11 Behavioral Perceptions and Policies Toward the Environment

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There is a strong relationship between the ways people think about the behavior of nature – the probabilities, rewards, and penalties it metes out – and how we as a society confront environmental problems. Many characteristics of environmental problems stimulate the side of people's perceptions and responses that a band of psychologists and economists have recently worked together to describe. Environmental concerns frequently involve small and ill-defined probabilities, at times incorporating scenarios that are hard to envision. Many decisions of the potentially gravest import, such as destruction of the ozone layer or alteration of the global climate, are unique situations; they have no precedents and offer no repeat plays. Experts often disagree significantly about environmental problems and about the models to employ in thinking about them. The measuring rod of money, so helpful in dealing with many policy concerns, is absent or at best one step removed in measuring environmental outputs. Such outputs are not traded on markets, and people have difficulty making trade-offs between them and other valuable commodities. These conditions challenge wise choice. In this hostile soil for rationality, behavioral decision can flourish. In an unkindly moment, we may liken behavioral decision to an alien plant. To the rationalist, it is a weed in the garden where only rationality should bloom. To the realist, it is better to understand this plant's anatomy, learning how to live with it, even harvesting it at times, since eradication seems unlikely. Realists recognize that certain conditions make behavioral decision virtually inevitable. Environmental policy offers such conditions.

Economic theory, and decision theory as its complement, have developed around a few axioms of individual choice behavior. Generally, these axioms assume that individuals have consistent preferences, and that they make choices among competing bundles of goods to satisfy them. Utility theory assumes that we can define a utility function that describes these preferences, and that actors will follow the function in a consistent fashion such that choices made have higher utility than choices foregone. Decision theory posits further that individuals can extend the rational methods to make choices about uncertain outcomes, in effect maximizing the expected value of utility, given logically calibrated subjective probabilities of the possible outcomes. From these assumptions all manner of benefits flow. Most fundamental are consistency and transitivity in choice, implying the ability to extrapolate from an individual's choices in laboratory contexts.

Individuals do splendidly in choosing between apples and pears. Once uncertainty enters, unfortunately, the choice problem becomes more complex, and many people exhibit behavior that tends not to maximize the expectation of consistent utility functions. If these choices under uncertainty were random, decision theory could tie descriptions of behavior to physics, utilizing such concepts as Brownian motion, and could predict people's aggregate behavior in accordance with the law of large numbers. Instead, these behaviors tend to trace particular patterns in ways that we have begun to understand. Behavioral decision theory is the emerging discipline that describes how people draw inferences and act in choice situations more challenging than those involving preferences among certain alternatives. In this important class of cases, expected utility often fails as a predictive science, whereas behavioral decision theory frequently provides descriptive insights. A substantial amount of research has identified specific areas of economic life where these biases are apparent. For instance, many people suffer from the *money illusion*, thinking in terms of nominal rather than real units of money (Shafir, Diamond, & Tversky, 1997; Shiller, 1997). People simplify problems in predictable ways. Understanding these ways lends insight into how people will make decisions. By examining how they treat environmental problems – what simplifications they make – we can better understand where and why assumptions of perfect rationality may lead us astray in predicting behavior.

We might expect trained environmental experts to show the behavioral biases discussed here. But environmental problems often bring out sharp disagreements among experts, even among those who share a desire for a cleaner environment. An example is global climate change, one of the most important environmental issues of our age. Humankind faces the possibility of permanently altering its own habitat at a global level. But the climate change problem also engenders a tremendous diversity of opinion and often bitter debate. Many economic models of climate change, such as the Dynamic Integrated Climate Economy (DICE) model (Nordhaus, 1994b), treat the climate as a relatively linear system with no sharp corners. In effect, these models imply that past experience can guide future predictions to a large extent, and they counsel undertaking very gradual mitigation steps as we continue to learn. For validation they point to the majority of historical experience, which involves neither thresholds nor discontinuities, and in which technological innovation and market forces tended to solve the environmental problem in question. Treating the problem as one that can be guided by historical experience allows economists to model optimum levels of emissions abatement (Nordhaus, 1994b), optimum timing of emissions abatement given learning (Manne & Richels, 1991), and alternative strategies for achieving the same goals at a higher level of efficiency (Schelling, 1995).

By contrast, many ecologists – who are used to predator–prey and ecosystem models where there are booms and crashes in populations – tend to view climate change as part of a class of problems where salient thresholds may be passed unwittingly. Whereas economists have the single macro economy to study, which implies a restricted time series, ecologists tend to record extreme instances selected from dozens or millions of instances. Judged from a modeling perspective, the economists' sample is too small, the ecologists' too selective.

Ecologists' models suggest that unprecedented action is needed now. For validation they too draw on historical analogies; they point to the numerous instances when societies have passed thresholds, with results such as the desertification of their arable land or the exhaustion of a fishery (e.g., Ludwig, Hilborn, & Walters, 1993). Although exploitation has ruined local fish stocks or rendered agricultural areas infertile, current and future practices could influence human development worldwide. The two models, the economists' and the ecologists', rely on different mental models for thinking about climate change, and they strongly incline to opposite sets of advice (Patt, 1999b). Many environmentalists see technology as the source of global problems and disdain geoengineering solutions, even those that could potentially be simple and cost effective (National Research Council, 1992). Geoengineering, by contrast, sometimes entrances economists; they are used to seeing technological advances bolster the well-being of societies as a whole. Importantly, each side tends to think that it is behaving rationally and that disciplinary blinders hinder the other side.

This chapter examines the role of behavioral decision theory in illuminating issues of environmental policy, and the role of environmental issues in developing and testing the theory of behavioral decision. It does not present new data; rather, we highlight the places where environmental policy and behavioral decision theory overlap. In doing so, we look beyond health risks and contingent valuation – well-illuminated areas in the behavioral literature – to examine issues of environmental quality and change. The environment is special in the affinity between its problems and behavioral decision theory. Hence the analysis of environmental issues has potential for helping to develop general theory. Understanding how the individual addresses a problem in isolation can and should be useful for predicting how society as a whole will respond to complex threats, though the relationship is hardly one to one. Environmental problems range from local to global and from acute to chronic. They are prime real estate for mapping the relationships of individual decision making and societal responses.

In this chapter, we first review the best-known heuristics and biases identified by behavioral decision theory and outline their relevance to environmental policy. Second, we look at key features of environmental decision making, which enable behavioral decision theory to make such contributions. Third, we make two modest proposals to improve assessment and policymaking. The first is a framework for analyzing behavioral decisions in the multidimensional arena of environmental policy. The framework we propose – one of excessive and insensitive reactions – applies most of all to issues of poorly known probabilities, poorly defined preferences, and poorly understood policies. On these counts the environment is at the head of the class of issues facing policymakers. The second proposal is to develop a futures market for environmental problems and policies. Such a market would create incentives to generate and provide reliable information about the environment, and would promote research in the private sector geared not to advocacy, but to profits from accurate assessment.

Classic Heuristics and Biases

People subconsciously use shortcuts, or heuristics, to solve complicated problems (Kahneman & Tversky, 1974). These shortcuts produce answers to problems that are predictable but inconsistent with expected utility theory, and allow people to arrive quickly at answers that are usually "good enough" but quite poor in certain circumstances – circumstances that frequently characterize environmental decisions. For example, such decisions may involve low probabilities and long time spans, in which case decision makers will not have significant experience and feedback from earlier choices. Frequent feedback plays a role in decision making akin to competition in market products; each tends to drive out faulty decision making. As people become more familiar with a particular problem, they refine these shortcuts and gradually make choices that come closer to utility optimization. New problems will thus be solved using the tools that tended to work in the past. But when random variability is high, as it often is, many people have a hard time discriminating between good decisions and bad or seeing trends obscured by background noise. Changing seasons and interannual variability make it hard to perceive that human actions are likely changing the Earth's climate, for example. The investor Warren Buffett has noted that the best training for real-life decision making is the card game bridge, in which the successful player learns over time to discriminate between good strategies and good outcomes.

