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Assessing poverty and the relative importance of small-scale lobster fishing activity in coastal communities, southeast Madagascar

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ABSTRACT

Over 1.3 billion people worldwide are living in multidimensional poverty, where income and access to critical goods, services and utilities is limited. A lack of reliable, accessible, and resource-efficient methods of measuring poverty is a barrier to assessing the effectiveness of conservation and development initiatives designed to alleviate poverty and promote prosperity. This study employed the Basic Necessities Survey (BNS) as a context-specific tool for measuring multidimensional poverty. The approach produces a BNS score based on the level of access to assets (e.g., cooking equipment) and services (e.g., access to a doctor) that are locally considered basic necessities. The BNS was applied in southeast Madagascar to assess levels of prosperity in six coastal communities and gain insights into the relative importance of lobster fishing as an economic activity. All households surveyed (n=533) were found to be below the context-specific poverty line, with most households lacking access to multiple basic assets and services. Across all six communities, households engaged in the lobster fishery were found to be experiencing significantly lower levels of poverty, demonstrating the socio-economic importance of this fishery. Poverty levels were similar between communities, despite differences in non-governmental organisation (NGO) interventions and community-based fishery management, with the exception of one community experiencing significantly higher levels of poverty. The findings demonstrate the pervasive nature of poverty and deprivation in this region and have implications for ongoing efforts to promote sustainable management of marine resources. The BNS survey was found to be a resource-efficient tool, capable of measuring multidimensional poverty in a context-specific manner to support comparison within and between communities. The study demonstrates the BNS approach is an accessible and powerful tool for conservation and development practitioners. It is a nuanced measure of multidimensional poverty in communities, providing a means to monitor the impact of conservation and development interventions.

RÉSUMÉ

Plus de 1,3 milliard de personnes dans le monde vivent dans une pauvreté multidimensionnelle, où les revenus et l'accès aux biens, services et services essentiels sont limités. Le manque de méthodes fiables, accessibles et économes en ressources pour mesurer la pauvreté est un obstacle à l'évaluation de l'efficacité des initiatives de conservation et de développement conçues pour réduire la pauvreté et promouvoir la prospérité. Cette étude a utilisé l'enquête sur les besoins de base (BNS) comme outil spécifique au contexte pour mesurer la pauvreté multidimensionnelle. L'approche produit un score BNS basé sur le niveau d'accès aux biens (par exemple, le matériel de cuisine) et aux services (par exemple, l'accès à un médecin) qui sont localement considérés comme des nécessités de base. Le BNS a été appliqué dans le sud-est de Madagascar pour évaluer les niveaux de prospérité dans six communautés côtières et mieux comprendre l'importance relative de la pêche au homard en tant qu'activité économique. Tous les ménages interrogés (n = 533) se trouvaient en dessous du seuil de pauvreté spécifique au contexte, la grande majorité des ménages n'ayant pas accès à plusieurs biens et services de base. Dans les six communautés, les ménages engagés dans la pêche au homard se sont avérés connaître des niveaux de pauvreté nettement inférieurs, démontrant l'importance socio-économique de cette pêche. Les niveaux de pauvreté étaient similaires entre les communautés, malgré les différences dans les interventions des organisations non gouvernementales (ONG) et la gestion communautaire des pêches, à l'exception d'une communauté connaissant des niveaux de pauvreté significativement plus élevés. Les résultats démontrent la nature omniprésente de la pauvreté et des privations dans cette région et ont des implications pour les efforts en cours visant à promouvoir la gestion durable des ressources marines. L'enquête BNS s'est avérée être un outil économe en ressources, capable de mesurer la pauvreté multidimensionnelle d'une manière spécifique au contexte pour soutenir la comparaison au sein et entre les communautés et entre elles. L'étude démontre que l'approche BNS est un outil ac-

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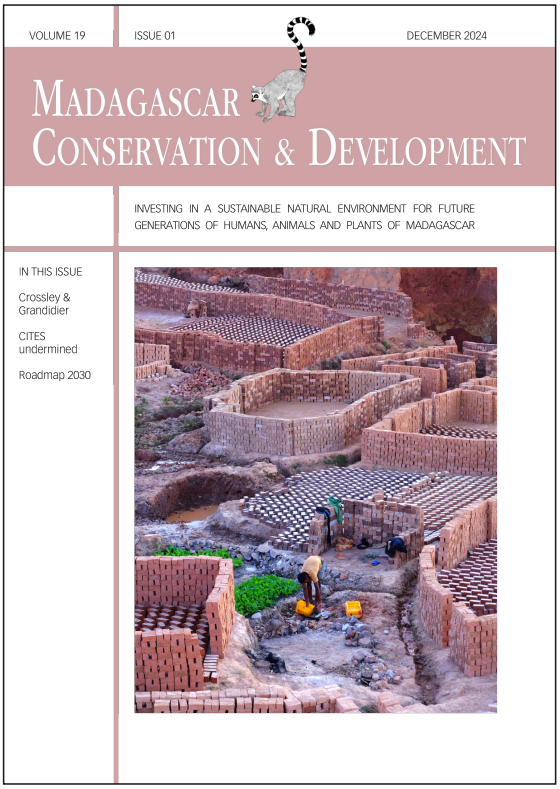

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cessible et puissant pour les praticiens de la conservation et du développement. Il s'agit d'une mesure nuancée de la pauvreté multidimensionnelle dans les communautés, offrant un moyen de surveiller l'impact des interventions de conservation et de développement.

INTRODUCTION

Despite significant progress, poverty remains widespread, with 600 million people living in extreme poverty below the international poverty line of US$1.90 purchasing power parity (PPP) (UNDP 2019a,b). Recognising the multidimensional nature of poverty is a critical first step to addressing it effectively. This includes social, economic, and political deprivation, such as limited access to education, sanitation, healthcare, and basic utilities (World Bank 2018). The Multidimensional Poverty Index (MPI) finds some 1.3 billion people in low-income countries are multidimensionally poor (UNDP 2019a). Sustainable Development Goal (SDG) 1 aims to "end poverty in all its forms everywhere" by 2030 (UN 2015), reflecting its intrinsic link with other SDGs and broader conservation and development objectives globally.

Designing and monitoring local conservation and development interventions requires understanding and tracking of poverty levels (Haughton and Khandker 2009). However, the multidimensional nature of poverty means it is challenging to define, let alone measure (Bibi 2005, Robeyns 2005, Flechtner 2021). Various well-established approaches exist, such as the MPI (Alkire and Santos 2014), but no single measure is universally optimal (Bibi 2005, Haughton and Khandker 2009). Established approaches are often impractical for practitioners, as they are expensive, time-consuming, require technical expertise and are not tailored to local contexts (Wilkie et al. 2015).

