

**ARTIFACTS, FACILITIES, AND CONTENT:
INFORMATION AS A COMMON-POOL RESOURCE**

by

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I. INTRODUCTION

We are in the midst of an information arms race with multiple sides battling for larger shares of the global knowledge pool. The records of scholarly communication, the foundations of an informed, democratic society, are at risk. Recent legal literature heightens our awareness of “the enclosure of the intellectual public domain” through new patent and copyright laws.¹ There are a number of issues concerning the conflicts and contradictions between new laws and new technologies.² Information that used to be “free” is now increasingly being privatized, monitored, encrypted, and restricted.

This “intellectual land grab”³ is a direct outcome of new technologies and global markets. Distributed digital technologies have the dual capacity to increase as well as restrict access to information. These technologies have brought a larger number of the people of this earth greater access to important information about history, science, art, literature, and current events in specific places. At the same time, however, these new technologies enable profit-oriented firms the capability of extracting resources previously held in common for their value and for establishing property rights.⁴ Multiple forces are vying for capture and restriction of traditionally available

¹There is a rapidly growing legal literature on the ramifications of recent intellectual property legislation and its impact on the intellectual public domain. Some of the works that seem particularly relevant to the question of the information commons are: Benkler, Yochai, “Free as the Air to Common Use: First Amendment Constraints on Enclosure of the Public Domain,” *New York University Law Review* 74 (1999): 354-446; Boyle, James, *Shamans, Software, and Spleens: Law and the Construction of the Information Society* (Cambridge, MA: Harvard University Press, 1996); Burk, Dan L. “Muddy Rules for Cyberspace,” *Cardozo L. Review* 21 (1999): 121-179; Cohen, Julie E., “Copyright and the Jurisprudence of Self-Help,” *Berkeley Tech L.J.* 13 (1998): 1189-1143; David, Paul A. “A Tragedy of the Public Knowledge ‘Commons’? Global Science, Intellectual Property and the Digital Technology Boomerang,” Stanford Institute for Economic Policy Research, SIEPR Discussion Paper, no. 00-02, Stanford University, Stanford, CA, 2000; Lemley, Mark A., “Beyond Preemption: The Law and Policy of Intellectual Property Licensing Beyond Preemption: The Law and Policy of Intellectual Property Licensing,” *California Law Review* 87 (1999): 111-172; Lessig, Lawrence, “Reclaiming a Commons,” presented as the keynote address at the Berkman Center, “Building a Digital Commons,” Harvard University, Cambridge, MA, May (1999); Madison, Michael J., “Complexity and Copyright in Contradiction,” *Cardozo Arts & Ent Law Journal* 18 (2000): 125-174; Merges, Robert P., “Property Rights Theory and the Commons; The Case of Scientific Research,” *Social Philosophy and Policy* 13(2) (1996): 145-167; Reichman, J.H., and Jonathan A. Franklin, “Privately Legislated Intellectual Property Rights: Reconciling Freedom of Contract with Public Good Uses of Information,” *University of Pennsylvania Law Review* 147(4) (1999): 875-970; Rose, C. M., “From Local to Global Commons: Private Property, Common Property, and Hybrid Property Regimes: Expanding the Choices for the Global Commons: Comparing Newfangled Tradable Allowance Schemes to Old-fashioned Common Property Regimes,” *Duke Env. L. & Policy F* 10 (Fall 1999): 45-72.

²See Benkler, Yochai, “Overcoming Agoraphobia: Building the Commons of the Digitally Networked Environment,” *Harvard Journal of Law and Technology* 11(2) (1998): 287-400; and Boyle, supra note 1, among others.

³Boyle, supra note 1, and Boyle, James, “A Politics of Intellectual Property: Environmentalism for the Net?,” *Duke Law Journal* 47 (1997), 87-116, p. 94.

⁴Many new common-pool resources have “remained unclaimed due to lack of technology for extracting their value and for establishing and sustaining property rights.” Buck, Susan J., *The Global Commons: An Introduction* (Covelo, CA: Island Press, 1998), p. xiii.

knowledge: corporations vs. indigenous peoples (Monsanto owning the patent on the genetic structure of the neem); federal and state governments vs. citizens (encryption and digital surveillance vs. privacy); universities vs. professors (institutional vs. individual intellectual property rights); publishers vs. libraries (ephemeralization of library collections through licensing, bundling, and withdrawal of information).

This competition for ownership of previously shared resources is not unique to the public domain of knowledge. Given the opening of vast markets for commodities of all kinds, many natural as well as human-made resources are under pressure. The world's fisheries are fighting depletion because of the capture capabilities of larger trawlers, wider and finer nets, and larger fleets. Indigenous forest systems are being privatized,⁵ with the forests being burnt or logged at alarming rates, not only rapidly reducing primary growth forests as a resource but polluting the global atmosphere as well. Indeed, commodification and privatization of resources is a trend and a problem in regard to virtually all resources. And radical changes in the structure and process of all natural and human-constructed resources can occur through the development of new technologies.⁶

The goal of this paper is to summarize the lessons learned from a large body of international, interdisciplinary research on common-pool resources (CPRs) in the past 25 years and consider its usefulness in the analysis of the information as a resource. We will suggest ways in which the study of the governance and management of common-pool resources can be applied to the analysis of information and "the intellectual public domain." The complexity of the issues is enormous for many reasons: the vast number of players, multiple conflicting interests, the general lack of understanding of digital technologies, local versus global arenas, and a chronic lack of precision about the information resource at hand. We suggest, in the tradition of Hayek⁷, that the combination of time and place analysis with general scientific knowledge is necessary for sufficient understanding of policy and action. In addition, the careful development of an unambiguous language and agreed-upon definitions is imperative.

As one of the framing papers for this conference, we will focus on the *language*, the *methodology*, and *outcomes* of research on common-pool resources in order to better understand how property regimes affect the provision, production, distribution, appropriation, and consumption of scholarly information. Our brief analysis will suggest that collective action and new institutional design play as large a part in the shaping of scholarly information as do legal restrictions and market forces.

⁵See Arnold, J. E. Michael, "Devolution of Control of Common-Pool Resources to Local Communities: Experiences in Forestry," in *Access to Land, Rural Poverty and Public Action*, ed. A. de Janvry, G. Gordillo, J. P. Platteau, and E. Sadoulet (New York: Oxford University Press, 2001).

⁶See, for instance, Palumbi, Stephen R., "Humans as the World's Greatest Evolutionary Force," *Science* 293 (Sept. 7, 2001): 1786-1790.

⁷Hayek, F. A., "The Use of Knowledge in Society," *American Economic Review* 35(4) (1945): 519-530.

II. WHAT IS A COMMONS?

*“The commons: There’s a part of our world, here and now, that we all get to enjoy without the permission of any.”*⁸

*“‘The commons’ refers to institutional devices that entail government abstention from designating anyone as having primary decision-making power over use of a resource. A commons-based information policy relies on the observation that some resources that serve as inputs for information production and exchange have economic or technological characteristics that make them susceptible to be allocated without requiring any single organization, regulatory agency, or property owner clear conflicting uses of the resource.”*⁹

*“The concept of the public domain is another import from the realm of real property. In the intellectual property context, the term describes a true commons comprising elements of intellectual property that are ineligible for private ownership. The contents of the public domain may be mined by any member of the public.”*¹⁰

While the term, “the commons,” has a positive emotional sound to it, it refers to a wide variety of concepts and events that can lead to so much analytical ambiguity that little progress is made in protecting what scholars wish to protect. We need to clarify what we are talking about. A survey of the recent literature related to the subject of this conference seems to confuse the meaning of a “commons” rather than clarify it.¹¹

The term “commons” is often used synonymously with the term “public domain.” Is it a given right, no assigned right, unclaimed, unmanaged, or something that should just be there in a democracy?¹² Unfortunately, a quick look at *Oran’s Dictionary of Law*¹³ does not clarify terms but only helps to identify why there is such confusion. There we find two definitions of public domain: “1) Land owned by the government. 2) Free for anyone to use; no longer protected by patent or copyright.” In the first definition, there is an owner—the government. In the second, there is *no* owner. Are scholars trying to protect a realm of government ownership or a realm of no ownership?

⁸Lessig, Lawrence, “Code and the Commons,” a keynote address presented at the conference “Media Convergence,” Fordham Law School, Fordham University, New York, NY, Feb. 9, 1999.

⁹Benkler, Yochai, “The Commons as a Neglected Factor of Information Policy,” presented at the Telecommunications Policy Research Conference, September 1998.

¹⁰Litman, Jessica, “The Public Domain,” *Emory Law Journal* 39 (1990): 965-1023, p. 975.

¹¹See Lessig, *supra* note 1. Lessig calls the commons *the core of the open society*. He refers to Charles Nesson’s idea of “building a commons in cyberspace where ideas are there for the taking.” He further writes: “We don’t see a place for the commons – we only see a place for property.”

¹²Boyle, *supra* note 1, p. xiv, does point out the institutional nature of a commons: “Even a conventional economic analysis supports the idea that it is in the interest of those who are exploiting a ‘commons’ to make sure that the commons continues to exist.”

¹³Oran, D., *Oran’s Dictionary of the Law* (St. Paul, MN: West, 1983).

In relation to the intellectual public domain, the commons appears to be an idea about democratic processes, freedom of speech, and the free exchange of information. While we agree that freedom of speech and open exchange of information are fundamental to the creation and sustenance of democratic systems of governance, we need to develop useful tools for analyzing what we mean by commons, public domain, and free exchange of information.

The use of the term “commons” has various histories: the house of British Parliament representing the non-titled citizens; agricultural fields in England and Europe prior to their enclosure; and particularly in the US, public spaces, such as the New England town square, campus dining halls, and concepts of the common good.¹⁴ In almost all uses, the term has a contested history. In regard to the legal study of property rights, the publication of *Ancient Law* by Henry Sumner Maine¹⁵ in 1861 set off a major debate about the origin of the very concept of property in ancient times.¹⁶ Drawing on his own extensive research in India and that of others in regard to the early European communities, Maine argued that joint-ownership by families and groups of kin (in other words, common property) was more likely the initial property regime in most parts of the world rather than the notion of property owned by a single individual.¹⁷ This great debate was not simply one between historians over which came first—common property or individual private property. The debate framed a perspective on whether landed proprietors have a special role in society that needed protection and the legitimacy of enclosing properties owned communally. The debate is not fully resolved. Ellickson, Rose, and Ackerman’s major textbook on property law¹⁸ devote their first chapter to “The Debate over Private Property” and their second chapter to “The Problem of the Commons.”

Social scientists have had their own related debates about the consequences of allowing multiple individuals or firms to jointly use a resource system. The debate was kicked off half a century ago by the pathbreaking work of Scott Gordon in 1954 and Anthony Scott in 1955¹⁹ when they introduced an economic analysis of a natural resource (fisheries) that had, prior to that time, been the domain of biologists. Their two articles are credited with outlining the conventional theory of

¹⁴See Hess, Charlotte, “Is There Anything New Under the Sun? A Discussion and Survey of Studies on New Commons and the Internet,” presented at “Constituting the Commons: Crafting Sustainable Commons in the New Millennium,” the Eighth Conference of the International Association for the Study of Common Property, Bloomington, Indiana, May 31-June 4, 2000. <http://129.79.82.45/IASCP/Papers/hessc042400.pdf>

¹⁵Maine, Henry Sumner, *Ancient Law; Its Connection with the Early History of Society and its Relation to Modern Ideas; With Introduction and Notes by Frederick Pollack*. Reprint of 1861 ed. (Boston: Beacon Press, 1963).