Decision-making heuristics combined with people's preferences can lead to predictable outcomes that are somewhat contradictory (e.g., Kahneman & Tversky, 1979; Tversky & Kahneman, 1988). If people are at a particular starting point, so that a change in wealth or some other commodity is perceived as a loss rather than a gain, they will take actions that simultaneously decrease the mean and increase the variance of the outcome they will face, in contrast to the action predicted by economic rationality. In short, framing a problem in a particular way can dramatically change an individual's decision in predictable ways. Empirical studies have also noted that real-world decision makers make consistent errors in judgment. One example is *bright line* behavior. DeGeorge, Patel, and Zeckhauser (1999) note that corporate managers manipulate reported earnings in order to meet specific targets such as positive net profits, the prior year's earnings, or earnings levels predicted by stock market analysts. Environmental policy provides its share of bright line anomalies, such as those associated with enshrining particular levels of environmental quality, setting standards at 1 part per some large number as opposed to 3 or 7 parts, or restoring quality to the level of some particular prior year, none of which may have a close connection with environmental protection outcomes.

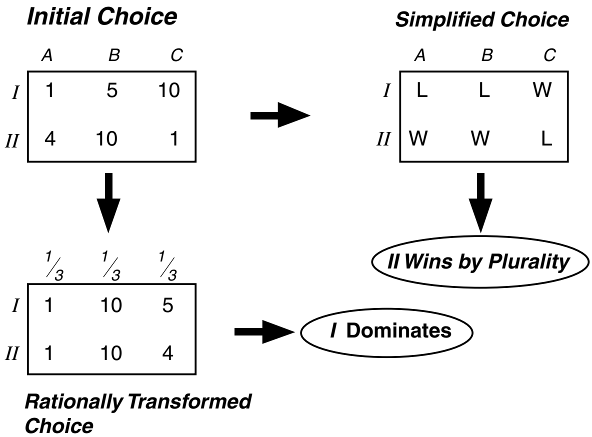

Figure 11.1. Simplified and rational transformation of two lotteries.

Bounded Rationality

Tversky and Kahneman (1988) identify a two-stage thought process when people confront tough decisions. First, people simplify the problem into an easier one; then they solve the easier problem. This is illustrated in Figure 11.1, which shows a choice between two lotteries, I and II, each giving payoffs in equally likely states of the world, A, B, and C. Here, a complicated choice between two different state-dependent lotteries is simplified to the perceived choice in the upper right. This is simpler, because it involves clear wins and losses; numbers are abandoned. Employing this simplification, many people will choose lottery I, because it gives them the better payoff two times out of three. An alternative but more complex way of viewing the problem would transform the choice by permutating the payoffs. This characterization of the problem – which employs the principle of stochastic dominance – shows that lottery I is the better choice. At every level of cumulative probability, lottery I gives a payoff at least as high as, and in one case higher than, that of lottery II. By simplifying the choice to a rule of thumb – wins and losses – people will choose the lottery that gives them the lower expected outcome and the greater degree of risk.

Two features of this type of problem are evident. First, when multiple rules of thumb can be applied to a problem, a number of competing problem frames suggest easy answers. Because deciding what rule of thumb to apply depends on the "norms, habits, and expectations" of the decision maker (Tversky & Kahneman, 1988, p. 172), we would expect differences of opinion to fall along lines correlated with other social and political factors. Put less nicely, interests influence biases. Not only will people disagree on what course of action the facts call for, they will disagree on what the facts are, based on their biased interpretations of ambiguous evidence. Following this logic, we would expect different academic disciplines to reach different answers to the same questions based on their different norms, habits, and expectations. Second, where the problem is one that is not repeated, so that feedback, which tends to push us beyond rule-of-thumb decision making, is limited, we would expect to see many people making the wrong decision.

A good example of this phenomenon can be seen with global warming. Although there is general scientific agreement that the problem is real and that cutbacks in greenhouse gas emissions would be wise, a great deal of uncertainty and some scientific controversy remain. Not surprisingly, there is much debate over what level of policy response is appropriate to address the problem; however, some also question the scientific findings that support the problem's existence in the first place. Industry groups, such as the Global Climate Coalition, argue that there is no sound evidence of the problem. As long as there remains a basis for reasonable doubt – and with issues of such complexity there almost always will – it is possible to give different interpretations to mixed evidence. For the problem of global warming this problem is especially serious because of the time delays involved. To be most effective, action to address the problem should probably occur before changes in climate are unambiguous to the lay observer.

Anchoring

Decision makers become anchored on their early estimates and fail to update those estimates as more reliable information becomes available (van der Sluijs, 1997). Walters (1986) developed the theory of *adaptive management,* in which environmental decision making approaches the optimum by incorporating feedback from past policy decisions. For example, if a fishery manager who wants to design the most effective salmon ladder to bypass a dam does not know what types of ladders salmon are likely to climb, she will have to monitor the salmon's reaction to preliminary designs, and change designs rapidly if the results do not match expectations. But Clark (in press) has observed that people are often unwilling to change a policy decision in midstream. At individual, social, and political levels of decision making, people dislike wavering, failing to change a decision even if doing so is the rational response to the best available knowledge. Behavioral decision theory suggests that if adaptive management is to occur, then people must take care to design institutions that will respond flexibly to new information. On their own, both individuals and groups show a profound resistance to incorporating new information and changing their decisions accordingly. In group settings, organizations rarely reward individuals for admitting that previous estimates were in error. Institutions should therefore incorporate incentive systems that correct for, rather than reinforce, the behavioral tendency to stick with original estimates and choices.

Availability

Environmental problems that are abstract or whose adverse consequences arise solely in the future are hard to contemplate because of the problem of availability or lack thereof. People tend to judge the frequency of a class of events by the ease with which they can bring to mind specific instances of that class (Thaler, 1991; Tversky & Kahneman, 1973). People worry about problems whose consequences are highly visible but underinvest when consequences are hard to bring to mind. In the context of endangered species protection, Metrick and Weitzman (1996) found that bodily characteristics (such as being a large mammal or bird) rather than scientific characteristics (such as the degree of endangerment or taxonomic uniqueness) better predicted governmental decisions to list a species as endangered and spend money for its preservation. It is not that bears or eagles are more endangered than smaller or more slimy species, or that preserving the larger animals benefits a given ecosystem more (arguably the reverse is true), but that people are more familiar with certain animals and care about them more for their symbolic value, in some sense attending to how much the wildlife reminds them of themselves.

As another example, climate change gained national policy attention during the summer of 1988, when abnormally hot temperatures plagued most of the country and much of Yellowstone National Park was lost to forest fires (Clark, in press). That same summer, Europe suffered through an abnormally cold season. The steamy summer in the United States did not necessarily indicate that the climate change was approaching, but it certainly helped people imagine what a climate-changed future could be like. Likewise, the loss of stratospheric ozone caused alarm, and the signing of an ambitious international treaty took place, only when scientists identified an ozone hole over Antarctica, an aspect of the problem that people could conceptualize, as opposed to a reduction in molecule concentrations, a more abstract but more accurate description. Relying on half-truth images can be misleading; some decision makers have expressed the view that were the ozone hole to be real, the atmosphere would "leak out." Since the air is still around us, they reasoned, ozone loss must be a myth.

Advocates can often take advantage of the availability problem (Patt, 1999a). In 1998, for example, an environmental advocacy group prepared a video demonstrating the potential effects of a sea level rise to Martha's Vineyard, an island off the New England coast. The video showed how a 1-meter rise in sea level – an eventual outcome foreseen as possible by global warming scientists – could inundate a small fraction of the island, but also how the effect would be magnified during a hurricane. The environmental organization that commissioned the video released it to the press the day before a major hurricane was predicted to strike Martha's Vineyard and the vacationing President Bill Clinton. The video was front-page news in the *Boston Globe*.

