20-YEAR REVIEW

OF THE LOW IMPACT HYDROPOWER CERTIFICATION PROGRAM

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DEDICATION

This report is dedicated to Mike Sale and Fred Ayers, former LIHI Executive Directors; and to Julie Keil, former board president and long-time advisor.
Mentors and friends always.

Recommended Reference: Ames, S.B.J, and M. Fischer, 2020. Low Impact Hydropower Institute 20-Year Review Report. Low Impact Hydropower Institute, Arlington, MA.

EXECUTIVE SUMMARY

The Low Impact Hydropower Institute (LIHI) has been the only national, independent program reviewing and certifying hydropower projects based on their environmental, recreational, and cultural impacts for two decades. Over that period, there have been significant changes in state and federal regulations, policy objectives and the general public's awareness of renewable energy, including hydropower and its roll in addressing climate change. This paper strives to capture and reflect on LIHI's past twenty years against this broad backdrop. Through a series of surveys, focus groups, literature reviews, and dataset comparisons the authors explored the details of the LIHI program and its certified facilities in great detail.

LIHI has stayed committed to its original objectives of:

1. Establishing science-based criteria against which facilities can be certified as Low Impact Hydropower,
2. Running an independent program to evaluate and certify facilities that meet these criteria, and
3. Being a resource about the impacts of hydropower so that the public can be informed consumers of hydropower generation.

The foundational document for LIHI's work is the LIHI Certification Handbook, first published in 2000, and updated in 2016 to reflect extensive public input based on an evolving understanding of hydropower's environmental and social impacts. Today's Certification Handbook provides more options for certification applicants to demonstrate that their facilities meet the LIHI Criteria, moving away from a sole reliance on government agency input.
This twenty-year retrospective reveals LIHI's impact and role in recognizing a subset of hydropower projects that are able to generate climate friendly electricity while minimizing, and often enhancing, ecological, recreational, and cultural outcomes. The paper offers valuable information for the public, particularly energy consumers and policy makers, to utilize in their critical decision-making processes.

- LIHI has issued 182 Certificates since being established, with 162 currently active Certificates comprising 276 individual powerhouses and dams in 23 states. These LIHI Certified® facilities provide:
    - River stewardship: Encompassing 1,000 river miles and associated aquatic and terrestrial habitats, 160 fish passage structures, 1,100 recreation facilities and services and protection for dozens of different threatened and endangered species.

- Climate friendly power: Nearly 4,000 megawatts (MW) of capacity and 16 terra-watt hours (TWh) of annual generation, enough to annually power 1.4 million homes while avoiding 11 million metric tons of carbon dioxide emissions.

- LIHI Certification is limited to projects that can meet the Criteria guidelines. Only 11% of all FERC licensed and FERC-exempt facilities are LIHI Certified®. Nearly 12% of applications received have not achieved LIHI Certification. The voluntary pursuit of Certification results in many more potential applicants self-selecting out of Certification.
- Certification and its associated stewardship are driven by the ability to monetize the LIHI Certificate. Eight-five percent of Certificate holders chose to renew because of their ability to monetize the value of the LIHI Certificates through LIHI Certified® power sales and/or recognition in voluntary (i.e. Green-e) or statutory (i.e. Massachusetts Renewable Portfolio Standard) programs. The percentage of facilities certified in jurisdictions that value LIHI Certification exceeds the national average of certified facilities.
- Conditions of certification, including the continuation, reporting, and monitoring of voluntary actions used to satisfy the LIHI criteria provide a high level of accountability and assurance to energy buyers and managers of voluntary and statutory programs that include LIHI Certified® facilities.
- Perceptions of hydropower vary greatly. Overall stakeholders trust LIHI's expertise, the latest LIHI Certification Handbook, consistent decision making and acknowledgement of impacts. Those surveyed who generally have a negative view of hydropower are critical of LIHI's program citing low perceived rejection rates, among other items.
- When compared to FERC license requirements and the Oak Ridge National Laboratory's Hydropower Mitigation Database, LIHI facilities typically demonstrate voluntary actions, additional accountability, and additional scrutiny.
- The LIHI website contains sought after information easily accessible to the general public, visited an average of 1,400 times a month to facilitate stakeholder engagement and obtain project information.

1. OVERVIEW

This paper reflects on the last twenty years of the Low Impact Hydropower Institute's (LIHI) certification program. LIHI was created in 1999 with the multiple objectives of establishing criteria for facilities to be identified as Low Impact Hydropower, running an independent program to certify facilities that meet the criteria, and providing information about the impacts of hydropower to the public so they can be informed consumers of hydropower generation.

