Participation in planning and social networks increase social monitoring in community-based conservation

Steven M. Alexander$^{1,2}$ | Graham Epstein$^3$ | Örjan Bodin$^2$ | Derek Armitage$^3$ | Donovan Campbell$^4$

$^1$National Socio-Environmental Synthesis Center, Maryland, United States
$^2$Stockholm Resilience Centre, Stockholm University, Sweden
$^3$Environmental Change and Governance Group, School of Environment, Resources, and Sustainability, University of Waterloo, Waterloo, Canada
$^4$University of the West Indies, Mona Campus, Kingston, Jamaica

Correspondence
Steven M. Alexander, National Socio-Environmental Synthesis Center, 1 Park Place, Suite 300, Annapolis, Maryland 21401, United States.
Email: salexander@sesync.org

Funding information
Social Sciences and Humanities Research Council of Canada; Division of Biological Infrastructure, Grant/Award Number: #DBI-1052875; International Development Research Centre

Steven M. Alexander and Graham Epstein contributed equally to this work.

Abstract
Biodiversity conservation is often limited by inadequate investments in monitoring and enforcement. However, monitoring and enforcement problems may be overcome by encouraging resource users to develop, endorse, and subsequently enforce conservation regulations. In this article, we draw upon the literature on common-pool resources and social networks to assess the impacts of participation and network ties on the decisions of fishers to voluntarily report rule violations in two Jamaican marine reserves. Data was collected using questionnaires administered through personal interviews with fishers ($n=277$). The results suggest that local fishers are more likely to report illegal fishing if they had participated in conservation planning and if they are directly linked to community-based wardens in information sharing networks. This research extends well-established findings regarding the role and impacts of participation on biodiversity conservation by highlighting the importance of synergies between participation and social networks for voluntary monitoring of conservation regulations.

KEYWORDS
Caribbean, comanagement, community-based conservation, conservation planning, marine protected areas, natural resource governance, participation, small-scale fisheries, social networks

1 | INTRODUCTION

Monitoring and enforcement is crucial for successful resource management and conservation (Hilborn et al., 2006; Keane, Jones, Edwards-Jones, & Milner-Gulland, 2008; Ostrom, 1990; Rustagi, Engel, & Kosfeld, 2010). However, in many contexts the capacity and resources of public authorities to adequately monitor conservation regulations is lacking (Gill et al., 2017), and hence depend upon the voluntary contributions of resource users to protect against exploitation by free-riders (Dietz et al., 2003; Kocher, Cherry, Kroll, Netzer, & Sutter, 2008; Rustagi et al., 2010). The challenge of monitoring and enforcement is particularly salient in the context of newly established conservation initiatives where long-term outcomes often depend critically upon the establishment of supportive social norms in the early stages of implementation (Walmasley & White, 2003). Accordingly, there is an urgent need to better understand the conditions in which resource users will choose to engage in social monitoring with respect to conservation and resource management rules. In this article, we seek to address this gap by studying the effects of participation in conservation planning, and social connections to community-based wardens (i.e., park rangers), on individuals’ decisions to voluntarily report rule violations.

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2018 The Authors. Conservation Letters published by Wiley Periodicals, Inc.

Conservation Letters. 2018;11:e12562.
https://doi.org/10.1111/conl.12562
Identifying strategies and mechanisms for encouraging pro-conservation behavior is critical for effective conservation (St. John, Keane, & Milner-Gulland, 2013; Reddy et al., 2017). Research on the governance of common-pool resources (CPR; i.e., Ostrom, 1990; Agrawal, 2003) provides important institutional insights for conservation initiatives concerned with fostering and sustaining pro-conservation behavior among resource users. First, one of the central features of CPR theory, which has abundant empirical support, is the crucial role of participation in rule making (Baggio et al., 2016; Cox, Arnold, & Tomás, 2010; Ostrom, 1990; Persha, Agrawal, & Chhatre, 2011). More specifically, stakeholder participation in conservation planning (e.g., decisions about the boundaries of protected areas, associated rules, and regulations) can lead to increased legitimacy and social acceptance (Fox et al., 2012; Mascia, 2004; Mills et al., 2013; Ostrom, 1990, 2000; Sterling et al., 2017); and encourage stakeholders to engage in social monitoring (Bastakoti & Shivakoti 2012; Lundquist & Granek 2005). As a result, stakeholder participation is increasingly seen as an important, if not, essential component of conservation planning (Sterling et al., 2017).

