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Experimental evidence for conservation conflict interventions: The importance of financial payments, community trust and equity attitudes

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Abstract

1. Conflicts between the objectives of agricultural production and conservation are becoming increasingly complex. Of vital importance to the success of conflict interventions is a detailed understanding of how stakeholders react to management interventions as well as the influence of interacting social and political factors.
2. Across Europe, goose populations have increased considerably, leading to widespread impacts on agriculture and significant conflicts between different stakeholder groups. We used a novel experimental game to understand farmer preferences regarding the design of goose conflict interventions in Scotland. We specifically examined how three alternative interventions (government financial support for scaring activities, subsidies and agglomeration payments that include bonus payments for adoption by neighbouring farms) affect farmer propensity to support goose conservation interests through reduced shooting and the provision of sacrificial crops. We also examined the links between within-game behaviour and real-life attributes and attitudes of farmers.
3. We found that all three interventions were conducive to pro-conservation behaviour in the games. The effects of all three interventions were stronger among farmers who had higher trust towards other community members. Agglomeration payments led to increased provision of sacrificial crops among farmers with negative attitudes towards the current allocation of goose finances in Scotland. Farmers with more positive attitudes towards wildlife tourism were more likely to provide more sacrificial crops, and less likely to shoot in the games.
4. Farmers' real-life traits had a statistically significant but marginal impact on the effectiveness of financial payments, such as the number of geese being shot on their own lands, remoteness and crop damage by geese.
5. These game results provide evidence for the potential of innovative financial instruments in conflict management and their interactions with social factors such

as community trust, equity attitude and real-life shooting levels. Our study highlights the importance of socio-political elements in fostering mutually beneficial outcomes in conservation conflicts in addition to addressing material losses to wildlife. We also show how games can help in addressing conservation conflicts in a wide range of settings.

KEYWORDS

agriculture, experimental game, geese, human–wildlife conflict, monetary incentives, Scotland

1 | INTRODUCTION

Conflicts over natural resources and conservation are widespread in many parts of the world (Hill et al., 2017; Redpath et al., 2015; Woodroffe et al., 2005). These conflicts are increasingly being understood as conflicts between different stakeholder groups who disagree over the management of wildlife or natural resources (Hill, 2015; Peterson et al., 2010; Redpath et al., 2015). Besides the material impacts, conservation conflicts arise when different individuals or groups of people hold divergent values in relation to wildlife or natural resource management, and when the interests of one party are threatened by another (Redpath et al., 2013). Conservation conflicts thus involve intertwined ecological, economic and socio-political elements. Management, therefore, cannot narrowly focus on the ecological but must take into account stakeholder values and perceptions as well as the social and political contexts of the conflict (Dickman, 2010; Hill et al., 2017; Madden & McQuinn, 2015).

Conflicts over natural resources and conservation are widespread in many parts of the world (Hill et al., 2017; Redpath, et al., 2015; Woodroffe et al., 2005). While largely understood as disagreements between different stakeholder groups over the management of wildlife or natural resources (Hill, 2015; Peterson et al., 2010; Redpath, et al., 2015), conflicts are multidimensional, with aspects that go well beyond divergent interests or values (Madden & McQuinn, 2014). For instance, stakeholders may experience material impacts, but are also affected by social, cultural, historical and political elements and the wider context in which the conflict is embedded (Dickman, 2010; Hill et al., 2017; Madden & McQuinn, 2015). Understanding both the material and non-material aspects of conflicts—and their influence on stakeholder perspectives, values and decision-making—is therefore of great importance to conflict management.

Trust and equity attitudes can significantly influence the likelihood of seeking shared solutions to biodiversity-related conflicts (e.g. Young et al., 2013; Young, Searle, et al., 2016). In addition, other factors, such as attitudes towards a conservation policy, and experiences with conflict interventions can strongly influence perceptions of conservation conflicts and their management (Dickman, 2010). For example, where conservation policies have prevented farmers from taking direct action against crop-raiding species, farmers may perceive a lack of control or ownership over wildlife as well as feelings of oppression from the state, and are more likely to oppose any alternative conflict mitigation strategies (von Essen et al., 2015; Hill, 2004).

In Europe, some of the critical conservation conflicts today relate to changes in land use, farming practices and policy. The introduction of agri-environment schemes, as well as the rapid increase in protected sites (such as Special Areas of Conservation under the EU Habitats Directive and the Natura 2000 network) and targeted actions for particular species (e.g. shooting regulations) all have markedly increased the populations of a number of species of conservation concern. This is the case for large grazing birds in particular, such as geese and cranes (Cusack et al., 2018; Fox & Abraham, 2017; Mason et al., 2018), which have also benefited from increased access to the better foraging opportunities offered by intensively managed grasslands. For instance, the greylag goose population (*Anser anser*) has increased by more than seven times in Europe, from an estimated 120,000–130,000 individuals in the 1980s to around 960,000 individuals in the 2010s (Fox & Leafloor, 2018). However, while this rapid increase in geese is seen as one of the major success stories of European bird conservation (Stroud et al., 2017), geese have caused significant agricultural damage to farmers (MacMillan et al., 2004; Tombre et al., 2013; Whitehouse, 2009).

Several management options have been trialled at varying scales to reduce agricultural damage by geese in Europe (Bainbridge, 2017; Fox et al., 2017). Interventions range from local-scale efforts by individual farmers to scare geese from their fields, to increasingly more complex and coordinated approaches at larger spatial scales. Such regional-scale policy encompasses coordinated scaring and financial compensations to affected farmers, or monetary subsidies to allow geese to feed on sacrificial crops or alternative feeding areas rather than farmland (Cusack et al., 2018; Eythórsson et al., 2017; McKenzie & Shaw, 2017; Simonsen et al., 2017). In some cases, interventions also include lethal control measures (McKenzie & Shaw, 2017). These management options, and culling in particular, have been fiercely opposed by some groups and fuelled conflicts among stakeholders (BBC, 2019; RSPB News, 2015; The Ferret, 2019). The large variation of conflict interventions across Europe and the United Kingdom and the social conflicts they have caused highlight the importance of understanding conflicts from farmer perspectives.

