Mitigating the Adverse Effects of Hydropower Projects: A Comparative Review of River Restoration and Hydropower Regulation in Sweden and the United States

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Abstract

Hydropower involves two of the most pressing global environmental challenges of modern society—accelerated biodiversity loss and climate change. On one hand, hydropower provides a reliable source of renewable energy. On the other, it contributes to significant biodiversity loss in freshwater ecosystems. Mature hydropower producing countries must increasingly restore habitats damaged by existing hydropower projects while attempting to increase their

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± The authors thank Christer Nilsson and Anne Hereford for reviewing this paper. A substantial part of the research was made possible through the GOVREP project funded by the Norwegian Research Council, Statkraft, and Adger Energi. The funders did not influence study design, collection, analysis, or interpretation of data.

production of renewable energy. Meanwhile, developing hydropower countries are only beginning to craft regulations for their burgeoning hydropower industries.

This article evaluates the application of environmental laws to hydropower projects in Sweden and the United States, comparing the relative contribution of each regulatory program to river restoration. It concludes that the United States has achieved greater ecosystem restoration, primarily due to its hydropower licensing framework. In the United States, regulators issue licenses for a limited term of thirty to fifty years. After the license expires, the operator must obtain a new license compliant with current environmental laws. In Sweden, licenses are perpetual, and only the environmental laws in effect at the time of the original licensing bind dam operators. Countries can strengthen laws governing hydropower operations by learning from the different extent of river restoration in these two similarly situated hydropower-producing countries. To improve hydropower regulation in developed countries and to create effective regulations in developing countries, the following two elements are essential: (1) mandatory, periodic review of licenses to adapt to new laws, changed circumstances, and scientific improvements; and (2) placing the burden of proof on project operators to demonstrate that a given project serves the public interest.

This article first discusses the conflict in hydropower regulation: fostering power generating technologies with limited carbon emissions versus protecting river ecosystems. It then compares hydropower productivity and river restoration in Sweden and the United States—two similarly situated hydropower-producing countries. The article then compares the differing procedural and substantive laws and regulations in Sweden and the United States before explaining how different environmental laws in the two countries results in different extent of river restoration. Ultimately, the article finds that the United States' system affords greater long-term environmental protection, a conclusion that offers suggestions for both developed and developing countries alike to craft and update hydropower policies.

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INTRODUCTION

Hydropower is a competitive source of electricity production, comprising more than 16% of the electricity generated worldwide.[1] Hydropower is a renewable source of energy and can be readily dispatched to balance the electric grid by meeting fluctuating demand and supply.[2] At the same time, hydropower projects also have negative social and ecological effects.[3] Measures to protect and restore the environment can limit the expansion of hydropower despite its positive attributes.

This conflict is particularly acute when building new hydropower projects.[4] The U.S. Department of Energy recently estimated that the capacity for new stream-reach development in the United States is 84.7 gigawatts (GW), with total undeveloped generation estimated at 460 terawatt hours (TWh) per year.[5] However, the estimated capacity falls to 65.5 GW by excluding federally protected areas.[6] This figure is only slightly lower than the combined existing hydropower capacity in the United States.[7]

There is also significant potential to increase hydropower capacity by upgrading existing projects within mature hydropower producing countries. In Sweden, upgrading medium- and large-scale facilities would result in an additional 3 TWh per year, representing an increase of almost 5% in hydropower production.[8] Between 2003 and 2012, upgrades to existing projects resulted in a production

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1. Haley Moller, *Hydropower Continues Steady Growth*, EARTH POL'Y INST. (June 14, 2012), http://www.earth-policy.org/data_highlights/2012/highlights29 (last visited Mar. 13, 2015); *Role of Dams*, INT'L COMM'N ON LARGE DAMS, http://www.icold-cigb.org/GB/Dams/Role_of_Dams.asp (last visited Mar. 13, 2015).

2. INT'L ENERGY AGENCY, TECHNOLOGY ROADMAP: HYDROPOWER 7, 9 (2012), *available at* http://www.iea.org/publications/freepublications/publication/2012_Hydropower_Roadmap.pdf.

3. *See, e.g.*, EDWARD GOLDSMITH & NICHOLAS HILDYARD, THE SOCIAL AND ENVIRONMENTAL EFFECTS OF LARGE DAMS xi, 18-19, 21-22, 29-34 (1984); D.M. Rosenberg et al., *Environmental and Social Impacts of Large Scale Hydroelectric Development: Who Is Listening?*, 5 GLOBAL ENVTL. CHANGE 127 (1995).

4. *See, e.g.*, Andrew L.R. Jackson, *Renewable Energy vs. Biodiversity: Policy Conflicts and the Future of Nature Conservation*, 21 GLOBAL ENVTL. CHANGE 1195, 1195 (2011).

5. SHIH-CHIEH KAO ET AL., U.S. DEP'T OF ENERGY, NEW STREAM-REACH DEVELOPMENT: A COMPREHENSIVE ASSESSMENT OF HYDROPOWER ENERGY POTENTIAL IN THE UNITED STATES 15 (2014), *available at* http://nhaap.ornl.gov/sites/default/files/ORNL_NSD_FY14_Final_Report.pdf.

6. *Id.* at 22.

7. *Id.*

8. PETER M. RUDBERG, STOCKHOLM ENV'T INST., SWEDEN'S EVOLVING HYDROPOWER SECTOR: RENOVATION, RESTORATION AND CONCESSION CHANGE 6 (2013), *available at* http://www.sei-international.org/mediamanager/documents/Publications/SEI-ProjectReport-Rudberg-SwedensEvolvingHydropowerSector-2013.pdf.

increase of 337 GWh per year in Sweden.[9] In the United States, production capacity has increased by 3.51% from 1986 to 2001 through capacity increases incident to relicensing.[10] The U.S. Department of Energy estimates that there is an additional potential 12.1 GW of hydropower capacity at the 54,000 dams in the United States that currently do not produce hydropower.[11]

Although there is important potential for expanded production by upgrading existing hydropower facilities across the United States,[12] there is increased recognition that the benefits of such expansion must balance the environmental costs. For example, expansion in regions with high fish endemism would become subject to regulations to avoid further harm to imperiled aquatic resources.[13]

As of March 2014, there were 3,700 hydropower projects with a capacity of greater than 1 megawatt (MW) planned (83%) or under construction (17%) globally.[14] If completed, these projects would increase global hydropower capacity from 980 GW in 2011 to 1,700 GW.[15] However, the expansion would result in the fragmentation of 25 of the 120 large river systems currently classified as free flowing, primarily in South America—a loss of 21% of large, free-flowing river systems worldwide.[16]

As shown in mature hydropower producing countries, dam-related habitat fragmentation and altered flow regimes disrupt freshwater ecosystems by, among other things, preventing freshwater species from migrating above and below dams.[17] These effects make hydropower projects one of the biggest causes of freshwater species loss globally.[18] Global species loss occurs at a rate that some

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9. *Id.*

10. *See* FED. ENERGY REGULATORY COMM'N, REPORT ON HYDROELECTRIC LICENSING POLICIES, PROCEDURES, AND REGULATIONS 50-51 n. 115 (2001), *available at* http://www.ferc.gov/legal/maj-ord-reg/land-docs/ortc_final.pdf.

11. BOUALEM HADJERIOUA ET AL., U.S. DEP'T OF ENERGY, AN ASSESSMENT OF ENERGY POTENTIAL AT NON-POWERED DAMS IN THE UNITED STATES 22 (2012), *available at* http://www1.eere.energy.gov/water/pdfs/npd_report.pdf.

