Y_t}\right)^2} \times 100$$

$$\text{Theil's inequality coefficient} = \frac{\sqrt{\frac{1}{n}\sum_{t=1}^{n}(\hat{Y}_t - Y_t)^2}}{\sqrt{\frac{1}{n}\sum_{t=1}^{n}(\hat{Y}_t)^2} + \sqrt{\frac{1}{n}\sum_{t=1}^{n}(Y_t)^2}}$$

The predictive accuracy of the model was assessed using both in-sample and out-of-sample error metrics. In-sample errors were calculated for each behavioral equation using data from August 2023 to May 2024. Table 13 presents the in-sample results, evaluated using MAPE, RMSPE, and Theil's U for each behavioral equation. Overall, the model demonstrated satisfactory predictive performance, with most equations exhibiting low error levels. In particular, all behavioral equations—except those related to export volumes to other countries—achieved strong predictive accuracy, with MAPE values ranging from 2.1% to 8.7%.

Relatively lower predictive accuracy observed in certain equations appears to stem from limitations in the availability of relevant exogenous data. In particular, export volumes to countries other than China exhibited a high MAPE of 30.6%, reflecting considerable forecast error. This result likely stems from the model's inability to adequately capture the heterogeneous and dynamic nature of these markets. Export volumes to such destinations are often subject to abrupt and irregular fluctuations. Moreover, aggregating these countries into a single residual category may obscure distinct market behaviors and distort estimated responses to price and macroeconomic variables. These findings underscore the importance of disaggregating export destinations and incorporating country-specific variables in

Table 13. In-sample error rate based on the estimation results of the abalone supply and demand model

Category	Endogenous variables	MAPE (%)	RMSPE (%)	Theil's U
Supply	Juvenile abalone input volume	2.11	0.24	0.00
	Grow-out stock under one year of age	2.69	3.73	0.02
	Grow-out stock one year and older	4.17	5.32	0.02
	Shipment volume	8.02	9.26	0.05
Demand	Per capita demand	6.86	8.72	0.04
	Export volume to Japan	8.69	9.43	0.05
	Export unit price to Japan	2.10	2.76	0.01
	Export volume to other countries (excluding China)	35.20	42.58	0.16
	Export unit price to other countries (excluding China)	5.93	6.85	0.03

Note: MAPE, Mean Absolute Percent Error; RMSPE, Root Mean Squared Percentage Error.

future model refinements.

To evaluate the out-of-sample forecasting performance of the abalone supply-demand model, the MAPE was selected as the primary evaluation criterion. Unlike in-sample error assessment, out-of-sample error was measured by generating monthly forecasts of endogenous variables and then comparing these forecasts with the actual observed values. Specifically, the MAPE was calculated by comparing forecast values with actual observations for the period from June 2024 to March 2025.

Given that the model developed in this study is intended to produce short-term forecasts, the evaluation approach followed the structure shown in Figure 3. Specifically, the model forecasted values for June using data available through May, forecasted July values using data through June, and forecasted August values using data through July. For example, to forecast the value for June, the model used all updated actual data available through May, and the forecast for June was generated accordingly. These forecast values were then compared with the corresponding actual values to calculate the out-of-sample forecast error.

The forecasted values generated by the model vary depending on how the prediction error for the forecast month is specified. In this study, five alternative approaches were applied to determine the prediction error for the forecast month. In all approaches, actual values of exogenous variables at the time of forecasting were used to generate the projections.

The first approach assumes a theoretical error of zero, setting the prediction error for the forecast month to zero. The second approach, referred to as the "same-as-previous-month" assumption, applies the estimated prediction error from the previous month to the forecast month. The third approach uses the "same-month average," assigning the forecast month's prediction error as the average of the estimated errors for the same month over the past three years. The fourth approach applies the "three-month average," using the average of the estimated errors over the past three months. The fifth approach, called the "Olympic average," calculates the forecast month's prediction error using the average of the most recent five months' estimated errors, excluding the highest and lowest values.

As summarized in Table 14, Approach 4—which incorporates the average prediction error over the most recent three months—consistently demonstrated the highest predictive accuracy across most endogenous variables. This result suggests

Figure 3. Out-of-sample error evaluation method for the abalone supply-demand model.

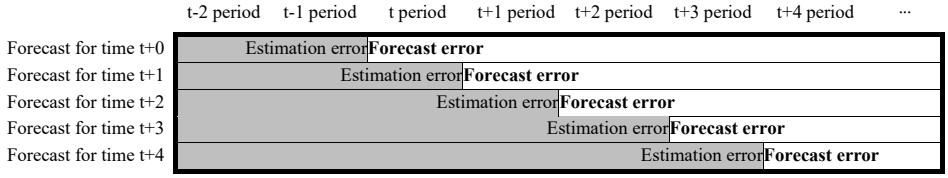


Table 14. Out-of-sample error rate based on the estimation results of the abalone supply and demand model

Endogenous variables	MAPE (%)				
	Approach 1	Approach 2	Approach 3	Approach 4	Approach 5
Juvenile abalone input volume	5.3	5.3	5.3	5.3	5.3
Grow-out stock under one year of age	4.2	4.5	2.5	4.5	4.6
Grow-out stock one year and older	7.9	4.9	5.9	5.1	5.5
Shipment volume	7.5	8.7	13.6	6.4	7.9
Per capita demand	8.0	10.4	15.5	7.2	8.9
Export volume to Japan	7.5	9.0	8.7	6.8	7.6
Export unit price to Japan	15.9	8.5	17.6	9.1	11.3
Export volume to other countries (excluding China)	40.8	28.7	37.6	27.4	33.2
Export unit price to other countries (excluding China)	28.5	10.9	27.7	11.9	12.9
Producer price for 10-piece abalone	18.2	11.0	23.1	13.9	16.6

Note: MAPE, Mean Absolute Percent Error.

that short-term averaging methods are particularly effective in improving forecast reliability in aquaculture sectors like abalone farming, which are subject to biological constraints and seasonal fluctuations.

Among supply-side variables, juvenile abalone input volume (5.3%), grow-out stock under one year of age (4.5%), and grow-out stock over one year of age (5.1%) exhibited notably low MAPE values. These results reflect relatively stable and structured decision-making processes. In particular, these variables are determined primarily by production cycles, facility capacity, and pre-scheduled stocking plans, rather than short-term market conditions. Accordingly, the strong predictability of these variables is economically plausible, as they are largely governed by internal production systems and forward planning.

In contrast, demand-side variables—especially those related to exports—showed considerably higher forecast errors. Export volume to countries excluding China recorded a MAPE of 27.4%, the highest among all variables, while the corresponding export unit price exhibited an error of 11.9%. This can be attributed to the model's inability to disaggregate country-specific export data. Aggregating export volumes and prices across heterogeneous markets fails to account for the distinct import conditions, consumer preferences, and regulatory environments of each country. As a result, the model falls short in capturing exogenous market-specific volatility, thereby limiting predictive performance in export-related outcomes.

5. Conclusion

The Korean abalone aquaculture industry has experienced remarkable growth, emerging as a major source of income in coastal communities (Ock, 2015). However, recent trends reveal growing concerns over declining profitability, largely driven by a mismatch between increasing production volumes and stagnant domestic and export demand (Han et al., 2020). In particular, although shipment volume has continued to grow, total production value has declined, indicating reduced total revenue driven by falling market prices. In response to elevated mortality risks associated with rising seawater temperatures, many abalone farms have shortened the grow-out period from the historical average of 36 months to approximately 18 months (Seong, 2021). This shift has led to a concentration of supply within shorter time frames and an increase in overall production volumes, thereby aggravating market oversupply and placing additional downward pressure on prices.

To effectively respond to evolving supply and demand conditions, decision-making must be grounded in scientific and objective data rather than relying solely on past experience (Han et al., 2020). Structural inefficiencies in the abalone distribution system—such as the prevalence of non-cooperative shipments, requests for side payments during farmgate transactions, and the widespread reliance on informal wholesale markets—have exacerbated market distortions and contributed to price volatility. Accordingly, the development of a quantitative and reliable forecasting model is essential to support the sustainable growth of the abalone industry.

This study aims to both the explanatory power and predictive accuracy of existing abalone supply forecasting models. Although biological characteristics are incorporated through a DEEM, consistent with previous studies, this study employs a SM rather than a RM. A well-designed forecasting model should not only produce accurate future projections but also enable scenario-based policy simulations (Lee, Heo, and Ha, 2019). The proposed model is developed with both of these objectives in mind.

The model determines the equilibrium producer price under the market-clearing condition where total supply equals total demand. On the supply side, the model incorporates behavioral equations for seedling (juvenile abalone) input, grow-out stocks categorized by age (under one year and one year or older), and shipment volume. On the demand side, equations are specified for per capita demand, export volume and price to Japan, and export volume and price to other countries (excluding China).

Consistent with previous studies, juvenile abalone input volume is estimated at the national level without regional disaggregation. The estimated coefficient for the average producer price of 10-piece abalone—calculated over the period from November of the previous year to April of the current year—is 0.1%.

Departing from the approach used by Han et al. (2020), the grow-out stock is disaggregated into two distinct age categories based on recent empirical distributions: abalone under one year of age and those one year or older. With regard to shipment volume, previous studies attempted to convert weight-based data into quantity-based estimates by employing size-to-weight conversion formulas (Cho, Choi, and Kim, 2016) or age-based conversion standards (Han et al., 2020). However, such methods rely on outdated sample survey data and may not adequately capture recent changes in market structure or consumption trends. Therefore, this study estimates total shipment volume in aggregate form, and identifies a pronounced seasonal concentration of shipments during the summer months, a period associated with heightened mortality risks due to rising sea temperatures. The estimated price elasticity of demand is –0.4, indicating that the demand for abalone is relatively inelastic. Income elasticity was estimated at 0.3, suggesting that abalone is regarded as a normal good, with demand exhibiting moderate responsiveness to income changes. On the export side, the model distinguishes between shipments to Japan and those to other countries excluding China, and separately estimates corresponding export unit price equations. This disaggregated approach represents a methodological advancement over previous studies, which did not account for such differentiation in export markets.

To assess the forecasting performance of the proposed model, both in-sample and out-of-sample forecast errors were evaluated. With the exception of the export equations, all behavioral equations exhibited MAPE values below 10%, indicating a generally high level of predictive accuracy. Among the export-related equations, the model demonstrated relatively large errors in forecasting shipments to other countries. This limitation is primarily attributable to the inherent volatility in exports to these markets, which is difficult to capture with the current model specification. Notably, the coefficient of variation for exports reached 102%, indicating substantial fluctuations. To address this issue, future research should incorporate more granular trade indicators as they become available, thereby enhancing the model's explanatory power and predictive accuracy.

Out-of-sample errors were assessed by generating monthly forecasts of endogenous variables and comparing them against actual observed values. The most accurate forecasts were obtained when the prediction errors for each target month were adjusted to reflect the average error observed over the preceding three months. Similar to the in-sample results, most behavioral equations in the out-of-sample forecasts exhibited low MAPE values, ranging from 4.5% to 13.9%, indicating a satisfactory level of predictive performance. However, the MAPE for exports to other countries was relatively high at 27.4%, reflecting limited predictive performance. Exports to these markets reached 125 metric tons in March 2025, marking a 200% increase from the previous month—an abrupt shift that could not be anticipated by the existing model specification. This underscores the need to refine the model's export component by incorporating real-time trade dynamics and more responsive explanatory variables.

Although this study primarily focused on refining the structural specification of the abalone supply-demand model without implementing policy simulations, the proposed framework is expected to serve as a valuable tool for future policy analysis through scenario-based simulations. Future research is encouraged to analyze policy effects by setting various scenarios, such as changes in tariffs or export volumes. In addition, if monthly disposable income data become available, incorporating them into the model is expected to enhance the explanatory power of demand-side factors. Recently, exports to countries such as Vietnam, Taiwan, and the United States have been increasing; with more data, disaggregated analyses by destination country are expected to further improve the model's predictive accuracy.

References

Bai, J. and Perron, P. (1998) Estimating and Testing Linear Models with Multiple Structural Changes. *Econometrica* 66(1):47-78.

Bank of Korea. (2023) *Monetary and Credit Policy Report (September 2025)*. Retrieved from https://www.bok.or.kr/portal/main/main.do

Cho, J. H., Choi, S. H., and Kim, B. S. (2016) *Maintenance of Supply and Demand Forecasting Models for Major Fisheries Products in 2015*. Busan: Korea Maritime Institute.

Cho, K. J. and Lee, H. D. (2024) Analysis of Asymmetric Price Transmission and Market Power between Producer and Wholesale Markets of Aquacultured Abalone. *The Journal of Fisheries Business Administration* 55(2): 55-70.

Choi, S. H. and Cho, J. H. (2018) A Study on the Model for Determining Cultivation Quantities of the Abalone. *Journal of the Korea Academia-Industrial Cooperation Society* 19(8):385-391.

Choi, Y. E. (2017) *A Bioeconomic Analysis of Abalone Cage Aquaculture* (Master's thesis). Pukyong National University, Busan.

Chow, G. C. (1960) Tests of Equality between Sets of Coefficients in Two Linear Regressions. *Econometrica* 28(3):591-605.

Cook, P. A. (2016) Recent Trends in Worldwide Abalone Production. *Journal of Shellfish Research* 35(3):581-583.

