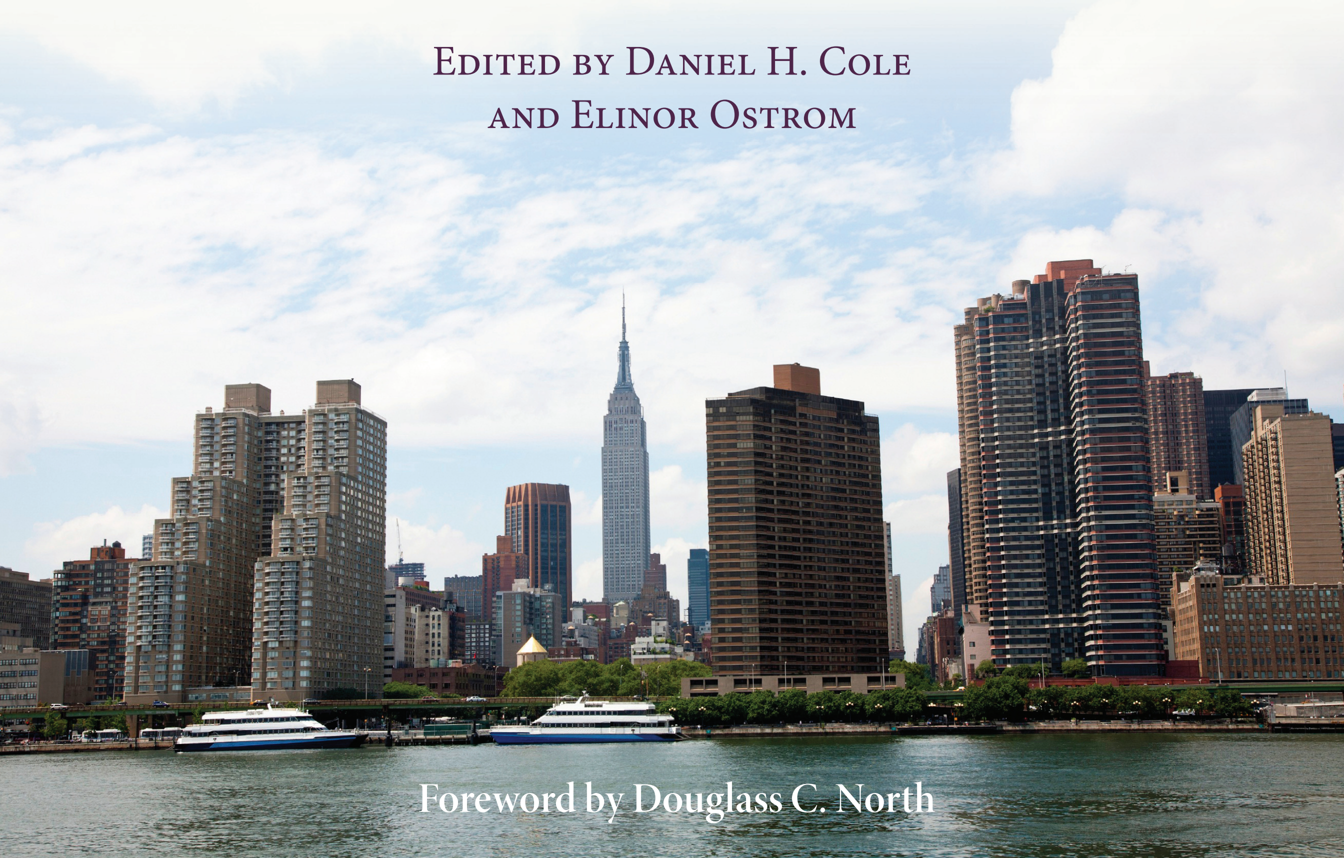
Property in Land and Other Resources

Edited by Daniel H. Cole and Elinor Ostrom



Foreword by Douglass C. North

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Who Owns Endangered Species?

JASON F. SHOGREN AND GREGORY M. PARKHURST

The United Nations declared 2010 the International Year of Biodiversity, a commemoration of the biological capital that makes human life possible. This declaration came 14 years after the publication of *Global Biodiversity Assessment*, the UN's analysis of the state of knowledge about risks to threatened and endangered species (Heywood 1996), and nearly 40 years after the United States Congress passed the Endangered Species Act (ESA) of 1973 (see the review edited by Goble, Scott, and Davis [2006]). The Year of Biodiversity, *Global Biodiversity Assessment*, and the ESA all capture the idea that some form of classic market failure exists such that a decentralized private property approach fails to protect biodiversity and endangered species for the social good. The market fails to price accurately the social benefits of species because ownership of species is typically not exclusive to any one person.

So who owns these endangered species? The brief answer is that we all do. But a full answer is more complicated because private landowners frequently pay the cost to shelter species that provide these nonrival and nonexcludable benefits to the general public. The bioeconomic property right challenge is the same it has always been: the benefits of species protection are widespread public goods, whereas the costs can be private when species live on private lands. In the United States, by one estimate nearly 90 percent of endangered species are sheltered on private lands (Brown and Shogren 1998).

Property and the ESA

The tension between private property and protection of endangered species has a long history. In the United States since 1973, the ESA has codified the idea that species have "ecological, educational, historical, recreational and scientific value" unaccounted for in the course of "economic growth and development" (ESA, sec. 2). The ESA has broadened the scope of species protection, making every species, subspecies, and discrete population, restricted to plants and animals, eligible for protection by being listed as either endangered or threatened. The original language of the act also implies that all species will be protected regardless of cost, a reversal of the preceding doctrine that species protection would be "practicable and consistent with primary purposes" of land use on both public and private property. The ESA prohibits landowners, public and private, from taking any threatened or endangered species on their private property; here a "taking" means any action that injures or kills a member of an endangered species or degrades its habitat. The U.S. Supreme Court has upheld this interpretation. Once an endangered species is found on property, a landowner works with a federal agency whose basic goal is to protect species by putting explicit restrictions on how the land can be used.

