Advancing Conservation by Understanding and Influencing Human Behavior

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Abstract
Behavioral sciences can advance conservation by systematically identifying behavioral barriers to conservation and how to best overcome them. Behavioral sciences have informed policy in many other realms (e.g., health, savings), but they are a largely untapped resource for conservation. We propose a set of guiding questions for applying behavioral insights to conservation policy. These questions help define the conservation problem as a behavior change problem, understand behavioral mechanisms and identify appropriate approaches for behavior change (awareness, incentives, nudges), and evaluate and adapt approaches based on new behavioral insights. We provide a foundation for the questions by synthesizing a wide range of behavior change models and evidence related to littering, water and energy conservation, and land management. We also discuss the methodology and data needed to answer these questions. We illustrate how these questions have been answered in practice to inform efforts to promote conservation for climate risk reduction. Although more comprehensive research programs to answer these questions are needed, some insights are emerging. Integrating two or more behavior change approaches that target multiple, context-dependent factors may be most successful; however, caution must be taken to avoid approaches that could undermine one another (e.g., economic incentives crowding out intrinsic incentives).

Introduction
Conservation practice has long attempted to influence the behavior of key actors. This practice has increasingly been informed by integrating behavior change models from economics (Daily et al. 2009) and psychology (Clayton et al. 2013) into conservation science. However, conservation science continues to focus more on nature or the benefits nature provides to people than on the science of people’s behavior (Cowling 2014). This is a risk because many emerging conservation strategies (e.g., water funds, urban conservation, climate risk reduction) require fundamental and widespread changes in human behavior (i.e., choices, actions).

As with natural systems, human behavior and the factors that influence it are complex. For example, to change even a relatively focused behavior, such as switching to low-water use landscaping, requires changing, and sometimes coordinating, the behaviors of multiple actors. These might include the homeowner, plant supplier, landscaper, and members of regulatory bodies. Behaviors of any one actor are affected by each other, as well as a number of internal and external factors, some of which are not easily observed. Values, beliefs, attitudes, preferences, habits, costs and benefits, technology, social norms, policies, and institutions all may interact to influence a behavior. A systematic understanding of human behaviors and their underlying mechanisms is needed.
Given that the behavioral sciences are new to many in conservation, selection of behavior change approaches can gravitate toward approaches that are familiar or popular (e.g., economic incentives). We provide an alternative.

We propose seven guiding questions to help design conservation programs and policies based on a scientific understanding of human behavior (Table 1). These questions can be integrated into an adaptive management process for conservation planning, such as the Open Standards (see http://cmp-openstandards.org/). The first set of questions (1–3) defines the conservation problem in terms of a behavior change problem by identifying the key actors and behaviors and the baseline conditions. The second set of questions (4–5) gathers evidence for alternative behavioral mechanisms in order to inform the selection of interventions that draw on three behavior change approaches (awareness, incentives, nudges). The third set of questions (6–7) evaluates the success of the intervention and gains insights for improving programs and policies.

We also use Table 1 to illustrate how each question has been addressed in practice. By gathering answers to the guiding questions, conservation practitioners are gaining behavioral insights into how to promote conservation of coastal habitats for climate risk reduction (i.e., natural infrastructure). Because no single study has covered all the questions we propose, we highlight evidence from multiple studies. Incorporating these guiding questions into adaptive management processes could help in planning for and funding more comprehensive research programs that include all the elements of our guiding questions.

**Defining the behavior change problem**

Defining the conservation problem as a behavior change problem helps to scope the opportunity for conservation programs and policies to use behavioral interventions. Conservation practitioners often identify threats that are the aggregate result of many decisions and behaviors (e.g., climate change, deforestation), which can obscure the link between threats and the behaviors we aim to influence. Instead, for a given conservation problem and scope, the first question can be *what is the human behavior of interest* (Table 1)? Various descriptive research methods (e.g., surveys, key informant interviews, consumption statistics) can be used to explore the behaviors that directly or indirectly affect the conservation problem in a given context. Research on behavior informs the second and third questions: *who is engaging in this behavior and what is their baseline level of behavior* (Table 1)? Actors are often viewed through the lens of market, government, or civil society actors (Figure 1A). These lenses focus attention on particular goals and decision contexts (i.e., economic, public, and private, respectively) that may influence behavior (Figure 1A). A single actor may be viewed through multiple lenses and any actor may engage in proconservation behaviors, although for different reasons (Figure 1A). Using these lenses to identify specific populations of actors in context can help narrow the scope for a baseline assessment of behavior and potential behavioral factors or barriers, which informs the fourth question (*why?*).