Many environmental problems are abstract, and are recognized as problems only because scientists tell us about them. People cannot directly sense ozone holes, increased climate variability, or the relationship between toxic waste and cancer rates. Thus they are readily subject to manipulating tales and images. For example, according to the Kemeny Commission (appointed by President Jimmy Carter to investigate the Three Mile Island nuclear accident), less than one statistical life was lost at Three Mile Island. Yet its highly visible status effectively ended the construction of new atomic generating facilities in the United States.

Further, the environmental commodities that advocates seek to protect are not traded on markets and have no price tag attached to indicate their value. In such situations, people do not do a good job at making trade-offs between competing needs and wants. Instead, they tend to frame issues in black and white terms, and use easily available arguments and salient but unrepresentative cases to support or justify their position. It is crucial that policymakers recognize the predictable biases in people's decision making. First, people will be overly sensitive to low-probability events, particularly scary ones they can bring to mind. Second, they will react insufficiently to changes in quantitative estimates of environmental harm, particularly if they are reported in hard-to-understand units, such as gallons of discharge or fractional concentrations. Third, people will have difficulty agreeing on consistent trade-offs between environmental quality and other competing societal objectives. Fourth, they will latch onto problems and push them onto the political agenda in response to events, not sound science. The challenge for policymakers is to design institutions that are capable of making sound and consistent environmental policy in this context. Such institutions should counter the claims of both alarmists and Pollyannas who attempt to manipulate the public's and policymaker's views of the environment.

Loss Aversion and Bias Toward the Status Quo

A central observation of behavioral decision theory is that people value losses more than equivalent gains. Prospect theory (Kahneman & Tversky, 1979) describes outcomes in terms of a departure from a starting reference point. It contrasts with traditional utility theory, which assumes that people view gains and losses along some absolute scale. Prospect theory incorporates two major findings. First, people respond to contingent gains with risk-averting behavior and to contingent losses with risk-taking behavior. Second, people have a strong aversion to losses, valuing them more, in an absolute sense, than gains of equivalent magnitude. Kahneman and Tversky suggested that instead of the standard concave utility function, people tend to operate in accordance with an S-shaped value function, as shown in Figure 11.2, with a sharp break in slope at 0. Since people value losses more than equivalent gains, they will generally reject any potential departure from their current

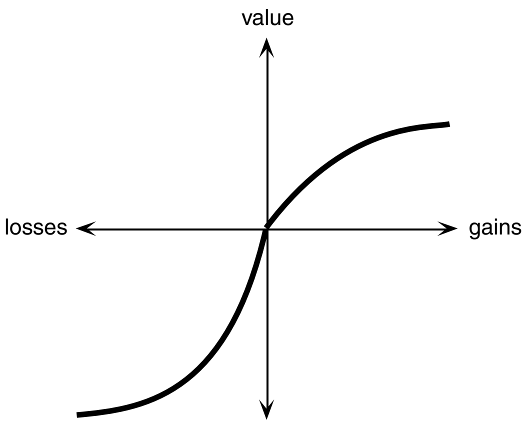

Figure 11.2. Value function.

position that involves gains and losses of roughly comparable magnitude on equally valued dimensions.

Samuelson and Zeckhauser (1988) found that people's decisions depend to a large extent on what they perceive as the current choice; they are biased toward the status quo. In the environmental context, status quo preference leads to inconsistent choices. It makes us forgo curtailing level H of harms, say by closing a plant, if J jobs must be sacrificed. Yet we might be unwilling to accept $H/3$ of environmental degradation nearby in order to create J jobs. Cost-benefit and cost-effectiveness analyses are supposed to curb such severe inconsistencies. However, many environmental advocates strongly oppose the use of such techniques for crafting policies, often as a strategy to capitalize on the status quo bias.

An important insight emerging from prospect theory and status quo bias is that the way a problem is framed can greatly affect the choices that are made. In some cases, it is possible for decision makers to adopt different reference points as the status quo, and the choice of reference point will largely determine the outcome of the decision. In other cases, decision makers anchor on an old reference point, even when conditions have changed enough to warrant a newly defined status quo. At other times, people have difficulty predicting how they will shift their reference points in the future if conditions change. In the environmental context, this class of problems has been most dramatically revealed in the contrast between people's willingness to pay for improved quality (WTP) versus their willingness to accept money in return for quality degradation (WTA). When consumers consider WTP, they consider what loss of wealth would be equal in value to a gain of environmental quality. For WTA, consumers answer the opposite question: What gain in wealth is required to counterbalance a given loss of environmental quality? As long as the change in environmental quality is the same (i.e., a gain from quality B to quality C or a loss from quality C to quality B), standard consumer theory predicts only a small discrepancy between WTP and WTA, arising out of the income effect. If we believe that people regard losses as worse than equivalent gains, however, we would expect estimates of WTA to be significantly larger than WTP. Survey data validate the latter prediction. Extensive empirical work has shown that WTA is two to five times higher in amount than WTP, a difference that cannot be explained by the income effects associated with utility theory (Gregory, Lichtenstein, & Slovic, 1993; Knetsch, 1990; Knetsch, this volume).

Overconfidence

People anchor on what they know and are insensitive to their level of ignorance. That is, they are overconfident. This has important consequences for the environment. Environmental policy problems require accurate predictions about the future of large, complex, poorly understood systems (Walters, 1986). Policymakers must ask, for example, what the likelihood is that sustained growth in carbon emissions will result in a 5-meter sea level rise, or some other disastrous outcome, in the next 200 years. Their answers to questions like this will probably be seriously in error. Over the years, we have asked students to estimate quantities such as the length of the Congo River, the oil production of Mexico, or the area of Thailand. To assess confidence, we have asked them to provide median estimates (best guesses), 25th and 75th percentiles, and 1st and 99th percentiles. The last two we have referred to as *surprise points*. Appropriately confident individuals ought to be surprised roughly 2% of the time. The thousands of people who have taken this test have been surprised more than one-third of the time, however. Whereas these questions were concerned with readily understood concepts, many environmental problems deal with outcomes that are difficult to imagine. Quite possibly, overconfidence will be more severe.

As expertise rises, does overconfidence diminish? Do experts, who presumably advise and make important policy decisions, better understand their ignorance? Experience with financial markets and energy resources is not reassuring. Gordon and Kammen (1996) find systematic overconfidence among professional financial analysts. In comparing forecasts to realized events, there is "a consistent underestimation of the probability of 'rare' events, or those lying far from the mean" (p. 190). Shlyakhter, Kammen, Broido, and Wilson (1994) find a similar pattern with projections of energy demand.

Frequently, uncertainties about the magnitude of interest are great because of cascading causes and effects, each with its own element of uncertainty. How likely is the temperature to rise by 3°C? If it does rise that much, how likely is it that a given glacier will disappear? If it does disappear, what will that do to river levels downstream, and how will that affect irrigation for agriculture? In the environmental context, looking specifically at flight in the stratosphere, Zeckhauser, Shearer, and Memishian (1975) provide a methodology for carrying such uncertainties through an analysis. More concretely, recent work by Morgan and Dowlatabadi (1996) and Morgan and Henrion (1990) modeling environmental problems such as climate change and acid rain has taken the approach of incorporating uncertainty at every stage of the modeling process, but these models are no more than attractive prototypes. Retail sensitivity analysis remains the norm. Rather than propagate uncertainty through their models, analysts continue to develop single-point estimates and then rework the estimates using alternative assumptions.

Many assessment agencies and decision makers attempt to correct for overconfidence by building margins of safety into administrative procedures, thus incorporating conservatism (Zeckhauser & Viscusi, 1990). But applying safety margins throughout a series of calculations can result in point estimates of health risks that are orders of magnitude higher than what is realistic. When these risks are compared to other risks, for which the number of calculations required is fewer or the safety margin less, society ends up doing more to protect people from the more complicated but often less dangerous risks. Alternatively, society shows an implicit preference to live with "old" risks that it understands and can estimate rather than replace them with "new" risks that may be of lesser magnitude but are less well understood (Huber & Litan, 1991).