12. *Recovery Act Announcement: Hydropower Upgrades to Yield Added Generation at Average Costs Less than 4 Cents per kWh—Without New Dams*, U.S. DEP'T OF ENERGY (Nov. 14, 2009), http://energy.gov/articles/hydropower-upgrades-yield-added-generation-average-costs-less-4-cents-kwh-without-new-dams.

13. *See* Robert I. McDonald et al., *Energy, Water and Fish: Biodiversity Impacts of Energy-Sector Water Demand in the United States Depend on Efficiency and Policy Measures,* 7 PLOS ONE 1, 14 (Nov. 2012), *available at* http://www.plosone.org/article/fetchObject.action?uri=info:doi/10.1371/journal.pone.0050219&representation=PDF.

14. Christiane Zarfl et al., *A Global Boom in Hydropower Dam Construction*, 77 AQUATIC SCI. 161, 165 (2015).

15. *Id.*

16. *Id.* at 166.

17. *See* Christer Nilsson et al., *Fragmentation and Flow of the World's Largest River Systems*, 308 SCI. 405, 405 (2005); Björn Malmqvist & Simon Rundle, *Threats to the Running Water Ecosystems of the World*, 29 ENVTL. CONSERVATION 134, 138 (2002); Christer Nilsson et al., *Long-Term Responses of River-Margin Vegetation to Water-Level Regulation*, 276 SCI. 798, 798 (1997).

18. *See* David Dudgeon et al., *Freshwater Biodiversity: Importance, Threats, Status and Conservative Challenges*, 81 BIOLOGICAL REV. 163, 166, 168 (2006); Charles Vörösmarty et al., *Global Threats to Human Water Security and River Biodiversity*, 467 NATURE 555, 558 (2010).

consider more alarming than the rate of climate change.[19]

A country's regulation of hydropower necessarily strikes a balance between promoting renewable, low-carbon energy and protecting river ecosystems. This article evaluates this balancing by comparing the hydropower regulations and river restoration efforts in two countries, the United States and Sweden. It concludes that effective regulation must include: (1) mandatory periodic review of licenses to adapt to changed circumstances and improved science; and (2) placing the burden of proof on project operators to demonstrate that the project is in the public interest.

This article looks at Sweden and the United States because both are mature, democratic hydropower producing countries. In 2010, the United States was the fourth-biggest producer of hydropower globally, and Sweden was the tenth-largest producer.[20] Sweden is a good case study because it is subject to European Union Directives, represents the European Union more broadly, and is one of Europe's most important hydropower producers.[21] Both Sweden and the United States have environmental regulations established in the 1970s, including those for the protection of threatened and endangered species.[22] Additionally, water regulation and fragmentation from dams impact a similarly high share of the largest river systems in each country.[23]

This article addresses three questions: (1) Are there significant differences in river restoration measures at hydropower projects in Sweden and the United States? (2) If there are significant differences, to what extent can the differences be attributed to differences in procedural laws? (3) To what extent can the differences be attributed to differences in substantive laws?

To answer the first question, the article compares specific river restoration measures—dam removal, construction of fish passage facilities and fish screens, and minimum flow releases requirements—because they directly mitigate the flow regime change and habitat fragmentation caused by hydropower projects.[24] Compared to Sweden, the United States has implemented more of these mea-

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19. Johan Rockström, *A Safe Operating Space for Humanity,* 461 NATURE 472, 472-75 (2009).

20. INT'L ENERGY AGENCY, *supra* note 2, at 10.

21. *See id*.

22. Endangered Species Act of 1973, 16 U.S.C. §§ 1531 *et seq.* (2015); Directive 2000/60, of the European Parliament and of the Council of 23 October 2000 Establishing a Framework for Community Action in the Field of Water Policy, art. 6, Annex IV, tbl. 1.3.5, tbl. 1.4.1, 2000 O.J. (L 327) 1, 12, 32 (EC), *available at* http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060 [hereinafter Water Framework Directive]; Directive 2009/28, of the European Parliament and of the Council of 23 April 2009 on the Promotion of the Use of Energy from Renewable Sources and Amending and Subsequently Repealing Directives 2001/77/EC and 2003/30/EC, Preamble para. 69, art. 17(3)(b)(ii), 2009 O.J. (L 140) 16, 23, 37 (EC), *available at* http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:32009L0028 [hereinafter Renewable Energy Directive].

23. Mats Dynesius & Christer Nilsson, *Fragmentation and Flow Regulation of River Systems in the Northern Third of the World*, 266 SCI. 753, 755-758 (1994).

24. *See* Emily Bernhardt et al., *Restoring Rivers One Reach at a Time: Results from a Survey of U.S. River Restoration Practitioners,* 15 RESTORATION ECOLOGY 482, 484 (2007).

sures, causing a slight reduction of hydropower productivity. To answer the second question, the article reviews and compares the procedural laws of the two countries with a focus on hydropower license review, including the term of granted licenses and the burden of proof in license review and relicensing proceedings. To answer the third question, the article reviews and compares substantive laws of the two countries with a focus on standards for biodiversity protection, renewable energy promotion, and climate change mitigation, as well as legal principles such as "polluter pays." While both Sweden and the United States have substantive laws that are similarly protective of aquatic ecosystems, their procedures for licensing hydropower projects differ in key respects, which explains the different extent of restoration. Specifically, the United States requires periodic review of licensed projects[25] and puts the burden of demonstrating that the project is in the public interest on the project operator as the license applicant.[26] Incorporating these procedures into the hydropower regulations of other countries should result in similar environmental results.

I. HYDROPOWER PRODUCTION AND RESTORATION MEASURES

This section first discusses the prevalence of hydropower and the basics of licensing in Sweden and the United States. It then compares hydropower production and the extent of environmental restoration in each country by quantifying the following: the number of hydropower licenses in each country; the number of licenses reviewed in a twenty-year period; the number of environmental measures implemented as a result of the license reviews; and the reduction in hydropower production resulting from the implementation of the environmental measures.

There are significant differences in river restoration measures between Sweden and the United States—particularly concerning incidents of project decommissioning in the United States, which are sometimes for failure to satisfy new requirements from relicensing or license amendment. For example, in 2009, one of several river restoration projects in the United States began on the Elwha River in Washington.[27] The project involved decommissioning and removing two medium-sized, functioning hydropower dams (108 and 210 feet tall) with a total installed capacity of 28 MW.[28] Most recently, the Federal Energy Regulatory Commission ("FERC") revoked a license and decommissioned a project for failure to construct fish passage facilities required by a license amendment to upgrade capacity.[29] Reports and scientific articles from Sweden do not discuss

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25. 16 U.S.C. § 808 (2015).

26. 5 U.S.C. § 556(d) (2015).

27. *Restoring Rivers: Major Upcoming Dam Removals in the Pacific Northwest*, CAL. DEP'T OF WATER RES., http://www.water.ca.gov/fishpassage/docs/dams/dams.pdf (last visited Mar. 13, 2015).

28. *Id.*

29. E. Hydroelec. Corp., 76 F.E.R.C. ¶ 62,170, 64,314 (2014).

any similar dam removals as a result of a revoked hydropower license. There is only evidence of one recent failed process in court to revoke a granted hydropower license.[30]

This article empirically evaluates the extent of river restoration activities using reports from relevant administrative and regulatory bodies as well as scientific articles. In Sweden, the analysis focuses on all of the hydropower projects, which are regulated by the Land and Environmental Court.[31] In the United States, the analysis focuses on non-federal hydropower projects licensed by FERC.[32]

A. PRODUCTION, CAPACITY, AND LICENSES

Sweden and the United States are similarly developed hydropower-producing nations, making them effective for comparing hydropower projects. For example, water regulation and fragmentation from dams impact the large river systems in both countries to a similar extent.[33] Sweden has approximately 2,100 hydropower projects and the United States approximately 2,400.[34] The total hydropower production capacity is 16 GW in Sweden and 75 GW in the United States.[35]

In Sweden, multiple licenses[36] can be issued to regulate different aspects of the same hydropower project.[37] In the United States, a single license regulates all aspects of project construction, operation, and maintenance.[38] FERC may even regulate multiple dams under a single license if the dams operate as a "complete unit of development."[39]

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30. Maria Harning, *Långforsens tillstånd dras inte tillbaka [The Permit of Långforsen Is Not Revoked]*, SVT (June 18, 2014), http://www.svt.se/nyheter/regionalt/jamtland/langforsens-tillstand-dras-inte-tillbaka (Swed.).

