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Addressing Marine Wildlife Entanglement in Derelict Fishing Nets Using Community-Based Social Marketing: Case Study and Lessons Learnt

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Abstract

Background: Entanglement of marine species, particularly endangered sea turtles and cetaceans, in abandoned, lost or otherwise discarded fishing gear is a major conservation concern.
Focus of the Article: This case study applies Community-Based Social Marketing (CBSM) to reduce marine wildlife net entanglement in the waters surrounding Masirah Island, a marine biodiversity hotspot in Oman.
Importance to the Social Marketing Field: The study demonstrates the use of social marketing tools in biodiversity conservation, bringing new knowledge to the cross-application of these two fields.
Methods: The CBSM methodology was applied to select behaviours, identify barriers and benefits, develop strategies and design a pilot study. The responsible disposal of derelict nets in skip bins was selected as the target behaviour, and a mix of behavioural change tools was applied to achieve change: convenience (installation of three skip bins), education (installation of informative signs, distribution of awareness posters, one-to-one engagement with fishers on the beaches), prompts (installation of signs and posters on vessels) and social norms (one-to-one engagement with key influencers and decision makers). The monitoring of behaviour change took place through structured observations over 23 weeks, focussing on the number of nets disposed of in the allocated skip bins.

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Results: Results showed a low level of behaviour adoption rate by skiff and launch vessel fisheries, respectively, 5.36% and 2.58%. Positive results were observed for a short time but did not reach the estimated target value throughout the study period.
Recommendations for Research: Our pilot study did not lead to broad-scale implementation and we recommend further awareness and engagement with the target audience, trials of various behaviour change tools and increase field monitoring time. We further recommend the application and funding of behaviour change methods applied to fishers with the incorporation of conventional financial, conservation and regulatory tools to support resource management.
Limitations: Our results show that focussing on specific behaviours with appropriate measurement is both resource and time demanding to solve pressing conservation problems, particularly ones generated by complex industries such as fishing. Various lessons, useful for other social marketers, have been drawn from our evaluation of the overall study.

Keywords
community-based social marketing, net entanglement, marine wildlife, Oman, behaviour change

Introduction

The Environment Society of Oman (ESO) is a charitable organisation in the Sultanate of Oman that promotes biodiversity conservation and environmental awareness since 2004. Long-term collaborative conservation programmes were established in response to significant anthropogenic threats and conventional conservation tools were used to bring about change (ESO, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018; Rare and The Behavioural Insights Team, 2019), somehow neglecting the human dimensions.

Funding was secured in 2018 in an attempt to apply novel techniques from the field of conservation psychology. The study focused on the application of Community-Based Social Marketing (CBSM) to influence fishers' behaviour towards a pressing conservation issue: entanglement of marine species in derelict fishing nets on the beaches and in the waters adjacent to Masirah Island. The island is situated approximately 13 km off the east coast of the Sultanate of Oman in the Indian Ocean and has one of the largest nesting grounds of loggerhead sea turtles (*Caretta caretta*) (Baldwin, 2003; Ross and Barwani, 1982; Tucker et al., 2018; Willson et al., 2020) and various marine mammals in its coastal environment (Minton et al., 2011).

Background and Literature

The Sultanate of Oman has 3165 km of coastline and artisanal fisheries represent the largest volume of contemporary fishing (99.1%) (MAF, 2018). This industry provides the main economic activity of many rural coastal communities (World Bank, 2015). Rapid growth in the fisheries sector since the establishment of the modern state in 1970, brought modernised fishing techniques and inflicted significant environmental impacts due to the exponential increase in catch, notably: overfishing in coastal areas, increased levels of bycatch, habitat degradation, use of destructive fishing methods and gear loss (Al-Jufaili et al., 1999; Al-Masroori, 2008; Al-Masroori, et al., 2004, 2009; Al-Oufi, 2002; Al-Shuely, 1998; Claereboudt, 2004, 2019; Hare, 1990; Hongskul, 1999; Minton et al., 2011; World Bank, 2015). These issues remain persistent to date and major concerns exist regarding fisheries interactions with marine mega-fauna in the Northern Indian Ocean, particularly sea turtle and

cetacean populations (Anderson et al., 2020; Brownell et al., 2019; Stelfox, Hudgins, & Sweet, 2016; Tiwari et al., 2015; Wallace et al., 2011; Willson et al., 2020).

Fishing gear becomes abandoned, lost or otherwise discarded (ALDFG) when the fisher loses control of the equipment (Macfadyen Huntington, & Cappell, 2009; Stelfox et al., 2016). ALDFG belongs to the larger family of ghost gear, and its impact on the environment includes the abundant catch of non-target species from a range of taxa, physical impacts on the benthos, introduction of synthetic material into the marine food web, and ingestion and entanglement by marine wildlife (Brown and Macfadyen, 2007; Huntington, 2016; Laist, 1997; Macfadyen et al., 2009; Matsuoka, Nakashima, & Nagasawa, 2005; Stelfox et al., 2016). ALDFG also presents entanglement obstacles on beaches for both nesting sea turtles and hatchlings (Stelfox et al., 2016).

