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LETTER

Local disconnects in global discourses—The unintended consequences of marine mammal protection on small-scale fishers

1 | INTRODUCTION

There has been a push for wildlife protection at national and international levels, particularly for "charismatic" mammals like tigers and elephants (Sibarani et al., 2019). This protection has been formalized through policies like the US Endangered Species Act (1973). Simultaneously, there has been an international push towards fulfilling the Sustainable Development Goals (SDG) (UN General Assembly 2015), particularly those focused on eradicating poverty. What is rarely acknowledged at global levels is the disconnect between these different policy aspirations (but see Tallis et al., 2008). This disconnect occurs when attempts to progress one goal negatively impact the achievement of the second, and may only surface when moving from global to local scales. Disconnects can occur when wildlife species generate large passive-use values for the international community (Subroy et al., 2019), but conservation imposes large costs on local peoples (Dickman et al., 2011). If the global community is committed to a post-2020 deal for nature and people—where goals regarding improvements to people's wellbeing and nature conservation are both fulfilled (the elusive "win-win" (Tallis et al., 2008))—then governments and scientists must engage with these "messy" local conflicts that repeat across the globe but resist high-level simplification.

An iconic group for wildlife protection is marine mammals. Marine mammal protection efforts have succeeded to the point where conservation narratives may not reflect current conditions. For example, most pinniped populations (e.g., seals, sea lions) were heavily exploited until the early 20th century, when protective legislation was gradually introduced. Under protection, the majority of these populations are recovering (Magera et al., 2013), triggering tensions with fisheries (Cook et al., 2015; Scordino, 2010). Small-scale coastal fisheries are particularly vulnerable to interactions with pinnipeds (Costalago et al., 2019; Read, 2008), and increases in this sector (e.g., Alfaro-Shigueto et al., 2010) may also be contributing to conflict. In South America, pinniped depredation is estimated to affect ~56% of catches (Sepúlveda et al., 2018; Szteren & Páez, 2003), and reportedly generates economic losses of up to 35% (Goetz et al., 2008; Oporto et al., 1991). Marine wildlife protection often overlooks the impact that conservation success can have on human–wildlife conflict (HWC) and the welfare of poor communities. Notwithstanding, marine mammals provide excellent opportunities to assess human–wildlife interactions (Redpath et al., 2013)—the dynamics of which make achieving the SDGs—particularly SDG 14: "Conserve and sustainably use the oceans, seas and marine resources for sustainable development" (UN General Assembly 2015)—so hard to achieve.

In this research, our objective is to identify the chief concerns that a recovering marine mammal species might cause local resource users. By identifying these concerns, we can better understand the roots of conflict and identify appropriate management solutions. We focus on the conflict between small-scale fisheries and sea lions in one of the world's largest upwelling systems—the Eastern Pacific Rim (Figure S1) (Idyll, 1973). In this region, the South American sea lion (*Otaria flavescens*) is an ideal study species because protection has allowed populations to recover (Figure S2), their foraging areas overlap with fisheries, and conflict with fisheries is local but widespread. We focus on coastal areas spanning Peru and Chile (see Figure S1), and recommend management solutions accounting for the needs of different fisher groups.

2 | MATERIALS AND METHODS

We surveyed 301 coastal small-scale fishers in Peru ($n = 100$) and Chile ($n = 201$) to assess their key concerns about sea lions. We used best–worst scaling (BWS), a discrete choice experiment where respondents identify the "best" and "worst" options from a list (i.e., choice set), to

TABLE 1 Reasons why sea lions concern small-scale fishers in Peru and Chile ($n = 301$) that were assessed in the best–worst scaling survey

