Of Rainbows and Rivers: Lessons for Telecommunications Spectrum Policy from Transitions in Property Rights and Commons in Water Law

by

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Abstract:
A number of industries utilize the telecommunications spectrum to provide billions of dollars of services. However, some have noted that technological development and implementation of spectrum applications have not progressed as fast in the United States as in other parts of the world To improve technological development, many have recommended significant changes in United States policy of allocating spectrum, some based on a "property rights" approach, and others based on a "commons" approach. This article takes a novel approach to this problem, by applying lessons from our two hundred year history of water law to spectrum policy. Also, instead of analyzing static characteristics of property systems, this article changes its focus to examine transitions in these systems. Based on a new classification of property, "marketable commons property," this article presents a solution to the allocation of spectrum: spectrum commons accounts (SCA).

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Some of our most important new technologies involve the use of the telecommunications spectrum. Cellular telephones, wireless internet service, cordless telephones, baby monitors: these all use some portion of the telecommunications spectrum to provide billions of dollars of services.

Until recently, interest in the telecommunications spectrum was confined primarily to television and radio broadcasts, ham radio operators, and military and public service (police, fire, and ambulance) uses. With these limited uses, the United States chose to allocate the telecommunications spectrum through decisions of a regulatory agency, the Federal Communications Commission (FCC). While many criticized this allocation system,[1] it nonetheless continued to be used up until the late 1990s.

With the development of recent technologies, many, including the FCC itself, realized that another approach was necessary. In response, the FCC auctioned off a portion of unallocated spectrum.[2] Auctions conducted between 1994 and 1996 raised revenues of approximately $20 billion.[3] A rationale of these auctions was to increase the development of new technologies that utilize the telecommunications spectrum, by opening up new frequencies to new uses. The revenue generated indicates how valuable these technologies are expected to be. However, despite the availability of these new frequencies, many believed that these auctions were insufficient to meet the rising demand for frequencies. This demand was both caused by recent innovations, and needed for additional technological progress. As one technology writer noted, technological development utilizing the spectrum has not progressed as fast in the United States as in other parts of the world: "[U.S.] policies … have … allowed Asia – Japan in particular – to not only catch up in the development and expansion of broadband and mobile phone technology, but to roundly pound us into the dirt."[4]

As a result, a new debate has raged over spectrum. To improve technological development, many have recommended significant changes in allocating spectrum, some based on a "property rights" approach, and others based on a "commons" approach.[5]

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[1] *See for instance*, Ronald H. Coase, *The Federal Communications Commission*, 2 J. L. & ECON. 1, 1 (1959).
[2] *See* John McMillan, Selling Spectrum Rights, 8 J. Econ. Persp. 145 (1994); and Teresa Riordan, *FCC's Auction Draws Rich Bids*, N.Y. TIMES, July 26, 1994, at D1, *cited* in Dean Lueck, *The Rule of First Possession and the Design of the Law*, 38 J. L. & ECON. 393, 421 (1995).
[3] *See* Peter Cramton, The Efficiency of the FCC Spectrum Auctions, 41 J. L. & ECON. 727 (1998).
[4] Dan Mitchell, *A Broadband Beat-Down*, N.Y. TIMES, June 25, 2005, at C1. This article goes on to state, "Japan, South Korea and other Asian countries are poised to leap ahead of the United States in any number of areas: teleconferencing, telecommuting, remote medical services, distance education, multimedia entertainment." Id.
[5] For more, *see* section III, *infra*.

This article takes a novel approach to this problem, by applying lessons from our two hundred year history of water law to spectrum policy. Also, instead of analyzing static characteristics of property systems, this article changes its focus to examine transitions in these systems. Based on a new classification of property, "marketable commons property,"[6] this article presents a solution to the allocation of spectrum: spectrum commons accounts (SCA).

This novel approach is closely related to the "Property Rights versus Commons" debate over spectrum.[7] Some favor a "property rights" approach, whereby spectrum is put to its highest valued purposes by permitting those who value spectrum the highest to purchase the right to use a portion of the spectrum from the "owner" of the property right to that portion. This approach works well for spectrum technologies, such as financial market transaction technologies, that suffer significant losses if they are interfered with. The property rights approach addresses this by limiting the use of a specific frequency to only the owner of that frequency.

Others instead favor a "commons" approach, whereby a specific portion of spectrum is shared by a number of users in such a manner as to permit most if not all of these users to achieve their purposes for use of spectrum. This approach works well for spectrum technologies that depend on a multitude of different inventors designing different applications that are less susceptible to interference problems, but also have little financing necessary to purchase the exclusive right to utilize a frequency. One example has been the rapid advances in technology for wireless computer networks, where a number of different inventors have developed different applications for wireless networks, all utilizing the same frequency.

In the end, this debate is all about the encouragement of technological development. Commons advocates believe that the commons approach is the way to achieve technological change, while property rights advocates believe that the protection of exclusive property rights is needed to properly advance technology. This is an important question whose answer provides a link to a multi-billion dollar market. Answering this question also involves better understanding the process of technological development, along with the role of risk and uncertainty.[8]

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[6] *See* Table 1 and section I, *infra*.
[7] The structure of this debate is similar to other "Commons versus Property Rights" debates over file-sharing technologies, the internet, and the copyright extension act. *For instance, see* LAWRENCE LESSIG, THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD (2001). See also Brett M. Frischmann, *An Economic Theory of Infrastructure and Commons Management*, 89 Minn. L.R. 917 (2005) [linking analysis of infrastructure resources with the commons approach, and identifying characteristics that lead to improved management through a commons approach].
[8] For more, *see* section VI.C.

Until now, this debate has missed an important consideration: the ability of a property system to adapt to changes. The choice of a commons approach or a property rights approach is in essence a selection of a system for managing telecommunications spectrum as property. One thing that has been clear over the history of property law is the need for a property system to adapt to changed circumstances. Our analysis of future interests has led to modifications of the application of a number of rules that have perplexed lawyers for hundreds of years: for instance, in most jurisdictions, the infamous "Rule in Shelley's Case" no longer applies.[9] Also, copyright law has adapted from its initial application to works reproduced by printing presses, to works reproducible by photocopying machines, and now as digital media. Consequently, the desirability of a particular property system may depend heavily on its ability to adapt to new circumstances.

One of the reasons for this lack of attention is the inherent difficulty of analyzing a property system's adaptability before-the-fact: how can you know how a commons system will adapt to changed circumstances if you do not know what these new circumstances will be? While we cannot see into the future, we can examine the past. Although there is a very limited history of commons and property rights for telecommunications spectrum, there are other property resources with a lengthy history of allocating that resource through both a commons approach and a property rights approach.

One such resource, water, shares many characteristics with telecommunications spectrum. While we have had very limited experience with commons and property rights approaches for spectrum, we have approximately two hundred years of experience with these approaches for water rights. The similarities between spectrum and water suggest that we can make predictions about the future adaptability of property systems for telecommunications spectrum by analyzing our past experiences with water rights.[10]

This article examines our experiences with using commons and property rights approaches to allocate water resources. In the United States, water law doctrine is split into two approaches: "riparian" [utilized primarily in Eastern states] and "prior appropriations" [utilized primarily in Western states]. This article explains how riparian doctrine for water rights is essentially a commons approach, while prior appropriations doctrine is a property rights approach. It then examines significant lessons from our

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[9] JESSE DUKEMINIER AND JAMES E. KRIER, PROPERTY, 5th ed., 300 (2002).
[10] Lueck, *supra* note 2, examines first possession doctrine under both water law and telecommunications spectrum, in addition to first possession of chattels, homesteading, adverse possession, mining, and intellectual property. However, his examination of spectrum focuses primarily on the early history of spectrum allocation (1920-1927), with some discussion of the recent auctions. *See id.*, at 419.

approximately two-hundred year history of water rights, and applies these lessons to telecommunications spectrum.

To aid with analysis, this article presents a new classification for property. In an earlier article,[11] Carol Rose suggested a third classification for property, "inherently public property," in addition to commons and property rights classifications. Inherently public property is essentially property that is held by private individuals with an option to convert the private property into a commons held by the government. For instance, real property is subject to the power of eminent domain, whereby the government can convert property formerly held as private property into property held as commons (for use by the government for the good of the public). This article extends Rose's framework to include a new classification, "marketable commons property." Marketable commons property is essentially property that is held as a commons, but with an option to convert it into property held privately.[12] This option essentially "completes the square" as a fourth option:

	Primary Owner: Private	Primary Owner: Public
No Option Held	Property Rights	Commons
Inherent Option Held	Inherently Public	Marketable Commons

Table 1: Classifications of Property

The lessons from water law suggest that internal contradictions within a property rights approach to spectrum may lead to transitions in the form of this property system to one that is not envisioned by current advocates of the property rights approach. In a similar manner, external forces may change a commons property system for spectrum into one that is not envisioned by current advocates of this approach. What is needed is a mechanism that responds well to transitions.

More recent developments in water law suggest an alternative property structure for spectrum to manage both these internal contradictions and external forces. This article labels this structure a "spectrum commons account" (SCA), and it is a form of marketable commons property. With a SCA, frequencies are available for use as a commons. When certain conditions are met, there remains an option to convert a particular frequency into one held as private property.

The advantage of an SCA is that initially, it enables significant innovation by a multitude of inventors, because the frequency is available as a commons. Moreover, if one of these technologies becomes very valuable but is susceptible to problems with interference that can affect a commons frequency, there remains an option to convert the commons frequency into private property.

[11] Carol Rose, *The Comedy of the Commons*, 53 U. CHI. L. REV. 711 (1986).
[12] For more on options, *see* Lee Anne Fennell, *Revealing Options*, 118 HARV. L. REV. 1399 (2005).

Consequently, a SCA achieves the best of both worlds: it enables large scale innovation as under a commons, but it also enables development of technologies that are extremely valuable but susceptible to interference, as would occur under a property rights approach.

After this introduction, the article begins with some foundational material on property classifications. It then presents some background on the technological aspects of spectrum, including our recent experiences. Following this, the article reviews the commons versus property rights debate for spectrum.[13] Next, it briefly describes the riparian and prior appropriations doctrines for water law. After that, it discusses the strong similarities between water resources and spectrum, between a commons approach and riparian doctrine, and between a property approach and prior appropriations doctrine. Drawing on these, it concludes by developing lessons for spectrum by analyzing our history with water law. In so doing, this article presents a novel approach to designing a property system for telecommunication spectrum that provides strong incentives to innovate extremely valuable new technologies under a wide range of circumstances.

I. Classifications for Property, and a New Classification: "Marketable Commons Property"

In many analyses, property can be classified under either a commons approach or a property rights approach. Under a commons approach, property is held by the public and all have the right to utilize that property. Under a property rights approach, property is held by a limited set of individuals, and an essential component of the property right is the right to exclude others from the use of that property.[14] These diametrically opposed approaches have generated a number of debates. For instance, there is a significant debate over whether future development of the internet should be under a commons

[13] In this literature, many advocates of these approaches do not advocate completely one-sided approaches to spectrum. For instance, as discussed further below, property rights advocates sometimes suggest schemes that are predominately property-rights based, but include minor "commons"-based components. And commons advocates sometimes suggest that initially, only a larger portion of the spectrum be allocated as commons. In this article, rather than considering transitions involving these more complex schemes, we will instead consider transitions involving systems based solely on the commons approach, or based solely on the property rights approach. This is necessary because the responses to transitional forces by these more complex systems depends on the details of their implementation, and at this point, the details of these recommended mixed-approach systems are insufficiently developed. On the other hand, we can develop predictions as to how systems based completely on one of the approaches will respond to these transitional forces, and so that is what we do in this article.

