TRADING DAMS

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ABSTRACT

Over the past forty years, environmental trading systems have emerged as one of the primary innovations of American environmental law. In fields ranging from climate change mitigation to wetlands protection, regulated entities now may proceed with otherwise proscribed activities in return for providing extra protection at some other place or time. At their best, these trades achieve environmental goals while increasing flexibility and lowering the economic costs of regulation. In practice, that promise has not always been achieved, and the emergence of environmental trading systems has at times been quite controversial. But they have become increasingly pervasive.

This Article considers environmental trading in a new context. The United States contains tens of thousands of dams, and these dams have drastically altered river systems. While many of these dams also provide important societal benefits, a major reconfiguration of America's dams would greatly improve those dams' collective balance between benefits and harms. To date, that kind of major reconfiguration has not taken place. But a restoration project on Maine's Penobscot River illustrates how trading might create such change. By exchanging reduced environmental regulatory constraints and increased energy generation in some locations for dam removals and other environmental improvements elsewhere, the project will create major environmental improvements without any loss of hydropower.

Using that project as a model, this Article analyzes how trading systems might facilitate better reconciliation of the positive benefits and negative impacts of dams. Our conclusions are qualified; while we argue that trading systems hold promise, applying them to dams will not be easy.

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Nevertheless, the concept is worth pursuing, and we offer a series of legal reforms to that end. More broadly, the analysis illustrates both the promise and the challenges that face environmental trading systems as they continue their expansion through the field of environmental law.

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I. INTRODUCTION

On the morning of July 22, 2013, an excavator smashed through the Veazie Dam, allowing the Penobscot River to spill through.[2] It was a historic moment. Opposition—often unsuccessful—to dam construction helped forge the American environmental movement, and the removal of any dam therefore carries potent symbolism.[3] This was no exception. Political figures flocked to the breaching; the Penobscot Indian Tribe commemorated the event with ceremonies; and the New York Times described the removal as emblematic "of a nationwide movement."[4] Dam removals can also bring enormous ecological benefits, and on this front the Veazie Dam removal seems particularly promising. Because of its somewhat remote location, the Penobscot River's profile remains lower than that of Chesapeake Bay, the Everglades, or California's Bay-Delta—the three tragically flawed icons of American environmental restoration. But the Penobscot River Restoration Project, of which the Veazie Dam removal is a key part, is one of the most ambitious river restoration projects in the world.

Even with these removals, however, the Penobscot remains a dammed river, and hydropower at some of its remaining dams actually is slated to increase.[5] This, too, reflects a larger story. The United States is the world's leader in dam removals,[6] but the overwhelming majority of its dams remain in place, with no plans for removal.[7] Hydropower continues to generate more electricity than all other sources of renewable energy[8]

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[2] Alyssa Botelho, *Breaching of Dam, Restoring Salmon's Passage Unite Many*, BOSTON GLOBE, July 23, 2013.

[3] *See, e.g.*, ROBERT W. RIGHTER, THE BATTLE OVER HETCH HETCHY: AMERICA'S MOST CONTROVERSIAL DAM AND THE BIRTH OF MODERN ENVIRONMENTALISM (2005). Perhaps the most vivid expression of dams' symbolism comes from John McPhee, who described a conservationist's layers of Hell, ending at "the absolute epicenter… where stands a dam." JOHN MCPHEE, ENCOUNTERS WITH THE ARCHDRUID 158 (1971).

[4] Editorial, *Down Comes another Dam*, N.Y. TIMES, July 22, 2013, at A18. *See generally* THE ASPEN INSTITUTE, DAM REMOVAL: A NEW OPTION FOR A NEW CENTURY (2002).

[5] Jeffrey J. Opperman et al., *The Penobscot River, Maine, USA: a Basin-Scale Approach to Balancing Power Generation and Ecosystem Restoration*, 16 ECOLOGY AND SOC'Y 7, 14 (2011).

[6] Emily H. Stanley & Martin W. Doyle, *Trading off: the Ecological Effects of Dam Removal*, 1 FRONTIERS IN ECOLOGY 15, 21 (2003) ("[T]he vast majority of intentional removals have occurred in the US.").

[7] THE ASPEN INSTITUTE, *supra* note 3, at 4 ("[V]ery few documented dams in the United States are even being considered for removal.").

[8] In this Article, we use the Energy Information Administration's definition of renewable energy: "renewable energy sources regenerate and can be sustained indefinitely." Hydropower generally meets this definition—at least until reservoirs fill with sediment or dams become structurally obsolete. Energy Information Administration, *What Is Renewable Energy?*, http://www.eia.gov/energyexplained/index.cfm?page=renewable_home (last visited

combined.[9] And many energy policy advocates—as well as many members of Congress—want more hydropower, particularly at the many dams that currently generate no hydropower or that could be upgraded to generate more.[10] In the United States, at least, enthusiasm for building new dams has waned,[11] but in many other nations it remains strong.[12] The environmental accounting of dams also has evolved, and dam supporters increasingly can draw upon arguments that ought to resonate with their traditional adversaries. Often—though, importantly, not always—hydropower is a relatively clean energy source, with low emissions of conventional air pollutants and greenhouse gases.[13]

Notwithstanding hydropower's emissions benefits, the tension between these stories might seem profound, for environmental advocates have long regarded dams simply as "evil—placed and solid."[14] On the Penobscot River, however, the two stories are closely—and legally—linked in a very different way: the dam removals and hydropower upgrades all are part of a negotiated deal.[15] The terms of the agreement are complex, but at its core is a trade. In return for withholding opposition to continued dam operations at several sites—and for paying the dams' owner a substantial sum of money—environmentalists and the Penobscot Indian Tribe secured the removal of two dams, the decommissioning of a third, and upgrades to fish passage capacity at several others.[16] In other words, they traded

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September 16, 2013). Some commentators, and some regulatory systems, include in their definition a sustainability test, which hydropower systems may not pass.

[9] U.S. Energy Information Administration, *How much of our electricity is generated from renewable energy?*, http://www.eia.gov/energy_in_brief/article/renewable_electricity.cfm (last updated May 7, 2013) (showing statistics for different energy sources).

[10] KELSI BRACMORT ET AL., HYDROPOWER: FEDERAL AND NONFEDERAL INVESTMENT 1 (2013) ("More than 25 bills dealing with various aspects of hydropower were introduced in the 112th Congress.").

[11] For chronicles of the rise and fall of large-scale hydropower development in the United States, see MARC REISNER, CADILLAC DESERT: THE AMERICAN WEST AND ITS DISAPPEARING WATER (rev. ed. 1993); Dan Tarlock, *Hydro Law and the Future of Hydroelectric Power Generation in the United States*, 65 VANDERBILT L. REV. 1723 (2012); Christine A. Klein, *On Dams and Democracy*, 78 OR. L. REV. 641 (1999). The most likely exception to this trend involves Alaska. *See* Felicity Barringer, *Proposed Dam Presents Economic and Environmental Challenges in Alaska*, N.Y. TIMES, March 6, 2013.

[12] *See* Jingsheng Jia et al., *Hydropower*, in HANDBOOK OF CLIMATE CHANGE MITIGATION 1355, 1357-75 (Wei-Yin Chen et al., eds. 2012)

[13] *See id.* at 1383; WILLIAM STEINHURST ET AL., HYDROPOWER GREENHOUSE GAS EMISSIONS: STATE OF THE RESEARCH 1 (2012) ("[T]he rate of emissions per unit of electric generation from hydropower (excluding tropical reservoirs) is much lower than for fossil fuel technologies.") (parentheses in original). Tropical reservoirs have high GHG footprints because the decomposition of flooded biomass produces methane and because flooding displaces forests that previously functioned as carbon sinks. *Id.* at 14.

[14] *See* MCPHEE, *supra* note 3, at 159 ("[P]ossibly the reaction to dams is so violent because rivers are the ultimate metaphor for existence, and dams destroy rivers.").

[15] *See generally* Opperman et al., *supra* note 5, at 14-16.

[16] *See id.*

environmental restoration in some places for increased hydropower generation in others (and, again, for money). The net result will be major improvements in environmental quality—including approximately a thousand miles of additional habitat access for migratory fish—with no net loss of hydropower capacity.[17] For good reason, the project has been hailed worldwide as a model.[18]

The core question considered by this Article is how to replicate that model—and, more specifically, how law can facilitate that replication. That is an important question, for the need for imitation is much greater than most people realize. The United States contains over 87,000 "large" dams, and their ecological impacts of dams are enormous. But energy remains a basic societal need, and other energy sources do immense environmental damage.[19] Projects that reduce the ecological impacts of dams while maximizing hydropower generating capacity therefore would be quite valuable. The potential for such projects also could be substantial. The United States contains over 87,000 "large" dams, only three percent of which actually generate hydropower.[20] On many rivers, combining hydropower installations or upgrades at some locations with environmental restoration projects at others seems possible, at least as a matter of science and engineering.[21] Similarly, in other countries where dam construction remains a national priority,[22] more rational siting processes could reduce dams' devastating impacts on river systems while at the same time lessening demand for energy sources—like coal—whose environmental and health impacts can be even worse.[23]

Economic and environmental need alone will not be sufficient to ensure replication, however. Law matters as well, and here, too, the Penobscot River Restoration Project shows promise as a model. Though it

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[17] *Id.*

[18] *See, e.g.*, Giulio Boccaletti, *It's a Mistake for NGOs not to Engage with Hydropower Companies*, CONSERVANCY TALK, August 20, 2013, http://blog.nature.org/conservancy/2013/08/20/its-a-mistake-for-ngos-not-to-engage-with-hydropower-companies/ (citing the Penobscot project as a global model); Ashish Khotari, *Liberating a River*, FRONTLINE, Jan. 16, 2009 ("Even if India does not manage to start decommissioning its dams, it should certainly learn a lesson from the Penobscot project.").

[19] *See generally* ANDREW GUZMAN, OVERHEATED: THE HUMAN COST OF CLIMATE CHANGE (2013); Bert Brunkreef & Stephen T. Holgate, *Air Pollution and Health*, 360 THE LANCET 1233 (2002). Energy also is by no means the only benefit dams can provide. While it is our primary focus in this article, regulatory systems that improve environmental conditions while maximizing other benefits of dams also could be quite valuable.

[20] *See* CorpsMap National Inventory of Dams, http://geo.usace.army.mil/pgis/f?p=397:5:0::NO (last visited September 16, 2013). The 87,359 number represents the sum of the numbers in the first chart.

[21] *See infra* Parts III and IV.

[22] *See* Boccaletti, *supra* note 18 ("We are entering a new hydro-dam era.").

[23] *See* UNITED STATES DEPT. OF THE INTERIOR ET AL., POTENTIAL HYDROELECTRIC DEVELOPMENT AT EXISTING FEDERAL FACILITIES 33 (2007) (quantifying the displacement). The calculus is very different, however, if the proposed project would flood a tropical forest. *See supra* note 13.

applies that concept in a novel setting, the project reflects environmental law's growing emphasis on trading systems.[24] Such systems now pervade conventional air quality regulation, and they have assumed increasingly important roles in greenhouse gas regulation, wetlands protection, fisheries management, habitat protection, and a variety of other contexts.[25] Within those many realms, trading systems come in a wide variety of forms; while the archetypal trading system is a cap-and-trade program, in which trades are numerous, trading currencies are well-developed, and transaction costs are low, there are other programs in which governmental intervention is nearly continuous and trades resemble bartered deals more than the outputs of a functioning market.[26] But in all of these contexts, trading systems share key common features; most importantly, they involve trading increased protection in some times or places for increased environmental degradation at others, and they use those trades as means to provide greater flexibility and economic efficiency.[27] They also have spawned an extraordinary volume of legal and economic research, and, in some circles, have become almost synonymous with regulatory innovation.[28] Indeed, some prominent commentators argue that trading systems are the economically and democratically optimal mode of regulation, and therefore should be the central regulatory instrument of environmental law.[29] Dams, then, might seem like the logical next frontier, and the Penobscot project, with its impressive balance of environmental improvement and sustained energy production, would seem to exemplify the possibilities.[30]

Environmental law's forty-year experiment with trading systems, however, demonstrates that applying trading concepts in this context would

[24] *See See* James Salzman & J.B. Ruhl, *Currencies and the Commodification of Environmental Law*, 53 STAN. L. REV. 607, 609 (2000) (describing "growing interest in market-based mechanisms").

[25] *See* Tom Tietenberg, *Tradable Permits in Theory and Practice*, *in* MOVING TO MARKETS IN ENVIRONMENTAL REGULATION: LESSONS FROM TWENTY YEARS OF EXPERIENCE 63 (Jody Freeman & Charles D. Kolstad eds., 2007) (hereinafter "MOVING TO MARKETS") (describing applications).

[26] *See generally* MOVING TO MARKETS, *supra* note 25 (discussing a wide variety of programs).

[27] *See generally* Salzman & Ruhl, *supra* note 24. To some environmental lawyers and policy analysts, the phrase "environmental trading system" connotes only true cap-and-trade systems. But others—including us—use a more expansive definition of the phrase. Nevertheless, and while we think some lessons cut across the field, we acknowledge that the differences between carbon markets and wetland or dam trading are substantial.

[28] *See, e.g.*, Carol A. Casazza Herman et al., *Breaking the Logjam: Environmental Reform for the New Congress and Administration*, 17 N.Y.U. ENVTL. L. J. 1, 2 (2008).

[29] Bruce A. Ackerman & Richard B. Stewart, *Reforming Environmental Law*, 37 STAN. L. REV. 1333 (1985); Bruce A. Ackerman & Richard B. Stewart, *Reforming Environmental Law: The Democratic Case for Market Incentives*, 13 COLUM. J. ENVTL. L. 171 (1988).

[30] One other article explores this possibility. *See* James G. Workman, *How to Fix Our Dam Problems*, ISSUES IN SCI. & TECHNOLOGY, Fall, 2007. Our analysis provides more depth than Workman's, and while we share his conclusion that the idea is worth exploring, our endorsement of dam trading is more cautious.

not be simple. While trading systems have succeeded in some contexts, in others their track record is quite mixed.[31] Many theoretical and empirical critiques of trading systems have helped explain their uneven record.[32] The history of environmental trading systems therefore provides grounds for caution, and the cautionary tale clearly applies to dams. The complexities of dams, and the rivers they occupy, will probably never allow for anything akin to the high-volume, low-transaction-cost markets that exist for things like carbon or sulfur dioxide emissions. Even more barter-like systems will be challenging to create.

But that cautionary note should not end the inquiry. A third lesson of environmental trading systems is that they can be functional, and useful, even where they never will approach an economist's ideal market. Trading systems also can become more effective as both regulators and the regulated learn and adapt.[33] And even in contexts that never will be optimal for trading systems, they can succeed as complementary components of broader regulatory regimes. These possibilities inform our core conclusions, which are that more dam trading should occur; that reforms to facilitate trading should be implemented; and that the process of regulatory experimentation and learning should begin.[34]

This Article's analysis proceeds as follows. Part II surveys the status of dams in the United States, discussing their current and potential value, their environmental harms, and the complex legal regimes to which they are subject. That analysis underscores the need for more projects like the Penobscot—as well as the extent to which dams, which lately have lacked the legal-academic cachet of wind, solar, or fracking, remain crucially important for energy and environmental law. Part III describes the Penobscot River Restoration Project in more detail. Part IV then draws on the history and literature of environmental trading systems to evaluate their potential application to dams, and to identify factors that could facilitate or discourage other projects like the Penobscot. Part V builds on that evaluation to recommend reforms that would make dam trading a more widespread option.

In describing those reforms, and in providing a broader analysis of the possibilities for dam trading, we offer three primary contributions to the

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[31] *See, e.g.*, Karen Fisher-Vanden & Sheila Olmstead, *Moving Pollution Trading from Air to Water: Potential, Problems, and Prognosis*, 27 J. ECON. PERSPECTIVES 147, 147 (2013) ("While nearly three dozen water pollution trading programs have been established in the United States, many have seen no trading at all, and few are operating on a scale that could be considered economically significant."); James Salzman & J.B. Ruhl, *"No Net Loss": Instrument Choice in Wetlands Protection*, *in* MOVING TO MARKETS, *supra* note 25, at 323 (noting the challenges associated with applying trading systems to habitat).

[32] *See, e.g.*, Salzman & Ruhl, *supra* note 24; Laurence H. Goulder, *Markets for Pollution Allowances: What Are the (New) Lessons?*, 27 J. ECON. PERSP. 87 (2013).

[33] *See infra* notes 264-266 and accompanying text (describing the evolution of wetlands mitigation programs).

[34] While we focus upon dams, there are other fish passage barriers, like culverts, that could be drawn into trading schemes.

existing literature. Most importantly, we identify steps that would help reconcile society's interest in reducing the massive environmental impacts of dams with its need for non-fossil fuel energy. While many articles have focused on the former problem,[35] and some, more recently, have considered hydropower's potential contributions to the latter goal,[36] none has provided an in-depth analysis of the extent to which these seemingly opposing goals may be legally reconciled.[37] Relatedly, this Article provides the broadest analysis of which we are aware of the legal incentive structures that drive—or, more often, inhibit—thoughtful management of our system of dams. Our final contribution is to provide a window into a cutting edge of environmental trading systems, which have evolved considerably since they first emerged in the 1970s and 1980s.[38] An analysis of dams illustrates both emerging possibilities and continuing challenges.

II. THE PREVALENCE, LAW, AND ECOLOGY OF DAMS

In any legal system, the desirability of new regulatory instruments depends in large part on the nature of the things being regulated and the structure of the existing legal regime. Dams are no exception, and this Part therefore provides a background account of the United States' dams and their governing laws. Although the law, economics, and ecology of dams are complicated, the basic point is straightforward: our physical system of dams is enormous and in many ways outdated, and reconfiguring that system could produce major social and environmental benefits. But existing legal systems do little to encourage such reconfiguration and in some ways are impediments to change. Consequently, any regulatory reform that better reconciles the benefits and costs of dams—which is exactly what trading systems are supposed to do—would be a significant improvement.

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[35] *See, e.g.*, Michael C. Blumm & Andrew B. Erickson, *Dam Removal in the Pacific Northwest: Lessons for the Nation*, 42 ENVTL. L. 1043 (2012); Margaret B. Bowman, *Legal Perspectives on Dam Removal*, 52 BIOSCIENCE 739 (2002).

[36] *See, e.g.*, Gina S. Warren, *Hydropower: Time for a Small Makeover*, papers.ssrn.com/abstract=2312095; Lea Kosnik, *The Potential of Water Power in the Fight Against Global Warming in the US*, 36 ENERGY POL'Y 3252 (2008).