Godfrey, L. G. (1978) Testing Against General Autoregressive and Moving Average Error Models When the Regressors Include Lagged Dependent Variables. *Econometrica* 46(6):1293-1301.

Han, S. H. and Jang, H. S. (2019) *Maintenance of Supply and Demand*

Forecasting Models for Major Fisheries Products in 2019: Abalone Forecasting Model. Busan: Korea Maritime Institute.

Han, S. H., Jang, H. S., Heo, S. J., and Lee, N. S. (2020) A Study of the Abalone Outlook Model using by Partial Equilibrium Model Approach Based on DEEM System. *The Journal of Fisheries Business Administration* 51(2): 51-69.

Japan Customs. (2025) *Japan's Tariff Schedule*. Retrieved from https://www.customs.go.jp/english/index.htm

Kim, B. H., Park, J. J., Son, M. H., Kim, T. I., and Lee, S. W. (2016) The Effect of Growth and Survival Rate on Feeding Rate of 3-Year-Old Abalone, Haliotis Discus Hannai Rearing in Net Cage Culture. *The Korean Journal of Malacology* 32(2):103-109.

Kim, B. H., Park, M. W., Son, M. H., Kim, T. I., Cho, J. K., and Myeong, J. I. (2013) A Study on the Optimum Stocking Density of the Juvenile Abalone, Haliotis Discus Hannai Net Cage Culture or Indoor Tank Culture. *The Korean Journal of Malacology* 29(3):189-195.

Kim, B. S., Ko, S. B., Hyun, C. S., Oh, H. S., Ko, K. H., Kim, C. H., and Eun, J. H. (2014) *Development of Forecasting Models for Major Fisheries Products in 2014*. Busan: Korea Maritime Institute.

Kim, C. H., Seo, H. S., Lee, H., and Kim, J. N. (2018) Developing a Supply and Demand Model of Hanwoo Using Beef Traceability Data. *Journal of Rural Development* 41(3):25-50.

Kim, N. L. (2020) *An Analysis on Management Performance of Abalone Sea-cage Aquaculture* (Master's thesis). Pukyong National University, Busan.

Korea Maritime Institute. (2012) *Abalone Observation Report*. Busan: Korea Maritime Institute.

Korea Maritime Institute. (2016) *Abalone Observation Report*. Busan: Korea Maritime Institute.

Korea Maritime Institute. (2017) *Survey Results on Consumer Intentions for Seafood Gifts during the 2017 Chuseok Holiday*. Busan: Korea Maritime Institute.

Lee, H. D., Heo, S. J., and Ha, H. J. (2019) *Study on the Operation and Revision of the 2019 Laver Supply Forecasting Model*. Busan: Korea Maritime Institute.

Lee, M. J., Choi, Y. H., and Kang, Y. S. (2016) The Improvement of Distribution System in the Production Areas of Abalone-Focused on Wando Area. *Journal of Korean Islands* 28(1):33-55.

Lee, N. S. and Park, E. Y. (2010) The Significance and Influence of an Addition on the Abalone Transaction. *The Journal of Fisheries Business Administration* 41(3):79-102.

Morash, A. J. and Alter, K. (2016) Effects of Environmental and Farm Stress on Abalone Physiology: Perspectives for Abalone Aquaculture in the Face of Global Climate Change. *Reviews in Aquaculture* 8(4):342-368.

Nam, J. and Sim, S. (2014) A Leading-Price Analysis of Wando Abalone Producer Prices by Shell Size using VAR Model. *Ocean and Polar Research* 36(4):327-341.

Newey, W. K. and West, K. D. (1994) Automatic Lag Selection in Covariance Matrix Estimation. *The Review of Economic Studies* 61(4):631-653.

Ock, Y. S. (2013) The Research on the Development Procedure and Current Problems of the Korean Abalone Industry. *The Journal of Fisheries Business Administration* 44(3):15-28.

Ock, Y. S. (2015) The Research on the Cost Analysis of the Abalone Aquacultural Management in Korea. *The Journal of Fisheries Business Administration* 46(2):13-29.

Oh, Y. J., Lee, N. S., and Kim, D. Y. (2020) Analysis of Management Efficiency for Abalone Seed Producer based on DEA Approach. *The Journal of Fisheries Business Administration* 51(1):37-52.

Rhew, C. (2017) Is a Target Price Responsible for Rice Oversupply? *Journal of Rural Development* 40(4):1-27.

Seong, J. W. (2021) Trends and Outlook of the Abalone Market. *Fisheries Outlook & Issue* 48:30-38.

Shin, Y. T., Jang, H. S., and Kim, B. T. (2008) *Production Control and Distribution Reform as a Way to Develop the Abalone Aquaculture Industry*. Busan: Korea Maritime Institute.

Statistics Korea. (2025) *Fisheries Production Trend Survey*. Retrieved from https://kosis.kr/index/index.do

Thurman, W. N. (1986) Endogeneity Testing in a Supply and Demand Framework. *The Review of Economics and Statistics* 68(4):638-646.

KMI International Journal of Maritime Affairs and Fisheries • Volume 17 Issue 2 December 2025 pp. 47-79 •
https://doi.org/10.54007/ijmaf.2025.e3

What Should a Sustainable and Inclusive Fisheries Value Chain Entail? Perspectives from Coastal Fishing Communities in Yunlin, Taiwan

Baker Matovu[*,**]

ABSTRACT

This study utilized a qualitative exploratory research design and explored perspectives from 43 stakeholders in Yunlin to question and shed light on what a sustainable and inclusive fisheries value chain (FVC) should entail. In Yunlin, coastal fisheries are a valuable socio-cultural asset and livelihood capital, through which families and local communities have been employed and obtained income. To sustain these benefits, unique and innovative micro-level FVC activities, networks, circular demand-supply patterns, and inclusive associations have been formed. In some communities, women manage all FVC activities and have designed innovative digital marketing strategies. However, the changing socioecological systems (SES) and seafood marketing dynamics have steadily made Yunlin's FVC perilous. This is worsened by the entry of external FVC actors or shifting demographic segments with limited knowledge of conventional win-win FVC practices. Moreover, changing marine environment conditions and coastal developments have affected primary production, catch, and fish farms. Although local communities have invaluable ideas for reinventing FVC and rejuvenating sustainable activities, institutional bottlenecks and the linear FVC dynamics limit their application. To co-create sustainable FVC, circularity actions were emphasized, and thus, a fair FVC model or design was conceptualized. Sustainable FVC practices must be based on three FVC levels, where specific actors' operational limits, roles, and interactions are established. Level 1 (primary FVC) should include actors privy to the micro-level SES, shared economic interests, cultural, environmental, and livelihood aspirations. Level 2 actors should only venture into Level 1 if they add value to Level 1 actors' operations. Level 3 should include large-scale actors, conglomerates, and importers whose immense power normally

[*] Future Earth Coasts (FEC) Fellow, Kampala, Uganda
[**] Postdoctoral Researcher, Department of Environmental Biology and Fisheries Science, National Taiwan Ocean University, Keelung, Taiwan, matker2010@gmail.com

Received July 17, 2025; Received in revised form October 31, 2025; Accepted November 17, 2025

shocks Level 1 actors and demand-supply dynamics. To advance replicable actions, six recommendations are given, including: (1) baseline SES impact assessments, (2) FVC equity and justice transitions, (3) prioritizing micro-level coastal communities' food security needs over large-scale consumers or actors, (4) shared empowerment models, (5) co-designing FVC business models, and (6) developing new site-specific or pilot models for coastal FVC. Such actions could progressively lead to blue transformations.

Key words : coastal fisheries and fisherwomen, fair fisheries value chain model, mullet roe, sustainable and inclusive fisheries, Yunlin, Taiwan

1. Introduction

Fishing and fishing-related activities, including those by commercial and small-scale fishers (SSF), are pivotal towards providing fish and fish products that are highly demanded globally (Lee et al., 2025; Matovu et al., 2024a, 2024b). In 2023, capture fisheries and aquaculture added 223.2 million tons of fish products to the global food table, with 185.4 million tons comprising aquatic animals and 37.8 million tons of algae (FAO, 2024b). More lucrative products, e.g., seaweeds, are now cultured, with demand and market value projected to reach USD 95 billion in 2027 (Sobuj, Rahman, and Ali, 2024). Through this, economies and coastal populations have reaped immense socioeconomic dividends. An estimated 492 million people's livelihoods and employment needs are satisfied through (in)direct participation in SSF (FAO, 2023). With 89 percent of the harvested fish products consumed by humans, equivalent to a per capita consumption of 20.7 kg in 2022, nutrition and health needs for several populations, e.g., for women and children, are satisfied (FAO, 2024a, 2024b). It is estimated that SSF fish landings alone could potentially cover up to 50 percent of the needed omega-3 fatty acids, and 20 percent of the recommended calcium, selenium, and zinc nutrient intakes for 987 and 477 million women globally (FAO, 2023). Little wonder that SSF, including fisherwomen, pride themselves as active contributors who must be valued and included in collaborative fisheries governance mechanisms steering towards SSF guidelines (FAO, 2023; Matovu et al., 2024a).

Several coastal, inland, and marine fishing nations have attained astronomical fisheries-induced revenues, boosting the national and global gross domestic products and economy. In 2022, for instance, global trade in aquatic products, involving 230+ countries and territories, yielded record revenues of USD 195 billion (FAO, 2024b). These indicators reinforce scholarly and policy narratives that in most coastal countries, fisheries are the fastest-growing sub-sector of the agricultural sector (Suresh et al., 2025) and play an invaluable role in global sustainable development and livelihood transformations (Etta, Matovu, and Lukambagire, 2025; Lee et al., 2025; Spalding et al., 2023). Unfortunately, the lucrative fisheries trade and value have compromised conventional fish value chain (FVC) practices, notably among SSF communities, which might compromise micro-level communities' livelihoods. Moreover, although global rhetoric for sustainability and blue transformations across fisheries are emphasized, few studies have documented micro-level fishing communities' perspectives on what or how a sustainable FVC should be or must entail. This study attempts to answer this question and contribute to scholarship by exploring perspectives of diverse SSF actors in Yunlin, Taiwan, and co-developing a sustainable FVC pathway or design. Before switching to this, a conceptual and analytical description of the global FVC landscape is given.

1.1 Conceptualizing Global Fisheries Value Chain Dynamics

For millennia, fisheries-related economy and businesses operate in formal and informal structures or systems through which various activities and actors operate. Although there is limited consensus on the meaning of FVCs, Lukambagire et al. (2024) shed light on FVC dynamics, especially in micro-level contexts. They argue that FVCs highlight interconnections where actors target a given service or product to satisfy a target customer base or demand-supply pattern. Most often, valuable fisheries products are extruded from the source (fishing ground), traded onsite or offsite, and sold to commercial and non-commercial consumers. This means that FVCs are characterized by linear supply-demand patterns, involving systematic activities, e.g., fish harvesting, processing, trade, and consumption (Siddique et al., 2024; Sobuj, Rahman, and Ali, 2024). The current FVC patterns have created specialized role allocations where diverse stakeholders and players, e.g., primary fishermen, fisherwomen, regulatory entities, and trading companies, operate to ensure sustained production and supply of fish and fish-related products, including seaweeds, and recently, sustainable fishing practices, to the ever-increasing fish-consuming population or markets (FAO, 2024b; Prakash et al., 2017; Sasi, Sarker, and Essam, 2024; Venugopal, 2022).

However, the lucrative micro-level fisheries landscape has attracted commercial fish dealers and huge investments to reap the economic benefits in the sector, which has come along with unfathomable socioecological externalities and trade-offs never seen before, across the FVC (Fabinyi et al., 2022; Fisher et al., 2021). Today, in primary fishing activities, illegal, unreported, and unregulated fishing activities, and increased bycatch, coupled with policy failures, have catapulted into overexploitation of wild fisheries resources (Belhabib, Greer, and Pauly, 2018; Belhabib et al., 2019). As conceded in the FAO (2024b) report, although variations occur across the fifteen FAO-monitored major fishing zones, in 2021, a decline of 62.3 percent of marine fish stocks fished within biologically sustainable levels was reported, increasing fears for fish-food insecurity. With a 19 percent value increase in aquatic animal products between 2019 to 2022, partly due to the demand for fish meal, fish consumers might either pay exorbitant prices or lack fish to eat soon. This is partly because the increase in fishing effort by commercial and distant fishing fleets fragmented fish demand-supply chains and price haggling, yet valuable but less demanded catches are disposed of as bycatch and increased discards, despite efforts to reduce fish waste (FAO, 2024a; Sasi et al., 2024). Additionally, complex global aquatic products trade gymnastics have created acute fragilities, e.g., in aquatic products certifications, and restrictions for fish products sourced from some countries headed to leading global markets (Belhabib et al., 2019), such as the European Union, which imported USD 62.7 billion worth of aquatic animal products in 2022 (FAO, 2024b). This means that FVC linearity accounts for 30 percent of production losses and creates higher, unsustainable environmental footprints (Venugopal, 2022).

