Check for updates

Received: 14 October 2021 | Revised: 14 September 2022 | Accepted: 4 November 2022

DOI: 10.1111/csp2.12857

RESEARCH NOTE

Conservation Science and Practice
A journal of the Society for Conservation Biology
Open Access
WILEY

# Spread the word: Sharing information on social media can stabilize conservation funding and improve ecological outcomes

**Nao Takashina**[1] | **Hubert Cheung**[1,2] | **Mieko Miyazawa**[1]

[1]Department of International Studies, The University of Tokyo, Chiba, Japan

[2]School of Earth and Sustainability, Northern Arizona University, Flagstaff, Arizona, USA

**Correspondence**
Nao Takashina, Department of International Studies, The University of Tokyo, 5-1-5 Kashiwa, Chiba 277-0459, Japan.
Email: takashina@edu.k.u-tokyo.ac.jp

**Funding information**
JSPS KAKENHI, Grant/Award Number: 21K17913

**Abstract**

Conservation needs adequate support and funding to address our ecological crises. People support conservation in different ways, from social media engagement to donating money. Various factors influence how people choose to support conservation, including social norms and ecological status. The rise of social media has provided people with an easy and low-cost way to support conservation: sharing information online. How valuable is social media engagement and activism for conservation funding and outcomes? Here, we develop an evolutionary game-theoretic framework to understand the complex interactions between individuals in the context of social media information sharing, conservation philanthropy, and how these interactions ultimately impact ecological outcomes. From a game theory perspective, we can consider donors to be hard-cooperators, sharers of information on social media to be soft-cooperators, and those who do nothing to be non-cooperators. Our model shows that soft-cooperators can help stabilize conservation funding flows and develop social norms. Supporting conservation through social media sharing can ultimately contribute to conservation success. Our study conceptualizes the complex decision-making processes of conservation funding and affirms the importance and value of mobilizing all types of supporters in conservation.

**KEYWORDS**

conservation funding, conservation philanthropy, game theory, social media

## 1 | INTRODUCTION

Effective conservation is necessary to address catastrophic biodiversity loss and extensive ecological harm (Shiono et al., 2021; Watson et al., 2014). Preserving healthy ecosystems globally on land and in the oceans is estimated to require \$300 to \$400 billion annually, but in practice only 13%–17% of this target currently flows from public and philanthropic funds to conservation projects (Credit Suisse Group AG and McKinsey Center for Business and Environment, 2016). An expert panel of the Convention on Biological Diversity concluded in their estimation of various scenario-based costs of conserving nature that "investment must increase substantially from current levels in order to 'bend the curve' on biodiversity loss" (The United Nations Convention on Biological Diversity, 2020).

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.
© 2022 The Authors. *Conservation Science and Practice* published by Wiley Periodicals LLC on behalf of Society for Conservation Biology.



25784854, 0, Downloaded from https://conbio.onlinelibrary.wiley.com/doi/10.1111/csp2.12857 by Cochrane Japan, Wiley Online Library on [11/12/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Financial contributions to conservation from the public (e.g., Global Environmental Facility, official development assistance) and private (e.g., corporate social responsibility, payment for ecosystem service) sectors are vital and relatively stable (Balmford & Whitten, 2003; Novelli et al., 2016), but individual contributions are less predictable (Ramutsindela et al., 2013). Despite the typically smaller size of individual donations, the conservation funding potential from individuals is rapidly growing in the era of social activism and democratization of charitable giving (Novelli et al., 2016). For example, since 2000, the second largest source—approximately 40%—of World Wide Fund (WWF) for Nature's total revenue has been smaller donations from individuals (excluding major donors) (Anyango-van Zwieten et al., 2019). Raising both individual awareness and boosting philanthropic giving can, therefore, provide vital new funding for conserving ecosystems and mitigating ecological harm. However, it is often hard to attract supporters willing to contribute financially due to its immediate economic cost. Reaching more people, and attracting more and larger individual donations, is a priority for conservation.

New technologies present conservationists with new avenues of communication and fundraising. For instance, online crowdfunding platforms are already generating significant capital for biodiversity conservation (Gallo-Cajiao et al., 2018). With more than half of the world's population being active social media users today (Johnson, 2021), social media is expanding the reach of conservation messaging, as information can be spread easily and quickly. Word of mouth (or spreading the word) is a powerful mechanism for spreading information, and is an important and established marketing tool that evolved into "electronic word of mouth" in the digital space with the advent of social networking (Aramendia-Muneta, 2017; Groeger & Buttle, 2014). Social media is also diversifying the ways in which people can contribute to conservation funding. For example, the 2019 Australian wildfires spurred the largest Facebook fundraiser in history (Rosenblatt, 2020). Many conservation organizations now integrate social media into their fundraising strategies (di Lauro et al., 2019).

The rise of social media has enabled the emergence of a contingent of conservation supporters who do not donate money directly but are otherwise engaged in conservation through social media engagement like spreading information (Büssing et al., 2019; Kubo, Veríssimo, et al., 2021). This phenomenon has been dubbed "slacktivism" (also referred to as "armchair advocacy" and can be further categorized into "clicktivism" and "hacktivism"), whereby individuals are able to "perform a relatively costless, token display of support for a social cause, with an accompanying lack of willingness to devote a significant effort to enact meaningful change" (Kristofferson et al., 2014). Leyva (2016) defined slacktivism as "low-risk, low-cost activities via social media whose purpose is to raise awareness, produce change, or grant satisfaction to the person engaged in the activity."

The value of such information sharing on social media without a direct financial contribution is debated among environmental scholars. Critics lament that slacktivists are unlikely to engage or contribute in more meaningful ways beyond easy (or even lazy) token gestures of support online, such as, liking or sharing social media posts (Morozov, n.d.). Halupka (Halupka, 2014) describes slacktivism as "an ignorant, low-level participation which is more self-serving than of practical use." On the other hand, other scholars defend the merits of such digital activism and argue that any form of activism is valuable and legitimate (Halupka, 2014; Madison & Klang, 2020; Piat, 2019). For instance, Parsons (Parsons, 2016) asserted that "slacktivism could have a role to play in promoting positive change, and shouldn't be thought of negatively, but instead as a potential gateway to more to more substantive activism and advocacy." Peer communication is an important factor in normative social influences (Geber et al., 2019), and social media posts have been shown to be able to influence behavioral intentions (Kim, 2018).