[37] Federal agencies have recently explored projects that could link hydropower expansion with environmental improvement, but they have not analyzed—at least in any publicly available documents—the legal steps necessary to accomplish those goals. *See, e.g.* Memorandum of Understanding for Hydropower among the Department of Energy, The Department of the Interior, and the Department of the Army, March 24, 2010, *available at* http://www.usbr.gov/power/SignedHydropowerMOU.pdf; *The Deschutes River Basin Scale Opportunities Assessment: A National Initiative to Help a Basin Increase Hydropower, Improve Environmental Sustainability While Considering Other Basin Values*, RMS JOURNAL, Winter, 2011, at 8.

[38] *See* Dave Owen, *Mapping, Modeling, and the Fragmentation of Environmental Law*, 2013 UTAH L. REV. 219, 267-73; JESSICA B. WILKINSON ET AL., THE NEXT GENERATION OF MITIGATION: LINKING CURRENT AND FUTURE MITIGATION PROGRAMS WITH STATE WILDLIFE ACTION PLANS AND OTHER STATE AND REGIONAL PLANS (2009).

A. The Continued Importance of Dams

Perhaps the best indicator of the continued importance of dams—and the law governing them—lies in sheer numbers. According to the National Inventory of Dams, there are over 87,359 dams in the United States.[39] The actual number is significantly higher, for the inventory includes only dams that meet certain size or safety thresholds, and one recent study estimated that an additional two million smaller dams populate the American landscape.[40] Even based on the inventory number alone, the United States contains approximately one dam for every day the nation has been in existence.[41] Because of those dams, the United States' river systems are heavily and pervasively engineered—so much so that a free-flowing river, for most Americans, is an exotic concept.[42] The Hudson River basin, for example, alone contains over 1,726 dams,[43] which translates to approximately one dam for every eight miles of stream or river.[44]

Collectively, dams serve a wide variety of purposes, including providing water supply, recreation, and flood control. Among those many purposes, one of the most important—and a central focus of this Article—is generating hydropower. According to the Energy Information Administration, hydropower generated approximately eight percent of the United States' electricity in 2011.[45] While that number may seem small—and is less than the global average of 16%—a few comparisons place it in perspective.[46] Based on the EIA's 2011 figures, hydropower generated twice as much electricity as wind and approximately fifty times as much

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[39] *See* CorpsMap National Inventory of Dams, http://geo.usace.army.mil/pgis/f?p=397:5:0::NO (last visited September 16, 2013). The 87,359 number represents the sum of the numbers in the first chart.

[40] *Id.* at http://geo.usace.army.mil/pgis/f?p=397:1:0::NO; *see* N. Leroy Poff & David D. Hart, *How Dams Vary and Why it Matters for the Emerging Science of Dam Removal*, 52 BIOSCIENCE 659, 662 (2002). Many culverts and roadway bridges obstruct fish passage and thus replicate some of the negative environmental impacts of dams.

[41] *See* Bruce Babbitt, *Dams Must Be Looked at Critically, with Eye Toward Environment*, WISCONSIN STATE J., Nov. 29, 1998. Since Babbitt wrote, the number of days has grown, but so too has the number of documented dams.

[42] In fact, in some long-dammed areas, even river ecologists misunderstood what an undammed stream would look like. *See* Robert C. Walters & Dorothy J. Merrill, *Natural Streams and the Legacy of Water-Powered Mills*, 319 SCI. 299 (2008) (concluding that conventional wisdom about the natural morphology of many East Coast streams was incorrect).

[43] Any dam tally necessitates a choice about how big a dam must be to count, and a different size threshold would produce a different result.

[44] ERIK H. MARTIN & COLIN D. APSE, NORTHEAST AQUATIC CONNECTIVITY: AN ASSESSMENT OF DAMS ON NORTHEASTERN RIVERS 67 (2011).

[45] Energy Information Administration, *supra* note 9.

[46] INTERNATIONAL ENERGY AGENCY, TECHNOLOGY ROADMAP: HYDROPOWER 7 (2012) ("It plays an important role in today's electricity mix, contributing to more than 16% of electricity generation worldwide and about 85% of global renewable electricity.").

energy as solar power.[47] The EIA's projections show those gaps closing, with hydropower in moderate decline and other renewable energy sources growing.[48] But at least for several more years, hydropower will remain the United States' predominant source of renewable energy. In many other countries, that dominance is even more pronounced.[49]

The energy generated by hydropower also is particularly important. Its cost per kilowatt hour can be relatively low, and it also provides energy managers with important flexibility.[50] Water discharges through turbines can be shifted to periods of higher energy demand,[51] and hydropower also can dispatch to a grid with minimal startup time, making it an important source following blackouts.[52] As intermittent sources like wind and solar grow more prevalent, that flexibility is likely to become increasingly valuable.[53] Perhaps most importantly, most of the United States' hydropower is nearly emissions-free,[54] while fossil fuel combustion generates most of the United States conventional air pollutants and greenhouse gases.[55] Consequently, if hydropower substitutes for fossil fuel energy generation—or provides the flexibility that allows increased reliance on other renewable sources—it offers an enormous environmental benefit.[56]

While hydropower is one of the most important societal benefits provided by dams, most dams do not actually generate hydropower. According to a recent study from the Idaho National Laboratory, "[t]he United States hydroelectric plant population is comprised of 2,388 licensed plants."[57] That number may sound large, but it means that approximately 97% of the dams in the national inventory do *not* produce hydropower.

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[47] Energy Information Administration, *supra* note 9.

[48] *Id.* Other sources, however, suggest that hydropower may grow significantly. *See, e.g.*, U.S. DEPT. OF ENERGY, WATER POWER FOR A CLEAN ENERGY FUTURE (2013) ("DOE is currently developing an aggressive strategy to support its vision of the nation obtaining 15% of its electricity needs from water power by 2030.").

[49] *See* Worldwatch Institute, *Use and Capacity of Global Hydropower Increases*, January 7, 2012, http://www.worldwatch.org/use-and-capacity-global-hydropower-increases.

[50] U.S. DEPT. OF HOMELAND SECURITY & U.S. DEPT. OF ENERGY, DAMS AND ENERGY SECTORS INTERDEPENDENCE STUDY 7-8 (2011) (providing reasons why "[h]ydropower is critical to the national economy and the overall energy reliability").

[51] Those shifts may have adverse environmental consequences, however. *See infra* notes 71-72 and accompanying text.

[52] U.S. DEPT. OF HOMELAND SECURITY AND U.S. DEPT. OF ENERGY, *supra* note 50, at 8.

[53] *See* TOMMY VITOLO ET AL., MEETING LOAD WITH A RESOURCE MIX BEYOND BUSINESS AS USUAL 9-10, 12, 14 (2013) (describing hydropower's contribution to system reliability).

[54] U.S. DEPT. OF HOMELAND SECURITY AND U.S. DEPT. OF ENERGY, *supra* note 50, at 8.

[55] United States Envtl. Prot. Agency, Sources of Greenhouse Gas Emissions, at http://www.epa.gov/climatechange/ghgemissions/sources.html (last visited September 27, 2013);

[56] Of course, if hydropower substitutes for other renewable sources or energy conservation, that advantage disappears.

[57] DOUGLAS G. HALL & KELLY S. REEVES, A STUDY OF UNITED STATES HYDROELECTRIC PLAN OWNERSHIP 1 (2006).

That percentage is somewhat misleading, for hydropower tends to be generated at larger dams, and most of the non-producing dams are relatively small.[58] Nevertheless, the huge number of dams that produce no hydropower has sparked widespread interest in increasing our hydropower capacity.[59] In addition to those dams, locks and other waterworks could be fitted with hydropower equipment, and dams with older turbines could be upgraded.[60] The extent to which those upgrades would be environmentally and economically feasible is a more difficult question—and also a question whose answer depends on the regulatory regime for, and economics of, other energy sources.[61] Nevertheless, a series of studies shows that even under existing regulatory and economic conditions, the power upgrades on some of the Penobscot River dams could be replicated elsewhere.[62]

The absence of hydropower at many existing dams underscores a larger point: some dams are less valuable than others, and some are not valuable at all. In addition to hydropower, many dams play valuable roles in storing water supplies, supporting recreation, and reducing floods. But other dams have long outlived their original purposes; the northeastern United States, for example, is filled with milldams that have long outlasted their mills.[63] Dams also become structurally obsolete as trapped sediment fills in their reservoirs and their structures decay.[64] Over time, these dams can turn into public hazards.[65] Others never made much sense, for the history of dam planning is filled with stories of pork-barrel boondoggles justified by fictitious cost-benefit analyses.[66] Despite that history, many

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[58] *See* U.S. DEPT. OF INTERIOR ET AL., at 38 ("All other things being equal, hydroelectric facilities become less expensive per unit of generation as they become larger.").

[59] *See, e.g.*, MWH, INC., ASSESSMENT OF POTENTIAL CAPACITY INCREASES AT EXISTING HYDROPOWER PLANTS (2010) (studying the potential for upgrades at dams managed by the United States Bureau of Reclamation); U.S. DEPT. OF THE INTERIOR ET AL., POTENTIAL HYDROELECTRIC DEVELOPMENT AT EXISTING FEDERAL FACILITIES (2007); DOUGLAS G. HALL ET AL., FEASIBILITY ASSESSMENT OF THE WATER ENERGY RESOURCES OF THE UNITED STATES FOR NEW LOW POWER AND SMALL HYDRO CLASSES OF HYDROELECTRIC PLANTS (2006).

[60] *E.g.* U.S. DEPT. OF THE INTERIOR ET AL., *supra* note 23, at App 9-1 (showing sites with favorable cost-benefit ratios; many are locks).

[61] *Id.* at 36 ("Numerous national studies of hydropower potential have reported thousands of undeveloped sites but ignore the economic and regulatory barriers that may confront those sites."); MWH, INC., *supra* note 59, at ES-2 (finding very modest potential for upgrades).

[62] A particularly optimistic estimate comes from a 2006 Department of Energy Study, which concludes that 130,000 new small or low-power hydro sites could be developed, resulting in 30,000 MW of new power supply. *See* HALL ET AL., *supra* note 59, at 35.

[63] THE HEINZ CENTER, DAM REMOVAL: SCIENCE AND DECISION MAKING 44-45 (2002) (documenting reasons for obsolescence).

[64] Stanley & Doyle, *supra* note 6, at 16.

[65] *See* WAYNE J. GRAHAM, A PROCEDURE FOR ESTIMATING LOSS OF LIFE CAUSED BY DAM FAILURE 1-10 (1999).

[66] *See* WORLD COMMISSION ON DAMS, DAMS AND DEVELOPMENT: A NEW FRAMEWORK FOR DECISION-MAKING ii (2000) ("T]his century we have collectively bought, on average, one large dam per day, and there have been precious few, if any, comprehensive,

dams continue to provide significant societal benefits, and others could be upgraded to serve more modern purposes.[67] But our present system of dams remains quite different from one optimally designed to serve contemporary needs.

For the legal field, the continued importance of dams has significant implications. In practice, at least, the law of dams has never really faded away. For decades, dams have been generating cases by the dozens, and hydropower licensing remains an important and active sub-field of energy and environmental law.[68] Nevertheless, while recent years have brought an energy law boom, academics and activists have focused primarily on wind, solar, and the enormous expansion in domestic oil and gas generation. One could easily form the impression that dams are nowhere near the cutting edge of energy law. But the continued prevalence of dams and the potential for upgrades—as well as pervasive problems with our existing dam systems—raise the possibility of a very different future, with major changes in our existing dam system helping hydropower reemerge as a dynamic and growing area of law.

B. The Adverse Impacts of Dams

While the conventional story of dams may miss their potential to be a dynamic and growing source of relatively carbon-free energy, there is another important respect in which that story is spot-on. Dams cause enormous environmental harms.[69]

Dams impact aquatic systems in many ways. Most obviously, most dams flood land behind the dam.[70] Dams also affect downstream flow, particularly if the flow schedule is governed by hydropower or other human

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independent analyses as to why dams came about, how dams perform over time, and whether we are getting a fair return from our $2 trillion investment.”). *See also* REISNER, *supra* note 11; ZYGMUNT J.B. PLATER, THE SNAIL DARTER AND THE DAM: HOW PORK-BARREL POLITICS ENDANGERED A LITTLE FISH AND KILLED A RIVER (2013).

[67] Sometimes, however, removals cost less than upgrades. HEINZ CENTER, *supra* note 63, at 44.

[68] The frequency with which dams appear on the United States Supreme Court’s limited docket provides one indicator of that importance. Arkansas Game and Fish Com’n v. U.S., 133 S.Ct. 511 (2012); PPL Montana, LLC v. Montana, 132 S.Ct. 1215 (2012); South Carolina v. North Carolina, 558 U.S. 256 (2010); S.D. Warren Co. v. Maine Bd. of Environmental Protection, 547 U.S. 370 (2006); PUD No. 1 of Jefferson County v. Washington Dept. of Ecology, 511 U.S. 700 (1994), and a long list of interstate water disputes. In all of these cases, dam operations were directly at issue.

[69] *See generally* MICHAEL COLLIER ET AL., DAMS AND RIVERS: A PRIMER ON THE DOWNSTREAM EFFECTS OF DAMS (1996). Dam construction also can be a major human rights issue. *See generally* Donald K. Anton & Dinah Shelton, *Problems in Human Rights and Large Dams* (2011) (unpublished manuscript at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1873030).

[70] According to Collier et al., reservoirs cover approximately three percent of the United States’ land area. *Id.* at 2; *see also* Tarlock, *supra* note 11, at 1737.

needs.[71] The annual hydrograph of a dam-managed river is often quite different from an undammed stream, and those fluctuations can wreak havoc on downstream species that have adapted to a natural flow regime.[72] Dams also can decrease the aggregate amount of water flowing downstream, both because of evaporation and because many dams operate in conjunction with off-stream water supply projects.[73] And dams can starve downstream reaches of sediment, which again can dramatically alter downstream habitats.[74]

All of those impacts are pervasive, but perhaps the most significant ecological impact of dams is to limit the movement of aquatic species. Many rivers play important roles in the life-cycle of diadromous species, like salmon or shad, which migrate between fresh and salt water.[75] Those species in turn can play central roles in the ecology of river systems, both by providing prey for other species and by moving huge quantities of nutrients between oceans and rivers.[76] By blocking access to habitat, dams can devastate those species' populations, with ripple effects on all the other species—including humans—that depend on their migrations.[77] Resident species—that is, species that do not migrate out of the river system—also can be adversely affected by dams. Barriers can prevent these species from migrating in response to habitat stress or seasonal changes, and they can promote inbreeding within isolated populations.[78] When a portion of a watershed loses its population of a species to disease or some other disturbance, barriers can prevent repopulation from areas where the species has survived.[79]

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[71] *See generally* Stuart E. Bunn & Angela H. Arthington, *Basic Principles and Ecological Consequences of Altered Flow Regimes for Aquatic Biodiversity*, 30 ENVTL. MGMT. 492 (2002).

[72] *See* Poff & Hart, *supra* note 40, at 660.

[73] *See, e.g.*, Natural Resources Defense Council v. Patterson, 333 F. Supp. 2d 906, 908-12 (E.D. Cal. 2004) (describing how the Friant Dam and associated diversions dried out the San Joaquin River).

[74] *See, e.g.*, COLLIER ET AL., *supra* note 69, at 24-37, 58-79 (describing effects of sediment entrapment).

[75] For a summary of different types of diadromous life cycles, see JOHN WALDMAN, RUNNING SILVER: RESTORING ATLANTIC RIVERS AND THEIR GREAT FISH MIGRATIONS 8 (2013).

[76] *Id.* at 15-17; DAVID MONTGOMERY, THE KING OF FISH: THE THOUSAND-YEAR RUN OF SALMON 29 (2003) ("Trees growing along salmon-bearing streams grow up to three times faster than those growing along salmon-free streams.").

[77] The impacts can affect even sedentary species, like mussels, that rely on migratory fish as vectors for movement. WALDMAN, *supra* note 75, at 128.

[78] *See, e.g.*, Lukas P. Neraas & Paul Spruell, *Fragmentation of Riverine Systems: the Genetic Effects of Dams on Bull Trout (Salvelinus confluentus) in the Clark Fork River System*, 10 MOLECULAR ECOLOGY 1153 (2001); Poff & Hart, *supra* note 40, at 660.

[79] *See, e.g.*, Kentaro Morita & Shoichiro Yamamoto, *Effects of Habitat Fragmentation by Damming on the Persistence of Stream-Dwelling Charr Populations*, 16 CONSERVATION BIOLOGY 1318 (2002) (finding an increased likelihood of extirpation for isolated populations).

The scale of these impacts has been profound. To provide one example, a single board blocking a fish ladder on Maine's St. Croix River caused a migratory population of alewives to drop from 2.6 million to 900 fish in the span of just seven years.[80] That story is not unique, and the aggregate impact of tens of thousands of migration barriers is sufficiently pervasive that few people even realize how productive many river systems once were.[81] Before the industrial revolution, East Coast fish runs were so abundant that, in one explorer's creative phrasing, "it seemed to mee, that one might goe over their backs drishod."[82] Even as late as 1832, the Potomac River shad catch was over fifty-one *million* kilograms.[83] The demise of the East Coast runs initially generated conflicts—fought with guns as well as petitions and legal briefs—and in the time of the United States' founding fathers, legal battles over fish passage were recurring phenomena (and phenomena in which the founding fathers themselves participated).[84] But outside of a few relic runs, that abundance has long since been lost, not just to river systems but also to cultural memory.[85] On the West Coast, where dams came later, some cultural memories remain, but migratory fish still have gone from storied abundance to chronic endangerment.[86] The changes aren't limited to iconic migrants, or even to fish. Aquatic freshwater species now are more likely to be listed as threatened or endangered than any other class of species, and dams and diversions are among the largest threats to their survival.[87]

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[80] Colin Woodard, EPA Orders State: Open St. Croix to Alewives, PORTLAND PRESS HERALD, July 11, 2012, at A1.

[81] *See* Poff & Hart, *supra* note 40, at 660 ("Dams occur so frequently in many watersheds that the cumulative ecological effects are likely to be profound."). For discussion of the impacts of culverts—and the legal repercussions of those impacts—see United States v. Washington, 2013 WL 133491 (D. Wash. 2013).

[82] WALDMAN, *supra* note 75, at 2 (compiling similar quotations, many wonderfully overwritten). This particular quote comes from a letter written by Captain John Smith.

[83] Karen E. Limburg & John A. Waldman, *Dramatic Declines in North American Anadromous Fisheries*, 59 BIOSCIENCE 955, 959 (2009).

[84] Waldman, *supra* note 75, at 83-95; *see generally* John F. Hart, *Fish, Dams, and James Madison: Eighteenth-Century Species Protection and the Original Understanding of the Takings Clause*, 63 MD. L. REV. 287, 292-306 (2004); American Rivers et al., Supplemental Historic Records Related to the Anadromous Fisheries of the Presumpscot River and Sebago Lake, Maine (2002) (describing legal battles and physical fights).