A global ghost gear review in 2016 recorded that reptiles accounted for 27% of all animals entangled and marine mammals for 70% (Stelfox et al., 2016). In Oman, a study on ghost fishing from traps estimated an annual loss of around 15,390 traps, equivalent to around 18 traps/fisher/year and resulting in an annual loss of US$ 2.63 million to the local economy (Al-Masroori et al., 2004, 2009). This number is equivalent to 2.1% of the total landing value of the Omani fishery in 2006 (Al-Masroori et al., 2009). We note that the Ministry of Agriculture, Fisheries and Water Resources is working towards mitigating the impact of fisheries on the marine environment by introducing a new law to ban catch use of cetaceans, and has already issued regulations on the use of drift gillnets (Ministry of Agriculture, Fisheries and Water Resources [MAF], 2019a, 2019b).

On Masirah, fishing is one of the largest employment sectors and engages most families from the island's resident population of 10,000. The local fleet comprises of over 38 'launches' (>12–32 m) and 1647 'skiffs' (5–9 m) (MAF, 2018). The fishing community actively uses the turtle nesting beaches for boat landing, gear storage and offloading catch. This is of particular concern as the island hosts a large loggerhead sea turtle (*C. caretta)* nesting rookery, that represents 35% of the global nesting population (Casale, 2015; Tucker et al., 2018; Willson et al., 2020). A long-term two-point trend assessment of this population revealed a 79% decline over a 20 year period (1985–1996 and 2008–2016) and concluded that the decline was most likely to be linked to repeated threats at sea and on the nesting beaches (Willson et al., 2020).

Marine entanglement records remain unpublished and anecdotal on a national scale. Despite the lack of formal records, evidence collected in the field implies that entanglement in fishing gear is a significant threat to marine species both on beaches and at sea (ESO, 2013, 2018). Here we present the findings of a behaviour change pilot study using CBSM to encourage the responsible disposal of nets by fishers, where the overarching goal is to reduce marine wildlife net entanglement on and around Masirah Island.

Method

Community-Based Social Marketing (CBSM) is a recognised tool to address global environmental issues and promote sustainable behaviour (McKenzie-Mohr and Schultz, 2014; Schultz, 2011). The five step CBSM methodology which consists of (i) behaviour selection, (ii) identification of barriers and benefits, (iii) strategy development, (iv) piloting and (v) broad-scale implementation (McKenzie-Mohr, 2011; McKenzie-Mohr and Schultz, 2014) has been adopted within our case study. In the third step (strategy development) recognised social science tools such as commitment, social norms, social diffusion, prompts, communication, incentives or convenience are selected to foster behaviour change (McKenzie-Mohr, 2011; McKenzie-Mohr and Schultz, 2014). Our target audience consists of middle-aged males: (i) contracted foreign fishing labour, (ii) local Masirah fishers and (iii) owners of fishing vessels operating from the island.

Step 1: Selection of End-State and Non-Divisible Behaviour

Table 1. Data Collection Methods Used for Audience Research, and for Determining Impact, Probability and Penetration of Selected Behaviours.

Data Collection Method	Detail	IPP Use
Review of unpublished and anecdotal information on marine entanglement records	Entanglement incidents are frequently reported through local mobile phone communication groups (notably *WhatsApp* Stranding Group of Oman) and email groups (Arabian Sea Whale Network)	Impact
Expert consultation	Consultation of expert team (consisting of fisheries academics, experts and governmental representatives) took place in both Muscat and Masirah	Impact, probability and penetration
Literature review	Rigorous review of local and global literature relevant to the impact of fisheries on marine species, with an emphasis on behaviour change and community-based fisheries initiatives	Impact and probability
Audience surveys	Review of past fishers questionnaire surveys on Masirah Island as part of ESO community-based fisheries projects in 2014 and 2017 (N = 100). Completion of new fishers questionnaires aiming to understand the fishing landscape and current fisher behaviours with regards to net disposal (N = 23)	Probability and penetration
Review of past observations	Unpublished data from conservation work (monitoring and community-based fisheries project) completed by ESO and other collaborators on the turtle nesting beaches of Masirah since 2008	Penetration

ESO, Environment Society of Oman.

A desk-based review of behaviours that reduce wildlife net entanglement both on land and at sea was generated by a group of conservation and marine professionals. These comprised both end-state (behaviour producing a desired outcome) and non-divisible (behaviour that cannot be further divided) behaviours. Four behaviours directly related to the actions of fishers were identified: (1) the responsible disposal of derelict fishing nets, (2) the responsible storage of derelict fishing nets on beaches, (3) the storage of derelict fishing gear on vessels for on-shore responsible disposal and (4) the recovery of derelict fishing gear at sea. A derelict net is defined as one in poor condition that can no longer be used. Methods for data collection (summarised in Table 1) included review of unpublished and anecdotal information of marine entanglement records, expert consultation, literature review, review of past and current audience surveys and behaviour observations.