[14] *See* Loretto v. Teleprompter Manhattan CATV Corp., 458 U.S. 419, 433 (1982); Penn Central Transportation Company v. City of New York, 438 U.S. 104 (1978) [dissent by Rehnquist, J.]; and Nollan v. California Coastal Commission, 483 U.S. 825 (1987).

approach or under a property rights approach.[15] Recently, this debate has also played out in our analysis of copyright. This debate underlies the arguments of the two sides in *Eldred v. Ashcroft*[16] about the Copyright Term Extension Act of 1998.[17] It has also played a significant role in the cases about file-sharing technologies, Napster and Grokster.[18]

In "The Comedy of the Commons,"[19] Carol Rose noted that there were certain types of property that did not fit within the classifications of either property rights or commons. For instance, while water rights are typically held by private individuals, these rights are limited by "public trust" rights that are held by the public.[20] Also, while copyrights are held by individuals, these rights are also limited by the "fair use" doctrine.[21] Also, real estate rights are similarly limited by the eminent domain right held by the government. Rose suggested that these property regimes did not fit neatly into either "commons" or "property rights" classifications. Instead, Rose suggested a new category: "inherently public property." Inherently public property is property that is primarily held by individuals with certain rights reserved to the public.

This article takes this concept and twists it to suggest another classification for property: "marketable commons property." Marketable commons property is property that is primarily held as commons, with certain rights reserved to individuals. In the case of a SCA, there will exist an option so that under certain circumstances, an individual user of a commons frequency might convert that particular frequency into excludable property. This instance of marketable commons property forms the basis of this article's recommendations for telecommunications spectrum policy.

II. The Technology of Spectrum, and our Experience with Unlicensed Use

What is the telecommunications spectrum? The spectrum refers to a collection of frequencies for conducting telecommunications. Telecommunications occur when a radio wave is sent from a transmitter to a receiver. Radio waves themselves are forms of electromagnetic radiation. When they

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[15] *See* Lessig, *supra* note 7.
[16] 537 U.S. 186, 123 S.Ct. 769 (2003).
[17] *See* 17 U.S.C. § 302(a).
[18] A&M Records, Inc. v. Napster, Inc., 239 F.3d 1004 (9th Cir. 2001); and MGM Studios Inc. v. Grokster Ltd. and StreamCast Networks Inc., 2005 WL 1499402 (U.S.), 75 U.S.P.Q.2d 1001 (2005).
[19] Rose, *supra* note 11.
[20] For more on "public trust," *see* section V.A, *infra*.
[21] Fair use is a defense to copyright liability that arises generally for uses that are of a non-profit nature, utilize a less substantial portion of the original work, and have limited impact on the market for the original work. *See* Sony Corp. of America v. Universal City Studios, Inc., 464 U.S. 417 (1984).

are generated, these waves oscillate at certain frequencies. The telecommunications spectrum then is the collection of frequencies used for telecommunications, which is currently approximately three kilohertz (3 kHz, or 3000 cycles per second) to 300 gigahertz (300 GHz, or 300 billion cycles per second).[22]

Guglielmo Marconi discovered that a signal generated by a transmitter at a specific frequency could be captured by a receiver tuned to the same frequency as the transmitter.[23] This enabled the separation of signals by putting them on different frequencies.[24] However, this ability to receive the signal is sometimes compromised by interference. Interference occurs when a receiver cannot identify the source transmission due to its receiving other transmissions generated at the same or close frequencies.

New developments in telecommunications have offered opportunities to combat interference. One is the use of spread-spectrum techniques. Developed initially during World War II for "jamming resistance,"[25] spread-spectrum utilizes signals sent over a wide range of frequencies but with lower power. The likelihood of interfering with other transmissions is reduced as power is reduced. Other new technologies for reducing the likelihood of interference include smart antennas and repeater networks.[26]

In addition with innovation in the technology behind telecommunications, we have also had innovations in the management of the spectrum. One important innovation is the opening of certain parts of the spectrum (such as 900 MHz, 2.4 GHz, and 5GHz) to unlicensed use. Because use is unlicensed in these frequencies, these frequencies essentially operate as a commons.[27] The core of the

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[22] *See* Nat'l Telecomms. & Info. Admin., U.S. Dep't of Commerce, United States Frequency Allocations: The Radio Spectrum (2003), available at http://www.ntia.doc.gov/osmhome/allochrt.pdf.

[23] *See* "The 7777 Wireless Patent," available at http://www.sparkmuseum.com/BOOK_MARCONI.HTM.

[24] *See* "Marconi Thanks the Newfoundland Government for Making Possible His Discovery of Radio Transmission," available at http://www.raabcollection.com/detail.aspx?cat=6&subcat=140&man=213.

[25] BERNARD SKLAR, DIGITAL COMMUNICATIONS: FUNDAMENTALS AND APPLICATIONS (2nd ed.) 719 (2001).

[26] *See* David P. Reed, How Wireless Networks Scale: The Illusion of Spectrum Scarcity, Presentation to the FCC Technological Advisory Council (Apr. 26, 2002), *available at* http://www.reed.com/OpenSpectrum/Spectrum%20capacity%20myth%20FCC%20TAC.ppt, *cited* in Kevin Werbach, Supercommons: Toward a Unified Theory of Wireless Communication, 82 Tex. L. Rev. 863 (2004)..

[27] With these frequencies already marked as commons, the current debate can be understood as whether to extend additional frequencies to commons, or whether to operate them as property rights. Taken to its extreme, the commons argument that technology could solve interference problems would suggest that (with the exception of whether certain frequencies – in particular the "beachfront property" currently used by television broadcast – that have considerably greater desirability than 900MHz and 2.4 GHz) the current availability of these frequencies as commons should be sufficient, which is clearly not the intent of commons advocates.

commons versus property rights debate for telecommunication spectrum derives from our current experience with the telecommunication spectrum.

At these unlicensed frequencies, all members of the public have the right to broadcast and receive transmissions, along with the right to design and sell equipment that broadcast and receive transmissions. With free access, this enables inventors of new technologies the opportunity to develop their technologies knowing not only that they will have the right to sell equipment that utilize these frequencies, but also that the potential consumers of their equipment will also have the right to use this equipment to broadcast and receive transmissions.

These opportunities have led to significant innovations, in a wide array of applications. Consider the 2.4 GHz band. Microwave ovens used this frequency, and developed ways to more effectively heat food.[28] Makers of cordless phones initially used frequencies around 50 MHz, and then began using 900MHz to provide better quality and range.[29] To further improve range and reduce interference from 900MHz baby monitors,[30] cordless phone manufacturers began using the 2.4 GHz range also. Completely new technologies also developed, that utilized this spectrum. One was Bluetooth, for which one of the applications enables cell-phone users to receive calls to their cell-phone on their automobiles' telephone system, which is presumed to be safer than holding the cell-phone while driving. Another significant innovation using the 2.4 GHz range was the IEEE 802.11b and 802.11g standards for wireless local area networks. These standards enabled manufacturers to develop very inexpensive equipment for operating wireless networks, and have been adopted by many businesses and many residential users also. Advocates of the commons approach make a strong argument that this experience with unlicensed spectrum suggests that the commons approach is a better way to encourage innovation.

Nonetheless, this experience with unlicensed spectrum also provides evidence in support of the property rights approach. The wide range of applications and users of equipment has led to significant problems with interference. For instance, say Alice is using a 2.4 GHz cordless phone to talk with her brother, Bob. While Alice is talking, her son, Carl, starts cooking popcorn in their microwave oven. As a result, although unable to directly hear the sound of popcorn popping, Alice and Bob instead may now hear significant static on both of their phones, to the extent that they may have to wait until the popcorn

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[28] 35th Annual Microwave Symposium, Microwave World (2000), *available at* http://www.impi.org/publications/microwaveworld/MicrowaveWorld.pdf.

[29] Marshall Brain, How the Radio Spectrum Works (1998), *available at* http://electronics.howstuffworks.com/radio-spectrum.htm.

[30] *Id.*

is finished to resume their conversation. This is because Alice's cordless phone handset is receiving signals not only from the cordless phone base, but also from the microwave oven (which tends to emit a strong pulse).

Microwaves and cordless phones may also interfere with wireless networks. This can be significantly problematic because of security concerns. For instance, Michael has set up his wireless network at his residence to provide maximum security for communications between his laptop and his wireless router. However, due to interference, his secure connection is lost. However, unnoticed by Michael, another nearby wireless network (perhaps his neighbor's) is available, and so his laptop automatically switches over to it. However, this connection is now not secure, because otherwise he would not have been able to connect to it. Consequently, although Michael had assumed that the financial transactions he was performing on his laptop were conducted through his secure wireless network, instead they are now broadcast over an unsecured network, and all of his data is susceptible of interception.

The successful innovation in this spectrum has greatly increased the potential for interference. As noted in a microwave oven industry research paper, "Never before have we had the potential for hundreds of millions of microwave devices interfereing [sic] with hundreds of millions of communications devices. The potential for consumer dissatisfaction and complaints could become exceedingly costly for both the microwave and communications industries."[31] Even very sophisticated equipment is susceptible to these interference problems.[32] As a result, advocates of the property rights approach will point to interference possibilities to oppose extending additional spectrum to commons.

III. A Brief history of the Property Rights versus Commons Debate

The primary approach for managing the telecommunications spectrum in the United States currently is through governmental control over licensing. Governmental control arose out of the Radio

[31] See Microwave World Symposium, supra note 28, at 31.

[32] Here is an anecdote from wireless professionals: "I was personally a witness to a wireless 2.4 GHz data circuit trial, the $40,000 non-WiFi gear designed to be a T1/1.5 Mbps replacement at distances of a couple of miles. The distance for this particular installation was less than three blocks, call it under 300 feet, clear line-of-site between the two antennas. Most of the time, it worked fine, but the link would intermittently cut out in the mornings, afternoon, and evenings. After a week or two, the downtimes were mapped to the up times of the one site's microwave oven, a sturdy early '90s model. Needless to say, the gear got dumped and replaced with a glorified DSL connection." Doug Mohney, "The cons and pros of 2.4GHz wireless connections," January 16, 2003, *available at* http://www.theinquirer.net/?article=7235.

Act of 1927,[33] which arose in response to problems with interference caused by the competing stations in the new broadcast industry.[34] This legislation was updated by the Communications Act of 1934,[35] which established the Federal Communications Commission (FCC). Under this regime, the FCC "assigns" frequencies to licensees,[36] who must then operate under certain technological and other regulations to prevent interference. Licensees are not allowed to sell their licenses without FCC approval.[37] This approach dominated the management of spectrum until the 1990s.

This approach came under attack by those who suggested that property rights would be a better way to manage the spectrum. First proposed in an initially little noticed law review article by Leo Herzel in 1951,[38] this idea was then famously expounded by Ronald Coase in the article "The Federal Communications Commission" which appeared in the Journal of Law & Economics in 1959.[39] In this article, Coase argued that, just as with other resources, the pricing system and private property are significantly better ways to allocate spectrum frequencies. Thirty-five years later, the FCC finally began to follow this recommendation when it auctioned a number of frequencies off during 1994 to 1996.

However, to many, the FCC had not gone far enough in following a property rights approach to spectrum. In 1996, a conference on "The Law and Economics of Property Rights to Radio Spectrum" was held, with many of the presenters advocating the extension of additional frequencies to management by property rights.[40] The organizer of this conference, Thomas Hazlett, later published another article in which he more forcefully argued for the adoption of the property rights mechanism to manage the telecommunications spectrum.[41] Lawrence White[42] and others[43] also published articles calling for the use of the property rights approach for managing the entire telecommunications spectrum.

