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Trialling the use of smartphones as a tool to address gaps in small-scale fisheries catch data in southwest Madagascar

Victoria F. Jeffers[a,*], Frances Humber[a], Thierry Nohasiarivelo[a], Radonirina Botosoamananto[a], Lucy G. Anderson[b]

[a] Blue Ventures Conservation, 39-41 North Road, London N7 9DP, UK
[b] Bath, UK

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ABSTRACT

Worldwide, small-scale fisheries (SSFs) contribute over half of global fish and invertebrate catch and generate employment for 90% of those working in the fishing capture industry, the majority of whom live in developing countries. Despite their importance, most of the world's estimated 10,000 SSFs are data deficient. Community data is critical to understanding fish stocks, and evaluating fisheries management policies, particularly in remote areas. This pilot study explores the potential for smartphones and the Open Data Kit software to assist in the collection of shark landings data in southwest Madagascar, where sustainable fisheries management is critical to economic and food security. The pilot builds on a previous study of participatory data collection using paper notebooks (2003–2016), which continued in eight villages throughout the smartphone trial (2013–2016), allowing comparisons in speed, accuracy and user experience to be drawn. Initial challenges, which included limited electricity supplies to charge the smartphones; typing errors caused by wet hands; and interpretation difficulties, were overcome during the trial with additional training and data accuracy improved as a result, with only 5% fewer records recorded on phones vs. paper notebooks by 2015. One major challenge - limited mobile network coverage – often prevented data from being uploaded from phones to an online database, meaning manual data extraction was required, with associated travel costs. With appropriate training, smartphones show promise as a useful and accurate tool for participatory fisheries data collection. However, this method may be better suited to regions with stronger mobile coverage.

1. Introduction

Small scale fisheries (SSFs) are critically important to the nutritional and economic security of developing nations [1,2]. They contribute to over half of global fish and invertebrate catch in developing countries [3] and generate employment for 90% of the 120 million people working in the capture fishing industry [4], the vast majority of whom live in developing countries [2,5,6]. Yet effective catch information is lacking for most SSFs due to the remoteness of their landing sites, and the decentralised nature of their activities, posing a threat to their future sustainability, and hindering their potential to drive development and social change [2,7–9].

Stock assessments have only been conducted in a small fraction of the world's estimated 10,000 fisheries with 90% considered 'data poor' [10]. While the available data allow the Food and Agriculture Organization of the United Nations (FAO) to develop a broad picture of global fisheries catches, they often under-represent SSF contributions. This masks their influence and results in the under-reporting of historical peaks in fisheries production and under-estimates the severity of fisheries declines [1,11]. This data paucity can lead to the over-estimation of resource availability, influencing fisheries legislation and jeopardising sustainable fisheries management with consequences for livelihoods and food security [11,12].

Where fisheries are operating sustainably, a lack of quantitative evidence (as well as access to the necessary financial support) can limit access to certification schemes such as the Marine Stewardship Council (MSC) and associated market benefits [13]. To date, fewer than 10% of fisheries certified against the MSC Standard are small-scale and/or based in developing countries, with no small-scale fisheries yet certified in Africa [14].

The inland waters of Madagascar comprise one of the most diverse and extensive shallow marine habitats in the western Indian Ocean region. The small-scale fisheries operating within them are critically important to both the domestic economy and food security [12].

* Corresponding author.
E-mail address: victoria@blueventures.org (V.F. Jeffers).

