CHAPTER 18

Communication in conservation physiology: linking diverse stakeholders, promoting public engagement, and encouraging application

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➲ Take-home message

Planning how research findings will be communicated with policy makers, stakeholders, and/or the general public, engaging stakeholders at various stages of the research process, and strategically choosing communication platforms are key elements that are critical to effective conservation outcomes.

18.1 Introduction

The preceding chapters have demonstrated how physiological concepts, tools, and knowledge can be applied to improving ecological conservation and management. Yet linking physiological data with real conservation action or changes in human behaviour can be difficult. Without a solid plan for communicating and engaging with policy makers, stakeholders, or the general public, even the most rigorous research findings can be overlooked or ignored.

In this chapter, we outline the benefits of communicating science beyond the 'ivory tower', provide guidance in navigating partnerships between researchers and practitioners, and outline the different modes of communication and stakeholder engagement that can suit a variety of conservation end-goals. In particular, we highlight knowledge co-production, collaboration with social scientists, citizen science, and social media as four complementary ways of engaging with stakeholders. They are presented in order of most to least time- and resource-intensive, so that readers can work on incorporating effective communication and engagement into their work, regardless of career stage. We discuss the benefits and disadvantages of each method and give advice on how to successfully integrate them into a research programme. Finally, we look towards the future of communication and collaboration to see how the skills discussed here can be spread to the broader scientific community.

18.2 Why communicate?

Conservation physiologists are typically interested in achieving conservation action through their

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research. Communication is the bridge that can connect research with the people who can affect change, including decision makers, stakeholders, and the public at large. What we hope to emphasize in this chapter is that success in changing human behaviour goes beyond the quality of research or where it is published; rather, success will depend on research findings in combination with skills in collaborating and communicating with others.

When done properly and throughout the research process, communication and engagement can engender cooperation and support of stakeholders and promote meaningful stewardship of natural resources. There are also academic benefits that can be gained from communication and engagement, such as increased visibility and impact of research and the possibility to generate funding for future research. Indeed, funding bodies are increasingly recognizing the importance of collaboration and communication; some are even adding a communications section to grant applications and allotting for such expenditures in the budget. Finally, engaging in participatory research can ensure that research is relevant and useful to stakeholders and perhaps could even turn small projects into larger, more impactful collaborations.

18.3 Knowledge co-production

For many physiologists hoping to achieve conservation action, research is thought to be the first step towards reaching that goal. When a project has been designed, the data collected and analysed, and a paper written, then the findings can be disseminated. If findings are disseminated to policy makers, managers, and decision makers to inform legislation, change can happen when and where it is needed. While this is the traditional way of approaching conservation action, this one-way transfer of knowledge can be challenging and, at times, ineffective (Sturgis and Allum 2004). However, another method for achieving conservation success—knowledge co-production—is growing in popularity. This strategy engages researchers and multiple stakeholders spanning the science–policy–society interface to contribute towards co-creating knowledge that will inform decision making (Lemos and Morehouse 2005).

With knowledge co-production, stakeholders are involved in the research process from the outset, often even initiating research projects. This early involvement means that research outputs from co-produced studies are often more relevant and useful for stakeholders (Meadow et al. 2015). Furthermore, stakeholders are more likely to perceive the results of co-produced studies as salient, credible, and legitimate, which in turn makes them more likely to incorporate results into the decision-making process (Cash et al. 2003). Not only is co-produced knowledge relevant and useful, it is also strengthened by incorporating multiple viewpoints. Local and cultural knowledge can provide examples of previous successes and failures (Fazey et al. 2006) and outline the most culturally appropriate ways to integrate research findings into conservation action (Naess 2013). Perhaps most importantly, co-produced research is based on the principles of democracy and social and environmental justice, meaning that researchers and stakeholders are placed on equal footing to achieve a mutually beneficial outcome (Cvitanovic et al. 2019).

To initiate a co-produced research project, the first step is to contact relevant stakeholders, unless they have already reached out to the research team. To ensure equity between all project members and improve uptake of project results, it is crucial that this step happens as early as possible. Determining the full range of relevant stakeholders can be tricky, but a starting place is to consider the primary users of the system or species of interest. Are they industry members, indigenous groups, managers, the general public, or some combination of these? Once a preliminary list has been collated, the next step is to determine the best ways to get in touch. Do the stakeholders frequently use and maintain a presence on social media (see Section 18.6)? One way to reach out to stakeholders is to work within social structures that already exist within the community (Djenontin and Meadow 2018). For instance, reaching out to well-connected leaders in a community can provide access to a wide sphere of stakeholders in a relatively short timeframe (Kirono et al. 2014).