**Understanding behavior to design conservation interventions**

The fourth question asks *why* do actors in the population behave as they do (i.e., what factors determine actors’ behavior, such as goals, beliefs, preferences, prices, social norms, policies, etc.) (Table 1)? The evidence gathered to understand behavioral mechanisms then informs the fifth question, *how can we design and implement behavior change interventions (i.e., what programs and policy tools are most likely to be successful?)* (Table 1)? To provide a theoretical and empirical foundation for answering these questions, we synthesized a wide range of behavior change models and evidence.

The primary approaches used to encourage proconservation (or discourage anticonservation) behaviors can be organized into three approaches: (1) promoting awareness and concern, (2) incentivizing behavior, and (3) nudging behavior. These categories are distinguished by their underlying rationale and associated barriers (Figures 1B and 2). Approaches 1 and 2 use reasoning, while Approach 3 relies primarily on intuition (Figure 2). The reasoning and intuition pathways are based on the dual process theory framework (e.g., Kahneman 2003). The theory posits that any given judgment, choice, and behavior can be produced by two parallel cognitive processes: an implicit/automatic, intuitive process (i.e., System 1, reasoning) and an explicit, deliberated, conscious process (i.e., System 2, intuition). Although the pathways and approaches are presented separately, in reality, they are not entirely separate and sophisticated behavior change interventions utilize two or more approaches (e.g., social comparisons and energy conservation tips; Allcott & Rogers 2014; Figure 3). We illustrate Approaches 2 and 3 with successful examples from energy and water conservation, littering, and land conservation (Figure 3).

By considering results from descriptive research in light of the proposed framework (organized here into the three lenses for actors and three behavior change approaches), the question of “why” can be formulated into testable hypotheses for behavioral factors and
### Table 1  Guiding questions and application to natural infrastructure

| Guiding questions | Example specific questions | Methodology and data | Example application: natural infrastructure |
|-------------------|---------------------------|----------------------|---------------------------------------------|
| **Defining the behavior change problem** | | | |
| 1. What is the human behavior of interest? | Function of conservation problem (e.g., what behaviors directly or indirectly affect coastal ecosystems?) | Descriptive research (data from surveys, interviews, focus groups) to define context and scope; enumerate and prioritize behavior(s) and actor(s); and quantify baseline conditions for behaviors of specific populations of actors and potential behavioral factors or barriers. Define goals and metrics for behavior change relative to the baseline. | Description: Selecting solutions to address coastal flooding and erosion, including natural (e.g., marshes, oyster reefs) and engineered solutions (e.g., seawalls) (Kochnower et al. 2015). |
| 2. Who is engaging in these behaviors? | Which market, government, and civil society actors? | | Description: U.S. Federal agencies (government), businesses (market), communities (government/civil), and engineering professionals (government/civil) engage in a task force to analyze these solutions after Hurricane Sandy (Sutton-Grier et al. 2015). |
| 3. What is the baseline level of behavior? | Baseline level of behavior for the focal population, geography? | | Description: NI projects are rare in the United States and globally (http://maps.coastalresilience.org/global). Maryland has an order of magnitude more NI projects than California or North Carolina (Kochnower et al. 2015). |
| **Understanding behavior to design conservation interventions** | Awareness of and attitudes toward the conservation problem? Nonconservation motivations (economic, social, intrinsic)? Intuition, habit, decision context? | Considering results from descriptive research and the conceptual framework (actors, approaches; Figures 1 and 2), formulate testable hypotheses. Gather evidence to evaluate hypotheses for behavioral mechanisms falling into three categories of approaches. If evidence exists, conduct systematic review and grade evidence. Identify evidence gaps and conduct experimental or quasi-experimental research as needed. | Evidence: Presidential order: “protect the dunes and wetlands that pull double duty as green space and as natural storm barriers” (within TNC 2014). Evidence: Community leaders and businesses voted not to appropriate funds to rechannelize around the Napa River and fund more expensive, sustainable NI (TNC 2014). A business decides not to alter the design of a levee because marshes do not provide sufficient protection from economic damages, although community and ecosystem benefits are recognized (Reddy et al. 2015). Evidence: Residents in Hatteras, North Carolina see NI in neighboring communities (social norm) and, together with an NGO, champion the solution to private land owners, the community, and county commissioners (Kochnower et al. 2015). |
| 4. Why do actors in the population behave as they do? | How can we use education, campaigns, and participatory processes? How can we use taxes, subsidies, rebates, injunctive social norms (what one ought to do), and affirmations of self-identify or image? How can we use behavioral nudges (e.g., social comparisons, defaults, message frames, commitment devices)? | Based on evidence for behavioral mechanisms, choose or develop interventions drawing on one or more of the appropriate approaches to target the key factors for those mechanisms. Pilot/implement interventions that target mechanisms identified through research. Ensure meaningful evaluation by employing experimental or quasi-experimental designs. | Intervention: NI design contest designed to foster stakeholder awareness, collaboration, and engagement, in addition to select and fund projects (Sutton-Grier et al. 2015). Intervention: Residents in Ventura Country, California catalyze the implementation of NI at Surfer’s Point through subsidies provided by the Federal Transportation Equity Act for the 21st Century (Kochnower et al. 2015). Intervention: Maryland changes policy in 2008 to make NI the default solution for coastal erosion (Kochnower et al. 2015). Business employees commit to one of a set of sustainability goals on Tumblr (http://dowchemical.tumblr.com). |
| 5. How can we design and implement behavior change interventions? | | | |

