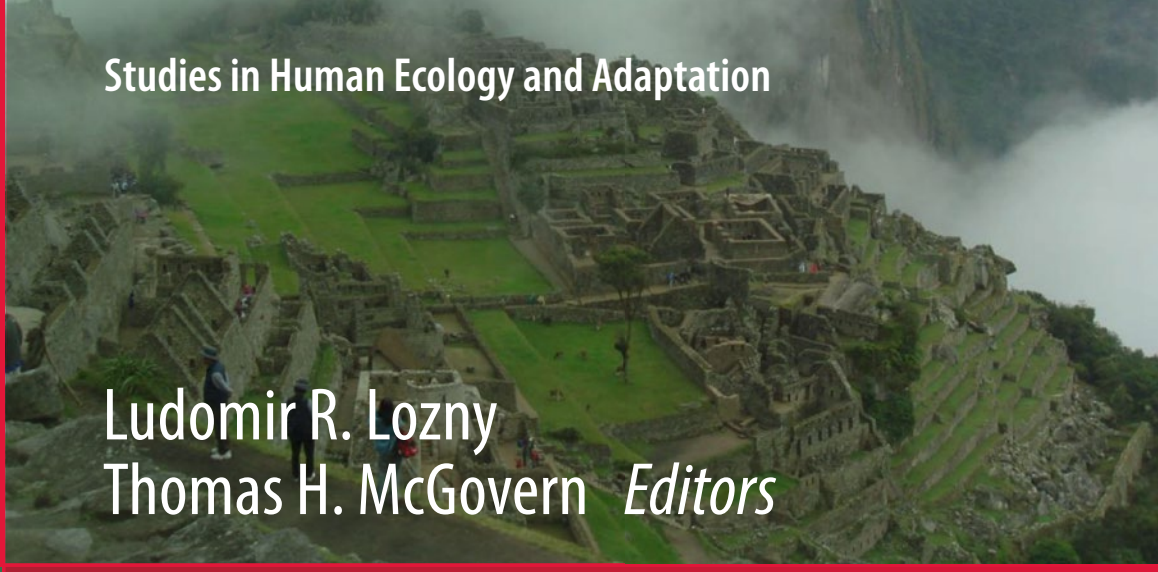
Studies in Human Ecology and Adaptation



Ludomir R. Lozny
Thomas H. McGovern *Editors*

Global Perspectives on Long Term Community Resource Management

With a Foreword by
Carole L. Crumley

Springer

Studies in Human Ecology and Adaptation

More information about this series at http://www.springer.com/series/6877

Ludomir R. Lozny • Thomas H. McGovern
Editors

Global Perspectives on Long Term Community Resource Management

With a Foreword by Carole L. Crumley

Springer

Editors
Ludomir R. Lozny
Hunter College, CUNY
New York, NY, USA

Thomas H. McGovern
Hunter College, CUNY
New York, NY, USA

ISSN 1574-0501
Studies in Human Ecology and Adaptation
ISBN 978-3-030-15799-9 ISBN 978-3-030-15800-2 (eBook)
https://doi.org/10.1007/978-3-030-15800-2

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Foreword

This book examines the aspects of the contemporary and historic management of resources held in common. The very existence of such management strategies runs counter to the long-held assertion that they are obsolete and must be removed from local management and subjected to state, corporate, or other external controls. A brief look at the not-so-distant history of this view can provide context for this important volume.

It may surprise some readers that the main point of Garrett Hardin's 1968 *Science* article 'The Tragedy of the Commons' is that *overpopulation* is the chief source of environmental degradation, not that communities are incapable of sustained management of the commons. At the time of its publication, the article was the focus of an enormous controversy about what was soon referred to as the 'population bomb' (Ehrlich and Ehrlich 1968). In the same period, but with a broader perspective more characteristic of contemporary opinion, the Club of Rome's *The Limits to Growth* (Meadows et al. 1972) argues that the number of humans is only part of the larger problem: the Earth's resources are finite.

Concerns of the tumultuous late 1960s to early 1970s reflect a long struggle to define the role of humanity in the degradation and depletion of resources. Which elements of society are at fault? For some, the 'overpopulation question' was key to a solution. It was also an opportunity to revisit the early twentieth-century ideas of progress and social engineering, the fundamental assumptions guiding the policies of Western nation-states (Scott 1999).

In the early twentieth century, the tenets of nationalism and of scientific racism proved particularly compatible, offering a solid justification for colonialism, class privilege, and persecution of minorities. Equally attractive was the argument that Europe and North America were doubly blest with the world's most intellectually invigorating climate and its most enlightened population.

In shifting blame away from the colonists and onto the colonized, Hardin's argument echoed the earlier concern about overpopulation. But it also cemented the idea that aside from the progressive, competitive West, the human impact on resources was the result of an outdated strategy of collaboration.

The rise of eugenics (the application of the principles of selective animal breeding to humans) between the two World Wars coincided with the apogee of Western domination of subject peoples and countries all over the globe in the name of progress, with a potent subtext of racism. In Germany, National Socialism adopted a suite of ideas that combined geographical determinism (drawing on Tacitus' *Germania*), cultural determinism (promoting the work of the linguist and archaeologist Gustaf Kossinna), and genetic determinism (the idea that human social and behavioural qualities are manifest in the form of 'racial character'). By 1933, the Nazis had embraced the work of several prominent American scholars, among them, physical anthropologists Aleš Hrdlička and Charles Davenport and geographers Walter Christaller and Ellsworth Huntington, a founder and early president of the Ecological Society of America.

Following statist economic perspectives and genetic theories that still bore the mark of this history, Hardin, who was an anti-immigrant and an advocate of forced sterilization and held white nationalist sentiments, asserts that individual's self-interest inevitably undermines communal action. Hardin's education by the inter-war generation of scholars (BS zoology 1936, PhD ecology 1941) and his own predilections follow these earlier trends in ecology, economics, and state planning.

Today, there is abundant evidence that, throughout human history and to the present day, communities have found precise and equitable ways to organize their collective and individual tasks without central authority. Ethnographic, archaeological, and documentary evidence points to a wide range of strategies that can benefit individuals, groups, and communities. Such equitable forms of governance go by many names: communitarian, collective, anarchist, and many others. Of particular current interest are communities that successfully manage common property (jointly held) as well as common-pool (open access) resources.

In 2009, anthropologists and archaeologists found Lin Ostrom and her colleagues' work especially welcome: Ostrom's Nobel Prize in Economics shone a light on Hardin's adherence to unsupported claims with carefully documented fieldwork, much of it drawn from anthropology. They identified 'design principles' of common-pool resource management that include local knowledge, effective communication, clear rules, monitoring, sanctions, paths for conflict resolution, internal trust, and recognition of self-determination by higher-level authorities (Ostrom 1990). These are principles that apply equally to agricultural collectives, anarchist squats, fishing communities, community-owned gardens, and employee-owned corporations.

