Chapter 4 – Avoiding the Budget Sponge and Other Lessons from Conservation Failures

Environmental scientists spend considerable time and effort measuring changes to the environment and often find that human actions are the cause of environmental problems. Likewise, environmental economists study various elements of conservation, such as payment programs and markets in their efforts to clearly identify the source of a problem and propose potential solutions. We argue throughout this book that one thing humans are currently doing that hurts the environment is not carefully designing their conservation programs and we propose cost-effective conservation strategies as a solution to the many problems that have plagued conservation efforts so far. We next consider some of those problems in greater detail.

Selecting budget sponges by ignoring costs

As previously discussed, BT has some intuitive appeal to conservationists since it insures that projects with the greatest environmental benefits are funded. However, its Achilles Heel is that it ignores costs and, therefore, frequently selects large "budget sponges" such as 477 acres of the Everglades that absorb a disproportionally high percentage of the funds available, requiring the program to reject more than 28,000 acres of other high-quality projects. As you will recall, the National Park Service in 2012 evaluated 34 projects for funding under a $25 million budget using a strictly rank-based BT process and ignoring project costs (Messer and Borchers, 2015). As a result, the service funded two projects in Florida: 43,000 acres in Big Cypress National Preserve at a cost of $5.5 million and 477 acres in Everglades National Park at a cost of $25 million. Had cost been considered, the park service could have funded 28,607 acres of high-quality landscapes in other states instead of less than 500 acres in the Everglades. Strategic conservation approaches would have allowed park service officials to balance costs and benefits and provide a greater aggregate benefit from the funds available.

Squandering funds because of asymmetric information and adverse selection

We are likely all familiar with the uncomfortable feeling of being presented with a large bill by an auto mechanic or a dentist to fix something that has yet to become a problem. It is reasonable (and common) to wonder whether your car's transmission actually needs to be replaced or if the mechanic only sees an opportunity to make some money. If that tooth doesn't hurt yet, does it actually need a crown? Economists have identified these types of instances as situations where there is "asymmetric information"—situations in which one side of the transactions knows much more about the situation than another. Few of us know much about car mechanics and therefore have a hard time evaluating whether or not one's transmission is going to have serious problems in the near future. Landowners have private information about their preferences for conservation and know more about the cost of providing ecosystem services on their land.

Individuals managing government conservation efforts rarely know the true intentions of landowners, such as whether they want to develop their land. Many people have deep connections to the land they live on and value managing it to support a wide variety of wildlife and habitats. They are willing to privately finance conservation and do not need government support. However, when a program offers to pay them for those efforts, they are unlikely to say no. Consequently, asymmetric information leads to an incentive problem called "adverse selection" in which publicly funded programs pay people to do what they would have done anyway or pay them more than is required to obtain their participation.

Adverse selection is common in conservation programs. As pointed out by Arnold and colleagues (2010), adverse selection is likely be particularly problematic in situations in which the goal is simply to acquire the most land at the lowest cost—programs that use cost targeting or reverse auctions that do not account for the benefits and development risk of the project. In those cases, the landowners who are most likely to enroll in the conservation program at a low price are those who were most likely to be inclined toward conservation in the first place.

It is difficult to avoid adverse selection unless an organization can find a way to identify landowners who are willing to make private contributions to the environment without the program (Arnold et al., 2010; Wu and Babcock, 1996), and the effects of adverse selection can be significant. For instance, Kirwan and co-authors (2005) evaluated the CRP and estimated that 10–40% of the program's payments went to landowners at prices that were higher than the cost to the landowner of providing the services. Given the program's average annual expenditures of nearly $6 billion per year, upwards of $1 billion per year was transferred from taxpayers to the landowners without any improvement in environmental outcomes.

Surprisingly, the remarkably large squandering of funds by the CRP so far has not caused significant concern in the conservation community. Some may argue that conserving those areas helps ensure that the ecosystem services they provide are preserved in perpetuity rather than only as long as the landowner is interested. Certainly, there is often the possibility that the properties would be developed in the future and lose their conservation value without the program. However, in that case, the degree of development threat should be accounted for when choosing how to spend limited conservation funds, and that would require additional information about the landowners' future intents (or about the intent of the landowners' heirs)—certainly a challenging undertaking. This is the challenge of presented by "additionality" since the goal is for public money to go toward securing additional environmental benefits, not just paying for benefits already provided (or, in some cases, paying multiple times for the same benefits).

