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# Perceptions of access and benefits from community-based aquaculture through Photovoice: A case study within a locally managed marine area in Madagascar

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## ABSTRACT

Small-scale fishers face a range of local and global environmental pressures including declining fish stocks and climate change. In coastal southwest Madagascar, community-based aquaculture (CBA) projects have been established within a locally managed marine area (LMMA) to provide alternative income streams for small-scale fishing communities and support community efforts in reducing local fishing pressures. This study focused on understanding community perceptions of both access to, and benefits from, two CBA projects within the Velondriake LMMA involving seaweed and sea cucumber aquaculture. Participants included seaweed farmers, sea cucumber farmers, and non-farmers, and research considered the impacts of the projects at the individual and community level. Participatory field research was conducted in Tampolove, Madagascar during 2018 using an adapted Photovoice method with participant-based photos and in-depth interviews. The integration of CBA projects into the LMMA resulted in a new governance model, with the aquaculture sites requiring 'private access' within a historically 'open-access' setting. Results showed that community members accepted this access change for the community's coastal area, with aquaculture benefits including more predictable income generation and benefit-sharing across the community, appearing to outweigh the loss of access to part of their traditional fishing grounds. However, further research is required to better understand how women and other marginalised community members are affected. Due to the benefits cited by community members, the CBA-LMMA model may have applicability to other coastal community settings in the Western Indian Ocean (WIO) where there is both a need and opportunity for positive alignment of community-based alternative livelihoods and marine conservation.

## 1. Introduction

## 1.1. Small-scale Fishers and overfishing

Small-scale fishers (SSF), 90% of whom live in low-income countries, depend on healthy marine systems for their livelihoods and survival. Ninety to 95% of SSF catch is consumed within local communities, providing critical protein and food security. Additionally, small-scale fishing provides cultural and historical value, often playing a central role in social identity, cultural norms, and governance systems. SSF societies tend to have high levels of economic poverty, with 5.8 million fishers earning less than 1 USD per day and are often "overlooked with regard to both resource management and from a broader social and economic development perspective" (FAO 2020). SSF are often reliant on fishing for survival, making them vulnerable to the effects of industrial overfishing, local overfishing, and global environmental pressures such as climate change (Daw et al., 2012; FAO, 2020; Etongo and Arrisol, 2021). In Madagascar, local overfishing and industrial fishing

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likely contribute to the degradation of near-shore fish stocks (Gilchrist et al., 2020). To reduce local pressures on fish stocks while promoting sustainable development, efforts are increasingly focused on community-based management and alternative livelihoods (Rocliffe et al., 2014; Ateweberhan et al., 2018). Addressing these complex socio-ecological systems necessitates a transdisciplinary understanding of marine systems and the links between environmental sustainability and sustainable development (Chuenpagdee and Jentoft, 2019; Diz and Morgera, 2018; FAO, 2020).

## 1.2. Local management of marine resources: LMMAs and CBA

Locally managed marine areas (LMMAs) have emerged as a promising way to sustainably manage complex marine socio-ecological systems through linking marine conservation with local management, putting communities at the heart of marine management (Govan, 2009; Rocliffe et al., 2014). LMMAs are gaining traction in part due to wider calls for more community-based conservation approaches and the international recognition of the value of locally led resource management, including the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries (SSF Guidelines), which emphasize community-based, participatory management of marine resources (FAO, 2015). Through focusing on local and traditional knowledge (LTK), local tenure, and community rights, LMMAs have had evidence of ecological conservation success (Diz et al., 2018; Gilchrist et al., 2020; Jupiter et al., 2017; Rocliffe et al., 2014). However, for vulnerable communities where fishing remains the main livelihood income source, and where fish stocks are declining due to local and global pressures, alternative livelihoods are needed to diversify small-scale fisher income sources and reduce local fishing pressures (Ateweberhan et al., 2018; FAO, 2020). Therefore, coastal communities such as those in the Western Indian Ocean (WIO) are increasingly relying on alternative livelihoods such as community-based aquaculture (CBA) to reduce their fishing dependency while providing a sustainable, diversified income and livelihood benefits (Ateweberhan et al., 2018; Galappaththi and Berkes, 2014). Providing alternative livelihoods could reduce economic poverty and overfishing pressures but only if fishers' behaviour changes as a result (Muallil et al., 2011).

In contrast to top-down and typically large-scale aquaculture, CBA in the WIO involves "local communities, research institutions, NGOs, and business partnerships" (Ateweberhan et al., 2018). This bottom-up, collaborative approach has the potential for income generation and environmental benefits including through reduced fishing pressures but only if there is a coordinated and sustained effort from all stakeholders (Ateweberhan et al., 2018). While the provision of alternative livelihoods like CBA aims to address some of the pressures local communities experience, it should be considered as an example of a tool and not a panacea, as a range of factors (e.g. socio-demographic) affect fishers' willingness to exit a fishery (Daw et al., 2012). In the Velondriake LMMA in southwest Madagascar, local communities and stakeholders have integrated CBA within the LMMA as a coupled model (CBA-LMMA), potentially strengthening social and ecological benefits. While both CBA and LMMAs share a common goal of putting communities at the forefront of managing marine resources, there is a lack of knowledge on how the two approaches work in partnership. Existing research has revealed positive socio-economic benefits from the Velondriake LMMA (Oliver et al., 2015; Barnes-Mauthe et al., 2015). However, given these CBA projects in Madagascar were novel upon establishment, there was no a priori knowledge of community perceptions on the merits of integrating CBA within an LMMA. While specific to this Madagascar context, should this CBA-LMMA model prove successful in enhancing equitable livelihood benefits across the community and reducing local fishing pressure, it may provide insights for the design and establishment of similar projects in other areas within the WIO. This may be particularly relevant for contexts where there is an interest in community-based alternative livelihoods which incorporate ecological and social needs and which emphasize equity and inclusivity.

## 1.3. Access and benefit-sharing

Ensuring equitable access and benefits to small-scale fisheries and aquaculture is of increasing interest to various stakeholders including local communities, field practitioners, and the international policy and business sectors (Wynberg and Hauck, 2014a; Brugere et al., 2021; Parlee et al., 2021; Bennett et al., 2018). The term, 'access and benefit-sharing' arose from the 1992 United Nations Convention on Biological Diversity and the concept is being increasingly applied in legal and nonlegal contexts (Wynberg and Hauck, 2014a; Diz and Morgera, 2018; Soliev and Theesfeld, 2017). More recently, the State of World Fisheries and Aquaculture underscored the importance of coastal communities having 'secure and equitable access to' marine resources (FAO, 2020) and there is an increasing application of the concepts of access and benefits within small-scale fisheries and aquaculture (see Brugere et al., 2021; Hicks and Cinner, 2014; Lau et al., 2020; Wynberg and Hauck, 2014b; Parlee et al., 2021). This framing can be useful in understanding access to, and benefits from, interventions in complex marine socio-ecological systems (Wynberg and Hauck, 2014a).

