

FISH for the PEOPLE

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Promoting inclusive and adaptive policies
towards resilient and sustainable
small-scale fisheries



Southeast Asian Fisheries Development Center

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Gender integration is vital in achieving sustainable fisheries and resilient aquaculture systems in Southeast Asia, where women compose nearly half of the small-scale workforce but remain underrepresented. While national strategies are committed to inclusive governance, entrenched social norms, gaps in policy implementation, and a lack of sex-disaggregated data persist. Ultimately, integrating gender across the fisheries value chain is a strategic requirement to enhance community welfare and promote food security in the region.

Policy alignment, gender equality, and regional cooperation are essential for achieving sustainable small-scale fisheries in Southeast Asia and South Asia. One such important tool is the FAO's Small-scale Fisheries Guidelines, which have been instrumental in raising awareness and fostering a fairer, more inclusive, and sustainable sector. Integrating these principles into national laws and policies has broadened support for community-based management.

Sustaining inland fisheries in Southeast Asia requires moving beyond top-down regulations toward adaptive governance. The Special Area for Conservation and Fish Refugia (SPEECTRA) model provides a practical framework for this shift, demonstrating that successful resource management depends on flexible, ecosystem-based principles rather than rigid templates, offering a valuable blueprint for regional fisheries cooperation.

Managing multispecies fisheries, in this case the Gulf of Thailand, requires moving beyond single-species frameworks. The GoTFish mechanism shows that transboundary governance can succeed, offering a scalable roadmap for regional organizations to build trust, strengthen ecological resilience, and improve fisheries-dependent livelihoods.

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The case study of the Ban Khlong Tob fishing community in Krabi Province, Thailand, shows the compounding environmental, climatic, and socioeconomic challenges confronting small-scale fisheries. Adaptive responses strengthen community resilience and long-term sustainability. Ultimately, the Ban Khlong Tob experience demonstrates that strong social capital and community-led conservation can foster resilience.

The same challenges confront the indigenous Urak Lawoi people of Thailand's Ban Toh Balew community, where resource depletion and restricted access to traditional fishing grounds threaten long-term food and livelihood security. Policies must move beyond top-down regulation to incorporate participatory co-management, marine habitat restoration, gender-inclusive adaptation strategies, and the formal protection of indigenous rights and cultural heritage.

One of the articles featured in this issue addresses workforce shortages in Thailand's marine fishing sector, highlighting what drives local crews to enter and remain in the industry. Social and individual motivations were cited as the main drivers, with the workplace environment also playing an important role. By drawing on these personal factors and improving onboard working conditions, vessel owners and policymakers can design targeted strategies to attract local workers, resolve labor deficits, and secure the long-term economic sustainability of the industry.

The brushtooth lizardfish is a key commercial marine species caught in the waters of Thailand. Maintaining sustainable harvests of this economically important resource relies on robust stock assessments to prevent overfishing and guide policy decisions. Moving away from traditional production models toward modern state-space Bayesian frameworks, such as JABBA, provides more reliable biomass estimates. Embracing these advanced models ensures data-driven catch limits, providing policymakers with science-based tools to conserve marine resources for long-term sustainability.

Developing JTF Phase 7 underscores an important lesson in project implementation: overcoming initial funding and technical challenges requires cross-departmental collaboration. By establishing measurable, results-based outcomes, project implementers were able to transform planning challenges into execution. These projects now directly empower regional fisheries managers, elevate institutional capacity across , and strengthen sustainable fisheries management across the region.



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Advancing Gender Mainstreaming for Sustainable Fisheries: Insights from Southeast Asia

Jariya Sornkliang, Thanyalak Suasi, and Rattana Tiaye

Keywords: gender mainstreaming, sustainable fisheries, Southeast Asia, SEAFDEC, women's empowerment

Gender integration is essential for achieving sustainable fisheries in Southeast Asia, where women play crucial yet underrecognized roles across the fisheries value chain. This article explores the region's progress and persistent challenges in mainstreaming gender, in alignment with global frameworks such as the SSF Guidelines and the Sustainable Development Goals (SDGs). It underscores the pivotal contribution of regional institutions, notably SEAFDEC, in driving gender-responsive actions through training, research, and tool development. National examples, including women's entrepreneurship in Thailand and leadership initiatives in Vietnam, demonstrate tangible benefits of inclusive approaches. However, critical gaps remain, such as weak policy implementation, entrenched cultural norms, and limited sex-disaggregated data. The article concludes that advancing gender equity in fisheries requires continuous institutional strengthening, improved data systems, and enhanced regional cooperation to empower women as central actors in fostering social justice and ecological resilience within Southeast Asia's fisheries sector.

United Nations Sustainable Development Goals, particularly SDG 5 (Gender Equality) and SDG 14 (Life Below Water), underscore the link between gender empowerment and sustainable use of aquatic resources (United Nations, 2015).

At the regional level, Southeast Asia has taken steps to institutionalize these commitments. The ASEAN Gender Mainstreaming Strategic Framework (2021–2025) provides a foundation for integrating gender considerations across all sectors, including fisheries and aquaculture. The Southeast Asian Fisheries Development Center (SEAFDEC) has likewise embedded gender equality and women's empowerment within its operations, projects, and regional programs through the Code of Ethics and Code of Conduct (2022). Guided by the SEAFDEC Gender Strategy (2019) and the Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030 (RES&POA-2030), SEAFDEC promotes gender mainstreaming as a cross-cutting element in fisheries management and development.

At the national level, many Southeast Asian countries have well promoted and implemented gender policies. For example, Thailand promotes gender equality through the Gender Equality Act of 2015, which serves as a key legal framework to eliminate gender-based discrimination and promote equal opportunities. The implementation of gender-related initiatives, including those in the fisheries sector, is supported by the Department of Fisheries in coordination with the Ministry of Social Development and Human Security. In Indonesia, gender mainstreaming in the marine and fisheries sector is guided by the Ministerial Regulation on Gender Mainstreaming in Marine and Fisheries (2016), implemented by the Ministry of Marine Affairs and Fisheries (MMAF) to ensure gender-responsive policies and practices across the sector. The Philippines advances gender equality through the Magna Carta of Women (2009) and the Gender and Development (GAD) Budget Policy, which mandate gender integration and resource allocation across government agencies, including the Bureau of Fisheries and Aquatic Resources (BFAR), to empower women and promote inclusivity. In Viet Nam, the National Strategy on Gender Equality (2021–2030) outlines long-term objectives to enhance women's participation and leadership in all sectors, including agriculture and fisheries, under the oversight of the Ministry of Agriculture and Rural Development (MARD).

Introduction

Gender plays a vital role in sustaining and strengthening the resilience of fisheries and aquaculture systems across Southeast Asia, where people of all genders engage in harvesting, aquaculture, post-harvest processing, marketing, and community governance. Women are central to household food security, value addition, and the stability of local economies, yet their contributions often remain undervalued due to entrenched norms, unequal access to resources, and limited decision-making power (Harper *et al.*, 2013; Kleiber *et al.*, 2015). Integrating gender perspectives into fisheries and aquaculture is therefore crucial for achieving sustainable livelihoods, food security, and climate resilience. Integrating gender-responsive approaches enhances productivity, innovation, and inclusive governance while empowering women and marginalized groups, strengthens community resilience, and promotes ecological and economic sustainability (FAO, 2023; Weeratunge *et al.*, 2010).

Global and regional frameworks reinforce these principles. The FAO Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries (SSF Guidelines) highlight gender equity as a guiding principle, advocating the full participation of women and marginalized groups in all aspects of fisheries development and governance (FAO, 2015). Similarly, the

Gender Mainstreaming in Fisheries

Gender mainstreaming in fisheries is a strategy to integrate the perspectives of women and men into the design, implementation, monitoring, and evaluation of policies and programs, ensuring equality and preventing disparities.

Box 1 provides the terminology of gender, core principles, and concepts of gender mainstreaming. It promotes inclusive fisheries by addressing barriers faced by women and marginalized groups, enhancing their visibility and participation along the value chain from harvesting and processing to governance and trade (SEAFDEC, 2018). Recognizing gender as both a social construct and a power dynamic that shapes access to resources, opportunities, and decision-making (ILO, 2000; FAO, 2013), gender mainstreaming seeks to achieve equality by systematically analyzing the roles, needs, and constraints of all actors throughout the fisheries value chain.

Box 1. Core principles and concepts of gender mainstreaming (SEAFDEC, 2018)

The principles of gender mainstreaming, as derived from SEAFDEC Fish for the People (Special Publication): Gender Mainstreaming in Fisheries and Aquaculture in Southeast Asia, include:

- 1. Integration, Not Separation:** It is not about creating separate programs for women but about integrating a gender perspective into all existing policies, programs, and projects at every stage of the development cycle (Satapornvanit, 2018, p. 11).
- 2. A Strategy for Equality:** The ultimate goal is to achieve gender equality, ensuring that women and men benefit equally from development initiatives and that existing inequalities are not reinforced (Sornkliang *et al.*, 2018).
- 3. Foundational First Step: Gender Analysis:** Mainstreaming requires a gender analysis, which is “a process of gathering and analyzing sex-disaggregated information to understand gender differences and to identify major issues that contribute to gender inequalities” (Satapornvanit, 2018, p. 11). This analysis examines the differences in the roles, norms, power levels, needs, and constraints of women and men (Sornkliang *et al.*, 2018).
- 4. Equity as a Means to Equality:** The document distinguishes between gender equality and gender equity. Equality is the end goal, while equity is the “fair allocation of resources, programs, opportunities, and decision-making to both women and men,” which may require compensatory measures to address historical and social disadvantages (Satapornvanit, 2018, p. 11).
- 5. Holistic Scope:** The approach should be applied across the entire fisheries value chain “from input supply to production (capture fisheries and aquaculture farming), processing, wholesale, and finally retail” and not just in isolated segments (Sornkliang *et al.*, 2018, p. 17).

Current Status and Regional Insights

Women play indispensable roles across Southeast Asia’s fisheries and aquaculture value chains, from harvesting and aquaculture production to post-harvest processing, marketing, and community resource management. They



Figure 1. Participants in the *Regional Workshop on Gender Mainstreaming in Fisheries in Southeast Asia*, held on 8–10 October 2024 at SEAFDEC/TD

constitute nearly half of the small-scale fisheries workforce (World Bank, 2012); however, their contributions remain undervalued and underrepresented in data and policy. Recognizing gender as a key factor in resource management, food security, and value addition underscores the need to integrate gender perspectives into fisheries governance for greater sustainability and inclusiveness (WorldFish Center, 2010; Kusakabe, 2017).

Overview of Women’s Roles in the Fishery Sector for Sustainable Fisheries

The status and regional insights were extracted from the “Regional Workshop on Gender Mainstreaming in Fisheries in Southeast Asia” held on 8–10 October 2024. Organized by SEAFDEC with support from the Japanese Trust Fund (JTF), the workshop underscored the importance of gender equality and was attended by 31 participants (26 women and 5 men) from SEAFDEC Member Countries, regional organizations, and academic institutions. The workshop featured presentations, group discussions, and case studies to share best practices and propose recommendations. Drawing on country reports, partner inputs, and plenary sessions, participants identified gaps, challenges, and success stories in gender mainstreaming, emphasizing the crucial roles of women in small-scale fisheries, particularly in post-harvest activities, marketing, decision-making, and community resilience (SEAFDEC, 2024).

Insights from the workshop highlighted persistent gender-based divisions of labor across Member Countries. Women are predominantly engaged in processing, marketing, aquaculture, and support activities, while men dominate offshore fishing and primary production. In Brunei Darussalam and Malaysia, women focus largely on processing and local market roles. In Cambodia, Myanmar, and the Philippines, women face persistent barriers to resources but are increasingly supported through capacity-building and post-harvest programs. Indonesia and Thailand show strong female participation in aquaculture and small-scale fisheries, though decision-making remains male-dominated. In the Lao PDR, women contribute significantly

through reservoir-based groups and local leadership, while Viet Nam has promoted women's economic and leadership roles through national programs.

Despite these efforts, women's work, especially in informal and post-harvest sectors, continues to be undervalued. Addressing this imbalance through inclusive policies, gender-responsive data collection, and recognition of women's roles is crucial to achieving equitable and sustainable fisheries development in the region. **Box 2** summarizes the country presentations on the Gender in Fisheries Project/Program.

Box 2. Diverse approaches to gender mainstreaming highlighted in country presentations

- **Brunei Darussalam:** Focused on capacity-building programs and promoting gender equality through educational initiatives. Challenges included a lack of sex-disaggregated data.
- **Cambodia:** Implemented policies such as the Gender Mainstreaming Action Plan, but faced obstacles like insufficient training opportunities and social discrimination.
- **Indonesia:** Promoted women's empowerment through initiatives like fish farmer groups and seaweed cultivation models while addressing issues like limited access to resources.
- **Lao PDR:** Increased women's participation in development strategies and decision-making positions but encountered cultural barriers.
- **Malaysia:** Encouraged women's roles in fish processing and marketing through community fisheries and entrepreneurship programs, contributing to local economic growth.
- **Myanmar:** Addressed gender dimensions in fisheries value chains but faced challenges related to limited access to resources and financial services for women.
- **Philippines:** Leveraged legal frameworks like the Magna Carta of Women to empower female fisherfolk but struggled with unequal resource access and representation.
- **Thailand:** Implemented the Gender Equality Act and promoted women's economic empowerment but noted low representation in decision-making roles.
- **Viet Nam:** Advanced women's participation in fisheries through laws and national programs but faced persistent traditional gender roles and economic barriers.

SEAFDEC Initiatives on Gender Mainstreaming

SEAFDEC has strengthened gender mainstreaming in fisheries through multiple complementary approaches. Capacity-building activities have enhanced knowledge and understanding among fisheries officers and stakeholders, while practical tools and guidelines support planning, implementation, and project monitoring. Research initiatives have incorporated gender analysis to highlight the roles, constraints, and opportunities of women and men in fisheries and aquaculture. These efforts are reinforced by regional collaboration and knowledge sharing with partners such as FAO, USAID, and Gender in Aquaculture and Fisheries (GAF), promoting best practices, harmonized approaches, and inclusive fisheries governance across Southeast Asia.

Enhanced Knowledge and Understanding of Gender Mainstreaming in Fisheries

Capacity building, executed through targeted training sessions and workshops, was a key strategy used to strengthen gender mainstreaming knowledge among ASEAN Member States (AMSs). The primary objective was to raise awareness and enhance the ability of fisheries officers and stakeholders to integrate gender perspectives into their work. This was achieved through a series of activities, including a regional training in Thailand (2022) and subsequent national workshops in Indonesia, Malaysia, Cambodia, and Viet Nam (2022–2023). These initiatives introduced practical concepts such as gender analysis frameworks, gender-responsive project design, and tools for assessing women's roles in value chains. As a result, participants from the ten AMSs have deepened their appreciation for gender-balanced participation and enhanced their capacity to identify gender gaps, integrate gender perspectives into national programs, and generate evidence-based recommendations. This strengthened capacity has directly contributed to more gender-responsive national planning, project activities, and a greater awareness of the value of women and youth in the sector.

Development of Tools and Guidelines for Gender Integration

To support the practical application of gender perspectives, the initiative focused on the development of dedicated tools and guidelines for gender integration. This involved creating gender-responsive manuals, training modules, and analytical tools to aid the planning, implementation, and monitoring of fisheries projects. Key outputs from this effort include the gender integration in fisheries guidelines and the “Training Module on Gender Mainstreaming in the Fisheries Sector” (SEAFDEC, 2022), which provides stakeholders with essential resources for operationalizing gender mainstreaming.



Figure 2. Publications developed by SEAFDEC in collaboration with its partners to guide the process of gender integration in fisheries

SEAFDEC has supported the development and dissemination of tools and guidelines that help integrate gender perspectives into fisheries policies, operations, and community-level initiatives. Existing tools from SEAFDEC and partners include the “Practical Guide for Gender Analysis in Small-scale Fisheries and Aquaculture in Southeast Asia” (SEAFDEC, 2020), “Gender Analysis Toolkit” for coastal management practitioners (MFF, SEI, and SEAFDEC, 2018) and “Gender

Research in Fisheries and Aquaculture” (SEAFDEC and USAID Ocean, 2018) for mainstreaming gender in project planning and monitoring, and reference materials that clarify gender concepts within the context of the small-scale fisheries sector. These publications provide step-by-step approaches that national agencies, researchers, and community practitioners can apply to conduct gender-responsive assessments, design interventions, and track gender outcomes.

Gender Integration in SEAFDEC Research Projects

A cornerstone of SEAFDEC’s approach has been the integration of gender analysis and participatory methods into its regional research and pilot initiatives. This strategic focus aims to develop a deeper, evidence-based understanding of gender roles, constraints, and opportunities within the fisheries sector. This commitment has been demonstrated through a series of key projects, including the long-running SEAFDEC–Sweden Project (2008–2019), the focused Gender Dimension in the Value Chain Project (2020–2022), and the Small-scale Fisheries Management for Better Livelihood and Fisheries Resources Project (2020–2024) under the Japanese Trust Fund (JTF). These initiatives have been instrumental in generating critical insights and advancing gender-responsive practices as documented in SEAFDEC’s publications. **Box 3** shows the SEAFDEC with a partner in conducting the gender analysis for the initiation of gender responsiveness.

Box 3. SEAFDEC and partner efforts on research and gender integration

SEAFDEC Sweden project: Conducted gender analyses in small-scale fisheries communities across Cambodia, Myanmar, and Thailand, documenting gender roles, labor division, and access to resources in capture and post-harvest activities, revealing women’s significant involvement in processing and marketing but limited representation in leadership, and resulting in gender-sensitive community fisheries guidelines and national gender training for fisheries officers.

USAID Oceans and Fisheries Partnership: The research on tuna value chains in the Philippines and Indonesia revealed that women dominate low-paid processing jobs with limited influence in management or market access, face barriers to participating in digital traceability systems, and prompted the development of Gender Action Plans alongside livelihood and digital-skills training for women.

FAO-SEAFDEC Collaboration: The study on the gender dimension in the value chain of small-scale fisheries and aquaculture in Southeast Asia (Lao PDR, Myanmar, Philippines, and Thailand under SEAFDEC-FAO revealed that women play critical roles across post-harvest, processing, and marketing activities but face limited access to resources, decision-making, and market opportunities, highlighting the need for targeted interventions to promote gender equity and women’s economic empowerment.

SEAFDEC JTF: The Small-scale Fisheries Management for Better Livelihood and Fisheries Resources supports the study on gender integration in fisheries in Thailand, which focuses on small-scale marine and inland fisheries management, with a specific focus on women as group leaders, found that women leaders credit their success to high levels of community participation and the respect they have earned through their education and family backgrounds.

Gender Mainstreaming in Southeast Asia: Good Practices

Good practices of gender mainstreaming in Southeast Asia have emerged through initiatives by SEAFDEC Member Countries, development partners, academic institutions, and NGOs, demonstrating that gender-responsive approaches strengthen fisheries management and improve community well-being. FAO, guided by its Gender Equality Policy (2020–2030), has empowered women in small-scale fisheries in the Philippines, enhancing participation in decision-making and livelihood activities, which increased incomes and household resilience. Sustainable Fish Asia Technical Support (USAID/SUFiA TS), funded by the Regional Development Mission Asia of the U.S. Agency for International Development (USAID’s RDMA) from 2020 to 2024, introduced innovative models such as Gender Equality Hubs and fisher empowerment programs to address cultural norms, promote women’s leadership, and expand skills development, resulting in stronger community engagement and access to economic opportunities. Academic institutions, including Mahidol University and the University of Tokyo, have contributed to integrating gender in fisheries management and highlighting women’s roles in cooperatives. NGOs have advocated for gender-sensitive policies, delivered capacity-building programs, and promoted ecosystem-based management, enhancing women’s resilience and contributions to sustainable fisheries.

Across SEAFDEC Member Countries, progress has been uneven, characterized by notable accomplishments and persistent challenges:

- **Brunei Darussalam:** focused on education but lacks sex-disaggregated data
- **Cambodia:** implemented gender action plans but faces training gaps
- **Indonesia:** promoted empowerment via farmer groups and seaweed cultivation, yet resource access remains limited
- **Lao PDR:** increased women’s participation in reservoir fisheries, but remains constrained by cultural norms
- **Malaysia:** strengthened women’s roles in processing and marketing through the MyAP and MyKP programs
- **Myanmar:** integrated gender in value chains but resource and financial access remain challenges
- **Philippines:** advanced legal and institutional support, though leadership gaps persist
- **Thailand:** promoted participation under the Gender Equality Act, yet decision-making representation is low
- **Viet Nam:** expanded women’s entrepreneurship via Project 939, with persistent traditional norms and inequality

Table 1. Good practices of gender mainstreaming in Southeast Asian countries and partners (SEAFDEC, 2024)

Country / Organization	Case Study / Initiative	Key Actions and Results	Lessons Learned / Success Factors
FAO (Philippines)	<i>Empowering Women in Small-Scale Fisheries</i>	Integrated gender in project planning; promoted women-friendly technologies; strengthened women's leadership.	Inclusive and gender-responsive approaches increase productivity and equity.
USAID SuFiA TS (Regional)	<i>Gender Equality Hubs & Fisher Empowerment Programs</i>	Built capacity, promoted women's leadership, and supported marginalized groups.	Institutional commitment and mentoring enhance gender inclusion in fisheries governance.
Cambodia	<i>CAPFISH Post-Harvest Programme</i>	Ensured equal participation of women and men in post-harvest value chains; offered business training.	Targeted support and enabling policies promote equitable benefits and participation.
Indonesia	<i>Smart Fisheries Villages & Seaweed Cultivation Models</i>	Promoted women's roles in aquaculture and income diversification.	Gender-inclusive community models strengthen livelihoods and empowerment.
Lao PDR	<i>Women's Groups in Nam Ngum & Nam Xouang Reservoirs</i>	Organized women's groups to engage in fisheries and income activities.	Collective action improves women's income and social standing.
Malaysia	<i>MyAP and MyKP Fisheries Programs</i>	Provided grants, training, and equipment for both women and men; promoted women's role in processing and marketing.	Economic inclusion of women drives local growth and job creation.
Myanmar	<i>Gender Dimension in Fisheries Value Chain Study</i>	Conducted gender analysis and capacity-building in collaboration with SEAFDEC and FAO.	Gender-disaggregated data supports evidence-based policy and intervention.
Philippines (BFAR)	<i>Implementation of the Magna Carta of Women in Fisheries</i>	Strengthened legal protection, provided training, and expanded market access for fisherwomen.	Strong legal frameworks and institutional backing reduce gender disparities.
Thailand	<i>Gender Equality Promotion Plan (2025-2027)</i>	Increased women's roles in SMEs and local fisheries committees.	Policy implementation must translate into leadership opportunities for women.
Viet Nam	<i>Project 939 - Supporting Women in Business (2021-2030)</i>	Enhanced women's leadership, credit access, and training in fisheries.	Sustained policy and financial support drive long-term gender equity.
Japan	<i>Women's Groups in Fisheries Cooperatives</i>	Established cooperative women's groups; developed leadership and capacity.	Empowered cooperatives enhance community resilience and resource stewardship.

Collectively, these initiatives show strong regional commitment to gender equality while highlighting the need for better data, inclusive policies, and ongoing capacity-building to fully realize women's contributions to fisheries development (SEAFDEC, 2024).

Challenges/Gaps

Despite these advancements, gaps remain in achieving consistent and effective gender mainstreaming across the region. One major challenge is the uneven implementation capacity among AMSs, particularly in data collection and institutional coordination. Many countries still lack sex-disaggregated data and gender analysis frameworks specific to the fisheries sector, which limits evidence-based policy design and evaluation (SEAFDEC, 2024). Cultural and

social norms continue to restrict women's participation in decision-making, especially in small-scale fisheries communities where traditional gender roles prevail. While policy frameworks exist, enforcement mechanisms and local-level integration often remain weak due to limited funding, insufficient technical expertise, and the absence of gender focal points in fisheries departments. Furthermore, policy fragmentation between gender agencies and fisheries ministries hampers the mainstreaming process. In several AMSs, gender policies are managed by ministries outside the fisheries sector, resulting in limited coordination and sector-specific adaptation. Without clear institutional linkages, gender mainstreaming risks being treated as a stand-alone activity rather than a cross-sectoral development principle. **Box 4** shows the conclusion of the common challenge in Southeast Asia.

Box 4. Persistent gender mainstreaming challenges across Southeast Asia (SEAFDEC, 2024)

- Limited gender-disaggregated data and weak monitoring systems
- Insufficient financial and technical resources for gender implementation
- Persistent gender norms that restrict women's mobility and participation in leadership
- Weak institutional capacity and low prioritization of gender at local governance levels
- Inconsistent integration of gender perspectives into national fisheries statistics and management frameworks

Opportunities

To strengthen regional coherence in gender-responsive fisheries governance, SEAFDEC can harmonize its Gender Strategy with the ASEAN Gender Mainstreaming Strategic Framework (2021–2025) to ensure consistent policy alignment across Member States (ASEAN, 2021). Institutionalizing capacity building by integrating gender training for fisheries officers and policymakers through SEAFDEC's Regional Capacity Building Network (RECAB) can be the initial step toward inclusive fisheries management. A unified Regional Gender and Fisheries Data Framework is also essential for systematic collection, analysis, and sharing of sex-disaggregated data, supporting evidence-based decision-making and reporting on SDG 5 and SDG 14 (FAO, 2017; UN Women, 2020). Strengthened institutional coordination is recommended through joint working groups linking gender ministries, fisheries departments, and regional bodies such as ASEAN, SEAFDEC, and FAO. Enhanced knowledge sharing, including documentation of women's cooperatives, co-management models, and gender-responsive budgeting, would amplify successful practices across the region.

Moreover, there is a clear direction toward mainstreaming gender perspectives in current SEAFDEC projects with various partners. Examples include the Gender Action Plan under the Blue Horizon: Ocean Relief through Seaweed Aquaculture initiative; the Japanese Trust Fund 7 project on improving fishers' livelihoods and co-management in small-scale fisheries, which aims to ensure equitable benefits for both women and men in fishing communities; the Bay of Bengal Large Marine Ecosystems Phase II (BOBLME II) program, which commits to integrating gender equity and social inclusion; and the Gender Strategy developed under the GoTFish Project on promoting the blue economy and strengthening fisheries governance in the Gulf of Thailand.

Finally, AMSs are encouraged to integrate gender-responsive budgeting within fisheries programs and allocate dedicated financial resources to support gender inclusion and women's economic empowerment (UN ESCAP, 2019).

Recommendations and Way Forward

The article focuses on advancing gender mainstreaming, which requires a multi-level strategy across organizational, agency, and project tiers.

Key strategies for advancing gender mainstreaming in the fisheries sector include strengthening institutional structures by embedding gender considerations into organizational mandates, policies, budgets, and accountability mechanisms. Continuous capacity development is also essential, with regular training provided to fisheries officers, policymakers, and community leaders on GESI analysis and gender-responsive planning. To support evidence-based decision-making, regional gender databases and monitoring systems should be established to track progress through relevant indicators. Policy integration further enhances effectiveness by aligning international frameworks such as the SSF Guidelines and the Sustainable Development Goals with national gender equality legislation and fisheries policies. In addition, documenting and sharing good practices, success stories, and lessons learned through regional platforms promotes wider adoption of successful approaches. Finally, enhancing partnerships with development organizations such as the FAO, GAF, universities, and various NGOs helps leverage technical expertise and financial resources to support sustainable, long-term gender-responsive fisheries development.

Future Role of SEAFDEC

Building on its mandate to promote sustainable fisheries development, SEAFDEC will continue to play a central role in supporting AMSs to strengthen gender equality and social inclusion within the fisheries sector. Moving forward, SEAFDEC will facilitate regional dialogues that foster shared understanding and coordinated action on gender-responsive fisheries governance, while also providing technical assistance to help countries integrate gender considerations into fisheries management plans and national programs.

The organization will expand its coordination of capacity-building initiatives and lead the development of regional guidelines that support consistent and practical approaches to gender mainstreaming. In addition, SEAFDEC will promote stronger cross-sectoral collaboration by linking fisheries with environmental and social development sectors to address gender issues more holistically. To ensure accountability and sustained progress, SEAFDEC will continue monitoring and reporting gender-related outcomes to the SEAFDEC Council and relevant ASEAN mechanisms, positioning gender integration as a key component of its future work and regional leadership (Figure 3).



Figure 3. Group discussion during the regional workshop on gender mainstreaming in fisheries in Southeast Asia on 8-10 October 2024

Conclusion

Gender mainstreaming in fisheries and aquaculture across Southeast Asia has emerged as a transformative pathway toward inclusive, resilient, and sustainable development. The collective efforts of AMSs, guided by frameworks such as the FAO SSF Guidelines, the ASEAN Gender Mainstreaming Strategic Framework (2021–2025), and SEAFDEC’s Gender Strategy, have laid a strong foundation for promoting gender equality and women’s empowerment within the sector. These initiatives have enhanced women’s visibility, strengthened their participation in value chains, and advanced equitable access to resources, decision-making, and livelihood opportunities. However, persistent challenges such as limited sex-disaggregated data, weak institutional coordination, and enduring social norms continue to constrain full gender integration at national and community levels.

Moving forward, harmonizing regional and national policies, institutionalizing gender-responsive budgeting, and investing in capacity development are critical for sustaining progress. Building comprehensive data systems and monitoring frameworks will enable evidence-based policy formulation and accountability. Regional cooperation through SEAFDEC and ASEAN can further facilitate

knowledge sharing, innovation, and policy coherence, ensuring that gender equality becomes an integral component of fisheries governance.

Ultimately, empowering women in fisheries is not only a matter of social justice but also a driver of ecological sustainability and economic resilience. By recognizing and amplifying women’s roles in resource management, value addition, and community leadership, Southeast Asia can foster more inclusive and adaptive fisheries systems. Strengthening gender mainstreaming will therefore remain essential to achieving sustainable livelihoods, food security, and the broader development goals envisioned under the SDGs and regional commitments.

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Evaluating the Implementation and Impact of FAO's Voluntary Guidelines for Securing Sustainable Small-scale Fisheries in Southeast Asia and South Asia: Challenges, Progress, and Pathways Forward

Rattana Tiaye, Thanyalak Suasi, and Jariya Sornkliang

Keywords: small-scale fisheries, community-based fisheries management, monitoring, evaluation and learning

Small-scale fisheries is vital to Asia, providing livelihoods for over 46 million people and contributing nearly half of the region's capture fisheries production (FAO, 2025). Beyond their economic value, small-scale fisheries support food security, nutrition, cultural identity, and social cohesion, especially in coastal and inland communities where alternative livelihoods are limited. Recognizing both their contributions and vulnerabilities, the Food and Agriculture Organization (FAO) endorsed the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries (SSF Guidelines) in 2014, the first global instrument dedicated to small-scale fisheries. The Guidelines focus on fairness, making sure fishers have secure livelihoods, equitable access to resources, gender equality, and social inclusion (FAO, 2015a).

The SSF Guidelines provide practical guidance for governments, civil society, and fishing communities, influencing policies, legal reforms, and capacity-building efforts (FAO, 2015a). Although voluntary, they are increasingly seen as a moral and political commitment in the face of climate change and socioeconomic challenges (Jentoft, 2017). In Southeast Asia, organizations like the Southeast Asian Fisheries Development Center (SEAFDEC) and the ASEAN's Sectoral Working Group on Fisheries (ASWGF) have helped countries integrate small-scale fisheries principles through regional platforms, co-management pilots, and gender mainstreaming efforts. Countries such as Thailand, Indonesia, and the Philippines have embedded these principles in their national strategies. Notably, in 2024, the Philippines became the first country in Asia to adopt a formal National Plan of Action for Small-scale Fisheries (NPOA-SSF) (FAO, 2024). In South Asia, countries like India, Sri Lanka, and Bangladesh have revised policies and legal frameworks to align with the SSF Guidelines, focusing on tenure rights, ecosystem-based management, and supporting vulnerable groups. However, they face challenges including weak enforcement, policy fragmentation, and limited investment in small-scale fisheries-specific programs. Despite progress, these constraints highlight the need for more integrated and well-supported implementation.