However, this method can risk feeding into existing power imbalances (Djenontin and Meadow 2018). Therefore, seeking input from a diverse range of stakeholders is advised to democratize the process. It may also be possible to benefit from intermediates like knowledge brokers and boundary organizations to help establish a working relationship with key stakeholders (Reinecke 2015). Knowledge brokers are often embedded within research institutions, while boundary organizations are separate entities that can facilitate interactions between groups that may initially have trouble finding a common ground (Cvitanovic et al. 2015).

Once a team of researchers and stakeholders has been assembled, the project can be designed. This is when stakeholders can lay out their priorities, goals, and values to make sure they are incorporated into the study, and the team can then ensure that outcomes will be relevant. At this stage, collaborators can decide not only on the research questions to be answered, but also on the methods for answering those questions. Where will the study take place? What metrics will be used to gauge success? Local knowledge is crucial at this stage. In some cases, local experts can provide a detailed understanding of the ecosystem under investigation (see Section 18.3.1) or clarify end-goals that might differ from traditional scientific metrics of success. The most successful co-produced studies have started with all parties entering into the design discussions with open minds and a focus on listening (Armitage et al. 2011). Failing this, some stakeholders may disengage during early conversations if they perceive themselves to lack certain expert knowledge (Djenontin and Meadow 2018). The study design stage is also a key time to consider financial contributions of different stakeholders, as an equitable design process may also promote an equitable sharing of budget and resources (Podestá et al. 2013).

When a solid design is in place, the project can be implemented. However, just because the research process has commenced, this does not mean that communication with stakeholders should cease. Rather, continued engagement and clear communication with stakeholders at this time is critical. Barriers to communication can include language differences and jargon, all of which can be overcome using interpreters, communications specialists, or drawings and visual representations (Djenontin and Meadow 2018). Similarly, research outputs should be tailored to reach all stakeholders. For instance, instead of technical graphs and jargon-laden texts, elements of storytelling can be used to communicate results. Stories can use narrative devices like plot, characters, and descriptions to connect research findings with stakeholder values and interests (Young et al. 2016). Additionally, a formal dissemination plan can ensure that stakeholders are informed at regular intervals via appropriate channels (Castellanos et al. 2013). By following this overall format, the continued participation and satisfaction of all stakeholders is more certain.

In addition to the aforementioned steps, there are some intangible factors that can improve a co-produced research project, such as social capital and trust. Social capital is a term used to describe the networks and norms, like trust, that facilitate social engagement (Putnam 1995). Trust can be built through visibility in the field and in the community, for example, by hosting workshops, attending community meetings, and informally engaging with users in their element. These seemingly simple activities can build new social capital or even help to overcome a history of mistrust between stakeholders and outside researchers (Djenontin and Meadow 2018).

Though the above framework represents the current best practices for co-producing research, a variety of institutional factors can impede progress and need to be changed to promote further research of this nature. For instance, many institutions have inflexible structures, such as policies that limit data sharing, which can slow progress. Financial flexibility is also crucial, as it allows for improvements as the project proceeds, such as bringing on new hires to bolster the team's skill set (Djenontin and Meadow 2018). Over the long term, research institutions should provide training support in key skills that are needed for knowledge co-production, such as mediation, brokering, facilitation, and translation (Cvitanovic et al. 2019). Furthermore, given the growing role and importance of co-produced studies, institutions should recognize and reward researchers who take part in this type of research, as

the diverse benefits and outputs are often not formally recognized through traditional pathways (Cvitanovic et al. 2019).

18.3.1 Case study: management of Greenland halibut

Biotelemetry—remote tracking of animal movements—has changed the way that scientists collect data about fish populations. With more accurate data that connect biological, environmental, and geographical factors to fish movements, managers can make informed decisions about fisheries stocks or marine protected areas (Crossin et al. 2017). Biotelemetry was used in a co-produced study on Greenland halibut in Cumberland Sound, Nunavut, Canada (Brooks et al. 2019).

Greenland halibut is a deep-water, circumpolar species that was primarily fished in Canadian waters by foreign fishing vessels until the 1980s (DFO 2006). Many of these quotas were then reallocated to coastal, indigenous communities to benefit local community economies (Brooks et al. 2019). For example, in 1994 the Pangnirtung community in Nunavut was allocated a 500-tonne quota. Initially, mark–recapture studies were undertaken to determine the geographical distribution of halibut across the region, but low tag returns resulted in suboptimal datasets (Treble 2003). Still, the tags that were returned suggested that there were two independent stocks of halibut: one offshore stock and one inshore stock. This prompted the Cumberland Sound Turbot Management Area (CSTMA) to be established such that the inshore stock could be specifically allocated to the Pangnirtung fishery (Figure 18.1).

