1 Strategic Conservation Matters

In July 2016, a Japanese company manufactured the last VCR, and there are probably a few holdouts who are grieving. Humans, for the most part, don't like change. Why, we wonder, does someone always have to go and muck up a perfectly familiar and predictable device, replacing it with some new form of technology that is going to cause confusion and may take a while to learn how to operate successfully? Eventually, we figure out how our newest smartphones work and realize we love their capabilities and have a hard time imagining living without them. But for many, it's an unnerving and grumpy process put off for as long as possible. Inertia in the face of new technologies is an ancient human trait. Imagine the early human who first realized that roasting food over a fire was a good thing. You can bet the rest of the group had their doubts.

Now consider the implications of our resistance to change and new technologies in the context of environmental conservation. Environmental problems such as water pollution or endangered species protection have been referred to as "wicked problems" (Kreuter et al., 2004; Redford, Adams, and Mace, 2013). They tend to be extremely complex, involving natural sciences, social sciences, and engineering, and the money needed to solve these problems is far from trivial. For instance, the annual budget for the Environmental Protection Agency (EPA) on water and air quality improvements has been around $4.9 billion (EPA, 2016). In European Union (EU) countries, the national expenditure for environmental protection in 2014 was around €297 billion, or US$324 billion (Eurostat, 2017). In the United States, the federal and state governments spent just more than $1.4 billion to protect endangered or threatened species under the Endangered Species Act in fiscal year 2014 (US Fish and Wildlife Services, 2014). Despite these apparently large expenditures, recent estimates suggest that the funds are still insufficient to meet important conservation objectives. For instance, McCarthy et al. (2012) estimate the need to spend up to $76.1 billion per year to protect endangered species around the world.

Since environmental issues broadly affect the public, the major source of funding has traditionally been public money collected from taxpayers, and the idea of raising and spending tax money is politically sensitive. In general, the more politically charged a problem is, the greater the anxiety associated with a new approach or technology possibly failing. Organizations such as the US Department of Agriculture (USDA) and National Park Service, which provide grants to environmental conservation organizations, face intense political and media scrutiny of decisions that are fraught with uncertainty even when using a known technology.

In fact, most of the government agencies and nongovernmental environmental organizations that allocate funds for conservation still rely on outdated and severely flawed methods of selecting projects. Research has shown that these approaches are as inferior and outdated as the VCR but are still used every day.

A key problem is that methods of selection commonly used in conservation efforts do not properly take the cost of the projects into account. Advances in applied mathematics and economics, such as linear programming, have led to the development of sophisticated systems that can analyze the costs and benefits of a suite of proposed projects and identify the set of selections that provides the total maximum conservation benefit for the lowest cost, and numerous studies have demonstrated that these algorithms could enable governmental and nonprofit agencies to provide the same or better outcomes as older methods while spending less money. Simply defined, strategic is a science-based planning process that evaluates multiple criteria to help identify the most important resources to conserve while accounting for the realities of budgets and other constraints. This is in contrast to relying solely on one criterion, such as environmental benefit, for selection.

Why have these conservation organizations so far failed to adopt these much-improved high-powered tools and technologies? They have good intentions, no doubt. They also follow emerging science in identifying new environmental threats and providing potential natural resource management solutions such as removing invasive plants. Certainly their leaders are not lazy and passionately care about the environment. As lifelong environmentalists who have worked closely with them, we know they are compassionate people who devote their personal and professional lives to addressing the wicked challenges facing the environment and work each day to accomplish great things. But they are not immune from inertia, risk-aversion, and political pressure.