1.2 Apportionment of Loss and Fragility from the Current Fisheries Value Chain (FVC) Tapestry

Studies emphasize that FVC shifts and the associated trade-offs are slapped onto historically vulnerable fishing zones and disempowered value chain actors, e.g., SSF and women, especially in tropical fishing regions. (Spalding et al., 2023). In most key and lucrative FVC activities, fishermen or male dominance is reported, and with decreasing fish harvest in some regions, men are venturing into activities historically managed by women, such as fish hawking and drying (Matovu et al., 2024b). This is concerning since women and SSFs are the unsung invisible drivers of fisheries activities and livelihoods (Matovu et al., 2024b). Although global and micro-level sustainable fishing guidelines, roadmaps, e.g., the 2021–2030 FAO blue transformation roadmap, and national-level sustainable fishing regulations have been developed (FAO, 2024b), their implementation has remained pedestrian, less implemented, and in some cases, manipulated. This predicament has led to infinite anxiety concerning future fish stock collapse and explosive FVC injustices. A perpetual worry and gap across coastal fishing zones or communities is that critical answers documenting how FVC unsustainability indicators morphed have been uncharted territory in research and policy. This is partly due to (i) fear of reprimand from the well-connected, powerful actors or commercial fishing dealers, (ii) unorganized, multifaceted, and fragmented nature of FVC activities and actors (Prakash et al., 2017), (iii) limited quantitative analyses and understanding of FVC network disruptions to inform policy and sustainable actions (Sasi, Sarker, and Essam, 2024), (iv) few exploratory studies diving into the murky coastal seafood landscape to identify the relationship between environmental-drivers of VC shocks or how diverse actors create unsustainable socioecological vulnerabilities, and (v) limited micro-level narratives or accounts on how 27 percent and 39 percent of the total annual fish catch is lost through the FVC processing side stream, where most SSF actors lack adequate processing or storage services (Siddique et al., 2024).

As reversing unsustainable FVC practices has been aggrandized in research and policy, plausible questions and perspectives to explore the systemic causes and effects of this ecosystem have been emerging, mostly among micro-level tropical fishing communities (Jyotishi, 2023; Lee et al., 2025; Spalding et al., 2023). These are promising signals that could be harnessed to comprehend and situate FVC ecologies and gain new threads of perspectives on different actors and their roles, which could be vital in re-creating sustainable FVC practices or perspectives. Understanding micro-level tropical fishers' perspectives, bottom-up effective fisheries and aquatic products VC, effective management practices that could further enhance stock recovery, and crafting urgent, replicable actions for creating successful and sustainable policies and reversing declining fisheries sustainability trends. As a way of contributing to coastal fisheries policy and the development of sustainable FVC frameworks or roadmaps, this study brings in holistic and integrated fishers' perspectives from the Yunlin fishing community in Taiwan, to

inextricably define and profile some sustainable FVC practices that have been utilized to promote a network of sustainable and inclusive FVC activities. Although the perspectives given in this study captured FVC activities involving households from a few fisher communities, the fishers' stories and perspectives mirror synergies around win-win FVC approaches that could be integrated into sustainable blue transformations and practices. Moreover, practical learning experiences are given that could be borrowed by other fishing communities in other jurisdictions. To bring out insightful findings, four valuable study objectives were targeted, including

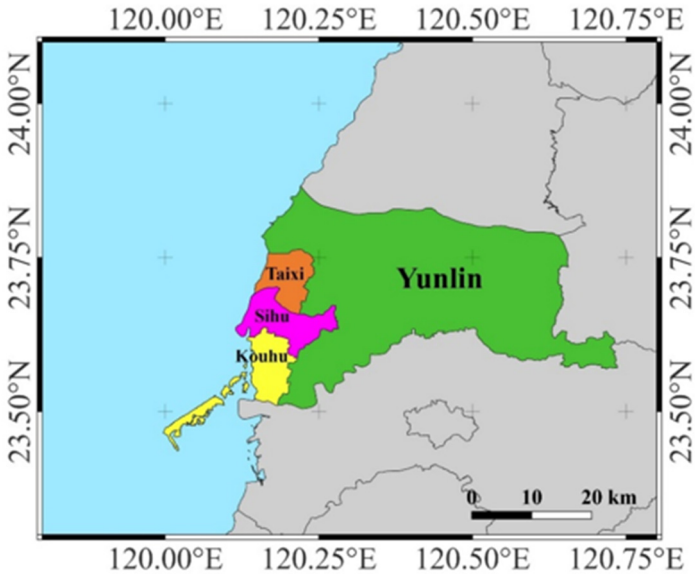
i) Exploring the FVC landscape and actor dynamics in Yunlin.
ii) Assessing the ramifications of Yunlin's current FVC practices on the local economy, livelihoods, and the coastal socioecological systems.
iii) Examining the valuable perspectives from Yunlin's diverse FVC actors that could be leveraged to advance sustainable FVC practices in other jurisdictions.
iv) Contextualizing Yunlin's perspectives to develop a unique, sustainable, and inclusive FVC design and model that could support sustainable fisheries practices in other coastal areas.

2. Methodology

2.1 Case Study and Its Rationale: Yunlin

The study was conducted in Yunlin, a coastal area nestled in the Western part of Taiwan (Figure 1). Yunlin's location along the Taiwan Strait has naturally blessed it with abundant marine resources, including fish (Lee and Lin, 2020; Yang et al., 2022). Fishery production accounts for about 66.45 percent of Yunlin's total area (Lee and Hou, 2011). For centuries, fishing activities have been woven into the socio-cultural and economic fabric of coastal communities (Lee and Hou, 2011; Lee and Lin, 2020; Yang et al., 2022). Yunlin's coastal location and plains have naturally carved out excellent fishing grounds and ports along its coastline, such as Boziliao, Santiaolun, Taixi, and Jinhu, where diverse FVC activities exist, and fisheries-related initiatives have been initiated (Chen, 2012; Yang et al., 2022). However, dominant livelihood activities, e.g., fishing, have become less lucrative, competitive, or threatened by coastal developments, forcing most coastal communities to migrate to urban areas for other opportunities (Chen, 2012; Yi et al., 2008). This emerging demographic and socioecological dividend is a worrying concern that requires exploration to at least sustain coastal communities' livelihoods. These emerging gauntlets present a case to examine perspectives on how coastal shifts, including in fisheries, are affecting livelihoods and FVC practices.

Figure 1. Yunlin County and the three sample sites.



Source: author's development.

2.2 Research Design

A qualitative exploratory research design (QERD) was utilized (Carson, 1990; Ward, Comer, and Stone, 2018), as the study focused on capturing non-numerical data in Yunlin, to gain coastal fishers' perspectives, narratives, experiences, and FVC behaviors. The rationale and the consideration of for the QERD in this study was based on three reasons, including: (i) QERD is grounded on ethnography and involves a small, non-representative sample size, thus enabling the timely collection of diverse coastal lived experiences or community or individual knowledge concepts that are less explored in mainstream studies, (ii) QERD promotes phased evolution of valuable themes, e.g., on FVC components through brainstorming and iterations, and (iii) it enhances participatory observation and capturing of diverse community practicalities. Studies that have utilized this method in coastal fisheries reportedly gained insights, identified patterns, and established a foundational understanding of the possible strategies for promoting fishers' livelihoods (Lukambagire et al., 2024).

2.3 Field Data Collection

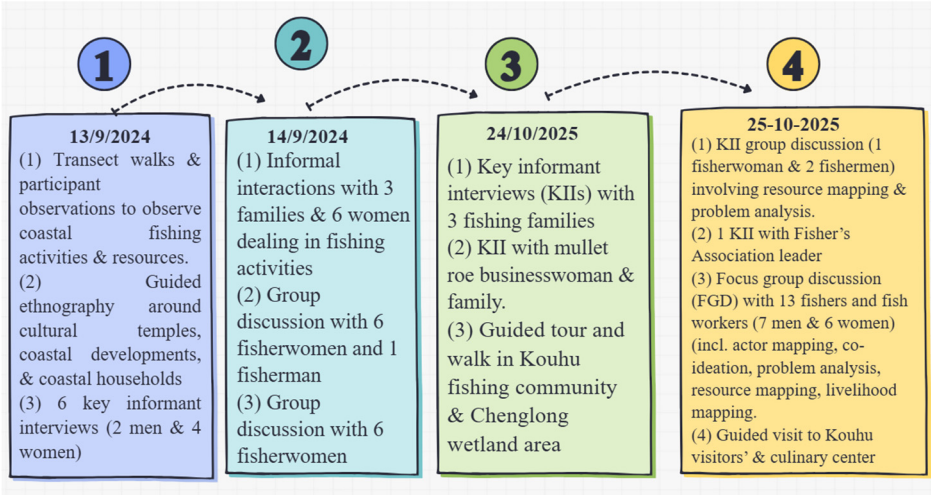
Field data collection was conducted in the coastal communities of Kouhu,

Jinhu, Changhwa, Beigang, Mailiao, Sihu, and Taixi, involving phased participatory processes and activities (Figure 2). Participatory interactions and interviews were conducted with 43 stakeholders or fisher households, 70 percent of whom were women, notably those recommended through snowballing, to be astute FVC dealers or businesswomen. The average time for the interviews and focus group discussion (FGDs) was 1 to 2 hours, depending on the pre-agreed schedule, data, or response saturation after probing or satisfactorily answering the targeted questions. Contemporary ethnography involved complete immersion in the culture and everyday life of the coastal people and fisheries, e.g., by visiting local markets, tourist centers, coastal zones, and supermarkets, primary fishing and processing sites, as well as residential areas of fishers or VC actors, to practically observe and understand the activities they do, challenges, and innovative strategies. During the interviews and interactions, seven thematic components were targeted to help understand the FVC dynamics, including: (i) participants' profiles, e.g., on whether they were born in or migrated to Yunlin, (ii) resource mapping (resources they are proud of or not proud of), (iii) livelihood documentation, (iv) seasonal FVC activities mapping, (v) FVC actors and their roles, (vi) FVC problem analysis, and (vii) co-ideating sustainable FVC activities or actions.

2.4 Data Analysis and Reporting

As recommended in social science research studies (Glaser, 1992), unlike explanatory research, exploratory data analysis began during the data collection phase. To do this, the written notes and audio were immediately transcribed

Figure 2. Field data collection phases.

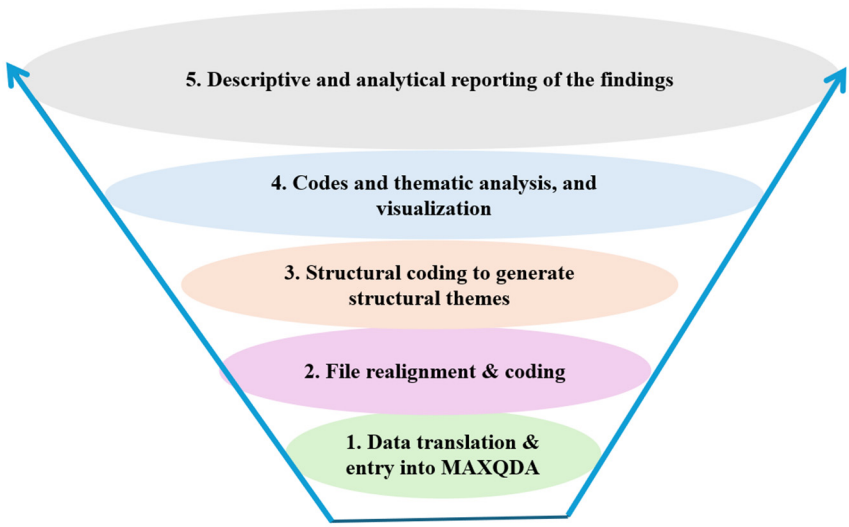


Source: author design.

verbatim from Taiwanese (Chinese) into English with the help of three research assistants. This helped in generating new ideas and concepts on Yunlin's FVC, including the cultural concept and socioecological systems (SES) links. All this information, including the entire areas traversed for data collection, was recorded as memos. To further analyze the collected data, MAXQDA software was utilized, and the process followed in data entry and analysis is indicated in Figure 3. The initial analytic phase in Max Weber Qualitative Data Analysis (MAXQDA) led to the generation of a single Microsoft Word document that included all the translated field data. This was followed by the utilization of the MAXQDA Analytics Pro software to: (i) import the converted Microsoft Word file into the MAXQDA analysis dashboard, (ii) develop codes, and (iii) generate qualitative narratives, themes, or insights from field data on FVC (Gizzi and Rädiker, 2021) (See coded transcript: https://tinyurl.com/4faks9d6). The coding focused on generating structural codes to enhance the grouping and mapping of themes relevant to Yunlin or regional FVC dynamics.

The reporting process involved the integration of rich field photos, MAXQDA-generated themes, and redesigned visualizations to comprehensively document diverse FVC aspects. Guided by Glaser's (1992) recommendations, a descriptive content analysis and reflective process were utilized to explain the diverse nuances around Yunlin's coastal communities, SES, and FVC aspects. Through this, interrelated issues around regional and global FVC were brought out, including unique narratives and perspectives from Yunlin, which could be replicated.

Figure 3. Interview content analysis process in MAXQDA.



Note: 1) Source: author design.
2) MAXQDA, Max Weber Qualitative Data Analysis.

