Food and Agriculture Organization of the United Nations

Restoration of productive aquatic ecosystems by small-scale fisheries and aquaculture communities in Asia

Good practices, innovations, and success stories

JAMES COOK UNIVERSITY AUSTRALIA

Restoration of productive aquatic ecosystems by small-scale fisheries and aquaculture communities in Asia

Good practices, innovations, and success stories

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Abbreviations and acronyms

ACIAR	Australian Centre for International Agricultural Research
ASEAN	Association of Southeast Asian Nations
BSC	blue swimmer crab
CCRES	Capturing Coral Reefs and Related Ecosystem Services
CFR	community fish refugia
CSG	community savings group
COVID-19	Coronavirus disease 2019
ECOFISHBD	Enhanced Coastal Fisheries in Bangladesh
ETP	endangered, threatened, or protected
FAD	fishery aggregation device
FAO	Food and Agriculture Organization of the United Nations
FIP	fishery improvement project
GEF	Global Environment Facility
GIZ	German Agency for International Cooperation
HFCA	Hinase Fishery Cooperative Association
ICMP	integrated coastal management program
IUCN	International Union for Conservation of Nature
IUU	illegal, unreported, and unregulated
IW:Learn	International Waters Learning Exchange and Resource Network
KIFCA	Kyeintali Inshore Fisheries Co-management Area
KJNP	Karimunjawa National Park
LINI	Indonesian Nature Foundation (Yayasan Alam Lestari Indonesia)
LMMA	locally managed marine area
MFF	Mangroves for the Future
MPA	marine protected area
MDPI	Masyarakat dan Perikanan Indonesia
NGO	non-government organization
RCA	Rakhine Coastal Region Conservation Association
SEAFDEC	Southeast Asian Fisheries Development Center
SIS	small indigenous species
SSF	small-scale fisheries
TBTI	Too Big to Ignore
TSA	Turtle Survival Alliance
TURF	territorial use rights in fisheries
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
WCS	World Conservation Society
WWF	World Wildlife Fund

Executive summary

This report showcases examples of actions taken by small-scale fishers and aquaculture farmers in Asia to restore the productivity of aquatic ecosystems. Small–scale fishers and fish farmers include some of the world's most marginalised and impoverished people groups, yet their harvests account for over half of the world's aquatic food production. The marine, coastal and freshwater ecosystems their livelihoods depend upon are degraded from human impacts and further at risk from climate change. Ecosystem restoration actions by fishing communities can revitalize the socio-ecological services and sustain progress over time. Both passive and active restoration approaches are being employed across Asia's marine, coastal and inland waterways. Fishers, fish farmers, and fish worker's restorative actions are focused on increasing the sustainability of their operations. Common approaches include eliminating destructive fishing, reducing overfishing through gear changes and effort control, restoring connectivity of floodplains and fish migration pathways, integrated aquaculture and rice–fish farming practices, re-stocking of native fisheries, and actively rehabilitating and / or re-establishing habitats. Progress is measurable through a diverse array of environmental, socioeconomic and governance related metrics. Changes in fisheries catches, ecological connectivity, water quality, habitat diversity and structure, and fish consumption provide important measures of biodiversity gains (or losses). Common enablers of success include economic incentives, co-management and legal recognition of fishing rights, highly engaged fisherfolk cooperatives or community groups, women's leadership and development, and community partnerships with stakeholders that focus on enabling fisherfolk's own goals for sustainable livelihoods. Ecosystem restoration activities have not lasted when these enablers are insufficiently attended to and when environmental aspects of project feasibility, such as the choice of rehabilitation locations and / or species, are poorly planned. Successes in ecosystem restoration by fisherfolk can and are being scaled out to neighboring communities and countries. Key to this is the sharing of stories, lessons learned, and tools, through South–South partnerships, learning exchanges, and women's groups. Simple, low cost tools and actions have enabled long term engagement by small-scale fishers in sustainable operations. More complex actions, such as the uptake of integrated aquaculture systems, are also enabling stepwise changes in ecosystem restoration. By sharing stories from different ecosystems, fisheries, and geographies, this report seeks to help fisherfolk and their partners glean from one another and achieve faster progress in ecosystem restoration.

1

Background and purpose

Artisanal fisheries and aquaculture in Asia dominates global seafood production and underpins much of the region's economy, health and culture. Globally, small-scale fisheries (SSF) contributes more than half of the world's annual fisheries and aquaculture production (FAO, 2020; Kelleher *et al.*, 2012). In developing countries around 100 million small-scale fishers, fish farmers and fish workers produce about two-thirds of the fish consumed by humans, globally (FAO, 2015; Kelleher *et al.*, 2012). Much of this production and employment is from Asia. Half of the world's wild capture fisheries and 90 percent of all aquaculture products derives from Asia (FAO, 2020). The small-scale fishery sector of Asia is responsible for over half of this production.

Small-scale fisherfolk are characteristically poor, rural or remote, often landless, vulnerable and marginalized (Kelleher *et al.*, 2012; Mills *et al*., 2011) with 25 percent estimated to live on less than USD 1 per day (Kelleher *et al.*, 2012). Their fishing gear, methods and target species and fished ecosystems are exceptionally diverse. Their gear is typically simple and low-cost, and their wild capture fishing areas are usually open-access systems. Women make up half of the SSF sector and work mostly in the post-harvest sector. But many are also involved in business and farm management and / or work as fishers. Without women households would not be fed and national fisheries outputs would not exist, yet they are underrepresented, marginalized, and historically poorly engaged in most fisheries improvement projects. The majority of artisanal fisheries products are consumed in the local community, particularly for inland fisheries, where they provide critical nutrition for subsistence fisherfolk (FAO, 2015; Hicks *et al.*, 2019). Several artisanal fishery and aquaculture products in Asia are also produced for global export chains. The economy, health, and social well–being of Asia's small-scale fisher populace is dependent upon the sustained productivity of the aquatic ecosystems they operate in.

Marine and freshwater ecosystems all over the world are degraded, overexploited, and polluted, and particularly so in Asia's waterways and oceans. Declining ecosystem health threatens the quality of human life wholistically (IPBES, 2019). Ecosystem services such as climate regulation, food production, clean water / water quality, hazard reduction, provision of living materials, biodiversity maintenance and provision of raw material for infrastructure are all dependent on functional aquatic environments. Climate change impacts will exacerbate the degraded state of over-exploited aquatic ecosystems within which functional processes are already quite disrupted (Hughes *et al.*, 2017; Nyström *et al.*, 2012; Scheffer *et al.*, 2015). Coral reefs destroyed by destructive bomb fishing on many Southeast Asian coasts have become unstable rubble fields in which new recruits can't get established before the next storm arrives (Ceccarelli *et al.*, 2020) and if they do the increased frequency of heatwaves induces coral bleaching and can lead to death. The hydrological connectivity of inland wetlands has been cut off by mass dam expansion, intensive irrigation for food production, and heavily polluted by urban and agricultural wastes (Gopal, 2013). With increasing climate impacts, waterways and reservoirs are then either inundated with sudden and heavier rain periods, increased erosion from de-vegetated floodplains, or clogged up through long dry periods with invasive weeds, agro-chemical poisons and in a de-oxygenated state (Gopal, 2013). Similarly, mangrove systems, heavily deforested to make way for intensive shrimp aquaculture, suffer increasing disease outbreaks because of insufficient tidal flow and pollution (López-Portillo *et al.*, 2017). Subsequently the coastal villages among or behind these mangrove forests are reported to suffer from increasing storm inundation with shorelines no longer protected by extensive mangrove stands (Mazda *et al.*, 1997). The fisheries products these marine and freshwater systems deliver are also unsustainable without the biophysical functions that the stock needs to recruit, grow, and successfully reproduce. The cost of this declining aquatic productivity is most acutely felt on the world's rural poor, often landless, artisanal fisher communities.

In recognition of the urgent need to conserve and sustain food system productivity, the climate crisis, and the degraded state of ecosystems globally, the United Nations General Assembly declared 2021–2030 the Decade of Ecosystem Restoration. The primary aim is to 'prevent, halt and reverse the degradation of ecosystems worldwide' (UNEP and FAO, 2019). Ecosystem restoration in this context includes the preservation of existing ecological functions as well as restoring those that have deteriorated. In aquatic environments, ecosystem restoration is particularly well known from mangroves and coral reefs. Mangrove restoration in the Sundarbans Bangladesh, since 1966, has restored 195 000 ha (Saenger and Siddiqi, 1993). Projects there have included active restoration techniques whereby new seedlings are planted out and coastal remediation conducted to improve tidal inundations. Coral reef restoration in Indonesia has re-established functional reef habitat up to two hectares, from a very depauperate state (Williams *et al.*, 2019). Coral fragments there have grown quickly and expanded the live coral coverage by 48 percent per year. Coral seeding techniques are also being trialled in the Philippines and Australia with a goal that genetic diversity of restored reefs is less constrained than when reliant on existing fragment growth (Cruz and Harrison, 2017; Doropoulos *et al.*, 2019). These and other aquatic restoration projects have predominantly been led by international development partners and national governments and some are achieving excellent environmental gains. To synergistically address declining ecosystem health, food security and poverty alleviation it is critical that the restoration of aquatic and marine ecosystems benefits the livelihoods of Asia's artisanal fisherfolk.

Enabling local fisher community involvement and leadership in ecosystem restoration can potentially enable sustained ecological, economic, and social changes. For example, the Sundarbans mangrove restoration project employed five million days worth of local labour over 25 years (Saenger and Siddiqi, 1993). Small-scale fisherfolk communities have incredible traditional knowledge of their natural environments including the productive cycles and hydrological conditions. By leveraging on this knowledge and empowering local user management, context specific protected area initiatives, like marine reserves, can successfully meet fisherfolk's economic aspirations, enable them to stop destructive fishing and result in enthusiastic local agency that expands awareness and progress in neighbouring communities (Tilley *et al.*, 2019a). Long term fisheries sustainability can also be achieved through engaging local leadership in initiatives to restore ecosystem productivity, where there is a central livelihoods (people first) focus. Small-scale fishers cannot improve their livelihoods nor ecosystems without substantive assistance. Enabling fisher led ecosystem restoration and poverty alleviation projects needs significant financial, technical, and political resources. Therein international development partners, national and international government parties are now joining with local fisherfolk communities to enable change. By sharing experiences among projects and geographies, fisherfolk communities and their partners can glean from one another and achieve faster progress.

The 2022 International Year of Artisanal Fisheries and Aquaculture (IYAFA) is an opportune time to share such knowledge.

IYAFA VISION STATEMENT

A world in which small-scale artisanal fishers, fish farmers and fish workers are fully recognized and empowered to continue their contributions to human well-being, healthy food systems and poverty eradication through the responsible and sustainable use of fisheries and aquaculture resources.

In order to harness global momentum, conduct and scale out successful ways to help artisanal fishers restore ecosystems, several critical questions need to be explored.

1. What kind of approaches and activities are fisherfolk doing to restore ecosystem productivity?
2. What have been the successes and the challenges?
3. How is progress measured? What are useful indicators of change?
4. How can successful approaches be scaled into new communities?
5. How are women involved and how can fisheries-based ecosystem restoration approaches improve women's livelihoods?
6. How is climate change considered in restoration objectives and/or impacting progress?

Objectives

This report seeks to showcase examples of small-scale fisher and fish farmer led efforts to restore ecosystem productivity. The report covers marine, coastal and freshwater environments in Asia, but with a strong focus on South and Southeast Asia. We explore the types of activities undertaken to improve the environment, and how well they did or did not work. Progress is identified across environmental and socioeconomic domains, specifically with the view that ecosystem restoration actions can only be sustained if fisherfolk attain livelihood benefits from their actions. Key pathways or enablers of success are compared, as are common challenges. Indicators or metrics of progress are extracted and compared across case studies. Success in scaling out restorative activities and overcoming challenges is shared. We highlight initiatives that have or are enabling women's leadership in restoring ecosystems and improving their livelihoods. The impact of climate change in directing fisherfolk activities and impacting progress is also evaluated.

By sharing these examples and re-telling the fisherfolk community's own stories, this report seeks to enable more community led restoration work, that leverages on the success and learnings of other initiatives.

2

Report methodology

Definitions and caveats

Ecosystem restoration herein is defined as "the process of assisting the recovery of a degraded, damaged, or destroyed ecosystem to reflect values regarded as inherent in the ecosystem and to provide goods and services that people value" (Martin, 2017). Ecosystems are viewed as socio-ecological systems that serve an array of stakeholders through the services they provide. The restoration activity or approach is taken as "any intentional activity that initiates or accelerates the recovery of an ecosystem from a degraded state" (IUCN, 2021).

The report considers both active and passive restoration activities (Perrow and Davy, 2002). Active restoration includes transplanting, planting, or releasing seeds, and we include juvenile fishery stocks in this. Passive restoration removes or reduces the environmental stressor. Activities that seek to restore ecosystem productivity considered herein include reduction or elimination of destructive fishing, reducing by-catch of juveniles and endangered, threatened, and protected species, reducing fishing capacity, reducing fishing pressure and reducing pollution. The use of protected areas as fisheries management plans that reduce fishing pressure, usually in concert with reducing destructive fishing practices are included as an activity that aids ecosystem restoration. Socio-ecological tools that help communities restore ecosystem productivity are also included.

This report primarily explores grassroots or bottom-up approaches to aquatic ecosystem restoration. Ecosystem restoration programs that were not led by or did not explicitly involve and enable leadership by small-scale fishers or fish farmers are not included. Similarly, activities that were not fisheries or aquaculture related were not considered. Small-scale fishers and smallholder aquaculture farmers are hitherto collectively referred to as fisherfolk. 'Fish' refers to any targeted fisheries stock, inclusive of finfish and invertebrates.

The selection of case studies within is not exhaustive but seeks to showcase a spectrum of activities across aquatic ecosystem types, fisheries, and geographies. Marine, coastal, estuarine, and inland freshwater ecosystems are included.

Knowledge search process

Formal and informal knowledge searches were conducted to identify and collate information for this report. We used the peer reviewed scientific literature, secondary literature such as government and development partner reports, websites, and direct discussions with several project partners. The following electronic reference databases were used: Web of Science, Scopus, Directory of Open Access Journals, Aquatic Sciences and Fisheries Abstracts (ASFA), and Google Scholar. BOOLEAN search terms were used including base phrases of: small-scale fish*, ecosystem restor* AND fish* OR rehabilitat*, aquaculture AND restore*, sustainable fish*, artisanal OR community-based OR livelihood, fisher OR fisherfolk AND organizations OR associations, women AND / IN fisher* organizations OR associations, freshwater OR inland OR lake AND fisheries, seagrass AND fisheries AND restor*, aquaculture AND integrat*, aquaculture and smallholder. The timeframe for published literature included that up to August 2021. Literature records were scanned to identify relevant case studies within Asia, and / or leads to further information and references. Websites and social media reports from known community-based fisheries programs and development partners in Asia were reviewed using combinations of the same search terms.

Focal habitats of fisherfolk-led restoration activities included mangroves, coral reefs, seagrass, soft-sediment and rocky areas, lagoons, wetlands, saltmarsh, and other estuarine areas, intertidal areas (rocky, soft sediment or other), subtidal areas, inshore-offshore marine areas, rivers and delta systems, lakes, aquaculture and mariculture systems. Where few or no cases from an ecosystem were located in the primary literature, additional searches were made using a combination of the ecosystem term and fisheries or aquaculture (e.g. lake AND fisher* OR aquaculture). All results were scanned to identify restoration relevant work by or with small-scale fisher or aquaculture farmers in Asia.

3

Case studies in small-scale fisher and fish farmer led ecosystem restoration

3.1. Marine and coastal ecosystems

3.1.1. Ornamental fisheries and reef restoration – Bali, Indonesia

@ Ocean Image Bank/Cinzia Osele Bismarck

Source: freevectormaps.com

Ornamental Fishers in Les village, Buleleng regency, North West Bali have shifted away from destructive cyanide poisoning and breaking corals to using small hand and barrier nets. Destructive fishing, overfishing, and coral bleaching events caused a crisis for reef condition and fisher livelihoods in North West Bali during the late 1990s to early 2000s (Frey and Berkes, 2014). Catches and coral cover were at their lowest point. An NGO group (Yayasan Bahtera Nusantera), at first pretending to be an export agent, showed fishers how to use small barrier nets instead of cyanide and talked to them about the impacts of destructive fishing (environmentally and economically). The fishers were aware that their reef was in very poor condition and getting worse, but not necessarily that they were causing a lot of this impact. When they heard about the issues and were shown a different way, two of the fishers enthusiastically took the lessons on and gradually influenced all the fishers in the village to change their ways (Frey and Berkes, 2014).

The NGO's approach was particularly successful because it aligned the conservation message with their community's Hindu cultural practices (Muswar and Satria, 2015) and identified community champions who ultimately drove the project's success. The NGO partner assisted the fishers with economic pathways, equipment, legal instruments, education, and training. Within two years cyanide fishing had nearly all stopped. The fishers formed an ornamental fisher association, and, at the village's request, the NGO partners began training the village in reef restoration and eco-tourism ventures. The ventures have grown exponentially, and Les village is transformed economically. It is an eco-tourism hub for reef restoration and education, recycles marine plastics into saleable products, hosts a training and research center for ornamental fish aquaculture, and efforts remain community led (Loke, 2019; Sea Communities, 2015; Yayasan LINI, 2021). With the help of reef restoration activities, by 2014, coral cover had recovered to 45 percent and reef fish to 70 percent of their perceived 1986 levels (Frey and Berkes, 2014). Ornamental fishing still continues but without destroying the reef and fishers have collaborated with the international Marine Aquarium Council on sustainable ornamental supply chain management (Muswar and Satria, 2015; Yayasan LINI, 2021).

