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Ideas, Artifacts, and Facilities: Information as a Common-Pool Resource

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LAW AND CONTEMPORARY PROBLEMS

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

Charlotte Hess
Elinor Ostrom

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THE PUBLIC DOMAIN

James Boyle
Special Editor

FOREWORD: THE OPPOSITE OF PROPERTY? 1
James Boyle

THE SECOND ENCLOSURE MOVEMENT AND THE CONSTRUCTION OF THE PUBLIC DOMAIN.....33
James Boyle

NINE-TENTHS OF THE LAW: THE ENGLISH COPYRIGHT DEBATES AND THE RHETORIC OF THE PUBLIC DOMAIN 75
Mark Rose

ROMANS, ROADS, AND ROMANTIC CREATORS: TRADITIONS OF PUBLIC PROPERTY IN THE INFORMATION AGE 89
Carol M. Rose

IDEAS, ARTIFACTS, AND FACILITIES: INFORMATION AS A COMMON-POOL RESOURCE..... 111
Charlotte Hess and Elinor Ostrom

MAPPING THE DIGITAL PUBLIC DOMAIN: THREATS AND OPPORTUNITIES..... 147
Pamela Samuelson

THROUGH THE LOOKING GLASS: ALICE AND THE CONSTITUTIONAL FOUNDATIONS OF THE PUBLIC DOMAIN 173
Yochai Benkler

RECONCILING WHAT THE FIRST AMENDMENT FORBIDS WITH WHAT THE COPYRIGHT CLAUSE PERMITS: A SUMMARY EXPLANATION AND REVIEW.....225
William W. Van Alstyne

TWO RELATIONSHIPS TO A CULTURAL PUBLIC DOMAIN.....239
Negativland

"FAIREST OF THEM ALL" AND OTHER FAIRY TALES OF FAIR USE 263
David Nimmer

BAYH-DOLE REFORM AND THE PROGRESS OF BIOMEDICINE 289
Arti K. Rai and Rebecca S. Eisenberg

A CONTRACTUALLY RECONSTRUCTED RESEARCH COMMONS FOR SCIENTIFIC DATA IN A HIGHLY PROTECTIONIST INTELLECTUAL PROPERTY ENVIRONMENT..... 315
J. H. Reichman and Paul F. Uhlir

REIMAGINING THE PUBLIC DOMAIN 463
David Lange

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

CHARLOTTE HESS* AND ELINOR OSTROM**

I
INTRODUCTION

There is an increasing concern about the implications of recent and impending legislation on the future of academic research, open science, traditional knowledge, and the intellectual public domain. The Duke Law School Conference on the Public Domain brought together, for the first time, an interdisciplinary group of leading scholars studying the increasing enclosure[1] of the global information commons. In the past five years, law review articles have described an information arms race from various perspectives, with multiple sides battling for larger shares of the global knowledge pool.[2]

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This article is also available online at http://www.law.duke.edu/journals/66LCPHess. * Director, Workshop Research Library; Information Officer, International Association for the Study of Common Property; Director, Digital Library of the Commons.

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1. *See* James Boyle, *The Second Enclosure Movement and (he Construction of the Public Domain,* 66 LAW & CONTEMP. PROBS. 33 (Winter/Spring 2003).

2. There 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: JAMES BOYLE, SHAMANS, SOFTWARE, AND SPLEENS: LAW AND THE CONSTRUCTION OF THE INFORMATION SOCIETY (1996); Yochai Benkler, *Free as the Air to Common Use: First Amendment Constraints on Enclosure of the Public Domain,* 74 N.Y.U. L. REV. 354 (1999); Dan L. Burk, *Muddy Rules for Cyberspace, 21* CARDOZO L. REV. 121 (1999); Julie E. Cohen, *Copyright and the Jurisprudence of Self-Help,* 13 BERKELEY TECH. LJ. 1089 (1998); Mark A. Lemley, *Beyond Preemption: The Law and Policy of Intellectual Property Licensing,* 87 CAL. L. REV. 111 (1999); Michael J. Madison, *Complexity and Copyright in Contradiction,* 18 CARDOZO ARTS & ENT. L.J. 125 (2000); Robert P. Merges, *Property Rights Theory and the Commons: The Case of Scientific Research,* 13 SOC. PHIL. & POL'Y 145 (1996); J.H. Reichman & Jonathan A. Franklin, *Privately Legislated Intellectual Property Rights: Reconciling Freedom of Contract with Public Good Uses of Information,* 147 U. PA. L. REV. 875 (1999); Carol M. Rose, *Expanding the Choices for the Global Commons: Comparing Newfangled Tradable Allowance Schemes to Old-Fashioned Common*

Information that used to be "free" is now increasingly being privatized, monitored, encrypted, and restricted. The enclosure is caused by the conflicts and contradictions between intellectual property laws and the expanded capacities of new technologies.[3] It leads to speculation that the records of scholarly communication, the foundations of an informed, democratic society, may be at risk.

This "intellectual land-grab"[4] is an outcome of new technologies and global markets. Distributed digital technologies have the dual capacity to increase access to information while in some instances restricting such access. These technologies have generated greater access to important information about history, science, art, literature, and current events, while at the same time enabling profit-oriented firms to extract value from resources previously held in common and to establish property rights[5] Multiple forces are vying for capture and restriction of traditionally available knowledge: corporations versus indigenous peoples, such as Monsanto owning the patent on the genetic structure of the neem; federal and state governments versus citizens regarding balancing encryption and digital surveillance with individual privacy; universities versus professors as to whether institutions or individuals will own intellectual property; and publishers versus libraries in the 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, for instance, are fighting depletion because of the capture capabilities of larger trawlers, wider and finer nets, and larger fleets. Local control of forests throughout the world is being increasingly encroached upon by state and private interests, resulting in alarming rates of deforestation. Resultant forest burning is not only rapidly reducing primary growth forests but is also contributing to the degradation of the global atmosphere as well.[6] Commodification and privatization of natural resources is

Property Regimes, 10 DUKE ENVTL. L. & POL'Y F. 45 (Fall 1999); Paul A. David, A Tragedy of the Public Knowledge "Commons"? Global Science, Intellectual Property and the Digital Technology Boomerang (SIEPR Discussion Paper no. 00-02, Stanford Institute for Economic Policy Research, 2000), *available at* http://siepr.stanford.edu/papers/pdf/00-02.html (last visited Oct. 10, 2002); Lawrence Lessig, Reclaiming a Commons, Keynote Address at Harvard University (May 20, 1999), *available at* http:// cyber.law.harvard.edu/events/lessigkeynote.pdf [hereinafter Lessig, Harvard].

3. *See* BOYLE, *supra* note 2,. at 6-7; Yochai Benkler, *Overcoming Agoraphobia: Building the Commons of the Digitally Networked Environment,* 11 HARV. J.L. & TECH. 287 (Winter 1998); Jane C. Ginsburg, *Copyright and Control of New Technologies of Dissemination,* 101 COLUM. L. REV. 1613 (2001).

4. Boyle, *supra* note 1, at _; James Boyle, *A Politics of Intellectual Property: Environmentalism for the Net?,* 47 DUKE L.J. 87, 94 (1997).

5. Many new common-pool resources have "remained unclaimed due to a lack of technology for extracting their value and for establishing and sustaining property rights." Elinor Ostrom, *Foreword, in* SUSAN J. BUCK, THE GLOBAL COMMONS: AN INTRODUCTION xiii (1998).

6. *See* J.E. Michael Arnold, *Devolution of Control of Common Pool Resources to Local Communities: Experiences in Forestry, in* ACCESS TO LAND, RURAL POVERTY, AND PUBLIC ACTION 163, 164-65 (Alain de Janvry et al. eds., 2001).

a trend with virtually all types of resources. And radical changes in the structure and process of all natural and human-constructed resources can occur through the development of new technologies.[7]

The problems are complex, multilayered, and of crucial importance. To direct attention to this evolving situation, James Boyle has called for the re-creation of the public domain, drawing from the intellectual construct of the environment. "Like the environment," he writes, "the public domain must be invented before it can be saved."[8] A greater depth of understanding of the public domain requires the concept to be more deeply analyzed and clarified. It is a logical step, therefore, to draw from the fruitful research and analytical methods applied to the study of common-pool resources ("CPRs") and natural resource management.

The goal of this article is to summarize the lessons learned from a large body of international, interdisciplinary research on common-pool resources in the past twenty-five years and consider its usefulness in the analysis of scholarly information as a resource. We will suggest ways in which the study of the governance and management of CPRs 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, rapid changes of technology, 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 Hayek, that the combination of time and place analysis with general scientific knowledge is necessary for sufficient understanding of policy and action.[9] In addition, the careful development of an unambiguous language and agreed-upon definitions is imperative.

We focus on the *language, methodology,* and *outcomes* of research on common-pool resources to better understand how various types of property regimes affect the provision, production, distribution, appropriation, and consumption of scholarly information. Our 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.

