



A decade and a half of learning from Madagascar's first locally managed marine area

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Funding information

UK Government's Darwin Initiative;
Leona M. and Harry B. Helmsley
Charitable Trust; John D. and Catherine
T. Macarthur Foundation

Abstract

While the participatory management of small scale fisheries has been widely promoted, we have limited understanding of the factors influencing its effectiveness. Here, we highlight lessons learnt from the implementation of Madagascar's first locally managed marine area (LMMA), drawing on our insights and experiences as staff of a comanaging nongovernmental organization (NGO). We describe the LMMA's context and history, and highlight aspects of our approach that we feel underpin its outcomes, including: (a) comanagement rather than community-management; (b) the permanent field presence of a supporting NGO; (c) a management focus on locally important natural resources; (d) the implementation of poverty alleviation initiatives aimed at reducing barriers to management; (e) decision-making by resource users rather than scientists; (f) a diversified, entrepreneurial funding model; and (g) an emphasis on monitoring and adaptive management. We also highlight several challenges, including: (a) the inability to influence fishery supply chains; (b) promoting participation and good governance; (c) promoting rule application; (d) standing up to outsiders; (e) promoting environmental management in the long term; and (f) maintaining funding. Our experiences suggest that small scale fishers can be effective natural resource managers in low-income contexts, but may need extended support from outsiders; however, the role of supporting NGO is nuanced and complex.

KEYWORDS

community-based management, conservation, coral reef, experiential data, fisheries, governance, natural resource management, nongovernmental organization, participation

1 | INTRODUCTION

Local resource users have been increasingly integrated into the management and governance of natural resources over recent decades, at least partly in response to the failures of

top-down governance systems and the lack of state capacity in low-income countries (Brooks, Wayle, & Mulder, 2012; Miller, 2014). This trend is particularly prevalent in small-scale fisheries (Blythe et al., 2017; Evans, Cherrett, & Pems, 2011), which directly and indirectly support several

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hundred million people globally, particularly in low-income tropical countries (Béné, Macfadyen, & Allison, 2007; FAO, 2016). Numerous forms of participatory fisheries management have evolved over this period, which we group under the umbrella term locally managed marine areas (LMMAs). While the specifics vary, each seeks to devolve management authority to local users and may have multiple social, economic, and ecological objectives, including the enhancement of food security, poverty alleviation, local community empowerment, and the maintenance of biodiversity and ecosystem health (Aswani, Albert, & Love, 2017; Govan, Aalbersberg, Tawake, & Parks, 2008; Jupiter, Cohen, Weeks, Tawake, & Govan, 2014).

Effectively managed LMMAs can lead to improved social (Gurney et al., 2014; Yang & Pomeroy, 2017), economic (Evans et al., 2011; Oliver et al., 2015), and ecological outcomes (Campos-Silva & Peres, 2016; Hamilton, Potuku, & Montambault, 2011). However, the effects of most efforts are never evaluated (Blythe et al., 2017) and many initiatives may have little impact on intended outcomes (Cinner et al., 2012, 2016; Evans et al., 2011).

To improve the effectiveness of LMMAs, we require an improved understanding of the conditions affecting their success. A growing body of research shows that effectiveness depends on project design principles (Blythe et al., 2017; Cinner et al., 2012; Gutierrez, Hilborn, & Defeo, 2011; Oviedo & Bursztyn, 2016; Serafini, Medeiros, & Andriquetto-Filho, 2017), contextual conditions such as social capital (Diedrich, Stoeckl, Gurney, Esparon, & Pollnac, 2016; Gutierrez et al., 2011; Kawaka et al., 2017; Kosamu, 2015; Sutton & Rudd, 2015), and the types, levels, and duration of inputs and support from outside stakeholders (Aswani et al., 2017; Freed, Dujon, Granek, & Mouhhdine, 2016; Mahajan & Daw, 2016; Weeks & Jupiter, 2013). Indeed over 50 variables have been identified which may influence the sustainability of such social-ecological systems (Blythe et al., 2017; Ostrom, 2007, 2009). However, this information has been drawn largely from empirical case study analyses and large-scale quantitative studies and, as a result, there has been little focus on the insights and experiences of practitioners involved in the implementation of management initiatives. This is despite the fact that such practitioner-generated “experiential data” may constitute a useful complement to empirical data in the development of policy and best practice, and can help orient research agendas to address on-the-ground needs (Adams & Sandbrook, 2013; Fazey, Fazey, Salisbury, Lindenmayer, & Dovers, 2006; Schwartz et al., 2019).

In this paper, we share insights from the first 15 years of implementation of Velondriake, Madagascar's first LMMA, based on our experiences as practitioners involved in the NGO-led program that catalyzed and

supports it. We first describe the social-ecological context of southwest Madagascar to illustrate the complexity of the challenges faced by coastal communities in the region, and briefly outline the history, scope, and impacts of the Velondriake initiative. We then highlight seven aspects of our approach that we feel contribute relevant lessons for policymakers, practitioners, and researchers globally, and discuss six challenges that have contributed to constraining intended impacts.

2 | METHODS

2.1 | Study system

The south-west coast of Madagascar comprises diverse marine ecosystems including extensive coral reefs, lagoons, and mangroves (Benson, Glass, Jones, Rav-aorinorotsihoarana, & Rakotomahazo, 2017; Harris, Manahira, Sheppard, Gough, & Sheppard, 2010). It is primarily populated by Vezo traditional fishers who depend on the harvest of marine resources for subsistence and income (Barnes & Rawlinson, 2009; Barnes-Mauthe, Olesen, & Zafindrasilivonona, 2013), as well as cultural identity (Astuti, 1995; Olesen et al., 2015).

