

The Unfolding of the Knowledge Commons

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ABSTRACT

This piece reports on some of the significant research and activities within the knowledge commons arena since the publication of Charlotte Hess and Elinor Ostrom's co-edited book *Understanding Knowledge as a Commons* in 2007. Hess uses this overview to identify major lacunae in the study of the knowledge commons. First, the relationship between local, indigenous knowledge and more globalised forms of knowledge is poorly understood. Second, the principles of local commons have not yet been tested against global commons, which may be characterised by regional inequalities. In both regards, careful case studies are needed to enrich our understanding of the knowledge commons.

After an impassioned plea from James Boyle, Elinor Ostrom agreed to present a paper at the inaugural Conference on the Public Domain held at Duke University in November 2001. She invited me to collaborate with her on a work that would combine her expertise on natural resource commons, collective action, and institutional analysis with my research on information and knowledge commons (KC). Our conference paper summarized some of the lessons learned from the large body of international and interdisciplinary research on common-pool resources (CPRs) that had grown up since the 1980s, and considered its usefulness in the analysis of knowledge and information as a shared resource.¹ Diving into the legal commons literature, we began to see ways in which study of the governance and management of common-pool resources might be helpful in analyzing the intellectual public domain. Our analysis demonstrated 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. The revised paper was published in 2003 in an issue of the journal *Law and Contemporary Problems* devoted to the public domain.²

That same year, Ostrom and I received funding from the Andrew W. Mellon Foundation to host the “Workshop on Scholarly Communication as a Commons.” The two-day event, occurring in March 2004, brought together leading interdisciplinary scholars in the United States who were publishing interesting studies in the new terrain of the information and knowledge commons. Our volume, *Understanding Knowledge as a Commons: From Theory to Practice (UCK)* was an outgrowth of that workshop. The book provided a new way of looking at knowledge as a shared resource, a complex ecosystem that is a *commons*—a resource shared by a group of people that is subject to social dilemmas. While we argued the logic of making the whole book available in open access (OA), we were grateful to our publisher for agreeing to provide in OA the preface, introduction, glossary, and index.³

The introduction is a useful starting place to learn about the brief evolution of the study of the knowledge commons and its relation to the study of traditional, natural-resource commons. It gives a brief history of the study of natural resource commons and the development of knowledge commons as an outgrowth. It illustrates the importance of applying an interdisciplinary approach to the study of any type of commons. Key concepts discussed are Ostrom’s design principles for robust, long-enduring commons,⁴ and Hardin’s “Tragedy of the Commons.”⁵ It underscores the essential role of collective action and self-governance in making commons work.

Especially important in the overview are the discussions of the difference between a “common-pool resource,” one type of economic good defined by the extent of subtractability and exclusion, and “common property,” a type of formal or informal property. But unlike any of our earlier works, we found it essential to provide a definition of the more general term “commons.” This was because we had noticed that many of the works on knowledge and other new types of commons were less concerned with property rights or the nature of the good. Rather, they were frequently exploring new types of enclosures of information and cultural resources made possible in the digital environment, or they addressed the new opportunities for online collective action and knowledge-sharing afforded the by the Internet.⁶ After much discussion we agreed on the following definition: a commons is a resource shared by a group of people that is subject to social dilemmas.

In the book we defined “knowledge” as all useful ideas, information, and data in whatever form in which it is expressed or obtained. Our focus was specifically on “useful knowledge,” whether indigenous,

scientific, scholarly, or non-academic. It included creative works—music and the visual and theatrical arts. We drew from Reichman and Franklin regarding the polemical nature of knowledge with its dual functions as a commodity and as a constitutive force of society.⁷ This dual function as a human need and an economic good immediately suggest the complex nature of this resource.