¹⁶See Grossi, Paolo, *An Alternative to Private Property; Collective Property in the Juridical Consciousness of the Nineteenth Century*, in L. G. Cochrane, ed. (Chicago: University of Chicago Press, 1981).

¹⁷Maine, supra note 15, p. 252.

¹⁸Ellickson, Robert C., Carol M. Rose, and Bruce A. Ackerman, eds., *Perspectives on Property Law*, 2d. ed. (Gaithersburg, MD: Aspen Publishers, 1995). (Perspectives on Law Series).

¹⁹Gordon, H. Scott, “The Economic Theory of a Common-Property Resource: The Fishery,” *Journal of Political Economy* 62 (1954): 124-142; and Scott, Anthony D., “The Fishery: The Objectives of Sole Ownership,” *Journal of Political Economy* 65 (1955): 116-124.

the commons.²⁰ They demonstrated that when multiple individuals jointly harvested fish in high demand without a limit on the amount that any fisher could withdraw, the quantity harvested would exceed both the maximum sustainable yield and the maximum economic yield. At that time, the only solution to this problem that they contemplated was ownership of the fishery by a single firm or by the government. In 1968, the biologist, Garrett Hardin, crystallized the thinking of many social scientists and policy makers with his metaphoric analysis of the “tragedy of the commons.” Hardin argued that the individuals who jointly use a commons are hopelessly trapped in an immutable tragedy. Given this trap of overuse (or, for Hardin, overpopulation), the “only” solution Hardin envisioned was externally imposed government or private ownership.²¹ Unfortunately, for the development of rigorous thinking, Hardin casually used the example of a pasture “open to all” as if all jointly owned pastures would be “open to all.”

Since the work of Gordon, Scott, and Hardin, most theoretical studies by political-economists have analyzed simple common-pool resource systems using relatively similar assumptions. In such systems, it is assumed that the resource generates a highly predictable, finite supply of one type of resource unit (one species, for example) in each relevant time period. Appropriators (those who harvest from a resource system, e.g., fishers, pastoralists, etc.) are assumed to be homogeneous in terms of their assets, skills, discount rates, and cultural views. They are also assumed to be short-term, profit-maximizing actors who possess complete information. In this theory, *anyone* can enter the resource and appropriate resource units. Appropriators gain property rights only to what they harvest. The harvested resource units are then privately owned and can be sold in an open competitive market. The open-access condition is a given. The appropriators make no effort to change it. Appropriators act independently and do not communicate or coordinate their activities in any way.²²

Many current textbooks in resource economics and law and economics still present this conventional theory of a simple common-pool resource as the only theory needed for understanding common-pool resources more generally (but, for a different approach, see Baland and Platteau).²³ With the growing use of game theory, appropriation from common-pool resources is frequently represented as a one-shot or finitely repeated, Prisoner’s Dilemma game.²⁴ These

²⁰See Feeny, David, et al., “The Tragedy of the Commons: Twenty-Two Years Later,” *Human Ecology* 18(1) (1990): 1-19, p. 2.

²¹Hardin, Garrett, “The Tragedy of the Commons,” *Science* 162 (1968): 1243-1248; Hardin, Garrett, “Extensions of ‘The Tragedy of the Commons,’” *Science* 280 (May 1, 1998): 682-683.

²²“In this setting, as the incisive analysis of Gordon and Scott demonstrates, each fisherman will take into account only his own marginal costs and revenues and ignores the fact that increases in his catch affect the returns to fishing effort for other fishermen as well as the health of future fish stocks. . . . [E]conomic rent is dissipated; economic overfishing, which may also lead to ecological overfishing, is the result.” Feeny, David, Susan Hanna, and Arthur F. McEvoy, “Questioning the Assumptions of the ‘Tragedy of the Commons’ Model of Fisheries,” *Land Economics* 72(2) (1996): 187-205, p. 189.

²³Baland, Jean-Marie, and Jean-Philippe Platteau, *Halting Degradation of Natural Resources: Is There A Role for Rural Communities?* (New York: Oxford University Press and FAO, 1996).

²⁴Dawes, Robyn M., “The Commons Dilemma Game: An N-Person Mixed-Motive Game With a Dominating Strategy for Defection,” *ORI Research Bulletin* 13(2) (1973) Oregon Research Institute; and Dasgupta, Partha, and Geoffrey M. Heal, *Economic Theory and Exhaustible Resources* (Garden City, NJ: J. Nisbet, 1979).

models formalize the problem differently, but do not change any of the basic theoretical assumptions about the finite and predictable supply of resource units, complete information, homogeneity of users, their maximization of expected profits, and their lack of interaction with one another or capacity to change their institutions.

A sufficient number of empirical examples have existed where the absence of property rights and the independence of actors captures the essence of the problem facing appropriators that the broad empirical applicability of the theory was not challenged until the mid-1980s. The massive deforestation in tropical countries and the collapse of the California sardine fishery and other ocean fisheries confirmed the worst predictions to be derived from this theory for many scholars.

Since appropriators are viewed as being trapped in these dilemmas, repeated recommendations were made that external authorities must impose a different set of political regimes and property rights on such settings. Some recommended private property as the most efficient form of ownership.²⁵ Others recommended government ownership and control.²⁶ Implicitly, theorists assumed that regulators will act in the public interest and understand how ecological systems work and how to change institutions so as to induce socially optimal behavior.²⁷

The possibility that the appropriators themselves would find ways to organize themselves has not been seriously considered in much of the political-economy literature until recently. Organizing so as to create rules that specify rights and duties of participants creates a public good for those involved. Anyone who is included in the community of users benefits from this public good, whether they contribute or not. Thus, getting “out of the trap” is itself a second-level dilemma. Further, investing in monitoring and sanctioning activities so as to increase the likelihood that participants follow the agreements they have made, also generates a public good. Thus, these investments represent a third-level dilemma. Since much of the initial problem exists because the individuals are stuck in a setting where they generate negative externalities on one another, it is not consistent with the conventional theory that they solve a second- and third-level dilemma in order to address the first-level dilemma under analysis.

The work of the National Academy of Sciences’ Panel on Common Property²⁸ challenged the application of this conventional theory to all common-pool resources regardless of the capacity of appropriators to communicate, coordinate their activities, and to create institutions to allocate property rights and make policies related to a jointly owned resource. The growing evidence from

²⁵See Demsetz, Harold, “Toward a Theory of Property Rights,” *American Economic Review* 62 (1967): 347-359; Posner, Richard A., *Economic Analysis of Law*, 2^d ed. (Boston, MA: Little, Brown, 1977); and Simmons, Randy T., Fred L. Smith, and Paul Georgia, “The Tragedy of the Commons Revisited: Politics vs. Private Property,” Center for Private Conservation, Competitive Enterprise Institute, Washington, DC, 1996.

²⁶Ophuls, William, “Leviathan or Oblivion,” in *Toward a Steady State Economy*, ed. H. E. Daly (San Francisco: Freeman, 1973).

²⁷Feeny, Hanna, and McEvoy, supra note 22, p. 195.

²⁸National Research Council, ed., *Proceedings of the Conference on Common Property Resource Management, April 21-26, 1985* (Washington, DC: National Academy Press, 1986).

many field studies of common-pool resources conducted by anthropologists²⁹ and historians³⁰ called for a serious re-thinking of the theoretical foundations for the analysis of common-pool resources.³¹ The cumulative impact of the extensive empirical studies does not challenge the empirical validity of the conventional theory *where it is relevant* but rather its presumed, universal, generalizability.

III. CLARIFYING KEY CONCEPTS

In order to develop a broader and empirically verifiable theory that encompassed the dominant “tragedy of the commons” theory as a special case, scholars learned that they had to make some key distinctions among things that had previously and casually been treated as being the same thing. Since we feel that a similar effort is needed in regard to the intellectual public domain, we will discuss these distinctions in some depth. There were four basic confusions that needed to be untangled. The source of confusion relates to the differences among 1) the nature of the good (common-pool *resources*) and a property regime (common-property *regimes*), 2) resource systems and the flow of resource units, 3) common property and open-access regimes, and 4) the set of property rights involved in “ownership.” All four sources of confusion reduce clarity in assigning meaning to terms and retard theoretical and empirical progress.

The Confusion between the Nature of a Good and a Property Regime

²⁹See Netting, Robert McC., *Balancing on an Alp: Ecological Change and Continuity in a Swiss Mountain Community* (New York: Cambridge University Press, 1981); Netting, Robert McC., “Territory, Property, and Tenure,” in *Behavioral and Social Science Research: A National Resource*, ed. R. McC. Adams, N. J. Smelser, and D. J. Treiman (Washington, D.C.: National Academy Press, 1982), 446-501; McCay, Bonnie J., and James M. Acheson, *The Question of the Commons: The Culture and Ecology of Communal Resources* (Tucson: University of Arizona Press, 1987).

³⁰Glick, Thomas F., *Irrigation and Society in Medieval Valencia* (Cambridge, MA: Harvard University Press, 1970); Maass, Arthur, and Raymond L. Anderson, . . . and the Desert Shall Rejoice: *Conflict, Growth, and Justice in Arid Environments* (Malabar, FL: R. E. Krieger, 1986).

³¹See Berkes, Fikret, “Local Level Management and the Commons Problem: A Comparative Study of Turkish Coastal Fisheries,” *Marine Policy* 10 (July 1986): 215-29; Berkes, Fikret, ed., *Common Property Resources; Ecology and Community-Based Sustainable Development* (London: Belhaven Press, 1989); Berkes, Fikret, David Feeny, Bonnie J. McCay, and James M. Acheson, “The Benefits of the Commons,” *Nature* 340 (July 1989): 91-93; Bromley, Daniel W., David Feeny, Margaret McKean, Pauline Peters, Jere Gilles, Ronald Oakerson, C. Ford Runge, and James Thomson, eds., *Making the Commons Work: Theory, Practice, and Policy* (Oakland, CA: ICS Press, 1992); Ostrom, Elinor, *Governing the Commons* (New York: Cambridge University Press, 1990); Pinkerton, Evelyn, “Local Fisheries Co-Management: A Review of International Experiences and Their Implications for Salmon Management in British Columbia,” *Canadian Journal of Fisheries and Aquatic Sciences* 51 (1994): 2363-78; Hess, Charlotte, *A Comprehensive Bibliography of Common Pool Resources*. (CD-ROM) (Bloomington: Indiana University, Workshop in Political Theory and Policy Analysis, 1999); Cordell, John C., ed., *A Sea of Small Boats* (Cambridge, MA: Cultural Survival, Inc., 1989); Wade, Robert, *Village Republics: Economic Conditions for Collective Action in South India* (Oakland, CA: ICS Press, 1994); Ruddle, Kenneth, and Robert E. Johannes, eds., *The Traditional Knowledge and Management of Coastal Systems in Asia and the Pacific* (Jakarta: Unesco, 1985); Sengupta, Nirmal, *Managing Common Property: Irrigation in India and the Philippines* (New Delhi: Sage, 1991).

