Establishing a community-based sea cucumber ranch: Merging science with local knowledge

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Tropical sea cucumbers *Holothuria scabra* or sandfish are grown in a sea ranch at Molocaboc Island, Sagay, Negros Occidental, Philippines

Sea cucumbers are expensive, but natural wild stocks are overfished, especially in the tropics. This is why sea cucumber farming is increasingly gaining popularity worldwide, aside from the anticipated high economic gains from its dried food products. Hatchery production and practical farming technologies are available and have been demonstrated in some countries in the Indo-Pacific. However, there are limitations in the establishment of sea cucumber farms elsewhere, especially in the Philippines. The most basic bottleneck is in the identification of the potential pilot site to start a sea-based farming venture.

A project at SEAFDEC/AQD, funded by ACIAR, aims to promote community-based production of the tropical sea cucumber *Holothuria scabra* or sandfish in the central Philippines, among other sites. Sandfish sea ranching involves culturing hatchery-bred native sandfish juveniles on intertidal coasts through a multi-stakeholder management approach. Although a number of scientific studies have established some general criteria for good ecological habitat for growing sandfish, the project has shown that technically generated environmental data is not sufficient information to guarantee a successful farming site. It should be complemented with traditional ecological knowledge to integrate sociocultural and local governance dimensions. Achieving consensus and cooperation among stakeholders (*e.g.* technical institutions, government, and local communities) are crucial in the initial planning and establishment of a pilot sea cucumber production site.

This article highlights the importance of merging traditional ecological knowledge and science-based data as an essential prerequisite in project planning processes and implementation activities. This key strategy ensures that the project is aligned with the needs and expectations of the local stakeholders in order to promote long-term active commitment and engagement, leading to project sustainability.

Introduction

Sea cucumbers are highly-valued marine fishery resources that are unfortunately overfished by coastal communities in the Indo-Pacific region, including Southeast Asia, since the 1980s (Altamirano & Zaidnuddin, 2022). These are commonly collected from shallow intertidal shores and processed into expensive dried exotic food products or as nutraceutical and cosmetics ingredients.

The most important of the tropical sea cucumbers is the sandfish *Holothuria scabra*, which, when large sizes are properly processed and dried, can fetch retail prices of over USD 1,800 in Hong Kong (Purcell *et al*., 2018). This very high demand for sandfish resulted in a drastic decline in its wild population, and has even led to its inclusion as "endangered" in the IUCN Red List in 2013 (Purcell *et al*., 2014).

Fortunately, the practical hatchery production technology for this tropical sea cucumber is now established (Altamirano & Rodriguez, 2022), and aquaculture farming has been demonstrated, especially in marine ponds in Nha Trang, Viet Nam (Duy, 2012) and in sea pens on expansive seagrass beds in Tampolove, Madagascar (Robinson & Pascal, 2012). However, the adoption of sandfish grow-out farming has been slow in the Philippines despite the availability of sandfish seeds and fingerlings. As one reason, typical aquaculture ponds in the Philippines are brackish, which is not conducive for growing highly marine sea cucumbers. Moreover, the archipelagic country has limited areas with vast seagrass beds to set up economically viable sea pens that will also require high costs for materials and labor to construct and maintain.

Alternatively, the community-based sea ranching approach is viewed to be the most practical mode of sandfish farming in the Philippines, as demonstrated in key pilot sites in the country (Juinio-Meñez *et al*., 2017; McClean & Fabinyi, 2022). Sea ranching is relatively simple, requires no complex infrastructure or feed inputs, and is considered environment-friendly. However, there are technical and social considerations to ensure successful site selection, establishment, and operation.

This article presents the valuable learnings from the establishment of the pilot sandfish sea ranching sites of SEAFDEC Aquaculture Department (AQD) in Baranggay Polopiña, Igbon Island in Concepcion, Iloilo and Molocaboc Island in Sagay, Negros Occidental in central Philippines (**Figure 1**), as part of the collaborative research projects supported by the Australian Center for International Agricultural Research or ACIAR (FIS-2010-042 and FIS-2016-122).