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Continued
Table 1 Continued

| Guiding questions | Example specific questions | Methodology and data | Example application: natural infrastructure |
|-------------------|---------------------------|----------------------|---------------------------------------------|
| 6. Did the intervention result in a desired change in behavior or in the factors underlying the behavior? | Did the focal market, government, and/or civil society actors increase or decrease conservation relative to baseline? Are changes attributable to the intervention or other factors? | Monitor and evaluate pilots/full-scale interventions. Evaluate evidence supporting hypothesized behavioral mechanisms and intervention. Measure outcomes relative to behavior change goals. | Natural or Quasi-Experiment (low inference): Seven years after 2008 policy that made nature-based solutions the default option in Maryland, there were 250 projects implemented compared to only 10 in California and 30 in North Carolina where engineered solutions remained the default (Kochnower et al. 2015). |
| 7. What insights into behavior did we gain that we can apply to adapting the current program or designing future programs? | Did the intervention work as predicted? Can variation in the success of the intervention across observable attributes of actors or the decision context provide insights? | Adapt interventions, policies based on new behavioral insights (go back to question 5). Scale-up to full-scale implementation, designed for evaluation. | Preliminary Insights: Business, community, and government actors get different benefits from NI, which suggests combining economic and social incentives to coordinate stakeholders with multiple, diverse motivations (Reddy et al. 2015). However, some businesses may have image concerns over receiving economic benefits for conservation. |

For an introduction to nudges, see Thaler & Sunstein (2008). For a database of empirical studies on a variety of nudges used in different applications (e.g., health, savings, energy), see the Nudge Database v1.2 (Egan 2013)

Note: While experimental work on the adoption of natural infrastructure (NI) over engineered solutions remains slim, we illustrate our guiding questions with published examples where these questions have been implicitly or explicitly addressed. For the sake of comparison, we limited our examples to the United States as enabling conditions include overarching federal funding, acts, and presidential decrees.