Community based natural resource management models, such as LMMAs and CBA, have been described as benefit-sharing mechanisms because of their focus on local institutions and participatory decisionmaking (Wynberg and Hauck, 2014a). The CBA-LMMA model can thus be considered as a benefit-sharing process, which emphasises equitable and transparent stakeholder involvement and benefit-sharing within and across communities. However, recognising that community-based projects are not necessarily equitable (Berkes, 2004; Cinner et al., 2014), access and benefit sharing within benefit-sharing mechanisms should be investigated in order to understand how different forms of access are expressed and how 'bundles of power' affect access (Ribot and Peluso, 2003). There is a need to better understand social equity, access barriers and mechanisms in marine coastal communities in particular (Hicks and Cinner, 2014; Milgroom et al., 2014; Wieland et al., 2016) and within marine protected areas (Kockel et al., 2020; Bennett et al., 2020).

For this research, we defined benefits as the tangible and intangible benefits (e.g. food security, knowledge access) that contribute to human wellbeing and benefit-sharing as the 'division and distribution of monetary and nonmonetary benefits in a way that has equitable outcomes and is procedurally fair' (Wynberg and Hauck, 2014a, p.1). We define access as how, and in what ways, individuals gain the ability to derive benefits (Ribot and Peluso, 2003) and use Lau et al.'s (2020) framing of access methods for small-scale fisheries which includes five mechanisms. This research also pulls from socio-ecological systems theory (SES) which helps in understanding the role of institutions in complex marine socio-ecological systems and which has been useful for analysing small-scale fisheries (Ostrom, 1990, 2009; Basurto et al., 2013).

## 1.4. Photovoice and importance of perceptions

Perceptions of the equitability of benefits and community support of interventions are vital in ensuring community buy-in and the long-term sustainability of management interventions (Gehrig et al., 2018; Mahajan and Daw, 2016; Bennett and Dearden, 2013). Participatory management and evaluation are key to effective, long-term marine management and there is a need to understand local perceptions and acceptability of interventions (Bennett, 2016; Diz and Morgera, 2018; McClanahan et al., 2014). Understanding local perceptions of how small-scale fishers perceive access and benefits from community-based management interventions can help communities and their implementing partners ensure the equitable sharing of benefits. Participatory evaluation methods, such as Photovoice, help reveal perceptions of both tangible and intangible aspects of projects and provide a way for local perceptions to be shared within and outside of communities.



Fig. 1. Drone photo of Tampolove (circled in red) and the sites of CBA (circled in yellow) within the Bay of Assassins (photo taken by Tim Klückow, 2020).

Photovoice, a form of Community-Based Participatory Research (CBPR), provides cameras to community members to take their own photos to 'identify, represent, and enhance their community' (Wang and Burris, 1997) and has been used across disciplines including in health, education, agriculture, and conservation (see Chilton et al., 2009; Johnson and Spencer, 2011; Killion and Wang, 2000; Kovacic et al., 2014; Mott et al., 2017; Quigley et al., 2014). Photovoice is 'recognized as an underutilized tool in social ecological research' (Mahajan and Daw, 2016) and is increasingly being used to understand the nuances of complex marine contexts (Bennett and Dearden, 2013; Pierce, 2020; Bennett, 2016). Due to its visual-based approach, the methodology often reveals 'hidden and often intangible connections to ecosystems, plural and disaggregated perceptions of complex social-ecological dynamics, and issues of access and distribution of ecosystem benefits' (Masterson et al., 2018).

Through using an adapted Photovoice method which includes semistructured interviews, this study focused on understanding community perceptions of the CBA projects within the Velondriake LMMA regarding access and benefits from these projects at the individual and community levels. Participatory field research was conducted in Tampolove, Madagascar during 2018 and included seaweed farmers, sea cucumber farmers, and non-farmers.

## 2. Case study overview

## 2.1. Study site and Vezo people

Field research was conducted in Tampolove, a 477-person fishing village at the mouth of the Bay of Assassins in southwest Madagascar (see Fig. 1). Tampolove lies within the Velondriake LMMA, an IUCN category V protected area, and location of the LMMA's first Community Based Aquaculture (CBA) projects for seaweed (Kappaphycus alvarezii) and sea cucumbers (Holothuria scabra) (Cripps and Harris, 2009; Rocliffe et al., 2014). The Velondriake LMMA encompasses 600 km<sup>2</sup> of reef-lined coast and includes 33 villages with a total of approximately 7800 inhabitants, most of whom belong to the historically semi-nomadic Vezo ethnic group (see Fig. 2 for LMMA location) (Cripps and Gardner, 2016; Blue Ventures, 2015b). The Vezo have been living along the coast of Madagascar for hundreds of years and are highly dependent on fisheries for their food, livelihoods and cultural identity [the term Vezo means to paddle] (Astuti, 1995; Grenier, 2013). Astuti argues that the Vezo identity is an 'act', not a genetic or geographic identity; 'being Vezo' means that you engage in activities on the coast (e.g., sailing, fishing, swimming) and if one stops these activities then they cease to be a Vezo (Astuti, 1995).

Tampolove is geographically isolated with the closest town 50 km away and reachable in 5–12 hours by pirogue [Vezo sailboat] depending on the weather. Like the other 32 villages across the Velondriake LMMA, residents of Tampolove rely on local fisheries for subsistence and income-generating livelihoods, with non-fishery-related alternative income limited to a few small businesses and a handful of public sector roles (e.g., teacher). Over 60 percent of villagers describe fishing as their primary occupation (Blue Ventures, 2015b)<sup>2</sup> and the average monthly income of residents in the LMMA is 19.92 USD (Blue Ventures, 2016). As in the rest of the LMMA, traditional fisheries tend to be gender-distinct, with women working as gleaners in the shallow coastal areas and men going out on pirogues to fish in deeper waters. The majority of villagers have been educated to a primary level and one-third have received no formal education with a significant barrier to school enrolment being tuition cost at 9.14 USD per year (personal comms, 2018).

# 2.2. LMMA and Community Based Aquaculture

Madagascar's first LMMA, the Velondriake, was established in 2006 by Vezo communities who had observed marked declines in their fisheries and became interested in community-based marine management through trailing temporary octopus fishery closures as suggested by the British NGO, Blue Ventures (Benbow et al., 2014; Blue Ventures, 2017; Cripps and Harris, 2009). Seeing the success of the octopus fishery closure in terms of economic benefits, Vezo communities worked with Blue Ventures (BV) to implement wider management measures. With financial, technical, and capacity building support provided by BV, local communities established the Velondriake (VDK) in 2006 as a marine protected area, and it was officially designated under Madagascar's protected area system in 2015 (Blue Ventures, 2017). The LMMA is legally managed by BV and is governed by national and local-level governance institutions, making it subject to national fisheries laws. At the local level, the LMMA is co-managed by local communities through an elected representative body, the Velondriake Association (VDK-A) and through existing local governance structures including the clan system and community-based rules called 'dina' (Gardner et al., 2020). The clan system is an integral part of historical local governance across the villages in the VDK, with each village containing approximately 2-10 family units called clans. The clan structure is hierarchical and male-led with each clan represented by a clan leader and each

<sup>&</sup>lt;sup>2</sup> This number is likely an underestimate because of the limitations of using 'primary occupation' in a piecemeal economy where villagers use multiple sources of income.