The region is arid, isolated, and infertile, and lacks industry and infrastructure (roads, irrigation, education, healthcare, etc.). Therefore local communities have extremely high dependence on marine resources: indeed, small-scale fisheries generate 82% of all household income and provide over 99% of dietary protein (Barnes-Mauthe et al., 2013). However, the coastal economy has transformed from subsistence-based to trade-based in recent decades (Cripps & Gardner, 2016; Iida, 2005), following the rise of global markets for seafood products including octopus (primarily *Octopus cyanea*), sea cucumber (Holothuroidea), mangrove mud crab (*Scylla serrata*), and shark fin (Elasmobranchii).

Coastal ecosystems in southwest Madagascar are rapidly degrading as a result of overfishing and the use of destructive fishing practices (Andréfouët et al., 2013; Bruggemann et al., 2012; Grenier, 2013). Demand for seafood is underpinned by overseas trade and rapid population growth (Brenier, Ferraris, & Mahafina, 2012), which is fuelled by (a) high fertility rates arising from the scarcity of reproductive healthcare services (Harris, Mohan, Flanagan, & Hill, 2012), and (b) the coastward migration of inland populations in response to climate change-driven agricultural failure, insecurity, and the attraction of perceived lucrative fishing opportunities (Bruggemann et al., 2012). In addition, small-scale fishers face occasional competition from legal and illegal industrial fleets (Harris, 2011; Le Manach et al., 2012). These pressures

are exacerbated by coral bleaching related to ocean warming (McClanahan, Ateweberhan, Omukoto, & Pearson, 2009), sedimentation (Maina et al., 2012; Sheridan, Baele, Kushmaro, Frejaville, & Eeckhaut, 2015), and an increase in destructive storms (Fitchett & Grab, 2014), which reduce coral cover and reef productivity.

Pressures on coastal ecosystems are compounded by the absence of robust fisheries governance systems, including a lack of quotas and access restrictions. The Malagasy state is largely absent from isolated rural areas and the ministry responsible for marine resources lacks the reach and capacity to effectively implement national legislation (Le Manach et al., 2012; Long, Jones, Randriana, & Hadj-Hammou, 2017). While Vezo communities have some customary institutions related to the sea (e.g., informal reef tenure, taboos) and are able to establish and adapt these to address contemporary resource management challenges (Westerman & Gardner, 2013), they are not traditionally intended to promote the sustainability of harvested resources. In addition, customary institutions may be diminishing in importance as a result of erosion of cultural norms and social cohesion (Cripps & Gardner, 2016; Lilette, 2006; Muttenger, 2013). Moreover, Madagascar's inshore fisheries are legally and culturally open access, with no formal limits to where or how much people can fish. Vezo fishers have very high discount rates (prioritizing resource use today over saving for tomorrow; Tucker, 2012), and lack any tradition or custom relating to resource management, financial saving, or long-term planning more generally (Astuti, 1995). Given the absence of economic or subsistence alternatives to fishing and pervasive extreme poverty, these fisher communities are highly vulnerable to shocks caused by the rapid pace of socio-economic and environmental change, and lack the capacity to adapt to them (Westerman, Olesen, & Harris, 2012).

Participatory fisheries management in the region began in 2004 when the NGOs Blue Ventures (BV) and Wildlife Conservation Society supported the village of Andavadoaka to implement a trial periodic fisheries closure (PFC) for octopus (Benbow et al., 2014; Harris, 2007). Neighboring villages replicated the model, and by 2006, 24 villages along 40 km of coastline were collaborating to develop strategies to manage the region's inshore waters. The initiative was named Velondriake (meaning "to live with the sea") and took on the moniker of LMMA in recognition of its parallels with longstanding initiatives in the southwest Pacific (see Govan et al., 2008; Jupiter et al., 2014) (Table S1). The LMMA has incorporated a growing number of marine management practices as it has evolved, and now includes five permanent coral reef reserves and two permanent mangrove reserves (totaling 2.3 km²), as well as numerous PFCs on reef flats (primarily

for octopus) and in mangroves. These are contained within an envelope of approximately 600 km² in which gear-based restrictions apply, notably prohibiting the use of destructive poison and mosquito net fishing gears (Figure 1). BV support for Velondriake is guided by its theory of change (Figure 2), and additionally includes the provision of health and education programs, and the development of livelihood-based interventions (seaweed and holothurian mariculture, ecotourism) (Table S2).

The LMMA is governed by the Velondriake Association (VA), which comprises three regional sub-committees representing northern, central, and southern villages. Velondriake is regulated by a *dina*—a locally developed set of laws that has been ratified in court to become a local by-law. The *dina* has sequential enforcement procedures: It can be applied at the village level, but escalated to the VA and eventually to the magistrate's court if the case cannot be settled locally (Andriamalala & Gardner, 2010). Madagascar lacks a legal framework specifically for LMMAs, but Velondriake was gazetted as a protected area in 2015 (Gardner et al., 2018), with BV as the site's delegated management authority and subdelegating aspects of management to the VA. Thus, while the protected area is *de jure* comanaged by BV and the Government of Madagascar, it is *de facto* comanaged by VA and BV.

