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Women are reshaping the blue swimming crab fishery in Lampung, Indonesia by turning waste into opportunity

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1 Introduction

Gender equity and equality in fisheries is crucial for sustainability (UN Women, 2021; FAO, 2022). Achieving it requires inclusive governance, greater recognition of women's contributions, and policies grounded in research to support fair participation and stronger management (GAF, 2018; Oloko et al., 2024; Rice et al., 2024). In Lampung, Indonesia this movement has begun for the blue swimming crab fishery (*Portunus pelagicus*). Women, who have long played a crucial yet overlooked role beyond fishing on the gillnet *kapal jaring* boats, mirroring women's global underrepresentation in fishery systems (Gopal et al., 2020), are coming together to strengthen livelihoods, drive innovation, and promote sustainable management.

Blue swimming crab is one of Indonesia's most important fishery resources valued at ~\$450 million USD in 2023, making it the fourth-highest export commodity by value (MMAF, 2022). Additionally, blue swimming crab export volume across Indonesia has remained steady since 2019, ranking as the fifth most exported fishery commodity by volume at 30,000 tons in 2023 (MMAF, 2024). However, this pressure has driven the fishery close to overexploitation (Yulianto et al., 2024). According to the Indonesian Ministry of Marine Affairs and Fisheries, the Ministerial Decree No. 19 year 2022 indicates that among 11 Fisheries Management Areas (FMA), blue swimming crab is fully exploited in six, overfished in four, and underfished in only one FMA (MMAF, 2022). Despite this, more than 270,000 blue swimming crab associated jobs operate across Indonesia (Nugraha, 2019; Ernawati et al., 2021). Primarily conducted by small artisanal boats, the fishery employs a range of gear types, including bottom mini-trawl *arad* nets, lift nets, and dredge nets, though collapsible traps and bottom-set gillnets remain the most common (Hutapea et al., 2019).

Back on land, the social characteristics of the fishery and supply chain adds another layer of complexity. The socio-economic dimension of the fishery, including the social diversity, agency, economic opportunity, and knowledge access (Mason et al., 2022), directly impacts the livelihoods and cultural practices of dependent communities. Despite not being a local culinary favorite, blue swimming crab has become a valuable secondary option in the domestic market. Whole fresh and frozen crabs are typically sold through various channels, including supermarkets, marketplaces, traditional markets, hotels, restaurants, and retail traders (H. Harlisa, pers. obs.). The blue swimming crab supply

chain in Lampung also operates through several stages. It begins with fishers who catch crabs and sell them to middlemen, often relying on them for financial support to cover fishing logistics. These middlemen typically handle the initial processing, boiling the crabs before passing them on to mini plants. At these plants, the crabmeat is extracted before being sent to processing units for pasteurization and distribution to international markets.

Despite the growth of this industry, the benefits remain unevenly distributed by gender. After the crabs are landed, women make up 63% of the workforce (Fitriana, 2021), engaging in tasks such as preparation, net mending, crab releasing, collection, trade, and processing in the mini plants, where they perform the difficult and labor-intensive task of peeling crab meat. Further, in Lampung, 74.3% of the traders and 82.2% of the processors are female (Fitriana, 2021). However, most of the financial rewards go to fishers, 98% of whom are men (Fitriana, 2021). Additionally, it is often their wives who manage the household's finances. Even though women have traditionally handled family budgets in Lampung, they have limited opportunities to build financial skills or explore alternative livelihoods. However, with more recognition and support through capacity building, women can strengthen their financial skills, reduce debt, and take on larger roles in the fishery system. These changes can pave the way for greater leadership, a stronger voice in management, and improved socio-economic wellbeing for their families.

2 Amplifying women's roles

Recognizing women's role in fishing household stability and fisheries governance (de la Torre-Castro, 2019; Galappaththi et al., 2022), the Environmental Defense Fund (EDF) introduced a multi-stakeholder and rightsholders sustainable fisheries management initiative in 2017. At that time, gender considerations were largely absent from small-scale fisheries livelihood programs, despite evidence of their importance in achieving poverty reduction and wellbeing outcomes (Stacey et al., 2019). Similarly, there were no female representatives involved in blue swimming crab management and governance. In collaboration with university researchers and Mitra Bentala, a local environmental non-profit organization and key partner, this prompted a gender assessment of the blue swimming crab supply chain, leading to the establishment of women's groups in 2021. A program was also established to enhance women's economic opportunities through processing and financial management trainings. What started with just two groups in two villages with 20 members for the initial program in 2021, initiated through on-the-ground outreach and in-person canvassing in the field, has since grown to eight groups across five villages, encompassing 94 members in 2024.