Probability Weighting

Individuals make inconsistent choices when outcomes are uncertain. They simultaneously purchase insurance and lottery tickets. Such behavior appears counterproductive and contradicts the very core of the expected utility model. In risk analysis, the key question is why people respond to risks in ways that seem to violate rational interpretation of the magnitude of the expected loss. Behavioral decision theorists have theorized that people are predictable in their over- or underweighting of certain probabilities, and that this can affect their decision making. This predictability of behavior can be tested by environmental problems and can be important for setting effective environmental policy.

There is a large literature pointing out a correlation between people's subjective probability assessment of a risk and their feelings about the potential outcomes. In other words, people's perceived probabilities and the utilities associated with outcomes are not independent of each other. In normative decision theory, by contrast, the magnitude of the outcome should have no influence on the assessed probability. Kammen, Shlyakhter, and Wilson (1994) note that people tend to place higher probability assessments on catastrophic and insidious risks than on risks they feel they control. Authors such as Fischhoff (1996) have identified factors associated with outcomes that make people respond as if those outcomes were more likely. The fields of risk analysis, management, and communication have incorporated many of the lessons of behavioral decision theory, no doubt because, with low-probability risks, the norm for risks to the environment, decision theoretic predictions miss the mark so widely. We argue here that other environmental problems, not simply those involving health risks, warrant a similar analysis of decisions in behavioral terms.

Hyperbolic Discounting

Environmental decisions often have consequences that stretch for years, decades, or centuries. Traditional discounting methods provide a clear normative tool for considering benefits and costs that take place over extended periods of time. However, citizens' preferences and choices rarely reflect what discounting would prescribe. Behavioral decision theory has developed a framework, hyperbolic discounting, that much more closely approximates what people actually do.

Two findings are especially relevant. First, people demonstrate discount rates that are present-biased; that is, they tend to discount the near term by a large factor and events further in the future by a significantly smaller factor (Laibson, 1997). These disparities in discount rate are compounded by normal agency problems, such as if one generation or government regime controls the early decisions and others control the later decisions. Second, people resist applying any discounting methods to decisions that do not involve market transactions and the productive capacity of capital. Thus, they are ready to apply a discount factor to money in a bank account, and say that being paid $100 today is equivalent to being paid $110 a year from now. They are far less willing, for a variety of reasons, to say that a policy saving 100 lives today is as attractive as one that saves 110 lives a year from now. When policymakers do start to make such determinations, they lack the same intuition that they have with money. In addition, ethical concerns, albeit rarely formulated crisply, weigh against discounting. The result may be choices that are inconsistent and preferences that vary substantially over time. People may commit to protect the environment in the future, but once that future arrives they will defer until an even later date.

Importantly, people learn that they are inconsistent over time, which may strongly influence the choices they make. They search for devices to commit their own future behavior. With long-lived environmental problems, generations take the role of successive periods. Our generation might willingly bequeath an environmental legacy to the future if subsequent generations would behave accordingly, and those subsequent generations might be willing to agree. But given the absence of a commitment mechanism, they are not to be trusted; they will be selfish when their own time comes. The problem is that generation 1 values 3 relative to 2 more than generation 2 does.

Environmentalists and altruists toward the future confront this problem by seeking to constrain the behavior of future generations to conform to today's desires. A common adjustment is the use of precommitment devices, what Laibson (1997) calls *golden eggs*. For example, people set up investment accounts with substantial penalties for early withdrawal. They know that they will be tempted to withdraw money later on, as opportunities to spend money arise and their short-term discount rate makes leaving the money in savings accounts unattractive. The presence of an early withdrawal penalty makes it more likely that the money will stay put in the future. The policy equivalent may be to pass legislation; overturning the legislation is much more expensive politically than failing to enact it in the first place.

Fairness

Fairness gets a great deal of attention in environmental discussions. Is a policy fair to the people on the south side of town, who are closer to the dump, or to those on the south side of the equator, who have fewer economic resources to adapt to environmental change? Are we unfairly destroying the environmental legacy that was left to us, presumably with the intent that we pass it on to future generations? Is it fair that we destroy the breeding grounds of seals and the otters so that our economic activities can stretch even further? People place a high value on fairness, often overlaying this value on the others already discussed.

Fairness is an elusive concept and, like beauty, often lies in the eye of the beholder. Its opposite, unfairness, is more easily spotted. Despite difficulties of definition, fairness can be a trump card, even when it is fuzzily defined. An unfair policy may be defeated, even though no one can specify what a fair policy would be. Often the status quo reigns as fair, because at least no one is newly hurt by sticking with it.

Fairness is particularly relevant for environmental decision making involving the social costs of private action, as is typical of problems with externalities – such as pollution – and common pool resources, or public goods. People do not act in the purely self-interested mode that economic models predict. For example, demand-driven environmental decision making can be important. Some people pay more for tuna fish that is "dolphin safe" even if their contribution to the cause greatly exceeds any private benefit they derive from the slight increase in cetaceans that their contribution creates. Similarly, some people buy expensive solar power despite the fact that they could easily be free riders instead.

Recent research has focused on the relationships among fairness, self-serving bias, and framing. Are people paying for the dolphins they are saving, purchasing a warm glow cheaply, or voting for environmental protection in the only way they know how? Diekman, Samuels, Ross, and Bazerman (1997) conclude that "most of us want to see ourselves, and be seen by others, not only as fair but as generous, or at least less self-serving than other actors would be in similar circumstances" (p. 1061). They find that people are far more likely to support unequal allocations, in which they themselves receive a greater share of some common resource, when the allocations are dictated by another or are seen as the status quo. People are far less likely to propose a self-serving allocation themselves.

Key Features of Environmental Decision Making

It is in our blood to value the environment and environmental quality. But more than hemoglobin and plasma is required to think about how to make choices between different levels of environmental quality and hedonic pleasures. When people are asked to make these trade-offs, their cognitive processes let them down. They may become confused, they may make poor or inconsistent choices, or they may rebel. Many, for example, have criticized economic solutions to environmental problems as morally wrong, because they place an implicit price tag on the environment. Unless environmental quality is a trumping value, it is hard to see how implicit prices – which merely provide a way to value one output relative to another – could be avoided.

Economists assume that people at least have preferences that are consistent across choice sets. For example, the introduction of good C in a choice set will not affect a preference for good A over good B. A reasonable way of representing preferences among alternatives is in terms of willingness to pay (WTP). If I am willing to pay $5 for good A, $4 for good B, and $3 for good C, then I must prefer A to B to C. Goods that are traded on the market have prices associated with them, prices that to some extent reflect people's WTP. Decisions involving public welfare can take these prices for granted; importantly, they can also take into account WTP for nonmarket goods. By finding out people's WTP for nonmarket goods, such as different kinds of environmental quality, decision makers can evaluate the welfare implications of trade-offs between different allocations of market and nonmarket goods. Furthermore, they can predict the choices that people will make when faced with scarcity and uncertainty.

But a growing body of evidence from both psychology and neuroscience indicates that this method of decision making is not innate, and if it is present at all, it must be learned. Rather, people form emotional reactions (or attitudes) to things and ideas that vary sign and magnitude, and this mechanism often works quite well. For example, Damasio (1994) describes patients who through head injuries lost the ability to form emotional responses. Though these patients possess fully normal intellects and reasoning abilities, they have lost the ability to make good decisions and choices for their own well-being. Importantly, the emotional responses that form the basis for decision making can depend highly on context. I may choose a particular model of car over a particular model of pickup truck, but when a newer version of the car comes out, that could well affect my opinion of the now outdated car while leaving my emotional response to the pickup truck unchanged. With the introduction of the new car, my positive emotional response to the old car would be diminished, and I might now choose the pickup over it. The implication is that problems bring their own implicit choice sets.

