Communication Technology Reshaping Environmental Institutions

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Abstract

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Environmental problems are immensely social and collaborative: their governance requires coordination among many different stakeholders, and the parties often must choose to compromise their immediate self-interests in a prisoner's dilemma to protect the shared resource. For example in Hardin's *"Tragedy of the Commons"* model, one single shepherd can destroy a pasture by overgrazing so they all must collectively find a mechanism to limit their consumption. Researchers in political, social, and environmental sciences have developed an extensive literature about the conditions that support successful environmental governance. However, the relationships among the diverse actors in environmental governance are being rapidly reshaped by the evolution of communication technology and its continuing spread around the world.

This thesis maps out the technology design space for environmental institutions and public engagement, and investigates communication technology's effects on institutional structures and community relationships. I present three case studies of communication technology in environmental institutions: first, a system using basic phone services like SMS and USSD for Ol Pejeta Conservancy in Kenya to engage communities living around its border. Second, I study wildlife-tracking maps with EarthRanger, the Giraffe Conservation Foundation, and Atlantic White Shark Conservancy to investigate the uses and limitations for interactive data visualizations towards environmental communication goals in high-connectivity, media-saturated settings. Third, I present a formative design study for an anti-poaching hotline in Laikipia, Kenya to probe at security con-

texts. Finally, I present a cross-sectional interview study of staff at various environmental institutions to generalize and cross-validate my findings. Together, these projects describe the mechanisms by which communication technology is reshaping environmental organizations' structures, operations, and social relationships; and stake out a technology design space to help environmental organizations have more meaningful, productive engagements with local communities and the pubic.

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GLOSSARY

Acronyms

AWSC. Atlantic White Shark Conservancy

CDP. Community Development Program

CSCW. Computer-Supported Cooperative Work and Social Computing

GCF. Giraffe Conservation Foundation

HCI. Human-Computer Interaction

HCI4S. Human-Computer Interaction for Sustainability

ICT. Information and Communication Technology

ICTD/ICT4D. Information and Communication Technology for Development

IVR. Interactive Voice Response

KPR. Kenyan Police Reserve

OPC. Ol Pejeta Conservancy

USSD. Unstructured Supplementary Service Data

Chapter 1

INTRODUCTION

1.1 Motivation

Wildlife conservancies and environmental institutions around the world—traditionally tasked with protecting flora and fauna—are increasingly expanding their mandates to address human factors. At local scales, heightening environmental stresses require conservation parks to co-manage shared natural resources like water, soil, pollinators, and wildlife diseases; especially in economically-developing regions where more people depend directly on the land for their livelihoods [161]. Modern environmental institutions have become progressively more cognizant of their social impacts and began to prioritize social equity and justice in their work, especially in the past decade. For example, conservation parks increasingly employ community development programs (such as scholarships and veterinary services) to ease local tensions and historical injustices with the often-marginalised people on their borders. Similarly at larger public scales, environmental institutions need to engage with the the masses for a variety of reasons: to promote awareness of their projects, raise awareness of environmental issues, build political support, raise funds, and encourage environment-friendly behavior [302].

This thesis examines the role of technology in these human, relational dimensions of environmentalism and conservation. The explosive growth of communication technology around the world is fundamentally changing the ways that environmental organizations operate, and transforming the relationships among the many stakeholders in environmental governance. This is especially true as the technology landscape rapidly shifts in remote rural areas that previously had minimal infrastructure and connectivity—where many conservation projects are located—and local residents face access barriers like limited literacy, low device ownership and restrictive gender norms.

The rapid proliferation of network connectivity and uptake of mobile phones around the world presents new opportunities for environmental institutions to reach out to the communities around them, especially in low-income regions. At the same time in more highly-connected, media-saturated regions, new communication opportunities arise as technologists develop new interaction modalities and user interfaces that alter the media landscape. Recognizing this opportunity, (and motivated to impress donors with flashy projects), environmental organizations big and small have rapidly increased their investment in community- and public-facing Information and Communication Technology (ICT) projects [320] like incentivising fishers to record their catch on mobile apps [320], designing citizen science apps to document local biodiversity knowledge [343], and alerting communities about lions to protect livestock [350].

Despite their rapid proliferation and hype, there is a distinct lack of neutral, critical research on these community-facing environmental ICT projects. Evaluations are scant; and best practices, design strategies, and potential pitfalls are not well understood. The large research communities in adjacent subfields of computer science—including Information and Communication Technologies for Development (ICTD), Human-Computer Interaction (HCI), Social Computing (CSCW), and conservation technology—can offer theories, evidence, and methodology that are ripe for application to environmental governance problems. However, their engagement with this topic has still been minimal.

This dissertation shows that there is enormous and underexplored potential to bring approaches from ICTD research into conservation and environmental projects. ICTD research has historically focused on technology deployments in economically-developing regions; projects often leverage technology in partnership with "development organizations" to advance objectives in sectors like health [99, 139, 260, 271, 273, 31, 276], agriculture [32, 63, 127, 361, 180, 289], and education [313, 333, 115]. ICTD researchers have only minimally engaged with environmental topics—which fall outside the traditional sphere of "development"—but many environmental organizations working in remote low-infrastructure regions face the same challenges. For example, ICTD practicioners have developed communication strategies to energize communities around development initiatives like health and agriculture, and have elaborated the affordances

of "basic" technologies that are most widely accessible in low-infrastructure settings, like SMS and USSD [272]. Additionally, ICTD researchers have developed a collection of methods for co-designing technology applications with communities, especially when there is a substantial distance between researchers and participants in power, culture, and technology skills [107, 30].

However, environmental problems have unique structures that complicate the adoption of traditional ICTD methods. They tend to be collective by nature and require community-wide engagements, and their success can depend on individuals making decisions against their own immediate self-interest: for example, Hardin's famous *Tradgedy of the Commons* model [164] is illustrated by shepherds using a common pasture and being individually incentivised to maximise their own grazing, but they must collectively agree to reduce their grazing to save the pasture from degradation. The complex social inter-dependencies of environmental problems raise a key question for research: how can communication technology approaches from ICTD be adapted to fit these unique social and environmental systems? My disseration will address these questions through a collection of user experience studies for different types of environmental problems, organization types, and technology ecosystems.

1.2 Contribution and Structure

My dissertation investigates communication technology's role in reshaping environmental institutions via a collection of exploratory studies. Each chapter of my thesis examines ICT applications in varied social, environmental, and technical contexts; characterizing the perspectives of different stakeholder groups that must work together for the project to succeed.

The chapters include:

1. A local-scale case study with Ol Pejeta Conservancy in Laikipia, Kenya working to engage nearby communities with basic phone technologies like SMS and USSD, to improve community relations and improve their capacity to address issues like human-wildlife conflict, water management, and tourism revenue sharing [373].

2. An analysis of interactive data visualizations' strengths and weaknesses for environmental

communication goals [372], investigated through the design and development of public-facing animal-tracking maps with EarthRanger[2], the Giraffe Conservation Foundation [135], and the Atlantic White Shark Conservancy [84].

3. A formative user study investigating security contexts, exploring the design space for a potential anti-poaching hotline in Laikipia, Kenya with input from local community members and security staff from several departments at Ol Pejeta Conservancy.

4. A cross-sectional study interviewing staff of environmental institutions about their use of mobile phones for interacting with nearby communities, and the way it shapes the social relationships and influences their institution's operations. This chapter supports the case studies in the three preceding chapters by cross-validating my results across many environmental organizations, and exploring the generalizability and limitations of my findings.

This work stakes out a new, under-explored problem area for computer science research—identifying some of the key challenges for future communication technology applications in environmental governance (Section 6.1). I elaborate these challenges through HCI and ICT4D methodologies and framings, such as user experience research, participatory design methodologies, and sociotechnical system approaches.

My first main contributions is centered on developing new communication technologies for environmental governance applications, with an eye towards finding the most promising potentials while identifying pitfalls and unintended consequences. For example, I examine new designs like partially-automated messaging systems for local community engagement in low-resource contexts, and visual applications for public engagement in media-rich settings. I contribute user research and a thorough qualitative account of these design contexts, as well as examine suitability of new and old technology affordances for environmental communication and community engagement.

My second main contribution is to explore the mechanisms by which communication technology shapes various aspects of environmental governance, particularly focused on environmen-

tal institutions' needs for community engagement and mass communications. This dissertation probes various types of environmental organizations (like security, education, and advocacy), institution structures, social-environmental contexts, and scale (local community engagement vs. public outreach). For this objective, I combine evidence from my case studies with existing research on social computing, institutional theory, and environmental governance. This contribution will help environmental organizations think more strategically about their use of communication technologies to achieve different types of community interactions, and contribute to political and social science research on environmental institutions.

1.3 Related Work

This section outlines related research in computer science and other adjacent fields to motivate and situate my own work.

1.3.1 Conservation Technology

Conservation technology is a rapidly growing field largely focused on sensing and monitoring. Progress in this area has markedly accelerated over the past decade, with a wave of increasingly available satellite imagery, cheapening of sensors, and improvements in artificial intelligence. Recent prominent applications include measuring biodiversity to evaluate conservation projects and identify biodiversity hotspots for targeting; and assisting in enforcement efforts against illegal logging [222], poaching [46], fishing [4], and wildlife trade. The latest wave has leveraged artificial intelligence analysis over data from satellites [4], camera traps, drones [46], audio recorders [61], and citizen science.

Partially because of their novelty, it remains a major open challenge to meaningfully embed conservation technologies into resource management systems. Most current work takes a birds-eye-view perspective, gathering and analyzing data to inform biology research, policy, and law enforcement efforts by large environmental intuitions—requiring the technical capacity to handle large datasets and implement policies. Citizen science projects have gained popularity as academics seek to engage the public in their research, but the citizen science approach has been

criticized for merely using participants as data-collection instruments and rarely giving them decision-making power [50].

The expense and required expertise of these initiatives creates difficulties for technology adoption by small groups. However, some groups have overcome these difficulties by tapping into the newly emerging "hacking" culture in conservation technology, producing devices like low-cost audio recorders that can be assembled for under $50 USD [171]. Other emerging examples and models of designing and deploying small-scale conservation technology include: (1) a project to reduce the workload of foresters by augmenting their on-the-ground forest inventory data with aerial remotely-sensed data [1], and (2) medium-sized organizations like Wildbook, which mediates between small conservation projects and larger technology providers [5]. Further work is needed to understand how to make recent conservation technologies relevant to small-scale and community-based management institutions, and to meaningfully engage the public in their use. The utilities and limits of these technologies remain underexplored in governance processes.

1.3.2 HCI for Sustainability

A small body of research on *Human-Computer Interaction for Sustainability* (HCI4S) emerged in the early 00's to investigate technology's role in mediating peoples' interactions with the natural environment. A small number of HCI papers describe systems where individuals can interact with companies or government agencies for resource management. Examples include systems for petitioning governments [103], studies of social media activism around environmental topics [367], or collaboration software for reducing energy usage within a firm [241]. In another common HCI4S theme, technology projects aim to help individuals reduce their resource consumption by appealing to the users' moral senses, but usually acting on an individual scale instead of negotiating tradeoffs among stakeholders [113, 112].

Most HCI4S research is situated within cities and developed economies, limiting its applicability to rural and economically developing contexts. In contrast to rural venues and much of the developing world, HCI4S contexts feature courts that are powerful, businesses that are well-established and have a large degree of influence on the human ecosystem, and resources that are

abundant. HCI4S artifacts do not typically ask users to make substantial sacrifices; rather, they prompt them to assume smaller inconveniences such as remembering to turn off an appliance or turn down the heat in their homes [112].

The HCI4S academic research community has waned over the past decade, perhaps unable to sustain interest because of lukewarm results. While this field of research has slowed in academia, there is recent interest from the technology industry as companies seek to incorporate energy-saving features into smarthome products. HCI4S literature offers a sample of exploratory technology projects, and there are opportunities for deeper engagement with environmental research in adjacent fields like political science, social science, and environmental communication.

1.3.3 ICTD

The field of Information and Communication Technology for Development (ICTD) typically studies technology use in low-income and economically developing contexts. ICTD is an interdisciplinary field, and is approached differently by researchers in various fields like economics, social science, and public health. Some computer science research in ICTD takes interventionist and exploratory approaches, often aimed towards designing new "development"-oriented technology applications in varied contexts. For example, one representative project in this style was the mobile health pilot by Perrier et al. [271] for engaging patients with an SMS nurse hotlines in a location with low internet access but high literacy rates.

Many HCI4S frameworks are not applicable in developing-world contexts. People in rural, low-income circumstances tend to have much more direct relationships with their natural environments [161], needing to eke out a living from their immediate surroundings—e.g. about 60% of people in India are smallholder farmers—instead of interacting with the environment through the long, detached supply chains of developed economies. Courts and law enforcement are less strong, and corruption tends to be more pervasive. Resources can be much more scarce for people experiencing poverty; restrictions or disruptions in access to important resources like water or firewood can cause severe hardship.

Conservation technology has the potential to benefit from the expensive lessons learned

through ICTD projects in sectors like health and education. At the onset of ICTD research, there was a broad, naive excitement; technologists pursued a variety of overly optimistic ideas with a supply-driven tech push [321]. However, early ICTD health projects tended overwhelmingly to be short-lived, disconnected, expensive pilots with disappointing results [139]. ICTD researchers and practitioners are frequently criticized for "parachuting in" new technologies from afar with little consideration of local circumstances; and for "techno utopianism:" over-reliance on technologies to address problems with social and institutional causes [321]. Uganda even issued a moratorium on ICTD health pilots in 2012, frustrated with the lack of coordination among donors and government health agencies [223].

The resulting blowback led to a discussion about the steps required to have sustained impact. Donors pushed for guidelines, which led to the widely adopted Principles for Digital Development [3], and academics produced a discourse on ICTD ethics [104]. There has been a subsequent maturity in some projects, with longer engagements and tighter ties with governments.

As the field of ICTD has matured, it has developed lenses for considering cultural, social, community, and institutional factors in technology interventions [132, 106, 54, 321]. For example, the influential "amplifier principle" posits that new technologies tend to reinforce existing institutional forces instead of "leveling the playing field" [321]. ICTD research has produced an extensive discourse on research methods for cases where a substantial power imbalance exists between researchers and participants [107, 20, 336].

Technologies are embedded in complex social, cultural, and institutional systems that determine whether and how people make use of them. The conservation technology domain can avoid repeating mistakes by building on lessons and frameworks from fields like ICTD, hopefully short-circuiting the long slog of failed interventions.

1.3.4 Environmental Communication

Environmental communication studies the various ways that individuals, corporations, politicians, environmental organizations, journalists, and other groups attempt to influence the policies that affect our planet's health. Fundamentally, the field explores media strategies for culture

change: starting from an idea that nature is something to dominate, and moving towards a notion of nature as something that we need to share for our own survival. Many attribute Rachel Carson's 1962 book *Silent Spring* as the the fields' beginning, whose vivid and provocative depiction of pesticides' environmental harms brought widespread public attention to environmental issues and led to new regulations in the USA [66, 302].

Scholarly research on media, communication, and the environment developed into the 1970s and subsequent decades, shaped by the key environmental issues of each era, and influenced by foundational early works like Anthony Downs' 1972 study of the environment as a social problem [114], Harvey Molotch and Marilyn Lester's 1975 study of news reporting following a major oil spill [236], and David Sachsman's 1976 study of source influence [293]. Developments in the 1980s focused largely on the media's impact on nuclear power narratives [162]. Recently as climate change has become the main environmental issue in the media, research has focused on building consensus towards large collective actions.

Through the 1990s and 2000s, environmental communications research continued to grow in relevance as university professors in the United States dedicated course material to environmental communications analysis. These decades also marked the rise of international environmental communication associations and societies, like the International Association of Media and Communication Research (1988), The Society of Environmental Journalists (1990), and the Science and Environment Communication section within the European Communication Education and Research Association. The International Environmental Communication Association formed in 2011, working to broaden the global cache of environmental communications beyond the United States and Europe [162]. Today, the study of environmental communications plays a pivotal role in advancing equitable ecological policies worldwide.

Environmental communications discourse has gradually developed a consensus on best practices for various types of environmental institutions, which is covered more deeply in the chapter on wildlife tracking maps (Section 3.2). However, environmental communications research continues to focus mostly on traditional media like television and radio, and over the past decade has shifted to study social media. There is still very little published research on the affordances of

new, emerging technologies for communication technology like interactive data visualizations or augmented reality. Additionally, academic research on environmental communication is heavily skewed towards media-rich western contexts, and environmental communications in low-income areas is vastly understudied.

1.3.5 Social Computing, Environmental Governance and Institutional Theory

Scholars in political and social sciences have developed a substantial body of theory on the social conditions, institutional structures, and environmental factors that allow for successful environmental governance. In parallel, social computing researchers have developed a body of theory that describes the interplay between technical and social factors in collaborative computer systems, punctuated by the *Computer Supported Co-operative Work and Social Computing* conference and journal (CSCW). Some influential CSCW work shares theoretical underpinnings derived from the early foundational work in environmental governance. For example, Elinor Ostrom won a Nobel Prize for her work on governance institutions for shared common-pool resources like water basins and forests [264, 266]—she laid out a set of design principals for successful community resource-management institutions, like clearly-defined boundaries and stakeholders, a shared understanding of the resource system, stakeholders' participation in rulemaking, and graduated sanctions for rulebreakers. Many CSCW researchers have applied Ostrom's principals by modeling social techology systems as "digital commons" to examine the design conditions that lead to their success and failures, for example studying online communities [268], Wikipedia [172], or community cellular networks [191, 133].

As modern institutions are reshaped by their reliance on communication technologies, I aim to re-apply this social computing research back to environmental governance problems to explore the ways that technology design shapes the relevant social interactions across their varied institutional, economic, and environmental contexts. I will develop this analysis further in later chapters.

Technology systems for remote work are an extensively studied topic, with structural implications for environmental institutions coordinating actions among many individuals, and often

working across distances. (In my interview study with environmental institution staff, described in Chapter 5, this was a common case: organizations used phones to coordinate projects in multiple locations, or to keep in touch with rural communities from urban NGO offices, for example.) Foundational work on this topic has identified important factors for the success and failures of remote-work systems, like structuring the remote interactions around loosely-coupled work, establishing a common culture between remotely located participants, and building from existing technology infrastructure [261]. Other work has characterized the challenges for developing collaborative software in organizations, like systems that create disparities in work and benefit for different stakeholders, difficulties reaching critical mass, the disruption of social processes, and inadequate exception handling [157].

Research on the dynamics of online communities also presents lessons for community-based conservation problems as they become increasingly mediated by technology. Community moderation systems are studied by an increasing number of researchers, e.g. investigating the factors that affect their perceived legitimacy [268], systems enabling members to participate in rulemaking [297, 129], and tactics to manage misinformation [185]. Other work describes the creation of norms and culture in online communities: for example, achieving a consensus around what behaviors are appropriate, and setting expectations of how conflicts will be handled [198]. Further research examines design features to create a common identity between forum users [288]. As illustrated here, many of these CSCW research topics for online communities correspond directly with Ostrom's aforementioned design principals for common-pool resource management.

1.3.6 Political Ecology and Environmental Justice

In response to historical shortcomings in addressing the worsening natural resource crises, recent counter-narratives have arisen in environmental studies that incorporate social sciences. Unlike earlier purely biological and Malthusian narratives, the study of *political ecology* emphasizes political and economic forces in natural systems [290]. The related study of *environmental justice* emerged from urban activists fighting for recognition of the fact that low-income communities and racial minorities have much greater exposure to pollutants [169, 329]. Both movements rec-

ognize that conservation programs create winners and losers instead of being purely benign. My own work takes a critical approach to conservation technology probing the inequities that technical systems can perpetuate in conservation work, informed by environmental justice and ICT4D framings.

Chapter 2

CAN PHONES BUILD RELATIONSHIPS? A CASE STUDY OF A KENYAN WILDLIFE CONSERVANCY'S COMMUNITY DEVELOPMENT

2.1 Summary

This chapter is the first of three case studies on communication technologies reshaping environmental institutions. It examines Ol Pejeta Conservancy's (OPC's) relationships with the communities around its borders showing how these community relations are crucial for the success of OPC's environmental missions. In this case study we see that mobile phones are absolutely foundational to these relationships, even in areas with high levels of poverty and relatively low levels of electricity and telecommunication infrastructure: OPC's community-facing staff spend huge amounts of time on the phone with community members, reacting to urgent issues, coordinating projects, and responding to questions and grievances. Especially as the surrounding communities are spread out across a wide area and travel is expensive, the use of mobile phones has been a crucial factor in helping OPC develop relationships with community members in order to serve them better, and build the capacity for them to work together when issues inevitably arise. By analyzing pilot technology deployments in OPC's communities—an SMS hotline and USSD application—we also reason about how community relationships can change as technology improves in the future. This case study motivates the main question of this dissertation; seeing how fundamental mobile phones are to OPC's community operations, how do they shape other environmental instutions around the world as they vary in their local technology, environmental, and social contexts?

Wildlife conservancies across the globe are increasingly recognizing their need to support their surrounding communities to sustainably operate. Rapidly shifting environmental and sociopolitical climates increasingly stress existing resource and service provisions, forcing wildlife

Figure 2.1: USSD screen about Ol Pejeta's community cookstove-building program

conservancies to co-manage with local communities shared resources like water, wildlife, soil, pollinators, and security. This work presents a case study in Laikipia, Kenya on Ol Pejeta Conservancy's use of text-based technologies to provide services and build relationships with the many widely-dispersed communities on its borders. Through technology deployments, staff interviews, and community focus groups, we investigate a potential role for basic mobile phone services, like SMS and USSD, to help conservancy personnel disseminate accurate and timely information, gather community feedback, address grievances, and improve accountability. Our findings show that communication with locals requires intense and ongoing effort from conservancy staff. Partially successful deployments of phone services provide a proof-of-concept for their utility in community relations but highlight particular design challenges for wildlife conservancies; having critical needs for broad inclusive engagement; clear, deliberate communication; and careful trust-building.

2.2 Introduction

Wildlife conservancies around the world—traditionally tasked with protecting flora and fauna—are expanding their mandates to address broader environmental and social problems affecting

local people [67, 12, 265]. Heightening environmental stresses require co-management of shared natural resources with communities, like water, soil, pollinators, and wildlife; especially in developing countries where more people depend directly on the land for their livelihoods [161]. Additionally, many conservancies take on responsibilities of providing parallel amenities that under-resourced governments lack the capacity to manage or provide, such as sanitation and agriculture extension [76, 264, 285]. Historically, conservancies' relationships with local people have suffered conflicts over resources, and mistrust over whether and which communities received economic benefits from tourism revenues and research activities [355, 285]. Environmental institutions in many parts of the world have underlying, complicated colonial histories, which amplify these surface tensions; for example, many of the national parks in the USA were created by violent expulsion of Indigenous people from their homes [216]. In light of their new mandates, however, conservancies must find ways to overcome past challenges and forge productive new relationships with local communities.

Ol Pejeta Conservancy (OPC) in Laikipia, Kenya, shares the broader mandate of addressing local environmental and service needs. Known globally as the refuge for the last two Northern White Rhinos, OPC is a recognized regional leader for its Community Development Program (CDP). The CDP engages with the 20 communities and 35,000+ people who live within 5km of the protected area's borders to co-manage shared rivers that flow in and out of conservancy boundaries, mitigate disease transmission between wildlife and livestock, support beekeeping and conservation agriculture, encourage reports on poaching, and reduce human-wildlife conflict with elephants, lions, and baboons; among other varied projects. OPC initiatives have shown a demonstrably positive impact. However, their reach and engagement with partner communities face ongoing challenges. With their limited staff they must address widespread community poverty, and the history of mistrust and disagreements that characterize former relationships.

Robust communication and relationship building are therefore seen as crucial factors in ensuring the conservancy's long-term operational sustainability. Decades of research on community environmental governance stress the importance of developing relationships based on trust and credibility so partnering groups can work together harmoniously and resolve grievances

promptly when issues arise [21, 22]. OPC now makes significant resource-intensive communication efforts. They hold regular and open community meetings, make frequent field visits, communicate daily with local officials, and issue printed community newsletters [87]. But their 'local' communities are widely dispersed, and travel among them is difficult. Information penetrates these areas slowly and in fragments, and misinformation is prone to spread.

This chapter explores the potential for conservancies to more meaningfully engage with their neighboring communities using ICTs (information and communication technologies). Because most households surrounding OPC have basic mobile phones but lack internet access, we focus on simple phone services like SMS, automated voice menus (IVR), and text-based menu applications (USSD). We evaluate pilot installations and examine broader questions: Can we improve community relations using basic phone services to open communication channels, improve community service provisions, and strengthen OPC's ability to work with communities when issues arise? Potential applications of these mobile phone platforms include widely circulating information about OPC's activities (e.g., health outreach dates, community meetings, agriculture and cattle tips, job postings, program announcements, and conservancy news), improving program impact (through accountability mechanisms such as widely announcing prices to ensure no extra fees for subsidised cookstoves, and monitoring irrigation projects with surveys), speeding up communication about human-wildlife conflict for faster responses, and gathering grievances and feedback.

Using OPC as a case study, we review existing scholarship on mobile phone-based engagement and community-oriented conservation (Section 2.3). Since any successful introduction of new technology depends heavily on cultural and socio-political context, we describe the theory and culture of community resource stewardship as it pertains to OPC (Section 2.4). We then shift focus to explore this area's technology infrastructure and strategies for mobile phones in community development. We review usage data, anecdotal evidence, survey results, and opinions regarding (1) a bulk SMS service for sending announcements to communities, with limited reach but demonstrable positive impacts on community engagement; (2) a partially-successful two-way SMS hotline for gathering community input, which was hindered by usability challenges for some

demographics but still used by community members to communicate about pressing needs; and (3) an early-stage pilot of a browsable text-based USSD application, which had promising uptake but also suffered from usability problems (Section 2.5).

To deepen our understanding of staff and community members' experiences with communication, general phone usage, and the pilot technology deployments, our research then shifts to a more structured qualitative approach via staff interviews and community focus groups (Section 2.6). We find that OPC staff regard communication as a crucial challenge, and community members get incomplete information through a patchwork of sources despite OPC staffs' intensive efforts. The needs for trust-building, potential for miscommunication, and security emerged as important challenges. ICTs could be a key for engaging tech-savvy young people who OPC has thus far struggled to reach, but many elder community members faced particular difficulty and frustration with text-based interfaces. We conclude by discussing the extent that basic mobile technology could better connect and support relationships between conservancy staff and community members, and the need for further design work and evaluation to better understand how to adapt these approaches for other environmental institutions (Section 2.7).

2.3 Related Work

2.3.1 Mobile Phone-Based Engagement in Development

We explore how ICT could activate environmental initiatives and what channels and messaging are most effective for meaningful communication between conservancies and the communities they serve. Although donors and non-governmental organizations increasingly view mobile phone engagement as a core component of development programming and impact, research across sectors highlights problems in recruitment [124, 251, 275], uptake [63, 127, 332, 362], usage [184, 337, 361, 310], and cross-channel compatibility [124, 131]. Thus far, ICT solutions have primarily been evaluated in sectors like health [99, 139, 260, 271, 273, 31, 276], agriculture [32, 63, 127, 361, 180, 289], and education [313, 333, 115] rather than conservation. Although ICTs can improve coordination among participants across varied development sectors [167, 73], results

on conservation and local resource management have emphasized challenges in these realms that are distinct from other sectors [10, 367, 350, 244]. Appropriate design, recruitment, and overall effectiveness of ICT interventions in conservation thus remain poorly understood in theory and practice.

2.3.2 Communities and Conservation

Growing concerns about environmental degradation and resource-based conflict have led stakeholders from wildlife conservancies, local communities, and governments to search for novel solutions to address these mounting challenges. Recent decades have seen the rise of integrated conservation and economic development initiatives with mixed success [19, 29]. Many previous efforts to address local development issues have been complicated by institutional deficiencies in service provision and protection [287, 147, 200, 44]. Pervasive throughout much of the developing world, these deficiencies often obfuscate the development of simple solutions to dispute management involving human, flora, and wildlife populations.

One identified challenge for maintaining local environmental resources in low-income countries involves incomplete property rights, which delineate ownership and management responsibilities of each community's common-pool resources (CPRs) [10]. Unlike traditional public goods, which are open to everyone (non-excludable) and infinite in supply (nonrival), CPRs are limited in supply and accessibility [265, 264]. Without formal property rights, such as land titles, the boundaries between individual and group assets are blurred with CPRs, creating space for conflict [164]. Accordingly, standard political economy scholarship stresses the deficiency of conventional solutions to CPR management given the incentives to free-ride in their use [164, 262], yet real-world examples of self-governance demonstrate that local communities frequently overcome barriers to collectively mobilize to manage CPRs [164]. These actions are typically facilitated not only through adequate resources, but also through strengthening communication among stakeholders, and from monitoring strategies that build trust and limit free-riding [264].

Positive demonstrations of community actions have encouraged governments, civil society, and conservancies to become more active in CPR management [265, 11], but conflicts among

stakeholders are intensifying as climate conditions worsen. As a result, external actors often leverage influence to reap the positive returns from collective community actions while sacrificing local welfare [149, 265]. Power asymmetries between local communities and both governments and private conservancies have enabled the historical exploitation of marginalized populations' natural resources [149, 75].[1] With expected spikes in regional temperatures and increased water scarcity for local populations [317], the frequency and intensity of these disputes will likely result in further conflict and human encroachment on protected conservation areas [265]. In response to these historical wrongs and mounting climate challenges, contemporary environmental stakeholders are prioritizing engagement with local communities to promote collaborations for protecting the shared environment.

2.4 Context

Our study occurs in Kenya, a country facing a variety of historical and contemporary challenges to sustaining environmental resources that are threatened by a dearth in arable land, sedentarization, the illegal razing of protected forests, frequent droughts, and extensive poaching [47]. Obstacles to successful common-pool resource (CPR) management have increased inter-community conflict; contestation has burgeoned where local communities have struggled to adjudicate distributional claims over shared economic and environmental resources [47, 193]. Foreign settlements and land grabs in the Rift Valley "White Highlands" (that overlap some of OPC's project area) have continually driven ethnic Kikuyus (primarily agriculturalists) and Maasai (primarily pastoralists) from their ancestral land [47], an issue that successive governments have failed to adequately address [193]. Instead, local and national politicians frequently opt to leverage the scarcity of tenable land for political gain [47, 75] by limiting land rights and service provision. These adversarial forms of patronage politics exacerbate resource-based contestation and electoral violence [75]. Weather shocks associated with climate shifts have further induced droughts and patterns of abnormal rain, worsening local resource-based conflict between groups, especially Kikuyus

[1] Profiteering has been most evident where tourism has been greatest, because gains are often disproportionately shared with local communities, if shared at all [341, 47, 265].

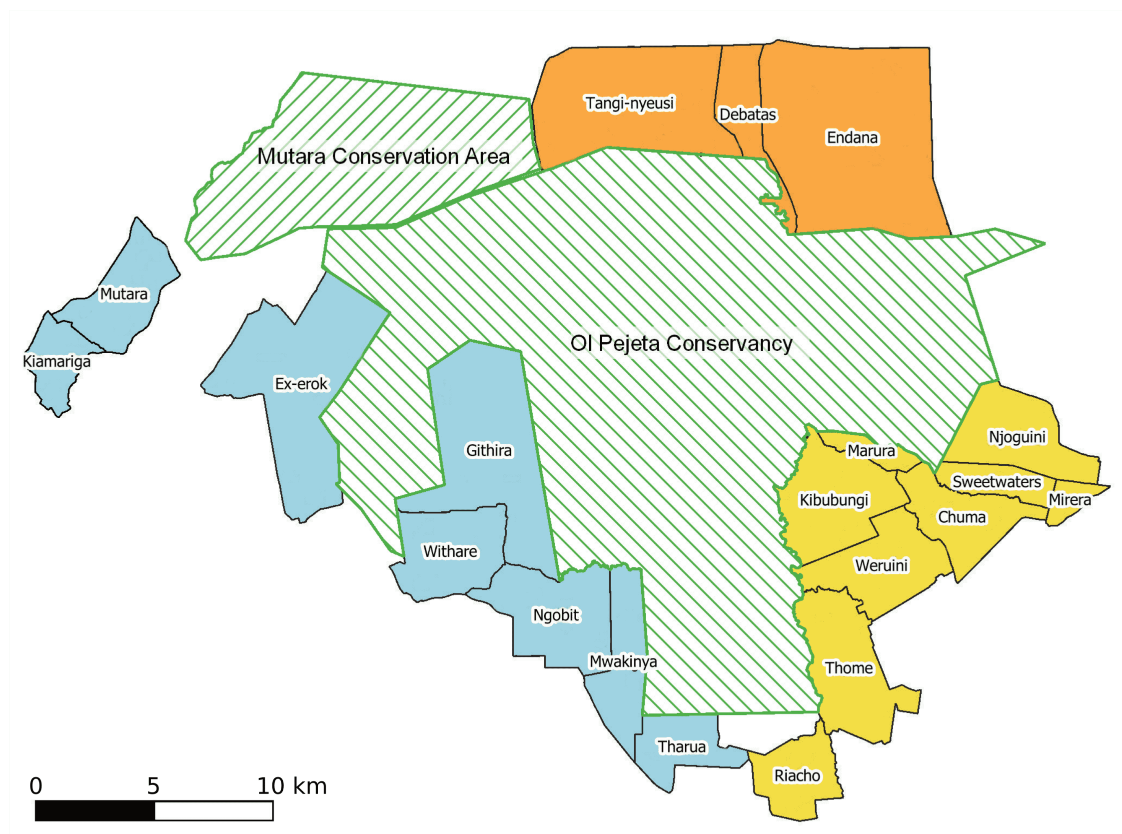


Figure 2.2: Ol Pejeta's communities. Northern communities (orange) are mostly pastoral with less-developed infrastructure. Southeastern communities (yellow) are agro-pastoral, and closer to a major town with better accesses to services. Southwestern communities (blue) are agro-pastoral and have significantly more human-wildlife conflict.

and Maasais.

The government attempted to address CPR issues following the adoption of a new constitution in 2010, which promotes devolved governance to manage land scarcity and marginalization [193]. These reforms place a greater onus on local governance of service provision and empower communities to place a larger participatory role in devolved structures. Unfortunately, these reforms, which extend significant authority to newly created local county councils, sometimes have created new platforms for corruption rather than refocusing resources on local inequalities in the distribution and use of tenable land [75]; they have also increased the frequency human-wildlife conflict [341, 249], with numerous reports detailing illegal hunting, poaching, and violence against wildlife [341, 149].

2.4.1 Ol Pejeta Conservancy

Ol Pejeta Conservancy (OPC), a private Kenyan-run not-for-profit organization, was created to fill this void in service provision and institutional capacity to improve wildlife and land protection for local communities [86]. OPC protects 150 critically endangered Black Rhinos and over 13,000 individual species, including the endangered African Wild Dog and Grevy's Zebra [89]. These attractions helped OPC host 104,354 tourists in 2018, (over 50% were Kenyan), enabling OPC to use their conservation work as a platform to engage with local communities. However, deficiencies in public investment have saddled OPC with a host of new and non-traditional responsibilities, ranging from irrigation to improvements in systems as disparate as agriculture and education [86], efforts that have been complicated by rising urbanization in the villages surrounding OPC and changes in seasonal weather patterns.

OPC also faces tensions with local people. The conservancy is located on the former colonial ranches created by the violent eviction of the Maasai people during foreign settlement in the colonial period [176]. Injustices of these re-settlements are still felt today, many locals arguing that their communities are still excluded from land, economic development, and decision-making. In the 2017 elections, local politicians took advantage of these tensions to promise conservancy land to locals in exchange for votes, inciting violence against area conservancies [248]. While OPC

was fortunately spared in this area—a result its leaders attribute to their relationship-building efforts with locals—communities complain that OPC has different development goals than they do, and that they do not receive promised economic benefits from tourism [182].

OPC's Community Development Program (CDP) began in 2004 during the transition from ranch to conservancy, with only one employee focused on agriculture. It has steadily grown to a team of 12. CDP initiatives include school technology and infrastructure support, conservation education, school bursaries, community visits to the conservancy, solar installations, rainwater retention, river management, well drilling, cattle extension and breeding, agriculture extension, beekeeping, support of government clinics, mobile health outreach, and fuel-efficient cookstove building. In 2018, OPC spent $600,234 USD on community projects [86]. It engages daily with 18 community representatives and 6 local chiefs, who are the primary liaisons with communities. Community representatives began in 2007, originally by approaching chiefs to find influential people to serve as links to the communities. Community boundaries were formalized in 2014 (Figure 2.2), and the unpaid community representatives became democratically elected. OPC holds meetings every 1-3 months in each community to receive feedback and plan programming. Community representatives organize the meetings, which are always attended by CDP staff. Additionally, OPC prioritizes local hiring for their approximately 850-person staff.

In recent years, CDP has begun using the Social Assessment of Protected Areas (SAPA) method [138] to assess its impacts on communities' livelihoods. The 2019 SAPA found the most-valued benefits to include OPC's fence that protects from cattle rustling and incursions by wildlife, security assistance, education support, and health facilities. Areas most critically in need of improvement include the perception that OPC cares more about wildlife than local people, reports and fears of human-wildlife-conflict, exclusion from job opportunities (particularly for women), and uneven distribution of CDP projects across communities [182]. While scaling these efforts would enable OPC to engage more fruitfully with local communities to improve service provision, outreach, feedback, and accountability, OPC currently lacks the technical and programmatic capabilities to meet these communities' diverse sets of needs.

2.5 Technology Ecosystem

Since 2014, OPC has experimented with mobile phone technologies to address challenges of community engagement, with mixed outcomes. A bulk SMS service for broadcasting announcements has successfully increased communication and further pilots with interactive two-way SMS and browsable USSD services have also proven useful for a limited set of community members. Thus far, however, the systems have struggled to gain widespread adoption, in part because of usability challenges. We next describe the successes and limitations of these systems, and design considerations for future work and broader engagement.

2.5.1 Bulk SMS

OPC began deploying a bulk SMS service in 2014 to broadcast organizational announcements to community members. The idea emerged from OPC's 2014 SAPA study, when community members reported a deficit in communication and OPC held follow-up meetings to discuss improvement strategies. Since then, OPC has gradually collected the phone numbers of 3,100 residents, mostly through community meetings and aggregating contacts from staffs' individual phones. Each month, they send out several messages most often related to job vacancies at OPC, community meetings, and health outreach dates. Sporadically, they also send messages about urgent issues as they arise (e.g., elephant breaches). OPC can issue system-wide messages or target individual subgroups; however, community members cannot directly reply to these messages.

Anecdotal evidence suggests that this SMS program has had a positive impact. Since its introduction, the average numbers of health outreach attendees and job applicants have more than doubled, and community meeting attendance has increased. Residents also report knowledge of this system: in OPC's 2019 SAPA survey, 68% of respondents "agree that OPC's text messages have been effective for sharing information" (9% disagreed, 21% didn't know, 2% no comment) [182]. Additionally, various government agencies have asked OPC to send messages on their behalf, utilizing OPC's community contacts.

Dear ol pejeta consaverncy am a community member but ai whant inform you if it is an any varncy just inform ifen a fance ripear and security patrol thanks

10 Erephants ware patroling kijabe thd whole night pls.

Hi!my name is [redacted] from [redacted] naomba kazi nimesikia you are searching for a storekeeper but naomba kazi yeyote ile please

Goodafternoon am a resindent of [redacted] and am borthed by a sheep diseases that afect lamps coursing small woulds aroud mouth

My Name is [redacted] am farming nearest to u here on the river whow can u helpers from these monkey theru inaharimbu everything in the shamba

Am a guardian from [redacted] and my sister achieved 332 marks how can I get a scholarship form?

Figure 2.3: Selected messages from the two-way SMS hotline. Community members tend to send messages only for urgent issues like unemployment and human-wildlife conflict.

2.5.2 Two-way SMS

Because the bulk SMS system enabled only one-way communication, a second SMS prototype was developed in 2019 that allows users to reply. The new prototype, designed to be more interactive, let OPC quickly find out about issues in the communities and gather feedback. Since community members commonly call OPC staff on their personal phones with questions and issues, the two-way SMS system also intended to centralize these communications to increase accountability and responsiveness.