This volume is a broad and sophisticated update on the commons, employing ethnographic accounts as well as archaeological and historical records. The authors examine how a diverse group of communities integrate communal enterprises and organizations into frameworks that necessarily include ranked, nested, and networked structures (e.g., governance at all levels, associations, individual rights, community norms). The authors of this volume emphasize the specificity of the enterprise, which is always necessary due to the diversity of historical, cultural, legal, and environmental parameters. They argue that risk management is a local, social enterprise, not amenable to imposition from above. Most importantly, their

careful work gives back to our human future a skill that is as old as the human experiment itself and as useful as ever: that of self-organization.

Carole L. Crumley
University of North Carolina
Chapel Hill, NC, USA

References

Ehrlich, P., & Ehrlich, A. (1968). *The Population Bomb*. New York: Ballantine Books.
Hardin, G. (1968). The tragedy of the commons. *Science 162*(3859), 1243–1248.
Meadows, D. H., Meadows, D. L., Randers, J., & Behrens, W. W., III. (1972). *The limits to growth: A report for the Club of Rome's project on the predicament of mankind*. New York: Universe Books.
Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge: Cambridge University Press.
Scott, J. C. (1999). *Seeing like a state: How certain schemes to improve the human condition have failed*. New Haven: Yale University Press.

Contents

Introduction

Ludomir R. Lozny and Thomas H. McGovern

Sustainability concerns the maintenance of societies through a combination of cultural continuation and change and is best understood through examination of long-term perspectives on the complexity of interactions between people and their environments. Such longitudinal studies reveal alternative views on how community-managed strategies mitigate a variety of ecological problems through time. They expose that adaptation to environmental pressures, shifting relationships between local and regional authorities, and external political challenges resonate in policies towards common-pool resources such as water, land, pastures, forest, and entire ecosystems. On the other hand, they also show that optimal adaptation, for instance locally resilient systems of production and exchange, can generate destabilizing positive feedback relations, as often seen in times of major perturbation such as drought, climatic shifts, market upheavals, or political conflict.

Our book presents 12 empirical studies of recurring patterns and trajectories of successes and failures in communal resource management. The participants address the dilemma of competition versus cooperation and examine cases of inter-scalar interactions with direct relevance to current efforts to manage global commons. They conclude that sustainability concerns an admixture of cultural continuation and change. In discussing the pressing issues of governance, sustainability and well-being, cooperation, and management of the commons, they link archaeology and anthropology with human and historical ecology and environmental sciences in a unique interdisciplinary approach to systematically study the commons in synchronic and diachronic scales. Such improved understanding of successful past and present strategies to solve managerial issues offers insightful framework for foster-

L. R. Lozny (✉) · T. H. McGovern
Hunter College, CUNY, New York, NY, USA
e-mail: llozny@hunter.cuny.edu

L. R. Lozny, T. H. McGovern (eds.), *Global Perspectives on Long Term Community Resource Management*, Studies in Human Ecology and Adaptation 11, https://doi.org/10.1007/978-3-030-15800-2_1

ing locally contingent approaches to the commons. Here are examples of what the contributors offer:

- They demonstrate that management of the commons and communal use of resources have been often successful on the millennial scale, for instance, in the North Atlantic, and such strategies were key to long-term communal survival and mitigation of systemic vulnerabilities.
- They demonstrate how forms of communal governance provide economic buffering, mitigate subsistence risk, foster cooperation, and serve as foundations for social organization.
- They argue that the use of certain commons, such as pastures, is best organized as an open system, in which a combination of individual decision-making and coordination of movements leads to an ideal type of distribution of mobile pastoralists.
- They show compelling evidence that the development of property rights is associated with scarcity of resources, rising populations, and increasing competition and suggest that such rights should be based on the ability to solve collective-action problems, which depend on several interactive variables, including competition, illegal activity, discount rate, government action, characteristics of communities, and changes in stocks of resources.
- They offer provocative hypothesis that because centralization of decision-making weakens communal cooperatives and contributes to local economic and social crises, participatory polycentric governance seems a viable alternative.
- They discuss recent successes and failures in communal resource management as articulated by the transdisciplinary theory of cooperation and collective-action and offer wider theoretical outlooks on varied strategies to link local segments into larger administrative systems to manage public goods and to solve cooperator problems.
- They offer conclusions that collective polities, by necessity, extensively reorganize the base of society, whether in rural communities or urban neighbourhoods, in such a way as to augment the degree of community-level paragovernmental management capability. Such new systems of local organization combine administrative policies with the new moral codes that emphasize the importance of individual obligation to society beyond the local community.

This book joins a range of studies that address sustainable development and governance of the commons. Authors of those studies also submitted their work to our volume. It thus expands the view regarding long-term communal resource managerial tactics and strategies.

Among the recently published works, Cooper and Sheets (2012) offered a selection of discussions regarding human-environment relations analysed in a diachronic scale. On the other hand, Purvis and Grainger (2004), Rogers et al. (2007), and Blewitt (2008) presented a general overview of sustainable development in a synchronic approach.

Our book offers insights from evolutionary biology, political science, economics, anthropology, and other fields to explain how interactions between our evolved selves and the institutional structures we have created make cooperation possible.

Cooperation is about equalizing chances; it does not contradict economic rules, but allows those who are less-fitted to survive and even prosper. Several authors discuss the dillema of cooperation vs. competition. Their studies expand the research presented in academic papers and books, by, for instance, Kohn (1992) and van der Dennen and Fogler (2012), who offered substantial critique of competition, or Sennett (2012), who discussed psychological fundamentals of cooperation. The contributors also address the theoretical aspect of cooperation presented recently by Cronk and Leech (2012). The key point being that, contrary to the commonly accepted wisdom, competition does not seem basic to human nature.

E. Ostrom et al. (2002) covered extensively the issue of governance of the commons in the fundamental volume *The Drama of the Commons*. The contributors examined the state of knowledge on the "drama of the commons" in the beginning of the twenty-first century. They offered empirical and theoretical approach in a synchronic scale of observation.

Dove and Kammen (2015) produced a volume in which they presented their insights on an interdisciplinary perspective for the natural and social science of sustainability. The authors argued that failures of conservation and development must be viewed systemically. Their book addresses a blind spot within the academic research community to focus attention on the seemingly common and mundane beliefs and practices that ultimately play the central role in the human interaction with the environment.

All contributors to our book, either directly or indirectly, point out to the significance of indigenous knowledge in designing policies and arranging access to commons. Indigenous knowledge has been recognized as a source of ideas that should be included in all programs dealing with resource management (see the contributions in Sillitoe 2017) and environmental stewardship. It has been regarded as significant by the recipient of a Nobel Prize in Physiology in 2015, the Chinese physiologist Tu Youyou, who combined traditional Chinese medical texts with modern research to discover antimalaria drug. Her efforts did not help to advocate indigenous knowledge as much as the Nobel Prize awarded to Elinor Ostrom in Economics in 2009, which significantly influenced the research on cooperation and governance of local resources globally.