Fig. 2. Field site location (Tampolove) and the Velondriake LMMA management zones. Adapted from Blue Ventures, 2017b.

village overseen by a village-level administrative leader, the Fokotany. Through the LMMA, a range of marine and coastal management measures have been implemented including temporary fishery closures, no-take marine reserves, fishing gear restrictions, community-based aquaculture, and sustainable mangrove management (Cripps and Gardner, 2016; Rocliffe et al., 2014). The LMMA seeks to reduce fishing pressure on the marine ecosystem while providing alternative livelihoods to community members, helping to alleviate economic poverty levels within local communities and increase resiliency through alternative livelihoods.

One of the interventions introduced by the VDK-A and BV to reduce fishing pressure and provide an alternative income source is Community-Based Aquaculture (CBA) of seaweed and sea cucumbers. These models were co-developed by the VDK-A and BV and piloted in 2007 through working with the commercial aquaculture businesses, Indian Ocean Trepang and Ocean Farmers (formerly COPEFRITO). Seaweed farming is now a well-established and widespread activity within the LMMA, engaging approximately 400 people as active farmers across multiple villages in the LMMA, of which 25 farmers reside in Tampolove. Sea cucumber farming is a newer activity which has evolved since its first trials in 2007, with a large-scale sea cucumber pilot project operational in Tampolove from 2009 to 2015, until a disease outbreak halted farming activity and led to an evaluation and re-design of the production system during 2015 and 2016. At the time this research was carried out, an improved sea cucumber farming system was being piloted, which is the focus of this research. Of the 477 Tampolove inhabitants, 103 adults now participate in a form of CBA (42% of adults), with some overlap where individuals participate in both activities (n =6). Both genders participate in farming with slightly more women participating: 55% of sea cucumber farmers and 60% of seaweed farmers are women (Blue Ventures, 2015b). The two forms of aquaculture, seaweed farming and sea cucumber farming, take place in parallel within a segment of Tampolove's coastal area and use approximately 19% of the village's near-shore area for sea cucumber pens and seaweed lines. Both production models rely on close operational partnerships with local commercial aquaculture operators for materials, technical



Fig. 3. Tampolove (background) and sea cucumber pens (foreground) as taken by drone (Blue Ventures, 2017).



Fig. 4. Left: Seaweed farmers tending to their seaweed lines as taken by research participant.



Fig. 5. Right: Seaweed lines in the water as taken by research participant.

supervision of production, and commercialisation of products to varying degrees for each model. See Fig. 3 for a photo of the sea cucumber aquaculture site and Figs. 4 -5 for photos of the seaweed aquaculture site.

## 2.3. Nested systems of governance and social equity

The CBA-LMMA model in Tampolove is governed by national, local, and community governance mechanisms and exists within larger social systems with differing forms of nested access control (see Fig. 6). With the introduction of the LMMA, Tampolove's once open-access nearshore area transitioned to a form of controlled access whereby villagers continue to use the area for fishing but also agree to adhere to LMMA management rules. The near-shore area is used as a transit area by male fishers returning from fishing in pirogues and by female fishers who glean wild sea cucumbers and bivalves at low tide. As sea cucumber and seaweed farming currently require a near-shore habitat, the village agreed to designate a portion of this controlled-access near-shore area to be used for CBA (private access for farmers). Taking place within this nested system of governance, aquaculture farming is thus subject to Madagascar's national coastal use laws, local LMMA rules, and CBA farming guidelines.

The CBA governance model integrates existing customary institutions (VDK-A, Fokotony, clan leaders) and aims to equitably involve both genders and all of the clans within Tampolove. Managing social and gender equity in this context is important as aquaculture takes place in shallow waters primarily used by female gleaners and as the local governance mechanisms used to design and enforce CBA are culturally patriarchal. In the WIO, women have been displaced and disadvantaged when work in the shallow areas (e.g. seaweed farming) becomes profitable on the international market and men start to participate in these activities (Harper et al., 2013; Porter et al., 2008; Murunga, 2021). In other regions of the WIO, where women equitably participate in activities such as seaweed farming, women endure longer workdays as they have dual responsibility for farming and the household (Frocklin et al., 2012; Murunga, 2021). In other words, equally including women in community-based management does not mean societal gender inequalities have been addressed or that active participation and benefits are equitably shared (Weeratunge et al., 2010).

Aquaculture farmers within the VDK are selected through a process designed to maximise community buy-in and facilitate the equitable sharing of benefits across the community. The VDK-A, with capacity support provided by BV, obtains a list of the clans in each village through the Fokotany, holds a meeting with each clan leader to explain the CBA



Fig. 6. Tampolove's CBA within the nested systems of governance.

process, and then delivers a presentation on CBA to the community. Interested individuals are asked to express their interest to a farming technician (employed by VDK-A and BV) and then clan leaders, the VDK-A, Fokotany, and BV select a proportionate number of male and female farmers from each clan to ensure clans and genders are equitably represented.

Farmers agree to a social contract with VDK-A, BV, and the Fokontany and must adhere to the farming terms of reference which include roles and responsibilities for farming. For sea cucumber farming, farmers agree to work in pairs to manage a 30 metre by 30 metre sea cucumber pen, adhere to the wider LMMA management rules, and comply with farmer obligations including participating in security patrols and cleaning pens (Klückow, 2020). Sea cucumber farmers must also agree to collectively sell their harvest to Indian Ocean Trepang (IOT), who provide juveniles and process the grown sea cucumbers, which are subsequently exported to Asia for consumption as a delicacy and luxury food (Blue Ventures, 2015a). For seaweed farming, production is entirely managed by Ocean Farmers (a subsidiary of seafood operator COPEFRITO) after BV handed over production management and technical support to the company in 2016 as part of its commitment to sustainable programmes. While BV continues to provide capacity support for seaweed farmers, Ocean Farmers manages the technical training and provides all required materials (ropes, pickets etc.) and entrants (seaweed cuttings). In return, seaweed farmers sign a contract agreeing to sell the totality of their production to Ocean Farmers at an agreed price, comply with farming good practices, and respect the rules of the wider LMMA.

## 3. Methodology

## 3.1. Mixed methods: adapted Photovoice and interviews

This research sought to understand community perceptions of the CBA-LMMA model and the distribution of benefits across the Tampolove community. In contrast to traditional top-down evaluations of projects, this research used an adapted form of the participatory method, Photovoice, to provide a platform for community members to share their perspectives. Informal fieldwork observations and analysis of farming data and grey literature provided additional contextual information (see Fig. 7 for the key components of the research approach).



Fig. 7. Multi-pronged field research methodology.

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Fig. 8. Participant learning how to use the camera. Photo taken by researcher.

The Photovoice methodology used in this research was adapted to include semi-qualitative interviews at the start of the process (including socio-demographic data collection), allowing for valuable background information to be collected and providing an opportunity for the researcher and participant to develop a rapport. The interview questions and adapted Photovoice methodology, including process and research prompts, were collaboratively developed and piloted with two community members employed as farming supervisors by VDK-A and BV. In response to their feedback, the Photovoice methodology was adapted to use individual interviews over group interviews to enable participants to speak more openly.