But private property owners do not see themselves as going against social norms with their land use decisions. Secure private property rights have long been promoted by Western countries as the key for sustained and prosperous economic growth; landowners are more likely to see themselves as stewards of the land who provide public goods than as corporate producers who create negative wedges between private and social objectives. A historical perception of entitlement and endowment arises with ownership of private property, irrespective of owners' actual rights and responsibilities as defined by current legal standards. People appreciate that neither land restrictions nor calls for conservation on private land are new. For centuries in Europe and in Euro-America, common-law restrictions have limited what people could do to or with their property (North and Thomas 1973).

But the ESA has produced a backlash because private property has held special status in the history of many nations, including the United States. Laws impose inequitable burdens every day (e.g., horse riders pay taxes for interstate highways). Many Americans, however, view laws that restrict private landowner autonomy to protect obscure species a threat to both the economic system and the broader social order (Epstein 1985; 1995; Norton 2002). They view land as capital, albeit natural capital, and they believe that capital is the key ingredient that allows people the ability to create, store, and share the wealth necessary for national prosperity.

Following the utilitarian view of nature promoted by John Stuart Mill and Gifford Pinchot, the resource conservation ethic is "the greatest good to the greatest number for the longest time" (Pinchot 1947, 382). Utilitarian landowners believe that their land ethic is valid, and they would like their ongoing stewardship to be appreciated. This classical liberal viewpoint takes a Hamiltonian perspective: the government should abdicate to market forces that create wealth by allowing resources to move freely from low-valued to high-valued uses. Classical liberals agree with James Madison's argument in the *Federalist Papers* that "the wide diffusion of independent property rights . . . was the essential foundation for stable republican government" (McEvoy 1998, 101). Rightly or wrongly, they fear that restricting private land for species protection without just compensation is another step down the slope toward collectivism.

In contrast, the romantic conservation ethic promoted in the United States by Ralph Waldo Emerson, Henry David Thoreau, and John Muir takes a different perspective on private property and endangered species. The preservationists believed that land had other uses than just for human financial gain. Landowners would be free to pursue private profits provided they also behaved as responsible social citizens, because by definition, land was already in public service. All land uses should be viewed as harm preventing rather than as public good providing. "The conviction that the freedom to wring the last speculative penny from one's land is of a piece with one's most fundamental civil, political, and personal liberties seems to be grounded less on argument than on assumption" (Sagoff 1997, 845).

A more pragmatic mind-set toward property and endangered species that emerged in the 1940s, in part from frustration with the other two views, is Leopold's evolutionary-ecological land ethic. Leopold (1949) based his ethic on the scientific notion that nature is not a collection of separate parts but an integrated system of actions, reactions, and feedbacks. This science-based mind-set focuses on defining the natural system within the context of human interaction and well-being. By integrating natural science and social science, one can promote more understanding by defining evaluative criteria that reflect the range of ethical views. For the private lands challenge, these criteria can address perceived biological needs, regulatory concerns, and landowner interests, such as compensation for land use restrictions.

But enforcement of the ESA typically has not risen to the level of a Fifth Amendment "taking"—private property shall not be taken for a public use without just compensation. Supreme Court decisions, for example, *Lucas v. South Carolina Coastal Council*, 506 U.S. 1003 (1992) and *Dolan v. City of Tigard*, 512 U.S. 374 (1994), have established rules that say that a regulation related to the public purpose will require compensation only if it singles out a vulnerable minority, deprives a landowner of all viable uses of his property, or physically invades or occupies the property (Sagoff 1997).

Although the courts have ruled that the government does not always need to compensate landowners, they have not answered the question whether the government should compensate private landowners who shelter endangered species (Innes, Polasky, and Tschirhart 1998). Bean believes that "without positive incentives, the Act's goals are unlikely to be achieved" (1998, 28 ELR 10707). Approaches exist that offer compensation to landowners for the costs of protecting species on their land. These approaches rely on incentives and financial rewards for better practices rather than prosecution for violating ESA's prohibition on harming listed species or their habitat. Policy makers have addressed the compensation question by offering voluntary programs to landowners to increase their incentives for private species protection and biodiversity conservation. The idea is to transform an environmental liability into a marketable asset.

The U.S. Fish and Wildlife Service and more than a thousand nonprofit land trusts promote habitat conservation by using voluntary incentive mechanisms to elicit the cooperation of private landowners. Mechanisms include conservation easements, leases, habitat banking, habitat-conservation planning, safe harbors, candidate conservation agreements, and the "no-surprises" policy (Bean 1999). A survey of state incentive programs found that at least 400 incentive programs enrolling some 70 million private acres existed in the 50 states by 2001, 50 percent of which had originated between 1990 and 2001. State departments of fish and game or wildlife administered 80 percent of these incentive programs (Defenders of Wildlife 2002). The typical state offered about four to six conservation incentives, usually in some form of direct payment and easement with tax relief. About 28 percent of the states made direct payments, 22 percent provided education and technical support, 20 percent gave tax relief, and 13 percent used property right tolls like easements and deed restrictions. Market institutions for species protection were used in about 3 percent of the programs.

The compensation question, however, has split both sides of the ESA debate. Some landowners want compensation; some want nothing to do with it. Some conservation groups want to pay compensation; others do not. Some ranchers and farmers say that they will retire acres for habitat or will put up with large predators (e.g., grizzly bears or wolves) provided they are compensated. Those landowners willing to consider compensation demand a fine level of detail about the program, need to see a local precedent, and need some basic reassurances to overcome an instinctual distrust of the regulatory aspects of the government (Korfmacher and Elsom 1998). Examples exist in which private landowners have voluntarily become partners in positive and proactive plans to protect and enhance natural resources on their land. Turner and Rylander (1998), for instance, describe several examples in which incentives have worked to protect species like the Louisiana black bear and the red-cockaded woodpecker.