Knowledge is cumulative. With ideas, the cumulative effect is a public good, so long as people have access to the vast storehouse. Maintaining knowledge as a public good by maintaining access and preservation were challenges long before the advent of digital technologies. An infinite amount of knowledge is waiting to be unearthed. The discovery of new knowledge is a common good and a treasure we owe to future generations. The challenge of today's generation is to keep the pathways to discovery opened and unclogged.

Knowledge as a public good in digital format is fragile and increasingly vulnerable for a number of reasons:

- Knowledge is rapidly changing and evolving;
- Digital code, protocols, and infrastructure are rarely understood by policymakers;
- Intellectual property rights for digital formats have greatly expanded since the advent of the Internet;
- Books, journals, and databases have been moved from the “first sale” world of property law to the much more restrictive domain of contract law where publishers’ licenses often restrict fair use for educational purposes, prohibit lending, and limit the number of users;
- An unknown amount of valuable digital information is being lost to the world every day through inadequate preservation and simple neglect; and
- Prices for digital publications continue to rise at unsustainable rates.

As a counterweight, the strength and resilience of shared knowledge are evident on a global basis through unprecedented forms of collaboration and collective action made possible by distributed networked information. The Arab Spring and Occupy Movements leave no doubt of the critical role of digital connectedness through the Internet, short messaging service (SMS), and mobile phones for collective action plays throughout the world.⁸ Demonstrations of the resilience of the scholarly knowledge commons and online civic action are all initiatives that are part of the open access movement. A few representative examples are:

- MIT Open Courseware <http://ocw.mit.edu/index.htm>;
- Open Courseware Consortium <http://www.ocwconsortium.org>;
- Flatworld Knowledge, <http://www.flatworldknowledge.com>, an open textbook initiative that has been in development since 2007;
- OpenWetWare <http://openwetware.org/wiki/Main—Page>, an effort to promote sharing information, know-how, and wisdom among researchers who are working in biology and biological engineering;
- Open Educational Resources (OER) Commons <http://www.oer-commons.org/oer>. OER Commons has forged alliances with over 120 major content partners to provide a single point of access through which educators and learners can search across collections to access over 30,000 items, find and provide descriptive information about each resource, and retrieve the ones they need.

Ostrom and I were fortunate to have our book reviewed in seventeen scholarly journals. While the reviews were generally quite positive, there were two criticisms that were mentioned by some reviewers. First, a book on the knowledge commons should be available in open access to the global community, and second, that it was too American-centric without sufficient attention to marginalized, information-poor users throughout the world. Crispin pointed out that “marginalized users are the focus only in Peter Levine’s chapter on involving adolescents in creating public knowledge.”⁹ While our focus in the book was applying traditional natural-resource commons analysis to the theory and practice of knowledge commons, and featuring various approaches to knowledge commons study of which we were aware at the time, it is certainly true that the questions of information equity, protection of indigenous, and traditional knowledge commons from predatory capture or “enclosure” are important. Shiva’s seminal work on biopiracy is as relevant today as it was fifteen years ago.¹⁰

Issues of information equity, universal access, and universal provision of knowledge and information remain crucially important. Fortunately the knowledge commons movement continues to grow as more people throughout the world become aware of not only information-poor regions’ needs for qualitative and scientific information, but at the same time, the critical need for access by “information-rich regions” to the wealth of scientific knowledge from marginalized regions that is not available online.

India has long been one of the countries at the forefront of the knowledge commons movement.¹¹ A great step forward for knowledge commons in India was the recent global Conference of the International Association for the Study of the Commons (IASC) held in Hyderabad, India in January 2011 that brought hundreds of practitioners, researchers, policymakers, journalists, and funders to share their thoughts and lessons learned about the commons. Besides the papers, publications, networks, community and government initiatives, and movements have grown out of this international event.¹² A tireless advocate for open access and provision in India is scientist Subbiah Arunachalam. In an interview with Richard Poynder, Arunachalam described the problem from the Indian point of view:

...research performed in India, and funded by Indian taxpayers, is reported in a few thousand journals, both Indian and foreign. Since some of these journals are very expensive, many Indian libraries—including sometimes the author's own institutional library—are not able to subscribe to them. As consequence, other Indian scientists working in the same, or related, areas are unable to read these papers. This is a problem common to all developing countries.¹³

But Arunachalam is critically aware that open access can solve both the problems of access and provision. In his review of *UKC*, he writes: “Indian librarians will do well to note that it is important to move from being mere keepers of archives and stewards of information goods, to active participants in the research process and in the production of scholarly information.”¹⁴

In 2011, the Initiative on Commons (IC) was co-founded by the Foundation for Ecological Security (FES) in India and the IASC in order to

bring together practitioners, policy makers and academia, working on various domains of commons—physical commons such as forests, grazing resources, protected areas, water, fisheries, coasts, lagoons, irrigation systems as well as new commons such as knowledge, digital and cultural commons, genetic resources, patents, climate, etc. It is an evolving platform to advance understanding, research and advocacy on the commons. The initiative ultimately aims to influence public perception, policy environment and programmatic action in favour of the commons.¹⁵

Recently, IC published an important, perhaps groundbreaking volume, *Vocabulary of the Commons*, “a collaborative effort in the knowledge commons” with the purpose of teaching local communities about the commons so that they can “retake the commons, and then refashion them into egalitarian ends. Retaking the commons needs a vocabulary of commons—in thought (attitude), speech (intent), law (norms) and programmes (practice).”¹⁶

Without the space to discuss the hundreds of local and global networks on knowledge commons, websites, collaborations, initiatives, and movements, that are thriving today, I would like to mention some serious studies of or events around the knowledge commons that deserve mention. In 2012, we can certainly say that the study of knowledge commons has blossomed. The launch of the (open access) *International Journal of the Commons (IJC)* in 2007, primarily through the tireless efforts of European scholars Erling Berge and Tine de Moor with the support of the International Association for the Study of the Commons, contains quite a few articles on the knowledge commons.¹⁷

The *Cornell Law Review* devoted an issue to the knowledge commons in 2010.¹⁸ Spearheaded by legal scholars Michael J. Madison, Brett M. Frischmann, and Katherine J. Strandburg, the volume explores the concept of “constructed” knowledge and cultural commons.¹⁹ In the lead article, the three editors present an adaptation of the Institutional Analysis and Development Framework adjusted for “humanly-constructed” rather than natural resource commons. They apply the framework to several types of commons: intellectual property pools, open source software, Wikipedia, the Associated Press, and jamband fan communities. Six commons scholars provide further analysis in separate articles. This issue was followed by a conference at New York University in 2011 and a forthcoming book in 2012 with contributions from Elinor Ostrom, Yochai Benkler, Carol Rose, Jorge Contreras, Charles Schweik, and other major commons scholars.

The international effort to create a Microbial Scientific Commons, led by Belgian scholar Tom Dedeurwaerdere, with US scholars Jerome Reichman and Paul Uhler, has made astounding inroads in the past five years with a section of an issue of the *IJC* devoted to the Microbial Commons.²⁰ A previous publication was the “Exploring the Microbiological Commons” issue of the *International Social Science Journal*.²¹ In fall 2010 the National Academy of Sciences hosted the international symposium “Designing the Microbial Research Commons.” The proceedings were published open-access in 2011 by the National Academies Press.²² Tom Dedeurwaerdere is chairing the IASC First Thematic Conference on the Knowledge Commons in Louvain, Belgium in September 2012.²³ Conference themes include:

- scientific research and innovation commons;
- digital information commons;
- historical experience of the knowledge commons;
- genetic resource commons; and
- cultural commons.

German scholar and advocate Silke Hilfrich teamed up with US activists and commons thinkers David Bollier and Michel Bauwens to host the International Commons Conference in Berlin in November 2012 attended by 200 people from thirty-five countries.²⁴ A forthcoming compendium preliminary titled *The Life of the Commons* about the state of the commons and the global movement that is building a new economic order is forthcoming in 2012.