In Part II we present a brief intellectual history of the commons and discuss the development of the understanding of the term. Part III discusses key concepts of the terms "commons," "common-pool resources," and "common property." Four frequent areas of confusion are identified and elucidated. Part IV presents a method of analyzing information as a commons. Part V illustrates the development and change of scholarly information as a shared resource. It focuses on collective action initiatives as a response to the dilemmas of new technological freedoms within an increasing amount of legal constraints.

7. *See, e.g.,* Stephen R. Palumbi, *Humans as the World's Greatest Evolutionary Force,* SCIENCE, Sept. 7, 2001, at 1786, *available at* http: www.sciencemag.org/cgi/content/full/293/5536/1786.

8. *See* Boyle, *supra* note 1, at 19.

9. F. A. Hayek, *The Use of Knowledge in Society,* 35 AM. ECON. REV. 519, 521 (1945).

II
WHAT IS A COMMONS?

A large body of international, interdisciplinary literature on the commons has grown in the past fifteen to twenty years.[10] It reflects concerted attempts to arrive at unified understandings of the definition of the commons. The recent law literature on the commons, however, presents various different concepts of the commons without reference to this literature. Lawrence Lessig's concept of the commons is one of a universal, open access: "The commons: There's a part of our world, here and now, that we all get to enjoy without the permission of any."[11] Yochai Benkler's concept involves legal constraints against controlling regimes: "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 that any single organization, regulatory agency, or property owner clear conflicting uses of the resource."[12] Litman equates the commons with the public domain: "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."[13]

. Indeed, in the law literature cited throughout this article, a wide variety of concepts and definitions of the commons or public domain is used. We feel there needs to be clarity, shared meanings, and a common language to research this area better. In the legal arena, the term "commons" is often used synonymously with the term public domain. Is it a given right, a nonassigned right, an unclaimed right, an unmanaged resource, or something that should just be there in a democracy?[14] A survey of law dictionaries does not clear matters up. *Oran's Dictionary of the Law,* for instance, gives two definitions of public domain: "land owned by the government" and "something free for anyone to

10. *See* CHARLOTTE HESS, A COMPREHENSIVE BIBLIOGRAPHY OF COMMON-POOL RESOURCES (CD-ROM, 1999). This bibliography contains 22,500 citations of works on the commons. A searchable version of this bibliography is available at http://www.iascp.org/cprbibs.html (last updated Dec. 16, 1999). A new edition with 35,000 citations is forthcoming.

11. Lawrence Lessig, Code and the Commons, Keynote Address at the Conference on Media Convergence, held at Fordham University Law School (Feb. 9,1999), *available at* http://cyber.law.harvard.edu/works/lessig/fordham.pdf (last visited Sept. 1,2002).

12. Yochai Benkler, The Commons as a Neglected Factor of Information Policy, Remarks at the Telecommunications Policy Research Conference (Sept. 1998), *available at* http://www.law.nyu.edu/benklery/commons.pdf (last visited Sept. 1, 2002).

13. Jessica Litman, *The Public Domain,* 39 EMORY L.J. 965, 975 (1990).

14. BOYLE, *supra* note 2, at xiv (pointing 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.").

use or something not protected by patent or copyright."[15] 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?

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. The term "commons," however, has various histories, from property to shared spaces to notions of democratic ideals. It refers to the house of British Parliament representing nontitled citizens, and agricultural fields in England and Europe prior to their enclosure. In the United States, commons refers to public spaces such as the New England town square, campus dining halls, and concepts of the "common" good.[16] In almost all uses, the term has been contested. In the realm of legal property rights, the publication of *Ancient Law* by Henry Sumner Maine[17] in 1861 set off a major debate about the origin of the very concept of property in ancient times.[18] Drawing on his own extensive research in India and the research of others on 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 than the notion of property owned by a single individual.[19] This great debate was not simply one between historians over whether common property or individual private property came first. Rather, 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 started long ago and is still not fully resolved. A major textbook on property law devotes the entire first chapter to *The Debate over Private Property* and the second chapter to *The Problem of the Commons.*[20]

Social scientists have had their own debates about the consequences of allowing multiple individuals or firms to use jointly a resource system. The debate was kicked off half a century ago by the path-breaking works of H. Scott Gordon in 1954 and Anthony Scott in 1955,[21] which introduced an economic analysis of a natural resource (fisheries) that had, prior to that time, been the

15. DANIEL ORAN, ORAN'S DICTIONARY OF THE LAW 392 (3d ed. 2000).

16. Charlotte Hess, Is There Anything New Under the Sun?: A Discussion and Survey of Studies on New Commons and the Internet, *presented at* Constituting the Commons: Grafting Sustainable Commons in the New Millennium, the eighth biennial conference of the International Association for the Study of Common Property (May 31-June 4, 2000), *available at* http://dlc.dlib.indiana.edu/documents/dirO/00/00/05/12/dlc-00000512-00/iascp2000.pdf (last visited Dec. 3,2002)

17. HENRY SUMNER MAINE, ANCIENT LAW (Raymond Firth ed., Beacon Press 1963) (1861).

18. *See* PAOLO GROSSI, AN ALTERNATIVE TO PRIVATE PROPERTY: COLLECTIVE PROPERTY IN THE JURIDICAL CONSCIOUSNESS OF THE NINETEENTH CENTURY 15 (1981).

19. MAINE, *supra* note 17, at 252.

20. PERSPECTIVES ON PROPERTY LAW (Robert C. Ellickson et al. eds., 2d ed. 1995).

21. H. Scott Gordon, *The Economic Theory of a Common-Property Resource: The Fishery,* 62 J. POL. ECON. 124 (1954); Anthony D. Scott, *The Fishery: The Objectives of Sole Ownership,* 63 J. POL. ECON. 116 (1955).

domain of biologists. The two articles are credited with outlining the conventional theory of the commons.[22] Gordon and Scott demonstrated that when multiple individuals jointly harvested high-demand fish 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 they contemplated to this problem was ownership of the fishery by a single firm or by the government. In 1968, biologist Garrett Hardin crystallized the thinking of many social scientists and policy makers with his metaphoric analysis of the "tragedy of the commons."[23] Hardin argued that individuals who jointly use a commons are hopelessly trapped in an immutable tragedy.[24] Given this inevitable trap of overuse (or, for Hardin, overpopulation), the *only* solution Hardin envisioned was externally imposed government or private ownership.[25] 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."[26]

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, such as fishers and pastoralists) 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 utilize 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 and the appropriators make no effort to change it. Appropriators act independently and do not communicate or coordinate their activities in any way,[27]

Many current textbooks in resource economics and in law and economics still present this conventional theory of a simple common-pool resource as the

22. *See* David Feeny et al., *The Tragedy of the Commons: Twenty-Two Years Later,* 18 HUM. ECOLOGY 1,2 (1990).

23. Garrett Hardin, *The Tragedy of the Commons,* SCIENCE, Dec. 13, 1968, at 1243.

24. *Id.* at 1244-45.

25. *Id.* at 1245.

26. *Id.* at 1244.

27. Commenting on Gordon and Scott's work. David Feeny says:

> 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.

David Feeny et al., *Questioning the Assumptions of the "Tragedy of the Commons" Model of Fisheries,* 72 LAND ECON. 187, 189 (1996).

only theory needed for achieving a more general understanding of common-pool resources.[28] 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.[29] These 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 exist 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 conventional 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 for many scholars the worst predictions to be derived from this theory.

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. Some scholars recommended private property as the most efficient form of ownership.[30] Others, drawing on Hobbes, recommended government ownership and control.[31] Implicitly, theorists assumed that regulators will act in the public interest and understand how ecological systems work and how to change institutions to induce socially optimal behavior.[32]

The possibility that the appropriators would find ways to organize themselves was not considered seriously in the political-economy literature until recently. Organizing 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" of the free-rider problem is itself a second-level dilemma. Further, investing in monitoring and sanctioning activities to increase the likelihood that participants follow the agreements they have made also generates a public good. Such investments represent a third-level dilemma. Since much of the initial problem exists because individuals are stuck in a

28. *But see* JEAN-MARIE BALAND & JEAN-PHILIPPE PLATTEAU, HALTING DEGRADATION OF NATURAL RESOURCES: IS THERE A ROLE FOR RURAL COMMUNITIES? 25-35 (1996).

29. *See* PARTHA DASGUPTA & GEOFFREY M. HEAL, ECONOMIC THEORY AND EXHAUSTIBLE RESOURCES (1979); Robyn M. Dawes, *The Commons Dilemma Game: An N-Person Mixed-Motive Game With a Dominating Strategy for Defection,* 13 OR. RES. BULL. (1973).

30. *See* RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW 28-30 (2d ed. 1977); Harold Dem-setz, *Toward a Theory of Property Rights,* 57 AM. ECON. REV. 347 (1967); Randy T. Simmons et al., The Tragedy of the Commons Revisited: Politics vs. Private Property (Center for Private Conservation, Competitive Enterprise Institute, Washington, D.C., 1996).

31. William Ophuls, *Leviathan or Oblivion?, in* TOWARD A STEADY STATE ECONOMY 214, 219 (Herman E. Daly ed., 1973) ("Hobbes's answer to the tragedy of the commons then is a benevolent form of autocracy ... .").

32. Feeny et al., *supra* note 27, at 195.

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 to address the first-level dilemma.