Since its deployment, the two-way SMS service has been a partial success. OPC began advertising the number to communities in February 2019 by explaining it in community meetings

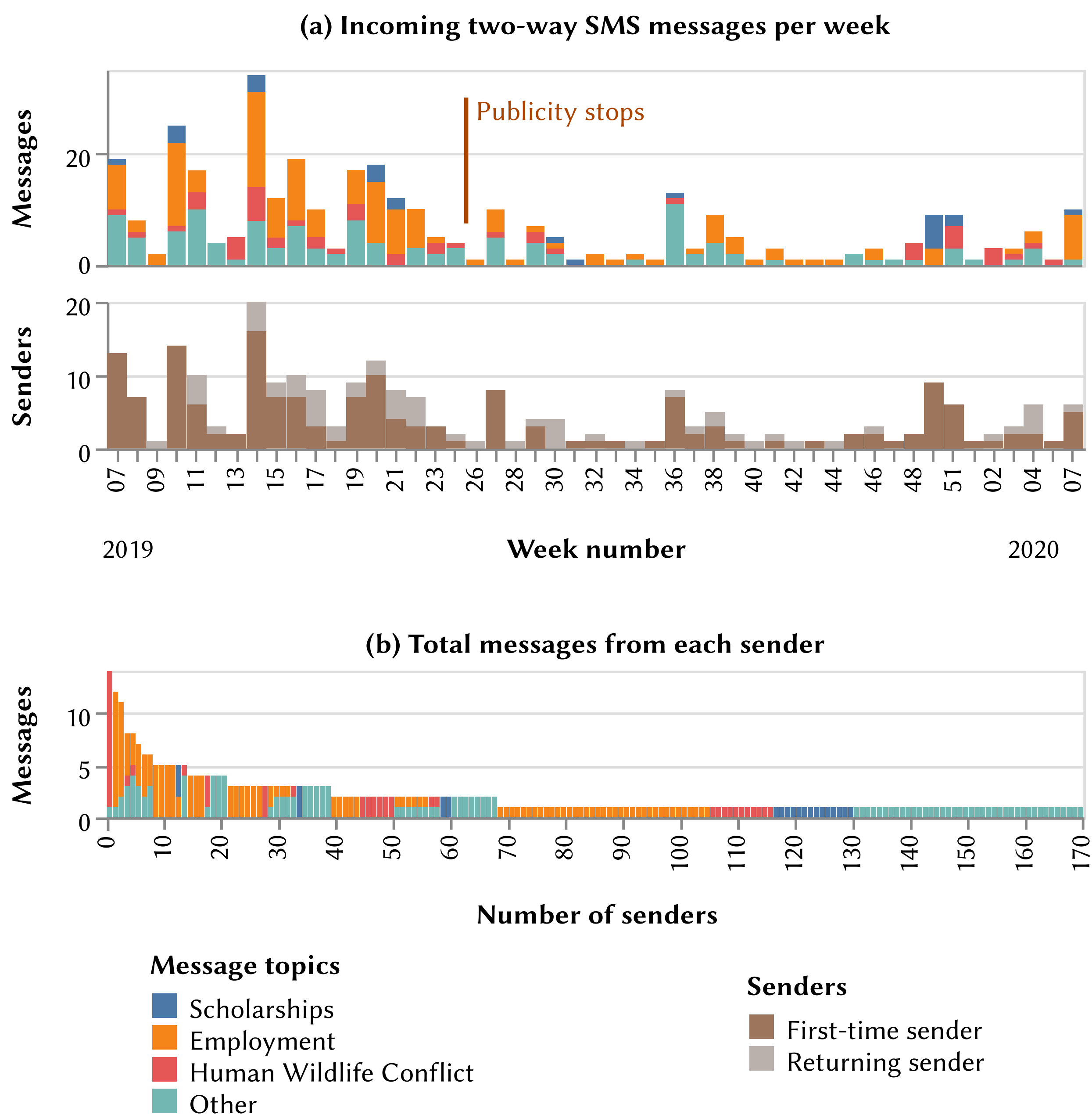


Figure 2.4: Incoming messages on the two-way SMS service. (a) Incoming messages over time: the service was first publicized to OPC's communities on February 14 2019, and reminder messages were periodically sent until June. Usage tapered off after publicity ended, but new users still continue to send messages. (b) Incoming messages per user: over half of users sent only one message, but a subset were very active.

and sending regular bulk messages saying: *"To contact Ol Pejeta about anything important, send a short message to 0712 345 678" (translated).* In the 1-year period after its initial launch, this number received 344 messages from 170 users, in both English and Swahili (Figures 2.3 and 2.4). The most common messages enquired about job opportunities (n=148), human-wildlife conflict (n=48), and scholarships (n=24); others related to water management, security, livestock, health outreach, and a variety of other topics. Some issues, like human-wildlife conflict, require extensive back and forth (and SMS messages often led to follow-up phone calls with OPC staff). Other messages asked for simple factual information (e.g., if there are any job vacancies) and required only one quick SMS reply from CDP.

This second prototype presented more complex technical challenges than the bulk SMS service. Since there was no suitable off-the-shelf software, new software was developed by a contractor. Usability challenges hindered adoption, since OPC's database of community contacts is heavily skewed towards elderly residents who often have trouble sending text messages. Technical problems with the system's implementation made it impossible for OPC to send large volumes of messages over the two-way SMS number—users regularly received messages from the bulk SMS number that they could not reply to directly and were asked to reply to a second number.[2] Users must also pay normal SMS rates, which may prohibit people from participating and act as a demand filter [282].

Although a main goal of the two-way SMS service was to establish sustained bidirectional communications, OPC found that usage was typically limited to urgent messaging (like unemployment and human-wildlife conflict). The SMS service has not effectively maintained comprehensive or consistent feedback about its broader range of issues and services. After OPC stopped actively advertising the two-way SMS number in June 2019, incoming messages gradually decreased, although OPC still receives several messages each week from new phone numbers (Figure 2.4), likely due to community members sharing the number peer-to-peer.

[2] Initially the contractor tried implementing the system with three successive short codes that could both send and receive bulk messages, but each of the short codes received thousands of spam messages that became too expensive to maintain.

2.5.3 USSD

Building from OPC's partial success and remaining challenges with the two-way SMS service, our research team partnered with OPC to develop a new prototype USSD service. USSD is a protocol that universally works on every mobile phone, including basic (non-internet capable) devices. With USSD, users dial a phone number and are presented with an interactive text-based menu that allows numeric responses from a standard keypad. It is a popular interface in Kenya and other developing countries to load pre-paid airtime; obtain information on users' telecom, banking, and electricity accounts; and send/receive money with mobile banking [272]. But unlike SMS, USSD responds instantly to a user's queries and can display browsable information, collect structured input, and show menu options to communicate possible interactions. It cannot directly "push" a session start for users (users must proactively dial the number to begin a session); and USSD codes are commonly advertised via SMS and other media. USSD cannot accept long user inputs because of a 30-second time limit on each screen, and it leaves no evidence of the interaction on a user's phone [272].

Our USSD prototype connects users to OPC's community projects (Figure 2.5), including browsable information about stove building (Fig 2.1), school scholarships, cattle, job postings, health outreach dates, and contacts of community representatives. It offers interactions for requesting services, such as ordering cattle supplies, registering a submitted scholarship application (Fig 2.5), and requesting a complimentary community visit to OPC.

Our initial feasibility study for USSD deployment focused on OPC's annual bursary (scholarship) application process. OPC distributes paper scholarship forms that applicants fill out and return to their community representative. The USSD application had two features (Fig 2.5 right): users could browse information about the scholarship program, and were asked to register their submitted applications via USSD by entering their name, phone number, and the recipient of their form (to ensure that no paper applications were lost or maliciously withheld); instructions were printed on the scholarship forms to dial the USSD shortcode upon submission. Community representatives were shown the USSD number in a meeting, and one bulk SMS was sent to all 3101

registered users advertising the USSD number for information on scholarships.

Over the next month, the USSD number received 805 connections from 256 unique phone numbers (Figure 2.6). Initial sessions reflect users mostly browsing information, while subsequent sessions mostly attempted to register applications. Many users successfully browsed several screens of information with each session, whereas others appeared unable to use the service because of unanticipated usability problems. For example, because users were asked to select their community from a two-page list, many were confused about selecting *"10: NEXT"* to go to the second page, a problem that has been documented with other USSD services [260].

Though many users successfully browsed scholarship application information on the USSD service, the pilot for registering applications was largely unsuccessful: OPC received 293 paper scholarship applications, of which only 44 registered via USSD. Many instead preferred to call OPC staff to confirm their applications (a phone number was published on the form for questions) or had community representatives to register on their behalves. Seventeen of the 61 USSD registrations came from one phone number, who was a community representative; eleven applicants registered more than once, mostly due to mistakes in data entry.

2.6 Formative Qualitative Results

To better understand the efficacy and impact of the existing SMS systems and our USSD prototype, and to inform future ICT design efforts, we conducted formative qualitative and user-based research with OPC and its surrounding communities. First, we discuss interviews with OPC staff about their experiences using the mobile systems, as well as challenges of communication and community engagement. We then report focus group results with local community members about their interactions, sources of information, and existing communication channels with OPC.

2.6.1 Staff Interviews

We conducted 11 semi-structured interviews with OPC staff (9 members of OPC's 12-person community development (CDP) team and the deputy managers of security and wildlife). After each interview, we sent typed notes back to each participant for their review. Interview topics included

Ol Pejeta Community Projects
1. Cookstoves
2. Bursaries
3. Health outreach
4. Jobs
5. Request visit
6. Cattle
7. My community rep
8. Send message

CANCEL SEND

Education bursary
1. About bursary program
2. How to apply
3. Important dates
4. Register application
5. Ask question

CANCEL SEND

Who received your application?
Please give their name.

CANCEL SEND

Figure 2.5: Prototype USSD screens. Left: a screen listing CDP projects. Right: scholarship information and registration.

participants' day-to-day tasks, communication with communities, phone usage for their jobs, and experiences with the SMS and USSD prototypes.

OPC's community-facing staff reported spending their days interacting with community members in a variety of ways: holding meetings and trainings, coordinating projects, visiting schools, fact-finding, responding to urgent security and wildlife issues, and taking frequent calls from various local leaders and community members. CDP devotes significant time toward communication, but with only 12 CDP staff for roughly 35,000 community members, maintaining robust communication is a challenge. While some community members are highly engaged, others are difficult to reach, never come to community meetings, and lack social connections to OPC programs. Obtaining nuanced and honest feedback is difficult.

Phone communication. Every staff participant reported that calls are a main way to interact with community members, especially because large distances make it difficult to be physically present in all 20 communities. The widespread availability of basic phones lets many community members reach OPC staff, but staff felt burdened by the sheer volume of calls: *"I get calls from communities every day, every night, even on weekends." "Sometimes I don't want to pick up the phone on my days off, but this is maybe urgent for them."* One participant reported an average of 6 hours per day on the phone, and most reported fielding many short calls frequently throughout the day (except for a couple staff in administrative roles). In fact, the majority of interviews for this paper were interrupted by phone calls, including one from an anxious parent of a scholarship recipient, a teacher asking for computer upgrades, and a community representative worrying about locusts, by way of example.

Many calls are repetitive and ask for only basic information that could theoretically be distributed in other ways: *"People call us asking the same questions over and over again; we answer a thousand calls about the simplest thing." "I wish everybody could automatically know the projects we are doing in their area. At community meetings, we get a lot of questions about things we are already doing."* Many community members have the contact of only one OPC staff person, who often becomes a general purpose point-of-contact for everything related to OPC. *"They call me*

simply because they have my contact and nobody else." "People call me about all kinds of random stuff. Human-wildlife conflict, water issues, conservation education…" "Everybody calls me about everything."

For specific community programs, CDP staff take calls for a variety of reasons. For example, cattle and agriculture extension officers frequently give advice over the phone, parents call to ask questions about the scholarship program, the supply chain for stove-building is coordinated over the phone, and locals call to report problems with wildlife. Organizing a meeting typically requires many phone calls with the community representative and attendees to confirm their attendance and share details. Even after a meeting is announced over a bulk SMS, CDP staff typically get phone calls asking for more information. Several staff members expressed a need for contacts of more community members, such as a database of teachers. Weak network coverage presents a challenge especially in the less-developed northern region: *"You find people that have 3 numbers that work best in different places."*

CDP staff occasionally reported using Whatsapp and SMS. Whatsapp helps them to send pictures with community members, like receipts for school fees and photos of livestock diseases. OPC has two communities where farming is very profitable and farmers are young, and the extension officer has been able to start Whatsapp groups for interacting with those farmers collectively. Depending on the demographics of each projects' participants, though, many staff members reported that they never use SMS because their contacts have neither smartphones or internet.

Community engagement. OPC's community engagement and outreach reveals important considerations that are potentially both aided and complicated by upgrades to extant mobile channels. OPC believes that direct contact with communities is a critical aspect of their work for building relationships and trust: *"If people don't see us regularly, they will think we have abandoned them. People need to see that we are concerned with their welfare, not that we just come when we want something."* CDP staff report spending around 1-3 days each week doing field work in the communities. Staff visit schools for conservation education programs, run health outreach clinics, give trainings on agriculture and cattle issues, perform maintenance on school computers, and

organize and attend various types of meetings. Sometimes urgent issues arise that need to be addressed immediately in the field, such as disputes between community stakeholders; transportation is a main challenge and expense since OPC's area is $360km^2$ and communities are spread apart. This limitation often forces OPC staff to rely on phones instead of being in the field, which can depersonalize the interactions and constrain information flows.

OPC staff attend and organize in-person meetings for various purposes when phone communication is not sufficient. These include negotiating issues with all stakeholders, complex demonstrations and presentations, and seeking nuanced, in-depth feedback about CDP's programs. Every 1-3 months, OPC also holds community meetings at each site that are organized by community representatives. Attendance varies widely, from 10 people to hundreds, and OPC staff are always present. Community meetings are an opportunity to give updates on programs, build relationships and collect feedback. CDP staff repeatedly stressed the importance of these meetings: *"Programming decisions get made from the issues that come up at community meetings. People argue, raise grievances, explain what they don't know, and negotiate about programming decisions."* Further, OPC is frequently invited to large meetings organized by local chiefs as well as small 10-15 person meetings held by community groups (e.g., savings associations). OPC invites community groups for guided tours of the conservancy that emphasize their roles in conservation as community members, and champions issues on human-wildlife conflict and the need to report suspicious activities. Cattle grazing committees and farming groups are put together to share knowledge and discuss issues. To address water issues, OPC holds stakeholder meetings that bring together resource users with government officials and local leaders to negotiate rules and obtain *Water Resource User Association* permits, in compliance with the law. Recent surveys indicate that most people feel the water situation has improved; the project coordinator stated that *"after the meetings, people were more likely to call us to report problems and violations… We found that it's been important to bring all stakeholders together, like every 3 months. It's been very effective."*

CDP staff repeatedly stressed that managing expectations was one of the most important and challenging parts of their jobs. Misinformation and rumors easily spread through communities,

messages can be misunderstood, and people feel that OPC's resources are not distributed fairly. *"People always see you as a donor. If you speak the wrong way, people think you can get them a job tomorrow... for example, if you gave somebody a dam liner before, they will expect another one the next time they see you, and you need to tell them the funding has run out and the project is over."* The scope of a project is therefore one of the hardest things to communicate. There are also fears of bias in reporting: *"I wish we could know people's real attitudes, what they really think, what they say to their neighbors."* There are some concerns that OPC is losing important information because users cannot reply to the bulk SMS messages, e.g., *"We don't know how our text messages are perceived by our communities."* It is hard to ask community members about some past events because there is no culture of recordkeeping, e.g., to know whether farmers' harvests have improved over time. Several OPC staff expressed desires for faster feedback to be able to react more quickly when faced with emergencies or floods.

CDP staff apply multiple strategies to improve communication and facilitate community engagement; their language must be timely and precise. As one staff member reported, *"Any opportunity that needs clarity must be dealt with immediately. Many people will pretend they don't know, but they will play you. Communication needs to be central. It can be dangerous to beat around the bush. We need to be honest and fair in all issues, and we need to hear both sides of all grievances. For example, I got a call from a women's group asking to buy tents and chairs. I explained that we don't do that. Not that maybe we will someday... Things that we don't do, we just say we don't do them. Relationships, clear communication, and appropriate communication carry the day."*

Security and poaching. One critical area for OPC community engagement and government liaising involves reporting on poaching and suspicious activities by residents to OPC: *"Security is information. Without information we cannot do anything."* CDP outreach emphasizes to communities that they can send tips on threats to wildlife due to illegal activities, which OPC is chartered to report to the government. But here again, relationship building is critical. OPC wants to solicit information from key trusted informants, and community members are likely to report to OPC only if they believe the organization will properly respond and the government will not exact

unfair retribution. Information of this sort tends to come through face-to-face interactions with trusted intermediaries because informants do not want to create phone records that could compromise their security: *"An informer should be treated with the most integrity and confidentiality... the two-way SMS system compromises the security of an informer."* (Security at OPC is further discussed in Chapter 4.)

Summary and ICT design implications. Our interviews with OPC staff repeatedly stressed the criticality of communication to conservancy operations and community development work. Although ICTs clearly cannot replace face-to-face communication in many cases, they could be helpful for some. The distribution of OPC staff's phone numbers and the volume of calls to staff, while showing the importance of two-way communication, have also become burdensome. Some of this burden could theoretically be relieved by partially-automated ICT services (especially for the many repetitive calls seeking only basic information), and improve information access throughout the communities. However, the limitations of simple SMS and USSD interfaces create challenges for the careful, nuanced, and diplomatic communications that OPC requires; like negotiations among many stakeholders or complex agriculture demonstrations. For sensitive topics like poaching, senders and receivers of information must trust one another and the system itself. Additionally, staff stressed the importance of their continuous presence in communities to build familiarity and trust. Regular community engagement over ICTs could conceivably help build credibility, but could also harm relationships if over-reliance on ICTs led to fewer face-to-face interactions.

2.6.2 Community Focus Groups

Our second formative research activity aimed to better understand community experiences with OPC, usage of existing SMS communications systems, and feedback on the USSD pilot. We conducted three community focus groups, one from each of OPC's major regions (Figure 2.2). Recruitment occurred via OPC's community representatives, who each were asked to find ten participants having an even mix of age, gender, and engagement levels with OPC, (about five

individuals who regularly attend community meetings and participate in programs, and five who never attend). The focus groups took about three hours each; participants were compensated 1,000 Kenyan shillings (about $10 USD) to cover their time and transportation.[3] In each focus group, we alternated between breakout sessions and group discussions. For breakout sessions we divided participants into subgroups of elders (over 55) and youths (mostly 20-35), gave a prompt (e.g., *"What are the positives and negatives of your communication with Ol Pejeta?"*) and asked participants to list answers on posters. Each group presented their answers in moderated plenary discussions. We varied the prompts for each session, trying to suit the discussion's flow. Topics included OPC's impact on their lives, interactions with OPC staff, information sources on OPC and community programs, and phone and technology usage. At the end of each session, we solicited feedback on OPC's existing SMS services and the USSD prototype. To motivate participant engagement and honest criticism [107, 336], we stressed that the services were still works-in-progress that their opinions could have influence.

Interactions and impact of OPC. There were varying levels of knowledge about OPC's programs in participants' communities. Participants generally knew about conservancy operations:[4] that it protected animals and brought in revenue from tourists. Specifically, we asked each group if they knew why OPC was famous for rhinos (having the last two Northern Whites); the groups agreed that they knew OPC had *"unique rhinos"* or had heard about Sudan's death (the last male) on the radio and social media, but each group seemed confused about the international significance of this information. Beyond this, a few individuals had in-depth knowledge of OPC's community programs and could list most of them, and most participants reported that they had benefited from at least one program (e.g., having visited a health outreach clinic or received a dam liner). However, some participants said they never used any OPC programs, and each focus group responded differently when asked which CDP programs had the most impact on their lives: health

[3] Most people in the area are farmers and casual laborers, earning ksh 300-500 per day. We expected some participants to travel up to 5km to attend the sessions.

[4] Importantly, we note that recruiting through community representatives probably led to participants who were more engaged with OPC than average.

outreach and security were most important for the first group, water capture and scholarships for the second, and health and employment for the third.

The sessions frequently digressed to discussions about new services that communities wanted—requiring careful facilitation from the moderators and highlighting locals' dependence on OPC for services. For example, one breakout group made an unsolicited sheet of project proposals, and another became a half-hour emotional discussion about fair resource distribution among communities.

During the sessions, clear differences in responses emerged between elder and youth subgroups. Elders (¿55) were more engaged with CDP programs, and many had direct phone numbers of OPC staff. They were mostly farmers, were more likely to own land, and were thus more concerned with issues like water, human-wildlife conflict, and agriculture extension. Conversely, youths (approx 20-35) mostly worked as laborers and were much more interested in securing jobs and furthering their education. Therefore, they were less engaged with OPC's environmental programs, and the topic of jobs frequently arose in focus groups: *"You should be fighting for more jobs to come to our community!"*

General OPC communication channels. Communities members reported receiving information about OPC from a patchwork of sources including community meetings, SMS alerts, OPC's community newsletters, park visits, posters, and community representatives; but no single authoritative source reached the majority of community members. Some had found information through mass media, (e.g., seeing OPC's cattle operation on a local TV show for farmers), and a few younger participants had accessed OPC's website and Facebook page. Roughly half of the participants had phone numbers of CDP staff, whom they sometimes called with questions and issues, e.g., *"We call the veterinarian who does artificial insemination, and he gives us the updates"*; others said they had staff contacts but never called. Participants chiefly obtained numbers from previous CDP interactions like scholarship meetings and human-wildlife conflict incidents, or from community representatives. Many also had friends and relatives who had gotten jobs at OPC; e.g., one participant knew a security guard: *"He's a relative, so we chat often but not really about OPC."*

Information also spread via word-of-mouth. Some learned about OPC's scholarships by knowing families of beneficiaries or saw that neighbors had installed plastic dam liners. A couple got news from relatives who received OPC's SMS messages. Some reported getting information from their children, who had learned about OPC at school.

Each information source, however, had limited and uneven reach. Only elder participants said they attend community meetings; youth almost never attend. One said she came to community meetings because *"we are dedicated, and we know we could benefit from them."* Asked why youths do not attend, participants consistently agreed that the youths were too busy working during the days, and that they felt that the meetings were more for elders: *"If you want youths to come, you should tailor the meetings for youths."*

General phone access and usage. The focus groups reported that most people have mobile phones and use them heavily. Everybody agreed that most locals have a basic mobile phone, but participants disagreed about how many had smartphones and internet access. Of our participants, nearly every one had his or her own mobile phone, and many youths had smartphones. Participants agreed that they experienced network issues and spotty connectivity (particularly in the less-developed northern region). Indeed, we sometimes had network problems during our USSD prototype demonstrations.

Even though participants owned phones, they enumerated challenges and user burdens that limit their abilities to use them. Participants agreed that they can go a long time without any credit on their phone. In one instance, someone said: *"Most of the time we don't have any balance." (Everyone laughs.) "We can go a long time without making any calls or messages."* Sometimes, charging phones is difficult, and they used a mix of ways to do so: a few had their homes connected to the power grid, many had solar panels at their houses, and some charged phones at a friend's house or a business. During the rainy season, there is often not enough sunlight to charge phones for days or weeks, presenting a particular problem for smartphones (having lower battery life). One person said: *"Lots of people have both a smartphone and a basic phone. The basic phone is a backup for when the battery dies."*

Participants' usage of phone features varied between demographics. Many elders disliked SMS and had trouble using it: *"It gives a headache."* They unanimously agreed that they preferred voice calls for a variety of reasons: some were illiterate and said they could not read SMS messages themselves, and they asked their children or neighbors for help. Many simply do not access SMS messages at all, as one youth reported: *"A lot of people don't have anyone to read messages for them. Sometimes an old person comes to me because their phone's memory is full of messages, and they don't know what to do... they haven't opened any of them."* Other SMS frustrations included difficulty typing with small buttons, reading from small phone screens, language barriers, and a general lack of interest. Younger participants, on the other hand, unanimously preferred SMS because it was cheaper and more private than voice calls.

We asked specifically how participants viewed USSD and about experience with other USSD codes. Both age groups noted a variety of services they use that feature USSD, including mobile banking, sports betting, selling milk through a dairy collective, and ordering goods for delivery to their houses (a service called Copia) [7]. Some elders said they still used text-based services even though they disliked them, (*"I only text on a need basis;"*) they would put up with the hassle of SMS and USSD if there were enough benefit for them.

OPC-specific SMS and USSD feedback. We asked the groups for feedback on OPC's existing SMS services and the USSD prototype. Even though older participants were generally reluctant to use SMS, nearly everyone who received OPC's bulk SMS messages were in the older group. We asked how to better recruit youths to use OPC's SMS messages since they usually do not attend community meetings where numbers are collected. We got varied suggestions, like advertising through churches, WhatsApp groups, and on vests of motorcycle taxi drivers; asking elders for phone numbers of their friends and relatives; and distributing printed T-shirts.

Participants generally indicated that they paid attention to OPC's text messages because they conveyed information of direct benefit, like job postings and health outreach dates: *"I can see when the message is from Ol Pejeta, so I give it to my son to tell me what it says."* Short SMS messages have the potential to be misinterpreted, though: we heard of one incident when OPC issued

a bulk SMS announcing that it provided dam liners to certain community groups. Some people misunderstood the message to mean that OPC was offering dam liners to their own communities, causing confusion and frustration when they found out that this was not the case. Regarding the two-way SMS service, no participant knew the number for sending SMS texts to OPC headquarters. A few said that they had seen it once in a message long ago, but they no longer had it. This confirms that having two separate SMS numbers is a usability problem, but some participants said that they would not send SMS to OPC in any case because it was easier to make voice calls.

Finally, we demonstrated the USSD prototype and asked participants to try it on their own phones. All of the youth navigated the USSD screens with ease, reading and understanding most of the information. However, we watched the elder group struggle with the prototype, encountering several usability problems. For example, many grew frustrated when the application timed out after 30 seconds of inactivity, misattributing it to network issues. Participants were generally unable to venture many suggestions to simplify the USSD application for older users, and instead every group suggested that OPC should offer training: *"They just have to get used to it, and they will learn."* People in every group also suggested that we should add more topics, including the types of animals on OPC lands, seeds and crops, livestock, tourism, and tree planting. They also wanted more comprehensive and detailed information, e.g., for screens on improved cookstoves to explain their disadvantages, *"since everything we use has disadvantages."*

Summary and ICT design implications.. Our focus group discussions showed a diversity of ways that community members engage and do not engage with OPC, experiencing different benefits and problems. Participants got information about OPC from a heterogeneous patchwork of sources—information reaches the communities in fragments and there is no central, authoritative source. The ubiquity of mobile phones suggests that ICT services could potentially have a wide reach, but certain demographics are marginalized by accessibility barriers like low literacy, unfamiliarity with SMS and USSD, network connectivity, and the cost of sending messages. Some of these barriers could be addressed by incorporating other technologies like voice-based IVR. Additionally, the nature of short SMS and USSD communications creates a liability for misun-

derstanding, and extra care must be taken for clarity, especially in the sensitive contexts of these community relations. Though elder community members are probably less likely to used text-based applications, they could be a key for reaching youth, who OPC has thus far struggled to engage.

2.7 Discussion and Conclusion

The charter of wildlife conservancies is expanding beyond their traditional focus on animals and ecosystems, elevating the need to work jointly and productively with communities outside their formal protected areas. We investigated text-based tools to support Ol Pejeta Conservancy's outreach and engagement efforts. Through pilot technology deployments, interviews with OPC staff, and community focus groups, our formative research demonstrates potential for ICT services to improve conservancies' community engagement, build sustainable relationships, and deliver effective programs. It also highlights important design and implementation challenges. While phone interactions are clearly no substitute for community meetings and face-to-face interactions, ICT's could still be integrated with existing communication processes to improve communities' access to critical information and services.

Our preliminary study sheds some light on the problem of community engagement for environmental institutions. Mobile phone services are already common across development sectors like health and agriculture, but deploying these services in wildlife conservancies requires a new consideration of their impact on the crucial relationships with the communities they depend on, and the mutual trust needed for conservancies and communities to work together. Although basic phone technologies are available in low-income communities surrounding many conservancies, their limited affordances create challenges for careful communication, negotiation, and relationship building that environmental governance requires.

Our preliminary work does not address cost-effectiveness. Phone-based services are expensive at scale: organizations and users typically pay for each SMS message, USSD session, or each minute of a voice call; costs add up fast with large deployments. Institutions running large-scale ICT services must think strategically about the cost effectiveness of each interaction, and how

best to register and engage the most users within budgetary constraints.

In OPC's case, because SMS and USSD present accessibility challenges for elder demographics and those with less formal education, exploring voice-based phone technologies (IVR) could extend access to these groups and help to scale. Elder community members, currently the most engaged with OPC activities, are unlikely to adopt a system that is burdensome even if it reduces the burden on OPC staff [157]. However, our early work suggests that ICTs could potentially be a key for engaging young people—who OPC has long struggled to engage—via their affinity for technology. This will require creative program development for issues important to young people, such as employment, micro-enterprise, and entrepreneurship. (For example, some projects have deployed USSD "yellow pages" to advertise local businesses [352, 110].)

Further work is required to understand the generalizability of our findings to other conservancies that have different models of community engagement. Designing effective and accessible ICT services takes time and investment, as evidenced by our partial success, and many conservancies lack the technical capacity for this process. However, many local and international conservancies look to OPC as a model for community relations: OPC provides consulting on community development to other organizations, and the Laikipia Conservancy Association is actively adopting OPC's model. Therefore, as OPC scales its development activities and outreach, it could provide evidence to action for policy, recognizing that ICT projects require some degree of customization for individual contexts: different settings can vary widely in technology access, literacy, infrastructure, culture, institutions, and environment.

After further work to design better systems for OPC and the communities it serves, more rigorous evaluation will be needed to know whether we can confidently recommend these ICT approaches for other environmental institutions, and to what extent they can help conservancies and their interlinked communities live and work together.

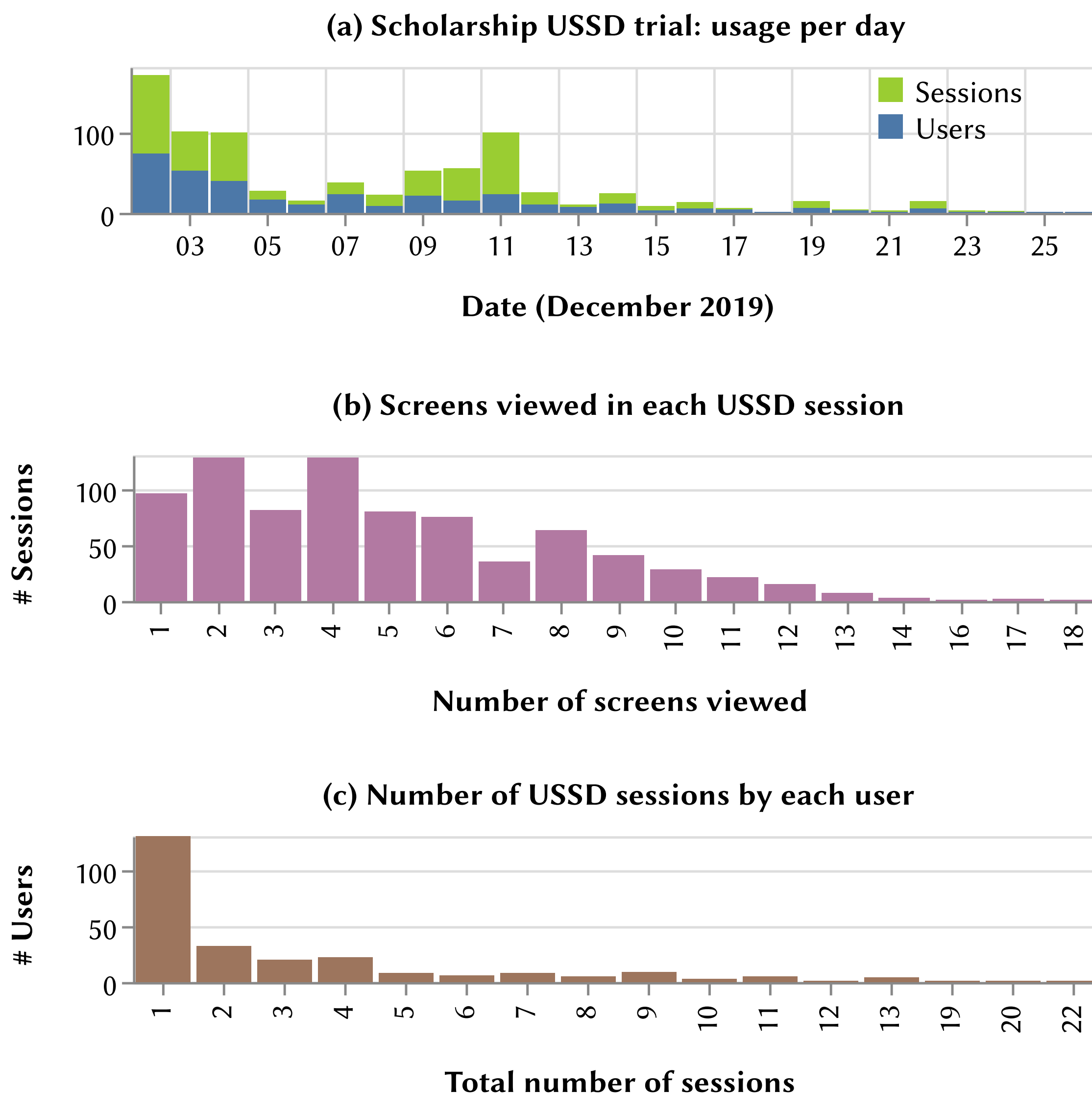


Figure 2.6: USSD usage during a 1-month trial for OPC's scholarship application process, with 805 connections from 256 users. (a) Traffic peaked on Dec 2 after an SMS announcement about the USSD code for scholarship information; with a second peak around the Dec 11 due date. (b) Many sessions ended on the 1st or 2nd screens due to usability problems, but most browsed several screens of information. (c) 130 users connected only once; some connected repeatedly.

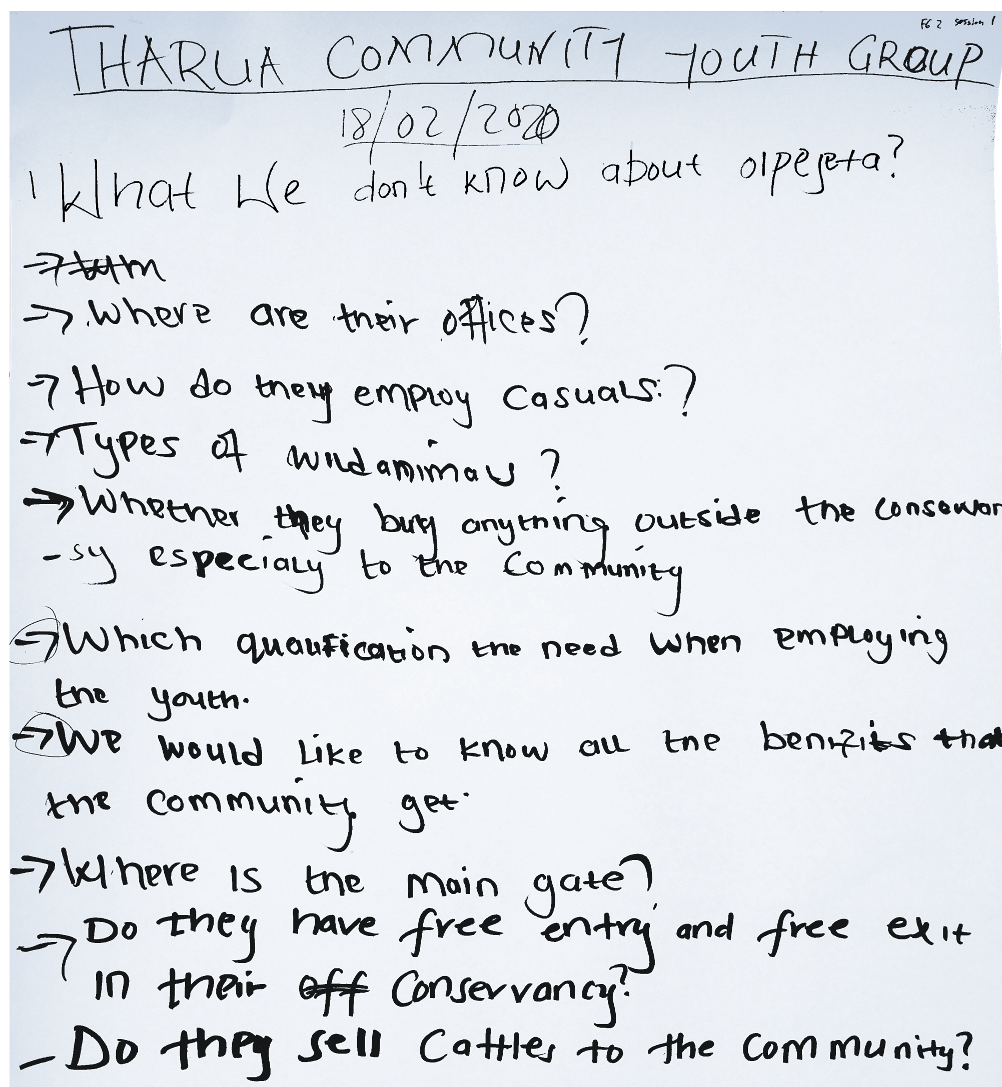


Figure 2.7: Example poster from focus group.

Chapter 3

“HOW’S SHELBY THE TURTLE TODAY?” STRENGTHS AND WEAKNESSES OF INTERACTIVE ANIMAL-TRACKING MAPS FOR ENVIRONMENTAL COMMUNICATION

3.1 Summary

This chapter is the second of the three case studies in this dissertation, focused on communication technology’s impacts on environmental organizations working in more urban, densely-connected settings. It examines the design of interactive map visualizations of wildlife-tracking data meant for public consumption. Through this window it explores environmental organizations’ goals and strategies for engaging the public to raise awareness of their organizations, rally support for environmental causes, and build relationships with potental partners. We uncover some of the specific strenths and weaknesses of these interactive wildlife-tracking visualizations as they integrate with the organizations’ existing digital communication operations, and explore how ICT’s continue to shape their specific public-engagement agendas. This chapter’s technology design exercise sheds light on how environmental organizations can harness future ICT developments in these well-connected, media-saturated settings; and also provides an example for organizations in lower-infrastructure areas to plan for the accelerating uptake of technology in the communities where they work.

Interactive wildlife-tracking maps on public-facing websites and apps have become a popular way to share scientific data with the public as more conservationists and wildlife researchers deploy tracking devices on animals. Environmental organizations engage with the public for a variety of reasons: to raise awareness of environmental causes, build relationships with potential partners, and encourage people to take political and personal actions. However while there is a large body of work comparing different media strategies for environmental communication goals,

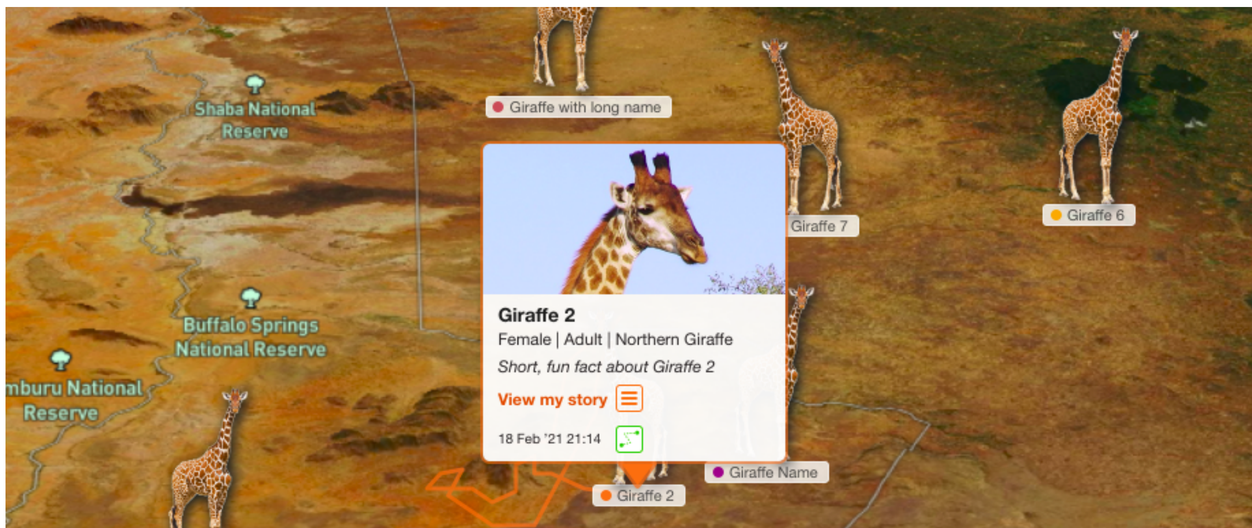


Figure 3.1: Example design mockup for an interactive animal-tracking map

the effectiveness of interactive data visualizations for these purposes remains unclear. This work examines the strengths and weaknesses of interactive wildlife-tracking maps for environmental communication. We interview conservationists about their aspirations for using these maps with their own data, and conduct a study gauging lay users' reactions to different designs. Many conservationists aspire to create deep, immersive user engagements with these maps—letting users relate to data-driven stories about individual animals and freely explore the nuances of the tracking data. Our findings show potential for the most highly-motivated users to deeply engage with these data and stories, but more casually-interested audiences struggle with the maps' complexities. However for casual audiences, wildlife tracking maps can still superficially but effectively showcase the organizations' work to protect the species; perhaps inspiring hope for their future, attracting audiences to other communication channels to learn more, and adding to the organizations' credibility. Following these insights, we present a set of design considerations for further development of similar wildlife-tracking map applications; emphasizing their needs for user onboarding, context for data interpretation, and integration with relatable media.

3.2 Introduction

Wildlife researchers and conservation institutions need to communicate with the public for a variety of reasons: to promote awareness of their projects, raise awareness of environmental issues, build political support, raise funds, and encourage environment-friendly behavior [302]. Similarly, many organizations and conservation parks look to new digital media to provide immersive natural experiences while avoiding the environmental harms of overtourism [39, 226]. To these ends, many environmental organizations are experimenting with interactive data visualizations in their outreach efforts [6, 340], showcasing data from their research projects and conservation operations. These organizations aspire to provide more interactive, engaging experiences than reading static articles, let viewers see the data and science behind environmental research claims, and allow users to freely explore for personally motivating information.

Interactive maps visualizing wildlife tracking data have become popular over the last decade as technology improvements allow wildlife researchers to gather vastly greater quantities of positional data for individuals and populations [243, 116]. Dozens, perhaps hundreds, of interactive maps featuring wildlife-tracking data have been published to the web (Fig 3.2). The most common designs show animals' locations with markers and use lines to trace their locations over time (Fig. 3.1). They also commonly incorporate text, pictures, and videos that give context to the data, showing information about the animals and research projects (Fig. 3.3). However, these interactive visualizations' effectiveness remains unclear for environmental communication goals, and they are often expensive and time-consuming for organizations to produce [33, 13].

The field of *environmental communication* emerged around the 1960's to examine media strategies for improving environmental outcomes. This large, multidisciplinary body of work addresses the challenge from a variety of angles, such as the psychological effects of emotion on environmental behaviors [65, 286]; and the effects of various advertising strategies on voters in environmental policy referendums [194]. Meanwhile, scholars of interactive data visualizations have characterized the affordances that distinguish them from other media like print and video [299, 311], but interactive visualizations' unique strengths and weaknesses remain unex-

plored in the context of environmental communication.

Addressing these questions, this paper presents formative design work for public-facing wildlife tracking maps in collaboration with EarthRanger (a geospatial domain awareness system for parks and protected areas), the Giraffe Conservation Foundation (GCF), and the Atlantic White Shark Conservancy (AWSC); as described in Section 3.4. First we contextualize this work with a review of research on environmental communication and interactive data visualizations, and explore the designs of existing wildlife tracking map applications (Section 3.3). We examine conservationists' aspirations for these interactive visualizations via focus groups with GCF and AWSC (Section 3.5). Then, we investigate lay audiences' experiences of these maps with a qualitative user study (Section 3.6).