To mark the 10th anniversary of the SSF Guidelines, a Regional Small-scale Fisheries Workshop was held in March 2025 in Bangkok, Thailand. Co-organized by the FAO and SEAFDEC, the event brought together representatives from 13 countries, regional partners, and civil society organizations. The workshop aimed to assess implementation progress, identify challenges and good practices, and chart a course for the future. It emphasized the importance of regional collaboration, policy alignment, and stakeholder engagement to ensure that small-scale fisheries communities in Asia can thrive sustainably over the next decade.

Conceptual Framework for Sustainable Small-scale Fisheries in Southeast Asia and South Asia

From the workshop, it was found that there are key factors that directly impact the achievement of sustainable development and management of small-scale fisheries in the Asia region, particularly in areas of governance, economic viability, social inclusion, environmental resilience, and regional cooperation. The conceptual framework, including key factors and mechanisms presented in **Figure 1**, was developed through a synthesis of deliberations and case studies shared during the workshop. This framework deliberately integrated social inclusion, climate resilience, and regional cooperation as equally important pillars of sustainability.

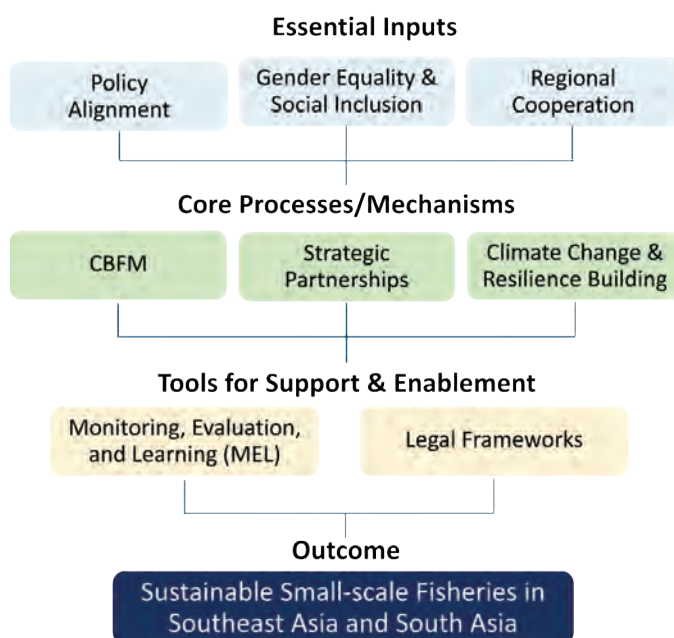


Figure 1. Conceptual framework for Sustainable Small-scale Fisheries in Southeast Asia and South Asia

Essential Inputs

The essential inputs for achieving sustainable small-scale fisheries in Southeast Asia and South Asia encompass key factors such as policy alignment, gender equality, and regional cooperation. These factors pave the way to integrate an inclusive fisheries governance that reflects the holistic vision of the SSF Guidelines. Policy alignment, for instance, involves not only incorporating environmental sustainability into national fisheries strategies but also embedding social dimensions such as tenure rights, participation, and equity, elements that have historically been underemphasized. Gender equality and social inclusion are equally vital, with growing recognition that empowering women and marginalized groups in fisheries governance leads to more resilient and equitable outcomes. At the regional level, cooperation among countries and institutions, such as through SEAFDEC and ASEAN platforms, supports the harmonization of efforts and addresses shared challenges such as IUU fishing, climate impacts, and legal reform.

Policy Alignment

The adoption of the SSF Guidelines by Asian nations has led to increased policy engagement, particularly in the integration of community-based management and environmental conservation into national fisheries development plans (**Box 1**). Countries such as Thailand and Indonesia have made notable progress in this area, reflecting a growing recognition of the value of inclusive and sustainable fisheries governance (Jentoft, 2017). However, this policy alignment remains uneven. While environmental components of the SSF Guidelines are relatively well integrated into national strategies, cross-cutting social dimensions, such as gender equality, tenure rights, and participation, are often addressed as secondary considerations. These issues may appear in broader social or environmental policies but are rarely centered within fisheries-specific strategies.

This shows a common problem where fisheries policies have mainly focused on increasing production, enforcing rules, and utilizing resources, without considering other important issues. This means the broader goals of the SSF Guidelines (fairness, equity, and sustainability) are not fully included in national fisheries policies.

To address this, governments must go beyond technical or environmental aspects and work toward the systematic inclusion of social and rights-based principles in fisheries policy. Countries should develop national or regional plans that bring fisheries policies in line with the SSF Guidelines.

Such plans should not only promote inter-agency coordination but also embed inclusivity and equity at the core of fisheries governance.

Box 1. Progress in policy alignment with SSF Guidelines

SEAFDEC Training Department (SEAFDEC/TD) collaborated with the Bay of Bengal Programme Inter-Governmental Organization (BOBP-IGO) to organize the “Regional Training on Enhancing Capacity for MCS of Domestic and international Fishing vessels to Combat IUU Fishing” in November 2024 under the FAO Project Bay of Bengal Large Marine Ecosystem Phase II. The training brought together fisheries officials from Bangladesh, India, Indonesia, Malaysia, Maldives, Sri Lanka, and Thailand to strengthen their understanding and implementation of updated MCS protocols. These protocols were developed in response to recent legal reforms aimed at combating IUU fishing and reflect a shift toward more integrated and rights-based fisheries management. By aligning national MCS practices with the SSF Guidelines, the training not only improved technical capacity but also fostered greater regional cooperation and policy coherence.

Gender Equality and Social Inclusion

One of the most transformative aspects of the SSF Guidelines is their explicit emphasis on gender equality and the inclusion of marginalized groups in fisheries governance. However, many South and Southeast Asian countries lack the gender-disaggregated data and policy tools needed to operationalize these principles. Although women make up a significant share of small-scale fisheries workers, especially in post-harvest processing, they are routinely excluded from formal decision-making structures, co-management committees, and access to resources.

This exclusion reflects both cultural norms and institutional issues within fisheries governance systems. In many cases, traditional gender roles and a lack of policy awareness among fisheries officials combine to reinforce the invisibility of women in the sector. This lack of recognition limits the potential benefits of involving women, such as stronger community resilience and fairness. The justification for integrating gender more robustly into small-scale fisheries governance is thus rooted in moral and developmental logic: inclusive participation leads to better outcomes (Chambon *et al.*, 2024). Building on the pathways identified by recent gender research in small-scale fisheries, governments and Non-Government Organizations (NGOs) need to invest in awareness raising, leadership development for women, gender-sensitive data systems, and inclusive governance mechanisms (Rice *et al.*, 2024). Additionally, programs that involve women directly in research and monitoring can give them a stronger voice in fisheries policy (**Box 2**).

Box 2. A workshop on gender equality and social inclusion

Co-hosted by SEAFDEC and Australia's Department of Agriculture, Fisheries and Forestry (DAFF), the Women in Fisheries Workshop was held in Bangkok, Thailand in May 2024 under the ASEAN RPOA-IUU program. It has shown how policy alignment and targeted capacity building can lead to concrete progress on gender equality in small-scale fisheries. These efforts have helped fisheries officers across ASEAN countries develop gender-sensitive action plans, strengthen women's roles in fisheries governance, and initiate regional networks for collaboration. Such outcomes demonstrate that when gender equity is prioritized through institutional support and training, it can shift both practices and mindsets, advancing the inclusive principles of the SSF Guidelines.

Box 3. Existing regional cooperation

Regional cooperation, driven by SEAFDEC, FAO RAP, ASEAN and partners, has translated policy alignment into practical results: enhanced market access, shared fisheries databases, regional traceability systems, streamlined Port State Measures, and harmonized management plans for migratory stocks. Through participatory workshops, strategic partnerships, and Regional Plans of Action, countries have pooled expertise, standardized tools, and implemented coordinated measures, demonstrating that cross-border collaboration is essential for tangible progress on IUU fishing, trade, resource sustainability, and small-scale fisheries resilience.

Regional Cooperation

Regional cooperation has been a key factor in advancing the implementation of the SSF Guidelines across Asia. Organizations such as SEAFDEC, FAO Regional Office for Asia and the Pacific (FAO RAP), and the ASEAN Secretariat have played central roles in facilitating knowledge exchange, regional dialogues, and technical assistance that support the development of both National and Regional Plans of Action (NPOAs and RPOAs). Through the workshops, countries shared experiences, align practices, and adopted common tools, particularly in tackling shared challenges such as fisheries related legal reform, climate change, and inclusive governance.

The results of these efforts show that collaboration at the regional level can assist countries to move forward faster, especially when facing common environmental and socioeconomic pressures. Regional cooperation is vital for shared problems such as IUU fishing, migratory fish stocks, and marine pollution, which no single country can solve alone (FAO, 2015b).

Nonetheless, gaps remain in sustained financing, the development of shared monitoring indicators, and the systematic inclusion of fisher organizations in regional decision-making processes, which continue to limit the depth and long-term effectiveness of regional collaboration.

To strengthen this momentum, there is a need for enhanced investment in regional platforms for small-scale fisheries coordination, including the development of shared monitoring indicators and the alignment of regional trade and conservation policies with the SSF Guidelines. Effective cooperation should also bring together diverse actors, including fisher organizations, academic institutions, and development partners, to build a more integrated and resilient regional fisheries governance system (**Box 3**).

Core Processes/Mechanisms

The key factors are operationalized through a range of processes/mechanisms. Community-based fisheries management (CBFM) is a participatory model that empowers local communities to steward their own resources. This often results in improved compliance and conservation outcomes. Strategic partnerships connect fisher organizations, governments, academia, and development partners. These partnerships support multi-sectoral collaboration and knowledge sharing to address complex and transboundary issues. Additionally, climate resilience measures are also increasingly important as coastal communities face growing climate threats. These measures include ecosystem-based approaches, early warning systems, and community-led adaptation planning.

Community-based Fisheries Management (CBFM)

CBFM has emerged as a promising model for operationalizing a participatory management process involving resource users, government agencies and institutions, an approach consistent with the principles outlined in the SSF Guidelines and aligned with the co-management framework (Jentoft *et al.*, 1998). Countries like Cambodia, with its Community Fisheries (CFi) model, and Indonesia, through co-management in anchovy fisheries, have demonstrated how locally governed systems can lead to better compliance, stronger social cohesion, and improved conservation outcomes. These initiatives demonstrate strong community buy-in and practical innovation, particularly when external support is aligned with local customs and governance systems. Gender equality plays a reinforcing role in these outcomes: inclusive CBFM arrangements that recognize women's roles across fisheries value chains tend to be more equitable, legitimate, and adaptive, thereby strengthening both social and ecological resilience. An example of a successful CBFM implementation is shown in **Box 4**.

This shows that giving more responsibility to local communities is an effective way to manage fisheries sustainably. However, scaling up CBFM remains a key challenge (Steenbergen *et al.*, 2022). Many pilot projects still face limitations such as insufficient funding, weak institutional support, and lack of policy recognition. There are two main reasons why scaling up CBFM is important: first, it supports the rights-based principles of the SSF Guidelines; and second, it strengthens the adaptive capacity of local communities.

To support this expansion, national governments should institutionalize CBFM through formal policy recognition, dedicated budgets, and integration into broader fisheries management plans. Capacity building should help both local fishers and officials, including skills for collaboration and conflict resolution.

Box 4. A CBFM success story

Ban Nai Nang, a coastal village in Krabi Province, Thailand, has established a well-organized community fisheries group that plays a central role in managing mangrove conservation, regulating local fishing practices, and promoting sustainable livelihoods. Through strong collaboration with government agencies, NGOs, and regional bodies, the community has developed locally agreed-upon fishing rules, reforested degraded mangrove areas, and implemented participatory monitoring systems such as the electronic ASEAN Catch Documentation Scheme (eACDS) to enhance traceability and transparency in small-scale fisheries. This locally driven approach has led to increased fish stocks, strengthened community cohesion, and improved income from eco-tourism activities linked to mangrove conservation. The success of Ban Nai Nang demonstrates how aligning external support with local knowledge, customs, and governance structures can lead to effective and enduring outcomes, reinforcing the importance of scaling up CBFM as a pathway toward rights-based and resilient small-scale fisheries governance.

Strategic Partnerships

Strategic collaboration among fisher organizations, academic institutions, development agencies, and regional bodies support the implementation of the SSF Guidelines by facilitating knowledge exchange and providing tools to address key issues such as gender equality, climate change, and legal reform. For example, the Asia-Pacific Fishery Commission (APFIC) has emphasized the need to “strengthen legal and policy frameworks in line with human rights and sustainable development” as outlined in the SSF Guidelines (FAO, 2020). Partnerships make it easier to solve difficult issues such as IUU fishing and migratory stocks, which no single country can tackle alone. Nevertheless, the effectiveness of such partnerships is often constrained

by structural challenges, including high coordination costs, and donor-driven priorities that may diverge from locally identified needs. Therefore, strengthening these partnerships is crucial to pooling resources and expertise for greater impact, as shown in **Box 5**. To act on this, inclusive platforms and multi-sectoral engagement must be expanded to build a resilient, coordinated regional governance system for small-scale fisheries.

Box 5. A success story in strategic partnerships

The Coral Triangle Initiative (CTI-CFF) is a successful strategic partnership involving six countries in Southeast Asia and the Pacific, alongside organizations like the FAO and the WWF. This collaboration focuses on sustainable marine resource management, coral reef conservation, and food security for fishing communities. Through joint efforts, the initiative has established marine protected areas, developed inclusive management frameworks, and enhanced regional data sharing. CTI-CFF exemplifies how strategic partnerships can effectively combine resources and expertise to promote sustainable small-scale fisheries and marine ecosystems.

Climate Change and Resilience Building

Climate change has increasingly disrupted small-scale fisheries livelihoods by intensifying climate-related disturbances that interact with existing socioeconomic and environmental pressures. These combined stresses heighten livelihood vulnerability, particularly in contexts where adaptive capacity remains constrained. Limited access to appropriate technologies, effective early warning mechanisms, and financial resources reduce the ability of fishing households to anticipate, absorb, and recover from climate-related impacts (Sadekin *et al.*, 2021).

Small-scale fisheries face two problems: climate impacts and limited support to adapt. These include insecure tenure, low levels of education and limited access to climate finance, factors identified in vulnerability frameworks as constraining adaptive capacity (Elías Ilosvay *et al.*, 2024). Helping fishers adapt to climate is important because they are on the frontlines – and their local knowledge can also guide wider climate solutions (Torrent Tucker, 2021). Therefore, it should focus on integrating small-scale fisheries-specific measures into national climate adaptation plans. This includes investing in early warning systems, insurance schemes, and ecosystem-based approaches to fisheries management. Community-driven vulnerability assessments and adaptation planning, supported by government and international donors, are essential to safeguard livelihoods while ensuring ecological sustainability (**Box 6**).

Box 6. A project focused on climate change and resilience building

The FAO conducted the project “Fishing for Climate Resilience” in the Philippines. This initiative supports the formal inclusion of small-scale fisheries in national climate adaptation plans and strengthens the governance of Fishery Management Areas. By aligning local fisheries regulations with climate resilience objectives, the project improved both ecosystem integrity and the security of fisher livelihoods (Rare *et al.*, 2023).

Tools for Support and Enablement

To support and enable these mechanisms, robust tools and systems are essential. Legal frameworks must be harmonized to integrate social and human rights-based principles and not just technical or environmental provisions. Similarly, the development of monitoring, evaluation, and learning (MEL) systems, especially those that are participatory and context-sensitive, can help track progress, ensure accountability, and facilitate adaptive management. Together, these interlinked key factors, processes/mechanisms, and support tools create a comprehensive pathway for realizing inclusive, sustainable, and resilient small-scale fisheries governance across Asia.

Monitoring, Evaluation, and Learning (MEL)

Although there has been progress in some areas, the overall implementation of the SSF Guidelines in Asia remains inconsistent, partly due to the lack of systematic monitoring and evaluation (FAO, 2023). Only a few countries have systems in place to track the outcomes of implementation or to assess whether the actions taken are making a meaningful difference for small-scale fisheries communities. Without robust data and evaluation, it is difficult to learn from experience and improve fisheries management.

This situation reflects both limited resources and the voluntary nature of the SSF Guidelines, which means that countries are not required to report on or strictly adhere to them. Nevertheless, there are compelling reasons to invest in stronger monitoring systems. Without clear objectives and regular feedback, it is impossible to assess whether the SSF Guidelines are achieving their intended outcomes or to identify and replicate successful practices. Effective monitoring is also essential for ensuring transparency and accountability to both fishing communities and donors.

Therefore, governments and regional organizations should develop participatory monitoring systems that involve small-scale fisheries representatives, academics, and civil society. Tools such as the FAO’s SSF Guidelines Monitoring Framework, along with country-level indicators, can help make reporting more consistent while still allowing for local needs (**Box 7**). These systems should be linked to learning platforms to ensure that monitoring can help improve both policy and practice.

Box 7. Application of Monitoring, Evaluation, and Learning (MEL)

The FAO and SEAFDEC demonstrate that well-designed monitoring, evaluation, and learning (MEL) systems can lead to tangible progress in small-scale fisheries governance. FAO has published the Handbook for Monitoring, Evaluation and Learning Framework for the SSF Guidelines and conducted regional workshops and training sessions to support countries in developing participatory and context-sensitive MEL systems. Similarly, SEAFDEC has organized a training on socioeconomic monitoring (SocMon) and convened a regional symposium on marine debris and gear marking, contributing to practical tools and shared learning across countries. These efforts show that when MEL tools are localized, inclusive, and linked to learning platforms, they not only enhance accountability but also drive evidence-based improvements in both policy and practice, contributing to more effective and adaptive implementation of the SSF Guidelines.

Legal Frameworks

The legal frameworks across Asian countries could show that while some elements of the SSF Guidelines, particularly those related to environmental sustainability, have been formally adopted into national fisheries laws, key social principles such as tenure rights, gender equality, and transparency remain largely absent or fragmented across non-fisheries legislation (Lawless *et al.*, 2021). This pattern can be interpreted as a legacy of narrowly focused legal systems that prioritize resource control and productivity over holistic, rights-based governance. Fragmented laws weaken the goal of making fisheries fair and sustainable. Countries should review their laws to find gaps and make them more inclusive. Action should therefore focus on legal harmonization, ensuring that fisheries laws are not only technically sound but also socially inclusive, and on embedding legal reform as a central objective within national and regional plans aligned with the SSF Guidelines (**Box 8**).

Box 8. An example of a successful case on legal frameworks

The Philippines has successfully integrated SSF Guideline principles into national legal frameworks (FAO, 2024). The amended Fisheries Code of 2015 reflects a shift toward human rights-based and equitable fisheries governance. It formally recognizes the rights of small-scale fishers to access municipal waters and mandates the establishment of community-based fishing zones, which help safeguard traditional livelihoods and promote sustainable resource use. The law also supports the participation of fisher organizations and local governments in fisheries management, embedding inclusive governance directly into the legal structure. This demonstrates a comprehensive interpretation of the SSF Guidelines and their practical application through law. It justifies the view that legal reform is both feasible and impactful when grounded in inclusive and participatory principles. Other countries can draw on the Philippines' experience to guide legal reviews of their own systems, placing rights recognition, decentralization, and community engagement at the core of fisheries law and policy reform.

The conceptual framework could pave the way to achieve sustainable small-scale fisheries in Southeast Asia and South Asia. By aligning national policies with the SSF Guidelines, promoting gender equality, fostering regional cooperation, scaling up community-based management, and embedding legal and institutional reforms, countries are progressively transforming their fisheries governance systems toward inclusivity, resilience, and sustainability. These efforts are further strengthened by strategic partnerships, climate adaptation initiatives, and participatory monitoring and learning frameworks, ensuring that both ecological and social dimensions are addressed. Together, these interlinked actions not only enhance the well-being of small-scale fisheries communities but also secure the long-term viability of coastal ecosystems and fisheries-based livelihoods. As these practices become more embedded and scaled across the region, they provide a clear pathway toward the realization of sustainable, equitable, and rights-based small-scale fisheries in Asia.

Conclusion and Recommendations

Over the past 10 years, the SSF Guidelines have helped raise awareness and guide action to make these fisheries fairer, more inclusive, and sustainable. Some countries have made good progress by including small-scale fisheries principles in their laws and policies, supporting community-based management, and promoting gender equality. Regional organizations have also helped countries learn from each other and work together.

However, significant challenges remain. Not all elements of the SSF Guidelines are being effectively implemented, particularly those related to social dimensions such as gender equality, rights, and social inclusion. Many governments lack robust monitoring systems and reliable data to track progress and inform evidence-based decision-making. At the same time, climate change is intensifying

pressures on small-scale fisheries communities, many of which have limited access to the tools, resources, and institutional support needed to adapt. Moreover, while a number of successful pilot initiatives demonstrate promising results, scaling up these approaches requires sustained financial investment, formal institutional recognition, and coherent, well-coordinated policy frameworks.

To enhance practical applicability, the following recommendations are prioritized:

Short-term Priorities (1–3 Years):

- Strengthen participatory MEL systems using existing regional tools to generate evidence and accountability.
- Mainstream gender equality measures within ongoing CBFM and policy processes, including gender-disaggregated data collection.
- Integrate small-scale fisheries considerations into national climate adaptation plans and disaster risk management strategies.

Medium- to Long-term Priorities (3–10 Years):

- Institutionalize policy alignment through fully funded NPOAs and RPOAs that integrate social, environmental, and economic dimensions.
- Scale up CBFM through legal recognition, sustained financing, and capacity development.
- Deepen regional cooperation by harmonizing indicators, strengthening fisher organization participation, and aligning trade and conservation policies with the SSF Guidelines.

With sustained political commitment, inclusive partnerships, and community leadership, the SSF Guidelines can move from aspiration to transformative practice, securing resilient livelihoods and sustainable fisheries across Asia.

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SPEECTRA: Linking Inland Fisheries Conservation and Regional Learning in Southeast Asia

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Keywords: inland fisheries, fish *refugia*, habitat conservation, adaptive management, regional knowledge sharing

Inland fisheries play an important role in supporting food security, nutrition, and livelihoods in Southeast Asia. However, these fisheries are increasingly affected by habitat degradation, climate variability, hydrological changes, and growing pressure on aquatic ecosystems. This article discusses the Special Area for Conservation and Fish *Refugia*, known as the SPEECTRA Model, as a practical conservation approach developed from local experience in swamp and floodplain ecosystems in South Sumatra, Indonesia. Implemented at Patra Tani in Muara Enim, SPEECTRA combines fish *refugia*, habitat protection, ecological monitoring, education, and community learning. Experience from the pilot site shows that conservation areas can function not only as protected habitats, but also as learning platforms for research, capacity building, and public awareness. The model highlights the importance of adapting conservation design to local ecological conditions, governance systems, and community needs. SPEECTRA offers useful lessons for strengthening sustainable inland fisheries management and regional cooperation in Southeast Asia.

water patterns, community practices, and governance systems. Effective management needs to be adaptive, locally appropriate, and supported by cooperation among government agencies, researchers, local communities, and other stakeholders (Schiemer *et al.*, 2024; Handayani & Ibrahim, 2025).

In this context, the Special Area for Conservation and Fish *Refugia*, known as the SPEECTRA Model, offers a practical example of how inland fisheries conservation can be linked with learning and community engagement. Developed in 2020 at Patra Tani in Muara Enim, South Sumatra, Indonesia, the model was initiated by the Southeast Asian Fisheries Development Center/Inland Fishery Resources Development and Management Department (SEAFDEC/IFRDMD) in collaboration with the Research Institute for Inland Fisheries and Extension (RIIFE). Rather than functioning only as a protected fish *refugia* site, SPEECTRA combines habitat protection, ecological monitoring, education, demonstration activities, and community learning.

Introduction

Inland fisheries are essential for food security, nutrition, livelihoods, and local economies in Southeast Asia. Rivers, floodplains, reservoirs, swamps, and wetlands provide important habitats for fish and support millions of people who depend on inland waters for food and income (Muthmainnah *et al.*, 2017; Utomo *et al.*, 2024). In flood-pulse-dependent systems such as the Mekong, inland fisheries are especially important because seasonal water movements support fish migration, breeding, nursery grounds, and local fish production (Tilley *et al.*, 2023).

However, these ecosystems are under increasing pressure. Habitat degradation, hydrological disruption, overexploitation, pollution, sedimentation, climate variability, and infrastructure development are changing the natural functions of inland waters (Sarkar *et al.*, 2020; Bond *et al.*, 2024; Utomo *et al.*, 2024). These pressures threaten both aquatic biodiversity and the social and nutritional benefits that inland fisheries provide to rural communities.

Conservation efforts, therefore, cannot rely solely on physical protection or top-down regulations. Inland fisheries are closely connected to local ecosystems, seasonal

Regional initiatives confirm that conservation success requires more than just the presence of protected water areas. In Cambodia, for example, Community Fish Refuges have contributed to inland fish production and rural food security, but their effectiveness depends on floodplain connectivity, local management capacity, coordination with irrigation systems, and sustained institutional support (Tilley *et al.*, 2023; Sithirith, 2026). These lessons show that fish *refugia* models must be tailored to local ecological and governance conditions.

This article discusses the SPEECTRA Model as a locally developed conservation approach with potential for wider regional learning. It highlights the ecological basis of the model, its flexible design, lessons from the Patra Tani pilot, and possible pathways for sharing SPEECTRA principles across Southeast Asia. Ultimately, SPEECTRA should not be promoted as a fixed design to be copied directly, but as an adaptable approach that can support sustainable inland fisheries management, biodiversity conservation, and regional cooperation through SEAFDEC/IFRDMD's knowledge-sharing role.

Conservation in Changing Inland Waters

The SPECTRA model was developed to address swamp and floodplain degradation in South Sumatra, Indonesia. These ecosystems are important habitats for native fish species, providing feeding, breeding, nursery, and refuge areas during different water seasons.

The pilot was launched at the Patra Tani installation in Muara Enim, South Sumatra (**Figure 1**), through a collaboration between SEAFDEC/IFRDMD and RIIFE of the Ministry of Marine Affairs and Fisheries (MMAF), Indonesia. The site has been used for conservation, monitoring, research, education, and demonstration activities related to sustainable swamp fisheries management.

SPECTRA is built on a clear ecological premise: in seasonally dynamic swamp and floodplain systems, fish persistence depends on access to safe refuge habitats and on maintaining hydrological connections that allow movement between open waters and protected habitats across wet and dry phases. These *refugia* protect fish during critical periods, such as low-water seasons or habitat disturbances, keeping fish populations connected to their natural environment.

This logic aligns with foundational floodplain research indicating that floodplains with permanent, either one- or two-sided lateral connectivity to the main channel, significantly favor total fish abundance and serve as essential nursery areas for riverine species (Stoffers *et al.*, 2022). During wet-season flood pulses, these connected floodplain habitats provide vital opportunities for feeding, breeding, and juvenile growth. As waters recede, strategic refuge areas retain fish, sustaining assemblages between flood events and supporting the recovery or recolonization of adjacent waterways.

However, establishing functional *refugia* is highly complex. Empirical data from tropical wet-dry river systems show that both wet-season connectivity and dry-season pool

persistence dictate fish assemblage structures (Pratt *et al.*, 2025). For instance, species richness increases dramatically when wet-season connection to the river lasts more than 25 days and refuges sit less than 2,000 meters from the main channel; conversely, persistent dry-season pools remain twice as species-rich as those that dry out (Pratt *et al.*, 2025).

Because these eco-hydrological requirements vary across landscapes, river and floodplain restoration offers no “one-size-fits-all” design (Stoffers *et al.*, 2022). This reality justifies SPECTRA’s structural diversity. Rather than enforcing a rigid blueprint, its varied configurations, such as integrated agroforestry networks and interconnected pond systems, are purposefully engineered to adapt to these precise distance, duration, and persistence thresholds.

SPECTRA Model Adaptive Design Principles

A key feature of the SPECTRA Model is its flexible design. It is not intended as a single pond layout that must be copied from one site to another; rather, SPECTRA provides a set of fish *refugia* principles that can be adjusted to local hydrology, landform, fish behavior, community needs, and management capacity.

This flexibility is important because swamp and floodplain ecosystems vary by location. Water depth, seasonal flooding, vegetation, connectivity with surrounding waterways, and fish movement patterns can vary greatly across inland water systems. Therefore, effective conservation design should respond to local ecological conditions rather than follow a standardized blueprint.

At the pilot site, several design variations have been developed to demonstrate how SPECTRA principles can be applied in different forms. These include fish refuge ponds, conservation ponds integrated with aquaculture, pond networks for predator protection, agroforestry-based

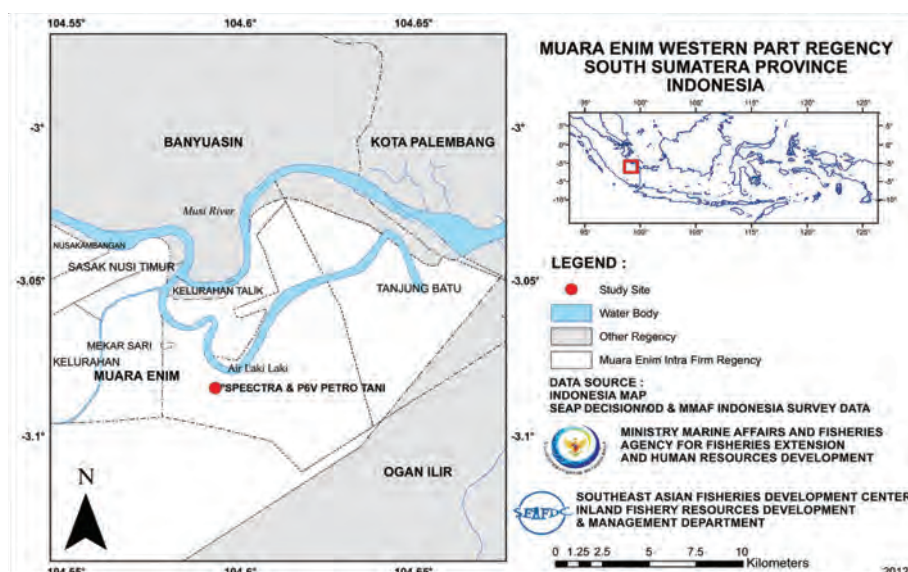
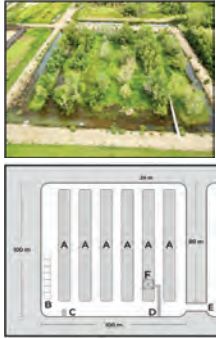
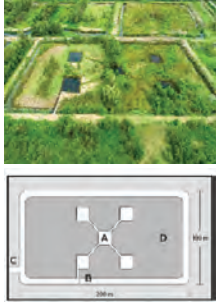
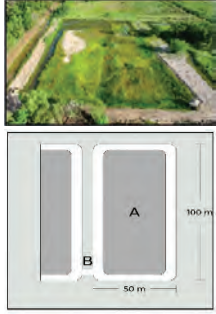


Figure 1. Location of the SPECTRA pilot site at Patra Tani, Muara Enim, South Sumatra, Indonesia

conservation areas, and larger interconnected pond systems. Each design has a specific function, but all are based on the same principle: providing safe habitats where fish can

survive, grow, reproduce, and later contribute to surrounding inland waters. **Box 1** summarizes these variations and their ecological functions.