Coding	Full description
Strategy	Having to change my fishing strategy (e.g., location, gear, net placement)
Fish	Sea lions eat and scare fish from my nets
Inputs	Spending more money to repair damaged gear or travel further
Population	There are too many sea lions
Profits	Getting less money for damaged catch
Safety	Travelling further offshore to avoid sea lions endangers myself and my crew
Time	Working longer hours/Spending more time away from my family (e.g., repairing gear or longer fishing trips)
Behavior	Sea lion behavior is changing; they are no longer afraid of approaching fishing boats
Employment	Being forced to seek alternative employment
Reputation	Conflict with sea lions is giving fishing a bad reputation
Harm	Hurting sea lions while I am fishing
Risks	Sea lions may present unknown risks (e.g., disease)

identify what aspect of fishers' interactions with sea lions concerns them most (see Supporting Information and Figure S3). In the survey, we defined negative interactions as "any interaction with sea lions that has the potential to cause economic, physical or emotional harm." We developed a list of 12 reasons why sea lions might concern fishers. These reasons span economic, social, and ecological concerns, and were selected through key informant interviews and pilot surveys (Table 1 and Supporting Information). We surveyed fishing crew and presidents of fishing syndicates—covering a range of perspectives regarding local issues and fisheries management. We surveyed fishers in 10 locations in Peru and 18 in Chile (Figure S1 and Table S1). Sites were chosen to capture the locations with greatest landings and to ensure representation in each geopolitical region. We note that our sampling strategy biases responses towards areas with higher potential for interactions with sea lions, hence results should be interpreted as indicative of these areas, rather than of all small-scale fishers. The percentage of registered small-scale fishers surveyed in each location ranged from 0.3% to 67%. We analyzed responses using conditional logit (CL) (Hole, 2009) and scale-adjusted latent class (SALC) (Rigby et al., 2015) models. The dependent variable for both models was respondents' selection of a reason as either of most or least concern among the choice set. In the SALC, we calculated the marginal effects of preference class (here described as "preference group") membership using a multinomial logit model (Greene, 2019). Results for CL and SALC models are presented as importance scores, which describe the probability a respondent will pick a given reason as "most important" from a set, assuming all other reasons are of average importance. Additional elements assessed in our survey regarded fishing activities, socio-demographic information, and interactions with sea lions. We assessed how fishers responded to the words "sea lion"; what they perceived were the impacts of interactions on catch and income; how fishers defended catch from sea lions; how they perceived sea lion interactions changing over time; and potential solutions. We analyzed changes in interactions over time using a censored negative binomial model (Hilbe, 2005). Finally, we reviewed the terrestrial HWC literature to identify solutions pertinent to each preference group. See Supporting Information for a full description of the survey approach, questions, and analytical methods.

3 | RESULTS

For a fifth of respondents, the first word that comes to their mind when they hear "sea lion" is "damage" (Figure 1 and Table S2). Other responses include "harmful" (~8% of respondents), "depredation" (~5%), and "pest" (~3%) (Figure 1). Most of the sample (87%) indicate their interactions with sea lions are negative, ~10% indicate neutral interactions, and 3% positive.

Results from the CL model indicate that fishers' main concern about their interactions with sea lions is that sea lion populations are too large, thus increasing the probability for negative interactions (Figure 2(A) and Table S3). These results also show that fishers are generally not concerned about harming sea lions or negative reputational impacts due to sea lion conflict. The SALC analysis identifies five groups of respondents with different concerns—respondents within each "preference group" share similar concerns—and two groups who respond to questions with similar consistency (i.e., scale classes)—using effects coding (Figures 2(B)–(F) and Tables S4 and S5). Involvement

TABLE 2 Marginal effects of socioeconomic and attitudinal characteristics, describing the change in a fishers' probability of being in each of the five-scale adjusted latent class preference groups (*Economically minded*, *Alternative livelihoods*, *Lifestyle impacts*, *Capacity focused*, *Nondifferentiated*; see Figure 2) for a unit change in the socioeconomic or attitudinal characteristic

Variable	*Economically minded*	*Alternative livelihoods*	*Lifestyle impacts*	*Capacity focused*	*Nondifferentiated*
Involved in sea lion tourism	−0.06 (−0.33:0.21)	**0.19** (0.07:0.31)	0.16 (−0.03:0.35)	0.02 (−0.13:0.08)	**−0.27** (−0.52:−0.02)
Impact of sea lions on earnings	**−0.05** (−0.09:−0.02)	0.00 (−0.02:0.02)	0.01 (−0.02:0.03)	0.01 (−0.01:0.03)	**0.03** (0.01:0.06)
Respondents from Peru	**−0.64** (−0.84:−0.45)	−0.02 (−0.16:0.13)	−0.05 (−0.33:0.23)	**0.15** (0.04:0.26)	**0.57** (0.40:0.73)

Median values are presented with 95% confidence intervals in brackets. Bold entries indicate significant coefficients ($p < 0.05$).