In a study by Kahneman, Ritov, and Schkade (1999), researchers asked people to rate the importance of losses in environmental quality (due to cyanide fishing around coral reefs in Asia) and human health (increased rates of myeloma, a form of skin cancer, among the elderly). The coral reef issue was surmised to be an important and offensive issue within the environmental purview. The melanoma was perceived to be a relatively benign problem within a much more important area, human health. On a scale of 1 to 6, respondents rated both the importance of the problem and their expected satisfaction from making a contribution to the problem. As Table 11.1 shows, the answers depended on whether the issues were presented in isolation or after a question about the other issue. In isolation, myeloma received a relatively low rating, reflecting its low importance within the area of human health. However, when compared

Table 11.1. *Contextual Attitudes or Preference Reversals*

Importance Ratings (1–6)			Expected Satisfaction (1–6)		
	Coral Reefs	*Myeloma*		*Coral Reefs*	*Myeloma*
Judged alone	3.78	3.24	Judged alone	3.54	2.84
Judged second	3.62	4.36	Judged second	3.24	4.18

with the coral reef issue, myeloma gained in importance because it deals with human health.

If environmental issues are unusually important as a class, then asking about them in isolation will understate their importance, and vice versa. Trade-offs and priorities across classes of issues will be missed. If people do make choices that reflect consistent preferences, it may be because they learn to do so in some situations. We would expect these situations to be ones they face often, and where feedback is available for good or bad decisions. By contrast, when people have to make choices in unfamiliar territory, where they are neither experienced at making the choices nor receive feedback on their decisions, we would expect less consistency. Without consistency of preferences, both predicting future choices and determining the welfare implications of public policies become problematic.

Irreversible Phenomena

The nature of many environmental problems suggests that people's heuristic-driven choices will bias their decisions. For example, economists tend to treat problems as well behaved and continuous; many natural systems, by contrast, respond in ways that are extremely nonlinear and have thresholds where outcomes diverge qualitatively. Managing a renewable resource, such as a fishery, provides a good and well-documented example. Below certain rates of harvesting, the system changes slowly, but beyond some catch threshold the population decline is rapid and accelerating. As the threshold is approached, decision makers may continue to be guided by wisdom derived from prior experience. Yet if they do not perceive when they have crossed the critical threshold and respond immediately, irreversible damage, such as species extinction, may result (Ludwig et al., 1993). Plummeting fish stocks have afflicted the Grand Banks, the Columbia River, and numerous other locales.

The problem with irreversibility is not just that we can reach bad outcomes, but also that we are unlikely to understand our circumstances clearly as we progress toward them. If we are on the preferred side of the irreversibility threshold, we might never have been on the other side before. Many environmental decisions involve irreversible problems. If the decision is wrong, there will be no opportunity to correct the problem. When we characterize a problem as irreversible, we recognize that we cannot be guided by past experience, except on a meta-analysis basis, which looks across a wide class of problems. Irreversible problems demand extreme caution – though less extreme than the peddlers of irreversibility may claim. Such individuals portray irreversibility as a danger so bad that it cannot be risked. But this may well be a politically motivated framing ploy, and it is crucial to determine how bad the irreversible event may be.

People may also argue, however, that the irreversibility threshold is still a long way off. If a problem can be seen as potentially irreversible, decision makers will differ more widely in their predictions and prescriptions. Problems will be framed competitively as irreversible or as commonplace; these framings will matter for how decision makers actually act.

Ambiguous Status Quo

Previously, we explained the status quo's strong influence and how this can significantly affect outcomes. With real environmental problems, there is rarely an unambiguous definition of what comprises the status quo. Advocates in the environmental policy realm attempt to capitalize on this phenomenon, each presenting his or her own frame of what should be considered the status quo. Disciplinary analysts practice this game as well.

For example, in 1993, the State of Vermont faced a decision over an application by the Stowe Mountain Resort to install lights for night skiing on Mount Mansfield, the highest mountain in the region. Opponents claimed that the lights would ruin the region's rural character from one of moonlit pastures to one dominated by metal halide luminescence. Proponents claimed that the lights would bring economic development to the town. But Vermont was hesitant to grant the permit. Advocates for the resort convinced the state authorities to conduct a 1-year experiment, allowing the lights to be put up without a permanent permit. During that year, two things happened. First, the resort failed to generate its predicted revenues; economically, night skiing was a failure. Second, most people got used to the lights on Mount Mansfield. By the end of the ski season, most of the opposition to the lights had dissipated. The state decided that it would not require the lights to be taken down, but issued strict guidelines limiting such development elsewhere in Vermont. The advocates for the mountain had been clever; in 1 year, people's conception of the status quo shifted from an unilluminated mountain to one with lights. That fact proved critical in the decision to allow the lights to remain.

How the status quo is framed has important implications for policy. For instance, environmental economists traditionally classify development that is unregulated by new environmental laws as the status quo. When conducting cost-benefit or other forms of analysis, economists typically treat as costs the effects on the economy of regulating for environmental quality, and the benefits as the improved environmental amenities that result from the regulation. They are thinking of the status quo in terms of rates and directions of change. But it is also possible to define the status quo in terms of the present environmental state, without regard to how that state may or may not change if current practices continue. In some cases, these two definitions are compatible, as with the cleanup of a polluted site or the imposition of a tighter pollution standard. In other cases, however, the two potential definitions of the status quo yield quite different results.

With climate change, for instance, economists mostly prepare their baseline scenarios assuming no further constraints on carbon emissions, implying a given level of economic growth, along with significant environmental deterioration over time. The policy alternatives are predicted to slow both economic growth and the rate of environmental change. One could just as easily argue that both the current level of economic output and the current state of the environment are the status quo. Under this definition, the failure to regulate greenhouse gas emissions actually results in a greater departure from the status quo than would a policy significantly reducing greenhouse gas emissions. Since people tilt toward the stand-pat solution, how the status quo is defined matters a great deal. The economists' standard framing should dampen policy efforts to slow greenhouse warming. The alternative framing, suggested by many ecologists (e.g. Mintzer, 1987), will make people much fiercer about slowing emissions rates. The problem is politically salient because implicit property rights get assigned to the status quo. In the United States, for example, there is tremendous resistance to taxing pollution but not to granting tradable permits to pollute. Although the former is probably more efficient when information is incomplete, tradable permits give current polluters the right to continue doing so.

Low-Probability, High-Consequence Events

Many of the most significant environmental problems for the 21st century revolve around low-probability events that have monumental consequences. The problem with global warming, for example, is not that it is inevitable, but that it could have any of a range of unlikely consequences (e.g., significant shifts in the patterns of ocean currents), each of which would threaten most civilizations. As a global threat, it is not unlike nuclear war in the 1960s and 1970s, unlikely but extremely consequential. Other threats of this nature involve new viruses brought out by rapid population expansion in developing regions, such as AIDS (acquired immune deficiency syndrome), massive radioactive contamination, and the loss of human fertility from chronic exposure to endocrine disrupters. Unfortunately, we are very poor at assessing the likelihoods of such low-probability events, and history gives us little guidance on any particular one of them. Indeed, even a meta-analysis looking across events does not reveal whether society has been foolhardy or appropriately prudent. There simply is not enough experience to enable us to tell whether what we judge to be 1 in 1,000 global catastrophes are really 1 in 100 or 1 in 100,000.

Behavioral decision theory can help alleviate our difficulties in these areas. It has the most to say when subjective and objective probabilities associated with uncertain events are furthest apart, as they are with events of very low probability, and when the outcomes are especially frightful. Numerous environmental issues share the fundamental features of low probability and a high-magnitude outcome. For example, Kammen et al. (1994) discuss potential catastrophes resulting from nuclear power, climate change, air pollution, and other causes falling under the umbrella of the environment. In its report *Unfinished Business*, the U.S. Environmental Protection Agency (1987) highlights how many of its policies reduce environmental harm, devoting disproportionate attention to the risks that people care about. Hence environmental problems such as toxic waste dumps receive ample federal funding, whereas others such as indoor air pollution go largely unnoticed, even though the undernoticed risks pose a much greater statistical danger to society.