Figure 1 Actors and approaches to behavior change: (A) actors are often viewed through the lens of market, government, or civil society actors that focus attention on particular goals and decision contexts (i.e., economic, public, and private, respectively), and the identification of specific populations of these actors in context, can help narrow and define potential behavioral factors and barriers (note that the subset of actors, viewed through any of these lenses, that actively support conservation are indicated by the green circle) and (B) representations of how the three approaches to behavior change work to (top) promote awareness and concern for conservation, represented by all actors turning “green” to indicate that they have conservation goals; (middle) align otherwise competing incentives, represented by having actors and their goals overlap with conservation; or (bottom) work around the precursors of behavior (e.g., knowledge, awareness, attitudes, or motivations) to change the decision context (represented as a gray oval) by using nudges (small changes in the decision context that do not limit choices or change economic incentives).
Figure 2 Three approaches to behavior change, their underlying rationale, and barriers (represented as orange blocks) to change. The approaches of promoting awareness and concern (1) and incentivizing behavior (2) take the Reasoning Pathway in which efforts are made to change precursors of behavior (i.e., knowledge, awareness, attitudes, motivations). In contrast, the approach of nudging behavior (3) works around these precursors, taking the Intuition Pathway that attempts to make behavior automatic, easy, and intuitive through the use of “nudges” (small changes in the decision context that do not restrict choices or change economic incentives). Nudges may tap into the heuristics and biases that result from humans having limited capacity for reasoning (i.e., bounded rationality). The three approaches are not truly separate and most successful interventions will likely draw on at least two or more of the approaches (as indicated by the gray dotted line) because, for example, even if incentives are aligned it is possible to still run into barriers related to bounded rationality.

Figure 3 Examples of behavior change interventions that use incentives (extrinsic: financial and social; intrinsic) and nudges to promote three conservation behaviors. Note that we did not include examples of awareness interventions because these interventions may be more familiar to conservation practitioners and evidence suggests that they rarely work well alone. References from top left to bottom right: Datta & Gulati (2014), Allcott & Rogers (2014), Pichert & Katsikopoulos (2008), Huffman et al. (1995), Heath & Heath (2007), Shultz et al. (2011), Lubell et al. (2013), Ryan et al. (2003), and Messer et al. (2015).

barriers. Testing these hypotheses may involve conducting new experiments (i.e., pilots), analyzing data using quasi-experimental methods (see next section), and/or reviewing existing studies to build evidence for alternative behavior change hypotheses. Evidence from existing studies should be carefully considered on the basis of strength of inference and applicability to the context at hand (Ferraro & Pattanayak 2006). The strength of evidence for the different behavior change approaches should then inform the selection of interventions or
policy tools associated with the approaches (see Table 1 for examples). This is where we weave together interventions drawing on one or more of the three approaches and targeting one or more of the actors into a program for behavior change. A practitioner could skip these science steps and instead rely on conventional wisdom or expert judgment; however, there are many examples where such shortcuts have failed or, worse, backfired (e.g., Reddy et al. 2014).

**Approach 1: promoting awareness and concern**

**Rationale and evidence**

Numerous environmental education and communication programs have been guided by the rationale that new knowledge/beliefs lead to increased awareness, followed by concern (i.e., change in attitude), which then increases proconservation behavior (Hungerford & Volk 1990). However, many studies suggest that the assumed direct link between awareness, attitudes, and proconservation behavior, such as water and energy conservation, is relatively weak and is often mediated by other factors (Bamberg & Möser 2007). Still more limiting, many education and communications programs that promote biodiversity conservation have never been evaluated for their effect on behavior (Ferraro & Pattanayak 2006).

**Barriers**

A behavior change approach relying primarily on the link between attitudes and behavior is oversimplistic (Stern 2000) because of the multitude of internal and external factors that may influence behavior (Gifford 2014). Common barriers include a lack of perceived responsibility, conflicting attitudes and incentives, and practical constraints (e.g., a lack of time, money, technology, information on how to conserve) (Blake 1999).

**Approach 2: incentivizing behavior**

**Rationale and evidence**

The underlying assumption for incentivizing behavior is simple—people are most likely to respond if there is something to be gained (or a loss to avoid). These potential gains and losses can create positive and negative incentives. The factors that create incentives can be extrinsic (e.g., financial benefits/costs, social norms [indicating what a person ought to do], regulations) (Stern 2000; Schultz et al. 2007) or intrinsic (e.g., personal values, norms, morals) (Stern et al. 1999) to the actor.