Notes: Membership of preference groups was modelled probabilistically as a function of individual specific characteristics using a multinomial logit functional form. *Involved in tourism* and *Respondents from Peru* are binary variables. *Impact of sea lions on earnings* is a continuous variable ranging from −10 to 9, with each unit representing a 10% change in the impact of sea lions on fishing income. Confidence interval estimates are derived from 1,000,000 draws from the simulated parameter distributions, evaluated at mean class shares.

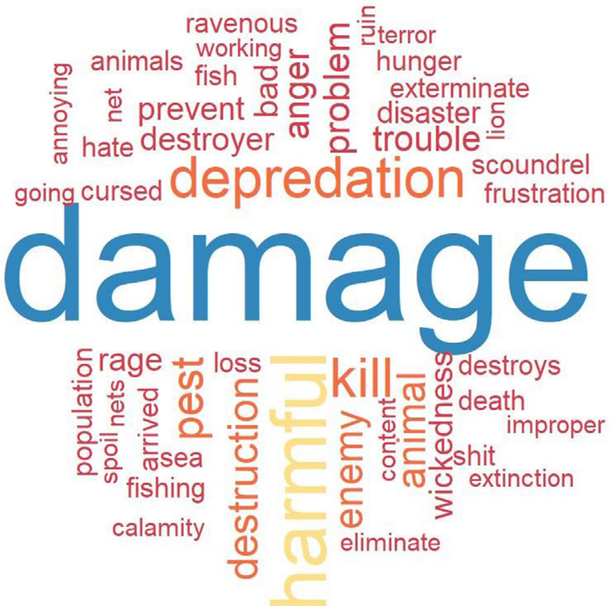

FIGURE 1 Word cloud of the first word that occurred to small-scale fishers in Peru and Chile ($n = 301$) when they heard the word "sea lion." Larger font size indicates a response was observed with greater frequency across the sample

in sea lion tourism, perceived impact of sea lions on earnings, and nationality significantly predict preference group membership (Table S6). The BWS approach identifies relative concern among reasons within groups of respondents, but does not indicate respondents' absolute concern within or across groups. This can be inferred from other questions in the survey, for example, fishers' response to the word "sea lion" (Figure 1).

Based on their different preferences and characteristics, we describe the five preference groups as: *Economically minded*, *Alternative livelihoods*, *Lifestyle impacts*, *Capacity focused*, and *Nondifferentiated*. Respondents in the *Economically minded*, *Alternative livelihoods*, and *Lifestyle impacts* groups identify sea lion population size as their chief concern regarding sea lions (Figures 2(B)–(D)). Respondents in the *Economically minded* group (27% of the sample) are more likely to be Chilean and focus on the negative economic impacts of sea lions (Table 2). Respondents in the *Alternative livelihoods* group (15% of sample) are 19% more likely to be involved in sea lion tourism. Respondents in the *Lifestyle impacts* group (21% of sample) are also linked with sea lion tourism, and their other concerns center on lifestyle impacts: time spent away from their families and safety issues. Although respondents in these three groups likely view sea lion population size as the underlying cause of other impacts, this is not true for all groups: the *Capacity focused* group (12% of sample) are most concerned about input costs, safety issues from increased travel, and working longer hours (Figure 2(E)). Respondents in this group are more likely to be Peruvian.

Respondents in the final group, the *Nondifferentiated* preference group (26% of sample), are more likely to be from Peru, are not linked with sea lion tourism, and report lower negative impacts of sea lions on income (Table 2). This group displays no differentiation across concerns (Table S4), reflecting all 12 reasons being of equal importance for them, or that these respondents were not engaging in the choice task.