Green halibut catches in the CSTMA declined throughout the 1990s and 2000s (Dennard et al. 2010), although catches were high in the offshore area just south of the CSTMA. These data supported Inuit Qaujimajatuqangit, or traditional knowledge, of fish movements, which suggested that the inshore halibut stock targeted by the Pangnirtung fishery was moving outside the CSTMA during the open season where they were fished by offshore vessels, thereby affecting quotas within the CSTMA (Brooks et al. 2019). Based on concerns voiced by Pangnirtung residents, the Pangnirtung Hunters and Trappers Association (HTA), and other fishers, a research project was developed to determine whether Greenland halibut were migrating between the CSTMA and the offshore regions during the open season. To do this, a collaboration was established between the Ocean Tracking Network and the University of Windsor, Canada, organizations that had previously worked together, and it was determined that acoustic biotelemetry would be the best method to track the halibut, given the previous difficulties with mark–recapture studies (Brooks et al. 2019). Researchers presented their draft plans to the Pangnirtung HTA for feedback and used both Inuit traditional knowledge and fishery data to design the placement of biotelemetry receivers in the Sound.

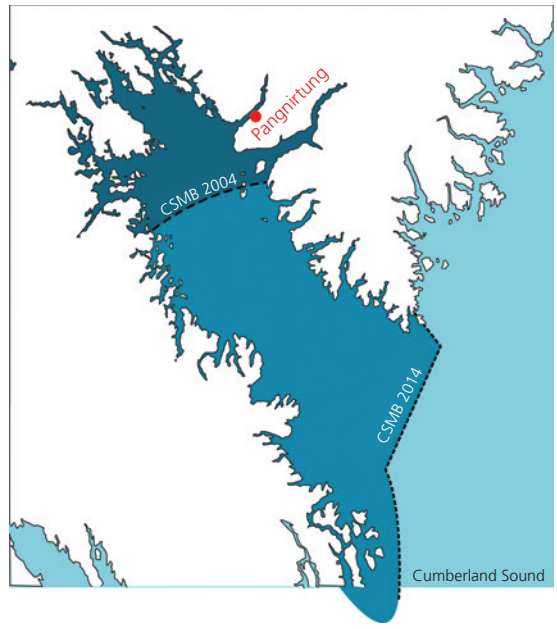

Figure 18.1 The Cumberland Sound Management Boundary (CSMB) shifted as a result of a co-produced study between Pangnirtung fishers, the Ocean Tracking Network, and the University of Windsor that demonstrated that Greenland halibut were moving out of the original management boundaries during the open season. Upon recommendation to Fisheries and Oceans Canada, the original boundary (CSMB 2004) was moved to 12 nautical miles offshore (CSMB 2014), ensuring that Pangnirtung fishers had access to the halibut stock. CSMB lines recreated from Brooks et al. (2019).

The study results showed that Greenland halibut were, indeed, moving out of the CSTMA during the open season. This confirmed the suspicions of

Pangnirtung residents that their stock was vulnerable to commercial, offshore fishers. To remedy this, the study results and Inuit traditional knowledge from Pangnirtung fishers were presented to the Nunavut Wildlife Management Board in July 2013. A recommendation was made to Fisheries and Oceans Canada to move the CSTMA boundary. Consequently, the boundary was moved to 12 nautical miles offshore, ensuring that the Pangnirtung fishers had access to the inshore stock during the open season, and offshore fishers would not exploit the inshore stock while targeting the offshore stock.

The case of Greenland halibut in Cumberland Sound is a prime example of knowledge co-production in conservation physiology because local fishers and members of the community were involved from the onset. In fact, it was the concerns raised by Pangnirtung residents, the Pangnirtung HTA, and other fishers that prompted the research being funded. Similarly, Inuit traditional knowledge was valued equally alongside physiological data and used to design the placement of biotelemetry. Still, the study did encounter roadblocks. In 2011, after only one season of data collection, community elders raised concerns that the receivers were frightening ringed seals, a culturally and nutritionally valuable species for Pangnirtung residents. The research team tried to explain that the equipment would likely not affect the seals, but this did not convince the community, and the research was halted. This example highlights the importance of ongoing two-way communication to develop and maintain community trust and buy-in, as well as the challenges that can present in co-produced research projects. Ultimately, though, the project was successful in its aim to connect the Pangnirtung community with researchers to determine the movement patterns of halibut and thereby inform fisheries management to protect the livelihood of Pangnirtung fishers and their community.

18.4 Collaborating: social science

Findings from conservation physiology studies can provide critical information to decision makers so that conservation actions can be achieved. Yet the path from evidence-based recommendations to actions can be fraught with competing political, social, and economic interests, meaning that even the most robust science may not be incorporated at the decision-making stage. Given the complexity of achieving conservation outcomes through human behavioural changes, it can be useful to collaborate with social scientists, who are experts in navigating this field.

Social science is a broad field, encompassing disciplines like sociology, economics, political science, and geography, to name a few. Together, these disciplines seek to understand social phenomena, such as culture and governance; social processes, such as decision making and social organization; and individual attributes, such as values and beliefs (Bennett et al. 2017). All of these factors contribute to conservation action and can be studied through the conservation social sciences. For instance, environmental psychologists can study how individual attitudes, beliefs, and norms shape people's responses to conservation actions, while environmental sociologists can reveal the patterns of influence among stakeholders and describe the relationships between stakeholders and their environment (for a complete guide to conservation social sciences, see Bennett et al. 2017).