Secondly, CPR theory also stresses the importance of shared norms for promoting and sustaining cooperation among resource users (Ostrom, 2000). Social networks can play a critical role in the adoption of social norms by providing critical conduits for the exchange of information and knowledge, and fostering the development of mutual trust (Bender & Swistak 2001; Levin, 2006). For example, social ties have been found to influence behavior in a wide range of relevant contexts, including fishing practices associated with bycatch avoidance (Barnes, Lynham, Kalberg, & Leung, 2016) and enforcement of sea tenure (Stevens, Frank, & Kramer, 2015). In general, there is abundant empirical evidence to suggest that the actions of local resource users are heavily influenced by their relationships in social networks (Bodin, 2017).

Here, we apply a social network perspective (Alexander & Armitage, 2015) to specifically focus on the role of social relationships between resource users and formally appointed community-based wardens. Repeated interactions with wardens in information sharing networks provides opportunities for establishing relationships based upon trust and reciprocity (Ostrom 2000), potentially increasing the likelihood of reporting rule violations. Moreover, as ideas and values spread within networks it is possible that fishers might come to adopt the pro-conservation values that appear to be held strongly by community-based wardens (see Alexander, Armitage, & Charles, 2015). It is important to note that the establishment of a social tie results from a number of different social processes (see Alexander, Bodin, & Barnes, 2018). By focusing on ties with wardens, we do not distinguish between these different processes explicitly, which would be beyond the scope of the article.

This article examines the impacts of participation in conservation planning and social ties to community-based wardens on social monitoring of conservation regulations by local small-scale fishers in two Jamaican marine reserves. The theoretical framework for this analysis is drawn from common-pool resource theory. We suggest that CPR theory is particularly relevant here because it draws attention to two general classes or social forces that may predict the likelihood of social monitoring. First, participation in conservation planning provides an institutional basis for investing in social monitoring through increased legitimacy and social acceptance of regulations. Second, social network ties provide a potentially critical relational basis for such investments by influencing social norms through interpersonal trust and the development of shared values. Although each of these factors is individually supported by empirical research, there remains an important gap regarding their relative importance and the ways in which they might interact, if at all, to influence behavior. We therefore hypothesize that although participation in conservation planning and social relationships with community-based wardens might be individually important, their impacts on social monitoring will be greatest when they are combined.

2 RESEARCH METHODS AND CONTEXT

In an effort to improve its fisheries, conserve biodiversity, and build resilience to climate change, Jamaica began the process of protecting more of its near shore marine area with the establishment of 12 Special Fishery Conservation Areas (SFCAs) – i.e., marine no-take areas – between 2009 and 2012. The SFCAs range in size from approximately 1 km² to 18.73 km². The majority of these SFCAs are in close proximity to small coastal communities with an active small-scale and artisanal fishery that is mixed gear (e.g., fish traps, spear guns) and multi-species (e.g., conch, lobster, reef fish) (Alexander et al., 2015). The Government of Jamaica (i.e., Fisheries Division) has established co-management arrangements with local non-governmental organizations and/or fishermen cooperatives that are responsible for the day-to-day management (e.g., monitoring) of these marine reserves (Alexander et al., 2015). Here, we focus on two of the SFCAs – Bluefields Bay SFC located along the southwest coast and Oracabessa Bay SFC located on the north coast (Figure 1). These SFCAs were selected to explore the social dynamics of conservation planning on the basis of several similarities that they share. First the SFCAs have been actively managed for a similar number of years (established between July 2009 and February 2010). Second, local organizations played a leading role in planning and implementation. Third, both SFCAs had a similar number of active fishers (Bluefields Bay, n = ~163-197; Oracabessa
Jamaica has established fourteen Special Fishery Conservation Areas to date with varying co-management arrangements. Not shown here is the South West Cay SFCA located at Pedro Bank, approximately 80 km south of Jamaica. The two SFCAs examined here are circled in red. (Map: D. Campbell)

Bay, \( n \approx 154-201 \); see SI 1.1 for additional details). Fourth and finally, a majority of wardens in each SFCA were selected based upon their relationship to fishing as a current or former fisher. These wardens are employed (i.e., not volunteers) by the respective local organizations with the management mandate.