Rapid appraisal of potential sea ranch sites

The establishment of a sea ranch begins with identifying the general area or location. Oftentimes, after a specific town or province is identified, multiple potential sites will need to be filtered. A rapid site appraisal will follow after coordination with the respective local governments to acquire the necessary permits for surveys. By this approach, a candidate pilot site was selected using a set of indicators, categorically constituting either positive (suitable) or negative (threat) points. Altamirano *et al*., (2022) selected a pilot sea ranch site in Concepcion, Iloilo, based on broad environmental criteria such as seagrass cover (30–60%), sandy-muddy sediments, presence of wild sandfish, exposure at lowest spring tide, protection from strong winds and freshwater intrusions; while social aspects such as the presence of an active local community or people's association as potential partners were also considered (**Figure 2**). The priority site that passed most of the general criteria was subjected to a detailed assessment, following the general chronology of site establishment (Fabinyi *et al*., 2022): 1) detailed biophysical site assessment; 2) community consultation and public orientation; 3) presentation to the local government unit (LGU) and securing of legal permits and use rights; 4) planning and signing of partnership agreement; and 5) site delineation and development.

Consensus building in site selection

In the Philippines, the sandfish sea ranching venture is largely community-based. Hence, consultations involving the local residents will be vital. This is especially relevant because the areas of concern are open-access seagrass beds that provide multiple services and benefits (*e.g.* navigation, gleaning, fishing, aquaculture, tourism) to many coastal sectors in the immediate vicinity (Herrera *et al*., 2022). Therefore, community participation in site selection is crucially important – from the initial information dissemination, consultation, collaboration, capacity building, and eventually empowerment during implementation (Luyet *et al*., 2012). In these study

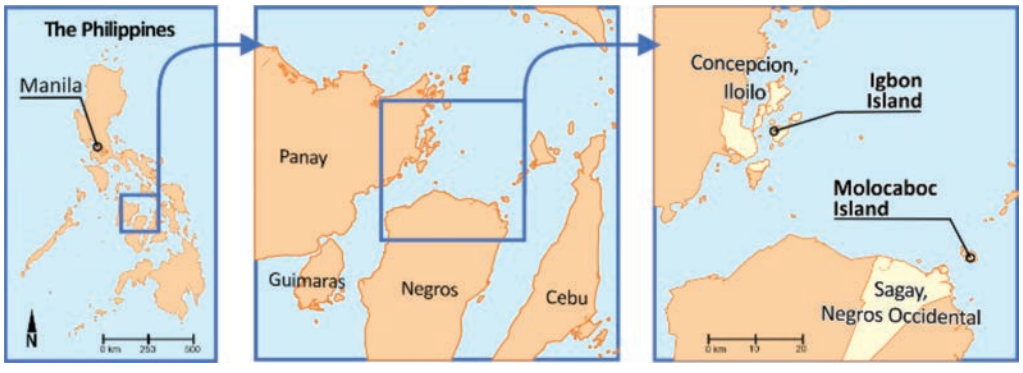

Figure 1. Study site locations in Igbon Island in Concepcion, Iloilo and Molocaboc Island in Sagay, Negros Occidental in central Philippines

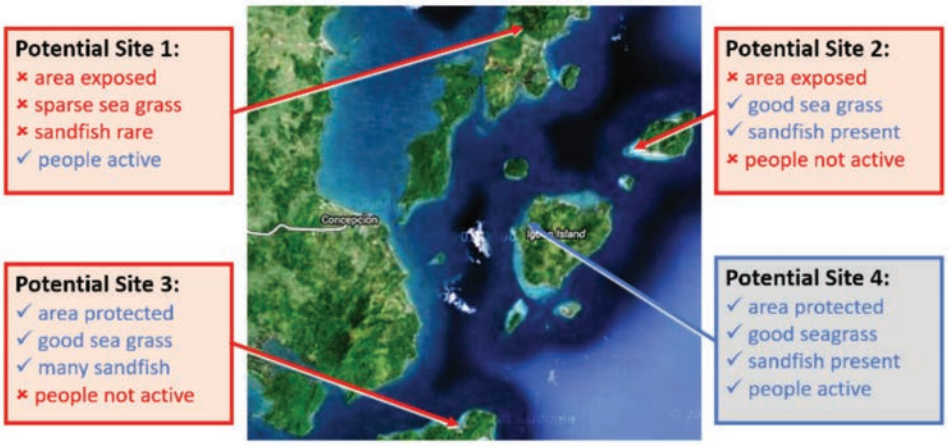

Figure 2. Multiple potential sea ranch sites with general attributes. Among the four sites above, Site 4 has the highest positive potential as a pilot site