Many ESA defenders agree that compensation is needed. They see compensation as a pragmatic way to bring private land into the fold of species protection. Compensation would reduce a landowner's incentive to wipe out the potential environmental value of land, thereby avoiding any potential ESA restrictions. Defenders of Wildlife, for example, has paid out more than $64,000 for nearly one hundred grizzly depredations since 1997 and more than $200,000 to about 180 ranchers for livestock losses to wolves since 1987.

But other landowners do not want to be paid to protect species. They say that they want nothing to do with a compensation policy because they fear further public erosion of autonomy and private control. They also fear the risk of unenforceability of contracts between private and federal ESA protection (Melions and Thorton 1999). They see compensation as a set of golden handcuffs through which more and more will be required of them and taken from them. Their view is that sometimes compensation is not enough; landowners want their privacy respected, their prior stewardship efforts acknowledged, and their ability to protect their investments flexible. As one rancher puts it, "It sounds to me like you're basically selling the state or federal government the right to control, not necessarily your land, but down the road it seems to me that the government then has control of private lands" (Korfmacher and Elsom 1998, 7).

Conservationists also think that compensation is a bad idea, both on moral grounds and because of pragmatic fears. They do not want compensation as part of the ESA because they view payments as a tool to paralyze the ESA through continual congressional underfunding of budget sources. They fear that mandatory compensation that is not coupled with the necessary federal funding would effectively gut the ESA.

The compensation question has helped stall ESA reauthorization for more than a decade. No one sees a quick end to the ESA controversy. Society is faced with difficult economic choices affected by biological needs and political realities. Working through this tangle requires more explicit attention to how economic incentives might affect private landowners, ESA supporters, and policy makers. People can point to voluntary programs that have worked to encourage some landowners to protect endangered species on their private property. These programs offer a regulatory safeguard to promote cooperation; some use explicit economic incentives, such as payments for easements. A variety of such flexible compensation schemes are possible: direct compensation from the government to owners of land; conservation banking and tradable rights in habitat, under which those who wish to develop land would buy permits from those who would then not be able to develop; insurance programs under which landowners are compensated if endangered species impose costs on them, like the fund created by Defenders of Wildlife; estate tax relief to allow large chunks of land to be preserved, rather than broken up to pay federal estate taxes; and tax deductions for conservation expenses. Private companies also are now playing a role. The goal of the developers Greenvest, for example, is to develop land to balance profit maximization with new green residential communities and commercial developments.

Creative suggestions on how to generate and use public monies more effectively are also welcome, even those with low odds of short-term political success. Easterbrook (1998) has proposed that Congress should codify a “build-and-save” plan: for each and every acre developed, another acre of habitat must be purchased and conserved for species protection. The idea is to align developers’ and conservationists’ interests such that if the economy grows, so do national parks and forests and grasslands. Over the last few decades, new development of about 1.5 million acres has occurred each year; therefore, a development fee of $1,000 per acre would generate a conservation fund of about $1.5 billion per year.

Other approaches try to add creative uses of compensation to existing programs in the government. The difficulties of implementing new programs suggest that one could fund conservation through existing programs such as the Wetlands Reserve Program (WRP) run by the Natural Resource Conservation Services of the U.S. Department of Agriculture (USDA). The WRP is a voluntary nationwide program that offers payment based on agricultural value for wetlands that have been drained and converted to agriculture uses. Another USDA incentive is the Wildlife Habitat Incentive Program, which provides cost sharing to assist landowners who use their habitat to protect wildlife and threatened and endangered species. In addition, Title II of the Farm Security and Rural Investment Act of 2002 budgeted about $17 billion for incentives for conservation on agricultural lands, including the newly created Conservation Security Program (CSP). The CSP pays producers who adopt and maintain conservation practices on private lands. Contracts run for periods of five to ten years, and annual payments range from $20,000 to $45,000. The CSP uses an initial “secretary’s” bonus to encourage people to sign up.

Another imaginative bonus scheme that could be incorporated into these existing incentive options is an agglomeration bonus. Suppose that the dual goal is to maximize species protection cost-effectively and to minimize private landowner resentment. The agglomeration bonus mechanism pays an extra bonus for every acre a landowner retires that borders on any other retired acre (Parkhurst et al. 2002). The mechanism provides an incentive for landowners to voluntarily create a contiguous reserve across their common border that provides a single large habitat usually desired for effective conservation. A government agency's role is to target the critical habitat, to integrate the agglomeration bonus into the compensation package, and to provide landowners the unconditional freedom to choose which acres to retire.

Oregon's Conservation Reserve Enhancement Program (CREP) illustrates the idea of an allied land retirement bonus scheme. The CREP pays an extra bonus to enrollees along a stream if at least 50 percent of the stream bank within a five-mile stream segment is enrolled in the USDA's Conservation Reserve Program (CRP). Additional increases in the CREP payment are made when in-stream water leases are made available on enrolled lands (OWEB 2011).

Spatial Configurations of Private Property

Protecting threatened and endangered species requires the creation of landscape-scale contiguous reserves and corridors to support viable species populations and ecological processes (Cincotta, Wisnewski, and Engelman 2000). Creating contiguous protected areas cannot be accomplished without the voluntary cooperation of private landholders. Their cooperation is more likely if they are compensated for financial losses, for example, through the CRP (Ferraro and Kiss 2002). Aldo Leopold stressed nearly half a century ago that the key to conservation was to compensate landowners for their efforts to protect nature on private lands. He argued that conservation "ultimately boil[s] down to reward the private landowner who conserves the public interest" (Leopold 1934, 136–137; see Innes, Polasky, and Tschirhart [1998]; R. B. W. Smith and Shogren [2002]). Compensation can be used to create an incentive to encourage landowners to maintain their land in an undeveloped state or to mitigate the environmental impact of development by helping the landowner meet costs of maintenance and restoration of environmentally sensitive areas. Compensation aligns a landowner's private incentives with the social desire to create nature reserves that shelter species at risk. In the United States compensation also reduces the odds that a landowner might claim a Fifth Amendment "taking" (private property taken for a public use) without just reimbursement. Landowners with a financial stake in conservation should provide more environmental stewardship if they are reimbursed for their efforts.