The work of the National Academy of Sciences' Panel on Common Property challenged the application of this conventional theory to all common-pool resources regardless of the capacity of appropriators to communicate, coordinate their activities, and create institutions to allocate property rights and make policies related to a jointly owned resource.[33] The growing evidence from many field studies of common-pool resources conducted by anthropologists[34] and historians[35] called for a serious rethinking of the theoretical foundations for analysis of common-pool resources.[36] The cumulative impact of the extensive empirical studies does not challenge the empirical validity of the conventional theory *where it is relevant,* but rather, questions its presumed, universal generalizability.

III

CLARIFYING KEY CONCEPTS

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 between concepts that had previously and casually been treated as the same. Because we feel that a similar effort is needed for the intellectual public domain, we will discuss these distinctions in some depth. There are four basic confusions that need to be untangled. The source of confusion relates to the differences between (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

33. *See* PROCEEDINGS OF THE CONFERENCE ON COMMON PROPERTY RESOURCE MANAGEMENT (National Research Council ed., 1986).

34. *See, e.g.,* ROBERT MCC. NETTING, BALANCING ON AN ALP: ECOLOGICAL CHANGE AND CONTINUITY IN A SWISS MOUNTAIN COMMUNITY (1981); THE QUESTION OF THE COMMONS: THE CULTURE AND ECOLOGY OF COMMUNAL RESOURCES (Bonnie J. McCay & James M. Acheson eds., 1987); Robert McC. Netting, *Territory, Property, and Tenure, in* BEHAVIORAL AND SOCIAL SCIENCE RESEARCH: A NATIONAL RESOURCE 446, 446 (R. McC. Adams et al. eds., 1982).

35. *See, e.g.,* THOMAS F. GLICK, IRRIGATION AND SOCIETY IN MEDIEVAL VALENCIA (1970) (focusing on the conflict arising from an irrigation system that necessitated cooperation); ARTHUR MAASS & RAYMOND L. ANDERSON, ... AND THE DESERT SHALL REJOICE: CONFLICT, GROWTH, AND JUSTICE IN ARID ENVIRONMENTS (1986) (observing irrigation systems in a number of the world's deserts, including southeastern Spain and the Western United States).

36. *See* COMMON PROPERTY RESOURCES: ECOLOGY AND COMMUNITY-BASED SUSTAINABLE DEVELOPMENT, at ix, 2 (Fikret Berkes ed., 1989); MAKING THE COMMONS WORK: THEORY, PRACTICE, AND POLICY, at xi, 4 (Daniel W. Bromley et al. eds., 1992); ELINOR OSTROM, GOVERNING THE COMMONS 2 (1990); ROBERT WADE, VILLAGE REPUBLICS: ECONOMIC CONDITIONS FOR COLLECTIVE ACTION IN SOUTH INDIA xiv (1994). *See also generally* NIRMAL SENGUPTA, MANAGING COMMON PROPERTY: IRRIGATION IN INDIA AND THE PHILIPPINES (1991); A SEA OF SMALL BOATS (John C. Cordell ed., 1989); THE TRADITIONAL KNOWLEDGE AND MANAGEMENT OF COASTAL SYSTEMS IN ASIA AND THE PACIFIC (Kenneth Ruddle & Robert E. Johannes eds., 1985).

involved in "ownership." All four sources of confusion reduce clarity in assigning meaning to terms and retard theoretical and empirical progress.

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

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 more appropriately 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 refers to the structure of the biophysical events as the nature of the goods.[37] For some time, economists struggled with classifying goods as either private or public.[38] By labeling all goods as fitting this dichotomy, scholars talked about those things that the market could solve most efficiently and those that would require government provision and production.

In the 1970s, a major breakthrough came with clear identification that there were more than two types of goods.[39] Two attributes have been identified in the political-economy literature that help identify four broad classes of goods. The first attribute is that the benefits consumed by one individual subtract from the benefits available to others.[40] 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.

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 a group utilizes resources for an extended period of time. Using "property" to refer to a type of good reinforces the impression that goods sharing these attributes tend to share uniformly the same property regime. This is certainly not the case.

37. *See* Paul Samuelson, *The Pure Theory of Public Expenditure,* 36 REV. ECON. & STAT. 387 (1954).

38. *See generally* RICHARD A. MUSGRAVE, THE THEORY OF PUBLIC FINANCE: A STUDY IN PUBLIC ECONOMY (1959).

39. Vincent Ostrom & Elinor Ostrom, *Public Goods and Public Choices, in* ALTERNATIVES FOR DELIVERING PUBLIC SERVICES: TOWARD IMPROVED PERFORMANCE 7, 9-14 (E. S. Savas ed., 1977).

40. *Id.* (describing this attribute as jointness of use or consumption); RULES, GAMES, AND COMMON-POOL RESOURCES 6 (Elinor Ostrom et al. eds., 1994) [hereinafter RULES].

FIGURE 1: **TYPES OF GOODS**

		SUBTRACTABILITY	
		Low	*High*
EXCLUSION	*Difficult*	**Public Goods** Sunset Common Knowledge	**Common-Pool Resources** Irrigation Systems Libraries
	Easy	**Toll or Club Goods** Day-Care Centers Country Clubs	**Private Goods** Doughnuts Personal Computers

As shown in Figure 1, 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 benefiting, a 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 the 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 in many other attributes that affect their economic usefulness including their extent, shape, and productivity, as well as the value, timing, and regularity of the resource units produced.[41]

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.[42] Examples exist of both successful and unsuccessful efforts by governments, communal groups, cooperatives, voluntary associations, and private individuals or firms to govern and manage common-pool resources.[43] Thus, no automatic association

41. *See* Edella Schlager et al., *Mobile Flows, Storage, and Self-Organized Institutions for Governing Common-Pool Resources,* 70 LAND ECON. 294 (1994).

42. Feeny et al., *supra* note 22, at 5-9.

43. Bromley et al., *supra* note 36, at 4; KATAR SINGH, MANAGING COMMON POOL RESOURCES: PRINCIPLES AND CASE STUDIES 314-19 (1994).

exists between common-pool resources and common-property regimes—*or, any other particular type of property regime.*

B. 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.[44] 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.[45] 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. Examples of resource units from a common-pool resource are water, timber, medicinal plants, fish, fodder, and central processing units. The resource units from a complex facility like the Internet may be the data packets or the computer files (information artifacts), depending upon whether it is being studied as an infrastructure resource or as an information resource.[46] Devising property regimes that effectively allow sustainable use of a common-pool resource requires one set of rules that limits access to the resource system and another set of rules that limits 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.

C. The Confusion between Common-Property and Open-Access Regimes

In a now classic article, Ciriacy-Wantrup and Bishop[47] 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, and *common property,* where members of a clearly defined group have a bundle of legal rights including the right to exclude nonmembers from using that resource.[48] Legal doctrine has long considered open-access regimes *(res nullius)*—including the

44. William Blomquist & Elinor Ostrom, *Institutional Capacity and the Resolution of a Commons Dilemma, 5* POL'Y STUD. REV. 383, 383 (1985).

45. *See, e.g.,* Dean Lueck, *Property Rights and the Economic Logic of Wildlife Institutions,* 35 NAT. RESOURCES J. 625, 636 (1995).

46. *See* Gerald Bernbom, 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 biennial conference of the International Association for the Study of Common Property (May 31-June 4, 2000), *available at* http://dlc.dlib.indiana.edu/documents/dirO/00/00/02/18/index.html.

47. Siegfried V. Ciriacy-Wantrup & Richard C. Bishop, *"Common Property" as a Concept in Natural Resource Policy,* 15 NAT. RESOURCES J. 713, 715 (1975).

48. *See* DANIEL W. BROMLEY, ENVIRONMENT AND ECONOMY: PROPERTY RIGHTS AND PUBLIC POLICY 22-23 (1991); Daniel W. Bromley, *The Commons, Property, and Common-Property Regimes, in* MAKING THE COMMONS WORK: THEORY, PRACTICE, AND POLICY 3, 3-4 (Daniel W. Bromley et al. eds., 1992).

classic cases of the open seas and the atmosphere—to involve no limits on who has authorized use. Thus, the work of Gordon, Scott, and Hardin focused on resources that were paired with open-access regimes.[49] 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 its improvements.

Some open-access regimes lack effective rules defining property rights by default.[50] 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 use a resource within a political jurisdiction.[51] The concept of *jus publicum* applies to their formal status, but effectively these resources are open-access.[52] Still other open-access regimes result 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.[53] Common-property regimes controlling access to and harvesting from local streams, forests, grazing areas, and inshore fisheries had evolved

49. *See supra* text accompanying notes 21-27.

50. *SEE* JOHN H. DALES, POLLUTION, PROPERTY, AND PRICES: AN ESSAY IN POLICY-MAKING AND ECONOMICS (1968).

51. As is the case for works in the public domain, works that are uncopyrightable, unprotectable, or for which copyright has expired. *See* Litman, *supra* note 13, at 967.