2.2 | Evaluating success and extracting lessons learnt

Although Velondriake is an ongoing initiative that is yet to be systematically evaluated, we suggest it can be considered a qualified success in terms of its social and environmental impacts. In conservation terms the impact of the LMMA is not known, but fish biomass in the five permanent reef reserves increased by 189% six years after implementation (Gilchrist, Rocliffe, Anderson, & Gough, 2020). However the LMMA has made limited progress in addressing the overexploitation of extremely high value and vulnerable species such as sharks and sea cucumber, the collection of which has essentially wiped out these species from within Velondriake and the wider region (Cripps & Gardner, 2016). Periodic fishery closures for octopus have a significant positive economic impact on participating villages (Oliver et al., 2015), although their impacts on the sustainability of the fishery, or other species, have not been evaluated. The LMMA has also had positive socio-economic impacts, building social capital within participating communities (Barnes-Mauthe et al., 2015). The provision of access to rights-based health services has resulted in reports of smaller families, more time to work, increased income, and better health (Singleton et al., 2019),

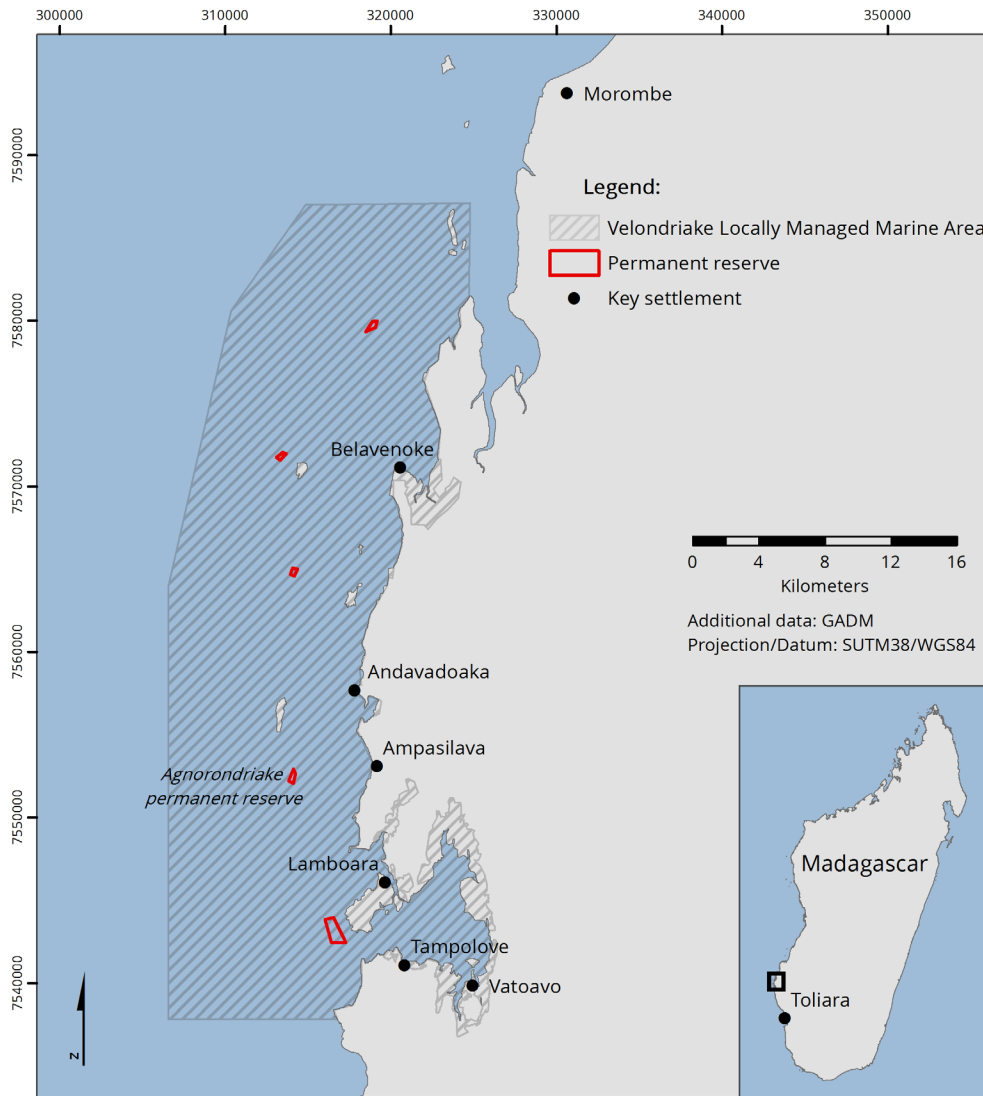


FIGURE 1 Map of Velondriake zoning and locations mentioned in the text. Inset shows location within southwest Madagascar