The First International Workshop on the Cultural Commons was held in Turin, Italy, in January 2010, resulting in a forthcoming volume, *Cultural Commons: A New Perspective on the Production and Evolution of Cultures*.²⁵ A French anthology of international works on knowledge commons was published in 2011.²⁶

Leslie Chan, who founded *Bioline International* and co-founded the Open Access Scholarly Information Sourcebook (OASIS) and the global Open Access Map, has made important inroads in improving information equity by building access worldwide to scientific journals.²⁷ He makes the interesting point that while knowledge seekers in developing countries have greater access to published scholarly information, there remains the enormous challenge of making accessible the kinds of information really needed. Citing a Nigerian writer he asks: “is it useful for doctors in Nigeria to read about the latest high-tech treatments for infertility published in a western journal when it is not economically feasible to implement these procedures in cash-strapped public hospital in Nigeria...?”²⁸ Chan, Kirsop, and Arunachalam’s very thought-provoking piece “Towards Open and Equitable Access to Research and Knowledge for Development” discusses initiatives that try to address the North-South knowledge inequity that has led to “the misguided notion that little, if any, research of substance is generated in the global South, and that the needs of researchers in poor countries are therefore met solely by information donation from the North. The one-way North to South flow of knowledge is not all that is necessary for development, and the Research4Life program only addresses part of the problem.”²⁹

Much more research needs to be done in the area of indigenous knowledge and commons. Jorason gives a good overview of some of the issues, particularly the problems of language inequity, endangered languages, and indigenous knowledge disseminating practices.³⁰ University of Massachusetts scholar Jane Anderson’s work on the growing conflicts over access and control of indigenous knowledge in libraries, archives, and museums is extremely timely, and her somewhat groundbreaking approach will appear as a chapter in the forthcoming Madison, Frischmann, and Strandberg book mentioned above. The Abrell et al. piece “Imagining a Traditional Knowledge Commons: A Community Approach to Sharing Traditional

Knowledge for Non-commercial Research” proposes a traditional knowledge commons that would require a community of traditional knowledge holders to develop in accordance with their bio-spiritual virtues the terms and conditions for non-commercial access to their traditional knowledge.

One interesting new area of research within the global commons arena revolves around cyber security, which is increasingly viewed as a very complex knowledge commons.³¹ Even the 2009 Obama administration “Cyberspace Policy Review” concurs: “One area needing further study is whether and in what ways elements of the information and communications infrastructure ought to be treated as a global commons.”³² Both the president and the report emphasize that the US cannot work in isolation, that within the US there need to be public-private partnerships to collaborate on cyber security; and that internationally we will need to bring like-minded nations together.

As many observers have pointed out, the knowledge commons is a *global commons*. Unfortunately, as McCay and Delaney recently pointed out, we still do not understand any types of global commons very well, and there does not seem to be a mass of research on it.³³ We understand the global knowledge commons even less than global traditional or natural resource commons. Most of the research on commons and common-pool resources to date has concentrated on micro-level analysis of local resources.³⁴

The most pressing need if we want to better understanding any type of knowledge commons is for more in-depth case studies—a need also emphasized throughout the *Cornell Law Review* issue mentioned above. As commons scholars, we realize how much we learned from Ostrom’s analysis of case studies in her award-winning book *Governing the Commons: The Evolution of Institutions for Collective Action*.³⁵ She rigorously applied the Institutional Analysis and Development (IAD) Framework to eighty-six case studies of long-enduring and robust natural resource commons from around the world. Her analysis led to an understanding of eight design principles that were shared by these commons:

- clearly defined boundaries;
- rules-in-use are well matched to local needs and conditions;
- individuals affected by these rules can usually participate in modifying the rules;
- the right of community members to devise their own rules is respected by external authorities;
- a system for self-monitoring members’ behavior;
- a graduated system of sanctions;

- community members have access to low-cost conflict resolution mechanisms;
- nested enterprises—i.e. appropriation, provision, monitoring and sanctioning, conflict resolution, and other governance activities are organized in a nested structure with multiple layers of activities.