To date, the acceptability of alternative goose conflict interventions and their impact on farmer decision-making have been poorly understood. Yet, pilot or real-world interventions to address this knowledge gap would be difficult to implement because of costs and ethical concerns (Redpath et al., 2018). Also, larger scale policy options come with challenges with respect to coordination among neighbouring farmers and cannot be easily uncovered with individual questionnaire surveys. Experimental games, where individual stakeholders actively participate, can help overcome these challenges by building a model of strategic situations in which stakeholders can interact. Games also offer a low-cost and low-risk tool for predicting the impacts of different policy interventions on farmer behaviour (Redpath et al., 2018). In addition, conflict situations are often politically sensitive, and stakeholders can be wary of revealing personal opinions. Games can provide a safe atmosphere for investigating sensitive issues. The associations between individual or group traits and attitudes, and game decisions can also shed light on the social drivers of conservation conflicts and heterogeneity within a stakeholder group.

In this study, we developed a spatially explicit and dynamic experimental game to investigate farmer willingness to support goose conservation actions, and the factors that are conducive to pro-goose interventions. We specifically examined (a) the effect of various goose conflict interventions on game decisions (i.e. limited shooting and provision of sacrificial crops for geese) and (b) the links between within-game behaviour and farmer characteristics (e.g. socio-demographics, real-life experiences of damage by geese, number of geese shot on farms) and attitudes (e.g. attitudes towards various goose management schemes and features, institutional and interpersonal trust). We focused on the following three interventions: (a) support for scaring efforts; (b) financial payments for the provision of sacrificial crops in the form of flat rate subsidy and (c) agglomeration payments, an innovative scheme that incentivises spatially connected sacrificial crops.

2 | GOOSE-AGRICULTURE CONFLICT CONTEXT

Geese can cause agricultural damage to grass and arable crops by reducing sward structure and causing soil puddling and compaction, which may decrease crop yield (Owen, 1990). The on-farm costs of goose damage on Islay (an island off the west coast of Scotland) were estimated to be £11,000 per farm or £13 per goose for the 1999–2000 growing season (MacMillan et al., 2004). Agricultural losses derived from estimations of goose densities and goose droppings amounted to approximately £1.6 million on Islay alone (McKenzie & Shaw, 2017). Crop damage can be localised, with a smaller number of farmers experiencing a larger proportion of the damage (Mason, et al., 2018). On a national scale, the magnitude of damage can be substantial (Bjerke et al., 2014; Cope et al., 2005).

Various scaring methods (e.g. gas guns, scarecrows, active scaring) are used by farmers to chase geese away from fields. While individual farmers may gain from chasing geese off their fields as a tool for immediate solution, it needs to be combined with the provision of sacrificial crops or alternative goose feeding areas to be effective at reducing damage in the landscape scale (Månsson, 2017; Simonsen et al., 2017). That is, if scaring methods are implemented by farmers in isolation, geese may fly up to neighbouring farmlands, thereby intensifying conflict among neighbouring farms. However, if local farmers collectively provide sacrificial crops, and all scare, then most geese are corralled into the sacrificial crops keeping them off productive farmland. Sacrificial crops combined with scaring hold promise to reduce the agricultural losses caused by geese, while simultaneously ensuring that goose conservation objectives are met.

However, geese attracted to sacrificial crops might over-spill to adjacent farmlands and increase the amount of crop damage (Simonsen et al., 2017). Put simply, sacrificial crops may make things better for some farms but worse for farms close to the sacrificial crops. However, sacrificial crops may come at an opportunity cost to landowners, for example, if their provision requires foregoing profitable land for agriculture.

As conservation benefits might depend on spatial connectivity of land parcels, a block of contiguous land parcels may yield more wildlife than the same acreage scattered across the landscape (Auffret et al., 2015). Therefore, sacrificial crops might be more effective at attracting geese, and thus in reducing crop

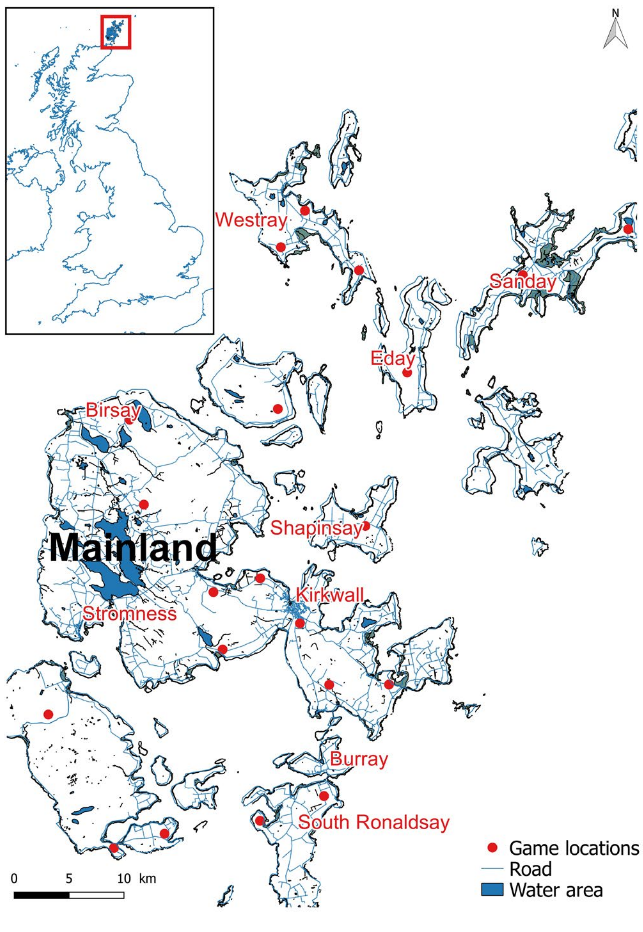


FIGURE 1 Geography of study area. Experimental games were conducted with 84 farmers in 17 locations across Orkney [Colour figure can be viewed at wileyonlinelibrary.com]

damage in farmland, when they are grouped in the same area than when fragmented (Madsen et al., 2014). A novel payment scheme termed 'agglomeration bonus' rewards such contiguity (Parkhurst & Shogren, 2007).

We developed a novel experimental game—Goosebumps—that explicitly accounts for context-specific information on the goose-agriculture conflict. Using Goosebumps, we tested the effect of three conflict interventions on farmer decisions: (a) financial and material support for scaring; (b) flat rate subsidy for sacrificial crops and (c) agglomeration payments that encourage spatial coordination of sacrificial crops.