The Basic Necessities Survey (BNS) is a participatory approach to measuring poverty developed in 1997 and addresses some of these challenges (Davies and Smith 1998, Wilkie et al. 2015). The BNS employs a broad, practical definition of poverty as "a lack of basic necessities" (Davies and Smith 1998: 3). In contrast to defined poverty lines, there is no a priori definition of what basic necessities are (Davies and Smith 1998). Instead, the BNS assesses poverty based on local perceptions of basic necessities, thus ensuring relevance to the local context (Wilkie et al. 2015). Households that do not own or have access to all items considered basic necessities are regarded as being below the locally defined poverty line. The BNS approach is comparatively quick, inexpensive and does not require specialist skills (Wilkie et al. 2015). It has been used to assess the socio-economic impacts of conservation initiatives, e.g., effects of terrestrial protected areas (Clements et al. 2014, Wei and Yali 2017, Beauchamp et al. 2018). The BNS has principally been used by NGOs (Davies and Smith 1998, Davies 2006, Clements and Milner-Gulland 2015) but has received only limited attention in the academic literature (Wilkie et al. 2015) and has not been applied to coastal communities dependent on marine resources.

Small-scale fisheries (SSFs) employ the vast majority of the world's fishers (Béné et al. 2007) and support an estimated 492 million people globally (FAO 2022). SSFs can alleviate poverty by contributing to food security, providing livelihoods, and supporting economies (Andrew et al. 2007). Consequently, the sustainable management of SSFs is subject to global commitments including SDG 14, Life Below Water, and Aichi Biodiversity Target 11 (CBD 2010, UN 2015). Community Based Natural Resource Management approaches and Locally Managed Marine Areas (LMMAs) have increasingly been employed to improve the sustainability of SSFs. Their effectiveness has been repeatedly demonstrated (Christie and White 1997, Wamukota et al. 2012) though some studies have highlighted the limitations and challenges of bottom-up approaches to marine resource governance (Jones and Long 2021, Parker et al. 2024). LMMAs in particular have proliferated, with numerous well-established examples in the Indo-Pacific (Cinner et al. 2005, Jupiter et al. 2014, Rocliffe et al. 2014) and more recently in Madagascar (Harris 2011, Mayol 2013).

Madagascar is one of the world's least developed countries, being 164 out of 189 countries on the Human Development Index (HDI) (UNDP 2020) and failing to achieve a single Millennium Development Goal (Waeber et al. 2016). Nearly eight in ten people (77.6%) live below the international poverty line of $1.90 PPP, and, more than half of the population (57.1%) experience severe multidimensional poverty (UNDP 2020). The majority of the country's 27.7 million people (UNDESA 2020) live within 100km of the 5,500km coastline (EarthTrends 2003, Harris 2011). Accordingly, SSFs are critically important for food security, nutrition, livelihoods, and the economy (Le Manach et al. 2012, Barnes-Mauthe et al. 2013), with at least 100,000 fishers involved in SSFs (Le Manach et al. 2011). However, landings from SSFs have peaked and many fisheries are in decline (Sáenz-Arroyo et al. 2005, Le Manach et al. 2012, World Bank 2015). In response, Madagascar has committed to the Aichi Biodiversity Targets, aiming to conserve 15% of marine and coastal areas (Rabarison et al. 2016) in addition to its 2014 pledge to triple marine protected area coverage within 10 years (speech presented at the VIth World Parks Congress in Sydney by Hery Rajaonarimampianina, President of Madagascar). Concurrently, there has been a proliferation of LMMAs, with over 170 now spanning approximately 17,270km^2 (MIHARI 2020).

Madagascar's southern regions (Atsimo Andrefana, Androy, and Anosy) are home to 12% of the country's population (Healy 2018) and are the poorest part of the country, where 91% of the largely rural population live below the $1.90 PPP international poverty line (Healy 2018). Communities here are subject to multiple forms of deprivation including insufficient access to clean water, food insecurity and malnutrition, and high levels of child mortality (Healy 2018, European Commission 2021). These challenges are compounded in coastal communities, where few viable livelihoods exist due to a lack of access to education, transport infrastructure and suitable agricultural land (Healy 2018). The regional fishery for spiny lobsters has few barriers to entry, consequently, many coastal communities depend on this high-value export commodity for livelihoods, which contributes significantly to the regional economy (Long 2017, Long et al. 2021). The fishery consists of approximately 40 coastal communities in the Androy and Anosy regions, employing an estimated 15,000 people (MAEP 2004) and accounts for the majority of Madagascar's annual lobster catch and export (Sabatini et al. 2008). The limited available evidence suggests that the regional stock is in decline, following increased fishing pressure driven by population growth and high export demand (Long 2017, Sabatini et al. 2008, Holloway and Short 2014).

Since 2013, Project Oratsimba, led by British NGO SEED Madagascar (henceforth SEED), has sought to establish a replicable model for sustainable, community-based lobster fishery management in three communities, whilst promoting prosperity (Azafady 2014, Skinner et al. 2016, Darwin Intiative 2018). This has included the introduction of periodic No Take Zones (Long 2017) and esta-

blishing the 160km² Sainte Luce LMMA (Long et al. 2021). A barrier to effectively implementing and assessing this project, is a lack of detailed understanding of poverty within the target communities and the relative economic importance of marine resources.

This study uses the BNS to assess the prevalence of poverty within six coastal communities in southeast Madagascar, focussing on the relative importance of lobster fishing to household poverty alleviation. It evaluates the BNS approach as a practical methodology for resource-constrained organizations to measure poverty. The findings are intended to have direct applications for the management of marine and other natural resources and provide a reference point for assessing changes in household prosperity in relation to fisheries management interventions.

METHODS

The data presented here were collected as part of a larger survey undertaken during Project Oratsimba Phase III (Darwin Intiative 2018). The full survey methodology is described by Savage (2020a). Here, only the components of the survey relevant to the data presented in this study are described, the survey is provided in the supplementary material. Prior to research, permission was granted by the Direction Régional de l'Agriculture, de l'Élevage et de la Pêche (Regional Directorate of Agriculture, Livestock and Fisheries) and the *Chef Fokontany* (community elected leader) in each of the communities surveyed. Due to low levels of literacy, full informed consent was obtained verbally from participants in the presence of at least two members of the survey team. Participants were informed that participation was voluntary and were given the opportunity to ask questions. This study was undertaken in accordance with SEED's Human Research Code of Ethics.

STUDY SITE. Data were collected from six coastal communities, each consisting of one or more hamlets, in the Anosy region, southeast Madagascar (Figure 1). One community (Baie d'Italie) is located 30 km south of the regional capital Fort-Dauphin and the other communities are within 60 km north of Fort Dauphin (Taolagnaro). Three of these communities (Sainte Luce, Elodrato, Itapera) were intended beneficiaries of Project Oratsimba and have been subject to efforts to establish community-based lobster fishery management. The other three communities (Ambanihazo, Antsotso, Baie d'Italie) were selected for comparative purposes as they have not been subject to any externally supported community-based fisheries management initiatives. Prior to selection, the six communities were visited to confirm they were broadly similar in terms of size and demographics and thus suitable for comparison. The six communities are briefly characterised below, noting any socio-economic features, they are presented in order from north to south.