Academics and practitioners alike have recognized the importance of incorporating the social sciences into the traditionally natural science-dominated field of conservation, highlighting the fundamental truth that conservation action cannot take place without human behavioural changes (Mascia et al. 2003; Schultz 2011; Hicks et al. 2016). Yet despite calls for social science to be mainstreamed into the conservation sciences (Bennett et al. 2016), collaborations between natural and social scientists are still not the norm. A survey of conservation experts across academia, government, and NGOs indicated that a host of barriers have prevented this type of collaboration from flourishing (Fox et al. 2006). Included among these barriers are insufficient funding for collaborative work, limited opportunities for interdisciplinary collaborations, a lack of support from the traditional academic rewards system for interdisciplinary work, and a mismatch in vocabulary between natural and social scientists. Indeed, beyond a difference in vocabulary, natural and social scientists can approach the same research problem with different

ideologies and epistemologies about the natural world, resulting in difficulties blending their expertise into a coherent project (Bennett et al. 2016).

However, enthusiastic natural scientists should not let these barriers dissuade them from embarking on collaborations with social scientists. Interdisciplinary research is growing in popularity (Van Noorden 2015), and integration with the social sciences is becoming a greater priority in the conservation sciences. This is further evidenced by the formation of the Social Science Working Group within the Society for Conservation Biology, which has grown to over 700 members since its inception in 2003 (Mascia et al. 2003). Collaborations with social scientists can be accomplished in much the same manner as co-produced research, as described in the above section. In the same way, it is crucial to collaborate with social scientists from the inception of a research project so that their contributions can shape the methodology and design of the project (Viseu 2015). From there, an openness to different philosophies and modes of conducting research will be critical, but the rewards of collaboration will be great. Social scientists can ensure greater application of research findings through understanding the ways different social and cultural groups perceive the environment, improving management practices, facilitating higher social equity in conservation outcomes, and innovating new ways of thinking about conservation (Bennett et al. 2017).

18.4.1 Case study: stress in human–gorilla interactions

Wildlife tourism is a field that is often praised for promoting public awareness of conservation issues and funding conservation-focused research projects (Macfie and Williamson 2010). However, close human contact with wildlife has the potential to negatively affect the animals involved (Higginbottom et al. 2003). To investigate the factors that influence human–animal interactions in wildlife tourism, Dr Kathryn Phillips (née Shutt) utilized both physiological and social science methods.

Phillips travelled to the Dzanga–Sangha Gorilla Habituation and Ecotourism Project in the Central African Republic and chose western lowland gorillas as her study species. At this site, wild gorillas were being habituated to humans via daily exposure until they eventually demonstrated low levels of attention and aggression towards humans (MGVP and WCS 2009). Yet despite this outward appearance of habituation, Phillips wanted to measure the gorillas' physiological stress levels using faecal glucocorticoid metabolites (FGCMs). Glucocorticoids are hormones that are released from the adrenal cortex in response to stress in vertebrates (Selye 1955) and can be maladaptive when elevated over the long term (Cyr and Romero 2008). She also measured parasite infections in the same gorillas. Phillips found that the process of habituation was stressful for the gorillas, as evidenced by their FGCM levels being significantly higher than FGCM levels in unhabituated gorillas (Shutt et al. 2014). Moreover, she found that even habituated gorillas had elevated FGCMs after close encounters with humans, suggesting that the habituation process did not completely eliminate human-related stress responses. She also demonstrated a positive correlation between FGCMs and parasite infection, which could indicate that the immune system was being suppressed when FGCMs were high. This is particularly problematic in a wildlife tourism setting, as the gorillas experience close contact with researchers, tourists, and guides, and are susceptible to contracting human diseases, given their phylogenetic proximity to humans (Köndgen et al. 2008).

After Phillips determined that human contact could risk infecting the gorillas, she needed to identify the factors that increased the risk of infection to ensure they were mitigated. By employing social science methods including semi-structured interviews, questionnaires, and behavioural observations of tourists and staff, she learned that tourists had a modest, at best, understanding of the risks of disease transmission, and that this ignorance decreased tourists' motivation to follow regulations (Setchell et al. 2017). Encouragingly, tourists demonstrated a high willingness to follow regulations if they were informed as to the reasons why the rules were necessary. For instance, tourists said they would wear facemasks, declare illnesses, and provide evidence of vaccinations to decrease the risk of infecting the gorillas (Shutt 2014). As a result of Phillips' research, changes were made to a number of health procedures at the site, including a

requirement for tourists and researchers to wear facemasks at all times and to disinfect their hands and boots before visiting the gorillas (K. Phillips, pers. comm.).