Most people are surprised to learn that there is little correlation between people's fears and typical objective measures of the dangers they face. For example, many people consider nuclear power to be the most substantial risk to public safety, whereas experts place it well down the list, after such risks as large construction, bicycles, and swimming (Slovic, 1987). Breyer (1993) identifies several causes of this result: public misperception of environmental risks; congressional attempts to mandate levels of safety; the difficulties that regulators face when trying to protect public safety in the face of uncertainty and ignorance; and at times ignorance about what the possibilities might be. In addition, people generally view risks differently based on where the risk comes from. Indoor air pollution is people's own responsibility, yet potential nuclear accidents occur because of factors beyond our control. People hate new risks that are imposed by other people, are willing to tolerate risks that they impose on themselves, and tend to ignore as background information risks generated by nature (e.g., Fischhoff, 1997).

The fact that many environmental risks are of low probability and thus subject to public misperception creates a substantial dilemma for policymakers: whether to leave the problem of these risks essentially to the market and people's private decision making, or to impose standards on risk regulation that are patently paternalistic (Zeckhauser & Viscusi, 1990, 1996). Although economists typically

> argue that individuals' preferences are to be relied on and taken as given, economists are the first to question the underlying rationality of individuals' choices about risks and to suggest that informed expert opinion offers a superior guide to policy. . . . Yet the rational decision framework remains the appropriate normative reference point: policies should not institutionalize the errors people make but, rather, should promote the outcomes they would choose if they understood the risks accurately. (Zeckhauser & Viscusi 1996, p. 149)

In effect, though economists are very accepting of people's values, they are willing to override people's probability judgments when those judgments are demonstrably in error. They are even prone to question choices that deviate from what the economists believe people's values would dictate. As a result, many policy choices guided by expert opinion make people angry, and a rift can easily develop between expert assessment of environmental risks and grassroots opinion, complicating the ability of all concerned to address the problem (Wynne, 1996).

As Fischhoff (1985, 1995) describes, the creation of constructive policies requires a great deal of attention to communicating the risks effectively and making people feel involved in the process. Increasingly, communicators of risk have used devices to help people understand new risks, compare them to others with which they are already familiar, and finally take part in the decision-making process.

The fact that people are likely to respond irrationally to low-probability, high-consequence risks is well recognized by those who make a living out of communicating those risks, either in an advocacy or a coalition-building role. Patt (1999a) analyzed scientific assessments of one particular low-probability, high-consequence risk – the possibility that global warming would cause the West Antarctic Ice Sheet to collapse, resulting in a rapid 5-meter rise in sea level – and found a great deal of strategizing. Advocates on the two sides of the global warming debate either used the ice sheet's collapse to provide a reason to fear climate change or pointed to its implausibility as a recurring feature of the other side's arguments and fears. Importantly, consensus groups such as the Intergovernmental Panel on Climate Change (IPCC) tended not to discuss the particular risk. Two reasons can account for the omission. First, these groups would have been challenged to reach an internal consensus on how best to communicate the facts of the low-probability, high-consequence risk. Second, these groups realized that discussing the risk was likely to be counterproductive to building an external consensus about what actions to take to address the climate change issue. Since their job is to forge consensus rather than to stir up controversy, groups such as the IPCC steer clear of such risks altogether.

Contingent Valuation and Its Problems

Contingent valuation (CV) is a common method used to value environmental change. Researchers use it to measure things such as air quality (Irwin et al., 1990; Schultz, 1985), wildlife (Walsh, Bjonback, Aiken, & Rosenthal, 1990), or other resources for which market data do not exist. Basically, CV asks people how much they would pay for various environmental amenities. Often the questions address resources lost or at risk elsewhere, such as otters whose lives may be lost. Economists have always been suspicious of survey results; CV reinforces their suspicions. A large literature has shown that CV data are unreliable, partly due to a number of behavioral effects. First, the phenomenon of *embedding* shows up; people value a given resource and a significantly smaller subset of that resource essentially the same (Binger, Copple, & Hoffman, 1995;

Gregory et al., 1993; Irwin, Slovic, Lichtenstein, & McClelland, 1993). For example, respondents to a phone survey expressed essentially the same WTP to save fish in a particular lake in Ontario, in several lakes in the area, and in all of the lakes in the entire province (Kahneman, 1986). The embedding takes place not only for the resource, but also for the decision-making unit: Individuals express the same WTP for themselves and for their family as a whole, even though the latter ought to be several times higher (Binger et al., 1995).

Loss aversion also diminishes the reliability of CV. Individuals value losses more than they do equivalent gains (Kahneman & Tversky, 1979), and hence it matters a great deal whether the CV questionnaire is framed in terms of an existing environment resource to be preserved against loss (WTA) or a new environmental resource to be acquired (WTP). When framing effects become so important, the underlying methodology cannot be relied on to give consistent results. The challenge to design a CV methodology that provides credible results remains elusive (Binger et al., 1995), despite efforts of environmental regulators and policymakers to standardize the techniques (e.g., U.S. NOAA, 1993); behavioral theory suggests that this may be akin to the search for a unicorn.

In responding to the challenge of valuing environmental goods (which are unfamiliar commodities), people frequently exhibit preference reversals. In a series of surveys, Irwin et al. (1993) found that people react differently when asked to place relative values on environmental goods and when asked to rank them against other goods. In one survey, 92 subjects were asked whether they would prefer improved air quality or a new computer. When the question was framed as a direct choice between the two, the majority of them preferred better air quality. When instead they were asked to give monetary values to each of the choices, the majority gave a higher value to the new computer. Indeed, a third of the respondents showed a reversal of preferences: they placed a higher value on the computer but preferred the cleaner air. In a related study, Fischhoff et al. (1993) noted that subjects show the embedding phenomenon less frequently when asked to make direct choices rather than assign values. Often, the dollar figure they provide reflects merely a "feel good" statement for preserving the environment, giving them a "warm glow." In the context of a direct choice, individuals rely on different factors to decide whether they prefer environmental preservation to other goods (Fischhoff et al., 1993). Perhaps they are expressing their solidarity with the environmental movement when they are asked to make direct choices, an expression that is more difficult to quantify when assigning monetary values.

The environment is an issue area where people have rarely had to make trade-offs, where they have received little feedback on the consistency of their choices, and yet where there is a need to obtain WTP measures in order to evaluate important policy options. For example, global warming threatens to disrupt ecosystems and exacerbate natural hazards, such as hurricanes, in particular geographic regions. Most people would probably have a negative reaction to global warming and a positive response to averting it. Yet people also have a positive response to cars, light bulbs, and all of the energy-consuming gizmos that contribute to global warming; indeed, they consider these part of their endowment. People in industrialized nations may also have a positive response to allowing developing nations to acquire some of the same material luxuries, although probably not if doing so meant forgoing significant amounts of these luxuries themselves. People have also been choosing cars and electronic gizmos for decades, but have not typically seen these purchases as having a direct effect on climate, and certainly have received no immediate feedback from weather patterns when they drive their car an extra kilometer. So it is likely that people will have poorly informed and poorly defined preferences on the issue of global warming and measures to combat it. At the same time, the issue demands the attention of policymakers, who must take action.

Insufficiency of Private Markets

The status quo bias impedes private markets in their pursuit of economically efficient outcomes. Coase (1960) suggested, in his seminal article leading to the Coase theorem, that many externalities could be dealt with adequately through private negotiations or through markets operating among the affected parties. Assuming minimal transaction costs and well-defined property rights, markets would form between those harmed by externalities and those who create them. Hence, if the damage caused by pollution were smaller than the costs of avoiding it, those people suffering from pollution would pay the polluter to stop. An important element of the Coase theorem is that it does not matter to whom the initial property rights are assigned when income effects are small. Whether the polluter has an initial right to pollute, or the neighbor an initial right to clean air, does not determine the level of pollution they will negotiate. Numerous experiments have attempted to test the Coase theorem empirically (Hoffman & Spitzer, 1993; Knetsch, 1990). The results suggest that the way property rights are initially assigned determines the status quo, and this in turn influences the result of negotiations. If the polluter has property rights, we will end up producing far more pollution than if those who suffer the pollution begin with a right to a clean environment (Kahneman, Knetsch, & Thaler, 1991). Because unresolved externalities are a major environmental problem, government intervention may be necessary to supplement market-based decision making.