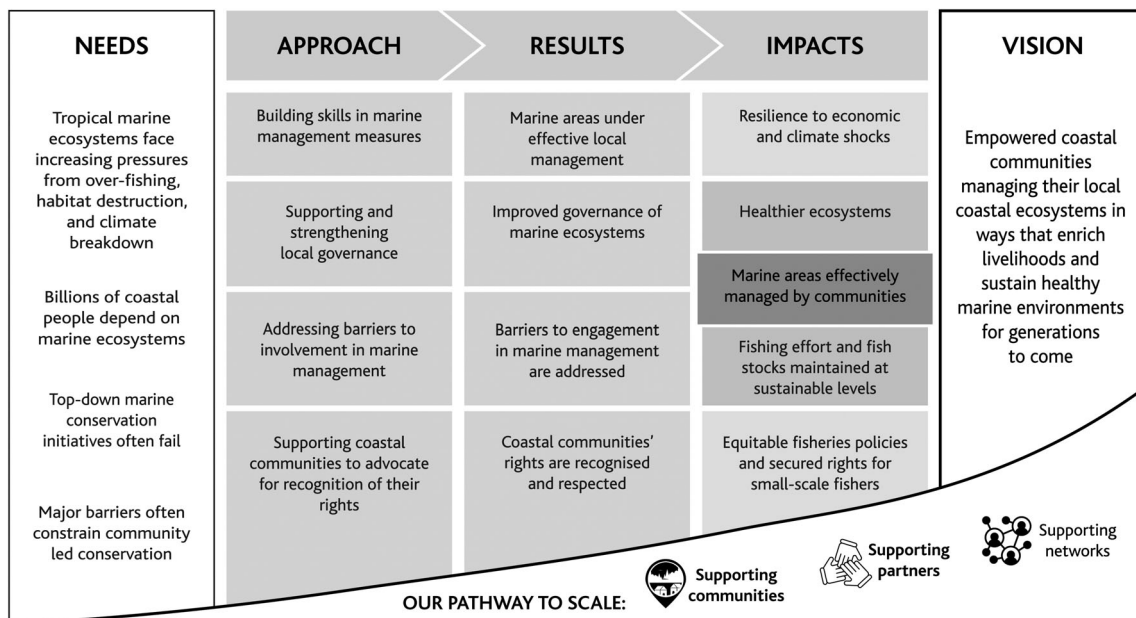


FIGURE 2 The theory of change guiding Blue Ventures' investments and interventions in the Velondriake locally managed marine area

while community members report that livelihood-based interventions support access to education, improvements to housing, the establishment of small businesses, and a reduced reliance on fishing (Funk, 2018).

As the first LMMA in Madagascar, Velondriake has pioneered the LMMA model in this region and delivered benefits beyond its boundaries, notably by providing experience and training to a generation of young Malagasy resource managers and scientists, influencing national fisheries policy, and stimulating the broad replication of LMMAs across Madagascar and overseas. Madagascar now has over 170 LMMAs (Mihari, 2019; Ratsimbazafy et al., 2019), and the underlying octopus PFC model has been exported to Tanzania, Mozambique, Comoros, Mayotte, Mauritius, Indonesia, and Mexico.

BV seeks to share the experiences of Velondriake managers with communities and civil society organizations across Madagascar and internationally, including through the development of the Madagascar LMMA network (Mihari) and fisheries learning exchanges (Gardner, Latham, & Roccliffe, 2017). This paper complements that

approach by sharing our experiences as staff of a supporting NGO with international conservation scientists, practitioners, and policymakers. The lessons we present were not derived through a formal process, but rather synthesized initially from a number of reflective internal documents. Synthesized lessons were then discussed and refined by all authors in an iterative process. We recognize that our lessons are anecdotal; however, it is increasingly recognized that the rich “experiential data” of conservation practitioners is a useful complement to empirical data and should be better integrated into the academic literature (Adams & Sandbrook, 2013; Schwartz et al., 2019).

3 | LESSONS LEARNED

3.1 | Comanagement not community-management

While global conservation policy and the literature place great emphasis on “community-based” management,

TABLE 1 Aspects of Blue Ventures’ (BV) approach that have contributed to outcomes in the Velondriake locally managed marine area (LMMA) (see Table S3 for further detail)

Lessons learnt	Examples and explanation
Comanagement not community management	As comanager, BV: <ul style="list-style-type: none"> • Brings strategic, technical and financial support which VA otherwise lacks access to. • Gives the VA means to pursue legal procedures that would otherwise be inaccessible (e.g., ratification of <i>dina</i>, protected area establishment). • Helps overcome social norms and dynamics (e.g., family ties, fear of retribution and witchcraft) that may otherwise prevent VA members from applying rules. • Helps maintain momentum, drive and mission focus.
Permanent field presence of supporting NGO and social enterprise	Uninterrupted presence of BV staff and paying dive tourists in the LMMA since 2003 facilitates the development of relationships of trust and acceptance, fosters a deeper understanding of social dynamics, and may contribute to respect for rules.
Focus on locally important resources	Demonstrable benefits of managing the fast-growing and economically important (but nonthreatened) <i>Octopus cyanea</i> fishery awakened an interest in broader resource management and catalyzed further initiatives (e.g., permanent reserves).
Addressing poverty-related barriers to enable resource management	Investments in education, healthcare and livelihoods partially alleviate the immediate pressures on fishers’ daily lives, opening up the space in which resource management and governance can take place. They may also help reduce dependence on fisheries and generate goodwill towards the VA and BV.
Decision-making by users, not scientists	LMMA zoning was based on willingness of VA membership to set aside fishing areas, not scientific prioritization, thus enhancing local legitimacy. This suggests that a lack of scientifically derived data need not act as a barrier to decision-making or action.
Diversified, entrepreneurial funding model	BV has built a diversified portfolio of revenues and incentive-driven models, adopting an entrepreneurial approach to fund both its own operations and those of the VA. This has increased resilience and helped the LMMA appeal to a broader range of donors.
Monitoring and adaptive management	The close relationship between BV and VA facilitates the frequent adjustment of management to adapt to changing conditions or unexpected outcomes, and community members value involvement in monitoring programs as it enables an understanding of the impacts of their management actions.

Abbreviations: VA, Velondriake Association.

both the initial PFCs and subsequent Velondriake protected area have been acknowledged as comanaged initiatives from the outset. The VA's dependence on third-party support from an NGO is unsurprising given the complexities and expense of natural resource management, even in wealthier countries with strong local and central government capacity. While decisions are made by the VA, the association lacks the capacity to function effectively in isolation, and depends on support in several areas. As well as helping to catalyze, fund, and implement diverse environmental, social, and economic development initiatives (Table S2) and build capacity of the VA, BV's presence also helps the VA to pursue legal procedures that would otherwise be inaccessible, and facilitates the application of rules (Tables 1 and S3).