52. This point is well illustrated in Robert Higgs, *Legally Induced Technical Regress in the Washington Salmon Fishery, in* EMPIRICAL STUDIES IN INSTITUTIONAL CHANGE 247, 251 (Lee J. Alston et al. eds., 1996). The article outlines the case where the state governments of Oregon and Washington intervened in the early twentieth century to prevent local salmon fishermen from devising rules that would have limited entry and established harvesting limits. Fishing unions along U.S. coastal areas tried to organize inshore fisheries 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. Ronald N. Johnson & Gary D. Libecap, *Contracting Problems and Regulation: The Case of the Fishery,* 72 AM. ECON. REV. 1005, 1007-08 (1982). 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* Evelyn Pinkerton, *Where Do We Go From Here? The Future of Traditional Ecological Knowledge and Resource Management in Native Communities, in* TRADITIONAL ECOLOGICAL KNOWLEDGE AND MODERN ENVIRONMENTAL ASSESSMENT 51, 56-58 (P. Boothroyd & B. Sadler eds., 1994); Evelyn Pinkerton, *Local Fisheries Co-Management: A Review of International Experiences and Their Implications for Salmon Management in British Columbia,* 51 CANADIAN J. FISHERIES & AQUATIC Sci. 2363 (1994); James A. Wilson, When are Common Property Institutions Efficient? (working paper, Department of Agriculture and Resource Economics, University of Maine, Orono, 1995) (on file with authors).

53. J.E. Michael Arnold & 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 425, 425 (National Research Council ed., 1986).

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.[54]

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.[55] 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 regime.

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.[56] The institutional arrangements that many local users had devised to limit entry and use frequently lost legal standing.[57] The national governments that declared ownership of these natural resources, however, frequently lacked monetary resources and personnel to exclude users or to monitor the harvesting activities of users.[58] 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 local participants have been nationalized, state control has usually proven to be less effective and efficient than control by those directly affected, if not disastrous in its consequences.[59]

54. Fikret Berkes & Carl Folke, *Linking Social and Ecological Systems for Resilience and Sustainability, in* LINKING SOCIAL AND ECOLOGICAL SYSTEMS: MANAGEMENT PRACTICES AND SOCIAL MECHANISMS FOR BUILDING RESILIENCE 1, 13-20 (Fikret Berkes & Carl Folke eds., 1998).

55. THRAINN EGGERTSSON, ECONOMIC BEHAVIOR AND INSTITUTIONS 223-28 (1990); Thrainn Eggertsson, *The Economic Rationale for Communal Resources, in* I A CONFERENCE ON COMMON PROPERTY REGIMES: LAW AND MANAGEMENT OF NON-PRIVATE RESOURCES 41 (Erling Berge ed., 1993); Dean Lueck, *Common Property as an Egalitarian Share Contract,* 25 J. ECON. BEHAV. & ORG. 93, 93-108 (1994).

56. *See, e.g.,* CLARK C. GIBSON, POLITICIANS AND POACHERS: THE POLITICAL ECONOMY OF WILDLIFE POLICY IN AFRICA 153-63 (1999).

57. *See, e.g.,* MINOTI CHAKRAVARTY-KAUL, COMMON LANDS AND CUSTOMARY LAW: INSTITUTIONAL CHANGES IN NORTH INDIA OVER THE PAST TWO CENTURIES 12-15 (1996).

58. *See* William Ascher, *Coping with Complexity and Organizational Interests in Natural Resource Management, 4* ECOSYSTEMS 742 (2001), *available at* http://www.fish.washington.edu/people/naiman/Watershed/readings/ascher.pdf (last visited Dec. 3, 2002-).

59. WILLIAM ASCHER, COMMUNITIES AND SUSTAINABLE FORESTRY IN DEVELOPING COUNTRIES 10-14 (1995); *see also* Rita Hilton, *Institutional Incentives for Resource Mobilization: An Analysis of Irrigation Schemes in Nepal,* 4 J. THEORETICAL POL. 283 (1992). The harmful effects of nationalizing forests that had earlier been governed by local user-groups have been well documented for Thailand, the Niger, Nepal, and India. Arnold, *supra* note 53, at 430-31; David Feeny, *Agricultural Expansion and Forest Depletion in Thailand, 1900-1975, in* WORLD DEFORESTATION IN THE TWENTIETH CENTURY 112, 125-26, 129 (John F. Richards & Richard P. Tucker eds., 1988); Madhav Gadgil & Prema Iyer, *On the Diversification of Common-Property Resource Use by Indian Society, in* COMMON PROPERTY RESOURCES: ECOLOGY AND COMMUNITY-BASED SUSTAINABLE DEVELOPMENT 240, 247-49 (Fikret Berkes ed., 1989); N.S. Jodha, *Depletion of Common Property Resources in India: Micro-Level Evidence, in* RURAL DEVELOPMENT AND POPULATION:

D. The Confusion Over What Rights Are Involved in "Ownership"

A property right is an enforceable authority to undertake particular actions in a specific domain.[60] Within the property regime, different kinds of 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. Edella Schlager and Elinor Ostrom identify five major bundles of rights that are most relevant for the use of common-pool resources: access, extraction,[61] management, exclusion, and alienation. These are defined as:

Access	The right to enter a defined physical area and enjoy nonsubtractive benefits (for example, hike, canoe, enjoy nature);
Extraction	The right to obtain resource units or products of a resource system (for example, 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; and
Alienation	The right to sell or lease management and exclusion rights.

In much of the economics literature, as well as in 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

INSTITUTIONS AND POLICY 261, 270-78 (Geoffery McNicoll & Mead Cain eds., 1990); James T. Thomson et al., *Institutional Dynamics: The Evolution and Dissolution of Common-Property Resource Management, in* MAKING THE COMMONS WORK: THEORY, PRACTICE, AND POLICY 129, 154-55 (Daniel W. Bromley et al. eds., 1992); *see also* Donald A. Messerschmidt, *People and Resources in Nepal: Customary Resource Management Systems of the Upper Kali Gandaki, in* PROCEEDINGS OF THE CONFERENCE ON COMMON PROPERTY RESOURCE MANAGEMENT 455 (National Research Council ed., 1986). Similar results have occurred when inshore fisheries were taken over by state or national agencies from local control. *See* PARTHA DASGUPTA, THE CONTROL OF RESOURCES 13-40 (1982); Wilfrido D. Cruz, *Overfishing and Conflict in a Traditional Fishery: San Miguel Bay, Philippines, in* PROCEEDINGS OF THE CONFERENCE ON COMMON PROPERTY RESOURCE MANAGEMENT 115, 115 (National Research Council ed., 1986); *see also* John C. Cordell & Margaret A. McKean, *Sea Tenure in Bahia, Brazil, in* MAKING THE COMMONS WORK: THEORY, PRACTICE, AND POLICY 183 (Daniel W. Bromley et al. eds., 1992).

60. *See* JOHN R. COMMONS, LEGAL FOUNDATIONS OF CAPITALISM (1968).

61. In Schlager and Ostrom, the term used for *extraction* is *withdrawal.* Edella Schlager & Elinor Ostrom, *Property-Rights Regimes and Natural Resources: A Conceptual Analysis,* 68 LAND ECON. 249, 250 (1992).

system purchase that system in whole or in part.[62] Consequently, it is assumed that property-rights systems that include the right to alienation will result in the highest-valued use of the resource systems affected. Bruce Larson and Daniel Bromley[63] 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 bundles of property rights are exercised in the field and what consequences result. In this view private individuals, private associations or firms, and governments may hold well-defined rights to a resource 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 which rights are possessed and who possesses them. While not the conventional view of lawyers, analysis of resources can benefit from viewing these rights bundles as diverse forms of property rights. In this respect, the analysis of distributed digital information would particularly benefit from a close examination of these bundles of rights.

"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." 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 is usually determined by operational rules devised by those holding the collective-choice rights (or authority) of management and exclusion over the resource system.[64] An external authority, however, may mandate that the owner of a resource system must allow some access 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

62. *See* Demsetz, *supra* note 30.

63. Bruce A. Larson & Daniel W. Bromley, *Property Rights, Externalities, and Resource Degradation: Locating the Tragedy,* 33 J. DEV. ECON. 235 (1990).

64. The operational rights of entry and use may be finely divided into quite specific "tenure niches" that vary by season, by use, by technology, and by space. JOHN W. BRUCE, LEGAL BASES FOR THE MANAGEMENT OF FOREST RESOURCES AS COMMON PROPERTY 12-14 (1999). 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. *See* John W. Bruce et al., *Tenures in Transition, Tenures in Conflict: Examples from the Zimbabwe Social Forest,* 58 RURAL Soc. 626 (1993). 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* Alien Adasiak, *Alaska's Experience with Limited Entry,* 36 J. FISHERIES RES. BOARD CAN. 770 (1979) (describing the rights of authorized users of the Alaskan salmon and herring fisheries).

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.[65] Farmers on large-scale government irrigation systems frequently devise rotation schemes for allocating water on a branch canal.[66]

"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 resource.[67] The rights of owners, however, are never absolute. Even private owners have responsibilities not to generate particular kinds of harms to others.[68]

What is particularly important in the context of the intellectual public domain 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.[69]

65. E. Paul Durrenberger & 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 370, 374-75 (B. J. McCay and J. M. Acheson eds. 1987). Another example is the net fishers of Jambudwip, India, who annually regulate the positioning of nets to avoid interference, but do not have the right to determine who may fish along the coast. *See* BIKASH RAYCHAUDHURI, THE MOON AND NET: STUDY OF A TRANSIENT COMMUNITY OF FISHERMEN AT JAMBUDWIP (Government of India Press, Anthropological Survey of India 1980).