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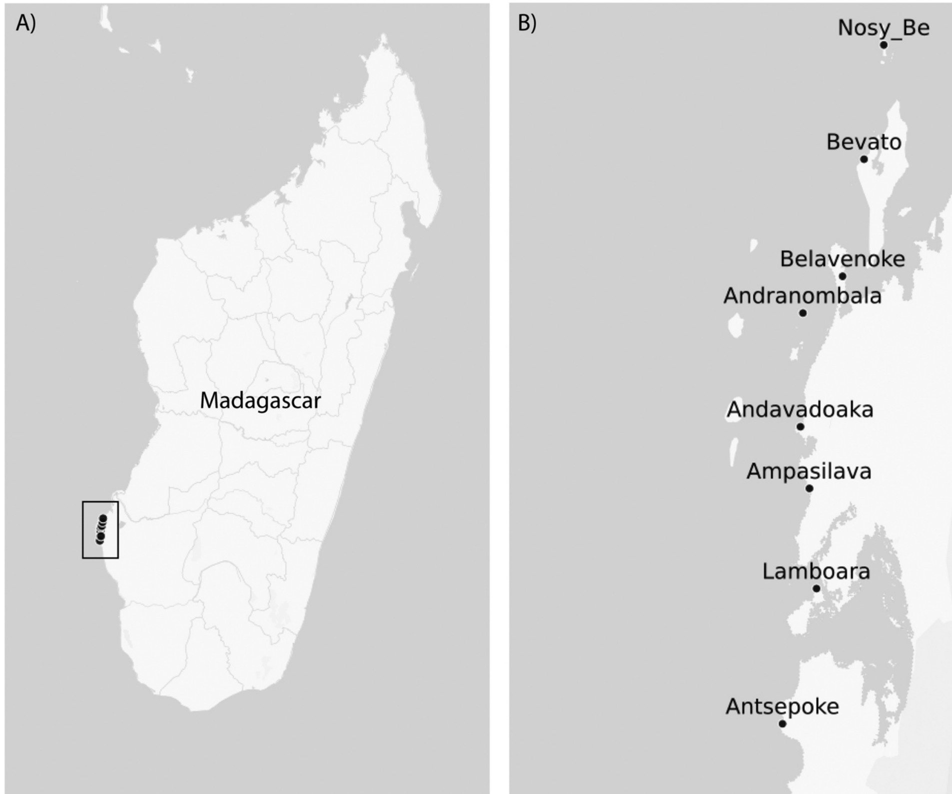

Fig. 1. Locations of the eight villages in southwest Madagascar within which smartphone data collection was piloted.

However, the country's 5500 km long coastline poses a logistical challenge to the collection of fisheries catch information. Actual total catches between 1950 and 2008 were estimated at twice the volume reported by the government of Madagascar to the FAO [12] and even now, detailed information on small-scale fishery catches are lacking for extensive lengths of the coastline. Innovative solutions for the collection of fisheries data are therefore urgently needed.

Since the early 2000s, mobile phone ownership has grown faster in Africa than anywhere else in the world with 83% of the population currently having mobile subscriptions [15,16]. Between 2017 and 2023, smartphone ownership in sub Saharan Africa is expected to increase by 158% [16]. Across the continent, the potential for mobile phones to be used as a tool to collect and share information across wide geographic scales is already being harnessed across healthcare [17] and agriculture [18]. For example, mobile phones have allowed community health workers to collect field-based data, disseminate health education messages and contact patients across remote settings, improving the delivery of health services [17].

The use of mobile phones in the small-scale fisheries sector shows promise. In West Africa and Sri Lanka, mobile phones are being used by fishing communities, and fisheries inspectors, respectively, to report cases of illegal, unregulated or unreported (IUU) fishing [19,20]. However, the use of mobile apps for fisheries catch landings is scarce, and freely available, modifiable, fisheries apps were not available at the start of this trial. Instead only consultancies offering their services to build bespoke apps, such as the *Hapi Fis Hapi Pipol*, developed by Point 97 to collect data from fish markets in the Solomon Islands [21] were on offer (private apps have subsequently been developed by the Smithsonian for use in Honduras and Belize). We therefore decided to test the feasibility of creating a data collection system based on freely available open software such as Open Data Kit (ODK; https://opendatakit.org/).

Coastal southwest Madagascar provides a valuable case study region to explore the feasibility of mobile phones, specifically smartphones, for the collection of small-scale fisheries landings data. Communities in this remote area are heavily reliant on small-scale fisheries: 87% of the adult population work as small-scale fishers; fishing accounts for 82% of household income and fish provides the sole protein source in 99% of all household meals [22]. Sustainable fisheries management is therefore critical to the future of the region's coastal communities.

The region also provides habitat for at least 81 recorded species of shark and ray and has an active shark fishery comprising artisanal and traditional fisheries in the southwest, though industrial fisheries operate elsewhere along the west coast, as well as in the region of the Mozambique Channel [23]. Sharks are targeted for the sale of fins (88% of sales) and meat (77% of sales) which are supplied to international markets, and as a source of food (31%) [23]. Yet despite the biodiversity, economic and social value of the region's shark populations, the country has no coherent and functioning legislation or conservation strategies in place to monitor their catches [23,24]. In this context, they are overexploited and anecdotal evidence shows that their populations are declining precipitously.