So, are individuals who only share information on social media a help or a hindrance to achieving conservation goals? At present, how significant role of information sharing via social media might play in generating philanthropic donations for conservation—and ultimately improving conservation outcomes—remains unclear. Evolutionary game theory provides a powerful framework for modeling complex socio-ecological feedback on strategic decision-making in which the outcome of an individual's actions is depends on the actions of others and ecological status also affect their decisions (Bauch et al., 2016; Iwasa et al., 2007; Lee et al., 2015; Sun & Hilker, 2020; Suzuki & Iwasa, 2009a; Suzuki & Iwasa, 2009b). Here, we employ a similar framework to address this research question.

The purpose of this article is to develop theoretical insights into the behavioral interactions of various actors in the context of information sharing on social media and conservation philanthropy. In this study, we posit that every individual can be categorized as (a) a non-cooperator (those who are not engaged in conservation), (b) a soft-cooperator (those who share information only; spread-the-word effect), or (c) a hard-cooperator (those who philanthropically contribute money to fund conservation and who also share information). Whether someone is a non-cooperator, soft-cooperator, or hard-cooperator depends on a personal preference (utility function) involving ecological status and the behaviors of other people (or players, in game theory terms). For instance, the awareness of environmental risks or poor ecological conditions may increase people's levels of

25784854, 0, Downloaded from https://conbio.onlinelibrary.wiley.com/doi/10.1111/csp2.12857 by Cochrane Japan, Wiley Online Library on [11/12/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

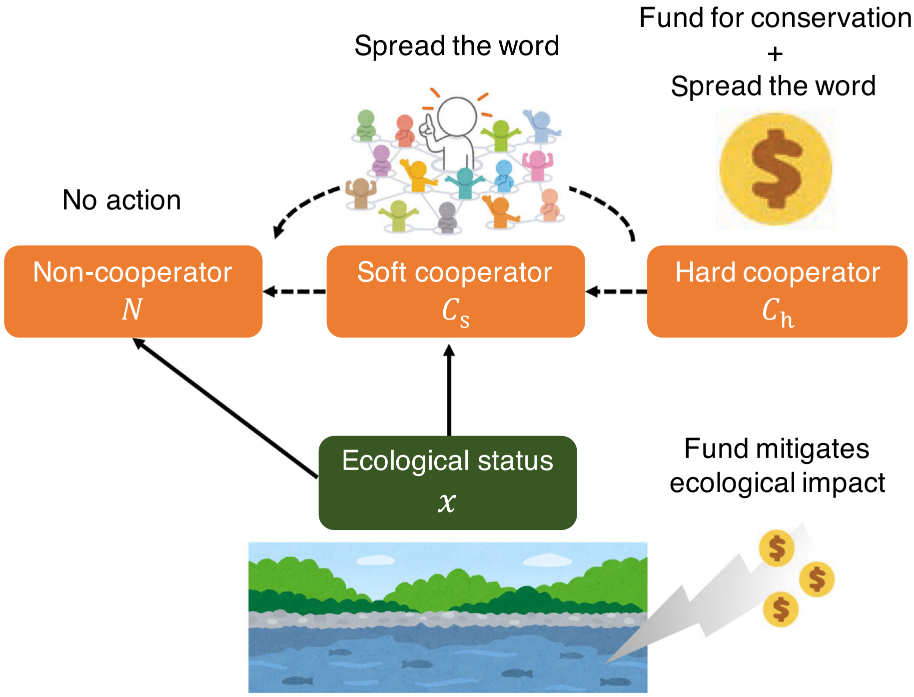


**FIGURE 1** Model scheme. Negative ecological impact degrades ecological status ($x$) at a non-persistent level. Soft cooperators ($C_s$) spread information on ecological systems (spread-the-word effect). In addition to spreading information, hard cooperators ($C_h$) contribute financially to conservation, thus mitigating ecological impact and improving ecological status. Solid arrows represent ecological concerns, and dashed arrows represent the social pressure to conform. The direction of arrows represents the direction of source and recipient of such effects.

**TABLE 1** Definition of key parameters

| Symbol | Parameter | Value |
|---|---|---|
| $h$ | Ecological impact | 1.5 |
| $a$ | Coefficient of funding efficiency | 3 |
| $q$ | Shape parameter of ecological concern | {1, 2, 10} |
| $\xi$ | Conformist coefficient | 3.0 |
| $\nu_s$ | Cost of being soft-cooperator | {0.05, 0,1, 0.5} |
| $\nu_h$ | Cost of being hard-cooperator | 3.0 |
| $k_s$ | Spread-the-word coefficient of soft-cooperator | 0–$10^4$ |
| $k_h$ | Spread-the-word coefficient of hard-cooperator | {10%, 30%, 50%} of $k_s$ |
| $\kappa_1$ | Background coefficient of ecological concern | 3.0 |
| $\kappa_2$ | Background half-saturation point of ecological concern | 10.0 |
| $\beta$ | Rationality parameter | 0–$10^2$ |
| $\rho$ | Rate of adapting new strategy | {1.0, 10} |

concern for the environment, which lowers the utility of non-cooperators and fosters a tendency for cooperation. We model the behavioral interactions of these different types of actors to investigate the impact of information sharing on conservation funding, as well as the downstream impact on ecological and conservation outcomes.

## 2 | MATERIALS AND METHODS

Here, we outline the model used in the analysis (Figure 1) in which a population consists of homogeneous individuals. Technical details are available online in the Supporting Information Appendix A. Key parameters of the model and parameter values used in the following discussion are given in Table 1.

### 2.1 | Strategic decision-making

In this model, we assume that there are three types of actors each individual reversibly takes: being non-cooperator ($N$), soft-cooperator ($C_s$), and hard-cooperator ($C_h$). We define each of them as follows:

25784854, 0, Downloaded from https://conbio.onlinelibrary.wiley.com/doi/10.1111/csp2.12857 by Cochrane Japan, Wiley Online Library on [11/12/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

- Soft-cooperators who share conservation information with the spread-the-word coefficient $k_s$
- Hard-cooperators who share conservation information with the spread-the-word coefficient $k_h$ and donate to conservation
- Non-cooperators who do neither

To be a soft- or hard-cooperator, one must reduce the utility that accounts for the cost of cooperation (Suzuki & Iwasa, 2009a). The cost for being a soft-cooperator is smaller than that of being a hard-cooperator ($\nu_s < \nu_h$). In our game-theoretic model, strategic decision-making occurs in such a way that each individual tends to improve their utility over time but with bounded rationality. To describe this situation, we employ the logit-response function (Alós-Ferrer & Netzer, 2010; Lee et al., 2015; Sun & Hilker, 2020; Suzuki & Iwasa, 2009b) where the accuracy of the decision is controlled by the rationality parameter $\beta$: (perfect) rational decision occurs when $\beta = \infty$ and random (i.e., utility-independent) decision occurs when $\beta = 0$. We present the form of the logit-response function in Figure A1 for the case of two types of actions.