The development training activities and associated program focused on four components: group strengthening, capacity building, alternative livelihoods, and ensuring that women's voices were heard as key actors, as an entry point to being actively included in decision-making. In addition, cross-group exchanges were common to foster social cohesion, since each group was from a different coastal village. In both the blue swimming crab

community and government spheres, women's contributions to conservation efforts have historically been overlooked. Because they were not traditionally seen as fishers, they have been excluded as key actors in the fishery. As a result, their voices and ideas were often absent from governance, limiting their influence on management decisions. Additionally, cultural practices place the burden of domestic responsibilities on women. This creates further barriers to their engagement, making it more challenging to identify women champions, when compared to men. These constraints are also evident in efforts to conduct training sessions and regular women's group meetings, where attendance and participation remained an ongoing challenge.

3 Innovation in crab processing

To improve livelihoods, the women's group *Dapur Bodol Cantyk*, who completed the initial development training activities, pioneered a value-add derivative product, turning waste into opportunity after researching the market potential for blue swimming crab shell waste (Trilaksani, 2021). The product took off, sparking interest across the other groups that had established. Recognizing an untapped potential of this shell waste, the women's groups sought to transform this previously unused byproduct into a resource, creating products that not only reduce waste, but also generate a social and monetary value-add (Croft et al., 2024). An individual blue swimming crab with a weight of 100–350 grams produces shell waste between 51 and 150 grams. The true innovation and contribution are the underlying micronutrients that were previously discarded. The shell waste contains valuable nutrients and bioactive compounds, including protein and collagen (from the residual meat), minerals (e.g., magnesium, zinc, and iron), chitin and chitosan (antioxidants), calcium, and phosphorus (Fawzya et al., 2008; Hidayat, 2016). These nutrients from the shells get transformed into “fish crispy” crackers and powder that is used in other products (Figure 1). While the product utilizes previously discarded nutrients, the products are typically consumed in snack form and don't substitute protein sources for primary meals. Nonetheless, in a province where micronutrient deficiencies and food insecurity remain a concern, even modest increases in dietary diversity and access to nutrient-dense foods can be meaningful. The derivative products are currently undergoing a formal nutrition evaluation.

The capacity building and learning sessions also encouraged women's groups to launch small-scale production businesses and connect their products to larger markets strengthening their role in the local economy. To support their business ventures, the women's groups participated in hands-on training sessions focused on product development, business operations and planning, production, and distribution costs, market strategies, and guidance for market expansion. These workshops covered essential skills, such as production methods, quality assurance, and packaging techniques, ensuring their products met market standards. Methods included live technical training, visioning and goal setting, focus group discussions, consensus-building exercises, participatory mapping and scenario planning, and peer-to-peer learning. Women from different



FIGURE 1

The women behind the blue swimming crab fishery in Lampung, Indonesia. (A) Net mending, in Kuala Teladas village. (B) A women's group in Muara Gading Mas making "fish crispy" cookies from blue swimming crab shell waste powder. (C) The blue swimming crab value-add derivative product labeled "Blue Swimming Crab Tempeh Chips." (D) Pendawi women's group showcasing their product before it goes to market. (E) Women blue swimming crab representatives speaking at the Blue Swimming Crab Co-Management meeting in March 2024. All individuals pictured provided informed consent for their images to be published. Photo credit: Wahyu Mulyono/EDF (A, C, D); Meutia Isty/EDF (B, E).

groups had the opportunity to exchange experiences and refine their production processes with one another, also joining villages. Women connected with local distributors, which enabled them to expand their market reach. As a result, their products appeared in provincial supermarkets as "crab crackers" and "crab sticks" (locally known as *akar kelapa*), purchased by community members, and thus, sharing the nutritional value locally.