Local or indigenous knowledge is not well-defined. Sillitoe (2002, pp. 8–13) proposed to view it as an understanding rooted in local culture that includes all knowledge held collectively by a community that informs interpretation of the world. It contributes, among other things, to promoting sustainable practices in resource use and to outline agendas for future work. Local ecological knowledge corresponds to and changes according to modifications in the environment and social context. It offers clues in understanding of such pressing issues as food security in small scale, sustainable use and conservation of critical resources, and prevention of environmental degradation.

The book presented here consists of 12 chapters and their authors discuss 23 case studies from Europe (Iceland, France), Africa (Kenya, Tanzania, Uganda, Madagascar, Gabon, Cameroon, Morocco, Ghana, Sierra Leone, Kenya, and Malawi), Asia (India, Mongolia), Southeast Asia, South America, Mesoamerica, North America (American West, American Southwest, and California), and the

Pacific Islands (Fiji, Kiribati). Below is a brief overview what the reader might expect in each chapter.

Jim Acheson opposes Hardin's proposition that access to commons should be based on coercive regulations and claims that Hardin's theory is based on culture-bound assumptions that do not hold true cross-culturally. The author offers a theoretical update and new directions to study the commons. Firstly, Acheson points out to the crucial distinction between open access and communally owned and managed resources. Secondly, he argues that all societies that use common resources regulate access to such resources through a variety of means. Thirdly, he points out to the misunderstanding of such terms as "open access", "state property", and "communally owned property". They, in fact, indicate a variety of managerial strategies. The new theory of the commons incorporates multiple claims such as private goods, public goods, toll goods, and common goods in a coherent concept of management and use. Acheson's case studies support the idea that development of common property or private property depends on their economic defendability. That is, when the costs of protecting an area are high relative to the value of the goods in that area, a commons will develop.

Michael Dove and his coauthors discuss practical aspects of cooperation and resource management strategies at community level. They define cooperating community and analyse interactions between such communities and outsiders, especially international organisations and states. Employing five case studies, the authors discuss the gendered politics of reforestation in Madagascar, different mode of care located in indigenous efforts to protect the bison in American West, while the cases from Gabon and India illustrate how the state and private partners actively engage in delineating commons and structuring their use by local communities. Both sections contribute to better understanding of inclusion/exclusion dialectics in community's coherence. The fifth case relates to the significance of swidden agriculture for indigenous wellbeing in general. Dove et al. conclude that changes in attitudes reflect the confrontation between local and metropolitan visions of proper relations between society and its environment. The authors declare that if the aim of community resource management is to determine these relationships through the promotion of specific practices, we must be mindful about who participates in decision-making.

Ragnhildur Sigurðardóttir and coauthors tackle the historical ecology of the Mývatn area in Northeast Iceland that has been occupied by farming communities since the arrival of Viking settlers in the late ninth century. Despite its inland location, and relatively high elevation, this lake basin was affected by continuous human occupation through periods of harsh climate, volcanic eruptions, epidemics, and also the world's economic system. The Mývatn's residents practiced farming, fishing, egg collecting, and hunting for over one millennium. They managed the landscape and its resources with the use of traditional knowledge, which included the story of the troll woman, Kráka. The story, the authors claim, provides a striking metaphor for the landscape history including water resources and environmental changes that the local agricultural community sustained overtime.

Ludomir Lozny discusses the organizational scheme of summer high-altitude pastures associated with transhumance in the Hautes-Pyrénées, France. His objective

is to identify and analyse cultural codes used to regulate access to scarce resources managed as commons. Lozny employs linguistic, ethnographic, and historic data on the communal-level collective action and rules that regulate access to vital but limited resources and hypothesizes that high likelihood of conflict forces their users to engage in cooperative interactions. He further theorizes on socioeconomic rationale of such arrangements and concludes that access to sparse resources must be regulated and communal rational cooperation becomes a viable strategy to mitigate conflict (risk) and ensures sustainable group wellbeing.

Lee Cronk and coauthors examine risk management frameworks and describe how societies manage risk socially. The authors use terms such as "need-based transfers" and "debt-based transfers" because these underlie the logic of formal, contractual risk management arrangements found in the eight societies they discuss in their chapter. They focus especially on "need-based transfers", an approach to buffer the effects of disasters and ecological uncertainty. Cronk et al. conclude that given the risk's inevitability, managing it is an important component of both individual and community strategies to adapt to local conditions. The authors provide abundant evidence that need-based transfers are a common strategy for the social management of risk. The Human Generosity Project, a transdisciplinary effort to examine both biological and cultural influences on human cooperation, has documented and analysed these and many other examples of social risk management.

Tobias Haller and coauthors discuss the results of two research projects carried out to examine large-scale land acquisitions in Africa. They examine case studies form Morocco, Ghana, Sierra Leone, Kenya, Tanzania, and Malawi. The authors analyse the drama of grabbed commons and economic consequences that affect marginalized groups. Their research revealed that foreign investors made new land deals with the local state officials and elites. The new rules made the land traditionally held as commons available for market-oriented productions. They further allowed transfer of the assets into state-, local elite-, or international company-owned properties. These changes adversely affected the traditional land rights scheme. New institutional changes eliminated communal ownership and access to land-related commons such as water, pasture, fisheries, forestry, non-timber forest products, and wildlife, all vital for local sustainable livelihoods. The authors analyse how local groups reacted to these dramas and what strategies they used to reinstall access to the commons. They conclude that only bottom-up institutional buildup provides essential basis for securing resilient livelihoods. These studies allow for better understanding how to use the commons in the future on local, national, and international level.

Mark Moritz and coauthors offer provocative discussion that counters Hardin's tragedy of the commons argument that pastoralists are responsible for overgrazing the range. The authors have shown that grazing ecosystems are much more complex and dynamic than was previously assumed and that they can be managed adaptively as commons. A longitudinal study that the authors conducted of pastoral mobility and primary production in the Logone floodplain in the Far North Region of Cameroon suggests that open access does not have to lead to a tragedy of the commons. They argue that pastoral system they study is best conceptualized as an open

system, in which a combination of individual decision-making and coordination of movements leads to an ideal-free type of distribution of mobile pastoralists. The authors conclude that self-organizing system of open access works and its implications are critical for theories of management of common-pool resources and our understanding of pastoral systems.

Frank Thomas analyses distributions of mollusc shells in archaeological sites in the Pacific Islands. The author draws primarily from direct observations and semi-structured interviews among mollusc gatherers in Kiribati, Eastern Micronesia, and examines selected case studies of archaeological shell deposits that could shed new light on marine resource management to complement the more widespread research conclusions that depict human impact in largely negative terms. Documented changes in species size, richness, and abundance have often been used as proxies for assessing environmental change as well as human impact and interpreted as evidence of resource abuse by shellfish gatherers. Thomas argues that while such assumption may be valid in some cases, archaeologists need to consider other variables to explain change (or stability) in shell distribution. The author concludes that a better understanding of ecological and biological characteristics of shell midden deposits may result in a reinterpretation of past human behaviour.