31. *Cf.* MILJÖBALK [MB] [ENVIRONMENTAL CODE] 21:1 (Swed.), *English translation available at* http://www.sweden.gov.se/sb/d/574/a/22847.

32. As under the U.S. Federal Power Act, the term "hydropower project" includes the dam, powerhouse, reservoir, and any other structures, rights, lands, and waters regulated by a license or exemption. *See* 16 U.S.C. § 797(e) (2015). Hydropower projects are classified by capacity using the following terminology: "Mini" up to 1.5 MW, "small" up to 5 MW, "medium" up to 30 MW, and "large" more than 30 MW.

33. *See* Dynesius & Nilsson, *supra* note 23, at 755-58.

34. Statens Offentliga Utredningar [SOU] 2009:42 Vattenverksamhet. Delbetänkande Av Miljöprocessutredningen [Water Operations. Interim Report from the Environmental Process Inquiry] [government report series] (Swed.), *available at* http://www.regeringen.se/sb/d/11597/a/125366 [hereinafter Vattenverksamhet]; DOUGLAS G. HALL & KELLY S. REEVES, IDAHO NAT'L LAB., A STUDY OF UNITED STATES HYDROELECTRIC PLANT OWNERSHIP 1 (2006), *available at* http://hydropower.inl.gov/hydrofacts/pdfs/a_study_of_united_states_hydroelectric_plant_ownership.pdf.

35. Statens Offentliga Utredningar [SOU] 2013:69 Ny tid ny prövning—förslag till ändrade vattenrättsliga regler [New Time New Assessment—Proposal for Changed Water Legislation] [government report series] (Swed.), *available at* http://www.regeringen.se/content/1/c6/22/52/62/0245ed3e.pdf; HALL & REEVES, *supra* note 34, at 5.

36. The term hydropower license is used with the same meaning as "permit for water operation," the formal legal term in Sweden.

37. Vattenverksamhet, *supra* note 34.

38. *See* 16 U.S.C. §§ 796(11)-(12), 797(e) (2015).

39. *See* 16 U.S.C. § 796(11) (2015).

Thus, except for a few differences, Sweden and the United States are equally situated as developed countries with high levels of hydropower development subject to licensing regulation.

B. RIVER RESTORATION MEASURES

In Sweden, the Land and Environmental Court decides river restoration measures related to fish and biodiversity through adding new conditions in a license review trial.[40] Between 1990 and 2010, the Court reviewed a total of 90 hydropower licenses, resulting in 132 biodiversity and fish improvement measures.[41] So far, there is no evidence that the Land and Environmental Court has required any dam removals through a license revocation process.[42]

In the United States, FERC issues licenses for periods of thirty to fifty years.[43] Once a license expires, the project operator must apply for a new license through the relicensing process.[44] During relicensing, FERC evaluates the project and determines whether continuing to operate the project is in the public interest and, if so, under what conditions.[45] Prior to approving a license, FERC may require "modification of any project and of the plans and specifications of the project works" to ensure the project is, in FERC's judgment, best adapted to a comprehensive plan of development for the affected waterway.[46]

Between 1990 and 2010, FERC relicensed 501 hydropower projects.[47] A nationwide study of 363 relicensings between 1987 and 2000 revealed that FERC approved 142 fish passage improvements in 112 projects.[48] Another study reported that at least 600 dams were removed in the United States,[49] 19 of which

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40. *See* MILJÖBALK [MB] [ENVIRONMENTAL CODE] 24:5.

41. MIKAEL HEDENSKOG & JENNY MONSÉN, LÄNSSTYRELSEN VÄRMLAND [CNTY. ADMIN. BD. OF VÄRMLAND], OMPRÖVNING AV VATTENDOMAR: MÖJLIG INDIKATOR FÖR MILJÖMÅLET: LEVANDE SJÖAR OCH VATTENDRAG [REVIEW OF CONCESSIONS: POSSIBLE INDICATOR FOR THE ENVIRONMENTAL QUALITY OBJECTIVE: LIVING LAKES AND RIVERS] 6 (rev. Oct. 2012), *available at* http://www.lansstyrelsen.se/varmland/SiteCollectionDocuments/Sv/publikationer/2012/rapport-2012-13-vattendomar-hedenskog.pdf.

42. Harning, *supra* note 30.

43. 16 U.S.C. § 808(e) (2015).

44. *Id.* § 808(a)(1).

45. *Id.* § 808(a)(2).

46. *Id.*

47. For a complete list of licenses issued by FERC, see FED. ENERGY REGULATORY COMM'N, *Complete List of Issued Licenses*, *available at* http://ferc.gov/industries/hydropower/gen-info/licensing/licenses.xls (last visited Mar. 13, 2015) [hereinafter *Complete List of Issued Licenses*].

48. FED. ENERGY REGULATORY COMM'N, EVALUATION OF MITIGATION EFFECTIVENESS AT HYDROPOWER PROJECTS: FISH PASSAGE 10 (2004), *available at* https://www.ferc.gov/EventCalendar/Files/20041018094218-fish-pass-final-report.pdf. There is no complete national database of river restoration measures resulting from relicensing, so this article relies on various studies that provide a reasonable overview of the situation.

49. Jamie Pittock & Joerg Harmann, *Taking a Second Look: Climate Change, Periodic Relicensing and Improved Management Of Dams*, 62 MARINE & FRESHWATER RES. 312, 316 (2011); Molly M. Pohl, H. JOHN HEINZ III CTR. FOR SCI., ECON. & ENV'T, *American Dam Removal Census: Available Data and Data Needs, in* DAM REMOVAL RESEARCH: STATUS AND PROSPECTS, 29 (William L. Graf ed., 2012).

were removed via FERC relicensing decisions from 1996 to 2005.[50]

In Sweden, between 1990 and 2010, the total loss of hydropower production due to minimum flow requirements added in license reviews of existing hydropower projects was only 0.02% of the total hydropower production in an average year.[51] By comparison, a 2001 FERC study found that, of the 246 relicensings between 1986 and 2001 in the United States, the average annual generation loss from relicensing was 4.23%.[52] Assuming the 246 relicensings between 1986 and 2001 are representative of production for all existing non-federal hydropower projects, the total estimated production loss from relicensing was approximately 0.5%.[53]

C. FINDINGS

The data extrapolated from the various reports on license reviews and relicensings demonstrate significant differences in the number of projects reviewed and the number of river restoration measures implemented in two countries. As shown in Table 1, the most striking difference is that, in Sweden,

TABLE 1
Hydropower License and River Restoration Statistics in Sweden and the United States

	Sweden	United States
Licensed capacity (GW)	16[54]	75[55]
Hydropower (percentage of electricity production)	42.2%[56]	7.6%[57]

50. Pittock & Hartmann, *supra* note 49, at 316.

51. HEDENSKOG & MONSÉN, *supra* note 41, at 1, 5.

52. FED. ENERGY REGULATORY COMM'N, *supra* note 10, at 50-51, n. 115. This figure includes Seattle City Light (71 FERC ¶ 61,159), although FERC argues it is atypical. *Id.*

53. Two hundred forty-six relicensings out of 1,245 FERC licenses represents 20% of production in Commission-licensed projects. This, in turn, represents 11% of total hydropower production in the United States. In 2010, 1,245 Commission-licensed hydropower projects generated 57% of total hydropower production in the United States. *See* KELSI BRACMORT ET AL., CONG. RESEARCH SERV., R42579, HYDROPOWER: FEDERAL AND NONFEDERAL INVESTMENT 12 (Jan. 22, 2013), *available at* http://www.fas.org/sgp/crs/misc/R42579.pdf). Production loss of 4.23% out of 11% equals approximately 0.5% loss of total production.