We contribute a set of design considerations for future animal-tracking maps in Section 3.8. Most of our study participants struggled to find meaning in the maps' geospatial data, so special attention is needed to integrate media that explains the tracking data and environmental context. Highly-directed introductory sequences can help to "onboard" new users, helping them quickly learn to interpret the data and navigate the interface. Additionally, incorporating real-time, frequently-updated tracking data opens up an additional affordance to continuously engage users in the long term, encouraging them to check back for updates and develop connections to their favorite animals.

Synthesizing our results, in Section 3.7 we explore the strengths and weaknesses of wildlife-tracking maps for various environmental communication goals, with implications for other types of interactive data visualization. These interactive maps can excel at providing immersive, open-ended experiences for the most highly-motivated audiences—such as AWSC's dedicated "sharkies" who enthusiastically follow their social media— allowing them to connect with stories of individual animals and deeply explore the data. However, these interactive maps struggle to meaningfully engage more casually-interested users due to their complexity in today's era of fast internet browsing and short attention spans; and often fall short of the immersive, relatable experiences that conservationists hope for. Other more-relatable media like short videos can be more effective for engaging these audiences. Though casual users most-often will not deeply engage with

the maps' data, they show potential to begin conversations with new audiences through other communication channels as many participants voiced that the maps made them want to learn more. They can help conservation organizations establish credibility by showing the scope of their work and showing that their missions are evidence-supported. Wildlife-tracking maps can also still potentially make an emotional impressions on casual audiences by illustrating the efforts to protect each species, perhaps inspiring hope for the future.

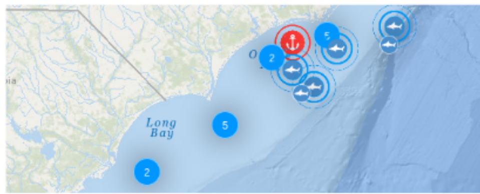
3.3 Related Work

In this section we contextualize our work by discussing the popular public-facing widlife-tracking maps developed by conservation organizations, and relate them to research on environmental communication and interactive data storytelling.

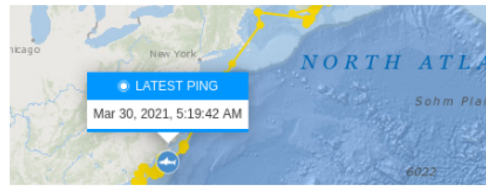
3.3.1 Wildlife tracking

The past decade has seen a monumental increase in wildlife tracking projects, and conservationists have amassed vast quantities of positional data. For example, the popular animal-tracking-data repository Movebank grew from 61 million records in 2014 to 2.4 billion in 2021, and currently gains 3 million new records every day [243]. This expansion has mostly been driven by cost reductions and technology improvements including cheaper tracking devices, improved battery life, cheaper satellite communications, and the advent of LoRa and Sigfox networks. Tracking technologies continue to progress rapidly, with innovations like improved transmission frequency and battery life, increased device lifespans (to minimize disturbing the animals for replacement), and trackers with new additional capabilities like acoustic sensors, cameras, and accelerometers. There are now a variety of well-developed use cases: conservationists employ tracking systems for basic behavioral research [189], advocacy to protect ranges and migratory routes [152], anti-poaching security and monitoring [316], and promotion of human-wildlife coexistence [350, 312].

All such tracking data mainly consists of geographic coordinates paired with time stamps, but the data still has considerable heterogeneity among projects. There is wide variation in projects'



(a) Icons show individual sharks. The animals with live, real-time incoming data are marked with a radial "ping" animation. The red marker shows the current location of a research vessel.



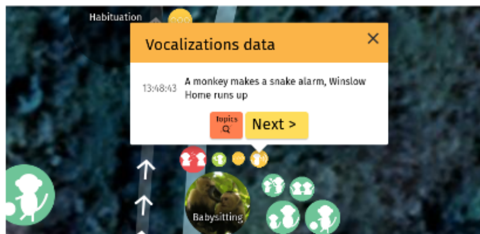
(b) Users select one shark at a time to see the vast distances it moves up and down the coast. Each transmission is marked by a dot, and users can mouse over for timestamps.

The *OCEARCH shark tracker* [55] maps hundreds of sharks, many in near-real-time. © OCEARCH

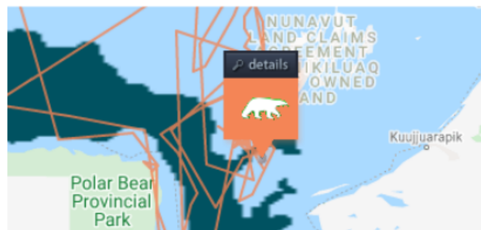
(c) The user starts with a map of WWF's tracking projects, and can click icons for information about each project.

(d) Zoomed into one project, the map shows GPS tracks for a few individuals alongside text and media about the research.

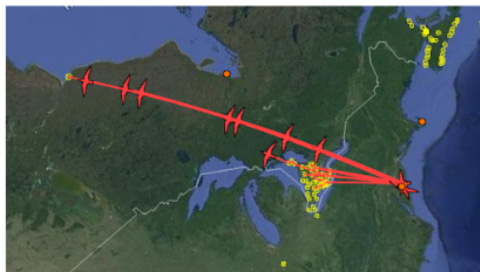
The *WWF Wildlife Tracker* [27] showcases several of the organizations' tracking projects. © WWF



(e) *How to Be A Monkey* shows a day of behavioral data for just one individual plotted on its GPS track. The interface directs the user between points-of-interest with a "next" button [26].



(f) *Polar Bears International*'s tracker [36] animates the bears' movement in response to the changing ice coverage, shown in dark blue [36]. © Polar Bears International



(g) The *MOTUS tracking system*'s website [69] shows migration patterns by animating hundreds of individual icons. © MOTUS

(h) Movebank's *Animal Tracker* app [35, 52] lets users animate animals' locations by dragging a timeline widget. © Movebank

Figure 3.2: Selected screenshots from wildlife-tracking apps and websites illustrating a variety of designs for data presentation and user-interaction modalities.

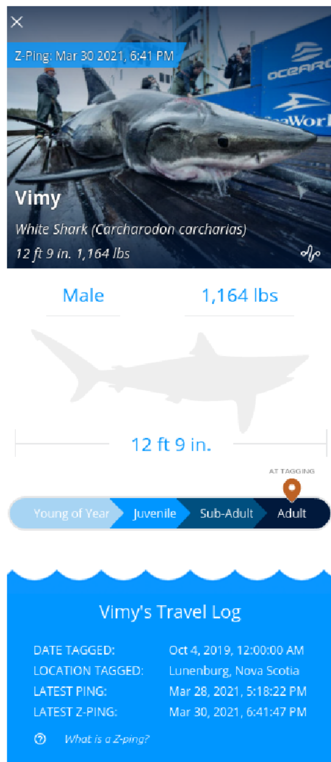
time resolutions—for example, underwater or dense jungle environments have fewer transmission opportunities, whereas security applications require data much more frequently. Larger animals can carry bigger batteries. Ethical and health considerations also contribute to the variety in tracking system designs; e.g. elephants cannot use sub-cutaneous trackers because they cause health issues.

3.3.2 Wildlife tracking maps

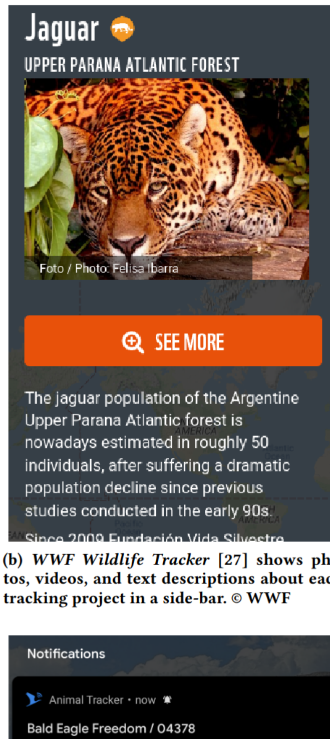
Public-facing wildlife-tracking maps have become a common fixture online and in mobile app stores as more organizations seek to share their data with the public for education, outreach, fundraising, and political advocacy. Parks, research labs, and NGO's commonly feature their animal tracking maps prominently on their websites and promote them heavily via social media and press releases [254, 101, 79, 307].

Nearly all such websites share a core set of features: the locations of animals are plotted as markers on a map, and lines show the trails of their previous locations (Fig. 3.2). The maps incorporate prose, pictures, and videos in a variety of ways (Fig. 3.3) to contextualize the data, explain the purpose of the research (Fig. 3.3b), and give information about individual animals (Fig. 3.3a).

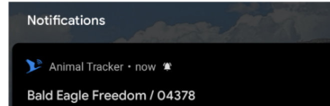
Wildlife tracking maps vary significantly in the ways that users can interact with the data. Some interfaces direct the user around a "guided tour" of points-of-interest (Figs. 3.2e, 3.3d); some show the user vast quantities of data to explore with minimal direction (Figs. 3.2a, 3.3c); and many find a middle path between these two approaches, guiding the user through curated sets of data where they can drill down to interesting examples as they desire (Figs. 3.2c, 3.2d, 3.2f). Map designers combine various strategies to avoid visual clutter, like using icons to represent clusters of individuals and showing only one individual track at a time (Figs. 3.2a, 3.2b). Additionally, the maps employ a variety of portrayals and interactions for the data's temporal dimension: some show the animals' movement over time with animations (Figs. 3.2f, 3.2g), many show timestamps under a tooltip for each individual transmission (Figs. 3.2b, 3.2e), and some provide controls for time manipulation (Fig. 3.2h).



(a) *OCEARCH Shark Tracker* [55] shows individual photos of each animal with biographical metrics and a short paragraph about how it was tagged. © OCEARCH



(b) *WWF Wildlife Tracker* [27] shows photos, videos, and text descriptions about each tracking project in a side-bar. © WWF



(c) Movebanks' *Animal Tracker* [35, 52] sends mobile notifications with news about animals. © Movebank

(d) *Elephant Story* [65] features a long-form written article and a map that animates to show different data as the user scrolls through the story. © Save The Elephants

(e) *How to Be a Monkey* [26] shows text popups, pictures, and videos describing monkey behaviors interspersed with behavioral data markers on the map.

Figure 3.3: Selected screenshots from wildlife-tracking showing various common design patterns for integrating contextual media and text with wildlife tracking data.

These websites and apps are designed with a variety of foci and messaging, but a few common themes prevail. Many focus mainly on the researchers and conservation projects, describing their purposes, showcasing the organizations' work, or commonly telling stories about how each animal was tagged. In one example, *Into the Okavango* mapped a month-long research expedition live as it happened [318, 254]. Other maps focus their narratives on the animals themselves, trying to personally connect with the user (Fig. 3.3a). Some maps focus on threats to a species, stressing the need for conservation efforts (Figs. 3.2f, 3.3d); for example, Polar Bears International shows the bears' movement over changing ice coverage to show their vulnerability to climate change. Additionally, many of the websites provided worksheets and curricula for classrooms, teaching students to analyze and interpret the tracking data and learning about the underlying conservation issues [242, 72].

3.3.3 Environmental communication

Environmental communication studies the various ways individuals, corporations, politicians, environmental organizations, journalists, and other groups attempt to influence the policies that affect our planet's health. Fundamentally, the field explores media strategies for culture change: starting from an idea that nature is something to dominate, and moving towards a notion of nature as something that we need to share for our own survival. Many attribute Rachel Carson's 1962 book *Silent Spring* as the the fields' beginning, whose vivid and provocative depiction of pesticides' environmental harms brought widespread public attention to environmental issues and led to new regulations in the USA [66, 302].

Scholarly research on media, communication, and the environment developed into the 1970s and subsequent decades, shaped by the key environmental issues of each era, and influenced by foundational early works like Anthony Downs' 1972 study of the environment as a social problem [114], Harvey Molotch and Marilyn Lester's 1975 study of news reporting following a major oil spill [236], and David Sachsman's 1976 study of source influence [293]. Developments in the 1980s focused largely on the media's impact on nuclear power narratives [162]. Recently as climate change has become the main environmental issue in the media, research has focused

on building consensus towards large collective actions.

Through the 1990s and 2000s, environmental communications research continued to grow in relevance as university professors in the United States dedicated course material to environmental communications analysis. These decades also marked the rise of international environmental communication associations and societies, like the International Association of Media and Communication Research (1988), The Society of Environmental Journalists (1990), and the Science and Environment Communication section within the European Communication Education and Research Association. The International Environmental Communication Association formed in 2011, working to broaden the global cache of environmental communications beyond the United States and Europe [162]. Today, the study of environmental communications plays a pivotal role in advancing equitable ecological policies worldwide.

Environmental communications and best practices for real-world impact

As the academic discipline of environmental communication developed, conservation practitioners look to harness the lessons learned to promote societal or behavioural change and maximise conservation impact.

Emotions. Emotions strongly impact audiences' attitudes towards environmental issues and their willingness to take action [360, 358], and there remains an open discussion on the long-term effects of positive and negative feelings. For example, anxiety around environmental issues can cause people to seek more information [174], and many campaigns try to motivate behavior change by evoking "eco-guilt" and "eco-shame" [234, 238].

However, newer work increasingly focuses on positivity amid an emerging consensus that decades of scare tactics have done more harm than good. Audiences disengage with environmental topics when they feel hopeless [174]. Many environmental communication efforts thus deliberately seek to cultivate hope for the future—hope and other positive emotions can motivate audiences as strongly as negative ones [259, 360]. In today's political landscape, practitioners commonly avoid using controversial terms to avoid scaring audiences away from uncomfortable

topics and increasingly drive positive narratives that emphasize progress and solutions [188, 217].

Continuous conversations. Ongoing, continuous conversations are important to sustain attention for environmental issues and build consensus towards collective actions. Environmental issues tend to move slowly—rarely the urgent, pressing issue of the day—and are prone to slip out of the mind. Communication practitioners have long worked to repeatedly bring them back to public attention [58]. The media's *"issue-attention cycle"* complicates this work, whereby public attention rarely stays sharply focused on one issue for long before moving on, unresolved, to the next issue [114].

Ongoing conversations play an important role towards building consensus and taking collective actions. For example, the 2020 Yale Climate Opinion Maps [218] show that most Americans believe that global warming is happening (72%) and support regulation of CO2 as a pollutant (75%), but very few hear about global warming at least once a week (25%) and most rarely or never discuss it (64%). These results show there is not an issue with consensus on climate change in the United States, but rather the problem is a reluctance from Americans to discuss or take action on the subject.

Recent environmental communications work explores media strategies to open spaces for such conversations. For example, a 2019 case study analyzed Twitter data to show the importance of online interactions between water professionals, activists, and the general public to construct a consensus around new paradigms of water management [49].

To this end, environmental organizations seek to build lasting relationships with their audiences, continue conversations, engage people over social media, and show them how to get involved. Communication practitioners stress the importance of knowing the audience in depth to tell stories they relate to [188, 217]. Organizations can additionally use interpersonal communication strategies to make science communication more relatable and effective, encouraging conversational engagement using elements like selfies and first-person pronoun-rich captions [219].

Relatability. Relatability has been central to environmental communications for decades, as audiences generally respond much more strongly to relatable media [188, 162, 158]. For example, a study that measured participants' reactions to polar bear messages found that participants were more likely to donate money when presented with empathetic portrayals of bears harmed by climate change, and found no benefit to messaging with a more objective approach [314]. Telling stories is critical: the aphorism *"one death is a tragedy, a million deaths is a statistic"* is especially true in this case.

Practitioners have recently began a shift to human-centered and place-based stories, instead of centering a particular issue [188]. Stories about familiar places resonate more strongly than vague ideas and far-away lands, and practitioners increasingly recognize the important role of local media [188, 153, 298]. Some of the most successful recent efforts have utilized human-centered stories [188, 158], which can be especially effective in communities that are skeptical of environmentalism. For example, it is difficult to draw attention to the negative effects of climate change on shellfish populations, but telling stories about dying fishing communities provokes emotion and draws attention. Human-based stories are some of the most tangible; they are a real thing that you can see today.

Connection to nature. A long thread of research addresses *connection to nature* as a catalyst for pro-environmental actions. Natural experiences help to cultivate this feeling, but as urbanization and industry make us less connected to nature than ever before, can media help to re-connect us? Studies with films and virtual reality have yielded mixed results [23, 53] and the extent to which this is possible remains unclear. For example, can we digitally re-create the experience of a safari? This remains an important question for parks and wildlife conservancies as they look towards virtual experiences to reduce their dependency on tourism and its ecological harms [160, 192].

3.3.4 Data visualization and narrative

This work also draws from research on interactive data visualizations for journalism and storytelling. These media have surged in popularity over the last decade as more news articles in-

corporate interactive elements and designers create immersive experiences centered around the data visualizations themselves. Compared to purely-linear narratives, these interactive data stories can allow users to explore on their own, verify claims, and ask their own questions of the data [299, 311].

However, recent work has shed light on interactive visualizations' limitations as storytelling media. Despite the field's initial excitement, recent discourses have noted their often-underwhelming user engagement and debated their value. For example, around 85%-90% of viewers do not engage with interactive graphics on New York Times articles [232, 13]. Published usage statistics from popular interactive data articles have shown that visits are often short, with most users spending under two minutes [83]. Designers need to consider that users often do not have time to explore interactive visualizations in depth, their levels of motivation vary substantially, and the visualizations' user interfaces are often not self-explanatory enough [33]. There has been significant controversy and debate about interactive data visualizations' effectiveness for storytelling and journalism, and whether they are worth their considerable expenses and effort to make compared to other media like articles or videos.

However, while interactive data visualizations often engage a more narrow audience than other digital media, they can excel for allowing the most-motivated users to dig deeper [14]. Design patterns have emerged that combine different narrative techniques and feature different degrees of direction and interactivity for the user, including some with linear, directed paths through the data; "random access" interfaces that do not direct users into any particular path but encourage them to explore freely; and "choose your own adventure" structures where users select a path from many options [299, 311]. A burgeoning community of data visualization enthusiasts is still continuously developing new interaction techniques and narrative methods.

3.4 Project Background

We address these open questions about interactive data visualization and environmental communication through the lens of product design, as we work towards implementing a toolkit for conservation organizations to deploy their own wildlife tracking maps through EarthRanger. This

section describes our projects' objectives and partnerships to contextualize the formative design work in this paper.

EarthRanger is a secure domain awareness system used by dozens of wildlife conservancies, protected areas, and other conservation organizations to manage their operations. Its core is a software platform that organizes real-time geospatial data over large areas, such as incident reports, locations of tracked animals, locations of ranger and vehicles, and data from various sensors and camera traps. EarthRanger was originally developed for anti-poaching security but has since expanded its scope to include ecological monitoring and has found increasing use by trans-boundary organizations other than parks and protected areas. Several conservation organizations now use it to track animal migrations across vast areas, including our two partners the Atlantic White Shark Conservancy (AWSC) and the Giraffe Conservation Foundation (GCF).

EarthRanger currently has no public-facing component, being designed fundamentally for private-facing use-cases by conservancies. However, many EarthRanger clients have requested a feature to selectively share some of their animal-tracking data with the public to display in their visitors' centers and websites. To this end, our research team has begun developing a customizable extension of EarthRanger to accommodate these communication goals with public-facing wildlife-tracking maps.

Here we briefly describe AWSC and GCF to contextualize and motivate this project, providing them as examples of organizations hoping to deploy these interactive maps.

3.4.1 Atlantic White Shark Conservancy

The Atlantic White Shark Conservancy (AWSC) is a small non-profit organization on Cape Cod, USA born from a collaboration of academics and local community leaders working to conserve vulnerable white sharks around the cape. After suffering an estimated 73% population decline into the 1970's and 80's, subsequent fishery management plans have recently seen their numbers start to rise [97]. AWSC's mission is to *"Support scientific research, improve public safety, and educate the community to inspire white shark conservation."* As the sharks' numbers increase, AWSC works to increase public awareness for the safety of both the public and the sharks—

chance human encounters are becoming one of the sharks' main conservation threats. AWSC concentrates their outreach efforts on Cape Cod where they have developed relationships with local lifeguards, beach managers, government leaders, and schools.

AWSC works closely with the Massachusetts Division of Marine Fisheries who have tagged over 200 white sharks with location-tracking acoustic receivers. The tags are used for basic research on shark behaviors, public safety, and conservation management; estimating the population size and profiling sharks' predatory behaviors. GPS and long-distance data transmissions do not work well underwater because of the radio waves' high attenuation, so it is not possible to get continuously-updated GPS data for the animals. Instead, the researchers use a network of acoustic receivers up and down the coast that log when a tagged shark passes by. This leads to much sparser data than most terrestrial animal-tracking projects.

3.4.2 Giraffe Conservation Foundation

The Giraffe Conservation Foundation (GCF) is a small organization with 19 staff working for giraffe conservation through strong international partnerships with governments of 16 African countries, park-management organizations, genetics experts, academic institutions, local stakeholders, and large research organizations like the Smithsonian. GCF works through research and advocacy to create more public interest for giraffe conservation and secure government buy-in to increase giraffe's chances of survival. All 4 species face considerable conservation threats; they have lost 30% of their population in the last 30 years and 90% of their habitat in 300 years. One species, the northern giraffe, is down to 5,600 individuals. However, the giraffe's decline has been dubbed the "silent extinction" due to the lack of public awareness, government action, and research.

In support of their mission, GCF has placed over 200 GPS trackers on giraffe across 11 countries with a main goal of scientific research. Little is currently known about giraffe's movements and the distances they cover, which is particularly important for conservation as their habitats are increasingly fragmented by fences and human development. The data allow researchers to investigate the connectivity between different protected areas and collect evidence to strategically

advocate for policies that support migration corridors. The large geographic scale of the tracking project allows for examination of behavioral differences in different landscapes; as it currently is unclear whether conservation lessons learned in certain habitats apply to others. Additionally, the GCF uses automatic immobility alerts to investigate when a giraffe stops moving, and sometimes sends a team to investigate.

3.5 Conservationist Focus Groups

To better understand conservationists' communication goals and their aspirations around public wildlife-tracking maps, we conducted focus groups with staff of two conservation organizations who use EarthRanger: the Atlantic White Shark Conservancy [84] (AWSC), and the Giraffe Conservation Foundation [135] (GCF). Each remote session lasted one hour and included 2-3 members of each organization with our research team. Discussion questions were framed by earlier meetings with the clients, and included their intended audiences, motivations for sharing their animal tracking data, intended user experiences, and other communication strategies. The sessions were recorded, transcribed, and then underwent thematic analysis by the authors. Each focus group participant was then provided with a copy of this manuscript to review for accuracy.

3.5.1 Motivation for public animal tracking map

Both organizations were excited to augment their existing communication strategies with interactive maps. They each had prior experiences showing their tracked GPS data and receiving strong reactions; and they cited this as a main motivation to share it with the wider public:

> *"You pull the [EarthRanger] app on your phone and show them the movements of a couple of giraffe, and people get really excited and engaged and they love seeing that. You can show and say, look: this is a female and she moves in this really small area back and forth, and her home range is really small. But then this male moves vast distances overnight, and people get really animated and excited about it. So we just wanted to share this excitement with a with a bigger group and really use it to draw attention to*

> *giraffe; to our work."*

Each had started using maps in their communications already: GCF had showed animated GIF's of giraffe movements on social media posts with very positive responses. Similarly, AWSC had considerable public interest in their Sharktivity mobile app [85] which maps shark sightings and has been downloaded over 100,000 times.

The conservationists were also motivated by a notion that *"people inherently understand maps"*—that the general public will not read research papers, for example, but can intuitively see a track on a map and understand how the animal is traveling through its home range to find what it needs to survive. Both groups hoped to keep audiences continuously engaged over time by frequently updating the data; so the map would be different, new, and interesting each time they returned. They all shared a hope that the maps' interactivity and visual appeal would help them broaden their audiences and reach more people.

Additionally, the conservationists simply loved exploring the data themselves and wanted to share their experiences with others:

> *"When I'm not in the field, opening this is a part of my morning routine, and I'll have my cup of coffee and see where the giraffe are. In the absence of actually seeing giraffe in the field, it's just a spark of joy."*

3.5.2 Communication goals

The conservationists all hoped to inspire an appreciation of the animals, raise a general awareness of conservation, showcase their own organizations' work, and encourage audiences to get involved and engage with them further. They each wanted to boost the public profiles of their animals: raising attention for giraffe conservation, and increasing public awareness of sharks as their numbers recover for both humans' and sharks' safety. Each organization already used a variety of channels for public engagement: photo contests, frequent public talks, mobile apps, websites, and various social media campaigns.

Audience

Both GCF and AWSC hoped to use the public animal-tracking maps to reach new audiences and interact broadly with the general public. Additionally though, they sought new ways to engage audiences who were already highly involved with their organizations: the *"sharkies:"*

> *"There's some people who are just kind of shark groupies. There are a lot of people in the public who are really interested in these sharks and what they're doing, and just want to learn more about them."*

and the *"giraffe lovers:"*

> "They just love giraffe, they love reading anything we do, they love seeing different things, and they would love seeing something like this."

Additionally, both specifically hoped that the wildlife tracking maps could be a tool for building relationships with other organizations, researchers, and donors: *"you want to get people interested in your work, because you don't want them only to donate once."* The AWSC, who concentrate their shark outreach programs on Cape Cod, also hoped the interactive website would help broaden their outreach efforts to new places.

User experience

Visual appeal. Both groups hoped to create an eye-catching experience with the interactive maps and viewed the visual appeal as a key for attracting audiences' attention: *"most people don't want to read scientific reports; they don't want to read long stories; they just want to see something that is visually attractive."* Towards this strategy, they each cited prior success with visual communications before: *"They just eat up a couple of pictures... it's worth a thousand words, right?"* One participant had previously used mobile apps for public outreach, but thought it would have been more effective if the app were less visually "clunky."

Connecting with individual animals. The conservationists agreed that their most important goal was to tell stories of individual animals and inspire empathetic connections. By providing a window into the animals' lives through their GPS tracks, pictures, and stories, they hoped to use the personal connections as a vehicle to teach users about the animals and their conservation: *"You know, I think of all these giraffe that are tagged... they're all individuals. So they all have their own story. And I think sometimes when you look at the [GPS] track—at least as a scientist—you just want to ask why, right?"*. They spoke about this at length:

> *"...just allowing people to get to know these sharks as as individuals. You know, relating to them as animals that have a tough life, that struggle. We have a lot of white sharks that have been hit by boats. They have fishing gear—I was just looking at video footage of one, right before we got on this call, where it looked like it got caught in a gill net and made it out. People don't tend to think of these animals that way a lot of times. "*

Both groups already used animal stories to relate with audiences in their other outreach efforts, and anticipated that people would be eager to see them on the maps: *"Some of these sharks are locally kind of famous, because they've heard about them. We've had sharks strand on the beach and get tags, and then everybody wants to know that shark has come back."* The giraffe researchers also wanted to link directly to certain animals on the map, so they could feature their stories in social media posts.

Additionally, GCF wondered about ways to visualize environmental context, like elevation and protected area boundaries. The giraffe's environments were key to the stories they hoped to tell:

> *"These giraffe are moving across these crazy diverse landscapes, and we're just trying to figure out ways to communicate this to the public to show there's lots of really interesting places that giraffe live... It just seems like a really ripe opportunity for an engaging website."*

Real-time data. Both groups were enthusiastic to use the animals' real-time data to connect with audiences, albeit for different reasons. GCF researchers hoped to engage users with regular scheduled updates about certain individuals, giving people *"some kind of update once a week; they'll get something [like] Simon the giraffe has moved 1400 kilometers in the past 30 days and it's now in this habitat."* They hoped to use these updates to start conversations on their social media; as well engaging with donors as part of their adopt-a-giraffe program, showing how their donation had made a tangible difference. (Similarly, AWSC hoped to use their map for their adopt-a-shark program.)

The AWSC, however, plans to share sharks' near-real-time data for public safety, alerting beach users when sharks are nearby. They already have a phone-tree system alerting lifeguards and surfers to shark sightings, and they hoped their map could also disseminate this information. They hoped to trigger the audiences' general awareness that there could be sharks around if they knew that the data was live: *"if you're here in the summer and the fall, just assume that there's a shark somewhere in the vicinity, and you know, consider that when you decide how you're gonna use the water."*

User takeaways

Conservationists from both groups waxed at length about the astonishing beauty of their animals and hoped audiences would learn to appreciate them by learning about their complexities and challenges: the vast distances they they traveled, the dangers they face, and their skillfulness. Additionally, they shared the secondary goal of teaching users about their organizations' work and their challenges: *"we want them to see this and be impressed by the scope, and realize... the problems may be more complicated than I imagined."*

Although many people are shocked disheartened to learn about the threats to the animals, the conservationists stressed that they did not want to dwell on doom and gloom: *"We really like to share good news stories, and how the partnerships work that we are engaged in, and how that works well."* They hoped to get users excited about the conservation work, and realize that people are working to figure it out: *"Giraffe are in trouble, but together we can make a difference."*

Uniquely for conservation organizations, AWSC has additional messaging goals around public safety. They work to raise awareness that sharks are often nearby in the water, helping people *"get an idea of where they occur; where the hot spots are,"* and consider the sharks when using the beaches.

Actions. Both groups hoped to inspire users to get involved in wildlife conservation: *"trying to, you know, promote action. Be it more direct engagement with us as partners, or donations, or just asking questions."* They all acknowledged, though, that it's difficult for people to know what actions to take, or to know how to get involved.

Both organizations hoped the maps would make people want to learn more. GCF particularly wanted to use the map to drive users to their website and social media channels: *"What I would hope that they're really interested in, is that they want to read more. You know, like redirecting to GCF's website and actually seeing what's being done on the ground. If that's the progression, I think that's a great end point."*

3.5.3 Summary of conservationist focus groups

Both groups were excited to deploy public-facing maps with their wildlife tracking data, hoping to create eye-catching experiences that were east to understand, and draw attention to their organizations. They each discussed getting strong positive reactions from showing people their geospatial data before. They felt strongly connected and excited about the data themselves, and wanted to share their own experience with others.

They hoped to use the data to inspire personal connections with individual animals and give the users vivid windows into their lives, helping people learn to appreciate the animals and want to take action. Although acknowledging the difficulty for most people to get involved in conservation, they hoped users would want to learn more about the animals and engage further with their organizations via donations, their websites, or social media. Both groups planned to integrate the maps with their other communication efforts, like telling stories about individual animals on social media and linking to their GPS tracks.

3.6 *User Study*

We conducted user sessions to better understand lay peoples' experiences with these wildlife-tracking maps. We sought to understand their likes and dislikes, their experiences navigating the interfaces, and the messages and knowledge they took away.

3.6.1 Methods

We recruited 10 participants for 30-minute video calls where they explored two wildlife-tracking maps. We then asked them for their impressions of each map and comparisons between the two, explaining their thoughts and reasoning. The purpose of the comparisons was not to evaluate the maps, but rather to solicit more critical feedback. Our questions included which map they liked better, which they would be more likely to use again, which they learned more from, and which made them feel stronger emotions; among others. We sought participants with varying interest levels in wildlife conservation, and recruited them by posting on an email list for college students in environmental management programs, a discussion board for graduate students in evolutionary biology, and a discussion board for computer science students.

With each participant, we showed two wildlife-tracking maps and asked them spend 5-7 minutes exploring each map in whatever way they they wanted. (Five to seven minutes is significantly longer than the median time of 1-2 minutes that web visitors will typically spend [83], but typically less time than the most dedicated users.) We asked participants to share their screens so we could observe their behavior. To diversify participants' responses, the maps were randomly drawn from this list of 4 maps chosen for their markedly different designs:

- *OCEARCH Shark Tracker* [258] (Figs. 3.2a, 3.2b, 3.3a), with an open, fairly undirected interface to explore data for hundreds of individual sharks and a storytelling emphasis on the individual animals;

- *WWF Wildlife Tracker* [143] (Figs. 3.2c, 3.2d, 3.3b), with a narrative centered around WWF's research projects, and a more guided approach that lets users explore curated data about

several different tracking projects;

- *How to Be a Monkey* [136, 370] (Figs. 3.2e, 3.3e), focusing on behavioral data for only one individual, and having a directed interface with a "guided tour" of key data points.

- Polar Bears International's *Bear Tracker* [183] (Fig. 3.2f), which animates the bears' movements against changing ice coverage.

3.6.2 Results

Our participants had mixed levels of background knowledge about wildlife conservation. Most cited social media as a main source of environmental news and information; roughly half followed specific organizations like wildlife rescue hospitals or animal sanctuaries, and roughly half mainly saw news shared by their friends. A few participants named newspapers as sources for environmental news, and one read journal articles. Three of the ten participants said they had seen wildlife tracking data before.

User experience

We observed a notable variety in the ways that participants explored the applications. Some focused mainly on the integrated text and media; some opted to read pages on the organizations' websites before diving into the map; and others looked mainly at the many GPS tracks, usually spending a few seconds on each track.

Some participants voiced that they preferred the sites with modern, more visually exciting designs. Asked which map they would be more likely to revisit, a majority explained that they would choose the one with more data and variety. About half said they probably would not revisit either map: *"Well, I might send them to my 12-year-old cousins."*

Learning curve. Even though the websites generally had well-polished and thought-out user interfaces, most participants spent the first couple minutes clicking around to see how the maps worked and familiarizing themselves with the interface before they could start exploring the data.

It took time to understand the many different types of data, controls, and layers of navigation. Most of the participants commented on this: *"The structure is ... confusing. There were so many different ways to redirect from the animal;"* and *"I could have gotten a better sense on how to navigate with more time."*

Data interpretation. By looking at the tracking data, most participants noted the animals' large ranges, and sometimes observed that they seemed to have territories: *"this whale has a nice home fjord."* Many complained that the maps were too visually noisy, the data were hard to see, and they lacked context to explain the animals' behaviors. Two described the GPS tracks as "hairballs:" big confusing blobs that were hard to make sense of. Most maps incorporated text and media about the animals, but one participant complained it did not help to explain the GPS data: *"I guess what I got out of it, I think I could have also gotten out of a PowerPoint... I don't think that the actual geospatial component was integrated into the other component."*

Some participants were disoriented by noise in the data: many GPS tracks had outlier points that a familiar researcher would recognize as errors, but confused some users. A few were confused by combinations of new and old data shown together the map: *"...did some of the bears die? Why are they not moving any more?"*

Unprompted, a majority of the participants complained that they wanted to better understand the timescales of the animals' movements: *"I didn't know the time period. Is all the movement for one year or many years?"* Many expressed that the missing time component was key for understanding the animals' stories:

> *"I wonder if there's some way to visualize ... how much time he spent here. Like, did he spend months there and then decide to move on? Or maybe he came from the other direction and found that was a good spot and was like* 'I'll just stay here?' "

Several participants wanted to know which seasons the animals were moving, as well as movements by night and day. A few voiced their appreciation of the the Polar Bear Tracker's animations to show time scales. Other example maps showed time data in more subtle ways, but

participants were generally unsatisfied.

Notably, while most participants' takeaways from the GPS data were fairly superficial, two of the participants with environmental backgrounds were able to perceive a lot more from the data:

> *"I can see that narwhals like to be closer to the coasts, rather than in the open ocean; and I learned that polar bears travel on both water and land... and [the fish] made a lot of jagged, erratic movements; they stayed in one area and then traveled in a straight line."*

User takeaways

We asked participants if they had learned anything from the maps. Many of the participants were impressed by the large distances that the animals traveled: *"Right off the bat, I didn't realize there were sharks that went literally from Miami to Maine."*A few participants said that they learned more from the integrated media than from the geospatial data itself:

> *"I probably learned more from the first one, just because they had those informational blurbs. So I learned how the monkeys interact with each other, and how they learn to eat by imitating their elders, and how they groom each other. With the second one I learned where each animal is located in the world, but nothing more past that."*

Some appreciated learning about the organizations, research projects, and methodology: "I learned a lot about how tracking animals works... I saw that you get a ping when they come to the surface and data is transferred!?"A few also felt that they did not learn anything, or were not sure what they learned: *"I don't know if I had a specific nugget that I took away, other than these things exist."*

Emotions. Asked what emotions they felt while using the maps, participants responded a variety of ways. Many first said they were just excited to see the animal-tracking maps, this being a new experience for them: "I was just excited to use it... it was a fun thing to volunteer for!" A few felt a new admiration of the animals, especially from seeing how far they traveled. A few remarked that the animals were cute: *"...and I don't know what emotion that is. Like, adoration a little bit maybe?"*

Some participants expressed that the maps made them feel optimistic for the animals' futures, seeing how the organizations were working to conserve them: *"It's nice to know with the WWF that they're doing a lot of work around the world... so that's a little bit of optimism."* One felt sad and frustrated that the animal tracking was necessary. For the polar bear map in particular, some users felt sad for the bears:

> *"I was pessimistic going into the polar bear one... It's nice to see that they're being followed, but I don't know that I felt any worse or better by the end of it."*

A few users, though, did not feel much emotion: *"It was interesting, but I didn't feel anything about the animals."* Also, many expressed disappointment when realizing the data on the map was old, perhaps dampening their reactions: *"it's very clearly not up to date.'*

Relatability. Asked what made them feel connected to the animals and researchers, most participants cited the websites' text, pictures, and videos rather than the mapped data itself: for example, *"I felt like I was getting a ground view... I'm seeing real life pictures, and the videos that the researchers and observers took;"* and *"If you click a specific animal, you can see the scientist or divers installing the devices on them, and you feel more connected to the people behind the tracking."* A couple participants voiced that they felt more connected when the data was real-time, and they could see where the animal was today. Unprompted, several also exclaimed that it would be fun to adopt an animal and receive continuous updates about it: *"it would be fun if you had a favorite shark or animal!"*

Actions. We asked participants if the maps made them want them to take any actions. Most said that the map did not make them particularly want to do anything, or that they did not know what to do:

> *"I don't really know what I could have done by looking at this. Like, I don't know if these animals are endangered, or what steps I could take. So I feel like it would take a lot of*

> *external research on my part to figure out what I could do, if I did feel like I wanted to do anything."*

However, half of the participants said the maps made them want to learn more about the animals and the conservation organizations: *"I honestly don't feel like I need to do anything right now except for learn more about what these projects are. I don't feel like I know enough to make any kind of action."*

Summary of user sessions

Most participants were excited to see the vast distances the animals traveled, and noted that some moved around territories, but struggled to find other meaning in the maps' geospatial data because they lacked context. Most also complained that they wanted to better understand the timing of the animals' movements. Some were excited to see real-time data about the animals and felt more connected when data was recent, and expressed disappointment when data was old. Most participants also felt that they learned more from the maps' integrated text, pictures, and videos than from the geospatial data itself, and felt more connected to the animals from these supporting media.

Many participants were impressed by the animals' long distances traveled, and felt like they learned more about the research and conservation efforts; although some were not sure if they learned anything. Most were just excited to see the map and the animals movements, and some reported other emotions like optimism from seeing the conservation efforts, adoration of the cute animals, and sadness and frustration that the conservation efforts were necessary. Most users did not know what actions to take after seeing the maps though; however many said that they wanted to learn more about the animals and conservation projects.

3.7 Interactive Data Visualizations and Environmental Communication

Here we synthesize our results to examine wildlife tracking maps' strengths and weaknesses for environmental communication goals. Many of our findings are generalizable to other interac-

tive data visualizations, hinging on their unique affordances that allow users to ask their own questions of the data and freely explore [299].

Deepening relationships with dedicated audiences. Interactive data visualizations are most effective when users are highly motivated to explore, willing to overcome the inherent learning curves to take advantage of their interactive affordances. Therefore one of the strongest potentials for wildlife-tracking maps is to meaningfully interact with their most dedicated audiences: their sharkies and giraffe lovers. These audiences are environmental organizations' champions, and sustaining these relationships is crucial.

The conservationists hoped to provide immersive windows into individual animals' lives—this requires the users to be driven by their curiosity to comb the tracking data for interesting nuances. When audiences are already engaged and already have knowledge about the animals, they also are much better positioned to find more meaning in the maps' data. For example, while some participants voiced that all the GPS tracks looked the same, a couple with stronger wildlife backgrounds speculated excitedly about the animals' behaviors.

Connecting with new audiences. Broadening participation is one of environmental communication's most important goals, but it is significantly more difficult for casually-interested users to have immersive experiences these applications: *'I had a hard time understanding the geospatial component of the map."* Their learning curves present a considerable barrier, especially as typical internet browsers tend to visit for only a minute or two [83]—many of our participants took longer than this just to get oriented with the interfaces and data before they could start confidently exploring. Many participants' main takeaways from the maps did not utilize the interactive affordances; instead they talked more about the pictures and descriptions; and could find only superficial meaning in the data, appreciating the animals' large ranges but seldom more than that.

However, these maps can still serve as a starting point to engage these casually-interested audiences in conservation issues, even while most will not interact deeply with the individual

animals' data. Brief visits can still advance some communication goals. Many participants voiced that the maps made them want to learn more about the animals and the organizations. They were still excited to see something stimulating and new. Some were impressed by the large scales of the projects and conservation efforts. Used effectively, these reactions could begin new conversations and relationships with users and serve as entry points for organizations' other communication channels—their apparent potential to begin relationships with new audiences may be one of their key strengths.

Relatability. Most participants reported that the applications' pictures and videos made them feel more connected to the animals and researchers, rather than the GPS data as they lacked the context to interpret it; for example: *"I didn't learn much from the GPS data itself, it was the pictures and stories."* For these casual users, other media like articles or videos can be more effective to create personal connections than dots on a map.

Many animal tracking maps try to achieve relatability by featuring stories of individual animals, but many of our participants found it easier to learn about the research projects than the animals themselves. This opens a door for telling relatable human-centered stories featuring the researchers: explaining why they are tracking the animals, how they use the data, their personal stake in the project, how it can help the animals, and how it can help humans.

Additionally, maps can be particularly strong for reaching local audiences and telling relatable stories about familiar places. For example, white shark sightings already receive a lot of media attention and public excitement on Cape Cod, and AWSC's map can contextualize and localize them for these audiences.