Vernon Scarborough and coauthors discuss the landscapes and natural environments of the tropics, which they consider as the setting for a particular understanding of modern ecological principles. Quoting Alexander von Humboldt and Charles Darwin, they argue that contemporary views of coupled human-nature dynamics were first "discovered" in the New World. The authors point out that unlike the prominent worldview identifiable in the Near East and subsequently in early colonizing Europe, Central and South American settings show the inextricable affinity between humanity and the slowly modified biogeography. They conclude that "technological thresholds and breakthroughs seldom accelerated through time; and the role of labour in an environment without widespread domesticated animals and zoonotic diseases made for a different ecological emphasis and a worldview that cultivated the role of plants, animals and their interplay".

Gary Feinman and David Carballo examine frameworks that have traditionally been employed in studies of the rise, diversity, and fall of preindustrial urban aggregations. They suggest that a comparative theoretical perspective, which foregrounds collective-action problems, unaligned individual and group interests, and the social mechanisms that promote or hamper cooperation, advances our understanding of variability in these early cooperative arrangements. They apply such a perspective to examine pre-Columbian Mesoamerican urban centres and to demonstrate tendencies for more collective systems to be larger and longer lasting than less collective ones, likely reflecting greater sustainability in the face of the ecological and cultural perturbations specific to the region and era. The authors conclude that although historical particulars are critical to understanding individual cases, there are scholarly and policy rationales for drawing broader implications regarding the growing corpus of cross-cultural data germane to understanding variability in the constitution of human societies, past and present.

Terry Jones and Brian Codding examine the effects of prehistoric hunting on indigenous fauna through the California archaeological records. The authors briefly

discuss the overkill hypothesis and optimal foraging concepts. They further point out that countering such over-exploitation, theories of native conservation typically argue for masterful management of the western North American resource landscape via such methods as controlled burning and ritually mediated resource sharing. The authors argue that the archaeological evidence does not corroborate either overkill or native stewardship. They discuss evidence for prehistoric extinction of the flightless duck (*Chendytes lawi*) along the California coast over a period of 8000 years, while shellfish on the southern California Islands show definite diminution over time due to increasingly frequent human harvest. The authors conclude that human population in most of California was below the carrying capacity, and fisheries were so rich that native peoples had no effect on them—negative or positive. Sociopolitical organization in most of western North America was defined by innumerable small autonomous polities with owned/tightly controlled resource patches within them. The degree to which such structures were intended to accomplish "stewardship" is at best debatable as they mostly promoted the exclusive use of localized resources for groups and individuals. Anadromous fisheries in Northwestern California were effectively shared and remained highly productive, but at the same time there is no evidence for large-scale cooperative agreements to manage other resources whose distributions transcended the limits of small political units such as migrating waterfowl or sea mammals. Nonetheless, most resources remained abundant owing to an epiphenomenal demographic situation that included an almost unthinkably rich and diverse resource base.

Michael Aiuvalasit discusses the case of indigenous water management in American Southwest. The author focuses on the question how the management of water as a common-pool resource affected sustainability of Ancestral Puebloan communities in the Jemez Mountains of New Mexico and presents the results of chronological analyses of 15 water reservoir features at nine Ancestral Puebloan village sites. Independent chronologies of water-related infrastructures serve as proxies for the emergence of social institutions to govern public access and distribution of water for household use. By testing reservoirs across the Jemez and Pajarito Plateaus, two adjoining regions settled by dryland maize agriculturalists between AD 1100 and 1700, Aiuvalasit shows how long-term archaeological records can be used to examine concepts central to the study of the commons and sustainability, such as institutional governance and inherent trade-offs at the nexus of mitigating food-water insecurities.

Communal-level resource management successes and failures comprise complex interactions that involve local, regional, and (increasingly) global-scale political, economic, and environmental changes, shown here to have recurring patterns and trajectories. The human past provides examples of long-term millennial and century scale successes followed by undesired transitions ("collapse") and rapid failure of collaborative management cooperation on the decadal scale. Thus, the book connects the past, present, and future by presenting geographically and chronologically spaced out case studies and overviews of the current cutting-edge research regarding managerial strategies of common-pool resources. The lesson learnt from studying past responses to various ecological stresses is that we must not wait for a disaster to happen to react, but must react, to mitigate conditions for emerging disasters.

This realization suggests that risk management underlined by strategies to minimize risk rather than to maximize gains would be the focal point behind sustainable development in the Twenty-first century.

Thus in opposition to the "tragedy of the commons" we foster the "joy of the commons," an approach to argue that cognitive (generosity) and practical (cooperation) attributes govern collective action to mitigate risk and sustain communal wellbeing.

We suppose that our book will attract readers among college students and participants of graduate level classes and seminars on culture change, indigenous and modern strategies for the management of resources, anthropology and archaeology classes on culture change and the rise of social complexity, historical and human ecology, human-environment dynamics, governmentality, sustainable development and management of critical resources, etc.

The book will also be of interest to professionals including college professors, governmental planners, and decision-makers of different levels of the political structure. It will serve as a guiding tool and reference for regional or global advisory boards and commissions, such as the EU, UN, etc.

The book sprung from a very successful session presented during the 112th AAA Annual Meeting in Chicago, November 2013, organized by Ludomir Lozny and Tom McGovern. We thank all the participants who agreed to present their papers and submitted chapters to this volume. Additionally, we have invited scholars who study sustainable development, governance schemes, and management of common-pool resources (commons), and they offered new insights from the perspective of their filed of specialty.

References

Blewitt, J. (2008). *Understanding sustainable development*. Abingdon: Routledge.

Cooper, J., & Sheets, P. (Eds.). (2012). *Surviving sudden environmental change. Answers from Archaeology*. Boulder: University Press of Colorado.

Cronk, L., & Leech, B. L. (2012). *Meeting at grand central: Understanding the social and evolutionary roots of cooperation*. Princeton, NJ: Princeton University Press.

Dove, M. R., & Kammen, D. M. (2015). *Science, society and the environment. Applying anthropology and physics to sustainability*. Abingdon: Routledge.

Kohn, A. (1992). *No contest: The case against competition* (2nd ed.). Boston: Houghton Mifflin.

Ostrom, E., Dietz, T., Dolšak, N., Stern, P. C., Stovich, S., & Weber, E. U. (Eds.). (2002). *The drama of the commons*. Washington, DC: National Academy Press.

Purvis, M., & Grainger, A. (Eds.). (2004). *Exploring sustainable development: Geographical perspectives*. London: Routledge.

Rogers, P. P., Jalal, K. F., & Boyd, J. A. (2007). *An introduction to sustainable development*. London: Routledge.

Sennett, R. (2012). *Together: The rituals, pleasures, and politics of cooperation* (p. 2012). New Haven, CT: Yale University Press.

Sillitoe, P. (2002). Participant observation to participatory development. Making anthropology work. In P. Sillitoe, A. Bicker, & J. Pottier (Eds.), *Participating in development. Approaches to indigenous knowledge* (pp. 8–13). London/New York: Routledge.