Bright Lines

People judge performance relative to bright lines. Usually one side of the bright line is good and the other is bad. How much the bright line is beaten is not so consequential. DeGeorge et al. (1999) find three bright lines (positive profit, last year's earnings, and the consensus of analysts' earnings estimates) for earnings in business firms, and find that businesses manipulate their earnings to get beyond them. These bright lines become important to managers, even if the means to achieve them, such as pushing sales by discounting when one is short of the target, are costly in the long run. Camerer, Babcock, Loewenstein, and Thaler (1997) examined the labor supply among New York City cabdrivers. They found that the drivers set daily earnings targets; on slow days they drive for many hours, whereas on busy days they leave work early. They could earn more money working fewer total hours by working the same number of hours each day, and could do better still by logging long hours on busy days and quitting early when the fares are slow. One way to explain the behavior of managers and cabbies is that people prefer to cross bright lines of some earnings target. They value having made their money goal in a given day or year and will strive to accomplish that goal.

With environmental problems as well, we often enshrine bright lines and struggle beyond them. For example, environmental negotiators in Europe have adopted the standard of *critical loads* for designing a regulatory framework for acid rain (United Nations, 1988). Recognizing that different ecosystems, and even different types of soil, can withstand different threshold levels of acidic deposition from air pollution, they have mapped the deposition levels across Europe that are the highest possible without any observable consequences. Using these maps and knowledge about how wind spreads pollution from factories to fields, they arrived at a very ambitious set of cost-effective emissions reductions, in some places as great as 90% from baseline amounts. Yet as Patt (1999c) discusses, these critical load models are highly arbitrary. The principal benefit of negotiating international policy around a critical load framework is that it provides an apparent bright line that helps to generate consensus.

There are two problems with bright lines. First, they take on too much importance. Moves that cross them are valued too much compared with equally important moves on either side of the bright line. Second, many bright lines in environmental policy are set inappropriately. They often revolve around some mathematical property, such as zero environmental impact or 1 part per million, when a little environmental impact or 3 parts per 10 million might be acceptable and far more achievable. To respond to concerns about equity, uniform bright lines are often set across situations where different standards would be desirable.

There is something particularly attractive about achieving the bright line of "no observable environmental impact." For the same policy problem, acid rain, U.S. policymakers have used equally bright lines of a different character. American air quality standards define an acceptable level of risk, and results are reported in terms of attainment or nonattainment, as opposed to quantitative risk levels. In another piece of regulation, the Clean Air Act Amendments of 1990, total sulfur emissions will be reduced by 10 million tons from baseline amounts. To achieve a cost-effective solution to this very different bright line, the amendments create a system of tradable emissions permits. Both the European and American regulations ensure that environmental targets are reached in a rational manner, but neither guarantees that the target itself is efficient or wise (Stavins & Whitehead, 1997).

Intergenerational Valuation and Commitment Devices

Environmental policy often involves issues that span generations. Schelling (1995) notes that this is a challenging problem. There is no reason, he suggests, that people should care less about the welfare of their great-great-grandchildren than they do about that of their great-grandchildren; they will never know either generation and have an attachment to them based only on genetic proximity. Thus, we should not expect people to continue to discount future events once those events are more than a few generations into the future. But people care very much about their own generation relative to the ones that follow. Should all generations that people will never know be discounted at some level more than those who are alive today should? If so, how does this compare to discounting the welfare of people who live oversees and whom we will never know? Schelling poses the question of whether it makes sense to invest our resources in avoiding climate change when we could potentially help far more people, over the long run, by investing in economic development programs to benefit today's poor and the poor to follow. Is there some sense from an intergenerational perspective in which environmental matters, such as preserving an ocean or the atmosphere from a measured amount of harm, count more than guaranteeing other aspects of material well-being through the provision of productive capital? We do not understand how people's altruism operates across time and space, and they do not seem to either. Absent this knowledge, it is difficult to implement preference-respecting decision making for global, long-term problems.

We argued earlier that long-term preferences might well be reflected with discounting models that consider problems of dynamic inconsistency and attempt to build in commitment devices (Laibson, 1997). Environmental policymaking shows these factors at work. For instance, leaders at the 1992 Earth Summit made a nonbinding commitment to reduce emissions to 1990 levels by the year 2000. The fact that this pledge proved unenforceable provided much of the impetus for the Kyoto Protocol (United Nations, 1997), which called on countries such as the United States to begin reducing greenhouse gas emissions toward a baseline starting in the year 2008. Given the excess weight, relative to straight discounting, that is placed on the present, policymakers are unwilling to take costly steps now to benefit the future, but they are willing to commit to such steps in the future. We can predict that in 2008 the United States and other nations will prefer not to reduce their greenhouse gas emissions to the extent called for by Kyoto, just as many holders of individual retirement accounts wish that they could withdraw their money early. But the agreements put in place now may be too much to overcome in the future and will be undertaken as planned. If we recognize that commitments to future action may be the only way to effect change, it is important to design mechanisms to create and enforce these commitments.

Destination-Driven Costs and Moving Equilibria

When choosing how to model the environment, economists have assumed that environmental cleanup can be represented by traditional supply-and-demand diagrams. Underlying such diagrams are the standard assumptions of continuity and diminishing returns to effort or scale. Even taking the economics approach, in many types of environmental problems this framework simply doesn't apply, as Philips and Zeckhauser (1998) argue. For example, for many types of environmental cleanup problems, the costs are driven not by the amount of cleanup undertaken, but by the level of cleanliness attained, regardless of the starting point. To make a toxic waste dump suitable for building a new school may require incinerating and replacing all of the soil that is contaminated. The cost depends little on the starting level of toxicity. A recognition that costs depend overwhelmingly on the destination and not the starting point, as the continuous case common in environmental economics assumes, leads to a different answer about what level of pollution is desirable, where the pollution should be, and what economic incentives the government should be using to achieve economic efficiency. It becomes desirable to concentrate pollution and to delay cleanup efforts, whereas in a standard economic model, pollution would be evenly spread and cleanup would be continuous.

The importance of increasing returns to scale and discontinuities in environmental problems is especially apparent when managers attempt to maintain a system in a steady state that is seen as most productive for humans. Often, the natural equilibrium is one that changes slowly for a period but then moves quite suddenly. For example, beaches shift in response to storms and accretion, small lakes fill with silt, and rivers alter course. Yet decision makers often perceive one of the various states of the resource as the only natural state and design human infrastructure around it. Oversimplifying the problem of what state or state of flux is natural puts human development at risk. Moreover, protecting that development means holding natural systems out of equilibrium. Shortsightedness creates environmental problems that conventional economics, with its emphasis on equilibrium, will both misperceive and misrepresent. Environmental realities move beyond the limited dimensions of our economic road maps, which have been honed through thinking about markets for apples and labor. Policy cannot be effective if environmental phenomena are crammed into the models and metaphors developed for worlds where property is owned, behavior is tidy, and extreme outcomes are not consequential.

Biased Risk Assessments

At best, expertise offers modest protection against behavioral propensities. For example, Nordhaus (1994a) surveyed a number of experts on climate change from several different disciplines. Economists tended to view climate change as far less of a problem than did the natural scientists – because the mental models of a discipline tend to fence in the imaginations of its practitioners. There was often a high correlation between the assessed seriousness of a particular problem, such as a rapid sea level rise from the melting of polar ice sheets, and the assessed probability of its occurrence. Ecologists, who worry about disruptions of natural systems, see these disruptions as quite probable. Economists, who are used to continuous behaviors, and who worry about the potential of mitigation strategies to produce economic inefficiency, think that acting to avoid climate change has risks at least as great as those of climate change itself. Because for climate change, as for many other environmental problems, there is no historical record on which to assess probabilities, there is little reason to believe that the experts are especially able to do a good job of forecasting the future. Moreover, experts are rewarded by the press or by advocacy groups by the attention they receive, and the spotlight shines when they predict the most extreme outcomes. This creates a substantial problem – selecting the proper estimates. There is no system in place to rate probability assessors, rewarding them after the fact should their estimates prove incisive.