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[33] Radio Act of 1927, Pub. L. No. 69-632, 44 Stat. 1162 (repealed 1934).
[34] Coase, *supra* note 1, at 1-6.
[35] Communications Act of 1934, Pub. L. No. 73-416, 48 Stat. 1064 (codified as amended at 47 U.S.C. §§ 151-615b (2000)).
[36] 47 U.S.C. § 303(c).
[37] 47 C.F.R. § 73.3540(a) (2004).
[38] Leo Herzel, Comment, *"Public Interest" and the Market in Color Television Regulation*, 18 U. CHI. L. REV. 802 (1951).
[39] Note 1, *supra*.
[40] Proceedings of this conference were published in a special issue of the Journal of Law & Economics, 41 J. LAW & ECON. 521 et seq. (1998).
[41] See Thomas W. Hazlett, *The Wireless Craze, the Unlimited Bandwidth Myth, the Spectrum Auction Faux Pas, and the Punchline to Ronald Coase's "Big Joke": An Essay on Airwave Allocation Policy*, 14 HARV. J. LAW & TECH. 335 (2001).
[42] Lawrence J. White, *"Propertyzing" the Electromagnetic Spectrum: Why It's Important, and How to Begin*, 9 MEDIA L. & POL'Y (2000).

However, at this same 1996 conference, another presenter, Eli Noam, called for a different approach to replacing government control over the spectrum. Drawing on earlier suggestions by George Gilder and Paul Baran,[44] Noam advocated the application of a commons mechanism for managing spectrum.[45] Specifically, Noam recommended an open access system for spectrum in which "nobody would control any particular frequency," and instead access would be granted to anyone paying a non-discriminatory access fee.[46] Yochai Benkler followed Noam with a number of articles offering arguments for the superiority of a commons approach to the property rights approach.[47] In particular, Benkler pointed to the new technologies of spread-spectrum, smart receivers, and repeater networks that meant that spectrum was no longer "an independent and finite resource."[48]

Additionally, drawing upon analogies to management of the internet, Lawrence Lessig in *The Future of Ideas* also began advocating the use of a commons approach to manage more of the telecommunication spectrum.[49] Kevin Werbach has extended this approach to what he calls a "Supercommons," in which management of telecommunications is not based on property principles but instead on reciprocal tort principles.[50] Similar to Benkler, Werbach emphasizes the ability of new technologies to "avoid [interference] conflicts dynamically."[51]

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[43] See, for instance, Pablo T. Spiller & Carlo Cardilli, *Towards a Property Rights Approach to Communications Spectrum*, 16 YALE J. ON REG. 53, 82 (1999).
[44] George Gilder, *The New Rule of Wireless*, FORBES ASAP, Mar. 29, 1993, at 96; and Paul Baran, Visions of the 21st Century Communications: Is the Shortage of Radio Spectrum for Broadband Networks of the Future a Self Made Problem?, Keynote Address at the 8th Annual Conference on Next Generation Networks (Nov. 9, 1994), *available at* http://www.eff.org/Infrastructure/Wireless_cellular_radio/false_scarcity_baran_cngn94.transcript.
[45] Eli Noam, *Spectrum Auctions: Yesterday's Heresy, Today's Orthodoxy, Tomorrow's Anachronism. Taking the Next Step to Open Spectrum Access*, 41 J.L. & ECON. 765 (1998). For a critique of Noam's recommendation, *see* Thomas Hazlett, *Spectrum Flash Dance: Eli Noam's Proposal for 'Open Access' to Radio Waves*, 41 J.L. & ECON. 805 (1998).
[46] Noam, *supra* note 45, at 777. The access fee would fluctuate depending on congestion, but would not be different from one user to another.
[47] See Yochai Benkler, *Overcoming Agoraphobia: Building the Commons of the Digitally Networked Environment*, 11 HARV. J.L. & TECH. 287 (1998); Yochai Benkler, *VIACOM-CBS MERGER: From Consumers to Users: Shifting the Deeper Structures of Regulation Toward Sustainable Commons and User Access*, 52 FED. COMM. L.J. 561 (2000); and Yochai Benkler, *Some Economics of Wireless Communications*, 16 HARV. J. LAW & TECH. 25 (2002).
[48] Benkler, *Some Economics of Wireless Communications*, *supra* note 47 at 23.
[49] Lessig, *supra* note 7, does advocate a mixed approach of property and commons for spectrum.
[50] Kevin Werbach, *Supercommons: Toward a Unified Theory of Wireless Communication*, 82 TEX. L. REV. 863 (2004).
[51] *Id.*, at 902.

There is an implication that due to technology, there may no longer face a shortage of spectrum. Property rights advocates strongly objected to this implication. Hazlett argued that even though new developments can increase capacity of the telecommunications system, additional transmissions eventually lead to degradation.[52] Hazlett then pointed to Say's law (supply creates its own demand) [53] to demonstrate that the increased capacity would lead to the additional transmissions that would cause signal degradation.[54]

Property rights and commons advocates again faced off at a conference held in 2003 at Stanford Law School, organized jointly by Lawrence Lessig and Thomas Hazlett.[55] At this conference, among other papers, a paper by a former chief economist and a former chief technologist of the FCC, Gerald Faulhaber and David Farber, synthesized the property rights and commons approaches.[56] One recommendation involved the use of public "parks" of spectrum frequencies within a system of otherwise private property controlled frequencies. These parks would then operate as a commons with open access. Another recommendation was the creation of a property rights regime combined with what they called a "non-interference easement." The non-interference easement would allow open access to spectrum frequencies as long as those open-access uses did not interfere with the uses operated by the holder of the property right for that frequency. Despite these attempts to find a compromise, the debate continues.

Furthermore, a debate within the property rights versus commons debate concerns the applicability of treating the telecommunications spectrum as a natural resource. This debate stretches back to Coase's article, in which Coase made the argument that as a resource, spectrum should be allocated by markets. In this article, Coase also made an analogy between land and spectrum.[57] However, in the same article, Coase also emphasizes that the relevant property right to spectrum is a usufructuary right, not a right to materially own the resource: "What does not seem to have been understood is that what is being allocated by the Federal Communications Commission … is the right to

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[52] Hazlett, *Airwave Allocation Policy*, *supra* note 41, at 488.
[53] See WILLIAM J. BAUMOL AND ALAN S. BLINDER, ECONOMICS PRINCIPLES AND POLICY, 5th ed., 851 (1991).
[54] Hazlett, *Airwave Allocation Policy*, *supra* note 41, at 489.
[55] Conference proceedings for "Spectrum Policy: Property or Commons?", Stanford Law School, Stanford, CA (March 1 & 2, 2003).
[56] Gerald R. Faulhaber & David Farber, *Spectrum Management: Property Rights, Markets, and the Commons*; later published in RETHINKING RIGHTS AND REGULATIONS: INSTITUTIONAL RESPONSES TO NEW COMMUNICATION TECHNOLOGIES 193 (2003).
[57] Coase used the land analogy to explain the problem of interference. Coase, *supra* note 1, at 25.

use a piece of equipment to transmit signals in particular way."[58] Some have interpreted this passage to imply that Coase "stated quite clearly that spectrum was not a physical resource."[59]

Following Coase, Harvey Levin in "The Radio Spectrum Resource" argued strongly that proper management of spectrum required a better understanding of its nature as a resource.[60] Christian Herter also made the case that spectrum was a natural resource.[61] He concluded that because spectrum was a "'scarce'" and "'limited'" natural resource, "equitable and careful management … is crucial."[62] Even a commons advocate, Stuart Buck, argues that the analogy between spectrum and "land and other [common pool] resources" is strong.[63]

However, recently, the applicability of the analogy between spectrum and natural resources has come under direct attack. [64] In "Supercommons," Kevin Werbach bluntly proclaims that the "basic analogy [of spectrum] to natural resources is flawed."[65] Werbach is particularly critical of analogies between spectrum and land,[66] because "wireless communication works differently" than managing land.[67] Werbach explains that what is important in spectrum policy is not management of a tangible, physical resource, but rather management of equipment that use that resource.[68] To explain the problems that arise from analogies of spectrum to natural resources, Werbach himself presents a colorful analogy:

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[58] *Id.*, at 33.
[59] Werbach, *supra* note 50, fn. 110, at 884.
[60] Harvey Levin, *The Radio Spectrum Resource*, 11 J.L. & ECON. 433 (1968). Levin followed this article with a book examining the management of spectrum as a resource. HARVEY J. LEVIN, THE INVISIBLE RESOURCE: USE AND REGULATION OF THE RADIO SPECTRUM (1971).
[61] Christian A. Herter, Jr., *The Electromagnetic Spectrum: A Critical Natural Resource*, 25 NAT. RESOURCES J. 651 (1985).
[62] *Id.*, at 663.
[63] Stuart Buck, *Replacing Spectrum Auctions with a Spectrum Commons*, 2002 STAN. TECH. L. REV. 2 (2002). Buck draws significantly on the work of Elinor Ostrom on the management of common pool resources through commons. See, for instance, ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION (1990). For an another view of the difficulty of managing common pool resources through the commons, see Barton H. Thompson, Jr., *Tragically Difficult: The Obstacles to Governing the Commons*, 30 ENVTL. L. 241 (2000).
[64] See David P. Reed, Why spectrum is not property - the case for an entirely new regime of wireless communications policy (2001), available at http://www.reed.com/dprframeweb/dprframe.asp?section=paper&fn=openspec.html, *cited* in Werbach, *supra* note 50.
[65] Werbach, *supra* note 50, fn. 116, at 886.
[66] See *id.*, at 866, at 881 and at 885.
[67] *Id.*, at 885.
[68] *See id.*, at 914.

> Spectrum policy falls victim to several fallacies. Each is demonstrably false, yet remarkably durable. The most damaging is the notion that there is such a thing as spectrum and that it behaves as a fixed physical resource like land. Establishing a legal regime under such a misconception is like sailing west from Europe to find a shorter trade route to India. You might find something interesting along the way, but you will never achieve your objective.[69]

This article reengages this debate by suggesting that while the connection to land may not be strong, there is another natural resource with many attributes similar to spectrum: water.[70]

IV. Description of Riparian and Prior Appropriation Water Doctrines

In the United States, management of water resources has generally been under either the riparian doctrine or the prior appropriation doctrine. Under riparian doctrine, only those who own waterfront property may use water from that source, and the water may only be used on the property itself. This immediately limits competition for supply, and puts a premium on access. In addition to the onsite requirement, only 'reasonable uses' are permitted.[71] 'Reasonable use' is defined by courts in a case-by-case manner. While a few uses are inherently reasonable (domestic and on-site uses), most of the time, whether a particular use is reasonable depends on a comparison to other uses.[72] Any downstream riparian has a claim against an upstream user for unreasonable use. So long as the use is reasonable, one may use as much as one wants—even to the extent of denying water to downstream users.

Riparian doctrine is derived from old English law, and has many features that make it problematic in a modern urbanized society, subject to significant scarcities in water resources. First, the lack of a first-in-time provision in riparianism discourages investment, as a later upstream use may devalue your investment by reducing water supply. The most upstream users may have little incentive to invest in industry, as they may be required to cede their usage to domestic and agricultural users downstream. Second, transferring a water right involves transfer of the underlying land—often an expensive and unwanted requirement. And because the right itself is difficult to quantify, the fair market price for the land and its accompanying right is also difficult to establish. Third, it promotes

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[69] *Id.*, at 882.

[70] For more on the similarities between spectrum and water, including the nature of rights to these resources as usufructuary as noted by Coase, *see* section V infra.

[71] Reasonable use is determined by comparing the benefit derived from the use with "the extent of detriment to [other] riparian proprietors." Snow v. Parsons, 28 Vt. 459 (1856).

[72] Historically, on-site domestic uses are *per se* reasonable and are of highest priority. Closely thereafter are agricultural uses. Other uses—industry, transport, and the like—must give way to higher priority uses when water demand exceeds supply. More recently, many states have adopted legislative definitions of what is considered 'reasonable use'.

waste: riparian users have no incentive to conserve, and nonriparians may not use any remaining water even if it is wasted.[73,74] Finally, it is significantly inefficient in assigning use; each dispute requires complex analysis of every use on the entire water body, and every change in use may lead to a new allocation of rights.[75] Recently, in response to some of these problems, some riparian states have moved toward a regulated riparian model. In regulated riparian states, permits are only required for major water users, while smaller users may make unpermitted withdrawals.