Sillitoe, P. (Ed.). (2017). *Indigenous knowledge. Enhancing its contribution to natural resources management*. Wallingford/Boston: Centre for Agriculture and Biosciences International.

van der Dennen, J., & Fogler, V. (2012). *Sociobiology and conflict: Evolutionary perspectives on competition, cooperation, violence and warfare*. New York: Springer Science.

The Tragedy of the Commons: A Theoretical Update

James M. Acheson

Tragedy of the Commons

In the past decades, the world has become increasingly concerned with environmental destruction. Every year there are thousands of articles on fisheries failure, soil erosion, deforestation, loss of wildlife habitat, depletion of soil, acid rain, etc. The most popular explanation for all of these phenomena is the theory of common property resources. According to this theory, all properties held in common (such as oceans, communal forests and grazing lands, rivers, and the atmosphere) are bound to be overexploited. The reason is that in the absence of ownership rights, the users of these resources are caught in a situation in which it is only logical that they place no limits on exploitation rates. Why should a fisherman limit the amount of herring he takes when other boat owners will take the remaining fish in the school within a matter of hours? As a result, resources without owners can be stripped bare quickly. By way of contrast, privately owned resources will not be overexploited since they gave a private owner an incentive to protect them. Private ownership results in conservation; a commons yields resource destruction. From this modest beginning, the theory was expanded to include several bodies of theory and far more than a concern with natural resources.

The idea that the commons are a problem has a long history in Western thought, but the work of Garrett Hardin in the 1960s gave it substantial popularity at the height of the ecology movement at that time.

Basically, Hardin argued that freedom to produce children inevitably produces disaster in a world with limited resources. The example he used was a pasture owned in common. The first few sheep added to the pasture cause no problem. But as more sheep are added, overgrazing occurs, and yields fall. But even then, herdsmen

J. M. Acheson (✉)
University of Maine, Orono, ME, USA
e-mail: acheson@umaine.edu

L. R. Lozny, T. H. McGovern (eds.), *Global Perspectives on Long Term Community Resource Management*, Studies in Human Ecology and Adaptation 11, https://doi.org/10.1007/978-3-030-15800-2_2

continue to add sheep; each herder gains the full output of the sheep he adds, while the costs in terms of overgrazing are shared by all herdsmen jointly. Thus, each herd owner increases herd size without limit, resulting in complete destruction of the pasture. The result is what Hardin called "the tragedy of the commons." Each herdsman has acted rationally, but the result is tragedy for a larger group. For Hardin, "therein lies the tragedy. Each man is locked into a system that compels his share—in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons." Freedom in a commons brings ruin to all (Hardin 1968).

He concludes the problem cannot be solved by voluntary action. Coercion is necessary to get people to restrain their use of the commons. We cannot expect them to voluntarily restrain their resource. "The coercion may be mutually agreed upon, but it need not be just" (Hardin and Baden 1977, p. 275). The alternative to the commons is too horrifying to contemplate. "Injustice is preferable to total ruin." Hardin saw nothing but disaster looming for societies in the Third World, because he did not believe their governments could limit their populations. The publication "The Tragedy of the Commons" in 1968 and the follow-up book in 1977 (Hardin and Baden 1977) created a firestorm because they openly suggested that the solution to ecological problems such as population pressure, overfishing, and over-harvesting of trees could only be solved by action of governments, imposed by autocratic means, and that victims of such actions deserved their fate.

Hardin's analysis and solutions have been criticized on a number of grounds, but none articulated what I see as the key problems: it rests on questionable assumptions that are highly culture bound. The theory's assumptions do not hold true cross-culturally and do not even hold for all situations in the United States. As we shall see, some societies have been able to solve commons problems at a local level by democratic means.

Economic Theory and the Commons

At root, the classic theory of the commons links resource problems with the absence of property rights. It was economists who first suggested that absence of ownership rights leads to serious problems. Property rights lower transaction costs (the costs of negotiating agreements with others).

If property rights are complete and clear, there is little difficulty in deciding who can claim benefits from the resource and who must be compensated if that property is destroyed. Common property makes such negotiation very costly. How can people whose trees have been destroyed by acid rain be compensated easily? They do not own the air, and only an expensive lawsuit can force owners of the coal-fired plant putting effluents into the atmosphere to pay for the damage they are doing to the land owner's trees (Acheson 1989).

Private property is also said to be more efficient because it leaves an owner able to use the land in ways that are most beneficial to him. He can farm the land, develop

housing tracts on it, rent it out, or sell it, whichever confers the most advantage to him. He has no incentive to make poor use of the land. Users of a commons have an incentive to use resources before someone does; only rarely does this lead to efficient use.

Overcapitalization is usually the fate of common property. In industries using common property, abnormally high profits are to be made since all of the costs of production are not being paid (e.g., costs of growing fish). As a result, far more firms using more capital are attracted to such industries than are needed to harvest the resource (Acheson 1989).

All of these problems inherent in using commons stem from the fact that incomplete ownership results in externalities. Externalities exist when one person's actions affect the payoffs of others.

Externalities may be positive or negative, and they always result in non-optimal solutions. If a landowner is allowed to pollute a stream, then he is being permitted to foist negative externalities on land owners downstream. He is also being permitted to act in a way that is not optimal for the society as a whole. Private property does away with such externalities and with them the temptation to act in ways that are not in the best interests of the society. Incomplete property rights lead to waste, inefficiency, and high transaction costs. With common property, there is always a divergence between what is in the best for the individual and what is in the best interest of the society. It is said to always result in escalating abuse of resources (Acheson 1989).

According to economists interested in the commons, the solution is fairly simple. Since the problem is traceable to a lack of property rights, the solution is to generate property rights. As a result, large numbers of resource economists have proposed solving commons problems by the invention of institutions such as quotas or licensing schemes of various sorts. Others, following Hardin, have argued that the solution is actions by the government.

Three of the earliest critiques of the theory of the commons are among the most important. First, early on social scientists pointed out that communally owned property was not always subject to overexploitation. Only property that can be overexploited by everyone without charge is subject to problems. Ciriacy-Wantrup and Bishop (1975) point out that the forests of Germany have been well managed even though they have been communally owned for centuries. Access to the forests is strictly controlled, however. It is "open access" resources that are subject to overexploitation, not communally owned resources. This is a crucial distinction.

Second, despite the work of Hardin, who assumes that people cannot and will not generate institutions to control resource exploitation rates, anthropologists have discovered case after case where people have done exactly that. Some involve the imposition of property rights of some kind or another; others involve restrictions on the way hunting or fishing may be done or the size of animals that can be taken. Other societies use secrecy as a means of controlling access to a select group of *cognoscenti*. Most important is the near universality of such rules. When commenting on fisheries, Fikret Berkes noted "These assets are almost never truly open access"

(Berkes 1985, p. 204). The same point can be made for other community-owned assets (e.g., forests, pasture). Open access always results in escalating abuse of resources, etc. None of this is to suggest that natural resources are always well-managed. In peasant and tribal societies, real tragedies of the commons exist. The well-advertised demise of the American bison is a case in point.