Field research was conducted during summer 2018 and involved 18 Tampolove adults (at least 18 years old). The 18 community members were randomly selected during an all-community meeting by drawing names from a hat using names, genders, and farming status (type of farmer or non-farmer) from the community roster. Each selected participant was asked if they would like to participate in the Photovoice research, and in cases where the selected person was not interested in participating (n = 2), another name was pulled from the hat. The research sought to understand perspectives across the community so an equal number of sea cucumber farmers, seaweed farmers, and nonfarmers were selected (6 from each group). The research aimed to involve an equal number of each gender so an equal number of males and females from each group were selected. Although only 18 community members could participate in the research due to logistical constraints, the research involved one-third of all adults in the community and allowed participants to take time to explore issues in depth. Figs. 8 and 9 further illustrate the adapted methods and process. All research was undertaken in Vezo, the main language of the community, and a Vezo-speaking translator from outside of the community provided translation.

# 4. Results

Of the 18 selected community members, 17 completed the Photovoice activity (6 seaweed farmers, 6 sea cucumber farmers, and 5 nonfarmers) with one male, non-farmer participant deciding to withdraw



Fig. 9. Adapted Photovoice methodology featuring an initial in-depth interview.

as he said he needed to use his time to go fishing instead. For this research, a non-farmer was considered any individual who did not participate in seaweed or sea cucumber aquaculture. The sociodemographic data collected from participants (see Appendix I) revealed that most participants (80%) rely on more than one livelihood activity (e.g., line fisher, business owner), with participants utilising an average of 2 separate livelihood sources to meet their needs. Almost all of those engaged in CBA (seaweed farmers and sea cucumber farmers) still engage in other livelihood activities, with approximately 80 percent of farmers continuing to work in the wild fishing sector. The 17 participants took a total of 1,087 photos, with an average of 63 photos taken per participant. During the 1:1 follow up with each participant where they explained each photo and its rationale, participants were asked to indicate any photos that they did not wish to be used for research. A total of 759 photos were removed due to being duplicates, taken while learning how to use the camera, taken in error, or containing sensitive information. These findings were expected as almost all participants had never used a digital camera before this research. The remaining 328 photos were used for analysis and were individually discussed with each participant to understand what the photo contained and why it was taken. These data were subsequently entered and coded in NVivo 12 by theme following Saldana (2009) and Suchar (1977)'s grounded coding methods, and then organised through the lens of access and benefits.

As part of a larger effort to decolonize research and elevate the voices of those traditionally not heard in academia, we try to use participant photos and words as much as possible in the following results section.

## 4.1. Perceived benefits of CBA

Through the Photovoice method, participants described a range of tangible and intangible socio-economic benefits from CBA, describing CBA as delivering benefits at the individual and community levels. The photos taken and described by participants showed tangible (e.g. live-stock) and intangible benefits (e.g. community reputation), as well as tacit and contextual knowledge (e.g. the flow of money and the purchasing of pirogues). The most widely discussed benefits perceived by sea cucumber farmers, seaweed farmers, and non-farmers are presented below in Table 3 and through examples of participant photos with

## Table 2

Access themes discussed by community members using the Photovoice methodology using access mechanisms from Lau et al. (2020).

Lens	Mechanism	Aspect	Theme Description
Access	Social and institutional	Physical health and identity	Not everyone can be farmers due to personal characteristics (age, health, lack of motivation)
	Social and	Customary	Not everyone can be a farmer
	institutional	institutional rules	because of external factors (waiting list, can't find partner, not enough pens)
	Knowledge;	Knowledge;	Some perceive a need for
	economic	capital capacity	interested farmers to have capital capacity (e.g. a pirogue for farming) or financial capacity (e.g., savings in case there is an outbreak of disease affecting the CBA)
	Social and institutional, Rights-based	Customary institutional rules	You can be a farmer only if you can follow the rules and attend meetings/there are a lot of rules/they are difficult to follow/we cannot do migration

## Table 3

Benefit and benefit-sharing	themes discussed by	community	members using th	ıe
Photovoice methodology.				

Lens	Aspect	Theme Description				
Benefits	Income source and adequate livelihoods	All CBA farmers make money from farming through the alternative livelihood source and spend their farming money in a range of ways.				
	Sufficient nutritious food; financial security; cultural	CBA farmers spend some of their farming money on purchasing animals which are used for income, savings, investment, food, emergency income, and in special cultural events				
	Required household goods	CBA famers use their farming money to buy basic house commodities including bedding, mosquito nets, plastic chairs, radios, solar-powered systems, suitcases, thermoeic and TV				
	Safe shelter	CBA farmers use their farming money on home improvement including repairing a damaged home or building a sturdier home made of sokai (rudimentary lime) or wood				
	Freedom of choice and education Ability to help others	CBA farmers use their farming money to pay for school fees for their children. CBA farmers share money with other community members, spend money in the community, and employ community members in their other businesses				
	Required transportation	CBA farmers use their farming money to buy pirogues for transportation.				
	Community-wide benefits	CBA farming means the community is 'no longer poor', it makes the community 'look good', foreigners have come to the village, and it has brought infrastructure to the community (e.g. mirador)				
	Peace of mind	CBA farming has allowed farmers to 'have everything that I want and need' and a 'peace of mind'				
	Reliable income source	CBA farming is a more reliable income source than fishing which also allows farmers to plan for the future and reduce their reliance on wild fishing				

accompanying photo descriptions (See Appendix II for the number of participants who discussed each theme).

# 4.1.1. Monetary and tangible benefits

All research participants reported that those participating in farming received monetary benefits, with VDK-A and BV data confirming this, showing sea cucumber farmers earning an average monthly income of 32 USD and seaweed farmers earning 19 USD. This is a significant finding in a village where the average monthly income is 19.92 USD and where community members previously had limited ability to purchase goods, save, and invest. Participants described how farmers mostly use this money to purchase household goods (e.g., furniture), buy or repair pirogues used for fishing and transportation, and invest in house repairs, community businesses, and livestock. Notably, when describing the purchase of livestock, participants described them as a form of income, savings, investment, food, emergency income source, and tool for Vezo cultural events (e.g., sacrifice to bless a new building). Participants reported that farmers use a portion of their money from farming to pay the school fees for their children. Figs. 10-13 provide examples of participant photos and accompanying descriptions related to this theme.



Participant: "We have 5 goats... these were bought using zanga and lomotse money." Researcher: Why did you buy goats? Participant: The money is quickly gone if you keep it. A goat is like a token. You buy them to keep your money.

Fig. 10. Participant photo and accompanying description.



Participant: I took this photo in order to show that this man is a lomotse farmer and in this photo it shows that he was able to buy a roka (pirogue hull)—from lomotse money.

Fig. 11. Participant photo and accompanying description.



Participant: I took this photo because I got these things using money from zanga farming. After each harvest, I buy one thing that I need in Toliara. I bought plastic chairs, a wooden bed, a pirogue, a pig, containers, a mosquito net, hat, lace cloth, nets, house, scholarship fees, goats, a mattress.

Fig. 12. Participant photo and accompanying description.