Phillips also noted that some tourists expressed a sense of unfairness pertaining to their vaccination requirements, given that local staff on-site had low access to healthcare and were predominantly unvaccinated. Phillips learned from senior management that the health of the staff was considered a low priority, as vaccinations were expensive and difficult to arrange logistically (Shutt 2014). Furthermore, senior management believed that staff and gorillas would have some immunity to local illnesses, and therefore would not need vaccinations. However, through the work of Phillips and another collaborator, the senior management grew to understand the risks of disease transmission by staff, consequently provided vaccinations for staff, and increased access to general healthcare (K. Phillips, pers. comm.).

Phillips' research demonstrates the value of collecting social science data to promote conservation action. While her physiological research revealed that human contact increased stress and possibly parasite infection in the habituated gorillas, it was her social science research that pinpointed the highest risks of infection and their causes. By identifying that tourists were uninformed about the risk of disease transmission, but willing to adhere to rules once informed, Phillips was able to suggest management actions that were successfully integrated into the programme. Similarly, her interviews with senior management revealed the misconceptions that led to the neglect of staff vaccinations and prompted management to prioritize staff health. Together, the physiological and social science data informed robust conservation decisions to protect the gorillas at this site.

18.5 Citizen science

For researchers keen to engage with the public, citizen science can be a useful tool. Citizen science, also known as participatory science, has a long history of bringing together members of the public to further scientific research. Though definitions for the term vary, here we define citizen science as research that involves non-professional scientists (i.e. members of the public) who take part in data collection and/or analysis. This differs from co-produced studies in that they tend to have deeper engagement with a targeted group of stakeholders who are involved from the outset in designing the research question, methods, and disseminating the results. Citizen science, on the other hand, can harness the power of numbers, drawing on the general public's enthusiasm to tackle huge datasets.

When designed correctly, citizen science projects can have major benefits for both research outputs and stakeholder engagement. By opening their research to public participation, researchers can save time and money while generating datasets at scales far greater than they could ever create on their own (Miller-Rushing et al. 2012). Additionally, citizen science gives researchers access to local knowledge that could be invaluable to a project's success (Kobori et al. 2016). For the general public, participating in research projects can increase scientific literacy (Cronje et al. 2011) as well as long-term environmental, civic, and research interests (Dickinson et al. 2012). Citizen science projects can also build social licence with local stakeholders to increase conservation action (Kelly et al. 2019).

The success of a citizen science project depends on careful planning. The first step is to decide how volunteers will be involved in data collection and/or analyses. Recent technological innovations have spurred an increase in citizen science projects, allowing researchers to easily disseminate information about their research while also broadening their pool of potential citizen scientists. Many popular projects have citizens collect environmental or wildlife data using emerging technology, such as smartphone apps, GPS, and photos (see Section 18.5.1). Other projects rely on citizens for analysis, asking them to classify photographs, videos, and sound recordings of plants or animals (Wiggins et al. 2014), which can then be used to create training sets for machine learning to classify the remaining data (Trouille et al. 2019). In either case, the project can be hosted on a pre-existing platform, such as Zooniverse, iNaturalist, or CitiSci.org, or, a new program can be created. Pre-existing platforms offer ease of use and affordability; whereas, new programs or interfaces are costly but can be tailored to suit unique projects.

Next, volunteer recruitment, engagement, and retention are crucial for successful citizen science projects (Locke et al. 2019). Recruiting through pre-existing platforms is fairly straightforward, as engaged citizens are already connected to the programme, but stand-alone projects can attract volunteers as well. It can be effective to reach out to local stakeholders through social media (see Section 18.6) or traditional media outlets like newspapers, TV, and radio. Magazine ads or flyers can also be created to post at conspicuous places used by potential stakeholders, such as community noticeboards. Once volunteers are recruited, they must be trained in proper methods for data collection and/or analysis. In the past, this step has made some researchers wary of using citizen science data, as researchers perceived the data to be less reliable than data produced by trained researchers. However, with proper training and oversight, volunteers can collect data of equal quality to data collected by professionals (Kosmala et al. 2016) The accuracy of citizen-collected data can be tested through expert validation and replication, while bias can be managed with high-performance computing and statistical programs (Bird et al. 2014). The training process should ideally be iterative, such that volunteers can give feedback to project staff about their experiences to improve protocols (Locke et al. 2019). Indeed, volunteer satisfaction is critical to retention and project completion. To retain volunteers, it can be useful to understand their motivations for participating in citizen science (Phillips et al. 2019), as volunteers whose citizen science experiences align with their motivations are more likely to continue participating (Clary et al. 1998) For instance, if volunteers are motivated by the prospect of contributing to scientific research, a series of regular communications about study outcomes can provide the spark to keep them engaged in the project (Locke et al. 2019). By ensuring volunteers remain motivated, citizen science projects can have long-term success in research outputs and stakeholder engagement.