Third, at the time of Hardin's writing, "common property" was a cover term (Berkes and Farver 1989) used to describe open access, state property, and communally owned property. The problem is that they are quite different and all three can be managed well in many instances (Feeny et al. 1990).

A New Conception of Property Rights

In the 1970s, the commons was defined in terms of joint ownership, meaning that it was free for any member of the society to use. In the 1990s, a new conception of the commons came into general use—one that defines common goods as one of four kinds of goods based on difficulty of exclusion and subtractability. Exclusion refers to how easy it is to exclude others from using the good; subtractability refers to one person's use that is not available to others. For example, fish caught by one skipper are not available for use by others, but the weather report he used in deciding to go to sea can be used by others. Arraying these attributes provides a general classification of goods: private, public, toll good, and common-pool resources. Each one of these is a huge continent by itself (Ostrom et al. 1994, pp. 6–8). Private goods are characterized by ease of exclusion and subtractability. Public goods are the opposite of private goods in both attributes. Toll goods share with private goods the ease of exclusion, and with public goods the high cost of exclusion.

Common property has high exclusion costs and subtractability problems. It is difficult to exclude others from using it and disastrous if one cannot do so (Ostrom et al. 1994, p. 16). This means that good management of a commons is subject to some complicated types of dilemmas. It also means that dealing with good management of a commons means dealing with one of four types of goods. None of these four can be analyzed alone.

In the expanding literature on property rights, some interesting work has been done on relations between property rights and types of goods produced. There is increased appreciation of the fact that property is very complicated. Within the same society, rights can be configured to create what von Benda-Beckmann and von Benda-Beckmann (2006) call master categories (private properties, state properties). Moreover, within the same society, different rights to a single object may be allocated to different combinations of people to create a complex matrix of claims (Schlager and Ostrom 1992).

Multiple Claims to Property: The Case of Maine Forest Land

Rights to property may be contested. Legal pluralism may exist so that two or more normative orders may apply to the same situation (Edwards and Steins 1996). The Maine forest land situation allows a chance to explore relations between types of goods and types of property in some detail. The relations are very complicated, and illustrate how one type of property can produce several types of goods. Maine forests produce all four types of goods described by Ostrom et al. (1994)—private goods, public good, toll goods, and common goods—at the same time.

Distinguishing between bundles of rights and the kinds of goods produced is essential to understanding the Maine forest scene, which is undergoing considerable change. In Maine, most forest land is said to be privately owned because 88% is deeded to individuals or private entities (Hagen et al. 2005, p. 9). However, land owners do not hold the entire bundle of rights over the land. There are restrictions on activities of land owners. First, the State of Maine has regulations about wildlife and fish. Second, private Maine forests have long been used by the public as a kind of recreational commons. The right to use the recreational commons is currently being heavily contested by land owners. Both sides have an ideology and legal arguments to support their positions. As a result, new kinds of property are coming into being.

Maine is the most heavily forested state in the nation with over 90% of land in forest. The northern part of the state is virtually uninhabited and was formerly held in huge blocks by pulp and paper companies. Land in this area is now for the most part in the hands of large investment companies who bought out the paper companies. The central part of the state has been cleared of forests. Communities here are small, population is sparse, there is little industry, and the forest land is divided into small parcels. The three southern counties are heavily populated and urbanized.

Land owners have full legal title to their property. They can pass it on to their heirs and can get all income from sale of goods from their land. At the same time, the public uses large amounts of Maine forest land for hunting, trapping, camping, snowmobiling, bird-watching, and cross-country skiing. Groups of campers and canoeists take trips on this land lasting for weeks.

Members of the public generally feel they have a right to use this land. Some ask permission, others do not. When land is posted against trespassing, it is very common for members of the public to destroy the sign with no hesitation or guilt.

The general use of private land by the public goes by several names. Some speak of Maine's "hunting tradition"; and the phrase "open land" tradition is widely used. Ideas and feelings about the rights of the public to use northern forests as a virtual commons were on full display in the case of Roxanne Quimby. In the recent past, Quimby, a large land owner and founder of the highly successful Burt's Bees company, proposed to give thousands of acres of her land to the federal government for a national park. Her request immediately created a firestorm of protests. Those who opposed said she was wrecking the local economy, closing off large amounts of

logging roads to trucks, and reducing hunting. The complainants were largely people who said they supported private property ownership (Austin 2003).[1]

The legal system hardly helps to clarify rights of Maine land owners. The open land tradition is very old in New England. The public's right to use private land is encoded in the 1641 "Great Pond" Law of Massachusetts, which became part of Maine law when Maine became a state in 1820. In essence, this law allows all ponds over 10 acres to be utilized by the public for fishing, fowling, and cutting ice. Since virtually all large land owners have a great pond on their property, they do not have a clear-cut right to keep the public off their land, if this means cutting off access to a great pond. People in Maine have become used to using land of large land owners and think they have been deprived if someone tries to keep them off private land. On the other hand, there is a well-developed body of common law concerning trespass. This conflict of laws makes it difficult for land owners to know what their rights are.

Public policy hardly helps. Maine has a long tradition of encouraging private land owners to allow the public to use private property by limiting the liability of land owners if someone is hurt on their land while engaged in a recreational activity. The objective is to boost tourism—Maine's largest industry.

Maine forest land presents forest users with a cultural bind. There is little consistency in expected behavior. Many studies show cultural support for two different types of behavior. One study indicated that 69% of the public said that the public does not have a right to use private land, while in another study 57% said they did not (Acheson and Acheson 2010, p. 558).

Hunters and land owners accommodate to each other in a variety of ways. First, they avoid each other. When one is using part of a forest, the other is not. Hunting clubs stress the importance of getting owners' permission to ease tensions. And both emphasize a policy of exchange, i.e., we both use each other's land. Most of the time conflict is controlled by avoidance.

More important, forest land produces every type of property right, and right of withdrawal is owned by still different groups. Private land produces timber, pulpwood, and agricultural goods. When used by hunters, it produces common property in the form of game and hunting benefits. It can also produce public goods in the form of snowmobiling, bird-watching, and cross-country skiing.

Some private land is sold for conservation easements in which long-term development rights are held by one group and rights to timber, pulp, and hunting are used by someone else. Rental rights can be held by still other groups to create toll goods (e.g., hunting right to land owned by hunting clubs). Cases where several types of goods have been produced by a single property regime have been noted by other authors. Short (2008) points out that common land in England and Wales has evolved to produce three classes of goods. A similar situation exists in Scandinavia

[1] Quimby later shifted the proposal to a national monument, which can be created by presidential proclamation under the Antiquities Act. In 2016 Elliotsville Plantation and the Quimby Family Foundation donated 87,563 acres of land to the National Park Service, and it was proclaimed as the Katahdin Woods and Waters National Monument by President Barack Obama (Sambides Jr., 2016). Local opposition still continues.