Ignoring thresholds and spatial dynamics

In environmental contexts, there can be situations in which sufficiently large changes make returning an environment to a more natural state impossible or impossibly expensive. Examples of these types of thresholds in the natural world include lakes switching from oligotrophic to eutrophic states, aquifers of fossilized water drained or irrevocably contaminated (Li et al., 2014), salinized soils from salt water intrusion in irrigation or storm surges, and loss of endangered species. These thresholds are serious complications that most conservation programs have simply ignored.

An emerging literature in environmental economics seeks to address the importance of these thresholds and spatial dynamics (e.g. Parkhurst et al., 2002; Parkhurst and Shogren, 2007; Banerjee et al., 2012, 2013; Fooks et al., 2016; Duke et al., 2015; Drechsler et al., 2010). While those studies demonstrate the important role of clustering conservation activities to achieve thresholds, most conservation programs (and, frankly, academic studies) ignore on-the-ground realities such as recognizing that the combined conservation benefit provided by two adjacent parcels is likely greater than the combined benefit provided by two identical parcels that are father apart.[1]

Strategic conservation acknowledges that, in many cases, there is a minimum level of conservation that needs to occur (Wu et al., 2000; Wu and Skelton-Groth, 2002; Wu, 2004)—a minimum amount of land or habitat needed to sustain an endangered species, retain a viable agricultural industry (Lynch, 2006), manage growth (Stoms et al., 2009), or preserve a scenic vista. Unless that threshold is achieved, the conservation effort is wasted. Spatial synergies introduce considerable complications to optimal selection. If existing synergies are ignored, project selections will suffer from systematic bias, which occurs because spatial independence is (incorrectly) assumed in cases in which a spatially interdependent process determines benefits or costs. This bias reduces the net benefits and/or cost-effectiveness of independent optimal selection strategies (except in the unusual case in which the interdependent and independent

[1] The desire for continuous land protection may be appreciated at a profound level by humans. For example, Kent recalls the time he took his daughter to the Philadelphia Zoo. In part of the jaguar display, there was a small machine that allowed visitors to donate a dollar to protect jaguar habitat in Central America. The machine displayed a blurry map of the habitat that would be protected by the dollar donation (essentially a GIS map enlarged to the point where a $1 donation would be meaningful). Kent proposed purchasing one of the squares on the edge of the display, but his five-year-old daughter corrected him, suggesting that it would be wiser to conserve land for jaguars that was next to other protected areas (though those $1 protected lands would be unlikely to encompass the entire area needed by the jaguars). Needless to say, Kent adjusted his purchase to accommodate the agglomeration inclinations of his precocious and wise daughter.

optimal selection sets happen to overlap because of a fortuitous benefit and cost ordering that matches the distance synergies).

Case study: The rationale for non-contiguous land preservation

The previous discussion enumerated benefits associated with preserving contiguous land parcels. However, it is important to note that strategic conservation at times calls for preservation of parcels that are not contiguous. One such case is migratory birds, which do not need an uninterrupted corridor of protected land. Rather, they need a series of safe stop-overs during their migrations. Additionally, there are times where protection of lands that are not contiguous can be advantageous when preserving areas from commercial development. For example, in the 1960s, Delaware Wild Lands successfully used *non-contiguous land preservation* to protect the shoreline of the Delaware River Basin from the development of a large oil refinery by Shell Oil. The leaders of Delaware Wild Lands recognized that the small nonprofit was unlikely to preserve the entire Delaware coastline but also recognized that a refinery required a relatively large amount of continuous land on the shoreline. They intentionally acquired a patchwork of small parcels that they then refused to sell to Shell Oil and successfully stopped development of the refinery. Their efforts subsequently led to passage of Delaware's Coastal Zone Act, which has protected the Delaware coast line for more than 50 years. According to Delaware Wild Land's current executive director, Kate Hackett "strategic conservation helped protect one of the most important migratory bird sanctuaries in the United States. Delaware Wild Lands' efforts proved that being cost effective . . . and smart . . . can make an important environmental impact for generations."