[85] *See* WALDMAN, *supra* note 75, at 63-71 (discussing the implications of this loss).

[86] *See generally* JIM LICHATOWICH, SALMON WITHOUT RIVERS: A HISTORY OF THE PACIFIC SALMON CRISIS (1999).

[87] *See* David S. Wilcove et al., Quantifying Threats to Imperiled Species in the United States, 48 BIOSCIENCE 607, 610 (1998) ("Ninety-one percent of endangered fish and 99% of endangered mussels are affected by water development."); Brian D. Richter et al., *Threats to Imperiled Freshwater Fauna*, 11 CONSERVATION BIOLOGY 1081, 1082 (2003) ("By virtually any measure, a large proportion of the world's freshwater fauna appears vulnerable to extinction.").

Of course, not all of the environmental impacts are negative. Some popular sport species thrive in dam-altered environments.[88] Dams can prevent the migration of invasive as well as native species.[89] Reservoirs allow flatwater boating, and altered flows also can support recreation in downstream areas where summer flows otherwise would be too low.[90] Finally, to the extent that hydropower obviates the need to burn oil, natural gas, or coal, dams provide an important environmental benefit to river systems, for climate change also ranks high as a threat to freshwater ecosystems.[91] In short, dams present environmental tradeoffs, and sometimes environmental damage is in the eye of the beholder. Nevertheless, there is little debate that the environmental impact of many dams, both individually and cumulatively, is profoundly negative.[92]

One consequence of these impacts has been to generate interest in dam removal. Twenty-five years ago, the idea was largely a novelty, though occasional dam removals have occurred throughout American history.[93] But beginning in the 1990s, the idea went mainstream.[94] Hundreds of dams have come out, and while most of the removals have involved small structures, a few medium-sized dams have recently been removed.[95] The trend is still a minor one; while dam removals tend to grab attention, only a small percentage of the United States dams has actually come out.[96] Dam removal also is not a panacea, for removals are unlikely to completely restore rivers to their prior condition.[97] But the improvements are often fast and dramatic.[98] Consequently, even if dam removal remains an incomplete and, to date, relatively rare approach to

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[88] Donald C. Jackson & Gerd Marmulla, The Influence of Dams on River Fisheries, in DAMS, FISH, AND FISHERIES: OPPORTUNITIES, CHALLENGES AND CONFLICT, at 1, 30 (Gerd Marmulla, ed. 2001) (describing dam-dependent recreational fisheries).

[89] P.S. Kemp & J.R. O'Hanley, Procedures for Evaluating and Prioritising the Removal of Fish Passage Barriers: A Synthesis, 17 FISHERIES MGMT. & ECOLOGY 297, 316 (2010).

[90] *See, e.g.*, Collier et al., *supra* note 69, at 42 (noting that recreational users of Georgia's Lake Sydney Lanier "spent $422 million recreating here in 1990").

[91] *See* Ashley D. Ficke et al., Potential Impacts of Global Climate Change on Freshwater Fisheries, 17 REV. IN FISH BIOLOGY AND FISHERIES 581 (2007).

[92] *See generally* WALDMAN, *supra* note 75 (discussing these impacts).

[93] Hart, *supra* note 84, at 289 ("Occasionally dams were ordered to be torn down altogether because they were found to be incompatible with fish passage.").

[94] See generally Klein, *supra* note 11 (describing the United States' shift away from the dam-building era).

[95] HEINZ FOUNDATION, *supra* note 63, at 50 ("Almost all dams removed thus far have been small ones…"); Blumm & Erickson, *supra* note 35 (describing major dam removal projects in the Pacific Northwest).

[96] To date, American Rivers has documented 925 dam removals, which would represent approximately one percent of the total number of dams in the Army Corps of Engineers' inventory. *See* American Rivers, Questions About Removing Dams, at http://www.americanrivers.org/initiatives/dams/faqs/ (last visited November 25, 2013). However, American Rivers cautions that it is "still in the process of gathering data." *Id.*

[97] *See* Stanley & Doyle, *supra* note 6, at 15.

[98] *See* Kemp & O'Hanley, *supra* note 89, at 303 ("The well-planned removal of barriers can be a highly effective means of river restoration….").

environmental restoration, it still holds transformative potential for many river systems.

To date, those removals have been largely opportunistic; rarely have dams come out pursuant to some larger plan.[99] But impacts vary significantly from dam to dam, and that variance creates opportunities for prioritization.[100] Obviously size matters, and a large dam generally will have greater impacts than a smaller one.[101] Location also is important. A dam near a natural fish barrier, or upstream of another dam, will do less ecological damage than one that blocks access to many miles of habitat.[102] The design of dams also is important. For example, some have better fish passage systems than others, and some have no fish passage at all.[103] Similarly, a dam operated in run-of-the-river mode[104] will generally have lower impacts than one that creates a large reservoir as it retains inflows.[105] Finally, the extent to which the dam alters the downstream flow regime can make a substantial difference, and mimicking the natural flow regime can reduce, though not eliminate, some of a dam's adverse effects.[106] Consequently, when engineers consider where and how to build dams, or when regulators consider where to require fish passage, flow changes or dam removals, there are significant differences between the environmental impacts of alternative proposals.[107]

C. The Legal Regime

The central point of the preceding discussion is that our system of dams is enormous, influential, and haphazardly matched to modern societal

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[99] *See generally* HEINZ CENTER, *supra* note 63, at 40-53 (discussing typical reasons for dam removal).

[100] *See generally* Poff & Hart, *supra* note 40 (discussing ways dams differ).

[101] *See generally* Lea Kosnik, The Potential for Small Scale Hydropower Development in the U.S., 38 ENERGY POL'Y 5512 (2010). *But see* Tasneem Abbasi & S.A. Abbasi, Small Hydro and the Environmental Implications of its Extensive Utilization, 15 RENEWABLE AND SUSTAINABLE ENERGY REV. 2134 (2011) (arguing that the environmental arguments for small hydropower facilities overlook the cumulative impacts of building many such facilities).

[102] *See* Kemp & O'Hanley, *supra* note 89, at 302-06.

[103] For detailed discussion of fish passage systems, see Carl R. Schilt, *Developing Fish Passage and Protection at Hydropower Dams*, 104 APPLIED ANIMAL BEHAVIOUR SCI. 295 (2007).

[104] A run-of-the-river dam lacks a significant impoundment and makes minimal changes to the amount or timing of water flowing downstream.

[105] *See* Poff & Hart, *supra* note 40, at 661 (describing run-of-the-river dams); *see generally* KARIN KRCHNAK ET AL., INTEGRATING ENVIRONMENTAL FLOWS INTO HYDROPOWER DAM PLANNING, DESIGN, AND OPERATIONS (2009). This generalization might not apply, however, to a run-of-the-river dam that diverts water from a relatively long reach.

[106] *See generally* Brian D. Richter & Gregory A. Thomas, Restoring Environmental Flows by Altering Dam Operations, 12 ECOLOGY AND SOC'Y (2007).

[107] *See generally* Kemp & O'Hanley, *supra* note 89 (describing research on dam removal prioritization).

needs. Ideally, our response would be a broad program of dam reform, in which many dams come out and others are re-operated to produce different benefits—including, sometimes, more hydropower—and in which those adjustments follow careful planning efforts designed to identify the best places for changes. The extent to which that response can occur, however, depends partly upon law, and this section therefore reviews the laws of dams. It is necessarily a brief overview, for these laws are much too complex to describe in detail in a few pages. Nevertheless, even this brief summary should illustrate two overarching points. First, key parts of existing law create a strong bias toward the status quo, and against any actions that would either generate new hydropower or lead to dam removals. Second, while the system *allows* systemic reassessment of dams, it does almost nothing to *compel* such analysis. It is, in short, a system suited primarily for sporadic, ad-hoc adjustments.

1. Federally-Regulated Hydropower Dams

The most extensive legal regime applies to hydropower dams that are licensed by the Federal Energy Regulatory Commission (FERC).[108] FERC has jurisdiction over all hydroelectric dams located on waterways to which federal commerce clause or public lands authority extends.[109] Only a small percentage of dams meet those criteria; because most dams do not generate hydropower, they fall outside FERC's jurisdiction, as do the dams that the federal government itself owns.[110] Nevertheless, hydropower dams are often relatively big, and FERC-regulated dams therefore produce a disproportionate share of social benefits and environmental costs.[111]

The core statute governing FERC's hydropower licensing authority is the Federal Power Act.[112] The FPA contains detailed procedural

[108] A possible exception to that claim is the set of dams governed by the Pacific Northwest Electric Power Planning and Conservation Act, which governs hydroelectric dams on the Columbia River and its tributaries. *See* 16 U.S.C. §§ 839-839h (2006). Detailed discussion of that act is beyond the scope of this paper, but for a useful summary, see Northwest Power and Conservation Council, Power Act: Summary, http://www.nwcouncil.org/reports/poweract/summary (last visited December 13, 2013).

[109] 16 U.S.C. § 797(e) (2006); *see also* 16 U.S.C. § 817 (2006) (allowing construction, without a FERC license, of hydroelectric facilities on waterways to which the federal commerce and lands powers do not extend, but only after notice to FERC). FERC may exempt hydropower projects with less than 10 MW generating capacity from some of the FPA's requirements. 16 U.S.C. § 2705 (2006).

[110] *See supra* notes 57-58 and accompanying text.

[111] FERC-regulated dams tend to be larger than non-hydropower dams and smaller than federally owned dams. *See* Hall & Reeves, *supra* note 57, at v.

[112] 16 U.S.C. §§ 791-828c (2006); See J.R. DeShazo & Jody Freeman, Public Agencies as Lobbyists, 105 COLUM. L. REV. 2217, 2235-36, 2258-60 (2005) (describing passage of the statute and later amendments).

provisions setting forth the requirements for licensing processes,[113] defines the substantive standards FERC must use to evaluate license applications,[114] and also defines the boundaries between state and federal authority over hydropower systems.[115] For decades, FERC interpreted and applied those provisions in ways that favored strong federal authority and expanding hydropower, and the agency was widely perceived as closely aligned with—perhaps captured by—the industry it was charged with regulating.[116] Congress often encouraged that alignment. Even in the 1970s, after the dawn of the environmental law era, an energy-hungry Congress continued to create incentives for aggressive hydropower development.[117]

In the 1970s and 1980s, however, the tide began to turn, and a series of legal changes turned the FPA into a more environmentally protective statute.[118] Some of those changes were internal to the FPA. Congress made environmental protection one of the core goals of the licensing process, and it also empowered other government agencies to demand that FERC condition licenses upon environmental protection measures, including the installation of facilities to allow fish passage.[119] Some derived from other environmental statutes. Most importantly, FERC must comply with the National Environmental Policy Act, which requires detailed assessments of the environmental impacts of licensing decisions;[120] the Endangered Species Act, which prohibits FERC from approving actions that would "jeopardize" the continued existence of protected species or adversely modify their "critical habitat," and also limits "take" of protected species;[121] and section 401 of the Clean Water Act, which obligates license applicants to obtain certifications that their proposed operations will be consistent with

[113] *See* 16 U.S.C. §§ 800 (2006) (setting procedures for preliminary licenses), 802 (informational requirements for license applications), 808 (license renewals), 820 (license revocations).

[114] *See* 16 U.S.C. §§ 797(e), 803 (2006),

[115] *See*, *e.g.*, 16 U.S.C. § 821 (2006); California v. F.E.R.C., 495 U.S. 490, 497, 506 (1990) (concluding that section 821 preserves state authority over water rights but not state authority to require instream flows).

[116] *See* DeShazo & Freeman, *supra* note 112, at 2236-41.

[117] *Id.* at 2243 ("A biologist working at FERC at the time described the package of incentives as a license to print money for hydropower.").

[118] *Id.* at 2252-63; Michael C. Blumm & Viki A. Nadol, *The Decline of the Hydropower Czar and the Rise of Agency Pluralism in Hydroelectric Licensing*, 26 COLUM. J. ENVTL. L. 81 (2001).

[119] Electric Consumers Protection Act of 1986, Pub. L. No. 99-495, § 3(a) (codified as amended at16 U.S.C. §§ 797(e) (2006)) (granting federal land management agencies authority to impose conditions for projects located within their reservations), 803(j) (allowing the FWS and NMFS to request conditions designed "to adequately and equitably protect, mitigate damages to, and enhance, fish and wildlife"); 811 ("The Commission shall require… such fishways as may be prescribed by the Secretary of the Interior or the Secretary of Commerce, as appropriate."). In theory, FERC was obligated to consult with other agencies prior to 1986, but "it did so rather half-heartedly, at best." DeShazo & Freeman, *supra* note 112, at 2222-23.

[120] 42 U.S.C. § 4332(C) (2006).

[121] 16 U.S.C. §§ 1536, 1538 (2006).

state water quality standards.[122] FERC initially resisted these requirements, but federal court decisions in the 1980s and 1990s made clear that each was mandatory.[123] These requirements give environmental regulators and advocates ample influence on licensing, and sometimes that influence produces dramatic changes.[124] Nearly every FERC license includes conditions designed to provide environmental protection, and occasionally the proposed conditions are sufficiently costly that dam owners elect to cease operation—or, at least, to enter negotiations over possible dam removals.[125]

Nevertheless, there are other ways in which the FERC process limits environmental regulators' and activists' leverage. Perhaps the most important is the duration of the licenses. FERC typically issues licenses for forty-year terms, and sometimes for longer.[126] While some legal obligations apply throughout the term of the license, and while FERC often includes "reopener" clauses allowing it to initiate proceedings to adjust the license terms,[127] the federal agency action necessary to trigger CWA section 401, NEPA, or section 7 of the ESA is absent in the period between licensing proceedings.[128] The FPA's relicensing requirements also favor the status quo in other ways. If a license expires without being replaced—which can happen if the relicensing proceeding becomes protracted—the default outcome is to replace the old license with a one-year license on the same terms.[129] That provides licensees with a favorable fallback option, particularly if, as is often the case, the proposed new license is likely to have more environmentally restrictive terms. Similarly, in 2005, Congress amended the FPA's procedural requirements to allow licensees to request

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[122] 33 U.S.C. § 1341 (2006); *see* PUD No. 1 of Jefferson Cnty. v. Wash. Dept. of Ecology, 511 U.S. 700, 722-23 (1994).

[123] *E.g. PUD No. 1 of Jefferson Cnty*; Escondido Mutual Water Co. v. La Jolla Band of Mission Indians, 466 U.S. 765, 772 (1984) (holding that FERC must include in its licenses conditions imposed pursuant to FPA section 4(e)); American Rivers v. F.E.R.C., 201 F.3d 1186, 1206-11 (9th Cir. 1999) (holding that FWS's and NMFS' fishway prescriptions are mandatory).

[124] *See generally* DeShazo & Freeman, *supra* note 112 (documenting the effectiveness of lobbying by other agencies).

[125] *See, e.g.*, Jeff Crane, *"Setting the river free": The Removal of the Edwards dam and the Restoration of the Kennebec River*, 1 WATER HIST. 131, 135-43 (2009).

[126] 16 U.S.C. § 799 (2006) ("Licenses under this subchapter shall be issued for a period not exceeding fifty years.").

[127] *See* FEDERAL ENERGY REGULATORY COMMISSION, HYDROPOWER LICENSING AND ENDANGERED SPECIES: A GUIDE FOR APPLICANTS, CONTRACTORS, AND STAFF 53 (2001) (providing a standard "reopener" clause for fish and wildlife protection).

[128] *See* California Sportfishing Protection Alliance v. F.E.R.C., 472 F.3d 593, 594-95 (9th Cir. 2006) (concluding that despite the existence of a "re-opener clause," ongoing operations under a valid FERC license did not require consultation).

[129] 16 U.S.C. § 808(a)(1) (2006).

evidentiary hearings on proposed fish-protection conditions.[130] The apparent intent of these amendments was to make the imposition of environmental constraints more procedurally difficult for the regulating agencies.[131] Preliminary anecdotal evidence suggests that Congress succeeded in achieving that goal.[132]

The net result of all of these legal provisions (and others not summarized here) has been to turn FERC licensing into one of the most complex processes in all of environmental law. To try to rationalize and accelerate the process, and to provide a better format for integrating input from the many other agencies, advocacy groups, and members of the public that typically participate, FERC has developed an "alternative licensing process" and, more recently, an "integrated licensing process."[133] FERC also encourages stakeholders to reach settlements before the formal FERC proceeding begins.[134] But even with those innovations, the process can be contentious and long. FERC demands that licensees begin preparing for relicensing at least five years before the old license's expiration date, and many licensing processes take at least that long.[135] These legal changes also have changed FERC's role. Once widely perceived as an active promoter of the hydropower industry, FERC now often occupies a role more akin to a judge trying facilitate a settlement in a complex civil case.[136] It rarely imposes its own vision on the proceedings, and instead now occupies a largely reactive and facilitative role.[137]

That complexity has contributed to another distinctive feature of the FERC licensing process. FERC tends to make decisions one project at a

[130] *See* 16 U.S.C. §§ 797(e), 811 (2006) (creating an entitlement "to a determination on the record, after opportunity for an agency trial-type hearing of no more than 90 days, of any disputed issues of material fact with respect to" conditions or fishway requirements).

[131] *See* Adell Louise Amos, *Hydropower Reform and the Impact of the Energy Policy Act of 2005 on the Klamath Basin: Renewed Optimism or Same Old Song?*, 22 J. ENVTL. L. & LITIGATION 1, 9-13 (2007).

[132] *See id.* at 27-29 (describing the hearings for the Klamath project).

[133] FEDERAL ENERGY REGULATORY COMMISSION, OFFICE OF ENERGY PROJECTS, IDEAS FOR IMPLEMENTING AND PARTICIPATING IN THE INTEGRATED LICENSING PROCESS (ILP) (2011); INTERAGENCY TASK FORCE ON IMPROVING HYDROPOWER LICENSING PROCESSES, GUIDELINES TO CONSIDER FOR PARTICIPATING IN THE ALTERNATIVE LICENSING PROCESS (2000).

[134] FEDERAL ENERGY REGULATORY COMMISSION, POLICY STATEMENT ON HYDROPOWER LICENSING SETTLEMENTS ¶ 2 (2006) ("[T]he Commission looks with great favor on settlements in licensing cases.").

[135] FEDERAL ENERGY REGULATORY COMMISSION, APPLICATIONS FOR NEW LICENSES (Relicenses), http://www.ferc.gov/industries/hydropower/gen-info/licensing/app-new.asp ("At least 5 years before a license expires, the licensee must file a notice of intent declaring whether or not it intends to seek a new license (relicense) for its project.").

[136] *See generally* Blumm & Nadol, *supra* note 118 (documenting the historical and legal context of this shift).