sites, participatory resource mapping activities were conducted among different groups in the community, where they shared traditional ecological knowledge about resources and services within the potential area (**Figure 3**). The resulting maps were then used as an effective tool in the discussions to arrive at a consensus among project stakeholders. Conversely, local ecological knowledge can be subjective and influenced by age, gender, experience, and personal bias. In **Figure 3**, for example, the different groups tended to have roughly similar ideas on where the tidal limits, seagrasses, and navigational lanes were. However, they tended to propose the location of the sea ranch to be closer to their respective place of residence. When no clear consensus can be reached among the people, data from scientific assessments can be used to clarify the issues.

In parallel with community consultation activities, detailed technical assessments of the site were independently conducted. At the most basic, determining the extent of water level at low tide is one of the important parameters to assess. This ensures that the sea ranch site will not be exposed during low tide, nor will it be too deep and difficult to access. Identification of dominant seagrass species may require technical knowledge, but this information is beneficial in choosing sites because seagrass cover is a good indicator of site conditions (*e.g.* exposure to wave actions and fluctuating salinity levels). Seagrass cover and patchiness are also important as they function as shelter and food-provider for juveniles and also as settlement substrates for sea cucumber larvae. Careful consideration of the composite of these results and other factors (*e.g.* navigational lanes, gleaning areas, etc.) will prescribe the best possible location of a pilot sea ranch site (**Figure 4**). In Figure 4-C, for example, given the narrow suitable tidal depth range of the site, the proposed 5-ha ranch can only be fitted on the upper portion of the bay, where seagrass conditions were also good while avoiding the traditional navigational lanes and docking areas for boats.

By merging the results of technical assessments and the evaluation of traditional ecological knowledge, the final specific location of the sea ranch can be decided through participatory consensus building during a community meeting (**Figure 5**).

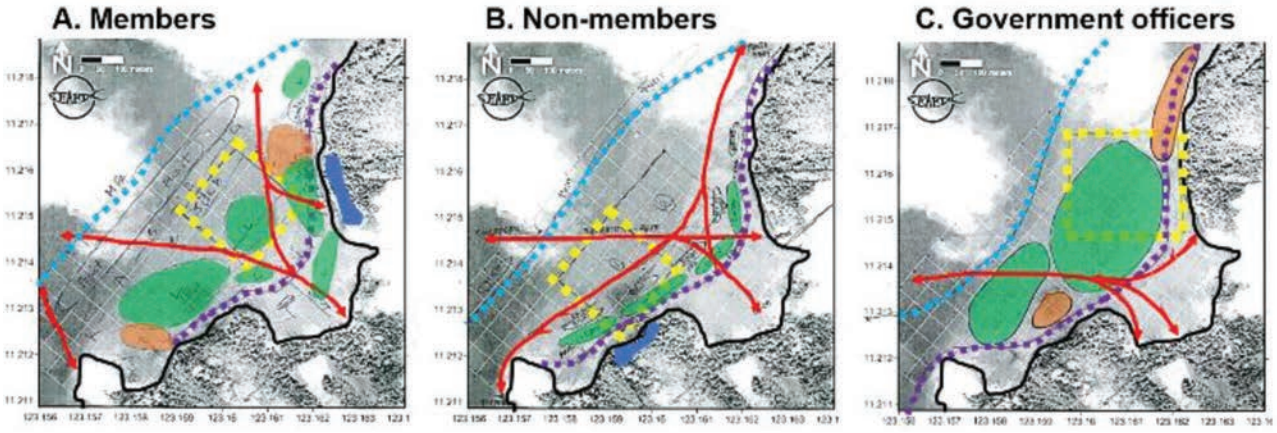

Figure 3. Resource mapping based on local and traditional ecological knowledge from three independent groups (A. Members of people's association, B. Non-members, and C. Government officers and fisheries staff), highlighting their recommended pilot sea ranch site (yellow dashed square), navigational routes (red lines), sea grass locations (green polygons), corals (orange polygons), lowest tide level (purple dashed line), and deep-water level of > 4 m (blue dashed line). Blue polygons indicate the residence of respective groups of participants.