Fishers describe other crews in their area actively protecting catch from sea lions. Approximately 62% of fishers ($n = 298$) report hearing of crews defending their catch from sea lions. Approximately 69% ($n = 208$) had heard of other crews killing sea lions to defend their catch. Finally, fishers ($n = 126$) estimated that crews on other vessels kill on average 3 (median, IQR = 1–7) sea lions per month (see Figure S4 for full details).

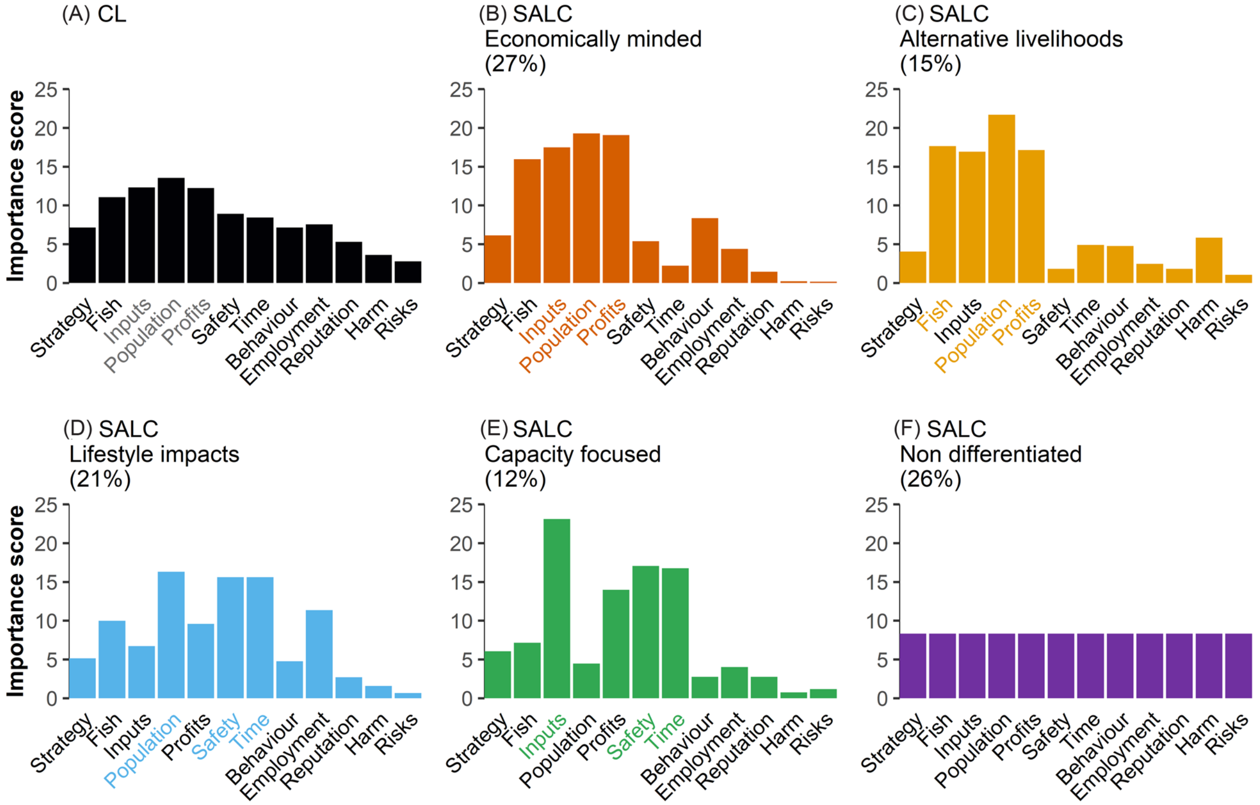

FIGURE 2 Importance scores for 12 reasons that sea lions may concern fishers in Peru and Chile (see Table S5 for coefficients). (A) Results from conditional logit (CL) model of pooled most and least important reasons. (B–F) Results from scale adjusted latent class (SALC) model of most and least important reasons for five preference groups. *X*-axes labels show three most important reasons in color. Class sizes are indicated in brackets. Sample size was 299, note that two respondents were dropped due to incomplete responses. For both the CL and SALC model, the dependent variable was respondents' selection of a reason for concern as either most or least important among the choice set.