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Another issue associated with thresholds is environmental stability and resilience, which are affected by both gradual pressures and sudden pulses that stress ecosystems (Collins et al., 2011). Environmental indicators such as water quality often exhibit key "thresholds" that represent sudden transitions from when something goes from high quality to a significantly lower quality. For example, Kent and his colleagues (Kecinski et al., 2017) tested the impact of servicing water from public drinking water sources that had been previously detected as having some level of arsenic in it. While the amounts were quite small (measured in the parts per billion), research participants reported being quite concerned about having any arsenic in their water. This was true even when the levels were significantly below the EPA's threshold for safety for *lifetime consumption*. Thus, participants requested significantly more to drink water from water than contained even a very small amount of arsenic, than compared to drinking water from sources that contained zero parts per billion of arsenic. Likewise, there were significant jumps in willingness to drink water when the values for arsenic were slightly below and slightly above the EPS threshold for lifetime consumption.[2] These types of discontinuous jumps are also referred to as "threshold effects" and are common both in individual behavior and in environmental conditions.

[2] Note that all of these studies imposed minimal risk since the water presented to participants to consider *voluntarily* drinking had been externally tested to show no health risk and all levels were lower than the *lifetime* levels of safe consumption. All of this research was reviewed and approved by the Institutional Review Board at the University of Delaware, which oversees the safe conduct of research.

The PBJ problem: Nullifying benefits by spreading funds too far

A common problem with conservation programs is that they often get caught up in political processes that seek to spread out their allocations of funds to various jurisdictions rather than seeking to maximize the aggregate environmental outcome. For instance, the CRP has stipulated that no more than 25% of a county's crop land can be part of the program (Sullivan et al., 2004). Think about making a sandwich with a teaspoon of peanut butter and a teaspoon of jelly. To cover the entire piece of bread, both will have to be spread thin—so thin that they do not contribute to the sandwich's flavor in any meaningful way. Conservation programs have the same problem. Spreading their resources over numerous regions or groups could potentially generate widespread political support for a program but simultaneously dilute the outcome of the program so much that the funds ultimately are wasted. Adding these types of jurisdictional constraints will, by definition, fail to improve the cost-effectiveness of a program by restricting the set of feasible solutions (Kaiser and Messer, 2011).

Consider Pennsylvania's Dirt and Gravel Roads program, which seeks to reduce nonpoint source water pollution by improving the quality of rural roads. It first allocates the available money to counties and then tries to identify the best projects within each county. As described in Fooks and Messer (2013), sometimes the allocations of funds are so thin that individual counties cannot fund even one project. As shown in Figure 4.1, just a small amount of flexibility in terms of budget transfer between counties to better target cost-effective projects could significantly improve the total benefit achieved. Requiring this transfer ultimately also becomes ineffective since a required transfer exceeding $40,000 begins to decrease the overall benefits achieved. Therefore, programs should be flexible enough to allow the targeting of best opportunities over political jurisdictions.

<Figure 4.1 Total benefits achieved given the amount of budget transfer>

Conservation Supply and Demand

Ecosystem services are rarely included in traditional markets for goods and services. You cannot buy them on Amazon or bid for them on eBay. Economists have long noted that a major failure of markets is the under provision of public goods, such as ecosystems services (Gardner, 1977). As will be discussed later, economists often believe that the best thing to do is measure things, even things as complex as ecosystem services, in monetary terms (Duke et al., 2014); however, most conservation efforts have yet to incorporate the measurement of the public's willingness to pay (WTP) for these ecosystem services as a measurement of conservation benefit. Instead, conservation programs have generally targeted goals such as air quality, biodiversity preservation, scenic vista quality, and habitat provision, and then develop measurements of benefits that can arise from a particular project (or set of projects). These various benefits can then be weighted by the priorities of the organization. For example, when considering conservation projects near the presidential retreat of Camp David in the Catoctin Mountains, the State of Maryland's Department of Natural Resources assigned the following weights for the available projects (Messer, 2006):

Acres of green infrastructure:	2
Percent of green infrastructure:	1
Ecological score:	3
Protected land within one mile:	1
Percent gain in protected area:	1

These weights imply that for this program, the ecological score (which consisted of 16 criteria) was three times more important than having the land being within one mile of other protected land. Likewise, the total number of acres was twice as important as the percentage of the land of the parcel that was within the designated green infrastructure hub and core areas.