To address these data-deficiencies, a paper-based catch monitoring system was trialled across the Toliara province between 2007 and 2012. The study revealed that paper-based community participatory monitoring provided a valuable insight into the artisanal fisheries of Madagascar [24,25], but experienced a number of challenges. For example, paper-based records were lost, and significant lag times occurred between the collection of data, and its collation, analysis and subsequent availability to resource managers for decision making.

Table 1
Order in which the smartphone data collection trial was expanded across the region.

Year	Villages
2013	
May	Andavadoaka
Jun	Nosy Be
August	Antsepoke, Belavanoke, Lamboara, Andranombala
Nov	Bevato
2014	
Jul	Ampasilava

However, in 2012, southwest Madagascar saw an increase in mobile phone connectivity and the arrival of 2 G mobile internet, offering a unique opportunity to evaluate the effectiveness of mobile phones as a tool to address some of the previous challenges when collecting management information in small-scale fisheries, and to directly compare the use of smartphones with paper-based recording.

This study describes the implementation and evolution of a smartphone data-collection protocol in coastal southwest Madagascar; compares the accuracy, cost effectiveness and user experience of smartphones compared to paper records; and discusses the benefits and challenges experienced by data-collectors and the project team during a three-year pilot.

2. Methods

2.1. Study site

This study was conducted in eight villages (Andavadoaka, Antsepoke, Ampasilava, Andranambala, Bevato, Belavenoke, Lamboara and Nosy-Be) of the Velondriake region of southwest Madagascar. Approximately 150 km north of the regional capital of Toliara (Fig. 1). The region is home to one of the largest concentrations of traditional shark fishers [23]. The inhabitants of these coastal villages and islands are almost entirely Vezo fishers and their families, semi-nomadic fishers who rely exclusively on the marine environment for their livelihoods [26]. Fishers use pirogues (small sailing canoes) with gill nets, lines or spears, limiting most fishing effort to the nearby reef systems [23].

The villages were initially selected as part of an earlier study exploring the use of paper-based community shark monitoring between 2007 and 2012 [27]. Since 2012, community data collectors have continued paper-based monitoring in eight of the 10 villages closest to the village of Andavadoaka. The smartphone-based trial was established in 2013 and was conducted by the same data collectors in these eight villages.

2.2. Data collection

2.2.1. Participant selection

Thirteen community members were trained as paper- and smartphone-based data collectors in the eight villages by the end of the three years (2013–2016). Eight community members had already been trained to collect data using paper forms as part of an earlier study [27] and a further five were trained in 2014 to support the expansion of data collection to both paper forms and smartphones. Community members were selected based on their level of literacy (attended school, basic skills in reading and writing) and social status within each village: village elders or their relatives were often chosen as they were considered to be in the best position to enable a monitoring programme to be accepted by the village residents.

Each data collector was paid a base monthly salary of 15,000–25,000 (≈GBP£3.50–£7.00) Malagasy Ariary (MGA) and an additional 300 MGA (≈GBP£0.07) was given for each landed shark they recorded, which was then paid to the fisherman at the end of the month to compensate them for waiting while data were collected on their landings. The average daily wage in the region was < GBP£ 1.50 at the time [27] so this payment supplemented their regular income but was not enough to encourage fishing.

2.2.2. Paper-based monitoring (2013–2016)

Community members were supplied with a set of monitoring equipment (tape measure, camera, notebook/data sheets, pen, number and species cards) and attended an initial 1–2 h training session on how to collect each piece of data, how to use a measuring tape to measure catch, and how to use a simple digital camera to verify the data (full details of paper-based training are provided in [27]).

For each shark landed, the data collector in that village took a photo of the shark and completed a paper-based form with biological data: the species, total length (cm) and sex of the shark caught, as well as fishing data: method of capture, details of the gear (e.g. mesh size) fishing site, estimated time fishing and lead fisher name.