Fishers report a decrease in catch due to their most recent interactions with sea lions (Table S7). Across the sample, 85% of fishers report average catch losses of >25%. The majority of respondents (90%) identify an average reduction of >20% in their take-home income due to sea lion interactions. No significant difference is identified between fishers from Peru and Chile.

Results from a censored negative binomial model show that fishers perceive their interactions with sea lions have increased by an average of 1.3% annually (p value 0.001; Table S8). Caution is required in the interpretation of this result given that data are retrospective. However, this result helps explain fishers' preoccupation with sea lion population numbers, which may have led to increasing numbers of interactions throughout their fishing careers.

We asked fishers what they thought was the best solution to manage their interactions with sea lions (Table 3). Responses were grouped into three broad categories: *removing* the problem, for example, population culls; *living* with the problem, for example, compensation for damaged catch or changing fishing practices; and *separating* the problem, for example, reserve creation. The majority of fishers (~72% of respondents) support sea lion population control, through culls or regulated harvesting, as the best way to manage their interactions with sea lions. This result mirrors findings from the BWS questions (Figure 2). Estimates of the number of sea lions currently killed by fishers each month (median per vessel = 3; Figure S4) suggest fishers are already enacting (albeit illegally) this solution. Approximately 11% of respondents say that there is no solution to conflict with sea lions.

Through a review of the terrestrial HWC literature, we identify four dominant management solutions specific to the preference groups identified in the SALC analysis (Figure 3). Sea lion population numbers are the top concern for the average respondent. Therefore, the first solution is sea lion culls, specifically regulated harvesting (Knott et al., 2014) or targeting problem individuals (Guerra, 2019; Lavigne, 2003). In the terrestrial literature, there is little evidence that culls increase yields of disputed prey species—so if culls are implemented, monitoring their effectiveness with the participation of fishers will be critical so they can be abandoned if ineffective. To protect fisher welfare, regulated population

TABLE 3 What small-scale fishers in Peru and Chile (n = 301) perceive would be the best solution to manage their interactions with sea lions

Solution: broad category	%	Solution: subcategory	%
Remove	71.8	Population control	60.1
		Exploit	11.6
Live with	23.3	No solution	10.6
		Change fishing practice	4.7
		Technology	4.0
		Research	2.7
		Compensation/help	1.3
Separate	3.3	Reserve	3.3
Other or NA	1.7	Change the law	0.7
		NA	1.0