Participant: This is his goat farm. He bought his goats using money from zanga [farming].

Fig. 13. Participant photo and accompanying description.

4.2. Distributing benefits within the wider community

Almost all participants described how CBA had brought benefits to the community in the form of infrastructure, noting the creation of the mirador (sea cucumber security watch tower) and magasin (farming centre building). Participants described how farmers have been able to start their own businesses which provide jobs to other members of the community, how farmers spend their money in the local market, and how some farmers give a portion of their earnings to other members of the community. They described how the CBA project had improved the community's image, noting the improvement of homes from vondro [reeds] to sokai [rudimentary lime] and how "the community is no



Participant: This is mama. She is cleaning clothes. Researcher: Why did you take this photo? Participant: Because mama works for a farmer. And the farmer pays her to wash and iron the clothes. Researcher: Is she a farmer? Participant: No, she has a leg problem and can't work.

Fig. 14. Participant photo and accompanying description.



Participant: From this photo of my house you can see that I don't have a good life and I wish that my life would change. For now, I thank my family because they don't forget me when they have money from the farming. They help me, give me some money to help me.

Fig. 15. Participant photo and accompanying description.

longer poor". Participants discussed how "vazaha" [foreigners] have come to Tampolove, and how the village has become well-known in the surrounding LMMA. Figs. 14 and 15 show participant photos and accompanying descriptions which relate to this theme.

<u>Participant:</u> When the (farming) project came here, it changed Tampolove. And as a result, the community is no longer poor anymore ... Before, in this place there were a lot of vondro (reed) houses and a lot of poor people. This has changed and the vondro houses have changed to be sokay (rudimentary quicklime) houses.

## 4.2.1. Intangible benefits – freedom of choice and income reliability

Participants noted that farmers have freedom of choice to use their money to meet their personal needs and enjoy a sense of calm from having access to farming as an income source. Participants described how farmers choose what they would like to spend their money on and expressed hope that participating in farming could help them achieve their goals.

<u>Participant:</u> It [my mind] is calmer (since I started farming) because I have the money that I need to buy the things that I want and need for my life.

<u>Participant:</u> The lives of the people here are not the same as before because before everyone used to make their living at sea—net fishing and line fishing. But now, people have another livelihood—either zanga or lomotse farming. I see that many people have, in general, better lives because of this.

Community members described how CBA farming provided farmers with a more reliable and safer livelihood activity than fishing, helping them to have access to adequate livelihoods. Over 75% of the participants described traditional fishing as difficult and/or unreliable, using phrases such as "there are no more fish in the sea", "the catch from the sea is not enough" and "the fish are almost finished". Participants described how they would go hungry if they did not catch fish when they solely relyied on fishing, whereas individuals who participated in farming benefited from a more reliable income source. Additionally, while 9 out of 12 farmers noted that they rely less on fishing now that they participate in farming, all of the non-farmers reported that they were catching less than before and have had to start night fishing because "the daily catch is less so we have to go at night to fish".

<u>Participant:</u> Before (I started farming), I had to dive every day even if it was bad weather because there was no other work. Now, I maybe take one or

two days for a rest and then I can go fishing. If the weather is bad, it doesn't matter as much to me because I know I have money from lomotse (seaweed) farming.

## 4.3. Perceived access to CBA

Understanding community members' perceptions of who has access to participating in the CBA model is key to understanding how the model is perceived across the community. The Photovoice method revealed that over half of the participants felt that there were barriers to becoming involved in CBA, despite confirmation from VDK-A and BV field staff that CBA is open to any interested community member. While being involved as a farmer does not necessarily mean all farmers equitably benefit from CBA, understanding access mechanisms which mediate participation is key to understanding access and benefits. Research participants described access barriers to farming which can be categorised as forms of social and institutional access, knowledge access, and economic access mechanisms. Key themes from the participant photos are described in Table 2 and exemplified through examples of participant photos and interview excerpts.

# 4.3.1. CBA rules and regulations

Ten out of 17 participants described how farming was only open to individuals who were able to follow the rules and requirements of farming, citing that the number and type of rules made it difficult to participate. A rights-based access mechanism controls who can participate and use the shallow area, where farmers are permitted access rights while non-farmers are not permitted to use the CBA area. Nearly half of these 10 participants expressed frustration with the amount and frequency of the required farmer meetings. Two non-farmers described how traditional nomadic Vezo fishing can take fishers away for weeks or months at a time and that this was incompatible with the required farmer meetings and obligations which necessitated regular physical presence.

Participant: You need to follow the access agreement. We need to stay here; we cannot do (Vezo) migration. And if you don't attend the meetings, you can't use a pen.



Researcher: Do you feel it is difficult to become a farmer? Participant: Yes, it will be difficult because they are old. Researcher: Because it is hard work for them physically? Participant: Yes, because the zanga (sea cucumber) work is really hard. And for them, they just need small jobs such as taking wood for cooking.

Fig. 16. Participant photo and accompanying description.



Participant: This is my first pirogue [I bought] from seaweed farming and I use this pirogue for lomotse work because there are not enough boats from BV so I use my own boat to transfer my lomotse.

Fig. 17. Participant photo and accompanying description.

# 4.3.2. Minimum level of health and motivation level

Ten out of 17 community members noted that certain individuals would not be able to participate in farming due to intrinsic characteristics including old age, poor mental or physical health, and 'motivation level'. See Fig. 16 for an example of a participant photo and accompanying description related to this theme. These were interesting findings as the farming guidelines do not stipulate a minimum required level of health or 'motivation level' to participate, and it raises questions about who is seen to be evaluating the health and motivation level of interested individuals.

<u>Participant:</u> It depends on the motivation of the person [if a person can become an aquaculture farmer]

# 4.3.3. Financial and capital capacity

Nine out of 17 participants perceived differences in access between participating in sea cucumber and seaweed farming which they attributed to lack of capital and financial access. See Fig. 17 for an example of a participant photo and accompanying description. Participants described how gaining access to seaweed farming was financially riskier than sea cucumber farming due to unpredictable seaweed disease, and how some farmers had to purchase their own materials (e.g. pirogue) to farm their seaweed. The latter was disputed by VDK-A and BV field staff who understood that all supplies for farming should be fully covered by Ocean Farmers who manage the operational aspects of seaweed aquaculture.

<u>Participant:</u> Lomotse (seaweed) farming is for people with privilege. It is not for the normal person like me because if you farm the seaweed, and it gets sick, you won't get anything for it.

# 4.3.4. 'There are not enough [sea cucumber] pens'

Six participants cited logistical factors that limited individuals from participating in farming activities including an insufficient number of sea cucumber pens, inability to find a partner to work with, and a waiting list to become a farmer. VDK-A and BV field staff stated that there was a waiting list to participate in sea cucumber farming and that an expansion in the number of sea cucumber pens was currently limited by the need for the pens to be in shallow, near-shore waters.

<u>Participant:</u> I can't register to become a sea cucumber farmer because you have to have two people, and everyone is already paired up.

<u>Participant:</u> Many people are interested in being a farmer because they know it's a lot of benefits from this project. We are waiting for more pens because there are not enough pens now.