[137] We based this assertion on our own experience and on informal discussions with experienced hydropower attorneys.

time.[138] The FPA doesn't mandate that approach; in fact, it specifically states that FERC's should approve only projects that "will be best adapted to a comprehensive plan for improving or developing a waterway or waterways…."[139] With the consent of a license applicant, FERC also will occasionally consolidate multiple licensing proceedings.[140] But FERC has essentially rejected its planning mandate, with the acquiescence of the courts,[141] and multi-project proceedings, while not unheard of, are rare.[142] The usual consequence is project-by-project decision-making.[143]

2. Federally Owned Dams

While the FERC regulatory process dominates the legal-academic literature on dams, the federal government also owns dams, and those dams are beyond FERC's jurisdiction.[144] Between them, seven federal agencies own 171 hydroelectric dams.[145] Many of these dams are among the nation's largest—collectively, they contain just over 50% of the nation's hydroelectric capacity—and they have some of the farthest-reaching environmental and non-environmental effects.[146] They also are subject to a very different legal regime.

The authorizing statute for each dam provides the primary legal blueprint for its management, with subsequent water resource development acts providing additional overlays. Those blueprints can be complex, often

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[138] There are rare exceptions to this generalization. *See infra* note 219 and accompanying text.

[139] 16 U.S.C. § 803(a)(1) (2006). Some other agencies that participate in relicensing processes also have planning mandates, and those plans could provide broader frameworks for dam decisions. *See, e.g.*, 16 U.S.C. 1533(f) (2006) (providing for endangered species recovery plans).

[140] *See, e.g.*, Great Lakes Hydro America, LLC Public Service Company of New Hampshire, 102 FERC 61018, 61028 (Jan. 9, 2003) (describing a consolidated proceeding).

[141] *See* D.H. Cole, *Reviving the Federal Power Act's Comprehensive Plan Requirement: A History of Neglect and Prospects for the Future*, 16 ENVTL. L. 639, 652-61 (1986).

[142] As of November 25, 2013, a search of Westlaw's database of FERC decisions for the term "consolidated licensing proceeding" produced eleven hits. Other decisions may use different terms, and this number therefore probably understates the number of consolidated proceedings, but it nevertheless indicates their rarity.

[143] Many key FERC documents do not even mention the possibility of more comprehensive proceedings. *See, e.g.*, FEDERAL ENERGY REGULATORY COMMISSION, HANDBOOK FOR HYDROELECTRIC PROJECT LICENSING AND 5 MW EXEMPTIONS FROM LICENSING (2004) (containing no mention of consolidated proceedings).

[144] *See* 16 U.S.C. § 817 (2006) (requiring "any person, State, or municipality" constructing a hydroelectric facility on navigable waterways to obtain a license, but not extending that requirement to other federal agencies).

[145] HALL & REEVES, *supra* note 57, at 8. Two agencies—the Army Corps of Engineers and the Bureau of Reclamation—own over three quarters of those dams. *Id.*.

[146] *See id.* at 2.

specifying multiple purposes for management of the dam.[147] What they generally do not do, however, is create administrative processes for reconsidering dam operations. Federally owned dams therefore are not subject to a process like FERC relicensing, and the leverage that the FPA supplies to other agencies and to environmental advocates is missing. Similarly, Clean Water Act section 401, which supplies states with significant leverage over FERC-regulated projects, does not apply.[148]

That does not mean federally owned dams are free of regulatory constraint. In addition to authorizing legislation, other federal statutes, like the Endangered Species Act and NEPA, do still apply.[149] Indeed, ESA obligations provide one of the primary legal levers that advocates can use to compel changes in federal dam management, and on ongoing dispute on California's Yuba River, where the National Marine Fisheries Service (NMFS) recently attempted to compel a massive fish passage project, illustrates the possibilities.[150] Congress also has often authorized, if not clearly obligated, changes designed to mitigate the adverse environmental effects of federal water projects.[151] But the absence of a relicensing process with a regulatory overseer creates a very different, and often weaker, leverage structure than exists for FERC-regulated dams.

Because of these differences, environmental advocates and regulators generally have less influence—though they do have some—over federally owned dams than they do over federally-regulated dams. That disparity in influence also can produce some interesting side-effects. On some river systems, the first dam anadromous fish encounter as they migrate upstream is a federally owned dam, and upstream from that dam is a series of FERC-regulated dams. In that circumstance, the federally owned dam can serve as a partial regulatory shield, keeping protected fish populations, and the legal obligations that come with them, from reaching the upstream dams.

3. State-Regulated Dams

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[147] *See, e.g.*, *In re* MDL-1824 Tri-State Water Rights Litig., 644 F.3d 1160, 1167-78 (11th Cir. 2011) (describing the complex historical and legal saga of the Buford Dam).

[148] 33 U.S.C. § 1341(a) (2006) (extending coverage only to projects that receive "a Federal license or permit").

[149] These laws apply because they are triggered by discretionary federal actions, and altering dam operations, which dam managers must do from time to time, involves discretion.

[150] *See* NMFS, Pacific Southwest Region, Biological Opinion for the Continued Operation and Maintenance of Englebright Dam and Reservoir, Daguerre Point Dam, and Recreational Facilities on and around Englebright Reservoir 220 (2012) (demanding fish passage at two major dams on California's Yuba River). This biological opinion was later withdrawn, but the controversy continues. *See* South Yuba River Citizens League v. NMFS, Slip Copy, 2013 WL 4094777 (E.D. Cal. 2013) (describing the status of the biological opinion and subsequent litigation).

[151] *See, e.g.*, 33 U.S.C. § 2309a (2006) (providing that authorization).

The legal literature on dams focuses overwhelmingly on those regulated or, to a much lesser extent, owned by the federal government, and in practice, those dams generate much of the controversy and litigation. There are obvious reasons for that focus; the largest and most heavily regulated dams generally fall within these groups, and advocates are sensible to focus their efforts where they can exert the most leverage.[152] But over 97% of dams are neither owned by the federal government nor regulated by FERC, and while their collective impacts may not rise to the level of the federal behemoths, those impacts still are significant.[153] No synopsis of dam regulation would be complete, therefore, without some discussion of state law.

Providing that discussion is difficult, however, because of two factors. First, dam laws vary from state to state, as do the financial and administrative resources that states devote to implementing their dam laws. Second, while a few studies summarize the dam laws of individual states, no comprehensive state-by-state guide to the environmental law of dams exists.[154] There are good and recent studies of state dam safety laws and of the treatment of hydropower in state renewable portfolio standards, but our discussion of the environmental regulation of dams is based largely on a review of the dam laws of a select set of states.[155]

Despite these caveats, even a partial review of state dam laws supports a few generalizations. The first is that state environmental regulation of *existing* dams is generally quite lax.[156] None of the states we reviewed had a re-licensing requirement analogous to that created by the FPA.[157] Moreover, we identified few other procedural or substantive levers to compel reconsideration of the impacts of existing dams.[158] Instead, in

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[152] Not all hydroelectric dams are large. *See* HALL ET AL., *supra* note 59, at 7 ("[T]he vast majority of hydroelectric plants are small or very small plants.").

[153] *See supra* notes 69-87 and accompanying text.

[154] *See, e.g.,* Jason J. Kelroy, Comment: *Can We Get that Dam Thing out of Here: An Analysis of Potential Dam Removal Options in Wisconsin*, 5 WISC. ENVTL. L. J. 187 (1998).

[155] We focused on Georgia, Maine, Montana, Oregon, Pennsylvania, Texas, and Wisconsin. We chose Georgia and Texas because they have large numbers of dams (Texas has more than any other state) and high levels of aquatic biodiversity. Montana and Oregon both have relatively abundant dams, significant hydropower capacity, and significant fishery resources. Wisconsin and Pennsylvania both have reputations as leaders in the field of dam removal. Finally, TNC studies show that Maine has very high potential as a focal area for dam removal projects, and, more parochially, we live there.

[156] *See generally* Georgia Safe Dams Act of 1978, GA. CODE. ANN. §§ 12-5-370-385 (1990); ME. REV. STAT. ANN., tit. 38, § 636 (2011) (requiring environmental review of new hydroelectric dams in Maine, but not existing ones)

[157] *E.g.* Kelroy, *supra* note 154, at 197 (discussing Wisconsin law).

[158] *See, e.g., id.* at 192 (noting the Wisconsin Department of Natural Resources' limited authority to regulate already-built dams). A limited exception to this generalization comes from Maine, where the commissioner of the Department of Marine Resources may require fish passage for dams on waterways "frequented by… migratory fish species." ME. REV. STAT. ANN. tit. 12, § 12760 (2011).

most states, a dam, once built, is grandfathered from the requirements of environmental laws.[159] Many of those dams were constructed before significant environmental laws existed—or, at least, before those laws were acknowledged and enforced—and the environmental laws of many states therefore have never really applied to most of those states' dams.[160] Indeed, in many states, the only way environmental laws would be triggered is if a dam owner proposes to do something different with a dam—like, for example, add hydropower capacity or take the dam out.[161]

On paper, state regulation of dam safety is more robust. Most states have safety standards and laws requiring periodic inspection of dams, and safety reviews ought to present opportunities to reexamine the operations or even existence of dams.[162] But on closer examination, those schemes also often appear—in the words of one leading expert—"pitiful."[163] Maine, for example, has robust requirements for dam inspections, but has never adequately funded the inspection program.[164] Texas recently passed legislation exempting many dams from its inspection program, and Texas law, at least as currently interpreted, also limits the public's ability to even access information about dam hazards.[165] Many other states face similar circumstances.[166] Dams do age and fail, but smaller dam owners in many states are all but legally invisible, so long as nothing goes drastically wrong. Indeed, there are thousands of state-regulated dams whose owners aren't even known.[167]

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[159] *See, e.g.*, GA. CODE ANN., § 12-3-375 (requiring periodic "re-inventories" of dams, but making no mention of environmental review).

[160] *See, e.g.*, Karrigan S. Bork et al., *The Rebirth of California Fish & Game Code Section 5937: Water for Fish*, 45 U.C. DAVIS L. REV. 809, 817-44 (2012) (chronicling years of non-implementation of California's fish passage law).

[161] *See*, *e.g.*, GA. CODE ANN. § 12-5-377(a) ("It shall be unlawful for the owner or operator of any dam for which a permit is required by this part to remove the dam without the approval of the director."); Save Our Sebasticook, Inc. v. Bd. of Envtl. Prot., 928 A.2d 736, 740-41 (Me., 2007) (citing state law that limits dam owners' ability to make flow changes).

[162] *See generally* ASSOCIATION OF AMERICAN DAM SAFETY OFFICIALS, SUMMARY OF STATE LAWS AND REGULATIONS ON DAM SAFETY (2000).

[163] Naomi Schalit & John Christie, *Maine's High-Hazard Dams Lack Inspection*, BANGOR DAILY NEWS, August 24, 2011 (quoting University of Hawaii civil engineering professor Peter Nicholson).

[164] ME. REV. STAT. ANN. tit. 37-B § 1113 (requiring inspections); Schalit & Christie, *supra* note 163.

[165] Mose Buchele, *How Hundreds of 'Significant Hazard' Dams Escape Inspection in Texas*, STATEIMPACT TEXAS, October 15, 2013, at http://stateimpact.npr.org/texas/2013/10/15/how-hundreds-of-significant-hazard-dams-escape-state-inspection/; Mose Buchele, *Want to Learn About a Nearby Dam? In Texas, Some Questions Are Off Limits*, STATEIMPACT TEXAS, October 16, 2013.

[166] *See* American Society of Civil Engineers, 2013 Report Card for America's Infrastructure: Dams: Conditions and Capacity, http://www.infrastructurereportcard.org/a/#p/dams/conditions-and-capacity.

[167] THE HEINZ CENTER, *supra* note 63, at 31 (classifying the ownership status of 14.8% of the dams in the Army Corps' database as "undetermined").

Despite the prevalence of laissez-faire regimes, there are some incentives for reducing the environmental and safety impacts of dams. In most states, a dam owner faces tort liability if his dam fails, or if a boater is injured by a deteriorating dam structure.[168] The United States has a long tradition of passing laws designed to promote fish passage—in some areas, those laws predated statehood—and while those laws were often observed largely in the breach, a few court decisions have given them significant effect.[169] And some states have created legal mechanisms and offices devoted to helping dam owners move through the removal process, or to allowing the state to assume responsibility for abandoned dams.[170] But those programs are rare—unless one counts laws empowering government agencies to dynamite beaver dams[171]—and state dam regulation on the whole remains rather limited. Consequently, quite often the most procedurally straightforward thing for a state-regulated dam owner to do with his dam turns out to be nothing at all.[172]

While state dam law does little to spur better environmental management, it sometimes does encourage hydropower development. States use an extraordinary variety of pricing mechanisms to incentivize renewable energy, including renewable portfolio standards,[173] net metering

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[168] *See* Catherine C. Engberg, *The Dam Owner's Guide to Retirement Planning: Assessing Owner Liability for Downstream Sediment Flow from Obsolete Dams*, 21 STAN. ENVTL. L. J. 177 (2002). But some elements of tort law may inhibit dam removals. *See id*. Owners also may not understand their responsibilities. Greg Bruno, *Local Aging Dams Need Repair*, TIMES HERALD-RECORD, May 14, 2007 (quoting the deputy executive director of the American Society of Civil Engineers: "Most private owners really don't have a very good understanding of the liability that they own.").

[169] *See, e.g.*, Natural Resources Defense Council v. Patterson, 333 F. Supp. 2d 906, 924-25 (E.D. Cal. 2004) (holding that the United States Bureau of Reclamation violated California Fish and Game Code section 5936 by failing to release water to the San Joaquin River below Friant Dam); Bork et al., *supra* note 160, at 860-74 (describing the Patterson litigation and other California cases).

[170] *See, e.g.*, ME. REV. STAT. ANN. tit. 37-B, § 1130 (2011) (creating a fund to support, among other things, "breaching of or removal of a dam"); Kelroy, *supra* note 154, at 200-04 (discussing Wisconsin law allowing removals of abandoned dams, but also limits upon that authority).

[171] *See* MONT. CODE ANN. § 87-1-224 (2013). One might assume that beaver dam removals also would bring fish passage benefits, but that assumption would be incorrect. Michael M. Pollock et al., *Hydrologic and Geomorphic Effects of Beaver Dams and Their Influence on Fishes*, 37 AM. FISHERIES SOC'Y SYMPOSIUM 213, 234 (2003) ("the pond habitat formed by beaver dams is highly beneficial to many fishes (and) species regularly cross dams in both upstream and downstream directions.").

[172] *See, e.g.*, Eva Hershaw, *Dams Are Coming Down, but not in Texas*, REPORTING TEXAS, December 9, 2011, at http://reportingtexas.com/dams-come-down-around-u-s-but-not-in-texas/ ("State regulators have limited powers to force down a dam, and even if they tried, the process is extraordinarily bureaucratic.").

[173] A renewable portfolio standard requires a state's energy suppliers to purchase or generate a percentage of their energy from renewable sources.

programs, green power purchasing options, and property tax rebates.[174] Some of these programs include hydropower.[175] Typically, but not always, state programs are limited to small hydropower sources, and environmental criteria sometimes apply.[176] Many dams, including larger hydropower systems, therefore are likely to be excluded from these programs, no matter how much the dam owners do to mitigate their facilities' adverse environmental effects.[177] Conversely, and perversely, in some states a small hydropower facility is eligible for favorable pricing even if its environmental impacts are drastic.[178] But a variety of programs does create incentives for constructing new hydropower systems.[179]

Nevertheless, state dam law on the whole generally provides only weak incentives to take proactive steps with dams. Aside from pricing incentives in a subset of states (and applicable to a subset of dams), states do little to encourage dam owners to upgrade their systems. Similarly, they do little to penalize owners whose dams produce adverse environmental consequences or even safety threats. And state programs to encourage comprehensive reassessment of dam systems are nearly unheard of.[180]

III. THE PENOBSCOT PROJECT

While the United States' dam laws may entrench the status quo, dam policy does retain moments of dynamism. In the past two decades, several hundred of the United States' dams have come out,[181] and the possibility of adding additional hydropower capacity has generated a flurry of studies.[182] But both trends are limited and largely piecemeal, and the trends also are almost entirely disconnected from each other. Efforts to prioritize environmental and energy improvement projects throughout entire river

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[174] For a thorough compilation of information on state renewable energy incentives, see U.S. Dept. of Energy et al., DSIRE: Database of State Incentives for Renewable Energy, at http://www.dsireusa.org/.

[175] *See* ASHLEY JOHNSON, STATE RENEWABLE PORTFOLIO STANDARD REPORT, 2011 Update (2011).

[176] *See id.*

[177] *See* KSE Focus, *States Debate Large-Scale Hydro Power and Renewable Portfolio Standards*, August 7, 2013.

[178] *See*, *e.g.*, David Beaujon, *Memorandum to Members of the Water Resources Review Committee*, Oct. 7, 2013, at 2 (describing the purely size-based criteria for including hydroelectric power in Colorado's RPS); Johnson, *supra* note 175, at 32-33 (describing Minnesota's size-based thresholds).

[179] *See generally* U.S. DEPT. OF ENERGY ET AL., *supra* note 174.

[180] The primary exception to this generalization is a statute known as the Maine Rivers Policy, which Maine enacted in 1983. *See* Leandro E. Miranda, *A Review of Guidance and Criteria for Managing Reservoirs and Associated Riverine Environments to Benefit Fish and Fisheries*, in DAMS, FISH, AND FISHERIES: OPPORTUNITIES, CHALLENGES, AND CONFLICT RESOLUTION, *supra* note 88, at 91, 120 (describing the Maine Rivers Policy).

[181] American Rivers, Questions about Removing Dams, http://www.americanrivers.org/initiatives/dams/faqs/ (last visited November 20, 2013).

[182] *See supra* note 59and accompanying text.

basins are generally absent from American dam policy.[183] That is problematic, and the Penobscot River Restoration Project, which this section describes in depth, illustrates the potential benefits of an alternative approach.

The Penobscot River arises in a lightly developed region of northeastern Maine. Forests, lakes, wetlands, and tributary streams fill the watershed, and the river discharges into what once were some of the richest fishing grounds in the world.[184] In its natural state, the river supported remarkable populations of fish, many of which migrated between fresh and saltwater to reproduce.[185] But as the United States industrialized, the timber industry began using the waterway for log drives,[186] and factories, mills, and municipal wastewater systems used the river as a conduit for their wastes.[187] With industrialization came dams, and as of 2011, 107 dams were distributed throughout the watershed.[188]

The effect on the river's fisheries was predictable and dramatic.[189] The log drives are long gone, and the Clean Water Act improved water quality, but fish populations remain a small fraction of their historic levels.[190] The Atlantic salmon run, which once topped 100,000 fish, now averages approximately 2,000 fish per year.[191] A 2004 National Research Council study explained why: "the greatest impediment to the increase of salmon populations in Maine is the obstruction of their passage up and down streams and degradation of their habitat caused by dams."[192] American shad, which once were the most commercially valuable species in the river—and were much more abundant than salmon—are nearly gone.[193] Along with Atlantic salmon, shortnose sturgeon are now endangered, and

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[183] *See* Michael J. Kuby et al., *A Multiobjective Optimization Model for Dam Removal: An Example Trading off Salmon Passage with Hydropower and Water Storage in the Willamette Basin*, 28 ADVANCES IN WATER RESOURCES 845, 853 (2005) ("Currently, dam removal is considered mainly on a dam-by-dam basis.").