Our games were conducted with farmers in Orkney (Figure 1) who actively manage farmlands and are familiar with the context in which land and goose management decisions are made. In Orkney, Scottish National Heritage (SNH) and local goose management groups established a 5-year (2012–2017) adaptive management pilot scheme which mostly consisted of goose culling (Milne, 2018). However, the pilot did not result in reduced agricultural damage (Milne, 2018). When the pilot ended in 2017, transitional funding was provided by SNH to support self-help and self-financing arrangements: local goose management groups were expected to develop business models that generate income from wildlife tourism, sport shooting and licenced sale of goose meat (Milne, 2018).

3 | METHODS

3.1 | Game design

The games were designed with Netlogo, a multi-agent modelling environment that allows the creation of interactive and multi-participant experiments and the incorporation of important spatial and ecological dynamics (Wilensky, 1999). The game design thus gave us the ability to use a stronger framing to capture higher degrees of social–ecological complexity than has been possible previously (Janssen et al., 2014). Our games were adapted from NonCropshare, a game built around pest management decisions (Bell et al., 2013).

The games were played in groups of four farmers using tablet computers linked via a mobile hotspot. Each of the four participants takes responsibility for land use decisions on a 3 × 3 grid-cell section (farm) of a 6 × 6 grid-cell agricultural landscape (Figure 2). Each participant had an equal share of the land in the game, a total of nine cells. In each of those cells, a player can: (a) farm the cell for private business, (b) farm the cell for private business and scare geese away, (c) farm the cell for private business and shoot geese and (d) provide sacrificial crops or alternative goose feeding areas, that is, sacrificial crops.

The game parameters were calibrated to reflect a realistic range of potential costs and benefit scenarios (the game protocol is in Appendix S1).

In each game round, there are a certain number of greylag geese in the landscape; geese decide where to go based on the 'attractiveness' of the land use options. Each land use has a weight assigned to it, with bigger weights meaning higher probability of attracting geese (Table 1). Sacrificial crops have a 'neighbourhood effect' of adding to the weight of any cell around them (in a radius 1 cell—up to 8 cells potentially affected). This captures the increased likelihood of geese grazing or foraging on farmers' lands that are close to roosting sites.

In a given round, if a farmer chooses scaring, then a subset of geese in scared cells leave and land elsewhere probabilistically based on cell weights. Scaring displaces geese with a probability of 0.6; displaced geese cannot return to the same cell. If a farmer chooses culling, then lethal shooting immediately removes geese from the landscape with a probability of 0.5. The number of geese in subsequent rounds therefore decreases with shooting efforts. Failed attempts at scaring or shooting imply that geese stay where they are. Reorientation of geese for the next round takes effect once all participants have confirmed their decisions in the current round.

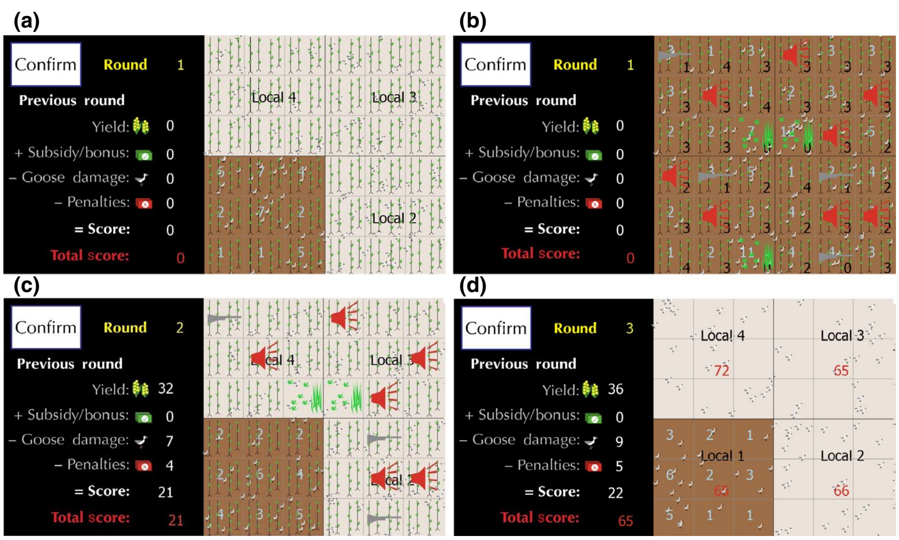
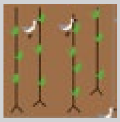
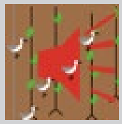
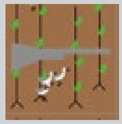
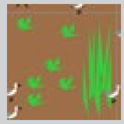


FIGURE 2 Visual representation of the digital farming landscape within Goosebumps. Game screen (a) Bottom-left corner of the landscape is the active player at round 1, geese are randomly distributed across the landscape; the white coloured number is the number of geese on each cell. (b) Game screen of the active player after all four players have made decisions. (c) Game screen at the start of round 2; actions taken by other players in previous turn are visible. The scores of the active player in previous round is shown in the left-hand side of the panel. (d) Game screen showing the total score for each player at the end of practice rounds [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 1 Parameters used in the game calibration

		1. Farm 	2. Farm and scare 	3. Farm and shoot 	4. Sacrificial crops 
Yield		4	4	4	0
Subsidy		0	0	0	X [2,4,6][a]
Crop damage		−0.16 per goose	−0.16 per goose	−0.16 per goose	0
Penalties or costs		0	−1	−2	0
Weight		10	5	2	80
Effectiveness			60%	50%	
Sacrificial crops neighbourhood effect		None	None	None	Adds 7 points of weight to all cells in a neighbourhood of 1[b]

[a]In the subsidy and agglomeration treatments, a subsidy of X points is awarded for each cell of sacrificial crops, where X is an integer taking one of three values [2, 4, 6]. The value is randomly assigned at the start of each game session.

[b]Affecting eight cells in total.