Box 1. Main design variations and ecological functions of the SPECTRA Model				
SPECTRA Model	Main characteristics	Ecological function	Suitable conditions	Scheme
Model 1: Fish refuge pond with bamboo boundary	A refuge pond with a bamboo boundary system. The pond is around 4 meters deep to maintain water during low-water periods.	Provides safe refuge for fish during dry seasons or habitat disturbance. Fish can grow and reproduce, while juveniles can later move back to surrounding waters.	Suitable for swamp or floodplain areas that experience seasonal water decline and require simple, low-cost protection.	
Model 2: Conservation pond integrated with aquaculture	A conservation pond of about 1 hectare and around 4 meters deep. The system is supported by surrounding vegetation and can be linked with aquaculture activities.	Supports fish conservation while allowing controlled aquaculture or learning activities. Vegetation contributes to organic matter and may support natural food production.	Suitable for sites that combine conservation, demonstration, education, and sustainable aquaculture practices.	
Model 3: Pond network for predator protection	A conservation area with smaller ponds inside the main pond system. The area covers about 2 hectares and includes pathways for juvenile fish movement.	Helps protect fish, especially juveniles, from predators. The inner pond network provides additional shelter and supports fish recruitment.	Suitable for areas where predator pressure is high or where juvenile fish need additional protection during early growth stages.	
Model 4: Agroforestry-based conservation area	A conservation concept that links fish <i>refugia</i> with surrounding trees, plants, and site stewardship.	Supports habitat quality through vegetation cover, organic matter input, water quality improvement, and phytoplankton growth.	Suitable for sites where fisheries conservation can be integrated with vegetation management, environmental education, and community stewardship.	
Model 5: Larger interconnected conservation pond system	A larger pond system of about 5 hectares, with interconnected water bodies, trees, grasses, and natural habitat features.	Provides broader habitat space for fish breeding, feeding, movement, and protection. It can support more complex ecological functions.	Suitable for larger areas with sufficient land and water availability, especially where long-term habitat protection and demonstration activities are planned.	

These designs show that SPECTRA is an adaptable conservation package that can be translated into different designs according to site conditions. For regional application, other countries do not need to copy the Patra Tani design exactly; instead, they can adopt core SPECTRA principles and adjust them to their own inland water ecosystems, governance systems, and community priorities.

From Conservation Infrastructure to Knowledge Sharing

Beyond physical conservation, SPECTRA implementation shows that a fish refugium can also serve as a multifunctional learning hub. Currently, the site integrates fish population monitoring, water quality observation, native fish aquaculture, environmental education, and community-based ecotourism activities (Sawestri *et al.*, 2023; Supriyadi *et al.*, 2023).

These activities generate practical field experience for managing fish *refugia* in swamp and floodplain ecosystems. Continuous monitoring provides useful information on fish growth, population structure, habitat conditions, and seasonal changes which are crucial for evaluating performance over time and for identifying aspects that may need adjustment. Insights from the Patra Tani experience regarding the application and adaptation of SPECTRA principles in other inland water systems are summarized in **Box 2**.

Box 2. Key messages from the SPECTRA experience
1. Conservation should follow ecological processes
The SPECTRA experience shows that conservation design should work with natural inland water dynamics. Seasonal water movements, floodplain conditions, and native fish behavior need to be considered so that fish can find suitable areas for feeding, breeding, nursery, and refuge. This ensures that conservation activities support, rather than disrupt, natural ecological cycles.
2. Local knowledge should be valued and integrated
Community understanding of fish habitats, seasonal water changes, and traditional <i>refugia</i> practices provides an important foundation for conservation. When combined with scientific monitoring and technical documentation, this knowledge becomes stronger, easier to explain, and more useful.
3. Conservation sites can serve multiple functions
A fish <i>refugia</i> site can be more than a closed sanctuary; it can also support research, education, demonstration activities, community awareness, and ecotourism. This multifunctionality strengthens local acceptance and encourages support from communities, local authorities, universities, and development partners.
4. Flexibility remains essential
SPECTRA is an adaptable approach, not a fixed design. Its application should respond to local water systems, land characteristics, fish habitats, governance arrangements, and community priorities. This flexibility is important if SPECTRA principles are to be shared and adapted in other inland water systems in Southeast Asia.

SPECTRA also offers learning opportunities for students, researchers, fisheries practitioners, local communities, and visitors. By combining habitat protection with research, capacity building, and public awareness, the site helps connect ecological knowledge with practical field management.

This multifunctional role gives SPECTRA broader value as a learning model for regional knowledge sharing. Rather than transferring a fixed model directly, lessons from the site can help other countries consider how similar principles may be adapted to their own ecological conditions, governance systems, and community needs.

Adapting SPECTRA for Regional Learning

Across several SEAFDEC Member Countries (Lao PDR, Thailand, Cambodia, Viet Nam, and Malaysia), inland waters such as rivers, floodplains, reservoirs, and wetlands support important fish habitats and local livelihoods. These seasonally connected ecosystems serve as feeding, breeding, nursery, and refuge areas, contributing to food security, income, and community-based fisheries in rural areas (Barut, 2016; Funge-Smith & Bennett, 2019; Lynch *et al.*, 2016).

However, inland water systems are increasingly affected by habitat degradation, hydrological changes, infrastructure development, pollution, climate variability, and competing water uses. In addition, inland fisheries often receive less attention in international development and conservation agendas compared with marine and terrestrial ecosystems despite their importance (Funge-Smith & Bennett, 2019; Lynch *et al.*, 2016).

These conditions create an opportunity to position the SPECTRA Model as a practical approach for regional learning. Instead of a fixed infrastructure design that must be copied directly, SPECTRA offers a set of adaptable principles for protecting critical fish habitats, maintaining refuge areas, supporting ecological monitoring, and linking conservation with education and community participation.

For example, in countries with floodplain systems, SPECTRA principles may be used to strengthen seasonal fish *refugia* and maintain connectivity between water bodies. In reservoirs, the approach may support habitat protection, fish monitoring, and community awareness activities. In swamps or wetlands, SPECTRA may help integrate fish conservation with vegetation management, local stewardship, and livelihood-oriented learning. Similar regional initiatives show that conservation outcomes depend on the ability to align ecological design with local governance, community participation, and long-term institutional support (Kunda *et al.*, 2022; Sithirith, 2026).

Therefore, the regional relevance of SPECTRA lies in its flexibility. Each country can adapt the model according to its own inland water characteristics, fish species, management institutions, and community needs. Through SEAFDEC/IFRDMD's role in knowledge sharing, technical cooperation, and regional networking, the experience from Patra Tani can provide useful lessons for strengthening sustainable inland fisheries management across Southeast Asia.

Pathways for Wider Knowledge Sharing

The wider promotion of SPECTRA requires more than explaining its technical design. To be useful for other inland water systems, the model needs to be communicated clearly, supported by field evidence, and shared through sustained partnerships. This is important because countries and communities may have different ecological conditions, institutional capacities, and management priorities.

Strengthening regional awareness is a priority. Although SPECTRA has been introduced through SEAFDEC-related forums and institutional discussions, broader recognition is still needed. Communication materials should be tailored for diverse audiences, including government agencies, universities, local governments, non-government organizations, community groups, private sector partners, and development agencies.

Documentation is also essential. Technical reports, monitoring summaries, case studies, maps, photographs, videos, and simple guidelines can help explain how SPECTRA works in practice. These materials would allow potential partners to understand the model, compare it with their own inland water systems, and identify suitable elements for local adaptation. A digital repository could also support wider access to these materials and strengthen regional learning across sites.

Knowledge sharing should not depend solely on one-time meetings or short-term activities. Workshops, webinars, field visits, technical exchanges, and collaborative research can build trust among institutions and countries. These activities can also encourage comparative learning between different types of inland water ecosystems, such as floodplains, reservoirs, swamps, wetlands, and riverine systems.

SPECTRA should also be framed within broader regional priorities. The model is not only about fishponds or conservation infrastructure. It is also linked to habitat protection, biodiversity conservation, climate resilience, sustainable livelihoods, environmental education, and ecosystem-based fisheries management. Where appropriate, SPECTRA-related sites could also be assessed in relation to area-based conservation approaches, including Other Effective Area-Based Conservation Measures (OECMs).

At the same time, wider application will require institutional and financial support. Interested countries may face constraints related to funding, land availability, technical capacity, monitoring systems, and long-term maintenance. For this reason, regional promotion should be gradual and realistic. Partnerships, site assessments, technical guidance, and phased planning are needed before pilot activities are expanded.

Table 1 summarizes how SPECTRA can be promoted gradually, beginning with awareness and documentation, followed by pilot exploration and partnerships, eventually moving toward institutional support and long-term sustainability. The table should be read as an indicative guide for regional knowledge sharing, not as a fixed implementation plan.

Table 1. Proposed phased roadmap for regional knowledge sharing on SPECTRA

Phase	Strategic focus	Possible activities	Expected contribution
Short-term	Awareness and documentation	Policy briefs, popular articles, technical guidelines, regional seminars, digital repository, and improved monitoring documentation	Stronger visibility, shared understanding, and initial regional recognition
Medium-term	Pilot exploration and partnerships	Site assessments in interested countries, joint research, field learning visits, regional working group, and engagement with universities, NGOs, CSR programs, and communities	Evidence for adaptation and stronger multi-stakeholder collaboration
Long-term	Institutionalization and sustainability	Integration into SEAFDEC programs, funding mechanisms, regional conservation initiatives, OECM-oriented assessment where relevant, and adaptive regional roadmap	Policy legitimacy, continuity, and wider use of SPECTRA principles

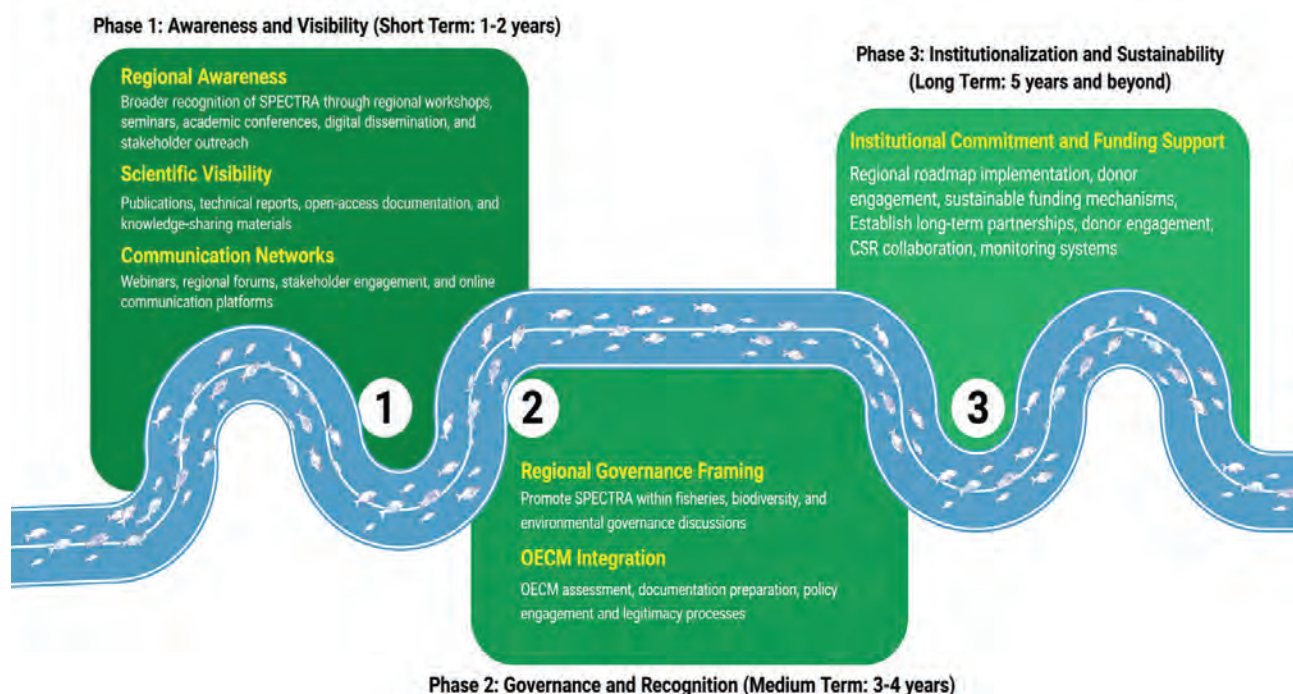


Figure 2. Regional roadmap for promoting the SPECTRA Model in Southeast Asia

As illustrated in **Figure 2**, adaptive replication should begin with site assessment. Potential sites need to be reviewed based on ecological suitability, water availability, fish habitat conditions, and local fisheries dependence. Local governance and community readiness should also be considered before any technical design is selected.

The roadmap shows that SPECTRA promotion should be carried out gradually. The process begins with identifying suitable sites and understanding local ecological and social conditions, before moving to technical adaptation, stakeholder engagement, pilot implementation, monitoring, and wider knowledge sharing. This step-by-step approach ensures that SPECTRA principles are adapted to local contexts rather than copied as a fixed design.

For SEAFDEC/IFRDMD, this approach reinforces its role as a regional knowledge broker for inland fisheries. By documenting experiences, facilitating learning, and connecting countries with similar challenges, SEAFDEC/IFRDMD can help SPECTRA develop from a local pilot model into a regional platform for cooperation and capacity building.

Conclusion and Way Forward

The SPECTRA Model offers a practical example of inland fisheries conservation that works with natural swamp and floodplain dynamics. Its value lies in combining fish *refugia*, habitat protection, ecological monitoring, education, and stakeholder engagement within one learning site.

For Southeast Asia, the main lesson is not to replicate the physical design of SPECTRA exactly. A more effective approach is to learn from its principles: protecting critical fish habitats, using local hydrological conditions, documenting ecological changes, involving communities, and linking conservation with learning and livelihoods.

With stronger documentation, continuous communication, inclusive participation, and regional cooperation, SPECTRA can contribute to sustainable inland fisheries, biodiversity conservation, and more resilient livelihoods in Southeast Asia. By strengthening partnerships and adaptive learning, SPECTRA can also support SEAFDEC/IFRDMD's role in promoting practical, ecosystem-based approaches for sustainable inland fisheries management in the region.

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Advancing Collaborative Fisheries Governance Through Multispecies Stock Assessment in the Gulf of Thailand: A GoTFish-Supported Partnership Mechanism for Sub-regional Fisheries Management

Pavarot Noranartragoon, Nipa Kulanujaree, Worawit Wanchana

Keywords: ecosystem-based fisheries management, multispecies fishery, multi-gear fishery, pelagic fish, transboundary species

Small-scale fisheries in the Gulf of Thailand depend heavily on shared pelagic resources—particularly short mackerel and anchovy—characterized by multispecies interactions, seasonal variability, and transboundary distribution. Effective management remains challenging due to fragmented assessment approaches, persistent data limitations, and the need to strengthen collaboration and trust among countries and stakeholders sharing the Gulf of Thailand.

This article introduces a GoTFish-supported partnership mechanism designed to advance collaborative governance through a multispecies stock assessment framework for shared pelagic fisheries. In Thailand, this framework is currently applied at the national level to inform fisheries management decisions, including the setting of effort limits for pelagic species. By explicitly accounting for species interactions and cumulative fishing pressures, the approach provides a more robust and policy-relevant basis for management than conventional single-species assessments.

Within Thai waters, ecosystem-based fisheries management (EBFM) has also been implemented using ecosystem indicators, complementing the multispecies assessment framework with plans to progressively expand EBFM to the sub-regional scale.

Rather than pursuing immediate harmonization of management measures, the GoTFish-supported mechanism prioritized alignment of analytical concepts, transparency of assumptions, and shared interpretation of results as foundations for collaboration and confidence-building. The paper further illustrates how this approach supports sustainable small-scale fisheries while maintaining functional coastal and marine ecosystems, contributing to resilient livelihoods, reduced conflicts, and enhanced ecosystem stability in shared, multispecies, and data-limited fisheries systems.

Introduction

Fisheries in the Gulf of Thailand (GoT) are embedded within a complex socio-ecological system, where biological processes, fishing practices, and governance structures are tightly interconnected. These fisheries are predominantly multispecies/multi-gear (MSMG) systems, where multiple species are harvested simultaneously using diverse gears across overlapping spatial and temporal scales (Sharma, 2026).

Globally, MSMG fisheries dominate tropical regions and are characterized by high biodiversity, non-selective fishing practices, and adaptive fishing behavior (FAO & SEAFDEC, 2026). Traditional single-species management is inadequate in these systems, as it fails to capture ecosystem interactions and mixed catch dynamics.

In response, management has shifted toward ecosystem-based and multispecies approaches that treat fisheries as integrated systems rather than isolated stocks (Garcia & Cochrane, 2005). Building on Thailand's experience, this paper introduces a GoTFish-supported partnership mechanism to strengthen collaborative governance in the Gulf of Thailand and proposes a structured pathway for improving transboundary MSMG fisheries governance.

Socio-Ecological Context of Fisheries in Thailand

Thailand's extensive maritime area, long coastline, and large coastal population contribute to strong dependence on marine resources for livelihoods and food security (**Table 1**). The national fisheries system is characterized by diverse fleets, multiple fishing gears, and a wide range of target species, reflecting both ecological richness and adaptive fishing practices.

Table 1. Geographic and fisheries profile of Thailand

Category	Description / Value
Geographic region	Southeast Asia
Ocean location	Andaman Sea and Gulf of Thailand
Population	~66 million (~21 million in coastal provinces)*
Land area*	513,115 km ²
Maritime area*	323,488 km ²
Coastline*	~3,151 km
Fisheries production**	~2.5 million t
Capture fisheries	~1.5 million t (1.4 million t marine, 0.1 million t freshwater)
Culture fisheries	~1.0 million t (0.5 million t coastal, 0.5 million t freshwater)

* Knowledge Management for Marine Interest Project (2026)

** Department of Fisheries (DOF), Thailand (2025)

Characteristics of MSMG Fisheries in the Gulf of Thailand

MSMG fisheries in the Gulf of Thailand exhibit three interrelated dimensions, consistent with FAO–SEAFDEC conceptualization.

Ecological Complexity

Species within MSMG systems differ significantly in growth rates, reproductive strategies, and vulnerability to fishing. These species are linked through trophic interactions, meaning that fishing pressure on one species can influence the abundance and productivity of others (FAO & SEAFDEC, 2026). This results in non-linear and non-independent stock dynamics, where system-level responses cannot be predicted from single-species models.

Operational Diversity

Fishing activities involve multiple fleets and gear types, each with distinct selectivity patterns. However, most fishing gear is not fully selective, and operations capture a wide range of species in varying proportions. Key implications include mixed catches that constrain species-specific management, difficulties in standardizing fishing effort across fleets, and overlapping impacts across fisheries.

Adaptive Fishing Behavior

Fishers respond dynamically to seasonal variability, market demand, and regulatory constraints, continuously adjusting their fishing strategies. This adaptive behavior (**Figure 1**) includes shifts in target species, fishing locations, and gear types, forming a key component of MSMG fisheries systems. While such flexibility supports livelihood resilience, it also increases variability in catch composition and fishing effort. This creates feedback loops between ecological and socioeconomic systems, where changes in

one domain influence the other (FAO & SEAFDEC, 2026). While increasing system resilience, this adaptive behavior complicates management interventions.

Limitations of Single-Species Management

The conventional fisheries paradigm is based on Maximum Sustainable Yield (MSY), which assumes independent stock dynamics. However, in MSMG systems, fishing mortality is applied simultaneously across multiple species, mixed catches prevent species from being managed independently, and ecological interactions modify stock productivity, thereby challenging the assumptions underlying single-species management.

As highlighted in the FAO–SEAFDEC webinar materials (Staples & Leadbitter, 2026), simply aggregating MSY across species systematically overestimates sustainable yield, increasing the risk of overfishing. Furthermore, maintaining all species at their individual MSY simultaneously is impossible; instead, fisheries operate at a system-level equilibrium where trade-offs are unavoidable.

Figure 2 illustrates the limitations of conventional single-species MSY in MSMG fisheries. The upper panel presents the traditional MSY concept, optimizing yield for a single stock and implicitly assuming species independence. In contrast, the lower panel depicts the MSMG system, characterized by mixed catches, multiple fishing gears, and interconnected ecosystem dynamics. Here, fishing effort simultaneously affects multiple species, and ecological interactions—such as predation and competition—further influence stock productivity. As a result, the assumptions underpinning single-species MSY are not met, and management based solely on this approach may lead to biased estimates and suboptimal outcomes. This comparison highlights the need for multispecies and ecosystem-based approaches to better reflect the complexity of real-world fisheries systems.

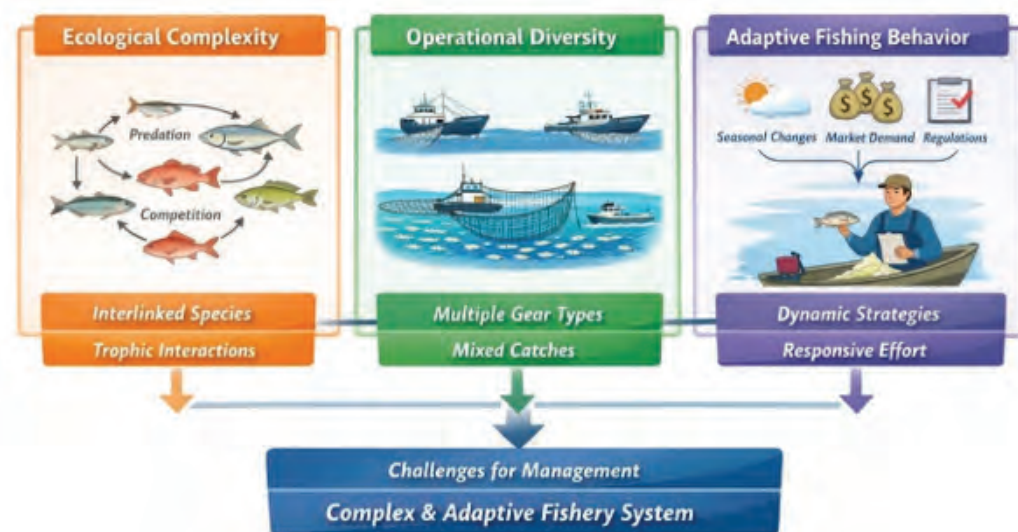


Figure 1. MSMG fisheries in the Gulf of Thailand (Source: FAO & SEAFDEC, 2026)

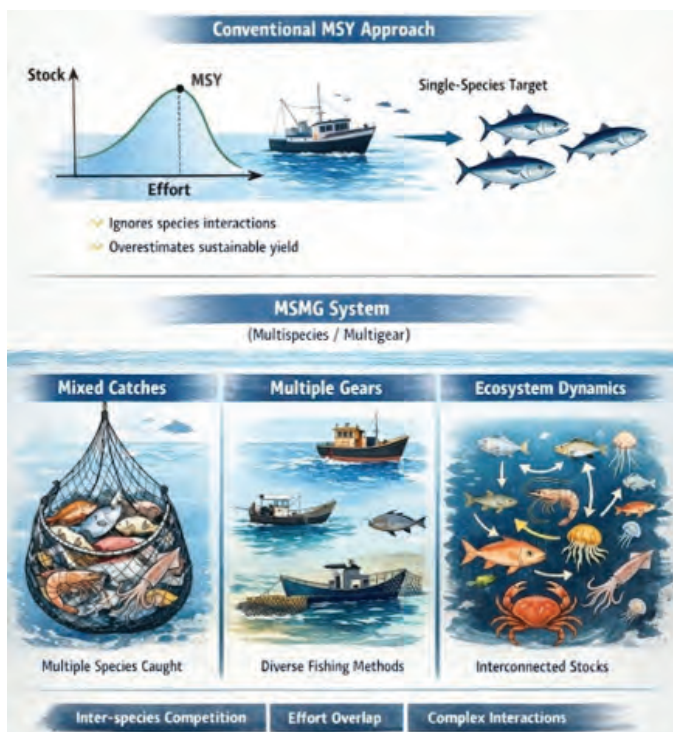


Figure 2. Limitations of single-species fisheries management

Multispecies Stock Assessment and EBFM in Thailand

Thailand has integrated multispecies assessment with Ecosystem-based Fisheries Management (EBFM) to better reflect the realities of MSMG fisheries. Implemented under the national fisheries management framework, this approach supports key decisions such as Total Allowable Catch (TAC), effort control, and resource allocation.

Multispecies MSY (MMSY)

The Multispecies Maximum Sustainable Yield (MMSY) framework extends the conventional MSY concept by estimating sustainable yield at an aggregated system level rather than for individual species. The approach explicitly considers:

- species interactions, including predation and competition
- cumulative fishing pressure across fleets and gears
- overall system productivity and biomass dynamics

In practice, species are often grouped into functional or ecological categories (*e.g.* pelagic, demersal), and indicator species are used to represent broader stock conditions, keeping assessments operational despite data limitations while still capturing key ecosystem dynamics. In the Gulf of Thailand, species are grouped by management objectives into three categories: demersal, pelagic, and anchovy. These are managed through their main fishing gear: trawls, purse seines, and anchovy purse seine/falling nets, respectively.

Unlike single-species MSY, MMSY recognizes maximizing yield for all species simultaneously is not possible. Instead, it identifies a system-level equilibrium balancing trade-offs across species and sectors, aligning with the concept of “Pretty Good Yield.”

The MMSY framework is supported by production models and time-series data on catch and effort and is complemented by ecosystem indicators to track changes in species composition and system structure. These elements are integrated into a broader management cycle, linking assessment results to management measures and adaptive decision-making. Overall, MMSY provides a more realistic and policy-relevant basis for determining TAC and managing fishing capacity in complex MSMG systems compared to conventional single-species approaches (Noranartragoon, 2025).

Indicator Species and Aggregated Groups

The multispecies assessment framework adopts a pragmatic approach by using aggregated species groups and indicator species to represent the dynamics of complex MSMG fisheries systems. In practice, species are first classified into functional or ecological groups—such as pelagic and demersal—based on similarities in habitat, life history characteristics, and exploitation patterns. This aggregation reduces analytical complexity while retaining key system-level signals.

Within each group, selected indicator species represent broader stock conditions and management priorities. These species are typically chosen based on ecological importance, vulnerability, economic value, data availability, and sensitivity to fishing pressure. For example, within the pelagic group, short mackerel may serve as an indicator for small, fast-growing pelagic species, while Spanish mackerel may represent large pelagic and predator species. For the demersal group, red snapper may represent market fish, and sharks may be selected as indicators of vulnerable species. Changes in these indicator species serve as proxies for the condition of the wider species group, supporting timely and cost-effective assessments.

The conceptual process of simplification is illustrated in **Figure 3**, where diverse species assemblages are aggregated into major groups and linked to representative indicator species. This approach translates complex ecosystem dynamics into manageable analytical units, facilitating the application of surplus production models and other data-limited assessment methods while providing a clear structure for management decision-making.

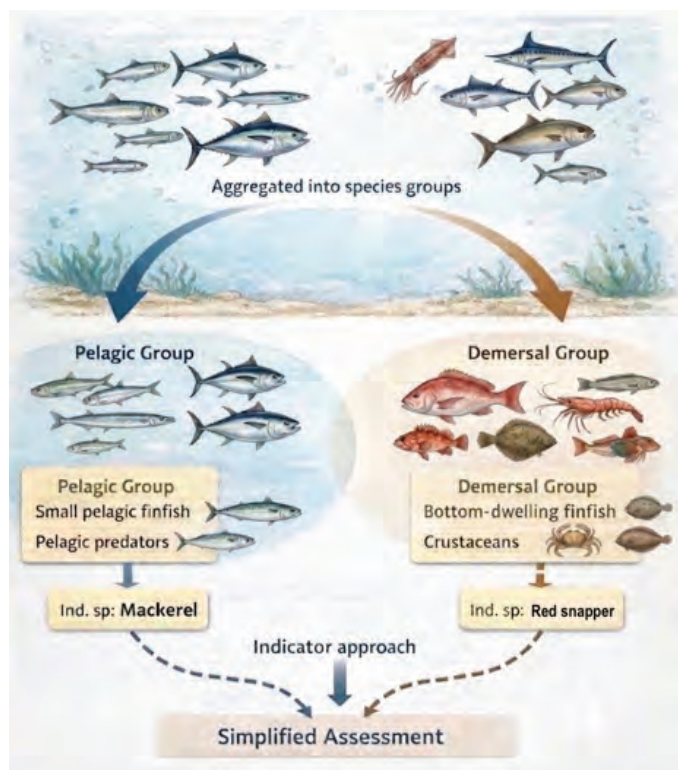


Figure 3. Conceptual framework for simplifying multispecies fisheries into aggregated groups and indicator species, enabling operational assessment under data-limited conditions by linking complex ecosystem structures to manageable analytical units.
Source: Adapted from Staples & Leadbitter (2026)

This approach is particularly suited to data-limited fisheries where comprehensive species-specific assessments are not feasible. By combining aggregated catch and effort data with indicator-based interpretation, the framework maintains operational feasibility while still capturing key ecological patterns. In addition, indicator species simplify complex scientific data into more understandable and policy-relevant signals. However, this approach requires careful consideration of representativeness and uncertainty, as indicator species may not fully capture variability within highly diverse species groups. Therefore, it is important to complement this method with ecosystem indicators and adaptive management processes to ensure that management responses remain robust over time. Overall, aggregated groups and indicator species bridge single-species and fully ecosystem-based approaches, enabling operational management in complex, data-constrained fisheries systems (Staples & Leadbitter, 2026).

Ecosystem Indicators

Ecosystem-based fisheries management (EBFM) in Thailand utilizes ecosystem indicators to capture structural, functional, and productivity changes within the fisheries system. These indicators complement multispecies stock assessment by providing broader insights into ecosystem dynamics not fully captured by catch and effort data alone.

Key ecosystem indicators include:

Biomass trends: Derived from assessment models and survey data to track overall stocks status and system productivity over time. Rather than focusing on individual species, biomass is often evaluated at the group level (e.g. pelagic and demersal), consistent with the multispecies framework.

- **Species composition:** Tracks shifts in the relative abundance of different species within the catch. A decline in high-value or larger-bodied species alongside an increase in smaller or lower-trophic-level species indicates ecosystem stress and fishing pressure. This indicator is particularly important in MSMG fisheries, where mixed catches reflect both ecological conditions and fishing practices.
- **Trophic structure:** Assesses species distribution across different trophic levels to detect ecosystem-level changes such as “fishing down the food web.” Metrics such as mean trophic level of the catch or the relative contribution of predator and prey species are commonly used to evaluate these changes.
- **Structural indicators:** Apply network theory to characterize marine food web organization and function. These include the Hub index, (identifying highly connected, influential species); Gao’s resilience, (quantifying capacity to absorb disturbances and maintain stability); and the Green Band (reflecting anthropogenic fishing pressure on ecosystem structure). These three metrics can be integrated into the Ecosystem Traits Index (ETI), a system level indicator that guides EBFM (Fulton and Sainsbury, 2025).

Together, these indicators support structured monitoring and evaluation within the fisheries management cycle, enabling managers to detect early warning signs of ecosystem change, assess management effectiveness, and adjust strategies. In the context of data-limited fisheries, they incorporate ecosystem considerations into decision-making without requiring highly complex models.

Table 2 summarizes these key ecosystem indicators by category, description, and management relevance. The table highlights how they collectively provide a comprehensive picture of fisheries system dynamics. By combining multiple indicators, managers can better interpret trends, cross-validate signals, and avoid relying on a single metric, improving the robustness of management decisions in complex MSMG systems.

Ecosystem indicators strengthen the link between science and policy by translating complex ecological dynamics into measurable and interpretable signals. When combined with multispecies stock assessment and stakeholder engagement, they enhance the capacity for adaptive management and support more resilient and sustainable fisheries systems.