[184] *See* ANDREW J. PERSHING ET AL., THE FUTURE OF COD IN THE GULF OF MAINE 1-3 (2013); Oliver A. Houck, *On the Law of Biodiversity and Ecosystem Management*, 81 MINN. L. REV. 869, 946-47 (1997) (describing the demise of northeastern fisheries).

[185] Opperman et al., *supra* note 5, at 2.

[186] In New England, the preferred way to deliver logs to mills once was to float them downriver.

[187] Laura Rose Day, *Restoring Native Fisheries to Maine's Largest Watershed: The Penobscot River Restoration Project*, 134 J. Contemp. Water Research & Educ. 29, 29 (2006); Opperman et al., *supra* note 5, at (2).

[188] MARTIN & APSE, *supra* note 44, at 62. Compared to other northeastern watersheds, this density of dams is quite low. *Id.*

[189] *See* Opperman et al., *supra* note 5, at 2-3.

[190] *See* NATIONAL RESEARCH COUNCIL, ATLANTIC SALMON IN MAINE 8 (2004) ("[D]ams… have made an enormous amount of habitat unavailable to Maine salmon and have affected much of the habitat that is still available.").

[191] Opperman et al., *supra* note 5, at 2, 12.

[192] NATIONAL RESEARCH COUNCIL, *supra* note 190, at 11.

[193] Opperman et al., *supra* note 5, at 2, 12.

the NMFS lists alewife and blueback herring as "species of concern."[194] Those ecological changes brought unfortunate human consequences. For the Penobscot Indian Tribe, which viewed the river as "a sacred, living entity that is central to the Tribe's cultural identity," the degradation was devastating.[195] Fishing was integral to the tribe's connection to the river, but the tribe hasn't been able to exercise its fishing rights for more than a century.[196] Non-native fishermen also have suffered. Recent fisheries research strongly suggests that diadromous fish population declines contributed to the poor condition of the Gulf of Maine's ocean fisheries, and that poor condition, and the turmoil it created, have led NMFS to classify the New England fishery as an "economic disaster."[197]

That combination of cultural and environmental loss, on the one hand, and recovery potential on the other made the Penobscot a target for restoration efforts.[198] A somewhat unique ownership situation heightened the potential. In many river basins, dam ownership is fragmented, and that fragmentation creates challenges for anyone interested in developing a coordinated management scheme.[199] In the lower reaches of the Penobscot watershed, however, a more consolidated ownership pattern existed. In 1999, PPL Corporation purchased all of the dams in the lower Penobscot basin, consolidating ownership within a single corporate entity.[200] Several of those dams' license renewals already were in dispute, with strong opposition from environmental groups and the Penobscot Indian Tribe, and PPL was willing to expand settlement discussions to encompass other dams

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[194] Tara R. Trinko Lake et al., *Evaluating Changes in Diadromous Species Distributions and Habitat Accessibility following the Penobscot River Restoration Project*, 4 MARINE AND COASTAL FISHERIES: DYNAMICS, MGMT., AND ECOSYSTEM SCI. 284, 285 (2012).

[195] Opperman et al., *supra* note 5, at 11; *see also* Gail Courey Tensing, $25 million raised to begin ambitious Penobscot River Restoration Project, INDIAN COUNTRY TODAY, February 11, 2008. Tensing quotes John Banks, director of the Penobscot Nation's Department of Natural Resources:

> You often hear people talk about we are the river, the river is us. It defines us as a tribe, it defines who we are, where we came from, and many of our cultural traditions are tied to the river and its resources. We've evolved as a riverine tribe for 10,000 years here. The river has provide all of our needs - physically, culturally, spiritually and allowed us to prosper for thousands of years.

Id.

[196] *Id.*

[197] *See* Edward P. Ames & John Lichter, *Gadids and Alewives: Structure within Complexity in the Gulf of Maine*, 141 FISHERIES RESEARCH 70, 75-78 (2013) ("if diadromous species recover, local gadids may re-establish their metapopulation structures in northeastern New England."); Kevin Miller, *New England Fishery Disaster Bill Sent to Senate*, PORTLAND PRESS HERALD, July 19, 2013.

[198] *See, e.g.*, NATIONAL RESEARCH COUNCIL, *supra* note 190, at 12 ("Since most Maine salmon are now in the Penobscot River, that population should be a primary focus for rehabilitating the species in Maine…. A program of dam removal should be started.").

[199] *See* HALL & REEVES, *supra* note 57, at 3 (showing dam ownership patterns).

[200] Opperman et al., *supra* note 5, at 6.

that were not presently under review.[201] For environmental groups and the Penobscot Indian Tribe, these dam relicensing processes presented an important opportunity.

Recent changes on other rivers provided some basis for optimism. A few years earlier, environmental regulators and advocacy organizations had used the relicensing process for the Edwards Dam, on the nearby Kennebec River, as an opportunity to advocate for improved fishways, and the end result was a nationally celebrated dam removal project.[202] Similar initiatives were underway at some major west coast dams, including the Elwha and Glines Canyon Dams, which had nearly exterminated salmon runs in one of the rivers draining Olympic National Park.[203] But the Penobscot relicensing processes offered an opportunity for a more systemic approach. Rather than considering each dam separately, the participants in the Penobscot project decided to concurrently evaluate the status of all of PPL's dams in the lower Penobscot basin. That concurrent evaluation would afford them an opportunity to identify cost-effective ways to rehabilitate the river's fisheries while retaining much of its hydropower.[204]

In 2004, the participants ultimately were able to strike a deal.[205] For between twenty four and twenty-six million dollars (the actual price would depend on the timing of the purchase), the environmental partners would purchase three dams.[206] Two would be removed.[207] The third would remain in place (upstream landowners were deeply attached to the flatwater impoundment it created) but it would be decommissioned and an innovative fish bypass facility would be installed.[208] Another upstream dam also would receive an additional fish bypass facility. In return for these environmental benefits, the environmental coalition agreed to withhold opposition to the renewal of hydropower licenses at five remaining dams. Those dams would either continue to produce hydropower at their current rate or would receive hydropower upgrades.[209]

The resulting environmental changes should be dramatic. While the exact amounts are difficult to calculate, scientists anticipate that thousands of kilometers of river and stream habitat will become more accessible to the

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[201] *Id.* At 4, 6-7.

[202] See Crane, *supra* note 125; John Holyoke, *Edwards Dam Success Foreshadows Penobscot Project's Future*, BANGOR DAILY NEWS, June 8, 2012.

[203] *See* Blumm & Erickson, *supra* note 35.

[204] *See* Opperman et al., *supra* note 5, at 12 – 16.

[205] Submittal of the Lower Penobscot River Basin Comprehensive Settlement Agreement with Explanatory Statement, FERC Docket No. D197-10, filed June 25, 2004.

[206] Opperman et al., *supra* note 5, at 7. They completed the purchase in 2008, using $25 million raised from a combination of public and private sources. Penobscot River Restoration Trust, *Press Release: Fisheries Restoration, Energy Balance Closer to Becoming Reality on Penobscot River*, August 21, 2008, *available at* http://www.penobscotriver.org/assets/FINAL_Penobscot_Aug_21_Event_pr.pdf.

[207] Opperman et al., *supra* note 5, at 7.

[208] *Id.*

[209] *Id.*

stronger swimmers (like salmon and shad) in the river system.[210] For species that cannot negotiate fish ladders and rapids, fewer additional river miles will become available, but the *percentage* increase in habitat will actually be much larger.[211] Numbers of increased fish are even more uncertain, but The Nature Conservancy's preliminary estimates suggest that dramatic changes are likely.[212] The potential changes also extend beyond improved fisheries. The removal of the Edwards Dam improved water quality, revitalized property values, and renewed community interest in the riverfront.[213] Towns along the Penobscot already are anticipating, and planning for, similar changes.[214]

On their own, those benefits would establish the Penobscot Project as one of the nation's most ambitious environmental restoration projects. But what sets the Penobscot Project apart is its impact—or lack thereof—on hydropower generating capacity.[215] Had this been a simple dam removal project, approximately 100 megawatts of generating power would have come out. That capacity might have been made up through fossil fuel combustion or some other environmentally damaging source. But by moving turbines from one of the decommissioned dams to one of the remaining dams, and by making several other adjustments, the dam owners will avoid any significant reduction in hydropower generation.[216] In fact, recent calculations have found that generating capacity has slightly increased.[217]

What happened in the Penobscot Basin is not entirely unique. FERC has a long history of ordering off-site mitigation to compensate for the impacts of new hydropower projects, and in some ways, the Penobscot project just represents a more sophisticated and ambitious application of that concept.[218] On a few other river basins, FERC also has considered multiple hydropower facilities in a single proceeding.[219] Indeed, a major

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210 *Id.* at 4.

211 *See* Trinko Lake et al., *supra* note 194, at 288.

212 Opperman et al., *supra* note 5, at 12.

213 *See* Lynne Y. Lewis et al., *Dams, Dam Removal and River Restoration: A Hedonic Property Value Analysis*, 26 CONTEMP. ECON. POL'Y 175 (2008) (documenting rising property values after the Edwards Dam removal).

214 Penobscot River Restoration Trust, Recent Updates on Economic Segments, http://www.penobscotriver.org/content/4012/economic-development (last visited November 24, 2013).

215 *See* Opperman et al., *supra* note 5, at 7.

216 *Id.*

217 *Id.*

218 *See* Public Service Company of Colorado, 132 FERC P 61224, 62261 (2010) (discussing FERC's policies on off-site mitigation, though disapproving it in the matter at hand). Dam removals have rarely been part of that mitigation, but FERC has approved that approach. *See, e.g.*, Bangor-Pacific Hydro Associates, 47 FERC P 61053, 61165 (1989) (approving a dam removal project as part of the mitigation package for a project receiving a new license).

219 *See*, *e.g.*, Erie Boulevard Hydropower, L.P., 98 FERC P 61145 (2002) (discussing a proceeding and settlement involving four projects on the Raquette River in New York); Joe

multi-dam proceeding might be nearing a resolution for the Klamath River, which for over a decade has been one of the nation's most prominent water conflicts.[220] In the wake of the Penobscot project, the federal government also has actively searched for other watersheds where basin-scale analyses might generate more effective systems of watershed management, and several agencies are currently pursuing a pilot project on the Deschutes River in Oregon and beginning studies on the Connecticut and Roanoke River basins.[221] Finally, ambitious basin-scale hydropower planning exercises are underway on major river systems in Africa, Asia, and Central and South America.[222] Nevertheless, the Penobscot remains a gold standard. To date, no river-basin project has done quite as effective a job of translating systemic planning into action, or at combining sustained hydropower production with potentially huge improvements in environmental quality.

IV. DAMS AND THE FRONTIERS OF ENVIRONMENTAL TRADING

To us, and to many observers, the Penobscot Project seems worthy of imitation.[223] The opportunity for imitation also exists, at least as a matter of ecology and engineering.[224] The key questions, then, are what legal and economic conditions would facilitate such replication; whether those conditions are present for dams; and, if they are not present, what reforms, if any, could remedy their absence.

Our answers to these questions turn on a key premise. While the Penobscot is a distinctive project, its tradeoff between environmental improvements in some locations and hydropower upgrades in others reflects an increasingly familiar approach to environmental protection. On a small scale, the Penobscot project created an environmental trading system. And

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DosSantos & Tim Swant, Collaboration or Confrontation? Take Your Pick: Clark Fork Projects Hydro Relicensing, at http://cas.umt.edu/clarkfork/Abstracts/presenters/DosSantospaper.htm (last visited December 13, 2013) (describing a relicensing process involving two major dams).

[220] Klamath Basin Settlement Agreement, February 18, 2010; Klamath Basin Restoration Agreement for the Sustainability of Public and Trust Resources and Affected Communities, February 18, 2010.

[221] *See* G.E. JOHNSON ET AL., THE INTEGRATED BASIN-SCALE OPPORTUNITY ASSESSMENT INITIATIVE: PHASE 1 METHODOLOGY AND PRELIMINARY SCOPING ASSESSMENTS FOR THE CONNECTICUT AND ROANOKE RIVER BASINS: ANNUAL REPORT 2013 (2013); Memorandum of Understanding, *supra* note 37; Simon Geerlofs et al., The *Deschutes River Basin Scale Opportunities Assessment*, RMS JOURNAL, Winter 2007, at 8.

[222] Telephone Interview with Jeffrey Opperman, The Nature Conservancy, July 3, 2013.

[223] In making this statement, we are not arguing that every dam removal project should be accompanied by an offsetting increase in hydropower capacity. Sometimes the lost hydropower capacity will be a very small price to pay for the associated environmental improvements.

[224] *See, e.g.*, Kuby et al., *supra* note 183, at 851 (concluding selective dam removal "could reconnect most of the drainage area of the Willamette River to the Pacific Ocean—with little loss of hydropower and/or storage capacity.").

while almost nothing has been written about applying trading system concepts to dams, the Penobscot project illustrates the possibilities.[225] Our premise, then, is that the lessons from several decades of environmental trading can help us assess whether trading dams will be viable, and about what reforms might increase that viability. We therefore begin this section with a background discussion of environmental trading systems, from which we extract general lessons for dam trading, and we then focus on specific metrics of potential failure or success.

Before launching into that discussion, however, we offer a few words about what we mean by trading dams. The concept could apply in several different scenarios. In the simplest, a dam owner might obtain authorization to build—or continue operating—a dam in one location in return for removing a dam somewhere else.[226] Somewhat more ambitiously, the trades could involve larger numbers of dams, with sustained or increased dam operations in a larger set of locations traded for a larger set of coordinated removal projects.[227] The Penobscot Project exemplifies that latter model.[228] Alternatively, the trades might involve using dam removals to mitigate environmentally damaging activities, like wetlands filling or other forms of habitat destruction, that don't involve dams.[229] Finally, and most ambitiously, dam removals might be integrated into watershed-scale, multi-activity trading programs, in which a broad suite of environmental restoration activities, including dam removal, offsets a broad range of economic activities, including but not limited to dam operations.[230]

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[225] We have found one article that contemplates this possibility. *See* Workman, *supra* note 30.

[226] For a somewhat analogous example, see Edwards Manufacturing Company, Inc. et al., 84 FERC P 61227 (1998). That decision approved a settlement agreement whereby upstream dam owners obtained delays in the imposition of fish passage requirements by contributing funding to support the Edwards Dam's removal. *Id.* at 62091.

[227] For any such program, defining the geographic scale of the trading area will be a challenge, and the choice will likely depend upon the environmental goals driving the trading system.

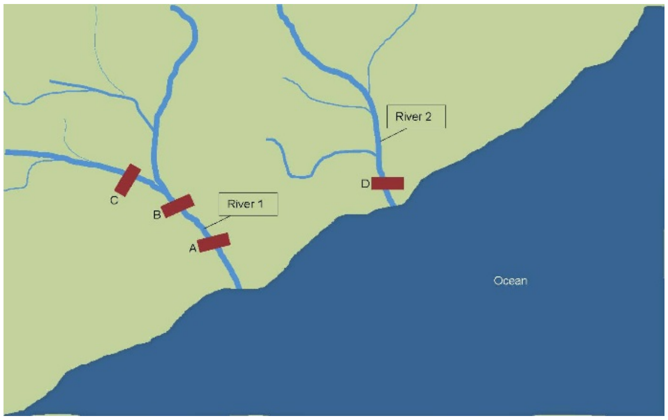
[228] *See supra* notes 198-217 and accompanying text.

[229] The Edwards Dam settlement also provides an example: Bath Ironworks contributed $2.5 million to the dam removal and in return obtained the ability to fill fifteen acres of wetlands. *See* Pete Didisheim, Dam Removal Foe Misinformed, BANGOR DAILY NEWS, July 12, 1999 (explaining the deal).

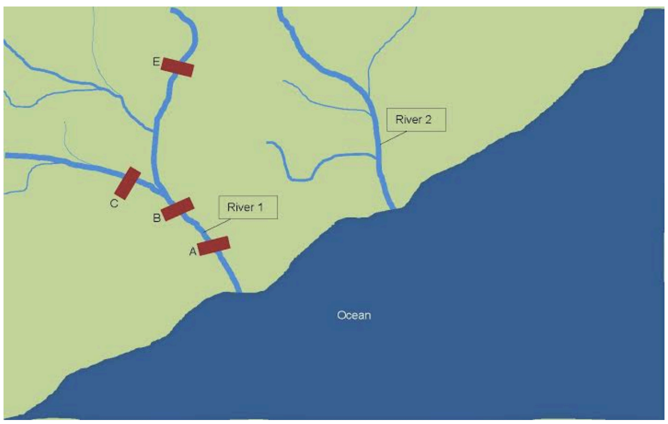
[230] *See* BECCA MADSEN ET AL., STATE OF BIODIVERSITY MARKETS: OFFSET AND COMPENSATION PROGRAMS WORLDWIDE 21 (2010) (describing pilot trading programs in the Willamette River and Chesapeake Bay basins).

Figure 1: A Simple Interbasin Trade

In return for constructing new Dam E on the river basin at the left, the construction company agrees to remove dam D, which previously blocked the river basin at right. Because the new dam E will be located above two other dams (which we assume, for purposes of illustration, already block fish passage), its environmental harm will be more than balanced by the gain from opening up river system 2.

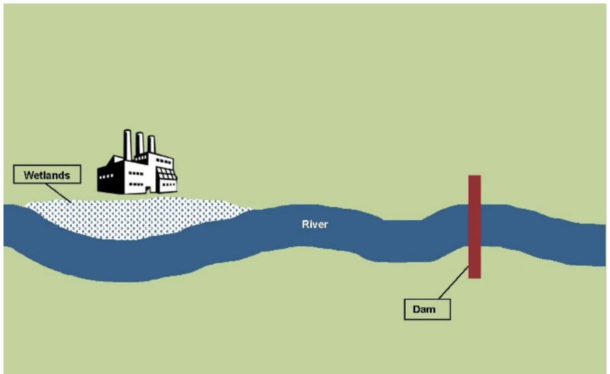


Before: Dams A, B, C, and D block fish passage on both rivers.