The U.S. Fish and Wildlife Service and many state agencies have started to design compensation programs to reduce the risk of defensive habitat destruction by providing landowners with regulatory relief in the event that restrictions are levied against their land (e.g., Safe Harbor Plans and Habitat Conservation Plans in the ESA of 1973; Bean 1998). Compensation takes the form of grants, loans, cash payments, and tax allowances offered by federal or state agencies or nonprofit organizations (Parkhurst and Shogren 2005). These programs are funded from numerous sources, including tax revenue, lottery funds, and special permits. A good example is Idaho Fish and Game's (IFG) Habitat Improvement Program (HIP). HIP is a cost-share program that allocates funds for improvements on both private and public lands. Recognizing the role landowners play in providing habitat for upland game and wild birds, the primary objective of HIP is to encourage private landowners to invest in habitat restoration and enhancement projects that increase the populations of wild birds. The agreements and compensation under HIP have evolved over time; compensation currently depends on the type of project and the duration of the project commitment. As much as 100 percent of costs can be reimbursed, and payments can be as large as $10,000 (IFG 2011).

But landowner compensation by itself does not guarantee the creation of habitats most suitable for species protection. Landowners still have no incentive to coordinate their land retirement decisions to create, say, one contiguous reserve that falls across property lines or to create optimal habitat configurations within their own property lines. Fragmented retirement decisions will affect species that prosper within a large habitat (e.g., the northern spotted owl, the red-cockaded woodpecker, or the grizzly bear). Most voluntary compensation programs are not designed to address directly biologists' concern that landowners may not coordinate conservation efforts across property lines or create habitat within their own property (Brown and Shogren 1998). Conservation biologists argue that many species face extinction because of fragmented habitats on both public and private lands. Habitat fragments are either too small to provide species with the physical and biological landscape characteristics necessary for survival and breeding or are too isolated from other fragments and cause species "bottlenecks," which are reduced chromosome types in the DNA of a species that emerge from inbreeding and increase susceptibility to changes in the environment of that species (Saunders, Hobbs, and Margules 1991). But biologists also point out that how one reconfigures fragmented habitat matters because different species thrive under different spatial habitat designs (Noss 1993).

The more private property fragments landscape, the more conservation and management of the habitats that shelter endangered species matter. Fragmentation results in a reduction of biodiversity and a loss of critical habitat. Regulators charged with the oversight and provision of natural resources have several incentive mechanisms at their disposal to combat the negative impacts on the environment and on ecosystems resulting from human consumptive uses. Two of the primary concerns of the regulator in implementing incentive mechanisms for conserving habitat are inducing voluntary participation by private landowners and coordinating conservation efforts in a desired spatial configuration.

Incentives that fail to compensate landowners for the cost of conserving their land potentially result in a decrease of available land and an increase in the cost of conservation. Alternatively, incentive mechanisms that compensate landowners for the foregone private use of their land are more effective at inducing landowners to assign their land to habitat protection. Increasing the available land for conservation objectives provides more options with the likelihood of lower costs.

In addition, many species require spatial habitat configurations to enhance the benefits they provide to society. Recently, spatially explicit models have been designed to capture the trade-offs between spatial allocation of conservation within the landscape and conservation costs (Ando et al. 1998; Grout 2009; Hamaide and Sheerin 2010; Hartig and Drechsler 2009). These research projects focus on low-cost landscape configuration in the absence of individual and group landowner decisions. However, these authors do not propose a method for transferring funds from the conservation coffers of governments and nongovernmental organizations to landowners (Chomitz et al. 2006). Given the current shortfalls in agency budgets, choosing an allocating mechanism is not a trivial matter. The assumption that compensation subsidies minimally equivalent to foregone productive use will induce landowners to voluntarily conserve the desired configuration ignores the strategic actions of landowners as they optimize the various land use rents and minimize the risk associated with coordinating conservation decisions within the landscape (Parkhurst and Shogren 2005). Furthermore, landowners possess private information concerning the productive value of their land and can use their private information to exact information rents from regulators (Ferraro 2008). A one-dimensional subsidy will be insufficient to meet a voluntary spatially dependent conservation agenda.

Meeting multiple objectives requires the use of multiple incentive mechanisms—potentially one for each objective. If the regulators' objective is to conserve a targeted spatial configuration voluntarily on private land, the incentive mechanism will need one component to induce voluntary participation and a second component to create the desired spatial configuration. Parkhurst et al. (2002) propose a mechanism, the agglomeration bonus, that is multidimensional and, as such, can be implemented to protect habitat critical for endangered species. The following section explores this mechanism in more detail.

Agglomeration Bonus

The agglomeration bonus, also referred to as a smart subsidy, is an incentive for landowners to conserve land voluntarily in a predetermined desired spatial configuration. This bonus is a set of subsidies that can be positive or negative and that attach to specific landscape characteristics. A flat subsidy induces voluntary participation, while a shared-border subsidy coordinates conservation within the landscape. Positive subsidies create an explicit network externality between adjacent land parcels and neighboring landowners by paying an additional agglomeration bonus when they retire land adjacent to other conserved parcels, both their own and their neighbors' (Parkhurst et al. 2002). Negative subsidies work to discourage land retirement decisions along the fence of a neighbor; rather, they encourage each landowner to create his or her own contiguous parcel that is separate and distinct from his neighbors' retired lands. Combining positive and negative subsidies makes smart subsidies flexible because they can create many different spatially conserved landscape configurations.

Parkhurst and Shogren (2007; 2008) examined the effectiveness of smart subsidies at conserving four different spatial configurations in the experimental lab. In a context-free experiment with four participants, each possessing 25 cells (parcels), a smart subsidy containing a menu of agglomeration bonuses was effective at conserving a coordinated landscape of long corridors, large contiguous regions, corridors with a midcorridor nesting area (resembling a cross), and isolated patches.