The latter is particularly important because local social norms and dynamics (e.g., family ties, fear of retribution, and witchcraft) may otherwise prevent association members from applying rules against local *dina*-breakers (see also Long et al., 2019). While the strength of the *dina* comes from the buy-in of community members and BV has explicitly never been involved in *dina* application, community members find it difficult to rise above local politics and family ties in the heat of a *dina* dispute. Recognizing this challenge, the community has regularly invited BV to play a role as mediator. As BV's team is composed of local, national, and international staff and is not bound by the same social norms, it is able to provide the needed neutrality and accountability that communities require in times of conflict (see section 4.3). While BV's direct involvement in the application of community-defined and community-enforced rules would probably diminish their legitimacy, the invited role of independent mediator appears to strengthen rule application.

3.2 | Permanent field presence of supporting NGO and social enterprise

Many LMMAs throughout the coastal tropics are supported by NGOs based outside the target community, which employ field outreach agents or community-based technicians to work with communities on short term "field missions." However, BV's center of operations for Velondriake has followed a different model, maintaining an uninterrupted staff presence within the LMMA since May 2003. Migrant staff, both international and from across Madagascar, contribute substantially to local economies, and the NGO also employs about 25 local residents (Tables 1 and S3). In addition, BV's conservation tourism program brings international paying visitors to Andavadoaka to participate in educational SCUBA-diving

(self-contained underwater breathing apparatus) expeditions and survey coral reefs to support long-term ecological monitoring of Velondriake's ecosystems. Participants spend time in homestays with local families, and around 150 women derive an income by providing catering. The presence of international tourists undoubtedly provides a vivid illustration of a nonextractive use value for the LMMA's marine ecosystems.

By nature of its operating model, BV is fully enmeshed as an active constituent within the Velondriake community, rather than a predominantly absent actor dispensing punctuated projects. This facilitates the development of relationships of trust and acceptance, and fosters a deeper understanding of social dynamics, including the political and economic interests of influential individuals, and the complex webs of family ties and feuds, which underlie governance and decision-making. This is particularly important in conservation in traditional societies, in which simplified understandings of communities—and particularly the assumption that they are homogeneous in terms of culture and interests—have plagued the history of participatory natural resource management interventions (Agrawal & Gibson, 1999; Kumar, 2005).

The presence of BV staff and tourists may also contribute to respect for rules. For example, the frequent presence of volunteer dive teams monitoring the biodiversity of permanent coral reef reserves is likely to be a significant deterrent to illicit fishing within these zones, and may also discourage the use of illegal gears such as beach seines in regularly visited areas (Laurance, 2013).

3.3 | Focus on locally important resources

While most conservation initiatives focus on threatened, range-restricted or charismatic species, these are not always salient to resource-using communities and may not present any direct interest to them. Environmental management interventions in Velondriake were founded on the management of *Octopus cyanea*, which is a widely distributed and unthreatened species, but forms an important component of the local economy, particularly for women (Westerman & Benbow, 2013). PFCs for this species yield significant economic benefits (Oliver et al., 2015), demonstrating the value of management and awakening an interest in broader resource management within a community lacking any such traditions. This has helped catalyze further initiatives such as the establishment of permanent reef and mangrove reserves, and the management of other high-value fisheries. Indeed, the creation of permanent reef reserves was initially deemed unviable by local communities on account of the

feared restrictions that they would impose on fishers. However, community support for reserves grew following the demonstration of tangible benefits from octopus management using PFCs (Oliver et al., 2015), and five permanent reserves totaling 1.96 km² have been established (Westerman & Gardner, 2013).

3.4 | Addressing poverty-related barriers to enable resource management

Since the early days of the LMMA, the VA has identified a number of poverty-related barriers to community engagement in local governance and compliance with management. In response, BV has invested in education (through schools scholarships, after school clubs, and broad scale community outreach and environmental education), the provision of healthcare (family planning, maternal and child healthcare and water, hygiene, and sanitation services) and the development of alternative livelihoods, generating opportunities that are not offered by the state (Tables 1, S2, and S3). Further initiatives in development include fisheries post-harvest value chain interventions (e.g., improving product quality and reducing post-harvest losses), partnerships with seafood buyers who might be willing to reward local fisheries management efforts through access to premium markets (Gardner et al., 2017), and “Blue Carbon” payments for ecosystem services initiatives generated through mangrove management (Rakotomahazo et al., 2019).

By partially alleviating the immediate pressures on fishers' daily lives, these initiatives help open up the space in which resource management and governance can take place (Singleton et al., 2019). Providing these desired services may also help reduce overfishing by reducing dependence on fisheries, and empowering women to become more active income generators, decision makers, and influencers within the community. Importantly, it may also help foster a willingness to collaborate on management initiatives, and help build trust between the local community, the VA and BV.

3.5 | Decision-making by users, not scientists

Although BV invests heavily in research to provide an evidence base for management, decisions within Velondriake are made by community members and not NGO staff or researchers. For example, high-resolution remote sensing-based habitat mapping and extensive biodiversity surveys were used in discussions over LMMA zoning, and scientific and traditional knowledge of

important coral reef sites agreed closely. However, the VA's location of permanent reserves was ultimately influenced by the perceived opportunity costs of placing key fishing areas out of bounds, rather than ecological criteria (Cripps & Harris, 2009). In subsequent mangrove management, zoning has been based entirely on the willingness of users to set aside areas for conservation (Rakotomahazo et al., 2019).

The research undertaken in Velondriake has generated valuable outputs, including the training of 30 Malagasy scientists from the University of Toliara's Institute of Marine Science, the publication of 14 peer-reviewed papers, and the establishment of regionally important monitoring sites documenting ecosystem condition. However, our experience suggests that a lack of scientifically derived data need not act as a barrier to decision-making or action, and thus that a pared-down, lighter touch and replicable model of LMMA development need not include large expenditure on ecosystem research. This is important because research may constitute a significant component of marine protected area expenditure, particularly when delivered by science-led conservation organizations or when deploying divers or research vessels.