The problems resulting from confusing concepts were particularly difficult to overcome given that the term “common-*property* resource” was frequently used to describe a type of economic good that is better referred to as a “common-*pool* resource.” For many scholars, the concept of a property regime and the nature of a good were thus conflated.

One of the key problems in developing a good analytical approach to the effect of diverse institutional arrangements on the incentives, activities, and outcomes of the individuals involved is getting a clear conception of the structure of events involved. The political-economy literature usually calls “the structure of the bio-physical events” as “the nature of the goods.” For some time, economists struggled with classifying goods as either private or public. By labeling all goods as fitting this dichotomy, scholars talked about those things that the market could solve most efficiently and those things that would require government provision and production.

In the 1970s, a major breakthrough came with clear identification that there were not just two types of goods. Two attributes have been identified in the political-economy literature that help identify four broad classes of goods. The first attribute is whether the benefits consumed by one individual subtract from the benefits available to others.³² Common-pool resource systems generate relatively subtractable benefit flows. This attribute is shared with private goods, as shown in Figure 1. The second attribute is that it is very costly to exclude individuals from using the flow of benefits either through physical barriers or legal instruments. Both attributes vary across a range.

Figure 1. **Types of Goods**

		SUBTRACTABILITY	
		<i>low</i>	<i>high</i>
E X C L U S I O N	<i>difficult</i>	public goods sunset common knowledge	common-pool resources irrigation systems libraries
	<i>easy</i>	toll or club goods day-care centers country clubs	private goods doughnuts personal computers

Recognizing a class of goods that shares these two attributes enables scholars to identify the core theoretical problems facing individuals whenever more than one individual or group utilizes such resources for an extended period of time. Using “property” in the term used to refer to a type of

³²Ostrom, Vincent, and Elinor Ostrom, “Public Goods and Public Choices,” in *Alternatives for Delivering Public Services: Toward Improved Performance*, ed. E. S. Savas (Boulder, CO: Westview Press, 1977), 7-49; Ostrom, Elinor, Roy Gardner, and James Walker, *Rules, Games, and Common-Pool Resources* (Ann Arbor: University of Michigan Press, 1994).

good, reinforces the impression that goods sharing these attributes tend everywhere to share the same property regime. As discussed below, this is certainly not the case.

Common-pool resources share with what economists call “public goods,” the difficulty of developing physical or institutional means of excluding beneficiaries. Unless means are devised to keep nonauthorized users from benefitting, the strong temptation to free ride on the efforts of others will lead to a suboptimal investment in improving the resource, monitoring use, and sanctioning rule-breaking behavior. Second, the products or resource units from common-pool resources share with what economists call “private goods,” the attribute that one person’s consumption subtracts from the quantity available to others. Thus, common-pool resources are subject to problems of congestion, overuse, pollution, and potential destruction unless harvesting or use limits are devised and enforced. In addition to sharing these two attributes, particular common-pool resources differ on many other attributes that affect their economic usefulness including their extent, shape, productivity and the value, timing, and regularity of the resource units produced.³³

Common-pool resources may be owned by national, regional, or local governments; by communal groups; by private individuals or corporations; or used as open-access resources by whomever can gain access. Each of the broad types of property regimes has different sets of advantages and disadvantages, but at times may rely upon similar bundles of operational rules.³⁴ Examples exist of both successful and unsuccessful efforts to govern and manage common-pool resources by governments, communal groups, cooperatives, voluntary associations, and private individuals or firms.³⁵ Thus, no automatic association exists between common-pool resources with common-property regimes—*or, with any other particular type of property regime.*

The Confusion between a Resource System and the Flow of Resource Units

The second confusion is related to the relationships between resource systems and a flow of resource units or benefits from these systems.³⁶ In regard to common-pool resources, the resource system (or alternatively, the stock or the facility) is what generates a flow of resource units or benefits over time.³⁷ Examples of typical common-pool resource systems include lakes, rivers, irrigation systems, groundwater basins, forests, fishery stocks, and grazing areas. Common-pool resources may also be facilities that are constructed for joint use, such as mainframe computers and the Internet. The resource units from a common-pool resource include water, timber, medicinal plants, fish, fodder, central processing units. The resource units for a complex facility

³³ See Schlager, Edella, William Blomquist, and Shui Yan Tang, “Mobile Flows, Storage, and Self-Organized Institutions for Governing Common-Pool Resources,” *Land Economics* 70(3) (1994): 294-317.

³⁴ Feeny et al., *supra* note 20.

³⁵ Bromley et al., *supra* note 31; Singh, Katar, *Managing Common Pool Resources: Principles and Case Studies* (Oxford: Oxford University Press, 1994); Singh, Katar, and Vishwa Ballabh, *Cooperative Management of Natural Resources* (New Delhi: Sage, 1996).

³⁶ Blomquist, William, and Elinor Ostrom, “Institutional Capacity and the Resolution of a Commons Dilemma,” *Policy Studies Review* 5(2) (1985): 383-393.

³⁷ Lueck, Dean, “Property Rights and the Economic Logic of Wildlife Institutions,” *Natural Resources Journal* 35(3) (1995): 625-670.

like the Internet may be the data packets or the computer files (information artifacts) depending upon whether one is studying it as an infrastructure resource or as an information resource.³⁸ Devising property regimes that effectively allow sustainable use of a common-pool resource requires one set of rules that limit access to the resource system and other rules that limit the amount, timing, and technology used to withdraw diverse resource units from the resource system. It is frequently the case that the resource system is jointly owned, while the resource units withdrawn from the system are individually owned by appropriators.

The Confusion between Common-Property and Open-Access Regimes

In a now classic article, Ciriacy-Wantrup and Bishop³⁹ clearly articulated the difference between property regimes that are *open access*, where no one has the legal right to exclude anyone from using a resource, from *common property*, where the members of a clearly defined group have a legal right to exclude nonmembers of that group from using a resource.⁴⁰ Open-access regimes (*res nullius*)—including the classic cases of the open seas and the atmosphere—have long been considered in legal doctrine as involving no limits on who is authorized to use these resources. Thus, the work of Gordon, Scott, and Hardin focused on resources that were paired with open-access regimes. If anyone can use a resource—the definition of an open-access resource—then, no one has an incentive to conserve its use or to invest in improvements.

Some open-access regimes lack effective rules defining property rights by default.⁴¹ Either the resources affected by these open-access regimes are not contained within a nation-state or no entity has successfully laid claim to legitimate ownership. Other open-access regimes are the consequence of conscious public policies to guarantee the access of all citizens to the use of a resource within a political jurisdiction.⁴² The concept of *jus publicum* applies to their formal status, but effectively these resources are open access.⁴³ Still other open-access regimes result

³⁸See Bernbom, Gerald, “Analyzing the Internet as a Common Pool Resource: The Problem of Network Congestion,” presented at “Constituting the Commons: Crafting Sustainable Commons in the New Millennium,” the Eighth Conference of the International Association for the Study of Common Property, Bloomington, Indiana, May 31-June 4, 2000. <http://dlc.dlib.indiana.edu/documents/dir0/00/00/02/18/index.html>

³⁹Ciriacy-Wantrup, Siegfried V., and Richard C. Bishop, “‘Common Property’ as a Concept in Natural Resource Policy,” *Natural Resources Journal* 15 (1975): 713-727.

⁴⁰See also Bromley, Daniel W., *Environment and Economy: Property Rights and Public Policy* (Cambridge, MA: Basil Blackwell, 1991); Bromley, Daniel W., “The Commons, Common Property, and Environmental Policy,” *Environmental and Resource Economics* 2 (1992): 1-17; Bromley, Daniel W., “The Commons, Property, and Common-Property Regimes,” in *Making the Commons Work: Theory, Practice, and Policy*, ed. Daniel W. Bromley, et al. (Oakland, CA, ICS Press, 1992), 3-15.

⁴¹Dales, John H., *Pollution, Property, and Prices: An Essay in Policy-making and Economics* (Toronto: University of Toronto Press, 1968).

⁴²As in the case of noncopyrightable or expired formerly copyrighted information—i.e., “the public domain.” See Litman 1990, *supra* note 10.

⁴³The state governments of Oregon and Washington, for example, intervened in the early twentieth century to prevent local salmon fishermen from devising rules that would have limited entry and established harvesting limits (Higgs, Robert, “Legally Induced Technical Regress in the Washington Salmon Fishery,” *Research in Economic History* 7 (1982): 55-86; Higgs, Robert, “Legally Induced Technical Regress in the Washington Salmon Fishery,” in *Empirical Studies in Institutional Change*, ed. Lee J. Alston, Thráinn Eggertsson, and Douglass C. North (New York: Cambridge University Press, 1996), 247-79). Fishing unions along the U.S. coastal areas tried to organize

from the ineffective exclusion of nonowners by the entity assigned formal rights of ownership. In many developing countries, the earlier confusion between open-access and common-property regimes paradoxically led to an increase in the number and extent of local resources that are *de facto* open access. Common-property regimes controlling access and harvesting from local streams, forests, grazing areas, and inshore fisheries had evolved over long periods of time in all parts of the world, but were rarely given formal status in the legal codes of newly independent countries.

Many common-property regimes do efficiently regulate the joint use and management of a resource. There is, however, nothing inherently efficient or inefficient about such regimes. A modern, private corporation is, after all, a common-property regime that has widespread use throughout the global economy—with both efficient and inefficient consequences. Common-property regimes are essentially share contracts.⁴⁴ As such, they face the potential of opportunistic behavior and moral hazard problems. Common-property regimes, however, are much more likely to have beneficial consequences for a resource system and its users than an open-access resource.

As concern for the protection of natural resources mounted during the second half of the last century, many developing countries nationalized all land and water resources that had not yet been recorded as private property. The institutional arrangements that local users had devised to limit entry and use lost their legal standing. The national governments that declared ownership of these natural resources, however, lacked monetary resources and personnel to exclude users or to monitor the harvesting activities of users. Thus, resources that had been under a *de facto* common-property regime enforced by local users were converted to a *de jure* government-property regime, but reverted to a *de facto* open-access regime. When resources that were previously controlled by

inshore fisheries so as to limit entry and establish harvesting limits during the 1950s. Even though their efforts could not have had a serious impact on prices due to the presence of an active international market for fish, the fishing unions were prosecuted by the U.S. Department of Justice and found in violation of the Sherman Antitrust Act (Johnson, Ronald N., and Gary D. Libecap, “Contracting Problems and Regulation: The Case of the Fishery,” *American Economic Review* 72 (1982): 1005-22). Thus, U.S. inshore fisheries have effectively been open-access resources during much of the twentieth century as a result of governmental action to prevent local fishing groups from establishing forms of common-property regimes within those political jurisdictions. In more recent times, however, both the national and state governments have reversed their prior stands and have actively sought ways of creating forms of co-management in inshore fisheries (see Pinkerton, Evelyn, “Conclusions: Where Do We Go From Here? The Future of Traditional Ecological Knowledge and Resource Management in Canadian Native Communities,” in *Traditional Ecological Knowledge and Environmental Assessment*, ed. P. Boothroyd and B. Sadler (Ottawa: Canadian Environmental Assessment Research Council, 1992); Pinkerton, *supra* note 31; Wilson, James A., “When are Common Property Institutions Efficient?,” working paper, Department of Agriculture and Resource Economics, University of Maine, Orono, 1995)).