3. Results

3.1 Yunlin's Coastal Fisheries and Fisheries Value Chain Dynamics

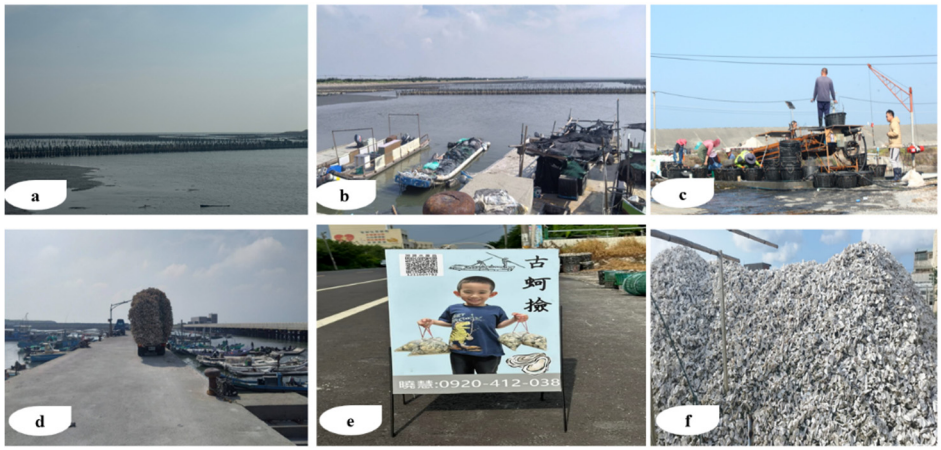
Key informants, especially from the Yunlin Offshore Fisheries Association (YOFA), reported that for centuries, the livelihood bedrock of Yunlin has been coastal and offshore fishing. Historically, unique fisheries practices existed based on the fish vessels and fishers' ability to reach the deep sea or offshore areas. Most often, large fishing vessels that harvested catch from the deep sea anchored and traded with distant or commercial fishing vessels of dealers, especially at Bazi Liao Fishing Port. Conversely, SSF and fishing vessels mostly operated in the nearshore areas. However, most commercial fishing vessels and dealers, e.g., those who traded in highly lucrative species, have shifted to other locations, partly due to Yunlin's changing coastal socioecological landscape and dwindling stocks. Today, Yunlin's coastal livelihood and FVC development activities vary depending on location, with some fishing ports, e.g., around wind and renewable energy installations, ports or ship-building zones, and integrated aquaculture and rice farming zones collapsing. In such areas, e.g., Taixi, fishers have resorted to small- and medium-scale FVC operations, mostly involving oyster and otolith ruber fishing, small-scale (family-run) aquaculture, fish processing, trade, and roadside fish-selling restaurants, e.g., at Kouhu Visitor Center or business (Figure 4).

Today, it was reported that the changing seasonal parameters, environmental conditions, and fishing pressures imply that fishing activities and species are varying. Dominant catches (although less lucrative), e.g., *Cynoglossidae*, are mainly harvested from October to March, and Mullets are caught in autumn and winter. In other seasons, *Sillaginidae* and Otolith ruber will be caught, but this is changing. Yunlin's unique coastal fishing history was candidly reported by some fishers and fishing households with over 40 years of fishing business, and managing a 20-year-old fishing business that

> 'In Yunlin, fishing has been the dominant livelihood activity. In the past, oyster and clam fishing predominated…There is also a small number of small-scale coastal fishers who harvest species, such as Otoliths ruber, Sillaginidae, and Epinephelinae….The elderly have worked in this industry for decades, generally don't switch to other sectors, and they still identify themselves as fishers, having deep roots in this land…Some fishers, e.g., in Kouhu township, have shifted to operating recreational fishing boats, which peaked about five or six years ago, but have since dwindled significantly.'

To safeguard this history and livelihood attachment, which is ingrained

Figure 4. Coastal fisheries value chain activities in the study sites of Yunlin (field photos).



Note: Photo A shows a fenced oyster and clam fish farm that is owned by a group of fishers, B shows the coastal fishing boats, loaded with storage and handling products to keep the harvested catch fresh before sending it to the market, C shows a family-run oyster fish-culture business that employs local women, especially during harvesting, D shows a fish harbor and port where large or commercial dealers of the harvested catch, including oyster shells, ship or load it to supply to other dealers and processing factories in towns, as far as Kaohsiung, E shows a family-run fresh oyster roadside business with contact details of the supplier. Here, local consumers constantly come and buy the catch. Prices vary depending on the quality of the oyster or clams. F shows the cleaned and ready-to-sell high-quality oyster shells from a family-run semi-modern production chain. The high-quality shells are highly demanded for processing fertilizers and making jewelry. The low-quality shells are not dumped but returned to the fish farms in the ocean, where they act as foundations onto which young clams and oysters attach and grow.

within Yunlin's socio-cultural fabric and beliefs, elderly persons who have lived in Kouhu reported an emphasis on citizens' science, art, music, and drama, as pioneered by influential writers, e.g., *Zheng Fengxi*, who documented Yunlin's potential and unique coastal and cultural activities, e.g., fishing festivals, and seminars, which are annually commemorated. To safeguard this uniqueness, during guided tours, most households, youths, and fishers decorate their houses, courtyards, and shared spaces with unique arts and designs, that represent Yunlin's fishing identity, and history, e.g., on previous tidal or flooding regimes (Figure 5). Accordingly, this is meant to naturally communicate Yunlin's treasures and shared willingness to drive sustainability transformations in marine and coastal activities, e.g., fishing, reducing fish products waste, and mangrove resource conservation. This unravels the unique attachment to fishing as a livelihood identity irrespective of adversity, including seasonal fishing activities and trade.

Through the safeguarding of Yunlin's fishing history, unique FVC networks and operations have become more resilient and sustainable. Among the most

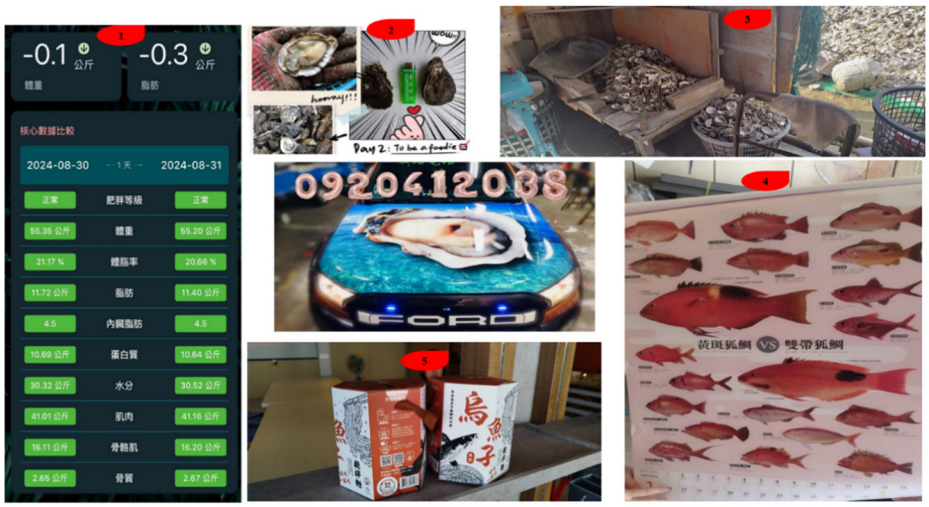
Figure 5. Yunlin's preserved fisheries history and stories (field photos).

Note: A indicates a community disaster refuge shelter with an Oyster-shell-designed fence. B indicates a traditional house with indications of the recordings of the highest tide ever recorded. C is a unique craft from natural mangrove products designed to safeguard the '*NuiNiaoKang*' history. D shows a traditional house decorated with Yunlin's traditionally dominant fish species.

reported sustainable FVC businesses and operations are intergenerational family businesses or household fishing enterprises, some of which have forced young people who had migrated to major cities, e.g., Taipei or Kaohsiung (in search of better lives and opportunities), to return to Yunlin. A key informant (woman) engaged in a family-run Mullet Roe business and has expanded it into a company called '*Li Mullet Roe'* candidly reported that she returned to Kouhu a few years ago to document and support the sales of the family's dried mullet (home-processed fish product). Today, this company has not only ventured into sustainable mullet roe culturing but also established market collaborations with regional companies in Japan and supplies fully processed and high-quality mullet roe to consumers all over Taiwan (Figure 6). This business model has been expanded to include a restaurant, processed pineapple cakes, digital delivery systems, and resource center where university students and researchers frequently learn about the dynamics of mullet roe FVC, including eco-friendly preservation, packaging, and natural aromatic techniques.

A related attachment and unique FVC model were reported in Taixi and Beigang by a fisherwomen's business group and women-led households dealing in oyster cultivation, harvesting, processing, selling, online marketing, and by-product recycling (Figure 6). These micro-level fishing groups, families, and households have created specialized FVC activities, including role allocation in fish harvesting, oyster planting, cleaning, processing, marketing, delivery, consumption, and recycling, although with diverse livelihood benefits and outcomes. In Taixi and Changhwa, it was narrated that key actors operate seasonally, e.g., small women-led businesses, local people, retailers, family members, individual

Figure 6. Some of the innovative products and FVC practices in Yunlin (field photos).



Note: 1) 1 indicates a locally designed real-time fish stock & price monitoring App in different markets. 2. Is a family/women-designed mobile vehicle marketing strategy for fresh oysters. 3 shows a shed beside the house of a prominent Oyster shell sorting and recycling site using conventional tools. Simple tools are utilized in puncturing low-grade Oyster shells, and in the background are high-grade and cleaned shells. 4 is a fish biography calendar developed by YOFA showing preferred and restricted fish species. 5 indicates packaged and ready to market Mullet roe at a family-run business in Kouhu.
2) FVC, fisheries value chain.

households, local markets, restaurants, local ice factories, local shops, and institutional players. Before August 2024, several oyster farmers sold to big wholesalers, but since August 2024, we have shifted to retailers and local business dealers, who offer quick and flexible payment means. Most oyster shells are sold to local businesspeople and community groups. The oyster business, e.g., in Taixi is conducted by cooperative groups, e.g., of women, and for deep-sea fishers, they are registered under YOFA. Through YOFA, dominant species calendars and names have been profiled to help fishers know Yunlin's fish species and their biology. To further boost their sales, most local fish families have developed unique digital marketing strategies, including the use of social media platforms, e.g., Facebook Pages and Line. Moreover, established cooperation mechanisms with local barbecue stores and restaurants in nearby towns, e.g., Beigang, are established. Additionally, families dealing in similar or related products share ideas on product value addition and market research for their processed and semi-processed products, after which profits are shared (money pooling). They intend to collaborate with investors and innovators to start up a local processing factory, which can process their harvested products in large quantities. This reveals that in Yunlin, FVC are

not seldom to men but women are increasingly visible at all FVC levels, and in some households, they reported significant power, e.g., in business management and community leadership. Some of the unique innovations and eco-friendly FVC practices were reported by women dealing in the oyster trade, who said that

> 'Most of us have (family, group, or household-owned) oyster farms. We have been doing this for the last 15 years. The oysters are bought, graded, and the bad or low-quality oyster is removed. We have a machine that punctures the low-quality shells, which are taken back to the sea to create new oyster platforms where young oysters hang, grow, and we re-harvest them from these platforms when they are ready. To supplement the production, we buy some of the harvested oysters from other farmers. Normally, bad oyster shells have a bad color and structure, and young oysters cannot hang or be attached to them. For this, we clean it and supply to processing factories to make other products, e.g., powder (fertilizers).'

The unique and promising sustainable micro-level FVC indicators are reportedly hinged on shared socio-cultural beliefs, norms, and values, coiled around noble religious temples or sites (Figure 7). Through Yunlin's coastal fishing areas, unique temples, e.g., the Mazu (Chaotian) Temple in Beigang, are the emblem of fishers' livelihood, fortunes, attraction, and way of life. The Mazu

Figure 7. Yunlin's diverse temples, a key facet of socio-cultural-religious attachment.

Note: 1 is the Chaotian Temple in Beigang, which was built in 1694 and is one of the most important and unique temples of the goddess *Mazu*. 2 is Sihu Temple. 3 is a temple in Taixi. 4 is a Temple in Kouhu.

temple in Beigang is a noble religious site that attracts over one million pilgrims annually. The prominence of the temple coincided with the era of Yunlin's coastal economic boom in the 17th century. All the socio-cultural, spiritual, and economic tapestries of Yunlin are in one way or another attached to the temple. Coastal fishers frequently visit the temple for blessings and offerings. Most elderly fishers and business owners succinctly argued that such cultural treasures must be preserved, and this knowledge must be passed on to new generations. The cultural connection to Yunlin's coastal livelihoods has further influenced the nature of local development projects, e.g., Provincial Highway 61, which was reportedly set up to improve accessibility of fishers to local markets, e.g., in Taixi and Kouhu, and link remote fishing communities, with several retired women who are engaged in fishing related activities, such as Oyster shell cleaning, and roadside marketing that are located in key nodal marketing zones. Most importantly, the role of local actors, especially coastal women and cultural leaders, in sustaining sustainable FVC safeguards is a consistent feature observed in Yunlin. This was candidly reported by a native who migrated from Pingtung to Kouhu after marriage in 1948, and recollected that,

> 'Kouhu is a place rich in talent, with contributions from local writers. Cultural learning has improved convenience in daily life and choices in retirement, focusing on community involvement and foundational work. These activities are relatively inexpensive and encourage more (schools and community) participation (i.e., in sustainable practices). Rebuilding of Zheng Fengxi memorial library and retaining the original ship-shaped building is great.'