Their experimental results were promising and showed that subjects were able to identify the underlying incentives and meet the spatial objective. Further research showed that the agglomeration bonus was better than a simple per unit subsidy or coerced conservation at meeting spatial conservation objectives.

Experimental Test

Landscape and Landowners

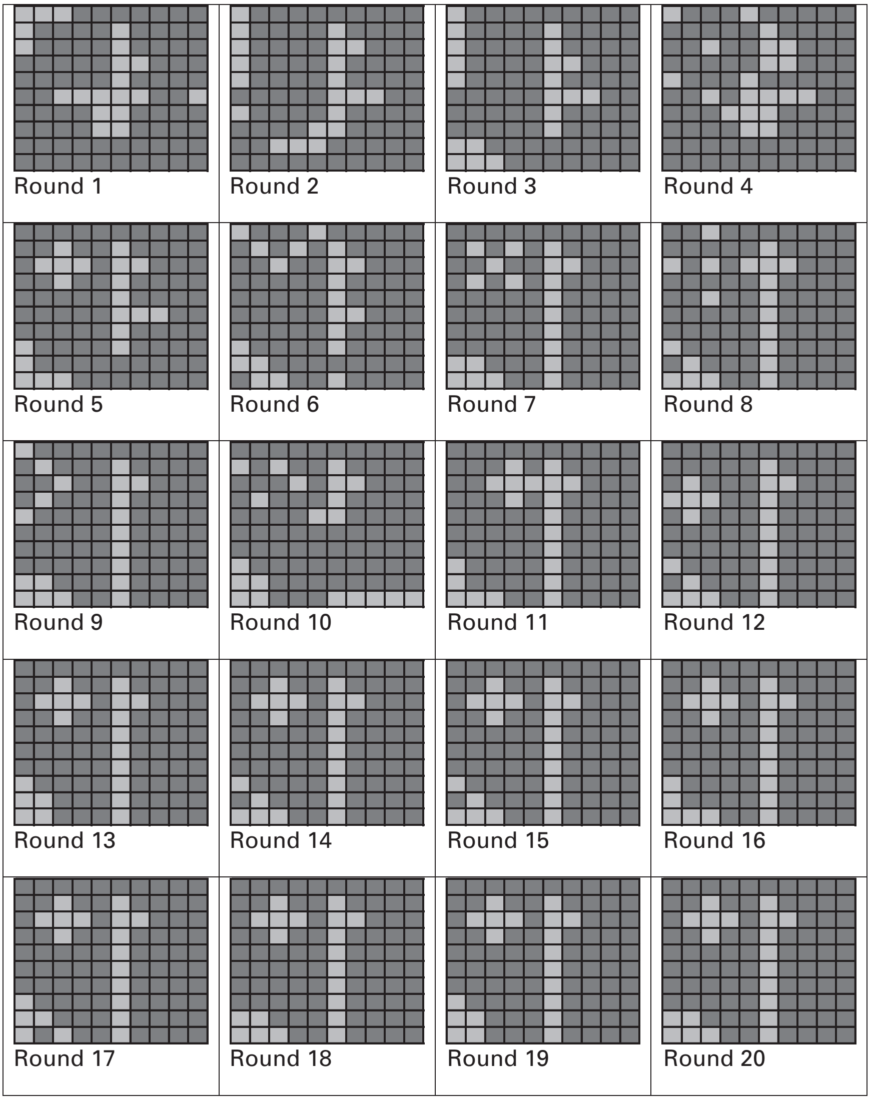
Parkhurst and Shogren represented the landscape with a 10×10 land grid divided into four private 5×5 landholdings. They used this grid design to extend and test the robustness of conservation incentives that used a classic normal-form 8×8 payoff matrix game in which the spatial element is implicit and embedded in the payoffs. As far as is known, this land grid is the first spatially explicit design in the experimental economics literature. Each cell in the land grid was assigned an economic value ranging from $20 to $50 per cell, which was the land's opportunity cost if it was retired for conservation. Land values differed across landholdings. Each landowner knew his own land values and those of the three other owners.

Policy Treatments and Subsidy Design

Parkhurst and Shogren compared three land retirement policy tools: compelled land retirement without a subsidy (figure 7.1), a simple $93 flat-fee subsidy per retired parcel (figure 7.2), and the subsidy with agglomeration bonus (figure 7.3). The subsidy divides a landowner's payment into four distinct parts: (1) a $20 flat fee per cell retired; (2) a $50 own-border bonus for each common border shared between two of his own retired cells; (3) a $24 row-border bonus for each shared border with his row neighbor; and (4) a $22 column-border bonus for each shared border with his column-neighbor (to the east). The amount of each bonus payment depends on the productive values and desired configuration and location of the habitat and can be positive, negative, or zero. Parkhurst and Shogren kept the absolute values of the simple and smart subsidies the same by equating the $93 simple fixed-fee subsidy with the average per cell payoff generated in the smart subsidy treatment. They conducted two 20-round sessions for each policy option. Eight subjects participated in each session.

Parkhurst and Shogren followed standard economic experimental procedures. All experiments were run on computers. Subjects were not told the objective of the experiment, and all wording in the instructions and on the computer screens was context free. Following standard protocol, subjects were recruited campuswide and were told to report to a computer lab at a given time. Experimental instructions were provided to each of the participants, and the monitor read them out loud while the subjects followed along. The experimental instructions are available upon request. Subjects had an opportunity to ask questions concerning the experimental procedures, which were answered by the monitor. The monitor also walked the subjects through two practice rounds to familiarize the subjects with the experimental design. The monitor handed out the agglomeration bonus specification page, which