⁴⁴Lueck, Dean, “Common Property as an Egalitarian Share Contract,” *Journal of Economic Behavior and Organization* 25 (1994): 93-108; Eggertsson, Thráinn, *Economic Behavior and Institutions* (Cambridge University Press, 1990); Eggertsson, Thráinn, “Analyzing Institutional Successes and Failures: A Millennium of Common Mountain Pastures in Iceland,” *International Review of Law and Economics* 12 (1992): 423-37; Eggertsson, Thráinn, “The Economic Rationale for Communal Resources,” in *Common Property Regimes: Law and Management of Non-Private Resources; Proceedings of the Conference, vol. I*, ed. Erling Berge (Ås, Norway: The Agricultural University of Norway, 1993); Eggertsson, Thráinn, “The Economics of Institutions: Avoiding the Open-Field Syndrome and the Perils of Path Dependence,” *Acta Sociologica* 36 (1993): 223-37.

local participants have been nationalized, state control has usually proved to be less effective and efficient than control by those directly affected, if not disastrous in its consequences.⁴⁵

The Confusion Over What Property Rights Are Involved in “Ownership”

A property right is an enforceable authority to undertake particular actions in a specific domain.⁴⁶ Property rights define actions that individuals can take in relation to other individuals regarding some “thing.” If one individual has a right, someone else has a commensurate duty to observe that right. Schlager and Ostrom identify five major types of property rights that are most relevant for

⁴⁵Hilton, Rita, “Institutional Incentives for Resource Mobilization: An Analysis of Irrigation Schemes in Nepal,” *Journal of Theoretical Politics* 4(3) (1992): 283-308; Curtis, Donald, *Beyond Government: Organizations for Common Benefit* (London: Macmillan, 1991); Panayotou, Theodore, and Peter S. Ashton, *Not by Timber Alone: Economics and Ecology for Sustaining Tropical Forests* (Washington, DC: Island Press, 1992); Ascher, William, *Communities and Sustainable Forestry in Developing Countries* (Oakland, CA: ICS Press, 1995). The harmful effects of nationalizing forests that had earlier been governed by local user-groups have been well documented for Thailand (Feeny, David, “Agricultural Expansion and Forest Depletion in Thailand, 1900-1975,” in *World Deforestation in the Twentieth Century*, ed. John F. Richards and Richard P. Tucker (Durham, NC: Duke University Press, 1988), 112-43), Niger (Thomson, James T., “Ecological Deterioration: Local-Level Rule-Making and Enforcement Problems in Niger,” in *Desertification: Environmental Degradation in and around Arid Lands*, ed. Michael H. Glantz (Boulder, CO: Westview Press, 1977), 57-79; Thomson, James T., David Feeny, and Ronald J. Oakerson, “Institutional Dynamics: The Evolution and Dissolution of Common-Property Resource Management,” in *Making the Commons Work: Theory, Practice, and Policy*, ed. Daniel W. Bromley, et al. (Oakland, CA: ICS Press, 1992), 129-60), Nepal (Arnold, J.E.M., and J. Gabriel Campbell, “Collective Management of Hill Forests in Nepal: The Community Forestry Development Project,” in *Proceedings of the Conference on Common Property Resource Management*, ed. National Research Council (Washington, DC: National Academy Press, 1986), 425-54; Messerschmidt, Donald A., “People and Resources in Nepal: Customary Resource Management Systems of the Upper Kali Gandaki,” in *Proceedings of the Conference on Common Property Resource Management*, ed. National Research Council (Washington, DC: National Academy Press, 1986), 455-80), and India (Gadgil, Madhav, and Prema Iyer, “On the Diversification of Common-Property Resource Use by Indian Society,” in *Common Property Resources: Ecology and Community-Based Sustainable Development*, ed. Fikret Berkes (London, Belhaven Press, 1989), 240-72; Jodha, Narpat S., “Depletion of Common Property Resources in India: Micro-level Evidence,” in *Rural Development and Population: Institutions and Policy*, ed. G. McNicoll and M. Cain (Oxford: Oxford University Press, 1990), 261-83; Jodha, Narpat S., “Property Rights and Development,” in *Rights to Nature*, ed. Susan S. Hanna, Carl Folke, and Karl-Göran Mäler (Washington, DC: Island Press, 1996), 205-22). Similar results have occurred in regard to inshore fisheries taken over by state or national agencies from local control by the inshore fishermen themselves (Cordell, John C., and Margaret A. McKean, “Sea Tenure in Bahia, Brazil,” in *Making the Commons Work: Theory, Practice, and Policy*, ed. Daniel W. Bromley, et al. (Oakland, CA: ICS Press, 1992), 183-205; Cruz, Wilfrido D., “Overfishing and Conflict in a Traditional Fishery: San Miguel Bay, Philippines,” in *Proceedings of the Conference on Common Property Resource Management*, ed. National Research Council (Washington, DC: National Academy Press, 1986), 115-35; Dasgupta, Partha, *The Control of Resources* (Cambridge, MA: Harvard University Press, 1982); Higgs, 1996, supra note 43; Panayotou, Theodore, “Management Concepts for Small-Scale Fisheries: Economic and Social Aspects,” FAO Fisheries Technical Paper no. 228, Food and Agriculture Organization of the United Nations, Rome, Italy, 1982; Pinkerton, Evelyn, ed., *Co-Operative Management of Local Fisheries: New Directions for Improved Management and Community Development* (Vancouver, Canada: University of British Columbia, 1989).

⁴⁶Commons, John R., *Legal Foundations of Capitalism* (Madison: University of Wisconsin Press, 1968).

the use of common-pool resources, including access, extraction,⁴⁷ management, exclusion, and alienation. These are defined as:

- Access: The right to enter a defined physical area and enjoy nonsubtractive benefits (e.g., hike, canoe, sit in the sun).
- Extraction: The right to obtain resource units or products of a resource system (e.g., catch fish, divert water).
- Management: The right to regulate internal use patterns and transform the resource by making improvements.
- Exclusion: The right to determine who will have access rights and withdrawal rights, and how those rights may be transferred.
- Alienation: The right to sell or lease management and exclusion rights.

In much of the economics literature, as well as the legal literature, private property is defined as holding the right of alienation. Property-rights systems that do not contain the right of alienation are considered by many scholars to be *ill-defined*. Further, they are presumed to lead to inefficiency since property-rights holders cannot trade their interest in an improved resource system for other resources, nor can someone who has a more efficient use of a resource system purchase that system in whole or in part.⁴⁸ Consequently, it is assumed that property-rights systems that include the right to alienation will be transferred to their highest valued use. Larson and Bromley⁴⁹ challenge this commonly held view and show that much more information must be known about the specific values of a large number of parameters before judgements can be made concerning the efficiency of a particular type of property right.

Scholars studying common-property systems have found that it is more useful to examine which of the five classes of property-rights bundles are exercised in the field and what kind of consequences result. In this view, private individuals, private associations or firms, and governments may hold well-defined property rights that include or do not include all five of the rights defined above. This approach separates the question of whether a particular right is well-defined from the questions of who possesses and which rights are possessed.

“Authorized entrants” include most recreational users of national parks who purchase an operational right to enter and enjoy the natural beauty of the park, but do not have a right to harvest forest products. Those who have both entry and withdrawal use-right units are “authorized users.”

⁴⁷In Schlager and Ostrom, the term used for *extraction* is *withdrawal* (Schlager, Edella, and Elinor Ostrom, “Property Rights Regimes and Natural Resources: A Conceptual Analysis,” *Land Economics* 68(3) (1992): 249-62).

⁴⁸Demsetz, *supra* note 25.

⁴⁹Larson, Bruce A., and Daniel W. Bromley, “Property Rights, Externalities, and Resource Degradation: Locating the Tragedy,” *Journal of Development Economics* 33 (1990): 235-62.

The contents of the bundle of rights of an authorized user may vary substantially in regard to the quantity, timing, location, and use of resource units appropriated from a resource system. The presence or absence of constraints upon the timing, technology used, purpose of use, and quantity of resource units harvested are usually determined by operational rules devised by those holding the collective-choice rights (or authority) of management and exclusion over the resource system.⁵⁰ An external authority, however, may mandate that the owner of a resource system must allow some access and/or withdrawal rights to another individual or group than the proprietor or owner of the resource system.

“Claimants” possess the operational rights of access and withdrawal plus a collective-choice right of managing a resource that includes decisions concerning the construction and maintenance of facilities and the authority to devise limits on withdrawal rights. Fishing territories are a frequent form of property for indigenous, inshore fishers.⁵¹ Farmers on large-scale government irrigation systems frequently devise rotation schemes for allocating water on a branch canal.⁵²

“Proprietors” hold the same rights as claimants with the addition of the right to determine who may access and harvest from a resource. Most of the property systems that are called “common-property” regimes involve participants who are proprietors and have four of the above rights, but do not possess the right to sell their management and exclusion rights even though they most frequently have the right to bequeath it to members of their family and to earn income from the resource. “Full Owners” possess the right of alienation—the right to transfer a good in any way the owner wishes that does not harm the physical attributes or uses of other owners—in addition to the bundle of rights held by a proprietor. An individual, a private corporation, a government, or a communal group may possess full ownership rights to any kind of good including a common-pool

⁵⁰The operational rights of entry and use may be finely divided into quite specific “tenure niches” (Bruce, John W., *Legal Bases for the Management of Land-Based Natural Resources as Common Property*, Forests, Trees and People Programme, Food and Agriculture Organization of the United Nations, Rome, Italy, 1995) that vary by season, by use, by technology, and by space. Tenure niches may overlap when one set of users owns the right to harvest fruits from trees, another set of users owns the right to the timber in these trees, and the trees may be located on land owned by still others (Bruce, John W., Louise Fortmann, and Calvin Nhira, “Tenures in Transition, Tenures in Conflict: Examples from the Zimbabwe Social Forest,” *Rural Sociology* 58(4) (1993): 626-42). Operational rules may allow authorized users to transfer access and withdrawal rights either temporarily through a rental agreement, or permanently when these rights are assigned or sold to others (see Adasiak, Allen, “Alaska’s Experience with Limited Entry,” *Journal of the Fisheries Research Board of Canada* 36(7) (1979): 770-82, for a description of the rights of authorized users of the Alaskan salmon and herring fisheries).

⁵¹Durrenberger, E. Paul, and Gisli Palsson, “The Grass Roots and the State: Resource Management in Icelandic Fishing,” in *The Question of the Commons: The Culture and Ecology of Communal Resources*, ed. B. J. McCay and J. M. Acheson (Tucson, AZ: University of Arizona Press, 1987). Another example is the net fishers of Jambudwip, India, who annually regulate the positioning of nets so as to avoid interference, but do not have the right to determine who may fish along the coast (Raychaudhuri, Bikash, *The Moon and the Net: Study of a Transient Community of Fishermen at Jambudwip* (Calcutta, India: Government of India Press, Anthropological Survey of India, 1980)).