3.6 | Diversified, entrepreneurial funding model

Initial BV operations were financed entirely by fee-paying volunteer dive expeditions, but reliance on tourism revenue decreased as philanthropic interest in LMMAs in Madagascar grew (but see section 4.6). The NGO has sought to build a diversified portfolio of revenues and incentive-driven models, and adopted an entrepreneurial approach to fund both the VA and its own operations. This has increased resilience and helped the LMMA appeal to a broader range of donors (e.g., those interested in health, livelihoods, gender, human rights, fisheries management, eco-labeling, carbon, and climate change adaptation, in addition to conservation); however, it has ultimately not served to reduce dependence on donors (see section 4.6). Similarly, the VA has developed diverse revenue streams including contributions from participants in seaweed aquaculture and the opening of octopus PFCs, LMMA entry fees from tourists, and small grants. However, it remains almost entirely reliant on subsidies from BV.

3.7 | Monitoring and adaptive management

The permanent presence of BV and its mentoring relationship with the VA and community members facilitates

the frequent adjustment of management to adapt to changing conditions or unexpected outcomes. For example, the opening of the first octopus PFC attracted 1,300 fishers from across the region, greatly diminishing per capita yields for Andavadoaka villagers. Discussions over subsequent months led to decisions that all villages should implement their own PFCs and that only residents of participating villages should be permitted to fish on the opening day (Benbow et al., 2014). More recently, an increase in local revenues resulting from aquaculture investments has triggered a boom in house-building using construction lime, a high-status indicator of wealth that drives mangrove degradation (Scales, Friess, Glass, & Ravaoarinorotsihoarana, 2018). In order to head-off such unforeseen consequences, the VA and BV are trialing the use of conservation contracts so that participation in livelihood-based projects is made conditional on beneficiaries agreeing to abide by the Velondriake *dina*.

In addition, community members increasingly value being involved in social, ecological and fisheries monitoring programs, which allow them to start understanding how their management actions, such as reef reserves and PFCs, are working. Thus, BV now focuses on the development of mixed methods evaluation protocols (see Singleton et al., 2019), complementary participatory

monitoring methods such as photovoice (Funk, 2018) and participatory video (Asadullah & Muniz, 2015), and mechanisms to enable feedback of monitoring results to communities, as tools to support discussions around adaptive management.

4 | CHALLENGES

4.1 | Inability to influence seafood supply chains

While local fisheries management initiatives have been successful in increasing incomes following the reopening of PFCs (Oliver et al., 2015), they have little power to address the broader-scale, market-driven influences that drive overfishing (Gardner, Rocliffe, et al., 2017, Tables 2 and S4). Currently the economic benefits of fisheries management accrue across the value chain, but it is the fishers and local associations implementing management who bear most of the costs. These costs are not “priced in” at the first point of sale, representing a conspicuous externality in the value chain. One way to correct this would be to raise prices through a tax or fee in order to pay for sustainable management. Attempts to achieve

TABLE 2 Outstanding challenges that hamper the achievement of desired outcomes in the Velondriake locally managed marine area (LMMA) (see Table S4 for further detail)

Challenge	Examples and explanation
Inability to influence seafood supply chains	Local fisheries management has successfully increased revenues through octopus PFCs but managers have little power to address broader-scale, market-driven influences on the fisheries. The high value of octopus has triggered an influx of commercial buyers and middlemen, in turn attracting new entrants to the fishery and promoting overfishing. In addition, fishers have little power to negotiate prices.
Promoting participation and good governance	VA leadership has been dominated by older, locally powerful men, while women and youth have been reluctant to stand for office or talk in meetings. Participation in meetings and elections is often low, and levels of consultation and reporting between leaders and the communities they represent remain variable.
Promoting rule application	VA members have legal authority to enforce <i>dina</i> regulations but infrequently do so. This may be influenced the complex webs of social, family and political ties within the community and a desire to avoid conflict.
Standing up to outsiders	The VA is legally empowered to apply rules, but in practice has limited power to prevent rule breaking by outsiders. It therefore requires state authorities to provide law enforcement “back-up”, but these are under-resourced, may not view LMMAs as a priority, and can be influenced by corruption. As a result, there is a lack of top-down support to protect and foster bottom-up decision-making.
Promoting long-term environmental management	Community members consistently prioritize their immediate needs for food, shelter, education, healthcare and entertainment above resource management concerns and future needs, raising questions for the sustainability of the initiatives should BV ever withdraw.
Maintaining funding	Income from fisheries management and tourism are insufficient, so VA and BV remain reliant on donor funding. However, maintaining funding has been a significant challenge, despite a track record of delivery.

Abbreviations: BV, Blue Ventures; PFC, periodic fisheries closure; VA, Velondriake Association.

this through the pursuit of the Marine Stewardship Council's eco-label have not yet advanced, because of the heavy technical and financial burden of certification against a framework that is poorly designed for small-scale fisheries with weak central regulation (Stratoudakis et al., 2016; Wakamatsu & Wakamatsu, 2017). Should certification be achieved, the benefits will primarily accrue to traders through improved market access, and there is no requirement for any premium to be returned to fishers.

4.2 | Promoting participation and good governance

Malagasy legislation requires local communities to form associations to participate in governance of protected areas or formal natural resource management. However, these associations do not resemble traditional community governance institutions, and local social norms do not always align with the state's good governance requirements. For example, leadership of the VA and its regional bodies has been dominated by a select group of older, locally powerful men, while women and youth have been reluctant to stand for office or talk in meetings. Initiatives to promote the participation of women have increased female representation on the Velondriake board to 38%, though this has not fully overcome social barriers to female decision-making.