Research was approved by the Office of Research Ethics at the University of Waterloo (ORE #18041). Permission to conduct research in Jamaica was obtained from the National Environment and Planning Agency. Data was collected between September 1st and October 31st, 2013 via questionnaires (see SI 2 for full questionnaire) administered through personal interviews with fishermen \( (n = 277) \). To capture as complete a network data set of fishermen as possible for each SFCA, lists of registered fishers provided by the Fisheries Division were coupled with lists of fishers produced by local community partners. Respondents from the list were also asked to suggest other fishers at each landing site. In addition, multiple visits to each landing site at varying times of day over the course of two weeks in September (Bluefields Bay) and two weeks in October (Oracabessa Bay) were made. This modified snowball sampling method was carried out until network closure had been reached—i.e., the addition and mention of new names was minimal, akin to saturation (Hanneman & Riddle, 2005). For specific details on data collection, ethics, and consent see Supplementary Information Section 1.1.

Network data collected was based on information-sharing ties. For specific details on the construction of the social network from the survey responses see Supplementary Information Section 1.2. This network data allowed us to capture a wide range of details about the structure of social interactions among actors in each SFCA, including whether fishers are tied to SFCA wardens. Data concerning other control variables concerning fishing activities and personal attributes of each respondent were also collected through the questionnaires (e.g., age, gear type). In addition, to capture participation in conservation planning, respondents were asked whether they attended one or more meetings associated with the planning and establishment of the marine reserve. Finally, respondents were asked: “If and when you see that someone is fishing illegally in the fish sanctuary, whom are you likely to share this with?” Due to the sensitive nature of the subject, the direct question was asked at the end of the survey following less sensitive questions relating to social network ties and after being reminded that their responses would be anonymous (see Nuno & St. John, 2015). This information was used to develop our measure of social monitoring, depending upon whether fishers included fish wardens or other government officials among their list of individuals with whom they would share information about illegal fishing. This question included a specific prompt allowing them to include a generic community-based warden or government official among their list of individuals. There was no distinction made as to whether the rule-breaker was from within or outside the community. See Figure 2 for the Analytical Framework illustrating the relationship between the focal variables, control variables, and outcome variable.

A logistic regression is used to estimate the impacts of participation and social network ties on the likelihood that a fisher would report illegal fishing in the marine reserves (i.e., social monitoring). Other approaches, including structural equation models, were considered but ultimately rejected due to the relatively small size of the sample and large number of potentially relevant indicators (Westland, 2010). Nonetheless, logistic regression allows us to explore the impacts of participation and social network ties on social monitoring, while controlling for several potentially important confounders.
Participation and network variables are effects coded (i.e., participation = 1; no participation = -1) to address issues associated with multcollinearity and to clearly distinguish between the main and interaction effects of participation and social network ties (for a detailed discussion on effects coding see Bech & Gyrd-Hansen, 2005). Summary statistics (i.e., mean, standard deviation, min, and max) and description of the variables included in the logistic regression model are presented in Table 1.

The logistic regression model also includes a number of control variables to account for potentially confounding factors. For instance, several studies have criticized Ostrom’s design principles for neglecting the role of shared interests and values in creating conditions conducive to participatory self-governance (e.g., Harkes, 2006; Singleton & Taylor, 1992), which could in theory explain both participation in conservation planning and social monitoring. We therefore control for membership in the local fisheries cooperative, which provides a general indication of the extent to which actors align their interests with that of the broader fishing community (Basurto, Bennett, Weaver, Rodriguez-Van Dyck, & Aceves-Bueno, 2013). It is, however, worth noting that membership can also provide individuals with access to lower cost fishing gear and other tangible benefits. We also include controls for

![Analytical framework identifying the variables of interest and causal relationships (solid arrows and dotted arrows)](image)