⁵²Benjamin, Paul, Wai Fung Lam, Elinor Ostrom, and Ganesh Shivakoti, *Institutions, Incentives, and Irrigation in Nepal*, Decentralization: Finance & Management Project Report, Burlington, VT, Associates in Rural Development, 1994.

resource.⁵³ The rights of owners, however, are never absolute. Even private owners have responsibilities not to generate particular kinds of harms for others.⁵⁴

What is important for the context of this conference about this view of property rights is that property rights to the flow of units from a resource system are frequently held by different actors than those who hold rights related to the system itself. Further, empirical studies of common-property institutions have found that proprietors (as contrasted to full owners) have sufficient rights to make decisions that promote long-term investment in, and sustainable harvesting from, a resource.⁵⁵

A key finding from multiple studies is that *no* set of property rights works equivalently in all types of settings. For private-property systems in land to make a difference in productivity gains, one needs 1) a somewhat dense population so competition for use is present and 2) the existence of effective markets related to credit, inputs, and the sale of commodities. In a series of studies of inshore fisheries, self-organized irrigation systems, forest user groups, and groundwater institutions, proprietors tended to develop strict boundary rules to exclude noncontributors; established authority rules to allocate withdrawal rights; devised methods for monitoring conformance; and used graduated sanctions against those who did not conform to these rules.⁵⁶

⁵³Montias, John Michael, *The Structure of Economic Systems* (New Haven, CT: Yale University Press, 1976); Dahl, Robert A., and Charles E. Lindblom, *Politics, Economics and Welfare: Planning and Politico-Economic Systems Resolved into Basic Social Processes* (New York: Harper, 1963).

⁵⁴Demsetz, supra note 25.

⁵⁵Place, Frank, and Peter Hazell, "Productivity Effects of Indigenous Land Tenure Systems in Sub-Saharan Africa," *American Journal of Agricultural Economics* 75 (1993): 10-19, conducted surveys in Ghana, Kenya, and Rwanda to ascertain if indigenous land-right systems were a constraint on agricultural productivity. They and others found that having the rights of a proprietor as contrasted to an owner in these settings did not affect investment decisions and productivity. In densely settled regions, however, proprietorship over agricultural land may not be sufficient (Feder, Gershon, T. Onchan, Y. Chalamwong, and C. Hangladoran, *Land Policies and Form Productivity in Thailand* (Baltimore, MD: Johns Hopkins University Press, 1988); Feder, Gershon, and David Feeny, "Land Tenure and Property Rights: Theory and Implications for Development Policy," *World Bank Economic Review* 5(1) (1991): 135-53; Anderson, Terry L., and Dean Lueck, "Land Tenure and Agricultural Productivity on Indian Reservations," *Journal of Law and Economics* 35 (1992): 427-54). As land is densely settled, the absence of a title reduces the options for farmers to sell their land and reap a return on this asset. And without a title, farmers lack collateral to obtain credit to invest more intensively in the productive potential of their land (see Alston, Lee J., Gary D. Libecap, and Robert Schneider, "The Determinants and Impact of Property Rights: Land Titles on the Brazilian Frontier," *Journal of Law, Economics and Organization* 12 (1996): 25-61).

⁵⁶Agrawal, Arun, "Rules, Rule Making, and Rule Breaking: Examining the Fit between Rule Systems and Resource Use," in *Rules, Games, and Common-Pool Resources*, ed. Elinor Ostrom, Roy Gardner, and James M. Walker (Ann Arbor: University of Michigan Press, 1994), 267-82; Blomquist, William, *Dividing the Waters: Governing Groundwater in Southern California* (Oakland, CA, ICS Press, 1992); Schlager, Edella, "Fishers' Institutional Responses to Common-Pool Resource Dilemmas," in *Rules, Games, and Common-Pool Resources*, ed. Elinor Ostrom, Roy Gardner, and James M. Walker (Ann Arbor: University of Michigan Press, 1994), 247-65; Tang, Shui Yan, "Building Community Organizations: Credible Commitment and the New Institutional Economics," *Human Systems Management* 13 (1994): 221-32; Lam, Wai Fung, *Governing Irrigation Systems in Nepal: Institutions, Infrastructure, and Collective Action* (Oakland, CA: ICS Press, 1998).

Further, it should be no surprise to this audience that the world of property rights is far more complex than simply government, private, and common property. These terms better reflect the status and organization of the *holder* of a particular bundle of rights. All of the above rights can be held by single individuals or by collectivities. Some communal fishing systems grant their members all five of the above rights, including the right of alienation.⁵⁷ Members in these communal fishing systems have full ownership rights. Similarly, farmer-managed irrigation systems in Nepal, the Philippines, and Spain have established transferable shares to the systems. Access, withdrawal, voting, and maintenance responsibilities are allocated by the amount of shares owned.⁵⁸ On the other hand, some proposals to “privatize” inshore fisheries through the devise of an Individual Transferable Quota (ITQ) allocate transferable use rights to authorized fishers, but do not allocate rights related to the management of the fisheries, the determination of who is a participant, nor the transfer of management and exclusion rights. Thus, proposals to establish ITQ systems, which are frequently referred to as forms of “privatization,” do not involve full ownership.

Most of the CPR examples discussed so far have been natural resource systems and human-made resources such as irrigation systems. In the past five years, more and more scholars have broken away from the erroneous idea that “commons” were antiquated institutions mainly prevalent in developing countries managed by indigenous peoples. Interdisciplinary researchers are finding great benefit in applying CPR analysis to a number of new and/or unrecognized common-pool resources.⁵⁹ Most works written to-date studying the Internet as a common-pool resource⁶⁰ center

⁵⁷Miller, David, “The Evolution of Mexico’s Spiny Lobster Fishery,” in *Common Property Resources: Ecology and Community-Based Sustainable Development*, ed. Fikret Berkes (London: Belhaven Press, 1989), 185-98.

⁵⁸Martin, Edward G., and Robert Yoder, “Review of Farmer-Managed Irrigation in Nepal,” in *Water Management in Nepal: Proceedings of the Seminar on Water Management Issues, July 31-August 2* (Kathmandu, Nepal: Ministry of Agriculture, Agricultural Projects Services Centre, and the Agricultural Development Council, 1983), 82-91; Martin, Edward G., and Robert Yoder, “The Chherlung Thulo Kulo: A Case Study of a Farmer-Managed Irrigation System,” in *Water Management in Nepal: Proceedings of the Seminar on Water Management Issues, July 31-August 2* (Kathmandu: Nepal, Ministry of Agriculture, Agricultural Projects Services Centre, and the Agricultural Development Council, 1983), 203-17; Martin, Edward G., and Robert Yoder, “Water Allocation and Resource Mobilization for Irrigation: A Comparison of Two Systems in Nepal,” presented at the annual meeting of the Nepal Studies Association, University of Wisconsin, Madison, November 4-6, 1983; Martin, Edward G., “Resource Mobilization, Water Allocation, and Farmer Organization in Hill Irrigation Systems in Nepal,” Ph.D. dissertation, Cornell University, 1986; Siy, Robert Y., Jr., *Community Resource Management: Lessons from the Zanjera* (Quezon City, Philippines: University of the Philippines Press, 1982); Maass, *supra* note 30.

⁵⁹Some of these include studies of: surfer’s waves, sports, national budgets, public radio, traditional music, indigenous knowledge, air slots, campus commons; urban commons [apartment communities and residential community associations, streets, parking places, playgrounds, reclaimed buildings etc.]; highways and transboundary transportation systems, the Internet [domain names, infrastructure, information, acceptable use policies]; tourism landscapes; cultural treasures; car-sharing institutions; garbage; and sewage. For citations to these works, see Hess, *supra* note 14.

⁶⁰Bernbom, *supra* note 38; Hess, Charlotte, “Untangling the Web: The Internet as a Commons,” revised version of paper presented at the Transnational Institute Workshop “Reinventing the Commons,” November 4-5, 1995, Bonn, Germany, 1996; Goldsmith, J., “The Internet, Conflicts of Regulation, and International Harmonization,” in *Governance of Global Networks in the Light of Differing Local Values*, ed. C. Engel and K. H. Keller (Baden:

on the technology infrastructure and the social network issues rather than the institutions developed about the distributed information per se. Addressing scientific information, some of the most useful works in recent years have been those based on Michael Heller's groundbreaking work on *anticommons*.⁶¹ Heller's work demonstrates that among the usual outcomes of a shared resource (particularly overuse,⁶² but also depletion, congestion, pollution, etc.), the occurrence of "underprovision" of a traditionally available resource is not only possible but of growing concern because of increasing commodification of information through new legislation, competing markets, and the recent run on patents.⁶³

IV. ARTIFACTS, FACILITIES, AND CONTENT OF SCHOLARLY INFORMATION

In CPR research, the distinction between resource system and resource units has proved very helpful in analyzing the impact of diverse property rights on the incentives of participants in regard to resource systems and resource units related to water, fisheries, and other natural resources. When water rights to a groundwater basin are adjudicated, litigants receive defined quantities or shares of the flow to the system. They are not receiving a portion of land that goes down below their surface land. That much-earlier conception proved to be inadequate in the adjudication of groundwater rights. So, where water rights have been adjudicated and privatized, what has been privatized is the *flow*. The resource system itself is a *facility* that holds the flow and is not privately owned by a single person or organization unless there is a single overlying owner that owns all the surface land over a groundwater basin. Similarly, with individual transferable quota systems that are extensively used in regard to fisheries, what has been privatized is either a proportion of the estimated yield or an amount of fish that is assigned to each boat for a season.

Nomos Vlg., 2000); Kollock, P., and M. Smith, "Managing the Virtual Commons: Cooperation and Conflict in Computer Communities," in *Computer-mediated Communication; Linguistic, Social and Cross-cultural Perspectives*, ed. S. C. Herring (Philadelphia: J. Benjamins, 1996); Huberman, B. A., and R. M. Lukose, "Social Dilemmas and Internet Congestion," *Science* 277(5325) (1997): 535-537; Nathenson, I. S., "Showdown at the Domain Name Corral: Property Rights and Personal Jurisdiction Over Squatters, Poachers and Other Parasites," *University of Pittsburgh Law Review* 58(4) (1997): 911-990; Noonan, Douglas S., "Internet Decentralization, Feedback, and Self-Organization," in *Managing the Commons*, ed. J. A. Baden and D. S. Noonan (Bloomington: Indiana University Press, 1998).

⁶¹Heller, Michael A., "The Tragedy of the Anticommons: Property in the Transition from Marx to Markets," *Harvard Law Review* 111(3) (1998): 622-688.

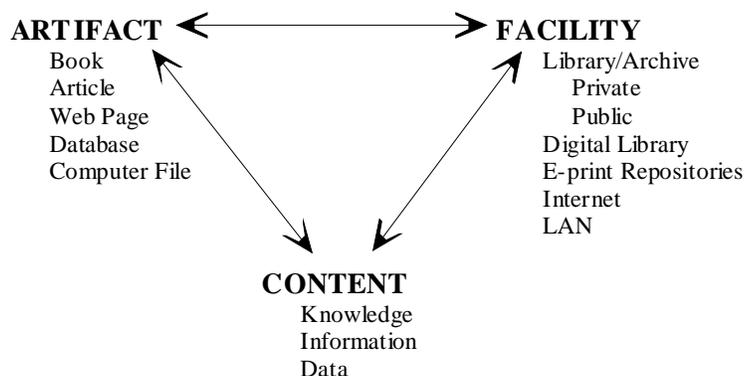
⁶²Ostrom, Elinor et al., "Revisiting the Commons: Local Lessons, Global Challenges," *Science* 284(5412) (1999): 278-82.