Continued conversations. Because modern environmental problems are so collective by nature and people do not know how to take meaningful actions individually, modern environmental communication theory stresses the need to keep conversations continuously alive [188]. Wildlife tracking maps have promising potential to engage users in the longer term by bringing them back for updates on their favorite animals, especially when continuously updated with real-time

data. Many participants noted this, unprompted: *"If it was an organization that had an 'adopt an elephant or whatever' program, then that would be* so awesome *if you could track your elephant."* Many participants cited the animals' real-time locations as a factor that helped them feel more connected, seeing what the animal was doing right now and knowing that the tracking projects were still active.

These continuous updates on favorite animals present a great opportunity for interactions between the tracking maps and other channels like social media or email lists, allowing organizations to tell detailed stories about the animals and link to the maps, and allowing audiences to respond and participate in the conversations. (As noted, these affordances also lend themselves particularly well to adopt-an-animal campaigns which are some of conservation organizations' most popular and successful fundraisers.)

3.8 Wildlife Map Design Considerations

From our findings, here we outline design considerations for future wildlife-tracking maps.

User onboarding. Interactive data visualizations, even when designed well, tend to have fairly complex user interfaces—in the first moments each user needs to piece together context to understand what the data are, how to interpret them, and how they can interact. In our user study, we watched many participants flounder to understand the maps before they were comfortable enough to explore. To reduce this friction, interactive data visualizations require special attention to "user onboarding" [33] to lower the cognitive burden of understanding the data. Interfaces for user onboarding commonly take the form of a graphic or an introductory sequence of screens explaining how to interpret and manipulate the data, for example.

Quick impressions. Given the reality of short online attention spans, there will always be a large fraction of users who do not try to substantially interact with the data. We encourage implementers to think carefully about their messaging for these 30-second visitors. For this segment, designers can consider approaches that circumvent the learning curve of interactive elements,

like a splash-screen with a short video, or a highly-directed introductory sequence highlighting key takeaways, or a story of just one individual.

Giving meaning to geospatial data. Most participants in our study could not find much meaning in the geospatial data, except for seeing animals' far travel distances or observing that they had territories. The difficulty of interpreting tracking data is a key shortcoming for this mediums' ability to convey the vivid impressions of the animals' lives that many conservationists hope for. Conservationists might struggle to appreciate this problem, though, because they relate to their own data so vividly.

Visually encoding information about animal behaviors and the environmental context is one way to make the maps' data more meaningful. For example, maps can prominently show habitat types, rivers, vegetation, weather, or shifting ice coverage (Figure 3.2f [183]); visually distinguish the animal movements' during day and night or in different seasons; or highlight sudden changes in travel speeds. However it is still a challenge to effectively communicate what these additional contexts mean for the animals; e.g. some example maps in our study showed vegetation in satellite images and marked rivers, but participants did not react to them.

Maps can also explain the data more directly with textual descriptions, photos, and videos about the animals' behaviors. This approach lends itself well to integration with other media types, like long-form articles or narratives on social media.

Time component. Most existing wildlife-tracking maps do not emphasize the time component of the tracking data. Most of our participants, though, wished that they could better understand the timescales of the animals' movements and voiced that this would help them understand the data better. Time data can be incorporated in a number of ways: animations, tooltips, or varying the tracks' color. One participant suggested a particularly interesting approach: a tooltip for each GPS transmission calling out the time since the last transmission, how far the animal traveled, and its average speed.

Participants were excited to see real-time live data about the animals, but also frequently

expressed disappointment and confusion upon realizing the data was old. Implementers ought to creatively balance the display of time data to keep the website feeling fresh.

Relatability. A large majority of our participants reported feeling more connected to the animals through pictures, videos and text rather than the dots and lines on the map. It is difficult to empathize with data alone, so thoughtful integration with more-relatable forms of media should be central to application designs.

Visual appeal. Lastly, users generally wanted the applications to be visually exciting with a high-quality, modern finish. Visual appeal is one of the most important elements for the users' excitement, often underestimated by software developers. Sites with less-polished interfaces shook some participants' confidence, unsure if it would work on their computers.

3.9 Discussion

Here we provide additional thoughts on data security and access limitations of these maps, discuss our study's limitations and future work directions.

3.9.1 Data security

Though not the focus of this paper, data security is a fundamental design problem for wildlife-tracking maps when sharing animals' location data. GCF and AWSC conservationists both shared concerns for the animals' safety: for example, tourist boats might use the data to find and crowd sharks. In another case, the International Wolf Center had offered tracking data as a part of a school program but withdrew the data for fear of the wolves being killed [72].

More work is needed to understand the range of security threats. Especially when providing continuously-updated data, not all risks are easy to predict ahead of time; e.g. it is potentially dangerous when an animal stops moving. There is also a risk that animals' current locations might be predicted from past locations, perhaps even by co-opting some of the predictive models developed for anti-poaching efforts [130, 148]. Publishing tracking data to the web may also draw

attention to the server infrastructure as a hacking target, where other sensitive non-pubic data are hosted.

There are many potential mitigation strategies, and more work is needed to understand their necessity, efficacy, and impacts on the user experience. Most projects will not share locations for the most threatened or poached animals, though they are frequently the most charismatic and draw the biggest audiences. GCF is choosing to delay their published data by two weeks for the giraffe's safety; the AWSC shares these safety concerns but is cautiously opting to publish data in near-real-time for public safety reasons and hope that live data will be more exciting for audiences. Differential privacy techniques may applicable to the unknown threat of predictive algorithms, by adding a jitter to the data, for example. Especially for live data, some commitment to human monitoring is unavoidable.

3.9.2 Access limitations

Interactive wildlife-tracking maps are typically made for international audiences and donors; best suited to audiences with computers, internet access, and prior science education. However, many conservation projects are located in remote, low-income areas where local people often face access barriers like device ownership, poor connectivity, language, and education. Organizations strive to engage these local audiences because their engagement is critical for conservation projects' successes [247, 138], and the role of interactive technologies is becoming a salient open question as technology access increases around the world [373]. There are opportunities for mediated access [295] to wildlife tracking maps whereby conservancy staff provide demonstrations or encourage communities to experience the maps together in collective settings [366, 239]. Interactive data applications also lend themselves well to community science approaches, potentially helping conservancies deepen their bilateral interactions with communities [342]

Maps and data visualizations are notoriously inaccessible for people with visual impairments [62]. Map implementers can mitigate this to a certain extent by ensuring the maps' incorporated videos and text are accessible by screen-readers. Sometimes other media like audio recordings are better suited. Recent waves of research on interactive data experiences for visually-impaired users also

present new opportunities for wildlife-tracking maps [303, 369, 128].

3.9.3 Study limitations

This study presents formative design work, and there is more to learn from a full deployment and observation of user behaviors in the real world. However, we expect similar patterns documented by other systems, having a small group of highly-engaged users and a long tail of short and minimally-interactive visits [14].

To present the conservationists' perspective we have worked with small, fairly technically-capable organizations with successful communication efforts. We have not included perspectives of other organizations using these maps, many having less technical capacity. In our user study, participants explored each map for 5-7 minutes, which is longer than most typical visits but not representative of the most dedicated users who visit repeatedly. Our sample contained some participants who are very passionate about wildlife, but we cannot be confident that our study represented the experiences of internet audiences who engage with these these conservation organizations online and we can only interpolate about them from the conservationists' descriptions. We intend to focus on these dedicated audiences in future work.

3.9.4 Future work

Our work suggests that interactive data visualizations can be most effective with audiences who are already highly-interested in conservation, and these audiences are crucial for environmental organizations as their biggest supporters. However, one of the most important, impactful questions for environmental communication how to get casually-interested audiences more deeply engaged. Therefore, adapting interactive data visualizations for broader audiences is a key objective. There are opportunities for design research on new interface approaches that integrate data with more relatable media types. We need to develop new, interactive narrative styles that draw on best-practices from environmental communication; such as using relatable, interpersonal communication styles and cultivating hope [219].

For wildlife-tracking maps specifically, more design work is needed to help users find deeper meaning in the animals' geospatial data—a key shortcoming of the current prevalent designs. We hope to find creative new ways to meaningfully incorporate other environmental and contextual information into the experience.

Lastly, better tools are needed as more conservation organizations collect wildlife tracking data and seek ways to share it. Many smaller organizations lack the technical capacity to develop effective wildlife tracking maps. Based on the formative work for this project, our team is working to develop a toolkit that allows organizations to easily deploy wildlife-tracking maps for their own projects, accommodating the heterogeneity between each organizations' data and communication goals.

3.10 Conclusion

Conservation organizations are increasingly investing in wildlife tracking maps and other interactive data visualizations for various communication goals. Through user sessions and focus groups with conservationists, we have explored this medium's unique strengths and weaknesses for environmental communication and outlined a set of design recommendations for future implementations.

Chapter 4

"WE SEE THINGS BUT WE'RE AFRAID TO CALL:" TENSIONS, PARADOXES, AND TRADEOFFS DESIGNING AN ANTI-POACHING HOTLINE

4.1 Summary

This chapter presents the third of three case studies in this dissertation, examining security contexts. We return to Ol Pejeta Conservancy but find a very different set of problems facing their anti-poaching security operations, as compared with their community outreach efforts already described in Chapter 2.

Environmental organizations have increasingly looked towards technology applications to encourage the public to report on wildlife poaching and other environmental crimes. However, their mixed effectiveness demonstrates that an anti-poaching hotline's success is highly dependent on local context, appropriate technology design, and broader communication strategies. In this paper we present formative user experience research and technology design perspectives in a case study of a potential future anti-poaching hotline at Ol Pejeta Conservancy in Laikipia, Kenya. We investigate stakeholders' relevant motivations and concerns using conservancy staff interviews and a local community focus group, and describe a web of tensions and tradeoffs that complicate the design of a successful anti-poaching hotline. For example, the conservancy has different but overlapping security goals than the surrounding surrounding communities; local people are afraid to report information for fear of retribution, but allowing anonymous reports could open the conservancy to counterintelligence and misdirection by adversaries; and tips must be tightly controlled and kept confidential while still ensuring a timely and appropriate response from the conservancy. Additionally, we compare technology options for hotline design along lines of community access, timeliness and reactiveness, and real and perceived security. Our case

study describes a set of conflicting, high-stakes design choices that must be carefully balanced for a successful hotline deployment in similar contexts. The need to carefully balance these factors illustrates how appropriate hotline designs can vary between regions; having different entanglements of social, environmental, and technological dimensions.

4.2 Introduction

Wildlife conservancies and other environmental institutions have increasingly experimented with phone numbers, websites, and other technology-mediated "tip lines" for community members to report poaching and other environmental crimes. In spite of their increasing prevalence, there is a scarcity of research on the design and effectiveness of these anti-poaching tip lines and the small body of published research shows mixed successes and failures. These heterogeneous results demonstrate that their efficacy is highly dependent on local context, appropriate technology design, and broader communication strategies. For example, one study in the USA found that participants' willingness to report on wildlife crimes was affected by their financial situations and individual values towards wildlife [207]. Bergseth et al. [37] surveyed fishers in seven tropical countries to find that most did not act after observing poaching from "(1) conflict avoidance; (2) a sense that it was not their responsibility or jurisdiction; and (3) the perception that poaching was a survival strategy." In another example, Green [156] found that citizens' poor understanding of wildlife regulations were a key reason for non-use of poaching hotlines in the USA.

In this chapter we consider Ol Pejeta Conservancy (OPC) in Laikipia, Kenya as a case study to explore design considerations for an anti-poaching security hotline from a user-centered perspective. Known globally as the refuge for the last two Northern White Rhinos, OPC is also a recognized regional leader for its Community Development Program (CDP) that engages with the 20 communities and 35,000+ people living along its border fence through projects like water management, agriculture extension, human-wildlife conflict mitigation, and conservation education. OPC park staff have cited their relationships with surrounding communities as their first line of defense against poaching, and they receive vital anti-poaching intelligence through their community relationships. OPC staff have long considered launching a community hotline for

Figure 4.1: A zebra trapped in a snare, found in one of the communities near OPC by rangers in 2022. (Photo credit: Abraham Njenga.)

poaching tips, but repeatedly tabled the idea because of staff's concerns about the potential risks.

To probe the opportunities, limitations, and challenges offered by an anti-poaching hotline in this context, and to identify considerations for a successful design, we present evidence from a formative needs-finding study at OPC (as described in section 4.4). We use methods from HCI (Human-Computer Interaction) research to take a user-centered perspective that examines the motivations and pain-points of each stakeholder, and consider design implications for creating an anti-poaching hotline system in this context. We gathered qualitative data for a stakeholder analysis by interviewing Ol Pejeta staff in their community and security departments, wildlife department, and Ol Pejeta's staff of Kenyan Police Reserve officers. To learn about the community's perspective, we held a focus group with 10 members from 5 villages around Ol Pejeta.

We contribute a description of the area's poaching and security threats, and outline OPC's security infrastructure to provide context (section 4.5). OPC sources information through a network of trusted informers built slowly over time, and information is tightly controlled within siloed departments to thwart counterintelligence efforts. Participants of our community focus

group felt that OPC plays a role in maintaining security outside of the conservancy's boundaries by their provision of tracking dogs to assist local police investigations, and were motivated to make reports because of their prevalent belief that poachers were the same people that committed crime in their villages like theft, harassment, and break-ins. To this end, we consider a combined "anti-poaching security" hotline that aligns the security needs of both the conservancy and surrounding communities.

We found a contradictory landscape of concerns and interests among the different stakeholders that reveals opportunities but also considerable risks and challenges for implementing an anti-poaching hotline (section 4.6). For example, community members strongly, unanimously agreed that they wanted a way to make reports anonymously for fear of leaks or retribution; but security staff wanted to know the identities of informants because they are wary of counterintelligence and because poachers deliberately make false reports to misdirect them. Community members wanted a way to easily contact OPC's security, but security staff cautioned that they would not have the resources to diligently investigate a barrage of reports and preferred instead to rely on their network of trusted informants. OPC security staff believe that the information they can source from the wider community is very limited because most poaching is conducted by international syndicates of which local people have no knowledge, but local people may have more knowledge that can help address the emerging bushmeat problem. Additionally since staff on OPC's community-facing projects were engaged heavily with local politics, security staff were wary that advertising a security hotline could compromise the trust of their their informants.

We also consider technology design options for a hotline implementation—such as a regular phone number, USSD shortcode, mobile app or WhatsApp number (Fig. 4.4) to examine how their affordances can affect a hotline's success or failure. Section 4.7 describes how they vary across important dimensions like access by local people, timeliness and reactiveness, and security. Focus group participants agreed that they wanted an anonymous hotline to directly contact OPC security without being transferred through other departments, and wanted the option for sending SMS when they needed to be discreet. However, staff were concerned that communities would frequently mix up anonymous and non-anonymous numbers if both were circulated. Some

community perceptions were unforeseen and surprising, emphasizing the need for co-design with local communities: for example technologists usually see WhatsApp as more secure than SMS for its end-to-end encryption, but our community participants unanimously agreed that they would never send confidential information over WhatsApp because they were used to WhatsApp messages being forwarded widely, damaging their trust.

In this case study we show the complexity and stubborn difficulty of designing an anti-poaching security hotline at OPC. A successful design needs to carefully balance many paradoxes, competing factors, and high-stakes risks. Communication and advertising about the hotline must be handled delicately. Information must be routed appropriately through the conservancy's security silos while both keeping information confidential and ensuring a timely appropriate response. Our work outlines a set of considerations for anti-poaching hotlines in some similar contexts; but as this complex web of social conditions, environmental factors, and local technology access varies so widely between locations, the appropriate design of an anti-poaching hotline will also vary.

4.3 Related Work

4.3.1 Ivory poaching and the illegal wildlife trade

The illegal wildlife trade is a major threat to biodiversity worldwide and a key driver of species extinction [119]. In addition to environmental impacts, illegal poaching also fuels geopolitical violence and undermines governments via corruption [325]. Environmental crimes are extremely lucrative; a 2018 UN report estimated their annual monetary value at $91-259 billion USD and called them *"likely the fourth largest criminal area in the world after drugs, counterfeits and human trafficking"* [325].

The illegal wildlife trade is dominated by a small number of highly-connected international syndicates—forensic evidence has demonstrated a very high degree of connectivity between tusk seizures at different ports across Africa [349]. These syndicates are tied to violent, transnational criminal and insurgent networks including al-Shabaab, the Janjaweed, and the Lord's Resistance

Figure 4.2: Anti-poaching hotlines are ubiquitous; this poster shows an example anti-poaching hotline advertisement in an Oregon, USA state park.

Army (LRA) [233], and provide them a significant source of funds.

The acute threat of ivory poaching (along with habitat loss) has decimated elephant populations across the African continent by much as 50% over the past 50 years [41], with many regions reporting even steeper losses [348]. Poaching in Chad led to a loss of 80% of its elephant population in only 5 years [277, 348]. Ivory poaching activity has recently seen a major increase since a lull in the 1990's and early 00's: the African Elephant Census estimated a net loss of 104,000-114,000 elephants in the survey area between 2007 and 2016, an approximate 20% decline in the African population in under 10 years [319].

The ivory trade has also been deadly for rhino populations. The Black Rhinoceros *(Diceros bicornis)* has been poached nearly to the brink of extinction. They are classified as critically

endangered by the IUCN, with only 3,142 mature individuals estimated worldwide in 2020 IUCN Red List assessment [121]. Their population is slowly increasing due to intensive management and expensive security programs.

The other species of rhino in Kenya, the White Rhinoceros *(Ceratotherium simum)*, has also been severely impacted by ivory poaching. Their worldwide population is estimated at only 10,080 mature individuals in IUCN 2020 assessment, with a decreasing population trend [120]. There are only two remaining individuals of the Northern subspecies (both female), and they are both housed at Ol Pejeta Conservancy.

Bushmeat hunting

Bushmeat hunting for food is an intractable problem in many low-income regions. The demand for wild meat is expected to increase over coming decades with human population growth and economic development, ratcheting up pressures on wildlife populations and posing a considerable conservation threat [357]. A large body of research has linked bushmeat hunting to major wildlife population declines and collapses in the global south [34]. Complicating the matter, bushmeat hunting is very difficult to track and quantify impacts on wildlife populations; the currently-available methods are likely producing under-estimates [165].

Though governments have invested in efforts to reduce bushmeat hunting, including alternative livelihoods and food systems, it still remains difficult to change incentives for people on the ground [357]. Wild meat is a crucially important food source for households facing food insecurity in the global south [220, 141]. Many households rely on wild meat for subsistence, and bushmeat demand has been shown to increase in times when other protein sources are scarce [51]. Case studies elsewhere have also seen bushmeat hunting increase during times of crisis, sometimes catalyzed by peoples' resentment of government institutions and conservation parks[363]. Government responses to bushmeat hunting have been criticized as neo-colonial and overly heavy-handed, enforcing western cultural norms around food and prioritizing conservation over the affected people's nutritional needs [328, 71].

In recent decades, a booming commercial wild meat trade is changing the nature of the prob-

lem in Africa. Though bushmeat is often perceived as a rural subsistence food source, research has found that wealthier households consume more bushmeat in many regions [52]. In cities, bushmeat is often perceived as a luxury item and status symbol; natural, healthy, and tasty [74]; with demand driven more by older age groups [212]. Large quantities of wild meat are transported to cities and sold openly in illegal urban markets [48, 212]; researchers have shown that wildlife faces higher hunting pressures in areas close to cities [34].

Many sources indicate that bushmeat hunting for subsistence increased worldwide during the COVID-19 pandemic [55]. Kenya saw a major increase in Antelope and Giraffe hunting in 2020 and 2021; with hunters desperate for income and consumers for an affordable protein source [225]. In addition, bushmeat handling has been implicated as a major source of zoonotic diseases causing other epidemics including HIV, Ebola, and SARS; and governments have struggled to develop appropriate responses to these risks [359, 204, 68].

Militarization of conservation

In response to the increasing militarization and sophistication of wildlife poachers, governments responded with increasingly centralized and militarized anti-poaching efforts. The semi-autonomous Kenyan Wildlife Service (KWS) was created in 1989 under the direction of Richard Leakey and fortified with military training, aircraft, equipment, and armaments funded by tourism money and World Bank loans [227]. The KWS's intensive enforcement efforts led to a steep reduction in poaching through the 1990's. However, they were criticized for their remote management style; their relative glut of resources enabled them to overpower other national and local branches of government and has led to resentment and conflict [227, 356]; and their aggressive efforts to build fences around protected areas has been criticized for unfairly forcing people away from land and harming wildlife populations via habitat fragmentation [356].

The perceived urgency of security allows environmental security agencies to override other values. For example, an account of Virunga National Park argues that the trope of "crisis" allows the park management to *"manoeuvre within an historically constructed colonial 'state of exception' "*, acting unilaterally and straining the relationships with nearby communities [125]. Other work

at Virunga has critiqued the instrumental role of fear among rangers and community members as motivation for further militarization, while also undermining collaboration [322]. Legal critiques argue that current anti-poaching efforts are modeled after historic laws that protected wild game for upper-class sport hunters, and still perpetuate class inequities and colonial legacies [118, 117]. Additionally, transnational corporations and other non-state actors have also increasingly co-opted environmental security discourse as a source of legitimacy to accumulate power to advance their own governance agendas [210].

A controversial but growing body of research has argued that militarization of conservation has led to increased poverty and socioeconomic stratification [173, 8]. Recent media scandals reporting harsh enforcement have also damaged the reputations of environmental organizations abroad, and among donors [16].

Recent decades have heard a call for community-based conservation paradigms in response to these problems, that re-center the role of local people [247, 137, 11, 264]. Newer narratives envision a co-production of shared environmental security among local communities in collaboration with government agencies, implemented with varying degrees of success. However as small community-based conservation organizations are massively overpowered by the transnational criminal networks behind the illegal wildlife trade, de-militarizing conservation remains an intractable problem.

4.3.2 Anti-poaching hotlines

In recent decades many governments have deployed hotlines to combat wildlife poaching and other environmental crimes (Fig. 4.2); [347, 263, 256, 237, 92, 24, 181, 207]. Despite this, there is very little published research on the effectiveness of anti-poaching hotlines. One 2008 study investigated Pennsylvania's *"Turn in a Poacher"* program by interviewing program staff and 30 participants who had called in a tip to the hotline [228]; they reported that callers were motivated by wanting to protect their ability to fish, and the program had led to enforcement actions. In a 1984 study that surveyed government officials across US states participants regarded anti-poaching rewards programs as mostly ineffective, but the study authors reasoned that the programs were

too new in most states or the participants did not have enough experience to form opinions [253].

Other work directly examining an anti-poaching hotline is scarce [207], perhaps from a lack of appropriate methodology and because usage data is usually kept confidential. Some other efforts have probed the hotlines' effectiveness by investigating proxies like surveying the public's general opinions of environmental crimes [344, 207, 306] or characterizing the role of enforcement in case studies of complicated socio-environmental contexts [37, 170, 253, 354].

Several studies point to the importance of positive relationships between conservation parks and local communities as a condition for their collaboration in security matters [11, 240, 306, 45]. For example, a cross-sectional study of private game reserves in Limpopo, South Africa reported that many security agents had formed WhatsApp groups with local community members to share intelligence [168], though these were not formal hotlines.

Other studies point to the importance of informants' awareness and expectations. In a case study from China, a hotline for reporting illegal wildlife trade received more tips after an intensive enforcement campaign led to greater coverage of anti-poaching enforcement in news media and increased public awareness [305]. A survey conducted in Mozambique, South Africa, and Zimbabwe found that respondents were hesitant to report environmental crimes because they feared the respective government agencies and perceived them as corruptable [306].

Many studies reported on a lack of effective mechanisms and resources to act upon tips for wildlife crimes. Wildlife crime is considered as less serious than other types of crime in various contexts [344]. Subsequently, several studies argue that wildlife crime is under-funded compared to other crime, leading to shortages of resources and manpower to handle investigations [344, 253]

4.4 Methods

For this case study we examine the needs and concerns of different stakeholders in Ol Pejeta Conservancy's security ecosystem using three main sources of information: first, semi-structured interviews of OPC staff; second, a focus group with members of nearby villages; and third, observational data from visits and work at OPC. The extremely sensitive nature of the topic constrained us in our methodology and reporting of our results in this paper: we are careful to balance a use-

ful presentation of information to readers without compromising OPC's security operations or the safety of our participants.

4.4.1 Staff interviews

We conducted semi-structured interviews of staff from several security and security-adjacent departments in OPC to capture their viewpoints and concerns and illustrate some of the tensions between stakeholders. The interview participants were selected by OPC. Topics included community relationships, departmental roles in OPC's security operations, and thoughts and concerns about a potential anti-poaching security hotline. Our eight participants included:

- Two OPC internal security staff (denoted as [Intel 1] and [Intel 2])
- One staff from OPC's wildlife department, which houses the park rangers ([Wildlife dept.]).
- Two staff from the Kenyan Police Reserve (KPR), who are OPC staff deputized as police to make arrests, and work jointly with local police agencies ([KPR 1] and [KPR 2]).
- Three staff from OPC's Community Development Program (CDP), who are heavily involved with local communities but do not work directly on security ([CDP 1], [CDP 2], and [CDP 3]).

Some relevant stakeholders declined to be interviewed because of the topic's sensitivity: for example, we did not receive permission to interview any rangers or staff from the Kenyan Wildlife Service. The research team agreed not to make audio recordings of any of the interviews, instead relying on handwritten and typed notes. All quotes in this chapter are paraphrased from our notes.

Interviews were open-ended, with initial topics informed by the relevant literature. A majority of staff participants were interviewed multiple times for this study, discussing the viewpoints of other staff which arose in earlier rounds. OPC staff were sent a copy of this manuscript prior to publication to ensure accuracy and make redactions.

4.4.2 Community focus group

We also conducted a focus group discussion with 10 community members from 5 villages on OPC's borders (denoted in this manuscript as [Community FGD]). The interview topics covered participants' views on poaching and security, their experiences of OPC's security roles, their desires and concerns surrounding a potential security hotline, and comparing different technical implementation options.

Participants were selected and recruited by staff from OPC's community department (CDP). We invited one representative from 5 different villages, who were trusted by OPC and already had good working relationships. We also sought to include participants in our sample who had less connections to OPC and would have less knowledge about how to reach them for security issues, so we instructed these 5 representatives to each bring one additional person who had minimal prior interaction with OPC. Our sample therefore had a bias towards community members who have positive relationships with OPC, as OPC staff hesitated discuss sensitive security issues in communities were the relationships were more tenuous. We speculate that these community members with good relationships are the ones most likely to utilize an OPC security hotline so our sample roughly corresponds to our targeted user group; however, we did not capture how security concerns might be different for OPC in community segments where they are perceived less favorably.

We selected the initial 5 community representatives aiming for diversity in age and gender; the group's final composition had 4 women and 6 men, 5 youth (under 40) and 5 elders. Each participant was compensated ksh 1,000 Kenyan shillings for their time, and provided lunch, tea, and snacks. (This corresponds to roughly $10 USD. For reference, a day's labor in this region typically earns about ksh 500.) We conducted the session in a mix of English, Kiswahili and Kikuyu; all participants could speak some of each of the languages. The focus group discussion was facilitated two OPC staff who spoke all 3 languages, and attended by the first author who does not speak Kiswahili or Kikuyu.

To provide confidentiality for the participants, a driver collected the participants from their

Figure 4.3: The community focus group was held in this hangar at a secluded location inside the conservancy to protect participants' privacy and confidentiality.

villages and brought them to a secluded location inside the conservancy for the focus group session (Fig 4.3). At the beginning of the session we discussed the risks of participating in the sensitive conversation about security: we informed participants that their comments during the session would be included anonymously in a public report, told them that they could ask for a comment to be redacted or leave the session at any time while still receiving compensation, and emphasized that we were only discussing the design of a potential security reporting system and that they were not to reveal anything incriminating during the session. All participants agreed not to discuss the session with other people. We agreed not to make any audio recording of the session, and relied on handwritten notes. All quotes in this chapter are paraphrased from notes. In reporting the results, we use "he" and "she" pronouns interchangeably so not to reveal the participants' genders who made a certain remark.

4.4.3 Observational data

We triangulate our findings from our interviews and focus group with observational data. The first author spent 5 months at Ol Pejeta Conservancy's main offices and operations center on various related research projects; and a 3-week trip was dedicated specifically to this project exploring an anti-poaching hotline. We kept notes about the operational and community occurrences around the conservancy each day, and gained context through frequent meetings and casual conversations with conservancy staff. Additionally, OPC staff have contributed to this manuscript and reviewed it to ensure its consistency with their long-term experiences working at OPC.

4.5 Results: Threats, Responses, and Infrastructure

Our qualitative investigation brought forth many tensions and contradictions among the desires and concerns of the different stakeholders. We organize this section by topic, discussing the agreements and disagreements among stakeholders for each issue in this complex ecosystem.

4.5.1 Threat models

The security ecosystem around Ol Pejeta is organized in response to three very different threats: (1) rhino and elephant poaching conducted by international syndicates; (2) local environmental crimes like bushmeat, firewood cutting, and illegal grazing; and (3) crimes experienced by people in the surrounding communities like livestock theft, home break-ins, and harassment. This section characterizes these security threats as a starting point to describe OPC's security ecosystem and consider how a hypothetical anti-poaching hotline could be woven in.

Rhino and elephant poaching

OPC is a refuge to the last two Northern White Rhinoceroses on the planet, 150 critically endangered black rhinos, and 39 near-threatened southern white rhinos; they additionally provide habitat for a migratory population of Savannah Elephants, often hosting over 300 at a time [88, 89]. These animals face acute poaching threats for their horns and ivory tusks which are trafficked out

of the country and sold internationally. At the time of writing OPC has not had a rhino poaching incident since 2018, and has never had an elephant poaching incident. They credit these successes to their well-coordinated security and intelligence operations [Intel 1] [KPR 2] [CDP 2], and to major increases in legal penalties for poachers that Kenya enacted in the past 2 years [Intel 1] [KPR 2].

Rhino and elephant poaching is conducted by distant international syndicates with only minimal involvement from the nearby communities—OPC has not directly linked a rhino poaching case to a local community member since 2010 [Intel 1]. The past decades' improvements in security operations require these poaching operations to be increasingly expensive and sophisticated: *"Criminals are getting more advanced. They're using secure communications on smartphones, and dart guns that are quiet and hard to detect. Poaching is not done by the poor; they don't have access to these things"* [Intel 1]. Consequentially, the local communities know very little information about rhino or elephant poachers.

Modern poaching is usually an inside job: syndicates conduct counter-intelligence against wildlife conservancies and security agencies, and they recruit moles to help them locate animals and evade detection. The actors in horn and tusk poaching are loosely related, often not knowing each others' identities, and are coordinated from afar via mobile phones and clandestine meetings:

> *"Nearly all poachers come from far away. They always need an insider—inside the conservancy—who tells them what is going on and then lies low during the poaching event. They'll take on different roles: like one person is the sniper, one person is the driver, one person is the facilitator who gets the weapon, etc. It goes through chains; one person will give the tusk to someone else and doesn't know what happens afterward; that person gives it to another person and doesn't know what happens afterward, and so on. The operations are slow to organize, usually taking a couple months"* [Intel 1][1].

Poaching rates in Kenya have substantially decreased over the past decade (though they have

[1] In this case it is ambiguous whether the source was speaking from experience or repeating what they had heard; we could not ask about their specific experiences on investigations.

increased elsewhere in Africa [319]), but our sources stressed that poaching was unpredictable and worried that poaching could potentially increase due to increasing population pressures around the conservancy [KPR 2], worsening economic conditions following the COVID-19 pandemic [Intel 1], political unrest during the coming elections [Intel 1], and increasing sophistication of poaching organizations [KPR 2] [Intel 1].

Bushmeat, firewood, and illegal grazing

Though OPC's surrounding communities are not involved in rhino or elephant poaching, OPC's security infrastructure has responded to a number of other environmental issues that involve local communities. These issues include hunting and trapping for bushmeat, and illegal tree-cutting for firewood and charcoal production.

Bushmeat. Staff reported that the area surrounding Ol Pejeta saw a rise in hunting and trapping for bushmeat during the COVID-19 pandemic, a problem that had *"diminished completely"* in the years prior [Intel 1]. This corresponded with the widespread increase in bushmeat trade across Kenya during the economic downturn: the loss of income drove more people to trap [80, 245]. The meat is sold to butchers and then distributed: *"The consumer, going to the butcher, doesn't know what kind of meat it is. People buy it because it's cheap."* [Intel 1].

Trapping and hunting at OPC happens outside the conservancy's fenced perimeter as migratory populations move in and out. Many of the species targeted for bushmeat—namely zebra and bovids—face considerable conservation threats and are legally protected by the government.

Staff reported that OPC has firmly dealt with prior incidences of bushmeat poaching near their fence. However because the prevalence has increased during the COVID-19 pandemic, staff reported that OPC is working to develop a more coordinated strategy to respond, develop new intelligence sources, and collect more data. Staff felt that few community members had information on bushmeat poaching: *"Snares are an individual thing, not a community thing. We haven't gotten many tips on snares; people don't know who is doing it"* [Intel 1].

Firewood cutting and charcoal burning. Most households in OPC's surrounding communities cook their food primarily over wood-burning stoves. The increasing population pressure over decades has led to a major scarcity of cooking fuel and chronic competition for firewood. This problem is widespread around the world: over one third of the world's population depends on wood as cooking fuel [163].

Competition for firewood has driven habitat loss for wildlife, and the firewood shortages have led to conflict over illegal firewood cutting on private lands. OPC is responding to the firewood shortage with a large program to provide more fuel-efficient cookstoves in nearby communities; 417 such stoves were built in 2021 [89].

Additionally, there is an illegal charcoal industry in areas around OPC, (though not directly within OPC's communities), selling mainly to urban markets. This has resulted in major deforestation in some areas, perpetuating desertification and climate impacts [252]. Charcoal is made by burning wood in a low-oxygen container, and accidental mismanagement of charcoal burn pits has also resulted in major wildfires during dry seasons. The government has made various attempts to regulate charcoal production and enacted periodic bans, but illegal production has frequently continued nonetheless [308, 255].

Crime in communities

Ol Pejeta's security infrastructure is also shaped by crimes affecting local community members; as OPC regularly sends its tracking dogs to assist in police investigations. Many people reach out to OPC before contacting local police because they see OPC as reliable and authoritative, and many have personal relationships with staff hired from their communities [CDP 1]. As shown in section 4.6.5, these security interactions are important for forming relationships with potential sources.

The main crime issues facing communities, as reported by our focus group, are livestock theft, crop theft (particularly maize and nuts), house and business break-ins, harassment, and illegal grazing on their land at night while they slept. Participants emphasized that crime was very common, especially livestock theft: *"Chicken theft is big! Rampant! It's normal these days. Peo-*

ple steal your chickens even when you're in your backyard!" OPC has also sent tracker dogs to communities to respond to severe violent crimes, including rape [CDP 2].

4.5.2 Conservancy security infrastructure

Here we outline some of the institutions within OPC that have important roles in security. Each of these organizations work in cooperation with the others, but they are intentionally siloed and highly selective of the information they share as a defense against counterintelligence operations.

Intelligence operations

OPC has its own in-house intelligence operations, whose members aggregate information from many sources to conduct investigations. Because they conduct investigations within the conservancy, their operations are highly secretive and information is tightly controlled, even among conservancy staff. They work in cohort with other organizations like government intelligence agencies and neighboring conservancies.

Of this group, some identities of the members are publicly known; these "overt" officers act as the public face of the conservancy's security forces and a point-of-contact for staff and community members: *"Overts have uniforms, and their phone numbers are known out in the open"* [Intel 1]. Others are covert—other staff in the conservancy don't know about their work in intelligence, and they conduct undercover investigations both inside the conservancy and out.

Investigations involve piecing together information from many different heterogeneous sources, using a suite of special tools and methodologies. Several participants of this study spoke of an *"arms race"* against the increasingly-sophisticated syndicates who are involved in poaching: *"It's an arms race; we need to keep getting better technology. Like drones, CCTV, and more manpower"* [KPR 2].

Rangers

OPC has a staff of several hundred rangers, under supervision of the wildlife department. The rangers are primarily tasked with patrolling and monitoring everything that happens inside the conservancy's perimeter. They play a dual role in wildlife monitoring and security: for example, rangers are tasked with confirming a visual sighting of all 150 individual black rhinos each day, and report their observations of wildlife behaviors like predation events. They also closely monitor the movement of vehicles and people around the conservancy's road system, listen for gunshots, and watch for evidence of intrusions.

Ol Pejeta's wildlife department and rangers are kept in a separate information silo from the intelligence team: rangers report information up the chain to security officers, but the rangers are usually not given details of the investigations [Wildlife dept.][Intel 1]. One participant described:

> *"The rangers play a support role in security. It is not core; it is sort of secondary. If a ranger picks up something of concern, they handle it to a certain point and then hand it over, similar to having a different jurisdiction. For example, rangers patrol different areas. If there is a threat, they'll find it and follow it. They can respond to the threat, but they should not be required to neutralize it."* [Wildlife dept.].

The rangers' activity is coordinated by a centralized "control room" where their movements, activities, and reports are aggregated into the *EarthRanger* platform [2]; very few individuals have access to this birds-eye-view of all the rangers' activity. Though they're mostly not involved in specific investigations, rangers receive training about poaching and criminal organizations to motivate them and give them context for their work [Intel 1].

The majority of rangers are recruited from OPC's surrounding villages, providing one of the most important links between the conservancy and the communities. Most rangers live in housing within the conservancy's perimeter while on duty, and periodically rotate out every few weeks for extended breaks in their home villages. Their relationships at home and their relationships within the conservancy allow them to be a social bridge to build trust between the two, and

therefore rangers are a vital source of intelligence about the goings-on in the communities. The rangers also respond to human-wildlife conflict instances, providing another point of community contact.

Kenyan Police Reserve

OPC also has a unit of Kenyan Police Reserve (KPR) officers funded by OPC and quartered at a camp inside the conservancy's perimeter. The Kenyan Police Reserve was established in 1948 initially as a volunteer-led force, deputized with the power to enforce laws and make arrests [9]. At Ol Pejeta, KPR forms the "muscle" behind the conservancy's security operation. The leadership of the KPR unit collaborates closely with OPC's intelligence unit and with local police.

The KPR unit at Ol Pejeta has a team of scent-tracking dogs, and they routinely bring them out to the surrounding villages to investigate crimes at the request of community members:

> *"Once we get a request and get the location, we go and start to track. Even if we know who did the crime, we use the dogs to find them for stronger evidence. The dogs can track someone for up to 12 kilometers, and follow a scent for up to 72 hours... When people call us, we just tell them to make sure they secure the scene until we get there."* [KPR 1].

In this capacity they work closely with local police stations: they require citizens to make a police report and get a case number before they bring the tracker dogs, and they receive calls from local police departments to assist with cases.

KPR does not proactively advertise this dog-tracking service, but it is widely known throughout the communities. One KPR interview participant reported that they receive 4-5 calls per day requesting the tracker dogs, about 85% of them for personal security issues like livestock theft. They additionally receive a smaller number of occasional calls about environmental crime like cutting trees and killing animals [KPR 1]. The KPR unit has a triage system for prioritizing the calls, assessing their severity and prioritizing the communities closest to OPC.

Importantly, the provision of tracking-dog services is an important mechanism for KPR to build its own relationships with nearby communities, and it serves as an entry point for building

their network of intelligence sources. (As discussed later in section 4.6.5, the security units in OPC work to build their own network of community relationships, separately from the Community Development Program.)

Community Development Program

OPC created its Community Development Program (CDP) in 2004 to build relationships, address tensions, and work towards a more equitable distribution of conservation's costs and benefits with people living nearby. Initiatives include school technology and infrastructure support, conservation education, school bursaries, community visits to the conservancy, solar installations, rainwater retention, river management, well drilling, cattle extension and breeding, agriculture extension, beekeeping, support of government clinics, mobile health outreach, and fuel-efficient cookstove building. In 2018, OPC spent $600,234 USD on community projects [86]. It engages daily with 18 community representatives and 6 local chiefs, who are the primary liaisons with communities. OPC holds meetings every 1-3 months in each community to receive feedback and plan programming.

CDP has a slogan: *"Our communities are the first line of defense against poaching."* Though CDP does not directly involve itself in security issues by design, they play a role by working to build good relationships with communities that are conducive to OPC's security goals. CDP works to build social capacity by convening regular meetings with community members to discuss issues, liaising with a *community representative* in each village who is elected by the community, attending local government meetings and working with local leaders, and running a suite of revenue-sharing programs to benefit the communities.

Notably, CDP runs environmental education programs including school visits, and free bus tours of the conservancy for schools and local community groups. These programs work to educate communities about the local wildlife, poaching threats, and their role in conservation as community members.

4.5.3 Current conservancy–community security interactions

The communities surrounding OPC have a variety of different security-related interactions with the conservancy. As each of OPC's different security units have their own preferred means of community interactions, so too do the heterogeneous members of OPC's communities have their own ways that they prefer to interact with OPC. This section outlines some of these interactions as they exist now, to provide context that will help us reason about the ways an anti-poaching security hotline could reshape them.

Security informants

The intelligence team at OPC collects information through a network of trusted informers who they call "sources," inside and outside the conservancy. This network of sources operates in secret—many sources do not know each other's identities; conservancy staff do not know details about the intelligence operations and many don't even know of their existence. We cannot reveal much information about them in this paper, to protect their operations and identities.

The network of sources operates in chains: many of the sources have their own sub-sources in turn; sometimes information travels up and down chains of multiple people who do not all know each other's identities. In an investigation, intelligence officers triangulate information through multiple, separate branches of this network. Sometimes sources take actions in investigations other than passively acquiring information and sending it up the chain: for example, sometimes a source will be asked to meet a certain person or ask certain questions.

The network of sources has been built slowly over decades, through trusted personal relationships. OPC holds training sessions for sources about how to protect their personal safety and communicate securely.

General public

OPC additionally has security-related community interactions through a variety of formal and informal channels. Some are related to environmental crime, but many are also for personal

security issues like break-ins—the types of problems that are ostensibly to be handled by local police. OPC staff reported occasionally receiving calls when local people hear gunshots or see suspicious people [CDP 1][CDP 2]; and some community members in our focus group reported contacting OPC staff about snares set for zebras and illegal firewood cutting, for example. All interviewed CDP staff reported that they had never received poaching-related reports from any community member.