**TABLE 1** Summary statistics and variable descriptions ($n = 216$)

| Variable               | Description                                                                 | Mean    | Std. Dev. | Min | Max |
|------------------------|-----------------------------------------------------------------------------|---------|-----------|-----|-----|
| Monitoring             | Binary. Respondent indicates they would report illegal fishing to warden or other formal authority (outcome variable) | 0.472   | 0.500     | 0   | 1   |
| Participation          | Binary. Respondent participated in planning processes for fish sanctuary (self-reported) | 0.532   | 0.500     | 0   | 1   |
| Tie to warden          | Binary. Respondent has a direct tie to fish warden in information network   | 0.167   | 0.374     | 0   | 1   |
| Participation X Tie to warden | Binary. Interaction between participation and tie to warden                   | 0.111   | 0.315     | 0   | 1   |
| Coop member            | Binary. Respondent is a member of a fishing cooperative.                     | 0.403   | 0.492     | 0   | 1   |
| Full-time              | Binary. Respondent fishes on a full-time basis.                             | 0.639   | 0.481     | 0   | 1   |
| Age                    | Continuous. Age of respondent                                               | 44.426  | 16.215    | 18  | 91  |
| Line                   | Binary. Respondent uses hook and line for fishing.                          | 0.685   | 0.466     | 0   | 1   |
| Trap                   | Binary. Respondent uses traps for fishing.                                  | 0.495   | 0.501     | 0   | 1   |
| Net                    | Binary. Respondent uses nets for fishing.                                   | 0.370   | 0.484     | 0   | 1   |
| Spear                  | Binary. Respondent uses spear for fishing                                   | 0.264   | 0.442     | 0   | 1   |
| Orracabessa            | Binary. Respondent fishes near Orracabessa Bay fish sanctuary.              | 0.389   | 0.489     | 0   | 1   |
full time versus part time fishing, age, gear type, and SFCA. Level of engagement in fishery (full or part time) could potentially be an important factor since it indicates how reliant the users are on the fishery, which could affect their incentives for monitoring (Ostrom, 1990). Age is an important demographic variable in a multitude of contexts, and is therefore included here. Using different gear types implies using different fishing techniques, targeting different species, in different locations at different time periods (e.g., Cox, Wilson, & Pavlowich, 2016). These differences could affect fishers’ possibilities to monitor others, and they could also affect their attitudes towards the need for monitoring.

### 3 | RESULTS

The results of the logistic regression model are presented in Table 2. Model fit was assessed by visually analyzing residuals (Figure S1) to identify potential outliers, and by comparing the proposed model to one that excludes the interaction term using Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC) measures (Table S2). AIC and BIC measures provide an indication of the relative likelihood of two or more models, while penalizing models for including variables that do not contribute strongly to explaining the outcome. The difference in BIC values between the two models provides positive support (Raftery, 1995) in favor of including the interaction term in the statistical model.

The results presented in Table 2 indicate that both participation in conservation planning and social ties to fish wardens have a positive and statistically significant impact on the likelihood that a fisher would report illegal fishing in the sanctuary. Furthermore, the results provide general support for our hypothesis that social network ties to fish wardens moderate the impact of participation in conservation planning on social monitoring. Figure 3 plots the predicted probability of reporting illegal fishing as a function of different combinations of participation and social network ties, while holding all other values at their respective sample means. Although participation itself increases the likelihood of reporting illegal fishing, the likelihood is not significantly different from non-participants with network ties, or those who neither participated nor had network ties. Nonparticipants with network ties had the lowest likelihood of reporting illegal fishing. However, as was hypothesized the likelihood of reporting illegal fishing was significantly higher for individuals who had participated in conservation planning and also had a direct tie to fish wardens in information networks, with a likelihood of approximately 79%.

Finally the results also indicate that other factors may play a role in promoting social monitoring, including membership in fisher cooperatives, age, and gear types. Membership in the fishermen’s cooperative and line fishing increases the likelihood of reporting illegal fishing by approximately 19% and 15%, respectively, while trap fishing reduced the likelihood by approximately 9% while holding all other

| Variable                | Coefficient | Standard error | P-value | 95% Confidence interval |
|-------------------------|-------------|----------------|---------|-------------------------|
| Participation           | 0.657       | 0.268          | 0.014   | 0.132 1.182             |
| Ties to warden          | 0.217       | 0.003          | 0.000   | 0.210 0.224             |
| Participation X Ties to warden | 0.462       | 0.163          | 0.004   | 0.143 0.781             |
| Coop member             | 0.770       | 0.337          | 0.022   | 0.110 1.430             |
| Full time               | −0.114      | 0.484          | 0.814   | −1.062 0.834            |
| Age                     | 0.568       | 0.048          | 0.000   | 0.473 0.662             |
| Line                    | 0.612       | 0.367          | 0.096   | −0.108 1.332            |
| Trap                    | −0.356      | 0.162          | 0.028   | −0.673 −0.038           |
| Net                     | −0.123      | 0.705          | 0.861   | −1.505 1.258            |
| Spear                   | 0.147       | 0.217          | 0.497   | −0.278 0.573            |
| Orracabessa             | 0.623       | 0.050          | 0.000   | 0.525 0.721             |
| Constant                | −0.724      | 0.209          | 0.001   | −1.133 −0.314           |
| N                       | 216         |                |         |                        |
| Log-likelihood          | −125.006    |                |         |                        |
| Count R²                | 0.667       |                |         |                        |
| AIC                     | 252.012     |                |         |                        |
| BIC                     | 255.387     |                |         |                        |
| Max VIF                 | 2.24        |                |         |                        |
| Mean VIF                | 1.45        |                |         |                        |

Coefficients are in unadjusted log-odds units. Standard errors are clustered by SFCA.
parameters at their sample means. As mentioned earlier we would generally expect coop membership to correlate with a fisher’s general tendency to uphold agreed-upon fishery practices, and thus it is not entirely surprising to observe this relationship.

