2021

Visibility and Indivisibility in Resource Arrangements

Lee Anne Fennell

DRAFT June 2021
Journal of Land Use & Environmental Law (forthcoming 2021)

VISIBILITY AND INDIVISIBILITY IN RESOURCE ARRANGEMENTS

*Lee Anne Fennell**

Projects like highways, bridges, pipelines, and wildlife corridors exhibit indivisibilities—we need the whole thing to have anything of value. Many environmental and social goals have a similar all-or-nothing character: staying above or below a certain critical threshold can make all the difference. This essay focuses on the role of visibility in addressing resource dilemmas that have this structure. I examine how two kinds of visibility can help avoid catastrophic consequences and advance desirable ones. The first involves recognizing when an indivisibility is present—that is, appreciating the vulnerability of resources to thresholds and cliff effects before it is too late. The second involves seeing how individual decisions about resources stack together to generate outcomes. When a resource problem suffers from poor visibility along these dimensions, finding ways to clear the view can improve the prospects for cooperative solutions.

INTRODUCTION

What we can see changes what we can do. The intuition is simple, but its implications are profound. Nowhere is this more true than in environmental, land use, and natural resource contexts, where collective action problems abound but their shapes—and those of their solutions—often remain obscure. This essay emphasizes the role of *visibility* in taking on these challenges.[1] By visibility, I mean two distinct things: perceiving the structure of a given

[*] Max Pam Professor of Law, University of Chicago Law School. I (virtually) presented a version of this essay as the Fall 2020 Distinguished Lecture at Florida State University College of Law as part of its Program on Environmental, Energy, and Land Use Law, and I am grateful to the participants in that event for their helpful comments and questions. For additional thoughtful suggestions and conversations, I thank Hanoch Dagan, Avihay Dorfman, Hajin Kim, Jonathan Masur, Richard McAdams, Arden Rowell, and participants in Tel Aviv University's Private Law Theory Workshop. Research support from the Harold J. Green Faculty Fund and the SNR Denton Fund is also gratefully acknowledged.

[1] The significance of visibility in environmental and other collective action contexts has long been recognized. *See, e.g.*, Robert C. Cass & Julian J. Edney, *The Commons Dilemma: A Simulation Testing the Effects of Resource Visibility and Territorial Division*, 6 HUM. ECOL. 371 (1978); Bonnie J. McCay, *Everyone's Concern; No One's Responsibility: A Review of Discourse on the Commons*, conference draft, Annual Meeting of the Society for Applied Anthropology, 10-11 (1984); Barton H. Thompson, Jr., *Tragically Difficult: The Obstacles to Governing the Commons*, 30 ENV'T. L. 241, 242-43, 265 (2000); Monika Ehrman, *Application of Natural Resources Property Theory to Hidden Resources*, 14 INT'L. J. COMMONS 627 (2020).

resource dilemma, and seeing how dispersed individual choices influence it.[2]

Seeing a resource dilemma's structure means more than recognizing the existence of a problem worth addressing—often a challenge in its own right.[3] It also means apprehending whether the problem has an all-or-nothing character, exhibits cliff or threshold effects, or involves increasing or decreasing returns to scale. Features like these are associated with *indivisibilities*—instances in which a given good is very costly to divide or is much less valuable when divided than when kept whole.[4] Highways, bridges, pipelines, and wildlife corridors have an indivisible character—one needs the entire thing in order to have much of value. Similar indivisibilities lurk in environmental goods (or bads)[5] that depend on aggregations or accumulations—the minimum viable population required to sustain a species, for example, or the critical threshold that a pollutant concentration cannot exceed without devastating effects. In other words, there is often a "lumpy" rather than smoothly linear relationship between inputs and outcomes.[6] Recognizing the shape of the problem is essential to solving it.

Seeing the impact of individual choices on a resource dilemma requires another type of visibility—apprehending how innumerable small, dispersed, interacting decisions stack together to produce real-world impacts. In some contexts, the way that individual decisions aggregate is easy to track and view. For example, if a particular string of land parcels is necessary to create a wildlife corridor, each of the owners along that path holds an essential element. But in many environmental contexts, the effects of human choices are diffuse, mobile, and sometimes literally invisible. The inability to get real-time feedback about choices and their effects can thwart attempts at coordination. Nonetheless, we can consciously construct focal points and

[2] These two kinds of visibility track distinctions about information conditions in the game theory literature. *See* DOUGLAS G. BAIRD, ROBERT H. GERTNER & RANDAL C. PICKER, GAME THEORY AND THE LAW 9-10 (1994). Whether a game's structure—its payoffs and available strategies—are known to the players determines whether the game is one of complete or incomplete information. *Id.* at 10. Whether the strategies or "moves" actually selected by the other players are observable determines whether the game is one of perfect or imperfect information. *Id.* If both structures and choices are known to the parties, the game is one of complete and perfect information. *Id.* The notion of visibility pursued in this paper focuses on how the information environment for a strategic interaction might be improved along these two dimensions.

[3] *See, e.g.*, Thompson, *supra* note 1, at 258-59 (noting that fisheries, groundwater, and climate change "[a]ll involve hidden resources," which can lead people to ignore or downplay problems); Kate Pride Brown, *Water, Water Everywhere (Or Seeing Is Believing): The Visibility of Water Supply and the Public Will for Conservation*, 12 NATURE & CULTURE 219, 224-25, 235 (2017) (discussing problems of groundwater invisibility); *see generally* ARDEN ROWELL & KENWORTHEY BILZ, THE PSYCHOLOGY OF ENVIRONMENTAL LAW (2021) (discussing factors that make environmental harms difficult to see, understand, and care about).

[4] *See* H. Peyton Young, *Dividing the Indivisible*, 38 AM. BEHAV. SCI. 904, 904, 906 (1995) (observing that the notion of indivisibility does not generally refer to the literal impossibility of division, but rather to the cost or loss of value associated with splitting something up).

[5] *See, e.g.*, RUSSELL HARDIN, COLLECTIVE ACTION 61-62 (1982) (defining "collective bads"). Collective action problems in environmental contexts often involve the avoidance of "bads" as well as the provision of "goods."

[6] *See* LEE ANNE FENNELL, SLICES AND LUMPS: DIVISION AND AGGREGATION IN LAW AND LIFE 9-26 (2019); Michael Taylor & Hugh Ward, *Chickens, Whales, and Lumpy Goods: Alternative Models of Public-Goods Provision*, 30 POL. STUD. 350, 353 (1982).

ways of visualizing cumulative impacts, even when these are not naturally part of the observable landscape.[7]

This essay proceeds in three parts. Part I discusses how indivisibility changes the nature of a collective action problem and upends the predictions that might follow from a tragedy of the commons template. Part II examines the structure of resource dilemmas that feature indivisibility. Understanding this structure, and recognizing how it influences the strategies of the players, is an important first step in addressing resource dilemmas that involve thresholds, cliff effects, or lumpy all-or-nothing outcomes. Part III turns to the role of visibility in compiling the cooperation necessary to resolve indivisible problems. Environmental and natural resource problems often suffer from poor visibility—their shapes are ill-defined and contributions to addressing them are not sharply delineated or easily observable. In these contexts, finding ways to clear the view can help us avoid catastrophic results and pursue desirable ones.

I. UNDERSTANDING INDIVISIBILITY

When most people think about problems involving resources, the tragedy of the commons springs immediately to mind.[8] The standard story tells us that herders with access to a common pasture will tend to overgraze it because they internalize all of the benefits of putting more livestock into the field but bear only a fraction of the costs that are visited on the pasture when they do so.[9] The mental template is a powerful one with a memorable, clear, and ultra-depressing prediction: that everyone will pursue an individually rational, but socially destructive, dominant strategy.[10]

Fortunately, reality rarely resembles this model. Social norms, repeat play, and other factors often intervene to change the payoffs that people face and hence the strategies that they will pursue. Elinor Ostrom's work explored many of the design features through which local institutions can avert tragedy in managing common pool resources.[11] In this Part, I focus on a structural

[7] *See infra* Part III.C.

[8] This framework is often associated with Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE, n.s. 1243 (1968). The roots of the idea reach back much further. *See, e.g.*, ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION 2-3 (1990) (discussing antecedents, including in the work of Aristotle); H. Scott Gordon, *The Economic Theory of a Common-Property Resource: The Fishery*, 62 J. POL. ECON. 124, 128-35 (1954) (analyzing common-pool resource problems in fisheries and noting parallels in other resource contexts).

[9] *See, e.g.*, Lee Anne Fennell, *Commons, Anticommons, Semicommons*, in RESEARCH HANDBOOK ON THE ECONOMICS OF PROPERTY LAW 35, 35-41 (Kenneth Ayotte & Henry E. Smith, eds., 2011) (discussing and critiquing this account).

[10] *See, e.g.*, *id*.

[11] *See generally* OSTROM, *supra* note 8. Although these small-scale solutions may be successful in preventing the destruction of the common-pool resource, it is worth emphasizing that some of them can embed oppression, hierarchy, and self-dealing—as Ostrom herself recognized. *See, e.g.*, Duncan Law & Nicole Pepperell, *Oppression*

reason why many resource dilemmas look nothing like the standard tragedy of the commons: the presence of indivisibilities.

A. What Indivisibility Means

Bridges, pipelines, and highways offer intuitive examples of indivisible goods. Although it would be physically possible to divide them up or remove segments from them, doing so would have a disproportionately negative impact on their value.[12] A ten-meter segment of a kilometer-long bridge only represents one percent of the span's total length, but removing it leaves behind something that is not 99% as good, but rather utterly worthless, at least as a bridge.[13] Even where it's trivially easy to remove an integral part—one card from a deck, one piece from a jigsaw puzzle, or one cog from a machine—doing so would destroy value because those goods are designed to work as indivisible wholes. Note also that indivisibility applies conceptually even when the whole has not yet been realized: stopping construction of a bridge when it is 99% complete defeats the purpose of building the bridge altogether, because bridges are useful only in whole-bridge units.[14]

Many environmental resources and problems lack the concreteness of a bridge or a jigsaw puzzle but share a similarly indivisible structure—taking away a portion of the resource, or failing to supply an element necessary to its continuing viability, can have catastrophic effects. Sometimes this all-or-nothing structure is just as evident as it is for any highway or bridge. Consider, for instance, the Path of the Pronghorn, a designated migratory route between Wyoming's Green River Valley and Grand Teton National Park.[15] Protecting a contiguous path requires a series of highway underpasses and overpasses as well as careful attention to the hundreds of fences the pronghorn encounter along the way.[16] Even one unnavigable segment would

---

in the Commons: Cautionary Notes on Elinor Ostrom's Concept of Self-Governance, in The Australian Sociological Association (TASA) 2018 Conference Proceedings: Precarity, Rights, and Resistance 7 (Grazyna Zajdow, ed., 2018) (discussing passages in Ostrom's writing that recognize such risks); Carol M. Rose, *Thinking About the Commons*, 14 INT'L J. COMMONS 557, 561 (2020) (observing that "many traditional communities are shot through with layers of hierarchy, and especially with norms about gender roles.").