Due to seasonal fish availability, primary fishers and families have ventured into large-scale aquaculture to ensure massive production and dividends. Through guided walks, several nearshore and coastal areas of Yunlin are layered with huge aquaculture farms producing diverse species. To local dealers, this has come along with mixed outcomes, especially to SSF or small enterprises, which cannot compete with commercial producers. As reported in Taixi and Kouhu, most of the large farmers target lucrative markets or sell to wholesalers who offer higher prices. Women reportedly fear that external actors and their activities (inputs) are steadily compromising the long-established, relatively sustainable, and innovative FVC practices. Some of the externalities include massive coastal developments limiting access to traditional fishing grounds with indigenous species. Also, key informants reported that massive production by commercial dealers would not have been a problem per se, but it has come at a time when Yunlin's coastal population is ageing, youths are migrating to towns, and the environmental conditions are worsening, including the frequency of typhoons, which destroy small oyster farms and small-scale primary and secondary FVC support infrastructure. Moreover, small-scale oyster and shrimp farmers are facing cut-throat

competition emanating from the importation of Vietnamese products into the local market. To minimize costs and remain in business, some family-run enterprises have recruited migrant labor, some of whom come from Indonesia and the Philippines to fill the labour gap in restaurants and on farms. Nevertheless, most local actors fear that these actions might not be enough to repel wholesalers or consumers who prefer huge volumes of fresh and processed products and have stringent certification requirements.

3.2 Ramifications of Yunlin's Fisheries Value Chain (FVC) Practices on the Local Economy and Coastal Socioecological Systems

Diverse FVC and SES ramifications were reported depending on the scale of operations, location, and livelihood assets or survival alternatives. Headlining this is the acknowledgement that FVC has become more complex and SSF are threatened. This is irrespective of the reported household or individual benefits reported, e.g., by YOFA and fishers in fish-trading or business. Four main drivers of FVC complexity were reported including: (i) limited cooperation among local fishing communities and commercial dealers, (ii) entry of external actors (local and foreign) into the FVC, (iii) coastal developments that affect primary FVC activities, and (iv) pedestrian institutional support or limited knowledge of the government support infrastructure, especially to small-scale dealers and fishing families in some coastal areas, such as Taixi. Micro-level FVC actors reportedly feel many livelihood survival pressures and that they might be knocked out of the secondary and tertiary FVC activities, e.g., in marketing and processing. This is worsened by the catastrophic shifts in SES across coastal Yunlin (Table 1). Most often, these challenges have mutated into bleak livelihood futures, and natural (fish) resource declines or conflicts, as natural resource or environmental damage in Yunlin is reportedly difficult to restore. Around Beigang, Taixi, and Changhwa, it was candidly reported that

> '…knowledge of small government support programs is unknown. Most people have not been given government support here. In nearby townships, such as Kouhu and Mailiao, we hear reports that their communities have been supported by giving them fish certificates. Certificates help the fishers get approvals and support from the government line agencies.'

3.3 Perspectives for Sustainable Fisheries Value Chain (FVC) Practices

Diverse stakeholders reported that Yunlin presents unique and diverse possibilities to circumvent historical, emerging, and future FVC conundrums. Prominently emphasized is the re-inventing of Yunlin's development visions by recognizing the shared place attachment, resources, and livelihood capitals, which

Table 1. Summarized FVC challenges, and the associated sustainability impact

Sustainability dimension	Reported challenge	Associated description	Impacted FVC component(s)
Economic	Challenging working environment for women	Hidden recognition of the role in some fishing communities.	Primary, secondary, & tertiary
	Threats from imported agricultural & fisheries products	Products, e.g., Oysters from Vietnam, affect markets & profits.	Secondary, tertiary
	Tedious work in Oyster VC	Oyster work is tiresome for women.	Primary, secondary
	Declining economic opportunities & benefits	These days, the local fishery is not profitable.	Secondary, tertiary
	Limited business cooperation	Everyone operates individually & few people are willing to cooperate.	Primary, secondary, & tertiary
	Cut-throat business competition	Competition for markets has increased with more people in the fisheries business.	Secondary, tertiary
	Increasing fishing costs	Fishing costs have increased…more fishers are leaving the fishing business.	Primary, secondary
	Exploitative middlemen or agents	Local producers sell to large-scale dealers or merchants & lose profits.	Primary, secondary
	Unscrupulous marketing conflicts	Some dealers hijack the marketing prices, causing artificial shortages from source points to inflate prices.	Primary, secondary, & tertiary
Socio-cultural	Declining Taiwanese cultural experiences	Community identities and shared experiences on livelihood values are eroding.	Primary, secondary, & tertiary
	Personality traits & attitudes	Some coastal fishermen & community members abhor women-led VCs.	Primary, secondary
	Socio-cultural grief & insecure livelihoods	We are feeling grief…techno/ ocean engineering projects have suppressed our livelihood and social networks. We feel sad.	Primary, secondary
	Ageing fisher population	Although fishing is our intergenerational profession, we are aging and tired, and young people don't want this job.	Primary, secondary
	Deteriorating health conditions	Women do masculine work, e.g., lifting the catch, causing health complications, e.g., in the spine.	Primary, secondary
Institutional	Competing coastal megaprojects	Coastal projects increased weather changes and affected the abundance of fish stock.	Primary

Table 1. Continued

Sustainability dimension	Reported challenge	Associated description	Impacted FVC component(s)
Institutional	Limited knowledge of existing government programs	In Taixi, most small-scale fishers don't know about government programs.	Primary, secondary, & tertiary
	Unbalanced institutional support initiatives	Some people, e.g., in Kouhu, have been given government support.	Primary, secondary
	Inadequate fisher certification	Primary fish VC actors in some places lack approved certificates to operate.	Primary, secondary
	Limited coastal consultations/engagement in coastal development projects	The central government only discusses with top stakeholders at the county or local government levels.	Primary, secondary, & tertiary
	Complex compensation process	Fishers do not understand the compensation law, the documents given, or the compensation settlement letters.	Primary
	Prohibitive fisheries access regulations	Fishing is now prohibited in the wind power generation area.	Primary
	Declining institutional trust	Fishers' expectations & trust in most government projects have reduced…are low & fishers are angry.	Primary, secondary
Environmental	Reduced catch	18 wind power construction fans or turbines set up on the seabed affected fish spawning, & historical migratory routes.	Primary, secondary
	Climate change-induced impacts, e.g., typhoons	Typhoons have increased in Taiwan. Most oyster farms are destroyed, and Oysters & shells shift to other locations.	Primary
	Changing tides & ocean waves	Ocean tidal flow has changed, affecting fish stocks.	Primary
	Shallow sea waters	The seawater is shallow (partly due to sand drifting & wind power construction project).	Primary
	Increased siltation	The Beigang Creek is closed in Kouhu, and this has increased siltation.	Primary
	Eutrophication	Algae blooms have increased near the harbor, thus the loss of oysters & fear of fishery collapse.	Primary
	Changing fishing location	The changes in the fishing zones require fishers to fish farther out in the sea.	Primary
	Changing fishing seasons	Mullets are caught in autumn and winter…but this has changed.	Primary, secondary

Table 1. Continued

Sustainability dimension	Reported challenge	Associated description	Impacted FVC component(s)
Environmental	Declining water quality	The Chichi diversion pier blocks freshwater, obstructs minerals, estuarine algae, impacts water quality, & slows oyster farming or growth.	Primary, secondary
	Sea level rise	Now, we must farm the area three times (farmed Oyster or Clam fishing area) to get the same yield as before, which is challenging. In the past, the high tide would reach about five meters deep, but now, it's only three meters.	Primary
	Coastal shoreline changes	The nearby Yunlin Sixth Naphtha Cracking complex used to dig up sand for construction, and dump it three nautical miles offshore from Taixi, but it eventually drifts back. The Wai Shanding sandbar is disappearing.	Primary

Source: author's synthesis of field findings.
Note: 1) Primary VC activities in the study comprise all aspects related to on-site fish harvesting & storage. Secondary are those done within the community, but away from the primary fishing site, e.g., home Oyster cleaning, marketing, and sorting. Tertiary activities include all post-harvest VC activities, e.g., large-scale processing, customer acquisition and retention, market analysis, and inter-regional trade.
2) FVC, fisheries value chain.

have made local actors and fishers more innovative and resilient. Through interactive sessions and qualitative analysis, 44 sustainability perspectives were revealed (Table 2). To individual fishers and fishing groups with attachment to Yunlin, these perspectives reminisce about the community wisdom, knowledge spaces, and innovations that are mostly unique to Yunlin's socio-cultural history and development perspectives. To resoundingly sustain better FVC operations, practices, and activate win-win sustainability outcomes, stakeholders emphasized the relegation of siloed institutional programs, focusing on fishing as an integrated business and social identity, and a focus on integrated resource nexus and SES approaches. Going forward, they argued that this can be legitimized through collaborative institutional mechanisms that not only recognize micro-level communities' value or role in coastal and FVC development but also ameliorate SES pressures. During FGDs, stakeholders resoundingly argued that if micro-level sustainability actions are not cemented, ripple effects and shocks, e.g., Oyster supplies will decline or collapse, affecting tertiary FVC activities and actors (who mostly rely on primary production and secondary FVC actors, e.g., Oyster and Clam fish and shell cleaning and sorting women.

Table 2. Valuable perspectives or strategies to promote sustainable fisheries VC

Socio-cultural	Environmental	Institutional	Economic
1. Cultural innovations involving youths, schools, & community training centers	1. Enhanced by-catch (Oyster/clam shells) recycling	1. Institutional collaboration among all stakeholders	1. Promotion of coastal communities' entrepreneurship, e.g., in fish processing
2. Rebuilding & preserving Yunlin's unique cultural centers, e.g., Zheng Fengxi library	2. Provision of safe and protective sea Oyster/clam harvesting gear, e.g., gloves	2. Funding & preserving of historical symbols & livelihood assets	2. Promoting & incentivizing family and community-led fisheries businesses
3. Leveraging the lived experiences & knowledge of the elderly, retirees, & returnees	3. Promotion of integrated trophic & multi-species aquaculture, e.g., Crassostrea angulata aquaculture	3. Integrated coastal zone planning, e.g., for coastal industrial parks	3. Promotion of innovative external marketing strategies, e.g., Household cars, evening markets
4. Women's empowerment across VC & activities	4. Processing of low-quality Clams or Oyster shells into fertilizers	4. Empowering village heads in sustainability projects	4. Promoting business partnerships along the VC between producers-suppliers-consumers
5. Inclusiveness, e.g., persons with disabilities	5. Implementing the proposed white dolphin plan in suitable non-Oyster/cultured fish locations	5. Promoting programs on healthy diets & living (seafood consumption)	5. Value-addition to harvested products, e.g., making of Oyster oil & soup
6. Documenting fisheries traditions & shared cultural histories	6. Cleaning up the drifting sand from the Oyster farming zones	6. Integrating local aesthetics into the socioeconomic fabric of the VCs	6. Co-ideation on market prospecting & product marketing
7. Promotion of visual arts, paintings & humanities in VC storytelling	7. Reviving seasonal recreational fishing & tourism activities	7. Affirmative actions to interest youth in fishing activities, e.g., capital for start-ups	7. Integrated community or group profit-sharing & reinvestment initiatives
8. Training fishers, e.g., on Oyster fish breeding	8. Promoting single-species Oyster farming culture	8. Emphasis on digitalizing fisheries VC & leveraging existing internet marketing channels	8. Online & hybrid fish selling & marketing, e.g., via WhatsApp groups, & snowball marketing
9. Formation of Primary producers marketing & production groups		9. Institutional lobbying for investments	9. Changes in marketing or supply chain model (inward-looking to promote communal dealers)
10. Enhanced advocacy & promotion of labor rights along the VC		10. Setting up cooperative community fish processing factories	10. Subsidization of fish farmers' equipment, e.g., in Taixi

Table 2. Continued

Socio-cultural	Environmental	Institutional	Economic
		11. Inclusive fisher certification programs	11. Economic diversification, e.g., into integrated home-based income-generating activities
		12. Just & transparent negotiations with affected fisher communities	12. Integrating wild and farmed fisheries production & marketing teams to boost market bargaining
		13. Relocation of the industrial area to other non-coastal zones	
		14. Targeted research funding to the regional Fisheries Research Institute	

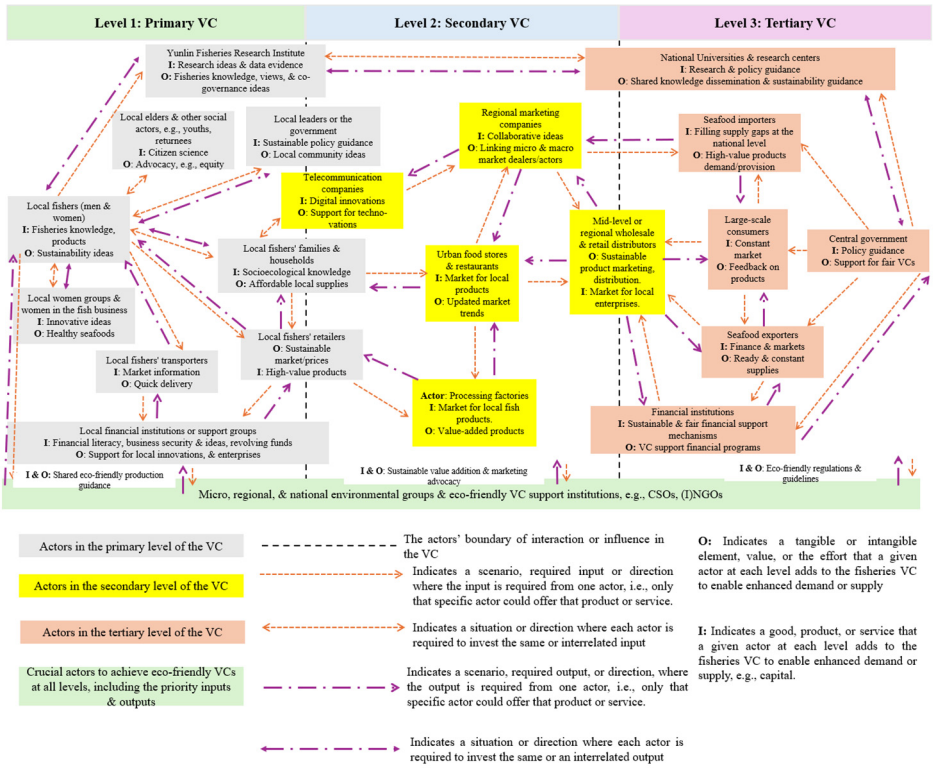
Source: author synthesis of fishers/coastal community perspectives.