4 | DISCUSSION

The results of this research provides further evidence that stakeholder participation in the early stages of conservation planning can play an important role in catalyzing collective action in conservation contexts. Indeed, participation in institutional design (i.e., setting boundaries, rule-making) is consistently associated with increased social acceptance, compliance, and collective action (Ban et al., 2013; Epstein, 2017; Fox et al., 2012; Mascia, 2004; Mills et al. 2013; Ostrom, Gardner, & Walker, 1994; Reed, 2008; Sterling et al., 2017); and in some cases better conservation outcomes as well (Brooks, 2017; Brooks, Waylen, & Mulder, 2012; Cinner et al., 2016; Cox et al., 2010; Persha et al., 2011). As a result, conservation initiatives facing problems with enforcement and compliance should consider moving towards a more participatory approach, although important questions remain regarding the role and impact of different types of participation on stakeholder behavior and conservation outcomes.

Participation in conservation planning remains a subject of considerable academic study and debate. Although a full account of these debates is beyond the scope of this article, an important area of contention is the role and impacts of stakeholder participation at different stages in the process of developing and implementing conservation initiatives (e.g., Brooks et al., 2012; Reed, 2008; Sterling et al., 2017). In this particular case, because reserves were established recently, stakeholders had the opportunity to participate in designing and defining the basic structure of sanctuaries and associated management systems (e.g., boundaries). As a result, our research indicates that participation at early stages in planning marine reserves may foster social monitoring; but does not necessarily speak to the impacts of participation at later stages in conservation planning. Finally, it is also worth noting that participation in conservation planning may indirectly contribute to enforcement by fostering the establishment and/or strengthening of social ties as stakeholders come together at planning meetings. Indeed there is a positive and marginally statistically significant association between participation and network ties to community-based wardens ($\rho = 0.2272$, $P < 0.10$).

While the impacts of participation in conservation planning are notable, the results provide clear evidence that social networks can play an important role in moderating its impacts on the behavior of fishers. More specifically, fishers who participated in conservation planning and who were linked to community-based wardens in information sharing networks were more likely to report illegal fishing than participants lacking such ties. These results are generally consistent with recent findings in Stevens et al. (2015) and Barnes et al. (2016), highlighting the influence of social ties and networks on the behavior of fishers with respect to the enforcement of tenure at sea and use of bycatch avoidance techniques respectively. Indeed, social ties are increasingly being implicated for shaping the values of actors, as well as the opportunities, constraints, and incentives as they make decisions about their interactions with the environment and each other (Bodin, 2017). As a result it is not entirely surprising to find that

**FIGURE 3** Predicted probability of reporting illegal fishing. All other values are held at their sample means.
network ties are implicated in moderating the impacts of participation in conservation planning on social monitoring, posing both challenges and opportunities for conservation planners as they seek to develop and implement strategies to achieve conservation goals.

The results suggest that choosing the right wardens can enhance prospects for social monitoring. More specifically, our results suggest that fishers are more likely to report illegal fishing to wardens that are part of information sharing networks. As a result we would generally expect that actors with extensive ties in such networks to be more effective in promoting social monitoring within fishing communities. However, a number of potentially important caveats should be noted. First, if the network is highly fragmented, a few well-connected wardens could undermine potential contributions from less well connected, but nonetheless important, parts or groupings of fisher networks (e.g., Alexander et al., 2015). Second, well-connected individuals may also be highly polarizing and thus perceived as legitimate by some fishers and not others (Alexander et al., 2015). Accordingly, it is equally important to consider the structure of fisher networks as well as the personal attributes of fishers (e.g., age, gear type, personal qualities related to their character) before determining how many and which individuals should be retained as fish wardens.