2.2.3. Smartphone monitoring (2013–2016)

Data were collected simultaneously via paper-based methods and smartphones to compare the relative merits and challenges of smartphones as a tool to facilitate community-led fisheries monitoring and a potential way to speed-up data collection, validation and analysis.

The smartphone element of the trial was rolled out to the eight villages in stages, due to the large distances between villages and the capacity of staff (Table 1). Data collectors in two villages (Andavadoaka and Nosy Be) were trained to input data into smartphones (Samsung Galaxy Pocket- GT S5301) during the first stage of the trial. This was extended to all eight villages (Andavadoaka, Antsepoke, Ampasilava, Andranambala, Bevato, Belavenoke, Lamboara and Nosy-Be; Fig. 1) by March 2014.

At the outset of the smartphone data-collection programme, many data collectors did not feel comfortable using smartphones and were wary of damaging the equipment. Therefore, in July 2013, participants attended a one-day workshop where they were trained in using ODK, as well as in basic smartphone operation including how to make and receive a phone call and load credit. Each village was then visited once a month by project staff to provide any additional training deemed necessary, to pay the data collectors, and to retrieve paper records and ODK records if limited internet had prevented it being sent remotely.

2.2.4. Selecting a smartphone data collection tool

The criteria for selecting suitable smartphone software included ease of maintenance (without the need for expert input), and the potential to be expanded across new sites and countries in future. As an open-source, freely available piece of software, Open Data Kit (ODK; https://opendatakit.org/), fulfilled both criteria as well as being simple for users with minimal prior experience of smartphone applications to learn. The ODK data collection system comprises three components: *ODK Collect*, an Android based application; *ODK Aggregate*, the server to store data; and *ODK Briefcase* a separate piece of software to assist with processing or sending data retrieved directly from devices. We used these as an off-the-shelf solution, building bespoke forms to sit within ODK Collect.

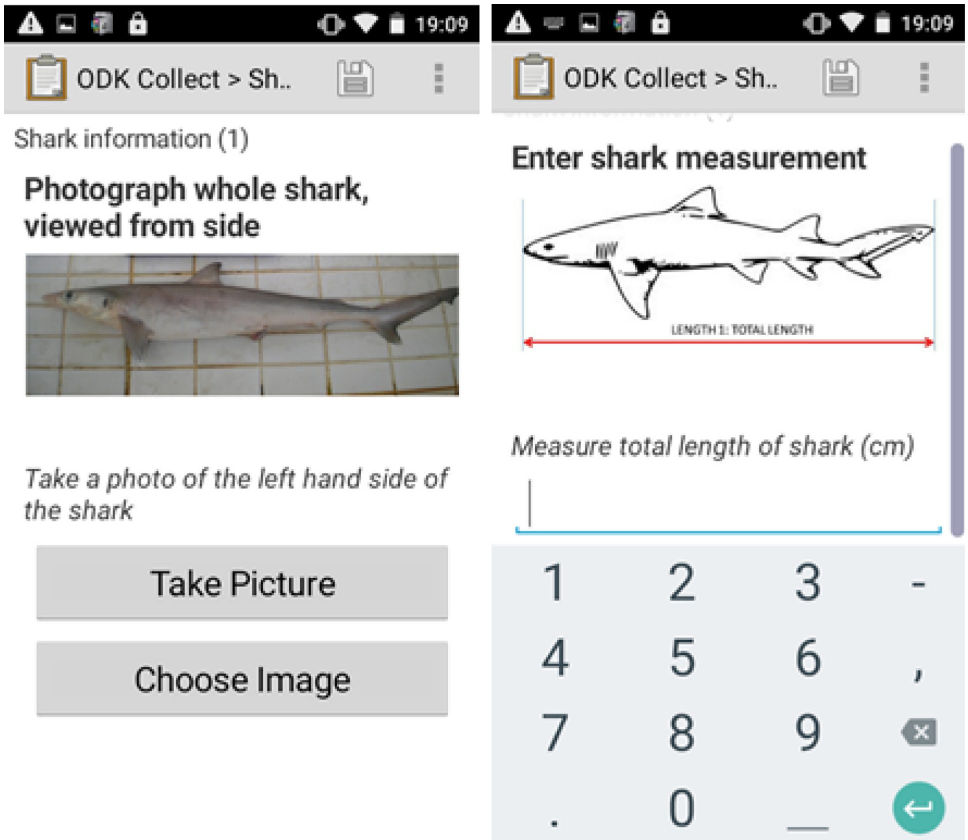

Fig. 2. Screenshot from the ODK form showing how shark length data was entered and verified.