Today, in Les village, the locally based Indonesian Nature Foundation (LINI) continues to work with the local fisher association, village enterprises, government agencies and international NGOs (Yayasan LINI, 2021). They identify emerging leaders, source, and supply training in needed techniques to local individuals and external institutions (such as local government, schools, and research agencies) and help broker village–government relations. These partnerships are enabling long-term sustainability of the Les village fisher's actions and livelihoods. Moreover, the initial and continued actions taken by Les fishers are being scaled out to other locations in Indonesia, through the LINI Foundation.

For more information on this case please visit:

- **seacommunities.com/sea-communities**
- **lini.or.id**
- Musar and Satria (2017): **communityconservation.net/les-village-bali-indonesia**
- Frey and Berkes (2014): **jstor.org/stable/26523151**

3.1.2. Coral reef restoration – Indonesia, the Philippines and Thailand

Biorock reef restoration @ Fenkie Andreas

Source: freevectormaps.com

Numerous SSF communities living in coral reef areas are now engaged with rehabilitating their reef resources via coral restoration activities. For some of these communities the rehabilitation activities have enabled them to diversity their income base and lessen their fisheries dependence. Often the coral reefs around the village have been so badly destroyed by destructive fishing practices (such as bombing, cyanide poisoning, trampling or breaking corals), coral bleaching events, typhoons, and other severe weather events, that there is little chance for corals to recruit and grow back naturally. There are various techniques for restoration or rehabilitation works being applied by these communities. Here we highlight several examples of how the local communities are leading or substantively involved in restoration projects that also provide them alternate or supplementary income streams.

In Pemuteran village of North West Bali, Indonesia (east of Les village) the villagers partner with Karang Lestari Foundation and utilize Biorock technology to rebuild their fringing coral reef (Trialfhianty and Suadi, 2017). Reef rebuilding and enforcement of destructive fishing bans by the community began in early 2000 and has reportedly built the reef back up from a barren and depauperate state, with substantive coral cover and reef fish (Goreau and Hilbertz, 2008). The restoration project has also been the recipient of several international eco-tourism and community development awards. Pemuteran community's pathway to success has involved strong community–NGO partnerships, the developing of community champions, fostering local business activities associated with eco-tourism and reef restoration (where the tourist pays for the services), creating alternative jobs for fishers including project leadership roles, and also benefited from the community's positive and collective culture. Critically, Trialfhianty and Suadi (2017) report that community engagement and changing fishing behaviour was enabled by communicating the environmental problems and solutions through local beliefs and by providing an alternate economic activity for fishers. People became more engaged when they saw an opportunity for personal economic gain. Just over half of the village has been actively involved in the project, and particularly the fishers, dive instructors, and local reef guards. Overall, the villagers perceive that the restoration activities have provided local employment, lifted the village's economic status, improved the marine environment, reduced destructive fishing, and provided alternative income for fishers most impacted by the declines in local marine resources.

In the Philippines at Lucero village district (Pangasinan, Bolinao) around 30 community members were involved in restoring *Acropora* coral thickets in a degraded shallow reef area behind their village (Cruz, Villanueva and Baria, 2014). This reef's corals had still not recovered from blast fishing ten years earlier. Here, the community and local research partners demonstrated that restoration can sometimes be done with very limited infrastructure and at very little cost. Local research partners collected suitable healthy coral fragments from a donor reef 21 km away and stored them in a sheltered area near the re-plant site for a few days. They also ran training and education workshops in the village. Using snorkel, the community members then attached the coral fragments to wired bamboo stakes that had been secured in the sand. Researchers monitored ecological progress at the sites (transplant coral survival, growth, absolute coral cover, fish biomass, abundance, and species richness) with common camera-based survey techniques. After 18 months coral cover increased from nil to 24 percent in low-density transplant plots and to 50 percent in high-density plots. Reef fish increased in abundance, species richness and biomass over time, but with more variation among sites. After 18 months there were, on average, two to three times more individuals and species in the high-density plots than control areas and biomass was six times greater. Good site selection was a key factor in this project's success. The research partners had investigated the ecological history of the Lucero reef, and determined what corals used to be there, and whether the simple attachment process would be strong enough to hold corals up while they grew. They then chose the most appropriate sites, corals and methods for their environmental context. Overall, the project demonstrated how local communities and researchers can work together to rebuild reefs in degraded area without always needing expensive rubble stabilisation techniques.

Fisher-folk on Olango Island, Central Visayas, the Philippines were employed in a coral farming and transplantation program, funded by the German government, philanthropic and university partners of Germany and the Philippines (Heeger *et al.*, 2001). Women were employed to fix the coral fragments to substrates, while men were paid to work out at sea on the nursery sites. Providing jobs for the community raises the sense of agency that the fisherfolk have for their reefs and the restoration activities. Here corals from the nursery site were planted out over 2000m^2 of degraded reef at nearby Mactan Island.

For more information on this case please visit:

- Pemuteran village: **biorock-indonesia.com/project/pemuteran-bali**, **link.springer.com/article/10.1007/s11852-017-0553-1**
- Lucero village: **academic.oup.com/icesjms/article/71/7/1866/664250**
- Olango Island coral farming: **repository.seafdec.org.ph/handle/10862/1811**

3.1.3. Small-scale fisherfolk mitigate impacts of mass tourism - Koh Chang Island, Thailand

@ Vassamon Anansukkasem

Source: freevectormaps.com

Fisherfolk on Koh Chang island, Thailand have adapted to the economic opportunities afforded by a mass tourism economy. With support from the GEF-UNEP South China Sea Project, 2005-2008, the traditional knowledge and stewardship of SSF communities towards their environment was re-enabled (Rogers *et al*., 2014). The natural resources of the island and surrounding waters have been heavily impacted by un-restrained, poorly planned, and damaging tourism developments. Destructive fishing, careless recreational activities, coastal sedimentation, and pollution have damaged reef areas. The GEF-UNEP project helped fisherfolk develop alternative and/or supplementary income streams (UNEP, 2008). Fisherfolk received training and later licences to run their own eco-tours that ultimately increased their income by 50 percent (Zakariah *et al*., 2007). A local tour guide centre was formed between fishers and tourism groups to facilitate training, tour bookings, and manage activities. The project drew together SSF, government, private tourism, local universities, and NGOs and undertook a suite of combined activities to mitigate damage and improve SSF livelihoods. These included reef patrols, volunteer clean-ups, active reef restoration, buoy installations to reduce anchoring, and awareness campaigns (UNEP, 2009). After the UNEP-GEF project ended, the partnerships between the diverse stakeholders continued thanks to the now stronger public tourism administrative agency (a government body). This agency was based locally and continued to provide start up support for new ventures by or with the fisherfolk communities and delivered training (Rogers *et al*., 2014). The initial project success was in capacity building local institutions, fostering strong partnerships, and training local SSF in alternative income streams. These activities had enabled the local community to economically adapt and take actions that mitigate theirs and other's collective impact on the environment. Unfortunately, the impact of the COVID-19 pandemic on these fisherfolk's tourism-based income streams is likely to have been quite negative.

For more information on this case please visit:

- **Rogers *et al*., 2014**
- UNEP 2009 National Reports on Coral Reefs in the Coastal Waters of the South China Sea. **UNEP/GEF/SCS Technical Publication No. 11**

3.1.4. Abalone fisheries, the Philippines

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Source: freevectormaps.com

Abalone gleaning has devastated many coral reef areas in Asia as fishers trampled broke and upended corals to extract stock. Abalone Haliotis asinina is a product highly valued for its meat and shell, with a strong market demand that small-scale fishers have long harvested and benefited from. Yet wild stocks easily crash with overfishing and environmental degradation. For example, in the Philippines wild stock based export from Palawan dropped from 100 metric tonnes in 1997 to just two tonnes in 2011 (Gonzales, 2015). Multiple initiatives in the Philippines are providing SSF ways to rebuild stock, rehabilitate degraded areas, and increase their economic opportunities through mariculture and re-stocking programs in nearshore reef areas. In Molocabac Island, Sagay Marine Reserve, hatchery raised abalone are released in a no-take zone (within a co-managed marine protected area), and local villagers guard stock (Salayo *et al.*, 2020). Spawning spillovers have resulted in increased catch rates and biomass in the fished areas. The community also implemented fishing restrictions on stock selection and techniques used such that reefs are no longer destroyed and the wild spawning stock is rehabilitating. Here and in North Palawan local fishers have learned skills in mariculture cage construction, grow out techniques, stock monitoring, shipping, marketing, and financial management (Gonzales, 2015; Salayo *et al.*, 2020). Local fisher committees have been formed that liaise with traders, government, and research partners, delivering successful co-management outcomes. When the sites are accessible to fishers, they have been able to monitor and guard stock leading to economic benefits from the catch sales. After juveniles are released, fishers also benefit from ability to grow and harvest stock with very simple infrastructure, and with minimal feed costs.

The major challenge and barrier for the fishery is the need for supply of juveniles, ideally from a local hatchery. The substantive infrastructure, research and development, and technical skills needed for hatching and rearing juveniles means that facilities are run by government, university, or large private businesses, and are costly. Appropriate stock-release strategies also need to be developed. Future developments of private-public-business partnerships could enable increased employment and training of small-scale fishers in the hatcheries and particularly women. Additional challenges exist in the selection of appropriate release sites and species. Research that works with fisher's local knowledge to co-design management and monitoring requirements has had success (Salayo *et al.*, 2020). Abalone stock enhancement for small-scale fishing enterprises is scalable to other sites in Asia where strong community, government and research development partners networks are established such as in Viet Nam's Bach Long Vi National Marine Protected Area. Initial trials of Abalone enhancement trials are being done there with local community members (Chieu *et al.*, 2016).

For more information on this case please visit:

- Gonzales 2015: **repository.seafdec.org.ph/handle/10862/2769**
- Salayo *et al*., 2020: **www.sciencedirect.com/science/article/abs/pii/S004484861732094X**

3.1.5. Blue Swimmer Crab fisheries – crab bank cooperatives

@Thomas de Aquino

Source: freevectormaps.com

Coastal fisher communities across Asia are increasingly engaged in Blue Swimmer Crab (BSC) fisheries, *Portunus pelagicus*. Developing the fishery has been a high priority program with SEAFDEC, ASEAN member countries and various development partners with multiple Fishery Improvement Projects (FIP) in progress (e.g. Sustainable Fisheries Partnership, 2021). Harvesting gravid females and juveniles leads to overharvesting and stock collapse. Communities in Thailand, Cambodia and Malaysia are improving their local stock levels by implementing 'crab banks', no-take zones, minimum size regulations, and bans on harvest of gravid (berried) females (Sopanha *et al.*, 2012; Sornkliang, Manajit and Isao, 2020; Suanrattanachai *et al.*, 2009).

Communities have formed fisher associations (e.g. Cambodia's Community Fisheries Initiatives) that, when successful, make cooperative decisions on restricted fishing gear, refuge locations, member allocations and minimum crab sizes. Members work together to enforce protected areas, resolve conflicts, and provide economic support to each other. Using a 'crab bank' system, gravid females are protected from fishing until after spawning (Sopanha *et al.*, 2012). Communities do this by either marking crabs, putting them in cages, mariculture pens or in land-based aquaculture systems depending on their local socioeconomic and environmental contexts. By participating, members get a proportion of the reserved females to sell while another set proportion is re-released into no-take areas. Successful SSF crab bank cooperatives have increased BSC catch rates, crab sizes, protected seagrass, mangrove, and coral reef areas from non-selective and damaging techniques and are also self-monitoring their stock levels and condition. Socially, the communities are now more cohesive, have greater awareness of marine resource challenges, have increased agency in the fishery, and are connected to larger sustainable fisheries research, trade, and governance networks (Suanrattanachai *et al.*, 2009).

Developing strong and influential community leaders has also enabled some communities to get started. Community education, technical training and learning exchanges between fisher groups (within and between countries) are also empowering fishers to continue their efforts and adapt techniques where viable (Sornkliang, Manajit and Isao, 2020). Economically, fishers report increases in member's household incomes and in their village's overall economic activity. Local youth are also being educated and engaged. Women are typically most active in the processing and selling of the catch, benefit from increased household incomes and are somewhat involved in the cooperative's decision–making (Sornkliang, Manajit and Isao, 2020).

In some locations the BSC fishery and / or crab bank system has not worked well because sites are too far away for guarding and monitoring, and/or don't have the right environmental conditions for the crab banks (e.g. waves are too big or predation is too high). In these cases economical returns to fishers have not been sufficient to motivate them to maintain the new initiatives (Suanrattanachai *et al.*, 2009). Other challenges have included accessing larger supply chains. Engagement with partner's networks, including private business, research institutes and government is helping tackle these challenges (Sornkliang, Manajit and Isao, 2020). Scaling out crab bank fisheries to more SSF communities is achievable using the considerable lessons learned and being learned by these communities and partnerships.

For more information on this case please visit:

- **Sustainable Fisheries Partnership 2021**
- Sophanha *et al.*, 2012: WorldFIsh **hdl.handle.net/20.500.12348/1001**
- Sornkliang, Manajit, and Isao, 2020: SEAFDEC **repository.seafdec.org/handle/20.500.12066/6449**

3.1.6. Small-scale tuna fisheries – Maluku, Indonesia

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Source: freevectormaps.com

In 2014, artisanal yellowfin tuna (*Thunnus albacares*) fishers in Buru Regency, Maluku Indonesia became the first small-scale fishery in the world to attain Fair Trade certification, and then in 2019 was the first to be assessed for Marine Stewardship Certification (Bailey *et al*., 2016; Zheng *et al.*, 2020). This fisher community has overcome significant socioeconomic and environmental challenges in their fishery to become true exemplars of how small-scale pelagic fishers in Asia can proactively improve their fishery's sustainability and realize economic security for their whole community. Their story started with engagement from a local NGO called Masyarakat dan Perikanan Indonesia (**MDPI**) whose goals are to drive responsible and sustainable fisheries for the well-being of Indonesian SSF communities and their resources. MDPI helped Buru fishers and local traders form their own association, built awareness and gave them a shared vision for social and ecologically sustainable fisheries and engaged fishers with sustainable fisheries supply chain initiatives. Strong cooperative decision–making ensued with regulations on fishing gear, landing prices, effort restrictions, and later also on marine debris, and protection of endangered, threatened, and protected species (ETP) such as turtles. Fishers stopped destructive fishing (purse seining, and bomb fishing), returned to traditional and selective handline and kite fishing methods ('One Hook, One Fish' policy) and implemented effort restrictions.

Cooperative funding models in the fishery have enabled economic gains for the whole community, with notable improvements in sewerage and water infrastructure, schools, and waste management facilities in the villages (Zheng *et al.*, 2020). Household level financial management has also improved with families investing in savings plans for school education, and social security for periods of illness or bereavement. Fisher folk receive training including safety at sea, first aid, leadership and organizational skills, financial management and more. Social cohesion and agency for environmental stewardship has also extended to turtle conservation with nesting beaches now protected by locals and egg harvesting forbidden. Catch data management systems have been implemented and data are being collected by the fishers themselves. Training fishers in logbook systems has increased their technical capacity and further empowered them to self-manage the fishery. This local fishery is now linked directly with technology partners and hook to plate traceability is being enabled for an international market. Supply chain management has also been improved, starting with improved landing facilities and processes. Fishing waste and by products have been reduced and the quality of the product improved.

Current challenges for the community include the high costs of international audits and certification programs as well as traceability systems, communication barriers (language and technology), continuing to develop strong partnerships and local leaders, maintaining trusted relations, and brand marketing in an increasingly competitive market (Bailey *et al*., 2016; Zheng *et al.*, 2020). The success of the local model is such that there are more buyers around and fishers are often tempted to abandon the regulations of the cooperative system for higher short-term gains. Thus, continued engagement, awareness and strengthening of trust between fishers and traders is essential. An additional challenge faced is to build consumer awareness and increase the market demand for socially sustainable fisheries as well as environmentally sustainable product.

The program has now scaled up successfully and includes over 800 fishers (and their households), with 32 fisher associations across multiple islands in Indonesia (Zheng *et al*., 2020). The local NGO partner has also increased their staffing size, capabilities, and engagement with a vast network of international and national stakeholders. Yet their focus on on-ground activities remains and relationships with the SSF communities remains foundational to success. The model is also being implemented in Mexico, the Maldives, United States of America, and the Solomon Islands (Zheng *et al.*, 2020).

For more information on this case please visit:

- **mdpi.or.id/en**
- Video*:* **Fair Trade Impact in Buru, Indonesia**
- Video*:* **bit.ly/SSFIndoBuru**
- Zheng *et al.*, 2020*:* **doi.org/10.4060/ca8402en**
- Bailey *et al.*, 2016*:* **doi.org/10.1016/j.fishres.2015.11.027**

3.1.7. Seagrass restoration by Tsuobomi fishers – Hinase, Japan

Eelgrass beds © Eric Heupel

Source: freevectormaps.com

Between 1945 and 1985 seagrass (or 'eelgrass', *Zostera marina*) in Japan's Seto Inland Sea, had declined from 590 ha to just 12 ha. The decline was because of multiple anthropogenic impacts including coastal pollution and overfishing (Tsurita *et al.*, 2018). The impact of declining water quality and seagrass loss was acutely felt by local pound net fisherfolk ("Tsuobami") such that in the late 1980's 19 fishers from Hinase started to re-seed the seagrass beds themselves. They used their traditional ecological knowledge of the system to plant out seeds, ultimately leading to functional recovery of the ecosystem with 250 ha of coverage by 2016 (Tsurita, Hori and Makino, 2017). Yet these fishers did not act alone.