Importantly, our study extends research emphasizing the role and impacts of institutional design on conservation; highlighting instead the important role that social networks play in moderating the impacts of institutional design on social monitoring. These findings, taken together provide important insights for policy and practice associated with community-based conservation with elements of external intervention. To improve the likelihood of success and avoid social dilemmas commonly associated with external interventions (e.g., shifting burden to intervenor; growth and underinvestment; see Cumming, 2018) our research points to three strategies that will contribute to strengthening reporting and enforcement: (1) encourage and support early participation in conservation planning; (2) foster opportunities for developing trust, legitimacy, and social ties—which will require accepting the additional transaction costs; and (3) identify individuals to serve as wardens who are not only well connected but are embedded across the network—particularly in heterogeneous communities.

It is important to note the limitations associated with this research. First and foremost is the reliance upon self-reports. Fishers were asked to indicate individuals with whom they would share details regarding the observation of illegal fishing, with the follow-up question of whether they would report illegal fishing to a fish warden or other formally designated official. Responses to these questions might overestimate levels of monitoring as a result of a social desirability bias (Shadish, Cook, & Campbell, 2002). Nonetheless we would not expect there to be systematic differences between participants and non-participants in conservation planning, nor between individuals that have or lack ties to wardens. Second, because this article uses information network measures alone, it is unclear whether our findings would extend to other types of networks (e.g., resource sharing, co-fishing). Third and finally, it is important to note that although fishers might report rule violations, this does not necessarily mean that this would result in sanctions. Indeed, wardens cannot rely exclusively upon information from others to determine whether an infraction has occurred, but may use this information to issue warnings or through future targeted enforcement.

5 | CONCLUSION

Conservation planners face growing pressures to accomplish ambitious targets despite limited resources. The Contracting Parties to the Convention on Biological Diversity reaffirmed their goal to protect and/or manage 10% of the world’s oceans and seas by means of MPAs by 2020 (Secretariat of the CBD, 2011). In addition, these targets have been adopted as part of the UN Sustainable Development Goal 14 (UN, 2016). Local resource users can therefore make invaluable contributions towards conservation, and enjoy the long-term benefits of these efforts. However, planners are increasingly recognizing the limits of institutional design for achieving conservation goals in challenging social and ecological contexts (Acheson, 2006; Levin et al., 2013). Our research, however, suggests that prospects for social monitoring in particular, and conservation in general might be enhanced by also being attentive to the value of user participation in planning activities and to social networks of fishing communities (Alexander, Andrichuck, & Armitage, 2016). Finally, this work illustrates the important contributions to be made to improve our understanding of community-based conservation and the governance of protected areas when a structurally explicit social relational network perspective (sensu Alexander & Armitage, 2015) is combined with an institutional perspective (sensu Nenadovic & Epstein, 2016).

ACKNOWLEDGMENTS

This research was supported by the Social Sciences and Humanities Research Council of Canada (SSHRC) and the International Development Research Centre (IDRC) through the Partnership for Canada-Caribbean Community Climate Change Adaptation, as well as through individual grants to S.M.A., D.A., and G.E. S.M.A. acknowledges support from the National Socio-Environmental Synthesis center through NSF Grant #DBI-1052875. Ö.B. acknowledges support from MISTRA. The authors also thank D.Gill and K.Wallen for their feedback on earlier drafts and suggestions for Figure 2.
REFERENCES

Acheson, J. M. (2006). Institutional failure in resource management. Annual Review of Anthropology, 35, 117–134.

Agrawal, A. (2003). Sustainable governance of common-pool resources: context, methods, and politics. Annual review of anthropology, 32(1), 243–262.

Alexander, S. M., Andrauchuck, M., & Armitage, D. (2016). Navigating governance networks for community-based conservation. Frontiers in Ecology and the Environment, 14(3), 155–164.

Alexander, S. M., & Armitage, D. (2015). A social relational network perspective for MPA science. Conservation Letters, 8(1), 1–13.

Alexander, S. M., Armitage, D., & Charles, A. (2015). Social networks and transitions to co-management in Jamaican marine reserves and small-scale fisheries. Global Environmental Change, 35, 213–225.

Alexander, S. M., Bodin, Ö., & Barnes, M. L. (2018). Untangling the drivers of community cohesion in small-scale fisheries. International Journal of the Commons, 12(1), 519–547.

Baggio, J., Barnett, A., Perez-Ibarra, I., Brady, U., Ratajczyk, E., Rollins, N., … Anderies, J. (2016). Explaining success and failure in the commons: The configurational nature of Ostrom's institutional design principles. International Journal of the Commons, 10(2), 417–439.