[12] *See* Young, *supra* note 4, at 906.

[13] Dismantling it (at some cost) would yield only scrap materials. *Cf.* CHARLES R. FRANK, JR., PRODUCTION THEORY AND INDIVISIBLE COMMODITIES 32 (1969) (illustrating indivisibility by observing that splitting up "an industrial heat exchanger with a two-million-ton capacity" yields "two piles of steel scrap and other debris," not "two heat exchangers with a capacity of a million tons apiece").

[14] *See* Taylor & Ward, *supra* note 6 at 353 (noting that goods like bridges "cannot be usefully provided in *any* amounts but only in more or less massive 'lumps'").

[15] *See, e.g.*, MARY ELLEN HANNIBAL, THE SPINE OF THE CONTINENT: THE RACE TO SAVE AMERICA'S LAST, BEST WILDERNESS 204-06 (paperback ed., 2013); Paul Tolmé, *Running the Gauntlet*, in *Conservation*, NAT'L WILDLIFE FED'N (June 1, 2019) https://www.nwf.org/Magazines/National-Wildlife/2019/June-July/Conservation/Habitat-Corridors.

[16] *See* Tolmé, *supra* note 15. Pronghorn do not jump fences, so they need to be able to go *under* any fences across their route. *See* HANNIBAL, *supra* note 15, at 205.

thwart the annual migration and threaten the pronghorn's survival—a point central to a petition recently filed in federal district court to challenge the Bureau of Land Management's decision to permit gas wells along the route.[17] Indivisibility changes the stakes and the nature of the dispute: the alleged disruption is not simply a small fraction of an animal's wide-ranging territory, but rather an essential segment of a larger whole.[18]

As this example suggests, whether a given resource problem is viewed as exhibiting indivisibilities is itself open to interpretation and construction. The answer depends not just on physical realities (the interconnectedness of nature, or the effects of gravity on cars trying to cross an incomplete bridge) but also on how we define the relevant goal, and what counts as success or failure in achieving it.[19] For example, what might seem like just a marginal diminution in wildlife overall takes on an all-or-nothing character if we focus on preventing the extinction of a particular species. Reframing problems in ways that emphasize indivisibilities can raise the stakes (e.g., make the situation an all-or-nothing one) and, potentially, help harness cooperation.[20]

Indivisibilities lurking in some resource systems may be difficult to detect. For example, if a fishery requires a certain minimum population level for a given species to remain sustainable, fishing that drops the breeding population below that level will eliminate that species from the resource system—a dramatic collapse.[21] But such a population crash often follows some period in which exploitation of the resource has little or no perceptible negative effect.[22] As Carol Rose puts it, "it is typical of environmental problems that they really are *not* problems at the outset."[23] Moreover, even after declines become observable, they may be deceptive—there may be a period during which the decline is fairly modest and unalarming. But the losses may begin to snowball rapidly as the critical mass necessary to sustain the population is broken apart through overextraction. Similar threshold effects exist in multiple environmental contexts: coral reefs can suffer

[17] Amended Petition for Review of Agency Action, Upper Green River All. v. U.S. Bureau of Land Mgmt., No. 2:19-cv-146-SWS (Feb. 19, 2020). *See* Cassidy Randall, *"They Won't Survive": Trump Gas Wells Would Block Pronghorn Migration Route*, THE GUARDIAN, Feb. 24, 2020.

[18] For more background on the ecology of wildlife corridors and the significance of connectivity, see generally JODI A. HILTY ET AL., CORRIDOR ECOLOGY: LINKING LANDSCAPES FOR BIODIVERSITY CONSERVATION AND CLIMATE ADAPTATION (2d ed. 2019).

[19] Of course, there may be foundational normative disagreements about the ends to be sought or the evaluative framework to be employed in assessing progress. For instance, conservation might be sought for reasons wholly unrelated to human welfare. The visibility analysis developed here does not require or rule out any particular way of defining goals, and the examples I give are meant to be illustrative rather than prescriptive.

[20] *See infra* Part I.B.

[21] *See, e.g.,* Taylor & Ward, *supra* note 6, at 353 (describing and depicting possible paths for such a collapse).

[22] *See, e.g., id*. ("Ecological systems such as lakes, rivers, the atmosphere, fisheries and so on can normally be exploited up to some critical level while largely maintaining their integrity and retaining much of their use value. If exploitation rates go beyond that critical level, use value falls catastrophically.").

[23] Carol M. Rose, *Evolution of Property Rights*, 2 THE NEW PALGRAVE DICTIONARY OF ECONOMICS AND THE LAW 93, 96 (Peter Newman, ed., 1998).

devastating collapses when contaminants or temperatures reach a certain critical level; small ocean temperature changes can trigger a dramatic increase in hurricanes.[24]

In cases like these, indivisibilities exist and strongly influence the potential for disastrous outcomes. But they may remain largely invisible to observers—until it is too late. A tragic example of this phenomenon can be found in the fate of the passenger pigeon, which was at one time the most common bird in North America, with massive flocks darkening the skies and populations numbering in the billions.[25] But intensive hunting quickly drove the passenger pigeon to extinction; the last surviving member of the species, Martha, died in the Cincinnati Zoo in 1914.[26] Because the passenger pigeon was a migratory species, it was only present intermittently in any given place, and because its evolutionary strategy was to form large flocks to evade predators, the birds always appeared in great quantity. There was no way to gauge their decline, and, just as important, no way to connect individual acts of groups of hunters to any particular increment of depletion.

The need for a critical mass of passenger pigeons to carry on the species made the problem a "lumpy" or indivisible one; once exploitation of the resource crossed a critical threshold, the population collapsed irretrievably. The problem was one of low visibility. This was true in both of the senses to be explored in this essay: the shape of the collective action problem was opaque, as was the way that individual acts aggregated to impact the outcome. There was no real-time feedback as hunting proceeded, and hence no way to calibrate the intensity of harvesting to align with sustainable levels. There was also no incentive to do so. Without any way to coordinate with the other hunters, any individual's acts of forbearance would be meaningless; someone else would take up the slack. Better visibility could have made it possible to see, and pursue, a cooperative solution.

It is easy to chalk up the fate of the passenger pigeon to a tragedy of the commons, and to blame the birds' extinction on the lack of property rights or inadequate government regulation.[27] But this misses the fact that a cooperative solution might have become possible if only the participants could have seen more clearly what was going on. The ability to monitor and trace the impact of individual actions, always important in contexts involving collective goods or commonly owned resources,[28] takes on special

---

[24] *See, e.g.*, RICHARD J. LAZARUS, THE MAKING OF ENVIRONMENTAL LAW 11-14 (2004) (discussing "all or nothing" threshold effects in environmental contexts and citing these examples).

[25] *See generally* JOEL GREENBERG, A FEATHERED RIVER ACROSS THE SKY: THE PASSENGER PIGEON'S FLIGHT TO EXTINCTION (2014).

[26] *See id.* at xii.

[27] *See* OSTROM, *supra* note 8, at 8-14 (1990) (critiquing commentators who argue that either "Leviathan" or privatization represent "the only way" to solve a commons dilemma).

[28] *Id.* at 45, 94-100 (discussing the importance of monitoring in common resource settings); Steven J. Karau

significance where indivisibilities are concerned. The reason relates to the ways in which the presence of indivisibilities alters the structure of a collective action problem and changes the prospects for cooperative action. The next section explains.

B. Beyond the Tragedy of the Commons

The standard tragedy of the commons story predicts that people with access to common-pool resources will act in a manner that is individually rational but socially harmful—they will "defect" by doing the selfish thing, rather than "cooperate." But that result depends on a set of quite specific assumptions, as becomes clear in examining the tragedy's two-person structural equivalent—the single-shot Prisoners' Dilemma (PD).[29]

The titular PD setup is one in which two prisoners, interrogated separately, each have the choice to cooperate (with each other) by remaining silent, or defect (by confessing).[30] If both confess, they both receive moderate sentences, say three years. If they both stay silent, they both receive short sentences, say one year. But if one confesses and the other stays silent, the confessor goes free and the silent one goes to prison for a long time, say seven years. Focusing solely on the prison consequences, each prisoner would rationally choose to confess no matter what the other person does. If the other person will stay silent, it is better to confess (going free versus one year), and if the other person will confess, it is still better to confess (three years versus seven).

Under these conditions, and assuming no repeat play, binding contracts, social norms, or extra-legal consequences, there is a single equilibrium outcome: mutual defection.[31] The same analysis holds if we translate the story into a resource context where defecting involves overharvesting or polluting, and cooperating involves refraining from these actions—so long as one always does better defecting regardless of what the other players in the story do. Public goods games in which contributions are multiplied and distributed

---

& Kipling D. Williams, *Social Loafing: A Meta-Analytic Review and Theoretical Integration*, J. PERSON. & SOC. PSYCH. 681, 683, 696, 700 (1993) (assessing studies examining how the ability to identify and evaluate individual contributions (including self-evaluation) can reduce "loafing" on group tasks).

[29] Scholars have often noted the structural equivalence between the Prisoners' Dilemma and the tragedy of the commons. *See* Rose *supra* note 11, at 564 (2020) (crediting Russell Hardin with the original insight and noting that it "is now a widely-accepted view") (citing Russell Hardin, *Collective Action as an Agreeable n-Prisoners' Dilemma*, 16 BEHAVIORAL SCIENCE 472 (1971)); *see also* OSTROM, *supra* note 8, at 3–5; BAIRD ET AL., supra note 2, at 34.

[30] *See, e.g.*, Lee Anne Fennell and Richard H. McAdams, *Inversion Aversion*, 86 U. CHI. L. REV. 797, 807-08 (2019) (presenting and describing a standard PD game matrix with these payoffs).

[31] *See, e.g.*, Richard H. McAdams, *Beyond the Prisoners' Dilemma Coordination, Game Theory, and Law*, 82 S. CAL. L. REV. 212 (2009). The mutual defection solution is a Nash equilibrium, named after John Nash, which describes a set of strategies in which no player can do better given the strategies of the other players. *See id.* at 212 n.9 (citing BAIRD ET AL., *supra* note 2, at 310).

evenly to the players epitomize this structure; as long as the "multiplier" is smaller than the number of players, each player does best by defecting and contributing nothing, regardless of what anyone else does.[32] However, researchers have found that few situations, inside or outside the lab, match the payoff structure specified by the PD game.[33] As a result, the analyses that flow from it are unlikely to track real-world resource dilemmas.[34] There are many reasons for this divergence, but the one of interest here is the indivisibility of the good or goal, which keeps any party from enjoying a positive payoff unless enough people cooperate.