TABLE 2 Treatment conditions

Treatments	Subsidy for sacrificial crops	Cost of scaring geese off farmlands	Agglomeration bonus
Control: No external intervention	None	1	0
Support for scaring	0	0	0
Flat rate subsidy	2, 4 or 6[a]	1	0
Agglomeration payment	2, 4 or 6[a]	1	1 for every sacrificial crop that is contiguous to another sacrificial crop, excluding diagonal cells.

[a]Subsidy values were randomly selected at the start of the game and kept constant for the remainder of the experimental session.

Each land use decision has different costs and benefits (Table 1). Geese grazing on farmed cells generate agricultural losses. Sacrificial crops bring no yield. In some of the treatments (Table 1), a subsidy and/or agglomeration bonus is given for every sacrificial crop in the landscape.

$$\text{Score} = \sum_{n=1}^{9} \left(\text{Yield}_n + \text{Subsidies}_n - \text{Damage}_n - \text{Costs}_n\right).$$

3.2 | Experimental design and sampling

We used a within-subject design to test the effect of four randomly ordered treatments of six to eight rounds each (Table 2) on game decisions. The number of rounds was randomised to prevent participants from anticipating the conclusion of the treatment. Each game session began with a short practice session of three rounds. Participants played at least six rounds per game session.

We invited all willing farmers in Orkney to take part in the games. We ensured we surveyed both farmers on the mainland as well as the smaller isles. The participants were identified through a snowball approach via members of local goose management groups. We also actively recruited participants via social media and local media through articles and radio interviews. Our sample was, thus, not randomly selected. However, the sample summary statistics (age, source income, size of arable land and education) were consistently representative of the farming community in Orkney (Table S1; Orkney Economic Review, 2017). Each game participant represented one farm and the games took place at participants' houses. In total, we conducted 21 games sessions with 84 farmers across 17 locations in Orkney (Figure 1) in May, August and October 2018.

While incentivising game players by rewarding them based on the outcomes of their decisions may make the tasks more salient and hence motivate participants to focus harder (List & Price, 2016), our piloting in February and May 2018 suggested that introducing cash or in-kind payments was not appropriate. We took great care during the game administration to ensure that participants see the games as realistically as possible and consider it as a tool to express their preferences over the design of conflict management strategies.

The games were followed by debriefing interviews with 15 game participants to understand participant motivations for their decisions. These debriefing discussions also helped shed light on the extent to which participants made decisions that correspond to their true preferences. Interviewees were selected to cover the full spectrum of participant strategies in the games, that is, those that engaged a lot in lethal control, those that mostly scared geese away, and those that exhibited varying levels of willingness to provide goose habitats. The interviews were not audio-recorded given the sensitive nature of the data (particularly attitudes towards killing). Instead, we took notes and direct quotes where appropriate to aid the interpretation of the game outcomes.

We also administered a questionnaire survey after the games to collect information on participant characteristics, experience with damage by geese and attitudes (the survey is available at http://reshare.ukdataservice.ac.uk/854068/).

The research ethics committee of the University of Stirling approved this study (GUEP286). We explained to participants that the aggregated results would be published but would not be linked to farmer identity or farm location. All participants signed a written informed consent document before participating in our study.

3.3 | Data analysis

We examined two main game outcomes measured at the individual participant level: (a) decision to shoot geese and (b) provision of sacrificial crops. While these two strategies might not be mutually exclusive in goose management schemes, they seldom happen together at the individual farmer scale. These two game outcomes are particularly relevant to the exploration of behavioural responses to conflict interventions.

We modelled these outcome variables as proportion data in a two-vector response variable (proportion of cells with decisions to shoot, or with sacrificial crops provided in a given round respectively) using binomial generalised linear mixed effect models (GLMMs) with a logit-link function implemented within the LME4 package (Bolker et al., 2009). Household ID was included as a nested random effect within game ID to account for inter-household intra-group correlations. We controlled for learning by including rounds in the game and rounds into the entire game session as explanatory variables.

To relate behaviour in the game to attitudinal variables, we also included other explanatory variables from the questionnaire survey: (a) One aggregated measure of interpersonal trust among local communities; (b) four measures of institutional trust and (c) four measures of equity indices (Figure S1; Table S2). We also included aggregated measures of farmer attitudes towards three management options recommended by the Scottish government to support self-help and self-financing arrangements (Milne, 2018). These management options consist of developing business models that generate income from wildlife tourism, sport shooting and licenced sale of goose meat (Figure S2), each aggregated measure is the weighted factor scores of three variables generated from exploratory factor analyses with the R 'PSYCH' package using *oblimin* rotation (Revelle, 2018; Tables S3a–d).

To explore the effects of real-life farming practices and remoteness on game outcomes, we included household-reported experiences of goose agricultural damage, the total number of geese shot on own lands and the total travel time[1] from the main city (Kirkwall—the largest settlement and administrative centre in Orkney) as explanatory variables. In addition, we controlled for other socio-economic variables such as age, gender, education, sources of income, area of arable crops, livestock and the strength of relationships in the group (the average measure of how well players in the game know each other). We also considered two-level interactions between the treatments and other participant-related variables (such as reported experiences of crop losses, trust and equity attitudes). Tables S1 and S2 provide a detailed summary of the explanatory variables included in our models.

Model selection was carried out using backward stepwise selection of fixed effects based on the corrected Akaike information criterion (AICc) value (Barton, 2009). If AIC values differed by >2, models with the lowest AIC were selected, for models with a difference in AIC of <2, models with fewer degrees of freedom were selected (Barton, 2009). To avoid multicollinearity issues, we ensured that there were no significant correlations between the predictors. The Spearman-method test showed generally low-level correlation between the numeric predictors ($r^2 < 0.3$), while Pearson's chi-squared test for categorical variables indicated no significant correlations between the predictors. All analyses were conducted in R version 3.5.1 (R Core Team, 2018).