The community has a heterogeneous patchwork of channels to engage OPC for security issues. Many different phone numbers circulate around, obtained through interactions with CDP staff, KPR, or rangers. In our 10-person community focus group, for example, 6 people reported that they would go through their area's community representative[2], 4 said that they would speak to a CDP staff member, 3 said they could go through a wildlife staff, 2 people knew the official number for OPC's radio room, and 1 mentioned the SMS hotline. (Notably, our focus group sample is much better connected to OPC than the general public.)

OPC leadership has long wrestled with communication problems from having too many communication channels and the inconsistencies that follow: *"There are already too many numbers going around!"* [Intel 2]. In one attempt to address this problem, the conservancy has circulated a number for the *"radio room"* around the community, which is then triaged to the right department. However, most community members do not have this number, and prefer to reach out to somebody they know directly. OPC similarly introduced another number as an SMS hotline for the surrounding communities in 2018, which has many of the same problems and limited uptake [373].

Importantly, Ol Pejeta has hired a large portion of it's 850-person staff from the surrounding area, and many community members utilize their neighbors, friends, and relatives working there as their main source of contact with OPC. The staff's deep relationships with the community are an important source of intelligence information: *"It's easy to get reports from the community because our staff are from there."* [KPR 2].

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[2]The community representatives are not OPC staff, but local community members elected in a meeting each year. Our sample was biased such that every participant was a community representative or was recruited by one

Conservation education. OPC's Community Development Project team runs conservation education programming in the nearby communities to spread awareness about the conservancy's work, build local support for conservation, and show local people the roles they can play in their communities [CDP 2]. CDP staff travel to schools and community groups to give presentations about the conservancy, and groups from the nearby villages are given free guided bus tours of Ol Pejeta.

Security personnel had mixed perceptions about the impact of OPC's conservation education programs on security. For example, one reported that there was no benefit: *"Totally nothing. Nothing is reported because of that"* [Intel 1]; but another was confident that it had led to security improvements: *"Yes, conservation education has made an impact. It's helped communities know the importance of conservation, and they know they'll be taken care of by conservation work. It has reduced poaching: seeing the 5-year trend, poaching has gone down"* [KPR 2].

4.6 Results: Hotline Design, Tensions, and Trade-offs

In probing the security needs and concerns of OPC's surrounding communities and its multitude of departments, we found a web of tensions and paradoxes. This section outlines these various tensions and their implications for designing a potential anti-poaching hotline.

4.6.1 Security motivations: tensions and alignments

As different departments in the conservancy have different security goals and concerns, so too do different groups of communities. Understanding the overlaps and tensions the stakeholders' motivations is essential for reasoning about a hypothetical security hotline. While OPC makes a considerable effort towards the community's security needs, there still remains a fundamental tension because OPC is primarily focused on protecting wildlife.

Tensions: community concerns and image management

All participants of our staff interviews and community FGD agreed that the nearby communities had a widespread awareness of OPC's anti-poaching security operations: *"People know. Why do*

we have a fence? Why do we have all the security people?" [Intel 1]. In our focus group, community members were able to list many wildlife- and business-related roles of OPC's security teams: to protect wildlife from poaching, to keep animals inside, repair the fence, and protect the guests. Most participants of the focus group knew about OPC's famed rhino conservation efforts: *"If we see rangers outside, we ask if the rhinos have been hit."* [Community FGD].

Staff of OPC's community development project are acutely worried about the community's perceptions of security: whether OPC's security staff are seen as too heavy-handed or unfair. In OPC's 2019 SAPA survey representing all 18 communities on its border, 35% of respondents agreed[3] that OPC had a rough approach to security. The highest-ranked negative impact of OPC—agreed by 79% of surveyed community members—was that OPC responded more quickly to poaching than human-wildlife conflict; the report stating that *"this statements reflects a widespread sentiment that OPC, through visible and costly responses to poaching, prioritizes the needs of wildlife over the needs of local people"* [182]. In our study's community FGD, one participant reported that there used to be a problem of *"harassment by Ol Pejeta's scaries [security guards]"*. The group asserted that this harassment no longer occurred and that they had no other problems with OPC's security (this answer, though, was probably biased by our sample selection and presence of OPC staff at the focus group).

OPC staff—particularly those from the community development project—worry about security initiatives that could increase the burden felt by communities [CDP 1][Wildlife dept.]. Some worried that advertising an anti-poaching hotline could damage the conservancy's reputation by reinforcing the perception that OPC prioritizes animal security over the communities' well-being; and they urged that communications about the hotline be handled delicately [CDP 1].

[3] The report notes that this number is higher in some communities where government agents actively enforce against water violations and livestock theft, and that community members may be conflating these other officials with OPC.

Alignments: shared goals and motivation for hotline reports

In spite of the tensions and complications, community members do have some important security goals in common with Ol Pejeta, and our interactions with staff and community members suggest that many local people would be motivated to utilize a security hotline. In this subsection we show how some local community members do see OPC as partners in creating security for themselves and their communities, and how some are motivated by their own environmental ethics to work with OPC.

Some community members view Ol Pejeta as a resource for security in their communities, because OPC's security efforts are highly visible, and many people have had security-related interactions in the past [Community FGD][KPR 1][Intel 1]. In the focus group, participants named a number of ways that OPC contributed to security in their communities: many knew about OPC's work with scent-tracking dogs in response to community crimes. One participant reported that 20 years ago before there was a fence, criminals would steal things and hide in the conservancy but now OPC keeps criminals out and this no longer happens. In the past cattle rustlers would cross the conservancy land to steal cows in the night, but the fence now prevents this: one participant even said OPC *"creates a sense of security so now we can sleep at night"* [Community FGD].

Some number of community members support the OPC conservation mission and are genuinely motivated by wanting to protect the wildlife: *"new generations will not get to know about these animals"* [Community FGD]. Among Ol Pejeta's staff, there are mixed opinions about how much the communities know about conservation and poaching; some believing through their interactions that communities had widespread awareness [Intel 1] [KPR 2] but others felt that communities need more sensitization: *"when new leaders come in, we need to first explain to them the meaning of this word 'poaching' "* [CDP 1].

In a similar vein, some support the conservancy's anti-poaching efforts because they believe their community benefits from OPC's presence. Focus group participants expressed some such concerns: that poaching would reduce the number of people coming to see the animals, divert tourists to other conservancies, thus reducing community development projects and limiting em-

ployment opportunities in the area.

Community members enthusiastically agreed that they would want to report poachers to OPC because they believed that poachers were the same people committing other crimes in their villages—their strong enthusiasm about this point suggests that this could be one of the most important motivations. One said: *"Poaching negatively affects security because poachers are also criminals; because the same people who are poachers are likely to be stealing."* Though this belief could be one of the strongest contributing factors towards a hotline's success, it raises important questions about unfair profiling and potential abuses.

Importantly, in this study we cannot quantify how many members of the local community would be motivated to utilize a security hotline and cooperate with OPC—our focus group was not representative of all of the views in the surrounding villages because of our biased sample and participant response bias. Staff who we interviewed noted mixed attitudes in the community: *"a lot of people wouldn't report because they have grievances with the conservancy. We can't please everybody"* [Intel 1]. Some community members likely have sympathy for poachers, though none of our focus group participants admitted so. Importantly though, not all community members need to use a security hotline for it to be successful, but there is a risk that this effort would lead to further marginalization or oppression of groups who don't trust OPC, who already tend to be more marginalized.

Rewards

OPC has occasionally given monetary rewards to informants, but security staff were strongly opposed to advertising these rewards. They worried that advertised rewards would lead to a high volume of bogus reports, noting that *"people will always ask about rewards anyway"* [Intel 1]. They emphasized that they only give out rewards when they get useful information that builds a solid case and an arrest has been made, emphasizing *"Don't talk publicly about rewards. Rewards are for good sources"* [Intel 1].

4.6.2 Useful information and noise

Many staff raised a concern that the general public would not have enough useful information to warrant the risks and costs of advertising an anti-poaching hotline [Intel 1][KPR 2][CDP 1][CDP 2] and some worried that they could be overwhelmed with too many reports that would not be useful [Intel 1][Intel 2][CDP 1]. They shared the belief that local people were not privy to the dealings of the criminal syndicates behind rhino and elephant poaching:

> "Ninety-nine percent of people in the communities don't know anything about poaching; they don't actually have any useful information. I don't actually really expect to get anything useful from a hotline" [Intel 1].

Types of useful information

Several staff agreed that it was useful to receive reports when new or suspicious people showed up in the villages around the conservancy, since poachers tend to cross the fence through the villages instead of the conservancy's front gate [Intel 1] [KPR 2]. They had trained a network of informers to report these instances, and indicated that they preferred to rely on their trained, trusted informants for this information instead of sourcing it from the broader community: *"We ask them to report how many people there are; their character, how they are behaving; their body structure, tall or short, their clothes; what they are carrying; whether they are socializing with other people in the community or keeping to themselves; what vehicle they are driving"* [Intel 1].

Notably, some security staff speculated that a hotline could be more useful to address the relatively new problem of snares and bushmeat, which involves more local people [Intel 2] [Intel 1][CDP 1][CDP 2]. There was disagreement on how much information a hotline could yield, and to what extent other community members knew who the bushmeat trappers were, or how much was done openly or in secret. Staff also reported that they occasionally receive calls to their personal phones about some miscellaneous security issues like people approaching the fence [Intel 2], fence breakages [Intel 2], or intentional blockages of rivers [Intel 2].

Quantity versus quality of information

Staff held differing opinions on whether OPC could be overwhelmed by excessive hotline calls. Many worried that a hotline could lead to fraudulent complaints against personal enemies, or many calls that are otherwise useless [Intel 1][Intel 2][CDP 2]. One noted that OPC already has triage systems in place for tracker dog requests and the radio room numbers, and a triage system could be developed for hotline tips: *"we would not be overwhelmed by more volume"* [KPR 1].

Others disagreed, explaining that diligent investigations move slowly and capacity was limited:

> *"When you have a lead, you need to slowly piece together information from many sources: where someone lives, what cars they drive. You talk to ten people and don't get any information; and then someone will tell you there is someone called James but they don't know the last name. So then you ask for characteristics, is he short or tall and such. But still, there are a lot of James in a village. So then later you maybe hear from someone else that there is a guy named James Mwangi... Then it takes months to follow someone and learn who they really are"* [Intel 1].

Because so many resources were needed for an investigation, for this reason they preferred to go through their trusted sources than rely on unreliable tips from a hotline [Intel 1].

Responsiveness

Staff and community members agreed that OPC had a duty to respond to hotline tips in a timely and appropriate manner, and that community members would stop using the hotline if responses were inadequate [CDP 1][CDP 3][Community FGD]. One community participant said that they don't usually call the police because of the lack of response: *"mostly we don't report theft cases, because even if we report nothing will happen. They will be apprehended and then released. It's useless to report."* Another noted: *"we know who the thieves are, but we can't make a report without evidence"* [Community FGD].

Some staff worried that OPC lacked the capacity to provide adequate responses to all of the community's needs, potentially causing a rift if security services were advertised: *"The system could easily collapse if we start saying chicken theft is trivial, and we will lose people's trust"* [Wildlife dept.]. Some staff were even hesitant to allow us to conduct the community focus group for fear of setting expectations that the conservancy couldn't meet and damaging relationships more broadly: *"we must careful going around to ask communities more questions about their needs, because we can't react to all of their needs"* [CDP 1].

4.6.3 Anonymity, confidentiality, retaliation, and fears

People in the local communities are afraid to make reports when they know about environmental crime. There was strong agreement by all participants of our community focus group and staff interviews. Many people spoke of *victimization*: retaliation, harassment, and punishment if their identities were found out by the wrong people. One said:

> *"We have people in communities who know that there are poachers and snares. Maybe people will sometimes report that they saw a snare, but they won't report who set it there. They are afraid of victimization"* [Community FGD].

Confidentiality. Conservancy staff, especially those in intelligence and KPR, repeatedly emphasized the importance of keeping information secret and informants' identities confidential. Community participants also emphasized that this was critical for people making hotline reports: *"the person taking the hotline calls should be well trained and respect privacy… they should be a person with integrity"* [Community FGD]. However important, it is difficult to control information in such a large organization. For example, one community member spoke of a time his confidence was breached, when information was passed to rangers:

> *"Years ago I reported some people cutting firewood. But then the rangers they sent were friends with the people cutting, and I got into some trouble"* [Community FGD].

Focus group participants said that they needed to trust that the person answering the hotline be *"someone with integrity,"* well-trained, and respecting privacy; and they needed to be assured that OPC would conduct diligent professional investigations not to persecute someone from false reports. We note that achieving public confidence about the hotline might be difficult since few people will have direct experience with it.

Anonymity. Community members in our study strongly agreed that they wanted an anonymous, untraceable way to make reports without ever revealing their identity. They saw anonymity as a way to protect themselves from unintentional leaks, but also some were afraid of being summoned to testify if they revealed their identities [Community FGD]. One staff suggested that people are worried about incriminating themselves: *"If people see something, they want to keep quiet; don't want anything to do with it. People are afraid we'll wonder how they knew about it"* [Intel 1]. Community members were familiar with an analogous anonymous crime-reporting hotline run by the Kenyan national government with advertisements stating *"our officers will not ask your name"* [102, 346][Community FGD].

However, OPC's security staff were very hesitant to allow anonymous reporting because they worried about misdirection and counterintelligence against them by poachers:

> *"This is a difference between [regular] police and conservation. It's important to know the individuals [who are making the reports]. Not everyone likes conservation, and poachers will call you for their own benefit. They have to find their own intelligence through our teams. They will confuse you; and call you to report any incident. They'll tell you there's an incident on the east side, and then poach on the north side. Or they'll go short the [electric] fence somewhere, and then go in somewhere else"* [KPR 2].

Notably, one community representative suggested that a well-publicized hotline could protect him in another way: by providing cover. He told a story of a time he had made a report of snares to catch animals and people came to victimize him, assuming he were the one who made the report because of his association with the conservancy. He remarked: *"if there was a hotline that*

everybody knew about, then the report could have come from anyone."

Even an anonymous or confidential reporting hotline would not protect participants from every risk when making a report. One community member commented on the need for investigations to be discreet: *"Even if you don't say my name, everybody will know it was me if you still come and park Land Cruisers in front of my house"* [Community FGD]. Another participant commented that it was hard to hide their identities from criminals, even if their report is confidential: *"If there is a secret hotline and you see something, and the criminals see that you saw them, then they still know who you are"* [Community FGD].

4.6.4 Silos, information control, and hotline placement

OPC has set up an intentional separation and siloization between its departments pertaining to security matters: the small intelligence team conducting investigations, wildlife rangers monitoring the protected area, and the Kenyan Police Reserve who participate in investigations and enforcement. These silos create challenges for coordination between the departments, necessitate some redundant efforts, and raises questions about where a community-facing anti-poaching hotline would integrate within these disjointed systems while appropriately controlling information access and coordinating responses.

Strategic separation

This siloization was built into the system to create checks and balances on the different actors, in response to the fact that modern rhino and elephant poaching always involves someone on the inside:

> *"The structuring came [to avoid] collusion—in the past there were a lot of poaching and security issues. The different departments were set up to cross-check vulnerabilities in each other. The police within the police; the system's way of checking itself"* [Wildlife dept.].

Security units also tightly control who has access to information within its ranks, and this is

crucially important for conducting complex investigations as well as thwarting counterintelligence: *"when information lands into so many hands it becomes harder to deal with—it increases the chances of losing a meaningful trail"* [Wildlife dept.]. Information percolates across management, depending on its sensitivity and each person's level of clearance [Intel 1] [Wildlife dept.]. Each decision about information access among the organizations receives deliberation: *"you have to be extremely careful about what information you reveal to each partner"* [Intel 1]. Other departments within OPC, such as the Community Development Project, lack these control mechanisms and therefore are kept out of investigations:

> *"We have to keep secrets so it's not good to be involved with other departments. We are very good at keeping secrets; people in CDP are not good at keeping secrets."* [KPR 2].

When other departments learn of information relevant to security, they pass it up the chain to security units in a largely one-way interaction:

> *"The only time I have ever gotten any tips from communities is that occasionally people will call me to say they have heard gunshots. I call [a security staff] to give him the information, and all he ever tells me in return is: 'We are aware. Thank you.' "* [CDP 1]

Hotline placement

Within these tightly-controlled silos, there was disagreement among staff about where a potential security hotline should be housed, who should have access to the information, who should be the public face of such a hotline, and whose relationships it should leverage.

For example, a KPR officer asserted *"We want people to go through us and not CDP. They have our numbers, and they have the radio room number"* [KPR 1]. However, another officer argued: *"It could be a good idea to spread the message that people can make reports without getting blamed, and tell people there's a number they can call. But it should be a CDP number. We need to keep CDP and security separate"* [Intel 1].

Information routing

Information from a security hotline would need to reach the right people within OPC's security infrastructure, but also needs to be kept very confidential to protect informants and minimize the number of hands which the information passes through. This creates a significant challenge in advertising the hotline, teaching communities to discriminate between different secure and non-secure communication channels and use each for the correct purposes.

For instance, if community members are supposed call a special number for security but another number to reach OPC for general purposes, this is difficult to communicate to the communities and people are likely to confuse the two and potentially mis-route information. Sensitive information may be sent through insecure channels, and conversely the secure channels can be inundated with unnecessary calls about other topics. At present, OPC staff get frequent calls about topics other than their own jobs [CDP 1][CDP 2]; i.e. security staff get frequent calls about wildlife issues [KPR 1]. One staff remarked:

> *"If you widely circulate around a security number, people will use it for all kinds of useless things. People will make jokes, it can overwhelm security staff. You will never sleep. When [the community department] did the 2-way SMS hotline, most of the messages were asking about jobs. There are already too many numbers going around."* [Intel 2]

Further illustrating this problem, one community group participant excitedly suggested that the hotline could be used for other issues apart from security. This problem is compounded by community members' different understandings of "security" that don't fit OPC's departmental structure; e.g. many community members repeatedly brought up human-wildlife conflict as a security issue which is handled by a separate department at OPC.

Additional complications would arise if the security hotline is anonymous, making it hard to follow up on calls that are mistakenly placed there:

> *"If the line is anonymous, people will use it for all kinds of things other than confidential information. It will be hard to communicate which line is anonymous and which is not.*

> *People will call it to report problems with elephants, but then you won't be able to call them back. I want to know the number of the person who is calling me."* [Intel 2]

We discussed some potential solutions to the routing problem with staff participants. One suggested that posters could be distributed in communities listing all the different numbers [Intel 2]. A community-facing smartphone app could include an interface that guides users to the correct communication channel, and mobile apps' ability to issue updates could accommodate future changes and mitigate the problem of too many old and retired phone numbers circulating in the community. Hotline numbers could play a recorded message to callers explaining which other numbers they can use. A triage system could be implemented for incoming calls—the conservancy's existing "radio room" number already functions as a triage system for routing calls to the correct department; however it reasons that if a system is used too broadly in the conservancy for too many purposes, it will be hard to control access.

One staff noted that the conservancy is likely to always have a large variety of communication channels with the communities, and it will not be possible to replace all of them by launching a new system:

> *"There will be people who continue communicating with us in traditional ways. There are people who are habitually inclined to call [individual CDP staff]; the relationships already exist. The number of people communicating with us keeps on growing through day-to-day interactions. We will have people who will continue communicating with the radio room; people will have their own way"* [CDP 3].

4.6.5 Relationship building amid secrecy and isolation

Building relationships is critical for security and intelligence at every level of the network; sources will only work with people and institutions that they trust. However, their circumstances are different than other community-facing relationship building efforts at the conservancy, and OPC has developed parallel mechanisms for security-related outreach.

Security departments keep relationships separate for several reasons: to tightly control confidential information, protect their network of informants, but also to keep their relationships from being compromised by politics. OPC's community development department is also highly invested in developing community relationships, highly visible and involved with local politics and public relations: CDP staff regularly attend government meetings, meet local leaders, hold open community meetings to discuss issues, and travel to communities for conflict resolution and damage control whenever issues arise. OPC's leadership and intelligence staff fear that this involvement in local politics could spook potential sources [Intel 1]; for example, one might fear for their safety if they had given information on someone associated with a local leader. Conversely community staff worry about their own liabilities mishandling sensitive information, or damaging relationships with communities via their involvement in contentious security issues [CDP 1][Wildlife dept.]. In addition, security staff expressed concerns about the faster churn of staff and participants through OPC's community-facing work and other departments, noting that intelligence work required more long-term personnel and stability and that frequent personnel changes made it hard to keep secrets [Intel 1][KPR 2].

Additionally, one participant noted that the security departments need to engage different community demographics than other branches of the conservancy: *"To build trust, you have to start with the seniors and then it will flow down. But most of the people engaged in crime are youths—not the elders—however CDP is mostly working with elders. The poaching is not done by some 70-year-old man"* [Intel 2].

OPC's builds its network of intelligence sources primarily through personal relationships of its staff, and sources reach sub-sources through their own personal networks. The process moves very slowly: *"First you do favors for each other; [like] ask them to be your driver. Then they will slowly start opening up."* [Intel 1]. One noted that it takes time takes time to overcome people's hesitancy to cooperate with security personnel: *"everybody thinks they are a suspect"* [Intel 2]. At the other end of the chain, sources approach people close to a person of interest to conduct investigations since *"poachers won't work with anybody they don't know."* [Intel 1].

OPC's security departments also make concerted efforts to make inroads into the nearby com-

munities, separately from other departments of the conservancy. The security services provided in communities—namely provision of tracking dogs and handling human-wildlife conflict—is sometimes a first point of contact for beginning new relationships. Certain uniformed staff are well known to the public through this work: *"People in every community have my number. It's no problem at all"* [KPR 2].

4.7 Results: Technology and Implementation Trade-offs

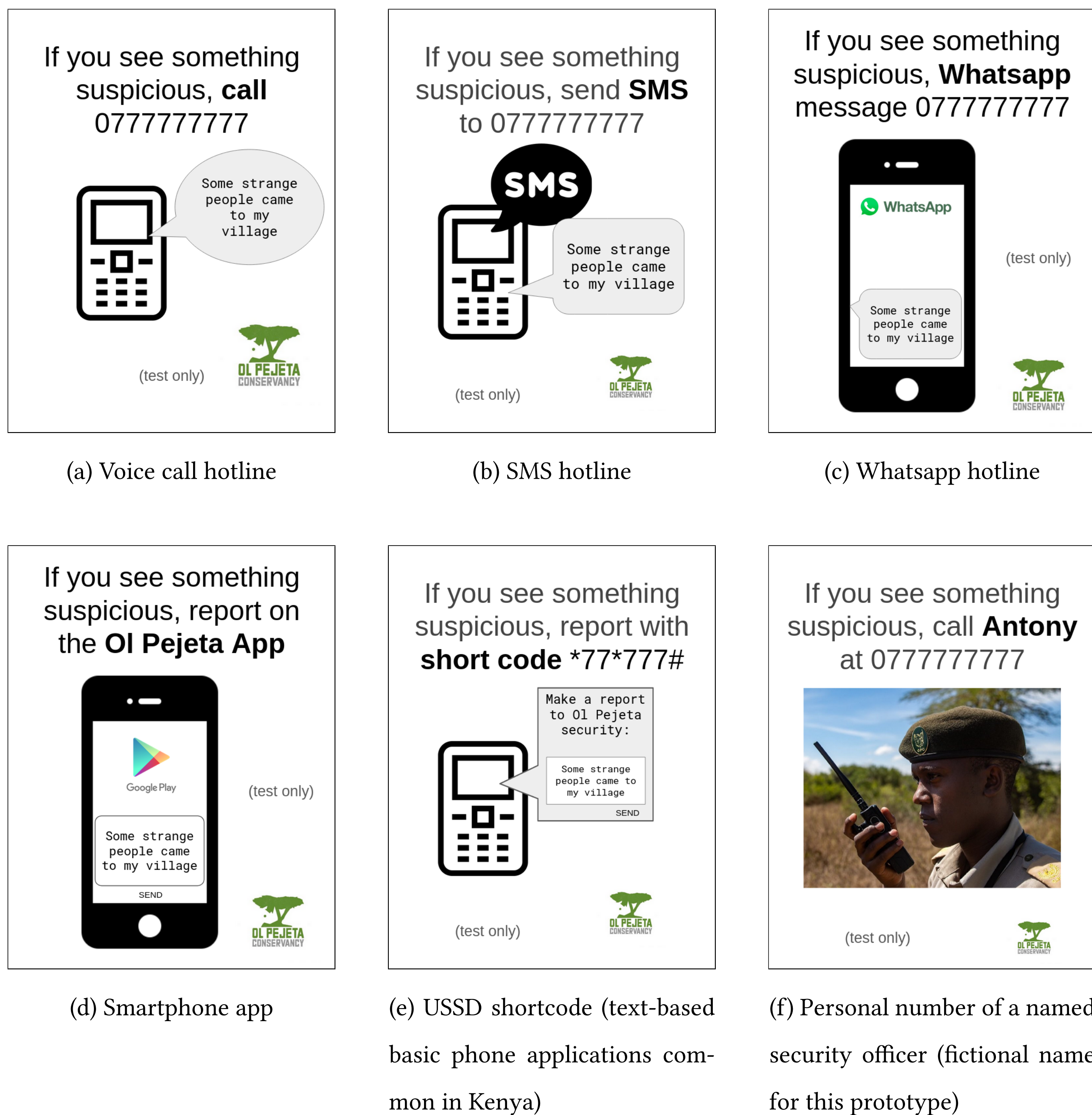
Here we compare the variety of technologies that could be used to implement an anti-poaching hotline, (Fig. 4.4); considering their security affordances, their convenience and accessibility to community members, and the community's perceptions of each one. We chose several potential technological routes to consider, based on what technologies were commonly in-use in the communities around Ol Pejeta: SMS, voice calls, USSD[4], WhatsApp, or a mobile app. Apart from advertising a "hotline," we also consider the option of advertising the phone number of a publicly-known security officer which is perhaps a more-systematic version of the current status quo.

4.7.1 Availability and Access

Members of the communities surrounding OPC have varying levels of access to technology, and the technologies chosen to implement a security hotline will affect its uptake. The surrounding regions vary in network connectivity, smartphone ownership, electricity access, literacy, and cultural norms around technology usage. Technology access also varies considerably among the people within each community, particularly stratified along age, gender, ethnicity, and social status.

Our community focus group was conducted with communities that were closer to an urban center, and known to have to have greater technology access than communities on the far side of

[4]USSD is a protocol for simple, text-based applications that is built into the GSM protocol and therefore works on every mobile phone. Users dial a phone number to open the application, and then navigate through a series of menus screens by pressing numbers on the keypad, or can be prompted to enter textual input [272]. USSD is widely used in Kenya for applications like mobile banking, phone balance management, and sports betting; and most people are familiar with it.



(a) Voice call hotline

(b) SMS hotline

(c) Whatsapp hotline

(d) Smartphone app

(e) USSD shortcode (text-based basic phone applications common in Kenya)

(f) Personal number of a named security officer (fictional name for this prototype)

Figure 4.4: Prototype hotline posters presented to the community focus group as prompts to discuss their thoughts, preferences, and concerns about different technology implementation options. Both English and Kiswahili versions were provided. When asked which method they preferred, most participants agreed that they preferred option (f)—the phone number of a named security officer—the most important reason being that this option would give them the most timely response. Some added that they also wanted the option of using SMS, for situations when they needed to be quiet and discreet.

the conservancy. Participants all agreed that mobile phones were extremely widespread in their areas, and *"nearly all youths"* have a smartphone. Fewer elders had a smartphone, but the group disagreed about how many: guesses ranged between 50%–75%. They reported that their community had seen a big increase in smartphone usage over the past 2-3 years during the COVID-19 pandemic, and had come to rely on smartphones for many more things: for example, virtual church services held over Facebook Live, Zoom, and YouTube had become commonplace. The group participants agreed that smartphone usage was roughly equal between men and women.

Connectivity. Notably, other communities on the conservancy's more-rural side have a lower prevalence of smartphones, network connectivity, electricity access, and formal education; these same communities also have less-favorable relationships with the conservancy [CDP 1][CDP 2]. (Also importantly for considering hotlines at other conservancies, Ol Pejeta also has more wireless connectivity than other area areas. Staff noted that some nearby conservancies had no connectivity at all [CDP 1].)

Generational divide. Our focus group discussed a major generational divide in community members' technology preferences and access. (This generational divide has also been corroborated by OPC staff's experiences visiting communities [CDP 1][CDP 2][CDP 3].) Youth participants agreed that they preferred using WhatsApp and SMS over voice calls, mainly because of the lesser cost than voice calls—they often used a free mode of Facebook and WhatsApp that could send messages without pictures or videos. The youths also reported using a variety of mobile apps: Instagram, TikTok, games, email (for *"job applications and official things"*), and a variety of shopping apps (naming Copia, Jumia, Kilimall, and Glovo). The group reported that they had commonly used USSD shortcodes years ago, but *"not so much"* anymore: *"now mainly old people use USSD for banking and things."*

The group agreed that elders had very different experiences with mobile phones: every elder participating agreed that they preferred voice calls because messaging was too difficult: *"They don't like messages because they fill up your phone. You might send a message to an elderly person*

but they won't read or reply." One elder said: *"The last time I sent an SMS was two years ago."* Many had trouble reading messages on small phone screens, being nearsighted or farsighted. While most youths could read well, elders had lower literacy levels than youths: one guessed their literacy was *"like fifty-fifty."* Some elders had smart phones, but the group agreed that elders had more limited use of apps: *"I live with my elderly mom. She has a smartphone but doesn't know how to use any apps. Only SMS and Whatsapp."* The group was concerned that if a hotline were implemented with WhatAapp or a mobile app, many elders would not be able to use it.

Gender. Gender norms present a potential hurdle for women using a reporting hotline; as the group reported that some would need to consult their husbands before calling. After asking the 4 women in the focus group, 2 said they would call directly if they had information to report, but the other 2 said that they would need to consult their husbands. A technology choice that provides more discretion could potentially lead to more reports by women: one said that she might call directly if she had enough privacy.

Cost sensitivity. Some remarked that the cost of sending messages may be prohibitive for using a hotline: *"the number should be toll-free!"*[Community FGD]. They reported that people commonly go without a balance on their phone, and might not be able to make a report during an emergency without buying an airtime bundle first. (Notably the main telecom provider allows customers to send a "please call me" message for free, but this reveals the sender's phone number.) They noted the convenience of using WhatsApp's "free mode" for sending messages without a balance; but that mobile apps require data bundles that not all will buy.

4.7.2 Timeliness and reactiveness

Our community FGD participants repeatedly, enthusiastically emphasized the importance of getting a quick response when they used a security hotline. They complained that current communications were too slow, which led to responses that were sometimes too late to do anything about the problem. For instance, one complained that many people in the communities knew about the

tracker dog services, but did not know how to reach them:

> *"The officers respond, but the stumbling block is communication. People will go through the community representatives. There might be delays. If they don't know the community representative, they'll go to the local chief. If the don't know a local chief, they'll go through the village elders. There are delays in the communication chain"* [Community FGD].

They also complained that the long process led to information being lost *"The first information gets to OPC by the fourth person sometimes... the location gets lost. Someone is describing their home to someone who doesn't know the place"* [Community FGD].

The group strongly agreed that voice calls led to a quicker response than sending messages. When asked which technology option the group preferred the most from a set of posters (Fig 4.4), the group enthusiastically agreed on poster 4.4f—a direct phone number for a named security officer—saying the most important reason was timeliness. They wanted a direct line, instead of needing to wait for a message to be passed around the organization: a *"one-on-one immediate response."* One voiced that she thought SMS was too slow and unreliable: *"You're not sure if the message will be read."*

4.7.3 Community perceptions of security tradeoffs

Each technology option comes with security advantages and disadvantages; concerning how easy it is to intercept messages or protect an informers' identity, for example. Community members have some idea of these security tradeoffs and would take them into consideration when choosing whether to use a security hotline. However, our focus group revealed that community member's perceptions of each technology's security affordances were sometimes different than our expectations, and sometimes had misconceptions. Here we investigate the community perceptions of technology security and its implications for hotline design.

Confidentiality. All focus group participants agreed that confidentiality was extremely important for anybody to use a hotline; they needed to be assured that their details would be kept private and would not be leaked. Several participants stressed that they needed to trust the OPC agent taking their call, that they be well trained and would handle their information responsibly.

To our surprise, the whole group enthusiastically agreed that WhatsApp was the least secure of all of the technology options. They agreed that WhatsApp messages were not confidential because messages could be shared so often:

> *"I would never say anything private over WhatsApp! It's not confidential. Everybody will see it... messages get delivered a million times."*

One staff later remarked that it used to be possible to add anybody to a WhatsApp group, where they would then see the whole history of the conversation. This is no longer possible in current versions of WhatsApp, but it has already damaged peoples' trust [Wildlife dept.].

The focus group raised no such confidentiality concerns over any of the other particular technologies. However, the group agreed that they wanted a direct line to communicate with security staff instead of passing messages through chains of multiple people, so the information would remain in fewer hands.

Encryption. WhatsApp and smartphone apps can offer stronger encryption than the other presented technology options (Fig. 4.4). WhatApp is end-to-end encrypted by default between the sender and receiver of messages; and mobile apps can communicate over servers with encrypted HTTPS. This encryption makes it more difficult for a third party to intercept messages in transit.[5] Security staff noted that they sometimes use WhatsApp and other encrypted protocols to communicate with sources; and that poachers often use WhatsApp because they know their messages are harder to intercept [Intel 1].

However, a large majority of community members around OPC do not know about encryption, and would not consider this when deciding to make a report. One facilitator of our com-

[5] SMS and voice calls are encrypted between the user and cell tower, so can only be easily intercepted by governments, telcoms, or others who have access to the infrastructure.

munity focus group gave a brief description of WhatsApp's encryption, and the participants all agreed that they did not know about it.

Authenticity. Technologies vary in their ability to provide authenticity: verifying that the communicating parties are indeed who they say they are. The telephone protocols for routing phone numbers are notoriously insecure, and adversaries can easily take control of a phone number through a variety of vulnerabilities like SIM swapping and porting [208, 199, 304, 296] and attacks on the SS7 network [56, 57]. For example, an adversary might re-route calls from an anti-poaching hotline to their own mobile phone with these attacks. WhatApp and mobile apps have security affordances that somewhat mitigate these threats (with "security numbers" and SSL certificates, respectively), but these features are not easy for most users to understand [339].

However, the vulnerabilities with phone number routing are not widely understood by the general public [195, 224] and this is also true for the communities around OPC. Our focus group participants did not raise phone-number-hijacking as a security concern. One expressed concerns about a hotline implemented with a mobile app, because she had seen apps that had scams. Another expressed that he preferred voice calls because you could identify the person by the sound of their voice, and judge if they were genuine.

OPC staff shared that there had previously been an incident of SMS fraud when somebody had sent text messages claiming to be from OPC and asked recipients to pay a bogus fee to be considered for jobs [CDP 2]. This highlights an important vulnerability—it could be extremely damaging if an adversary were to circulate a fake security hotline number in the communities.

Anonymity. Community members enthusiastically and unanimously expressed that they wanted a completely anonymous way to report security incidents to OPC; however, security staff were hesitant to allow anonymous communications and felt it was important to know the identities of sources (as discussed in sections 4.6.3 and 4.6.4).

Technical constraints with most of the implementation options would make it difficult to build a truly anonymous hotline though, even if the conservancy chose to do so. Because identity is

built into the GSM protocol for cellular calls and text messages [280], records of phone numbers can be generated at several steps in the connection even if OPC discards the numbers itself at the end of the pipe. Similarly, it is not possible to send anonymous messages on WhatsApp. FGD participants said they would protect themselves by not saying their names and hiding their caller ID, which offers a rudimentary level of protection.

A mobile app, on the other hand, can utilize a multitude of schemes that provide anonymity over the internet protocol, such as Tor [111] and SecureDrop [109]. Our focus group participants did not know this though, and erroneously believed that mobile apps and WhatsApp were more traceable because of their use of mobile data: *"You need to be online and you can be traced. It's easy to trace you when you're online."*

Security staff reported that a small number of people have called them to report information anonymously using burner phones; as it was possible to acquire a phone number without providing ID [Intel 1][Intel 2].

Records on device. Each technology operation generates different sets of records on a sources' phone. For example, SMS initially creates a record of the recipient, time, and conversation text; while voice calls create records of the recipient and time, but not the content of the conversation. Notably, USSD shortcode sessions do not create any records on a users' phone and therefore is sometimes used for applications where this is important, such as accessing information about stigmatized conditions like HIV [272].

Minimizing the records left on phones is important especially in contexts where phone-sharing is common [272]. Perhaps because most people had their own phone, our community FGD participants were less worried about this issue, agreeing that they could just delete records.

Discretion and privacy. Participants worried about being overheard when in emergencies or dangerous situations, and agreed that they wanted the option to send messages for this purpose: *"Text is good when something is happening right now, because nobody would know I am calling."* Participants also noted that they knew to make calls far away from other people so they wouldn't be

overheard. One security staff noted that sources were often hesitant to give information over the phone, preferring to meet face-to-face, because *"you don't know who else is in the room"*.

4.8 Discussion and Conclusion

Through our qualitative work we have described the complicated context and enumerated a set of paradoxical tradeoffs and design considerations impacting a potential future anti-poaching hotline at OPC. In this section, we distill the set of design tradeoffs for OPC and similar contexts, discuss study limitations, and discuss implementation decisions appropriate for OPC.

The situation's sheer complexity and difficulty is perhaps the most striking observation to make from our qualitative findings. There are a large range of stakeholders with competing interests, and the wildlife and communities' protection depends on maintaining their delicate balance. In addition, there are a large range of crimes associated with the conservancy that affect different constituencies, warrant different responses, but also are treated with different levels of severity. Further complicating the matter, the stakes are high and risk is considerable: missteps can lead to further degradation of already critically-endangered wildlife species, and interactions with poaching syndicates can even be deadly for community members and conservancy staff.

The institutional process making decisions about a potential anti-poaching hotline has been slow and complicated because there is such a large number of stakeholders, contrasting points of view, and risks. Furthermore, OPC must coordinate with government agencies and nearby conservancies and reach agreement before launching a phone number. OPC staff have thus discussed implementing an anti-poaching hotline for years without arriving at a decision one way or the other. Many other conservancies are less well-resourced than OPC and are likely to have similar institutional friction when considering an anti-poaching hotline.

Technology, implementation, and publicity choices can affect community members' experiences with the hotline and their comfort making reports. The implementation options vary significantly in their ease of use, timeliness, responsiveness, access within local populations, and their degree to which users' identities are protected. However, the limited technology access within the communities and organizational challenges within the conservancy also complicate the de-

sign space, as well as community members' misconceptions and unexpected concerns about the technologies' security aspects.

The conservancy balances different infrastructures for security and community relations, that each require different and competing considerations. An anti-poaching security hotline impacts both sides, and a successful design must thread the needle between security-oriented and community-oriented schools of environmentalism.

4.8.1 Appropriate design at OPC

Through the process of this formative study, the staff at OPC have reached a tentative agreement that launching a dedicated anti-poaching hotline is not worth the associated trouble and risk, for the time being. For the problem of rhino and elephant poaching, a hotline would probably have limited usefulness and generate more noise than signal. Local people lack relevant information, staff fear a deluge of bogus reports that are too difficult to verify, and they fear that an anti-poaching hotline would create confusion in the communities and complicate public relation efforts. Rather, OPC staff prefer to rely on their trusted network of sources to gain intelligence about poachers and goings-on in the communities.

However, OPC may revisit the idea if increased bushmeat poaching persists after the recovery from the COVID-19 pandemic. Local people likely have more information about bushmeat poaching, and risks for community members making a report could be lower as bushmeat does not involve as sophisticated and deadly criminal syndicates. However since bushmeat poaching at OPC appears to be mostly for subsistence and has not developed the large-scale commercial industries seen elsewhere, local people may sympathize with bushmeat poachers and choose not to report. OPC is still working to develop an ethical, effective response to the increased bushmeat problem, which may simply decrease on its own as the economy recovers from COVID-19.

Through this research process, participants reached a tentative agreement that if OPC were to pursue an anti-poaching hotline in the future, the best implementation approach for OPC may be to circulate the name and phone number of a security officer rather than launch a specific dedicated hotline. We hope that this approach could help to establish good community rapport

and trust with these individual security staff, and give community members confidence that their confidentiality would be protected and issues would be expediently handled; more-so than interacting with a nameless, faceless hotline. Even though community members in our focus group voiced strong support for an anonymous hotline, it is likely too difficult to implement a truly-anonymous hotline because of the technical constraints of common mobile phone protocols, and because of community members' lack of access and reluctance to trust smartphone apps.

In addition, OPC staff are wary of publicizing more phone numbers in the community and creating confusion, having circulated several contact numbers in the past and discontinued some: *"There are already too many numbers going around!"*[Intel 2]. For this reason staff are hesitant to conduct even a temporary pilot of a security hotline. In the future as more community members have access to smartphones and mobile data, a mobile app may help to address this problem of ever-changing points of contact by issuing updates as systems change.

4.8.2 Study limitations

In this manuscript we are limited in the information we can reveal about OPC's security operations in order to protect their staff and sources, and to protect against counterintelligence efforts. However, this omitted information does not substantially change our analysis of the role of anti-poaching hotlines presented in this paper.

Another notable limitation is our limited view into community perspectives. In our community focus group discussion the sample was biased to over-represent community members who had close relationships with OPC and favorable views. We were not able to discuss this issue with a wider sample because of its extreme sensitivity, and therefore could not sample other perspectives in the community. We speculate that this segment would be the most likely users of an anti-poaching hotline, but we still lack the perspectives of people with less favorable views towards the conservancy.

This paper presents a single case study of one wildlife conservancy, and collecting data from other conservancies is beyond the scope of this work. In the next section, we discuss the generalizability of our findings from this case.

4.8.3 Design considerations for other conservancies

Our qualitative findings, combined with existing studies that show anti-poaching hotlines' mixed effectiveness, demonstrate that an anti-poaching hotline's success is highly dependent on local context, appropriate technology design, and broader communication strategies. Because these factors have complex interactions, the appropriate design choices at each site will differ.