Antsotso. Antsotso is located next to the Route Nationale 12 (RN12) and consists of 12 small hamlets, at least six of which were identified as involved in lobster fishing by the *Chef Fokontany*. Maximum travel time to the fishery landing site is 1.5 hours by foot and canoe. None of the hamlets making up Antsotso are located at the landing site. Antsotso has had no previous experience with community-based fisheries management, although the community is aware of fisheries management measures in Sainte Luce. However, the community has had support from various NGOs in the past including a sea turtle conservation project in 2001–2002 led by SEED; the provision of education, water, and sanitation infrastructure by UNICEF; and forest conservation initiatives led by Asity Madagascar.

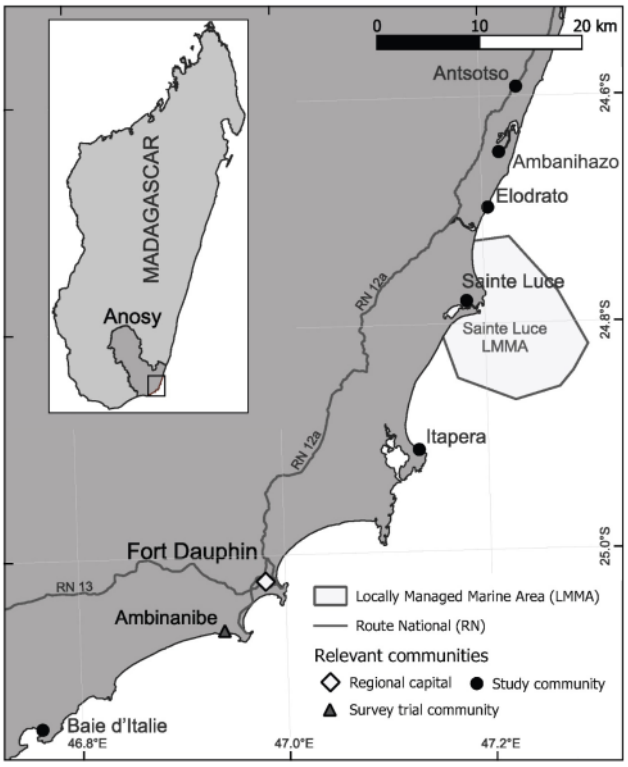

Figure 1. Study area showing relevant communities, major roads (Routes Nationales) and the Sainte Luce Locally Managed Marine Area (LMMA). (For graphical clarity watercourses, minor roads and constitute hamlets of study communities are not shown. Inset locator map shows Anosy region within Madagascar and the coverage of main map)

Ambanihazo. Ambanihazo is located along the Voendry river and the RN12, and consists of 11 small hamlets, with seven of these identified as involved in lobster fishing by the *Chef Fokontany*. Recent house fires in the largest hamlet in Ambanihazo, led the community to disperse and rebuild in several smaller hamlets. Maximum travel time to the landing site is two hours by foot and canoe. It is understood that the community tried to establish their own No Take Zone in 2015 driven by their perception of successes in Sainte Luce. The management measures introduced by the community reportedly did not persist due to a lack of community cooperation, an absence of external support (financial and technical) and difficulties with peer enforcement, replicating the enforcement model in Sainte Luce (Long 2017).

Elodrato. Elodrato was originally a farming community; however, cultural exchange and migration from Sainte Luce brought lobster fishing to this community (SEED Madagascar 2018). Fishers from five hamlets (Ebakika North, Ebakika South, Esohihy North, Esohihy South and Elodrato) use the same landing site (in Elodrato) and fishing grounds. For the purpose of fisheries management and this study, they are considered one fishing community, 'Elodrato'. Three of the hamlets are located along RN 12, whilst two are only accessible by foot. Travel time to the landing site from Ebakika South, the furthest of these five hamlets from the coast, is two hours by foot and canoe. Following the successes observed in Sainte Luce, Elodrato established their own No Take Zone in 2014 (Long 2017). However, the No Take Zone ceased operation due to a lack of formal governance structures and NGO support. In 2016 during Phase II, Project Oratsimba began informally supporting this community (Skinner et al. 2016). In 2018, Elodrato was formally incorporated into Project Oratsimba Phase III. At the time of this study, the beginning of Phase III, support focussed on forming the necessary conditions for LMMA establishment through meetings

with the *Chef Fokontany* and community and formation of a fisher's association. The surfacing of sections of road immediately north of Elodrato has been an ongoing source of employment and income for this community since 2015 (SEED Madagascar 2018).

Sainte Luce. Sainte Luce is the focal point of lobster fishing in the southeast (Sabatini et al. 2008). It is believed locally that lobster fishing in Anosy originated here in the 1960s (Charbonnier and Crosner 1961). Sainte Luce is comprised of three hamlets, with the largest located adjacent to the beach which serves as the principal landing site. SEED has been working with the community since 2000 on various conservation, health, and sustainable livelihoods projects. Since 2013, this has included Project Oratsimba, which was initiated in response to widespread community perceptions of declining lobster catches and resultant decreases in household income (Holloway and Short 2014). The project has supported the community to establish an LMMA with a periodic No Take Zone as the primary management measure, which has been operational since 2014. A detailed analysis of the governance of the LMMA is provided by Long et al. (2021). Short-term increases in catch per unit effort and the price fishers received were associated with No Take Zone openings (Long 2017). NGO (SEED) related activities and a luxury eco-lodge (which subsequently ceased operation in 2020) provide employment opportunities in this community. QMM (QIT Madagascar Minerals, a subsidiary of Rio Tinto) holds mining rights for areas adjacent to this community, with the intention of undertaking ilmenite mining here in the future (Smith et al. 2012, Hyde Roberts 2023). Exploration, planning, and mitigation activities associated with this have provided limited local employment (Holloway and Short 2014) and resulted in the introduction of protected areas of littoral forest (Temple et al. 2012). Community perceptions of the effects of mining activities in the region are largely negative (Zaehringer et al. 2024).

Itapera. Lobster fishing in Itapera is also thought to have begun in the 1960s (Charbonnier and Crosner 1961). Itapera consists of a single hamlet located on the coast at the landing site. Although located closest to Fort Dauphin, the community is somewhat isolated, as no part of it can be directly accessed by car. Itapera has a high proportion of migrant fishers from southwest Madagascar, of the Vezo ethnicity, who have been present since at least 2001 and possibly since the 1970s (SEED Madagascar 2018). The migrant fishers initially used free diving and gill nets targeting sharks and turtles. The settled migrant fishers have since become involved in lobster fishing, and this has caused ongoing tensions with residents about different fishing gear usage and access to fishing grounds. Itapera was also previously subjected to efforts to establish a marine protected area through the World Bank funded Projet Pôles Intégrés de Croissance (Integrated Growth Poles Project) (IAP 2014). Our understanding is this project was unsuccessful as the top-down approach was not widely accepted by the community. Similar to Elodrato, the success observed in Sainte Luce also catalysed the community to establish their own NTZ (Long 2017) and in 2016 Project Oratsimba Phase II began informally supporting the community (Skinner et al. 2016). In 2018, Itapera was formally incorporated into Project Oratsimba Phase III. A lack of cooperation within the community and mistrust of outsiders have been barriers to implementing any community-based fishery management measures with NGO support (Antilahy et al. 2020, Savage 2020b).