2.2.5. *Evolution of the smartphone data collection form*

The first iteration of the ODK form was trialled in 2013, and a further 14 iterations of the form were tested over the following year. From November 2014 the same form was used to collect data across all villages (Fig. 2).

At each stage of development, user feedback was sought through informal discussions designed to gather feedback on user experience, and observations of participants entering data. These were carried out during monthly check-in meetings during 2014 and 2015.

Data collectors were also invited to two focus groups: the first in March 2015, after the form had been finalised and again in February 2016, allowing users to reflect on a year of smartphone use with the new form. The focus groups were designed to identify any benefits or challenges associated with smartphone-based data collection. All interviews and focus groups were conducted in Malagasy by the Project Coordinator and/or Assistant(s) and a translator.

2.2.6. *Data validation/verification*

Paper-based records were recorded on forms which were retrieved by project staff on a monthly basis. On return from the field-site, paper-based data were double-entered into a Microsoft Excel data form and verified by a staff member using a macro to highlight discrepancies between the two datasets. When discrepancies or duplicates were found, these were verified and corrected by cross-referencing with the original paper records and photographs.

Smartphone-based records were sent directly from the phone to an online database when mobile internet connectivity allowed, otherwise data were transferred from the phones onto the project laptop during monthly check-ins and later uploaded to the server using *ODK briefcase*. To prevent errors in data-entry using the smartphone-based ODK form, inbuilt validation checks were used, such as drop-down options for shark species, and constraints on integer entries. Shark images were also collected for both paper- and smartphone-based records to verify species IDs.

Spot-checks were conducted 1:1 by project assistants during monthly check-up meetings, to ensure data collectors were accurately recording landings, and to compare the accuracy of paper versus smartphone records. This involved spot checking some of the entries on the phone before they were sent to the server and a quick refresh training which included observing the data collector completing data forms in the phone to check for any difficulties (e.g. it was common for them to forget how to retrieve a half-completed form and instead re-enter the same data twice).

2.3. *Data analysis*

To compare the quality of smartphone vs. paper-based monitoring, data collected over the course of the trial were compared over two time periods: at the start of the smartphone trial once the initial form had been refined (June-Sept 2014); and later in the trial once the final version of the form had been used for 11 months (Oct 2015 - Jan 2016).

Records were compared by taking the records from the phone, trying to match this with the paper data and then comparing key, specific details between the two records for discrepancies. These were: date, fishing gear, fishing site, number of sharks, species and length measurement.

A cost-comparison was also calculated to compare the start-up and ongoing equipment, staff and data retrieval costs associated with the paper- and smartphone-based monitoring systems.

3. Results

Between November 2014 and September 2016, the 22-month period when the final version of form was used, 894 fishing trips and the

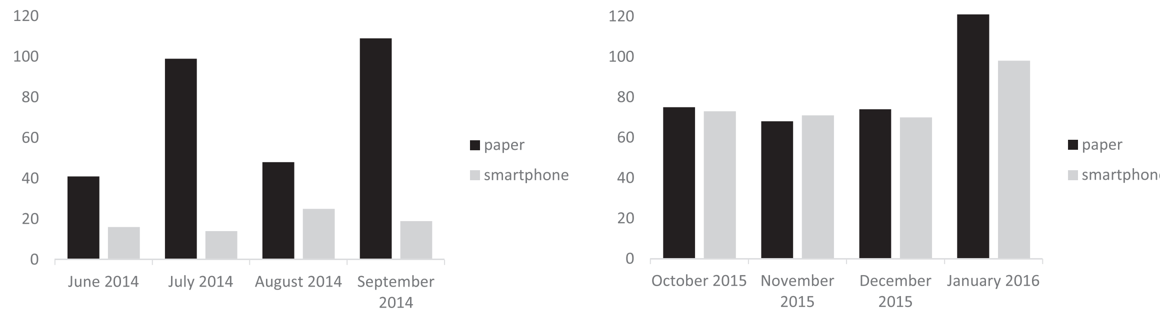

Fig. 3. Number of records collected via paper vs. smartphone over the course of the mobile phone trial. Left graph shows differences in the number of records collected immediately after the ODK form was finalised; right graph shows differences in the number of records collected once the final version of the smartphone form had been in place for a year.

details of 1548 sharks were recorded on the phones (compared to 1963 sharks in the paper forms), including 21 different species. Although smartphone accuracy and uptake was slow to begin with (78% difference between the two methods in July 2014), the number of records collected via smartphones increased over time, with little difference (5.3%) in the number of smartphone vs. paper records by October 2015 (Fig 3).