While some scholars of new or knowledge commons tend to use these design principles as a place to start their own analysis, we do not really know how much they pertain to large, complex, constructed commons such as scientific collaborations, Wikipedia, or genetic resources. We need new case studies that focus specifically on knowledge as a shared resource, investigate the community of users and the rules in use of individual knowledge commons, and then apply the rest of the IAD framework, the action arena, and how those variables lead to outcomes. Such case studies would elucidate our understanding of why some of these commons are successful while others are vulnerable and subject to failure. Madison, Frischmann, and Strandberg underscore the importance of concerted studies in their 2010 article:

Structured inquiry into a series of case studies will provide a basis from developing theories to explain the emergence, form, and stability of the observed variety of cultural commons and, eventually, to design models to explicate and inform institutional design.³⁶

There are already some good case studies that should be mentioned.³⁷ Ostrom and Hess applied the IAD framework to libraries not as a case study but rather as an example of how to apply the framework in the case of knowledge commons.³⁸

This is a brief, and perhaps unsatisfying, overview of some of the developments in the knowledge commons research arena since *UKC*. Countless important references are unjustly missing from this piece. The idea, at least, is to sow some seeds and provide suggestions for further investigation. I applaud *STAIR* for this timely issue that so rightly focuses on inequity and the urgency of universal access. For those with access, these articles will contribute to a deeper understanding of the knowledge commons. ■

Notes

¹ Charlotte Hess and Elinor Ostrom, "Artifacts, Facilities, and Content: Information as a Common-Pool Resource," (Paper presented at the Conference on the Public Domain, Duke Law School, Durham, North Carolina, November 9-11, 2001). We

decided to change the title of the published version to “Ideas, Artifacts, and Facilities...” after an extended conversation with John Perry Barlow about the meaninglessness of the word “content” in that context.

² *Law and Contemporary Problems* 66, nos. 1 and 2 (2003).

³ Charlotte Hess and Elinor Ostrom, eds., *Understanding Knowledge as a Commons* (Cambridge, MA: MIT Press, 2007). As mentioned, portions of the book are available OA at <http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=11012>.

⁴ Elinor Ostrom, *Governing the Commons: The Evolution of Institutions for Collective Action* (New York: Cambridge University Press, 1990).

⁵ Garrett Hardin, “The Tragedy of the Commons,” *Science* 162 (1968): 1243-1248.

⁶ See James Boyle, “The Second Enclosure Movement and the Construction of the Public Domain,” *Law and Contemporary Problems* 66 (Winter 2003): 33-74.

⁷ Jerome H. Reichman and Jonathan A. Franklin, “Privately Legislated Intellectual Property Rights: Reconciling Freedom of Contract with Public Good Uses of Information,” *University of Pennsylvania Law Review* 147, no. 4 (1999): 875-970.

⁸ See Lee Rainie, Kristen Purcell, and Aaron Smith, “The Social Side of the Internet,” PEW Report, January 18, 2011.

⁹ See Jennifer J. Crispin, review of *Understanding Knowledge as a Commons: From Theory to Practice*, ed. Charlotte Hess and Elinor Ostrom, *InterActions: UCLA Journal of Education and Information Studies* 4, no. 2 (2008); A. Whitworth, review of *Understanding Knowledge as a Commons: From Theory to Practice*, ed. Charlotte Hess and Elinor Ostrom, *New Media & Society* 10, no. 1 (2008): 169-172; Charles Oppenheim, review of *Understanding Knowledge as Commons: From Theory to Practice*, ed. Charlotte Hess and Elinor Ostrom, *Library Review* 57, no. 6 (2008): 478-480.