Baie d'Italie. Baie d'Italie is the only community surveyed located south of Fort Dauphin and consists of one hamlet located on the beach, which serves as the fishery's landing site. Despite the proximity to Fort Dauphin, this community is relatively isolated as unmaintained roads mean the community is not easily accessible by vehicle. The community has had no previous experience with community-based fishery management. This community has the least infrastructure in terms of health and education. Community members report this community receives little or no external support, from the state, NGOs, or similar.

SURVEY METHODOLOGY. The survey was conducted in January–March 2019. Prior to this, the survey was trialled in Ambinanibe, a small-scale lobster fishing community on the outskirts of Fort Dauphin, which has an established LMMA supported by NGO Aquatic Service. The trial survey was conducted with eight households to evaluate the suitability of the survey questions and refine the methodology. The survey was conducted in Malagasy, by translators with prior experience conducting socio-economic surveys in the region, ensuring functional translation from Malagasy to English. Data were recorded in English by SEED staff on smartphones (Android operating system) using the ODK Collect application (version 1.18.2, Hartung et al. 2010). The survey participant representing each household was the self-identified head of the household when available. Otherwise, another adult from the household who was present participated. Survey participants were asked questions to provide basic demographic information, details about livelihoods, and information needed to estimate poverty, using the BNS approach.

Sampling approach. The total survey hours were approximately evenly distributed among the lobster fishing hamlets within each of the six communities. Hamlets identified by the *Chef Fokontany* as not involved in lobster fishing were not surveyed, in line with the study's scope. Households were selected using a spinner to determine the travel direction and dice to determine the travel distance (in terms of the number of houses) to approximate randomness, starting from the centre of each hamlet. To control against the timing of gender specific activities and minimise gender bias, surveys were conducted from approximately 07:00 to 18:00. The sampling sought to ensure a similarly representative sample size from each community with a minimum of 10% of households in each community sampled. Beyond this threshold, the actual number of surveys conducted depended on the number of households available, travel time between hamlets, and events occurring within the communities.

Demographic data collection. Estimates of the population size for each community were obtained from the *Chef Fokontany*. Participants were asked to provide the total number of people living in their household along with the gender and ages of each member. Additionally, participants were asked if they were the head of the household, how many years of formal education they had received, and whether they were an active lobster fisher.

Livelihood data collection. Each household surveyed was asked to list all the livelihood activities that generated income for their household, specifically excluding activities solely for subsistence. Participants were then asked to rank the first and second most important activity in terms of household income. Following completion of the survey, the reported activities were standardised into nine groups of income-generating activities. This allowed the calculation of the mean number of income-generating activities per household. Participants were also explicitly asked about household participation in extractive resource use of conservation

concern (shark fishing, non-subsistence production/sale of charcoal, firewood or timber, mosquito net fishing and, bushmeat consumption).

Modified Basic Necessities Survey. In November and December 2018, before conducting the household surveys, two focus groups were held in each of the six communities, divided by gender. Participants were selected to represent a range of ages and household wealth. These focus groups were asked to identify potential basic necessities (assets and services), defined as "something all families should have and no family should live without" (Wilkie et al. 2015: 31). The resulting list contained 33 potential basic necessities, of which 29 were assets and four were services, which was then used in the household surveys, see supplementary material.

During each household survey, participants were shown picture cards representing each of the potential basic necessities in a random order. Picture cards were not used for services, which were instead verbally described. Participants were first asked if their household owned or had access to the item. They were then asked whether they considered the item a basic necessity in their community, i.e., whether it was something "all families should have and no family should live without" (Wilkie et al. 2015: 31).

The BNS score 'S' for each household was calculated per Equation 1:

$$S = \left(\frac{\sum(A \times B)}{\sum A}\right) \times 100$$

Where, any item that was identified as a basic necessity by less than 50% of households surveyed was excluded from the BNS score calculation i.e., not deemed a basic necessity. For each of the remaining items: i) a weighting 'A' was determined as the proportion of households identifying the item as a basic necessity; and ii) a binary score 'B' (one or zero) was given, according to whether they did or did not have access/ownership.

BNS scores can range from 0% to 100%. A score of 0% indicates a household experiencing extreme poverty, lacking access to or ownership of any basic necessities. In contrast, a score of 100% represents a household at or above the locally defined poverty line, with access to or ownership of all of the basic necessities (Wilkie et al. 2015). A diagrammatic overview of the BNS methodology is provided in the supplementary material.

STATISTICAL ANALYSIS. If participants were unable or chose not to provide an answer, those responses were excluded from the relevant analysis, which is reflected in reported sample size. Statistical analysis was performed in R version 3.6.2 (R Core Team 2020). Household BNS score was modelled using Generalised Linear Models (GLM) employing lobster fishing status (categorical, two levels) and community (categorical, six levels) as explanatory variables. The full model included both explanatory variables and the interaction between them. Stepwise model simplification was conducted using F-tests to determine the significance of dropped terms to produce a minimum adequate model. The resulting model contained both lobster fishing status and community. Post-hoc pairwise comparisons between variable levels were conducted using Tukey's test.

RESULTS

DEMOGRAPHIC DATA. A total of 553 households were surveyed. Household demographics in the communities were similar with regards to the proportion of the population below the age of 18 and over the age 65 and, the household size (Table 1). Notably, across all communities, household size was consistently larger in lobster fishing households compared to non-fishing households. There was some variation in the ages of survey participants representing each household, though median age was similar across communities. The level of education among survey participants was similar between communities, with the exception of Baie d'Italie, where nearly half of participants (48.5%) had no formal education.

INCOME-GENERATING ACTIVITY DATA. Lobster fishery-related activities (fishing or buying) were the most commonly practiced primary income-generating activity in all six communities. These activities were practiced by more than 50% of households in every community except for Elodrato (Figure 2). Eight households reported no participation in any income-generating activities, and 41 households reported relying on only one activity.

Most households participated in more than one income-generating activity, with the mean number of activities per household being 3.2 (± 1.3). The mean number of income-generating activities was higher for lobster fishing households (3.6 ± 1.1) compared to non-fishing households (2.1 ± 1.1), a trend observed across all communities (Table 2). In Baie d'Italie, Itapera, and Sainte Luce, fishing for other marine species was the most common secondary income-generating activity, practiced by more than 50% of households. In contrast, households in Ambanihazo, Antsotso, and Elodrato engaged in a more diverse range of secondary income-generating activities (Figure 3).

EXTRACTIVE RESOURCE USE OF CONSERVATION CONCERN. Of households surveyed, 69.3% participated in one or more extractive resource activities of conservation concern. In each community fishing for, or selling, shark fins and meat was the most widely practiced extractive resource activity of conservation concern and bushmeat hunting the least (Table 2).