Table 2. Key ecosystem indicators for EBFM in multispecies fisheries

Indicator Category	Indicator	Description	Management Relevance
Biomass	Total biomass (by group)	Estimated biomass of aggregated species groups (e.g. pelagic, demersal)	Indicates overall stock status and productivity
	Biomass trend over time	Changes in biomass across years	Detects recovery or decline of fish stocks
Species Composition	Catch composition	Proportion of species/groups in total catch	Reflects shifts in resource availability, management change, and fishing pressure
	Size structure	Distribution of fish sizes in catch	Indicates fishing pressure and stock health
Trophic Structure	Mean trophic level of catch	Average trophic level of harvested species	Detects “fishing down the food web”
	Predator-prey balance	Relative abundance of predator vs. prey species	Reflects ecosystem stability
Fishing Pressure	Fishing effort	Number of vessels, gear use, fishing days	Indicates pressure on the ecosystem
	Catch per unit effort (CPUE)	Catch relative to effort	Proxy for stock abundance
Ecosystem State	Biodiversity (species richness)	Number of species in catch or ecosystem	Indicates ecosystem resilience
	Habitat condition (qualitative)	Status of key habitats (e.g. coastal, benthic)	Supports long-term sustainability
Structural Indicators	Hub index	Measures the relative importance of species within the food web based on their connectivity and influence on energy flow and trophic interactions	Identifies key or highly influential species that are critical for maintaining ecosystem structure; supports prioritization for monitoring and conservation
	Gao's resilience	Quantifies the capacity of the ecosystem network to absorb disturbances and maintain its structural and functional integrity	Provides an early warning of reduced ecosystem stability; supports precautionary management and helps define safe operating limits for fishing pressure
	Green Band	Represents the level of fishing pressure on the ecosystem	Helps evaluate whether fishing pressure is within sustainable limits; supports adjustment of fishing effort and management measures
	ETI	An integrated index combining Hub index, Gao's resilience, and Green Band to reflect overall ecosystem structure and condition	Provides a system-level indicator to guide EBFM, enabling holistic assessment and adaptive decision-making

Source: Adapted from FAO-SEAFDEC MSMG Webinar Series (2026), Noranarttragoon (2025), and Fulton & Sainsbury (2025)

Management Cycle Integration

The approach aligns with the MSMG management cycle, which provides a structured and iterative framework for decision-making in complex multispecies fisheries systems. This cycle begins by defining a clear vision and long-term objectives that balance ecological integrity, economic viability, and social well-being over the long-term.

These high-level goals are translated into measurable and time-bound operational objectives and indicators (such as biomass trends, species composition, and fishing effort). These are linked to reference points that define target and limit conditions, ensuring management goals are actionable and grounded in measurable outcomes.

Management measures and control rules are then developed to achieve these objectives and may include Total Allowable Catch (TAC), effort controls, spatial and temporal closures,

and gear restrictions. Predefined harvest control rules provide responses to changes in indicator status, improving transparency, predictability, and consistency in decision-making.

Monitoring and evaluation follow, involving the systematic collection and analysis of data to assess whether management measures achieve intended outcomes, detect trends, identify emerging risks, and evaluate management effectiveness in relation to defined objectives.

Finally, adaptive feedback ensures that management strategies are continuously refined. Given the inherent uncertainty in MSMG fisheries—arising from environmental variability, data limitations, and dynamic human behavior—this feedback loop is essential for maintaining system resilience and responsiveness.

The overall process is illustrated in **Figure 4**, which presents the MSMG management cycle as a continuous and interconnected loop. The diagram highlights how each component—from vision setting to adaptive feedback—is linked through iterative feedback mechanisms. It emphasizes that management is not a linear process but a dynamic cycle where monitoring results inform adjustments to objectives, indicators, and management measures. This cyclical structure enables fisheries management systems to respond effectively to uncertainty and evolving conditions.

Together, these components form an integrated framework that links science, policy, and implementation. By explicitly incorporating uncertainty, trade-offs, and stakeholder participation, the MSMG management cycle provides a practical foundation for ecosystem-based and multispecies fisheries management (FAO & SEAFDEC, 2026).



Figure 4. The MSMG management cycle, illustrating the iterative process linking objectives, indicators, management measures, monitoring, and adaptive feedback in multispecies fisheries management (Source: FAO & SEAFDEC, 2026)

GoTFish-Supported Partnership Mechanism

Conceptual Foundation

The Gulf of Thailand is a highly interconnected marine ecosystem where key fish stocks, particularly small pelagic species, are distributed across national jurisdictions and exploited by multiple countries. This transboundary nature requires coordinated management to ensure sustainability, avoid resource depletion, and mitigate conflicts. In practice, however, achieving full harmonization of fisheries management measures remains challenging due to differences in national governance structures, legal frameworks, data systems, technical capacity, and management priorities.

In this context, the GoTFish-supported partnership mechanism adopts a process-oriented, adaptive approach emphasizing alignment rather than uniformity. Rather than

requiring identical regulations or management measures, the mechanism builds a shared understanding by aligning analytical frameworks, assessment methodologies, and key concepts. This includes promoting common approaches to multispecies stock assessments, ecosystem indicators, and management reference points.

Trust and cooperation are developed progressively through technical collaboration. By fostering transparency in data, assumptions, and analytical processes, the mechanism helps reduce uncertainty and build confidence among participating countries. Joint technical discussions, knowledge exchange, and capacity development support the gradual convergence of scientific understanding to inform future policy-level coordination.

This conceptual foundation reflects a pragmatic pathway toward sub-regional governance in complex, data-limited MSMG fisheries systems. By prioritizing process alignment and shared learning, the GoTFish mechanism creates conditions necessary for more effective collaboration, while allowing flexibility for countries to adapt management measures to their specific national contexts. Over time, this approach can support the development of compatible management strategies and contribute to a more coherent and resilient fisheries governance.

Key Principles

The GoTFish-supported partnership mechanism relies on three technical and analytical principles to enable effective collaboration in transboundary, data-limited multispecies fisheries systems.

The alignment of analytical frameworks involves adopting comparable approaches to multispecies stock assessment, ecosystem indicators, and reference points across participating countries. This does not require identical models or datasets, but rather a shared structure and logic in how fisheries systems are analyzed and interpreted. Such alignment facilitates comparability of results and supports more coherent regional understanding of stock status and fishing impacts.

The transparency of assumptions (including those related to data sources, model structure, parameter selection, and uncertainty) allows countries to better understand the differences in assessment outcomes and reduce potential misunderstandings. Transparency also enhances the credibility of scientific advice and supports more informed decision-making.

The shared interpretation of results through joint technical discussions and collaborative review processes allows stakeholders to develop a common understanding of key indicators, trends, and management implications to inform coordinated action.

Together, these principles build trust and confidence among participating countries. In complex MSMG fisheries systems, where uncertainty is high and interests may differ, such trust is a critical prerequisite for sustained cooperation. By focusing on process, transparency, and shared learning, the mechanism creates a stable foundation upon which more formal coordination and policy alignment can be built over time.

Operational Components

The GoTFish-supported partnership mechanism translates its guiding principles into coordinated action and is designed to function within existing national systems while progressively strengthening sub-regional collaboration.

A central element is the establishment of joint technical platforms, which provide regular forums for scientists, managers, and technical experts to exchange information, discuss methodologies, and review assessment results. These platforms may take the form of regional workshops, technical working groups, or virtual coordination meetings.

The mechanism also promotes the use of shared datasets and models, where feasible, to improve consistency and comparability of assessments. This includes harmonizing key data inputs—such as catch, effort, and biological parameters—as well as encouraging the use of comparable modeling frameworks for multispecies stock assessment. While full data integration may not always be possible, even partial standardization enhances transparency and facilitates cross-country analysis.

Capacity development through training programs, technical exchanges, and collaborative analyses are used to strengthen national capacities in areas such as stock assessment, ecosystem indicators, and data management. By reducing disparities in technical capability, the mechanism supports more equitable participation and improves the overall quality of regional assessments.

In addition, the mechanism supports the gradual development of common reference points, such as shared indicators, thresholds, and target ranges for key variables (*e.g.* biomass, fishing effort, or catch composition). These reference points do not need to be identical across countries but should be conceptually aligned to enable coordinated interpretation and decision-making. Over time, this process can facilitate convergence toward more harmonized management approaches.

These operational components enable incremental progress while respecting national contexts and governance structures. By allowing flexibility in implementation and emphasizing voluntary collaboration, the mechanism fosters sustained engagement and reduces barriers to participation. Collectively,

these elements provide a practical pathway for strengthening sub-regional cooperation and advancing ecosystem-based, multispecies fisheries management in the Gulf of Thailand.

Trade-offs in MSMG Fisheries Management

Trade-offs are inherent in MSMG fisheries systems due to competing management objectives, including maximizing yield, maintaining ecosystem integrity, and supporting livelihoods. As illustrated in **Figure 5**, these objectives cannot be simultaneously maximized; instead, improving performance in one dimension often leads to trade-offs in others. For example, increasing fishing effort to maximize yield may reduce ecosystem resilience, while stricter conservation measures may constrain short-term economic returns and fishing opportunities.

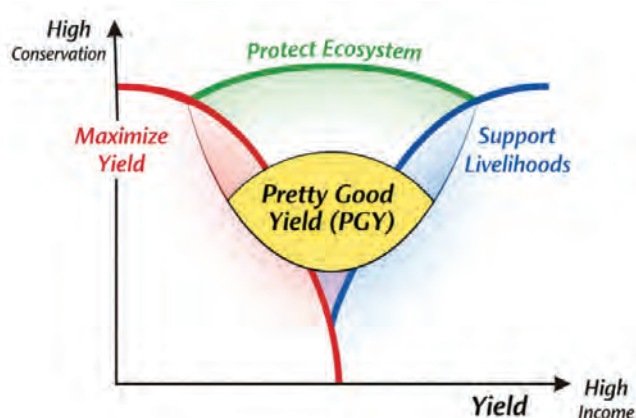


Figure 5. Trade-offs in multispecies/multi-gear (MSMG) fisheries illustrating the concept of “Pretty Good Yield (PGY)” as a balance among maximizing yield, maintaining ecosystem integrity, and supporting livelihoods. Source: Adapted from Hilborn (2010, 2011) and FAO-SEAFDEC (2026)

Rather than seeking an optimal solution for a single objective, fisheries management increasingly adopts the concept of “**Pretty Good Yield**” (PGY), which recognizes that a range of outcomes can provide acceptable performance across multiple objectives without maximizing any single one (Hilborn, 2010). The goal is to identify a balanced operating space (represented in the figure as the central overlap) where yield, ecosystem health, and livelihoods are jointly sustained at satisfactory levels.

As emphasized in the FAO–SEAFDEC webinar in 2026, these trade-offs are unavoidable and must be explicitly recognized and managed rather than avoided (FAO & SEAFDEC, 2026). This requires transparent decision-making processes in which priorities are clearly defined and the implications of alternative strategies are understood by stakeholders. Analytical tools such as multispecies stock assessment, ecosystem indicators, and Management Strategy Evaluation (MSE) provide a structured means to evaluate these trade-offs and support the selection of robust and balanced management strategies.

Management Strategy Evaluation (MSE) and Uncertainty

Fisheries management in MSMG systems operates under multiple sources of uncertainty that affect both scientific assessments and management outcomes. These include observation uncertainty arising from data limitations and measurement errors; process uncertainty associated with environmental variability and natural fluctuations in stock dynamics; model uncertainty related to assumptions and structural choices in assessment models; and implementation uncertainty resulting from imperfect compliance, enforcement, and variability in human behavior.

In MSMG fisheries, these uncertainties are amplified by mixed catches, complex species interactions, and dynamic fishing practices. As a result, relying on a single “best estimate” of stock status or management outcome can be misleading and may lead to ineffective or overly risky decisions.

Management Strategy Evaluation (MSE) provides a structured, simulation-based framework to address these challenges. Rather than identifying a single optimal solution, MSE evaluates how alternative management strategies perform under a range of plausible conditions by simulating the full fisheries system—including stock dynamics, fishing behavior, data collection processes, and management responses.

Through this process, MSE enables:

- the simulation of system dynamics under uncertainty
- the testing of alternative management strategies (*e.g.* TAC rules, effort controls, harvest control rules)
- the evaluation of performance against multiple objectives, such as yield, ecosystem health, and socioeconomic outcomes

Performance is typically assessed using predefined indicators and reference points, allowing managers to compare trade-offs among different strategies in a transparent and quantitative manner. Furthermore, MSE shifts the focus from finding the “best” assessment to identifying robust strategies that perform consistently well across a wide range of uncertain scenarios (Amoroso & Pons, 2026).

By explicitly incorporating uncertainty and trade-offs into the decision-making process, MSE complements multispecies stock assessment and ecosystem indicators and strengthens the overall MSMG management cycle. It provides a practical tool for supporting adaptive management, improving resilience, and enhancing confidence in fisheries governance in complex and data-limited systems.

Implications for Sub-regional Governance

The integration of multispecies stock assessment, EBFM, and collaborative mechanisms such as the GoTFish-supported partnership has important implications for strengthening sub-regional fisheries governance in the Gulf of Thailand. By linking scientific approaches with cooperative processes, this integrated framework supports more coherent, adaptive, and resilient management of shared marine resources.

Governance

At the governance level, this approach enhances transparency, coordination, and evidence-based decision-making. Aligning analytical frameworks and sharing data and methodologies improve the comparability of assessment results and reduce interpretive uncertainty, facilitating informed dialogue and building trust. Crucially, this process-oriented mechanism allows countries to coordinate without requiring immediate policy harmonization, lowering institutional barriers to cooperation while strengthening the scientific basis for joint decision-making.

Livelihoods

From a socioeconomic perspective, the approach supports small-scale fisheries by promoting sustainable resource use and reducing competition over shared stocks. By incorporating ecosystem indicators and multispecies dynamics, management measures can be better tailored to reflect the realities of mixed fisheries, helping to avoid unintended impacts on fishing communities. In addition, improved transparency and stakeholder engagement contribute to more inclusive decision-making processes, enhancing legitimacy and compliance. Over time, this can reduce conflicts among user groups and contribute to more stable and resilient coastal livelihoods.

Ecosystem Sustainability

In terms of ecological outcomes, the integrated framework strengthens the capacity to maintain ecosystem structure and function. By moving beyond single-species management and incorporating multispecies interactions and ecosystem indicators, the approach supports more holistic assessments of fishing impacts. This helps prevent the overexploitation of vulnerable species, mitigates ecosystem imbalances, and promotes long-term productivity of marine resources. Furthermore, the incorporation of adaptive management and tools such as MSE enables management strategies to respond to uncertainty and environmental variability.

Conclusion and Way Forward

MSMG fisheries represent the dominant and most complex fisheries systems in the Gulf of Thailand, where high biodiversity and mixed catches challenge conventional single-species management approaches. This analysis demonstrates that multispecies approaches provide a more realistic basis for stock assessment by accounting for species interactions, cumulative fishing pressure, and system-level dynamics. When combined with EBFM, these approaches enhance understanding of broader ecosystem processes, enabling managers to better interpret changes in biomass, species composition, and trophic structure.

At the governance level, the GoTFish-supported partnership mechanism illustrates how collaborative approaches can strengthen coordination in transboundary fisheries systems. By emphasizing alignment of analytical frameworks, transparency of assumptions, and shared interpretation of results, the mechanism builds trust and supports gradual convergence in management practices without requiring immediate harmonization of national policies.

Notably, the authors emphasize that uncertainty and trade-offs are inherent in MSMG fisheries and must be explicitly addressed through structured processes such as the MSMG management cycle and Management Strategy Evaluation (MSE). These tools enable the identification of robust management strategies that perform well across multiple objectives, consistent with the concept of “Pretty Good Yield” (PGY).

Overall, a focus on analytical alignment, transparency, and adaptive learning offers a practical and scalable pathway toward sustainable, cooperative, and resilient fisheries management in the Gulf of Thailand. Through practical, operational components such as joint technical platforms, shared datasets, and targeted capacity development, this mechanism allows neighboring countries to progressively build trust and align their scientific methodologies without requiring immediate policy harmonization. Because MSMG fisheries dominate tropical regions like Southeast Asia, this approach serves as a highly adaptable model for other transboundary and data-limited systems in the region. It offers a concrete roadmap for regional bodies seeking to collaboratively balance ecological sustainability, economic viability, and social well-being while respecting diverse national governance structures.

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Resilience and Adaptive Responses in Small-scale Coastal Fisheries: Lessons from Ban Khlong Tob, Krabi Province, Thailand

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Keywords: small-scale fisheries, fisheries productivity, resilience, livelihood diversification, digital marketing

Small-scale fisheries are crucial in ensuring the food security, nutrition, livelihoods, economic stability, and cultural identity of millions across Southeast Asia (FAO, 2015; FAO, 2022). In Thailand, many coastal communities depend on healthy marine ecosystems and open-access fishing grounds. However, these traditional fisheries systems are increasingly under pressure from multiple sources, including climate change, coastal erosion, marine pollution, IUU fishing, urban development, and global market disruptions, such as those experienced during the COVID-19 pandemic, all of which have heightened the vulnerability of small-scale fishers (SEAFDEC, 2023).

To cope with these pressures, small-scale fishing communities must continuously adapt. Adaptive strategies, such as livelihood diversification, the use of digital marketing, and participation in conservation initiatives, are critical for strengthening resilience and supporting long-term sustainability (Pomeroy & Rivera-Guieb, 2006; Berkes *et al.*, 2001). In the context of small-scale fisheries, resilience refers to the capacity of a social-ecological system to

absorb disturbances, adapt to change, and reorganize while maintaining its core functions, livelihood structures, and cultural identity. It encompasses not only ecological stability but also social, economic, and institutional dimensions that enable communities to respond effectively to external shocks and long-term environmental change.

This article examines the adaptive responses and resilience-building strategies of the Ban Khlong Tob fishing community in Krabi Province, Thailand. Data were collected through key informant interviews and focus group discussions with 17 community members during the “Training Workshop on Fisheries Resilience to Fisheries Management in Small-scale Fisheries and Field Trip to Conduct an Impact Assessment Study in Selecting Sites,” conducted from 18 to 25 June 2024 (SEAFDEC, 2024). The results show changes in fisheries productivity, livelihood structures, and ecosystem conditions, and analyze how local responses interact with governance and environmental constraints. This article also provides practical lessons for strengthening resilience in small-scale fisheries facing multiple overlapping shocks.

Introduction

Background of Ban Khlong Tob Fishing Community

Ban Khlong Tob is a small coastal village located in the Koh Lanta Yai Sub-district, Ko Lanta District, Krabi Province, in southern Thailand (**Figure 1**). The community comprises 432 households with a total population of 715 people. Fishing has long been the cultural and economic backbone of the village, although households also engage in rubber cultivation, small-scale trade, and tourism. Like many coastal communities in Southeast Asia, Ban Khlong Tob exemplifies a mixed rural economy rooted in natural resource use and informal employment (FAO, 2022).

The village benefits from access to rich coastal and marine ecosystems, including coral reefs, seagrass beds, and mangrove forests. These ecosystems are not only ecologically valuable but also provide essential habitats for commercially important fish species, supporting local livelihoods (Berkes *et al.*, 2001). However, despite this natural wealth, only about 30 households now engage in year-round fishing, reflecting both demographic shifts and increasing livelihood diversification.



Figure 1. Ban Khlong Tob, Koh Lanta Yai Sub-district, Ko Lanta District, Krabi Province, Thailand

Traditional fishing gear used in the area include crab gillnets, shrimp trammel nets, squid cast nets, fish gillnets, and squid light-luring gear. The village has one small community port located on the beach, which serves as a hub for fish landings, trade, and social interaction. While modest in scale, this infrastructure is critical for supporting both the fishing economy and community cohesion.

In recent years, Ban Khlong Tob has become increasingly connected to external markets and tourism circuits due to improved road access and digital connectivity. These changes present both opportunities and challenges for local fishers, prompting the need for adaptive strategies to sustain livelihoods and preserve cultural identity in a rapidly evolving coastal context.

Study Method

Study Site and Data Collection

The study was conducted in Ban Khlong Tob, Koh Lanta Yai Sub-district, Ko Lanta District, Krabi Province, Thailand. The primary data were collected during a one-day field exercise conducted as part of the “Training Workshop on Fisheries Resilience to Fisheries Management in Small-scale Fisheries and a Field Trip to Conduct an Impact Assessment Study in Selecting Sites,” organized by SEAFDEC and partners from 18 to 25 June 2024. The data collection methods included key informant interviews and focus group discussions (FGDs). A purposive sampling approach was applied to ensure representation of key stakeholder groups, including community leaders, religious leaders, committee members, and active small-scale fishers (both men and women). A total

of 17 interviewees were involved (**Figure 2**). As data were collected during a one-day field exercise, findings represent a snapshot of community perceptions and may not fully capture seasonal variation or long-term trends. However, triangulation with secondary ecological data strengthens the reliability of the findings.

Data Types and Analysis

The discussions followed semi-structured interview guides covering: 1) livelihoods and fishing practices, 2) environmental conditions, 3) perceived changes in fisheries, and 4) adaptive strategies and challenges. Additionally, secondary data were obtained from government sources, particularly the Department of Marine and Coastal Resources. Data were analyzed using descriptive qualitative analysis as well as quantitative summaries (*e.g.* counts and percentages).

Key Findings

Socioeconomic and Livelihood Characteristics

Although the livelihoods of Ban Khlong Tob community are increasingly diversified, around 30 households (about 7 percent) continue to rely on full-time small-scale fishing. Most of the residents are between 25 and 50 years old, with education levels generally reaching upper secondary school. The community is socially cohesive and predominantly Muslim (98 percent), with a small Buddhist minority. Women make up roughly 60 percent of the population.

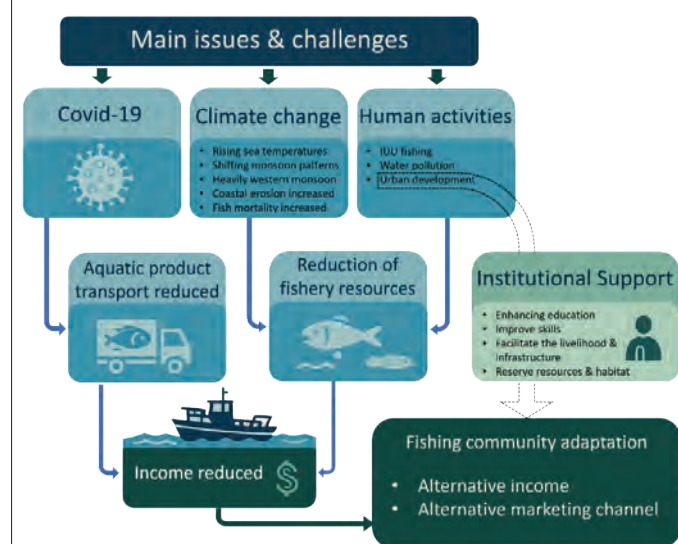
Livelihoods combine small-scale fisheries with agriculture, tourism-related services, trade, and public-sector employment. Fishing activities are conducted within three nautical miles from shore using traditional gear such as crab gillnets, shrimp trammel nets, traps, and squid cast nets with or without luring lights. The monsoon season occurs between April and November. Fish catches have declined substantially over time, with historical catches of 40–100 kg per trip now reduced to an average catch of around 10 kg per trip, and occasional minimum catches of 0–3 kg per trip.

In response to declining fisheries productivity, households are increasingly diversifying their income sources. Tourism-related activities, including island tours and recreational fishing, are undertaken 8–10 days per month and generate approximately THB 1,200–1,500 per trip, while trap fishing provides an additional income of around THB 1,000 per trip. Strong community organizations—such as fisher groups, farmer groups, savings groups, and village funds—along with access to formal and informal financial services, reflect the community’s relatively strong human and social capital and its capacity to adapt.



Figure 2. Key informant interviews and focus group discussions

Box 1. Main issues, challenges, and adaptive responses in Ban Khlong Tob's small-scale fisheries



This conceptual diagram summarizes the interlinked drivers of vulnerability, impacts, and adaptive responses in the Ban Khlong Tob fishing community. External shocks, such as the COVID-19 pandemic, disrupted aquatic product transportation and market access. At the same time, climate change and human pressures—including IUU fishing, marine pollution, and unplanned coastal development—have contributed to ecosystem degradation and declining fishery resources, leading to reduced fishing income and increased livelihood vulnerability.

Urban development plays a dual role in this process. While coastal infrastructure expansion and tourism-related activities can place additional pressure on marine ecosystems, improved roads, services, and digital connectivity have also enhanced accessibility, facilitated tourism and trade, and enabled new livelihood opportunities for community members. In response to these interacting challenges and opportunities, the community—supported by institutional efforts in education, skills development, and infrastructure—has adopted adaptive strategies, such as livelihood diversification and alternative marketing channels, to strengthen resilience and support long-term sustainability. The relationships illustrated in this diagram are further examined in the Discussion section.

Environmental Conditions and Fishery Resources

According to the Department of Marine and Coastal Resources (DMCR, 2022), coral reef conditions in Krabi vary significantly by location; while reefs within Mu Ko Lanta National Park—such as Ko Rok, Ko Ha, and Ko Ngai—remain in ‘Good’ condition, the western coast of Koh Lanta Yai, including Ban Khlong Tob, is currently categorized as ‘Damaged’ due to marine debris and seasonal bleaching. This ecological degradation is further compounded by a declining trend in water quality observed in 2022, characterized by elevated levels of fecal coliform bacteria and phosphates linked to community wastewater and the resurgence of tourism.

Despite 93 percent of the province’s seawater being rated as good overall, the combination of these water quality issues and stressors, like sedimentation from coastal development, has severely impacted the marine ecosystem. Consequently, local communities have reported a sharp decline in the diversity and abundance of economically important fish species. To address these challenges, management measures, such as relocating mooring buoys away from vulnerable reef sites, have been implemented to mitigate the ongoing pressures from maritime and tourism activities (DMCR, 2022).

Vulnerability and Adaptive Capacity

The community is exposed to multiple stressors, including climate change (*e.g.* more intense and less predictable monsoon patterns), tourism development, and external market shocks. Adaptive capacity varies among households and is strongly influenced by access to alternative skills, social networks, and financial capital. While social cohesion and community organizations are strong, governance gaps and weak enforcement limit long-term resilience.

Discussion

Interaction of Vulnerability Drivers

The findings demonstrate that the decline in fisheries productivity in Ban Khlong Tob is not attributable to a single stressor but rather to the interaction of multiple environmental, climatic, and socioeconomic drivers. Environmental degradation, particularly the deterioration of coral reef habitats, has reduced the availability of fish resources and undermined the ecosystem services that support small-scale fisheries. These ecological changes are closely linked to climate variability, including rising sea temperatures, stronger and less predictable monsoon patterns, and increased storm frequency, all of which have reduced fishing reliability and increased operational risks for fishers.

The COVID-19 pandemic further exposed structural vulnerabilities within the local fisheries system, especially the community’s dependence on external markets and middlepersons. Disruptions to transportation and market access led to sharp income losses, revealing the limited buffering capacity of households reliant on a single livelihood source. At the same time, human pressures, such as IUU fishing, marine pollution, and coastal and urban development, have intensified stress on marine ecosystems. While urban development has contributed to habitat modification and increased pollution in some areas, it has also accelerated social and economic change by improving infrastructure, accessibility, and connectivity to tourism and markets. Together, these factors have increased livelihood insecurity, pushed some people to shift away from fishing, and in some cases led remaining fishers to fish more intensively.

These interacting effects create feedback loops that threaten both environmental sustainability and community well-being, highlighting the complex and interconnected nature of vulnerability in small-scale fisheries. Similar patterns of interacting stressors have been documented in small-scale fisheries across Southeast Asia, reinforcing the regional relevance of this case.

Adaptive Responses and Their Implications

In response to these interacting stressors, the Ban Khlong Tob community has adopted a range of adaptive strategies aimed at stabilizing livelihoods and reducing dependence on declining fishery resources. Livelihood diversification has emerged as a central response, with households engaging in tourism-related services, small businesses, and supplementary fishing activities. The expansion of digital marketing and direct seafood sales through social media has further enabled fishers to maintain income during periods of market disruption and to capture greater value by reducing reliance on middleperson.

Participation in conservation and community-based initiatives, including habitat restoration and pollution management activities, has also contributed to strengthening social cohesion and reinforcing stewardship of marine resources. Collectively, these responses have enhanced short-term resilience by spreading risk, improving income stability, and fostering innovation at the community level.

However, households with greater access to education, digital skills, financial capital, and social networks are better positioned to diversify livelihoods and adopt new technologies. In contrast, more vulnerable households face barriers to participation and remain highly dependent on fishing. Moreover, without effective fisheries governance, environmental enforcement, and institutional coordination, there is a risk that some adaptive strategies function primarily as short-term coping mechanisms rather than pathways to long-term sustainability. These findings underscore the importance of aligning community-level adaptation with supportive policy frameworks and governance reforms.

Lessons Learned and Transferability to Other Coastal Communities

This case study offers several contributions that extend existing knowledge on resilience in small-scale fisheries. First, it integrates ecological assessment data with household-level livelihood analysis, indicating that ecosystem degradation—such as declining coral reef conditions and reduced catch volumes—directly influences livelihood decisions and adaptive behavior. This integrated perspective strengthens the understanding of the socio-ecological linkages that shape resilience outcomes.

Second, the post-COVID digital adaptation in a small-scale fishing context, specifically the use of social media for direct seafood marketing, represents a low-cost, scalable innovation that enhances market access, improves profit margins, and engages younger community members. This approach demonstrates how digital tools can serve as effective resilience mechanisms for small-scale fisheries, particularly in contexts with growing connectivity.

Third, the Ban Khlong Tob case provides evidence of partial resilience under governance constraints. Strong social capital, community organization, and local initiatives have enabled adaptation despite limited enforcement capacity and fragmented institutional support. At the same time, the case highlights the limits of community-driven responses in the absence of effective fisheries management, environmental regulation, and cross-sectoral coordination. These insights emphasize that resilience in small-scale fisheries is not solely a function of local capacity but also depends on enabling governance conditions.

Taken together, the lessons from Ban Khlong Tob are highly relevant for coastal communities across Southeast Asia facing similar combinations of environmental change, economic uncertainty, and development pressure. The case illustrates that resilience emerges through the interaction of local innovation, ecosystem stewardship, and supportive institutions, offering transferable insights for policy and practice in small-scale fisheries management.

Conclusion and Recommendations

Ban Khlong Tob illustrates how small-scale fishing communities can respond to compounded environmental and socioeconomic challenges through locally driven adaptation. While livelihood diversification, digital innovation, and strong community cohesion have enhanced resilience in the short term, achieving long-term sustainability will require strengthened fisheries governance, targeted infrastructure investments, and continued ecosystem restoration. The lessons from this case offer practical guidance for policymakers and practitioners seeking to enhance resilience in small-scale fisheries across Southeast Asia. This study provides practical recommendations to serve as a guideline for other areas with similar characteristics, allowing them to adapt these insights for effective implementation, as summarized in **Box 2**. However, without strengthened fisheries governance and sustained ecosystem restoration, current adaptive strategies may mitigate vulnerability in the short term but will not ensure the long-term sustainability of the social-ecological system.

Box 2. Recommendations for strengthening resilience in Ban Khlong Tob's small-scale fisheries

Recommendations	Key actions	Responsible agencies	Timeline	Indicators of success
Strengthen skills and adaptive capacity	Implement annual training programs on climate literacy, digital marketing, and alternative livelihoods	Department of Fisheries, Local NGOs, SEAFDEC	Short-term (0-2 years)	At least 50 % of fishing households participate; increased income from non-fishing sources
Improve coastal and community infrastructure	Upgrade boat hauling facilities, cold storage, waste management systems, and internet connectivity	Local government authorities, Department of Fisheries, Ministry of Transport, Ministry of Digital Economy and Society	Medium-term (2-5 years)	Reduced post-harvest losses; improved market access
Enhance fisheries governance and enforcement	Strengthen enforcement against IUU fishing and establish participatory monitoring involving the community	Community committees, Department of Fisheries, Marine Police	Medium-term (2-5 years)	Reduced illegal fishing incidents; improved regulatory compliance
Restore ecosystems and reduce marine pollution	Conduct quarterly beach clean-ups, install artificial reefs, and implement waste-sorting campaigns	Community groups, Local schools, Department of Fisheries, Department of Marine and Coastal Resources	Ongoing (0 to 10 years)	Improved reef conditions; reduced marine debris

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Assessing the Resilience of Small-scale Fisheries (SSF) at Ban Toh Balew Community, Koh Lanta, Thailand Through Socio-Ecological Perspectives and Community Adaptation

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Keywords: small-scale fisheries, socio-ecological systems framework, indigenous knowledge, rapid rural appraisal

Small-scale fisheries (SSF) are essential for livelihoods, food security, and cultural identity in coastal communities, yet they are increasingly threatened by climate change, declining marine resources, and socio-economic changes. This study examines the resilience and adaptive capacity of the Urak Lawoi indigenous fishing community in the Ban Toh Balew community using the Social-Ecological Systems (SES) framework. Data were collected through focus group discussions and field observations with five purposively selected key informants, and qualitative data were analyzed using thematic content analysis based on SES resilience dimensions. The findings reveal that the community is affected by declining fishery resources, coral bleaching, seagrass degradation, coastal erosion, tourism-related pollution, and restricted access to fishing grounds.