18.5.1 Case study: Redmap (range extension database and mapping project)

Climate change is altering environmental conditions on a global scale, and many species have responded to these changes by shifting their geographical distributions to stay within their preferred environmental conditions (Chen et al. 2011). As species redistribute across the globe, this can impact biodiversity, ecosystem functioning, and human well-being (Pecl et al. 2017). Long-term monitoring programmes that are designed to document range shifts can be costly, particularly in the marine environment. Yet range shifts are occurring in marine ecosystems at nearly an order of magnitude faster than in terrestrial ecosystems (Sorte et al. 2010; Poloczanska et al. 2013), making monitoring programmes in marine ecosystems all the more urgent.

Professor Greta Pecl sought to address this knowledge gap when she founded Redmap in 2009. This citizen science project aimed to provide an early indication of range shifts in marine species by drawing from the knowledge of local fishers, divers, boaters, and other members of the public. To participate, citizens are encouraged to photograph marine species that they find living outside their normal range and submit those photographs to the Redmap website or upload them via the smartphone app. Species identifications are confirmed by one of more than 80 expert Australian scientists, and then the sighting is added to the dataset. Initially, the project was piloted in Tasmania, an area considered to be a 'hotspot' for ocean warming, as waters off the east coast are warming at nearly four times the global average (Johnson et al. 2011; Hobday and Pecl 2014). Based on the Redmap project's success in Tasmania, Redmap was expanded to encompass all Australian waters after 3 years.

Since the project was conceived, data generated by citizen scientists have already been incorporated into more than 20 scientific publications. The data have been used to parameterize habitat models to quantify shifts in habitat suitability (Champion et al. 2018), assess the likelihood of species undergoing range shifts (Robinson et al. 2015), and prompt scientific studies on data-poor species that may be undergoing range shifts (Ramos et al. 2015). The data may also be used in the future to reference historical distribution patterns and habitat ranges as they continue to shift with changing conditions.

Over the first decade of its existence, the Redmap programme logged more than 1900 unusual species sightings, but this does not necessarily mean that the public has learned about climate change in the process. Therefore, another goal of the Redmap programme has been to engage the public about the effects of climate change on marine ecosystems. To do this, Pecl collaborated with Melissa Nursey-Bray and Robert Palmer to assess the efficacy of Redmap in engaging with citizen scientists. Surveys revealed that Redmap users were learning about new range extension sightings, fish species, and what was happening in other parts of Australia (Nursey-Bray et al. 2018). However, surveys were unable to determine whether users connected the range extension sightings explicitly with the effects of climate change, indicating that a deeper enquiry into user knowledge of climate change will be necessary to evaluate this goal. Still, the survey did reveal that Redmap aligns well with many best practices of stakeholder participation in environmental management, such as early involvement of the public, integration of local and scientific knowledge, and a philosophy of equity, trust, and learning. Thus, Redmap can serve as a model for marine citizen science projects that contribute to science and improve community engagement with environmental issues.

18.6 Social media

Thanks to social media, it has never been easier to communicate than it is today. There were 2.62 billion social media users in the year 2018, and projections indicate that there could be over 3 billion users by 2021 (Clement 2018). The high prevalence of social media use can make it easier for researchers to reach out to the public, but these numbers can also seem daunting. How can one account stand out in the sea of content? As this section will reveal, deliberate, targeted use of social media can get information to the right people, create collaborations, and even launch grassroots campaigns.

Social media can help researchers to reach a broad audience by leveraging the power of networks and a special kind of relationship known as weak ties. Weak ties are low-investment relationships that are not based on personal relationships. Despite their casual nature, weak ties have been shown to be more useful than strong ties for reaching a broad network of people, as they foster the transfer of information across cultural and geographic boundaries (Granovetter 1973). This is particularly useful in the realm of social media, where most users are weakly connected, allowing for rapid dispersal of information to a wide audience (Zhao et al. 2010). This theory of weak ties can help researchers boost their media presence and build networks with journalists and decision makers (Evans and Cvitanovic 2018) while also using targeted messaging or groups to reach more specialized audiences (Shiffman 2018).

However, as with other forms of communication, social media has some limitations. Not everyone uses or has access to this technology; therefore, broad communication campaigns should incorporate components of both social and traditional media to ensure everyone gets the message. It is also wise to save sensitive topics for in-person meetings, as written communications strip away social cues such as body language and tone of voice, potentially leading to miscommunication. Keeping these limitations in mind, social media can be a valuable tool in a researcher's communications toolbox.

Twitter, Instagram, Facebook, LinkedIn, Reddit, YouTube, and Pinterest: the list of social media platforms can be dizzying, and each platform has its own nuances, benefits, and drawbacks. Here, we will focus on the 'Big Three' of social media: Twitter, Facebook, and Instagram. We outline the basics of each platform, their benefits and disadvantages, and the audiences that tend to congregate on each (Figure 18.2). For a more detailed explanation of the technical side of setting up each type of account, we recommend a number of excellent guides on social media for scientists (Bik and Goldstein 2013; Shiffman 2018).