⁶³See also, Aoki, Keith, "Neocolonialism, Anticommons Property, and Biopiracy in the (Not-So-Brave) New World Order of International Intellectual Property Protection," *Indiana Journal of Global Legal Studies* 6(1) (1998): 11-58; Heller, M. A., and R. S. Eisenberg, "Can Patents Deter Innovation? The Anticommons in Biomedical Research," *Science* 280(5364) (1998): 698-701; Parisi, Francesco, Norbert Schulz, and Ben Depoorter, "Duality in Property: Commons and Anticommons," Würzburg Economic Papers, no. 21, Universität Würzburg, Lehrstuhl für Volkswirtschaftslehre, Würzburg, Germany, 2000; and Rose, Carol M., "Symposium: Critical Approaches to Property Institutions: Left Brain, Right Brain and History in the New Law and Economics of Property," *Oregon Law Review* 79 (2000), p. 479.

In struggling with the application of the evolving theory of common-pool resources to the study of information and the intellectual public domain, we would like to pose that this two-way distinction is not as useful as a three-way distinction between the artifact, the facility, and the content.

- An *artifact* is a discreet, observable, namable representation of an idea or set of ideas. In regard to scholarly information, examples of artifacts include articles, research notes, books, databases, maps, computer files, webpages. Artifacts vary in their durability. Physical artifacts can be used in a sequential fashion by multiple readers. Digital artifacts can be used concurrently by multiple users. Artifacts are the physical flow units from an information facility.
- A *facility* stores and makes available artifacts. It is a resource system storing the artifacts and their informational content. Prior to the development of digital artifacts, traditional facilities were public and private libraries and archives that stored physical artifacts. A facility had a physical limit on the number and type of artifacts that could be stored. While the cost of excluding users was not usually extremely high, many libraries and archives did invest in the development of well-defined rules regarding who would be considered legitimate users, how long individuals could legally remove artifacts from the facilities, and the practices that were

Figure 2. **Forms of Information**



to be followed within the facility (silence, no dancing) and in the use of the artifact (no highlighting, tearing out pages, etc.) and guards for monitoring and enforcing these rules. The facilities themselves were subject to deterioration if a substantial investment was not made in their maintenance. Private collections were usually not open to the public.

- The *content* of an artifact in a facility is usually referred to as information—the bundle of data, ideas, and knowledge. Information is the nonphysical flow units contained in an artifact. This is the element that copyright does not protect.⁶⁴

⁶⁴Jessica Litman writes, “The copyright will protect the expression in the work from being copied without permission, but will give *no protection whatsoever to the underlying ideas, facts, systems, procedures, methods of operation, principles, or discoveries*” (our emphasis). Litman, Jessica, *Digital Copyright* (Amherst, NY:

It is our sense that in analyzing information in the public domain, developing a more careful understanding of the processes of providing and producing the information and artifacts, providing and producing information facilities, distributing artifacts to facilities and to users, and the various forms of consuming and using the information content of these artifacts is needed before one can begin to develop a better legal structure for these processes as they are challenged by new technology in a global environment.

“Information” is a difficult term to define.⁶⁵ To economists, it can mean complete or incomplete knowledge, true or accurate knowledge; to governments, it can mean knowledge ranging from public to top-secret. In legal terms, it can mean that the conduit of information is currently owned, previously owned, or as yet unclaimed. NGOs and donor agencies see access to information as the key ingredient for economic development. Referring to the multiple types of information issues, Boyle has written: “. . . is there anything, apart from the word information, that holds these issues together. If there is some useful link, is it new to our society?”⁶⁶

Information and knowledge as raw terms have been dissected and defined in several ways. Machlup introduced the division of data-information-knowledge, with data being raw bits of information; information as organized data in context; and knowledge as the assimilation of the information and understanding of how to use it.⁶⁷ Reichman and Franklin discuss the “dual function of information,” which has high value as a commodity and as “the foundation of knowledge in the information economy.”⁶⁸ Lyman writes that the “the definition of the concept of information must be at the heart of any information policy.”⁶⁹ Popper earlier stressed that the knowledge contained in scientific reports, articles, and books comes to have an autonomous existence as it affects the thinking and research of the next generation of scientists.⁷⁰

Braman presents a thorough survey of ways to look at information for policymakers, pointing out that the argument over how to define information is critical. Examined are information as a commodity, as a perception of pattern, as a constitutive force in society. Her analysis of information as a resource emphasizes how people **use** information rather than information’s effect

Prometheus Books, 2001), p. 17.

⁶⁵A recent *New York Times* article reported on an informal meeting of physicists and computer scientists to debate the meaning of the technology revolution. “The scholars found that instead that they could not even agree on useful definitions of their field’s most common terms, like ‘information’ and ‘complexity,’ let alone the meaning and future of this revolution” (Overbye, Dennis, “Time of Growing Pains for Information Age,” *New York Times*, Aug. 7, 2001).

⁶⁶Boyle, *supra* note 1, p. 6.

⁶⁷Machlup, F., “The Economics of Information: A New Classification,” *InterMedia* 11(2) (1983): 28-37.

⁶⁸Reichman and Franklin, *supra* note 1.

⁶⁹See Lyman, Peter, “The Article 2B debate and the Sociology of the Information Age,” *Berkeley Tech L. J.* 13 (1998): 1063-1087.

⁷⁰“The world of language, of conjectures, theories, and arguments—in brief, the university of objective knowledge—is one of the most important of these man-created, yet at the same time largely autonomous, universes” (Popper, Karl, “Epistemology Without a Knowing Subject,” in *Objective Knowledge* (Oxford: Oxford University Press, 1972), p. 188).

upon people.⁷¹ For the purposes of our paper, Hayek’s classic analysis of the essential two types of knowledge in order to bring a clear understanding remains crucially relevant in the construction of scientific knowledge and information policy. He wrote in 1945 that while we are used to respecting scientific knowledge gathered by experts, it is only in combination with “local knowledge” that the knowledge takes on a real value. All of the valid research on common-pool resources involves this combination of scientific knowledge with time and place analysis, or as Hayek puts it, the “special knowledge of circumstances.”⁷²

In any discussion of information it is useful to remember that information is an institution, a human artifact, with agreements and rules, and strongly tied to the rules of language itself.⁷³ Thus, information has an important cultural component as well as intellectual, economic, political functions. As such, it is a *flow resource* that must be passed from one individual to another in order to have any public value.⁷⁴

Information property and contract laws are only a few of the complex issues facing scholarly communication. Current and future dilemmas extend much further than the legal questions of formal ownership and regulation. Other important areas include informal agreements and standards, transaction costs, new user communities, globalization, growing international collaborative research, language, interdisciplinarity, interoperability, reliability, and accessibility. But analyzing the whole ecosystem of scholarly information is much more tenuous than in *Governing the Commons*,⁷⁵ where 1) the boundaries were clear, 2) the resource systems studied were small and easy to observe, 3) solving problems was of high salience to appropriators, 4) institutions were long-enduring and had evolved over time, and 5) extensive field observation was available. The CPR resources were analyzed by examining the physical characteristics of that resource, the community of users and the actors involved in a situation, along with the rules-in-use that determine actions taken, the costs of those actions, the outcomes that can be achieved, how those actions are linked to outcomes, what information is available, how much control individuals can exercise, and what payoffs are to be assigned to particular combinations of actions and outcomes.⁷⁶

⁷¹Braman, Sandra, “Defining Information: An Approach for Policymakers,” in *The Economics of Communication and Information*, ed. D. M. Lambertson, pp. 1-12 (Brookfield, MA: Elgar, 1989).

⁷²Hayek, supra note 7.

⁷³Vincent Ostrom has repeatedly emphasized the artifactual nature of knowledge and institutions: “*Every development—street sweeping, production of fertilizers, irrigation works, the development of new seed stocks—has a component to it that is concerned with how the activities of people are organized in relation to one another*” (Ostrom, Vincent, “Organization of Decision-Making Arrangements and the Development of Atmospheric Resources,” Working Paper, Workshop in Political Theory and Policy Analysis, Indiana University, Bloomington, Indiana, 1968).

⁷⁴See Cooper, Mark, “Symposium Overview: Part II: Unbundling and Open Access Policies: Open Access to the Broadband Internet: Technical and Economic Discrimination in Closed, Proprietary Networks,” *U. Colorado L. Rev.* 71 (2000): p. 1046+, for a discussion of the problem of *flow control* or filtering the flow of distributed information.

⁷⁵E. Ostrom, supra note 31.

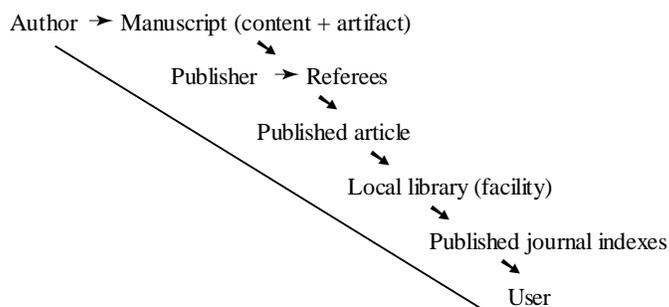
⁷⁶This methodological tool, called the Institutional Analysis and Development (IAD) Framework, is discussed at length in chapter 2 of Ostrom, Gardner, and Walker, supra note 32.

Information, on the other hand, often has complex tangible and intangible attributes; unclear or no boundaries; a diverse community of users on local, regional, national, and international levels; and multiple layers of rule-making institutions. Until the invention of digital technologies, the flow of most scholarly information was easy to follow. One typical flow pattern was:

Each of the arrows in Figures 3 through 5 represents a transition where property rights may change in regard to the person or organization who holds the rights and/or in regard to the specific bundle of rights held. While the author retained copyright protection for her unique expression of ideas in a book or journal, the publishers owned reproduction rights to the work, and sold copies of their artifacts to decentralized facilities (in this case, local libraries). The libraries owned their individual copies of the book, took responsibility for the organization, storage, preservation, and distribution of their “resource units.” Working within the parameters of the formal rules of copyright and fair use, the individual facilities designed the rules-in-use regarding the distribution and the qualified community of users.

The journal articles as resource units are renewable over time. The content is nonsubtractable and the physical artifact is only temporarily subtractable during one person’s use. Even if the artifact is stolen or destroyed, replenishment is possible through re-purchase or through Interlibrary Loan.

Figure 3. **Traditional Flow Pattern of Content → Artifact → Facility → User**



The rules are different with digital information. Barlow pointed out several years ago that digitization, which converts information to ones and zeroes as a conduit of information content, has obfuscated the “wine from the bottle”⁷⁷; that is, the physical characteristics and the boundaries of the resource are no longer clear. The information is often licensed rather than owned. It is “fugitive” rather than fixed, in that all the information can be withdrawn by the publishers when the license agreements run out. Digital information can also be more fragile in that storage of the primary databases and/or digital collections is often centralized. And, digitization provides new and previously unimagined uses for information.