## 5. Discussion

Using the participatory Photovoice method, this research involved community members in the design and co-production of knowledge and created an opportunity for individuals to share their perceptions of the CBA project within the Velondriake LMMA. This method proved to be a useful tool for facilitating community evaluation of these projects, given the need for community support to ensure the sustainability of such interventions. The Photovoice data showed that integrating CBA into an LMMA is perceived to have livelihood and social benefits for both individuals and the wider community. The method also highlighted a range of access mechanisms which influence who has access to aquaculture farming and how benefits are distributed. Participants perceived there to be 'no more fish in the sea' and that CBA provided the benefit of a more reliable and safer income source than fishing. In the following sections we first discuss the benefits that community members highlighted from the projects, and then consider the dynamics around how the projects were accessed by different community members.

#### 5.1. Livelihood benefits and benefit-sharing within the community

Similar to related research on fisheries management interventions (Cinner et al., 2014; McClanahan et al., 2014), the results demonstrate that community members perceived there to be socio-economic benefits for individuals, as well as some benefits being distributed across the community. Farmers were seen as the main beneficiaries of the projects overall, with all participants discussing how the projects provided

monetary benefits for farmers, indicating a high level of success in terms of income-generating outcomes. This finding is consistent with related research that reported an increase in incomes from community-based aquaculture (Ateweberhan et al., 2018) and with research finding an uneven distribution of benefits from projects (Cinner et al., 2014). Specifically, farmers were described as being able to buy animals for food and investment as well as start or improve other businesses. This is significant because it shows that income from farming enables farmers to develop savings for the future and/or pursue other livelihood options. This may aid in resolving a recognised livelihood barrier, where insufficient income and credit options can limit people's access to other livelihood opportunities (Cinner, 2011).

The Photovoice process provided clarity on how money was spent and how farmers were sharing these and other benefits within the community. For example, in describing their photos, some farmers discussed how they were able to hire community members to work with them on small-scale village businesses, and how they helped those in need of food or shelter. Other tangible and intangible community benefits were voiced by participants (e.g. 'the community is no longer poor'), showing how respondents viewed benefits as being distributed across the community. This perception of benefit-sharing provides support to the claim that co-management can function as a benefitsharing mechanism which produces both individual and communitylevel benefits. If community members perceive CBA to be a 'positive sum interaction', the model may have long-term sustainability (Soliev and Thessfield, 2017). It is significant that farmers and non-farmers alike cited a range of community benefits, as non-farmers are not directly involved in farming. That farming is also perceived as not being accessible to all community members and that farmers are seen as the main beneficiaries of the project, potentially creates an environment for community social conflict. On the contrary, all participants cited wider community benefits, suggesting that individuals (even non-farmers) perceive the projects' community benefits as outweighing perceptions of inequitable access to farming. This is related in principle to a study in a similar context which found fishing groups were receptive to changes from open to closed access if the latter generated more benefits (Basurto et al., 2013).

# 5.2. Becoming a CBA farmer: access mechanisms

The CBA model has the potential to be long-lasting due to perceived individual and community benefits and since nested governance structures have been considered by Ostrom to be predictors of successful comanagement where there is a mix of open and closed access areas (Ostrom, 1990). Because CBA (private access) occurs in an area previously used for community fishing (controlled access) and historically open-access (before the LMMA), perceptions of fair and equitable access to aquaculture farming are vital to ensure the sustainability of the CBA-LMMA model. While those 'wielding power' (VDK-A, Fokotany, and BV) say that the CBA is open to all interested community members, participants in this research perceived that not every interested individual could gain access to farming. This finding is similar to other research that found that equal participation and benefits of all community members cannot be assumed just because the project is community-led (Mahajan and Daw, 2016; Cinner et al., 2014). Framing these findings through the lens of access theory shows participants describing access barriers related to rights-based access, social and institutional access, knowledge access, and economic access mechanisms. Further analysis of the farmer selection process uncovers additional access barriers (e.g. gender) and possible tensions between the patriarchal power structures of customary institutions (clan system) and the CBA governance system.

## 5.3. Displacement and CBA

Previous research on CBA in the WIO hypothesized that expanding aquaculture into open access areas could disproportionately affect marginalised community members by restricting their access to fishing grounds (Ateweberhan et al., 2018). In this case study, women have been equally selected to participate in farming and, in contrast to other studies, have not been pushed away from participating in sea cucumber and seaweed farming (Fröcklin et al., 2012). However, women in the community may be more affected than men by the reallocation of 19% of the coastal area for CBA (private access) as male fishers are likely able to navigate their pirogues to another part of the near-shore area to land their catch while women may have permanently lost a portion of their gleaning grounds. Women may also face access barriers to participating in the decision-making process and governance model of CBA as field observations of meetings, and other research within the Velondriake LMMA, suggests that although women are invited to participate in CBA meetings, they may not be able to attend or actively participate due to juggling domestic work and not having the 'political voice to speak' (Singleton et al., 2019). These observations are in line with similar research from seaweed farming in Zanzibar where a CBA project inadvertently overburdened women with dual responsibility for 'market' and 'household' tasks (Fröcklin et al., 2012). Thus, to ensure that women are equitably benefiting from their involvement in CBA, understanding how women's participation in CBA contributes to their responsibility burden is crucial. Transforming gendered systems, however, does not happen overnight and promoting gender equality 'starts by understanding how power works in society' (Cinner et al., 2015; Murunga, 2021). Any community plans to scale-up the number of sea cucumber pens should be done through careful and targeted consultations with the women who rely most on the areas used by CBA to avoid disproportionately impacting community women.

Some participants in this research also described barriers to access in the form of needing existing forms of capital (e.g. pirogue) to participate in seaweed farming and/or needing a financial buffer in case sea cucumber or seaweed disease affected production. While VDK-A and BV refute the claim that a pirogue is needed for seaweed farming (this should be supplied by Ocean Farmers), if this is the case, then CBA may be exacerbating existing power imbalances by making it more difficult for marginalised community members to participate. Instead of trying to understand what the 'actual' situation is rather than the 'perceived', it is more helpful to understand how power and institutions interact (Berkes, 2004; Ostrom 1990, 2009) and how social and institutional access mechanisms have led to different understandings by people with different types of power. Framing these findings through access and benefit-sharing and access theories reveals how gaining access to farming is not just about filling in an application form and meeting the farming requirements (as is described by VDK-A governance members), but that access is mediated through various mechanisms involving social and cultural norms and power-relations. It may be that there are knowledge barriers (e.g., the process of becoming a farmer) and social dynamics (e.g., having access to a clan leader) which prevents some individuals from having access to information on what is needed to participate in farming. While the perception that a pirogue is needed may be a misunderstanding which reveals knowledge and social barriers, the potential of sea cucumber or seaweed disease is a widely observed risk which could disproportionately affect poorer farmers who might not have a large financial buffer. While CBA farmers do not contribute financial capital to participate, they could still feel the effect of poor CBA production through loss of expected wages, time invested on the farm, and/or loss of other livelihood activities through replacement with CBA.