Under prior appropriation doctrine, a new user may appropriate unused water by applying for a permit to use.[76] Once a permit has been granted and use has begun, he 'owns' the right to use that amount of water at that site of withdrawal, and, subject to certain legislative restrictions, may transfer it to others without transferring the underlying land.[77] Unlike riparianism, appropriation is first-in-time, first-in-right: early appropriators are senior to those who come later, and in times of drought, may use their full appropriation to the exclusion of all junior members.[78]

Appropriation doctrine addresses many of the criticisms of riparianism. By providing a clear and enforceable right to use water, it allows for investment without regard for later users' behavior. By the process of registration, it allows the permitting body to bestow use rights with some regard for the common good. The clear rights structure greatly speeds resolution of disputes, and allows for accurate valuation of water rights. Furthermore, the permitting process allows for public input and control over water users.

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[73] Although from a legal standpoint wasteful uses are not beneficial, the legal definition of 'waste' is extremely limited, and much of what an ordinary man would consider wasteful is not covered.

[74] A spectrum equivalent is a permit for transmission power. If the goal of a station to is transmit traffic data by AM radio to the city of Providence, and a permit is obtained for a 10kW station, there is a possibility that the allowed transmission power will be higher than needed in that limited area. Although the higher power results in more interference for other users—needlessly 'snatching' a piece of the commons—there is no incentive to reduce power in an appropriative model.

[75] There are similarities to the supercommons model of Werbach, *supra* note 50.

[76] Generally, an appropriation requires imminent actual use of the water, as opposed to long term future planned use.

[77] Many other restrictions apply in different states. One notable example is a 'use restriction', which might affect the conversion of water rights from agricultural use to industry use. This allows transfers in general and encourages efficient use within certain communities, while protecting economically undervalued uses that the public values for other reasons. *See, e.g.,* Santa Fe Trail Ranches Property Owners Assn. v. Simpson, 990 P.2d 46 (1999). Similarly, restricting certain spectrum 'space' to certain types of transmissions—broadcast radio, for example—ensures the existence of radio stations even if better uses exist from a purely economical standpoint.

[78] This is the classical appropriations approach; modern cases sometimes give deference to growing domestic needs.

Yet the relatively high transaction costs to control and maintain an efficient rights structure preclude its adoption outside the arid West. Appropriation states frequently suffer from over-appropriation, where early measures of water flow were later found to overstate the amount available.[79]

V. Similarities between Spectrum and Water Resources

In this section, we describe the strong similarities between the telecommunications spectrum and water resources as resources; between the commons approach to spectrum and riparian water rights; and between the property rights approach to spectrum and the appropriation doctrine for water rights. Due to these similarities, we conjecture that our history with these property systems for water have significant lessons for the pressures and transitions we may expect in implementing property systems for the telecommunications spectrum.

V.A. Similarities as a Resource

Spectrum and water share a number of characteristics as natural resources. For many natural resources, such as oil and gas, use of a portion of the resource by one user prevents another user from using that particular portion. However, for spectrum and water, multiple users can use the same portion of the resource. For instance, the 2.4 GHz band of telecommunication spectrum is used by a number of different technologies: cordless phones, wireless internet access, and even microwave ovens. While conflicts may arise if all of these technologies are being used locally and simultaneously, sequences of uses of the same bandwidth by different users are compatible.

Similarly, water resources can also be used by many different users. A reservoir can offer opportunities for boating, swimming, and fishing, in addition to providing drinking water. Additionally, water in an aqueduct that is being delivered to one farmer can help propel (through increased flow) delivery to another farmer. Even water that is diverted and "used" by one farmer may still be used by another farmer who is downstream, through what is known as "return flow."[80]

This multiple-use characteristic has important ramifications. Economists call resources that can be used by only a single user "exhaustible," whereas resources that can be used by multiple users (up to a point) are "non-exhaustible." Non-exhaustible resources are a category of what economists call

[79] The total appropriations for the Colorado River, for example, far exceed the total flow. The river flows to the sea primarily because these appropriations are restricted by environmental and treaty concerns.
[80] Return flow is the quantity of water that returns to a water body through runoff, percolation, or other means after it has been diverted. Also, *see* Figure 1.

"public goods."[81] Economists generally believe that resources that are not public goods are best allocated through a system of private property rights. However, complications arise with public goods, and it is difficult to determine the best way to allocate resources that are public goods.[82] Thus, because both spectrum and water can be used by multiple users, they will share similar issues in determining appropriate allocation systems.

Another similarity between spectrum and water is their mixed ownership structures. Some resources are owned by private individuals (again, such as oil and gas), while others are owned entirely by the public (such as air). Both spectrum and water have an ownership structure that is partially private and partially public. For spectrum, many broadcasters have exclusive licenses to the use of a certain bandwidth in a locality. However, the government maintains its "ownership" of even these licensed bandwidths, and designates certain bandwidths for free use of the entire public.

Similarly, many irrigators and industrial users have private rights to put specific water to reasonable and beneficial uses.[83] On the other hand, in many states, these rights are subject to what is known as the "public trust doctrine." Under this doctrine, "The waters of the State ... are a natural resource owned by the State in trust for the public and subject to the State's sovereign power to plan, regulate, and control the withdrawal and use of those waters, under law, in order to protect the public health, safety, and welfare."[84] Thus, ownership of water is also shared between private individuals and the public.

This characteristic of shared ownership again has important effects on the determination of appropriate allocation structures. Conflicts between public and private purposes will arise, and the allocation structure should include mechanisms for resolving these conflicts.

One other significant characteristic that is present for both spectrum and water is that the rights to the resource are "usufructuary" in nature. A usufructuary right is the right to use the resource, not necessarily "possess" the resource. This characteristic derives fundamentally from the shared ownership

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[81] The other categories are non-excludable resources, from which nobody is excluded once the resource has been produced; and resources that are both non-exhaustible and non-excludable.
[82] As evidenced by the commons versus property rights debate for telecommunications spectrum.
[83] Beneficial use is a requirement that a particular use must be both "permissible" and "not … wasteful in amount." JOSEPH L. SAX, BARTON H. THOMPSON, JR., JOHN D. LESHY, AND ROBERT H. ABRAMS, LEGAL CONTROL OF WATER RESOURCES, 3rd ed.(Hereinafter STLA), 124 (2000).
[84] Dale B. Thompson, Primary Lead, PRELIMINARY FINDINGS OF THE SUBCOMMITTEE ON WATER RIGHTS AND REGULATORY AUTHORITIES, SUBMITTED TO THE RHODE ISLAND WATER RESOURCES BOARD (2003) [hereinafter Water Rights Subcommittee Report] 2, citing Regulated Riparian Model Water Code (1997).

characteristic discussed above.[85] Spectrum users have the license to use a particular bandwidth. Water users have the right to put certain water to a reasonable and beneficial use. Again, this shared characteristic will help analyze appropriate allocation systems, because a usufructuary right is a more narrowly defined right.

Another similarity comes from analysis of groundwater law.[86] Groundwater use differs from surface water use in that groundwater removal by pumping propagates a 'dip' in the subsurface water level. These water level 'dips' occur in a fashion and form similar to short range spectrum interference. Neighbors who withdraw too much groundwater can force the local water level to drop below the level of a user's well, much as a neighboring transmission can cause local interference. In response to a drop in water level below their existing well, users can dig a deeper well (or in the case of spectrum, increase transmission power), which has the dual effect of solving their own personal problem and producing a farther-reaching effect on their neighbors.

While spectrum and water do share these characteristics, they do differ in a number of ways. For instance, spectrum use is more dependent on technological change. Managing conflicting water uses does rely on the technological aspects of water extraction, application, and runoff and discharge management, along with the physics and hydrogeology of water diffusion. However, the effect on other users is not as closely related to the sensitivity of receivers in spectrum usage. Nonetheless, despite these differences, their shared characteristics suggest that analysis of our history with water law can improve our understanding of the challenges in developing a property system for spectrum.

V.B. Shared Characteristics of Spectrum Regimes and Water Doctrines

In addition to these similarities as resources, there are other strong similarities between the approaches associated with spectrum and water. The commons approach to spectrum shares many characteristics with the riparian doctrine for water rights. Under the commons approach, ownership of equipment for sending or receiving telecommunications broadcasts is required to use spectrum. Ownership of this equipment thus serves as a limit on the availability of the commons right to spectrum. However, if someone has this equipment, that person is free to use spectrum, subject only to the

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[85] However, it is important to note that these characteristics are not identical, because shared ownership could have led to a different parsing of the right.

[86] Although groundwater doctrine is not as established and is not well suited to a national frequency allocation analysis, a later investigation of groundwater law may be useful in establishing functional rules for local interference.

constraints of tort law. Under tort law, behavior is constrained by the "reasonable person"[87] standard. Thus, under the commons approach, spectrum is allocated only to those who own the necessary equipment, and is allocated between different users and uses through the application of the reasonable person standard.

Under the riparian doctrine, ownership of riparian land is required to use water. Ownership of this land thus serves as a limit to the riparian right to water. However, if someone owns riparian land, that person is free to use water, subject only to the "reasonable use" doctrine. Thus, under the riparian doctrine, water is allocated only to those who own riparian land, and is allocated between different users and uses through the application of the reasonable use doctrine. The similarities between the commons approach and riparian doctrine are therefore strong, and much can be learned about the commons approach by examining the history of the riparian doctrine.

Moreover, the property rights approach to spectrum shares many characteristics with the appropriation doctrine for water rights. Under the property rights approach, someone wishing to have a guaranteed right to use spectrum must obtain a permit to do so. Ownership of equipment is insufficient. Once somebody has a permit, they are free to use the spectrum, subject to the conditions of their permit. Furthermore, subject to oversight by a regulatory agency, somebody with a spectrum permit can transfer her right to use spectrum. Also, under the Faulhaber and Farber idea of an implied non-interference easement, while someone who owns a permit has a guaranteed right to use spectrum, if that person is not using their designated portion of the spectrum at some particular time, then others have right to use that spectrum, because they will not be interfering with the permit owners' right to use that spectrum.

Meanwhile, under the appropriations doctrine, someone wishing to have a right to use water must obtain a permit to do so. Ownership of land is insufficient. Once somebody has a permit, they are allowed to take water and use it, subject to the conditions of their permit. Furthermore, in many jurisdictions,[88] subject to oversight by a regulatory agency, somebody with an appropriative permit can transfer their right to use water. Also, under the appropriations doctrine, if someone with an appropriative permit is not using their water, that water is then freed for others to appropriate.

While there are these similarities, there is one important distinction between the property rights approach and appropriation doctrine. In spectrum, we had the advantage of having extra resource available: as technology improved, more spectrum became available to allocate to new users. Hence, we

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[87] A reasonable person takes the care that a care that a person of ordinary prudence would use in the same circumstances. *See* RICHARD A. EPSTEIN, CASES AND MATERIALS ON TORTS, 7th ed., 155 (2000).
[88] See STLA, *supra* note 83, at 223-254.

were able to put up this extra spectrum for auction for new users.[89] As a result, we have not needed to initiate markets and transfers initially.

On the other hand, water resources in the Western United States have been significantly constrained. As a result, there has been a strong need for markets and transfers of some water rights.

Nonetheless, the surplus of currently available spectrum is ending. Even if additional technological advances could provide more spectrum, if one believes in Say's law - that supply creates its own demand, then even this new surplus will also end, and the two situations become more similar again. As a result, the similarities between the property rights approach and appropriation doctrine remain strong. Much can then be learned about the property rights approach by examining the history of the appropriation doctrine.