When indivisibilities are present, the game differs markedly from the one suggested by the PD or tragedy of the commons template. Two other game theory templates are especially relevant, both evocatively named: the Stag Hunt (also called the Assurance Game), and Chicken (also called the Hawk-Dove Game).[35] The Stag Hunt story, based on a passage from Rousseau, involves two hunters who must choose whether to cooperate with each other to bring down a deer or defect by hunting rabbits individually.[36] The deer is a much better food source for the pair than the rabbits they can hunt on their own, but it is impossible for either of them to bag it alone.[37] A deer kill is an indivisible event; it is not helpful to halfway hunt a deer.[38] As a result, neither hunter wants to go deer hunting on her own; doing so would leave her hungry at the end of a wasted day. If the other hunter is not going to help bag a deer, rabbit hunting is her best bet. Here, the two hunters do best if they can be sure both will cooperate; with that assurance in place, they are not tempted (as

[32] *See* Pamela Oliver et al., *A Theory of the Critical Mass. I. Interdependence, Group Heterogeneity, and the Production of Collective Action*, 91 AM. J. SOC. 522, 540 (1985) (explaining that under such conditions, "predictions about others' behavior are irrelevant, for contributions are irrational no matter what other people do"). If, on the other hand, the multiplier is *larger* than the number of players, there is a different dominant strategy: everyone will contribute everything they have, regardless of what anyone else does. *See id*. at 533-34 (explaining that when production functions are linear, the slope determines which of two patterns will prevail: "[e]veryone will contribute either everything possible or nothing").

[33] *See, e.g.,* McAdams, *supra* note 31; Glenn W. Harrison & Jack Hirshleifer, *An Experimental Evaluation of Weakest Link/Best Shot Models of Public Goods*, 97 J. POL. ECON. 201, 201-02 (1989).

[34] *See, e.g.,* Fennell & McAdams, *supra* note 30, at 807-10 (discussing and citing literature on this point); OSTROM, *supra* note 8 at 33-30 (criticizing the assumption that all collective-action problems are Prisoners' Dilemmas); McAdams, *supra* note 31 (describing widespread overuse and misuse of the Prisoners' Dilemma framework by legal academics).

[35] *See, e.g.,* Taylor & Ward, *supra* note 6; McAdams, *supra* note 31. There are minor variations, not relevant here, between certain versions of the Assurance Game and the Stag Hunt. *See* Daphna Lewinsohn-Zamir, *Consumer Preferences, Citizen Preferences, and the Provision of Public Goods*, 108 YALE L.J. 377, 392 nn.39-40 (1998); *see also* Amartya K. Sen, *Isolation, Assurance and the Social Rate of Discount*, 81 Q.J. ECON. 112, 114-15 (1967) (formulating the "Assurance Problem").

[36] *See* EDNA ULLMANN-MARGALIT, THE EMERGENCE OF NORMS 121 n.15 (1977) (quoting JEAN JACQUES ROUSSEAU, ON THE ORIGIN OF INEQUALITY 349 (G.D.H. Cole trans. 1952)).

[37] *See id.* at 121 (quoting DAVID K. LEWIS, CONVENTION: A PHILOSOPHICAL STUDY 7 (1969).

[38] *See* Kristen Hawkes, *Sharing and Collective Action*, in EVOLUTIONARY ECOLOGY AND HUMAN BEHAVIOR 269, 288 (Eric Alden Smith & Bruce Winterhalder, eds., 1992) ("Hunters cannot bring down part of a giraffe."); LEWIS, *supra* note 37, at 7 ("[I]f even one of us deserts the stag hunt to catch a rabbit, the stag will get away; so the other stag hunters will not eat unless they desert too.").

they are in the PD game) to defect.[39]

This game setup illustrates the effects of indivisibility, but it diverges from most environmental or resource dilemmas in other respects. In the two-person Stag Hunt game, each of the two players is necessary to bring down the lumpy ungulate, and the payoffs are symmetric. In most real-world situations, however, some degree of cooperation is needed to achieve an indivisible goal, but usually unanimous cooperation is not essential, and payoffs vary because different people need not all contribute the same amount of money, materials, or effort. In these cases, a second strategic interaction comes into play: Chicken.[40]

Chicken is named for a hazardous driving game in which two foolhardy motorists are set on a head-on collision course and one (or both) must swerve to avoid catastrophe.[41] A player can lose the game by swerving, but both players lose far worse by crashing. Each player would rather drive straight and win out over the swerver, yet she cannot safely do so unless she expects her opponent to swerve.[42] A crash is an indivisible event, a bad shared by all who experience it, and everyone has an interest in keeping it from happening. Dealmaking often features this dynamic—the worst outcome is the total loss of the surplus from completing the deal (a kind of crash), but each party wants more of that surplus.[43]

Putting the two games together, we can see that often there is a Chicken game in progress about who will cooperate to bring down the metaphorical stag in the story—the indivisible good that can be enjoyed only with enough cooperation.[44] Everyone loses if the stag is not brought down, but the ones who lose the most are those who chose the cooperative strategy only to go hungry. Everyone wins if the stag is brought down (assuming that sharing is required, or that it's impossible to exclude people from the spoils), but those who win the most are those who did not contribute anything to its demise (assuming unanimous participation is not required to bag the stag).

Indivisibilities change the collective action problem from one in which the dominant strategy is to defect, no matter what anyone else does, to one in which one's own best strategy depends crucially on what one expects others to do. In game theory jargon, there are *multiple equilibria*:[45] players may cooperate and achieve the indivisible good, or things may fall apart entirely

[39] *See, e.g.,* McAdams, *supra* note 31, at 221.
[40] *See, e.g.,* Taylor & Ward, *supra* note 6.
[41] *See, e.g.,* BAIRD ET AL., *supra* note 2, at 44.
[42] *See id.* at 44.
[43] *See id.* at 43-44.
[44] *See* Hawkes, *supra* note 38, at 289 ("If there are more potential participants than the minimum required, however, games of Chicken arise over who shall complete the working group."); Taylor & Ward, *supra* note 6, at 357-58 (describing how Chicken and Assurance games interact in a fishing scenario where not everyone's cooperation is required).
[45] *See* McAdams, *supra* note 31, at 212.

due to miscalculations, lapses in communication, or strategic behavior. Recognizing that *expectations* determine actions and outcomes shifts the emphasis to how people form expectations about how others will act.[46]

II. STRUCTURE AND STRATEGY

Indivisibility is a game changer. Defecting is no longer the single dominant strategy; cooperation may be rational depending on what others will do. But players faced with indivisible resource problems may still act as if they are trapped in a tragedy of the commons.[47] A core problem is the inability to observe or predict the choices that other people will make.[48] More foundationally, however, the terms of the game itself may be unclear. In this Part, I examine the structural features of indivisible resource problems and show how these features—and differences among them—influence the strategies of the players.

A. Anatomy of a Collective Action Problem

The Stag Hunt and Chicken games both provide an intuitive sense of why indivisibility matters to cooperation: everyone stands to lose unless enough players choose the cooperative strategy. Real-world resource dilemmas are, of course, far more complex than these simple two-player games. We can further refine our understanding of collective action problems involving indivisibilities by focusing on three defining features: production functions, participation requirements, and payoffs.[49]

1. Production Functions

A production function is simply a way of capturing the relationship between inputs and outcomes in producing a particular good or bad.[50] Suppose we want to create a migration pathway. What happens to the value of the pathway as each incremental segment is added? If the pathway is only useful when it is complete (perhaps because it is essential that the animals using it be able to move between habitat patches located at each end),[51] then

[46] *See* THOMAS C. SCHELLING, THE STRATEGY OF CONFLICT 54-58 (1960); Robert B. Ahdieh, *The Visible Hand: Coordination Functions of the Regulatory State*, 95 MINN. L. REV. 578, 618-19 (2010).

[47] *See* HARDIN, *supra* note 5, at 57-59 (discussing several reasons why the universal defection outcome associated with the PD might occur even when step goods are involved).

[48] *See id.* at 58-59 (describing the situation in which "members of a group must choose when they have deficient knowledge of how others are choosing").

[49] *See* FENNELL, *supra* note 6, at 47-49.

[50] *See* Oliver et al., *supra* note 32 (describing and depicting various production functions for public goods).

[51] *See, e.g.,* Lynne Gilbert-Norton et al., *A Meta-Analytic Review of Corridor Effectiveness*, 24 CONSERV. BIO. 660, 667 (2010).

nothing happens to the value of the pathway as each segment is added, until the final piece is put in place. Graphically, value follows a flat line until it suddenly jumps up in a large single step when the last segment is added and the path is completed.[52]

By contrast, a linear production function provides proportionate benefits as inputs are contributed. Think of a parking meter where adding each coin buys a proportionately calibrated unit of parking time, or a soup kitchen where each marginal ladle-full delivers a roughly equivalent nutritional benefit to an additional person. It is possible to quibble with all of these examples: even a partial wildlife corridor might provide some habitat benefits, people often need to park for discrete chunks of time, and soup production usually involves economies of scale. More generally, few if any goods involve a literal single step of value or exhibit a fully linear production function. Many production functions follow a more complex path that combines steps with slopes or contains regions of increasing or decreasing returns—or some of each.[53]

It may also be unclear what production function best describes observed phenomena. For example, we may be uncertain whether a particular resource is more valuable consolidated into a single large chunk (which would suggest increasing returns to scale) or divided into smaller, scattered segments (which would suggest the opposite).[54] In environmental science, the famous SLOSS ("single large or several small") debate took up just this question in the habitat context, with largely inconclusive results.[55] Interconnectedness among organisms and habitats can make fragmentation harmful and consolidation valuable,[56] but smaller, well-separated areas can provide greater diversification of risk and may be less costly to add in already developed areas.[57] Still, we know that for many environmental goods, the whole is greater than the sum of the parts, and relatively small changes, such as those that break up minimum sustainable populations, can cause disproportionate harm.[58]

---

[52] The "last segment" might be any of the segments along the path, if each is essential.

[53] *See, e.g.,* HARDIN, *supra* note 5, at 57-59; Oliver et al., *supra* note 32, at 525-28.

[54] Similar questions crop up in land assembly contexts, where holdout dynamics can make it difficult or impossible to tell whether component parcels are more highly valued separately in their existing uses or aggregated for a new use. *See, e.g.,* FENNELL, *supra* note 6, at 36-37.

[55] *See, e.g.,* ENRIC SALA, THE NATURE OF NATURE: WHY WE NEED THE WILD 154 (2020); HILTY ET AL., *supra* note 18, at 60.

[56] On the costs of fragmentation, see, for example SALA, *supra* note 55, at 153; HILTY ET AL., *supra* note 18, at 55-82; Nick M. Haddad et al., *Habitat Fragmentation and Its Lasting Impact on Earth's Ecosystems*, 1 SCI. ADV. (March 20, 2015), https://advances.sciencemag.org/content/1/2/e1500052.full.

[57] *See, e.g.,* SALA, *supra* note 55, at 154 (observing that "[s]mall protected areas may be the only practical tool in regions heavily populated by humans"); HILTY ET AL., *supra* note 18, at 146-63 (discussing potential drawbacks to corridors, including economic costs and "edge effects" from long and narrow pathways).