66. *See generally* PAUL BENJAMIN ET AL., INSTITUTIONS, INCENTIVES, AND IRRIGATION IN NEPAL (1994).

67. *See generally* ROBERT A. DAHL & CHARLES E. LINDBLOM, POLITICS, ECONOMICS AND WELFARE: PLANNING AND POLITICO-ECONOMIC SYSTEMS RESOLVED INTO BASIC SOCIAL PROCESSES (1963); JOHN MICHAEL MONTIAS, THE STRUCTURE OF ECONOMIC SYSTEMS (1976).

68. *See* Demsetz, *supra* note 30, at 355-57.

69. Frank Place and Peter Hazell 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. *See* Frank Place & Peter Hazell, *Productivity Effects of Indigenous Land Tenure Systems in Sub-Saharan Africa,* 75 AM. J. AGRIC. ECON. 10 (1993). In densely settled regions, however, proprietorship over agricultural land may not be sufficient. *See* GERSHON FEDER ET AL., LAND POLICIES AND FARM PRODUCTIVITY IN THAILAND (1988); Terry L. Anderson & Dean Lueck, *Land Tenure and Agricultural Productivity on Indian Reservations,* 35 J.L. & ECON. 427 (1992). As land is densely settled, the absence of a title reduces the options for farmers to sell their land and

A key finding from multiple studies is that *no* set of property rights work 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.[70]

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.[71] 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, and maintenance responsibilities may be allocated by the amount of water shares owned rather than by the amount of land owned.[72] On the other hand, some proposals to "privatize" inshore fisheries through the device 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, interdisciplinary researchers are finding great benefit in applying CPR

reap a return on this asset. Without a title, farmers lack collateral to obtain credit to invest more intensively in the productive potential of their land. *See* Lee J. Alston et al., *The Determinants and Impact of Property Rights: Land Titles on the Brazilian Frontier,* 12 J.L. ECON. & ORG. 25 (1996).

70. *See generally* Arun Agrawal, *Rules, Rule Making, and Rule Breaking: Examining the Fit between Rule Systems and Resource Use, in* RULES, *supra* note 40, at 267; WILLIAM BLOMQUIST, DIVIDING THE WATERS: GOVERNING GROUNDWATER IN SOUTHERN CALIFORNIA (1992); WAI FUNG LAM, GOVERNING IRRIGATION SYSTEMS IN NEPAL: INSTITUTIONS, INFRASTRUCTURE, AND COLLECTIVE ACTION (1998); Edella Schlager, *Fishers' Institutional Responses to Common-Pool Resource Dilemmas, in* RULES, *supra* note 40 at 247; Shui-Yan Tang, *Building Community Organizations: Credible Commitment and the New Institutional Economics,* 13 HUMAN SYS. MGMT. 221 (1994).

71. David Miller, *The Evolution of Mexico's Caribbean Spiny Lobster Fishery, in* COMMON PROPERTY RESOURCES: ECOLOGY AND COMMUNITY-BASED SUSTAINABLE DEVELOPMENT 185 (Fikret Berkes ed., 1989).

72. *See* Robert Yoder & Edward Martin, *Water Rights and Equity Issue. A Case from Nepal, in* SEARCHING FOR EQUITY: CONCEPTIONS OF JUSTICE AND EQUITY IN PEASANT IRRIGATION 133 (R. Boelens & G. DaVila eds., 1998); *see also* ROBERT Y. SIY, JR., COMMUNITY RESOURCE MANAGEMENT: LESSONS FROM THE ZANJERA (1982); MAASS, *supra* note 35.

analysis to a number of new or previously ignored common-pool resources.[73] Studies that have been written to date on the Internet as a common-pool resource[74] tend to focus 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.[75] Heller's work demonstrates that among the usual outcomes of a shared resource (particularly overuse,[76] 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.[77]

IV

IDEAS, ARTIFACTS, FACILITIES: THE ECOLOGICAL MAKEUP OF SCHOLARLY INFORMATION

In CPR research, the distinction between resource system and resource units has proved 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

73. Some of these include studies of surfer's waves, sports, national budgets, public radio, traditional music, knowledge and information, 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, acceptable use policies), tourism landscapes, cultural treasures, car-sharing institutions, garbage, and sewage. For citations to these works, see Hess, *supra* note 16.

74. *See* P. Kollock & Marc Smith, *Managing the Virtual Commons: Cooperation and Conflict in Computer Communities, in* COMPUTER-MEDIATED COMMUNICATION: LINGUISTIC, SOCIAL AND CROSS-CULTURAL PERSPECTIVES 109 (S. C. Herring ed., 1996); Douglas S. Noonan, *Internet Decentralization, Feedback, and Self-Organization, in* MANAGING THE COMMONS 188 (John A. Baden & Douglas S. Noonan eds., 1998); B. A. Huberman & Rajan M. Lukose, *Social Dilemmas and Internet Congestion,* SCIENCE, Jul. 25, 1997, at 535.

75. Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets,* 111 HARV. L. REV. 621 (1998).

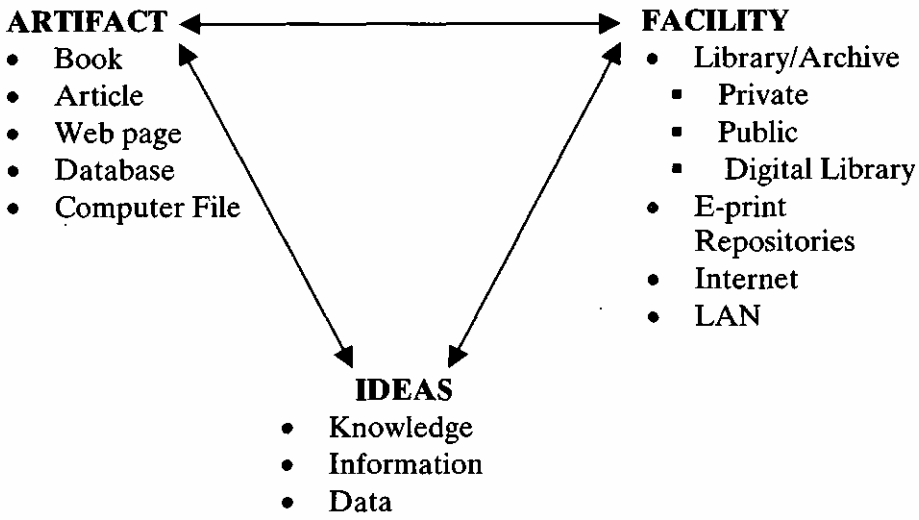
76. *See generally* Elinor Ostrom et al., *Revisiting the Commons: Local Lessons, Global Challenges,* SCIENCE, Apr. 9, 1999, at 278.

77. *See, e.g.,* Keith Aoki, *Neocolonialism, Anticommons Property, and Biopiracy in the (Not-So-Brave) New World Order of International Intellectual Property Protection, 6* IND. J. GLOBAL LEGAL STUD. 11 (1998); Michael A. Heller, & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research,* SCIENCE, May 1, 1998, at 698.

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.

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 *ideas.*

FIGURE 2
FORMS OF INFORMATION



- An *artifact* is a discreet, observable, nameable 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, and web pages. 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. Users can usually be excluded from using physical artifacts, but the process of excluding potential users has become more complex and less transparent with digital artifacts.
- A *facility* stores artifacts and makes them available. It is a resource system storing the artifacts and their ideas. 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 to

be followed within the facility (silence, no dancing) and in the use of the artifacts (no highlighting, tearing out pages, etc.) as well as 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 *ideas* contained in an artifact can be understood to mean the creative vision, the intangible content, innovative information, and knowledge. Ideas are the nonphysical flow units contained in an artifact. This is the element that copyright does not protect.[78] Analytically, one person's use of an idea does not subtract from the corpus of that idea for use by others. It may, however, be possible to exclude others from knowing an idea by keeping it a secret.

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 technologies in a global environment.

"Information" is a difficult term to define.[79] To economists, it can mean complete or incomplete knowledge, true or inaccurate 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. Non-Governmental Organizations and donor agencies see access to information as the key ingredient for economic development. Referring to the multiple types of information issues, James 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?"[80]

"Information" and "knowledge" as raw terms have been dissected and defined in several ways. Fritz 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.[81] Jerome Reichman and Jonathan Franklin

78. "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."* JESSICA LITMAN, DIGITAL COPYRIGHT 17 (2001) (emphasis added).

79. A 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 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." Dennis Overbye, *Time of Growing Pains for Information Age,* N.Y. TIMES, Aug. 7, 2001, at F3.