VI. Lessons from Water Law for Spectrum

Because of these similarities, there are many insights to spectrum policy we can gain from our analysis of our history with water law.

VI.A. Transitions from Pure Property Rights Systems

One of these insights is the possible impediment to the transferability of spectrum property rights presented by third parties. The free transferability of spectrum rights is one of the most important justifications of the efficiency of the property rights system.[90] For instance, consider the following example. Alice is the current holder of the right to use a certain band of spectrum. Alice runs a business that generates a significant profit, and that must have this band of spectrum to operate. The value of this right to use spectrum to Alice is the present net value of her profits from operating this business, which is one million dollars ($1,000,000). However, Bob wants to start a new business that would also need to use this same band of spectrum to operate. The value of this spectrum to Bob is one and a half million dollars ($1,500,000).

If the property right to use this band of spectrum is freely transferable, Alice could sell this right, say for $1,300,000. This sale is favorable to both Alice and Bob, because Alice is being paid more than the right is worth to her, and Bob is paying less than the right is worth to him. Society also benefits from this sale. To calculate social welfare, we add the values to the different individuals in society. The value

[89] See note 2 supra.
[90] Increasing the incentive to invest to improve the value of the right is the other most important justification.

to society of the right before the sale is its value to Alice, $1,000,000. However, after the sale, Alice now has $1,300,000 cash, and Bob has a net benefit from the sale of $200,000 (which is his value, $1,500,000 minus the price he paid, $1,300,000). Adding the two together, we see that the value of the right to society after the sale is $1,500,000. Thus, social welfare has thus increased by $500,000 because of this sale. This increase is equal to the sum of the increased value to Alice ($300,000) plus the net benefit to Bob ($200,000).

In a similar manner, any trade that will make both parties better off will also benefit society. Social welfare will improve by the sum of the two parties' benefits from the trade. As a result, the transferability of spectrum rights seems to make a property rights regime an efficient approach.

Over the past 100 years, we have had some experiences with transfers of appropriative rights to water. One place where there has been significant interest in water transfers is California. In California, much of the rights to the first priorities in water allocation are held by farmers, while urban areas regularly have much lower priority. Consequently, during extended droughts, such as the 1987-1992 drought, there is significant interest in transfers between farmers with first priority to water and cities that have access to much less water but do have significant funds to purchase water if it would be made available through water markets.

While there has been significant interest in water markets, there have been significantly fewer transfers of water rights than might be expected.[91] A primary reason for this lack of transfers is the institutional protection of "third parties" to water transfers. Water transfers occur directly between two parties - the buyer and seller. However, a wide variety of "third parties" also may be affected by these transfers. Early on, it was recognized that the rights of junior appropriators who took advantage of the non-use of water by senior appropriators may be harmed by the transfer of a senior appropriator's water right. Additionally, downstream users of an upstream appropriator's "return flow" would also be harmed if the upstream appropriator was allowed to transfer her entire appropriative water right.[92]

More recently, new third-party concerns have been raised about communities affected by "out-of-basin" water transfers.[93] The most famous such case is that of the Owens Valley community in

[91] Barton H. Thompson, Jr., *Institutional Perspectives on Water Policy and Markets*, 81 CALIF. L. REV. 673 (1993).
[92] *See* figure 2.
[93] *See* Joseph Sax, *Understanding Transfers: Community Rights and the Privatization of Water* 1 WEST-NORTHWEST 13 (1994); Barton Thompson, *Water Law as a Pragmatic Exercise: Professor Joseph Sax's Water Scholarship*, 25 ECOLOGY L.Q. 363 (1998); both cited in STLA, *supra* note 83, at 249. Also, *see* A. Dan Tarlock, *New Water Transfer Restrictions: The West Returns to Riparianism*, 27 WATER RESOURCES RES.

California. This case forms the background of the movie Chinatown[94] and is also discussed in Marc Reisner's novel, Cadillac Desert.[95] The Owens Valley was once a fertile agricultural area. However, through a number of machinations, the City of Los Angeles acquired the rights to Owens Valley water, and constructed a long aqueduct to access this water. Consequently, almost no water remained for use by Owens Valley residents, and all farming and development left the Owens Valley.[96] This incident continues to cast a large shadow over all water transfers in California.

As a result of these concerns, a number of procedural barriers to water transfers have been put in place to protect third parties.[97] A party wishing to transfer her right must prove that this water satisfies "historical use,"[98] in order to protect those junior appropriators who invested in reliance on the non-use of senior appropriators. Furthermore, transfers may also be limited to "consumptive use,"[99] to protect downstream users of upstream return flow. These protections arise generally under the "no injury" rule, which says that "a proposed change will be approved only if it will not injure junior appropriators."[100] Meanwhile, to protect communities, most transfers[101] require approval through a lengthy, formal application process. During this process, communities and other users have the opportunity to file protests against a proposed transfer.[102] Even if a transfer is initially approved, there is a possibility that the board may then "reconsider" the transfer and deny it later. This extremely lengthy, cumbersome, and risky process has been a significant barrier to the free transferability of appropriative water permits.[103]

987(1991); Committee on Western Water Management, National Research Council, *Water Transfers in the West: Efficiency, Equity, and the Environment* (1992); and Dale B. Thompson, Defining a New Market for a Common Resource: Lessons from the 1991-92 California Drought Water Bank, unpublished manuscript (1992).

[94] Roman Polanski, director, CHINATOWN (1974).

[95] MARC REISNER, CADILLAC DESERT: THE AMERICAN WEST AND ITS DISAPPEARING WATER (1993).

[96] It is now an area attractive to migratory birds because of its natural characteristics and lack of human activity.

[97] See W. R. Easter, Mark W. Rosegrant, and Ariel Dinar, *Formal and informal markets for water: Institutions, performance, and constraints*, 14 WORLD BANK OBSERVER 99 (1999); B.C. Saliba, *Do Water Markets "Work"?*. 23 WATER RESOURCES RESEARCH 1113(1987).; and Bonnie Colby, *Transaction Costs and Efficiency in Western Water Allocation*, 72 AM. J. AGRIC. ECON. 1184 (1990).

[98] STLA, *supra* note 83, at 236.

[99] Consumptive use is the amount of the water equal to the amount of water diverted minus the return flow.

[100] STLA, *supra* note 83, at 230.

[101] Exceptions are primarily within irrigation districts, and in emergency situations such as the California Drought Water Bank.

[102] STLA, *supra* note 83, at 229.

[103] Bonnie Colby has suggested that the transaction costs associated with water transfers act as a substitute for third-party effects. See Colby, *supra* note 97.

Returning to our prior example of a spectrum transfer, we see that third party concerns could affect the efficiency of a spectrum transfer. Earlier, we found that, from society's perspective considering only the effect on Alice and Bob, social welfare would be increased by $500,000 by the transfer from Alice to Bob. However, let us now add in the effect of this transfer on third parties. Alice's customer, Charlie, had made a significant investment in technology to utilize a service provided by Alice's band of spectrum. Bob's use of this spectrum will conflict with Charlie's use, and consequently, Bob will not allow Charlie to use this spectrum. As a result, Charlie will have to find an alternative band of spectrum for his service, and will need to invest an additional $900,000 in technology to receive the same quality service as he previously had while using Alice's band of spectrum.

This additional cost to Charlie therefore represents a $900,000 opportunity cost of this transfer, and will reduce social welfare after the transfer to $600,000 (= previous social value of $1,500,000 minus the $900,000 opportunity cost). As a result, social welfare is actually reduced by $400,000 (= the prior social value of $1,000,000 minus the net-after social value of $600,000) by the transfer between Alice and Bob. Nonetheless, if Charlie has no right to object to this transfer, it will go through because both Alice and Bob individually benefit from it. This example and our history with water transfers therefore suggest that a property rights regime for spectrum rights should pay careful attention to the effects of third parties from transfers of spectrum rights. When these third party effects are taken into consideration, the efficiency advantages of the property rights system may be significantly limited.

Questions then arise as to who the third parties to transfers of spectrum rights would be, and in what situations would these third party effects be significant? Our hypothetical example suggests one possible third party group: licensed users of a particular band of spectrum who have made significant investments in technological equipment to utilize that band of spectrum, where their use will not be permitted after the transfer of the spectrum right. For example, many people have made significant investments in cellular phones that utilize a certain band of spectrum currently controlled by Verizon. If some other company were to offer Verizon an extremely large sum of money to transfer this right, our experience with water markets suggests that in addition to considering the effects on the profits of Verizon, the concerns of third parties that have made significant investments in Verizon cellular phones should also be considered before approval of this transfer.

These concerns could lead to a future transition away from a property system for spectrum based on the property-rights approach. As in the case with water, third parties may turn to the legal system or the political system to enjoin, delay, or block a proposed transfer.[104] An administrative institution may then arise in response to these concerns. This institution would include a procedural mechanism for reviewing the effects of transfers on third parties. As a result, this procedural mechanism for protecting third party rights may become an important component of a property-rights-based system for spectrum.

This mechanism may have significant effects on the efficiency of the property rights system. In addition to the transaction costs of operating this mechanism, a significant number of trades would not occur, as suggested by our experience with water markets. While this mechanism might prevent some trades that were on balance, a net detriment to social welfare due to their third party impacts, it is likely that a large number of socially beneficial trades will be prevented due to the individual parties concerns with the lengthy, cumbersome, and risky process of spectrum rights transfer approval. In the end, this mechanism might curtail trades to the point that, after this transition, the property-rights system for spectrum might look very similar to the allocation system we currently use for spectrum.

VI.B. Transitions from Pure Commons Systems

Another lesson we can learn about property systems for spectrum is how a commons approach might adapt to increasing scarcity. One argument for utilizing a commons approach now is that if conditions change, it may be easier to transition from a commons to a property rights approach, in contrast to the difficulty of transitioning from a property rights to a commons approach. This argument recognizes that it may be possible that there may come a time in which high-valued uses of spectrum may not be well-served by a commons approach, perhaps due to interference.[105] This argument suggests that the governing system for the spectrum commons will then enable the creation of a niche of spectrum that will then be governed by a property rights approach. This would then result in a hybrid approach to spectrum.

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[104] Some may suggest that the political power of third parties may be limited because as a group of consumers, they may face high organizational costs and have little information. See ANTHONY DOWNS, AN ECONOMIC THEORY OF DEMOCRACY (1957); MANCUR OLSON, THE LOGIC OF COLLECTIVE ACTION (1965); AND JAMES Q. WILSON, THE POLITICS OF REGULATION (1980). However, this problem may be solved by a political entrepreneur, who could provide the organization and information to these consumers, thereby empowering them. See Dale B. Thompson, Political Entrepreneurs and Consumer Interest Groups: Theory and Evidence from Emissions Trading (2002).

[105] We currently have some frequencies as a commons. However, commons advocates do support adding additional frequencies to be used as commons. This suggests that even commons advocates recognize the problem of over-utilization leading to interference under a commons.

However, our experience with transitions in water law suggests that the transition will not be to this hybrid approach, but rather to a regulated commons. The riparian system has undergone many transitions over time. One significant transition was when water law was initially established in the Western United States. Initially, the doctrine applied for water rights in the West was the riparian doctrine, which was then used in the Eastern United States. However, the inappropriateness of the riparian doctrine in the arid West quickly became clear, and the prior appropriation doctrine was instead developed and implemented in Western states.

Two different approaches to this transition were tried. One was to completely abolish existing riparian rights, and implement a rights system based only on prior appropriations. The leading state that took this approach was Colorado.[106] The other was to adopt a hybrid approach where existing riparian rights would continue to be recognized, but that all new water rights would be under the prior appropriations doctrine. The leading state in the hybrid approach was California.