Previous theoretical studies accounted for the effect of social norms (conformist tendency) and ecological concern in the utility function of non-cooperators with the following form: (ecological benefit)–(social pressure) (Suzuki & Iwasa, 2009a), where the model was used in analyzing conflict between two groups over the environmental issue of lake water pollution. In the model, ecological benefit comes from the concerned ecosystem and social pressure is composed of social norm and ecological concern. These are physiological factors and dimensionless; hence, it is possible to multiply and subtract them.

Past studies have found charitable behavior to be influenced by perceptions of what others are doing or giving, and that such conditional cooperation is able to increase both contribution rates and donation levels (Wiepking & Heijnen, 2011). This is because charitable actions can accrue benefits to social reputation, while uncharitable actions can incur costs to social reputation (Milinski et al., 2006; Reinstein & Riener, 2012). For instance, a natural field experiment found that manipulating the social information available to potential donors by altering what was visible in a donation box had a significant impact on donation composition (coins or bills), frequency, and value (Martin & Randal, 2008). Croson et al. (2009) also found that donation behavior is influenced by norm perceptions, with donors making higher contributions if they are under the impression that others are also making large donations. Increasing the visibility of acknowledgements of monetary contributions to conservation efforts by hard-cooperators may also play positively into the psychology of charitable giving and ultimately generate more funds for conservation (Reinstein & Riener, 2012).

Peoples' attitudes toward conservation may also be influenced by ecological status. Clements (Clements, 2013) noted that peaks in public interest from highly publicized extinction events, such as Yangtze River Dolphin (*Lipotes vexillifer*) in 2007 and the Japanese River Otter (*Lutra lutra whiteleyi*) in 2012, seem to coincide with increases in the number of charitable pledges made. Milinski et al. (Milinski et al., 2006) found through a public goods game that people tends to invest more money when they are well informed about climatic state than when they are less informed. Furthermore, they showed that when people know others' status of investment, the well-informed group substantially increased their own investment.

These empirical observations support the form of the utility function of non-cooperators introduced above. Note that there are the utility functions that do not specify the ecological benefit (e.g., Sun & Hilker, 2020; Suzuki & Iwasa, 2009b), but people's decision-making is assumed to be based on the difference of the cost of strategies. In this regard, these definitions are consistent with each other.

Here, we adopt the aforementioned definition of the utility function of non-cooperators as:

$$\begin{aligned}\text{Utility of non}-\text{cooperator} = &(\text{Ecological benefit})\\ &-(\text{Social norm})\\ &\times(\text{Ecological concern}).\end{aligned}$$

These can be formally described as (see Supporting Information Appendix A):

$$U_N = \underbrace{\lambda(x(t))}_{\text{ecological benefit}} - \{\overbrace{\xi(C_s + C_h)}^{\text{social norm}} + \kappa_1\} \underbrace{\frac{\left(\kappa_2 + \overbrace{k_s C_s + k_h C_h}^{\text{spread-the-word effect}}\right)^q}{(\kappa_2 + k_s C_s + k_h C_h)^q + x^q}}_{\text{ecological concern}}, \tag{1}$$

where $U_N$ indicates the utility of non-cooperators, and the magnitude of ecological concern is amplified by the social norm term (conformist tendency) that is a function of the fractions of soft- and hard-cooperators and the conformist coefficient ($\xi$). If social pressure (the second term in Equation (1)) becomes large, it reduces the incentive to be a non-cooperator. This drives an individual to choose a cooperative action. $\kappa_1$ and $\kappa_2$ are the background (i.e., without spread-the-word effect) coefficient and half-saturation point of ecological concern, respectively. Note that $\kappa_2$ accounts for background conservation information as this is a shape parameter of the function of ecological concern. Likewise, the spread-the-word effect of soft-

25784854, 0, Downloaded from https://conbio.onlinelibrary.wiley.com/doi/10.1111/csp2.12857 by Cochrane Japan, Wiley Online Library on [11/12/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

and hard-cooperators alters the response to ecological concern $x$, and these magnitudes are controlled by the spread-of-the-word coefficients $k_s$ and $k_h$, respectively. We provide examples of the functional form of ecological concern in Figure A2. Note that for a non-cooperator to become a soft-cooperator, the cost of being a soft-cooperator $\nu_s$ must be incurred. In return, social pressure is mitigated as this effect comes only from hard-cooperators, rather than both soft- and hard-cooperators.

### 2.2 | Ecological status and funding effect

We describe the dynamics of ecological status (e.g., forest cover, population size of a species) $x$ using logistic growth with the maximum growth rate $r$ and carrying capacity $K$, and ecological impact $h$ that is set at a biologically unsustainable level (i.e., $h \geq r$). The ecological impact is mitigated by the factor $e^{-a'}F$. Conservation funding currently available is a function of the number of non-cooperators that is denoted by $F = mnC_h$, where $m$ is a donation per individual and $n \gg 1$ is the population in the concerned community. $a'$ is the coefficient of the funding effect on the mitigation of ecological impact.

### 2.3 | Dynamics of socio-ecological feedback

Without loss of generality, we use the following notation $aC_h = a'F$ to make the fraction of hard-cooperators $C_h$ explicit in the dynamics of ecological status. From the viewpoint of evolutionary game theory, the dynamics of the whole system can then be written (see Appendix A) as:

$$\frac{dx}{dt} = rx\left(1-\frac{x}{K}\right) - he^{-aC_f}x, \tag{2a}$$

$$\frac{dC_s}{dt} = \rho\left(\frac{1}{1+e^{-\beta\Delta U_{C_s,N}}+e^{-\beta\Delta U_{C_s,C_h}}} - C_s\right), \tag{2b}$$

$$\frac{dC_h}{dt} = \rho\left(\frac{1}{1+e^{-\beta\Delta U_{C_h,N}}+e^{-\beta\Delta U_{C_h,C_s}}} - C_h\right), \tag{2c}$$

where the notation $\Delta U_{y,z} = U_y - U_z$ describes the difference between the utilities of the strategy $y$ and $z$ (these functional forms are provided in Appendix A).

Due to its complex structure, Equations (2a–2c) are not amenable to mathematical analysis. However, approximating the model as two-strategy dynamics demonstrates the possibility of obtaining general insights into model behaviors and parameter dependencies. We utilize these results to instruct our numerical simulations (see Appendix B for technical details).