Selected behaviours were then analysed according to the three characteristics of Impact, Probability and Penetration (IPP) within the target audience. A score was attributed to each IPP characteristic and a weight was calculated by applying the formula below (Table 2)

$$\text{Weight} = \text{Impact} \times \text{Probability} \times \text{Penetration}$$

The ideal behaviour represents the highest of weighting metrics associated with high impact, high probability and low penetration (McKenzie-Mohr, 2011). The ‘responsible disposal of

Table 2. Scoring Associated to the Impact, Probability and Penetration of the Selected Behaviour Within the Target Audience.

Characteristic	Aim	Score
Impact	Determine how impactful the behaviour is	0 = No impact 4 = Significant impact
Probability	Determine the probability of engaging in the behaviour	0 = No likelihood 4 = High likelihood
Penetration	Assess the level the behaviour is currently obtained within the audience	.00 = Behaviour not obtained 1.00 = Behaviour already obtained

derelict fishing nets' was adopted as the target behaviour for the project, scoring the highest weight (2.4) and showing high levels of impact and probability (3 and 4, respectively), and a relatively low penetration (0.2) (Table 3).

Step 2: Identifying Barriers and Benefits of the Target Behaviour

To identify the barriers and benefits the audience might face in adopting the selected behaviour, we completed a literature review, made behaviour observations and organised a focus group meeting. These methods are also summarised in Table 1.

Literature Review and Behaviour Observations

Various studies describe community fisheries projects promoting change and sustainable fishing practices (Food and Agriculture Organization of the United Nations, 2010; Gerosa and Casale, 1999; Gutiérrez, Hilborn, & Defeo, 2011; Lopes, 2011; Salas and Gaertner, 2004). However, no specific study was found addressing the issue of responsible net disposal using behaviour change tools. Regular disposal of ALDFG on the nesting beaches has been observed and confirmed by the presence of five members of ESO staff on Masirah, and by the cumulative knowledge gained from ESO's conservation projects on the island since 2008 (ESO, 2016, 2017, 2018).

Focus Group

The focus group was held in Muscat with the participation of fisheries academics, marine conservation professionals and government representatives. These experts assisted in the behaviour selection and the identification of the perceived barriers and benefits towards its adoption by the target audience.

Throughout the focus group, the barriers identified to hinder the responsible disposal of derelict fishing nets were structural/external (physical difficulty and lack of access) and motivational/internal (lack of knowledge, motivation and perception). The benefits to promote the adoption of the behaviour were identified as external (social approval, environmental protection, community improvement) and internal (sense of achievement, personal benefits, sense of stewardship of their future and livelihood). A summary of the identified barriers and benefits is given in Table 4.

Step 3: Strategy Development

Application of Customised Strategies

Authors drew from CBSM and social marketing literature together with benefits and barriers identified by the focus group in the design of an effective strategy. Four interventions were selected

Table 3. Calculating Weights of Selected Behaviours Aimed to Reduce Wildlife Entanglement in Fishing Nets.

No	Behaviour	Impact	Rationale	Probability	Rationale	Penetration	Rationale	Weight
1	Responsible disposal of derelict fishing nets	3	High impact on wildlife as it directly reduces net entanglement risk	4	Beaches where nets are commonly disposed of are the most accessible by car and closest to fishing grounds	.20	Unsustainable beach use practices have been well documented	2.4
2	Responsible storage of derelict fishing nets on beaches	3	High impact on wildlife as it directly reduces net entanglement risk	2	Designation of zoned beach areas requires permission and agreements with many stakeholders. Boats too dispersed across the nesting beaches makes it difficult to select a single practical location for net storage areas. Nets are heavy and dragging them to storage areas is physically difficult	.20	Unsustainable beach use practices have been well documented	1.2
3	Storage of derelict fishing gear on vessels for on-shore responsible disposal	4	Very high impact on wildlife as it directly reduces net entanglement risk at sea	2	Bringing back damaged nets may take up valuable space in the boat. No incentive to return nets to shore. Has to be self-policed/enforced	.10	Disposal of nets at sea is a practical solution for fishers	.8
4	Recovery of derelict fishing gear at sea	4	Very high impact on wildlife as it directly reduces net entanglement risk at sea	1	Anticipated resistance from fishers as it requires extra physical effort and time. Bringing back damaged nets may take up valuable space in the boat. The nets could be caught on the bottom making it difficult or dangerous to remove	.10	Disposal of nets at sea is a practical solution for fishers	.4

Table 4. Summary of Barriers and Benefits of the Target Behaviour and Strategic Tools Used to Overcome Barriers and Enhance Motivation.