Our experience in operating the hybrid approach in California suggests that attempting to transition from a commons to a hybrid approach for spectrum may be troublesome. In California, conflicts between appropriators and riparians arose, and led to significant political battles, which was highlighted in the 1884 case *Lux v. Haggin*,[107] where the California Supreme Court first found for the riparian interest. This decision "set off a political fire storm."[108] The public outcry convinced the court to vacate its earlier decision and rehear the case. Nonetheless, the court then again upheld the rights of the riparians over the appropriators.[109]

In later years, the problem of unexercised riparian rights that would have priority over all appropriative rights generated significant risk for appropriators in California. In 1913, the California legislature attempted to abolish unexercised riparian rights, but this statute was later ruled unconstitutional.[110] Only more recently has California found a solution to this problem, where unexercised riparian rights in adjudicated water bodies are not abolished but are instead given priority lower than previously established appropriative rights.[111]

Our more recent experiences with riparian transitions suggest that, instead of transitioning to a hybrid property rights - commons property system, the more likely response to increased scarcity would

[106] Other Colorado doctrine states include Arizona, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming.
[107] Lux v. Haggin, 4 P. 919 (Cal. 1884).
[108] STLA, *supra* note 83, at 297.
[109] Lux v. Haggin, 69 Cal. 255, 10 P. 674 (1886).
[110] Tulare Irr. Dist. V. Lindsay-Strathmore Irr. Dist., 3 Cal.2d 489, 45 P.2d 972 (Cal.1935).
[111] In re Waters of Long Valley Creek Stream System, 25 Cal. 3d 339, 599 P.2d 656 (Cal.1979).

be to transition from a commons system to a regulated commons. While initially, Eastern states in the United States seemed to have plentiful water, over the past fifty years, the pressures of extended droughts and the rapid increase of urban populations has put significant pressure on allocations derived from the riparian system. Consequently, over the past twenty-five years, a number of eastern states have adopted a form of regulated riparianism, requiring permits for use of water.[112] This development has been punctuated by the drafting Regulated Riparian Model Water Code.[113]

An alternative to a regulated riparian system in order to deal with these new stresses would be to adopt a property-rights trading system. However, the principal reason for the movement to a regulated riparian system rather than a property-rights/trading system is to reduce the transition costs and risks that would result from a shift towards trading.[114] A regulated riparian system would functionally operate very similar to the previous riparian system, except in times of extended drought.[115] As a result, during non-drought times, the transition could seem very simple, and investments made under the previous riparian system would continue to remain useful. A trading system could operate very differently in all times, and so in comparison, a transition to a regulated riparian system is more attractive. As a result, many of the Eastern states look to a regulated riparian system to address these new stresses on their water resources.

This experience suggests that in the future, if "shortages" of spectrum arise under a commons approach, the likely response will be to transition to a regulated commons. Similar to our experience with water, a transition to a regulated commons would be more simple than transitioning to a hybrid system involving limited trading. Also, the regulations could also then be designed to protect previous investments more fully than under a trading system. In the face of shortages of spectrum, it is likely that groups with significant investments in utilization of that spectrum will be harmed by these shortages. These groups may then push for modifications to the spectrum allocation system. These groups would be well organized, and have considerably more political power than other groups who might also have

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[112] These include Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Kentucky, Maine, Maryland, Mississippi, New Jersey, New York, North Carolina, Ohio, South Carolina, Tennessee, Virginia, West Virginia, and Wisconsin. *See* STLA, *supra* note 83, at 79. Additionally, a recent recommendation is that Rhode Island also adopt a regulated riparian system. Water Rights Subcommittee Report, *supra* note 84.
[113] ASCE, Regulated Riparian Model Water Code, (1997).
[114] Water Rights Subcommittee Report, *supra* note 84.
[115] *Id.*

an interest in the response to the shortage.[116] These groups can then utilize their power to "capture" the administrative agency in charge of regulating the commons.[117]

Well organized groups would therefore have a strong incentive to push for a regulated commons, rather than a market system. The reason for this is that the operation of a regulatory system enables well-organized interest groups to initially influence the design of that system, and continue to exert strong influence over the operation of that system. In contrast, in a market, the influence of these groups would be limited to the initial design of a market system, and possibly also enforcement of that system's rules. As a result, by pushing for a regulated commons, well-organized interest groups with significant investments in the use of spectrum could then utilize their political influence to ensure that the system would protect their investments. Thus, both our experiences with water and our current experience with spectrum suggest that a commons system, under the pressure of shortages in spectrum, would transition to a regulated commons.

This can also be understood with the following example. In this example, the question is: how would a commons system respond to increasing interference problems that significantly damage the usefulness of a very valuable application that utilizes a commons frequency?

Let's say that some frequency, say 1.8GHz, is a new frequency that is opened to the commons approach. As a result, a few inventors design devices across different applications that communicate using this frequency. Of these applications, let us assume that there are three that are small commercial successes, with each of these having a few devices sold and operated (and all others are unsuccessful). We also assume that, for each of these applications, the chance of slightly delayed or lost communications does not impede their usefulness.[118]

However, a little later, another inventor also uses this same spectrum portion to design a new application. This application is much more sensitive to interference problems, but initially, the paucity of other devices allows interference to be kept to a minimum. While being very sensitive, this

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[116] The political power of well-organized interest groups in spectrum policy is demonstrated by the power exerted by HAM radio operators and radio and television broadcasters, who have been able to utilize this power to delay a transition away from our current system.

[117] For more on regulatory capture, see Richard Posner, *Theories of Economic Regulation*, 5 BELL JOURNAL OF ECONOMICS AND MANAGEMENT SCIENCE 335 (1974); Gary Becker, *A Theory of Competition Among Pressure Groups for Political Influence*, 98 QUARTERLY JOURNAL OF ECONOMICS 371 (1983); George Stigler, *The Theory of Economic Regulation*, 2 BELL JOURNAL OF ECONOMICS AND MANAGEMENT SCIENCE 3 (1971); and Sam Peltzman, *Toward a More General Theory of Regulation*, 19 J. L. & ECON. 211 (1976).

[118] This assumption means that these three applications could continue to operate successfully under a commons approach, because interference would not present a problem.

application also becomes extremely valuable.[119] [120] While things operate smoothly for a short period, after a little time, the other three applications then become more popular, and more devices using the 1.8 GHz band begin operating. The higher utilization of this bandwidth now creates significant interference problems for the extremely valuable application, problems that existing technology cannot remedy. What will be the response to this situation?

There are four possible responses. Some might suggest that technology could improve to eliminate the interference problem, which would enable us to continue under the pure commons approach. However, as these other devices continue to multiply in the marketplace, the pace of technological improvement may be unable to keep up with the pace of interference.

Another response might be for the inventor of this very valuable application to acquire some exclusive-rights frequency and redesign the application to utilize that frequency. However, if successful, this response would result in the complete loss of the investment consumers of this application[121] had made in the purchase and implementation of earlier devices using the commons frequency. Because of the magnitude of this investment, it is politically likely that these consumers would successfully push for some alternative response.

Yet another possibility would be to transition this particular commons spectrum frequency into a property-rights-based, exclusive-rights frequency. Under this approach, the government could award property rights to the different inventors of the devices that utilize the spectrum, and if the inventor of the very valuable application could acquire all of these rights, then the interference problem would be solved. However, there are two problems with this response. One is the "hold-out" problem: each of the other inventors would have a strong incentive to hold-out against selling their right to spectrum, in an effort to extract the maximum amount from the inventor of the very valuable application. The other problem is the same problem mentioned above in the property-rights transition section: "third parties." Under this response, the inventors of the other devices would be compensated, but none of that

[119] For instance, it may be designed to facilitate certain extremely valuable financial transactions.

[120] As noted above, commons advocates do not always advocate opening all spectrum frequencies to commons, and instead might use some mix between exclusive-rights frequencies and commons frequencies. If exclusive-rights spectrum frequencies were available, one might ask why an inventor of an extremely valuable application might choose to utilize a commons frequency. The answer is simply that these inventions are very risky, and that purchasing the right to use an exclusive-right frequency could be more costly than the inventor would be willing to invest, prior to learning the true (extremely large) value of the invention.

[121] *E.g.* wealthy financial institutions.

compensation would then flow to the third-party purchasers of the less-valuable devices.[122] Just as in the case with water, a transition like this that deprived these third parties of all economically viable use of their prior investments in these devices may lead to takings claims against the government.[123] This response therefore seems likely to be either ineffective, or politically and legally problematic.

In the end, just as has happened with riparian systems, the most likely response seems to be that regulations would be applied to this frequency to reduce the impact of interference problems. Both the vendor and the customers of the extremely valuable application would have strong incentives to lobby for regulations that would protect their use of this portion of the spectrum. And so the likely outcome in this case is to transition to a regulated commons.

Consequently, a likely transition to a regulated commons presents an argument against adopting the commons approach for spectrum. The one thing that both property rights advocates and commons advocates seem to agree upon is the inappropriateness of the current regulatory system for allocating spectrum. However, there might be significant similarities between how the current FCC regulatory system operates and how a regulated commons system would operate. In the end, a transition to a regulated commons could end up looking similar to our current system, with all of its associated problems.

VI.C. An Alternative Structure to Enable More Flexibility to Respond to Transitional Forces

Thus, we learn two major lessons from water law. Our first lesson is based on experiences with prior appropriation doctrine. These experiences suggest that concerns about "third party" effects could be very detrimental to the efficiency of a property rights system of spectrum allocation. These pressures would likely lead to a transition to a more regulated system of property rights. Our second lesson is based on experiences with transitions in riparian doctrine. These transitions suggest that under pressure due to scarcity, a commons system for spectrum allocation likely will transition to a regulated commons, which could look similar to our current system for commons with all of its attendant problems.

[122] One might suggest extending the awarding of property rights to these third parties also, but this would multiply the hold-out problem, because each third party then could also hold out.

[123] *See* Lucas v. South Carolina Coastal Council, 505 U.S. 1003 (1992); and Palazzolo v. Rhode Island, 533 U.S. 606 (2001).

Taken together, these lessons suggest additional criticisms of both a property rights approach and a commons approach. Yet our experiences with water law also suggest an alternative structure—one that more properly combines aspects of both property rights and commons.

One of the more interesting recent developments in water law is the Environmental Water Account (EWA). An extremely difficult issue when protecting environmental interests in water bodies is the timing of when these interests are most endangered. While pollutant load[124] and pollutant type certainly are major factors in protecting environmental interests in waters, the quantity of water in the water body itself plays perhaps the most important role. For many pollutants, a sufficient quantity of water can enable dilution to the point that the presence of the pollutants in their diluted state is no longer harmful to the environmental interests.[125] Therefore, a key factor in the environmental health of a water body is often as simple as the quantity of water in it.

Consequently, environmental interests tend to be threatened most during extended droughts, which inevitably lead to significant water quantity reductions in water bodies. We want to be able to save more water for these environmental interests during these drought times. However, unfortunately, these periods of extended droughts are precisely the same time when non-environmental interests are affected the most by the scarcity of water resources. In other words, the time when the fish need more water the most is exactly the same time that farmers and cities need more water most. This dilemma presents severe obstacles to protecting environmental interests in water bodies.

To deal with this, one approach has been to create what are known as Environmental Water Accounts.[126] An EWA takes advantage of both temporal and locational flexibility in water resources to balance these competing needs for water during water scarcities. While there is a natural conflict between environmental and non-environmental interests for water resources in times of drought, a manager of an EWA can nonetheless use temporal transfers of water to protect environmental interests.