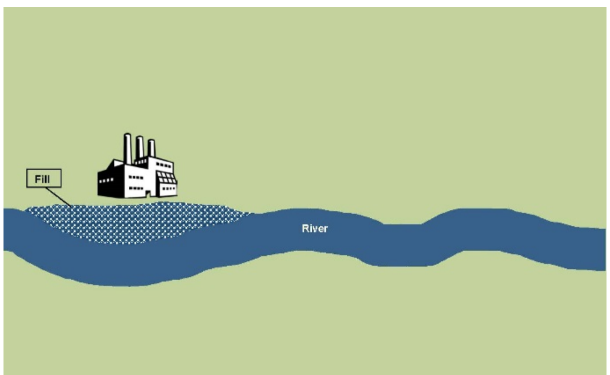


After: New Dam E has gone in, but old dam D has been removed, opening one whole river system to fish.

Figure 2: Trading Dam Removals for other Activities
In return for obtaining authorization to fill a wetland area, the factory owners agree to fund the removal of an upstream dam. If the value of increased river connectivity is greater than the damage done by the wetland fill, then the trade should lead to improved environmental and economic outcomes.



Before: The dam blocks the river, and the factory owners want to expand into the wetland area.



After: The wetlands have been filled, and in return the factory owners fund dam removal.

We also envision dam trading achieving a variety of goals. In a basin where improved environmental conditions are the primary goal, selective trading could help minimize the energy loss associated with achieving that goal; dam owners could obtain the right to continue operating in more economically desirable locations by agreeing to remove less economically valuable dams.[231] Conversely, in places where government policy demands increases in hydropower capacity, dam trading could help planners achieve their energy capacity goals—or at least most of them—while minimizing negative environmental side effects.[232] In a place where increased renewable energy generation and improved environmental quality

[231] The Bonneville Power Administration, which runs hydropower dams throughout the Columbia River Basin, maintains an environmental mitigation fund designed to serve this general purpose. *See* Bonneville Power Administration, Dam Removal on Snake River Tributary: Dutch Flat Dam, Nov. 8, 2013, http://www.bpa.gov/news/newsroom/Pages/Dam-removal-on-Snake-River-tributary-Dutch-Flat-Dam.aspx (describing a specific dam removal and the larger program).

[232] *See* Opperman Interview, *supra* note 222 (describing several countries in which TNC is working on this challenge).

both are important public policy goals, trading could help reconcile these two otherwise conflicting priorities. In short, endorsing the possibility of a trading regime does not imply an associated endorsement of a particular balance between hydropower generation and environmental protection.

A. The Evolution of Environmental Trading Systems

The reforms we advocate for dams can trace their intellectual roots to smokestacks and swamps.[233] In the early 1970s, air quality regulators emphasized uniform standards for all analogous sources of pollution. But critics noted that uniform standards might be inefficient if, as is often the case, compliance costs differ from source to source.[234] If regulators instead established overall caps on levels of pollution, gave (or auctioned) regulated firms entitlements to pollute up to that cap, and allowed those regulated firms to trade their entitlements, the same environmental outcomes might be achieved with greater economic efficiency.[235] Firms that could abate pollution more cheaply could reduce their emissions more than they otherwise would have been required to, and then could sell the "credits" created by the excess reductions to firms for which pollution abatement would be more costly.[236] Compliance burdens, in other words, would be allocated through trading to those firms that could shoulder those costs most cheaply.

In a relatively short time, this idea metamorphosed from a fringe critique into one of environmental law's central policy innovations.[237] Regulators first tested this concept at individual facilities, allowing increases in pollution at one smokestack to be offset by reductions at another.[238] They soon expanded the concept to allow trading among different—and separately owned—facilities. They also allowed "banking," which means allowing regulated entities to trade excess reductions of pollution in the short-term for more generous allowances in the future.[239] Trading initially was quite controversial; in addition to concerns about its

[233] For discussion of this early history, see TOM TIETENBERG, EMISSIONS TRADING: AN EXERCISE IN REFORMING POLLUTION POLICY (1985).

[234] Robert W. Hahn & Robert N. Stavins, *Incentive-Based Environmental Regulation: A New Era from an Old Idea*, 18 ECOLOGY L.Q. 1, 6 (1991) (asserting that "[u]niform emission standards…tend to lead to inefficient outcomes" because "the costs of controlling pollutant emissions vary greatly among and even within firms.").

[235] Jody Freeman, *The Story of Chevron: Environmental Law and Administrative Discretion*, *in* ENVIRONMENTAL LAW STORIES 172, 178-79 (Richard J. Lazarus & Oliver A. Houck eds., 2005).

[236] *Id.*

[237] *See* Hahn & Stavins, *supra* note 234, at 3 (arguing that policymakers had "largely ignored" economists' calls for incentive-based regulatory systems).

[238] *See* Freeman, *supra* note 235, at 178-84 (describing the evolution of this "bubble" concept).

[239] *See* Robert W. Hahn & Gordon L. Hester, *Marketable Permits: Lessons for Theory and Practice*, 16 ECOLOGY L.Q. 361, 368 (1989).

efficacy, many environmentalists worried that trading systems implied a normative endorsement of pollution, or the creation of "rights" to pollute.[240] But air quality trading programs became increasingly prevalent, and they also appeared to succeed.[241] Trading programs have now become deeply entrenched, and broadly supported, in the field of air quality regulation, and new regulatory programs for greenhouse gas emissions often place central reliance upon this approach.[242] They also have generated some of environmental law's most enduring academic debates.

Meanwhile, habitat protection programs were evolving along a similar trajectory.[243] Offsetting, or "mitigating," habitat degradation at one place or time with environmental improvements elsewhere had a long history in environmental regulation. With dams, for example, mitigation had been widely (and often disastrously) used for decades; dam builders often attempted to mitigate their dams' impacts by constructing fish ladders and hatcheries.[244] But use of this approach accelerated with the emergence of Clean Water Section 404, which prohibits unpermitted dredging and filling of wetlands and waterways.[245] The national wetlands policy implemented under section 404 is somewhat like a cap-and-trade scheme. The cap is a national policy against net loss of wetlands.[246] Pursuant to that policy, the Army Corps of Engineers, which holds primary responsibility for implementing section 404, generally requires permit applicants to avoid wetlands entirely, if possible, and to minimize any impacts that cannot be avoided.[247] For many development projects, however, some impact remains unavoidable, and stopping all of those projects has never been a politically tenable option. The Army Corps instead has turned to compensatory mitigation.[248] Sometimes that compensatory mitigation occurs through the permittee itself constructing or restoring a substitute wetland, and

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[240] Richard Schmalansee & Robert Stavins, *The SO_2 Allowance Trading System: The Ironic History of a Grand Policy Experiment*, 27 J. ECON. PERSPECTIVES 103, 103 (2013) (describing that hostility).

[241] *See* Schmalansee & Stavins, *supra* note 240, at 104 (arguing that the acid rain program succeeded, albeit in unexpected ways); Goulder, *supra* note 32, at 100.

[242] *See* Richard G. Newell et al., *Carbon Markets 15 Years after Kyoto: Lessons Learned, New Challenges*, 27 J. ECON. PERSPECTIVES 123, 123-24 (2013) (describing the international proliferation of carbon trading schemes).

[243] *See generally* Salzman & Ruhl, *supra* note 24 (describing habitat trading, with a particular focus on wetlands).

[244] *See generally* LICHATOWICH, *supra* note 86 (describing decades of failed salmon management).

[245] 33 U.S.C. § 1344 (2006).

[246] *See* J.B. Ruhl & James Salzman, *Gaming the Past: The Theory and Practice of Historic Baselines in the Administrative State*, 64 VANDERBILT. L. REV. 1, 29-35 (2011) (describing the evolution and implementation of the "no-net-loss" policy).

[247] *See* U.S. Envtl. Prot. Agency, Wetlands Compensatory Mitigation, http://water.epa.gov/lawsregs/guidance/wetlands/upload/2003_05_30_wetlands_CMitigation.pdf (last visited December 2, 2013).

[248] *See* NATIONAL RESEARCH COUNCIL, COMPENSATING FOR WETLAND LOSSES UNDER THE CLEAN WATER ACT 64-67 (2001)

sometimes it occurs through the payment of fees (referred to as in-lieu fees) that support some other entity's wetland restoration work.[249] In other circumstances, private wetlands mitigation "banks" create or restore wetlands and then sell credits to future developers.[250] In a relatively short time, wetlands mitigation has become a billion-dollar industry.[251]

While air quality and wetlands are the two most prominent examples of environmental trading systems, variations on trading concepts now pervade environmental law.[252] Off-site mitigation, often involving banking, is now central to the habitat conservation planning process under section ten of the Endangered Species Act.[253] Transferable fishing quotas have become increasingly popular.[254] Advocates have argued that trading systems can bring conservation into otherwise wasteful systems of water rights.[255] Many municipal governments attempt to use tradable development rights to direct urban growth toward preferred locations.[256] Though the trading systems vary considerably, the common foundation of nearly all of these systems is a belief that allowing regulated entities to trade increased environmental degradation in some locations for increased protection in others can be a more efficient and less intrusive way to conduct environmental regulation.[257]

Despite some successes, actual results have not always lived up to that theoretical promise. Wetlands mitigation provides one prominent example: for years, plenty of trading occurred, but the constructed or restored wetlands often offered poor compensation for the wetlands that had been lost.[258] In other contexts, programs have failed to get started. EPA has been promoting water quality trading systems for years, but the few programs that even exist have generated very low volumes of trading.[259] In others, a lack of post-trade monitoring makes the program difficult to

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[249] *See generally* ENVTL. L. INST., THE STATUS AND CHARACTER OF IN-LIEU FEE MITIGATION IN THE UNITED STATES (2007).

[250] *See generally* Royal C. Gardner, *Banking on Entrepeneurs: Wetlands, Mitigation Banking, and Takings*, 81 IOWA L. REV. 527 (1993).

[251] MADSEN ET AL., *supra* note 230 (describing wetlands mitigation in the United States).

[252] *See* Tietenberg, *supra* note 25 (describing many applications).

[253] *See* Salzman & Ruhl, *supra* note 24, at 648-49 & n.102.

[254] Cindy Chu, *Thirty Years Later: The Global Growth of ITQs and their Influence on Stock Status in Marine Fisheries*, 10 FISH & FISHERIES 217 (2009).

[255] *See, e.g.,* Thomas Graff & David Yardas, *Reforming Western Water Policy: Markets and Regulation*, 12 NAT. RESOURCES & ENV'T 165 (1998).

[256] *See* MARGARET WALLS & VIRGINIA MCCONNELL, TRANSFER OF DEVELOPMENT RIGHTS IN U.S. COMMUNITIES: EVALUATING PROGRAM DESIGN, IMPLEMENTATION, AND OUTCOMES (2007).

[257] *See generally* Ackerman & Stewart, *supra* note 29.

[258] *See* Todd BenDor & Nicholas Brozovic, *Determinants of Spatial and Temporal Patterns in Compensatory Wetland Mitigation*, 40 ENVTL. MGMT. 349, 351 (2007) (summarizing critiques of traditional wetland mitigation).

[259] Fisher-Vanden & Olmstead, *supra* note 31, at 147.

evaluate.[260] And even with the programs most commonly hailed as successes, debate continues about the extent of their success, and the reasons for it.[261] Trading also continues to generate more theoretical and normative critiques. One key objection is that trading programs far too often involve trading things that are incommensurate, with environmental protection typically on the losing end of the deal.[262] More broadly, some critics still argue that trading entrenches a market-oriented worldview, in which environmental ethics are subordinated to utilitarian calculations of profit.[263]

Those critiques have force, but the history of trading systems offers a third key lesson: the world of environmental trading systems is not rigidly divided between successes and failures. Trading systems can improve, and perhaps the best example of this improvement is the wetlands mitigation system. Originally, the Army Corps of Engineers favored compensation through construction of on-site wetlands. Regulators thought, reasonably enough, that creating new wetlands close to the site of the old destroyed wetlands would be a good idea. But the new wetlands often failed, in large part because their geographic isolation; a constructed wetland surrounded by shopping mall parking is unlikely to thrive. In response to those failures, the Corps has moved toward systems that aggregate compensatory mitigation funds into larger accounts and use those funds to restore and protect higher-value wetlands, an approach that mitigation experts generally agree holds more promise.[264] That is just one change, of course, but the wetlands program also offers other examples,[265] and in many other contexts, trading programs can improve as participants learn from experience.[266]

For dams, then, the still-unfolding story of environmental trading systems offers economic promise, warning, and the possibility of learning. The promise remains the theoretical flexibility and cost savings associated

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[260] *See, e.g.*, Rebecca Lave et al., *Why You Should Pay Attention to Stream Mitigation Banking*, 26 ECOLOGICAL RESTORATION 287, 288 (2008) (arguing that the question "does aquatic ecosystem restoration actually work?" has received "relatively little documentation"); Jessica Fox & Anamaria Nino-Murcia, *Status of Species Conservation Banking in the United States*, 19 CONSERVATION BIOLOGY 996, 997 (2005) ("Government-initiated websites maintaining conservation bank data are out of date, incomplete, and not useful for gaining a comprehensive understanding of the practice.").

[261] *See, e.g.*, Schmalensee & Stavins, *supra* note 240 (arguing that the SO_2 trading system performed in unexpected ways and succeeded for unexpected reasons).

[262] The most thorough development of this critique comes from Salzman and Ruhl, *supra* note 24.

[263] *See, e.g.*, Eric Freyfogle, *Water Rights and the Common Wealth*, 26 ENVTL. L. 27, 35-37 (1996) (critiquing water rights trading).

[264] *See* WILKINSON ET AL., *supra* note 38, at 30-31 (describing the Corps' movement toward a "watershed" approach).

[265] The development of new pricing systems, like in-lieu fees, and of both private and public expertise are also important examples.

[266] *See generally id.* (describing the recent and potential future evolution of habitat trading systems); Owen, *supra* note 38, at 267-73; MADSEN ET AL., *supra* note 230, at 19 (noting that developing transparency systems has been an important innovation).

with trading systems, as well as their track record of success in some circumstances.[267] The warning stems from their struggles and, sometimes, failures in other realms. Trading systems are useful tools, but not for every problem, and not unless they are designed and implemented with care.[268] And the possibility of learning should provide some reassurance that dam trading, even if initially tentative, limited, and sometimes unsuccessful, can evolve—if the first experiments begin.

B. Metrics of Success

Beyond these general lessons, the history of environmental trading systems provides several metrics by which to evaluate their potential utility for dams. In our view, three categories of metrics are particularly important. The first is the presence of legal authorization for trading systems. Without such authorization, trading is simply not possible. The second is the presence of sufficient incentives, both legal and economic (the two are highly intertwined), for the relevant actors to engage in trading. Third, to function effectively, most trading systems require abundant information, both about the things to be traded and the environmental and social consequences of those trades. Absent that information, trading systems are likely to be economically or environmentally dysfunctional. Below, we explain and apply each of these metrics.

1. Authorization

Perhaps the clearest bar to an environmental trading system is the absence of legal authorization to engage in trading. Almost any trading system will be implemented by government agencies, and those agencies only can use the regulatory tools given unto them by law. That might seem like a rather obvious point, but it remains an important one; in recent years, the United States Environmental Protection Agency has lost court cases because judges were convinced that the agency's trading systems were contrary to governing statutes.[269]

For dams, which are often embedded in complex legal webs constructed without any thought of trading, this lesson might seem daunting. Nevertheless, there are few general prohibitions to trading in those laws. Instead, many existing provisions and established practices could provide foundations for increased use of dam trading. The Federal Power Act's mandate for license approvals to comport with "comprehensive plans" provides an obvious foundation for the planning that would precede development of trading systems.[270] Similarly, FERC's established, and

[267] *See* Goulder, *supra* note 32, at 91.

[268] *See id.* at 9469 (emphasizing the importance of context-appropriate design).

[269] EME Homer City Generation, L.P. v. E.P.A., 696 F.3d 7 (D.C. Cir. 2012), rev'd, 134 S.Ct. 1584 (2104); North Carolina v. U.S. EPA, 531 F.3d 896, 910 (D.C. Cir. 2008).

[270] 16 U.S.C. § 803(a)(1) (2006).

occasionally-used, practice of consolidating multiple licensing proceedings would provide an opportunity for more systemic decision-making.[271] Indeed, on future licenses, FERC could draw upon another existing practice—including reopener clauses in licenses—to align the timing of licensing proceedings throughout a river basin.[272] FERC already allows off-site mitigation, and extending that practice to encompass dam-removal mitigation banks also would be a logical next step.[273] For state-regulated dams, the potential toolbox is even larger. And we have not uncovered any state laws that would preclude state-regulated dam owners from participating in trading systems.

The greatest complexities would likely arise with Congressionally-authorized, federally owned dams. If Congress has authorized the creation of a dam for a specific purpose, then additional Congressional action might be necessary to authorize that same dam's removal.[274] But even that limitation would not preclude the inclusion of federally owned dams in a trading scheme, for federal dam managers could still compensate for the impacts of their dams by funding removals of other dams in other locations.[275] In fact, given the scale of the impacts caused by federal dams, those federal agencies could become major buyers.[276]

2. Levers and Incentives

A more complicated story emerges from the incentive structures applicable to dam trading. Environmental trades almost always occur because some combination of regulatory leverage and financial incentives induces a redirection of environmentally harmful behavior.[277] But for dams, these incentives are limited. That need not preclude trading, but the negative signals make it less likely and offer promising targets for reform.

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[271] *See supra* note 219 and accompanying text.

[272] FERC uses reopener clauses primarily to allow reinitiation of proceedings when additional fish protection measures become necessary. *See* Wisconsin Public Service Corp. v. Fed. Energy Regulatory Comm'n, 32 F.3d 1165 (1994) (upholding this practice against a challenge from licensees).

[273] *See, e.g.*, Public Service Company of Colorado, 132 FERC P 61224, 62261 (2010) (noting FERC's willingness to use off-site mitigation).

[274] A series of cases involving the Buford Dam, which lies at the center of one of the Southeast's largest water disputes, exemplifies the potential complexity of the legal regime for federally owned dams. *See In re* MDL -1824 Tri-State Water Rights Litig., 644 F.3d 1160 (11th Cir. 2011) (summarizing the controversy and prior rounds of prior litigation).

[275] *See* 33 U.S.C. § 2283 (2006) ("After consultation with appropriate Federal and non-Federal agencies, the Secretary is authorized to mitigate damages to fish and wildlife resulting from any water resources project under his jurisdiction.").

[276] *See supra* note 146 and accompanying text (discussing the size of different classes of dams).

[277] *See generally* Amy Sinden, *The Tragedy of the Commons and the Myth of a Private Property Solution*, 78 U. COLO. L. REV. 533, 570-76 (2007) (explaining how regulatory caps allow environmental trading systems to function).

a. Stakes

One of the most important sources of both leverage and incentive is the presence of high economic and environmental stakes. Simply put, something that is not economically valuable is not likely to be traded. Any such system creates transaction costs, and some economic value is necessary to make shouldering those costs worthwhile. Similarly, if the environmental stakes are low, there will be little reason to create the regulatory structures necessary to support a trading system.