These factors along with a lack of public pressure and limited budgets and staff resources all contribute to conservation organizations being "stuck" in the past when it comes to strategic conservation. There's no question that the mundane human tendency to avoid change plays a part. It is easier for individuals and organizations to continue to do what they already know how to do, even when it does not provide the best outcome and does not efficiently use taxpayer money. Skill sets also play a part. Most conservation professionals are not trained in economics or mathematics; they are trained as natural or physical scientists. In fact, many of them likely shunned economics courses because of a mistaken view that economics promotes business interests over environmental concerns, so they have not followed the development of economics and mathematical programming relative to conservation and have not imagined how these tools could enhance their work. Furthermore, computer programming and algorithms can seem complicated; it is easier to use a conservation selection mechanism you thoroughly understand and more difficult to explain a programming method to stakeholders who value a transparent, simple process.

The dirty little secret among those who fund such projects is that failing to adopt new scientifically proven techniques for allocating their funds is wasting literally billions of dollars and severely restricting what they are accomplishing with those funds. The question we address in this book is how to overcome those barriers. We highlight how conservation efforts have made mistakes and missed important opportunities, measure the magnitude of those errors, and provide, in essence, a quick start guide to superior technologies based on the science of strategic conservation.

A NUDGE (OR PERHAPS A SHOVE) IS NEEDED

We and other people who study conservation have long considered why conservation professionals have not actively sought cost-effective selection techniques to try and have called for greater collaboration between academics and conservationists (Prendergast et al., 1999; Armsworth et al., 2004; Allen et al., 2011; Messer and Allen, 2010; Banzhaf, 2010; Duke et al., 2013; Grand et al., 2017; Messer et al., 2016). Some writers had noted that, initially, there was a lack of awareness of the methods among conservationists (Ferraro and Pattanayak, 2006) and perhaps some misunderstandings about potential challenges associated with implementing them because they were perceived as too "prescriptive" (Prendergast et al., 1999). We and our colleagues have worked in the decades since to allay those concerns and demonstrate the value of adopting cost-effective selection methods.

A lack of public pressure plays a major role. Environmental crises such as contamination of the water supply with lead in Flint, Michigan, and increasing poaching of elephants in Africa attract media attention that stirs people living far from the affected area to demand action. People want to see these problems solved and understand that they won't be solved without spending money. However, many do not think much about where the money comes from (taxes they and others pay) or pay close attention to the processes by which their money is spent. So when a conservation program fails to meet its objectives, taxpayers rarely ask why the conservation organization failed to make the best possible use of their money. There is no public push for conservation agencies to upgrade their selection methods.

Many conservationists know that their current selection methods are inadequate and want to do better, but they report having little incentive or ability to make needed changes. Thus, public pressure – from the members of the public who care most about conservation – will be required to make effective conservation a higher priority.

While some in the conservation community may feel uncomfortable with our critique, we believe fundamentally that the best path forward includes honest assessments and critical analysis of the practices of the conservation community in the hopes of continually improving our efforts. Failure to openly discuss conservations challenges and failures will not improve conservation or get us closer to following the core principles of strategic conservation.

LEARN FROM BASEBALL HISTORY

As documented in the book *Moneyball: The Art of Winning an Unfair Game* and the subsequent movie starring Brad Pitt, the Oakland Athletics professional baseball team and general manager Billy Beane used new applied mathematics and statistical analytics (referred to as sabermetrics) and an evidence-based approach to assemble a winning team in the late 1990s and early 2000s, despite having a significantly smaller budget than other successful teams. They found that the collective wisdom of baseball insiders who relied on statistics such as runs batted in (RBIs), batting averages, and number of stolen bases to evaluate players did not produce winning teams. So instead, the Athletics' management used statistical analyses to identify factors that did affect a team's ability to win, such as players' on-base percentages and slugging percentages, and sought players who excelled in those areas and could be acquired at a lower cost. The approach was unconventional and was initially dismissed by baseball 'experts'. But after the Athletics repeatedly made the playoffs despite a payroll about one-third the size of the New York Yankees' $125 million payroll, the approach spread widely, first in baseball and eventually in numerous sports as teams hired sabermetric experts.

We believe a similar transformation is needed in conservation. Agencies and organizations that fund and initiate environmental projects can make better use of the public and private funds they administer and significantly improve their "batting averages" in terms of how well they protect and remediate the environment with their efforts by hiring people who specialize in strategic conservation tools and principles.