Ban, N. C., Mills, M., Tam, J., Hicks, C. C., Klain, S., Stoeckl, N., … Chan, K. (2013). A social–ecological approach to conservation planning: Embedding social considerations. Frontiers in Ecology and the Environment, 11(4), 194–202.

Barnes, M., Lynham, J., Kalberg, K., & Leung, P. S. (2016). Social networks and environmental outcomes. Proceedings of the National Academy of Sciences of the United States of America, 113(23), 6466–6471.

Bastakoti, R. C., & Shivakoti, G. P. (2012). Rules and collective action: An institutional analysis of the performance of irrigation systems in Nepal. Journal of Institutional Economics, 8(2), 225–246.

Basurto, X., Bennett, A., Weaver, A. H., Rodriguez-Van Dyck, S., & Aceves-Bueno, J. S. (2013). Cooperative and noncooperative strategies for small-scale fisheries' self-governance in the globalization era: Implications for conservation. Ecology and Society, 18(4), 38.

Bech, M., & Gyrd-Hansen, D. (2005). Effects coding in discrete choice experiments. Health Economics, 14(10), 1079–1083.

Bender, J., & Swistak, P. (2001). The evolution of norms. Journal of the American Chemical Society, 106, 1493–1545.

Brooks, J. S. (2017). Design features and project age contribute to joint success in social, ecological, and economic outcomes of community-based conservation projects. Conservation Letters, 10(1), 23–32.

Brooks, J. S., Waylen, K. A., & Mulder, M. B. (2012). How national context, project design, and local community characteristics influence success in community-based conservation projects. Proceedings of the National Academy of Sciences of the United States of America, 109(52), 21265–21270.

Bodin, Ö. (2017). Collaborative environmental governance: Achieving collective action in social-ecological systems. Science, 357(6352), eaan1114.

Cinner, J. E., Huchery, C., MacNeil, M. A., Graham, N. A., Mcclanahan, T. R., Maina, J., … Mouillot, D. (2016). Bright spots among the world's coral reefs. Nature, 535(7612), 416–419.

Cox, M., Arnold, G., & Tomáš, S. V. (2010). A review of design principles for community-based natural resource management. Ecology and Society, 15(4), 38.

Cox, M., Wilson, M., & Pavlovich, T. (2016). The challenges of local governance: Gear-based fragmentation in the Dominican fishery of Buen Hombre. Marine Policy, 63, 109–117.

Cumming, G. (2018). A review of social dilemmas and social-ecological traps in conservation and natural resource management. Conservation Letters, 11(1), 1–15.

Dietz, T., Ostrom, E., & Stern, P. C. (2003). The struggle to govern the commons. Science, 302(5652), 1907–1912.

Epstein, G. (2017). Local rulemaking, enforcement and compliance in state-owned forest commons. Ecological Economics, 131, 312–321.

Fox, H. E., Mascia, M. B., Basurto, X., Costa, A., Glew, L., Heinemann, D., … White, A. T. (2012). Reexamining the science of marine protected areas: Linking knowledge to action. Conservation Letters, 5(1), 1–10.

Gill, D. A., Mascia, M. B., Ahmadian, G. N., Glew, L., Lester, S. E., Barnes, M., … Holst, S. (2017). Capacity shortfalls hinder the performance of marine protected areas globally. Nature, 543(7647), 665–669.

Harkes, I. H. (2006). Fisheries co-management, the role of local institutions and decentralisation in Southeast Asia: With specific reference to marine sasi in Central Maluku, Indonesia. Centre of Environmental Sciences (CMLS), Faculty of Social and Behavioural Sciences, Leiden University.

Hanneman, R., & Riddle, M. (2005). Introduction to social network methods: Free introductory textbook on social network analysis. Retrieved from https://www.faculty.ucr.edu/~hanneman/nettext/

Hilborn, R., Arcese, P., Borner, M., Hando, J., Hopcraft, G., Loibooki, M., … Sinclair, A. R. (2006). Effective enforcement in a conservation area. Science, 314(5803), 1266–1266.

Keane, A., Jones, J. P., Edwards-Jones, G., & Milner-Gulland, E. J. (2008). The sleeping policeman: Understanding issues of enforcement and compliance in conservation. Animal Conservation, 11(2), 75–82.

Kocher, M. G., Cherry, T., Kroll, S., Netzer, R. J., & Sutter, M. (2008). Conditional cooperation on three continents. Economics Letters, 101(3), 175–178.

Levin, S. (2006). Learning to live in a global commons: Socioeconomic challenges for a sustainable environment. Ecological Research, 21, 328–333.