4 | RESULTS

4.1 | Participants' characteristics and attitudes

On average, game participants were 45 years old, had 13 years of formal education, owned 55.46 acres of arable land and reported

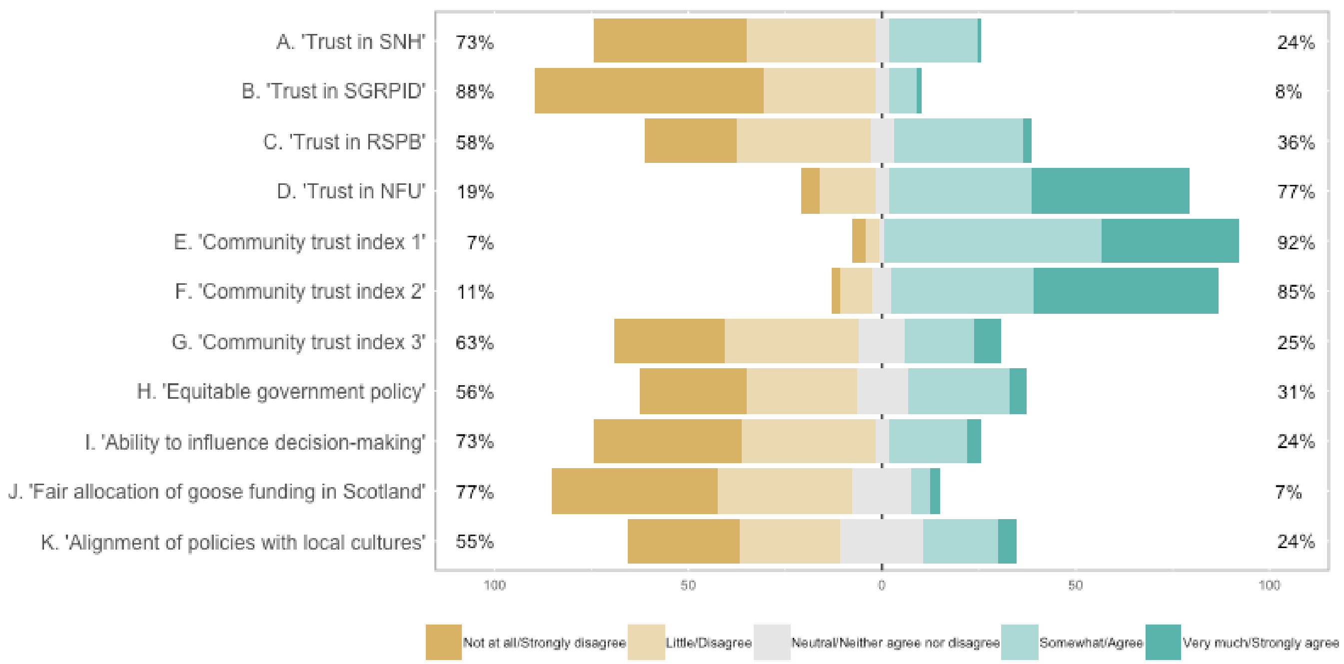


FIGURE 3 Diverging stacked bar charts of attitudinal trust and equity—Statements A to D were based on 'Not at all' to 'Very much' Likert scales, Statements D to K were based on 'Strongly disagree' to 'Strongly agree' [Colour figure can be viewed at wileyonlinelibrary.com]

20% agricultural losses to geese for the past 12 months (Table S1); 93% of participants were male. Interpersonal community trust was relatively high (>63%; Figure 3).

Participants generally reported negative attitudes on key equity indices; the share of participants who felt that the allocation of finances for the management of geese in Scotland is fairly distributed was <7% (Figure 3). Most participants (>73%) also perceived inequitable participation in decision-making processes (Figure 3). More than half of participants reported little or no trust towards governmental organisations (such as Scottish National Heritage; SNH) or non-governmental organisations (such as the Royal Society for the Protection of Birds; RSPB; Figure 3). However, more than 77% of the sample reported high levels of trust in the National Farmers Union (NFU). Interesting contrasts emerged from farmers' attitudes towards the three self-help management options: licenced sale of goose meat; wildlife or bird watching tourism; and sport shooting. For instance, more than 62% of the sample positively valued sport shooting and the sale of goose meat whereas the majority (>67%) rated wildlife tourism negatively (Figure S1).

4.2 | Factors affecting decisions to shoot geese in the games

All three alternative interventions, support for scaring, flat rate subsidy and agglomeration payments, significantly decreased decisions to shoot geese in the games (Table 3; Figure S2 and S3). Also, participants with more positive attitudes towards wildlife tourism were less likely to shoot (log-odds: −0.37, 0.95CI: −0.57 to −0.17; Table 3). Higher community trust levels strengthened the effects of the interventions in reducing farmers' decisions to shoot (cf. log-odds of interaction effects in Table 3 and Figure 4a). At lower community trust level, the effect of all three treatments (the support for deterrent in particular) on farmers' propensity to shoot geese were more pronounced (Figure 4a). Predicted mean proportions of shooting decisions decreased from 50%–60% to 20%–30% along increasing measures of community trust (Figure 4c). At the highest community trust level, discrepancies between the baseline and financial payments became smaller (Figure 4a).

Other farmers' real-life traits affected the impact of the interventions in the games; however, their effect size was small. The financial payments were more effective at reducing shooting among farmers who had more shooting on their own land in real life (self-reported estimates of number of geese shot on the respondent's own land for the past 12 months including geese shot by others; Table S1), and who were more remote (proxied by the total travel time from the main city, Kirkwall; Figure 4b,c. There was an increasing effect of the support for deterrent treatment on shooting for more remote farmers (Figure 4c).

Other game variables affected game decisions; decisions to shoot geese decreased as participants progressed through a game. Higher levels of payments in the monetary treatments were also significantly associated with more shooting (Figure S4). However, none of the institutional trust and other equity attitudinal variables (nor their interactions with treatments) were significant predictors of decisions to shoot geese in the games. While self-reported agricultural damage by geese slightly improved model fit, it did not affect farmers' shooting decisions (Table 3).