¹⁰ Vandana Shiva, *Biopiracy: the Plunder of Nature and Knowledge* (Cambridge, MA: South End Press, 1997).

¹¹ Frederick Noronha, “India at the Forefront of Knowledge Commons Debate,” Intellectual Property Watch, 2006, <http://www.ip-watch.org/2006/09/03/india-at-the-forefront-of-the-knowledge-commons-debate/> (Accessed March 28, 2012).

¹² 273 papers from the conference are available on the Digital Library of the Commons at <http://dlc.dlib.indiana.edu> (accessed March 28, 2012). Of particular interest are Padini Nirmal, “Understanding Global Knowledge-dynamics: A Case-study of NFSCs Project Digital Community Archiving—Does it Protect or Plunder the Indigenous Knowledge of the Nari Kuravar Community?” <http://hdl.handle.net/10535/7135>; V. Joseph Satish, “Indigenous Arts and the Commons,” (Paper presented at the Thirteenth Biennial Conference of the International Association for the Study of the Commons, Hyderabad, India, January, 2011), <http://hdl.handle.net/10535/7166>; Kabir Sanjay Bavikatte et al., “Imaging a Traditional Knowledge Commons: A Community Approach to Ensuring the Local Integrity of Environmental Law and Policy,” (Paper presented at the Thirteenth Biennial Conference of the International Association for the Study of the Commons, Hyderabad, India, January, 2011), <http://hdl.handle.net/10535/7368>; Soutrik Basu, Guido Ruivenkamp, and Joost Jongerden, “Open Source, Commons and Development: A Research

Agenda on Common Pool of Services of Generation Challenge Programm (GCP)," (Paper presented at the Thirteenth Biennial Conference of the International Association for the Study of the Commons, Hyderabad, India, January, 2011), <http://hdl.handle.net/10535/7308>.

¹³ Richard Poynder, "Why India Needs Open Access," *Open and Shut* (blog), May 5, 2006, <http://poynder.blogspot.com/2006/05/why-india-needs-open-access.html?m=1> (accessed March 28, 2012).

¹⁴ Subbiah Arunachalam, review of *Understanding Knowledge as a Commons: From Theory to Practice*, ed. Charlotte Hess and Elinor Ostrom, *Current Science* 93, no. 6 (2007): 860-861.

¹⁵ Foundation for Ecological Security, Vocabulary of Commons, January, 2011, 24, <http://www.slideshare.net/OpenSpace/vocabulary-of-commons> (accessed March 26, 2012).

¹⁶ Ibid.

¹⁷ *International Journal of the Commons* 6, no. 1 (2012).

¹⁸ *Cornell Law Review* 95, no. 4 (2010).

¹⁹ Although the authors call the resource at hand a "cultural commons", they are referring to constructed knowledge resources.

²⁰ *International Journal of the Commons* 4, no. 1 (2010).

²¹ *International Social Science Journal* 188 (June 2006).

²² Paul F. Uhler, ed., *Designing the Microbial Research: Proceedings of an International Workshop* (Washington: National Academies Press, 2011).

²³ International Association for the Study of the Commons, *1st Thematic Conference on the "Knowledge Commons"*, Louvain, September 12-14, 2012.

²⁴ "Interpretive Summary of the International Commons Conference," p2p foundation, <http://p2pfoundation.net/Interpretative-Summary-of-the-International-Commons-Conference#An-Overview-of-the-Conference> (accessed March 11, 2012).

²⁵ Walter Santagata and Enrico Bertacchini, eds., *Cultural Commons: A New Perspective on the Production and Evolution of Cultures* (Northampton, MA: Edward Elgar, forthcoming).

²⁶ Hervé Le Crosnier, ed., *Libres Savoirs: Les biens communs de la connaissance* (Caen : C&F Editions, 2011).

²⁷ Leslie Chan and Sely Costa, "Participation in the global Knowledge Commons: Challenges and opportunities for research dissemination in developing countries," *New Library World* 106, no. 3/4 (2005): 141-163.