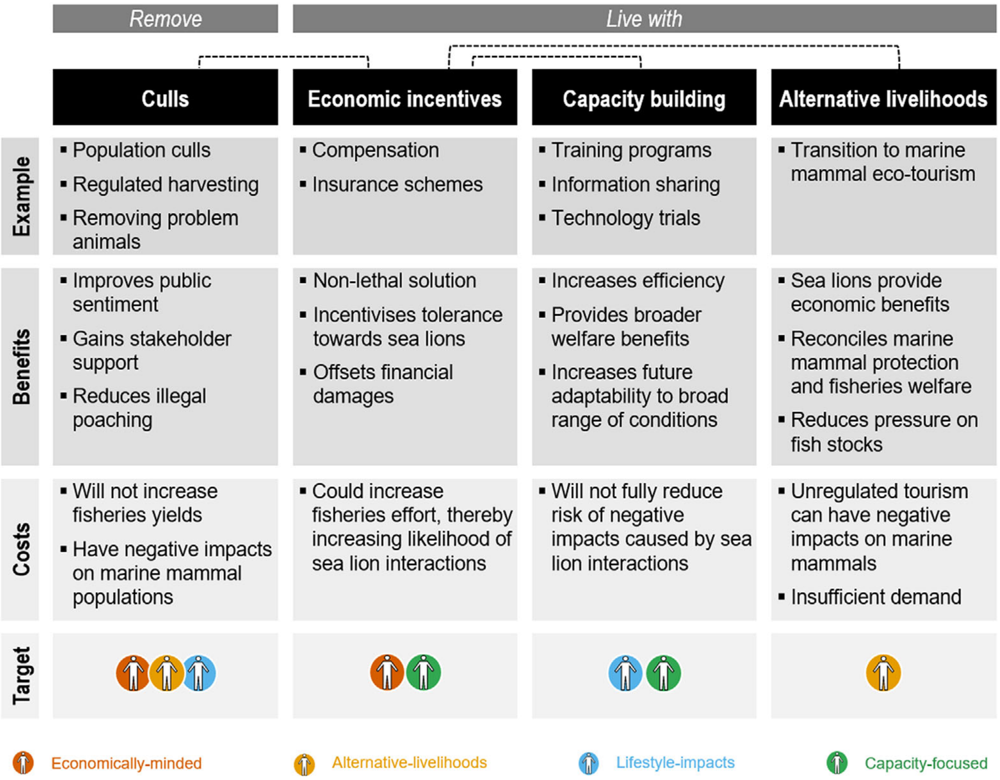

FIGURE 3 The benefits and costs of four management solutions to sea lion–fisheries conflict drawn from the terrestrial and marine human–wildlife conflict literature. Solutions are consistent with the "Remove" and "Live with" solution categories described in Table 3. Each management solution will be appropriate for different groups of fishers, previously identified in the scale-adjusted latent class analysis (see Figure 2). Solutions will be most effective when used in combination, as indicated by dashed lines

control will be most effective in combination with other management solutions, including economic incentives. Economic incentives would be most appropriate for fishers who expressed concern over the financial impacts of sea lion interactions. Economic incentives include compensation and insurance schemes. Compensation is designed to reimburse, with cash or in-kind payments, damage due to wildlife impacts (Nyhus, 2016)—with the objective of increasing tolerance for wildlife (Nyhus et al., 2005). Compensation could be funded by revenues raised from controlled harvesting (i.e., culls) (Knott et al., 2014) or marine mammal ecotourism (i.e., alternative livelihoods, see below). Insurance schemes typically require participants to pay a premium and allow affected individuals to recoup their losses from wildlife impacts (Dickman et al., 2011). Capacity-building would help fishers identify fishing practices that minimize exposure or risk from conflict with sea lions. Examples from other marine settings (Guerra, 2019) include reducing fishing gear soak times (Ward et al., 2004), communication about areas with high densities of sea lions to avoid (Gilman et al., 2006), or the use of technology (e.g., acoustic deterrent devices) to discourage wildlife interactions (Rabearisoa et al., 2015). Capacity building is appropriate for fishers who express concern about how sea lions are affecting their safety or fishing efficiency. Finally, supporting some fishers to transition to alternative livelihoods, such as marine mammal ecotourism (Nyhus, 2016), could provide a solution to sea lion–HWC. Transitioning to alternative livelihoods will be more feasible for fishers with experience or contacts in alternative industries.

4 | DISCUSSION

Small-scale fishers in the Eastern Pacific Rim perceive that successful protection of marine mammals, specifically the South American sea lion, has led to negative impacts on their welfare. The majority of fishers report sea lion-driven catch and income losses of ≥26%, and an average increase of ~1.3% in interactions annually. This increase is reflected in an average annual increase of 2.1% in sea lion populations in central Chile between 1970 and 1985 (Sepúlveda et al., 2011). Reports of catch and income losses caused by sea lions vary around the world. For example, dockside interviews from the west coast of the USA suggested revenue losses caused by sea lions equated to 14%, 84%, and 26% of total commercial salmon revenues in 1997, 1998, and 1999, respectively (Scordino, 2010). In Coquimbo, Chile, fisher-reported catch losses due to sea lion predation have previously been estimated at 35% of total catch (Oporto et al., 1991). Fisher-reported estimates of catch and income losses are subject to strategic bias—fishers have strong incentives to over-represent damages. Understanding the true catch and income losses will be important if compensation policies are to be viable. Nevertheless, our results suggest that sea lion populations—bolstered by conservation success—may be contributing to the economic difficulties experienced by already income-insecure small-scale fishers. These economic difficulties have negative implications for the achievement of SDGs (UN General Assembly 2015), including SDG 1 and SDG 14 (end poverty and sustainable marine resource use, respectively).