One of the advantages of using weights is that they can be updated. For instance, the wetland Reserve Program and the CRP periodically update the weights used to target lands (Cattaneo et al., 2006). While weights make intuitive sense, they also are challenging to identify correctly, especially if one considers not only an individual's choice but also the preferences for others (Hajkowicz et al., 2009; Messer et al., 2010).

Case Study: The Devil Was in the Details, the Failure of Transfers of Development Right Programs

For environmentalists, the idea of real estate developers paying for conservation seems like a dream too good to pass up. So when the proponents of transfer of development rights (TDR) programs started talking with conservation professionals in the 1980s and 1990s and showing them some promising results from a couple of places, there was a rush for local governments to establish their own TDR programs in the hope of a "magical money tree" for conservation. However, a couple of decades later the evidence is clear—these magical trees bore little to no fruit (Messer, 2007). Why? Like most things related to conservation project selection, the devil was in the details.

The basic concept of a TDR program seems so inviting. You limit the number of units that developers can build in urban areas (the receiving area) and allow developers to purchase the right to have more dense development in the receiving areas by having them pay for conservation efforts in more ecologically sensitive locations (the sending areas). In an ideal TDR program, the developers would buy these development rights directly from willing sellers; the only thing the government needed to do was establish the rules of the market and perhaps certify the trades.

Despite the minimal financial burden and the ecological benefits provided, the TDR programs were never successful. Kent's previous research (Messer, 2007), he identified looked a the TDR programs that had been established in the United States. Yet less than 5% of these program had ever preserved more than 100 acres. In fact, when we looked deeper into the TDR programs that did report having preserved a substantial number of acres, we found that several were not TDR programs at all. The funds for the conservation activity had not come from private developers; they were provided by the government to create a "bank" of TDR credits with the hope that developers would later come along and purchases these credits. However, in many cases these private buyers never emerged. Therefore, these programs were effectively a traditional Purchase of Development Rights (PDR) program that relied upon government money and not a TDR.

One example of this is in Sarasota, Florida, where the TDR program reports having preserved 8,200 acres. However, inspection of this program shows that the county had actually purchased 8,169 of these acres—99.5% of the total (Pruetz and Standridge, 2009). Similarly in the Seattle area, King County set up a TDR program and reportedly conserved more than 100,000 acres in the sending zones. However, the vast majority of these acres were purchased by the county, not private developers (Messer, 2007).

Why did the programs fail? Simple economics. There was not enough demand to meet the potential supply. In other words, plenty of people in the sending areas were willing to sell their development rights—for the right price. The problem was that there was not enough demand in the sending areas to create situations where the price that developers would pay was higher than the price that suppliers were willing to receive. In most cases, the zoning regulations were not strict enough on developers, and thus developers found alternative ways of meeting their development objectives. These alternative ways, such as requesting zoning variances or developing in areas outside of the receiving area, ended up being cheaper and more profitable than buying the development rights through a TDR program (Messer, 2007). For instance, in Birmingham Township Pennsylvania, developers ended up buying up the two core receiving areas and then used their political ties to get these areas rezoned to permit development. Thus, the TDR program in Birmingham was subsequently discontinued (Pruetz and Standridge, 2009).

Benefits that are poorly defined, measured, or scaled

Prior studies of conservation have suffered from numerous pitfalls related to how benefits were identified and/or measured. Olmsted's recommendations for selecting a campsite, for example, included both a benefit (a supply of firewood) and a cost of obtaining that benefit (firewood located at a convenient distance). Considering a reduction in the cost of obtaining a benefit (in Olmsted's case, a travel cost) as a "benefit" can lead to a variety of suboptimal choices (Hajkowicz et al., 2009; Duke et al., 2013). Therefore, for a selection process to be strategic, it must measure the benefits directly (for Olmstead, (adequate) firewood being available) and then account for the costs (travel) as a constraint on the optimization problem, as will be described later in Chapter 5.

