Game-Theoretic Insights into Effective Cooperation Among National Parks and Indian Tribes

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For most of the twentieth century, U.S. land management agencies saw their missions largely in terms of what happened inside their own units. However, recent decades have seen transboundary collaboration playing an important role in what managers do.

Many have advised managers how to make collaboration better, in the form of generalities such as "communicate better," "collect more information," or "institutionalize consultation." This advice doesn't help managers prioritize very well. As we will see, information collection and better communication can be irrelevant to solving some types of cooperation problems. In other cases, we should not expect any collaboration at all. The most important distinctions in most of this paper are between "coordination" and "collaboration"(Snidal 1985; Stein 1982). These affect the role of communication, information gathering, and the usefulness of institutions.

Modeling collaboration

This paper examines cooperation between U.S. agencies and Indian reservations (see Ashley and Hubbard 2004; Burnham 2000; Keller and Turek 1998; Spence 1999; Wilson 2002). To model such collaboration, this paper will use very simple game theory, with only two players, each with two choices. Game theory finds the solution to such choice problems with the concept of a Nash equilibrium, in which neither player has an incentive to change her choice unilaterally if the other person's choice doesn't change either.

Coordination problems. Pure coordination problems lack any substantive disagreement. One simple example is deciding whether a country should require that everyone drive on the left or the right of the road. No one cares what we decide, but we all want to drive on the same side.

Such problems are regularly found in National Park Service (NPS)-tribal collaboration. Imagine a wildlife population that could be studied with several different survey methods. If the wildlife crosses boundaries, there's clearly an advantage to developing a common survey methodology.

PURE COORDINATION		Tribe	
		Method 1	Method 2
NPS	Method 1	1 1	0 0
	Method 2	0 0	1 1

This is a pure coordination game, as shown in the adjacent box. (I arbitrarily set the payoffs at 1 if they coordinate, 0 if they don't.). The upper-left and lower-right boxes are each Nash equilibria, as no one will change away from such an outcome. This game is easily solved with communication (Crawford and Sobel 1982), with players announcing their intentions and then acting on them when they agree. This fact yields our first claim:

Claim C-1. Communication helps solve Pure Coordination problems.

Scientists working for land managers confront such problems frequently, and move to common methods without political difficulty.

One variant of this game is coordination when the two sides disagree. We often see this problem in cultural interpretation. The NPS and an affiliated tribe may tell the story of a park's history differently but both sides prefer that casual visitors to the park receive a single story.

COORDINATION WITH DISAGREEMENT		Tribe	
		Version 1	Version 2
NPS	Version 1	2 1	0 0
	Version 2	0 0	1 2

Both the upper-left and lower-right boxes are equilibria: neither side has an incentive to switch unilaterally. History plays an important role in the outcome of the game. If the NPS has been telling "Version 1" for a long time, and the tribe has acquiesced, the tribe may not be able to start telling a different story. Thus,

Claim C-2. History often determines the outcomes of Coordination games when the two sides favor different solutions to the game.

This dependence on history can be frustrating for the side, usually the Tribe, coordinating around their second-best outcome (or simply being silent). However, the last few decades have seen NPS interpretation change at many locations, for reasons external to this game.

For example, Little Bighorn Battlefield National Monument (née Custer Battlefield National Monument) had focused interpretation on Custer and the 7th Cavalry. Its new name reflects an act of Congress and underlying changes in social beliefs. These social changes led to a desire to treat both sides of the battle as "Americans." The result, in terms of the game, is a shift in NPS preferences such that the lower-right box above now has preferences {2, 2}, with {1, 1} in the upper-left box. Working together, the NPS and Native Americans shifted interpretation from Version 1 to Version 2.

Stag hunt. Many situations of NPS-tribal collaboration can be classified as "Stag Hunt" problems. This game takes its name from Rousseau's parable about two people in a state of nature who can hunt either hare or stag. They must work together for stag, which both prefer to hare. This is shown with a payoff of 4 in the figure. However, either one could catch a hare by herself. If A hunts hare, she catches one and eats it, with an outcome in the lower row of the figure (depending on what B does). Finally, if A hunts stag but B wanders off and gets a hare, A goes hungry—her worst outcome.