TABLE 3 Log-odds estimates from the reduced GLMM showing the effect of treatments and other farmers' characteristics and attitudes on participants' propensity to shoot geese in the games. Random effects included in the model were 'individuals' and 'groups'

	Proportion of decisions to shoot geese	
	Log-odds	95% CI
(Intercept: control treatment)	**−1.35***	**−1.69** to **−1.01**
Deterrents	**−0.22***	**−0.35** to **−0.10**
Subsidy	**−0.16**	**−0.28** to **−0.05**
Agglomeration	**−0.21***	**−0.34** to **−0.09**
Rounds within a game	**−0.47***	**−0.52** to **−0.43**
Rounds within a session	0.01	−0.05 to 0.06
Attitudes towards wildlife tourism	**−0.37***	**−0.57** to **−0.17**
Crop damage by geese	0.12	−0.09 to 0.33
Total travel time from the main city (a proxy of remoteness)	0.16	−0.18 to 0.51
Number of geese shot on own farm (in real life)	0.09	−0.12 to 0.29
Interpersonal trust among community members (Community trust)	−0.09	−0.31 to 0.13
Deterrents × Total travel time from the main city	0.12	−0.01 to 0.24
Subsidy × Total travel time from the main city	**−0.29***	**−0.41** to **−0.18**
Agglomeration × Total travel time from the main city	**−0.22***	**−0.34** to **−0.10**
Deterrents × Number of geese shot on own farm	**−0.13***	**−0.24** to **−0.02**
Subsidy × Number of geese shot on own farm	**−0.15***	**−0.26** to **−0.03**
Agglomeration × Number of geese shot on own farm	**−0.21***	**−0.32** to **−0.09**
Deterrents × Community trust	**−0.27***	**−0.39** to **−0.14**
Subsidy × Community trust	**−0.12***	**−0.24** to **−0.00**
Agglomeration × Community trust	**−0.22***	**−0.34** to **−0.10**
Random effects		
σ^2	3.29	
$\tau_{00\ HHID:GameID}$	0.46	
$\tau_{00\ GameID}$	0.42	
Observations	1,632	
Marginal R^2/Conditional R^2	0.108/0.296	

Bold values indicate coefficient estimates that are statistically significant.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

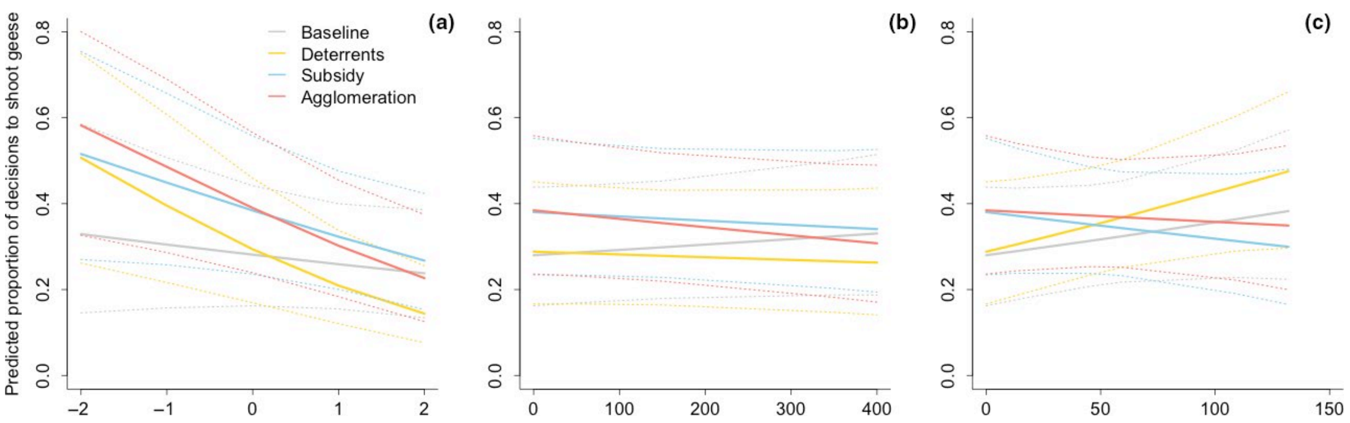


FIGURE 4 Predicted proportions of decisions to shoot geese in each treatment as a function of (a) Interpersonal trust among community members, (b) Number of geese shot on farm in real life, (c) Total travel time from the main city. Predicted values computed from the reduced model (Table 3) are shown for the average household and group. Dotted lines represent 95% confidence intervals [Colour figure can be viewed at wileyonlinelibrary.com]

4.3 | Determinants of decisions to provide sacrificial crops for geese

The three interventions all significantly increased decisions to provide sacrificial crops although the effect sizes of the two financial treatments were much stronger than the support for deterrents (Figure S2 and S3; Table 4). Farmers with more positive attitudes towards wildlife tourism (as a conflict mitigation tool) were also more likely to provide sacrificial crops (log-odds: 0.37, 0.95CI: 0.11–0.69; Table 4). The agglomeration payments were more effective at encouraging the provision of sacrificial crops when participants' perceived equity regarding the allocation of finances for conflict management was low (Figure 5c; Table 4). The predicted percentages of habitat decisions in the agglomeration treatment decreased from 32% to 9% along increasing levels of equity attitude.

The interaction coefficients of the treatments and farmers' real-life traits showed that farmers were slightly more responsive to the two monetary interventions when real-life self-reported crop damage was low, and when farmers had more shooting on their own lands in real life (proxied by the number of geese shot on farmers' land (Table 4; Figure 5a,b).

In addition, higher levels of payments in the monetary treatments were also associated with more sacrificial crops (Figure S4). However, unlike shooting decisions, neither remoteness, nor trust in neighbouring farmers had a significant effect on farmer decisions to provide sacrificial crops. As participants played more rounds through the entire game session, they were more likely to provide sacrificial crops for geese (Table 4). However, the proportions of sacrificial crops slightly decreased as participants progressed within a given treatment (defined as 'rounds in a game'; Figure S3; Table 4).