FIGURE 7.1
Compelled-Retirement Results

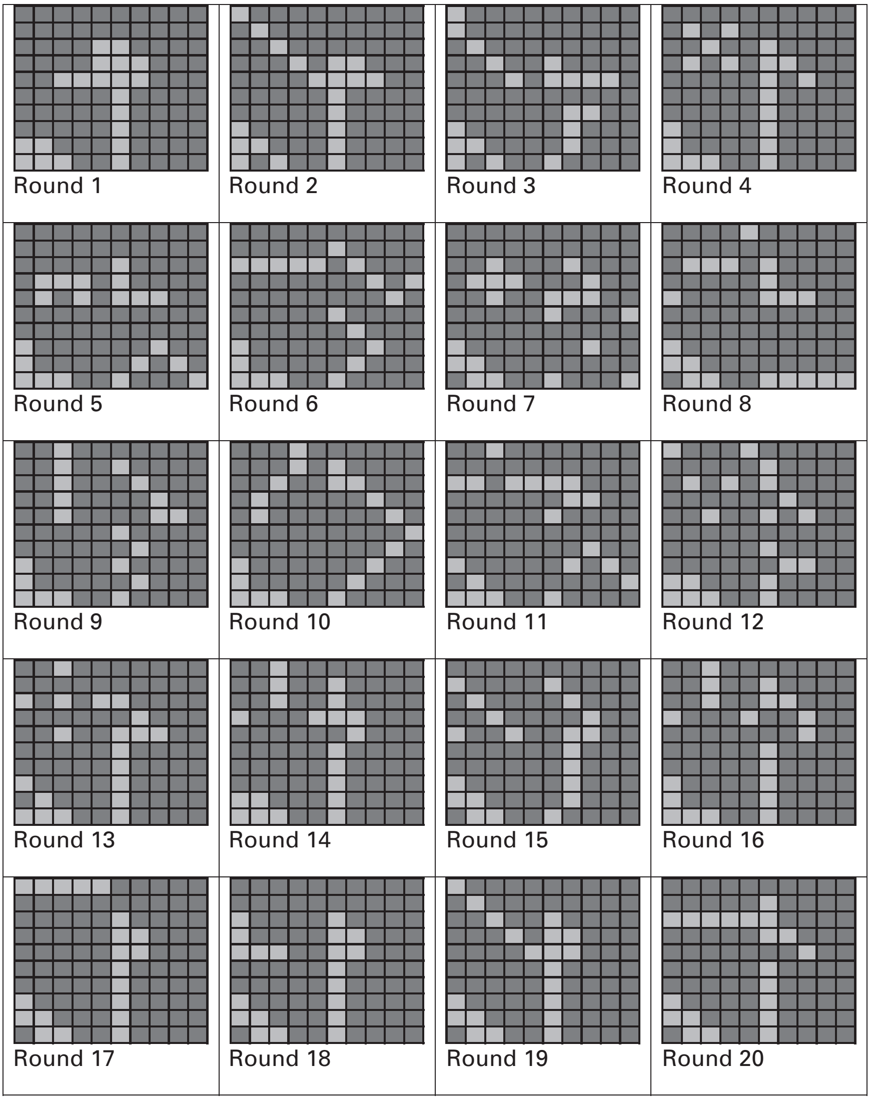


the subjects were allowed to review. The subjects then entered their name and student identification numbers into the computer, and the computer randomly assigned the subjects to groups of four.

Game Strategies

In the compulsion session, each subject was required to retire 5 cells (the white cells in the figures); the remaining 20 cells were left in production (the black cells in the figures) and earned the specified value for the cell. In the simple and smart subsidies, each subject could retire up to 5 cells {0, 1, 2, 3, 4, or 5} to receive the policy