[58] Similarly, protecting a resource like a fishery incompletely may do very little good compared with providing full protection. *See e.g.,* SALA, *supra* note 55, at 150 ("In protected areas that allow some fishing, the fish biomass does not even double. But in fully protected areas, the total biomass of fish is, on average, six times greater than in

A related problem is that even if we know that crossing a critical line will make a large difference, it may be unclear what state of the world that line corresponds to, or where our current state of affairs stands relative to it. In other words, we might know that there is a cliff effect in a particular resource context, but have no idea whether we are about to go over the cliff. Projections that extrapolate from existing or historical data may present a false picture where significant nonlinearities are present. As a result, models are constantly contested and revised, and an accurate story may emerge only after much damage has already occurred.[59]

Despite these caveats, the distinction between incremental and all-or-nothing effects remains structurally significant. The lumpier or more indivisible a given good or goal is, the less possible it is for anyone to enjoy its benefits until the critical threshold is reached. This does not mean that people will always cooperate to produce the good, only that they are not categorically better off choosing not to do so. The good may be provided or preserved in its entirety, or it may be lost altogether. Which result will prevail? The answer depends on whose cooperation is necessary to the outcome, which brings us to participation requirements.

2. Participation Requirements

Participation requirements tell us who, exactly, must agree or contribute in order for a particular goal to be reached.[60] Where a physical input like real estate is necessary to produce the good, as in the case of a highway or wildlife corridor, cooperation must come from those who own or control the land lying along the path. If there is only one viable path, then every one of the people who owns land along it must cooperate, unless there is a coercive process like eminent domain to override their failure to cooperate. Other situations have more flexible participation requirements—often, merely "enough" people must cooperate, not any specific set of actors. For example, if vaccination of 90% of a population against a disease produces herd immunity sufficient to protect the community as a whole, then most, but not all, people must cooperate to produce that good.[61]

For common pool resources like the passenger pigeon, participation requirements are tricky: forbearance by some people may be met by

---

unprotected areas nearby, and sharks are 15 times more abundant.").

[59] *See, e.g.,* Gordon, *supra* note 8, at 126–28 (discussing shifts in views about the state of fisheries); Thompson, *supra* note 1, at 258-59 (noting the significance of "scientific uncertainty" about the state of resources such as fisheries, and the tendency toward "tremendous wishful thinking" and overly optimistic construal of ambiguity).

[60] Although the discussion here focuses on the cooperation of individuals, many resource problems will require the cooperation of larger entities like firms or governments. We might think of these situations as involving an antecedent collective action problem among stakeholders or constituents to influence the incentives of the entities in question.

[61] *See* THOMAS C. SCHELLING, MICROMOTIVES AND MACROBEHAVIOR 222-23 (revised ed. 2006)

intensified hunting from others. Everyone who is in a position to hunt intensively can affect the outcome. By contrast, participation requirements are quite open-ended when a monetary goal is involved because the necessary threshold can be met by any one person or combination of persons with the necessary funds. The indivisibility of the good in question and the stringency of the participation requirements tell us a great deal about who needs to cooperate, but these factors do not tell us whether that cooperation will occur. For that, we need to examine payoffs.

3. Payoffs

The signature feature of an indivisible good is that no one can enjoy any increment of the good until it is supplied in full (or in some minimally useful chunk). As a result, payoffs do not rise above zero for *anyone* unless enough people cooperate (per the participation requirements) to supply the good (or avoid the bad). This foundationally changes the dynamics of the situation and keeps noncooperation from being the dominant strategy under all circumstances. Failing to cooperate *could* win one a higher payoff (if it is possible to free ride on others or extract more surplus), and cooperating *could* reduce one's payoff below the initial baseline (wasting effort futilely hunting a stag alone), but cooperating might also make the critical difference between being able to enjoy a large indivisible good (or dodge a catastrophe) and losing out on that opportunity altogether.

Several features determine the specifics of a given payoff structure. If not everyone's participation is essential to supply the good, is it possible to exclude noncontributors from the benefits? If the indivisible good is supplied, are the gains distributed symmetrically (as in the Stag Hunt) or asymmetrically (as in Chicken)? If the threshold is not reached, can those who have contributed get their contributions back, or are they simply forfeited? If the threshold is exceeded, who (if anyone) gets the excess? Finally, once people contribute to the good in question, can their contributions be "raided" or eroded by noncontributors? For example, if some fishers curtail their fishing to improve sustainability, can a noncooperating subset of fishers intensify their own efforts to nullify (and profit from) those efforts?

Any factor that influences how and whether contributions to the good can be wasted, enjoyed, eroded, raided, or undone by other actors can alter the expected payoff from cooperating. The next sections elaborate on these and other aspects of a resource game's structure. The prospects for cooperation depend on one's ability to see this structure and predict the moves of others within it.

B. A Lumpy Public Goods Game

Research has investigated contribution decisions in stylized experimental settings where the rules of the game are made explicit. Of particular interest for our discussion are games in which players must choose whether or not to contribute to a central fund, where meeting a particular threshold of contributions will trigger the payment of a large bonus to be distributed among all the players. This setup replicates a lumpy public good, like finding a cure for a disease or saving a species. The good has an all-or-nothing quality; it generates benefits for everyone if it is provided, and no benefits for anyone if it is not.

A standard game might involve seven players who are each given $5 that they can contribute (entirely) or keep.[62] If at least five contribute, a bonus of $70 pays out to the group in equal shares ($10 each). But if the threshold is not reached, the contributors go home empty-handed. Likewise, if the contribution is exceeded, no one gets more than their share of the bonus. Notably, players need not engage in guesswork about production functions, participation requirements, or payoffs. Unlike real-world resource dilemmas, where the shape of the problem is often opaque, the experimental game's structure is expressly conveyed in the instructions. This transparency immediately resolves one set of visibility problems, but it leaves players uncertain about the strategies that other players will pursue.

What do we expect will happen? No one can enjoy any payoffs unless the threshold is reached, so there is some motive to contribute. At the same time, there is a risk of losing the money if the threshold is not reached, as well as an opportunity to gain even more by hanging onto one's money if the threshold will be reached in any case. In an experiment similar to this, nearly two-thirds of the players chose to contribute under such conditions.[63] Is it possible to do better? One experimental intervention involved a money-back guarantee similar to the funding one might find on a platform like Kickstarter: if the threshold is not reached, everyone gets their money back. Interestingly, this did not seem to help significantly.[64] On the one hand, it was reassuring to the players that they would not lose their money if the threshold was not reached. But on the other hand, they could also predict that the money-back feature would reassure others, making it more likely their own contribution

[62] *See, e.g.*, Robyn M. Dawes et al., *Organizing Groups for Collective Action*, 80 AM. POL. SCI. REV. 1171 (1986) (presenting results of similarly structured games); Christopher C. Fennell & Lee Anne Fennell, *Fear and Greed in Tax Policy: A Qualitative Research Agenda*, 13 WASH. U. J. L. & POL'Y 75, 93-100 (2003) (discussing and analyzing games involving step-level goods).

[63] *See* Dawes et al., *supra* note 62, at 1176-78 & tbl. 2.

[64] *See id*. at 1175-78. There are, however, anecdotal reports of success with this method. *See id.* at 1172. For discussion of this approach and variations on it, see generally Julia Y. Lee, *Gaining Assurances*, 2012 WIS. L. REV. 1137 (2012).

would not be needed after all.[65] Free riding remained a problem.

More effective was an intervention that effectively kept noncontributors from gaining anything by defecting.[66] It was easy to accomplish this result in the experimental setting by specifying that no one could leave with more than $10 (the share of the bonus that each player would receive if the threshold was reached). As long as the threshold was reached, everyone received an identical payoff, whether they contributed or not. Yet in many real-world contexts, there is no way to meaningfully offer refunds or keep noncontributors from free riding. Efforts expended on conservation measures generally cannot be clawed back if those efforts fail; if they succeed, the results will be enjoyed or shared by noncontributors as well as contributors.

What alternatives exist? One answer is to inculcate norms of cooperation, so that people suffer shame and social stigma if they do not cooperate, and enjoy peer approval or esteem if they do cooperate.[67] This is another way of rewarding cooperation and punishing defection, only using non-monetary payoffs. We will return to this possibility, and its connections to visibility, below.[68] But first it is worth emphasizing a way in which self-interest alone can solve the free-rider problem: if people are convinced that their own contribution is essential to the outcome. When goods are indivisible and everyone stands to benefit from their provision—or suffer from their absence—it can be rational (in a narrow self-interested sense) for people to contribute.[69] The next section explains.

C. The Importance of Being Essential

When goods are indivisible, each piece of the whole matters. That can generate holdout problems, because each person who controls an essential element has an effective veto. However, participation requirements vary: often, the good may be supplied (or the bad avoided), even if some people do not cooperate or contribute. That eases the holdout problem, but introduces a second problem: noncooperators can improve their payoff relative to cooperators by free riding, if enough cooperators exist to provide the good.

A third problem, a sense of futility, can block progress whenever a high threshold must be reached in order to supply a good or avoid a bad. People

---

[65] *See* Dawes et al., *supra* note 62, at 1174.

[66] *Id.* at 1175, 1183.

[67] *See, e.g.,* Richard H. McAdams, *The Origin, Development, and Regulation of Norms*, 96 MICH. L. REV. 338 (1997).

[68] *See infra* Part III.D.

[69] *See, e.g.*, Glenn W. Harrison & Jack Hirshleifer, *An Experimental Analysis of Weakest Link/Best Shot Models of Public Goods*, 97 J. POLIT. ECON. 201, 203 (1989) ("In desperate circumstances in which each person must do his or her duty (and even more) if the community is to survive, what appears to be self-sacrificing behavior may actually be selfishly optimal in swinging the balance between community viability and social collapse.").

may refrain from cooperating or contributing because they feel their efforts can make no difference against such a vast problem. Benjamin Hale describes the disabling sense of "causal impotence" that can impede progress in the climate change context,[70] and other scholars have noted how "drop in the bucket" perceptions can deter action and dissipate personal responsibility.[71] As Arden Rowell and Kenworthey Bilz explain, people may distance themselves from environmental problems by emphasizing the insignificance of their own marginal impact: "'It's not like me riding my bike to work is going to magically fix local air quality'"[72]

All three of these problems (holding out, free riding, and futility) relate to the significance of being essential to producing a particular good, whether that means putting together a physical assembly like a wildlife corridor or highway, reaching a goal like curing a disease or winning an election, or avoiding a catastrophic result like species collapse. Where a good has a lumpy all-or-nothing character, contributions toward producing it can be futile, critical, or superfluous.[73] If one's payoffs stem only from the provision of the good (or lack thereof), and not also from intrinsic or social rewards from cooperating (or punishments for not cooperating), then one would rationally contribute one's own efforts or resources when three conditions are met: (1) one's contribution will be critical to the outcome; (2) one will reap enough from the provision of the good to more than cover the cost of contributing; and (3) it is not possible to improve one's payoff by deviating from the cooperative strategy.

In a simple two-person Stag Hunt game, these conditions are relatively easy to meet. The participation of either party makes the other party's participation critical to the outcome, and the payoffs assume that the spoils will be shared in a way that makes that critical participation worthwhile. Futility—hunting stag alone—is the only risk in the story, and it is entirely eliminated if the (only) other player can be counted on to hunt stag. The cooperative solution is assured if each party can see that the other will cooperate. In other words, visibility alone can do the trick. This outcome is also stable: neither party will do better defecting so long as the other

[70] Benjamin Hale, *Nonrenewable Resources and the Inevitability of Outcomes*, 94 THE MONIST 369, 381-82 (2011).