80. BOYLE, *supra* note 2, at 6 (emphasis added).

81. *See* Fritz Machlup, *Semantic Quirks in Studies of Information, in* THE STUDY OF INFORMATION: INTERDISCIPLINARY MESSAGES 641 (Fritz Machlup & Una Mansfield eds., 1983).

discuss the "dual function of information," which has high value as a commodity and as "the foundation of knowledge in the information economy."[82] Peter Lyman writes that the "the definition of the concept of information must be at the heart of any information policy."[83] Karl 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.[84]

Sandra 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.[85] Examined are information as a commodity, as a perception of pattern, as a constitutive force in society.[86] Her analysis of information as a resource emphasizes how people *use* information rather than information's effect upon people.[87] For the purposes of our paper, Hayek's classic analysis of the two types of knowledge essential to bringing 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."[88]

In any discussion of information (including digital software) it is useful to remember that information is a human artifact, with agreements and rules, and strongly tied to the rules of language itself.[89] Thus, information has an important cultural component as well as intellectual, economic, and political functions. As such, it is a "flow resource" that must be passed from one individual to another to have any public value.[90]

82. Reichman & Franklin, *supra* note 2, at 884.

83. *See* Peter Lyman, *The Article 2B Debate and the Sociology of the Information Age,* 13 BERKELEY TECH. L.J. 1063, 1068 (1998).

84. "The world of language, of conjectures, theories, and arguments—in brief, the universe of objective knowledge—is one of the most important of these man-created, yet at the same time largely autonomous, universes." Karl Popper, *Epistemology Without a Knowing Subject, in* OBJECTIVE KNOWLEDGE: AN EVOLUTIONARY APPROACH 118 (1972).

85. Sandra Braman, *Defining Information: An Approach for Policymakers, in* THE ECONOMICS OF COMMUNICATION AND INFORMATION 3, 4 (D. M. Lamberton ed., 1989).

86. *Id.* at 6-11.

87. *Id.* at 6.

88. Hayek, *supra* note 9, at 521.

89. Vincent 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—a component to it that is concerned with how the activities of people are organized in relation to one another.

Vincent Ostrom, Organization (working paper, Workshop in Political Theory and Policy Analysis, Indiana University, Bloomington, Indiana, 1969) (on file with authors).

90. *See* Mark Cooper, *Symposium Overview: Part II: Unbundling and Open Access Policies: Open Access to the Broadband Internet: Technical and Economic Discrimination in Closed, Proprietary Net-*

Intellectual 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 rights, 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,*[91] 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.[92]

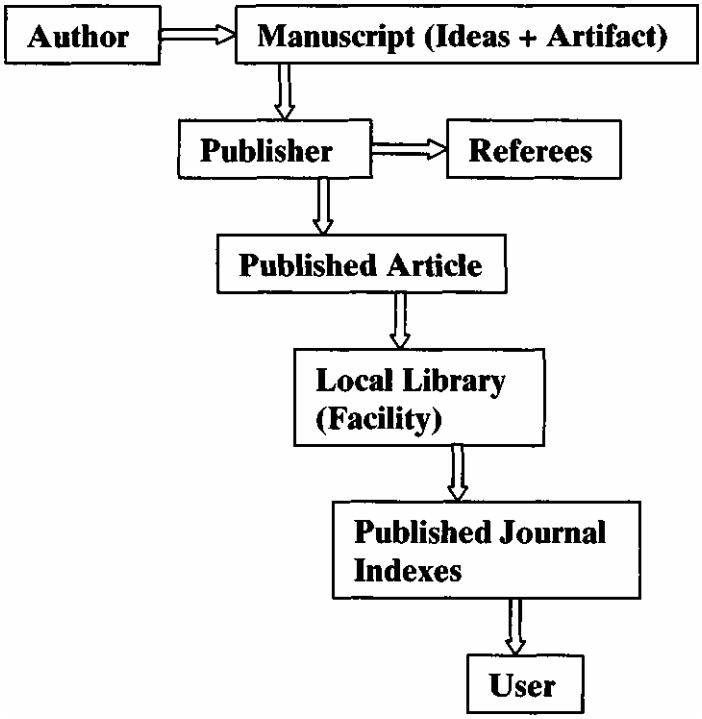
Information, on the other hand, often has complex tangible and intangible attributes: fuzzy boundaries, a diverse community of users on local, regional, national, and international levels, and multiple layers of rule-making institutions. Until the invention of digital technologies, the flow of most scholarly information was easy to follow. One typical flow pattern was:

works, 71 U. COLO. L. REV. 1011, 1047-49 (2000) (discussing the problem of *flow control* or filtering the flow of distributed information).

91. OSTROM, *supra* note 36.

92. This methodological tool, called the *Institutional Analysis and Development (IAD) Framework,* is discussed at length in Chapter 2 of RULES, *supra* note 40, at 23-50.

FIGURE 3 TRADITIONAL FLOW PATTERN OF IDEAS -> ARTIFACT -> FACILITY -> USER



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 the 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, first sale, and fair use, the individual facilities designed the rules in use regarding the distribution and the qualified community of users.

The journal volumes, like books, are only temporarily subtractable, during one person's use, and are, thus, renewable resources over time. If the artifact is stolen or destroyed, replenishment is possible through re-purchase or through interlibrary loan. Journal articles are less subtractable because photocopying allowed through fair use lessens the competition for the resource. The ideas contained within the works are generally nonsubtractable.

The rules and flow patterns are different with digital information. John Perry Barlow pointed out several years ago that digitization, which converts information to ones and zeroes as a conduit of ideas, has obfuscated the "wine

from the bottle";[93] that is, the physical characteristics and the boundaries of the resource are no longer clear. Digital artifacts are increasingly being licensed rather than sold, which means that publications are becoming more and more centralized. Centralization creates less stable and more "fugitive" artifacts, in that the publishers have the right of withdrawal. Libraries' distribution rights are increasingly limited by their contracts.

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.).[94]

V THE EVOLUTION OF SCHOLARLY INFORMATION

Prior to thirty 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"[95] by collecting, storing, preserving, and making available scholarly artifacts—primarily books and journal articles. Rules such as the fair use and first sale doctrines allowed libraries to provide access to the scholarly community.[96] Librarians consulted with university scholars and mainly purchased published scientific and academic books and journals. They made the distribution rules or lending policies and defined the eligible community of users. At that time, it was clear who was included in their community. 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.

93. *See* John Perry Barlow, *The Economy of Ideas: Selling Wine Without Bottles: The Economy of Mind on the Global Net.,* WIRED, Mar. 1994, at 86, *available at* http://www.wired.com/wired/archive/2.03/economy.ideas_pr.html ("[T]he bottle was protected, not the wine."). In the same vein, Jessica Litman points out "copyright protects a painting or photograph of an automobile, but gives no protection to the automobile itself." LITMAN, *supra* note 78, at 18.

94. See Madison, *supra* note 2, 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." *Id.* at 133.

95. Clifford A. Lynch, *The Transformation of Scholarly Communication and the Role of the Library in the Age of Network Information,* SERIALS LIBRARIAN, Summer 1993, at 5, 14.

96. *See* LITMAN, *supra* note 78, at 80, 81, 83.

Interlibrary Loan ("ILL")[97] was enhanced in the 1970s through the proliferation of new technology—the photocopy machine,[98] which allowed for duplication and easy lending of journal articles. It was further developed by the organization of the Online Computer Library Center ("OCLC"), the first electronic union catalog. ILL changed the user communities from local to local-regional-national (and later international) communities. With the costs of books and journals skyrocketing, the focus of library services changed from *owning collections* to serve present and future needs, to *accessing materials* for use upon demand.

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 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,[99] the Sonny Bono Copyright Term Extension Act,[100] the proposed legislation of the Uniform Computer Information Transactions Act ("UCITA"),[101] may all adversely affect the costs, access, and availability of scholarly information.[102] This focus of the intellectual public domain literature on commodification and privatization (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. A sample flow pattern is shown in Figure 4:

97. Interlibrary Loan was formally proposed in the United States in 1898 by the University of California-Berkeley. The Library of Congress first began lending books in 1902. *See* http://www.loc.gov/rr/loan/ (last visited Oct. 17. 2002).

98. The first office copier was introduced in 1959. *See* Chip Holt, *Working Knowledge: Photocopiers,* Sci. AM., Oct. 1996, at 128.

99. 17 U.S.C. §§ 512, 1201-1205, 1301-1332; 28 U.S.C. § 4001 (1998).