The importance of high stakes also may seem rather obvious, but it is worth emphasizing for a simple reason. With dams, the economic stakes are not accidental byproducts of some invisible hand, but instead are determined in large part by law.[278] Energy markets are heavily subsidized and—sometimes—heavily regulated, and the combination of subsidies, regulatory constraints, and regulatory exemptions plays a significant role in determining prices. If competing energy sources like coal and oil can continue to externalize many of their environmental costs, their prices will remain relatively low, and hydropower's competitive position will suffer.[279] But if climate regulation or even more traditional Clean Air Act implementation leads to tougher controls on fossil fuel emissions, the economic appeal of hydropower should rise.[280] Similarly, if more states adopt renewable portfolio standards or other energy pricing incentives that include hydropower, then energy suppliers will be willing to pay a premium for hydropower.[281] Those changes in turn should accelerate interest in upgrading dams and other waterworks.[282] That could simply entrench existing dams, even if their environmental impacts are substantial. But increases in the economic value of hydropower also could generate profits that then could be tapped to support environmental mitigation. In short, the fate of dam trading is closely linked to climate and energy policy more generally, and among the many potential benefits of more progressive energy laws could be a more dynamic approach to dams.

The importance of high stakes does come with one caveat: for the trading system to work, those stakes cannot be equally high everywhere. If every dam has a similar ratio of social benefit to environmental harm, there

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[278] *See generally* Uma Outka, *Environmental Law and Fossil Fuels: Barriers to Renewable Energy*, 65 VANDERBILT L. REV. 1679 (2012).

[279] *See id.* at 1696, 1702-19 (cataloguing legal advantages enjoyed by fossil fuels).

[280] LORI BIRD ET AL., IMPLICATIONS OF CARBON REGULATION FOR GREEN POWER MARKETS 2 (2007).

[281] *See generally* Lincoln Davies, *Incentivizing Renewable Energy Deployment: Renewable Portfolio Standards and Feed-In Tariffs*, 1 KRLI J. L. & LEGISLATION 40 (2011).

[282] *See* U.S. DEPT. OF ENERGY, *supra* note 48 (showing hundreds of non-powered dams across the nation).

will be little to gain from trades.[283] Only where significant disparities exist—in other words, where some dams produce much more positive social value for each increment of environmental harm than others—will there be an incentive to trade upgrades or maintenance at the higher value dams for removals at the lower-value sites. For dams, such disparities of value clearly do exist.[284] In general, larger dams tend to produce more positive and negative impacts than smaller ones. But the relationships are not uniform, and the American landscape is heavily populated with dams that produce significant environmental impacts while providing few public benefits, if any at all.[285]

In short, the stakes already weigh in favor of dam trading. And if energy and environmental law generally move toward greater regulation of greenhouse gas emissions or conventional air pollutants, the stakes could become even more favorable.

b. Regulatory Leverage

While high stakes and disparities in value are necessary for a successful trading regime, they are by no means sufficient. Potential traders will generally need additional incentives for participation, and those incentives generally come from some combination of regulatory sticks and financial carrots. With dams, some of those sticks and carrots exist, but the resulting incentives are mixed and uneven.

The importance of carrots and sticks arises from a simple problem: Often an activity that has high costs for society as a whole does not have high costs for the people actually engaged in that activity, usually because the actors are able to externalize those costs. Until those costs become the focus of either regulatory limitations or positive financial incentives—or both—the actors will have little reason to participate in a trading scheme. That simple principle explains why a regulatory cap is a key element of most environmental trading schemes: it is the simplest—though by no means the only—way of creating that regulatory push.

Dam management is by no means immune from this need for incentives. A high-environmental-impact, low-value, non-powered dam might seem like an optimal candidate for participation in a trading scheme designed to encourage upgrades or removals. But if the dam's owner does not bear the cost of those environmental impacts, his participation in a trading scheme is unlikely.[286] The incentives are even lower if the dam

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[283] *See generally* Hahn & Stavins, *supra* note 234, at 6 (noting the importance of disparities in compliance costs).

[284] *See, e.g.*, MARTIN & APSE, *supra* note 44 (prioritizing dams on the basis of environmental impact); ERIK H. MARTIN & COLIN D. APSE, CHESAPEAKE FISH PASSAGE PRIORITIZATION: AN ASSESSMENT OF DAMS IN THE CHESAPEAKE BAY WATERSHED (2013).

[285] *See supra* notes 63-67 and accompanying text.

[286] The Edwards Dam story illustrates this dynamic. While the dam made little economic sense, its owners were only willing to consider removal when confronted with a

owner faces no safety-related obligations, does not pay to insure the dam, and—as is entirely plausible in some states—does not even need to provide public information about the dam.[287] For that reason, some regulatory compulsion for dam owners to internalize the negative impacts of their dams is a key element of a successful trading scheme.[288]

Existing dam law does an uneven job of providing those incentives. No federal or state law creates an overall cap on any of the environmental impacts of dams, and environmental limits instead derive from a patchwork of legal obligations. Those obligations are strongest during FERC relicensing processes, when the combination of extensive procedural requirements and multiple environmental law levers creates a powerful incentive for dam owners to consider whether continued operation of a dam really is worthwhile.[289] But even the FERC process contains countervailing incentives, including a default preference toward preserving dams, and FERC itself has been reluctant to actually order dam removals.[290] Recent Congressional changes have been designed primarily to weaken regulatory leverage over dams, and those changes undermine dam owners' incentives to account for their projects' negative effects.[291] In the long periods between licensing processes, the incentives toward maintaining the status quo are even more powerful.[292] Unless FERC or another regulatory agency invokes a "reopener" clause and reconsiders license terms, dam owners are largely exempt from regulatory reexamination during those long interim periods.[293] Consequently, a set of moderately favorable incentives can exist, but only once every several decades.

For federal dams that are not regulated by FERC, the incentives toward maintaining the status quo are similar, if not more powerful. No relicensing process exists, and once Congress authorizes a federally owned dam, the default presumption is that it will remain in place.[294] Indeed, making significant changes to dam operations might actually be precluded by the dam's authorizing legislation.[295] Nor does any statute prescribe a

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combination of legal threats and financial carrots. *See* Crane, *supra* note 125, at 135-43; *see also* Blumm & Erickson, *supra* note 35, at 1073-76 (describing how legal leverage and federal funding facilitated the removal of the Savage Rapids Dam in Oregon).

[287] *See supra* notes 162-167 and accompanying text.

[288] Financial payments could substitute for regulatory leverage—if sufficient money is available. *See* Barton H. Thompson, *Markets for Nature*, 25 WM. & MARY ENVTL. L. & POL'Y REV. 261, 268-94 (2000) (describing acquisition programs and their funding challenges).

[289] *See supra* notes 108-137 and accompanying text.

[290] *See supra* note 129 and accompanying text.

[291] *See* Amos, *supra* note 131, at 9-13.

[292] *See* 16 U.S.C. § 799 (2006) (authorizing up to fifty-year license terms).

[293] *See* California Sportfishing Protection Alliance v. F.E.R.C., 472 F.3d 593, 594-95 (9th Cir. 2006) (finding that ongoing dam operations under a federal license did not require ESA consultation).

[294] *See supra* notes 147-148 and accompanying text.

[295] We are not aware of any court that has so held, and there are potential legal arguments to the contrary. But cases from other contexts illustrate how authorizing

process for concurrently evaluating the status of multiple dams, and therefore considering how multi-dam systems might be realigned. That does not mean that federal dams, once built, are exempt from regulatory oversight. Perhaps most importantly, dam operations remain subject to the Endangered Species Act, and consultation processes may lead to significant new constraints.[296] But both procedural and substantive levers for reconsidering dam operations are significantly weaker than they are for FERC-regulated dams.

For state-regulated dams, those levers are generally weakest of all. As discussed above, few states have any procedural requirement for re-examining the environmental impacts of existing dams—unless someone proposes to make a change to the dam.[297] In many states, substantive environmental constraints on those operations are similarly sparse; while a few states have potentially important environmental requirements for existing dams, in many those dams' environmental impacts are largely unregulated.[298] Safety regulation could be a substitute incentive, but in many states, that regulation exists largely on paper.[299] That does not mean state dam owners are entirely immune to legal leverage. Even absent coverage under regulatory programs, the potential tort liability associated with a failing dam might be incentive enough for a landowner to take some action.[300] The willingness of government agencies and environmental groups to pay for dam removal also provides an important lever, though one limited by the sizes of government and private purses.[301] But the reality in many states is that the path of least resistance, even for a dam with high environmental impacts and very little social value, is to simply leave it in place.

Incentives to upgrade dams, and add additional or new hydropower capacity, are stronger but still quite uneven. Obviously the potential profits from electricity sales are one incentive, particularly where renewable incentive programs elevate the price for that electricity.[302] Similarly, recent federal interest in new hydropower capacity may spur some development.[303] But we found very few legal *processes* designed to promote the positive externalities of hydropower. FERC, for example, does not tell its relicensing applicants, "your equipment is old and underperforming, and we

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legislation can constrain dam operations. *See, e.g.*, *In re* MDL-1824 Tri-State Water Rights Litig., 644 F.3d 1160 (11th Cir. 2011).

[296] *See supra* note 150 and accompanying text (describing controversies surrounding California's Yuba River).

[297] *See supra* notes 156-161 and accompanying text.

[298] *See id*.

[299] *See supra* notes 162-167 and accompanying text.

[300] *See generally* Engberg, *supra* note 168 (discussing tort liabilities associated with dams).

[301] *See generally* Blumm & Erickson, *supra* note 35 (describing multiple dam removals that involved infusions of government money).

[302] *See supra* notes 173-179 and accompanying text.

[303] *See, e.g.*, UNITED STATES DEPT. OF ENERGY, *supra* note 48.

won't grant this license unless you make changes to generate more hydropower." Nor do dams, or other renewable energy projects, get any special treatment through NEPA or ESA processes because of their potential benefits for air quality and climate.[304] Similarly, few, if any, states have programs designed to identify promising locations for new hydropower installations or upgrades.[305] Consequently, dam owners' easiest course of action is often to preserve not just the environmental but also the energy status quo.

The consequence of these uneven incentives is a fragmented regulatory terrain only weakly conducive to trading. The FERC process does provide relatively strong incentives, and when the relicensing process is impending or in progress, dam owners might be particularly interested in identifying other dam removals that could serve as mitigation. And there might be many other dams nearby that could be part of an environmentally and economically sensible deal. But without substantial increases in, and adjustments to, regulatory oversight, the other dam owners will have little regulatory incentive to participate in such deals, even if their dams produce little economic or societal value, and are likely to become involved only if the offering price is sufficiently high. Sometimes it may be, but both private and public funds for environmental restoration are fairly limited. Consequently, while the Penobscot project succeeded largely because many dams were part of the discussion, the existing regulatory system misses most opportunities for recreating that circumstance.

3. *Information*

A third key element in the success of almost any trading scheme is governmental procurement, management, and dissemination of information. For dam trading, that poses a serious challenge, and, again, a potential focus for reforms.

The claim that trading systems necessitate information management may initially sound surprising, for some of the early literature on trading suggested otherwise. Much like other market systems, the thinking went, a trading system could draw upon the knowledge of many dispersed actors, significantly reducing the knowledge burdens placed upon centralized government regulators.[306] Decades later, however, the bloom is off that rose. Regulators have learned that setting the initial rules for trading systems, determining whether trades actually would be environmentally protective, and verifying that traders are following through on their

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[304] J.B. Ruhl, *Harmonizing Commercial Wind Power and the Endangered Species Act through Administrative Reform*, 65 VANDERBILT L. REV. 1769, 1788 (2012) ("There is no green pass under the ESA.").

[305] In the course of our research, we have not identified any such programs.

[306] *See, e.g.*, Ackerman & Stewart, *supra* note 29, at 180 (arguing that a tradable permits system "would immediately eliminate most of the information processing tasks that are presently overwhelming the federal and state bureaucracies").

commitments all can be information-intensive exercises.[307] Without the requisite information, a trading system can fail to fulfill its environmentally protective goals, or can simply collapse.[308]

The informational challenges of environmental trading systems derive largely from the necessity of trading incommensurable things.[309] Most of the items that environmental traders deal are not fully fungible. For air pollutants, for example, location usually matters; a decrease in emissions in a downwind area may not offset an increase farther upwind, even if the amounts are exactly the same.[310] For wetlands and habitat trading programs, the non-fungibility problems are even more acute.[311] No two wetlands, forests, or meadows are exactly the same, and a wide variety of geographic, ecological, and social factors will determine whether the habitat that is created or preserved offers reasonable compensation for the habitat destroyed.[312] That creates a potentially enormous challenge for trading systems: how does one obtain and process the information necessary to determine whether trades are adequate—or compensate for that information's absence?

Existing trading programs address these issues in several ways, each somewhat flawed. One is to measure trades by using some simple currency—pounds of CO_2e,[313] for example, or acres of wetlands—and to ignore any incommensurability that the currency fails to capture.[314] That approach lowers transaction costs, but, unfortunately, it also can routinely place environmental protection on the losing side of deals.[315] Alternatively, regulators can establish trading ratios—that is, they can require 10 acres of protection for each acre of loss—to compensate for potential unevenness, or they can review each trade to make sure it offers fair value.[316] Both approaches offer better assurances of environmental protection, but the

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[307] For a general discussion of the role of information in environmental trading systems, see Owen, *supra* note 38, at 267-73.

[308] *See* Susan Walker et al., *Why Bartering Biodiversity Fails*, 2 CONSERVATION LETTERS 149 (2009).

[309] Salzman & Ruhl, *supra* note 24, at 622-30 (describing the prevalence of non-fungibility).

[310] *See* Richard Toshiyuki Drury et al., *Pollution Trading and Environmental Injustice: Los Angeles' Failed Experiment in Air Quality Policy*, 9 DUKE ENVTL. L. & POL'Y F. 231, 252 (1999).

[311] *See* Salzman & Ruhl, *supra* note 31, at 323.

[312] *See* Salzman & Ruhl, *supra* note 24, at 612 (arguing that wetlands trading historically involved too much tolerance for non-fungible trades).

[313] CO_2e stands for CO_2 equivalent, which is the metric of choice for greenhouse gas trading.

[314] *See* B. Kelsey Jack et al., *Designing Payments for Ecosystem Services: Lessons from Previous Experience with Incentive-Based Mechanisms*, 105 PROCEEDINGS OF THE NAT'L ACADAMY OF SCI. 9465, 9467 (2008) (noting the role of proxy measures in environmental trading systems).

[315] *See* Tietenberg, *supra* note 25, at 87 (noting that traders will generally seek the lowest-cost transaction without regard to environmental benefits).

[316] *See* Owen, *supra* note 38, at 267-68.

costs to regulated entities are higher.[317] Indeed, if the regulators' information demands are sufficiently high, deals may not be worth pursuing at all.

These informational complexities raise a related challenge: addressing them often requires specialized expertise. There are some environmental trading systems that function like an economist's idealized market, with arms-length, low-transaction cost deals somewhat akin to traditional stock or bond trades.[318] But even those markets require tremendous effort to create. In other environmental trading systems—wetlands again are a good example—each trade tends to require oversight and review.[319] That in turn creates the need for experience-based knowledge, both among the traders and the regulators.[320] Traders will need the ability to predict what sort of deal will be approved, lest the system be untenably uncertain, and regulators will need some basis for judging—quickly—whether a trade is satisfactory, lest they approve unreasonable deals or drive up costs by making slow decisions. These problems are not insurmountable, but addressing them takes time and effort.

For dam trading, these informational challenges are potentially substantial. Each dam is embedded in a unique context, and the significant effects, both positive and negative, of dam removals will generally ensure the need for ample information about any potential trade. The intricacies of river ecology contribute to those complexities, and the webs of human interests associated with dams also can take time to sort out. Particularly in western states, where water is relatively scarce, dams are likely to be embedded in complex legal regimes of property rights in water and land.[321] Even beyond those rights, the normal human tendency to view a river—or a reservoir—as a community resource creates a need to gather information about, inform, and respond to public preferences.[322] Dam trading also is an almost completely new concept (and our recent emphasis on dam removal isn't much older), and that too creates challenges. Agency guidance on dam

[317] *Id.*

[318] *See, e.g.*, U.S. Envtl. Prot. Agency, Acid Rain Program SO2 Allowances Fact Sheet, http://www.epa.gov/airmarkt/trading/factsheet.html (describing the program, and offering links for anyone interested in participating).

[319] *See* Morgan Robertson, *The Work of Wetland Credit Markets: Two Cases in Entrepeneurial Wetland Banking*, 17 WETLANDS ECOLOGY & MGMT. 35 (2009) (explaining how wetlands banking requires human contact and site-specific expertise).

[320] *See, e.g.*, *id.*

[321] For a general description of those laws, and they ways they can constrain changes in water use, see BARTON H. THOMPSON ET AL., LEGAL CONTROL OF WATER RESOURCES 167-443 (5th ed. 2013).

[322] *See* New Jersey v. New York, 283 U.S. 336 (1931) ("A river is more than an amenity, it is a treasure."). As one would-be dam trader explained to us, "[t]he main challenge I found was that each dam has such unique and intricate characteristics and even when there's no clear title, or it's been abandoned, the surrounding community feels a ''claim' on it, as a historical or cultural heritage…." Email from James Workman to Dave Owen, Dec. 5, 2011, at 12:02 AM.

trading is nearly non-existent, and the decades-long learning processes that inform air quality and wetlands trading have barely begun to occur.[323] Even with the Penobscot project as a potential model, any entity embarking on a dam trading exercise would still be a pioneer.

Nevertheless, these challenges could become more manageable. Perhaps most importantly, scientists and engineers can analyze river systems in ways that weren't possible twenty or thirty years ago.[324] Using geographic information systems and computer-based modeling, water resource planners have begun creating prioritization maps that identify dams that ought to be prime ecological candidates for removal.[325] Other studies have moved beyond single-dam prioritization lists and developed optimization systems, which are designed to identify what sequence of dam changes will best balance competing goals.[326] Several more recent studies have broadened the scope of the analysis, attempting to identify environmental and hydropower opportunities throughout entire river basins.[327] All of these trends reflect water planners' increasing reliance on sophisticated basin-scale modeling, which can allow planners to identify management approaches that optimize multiple competing goals.[328] The changes also aren't just technocratic. As dam removals become increasingly prevalent, communities are beginning to appreciate the values associated with restoring free-flowing rivers.[329]

The resulting studies could benefit dam trading operations in multiple ways. Initially, they could help identify dams that should be targets for mitigation or upgrades.[330] That identification might be done by the potential traders themselves or by third-party advocacy organizations. Alternatively, regulators might use basin-scale modeling to help pre-define the rules of a trading system. By identifying targeted locations for mitigation projects, and by predetermining the credits associated with those

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[323] We have found only one example of such guidance. *See infra* notes 332-334 and accompanying text.