Fishers in the Hinase area of Seto inland sea have cooperatively managed their marine resources for at least a hundred years with records of a collective fisher association dating back to 1895 (Ota *et al.*, 2011 cited in Tsurita *et al*., 2018). The current Hinase Fishery Cooperative Association (HFCA) draws together different local fisher operations and traders facilitating cooperative decision–making and conflict resolution. Historically, members have recognized fisher user rights, seasonal and area closures, quota restrictions (on number of fishers and vessels), and gear regulations so as to reduce destructive fishing, and rehabilitate the ecosystems (Tsurita, Hori and Makino, 2017).

As coastal development pressures increased in the 1990s and early 2000s there were fewer fishers and the traditional maritime cultures appeared threatened (Yanagi, 2018). The HFCA recognized the declining social agency and connection that their young people had to fisheries. They combatted this by having all members join the Tsuobami fisher's seagrass restoration efforts as a collective cause (Tsurita, Hori and Makino, 2017). Their community wide actions were soon noticed by conservation NGOs, media and tourism agencies giving the (surprised) fisherfolk expanded social networks and followings. Their restoration programs got more support and began to be emulated by neighbouring communities, included in school education and outreach activities, and featured in eco- and traditional tourism ventures (Tsurita *et al.*, 2018). Younger people also joined the fisheries, addressing ageing demographic challenges. Additional environmental actions started up, including mass clean ups of marine debris that continue today (Yanagi, 2018). This collective movement has all resulted in significant increases in social agency, pride, environmental awareness (and activity), community cohesion, a re-invigorated traditional culture and knowledge sharing.

From 2011 to 2014, HFCA's traditional management regulations and a desired no-take area were recognized in both national and provincial government policies (Tsurita *et al*., 2018). Simultaneously major coastal development was stopped through efforts of their partners and the enlarged social network. Water quality also improved to the point that oyster farming over the seagrass beds began, today comprising 88 percent of the HFCA catch (Tsurita, Hori and Makino, 2017). By developing good relationships with government, science, and industry agencies, and through implementing territorial use rights in fisheries (TURF) based, multi-use marine protected area

(MPA) management zoning, the community has the means to adapt to new economic opportunities and mitigate against future threats (including climate change).

No single metric adequately summarizes the socio-ecological and economic changes in the Hinase region since the 1980s and changes have been variable over time (Tsurita *et al.*, 2018; Tsurita, Hori and Makino, 2017). Ecologically the seagrass beds increased in area (peaking in 2007) and are now self-sustaining with good biophysical function. Genetic studies indicate that the re-seeded plants have naturally spread throughout the area, akin to spillover. Fish biomass and diversity has generally improved, though it varies among locations. The economic activity in the community has gone up and down through time, but importantly is vigorous and innovative with expanding marine-based tourism and fishing related industries. Socially there are increased networks, a greater sense of agency and responsibility, more employment options for youth, increased environmental awareness and strong community leadership continues.

The actions taken by fishers to restore the ecosystem health did not directly translate into increased fishery incomes. Instead, catch rates and sale values were affected by a variety of market-based changes including shifts in consumer's seafood preferences and increased market competition from the expansion of seafood products sold on the market (Tsurita, Hori and Makino, 2017; Yanagi, 2018). Ecologically, the larger monospecific stands of seagrass *Zostera marina* may be limiting fisheries benefits as fish tend to be more abundant on the narrow edges of beds (Tsurita 2017 cited in Tsurita *et al.*, 2018). Thus, further rehabilitation efforts are now trialing smaller and mixed species beds. Fishers are also concerned about climate change impacts on the highly valued oyster farming operations. However, it might be that the recovered seagrass beds help increase the resilience of oysters by improving water quality and the oyster rafts aid seagrass health by reducing water flow and providing shade (Yanagi, 2018).

Overall, the bottom-up management actions taken by Hinase's small-scale fishers and their proactive partner engagement is stewarding environmental resources and sustaining an adaptive community. Their model is now famous in Japan, known as the Suto-omi concept, and being scaled out to other land and sea locations (Tsurita *et al.*, 2018).

For more information on this case please visit:

- Video: **youtu.be/6Sod3mhwMMg**
- Tsurita *et al*., 2018: **doi.org/10.1016/j.marpol.2018.02.001**
- Yanagi 2018: **emecs.or.jp/s-13/en/publication/reb_2018**

3.1.8. Kyeintali community fisheries – Southern Rakhine, Myanmar

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Source: freevectormaps.com

Myanmar's marine fisheries are heavily overexploited. Pelagic stocks were last estimated to be at 10 percent of 1980 estimates and demersal offshore and inshore stocks at 50 percent (DoF Myanmar, 2017 cited in WCS Myanmar, 2018; Krakstad *et al.*, 2014). There are about 1.4 million people in Myanmar coastal regions whose primary income source is fisheries derived (WCS Myanmar, 2018). In the Kyeintali townships of Southern Rakhine, on the Bay of Bengal, a variety of inshore and offshore fisheries exist. The dominant fishery is purse seining for sardine (*Sardinella* spp.), anchovy (*Stolephorus* spp. and *Dussumieria* spp.) and other small shoaling fish (Exeter *et al.*, 2021). Most fishers in the area already perceive their fishery is declining and that their family's income is insufficient (WCS Myanmar, 2018). Compounding the ecosystem degradation and resource exploitation pressures impact on livelihoods, is the continued political instability of Myanmar. Community fisheries cooperatives and co-management are enabling change.

The Kyeintali Inshore Fisheries Co-management Area committee (KIFCA) was formed with the assistance of Rakhine Coastal Region Conservation Association (**RCA**) who helped gather and organize the local fisher communities in Kyeintali. The committee represents 10 villages with one female and one male leader per village. Kyeintali fishers, RCA, Wildlife Conservation Society (WCS) and Myanmar government worked together on marine spatial planning to design the KIFCA co-management area and it was recognized by the state in 2016. Within this area there are zoning arrangements for the types of fishing permitted, including demarcation of inshore and offshore areas, no take zones, seasonal closures, and turtle conservation zones (nesting beaches). The co-management system ensures the communities' voice on management regulations and processes is recognized by law and they are actively involved in implementing management (Mizrahi, 2021).

Early indicators of the KIFCA impact have included community fishing practices alignment with the new zones. Records of infringements and penalties imposed are also indicative of active engagement and monitoring. There is anecdotal evidence that fishery catch has improved, and illegal fishing has declined (M Mizhari, personal communication, 2021). A major challenge is the limited government capacity to monitor or enforce illegal activities (WCS Myanmar, 2018). Government agencies primarily provide administrative assistance, but their limited capacity means that local KIFCA representatives are usually the only on-water management presence (M Mizhari, personal communication, 2021). Additionally, COVID-19 impacts combined with substantive political unrest means that further illegal, unreported and unregulated (IUU) fishing patrols are probably inactive. However, community engagement and agency in the co-management area remains evident in their actions towards local turtle conservation.

Protecting marine megafauna aligns well with their local Buddhist culture and turtle conservation has become an active and collective community program (**KIFCA Facebook page**). Active since 2015, KIFCA community members guard, patrol and monitor turtle nesting behaviour and also relocate nests from flood-prone areas. The community was supported in this with training and engagement activities from WCS and Turtle Survival Alliance (**TSA**). There have also been some community efforts to help other threatened megafauna species (e.g. whale sharks) (Saw, 2021).

The initiation of co-management in the southern Rakhine communities has opened the way for exciting gender equity initiatives locally. Marine products sourced from the co-managed area are processed and sold by women in the villages. To empower and support their livelihoods WCS Myanmar and SHE Investments are providing business support including small loans, financial training, leadership, and mentoring (Mathews *et al.*, 2021; Myae, 2019; SHE Investments and WCS Myanmar, 2020). The program is already increasing women fisherfolk's confidence and self-value, income, planning, and decision making. Additionally, their awareness about local marine resources and sense of agency in sustaining these has increased (Mathews *et al.,* 2021).

Co-management programs initiated from the ground level provide a model for the future. KIFCAs implementation partners are now helping Kyeintali's neighbours to develop their own marine resource management plans, via similar partnerships, participatory approaches, and spatial planning models (Mizrahi, 2021). By working in communities where there are existing local partners and community awareness of a neighbour's success, the co-management model will likely be successful again.

For more information on this case please visit:

- **myanmar.wcs.org**
- **sheinvestments.com**
- SPC Information Bulletin #32 **coastfish.spc.int/en/publications/bulletins/women-in-fisheries/514**
- Exeter *et al*., 2021: **doi.org/10.3389/fmars.2020.625766**

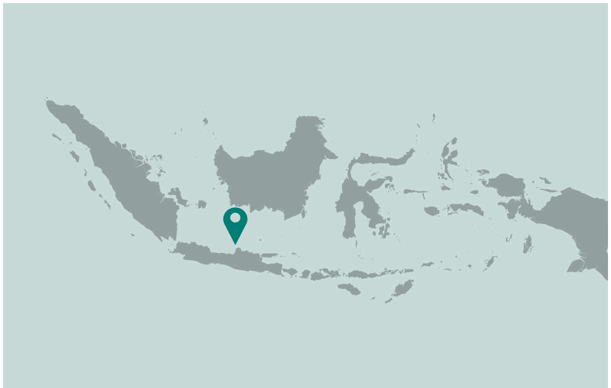
3.1.9. Co-management and marine protected areas

Marine parks have a convoluted history throughout coastal Asia. Their intended objectives, design, and outcomes have often not benefited small-scale fisher communities (Mizrahi *et al.*, 2020), in some cases even worsening their livelihoods (Stacey *et al.*, 2021). And in many cases, because of insufficient enforcement, inappropriate site selection and/or poor community consultation they fail ecologically (Giakoumi *et al.*, 2018). Yet, there is hope. Increasingly co-management designs are being used that partner top down and bottom-up approaches to resource management. Here, a community's traditional user rights-based approach and/or their identified preferences for ecosystem management can be empowered and enabled by the resources and legal frameworks of the government systems above them. Communities are regaining the capacity to steward their fisheries resources and begin to restore ecosystem function through the help afforded by government, research, and NGO networks. Marine park systems are a great tool for conserving and rebuilding ecosystem health and, when their design and implementation is sufficiently led by local fisher communities, they can achieve great socioeconomic outcomes for fisherfolk. Using spatial planning tools community partnerships can designate various combinations of zoning and fishing regulations. For example, no-take areas, multi-use areas, local access only, buffer zones, habitat rehabilitation zones, recreational zones, commercial fishing areas, prohibited gear types in some zones, catch quotas, fish size limits, licensed user restrictions and so on.

Herein are examples of several marine park programs that have had, or are on the way to having, success in fisherfolk-led actions to restore fisheries productivity, marine ecosystem health, and realize socioeconomic benefits.

Karimunjawa National Park, Java Sea, Indonesia

© Ocean Image Bank/Erik Lukas



Source: freevectormaps.com

Karimunjawa National Park (KJNP) was established in 1986 by the federal government as one of Indonesia's first marine parks (Campbell *et al.*, 2013). It covers 1 116 km^2 of sea and land, within which live about 9 000 people over 27 islands. There have been two re-zoning processes since the park's inception and since 2003 communities have been able to participate in decision-making and have traditional user rights recognized. Socioeconomic improvements for the communities have been incentivized through engagement in conservation and education activities, employment, training in MPA surveillance and enforcement, training and development of local based tourism and mariculture industries and their income benefits, improvements to village infrastructure and increased educational activities at local schools (Campbell *et al.*, 2013). While community agency in managing the resources has increased through these activities and through TURF implementations, there is community concern that some of the traditional fishing areas don't provide sufficient resources and young fishers are going outside the park to fish or may fish (illegally) in non-permitted zones (Nurhidayah and Alam, 2017).

Gear restrictions implemented by communities have probably been the most major contribution to ecological recovery and ecosystem resilience in the park. Fishers stopped using destructive Muroami and bombing techniques switching to handlines, bubu traps and speargun s. Since then, coral reefs have shifted from massive coral dominance to more complex and fragile corals (branching and foliose forms) that would previously have been easily destroyed (Kennedy *et al.*, 2020). Herbivore reef fish have increased somewhat, often perceived as a measure of increased reef health and resilience to climate impacts (Bejarano *et al.*, 2019; but see Russ *et al.*, 2015). The reefs recovered well from 2016 mass bleaching events and coral cover has generally been maintained (Kennedy *et al.*, 2020), indicating that change in destructive fishing is making a difference. In 2011, fisherfolk cooperatively decided to stop fishing certain high value threatened grouper species and implemented restrictions on fishing during spawning seasons (Yulianto *et al.*, 2015a, 2015b). While these and most other reef fish stocks in KJNP have not increased, ecological surveys show they are not declining and also that there is minimal difference in stock levels among zones (Campbell *et al.*, 2013; Kennedy *et al.*, 2020). Fishers, however, have reported declining catches of small pelagic, demersal fish and some reef species (Fitriana and Adhuri, 2014). Community surveillance on illegal fishing from external users has helped efforts to stop Danish purse seining and thereby increase some targeted groupers and other soft bottom demersal fish (Yulianto *et al.*, 2015b). Major environmental challenges include pollution from oil spills and ship groundings with large oil and coal tankers passing close by, and poor water quality stemming from land use practices outside of the park (Kennedy *et al.*, 2020).

For more information on this case please visit:

- Campbell *et al.*, 2013 **doi.org/10.1016/j.marpol.2012.12.022**
- Kennedy *et al.*, 2020: **doi.org/10.3390/jmse8100760**
- Nurhdiayah and Alam 2017: **fao.org/3/i6742e/i6742e.pdf**

Community led marine protected areas – Raja Ampat, West Papua, Indonesia

© Ocean Image Bank/Alex Mustard

Source: freevectormaps.com

In contrast to KJNP, the implementation of marine parks in Raja Ampat Indonesia has primarily been bottom-up, wherein customary practices have been used to designate spatial planning regulations including area closures (temporal and spatial), and user access rights. Central government has recognized, promoted, and reinforced these systems (Mangubhai *et al.*, 2012). Like other places in Southeast Asia, destructive fishing and overfishing has been a major threat to ecosystem health, and long term socioeconomic sustainability of livelihoods in Raja Ampat (Purwanto *et al.*, 2021). International and local NGOs have worked with communities in spatial planning exercises and helped develop government and private business partnerships.

In Mayalibit Bay, traditional tenure rights delineate each village's fishing and access areas, and visitors must obtain permission to use local areas (Nurhidayah and

Alam, 2017; Purwanto *et al.*, 2021). Communities also restrict fishing effort through no fishing day rules on Saturday and Sundays, in alignment with local spiritual practices. There is usually minimal resource-based conflict between locals and neighbours, and fishing supplies most daily needs. Fishers use more sustainable techniques (e.g. handlines) and there are dedicated areas for particular techniques, limiting conflict and ecological damage (Purwanto *et al.*, 2021). Local community and state-based regulations also ban large-scale fishing, commercial aquaculture, and fishing of ETP species.

The remoteness of the Mayalibit Bay communities is an ongoing challenge and limits their economic development, with only basic infrastructure services available (Nurhidayah and Alam, 2017). The traditional system of marine resource management, coupled with state and development agency partnerships, has successfully conserved ecosystem function in the region (Purwanto *et al.*, 2021) however economic gains through fisheries or other marine resources have not been widely realized (Nurhidayah and Alam, 2017). Without increased economic opportunities the threat is that impoverished communities degrade natural resources to meet their economic needs and aspirations. COVID-19 pandemic effects on tourism, local employment and fisher livelihoods have indeed decreased incomes and increased isolation (Awaludinnoer *et al.*, 2021). Local environmental degradation risk is perhaps mitigated by strong community cohesion, generally strong agency and awareness on marine resource values, and (rebounding) supplementary income from tourism and mariculture. But infrastructure development, increased tourism opportunities and other sustainable eco-venture opportunities are needed for longer term social and ecological stability. Successful collaborative partnerships between communities, government, enterprises, and NGOs have the potential to deliver these opportunities (Nurhidayah and Alam, 2017).