Incentives for conservation do not necessarily require awareness or concern for conservation in order to change behavior. For example, government actors offer financial incentives for water or energy efficient appliances (Datta & Gulati 2014) and for conservation easements (Lubell et al. 2013), and financial disincentives for littering (i.e., fines) (Huffman et al. 1995) (Figure 3). Actors may choose to engage in these behaviors because of the financial benefits or costs irrespective of feelings of concern for conservation. Social norms, identities, and personal values can also be leveraged to incentivize behaviors that help actors create relationships and personal images that are desirable to themselves and others (Bénabou & Tirole 2011). For example, the “Don’t Mess with Texas” antilittering campaign dramatically reduced highway litter by appealing to a Texan identity and to a strong, self-reliant or “macho” self-image particularly popular among Texan men at that time (Heath & Heath 2007) (Figure 3). Intrinsic incentives can also come about as a result of individuals’ personal desires and values. For instance, attachment to land has been shown to be more important for motivating farmers to engage in conservation practices than financial incentives (Ryan et al. 2003) (Figure 3).

**Barriers**

Incentive programs designed without a thorough understanding of the target actors may have a limited impact and could sometimes even backfire. For instance, alternative income programs that use the same level of financial incentive for all participants may only motivate behavior for those actors who have the least to lose (or most to gain) (Reddy et al. 2014). Low financial incentives can inadvertently communicate to an actor that the behavior is not valuable, counteracting or “crowding out” the actor’s intrinsic motivations and resulting in decreased conservation (Gneezy et al. 2011). Incentives could also simply fail because the actor is unaware of the potential benefit (e.g., savings from energy-efficient light bulbs; Allcott & Taubinsky 2015) or because there is an actual or perceived inability to change the behavior (Bandura 1994) (Figure 3).

**Approach 3: nudging behavior**

**Rationale and evidence**

“Nudges” make small changes to the decision context (i.e., choice architecture) that target intuitive thinking, without restricting choices or significantly altering economic incentives, such that proconservation behavior is more likely (Thaler & Sunstein 2008). For example, installing trash bins decreased littering by making disposing trash in the bin as easy as littering (Schultz et al. 2011) (Figure 3). Making electricity from renewable-energy
sources the default on a power bill increased purchases of renewable energy, compared to when customers had to actively switch away from cheaper conventional energy supplies (Pichert & Katsikopoulos 2008) (Figure 3). Setting the online slider-bar to start at 100% cost-share (on a range of 0%-100%) in an online auction for conservation contracts that require farmers to adopt conservation practices resulted in higher bids than setting the slider bar initially at 0% (Messer et al. 2015) (Figure 3). These type of nudges are attractive because they may be less costly and better preserve freedom of choice than regulations or price-based incentives (e.g., taxes, subsidies) (Allcott & Taubinsky 2015).

Nudges work by making the desired behavior easier, simpler, more engaging, or intuitive (Thaler & Sunstein 2008) (Figure 2). Intuitive decision-making often relies on “mental shortcuts” or “heuristics” to make decisions because humans have limited resources for processing information (one limitation that defines “bounded rationality”) (Tversky & Kahneman 1974). It is important to note that although heuristics may lead to good decisions, they can also lead to systematic biases (Tversky & Kahneman 1974). Nudges that leverage heuristics or biases (e.g., defaults leverage our status quo bias) simplify the choice process, allowing for more automatic, quick decisions based on intuition (Figure 2).

The primary distinction between nudges and incentives as described in Approach 2 is that nudges target intuitive thinking, while incentives tend to target reasoning or rational thinking. However, there is some overlap between nudges and incentives. Social comparisons of household energy or water bills are an example of an intervention that blends incentives and a nudge (Figure 3). The social comparison conveys an injunctive social norm (what one ought to do) that provides a social incentive for conservation, which interacts with intrinsic incentives for being accepted by the social group. At the same time, it conveys a descriptive social norm (what one actually does) that serves as a heuristic for intuitive judgments about how much energy or water to use, for example. Notably, however, interventions that change incentive are not always nudges (e.g., taxes) and nudges do not always change incentives (e.g., defaults).

**Barriers**

Despite their attractiveness and increased popularity (e.g., the U.S. and U.K. governments have “nudge units”), nudges may only result in small changes and they could fail if the decision maker has strong preferences for a particular option (Sunstein 2013). Nudges are also perceived negatively by those who view them as paternalistic and as eroding autonomy (Felsen et al. 2013). Eroding actors’ autonomy could even have adverse consequences for conservation behavior by crowding out intrinsic incentives for conservation.