TABLE 4 Log-odds estimates from the reduced GLMM showing the effect of treatments and other household characteristics and attitudes on participants' propensity to provide sacrificial crops in the games. Random effects included in the model were 'individuals' and 'groups'

	Proportions of decisions to provide sacrificial crops	
Predictors	**Log-odds**	**Log-odds**
Intercept: Control treatment	**−4.78*****	**−5.48** to **−4.07**
Deterrents	**0.38***	**0.08** to **0.68**
Subsidy	**2.62*****	**2.37** to **2.88**
Agglomeration	**3.26*****	**3.01** to **3.52**
Rounds within a game	**−0.07***	**−0.12** to **−0.01**
Rounds within a session	**0.08***	**0.01** to **0.15**
Total travel time from the main city	0.01	−0.66 to 0.68
Crop damage by geese	**0.33***	**0.01** to **0.64**
Equity attitude: Fairness of goose finance allocation in Scotland	0.13	−0.20 to 0.46
Number of geese shot on own farm (in real life)	**−0.50***	**−0.89** to **−0.12**
Attitudes towards wildlife tourism	**0.37****	**0.11** to **0.64**
Deterrents × Crop damage by geese	−0.17	−0.43 to 0.08
Subsidy × Crop damage by geese	**−0.26***	**−0.46** to **−0.05**
Agglomeration × Crop damage by geese	**−0.46*****	**−0.66** to **−0.25**
Deterrents: × Equity attitude: Fairness of goose finance allocation in Scotland	0.00	−0.26 to 0.27
Subsidy: × Equity attitude: Fairness of goose finance allocation in Scotland	**−0.40*****	**−0.63** to **−0.17**
Agglomeration × Equity attitude: Fairness of goose finance allocation in Scotland	**−0.54*****	**−0.76** to **−0.31**
Deterrents × Number of geese shot on own farm	0.06	−0.29 to 0.41
Subsidy × Number of geese shot on own farm	**0.72*****	**0.42** to **1.03**
Agglomeration × Number of geese shot on own farm	**0.69*****	**0.38** to **1.00**
Random effects		
σ^2	3.29	
$\tau_{00\ \mathrm{HHID:GameID}}$	0.66	
$\tau_{00\ \mathrm{GameID}}$	2.02	
Observations	1,632	
Marginal R^2/Conditional R^2	0.293/0.610	

Bold values indicate coefficient estimates that are statistically significant.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

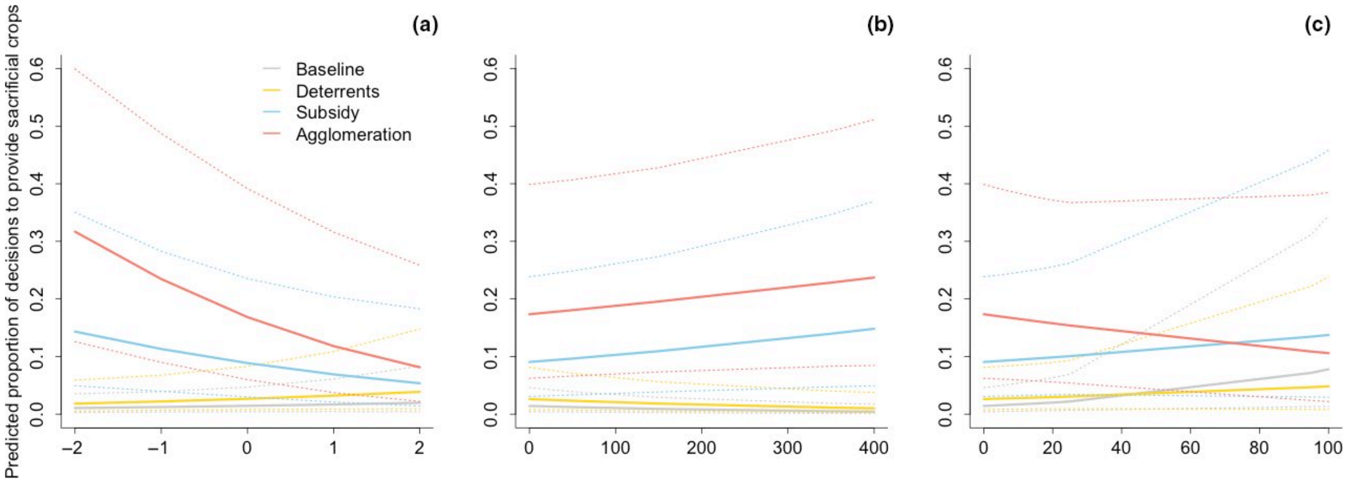


FIGURE 5 Predicted proportions of decisions to provide sacrificial crops in each treatment as a function of (a) Equity attitude: fairness of goose finance allocation in Scotland, (b) Number of geese shot on farm in real life, (c) Percentage of crop damage by geese. Predicted values computed from the reduced model (Table 4) are shown for the average household and group. Dotted lines represent 95% confidence intervals [Colour figure can be viewed at wileyonlinelibrary.com]

5 | DISCUSSION AND POLICY IMPLICATIONS

Conservation conflicts are notoriously complex, as involved stakeholders are not just influenced by material impacts but also by wider social and political factors (Madden & McQuinn, 2014). Our study highlights the critical role of community interpersonal trust and equity attitudes in supporting conflict resolution. All three conflict interventions were more likely to lower shooting in the game where levels of trust in other community members were higher. These results are consistent with previous experimental findings where participants with higher trust levels were more likely to cooperate and for local self-governance institutions to work (Bouma et al., 2008; Gelcich et al., 2013; Ostrom & Walker, 2003). In contrast to these previous studies, we did not find a significant effect of trust in conservation and government agencies (despite low levels; Figure 3), possibly because the framing of the game made no explicit reference to the agencies. The agglomeration payments led to an increased provision of sacrificial crops among farmers with negative attitudes towards the current allocation of goose finances in Scotland. This suggests that a more equitable redistribution of goose finances across different localities with goose-agriculture conflicts could improve farmers' attitudes and hence the efficiency of financial payments.

The role of increased community trust in promoting pro-conservation behaviour highlights the need to improve social cohesion, for example through community-based organisations and community workshops. Such improvement in community cohesion would in turn foster shared values among communities and improve structures for more cohesive democratic societies (International Institute for Democracy & Electoral Assistance, 2009; Young, Thompson, et al., 2016).

The game results also revealed that performance-based payments encouraged the provision of conservation outcomes, that is, reduced shooting and increased sacrificial crops for geese. Providing financial payments to people negatively affected by wildlife has been a common strategy in managing conservation conflicts (Dickman et al., 2011). However, these payments have been prioritised for highly valued species such as large carnivores (e.g. Zabel & Holm-Müller, 2008) or birds with a higher protected status such as barnacle geese (McKenzie & Shaw, 2017) but have not been considered for unprotected or partially protected species such as greylag geese despite the significant agricultural damage they cause to farmers in Orkney (Milne, 2018). While conservation payments have some challenges, such as determining the eligibility criteria, the appropriate payment level and monitoring methods (Dickman et al., 2011), they might reduce the financial impacts of greylag geese and improve distributional equity attitudes. Besides using monetary incentives to encourage pro-conservation behaviour, financial payments can also be a part of agri-environment and insurance schemes to offset the high-economic costs imposed by geese at a local scale.