Despite these pressures, the community demonstrates strong adaptive capacity through indigenous knowledge, social cohesion, livelihood diversification, and gender-based roles. Women contribute significantly through seafood processing, household financial management, and alternative livelihoods, while men provide traditional fishing knowledge and marine resource management. Community resilience is further strengthened through cooperation with external agencies and the preservation of cultural identity. However, challenges such as resource depletion, limited market access, and reduced participation in formal governance continue to constrain resilience. The study recommends strengthening co-management, supporting marine habitat restoration, promoting gender-inclusive adaptation strategies, and enhancing community-based livelihood development to improve resilience in small-scale fisheries.

Introduction

Ban Toh Balew (**Figure 1**) is a small coastal fishing community located in Sala Dan Subdistrict, Ko Lanta District, Krabi Province, Thailand. The community is home to the Urak Lawoi, an indigenous sea nomadic ethnic group that has traditionally depended on small-scale fisheries and marine resources for their livelihoods and cultural identity. The community consists of approximately 100 households with a population of around 297 people. Fishing remains the primary occupation, although some households are also involved in tourism-related services, agriculture, and wage labor.



Figure 1. Ban Toh Balew Community, Ko Lanta District, Krabi Province, Thailand

The Urak Lawoi fishers conduct fishing activities around Koh Ha, Koh Rok, Koh Kradan, Koh Ngai, Koh Phi Phi, Koh Ma, and Koh Jum, including nearby mangrove areas and artificial reefs. Fishers own small fishing boats and use various traditional fishing gear such as fish traps (*sai pla*), squid traps, crab and shrimp gillnets, fish gillnets, spears, cast nets, and hook-and-line gear. The fish trap is considered an important part of the cultural identity of the Urak Lawoi people and has been used for generations. Fishing gear is rotated according to the season and target species, particularly during the monsoon season between June and November.

Ban Toh Balew was selected as a study site because it represents a highly vulnerable small-scale fisheries community that strongly depends on coastal and marine ecosystems. The community possesses unique traditional ecological knowledge and cultural practices while facing increasing pressures from climate change, tourism expansion, and resource degradation. The community also actively participates in fisheries and conservation activities, making it suitable for fisheries resilience and community-based management studies.

The community faces several ecological, social, cultural, and governance issues. Environmental challenges include coral bleaching, declining seagrass beds, marine pollution, and decreasing fishery resources. Socioeconomic issues include unstable livelihoods, limited income opportunities,

and restricted access to fishing grounds due to conservation zones and tourism activities. In addition, traditional fishing systems, cultural ceremonies, and the Urak Lawoi language are gradually disappearing. The community also faces challenges related to legal rights, ethnic discrimination, access to justice, and encroachment into sacred and residential areas. These issues highlight the importance of integrated fisheries resilience approaches that combine sustainable fisheries management, cultural preservation, livelihood diversification, ecosystem restoration, and inclusive governance.

Data Collection and Analysis

This study uses the Socio-Ecological Systems (SES) framework to assess resilience across ecological, governance, cultural, and socioeconomic dimensions. Insights are derived from group discussions, community narratives, and secondary sources, with a particular emphasis on local perspectives regarding challenges, strengths, and pathways for adaptation.

The SES framework (**Figure 2**) provides a holistic lens for assessing the resilience of small-scale fisheries (SSF) by recognizing the dynamic interconnections between people and the ecosystems on which they depend (Berkes *et al.*, 2003; Folke, 2006). In the case of the Ban Toh Balew community, Koh Lanta, the SES approach allows for the integration of ecological factors such as fish stocks, coral reefs, and mangroves with social dimensions, including cultural practices, local knowledge, governance structures, and livelihood strategies. By treating humans and nature as one adaptive system with feedback loops, SES helps to evaluate how communities absorb shocks, reorganize, and adapt to changing environmental and socio-economic conditions (Walker *et al.*, 2004; Ostrom, 2009). This framework is particularly useful for understanding community adaptation in SSF, as it highlights both ecological vulnerabilities and the capacity of fishers and households to innovate, diversify, and strengthen governance in the face of challenges such as climate change, resource depletion, and policy pressures (Folke *et al.*, 2010; FAO, 2015).

Rapid Rural Appraisal (RRA) was applied in this survey in the Ban Toh Balew community using a Focus Group Discussion (FGD) approach with five purposively selected key informants. The informants included the village leader, community group leaders, youth representatives, and the *Toh Mo*, the traditional spiritual leader of the Urak Lawoi community. They were selected based on their knowledge, experience, and roles in representing community leadership, traditional knowledge, fisheries livelihoods, and perspectives on climate change and community adaptation.



Figure 2. Socio-Ecological Systems (SES)
Adapted from the Social-Ecological Systems (SES) framework
(Berkes & Folke, 1998; Folke, 2006)

The study was conducted by SEAFDEC/TD in collaboration with the U.S. Department of the Interior during the training on fisheries resilience and climate adaptation held on 21–25 June 2024. The discussion framework focused on three main topics: (1) the history of the community, (2) changes affecting local livelihoods and ways of life, and (3) support from external organizations and the community’s adaptive responses.

Qualitative data obtained from the FGDs (**Figure 3**) were analyzed using thematic content analysis based on the Social-Ecological Systems (SES) resilience framework. The information was categorized into key resilience dimensions, including socioeconomic conditions, environmental changes, governance, cultural adaptation, vulnerabilities, and adaptive capacities. The findings were then interpreted descriptively to explain how climate change and other stressors affect the community and how local knowledge, gender roles, and community networks contribute to resilience and adaptation.



Figure 3. Group discussion with five key informants

Survey Results of Group Discussions in Ban Toh Balew Community, Koh Lanta, Krabi Province

Historical Background of the Village

Historically, the Ban Toh Balew community originally lived in the Laem Tueng area of Ban Sala Dan before gradually relocating several times to the present settlement area. During earlier periods, community members worked in logging and charcoal production in the Bo Nae area (Khlong Lat Bo Nae). After the logging concession ended, the community permanently settled in the current location. At the same time, the sacred shrine known as San Chao Toh Balew was relocated from Bo Nae to the village to preserve the spiritual and cultural center of the community and maintain its identity as a cultural space for the Urak Lawoi people.

An important community leader is *Mr. Madee-en Chang Nam*, locally known as the *Toh Mo* (spiritual leader), who has lived in the area for more than 60 years and serves as the leader of the traditional ceremonies and spiritual practices of the sea nomad community. The Urak Lawoi community continues to maintain close cultural and spiritual connections with the sea through traditional beliefs, fishing knowledge, and local wisdom, such as weather prediction based on observing the sky, stars, wind, and sea conditions.

Cultural Changes: Lost and Remaining Traditions

The survey found that several traditional cultural practices in Ban Toh Balew (**Figure 4**) have gradually disappeared due to modernization, tourism expansion, changing livelihoods, and external influences. Lost traditions include *Wian Koh* (island rotation practice) and *Pui Ya Le* ceremonies. Traditional practices such as “rotational sea use” and “beach sleeping ceremonies” have also declined following the establishment of conservation zones and national parks that restricted access to traditional activity areas. In addition, the sharing culture and mutual support among community members have weakened due to the increasing influence of outside groups and commercialization.

However, some cultural practices remain important within the community, including *Duean Sib* ceremonies, sea spiritual beliefs, and traditional ecological knowledge, such as “reading the sky, stars, water, and wind” to predict weather and fishing conditions. The community still maintains strong spiritual ties with the sea and continues to preserve some traditional fishing practices and rituals.



Figure 4. Ban Toh Balew Community, Ko Lanta District, Krabi Province, Thailand

Fishing Activities and Fish Marketing

Fishing remains the main livelihood activity in Ban Toh Balew (**Box 1**). Fishers operate mainly during the high fishing season from November to April, while tourism and wage labor become more important during the low fishing season between May and October. The community uses various traditional fishing gears such as fish traps, squid traps, crab nets, shrimp nets, fish gillnets, spears, cast nets, and hook-and-line gear. Major economically important species include grouper, squid, shrimp, and crab.

Fish products are mainly sold through middlemen, local fish traders, and fish landing platforms such as Pae Nayok and Le Lanta. Community members expressed a strong need to establish a community fish landing center and cooperative to improve bargaining power, income distribution, and direct seafood marketing. However, they reported lacking technical knowledge and organizational capacity to establish such systems.

Box 1. Fishing gear and methods used in the Toh Balew community	
Fish Traps	Used year-round, fish traps are set near underwater rock piles or coral reefs, around 5-10 meters from the reef. The traps are left for approximately 15 days before retrieval, with each fishing boat deploying about 20 traps.
Squid Traps (Figure 5)	Squid traps are also used throughout the year. Fishers set the traps at around 2:00 PM and retrieve them in the afternoon (around 2:30 PM) to bring them back to shore, preventing damage from other fishing activities. This method is locally known as “Sai Yok.”
Crab Nets	Used seasonally from May to October, crab nets are set in the sea and retrieved the following morning. Fishing is typically conducted during slack tide (from the 5 th to the 11 th lunar day).
Shrimp Nets	Used from May to October, shrimp nets are set early in the morning. If shrimp are plentiful, fishers return in the evening; otherwise, they return around noon. Shrimp fishing is most successful during high tides (from the 12 th to the 6 th lunar day).
Cuttlefish Nets	Employed from November to February, cuttlefish nets are used early in the morning, with fishers returning in the afternoon or evening, depending on the catch. This method is most effective during high tides (from the 12 th to the 5 th lunar day).
Dry Season Fish Nets	Used from October to May, this method involves nighttime fishing. If the catch is abundant, fishers return to shore by 11:00 PM; otherwise, they stay until the next morning.
Krill Scooping	Conducted from October to December, fishers use fine-mesh nets to scoop krill along the shore. Fishing is carried out daily, depending on krill availability.
Line Fishing	Practiced from October to May, this method involves fishing near underwater rock piles or coral reefs.
Spotted Clam Harvesting	From November to March, fishers dive in deeper waters to collect spotted clams, which are abundant during this period.
Squid Jigging	Squid is caught from December to January using artificial shrimp bait while drifting in squid fishing areas.
Spearfishing	Conducted from December to March, fishers dive underwater to selectively target fish using harpoons, typically during slack tide (from the 7 th to the 11 th lunar day) when water clarity is optimal.
Hand-Harpooning	This traditional method, practiced during high tides (from the 14 th to the 5 th lunar day), focuses on subsistence fishing, leaving surplus for sale.
Tib Clam Collection	Practiced during high tides (from the 14 th to the 5 th lunar day), this method involves subsistence harvesting, with excess clams sold for income.
Cast Nets	This method can be practiced year-round and involves the use of throw nets to catch fish.

The community’s fishing methods reflect a balance between traditional practices and sustainable resource use, ensuring the long-term availability of marine resources for their livelihoods.



Figure 5. Squid trap used as an example of fishing gear documented during the survey

Ecological and Socioeconomic Changes

The community has experienced significant ecological changes, including coral bleaching, declining seagrass beds, marine pollution, and declining fishery resources. Species such as Indian mackerel, short-bodied mackerel, and hardtail scads have become increasingly scarce. Dugongs and sea turtles are also observed less frequently because of seagrass degradation and tourism impacts. Community members identified climate change, tourism expansion, wastewater discharge, marine debris, and restrictions from marine protected areas as major drivers of environmental degradation.

At the same time, socioeconomic changes include increased dependence on tourism-related employment, declining fisheries income, and livelihood uncertainty. Although tourism has created additional income opportunities, it has also increased the cost of living and reduced access to traditional fishing grounds. The establishment of Marine National Park zones limited fishing areas and traditional cultural activities. However, after the 2004 tsunami, the community gained greater visibility and received increased support from government agencies, NGOs, and academic institutions.

Community Needs

The community identified several important needs, including:

- Establishment of a community fish landing center and cooperative
- Support for seafood preservation and processing technologies
- Training in value-added seafood products and packaging
- Stronger participation in fisheries and coastal resource management
- Support for indigenous rights and culturally appropriate management policies
- Documentation and preservation of Urak Lawoi traditional knowledge and culture

Social Dimensions of Resilience in Toh Balew

Table 1 outlines the operationalization of the social dimensions of resilience in the Toh Balew (Urak Lawoi) socio-ecological system based on the six adaptive capacity domains proposed by Cinner and Barnes (2019): assets,

flexibility, social organization, learning, socio-cognitive constructs, and agency. **Box 2** shows the results of the group discussions of the community’s strengths, opportunities, limitations, and external drivers.

Using the social dimensions framework, resilience in the Toh Balew socio-ecological system is supported by access to ecological and technological assets, flexible livelihood strategies that combine fishing and tourism, strong cultural and organizational structures, and learning processes that integrate traditional knowledge with modern tools. Socio-cognitive dimensions, including cultural identity and conservation attitudes, further enable adaptive responses, while agency is expressed through community engagement in governance and market systems. However, resilience is constrained by weak tenure security, erosion of intergenerational knowledge, limited infrastructure, occupational attachment to fishing, and reduced bargaining power in tourism and seafood markets. Strengthening resilience, therefore requires not only ecological management but also investments in social assets, learning institutions, governance recognition, and community empowerment.

Table 1. Social dimensions of resilience in the Toh Balew socio-ecological system

Resilience Domain	Information from Toh Balew SES	Contribution to Resilience	Key Constraints
Assets	Reefs and seagrass fisheries, GPS, weather apps, education, healthcare, market access	Supports livelihoods, safety, and market connections	Limited fish landing, cold storage, and processing facilities
Flexibility	Mixed traditional and modern fishing practices, tourism jobs, willingness to relocate if culture respected	Enhance adaptation and income diversification	Dependence on fishing and restricted fishing zones
Social organization	Fisher groups, health volunteers, support from government, NGOs, academia, Toh Mo leadership	Strengthens cooperation and resource management	Weak indigenous tenure recognition
Learning	Traditional ecological knowledge combined with scientific information and conservation awareness	Improves adaptive capacity and environmental understanding	Loss of traditional knowledge among younger generations
Socio-cognitive constructs	Strong sea-based cultural identity, Loi Ruea ritual, and positive conservation attitudes	Encourages stewardship and community cooperation	Discrimination and limited livelihood alternatives
Agency	Engagement with external organizations, demand for fish landing and processing facilities	Supports participation and proactive adaptation	Dependence on middle buyers and limited market power

Box 2. Group discussion results: strengths, opportunities, limitations, and external drivers

Strengths: • Deep traditional ecological knowledge and sustainable practices • Flexible and adaptive mindset, including openness to rules and external collaboration • Strong local leadership with extensive networks	Opportunities: • Post-tsunami recognition has enhanced access to support and resources. • Eco-tourism offers potential for cultural preservation and economic diversification. • Community solidarity remains a strong foundation for collective action.
Limitations: • Ecological restoration capacity is weak, leaving fisheries highly vulnerable to decline. • Cultural knowledge transfer is diminishing, threatening long-term identity. • Economic dependency on fisheries creates exposure to stock fluctuations and market volatility.	External drivers: • Climate change remains the most pressing factor, manifesting in stronger storms, rising sea levels, and coral bleaching. • Tourism expansion contributes both income and ecological stress, requiring regulation and sustainable planning. • National Park policies highlight the tension between biodiversity conservation and indigenous livelihood rights, emphasizing the need for co-management frameworks.

Conclusion

This study, based on qualitative discussions with selected key informants, provides valuable insights into the resilience, vulnerabilities, and adaptive capacities of the Urak Lawoi indigenous community in Ban Toh Balew Community. The results show that the community remains deeply connected to small-scale fisheries, coastal ecosystems, and traditional cultural practices, which together form the foundation of their livelihoods, identity, and social cohesion. The findings also reveal important resilience attributes, including strong traditional ecological knowledge, flexible livelihood strategies, close social networks, cultural values, and a willingness to adapt to changing environmental and socioeconomic conditions. These characteristics have enabled the community to cope with climate variability, declining fisheries resources, and rapid coastal development.

At the same time, the study highlights how multiple stressors are increasingly threatening the sustainability of both the marine ecosystem and the community's cultural identity. Climate change, coral bleaching, seagrass degradation, tourism expansion, pollution, and restricted access to traditional fishing grounds are not only affecting fishery productivity but also transforming traditional ways of life and weakening intergenerational knowledge transmission. The gradual erosion of cultural practices and indigenous knowledge systems suggests that resilience in coastal communities is closely linked not only to ecological conditions but also to cultural continuity, social inclusion,

and equitable governance. The findings further demonstrate that resilience in small-scale fisheries should be understood as a dynamic socio-ecological process rather than simply the ability to recover from environmental shocks. In the case of Ban Toh Balew, resilience is strengthened through the interaction of local knowledge, community cooperation, livelihood diversification, and external support from government agencies, academic institutions, and civil society organizations.

Women's contributions to seafood processing, household adaptation, and community networks, together with men's fishing knowledge and resource-use practices, highlight the importance of gender roles in sustaining adaptive capacity and community well-being. This study provides broader implications for fisheries management and climate adaptation in coastal and indigenous communities across Southeast Asia. It underscores the need for integrated and culturally sensitive approaches that combine sustainable fisheries management, habitat restoration, livelihood support, gender inclusion, and protection of indigenous cultural heritage. Policies that overlook local knowledge systems and customary resource-use practices may inadvertently weaken community resilience and increase vulnerability.

Therefore, participatory governance and co-management approaches that actively involve indigenous and small-scale fishing communities are essential for achieving long-term sustainability. The study also contributes to the broader discourse on social-ecological resilience by demonstrating how indigenous coastal communities can serve as important sources of local knowledge and adaptive practices in responding to environmental change. The experiences of the Ban Toh Balew community provide practical lessons for policymakers, researchers, and development practitioners seeking to strengthen resilience in small-scale fisheries under increasing climate and socioeconomic pressures. Supporting community participation, improving market opportunities and seafood value addition, preserving indigenous knowledge, and promoting equitable and culturally appropriate policies will be critical for enhancing both resilience and long-term well-being of coastal fishing communities.



Locals assist each other in cleaning mussels in Toh Balew

Recommendations for Enhancing the Resilience of the Toh Balew Fishing Community

Enhancing resilience in Ban Toh Balew requires integrated approaches that strengthen ecological sustainability, community livelihoods, cultural preservation, and participatory governance. The study results show that the Urak Lawoi community possesses strong adaptive capacity through traditional ecological knowledge, flexible attitudes, and strong community networks. However, the community continues to face challenges from climate change, declining fishery resources, tourism impacts, and restricted access to traditional fishing grounds. Therefore, resilience can be enhanced through habitat restoration, sustainable fisheries management, support for community fish landing and seafood processing facilities, promotion of eco-cultural tourism, and strengthening the participation of the community in coastal resource management and policy development. Preserving indigenous knowledge and cultural practices, while improving livelihood opportunities and collaboration with government agencies and external organizations, will support the community's long-term sustainability and well-being.

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Labor Motivation in the Fishing Industry: A Case Study in Thailand

Donrudee Suwankiri

Keywords: fishing industry, individual motivation, social motivation, workplace environment motivation

The fishery industry is a vital economic and nutritional lifeline for Southeast Asia, supporting millions of livelihoods and serving as the primary source of protein for over half a billion people across the region. From 2011 to 2022, Thailand's fishing industry saw declining catches but rising economic value, indicating a shift to higher-value species (Fisheries Policy and Planning Division, 2021). Southeast Asian nations are also facing widespread declines in wild marine catches, driven by climate change, destructive fishing gear, overfishing, and Illegal, Unreported, and Unregulated (IUU) fishing. These factors have heavily impacted coastal stocks, threatening local food security, ocean ecosystems, and the livelihoods of traditional fishers across the region (Geopolitical Monitor, 2018).

Researchers surveyed 394 Thai fishing vessel crews across 22 coastal provinces (a sample size determined to represent the wider workforce) using a structured questionnaire. Statistical analysis was then used to compare groups and identify relationships between variables.

The findings showed that social motivation, particularly family responsibilities and relationships with vessel owners, was the most significant influencing factor among Thai fishing crews. Individual motivations also scored highly, while workplace environment motivation (including safety and hygiene) was rated positively but remained less influential than personal and social motivations.

These findings point to ways on how vessel owners and policymakers can attract Thai workers to join the fishery sector: enhance job satisfaction, foster supportive social relationships, and improve workplace conditions. Doing so would help secure the industry's sustainability and economic growth.

However, demanding, unsanitary, and hazardous conditions have deterred local workers from entering the industry, leading to workforce shortage and increased reliance on foreign fishing crews. Labor data from January 5, 2022, showed a total of 60,967 crew members in the fishing industry, far short of the estimated demand of around 150,000. Among these, 25,433 were Thai nationals, while 35,534 were migrant workers (Resource Management and Measures Determination Division, 2021). In 2023, crew members decreased to 58,696 which 34,038 were migrant workers and 24,658 were Thai nationals (Department of Fisheries, 2023).

Thailand has been consistently striving to tackle labor issues within the sector to meet demand. Yet, despite these efforts, undocumented foreign workers continue to enter the country to work on vessels, exacerbating issues such as illegal labor, human trafficking, forced labor, and child labor. As a result, Thailand was downgraded to Tier 3, the lowest ranking, by the United States Department of State in its 2014 Trafficking in Persons (TIP) Report (U.S. Department of State, 2015). Following this, in 2015, the European Union announced that Thailand was at risk of non-cooperation in combating IUU fishing. Considering the issues, Thailand faces the risk of trade sanctions from both the United States and the European Union. Such sanctions could block seafood exports to these markets, which would negatively impact the industry and the economy. Moreover, it could lead to job losses, increased criminal activity, strained diplomatic relations, and damage to Thailand's international image.

While labor shortages have increased reliance on migrant workers, with an estimated 160,000 to over 300,000 migrants from Cambodia, Lao PDR, and Myanmar employed in its fisheries and seafood processing sectors (International Organization for Migration [IOM], 2023), this study deliberately examines the motivations of Thai fishing crews to join fishing vessels, considering demographic, personal, social, and workplace factors.

Therefore, it is worthwhile to explore the motivating factors that drive Thai individuals to pursue careers as fishing crews in the industry. By understanding these factors, targeted information campaigns can be designed to raise awareness and interest among potential local workers to join the sector, thus encouraging more individuals to enter this field. This, in turn, will ensure the long-term sustainability of the industry and establish it as a viable career path, ultimately contributing to GDP growth and overall national prosperity.

Introduction

The Thai fishery industry is considered vital to the economy and serves as a significant source of income for national development. It has created many businesses, with overall production value averaging THB 66,741 million (USD 2,134 million) per year over the past decade (2011-2020). In particular, the marine fishery sector has been the predominant contributor, accounting for THB 56,961 million (USD 1,821 million) per year, or 85.35 percent of the total (Fisheries Policy and Planning Division, 2021). Labor plays a crucial role, driving the momentum of the marine fishery industry.

Motivation, Job Satisfaction, and Labor

Motivation is the internal drive that stimulates a person's desire and effort to reach specific goals, guiding their behavior and satisfaction (Alcivar *et al.*, 2020; Astuti *et al.*, 2020). Intrinsic motivation is rooted in personal interest and enjoyment, while extrinsic motivation is influenced by external rewards or punishments (Sadiah *et al.*, 2023). An individual's motivation is shaped by their self-concept (Markus, 1977), alongside genetic (physical needs), social (need for acceptance), cultural (values and norms), and experiential factors (learned patterns), which is expressed through its intensity and direction (Smithikrai, 2022).

Workplace and social environments heavily influence employee behavior. As teams form, they develop norms and use social cues (such as non-verbal signs of disapproval) to control member behavior. While high social intensity fosters security, it can also lead to "groupthink," stifling an individual's initiative. Moreover, physical environments affect employee wellness and focus across ambient, sensational, and interactive dimensions (Horayangkura, 2019). Overcrowding can result in a "behavior sink," where social structures collapse and workers withdraw, permanently impacting work productivity.

Job satisfaction reflects whether worker's expectations are met (Muchinsky, 2000) and depends on factors such as age, nature of tasks, and compensation. Optimal job performance is achieved through the integration of intrinsic and extrinsic motivation (Amabile, 1993). Although recognition and responsibility are key variables for efficiency (Boonrueang, 2017; Boonrit, 2015), hygiene factors like salary and workplace relationships may have more impact to productivity where basic security is a primary driver (Bexheti & Bexheti, 2016). For Thai employees specifically, core drivers of effectiveness include human resource development, achievement orientation, and teamwork (Wongchiangyuen, 2015).

Methodology

Population and Sampling

The study population comprised 24,685 Thai crew members working on 9,594 licensed commercial fishing vessels in 22 coastal provinces of Thailand. The sampling method used proportional allocation formula by province to ensure widespread distribution of the sample. Using the Taro Yamane's formula with a 95% confidence level, the minimum required sample size was determined to be 394 Thai nationals of any gender, aged 20 or older. This

method ensured a statistically significant sample size that represented the target population, allowing reliable research results within the specified parameters. To collect the data, the researchers partnered with local fishery officials, who distributed the questionnaires to crew members during scheduled boat inspections after being briefed by the research team (Figure 1).



Figure 1. Conduct of survey interviews

Research Instrument

The questionnaire asked respondents to rate statements on a five-point Likert scale, from 5 (strongly agree) to 1 (strongly disagree). Content accuracy was verified by the Deputy Director-General of the Department of Fisheries of Thailand, and the Index of Item-Objective Congruence (IOC) was evaluated by a specialist from the National Research Council of Thailand.

Data Analysis

Data were analyzed using both descriptive and inferential statistics. Descriptive statistics were used to summarize and present the data, while inferential statistics, specifically ANOVA, were applied to draw conclusions and make predictions. Group differences were evaluated using *t*-tests and *F*-tests, while the strength and direction of relationships between variables were assessed using Pearson correlation coefficients.

Results and Discussion

The survey explored the driving forces that motivate individuals at work and how they impact productivity, performance, and overall job satisfaction.

Demographic Profiles and Their Impacts

Gender and Age

The sample exhibited a stark gender disparity, with males comprising 99.0 percent and females accounting for just 1.0 percent of the workforce, reflecting the physically demanding nature of fishing and traditional gender roles within the industry (**Figure 2**).

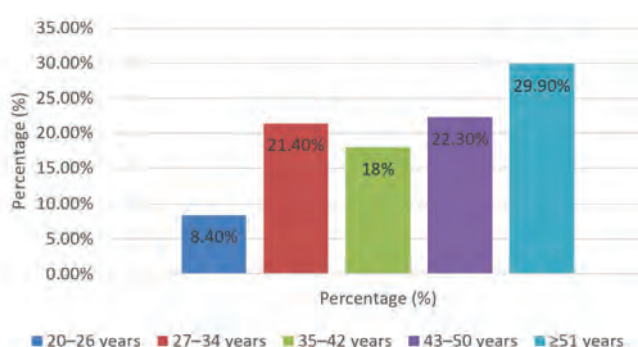


Figure 2. Fishing crew by age group

The local fishing workforce is aging: crew at least 51 years old comprise 29.9 percent, followed by those aged 43–50 years at 22.3 percent. The youngest cohort (20–26 years) accounts for only 8.4 percent, a sign that few young people are entering the industry. Age significantly influences motivation: crew members aged 51 years and older exhibited the highest motivation, while younger workers (35–42 years) reported the lowest, suggesting that veteran crews find greater satisfaction from industry longevity. Moreover, female Thai crew showed slightly higher motivation than males, although the variation was statistically insignificant.

Marital Status and Family Responsibilities

Half of the respondents (50.0 percent) were married or cohabiting, 35.0 percent were single, and 15.0 percent were divorced/separated (**Figure 3**). Married crew members reported higher motivation compared to other groups, consistent with the idea that providing economic support to the family drives work motivation, and aligns with Adler's philosophy that work contributes to the welfare of others (Chan & Kalliath, 2020; Kishimi, 2018). This matches other research showing that financial stability for the family is a major motivator for married workers (Radević *et al.*, 2023; Kohnen *et al.* (2023).

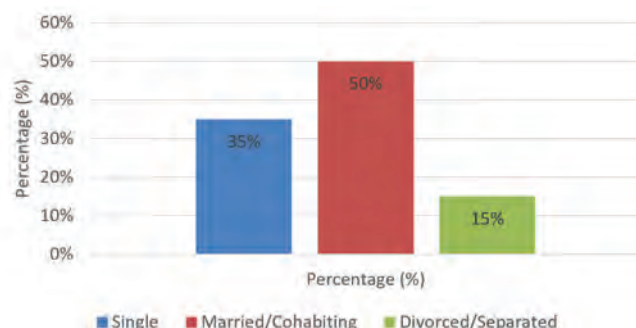


Figure 3. Fishing crew by marital status

Income, Tenure, and Education

Nearly half of workers (45.4 percent) earned THB 15,001–25,000 (USD 428–714) per month, 23.4 percent earned more than THB 35,000 (USD 1,000) per month, while just 9.4 percent earned at most THB 15,000 (USD 428) (**Figure 4**). Income level significantly impacted motivation; crew members earning THB 25,001–35,000 reporting the highest motivation, while those in the lowest income bracket reported the lowest.

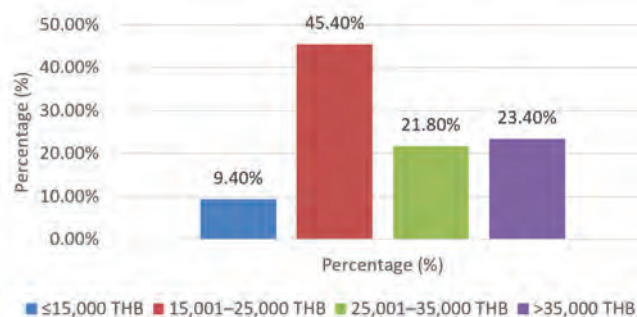


Figure 4. Fishing crew by monthly income

Most crew members (91.9 percent) completed high school or lower, while 6.3 percent held vocational diplomas and 1.8 percent had a bachelor's degree (**Figure 5**). Higher educational attainment strongly correlates with elevated motivation, with bachelor's degree holders scoring higher than those with high school education.

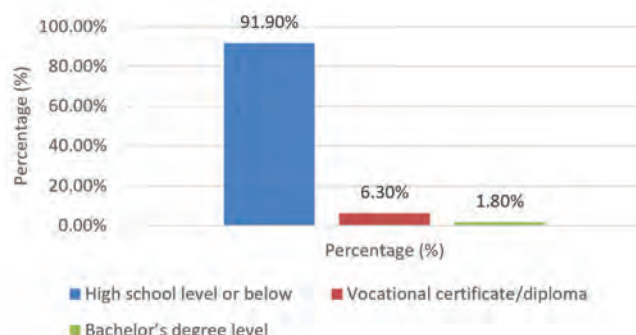


Figure 5. Fishing crew by educational attainment

Employment tenures also varied widely: 45.4 percent worked in the industry from 2 to 10 years, while 23.4 percent had served for 20 years or more (**Figure 6**). Crew members working for at least 20 years exhibited the highest motivation, whereas those in the 2–10-year bracket reported the lowest, indicating that while the industry faces retention challenges, long-term tenure builds expertise and commitment (Ngamlert, 2016).

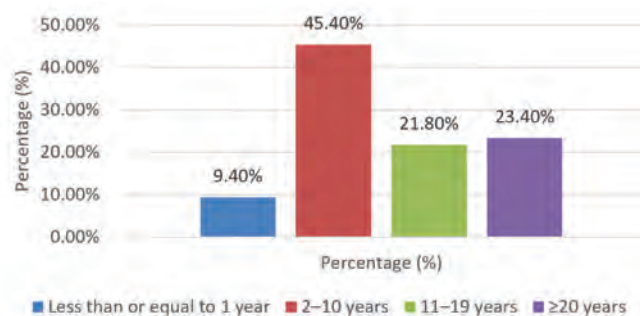


Figure 6. Fishing crew by employment tenure

Factors that Influence Crew Motivation

Individual Motivation

Individual job satisfaction was high, driven heavily by goal achievement, skill utilization, and task completion, reflecting a clear link between effort and outcomes. Grant (2019) posits that goal setting and performance measurements are key to sustained motivation. While anxiety-related motivation scored highly (indicating that a peaceful work environment free from competition or fear of termination significantly reduces stress), workers noted that strong relationships among colleagues and supervisors mitigate workplace anxiety (Jaikliang & Hongsangiam, 2018). Moreover, while crew members viewed their job as a fundamental purpose, long-term commitment to the industry remains low.