54. Statens Offentliga Utredningar [SOU] 2013:69 Ny tid ny prövning—förslag till ändrade vattenrättsliga regler [New Time New Assessment—Proposal for Changed Water Legislation] [government report series] (Swed.), *available at* http://www.regeringen.se/content/1/c6/22/52/62/0245ed3e.pdf.

55. HALL & REEVES, *supra* note 34, at 5.

56. INT'L ENERGY AGENCY, *supra* note 2, at 10.

57. *Id.*

	Sweden	United States
Hydropower produced in 2010 (TWh)	67[58]	328[59]
Approximate number of hydropower projects	2,100[60]	2,370[61]
Licenses and exemptions	3,700[62]	1,700[63]
Licenses reviewed between 1990-2010	90[64]	501[65]
Fish passage measures required after review	29[66]	142/363[67]
Minimum flow measures required after review	64[68]	12/13[69]
Dam removal required after review	0[70]	19[71]
Average hydropower loss from license review (percentage per individual project)	<5%[72]	4.23%[73]
Approximate production loss from license review (percentage of national annual hydropower production)	0.02%[74]	0.5%[75]

only 2% of total hydropower licenses (90 hydropower licenses in total) were reviewed between 1990 and 2010,[76] while in the United States, 28% of non-federal hydropower licenses were reviewed (501 licenses in total).[77]

The second significant difference between the two countries illustrated by Table 1 is that Sweden did not decommission or remove any dams as a result of

58. *Id.*
59. *Id.*
60. Vattenverksamhet, *supra* note 34.
61. BRACMORT ET AL., *supra* note 53, at 8; HALL & REEVES, *supra* note 34, at 2.
62. Vattenverksamhet, *supra* note 34.
63. *See* BRACMORT ET AL., *supra* note 53, at 13.
64. HEDENSKOG & MONSÉN, *supra* note 41, at 1, 3.
65. For a complete list of licenses issued by FERC, see *Complete List of Issued Licenses*, *supra* note 47.
66. HEDENSKOG & MONSÉN, *supra* note 41, at 3.
67. FED. ENERGY REGULATORY COMM'N, *supra* note 10, at 10 (the denominator changes as the number of fish passages were analyzed for the period between 1987 to 2002).
68. HEDENSKOG & MONSÉN, *supra* note 41, at 3.
69. PETER B. MOYLE ET. AL., UNIV. OF CAL., DAVIS, IMPROVING ENVIRONMENTAL FLOW METHODS USED IN CALIFORNIA FEDERAL ENERGY REGULATORY COMMISSION RELICENSING 84-115 (Jan. 2011), *available at* https://watershed.ucdavis.edu/pdf/Moyle%20et%20al.%20PIER%20final_Jan%202011.pdf.
70. Harning, *supra* note 30.
71. Pittock & Hartmann, *supra* note 49, at 316.
72. *See* HEDENSKOG & MONSÉN, *supra* note 41, at 3.
73. FED. ENERGY REGULATORY COMM'N, *supra* note 10, at 50-51, n. 115 and accompanying note.
74. HEDENSKOG & MONSÉN, *supra* note 41, at 1, 5.
75. A rough calculation based on the assumption that the relicensed projects between 1986 and 2001 can be treated as representative in terms of energy production for the totality of non-federal hydropower facilities in the United States. *See supra* note 53.
76. *See supra* Table 1.
77. *See supra* Table 1.

license revocation, but the United States has done so.[78] Table 1 also displays significant differences in the total production loss from hydropower license revisions, with production loss many times higher in the United States over fifteen years of relicensing than in Sweden over twenty years of license reviews.[79]

While both countries are mature hydropower-producing countries that require licenses and have stringent environmental laws, the United States requires more frequent license review. As a result of these mandatory reviews, the United States has implemented more environmental restoration measures than Sweden with a greater cost to hydropower generation.

II. HYDROPOWER REGULATION

This section compares the laws in Sweden and the United States that led to the different extent of river restoration described in Part I. Section A first examines the procedural and substantive laws governing hydropower production in Sweden. The discussion of substantive laws in Sweden includes both Swedish national laws and mandatory European Union Directives. Section B then highlights the key procedural and substantive laws governing hydropower production in the United States.

The review of substantive laws focuses on standards for biodiversity protection, renewable energy promotion, and climate change mitigation, as well as legal principles such as "polluter pays." The review of procedural laws highlights procedures for hydropower license review, including the term of granted licenses and the burden of proof in license review and relicensing proceedings. The comparison between the two countries shows that while substantive laws are similar, there are important differences between the procedural laws.

A. SWEDEN

This section outlines the key elements of the procedural and substantive laws that regulate hydropower in Sweden. The substantive law consists of both Swedish national laws, such as the Environmental Code,[80] and European Union Directives, including the Water Framework Directive and Renewable Energy Directive,[81] which set mandatory targets, or end results, for Sweden.[82]

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78. *See supra* Table 1.

79. *See supra* Table 1.

80. MILJÖBALK [MB] [ENVIRONMENTAL CODE].

81. Water Framework Directive, *supra* note 22; Renewable Energy Directive, *supra* note 22.

82. Consolidated Version of the Treaty on the Functioning of the European Union art. 288, March 30, 2010, 2010 O.J. (C 83) 172.

1. Procedural Law

Hydropower licenses are granted in five courts of law that are part of the general court system of Sweden.[83] Chapter 24 of the Swedish Environmental Code regulates the review of licenses.[84] The conditions for operation stipulated in a license are legally enforceable and are granted for an unlimited term.[85] Either the hydropower operator or a public authority with standing must bring a claim in court in order to change any of the operational conditions specified in a license.[86]

As discussed below, license review initiated by a public authority must satisfy similar requirements with a proceeding to obtain a license to construct a new hydropower plant, except that an Environmental Impact Assessment is not required.[87] The responsible public authority, rather than the operator, must provide technical studies and documentation to persuade the court that proposed changes to a license—such as mandatory minimum flow releases and construction of fish passage facilities—are technically feasible, reasonable, and do not lead to the imposition of conditions that significantly interfere with hydropower production.[88] The current application of the procedural laws thereby shifts the burden of proof from the operator of a hydropower project to the responsible public authority pursuing review. The public authority initiating a license review must also pay the litigation costs of the opposing parties in a trial, excluding those of the operator.[89] This disincentivizes public authorities from initiating reviews.

2. Substantive Law

a. Swedish Law

This section describes the substantive Swedish environmental laws, which inform the license conditions with which a project operator must comply. The Environmental Code is the primary legal authority for regulation of hydropower in Sweden.[90] Chapter 2 of the Code establishes what is generally referred to as "general rules of consideration." It requires operators to demonstrate that they operate in an environmentally acceptable manner in line with the requirements of the Environmental Code.[91] It establishes the "polluter pays" principle: operators

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83. *The Swedish Court System: Land and Environmental Courts*, SVERIGES DOMSTOLAR [THE SWEDISH COURTS], http://www.domstol.se/Funktioner/English/The-Swedish-courts/District-court/Land-and-Environment-Courts/ (last updated Aug. 5, 2012).