## 3 | RESULTS

Our numerical simulations suggest that the model dynamics show two phases: oscillation and stable dynamics of ecological status and the proportion of each strategy. In practice, oscillations in the system dynamics indicate highly variable funding flow over time, resulting in unstable levels of ecological status. These two phases occur in a wide range of parameters, such as, the cost of being soft-cooperator ($\nu_s$), the shape parameter of ecological concerns ($q$), and the spread-the-word coefficient of hard-cooperators ($k_h$). Such phases in a parameter space are summarized along with the population size, where a brighter color represents a larger population size (Figure 2) and the fraction of hard-cooperators (Figure 3) when the shape parameter of ecological concerns is $q = 2$. In each panel, the lower region of the black curve represents a parameter space where dynamics tend to converge to equilibrium (stable phase) and fluctuate (oscillation phase) otherwise.

Overall, the oscillation phase in the dynamics tends to occur when the rationality parameter ($\beta$) is large and the spread-the-word coefficient of the soft-cooperator ($k_s$) is small. In the oscillation phase, (average) ecological status ($x$), and the (average) fraction of hard-cooperators ($C_h$) tend to be smaller than stable phase (e.g., Figures 2d and 3d, respectively). On the other hand, the oscillatory dynamics are replaced with the stable phase as the spread-the-word coefficient of soft-cooperators ($k_s$) becomes larger: this is the effect of information sharing. The stable phase tends to provide a higher ecological status at equilibrium ($x$*) and fraction of hard-cooperators ($C_h$; e.g., Figures 2d and 3d, respectively). This stabilizing effect due to information sharing becomes more significant when hard-cooperators also share information (i.e., $k_h$ is large). The mathematical reasoning of the stabilizing effect is provided in Appendix B. Our results demonstrate that a lower cost of being a soft-cooperator makes the region of the oscillation phase smaller (e.g., see Figure 2a vs. 2d). Qualitatively similar trends are found with different values of the effect of shape parameter in ecological concern $q = 1$ (Figures A3, A4) and $q = 10$ (Figures A5, A6). Additionally, we examined the effect of the rate of adapting to a new strategy ($\rho = 10$) in Figures A7 and A8. This parameter does not affect the shape of isocline and equilibrium value, but it influences the stability of equilibrium (Suzuki & Iwasa, 2009b). Accordingly, parameter space exhibiting

25784854, 0, Downloaded from https://conbio.onlinelibrary.wiley.com/doi/10.1111/csp2.12857 by Cochrane Japan, Wiley Online Library on [11/12/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

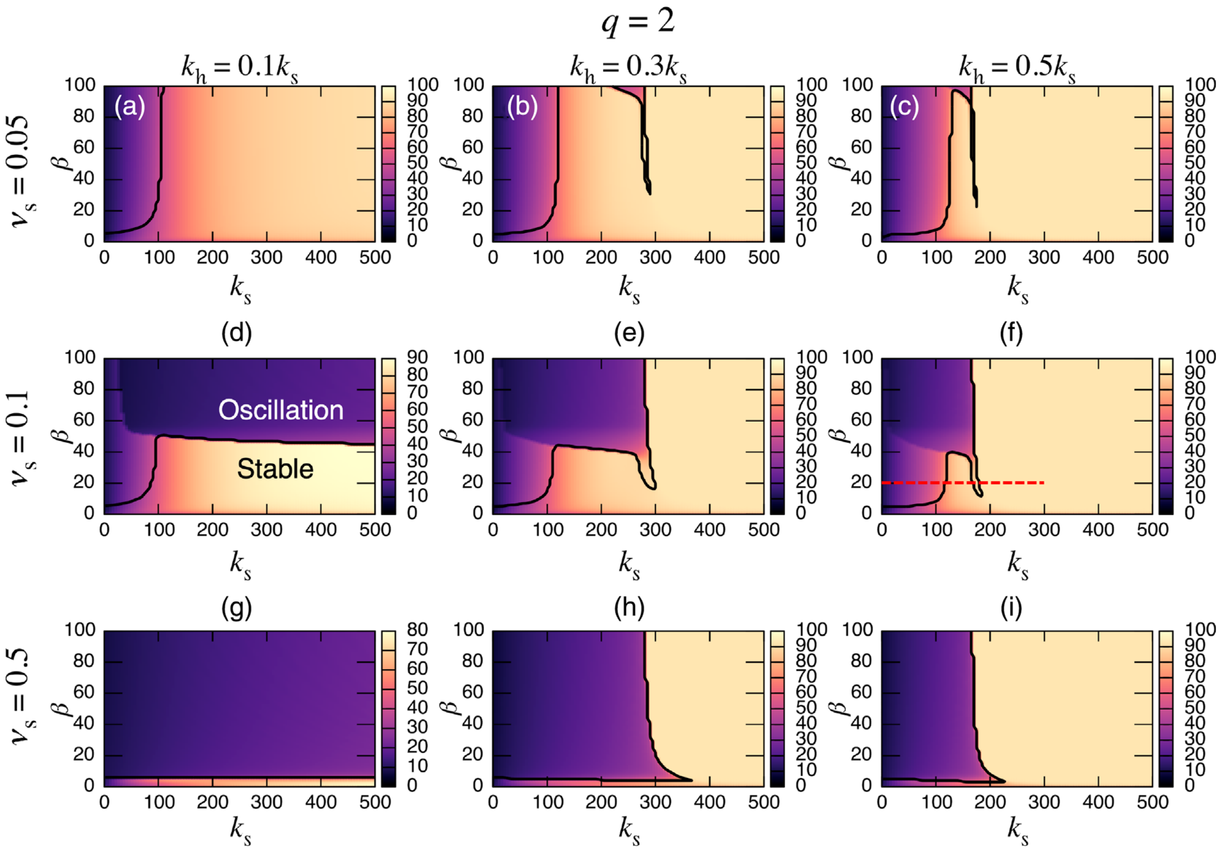


**FIGURE 2** Phase diagrams overlapped with ecological status ($x$). Each column represents the different strength of the spread-the-word effect of the hard-cooperator ($k_h$); and each row represents different costs of being the soft-cooperator ($\nu_s$). Parameter values used are $r = 1.0$, $K = 100$. See Table 1 for the other parameter values used. The black bold curve divides oscillation and stable phases of the dynamics and the panel (d) describes this explicitly. The red dashed line is the region used for the bifurcation analysis. See the main text for more explanation.

oscillatory dynamics are slightly expanded (e.g., compare Figure 2a with Figure A7a). However, similar qualitative trends still hold.