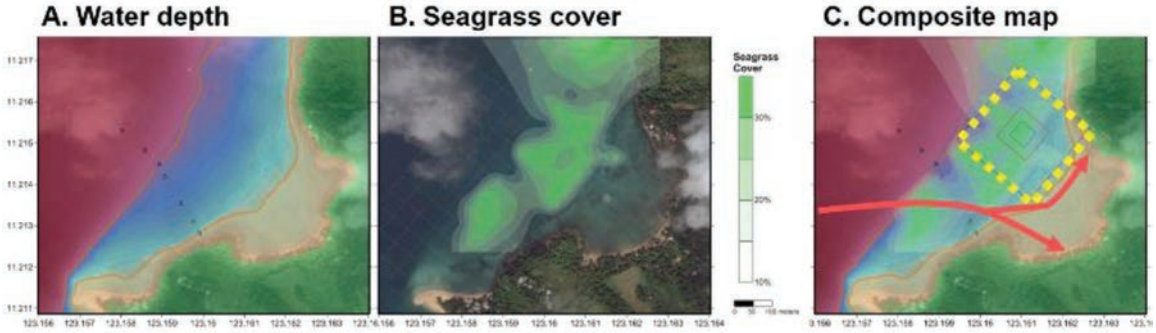

Figure 4. Basic technical profile of the potential sea ranch site in terms of water depth (A) and seagrass cover (B). The composite of these (C) aided in identifying a proposed 5-ha pilot sea ranch (yellow square). Red arrows are traditional navigational lanes.

Figure 5. A local diver assists in seagrass and sediment assessment in Molocaboc Island (A). Community meeting about sea ranch site location in Baranggay Polopiña, Igbon Island (B).

Ensuring long-term operational success

Collaboration and consensus building among various stakeholders of the sea ranch must be maintained to ensure the long-term sustainability at the site. At the most basic partnership, Salayo *et al* (2021) emphasized the tri-party collaboration, involving: 1) the LGU that facilitates the legal framework of activities and provides counterpart financial or logistics support; 2) a technical institution providing technological and science-based guidance and fund sourcing; and 3) the local communities who are the primary stakeholder and resource users and mainly in charge of guarding, maintaining, and monitoring of the sandfish stocks.

The local government plays a huge role in the establishment and management process because they guarantee that policies are in place to legitimize the sea ranch operations. They also function as the judiciary and regulatory body to ensure policy enforcement and compliance (Salayo *et al*., 2015).

Crucially important is the involvement of researchers who provide technical support in a science-based approach, starting from site assessment, maintenance, and monitoring of the ranch (McClean & Fabinyi, 2022). Sandfish sea ranching largely depends on the farming site's environmental suitability in providing a conducive habitat and sufficient natural food. Therefore, regular monitoring of the ranch is important to verify that the area is sustaining an acceptable level of suitability, especially in aspects of seagrass condition, sediment quality, food potential, and others (**Figure 6**). Technical partners are also involved in the simplification of the assessment methods and training of local residents as "citizen scientists" to achieve continuous monitoring of basic parameters.

The participation and efforts of the LGU and researchers will not materialize without the active participation of the local communities and their willingness to share their resources in terms of time, skills, and knowledge in order to improve the resource utilization practices in the area (Salayo *et al*., 2021). In addition, the integration of their traditional ecological knowledge in developing strategies in operations and management results in "tailor-made" policies that are congruent to local conditions. Participation of the local stakeholders in the decision-making process, project establishment, and management improves the efficacy of project initiatives (Fidler *et al*., 2022).