However, from our work we can offer a set of design considerations for anti-poaching hotlines in similar contexts as OPC. Here, as compared to much of the other published research on anti-poaching hotlines in wealthier economic settings (see Section 4.3.2), risks to reporters' safety is higher, people's access to technology is generally more limited, and people have weaker trust in government institutions.

Communities' access to technology varies across locations, and this impacts the appropriate design of a hotline at each site. Many conservation areas are located in remote places where people don't have access to electricity or network connectivity nearby. Where connectivity is available, users often face barriers of device ownership, reception, and literacy. Technology implementation options vary in their convenience and accessibility to potential users, and each implementation decision affects who is included and excluded. Technologies also vary in their ability to protect users' information and identities. Hotline implementers must choose when to provide anonymity (which can be technically very difficult), or when it is necessary to know informants' identities. Organizations crucially must be extremely careful to protect a hotlines' incoming information within the organization, ensuring that information does not fall into too many hands, especially the informants' identity. Furthermore, hotline success can be affected by unexpected user perceptions about the technologies' security affordances (e.g. in our case, community members felt WhatsApp was insecure even though it has stronger security features than SMS).

It is very difficult to spread complex information about a security hotline and set community expectations, and this is especially true in contexts with limited connectivity and media. In areas where smartphone apps, websites, and social media are available, it may be easier to communicate

these points and set expectations. It is crucial to broadcast that the hotline is trustworthy, and show that the participants will be protected. The conservancy must also create expectations that hotline users will receive an appropriate, timely response in order for their report to be worth the risk.

Lastly, there are many institutional factors to consider. A hotline, if implemented at all, must be housed appropriately within the internal security infrastructure of an institution, and access must be controlled appropriately. Implementers should consider how a hotline might affect the slow relationship-building processes with communities for the variety of purposes it needs; for example, one must be careful not to compromise trusted security relationships by association with political arms of the organization, or over-prioritize security to the detriment of communities. Hotline implementers should carefully consider how an anti-poaching hotline can integrate with the security needs and concerns of the communities, to consider how motivations are aligned and misaligned, and how new communication channels could help co-create a shared security.

Chapter 5

A CROSS-SECTIONAL STUDY OF COMMUNICATION TECHNOLOGY PRACTICES IN ENVIRONMENTAL INSTITUTIONS

5.1 Summary

This chapter cross-validates my research findings from the case studies in Chapters 2, 3, and 4. To learn how my findings generalize to other environmental organizations beyond the three case studies, I interviewed staff from other organizations using questions based on my prior findings.

Environmental problems require complex coordination among many different stakeholders to manage shared resources, and the explosive growth of communication technology around the world is rapidly reshaping the relationships between all of the actors in environmental governance. As communities around the world gain more access to mobile phones and the Internet, environmental institutions like government agencies are restructuring themselves to develop new types of community relationships and implement new projects that were previously out of reach with their limited resources. While there is a large body of research on effective environmental governance structures, the impact of communication technology on these institutions is poorly understood.

To better understand the the effects of communication technology on environmental institutions, we conducted semi-structured interviews with a cross-section of 22 staff at different organizations in Uganda, India, and the USA. We sampled for diverse geographies, institution types, and levels of local technology access. From our participants' experiences, we describe how environmental intuitions are fundamentally shaped and constrained by the availability of technology in the communities they serve. For example, organizations working in extremely remote conservation areas still commonly rely on tenuous mobile phone and radio connections to relay messages with the isolated communities living there, often acting as their liaisons with the

government and outside world. In rural areas having more phone connectivity, organizations often rely on the availability of SMS, voice calls, group chats, and picture messaging to coordinate projects between many sites: distributing information, implementing accountability mechanisms, monitoring project statuses, and collecting data. In highly-connected urban areas, institutions take advantage of social media and rich multimedia experiences to engage with mass audiences: advertising their organizations, beginning new relationships, promoting environmental causes, and holding complex conversations in virtual spaces. Participants also discussed technology's effects on social aspects of their work, sometimes both helping and hindering relationship-building and trust; sometimes leading to more top-down formalization in relationships; and often having lukewarm effects on diversity and inclusion efforts. These findings can help environmental organizations think more strategically about their use of communication technology in community engagement, and can lead to technology improvements to help organizations work with communities in various stages of technology adoption.

5.2 Introduction

Environmental problems call for intensely social and collaborative solutions, requiring interactions between many different types of intertwined stakeholders like governments, communities, businesses, and Non-Governmental Organizations (NGOs). The famous *Tragedy of the Commons* model illustrates this vital interdependence of their every stakeholder: considering a field shared by many shepherds grazing sheep, one shepherd's overgrazing can destroy the pasture for everyone [164]. We see the social complexities of managing shared resources when we consider potential solutions to the *Tragedy of the Commons* model: one strategy is for shepherds to agree to divide and privatize the pasture, whereby each is motivated to responsibly manage their own allotment; alternatively, an external entity like a government must set rules for the shepherds and enforce against overgrazing; or instead, the shepherds must collectively agree on a system for cooperating and managing the shared pasture together [264].

These complex social interactions can be seen across many different environmental sectors, where systems and institutions arise to facilitate interactions between heterogeneous actors with

differing motivations, often across scales. For example, national governments work in diplomatic arenas to negotiate fishing rights in shared waters [18, 142], city governments combat water scarcity with campaigns encouraging citizens to replace lawns and conserve water [38, 231], and citizen groups lobby governments to regulate environmental harms from industry [329, 315]. Political science and social science researchers have extensively studied the social dynamics that lead to successes and failures in environmental governance [100, 126], and this extensive body of environmental governance theory has been put into practice by environmental organizations, like encouraging fishers to organize community-based management solutions [94], or facilitating citizen science projects to help a community advocate for their environmental goals [269]. In addition, the *environmental justice* movement has brought attention to the social inequities pervasive in environmental problems, and highlighted the uneven distribution of costs in conservation projects. Especially over the past decade, environmental justice advocates have encouraged institutions to strategize more carefully about the social impacts of their work and include more marginalized voices in their environmental decision-making [257, 329].

These environmental relationships are being rapidly reorganized by the explosive growth of Information and Communication Technologies (ICTs); changing the structures of environmental institutions, shifting the balances of power among the actors, and altering social aspects like relationship-building, trust, and inclusion. The landscape of ICTs is changing extremely fast. For example, both smartphones and basic (push-button) mobile phones are rapidly proliferating into rural regions that recently had no network connectivity—especially in the developing world—and even into remote regions with minimal electricity infrastructure. Illustrating this point, the proportion of the world's population using mobile phones rose from 35% to 55% in just 7 years between 2015 and 2021 [26]. Communication technology is also changing in well-connected urban places: new media-rich social apps arise every year and change the way people communicate: for example, video chat was instrumental in restructuring organizations through the COVID-19 pandemic. Computer scientists have developed a body of theory on how technology designs and have shaped social phenomena and institutional structures [261, 351, 198], in parallel to the social and political research in environmental governance structures.

However despite the clear importance of ICTs as they change institutions around the world, there is a scarcity of research on they are reshaping environmental governance. The transformative effect of communication technologies are evident from the case studies presented in earlier chapters of this thesis: the widespread access to basic mobile phones around Ol Pejeta Conservancy allows staff to provide services and react quickly to issues in communities that are widely dispersed and difficult to reach; the Atlantic White Shark Conservancy and Giraffe Conservation Foundation are leveraging social media and digital multimedia to build a community of supporters in urban settings; and many organizations have implemented anti-poaching tip services via phone lines and anonymous websites to aid in environmental law enforcement.

This study uses qualitative inquiry to characterize ICTs' impact on environmental institutions and community relationships. We conducted one-time, cross-sectional semi-structured interviews with staff from 22 environmental institutions about their organizations' work, their interactions with the public and local communities, their use of technology in these community interactions, and technology's effects on social factors like trust and inclusion. We sampled participants to cover a wide range of environmental institutions; including 3 countries (India, n=14; Uganda, n=6; and the USA, n=2) and several types of institutions including conservation parks, government agencies, academia, and NGOs. We then conducted an inductive process-outcomes analysis to explore how the varying availability of technology in communities impacted each organizations' institutional structures, project types, and community relations.

We found that environmental organizations operated very differently in areas having different levels of phone ownership and network connectivity. (These differences were caused in part because these communities had different needs.) However, our participants detailed how the availability of different communication channels in each region allowed them to implement different projects and build different styles of community relationships:

- **Remote rural organizations:** Several participants worked in very remote areas that were difficult to access by road. These communities were very isolated, often lacking government services like schools, but environmental organizations were active there because conser-

vation areas tend to be located in remote places. They lacked electricity infrastructure and cellular reception, yet mobile phones still percolated into some of these regions. Organizations often passed messages through relay chains, calling someone in a village with cellular reception, and then passing the message to other villages on foot or via two-way radios. Many of the organizations acted as liaisons to help these communities interact with governments and the outside world; and these tenuous mobile phone and radio connections were critical for relaying messages and updates, and keeping personal relationships alive.

- **Peri-rural organizations:** The largest number of participants worked in rural regions that were more easily accessible by road. Mobile phones were common in all of these communities, albeit with varying levels of cellular reception and smartphone/Internet access. Organizations operating in these peri-rural communities tended towards more interventionist styles, implementing projects like tree-planting campaigns, encouraging sustainable agriculture techniques, or developing alternative livelihoods that are less dependent on natural resources. The availability of mobile phones allowed these organizations to coordinate projects across many sites, sharing information, implementing accountability mechanisms, monitoring project statuses, and collecting data using technologies like voice calls, SMS, WhatsApp groups, photo messages, and sometimes custom apps. Many of the organizations implemented hub-and-spoke structures, using phones to stay in touch with key people in each community who coordinated projects on the ground. Peri-rural organizations mostly did not attempt to widely broadcast messages or engage large groups over ICT's, finding the available technologies (like SMS and voice calls) too limiting.

- **Urban organizations:** Urban organizations operated in highly-connected environments. The widespread availability of social media and rich multimedia interfaces via apps and websites gave them opportunities to broadly engage mass audiences. Urban organizations made especially high use of communication technology to advertise their organization and begin new relationships. Many of them made heavy use of visual multimedia like videos and infographics to catch audiences' attention and communicate complex ideas. Some of

> the organizations were able to have complex, lively group discussions over social media; but others worried that their mass-communication efforts only led to superficial interactions, having to compete for attention on media-saturated platforms, and questioning whether they led to any meaningful action.

Participants also discussed how ICT communications affected their relationship-building efforts with communities. Reliance on ICTs sometimes hindered the slow process of relationship building and trust by over-formalizing communications, and communities sometimes perceived them as intimidating. Conversely, some participants also felt that mobile phones helped build trust by allowing them to keep in touch with communities when they couldn't always be physically present. Some reported that increased reliance on ICTs led to more top-down control of projects: the constraints and limitations of virtual communication channels made it difficult to deeply understand the needs of communities and give them a voice in project design, and ICTs imposed more accountability mechanisms that took away communities' agency. Additionally, nearly all participants agreed that diversity and inclusion was important to their organizations' work, but most agreed that the shift to technology-based communications neither helped nor harmed inclusion efforts in any significant way, and mostly just perpetuated existing social inequities and barriers to participation. Many participants were eager to find better ways to engage communities with ICTs and improve social equity in their organizations' work; but some complained that their organizations' upper leadership did not prioritize these issues.

This study offers three main contributions. First, it characterizes the range of ways that environmental organizations use communication technology in community engagement, both formally and informally. Second, it describes how variations in the availability of technology fundamentally shapes environmental institutions' structures and activities. Third, it characterizes the (sometimes unintended) effects of communication technology on these organizations' community relationships. These results can suggest directions for new technology developments to help environmental organizations engage communities in various stages of technology adoption; and can help environmental organizations think more strategically about their use of ICTs in

community engagement, and plan for future technology changes in communities where they work. Additionally, this chapter stakes out research questions on this understudied topic, and demonstrates its importance for additional research by environmental social scientists and social computing researchers.

5.3 Related Work

This section brings together relevant research in environmental governance, social computing, eCivics, and ICTD to situate our work.

5.3.1 Environmental institutions

Elinor Ostrom's pivotal work *Governing the Commons* [264] laid the bedrock for decades of thinking and research on environmental institutions that followed. By analyzing successful cases of community-based institutions governing shared environmental resources—such as water basins, forests, and irrigation systems—Ostrom famously theorized a set of institutional design principals for their success, including clearly-defined boundaries, shared understandings of the resource system, rules that can be modified by stakeholders, and graduated sanctions for rule-breakers. Ostrom defined institutions as *"enduring regularities of human action in situations structured by rules, norms, and shared strategies, as well as by the physical world"* [91]. We form institutions to bring stability to our actions and expectations in environmental governance, using formal and informal rules [11]. They take the shape of government bodies, firms, NGOs, schools, churches, and a variety of other structured social phenomena, often embodying power relations, and often creating independent effects from the forces that led to their formation [11].

Subsequent work has enumerated the variations in environmental institutions and explored how their structures and aims lead to differential environmental and social outcomes [91, 267]. For example, communities have been shown to have varying abilities to form collective environmental institutions stemming from the local socioeconomic and political contexts: e.g. a study of canal irrigation systems showed that farmers were more likely to successfully co-manage water in areas closer to market towns, having more college graduates and influential leaders [229].

Similarly, a study of 130 co-managed fisheries found strong leadership to be the most important factor towards their success, also identifying social cohesion as an important factor [159]. An adjacent body of scholarship has underscored the role of *social capacity* (or *social capital*) in environmental governance, building strong interpersonal relationships between different actors to be able to work together effectively [279, 278, 90, 42]. Comparative studies have enumerated taxonomies of different important relationship types: strong trusting relationships within like-minded groups (*bonding*) enabling co-operation, often-weaker relationships between individuals of similar but different groups (*bridging*) that spread knowledge and information, and relationships between different levels of regulatory hierarchies (*linking*) to effectively coordinate governance [155]. Another large body of research compares the effectiveness of different rule-enforcement mechanisms [150, 59].

Many environmental organizations and government agencies have put these ideas into practice, modeling many of their initiatives on ideas from environmental governance theory. For example, an industry of NGOs has emerged that encourages fishing communities to form community-based protected areas [93, 94] and many countries have adopted policies that devolve coastal management responsibilities to smaller-scale community-based institutions [77]. In another instance, the 2002 Water Act by Kenya's national government delegated water basin management to Water Resources User Associations modeled after Ostrom's design principals [108, 345]. Other initiatives have specifically worked to build social capacity among communities and government workers to improve their abilities to collaborate [90], or form lateral networking opportunities for communities and staff of similar conservation projects in different locations [98].

However despite environmental organizations' increased emphasis on community-based approaches, conflicts and tensions are still common among conservationists and the local communities with whom they work. Environmental projects often falter because of goal mismatches, whereby the organizations prioritize accountability to their funders above their accountability to communities [96]. Researchers have long called for environmental organizations to better integrate into their local social contexts, develop effective conflict management strategies, and avoid situations where environmentalists assert their interests over those of the local people [285]. The

environmental justice movement has brought attention to disproportionate environmental harms impacting marginalized communities along racial and socioeconomic lines, and demonstrated the often-unfair distributions conservation's costs and benefits [329]; while environmentalists increasingly recognize that equitable inclusion of marginalized voices in governance processes is crucial to have the best chances of positive environmental outcomes [95]. However while many NGOs have recently sought to reform their management structures to give more decision-making power to local communities, critical evaluations have often shown that these reforms have not adequately addressed the problems and still reinforce control by outsiders, leading to damaging cultural and environmental effects [257, 93, 355]. The complexity and mixed evaluations of these community-facing environmental initiatives underscore the importance of understanding technology's changing impacts on them, especially considering the high risks of environmental degradation and social injustices.

5.3.2 Social computing

Social computing research examines the interplay between technology designs and the social dynamics which form around them. In an interesting parallel, some branches of social computing work draw on the same foundational influences as environmental governance theory. Researchers have frequently applied Ostrom's design principals for common-pool resources to "digital commons;" shared resources like co-produced knowledge on Wikipedia, the health of online communities, or open-source software projects [82, 35]. For example, a comparison of different-language Wikipedia editions found that effective dispute resolution mechanisms, a sense of common identity, and social support for new contributors were important for their differential success in building large communities of contributors; as well as a larger more-decentralized leadership that had more prior experience with participatory governance [197]. In many cases, technologists have also prescriptively applied environmental governance theory towards technology designs: e.g. Johnson et al. used Ostrom's principals to co-design tools for managing network congestion in community-run cellular networks [191].

Active research on the design and moderation of online communities provides a compelling

example of the interplay between technology design and emergent social dynamics. Researchers in this space also commonly invoke environmental governance theory, modeling online moderation and disinformation as collaborative work towards a shared common-good, with most platforms outsourcing moderation to community members aided by various technical mechanisms like voting, reporting, and AI classifiers [309]. Differences in Twitter and Reddit's moderation mechanisms (combined with varying norms among the platforms' sub-communities) have significant impacts on the speed at which disinformation spreads [351]; and differing moderation styles among Reddit communities can predict differences in their members' values (e.g. trust vs. safety vs. inclusion) [353]. Researchers in this space are also applying governance theory prescriptively, experimenting with designs of various interactions and moderation tools to improve discussion quality within the communities, and considering their impacts on various social aspects [268, 368, 186].

Additionally, studies into workplace technologies provide insights into how software design can shift power and change organizational structures. For example, organizations' adoption of new co-working software often creates disparities in costs and benefits for each user [196, 157, 27]: e.g. upper management commonly requires lower-level staff to enter various data in formats that are convenient for management to analyze, leading to tension and resistance from staff when the new processes are inconvenient and time-consuming for them. Grudin's analysis of failed co-working software projects described other challenges, such as interrupting existing social processes (e.g. violating taboos or upsetting existing political structures, like circumventing management), lacking the flexibility to handle anomalies and exceptions in normal processes, or failure to achieve a "critical mass" of users within the organization [157].

Foundational research on remote work has elaborated the strength and weaknesses of ICTs in lieu of in-person interactions. Face-to-face interactions have many distinct advantages over remote work: e.g. a shared local context allows for easier socializing, mutual understanding of thoughts, and easy references to objects with gestures and gaze; the multiplicity and richness of communication channels (like body language and tone of voice) help communicate complex or subtle topics while providing redundancy; and unstructured times facilitate social bonding

and impromptu information exchanges [40, 261]. Due to these constraints, Olson and Olson posited that technology-mediated interactions are most useful for "loosely-coupled tasks," where geographically-separated teams can each work relatively independently, needing simpler or less-frequent interactions—for example, loosely-coupled co-authors can each work on separate sections of a document [261]. Ambiguous tasks require tighter coupling, and loosely-coupled interactions require more structure. Though technology has improved, these fundamental problems still remain. Mattheisen and Bjørn [221] illustrated the constraints of ICT-mediated work with a 2017 case study of a failed software outsourcing project: reliance on mundane project-management tools and messaging apps (compounded by delays from a time-zone difference) led to misconceptions about task assignments and socio-technical abilities among remote teams, hiding serious problems that ultimately doomed the project; they argued that these problems could have been discovered and avoided by in-person teams, having much better much better capabilities to exchange information.

Social computing researchers continue to experiment with new interaction designs to improve the richness and social context in online interactions. For example, some work investigates design factors that lead to common social identities and interpersonal bonds among online communities [288]. In other work, researchers seek to create *"social translucence"* in online interactions, referring to a groups' awareness of each others' actions in context, allowing individuals to know more about each other and make better use of their social skills while facilitating better coordination and trust. Researchers have experimented with socially translucent system designs to make co-workers activities more visible to each other for a better shared understanding of the whole organization's activities [123], for example, and experimented with designs on social networking platforms like showing users which links their friends have seen [151]. Another body of work has explored mechanisms for establishing norms in online communities to motivate good behavior [198]. Consider one example moderation strategy, whereby some forum designs publicly announce sanctions to shame online trolls or rule-breakers: this may be effective because communities perceive sanctions as more legitimate when given through fair, transparent procedures [324]. However, other research shows how this strategy can backfire as people tend towards

conformity and look for cues about norms [198]: in one experiment, when signs warned park visitors not to take petrified wood but created an impression that many people were doing it, this resulted in more petrified wood being stolen [78].

5.3.3 eCivics

Here we briefly discuss *eCivics* (or *eGovernment*) research in computer science, which is primarily concerned with software interaction designs to connect citizens with government processes. (None of our study participants reported using dedicated eCivics technologies like the ones described in this section, but many faced these relevant problems in their work.)

eCivics researchers have explored a variety of interaction types. In one genre of projects, researchers work to improve transparency by making government data more accessible to the public [201]. These projects often aggregate publicly-available data from official sources that are difficult to use, presenting them with more convenient and accessible interfaces, or offering more powerful analysis tools. In another genre of eCivics work, technologists design platforms to mediate interactions between citizens and government officials, like reporting maintenance problems to a city [134]; or technologies involving citizens in planning processes, exploring information about the plans and giving feedback to officials [292, 43]. In a third emerging genre, firms and governments are developing "robot lawyer" services that help users automate navigation of complex bureaucratic processes [215, 213]. These services provide a comparatively simple interface to the user (like a chat bot) to collect some necessary information, and then automatically fill government forms or follow up on processes to contest a parking ticket or apply for public housing, for example. Academic research on automated robot-lawyer services is currently scant is likely to grow in the coming years. A fourth approach to eCivics research has characterized the integral and evolving use of social media by activists in grassroots social movements [140, 365]. A large adjacent body of work in the field of *environmental communication* explores a range of media strategies for environmental organizations engaging the public and promoting their causes over social media [219, 49].

Critical literature has emerged that highlights some shortcomings of current eCivics approaches.

Erete and Burrell's longitudinal study of eCivics tools in Chicago found that citizens were sometimes able leverage the technology to raise visibility for their causes and concerns, but government officials varied in their responsiveness [122]. They argue that popular eCivics approaches are not enough to increase marginalized citizens' political power: *"technology alone cannot equitably empower citizens to solve deep-seated social problems as such crime without addressing the underlying inequities across communities"* [122]. Recognizing that the time commitment to participate in governance processes is a major obstacle for many potential participants, a number of projects have emerged that aim to crowdsource feedback from citizens using small, simple microtasks to lower the barrier for civic participation [250, 214]. However, these sorts of volunteer crowdsourcing projects are often criticized for not giving enough meaningful decision-making power to participants, rather just using them to collect data for for the project designers' predetermined goals [50].

5.3.4 ICTD

Research in Information and Communication Technology for Development (ICTD) studies technology experiences, design, and implementation in low-resource, low-infrastructure places; typically in economically developing regions. Most research on social computing and eCivics, described above, is mostly focused on understanding social implications of the newest communication technologies on the bleeding edge, or developing future technologies. In contrast, ICTD research focuses on the "long tail" of technology access and the experiences of users who do not have access to the newest technologies, who make up a large portion of the world's population.

To this effect, ICTD researchers have elaborated the potentials and constraints of "old technologies" like basic push-button phones, SMS, and automated voice call menus (IVR) in contexts that often have low levels of technology infrastructure, such as sparse or unreliable electricity access, poor cellular network availability, low ownership of mobile phones, lower-powered phones, low literacy, language barriers, or restrictive cultural norms. Technology access is changing fast in many parts of the world [26] and ICTD research has seen a recent corresponding increase in smartphone applications, but it is clear that older technologies like push-button phones will

remain important for reaching large segments of the world population for a long time to come.

A large body of ICTD research has explored various ways for organizations to engage with communities over ICTs in these resource-constrained environments, and this work is highly relevant for community-facing environmental organizations who face many of the same problems and community-engagement goals. However for historical and structural reasons, the ICTD community has had minimal engagement with the environmental sector, instead working mainly with organizations in traditional "development" sectors like health, agriculture, and education. This presents a significant research gap and major opportunities for improvements.

When working with community segments that have access to basic phones but few smartphones, ICTD researchers have developed a variety of creative, partially-automated design patterns for engaging individuals and communities over SMS, voice calls, and USSD. A large number of tools and projects have emerged that programmatically leverage SMS to broadcast information, conduct surveys, or direct users through structured conversation "flows" [326, 281]: for example, a variety of clinical trials have demonstrated positive effects on medicine adherence from sending regular SMS reminders to patients reminding them to take their medications [209, 105]. A diverse set of other projects combine automated messages with human interactions: e.g. the mWatch project sent SMS messages to pregnant women with health tips on a schedule relative to their due dates; and participants could reply to the messages to chat with a nurse, ask questions, and voice concerns [271, 273]. ICTD researchers have also developed a set of design patterns for automated voice call menus (IVR), which are especially useful for populations with low literacy, low vision, or having languages that are poorly supported on basic mobile phones [337, 338, 300]. ICTD researchers and practitioners have developed IVR-based voice forums and deployed them for a variety of projects: participants can call a number to record a voice message, listen to other peoples' voice messages in a forum, and in some cases moderate messages by pressing phone keys to vote or report. In one example environmental application by Gram Vaani, forum users were asked to leave messages discussing water quality concerns, and selected messages were played out on local radio stations to press the government into action [327, 235]. ICTD researchers have also developed patterns for USSD applications in regions where it is available, whereby basic

phone users can dial a shortcode number to open a simple text menu application [272]; their interactive affordances allow for useful, private, and quick interactions: for example, the eKichabi project used USSD to launch a browsable, searchable directory of agriculture businesses that works on nearly every mobile phone [352].

Working with communities having some access to smartphones and Internet connectivity, ICTD literature has also elaborated a set of design patterns that combine different technologies to achieve complex community interactions in these resource-constrained environments. For example, the International Federation of Red Cross and Red Crescent Societies developed the *WhatFutures* program, where young volunteers are organized into small WhatsApp groups and given prompts to brainstorm ideas about the Red Cross's future and express their communities' needs and aspirations, before rejoining the large group to share their ideas in several rounds [206]. In Jakarta, Indonesia which faces severe and frequent flooding and has very high Twitter use, the Peta Jakarta project scans for tweets that mention flood locations [323, 205]. The system uses the incoming data to build real-time maps of flooded areas, safe areas, and shelters; and the maps are tweeted back out to users, and used for official planning and disaster responses. As another example, Open Data Kit and similar tools are built with design patterns to handle data collection in environments with limited connectivity [284, 60, 166], and a wide variety of organizations have deployed them across many different sectors: like tracking vaccine administration in remote areas, logistical management in refugee camps, monitoring cold chain infrastructure for vaccine transport, and wildlife behavior tracking. Various ICTD projects have also made innovative uses of video in low-infrastructure regions [203, 335]; for example, Digital Green supplies equipment and teaches farmers to produce videos on agriculture topics, which are then shared on mobile phones and in community video screening events with battery-powered projectors [146].

Apart from design patterns, researchers have also produced a literature on the ethical and social impacts of ICTD projects, and lenses for incorporating these findings back into future project designs. Researchers have a widespread consensus that ICT-based initiatives to reach marginalized beneficiaries are often confounded by technology access barriers that mirror other inequities faced by these population segments, frequently along lines of gender, socioeconomic status, eth-

nicity, and disability [330, 179, 178]. Often the most marginalized community segments are the hardest groups to reach with ICTD interventions, requiring dedicated effort and attention. Other work has demonstrated how ICTD interventions can expose communities to risks. Technology projects can open communities up to security vulnerabilities, data leaks, privacy threats, and fraud; this can be an especially severe problem in regions where technology is new and people are less prepared to protect themselves from threats [69, 81, 331, 283, 274]. Researchers have also documented cases where increasing reliance on technology opens marginalized groups up to abuse and harassment [334, 294].

Critical work in ICTD has illustrated a variety of ways that technology interventions can lead to more top-down control. Technology tends to reconfigure structures and workflows within organizations, creating additional time-consuming responsibilities for workers logging data, caring for expensive devices, and coping with IT problems [291]; while increasingly under the thumb of monitoring and accountability mechanisms, with more pressure to meet the "effectiveness" and "efficiency" metrics determined by upper management [202]. Informal communication channels like messaging platforms become used for increasingly formal work purposes, and burden staff with the expectation to always be responsive [196]. ICTD's frequently top-down approaches, though many strive to involve communities in decision-making, still often perpetuate the imposition of western views onto people of other cultures, or otherwise imposing ideas from privileged outsiders onto less privileged participants [177, 230, 187, 64]. The power imbalances between researchers and participants can lead to imposition of unwanted technologies and changes; sometimes because of powerful institutional forces, or sometimes when participants are too afraid to give critical feedback for fear of causing offence or damaging relationships [107, 336]. These top-down oroject impositions sometimes have serious negative outcomes for communities. For example, as many initiatives incentivize or coerce women to adopt mobile banking instead of cash, they intend to empower them with more autonomy over their finances and access to services like loans; but these initiatives can have damaging impacts like a loss of privacy when money becomes harder to hide from family members, creating barriers to transact with businesses who only accept cash, or making it harder to use traditional informal savings mechanisms; while delivering

no actual benefit [246].

5.4 Methods

To gather their perspectives, we recruited participants working for a variety of community-facing environmental organizations including NGO's, government agencies, and conservation parks. We conducted semi-structured interviews which were recorded, transcribed, assigned codes, and then underwent inductive analysis to find themes and patterns in the responses.

5.4.1 Recruitment

We intentionally sampled participants from a diverse range of organization types, environmental contexts, and locations to allow for comparisons. Participants were recruited through snowball sampling via the authors' personal network; connections were asked to forward the invitation letter to potential participants. We also advertised the study on forums and mailing lists from contacts' suggestions, including WildLabs [371], the American Sociological Scociety's environmental sociology mailing list [25], and Twitter. Two inclusion criteria were required for participation in the study:

1. Participants must work (or have recently worked) at an environmental institution, such as a government agency, NGO, or conservation park.

2. Participants must have a people-facing role, working with the general public or local communities as a part of their job.

We informed potential participants in the recruitment message, invitation letter, and consent form that the interviews would take approximately 90 minutes, they would be compensated $10 USD for their time, and that they could remain anonymous. Once contacted over email, we first screened candidates to make sure they fit the inclusion criteria by asking them about their work, and then we scheduled them for interviews.

Recruiting participants for the study proved difficult. Posts on forums led to very few responses from people who met both inclusion criteria, as did messages to personal contacts. The majority of respondents came from two sources: the YETI mailing list primarily in India (Young Ecologists Talk and Interact [364]); and a private email list of conservation professionals working in Uganda, maintained by Dr. Robert Ddamulira [70]. We hypothesize a few reasons for the difficulty recruiting participants: some people probably balked at the 90-minute length of the interview, and we hypothesize that community-facing staff are not as well-networked into professional organizations (compared to management or ecology-focused staff) and were thus harder to reach. Lower-income regions (India and Uganda) are over-represented in our sample, likely because the respective currency exchange rates made the $10USD compensation rate more enticing than for participants in higher-income countries. Our sample is likely self-selected to represent organizations and individuals that have greater interest in community engagement. Since we only interviewed participants from organizations that had community-facing job positions, it is hard to quantify what proportion of all environmental organizations is represented in our sample.

5.4.2 Interviews

Interviews were conducted remotely (over Zoom, WhatsApp, or Google Meet depending on the participants' preference), and were recorded. At the beginning of each call before we began recording, participants were given an brief review of the interview protocol and consent form, and given a chance to ask any clarifying questions. The interviews were halted at 90 minutes.

The interviews were semi-structured, following an interview guide while remaining open-ended, allowing the discussion to go into depth on questions that excited the participants, and sometimes covered additional topics outside the interview guide. Interview questions were informed by the first authors' own experience working with communities and conservation (discussed in prior chapters), and by themes from the literature review (Section 5.3); we briefly discussed these experiences and ideas in some of the interviews, prompting participants to compare and contrast their own relevant experiences and providing jumping-off points for discussion. The interview topics included: the participant's work, their interactions with the public and local

	ID	Country	Organization type	Project types summary
Remote rural	Ro1	Uganda	NGO	Wildlife rescue, poaching enforcement, poacher rehabilitation
	Ro2	Uganda	NGO	Forest outreach, alternative livelihoods, civic education
	Ro3*	India	Govt. & Park	People's Biodiversity Register implementation
	Ro4	India	NGO	Wildlife conservation, alternative livelihoods, civic education
	Ro5	India	Academia	Wildlife research, studying community perspectives
	Ro6	India	NGO & Park	Wildlife conservation, human-wildlife conflict
	Ro7	India	NGO	Wildlife conservation, community outreach
Peri-rural	Ru1	Uganda	NGO	Implementing various environmental projects for donors
	Ru2	Uganda	Park	Wildlife park with community-relations department
	Ru3*	Uganda	NGO	Community forestry, REDD+ implementation
	Ru4	Uganda	NGO	Volunteer-run community forestry organization
	Ru5	USA	Government	Conservation district, grant-funded project implementation
	Ru6*	India	Govt. & Park	Wildlife conservation, outreach, ecology
	Ru7	India	NGO	Wildfire reduction, forest products, grazing management
	Ru8*	India	Academia & NGO	Wildlife rescue organization, human-wildlife conflict research
	Ru9*	India	NGO	Sustainable agriculture extension with demonstration farms
	Ru10	India	NGO	PBR implementation, environmental education, forest outreach
	Ru11	India	NGO	Participatory action research, riverbank restoration
	Ru12	India	Academia & NGO	Research: protected area impacts on Indigenous communities
	Ru13	India	Govt. & Park	Poaching investigation and enforcement
Urban	U1*	Uganda	NGO	Policy research, government transparency, civic education
	U2	USA	Government	Urban waterfront restoration with private landowners
	U3	India	Government	Large city forest department, handling tree and wildlife issues
	U4	India	NGO	Environmental education in many schools
	U5*	India	Academia	Urban wildlife research, human-wildlife conflict
	U6*	India	School	Teacher, environmental education

Table 5.1: List of participants, with brief summaries of organization and project types. (*Some participants discussed multiple jobs that fell into multiple categories, and their interview transcripts were split and assigned multiple participant codes for this analysis. Each of these pairs denote the same individual: Ro3 & Ru6, U1 & Ru3, U5 & Ru8, U6 & Ru9.)

community members, the role of mobile phones in community relations, current communication challenges, and their technology ideas for community engagement. We discussed the COVID-19 pandemic and the resulting shifts in their organizations and community interactions, not as a main focus of the study but rather as a lens to understand the organizations' reliance on technology. Because of time constraints, not every interview reached all questions in the interview guide. Some participants had held multiple recent job positions that fit the study's inclusion criteria, and in these cases we discussed each of the jobs separately and sometimes in comparison.

5.4.3 Analysis

The interview recordings were transcribed and underwent inductive thematic analysis using the AtlasTI software [154]. Quotations were coded with topic tags on-the-fly during a first pass through all of the interview transcripts. A final set of codes was then determined; merging, splitting, and removing some; and then all of the interview transcripts underwent a second pass re-assigning topic codes to ensure consistency.

A divergent pattern emerged from the first analytic pass through the interview transcripts as we observed that participants' experiences with technology varied significantly by their location in urban vs. rural contexts, seemingly more so than by other factors like their country. Following this lead we divided participants into 3 groups based on their sites of work (Table 5.1):

- **Remote rural** participants in areas that were very remote and usually difficult to access by road (where many conservation areas are located). These communities were often very isolated, had low rates of device ownership, and very low rates of electricity access and network connectivity without traveling considerable distances.

- **Peri-rural** participants worked in areas with low population density that were easier to access and generally more well-connected by roads. These communities had a high or medium degree of cellular device access, network connectivity, and electricity access.

- **Urban** participants, working in population-dense areas where a large proportion of target

communities had high degrees of technology access and connectivity.

Some participants discussed multiple jobs that fell into multiple categories, and these interviews were split into two and each segment was assigned a separate participant code. In our write-up of the qualitative data, we do not identify which specific participants made each quotation or statement. (This was a condition of our IRB and and consent form; participants were told that quotations would not be attributed specifically to them, to encourage participants to discuss their organizations and projects more freely and critically.) This report also uses he/she/they gender pronouns interchangeably when giving quotes or statements from participants to further protect their identities.

We analyzed the interview data using a process-outcomes matrix approach [270] (Table 5.2) to understand the connections between local technology access, interaction structures between organizations and communities, and social impacts. Our sample is not large enough to quantitatively infer correlations or causality with any statistically significance. Instead, we directly asked our participants about their own beliefs regarding technology's causal impacts on their organizations' work and community relations, and we offer qualitative evidence informed by their own experiences.

5.5 Results

We conducted interviews with 22 participants (Table 5.1) spanning 3 countries: Uganda (N=6), India (N=14), and the USA (N=2). Participants represented several organization types including conservation parks, government agencies, academics, and NGOs engaged in project implementation and advocacy. Participants were involved in a variety of sectors including wildlife conservation, agriculture, forestry, anti-poaching, water, oil development, and ecotourism.

All participants had community-facing roles (to fit the inclusion criteria), and all stressed the importance of building strong community relationships for a variety of reasons. Building rapport for research was one common reason, learning about communities' environmental perspectives and practices. Others built relationships with communities to implement projects, working

Figure 5.1: Diagram showing our process-outcomes analysis framework. We investigate how communities vary in their access to technology, how it shapes each organization's technology-mediated community interactions, and the resulting institutional and social effects.

closely together to co-design projects that suite their needs, and develop local capacity to continue the project when the participant was off-site. In some instances, participants worked with communities in attempts to change behavior. Many worked to energize communities to take environmental actions, such as supporting public policies, adopting environmentally-friendly agricultural practices, or protecting wildlife on public lands. They described a wide variety of technology uses with communities: in some cases they were intentionally planned, and arose organically in others.

We analyzed our qualitative data with a process-outcomes framework: as each community's technology access varied from place to place, we asked how organizations used technology to interact with communities (Figure 5.1). From there, we analyzed how the ICT-mediated interactions affected the organization's structures, project choices, and operations; as well as technology's influence on social factors and community relationships. In this analysis, three categories emerged with different patterns of technology use: organizations operating in urban places, remote rural places, and peri-rural places (rural but not remote).

This section is structured by our process-outcomes framework (Table 5.2), going through each of the categories (remote rural, peri-rural, and urban) and for each one describing technology access in communities, organizations' technology-mediated community interactions, and institutional and social effects . We lastly describe cross-cutting themes that were common across the

three groups.

5.5.1 Remote rural organizations

Some participants' organizations worked in very remote rural communities such as those situated deep in forest reserves, nestled high up in mountain ranges, and spread across vast deserts. These locations are characterized by their isolation, and most were very difficult to access by road. For example, one participant reminisced that he had worked with a village that required him to make 12 river crossings, each way, every time he visited. Another participant worked with desert communities, traversing difficult terrain where roads could not be built because they would quickly disappear under shifting sand dunes. These communities' remoteness in many cases led to a distinct lack of public services like schools, healthcare, and electricity.

Despite their difficulty to reach and lack of services, a high proportion of our study participants worked with these communities because conservation projects are often located in these remote, undeveloped places. In some cases participants worked with communities who were living illegally in protected areas and denied government services as a coerced incentive to relocate (as asserted by some participants but disputed by others): *"the government says 'if you leave the protected area, then we can provide.' "*

Environmental organizations worked with these communities for a variety of reasons: sometimes to advocate on their behalf, sometimes to encourage them to relocate out of the protected area, or sometimes to encourage alternative livelihoods less damaging to natural resources. Some other participants engaged with them mainly for research, not working to change anything but rather seeking to to understand their knowledge and perceptions of local wildlife.

Community technology access

Communities in remote regions faced major technology access barriers: many participants worked in villages lacking electricity, far from cellular towers. Language, literacy, and education barriers also frequently created challenges for technology uptake: many communities in these isolated regions spoke distinctive languages and dialects. One participant noted that many government

Table 5.2: Process-outcomes matrix analysis

	Remote rural	Peri-rural	Urban
Technology access in communities	Low/mixed device ownership Low/mixed literacy Low network availability: in some cases people could travel distances for network access Very low smartphone/internet access	High device ownership High/mixed literacy High/mixed network availability Low/medium/mixed smartphone/internet access	High device ownership High/mixed literacy High network availability High/mixed smartphone/internet access
Technology interactions; influences on organization structures and operations	Environmental organizations commonly mediate between isolated communities and government agencies, using phones to pass along messages Passing information via relay chains; e.g. calling someone in one village, who passes a message on foot to the next village, sometimes in chains Common use of 2-way radio	Many organizations have intervention-style projects, and use ICT's to coordinate parallel projects across many sites. Common hub-and-spoke organization structure. Central offices use phones to keep in touch with designated point-people in rural communities. Top-down data collection and accountability mechanisms, often using picture messaging when available. Most made no attempts to broadly engage whole communities using mobile technology; instead just interacting with key individuals. (Exceptions: some radio ads, some limited use of WhatsApp groups.)	Mass communication to advertise organizations and raise support for environmental causes over social media, email lists, websites. Sometimes lively group discussions with social media and WhatsApp More use of visual media for complex communication, like considering options for a restoration project..
Social impacts of technology	Organizations act as liaisons/advocates for remote communities that are prohibitively remote/difficult for governments to reach; keep in touch via tenuous phone communication channels. In many cases, environmental organizations become a community's trusted link to the outside world. E.g. some participants received calls from remote communities asking for help understanding covid-19.	No attempts to begin new relationships over technology, relationships must start in person. Imposition of top-down structures via accountability mechanisms Formalization of relationships. Communications over messages become more terse, lacking "warmth." Sometimes it is hard to gather rich information about what is really going on in communities, people tell you more what they think you want to hear In some cases, participants used phones to keep in touch and maintain warm relationships	Beginning relationships with new audiences over social media Mass communications reach large audiences, but often only with superficial interactions. Promoting awareness of causes or political positions. Language barriers create social inequities in group discussions.

schemes required a mobile phone, leading to the further exclusion and marginalization of these groups.

Nevertheless, communication technology is still percolating into these very remote places. One participant described *"someone might have a mobile phone, but to get in touch with someone he has to travel some 15 kilometers or 20 kilometers to a point where he can get well connected to the network."* Other participants described cases when some community members had mobile phones even though they could not use them at their homes, and used them when traveling to towns for work or business.