[324] For general discussion of advances in computer-based river system modeling, see CONVERGING WATERS: INTEGRATING COLLABORATIVE MODELING WITH PARTICIPATORY PROCESSES TO MAKE WATER RESOURCE DECISIONS (Lisa Bourget, ed. 2011).

[325] *See, e.g.*, MARTIN & APSE, *supra* note 44.

[326] *See* Kemp & O'Hanley, *supra* note 89 (summarizing this literature).

[327] *See* JOHNSON ET AL., *supra* note 221; GEERLOFS ET AL., *supra* note 221.

[328] *See generally* Converging Waters, *supra* note 324. For cautionary studies discussing the limits of environmental modeling, see Wendy Wagner et al., *Misunderstanding Models in Environmental and Public Health Regulation*, 18 N.Y.U. ENVTL. L. J. 293 (2010); James D. Fine & Dave Owen, *Technocracy and Democracy: Conflicts Between Modeling and Participation in Environmental Law and Planning*, 56 HASTINGS L.J. 901 (2005)

[329] *See, e.g.*, Bill Provencher et al., *Does Small Dam Removal Affect Local Property Values? An Empirical Analysis*, 26 CONTEMP. ECON. POL'Y 187, 187 (2008) (finding that dam removal is value-neutral for riparian parcels and increases value for other nearby parcels); *see also* Sara E. Johnson & Brian E. Graber, *Enlisting the Social Sciences in Decisions about Dam Removal*, 52 BIOSCIENCE 731 (2008) (describing techniques for enlisting community support).

[330] *See, e.g.*, MARTIN & APSE, *supra* note 44.

projects, they could create greater certainty for future traders, lowering the transaction costs and accelerating the operations of the trading system.[331] Alternatively, modeling might help regulators define more sophisticated currencies for dam trading systems. By moving beyond relatively simple metrics, like river miles, and instead using metrics that integrate multiple values, regulators might direct system participants toward higher-value trades.

For trading to succeed, however, sophisticated informational tools are certainly not enough. Potential traders also need guidance on how that information base would be integrated into regulatory decision-making. Here, as well, some nascent efforts show promise. Perhaps the most intriguing comes from North Carolina, where state environmental agencies and the U.S. Army Corps of Engineers have begun to develop trading ratios when dam removal projects are used as mitigation for filling streams.[332] Their initiative was limited (and short-lived[333]); they only contemplated trades in which dam removals would create credits for filling streams, and not for other activities like maintaining other existing dams.[334] But the basic concept could be refined and extended to other forms of trades; for example, similar guidance could govern trades in which dam removal compensates for other habitat-impacting activities.[335] These initial efforts are just a beginning; the decades-long and still-ongoing process of developing the wetlands trading program demonstrates just how much guidance and experience may ultimately be necessary.[336] But they still provide promising signs.

In conclusion, the need for information creates big challenges and important reform opportunities for dam management. With rare exceptions, existing informational systems are not robust enough to support extensive trading. And some informational challenges probably always will remain; environmental trades involving dams will always face more friction than those involving sulfur dioxide emissions, for example, and the unique

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[331] *See* Owen, *supra* note 38, at 268-73 (explaining how up-front planning can help regulators design environmental trading systems).

[332] U.S. Army Corps of Engineers et al., Determining Appropriate Compensatory Mitigation Credit for Dam Removal Projects in North Carolina, February 13, 2008.

[333] *See* U.S. Army Corps of Engineers, Wilmington District, *Public Notice*, May 7, 2012 (withdrawing the guidance).

[334] Some scientists might also criticize their currency as crude, for it focuses primarily on linear miles of restored streams. *See* Lave et al., *supra* note 260, at 288 (claiming reliance on linear stream length as the sole currency "is deeply problematic"). But the guidance does identify additional adjustment factors, and dam removers can obtain additional credit by monitoring the recovery of the undammed stream system. *See* U.S. Army Corps of Engineers et al., *supra* note 332.

[335] *See, e.g.*, Dave Owen, *Critical Habitat and the Challenge of Regulating Small Harms*, 64 FLORIDA L. REV. 141, 193-94 (2012) (suggesting that dam removals might be used to mitigate impacts to endangered species' critical habitat).

[336] *See, e.g.*, Tammy Hill et al., *Compensatory Stream and Wetland Mitigation in North Carolina: An Evaluation of Regulatory Success*, 51 ENVTL. MGMT. 1077 (2013) (documenting improving performance).

context of each dam will necessitate some site-specific tailoring of each trade. But a combination of evolving information technology and increasing experience could make information demands less of a barrier, particularly if regulators take active steps toward developing a stronger informational base.

V. INTEGRATING REFORMS: A MODEL PROGRAM

The preceding discussion identifies a variety of challenges and implies many reforms. To bring our reform ideas into focus, we therefore close with a sketch of a model reform program. For several reasons, we focus on states (though some analogous changes could occur at the federal level). First, state dam laws have tremendous room for improvement. As discussed above, state dam law is often highly underdeveloped, and what law exists is not always implemented in any meaningful way.[337] Second, in the literature on dams, states have received the least attention. Consequently, while we think promising reforms could and should occur at the federal level,[338] the prescriptions that follow explain what a thoughtful state might do with its dams.

A. Environmental Regulation

An effective dam policy requires regulatory sticks, and on that front states have ample room for improvement. At a minimum, a state dam

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[337] *See supra* notes 156-180 and accompanying text.

[338] While a full description of these recommendations is beyond the scope of this paper, we think several federal reforms offer promise:

- FWS and NMFS could issue guidance on using dam removals as mitigation for impacts to endangered species;
- FWS could use endangered species recovery planning as a platform for developing basin-scale restoration plans. Those plans could identify opportunities—and mitigation values—for dam removals, and could also identify overall caps on dam-related species impacts;
- The U.S. Army Corps of Engineers could develop guidance documents on using dam removal to mitigate the impacts of filling wetlands and waterways;
- FERC could reserve authority to reopen licenses whenever a basin-scale planning effort is underway;
- FERC could adjust the duration of licenses so that multiple facilities on the same river come up for relicensing at the same time;
- FERC could impose system benefits charges on all hydropower operators to create a funding base for basin-scale planning;
- Integrating and expanding upon the preceding ideas, FERC, other federal agencies, and state agencies could create procedures for "general dam adjudications," which would concurrently address the environmental impacts of dams throughout a river system;
- FERC could create a revolving planning fund, which would be replenished by charging a portion of the profits of dams allowed to remain in place.

We are indebted to Richard Roos-Collins for that last suggestion.

regulatory program ought to include three elements, all designed to compel more careful accounting—and, then, elimination, reduction, or mitigation—of the costs of dams.

The first, and most important, step would be to create environmental performance requirements for existing dams. While states might choose to establish lower performance standards for existing facilities, or might choose to phase those requirements in, there is no compelling reason to grant environmentally destructive facilities near-permanent exemptions from environmental law.[339] Second, and relatedly, the state should create periodic procedural opportunities for re-examining the status of dams. Here, the FERC relicensing process provides a useful starting point, though shorter license terms would be preferable, as would schedules creating concurrent review processes for all dams within a watershed.[340] Rivers, dams, and societal needs all change over time, and a relicensing process provides a valuable opportunity to examine whether a dam still makes sense, or whether it should be operated differently, or removed. Third, and finally, the state should have a meaningful dam safety program that actually gets implemented.[341] Dams do fail, sometimes with tragic consequences, and a failure to monitor dam conditions therefore is a public safety problem as well as a missed opportunity to reconsider dams' existence or operations.

All of these recommendations might raise one question: do states have the power to make these changes? Legally, at least, the answer should be a clear yes. Dams and the associated water rights do implicate systems of property law, and to many people, property rights connote permanence.[342] But property rights nearly always are subject to reasonable regulation, and that has been particularly true of rights that implicate water resources and wildlife.[343] Dams themselves fall well within that tradition. Even at the time of the founding fathers, statutes requiring fish passage and, sometimes, dam removals were quite prevalent—James Madison himself sponsored one such law—and the Framers appeared to view those laws as

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[339] For a summary of problems with long-term grandfathering, see Bruce R. Huber, *Transition Policy in Environmental Law*, 35 HARV. ENVTL. L. REV. 91, 93-94 (2011).

[340] *See supra* notes 292-293 and accompanying text (explaining problems caused by long license periods and staggered review obligations).

[341] *See supra* notes 297-301 and accompanying text (critiquing state programs).

[342] *See* Joseph L. Sax, *The Constitution, Property Rights and the Future of Water Law*, 61 U. COLO. L. REV. 257, 260 (1990) ("Water rights *are* property.").

[343] *See* United States v. Willow River Power Co., 324 U.S. 499, 510 (1945) ("Rights, property or otherwise, which are absolute against all the world are certainly rare, and water rights are not among them."). *See generally* Michael C. Blumm & Aurora Paulsen, The Public Trust in Wildlife, 2013 UTAH L. REV. __ (forthcoming) (discussing how sovereign ownership of wildlife empowers governmental regulation); Brian E. Gray, *The Property Right in Water*, 9 HASTINGS W.-NW. J. ENVTL. L. & POL'Y 1 (2002) (discussing the inherent malleability of property rights); Sax, *supra* note 342.

entirely compatible with property law.[344] That compatibility should persist to the present day, and should offer states ample latitude for more robust regulatory governance.[345]

B. Information

While legal constraints are essential to the success of any trading schemes, softer forms of regulation also have key roles to play. Most importantly, a reform-minded state could improve its dam policy by providing more information about dams.

A model dam information program would include several elements. At the most basic levels, states could maintain more thorough dam inventories, which include the results of recent environmental and safety reviews, and make the information in those inventories publicly available. States also could work with federal agencies and non-profits, many of whom already are engaged in mapping projects to identify fish passage impediments and sites with hydropower potential, to make the results of their studies available on-line.[346] And, more ambitiously, states could sponsor and disseminate (or require dam owners to fund) basin-scale dam optimization studies, and could make those studies available for public review.[347] All of these changes still would leave information gaps, for the complexity of river systems would ensure that some key information is left out. But they would at least provide would-be dam traders with information about which dams to target and which people to contact.

C. Trading System Guidance

The state also could provide informational support in another key way. Established environmental trading systems often are supported by detailed, pre-specified rules and ample agency guidance.[348] The Army Corps of Engineers and EPA, for example, have spent years refining and explaining their approaches to wetlands mitigation, and the resulting guidance has helped create predictability and build public- and private-

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[344] *See generally* Hart, *supra* note 84; *see also* John F. Hart, *Colonial Land Use Law and its Significance for Modern Takings Doctrine*, 109 HARV. L. REV. 1252 (1996) (arguing that land use regulation has been pervasive since the colonial era).

[345] *See generally* Dave Owen, *Taking Groundwater*, 91 WASH. U. L. REV. __ (forthcoming) (providing doctrinal and theoretical arguments for extensive regulatory authority over water use).

[346] *See, e.g.,* Maine Stream Connectivity Workgroup & Maine Office of GIS, Maine Stream Habitat Viewer, at http://mapserver.maine.gov/streamviewer/streamdocHome.html (last visited January 9, 2014).

[347] The federal government's studies of the Deschutes, Connecticut, and Roanoke basins provide one model for such studies. *See supra* note 221 and accompanying text.

[348] *See, e.g.*, EPA, Compensatory Mitigation, at http://water.epa.gov/lawsregs/guidance/wetlands/wetlandsmitigation_index.cfm (last visited January 9, 2014) (providing links to a library of guidance documents).

sector expertise.[349] If dam trading is to succeed, a similar level of effort will be necessary.

States could offer that guidance in several ways. First, following the recent example of North Carolina, they could pre-specify generic currencies and trading ratios for mitigation projects involving dam removals.[350] Second, they could study river basins, identify potential removal and upgrade sites, and establish basin-specific or even dam-specific trading ratios. Third, if states decide that pre-set currencies and trading ratios are too crude to capture the environmental complexities of dam systems, they at least could set forth criteria and procedures for reviewing potential trades. Absent that sort of guidance, each dam trade will be a one-off exercise, with all the time, costs, and risks associated with doing something almost completely new. With it, potential trade participants will at least have a set of structured expectations and a starting point for institutional learning.

For the state, fulfilling this recommendation will not be easy. Any set of trading system rules will necessarily ignore some of the complexity of the real world, and thus will allow traders to dismiss some consequences that reasonable people would care about.[351] For that reason, the scientists involved in basin-scale studies often seem quite reluctant to translate any of their recommendations into policy prescriptions. But some messiness is an unavoidable component of any regulatory system, including the status quo.[352] The key question, then, is not whether a trading system would involve serious flaws; no doubt it would. Instead, it is whether trades could improve on existing legal systems that leave a problematic status quo largely entrenched. The answer to that question might well be yes, and until innovations are tested, no one will know.

D. Institutional Support

Implicit in all the suggestions we have made thus far are two more recommendations. First, the state needs to have people who come to work thinking about improved dam systems. Second, the state needs to pay for those people's work.

The former recommendation is important because dam regulation requires policy innovation, and innovation is not the sort of thing that can be automated. Instead, all of the steps we have described require human expertise and judgment. And these steps are just the tip of the iceberg, for implementing an improved dam removal program will necessarily require working with other state agencies, federal agencies, local governments and communities, water users, the hydropower industry, other dam owners, and

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[349] *See supra* notes 264-266 and accompanying text (describing this evolution).

[350] *See* U.S. ARMY CORPS OF ENGINEERS ET AL., *supra* note 332.

[351] For a detailed development of this critique in the context of water rights trading, see Freyfogle, *supra* note 263, at 31-33.

[352] *See* Owen, *supra* note 335, at 193-94 (explaining how alternatives to trading systems can present their own problems).

environmental non-profits. The track records of state dam programs bear this out. It is no coincidence states with particularly robust dam removal programs—Pennsylvania, for example—have had environmental agency staff assigned to dam management.[353]

The latter recommendation follows from the former. In an era of limited general funds, one cannot simply assume that financial support for dam management will magically appear, and we recommend that our model state consider alternative funding mechanisms. One possibility is a general dam ownership fee, which could be pro-rated to the scale of the dam. An alternative possibility is a revolving loan fund, which would use planning to support a mixed program of dam removals and hydropower upgrades, and then use some of the profits from the hydropower upgrades to replenish the fund and support new rounds of hydropower planning. A third, and more ambitious, possibility would be to impose a fee requirement on some other related activity, like energy use or water consumption. Obviously all of these possibilities have their strengths and weaknesses, but the key point is that our state should avoid the circumstance—presently quite common for dam safety programs—in which a superficially robust program languishes for lack of financial support.[354]

E. Pricing Incentives

So far, our recommendations have focused primarily on increasing environmental constraints upon existing dams. That is appropriate, for those constraints are presently too weak, but positive incentives also have a role to play. Some of the most important incentives involve creating a favorable economic environment for environmentally sensitive hydropower.

There are several ways to do this. One is to ensure that the environmental impacts of other energy sources are adequately regulated. Every subsidy or exemption directed at the fossil fuel industry, for example, effectively negates an economic edge that hydropower ought to receive.[355] Similarly, any regulatory program that prices greenhouse gas emissions, like the northeastern states' Regional Greenhouse Gas Initiative or California's AB 32 program, will create collateral benefits for hydropower.[356] An alternative, or perhaps complementary, mechanism is to pass a renewable portfolio standard that includes sustainable hydropower—and to use environmental performance, not size, as the key criterion for

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[353] *See* Pennsylvania Dept. of Envtl. Prot., Waterways Engineering and Wetlands (describing the state DEP's active role in dam removals); Kevin Begos, *Report: Pa. Lead Nation in Dam Removal in 2012*, ASSOC. PRESS, March 12, 2013.

[354] *See supra* notes 162-167 and accompanying text.

[355] *See* Outka, *supra* note 278, at 1702-19.

[356] *See* California Environmental Protection Agency, Air Resources Board, Assembly Bill 32: Global Warming Solutions Act, http://www.arb.ca.gov/cc/ab32/ab32.htm (last visited December 17, 2013); Regional Greenhouse Gas Initiative, http://www.rggi.org/ (last visited December 17, 2013).

inclusion in that standard.[357] Massachusetts already has modeled this approach, and its innovation encourages hydropower while also providing incentives to generate that hydropower in relatively sustainable ways.[358]

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These reform proposals hardly exhaust the field. But a state that adopts the program we have described would be taking huge steps toward a more progressive dam policy, in which exchanges like the Penobscot River Restoration Project help lead to more sensible uses of rivers and dams.

CONCLUSION

In a sense, the dams of the Penobscot River all are relics of an earlier age. The United States stopped building dams during the Reagan Administration, and outside of Alaska, there are hardly any serious proposals for large-scale dam construction to resume.[359] But in much of the rest of the world, the situation is quite different. Hundreds of dams, many of them enormous, are currently planned across South America, Asia, and Africa. Many national governments view those planned dams as integral components of their economic development strategies, and while the judgments informing these views are sometimes slanted or dubious, the plans nevertheless are quite real. If those dams are sited and built without regard to environmental impacts—in other words, if they are built the same way the dams on the Penobscot, and throughout much of the rest of the United States, were—the ecological consequences will be devastating.

The dam laws of other nations are not the subject of this Article; our discussion instead has focused almost entirely upon the United States. But the still-unfolding international age of dams highlights the importance of any successful United States reforms. If some hydropower development is inevitable, then there is a glaring and urgent need for legal mechanisms that will reduce the impacts of those dams that are built. Environmental trading systems could be one such mechanism. And there is precedent for imitation, for the United States' pioneering experiments with environmental trading systems have now influenced regulatory approaches around the world.[360] Dams, then, could be the next frontier.

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[357] *See supra* notes **Error! Bookmark not defined.**-179 and accompanying text (noting states' tendency to use size as a key eligibility criterion for pricing incentive programs).

[358] To be eligible for Massachusetts' renewable portfolio standard, a dam must be certified by the Low Impact Hydropower Institute, a private organization. *See* Johnson, *supra* note 175, at 25-30.

[359] *See* REISNER, *supra* note 11, at 306-31 (describing the demise of the dam-building era); Barringer, *supra* note 11 (describing a major Alaskan dam proposal).

[360] *See generally* MADSEN, *supra* note 230 (describing the global proliferation of environmental trading systems).

We do not claim that crossing that frontier will be easy. Trading systems will never be a perfect fit for dams, or for river management more generally. Nor will they be fully effective upon first emergence; in this realm, as in most areas of regulatory policy, learning will take time. But the restoration of the Penobscot illustrates how the concept of trading holds promise.