Social Motivation

Social motivation scored highly overall, with Thai fishing crews placing real value on compassionate colleagues. Supportive peer structures foster workplace happiness and belonging, which correlates positively with job satisfaction metrics (Kaenchan & Buddhawong, 2018).

A good relationship with the boat owners was one of the major motivators the crew members identified. Fairness and encouragement from boat owners promoted long-term retention. This aligns with studies showing that supportive management and empathetic leadership reduces turnover intentions, improve employee morale and motivation, and enhances problem-solving skills and commitment (Abu Shmais, 2013; Sadiah *et al.*, 2023; Suminthron, 2011; Tipraruksa, 2013).

Workplace Environment

Within the workplace, ease of work scored highest, as crew members consider themselves highly skilled and enjoy their jobs. Acquiring new skills and expertise contributes to job satisfaction, as it enhances work engagement (Rhoades & Eisenberger, 2002). Social motivation has the highest impact on overall motivation, emphasizing the role of social acceptance in confidence and achievement. This supports social exchange theory, which links employee satisfaction to workplace rewards and collaboration (Ejigu *et al.*, 2023; Günay, 2017).

Workplace hygiene, good ventilation and sanitary standards also boosted crew motivation. Research showed that smaller crews and less crowding improve air quality and reduce risks of disease (Horayangkura *et al.*, 2019). While Thai fishing crews acknowledged existing protocols, they still expressed concerns about personal safety, highlighting the need for a proactive safety culture to reduce workplace hazards and build worker trust (Koonchalee, 2017; Snell & Morris, 2019).

Motivational Interactions and Policy Implications

Results revealed that social motivation was the most powerful driver for the crew members, followed by individual motivation and workplace conditions. All three factors are closely linked, suggesting that individuals with strong personal motivation also exhibit high workplace and social motivation (Füz *et al.*, 2022; Pincus 2022). Furthermore, crew members perceive work as central to their lives and tied closely to their livelihood, skills, and sense of satisfaction (Bhandesa & Wibawa, 2022). While compensation and stability factors influence motivation, trust in boat owners and fair performance evaluations foster retention (Lorincová *et al.*, 2018; Wei *et al.*, 2024).

The findings emphasize that job satisfaction, social relationships, and workplace conditions are essential in sustaining workforce motivation. Policies focusing on fair compensation, supportive supervision, and work-life balance can enhance job retention and performance. Ultimately, addressing these insights will support evidence-based policies to improve crew conditions, ensuring sustainability and workforce well-being. Prioritizing worker motivation and job satisfaction will contribute to a more stable and productive fishing sector.

Conclusion and Way Forward

This study examined the factors influencing crew motivation within the Thai fishing industry. Thailand's domestic labor shortages in fisheries mirror a widespread workforce crisis across Southeast Asia, where gaps are typically filled by vulnerable migrant workers. For instance, Thailand relies heavily on crews from Cambodia, Myanmar, and Viet Nam, just as destination fleets in Taiwan and South Korea rely on migrants from the Philippines, Indonesia, and Viet Nam.

The findings show that workforce motivation is driven by job satisfaction, workplace relationships, and working conditions. Marital status, income, and experience significantly impact motivation, with higher earnings fostering greater commitment. Future research should integrate qualitative methods to capture Thai fishing crews' perspectives and cross-industry comparisons for broader insights. Longitudinal studies and intervention evaluations, such as safety measures and social support, can offer strategies to enhance workforce retention, fostering a more sustainable and productive work environment.

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Stock Assessment and Management of Brushtooth Lizardfish (*Saurida undosquamis*) in the Gulf of Thailand Using the Menu Driven JABBA Software

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Keywords: menu driven JABBA software, Harvest Control Rule, species composition, brushtooth lizardfish, CPUE standardization

Aims of This Study

There are two aims in this study: (1) to conduct the first formal stock assessment of the brushtooth lizardfish (*Saurida undosquamis*) in the Gulf of Thailand using 52 years of data (1971–2023) by the menu driven JABBA (Just Another Bayesian Biomass Assessment) software; and (2) to evaluate whether JABBA is a promising single-species surplus production model for future adoption by the Department of Fisheries (DOF), Thailand to replace current models.

Catch Estimation, q (Catchability) and CPUE Standardization

Because the six lizardfish species are reported as one species group in national statistics, species-specific catches were estimated using annual species compositions derived by the research data (demersal trawl surveys and port sampling programs). Four different catchability (q) periods were identified, reflecting historical and technological changes in fisheries. Accordingly, four standardized CPUE series from national statistics and research data were estimated for each q period using Generalized Linear Models (GLMs) to be used as inputs for the JABBA assessments.

Assessments by the Menu Driven JABBA Software

Using catch data, standardized CPUE, and parameter priors required for the Bayesian model, JABBA assessments were conducted. Consequently, three major findings were obtained: (1) JABBA results and risk assessments are reliable, robust and

plausible according to retrospective and hindcast analyses; (2) stock status in 2023 (the last stock assessment year) was in the safe (green) zone in the Kobe plot, suggesting that the 2015 fisheries reforms allowed unhealthy pre-2014 stock (orange zone) to quickly recover; and (3) while a high TAC can be set due to the safe stock status, determining the TAC is complex and must be done carefully because the MMM (multi-gear and multi-species fisheries management) framework must also consider the stock status and MSY of other management species and other relevant factors.

Way Forward

Based on this study, the authors recommend four actions for the DOF to: (1) switch from current models to JABBA surplus production model to conduct single-species stock assessments; (2) apply the JABBA-HCR (Harvest Control Rule) approach to reduce the DOF's workload, as JABBA requires substantial effort. This can be done through a routine scheme where full JABBA assessments can be implemented, for example, every five years, while a simple HCR can be conducted during the four years in between. In this way, stock status and TACs can be derived with less effort; (3) enhance the ongoing MMM framework by incorporating results from JABBA-HCR single-species assessments; and (4) (if time allows) explore the Multiple Maximum Sustainable Yield (MMSY) approach (recently introduced by SEAFDEC and FAO) as a reference for the MMM framework.

Introduction

Background

Thailand has been conducting stock assessments for aggregated species of pelagic fish, demersal fish and anchovies following the 2015 national fisheries reforms, enabling the direct application of stock assessment results to marine fisheries management. The DOF has been using the original equilibrium Fox Surplus Production Model (SPM) (Fox, 1970) to assess the status of these fishery resources, although aggregated-species assessments produce uncertainties. The results have been used to allocate Total Allowable Catch (TAC) within fisheries management frameworks (DOF, n.d.). For individual species, the length-based Thompson & Bell (TB) model (1934) has been used; however, because its results are considered unreliable, they have served only as a reference.

Aims of This Study

The DOF and [MENU] (Menu driven fish stock assessment software development team) (Japan) co-organized two workshops in 2024 and 2025 to assess important species in Thailand. During the second workshop (2025), JABBA (Just Another Bayesian Biomass Assessment) (Winker *et al.*, 2018) was introduced, and participants received training in its application. JABBA is an advanced SPM designed for data-moderate stock assessments using more than 10 years of catch and Catch-per-Unit-Effort (CPUE) data alongside parameter priors for the Bayesian framework. It not only produces more theoretically reliable, robust and plausible results than previous SPMs, such as ASPIC (Prager, 2004), but also provides practical advantages. JABBA was applied to brushtooth lizardfish (*Saurida undosquamis*), a commercially important lizardfish species that serves as a primary raw material for *surimi* production in Thailand. Notably, despite being exploited for a long time, this important species has never undergone a formal stock assessment.

In response to this situation, this study sets three objectives: (1) to conduct the first formal stock assessment of brushtooth lizardfish using JABBA, with the aim of becoming the DOF's official assessment model if the results are promising; (2) if the DOF adopts JABBA, the JABBA-HCR (Harvest Control Rule) approach should be considered to reduce the DOF's workload, given the time-consuming nature of JABBA assessments; and (3) to enhance the MMM (multi-gear and multi-species fisheries management) framework currently implemented by the DOF by incorporating additional species-specific stock assessments.

Figure 1 shows the participants and activities of the demersal fish working group members who conducted JABBA assessments for brushtooth lizardfish in the second workshop in 2025.



Figure 1. (top) Participants at the second workshop co-organized by DOF and [MENU]* on May 2025; (lower two pictures) Activities on the JABBA assessments of brushtooth lizardfish by the demersal fish working group members

*[MENU] Menu driven fish stock assessment software development team (Japan)

Ecology, Biology and Stock Structure

Lizardfishes are bottom-dwelling species that live in shallow waters on sandy or muddy seabed. They have an elongated, cylindrical body and a lizard-like head with a large terminal mouth, feeding on bottom-dwelling invertebrates and fish (Carpenter & Niem, 1999). The species is distributed mainly throughout the eastern Indian Ocean, the Malay Peninsula, the southern Philippines, northern Java, the Arafura Sea, and the northern and southwestern coasts of Australia (FishBase, 2026) (**Figure 2, top**). Because the stock structure around the Gulf of Thailand is currently unknown (**Figure 2, bottom**), the Gulf of Thailand was assumed to be one of the sub-stock areas in this study. This assumption introduces uncertainties into the assessment results. The Thai national statistical bulletin reports the catches of six relevant lizardfish species together. Among these, the two dominant species are the brushtooth lizardfish (*Saurida undosquamis*) and the slender lizardfish (*Saurida elongata*) (**Figures 3 and 6**).

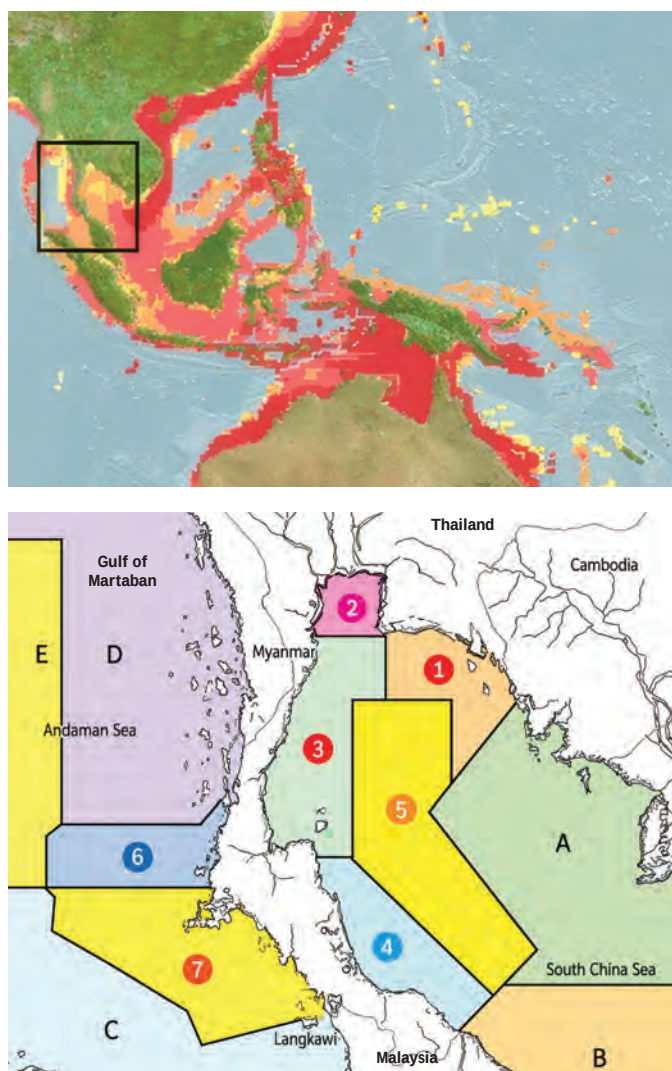


Figure 2. (top) Distribution of brushtooth lizardfish (*Saurida undosquamis*) (FishBase, 2026); (bottom) Thai waters presented by the statistical areas (Gulf of Thailand and Andaman Sea). The study area is the Gulf of Thailand covering areas ①-⑤



Figure 3. Six common lizardfish species identified in Thai waters

Fisheries and Change of Catchability (q)

Lizardfish are primarily caught by trawls (**Figure 4**), with small contributions from gillnets, purse seines and other demersal gear types.

Catchability (q) is an important parameter in fish stock assessments. The value of q increases over time due to various factors related to fisheries development; hence, different q values across different periods should be standardized for the assessments. In this study, the development of Thai fisheries (1960–2023) was divided into four q periods (**Table 1**). Technological advances in gear, boats and other equipment are assumed to correspond to these developments. These four q periods were incorporated into both the CPUE standardization and the JABBA assessments.



Figure 4. A trawl fishing vessel targeting mixed demersal fish (including brushtooth lizardfish) in Thai waters

Table 1. Development of Thai fisheries and corresponding q (catchability), 1960–2023

q	Period	Fisheries developments affecting q (catchability)	Assignments of q for JABBA (1971–2023)
q_1	1960–1974	- Initial development of Thai Fisheries - Expansion from coastal to offshore fisheries	q_{12} (1971–1994) ($n=24$). Because q_1 (1971–1974) is only for 4 years, the combined q_{12} will be used
q_2	1975–1994	- Fisheries were mostly limited to the Thai EEZ due to the fishing technology of that time - Expansion of large trawl fisheries to neighboring countries in the mid-1990s	
q_3	1995–2015	- Thai vessels fished in Thai EEZ, with some operating in the high seas of the Indian Ocean - No fishing in neighboring EEZs like Myanmar, Cambodia, and Indonesia	q_3 (1995–2015) ($n=21$)
q_4	2016–2023	- Establishment of strict management measures - Change of data collection & reporting systems	q_4 (2016–2023) ($n=8$)

Data

Two types of input data are required to run JABBA: total catch and gear-specific nominal CPUE from the same stock or sub-stock area; in addition, prior information on the parameters is required to run this Bayesian model.

Total catch

The 52-year time series of aggregated lizardfish catch (comprising six species) in the Gulf of Thailand (1971–2023) was obtained from national fisheries statistics. The brushtooth lizardfish catch used in the JABBA assessment was estimated using species compositions.

Nominal CPUE

Two data sources were used to obtain nominal CPUE, *i.e.* national fisheries statistics and research data (demersal trawl surveys and the port sampling program). Demersal trawl surveys have been conducted by four fishery research vessels of the Marine Fisheries Research and Development Division

of the DOF. Haul-by-haul survey data are available for 21 years (2003–2023), while port sampling data are available at the individual-vessel (trip) level for 10 years (2014–2023). After examining these data, 20 nominal CPUE datasets are compiled by data source, catchability (*q*) period, gear, and CPUE unit (**Table 2**).

Table 2. Summary of nominal CPUE of brushtooth lizardfish

Source	Scale	Period of catchability (q)	Period	Gear	No. of years	No	CPUE Unit: Catch (kg) and effort (below)			
National Statistics	Coarse scale by month	q12	1971–1994	PT	24	1	day			
						2	hour			
				OBT		3	day			
						4	hour			
		q3	1995–2015	PS	21	5	day			
						6	hr			
				PT		7	day			
						8	hr			
				OBT		9	day			
						10	hour			
				q4		2016–2023	PS	8	11	day
									12	hr
		PT	13		day					
			14		hour					
		OBT	15		day					
			16		hour					
Research data	Port sampling	Fine scale (set by set data)	q4	2016–2023	PT	8	17	day		
							18	hour		
	Survey	q3	2003–2015	OBT	13	19	tow			
		q4	2016–2023	OBT	8	20	tow hour			

PT: Pair Trawl, OBT: Otter Board Trawl, and PS: Purse Seine

Catch Estimation

The 52-year annual total catch of lizardfish is reported as species-aggregated data (six different species combined) (**Figure 3**) in the National Fisheries Statistics. Therefore, the total catch had to be disaggregated into individual species catches prior to conducting the stock assessments. The disaggregation was based on annual species compositions from two types of research data (trawl survey and port sampling). Equation (1) shows the estimation formula:

$$\text{Annual brushtooth lizardfish (SU) catch} = (\text{OBT} \times p_{\text{obt}}) + (\text{PT} \times p_{\text{pt}}) + (\text{OTH} \times 0.1)$$

OBT : Annual lizardfish catch by the otter board trawl
p_{obt} : Annual SU catch composition (%) in the demersal trawl survey (2003–2023)
PT : Annual lizardfish catch by the pair trawl
p_{pt} : Annual SU catch composition (%) in the pair trawl survey (port sampling program) (2014–2023)
OTH : Annual lizardfish catch by all other gear without OBT and PT
0.1 : Annual average SU composition (10%) in the other gear (assumed value)

For periods when no research data are available, the annual catch composition of brushtooth lizardfish (SU) was estimated using the overall average SU composition by gear type from the two-research data: 1971–2002 for OBT (trawl survey) and 1971–2013 for PT (port sampling). For periods when the research data are available, the annual catch composition of brushtooth lizardfish was estimated by gear type across the two research periods mentioned above. For all other gear, due to limited information, a constant value of 10 percent was applied throughout the entire period (1971–2023). **Figure 5** illustrates the trend in the estimated annual catch composition (%) of brushtooth lizardfish by gear. **Figure 6** shows the species composition (%) of the six lizardfish species within the OBT and PT catches based on the overall average species composition.

The annual catch of brushtooth lizardfish was estimated using Equation (1) as shown in **Figure 7**. SU catch gradually increased from 1971 to 1995 (1,600–5,200 t) with some fluctuations, followed by a decline to 2,600 t by 2000. During the following 13 years (2001–2013), catches increased sharply to 7,500 t

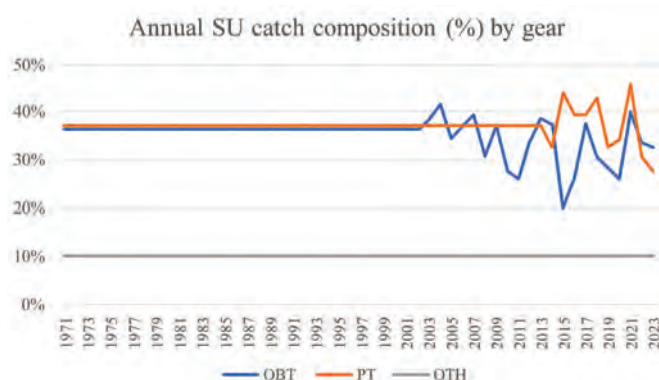


Figure 5. Estimated catch composition (%) of brushtooth lizardfish in the total lizardfish (six species combined) catch by year and gear (1971–2023)

OBT: Otter Board Trawl; PT: Pair Trawl, and OTH: Other gear

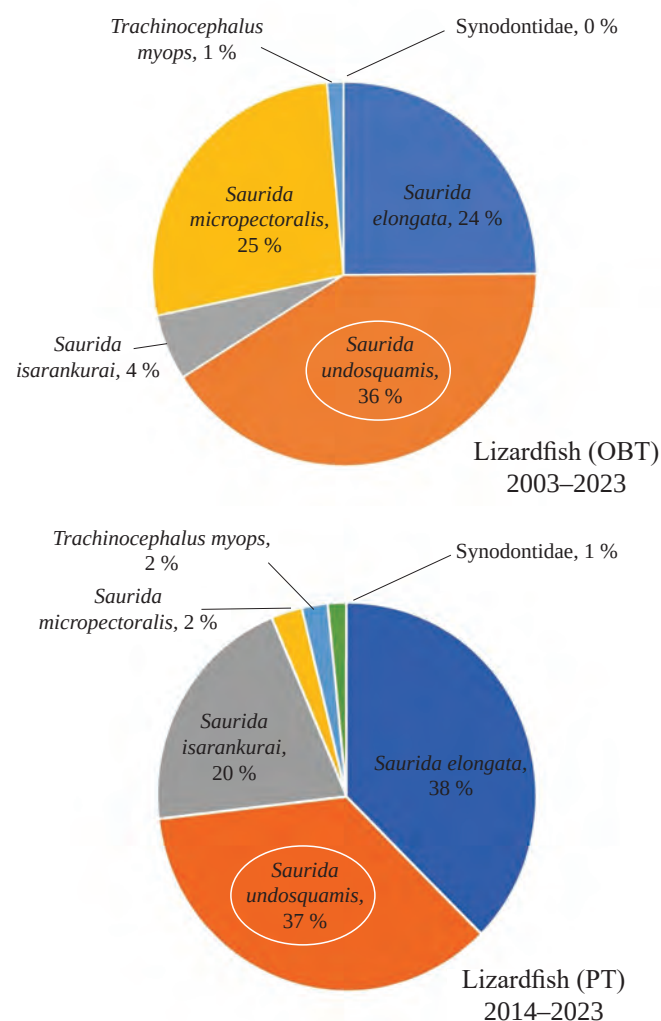


Figure 6. Estimated overall species composition (%) of the lizardfish catch (six species) based on Otter Board Trawl (OBT) survey data (2003–2023, top) and Pair Trawl (PT) port sampling data (2014–2023, bottom); brushtooth lizardfish (SU) composition is highlighted by a circle

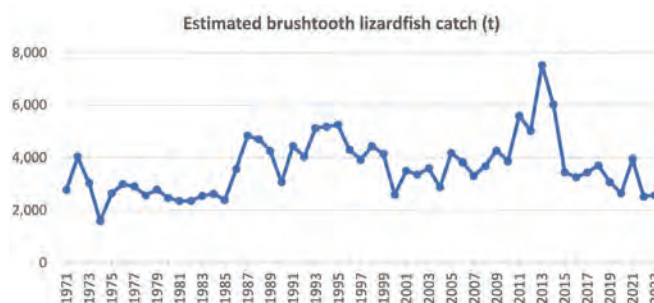


Figure 7. Estimated brushtooth lizardfish catch (1971–2023)

due to the development of trawl vessels. Afterward, catches declined sharply following fisheries reforms introduced in 2015, which imposed strict regulations to combat IUU fishing. Subsequently, the catch continued to decline through 2023 to 2,600 t (35 percent of the 2013 peak). These reforms included prohibiting unregistered and unlicensed vessels, restricting trawl fishing efforts through an allowable fishing-day scheme, and other management measures.

Nominal CPUE and CPUE Standardization

Nominal CPUE

As noted above, 20 nominal CPUE datasets were available (**Table 2**). They were evaluated for suitability for CPUE standardization using three criteria: (1) a visual inspection (scatterplot of catch vs. nominal CPUE) to investigate outliers and negative correlations; (2) the Pearson correlation coefficient (r) between catch and nominal CPUE; and (3) periods of catchability (q) if they cover all four periods.

As a result, seven nominal CPUEs (No. 1, 2, 8, 15, 16, 19, and 20 in **Table 2**) were selected for CPUE standardization (**Table 3**). Two additional considerations were applied: (1) if two CPUEs for the same gear with different units were chosen, the one with the lower correlation coefficient (r) was selected to avoid duplicate use, and (2) purse seine (PS) nominal CPUEs (No. 5, 6, 11, and 12 in **Table 2**) were not selected because brushtooth lizardfish catch could not be estimated due to the lack of PS species compositions.

CPUE Standardization

The seven selected nominal CPUEs were standardized using a log-normal General Linear Model (GLM). Because their zero-CPUE rates were less than 30 percent, this model was considered theoretically appropriate (Shono, 2004). The equation is shown below, using nominal CPUE No. 19 as an example.

$$\begin{aligned} &\text{Log}(\text{CPUE} + \text{Constant}) \\ &= \text{Intercept} + \text{Year} + \text{Month} + \text{Area} + \text{Month} * \text{Area} \\ &+ \text{boat name} + \text{depth} + \text{Error} \sim N(0, \sigma^2), \\ &\text{where Constant} = 0.1 * \text{average of nominal CPUE (Campbell} \\ &\text{et al., 1996)} \end{aligned}$$

Table 3. Summary of CPUE standardization

Source	Scale	Period of catchability (q)	Period	Gear	CPUE unit	No. of years	No	Pearson correlation coefficient (r)	Covariates	0-CPUE rates	Model	Selected standardized CPUE for JABBA?
National Statistics	Coarse scale by area	q12	1971-1994	PT	kg/day	24	1	-25 %	year & area	6 %	log normal GLM	No
					lg/hr		2	-28 %		6 %		Yes
		q3	1995-2015	PT	kg/hr		8	10 %		13 %		Yes
	Coarse scale by month & area	q4	2016-2023	OBT	kg/day		15	47 %	year, month & area	0 %		No
					kg/hr		16	27 %		0 %		No
Research data	Survey	Fine scale (set by set data)	2003-2015	OBT	kg/hr	13	19	-14 %	year, month, area, boat name & depth	26 %		Yes
			2016-2023	OBT	kg/hr	8	20	19 %		22 %		Yes

OBT: Otter Board Trawl, PT: Pair Trawl and PS: Purse Seine

Software

CPUE standardization was implemented using the menu driven CPUE_Manager software. **Figure 8** shows the icon and the main menu. Upon selecting the second menu option, the CPUE standardization input window appears (**Figure 9**). After entering the required inputs (using nominal CPUE No. 19 as a demo) and executing the run, a standardized report file containing the results is automatically provided. For more information, refer to the user manual (Nishida & Iwasaki, 2026).

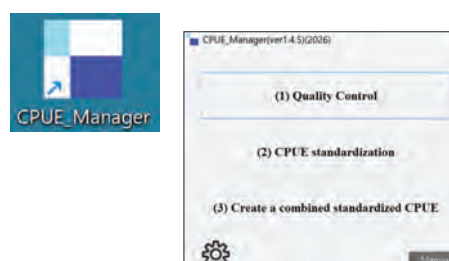


Figure 8. The software icon (left) and the main menu (right) of the CPUE_Manager software developed by [MENU]; “Manager” means that all necessary internal and external functions/ applications are integrated into the software package

The distribution of D (core) n.dek, Selection of the n.dek, and Selection of the covariates.

Sample size (n*)

year	Sample size (n*)
1998	178
2000	146
2002	196
2003	176
2004	196
2006	243
2013	208
2015	169
2017.5	197
2021.5	209
June 8	154
All	188

n*	Sample size (n*)
1	172
2	177
3	215
4	124

- Select main (core) covariates

☐ year

☒ NO

☒ area

☐ NO * area

Select additional covariates

☒ river

☒ depth

Select model

☒ Non-normal GLM: D (core) CPUC (each) rate (= coreal 28%

☐ Delta type 2 stage log-normal model: D (core) CPUC (each) rate (> coreal 28%

D (core) CPUC (each) rate (red bar) = 28%

% frequency distribution of normal CPUC

Note If result of the delta model in NC CPUC rate is 200~300%, try log-normal GLM resulting 0 CPUC.

OK Cancel

Figure 9. The input window of the CPUE standardization menu. Nominal CPUE No. 19 (research data) is shown for demonstration purposes

Results

Seven nominal CPUE datasets area standardized. Four screening methods are used to select the plausible standardized CPUE: (1) the Pearson correlation coefficient (r); (2) analysis of variance (ANOVA); (3) model fit based on residual analysis (normal distributions and quantile–quantile [QQ] plots); and (4) coverage of four different periods of q . As a result, four standardized CPUEs (Nos. 2, 8, 19 and 20 in **Table 2**) are selected. **Figure 10** shows the results of CPUE standardization using No. 19 as an example, which indicates that the log-normal GLM (model) and all covariates are statistically acceptable. **Figure 11** illustrates the time-series trends of the estimated standardized CPUE for four q periods with their 95 percent confidence intervals.

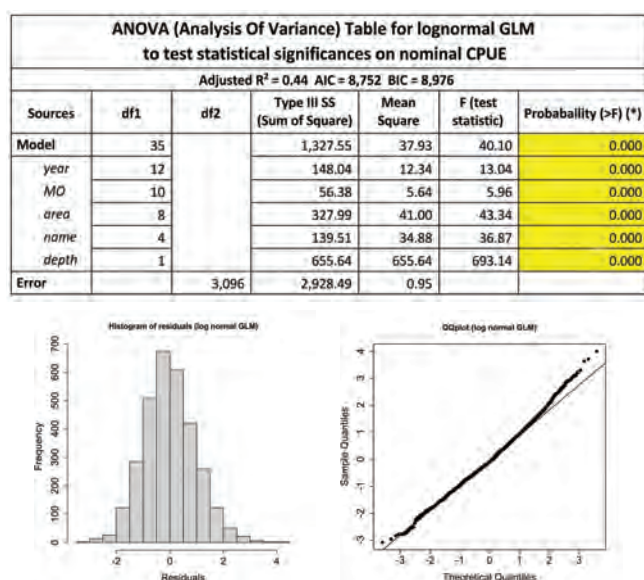


Figure 10. Results of CPUE standardization (No.19: research data): (Top) ANOVA shows that the model and all covariates are statistically significant at the 0.1 % level, thus accepted; (Bottom left) Error distribution of CPUE residuals forming the normal distribution indicates that the log normal GLM is acceptable; (Bottom right) The QQ plot shows that observed and the theoretical quantile are almost identical except for both ends, which implies that the log normal GLM is acceptable

Application of JABBA Software to Brushtooth Lizardfish Data

Outline of JABBA

The main objective of applying JABBA is to conduct the first formal stock assessment of brushtooth lizardfish and evaluate whether JABBA can serve as the DOF's official single-species stock assessment model in the future if the results are promising. The DOF has been using the Thompson & Bell (TB) model based on short-term length-frequency data. However, because the model does not consistently produce reliable results, it has been used mainly as a reference. Compared to the TB model for data-limited assessments, JABBA for data-moderate assessments offer several advantages. It uses long-term (> 10 years) catch and CPUE data based on the Bayesian

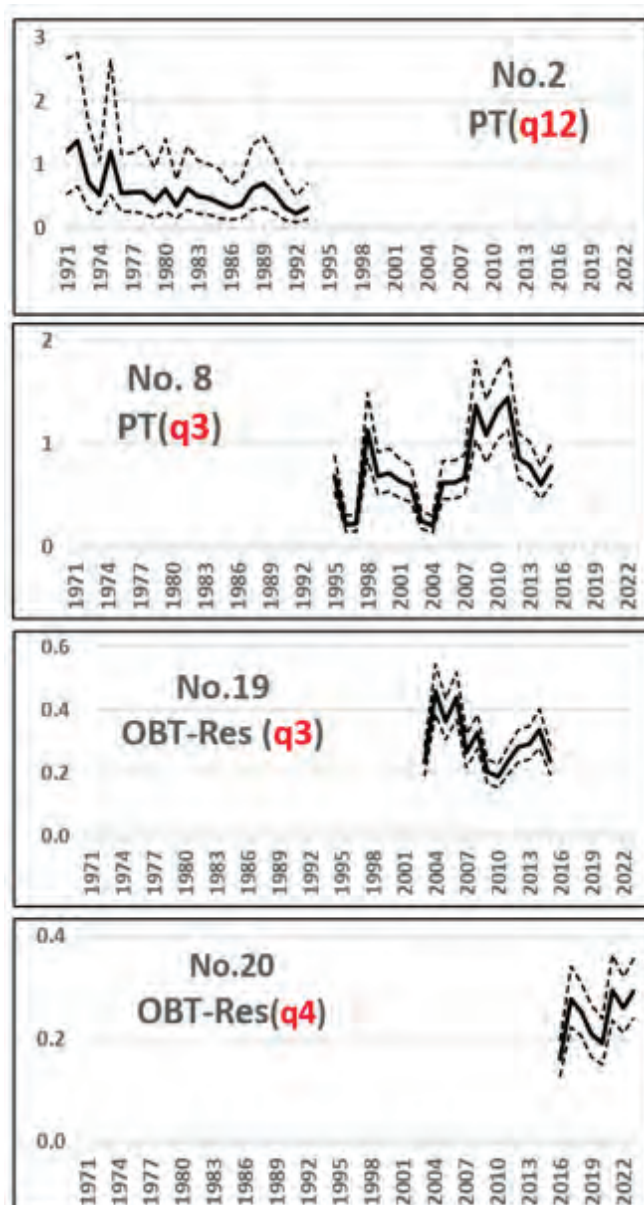


Figure 11. Four estimated standardized CPUE by catchability (q) period (refer to **Table 1**) with 95 % confidence intervals

statistical framework and is also a state-space model that incorporates both observation and model errors. Therefore, JABBA can capture real population dynamics, providing a more comprehensive and reliable picture of stock status. As a result, management advice, such as Total Allowable Catch (TAC) recommendations, becomes more robust and reliable.