3.4 Contextualized Sustainable and Inclusive Fisheries Value Chain (FVC) Model and Design

All stakeholders recognized the fragility of Yunlin's FVC and thus, through a guided co-designing process, participants re-created and re-constructed an inclusive FVC that could advance blue transformations and win-win actor benefits (Figure 8). The contextual model or design focused on mind mapping and a collaborative actor mapping approach to identify and situate which actors and actor roles could promote 'fair' FVC practices, and what is needed to achieve these prospects. The conceptualized FVC model includes three levels that specify system boundary operation zones for key actors, inclusive actors' activities (inputs and outputs), and their interactions, which could create positive synergies and intersections for sustainable FVC operations. A detailed description of the model and its relevance towards sustainable fisheries VC is explained below.

The insightful and conceptualized perspectives in Yunlin demonstrate feasible inroads for sustainable FVCs. Invaluably, it was acknowledged that the entire FVC is and must be a theatre where external and internal actors operate. Nevertheless, given the special case of Yunlin, they argued that stakeholder interplay must be based on resilience rather than irreparable primary FVC losses or SES threats. This is because most external actors (i.e., non-residents or actors without the intrinsic and established socio-economic and historical resource user networks), and their activities are mostly hinged on quick profits, or massive fishery resource exploitation to satisfy the demand-supply agreements, especially

Figure 8. The conceptualized sustainable and fair fisheries value chain (FVC) model and design.



Source: author's recreation of field narratives and perspectives.

with large conglomerates. Thus, the primary or micro-level FVC system should be less linear (production-processing-marketing-consumption-waste) but more circular (production-processing-marketing-consumption-recycling-reuse). This can help sustain fish as food or consumable for all, rather than fish as an extractive resource for a few. To cascade away from this complex and unsustainable ecology, actors argued that a sustainable and fair FVC should:

a) Include operational boundary levels for primary, secondary, and tertiary actors
b) Focus on strategic stakeholder identification and role allocation at each FVC stage or level
c) Link actor interactions through integrated system analysis, including the elucidation of the inputs and outputs the actors have in the FVC or SES, e.g., goods, services, value added, or value composition, and
d) Cobweb holistic sustainability targets, outcomes, and value at all FVC levels.

At Level 1 (primary FVC), it was argued that external factors, such as telecommunication companies or research institutions, e.g., the National Taiwan Ocean University (NTOU) or National Taiwan University, and environmental or eco-friendly FVC actors, should come in only if they add value or unique inputs or outputs that sustain the local fisheries FVC, e.g., through impactful anthropology or oceanography and fisheries research. For instance, women in the fish business argued that telecommunication companies or digital technologies dealers could add value by providing affordable technological products or data bundles that increase or support the already existing innovations, such as social media or digital platforms, to stimulate small-scale fisherwomen's businesses or increase real-time monitoring of demand and supply patterns or markets. Additionally, a case was presented to include key local stakeholders, such as the elderly and youth, as they can advance socioecological knowledge dissemination or advocacy for sustainable practices, with environmental actors or research institutions. An insightful inclusion was the fisheries research institute at Beigang, which has been paramount in conducting marine fisheries science research. However, fishers argued that marine socioecological knowledge could strategically be included in the research menu to provide a holistic lens of Yunlin's marine socio-cultural, ecological, and fisheries perspectives or science, to improve local SES resilience and livelihood knowledge, thus co-creating sustainable governance ideas. Three valuable takeaways stood out at the primary level: (1) micro-level actors can satisfy the local demand-supply requirements of Yunlin if safeguards and a few system shocking actors or negative feedback interactions, e.g., exploitative or economic-centered actors come in, (2) the core driver of primary FVC activities are the fisher families, households, and women, (3) through local fishers (women and elderly) history and experience in creating marketing networks or increasing customer base, local fisher families, households, and retailers become stewards in linking secondary to primary actors, reducing chances of unscrupulous micro-level dealers or price manipulation by monopolies. Micro-level primary FVC safeguards increase chances for fish conversion into sustainable and highly valuable or sellable products, including fishmeal for small-scale aquaculture dealers and fish-consuming families or households.

Level 2 covers the actors at the secondary FVCs. Accordingly, this level must encompass fish dealers (both large and medium scale). To mitigate micro-level fish scarcity or price distortions, the sourced resources, inputs, and outputs of these actors should be in tandem with each other and be based on supplies from micro-level actors (i.e., Level 1). As indicated in Figure 8, the key input required from these actors is sustainable market provision to all sourced fish species or semi-processed fish products, including shells. These products can be utilized for value addition and traded with large (regional) wholesalers, e.g., in Beigang, who have the capital and ability to supply to other regional, national, or international consumers. Additionally, as part of corporate social responsibility, Level 2 actors could steer and support digital transformations (as an input), in partnership with

telecommunications and or digital technologies actors. This could then be harnessed by Level 1 actors, e.g., in comprehending market trends, knowing who and when to sell to, and how to deliver goods or services to a given consumer segment, among others. Most importantly, eco-friendly financing support initiatives, e.g., green home-based fish value addition financing, with Level 2 actors were emphasized. These can mitigate 'money rush' and unfairness in investment entries by Level 2 actors, which normally knock out the financially constrained Level 1 actors, via patron-client exploitation (by powerful conglomerates). This could alleviate economic and resource access pressures by Level 1 actors. This mechanism could be supported through collaborative transitions with intermediary dealers or the highest bidding companies, who focus on sustainable production mechanisms, including on sustained provision of micro-level community fish food needs.

In Level 3 (tertiary FVC), preference for large-scale or powerful external actors, including large wholesalers and conglomerates, with huge capital and investment potential, was emphasized. In other words, large-scale and external actors should mostly operate at tertiary FVC levels, as such actors can compromise demand-supply mechanisms, customer base, or flood micro-level and regional-level markets with products that increase rivalry between Level 1 and Level 2 actors. Additionally, as powerful actors normally get unfair preferences, e.g., tax rebates and subsidies, e.g., on imported seafood products, acceptable limits on their operations must be set up. This is because, in Yunlin's case, conglomerates importing seafood products have: (i) created a parallel or external FVC system, making it difficult for small-scale retailers and primary dealers, e.g., to supply local stores or markets, that have historically taken their excess or semi-processed products, and (ii) increased production stresses as local producers harvest any type of fish to supply exporters and processors, e.g., of fish meal. These emerging local and regional market dynamics have lessened the volume of fishery products reaching Level 1 and 2 actors, and caused price spikes, making it hard to put fish on the table. Thus, at Level 3, the key actor who can reverse or balance the FVC conundrum is the Central government, and this can be done through the promotion of inclusive and supportive FVC programs or mechanisms. Such mechanisms must encompass eco-friendly guidelines and legislation, e.g., on reducing fish waste and price controls along the FVCs. This can be done through collaborative research and knowledge sharing with key actors, e.g., research institutions, fishers or coastal community groups, environmental advocacy groups, and (International) or national Non-Governmental Organizations (INGOs), among others. In all cases, the central government's actions must be coherent and systematically hinge on factual data and transdisciplinary evidence from experts and local SES knowledge.

4. Discussion and Reflections

This study explored the complex nuances around coastal fisheries and FVC in Yunlin, to unmask valuable perspectives from coastal communities on how or what a sustainable and inclusive FVC should be or encompass. Perspectives in Yunlin reinforce existing literature about FVC complexities and the associated or emerging trade-offs. As reported in Yunlin, although fish and fishing are critically important to livelihoods and community identity (Harding et al., 2022; Korowi et al., 2025; Mahmud, Zaman, and Haque, 2025; Spalding et al., 2023), an interplay of shifting SES and FVC dynamics implies that this may be no more (Shea et al., 2025; Smith, Khoa, and Lorenzen, 2005; Temesgen, Getahun, and Lemma, 2019). This is because SSF and micro-level actors, e.g., women entrepreneurs and family-run businesses, which have historically been embedded within fishing activities and driving FVC, are slowly but steadily losing their grip on key markets and products, especially to large-scale dealers or powerful actors. As reported by Thara (2016) and Rubinoff (1999), it signifies that the (in)-visible role that primary FVC actors have played, including their unique skills, e.g., in fish value addition, could be lost. Similar observations are reported in Vietnam (Harper et al., 2017; Mahmud, Zaman, and Haque, 2025) and Papua New Guinea (Chapman, 1987; Rohe, Schlüter, and Ferse, 2018), among others. Nevertheless, insightful eco-friendly practices which could reverse this trajectory were reported in Yunlin, including bycatch recycling, creation of oyster foundations, or fertilizers, among others. If supported, such opportunities and contributions could aid innovations, e.g., in making agro-based fish or nutrient-rich poultry meals, as recommended by (Brugere et al., 2021; Thakur, Kotiyal, and Thoudam, 2025), thus mitigating the increasing worries associated with fish-meal costs, especially among aquaculture farmers (Thakur, Kotiyal, and Thoudam, 2025).

Unfortunately, as reported and observed in Yunlin, the commendable role of micro-level actors is mostly under-reported, underrated, or less appreciated, creating perilous indicators for coastal FVC activities, SES, and community livelihoods. The perilous nature of the utterly fragmented, unsustainable shifts across regional and global FVC, thus requiring a fish-food-food system thinking lens, is reported in several studies (Jyotishi, 2023; Nyiawung, Bennett, and Loring, 2023; Shea et al., 2025). Scholars argue that populist economic-centered FVC models proliferate, creating unsustainable demand-supply landscapes, and a need for a rethink of the FVC *modus operandi*. Consistent with Yunlin fishers' perspectives, reversing this requires a tiered approach (levels) that situates actors' diverse operations into the site-specific FVC realities, including in capture production, provisioning, governance, and consumption constellations. Such mechanisms could advance important foundational steps for understanding FVC complexity, thus promoting sustainable governance, policy formulation, and collaborative extra-transactional actors mechanisms that shape seafood or fish

product or material flows. Through such mechanisms, possibilities of sustaining fish provisioning for consumption and for other values, e.g., processing for fishmeal, could be sustained (Erzini et al., 2024; FAO, 2024a; Oosterveer, 2008).

The rationale for this perspective is supported by the sickening fish production and provisioning trends, both as a consumer and a user commodity. This debacle is magnified by globalized trends in FVC, which have created governance challenges, e.g., in sustainable marketing and consumption patterns (Jyotishi, 2023; Oosterveer, 2008). Global FVC shifts and demand patterns have turned fish into a commodified asset destined to satisfy the more lucrative global fishmeal production market, rather than serve the human consumption needs (Shea et al., 2025). Today, 66 percent of wild fish are utilized by fish processing dealers as aquaculture feed or fishmeal (Shea et al., 2025). This implies that if no safeguards are established, e.g., in Yunlin, fish for human consumption might be compromised or diverted to support aquaculture feed in the ever-increasing aquaculture farms. More worryingly, on a global and regional scale, countries with food security or population nutrition needs, e.g., Peru (1,003.36 thousand metric tons of harvested fish) are unwittingly supplied and processed as fish meal, and 100.33 thousand metric tons target massive fish oil processing (Shea et al., 2025). This could slap astronomical fish price volatilities, artificial shortages created by dealers, and fish-for-consumption volume declines, as warned by Asche, Dahl, and Steen (2015) and Deb, Dey, and Surathkal (2022).