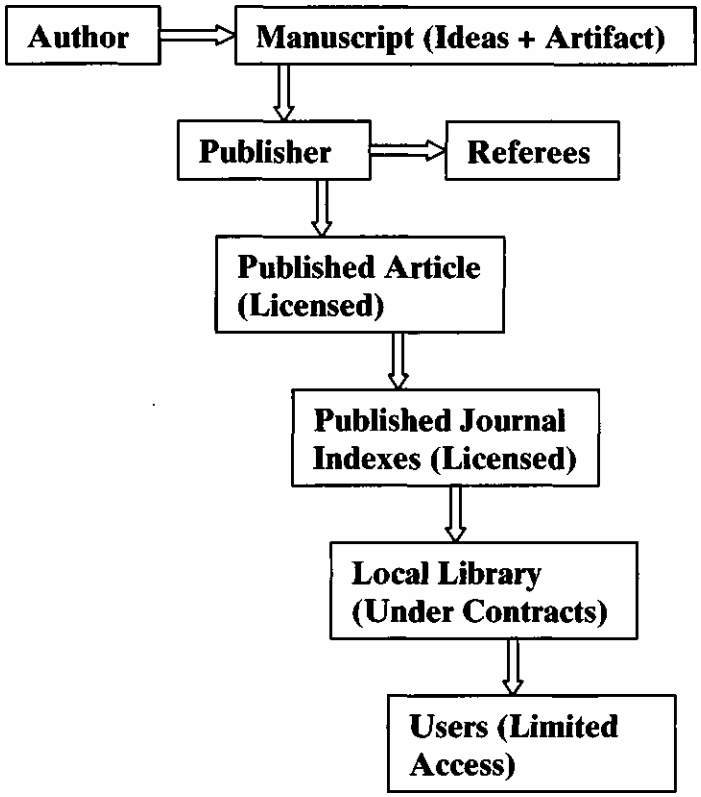
100. Pub. L. No. 105-298, Title I, 112 Stat. 2827 (1998).

101. UNIF. COMPUTER INFO. TRANSACTIONS ACT (UCITA) (2001), *available at* http://www.law.upenn.edu/bll/ulc/ulc.htm. For discussions of "technological locks" for information proposed by UCITA, see Lyman, *supra* note 83 and Hannibal Travis, *Pirates of the Information Infrastructure,* 15 BERKELEY TECH. L.J. 777 (2000).

102. *See* Arnold Lutzker, *What the DMCA and the Copyright Term Extension Act Mean to the Library Community: Primer* (Mar. 8, 1999), *available at* http://www.ala.org/washoff/primer.html.

FIGURE 4

TRADITIONAL FLOW OF DIGITIZED INFORMATION TODAY



In this scenario, many of the rules in use are now determined by the publisher rather than the library. The facility, in other words, must now license access rights rather than purchase the 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. At the same time, some contracts allow the publishers to makes changes to the bundles at their discretion.[103] Because of the enormous costs of these bundles, there is a growing inequity between the capacity of small versus large libraries

103. 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." Kenneth Frazier, *The Librarians' Dilemma: Contemplating the Costs of the "Big Deal",* D-LlB MAG., Mar. 2001, *available at* http://www.dlib.org/dlib/march01/frazier/03frazier.html.

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.

A major spokesperson for the complexities of digital information for libraries, Clifford Lynch, noted in 1994 that if libraries did not make major changes in their collection practices, their role in store-housing scholarly information would be called into doubt.[104] 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.[105]

Libraries seem to be 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. Because they add and delete 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. Even with the constraints of the new formal rules, however, 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 Lots of Copies Keep Stuff Safe ("LOCKSS"), which allows facilities to give permanence to the digital journals to which they subscribe.[106] 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 intellectual property legislation, which more and more often contradicts the very nature of digital information.

104. Clifford A. Lynch, *Rethinking the Integrity of the Scholarly Record in the Networked Information Age,* EDUCOM REV. (1994) *at* http://www.educause.edu/pub/er/review/reviewArticles/29238.html; *see also* Pamela Samuelson & R. Davis, The Digital Dilemma: A Perspective on Intellectual Property in the Information Age, *presented at* the Telecommunications Policy Research Conference (2000), *available at* http://www.sims.berkeley.edu/~pam/papers/digdilsyn.pdf (last visited Oct. 11, 2002).

105. Lynch, *supra* note 104, at 39.

106. *See* http://lockss.stanford.edu/projectdescfaq.htm (last visited Oct. 10, 2002). This voluntary system developed at Stanford in 2000 "permits libraries to cache content they can access. If a library cancels a subscription and has not cached the content, they cannot 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." *Id.* Over forty major libraries worldwide are now running the beta tests on this software, http://lockss.stanford.edu/projectstatus.htm (last visited Oct. 11, 2002).

> [C]opying 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: 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. [107]

One type of action in response to the "digital dilemmas" is the increased monitoring, reporting, and educating to 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 Association ("ALA"),[108] 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 Gueedon 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."[109]

One of the most important sources of information on the developments of digital scholarly communication and research since December 2001 has been *The Free Online Scholarship (FOS) Newsletter*[110] written and compiled by Peter Suber, a professor of philosophy at Earhlam College. The newsletter presents a wide range of news and discussion on the migration of print scholarship to the Internet and efforts to make scholarly information available to readers free of charge. Its broader purpose is "to explore how the internet is transforming scholarly research and how researchers can realize its full potential."[111]

Libraries face many complex issues pertaining to the future of academic scholarly materials and its availability. Jessica Litman[112] and Lawrence Lessig,[113] among others, have discussed the precariousness of the fair use and first sale

107. COMMISSION ON PHYSICAL SCIENCES, MATHEMATICS, AND APPLICATIONS, THE DIGITAL DILEMMA: INTELLECTUAL PROPERTY IN THE INFORMATION AGE 31 (2000), *available at* http://www. nap.edu/html/digital_dilemma/index.html (last visited Sept. 6, 2002) [hereinafter DIGITAL DILEMMA].

108. *See, e.g.,* ALA's Washington Office homepage *at* http://www.ala.org/washoff/index.html (last visited Sept. 8, 2002); ARL's pages on its Scholarly Publishing and Academic Resources Coalition (SPARC) *at* http://www.arl.org/sparc/home/ (last visited Sept. 8, 2002); EDUCAUSE's Washington Office on information technology Policy Issues *at* http://www.educause.edu/policy/policy.html (last visited Sept. 8, 2002).

109. *See* Jean-Claude Gu6don, *In Oldenburg's Long Shadow: Librarians, Research Scientists, Publishers, and the Control of Scientific Publishing, at* http://www.arl.org/arl/proceedings/138/guedon.html (last visited Sept. 8, 2002).

110. *See* http://www.earlham.edu/~peters/fos/index.html (last visited Sept. 8, 2002).

111. *Id.*

112. *See* LITMAN, *supra* note 78; Litman, *supra* note 13.

113. *See* LAWRENCE LESSIG, CODE AND OTHER LAWS OF CYBERSPACE 134 (1999).

doctrines as applied to licensed digital information.[114] As authors and information providers design new institutions to disseminate scholarly communication, library professionals must redefine many of their own institutions. Librarians can no longer build viable collections by selecting materials out of publishers' catalogs. They are becoming more actively involved in working with scholars, technologists, and policy makers to build trusted, reciprocal digital archive and repository systems.

The international e-prints "revolution" makes scholarly research freely available in unprecedented ways, in great contrast with the new legislation which increases copyright and patent restrictions, and encourages contract over property law through the constraints of embedded licensing agreements. The movement officially began with the mounting of arXiv.org at Los Alamos National Laboratory.[115] Developed in 1991 by physicist and information specialist Paul Ginsparg, arXiv.org 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 24, 2002, the site had received 209,565 submitted papers.[116] Importantly, around 70% of the submissions came from outside of the United States.[117] 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 to judge for themselves the accuracy and quality of the work. This archive is the first that actually changes the representation and visibility of the scholarly record.[118] The average number of site users range from 60,000 to 130,000 per day depending upon the day of the week.[119]

114. *See Individual Behavior, Private Use and Fair Use, and the System for Copyright,* DIGITAL DILEMMA, *supra* note 107 at 123-151.

115. The administration of arXiv.org was moved to the Cornell University Library site in September 2001; the main site hardware operations were transferred in December 2001. *See* http://arxiv.org/new (last visited Sept. 7, 2002).

116. *See* http://arxiv.org/show_monthly_submissions (last visited Sept. 7, 2002)

117. Figures from Paul Ginsparg, Creating a Global Knowledge Network, *presented at* UNESCO-HQ, Paris (Feb. 19-23, 2001), *available at* http://arXiv.org/blurb/pg01unesco.html.

118. A 1995 survey revealed that the main index of scientific journals, the *Science Citation Index,* indexes more than 3,300 journals of the roughly 70,000 that are published worldwide. *See* W. Wyat Gibbs, *Lost Science in the Third World,* SCI. AM., Aug. 1995, at 92, 92. A mere 2% of the journals indexed are written by authors from developing countries (with 80% of the world's population). *Id.* at 96. 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." *Id.* at 92. 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. co-authorship reflects increases in international collaboration. By the mid-1990s, nearly one of every five U.S. articles had one or more international co-authors, up from 12 percent earlier in the decade." NATIONAL SCIENCE BOARD, SCIENCE AND ENGINEERING INDICATORS 2000 6-4, *available at* http://www.nsf.gov/sbe/srs/seindOO/access/c6/c6h.htm (last visited Sept. 6, 2002).