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[124] Pollutant load is the quantity of pollutants introduced into water bodies.
[125] *See* Dale B. Thompson, AN EXAMINATION OF THE CONSEQUENCES OF POLITICAL, ADMINISTRATIVE, AND LEGAL INSTITUTIONS ON THE IMPLEMENTATION AND PERFORMANCE OF ENVIRONMENTAL POLICIES, Ph.D. dissertation, Stanford University (1998); and Dale B. Thompson, *Beyond Benefit-Cost Analysis: Institutional Transaction Costs and the Regulation of Water Quality*, 39 NAT. RESOURCES J. 517 (1999).
[126] For more on Environmental Water Accounts, *see* http://calwater.ca.gov/Programs/EnvironmentalWaterAccount/EnvironmentalWaterAccount.shtml; and STANFORD LAW SCHOOL ENVIRONMENTAL AND NATURAL RESOURCES LAW AND POLICY PROGRAM, Bay-Delta: The Environmental Water Account, SLS Case No. 039-99 (1999)..

The manager does this by acquiring additional water resources in times of plenty, and then utilizing excess capacity in reservoirs to store the water for later use.

Additionally, while environmental interests in water bodies have localized needs for water, i.e. water in the Green River does not help fish in the Blue River, non-environmental interests are less concerned with where the water came from than with ensuring that the water reaches them. This characteristic provides locational flexibility that the manager of the EWA can utilize to protect environmental interests. For example, two rivers flow through the town of Blackstown, the Green and the Blue. Fish live in the Blue River but not in the Green. However, the town's permit specifies that withdrawals for the town's water supplies should occur from the Blue River. In times of scarce water supplies, withdrawals by the town are detrimental to the fish in the Blue River.

On the other hand, the EWA owns rights to withdraw water from the Green River. To protect the fish in the Blue River, when necessary, the manager of the EWA can "trade" withdrawal rights from the Green River to the town for its withdrawal rights from the Blue River.[127] After this transfer, the manager of the EWA can then ensure that the water remains in the Blue River and thereby protect the fish in the Blue River. As this example demonstrates, two important characteristics of EWAs are the ability to collect timely information on the precise location of environmental needs for water, and the ability to utilize alternative transportation facilities to "wheel" the water involved in a transfer.[128]

This example suggests an alternative property system to balance the competing interests of different users of spectrum: a property rights system involving trading of spectrum rights, and including as a significant component a Spectrum Commons Account (SCA). The way the SCA would work is as follows. Most spectrum would be owned as a private property right, for the use of an individual owner. However, one of the owners of spectrum would be the SCA. Spectrum owned by the SCA could be used by anyone, and would thus have the characteristics of a commons. Meanwhile, the manager of a SCA then would buy and sell certain portions of spectrum rights that are available on the general spectrum rights market.[129]

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[127] Recall that, due to restraints on transfers arising out of protections for third parties, the operation of an appropriation system is very rigid, and this type of transfer would normally not occur without outside intervention.

[128] Water "wheeling" refers to using someone else's facilities to convey marketed water; *see* STLA, *supra* note 83, at 645.

[129] An SCA is similar to the "parks" suggestion of Faulhaber and Farber, *supra* note 56, in that a portion of the spectrum would be utilized as commons under an otherwise property-rights regime. However, the significant difference is that the extent of commons frequencies would be actively managed by SCA managers, including possibly selling a formerly commons frequency for exclusive use.

In doing so, the manager of the SCA can take advantage of flexibilities to provide additional spectrum for use as a commons. Flexibilities in spectrum derive from two sources: applications where interference poses minimal adverse consequences; and devices that are designed (or could be redesigned at a very low cost) to enable operation over a wider range of frequencies without any significant loss in performance.

There would be two purposes in operating the SCA. One would be to expand the amount of spectrum available as a commons resource. The other would be to minimize the effects on third parties from transfers of spectrum rights. On this second purpose, it could be important to grant third-parties certain statutory rights that would be satisfied through a properly executed SCA operation. One of the important backdrops to EWAs is the Endangered Species Act (ESA). Certain species of the fish protected in the operation of an EWA are also protected under the ESA. This backdrop provides incentives for EWA managers to properly consider the needs of these fish, and for other water users to cooperate with EWA managers to prevent outcomes that could lead to litigation under the ESA. In a similar manner, providing third parties certain statutory rights might then provide proper incentives to SCA managers, and induce owners of spectrum rights to cooperate with SCA managers before conducting frequency transfers that might affect third parties.

One of the important lessons from EWAs is that the manager needs to have complete information to properly respond to changing conditions. Under an SCA, this information would come through a registration system.[130] In a SCA registration system, the vendor of devices utilizing a commons spectrum frequency could decide to register its device with the SCA. Registration by the vendor would entail provision of information about the device, concerning its susceptibility to interference problems, and the steps that the vendor would expect would need to occur to enable the devices to operate on a different commons frequency. The benefit for registration would be that a vendor could then include a symbol on the device (and in marketing literature) indicating that this device had the opportunity of protection under a SCA.[131] Consumers of this device could then go on the internet to register their own purchase and use of the device. Consumers that did so would be entitled to the "third-party insurance" provided by the SCA. Registration by both vendors and consumers would

[130] Registration is also important under prior appropriation doctrine, and under regulated riparian systems. *See* STLA, *supra* note 83, at 183-187, and at 79-91.
[131] This advantage would be similar to the ability of banks to advertise that "deposits up to $100,000 are insured by the Federal Deposit Insurance Corporation."

provide the information an SCA manager would need to determine whether for any proposed purchase of commons frequency, the offered price would exceed the costs to all affected parties.

The registration system would also extend to protect third parties to transfers of private spectrum rights. Prior to making a transfer that might violate statutory rights of third parties, as discussed above, the holder of a private spectrum right could first approach the SCA manager. We assume that this transfer would damage certain third party interests. The SCA manager would examine the consequences of this transfer on third parties, and then determine the circumstances[132] under which the flexibilities of the SCA could protect these third parties. In order to do so, the SCA manager would again need registration information from both the vendors and consumers of devices utilizing this frequency. After receiving this information, the SCA manager could then determine whether it would be possible to protect the third parties affected by this proposed transfer. If so, the SCA manager could then give a "SCA stamp of approval" to the transfer, which would relieve the trading parties of any liability under the third-party protection statute. The SCA manager would then also be responsible to provide registered third parties with equipment[133] utilizing a commons spectrum frequency, paid for by the former holder of the private spectrum right. In this manner, the SCA manager could be an important party to transfers of private spectrum rights.

An example may better explicate the operation of an SCA. We shall again consider the example of the extremely valuable invention susceptible to interference problems using a commons frequency. Whereas under the pure commons system, as discussed above, this would likely lead to a regulated commons. However, an SCA manager would be able to more directly deal with this.

Consider a portion of spectrum initially operated as a commons, part of an SCA. A number of technologies utilize this frequency. One of these technologies becomes extremely valuable. Furthermore, this particular technology is sensitive to interference from others using the same frequency for other technologies. What can be done?

If this was a traditional commons regime, a technical solution would be the only way for the owner of this technology to alleviate this interference problem. For instance, this technology could be utilized by better identifying the source of the signals, and ensuring that this source is desired one. Meanwhile, under a mixed commons-property-rights regime as has been discussed previously (CITE), where a portion of bandwidth is devoted to commons and another portion devoted to property rights,

[132] Including possibly a payment by the holder of the spectrum right to cover the costs of purchasing new devices for third parties.
[133] Perhaps all that would be required is changing the default frequency.

another alternative arises. The owner of the technology may purchase a portion of the spectrum that operates under the property rights regime. She can then modify the technology to utilize this alternative frequency, and then distribute new equipment that used the alternative frequency.

Under a SCA, yet another opportunity arises.[134] The owner of the technology can approach the manager of the SCA, and suggest that she might be interested in acquiring an exclusive right to utilize this frequency. The SCA manager will then investigate the costs of moving other users of this commons frequency to another frequency. These costs include both the costs of acquiring other spectrum frequencies to use as commons for these users, and the costs of developing and distributing new equipment for these individual users.[135] The owner of the technology could then determine whether this option would be the best response to the interference problem. If so, the owner would then pay the required compensation to the manager of the SCA, and would then acquire an exclusive right to use this frequency. As long as this new technology was valuable enough to make this transfer feasible, the net result of this flexibility is the opportunity to properly respond to the problem of interference suffered by a valuable technology that utilized a commons frequency. Why would this be necessary? The answer lies with risk and how technological development occurs. Most of the time, technological development is not a completely foreseeable activity. Promising technologies may go nowhere, and seemingly pedantic technologies may be runaway hits.[136] As a result, the planning and financing process is never completely clear.

Furthermore, technological development frequently occurs in stages. For example, multiple editions of software are frequently released.[137] While each of these stages may not be a revolutionary change,[138] each evolutionary stage requires considerable amounts of investment to be successful. Because of the uncertainty and risk involved, it may be impossible to foresee whether this investment will be a good one. It is therefore unlikely that a risky investment by an innovator with no financial

[134] It is important to recognize that the other two reactions are also possible under a SCA. Economic theory suggests that owners of technologies hindered by interference will choose the reaction that has the lowest total cost (which could include the costs of impaired transmissions as different frequencies are used than under the original design).
[135] These costs also could include estimated costs of compensating users for impaired transmissions as different frequencies are used.
[136] One example frequently cited is the triumph of the VHS technology over the Betamax technology for video tape recording.
[137] For example, the previous family of Windows (the current family, Windows XP is based on the NT kernel) was released as Windows 1.0, 2.0, 3.0, 3.1 3.11 Workgroup Edition, 95, 98, 98 Second Edition, and Millenium Edition.
[138] For the difference between revolutionary and evolutionary technological change, *see* CARL SHAPIRO AND HAL R. VARIAN, INFORMATION RULES (1999), at 191-6.

backing would secure financing for secondary and tertiary development stages before implementing the primary stage.

So what does this mean for an SCA? What this suggests is that there is a possibility that one of the many innovators developing new technologies that utilize a commons frequency may develop an extremely valuable technology. It is unlikely that the true value of this technology could be ascertained prior to implementation. Could the innovator attract additional financing to refine this technology?

Let's consider a technology sensitive to interference. If the innovator could alter the frequency used by the technology, then the innovator could acquire a frequency operating under an exclusive license. The innovator could therefore solve the interference problem by switching the frequency used. With this problem solved, the innovator would more likely attract financing.

However, if design and usability standards required the continued use of the same frequency, it is unlikely under a commons approach that the innovator would attract the needed financing. This is because it is unlikely that the innovator would be able to convince all users of the commons frequency to yield exclusive control.

On the other hand, the SCA provides another option for the innovator. If the innovator can comply with the required terms set by the SCA manager,[139] the innovator can gain exclusive control over the frequency. With exclusive control, this technology becomes more attractive for financing additional refinements.

Consequently, the flexibility offered under an SCA will provide a stronger incentive to develop[140] more valuable technologies. Meanwhile, portions of spectrum would always be available as commons to enable those wishing to experiment with a new technology the opportunity to do so.

The SCA can therefore serve to alleviate some of the detrimental effects of a property-rights-trading system, while enabling the market for spectrum rights to operate, thereby providing the efficiency advantages of this system along with incentives to invest in improving the value of rights to use spectrum.

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[139] In essence, this is like the liability rule option under the Calabresi-Melamed framework. *See* Guido Calabresi and A. Douglas Melamed, *Property Rules, Liability Rules and Inalienability: One View of the Cathedral*, 85 HARV. L. R. 1089 (1972). What is essential under both this situation and under the liability rule is that an external source sets the terms of the bargain rather than the parties themselves. When the parties are responsible for setting the terms, as under the property rule option, hold-outs can result. Under the Calabresi-Melamed framework, the external source is the court, while here, it is the SCA manager.

[140] Also important is the incentive to make additional investments in refining a technology using a commons frequency. An initial success may therefore spur additional investment in improving the technology.