[71] *See, e.g.*, Daniel Bartels & Russell C. Burnett, *A Group Construal Account of Drop-in-the-Bucket Thinking in Policy Preference and Moral Judgment*, 47 J. EXPERIMENTAL SOC. PSYCH. 50, 50-51 (2011) (discussing Peter Unger's notion of "futility thinking" and connecting it to "drop-in-the-bucket thinking" in which a larger denominator makes a given saving of lives or resources seem less compelling)*; see also* ULLMANN-MARGALIT, *supra* note 36, at 28–29 (discussing how the "condition of individual insignificance" can produce higher levels of defection).

[72] ROWELL & BILZ, *supra* note 3, at 34.

[73] *See* Amnon Rapoport, *Provision of Public Goods and the MCS Experimental Paradigm*, 79 AM. POL. SCI. REV. 148, 149-51 (1985) (discussing payoff calculations that depend on whether one's will be "critical" rather than wasted or unnecessary); Dawes et al., *supra* note 62, at 1178-81 (examining probabilities of being "futile, critical, and redundant"); *see also* Fennell & Fennell, *supra* note 62, at 93-96.

cooperates. In many real-world settings, however, at least one of these conditions fails.

Futility often presents a large threat in many-player contexts. Convincing people that their efforts are important—that they will add up to something—can, counterintuitively, be approached by asking for very little. The 1938 "March of Dimes" campaign to eradicate polio took just this tack, soliciting a contribution increment that was both clear and broadly attainable—one dime.[74] Research on charitable contributions has found that communicating messages like "even a penny will help" can induce more people to contribute, at least in face-to-face solicitation settings—an effect known as "legitimizing paltry contributions."[75] In the context of an indivisible good, the message is only conditionally true; a penny or a dime will not help at all, unless enough other people contribute as well. Perhaps such solicitations send the message that the solicitors are confident about being able to assemble a large enough chunk of contributions to supply a large indivisible good like curing a disease.

Where not everyone's participation is essential, the prospect of free riding arises—assuming the good is one from which noncontributors cannot be excluded. Here visibility might actually seem to backfire if it enables people to see when enough others have contributed and they can safely free ride. If everyone tries to sit back and watch, making contributions visible might mean that there are no contributions to see. Yet keeping contributions hidden leaves people with no guidance about the best strategy to pursue, other than their own assumptions about what others are doing—assumptions that are prone to systematic distortions.[76] Making choices in the dark, people may be paralyzed by a sense of futility, tempted by the prospect of free riding on others, or fearful of others free riding on them. In the absence of a regulatory approach that *requires* participation, what alternatives remain?

One possibility is to construct indivisible goals that effectively make everyone's cooperation essential (as it is in the two-person Stag Hunt). Samuel Popkin's analysis of political entrepreneurship in peasant movements

---

[74] *See Origin Of Our Name,* March of Dimes, https://www.marchofdimes.org/mission/eddie-cantor-and-the-origin-of-the-march-of-dimes.aspx.

[75] *See* Robert B. Cialdini & David A. Schroeder, *Increasing Compliance by Legitimizing Paltry Contributions: When Even a Penny Helps*, 34 J. PERSONALITY & SOC. PSYCH. 599 (1976); *see also* Indranil Goswami & Oleg Urminsky, *When Should the Ask be a Nudge? The Effect of Default Amounts on Charitable Donations*, 59 J. MKTG. RESEARCH 829 (2016) (presenting results indicating that low defaults increase contribution rates, but also cause people to scale back their contributions to the default amount).

[76] The psychological study of "social projection" has identified a number of biases, including "the false consensus effect" (assuming that one's own behaviors or beliefs are more prevalent than they actually are) and the "uniqueness bias" (underestimating how many others will act as commendably as oneself when engaged in good behaviors, or overestimating how many others will act as poorly as oneself when engaged in bad behaviors). *See, e.g.*, Benoit Monin & Michael Norton, *Perceptions of a Fluid Consensus: Uniqueness Bias, False Consensus, False Polarization, and Pluralistic Ignorance in a Water Conservation Crisis*, 29 PERSONALITY AND SOC. PSYCH. BULL. 559 (2003). *See also* McAdams, *supra* note 67, at 400-05 (discussing problems communicating a consensus and the prevalence of "false consensus" effects).

offers useful insight on this point: "if a large overall goal can be broken into many small independent pieces, all of which are necessary, the free-rider problem can be overcome, for if each person has a monopoly on a necessary factor for the final goal, all contributions are essential."[77] This observation is consistent with research findings on dilemmas that have a "weakest link" structure in which any failure to contribute is fatal to the goal.[78]

Returning to the lumpy public goods game above, suppose that *every* player had to contribute their $5 in order for the threshold to be met for receiving the bonus. This makes the game easier to solve in one way, because there is no opportunity for anyone to free ride, but it also makes it seem riskier to contribute if people are uncertain that others will also contribute. The prospects for cooperation remain relatively high, however, because everyone is in symmetrical positions with respect to contributions and payoffs; all that is needed is mutual assurance that all will contribute.

A different dynamic occurs in many land assembly contexts. Here, the fact that each landowner's parcel is essential to a planned project (a highway, say, or a major redevelopment effort) presents a holdout problem that can thwart efforts to put the pieces together through private sales. Such holdout problems form a primary rationale for eminent domain, which overrides the need to assemble cooperation from all of the landowners. Far from facilitating cooperation, knowledge of one's own centrality to the overall scheme can prompt strategic behavior in attempting to gain more of the assembly surplus. This strategizing can raise costs or even sink the assembly altogether. Hence the observation that private developers, who are not subject to the same transparency requirements as governments, might be in a better position to assemble land in some contexts because they can rely on secrecy and proxy purchasers to obscure their assembly plans.[79]

Being essential, and knowing it, goes from spurring cooperation in a public goods game to impeding it in the land assembly case. Why? The answer relates to whether a player can do even better by *threatening* not to cooperate. This possibility did not exist in the stylized Stag Hunt, because cooperation involved symmetrical and essential contributions and both players stood to get equal payoffs. By contrast, Chicken presents the possibility that, in achieving an indivisible good (avoiding a crash) one party wins more than the other—facts that much more closely resemble real-world resource dilemmas in which different parties stand to gain or lose different

---

[77] SAMUEL L. POPKIN, THE RATIONAL PEASANT: THE POLITICAL ECONOMY OF RURAL SOCIETY IN VIETNAM 257 (1979).

[78] *See, e.g.,* Harrison & Hirshleifer, *supra* note 33; Hawkes, *supra* note 38, at 288-89.

[79] *See* Daniel B. Kelly, *The "Public Use" Requirement in Eminent Domain Law: A Rationale Based on Secret Purchases and Private Influence*, 92 CORNELL L. REV. 1, 20–24 (2006).

amounts from realizing an indivisible goal.[80]

Even in Chicken, everyone finds it in their own interest to cooperate if necessary, to avoid the crash outcome. But the game is a dangerous one because each party wants to glean more surplus along the way. Parties miscalculate and wind up destroying deals that would be valuable for all concerned. Even though visibility seems like part of the problem, it is the knowledge of one's own centrality to the goal coupled with *misreading* what the other party will do that leads to tragedy. Refusal to swerve in Chicken is always based on a prediction that the other party *will* swerve. Where it is clear that this is not the case, swerving becomes the best strategy. This is why one party's unilateral precommitment to not swerving (by tearing out the steering wheel, for example) can ensure a win while precluding a tragic crash—but only if the other party sees it![81]

In short, visibility can improve predictions about the behavior of others, as well as about the structure of the game that is underway. The next Part explains how enhanced visibility can promote cooperative rather than destructive equilibria.

III. ENHANCING VISIBILITY

Because indivisible goods have an all-or-nothing structure, there can often be a razor's edge dynamic in which things could go either of two very different directions—complete success or total failure. How can visibility tip equilibria in the direction of conservation rather than devastation, viability rather than extinction, sustainability rather than catastrophe? The good news is that a problem's indivisible structure can help catalyze cooperation. The fact that achieving the cooperative solution is in the interest of all concerned makes it possible for policies to work with, rather than against, self-interest. The bad news is that indivisible environmental problems often suffer from low visibility along a number of dimensions. Not only is their structure often opaque, the strategies undertaken by other players may be impossible to

[80] A related possibility is that there might be two (or more) alternative goals that the parties could pursue cooperatively, either of which would bring gains to both of them, but in different proportions. This payoff structure tracks a standard game dubbed the Battle of the Sexes (BOS) in which both members of a couple will gain by attending an event together but one will gain more from attending Event A and the other will gain more from attending Event B. *See* BAIRD ET AL., *supra* note 2, at 41-42. Similarly, the hunters in our story might coordinate on hunting stag or on hunting bison, with one player benefiting more from the former, and the other player benefiting more from the latter. Hence, we might see a strategic interaction over *what* to cooperatively hunt embedded in the decision to cooperatively hunt in the first place (rather than just hunt rabbits alone). *Cf.* RICHARD H. MCADAMS, THE EXPRESSIVE POWERS OF LAW: THEORIES AND LIMITS 69 (2015) (discussing instances in which a BOS is embedded within a PD game). Environmental analogues are plentiful; progress typically requires cooperation, but that cooperation could take a variety of different forms with different distributive consequences.

[81] *See* HERMAN KAHN, ON ESCALATION: METAPHORS AND SCENARIOS 11 (1965) (describing a player's strategy of throwing the steering wheel out the window and observing that "[i]f his opponent is watching, he has won. If his opponent is not watching, he has a problem . . . ."; *cf.* SCHELLING, *supra* note 46, at 24 ("if the buyer can accept an irrevocable *commitment*, in a way that is unambiguously visible to the seller, he can squeeze the range of indeterminacy down to the point most favorable to him.").

observe or predict.

These two shortfalls in visibility, although conceptually distinct, are empirically entwined in many environmental settings. The payoffs that will flow from particular combinations of choices—crucial to understanding the structure of the game—will often be contested and unclear. Because human actions and resource outcomes are often highly attenuated and temporally lagged, the way one's own choices combine with those of others will generally be unknown. For similar reasons, it may be impossible to infer what strategies others are pursuing from the current state of a given resource system, or to guess what choices others are likely to make next.

Both sorts of visibility challenges—seeing the problem's structure and seeing the strategies of others—are exacerbated by a predicate problem: recognizing that a problem worth solving exists in the first place. Many environmental threats are hard to visualize because they depend on complex interactions that are not directly observable, that are diffuse across time and space, and that often have little immediate effect on human beings.[82] It is impossible to apprehend the structure of a problem or to predict how others will respond to it without first recognizing it *as* a problem. Although this point is not unique to indivisible resource problems, it carries particular significance where a certain threshold of cooperation is critical to success.

The sections below consider how we might overcome those obstacles to enable people to put together resources and cooperation in socially valuable ways.