One also must be careful when evaluating projects and measuring their conservation benefits to not confuse scales. Both benefits and costs can be measured per project, parcel, or acre. As we showed in our (2010) article, the selection process will mistakenly target small parcel at the expensive of higher quality, larger parcels (Table 4.1) unless the scales of the relevant conservation benefits and costs match.

[Table 4.1 Importance of scaling benefits by parcel size.]

Inadequately measuring and applying costs

Measuring all of the costs of conservation, including the parcel acquisition, the transaction expenses, the continuous costs of monitoring and enforcement of environmental protection and the cost of stewardship costs should be straightforward as generally these costs can be measured through existing markets.[3] However, Ando et al. (1998) noted that these costs generally were not appropriately included in targeting decisions.

[3] For a list of costs associated with conservation, see Wilson et al. (2009) and Naidoo et al. (2006).

One challenge to strategic conservation is that few conservation efforts collect information on cost *before deciding* which projects to pursue even though they nearly always collection information on the conservation benefit before deciding. Therefore, a tenet of strategic conservation is that the entire cost of a project (for acquisition subsequent stewardship) should be measured *before selecting* projects.

Interdependent systems addressed in isolation

The numerous conservation programs in the United States target different areas of concern and consequently have unique sets of objectives and rules. Some desire to preserve forests, others to protect water quality, and others to protect endangered species. Since each program works in isolation, it ignores the fact that ecosystem services are often jointly produced. Protecting a forest is likely to benefit water quality, which can, in turn, better support species diversity. If the selection processes of those various programs could be integrated, aggregated environmental benefits could be better achieved.

As an example, consider the case of agricultural land preservation in Maryland. As detailed in Messer et al. (2016), officials in Baltimore County had two primary sources for funding agricultural land preservation: state funds and county funds. Each year, they received a pool of potential sellers and county officials made their funding decisions for both funding pools sequentially. However, if they made their decisions simultaneously for these pools of funding they could have protected 5.7% more conservation benefits and 4.4% more acres. In a three-year period, these increases in benefits would have cost the county approximately $1.2 to $1.7 million to achieve. Again, an opportunity to use strategic conservation to protect more with less.

Inability to account for actual risk of development

Conservation efforts are frequently made in a context that includes uncertainty over the future. In some cases, private landowners choose to act to conserve their properties as rural or agricultural and protect them from development, providing environmental benefits to the public for "free" (Fooks et al., 2015). In other cases, the provision of ecosystems is seriously endangered by landowners' desire to profit from development. Thus, conservation organizations are interested in targeting the lands that are most vulnerable to development. Unfortunately, academic studies have not yet reached a consensus on how to most effectively do that. For instance, some research, such as Messer (2006), has sought to predict development threat through parcel characteristics, such as its soil quality and proximity to highways and urban areas. If these attributes can be successfully measured, they can then be used to weight the conservation benefits of potential lands. Similarly, Newburn et al. (2005) and Costello and Polasky (2004) developed selection processes that sought to account for development risks.

Small flaws can cause big problems

In these chapters, we have presented the nature of the critical problem facing the conservation community: (1) selection processes that squander natural and financial resources, severely limiting what can be accomplished with the substantial but also inadequate funds available and abusing the public's trust and (2) failing to adopt powerful new tools that offer the ability to select projects for funding and implementation by weighing each candidate project's relative benefit and cost and potentially consider additional factors as well. We have examined how the flawed system currently in place developed and barriers to replacing it. And throughout our discussion, we have emphasized the significant magnitude—millions to billions of wasted public dollars—and foregone opportunities that are the consequences of clinging to an outdated and ineffective approach for funding conservation.

Now, we turn our attention to the mechanics of establishing and practicing cost-effective conservation strategies by adopting powerful mathematical programming tools and honing processes for identifying and quantifying costs, benefits, and outcomes.