**Evaluating and gaining insights from behavior change interventions**

After piloting and full-scale implementation, we use program evaluation to answer the sixth question: did the intervention result in a desired change in behavior or in the factors underlying the behavior (Table 1)? Pilots and full-scale programs should be designed and implemented in a way that enables evaluation and continued assessment of their impact on the behavior of interest, and if possible, on the behavioral factors. In order to reliably evaluate whether the intervention had a causal effect on the behavior, pilots and programs should be designed as experiments or quasi-experiments (Ferraro & Pattanayak 2006). Experimental designs allow evaluators to draw the strongest inference about the causal effects of an intervention because they randomly assign subjects to treatments and controls, which also randomizes alternative explanations. Quasi-experimental methods identify and eliminate alternative explanations through sampling and analytical methods. Common quasi-experimental methods include natural experiments (e.g., environmental shocks create treatments and controls), instrumental variables (e.g., exogenous policy changes), and matching methods (e.g., selecting controls by matching on other variables) (for more on program evaluation in conservation, see Ferraro & Pattanayak 2006).

Program evaluation that also measures potentially relevant behavioral factors can help answer a final question: what insights into behavior did we gain that we can apply to adapting the current program or designing future programs? For example, experimental trials to promote prosocial behavior, such as conservation, are providing emerging insights into how to design extrinsic incentives (e.g., economic) to avoid crowding out intrinsic incentives. Gneezy et al. (2011) conclude that economic incentives, while effective under some conditions, can have adverse effects on prosocial behavior if they convey distrust, erode social norms (or beliefs regarding social norms), or reduce image motivations (e.g., wanting to be viewed as a “good” person). These adverse effects are in part the consequence of misinformation about the intent of the economic incentive or the actors. This suggests that economic incentives may be most successful for private behavior (avoiding public image problems) or when combined with awareness and social incentives. For example, a program could communicate that the economic incentive is intended to achieve a shared goal (enhancing trust), show the actor how their behavior results not
only in an economic reward for themselves but also in benefits for conservation or society (reinforcing intrinsic motivations and image motivations), and enable the actor to share the good results of their behavior with others (enhancing social norms and image motivations).

**Conclusions and applying the questions in practice**

Behavioral science brings a new set of theories and methods that can help expand the impact of conservation efforts. Systematically evaluating behavior change approaches can allow conservation practitioners to consider ways to remove barriers between awareness and action, align incentives appropriately, and harness behaviors driven by automatic, intuitive responses. In some cases, this may mean abandoning simplistic, if popular, models of behavior change involving single-faceted emotional appeals or financial incentives in exchange for more tailored, multi-pronged approaches. Notably, nudges have exciting potential for conservation because they do not require changes in awareness or attitudes or potentially costly financial incentives.

The guiding questions we propose here are just beginning to be applied in practice to conservation programs and policies, such as those related to coastal natural infrastructure (Table 1). Currently, behavior change research for natural infrastructure relies primarily on evidence generated by descriptive studies. However, such evidence can be used as the basis to generate hypotheses for behavioral mechanisms and interventions that can be formally tested. For example, experimental and quasi-experimental research could identify when economic incentives are effective (e.g., decisions by businesses, private landowners?) and when they need to be combined with social incentives or awareness (e.g., businesses with sustainability goals and substantial reputational concerns, private landowners making highly visible decisions or with strong social and intrinsic incentives?), or when defaults can nudge actors toward natural infrastructure (i.e., is the Maryland state policy replicable?).

Although behavioral science promises new and innovative pathways toward conservation outcomes, there are challenges for research and practice. Behavior change is context- and actor-dependent; dynamic interactions between human behavior and natural resources are relatively unexplored. This means that, in some cases, relevant, high-quality evidence will be sparse and experimentation in different contexts presents technical, logistical, financial, cultural, and ethical challenges. Integrating behavioral science into conservation practice requires additional capacity and resources, including new practices and institutions to support translational research.

Comprehensive research programs that answer the guiding questions proposed here could help advance conservation of climate, freshwater, land, and ocean systems by providing the much-needed scientific basis for behavior change interventions in conservation programs and policies. This research should help avoid designing programs that are ineffective or even backfire by identifying when to use different behavior change approaches and how to avoid choosing approaches that undermine one another.

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