Barriers/Benefits		
External Barriers	Description	Strategic Tool
Difficulty	Nets are heavy and dirty. Removing them from beaches is impractical and requires physical effort	Convenience
Lack of access	No current net reception facilities	Convenience
Internal barriers		
Lack of knowledge	Fishers unaware of the potential ecological damage and economic losses caused by ghost fishing	Education
	Fishers unaware of the long-term impact of fisheries on marine ecosystem health	Education
Perception	Net disposal on beaches is already an established norm	Social norms
	Tragedy of the commons – lack of individual sense of responsibility for the environment	Social diffusion
	May be resistance to suggested change as traditional views of net fishing as noble/honourable	Social diffusion
	Distrust of intervention from institutions/higher authorities	Social norms
Motivation	Feeling blamed for the degradation of the beaches and marine environment may cause uncomfortable feelings, and reduce the desire to engage and cooperate	Social norms
	Feeling shame/guilt for knowingly contributing to the degradation/destruction of the marine environment	Social norms
	No incentives to responsibly dispose of nets	Prompt
	Regulatory enforcement could be expensive and can be culturally awkward	Social norms
External Benefits		
Social approval and environmental protection	Currently socially accepted to conserve the environment	Social diffusion
	Being seen at doing the right thing	Social diffusion
Community improvement	Free – nature of business and majority of social economic positions of fishers make this an important factor	Social diffusion
	Voluntary participation, no governance in place or being enforced	Commitment
Logistics	Beaches provide a place where behavioural change can be observed, monitored and addressed cheaply and unobtrusively	Education
Internal benefits		
Sense of achievement, stewardship and personal benefits	Feeling pride for knowingly contributing to the protection of the marine environment and setting the right example	Social norms

to decrease barriers and increase benefits of the target behaviour (Table 4), and are presented below. The interventions, listed below, follow the CBSM framework (specific behaviour change tools), and social marketing framework (4Ps of marketing: Product, Price, Place and Promotion).

Convenience Tool. The reduction of external barriers to gear disposal (physical difficulty and lack of access) was considered a principal pathway to promote change as no suitable containers for the disposal of nets or general waste were available on the nesting beaches. This approach addressed product, price and place issues related to proper disposal of fishing gear. Our primary intervention to address this barrier consisted of providing three skip bins, one on each of the three pre-determined fish landing sites (discussed in Step 4). The skip bin was designed to be suitable for net disposal, minimising the amount of lifting required. Regular bin collection services were carried out by the local waste management company. To address problems related to place and promote adoption in the use of the product in priority conservation areas, the bins were placed on three high density turtle nesting beaches commonly frequented by fishers. The waste management company committed to collect all nets dragged within a 25-m radius of the bin to address the practical barrier of lifting heavy nets into the skip bins.

Promotion strategies included education, prompts and social diffusion.

Education and Prompt Tools. Visual educative methods, in the form of signage and posters were employed to highlight the desired behaviour. An illustrated, informative sign was installed next to each bin in the five most commonly spoken languages by the local fishing community (English, Arabic, Hindi, Bengali and Urdu) (Figure 1). The sign portrayed the impact of ghost fishing in colourful and attractive illustrations, and showed local fishers disposing of their nets in skip bins. In addition to being educational, the presence of these signs acted as a prompt, constantly reminding fishers to responsibly dispose of their nets. To increase awareness and education, two posters were designed: one showing the overall impact of ghost gear on the marine environment and local losses associated with turtle mortality; and the second called on fishers to bring their nets