Despite mechanisms for popular decision-making, participation in association meetings and elections is often low, and the levels of consultation and reporting between leaders and their communities remain variable. This may arise because it is difficult for chronically poor communities to devote time to engage in management and community governance (Long et al., 2017), though it may also reflect a level of apathy that naturally occurs over time with associative structures. It may be difficult for community members to keep abreast of the complex suite of initiatives underway at any time, leading to a withdrawal from participation. To address these issues, much of BV's work focuses on promoting participation, through a mix of social marketing and participatory learning. In addition, elected VA members are now compensated to conduct outreach and promote participation across the LMMA. Providing monetary compensation ("per diems") to community members to attend meetings has been successful in enhancing participation, though it is widely perceived that the amount offered is insufficient to compensate for time not spent fishing. Further, providing financial inducements risks eroding community ownership of participatory governance processes.

4.3 | Promoting rule application

Velondriake's *dina* was drawn up in a bottom-up process and allows for rules to be applied at the village level (Andriamalala & Gardner, 2010). However, despite the implementation of a social marketing program designed to promote enforcement by villagers and local leaders (Andriamalala, Peabody, Gardner, & Westerman, 2013) and ongoing outreach efforts in all villages, the *dina* is only infrequently applied locally to punish infractions (12 times in 6 years).

A reluctance to prosecute community members may be explained by the complex webs of social, family, and political ties within the community and a desire to avoid conflict; however, the community is regulated by several traditional *dina* (concerning e.g., theft, domestic violence) which are regularly applied with little hesitation. These traditional *dina* are informal, unwritten, and lack prescribed punishments; it may therefore be that the formalization of rules and application procedures of the LMMA *dina* has rendered it sufficiently different to the traditional form as to reduce local ownership of it, or that the formal procedures are not fully understood. Alternatively, the poor record of *dina* application may indicate that the LMMA *dina* is not perceived as particularly worthwhile upholding by participating communities, perhaps because marine management is perceived as less important than other aspects of life, or because the LMMA *dina*, which was created by living people, is inherently less important than traditional *dina* created by the ancestors. While BV's presence may encourage rule application and help bypass social barriers (see section 3.1), promoting the ownership and application of rules within the community remains a major challenge.

4.4 | Standing up to outsiders

While the ratification of the Velondriake *dina* and recognition of the LMMA as a protected area legally empower the VA to apply rules, in practice the association has limited ability to prevent rule breaking by outsiders (Tables 2 and S4). Fisher communities lacking the power to counter outsiders depend on state authorities to provide "back-up" to enforce the law (Anderson & Mehta, 2013; Ferse, Costa, Schwerdtner Manez, Adhuri, & Glaser, 2010), but in Madagascar the responsible state agencies are severely under-resourced, lack guidance on how to support the enforcement of local environmental *dina*, may not view LMMAs as a priority, and can be influenced by corruption. The resulting lack of top-down support to protect and foster bottom-up decision-making has been identified as a constraint on local management of crab and lobster fisheries elsewhere in Madagascar

(Long et al., 2017, 2019), and is particularly problematic because protecting fishery resources from outsiders may be one of the main motivations for communities to support marine management (Wilson, Ahmed, Siar, & Kanagaratnam, 2006). Given the current lack of on-the-ground state support for local resource managers, NGO partners (and the national LMMA network, Mihari) have an important role in advocating on behalf of LMMA managers to regional and national authorities.

4.5 | Promoting long-term environmental management

Although Velondriake communities are composed almost entirely of fishers and fisheries management remains the core of the LMMA's mission, our experiences suggest that, for most participating villagers, environmental concerns remain at best a secondary priority. The rarity with which the Velondriake *dina* is applied, compared to traditional *dina*, may further suggest a limited concern for the LMMA and its regulations (see section 4.3). If fisher communities are more interested in the financial and development opportunities that involvement with environmental NGOs brings, rather than the environmental interventions themselves, this raises serious questions for the sustainability of the initiatives should BV ever withdraw. Indeed the very notion of an "exit strategy" for an environmental co-management partner, in a context in which communities suffer from such severe poverty and disenfranchisement, have critical unmet needs beyond conservation, and limited capacity for organizational management, is unrealistic in the short or medium term. Moving forward, BV will continue investing in building management capacity of the VA as an independent community-based organization, allowing the progressive scaling-back of direct NGO involvement. This will see work currently carried out by BV increasingly subcontracted to the VA, without cutting off technical support (Rocliffe & Quinlan, 2020).

4.6 | Maintaining funding

Long-term support is critical for successful LMMA management (Aswani et al., 2017; Freed et al., 2016; Mahajan & Daw, 2016), and our experience shows that this is needed over a timeframe of decades, not years. However, maintaining funding has been a significant challenge for both the VA and BV, despite the latter's track record of delivery and the innovative nature of its initiatives. Although the expedition program subsidizes some day-to-day logistical and operational costs (see section 3.6), these initiatives do not fully finance the LMMA or NGO

activities, and the LMMA thus remains reliant on donor funding. However, the short-term project funding cycle is inappropriate and unrealistic for establishing robust and sustainable LMMAs, and even long-term financial partners have, over time, withdrawn support in favor of pursuing novelty. For example, the two private foundations that have largely funded Velondriake's operations over the past decade have recently announced the closure of their conservation programs in Madagascar. We suggest that LMMA effectiveness would be improved if funders ensured the long-term provision of unrestricted funding for demonstrably effective initiatives, rather than prioritizing the pursuit of innovation. This would allow supporting NGOs to focus on implementation and local capacity building, rather than fundraising and re-marketing projects. A trust fund for Madagascar's LMMAs may provide a suitable mechanism, insulating local initiatives from the financial shocks of capricious donors: This approach has been established for the country's protected areas (Gardner et al., 2018). Such a transition in conservation philanthropy would necessitate recognition on the part of donors that there are unavoidable long-term costs associated with local marine management; just as there are with centrally delivered conservation efforts.