We can take a closer look at the results above. Figure 4a is a bifurcation diagram where parameter values correspond to the dashed line in the parameter space shown in Figure 2f. The bifurcation diagram demonstrates that there are three points in the value of the spread-the-word coefficient of the soft-cooperator ($k_s$) where the oscillatory and stable phases switch, giving rise to four characteristic model dynamics (Figure 4b–e). When the spread-the-word coefficient of the soft-cooperator ("the spread-the-word coefficient" hereafter in this section) is small (Figure 4b), the dynamics show oscillatory behavior; when the spread-the-word coefficient is increased, ecological status converges to equilibrium (Figure 4c); the phase is again reversed, and oscillation again occurs as the spread-the-word coefficient is further increased (Figure 4d); and after crossing a certain value, oscillation is suppressed (Figure 4e). The bifurcation diagram also shows that as the spread-the-word coefficient ($k_s$) increases, ecological status ($x$) tends to increase, and the effect on ecological status eventually saturates as the spread-the-word coefficient becomes sufficiently large. At this limit, the ecological status becomes the largest, and all players become hard-cooperators. It is curious that the fraction of the non-cooperators ($N$) tends to be very small or zero when the spread-the-word coefficient ($k_s$) is small (e.g., Figure 4b,c) while it becomes large when the coefficient is relatively large (e.g., Figure 4d). This may be a product of a high non-linearity induced by strategic decision-making. A similar bifurcation map can be drawn using, for instance, Figures 2e or A3e varying $k_s$ from 0 to 330 at $\beta = 20$.

# 4 | DISCUSSION

## 4.1 | Spreading the word can improve conservation outcomes

Motivated by the need for understanding the complex human dimensions involved in conservation funding and

25784854, 0, Downloaded from https://conbio.onlinelibrary.wiley.com/doi/10.1111/csp2.12857 by Cochrane Japan, Wiley Online Library on [11/12/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

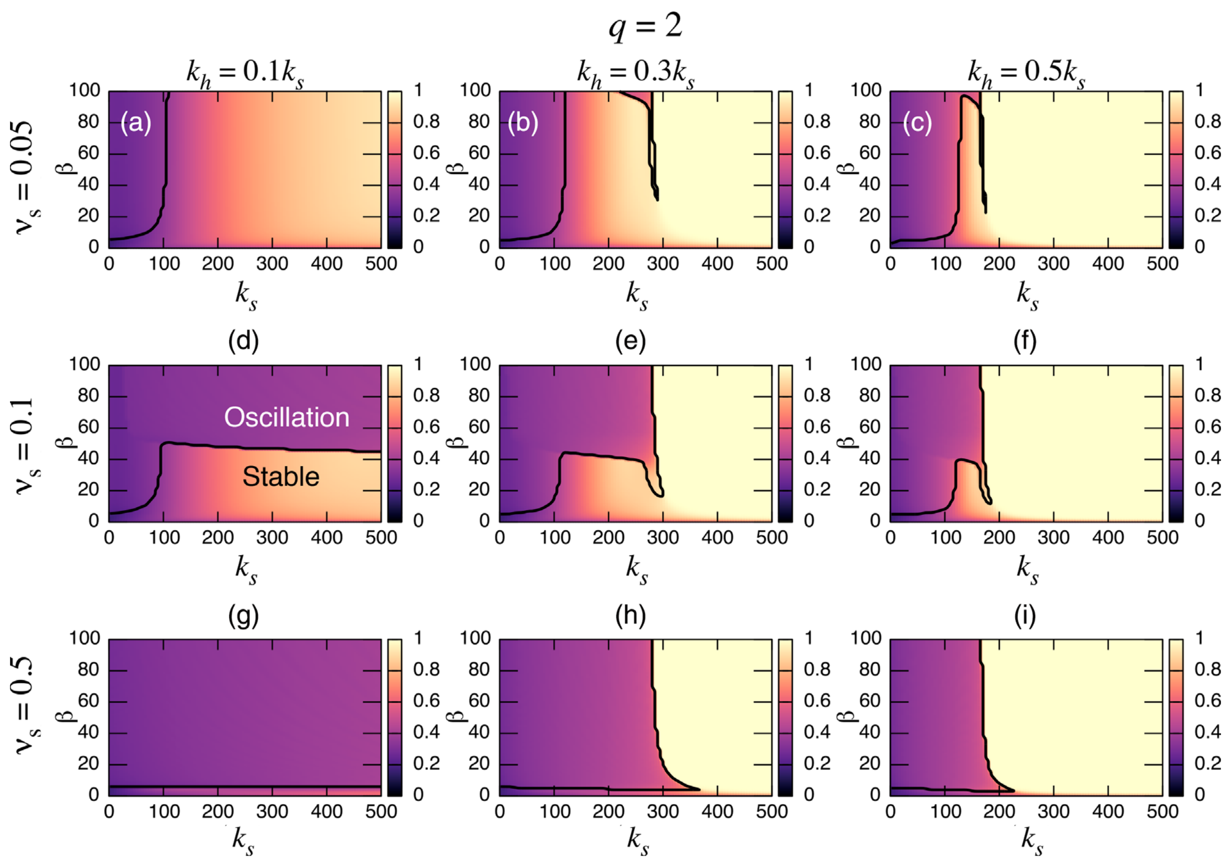


FIGURE 3 Phase diagrams overlapped with the fraction of hard-cooperators ($C_h$). Each column represents the different strength of the spread-the-word effect of the hard-cooperator ($k_h$); and each row represents different cost of being soft-cooperator ($\nu_s$). Parameter values used are the same as in Figure 2. The black bold curve divides oscillation and stable phases of the dynamics and the panel (d) describes this explicitly.

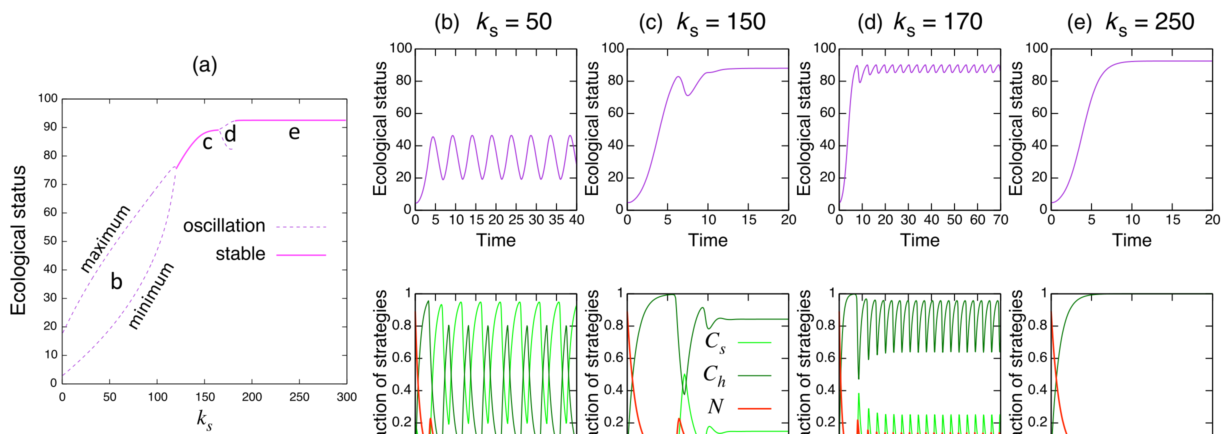


FIGURE 4 (a) Bifurcation diagram where the parameter space corresponds to the dashed line in Figure 2 middle-right panel; and (b–e) dynamics of ecological status (top) and the fraction of each strategy (bottom). In the bifurcation map, we plot the maximum and minimum ecological status of the oscillating dynamics. Parameter values used are the same as in Figure 2 (middle-right panel)