A. Concretization

Problems that are vivid, concrete, immediate, and discrete attract more attention—and are more likely to spur cooperative action—than diffuse, distant, and abstract threats. One manifestation of this tendency is found in the psychological preference for helping specific "identifiable victims" over larger numbers of undifferentiated people or "statistical lives."[83] That environmental concerns often involve long-run harms to large numbers of unidentified people (many of whom are not yet born) presents a policy

[82] *See, e.g.*, ROWELL & BILZ, *supra* note 3, at 13 (emphasizing that environmental problems are difficult to solve because they are diffuse, complex, and tend to impact nonhuman species); RHETT LARSON, JUST ADD WATER 11-12 (2020) (observing that climate change lacks resonance for many because it is framed in terms that inconsequential, distant, or abstract); Elke U. Weber, *Experience-Based and Description-Based Perceptions of Long-Term Risk: Why Global Warming Does Not Scare Us (Yet)*, 77 CLIMATIC CHANGE 103, 108 (2006) (explaining why the threat of climate change does not elicit visceral reactions from many Americans).

[83] *See, e.g.*, Thomas C. Schelling, *The Life You Save May Be Your Own*, CHOICE AND CONSEQUENCE 113, 115 (1984); Cynthia Cryder and George Loewenstein, *The Critical Link Between Tangibility and Generosity*, in THE SCIENCE OF GIVING: EXPERIMENTAL APPROACHES TO THE STUDY OF CHARITY 237 (Daniel M. Oppenheimer and Christopher Y. Olivola, eds., 2010).

challenge.[84] Similarly, conservation resources are disproportionately directed toward "charismatic megafauna" like tigers or polar bears over species that are less visible or harder to identify with, like insects, fish, or invertebrates.[85] Resource threats that are entirely invisible, like greenhouse gases, or that are masked by the mobility of the resource units, as in the case of the passenger pigeon, may escape attention altogether.[86]

Although these tendencies seem like cognitive biases or errors, we can also understand them as rational reactions to coordination problems that depend on attracting the attention—and cooperation—of others. A stag hunt is a compelling metaphor for a coordination game because it features a visible, concrete, well-defined objective that two players can completely achieve if they work together. There is no similarly stylized game for addressing the long-range effects of incremental sea rise or the chain reactions that accompany diminutions in biodiversity. People may perceive that their efforts are best directed towards problems that are compelling enough to also appear on the radars of many other people.

We need not take problems as we find them, however. The way in which issues and contributions are framed can add concreteness and immediacy to situations that might otherwise appear hopelessly vague and abstract. Charitable organizations employ a variety of strategies to make problems appear concrete and their solutions achievable. The idea of "symbolically adopting" or sponsoring a particular animal, or funding some specific need (acquisition of a certain increment of habitat space, for example), can turn large and abstract problems into a series of discrete and solvable ones. The more visible these targeted efforts appear, the more confidence they will inspire in would-be contributors that others will similarly contribute.

A compelling image can help supply this type of visibility. For example, a recent online news feature used infrared images to show methane gas emissions—a form of pollution that is otherwise invisible to the naked eye.[87] Vivid manifestations of problems that are otherwise hard to access visually can also attract attention and mobilize support for solutions. The 2010

[84] *See e.g.*, Shi-Ling Hsu, *The Identifiability Bias in Environmental Law*, 35 FLA. ST. L. REV. 433 (2008).

[85] *See, e.g.*, ROWELL & BILZ, *supra* note 3, at 198-203; Andrew Metrick & Martin L. Weitzman, *Patterns of Behavior in Endangered Species Preservation*, 72 LAND ECON. 1 (1996).

[86] *See, e.g.*, ROWELL & BILZ, *supra* note 3, at 38 ("[Pollutants'] diffuse, invisible nature makes it hard to take them seriously—we tend to forget their effects or their importance in favor of more immediate, visible phenomena."); Edella Schlager et al., *Mobile Flows, Storage, and Self-Organized Institutions for Governing Common-Pool Resources*, 70 LAND ECON. 294, 297-98 (1994) (detailing the informational challenges presented by mobile resource flows, including the difficulty of assessing declines and connecting them with harvesting behavior, and the resulting dampening of incentives to take corrective action); Graham Epstein et al., *Governing the Invisible Commons: Ozone Regulation and the Montreal Protocol*, 8 INT'L J. COMMONS 337, 347 (2014) (noting the problems presented by the mobility and invisibility of ozone and ozone-depleting substances).

[87] *See* Jonah M. Kessel and Hiroko Tabuchi, *It's a Vast, Invisible Climate Menace. We Made It Visible*, N.Y. TIMES (Dec. 12, 2019 https://www.nytimes.com/interactive/2019/12/12/climate/texas-methane-super-emitters.html.

Deepwater Horizon oil spill, a massive leak in a BP-operated well 5,000 feet underwater, became urgently real to many people only after BP released an underwater video feed showing the leak gushing forth in real time. As Barack Obama explains, "Suddenly people around the world could see the oil pulsing in thick columns from the surrounding wreckage."[88]

Interestingly, the high degree of connectivity among resources—their very indivisibility—often works in favor of approaches that focus on their most highly salient features. A keystone species, for example, can serve as a bellwether for how a larger ecosystem is doing as well as a visceral representation of the stakes involved.[89] A simple, periodic measure of some visible attribute—the measured clarity of Lake Tahoe, for example[90]—can stand in for tomes of detailed data about how development, runoff, and micro-organisms relate to each other. Having concrete, solvable problems stand in for larger and more abstract ones has another advantage: it enables people to signal their willingness to cooperate in the larger enterprise.[91] In short, we should look for ways to use the visible to leverage the invisible.

In the climate change context, for example, researchers have noted the potential value of focusing policy attention on "co-emissions"—ambient air pollution that accompanies carbon dioxide emissions but that has localized, near-term health effects.[92] Building mitigation efforts around these more tangible and immediate impacts can help make headway on the larger and more abstract problem of carbon emissions as well. Rhett Larson suggests another interesting concretization move: shifting the focus of environmental discourse from climate change to water security.[93] The two are related, but the latter concretely affects people's lives in ways that tend to be more visible and immediate.[94] Coordinating to address water issues that will have a direct impact on people's lives today can both further larger sustainability goals and provide a workable platform for coordinating toward larger efforts.

Yet even water may prove an insufficiently visible resource in some contexts. Interestingly, droughts and water shortages may be more visible in

---

[88] BARACK OBAMA, A PROMISED LAND 568 (2020).

[89] *See* SALA, *supra* note 55, at 81 (citing Robert T. Paine for the idea of a "keystone species" which "has an effect on the entire ecosystem" that "is disproportionately greater than its abundance.").

[90] Lake clarity is measured annually by lowering a white Secchi disc into the lake to determine the depth at which it remains visible. U.C. Davis, Tahoe Environmental Research Center, *Tahoe: State of the Lake 2020*, (2020), https://tahoe.ucdavis.edu/sites/g/files/dgvnsk4286/files/inline-files/2020_SOTL_Complete.pdf

[91] *See* SCHELLING, supra note 46, at 112 (explaining how a focal point may be "a small piece of the game that comes to symbolize the game itself, setting a pattern of expectations that extends beyond the substance of the point involved"). Similarly, a visible practice can serve as a signal of compliance with related but less visible norms, potentially spurring broader compliance with even the less visible norms. *See* McAdams, *supra* note 67, at 415 n. 259 ("If a visible test reliably predicts compliance with a norm for which violations are more difficult to detect, and the latter norm benefits the group, then the group may be better off having the former norm.").

[92] *See* Drew Shindell et al., *Quantified, Localized Health Benefits of Accelerated Carbon Dioxide Emissions Reductions*, 8 NATURE CLIMATE CHANGE 291 (2018). I thank Hajin Kim for this example.

[93] LARSON, *supra* note 82, at 11-29.

[94] *See id.*

places that generally have ample surface water supplies, as Kate Pride Brown points out, because it is possible to actually observe changes in water levels.[95] She notes that people in Atlanta are better able to "see" water scarcity than people in a desert environment like Phoenix that relies on groundwater that is out of sight—making its scarcity invisible. Here too, conscious efforts at improving visibility may become important. For example, San Antonio has been able to consciously raise the visibility of its groundwater supply by including the Edwards aquifer level in daily weather reports.[96] This example connects to a second approach to problems of visibility: finding ways to provide observable feedback about the changing state of a resource system.

B. Feedback

Solving collective action problems requires perceiving causal connections between individual decisions and the results that play out in the world. In stylized games or simple physical interactions, players receive immediate, tangible feedback about the effects of their decisions.[97] But in many resource settings, these connections are opaque or attenuated.

Extreme forms of attenuation between acts and outcomes prevail in many environmental contexts. As Rowell & Bilz explain, "[i]n a literal and figurative sense, . . . it is impossible for individuals to 'see' the impacts of their climate behaviors on the global climate."[98] Globalization contributes to what Richard Lazarus has called "a cognitive severance of environmental cause and effect."[99] Those making decisions with environmental impacts frequently do not have to live with, or in some cases even know about, the negative effects of their actions. As Lazarus explains, "American consumers . . . could not readily perceive the environmental impact of their purchasing decisions, as the impact on the world environment was effectively masked by distance."[100] In addition to being spatially distant and causally attenuated, environmental impacts may be dispersed in ways that make them hard to track, as in the case of the passenger pigeon.[101]

When feedback comes too slowly, coordination can fail dramatically, especially where indivisible goods are concerned. Schelling illustrates the effects of lagged feedback with the example of a sightseeing boat that

---

[95] Brown, *supra* note 3.
[96] *See id.* at 230-31.
[97] *See, e.g.*, MCADAMS, *supra* note 80, at 5-6 (explaining how the center line on a road "gives immediate feedback on far it is safe to venture in that direction").
[98] ROWELL & BILZ, *supra* note 3, at 232.
[99] LAZARUS, *supra* note 24, at 213.
[100] *Id.*
[101] *See supra* notes 25-26 and accompanying text.

encounters a group of porpoises.[102] The passengers all rush to one railing to view the porpoises, which soon causes the ship to tilt dangerously to one side. Fearing the boat will capsize, all of the passengers rush to the opposite railing. But their initial relief—the deck is leveling out!—turns quickly to terror when they understand that the ship is now tilting even more violently (due to momentum) in the opposite direction.[103] Capsizing is an all-or-nothing event that everyone in the boat has an interest in avoiding, but their concerted action may actually bring it about.

As this example suggests, if we wait for observable feedback from the physical world about the aggregate effects of our individual choices, it may be too late to salvage the situation. If we can help people see what is happening sooner, and how it connects to individual choices, it becomes easier to avert disaster. Even a simple metric—the daily information about aquifer levels mentioned above, for example—can help people recognize shortages and calibrate their conservation efforts accordingly. In one influential study, the ability to see resource units declining in a simulated replenishing resource game helped move participants closer to an optimal harvesting strategy.[104]

Some forms of feedback enable people to monitor the impact of their own choices, such as data about household energy usage and how it compares to that of one's neighbors.[105] Because people tend to view their own acts through a self-biased lens, even those who mean to act fairly may unwittingly take more than their share.[106] Left to guess about how one's behavior measures up to that of others, people tend to mentally amplify their own positive contributions or minimize their negative impacts. Objective data about how one's choices measure up can act like a mirror to correct misimpressions about conduct and encourage better choices.[107] Feedback can even be built into the resource environment itself, whether through resource units that are segmented in some way or standardized harvesting equipment (a particular type of net, for example) that facilitates metering and self-monitoring.[108]

---

[102] SCHELLING, *supra* note 61, at 85.