For more information on this case please visit:

- Purwanto *et al*., 2021: **doi.org/10.1111/csp2.393**
- Nurhdiayah and Alam 2017: **fao.org/3/i6742e/i6742e.pdf**

Tools for Community Management – Selayar Island, Indonesia

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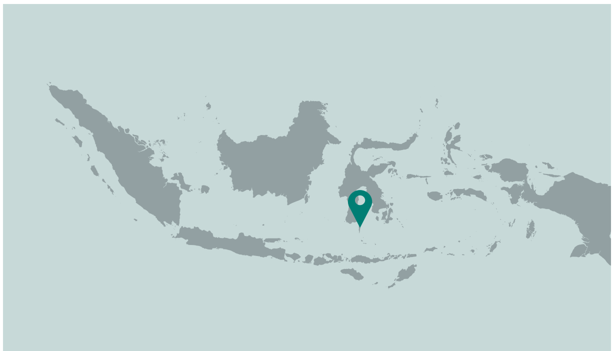


Source: freevectormaps.com

Villagers of Bungaiya in Selayar Island (south Sulawesi) implemented changes to where and how they fished in their traditional waters. The community instigated bans on destructive cyanide and bomb fishing on their coral reefs and designated some no-take fishing areas. There were positive signs of fish stock increasing in the reserved areas. However, the community's efforts were also threatened by limited recognition of their decisions by district and national government policy, and also by conflicts with neighbours regarding access rights and prohibited gears in the no take area (Krueck *et al.*, 2019). The Bungaiya villagers invited scientists from the World Bank Capturing Coral Reefs and Related Ecosystem Services project (**CCRES**) to help them move forward. Together, the community, neighbours, researchers, and government agencies then used and adapted a series of tools to make progress towards sustainable fisheries co-management in Selayar (Abdurrahim *et al.*, 2018; Ross *et al.*, 2018). They developed (1) conflict resolution mapping tools, (2) undertook a participatory MPA planning process identifying the most beneficial zoning plan for both social and ecological success, (3) attained government recognition of the community's management plans and (4) identified community centric progress metrics (i.e. indicators of success in the community's own eyes). Scientists worked in the community to measure baseline socioeconomic, fisheries productivity and coral reef conditions. Their results showed disagreement between the community's preferred no take zones areas and the most ecologically viable area for sustaining long term reef productivity. With the participatory mapping and conflict resolution tools, the CCRES partners helped the village identify sites that were both ecologically and socially viable (Krueck *et al.*, 2019).

Core elements to the successful implementation of resource rehabilitation and sustainability in Bungaiya, Selayar have been the participatory framework employed by researchers, identifying and empowering community champions, the visualizations of scientific results that facilitated community dialogue at each step, the engagement with stakeholders across the village–district–national government spectrum, and capacity building programs. Institutional relationships between the multiple government agencies, local and international universities and NGO partners have been strengthened by working together. The project was also successful because it built on the legacy of several previous development, education, and conservation projects in Selayar (Krueck *et al.*, 2019). These had helped raise community awareness, capacity and built relationships that the CCRES project was able to pick up on. There are still some challenges with neighbouring villages regarding who can fish where and with what gear (PJ Mumby, personal communication, 2021). However, while the funded project has finished, the village representatives will be able to use their learnings and increased communication and leadership skills to negotiate mutually beneficial outcomes.

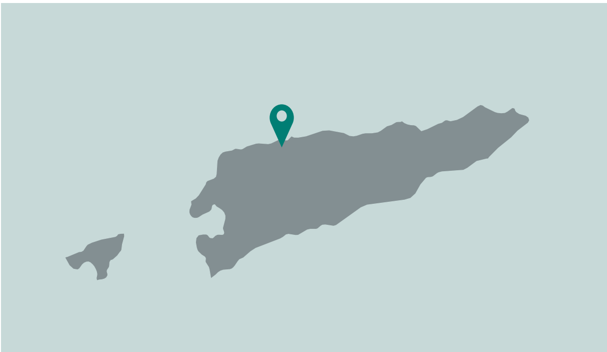
Longer term socio-ecological indicators of success and impact in Selayar remain to be measured. In the meantime, the fisher community has improved their governance, understanding of their marine system (and its functions), identified and strengthened their socio-cultural values (e.g. pride), set up sustainable fisheries yield for the long-term, increased the ecological resilience to climate impacts by investing in an (evidence based) MPA zoning management plan, and improved their relations with neighbours and governance systems. Each of these activities breaks the cycle of declining ecological and social systems and increases the community's capacity to adapt to future climate (and other) shocks.

For more information on this case please visit:

- **ccres.net**
- Krueck *et al*., 2019 **ecologyandsociety.org/vol24/iss4/art6/**

Timor-Leste: Customary management and female leadership

© WorldFish/Dave Mills



Source: freevectormaps.com

In 2018, the Behau community of Timor-Leste established a marine protected area under their customary law practice called 'Tara Bandu', with the goal of sustaining their livelihoods. NGO partner Blue Ventures helped the community develop their own marine management program. Importantly, the community have been the initiators of the management design. In Behau, customary marine tenure laws have been investigated, discussed, and synthesized with more recent scientific understandings of coral reef fisheries and successful nearshore resource management actions. The communities have participated in learning exchange visits to other established locally managed marine area (LMMA) sites in Indonesia and actively participated in local dialogues. The Behau community cooperative has now implemented their own LMMA design, that includes fishing gear regulations, no-take protected areas, access and anchorage restrictions, and multipurpose zones (Blue Ventures 2019). There is a locally-led fisheries monitoring group, and the community has installed buoys to demarcate protected zones.

The monitoring group, with support from Blue Ventures, is developing a female-led monitoring program. This program trains and facilitates women's empowerment and engagement in the community's resource management process. Using the same program, women in Atauro Island, Timor-Leste, have been collecting socioeconomic data on local fisheries catches, which informs their community LMMA development and will enable the community to self-monitor and report future outcomes (Blue Ventures, 2018). Behau and Atauro are popular marine tourism destinations in Timor-Leste, and development of local tourism businesses has the potential to support women's livelihoods and a sustainable local economy.

On Atauro island, 13 villages have now designated customary marine management or 'Tara Bandu' areas. One of these locations is Adara village. Adara community has been the leaders in community-based protected area management in Timor-Leste. They first approached WorldFish for assistance in facilitating customary management practice, in 2013 (Tilley *et al.*, 2019a). The community's objectives centred on their concern about locally declining reef fish resources and wanting to increase income from tourism (Mills *et al.*, 2017). After many meetings in the village, including women only focus groups, the community implemented a protected area (restricted fishing and anchoring), and banned destructive fishing practices generally. They also implemented a reef-tax for tourists (Tilley *et al.*, 2019a). The economic incentive of the MPA plan has been a key driver in sustaining the regulations and community cohesion for the MPA (Tilley *et al.*, 2019a).

Villagers also developed homestay accommodation and sell local crafts to tourists as a means of supporting their livelihood (e.g. Adara eco-resort). The reef area in Adara has remained healthy to date and supports a high diversity and cover of coral reef organisms (Lara-Lopez *et al.*, 2019). Fishing pressure on local reef resources is mitigated by the MPA but perhaps more so by the installation of nearshore fishery aggregation devices (FADs) that improve the accessibility and catch of small pelagic fish and reduce pressure on the reef fish resources (Tilley *et al.*, 2019b). Women fisherfolk in Adara are very active fishers and glean the reef flat areas (Tilley *et al.*, 2021). The community's no-take area stopped them from gleaning in the most accessible part of the reef, right in front of the village. However, this decision was made with the women, who felt that they would be compensated through the tourism opportunities they would gain (Mills *et al.*, 2017).

The actions of the Adara fisher community to implement customary management has enabled them to protect reef resources, gain supplementary income, build a community fund and infrastructure from this, access knowledge training and partnerships, and actively share their experience with other communities (Mills *et al.*, 2017; Tilley *et al.*, 2019a). Timor-Leste government legislation recognizes the customary law and practices of Adara and other communities and has supported communities in developing their own regulations, albeit with very limited provincial and national governance resources. Challenges in Timor-Leste's ongoing marine resource management include limited fisheries monitoring resources and capacity, user conflicts and unequal access to natural environmental resources, limited capacity to navigate intentions and relationships with multiple development partners, limited enforcement (particularly of external parties rather than local village members), and where tourism is not viable there are limited alternative livelihood options (USAID, 2021).

For more information on this case please visit:

- **worldfishcenter.org/pages/adara**
- Blue Ventures:
  - **blog.blueventures.org/en/taking-control-with-tara-bandu**
  - **blog.blueventures.org/en/using-fisheries-monitoring-as-a-tool-for-empowering-women-in-timor-leste**
- Tilley *et al*., 2019: **doi.org/10.3389/fmars.2019.00392**
- Mills *et al*., 2017: **doi.org/10.1016/j.marpol.2017.04.021**

3.2. Mangrove ecosystems

South and Southeast Asia contain approximately 40 percent of the world's mangroves, covering over 75 143 km^2, and the highest diversity of mangrove species (Spalding, Blasco and Field, 1997). Widespread loss of these forests estimated at 1-2 percent / year (Valiela, Bowen and York, 2001), is because of a multitude of coastal development impacts, timber harvesting, conversion of forests for agriculture and aquaculture, coastal pollution, and development induced changes in tidal flows (López-Portillo *et al.*, 2017). Mangrove areas also suffer from storm damage, coastal erosion, inundation from flooding, and storm surges including the 2004 Indian Ocean tsunami.

Global movements to restore mangrove systems by means of conserving and replanting lost areas have been active since at least the 1980s. National governments and global aid and conservation agencies have funded varieties of mangrove rehabilitation efforts throughout South and Southeast Asia (López-Portillo *et al.*, 2017). A wide variety of restoration or rehabilitation techniques have been used around the world, seeking to address losses in ecosystem services, increased ecological functions, protect coast-lines and other objectives. Climate change mitigation and adaptation is a notable objective in most recent restoration programs (e.g. in Viet Nam – Hai *et al.*, 2020). Inclusion of complementary, local livelihood objectives has varied (Hai *et al.*, 2020).

Mangrove systems provide critical coastal protection from storms, erosion, and coastal inundation. With climate change increasing the severity and frequency of these events, restoring and conserving mangroves and their function is indeed essential. Coastal communities across Asia are often quite aware of their need for mangroves and the benefits they afford (Brown *et al.*, 2014; Jhaveri, Nguyen and Nguyen, 2018; Setiyaningrum, 2019; Stone *et al.*, 2008) and many have been many actively involved in replanting efforts (e.g. Walters, 1997). For small-scale fishers and aquaculture holders, mangroves buffer or filter water quality, provide habitat for a variety of inshore fishery products (mostly invertebrate) and have long been a source of wood for cooking and infrastructure.

An overarching challenge with mangrove restoration programs globally has been their top-down nature with limited involvement of local stakeholders in the decision-making processes (Gevaña, Camacho and Pulhin, 2018; Walters, 2004; Wylie, Sutton-Grier and Moore, 2016). This has impacted the income generating capacity of vulnerable artisanal fishers, especially if they happen to live inside a newly protected area with strict conservation regulations on how mangrove resources can be used (or not). In many cases this gap in consultation and coordination has also meant that mangrove restoration projects don't outlast the project funding periods because there is no economic incentive for residents to maintain new plantations and / or conserve older ones (Jhaveri, Nguyen and Nguyen, 2018; Walters, 1997). Thankfully, international aid and national governments are now turning to co-management models to facilitate authentic partnerships, enact local tenure and decision-making authority, and enable long term sustainability of initiatives (Gevaña, Camacho and Pulhin, 2018; Jhaveri, Nguyen and Nguyen, 2018).

Integrated mangrove aquaculture (silvo aquaculture)

A third of global mangrove loss results from shrimp farming, wherein mangroves have been cleared and aquaculture ponds installed (Valiela, Bowen and York, 2001). Integrated mangrove aquaculture systems provide great hope for addressing both mangrove restoration needs, local livelihoods, and environmentally friendly aquaculture systems. In an integrated mangrove–aquaculture system smallholder aquaculture farmers (or wild capture fishers) leverage the ecological benefits of a healthy mangrove system to farm or capture their stock within the mangrove area. There are various types of integrated mangrove–aquaculture or fishery systems including mangrove–shrimp farming, clam gleaning, mud crabs, cockle fisheries, and mixed cultivation methods of shrimp, fish, molluscs and bivalves and sea cucumbers within mangrove areas. Most of these mangrove systems have been developed in southeast Asia but there is expansion into south Asia, particularly in Bangladesh (Ahmed *et al.*, 2017). Coupled with co-management frameworks there is potential for communities to conserve, protect and enhance their local mangrove areas while also developing secure livelihoods.

3.2.1. Integrated mangrove–shrimp farming – Ca Mau, Viet Nam

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In Ca Mau province of Viet Nam, farmer's success in integrated mangrove–shrimp systems is being scaled out to more communities with support from the seafood industry, government, and development partners. Fifty percent of Viet Nam's mangroves are in Ca Mau province, and many of these are in the Mui Ca Mau National park which is a world biosphere reserve and Ramsar site. The reserve contains 22 species of mangroves, that provide habitat to a myriad of endangered and threatened species (WWF, 2013). Herbicides and defoliant in the Viet Nam war, followed by extensive clearing for agriculture and shrimp farming led to a halving of Ca Mau's mangrove cover since the 1950s (Van *et al.*, 2015). Restoration efforts have contributed to expanded cover, but the density of the mangroves has been limited (Vo, Kuenzer and Oppelt, 2015).

Government law in Viet Nam mandates that a minimum of 70 percent of mangrove cover in shrimp production areas must be maintained (Bosma *et al.*, 2016; Jhaveri, Nguyen and Nguyen, 2018). Smallholder farmers are using an 'extensive' pond model where large ponds are stocked with shrimp and existing mangrove stands within and around the ponds are maintained or extended where necessary to improve canopy cover (Ha *et al.*, 2012). The mangroves benefit the shrimp survival rate, in some cases doubling it, reduce disease risk, improve pond water quality, provide shade and habitat within ponds, improve feeding efficiency, allow for shallower ponds, reduce chemical and anti-biotic use, and increase the overall quality of the shrimp products (Bosma *et al.*, 2016; GIZ, 2018). Farmers are thus using more environmentally friendly techniques in their systems and also actively conserving and restoring mangroves. Shrimp are stocked at lower densities than in typical 'intensive' shrimp farming and while this reduces the harvest rates, the quality of shrimp is better and the farm and farms are more adaptative and resilient ecologically, economically, and socially (GIZ, 2018).For example, when white-spot disease outbreaks decimated shrimp farm cultures in 2012, the integrated mangrove–shrimp farms remained profitable (GIZ, 2018).

Smallholder farmers join in small clusters and larger cooperatives where they gain access to traders (the market at large), get technical and financial training, share knowledge, learn about new innovations, get access to micro-credit loans, and collaborate strongly with each other for mutual benefit (Ha *et al.*, 2013). Farmers have had to learn a lot about how the integrated system works and how to implement it. Training is also given on using mixed systems of shrimp, crabs and fish which can lead to even higher yields (GIZ, 2018; Ha, van Dijk and Visser, 2014). The joint GIZ and Australian Aid sponsored Integrated Coastal Management Program (ICMP) in Viet Nam reported that farmers' income improved by some 45 percent (GIZ, 2018).

Organic mangrove–shrimp farming in Ca Mau has also been successfully developed, extending on integrated practices, and enabled farmers to further improve their environmental practices and income. The initiative partners smallholder farmers, private seafood businesses, the government, and NGOs (Ha *et al.*, 2012; Jhaveri, Nguyen and Nguyen, 2018). Between 2013 and 2016 over 1 200 households and 5 000 ha of integrated mangrove–shrimp farm systems received organic certification (Jhaveri, Nguyen and Nguyen, 2018). Farmers receive financial help and training to improve their practices to the necessary standard from the industry partners. Part of the income received through their cooperatives is used to restore more mangroves, with 80 ha planted out by one sector. Additionally, by going organic, farmers have reduced aquaculture waste, cleaned up farm and living facilities, are maintaining mangrove forests, and stopped using (inorganic) chemicals that frequently end up polluting the coastal environment. Farmers receive income from their harvests, shares in the business, and additional benefits for their mangrove forestry services. The high costs of achieving certification for each household have been covered by the industry and other partners.

Communities throughout the Mekong Delta are benefiting widely from the integrated mangrove–shrimp farming models (GIZ, 2018). Environmental education has been developed and included in primary and secondary schools, and in teacher training modules. Public awareness campaigns have fostered increased environmental awareness. Civil servants have attended workshops to improve their environmental education. Multi-stakeholder discussion forums also take place regularly on aquaculture practices, mangrove restoration and other local conservation topics. Small-scale famers and their communities are now connected to government, large businesses, and a global market, and vice versa. Gender equity initiatives are also increasing with 215 women, or 25 percent of the farmers involved with the ICMP, attaining higher income capacity. Global networks such as Mangroves for the Future (MFF) are providing toolkits and training for partners to implement Gender equity strategies (MFF, SEI and SEAFEC, 2018). It is also worth noting that many of these socioeconomic successes have benefited from the deep legacy of more than 20 years of mangrove restoration projects in Viet Nam wherein learnings from previous success and failures are being applied, and pre-existing partnerships engaged again (Jhaveri, Nguyen and Nguyen, 2018).

Major challenges in Viet Nam's integrated mangrove aquaculture systems have included attaining (1) adequate and consistent government policy recognition of the small-scale fisher or smallholder's tenure (Ha, van Dijk and Visser, 2014), and (2) sufficient supply chain access, demand, and marketability of the smallholder's products (leading to income) (Baumgartner and Nguyen, 2017; Ha *et al.*, 2012). In particular, the costs of organic farming practices to farmers and the partners are much higher than typical 'intensive' shrimp farming. Higher demand for the products can incentivize the farmers to keep going and foster scalability. This requires improved marketability and addressing global consumer preferences (e.g. certification by the Aquaculture Stewardship Council), as well as improving supply chain efficiencies in Viet Nam (GIZ, 2018).