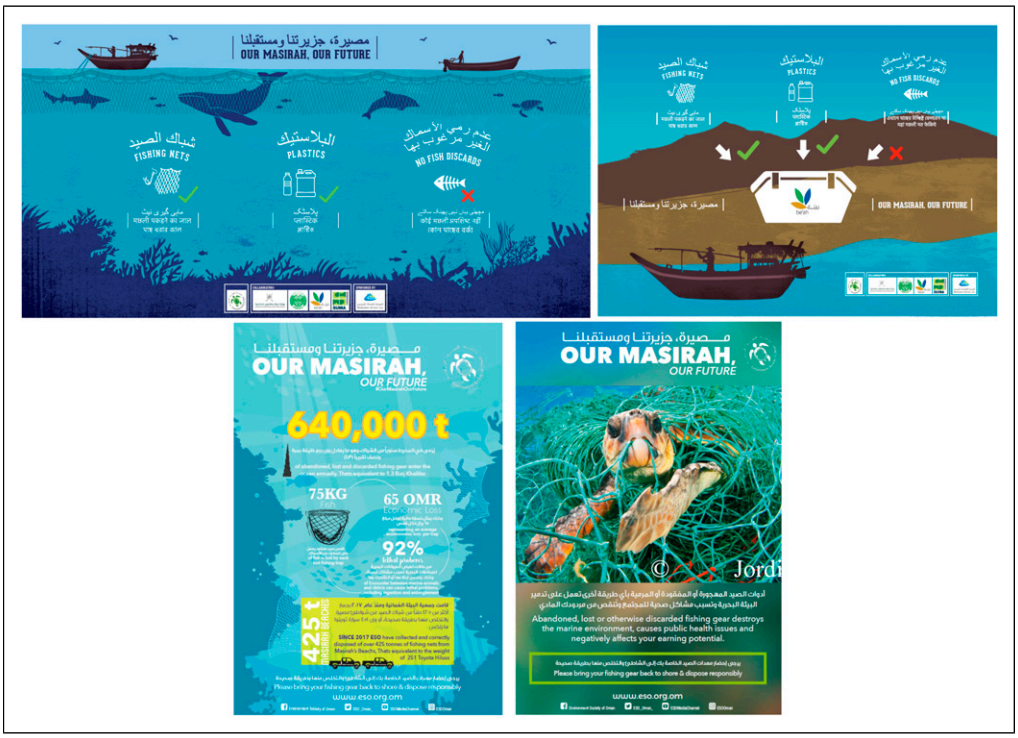

Figure 1. Signs and posters designed to convey awareness and educational messages.

back to shore and dispose of them responsibly. The posters were displayed in areas that fishers frequent regularly, with the aim of becoming a talking point for the local community. An additional third poster was designed to act as a prompt for launch fishers to encourage them in the responsible disposal of derelict nets. Engagement with fishers was ensured by the presence of two full time ESO staff on the fish landing sites. The team introduced fishers to the newly installed bins and signs, explained how the actions of individuals and the fishing community is essential to sustain their own livelihoods, maintain the fish stocks on which they depend, and protect endangered marine fauna. Interaction was informal, with one-to-one discussions aiming to deliver sustained education and awareness messages. Food and beverages were often offered in order to draw fishers into discussions, lengthen conversations and build relationships.

Social Diffusion Tool. Non-monetary incentives were offered to the audience in an attempt to accelerate behaviour adoption, in the form of social diffusion through social networks. Engagement was held with a variety of local stakeholders on the island, such as the head of the island district and other well-respected community leaders. (Ardoin et al., 2013) note that the lack of early stakeholder engagement and involvement can hinder successful conservation projects. Local authorities on the island such as the governor, the offices of the Environment Authority (former Ministry of Environment and Climate Affairs), the Ministry of Agriculture, Fisheries and Water Resources (former Ministry of Agriculture and Fisheries Wealth) and the municipality were also engaged. Although no formal assessment was conducted, these people are believed to have spread the word about the project and try to influence fishermen to use the bins.

Intercept Surveys with Fishers

Intercept surveys were distributed among fishers on Masirah Island in two rounds, aiming to understand the fishing landscape, current fisher behaviours with regards to net disposal and gauge their perceived engagement on the responsible disposal of derelict fishing nets in skip bins (selected behaviour). The first round of surveys ($N = 14$) was distributed prior to the installation of the bins. The surveys were conducted in the residences of fishers by ESO's field assistants, who themselves are ex or part-time fishers from Masirah. The fishers were asked how likely they were to use the provided bins ($N = 14$) and 64% responded favourably, whilst 20% were uncertain. The second round of surveys ($N = 23$) was conducted on an ad-hoc, interview style basis on landing sites by the observation team 2 months after the installation of the bins and focused on the fishers' perception of environmental problems and their proposed solutions.

Monitoring Change

To monitor change, structured behavioural observations took place on the selected three landing sites (step 4). Two observers followed a consistent observation schedule, recording various metrics, such as the number of engaged vessels on the beach, the type of fishing taking place, the use of skip bins, the type of waste being dumped, among others.

Step 4: Pilot Testing the Project on a Small Segment of the Community (Site Selection and Study Duration)

Three 7000 L skip bins and informative signs were installed in three locations (one in each location). The sites were chosen based on accessibility, frequency of use by both launch and skiff vessels and presence of key conservation indicators. After discussion with local ESO staff and the completion of two reconnaissance surveys, the selected sites were Masirah jetty (Site 1), where all launch vessels come to refuel, load ice and unload fish; and two key turtle nesting sites frequently

Figure 2. Map showing the selected pilot sites on Masirah Island.

used by skiff-based fishers (Site 2 and Site 3) (Figure 2). Monitoring and observation took place over a 23-week period from February to August 2019 with two different observation teams. A non-local team operated until week 17, tasked with fishers' engagement and bin content monitoring; and a local team operated from weeks 17 to 23, tasked only to monitor bin content. The decision for the local team to only monitor (and not engage with fishers) was made in order to avoid local sensitivities.

Step 5: Evaluating the Programme for Wider Application

An evaluation of the pilot study is presented in the '*Findings*' and '*Discussion*' sections below, providing an evaluation and critique of similar interventions for broad-scale implementation.

Findings

Findings from structured observations were used to estimate the behaviour adoption rate. We note that qualitative data deriving from participant observation are notoriously challenging to analyse (Bryman, 2004), and an iterative approach has been adopted, with a repetitive interplay between the collection and analysis of data.