THE NEXT GENERATION OF ENVIRONMENTAL PROBLEMS

Current conservation efforts are often less about saving large, irreplaceable landscapes or even protecting charismatic endangered species. Instead, large sums are being spent to reduce carbon emissions, improve water quality through better nutrient management, conserve open space and farmland, and protect green infrastructure, such as forested headwaters, that provide drinking water and flood protection. In the vast majority of cases, the projects under consideration for funding are not unique; many of them, if not all of them, can deliver the desired benefit to some degree. Some projects provide a greater benefit than others, but the cost of acquiring them also varies. These types of projects are the next generation of conservation, and they are uniquely suited to strategic conservation approaches.

HOW TO USE THIS BOOK

This book seeks to both introduce readers to the principles of strategic conservation and educate the reader to the level where they could apply these techniques and decision support tools in their own work. In writing this book, we assumed that the reader has general knowledge of environmental and natural resources issues, but not specific skills in economics, geographic information systems (GIS), mathematics, or planning. The book is designed to be read in full by conservation practitioners and program administrators. Likewise, the book is designed to be a textbook for upper-level undergraduate or Master's level classes in environmental planning, conservation biology, or environmental economics. The book, especially the first four chapters are also well designed for lower-level undergraduate courses such as those in environmental studies, environmental and resource economics, planning, and sustainable development. The last two chapters are hands-on activities that help put into practice the techniques of strategic conservation, as they provide a free introduction the readers to the online tools related to the optimization and the Logic Scoring of Preference methods. For the reader who wants to understand things at a deeper level, Appendix A describes the mathematical foundations of the Logic Scoring of Preference method, while the Jozo Dujmović book entitled *Soft Computing Evaluation Logic: The LSP Decision Method and Its Applications* (Dujmović, 2018) provides an in depth examination of its many complexities and applications. For readers who want to understand the underpinnings of optimization, we encourage people to read Kent's coauthored book, entitled *Mathematical Programming for Agricultural, Environmental and Resource Economics* (Kaiser and Messer, 2011) and an online Appendix B is provided with this book as it is a user manual of the Optimization Decision Support Tool. Finally, to learn more about the various case studies and conservation projects highlighted in this book we encourage readers to check out the references provided in the text.

OUR BACKGROUNDS IN STRATEGIC CONSERVATION

It may seem a bit odd and perhaps overly vain to include a description of our backgrounds as part of the first chapter. However, we felt that by telling our stories, as lifelong environmentalists who had dedicated our professional careers to solving these wicked problems, we could help provide some insights into the challenges that conservation efforts in general face. We can also explain where these principles and tools for strategic conservation have come from and what problems they were designed to address. If you find this background information to be a bit too much self-reflection, then we encourage you to jump to the serendipitous convergence section later in this chapter where we describe our initial collaborations in optimization.

We have worked on conservation issues within nongovernmental agencies, governmental agencies, and academia. We love spending time outside with our families and are passionate about environmental protection. However, we have to admit that we are also nerds. We grew up marveling at state-of-the-art computers such as the Commodore 64, and our summer camps included not only hiking and camping but also computer programming. While many of our geeky contemporaries took their love of computers and programming into creating the businesses of Silicon Valley, we sought to combine our passion for computers with our love for the outdoors. So while we saw millions of people stand in line for the next iPhone so they could more quickly play Candy Crush, we stood amazed as the science of strategic conservation continually evolved and the rush from the environmental community for these new tools and technologies was more like a whisper.

Background of Kent Messer

In 1992, Kent Messer attended the United Nations Earth Summit in Rio de Janeiro, Brazil, as a student reporter. That global summit was attended by leaders of more than 150 countries and by several thousand nongovernmental organizations (NGOs) and laid the groundwork for the Climate Change Convention, the Kyoto Protocol, and the Paris Accord. The issues negotiated were (and are) complex scientifically and politically. As a sophomore in college, Kent had previously experienced environmental conservation mostly as slogans on T-shirts and posters. It became clear to him at the Earth Summit that conservation work would require teams of experts in various disciplines, including science, behavior, sociology, and economics; no one person could bring all of the expertise needed even for relatively small-scale problems.