84. *See* MILJÖBALK [MB] [ENVIRONMENTAL CODE] 24.

85. *See id.* at 24:1.

86. *See id.* at 24:5, 24:7.

87. *See id.* at 6:1.

88. *Cf. id.* at 2:7, 11, 24:5.

89. *See id.* at 25:3.

90. *See id.* at 11:9.

91. *See id.* at 2:3.

that cause an environmental impact must pay for preventive or remedial measures.[92] It also requires using the best possible technology in the operation of an enterprise.[93] The general rules of consideration are mandatory to the extent they are deemed reasonable, particularly in relation to the costs and benefits.[94]

Chapter 11 of the Environmental Code specifically addresses water operations, including the construction or modification of hydropower facilities and production conditions, and it stipulates that water operations may only be undertaken if the benefits to public and private interests are greater than their environmental impacts.[95] The chapter further requires that operators who intend to carry out water operations that may be detrimental to fish, aquatic mollusks, and crustaceans must, at their own expense, construct and maintain any facilities necessary for the passage of these organisms.[96] If the Court finds that the benefits of such facilities do not justify the expense, it may choose to relieve the operator of this obligation.[97]

Chapter 24 specifies the conditions under which a public authority can initiate a license review for river restoration and other purposes.[98] A license review can be initiated for a number of reasons, for example complying with European Union membership obligations or ensuring adequacy of existing measures to protect fish.[99] The chapter specifies that a license review is not permissible if it leads to intrusive conditions that significantly hamper or stop hydropower.[100]

The Law of Introduction of the Environmental Code[101] stipulates that a hydropower operator with a license under the 1918 Water Law or under older legislation—representing just less than 90% of all current licenses in Sweden—must accept only a 5% loss in production value from a license review unless compensated.[102]

In 1998, the Swedish Parliament adopted the Swedish Environmental Quality Objectives (hereinafter, the "Objectives") in conjunction with the Swedish Environmental Code.[103] The sixteen Objectives, which Sweden intends to achieve by 2020, form an overarching framework for Swedish environmental policy.[104] These non-binding policy goals include "limit[ing] climate change" and ensuring "flourishing

92. *Id.*
93. *Id.*
94. *See id.* at 2:7.
95. *See id.* at 11:2, 11:6.
96. *See id.* at 11:8.
97. *Id.*
98. *See id.* at 24:5.
99. *Id.*
100. *Id.*
101. 39 § LAG OM INFÖRANDE AV MILJÖBALKEN [IMPLEMENTATION OF THE ENVIRONMENTAL CODE ACT] (Svensk författningssamling [Swedish Code of Statutes] [SFS]) 1998:881 (Swed.).
102. *Id.*
103. Betänkande 1998/99:MJU6 Miljöpolitiken [Decision 1998/99:MJU6 Environmental Policy] [parliamentary decision] (Swed.).
104. *Id.*

lakes and streams," both relevant to hydropower production.[105]

b. European Union Directives

European Union Directives set mandatory targets for every member state, including Sweden.[106] There are three primary European Union Directives governing hydropower: the (1) Renewable Energy Directive;[107] (2) Water Framework Directive;[108] and (3) Habitats Directive.[109]

The Renewable Energy Directive establishes a framework to promote energy from renewable sources.[110] It establishes a European Union-wide target of 20% renewable energy by 2020 as a percentage of gross domestic consumption of energy.[111] The directive translates this overall EU target into national targets, and in Sweden's case, the renewable target requires an increase from a 39.8% renewable share in 2005 to a 49% share in 2020.[112] In Sweden, the Renewable Electricity Certificate System provides subsidies for renewable energy production that are available to certain hydropower projects; these subsidies are the most important tool for implementing the directive and reaching Sweden's renewable target.[113]

The Water Framework Directive establishes a framework for the protection of inland surface waters, transitional waters, coastal waters, and groundwater.[114] This directive ensures that no water body in the European Union experiences a decrease in water quality and that water bodies achieve "Good Chemical and Ecological Status" by 2015.[115] The directive also requires the establishment of Environmental Quality Standards for Sweden's water bodies.[116] Sweden has created five River Basin District Authorities to monitor water quality and to create River Basin Management Plans, including programs to reach "Good Water Status."[117] Water bodies designated as "heavily modified water bodies," includ-

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105. *Id.*

106. *Monitoring Implementation of EU Directives*, EUROPEAN COMM'N, http://ec.europa.eu/atwork/applying-eu-law/implementation-monitoring/index_en.htm (last updated Dec. 9, 2014).

107. Renewable Energy Directive, *supra* note 22.

108. Water Framework Directive, *supra* note 22.

109. Directive 92/43, of the European Parliament and of the Council of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora, 1992 O.J. (L 206) 1 (EC) [hereinafter Habitats Directive].

110. Renewable Energy Directive, *supra* note 22, art. 1.

111. *Id.* art. 96.

112. *Id.* Annex I.

113. STATENS ENERGIMYNDIGHET [SWEDISH ENERGY AGENCY], ELCERTIFIKATSYSTEMET 2011 [THE ELECTRICITY CERTIFICATE SYSTEM 2011] 7 (2011).

114. Water Framework Directive, *supra* note 22, art. 1.

115. *Id.* art. 4(1)(a)(iii).

116. *Id.* art. 7(1), art. 16(7), Annex V, Annex IX.

117. SWEDISH RIVER BASIN DISTRICT AUTHORITIES, FÖRVALTNINGSPLAN 2009-2015 FÖR BOTTENHAVETS VATTENDISTRIKT [ADMINISTRATION PLAN 2009-2015 FOR BOTHNIAN SEA WATER DISTRICT] (2009), *available at* http://www.lansstyrelsen.se/vasternorrland/SiteCollectionDocuments/Sv/publikationer/rapporter/2010/2010-1-forvaltningsplan-bottenhavets-vattendistrikt-2009-2015/2010-1-del-11-miljokvalitetsnormer.pdf.

ing some water bodies affected by hydropower, need to reach the less strict Environmental Quality Standard requirement of "Good Ecological Potential."[118]

Finally, the Habitats Directive forms the cornerstone of the European Union's nature conservation policy together with the Birds Directive.[119] The Habitats Directive is built around the Natura 2000 network of protected sites,[120] which includes different habitats of European importance and a strict system of species protection for over 1,000 animal and plant species.[121] For the habitat types and species protected, the directive maintains and restores "Favorable Conservation Status" through sustainable land and water management.[122] This directive protects various species that depend upon riverine habitats and currently have an imperiled conservation status.[123] Protecting areas with sustainable land and water management is meant to preserve threatened species and habitats.[124]

B. UNITED STATES

This section discusses the key elements of procedural and substantive laws regulating hydropower in the United States. This discussion forms the basis for the article's conclusion that the procedural requirements for licensing and relicensing are the primary reasons for greater implementation of river restoration measures at hydropower projects in the United States as compared to Sweden.

1. Procedural Law

FERC has the authority to regulate non-federal hydropower projects by granting a license or exemption.[125] For non-federal hydropower projects that do not qualify for an exemption, an operator must obtain a license from FERC.[126] FERC grants a license for a term of thirty to fifty years.[127] Five years before an

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118. Water Framework Directive, *supra* note 22, art. 4.1(a), Annex V, tbl.1.2.5.

119. *See generally* Directive 2009/147, of the European Parliament and of the Council of 30 November 2009 on the Conservation of Wild Birds, 2010 O.J. (L 20) (EC); Habitats Directive, *supra* note 109.