5 | DISCUSSION

Over the last 15 years the coastal waters of southwest Madagascar have transitioned from an open access system with no precedent for local engagement in marine management to one in which local communities have implemented fisheries management interventions, developed rules, and become legally recognized managers of their resources. While the effectiveness of this management in stemming the soaring impacts on local fisheries remains uncertain, these local management institutions provide a culturally nuanced framework for managing local resources. In this paper, we have shared our insights into the factors we feel have contributed to these outcomes, and highlighted a number of outstanding challenges.

Velondriake is underpinned by a close, long-term collaboration between fisher communities and an NGO. While the important role of outside agencies in catalyzing, financing, and supporting the grass-roots management of natural resources is recognized (Aswani et al., 2017; Freed et al., 2016; Mahajan & Daw, 2016), conservation policy and the literature frequently use terms (e.g., community-based management, LMMAs) implying that local users single-handedly manage their resources. Failure to acknowledge and account for the role of state agencies, NGOs, or other actors in such initiatives hampers our ability to understand these systems,

and muddies debates about the role of local users in the conservation of natural resources and the effectiveness and sustainability of community-based interventions. Our experiences suggest that local communities can be effective and efficient managers of the natural resources they use and live with, but they may need extended technical and financial support to do so. Nevertheless, the role of the supporting NGO is delicate; it must support without assuming control, or there is a risk that a locally led initiative instead becomes an NGO one, crowding out local motivation to participate in management.

It has been suggested that community-based management should build from existing customary rules and institutions (Berkes, 2007; Ferse et al., 2010), though Velondriake shows that LMMAs can be successfully catalyzed in areas that lack any tradition of resource management. We suggest that Velondriake's success in engaging fisher communities stems from BV's holistic approach, which has sought to remove barriers to governance and management identified by association members, rather than implement a specific agenda. This has generated a willingness to engage in fisheries and environmental management in a way that may not have existed had PFCs been imposed from the top down by an absent actor or the state. Velondriake also focused on locally important resources rather than traditional conservation targets, and thus was able to develop management initiatives that result in significant economic returns for participants (Oliver et al., 2015). However, while such short-term gains might be necessary to demonstrate the value of management and stimulate the interest of resource users (Mahajan & Daw, 2016; Pilgrim, Eberhardt, Eames, Vorsak, & Anh, 2011), they are not sufficient: our experiences suggest that, despite the economic importance of octopus, the benefits derived from its management may be less attractive to fishers than other opportunities arising from economic transformation through livelihood diversification or education.

Most fisheries comanagement globally is between local communities and the state (Brewer & Moon, 2015; Evans et al., 2011); however, in tropical low-income countries with weak and under-resourced state agencies, NGOs may be best placed to provide rural communities with the support required. Nevertheless, the state retains a critical role in providing enforcement "back up" because community managers often lack the power to apply the law, even when legislation authorizes them to do so (Anderson & Mehta, 2013; Ferse et al., 2010; Long et al., 2019). However, despite government commitments to expand LMMAs and reinforce their legal status (Rajaonarimampianina, 2014), they are not a priority for state authorities in Madagascar. Indeed, several of the challenges faced by the LMMA managers, including over-licensing of traders and conflicts with artisanal and industrial fishers, are exacerbated by misalignment of national fisheries

policy with LMMA needs. Thus, in addition to financing law enforcement agencies to support local communities in *dina* application, NGOs also retain a critical role in advocating for LMMAs in national policy.

In conclusion, while Velondriake demonstrates the potential for isolated fisher communities to establish robust and legitimate resource management and governance structures to regulate previously open access fisheries, it remains dependent on sustained external funding and the support of both its partner NGO and state agencies. We hope that this paper demonstrates the value of generating and publishing the "experiential data" of conservation practitioners as a complement to traditional conservation science research.

ACKNOWLEDGMENTS

We are grateful to the John D. and Catherine T. MacArthur Foundation, the Leona M. and Harry B. Helmsley Charitable Trust, the UK Government's Darwin Initiative for funding conservation efforts in the Velondriake LMMA. We thank Lalao Aigrette Ravaoarinosihoarana, Daniel Raberinary, Brian Jones, Kitty Brayne, Hannah Gilchrist, Vik Mohan, David Parreno Duque, Abigail Leadbetter, Jenny Oates, and others for providing data, and Leah Glass and Martin Muir for preparing figures.

CONFLICT OF INTEREST

All authors are or have been employees of Blue Ventures, the NGO comanagers of the LMMA initiative discussed in this research.

AUTHOR CONTRIBUTIONS

Charlie J. Gardner, Liz Prèmesnil Day, Katrina Dewar, and Alasdair Harris conceived the paper; all authors wrote the paper.

DATA ACCESSIBILITY STATEMENT

This paper is based on experiential data held by all authors and is not available in any other form. For further information, please contact the authors.

ETHICS STATEMENT

No individuals were involved in data collection for this study. Any data used were collected as part of BV's ongoing work in partnership with the Velondriake Association in managing the LMMA. BV has a Memorandum of Understanding with the Velondriake Association that permits BV to collate and share results on the progress of the LMMA, and an *Accord de Siège* with the Madagascar Government.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

How to cite this article: Gardner CJ, Cripps G, Day LP, et al. A decade and a half of learning from Madagascar’s first locally managed marine area. *Conservation Science and Practice*. 2020;e298. <https://doi.org/10.1111/csp2.298>