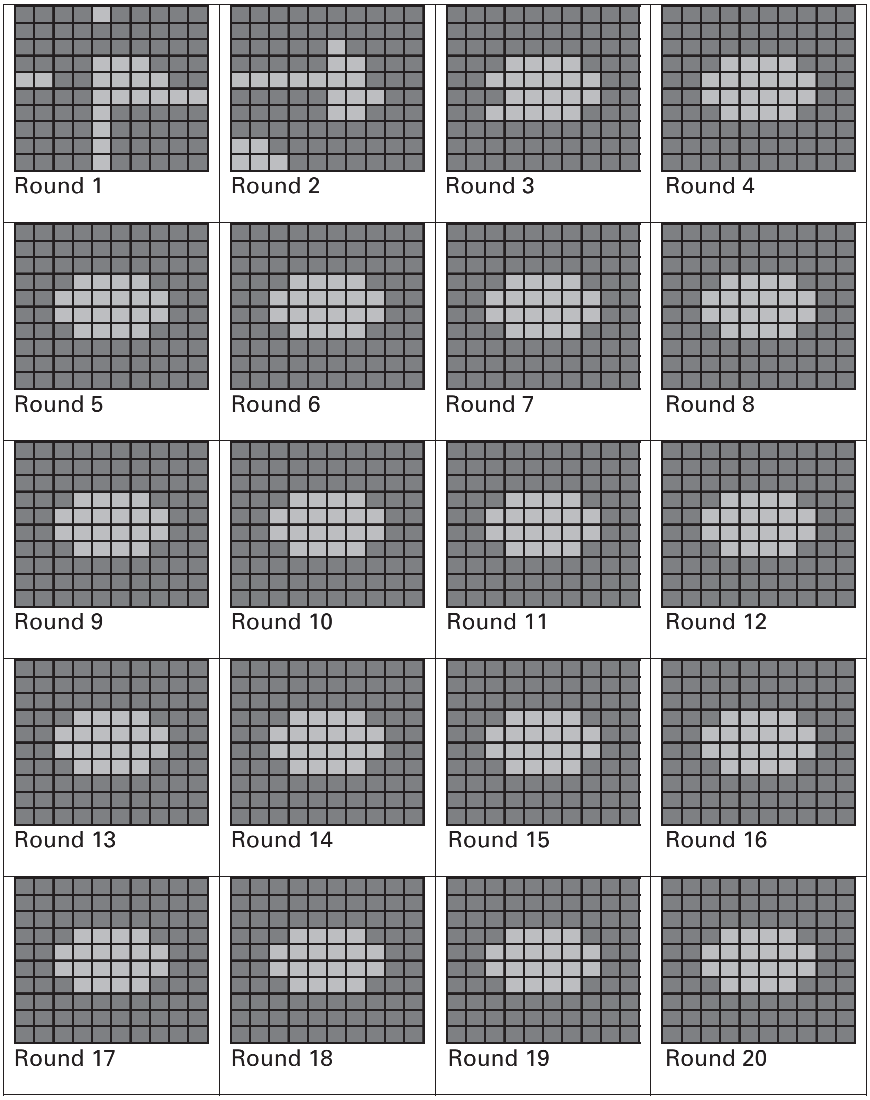
FIGURE 7.2
Simple-Subsidy Results



subsidy; the remaining cells were left in production. Note the large set of potential strategy permutations. Subjects presented with the land grid and allowed voluntary participation had 68,406 strategies to choose from. (N was an element of the set {0, 1, 2, 3, 4, 5}, and the number of cells to choose from was 25. The equation is [25!/5!20!] + [25!/4!21!] + [25!/3!22!] + [25!/2!23!] + [25!/1!24!] + [25!/0!25!] = 68,406.) With four subjects in each group, the possible group outcomes for the corridor treatment are $(68{,}406)^4$.

For the compulsion and simple-subsidy policies, each subject has one clear dominant strategy: retire his five lowest-valued cells. A dominant strategy is any strategy

FIGURE 7.3
Subsidy with Agglomeration Bonus Results



that maximizes a player's payoffs irrespective of the strategy choices of the other players. In the smart-subsidy policy, however, each player has at least two non-dominated strategies. The players in the northwest, northeast, and southeast sections of the land grid have two dominant strategies: both strategies retire land at the borderline with the three neighbors, although only one of these strategies creates exactly one-quarter of the targeted habitat. The southwest player has five dominant strategies, four at the borderline and one in the far corner with lowest land values.

Calculator and Communication

Each subject had a 10×10 grid calculator on the computer screen for assistance in calculating profits. The subject could experiment with different retirement strategies for himself and for the other three landowners before having to make a binding decision. The subject's potential profits based on the configuration of retired cells on the calculator were calculated and displayed. Subjects could send one message per round to the group. Communication was nonbinding and unstructured, with no restrictions on timing or content, and a common language was implemented by allowing subjects to send messages in their natural language. Subjects had two minutes to send messages, use the calculator, and send their choices.

Information and History

After all four subjects' retirement choices were submitted, the resulting land grid was shown to the group. The subjects' 5×5 grid of values, the maximum allowed number of retired cells, a message box, and the grid calculator came up on the computer screen, and players chose the cells to retire. Subjects had common knowledge regarding payoffs and strategies. Each subject's individual payoffs and accumulated payoffs were private information. The entire 10×10 grid showing the configuration of retired cells and the payoffs for each subject within the group then appeared in the history box. Subjects had record sheets and the history box to help them keep track of their own and the other group members' choices of strategies and associated payoffs in previous rounds.

Results

Three illustrative examples are presented of groups' land retirement decisions and the resulting habitat configurations given each policy treatment. For the compulsion treatment, figure 7.1 shows that a noncontiguous pattern of habitat retirement emerges. Once all subjects learned to play their dominant strategies (by round 6), they retired their cheapest cells and created fragmented habitat. Figure 7.2 illustrates a similar noncontiguous pattern for the simple-subsidy treatment. Here subjects played their dominant strategy in every round and again created a fragmented reserve. In contrast, figure 7.3 shows that the smart subsidy induced the desired contiguous spatial pattern. Once all subjects realized the dominant strategy created by connectivity incentives of the agglomeration bonus (rounds 4–20), they voluntarily created a contiguous reserve. The smart subsidy provided the proper incentives for subjects to minimize the fragmentation of the conservation efforts.

Now consider all data from two perspectives of efficiency, economic and biological. Economic efficiency (EE) measures the frequencies with which groups make land retirement choices that maximize personal wealth. EE ([group earnings – minimum earnings]/[maximum earnings – minimum earnings]) is the percentage of available program rents captured by the group, and an EE of 100 percent means that all rents are captured. Biological efficiency (BE) measures the connectivity of the group's habitat. Formally, BE is the percentage of the shared borders between conserved parcels achieved by the group relative to the maximum number of shared borders. A BE of 100 percent implies that the targeted contiguous habitat was created.

For the agglomeration bonus treatment, in which the incentive mechanism is positively correlated with the conservation objective, if a group coordinates to achieve the desired habitat, all efficiency measures equal unity (EE = BE = 100 percent). For the simple-subsidy and compulsion treatments, no correlation, positive or negative, exists between economic and biological efficiency. For expediency, the three efficiency measures are average group outcomes for 5-round intervals {1–5, 6–10, 11–15, and 15–20}. The group outcome is the most precise measure of effectiveness because all four players must select the dominant payoff strategy for the outcome to be considered first best.

All three policies induced approximately the same range of economic efficiency, between 80 and 99 percent. The groups captured most of the rents. In contrast, biological efficiency differed substantially by policy option. For compulsion, BE starts at 50 percent and drops to about 40 percent in rounds 6–20; for the simple subsidy, BE starts at about 60 percent and drops to about 52 percent in rounds 6–20. For the smart subsidy, however, BE increases with rounds, starting at 91 percent and increasing to about 99 percent. In summary, the smart subsidy, which links earnings and the conservation objective, is more biologically efficient at creating contiguous conservation reserves than the current status quo policies of compulsion and a simple flat-fee subsidy.

Applications

A need exists for coordinated landowner conservation efforts when natural ecosystem services benefit many landowners within the landscape (Zhang et al. 2007). When conservation efforts benefit the common good, landowners underinvest in conservation efforts. Understanding the dynamics of ecosystem services provides the opportunity to pool conservation dollars across landowners and reduce the collective costs by coordinating conservation efforts spatially. A mechanism such as the agglomeration bonus is proposed as an alternative to the incentives currently offered at the individual landowner level.