STAG HUNT		B	
		Stag	Hare
A	Stag	4 4	1 3
	Hare	3 1	2 2

There are two Nash equilibria here: {Stag, Stag} and {Hare, Hare}. But if both players are hunting hare, they would like to switch to stag. Neither has an incentive to switch unilaterally, but communication solves the problem easily if players announce, "I'll hunt stag if you

will," and then switch simultaneously at an agreed time. Two main propositions follow:

Claim SH-1. Assuring other players of your intentions and actions is central to solving Stag Hunt problems.

Claim SH-2. Communication, and institutional mechanisms for communication, provide assurance and help solve Stag Hunt problems.

One example is the collaboration among national park units and the Grand Portage Indian Reservation to address the threat of Viral Hemorrhagic Septicemia (VHS) in Lake Superior (NPS and Grand Portage Band 2008). Taking unilateral actions against an outbreak of VHS would be ineffective, so no party has an incentive to do anything unless it knows that others will help. If others help, then everyone prefers to take aggressive actions against the spread of VHS. In this plan, the park units and the Grand Portage Band of Chippewa agree to common responses before and after the appearance of VHS in Lake Superior.

The emphasis on institutional mechanisms and communication when deeper collaboration is necessary—that is, in the event of an actual VHS breakout—is an excellent response to Stag Hunt problems. As Claims SH-1 and SH-2 suggest, these actions will help participants move from inaction to action when it is necessary.

Prisoners' dilemma. The Prisoners' Dilemma (PD) is probably game theory's most famous game, reflecting the mixture of cooperation and conflict between the players. In PD, two players may "cooperate" or "defect" in addressing some common problem. Mutual cooperation, CC, is better for both than mutual noncooperation (defection), DD. It's tempting not to live up to one's commitments, so A prefers DC to CC. Being cheated on is the worst outcome, so for A, CD is worse than DD and all other outcomes. B's preferences are symmetric (see figure).

PRISONERS' DILEMMA		B	
		Cooperate	Defect
A	Cooperate	3 3	1 4
	Defect	4 1	2 2

The central dilemma is that DD is a Nash equilibrium, while the mutually preferable CC is not—each player would rather switch to playing D, given that her partner is playing C. If this game is played once, there is no way around this problem.

If the game is played repeatedly, mutual cooperation may be feasible. Players will monitor one another's behavior, so that if either cheats the other one will know. Cooperation further requires some punishment or enforcement mechanism so that if cheating is detected it will be punished.

Whereas communication was important in Stag Hunt, communication is unnecessary in establishing cooperation in the PD. Each player will lie about their intentions, hoping to take advantage of the other.

Claim PD-1. Cooperation in the Prisoners' Dilemma requires repeated play and a long time horizon.

Claim PD-2. Cooperation in the Prisoners' Dilemma requires monitoring and enforcement mechanisms.

Claim PD-3. Though information about compliance can be important ex post, ex ante communication is unnecessary for cooperation in the Prisoners' Dilemma.

Prisoners' Dilemma applies to a wide range of contractual settings in which each party offers something to the other party in exchange for something else. One example, with negotiations still in progress, is management of the South Unit of Badlands National Park inside Pine Ridge Indian Reservation (Burnham 2000, chapter 3). Past NPS actions have often been problematic for the Oglala Sioux, and the reservation would also like to manage the lands in ways different than what the NPS would like.

The NPS and Oglala Sioux are currently discussing several "concepts" for future management, from the status quo (NPS management) through shared management to a change of status as a tribal protected area under Oglala Sioux management (NPS 2008). Some seem likely to raise PD questions. How will each side monitor the other's actions? How will each side respond to real or perceived violations of agreements or non-written understandings?

Chicken. While PD's mixture of conflict and cooperation reflects a greater degree of conflict than does Stag Hunt, Chicken is even more conflictual than PD. There is a common interest in avoiding the worst outcome, DD, but conflict exists over exactly *how* to avoid this outcome. The central conflict comes from the existence of two pure-strategy equilibria, DC and CD. In each of these, there is a clear "winner" (A and B, respectively).