VII. Conclusion

In examining the debate over whether the appropriate property system for spectrum should be based on a property-rights approach or a commons approach, we should also consider the transitions these property systems may undergo as they respond to changes in conditions or internal contradictions. Looking at the future is an inherently difficult task, and so this article instead looks to the past – in particular our prior experience with water law – to learn more about a possible future for spectrum. This article examines a number of strong similarities between water resources and doctrines, and spectrum resources and doctrines, to establish the relevance of our past with water as a guide to the future of spectrum.

The lessons we draw from water law suggest the following irony: the transitions that property systems, based either on a property-rights approach or a commons approach, may undertake could leave these systems looking fairly similar to our current property system for spectrum: FCC regulation. Just as we have seen in the limited development of water markets under prior appropriation, the need to protect third-party interests from transfers of spectrum property rights could lead to procedural mechanisms that could effectively quash many of these spectrum trades before they occur. Furthermore, just as we have seen riparian doctrine states respond to new scarcity in water resources by transitioning to a regulated riparian system, we could also expect that a commons-based property system for spectrum would also respond to an inevitable scarcity in spectrum by transitioning to a regulated commons system.

Thus, regardless of whether we choose to adopt a system for spectrum based on property rights, or one based on commons, future transitions to these systems could leave us back where we started: a property system similar to FCC regulation, with all of its associated problems. The following table summarizes the advantages and disadvantages of property rights and commons approaches for spectrum, and the transitional pressures and outcomes that may result from use of these approaches:

Property System	**Flexibility in Responding to Interference Problems**	**Provides Capability and Incentives to Innovate for the Following Groups**	**Transitional Pressure**	**Transitional Outcome**
Property Rights	Can respond through both technological solutions and market mechanisms	Well-financed innovators expecting very large returns	Possibly detrimental effects on third parties from frequency license transfers	Regulatory oversight of frequency transfers
Commons	Can only respond	A wider range of	Possible interference	Regulatory

	through technological solutions	innovators, including those without the financing to acquire licenses under the property right regime	effects on very valuable use of commons frequency	oversight of commons frequency

Table 2: Advantages, Disadvantages, & Transitions for Property Rights and Commons in Spectrum

To find some solution to this conundrum, an alternative is suggested by our recent experience with Environmental Water Accounts (EWA). While operating in a property-rights-trading based system, EWA provide commons benefits for environmental interests in water bodies. In a similar manner, this article proposes the development of Spectrum Commons Accounts (SCA). Similar to EWA, SCA would operate within a property-rights-trading based system for spectrum. Through the SCA, significant portions of the spectrum would be acquired for use as commons, and also to protect third-party interests. However, by operating through a baseline market system, this property system can use market signals to respond to scarcities of spectrum, and so the imposition of regulatory controls would be unnecessary. Thus, a property system involving SCA could offer the advantages of both property rights and commons for spectrum. The following table summarizes these features of Spectrum Commons Accounts:

Property System	**Flexibility in Responding to Interference Problems**	**Provides Capability and Incentives to Innovate for the Following Groups**	**Transitional Pressures**	**Outcome Utilizing Flexibility of SCA (No Transition Needed)**
Spectrum Commons Accounts	Can respond through both technological solutions and market mechanisms	A wide range of innovators, including those without the financing to acquire licenses under the property right regime	Possibly detrimental effects on third parties from frequency license transfers	SCA manager will provide funds for purchases of new equipment and new spectrum frequencies
			Possible interference effects on very valuable use of commons frequency	SCA manager can negotiate the purchase of a commons spectrum frequency by the owner of a very valuable use of that frequency

Table 3: Spectrum Commons Accounts Provide Advantages of Commons and Property Rights, and Respond to Transitional Pressures

This article has applications beyond water and spectrum. Spectrum Commons Accounts are a form of marketable commons property. As a new fourth category of property systems,[141] marketable commons property enables us to better achieve our objectives depending on circumstances. Water law utilizes all four categories: property rights in prior appropriations doctrine, commons in riparian doctrine, inherently public in the public trust doctrine, and marketable commons in Environmental Water Accounts.

Recognizing the possibility of this new category will provide opportunities to better manage other resources. Utilizing the marketable commons system will be best under the following conditions:

(1) organization under a commons approach in most cases is necessary to achieve the primary objective of managing the resource;
(2) in rare situations, internal or external conditions may make the application of the commons approach extremely costly for a particular participant; and
(3) that participant detrimentally affected could assert political power that would lead to a transition away from a pure commons system.

Under these conditions, use of a marketable commons property system will enable the achievement of the innovation and distribution advantages offered by the commons approach. At the same time, the possibility of having an extremely costly conflict is eliminated by making the entire system responsive to market signals. Marketable commons property will thus likely find many applications beyond water law and telecommunications spectrum.

[141] *See* Table 1.

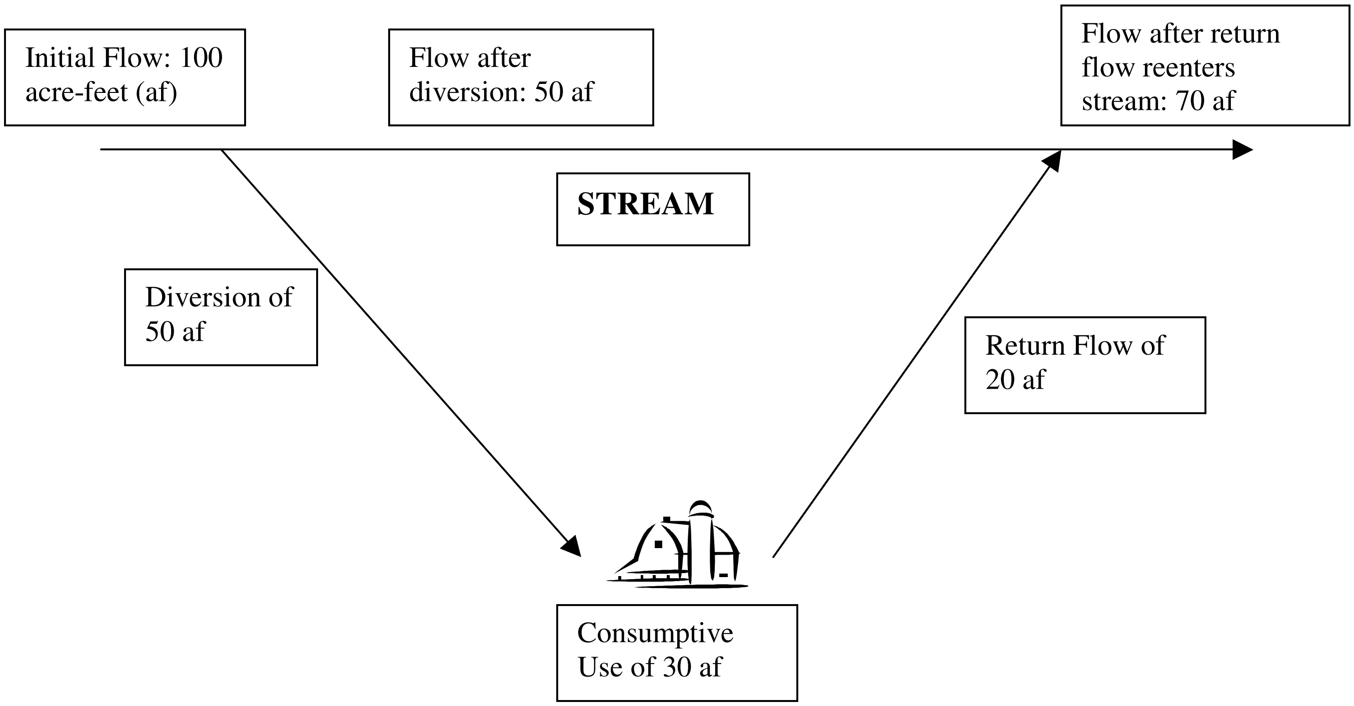

Figure 1: Diagram showing effects on stream flow from diversion and return flow

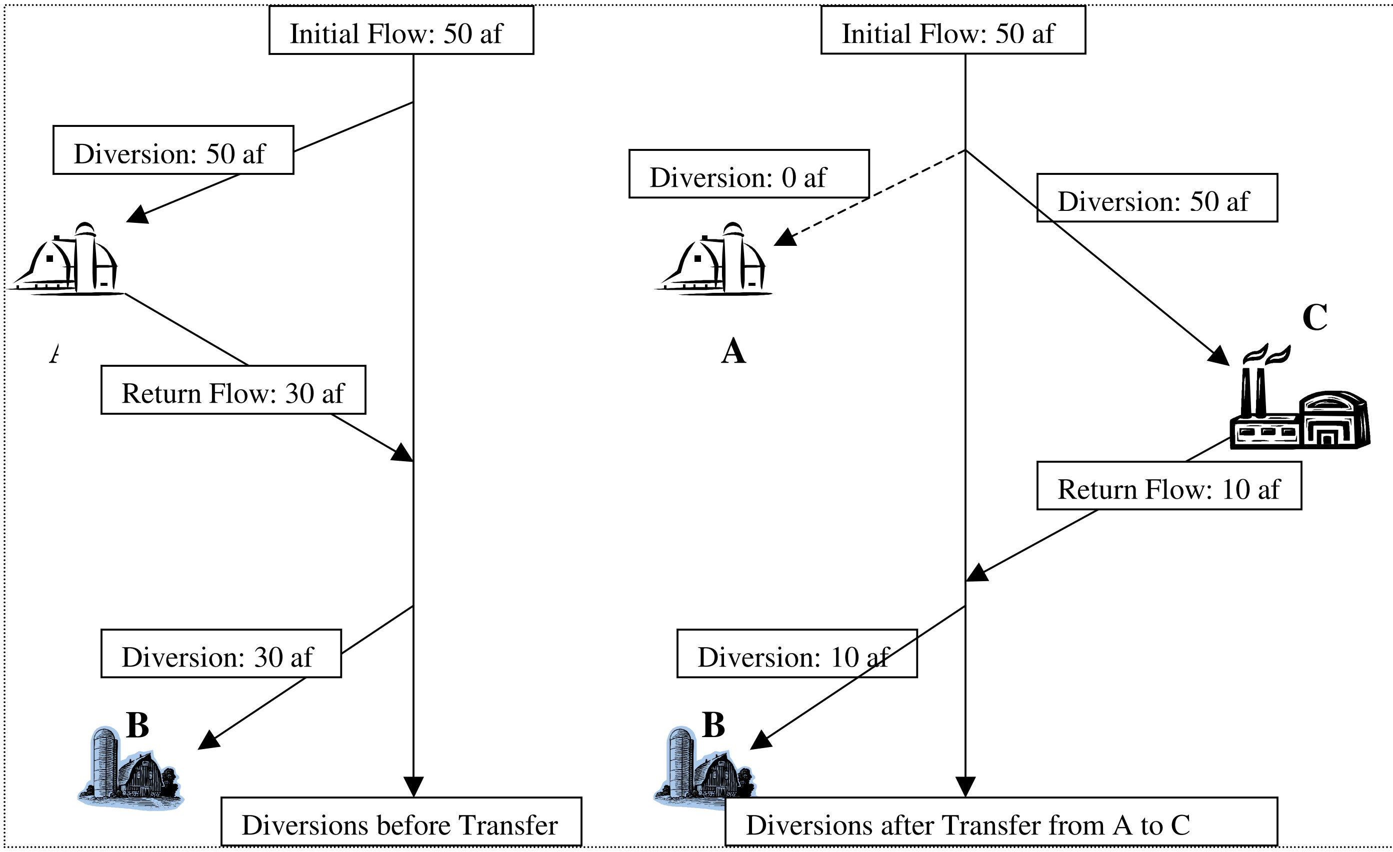

Figure 2: Diagram showing effect of available water to Farm B after a transfer from Farm A to Factory C. Due to a difference in return flow, water available to Farm B has reduced from 30af to 10af.