Independent of the losses imposed on small-scale fishers by sea lions, it is common for human populations affected by HWC to retaliate based on their perception of losses (Guerra, 2019). In our study, fishers report that large numbers of sea lions are being killed by fishers to defend their catch. We note that a precise estimate of these numbers was not the focus of the current study and would require a different approach, for example, random response methods (Oyanedel et al., 2018). Retaliatory actions are concerning for two reasons. First, this mortality could affect sea lion population viability—particularly under future climate change scenarios (de Oliveira et al., 2012). Second, it suggests a weakening in the perceived legitimacy of marine conservation policy—which fishers perceive to favor marine mammal protection at the expense of their own welfare. Hence, government action is needed to manage conflict, but this action must be sensitive to the needs and perceptions of different groups of fishers.

For management to successfully address conflict between sea lions and fishers, different views among fishers towards sea lions must be identified and addressed (Gelcich et al., 2005a). We identified five groups of fishers across Peru and Chile with different concerns about sea lions. Most groups were principally concerned with increases in sea lion populations—this perception may also underpin concerns about the economic impact of sea lions. Hurting sea lions through fishing activities was not a concern for most fishers, and the majority identified population culls as the best way to resolve conflict. However, additional management strategies (e.g., capacity building activities) could supplement, or potentially replace, managed culls. These additional strategies will be essential in the current case, as some small-scale fisheries in Peru and Chile export fish and fish products to the USA (NOAA 2020). According to the US Marine Mammal Protection Act (MMPA 1972), nations that export their catch to the USA must either prohibit the intentional killing of marine mammals or certify that their fishery products do not result from the intentional killing of marine mammals. Therefore, to continue to export their catch to the USA, small-scale fisheries in Peru and Chile cannot intentionally kill marine mammals—hence nonlethal methods of conflict resolution will be necessary.

There are many global policies that aim to support small-scale fisheries. These include directives from the Food and Agricultural Organisation (FAO, 2015), shifts to comanagement systems (Gelcich et al., 2005b), and incorporating local knowledge into management decisions (Basurto et al., 2013). However, these policies do not address fishers' relationships with wildlife, particularly with other fish predators such as marine mammals. This omission of HWC from fisheries policy contrasts with the focus of global conservation policy, which identifies HWC as a key challenge for effective wildlife protection. If the disconnects between global policies to protect wildlife and improve human welfare outcomes are not resolved, then local communities will continue to bear the costs of wildlife conservation (Guerra, 2019), eventually jeopardizing conservation outcomes.

Historically in Peru and Chile, sea lion-management strategies were dominated by commercial hunting or population culls (Mancilla González, 2018)—leading to small populations. In the current survey, fishers express an expectation that these management approaches should be resumed. This result suggests that marine mammal conflict resolution in Peru and Chile is path dependent—fishing communities' have never developed methods to reduce the impact of sea lion predation and expect historical management approaches to resume, returning populations to low levels (Knott et al., 2014; Nyhus, 2016). By contrast, terrestrial HWC management has been more nuanced, and we suggest terrestrial approaches (including insurance and capacity building) could stimulate new debate to resolve marine HWC.

To avoid alienating fishers, the nuances associated with interactions between marine mammals and small-scale fishers need to be addressed in global forums. This implies the need for open dialogue with fishers and avoiding broadly enacted conservation policy that treats all marine mammals and all places equally. By incorporating the different needs and opinions of fishers in global dialogue, marine mammal policies are more likely to find solutions that protect the welfare of small-scale fisheries while maintaining viable marine mammal populations. This action will allow the global community to advance a post-2020 deal for nature and people—where improvements in one global target do not undermine another.

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AUTHOR CONTRIBUTIONS

All authors contributed to the design of the research and final survey instrument. S. G. and J. P. D. oversaw the survey implementation in Chile; J. A. S., J. M., and W. A. oversaw the survey implementation in Peru. K. D. and M. B. conducted analysis of best–worst scaling data. K. D. conducted all other analyses. K. D. wrote the manuscript and all authors contributed revisions to the manuscript.

ETHICS STATEMENT

The University of Exeter Business School provided ethics approval for this research (eUEBS000824 v2.0).

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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SUPPORTING INFORMATION

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

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