Building on this foundation, the women's groups began diversifying their product lines, expanding local market presence, and deepening their economic and social contributions. Other products made with blue swimming crab "flour" powder gained attention in informal markets at the village scale, including fish balls, fish cakes (*pempek*), crab biscuits, squid steak, blood

clam sambal, and fish paste. The products helped generate revenue and enhanced economic independence, or agency (Mason et al., 2022). Female youth also contributed to marketing and social media promotions, with future efforts directed to online sales. A pre-order system via WhatsApp was also established for the local markets within the associated villages. Through these efforts, the women had not only diversified their income but also taken on leadership roles, encouraging further innovation and entrepreneurship, and established a collective voice. Currently, the quantity of raw material generated during the blue swimming crab harvest season (December to March) remains much higher than what the groups can process, with the surplus waste primarily being used for fish feed.

4 Legal recognition of women's groups

In 2022, women were first formally recognized by the Sustainable Blue Swimming Crab Co-Management Team, an ad hoc organization led by the head of Lampung Provincial Marine and Fisheries Agency. This decision came as stakeholders acknowledged the significant contributions of women, who are also rightsholders, particularly in post-harvest activities. Their inclusion was a key milestone in recognizing the diverse roles women play in the blue swimming crab industry, underscoring the importance of gender equity and its broader relevance to equity in ocean governance (Bennett et al., 2025). The following year, in 2023, the Governor of Lampung issued Decree No. 554 year 2023, officially recognizing women's groups who participated in the program and are active in the processing and product development as members of the provincial fishery management team (Governor of Lampung, 2023). For the first time, women were granted voting rights in decisions related to the management and economic development strategies of the blue swimming crab fishery, including evaluating fisheries performance indicators and providing recommendations for adaptive management. This recognition, historically something very rare in the post-harvest sector for global fisheries (Gopal et al., 2020), allowed women to directly influence key decisions, ensuring their perspectives were integrated into the governance of the industry and its future direction.

A key step in the process was the official registration of their groups with the Indonesia Ministry of Maritime Affairs and Fisheries granting them legal recognition. This milestone allowed the women's collectives to be formally established as community organizations, providing them with the opportunity to access government programs, propose projects, and receive support for production equipment and capacity building efforts. With this legal status, the women's groups were better positioned to grow their businesses, expand their product diversity, and strengthen their ties with other organizations. This support has increased the economic diversity, social capital, an example of the non-monetary benefits generated, and participatory governance of these groups, attributes that lead to fishery system resilience in traditional small-scale fishery-dependent contexts (Eurich et al., 2024), giving them, and the fishery, the tools needed to thrive in future changing conditions.

5 Conclusion

The inclusion of women and equitable participation in governance and decision-making not only benefits women by enhancing or diversifying their livelihoods but also strengthens the fishery system by fostering more transparent, responsible, and sustainable management practices (Gopal et al., 2020; Oloko et al., 2024). This has increased gender equity and significantly contributed to both the sustainability and resilience of the sector (de la Torre-Castro, 2019; Rice et al., 2024). By ensuring women are actively involved in governance, the fishery has become more inclusive and better equipped to respond to changing economic and environmental conditions. Their participation brings diverse knowledge, strengthens social resilience, and fosters more equitable decision-making, ultimately contributing to a more sustainable and

adaptive fishery (Bennett et al., 2025; Croft et al., 2024; Kleiber et al., 2015). Such approaches also broadly complement gender transformative initiatives (Lau et al., 2021).

As Sunamah, a leader of one of the women's groups, expressed during a provincial blue swimming crab meeting: "we really want to make things more sustainable, to keep this going for our future."

The meeting, attended by provincial and district officials, marked more than just a routine discussion—it symbolized a pivotal moment where women, who had largely been sidelined in the past, are now actively participating in the management of the blue swimming crab fishery. The establishment of women's groups and this initiative represents significant progress in embedding gender equality and human rights-based approaches into fisheries governance (Finkbeiner et al., 2025), aligning with the Sustainable Development Goals, where gender equality is a central focus (UN Women, 2021). These shifts reflect broader movements in the fisheries sector toward inclusive and co-produced strategies for resilience (Mills et al., 2022). With sustained support from government programs and continued investment in inclusive approaches, these women's groups can achieve greater independence, ensuring sustainable crab fishery management.

Ethics statement

Written informed consent was obtained from the individual(s) for the publication of any identifiable images or data included in this article.

Author contributions

OD: Conceptualization, Project administration, Writing – review & editing. MK: Conceptualization, Project administration, Writing – review & editing. HH: Conceptualization, Project administration, Writing – review & editing. NLK: Project administration, Resources, Writing – review & editing. JGE: Conceptualization, Supervision, Visualization, Writing – original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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