Good harvest of shrimp in Bac Lieu Bac

@ FAO, PT Cuong

For more information on this case please visit:

- Jhaveri *et al.*, 2018. USAID report **land-links.org/project/tenure-global-climate-change-Viet Nam**
- GIZ 2018 **giz.de/en/worldwide/18661.html**
- Mangroves for the Future (MFF): **mangrovesforthefuture.org**

3.3. River ecosystems

3.3.1. Hilsa fishery and fisherwomen champions – Bangladesh

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Source: freevectormaps.com

Fisherwomen in Bangladesh are helping restore populations of the nation's national fish, the Hilsa shad (*Tenualosa ilisha*), and its depleted fishery. By participating in women-led community savings groups (CSG), and in village conservation committees, the women have increased their agency in rebuilding Hilsa stocks and are championing change in their families and wider community (Wahab *et al.*, 2020). Through the knowledge and financial empowerment the CSG program provides, they motivate their family's fishermen to comply with Hilsa conservation measures that include a 22-day fishing ban when Hilsa fish are spawning, minimum size restrictions, and six no-take sanctuary areas (Islam, Nahiduzzaman and Wahab, 2020). The women's leadership is making a difference in addressing high levels of illegal fishing and implementing sustainable co-management of the national fishery.

One hundred and forty-eight women-led CSGs have been created across 136 villages through the USAID funded Enhanced Coastal Fisheries in Bangladesh project (ECOFISHBD) which was delivered by WorldFish and the Government of Bangladesh (2014–2019). Each CSG has 30–35 women, who were invited because they were the most impoverished in their household, and from some of the most marginalized fisher communities in Bangladesh (Wahab *et al.*, 2020). In the CSG women receive training in basic literacy, financial management skills, and technical skills related to their preferred business (e.g. sewing or goat rearing). They also gain access to technology assets that support their livelihoods, such as rooftop solar panels for those living in house boats.

The women's collective savings are matched by a donor to create the community fund. These funds are then accessible as interest free and short-term soft loans, with debt payments waived during the fishing ban periods. Women use the loans to diversify their family income by starting new businesses like tailoring, goat rearing, cattle raising, market gardens, and small stores. These loans are freeing fisher families from debt traps (Islam *et al.*, 2016; Islam, Nahiduzzaman and Wahab, 2020), and greatly increasing the women's social capital. Members say their honour and value in the community has increased and they are able to support their families, so their husband does not need to fish illegally in the Hilsa ban periods (Wahab *et al.*, 2020). Women are further increasing their leadership skills by participating in the village's fishing committee. Here they help lead the community in co-management decisions towards fisheries conservation and improving socioeconomic livelihoods. In addition, women have joined together in an annual fisher women congress to share and celebrate their collective achievements, and further empower women to participate in community decisions and lead natural resource management.

Key ecological and socioeconomic results of the broader ECOFISHBD and Bangladesh government project (2014–2019) include an 11 percent increase in annual Hilsa catch, 40 percent increase in the average biomass of individual fish, 25 percent increase in average household income (and higher in fisher households) and increase in diversity and abundance of other riverine fish (Rahman *et al.*, 2020). The program has built a collaborative, science-based adaptive co-management framework to conserve and restore Hilsa stocks while also empowering marginalized fishers and improving livelihoods. Key successes in incentive-based management of Hilsa stocks are now being scaled in India and Myanmar through regional transboundary cooperation (Wahab *et al.*, 2020; Rahman *et al.*, 2020).

For more information on this case please visit:

- Enhanced Coastal Fisheries in Bangladesh Project (ECOFISHBD) and Rahman *et. al.*, 2020 **iopscience.iop.org/article/10.1088/1755-1315/414/1/012018**
- Video: Worldfish 2015 **youtube.com/watch?v=RC0O2sPaJGM**

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3.4. Inland freshwater ecosystems

The inland aquatic systems of Asia are incredibly diverse, containing 25 percent of all freshwater fish species, a large proportion of which are endemic (Nguyen and De Silva, 2006). These systems provide over two thirds of the world's inland fisheries production (FAO, 2020) and make up a third of the world's wetlands (Davidson, Fluet-Chouinard and Finlayson, 2018). Across Asia there are about 360 Ramsar sites (wetlands of international importance) indicative of how important Asia's inland aquatic systems are to sustaining global biodiversity. Besides hosting diverse assemblages, the fisheries of freshwater wetlands have sustained millions of people for thousands of years, particularly through the ancient practice of rice–fish farming. Therein a variety of aquatic organisms (but mostly finfish) have been cultivated alongside rice. The co-production system remains one of the most efficient, nutritious, and ecologically sound practices for food production today (Halwart and Gupta, 2004). It is also a recognized 'globally important agricultural heritage site' by the United Nations.

Small indigenous species (SIS) of freshwater fish dominate Asia's freshwater systems and include over 270 species. SIS fish catch from rice-fish farming, aquaculture and wild capture sources supplies the nutritional needs of poor people living in remote areas of inland Asia. The fishery resources in waterways are typically open access providing landless fisherfolk a critical means of survival, and supplemental food and income for rice farmer households. Most SIS catch is consumed directly, and the practice of eating it whole provides a source of essential vitamins and minerals especially important in women and children's health (Bogard *et al.*, 2015; Hortle, 2007; Roos *et al.*, 2007). Like in other small-scale fisheries, women have a dominant, but typically uncounted role in SIS fisheries, acting as fishers, managers, business owners and more.

The productive cycles of wetlands and their fisheries depends on connectivity of the waterways, but they are now some of the most degraded ecosystems in the world (Funge-Smith, 2018; Gregory, Funge-Smith and Baumgartne, 2018). Massive hydrological changes from intensified irrigation systems and dams have broken or disrupted this connectivity, in some places completely. Further, widespread use of agro-chemicals and urban development have polluted waterways poisoning native aquatic plants and animals. Wild fish species are increasingly rare, threatened, endangered and likely locally extinct in many regions (Ali, 1990; Berg *et al*., 2017). Invasive species, some introduced to increase aquaculture production, have also shifted trophic dynamics and reduced populations of native species. Limited vegetation management of remaining water reservoirs has resulted in clogged up, de-oxygenated, and closed systems that fish can't survive in. Other typical impacts are poor land management, increased erosion and sediment loads, industrial pollution, urban effluents, overexploitation of broodstock, overfishing and selective pressure on target stock, and increased disease in farmed and wild stock (Funge-Smith, 2018; Funge-Smith and Bennett, 2019; Gregory, Funge-Smith and Baumgartne, 2018; Vörösmarty *et al.*, 2010). Climate change will further exacerbate environmental impacts with increased severity of flood and drought events, and less predictive weather cycles that farmers have long depended on (Gopal, 2013). But there is hope. Restoring productivity of inland waterways and native fisheries can be done, bit by bit, by local fisher communities with help from government and non-government partners.

3.4.1. Rice–fish and aquaculture farmers rehabilitate native inland fish systems

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Source: freevectormaps.com

Public awareness on the value of small native fish to nutrition and livelihoods is increasing throughout inland Asia and fisherfolk are actively rebuilding the productivity of native fisheries, their habitats and revitalizing traditional agricultural practices. Notable activities by rice–fish farmer communities and smallholder aquaculturists are being done in India, Sri Lanka, Bangladesh, Viet Nam, Lao People's Democratic Republic, China, and Nepal among others.

Rice–fish farmers are adopting environmentally friendly techniques to co-culture small native fish and other aquatic organisms, larger fish (typically carp and tilapia) and/or shrimp within rice paddies and home ponds. The integrated practice has various forms including co- or polyculture, Integrated Multi Trophic Aquaculture (IMTA), aqua–agriculture and integrated aquaculture (Halwart and Gupta, 2004). Within these systems farmers culture SIS and gain improvements in water quality, vegetation control, biodiversity, and fishery productivity (Islam *et al.*, 2018; Rai *et al.*, 2012; Saha and Barman, 2020; Sunny *et al.*, 2020). These systems are more self-sustaining than intensive aquaculture ones, require less food input, less chemicals and consequently can have lower effluent output (Halwart and Gupta, 2004). Household nutrition is improved, particularly for mixed species polyculture, output costs are reduced, and household income is both diversified and increased as productivity rises (Castine *et al.*, 2017). Farmers who make hydrological improvements, revegetate, reduce erosion, and remove weeds (or plant overgrowth) further improve water quality and help increase waterway connectivity (Berg *et al.*, 2017; Gregory, Funge-Smith and Baumgartne, 2018). Additionally, by growing native fish species, genetic diversity of endemic species is conserved and the reliance on introduced species (which are sometimes invasive) can be reduced. Small farm holders have been able to stock their home ponds with a proportion of SIS (Islam *et al.*, 2018; Keus *et al.*, 2017; Rai *et al.*, 2012; Saha and Barman, 2020), and some communities are rehabilitating larger communal water bodies by releasing SIS stock (e.g. in ponds, lakes, reservoirs and rivers: Barman *et al.*, 2013 in Saha and Barman, 2020; Chen, Li and Wang, 2012).

A substantial challenge for restoring the aquatic ecosystems of inland Asia is that very little is known to science about the biodiversity, biology, and ecology of native fish and other aquatic species (Dudgeon, 2005; Funge-Smith and Bennett, 2019). Small-scale rice fishers and farm holders are helping address this challenge by assisting researchers to determine biodiversity, monitor changes, and understand stock dynamics. For example, in the Sunamganj district of Northeastern Bangladesh, fisherfolk assist researchers with biological and socioeconomic surveys on fish taxa distribution and abundance, biomass, catch per unit effort values, consumption, and sales reporting (Sunny *et al.*, 2020). Women fisherfolk are also aiding research to improve gear design. Access to new low-cost gear that is easy to operate and still efficient will enable women to catch fish themselves, and with a sustainable mesh size that limits bycatch of undersized fish (Islam *et al.*, 2018). In Barisal district, Bangladesh, these modifications would mean women don't have to rely on their husbands who are typically away, nor hire labour to manage the home pond (Islam *et al.*, 2018).

Broodstock development programs for SIS are supporting stocking needs of small farm holders and building local family-owned hatchery businesses. In Bangladesh, hatchery training delivered by WorldFish through the USAID-funded Aquaculture for Income and Nutrition (AIN) program has focused on building best practice, environmentally friendly methods that prevent disease transmission, reduce health risks, and uses wild broodstock (Keus *et al.*, 2017). Strong female leaders of local hatchery businesses have also been empowered and now actively train other women in sustainable aquaculture techniques that best suit the local environmental conditions (**AIN Video**). By engaging with sustainable aquaculture practices communities are reducing the ecosystem impacts of intensive aquaculture.

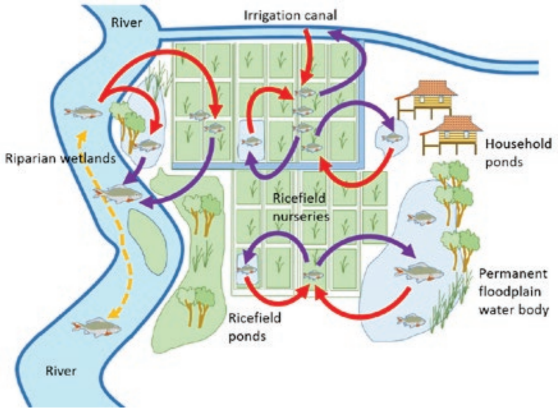

Figure 1: The connectivity of inland fish populations between rivers, floodplains, waterbodies, rice fields and irrigation systems. Arrows indicate migration pathways into the rice fields in the wet season and then back out into more permanent water bodies during the dry season, as well as the up- and down-stream migration of riverine fish. Image from Gregory, Funge-Smith and Baumgartner, 2018.

© WorldFish/Finn Thilsted

Broodfish ponds, Bangladesh **https://flic.kr/p/dkWMGc**

For more information on this case please visit:

- Halwart and Gupta 2014: **fao.org/3/a0823e/a0823e00.htm**
- Keus *et al.*, 2017, AIN project: **hdl.handle.net/20.500.12348/14**
  - AIN Video: **youtube.com/watch?v=CXTYADa18aQ**
- Saha and Barman 2020, WorldFish Bangladesh: **worldfishcenter.org/publication/strategy-increase-production-and-marketing-mola-and-other-small-indigenous-species-fish**.

3.4.2. Fishways – Pak Peung wetland, Lao People's Democratic Republic

Pak Peung Wetland Fishway @ Garry Thorncraft

Source: freevectormaps.com

In a world first for Asian wetland restoration, the Pak Peung community in Lao People's Democratic Republic supported installation of a 'fishway' in the outflow regulator channel that links their rice farms and 500 ha wetland to the Mekong River (Baumgartner *et al.*, 2021). The fishway has re-enabled upstream and downstream migration of fish and restored connectivity of the irrigated wetlands, resulting in increased catch and biodiversity of native fish by villagers (Millar *et al.*, 2019). A participatory research and infrastructure development model was used to successfully co-design, build and test the fishway with the local community (Baumgartner *et al.*, 2016, 2021). This was funded by ACIAR and led by Laos and Australian researchers. Village leaders actively championed the research program because they appreciated the substantial livelihood benefits the community could receive. Traditional knowledge on hydrological connections, local fish diversity, fish behaviour and catch dynamics informed the fishway design. Several fishway models were tested in the regulator channel with community members helping assess the results. The most ecologically successful model, that had the highest proportion of fish migration, was then further adjusted to accommodate the community's concern for child safety (easier access and egress that mitigates possible drowning) and to stop water loss from rice fields in the dry season. Local labourers were employed to build the fishway. Over time community members have also learned how to monitor fish migration and self-manage sluice gate operations (Baumgartner *et al.*, 2021).

The community's involvement in the design, testing and installation of the fishway was critical to success (Baumgartner *et al.*, 2021). Villager's pride and agency in managing the wetland ecosystem has increased and they now actively share knowledge with other communities. The location is now a demonstration site for fishway installations elsewhere in Lao People's Democratic Republic and in neighbouring countries. The fishway design has been installed at 14 other sites and is in development at 26 more, through World Bank and the Lao People's Democratic Republic government irrigation program (Baumgartner *et al.*, 2021). The fishway development also empowered the community to develop their own fishing co-management scheme (Baumgartner *et al.*, 2021; Millar *et al.*, 2019). They implemented a ban on fishing in the fishway, designated a conservation zone upstream and actively enforce the regulations. These regulations safeguard fish stock during their migratory movements as well as enabling greater resource equity among fishers (Baumgartner *et al.*, 2021).

For more information on this case please visit:

- Baumgartner *et al*., 2021: **doi.org/10.1016/j.aaf.2018.12.008**
- Project reports: **aciar.gov.au/project/fis-2009-041**

Community benefits and scalability

Activities to restore aquatic ecosystem productivity and mitigate degradation are benefiting communities in numerous social, economic, and physical ways. Firstly, increased catch, diversity and productivity of SIS is improving nutritional health, food security and incomes of fishing communities. Agricultural productivity and soil health is increased. Knowledge of sustainable natural resource management has increased and is shared among communities. Resource equity is enabled both among neighbouring villages (Baumgartner *et al.*, 2021) and for women (Castine *et al.*, 2017; Islam *et al.*, 2018; Rai *et al.*, 2012). There is stronger cohesion among neighbouring villages that share waterways and networks with governance, research, and development partners (Baumgartner *et al.*, 2016; Keus *et al.*, 2017). Community's agency and socioeconomic capital is increased. Capacity building programs provide leadership, financial management, business development and technical training (Keus *et al.*, 2017, Baumgartner *et al.*, 2016, Saha and Barman 2020). Fisherfolk are directly engaged in fish and waterway monitoring which improves their literacy and numeracy as well as agency in resource management. Successful initiatives are also being scaled to more locations. For example, polyculture practices are being trialled in saline–aquatic ecosystems of China and co-culture practices extended in other countries (Liu *et al.*, 2020; Rai *et al.*, 2012; Saha and Barman, 2020). Scalability is aided by villages acting as demonstration sites, through international learning exchanges, and by local knowledge sharing of good practices. Institutional partnerships and technical capacity of national researchers have also been strengthened through these activities (Baumgartner *et al.*, 2016).

Challenges

Rehabilitating waterways and native fisheries of inland Asia continues to face many challenges. Sparse scientific knowledge on wetland biodiversity and ecosystem function limits management actions and also global awareness about the importance of inland fisheries (Funge-Smith and Bennett, 2019; Gregory, Funge-Smith and Baumgartner, 2018). Knowledge gaps, limited monitoring, unsustainable broodstock collection and mono-culture risks overexploitation of some native species (Dudgeon, 2005; Saha and Barman, 2020). Limited genetic diversity of native broodstock could also lead to enhanced disease, pest outbreaks, and genetic bottlenecks (Dudgeon, 2005). Climate change induced increases in water temperature, salinity and more variable seasonality affect native fish growth and reproductive patterns (Harrod *et al.*, 2019; Sarkar *et al.*, 2021). Government agencies are often under-resourced, compartmentalized and / or unable to provide the necessary system wide coordination (Baumgartner *et al.*, 2016). Overly conservative regulations also restrict subsistence fishing of SIS in some countries (e.g. Amarasinghe, Ajith Kumara and De Silva, 2016). Substantial global investments to modernize irrigation infrastructure are underway across inland and coastal Asia (Gregory, Funge-Smith and Baumgartner, 2018), but with minimal consideration of native fisheries systems and their required connectivity. This oversight could ultimately worsen the nutritional outcomes infrastructure improvements set out to improve.