emergent behavior toward conservation with the advent of new technologies in cyberspace, we developed a new mathematical framework to investigate the importance of information sharing in conservation philanthropy. Our findings suggest that conservation information shared on social media has the potential to improve people's

25784854, 0, Downloaded from https://conbio.onlinelibrary.wiley.com/doi/10.1111/csp2.12857 by Cochrane Japan, Wiley Online Library on [11/12/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

conservation awareness. The theoretical findings from our study are consistent with the fact that raising public awareness improves conservation outcomes (Duarte et al., 2008). As in the similar modeling framework (Sun & Hilker, 2020; Suzuki & Iwasa, 2009a; Suzuki & Iwasa, 2009b), our model also demonstrates the tendency of oscillations, leading to fluctuation of environmental status and cooperators or non-cooperators. However, we find that the spread-the-word effect is a strong stabilizing mechanism that promotes stable funding flows for conservation.

In particular, we demonstrated that effectively mobilizing soft-cooperators, who spread the word but do not contribute monetarily, is key for catalyzing conservation awareness in society. Their actions come at a much lower cost than the cost of being a hard-cooperator who both shares information and provides funding for conservation. Our modeling lends support to Parsons's assertion that "slacktivism could have a role to play in promoting positive change, and shouldn't be thought of negatively, but instead as a potential gateway to more to more substantive activism and advocacy" (Parsons, 2016). More social media information sharing can bring in greater and more stable funding for conservation, ultimately improving ecological outcomes.

## 4.2 | The influence of psychological factors and ecological status on charitable giving

Research into the psychology of charitable giving demonstrates that social norms play an important role in an individual's decision-making (Zagefka & James, 2015). As personal behavior is guided by an individual's subjective perceptions of social norms, Tankard and Paluck (Tankard & Paluck, 2016) posit that social change interventions may be better served by focusing on shaping norm perceptions (subjective perceptions of the informal rules that govern behavior in groups) rather than other precursors of behavior like attitudes (a person's beliefs, affect, and behavioral intentions regarding environmentally related activities or issues) and values (underlying determinants of more specific attitudes, behaviors, and beliefs) (Schultz et al., 2005; Tankard & Paluck, 2016). Attitudes and values can be very challenging to influence meaningfully for the purposes of conservation (Manfredo et al., 2017). Conservation is perpetually constrained by limited resources, necessitating difficult decisions to be made over how to most efficiently allocate scarce funds (Bottrill et al., 2008). More effectively influencing the perceived norms surrounding charitable giving can be a means by which to increase the available resources for conservation.

## 4.3 | Study limitations and future directions

While we built utility functions based on the findings of sociological experiments and surveys (Clements, 2013; Milinski et al., 2006; Wiepking & Heijnen, 2011) and the assumptions of the previous studies (Sun & Hilker, 2020; Suzuki & Iwasa, 2009b), relevant data is still largely deficient (Mukherjee et al., 2018). Conservation decision-making is highly complex and interdisciplinary, and including social-psychological approaches (St. John et al., 2010) would help maximize the funds available for conservation.

In this study, we aimed to unveil the importance of conservation information, and we constructed a minimal model based on previous findings for this purpose. While our approach is ideal for investigating general insights into conservation information, it has limitations and further studies will be necessary. For instance, this model cannot directly address the influence on conservation funding by highly heterogeneous individuals or groups, such as billionaires and celebrity endorsements (i.e., philanthrocapitalism; [Bishop & Green, 2015; Olmedo et al., 2020]). Also, while we assumed that information could promote conservation programs, media reports on conservation action are not always consistent and can be variably portrayed in positive or negative lights in different media sources (Braczkowski et al., 2018). When a group of individuals tends to share negative conservation information, the spread-the-word coefficient can take a negative value. Further, we acknowledge the attitude-behavior gap in environmental contexts and that increased knowledge and awareness does not necessarily translate into pro-environmental behaviors (Venghaus et al., 2022), and have mitigated this limitation in our model (with the use of bounded rationality instead of perfect rationality). Additionally, the inflow of conservation funding is broad and the charitable giving of donors may be driven by diverse motivations, such as tax deductions and social and reputation benefits (Bekkers & Wiepking, 2011; Ramutsindela et al., 2013). Similarly, aside from the donation, conservation impact can be improved in a variety of ways, such as mobilization of citizen scientists (Danielsen et al., 2014) and adoption of expert knowledge (Martin et al., 2012).

These aspects can be incorporated into the model in future research by introducing additional groups of individuals (e.g., individual groups ($C_1$, $C_2$, ..., $C_{n1}$) with cooperative tendencies toward ecosystem conservation, and groups ($N_1$, $N_2$, ..., $N_{n2}$) with non-cooperative tendencies). Each of these groups of individuals is characterized, for example, by different spread-the-word coefficients, costs, and influences the mitigation of ecological impact.

25784854, 0, Downloaded from https://conbio.onlinelibrary.wiley.com/doi/10.1111/csp2.12857 by Cochrane Japan, Wiley Online Library on [11/12/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Although the introduction of further individual groups improves the situation that the model can describe, it also significantly increases the complexity of the model and the scenarios that need to be considered. This trade-off in model building should be addressed in light of the research question at hand.

### 4.4 | Conclusions

In this study, we conceptualized the multiple types of cooperation behaviors in conservation along with ecological dynamics. While our model is not comprehensive and is limited by the existing knowledge gap over conservation decision-making, establishing a conceptual framework provides us with the tools to investigate various scenarios and the role of social media information sharing in conservation funding. Key factors for the success of online fundraising have recently been identified (Kubo, Veríssimo, et al., 2021; Kubo, Yokoo, et al., 2021), and along with these investigations, our theoretical framework can serve as part of the basis for future research to quantify the impact of social media information sharing on conservation funding and outcomes.