120. Habitas Directive, *supra* note 109, Annex I and II.

121. *Id.* art. 12:1, Annex IV.

122. *Id.* art. 2:2.

123. ANNIKA SOHLMAN, ARTER & NATURTYPER I HABITATDIREKTIVET—TILLSTÅNDET I SVERIGE 2007 [SPECIES & HABITATS IN THE HABITATS DIRECTIVE—THE STATUS IN SWEDEN 2007] 6, (Artdatabanken SLU) (2007), *available at* http://www.artdata.slu.se/filer/Arter_och_naturtyper_i_habitatdirektivet_lowres.pdf.

124. Habitats Directive, *supra* note 109, art. 4:4.

125. The Commission may issue a conduit exemption for a hydroelectric facility up to 40 MW that uses a manmade conduit operated primarily for non-hydroelectric purposes. It can issue a 10 MW exemption for a hydroelectric project of 10 MW or less. Exemptions are granted in perpetuity. For the 40 MW exemption, an environmental assessment is required. *See* 16 U.S.C. § 823a (2015); *see also* 18 C.F.R. §§ 4.30(b)(28), 4.90-4.96 (2015).

126. *Exemptions from Licensing*, FED. ENERGY REGULATORY COMM'N, http://www.ferc.gov/industries/hydropower/gen-info/licensing/exemptions.asp (last visited Mar. 14, 2015).

127. 16 U.S.C. § 808(e) (2015); 16 U.S.C. §§ 799, 808 (2015).

existing license expires, the operator must notify FERC whether it intends to seek a new license.[128] A competitor may also apply for the new license, in which case FERC will issue the license to the applicant whose proposal provides the greatest public benefits.[129] During the relicensing process, the hydropower project is subject to all applicable laws at the time of relicensing.[130] Given the evolution of environmental laws, there is no presumption that a new license will be issued on the same terms as the previous license. The license applicant is required to consult with federal and state resource agencies, Indian tribes, and the public in the course of relicensing.[131]

Under the Federal Power Act, a non-federal hydropower license is a privilege to use public lands and waters.[132] Accordingly, the U.S. Supreme Court has held that, under the Federal Power Act, an applicant must demonstrate that its proposal is in the public interest.[133] Further, under the Administrative Procedures Act, any applicant for a federally issued license has the burden of proof to support its license application.[134] FERC has four options for its final decision in a relicensing: a new license,[135] non-power license,[136] decommissioning,[137] or federal takeover.

During the relicensing process, FERC must conduct an environmental analysis under the National Environmental Policy Act ("NEPA").[138] This includes the preparation of an Environmental Assessment or Environmental Impact Statement, which discloses the environmental impacts of the proposed and alternative license conditions and evaluates measures to mitigate such impacts.[139] The NEPA document[140] includes a study and evaluation of the environmental effects of proposed and alternative actions in a hydropower relicensing.[141]

2. Substantive Law

FERC regulates non-federal hydropower projects under the Federal Power Act,[142] which calls for the comprehensive improvement of rivers for energy generation, water supply, recreation, fish and wildlife, and other beneficial

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128. This is true unless the operator wishes to abandon the project.
129. 16 U.S.C. § 808(a)(2) (2015).
130. *Id.* § 808(a)(1).
131. 18 C.F.R. § 4.38 (2015).
132. *See* Udall v. Fed. Power Comm'n, 387 U.S. 428, 450 (1967).
133. *See id.*
134. 5 U.S.C. § 556(d) (2015).
135. 16 U.S.C. § 808(a)(2) (2015).
136. *Id.* § 808(f).
137. *See* 16 U.S.C. § 803(a)(1) (2015); *see also* Project Decommissioning at Relicensing; Policy Statement, 60 Fed. Reg. 339 (Jan. 4, 1995).
138. 18 C.F.R. §§ 2.80 (2015); 42 U.S.C. §§ 4321, *et seq.* (2015).
139. 18 C.F.R. §§ 380.5(b)(6), 380.6(a)(4) (2015).
140. Either an Environmental Assessment or an Environmental Impact Statement.
141. 18 C.F.R. § 380.7 (2015); 42 U.S.C. § 4332(2)(E) (2015); 40 C.F.R. § 1508.9(b) (2015).
142. *See* Federal Power Act, 16 U.S.C. § 791 *et seq.* (2015).

uses.[143] In addition to the Federal Power Act, FERC must comply with other environmental statutes, including the Clean Water Act[144] and the Endangered Species Act,[145] prior to issuing a license.[146]

Under Federal Power Act section 10(a), FERC must determine that a project is "best adapted to a comprehensive plan of development" of the affected river basin for the beneficial uses of energy generation, water supply, flood control, recreation, fish, and wildlife.[147]

Under Federal Power Act section 4(e), FERC must give "equal consideration to energy conservation, the protection, mitigation of damage to, and enhancement of, fish and wildlife (including their spawning grounds and habitat), the protection of recreational opportunities, and the preservation of other aspects of environmental quality."[148] Section 4(e) also requires that, for any project located on public lands or reservations, such as a National Forest, FERC must find that the license will not interfere with the original purpose of the reservation, and the federal agency with jurisdiction over the federal reservation, such as the U.S. Forest Service, which administers National Forests, may require any additional conditions it finds necessary to protect the reservation.[149]

Under Federal Power Act section 18, the Fish and Wildlife Service ("FWS") and the National Marine Fisheries Service ("NMFS") may condition a license on measures to provide fish passage.[150] In sum, the Federal Power Act requires that any new licensed project achieve a balance of beneficial uses of the affected waters and lands that is in the public interest.[151]

Under Endangered Species Act section 7(a)(2), FERC must consult with FWS and NMFS to demonstrate that the new license will not jeopardize endangered or threatened species, or habitat designated critical for such species.[152] FWS and NMFS may require that FERC include certain mitigation measures in the new license to avoid liability under the Endangered Species Act for harming listed species or critical habitat.[153] Under Endangered Species Act section 7(a)(1), FERC has a more general obligation to contribute to the conservation of all threatened and endangered species affected by its actions.[154]

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143. 16 U.S.C. § 803(a)(1) (2015).
144. 33 U.S.C. § 1251 (2015).
145. Endangered Species Act of 1973, 16 U.S.C. § 1531 *et seq.* (2015).
146. *See, e.g.*, 33 U.S.C. § 1341(a)(1) (2015); 16 U.S.C. § 1536(a) (2015).
147. 16 U.S.C. § 803(a)(1) (2015).
148. 16 U.S.C. § 797(e) (2015).
149. *Id.*
150. 16 U.S.C. § 811 (2015).
151. *See* 16 U.S.C § 803(a)(1) (2015); *see also Udall*, 387 U.S. at 450; Policy Statement on Hydropower Licensing Settlements, 116 F.E.R.C. ¶ 61,270, 62,085 (2006).
152. 16 U.S.C. § 1536(a)(2) (2015).
153. 16 U.S.C. § 1536(b)(4)(ii) (2015); *see, e.g.*, 50 C.F.R. §§ 402.02 (defining "[r]easonable and prudent measures"), 402.14(i)(1)(ii) (2015).
154. 16 U.S.C. § 1536(a)(1) (2015).