⁷⁷“ . . . the bottle was protected, not the wine” (see Barlow, J. P., “Selling Wine Without Bottles: The Economy of Mind on the Global Net.” *Wired* 2(03) (1993), p. 86. In the same vein, Litman points out that “copyright protects a painting or photograph of an automobile, but gives no protection to the automobile itself” (Litman, *supra* note 64, p. 18.

Distributed digitized information, such as that on the Internet, adds more layers of complexity to the flow. And, as with all common-pool resources, when technology changes the capture and use of the resource, the rules-in use and the community of users will also change. On the other hand, digital information, though subject to congestion, is generally nonsubtractive; thus, the resource flow is not subject to erosion (deterioration) in that same way that physical information artifacts are (books, journals, newspapers, etc.)⁷⁸

V. THE EVOLUTION OF SCHOLARLY INFORMATION

Prior to 30 years ago, the primary information facilities for scholarly information were public and academic libraries. These facilities were in charge of preserving “the scholarly record and the materials for future research”⁷⁹ by collecting, storing, preserving, and making available scholarly artifacts—primarily books and journal articles. Legislation such as the Fair Use and First Sale Doctrines allowed libraries to provide access to the scholarly community.⁸⁰ Librarians consulted with university scholars and purchased mainly published scientific and academic books and journals. They made the distribution (lending) rules and defined the eligible community of users. At that time, it was clear who their community was. For a state university library, for example, this usually included the faculty, students, and staff at that university, and any citizen of that state. The library owned its collection and was responsible for the storage, organization, and long-term preservation of the artifacts. The scholarly community sent their articles off for publication and depended on library personnel to meet their needs.

Interlibrary Loan (ILL)⁸¹ was enhanced in the 1970s through the proliferation of new technology—the photocopy machine,⁸² which allowed for duplication and easy lending of journal articles. It was further developed by organization of OCLC, the first electronic union catalog. ILL changed the user communities to both local and remote groups. With the costs of books and journals skyrocketing, the focus of library services changed from primarily *owning* collections to primarily *accessing* collections.

Since 1995, the development of distributed digital information through network browsers has radically changed many of the traditional institutions of scholarly communication. Research information is moving much faster and much farther, often bypassing the normal publication process. While it is true that recent commodification and privatization of research information

⁷⁸See Madison, *supra* note 1, for a discussion of the essential problems with the architecture and boundaries of digital information: Digital computer network architecture—the substrate of cyberspace—has physical, virtual, and conceptual embodiments.

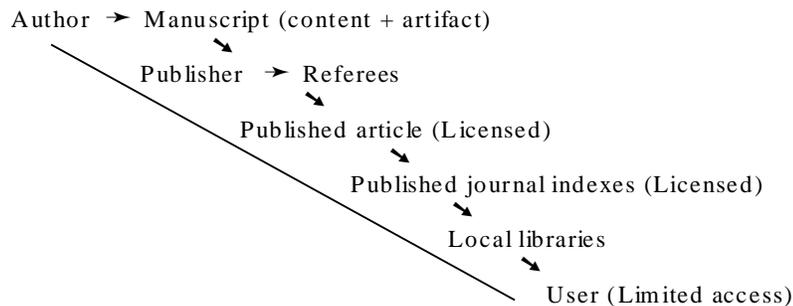
⁷⁹Lynch, Clifford A., “The Transformation of Scholarly communication and the Role of the Library in the Age of Network Information,” *Serials Librarian* 23(3/4) (1993), p. 14.

⁸⁰See Litman, *supra* note 64, p. 81+.

⁸¹ILL for books was begun by the Library of Congress in 1901. See http://www.nelinet.net/conf/ill/illac99/betsy_like.htm

⁸²The first office copier was introduced in 1959. See: <http://inventors.about.com/gi/dynamic/offsite.htm?site=http://www.sciam.com/1096issue/1096working.html>

Figure 4. **Traditional Flow of Digitized Information Today**



threatens the future of libraries' freedom to collect and distribute information, it is only one part of the story. Recent legislation, such as the Digital Millennium Copyright Act, the Sonny Bono Extension Act, the proposed legislation of the Uniform Computer Information Transactions Act (UCITA),⁸³ may all adversely affect the costs, access, and availability of scholarly information. This focus of the intellectual public domain literature (along with issues of privacy and encryption) concentrates almost solely on the history, interpretation, and possible outcomes of such legislation on copyrighted works that have been *published*. But formal publication is only one type of scholarly communication.

With distributed digitized information, there are various flow patterns of the artifacts with varying property rights or contract arrangements at different points of the process.

In this scenario, many of the rules-in-use are now determined by the publisher rather than the library, who may now license access rights rather than purchase the published artifacts. This change from property rights to contracts has multiple impacts on the distribution of scholarly information. The publisher may insist on a pay-per-view agreement, limiting the number of times the artifact can be accessed. Or, it may arbitrarily decide to withdraw certain journals that were formerly available. Frequently, publishers are “bundling” journals in a license package so that individual subscriptions cannot be cancelled by the libraries under that license agreement.⁸⁴ Because of the enormous costs of these “bundles,” there is a growing inequity between the capacity of small vs. large libraries to participate in these deals. The license agreements also raise questions about the future of Interlibrary Loan (which would be a remedy for smaller libraries) since most of the licenses will not allow the copying of digital information.

⁸³ For discussions of “technological locks” for information proposed by UCITA, see Travis, Hannibal, “Pirates of the Information Infrastructure,” *Berkeley Tech. L.J.* 15 (2000): 777-864; and Lyman, *supra* note 69.

⁸⁴ Kenneth Frazier gives as prime example Reed Elsevier, publishers of Lexis-Nexis, who have “both added and deleted content from their database at their discretion.” Frazier, K., “The Librarians’ Dilemma Contemplating the Costs of the ‘Big Deal.’” *D-Lib Magazine* 7(3) (March 2001).
<http://www.dlib.org/dlib/march01/frizier/03frazier.html>

A major spokesperson for the complexities of digital information for libraries, Clifford Lynch, noted in 1994 that if libraries didn't make major changes in their collection practices, their role in store-housing scholarly information would be called into doubt.⁸⁵ One of the primary worries is the centralization of digital information:

We have also yet to encounter the electronic analog of the burning of the great library at Alexandria (either due to natural disaster and inept off-site backup procedures or out of malice or cold, commercial calculation), which was so devastating precisely because in a pre-printing-press world there was such centralization of information at a single site. In a post-printing-press world, we run the danger of returning to the vulnerabilities inherent in such centralization. And it is not only publishers (both commercial and nonprofit) who are moving to centralized storage sites: government at all levels as well is exploiting the potential for low-cost distribution of information through computer networks.⁸⁶

Libraries seem at the mercy of the publishers of scholarly digital information. They are dependent on digital publishers not only for the primary journals but also for the indexing and cataloging of scholarly journals. With the routine adding and deleting of journal titles from journal indexes, publishers have enormous power to shape the appearance and availability of research. Hence, libraries are able to provide only limited access, rather than the previous open access to journals in their collection. However, even with the constraints of the new formal rules, library and information specialists are designing new institutions to deal with some of these problems. For instance, to tackle the problem of the precariousness or "fugitiveness" of digital information, one collective action initiative to counteract the loss of control over information is LOCKSS (Lots of Copies Keep Stuff Safe), which allows facilities to give permanence to the digital journals to which they subscribe.⁸⁷ If license agreements are cancelled, the libraries will still have digital copies of the journals to which they previously subscribed.

Public and academic libraries are also struggling with the possible ramifications of new IP legislation, which more and more often contradicts the very nature of digital information.

... copying occurs with all digital information. Use your computer to read a book, look at a picture, watch a movie, or listen to a song, and you inevitably make one or more copies. Contrast this with the use of traditional media:

⁸⁵Lynch, Clifford A., "Rethinking the Integrity of the Scholarly Record in the Networked Information Age," *Educom Review* 29(2) (1994) <http://www.educause.edu/pub/er/review/reviewArticles/29238.html>. See also Samuelson, P., and Davis, R., "The Digital Dilemma: A Perspective on Intellectual Property in the Information Age," presented at the Telecommunications Policy Research Conference '00, 2000, p. 18+. <http://www.sims.berkeley.edu/~pam/papers/digdilsyn.pdf>.

⁸⁶Lynch, *ibid*.

⁸⁷See <http://lockss.stanford.edu/projectdesfaq.htm>. This voluntary system "permits libraries to cache content they can access. If a library cancels a subscription and has not cached the content, they can not get access to that content in the future. If a library caches content and then cancels their subscription, they continue to have access to the content they cached."

Reading a book does not involve making a copy of it, nor does watching a movie or listening to a song.

This intimate connection between access and copying has considerable significance in the context of intellectual property protection. One of the essential elements of copyright—the right to control reproduction—works as expected in the world of traditional media, where there is an obvious distinction between access and reproduction and where the copyright owner’s control of reproduction provides just that. But in the digital world, where no access is possible except by copying, complete control of copying would mean control of access as well.⁸⁸

One type of action in response to the “digital dilemmas” is the increased monitoring, reporting, and educating in order to better inform the public and information professionals about proposed legislation that may affect the access, costs, and distribution of scholarly information. Professional groups such as the American Library Association⁸⁹ (ALA), EDUCAUSE, and the Association of Research Libraries (ARL) are taking on proactive roles to promote continued access to scholarly information. In ARL’s May 2001 Membership Meeting Proceedings, Jean-Claude Guédon stressed that “mapping effective counterattacks” against journal publishers who have transformed scholarly publication into big business “will require a fuller understanding of the situation and its roots.”⁹⁰

There are many other issues concerning digital information and libraries. Litman⁹¹ and Lessig,⁹² among others, have discussed the precariousness of the Fair Use and First Sale Doctrines applied to licensed digital information.⁹³ On the other hand, information providers are beginning to design new institutions in order to safeguard scholarly communication for future generations. Only slowly are they awakening to the realization that with international collaborative scientific research now routine, and with the global reach of distributed information, their community of users has greatly expanded. No longer can an information professional just select materials out of publishers’ catalogs to build viable collections. They also need to build trusted, reciprocal digital archive and repository systems.

⁸⁸Committee on Intellectual Property Rights and the Emerging Information Infrastructure, Computer Science and Telecommunications Board, Commission on Physical Sciences, Mathematics, and Applications, *The Digital Dilemma: Intellectual Property in the Information Age* (Washington, DC: National Research Council, National Academy Press, 2001), p. 31.

⁸⁹See, for instance, ALA’s Washington Office homepage at <http://www.ala.org/washoff/>; ARL’s pages on its Scholarly Publishing and Academic Resources Coalition (SPARC) at <http://www.arl.org/sparc/>; EDUCAUSE’s Washington Office on information technology Policy Issues at <http://www.educause.edu/policy/policy.html>.

⁹⁰ See Guédon, J-C., *In Oldenburg's Long Shadow: Librarians, Research Scientists, Publishers and the Control of Scientific Publishing* (Washington, DC: ARL, 2001).
<http://www.arl.org/arl/proceedings/138/guedon.html>

⁹¹Litman, *supra* note 10 and Litman, *supra* note 64.

⁹²See Lessig’s discussion of these issues in Lessig, L., *Code and Other Laws of Cyberspace* (NY: Basic Books, 1999), pp. 134+.

⁹³See also chapter 4, “Individual Behavior, Private Use and Fair Use, and the System for Copyright,” in Computer Science and Telecommunications Board, *supra* note 88.