3.4.3. Rice–fish systems and community fish refugia – Cambodia

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Source: freevectormaps.com

In the Mekong delta floodplains, Cambodia's rice farming communities are working to improve their native fisheries and livelihood security using a community fish refugia system (CFR). Here, villagers get together to choose a suitable perennial water body that usually holds fish in the dry season and close it off to fishing. Communities elect a CFR committee of ten local members (half female and half male) whose role it is to coordinate monitoring patrols, and give infringements, manage community funds, decide on water use regulations, coordinate activities to improve the refugia, share information and raise awareness in the community, and report to the local government on the community's CFR progress (Kim *et al.*, 2019). The refugia need to be deep-water bodies that don't dry out, even in extended dry seasons. CFRs act to protect the juveniles and broodstock of wild fish, preserve local genetic diversity and provide communities a source of clean water to use through the dry season (Kim *et al.*, 2019). When the floods come, fish disperse and fill nearby channels and rice farms. While rice farms are privately owned, fish are deemed a common pool resource, and everyone is allowed to fish in and around the rice fields and does.

Community committees receive training in how to design and manage their CFR, collect, and manage community funds, how to share knowledge and build awareness about the rice–fish ecosystems, and how to monitor their ecological progress (Joffre *et al.,* 2012). They improve the water quality of the floodplains and the CFR through revegetation, weed removal, making various hydrological changes (e.g. opening dikes and building channel connections) and taking steps to control erosion (Kim *et al.*, 2019). In some places wild fish are also being restocked. Fishing is usually banned in the CFR, but some are used as water sources for household needs and limited agricultural purposes. Importantly, it is the community's collective decision that selects what regulations are implemented.

High biodiversity and ecosystem functionality is a direct impact of the community's activities to preserve and rehabilitate degraded waterways. One hundred thirty-five different finfish species have now been observed in the CFRs with an estimated productivity of 104 kg per ha (Freed *et al.*, 2020b). Aquatic plant diversity has also increased (Kamoshita, Araki and Nguyen, 2014). The rice fields provide important habitat and prey for the wild fish, particularly through the wet seasons (Mustow, 2002). The fish help improve rich farm productivity by eating plant and animal pests, aerating soil and water, and reducing farmer's reliance on fertilisers and pesticides (Berg, 2001; Dao, Yi and Chang, 2005; Dugan, Dey and Sugunan, 2006; Halwart and Gupta, 2004). Most households in these areas fish and 60 percent of the catch is consumed directly with a smaller proportion going to market (Freed *et al.*, 2020b). CFRs activities have improved local fish catch, and by as much as 70 percent in the poorest households (Kim *et al.*, 2019). Thirteen percent more small fish, with high micro-nutrient loads, are being caught and eaten and 23 percent more by youngest children. Additionally, income from selling fish has gone up 10-fold (Kim *et al.*, 2019). The health, food security and poverty alleviation impacts, derived from community led ecosystem restoration activities, are clearly transformative.

Approximately 30 percent of Cambodia's total fisheries production comes from rice field fisheries, at 42–165 kg per ha (Hortle, 2007), contributing to the fifth largest inland fishery system in Asia (Funge-Smith, 2018). Maintaining and restoring the economic and livelihood security from these fisheries systems is a high priority for the national government and international aid agencies. Therein, the Cambodian government is actively championing CFRs and had a goal for 75 percent of communes (1200) to have a CFR by 2019 (Kim *et al*., 2019). In 2018 there were already 800 CFRs (Freed *et al*., 2020a). When CFRs are managed well by a strong local committee, within a very engaged local community (i.e. a high proportion of households are involved in CFR activities), and where they are hydrologically well connected to the wider floodplains, they work really well (Freed *et al*., 2020a). However not all CFRs that have been designated are successful. Reasons for failure or limited success, as noted by Kim *et al*., (2019), include:

- A lack of collective decision–making and / or awareness in the community.
- Poor site selection of the CFR, environmentally. The site may not be sufficiently connected to other water ways, dry out, and/or have poor water quality.
- Infrastructure up- or downstream alters flow regimes and the CFR dries out.
- Poor waste and/or vegetation management. Water is clogged up or overgrown with plants and chokes fish life (de-oxygenation).
- Poor enforcement because the site is too far and inconvenient for the village to monitor easily.
- User conflict over local waterway resources and CFR, particularly in times of climate stress.

WorldFish partners in Cambodia, funded by USAID, have been supporting communities, local NGOs, and the provincial and national government to address these challenges and improve the environmental and socioeconomic efficacy of CFR systems (Brooks and Sieu, 2016). The national government's fisheries and rice agriculture policies recognize and support community management of water ways (Miratori and Brooks, 2015; de Silva *et al*., 2017). There are coordinating frameworks in place for two-way dialogues between communities and governments. These include coordination of local enforcement and infringement decisions, socio-ecological monitoring, and program evaluation (Kim *et al*., 2019). Knowledge sharing workshops allow communities to access new innovations and implementation tools (e.g. best practice guidelines). Local NGOs and scientific institutions have also been strengthened in their capacity to support the community's self-management of waterways, by participating in the CFR development programs (de Silva *et al*., 2017). Guidelines for implementing gender equity and nutrition improvement strategies have also been produced for practitioners (Shieh *et al*., 2021).

Through the CFR model communities can self-manage their own resource. This leads to a greater sense of responsibility, care and pride for their ecosystem and a greater environmental awareness evidenced by high engagement in CFR related activities (Miratori and Brooks, 2015). CFRs also improve the ecological and social resilience of the Cambodian rice farming communities to climate change impacts. They provide a buffer for communities through prolonged dry seasons and, in some cases, refugia have been fished from to help get the village through times of very low food supply (e.g. during the 2015–2016 drought, Kim *et al*., 2019). By increasing local fish stocks, they also address resource equity as everyone can capture fish through the wet and dry seasons.

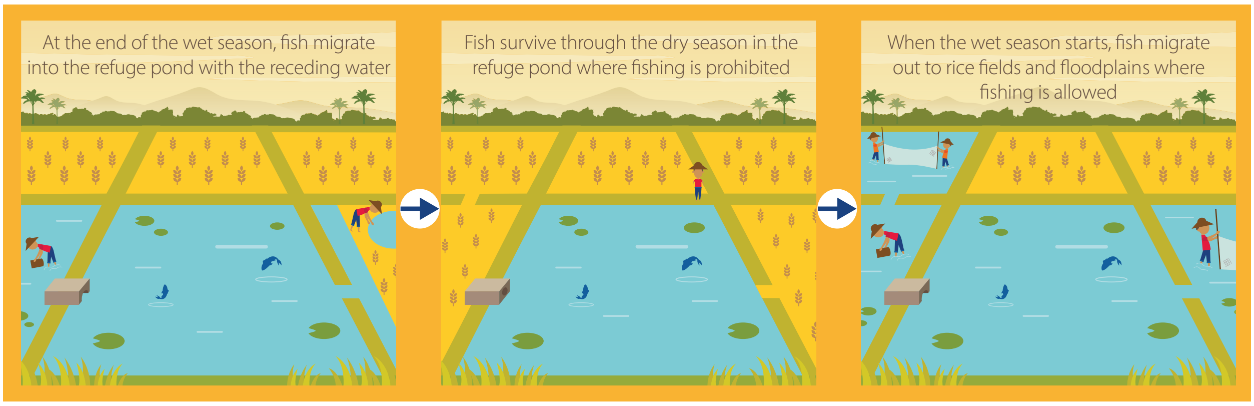

Figure 2: Schematic of Cambodia's Community Fish Refugia system, from Kim *et al*., 2019

For more information on this case please visit:

- WorldFish Cambodia: **Feed The Future Cambodia Rice Field Fisheries**

4

Discussion

4.1. Fisherfolk activities

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Across multiple geographies and ecosystems artisanal fishers and smallholder aquaculture farmers are taking similar approaches for restoring ecosystem productivity (Table 1). This includes typical active restoration efforts like re-planting vegetation, seagrass, mangroves, or corals, but more extensive and important are their direct actions to reduce destructive fishing, reduce fishing pressure, and set up long term sustainability of local fisheries and aquaculture systems. Destructive practices like dynamite bombing on coral reefs, cutting down mangrove forests to put in intensive aquaculture ponds, intensive and inefficient farming with high levels of waste and effluent, using poisons to catch fish, overturning corals and trampling reef flats for abalone, purse-seining for pelagic fish, and danish purse-seining along soft bottom seafloors have all been stopped or greatly reduced thanks to fisherfolk actions.

Most communities highlighted here have implemented protected areas where fishing is not allowed. For example, community refugia in Cambodia's rice–fish floodplains, no-take reserves in Selayar, Indonesia, blue swimmer crab 'bank' refugia, and banning fishing within the Pak Peung fishway channel in Lao People's Democratic Republic. The ecological effect of these actions is that particularly vulnerable phases in the stock's lifespan (when they are very easy to catch) are protected, and mature stock are able to spawn and generate the next cohort. Through this action fisherfolk are directly investing in their own future catch and livelihood, and also preserving the ecological function the stock performs within its ecosystem.

The sustainability of ecosystem productivity is further enabled by fisherfolk learning to monitor their own stocks and the health of the ecosystem. Information about stock abundance, size distributions, spawning biomass, geographic distributions, and the like is crucial for informing timely fisheries management actions. Similarly, tracking the health of waterways and aquaculture systems lets fishers, farmers and their partners know where, when and what kinds of management steps might be needed next. For example, tuna handline fishers in Indonesia complete logbooks for each fishing trip recording the catch of primary species, bycatch, and interactions with ETP species (Zheng *et al.*, 2020). Partners MDPI, Fair Trade USA and the seafood business Anova Food, are helping train members of the local fisher committee in basic literacy and numeracy to complete the logbooks, and in tracking the progress of their local management regimes (Zheng *et al.*, 2020). Electronic vessel monitoring systems are also being trialled on the fisher's canoes. In Timor-Leste, women led teams are doing social surveys to record catch data, with training and support from Blue Ventures (Blue Ventures, 2017). In the fish-way model of Pak Peung wetland (Lao People's Democratic Republic), villagers have learned how to record and report on fish taxa present in the waterways and worked alongside international researchers in the design and monitoring phases (Baumgartner *et al.*, 2021). Community Fish Refugia committees in Cambodia monitor their progress in achieving specific actions towards their committee's vision including planting trees, changing water flow, improving rice farm practices, making pond repairs, and preventing illegal fishing (Miratori and Brooks, 2015). By collecting this information fishers and fish farmers are rapidly expanding the reach of evidence-based stock assessments and able to self-manage local systems. This is also usually in remote areas where government resources are very limited.

Table 1: Common approaches. Examples of actions taken by small-scale fishers and fish farmers to restore aquatic ecosystems. Case numbers refer to communities and projects highlighted in the main text, where these activities have been carried out. ETP: Endangered, Threatened or Protected.

ACTIVITIES THAT:	CASE NUMBERS
Reduce or eliminate destructive fishing	
Bans implemented and practice reduced or stopped (e.g. bomb fishing, cyanide poisoning, use of less selective gears, anchoring, bottom trawling, restrictions on threatened target species)	1, 2, 9, 11, 12, 14, 17
Reduce fishing effort	
Spatial closures	2, 8, 9, 11, 12, 14, 17–19
Temporal closures	7, 9, 14, 17
Quotas or other related catch restrictions	9, 12, 14
Reduce bycatch	
Size restrictions (to protect juveniles and/or spawning stock)	8, 9, 17
Increased gear selectivity	7, 9, 11–13
Endangered, threatened, or protected species	7, 11
Reduce or mitigate environmental impact	
Reduce production or supply chain waste (of by-products, supply chain waste, excess feed, agro-chemicals, etc.)	7, 9, 15, 16
Clean up pollution, debris, plastics, or other waste products	1, 6
Reduce coastal and land-sourced pollution (incl. erosion)	10, 13, 15, 16, 19
Improve farm infrastructure and waste management processes (sewerage, run-off, bioremediation work etc)	12, 15
Enhance, re-stock, build or replant species / habitats (i.e. active restoration)	
Enhance habitat (e.g. outplant corals, mangroves, seagrass, revegetate banks)	1, 4, 6, 7, 9, 12, 15, 16, 19, 20
Re-stock species through hatchery and seeding activities (using native species or non-invasive resilient stock)	8, 9, 20
ETP conservation activities (e.g. guard turtle nests, monitor populations)	7, 11
Conduct stock assessments and ecosystem monitoring	1, 3, 7, 12, 14, 16, 18, 19
Improve hydrological connectivity (to enable fish migration in rivers and floodplains)	17–19

Case ID: 1. Ornamental reef fisheries, Les village, Bali, Indonesia. 2. Tools for community management, Selayar, Indonesia. 3. Coral reef restoration, Pemuteran village, Bali, Indonesia. 4. Coral reef restoration, Lucero village, Bolinao, the Philippines. 5. Coral farming, Olango island, Central Visayas, the Philippines. 6. Small-scale fishers and mass tourism, Koh Chang Island, Thailand. 7. Artisanal tuna fisheries, Maluku, Indonesia. 8. Abalone fisheries, the Philippines. 9. Blue swimmer crab banks. 10. Seagrass restoration, Hinase, Japan. 11. Kyeintali community fisheries, Southern Rakhine, Myanmar. 12. Karimunjawa National Park, Indonesia. 13. Community led MPAs, Raja Ampat, West Papua, Indonesia. 14. Customary law and women leaders in Timor-Leste. 15. Integrated mangrove–shrimp farming, Ca Mau, Viet Nam. 16. Organic mangrove–shrimp farming, Ca Mau, Viet Nam. 17. Hilsa river fishery, Bangladesh. 18. Fishway model, Pak Peung wetland, Lao People's Democratic Republic. 19. Community fish refugia, Cambodia. 20. Integrated aquaculture for rehabilitating native inland fisheries.

4.2. Measuring change

Indicators of progress in fisherfolk led activities to restore ecosystem productivity are diverse across environmental, social, economic and governance domains. Environmental metrics depend somewhat on the particular ecosystem, although commonalities exist (Table 2A). Methods of measuring socioeconomic indicators show some consistencies across geographies and ecosystems (Table 2B). However, reported measurables vary with the maturity of a restoration program, wherein a community's economic gains may have long superseded concerns of nutritional poverty or poor market access. Government actions in supporting bottom-up restoration activities are consistent in the type of things that could be measured (Table 2C), but diverse in whether they are progressing or not (e.g. co-management recognition, surveillance and infringement support, and coordinative mechanisms between state parties).

The accessible literature for case-studies highlighted in this report does not always explicitly state what metrics were intentionally measured. Measurable indicators of progress are therefore inferred from both stories of success and challenges faced and collated with notable common and stated indicators of impact.

In terms of environmental metrics (Table 2A), fisheries productivity metrics like total catch, catch per unit effort, biomass and density are perhaps the most relevant to small-scale fishers. Similarly, broodstock survival, stocking levels, recruitment, and growth rates are common metrics in aquaculture farms. Positive changes in these measures also link directly to positive income benefits for households. Ecosystem connectivity both ecologically and hydrologically is an important measure of expanding ecological health from the activities. Genetic evidence of ecological spillover is a gold standard for fisheries reserve impacts (Harrison *et al.*, 2020) and a notable feature of seagrass restoration success in Japan (Tsurita *et al.*, 2018). However, measuring it is out of reach for most SSF activities in the global south. Hydrological connectivity in inland waters and rivers is improved with the removal of dams, channel deepening and installing fishway systems that effectively restore fish migration up and downstream.

Biodiversity measures

Metrics of biodiversity changes include the diversity of fished species in waterways, ponds, and protected areas, such as the increases recorded in the fishway project in Lao People's Democratic Republic. These can be evaluated immediately by fishers or farmers who are familiar with local stock diversity. Some studies have used social surveys asking fishers about ecological conditions in past periods (> 20 years ago). These qualitative perceptions can be useful comparative benchmarks when no quantitative baseline ecological data is available. Changes in ecological or biological condition of fished catches and species are then compared before and after the project interventions.

Habitat based biodiversity metrics include the diversity of habitat species, area of coverage, and changes in the structural nature of the habitat. For example, the number of different mangroves, coral, or seagrass species outplanted, the number of hectares or proportion of area covered, and the changes in the physical dimensions or complexity of the restoration area. Increases in the latter usually correlates to better quality refugia for fish and other aquatic animals, and improved ecosystem function.

Decreased bycatch or discard levels from increased gear selectivity are important measures of biodiversity conservation, indicative of reduced pressure on local (non-target) species. The contributing function of non-target species groups to the ecosystem can be conserved through reducing bycatch. Similarly, increased target juvenile and spawning stock levels provide a measure of how much target stock there is to contribute to ecosystem health, particularly via predator–prey dynamics. Understanding the functional roles of different species groups, and the ecological dynamics of the ecosystem is helpful for determining the value of these fishery-based metrics to measuring progress in ecosystem restoration. Human health surveys of dietary intakes can also indicate increased diversity of fished species. For example, noted increases in the consumption of small fish by rice–fish farmer households (Kim *et al.*, 2019) coupled with catch records of the diversity of native fish taken from rice–fish systems (Freed *et al.*, 2020b). Measuring such changes will be indicative of progress towards healthier more biodiverse wetlands.

Measures of changes in water quality such as nitrogen and phosphorus loads are further important biodiversity measures. These evaluate effluent load and the effect of improved farming and aquaculture practices. Sound sampling procedures are needed to ensure the voracity of monitoring regimes (i.e. sampling across inflow and outflow periods, times of year and across different periods of farming cycles). Increased water quality improves ecological health and increases the survival of newly planted habitats (e.g. survival of coral fragments and seagrass seeds). It can also enable new environmentally friendly business initiatives to start up (e.g. oyster farming above restored seagrass beds in Japan).