²⁸ Ibid.

²⁹ Leslie Chan, Barbara Kirsop, Subbiah Arunachalam, "Towards Open and Equitable Access to Research and Knowledge for Development," *PLoS Med* 8, no. 3 (2011).

- ³⁰ Kate Jorason, "Indigenous Knowledge and the Knowledge Commons" *International Information and Library Review* 40, no. 1 (2008): 64-72.
- ³¹ See, for instance, Abraham M. Denmark, "Managing the Global Commons," Center for a New American Security Commentary, 2010, <http://www.cnas.org/node/4695>; Abraham M. Denmark, and James Mulvenon, eds., *Contested Commons: The Future of American Power in a Multipolar World* (Washington: Center for a New American Security, 2010); ITU Global Cybersecurity Agenda (GCA), "Framework for International Cooperation in Cybersecurity," 2011, www.itu.int/cybersecurity/gca (accessed March 23, 2012); Kenneth N. Clark, "Institutions and Self-Governing social systems: Linking Reflexivity and Institutional Theories for Cybersecurity and Other Commons Governance Policies" (PhD thesis, George Washington University, 2012); Jorason, "Indigenous Knowledge and the Knowledge Commons."
- ³² White House, "Cyberspace Policy Review," B4, <http://www.whitehouse.gov/assets/documents/Cyberspace—Policy—Review—final.pdf> (accessed March 23, 2012).
- ³³ Bonnie McCay, "Expanding the boundaries of commons scholarship: The 2008 Conference of the International Association for the Study of the Commons," *International Review of the Commons* 4, no. 1(2010): 213-225.
- ³⁴ M. McGinnis and Elinor Ostrom, "Design Principles for Local and Global Commons," in *International Political Economy and International Institutions*, Vol. 2, ed. O. R. Young (Brookfield, VT: Edward Elgar, 1996).
- ³⁵ Elinor Ostrom, *Governing the Commons*.
- ³⁶ Michael J. Madison, Brett M. Frischmann and Katherine J. Strandburg, "Constructing Commons in the Cultural Environment," *Cornell Law Review* 95 (2010): 658.
- ³⁷ J.L. Contreras, "Bermuda's Legacy: Policy, Patents and the Design of the Genome Commons," *Minnesota Journal of Law, Science & Technology* 12 (Winter 2011): 61; Armano Srblijinovic, Ljubica Bakic-Tomic and Jasmina Bozic, "Virtual Communities as Commons: Case Study of 'Connect'," *Interdisciplinary Description of Complex Systems* 6, no. 1 (2008):37-52; Charles M. Schweik, "Free/Open-Source Software as a Framework for Establishing Commons in Science," in *Understanding Knowledge as a Commons*, ed. Hess and Ostrom; Charles M. Schweik, "An Institutional Analysis Approach to Studying Libre Software 'Commons,'" *Upgrade* 6, no.3 (2006):17- 27; Peter Kollock, "Design Principles for Online Communities," (Paper presented at the First International Harvard Conference on the Internet and Society, 1996), <http://www.loa-cnr.it/Files/CollabKWork/Design%20Principles%20for%20Online%20Communities-%20Kollock.html#Footnote%201>; Ruben van Wendel de Joode, "Understanding Open Source Communities: An Organization Perspective," (PhD dissertation, Delft University of Technology, 2005), <http://repository.tudelft.nl/view/ir/uuid%3A297bc2ff-956b-436b-addb-98eb1d4a3b4f/>; J. Hofmokr, "The Internet Commons: Towards an Eclectic Theoretical Framework," *International Journal of the Commons* 4, no.1 (2010): 226-250.
- ³⁸ Charlotte Hess and Elinor Ostrom, "A Framework for Analyzing the Knowledge Commons," in *Understanding Knowledge as a Commons*, ed. Hess and Ostrom.