Structured Observations of Behaviour Change

The landing sites and bin contents were checked three times per day, at hours most likely to coincide with fishers returning from sea (early morning, mid-morning and late afternoon). Throughout the study period, 86 vessels were engaged on the beaches (29 skiff vessels and 57 launch vessels), and 39 nets were dumped in the allocated bins between week 4 and week 23, with individual numbers as follows: 25 nets at Site 1, 4 nets at Site 2 and 10 nets at Site 3. The allocated

Table 5. Estimated Number of Derelict Nets per Vessel to be Generated Over the Study Period.

	Average No. of Nets Used/Year/ Vessel	Average No. of Nets Lost at Sea/Year/ Vessel	Average No. of Derelict Nets/Year/ Vessel	Average No. of Derelict Nets/23 Weeks/Vessel
Skiff vessels (Site 2 and 3)	25 (Range 4–60), *N* = 23	4 (Range 0–14), *N* = 23	21	9
Launch vessels (Site 1)	67 (Range 50–90), *N* = 15	28 (Range 2–40), *N* = 15	39	17

bins were also used to dispose other types of waste such as plastic, rubbish bags and fish discards more regularly.

Behaviour Adoption Rate

An estimation of the average annual number of nets used by skiff and launch vessels, and the average annual number of nets lost to sea was compiled from the intercept surveys. By deducting the total number of used nets from the number of lost nets, we calculated the number of derelict nets estimated to be disposed of responsibly per year/per vessel. This estimated number provides a target metric useful for comparing actual net disposal. An average of 9 derelict nets per skiff vessel, and of 17 derelict nets per launch vessel was estimated to be generated over 23 weeks (Table 5).

The estimated total number of generated derelict nets was obtained by multiplying the number of engaged vessels on the beaches by the average number of derelict nets generated per vessel. To determine the behaviour adoption rate, a percentage was calculated from the estimated number of derelict nets and actual number of disposed nets.

Results show an estimated 5.36% adoption rate by skiff fisheries, and 2.58% adoption rate by launch fisheries (Table 6). Various external variables such as net lifetime, frequency of use, catch type, fishing methods, weather and sea conditions influence the deterioration of nets and question the certainty of these findings as a definite behaviour adoption rate. The number of disposed derelict nets is also influenced by other factors such as the sale of nets in local second-hand markets, or the act of giving them away for others to use.

Behaviour adoption fluctuated during the weeks, starting with an initial resistance. The first positive observation was reported at week 4, followed by low to no levels of adoption (Figure 3). Most disposed nets took place when the observation team was present on site, which might suggest that the behaviour adoption was more successful with their presence on the beaches. We note that the use of nets and their subsequent end of life do not follow a continuous and stable rhythm. Therefore, the frequency of disposing derelict nets might not be related to the level of fishers' engagement or behaviour adoption rate, but rather to the occasional, seasonal and sporadic nature of net use.

Lack of Awareness

During the intercept surveys 87% of fishers ($N = 23$) acknowledged that the disposal of plastics and nets in the open ocean is a problem. 52% gave no explicit reason why this could be a problem, and 20% thought it would cause decline of fish stocks. When asked about their proposed solutions to reduce the presence of derelict nets and improve the beaches ($N = 38$), 31% favoured beach clean-ups and awareness campaigns, and 23% favoured policy, monitoring and enforcement,

Table 6. Calculation of Behaviour Adoption Rate Based on Total Estimated Derelict Nets and Actual Disposed Nets in Allocated Bins.

Vessel Type/ Location	No. of Engaged Vessels/23 Weeks	Average No. of Derelict Nets/ Vessel/23 Weeks	No. Derelict Nets/23 Weeks	Actual No. of Disposed Nets	Behaviour Adoption Rate (%)
Skiff vessels (Site 2 and 3)	29	9	261	14	5.36
Launch vessels (Site 1)	57	17	969	25	2.58