Livelihood metrics

Socioeconomic progress (Table 2B) is commonly measured through fishery catch and income data, usually from social surveys. For example, the fisherfolk's report on catch, income, diet, and expenses. An increased diversity of household income sources can reflect gains in entrepreneurial activities, economic security, and the degree of reliance on catch and production derived income. Household consumption of catch, the diversity of species consumed, and the body size of fish are important indicators of progress in women's and children's health and food security in impoverished fisher communities, as noted in several case studies herein.

Disaggregated data metrics are needed to monitor progress in gender and social equity. These can be collected through surveys on community participation in decisions, household, or marketplace surveys on resource access targeting minority groups. Community savings and expenditure from fisher cooperatives reflect progress in collective agency and cohesion towards ecosystem restoration goals. Expenditure on community wide infrastructure (e.g. waste management facilities, educational and faith-based buildings) can help motivate sustained action by fishers, particularly fisherwomen, when the value of the gain for the wider community is seen. Attendance in capacity building or awareness raising workshops is easily recorded. The outcomes of such training in terms of behaviour change, leadership confidence, and knowledge sharing are important but harder to measure.

Governance

Measurable changes in governance (Table 2C) include stepwise policy developments and legislative changes to legally recognize the community's management regimes. In particular, the recognition of local user-access laws that a community seeks to implement that regulate who has access to the aquatic resource. Surveillance and enforcement records indicate the frequency of compliance actions by both community and government parties as well as the strength of their partnership. For example, who led the surveillance and how often, who was penalized and how often, whether the surveillance and infringement records align, and what the nature of penalties given was. Low or infrequent surveillance by government agents (i.e. police and/or park rangers) may be from limited resources or result from a weak engagement of the government with the community (and thus a low prioritization of government resources). Community surveillance can usually occur more frequently than government patrol teams because of proximity. A community's surveillance reports can indicate how organized and self-sufficient they are, as well as their agency in sustainable resource management. Records of infringements issued, coupled to the surveillance reports of illegal activities are helpful metrics of progress in coordination. Penalties issued in some communities might restrict a user's local fishing rights temporarily while government issued infringements (e.g. financial penalties) are important for external perpetrators, so long as they are followed up. Thus, the records of penalties issued, pursued and received coupled with numbers of surveillance periods, reports and infringements are useful indicators of governance coordination between the community and state parties. A range of surveillance and infringement reporting metrics has been utilized by case studies reviewed herein (Table 2C).

The development of civil servant's skills and knowledge is another notable metric of governance progress. Effective co-management requires skilled communications by civil servants and sufficient understandings of the community's dynamics to enable two-way dialogues and the fostering of strong partnerships. The frequency and outcomes of community–government dialogues can indicate the functionality of partnerships. Measures of changes in civil servant's perceptions and skills in co-management, their written and oral communication skills, conflict management and negotiating skills would indicate progress. Greater development of technical skills for stock assessments, aquaculture system management, operation of boating and surveillance equipment, and modern data systems (e.g. mobile application reporting systems) will also aid performance of civil servants and their coordination with communities. Indicators of community and government relationships being strengthened will highlight potential areas for external development partners to target assistance at.

Table 2: Measuring change. Metrics or indicators used for measuring progress in ecosystem restoration by small-scale fisherfolk and fish farmers. Case studies are noted where there is evidence of progress per metric, whether specifically measured or not. A: Measures of biophysical or environmental parameters. B: Measures of socioeconomic parameters related to changes in the fisherfolk community. C: Measures of changes in governance performance, within government agencies.

MEASURABLES	CASES
A. Biophysical or environmental measures	
Benthic cover (e.g. percent coral cover or forest canopy cover)	1, 3, 4, 12
Architectural structure of habitats (natural or artificial habitat)	1, 4, 6, 10, 18, 19
Area protected from fishing (either full or part closures)	2, 8, 9, 11, 14, 17–19
Stock abundance or density	1–4, 10, 12, 17–19
Species diversity (stock and/or other species)	3, 4, 10, 12, 15, 17-19
Stock biomass	1–4, 8–10, 12, 17
Growth of individuals and size distribution of population (e.g. more larger individuals)	17
Catch or catch per unit effort	8-10, 14, 17, 19
Stock survival	8, 9, 15, 16, 20
Abundance of ETP and non-target species (e.g. turtles and bycatch)	7, 11, 18, 19
Connectivity (ecological or hydrological) • spillover of enhanced stock or habitat species • genetic flow between focal site and surrounding areas • improved water flow through floodplains, rivers, and water channels	10, 17–19
Bio-chemical measures of ecosystem function (e.g. soil health, water quality, pH, oxygen, calcium carbonate, algae, ammonium or other)	10, 12, 13, 15, 16, 19
Other ecological measures of ecosystem function (e.g. numbers of herbivores, predation, invasive species controls)	8, 12, 19
Ecosystem's response to severe weather event (did it bounce back?)	1, 3, 4, 12
B. Socioeconomic conditions of fisherfolk community	
Cumulative income • individual or household • community funds (savings groups)	1, 7, 9, 10, 14, 16
Expenses (amount and type) • production related • household expenses • community funds spent	7, 8, 14, 16, 19, 20
Income diversity • number of income sources and distribution • access to microloans and their use • employment options	1-6, 8, 9, 10, 12, 14, 15
Financial management skill development • access to training, participation, • application and progress in self- or group management skills	1, 2, 5, 6-9, 15, 16, 19
Nutrition, diet and/or consumption patterns	19, 20

MEASURABLES	CASES
Capacity building • technical or production related • environmental awareness • youth education and engagement • knowledge sharing led by community members	1–12, 15–20
Community cohesion • representation in decision–making process (equity) • user conflicts and resolution processes • number and diversity of community members participating in activities (e.g. in surveillance and monitoring, active restoration, debris clean ups, and community meetings)	1–7, 9–17, 19
Agency of individuals and community • degree of self-management vs external dependence • presence of local champions and active community leaders	1–5, 6, 7, 9–13, 15–19,
Equity • of resource access • of economic gain from activities	7, 9, 11–17
Community relations with external parties • number and diversity of partnerships • strength of partnerships (e.g. authentic two-way dialogues, ongoing communication, active on the ground projects) • types of partners (government, industry, scientific, NGOs and whether local, national, or international) • tenure of partnerships • expansion of partnerships (is reach extending?)	1–4, 6-11, 14–20
Enforcement and compliance • reports of illegal fishing / actions (i.e. compliance) • infringements or penalties imposed (financial or other) • changes in use of destructive fishing gear	8, 9, 12–14, 17–19
C. Government actions	
Policy changes that recognize community regulations or activities • in development or implemented	1–2, 8–17, 19
Enforcement • surveillance (with or in addition to community led actions) • infringements issued	11, 12
Resource capacity • physical resources (e.g. boats, technology systems) • technical abilities of staff • coordination mechanisms	6, 15, 16, 18, 19
Engagement with community • communication and two-way dialogues • understanding and respect for SSF led actions and community dynamics	4, 6, 10–12, 14–19

Case ID: 1. Ornamental reef fisheries, Les village, Bali, Indonesia. 2. Tools for community management, Selayar, Indonesia. 3. Coral reef restoration, Pemuteran village, Bali, Indonesia. 4. Coral reef restoration, Lucero village, Bolinao, the Philippines. 5. Coral farming, Olango island, Central Visayas, the Philippines. 6. Small-scale fishers and mass tourism, Koh Chang Island, Thailand. 7. Artisanal tuna fisheries, Maluku, Indonesia. 8. Abalone fisheries, the Philippines. 9. Blue swimmer crab canks. 10. Seagrass restoration, Hinase, Japan. 11. Kyeintali community fisheries, Southern Rakhine, Myanmar. 12. Karimunjawa National Park, Indonesia. 13. Community led MPAs, Raja Ampat, West Papua, Indonesia. 14. Customary law and women leaders in Timor-Leste. 15. Integrated mangrove–shrimp farming, Ca Mau, Viet Nam. 16. Organic mangrove–shrimp farming, Ca Mau, Viet Nam. 17. Hilsa river fishery, Bangladesh. 18. Fishway model, Pak Peung wetland, Lao People's Democratic Republic. 19. Community fish refugia, Cambodia. 20. Integrated aquaculture for rehabilitating native inland fisheries.

4.3. Enablers of success and challenges to overcome

Success definitely does not happen overnight. Not for fishers nor for the ecosystems they depend on. There are many contributing aspects behind the achievements highlighted in this report (Table 3). Aspects related to environmental or biophysical features of a restoration project include consideration (and some understanding) of the ecosystem's ecological and physical processes including hydrological and ecological connectivity, functional dynamics and the biology of the species group being fished or preserved (e.g. the types of coral species, their likely growth rates and how resilient they might be to further bleaching or disease outbreaks). Understanding of these matters and careful project design enables appropriate site and species selection where active restoration activities will have the best chance of success. In contrast, poor design has meant actions and resources are wasted because the water quality was not suitable for coral growth in that locale, or mangroves didn't have enough tidal flux to grow in some ponds, or the hatchery-reared species used to seed grow-out pens was not able to handle local conditions, or there needed to be more channel connections between rice–fish refugia to sustain native stocks, and so on (Table 4).

Perhaps more critical than environmental elements, and more substantive, are the common socioeconomic enablers of ecosystem restoration. Fisherfolk activities to improve environmental health are being sustained over long timeframes, beyond development project tenures, when several core social, cultural, and economic factors operate. These critical success factors are slowly gaining recognition by national governments and international development agencies.

Co-management is best practice, wherein community decisions on resource management are supported by government, and partners collaborate closely. Research and development partners that have used participatory mapping of the community's socioeconomic needs have been successful in supporting fisher led restorative actions, including protected areas and gear restrictions. Authentic consultation and continued deep engagement with communities, which takes a long time, is an enabler of success. The fisher or farmer community's partnerships with multiple stakeholders are also important so long as the partnerships remain fisher or livelihood centric.

To sustain fisherfolk involvement in restorative activities there needs to be direct economic benefits for the household and community. Such benefits lead to longer term economic security and should enable community resilience to future climate shocks or global pandemics. Realizing economic benefits is challenging but enabled through targeted capacity building, income diversification, private public partnerships, securing market supply and long-term market partners, and state recognition of fisher livelihoods and co-management regulations. If fishers, particularly the most impoverished, remote, and landless groups, don't get an income or sustenance from the environmental resources, good practice is not sustained. Therefore, economic gain needs to be secured beyond the tenure of development projects and immediate government assistance packages. Targeted and well-designed capacity building programs are a complementary enabler of economic security.

Capacity building is a diverse enabler, covering relatively simple awareness raising workshops about environmental health such as the effects of destructive fishing on reef fish abundance, or the migratory pathways of Hilsa shads, through to multi-level training on organizational management and technical skills in running an environmentally friendly hatchery. All are needed. Projects achieving long term success and impressive immediate impacts include those that mentor female fisherfolk in managing community funds, provide basic business skills for selling new products in local markets, develop longer term leadership skills and 'train the trainer' programs such that local champions begin sharing their knowledge within and between communities. It is through the empowerment of local leadership and passionate knowledge sharing that project scalability seems to become most successful and sustainable (e.g. Pak Peung community demonstration site, Lao People's Democratic Republic, and international learning exchanges between BSC crab bank groups).

Initiation of many community activities exampled herein started with the development or engagement of fisher/fish farmer organizations or cooperatives. When small-scale fisherfolk can gather in a collective they are empowered to collaborate and develop mutually beneficial management decisions with longer term economic and environmentally sustainable goals. In some situations, or cultures, like Adara village in Timor-Leste, community traditions and cohesion have remained strong through centuries of colonial rule and it is relatively easy for community wide consultations to take place. In other places community collectives have been enabled or assisted by local NGOs or development partners. Developing the capabilities, organizational management, cooperative, and equitable decision-making processes within fisher cooperatives has enabled longer term progress in ecosystem restoration, and self-management of local fishery resources. For many communities these cooperatives enact surveillance of protected areas, manage and direct community funds from fishery savings, organize collective activities (e.g. seagrass planting and marine debris clean ups in Hinase region, Japan), conduct ecosystem monitoring and share knowledge on the state of the ecosystem and/or fishery resources with the village and the state government. Without strong local cohesion and strong local leaders or champions restoration actions have not been so successful (Table 4).

As a community makes progress in their economic and environmental gains, partnerships expand to include more sectors, researchers, national and international agencies, and private industries. Ten to twenty year success and even 40 years in Japan have gone well beyond the initial actions of several fisherfolk leaders to now involve many private and public partnerships in international tourism, education, health, global seafood supply chains, national and international researchers, and others. The challenge therein is managing these partnerships such that the fisher community's livelihoods and goals remain central to ecosystem restoration or global conservation goals. This challenge is particularly acute in countries or communities where government capacity is very limited and still developing (e.g. Timor-Leste).

A considerable element of success is that government policies recognize community led regulations and decisions, via co-management legislation or similar. Co-management legislation and coordinating processes are being scaled out in new communities (e.g. in the southern Rakhine region of Myanmar before the current period of governance conflict), and even backtracked in well-established but state led ecosystem restoration and conservation programs (e.g. co-management development in Karimunjawa National Park, Indonesia, and Viet Nam's integrated mangrove–shrimp farming systems). Policies need to be consistent across government departments and across village, provincial and national jurisdictions. This is often not the case and challenging because of the diverse policy portfolios involved including environmental resource management (land and water, conservation park management, agriculture, and fisheries), social services (health and well–being), economic development (farming, mining related and tourism), infrastructure and planning services (urban, rural, and marine), financial services (taxation, business development) and education. Legislative policies regarding fishing access, resource ownership or village boundaries, water allocations or allowance to alter water flows may not be consistent across these portfolios. It can result in fisherfolk communities having limited security or assurance in regard to the community's resource management decisions, and user-conflicts between neighbouring villages occur. For example, in Selayar Indonesia, Bungaiya community's decision to instate a no-take area and ban use of destructive fishing gears was in conflict with neighbours who fished the area and used such gears. But there were different interpretations of prevailing laws on who had access and what gear was allowed between the community's traditional law, the village administration, the sub-district fisheries, and law enforcement agencies (Abdurrahim *et al.*, 2018). Additionally, recent changes in governance responsibility of Indonesia's fisheries (from federal to provincial levels) have meant that lines of authority are even more blurred. This has stalled some of the community's desired actions on fisheries management (Abdurrahim *et al.*, 2018). Laws that are not complementary across government departments create confusion and can increase inequities among fisher groups. For instance, integrated mangrove–shrimp farmers and supply chain actors in Viet Nam have faced multiple legal uncertainties on forest use rules, land ownership and tenure of leasing certificates, and who can make operational decisions for farming needs (Ha *et al.*, 2012). Some farming communities have benefited more than others where national law benefits their operations. Inconsistencies in law also increase uncertainty and financial risks for commercial investors.

Coordination and good governance are a massive challenge to most countries in Asia. Poor coordination and weak institutional capacity limit the sustainability and scalability of community agency in restoration for many countries. But progress is being made with assistance from international development partners, as noted in the cases herein. Capacity building of civil servants is improving authentic two-way dialogues necessary for co-management, and also the technical capabilities needed to facilitate state-wide monitoring of fishery stocks and ecosystem or national biodiversity assessments (Table 2B and 2C).

Table 3: Enablers of Success. Key pathways and approaches that have enabled progress in ecosystem restoration by or with small-scale fishers and fish farmers in Asia.

ENVIRONMENTAL ASPECTS	Socioeconomic ASPECTS		GOVERNANCE ASPECTS
Use of spatial planning and mapping tools	Fisher or fish farmer organizations • local cooperatives • groups initiated or existing groups used • groups are engaged, strengthened, and self-management enabled	Direct economic gains for fisherfolk • increased income per household • self-managed community funds. • reduced operational costs • income diversification • greater market access • market price stability	Co-partnership with communities • authentic two-way dialogues • cooperative decision–making • transparency developed or developing • partnership getting stronger
Selecting ecologically appropriate sites and species to rehabilitate / restock	Participatory approaches • socioeconomic mapping • co-management principles and actions	Multi stakeholder partnerships • public and private partners • growth / extension over time • local, provincial, national, and international partners • between fisher / farmer communities (South–South)	Capacity building of civil institutions • in technical skills • in stakeholder engagement • in monitoring and evaluation tools • in use of modern / emerging technologies
Improving hydrological connectivity	Self-management enabled • traditional knowledge and management accessed and applied • community decides on resource regulations and management is adaptive • community collects data on stock and environment	Capacity building and knowledge sharing • skill development (financial, organizational, leadership, conflict management, technical) • environmental awareness • sharing of knowledge by local fishers and leaders enabled • demonstration sites and learning exchanges	Policy recognition of co-management • community regulations and practice recognized in law • state and national policies • local council policies
Monitoring stock dynamics and measures of environmental health	Local champions and leaders • identified and resourced • leadership skills developed	Community based surveillance and enforcement of regulations • cultural or economic penalties • recognized by state authorities • resource & training support by state authorities or other partners	Good coordination mechanisms • Effective processes either in place or being strengthened • Between local, state, national and international sectors • Between private and public sector

ENVIRONMENTAL ASPECTS	Socioeconomic ASPECTS		GOVERNANCE ASPECTS
Conducting surveillance and enforcing environmental protection regulations	Communications • culturally appropriate messaging motivates resource stewardship • visualizations of messages and progress reports • delivered by / with local leaders	Women led groups • leadership fostered • financial skills training • stock or catch monitoring • management of community funds	Surveillance and infringement actions support community's regulations and efforts.
	Social cohesion • collective culture • social equity strengthened • collective stewardship • collective agency increasing	Income diversification • opportunities provided • training • micro-enterprise loans	

Table 4: Challenges faced. Examples of key issues contributing to failure and / or limited impact of restorative actions by small-scale fishers and smallholder aquaculture farmers.