BASIC NECESSITIES SURVEY DATA. A total of 22 items, out of an initial list of 33, were identified as basic necessities (by more than 50% of surveyed households). No household owned or had access to all 22 basic necessity items (Table 3). Therefore, all households had a BNS score less than 100.0% and can be considered as living below the locally defined poverty line. The vast majority of households, 87.3%, had a BNS score below 75.0% and were considered to be far from the locally defined poverty line, experiencing severe poverty. Mean household BNS score of all households surveyed was 60.3% (Table 4). In all communities, lobster fishing households had a significantly higher BNS score and thus were experiencing less severe poverty compared to non-fishing households ($F_{1,547}$=42.9, $p<0.001$). BNS score also varied significantly between communities ($F_{5,551}$=,11.5, $p<0.001$) (Figure 4). A post hoc Tukey test demonstrated that Baie d'Italie had a significantly lower BNS score compared to all other communities ($p<0.05$) and Itapera had a significantly lower BNS score compared to Sainte Luce ($p<0.05$). BNS score comparisons between the other four communities did not differ significantly ($p>0.05$).

Table 1. Demographic data from the household survey, disaggregated by community. (Amb = Ambanihazo, Ant = Antsotso, Bdl = Baie d'Italie, Elo = Elodrato, Ita = Itapera and StL = Sainte Luce; means are presented (± standard deviation); the sample size was n=533, unless otherwise stated; * As provided by the *Chef Fokontany* in each community; † Estimated from the ages reported at the household level; ‡ Includes participants with no years of formal education)

	Amb	Ant	Bdl	Elo	Ita	StL	ALL
Community-level							
Population*	2400	1500	1300	4200	1600	4800	15,800
Households surveyed	82	98	102	95	74	102	553
Est. population <18 (%)†	41.2	46.3	50.9	44.3	53.2	42.4	46.5
Est. population ≥ 65 (%)†	6.0	2.2	1.9	2.5	2.5	2.5	2.8
Household-level							
Mean household size all	4.4 (1.8)	4.7 (2.2)	5.1 (2.0)	4.6 (2.2)	5.9 (2.2)	5.1 (2.1)	4.9 (2.1)
Mean household size fishing	4.8 (1.7)	4.9 (2.2)	5.3 (1.9)	5.0 (2.4)	5.9 (2.2)	5.2 (2.1)	5.2 (2.1)
Mean household size non-fishing	3.9 (1.9)	3.9 (2.0)	3.9 (2.6)	4.1 (1.9)	5.5 (2.3)	4.3 (2.2)	4.1 (2.1)
Mean number of children <18	1.8 (1.3)	2.2 (1.5)	2.6 (1.7)	2.0 (1.6)	3.1 (1.6)	2.1 (1.5)	2.3 (1.6)
Mean number of adults ≥65	0.3 (0.5)	0.1 (0.3)	0.1 (0.4)	0.1 (0.4)	0.1 (0.4)	0.1 (0.4)	0.1 (0.4)
Participant-level							
Median age, n=551	34.5	34.0	37.0	31.0	32.5	35.0	34.0
Head of household (%)	63.4	61.2	61.8	51.6	71.6	53.9	60
Female (%)	51.2	53.1	54.9	62.1	41.9	57.8	54.1
Active lobster fisher (%)	36.6	42.9	44.1	26.3	54.1	40.2	40.3
No formal education (%) n=549	24.4	18.6	48.5	22.3	25.7	14.9	25.9
Mean years of formal education, n=549 ‡	3.9 (3.3)	4.2 (3.2)	1.8 (2.2)	3.9 (3.3)	3.2 (2.8)	4.4 (2.8)	3.6 (3.1)

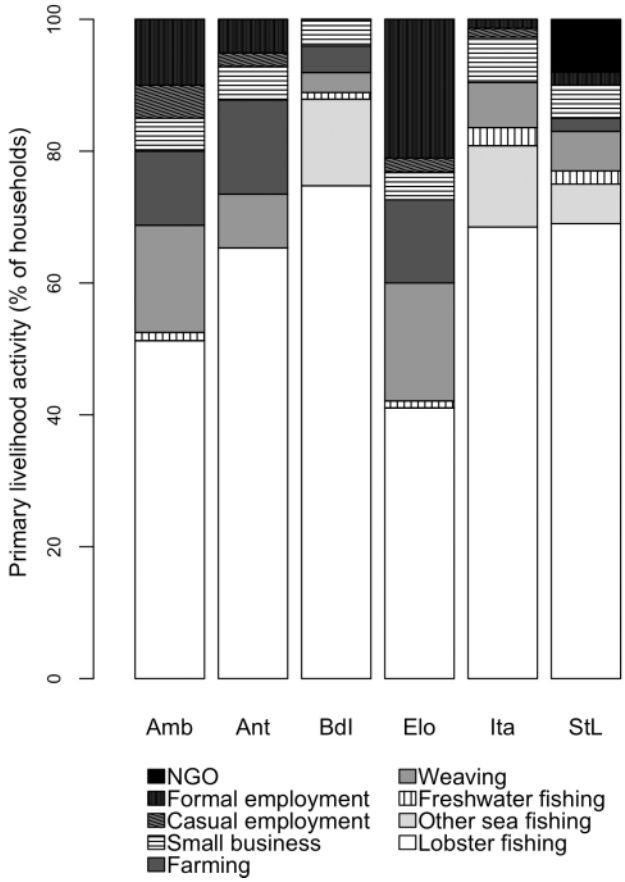

Figure 2. Primary income-generating activities of households disaggregated by community. (The category 'NGO' represents direct employment with NGOs and income gained through NGO initiatives such as selling products of women's co-operatives; household responses (n=545) were from: Amb = Ambanihazo, Ant = Antsotso, Bdl = Baie d'Italie, Elo = Elodrato, Ita = Itapera and StL = Sainte Luce)