Moreover, in Yunlin, as summarized in Table 1, the emerging unbridled FVC dynamics and challenges have gained limited key institutional stakeholders' interest, jeopardizing long-established FVC practices, including specializations on role allocation, food security, fair FVC networks, and trust in shared resources. Institutional disregard of primary FVC practices has emerged as a topical issue in tropical regions, e.g., West Africa, and has mutated into meteoric fish declines (due to the entry of external or commercial actors in micro-level FVC activities) (Belhabib, Greer, and Pauly, 2018; Belhabib et al., 2019; Etta, Matovu, and Lukambagire, 2025; Failler, 2014; Wamukota and McClanahan, 2017). Without institutional support, resilience options, including unique SES knowledge or innovations, hardly become sustainable (Brugere et al., 2021; Harding et al., 2022; Korowi et al., 2025; Mahmud, Zaman, and Haque, 2025). Fortunately, in Yunlin, as indicated in Table 2, invaluable stakeholder views on how to re-create fair and integrated FVC were reported. Moreover, as a way of re-inventing FVC practices, a sustainable and integrated FVC model or design was co-developed. A key takeaway from Yunlin is that for sustainable FVC to emerge, a need to diverge from linear to circular FVC practices is needed. In other words, fish actors should not exclusively focus on quick economic gains but integrate other sustainability and SES components, including recycling and socio-cultural resilience. To achieve scalability and impact, specific levels of FVC and actor operations are needed. Critically, most of the tenets reported in Yunlin encompass diverse empowerment and sustainability spaces, including digital marketing and eco-friendly practices,

implying that they could be integrated into emerging regional and global roadmaps, e.g., the 2021–2030 FAO blue transformation roadmap and SSF guidelines on sustainable fishing. Indeed, as argued by actors in Yunlin, perspectives in Yunlin present and unravel insightful opportunities that could be scaled up for sustainable fisheries and community transformations.

5. Conclusion and Way Forward

This study utilized a QERD and explored perspectives from 43 coastal fishing communities from Yunlin to question and shed light on what a sustainable and inclusive FVC must entail. Stakeholders unmasked premium fisheries and FVC dynamics vis-à-vis the changing SES in coastal areas. Stakeholders, especially family business owners, and innovative fisherwomen groups trained us that, irrespective of FVC complexity, promoting sustainable and inclusive FVC practices, especially at micro-levels where long-established socio-cultural ties exist, is possible. These ties are strengthened through collaborative actor mechanisms and role allocation across the FVC, including youths, women, the elderly, fisher groups, and community or regional wholesalers. However, the success of these mechanisms depends on robust institutional and FVC safeguards. In Yunlin, these safeguards are increasingly breached through a nexus of external actors' entry, SES, environmental pressures, and mushrooming coastal developments. Although innovative practices, e.g., oyster shell recycling, and women-led marketing groups or fishers' associations, have been developed, the limited institutional support, coupled with market volatility, implies that micro-level fisheries and primary FVC actors are increasingly threatened. More worryingly, due to massive renewable energy projects and developments, fishers argue that even primary wild species are migrating, and yet transitions to capital-intensive aquaculture are beyond reach, notably for elderly or socioeconomically disadvantaged families. To Yunlin's FVC actors, e.g., wild oyster cultivators, current FVC practices and coastal developments have regurgitated socioeconomic and environmental losses, ruined foundational social governance hegemony, and created parallels between institutional state and non-state FVC actors. These challenges might proliferate into natural resource user conflicts or disregard for shared coastal resources governance in the future, if micro-level community perspectives are disbanded or ignored. Nevertheless, the FVC reconceptualization process highlighted that immense opportunities for better futures are present and require unlocking. The developed fair and sustainable FVC design reveals that safeguards are needed to shield or apportion FVC and actor operations. This can create a win-win FVC system practice and save the reported unique resilience and sustainable practices. As this paper documented, an initial but vital step that could guide sustainable fisheries and FVC practices, most of which are replicable, six practical and policy recommendations are put forward, including;

1) Kickstarting baseline SES impact assessments and fisheries inventories amidst emerging coastal megatrends and projects is vital. This can help safeguard fisheries resources, valuable FVC practices, and unique community livelihood capitals that aid resilience.
2) Advancing FVC and coastal equity and justice in fishing and marine-based related activities, projects, and programs that directly and indirectly affect livelihood assets, communal or shared capitals. This can promote a sustainable blue economy and blue transitions, including fish-related value-addition practices.
3) Prioritizing food security needs of small-scale and primary FVC actors over wholesalers is vital for community livelihood resilience. This is because, as wild catch and farmed species harvests are declining, livelihood security is compromised. This can be done through creating direct and innovative seafood marketing and flexible customer acquisition avenues, rather than cooperating or preferring external large FVC conglomerates.
4) Promotion of a shared FVC empowerment model. This should be co-designed in a manner that promotes and advances micro-level household or existing innovative marketing platforms or seafood certification, or clean production models, and social systems, managed based on specific FVC actors, levels, or eco-friendly FVC guidelines or practices. This can be done in collaboration with supporting entities, non-state, and state actors, to enable (in)-direct sharing of benefits emanating from established FVC practices.
5) Co-designing cooperative FVC business models. These should involve neutral co-managers across the production and marketing FVC rather than lead managers (who oversee all FVC activities). This can promote willingness to cooperate or operate together and support the development of unique certification guidelines or programs for fish products or actors advancing sustainable practices, e.g., in recycling, clean post-harvest handling, and transparent digital marketing models.
6) Developing new site-specific or pilot models for coastal FVC. Since most micro-level FVC systems or operations are similar, yet the inputs and outputs vary, innovative business applications or production systems are needed to reduce reliance on wild catch and preferential favors for powerful or select FVC actors. Thus, one-stop pilot fishing ports or sites for specific producers, e.g., small-scale and large-scale dealers, could be set up. In Yunlin, for instance, large ports can be designed as sites for conglomerates that target regional, national, and international markets. Conversely, small fishing zones, e.g., in Taixi, could be designated as hubs for local and small-scale FVC actors. This could ease institutional monitoring of sustainable FVC processes and clear or interconnected producers-suppliers' channels. All pilot sites could be supported with digitalized demand-price-consumer monitoring applications to ease marketing, consumer access, acquisition, and delivery.

Acknowledgments

This work is part of the project titled 'The Blue Economy and Empowerment of Vulnerable Coastal Communities (through co-design)' and contributes to Future Earth Coasts, a Global Research Project of Future Earth. Special thanks to the Korea Maritime Institute (KMI) for the opportunity to submit this article. The author thanks the coastal communities in Yunlin who willingly agreed to share their amazing ideas.

References

Asche, F., Dahl, R. E., and Steen, M. (2015) Price Volatility in Seafood Markets: Farmed vs. Wild Fish. *Aquaculture Economics & Management* 19(3): 316-335.

Belhabib, D., Greer, K., and Pauly, D. (2018) Trends in Industrial and Artisanal Catch per Effort in West African Fisheries. *Conservation Letters* 11(1): e12360.

Belhabib, D., Rashid Sumaila, U., and Le Billon, P. (2019) The Fisheries of Africa: Exploitation, Policy, and Maritime Security Trends. *Marine Policy* 101:80-92.

Brugere, C., Padmakumar, K. P., Leschen, W., and Tocher, D. R. (2021) What Influences the Intention to Adopt Aquaculture Innovations? Concepts and Empirical Assessment of Fish Farmers' Perceptions and Beliefs about Aquafeed Containing Non-Conventional Ingredients. *Aquaculture Economics & Management* 25(3):339-366.

Carson, D. (1990) Some Exploratory Models for Assessing Small Firms' Marketing Performance (A Qualitative Approach). *European Journal of Marketing* 24(11):8-51.

Chapman, M. D. (1987) Women's Fishing in Oceania. *Human Ecology* 15(3): 267-288.

Chen, C. Y. (2012) *The Impact of Social Networks and Human Capital on Social Mobility: A Study of the Yunlin County Association of New Taipei City* (Master's thesis). Taipei City: National Taiwan University.

Deb, P., Dey, M. M., and Surathkal, P. (2022) Fish price volatility dynamics in Bangladesh. *Aquaculture Economics & Management* 26(4):462-482.

Erzini, K., Sadat, Z., Bentes, L., Coelho, R., Lino, P. G., Monteiro, P., Oliveira, F., Ribeiro, J., and Gonçalves, J. M. S. (2024) The Potential Fish

Provisioning Services of Vegetated and Unvegetated Habitat in a Lagoon Nursery. *Fisheries Research* 278:107115.

Etta, L. A., Matovu, B., and Lukambagire, I. (2025) A Bibliometric Analysis of the Marine Fishing Landscape in Africa and its Implications for Sustainable Coastal Communities' Resilience and Governance to the Increasing Human-Environmental Risks. *Anthropocene Coasts* 8(1):4.

Fabinyi, M., Belton, B., Dressler, W. H., Knudsen, M., Adhuri, D. S., Aziz, A. A., Akber, M. A., Kittitornkool, J., Kongkaew, C., Marschke, M., Pido, M., Stacey, N., Steenbergen, D. J., and Vandergeest, P. (2022) Coastal Transitions: Small-scale Fisheries, Livelihoods, and Maritime Zone Developments in Southeast Asia. *Journal of Rural Studies* 91:184-194.

Failler, P. (2014) Climate Variability and Food Security in Africa: The Case of Small Pelagic Fish in West Africa. *Journal of Fisheries & Livestock Production* 2(2):1-11.

FAO. (2023) *Illuminating Hidden Harvests: The Contributions of Small-Scale Fisheries to Sustainable Development – Executive Summary.* Rome: FAO.

FAO. (2024a) *Developing and Implementing a National Plan of Action for Small-Scale Fisheries (NPOA-SSF). A Manual in Support of the Implementation of the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication*. Rome: FAO.

FAO. (2024b) *In Brief to The State of World Fisheries and Aquaculture 2024*. Rome: Blue Transformation in Action.

Fisher, M. C., Moore, S. K., Jardine, S. L., Watson, J. R., and Samhouri, J. F. (2021) Climate Shock Effects and Mediation in Fisheries. *Proceedings of the National Academy of Sciences USA* 118(2):e2014379117.

Gizzi, M. C. and Rädiker, S. (2021) *The Practice of Qualitative Data Analysis: Research Examples Using MAXQDA*. Berlin: BoD–Books on Demand, MAXQDA Press.

Glaser, B. G. (1992) *Basics of Grounded Theory Analysis*. Mill Valley, CA: The Sociology Press.

Harding, S., Marama, K., Breckwoldt, A., Matairakula, U., and Fache, E. (2022) Marine Resources and their Value in Kadavu, Fiji. *Ambio* 51(12):2414-2430.

Harper, S., Grubb, C., Stiles, M., and Sumaila, U. R. (2017) Contributions by Women to Fisheries Economies: Insights from Five Maritime Countries. *Coastal Management* 45(2):91-106.

Jyotishi, A. (2023) *Fish for Food or Fish for Feed: New Populism and Blue Economy Perspective*, Chacko Chennattuserry, J., Deshpande, M., and Hong, P. (eds.), pp. 1-6. Singapore: Springer Nature Singapore.

Korowi, L. G., Mammel, M., Matovu, B., Huang, P. T., Raj, A., Hsiao, Y. J., and Lee, M. A. (2025) Small-Scale Fisherfolk in Papua New Guinea: Perspectives on Climate Variability and Its Impact on Coastal Fishing Operations and Activities. *Environmental Challenges* 20:101221.

Lee, M. A., Mammel, M., Matovu, B., Korowi, L. G., Mondal, B. K., Martins, I., Mahata, S., and Sedanza, M. G. (2025) Exploring Cross-Country Externalities, Viable Resilience, and Sustainability Options for Small-Scale Fishing Communities in the Tropics. *Frontiers in Ocean Sustainability* 3:1541847.

Lee, S. H. and Hou, J. S. (2011) Agriculture Landscape Planning based on Biotop Area Factor in Yunlin, Taiwan. *32nd Asian Conference on Remote Sensing 2011, ACRS2011*. Makassar, Indonesia.

Lee, Y. J. and Lin, S. Y. (2020) Vulnerability and Ecological Footprint: A Comparison between Urban Taipei and Rural Yunlin, Taiwan. *Environmental Science and Pollution Research* 27(28):34624-34637.

Lukambagire, I., Agrah, T., von Lieres, J. S., Matovu, B., and Bhavani, R. R. (2024) Fishermen's Attitudes towards Drone Use for Sustainable Fishing in a Coastal Community in Kerala, India: An Exploratory Qualitative Study. *Sustainable Futures* 7:100225.

Mahmud, K. T., Zaman, F., and Haque, A. B. M. M. (2025) Gender Disparities and Barriers for Fisherwomen in the Fisheries Value Chain System: A Review of Global Perspectives. *Gender, Technology and Development* 29(2):304-325.

Matovu, B., Bleischwitz, R., Alkoyak-Yildiz, M., and Arlikatti, S. (2024a) Invigorating Women's Empowerment in Marine Fishing to Promote Transformative Cultures and Narratives for Sustainability in the Blue Economy: A Scoping Literature Review from the Global South. *Mitigation and Adaptation Strategies for Global Change* 29(8):83.

Matovu, B., Lukambagire, I., Mwabvu, B., Manianga, A., Alkoyak-Yildiz, M., Niranjanaa, S., Jabbi, B., and Etta, L. A. (2024b) Co-designing Transformative Ocean Sustainability Narratives to Address Complex Human-Environmental Challenges facing Coastal Fisherwomen: An Evidence-based Study. *Environmental Challenges* 15:100923.

Nyiawung, R. A., Bennett, N. J., and Loring, P. A. (2023) Understanding Change, Complexities, and Governability Challenges in Small-Scale Fisheries: A Case Study of Limbe, Cameroon, Central Africa. *Maritime Studies*

22(1):7.

Oosterveer, P. (2008) Governing Global Fish Provisioning: Ownership and Management of Marine Resources. *Ocean & Coastal Management* 51(12):797-805.