3.1. Challenges encountered by trial participants

Throughout the course of the smartphone trial, a series of challenges were encountered by data collectors and project staff. The solutions implemented to overcome each challenge, and the outcomes of those solutions area detailed in Table 2.

3.2. Comparing the relative accuracy of paper vs. smartphone data collection

From early in the trial, the accuracy of fishing gear, shark species and length data was similar between the two methods of data collection. However, there were some discrepancies between the two methods relating to dates, fishing sites and to a lesser extent the fishing gear used (Table 3).

3.3. Cost-comparison

Overall, assuming that data could be successfully sent via the mobile network after six months (and therefore no check-in visits would be required), data collection costs were slightly higher for smartphones

Table 2
Challenges encountered during the smartphone-based data collection trial, and solutions implemented to overcome them.

Theme	Challenge encountered	Solution to challenge	Outcome (where solution applied)
Infrastructure	Lack of phone/2 G signal, prevented or delayed data uploads, particularly images.	ODK Briefcase can be used where mobile data or Wi-Fi are not available and used to send data at a later date or pull data into a csv file offline.	Physical retrieval possible but removes some of the benefits of smartphone use. This issue would be avoided in areas of stronger mobile internet coverage.
	Unreliable electricity prevented regular phone charging.	Solar powered chargers distributed to data collectors instead of mains chargers.	Phones were able to be charged more frequently and batteries were less likely to be broken by unreliable currents, plus the light on the solar chargers was an added bonus.
Data entry	Data collectors reported typing errors and difficulties swiping between screens due to wet/dirty hands (having measured shark) when entering data.	Stylus introduced to allow data collectors to enter data more accurately.	Typing issues were quickly resolved through the use of a stylus.
	Long lists of fishing sites to choose from, slowing data entry.	Lists were filtered depending on the village selected.	Quicker to select the correct fishing sites, whilst still avoiding spelling mistakes.
	Participants struggled to interpret the 24-h clock.	Several different ways of asking for time were tested to find the best method to gather an estimate of fishing effort. Finally, users were asked to estimate the amount of time fishing, rather than focusing on times.	Forms were easier and faster to complete. Although users also struggled to estimate times accurately, this was deemed more reliable than using a clock entry system.
	Unrestricted text and number entry	Constraints on upper and lower limits added to numerical entry fields to limit mistakes. Lists added to other fields (e.g. data collector name) to improve consistency of data entry.	Obvious measurement and spelling mistakes were immediately avoided.
	Slow data entry, frustrating fishers who had landed the sharks. Multiple forms initially required completion where > 1 shark landed. Similarly, photos were initially requested for every shark.	The form was adapted allowing data on > 1 shark to be entered into the same form, under the same fishing trip. Once the common species were clear, photos were no longer required to be taken.	Sped up the process and reduced file size for storage on the ODK server and for sending data via phones directly to the server.
Interpretation	Photograph of sharks: images initially taken from wrong angle, preventing species ID.	Diagram was introduced to the form showing users how to measure a shark and giving examples of which angles to take pictures from. This was also part of each refresher training.	Less reliant on language. Clarity on simple measuring techniques.
	Photos initially required for all sharks, slowing the process.	Once main species were identified, photos were only requested for less common species.	Sped up the process and reduced file size for storage on the ODK server and for sending data via phones directly to the server.
Smartphones	Smartphones can break, particularly when used regularly in areas with sand/water.	Use high quality/weather resistant phones. Provide data collector with cases, boxes and silica gel packs and educate them about damage avoidance.	Very few broken phones during the lifetime of the project and problems were mostly battery (see above about electricity) or charging lead related.