Toward More Accurate Assessments and Superior Policies

A central theme of this chapter is that environmental problems bring behavioral decisions to the fore, challenging effective long-term decision making. We make two modest proposals: the first a diagnostic tool, the second a proposed therapy. First, we set forth a framework for thinking about the predictions of behavioral decision theory for environmental issues, which typically involve several heuristics and biases. The framework identifies a common thread: the human tendency to have either excessive or insensitive reactions to environmental problems. Second, we propose a mechanism that we believe could help increase the accuracy of assessments of environmental problems that drive policy. Basically, we propose the establishment of future markets, in effect betting markets, that would enable analysts to “put their money where their mouth is” when making predictions about environmental consequences. Such a mechanism would reduce the rewards for vociferous and extreme advocacy, and provide a venue where the best current estimates could be found.

Table 11.2. *Attributes of and Responses to Environmental Risks*

	Responses	
Attributes	*Excessive Reactions*	*Insensitive Reactions*
Probabilities	Small probabilities; changes near 0 and 1	Changes elsewhere
Presence of money	Changes in money	Changes in other valued attributes
Direction of change	Losses; gains versus losses	Gains
Timing of problem	Now to $t + 1$	Periods after $t + 1$

A Behavioral Biases Framework: Excessive and Insensitive Reactions

Behavioral decision theory predicts how individuals' decisions deviate from a rational norm. With respect to environmental policy, these deviations take the form of excess or insensitive reactions: Sometimes policy responses are greater than the assessed risks justify; sometimes policy responses are too little, too late, or nonexistent. Because in many instances we can predict when each of these biases is likely to appear, this unidimensional characterization of biases informs us about our central policy concern: how policy should be shifted.

Table 11.2 organizes the typology. The dependent variable is the response to the problem and it is excessive or insensitive relative to the problem's magnitude. We address four attributes of risk: their probabilities, whether money (and hence other forms of consumption) is involved, the direction of change, and timing. To illustrate, an increase in a risk for the left-hand column – excessive reactions – will get more weight than one for the right-hand column. For example, a .01 reduction in risk when a risk starts at .01 will be valued more than when the initial risk is .4. Knowing the values of these four variables, one could predict the nature of the response to the environmental problem. Indeed, in theory, one could run a regression on a number of environmental problems and obtain beta values for each of the independent variables. Bright line thresholds are involved with each attribute. Thus, crossing the loss–gain threshold or approaching the 0 or 1 bright line for probabilities increases the importance of a fixed increment of something harmful or beneficial. Whether the risk is financial is important for two reasons: First, it changes a person's consumption in other areas of life; second, it is a means of accounting more familiar to most people than numbers of bacteria or adjusted life years. Other factors equal, we posit that people make better decisions when money is involved. For example, they are more sensitive to differences in money quantities than in quantities of air pollution.

Other heuristics or problems could be included in our table. For each, we would want to determine the circumstances in which society would over- and underact. For example, new risks get an excessive reaction because they come against a background of zero known risk in that category, and the benefits that come with those risks are not part of people's endowments. Politically, interest groups will not yet have formed to protect these benefits for a segment of society. There are, of course, other bright lines in the environmental field and perhaps other illuminated dimensions. The central point is that particular changes in outcomes will make the risk especially salient for decision making. For example, we strive for complete safety, we struggle hard to avoid losses in wealth, and we cater excessively to the present. Advocacy groups recognize these tendencies by citizens and policymakers. When confronting a real environmental problem, proenvironment groups attempt to frame the issue using the four independent variables to promote an excessive response. Their opposition, often industry groups, makes policymakers and citizens feel that an insensitive response is more appropriate.

Futures Market

One way to force more systematic analysis is to open up derivative markets for environmental problems. One of the great virtues of ordinary financial markets is that they elicit all available information, say about the value of a stock. If an individual knows that IBM is undervalued, she will purchase the company's stock until it is brought into line. The possible poaching on others' poor decisions ensures that prices reasonably represent value. A second great virtue of these markets, which reward foresightful decisions, is that extremely intelligent individuals research the value of securities. Some critics would claim that there is excess attention to securities valuation, because most of the return from research comes from extracting value from others, not from any social gain. This argument would hardly apply to research on the likely global warming consequences of our present emissions policies, where research leading to a convergence of beliefs would be of enormous value. If policymakers had a much firmer grasp of what would happen their policies would be much improved. In other words, the ratio of public benefit relative to private gain from a futures market is much greater for global warming than for the prices of computer stocks.

The third virtue of establishing a futures market is that it would dampen the ability of advocacy groups to misrepresent their true beliefs. For example, if an energy company confidently announced that global temperatures were unlikely to rise by more than 1°C over the next two decades but the futures market predicted a median increase of 3°C, the company would have a hard time explaining why the market had gotten the answer so wrong. Why hadn't experts and arbitrageurs listened to the company and driven down the estimates of the consequences? Why hadn't the company itself engaged in arbitrage to profit heavily from an incorrect assessment?

There would be a number of difficulties in developing a derivatives market relating to environmental consequences. We mention two. First, many of the consequences would be hard to measure. Second, the consequences may not become known for decades. In theory, the long time delays are not a problem. We might, in effect, have a security that would pay off in 50 years. Its current value will anticipate how each period would sell it to the next, in somewhat the same way that growth stocks, with no earnings expected for years, are able to value the far future. But whether investors would be willing to tie up their capital for such a long period is not clear. And arbitrageurs, whose participation would be welcome, have particularly high discount rates, given their ability to reap high returns from their capital at work. Recognizing these problems, we believe that an effective futures market might rely on indicators of environmental consequences, not the consequences themselves. The indicators might be available in a relatively short period of time. For example, we might use the degree of concentration of greenhouse gases in the environment as the surrogate for the longer-term problem of global warming.

An environmental futures market would bring a fourth benefit. It would provide immediate feedback on the expected environmental consequences of policy actions. This benefit is well understood now in the economics world. Financial markets discipline the behaviors of prime ministers and finance ministers, and punish those who boost the deficit. So too, a futures market for the environment would provide a continuous barometer of the consequences of policy, such as altering the Clean

Air Act or signing a global treaty on the environment. It would tell us which actions are consequential and which ones mere bandages.

Conclusion

Citizens confronting environmental issues have severe problems thinking systematically about the likelihood of and valuation of possible outcomes. And the disagreements between economists, the self-appointed guardians of material well-being, and ecologists, who view the environment as their domain of responsibility, are harsher still. When the experts disagree, it is harder for citizens to think clearly, much less advocate sensible decisions.

The most consequential environmental problems – climate change, loss of biodiversity, and sustainable development – involve uncertainty, requiring the calculation and use of probabilities, an area of profound misunderstanding for the public. Such problems are not mere exercises in computation; probabilistic phenomena do not lend themselves to determining in a dispute who was right and who was wrong. When the events involve relatively small probabilities of something consequential, as is frequently the case with the environment – living near this dump gives you 1 chance in 10,000 of developing cancer – learning is further diminished. And when something bad does happen, it often comes many years into the future, when it is too late to reverse course. Often, as with cancer, even if the outcome is known, it is hard to determine the contribution of environmental causes.

Legislators may be no better equipped than citizens to make decisions, but this matters little because citizens' perceptions, not reality as viewed by experts, are the primary basis for legislative actions pertaining to the environment. But some players do understand how citizens and legislators respond, whether behaviorally or rationally. Mostly these are the players in the environment – the activists, the lobbyists, and the expert witnesses. These actors seek to harness human proclivities to their own purposes, whether it be to get a high valuation of some environmental amenity or harm, or to frame the loss of jobs from some environmental measure as monumental.

Behavioral decision theory best models human intelligence in worlds with severe uncertainties, many attributes, long time frames, and a primordial measuring rod other than money. These are the conditions of the field of environmental decision making. Researchers in many fields – economics, political science, and sociology, to name three – would be wise to consider the lessons of behavioral decision theory as they examine people's motives for acting toward the environment. At the same time, researchers into behavioral decisions would be wise to look to the environment as a rich source of new data on people's decision-making abilities and predictable pathologies.

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