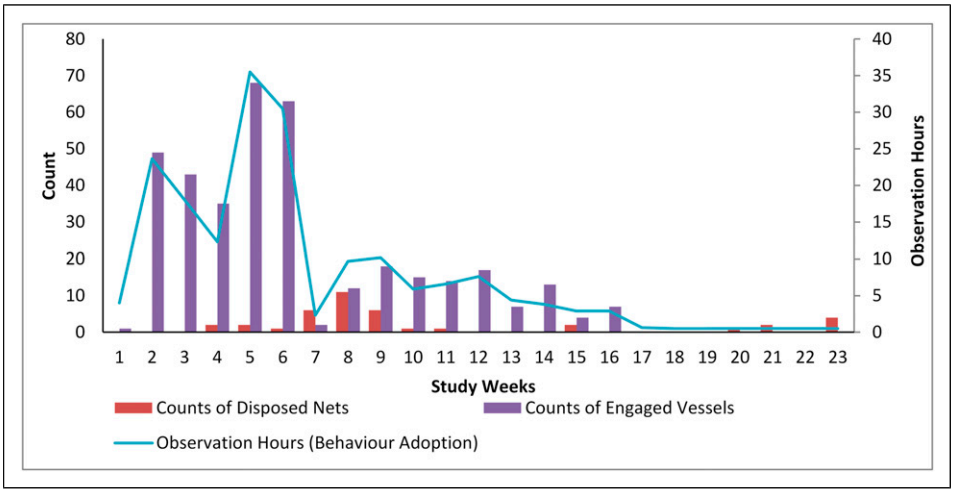

Figure 3. Bar chart showing weekly counts of vessel engagement, disposed nets and observer presence.

followed by 13% preferring the introduction of fines. Only 10% mentioned a desired change in the existing facilities, including the provision of bins and a zoning of fish landing sites.

This shows that whilst the fishing community is the target audience for the reduction of derelict fishing nets, it is not the group that identifies ghost gear as an issue and their prospective individual actions to be part of the solutions. The surveys showed that fishers were not knowledgeable of the impact their industry has on the environment and do not associate their individual practices as harmful or causing the depletion of resources.

Discussion

The deployment of skip bins provided an opportunity to keep the turtle nesting beaches clean, and all waste collected was prevented from entering the marine environment and harming wildlife. This can therefore be considered a positive impact of the study. However, it is important to account how large this impact is compared to the scale of the issue on Masirah. During five net clean-up campaigns between 2017 and 2020, the ESO collected an estimated 695 tonnes of nets from 78 km of turtle nesting beach on the ocean-facing side of the island. This may possibly be the world's largest net clean-up to date. This number gives an idea of the volume of derelict nets generated

from Masirah's fisheries. Furthermore, interviews with fishers have indicated the scale of the problem may be many magnitudes higher in the seas surrounding Masirah than on the beaches. In light of this information, we conclude the interventions were of relatively low immediate impact to the environment. Fishers initially responded positively to messages and interventions, but this did not translate to a salient behaviour. The low behaviour adoption rate could be due to the diffusion process in the spread of an innovative practice (Rogers, 2003). Throughout the 23-week study period, the fishers might have become aware of the consequences of net entanglement to marine wildlife, and could have been persuaded of its relevance to their activities and livelihood, but may not have been engaged long enough to adopt the desired behaviour. Additional behaviour change methods, as well as increased engagement and field monitoring time might be needed for the adoption of a new norm, or for a newly introduced behaviour to reach a tipping point.

Various challenges influenced the success of the CBSM pilot project. These are related to structured observations, no-adherence to bin use instructions, seasonality of fishing, and limited funding and human resources availability. Structured observations enabled us to obtain direct and reliable information about fishing methods, gear and beach use, catch information, logistics of fishing trips and a deeper understanding of the socio-economic environment of the fishing industry. The observer team reported that their presence on the beaches had the perceived effect of putting fishers under scrutiny. Scrutiny during structured observation is a recognised criticism of that method (Bryman, 2004). Additionally, the observer team struggled with their public perception among fishers. Despite regular explanations, there was often a confusion about the observers' role on the beach, implying it was to report or penalise fishers. This is most likely due to regular and pervasive violation of the laws among many of the fishing community.

Prior to the instalment of the bins, fishers discarded fish waste on the beach or further inland. Despite one-to-one engagement and multi-lingual informative signs deterring them from discarding fish waste in the new bins (flagged as a health and safety concern by the waste management company), there were 12 observations of such actions. This non-compliance might indicate a high illiteracy level amongst fishing crews and inability to follow instructions. The engagement effort of the observer team was not enough to deter fishers from engaging in this action and the bins facilitated an easier method of disposal compared to their previous actions. This is an example of how our intervention of convenience created an undesirable behaviour. In the future, it may be necessary to have a second bin dedicated to fish discards.

Fishing techniques and gear use change seasonally and often involve multiple socio-economic groups. Oman's fishing community does not represent one cohesive group, but instead spans across multiple tiers of society that have different, and sometimes conflicting desires. A further break down of behaviour sequences for various target audiences would require an increase in both funding and resources.

Various lessons have been learnt from our evaluation of the methodology and development of strategies that could be useful for other social marketing experts. These are listed below:

-. Engage the target audience in barriers and benefits identification. Barriers and benefits of the selected behaviour were based on the assumptions of experts, and intercept surveys were conducted with the target audience after the development of strategies. These aimed to gauge the fishers position towards the selected behaviour. We recommend the extensive involvement of the target audience (fishers in our case) on their perceptions of barriers and benefits prior to the development of strategies, as this could lead to alternative approaches.
-. Increase public participation in strategy development. Target audience involvement in the decision-making process could lead to the development of human-centred solutions, and enable communities to make informed decisions for resolving their own problems. Although

challenging to achieve, consensus would likely increase ownership, compliance and likelihood of adoption.