Levin, S., Xepapadeas, T., Crépin, A. S., Norberg, J., De Zeeuw, A., Folke, C., … Ehrlich, P. (2013). Social-ecological systems as complex adaptive systems: Modeling and policy implications. Environment and Development Economics, 18(2), 111–132.

Lundquist, C. J., & Granek, E. F. (2005). Strategies for successful marine conservation: Integrating socioeconomic, political, and scientific factors. Conservation Biology, 19(6), 1771–1778.
Mascia, M. (2004). Social dimensions of marine reserves. In J., Sobel & C., Dahlgren (Eds.), Marine reserves: A guide to science, design and use (pp. 164–186). Washington, DC: Island Press.

Mills, M., Pressley, R. L., Ban, N. C., Foale, S., Aswani, S., & Knight, A. T. (2013). Understanding characteristics that define the feasibility of conservation actions in a common pool marine resource governance system. Conservation Letters, 6(6), 418–429.

Nenadovic, M., & Epstein, G. (2016). The relationship of social capital and fishers’ participation in multi-level governance arrangements. Environmental Science & Policy, 61, 77–86.

Nuno, A., & St. John, F. A. (2015). How to ask sensitive questions in conservation: A review of specialised questioning techniques. Biological Conservation, 189, 5–15

Ostrom, E. (1990). Governing the commons: The evolution of institutions for collective action. Cambridge: Cambridge University Press.

Ostrom, E. (2000). Collective action and the evolution of social norms. J Econ Perspect, 14(3), 137–158.

Ostrom, E., Gardner, R., & Walker, J. (1994). Rules, games, and common-pool resources. Ann Arbor: University of Michigan Press.

Pershia, L., Agrawal, A., & Chhatre, A. (2011). Social and ecological synergy: Local rulemaking, forest livelihoods, and biodiversity conservation. Science, 331(6024), 1606–1608.

Rafer, A. E. (1995). Bayesian model selection in social research. Sociological Methodology, 25, 111–163.

Reddy, S. M., Montambault, J., Masuda, Y. J., Keenan, E., Butler, W., Fisher, J. R., … Gneezy, A. (2017). Advancing conservation by understanding and influencing human behavior. Conservation Letters, 10(2), 248–256.

Reed, M. S. (2008). Stakeholder participation for environmental management: A literature review. Biological Conservation, 141, 2417–2431.

Rustagi, D., Engel, S., & Kosfeld, M. (2010). Conditional cooperation and costly monitoring explain success in forest commons management. Science, 330(6006), 961–965.

Secretariat of the CBD. (2011). Aichi Target 11. Decision X/2. Convention on Biological Diversity.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). Experimental and quasi-experimental designs for generalized causal inference. New York: Wadsworth Cengage learning, Houghton Mifflin Company.

Singleton, S., & Taylor, M. (1992). Common property, collective action and community. Journal of Theoretical Politics, 4(3), 309–324.

St. John, F. A., Keane, A. M., & Milner-Gulland, E. J. (2013). Effective conservation depends upon understanding human behaviour. In Key Topics in Conservation Biology (Vol. 2, pp. 344–361). Oxford: John Wiley & Sons.

Sterling, E. J., Betley, E., Sigouin, A., Gomez, A., Toomey, A., Cullman, G., … Filardi, C. (2017). Assessing the evidence for stakeholder engagement in biodiversity conservation. Biological Conservation, 209, 159–171.

Stevens, K., Frank, K. A., & Kramer, D. B. (2015). Do social networks influence small-scale fisherman's enforcement of sea tenure? Plos one, 10(3). p.e0121431.

United Nations (2016). United Nations Sustainable Development Goal 14: Conserve and sustainably use the oceans, seas and marine resources. Retrieved from https://www.un.org/sustainabledevelopment/oceans/

Walmsley, S. F., & White, A. T. (2003). Influence of social, management and enforcement factors on the long-term ecological effects of marine sanctuaries. Environmental Conservation, 30(4), 388–407.

Westland, J. C. (2010). Lower bounds on sample size in structural equation modeling. Electronic Commerce Research and Applications, 9(6), 476–487.

SUPPORTING INFORMATION

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

How to cite this article: Alexander SM, Epstein G, Bodin Ö, Armitage D, and Campbell D. Participation in planning and social networks increase social monitoring in community-based conservation. Conservation Letters. 2018;11:e12562. https://doi.org/10.1111/conl.12562