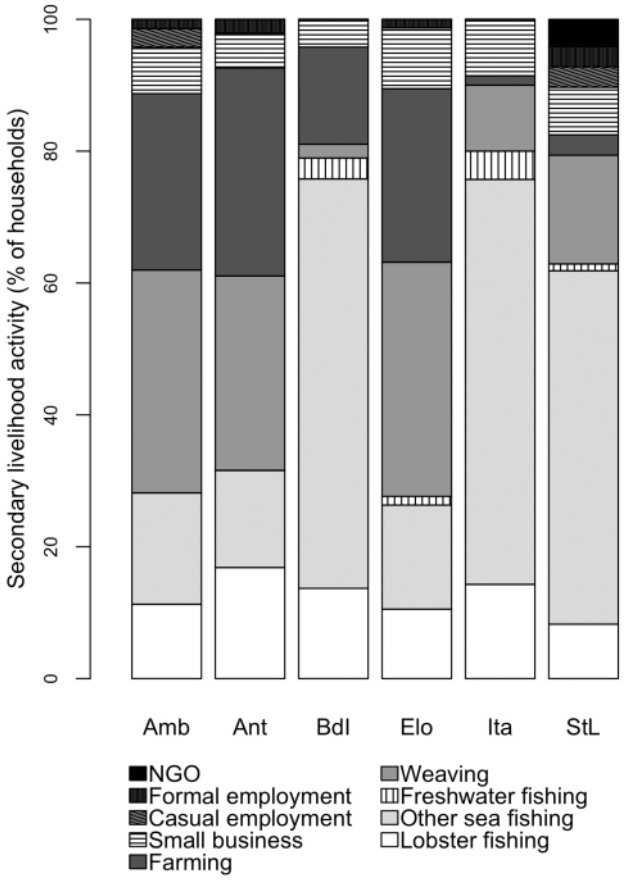

Figure 3. Secondary income-generating activity of households disaggregated by community. (The category 'NGO' represents direct employment with NGOs and income gained through NGO initiatives such as selling products of women's co-operatives; household responses (n=504) were from: Amb = Ambanihazo, Ant = Antsotso, Bdl = Baie d'Italie, Elo = Elodrato, Ita = Itapera and StL = Sainte Luce)

Table 2. Number of income-generating activities and participation rates for extractive activities of conservation concern, at the household level, disaggregated by community (n=553 for: Amb = Ambanihazo, Ant = Antsotso, Bdl = Baie d'Italie, Elo = Elodrato, Ita = Itapera and StL = Sainte Luce; means are presented (± standard deviation); * Primary purpose is for income generation; unsold catch will be used for subsistence; † Excludes for subsistence purposes)

	Amb	Ant	Bdl	Elo	Ita	StL	ALL
Number of livelihoods							
Mean number of livelihood activities per household	2.9 (1.3)	3.4 (1.0)	3.1 (1.4)	2.9 (1.3)	3.7 (1.2)	3.3 (1.4)	3.2 (1.3)
Mean number of livelihood activities per lobster fishing household	3.5 (1.1)	3.6 (0.9)	3.3 (1.2)	3.7 (1.6)	3.9 (1.0)	3.6 (1.3)	3.6 (1.1)
Mean number of livelihood activities per non-fishing household	2.0 (1.0)	2.3 (0.8	1.5 (1.3)	2.0 (1.7)	2.4 (1.4)	2.1 (1.2)	2.1 (1.1)
Participation rates for extractive activities of conservation concern (% of households)							
Shark fishery*	36.6	61.2	66.7	33.7	52.7	59.8	52.4
Production/sale of charcoal, firewood or timber†	17.1	41.8	34.3	22.1	31.1	35.3	30.7
Fishing with mosquito net*	22	32.7	33.3	18.9	45.9	42.2	32.4
Bushmeat consumption	3.7	7.1	0	3.2	4.1	5.9	4
One or more activities of conservation concern	48.8	73.5	84.3	47.4	81.1	78.4	69.3

Table 3. The 22 basic necessities items identified by participants across all communities from an initial list of 33. (Items are ordered by frequency of identification as a necessity. The percentage of households which had access to, or ownership of each item is shown, disaggregated by community (n=553) for: Amb = Ambanihazo, Ant = Antsotso, Bdl = Baie d'Italie, Elo = Elodrato, Ita = Itapera and StL = Sainte Luce; * Wooden lobster pots are commonly used as they are inexpensive and are handmade using locally available materials. In contrast metal lobster pots are used rarely for lobster fishing as they are expensive and not locally available and instead are used to store lobsters adjacent to the landing site prior to sale)

	Amb	Ant	Bdl	Elo	Ita	StL	ALL
Metal spoon	100.0	99.0	100.0	98.9	98.6	99.0	99.3
Cooking pot for rice	100.0	100.0	97.1	98.9	100.0	98.0	98.9
Tin plate	100.0	96.9	98.0	98.9	100.0	99.0	98.7
Mahampy mat, hand woven reed mat	98.8	99.0	97.1	97.9	97.3	99.0	98.2
Metal cooking tripod	98.8	100.0	84.3	93.7	93.2	99.0	94.8
Plastic bucket	96.3	99.0	78.4	96.8	94.6	98.0	93.7
Shoes	95.1	92.9	91.2	91.6	90.5	95.1	92.8
Fleece blanket	91.5	89.8	38.2	88.4	81.1	88.2	78.8
Lobster pot (wooden)*	63.4	81.6	83.3	51.6	79.7	73.5	72.3
Bed	73.2	60.2	30.4	71.6	60.8	78.4	62.0
Water well or tap in the community	11.0	40.8	99.0	42.1	91.9	81.4	61.7
Glass cup	76.8	75.5	29.4	67.4	40.5	74.5	60.9
Zebu, dry adapted indicine cattle (*Bos indicus*)	75.6	54.1	43.1	50.5	20.3	29.4	45.6
Radio	36.6	27.6	18.6	42.1	39.2	47.1	34.9
Antanosy pirogue, wooden dugout canoe	37.8	19.4	36.3	13.7	16.2	40.2	27.7
Life jacket	11.0	14.3	14.7	7.4	10.8	63.7	21.3
Money to send all children to primary school	35.4	34.7	13.8	18.9	12.2	13.7	21.3
Large cooking pot for celebrations	23.2	20.4	15.7	28.4	12.2	24.5	21.0
Money to visit a doctor	17.1	26.5	5.9	26.3	24.3	16.7	19.2
Enough money to be able to save money	22.0	25.5	2.9	25.3	24.3	16.7	19.0
Lobster pot (metal)*	31.7	22.4	8.8	10.5	10.8	8.8	15.2
Household latrine	0.0	1.0	0.0	1.1	0.0	4.9	1.3

Table 4. Mean Basic Necessities Survey score disaggregated according to whether the household derives income from lobster fishing or not. (n=553 for: Amb = Ambanihazo, Ant = Antsotso, Bdl = Baie d'Italie, Elo = Elodrato, Ita = Itapera and StL = Sainte Luce; means are presented (± standard deviation))

	Amb	Ant	Bdl	Elo	Ita	StL	ALL
All households	62.4 (11.8)	62.4 (13.0)	54.0 (13.0)	59.4 (12.3)	59.1 (11.8)	64.6 (11.2)	60.3 (12.7)
Lobster fishing households	66.2 (9.2)	63.4 (12.3)	55.6 (12.7)	62.0 (11.2)	60.8 (11.4)	65.7 (10.9)	62.0 (12.0)
Non-fishing households	56.6 (13.0)	58.2 (15.2)	43.0 (8.7)	56.2 (12.9)	51.1 (10.7)	58.9 (11.1)	55.2 (13.1)