Sandfish sea ranching is a livelihood project, and one of the primary goals is to eventually provide monetary benefits to the community in the long term. However, the early stages of a new project will require inception funds, especially for new

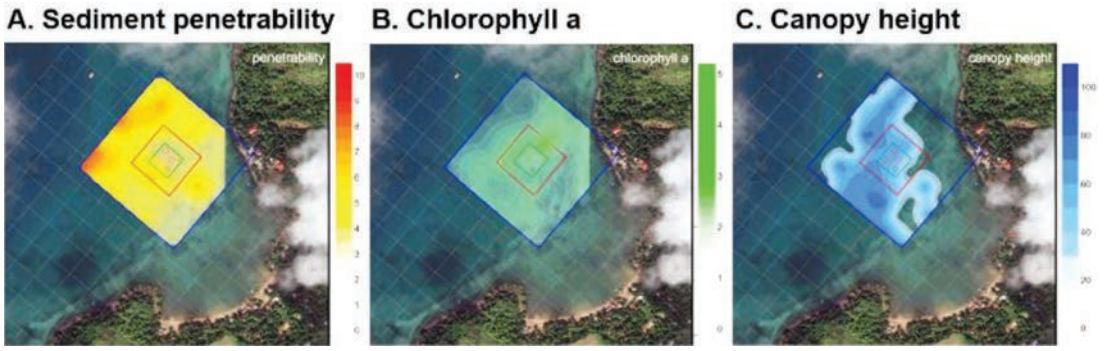

Figure 6. Contour profile of some biophysical parameters of a pilot sea ranch site: sediment penetrability to indicate softness of the sea bed for burying by sandfish (A), chlorophyll *a* as an indicator of availability of potential microalgal food (B), and canopy height that shows relative lengths of seagrass leaves which can indicate the type of seagrass and intensity of prevailing water movement (C)

concepts like sea cucumber ranching. In this project, start-up funds were provided from research and development grants facilitated by research institutions like SEAFDEC/AQD. The research objective of the project was important because protocols that are specific to the area need to be developed. This also involved the production of locally sourced sandfish seeds within the institution's facilities while local partners were being trained to produce sandfish juveniles locally in an on-site hatchery. Meanwhile, sea ranching is community-driven and the local partners also invest their time and effort in keeping the sea ranch operational and secured.

On the other hand, the sea ranch provides multiple benefits to the general public as well, so the appropriation of counterpart funds by the government is necessary for relevant operations like supporting local sea wardens, as well as providing incentives (monetary or in-kind) to those who actively engage in sea ranch-related activities. Moreover, the role of local government in budget allocation and fund generation is critical in ensuring project sustainability because projects are often bounded by specific limitations in terms of objectives, resources, and project duration (Sondita *et al*., 2020). Strategies such as utilization of national or international development grants, securing potential partners and donors, market development and accessibility, and ecotourism initiatives, among others, are possible strategies for ensuring project continuity.

Conclusion

The key to the effective establishment and implementation of a multi-stakeholder community-based sea ranching project is the complementarity of functions among the stakeholders involved. The technical skills of researchers on environmental suitability are necessary, but these will not be sufficient without the participation and commitment of local partners, as well as having strong support from the government.

The integration of traditional knowledge and community involvement in the decision-making process creates a more inclusive and holistic management system. Traditional knowledge may not be strictly science-based, but may even be more valuable in the sense that it humanizes and paints a more realistic scenario when consolidated with technically generated data.

Development projects may come with ready-made objectives, pre-identified study sites, and plans conceived by the funding donor or proponent institution after careful research and studies. However, since the local communities are the main users of the resources in a sea ranch project, they must be critically involved throughout, especially in the early stages where they participate in the design and planning processes, aided by their rich experience and traditional ecological knowledge of the area. Their involvement ensures holistic representation and realistic adaptation of science-based survey results in successfully identifying the best possible site to start a sea ranch. In addition, the merging of ideas or consensus-building nurtures trust and cultivates a sense of co-ownership of the project's investments, responsibilities, and future rewards among stakeholders.

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