# 5.4. Customary institutional rules and CBA

While SES and benefit-sharing literature emphasise the need to work with existing customary institutions to develop rules and governance structures, it appears that working within the clan system may, at times, be further exacerbating existing power inequalities, similar to other findings on co-management (Mahajan and Daw, 2016). Integrating existing customary institutions into CBA governance has meant that clan leaders and others in power are involved in the rule-setting process and farmer selection. This means that although farmers are selected through a process, social and gender norms will inevitably affect the decision of who is given the rights to become a farmer. These existing biases may be amplified with the limited number of CBA spaces and waiting list of interested farmers. That farmers are selected by a committee of those in power explains why participants in this research emphasized the need to 'be motivated' to participate in farming (i.e., appear motivated in the eyes of those in power so that they are chosen). This farmer selection bias could be mitigated by implementing a more democratic and transparent farmer selection process which uses both clan leaders and members.

Tensions relating to customary institutional rules and the new CBA governance system were suggested when participants discussed frustration with the rules of farming, specifically noting the number of rules to follow and the required frequency of tending to farms. SES theory and related literature on access and benefit-sharing theorize that if rules are developed in a participatory way and using existing governance structures, they are more likely to be accepted (Bennett and Dearden, 2013; Ostrom, 1990). Community members describing that there are too many rules and that they are hard to follow may reveal that they were not actively involved in the rule-setting process or that they were involved in the process but don't agree with the resulting rules. Because participating in farming means that farmers must obey a set of rules, participants may be revealing perceived tensions of moving from being a completely independent fisher to now working independently but to a set of pre-established guidelines (i.e. more akin to an independent consultant). On the other hand, as the customary rules for CBA were developed using existing customary institutions of the village, it is possible that participants are actually expressing frustration with the village's clan system governance structure. With male voices culturally prioritised over women's and a handful of individuals 'yielding power' (e.g. clan leaders) making decisions for the community, integrating these customary institutions into CBA governance may be extending existing inequalities. As these structural and institutional access mechanisms can affect who gains access to farming and how people benefit from this access, it will be important to monitor the evolution of these customary institutions (Lau et al., 2020).

## 5.5. Wild fishing vs aquaculture livelihoods

In spite of the above challenges expressed on the procedures and practices around aquaculture farming, the apparent community acceptance of CBA farming could relate to participant perceptions of the reliability of farming over traditional fishing. CBA farmers described how they used to need to take life risks to meet their livelihood needs (e. g., fishing in dangerous conditions) but now can rely on a stable income from aquaculture which also provides an intangible benefit of providing 'peace of mind'. That community members feel they have access to a reliable livelihood is significant because over 75% of participants described their traditional fishing livelihoods as insufficient because 'there are no more fish in the sea'. Consistent with a social survey undertaken by BV in 2017, this research shows that sea cucumber and seaweed aquaculture is used as an additional income source, not as a replacement for fishing. This research data showed that all farmers who previously fished continued to do so, but to a lesser degree. This suggests that in addition to social benefits from the provision of alternative livelihoods, CBA may provide some environmental benefits in terms of reducing local overfishing, however further evaluation is required. Research on fishers' willingness to exit fisheries for other livelihoods has shown the importance of local context, governance institutions, socioeconomic dynamics, and 'occupational identity' (Daw et al., 2012; Muallil et al., 2011). That aquaculture farmers continue to fish, even though fishing is perceived to be less reliable, is an important finding that is likely related to the historical and cultural reliance of Vezo communities on fish (Barnes-Mauthe et al., 2015). With fishing being an integral part of Vezo identity (Astuti, 1995), it would be difficult for fishers to completely exit the fishery.

As the Vezo are likely to continue to fish for as long as they can, and as one of the cited access barriers is that farmers need to be regularly on their farms and cannot participate in Vezo migration, it would be worthwhile for the aquaculture governance structure to revisit how wild fishing and aquaculture can occur in parallel. This review of the farming rules and how farming can occur alongside wild fishing should involve community voices both within and outside of the CBA governance structure (e.g., farmers and non-farmers) and specifically seek to actively involve women. It may be that as fishers' catch continues to decline due to a range of pressures, and if CBA continues to be seen as more reliable than fishing, then interest and involvement in CBA may continue to increase. Additionally, as Astuti found that participating in activities 'on land' such as farming meant a person was no longer considered a Vezo (Astuti, 1995), it would be helpful to understand if the Vezo view aquaculture farming as an 'on land' activity. If the Vezo conceptualise aquaculture farming as a type of 'fishing' and not a type of 'farming', they may be willing to transition from wild fishing to 'land fishing' more quickly- all while keeping their Vezo identity.

## 5.6. Photovoice as an evaluation tool for community-based management

Using the adapted Photovoice methodology in this research actively involved community members in the co-production of knowledge and created the space for individuals to share their perceptions of the CBA project within the LMMA. Through the 328 photos and accompanying descriptions for each photo, participants revealed tangible and intangible benefits from CBA. As others have shown (Mahajan and Daw, 2016; Masterson et al., 2018), the Photovoice methodology proved useful in communicating tacit, contextual, and cultural knowledge, such as the flow of money from farmers to local businesses and the use of farming money to purchase pirogues. Additionally, while taking photos throughout the small village, participants engaged in community conversations on the CBA project and spoke with interested non-farmers who wanted to partake in CBA. This suggests that Photovoice has the potential to be a useful tool for engaging community members in community-based evaluation of projects as well as sparking conversation within the community. Future applications in a similar context using the Photovoice method should plan on encouraging community meetings after participant themes are uncovered to discuss research findings and develop an action plan. While other applications of the Photovoice method have involved participants in the identification of photo themes across participant data, the appropriateness of this approach should be carefully considered in terms of technical constraints (e.g., no reliable electricity to view photos) and privacy concerns (e.g. a small village where photos can easily be attributed to an individual).

A limitation of this research is that there may be bias in favour of the CBA project, as in trying to obtain perspectives from different types of

community members (e.g., type of farmer), the research involved 12 farmers (6 sea cucumber and 6 seaweed) but only 6 non-farmers. As other research has shown, those who perceive benefits from a project will likely be supportive of it. Even so, the 6 non-farmers noted benefits for farmers and community benefits from the project, suggesting that even though they might not directly participate in the model, they perceive there to be benefits for the community. Due to the tight social community within the village and the fact that some participants report sharing their income with others not involved in farming, it is also possible that non-farmers benefit from the project monetarily. Further research should look at untangling the community web and bundles of power to more fully understand if, and how, monetary benefits are distributed across the community.

# 6. Conclusion

Community-based approaches such as CBA and LMMAs have been shown to be successful in managing marine resources while providing a range of socio-ecological benefits for implementing communities. This study, through using the participatory methodology of Photovoice, contributed to the literature by revealing community perceptions of a coupled CBA-LMMA model in terms of perceived access and benefits. Principally, this research showed that integrating CBA into a LMMA was perceived to have livelihood and social benefits at the individual and community levels. Notably, community members described how CBA farmers fished less than before they started participating in CBA and that they no longer had to take risks by wild fishing in poor weather. This suggests a degree of success with the CBA-LMMA model in terms of reducing fishing pressures but also reveals the intangible benefit of having access to a physically safer and more reliable livelihood. While there were a range of other perceived tangible and intangible social benefits at the individual and community levels, we found there to be perceived barriers to gaining access to farming, mostly related to social and institutional access mechanisms such as customary rules which dictated who could become a farmer. There appears to be a tension between the clan system governance structure and the CBA governance mechanism which aims to be more equitable, as well as potential gender inequalities in terms of access to, and benefits from, farming. Even so, the data showed a high degree of community support for the project, seemingly due to individual and community-level benefits, suggesting that the social benefits and their distribution within the community outweighs the perception of inequitable access to farming. However, further research on gendered power dynamics within the CBA system would be helpful to promote more equitable access and benefits for women.