Table 3
Percentage difference between paper records and smartphones showing an increase in similarity between the two. Note that the eighth and final village Ampasilava was added to the project in July 2014, accounting for the uplift in errors from August 2014.

Month	Percentage error between paper and smartphone data				
	Date	Fishing site	Fishing gear	Species	Length
June 2014	22.22	22.2	0	0	0
July 2014	0.00	0.00	0	0	0
Aug 2014	46.67	13.3	0	0	0.2
Sept 2014	5.88	5.9	0	0	0
Oct 2015	11.3	8.5	0	2.8	4.2
Nov 2015	22.4	1.5	20.9	1.5	0
Dec 2015	1.4	0	9.5	0	2.7
Jan 2016	1.1	1.1	4.6	0	2.3

(£463 per collector per year, including the set-up and equipment costs) compared to paper-based forms (£408 per collector) due to the initial investment in equipment (Table 4).

4. Discussion

Information on the status of SSF is critical to fisheries policy development, decision making and sustainable fisheries management, particularly in developing countries [6,28]. The participatory smartphone trial in southwest Madagascar has demonstrated the potential for smartphones to empower communities to help fill these data deficiencies that can mask inadequacies in SSF management [1,2,11] an issue particularly pertinent in shark fisheries [12,27].

The smartphone trial empowered communities to collect data on shark landings and demonstrates that with effective training and sufficient mobile infrastructure, coastal communities can collect accurate data, include images and GPS coordinates, and upload data to an online database to speed up analysis and subsequent adaptive management. These findings reinforce earlier studies which have demonstrated the potential for smartphones to assist in monitoring illegal, unreported and unregulated fishing [19,20]; map intertidal fishing grounds [29]; and mark the locations of static fishing gear and catch sites to aid navigation [30]. More recently, an app developed by the Smithsonian has helped to gather data on fisheries landings inHonduras and Belize, however to our knowledge this app is not yet publicly accessible for wider use [31]. More broadly, participatory data collection initiatives have empowered communities to manage their own resources [32,33]; greatly improved the accuracy of long-term fishing effort estimates [9]; and improved conservation decision making within communities [34,35].

Although it was not possible to directly compare the relative accuracy of paper and smartphones, results show that the biggest discrepancies in data between the two input methods related to dates and fishing site names. ODK uses inbuilt verification tools which can immediately limit known errors in the input of dates and measurements (e.g. shark length) by ensuring that they fall within a pre-defined date/length range. Similarly, users can select fishing sites from a smartphone list, preventing poor handwriting leading to inaccurate information. However, had more complicated information been required, data entry into smartphones could have become complex and slower than handwriting.

Given that most of the data collectors had never used smartphones before the pilot began, extensive training was required to equip them with the necessary skills and confidence to use smartphones, as well as to collect accurate data using the ODK form. Smartphone uptake was slow initially but the quantity of data entered was comparable with paper notebooks towards the end of the pilot. Initial difficulties experienced by users included difficulty using smartphone cameras and errors inputting data via unfamiliar touch screens with wet hands, or in bright sunlight. This caused spelling errors, a slow speed of data entry

Table 4
Cost comparison between paper notebook and smartphone data collection, including both initial set up and on-going costs, based on 13 data collectors. All costs provided in GBP. Annual smartphone costs assume data cannot be sent via mobile network until after the first six months, and therefore includes six months' worth of in-person visits for manual data download and collection.

			Smartphone costs (£)			Paper-based costs (£)		
			Initial investment costs	Ongoing monthly costs	Annual total (per data collector)****	Initial investment costs	Ongoing monthly costs	Annual total (per data based on 1 collector)
Costs per collector	**Equipment set-up costs**	Phone	40	–	40	–	–	0
		Solar charger, leads and waterproof case	62	–	62	–	–	0
		SIM cards	1	–	1	–	–	0
		Pens, paper, folder, tape measure, laminated cards	4	–	4	4	4	4
	Monthly costs	Notebooks/paper (@ 0.4)	0.3	0.3	1.8	0.3	0.3	4.8
		Phone credit	0.4	0.4	4.8	–	–	0
Overheads		Data collector	5.6	5.6	67	5.6	5.6	67
		Project staff*	250	250	231	250	250	231
	Data entry and retrieval costs	Logistical costs**	67	67	31	67	67	62
		Data entry staff costs***	0	0.1	0.6	0	0.1	1.2
Total			430.3	323.4	443.2	71	327	408