[103] *Id.*

[104] Cass & Edney, *supra* note 1.

[105] *See, e.g.*, Ian Ayres et al., *Evidence from Two Large Field Experiments that Peer Comparison Feedback Can Reduce Residential Energy Usage*, 29 J.L. ECON. & ORG. 992 (2013); Hunt Allcott, *Social Norms and Energy Conservation*, 95 J. PUB. ECON. 1082, 1087, 1090-91 (2011) (finding modest average reductions in energy conservation through a system of providing feedback about how a household's usage compared to its neighbors, with significant heterogeneity, and with decay over time).

[106] *See, e.g.*, Linda Babcock et al., *Biased Judgments of Fairness in Bargaining*, 85 AM. ECON. REV. 1337 (1995) (examining self-serving evaluations of fairness in the settlement context); Kimberly A. Wade-Benzoni et al., *Egocentric Interpretations of Fairness in Asymmetric, Environmental Social Dilemmas: Explaining Harvesting Behavior and the Role of Communication* 67 ORGANIZATIONAL BEHAV. & HUM. DECISION PROCESSES 111 (1996) (finding egocentric biases in a simulated resource dilemma); Thompson, *supra* note 1, at 260.

[107] *See* Gregory Mitchell, *Libertarian Paternalism Is an Oxymoron*, 99 NW. U. L. REV. 1245, 1257–58 & n.46 (2005) (citing studies on the effects that actual mirrors have on behavior).

[108] *See* Lee Anne Fennell, *Slicing Spontaneity*, 100 IOWA L. REV. 2365, 2369-71 (2015).

Making problems and their connections to human decisions more visible and salient does not always result in a cooperative outcome, however. In some contexts, understanding the game more clearly might make people behave even more selfishly (so as to get more of the resource before things collapse altogether). But, as we have seen, it can actually serve one's narrow self-interest to act cooperatively in contexts involving indivisible goods—although this depends crucially on what others will do. This brings us to a third approach to enhancing visibility: constructing focal points that enable people to more accurately predict the strategies others will adopt.

C. Focal Points

Focal points can help people coordinate their responses to achieve indivisible goals.[109] Consider a pure coordination game: deciding which side of the road to drive on.[110] No one needs to appeal to legal enforcement or even shared norms to make people cooperate by sticking to the appropriate side of the road; self-interest can do the job quite nicely. Getting everyone to coordinate in this manner creates an indivisible good of safe travel, and it is in everyone's interest to contribute to providing it. All that is necessary is a focal point that enables everyone to coordinate their actions.[111] The law—even without enforcement—can serve as that focal point.[112] So too could any highly visible signal, sign, or feature of the environment.[113]

A simple signal or announced rule is sufficient in the driving setting because the terms of the game are clear: the stakes are high, everyone's cooperation is essential, no one has anything to gain by defecting (or threatening to), and the effects of noncooperation are straightforward and evident to all. In other words, the problem, its structure, and its basic solution (choose a side) are already visible, and all that is needed is some basis for predicting what others will do. A clear, shared focal point provides that basis.

As the "focal" metaphor suggests, these points of reference must be visible and salient to the participants in a given collective action game. They need not be announced in advance if shared knowledge or other clues can make a certain reference point stand out within a particular community. Thomas Schelling famously posed the problem of when and where to meet in New York City on a given day if there was no chance to coordinate: the

---

[109] Thomas Schelling famously developed the idea of focal points. *See* SCHELLING, *supra* note 46, at 53-118.
[110] *See, e.g.*, MCADAMS, *supra* note 80, at 22-23 (discussing this "classic example").
[111] *See* MCADAMS, *supra* note 80, at 22-23.
[112] *Id.*
[113] *See, e.g.*, *id.* at 23-26 (describing how a visible "Bystander" with no formal authority can successfully direct traffic in an intersection); FENNELL, *supra* note 6, at 60-61 (discussing how physical segmentation can serve as a focal point).

most popular response was Grand Central Station at noon.[114] Some feature of the landscape that stands out can help people to match their strategies, even when their interests are at least partially in conflict. For this reason certain solutions like splitting things 50-50 can stand out and enable deal-making by resisting small shifts in either direction that would unravel consensus.[115]

Similarly, a focal solution can emerge organically out of a situation involving shared resources if there is an obvious basis for making an allocation. For example, ten friends who meet regularly and share a plate of twenty shrimp may naturally fixate on the solution of eating two shrimp per person (a choice made easier by the readily divisible number of shrimp, the discreteness of the shrimp units, and the tails that serve as reminders of one's consumption tally).[116] This solution is by no means guaranteed: the situation may instead devolve into a free-for-all.[117] But the prospects for cooperation get a boost when players can quickly identify an easy-to-implement strategy that everyone can observe as it unfolds. Not only can participants readily see what strategy others are pursuing, they can also keep tabs on how their own consumption compares.

Some visible actions can serve as proof of investments made toward a cooperative strategy. Imagine, for example, that a particular piece of clothing or equipment was essential to hunting stag, so that wearing or carrying that item would credibly communicate to others that one was planning to hunt stag rather than chase rabbits. Here it becomes interesting to consider what kinds of cooperative strategies are visible to others or can be made so with the right framing devices.[118] Consider the push to make brown lawns a source of pride during a drought—a strategy that the City of Santa Barbara pursued some years ago.[119] One's brown lawn evinced cooperation and elicited more cooperation from others. By making the brown lawn trendy, social norms and pressures could push in a conservation direction.[120]

---

[114] SCHELLING, *supra* note 46, at 55.

[115] *See id.* at 71-72.

[116] *See* LEWIS, *supra* note 37, at 96; FENNELL, *supra* note 6, at 54.

[117] *See* LEWIS, *supra* note 37, at 96 (noting that the shrimp situation has two stable solutions: a "social contract" or a "state of nature" in which participants grab all they can as quickly as they can).

[118] *See, e.g.*, Daphna Lewinsohn-Zamir, *The Conservation Game*, 20 HARV. J. OF L. & PUB. POL'Y 733, 756-57 (1997) (discussing the importance of visibility in promoting cooperation and observing that certain actions with respect to historic preservation, like demolishing a building, are highly visible).

[119] *See* Jeremy Chow, *Gold Is the New Green: Thinking Environmental Shame in Drought Times*, 6 RESILIENCE 1 (2018).

[120] Scholars have recognized the role of visibility in promoting the spread of social norms. *See, e.g.*, Maria Knight Lapinski & Rajiv N. Rimal, *An Explication of Social Norms*, 15 COMMUNICATION THEORY 127, 141-43 (2005); Patrice Wylly, *Evaluating the Costs of Technology Neutrality in Light of the Importance of Social Network Influences and Bandwagon Effects for Innovation Diffusion*, 23 N.Y.U. ENVTL. L.J. 298, 341-49 (2015); Jed S. Ela, *Law and Norms in Collective Action: Maximizing Social Influence to Minimize Carbon Emissions*, 27 UCLA J. ENVTL. L. & POL'Y 93, 123-43 (2009); McAdams, *supra* note 67, at 361 (describing how the "risk of detection" contributes to the development of norms). *But see* Wokje Abrahamse & Linda Steg, *Social Influence Approaches to Encourage Resource Conservation*, 23 GLOBAL ENV'T CHANGE 1773 (2013) (in a meta-analysis of social influence approaches, finding that "[a] social influence approach was no more or less effective for observable

Contrast this situation with a sudden water shortage at Stanford that led the campus to call for students to cease showering for roughly three days.[121] Unlike the brown lawn, which is highly visible and public, showering is conducted in private and is not observable to others. A study of this situation found systematic misperceptions about what others were doing. For example, students who showered during the water crisis tended to believe that others were showering to a greater extent than did students who did not shower.[122] It would have been interesting to see whether some visible marker (an ink stamp on the forearm that would readily wash off during showering, perhaps, or a wristband that would disintegrate with prolonged contact with water) would have made a difference in behavior by correcting beliefs about the behavior of others.

Where the visibility of a practice is central to solving a resource dilemma, invisible cooperation can be unhelpful or even counterproductive. For example, some homeowners have resorted to painting their lawns green during droughts.[123] This enables those who are actually pursuing the conservation strategy to enjoy the aesthetic benefits of failing to do so, but it masks the prevalence of cooperation. It likewise provides protective cover for non-cooperators—shaming people for having green lawns may misfire if some of the green lawns are really brown lawns that have been dyed. Similar points might be made about plant-based food that looks like meat, synthetics that look like fur or leather, and so on. These innovations can make it easier for people to opt for what might be regarded as the more sustainable or "cooperative" path but, by allowing cooperators to blend in with noncooperators, can also reduce the visibility of their choice in ways that may keep it from gaining ground.

More broadly, the phenomenon of "conspicuous conservation"—a counterpoint to earlier forms of "conspicuous consumption"—has received attention.[124] Bright blue recycling bins, "I Voted" stickers (and similar new stickers for being vaccinated against COVID-19),[125] and distinctively shaped

---

behaviours compared to behaviours that are less observable"). These findings suggest that where other forms of direct social influence are present, visibility in the form of observable behavior may not make a marginal difference.

[121] *See* Monin & Norton, *supra* note 76.

[122] *Id.*

[123] *See* Amy Graff, *More Californians Painting Their Lawns Green*, SFGate, (May 14, 2015, , https://blog.sfgate.com/stew/2015/05/14/more-californians-painting-their-dry-lawns-green/.

[124] The concept of "conspicuous consumption" comes from THORSTEIN VEBLEN, THE THEORY OF THE LEISURE CLASS (1899). For a recent discussion, see Nestor M. Davidson, *Property and Relative Status*, 107 MICH. L. REV. 757 (2009). On "conspicuous conservation," see, e.g., Steven E. Sexton & Alison L. Sexton, *Conspicuous Conservation: The Prius Halo and Willingness to Pay for Environmental Bona Fides*, 67 J. ENVIRON. ECON. & MGT 303 (2014); Vladas Griskevicius et al., *Going Green to Be Seen: Status, Reputation, and Conspicuous Conservation*, 98 J. PERSONALITY & SOC. PSYCH. 392 (2010).