The Photovoice method in this study aided community members in further engaging with the CBA-LMMA model through sharing and discussing their perceptions of the project's tangible and intangible benefits with other community members, the governance bodies (e.g. VDK-A), and the project partner (BV). Continuing to use Photovoice to understand complex socio-ecological marine systems, especially involving community-based management, will be key to identifying perceptions of benefits and their distribution within communities. In this, and other related contexts, the CBA-LMMA nested governance model may have the potential to positively contribute to improved collective natural resource governance, in particular where conservation goals to reduce fishing pressure are supported by tangible alternative livelihoods with community and individual benefits that are recognized by the community. Integrating CBA into an LMMA, or in similar coastal contexts such as within the WIO, where livelihood options are limited may provide similar levels of individual and community benefits. The findings from this research will support the VDK-A and BV scale CBA across the 33 villages within the Velondriake LMMA, potentially reaching 7,800 people. However, to implement such projects in other contexts, it is likely that fishing communities may need financial, technical, and capacity building assistance like that provided by BV. This NGO-assisted implementation may be workable in these contexts as long as there is a similar commitment to supporting such projects in the medium-term and an exit plan in the long-term which involves capacity building of local people. This study highlighted that benefits are being seen by communities; however, access and benefits appear to be mediated by existing inequalities and power dynamics and scaling of the model would benefit from further research to understand how these might be addressed.

## Author statement

Lara Funk: Methodology, Data Curation, Formal Analysis, Investigation, Writing- Original Draft, Visualization.

Meriwether W. Wilson: Conceptualization, Writing- Review & Editing, Supervision, Funding Acquisition.

Charlotte Gough: Investigation, Methodology, Resources, Writing-Review & Editing.

Kitty Brayne: Conceptualization, Writing - Review & Editing, Project Administration, Funding Acquisition.

Noelinaud Robert Djerryh: Investigation, Methodology.

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## Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

A. Meriwether W. Wilson reports financial support was provided by Prince Albert II of Monaco Foundation. Kitty Brayne reports a relationship with Blue Ventures that includes: employment. Charlotte Gough reports a relationship with Blue Ventures that includes: employment. Blue Ventures is one of the implementing partners in the community-based aquaculture initiative and a co-manager of the Velondriake LMMA. Noelinaud Robert Djerryh reports a relationship with Blue Ventures that includes: employment. Three authors (Kitty Brayne, Charlie Gough, and Noelinaud Robert Djerryh) are employed by this organisation. This should not affect the validity of the research.

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# Appendix I

# Socio-demographic data.

Participant number 17 withdrew from the process so their data is not shown.

Participant Gender Age		Age	e Education	Participant-described livelihoods											
		level	Community Based Aquaculture		Wild Fisheries			Land-based farming		Public Sector	Other				
				Seaweed farming	Sea cucumber farming	Net or line fisher	Diver	Gleaner	Fish business	Agriculture	Livestock	Education	Odd jobs	Wood collector	Business
1	Male	22	Primary	1	1	1	1								
2	Female	38	Primary	1	1			1							
3	Male	57	Primary		1							1			
4	Female	24	Primary		1										1
5	Female	45	Tertiary	1								1			1
6	Female	30	Secondary	1	1				1						
7	Female	52	Primary	1		1		1							
8	Male	32	Secondary	1						1					
9	Male	44	Primary	1		1	1				1				
10	Male	30	Primary	1	1	1	1				1		1		
11	Female	34	Primary	1											
12	Male	39	Primary	1			1								
13	Female	20	None					1							
14	Male	28	Primary			1	1								
15	Female	20	Secondary					1							
16	Male	45	Primary				1	1							
18	Female	60	Primary			1		1						1	

# Appendix II

Number of participants who discussed each theme. Sea cucumber and seaweed farmers' responses were aggregated to avoid double counting as some participants participanted in both forms of farming and participants did not always differentiate between the two types of farming when discussing perceived access and benefits (e.g. "the CBA projects").

Lens	Aspect		Theme De	scription	Number of farmers	Number of non-farmers	Total
Benefits	nefits Income source and adequate livelihoods			rmers make money from farming through the alternative livelihood source and r farming money in a range of ways.	12	5	17
	Sufficient nutritious fo financial security; cult	od; ural	CBA farme	ers spend some of their farming money on purchasing animals which are used e, savings, investment, food, emergency income, and in special cultural events	10	4	14
	Required household go	oods	CBA famer mosquito : TVs.	s use their farming money to buy basic house commodities including bedding, nets, plastic chairs, radios, solar-powered systems, suitcases, thermos's, and	10	4	14
	Safe shelter		CBA farme damaged l	ers use their farming money on home improvement including repairing a nome or building a sturdier home made of sokai (rudimentary lime) or wood.	11	3	14
	Freedom of choice and education		CBA farme	ers use their farming money to pay for school fees for their children.	8	2	10
	Ability to help others	Ability to help others		ers share money with other community members, spend money in the y, and employ community members in their other businesses	7	3	10
Required transportation			CBA farme	ers use their farming money to buy pirogues for transportation.	8	1	9
	Community-wide benefits C g Peace of mind C		CBA farmi good', for communit	ng means the community is 'no longer poor', it makes the community 'look eigners have come to the village, and it has brought infrastructure to the y (e.g. mirador).	11	5	16
			CBA farmi of mind'	ng has allowed farmers to 'have everything that I want and need' and a 'peace	8	5	13
	Reliable income source			ng is a more reliable income source than fishing which also allows farmers to the future and reduce their reliance on wild fishing	6	1	7
Lens	Mechanism	Aspect		Theme Description	Number of farmers	Number of non-farmers	Total
Access	Social and institutional	Physical and iden	health ntity	Not everyone can be farmers due to personal characteristics (age, health, lack of motivation)	7	3	10
	Social and institutional	Customa institutio	ary onal rules	Not everyone can be a farmer because of external factors (waiting list, can't find partner, not enough pens)	4	2	6

(continued on next page)

#### (continued)

Lens	Mechanism	Aspect	Theme Description	Number of farmers	Number of non-farmers	Total
	Knowledge; economic	Knowledge; capital capacity	Some perceive a need for interested farmers to have capital capacity (e.g. a pirogue for farming) or financial capacity (e.g., savings in case there is an outbreak of disease affecting the CBA)	5	4	9
	Social and institutional, Rights- based	Customary institutional rules	You can be a farmer only if you can follow the rules and attend meetings/ there are a lot of rules/they are difficult to follow/we cannot do migration	6	4	10

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