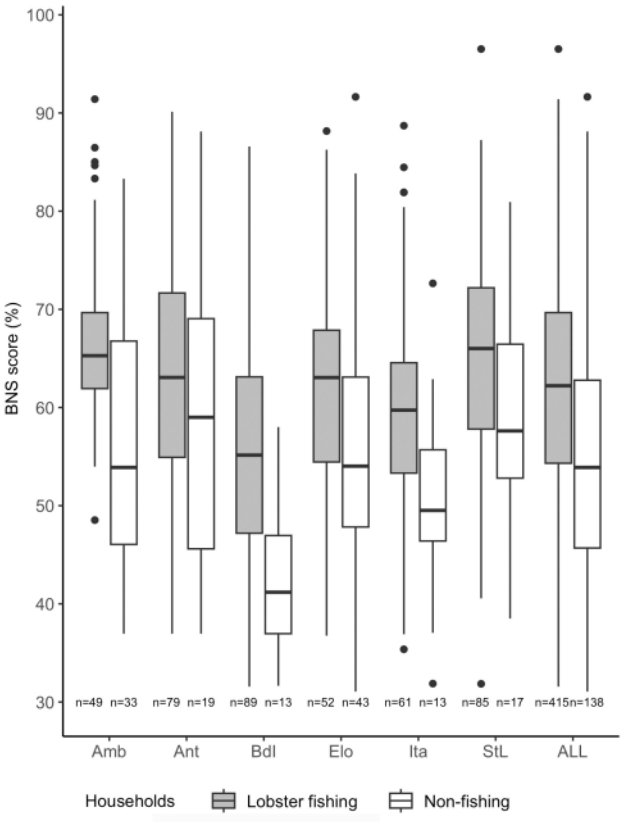

Figure 4. Boxplot showing the Basic Necessities Survey (BNS) score of households in six communities. (n=553 households disaggregated according to whether the household derives income from lobster fishing (grey) or not (white) for: Amb = Ambanihazo, Ant = Antsotso, Bdl = Baie d'Italie, Elo = Elodrato, Ita = Itapera and StL = Sainte Luce; the median (thick line) interquartile range (IQR, filled box) are shown; the range is indicated by whiskers (thin line) extending no more than 1.5 times the IQR, values beyond this are considered outliers and are drawn (filled circles))

DISCUSSION

CHOICE OF TERMINOLOGY. A challenge in the preparation of this work was the choice of terminology. When using terminology surrounding poverty, there is a danger that well-intentioned work can reinforce, rather than address, prevailing narratives, and promote a narrow perspective (Thomas et al. 2020) i.e., presenting Madagascar as a place defined by poverty. Madagascar is a rich, complex, and varied nation with many opportunities and challenges. Poverty is a situation, and it is not a defining characteristic of Madagascar, nor of its people. It is also important to note that a key contributor to many of the challenges facing Madagascar, including poverty, is the colonisation of Madagascar, theft of generational wealth, economic exploitation, and attempted severance of Malagasy people from traditional resource use and cultural practices by colonising nations (Kull 2000, Scales 2011). This historical and contemporary context must be recognised when speaking about poverty as a condition.

Within this context, rather than eliminating poverty, as per SDG 1, a more positive goal would be to go beyond that and promote prosperity, as defined by the cultures and values of people within a given nation. For these reasons, where appropriate, the term prosperity is deliberately used, when referring to levels of wealth more broadly, whilst poverty is used when referring specifically to multi-dimensional poverty, including as defined and measured by the BNS methodology. Nevertheless, this study seeks to specifically measure poverty.

POVERTY ASSESSMENT. No household had a BNS score of 100.0%, meaning every household surveyed was living below the context-specific poverty line, lacking access to one or more basic necessities. Few households had a score close to 100.0%, with the overall mean score being 60.3%. This means that a large majority of households lacked access to multiple assets and services deemed locally as basic necessities. Whilst almost all household had access to the most basic items (e.g., those required for

cooking), access to services (e.g., schooling and medical) and sanitation (latrines) was only available to a small minority of households. The absence of these key elements represents a serious impediment to development, as meaningful progress is unlikely when so few people have access to adequate education and healthcare. The assessed poverty levels are unsurprising given that 91.0% Madagascar's southern population live below the PPP $1.90 international poverty line (Healy 2018).

Poverty levels were broadly similar between communities, with the exception of Baie d'Italie which had a significantly lower BNS score and is therefore considered to be experiencing higher poverty levels. Comparatively, Baie d'Italie is less accessible by road, further from forest resources, is the only community located south of Fort Dauphin in the study and has had the least historical NGO presence, all of which could influence household poverty. Locally, Sainte Luce is perceived as the wealthiest community. However, poverty levels in Sainte Luce were comparable with the neighbouring fishing communities. This is perhaps surprising given the long history in Sainte Luce of NGO interventions, tourism opportunities and income associated with mining exploration (Kraemer 2012, Seagle 2012). However, there is no counterfactual to determine the level of poverty without the effect of these factors. It may be the case that the opportunities in Sainte Luce have supported the growth of the community (it is the largest of those surveyed) rather than increasing household wealth, or that income generated in Sainte Luce is shared with family members residing outside the community.

CONTRIBUTION OF LOBSTER FISHING TO HOUSEHOLD PROSPERITY. Lobster fishing households had a significantly higher BNS score (i.e., were more prosperous) in all six communities surveyed, demonstrating that lobster fishing plays an important role in in income generation in the region. Whilst there is limited travel infrastructure in this region, it is notable that lobster fishing households are participating in the international spiny lobster supply chain (Long et al. 2021). Although the income fishers receive at the first point of sale is low (~22,000 MGA/kg; 6.80 US$/kg (Long et al. 2021)), relative to the rest of the value-chain, the commodity remains one whose value is attached to lucrative international markets. This is an exception to almost all other potential livelihood activities in the surveyed communities, perhaps with the exception of limited opportunities for NGO or ecotourism related work. The comparatively high value of lobster thus explains the significant positive contribution of the fishery to household income and prosperity.

Fishing households practiced a more diverse range of income-generating activities, i.e., they had a higher mean number of income-generating activities. However, it is not clear whether a greater diversification of income-generating activities drives a higher BNS score, or whether the inclusion of lobster fishing specifically as one of those activities accounts for this difference in poverty levels. The comparatively high income-generating potential of lobster fishing as a livelihood points towards the latter; however, there may be other confounding factors. The broader literature demonstrates that factors determining the extent of rural livelihood diversification are varied, complex, and context-dependent (Ayana et al. 2021, Gebru et al. 2021). For example, in this context declines in catch per unit effort of lobsters may necessitate households employing other livelihood activities in addition to lobster fishing to maintain household income. Additionally, it is important to note lobster fishing households were larger than non-fishing households. It is plausible that larger households are able to engage in more income-generating activities, though a larger household does not necessarily signify the ability to participate in the lobster fishery. In addition, this study specifically assessed only income-generating livelihoods, excluding livelihoods carried out purely for subsistence. It is possible that non-fishing households may rely more highly on subsistence activities. Further studies may wish to investigate which factors drive the pursuit of lobster fishing as a livelihood. Nonetheless, the results highlight the need for effective sustainable management of the fishery and highlight the relative importance of lobster fishing for poverty alleviation and prosperity in southeast Madagascar.