Prakash, S., Kumar, T. T. A., Raghavan, R., Rhyne, A., Tlusty, M. F., and Subramoniam, T. (2017) Marine Aquarium Trade in India: Challenges and Opportunities for Conservation and Policy. *Marine Policy* 77:120-129.

Rohe, J., Schlüter, A., and Ferse, S. C. A. (2018) A Gender Lens on Women's Harvesting Activities and Interactions with Local Marine Governance in a South Pacific Fishing Community. *Maritime Studies* 17(2):155-162.

Rubinoff, J. A. (1999) Fishing for Status: Impact of Development on Goa's Fisherwomen. *Women's Studies International Forum* 22(6):631-644.

Sasi, M. B., Sarker, R. A., and Essam, D. L. (2024) A Novel Heuristic Algorithm for Disruption Mitigation in a Global Food Supply Chain. *Computers & Industrial Engineering* 194:110334.

Shea, L. A., Wabnitz, C. C. C., Cheung, W. W. L., Pauly, D., and Sumaila, U. R. (2025) Spatial Distribution of Fishmeal and Fish Oil Factories around the Globe. *Science Advances* 11(17):eadr6921.

Siddiqui, S. A., Singh, S., Bahmid, N. A., and Sasidharan, A. (2024) Applying Innovative Technological Interventions in the Preservation and Packaging of Fresh Seafood Products to Minimize Spoilage: A Systematic Review and Meta-analysis. *Heliyon* 10(8):e29066.

Smith, L. E. D., Khoa, S. N., and Lorenzen, K. (2005) Livelihood Functions of Inland Fisheries: Policy Implications in Developing Countries. *Water Policy* 7(4):359-383.

Sobuj, M. K. A., Rahman, S., and Ali, M. Z. (2024) A Review on Commercially Important Seaweed Resources from the Bangladesh Coast. *Food Chemistry Advances* 4:100655.

Spalding, A. K., Grorud-Colvert, K., Allison, E. H., Amon, D. J., Collin, R., de Vos, A., Friedlander, A. M., Mana'oakamai Johnson, S., Mayorga, J., Paris, C. B., Scott, C., Suman, D. O., Cisneros-Montemayor, A. M., Estradivari, Giron-Nava, A., Gurney, G. G., Harris, J. M., Hicks, C., Mangubhai, S., Micheli, F., Naggea, J., Obura, D., Palacios-Abrantes, J., Pouponneau, A., and Thurber, R. V. (2023) Engaging the Tropical Majority to make Ocean Governance and Science More Equitable and Effective. *npj Ocean Sustainability* 2(1):8.

Suresh, A., Sabu, S. S., Kishore, P., and Panda, S. K. (2025) Non-tariff Measures

and Export of Marine Products from India: Trends and Future Prospects. *Current Science* 128(4):373-380.

Temesgen, M., Getahun, A., and Lemma, B. (2019) Livelihood Functions of Capture Fisheries in Sub-Saharan Africa: Food Security, Nutritional, and Economic Implications. *Reviews in Fisheries Science & Aquaculture* 27(2):215-225.

Thakur, A., Kotiyal, A., and Thoudam, J. (2025) Fruit Peel Waste: A Sustainable Food Source for Fish Culture. *World Development Sustainability* 7: 100234.

Thara, K. (2016) Protecting Caste Livelihoods on the Western Coast of India: An Intersectional Analysis of Udupi's Fisherwomen. *Environment and Urbanization* 28(2):423-436.

Venugopal, V. (2022) Green Processing of Seafood Waste Biomass towards Blue Economy. *Current Research in Environmental Sustainability* 4:100164.

Wamukota, A. W. and McClanahan, T. R. (2017) Global Fish Trade, Prices, and Food Security in an African Coral Reef Fishery. *Coastal Management* 45(2):143-160.

Ward, J. K., Comer, U., and Stone, S. (2018) On Qualifying Qualitative Research: Emerging Perspectives and the "Deer" (Descriptive, Exploratory, Evolutionary, Repeat) Paradigm. *Interchange* 49(1):133-146.

Yi, C. C., Kung, H. M., Chen, Y. H., and Chu, J. (2008) The Importance of Social Context in the Formation of the Value of Children for Adolescents: Social Class and Rural Urban Differences in Taiwan. *Journal of Comparative Family Studies* 39(3):371-392.

Notes to Contributors

Manuscript. Submissions should be clear and concise. Manuscripts will be accepted with the understanding that their contents are unpublished and not being submitted for publication elsewhere. All parts of the manuscript, including the title page, abstract, tables and legends should be typed in English. Allow margins of at least 3cm on all sides of typed pages. Pages must be numbered consecutively throughout the paper.

Title. Must be as brief as possible and consistent with clarity (6 to 12 words). Authors should also supply a shortened version of the title suitable for the running head, not to exceed 50 character spaces.

Author Affiliation. Include the full names of authors, academic and/or professional affiliations and the complete mailing address of the author to whom proofs and correspondence should be sent as well as the address information of all of the authors.

Abstract. Each paper should be summarized in an abstract of not more than 150 words. Avoid abbreviations, diagrams and references to the text.

Key words. Authors must supply three to five keywords or phrases which identify the most important subjects covered by the paper.

Mathematical Notation. Use only essential mathematical notation as it is costly to typeset and may limit readership. Where mathematical notation is essential, keep it simple and in conformance with conventions of the profession.

References. Citations within the text must include the author name(s) and the data in parentheses [i.e., Smith, Jones, and Cutler (1993)]. Use et al. in the text only when four or more authors are cited. Do not use et al. in the references. Alphabetize the reference section and include all text citations. For more information, consult the *Chicago Manual of Style*. Follow these examples:

- **Journal** - Koenig, E. F. (1984) Fisheries Regulation Under Uncertainty: A Dynamic Analysis. *Marine Resource Economics* 1(2):193-208.
- **Book** - Heaps, T. and Helliwll, J. F. (1985) *The Taxation of Natural Resources. Handbook of Public Economics*, Vol. I, Auerback, A. J. and Feldstein, M. (eds.), pp. 21-72. Amsterdam: North-Holland.

Data and Documentation. Data sources, models and estimation procedures are expected to be documented to permit replication by other researchers. Data used in the analyses should be made available to other researchers for replication purposes. Submission of appendices, model documentation and other supporting materials is encouraged to facilitate the review process.

The Ethical Guidelines

Preamble.

The KMI International Journal of Maritime Affairs and Fisheries (hereinafter referred to as the "the journal", www.kmij.org) is a peer-review journal of ocean policy studies and marine data analytics. The journal offers researchers, analysts and policy makers a distinct combination of legal, political, social and economic analyses. The journal covers a range of international, regional and national marine policies; management and regulation of marine activities including fisheries, ports and logistics; marine affairs, which encompasses the topics of marine pollution and conservation as well as the use of marine resources. Editors of the journal are responsible for organizing and keeping guidelines of reviewing and accepting manuscripts submitted to the journal.

1. General rules

- The guidelines describe measures to set up ethics and hinder malpractices in management of the journal.
- The guidelines apply to those who join the publication of the journal.
- The terms are defined as follows.

Forgery implies the behavior of distorting data.

Falsification implies the behavior of twisting the truth of research performance or findings by deforming research findings, processes, devices, etc., artificially transforming or deleting data arbitrarily.

KMI is an initialism for the Korea Maritime Institute.

Plagiarism implies the behavior of borrowing the concepts, research facts, results, etc., of other people without proper references or notations.

Display of unjustified manuscript and paper authors implies the behavior of granting authorship to a person who has not given or made technical or scientific contribution to the content or results of research.

Double publication implies the act of publishing texts identical or similar to two or more academic journals.

Self-plagiarism implies a sort of **Plagiarism** in which an author republishes a previous work entirely or partially without referring to the previous publication.

The guidelines refer to the Ethical Guidelines.

2. Ethical rules for editors

- **Liability of editors:** Editors should be responsible for deciding whether to respect authors' character, independently as scholars, and publish submitted manuscripts and papers.
- **Fairness of paper treatment:** Editors should treat manuscripts and papers fairly on the basis of manuscript and paper quality and the Ethical Guidelines regardless of gender, age, nationality, organization, prejudice, or private relationship.
- **Objectivity of reviewer selection:** Editors should assist the reviewers utilizing their expertise and fair judgment to evaluate submitted manuscripts and papers. Editors should ensure manuscripts and papers evaluated as objectively as possible by avoiding the reviewers who may have an antagonistic or positive bias towards certain authors.
- **Non-exposure of the manuscripts and the paper review process:** Editors should not expose information on authors or submitted manuscripts and papers to persons except reviewers until it is decided whether to publish the manuscripts and papers.

3. Ethical rules for reviewers

- **Honesty and punctuality of manuscript and paper review:** Reviewers editors assigned to assess should evaluate the manuscripts and the papers reliably and give notice of the results to editors within a certain period of time. When considering themselves disqualified for review, reviewers should inform editors of the fact without hesitation.
- **Impartiality of manuscript and paper review:** Reviewers should review the manuscripts and papers evenly in accordance with the objective criteria. The reviewers should not depreciate the manuscripts and the papers without sufficient basis or refuse them for the reason of colliding with their own views or interpretations.
- **Validity of manuscript and paper review:** Reviewers should respect the intellectual tendency of the author. The reviewers should clarify their judgments and explain in detail the reasons for supplementation in an evaluation sheet, if necessary.
- **Confidentiality of review and disallowance of prior citation:** Reviewers should maintain confidentiality of the contents within the manuscripts and the papers. Except when seeking special advice for evaluation, it is recommended that reviewers do not show manuscripts and papers to others or discuss them on any level. Additionally, reviewers should not cite manuscripts and papers without authors' consent before the publication of the journal that includes the manuscripts and the papers.

4. Ethical rules for authors

- **Research wrongdoing:** Authors are not allowed to forge, falsify or pirate manuscripts and papers, or display unreasonable authorship.
- **Double publication:** Authors are not allowed to submit the studies previously published, nor those set to be published, nor those under review to other academic journals or

publications. This principle does not apply to manuscripts and papers presented at research conferences, research reports, dissertations, nor those openly unpublished, etc. In this case, the fact should be notified to editors and readers.

- **Citation:** Academic materials should be cited precisely and along with their clear and distinct sources. Data privately obtained should be cited only after receiving agreement from the person who produced the information. If the writings or ideas of others are cited or borrowed, respectively, the fact must be specified using footnotes.

5. Enforcement guidelines for research ethics

- **Vow of ethics keeping:** Authors who submit their manuscripts and papers to the KMI or are entrusted with manuscript review and paper review will be considered to have pledged to keep these guidelines.
- **Report of ethics violation:** If authors or reviewers have violated research ethics, the editor-in-chief of the journal as a representative of KMI should rectify the problems involving processes or results. If any problem has proved to be a clear violation of research ethics, the case should be assigned to the Ethics Committee of the journal. The editor-in-chief of the journal nominates the Director and four members of the Ethics Committee of the journal.
- **Composition and convocation of the Ethics Committee:** The Director should convene a meeting of the Ethics Committee within 7 working days after the appointment of the Director and the four members. The Director should be the Chair of the Ethics Committee meeting.
- **Request for attending and material submission:** The Ethics Committee may request informer and suspect to submit materials and to attend its meeting. In this case, suspects should accept the request. The very non-acceptance of suspects violates research ethics.
- **Right protection and confidentiality of informer and suspect**: The identities of informer shall not be disclosed to any third person directly or indirectly. Care should be taken lest the suspects' honor or rights should be infringed on until verification is completed on whether they are involved in any wrongdoing.
- **Judgement of the Ethics Committee meeting:** The Ethics Committee meeting can discuss with more than half of the members present and vote on the contents and results with two-thirds of the members or more present.
- **Report of the Ethics Committee meeting:** The Director shall prepare a results report of the Ethics Committee meeting and submit the result to the editor-in-chief of the journal in five working days following the judgement.
- **Notice of the judgement and decision of editor-in-chief to the author:** The editor-in-chief of the journal shall accept the **Judgement of** the Ethics Committee meeting if any prejudice or private interest of the Ethics Committee is not found. The **Judgement of** the Ethics Committee includes ethics violation, measures and sanctions for the ethics violation. The editor-in-chief of the journal shall notice **the judgement of** the Ethics Committee and the final decision of the editor-in-chief **to the author** in five working days after the arrival of the judgement. If the editor-in-chief of the journal finds any prejudice or private interest

of the Ethics Committee, the editor-in-chief re-appoints the Director and four members of the Ethics Committee of the journal.

- **Opposition of the author:** If the author or the information provider of the **ethics violation is not satisfied with the judgement of** the Ethics Committee and the decision of the editor-in-chief, the author or the information provider may file up the objection to the editor-in-chief. In that case, the editor-in-chief shall give notice of the objection to the Director within 7 working days after the filing. The Director shall review the case within 12 working days after notice is given by the editor-in-chief.
- **Measures and sanctions for ethical violations:** The Ethics Committee shall apply measures and sanctions in accordance with the types, contents, and degrees of the intention of ethical violations, such as amendment or prohibition of publication in the journal, cautions or warnings, and restrictions of submission of an article to the journal.

6. Date of Enforcement

The guidelines shall come into effect as of the 29th of May, 2021.