PRISONERS' DILEMMA		B	
		Cooperate	Defect
A	Cooperate	3 3	1 4
	Defect	4 1	2 2

In Chicken, each player will want to demonstrate her "commitment" to "winning" the game. If this commitment is credible, and believed, then the other player will concede (play C). Communication may help players commit to winning, but they will also find it advantageous to lie about their true commitment. As a result, many communications are not believable. Thus:

Claim C-1. Players will attempt to establish a credible commitment to "winning" a game of Chicken

Claim C-2. Players will likely communicate as part of their attempts to establish credibility, but these communications will likely not be believed.

Consider the case of Native human remains and archaeological artifacts before the Native American Graves Protection and Repatriation Act (NAGPRA) of 1990. People and organizations holding Native remains and cultural objects were in the condition of the DC outcome, with a credible commitment to holding on to them. After NAGPRA, the property rights in these holdings shifted abruptly to Native communities culturally affiliated to them. Tribes could, if they wish, demand immediate return of everything, to the horror of curators.

Because they lacked the infrastructure to handle the immediate return of all human remains and cultural objects, Native Americans moved more slowly. Compromises, such as Native loans of cultural objects to museums, were attractive in some cases, as were training programs to develop Native expertise as they developed their own collections. Negotiations over such compromises were always held in the shadow of the Native ability to demand immediate return, which Chicken represents as a credible commitment to defection.

Deadlock. Our final, and most conflictual game is Deadlock. As its name suggests, cases

of Deadlock are not amenable to solution. Collaboration will not occur, with or without communication.

"Deadlock" is a family of games, symmetric and asymmetric. In the symmetric form, neither side wants to collaborate. The symmetric illustration simply reverses both sides' payoffs in PD, switching CC and DD. Both sides will choose Defect no matter what the other side does. Unlike PD, the players do not wish to move to CC, so there is no collaboration problem.

PRISONERS' DILEMMA		B	
		Cooperate	Defect
A	Cooperate	3 3	1 4
	Defect	4 1	2 2

A more interesting situation occurs when one side would like to collaborate but the other side is not interested. One example is management of wildlife that moves from the higher elevations of Glacier NP to lower-elevation winter habitat on the Blackfoot Indian Reservation. Tribal members hunt several of these species, including elk, deer, bighorn, and bear. Tribal members also conduct guided hunts for outsiders, and the tribe advertises that its location allows outsiders to hunt the abundant wildlife of Glacier NP. Such hunts reduce the number of animals that return to summer habitat inside the park, creating an issue of concern to the NPS.

Because of the tribe's poverty, the reliance of many members on hunting for meat, and the income potential from guiding outsiders, the Blackfoot Indian Reservation is clearly best off managing the hunting on its lands without reference to NPS management concerns. In contrast, the NPS would prefer to restrict hunting so as to increase the wildlife population, though in the case of elk the NPS usually wants a smaller population.

ASYMMETRIC DEADLOCK		Blackfoot Indian Reservation	
		Cooperate	Defect
NPS	Cooperate	3 2	1 4
	Defect	4 1	2 3

The adjacent game illustrates asymmetric deadlock for species other than elk. The Nash equilibrium lies at DD. The NPS prefers mutual cooperation (CC) to mutual noncooperation (DD). Because the Blackfoot prefer DD to CC, NPS desires for cooperation will not yield fruit—the tribe strictly prefers the status quo. Whenever we observe a failure of cooperation, Deadlock should always be kept in mind as a possible solution.

Summary

These various games fall into three rough groups, coordination (Coordination, Stag Hunt), collaboration (PD, Chicken), and Deadlock. Communication plays an important role in coordination games, helping both sides find mutually-beneficial outcomes. Communication is irrelevant in Deadlock, since there is nothing to coordinate. Communication plays a more ambiguous role in Chicken and PD. As I have discussed, communication might help coordination in repeated-play Chicken (and by extension in PD), though both sides also have an incentive to lie.

Conclusions

This paper has sought to clarify the conditions for successful cooperation across a variety of settings. Information, institution-building, and the influence of history on coordination have provided recurring themes. If this analysis is right, then studies of Native–NPS cooperation should not make unconditional claims about the effects of "consultation" or "building relationships." Instead, studies should make conditional claims that building relationships is valuable under condition X but not under condition Y. In a world of time and budget constraints, such conditional claims help decision-makers set priorities among the range of worthy initiatives that cannot all be accomplished.

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