One alternative conflict intervention is to channel some of the revenue generated by wildlife, for instance through wildlife tourism, to indirectly help offset costs and increase farmer tolerance towards problem species (Dickman et al., 2011). In Orkney, geese bring significant economic benefits by attracting winter tourism by bird watchers and shooters. Farmers can also earn revenue from allowing tourists to shoot geese on their lands. Our findings suggest that farmers with more positive attitudes towards wildlife tourism were more willing to support goose conservation interests. However, only 12% of the total sample had positive attitudes towards wildlife tourism as a conflict mitigation tool (Figure 3). Debriefing interviews with game participants revealed that while wildlife tourism significantly contributes to Orkney's economy, wildlife-related revenue is still limited and does not reflect the costs that individual farmers incur from crop damage by geese. Importantly, not every farmer equally benefits from tourism, especially those who are further away from the mainland, which may generate further social conflicts.

The success of conservation payments in our study was also a contingent on real-life shooting intensity on farmers' lands; farmers were more responsive to the payments at higher levels of shooting. The control measures implemented as part of the 'adaptive management pilot' were perceived by farmers to have only capped goose numbers but not significantly reduced the population (Milne, 2018). These licenced shootings have not, therefore, reduced farmers' concerns regarding the agricultural damage by geese. Other socio-economic factors strengthened the effectiveness of conservation payments in increasing participants' willingness to support goose conservation, such as lower agricultural damage and increased remoteness. More remote farmers (especially those on the isles) were more responsive to financial payments. Post-game debriefings revealed that in response to shooting pressure on the mainland, geese were displaced to more remote areas where there was very little impact before, and where there is seldom shooting because of the increased costs. As a result, more remote farmers were therefore more exposed to agricultural damage, and thus valued external help more highly.

Our study indicates that conflict interventions will need to go beyond understanding the ecological system (e.g. a focus on shooting bag targets) and seek to develop collaborative approaches that might lead to ownership of conflict interventions and improved social outcomes (Redpath et al., 2017). Collaborative governance strengthens democracy and improves equity attitudes by dealing with issues related to a lack of both legitimacy and acceptance of top-down approaches; improved equity might in turn lead to better conservation outcomes, as we found in this study. Such collaborative approaches could be materialised by the creation of committees tasked with understanding conflict context and indicators, developing conflict interventions, and monitoring and information sharing (Redpath et al., 2017).

Where conservation policy and practice have prevented farmers from taking direct action against crop-raiding species (e.g. by limiting shooting), farmers may expect government agencies to assume responsibility for providing adequate crop protection against wildlife (Hill, 2004). This can encourage people to expect compensation or extensive efforts from government agencies to control wildlife populations. If these expectations are not met, self-help arrangements might not suffice and might in the worst case further accentuate farmers' resentment towards conservation agencies (Hill et al., 2017).

6 | EXPERIMENTAL GAMES TO STUDY ENVIRONMENTAL ISSUES

Experimental games, also known as framed field experiments, are emerging as an important tool in the examination of natural resource dilemmas, with a range of applications in irrigation (Meinzen-Dick et al., 2016), fisheries (Cardenas et al., 2009), agriculture (Bell et al., 2016) and forests (Cardenas et al., 2009). Games which include dynamic simulations have improved our conceptual understanding of complex socio-ecological systems and human behaviour (Redpath et al., 2018). The constructivist approach to games, which includes board games and role-playing games have been used to promote engagement and foster dialogue among stakeholders (Garcia et al., 2016). Games have also been used as learning and facilitation tools among local communities by simulating long-term behavioural change over the span of a few hours (Janssen et al., 2014).

This study provides some of the first experimental evidence for the roles of games in addressing the multifaceted complexities of conservation conflicts embedded in socio-ecological systems (Mason, et al., 2018). Our study shows how complex the behavioural effects of varying policy interventions and their associations with social factors. The debriefing interviews also gave us additional insights into the complexity of farmer motivations. Our results provide support for the importance of innovative financial instruments in encouraging pro-conservation behaviour and allow for more targeted conflict interventions. Our findings also highlight the importance of socio-political elements such as community trust and equity attitudes in managing conservation conflicts in addition to addressing material losses to wildlife.

As experimental games are often designed to be simplistic and narrow in scope to isolate potential confounding effects, doubts might exist about the relevance of their results for predicting behaviour in the real world and the scope for generalisation (Bouma et al., 2008; Gelcich et al., 2013; Jackson, 2012). For instance, the games were set in a way that shooting reduces goose number and potentially leads to extinction, which would be a negative conservation outcome. However, there might be shooting levels that are ecologically sustainable. While it would have been ideal to incorporate such socio-ecological optimum in our game design, it would have come at the cost of tractability. Despite such limitations, the games provided farmers with a platform for trading off goose population against farming interests.

Games are part of a larger body of experimental findings that cumulatively can lead to improved insights (Janssen et al., 2014). We developed a game as a starting point for a conservation conflict where we know very little about farmers' perspectives and decision-making (but see Pollard et al., 2019). Our results demonstrate a number of relevant associations between farmers' experimental play and their real-life characteristics. In addition, the debriefing interviews uncovered rationales that are in line with the patterns observed. Most importantly, our experimental approach adds relevant insights and empirical evidence to existing conflict management tools (Young, et al., 2016) and is widely applicable to other conflict contexts.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTIONS

O.S.R. and A.B. conceived the ideas and designed the games, O.S.R., A.B., A.B.D., I.L.J., J.C. and N.B. provided important inputs on the research design; O.S.R., I.L.J., N.B. and J.H. collected the data; O.S.R. and J.C. analysed the data; O.S.R. led the writing of the manuscript. All the authors have contributed critically to the drafts and have given final approval for publication.

DATA AVAILABILITY STATEMENT

The data are archived at http://reshare.ukdataservice.ac.uk/854068/ (Rakotonarivo et al., 2020).

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ENDNOTE

[1] We used travel time instead of distance alone because of the need to account for ferry crossings.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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