18.6.1 Twitter

Twitter is a micro-blogging site that allows users to post messages of 280 characters or less, as well as photos, videos, and links to external websites. Users can search for topics or promote their work using hashtags (#). Twitter has emerged as one of the most-used social media platforms for scientists (Collins et al. 2016), serving as an online global

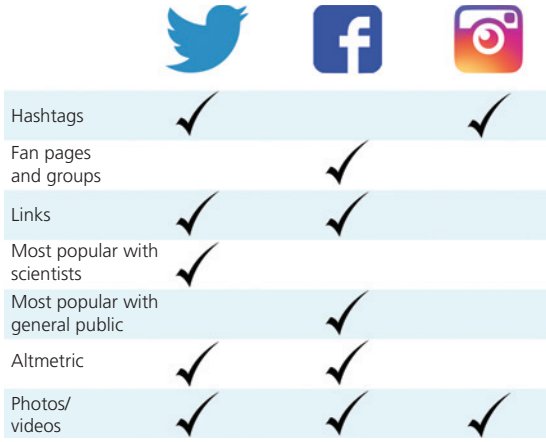

Figure 18.2 The social media focus includes the 'Big Three': Twitter, Facebook, and Instagram, respectively, across the top of the figure with checkmarks (✓) indicating relevance to various functions (e.g. hashtags, fan pages and groups, links, photos/videos), audience (e.g. scientists, general public), and benefits to altmetric scores along the left side of the figure.

faculty lounge that can connect far-flung researchers (Darling et al. 2013) and thereby facilitating collaborations and interdisciplinary research (Bik and Goldstein 2013).

One of the most-used features of Twitter among scientists is sharing and reading about the latest research (Collins et al. 2016). This makes sense, given that most scientists on Twitter follow and are followed by other scientists (Côté and Darling 2018). However, as scientists amass more followers, they can reach wider audiences; one study indicated that beyond a threshold of 1000 followers, scientists were able to reach a more diverse audience including journalists, policy makers, and the general public (Côté and Darling 2018).

Tweeting about a paper can increase its reach online and in academia. The alternative metric or 'altmetric' score of a paper quantifies its reach beyond traditional means (i.e., journal citations) through social and traditional media; an altmetric score can be increased by tweeting a link to the paper, so long as the associated website bears the digital object identifier (doi) of the paper. While a high altmetric score has inherent value, it can also affect academic impact. In some fields, highly tweeted papers are 11 times more likely to be highly cited (Eysenbach 2011). It is likely this combination of broad and narrow outcomes—reaching wide audiences while also improving traditional academic metrics—that has led to the rise of Twitter within the scientific community.

18.6.2 Facebook

Facebook is the ubiquitous social media site, boasting a base of over 2.32 billion monthly users in December 2018 (Clement 2019). As such, many stakeholders will already have Facebook accounts set up, making this a convenient way to connect. Generally, Facebook interactions are more restricted than Twitter interactions because users must have mutually agreed to be 'friends' in order to communicate. However, a popular way for scientists to connect with stakeholders on Facebook without this step is through groups or fan pages. These are specialized features that allow people with similar interests to congregate and share ideas.

Groups or fan pages can be established for lab groups or for individual projects. These pages can be a useful jumping-off point for meeting conservation and science enthusiasts. For instance, researchers could establish a page for their lab group, then join related Facebook groups with similar topics to advertise the new page to quickly grow a following. Once a page has been established, it can be used not only to communicate directly with stakeholders, but also to promote other endeavours such as citizen science projects or crowd-funding opportunities, whereby researchers can source research funding directly from interested citizens (Hui and Gerber 2015). Finally, as with Twitter, links to papers shared on Facebook pages can increase altmetric scores.

18.6.3 Instagram

Instagram is a social media platform for sharing photos and videos. It may not be perceived as a space for academics; yet, research has shown that viewers pay more attention to pictures than text (Fahmy et al. 2014). This suggests that platforms like Instagram may have been overlooked for their potential to communicate science (Russmann and Svensson 2016).

Instagram is organized similarly to Twitter, where researchers can follow specific users or search for

specific topics using hashtags (#). While accounts with professional photographs tend to accrue the most followers, niche accounts, such as science pages, can have success without the help of a professional photographer, so long as the images are particularly captivating. In the field of conservation physiology, photos or videos of experimental setups, charismatic study species, or research outcomes would transfer well to a platform like Instagram. Instagram can also be used to reach out to stakeholders who are frequent users of the platform and might not be reachable on Twitter or Facebook. The #keepemwet campaign is an excellent example of reaching out to a community on Instagram to promote conservation actions (see Section 18.6.4).