Since the original LIHI Certification Handbook was published in 2000, the LIHI Criteria and Standards have been updated to reflect an evolving understanding of hydropower's environmental and social impacts. The first major update was the result of over ten years of work and public input. The 2nd Edition Handbook was published in 2016 and contained more methods (standards) by which applicants could demonstrate that their facilities meet the LIHI Criteria. The emphasis moved away from relying solely on recommendations by governmental agencies to science-based, alternative standards.

LIHI Certified® Facilities

There are currently 162 active Certificates comprising 276 individual powerhouses and dams in 23 states. Over its programmatic lifetime, LIHI has issued 182 Certificates. Eighty nine percent have chosen to renew, largely because of the owner's ability to monetize the value of the LIHI Certificate. Eleven percent of all Federal Energy Regulatory Commission (FERC)-licensed and FERC-exempt facilities are now LIHI Certified. Most certified facilities have undergone at least one recertification. Some applications (11.9%) did not result in LIHI Certification. LIHI Certified® facilities provide over 3,970 MW of capacity and generate over 16,100 GW hours of electricity annually – enough to supply 1.4 million average US households and avoiding 11 million metric tons of carbon dioxide emissions, equivalent to 26 million barrels of oil.

LIHI Certified® facilities have stewardship of over 1,000 river miles and associated aquatic and terrestrial habitats. They collectively provide 160 fish passage structures, protect dozens of different threatened and endangered species, and provide over 1,100 recreation facilities and services.

Twenty-nine percent of LIHI Certified® facilities have taken voluntary action in order to become Certified or have taken actions that go beyond the basic LIHI Criteria (PLUS standards). These voluntary and additional actions have occurred primarily in the fish passage, recreation, and communications/stakeholder relations areas.

LIHI in the Markets

LIHI was the catalyst for hydropower's inclusion in the first voluntary renewable energy credit (REC) market, the Green-e market established by the Center for Resource Solutions. LIHI Certified® hydropower is now included by name in multiple state and national programs. Hydropower overall is included in all state renewable programs in one way or another, usually limited only by size. LIHI's criteria, however, have influenced multiple state programs and serve as the standard referred to directly or indirectly as the definition of environmentally preferable hydropower. Massachusetts' Renewable Portfolio Standard (RPS) has driven the majority of LIHI Certifications.

Voluntary markets, as demonstrated by Green-e, are on the rise with Community Choice Aggregators and residential sales leading the way. However, non-residential customers are procuring the largest amount of renewable generation. The vast majority (90%) of the renewable power comes from wind and solar. LIHI Certified® hydropower is just 0.75% of renewable facility supplies. Nearly half of all LIHI Certified® facilities are included in a long-term direct purchase contract.

According to LIHI Certificate holders, inclusion of LIHI Certified® hydropower in state regulatory programs is the main driver for LIHI Certification, followed by its requirement in voluntary programs and by internal corporate sustainability goals.

Stakeholder Perceptions and Consumer Confidence

Stakeholder perceptions of hydropower play a role in the selection of hydropower in renewable procurements and play an important role in the LIHI Certification process. Stakeholders comment on applications and provide feedback on programmatic enhancements. LIHI conducted an online survey of stakeholders in the summer of 2020 (see Section 4.2). Thirty individuals responded (5% response rate). Most of the participants were from the New England region, reflecting the importance of that market relative to the rest of the country. Responses demonstrated that stakeholders have trust in LIHI's expertise, approve of the 2nd Edition handbook, believe LIHI is consistent in decision making, acknowledge that LIHI recognizes hydropower's impacts, and applaud the fact that FERC exempt projects demonstrate improvements over time through the LIHI program. Regarding hydropower more generally, 47% have a positive view and 27% have a negative view. All respondents who do not think positively about hydropower in general also do not feel the LIHI Certification program is objective. Criticisms of the program include a perception that LIHI does not reject any applications and that LIHI is not sufficiently transparent.

It is not common for any certification program to publish rejections. Therefore, it is not surprising that respondents were not aware of the 11.9% of applications that never achieve LIHI Certification. Issues preventing final Certification without further action were typically related to fish passage, flows, and water quality. LIHI has also seen self-selection taking place where potential applicants review the LIHI Criteria and determine for themselves that their projects will not meet the LIHI standards, before ever consulting with LIHI staff.

Fifty percent of current LIHI Certificates have received public comments during the application process. Comments tended to focus on the fish passage, flows, and recreation criteria. Two-thirds of comments were positive or neutral. Seventy percent of applications with adverse or neutral comments resulted in conditions imposed upon their LIHI Certificate that related to the comments and require certain actions during the Certificate term.

Certification conditions help ensure that a LIHI Certificate holder stays accountable and continues to meet the LIHI Criteria throughout the Certificate term. Conditions have been used throughout the LIHI Certification program's history but have declined in usage since the publishing of the 2nd Edition Handbook. This is due, at least in part, to the alternative standards and the ability to use alternative data to demonstrate compliance with the LIHI Criteria. Certification conditions also serve to require the continuation of voluntary actions taken by an applicant that go above and beyond the LIHI Criteria.