Menu Driven JABBA Software

In the workshop, the menu driven JABBA software developed by [MENU] was introduced, and participants were trained in its application. It is designed for users who are unfamiliar with R (the core engine of the original JABBA software), allowing them to run the application without directly interacting with R. The software can implement both the Schaefer and Fox surplus production models. The Pella-Tomlinson model is included in the original JABBA but is not used because its

results are generally similar to those of the Schaefer or Fox models. For more information, refer to the Manual (Nishida & Iwasaki, 2026) and Nishida *et al.*, (2026).

To start using the software, the users need to click on the application icon (left, **Figure 12**). The main window then appears, from which the desired model (e.g. Schaefer) is selected (right, **Figure 12**). The input window then appears (**Figure 13, top**). After importing the input files, the users enter the following four inputs: (1) the Run ID; (2) the prior values for r which can be selected from the pop-up Excel file (Figure 13, bottom). If no prior values are available, those for the working species will be selected from FishBase (2026), then values will be entered in the pop-up Excel file and saved for the future use; (3) the prior values for K ; and (4) the depletion rate for the grid search.



Figure 12. Menu driven JABBA software icon (top) and the first window (bottom)

Input, Run & Report(Schaefer)

Edit input info. then click (left bottom corner) to save, run and make Report.

Select data folder

C:\SU\KSchaefer\

Model selected Schaefer (To change to Fox, go back to the main menu)

Inputs

Run name (Max 10 letters)

r prior (Default: Uniform model) Ref

K prior

Uniform model

Mini=2*Max(catch)

Max=10*Max(catch)

Change values if needed

B0/K (depletion)

$0 < B0/K \leq 1$

Edit

SU 0.6s

☒ Uniform model
 ☐ Log normal model

0.37

0.85

Minimum

Maximum

0.10

2.20

Median (FishBase etc.)

SE=1 (Default)

15,077

75,384

Log normal model

0.60

0.2

mean

SE

[Note] The job is running. Wait for a few – 15 minutes until “Run completed” is displayed.

Click to save, run & Report

Back

Reference of Mini & Max for r by species. Users can add.						
Min~Max is based on the 95% CI						
species			Mini	Max	Median	Source
code	English name	area				
SWO	Swordfish	all ocean	0.30	0.69	0.46	FishBASE
IM	Indian mackerel	Sri Lanka	0.41	0.93	0.62	FishBASE
SM	Short mackerel	G.of Thailand	0.79	1.79	1.19	FishBASE
SU	brushtooth lizardfish	G.of Thailand	0.37	0.85	0.57	FishBASE
KAW	Kawakawa	World	0.57	0.45	0.95	FishBASE

Figure 13. (top) Input window for the Schaefer run (example)
(bottom) Pop-up excel file for r values by species. It will appear after Ref (red box on top) is clicked

Note on K: the software automatically calculates and displays the minimum and maximum K values based on the empirical priors presented by the formula shown in the window; thus, manual entry of these values is not required.

Grid Search Approach for Optimal Depletion Levels

Outline

When no information on depletion-rate priors is available, some arbitrary values are assigned and JABBA is implemented. After several trials, optimal parameters are selected based on the best diagnostics, which is the normal approach. However, there is a risk of selecting apparent priors if the search range is insufficient. To prevent such risks, a grid search approach for optimal depletion level is applied in this software. In the first step (the base case), the full depletion range (0–1) at 0.2 intervals (0.2, 0.4, 0.6 and 0.8) is inspected to identify the optimal depletion level that produces the best (optimal) results based on diagnostics. In the second step, sensitivities

are applied to search for a finer optimal depletion at the 0.1 interval before and after the selected optimal base case by 0.2 intervals. If the prior knowledge of the depletion level is available, there is no need to search the full range (0–1); instead, only a few search runs around the prior levels can be inspected (Nishida *et al.*, 2026).

Diagnostics

Diagnostics were used to select the optimal run in the grid search approach for the base case and sensitivities. There were 11 specific diagnostics across five categories: (1) overall, (2) convergence, (3) model fits, (4) retrospective statistical analyses and (5) hindcast analyses (**Figure 14**). The two diagnostics (Kobe plots and retrospective patterns) in category (1) were the most important because they reflect the overall results and are both evaluated by visual inspection. The remaining nine diagnostics, items (3) through (11), were evaluated to select the optimal run only after the initial two diagnostics were accepted.

Selection form (Base case)																	
Diagnostics	1. Overall diagnostics				2. Convergence (MCMC)		3. Model Fit			4. Retrospective analyses			5. Hindcast analyses				
	Most important diagnostics			Secondary important diagnostics													
	Kobe plot	retrospective patterns			Estimated parameters (13)		Heidelberger test		CPUE residuals		RMSE	Mohn's p (-0.15~2.0)		MASE	Visual inspection		
	Visual inspection				r is evaluated as representative		Geweke p value		randomness and outliers (see 80% CI band)		%	2 important parameters (B/Bmsy & F/Fmsy) are evaluated		Ave MASE < 1 (accepted)	# of large color circles beyond the 80% CI bands		
Methods				Enter the median value (FishBase) (0.57)	K	r	# of orange band	# of outliers	# of yellow markers (excluding average) (outside of the Mohn's p value)								
Metrics	Kobe plot should be plausible	2 important retrospective patterns (B/Bmeay & F/Fmsy) should be similar			Closely to this value better		Larger values better		Less # better		Less % better fit	Less # better		Smaller better	Less # better		
Criteria																	
Output # (Report)	#18	#40			#21		#20		#13		#10	#42		#43	#41		
Page # (Report)	p3	p3			p4		p3		p3		p3	p3		p4	p4		
Diagnostics #	1	2			3		4	5	6	7	8	9		10	11		
Refer to sheet # for details												sheet (4)		sheet (5)			
Scenario	#	Yellow marker (OK or fair)			Highlight yellow marker to the best scenario for each diagnostics.										Total counts	Result	Sensitivity
	0.2s	NG	NG														
	0.2f	Fair	NG														
	0.4s	NG	Fair														
	0.4f	NG	Fair														
	0.6s	Fair	OK		0.58	0.52	0.80	1	4	45.9%	1	0.76	1	selected	0.5s,05f,0.7s,0.7f		
	0.6f	Ok	NG														
	0.8s	Fair	NG														
	0.8f	NG	Fair														
Comments	Only 0.6s satisfies both the Kobe plot and the retrospective patterns, thus it is selected as the best run (arid).																

Figure 14. Selection form to select the optimum run (grid) from the eight runs (grids)

Note: 0.6s is selected because the other seven runs do not satisfy the two most important diagnostics (Kobe plot and retrospective patterns)

Results

Grid Search

The grid search approach was applied because there was no prior knowledge of the initial depletion levels. Results are based on the base case and sensitivities in the grid search.

Base Case

Using the Selection Form, the results of all eight runs were examined by 11 diagnostics. For each run, Diagnostics #1 and #2 were prioritized. In this case, only 0.6s (0.6 initial depletion level by the Schaefer model) satisfied both diagnostics (**Figure 14**); thus, it was selected as the optimal base-case run. Normally, when multiple runs satisfy both the Kobe plot

and retrospective patterns, the remaining nine diagnostics are evaluated to select one optimal run. It should be noted that this brushtooth lizardfish assessment was a unique case, as only one run (0.6s) out of eight satisfied both the Kobe plot and the retrospective patterns.

Sensitivities

Because 0.6s was selected as the base case, four grids for sensitivities around 0.6 (0.5s, 0.5f, 0.7s, and 0.7f) were inspected. Then, the five grids including the best case (0.6s) and the four sensitivities were evaluated again using the same Selection Form. Finally, 0.6s was re-selected as the optimum run because only 0.6s satisfied both the Kobe plot and the retrospective patterns again.

Additional Sensitivities

The 0.6s results included one autocorrelated CPUE (PT_hr.95.15.) (red band in **Figure 15**). Therefore, additional sensitivity analyses were needed to determine whether this CPUE should be retained. Using the additional sensitivity form in the Selection Form, the same evaluation was carried out. As a result of the additional sensitivities, the 0.6s with the autocorrelated CPUE was re-selected because it produced more satisfactory retrospective patterns than the 0.6s without it (**Figure 16**), even though both satisfied the Kobe plot. Thus, 0.6s with one autocorrelated CPUE was selected as the final optimal run. **Figures 17–18** show the major results.

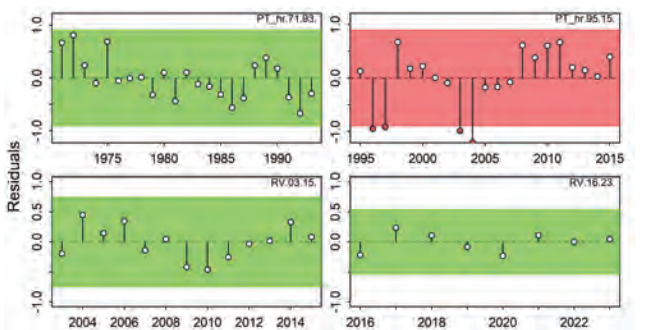


Figure 15. Four standardized CPUEs in the selected run (0.6s), including one autocorrelated CPUE (pink band)

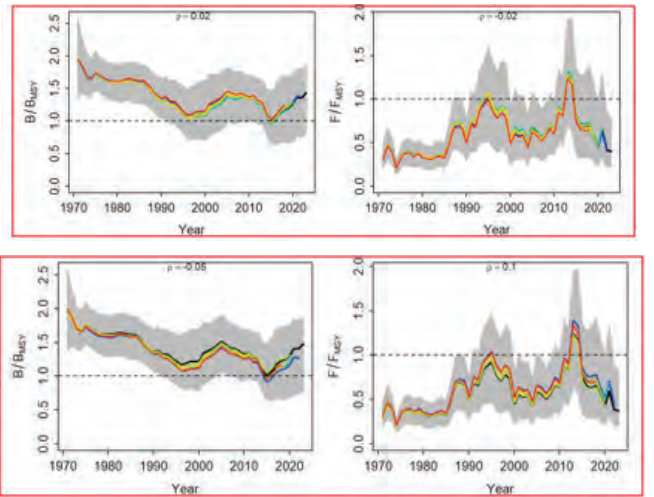


Figure 16. A comparison of retrospective patterns with (above) and without (below) autocorrelated CPUE
Note: 0.6s with autocorrelated CPUE (above) show almost identical patterns, while 0.6s without (below) show small discrepancies

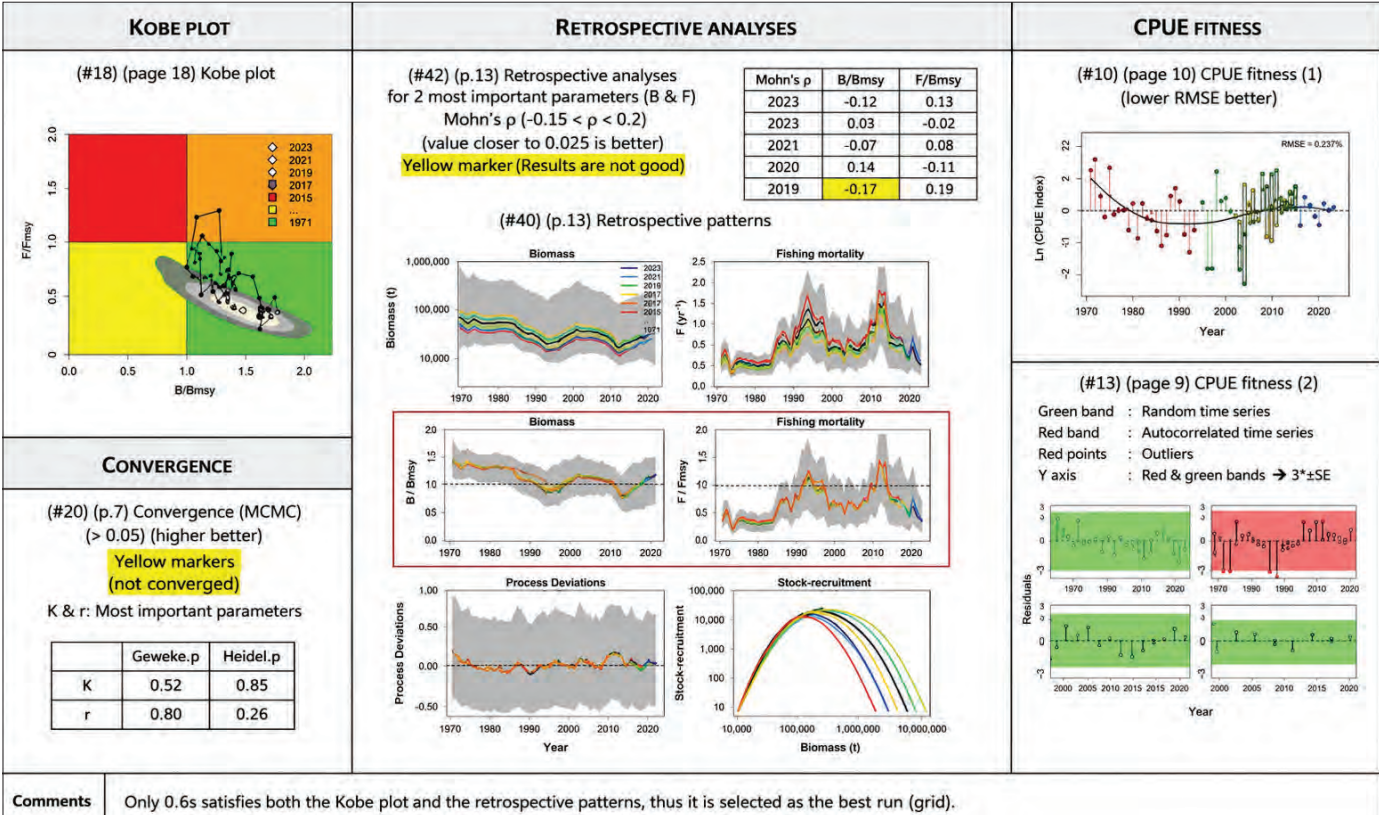


Figure 17. Key results 1/2

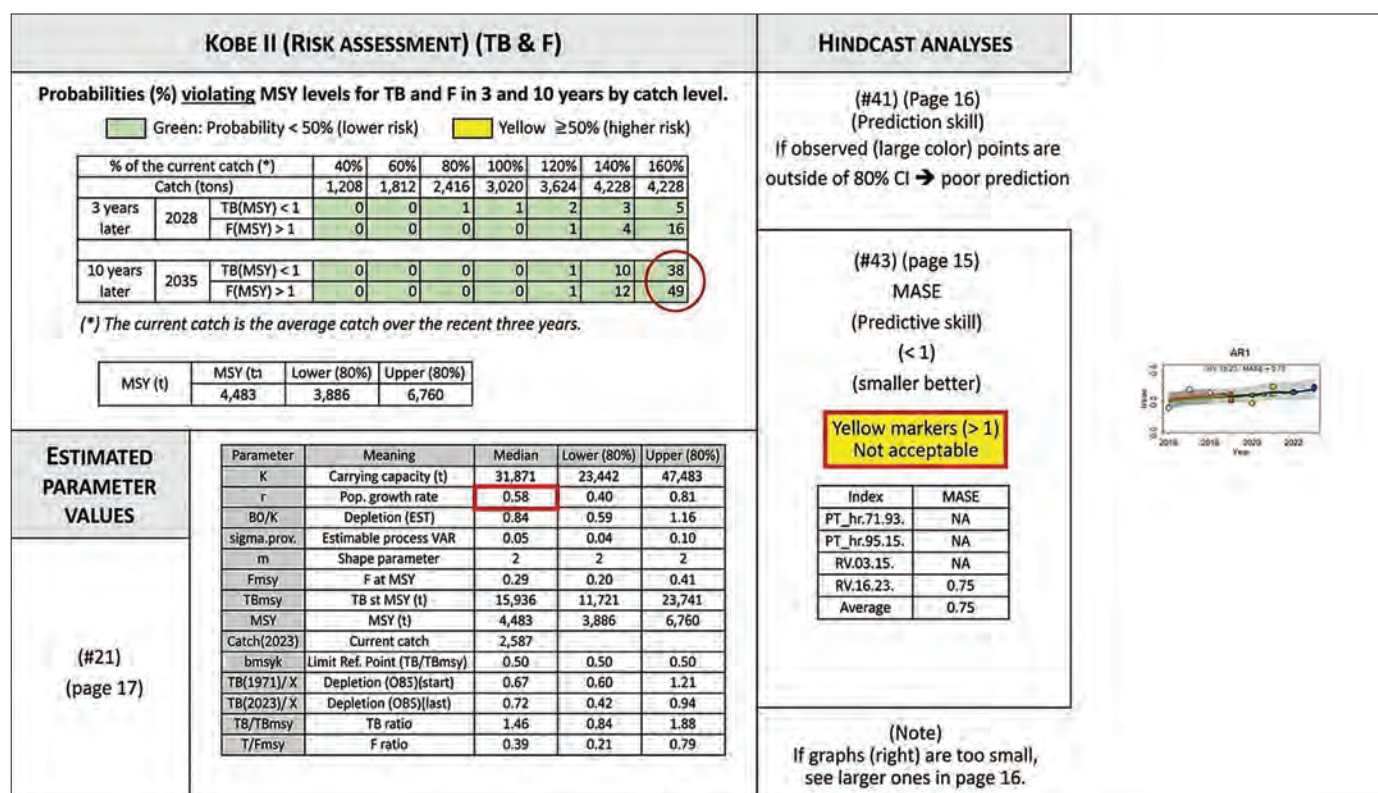


Figure 18. Key results 2/2

Discussion

Estimation of Species Compositions and Catch

For the first three decades (from 1971 to the 2000s), when research data were unavailable, the species composition of brushtooth lizardfish for OBT (Otter Board Trawl) and PT (Pair Trawl) was estimated using their respective overall averages. However, these averages did not account for changes in species composition caused by changes in fishing patterns, technological advancements and the evolution of the Gulf of Thailand ecosystem. Consequently, this approach produced substantial uncertainties, making the estimated catches less reliable.

In addition, due to limited information, a constant value of 10 percent was applied to OTH (other gear types) to estimate the brushtooth lizardfish catch throughout the entire period (1971–2023). While this assumption may have introduced uncertainties, its low contribution may have minimal influence on the total catch. Conversely, once research data became available in the 2000s, annual species compositions for OBT and PT were applied to estimate the catch (Figure 5). This approach was both reasonable and pragmatic for estimating individual species catch, resulting in less uncertainty.

CPUE (National Statistics)

Initially, national fisheries statistics were not considered a suitable source of nominal CPUE for standardization. However, they were recognized as useful because they included area and/or monthly data (essential covariates), despite being aggregated annually. Although the derived standardized CPUE was initially considered low quality due to coarse-scale data, data quality control and GLM results showed that three nominal CPUEs were useful and were subsequently standardized and applied to the JABBA assessments (Table 3). From this experience, it was learned that some coarse-scale annual nominal CPUE datasets are effective for CPUE standardization and are therefore useful for assessments.

CPUE (Port Sampling)

Nominal CPUEs from port samplings were not selected as candidates for CPUE standardization (Table 2 and Table 3) due to the following three reasons: (1) only eight years of data were available, which is not robust enough; (2) quality control (QC) indicated that the nominal CPUEs were of low quality because they originated from commercial fisheries; and (3) data from fisheries-independent surveys were not covered.

CPUE (Fisheries-Independent Trawl Surveys)

Figure 10 clearly demonstrates the high quality of the fisheries-independent trawl survey data based on ANOVA and almost perfect data fit to the log-normal GLM because the residual distribution formed a clear bell shape, and the observed Q-Q points closely aligned with the theoretical straight line. Thus, it is commendable that the DOF has maintained this high-performance scientific survey program for nearly two decades using consistent designs and protocols despite the costs involved.

Menu Driven JABBA Software Using the Grid Search Approach

All participants were able to operate the software because of its simple and practical design. This software was particularly helpful for individuals unfamiliar with R; thus, stock assessment practitioners, especially in developing countries, can readily adopt advanced stock assessment models like JABBA. Although the grid search approach required running eight grids (base case) and four sensitivity analyses, it proved effective in identifying the actual optimal run (grid) and avoiding apparent results. The Selection Forms, which evaluate 11 diagnostics, were also helpful and effective in selecting the optimal run.

Diagnostics and Weightings

To evaluate the optimal results effectively, 11 diagnostics in five categories are defined, *i.e.* “overall,” “convergence,” “model fits,” “retrospective analyses,” and “hindcast analyses.” More diagnostics are available in the original JABBA results. However, based on lessons learned from previous assessments, using too many diagnostics will give some categories (*e.g.* model fits) more diagnostics

(weighting) than others, increasing the risk of misidentifying the optimal depletion level. To avoid this, a few representative diagnostics in each of the five categories are assigned in order to identify the optimal run more objectively. If users want to change diagnostics and/or weightings, they can do so freely by arranging them using the Selection Form (Excel file).

Stock Status

A significant finding of this assessment is the successful recovery of fish stocks following the 2015 fisheries reforms. These enforced strict regulations following an increase in fishing operations by illegal, unreported and unregulated (IUU) vessels under an open-access (Olympic) fishery during the two decades preceding 2015. The reforms were highly effective, as shown by two clear pieces of evidence in the assessment results: (1) the stock trajectory in the Kobe plot shows that F/F_{MSY} dropped sharply from 2014 (orange) to 2015 (yellow) and moved toward 2023 (green, far from MSY levels for TB and F), indicating that the stock appears to have fully recovered (**Figure 19, left**); and (2) the recent increase in the abundance index, as shown in the reliable CPUE data from the fisheries-independent research survey (**Figure 19, lower right**).

It is well known that fisheries resources in the Gulf of Thailand have been heavily exploited, especially by trawl fisheries. However, the brushtooth lizardfish stock has been moderately exploited, as shown in **Figure 19** (upper right). It indicates that fishing mortality (F/F_{MSY}) was in the orange zone of the Kobe plot in only three years (above the MSY level), while total biomass (TB/TB_{MSY}) is always in the green zone, except in 2015 (yellow). It would be worthwhile to assess the stock trajectories of the other five lizardfish species, as well as those of other demersal resources, for comparison.

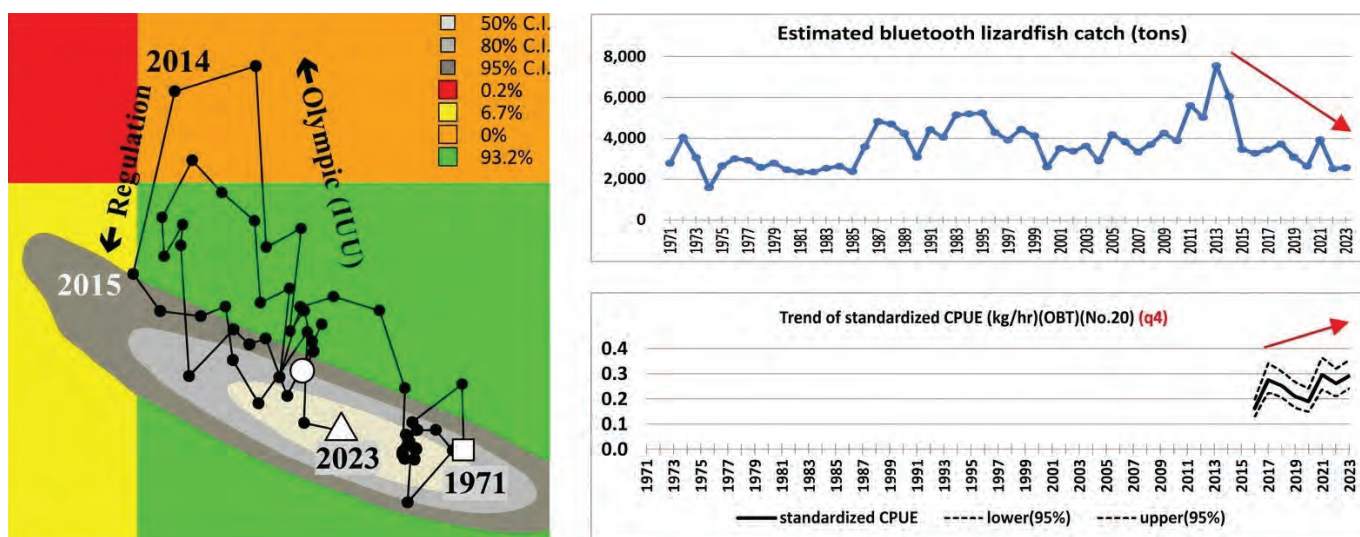


Figure 19. The stock status trajectory (Kobe plot) (*left*), the catch trends (*upper right*) and the standardized CPUE trend by the fisheries independent research trawl survey (total biomass index) (*lower right*)

Comparison Between the JABBA and TB Models

The DOF has been using the Thompson and Bell (TB) model (1934) for single-species stock assessments only as a reference because its results are unreliable. During the workshop, clear evidence of this was obtained: there were large discrepancies in assessment results between these two models, *i.e.* the stock status in 2023 estimates were completely opposite (falling in the red zone of the Kobe plot in the TB model, while located in the green zone in JABBA) (**Figure 20**).

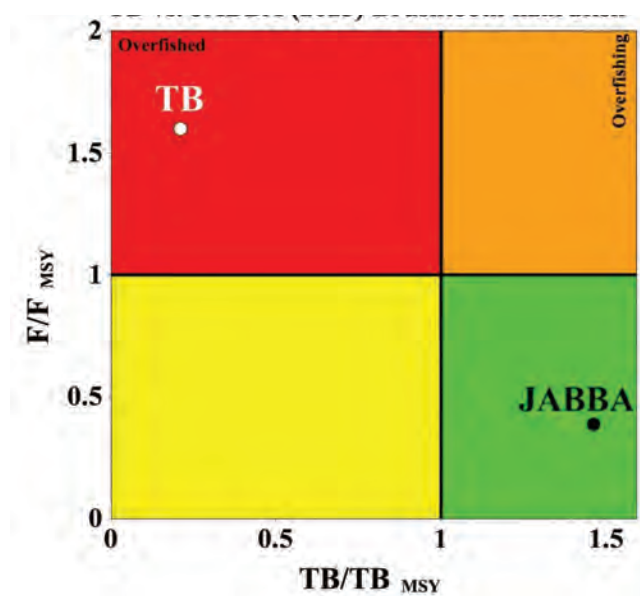


Figure 20. Comparison of results of brushtooth lizardfish stock assessment between Thompson and Bell (TB) model by DOF and JABBA (this study)

The TB model was developed for data-limited assessments using only recent length data along with biological parameters, while JABBA was developed for data-moderate assessments using catch, CPUE, and priors; thus, the concepts of these two models are essentially different. In addition, there are three possible problems with the data and parameters in the TB model: (1) the length data may not have been sampled at random; (2) the sample size of the length data may be too small; and/or (3) the biological parameters are based on studies conducted in the past, which may not reflect the current fish biology. The authors' recommendations are presented in the Way Forward and Conclusion sections to tackle these issues.

Future Management and Conservation Strategies

Management decisions should reflect current stock status based on a long-term population-dynamics model such as JABBA. In risk assessments, management targets are typically set at a 50 percent probability threshold, or at the MSY level when risk assessment results are unavailable.

The JABBA results are concluded to be reliable and plausible based on retrospective analyses. In addition, the risk assessment (Kobe II) results are also proven as robust and reliable based on hindcast analyses. Thus, the following management suggestions are highly certain, *i.e.* even if the annual catch increases by 60 percent (4,832 t) from the current level (3,020 t), there is less than a 49 percent probability of violating both TB/TB_{MSY} and F/F_{MSY} within ten years (by 2035). Furthermore, because the current stock status is in the green zone with 93 percent confidence, a catch level 60 percent above the current level (4,832 t) or at the MSY level (4,883 t) can be considered as appropriate.

However, the brushtooth lizardfish catch is just one of six lizardfish species caught together with other multi-species resources exploited by typical multi-gear and multi-species fisheries (trawls, pair trawl and others). To manage such resources effectively, the MMM (multi-gear and multi-species fisheries management) framework must be considered. Further details are provided in the Way Forward section.

Way Forward

Recommendation to Switch to JABBA

The initial JABBA assessment took considerable time to complete. However, subsequent assessments will require much less time because the main task will simply be updating the database, with JABBA running according to the procedure developed during this initial assessment. Nevertheless, this task is more demanding than the current assessment models (Fox and Thompson & Bell) used by the DOF. JABBA is a scientifically sound and plausible model that is theoretically and practically far superior to the other two models. Therefore, the authors recommend that the DOF shift to the JABBA surplus production model, starting with a few key species such as the brushtooth lizardfish, and gradually expanding to other important species over time considering the workforce and budget.

Management of Brushtooth Lizardfish Within the MMM Framework

Managing brushtooth lizardfish is difficult as it is exploited by multi-gear and multispecies fisheries and therefore requires consideration of the stock status of other species and other relevant factors. In such cases, the MMM (multi-gear and multi-species fisheries management) framework (**Figure 21**) should be conducted, which includes four key points: (1) experienced managers, who know the local situation well, need to decide the optimal regulations (such as TAC, closed areas/seasons and mesh size limits, etc.) by considering relevant factors together (such as stock status/

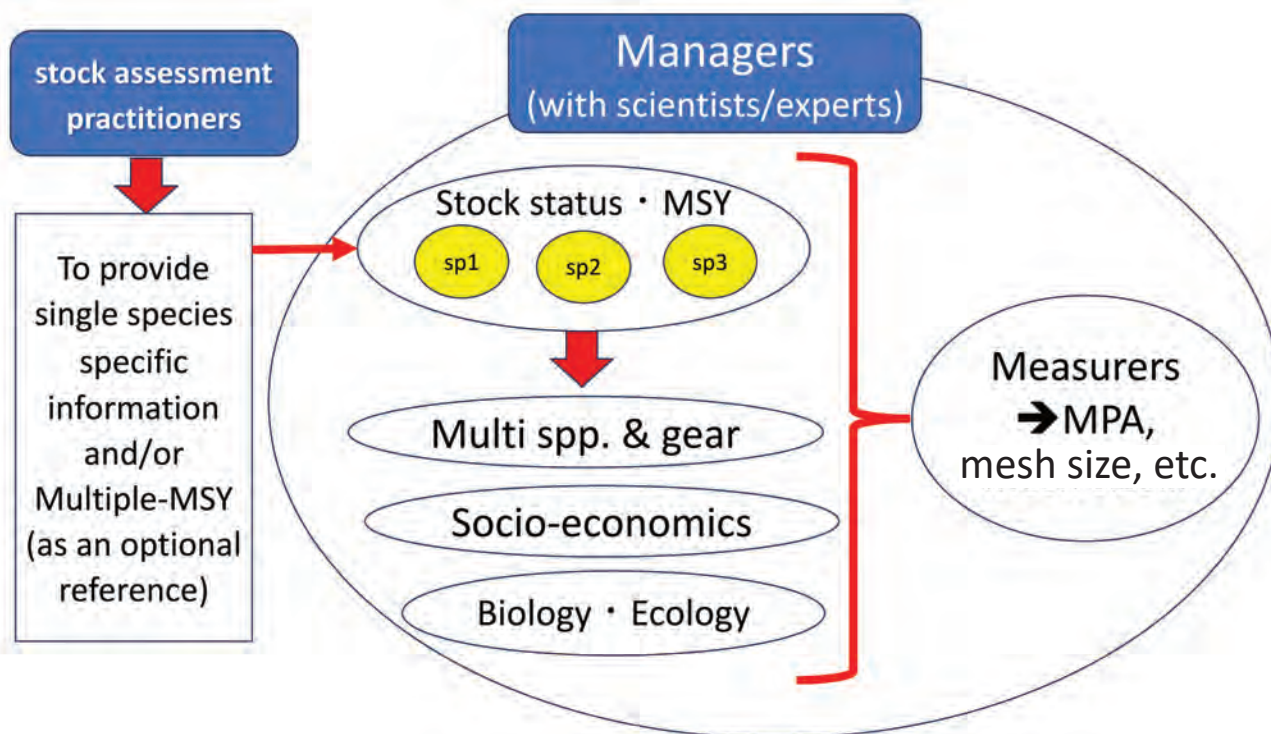


Figure 21. The framework of the MMM (Multi-gear and Multi-species fisheries Management) heightening the roles of managers and stock assessment (SA) practitioners

MSY of management species, socioeconomics, biology, ecology, and gear/boat configurations); (2) stock assessment practitioners conduct single-species and risk assessments and provide the results for managers to implement the MMM; (3) experts/scientists across these specific fields also need to assist the managers to execute the framework more efficiently; and (4) the DOF (which has been applying a similar MMM framework) needs to further enhance its approach by increasing and incorporating single-species stock assessments.