The agglomeration bonus also appears to be an important approach for conserving spatial habitat when regulatory budgets are small (Drechsler et al. 2007). Using an ecological-economic model for protecting an endangered butterfly species in Landau, Germany, Drechsler et al. (2007) show that when budgets are small, the need to coordinate conservation efforts across the landscape increases. They conclude that under some conditions, heterogeneous payments may be dominated by the agglomeration bonus. Kurttila et al. (2008) discuss agglomeration bonuses in Finnish forests, and Stoneham et al. (2005) study agglomeration and auctions in marine management.

Researchers have examined how to implement voluntary incentive mechanisms to induce private landowner conservation in the Brazilian Atlantic Forest in southern Bahia (Chomitz et al. 2006). Their research suggests that individual contracts targeting larger contiguous parcels of land for conservation will be more effective at creating continuity within the landscape. They suggest payment schemes that include an agglomeration bonus to increase connectivity.

Challenges

Competing Objectives

Conservation efforts within an organization or across organizations may have competing objectives in a common target area for conservation. Spatially targeted conservation efforts that increase the benefits for one objective may decrease the benefits for a secondary objective. The overall impact of conservation may be less than expected because of the competing spatial conservation demands for the various objectives. Nelson et al. (2008) explore this scenario in examining the spatial conservation needs for meeting different objectives such as species habitat, carbon sequestration, and riparian protection. Further, anthropogenic conservation programs are typically myopic in their focus on measurable human benefits and do not account for all the dynamic characteristics and needs of ecosystems, such as natural fires and floods. Models should identify the trade-offs between anthropogenic and biological objectives (Chan et al. 2006).

Administration of Conservation Contracts

Ferraro (2008) evaluates the differing approaches to allocating contracts for conserving biological amenities. Information rents exist in all scenarios because of landowners' private information. A common approach to allocating conservation contracts is to have landowners submit bids indicating the payment they require to conserve their land. The regulator can then compare the environmental benefits per dollar derived from each contract and choose those contracts that provide the largest benefit per dollar. Adjusting this process to satisfy an agglomeration bonus when each contract represents a contiguous land mass and several landowners may not be simple. The number of contracts offered decreases, potentially creating market power for landowners that could increase information rents (Ferraro 2008). Further, educating landowners and facilitating their understanding of the agglomeration bonus and coordinated bids could impose additional costs on landowners and regulatory agencies (Parkhurst et al. 2002). Evidence on combinatorial auctions suggests that when the items being auctioned are complements, as is the case with spatially configured habitats, combinatorial auctions outperform simultaneous auctions (Tanaka 2007).

Budgetary Constraints

The agglomeration bonus provides landowners an extra payment to coordinate their conservation in the desired landscape configuration. The extra payment offsets transaction costs associated with coordinating landscapes and the risk associated with reliance on others' initial and continual conservation actions. If contract payments are contingent on landowners maintaining conserved land for endangered species protection, payments are contingent on the actions of all landowners. The larger the custodial costs, the larger the number of coordinating landowners, and the longer the contract horizon, the greater the risk that must be incorporated into a landowner's land use decision. Consequently, the agglomeration bonus will need to be sufficient to compensate for the risk. With limited conservation dollars, the open question is under what conditions agglomeration bonuses are preferable to other payment mechanisms, such as heterogeneous landowner subsidies (Drechsler et al. 2007; 2010).

Further, landowners earning a disproportionate share of the subsidy are incentivized to coordinate group conservation efforts to ensure their earnings. The agglomeration bonus can be designed to provide for landowners to earn excessive rents which could facilitate members of the group to incur the costs of collaboration. Heterogeneous payments serve to compensate landowners for lost productivity. They do not create network externalities that will promote collaborative conservation efforts (Raymond 2006).

Uniqueness of the Nash Equilibrium

The agglomeration bonus creates a coordination game in which landowners coordinate their conservation within the landscape. Many equilibrium points may exist within the framework of the incentive mechanism design and the landscape costs and benefits in which it is implemented. The design of the agglomeration bonus makes the desired landscape configuration the payoff dominant Nash equilibrium (the equilibrium with the largest payoff). In practice, however, achieving this payoff dominant Nash equilibrium is a challenge (Parkhurst and Shogren 2007). M. D. Smith, Sanchirico, and Wilen (2009) find that the agglomeration bonus is a promising policy instrument for allocating effort across patches in fisheries.

Who owns endangered species? We all do. But it makes economic sense to compensate private landowners who shelter species for their stewardship. Economic incentives can help align their land use decisions with social goals of species protection. The challenge is to provide a compensation mechanism that both is voluntary and can create spatially contiguous habitats across holdings of several private landowners. The agglomeration bonus is one potential incentive mechanism that could help meet this challenge. By making participation voluntary, the agglomeration bonus creates a setting that aligns landowners' incentives and species protection goals into contiguous habitat preserves. Although the laboratory test discussed in this chapter was conducted under stylized conditions, its results suggest that an agglomeration bonus subsidy could work. The scheme was more effective than current policy options of compulsion and a simple fixed-fee subsidy at inducing people to coordinate their conservation decisions voluntarily By formally creating a link between the payment and the conservation objective, the agglomeration bonus achieves both economic and biological goals without resorting to compulsion or land-specific compensation schemes. The landowners in the experiment chose to retire the targeted land willingly, whereas with compulsion and fixed fees, people still secured the economic rents but did not create the desired habitat.

But can the agglomeration bonus subsidy be implemented in the natural environment with real private property? The answer will depend on specific local bioeconomic and political conditions of a given site. For example, will landowners accept the idea that their compensation is linked to the actions of a neighbor?

Will there be holdouts and holdups as land values increase once neighbors agree to retire land? The results presented in this chapter cannot answer these questions directly, but they do suggest that policy makers might consider adding the agglomeration bonus to their list of potential policy options for cost-effectively conserving habitat across private or public-private landholdings to protect endangered species.

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