Under Clean Water Act section 401, FERC may license a hydropower project only if the state where the project discharge will occur certifies that the project will comply with applicable water quality standards.[155] States may condition their certification on measures necessary to ensure compliance with water quality standards.[156] For example, the state may require minimum in-stream flows[157] or the installation of aeration devices to enhance dissolved oxygen concentrations.[158] FERC must incorporate any certification conditions into the license without modification.[159] Over the last few decades there have been federal tax credits for the promotion of renewable energy.[160] The U.S. Department of Energy makes funding available for the implementation of renewable technologies, including hydropower.[161] As of January 2012, thirty states have adopted mandatory Renewable Portfolio Standards ("RPS") or similar policies to increase the generation of renewable electricity.[162] These policies require producers to supply a certain share of their electricity from designated renewable energy sources by a specified date.[163] Some RPS programs include hydropower production facilities.[164] To date, there is no federal policy similar to state RPS.[165]

While all hydropower projects in Sweden are subject to the same regulations,[166] different types of dams are subject to different regulations in the United States.[167] FERC's regulation and periodic review does not apply to the small hydropower projects and conduits that qualify for exemptions from licensing.[168] More importantly, the largest hydropower projects in the United States, federal hydropower dams, are regulated by either the U.S. Army Corps of Engineers

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155. 33 U.S.C. § 1341(a) (2015).

156. Under the Clean Water Act, water quality standards must include designated beneficial uses (e.g., fish and wildlife, recreation, water supply), criteria necessary to protect those uses (e.g., minimum dissolved oxygen and temperature thresholds), and an anti-degradation standard to maintain existing water quality at the time the standards were adopted.

157. *See, e.g.*, PUD No. 1 of Jefferson Cnty. v. Wash. Dep't of Ecology, 511 U.S. 700, 723 (1994).

158. *See, e.g.*, Union Elec. Co., 118 F.E.R.C. ¶ 62,247, 64,732 (2007) (discussing re-aeration flows under art. 410).

159. Am. Rivers, Inc. v. FERC, 129 F.3d 99, 102 (2d Cir. 1997).

160. *See, e.g.*, U.S. ENERGY INFO. ADMIN., POLICIES TO PROMOTE NON-HYDRO RENEWABLE ENERGY IN THE UNITED STATES AND SELECTED COUNTRIES 7 (2005), *available at* http://www.eia.gov/renewable/archive/nonhydrorenewablespaper_final.pdf.

161. *See Financial Opportunities*, U.S. DEP'T OF ENERGY, http://www1.eere.energy.gov/financing/ (last visited Mar. 13, 2015).

162. *Most States Have Renewable Portfolio Standards*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/todayinenergy/detail.cfm?id=4850 (last visited Mar. 13, 2015).

163. *See, e.g.*, CAL. PUB. UTIL. CODE § 399.15(b)(2)(B) (West 2015) (requiring 33% renewables by 2020).

164. *See, e.g.*, OR. REV. STAT. § 469A.020(3) (2015).

165. The American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong., was the last failed attempt to establish a federal RPS.

166. *See* MILJÖBALK [MB] [ENVIRONMENTAL CODE] 24:1.

167. *See, e.g.*, 16 U.S.C. § 823a (2015); 18 C.F.R. §§ 4.30(b)(29), 4.90-4.96. (2015); 43 U.S.C. §§ 372, 373, 383, 391, 392, 411, 416, 419, 421, 431, 432, 434, 439, 461, 491, 498 (2015).

168. 16 U.S.C. § 823a (2015).

("USACE") or the U.S. Bureau of Reclamation, and not by FERC.[169] USACE and the Bureau of Reclamation have adopted rules and practices for periodic review of operations at dams but do not enforce their requirements as diligently as FERC.[170] Efforts to enforce these requirements have resulted in limited river restoration measures utilized in federal hydropower projects.

The Federal Power Act, Clean Water Act, and Endangered Species Act are the three primary environmental statutes that regulate hydropower projects in the United States and empower federal and state agencies to enforce their respective mandates.

III. COMPARISON

This section compares the significant differences between the regulation of hydropower in the United States and Sweden that produce disparate differences in river restoration measures.[171] The most important distinctions between the countries' measures are the scope and timing of license reviews; the number of dam decommissionings and removals; and the share of total hydropower production redirected to river restoration efforts. By all of these measures, river restoration is significantly more prevalent in the United States than in Sweden.[172] Because hydropower production is highly regulated in both countries, these differences likely result from the countries' different approaches to hydropower regulation.

The substantive environmental laws provide a comparable level of protection for non-developmental uses of water, such as water quality, fish, wildlife, endangered species, and recreation. In the United States, the Clean Water Act, Endangered Species Act, Federal Power Act, and NEPA are the primary laws that apply in a relicensing proceeding. In Sweden, there are both national laws (the Swedish Environmental Code and Environmental Quality Objectives) and European Union Directives (for example, the Habitats Directive and the Water Framework Directive) that apply in a license review.[173]

The term of licenses (thirty- to fifty-year terms in the United States compared to unlimited terms in Sweden) and the procedural laws regulating license review are the biggest differences between the two countries. When a license expires in the United States, the project operator must apply for a new license subject to then-current environmental laws and public comment.[174] By contrast, in Sweden,

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169. 43 U.S.C. §§ 373, 391, 411, 419, 491 (2015).

170. *See, e.g.*, RICHARD ROOS-COLLINS & JULIE GANTENBEIN, THE NATURE CONSERVANCY, INTEGRATING ECOLOGICAL SUSTAINABILITY INTO THE OPERATIONS OF U.S. ARMY CORPS OF ENGINEERS DAMS, RESERVOIRS, AND RELATED FACILITIES 10 (2007) (addressing the issue as related to the U.S. Army Corps).

171. *See supra* Table 1.

172. *See supra* Table 1.

173. *See* MILJÖBALK [MB] [ENVIRONMENTAL CODE] 1998:808.

174. 16 U.S.C. § 808(b)(2) (2015); 18 C.F.R. 380.10 (2015).

license reviews are discretionary and must be initiated by a public agency or by the operator.[175] Mandatory license review in the United States means that far more licenses are reviewed than in Sweden.[176]

Additionally, under U.S. law, the license applicant must demonstrate that the proposed project is in the public interest for the term of the new license.[177] Thus, the burden is on the applicant to show that it should be awarded the privilege to appropriate public waters, and not on the public to show that the project interferes with the public interest. In Sweden, the public agency or a third party must show that additional environmental measures are needed and that these measures will not unreasonably interfere with hydropower production.[178]

In Sweden, the Renewable Energy Directive incentivizes the expansion of renewable energy production with hydropower projects.[179] In the United States, there are limited federal incentives,[180] and most renewable energy incentives are offered at the state level.[181] The countries' differences may be attributable to greater public acceptance of climate change in Sweden and in the European Union as compared to the United States.[182] Hydropower is a renewable energy source that can contribute to the reduction of emission of greenhouse gases and is often highlighted in Sweden as combatting climate change.[183] The popularity of hydropower and national incentives may be another factor contributing to the lower rate of river restoration in Sweden, as river restoration often reduces the amount of water available for hydropower production.

Both countries have substantive provisions for protecting endangered species and aquatic ecosystems. In Sweden, however, the country's substantive provisions are more sharply contradicted by incentives to expand renewable energy production to combat climate change. These incentives benefit some hydropower projects in Sweden, but may also limit river restoration measures because they come at a cost to renewable hydropower generation. Sweden's prohibition on excessively costly restoration measures also limits their implementation through license reviews.[184] In contrast, there is no requirement under the Federal Power

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175. MILJÖBALK [MB] [ENVIRONMENTAL CODE] 24:5.

176. *See supra* Table 1.

177. 16 U.S.C. § 803(a)(1) (2015).

178. MILJÖBALK [MB] [ENVIRONMENTAL CODE] 24:5.

179. Renewable Energy Directive, *supra* note 22, Preamble para. 30, art. 5(3), Annex II.

180. *Registration Requirements for EERE Financial Opportunities*, U.S. DEP'T OF ENERGY (May 1, 2014), http://www1.eere.energy.gov/financing/process.html.