Multiple Maximum Sustainable Yield (MMSY) Approach

A number of numerical modelling approaches have been developed for the MMM framework but their implementation has been difficult because of insufficient data and/or parameters, as the situations are complex and vary by country and area. However, if time permits, a more practical Multiple MSY (MMSY) approach, recently introduced by SEAFDEC and FAO (2026) including MMSY modelling developed by Fogarty (2014), can be used as a reference for the single-species MSY approach. This will be a future research topic, while the ongoing MMM framework based on single-species assessments should remain as the primary and basic approach.

Routine Assessments Using the JABBA-HCR Approach

In conducting the JABBA-HCR approach, the type of HCR to be applied needs to be investigated. Several types of HCR are available. One simple and effective method is to use the CPUE slope over the past five years to estimate the TAC and evaluate the stock status during non-stock assessment years (**Figure 22**). This simple but effective approach has been used in Regional Fisheries Management Organizations (RFMOs) such as the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), the Northwest Atlantic Fisheries Organization (NAFO), and the South East Atlantic Fisheries Organization (SEAFO).

Harvest Control Rule (HCR)

$$TAC_{y+1} = \begin{cases} TAC_y \times (1 + \lambda_u \times slope) & \text{if } slope \geq 0 \\ TAC_y \times (1 + \lambda_d \times slope) & \text{if } slope < 0 \end{cases}$$

Slope: average CPUE slope in recent 5 years
 λ :TAC control coefficient ($\lambda=2$ if slope ≥ 0 and $\lambda=1$ if slope < 0)

TAC generated by the HCR is constrained to $\pm 5\%$ of the TAC in the preceding year.

Figure 22. Harvest Control Rule for deriving TAC from the average CPUE slope over the most recent five years (SEAFO, 2014)

Important species	Method	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
1	JABBA											
	HCR											
2	JABBA											
	HCR											
3	JABBA											
	HCR											

Figure 23. A five-year routine assessment cycle using the JABBA-HCR approach for three important species

Note: Color indicates the years in which updates are conducted

Figure 23 provides an example of a five-year JABBA-HCR cycle for three important species. Red boxes indicate JABBA assessment years, and yellow boxes represent HCR implementation years.

Continuation of Research Activities (Mitigation of Uncertainties)

To ensure stock assessment results remain reliable and plausible, uncertainties should be minimized as much as possible. In this regard, the ongoing research activities (*e.g.* the demersal bottom trawl fisheries-independent survey, port sampling, biological and ecological data collection) must continue. This is because several pieces of information were extremely useful in this study *i.e.* estimation of species composition, catch estimation, and CPUE standardization.

Conclusion

The first formal JABBA assessment of the brushtooth lizardfish indicates that stock in the Gulf of Thailand was in a healthy condition in 2023, meaning it is neither overfished nor subject to overfishing. This suggests that the 2015 fisheries reforms contributed to its successful recovery from its unhealthy status prior to 2015 and highlights that strong regulatory enforcement can rapidly rehabilitate tropical multispecies stocks.

Disaggregating the combined six-species lizardfish catch using annual species compositions derived from research data (demersal surveys and port sampling) proved successful. This method can be applied to similar cases for conducting single-species assessments, thereby enhancing the MMM framework.

While the risk assessment indicates that even a 60 percent higher catch could be sustained over ten years, the non-selective nature of trawl fisheries requires careful consideration. Optimal management measures (such as TACs, closed fishing areas or seasons, effort limits, and mesh size regulations) should be decided by experienced managers who must consider all relevant factors together.

This study reveals significant discrepancies between the Thompson & Bell model (used by the DOF for data-limited assessments) and the advanced state-space Bayesian JABBA surplus production model. In addition, the authors recommend that the original Fox model (used by the DOF for aggregated-species assessments) should be replaced with JABBA for single-species assessments, as JABBA is more reliable, robust, and plausible than the other two models. Therefore, the DOF should switch to JABBA to ensure more reliable species-specific assessments, starting with a few priority species such as the brushtooth lizardfish before expanding gradually to other important species.

The above results and findings serve as valuable initial assessments. However, the authors recognize that uncertainties remain from different sources (data and models). It is important to mitigate these uncertainties through ongoing research (demersal surveys, port sampling, biological and ecological data collections, etc.), which must be continued and enhanced if resources and budget allow.

Given the DOF's staffing, budget, and time constraints, conducting annual JABBA assessments represents a significant workload. Thus, the authors recommend establishing routine assessments using the JABBA-HCR approach. For instance, a full JABBA assessment could be conducted once every five years, with a simple but reliable HCR applied during the four intervening years. This approach will enable the DOF to monitor stock status and derive TACs annually, providing results that managers can use to implement measures within the MMM framework.

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Unfolding the Development Process of JTF 7 Projects to Address Fisheries and Aquaculture Issues in the Southeast Asian Region

Tomoko Nakazato

Keywords: project implementation, planning and evaluation, sustainable fisheries, stock assessment, environment friendly aquaculture, collaboration with SEAFDEC Departments and AMSs

As the Deputy Secretary-General of SEAFDEC and Japanese Trust Fund (JTF) Manager, I had the responsibility of leading the project planning under the JTF Phase 7 (JTF 7) from June 2022 to May 2025. The JTF 7 projects, scheduled for implementation between 2025 and 2029, were approved during the 46th Meeting of the SEAFDEC Program Committee (PCM) in 2023 and endorsed by the SEAFDEC Council during its 56th meeting in 2024. In this article, I am sharing my experiences and involvement in developing these projects. The process was quite challenging, and I felt anxious about the implementation due to various difficulties, including budgetary constraints. However, my worries turned out to be unfounded, and I am truly delighted to see each JTF 7 project proceeding well, as reflected in the progress highlighted on SEAFDEC publications, websites and social media posts. I extend my sincere thanks to the dedicated SEAFDEC staff who collaborated on these plans with me, as well as to our many partners, friends and colleagues across the SEAFDEC Member Countries. It is my hope that this article serves as an encouragement to all concerned SEAFDEC staff who continue to work diligently to implement these projects.

The JTF 7 Planning Stage

Through the Japanese Trust Fund (JTF), the Fisheries Agency of Japan has been supporting SEAFDEC since 1998 in implementing projects across Southeast Asia. For JTF 6, projects were implemented from 2015 to 2019. Subsequently, it was decided to continue the projects under the same concept for another five years (2020–2024) as the second phase of the sixth cycle of JTF known as JTF6-2.

In February 2022, my predecessor, *Mr. Koichi Honda* (then Deputy Secretary-General of SEAFDEC), and *Mr. Takatsugu Kudoh* (Assistant Trust Fund Manager [ATFM]) held a kickoff meeting to review the implementation status of JTF 6-2 projects. They discussed potential JTF 7 projects in consultation with the SEAFDEC Secretariat and the Training Department (TD), Aquaculture Department (AQD), Marine Fishery Resources Development and Management Department (MFRDMD), and Inland Fishery Resources Development and Management Department (IFRDMD). However, the Marine Fisheries Research Department (MFRD) was not consulted directly at the time due to restrictions imposed by the COVID-19 pandemic.

When I started to develop JTF 7 in June 2022, I was required to submit an overall project outline for the 2022 Program Committee Meeting (PCM) to formally request funding support from the Government of Japan. In August 2022, I had online meetings with the Deputy Chiefs of SEAFDEC Departments—*Dr. Sayaka Ito* (AQD), *Dr. Masahito Hirota* (MFRDMD), and *Mr. Tomohito Shimizu* (IFRDMD)—alongside SEAFDEC Special Adviser *Mr. Masanami Izumi* and *Mr. Kudoh* to discuss the future direction of JTF 7. Over the ten-year span of JTF 6 and JTF 6-2 starting in 2015, the fisheries landscape in the region has changed significantly. Therefore, we believed that new initiatives were necessary for the next five years to make it suitable for JTF 7.

Deliberating the JTF 7 Theme

During a series of consultations, the discussions branched out into many new ideas regarding which core areas to pursue, which initiatives to continue, practicability of implementation, and so on. Eventually, we settled on the main theme of JTF 7 around “*Enhanced Capability of Fisheries and Aquaculture in Southeast-Asia*” stemming from the belief that basic capabilities are essential for disseminating fisheries technology. We also considered incorporating training programs in Japan within the project, including establishing connections with Japanese universities and research institutions. Furthermore, we identified two fields that SEAFDEC should particularly focus on: “*Improvement of the reliability of fishery stock assessment of each AMS though sharing good practices and methods in collaboration with SEAFDEC Departments and AMSs*” and “*Dissemination of updated aquaculture technology in collaboration with SEAFDEC Departments and AMSs.*”

The SEAFDEC Member Countries recognized the importance of fishery resource assessments. Although some Member Countries expressed high interest and possess advanced knowledge and technical capabilities, others showed greater interest in resource enhancement technologies such as artificial reefs.

On the other hand, all countries expressed a high level of interest in countering IUU (illegal, unreported, and unregulated) fishing. This may be influenced by pressure from

trading partners such as the European Union (EU), alongside international political factors, given that IUU fishing remains a matter of global concern. However, we emphasized that resource assessment is essential for these efforts; without fishery stock assessments, stock management would be inadequate, and without effective stock management, there would be no technical basis for implementing such countermeasures.

Regarding aquaculture technology, while Member Countries expressed strong enthusiasm, it was also noted that promoting technologies that minimize environmental impacts is necessary to sustain productivity.

Formulating JTF 7 Projects

In September 2022, I visited MFRD in Singapore with the ATFM, where I had the opportunity to talk to *Mr. Lim Huan Sein* (Alternative Council Director to Singapore) and *Mr. Ong Yihang* (Chief of MFRD). This meeting marked the first time MFRD expressed an intention to implement an aquaculture-related project. While I thought that it might be necessary for MFRD to coordinate with AQD, I also considered whether MFRD would propose projects centered on aquaculture traceability or eco-labeling to avoid overlapping with AQD’s mandate. However, MFRD submitted a project proposal for JTF 7 focused on aquaculture technology dealing with global warming. I realized that it was beyond my coordination scope. Subsequently, at the 2024 SEAFDEC Council Meeting, a proposal emerged to pivot MFRD’s terms of reference toward aquaculture technology. As we had to await formal approval for this change, the opportunity to allocate a budget for JTF 7 projects for MFRD was unfortunately missed.

At the 2022 PCM, the JTF 7 framework comprised four pillars in accordance with the central theme, and two priorities were approved. Subsequently, the SEAFDEC Secretary-General issued an official letter to the Council Member for Japan to formally request support from the Government of Japan. Finally, the JTF7 outline was recomposed into three pillars (**Box 1**) and was approved during the 56th Council Meeting in 2024.

Looking back, I didn’t have extensive experience at that stage and could not fully understand the projects that were underway. My understanding of the fisheries landscape in Thailand (where I was assigned at the time) and other Southeast Asian countries was still developing. Yet somehow, I managed to draft the overall outline thanks to the SEAFDEC staff around me. I am particularly grateful to *Mr. Kudoh*, who served as the ATFM at the time, for thoroughly explaining the situation to me, sometimes even taking me into the field to understand the operations firsthand. It was also thanks to all the JTF co-managers serving as Deputy Chiefs of the respective SEAFDEC Departments, who communicated with

their colleagues and consolidated information. *Mr. Izumi*, in his role as the Special Advisor of SEAFDEC, constantly provided valuable guidance and assisted me in drafting the English text.

Box 1. Three (3) Pillars and prospective subjects of JTF 7 projects
Pillar 1. Strengthened collaboration and capacity building on common issues in Southeast Asia - Enhancement of regional cooperation and human resource development to eliminate IUU fishing - Digital transformation of regional fisheries and enhanced utilization of fishery statistics and information - Research and dissemination of sustainable fishing technology - Enhancing regional responses to emerging international fisheries-related issues
Pillar 2. Enhanced national and regional research capacities to manage fisheries resources including small scale fisheries - System design and construction of bio-research for good marine fishery resources (small pelagic/neritic tuna) - Capacity building for the monitoring of marine environmental changes and the estimation of impacts on fishery resources - Capacity building for estimation of fishery biomass with scientific hydroacoustic survey - Research capacities for sustainable utilization and management of sharks and rays - Research capacities for sustainable utilization and management of eel and other inland fisheries resources - Improving fisher’s livelihood and fisheries co-management in inland and coastal small-scale fisheries
Pillar 3. Improved sustainability and productivity in aquaculture - Promotion of aquaculture technologies for emerging species through good aquaculture practices (GAqP) - Capacity building on the utilization of certification schemas for aquaculture seafood safety

Over the next two years (2023–2025), the JTF team worked together to develop projects year by year, taking into account the status of ongoing projects and current fisheries conditions in each Member Country. I had to prioritize projects based on the limited budget and available human resources.

Regarding the project on reliable fishery stock assessment and management, *Dr. Hirota* of MFRDMD requested applying biological data to their assessments because incorporating catch volumes, age (through otolith analysis) and size is essential for understanding annual growth rates. He emphasized that for Member Countries to ensure the reliability of their stock assessments, they must incorporate more real biological data alongside mathematical analysis. He also highlighted the need to conducting experiments on the cultivation of target fish species to observe their life cycles.



There was high interest among the Member Countries in conducting scientific acoustic surveys and integrating acoustic data into stock assessments. While the research vessel M.V. SEAFDEC 2 is equipped with a SIMRAD EK80 scientific echosounder, researchers within TD initially had limited knowledge and skills in operating the equipment. Consequently, *Ms. Malinee Smithrithee*, the Secretary-General of SEAFDEC at the time, asked me to request the Fishery Agency of Japan to send an expert on acoustic surveys to support TD. The Government of Japan granted this request and sent *Dr. Koki Abe*, a researcher from the Japan Fisheries Research and Education Agency. With *Dr. Abe* serving as Senior Adviser, SEAFDEC successfully explored advanced resource assessment techniques, such as estimating stock abundance by analyzing echoes from sound waves reflected by fish swim bladders. This method is also popular among researchers in the Member Countries.

Regarding inland fisheries, the Deputy Chiefs of IFRDMD—initially *Mr. Shimizu* and later *Mr. Shimoda*—faced challenges in developing JTF 7 projects. Because inland fisheries in the region are mostly operated by local communities, they recognized that supporting community-based livelihoods would be more beneficial rather than embarking solely on fishery resource assessments and management. Given the diversity of inland fish species, the tropical eel survey for stock structure analysis has made outstanding progress,

which is expected to contribute to upcoming discussions within Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Under JTF 7, the project will expand these survey methods and data analysis techniques not only to Indonesia, which hosts IFRDMD, but also to other Member Countries.

Regarding aquaculture technology, *Dr. Ito*, the Deputy Chief of the AQD, prioritized improving rearing techniques for economically high-demand species such as the kawakawa (a kind of tuna species). Furthermore, he emphasized the necessity of implementing environmentally friendly farming methods such as integrated aquaculture systems. *Dr. Ito* reiterated the importance of updating the skills and knowledge of researchers, which led to the organization of relevant training activities under JTF 7.

Evaluating the Implementation of JTF 7 Projects

Another pivotal event occurred while developing the JTF 7 project plan. At the 2023 PCM, SEAFDEC was requested to clearly demonstrate project achievements. Internally, there had been ongoing discussions about clearly defining the project's five-year goals and presenting their annual progress. *Dr. Sheila Villamor Chumchuen*, a technical writer/editor at the Secretariat, made significant contributions to this effort and suggested a format for the project plan based on her expertise, outlining how to set outcomes and outputs and how to present them effectively.

Applying the Results-Based Management (RBM) approach introduced by *Dr. Villamor Chumchuen*, establishing baselines for key performance indicators proved to be quite challenging, considering the baseline data limitations. While some might criticize us for implementing projects without first assessing the current situation, standardized statistical data for baseline assessment are not uniformly available across all countries. For example, when setting a target such as “raising the income of small-scale fishers in Southeast Asia by 30 percent,” it is necessary to determine whether this should be based on the average across Member Countries or the figures for a specific country. Where statistical data is unavailable, baseline surveys must first be conducted. Moreover, even if indicators of the fisheries situation in Member Countries are used, it is likely that factors beyond the JTF 7 project—such as various policies and environmental factors—may contribute to increases in fishers' incomes. This makes it difficult to directly isolate and demonstrate the effectiveness of the project.

After extensive discussions within the SEAFDEC Secretariat, I decided to develop achievable targets for each project and evaluation criteria for measurable outcomes. Fortunately, *Mr. Fumiya Takahashi*, who was the ATFM at the time, managed to do this challenging formulation based on his previous

experiences. Because JTF 7 projects primarily target fisheries officers and researchers from the Member Countries, we defined the project outcomes based on how large the impact on them is. To evaluate project effectiveness, the baseline was set to zero. Examples of these project outcome criteria include the number of fisheries officers in Member Countries who gained new knowledge and the extent of the skills they have acquired; the number of policies or systems inspired or improved by the project outputs; and the volume of scientific papers published by the researchers.

An online internal workshop on the formulation of JTF 7 projects was organized in June 2024. Officials and relevant staff from the Secretariat and Technical Departments were briefed on the updated Project Document format for JTF 7. The workshop served as a venue for reviewing the RBM concept to guide the Lead Technical Officers (LTOs) in developing their respective projects. I highly appreciate the project LTOs for their dedication to establishing these outcomes within a short timeframe, especially given how these new evaluation criteria differed from the approaches used in the previous JTF 6-2 project cycle.

Dr. Suttinee Limthammahisorn, the Secretary-General of SEAFDEC at that time, supervised the drafting of the JTF 7 projects. Through this process, I realized that setting outcomes ahead of implementing the five-year plan is the best



approach. It is my hope that JTF can establish better project evaluation criteria moving forward. In any case, this marks an important first step in project evaluation, and I am grateful to the SEAFDEC Member Countries and the Secretariat for contributing such valuable insights.

Promoting Collaboration Among SEAFDEC Departments

Another important issue was collaboration. During the JTF 7 project planning discussions, the Deputy Chiefs emphasized that projects should be designed to foster stronger cooperation among SEAFDEC Departments. Thus, the budget for projects was allocated to the respective Departments, which then implemented projects according to their mandates. However, real-world fisheries are inherently more comprehensive. Fishing gear technology, fishing methods, and fishery stock assessment are expected to yield greater effectiveness when implemented collaboratively.

To address this, JTF 7 established joint projects between TD and MFRDMD on stock assessment. Under this arrangement, TD operates the M.V. SEAFDEC 2 to collect data on the marine environment and acoustic data using the SIMRAD EK80 scientific echosounder, while MFRDMD concurrently collects data on spawning stock biomass and larvae on the same cruise. This way, fishery officers from the Member Countries can also learn more precise stock assessment methodologies. For the tropical eel project, survey insights obtained by IFRDMD can be applied by AQD to advance eel farming technologies. Looking ahead, I expect more collaborative efforts between TD and IFRDMD in supporting small-scale coastal and inland fisheries. I was very pleased to learn that TD and MFRDMD jointly conducted a pelagic fish stock survey aboard the M.V. SEAFDEC 2 in October 2025.

Of course, not everything will proceed exactly as planned, but I believe that the essential elements of the project plan we discussed and developed back then are still alive.

Although I am no longer directly involved, I sincerely hope that the implementation of JTF 7 projects will continue to enhance the basic capabilities of fisheries managers across the Member Countries, improve the technical skills of SEAFDEC staff, and foster even stronger inter-departmental collaboration.

About the Author

Dr. Tomoko Nakazato (tomoko_nakazato010@maff.go.jp, hiratakuwa32@gmail.com) served as the SEAFDEC Deputy Secretary-General, Deputy Chief of the SEAFDEC Training Department, and Japanese Trust Fund Program Manager from June 2022 to May 2025. She has since returned to the Fisheries Agency of Japan in Tokyo.

Calendar of Events

Date	Venue/Mode	Event	Organizer/s
2026			
7 August	Bangkok, Thailand	ASEAN Regional Workshop: Mitigation of Microplastic Pollution and Implications for Fisheries and Human Health	CSEAS & NIVA
10-14 August	Rizal, Philippines	Training Course on Tilapia Hatchery & Grow-out Operations	SEAFDEC/AQD
10-14 August	Lao PDR	On-Site Training Course on Good Aquaculture Practices in Lao PDR	SEAFDEC/AQD (ASEAN-JICA FVC Project)
10-19 August	Iloilo, Philippines	Training Course on Propagation & Farming of Tissue-cultured Seaweeds	SEAFDEC/AQD
12-14 August	Melaka, Malaysia	Regional End-of-Project Evaluation Meeting on the Implementation and Assessment of the ASEAN Regional Plan of Action for the Management of Fishing Capacity	SEAFDEC/MFRDMD
17-18 August	Vientiane, Lao PDR	Workshop on Finalization and Handover of the EAFM Plan and Capacity Building in EAFM and Gender Equality and Social Inclusion (GESI) for Trapaing Sangke Community Leaders, Cambodia	SEAFDEC/TD
17-21 August	Singapore	Workshop for Technical Input on Laboratory Testing Methods to the Inspection Guidelines for Imported Aquaculture Fish and Fishery Products	MFRD (ASEAN-JICA FVC Project)
17-26 August	Iloilo, Philippines	Training Course on Micropropagation and Farming of Seaweeds	SEAFDEC/AQD
25-27 August 2026	Samut Prakan, Thailand	Training on Gender Equality and Social Inclusion (GESI) in Fisheries Management	SEAFDEC/TD
31 Aug-3 Sept	Thailand	Advanced Regional Training Course on Port State Measures (PSMA) Inspection Focused on Containerized Fish and Offload Control	SEAFDEC/TD (NOAA-supported)
4-6 September	Rome, Italy	3 rd Small-Scale Fisheries Summit (SSF Summit 2026)	FAO
4-5 and 11 September	Rome, Italy	11 th Meeting of the Regional Secretariat Network (RSN)	FAO
7-11 September	Rome, Italy	37 th Session of FAO Committee on Fisheries (COFI)	FAO
8-10 September	Cebu, Philippines	SAFET Conference '26	SAFET
14-19 September	Bangkok, Thailand	International Fisheries Negotiations Workshop	ANCORS
16-18 September	Philippines	18 th Meeting of the ASEAN Fisheries Consultative Forum (AFCF) 34 th Meeting of the ASEAN Sectoral Working Group on Fisheries (ASWGFI)	ASEAN & Philippines
29-30 September	Sarawak, Malaysia	13 th International Conference on Fisheries and Aquaculture (ICFA 2026)	ICFA
5 October	Bangkok, Thailand	Regional Webinar on the Implementation of the WTO Fisheries Subsidies Agreement: Its Implications, Challenges, and Opportunities for ASEAN Member States	SEAFDEC/SEC
7-9 October	Makati City, Philippines	35 th NACA Governing Council Meeting	NACA
12-16 October	Viet Nam	On-Site Training Course on Good Aquaculture Practices in Viet Nam	SEAFDEC/AQD (ASEAN-JICA FVC Project)
14-16 October	Bangkok, Thailand	Regional Capacity Building Workshop on Enhancing Policies and Countermeasures Against IUU Fishing in Southeast Asia	SEAFDEC/TD
19-22 October	Bali, Indonesia	11 th GEF Biennial International Waters Conference (IWC11)	GEF
20-24 October	Hainan, China	2026 Asia-Pacific (Hainan) Seafood Industry Supply Chain Conference	APSIC
27 October	Bangkok, Thailand	Side-event "Science-informed and Stronger Together: Strengthening Regional Action and Commitment for a More Resilient South China Sea and Gulf of Thailand"	COBSEA
9-13 November	Cambodia	On-Site Training Course on Good Aquaculture Practices in Cambodia	SEAFDEC/AQD (ASEAN-JICA FVC Project)
10-24 November	Rizal, Philippines	Training Course on Community-based Freshwater Aquaculture for Remote Rural Areas of Southeast Asia	SEAFDEC/AQD
16-18 November	Chiangmai, Thailand	49 th Meeting of SEAFDEC Program Committee	SEAFDEC/SEC & TD
19-20 November	Chiangmai, Thailand	29 th Meeting of the Fisheries Consultative Group of the ASEAN-SEAFDEC Strategic Partnership	SEAFDEC/SEC
25-26 November	Aceh, Indonesia	Regional Workshop on EAFM Implementation: Sharing Results and Lessons Learned from 2026 Activities & Planning for 2027	SEAFDEC/TD
16-18 December	Bangkok, Thailand	On-site Training on Traceability for Fish and Fishery Products for Myanmar	SEAFDEC/TD

Guide to Contributing Articles

Fish for the People is a policy-oriented Special Publication produced by the Southeast Asian Fisheries Development Center (SEAFDEC). The first issue of the Special Publication was launched in early 2003 to commemorate the first anniversary of the ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in the New Millennium: “Fish for the People” organized in 2001 from which the Special Publication got its banner title *Fish for the People*. Through the years, *Fish for the People* has been recognized by various stakeholders as a significant source of information to support their works on the sustainable development and management of fisheries and aquaculture in the region. The SEAFDEC Secretariat publishes three issues of the Special Publication each year with support from the Japanese Trust Fund. The publication of articles in *Fish for the People* is free of charge.

Prospective Contributors

- SEAFDEC Secretariat and Departments (researchers, technical staff, project managers)
- SEAFDEC Member Countries (national focal persons of SEAFDEC projects, researchers, fishery officers, professors, students)
- SEAFDEC partner organizations (researchers, technical staff, project managers)
- Non-member countries and other organizations (researchers, managers of projects in the SEAFDEC Member Countries, researchers, fishery officers, professors, students, and those who wish to share experiences that could be applicable to Southeast Asia)

Types of Articles

- **Research article** - report of new and original research findings including the methodology, data, and analysis in popularized format (2,000–4,000 words)
- **Short communications** - brief analysis and commentary on fisheries development and management that may not be suitable for a full-length research article (1,000–2,000 words)
- **Report on activities under projects** - results and implications including strategy or approach, conclusions, and recommendations for the future direction of work (2,000–4,000 words)
- **Conference analysis** - a comprehensive overview of a meeting or session and discuss how the presentations and discussions may affect fisheries development and management (1,000–1,500 words)
- **Feature article** - a brief overview of scientific findings for a general audience; interviews and newsworthy topic based on the author's personal experience
- **Review article** - critical and constructive analysis of existing published literature in fisheries and aquaculture, through summary, analysis, and comparison, often identifying specific gaps or problems and providing recommendations (1,000–2,000 words)
- **Book review** - analysis of recent publications relevant to fisheries development and management (500–1,500 words)
- **Emerging studies** - discuss and analyze new fields of research and methodologies relevant to ecological, economic, cultural, and social aspects of fisheries development and management (1,000–2,000 words)

Format and Structure

- Articles should be written in Times New Roman font 11, single space, one-column layout
- The total number of words excludes the abstract, acknowledgments, references, etc.
- Articles should be written in correct English by using spell-check and grammar-check functions and applications to avoid unnecessary errors
- Articles should contain standard style and formats based on SEAFDEC Style (access at <http://www.seafdec.org/documents/2021/12/seafdec-style.pdf>)
- Articles should be written in gender-sensitive and inclusive language
- The title should be concise and informative for easy retrieval in information systems

- Authorship should be limited to those who have made a significant contribution to the conception, design, execution, or interpretation of the article, and therefore share collective responsibility and accountability for the information provided
- Abstract/summary should be concise and accurate and should be able to stand alone and briefly state the issues/problems, objectives, methods, key results, discussions, and major conclusions (200–300 words)
- A maximum of five keywords should be provided for indexing purposes and easy retrieval of the article in search engines
- Introduction should provide sufficient background (e.g. relevance to the RES&POA-2030 and/or other international, regional, or national instruments) and specify the goal and objectives of the work
- Describe the details of materials and method applied, as appropriate for the specific type of article
- Discuss the significance of the key results of the work
- Tables should be created as editable text and not as images
- Figures should be in line with text and not wrapped with text; figure caption should be written below the figure and not in a text box
- Math equations should be given in editable text and not as images
- National currencies should be converted to or provided with equivalent US Dollars (USD)
- Present the main conclusions based on the objectives of the work and applicability of the work to other sites, countries, or regions
- Indicate the future activities of the work, if any
- For non-SEAFDEC articles, indicate the relevance of the work to Southeast Asia
- Briefly describe the role of the donor(s) in the conduct of the work and/or preparation of the article
- Recognize the individuals who provided help during the research and participated in certain substantive aspects of the article (e.g. data collection, translations, language editing)
- Ensure that all in-text citations are included in the reference list, and vice versa, please see SEAFDEC Style for the detailed guide to the proper format; consider using a reference management software (e.g. Zotero, Mendeley, others) for automatic formatting and make sure to unlink citations and remove all field codes before submitting the article
- Provide the complete names and affiliations of each author including the office/organization's full name and address, email, and other contact details
- Articles should be free of plagiarism and false information; SEAFDEC will not be responsible for any copyright violations

Publication Process

- Please submit the editable file of the article to the Editor of *Fish for the People* through the SEAFDEC Secretariat at fish@seafdec.org
- Articles will be reviewed through the SEAFDEC review mechanism
- Approved articles will be published in electronic and printed formats
- Published articles in electronic format are immediately and permanently made accessible for free read and download from the SEAFDEC Institutional Repository; a unique link is assigned to each published article which can be shared through any communication channels including email and social media
- Printed copies of *Fish for the People* are distributed for free to authors, SEAFDEC Departments, Member Countries, partner organizations, libraries, and other networks around the world



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Southeast Asian Fisheries Development Center (SEAFDEC)

What is SEAFDEC?

SEAFDEC is an autonomous intergovernmental body established as a regional treaty organization in 1967 to promote sustainable fisheries development in Southeast Asia. SEAFDEC currently comprises 11 Member Countries: namely: Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam.

Vision

Sustainable management and development of fisheries and aquaculture to contribute to food security, poverty alleviation and livelihood of people in the Southeast Asian region

Mission

To promote and facilitate concerted actions among the Member Countries to ensure the sustainability of fisheries and aquaculture in Southeast Asia through:

- i. Research and development in fisheries, aquaculture, post-harvest, processing, and marketing of fish and fisheries products, socio-economy and ecosystem to provide reliable scientific data and information.
- ii. Formulation and provision of policy guidelines based on the available scientific data and information, local knowledge, regional consultations and prevailing international measures.
- iii. Technology transfer and capacity building to enhance the capacity of Member Countries in the application of technologies, and implementation of fisheries policies and management tools for the sustainable utilization of fishery resources and aquaculture.
- iv. Monitoring and evaluation of the implementation of the regional fisheries policies and management frameworks adopted under the ASEAN-SEAFDEC collaborative mechanism, and the emerging international fisheries-related issues including their impacts on fisheries, food security and socio-economics of the region.



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The fourth-prize winner, *Pham Khanh Vy*, from the national drawing contest in Viet Nam.

National Drawing Contests were organized in all ASEAN-SEAFDEC Member Countries as part of the preparatory process for the ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security Towards 2020 "Fish for the People 2020: Adaptation to a Changing Environment" held by ASEAN and SEAFDEC in June 2011 in Bangkok, Thailand, in order to create awareness on the importance of fisheries for food security and well-being of people in the region.