Technology use by environmental organizations

Communication technology still played an important role in environmental organizations' work with these remote communities, despite the low levels of access. Organizations relied on mobile phones to pass messages back and forth to communities; often to coordinate plans for visits and deliver updates on government processes. Several participants described having to relay messages through multiple intermediaries to reach these remote communities:

> *"Most of time they're loose [tenuous] communications, or there's no telephone signals for that area, so they pass the message to the nearest village or [person who works or volunteers for the organization], and that local person provides the message to another village or another community... Sometimes it's a direct message to the community, sometime it's like step by step... It's like a message for their problems, or whatever [the organization] has done to get the problems from the community and try to pass it. They work as a postman to take their problem to the government, administrative bodies or local authorities.... So [the organization] tries to provide good news for the local communities: that they solved their problems; that the local authorities heard them... Sometimes it's for some resources, like [the organization] provides them some things, and provides the message 'we have purchased this for you; we will reach you so try to not go anywhere; meet at this place for our person at this time.' So lots of these kinds of messages are*

deployed by a step-by-step process."

Multiple participants also reported using 2-way radios to communicate with villages where cellular reception was not available, frequently as a link in these message-relay chains: e.g. someone might call a leader in one village, who passes a message to the next over 2-way radio.

Some participants reported that their organizations had made efforts to set up telecommunication infrastructure in these remote communities, to improve their abilities to reach them. In one case, they provided smartphones and trained people to use an app for patrolling. Another participant reported an instance where an organization brought technology and training into communities to encourage economic development, believing that this would eventually lead them to find jobs in other areas and move out of the protected area. One organization landed in trouble with the government for trying to provide infrastructure, though—several participants described how governments forbade the installation of cell towers and other infrastructure, for fears of increasing economic activity in the protected areas and facilitating technology use by poachers; as well as fearing negative effects on flora and fauna (especially birds).

Technology influence on organization structure, projects, and operations

As these remote communities were so isolated, environmental organizations frequently served as a bridge to the outside world. Some participants' organizations focused specifically on civic education: teaching people how to interact with the government, empowering them to approach the government for services, understanding what authorities can do and how to access resources. Several organizations also acted as direct liaisons between communities and the government, helping them navigate processes and government programs like compensation schemes. One noted that the tone of government communications was very formal, and their organization tried to make the tone more accessible. Providing context, one participant described:

"They don't even know about what is the life outside their village; something that happened because they live in the these kind of remote areas. Even they said it's very hard to

> *reach the cities for severe medical conditions. If someone dropped down from the mountains, more than 120 feet, they need emergency medical services. But they don't know where to reach, so the people die on the spot. Every kind of community, every landscape of communities has different needs... So when we talk, we only say* 'what's your problem now? How do you think, how does your community think of what should the authorities do for you? And what do you want back from authorities? And what are your kind of thoughts?' *We give them a window to what authorities can do for you, what authorities want with you, how can you incorporate with them, how is it possible, how is it profitable or sustainable to you, especially for the conservation. So it's a very delicate thing to communicate with them or to try to understand their problems. Because we don't know; we've never suffered these kinds of harsh conditions. Because if you want medical service, we just call an ambulance within 2 or 5 minutes. But in the community areas it's very harsh. They don't even know what an ambulance is, still."*

These interactions were made much more efficient by mobile phones, despite their limited access. Phone communications allowed organizations to keep communities updated as they raised issues with the government and went through processes, and send news of new resources. They also gave the organizations a greater ability to know about changes and new issues in the communities, especially given the difficulty of in-person visits. One also described that ICTs helped make their in-person visits more effective, by passing messages to coordinate beforehand, announcing future meetings and ensuring that key people would attend.

Multiple participants in India had interactions with government forest departments in their work with remote communities, sometimes using their radio system to pass messages. One participant reported that sometimes the forest department would approach her for help interacting with the remote communities since she had prior relationships.

Remote environmental organizations typically did not try to engage whole communities over ICTs, needing to visit in-person for this purple. Rather, they only had phone interactions with local leaders or a small number of key individuals. One clarified that word still spread quickly

around the remote communities because they tended to be small and close-knit: *"everybody knows everyone. So in case you need to reach out to me you do not need to call me, you can call anyone in the village and I get the message."* Participants working in these remote communities made many mentions of big meetings to spread news and energize whole communities around issues; this required a physical presence: *"They announce things very loudly, and collect all the people to one place."* One held sessions with dramas and skits to educate and energize people around issues. Some used posters and fliers to spread messages around the communities, sometimes relying on pictures because of low literacy in the communities.

The limited telecommunication infrastructure made organizations' links to communities much more fragile during the COVID-19 pandemic, and many had to stop work entirely. One had completely lost contact with the communities where she had been working: *"All my contact people who [I had been working with], I don't even know if they are alive."* Another regretted that they had not built telecommunication capacity and done technology training in these communities earlier, and noted that this made their work very difficult during the COVID-19 pandemic.

Technology influence on social factors and community relationships

Many participants described a severe distrust of institutions in remote communities, from prior experiences of governments and NGOs trying to force them to move, extracting resources, or making promises that they don't fulfill. One described these hostilities: *"They don't know about education; they don't know about other cities. They want to protect themselves—if you are from the forest department or army they will attack. Don't wear camouflage."*

Participants stressed that building trust with remote communities was an especially slow process. Some organizations relied on having long-term staff living with communities to build trust, or making extended visits. Another relied on making frequent visits instead, because they could not get permission from the local government to live there or make longer stays. Multiple participants discussed the importance of speaking the local dialect to gain trust. One noted the importance of wearing traditional clothes to gain trust, or bringing local people along when approaching new communities: *"When I go alone, they don't have anything. They don't want to talk*

to you. They close their house; they don't tell if you are alone. If you have local people with you, then they will tell. They [must] know about tradition, how we speak, because the communication level is very important." This delicate process of trust-building cannot happen over the phone, and requires intensive in-person efforts to begin relationships.

Multiple participants described how remote communities were often intimidated by technology, perceiving it as formal, official, and suspicious. One said *"If you have a mobile phone then they won't tell you. If you have any mobile phone, hide it. Because they think 'they'll click my pictures, they'll record my voice.' "* However, one participant remarked that technology (having a laptop) gave him credibility with local youth even though it sparked suspicion among the elders.

5.5.2 Peri-rural organizations

The largest number of our participants worked in *peri-rural* communities, outside of cities and having far lower population density, but still well-connected by road networks. The relative ease of reaching these communities affords higher levels of service from governments, businesses, and NGOs relative to remote rural sites (e.g. more schools, etc.). Electricity and network connectivity were generally available in these communities, though in varying levels, and often having differential access among subpopulations within each one. For example, many participants described cases where some community members had to travel short distances to get network reception.

Organizations working in peri-rural regions tended to have more directly hands-on, intervention-style projects than their urban and remote counterparts; working with communities to implement various projects, change behaviors, or set up infrastructure. For example, some of the organizations pursued tree-planting projects with communities, alternative livelihood programs to reduce dependence on natural resources, anti-poaching efforts, forest and landscape management, certifying trees for REDD+ carbon credit payments, wildlife monitoring, and habitat improvements.

Most of the organizations worked across many sites, implementing similar projects with many different communities. This section shows how the availability of ICTs enabled them to utilize institutional structures for coordinating these projects across various sites: collecting and distributing information, monitoring project status, and employing accountability mechanisms. Many of

these participants coordinated across many institutions, like NGOs partnering with local leaders, coordination between multiple government agencies, or small organizations implementing projects on behalf of large donors; ICTs helped them coordinate projects both vertically and horizontally across these various organizational structures.

Not every organization followed this pattern, though. A smaller number worked in only one long-term site or very few; they still made heavy use of mobile phones for reacting quickly to urgent situations, making themselves available to handle issues or questions as they arose, or keeping in touch during the isolation of the COVID-19 pandemic. Some other participants only made one-time visits to communities and never returned for followup, and did not need to create longer-term relationships.[1]

Community technology access

Mobile phones were present in all of these peri-rural communities, despite many of their high levels of poverty and patchy infrastructure. Each community had different levels of basic phone and smartphone ownership, though; and device ownership was often heterogeneous among the community members. For example, some areas had high levels of smartphone ownership among all demographics; there were also communities where phone ownership was mixed between smartphones and basic phones; and in some others, most people had basic phones and smartphones were uncommon.

Some degree of network connectivity was also available in all of these peri-rural communities. This also varied from site to site. Most peri-rural participants reported that reception was patchy in the communities where they worked, with reception available in some places but not in others nearby (sometimes because of sparsely-distributed phone towers, and also often geographic

[1]Most of the cases where participants made one-time visits were organizations implementing *"People's Biodiversity Registers,"* a program created by the national government of India and implemented by various agencies to record species occurrences around communities and document their traditional, food, and medicine uses; also formalizing certain legal rights for communities to harvest and export the natural products in the process [144, 145]. Several participants worked on these People's Biodiversity Register projects, making 1-time, multi-day visits to communities and facilitating the process through a series of workshops with key community members. In many cases, they still relied on mobile phones and two-way radios to coordinate the visits before their arrival, and sometimes used mobile apps and multimedia to help identify and discuss the species present in each area.

features like hills)[2]. It was a *very* commonly-described case for community members to regularly travel to get reception; for instance, some had reception at their workplace but not at home. One described:

> *"I've seen the remotest places in [this region] and everyone has a mobile... I'm very sure about it. But there are not networks easily available... To make a call you need a basic phone, and sometimes they have to travel at least 100 meters or 200 meters from their house and keep it in a place where they get network. I've seen these things happening, but still every household has a mobile."*

These differences in device ownership and network connectivity led to high usage of mobile apps, Internet usage, Facebook, and WhatsApp among some communities; whereas communities with more basic phones and poorer networks relied more on SMS and regular voice calls.

Participants frequently reported that technology access within each community varied along demographic lines like gender, ethnicity, caste, and economic status; agreeing with prior literature in ICTD (Section 5.3.4). For example, many participants reported that smartphone ownership was higher among youth than elders, or higher among men than women. Sometimes smartphones were common only among higher-level officials in a village, or people who traveled for outside work. Literacy and formal education were heterogeneous within this peri-rural sample; very high in some places and mixed in others.

A large number of participants in these peri-rural areas reported that language barriers were a significant challenge for using technology with communities[3]. Many participants found it hard to find mobile apps in the local language, even for languages like Swahili or Malayalam that are spoken by tens of millions of people. Some communities spoke in distinct local dialects, further

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[2]Network connectivity was sometimes available in surprising places. One participant reported fishers using mobile apps at sea, and able to get good reception. However another participant reported that fishers used smartphones at home, and push-button phones on the water because they were cheaper and prone to water damage.

[3]Language barriers also posed significant challenges for organizations working in these communities, aside from technology adoption. For example some had to hire interpreters, and multiple participants described how reliance on interpreters created additional challenges by adding *"noise in the signals."* Another described how their organization lacked the capacity to develop posters and other resources in the local languages.

complicating this problem. Optimistically though, one participant remarked that auto-translation software had improved enough in the past 2-3 years that it was beginning to be useful for these problems.

Environmental organizations' technology use

Most of the organizations in peri-rural areas relied on a variety of ICT communication channels to coordinate parallel projects across many different spread-out communities, and keep in touch with local people when they could not always be physically present themselves. Many staff described how network connectivity was crucial to their organizations' projects, and the often-patchy connectivity is a major obstacle for their success[4]: *"Network is critical, you understand, and [the government] needs to take an extra mile to improve the network coverage."* Further punctuating the importance of ICT infrastructure, several peri-rural participants described that their organizations provided smartphones and tablets to key individuals in the communities (often accompanied by training) to keep in touch, report certain information, or collect data.

The predominant ICT communication channel between environmental institutions and peri-rural communities was voice calls, because of basic phones' widespread availability and mixed network access. A majority reported using voice calls very heavily, making and receiving calls with communities for a variety of purposes: arranging field visits, coordinating projects, discussing emergencies or new issues that arise, or simply keeping in touch. A few regularly used SMS to keep in touch, often because they were easier to send when reception was poor; though some participants noted that SMS was inconvenient, difficult or inaccessible for some community members. A small number of participants working in communities with greater technology access used communication channels like Facebook messages, video calls, email, and websites for coordinating work and keeping in touch.

Most peri-rural participants described ICT communications that were bilateral (between two

[4]A few participants had their organizations' work disrupted by government-imposed internet blackouts in Uganda following the 2021 election, making it hard to reach their community contacts and follow up on projects. One also reported that wildlife tracking devices all stopped working, which relied on GSM.

individuals), like a call between just one staff and one community member. A small number, though, were able to use WhatsApp for group conversations among several community members and government officials. A couple other participants suggested that they would like to use WhatsApp groups but not enough community members had smartphones.

Many participants made heavy use of picture and video messages, finding them especially helpful for communicating details about issues that were hard to describe. For example, one said that they often asked people to send photos when they called with an issue, to get a better understanding. Some also relied on photo messages to provide evidence for accountability purposes, like proving to donors that work was happening. Especially in areas where sending pictures and videos was difficult, several participants also used their phones or brought projectors to show videos and photos in in-person presentations, for purposes like educating community about threatened wildlife or training people to identify certain animal tracks.

Most organizations used unstructured communication channels like SMS, voice calls, or Whatsapp to collect data and reports. However, a few used specialized structured applications like Open Data Kit [60, 166] for data collection and management, and a small number had developed custom mobile apps for this purpose. Some also mentioned institutional use of other mobile apps in their work, like various GPS mapping applications, or apps for identifying plants and animals.

Technology influence on organization structure, projects, and operations

The largest outstanding institutional change from ICTs in peri-rural organizations was that it allowed many of them to effectively coordinate projects among many different communities, when their staff could not always be physically present in the field. In most instances, organizations relied on mobile phones to orchestrate projects top-down, while still collecting information up the management chain to adapt to feedback and changing circumstances. In some other instances ICTs helped to coordinate projects laterally: one participant described starting a WhatsApp group of motivated volunteers who used the group to discuss environmental issues affecting them, share ideas and opportunities, share pictures of how they did things, and compare their work.

(Notably, much of this section about coordination does not apply to the organizations that

only worked in one long-term community or just made one-time community visits. However they still relied on ICTs for some project-implementation purposes, like like quickly learning and reacting to urgent situations, making themselves conveniently available to be contacted by community members with questions or issues, or making arrangements before their visits.)

Delegates and hub-and-spoke management. Many organizations relied on hub-and-spoke management structures to implement projects across communities, appointing a key person[5] in each community to take charge of the project, coordinate with the organization's central management, and liaise with the community. These key people went by various names: *"project leaders," "conservation committees," "community representatives," "community stewards," "focal people," "change agents," "forest monitors,"* or *"watermen;"* in this paper we will refer to them as *delegates*. The delegates received payments in some instances, and were volunteers in others. Some organizations focused on training delegates for project sustainability, so that a community would take ownership of a project and continue it after the external NGO or funding source had left.

These delegates were tasked with getting communities excited about projects, carrying out project work (like managing irrigation systems), coordinating work among organizations and community members, collecting data, relaying information to community members, arranging meetings, and sometimes translation. Many participants also described how working closely with the delegates helped them gain trust and buy-in from the communities, having delegates leverage their own social networks and good community standings to build support. During the COVID-19 pandemic, several organizations shifted more responsibility to the delegates since organization staff couldn't travel to communities themselves: for instance one participant described how delegates went door-to-door to discuss issues with communities since they could no longer have big meetings. In another example, one said:

[5] Many institutions had established processes to identify key people to act as project delegates: sometimes working with local leaders like government officials or other influential people, sometimes asking village leaders for recommendations, sometimes holding large community meetings and asking for nominations or elections, or sometimes just asking for volunteers. Several participants stressed that the process of choosing delegates was important to the projects' success, needing to be someone well-connected that the community trusts, and noting that delegate selection can sometimes lead to disputes and jeopardize projects.

> *"Once the first [COVID-19] wave went down and we understood the illness, (or what we thought we understood at that point), we slowly started to start work again. But we kind of decentralized everything. We didn't go there as much, and we would use phones [and] WhatsApp to communicate. There was a lot of back and forth, of photos being sent, in terms of what work was being done. I actually managed to coordinate a restoration project only through the phone with one of the community stewards who I had worked with, and he did a fantastic job despite the community being very new to the organization... He would send me photos and then we would talk on the phone and he would give me updates."*

Many organizations kept in close contact with these project delegates with ICTs as their main way to interact with communities (when they couldn't be physically present), instead of trying to engage the whole community over the phone. For instance, one participant reported that he asked community members to contact the delegates with issues instead of calling him directly, finding it more effective and efficient for the delegates to resolve the issues locally. Several participants also described how they worked hard to build trusting relationships with delegates through frequent communication, and they became vital sources information about the goings-on and issues facing the community.

Data collection, monitoring, and accountability mechanisms. Institutions often also used ICTs to task these community delegates with structured data collection, sent up the organization's management chain for project coordination and accountability purposes. Delegates collected data for a variety of purposes: project implementation statuses, wildlife sightings, reporting illegal activities like poaching and charcoal burning, or surveying which crops farmers were growing in an area. These tasks were often fairly labor intensive for delegates and constituted a major time commitment from them: for example, sometimes they went door-to-door visiting households, or made daily checks of an area. Most often, the delegates reported the data to the central organization using unstructured communication channels like voice calls or SMS messages: for example, one participant had engaged some fishermen to monitor activity at otter dens and they called

him 6-7 times weekly with short updates. Some other organizations used picture messages for this purpose, to create a trail of evidence, identify unknown animals, or capture field conditions that were difficult to describe. A small number also used Open Data Kit or custom software, like a case where forest monitors used a custom app for their complex workflow mapping properties and recording the state of trees to certify them for carbon credits.

In some cases, organizations used ICTs for accountability mechanisms to keep track of the delegates' work, especially when they were being paid. For example, one organization required delegates to take pictures of themselves when they went to the field to prove that they were carrying out the work, also relying on the phones' automatic tagging of time and GPS coordinates in the picture. In another example, one organization asked delegates to take a photo showing the number of participants who came to community meetings. While organizations sometimes used these ICT-based accountability mechanisms to keep track of workers on their payroll, sometimes this data was sent upstream to donors in another layer of checks, to prove to the donors that work was happening. (One participant argued that these mechanisms were ineffective though, and that people always found ways to evade them.)

Large group engagement and it's difficulties over ICTs. Almost none of the peri-rural organizations tried to engage mass audiences over mobile phones or the Internet. Given the limitations of the most widely available technologies like SMS and voice calls, it was too difficult for the organizations to engage large groups in meaningful ways that significantly furthered the organizations' goals.

Engaging large groups of community members was highly important for most of the organizations' work, and study participants described a range of in-person community meetings for their projects. These interactions are simply too complex to handle over a constrained channel like SMS. Several held large community meetings to plan projects, bringing together different stakeholders with local leaders to understand the community's needs, resolve disputes, and get the community's buy-in for the project. In one example that highlights the social complexity, a participant convened community meetings after a devastating wildfire to discuss the commu-

nity's potential steps forward. Meetings are also important for exciting and mobilizing people; several participants described that their biggest challenges were energizing communities to take action. They worked hard towards this goal, investing substantial efforts into designing community meetings and presentations, sometimes showing plays and educational speakers. This particular vignette by a participant highlights the complexities of these community-wide interactions, showing the critical importance of tone, nuance, and group dynamics; and underscores how difficult they would be to re-create over such a limited channel as SMS:

> *"We were working on the forest fire campaign [and] it was very difficult to convince them—the people who are using the traditional way of collecting firewood—that it is not all good for your health as well as your time, because you will take a lot of time collecting firewood, storing them, [and] having suffocating smoke. Instead, you can have the small latest versions of stoves which require [much less wood] and also not smoking. So at first they were very reluctant. Later, some initiative gave new stoves to the poor people, and they said it was better, so then people started to buy it. So it takes a lot of time investing. So first of all, I say taking the trust from the people is a difficult task, and that has to be done very cautiously....*
>
> *We can't force them. There are some religious issues also; we have to cope with that. We can't say 'you can't cook inside the forest;' we can't say that outright. We have to explain the consequences of cooking inside the forest in dry weather like summer. It's not that easy. We have to tell them in a way that doesn't hurt their feelings. And definitely, out of a hundred there will always be two or three people against us, whatever we say... We have to maintain the balance. What I found out in the past 10 years is that there will always be one person saying that this is bullshit he's talking about. But there are people who are listening to you, and you have to grab their attention and they can come to your intention... I found people will always oblige you when you're saying the facts, and not demanding them or not forcing them."*

In some cases, organizations also routinely engaged large communities one by one, employing staff or delegates to visit households door-to-door, sometimes broadly or sometimes targeting key people. This was very time-consuming and resource intensive, but participants felt it was often quite impactful for building relationships, sensitizing communities about environmental issues, learning about local issues, and conducting interviews and surveys.

Some organizations had used other forms of media advertising to promote agendas to mass audiences. A small number used radio advertisements but participants noted their many disadvantages: radio advertisements were prohibitively expensive for many organizations, community radio stations were unavailable in many places, and the wide geographical ranges of radio stations' broadcasts often carried far beyond the specific communities they sought to target. Several organizations used posters and fliers to promote agendas, but many expressed skepticism of their effectiveness, sometimes noting the spammy over-abundance of posters in many areas.

Though the large majority of peri-rural participants did not attempt mass community engagement over ICTs, there were a couple exceptions. One regularly sent bulk SMS messages to community members, manually sending them on his personal phone to 50-100 people at a time; with messages reminding members to plant food and trees before the rainy season, or asking how many people raised the tree saplings they received, for example. He felt it was a highly effective way to interact with communities and was eager to try technologies to automate these messages and make them easier to send. Another had began conducting farmer interviews over the phone during the COVID-19 pandemic and found them more cost-effective than the prior in-person interviews. He had gotten their phone numbers from local leaders, and felt that the farmers agreed to participate because of the local leaders' support. A small number had successfully used WhatsApp groups with community members for purposes like coordinating field visits, coordinating compensation for plant diseases and wildlife kills, and exchanging project ideas and opportunities among volunteers. Some noted problems moderating spam on WhatsApp groups, however, and many communities lacked enough smartphones to use WhatsApp groups.

The benefits of mass community engagement—like handling complex social dynamics, exciting communities to take action, and building consensus towards suitable plans—were very hard

for peri-rural organizations to replicate virtually, especially where technology access is limited to basic phones. Social media, multimedia, and video chats may be better equipped to these tasks, though they were not widely available in most of these communities at the time of these interviews. However, technology access in many communities is changing fast and these abilities may soon improve.

Technology influence on social factors and community relationships

In many cases, ICT adoption led to more structure and formality in organizations' community interactions. In some cases this was intentional: organizations employed systems for implementing projects to donors' specifications and ensuring consistency; and they sought to efficiently balance the unique needs of each community while working at scale across many sites. Some participants described gradually moving to more-structured interactions to simplify management tasks: for example, one had set up WhatsApp groups for coordinating meetings and specifically instructed members not to post other things on them to avoid clutter. In other cases, organizations adopted more structure to collect data that was easier to manage and analyze: several reported switching from community members reporting data via calls and picture messages, training them to fill pre-determined forms in Open Data Kit instead.

While participants felt these ICT communications were useful for managing logistical minutia, several expressed that their phone interactions with community members became more superficial and that it was hard to learn important, complex information that was essential for working productively with communities. These conversations required a deeper engagement and personal warmth that was difficult over the phone. Several felt that mobile phones led to more formality in interactions, one remarking that *"...if I need to go through a system, then I feel a bit stressed out"* and wished he was able to better empathize with communities over the phone. Summing up the issue, one participant offered that: *"For serious issues it's very difficult to go over the phone and talk about it. For stuff like... 'these materials are coming tomorrow and you have to come get it,' these [types of issues] are fine on the phone. But when you have to talk about something—a serious matter—like a thing that might affect the community, or something the community is going through*

but no one knows about, I don't think that talking over the phone can do much."

Multiple participants felt that their organization's shift towards more phone interactions had led to less time visiting with communities in person, face-to-face. (This was especially true during the COVID-19 pandemic.) Some worried that this chilled their relationships with community members; they felt less comfortable speaking freely and expressing their true wants and concerns:

> *"[When communicating more over the phone,] I think they just kept putting things that they thought you wanted to see, rather than thinking out of the box, and rather than just being uninhibited and saying what they wanted to say. Because we are using these things to just track updates and things like that. But when you go to the field certain stories come out which you won't be able to capture through technology. It's personal things which come out, and you're able to build relationships better when you're face-to-face. Technology is a good substitute during tough times, but I don't think it would be able to replace the kind of intimacy and relationships you build while you're working with communities in the field."*

Furthermore, these participants expressed concerns that the increased reliance on mobile phones had dampened the communities' voices in project designs and diminished their agency and decision-making power. ICTs allowed organizations to arrive in communities with more structures preemptively already in place like coordination systems and accountability mechanisms, perpetuating more top-down control of the projects by upper-level management and donors. Several felt that these mechanisms made it difficult to adapt the projects to each communities' specific wants and nuances: one felt that organizations came in with more fixed objectives than before, and another complained that too many projects were designed *"through your organizations' needs and wants"*.

Interestingly, one participant observed that the technologies available in these rural communities—like SMS and voice calls—inhibited communities' abilities to advocate for themselves directly. Instead, they could only relay their concerns to representatives of organizations who passed them through layers of bureaucracy in a telephone game, where they gradually lost their meaning:

> *"See for us, we're privileged enough to have social media and everything, and whenever something's happening we can put it out there. People get to know what's happening and what's not happening. But for people and communities in rural areas, even if they wanted to say something about what's happening, or share ideas with a broader network, or advocate for change or something like that, it's very difficult for them. Because number one, they don't have proper Internet connection, and [they're] not really familiar with the whole social media thing. And in that way, even if they do send out their problems or their ideas or concern or whatever to these organizations, it gets a little bit misinterpreted in a way. Where you know, what they really want to say gets to these organizations, and a little bit goes from the organizations to the forest department. So it's like, it goes through certain people, and it reaches a certain destination, and in the way the message becomes kinda like, not as important as the first person portrayed it, or something like that. It's kind of like sad to see that they're not able to really voice out their problems or concerns directly."*

Several participants lamented that too much top-down decision making often led to project failures and poor outcomes for communities, and worried that increased reliance on ICTs was perpetuating this problem: *"That's the thing, right? We think that we're the ones telling them what to do, but actually it's the other way around. We hardly ever listen to them, and I guess that's where I feel the problems lie."*

5.5.3 Urban organizations

Some participants worked with communities in dense, urban cities. In many cases, they had built their organizations around engaging communities with technology differently than their rural counterparts in part because these communities had better access to richer interactive technologies like social media, group chats, and digital multimedia.

Our urban participants came from various organization types and sizes; in government, academia, and NGOs. Their varied activities included private landscape restoration, managing urban wildlife

issues, environmental education in schools, activism to hold government accountable to the public, and urban wildlife research. Similarly to rural organizations, most of the urban participants worked to engage many sub-communities within the city, and worked to build long-lasting relationships to carry out their missions and projects. There were a couple exceptions: one described their organization working with *"more a churn of new people all the time"* rather than persistent relationships; another had their main community interactions by working with TV news channels to make broadcasts in a largely one-way interaction.

Community technology access

Urban participants described decidedly more technology access among their target communities than their rural counterparts. They unanimously reported high rates of smartphone ownership, high network connectivity, reliable electricity, and high literacy. Laptop and desktop computers were much more prevalent among urban communities. Following the improved network and device access, community members made much greater use of Internet-enabled ICTs like mobile apps, social media, email, and websites. Many participants also described a widespread adoption of video calls during the COVID-19 pandemic.

However, some participants described working in cities where some demographics had considerably less technology access, often along along racial and socioeconomic lines. For example, some participants remarked that certain groups had less desktop/laptop access, less reliable connectivity, or different patterns of social media and app usage. Notably though, most participants reported that their organizations did not work much with these less-connected demographics; not specifically because of their lower technology access but rather because of their organizations' histories targeting more affluent groups. Several of the participants were making efforts to better connect with underserved community segments; one noted that they were ill-eqipped to market their organizations to them, partially due to a lack of knowledge about their ICT access and usage. Additionally, some participants also described language barriers among community members (also along racial and socioeconomic lines), but this may not have been as significant of a technology-access barrier compared to rural regions.

Technology use by environmental organizations

Unlike organizations in rural regions, urban participants made much more use of technologies to broadcast messages to large audiences. A few had leveraged radio and TV programs to spread awareness about issues like urban wildlife or government policies. Importantly though, the wide availability of social media, websites, and email lists made it significantly easier to engage large audiences—most participants reported using these technologies to advertise and raise name recognition for their organization, promote events, or boost public awareness of causes.[6] One had used paid advertisements on Facebook, having won some credits through a grant, and found them helpful for reaching new people. Some participants also tried to spur group interactions among the community, (reporting mixed success), by making posts about interesting conservation facts and encouraging people to respond.

Many of the participants described frequent messaging with community members to discuss individual issues; e.g. reporting a fallen tree or asking questions about something on their property. Several reported that they used a mix of different technologies to accommodate community members' varying preferences, juggling combinations of SMS, email, WhatsApp, and Facebook messages, for example. A few participants described taking phone calls from community members, but in general these urban organizations relied more on messaging than phone calls, relative to their rural counterparts. Many of them fielded large volumes of messages every day.

Most urban participants had began using video conference software (most often Zoom) to engage with the communities, spurred by the COVID-19 pandemic. They described a variety of uses: one-on-one meetings with individual stakeholders, large group meetings with community members (sometimes recreating specific events they'd previously held in-person), as well as internal use among staff. Some described downsides: one reported wasting time when community members scheduled meetings but frequently didn't show up, and some reported that they needed

[6]One organization used broadcast media to mainly educate the public about the governments' environmental actions, regulations, and policies. This use of ICTs as a bottom-up accountability mechanism makes an interesting comparison with the top-down accountability mechanisms used by many peri-rural organizations as discussed in section 5.5.2.

to spend significant time teaching people how to use video calls.

A couple participants reported an unexpected silver lining of the pandemics' shift to video calls, finding that they bad begun to make more effective use of multimedia in community interactions. They expressed that this was a big help with planning and communicating about complex topics. One described pulling up GIS mapping tools during Zoom calls with community members, finding them really helpful to excite people and spur discussions. Another used video calls to go on a virtual field trip, with photos and videos showing them starting at the school, getting on a bus, and exploring sites. One also had asked landowners use videos and photos on their phones to show aspects of their properties, noting that it was helpful to visually see the extent of flooding, for example. (In a notable comparison, participants from some rural organizations also described using multimedia like photos and infographics during in-person presentations.)

Technology influence on organization structure, projects, and operations

Perhaps the most striking difference between urban and rural organizations was that urban organizations made use use of mass-media to engage new audiences and begin new community relationships. Communities in urban regions are distinctly characterized by a saturated media ecosystem, and environmental organizations compete for audiences' attention against a smattering of other entities. (This is much less the case in rural regions with much less connectivity, where organizations can more easily draw attention to themselves by simply showing up.) Several participants echoed this problem; community members that they hoped to work with simply didn't know that their organization exists: one explained *"we have a name recognition issue."* Another echoed that not many people in the city knew about their organization, and even fewer understood the official channels and processes for interacting with them.

Faced with this problem, and equipped with better suitable bulk communication technologies (social media, websites, email lists, radio, or TV), most made heavy use of these technologies to advertise their organizations to new people who they had not previously interacted with, and to drum up continued interest from prior contacts. Some worked hard to attract new audiences through creative means: sharing stories on their own personal profiles, encouraging personal

connections to re-share stories, and even reaching out to influencers who had large followings. Several used social media and email lists to promote events, drawing people towards in-person interactions. A few were able to build community through lively social media discussions:

> *"We had a lot of people sometimes who would post on the [WhatsApp] group telling us [about other events], or they would be requesting a different kind of workshop: can we try focusing on gardening this month, or can we try having a tree walk? ... We would share infographics or fun facts or something. So we would also post them to our WhatsApp group, based on that also they would react to it; they would interact; they would have conversations. And sometimes it would lead to a full blown conversation about* 'what is happening, what should we do, how should we help, what do you think about the pollution,' *and all these things."*

However while several organizations were able to engage fairly large audiences, some participants felt they were only superficial and they struggled to have more meaningful engagements over these bulk media. For example, one organization had an email list with hundreds of contacts, but found that their emails had a low open rate under 10%. Another remarked that their events were effective at driving people to social media, but social media was less effective at driving people to their events. One participant who was heavily engaged in media and communication described their biggest challenge as energizing busy stakeholders to take action. Similarly, one of the participants with the most successful media operations still felt that in-person meetings were much more effective for bringing people on board.

Managing social media and bulk communications was very time- and resource-intensive for these organizations; and this was a considerable barrier for some. Some had dedicated social media staff, planning posts and narratives in advance and strategizing about how to promote them within the network: *"...consistency is the key! You need to make sure that you're posting regularly on social media in order to get more and more people."* One was always on the lookout for young volunteers who were good at social media.

Several reported that they had major challenges finding enough manpower to manage com-

munications. As a result, instead of increasing virtual engagement during the COVID-19 pandemic many instead fell behind from a lack of capacity. In addition, one reported that social media and communication work was hard to fund, especially as their organization's funding was tied to specific projects.

Participants also described difficulties managing the large volumes of communication coming into their offices via email, messaging, and phone calls. Several spent multiple hours every day fielding calls, messages, and email. One complained that it was difficult to triage and prioritize incoming messages, especially they often lacked critical details that required more back-and-forth to clarify, further slowing the process. One used a customer relations management software (SalesForce) to organize communications, but still described the process as tedious and painful. Another offered a pointed story that illustrated the difficulty making sense of so many communications coming in: they had to coordinate government agencies and NGOs responding to a dangerous animal spotted in the city, fielding information from emails, calls, and WhatsApp messages. They tried to locate the animal based on videos and pictures circulating around WhatsApp, and it was impossible to know which information was current what was old. He remarked that it was very hard to know what was happening in real time when the volume of information was so high.

Especially considering the cost of communications and community engagement, multiple participants described a rift between senior management and lower level staff: they wished their organizations would do more digital outreach but received pushback from senior leadership who were less interested, and did not prioritize community engagement. For instance, one described how their organization had no official social media, but some staff did on their own. One participant griped that before they worked for this organization *"...I was convinced they were defunct... because I saw their website was never up to date, I never saw them do anything, I emailed them once and never heard back."*

The shift to remote work during the COVID-19 pandemic also prompted geographical reorganizations of these environmental institutions, impacting their work with communities. One had permanently shifted to remote work and closed their central office; the participant was optimistic that this would allow staff to better serve communities spanning a wider area across the city since

they were all based in different neighborhoods. (However, they felt this had created more silos within the organization.) In addition, multiple participants felt that the rise of video calls allowed them to spend time more efficiently in their community work by eliminating several hours spent traveling each day between different sites.

Technology influence on social factors and community relationships

Communication technologies allowed urban organizations to broadly engage with large audiences, but most participants still reported challenges breaking past the superficialities of online interactions and building deeper relationships that would allow them to work effectively with communities:

> *"They will be too afraid to speak up… You cannot just call them and ask them: 'tell us what the problem is;' right? They cannot simply tell you what the issues are until you have a connection with them. Which is so missing. I just cannot emphasize more the importance of this. It's just missing."*

The participants who had the most success with online interactions had anchored themselves to institutions that already had strong community relationships, like churches and schools. They agreed that the existing familiarity, trust, and common identity that these community members already shared were an important factor that facilitated these lively interactions. One participant reported that they relied on the leaders of these partner institutions to know the goings-on in these sub-communities and better understand the issues they faced.

A few participants agreed that ICTs helped them provide the consistency that was necessary to build trust. One felt they made inroads into the community by making themselves readily available to answer questions, although it proved time-consuming: *"One of the drawbacks, occasionally, is I get [community members] that really like to text me. And that is not always great, but at the same time, I think it builds trust."* Another described that consistent outreach on social media was key to getting people to open up: by posting regularly, people began to form a habit of seeing your messages and became more comfortable opening up and engaging.

Though video calls can perhaps allow for richer virtual interactions, participants had little to say on whether they allowed for better relationship-building than other digital media. This is perhaps because video calls had not been in use for long enough for them to see the long-term effects. In some cases though, the ability to show pictures and videos in a call allowed staff to show examples of their organizations' work and sometimes clear up misconceptions (i.e. in one instance, when a landowner thought riverbank remediation involved just dumping rocks onto the bank, they could show pictures of prior work to show that they routinely planted native vegetation instead). This convenient multimedia interaction allowed them to reassure skeptical community members and gain their confidence.

The organizations featured in this study mostly tended to work with wealthier, higher-status communities within their cities; and none specifically targeted lower-income lower-status demographics. One said that he had never seen his organization have an official interaction with anyone who wasn't *"economically well-off."* However, several participants expressed that changing this was their personal highest priority.

Several participants reported that they were in early stages of trying to figure out how to engage these communities. A few were in communication with leaders of local community organizations to begin these relationships. One described that they were working to find strategies to advertise themselves to lower-income and diverse racial groups, investigating *"...more effective ways to reach them... like how these people are consuming their news, or learning about things; and obviously that's extremely broad."*

Although underprivileged demographics usually have more limited access to technology, participants varied in how much of a challenge they felt this presented for their outreach efforts. In some cases, they wished to reach new demographics that had ample access to ICTs and social media and this presented an opportunity. In other cases some organizations were entirely reliant on very formal websites and email interactions which were completely inaccessible to communities beyond the most well-off. Additionally, some felt that the COVID-19 pandemic had created additional barriers: in environmental education, many children from poorer families were out of school and lacked access to online classes, and students with learning disabilities especially

struggled as many benefited from sensory aspects that couldn't be created online.

Several felt that technology was only incidental to the inclusion challenges they faced though, not making a major difference in either direction. Many organizations had legacies of working with only wealthy upper-class segments, and a deep-rooted generational divide between staff and leadership. One participant felt that their organization needed a total overhaul of its structure, communication style, tone, and messaging to even begin to be accessible for a broader range of demographics, but that senior leadership was so entrenched in the status quo it would take a whole generational shift to make progress.

5.5.4 Cross-cutting themes

Here we discuss themes that were common across all three remote, peri-rural, and urban categories and their corresponding differences in technology access.

Diversity and inclusion

Most participants voiced that diversity and inclusion were important for their organizations' work. They aimed for their programming to benefit different demographic groups in equitable ways, and often designed programs specifically geared towards working with marginalized groups. In some cases this diversity focus was driven from above by donors or upper-level management; in some cases it was motivated by the values and experiences of lower-level staff; and it was also sometimes motivated by a recognition that working broadly with many different intersectional sub-communities was crucial for achieving positive environmental outcomes.

Environmental problems frequeltly affected communities differently along lines of income, social status, gender, race, ethnicity and caste; and many organizations recognized this in their work. For example, rural people experiencing poverty are often more directly dependent on natural resources because they face a lack of alternative livelihoods. For example, one participant described working with forest-dependent communities impacted by climate change:

> *"They said, 'what do we do? We don't have resources, we don't have support from the*

> *authorities, so what do we do?' They said 'we also want to live,' so they take whatever possible resources from the forest, [saying] 'because they are free of cost for us.' "*

In many cases, groups were already marginalized and stigmatized because of their environmental resource use; e.g. one participant described that some ethnic groups were seen as backwards for bushmeat hunting and their organization needed to be careful not to stigmatize or shame them further while working on this issue, nor take actions that might jeopardize their food security. Conversely, some other participants described that their organizations mostly served wealthier more privileged groups like landowners, focusing primarily on the environmental issues that affected them. Men and women were affected by environmental issues differently in many cases; e.g. some participants described working in villages where men commonly migrated to cities for jobs, putting pressure on women to farm and raise livestock on the family land. Some participants had seen these environmental inequities intensify during the COVID-19 pandemic, as poorer communities were more affected with lost income, for example.

Many of the organizations had developed specific programs and strategies to engage marginalized groups, recognizing that engaging them required special efforts and attention to keep them from being pushed out by the area's prevailing social forces[7]. One explained: *"I mean, we wouldn't plan a meeting to bring about two communities who are kind of, not talking in that way. We will try and do them separately, so that we're using different strategies based on how we understood and knew the communities' interactions with each other. So with marginalized communities in that sense, we know where to go and talk to them to get their viewpoint about certain things."* Several of the organizations had specific projects that focused on women, for instance; holding women-only meetings to discuss their issues without being drowned out by men, or having female field staff to engage with women in cases where communities frowned upon women interacting with unre-

[7]Many participants described that they tried to work through local leadership structures in their projects, to help secure community buy-in and avoid rustling feathers. However, these local leadership structures caused problems for diversity and inclusion efforts in some cases when leaders were biased against certain groups. In another example, one India-based participant described how members of one caste would often be offended if they knew you were working with another caste. To address this problem the organizations had to be careful dealing with these leadership structures, one saying *"We chose [project] leaders to address inclusion gaps."*

lated men. One participant described that their organization made concerted efforts encouraging men to be more accepting of women attending meetings and making decisions. In other examples, organizations had programs that specifically focused on youth, elders, or certain ethnic groups depending on the needs of each project.

The prevailing sentiment among participants was that technology did not significantly affect their organizations' inclusion efforts, either in a positive or negative way. Most echoed this thought: *"For diversity and inclusion, the mobile phone has not made any impact, from what I have seen."* (Underscoring this point, most participants responded similarly to this question about mobile phones affecting diversity and inclusion. In a further example, another said: *"honestly I haven't seen any of it, you know. I haven't seen any impact of [technology] on gender diversity things."*)

The participants described many cases where uneven technology access only echoed the societal inequities that already existed. Projects that relied on ICTs often failed to benefit the most marginalized groups because these groups had the lowest access to ICTs, further perpetuating their marginalization. Many participants worried about this *"digital divide"—"[relying on phones], a certain section of the society will be left out."* A main driver of this discrepancy was income: many participants described poorer community members having less device ownership and worse network access. Gender norms also played a role; some participants worked in communities where people believed *"women should not hold phones."* Some described that their organizations rarely got phone calls from women, in places where women were not supposed to talk to strangers and were expected to handle issues via male relatives instead. Some community members with disabilities were negatively affected by the shift to ICTs; one environmental educator described how her students with special learning needs were acutely disadvantaged by the shift to online learning. More marginalized communities also faced higher literacy and language barriers for using technology, which further kept them from benefiting from these environmental projects.

In addition to presenting inequitable access barriers, technology also sometimes led to discrimination when organizations brought groups together for virtual interactions. For example, one participant described a case where her organization made urban ecology WhatsApp groups

mixed with people of different languages and socioeconomic statuses, and found that English quickly became the groups' main language and lower-status people (who spoke the local language) stopped participating. Another participant described needing to make different groups for different castes, as members from one refused to interact with the other. These group interactions required careful moderation from the organizations.