-. Further explore benefits for the target audience. The lack of a tangible incentive to net disposal, such as a payback scheme for derelict gear or a discount on new gears could be a criticism of our approach. Although this was discussed thoroughly with the project team and stakeholders during the focus groups, it was decided that offering a physical incentive was unsustainable given the limited time-line and funding available for the project. Given access to multi-year funding and time to create sustainable partnerships, a tangible incentive scheme could encourage behaviour adoption, if designed in a self-sustaining way.

-. Test several interventions concurrently. Running several small-scale community-based social marketing pilots concurrently could provide a higher probability of success, and allow both the ability to measure change, and the relative Return on Investment for each strategy. The promotion of behavioural change is often difficult and parallel pilot testing could increase the ability to find successful strategies.

-. Properly time the development of awareness materials. It is critical not to misjudge the lengthy process of developing communication awareness materials. The production of an animation and video were initiated during the planning phase about the socio-economic impacts of ghost fishing on livelihoods and the environment. Despite our continued co-ordination these were only ready after the monitoring phase was over. We therefore recommend initiating awareness material well in advance.

-. Importance of securing multi-year funding. Limited project funding to cover on-ground expenses and human resources made the trial of new interventions and follow-up with existing ones difficult to sustain. Given a longer time-frame and additional human resources, the focus could be on education to create awareness of the livelihood benefits of responsible gear disposal and the creation of social norms (possibly combined with disincentives) which could entrench long-term behaviour change.

-. Acknowledge the existing gaps in the supporting environment. The absence of best practice operational systems for fishing (such as on-board waste management guidelines) made it hard to convey sustainability messages to fishing crews. Additionally, the lack of thorough and regular monitoring schemes of the fishing industry (such as the number of vessels, catching power, operation intensity, time at sea, fish quotas and use of restricted gears) makes compliance harder to achieve. Various studies have addressed the low existing level of compliance among fishers in Oman (Al-Qartoubi, et al., 2020; Al-Qartoubi & Al-Masroori, 2020; Al-Subhi, et al., 2013). Factoring the absence/presence of such supporting environment in any social marketing study.

Conclusion

The CBSM methodology stresses that success is more probable when addressing a single, achievable and specific action (McKenzie-Mohr and Schultz, 2014; Schultz, 2011). Our pilot study shows that focussing on specific behaviours with appropriate measurements is both resource and time demanding to solve pressing conservation problems, particularly ones generated by industries with complex dynamics such as fishing (Salas and Gaertner, 2004). Implementing a pilot study such as the one presented in this paper, could cost between US$ 50,000 and US$ 100,000 (depending on labour and available expertise), and may not automatically lead to broad-scale implementation. ALDFG causes devastating environmental degradation of critical marine habitats and is an urgent and time sensitive issue that requires swift attention and concrete actions to prevent potentially irreversible impacts (Huntington, 2016; Macfadyen et al., 2009; Stelfox et al., 2016). Our study has been applied to a limited selection of landing sites on Masirah, where

there are 1685 operational artisanal fishing vessels, including skiff and launch vessels, registered in 2018 (MAF, 2018). This implies that the estimated annual amount of net loss to the environment is considered to be relatively high. Across Oman there are 24,414 registered artisanal fishing vessels (MAF, 2018) and therefore this issue needs attention as a nationwide concern.

Our findings of CBSM as a lengthy and expensive tool for conservation could be specific to its application within Oman's fisheries industry, which includes a variety of stakeholders with multiple socio-economic backgrounds and education levels. Future modifications to the project design might include the identification of people within the fishing community able to spread awareness, rather than relying on paid observers; the consideration of financial incentives (van Vugt et al., 2014) such as closed-loop schemes for the disposal of derelict fishing nets; and the exploration of benefit-based incentives (Hilborn, Orensanz, & Parma, 2005) for net recovery and disposal.

Conventional tools such as conservation science, policy, legislation, monitoring and enforcement may have more immediate impacts than individualised behaviour change. However, their shortcomings in preventing declines on a global scale (Williams et al., 2020) imply they should be augmented with the parallel consideration of drivers of human behaviour, and the application of behaviour change tools. It is crucial for community members to be active participants in these programmes to increase compliance levels (Salas and Gaertner, 2004). Social marketing tools help engage audiences in conservation actions as well as in the human dimensions of biodiversity loss (Ryan, Mellish, Dorrian, Winefield, & Litchfield, 2019), and we support the global call to further test the incorporation of social marketing tools within conservation programs (Green, Crawford, Williamson, & DeWan, 2019; Veríssimo, 2019). We finally conclude by recommending the further exploration of fishers behaviour change methods, the consideration of human behaviours as indicators of conservation outcomes (Nilsson, Fielding, & Dean, 2019), and the enhancement of training in social marketing skills in the conservation sector (Robinson, Creasey, Skeats, Coverdale, & Barlow, 2019).

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