* Yearly staff costs do not necessarily scale proportionally with number of data collectors, for an approximate figure the yearly cost of GBP £ 3000 has been divided by 13 data collectors.
** Based on visits to data collectors in 8 sites @ GBP £ 67 per month and only for the first 6 months for phone users.
*** Based on per line of data cost for average of 25 sharks per month.
**** Based in data being entered into phones only after 6 months.

and inconsistent photography of sharks, prompting frustration in the waiting shark fishers whose catch was being recorded. However, all of these initial issues were overcome through regular training and the adaptations to the form made throughout the trial.

Smartphones inevitably have higher set up expenses – the phones themselves, solar chargers and mobile phone credit – than paper notebooks. Yet by enabling data to be remotely uploaded to an online database, there is potential to reduce the time and cost of data retrieval and analysis, relative to paper-based methods, allowing data to inform adaptive management [28]. Lamentably, this long-term cost efficiency was not realised during this smartphone trial due to unreliable mobile phone coverage, preventing landings data from reliably being uploaded remotely and so regular data collection visits were still required. The significant time demand on NGO staff has been experienced in comparable participatory data collection projects in East Africa in the short-term [29]. Although some costs could be mitigated in regions of higher mobile phone connectivity allowing remote data uploads, and remote training and issue-resolution to be provided (e.g. via Skype), as well as by training community ODK 'champions' who can support new users, there may always be a need for an expert to be on hand to ensure any such project runs smoothly [29].

There is also an opportunity cost associated with community participation in data-collection, where community members are taking time away from income generation activities such as fishing to collect data [29]. In this pilot study, financial incentives were provided to data collectors, and also to fishers who waited for data to be collected from their landings, yet this has historically encouraged falsified data, though the use of photographic evidence to accompany landings data has deterred this behaviour [27]. Whether such schemes could be effective on a larger scale, on a longer-term basis without frequent project staff intervention or payment remains unclear. Options being trialled elsewhere include community-funded initiatives whereby funds or resources (such as food rations) from a central community management association are used to compensate community data collectors (e.g. OurSeaOurLife project, Mozambique).

Participatory data collection offers a means of empowering community members to monitor and co-manage fisheries, bridging formal ad traditional governance [29,33,36]. This is particularly pertinent given the recent implementation of the Voluntary Guidelines for Securing Sustainable Small-scale Fisheries in the Context of Food Security and Poverty Eradication [37], developed mainly by the FAO. The guidelines focus on empowering fishers to co-manage their resources, transforming unequal dynamics [37], a movement that can only be supported by the use of affordable monitoring equipment like smartphones [38]. In addition to gaining increased ownership of resources by participating in data collection, smartphones also offered some additional social benefits to community data collectors in this trial. For example, data collectors developed skills in smartphone use, an ability to contact their families, to listen to music, take photographs, and to record videos, their own voice or their children's voices (pers comm. Thierry Nohasiarivelo). Studies of rural communities in Tanzania and India have shown the benefits of mobile phone use in improving social networks, maintaining relationships between fishers/farmers and traders, the prevention of unnecessary travel, and an increased ability to respond to emergencies [32,39].

The ODK system is also now being trialled more extensively, to monitor broader fisheries landings in other parts of the world including East Africa and Timor-Leste. There, improved mobile phone signal may provide significant efficiencies in cost and time. The improved version of the ODK Collect app now allows data collectors to more easily view sent data and portable projectors are also being trialled so that data summaries can be shared more easily with village committees and used to inform and improve fisheries management planning. This downstream use of the smartphone data will also be evaluated so that its potential use in adaptive fisheries management can be explored.

This pilot study has provided an important proof of concept of the use of ODK and smartphones to gather data on small-scale fishery landings. Despite the challenges described, lessons learned from the pilot have already catalysed improvements. For example, the monitoring protocols were effective in collecting data on shark landings and the methods are being used to develop a global Rapid Assessment Toolkit [40] which aims to help countries acquire and analyse critical data on endangered shark populations.

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Declarations of interest

None.

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