(Kaltenborn et al. 2001). Ostrom has noted (2003, p. 240) that common-pool resources are not automatically associated with common property regimes—or any other type of property regime. The Maine forest land case suggests that the situation is even more complicated. It is possible that all kinds of goods might be produced by all kinds of property regimes.

Sea Tenure, Land Tenure, and the Commons

In recent years, there has been increasing interest in the origin of property rights. Much of the work on property rights stems from the insight that property rights are generated in situations of conflict for resources. Yet this insight ignores several important points: (1) It says nothing about the type of property that will be developed (e.g., common property, private property); (2) it says nothing about whether property rights will be developed at sea or in estuarine areas, as well as on land; and (3) it says nothing about costs or benefits of developing property rights. Recent work begins to fill these gaps.

My case studies support the idea that development of common property or private property depends on economic defendability. That is, when the costs of protecting an area are high relative to the value of the goods on that area, a commons will develop. If the value of the goods in the area is high relative to costs of exclusion, then private property will likely evolve (Acheson 2015, p. 29). The only thing that influences whether property rights develop at sea or not is economic defendability. As we shall see, the mix of variables influencing economic defendability at sea is apt to be different than those on land, but the same factors are involved.

Economic defendability involves the worth of defending an area—not just the value of the goods in an area. An area producing a small amount of goods might be worth defending if those goods are worth a good deal (Dyson-Hudson and Smith 1978). By the same token, an area producing a huge volume of goods may not be worth defending if the cost of defense is prohibitively high. Many factors influence economic defendability including abundance of product, market, predictability, economic density, costs of exclusion, costs of labor, etc. Obviously, the costs of producing agricultural goods are very different from costs of producing fish, but "costs of production" are involved in both cases. Such costs can differ from case to case. In order to study the effects of economic defendability on property rights, a large number of cases were examined. Cases were selected for this study when they met two criteria: (1) There was or is a common property regime and (2) when the ethnography contained enough data to determine economic defendability.

The sample contained six types of cases: (1) Cases in which land held as commons was transformed to private property, (2) cases where land held as common property remains as common property, (3) a case where commonly held land morphed into private property for one type of resource and open access for another, (4) a case where land tenure changed from open access to common property, (5) cases where ocean area remained as common area, and (6) cases in which ocean

area is held as private property. Table 1 (Acheson 2015, pp. 32–33) shows all of the cases used in this study.

In 14 of 21 land cases, there was increasing pressure on the resource due to population increase. In these cases, economic defendability increased leading to a change from common property to private property. Five cases are presented to show the exact changes involved leading to increased economic defendability and private property. In the case of US western rangelands, population rose due to migration from the eastern part of the country, and by organizing, stock growers' associations were able to control grazing on public lands (Anderson and Hill 1998). Among the Samburu (Lesorogol 2008) the government instituted a policy of private ownership, which combined with the advent of wheat farming, increased land values, and the change to private property. In six cases land began as common property and continued as common property. This occurred in the highland Mesoamerican Indian communities' case (Wolf 1955). Even though resources were put under competitive pressure, the economic value of land is low because of low technology, and exclusion costs are high due to pressure from powerful mestizos who want to acquire land. Holding land in common helps to lower exclusion costs by making it impossible to sell land.

In general, it is correct to say that marine resources put under competitive pressure will be held as common property regimes. Of 15 marine cases in our sample, 13 are held as common property regimes. The reasons are various. There is one general factor involved: the economic defendability of ocean area is not high enough to warrant holding ocean privately, but the reasons vary considerably (Acheson 2015). In the case of the Maine lobster industry (Acheson 2003), ocean area on bays is valuable enough for a group to warrant defense as commons. Further offshore, traps become less competitive, making it less worthwhile to hold ocean area. The result is an open-access area.

In one village described by Aswani (2002), population growth, in combination with poor enforcement of fishing rules and ease with which foreigners are permitted to fish locally, makes it less worthwhile to hold ocean area. The result is a common property regime.

The case studies give a good deal of evidence that economic defendability correlates with property rights. High economic defendability is linked with the advent of private property. What is surprising is the number of variables affecting the value of resources or the cost of defending them. Virtually each case has a different set of factors influencing economic defendability.

Several general conclusions are warranted about common property. First, it is an error to think common property can be studied as a single phenomenon. Conditions producing a commons do not have to change much to produce a private property regime. Second, land tenure and sea tenure are the result of the same variables. What distinguishes them is the difference in factors influencing the cost of defense. It is more costly to defend the ocean area as fish are more mobile and less visible and thus more difficult to quantify and monitoring fishing gear far from shore is very costly. But a piece of ocean can be held as a commons or privately, if economic defendability is high enough.

It is notable in studying landholding patterns in Third World countries that there are many cases where arable land is privatized under competitive pressure, while ocean and large lakes are held as a commons (Pinkerton and Weinstein 1995). This suggests that privatization is a rational and efficient use for land but may be less so for oceans. Holding oceans as a commons may help to solve the problem of defense. The value of resources may not be high enough to be worth holding privately, but they may be valuable enough to be worthy of defense costs if those costs are shared. In addition, holding land as a commons may avoid expensive policing and administrative costs (Baland and Platteau 1996, pp. 196, 173). Also, holding resources as a commons is more equitable and avoids the potential for conflicts that come with privatization. It is also a way of pooling user risks (Baland and Platteau 1996, p. 174). Holding ocean areas as a commons may have the value of ensuring that people have access to resources a high percentage of the time.

Theory of Cooperation and the Commons

According to the classic theory of the commons, people do not cooperate where common property resources are concerned because it is rational not to do so. These are cases where rational action by individuals brings disaster for the group. They are best modelled as prisoner's dilemma games, which are notoriously difficult to solve. All common property resources including marine fisheries can be modelled as a prisoner's dilemma. The basic logic of the prisoner's dilemma dictates that both players have a dominant strategy to defect even though the equilibrium outcome that results is worse for both than if they played their dominated strategy. That is, if both players cooperate in a PD game, both players get a high reward. If both defect, both get low payoffs. If one defects and the other does not, the defector gets a big reward, while the other gets a low payoff. Unfortunately, the high reward for defection motivates both to defect, with the result that they get the worst of all payoffs. Defection dominates cooperation even though cooperation by both would bring higher payoffs and a more efficient equilibrium (Elster 1989; Taylor 1990).

There are several standard ways of producing cooperation in a prisoner's dilemma. The first is a norm or rule which outlaws defection. It is logical for fishermen to overfish. Thus, rules are passed making it impossible or costly to overharvest. In the parlance of game theory, these rules outlaw the use of the dominant strategy by both players.

The second is repeated play over an iterated game. If a game is played once, then it is rational to defect (Axelrod 1984). But if the game has no certain ending and is played many times, cooperation can be maintained with the use of the correct strategy (e.g., tit for tat).

The third is leadership (Dixit and Skeath 2004). In these cases, players obtain so much from these public goods they are willing to produce them even though others free ride off their efforts.