## AUTHOR CONTRIBUTIONS

Nao Takashina: Conceptualization, methodology, formal analysis, validation, visualization, Writing - Original daft preparation, review & editing, funding acquisition. Hubert Cheung: Validation, writing - original daft preparation, review & editing, funding acquisition. Mieko Miyazawa: Validation, writing - original daft preparation, review & editing.

## ACKNOWLEDGMENTS

We would like to thank J. H. Lee and Y. Chen for their valuable comments on the the manuscript.

## FUNDING INFORMATION

This work was supported by JSPS KAKENHI Grant Number 21K17913 to Nao Takashina. Hubert Cheung is supported by a JSPS Postdoctoral Fellowship for Research in Japan.

## CONFLICT OF INTEREST

The authors declare no conflicts of interest.

## DATA AVAILABILITY STATEMENT

No data were collected for this study.

## ORCID

*Nao Takashina* https://orcid.org/0000-0002-9594-9264
*Hubert Cheung* https://orcid.org/0000-0002-5918-9907

## REFERENCES

Alós-Ferrer, C., & Netzer, N. (2010). The logit-response dynamics. *Games and Economic Behavior*, *68*, 413–427.

Anyango-van Zwieten, N., Lamers, M., & van der Duim, R. (2019). Funding for nature conservation: A study of public finance networks at World Wide Fund for nature (WWF). *Biodiversity and Conservation*, *28*, 3749–3766.

Aramendia-Muneta, M. E. (2017). Spread the word the effect of word of mouth in e-marketing. In *Commercial Communication in the Digital Age*. De Gruyter Mouton.

Balmford, A., & Whitten, T. (2003). Who should pay for tropical conservation, and how could the costs be met? *Oryx*, *37*(2), 238–250.

Bauch, C. T., Sigdel, R., Pharaon, J., & Anand, M. (2016). Early warning signals of regime shifts in coupled human-environment systems. *Proceedings of the National Academy of Sciences of the United States of America*, *113*, 14560–14567.

Bekkers, R., & Wiepking, P. (2011). A literature review of empirical studies of philanthropy: Eight mechanisms that drive charitable giving. *Nonprofit and Voluntary Sector Quarterly*, *40*(5), 924–973.

Bishop, M., & Green, M. (2015). Philanthrocapitalism rising. *Society*, *52*(6), 541–548.

Bottrill, M. C., Joseph, L. N., Carwardine, J., Bode, M., Cook, C., Game, E. T., Grantham, H., Kark, S., Linke, S., McDonald-Madden, E., Pressey, R. L., Walker, S., Wilson, K. A., & Possingham, H. P. (2008). Is conservation triage just smart decision making? *Trends in Ecology & Evolution*, *23*(12), 649–654.

Braczkowski, A., Holden, M. H., O'Bryan, C., Choi, C. Y., Gan, X., Beesley, N., Gao, Y., Allan, J., Tyrrell, P., Stiles, D., Brehony, P., Meney, R., Brink, H., Takashina, N., Lin, M. C., Lin, H. Y., Rust, N., Salmo, S. G., Watson, J. E., … Biggs, D. (2018). Reach and messages of the world's largest ivory burn. *Conservation Biology*, *32*, 765–773.

Büssing, A. G., Thielking, A., & Menzel, S. (2019). Can a like save the planet? Comparing antecedents of and correlations between environmental liking on social media, money donation, and volunteering. *Frontiers in Psychology*, *10*, 1989.

Clements, C. F. (2013). Public interest in the extinction of a species may lead to an increase in donations to a large conservation charity. *Biodiversity and Conservation*, *22*(11), 2695–2699.

Credit Suisse Group AG and McKinsey Center for Business and Environment. (2016). Conservation finance from niche to mainstream: The building of an institutional asset class. Technical Report.

Croson, R., Handy, F., & Shang, J. (2009). Keeping up with the joneses: The relationship of perceived descriptive social norms, social information, and charitable giving. *Nonprofit Management & Leadership*, *19*(4), 467–489.

Danielsen, F., Jensen, P. M., Burgess, N. D., Altamirano, R., Alviola, P. A., Andrianandrasana, H., Brashares, J. S., Burton, A. C., Coronado, I., Corpuz, N., Enghoff, M., Fjeldså, J., Funder, M., Holt, S., Hübertz, H., Jensen, A. E., Lewis, R., Massao, J., Mendoza, M. M., … Young, R. (2014). A multicountry assessment of tropical resource monitoring by local communities. *Bioscience*, *64*, 236–251.

di Lauro, S., Tursunbayeva, A., & Antonelli, G. (2019). How nonprofit organizations use social Media for Fundraising: A systematic literature review. *International Journal of Business and Management*, *14*(7), 1.

25784854, 0, Downloaded from https://conbio.onlinelibrary.wiley.com/doi/10.1111/csp2.12857 by Cochrane Japan, Wiley Online Library on [11/12/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Duarte, C. M., Dennison, W. C., Orth, R. J., & Carruthers, T. J. (2008). The charisma of coastal ecosystems: Addressing the imbalance. *Estuaries and Coasts*, *31*, 233–238.

Gallo-Cajiao, E., Archibald, C., Friedman, R., Steven, R., Fuller, R. A., Game, E. T., Morrison, T. H., & Ritchie, E. G. (2018). Crowdfunding biodiversity conservation. *Conservation Biology*, *32*(6), 1426–1435.

Geber, S., Baumann, E., & Klimmt, C. (2019). Where do norms come from? Peer communication as a factor in normative social influences on risk behavior. *Communication Research*, *46*, 708–730.

Groeger, L., & Buttle, F. (2014). Word-of-mouth marketing: Towards an improved understanding of multi-generational campaign reach. *European Journal of Marketing*, *48*, 1186–1208.

Halupka, M. (2014). Clicktivism: A systematic heuristic. *Policy & Internet*, *6*, 115–132.

Iwasa, Y., Uchida, T., & Yokomizo, H. (2007). Nonlinear behavior of the socio-economic dynamics for lake eutrophication control. *Ecological Economics*, *63*, 219–229.

Johnson, J. (2021). Number of internet users worldwide from 2005 to 2021.

Kim, J. W. (2018). They liked and shared: Effects of social media virality metrics on perceptions of message influence and behavioral intentions. *Computers in Human Behavior*, *84*, 153–161.

Kristofferson, K., White, K., & Peloza, J. (2014). The nature of slacktivism: How the social observability of an initial act of token support affects subsequent prosocial action. *Journal of Consumer Research*, *40*(6), 1149–1166.

Kubo, T., Veríssimo, D., Uryu, S., Mieno, T., & Macmillan, D. (2021). What determines the success and failure of environmental crowdfunding? *Ambio*, *50*, 1659–1669.