In great contrast with the new legislation increasing copyright and patent restrictions, encouraging contract over property law with the constraints of embedded licensing agreements, is the international E-prints “revolution” that is making scholarly research freely available in unprecedented ways. The movement officially began with the mounting of arXiv.org at Los Alamos National Laboratory. Developed in 1991 by physicist and information specialist Paul Ginsparg, it was designed to serve as a repository for digital papers in physics and mathematics. By 1993, the site had received around 500 submissions. By September 30, 2001, the site had received 174,842 submitted papers.⁹⁴ Importantly, around 70% of the submissions came from outside of the United States.⁹⁵ The numbers reflect a better balance with much greater provision and access to international information, particularly in developing countries. The papers are free but unrefereed, requiring scholars themselves to judge the accuracy and quality of the work. This archive is the first that actually changes the representation and visibility of the scholarly record.⁹⁶ The average number of site users range from 60,000 to 160,000 per day depending upon the day of the week. [http://arxiv.org/show_weekdays_graph]

There are hundreds of other digital archives.⁹⁷ Some, like EconWPA <http://econwpa.wustl.edu/> are devoted to self-archiving and free distribution of working papers in economics. It is an impressive archive because of the number of other participating institutes. Others, like the Oxford Text Archive <http://ota.ahds.ac.uk/>, make available historical scholarly materials that are in the public domain and make the authorized, full-text versions universally available for free. BioMed Central <http://www.biomedcentral.com/> is the site of a commercial publisher that offers all its medicine and biology journal articles free of charge and provides a systematic pre-print service for research reports. The Digital Library of the Commons <http://dlc.dlib.indiana.edu/> is both an e-print repository for self-archiving as well as a traditional/digital library.

An example of an effective grassroots initiative is that taken by the Public Library of Science, a nonprofit organization of scientists dedicated to making the world’s scientific and medical literature freely accessible “for the benefit of scientific progress, education and the public good.”⁹⁸

⁹⁴See http://arxiv.org/show_monthly_submissions.

⁹⁵Figures from Ginsparg, Paul, “OAI and Scholarly Communication,” presented at the OAI meeting, Staatsbibliothek zu Berlin, Germany, February 26, 2001.

⁹⁶A 1995 survey revealed that the main index of scientific journals, the *Science Citation Index*, indexes 3,300 journals of the 70,000 that are published worldwide. Less than 2% of the journals indexed are from developing countries (with 80% of the world’s population). The author writes that the “near invisibility of less developed nations may reflect the economics and biases of science publishing as much as the actual quality of Third World Research” (see Gibbs, W. W., “Lost Science in the Third World,” *Scientific American* (August 1995): 92-99). On the other hand, scientific research collaboration is rapidly increasing on an international scale. According to the National Science Board’s *Science and Engineering Indicators—2000*, “growth in U.S. coauthorship reflects increases in international collaboration. By the mid-1990s, nearly one of every five U.S. articles had one or more international coauthors, up from 12 percent earlier in the decade” (National Science Board, *Science and Engineering Indicators 2000* (Washington, DC, 2000), chapter 6).

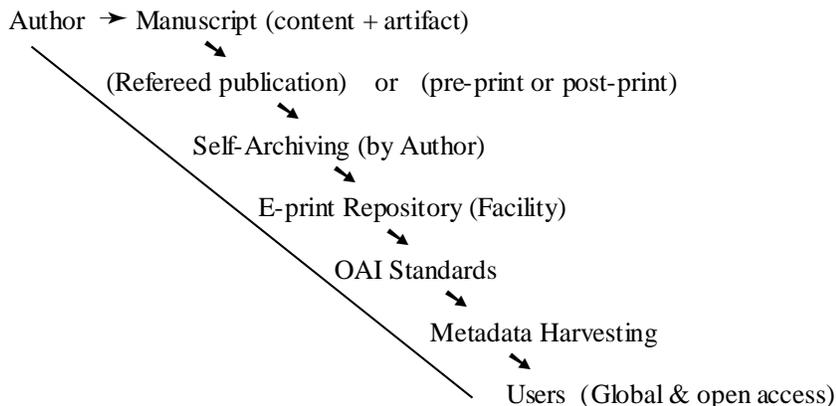
<http://www.nsf.gov/sbe/srs/seind00/access/toc.htm>

⁹⁷See Odlyzko, A., “The Rapid Evolution of Scholarly Communication” (2001) at <http://www.research.att.com/~amo> for statistics on increased usage of electronic papers, journals, and citations.

⁹⁸See <http://www.publiclibraryofscience.org> (Revisited 10-15-01).

PLS has so far encouraged over 28,000 scientists from 172 countries to sign its open letter to publishers to make their publications freely available on the website PubMed Central at <http://www.pubmedcentral.nih.gov/>. In October 2001, there were over 50 full-text journals available at this site.

Figure 5. **Self-archiving Digital Information Flow Using the Internet**



A breakthrough for alternative publishing initiatives came only two years ago with the development of new technologies, data and metadata standards, and information provision communities. The Open Archives Initiative (OAI) and the development of the free e-prints software [<http://www.eprints.org/>] are already reshaping the direction of scholarly publication by establishing “low-barrier” interoperable standards.⁹⁹ OAI was established in October 1999 by an international group of information scholars to develop and promote interoperability standards that aim to facilitate the efficient dissemination of scholarly communication through the establishment of archives for e-prints and other digital materials. In OAI terminology the information artifact is a “record.” The protocol developed by OAI provides access to the metadata of all OAI-compliant repositories by all networked servers (not limited to e-print servers).¹⁰⁰

In this scenario, the author takes on a self-governing role of distribution of scholarly information by submitting her digital file to an E-print repository (facility), such as CogPrints [<http://cogprints.soton.ac.uk/>], a repository for Cognitive Science, Psychology, Neuroscience, Philosophy, Linguistics, and Biology. If the article has been, or is to be, published, she may either

⁹⁹See, for instance, Lagoze, Carl, and Van De Sempel, Herbert, “The Open Archives Initiative: Building a Low-Barrier Interoperability Framework” (2001) <http://www.openarchives.org/documents/oai.pdf>

¹⁰⁰See Lynch, C., “Metadata Harvesting and the Open Archives Initiative,” *ARL Bimonthly Report* 217 (2001). <http://www.arl.org/newsltr/217/mhp.html>.

get permission from the publisher,¹⁰¹ amend the copyright transfer agreement with the publisher,¹⁰² or submit the preprint (the refereed version) or a postscript (a subsequent revision to the published version).

What's new in the self-archiving initiative is that authors are participating, independently of governments and markets, in an international epistemic community that is committed to building an interoperable global scholarly library—a universal public good for which the more who have access, the greater the benefit for everyone.

Earlier we stated that if anyone can use a resource . . . then no one has an incentive to conserve its use to invest in improvements (p. 10). However, this may not be the case for scholarly information. There are several incentives for taking an active role in these new information-production institutions. Cost is one. Paul Ginsparg estimates the average cost per published journal article to be between \$1000-2000; compared with the average cost of putting a self-archived paper on the web between \$1-\$100.¹⁰³ Universities have incentives to support such self-archiving initiatives. Stevan Harnad points out that such action would free libraries from the increasing burden of their serials budgets. “This would be a small investment with an eventually huge return (reduction and eventual elimination of all annual Subscription/Site-License/Pay-Per-View [S/L/P] expenditure).”¹⁰⁴ Rebecca Eisenberg points to scientific recognition and credibility that comes with public disclosure and increased visibility of information.¹⁰⁵ Global distribution of information facilitates better scholarly collaborative research. And, of course, a primary incentive is the sheer timeliness of distributed digital information with its ability to instantly publish and disseminate information, obviating the long delays of traditional publications.

A further development in building new standards, rules, and cooperative institutions to create resilience for the global knowledge resource is the growing movement to create *Trusted Digital Repositories*. A recent report by the Research Libraries Group and OCLC define the required actions and rules for such systems as having 1) Audibility, security, and communication; 2) Compliance and conscientiousness; 3) Certification, copying controls, and following rules; 4)

¹⁰¹As happened with a paper submitted to the Digital Library of the Commons, <http://dlc.dlib.indiana.edu/>, which had been published by the journal *Development and Change* in 1998.

¹⁰²See Harnad, Stevan, “For Whom the Gate Tolls? How and Why to Free the Refereed Research Literature Online Through Author/Institution Self-Archiving, Now” (2001) <http://www.cogsci.soton.ac.uk/~harnad/tp/resolution.htm>. Harnad, leader of the Self-Archiving Initiative, recommends that authors amend their copyright transfer agreements with their publishers as follows:

I hereby transfer to [publisher or journal] all rights to sell or lease the text (on-paper and on-line) of my paper [paper-title]. I retain only the right to distribute it for free for scholarly/scientific purposes, in particular, the right to self-archive it publicly online on the Web.

¹⁰³See Ginsparg, supra note 95. See also Ginsparg, P. “Creating a Global Knowledge Network,” presented at the Freedom of Information Conference, “The Impact of Open Access on Biomedical Research,” New York Academy of Medicine, June 6-7, 2000. <http://www.biomedcentral.com/info/ginsparg-ed.asp>.

¹⁰⁴Harnad, S., “Free at Last: The Future of Peer-Reviewed Journals.” *D-Lib Magazine* 5(12) (Dec. 1999). <http://www.dlib.org/dlib/december99/12harnad.html>.

¹⁰⁵Eisenberg, Rebecca S., “The Public Domain in Genomics” (2000) http://www.law.nyu.edu/ili/conferences/freeinfo2000/abstracts/eisenberg.html#N_1

Backup policies and avoiding, detecting, and restoring lost/corrupted information; 5) Reputation and performance; 6) Agreements between creators and providers; 7) Open sharing of information about what it is preserving and for whom; 8) Balanced risk, benefit, and cost; 9) Complementarity, cost-effectiveness, scalability, and confidence; and 10) Evaluation of system components.¹⁰⁶ These design principles point to the kinds of cooperative behaviors and system resilience that are needed in order to sustain scholarly information as a common-pool resource in an increasingly digital world.

¹⁰⁶Research Libraries Group, “Attributes of a Trusted Digital Repository: Meeting the Needs of Research Resources: An RLG-OCLC Report” (August 2001). <http://www.rlg.org/longterm/attributes01.pdf>.

VI. CONCLUSION

Governments, market forces, publishers, and traditional academic libraries can influence, but are not able to, stop the international movement of distributed information. The physical and virtual characteristics of distributed digital information have created a completely new type of information artifact.

The community of users—the international scholarly community—has grown increasingly aware that its shared resource of scholarly information is at risk. Growing international collaborative research necessitates immediate access and exchange of communication. Groups of scholars and information specialists have begun coordinating strategies to obtain higher joint benefits and to reduce their joint harm. Many of these collective-action initiatives are at the experimental stage, but the success of arXiv.org gives reason to believe in the success of other efforts to sustain the intellectual public domain.

We have described a gravitation of scholars' roles from passive *appropriator* of information to active *provider* of information by contributing directly into the common pool. Their multiple goals include not only sustaining the resource (the intellectual public domain) but building equity of information access and provision, and creating more efficient methods of dissemination through informal, shared protocols, standards, and rules among the local and global scholarly community.