18.6.4 Case study: Keep 'em Wet (#keepemwet) fishing

Recreational fishing is a popular pastime, with estimates indicating that recreational fishers land approximately 47 billion fish annually (Cooke and Cowx 2006). Over 60 per cent of those fish are later returned to the wild in what is known as catch-and-release fishing (Cooke and Cowx 2006). While the goal of this method is to return fish back to the environment unharmed, scientific studies have found a range of negative effects on physiological performance that are associated with commonly used catch-and-release methods (Arlinghaus et al. 2007). Based on these findings, best-practice guidelines for catch-and-release fishing have been developed (Brownscombe et al. 2016). Yet conveying this information to the broad community of recreational fishers has proven difficult, as even state/provincial agencies sometimes provide inaccurate information about catch-and-release best practices (Pelletier et al. 2007).

In contrast to this top-down approach to communicating catch-and-release best practices, nature photographer Bryan Huskey decided to approach the issue from the bottom up. His grassroots conservation movement began in May 2013 when he coined the Instagram hashtag #keepemwet. This movement was born from his frustration with the online recreational fishing community, who frequently tagged images with the hashtag #catchandrelease that depicted fish dry on banks or clearly being held out of the water for long periods of time. He was concerned that fishers were amassing followers with these photos that promoted harmful catch-and-release practices, and that such messages could potentially encourage others to take similar photos at the expense of the fish. Huskey started tagging his photos with #keepemwet, a phrase that was both catchy and directly related to conservation actions that fishers could take (Danylchuk et al. 2018). The tag caught on quickly and spread throughout the fly-fishing community. As a result, Huskey created official Instagram and Facebook pages, as well as the keepemwet.org website in 2015. The website was created to serve as a resource for learning science-backed methods for catch-and-release fishing. Huskey was able to drive traffic to the website by partnering with recreational fishing industry members, such as travel companies and gear manufacturers. Later, in 2016, Keepemwet Fishing launched an ambassador programme, which is a common practice in social media to use high-profile members of a community to promote a product or service. While ambassadors are commonly paid for their promotion of a product, the Keepemwet Fishing campaign only asked the angling professionals to promote science-backed catch-and-release guidelines.

The Keepemwet Fishing campaign has shown consistent growth in its reach across social media platforms, but measuring its impact is more difficult. Oftentimes, popular hashtags can take on a life of their own, and thus #keepemwet may be used on photos that do not promote catch-and-release best practices. Still, the organic origin and growth of this movement can serve as a useful case study for those looking to use social media for conservation physiology. Because Huskey was involved in the recreational fishing community, he knew that Instagram was a popular platform for other fishers, making it easy to reach out to them. As the Keepemwet Fishing campaign grew, it remained unaffiliated with government or corporate organizations, which may have contributed to its acceptance by the recreational fishing community (Hollenbeck and Zinkhan 2006). Then, by establishing an ambassador programme with high-profile anglers, the campaign was able to increase its reach without reducing its

authenticity. Finally, the campaign may have succeeded because of its association with social pressure. Research from the social sciences has shown that anglers are willing to sanction other anglers' inappropriate catch-and-release practices, and this could increase as fishers learn more about science-based best practices for catch-and-release fishing (Guckian et al. 2018). Thus, the information provided by the Keepemwet Fishing campaign could increase social pressure and sanctioning within the recreational fishing community. Together, these strategies can be employed by other conservation physiologists looking to promote change in their stakeholder communities.

18.7 Conclusions and future directions

Effective communication and engagement are vital in translating research outputs into conservation action. However, there is no one-size-fits-all approach; the goals of the study will determine the audience, and the audience will dictate the best methods for engaging stakeholders and communicating the findings. Here, we have differentiated between a number of engagement and communication methods, but in reality, these methods can be mixed and matched in different combinations to best fit the needs of the researchers, the project, and the communities involved. For example, citizen science projects can be advertised on social media, and social scientists can join in on knowledge co-production teams. It is important to think outside the box in order to create a research programme with meaningful and effective impact.

Once these modes of communication and engagement have been mastered, it is key that researchers consider ways to enable other researchers to develop these skills. Avid social media users can help their colleagues set up Twitter accounts. Chief investigators on citizen science projects can share tips on volunteer recruitment and retention strategies. Researchers in co-produced studies can bring interested colleagues along to stakeholder meetings. Importantly, though, it is no one researcher's task to single-handedly up-skill their colleagues. Research institutions must facilitate improved engagement and communication skills in their researchers. This support can come in the form of funding for workshops, external speakers, or short courses. It can also take the form of incentives for researchers to co-produce research and engage with stakeholders and the broader public. Institutions should recognize the key roles of communication and engagement in solving conservation problems and reward researchers that undertake non-traditional research projects. These skills are essential for researchers to produce high-quality, applicable outputs that are useable and useful to stakeholders, decision makers, and the broader community.

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