Kubo, T., Yokoo, H.-F., & Veríssimo, D. (2021). Evidence for effective conservation fundraising: Comparing social media with traditional mailshot field experiments. Technical Report, Center for Open Science.

Lee, J. H., Kakinuma, K., Okuro, T., & Iwasa, Y. (2015). Coupled social and ecological dynamics of herders in Mongolian rangelands. *Ecological Economics*, *114*, 208–217.

Leyva, R. (2016). Exploring UK Millennials' social media consumption patterns and participation in elections, activism, and “slacktivism”. *Social Science Computer Review*, *35*(4), 462–479.

Madison, N., & Klang, M. (2020). The case for digital activism: Refuting the fallacies of slacktivism. *Journal of Digital Social Research*, *2*(2), 28–47.

Manfredo, M. J., Bruskotter, J. T., Teel, T. L., Fulton, D., Schwartz, S. H., Arlinghaus, R., Oishi, S., Uskul, A. K., Redford, K., Kitayama, S., & Sullivan, L. (2017). Why social values cannot be changed for the sake of conservation. *Conservation Biology*, *31*(4), 772–780.

Martin, R., & Randal, J. (2008). How is donation behaviour affected by the donations of others? *Journal of Economic Behavior and Organization*, *67*(1), 228–238.

Martin, T. G., Burgman, M. A., Fidler, F., Kuhnert, P. M., Low-Choy, S., Mcbride, M., & Mengersen, K. (2012). Eliciting expert knowledge in conservation science. *Conservation Biology*, *26*, 29–38.

Milinski, M., Semmann, D., Krambeck, H. J., & Marotzke, J. (2006). Stabilizing the Earth's climate is not a losing game: Supporting evidence from public goods experiments. *Proceedings of the National Academy of Sciences of the United States of America*, *103*, 3994–3998.

Morozov, E. The brave new world of slacktivism. Foreign Policy.

Mukherjee, N., Zabala, A., Huge, J., Nyumba, T. O., Adem Esmail, B., & Sutherland, W. J. (2018). Comparison of techniques for eliciting views and judgements in decision-making. *Methods in Ecology and Evolution*, *9*, 54–63.

Novelli, M., Morgan, N., Mitchell, G., & Ivanov, K. (2016). Travel philanthropy and sustainable development: The case of the Plymouth-Banjul challenge. *Journal of Sustainable Tourism*, *24*(6), 824–845.

Olmedo, A., Milner-Gulland, E. J., Challender, D. W. S., Cugnière, L., Dao, H. T. T., Nguyen, L. B., Nuno, A., Potier, E., Ribadeneira, M., Thomas-Walters, L., Wan, A. K. Y., Wang, Y., & Veríssimo, D. (2020). A scoping review of celebrity endorsement in environmental campaigns and evidence for its effectiveness. *Conservation Science and Practice*, *2*, e261.

Parsons, E. C. (2016). "Advocacy" and "activism" are not dirty words-how activists can better help conservation scientists. *Frontiers in Marine Science*, *3*, 229.

Piat, C. (2019). Slacktivism: Not simply a means to an end, but a legitimate form of civic participation. *Canadian Journal of Family and Youth*, *11*, 162–179.

Ramutsindela, M., Spierenburg, M., & Wels, H. (2013). *Sponsoring nature: Environmental philanthropy for conservation*. Routledge.

Reinstein, D., & Riener, G. (2012). Reputation and influence in charitable giving: An experiment. *Theory and Decision*, *72*, 221–243.

Rosenblatt, K. (2020). Australian wildfires spur biggest Facebook fundraiser ever.

Schultz, P. W., Gouveia, V. V., Cameron, L. D., Tankha, G., Schmuck, P., & Franěk, M. (2005). Values and their relationship to environmental concern and conservation behavior. *Journal of Cross-Cultural Psychology*, *36*, 457–475.

Shiono, T., Kubota, Y., & Kusumoto, B. (2021). Area-based conservation planning in Japan: The importance of OECMs in the post-2020 global biodiversity framework. *Global Ecology and Conservation*, *30*, e01783.

St. John, F. A., Edwards-Jones, G., & Jones, J. P. (2010). Conservation and human behaviour: Lessons from social psychology. *Wildlife Research*, *37*, 658–667.

Sun, T. A., & Hilker, F. M. (2020). Analyzing the mutual feedbacks between lake pollution and human behaviour in a mathematical social-ecological model. *Ecological Complexity*, *43*, 100834.

Suzuki, Y., & Iwasa, Y. (2009a). Conflict between groups of players in coupled socio-economic and ecological dynamics. *Ecological Economics*, *68*, 1106–1115.

Suzuki, Y., & Iwasa, Y. (2009b). The coupled dynamics of human socio-economic choice and lake water system: The interaction of two sources of nonlinearity. *Ecological Research*, *24*, 479–489.

Tankard, M. E., & Paluck, E. L. (2016). Norm perception as a vehicle for social change. *Social Issues and Policy Review*, *10*, 181–211.

The United Nations Convention on Biological Diversity. (2020). Estimation of resources needed for implementing the post-2020 global biodiversity framework preliminary second report of the panel of experts on resource mobilization. Technical Report.

25784854, 0, Downloaded from https://conbio.onlinelibrary.wiley.com/doi/10.1111/csp2.12857 by Cochrane Japan, Wiley Online Library on [11/12/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Venghaus, S., Henseleit, M., & Belka, M. (2022). The impact of climate change awareness on behavioral changes in Germany: Changing minds or changing behavior? *Energy, Sustainability and Society*, *12*, 12.

Watson, J. E., Dudley, N., Segan, D. B., & Hockings, M. (2014). The performance and potential of protected areas. *Nature*, *515*, 67–73.

Wiepking, P., & Heijnen, M. (2011). The giving standard: Conditional cooperation in the case of charitable giving. *International Journal of Nonprofit and Voluntary Sector Marketing*, *16*(1), 13–22.

Zagefka, H., & James, T. (2015). The psychology of charitable donations to disaster victims and beyond. *Social Issues and Policy Review*, *9*(1), 155–192.

## SUPPORTING INFORMATION

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

**How to cite this article:** Takashina, N., Cheung, H., & Miyazawa, M. (2022). Spread the word: Sharing information on social media can stabilize conservation funding and improve ecological outcomes. *Conservation Science and Practice*, e12857. https://doi.org/10.1111/csp2.12857

25784854, 0, Downloaded from https://conbio.onlinelibrary.wiley.com/doi/10.1111/csp2.12857 by Cochrane Japan, Wiley Online Library on [11/12/2022]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License