Kent was earning his bachelor's degree at Grinnell College in Iowa in the anthropology department, studying human behavior in general and the nexus of agricultural and environmental concerns in particular. To understand how farmers made decisions about moving to sustainable practices, he supplemented his anthropology courses with time spent riding tractors and combines during the fall harvest and sitting around dinner tables talking with farm families about the risks and financial challenges they faced. He also spent a summer in the Talamanca Mountains on the Caribbean side of Costa Rica, where poor farmers were actively clearing the rainforest to plant rice and beans in the hope of securing a better future for their families. Once again, the behaviors observed were more complex than he expected. Some farmers in Iowa, for example, were early adopters of no-till agriculture to prevent soil erosion and integrated pest management, while others stuck with traditional methods and at times over-applied fertilizers, thus polluting streams and aquifers. In Costa Rica, some poor farmers retained the rainforests on their property despite the financial sacrifice it meant for their livelihoods. These experiences convinced Kent that the only way he could have a positive influence on the environment was to understand the economic forces that drive both positive and negative behaviors by governments, organizations, and individuals.

Fresh out of college and armed with a better understanding of human behavior, Kent responded to a three-line newspaper advertisement for the job of executive director of Bluff Lake Nature Center, a newly established environmental education program in Denver, Colorado. The fledgling organization's four-person board of directors had secured nine months' salary and hoped to find someone crazy enough to take the job. At 23, Kent embraced the challenge and began developing environmental education programs for low-income residents of a handful of inner-city communities who had lived next to Bluff Lake for generations and never visited it because it was sequestered behind barbed wire fences as part of the old Stapleton International Airport's "crash zone."

Given its outdoor location, its young (and cheap) staff, and its reliance on volunteers, Bluff Lake Nature Center (like the Oakland Athletics) could deliver high-quality educational programs to schoolchildren for a low cost. Kent quickly learned, however, that governmental and philanthropic funders were not very concerned about cost-effectiveness. As he struggled to write grants to fund Bluff Lake's educational programs, he noticed that the funding agencies, such as Denver's renowned Scientific and Cultural Facilities District, which spends more than $50 million per year of taxpayer funds, seemed not to care that Bluff Lake's educational programs delivered a similar-quality educational experience at much lower cost to what was delivered at the large and fancy Denver Museum of Nature and Science down the street. Instead of receiving extra points by grant reviewers for Bluff Lake's cost-effectiveness, the museum's proposals, prepared by a large team of professional staff members committed to grant writing and fund-raising, were frequently funded at high levels, and Bluff Lake would get a trickle of the remaining funds.

Kent's story is not one of sour grapes over failed grant proposals. In fact, as executive director, he raised sufficient funds for his own salary and for salaries for two additional staff members and put the organization on a solid financial path; Bluff Lake Nature Center and its environmental education programs were still thriving at the time of writing, 25 years after its founding. Instead, it highlights the fact that reviews of grant proposals rarely consider the cost of the successful outcomes of the applicants. Thus, if the Denver Museum of Nature and Science submitted a well-polished grant proposal that delivered an exceptional educational program to 1,000 students for $45,000, that was considered superior to a solid grant proposal that delivered a very high-quality educational program to 1,000 students for $15,000. Sure, the educational programs at the Denver Museum of Nature and Science were likely better. But the differences weren't that great and certainly not worth three times more money per kid. Thus, if the goal was truly to educate kids about the environment, why weren't the funders more concerned about getting a good "bang for their buck" when it came to limited funding?

Kent also became aware that this problem was not limited to a handful of foundations focused on education; it was widespread. Another example was the Great Outdoors Colorado, which has spent