181. For detailed information about state incentives, see *Database of State Incentives for Renewables and Efficiency*, DSIREUSA, *available at* http://www.dsireusa.org. The DSIRE website is managed, in part, by the U.S. Department of Energy and tracks renewable portfolio standards by state.

182. *See generally* Irene Lorenzoni & Nick F. Pidgeon, *Public Views on Climate Change: European and USA Perspectives*, 77 CLIMATIC CHANGE 73 (2006).

183. SVENSK ENERGI, VATTENKRAFTEN MÖJLIGGÖR MILJÖMÅL [HYDROPOWER ENABLES ENVIRONMENTAL GOALS] (Jan. 26, 2012), *available at* http://www.svenskenergi.se/Global/Dokument/information/Fokus-120126-Vattenkraften%20m%c3%b6jligg%c3%b6r%20milj%c3%b6m%c3%a5l.pdf.

184. *See* MILJÖBALK [MB] [ENVIRONMENTAL CODE] 24:5.

Act that FERC issue a license on terms economically feasible from the licensee's perspective.

A hydropower license in Sweden is granted with no time limit[185] and is treated like a property right to use the watercourse in accordance with the conditions specified in the license. In practice, a license review initiated by a public authority is the only means of applying new substantive laws requiring river restoration to the operations of a Swedish hydropower project. A license review that results in additional limitations on the right to use the water is treated as an expropriation of property that requires compensation.[186]

The burden of proof lies with the public authority initiating the license review process in Sweden, causing considerable administrative and legal costs for that agency.[187] These costs typically amount to two-thirds of the total cost of a river restoration project.[188] In addition, the Environmental Code limits the "polluter pays" principle in two ways. First, new conditions from a license review cannot lead to the imposition of conditions that significantly hamper hydropower production.[189] Second, an operator holding a license granted under the 1918 Water Law, or older legislation—approximately 90% of all licenses in Sweden—must only tolerate a loss of 5% of production value from a license review.[190] After that point, the responsible agency must compensate the operator with public and other funds.[191]

In addition, the public authority initiating a concession review must convince the court that the proposed river restoration efforts are reasonable in light of the costs and benefits of the proposed remedial measures.[192] Benefits from river restoration—for example, ecosystem restoration and fish passage measures—are often more difficult to quantify and prove than the costs of construction and reduced electricity production.

In the United States, by contrast, FERC licenses are granted for a limited term of thirty to fifty years.[193] When the license period ends, the hydropower project must be relicensed in accordance with existing law at the time of the relicensing

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185. *See id.* at 24:1.

186. *See* 39 § LAG OM INFÖRANDE AV MILJÖBALKEN [IMPLEMENTATION OF THE ENVIRONMENTAL CODE ACT] (Svensk författningssamling [Swedish Code of Statutes] [SFS]) 1998:881 (Swed.).

187. *See* LÄNSSTYRELSEN VÄSTERNORRLAND & LÄNSSTYRELSEN ÖSTERGÖTLAND [THE VÄSTERNORRLAND CNTY. ADMIN. BD. & THE ÖSTERGÖTLAND CNTY. ADMIN. BD.], FRIA VANDRINGSVÄGAR: REDOVISNING AV REGERINGSUPPDRAG 51A [OPEN PASSAGE: ACCOUNT OF THE GOVERNMENT ASSIGNMENT 51A] 24, 26 (2008), *available at* http://www.vattenmyndigheterna.se/SiteCollectionDocuments/sv/bottenhavet/publikationer/fria-vandringsvagar-2008.pdf.

188. *Id.*

189. *See* MILJÖBALK [MB] [ENVIRONMENTAL CODE] 24:5.

190. 39 § LAG OM INFÖRANDE AV MILJÖBALKEN [IMPLEMENTATION OF THE ENVIRONMENTAL CODE ACT] (Svensk författningssamling [Swedish Code of Statutes] [SFS]) 1998:881 (Swed.).

191. *Id.*

192. *See* MILJÖBALK [MB] [ENVIRONMENTAL CODE] 2:7.

193. 16 U.S.C. §§ 799, 808 (2015).

procedure.[194] Thus, many projects that were originally licensed in the first half of the twentieth century, prior to the enactment of environmental laws like the Endangered Species Act and Clean Water Act, became compliant with current laws when they underwent the relicensing process. Competing interests are balanced again at the time of the review for relicensing based on evidence in the record, existing laws, and current public values.[195] FERC has never issued a new license on the same terms as the previous license. In several instances, FERC relicensing has resulted in decommissioning of hydropower projects and removal of project dams after the licenses expired.[196]

In the United States, hydropower licenses are treated as temporary privileges to use public waters.[197] This explains why, unlike in Sweden, the project operator must demonstrate that the project is in the public interest.[198] Furthermore, resource agencies can prescribe mandatory facilities for fish passage and water quality, thereby providing additional checks on projects that would unreasonably favor power generation over the environment.[199] That FERC relicensed 28% of licenses between 1990 and 2010 and required the implementation of river restoration measures in most of them indicates that the system in the United States allows for the adaption of operations to evolving substantive environmental laws.

IV. CONCLUSION

There are significant differences in the extent of river restoration efforts in Sweden and the United States, with more river restoration measures in the United States. While only 2% of hydropower licenses were reviewed in Sweden between 1990 and 2010, 28% were reviewed in the United States.[200] While there have been several dam removals as a result of a license review in the United States,[201] not a single hydropower dam has been removed in Sweden as a result of a license revocation.[202] The higher rate of license review and imposition of restoration measures has resulted in a higher level of hydropower production loss to restoration in the United States: approximately 0.5% of total production,[203] compared to 0.02% in Sweden.[204]

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194. 16 U.S.C. § 808(a) (2015).
195. *See* 16 U.S.C. § 803 (2015).
196. *See* Pittock & Hartmann, *supra* note 49, at 317.
197. Udall v. Fed. Power Comm'n, 387 U.S. 428, 450 (1967).
198. *See id.*
199. 16 U.S.C. § 811 (2015).
200. *See supra* Table 1.
201. Pittock & Hartmann, *supra* note 49, at 317; *Restoring Rivers*, *supra* note 27.
202. Harning, *supra* note 30.
203. *See supra* note 53.
204. HEDENSKOG & MONSÉN, *supra* note 41, at 1, 5.

The difference in procedural laws provides the best explanation for the disparate extent of river restoration between Sweden and the United States. A hydropower license in Sweden is granted in perpetuity, which means that a public authority must initiate a license review to implement river restoration measures.[205] In the United States, FERC grants hydropower licenses for non-federal projects with a limited term of thirty to fifty years, after which the operator must apply for a new license.[206] Furthermore, Sweden places the burden of proof during a license review on the public authorities, while this burden is on the applicant in the United States.[207]

Substantive environmental legislation must be supported by adequate procedural legislation to be effectively implemented. The EU Water Framework Directive in Sweden provides an example of incomplete implementation, at the time of writing, because Sweden has created limited legal tools or economic incentives to achieve the environmental goals of the Directive. In practice, a license review initiated by a public authority, with the hurdles outlined above, continues to be the only way to implement river restoration measures at hydropower projects in Sweden to meet the environmental objectives of the Directive.

Hydropower regulation with the periodic review of licenses balances the need for security of investment with the need to keep hydropower projects accountable for environmental best practices. The U.S. system of license reviews is closer to this ideal.

205. *See* MILJÖBALK [MB] [ENVIRONMENTAL CODE] 24:5.
206. 16 U.S.C. §§ 799, 808 (2015).
207. 5 U.S.C. § 556(d) (2015); *see also* 18 C.F.R. § 380.3 (2015).