[125] The Center for Disease Control (CDC) has released sticker designs that proclaim, "I Got My Covid-19 Vaccine!" *COVID-19 Vaccination Communication Toolkit,* CDC, , https://www.cdc.gov/vaccines/covid-19/health-systems-communication-toolkit.html#stickers.

electric cars all can help make a particular practice visible.[126] Having a centralized source of visible information about the strategies that others are pursuing can also help spur what Robert Frank has called "behavioral contagion."[127] Frank gives the example of Google's Project Sunroof, which lets people easily see who has installed solar panels—a source of information that can both document and encourage the spread of the practice.[128]

One concern with prioritizing visibility is that it might lead people to fixate unduly on following a practice that is highly visible, to the detriment of alternative approaches that are actually more effective (or less costly and equally effective) but that operate out of sight. For example, some people might more effectively reduce their carbon footprints or their water consumption through means other than solar panels or brown lawns. One response would be to find ways to make less visible practices focal for subsets of the population that value them (for example, gardeners who find other ways to support sustainable water use practices), through information-sharing mechanisms.[129] Although there are no doubt limits to how much can be made focal, given the limits of human attention, the takeaway is not that we should rally around whatever practices happen to be most visible now. Rather, considering how existing forms of visibility support coordination can help us more thoughtfully construct focal points.

D. Social Norms and Self Interest

Much of the scholarly discussion around visibility has focused on its capacity to activate and spread social norms.[130] As the examples above suggest, conservation norms can catch on as people observe others adopting them.[131] Despite concerns about faux signaling that does not correspond to real behavioral changes (as well as worries about being perceived to engage in such insincere behavior),[132] visibility enhancing measures can serve as an important form of norm entrepreneurship.[133] But, importantly, norms are not

[126] *See, e.g.,* Griskevicius et al., *supra* note 124, at 399 (observing that "the highly visible and easily identifiable Toyota Prius . . . essentially functions as a mobile, self-promoting billboard for proenvironmentalism"); Wylly, *supra* note 120, at 342 (observing that the Prius was "purposefully contrived to be visible").

[127] ROBERT H. FRANK, UNDER THE INFLUENCE: PUTTING PEER PRESSURE TO WORK 156 (2020).

[128] *Id.* at 156-57 (discussing Google's Project Sunroof, https://www.google.com/get/sunroof).

[129] I thank Richard McAdams for conversations on this point.

[130] *See supra* note 120 and accompanying text. *See also* Gregg Sparkman and Gregory M. Walton, *Dynamic Norms Promote Sustainable Behavior, Even if It Is Counternormative*, 28 PSYCH. SCI. 1663, 1673 (2017) (observing that a changing trend can push people to adopt practices (like eating less meat) that diverge from current prevailing practices "[i]f this change is visible, appears willful, reflects the importance of the issue, and is taken as a sign of what is to come").

[131] Visibility can also activate existing norms by enabling self-monitoring that makes one's own acts clearer. *See supra* note 106 and accompanying text.

[132] *See, e.g.*, Jonathan Z. Berman, *The Braggart's Dilemma: On the Social Rewards and Penalties of Advertising Prosocial Behavior*, 52 J. MKTG. RES. 90 (2015).

[133] *See* Cass R. Sunstein, *Social Norms and Social Roles*, 96 COLUM. L. REV. 903, 929 (1996).

the only moving part in the story, when it comes to achieving indivisible goals. Narrow self-interest can also help to support cooperation even in the absence of shared norms, as we have seen already. How do these two factors combine?

Where a practice (recycling, say) is indeed backed by shared norms, people who follow the practice may receive an immediate payoff in the form of esteem from others or a sense of pride in having done the right thing.[134] This payoff helps support the cooperative move even where it is not likely to be pivotal to achieving a lumpy shared goal (such as preserving a species). Put in terms of our stylized games, it is as if hunting stag becomes inherently more rewarding as an activity than chasing rabbits (whether or not any stag are brought down), or as if one earns honor in a game of Chicken from swerving rather than driving straight. In other words, it changes the payoffs of the cooperative strategy even in the event the other person does not also cooperate. In this way, widely shared norms can promote *unconditional* cooperation within a particular interaction.[135]

Making contributory efforts feel independently worthwhile as a matter of principle thus offers a way to square small concrete steps with large indivisible goals. In the context of voting, the notion of doing one's civic duty for internally compelling reasons helps to overcome the sense that it is irrational to bother when one's chance of making a difference is so remote.[136] Benjamin Hale has recommended a similar approach in the climate change context: by individually taking steps that are deemed worthwhile for their own sake, people may be able to collectively stave off some of the worst outcomes.[137] Indivisibilities in social norms themselves—the fact that they are generally adopted in "lumps" rather than picked up and discarded situation by situation—can allow small visible acts to stand in for larger commitments.[138]

The other channel through which visible practices work to promote cooperation relies not on shared norms but rather on enabling people to better observe or predict whether other players are choosing the cooperative strategy. Such insights provide no traction in a Prisoner's Dilemma game because one's best choice (under the strict assumptions of the game's payoffs, and assuming no repeat play) does not depend on what others do; defection

[134] *See, e.g.*, McAdams, *supra* note 76, at 380-81; *cf.* ULLMANN-MARGALIT, *supra* note 36, at 37 (describing how factors like esteem and dishonor alter payoffs for soldiers confronting a strategic dilemma);.

[135] This cooperation remains contingent on norms being widely enough shared and adopted in the relevant society to generate payoffs that favor cooperation regardless of the specific moves of the other player.

[136] *See* Hale, *supra* note 70, at 381, 386 (discussing the "paradox of voting" identified in ANTHONY DOWNS, AN ECONOMIC THEORY OF DEMOCRACY (1957)).

[137] *Id.* at 386

[138] *See supra* note 91 and accompanying text. For discussion of drawbacks of lumpiness in norms, see Adrian Vermeule, *The Invisible Hand in Legal and Political Theory*, 96 VA. L. REV. 1417, 1431-38 (2010).

is always best.[139] But in differently structured games like the Stag Hunt or Chicken, one's best strategy (on a purely rational calculus) depends on what the other players are going to do. In those game structures, a better payoff from cooperation arises not unconditionally (as it does in the case of norm-following) but rather conditionally, based on how one's own choices combine with those of others.[140]

Where an indivisible good is involved, being able to see others' strategies can avoid disaster, but it can also help some parties take advantage of others to reap larger rewards. Fearing being suckered, parties may miscalculate and wind up contributing to a disaster. Norms that make the cooperative action independently attractive (or that allow for a form of "punishment" of defectors through shaming or withholding esteem) can therefore backstop self-interest in ways that support cooperation.

E. Putting it All Together

Concretization, feedback, focal points, and norms can all leverage visibility to produce indivisible goods and avoid indivisible bads. But they work best in combination. The core challenge of many large, intractable problems is to get people to see how their many small interacting decisions can change the world. This requires two kinds of vision: seeing the structure of problems clearly, and seeing how one's own choices can combine with those of others to solve them.. Developing these ways of seeing is not costless, however. Solving resource dilemmas on the ground requires solving a second-order collective action problem: building platforms and technologies that can enable people to view problems concretely and coordinate strategies. What is required is widespread investment in *configuration entrepreneurship*—the art and science of putting resources and cooperation together in their most valuable combinations.[141]

Modern technology offers ample tools for innovating in the configuration space, as many existing and emerging models attest—from Airbnb to Zipcar, from Groupon to Kickstarter. The same moving parts can be used to make resource problems concrete, offer focal solutions, and provide real-time feedback on progress. Mechanisms for dividing up contributions to common goals into slices that people are willing and able to provide can combat the sense that one's own choices are too insubstantial to matter by making the power of aggregation visible.

Consider the emerging consensus that one of the most useful measures

[139] *See supra* notes 30-31 and accompanying text.
[140] *See supra* Part I.B.
[141] *See* FENNELL, *supra* note 6, at 2.

that ordinary people can take against climate change involves a shift in dietary habits.[142] Plant-based diets dramatically reduce greenhouse gas emissions. Yet going fully vegetarian or vegan, framed as an all-or-nothing proposition, may be too large a step for many meat eaters. Nonetheless, a much smaller dietary shift could have a tremendous cumulative effect when multiplied by hundreds of thousands of people. In this vein, some have advocated part-time vegetarianism or other forms of "flexitarian" diets.[143] But these calls would be more successful if people could actually see how their small contributions combine with those of others to produce concrete change.[144]

Imagine, following an idea proposed by Matt Johnson, a "build a vegan" site on which people could commit to giving up meat for some portion of a day or week in order to assemble together the dietary equivalent of a person shifting entirely to a meatless diet.[145] As the number of plant-based virtual people grew, graphics might show how these gains translate into influencing real metrics, like ice cap melt or sea level rise, with impacts on people's lives or on the survival of high-profile animals like polar bears. Once people can see how changes translate into results (even through a virtual representation) such a site could become focal. Many variations on these ideas are of course possible. The central point is that enhancing visibility to support cooperation is within our reach. The key is developing tools that help people see what they can do.

CONCLUSION

Resource dilemmas often seem intractable. Although the stakes are high, environmental impacts, and their connection to innumerable small, interacting, individual decisions, can be hard to pin down. It is easy to assume that tragedy will prevail, at least in contexts where coercion is unlikely to be feasible or availing. But one underappreciated factor—the indivisibility of many of the relevant goods and bads—dramatically changes the game from one in which everyone is always better off defecting to one in which winning strategies depend crucially on expectations about the behavior of others.

By no means is cooperation assured: things can go very badly indeed

[142] *See, e.g.,* Lingxi Chenyang, *Is Meat the New Tobacco? Regulating Food Demand in the Age of Climate Change*, 40 ENVT'L L. REPORTER 10344-45.

[143] *See, e.g.,* SALA, *supra* note 55, at 214-15 (noting the environmental advantages of "[a] 'flexitarian' diet based mostly on plants, with occasional meat consumption"); Ian Ayres, *Vegetarianism as a Sometimes Thing*, Freakonomics, (June 19, 2009), http://freakonomics.com/2009/06/19/vegetarianism-as-a-sometimes-thing/ (presenting a one-day-a-week-vegetarian idea suggested by Matt Johnson).

[144] *Cf.* Sparkman & Walton, *supra* note 130 (investigating how "dynamic norms"—the knowledge of a growing trend, even if not yet a dominant practice—might support reduced meat consumption).

[145] Johnson explained his idea this way: "[S]ay a group of 7 people signed a contract saying that each of them would go meatless on an assigned day each week. Thus, within the group each member could eat meat 6 days a week, but there would be one vegetarian at all times." Ayres, *supra* note 143 (quoting Johnson).

where cliff effects and all-or-nothing dynamics are involved. Yet the potential exists for people to coordinate their decisions, avoid tragedy, and achieve sustainable results. Visibility, I argue, is a key lever for making cooperation work under conditions of indivisibility. And the fact that both indivisibility and visibility can contribute to cooperative solutions means that we can actively work to frame resource dilemmas around these features.

In a sense, visibility is a metaphor for perception and understanding—seeing the problem as a problem, perceiving its structure, and understanding the connection between individual decisions and outcomes. But visibility is also literal. Resource problems that provide visceral feedback can be used to coordinate action. Harvesting methods or conservation practices that enable observation and monitoring can assist in generating and sustaining cooperation. Focal points, which often rely on visible features, can give rise to shared expectations about actions.

For all its power, visibility is not a panacea. It can even backfire in some contexts by allowing people to see opportunities to gain from noncooperative behavior. But recognizing where and how it works can shed new light on how to approach our most important—and most indivisible—problems.