ENVIRONMENTAL ASPECTS	Socioeconomic ASPECTS		GOVERNANCE ASPECTS
Severe weather events • coral bleaching • storm damage • flood inundation • prolonged droughts / floods • less predictable seasons	Weak social cohesion within / among communities • inequity in decision–making, resource access and/or benefits gained (either perceived or realised) • ethnicity, age, gender and/or caste-based inequity • user conflicts • local cooperative not well organised / functional • Weak local leadership or lack of local champions	External impacts on resource access and economic benefits (e.g. mass tourism)	Insufficient legal policy • community regulations not recognized • limited political support for community management • contradicting agricultural, conservation and / or economic policies
Pollution from • land practices (erosion, agro-chemicals) • offshore shipping and mining • rubbish, plastics, polluted waterways, marine debris etc. • aquaculture product effluents		Weak surveillance and compliance • ineffective protection or implementation of local regulations • weak / absent infringements	

ENVIRONMENTAL ASPECTS	Socioeconomic ASPECTS		GOVERNANCE ASPECTS
Design flaws • inappropriate sites (limited hydrological or ecological connectivity, prone to damage, too remote for monitoring) • inappropriate species (poor diversity, invasive, non-natives, monocultures) • resource inaccessible to fisherfolk (seasonally or otherwise) • stock dynamics not understood	Insufficient cooperation and consultation • limited local agency • top down governance • community ownership / self-management not sufficiently enabled • inequity in decision–making • high operational dependence on external partners • communication barriers • limited local awareness of progress • partners' ignorance of local social dynamics and politics	Infrastructure gaps • poor production and market facilities • reliance on external seed supply • high gear costs inaccessible to fishers • fishing sites inaccessible / isolation • poor market access • poor transport facilities	Limited institutional capacity • weak coordination within government agencies, communities, and private partners • weak monitoring and evaluation • low skill base of civil servants • poor planning of programs • limited understanding of fishery, ecosystem, or rural community's needs
Overfishing or destructive practices continue • habitat degradation continues • stock collapse • ETP species not protected Resource degradation from external actor/s • mass tourism • poaching by outsiders • pollution from land and water activities including waste products	Limited economic gain • no income incentive so fishers forced to continue past practices • supply chain or industry benefits more than local fishers • environmental conservation gains not matched with local livelihood gains • debt traps / poverty cycles continue	Weak knowledge and skills • community capacity for self-management and monitoring not enabled • limited organizational capability of fisher cooperatives	Top-down governance • co-management practice not realised • insufficient dialogue with communities • conservationist agenda or intensified exploitation agendas (e.g. intensive irrigation, aquaculture or farming practices) • limited partnerships with fisherfolk communities
Poor infrastructure • fishing materials not environmentally friendly • coastal infrastructure insufficient to protect environment • sewerage and coastal pollution	External market issues • limited product demand • consumer preferences • weak branding • weak private industry links with fishers • supply chain inefficiencies limit fisher returns • market volatility	Limited stock monitoring and evaluation of stock levels • by community or partners	
Natural causes of stock loss • predation		Communication barriers with external partners • language • technology • weak reporting / tracking systems	

4.4. Scaling ecosystem restoration in small-scale fisheries

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Successful ecosystem restoration work by and / or with small-scale fisher and aquaculture communities needs to be scaled out. Expanding or extending work into new communities and new domains can be done using the learnings identified herein. This will involve deepening existing partnerships with communities and developing new ones, particularly south–south partnerships. Several case studies herein have had or are having notable success in scalability. For example, the model for 'One Hook, One Fish' tuna fisheries in Maluku, Indonesia, has been extended to 800 fisher households and 32 fisher associations across Indonesia (Zheng *et al*., 2020). Lao People's Democratic Republic's fishway system has been extended from the initial demonstration site to 40 other locations (Baumgartner *et al.*, 2021). Crab bank cooperatives are successfully operating in parts of Thailand, Cambodia and Malaysia incorporating international learning exchanges (Sornkliang, Manajit and Isao, 2020). Hilsa fisheries women's leadership groups in Bangladesh have multiplied to 148 groups over 136 villages (Wahab *et al.*, 2020), and Cambodia's Community Fish Refugia system is getting adopted by more of the nation's 1 200 freshwater wetland communes enroute to the national government's target of 75 percent adoption (Kim *et al.*, 2019). These projects are scaling out through the extension of relationships with local fisher and community organizations, and particularly when neighbouring communities see the successful outcomes and request help to replicate the approaches in their community. The key enablers, common challenges and metrics identified earlier highlight essential tools and processes that need to be considered, measured, and funded for scaling out ecosystem restoration projects.

Much of the critical work is in the early design and conceptual phase of projects. Deep community engagement and participatory mapping needs to identify the community's socioeconomic needs, their priorities, risks, and barriers to progress including likely conflicts among resource users. The long-term motivation or objective of programs needs to be that communities can drive and sustain their own restorative actions, enabled by improved economic gains from sustainable fisheries and aquaculture production and / or alternative income streams. Current and future impediments to progress need to be discussed and mapped out with (or by) the community members, and solutions that give communities the tools to manage or adapt embedded in new projects. This is typically not easy nor quick work. Funding of new projects that provides for substantive, repeated on the ground consultation with equitable representation of all community members (especially women and ethnic minorities) and that enables communities to drive the design of restoration projects will be most helpful, even if it is probably the most challenging and requires longer timeframes. Skilled facilitators fluent in local languages and customs are needed, who are also culturally acceptable to the community (i.e. someone they will communicate and build rapport with). For many locations such people will need to be trained up. Live-in facilitators that map socioeconomic conditions and priorities of the communities over time, build rapport, trust and a deeper understanding of community dynamics have proven quite useful. For example, the year-long work by CCRES social scientists in Selayar Indonesia (Krueck *et al.*, 2019; Ross *et al.*, 2018). Successful scaling can also build on the legacy of long-term relationships within communities from past government and /or development partner engagements. For example, the community led MPA implementation in Adara of Timor-Leste, evolved after years of repeated and sustained engagement between WorldFish and the community wherein the rapport with the external partner enabled the community to drive MPA decision–making (Mills *et al.*, 2017; Tilley *et al.*, 2019a).

Engaging with extensive, community wide participatory mapping approaches may well be beyond the scope and expertise of small development agencies and some government groups. Simple, small-scale projects working on just one restorative approach do make a difference, especially when they enable the fisherfolk or fish farmer to lead further changes. Several case studies herein started as small initiatives to help fishers and / or farmers, fish (or produce) more sustainably (reduce overfishing and destructive fishing pressure). For example, the case of ornamental fishers in Bali (Trialfhianty and Suadi, 2017), and the seagrass planting by a small group of fishers in Japan's Seto Sea (Tsurita, Hori and Makino, 2017). Both have now been going for more than 30 years and the communities have been transformed (economically, socially, and environmentally). Using simple, cheap, and low-tech approaches are good activities to focus community efforts on for small-scale projects. For example, the coral fragment planting with bamboo stakes in Bolinao, Philippines (Cruz, Villanueva and Baria, 2014), and abalone grow out cages in north Palawan, the Philippines (Gonzales, 2015). However, the sites used must be environmentally appropriate to foster growth and survival of outplants. Additionally, the uptake of various integrated approaches like polyculture, rice–fish farming, and integrated marine trophic aquaculture are enabling

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stepwise changes in ecosystem restoration coupled with economic benefits to the community. These are promising approaches to extend current restoration efforts with.

A key element to scalability success has been the South–South manner of knowledge sharing by communities. When success happens, and economic gains are made as well as governance, and environmental gains, news spreads between communities and new communities seek to take up the model. For example, the expansion of women led community savings groups in Bangladesh Hilsa fishery villages, and the expansion of crab bank models in southeast Asia. The voice of a known and trusted local, indigenous fisher influences others in the immediate community more than an external partner representative can. And helping that community's testimony spread out to prospective sites nationally and internationally has proven effective in seeding and expanding success elsewhere. South–South expansion is helped by visits of prospective community representatives to demonstration sites, where inter-community dialogue can occur and direct community to community relationships begin. Demonstration sites noted herein include the Pak Peung wetland fishway in Lao People's Democratic Republic and the crab bank models in Chumphon, Thailand (Sornkliang, Manajit and Isao, 2020; Suanrattanachai *et al.*, 2009). Community exchanges of this nature need to be supported financially. Regional networks and platforms for community partners to share learnings, tools and collaborate, are also invaluable. Within these small and / or newer NGOs, government groups, private business partners and local researchers can improve their knowledge, skills, networks, and processes to help more communities progress sustainable fisheries and ecosystem restoration goals. Global funding bodies, development agencies, national governments and international alliances would do well to target support for such initiatives.

Support for activities that shares stories and initiatives from small–scale fisheries and aquaculture groups, such as this report, are also needed. Sharing stories from artisanal fisheries and aquaculture communities increases the global community's awareness of their needs, the real possibilities for positive change, and helps spreads their innovative ideas and ventures to new communities. Knowledge sharing platforms and communities like Too Big To Ignore (**TBTI**), SSF Hub (**ssfhub.org**) and the International Waters Learning Exchange and Resource Network (**IW:Learn**), are examples of initiatives that help partners collaborate on methods, tools, and compare outcomes among otherwise very isolated fisherfolk villages.

The longer-term community work profiled herein (e.g. ornamental fisheries in Les village, Indonesia, seagrass restoration in Japan and mangrove–shrimp farming in Viet Nam) have a diverse group of private and public partners involved in their work. The reliance on an initial donor to support the community economically has lessened and the community's own organization (the fisher cooperative) appear to have more direct access to seafood suppliers, international ecotourism ventures, research and development agencies including technology partners, and even international trade agencies (e.g. **FairTrade International** and the **Marine Stewardship Council**). Thus, work to scale up projects should target increasing the community's own network of partners and reducing their economic reliance on a sole immediate project donor. But new partnerships and endeavours can fail if the community's aspirations are not central. A community's good will and agency can also be harmed if partnerships are not well aligned. Support is therefore needed to equitably manage new partnerships between large global agencies (private or public) and small state governments and/or communities. The known, trusted, and longer-term partners have a role in knowledge brokering that could help communities navigate this.

4.5. Impacts on women's livelihoods

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Ecosystem restoration activities have great potential to improve women's livelihoods and their equity in fisheries and aquaculture. Several case studies herein highlight mechanisms for achieving impact. Firstly, through participatory mapping that collates disaggregated data, targets female inclusion in community discussion groups and especially through women only focus groups (facilitated by a female). The evidence from these approaches enables community driven strategies in ecosystem restoration that include and even champion women's livelihoods. Secondly, through training women in financial management, business development, and monitoring and evaluation techniques. Given the tools and support to better manage household finances and product values, women are innovating and diversifying fisher household incomes and expanding businesses. Through targeted and ongoing mentoring programs women's self-confidence and leadership is being enabled. Women are accessing and strengthening their innate capacity to lead, innovate, adapt, and care for their families, communities, and the environmental resources they depend upon. Good and emerging examples of this are the SHE Investments business model development in Myanmar, Blue Ventures sponsored women-led monitoring groups in Timor-Leste, and Bangladesh fisherwomen's leadership of community savings groups and community conservation groups.

Third, by enabling women to share their knowledge, the whole community's agency in restoring ecosystem productivity is expanding, seemingly faster than it has in prior endeavours. For example, female hatchery owners are delivering well attended training workshops for other women and small holders to adopt economically beneficial and environmentally friendly techniques (Keus *et al.*, 2017). Similarly, women are motivating positive social change in fishery compliance in Bangladesh's Hilsa fishery within their households and in the greater community. Overall women's livelihoods can be and are being improved through fisheries focused ecosystem restoration programs. Household incomes can be increased, and diversified, nutritional health improved, and equity in resource access and decision–making enabled. Scaling success from examples seen herein could focus on helping communities identify women's voices and their needs, improve women's resource access, and developing women's leadership in expanding sustainable fisheries and aquaculture.

4.6. Climate considerations

The foremost objective in fisher community led restoration activities is to improve their livelihood, and primarily their income. Climate objectives are not foremost in mind for fisherfolk communities. But in some cases, climate impacts on fisherfolk livelihoods have been acute and obvious to the community, in turn motivating their involvement in ecosystem restoration. For example, the loss of mangrove forests has increased the impacts of flooding, tidal inundation, and storms on many coastal fisher communities in Asia. The increasing frequency of such impacts coupled has motivated the people to engage in mangrove restoration so that their villages and farms are better protected (Walters, 1997). Prolonged droughts and floods in inland wetlands also help motivate rice–fish farmer communities to adopt community refugia and improve hydrological connectivity and / or health of home ponds so that local sources of small indigenous fish, and water for growing crops can reliably sustain households through dry seasons (Kim *et al.*, 2019; Rai *et al.*, 2012). Climate change adaptation is a core principle in most development partner and national government sponsored initiatives included herein.

Climate change related events impact fisherfolk led ecosystem restoration activities. However, the current impacts are not yet well documented. Mass coral bleaching events, from increased sea surface temperatures, occurs within co-managed marine protected areas (e.g. Kennedy *et al.*, 2020), and negatively effects the survival and growth of coral fragments and seeded recruits in active reef restoration sites (e.g. Shaish *et al.*, 2010). Severe typhoons, flooding, storm surges and increased rainfall also negatively impact rehabilitated areas of mangroves and seagrass, and does decrease output from integrated aquaculture systems within them (Ahmed *et al.*, 2017). Climate changes are also predicted to effect inland fisheries production, to a varying extent among countries and water basins (Harrod *et al.*, 2018). However, the impact of these events on small-scale fisher livelihoods and restorative actions is generally masked by the greater effect of overfishing, habitat degradation and /or land-use practices decreasing fisheries productivity.

The primary ways fisherfolk communities are improving their adaptiveness to climate shocks, and their environment is by reducing destructive practices, improving connectivity, and enhancing or restoring ecosystem functionality. By increasing the health of the ecosystem, fisher and fish farmers are also improving the natural capacity of ecosystem to withstand or rebound from increased climate change impacts. Longer term projects highlighted herein indicate success in this. For example, in Karimunjawa, Indonesia, the fisher's actions to stop bomb and muroami fishing that destroy live corals and their structure has enabled live coral to grow back and functionally diversify (Kennedy *et al.*, 2020). Following the global 2016 bleaching event, while corals bleached there was minimal change in live coral coverage indicating the system was quite resilient (Kennedy *et al.*, 2020). Japan's Hinase seagrass restoration programs have improved water quality enabling oyster farming which may in turn buffer the effect of heatwaves on seagrass health (Yanagi, 2016). Mangrove stands in Viet Nam are healthier where farmers have adopted organic mangrove–shrimp farming reducing chemical pollution and improving tidal flows (Jhaveri, Nguyen and Nguyen, 2018). Community led efforts to improve aquatic ecosystem resilience to climate change is even improving agricultural product resilience, such as rice growing in rice–fish culture systems (Halwart and Gupta, 2004).

How small-scale fishers and fish farmers have coped and responded to climate change impacts could be monitored in the future by evaluating the differences in fisheries productivity, economic and nutritional gain before and after events, and over longer durations. Recent evaluations of fisherfolk conditions through the COVID-19 pandemic (Bennett *et al.*, 2020), and of marine protected area management (Phua *et al.*, 2021) provide helpful models. Quantitative and qualitative evidence of improved, maintained or weakened ecosystem productivity, because of fisher-led actions before and after severe climate impacts, coupled with livelihood indicators, will help direct ongoing restoration partnerships.

5

Conclusion

Small-scale fishers and fish farmers are actively restoring aquatic ecosystems. Their efforts are reverting degraded unproductive systems back into functional, connected and expanding systems that provide nutrition, income, and physical security for their stewards. By sharing just some of their stories this report seeks to enable more communities and their partners to restore productivity of aquatic ecosystems and enable sustainable fisheries.

Practices range from reducing fishing pressure through to area closures and increased gear selectivity, stopping destructive practices, cleaning up pollution and village waste facilities, reducing aquaculture effluents and farming chemicals, restocking ecosystems with native species, and active restoration through replanting benthic habitats. The environmental outcomes have included increased biodiversity, renewed ecological connectivity, increased fisheries recruitment and spawning activity, improved water quality, and improved biophysical function of waterways. Fisherfolk livelihoods can be improved with ecosystem restoration initiatives when such initiatives provide direct economic benefits and enable long-term sustainability of practice. Livelihood impacts on fisherfolk have included increased and diversified income, improved nutrition, improved water and food security, knowledge and technical capacity, financial literacy, community cohesion (social stability), and leadership development. Emerging initiatives to improve livelihoods for women are particularly notable and are resulting in increased community wide agency for restorative activities. Small-scale fisher and fish farmer communities in Asia are characteristically innovative and adaptive. With the help of authentic and long-term partnerships they are empowered to take the lead in restoring the productivity of the aquatic ecosystems their lives and cultures depend upon.

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