While this study's participants were lukewarm about their experiences engaging marginalized groups with technology, we can identify some opportunities and reasons to be hopeful. Similarly to how organizations make specific efforts to engage key demographics (like women-only meetings), there is the same potential to specifically reach out to them via ICTs (like women-focused WhatsApp groups, for example). One described how their organization was specifically researching how to best engage new demographics via new social media avenues, for example. In another case, another participant described how mobile phones provided some discretion for interacting with different communities who didn't like each other, drawing less attention than in-person visits. Several participants had found that ICTs were helpful for reaching out to tech-savvy youth, who sometimes were otherwise difficult for their organizations to engage. It seems clear that improving ICT outreach to marginalized communities will take targeted efforts and dedicated resources from environmental organizations. Some staff reported reluctance from upper management to change their organizations' ways, but our participants' enthusiasm for this work is a reason for optimism.

Relationship building and trust

Every participant enthusiastically agreed, without exception, that building trust and relationships with communities was crucial for their work. Strong relationships allowed organizations and communities to work together effectively and co-design projects that met both the communities' and organizations' needs. Communities needed to have trust that the organization was competent, genuinely had the community's interests in mind, and could deliver strong-enough results for it to be worth the time, effort, and risk inherent in working together. In addition, personal relationships kept things working smoothly when systems faltered, and allowed the institutions

and communities to work together when difficulties and disputes arose.

Initially, building trust was not easy among most of the communities where participants worked. This was primarily because community members had distrust and negative perceptions of environmental organizations, as well as with government agencies and NGOs in other sectors. Oftentimes people had previous bad experiences with organizations not delivering on promises, trying to regulate them, taking away rights, or extracting resources. They often viewed organizations as outsiders with language and cultural barriers. Many participants described that communities were initially very hesitant to share information with them, for example one working on rural wildlife projects described:

> *"Trust is a very good question, actually. Basically, the thing is that each of these communities have assumptions towards city people. And there will people who know that we're working for wildlife, and we are basically not working for communities. So you know, they start lying about stuff and there is usually no trust. The trust comes only after you [work together] for a particular time, and then there is a bit of trust. And then there is truth in whatever they speak. But until that time, through that gradual process, you really cannot believe any of these people."*

Even when some community members would start to support the organization and their mission, participants reported there were often still family and community pressures not to talk to them.

Most of them agreed that time and consistency were the keys to building trust with communities—participants stressed the slowness of this process. Trust was built through many repeated interactions with community members over time. Through observing your actions, they get to see your intentions and your capabilities, and gain confidence in you. Oftentimes this required a consistent physical presence in communities, with staff living together with them or making frequent visits. After some community members have had positive interactions, word begins to spread around the community: for example, one participant described how people were initially afraid to call and report snares in the forest because they were afraid that they would receive blame, but through repeated interactions and hearing stories from others they became assured that report-

ing was safe for them. Building trust was often very personal; some described how communities wanted to know them as a person before they were confident enough to do business:

> *"They ask like you are a family member. Starting from the family:* 'how are you, how many people are in your family? Do you have any brothers? Child? Wife? Education level? Religion?' *They ask more and more and more, with a slow slow process. Don't ask* 'did you see any tigers? Did you see anyone cutting trees in your community?' *Then they don't tell you."*

Communities also needed time to learn about the organization and its intentions, built upon this layer of personal trust. One explained how initially people were skeptical, but *"after some time they knew what we are doing and why we're doing that, and what are the pros or cons of that. Then they became comfortable with us and they started sharing all the information."*

While it was important to be present and consistent, this was not always enough by itself. Participants also stressed that interactions needed to be positive, and must be reinforced with positive results to set good expectations. Organizations built relationships through small wins. One explained:

> *"Initial trust comes with time. First built over time from the words you say to a place, what you do, how you do it, and how you work with the people around you is what contributes to building the trust. And for us, our focus has been to do small bits of the work in a very good way that, you know, we build the trust of the people. And we always give people priority in their participation—we don't impose programs on people."*

Conversely, negative interactions damage trust. Multiple participants gave examples of organizational failures that damaged their abilities to work with communities going forward. In one case community members were promised compensation for maintaining forests on their land, but did not actually receive it after funding was cut, understandably causing many people to drop out of the program and damaging the organization's reputation. In another example, a participant

complained that their organization's bureaucratic systems for addressing community issues was too slow to respond and too painful to navigate, so many people had given up trying.

For some environmental organizations, in a way, their long-term community relationships can become their most valuable assets. Some participants described how donor-funded projects come and go, but their community relationships are built over the long term through successive different projects. One remarked that these prior relationships are what allow them to deliver results to donors in the time-frames they expect, as well as allow the impact to be sustained after the funding has ended. Another participant remarked though, that this slow but essential relationship-building work was very hard to fund when donors wanted immediate short-term results.

To gain the trust of entire communities, organizations worked within their local social structures. Organizations prioritized developing relationships with key individuals like local leaders and project delegates (see section 5.5.2), who then championed the organization to the whole community. Many discussed the importance of relationships with local leaders as bridges to the rest of the community: *"You can never implement a project without using the community leaders. So if you don't trust them from day one, you may not achieve your intended project objectives."* In one striking example of leveraging trust in social networks, a participant worked with former poachers (a particularly reclusive group) and recruited them through the personal networks of law enforcement and other former poachers with whom they had built strong relationships. Some organizations also partnered with "anchor institutions" to gain access to communities, organizations that already had strong community ties like schools and church groups.

In addition, some participants noted that were very careful to present themselves in ways that were relatable when they first approached communities, and tried to avoid being pegged as outsiders, threats, or distant people who lived completely alien, unrelatable lives. Some participants worked primarily in communities with similar backgrounds to them, and felt that this helped gain the communities' trust as insiders. Staff who did come from different cultures, though, often faced considerable challenges: they hoped to avoid immediately being pegged as outsiders, and avoid appearing like police or government officials. For example, many asserted that it was

important to dress similarly to the communities: one described, *"People already have an intuition about you... They judge you by the dress you're wearing, ok, they identify who you are just by your looks. This happens in communities because in the city you're a normal guy; no one will look at you and say anything, but in communities they way you dress up and approach them will certainly make a difference."* Several participants also underscored the importance of speaking the local dialect to gain people's trust, or hiring local project assistance who spoke the local dialect. A few also shared experiences where they had lived among communities or made extended visits, trying to partake in their cultures and farm in the ways that they farmed to gain respect and show themselves to be relatable, not so different to the communities.

Many participants voiced that it was very difficult or even impossible to build trust over phones or the Internet. Technology-mediated communication crucially lacked the warmth of in-person human interactions, and could not convey the same social and cultural cues needed to convey mutual respect. For example, one described challenges building relationships while social-distancing during the COVID-19 pandemic:

> *"This is an area where a lot of stuff gets done on handshakes, and obviously we don't do that anymore. So the initial trust has been hard to garner for that reason. And a lot of the people that I have been working with for a long time, you know when I don't shake their hand, or if I don't come in to have coffee with them, that is a barrier now to continue working. That human contact is no longer there, or it's just kind of dampened... It's harder to make a connection with people if you're not looking them in the eye, being in close contact, shaking hands, that sort of thing makes it very difficult."*

Others added that the social immersion was missing in virtual interactions: it took a long time, getting to know a person and seeing them behave in a social context before communities could begin to trust that they were who they said they were. Many felt that personal relationships were dampened by the formality brought on by virtual interactions (discussed in section 5.5.2); whereby people felt less free to express themselves freely or discuss delicate issues. Through the limited affordances of ICT communication channels, it was difficult to deeply understand the

community's' situations and needs, and subsequently demonstrate that the organizations were listening and genuinely took up their interests.

Almost none of the participants tried to begin new relationships and build initial trust over ICTs (with some potential exceptions of urban organizations using social media[8]). Participants from all three groups (remote, peri-rural, and urban) expressed these concerns about relationship-building via technology, though the richer social-media and multimedia interactions in well-connected environments may help provide social context to mitigate this problem somewhat. These problems are likely more pronounced in rural areas relying on more severely limited channels like SMS or voice calls, where environmental staff already tend to live more different lives from communities, communities are sometimes more marginalised, and trust is already more difficult.

However, it emerged that many participants were able to use phones and social media to keep relationships open once they were already established. Many environmental staff relied on mobile phones to keep in touch with community members when they were away, and they felt that this helped them to build trust by being consistently available to community members when they couldn't be physically present. In these cases, phones were useful to keep relationships friendly and warm. One participant who had made close friends in the communities explained *"...if they asked for my number, just to stay in touch and all that, I was totally cool with it... 'Whenever you visit, give me a call, and I'll definitely help you out with anything you need...' I had already gained their trust."*

During the COVID-19 pandemic, several participants had called communities they had worked with just to keep in touch, and see if they were okay. They were still able to provide some services over the phone: one described how they had been working hard to build inroads with new communities that were interrupted by the start of the pandemic, but still they were able to make progress as community members regularly called them to ask medical questions about livestock.

[8]In a couple potential exceptions, some urban organizations used advertising and social media to reach out to new audiences; though from our study it is difficult to judge whether any of these online-only interactions were trusting relationships, and some participants voiced skepticism that they led to meaningful in-person interactions.

This point about phones keeping relationships alive is underscored by this extraordinary story from one participant. He had developed close personal relationships with a community where he had worked years ago, and had no longer worked there but still occasionally called them to keep in touch. During the chaotic 2020 mass migrations in India during its national lockdown, they called him in distress and he was able to coordinate food supplies and transport for them back to their home village:

> *"If I can give you an example of last year's lockdown, [years ago I worked with a small village.] So still today I have very friendly homely relationships with almost every household of that village. It's a thirty-household, small, small village at the end of the road. Still today, I have a personal relationship with all 30 of them and every summer I knew that people from that village go outside for livelihood. So mostly, they go to a bigger city so that they can earn something for the two months when they don't have any agriculture-related work in their own villages. So last year, when I came back home from my field, I had this click in my mind.* 'Hey, people from this village, they also go to for employment to other areas,' *so I quickly dialed two, three numbers so and and was able to get in touch with one of them. [They were in my home state; and I told them]* 'if you have any difficulties just give me a call, I will see whatever I can do.' *So they were there, and after some 10, 15 days they called me up saying that there is some problem with food. They don't have food items with them. I said okay, so I got in touch with one of my friends over here and told him the number and the name of that place, this number of people are there, and they need some food items. So he got in touch with some some of his friends and relatives and they alerted the administration over there, and you know the food material was provided to them. Then afterward again I dialed some of my contacts [there] who are the people from the press, and asked them,* 'who is the administrative authority? Who is coordinating the movement of people from one state to another?' *Because there were a lot of people who had got another place and wanted to come back to their home. So I shared that number with these villagers... and*

> *I told them to talk to them.* 'Any difficulty you have, even if you want to go home, talk to them, they will arrange for you. But don't go walking or cycling to back to your home. don't do that. If you have too much difficulty, let me know I will arrange something for you.' *So, after a month and a half they were provided one transport by the government and they all did go. And the day when they were leaving from here, they called me up:* 'Thank you so much, and we are leaving for our home today.' *They all went home safely. And one of my colleagues from that project later on went to that village when they were having a program over there. And it was said, on a public platform by other villagers that* 'till now in our lives, we have seen organizations or people who had come for their work and never looked back. And here—this organization—and here is a person who, even after leaving this place, is in constant touch with us and he has helped us in so many ways, when we were over there.' *So that is something for mobiles, you know, that they are tool for trust-building also!"*

Staff burden

ICT interactions with communities was a major resource investment for organizations; several of the participants reported spending hours every day on calls with community members. Many described being stressed and annoyed from being bombarded with calls: one described *"one of the drawbacks occasionally is I get [community members] that really like to text me, and that is not always great, but at the same time I think it builds trust."* Another complained *"they expect you to be on standby all the time."* One switched off their phone on weekends because of this.

Additionally, some participants had to field frequent calls from community members asking for personal favors. One had stopped giving out her phone number because she received too many calls from community members asking for money. Another described:

> *"They have actually called and asked for, you know, like they are having some financial problems so they need this particular thing, medicine and the like... But when it comes to medicine, or you know, maybe some food kind of things, or any emergency in which*

> *you feel you can help, then you try to. But then what happens, once you do it once, now it becomes like a habit. Every day you get bombarded with a different call. And now, even the issue is very small like* 'we don't have any electricity; it has gone for one hour.' *Now that has also come onto us. And you have to tell them, like,* 'we are working for conservation for wildlife; we are not here for this.' "

In many ways mobile phones allow environmental organization staff to keep up personal relationships with community members, but in this way they can also create highly-personal stresses for them. By allowing community members to contact them at any time, staff must work harder to determine and enforce their appropriate personal boundaries.

Misinformation

Misinformation and rumors were a problem reported by several participants. Many communities distrust environmental organizations because of political messaging and bad prior experiences with NGOs and government agencies (sometimes environmental, sometimes otherwise) where organizations had failed to deliver on promises, taken overly harsh enforcement actions, or had other conflicts. Rumors and misinformation circulated against this backdrop of mistrust, and ICTs often amplified them. A few discussed having to address exaggerated rumors circulating on social media, such as people claiming the organization was trying to take their land, or (during the COVID-19 pandemic) that the organization was trying to force people into quarantine. One participant discussed an extreme example where staff were threatened because of WhatsApp rumors and they had to stop work in some communities, but could keep working in areas where WhatsApp wasn't available:

> *"Somebody said on a WhatsApp group that we are working to relocate the villages from that area. So all of a sudden, we had to stop our [service projects] and everything. Some people even came to our offices and threatened our staff. All these things did happen because we have a human tendency that the good news will travel slower, but the bad news will always travel faster! ... We have left that particular area because of that...*

> *We have some areas that we have left, where we are not working. But one good thing we did was that we continued to work where people did not say anything. So again, non-penetration of mobiles is also an advantage in this case! We were able to go and do this [service project] where the mobile penetration was very, very less—only one or two percent there—and they were not bothered: [saying] 'Okay you want to [do this good thing for us,] okay you can go.'... And because we were able to continue those [projects], later on some other villages who had objected to our presence also became friendly because they were seeing that we are still constantly continuing with our work.*
> *"*

The most important way to effectively handle misinformation, according to participants, was to build trusting relationships with communities. Once trust was established, they could speak openly and clear up misconceptions. Many communities began to view environmental organization staff with some confidence and authority: for example, several participants reported that community members had called them to ask questions and seek clarification about rumors and misinformation regarding vaccines and the COVID-19 pandemic.

Some other participants reported that community members sometimes posted misinformation on group chats, or submitted false information through reporting processes. They faced a need to moderate these group chats and verify incoming information, which sometimes was difficult.

Secrecy and taboo topics

Most organizations interviewed for this study aimed to share information widely and transparently across whole communities. There were a couple interesting exceptions, however. In one case a wildlife researcher worked on a topic that communities were afraid to talk about: lorises. These animals were seen as a bad omen and a taboo subject, even discussing them could bring misfortune, and people were additionally afraid because they had very strict legal protection. She had to be very careful and discrete when broaching this topic with communities to avoid being outcasted, only discussing it with certain trusted individuals to better understand the communi-

ties' perceptions. These communities' technology access was very minimal so was not yet causing major challenges for maintaining her cover, but this case still provides an intriguing counterexample to the broad information-spreading and transparency goals of most other organizations in this study, and it is easy to speculate how this researchers' discretion could be mightily complicated by increased technology access via WhatsApp rumors, for example.

In another example of an organization where secrecy was essential, one participant worked undercover to investigate illegal poaching syndicates. For this work they had to slowly develop relationships with poachers and work their way into the social networks of the syndicates, to identify all of the individuals, know the whole organizational structure, and gather enough evidence before making arrests and seizures. They needed to methodically craft a false identity and cover story for each case, explaining that the story needed to be consistent in their interactions with each individual, and that one slip-up could ruin the whole operation. In one sense this work was made more complicated by mobile phones, because criminals talked between different communities and could sometimes link them to a person on another investigation. Mobile phones also provided privacy and anonymity though, allowing them not to be seen meeting with someone in public, or allowing them to talk discreetly when other people were around—they reported receiving more confidential information over the phone than in public. Mobile phone conversations were fraught though; one couldn't always know if they were being recorded, or if anybody was listening on the call.

Technology investments: training and providing devices

Recognizing that technology infrastructure was crucial for their operations, urban and rural environmental organizations made investments to improve technology capacity in the communities where they worked. These investments sometimes comprised of providing mobile phones or tablets to community members, often involved technology training, paying for airtime/data, and sometimes even setting up network infrastructure. Participants described that these investments were often expensive and resource-intensive, forming a significant constraint for many organizations but also indicating their strong beliefs about ICTs importance for their missions. Multiple

participants lamented that they wished their organization had built more technology capacity in communities before the COVID-19 pandemic, thinking that this would have given them better opportunities to continue work through social-distancing and restrictions instead of needing to halt operations.

Several peri-rural and remote participants reported that their organizations routinely provided mobile phones or tablets to key community members on their projects. (A few others described how they wished they could provide devices, but lacked sufficient funding.) Some of the provided phones were primarily used to keep in touch with project leaders and coordinate operations; in some other cases smartphones or tablets were provided to run specialized software for specific tasks like patrolling or data-collection. A few participants had experienced problems when cased by personal use of the organization-provided devices, like depleting the data budget or filling up storage space with games.

Many of the organizations in every geographic category invested in technology skills training for community members. In some cases organizations taught people certain specialized skills required for project tasks, like how to take a GPS reading or use a data-collection app. Oftentimes though, organizations spent considerable time teaching basic technology literacy and skills to community members. This was especially true as organizations rapidly pivoted to online interactions during the COVID-19 pandemic: one urban participant described *"When we have zoom calls, like... I was just tech support last night for a community meeting we had in [location] and it was like, helping an old lady with how to connect and that kind of thing."* This was even more common in peri-rural and remote areas, where more of the participants had lower technology literacy and limited prior experience: some participants described training project delegates to use touch screen phones, take pictures, and send messages, for example. Some of the organizations had built considerable institutional infrastructure for large-scale training operations, *"training people as trainers,"* and some even regularly provided technology training to government agency staff who they worked with.

Some participants had heard of other environmental organizations who had set up cellular networks to be able to communicate with remote communities where they worked; though none

of them reported that their own organizations had done it themselves, often being too difficult, expensive, and beyond their capabilities. Some had looked into other connectivity options for remote areas like satellite phones (though none reported deploying them). Many participants complained that the mixed network connectivity created major challenges for their work and called for more investment by governments and business: *"Network is critical, you understand. I think [the government] needs to take an extra mile to improve the network coverage."*

Rapid technology change

Participants from every geography described how they had seen communities' technology access rapidly improve over the past years. They had seen more people get basic phones and smartphones in many remote areas with major improvements in network connectivity and Internet access, with more community members using mobile apps, WhatsApp, pictures and video. In urban areas, many thought that aspects of the pandemic-induced technology shift would stay, like more use of video calls. Many of the participants welcomed this change because it would allow their organizations to do more mobile engagement while also reducing the need for training as the communities' technology literacy grew. Some expressed hesitations though, worried how the increases in screen-time might affect the health and social dynamics of communities.

Many of the participants were excited about the new possibilities opening up for their organizations amidst this technology expansion. For example, one was hopeful that auto-translation was recently becoming good enough to use in her fieldwork, and was excited about the improved language support she had recently started to see in many apps. Several were keen to make more use of picture messaging and WhatsApp groups in communities as Internet access expanded. In another example, one participant was thinking about how to engage community members with mobile videos after they'd observed more people watching shows on their phones following cheaper data costs. They excitedly remarked that the connectivity improvements were *"...a game changer in this field. I definitely believe that."*

5.6 Discussion

From our staff interviews we have shown the myriad of ways that communication technology is changing the interactions between environmental organizations and the communities where they work. These technological shifts have fundamentally altered the ways that environmental organizations operate and shaped their institutional structures, heavily influenced their selection of projects, and impacted the relational and social dynamics among organizations and communities. Here we summarize the key impacts of ICT's on institutional and social aspects of environmental organizations, discuss study limitations, and list potential future technology developments.

These findings can help environmental organizations think more strategically about their technology use in community engagement as well as suggest new directions for technology, environmental, and social science research towards improving community-focused environmental governance. Environmental organizations and technologists should work together to prepare for improved community engagement strategies as technology access is rapidly increases around the world in the coming years.

5.6.1 Summary of institutional shaping effects

The spread of mobile phones into rural areas allowed organizations to quickly communicate with key community members across distances, when the organizations could not always be physically present in the field. This enabled a range of activities that were too difficult and expensive beforehand.

For many organizations working in very remote areas (where conservation projects are often located), mobile phone connections were often tenuous and difficult but nonetheless gave them vital communication channels with the isolated communities there. Organizations passed messages to communities in places where cellular connectivity was scant, often through relay chains of two-way radios or passing messages on-foot from village to village. These connections enabled many of the environmental organizations to act as liaisons and advocates for these communities with the government and outside world, allowing them to more quickly know about issues af-

fecting the communities and pass along updates as they navigated government processes.

In rural areas where mobile phones and network connectivity were more available, the greater ease of communications allowed environmental organizations to coordinate more intervention-style projects to provide services and change behaviors. For example, rural regions with greater connectivity had many more projects like encouraging sustainable agriculture methods, developing alternative livelihoods to reduce dependence on natural resources, managing water and sanitation, and enforcing against poaching. ICTs allowed organizations to coordinate similar projects across many different sites at once. Many of the organizations adopted hub-and-spoke organizational structures, appointing local delegates to manage projects on-the-ground and coordinating with them through frequent phone interactions. Many of the organizations also used ICTs to implement formal mechanisms for structured data-collection (collected on the ground and sent up the organizational structure), as well as top-down accountability mechanisms for field-level staff and delegates. Where it was possible, many used picture and video messages to gather evidence and communicate more clearly about complex situations. Organizations found it difficult to broadly engage large audiences and entire communities over the commonly-available ICTs in these areas (namely SMS, voice calls, and WhatsApp), instead they mostly relied on in-person meetings to energize whole communities and mostly limited their ICT interactions to key individuals.

Urban organizations in highly-connected environments could make much more use of channels like social media and websites to engage with mass audiences, which was prohibitively difficult to do over the more limited channels available in more rural areas. However, these organizations more often had to compete for audiences' attention on these densely media-saturated platforms. Organizations commonly used social media to advertise their organizations and services to new audiences, as well as promote environmental messages. Some were able to have complex, lively group discussions over social media, taking advantages of their richer interfaces. Many of them made heavy use of visual multimedia like videos and infographics to catch audiences' attention and communicate complex ideas, especially during the rise of video calls amid the COVID-19 pandemic.

5.6.2 Summary of social/relationship effects

Participants saw social dynamics and community relationships change as their organization began to incorporate more technology in their community interactions. Many of these social changes were subtle, like formalization in relationships or barriers to trust—not immediately obvious or easy to measure, but apparent as participants reflected on their long-term experiences. However despite their subtlety, participants described how these social factors were crucial for their projects' successes and failures.

Participants all agreed that building relationships and trust was crucial in their work. Before communities were willing to work together with environmental staff and organizations, they needed to be confident that they were competent and reliable, genuinely had the communities' interests in mind, and would not cause them harm (e.g. taking enforcement actions against them or extracting resources). Good personal relationships were important for working together when systems broke down or disputes arose. Participants gradually built trust with communities through repeated positive interactions: getting to know them personally, completing initial small tasks well ("small wins"), and conveying respect. Cultural context was important: many participants worked to avoid being pegged as outsiders, and gain whole communities' trust by working through existing social networks.

This initial relationship-building was very difficult over comparatively limited ICT channels like voice calls or SMS: participants found it extremely hard to navigate the complex social contexts, give human warmth, and recreate the depth and familiarity of face-to-face interactions. Technology was perceived as intimidating in some of the communities who had less prior experience with ICTs, increasing the social distance and prompting fears that they would be recorded. None of the rural participants attempted to initially build relationships and trust over the phone. However, some found it useful to keep relationships alive after some trust had already been established, able to keep in touch with communities and be reliably in-reach when they couldn't be physically present.

Newer technologies like social media and video calls might be more effective for building trust

and relationships, however. Some urban organizations used social media advertisements to promote their organization to new audiences; though many of these interactions were superficial, and participants had mixed views of whether these online-first interactions led to meaningful relationships. Many felt that in-person interactions were still necessary for environmental organizations to take meaningful actions with communities. The richer multimedia experiences of these new technologies might help to give human warmth for example, or build an organization's credibility by showing their prior work online.

ICTs also brought about shifts in power structures among communities and environmental organizations. For example, when organizations coordinated projects from afar, ICTs often allowed them to exercise more top-down control via accountability mechanisms and structured data collection tasks. Additionally, many participants felt that increased reliance on ICTs led to more formality in their interactions with community members, chilling relationships and lacking the human warmth that allowed community members to speak freely. For these reasons, many participants found it difficult for their organizations to gain deep understandings of the communities' circumstances and needs over these structured and formal ICT channels, as compared to in-person visits. Several participants worried that communities were losing decision-making power from organizations' increased reliance on ICTs, from the increase in top-down control and difficulty bringing community voices into the environmental organizations' leadership structures.

The shift to ICTs has had complicated effects on environmental organization's diversity and inclusion efforts, but the sentiment among most participants was lukewarm: they mostly felt that ICTs neither made a significant positive or negative impact. Most participants agreed that diversity and inclusion were important to their organizations' missions: they tried to equitably share the costs and benfits of environmental conservation, and work with marginalized demographics was important for achieving environmental outcomes because they are often differential affected by environmental problems. Organizations often struggled to broaden their inclusion efforts with ICTs though, because technology access barriers like device ownership, network access, language barriers, and literacy often mirrored other predominant social inequities along lines of race, gender socioeconomic status, ethnicity, and caste. Furthermore, inequities were often visible when

environmental organizations brought different communities together in online interactions: for example, higher-status individuals contributed more to WhatsApp group chats and marginalised demographics became quiet. In these cases, participants reported that the groups required careful moderation. There is potential for ICTs to help organizations strengthen their inclusion efforts when they make specific, targeted efforts to use technology with marginalized groups (similarly to how many organizations already dedicate specific resources to marginalized groups in-person, such as holding women-only discussions, for example).

5.6.3 Study limitations

A main limitation of this study is the bias inherent in our sample: by reaching out through our personal and professional networks, and advertising on certain mailing lists and forums, we cannot claim to be widely representative of all types of environmental organizations. Our sample additionally has a self-selection bias: we advertised that the study's purpose was to investigate communication technology and community engagement, so participants who took interest in the study are likely to be more enthusiastic about this topic than what is typical among all environmental organizations. From our qualitative data we are able to show that there is at least a significant subset of environmental organizations for which these scenarios commonly apply; however we are not able to make any claims about how common these are in the general population of environmental organizations.

Our study also has some potential for a response bias whereby participants may have sought to portray themselves and their organizations in a positive light, perhaps withholding some negative information. We attempted to mitigate this and encourage participants to speak candidly and freely by taking several steps to ensure them of the study's confidentiality, including promising a degree of anonymity and assuring them that they could review the manuscript before its publication and request redactions. We also solicited balanced, critical perspectives by specifically asking participants about both positive and negative experiences.

This study is also limited by its focus only on perspectives of environmental organization staff. We have not collected input from the community members impacted by these projects; in

this study we only make some inferences about their perspectives from drawing on other ICTD literature. Similarly, we did not interview other organizational layers like upper management or donors.

We described distinctions among the categories of urban, peri-rural, and remote organizations, as we had enough participants from each group for this pattern to clearly emerge from the qualitative data. With a bigger sample we expect that we might find more distinctions among other dimensions like organization sizes, sector, project types, or cultural factors. The high diversity among organizations in our sample made it too difficult to generalize about these other categories, but a larger set of interviews could yield more interesting comparisons.

5.6.4 Potential future technology developments

Our staff interviews suggest several potential directions for new technology developments that could help environmental organizations engage communities more effectively. Many of these applications already exist in other sectors, and additional research can help determine how they can be adapted for environmental organizations' needs.

(However, off-the-shelf commercially available software might be sufficient for many of these use cases. The fact that many organizations did not find these off-the-shelf solutions on their own underscores their lack of basic IT capacity. Some participants complained that their organizations lacked IT support and that it was too difficult to fund. In the process of the interviews, there were several times when we connected participants with off-the-shelf software for problems they discussed, like free phone-based GIS software or bulk SMS services that they didn't know about; we also answered their technical questions on several occasions.)

Design patterns from ICTD research (Section 5.3.4) can be a source of inspiration towards some of these solutions, showing a variety of creative applications of simple technologies for complex, rich community engagements: i.e. partially automated SMS chat-bots or interactive forums using voice calls. For example, many participants' organizations' made use of in-person surveys, and ICTD researchers have explored the strengths and weaknesses of SMS-based survey systems that could be helpful in some of these instances [275, 15]. As another example, most

organizations needed to broadcast information out to communities, but remote and peri-rural organizations rarely attempted this with SMS or voice calls because of their difficulty and limitations. ICTD researchers, in contrast, have extensively studied various broadcasting strategies over ICTs and analyzed their cost-effectiveness; this work is immediately applicable to some of these participants' problems [251, 313, 335]. Auto-translation for under-resourced languages may also soon reach a stage where it is useful for many of our participants, allowing them to speak across language barriers when no translator is available, and giving access to more software in local languages.

Many of the organizations had roles mediating between communities and the government, and sought ways to give them more power in official processes, potentially calling for eCivics approaches. Many of the technological approaches described in section 5.3.3, like applications for submitting data to officials or providing feedback on plans, are best suited for more-structured interactions where communities have greater Internet access. For example, interactive eCivics applications could be helpful for some of the problems our participants described like quickly reporting the locations of wildlife problems in a city, or consulting community members about urban river restoration plans. However, many of the participants needed to advocate for communities' needs to governments or upper management of their own organizations, in areas having lower technology access and requiring less-structured interactions. ICTD projects like Gram Vaani [327, 300, 73] and Red Cross WhatFutures [206] show examples of systems that aggregate messages directly from community members into a presentation or petition to leaders.

Many of the participants faced problems managing large volumes of messages with community members, and coordinating appropriate responses. Some were bombarded by nonstop calls to their personal phones; some struggled to coordinate activities between community members, governments, and NGOs; and some had headaches fielding messages from many different communication channels, each preferred by community members with differing levels of access. These organizations might benefit from Customer Relationship Management (CRM) systems [211], which are widely used to centrally manage an organizations' communications with individuals. Some urban participants did already did use CRM's; e.g. managing email campaigns

with SalesForce. There are a wide variety of off-the-shelf CRM systems available that are highly customizable to each organization's structures; future research could explore how to adapt them for environmental institutions, perhaps integrating with other environmental data systems like EarthRanger. There also exists a variety of off-the-shelf project management software that may be helpful for these organizations; some have specialized in coordinating projects across low-connectivity environments [28].

Creating personal-feeling interactions and human warmth with ICTs is difficult, especially in rural areas having the most limited technology access, where communities' trust may also be harder for environmental organizations to gain. ICTD and social computing research have explored a variety of relevant angles for creating human warmth in semi-automated systems, exploring various designs that hybridize human and automated interactions; such as a nurse hotline that automatically sends out scheduled messages using a warm tone, interpersonal language, and being addressed from a nurse that the user knows [271]. As many participants discussed that they gained a community's trust by first developing relationships with key influential people, the small body of ICTD research on social infrastructure and mediated access can provide suggestions for how to utilize these relationships in ICT interventions [295]. To build personal relationships in regions with higher connectivity, researchers can further connect social computing theories like group identity and social translucence (section 5.3.2) to understand their implications towards environmental organization's communication goals.

Many of our participants called for better network infrastructure in the communities where they work, naming bad connectivity as a major pain point for many of their projects. None of the participants had the capacity to build networks themselves, and further developments in low-cost cellular networking and community-led deployments may soon lower this barrier [17, 190, 301].

5.7 Conclusion

Presenting qualitative evidence from environmental organizations' staff, we have shown how the rapid evolution and spread of communication technology is fundamentally changing the human structures of environmental governance. We have characterized the range of ways that environ-

mental institutions are using technology to engage with communities and the public, and how these uses fundamentally shape their organizations' structures and activities. We have also shown the sometimes-unintended effects of communication technology on social factors like relationships building, decision-making power, and inclusion. These results can suggest future technology developments to help environmental institutions work more effectively with communities, and help environmental organizations think more strategically about their technology use with communities as ICTs continue to proliferate in the future.

Chapter 6

CONCLUSION: COMMUNICATION TECHNOLOGY AND ENVIRONMENTAL INSTITUTIONS

6.1 New Problem Spaces

I conclude by calling for future research attention to this neglected topic. As communication technology evolves, it is changing the relationships among all of the actors in environmental governance. Together, the studies in this thesis show how ICTs are fundamentally reshaping environmental institutions and the way they interact with communities; both through formal, intentional technology deployments, and through informal, organic uses by staff and community members. Despite communication technology's considerable impact on the structures of environmental governance, research on this topic remains surprisingly scant.

The chapters of this dissertation stakes out directions for future research on this important but neglected topic, bringing together perspectives from fields like environmental governance, human-computer interaction, and ICTD. In concert, the new research questions explored by these projects can provide some structure for understanding these problems and shaping future inquiry.

In Chapter 2's case study of mobile phones and Ol Pejeta Conservancy's community engagement work, we elaborate these understudied questions: how do mobile phones shape rural conservancies' community relations, and how could technology improvements help? This foundational work identified some of the challenges that future technical work will need to overcome, like the danger of potential miscommunication over constrained channels like SMS in conservation contexts where relationships are often difficult and volatile, the importance of personal connections in local-scale environmental governance and the difficulty of recreating them via automated technologies, and the differential accessibility of technology to different population segments who each play important roles in environmental governance. This detailed presen-

tation of OPC's community engagement work shows how foundational mobile phones are to its operations, even in an area with limited technology infrastructure, and it invites researchers from other disciplines to study this problem for the benefit of OPC and other conservancies.

Chapter 3's examination of public-facing interactive wildlife-tracking maps broadens this inquiry by asking similar questions in a different context. Among environmental organizations operating in densely-connected, media-saturated environments, how are the Internet, social media, and interactive software shaping their engagement with the public? Through our case study, we show how ever-changing technology is foundational to Giraffe Conservation Foundation and Atlantic White Shark Conservancy's strategies; as they seek to build relationships, spread messages, excite people about their work, and raise support their causes. Research in *environmental communication* has extensively studied effective strategies to these ends, largely focusing on traditional media like print and TV and increasingly shifting focus to social media, but lacking engagement from the HCI community. Our study examines interactive data visualizations' effectiveness towards various environmental communication goals. What are their strengths and weaknesses for evoking hopeful emotions? Or driving continuous awareness of slow-moving environmental issues? Providing relatable experiences with animals or researchers? Or bringing non-traditional audiences into the environmental movement? This framing provides an example for further research to examine future technologies and their strengths and weaknesses for environmental communication goals.

Chapter 4 examines ICTs in yet another environmental governance context by examining anti-poaching hotlines and their role in enforcement against environmental crime. This chapter contributes the first user-centered design study for anti-poaching hotlines, documenting the complex ecosystem of stakeholders and each of their important concerns and considerations for a successful hotline system design. Returning again to Ol Pejeta for our case study, I show the complex ecosystem of contradictions and tradeoffs among the many stakeholders' concerns, and show how technology design factors play sometimes unexpected roles. While anti-poaching hotlines are deployed in ubiquity by a large number of different environmental institutions, this analysis shows how their success can depend on a number of social and environmental factors,

along with technology design and implementation decisions. The user-centered framing of this case study suggests a methodology for designing and evaluating anti-poaching hotlines in other contexts.

The interview study in section 5 generalizes these themes to a wider range of environmental organizations. By drawing on the experiences of 22 staff of environmental organizations, we see how the availability of technology in each place reshapes and constrains their structures, activities, and community relationships. This last study poses questions about how environmental organizations can think more strategically about their technology use with communities, comparing these organizations to see the potentials, limits, and often-unintended consequences that technology brings. By showing organizational shifts across gradients of technology access, this study also poses questions about how organizations should plan for the fast-moving future technology changes in the communities where they work.

6.2 Challenges: Why are these problems understudied?

Despite ICT's considerable impact on environmental governance structures, this topic receives little attention from academic researchers or leadership of environmental organizations. Here I outline some of the obstacles for work on this topic, suggesting why this may be the case.

Academia is one of the main institutions with the capacity to research ICTs and environmental governance, but incentive mismatches have allowed this topic to fall through the cracks. Echoing an age-old problem, interdisciplinary projects between different fields are hard to fund and execute as each department has their own orthogonal incentive structures for research; i.e. computer scientists often are pressured away from working on applied topics like environmental governance, and instead rewarded for work in more "core" CS areas. In a related problem, research fields often do not recognize the validity of each others' methods; i.e. it may be difficult to publish design studies with HCI methods in a political science journal where these methods are unfamiliar to reviewers.

Studies in this topic are also prone to face a familiar obstacle in ICTD: that social effects of technology on an institution are messy and take time to measure, clashing with academic in-

centive structures that reward quick, punchy publications. Compared to many other genres of computer science where researchers can quickly run experiments or iterate on prototypes without leaving their desk, ICTD research with "in situ" deployments can move very slowly. For example, to research a new technology's effect on an institution, the researcher must navigate the partner institution's politics, iterate with partners on the project design, extensively coordinate the deployment with different branches of the organization, and then wait to see if the technology intervention worked. These slow-moving projects are not well-suited for quick publication cycles. The complexities of measuring a technology's effects on an intuition are messy, and not as cleanly well-aligned with the scientific process. Additionally, practical research that prioritizes environmental or social outcomes often requires technology that is too mundane—it is difficult to generate the same amount of hype and recognition compared to work with flashy new technologies.

Environmental research at universities and other institutions is commonly dominated by biologists, ecologists, and other natural scientists; and social and interdisciplinary scientists are often sidelined [175, 36]. Environmental CS research mirrors this pattern, mostly focusing on natural sciences while neglecting social elements. This is probably due, in part, to the much greater availability of natural scientists as collaborators in universities. This is changing, however, as environmental studies has increasingly recognized the importance of human dimensions, leading to the rise of fields like *political ecology* and *environmental justice* [329, 290]. However, environmental CS research has been slow to follow this trend.

Social effects of technology are also difficult to study inside many environmental institutions. Organizations often fear to invite critical research on their community engagement efforts because they fear damaging their reputations, and instead want to trumpet their successes to donors. The legwork of ICT-based community engagement falls on lower-level staff in the field, and upper-level leadership often lacks interest in these logistical minutiae. Donors and top-level leadership often have poor understandings of technical topics, and this creates challenges for large organization-wide improvements. Many organizations also lack basic technical capacity, having difficulty managing their internal IT and the relatively simple technologies that power

their community interactions—it is a common complaint that this "boring technology" is unexciting to donors and difficult to fund.

6.3 Future Directions

What could a future body of research look like for computing to support social interactions in environmentalism? The most immediate research progress can come by bringing together researchers from their respective silos in computer science and environmental governance.[1] We can broadly consider future directions using ICTD research as a model, which has developed several relevant branches: exploratory ground-work, interventions, evaluations, criticism, and theory.

At the formative stage of the pipeline, much exploratory ICTD work seeks to understand how people use technologies in these contexts; the cross-sectional study presented in Chapter 5 is an example of this work in environmental organizations, and there are many other angles to explore like sampling different types of organizations or using different qualitative methods. Intervention-style projects can investigate specific technology applications through design exercises and deployment studies; Chapters 2-4 exemplify this style of work. ICTD researchers in adjacent fields like economics and public health use randomized controlled trials and a variety of other rigorous quantitative methods to evaluate project outcomes. (As one example in this style, we hoped to conduct a quantitative evaluation of the community outreach projects in Chapter 2 before our work was derailed by the COVID-19 pandemic. We had proposed to conduct surveys before and after our technology scale-up, to evaluate if the ICT services actually helped OPC deliver community services more effectively or improved community relationships in a measurable way.) ICTD's body of critical work can provide a model to probe the human impacts, power dynamics, and social justice implications of ICT's successes and failures in conservation. This problem is also ripe for theoretical work that incorporates elements of HCI and social computing

[1] Conversely, ICTD research can benefit from the rich understanding of environmental institutions developed by social and political scientists. Many ICTD researchers grapple with institutions in nearly all aspects of their work, and well-functioning institutions are essential for successful ICTD projects, but they are not formally studied in the same depth.

theory to understand their interplay with the with complex structures of environmental governance.

Technology improvements are one pathway to put this research into action towards environmental and social impacts. Design patterns from ICTD research (section 5.3.4) are a source of inspiration, showing a variety of creative uses of simple technologies for complex, rich community engagements: like partially automated SMS chat-bots, or public advocacy campaigns with automated voice-call forums, for example. Further work is needed to scale these projects up beyond bespoke pilots, identifying and generalizing technology tools that can be useful for many organizations—for example, we built a toolkit for organizations to deploy their own wildlife-tracking maps, relying on EarthRanger's extensive experience with many different environmental organizations and deep understandings of their varied needs. As another example, our case studies and interview responses suggest that many environmental organizations could benefit from Customer Relations Management software for a centralized system to coordinate their interactions with community members, perhaps integrating more "basic" technologies like SMS or IVR, or perhaps integrating with a platform like EarthRanger to integrate with environmental data. Additionally, many environmental organizations could benefit from project-management software that works in lower-infrastructure environments, as they coordinate projects across various sites. Scaling up these efforts would require dedicated efforts working with many partners to understand their range of needs and to design for appropriate customizability.

Policy approaches also have potential to put this research into practice, helping environmental institutions think more strategically about their use of ICTs with communities. Donors, policymakers, and other top-level decision-makers often lack the expertise to make well-informed decisions about technology use within their organizations. Concise, targeted communications like op-eds could be helpful for educating these audiences about the social impacts of their organizations' technology use. Policy tools to streamline the evaluation of technology projects could also make an impact in this regard, perhaps modeled from the Digital Development Principals [3] adopted by major donors to codify best practices for ICTD projects. These policy approaches could help organizations avoid some of the unintended consequences from emergent technology

uses within their organizations, and call for more attention and investment towards the "boring technologies" that power these organizations and their community interactions.

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