However, there are increasing numbers of cases showing that people are far more cooperative than would be predicted on the basis of game theory (Ostrom 1990, 2000; Baland and Platteau 1996; Fehr and Gächter 2000; Henrich 2000; Camerer 2003). Henrich and colleagues state "researchers from across the social sciences have found consistent deviations from the canonical model of self interest in hundreds of experiments around the world" (Henrich et al. 2005, p. 795). They are cooperating in cases where this behavior appears irrational.

There is growing work on cooperation that gives a variety of insights on the reasons people might cooperate in the face of a prisoner's dilemma (Agrawal 2002). Axelrod argues that two phenomena can lead to such cooperation: One is altruism in which people are motivated to put the interests of others' ahead of their own selfish goals. Nowak and Sigmund (2005) make a distinction between direct reciprocity (you help me and I will help you) and indirect reciprocity where there is no necessary reward between the help one gives and what one receives (I help you and you help someone else). They stress that indirect reciprocity is rewarded by less tangible factors—especially reputation.

Axelrod (1984) also points out that the discount rate or the future value of investments can influence the willingness to cooperate. He notes that mutual cooperation can be stable if the future is sufficiently important relative to the present (Axelrod 1984, p. 109). Dixit and Skeath (2004, p. 372) write: "In a prisoner's dilemma a player has a short run incentive to defect but can do better in the long run by developing a pattern of cooperation with the other. But the player will only do this if he is sure the discounted benefits of cooperation over time outweigh the onetime benefits to be had from defection."

Another set of ideas coming from "social preferences" also promotes cooperation (Charness and Rabin 2002). In game theory social preferences refer to a situation in which a player's payoff no longer depends solely on his or her economic reward but more broadly to a concern (or lack thereof) that people have for each other's welfare. Social preferences include everything from altruism, reciprocity, a concern with justice, and a willingness to punish violators of the law.

The Maine Lobster V-Notch Practice

Maine fishermen's practice of V-notching lobsters is a good example of cooperation where it is difficult to understand why participants do what they do. If a Maine lobster fisherman catches a female lobster with eggs, he may cut a small notch in her tail. Maine law protects such lobsters from being taken again as they are proven breeding stock. Fishermen throw such lobsters overboard by the thousands, convinced such lobsters play an essential role in replenishing the stock. In the view of fishermen, the two laws that ensure the future of the industry are (a) the V-notch and (b) the oversize law. The rest of the conservation laws are of far less importance (see Acheson 2003; Acheson and Gardner 2010).

The key question is: Why should a fisherman V-notch? There is little evidence that the V-notch is beneficial—especially in the local area. There is no evidence if a fisherman has V-notched a lobster. Nor is there evidence a lobster contributes to the pool of eggs in the water column. Once a lobster is stripped of eggs, there is no indication where its eggs went or where eggs in the water came from. Nevertheless, Maine fishermen do protect such lobsters by the thousands in the belief this augments the stock generally. V-notching essentially involves fishermen—presumably acting with others—sacrificing some time to mark gravid females to increase the breeding stock to the benefit of all, with little evidence such rewards will materialize.

We believe there are several disparate threads in the new literature on cooperation which provide an explanation for the V-notch.

First, lobster fishermen have a low discount rate. It is important that the industry persists and that families of fishermen have an opportunity to earn their living in the fishery (Acheson 2003, pp. 160–64). In their view, V-notching provides a path to this end.

Second, it is noteworthy that fishermen who are V-notching brag about it and that those who do not say little. In fishing circles, reputation is determined by being known as a person who helps the industry. Some of the most successful fishermen were known as prolific V-notchers, and fishermen want to advertise that fact. V-notching can best be considered as a case of indirect reciprocity. It is typical in such cases that rewards are intangible. Most lobstering communities have a long history. They are small, homogenous places where people know each other well. If the work of Fehr and Gächter (2000) is correct, it is exactly in such communities that having a reputation could result in less free riding and more cooperation.

Third, the horrible history of the lobster bust in the early 1930s when 40% of lobstermen went broke reinforces the idea that lack of conservation rules, or failure to observe existing rules, can be very dangerous.

Fourth, all of these are connected to the idea that cooperation to ensure the stock is good policy and profitable.

The Knowledge Commons

In the past 20 years or so, the concept of the commons has been applied to knowledge, defined broadly. This conception shares a good deal with the older theory of common property resources, but there are some major differences. The theory of common property resources refers to physical resources or physical property. The information commons "refers to shared knowledge base and the processes that facilitate or hinder its use. It also refers to a physical space, usually an academic library, where any and all can participate in the process of information research, gathering and production" (Wikipedia—Information Commons). From this perspective, knowledge is all useful ideas, information, and data in whatever form. Hess (2012, p. 40) says that she and her colleagues agreed on the following definition: commons is a resource shared by a group of people that is subject to social dilemmas (Hess

2012, p. 140). This seemingly straightforward definition has been used to describe work in a wide variety of different fields. One is the launching of the open access journal, *International Journal of the Commons*. The *Cornell Law Review* devoted an issue to the information commons in 2010 which explored "constructed" knowledge and cultural commons. An international effort made astounding headway in establishing a microbiological scientific commons. A conference on the knowledge commons in Belgium in 2012 published articles on a variety of topics ranging from the innovation commons and digital information commons to genetic resource commons and cultural commons. These topics give only a cursory idea of the breadth of research on the information commons (see Hess 2012, pp. 18–20). The "unifying thread in all commons resources is that they are jointly used, managed by groups of varying sizes and interests" (Hess and Ostrom 2012, p. 5). The knowledge commons is subject to similar behavior and conditions that had long been identified with other types of commons, e.g., congestion, free riding, conflict, overuse, and "pollution" (Hess and Ostrom 2012, p. 4). Hess and Ostrom note that "there is continual challenge to identify the similarities between knowledge commons and traditional commons such as forests or fisheries, all the while exploring the ways knowledge as a resource is fundamentally different from natural—resource commons" (2012, p. 5). The similarities and differences are still not all obvious.

Much more research needs to be done, however. McCay and Delaney point out that we do not understand any kind of global commons very well (Hess 2012). Hess (2012, pp. 29–31) notes the need for good case studies is especially acute; I will make no pretense of covering this vast and continually changing field, except to note that this topic will occupy us for many years to come.

Still Other Directions in the Study of the Commons

This article has covered a number of ways in which the study of the commons has been expanded and pushed in new directions since Hardin's time. There are others I have not had the time to develop here in any detail:

1. A large number of psychological variables have been shown to influence cooperation in the solution of commons problems, including social motives and personality type (Kopelman et al. 2002).
2. Studies in complexity show how actors or agents interacting at one level of analysis can affect behavior and events at another (Poteete et al. 2010).
3. Experimental games are being applied in laboratory settings to understand the conditions under which people are willing to cooperate to solve commons dilemmas, e.g., Fehr and Gächter (2000) and Ostrom et al. (1994).
4. Richerson et al. (2002) discuss other ways of viewing a commons from an evolutionary perspective.