119. *See* http://arxiv.org/show_weekdays_graph (last visited Sept. 6, 2002)

There are hundreds of other digital archives.[120] Some, like EconWPA,[121] 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,[122] make available historical scholarly materials that are in the public domain and make the authorized, full-text versions universally available for free. BioMed Central[123] 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.[124] The Digital Library of the Commons[125] 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 ("PLS"), 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."[126] PLS has so far encouraged over 30,888 scientists from 182 countries to sign its open letter to publishers to make their publications freely available on the web site PubMed Central.[127] By September 2002, there were over eighty full-text journals available at this site.[128] Another new collective action initiative is the Creative Commons[129] founded by Lawrence Lessig, James Boyle, and others to promote "the innovative reuse of all sorts of intellectual works."[130] Their first project is to "offer the public a set of copyright licenses free of charge."[131]

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

120. For statistics on increased usage of electronic papers, journals, and citations, see Andrew Odlyzko, *The Rapid Evolution of Scholarly Communication,* LEARNED PUBLISHING, Jan. 2001, at 7, *available at* http://www.dtc.umn.edu/~odlyzko/doc/rapid.evolution.pdf (last visited Sept. 7, 2002).

121. *See* http://econwpa.wustl.edu/ (last visited Sept. 6, 2002).

122. *See* http://ota.ahds.ac.uk/ (last visited Sept. 6, 2002).

123. *See* http://www.biomedcentral.com (last visited Sept. 8, 2002).

124. Publisher Jan Velterop wrote in the online Free Online Scholarship Forum that BioMed Central differs from other, conventional, publishers, in that "authors are not 'giving' their article to us. They keep all the rights to their article, are not asked to transfer copyright, and are totally free to distribute their article in any way they like. What we provide, and what authors' institutions are paying for (a fraction, by the way, of what they collectively pay for articles published conventionally), is the service of organising and handling the process of having the article peer-reviewed, and, if accepted, published (given a unique bibliographic journal citation, DOT and URL) in open access, presented in various standardised formats (PDF and XML-generated HTML) and hotlinked (via CrossRef and others) and indexed (PubMed, Biosis and others) to enable optimum findability, citeability, dissemination, and 'embedding' in the network that science literature is." Posting of Jan Velterop to FOS Forum, http:// www.topica.com/lists/fos-forum/index.html (Aug. 25, 2002) (copy on file with Law & Contemporary Problems).

125. *See* http://dlc.dlib.indiana.edu/index.html (last visited Sept. 6, 2002).

126. *See* http://www.publiclibraryofscience.org (last visited Oct. 29, 2002).

127. *Id.*

128. *See* http://www.pubmedcentral.nih.gov/index.html (last visited Oct. 29, 2002).

129. http://www.creativecommons.org/index.html (last visited Oct. 10, 2002).

130. *Id.*

131. *Id.*

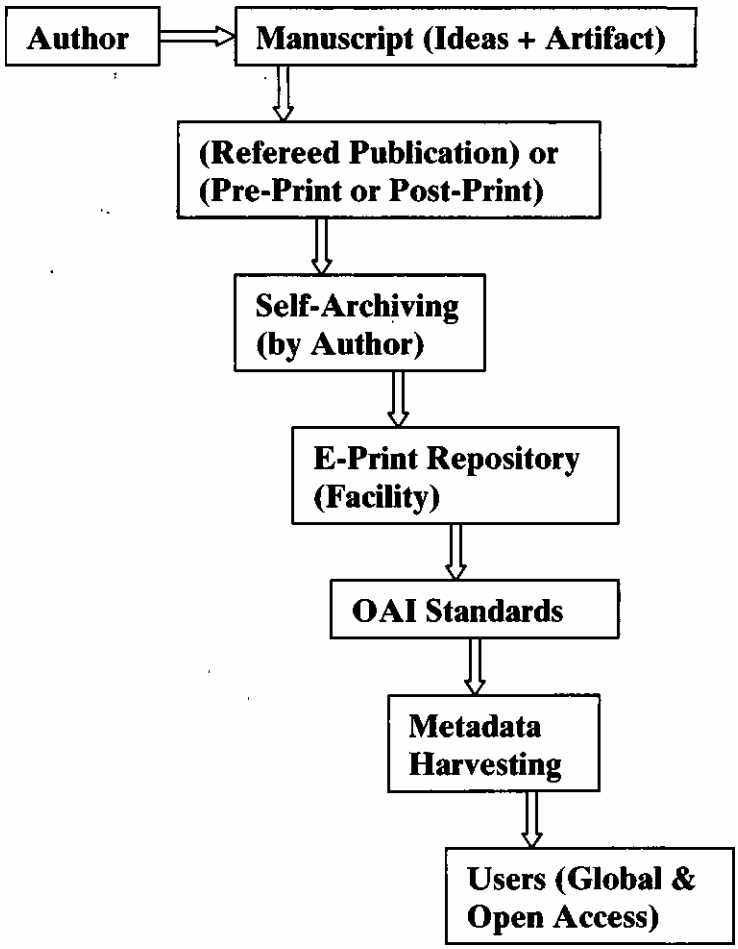
("OAI") and the development of the free E-prints software[132] are already reshaping the direction of scholarly publication by establishing "low-barrier" interoperable standards.[133] OAI was established in October 1999 by an international group of information scholars to develop and promote interoperability 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).[134]

132. *See* http://www.eprints.org (last visited Sept. 7, 2002).

133. *See, e.g.,* Carl Lagoze & Herbert Van De Sempel, *The Open Archives Initiative: Building a Low-Barrier Interoperability Framework* (2001) *at* http://www.openarchives.org/documents/oai.pdf (last visited Sept. 6, 2002).

134. *See* Clifford A. Lynch, *Metadata Harvesting and the Open Archives Initiative,* ARL BIMONTHLY REPORT, Aug. 2001, at 217, *at* http://www.arl.org/newsltr/217/mhp.html (last visited Sept. 6, 2002).

FIGURE 5 SELF-ARCHIVING DIGITAL INFORMATION FLOW USING THE INTERNET



In this scenario, the author takes on a self-governing role in the distribution of scholarly information by submitting her digital file to an E-print repository (facility), such as CogPrints,[135] a repository for cognitive science, psychology, neuroscience, philosophy, linguistics, and biology. If the article has been, or is to be, published, she may get permission from the publisher,[136] amend the copyright transfer agreement with the publisher,[137] or submit the preprint (the

135. *See* http://cogprints.soton.ac.uk/ (last visited Sept. 7, 2002).

136. As happened with a published paper submitted to the Digital Library of the Commons ("DLC"), Jesse Ribot, *Theorizing Access: Forest Profits Along Senegal's Charcoal Commodity Chain,* 29 DEVELOPMENT AND CHANGE (1998), *available at* http://dlc.dlib.indiana.edu/documents/dirO/00/00/04/43/index.html. In this case the publisher granted the author the right to self-publish the paper on the DLC web site.

137. *See* Stevan Harnad, *For Whom the Gate Tolls? How and Why to Free the Refereed Research Literature Online Through Author/Institution Self-Archiving, Now, at* http://www.cogsci.soton.ac.uk/

refereed version) or a postscript (a subsequent revision to the published version).

What is 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 mentioned a prevalent view (particularly of Hardin advocates) that if anyone can use a resource, no one will have an incentive to conserve its use or to invest in improvements.[138] This does not seem to 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 and $2000, compared with the average cost of putting a self-archived paper on the web between $1 and $100.[139] 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)."[140] Rebecca Eisenberg points to scientific recognition and credibility that comes with public disclosure and increased visibility of information.[141] 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 publish instantly 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 defines 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) backup policies and avoiding, detecting, and restoring

~harnad/Tp/resolution.htm (last visited Sept. 4, 2002). 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 online) 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. *Id.*

138. *See supra* Part III. A.

139. *See* Ginsparg, *supra* note 117.

140. Stevan Harnad, *Free at Last: The Future of Peer-Reviewed Journals,* D-LIB MAG., Dec. 1999, *available at* http://www.dlib.org/dlib/december99/12harnad.html.

141. Rebecca S. Eisenberg, The Public Domain in Genomics (paper presented at New York University School of Law, Mar. 31-Apr. 2, 2000), *available at* http://www.law.nyu.edu/ili/conferences/freeinfo 2000/abstracts/eisengberg.html (last visited Dec. 3, 2002).

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.[142] These design principles point to the kinds of cooperative behaviors and system resilience that are needed to sustain scholarly information as a common-pool resource in an increasingly digital world.

The purpose of this section has been to give examples of collective action initiatives that create new institutions to manage and disseminate scholarly information. We have not discussed the risks and costs that may be involved. There are concerns among some academics that self-archiving may drive academic publishers out of business. Others question whether peer-review will be as respected and authoritative outside of commercial publications. There is also a delicate balance between a possible decline in the well-managed files that have been provided by library professionals in the past and the advantages of increased online accessibility. Confusion over versions and provenance of artifacts is inevitable without standards like the Machine-Readable Catalogue ("MARC")[143] record format. In addition, the fugitive nature of digital archives where authors usually have the right to submit *and* unsubmit is very different from traditional libraries where authors and editors are not permitted to remove their articles and books at whim.

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

142. Research Libraries Group, *Attributes of a Trusted Digital Repository: Meeting the Needs of Research Resources: An RLG-OCLC Report* (Aug. 2001), *at* http://www.rlg.org/longterm/attributes0l.pdf (last visited Dec. 3, 2002).

143. *See* MARC Standards, http://www.loc.gov/marc/index.html (last visited Oct. 4, 2002).

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.