IMPLICATIONS FOR THE MANAGEMENT OF THE LOBSTER FISHERY AND OTHER NATURAL RESOURCES. The income-generating potential of lobster fishing, as demonstrated in this study, explains the increasing effort observed in the regional fishery over the past decades (Long et al. 2021). With few barriers to entry —since all materials can be sourced locally and there are no restrictions on participation—lobster fishing has become critically important for these communities. This significance has implications for fisheries management, particularly in transitioning the fishery to a more sustainable model and enabling stock recovery. Management measures and NGO interventions should be carefully designed to avoid negatively impacting incomes, as this could lead to higher poverty levels. In practical terms, transitioning the fishery toward sustainability would require altering the value chain to ensure fishers can earn more by catching less (Long et al. 2021).

An alternative, or complementary approach is to support the diversification of livelihoods, to reduce the reliance on the lobster fishery and reduce total fishing effort. This is however extremely challenging in this context. Formal employment opportunities are limited, as is access to infrastructure for the movement of goods and people. This creates significant barriers to diversifying livelihoods and increasing income. Accordingly, communities remain isolated in terms of economic opportunities with the exception of their dependence on the lobster fishery and its export controlled by foreign companies (Holloway and Short 2014, Long et al. 2021). Additionally, strong empirical evidence of a link between diversified livelihoods and improved conservation outcomes within small-scale fisheries is sparse, with no guarantee that diversification will result in reduced fishing effort (Roscher et al. 2022). With the high levels of poverty observed in these communities, it is plausible that income derived from initiatives to support diverse livelihoods will be supplementary to fishing income, rather than replacing fishing income.

Collapse or further decline in the productivity of the lobster fishery would have knock-on effects on the status of other natural resources (Brashares et al. 2004). While behaviours such as bush meat harvesting and fishing of endangered sharks would be activities of concern in virtually all marine fisheries with proposed conservation interventions, they are of particularly notable concern within the local context and location. The littoral forest, which many coastal communities rely on for resources, is one of the most threatened ecosystems in Madagascar, having lost up to 90% of its original cover (Ganzhorn et al. 2001, Consiglio et al. 2006, Hyde Roberts 2023). Additionally, exceptionally high rates of flora and fauna across Madagascar are threatened with extinction (Myers et al. 2000, Waeber et al. 2015, Michielsen et al. 2023), in-

cluding 98% of all lemur species, a third of which are listed as Critically Endangered (IUCN 2020). While the collapse of the fishery would have demonstrated dire socioeconomic implications, onwards pressure on natural resources in the nearby significantly threatened areas would also increase. A limitation of the present study is utilising self-reporting to determine rates of extractive resource use of conservation concern. Some activities of conservation concern such as bush meat harvesting are illegal, and households may have underreported involvement.

BASIC NECESSITIES SURVEY AS A TOOL FOR MEASURING POVERTY. The practical and conceptual challenges of measuring poverty is recognised by both practitioners and academics, arising in part from its multi-dimensional nature and context dependency (see discussion in Flechtner 2021). In this study the BNS approach proved to be a practical, cost-effective solution to measuring poverty levels. It yielded a deeper understanding of levels of deprivation and prosperity, providing a more meaningful, context-specific portrait of poverty and its multidimensional nature, beyond a binary definition of above or below the international poverty line. It also allowed informative comparisons between communities. To monitor conservation and development interventions and their impact on prosperity, it is necessary to measure and track poverty levels within and between communities (Haughton and Khandker 2009). For a resource limited NGO, the BNS proved to be a simple but effective method to collect baseline data related to levels of poverty experienced by households and draw comparisons. Crucially, its relatively quick and inexpensive nature enabled its use within both limited capacity and budget, rendering it an accessible tool. This accessibility is a great strength, especially in response to concerns that the Global North monopolises research into poverty (e.g., Flechtner 2021). Furthermore, the methodology was minimally intrusive and time consuming for participants. It could be argued that the BNS is a means to democratise the measurement of poverty. Its accessibility means it can be widely employed by organisations, or individuals, with limited resource or technical capacity, facilitating research by a greater range of actors in a greater range of contexts.

As discussed in the above sections, measuring poverty using the BNS provided insights relevant to the management of natural resources and assessing conservation actions and their impacts on communities. This functionality has also been reported elsewhere where the BNS has, for example, been successfully used to assess poverty in relation to payment for ecosystem services (Clements and Milner-Gulland 2015); protected areas (Clements et al. 2014) and illegal activities (Wilfred et al. 2019).

The biggest practical challenge faced in conducting the BNS was the lack of direct translation for the phrase "basic necessity" into Malagasy Antanosy (the regional dialect), necessitating further discussion on the best translation for functional equivalence. Whilst the BNS did not require technical expertise, it did require extensive knowledge of the local context, particularly during the design of the basic necessities item list. It is therefore advisable for users of the BNS to work closely with people with expert knowledge of the local context in the design, testing, and delivery of the survey.

A more conceptual limitation arises from the reliance on the core concept of 'basic necessities'. Whilst the BNS by design measures multi-dimensional poverty, perhaps inevitably the phrase 'basic necessities' leads to a focus on tangible assets and services, especially when relying on translation. Broader conceptualisations of poverty include less tangible dimensions such as the opportunity to make choices, participate in social activities and freedom to express oneself. For example, refer to the 'capability approach' developed by Amartya Sen (cf. overview in Robeyns 2005), in which poverty can be viewed as the deprivation of capabilities. It should be recognised that such broader conceptualisations of poverty are not measured by the BNS approach.

The results presented here are consistent with other assessments of poverty (i.e., poverty is prevalent) that have been conducted: in the region, using the US$1.90 PPP international poverty line (cf. Healy 2018); and nationally employing multi-dimensional measures of poverty (e.g., HDI UNDP 2020). This concurrence provides confidence in the validity of the BNS approach, arriving at a similar conclusion but offering particular advantages in terms of depth of understanding and/or the practical merits of the methodology.

CONCLUSION

The BNS proved to be a practical and effective tool for measuring multidimensional poverty, highlighting the widespread poverty in the study area, where all surveyed households were below the context-specific poverty line and lacked access to basic necessities. The survey also highlighted the socio-economic importance of the lobster fishery, showing that households engaged in this activity were experiencing significantly lower levels of poverty. These findings have critical implications for conservation and development in the region, underscoring the need to support the sustainable management of marine resources, which are vital for these communities, while also addressing multidimensional poverty by improving access to basic goods and services. The BNS offers an accessible and powerful method for both practitioners and academics, to measure multidimensional poverty, enabling consistent monitoring and comparison over time and across different locations. We believe the BNS is an underutilised, resource-efficient tool with broad applications in conservation and development.

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SUPPLEMENTARY MATERIAL

Available online
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Household survey

Table S1. The 33 potential Basic Necessities Survey items used in household surveys (n=533). The percentage of households who identified each item as a basic necessity is shown for all communities aggregated and items are ordered by frequency of identification. Items shaded in grey were identified by less than 50.0% of participants and were excluded from subsequent analysis.

Figure S1. Diagrammatic overview of Basic Necessities Survey methodology.