Comparisons

There are few comprehensive sources of aggregated hydropower data. The FERC is one such source. The Oak Ridge National Lab (ORNL) HydroSource and Mitigation Databases are others. All were used for comparisons with LIHI Certified® facilities in this report.

Within the FERC lists of jurisdictional projects (FERC licensed or exempt), LIHI Certified® facilities are more likely to be store-and-release, and less likely to be conduits - unless they are FERC licensed conduits in which case, they are more likely to be LIHI Certified®. LIHI Certified® facilities are more likely to be between 1 and 5 MW and less likely to be smaller or larger than that. This is more than likely driven by the size limitations in many state RPS programs. For example, Massachusetts Class 2 eligibility is limited to facilities smaller than 7.5 MW and the Class 1 cap is 30 MW. According to the certificate holder survey, the geographic distribution of LIHI Certified® facilities is largely driven by state RPS programs. LIHI has certified 64% of all FERC jurisdictional facilities in Massachusetts for example, and 38% of all New England facilities as a whole. While most FERC regulated hydropower facilities are located in New York, LIHI has

certified 29% of all FERC jurisdictional projects in that state. LIHI has also certified both of the FERC jurisdictional projects in Tennessee.
A primary database used to contrast LIHI Certified facilities was the Oak Ridge National Lab's Hydropower Mitigation Database. This dataset provides information from the Protection, Mitigation, and Enhancement sections of all FERC license orders issued between 1998 and 2013. It captured 5,130 mitigations – specific protection, mitigation, and enhancement measures required in FERC licenses. Sixty percent of current LIHI Certificates (as of July 2020 when the database analysis was completed) have licenses that were issued prior to 1999 or after 2013 and are therefore not captured in the ORNL dataset. Overall, the number of license-required mitigations is comparable between LIHI Certified® and non-certified facilities.

The mitigation categories ORNL considered broadly mirror the LIHI Criteria with the exception of the LIHI Cultural and Historic Resources criterion for which there were only a few mitigations within the ORNL database. In addition, ORNL captured only mitigations required in the FERC license and therefore did not include voluntary or other measures taken outside of that process such as those that may be specified in settlement agreements, nor those that were later overturned. Mitigation actions were quantified but not qualified so while the number of mitigations were comparable across facility size, license vintage, and/or location, the quality of those mitigations was not considered. To understand the mitigations better, LIHI evaluated comparable LIHI Certified® and non-certified facilities through several examples and case studies. These comparisons highlight the site-specific nature of hydropower facilities and the fact that LIHI facilities typically demonstrate voluntary actions, additional accountability, and additional scrutiny that is not captured in the ORNL database nor in FERC license requirements.

Outreach and Communication

LIHI strives to educate energy consumers about hydropower. Publishing applications, application review reports, public comments on applications, and project descriptions on the LIHI website is an important way this information is disseminated. The LIHI website is well trafficked and visited an average of 1,400 times per month with nearly 6,000 page-views. LIHI email newsletters, application notifications, and the submission of comments on applications are the primary way that stakeholders interact with LIHI. LIHI also presents information about the program and hydropower impacts at conferences and meetings each year. Audiences include the hydropower industry, renewable market participants, state and federal agencies, and individual NGOs. LIHI staff take part in local and national dialogues on the role of hydropower in combating climate change and in developing new technologies and design approaches to lessen hydropower's impact. LIHI hosts and facilitates site visits for stakeholders ranging from fourth graders to international delegations.

The skepticism of some stakeholders for the LIHI Certification program, as reflected in the stakeholder survey, is an indication that LIHI must engage in more outreach to environmental advocates in particular; however, it is not the goal of LIHI to change peoples' perspectives on the hydropower industry as a whole. LIHI's program exists to credibly differentiate hydropower for consumers. LIHI also has a responsibility to help ensure that LIHI Certified® facilities are able to leverage the Certification to participate in regulated and voluntary markets, and gain value for the LIHI Certificate in other ways such as by securing long term power contracts. Demonstrating the value of LIHI Certification attracts more applicants, which supports additional benefits to rivers where facilities are certified.

Conclusion

LIHI Certified® facilities are in fact different from non-certified facilities. They publicly disclose details on their operations. They open themselves up to public comment, potentially subjecting themselves to additional environmental and social requirements. They are held accountable for compliance on a yearly basis. They make voluntary improvements to meet the LIHI Criteria which in turn benefit river ecosystems. Hydropower is extremely site-specific as are LIHI Certified® facilities. These details are evaluated in application reviewer reports which are then published on an easily accessible platform.

LIHI Certified® facilities are still a rarity, accounting for only 11% of FERC regulated facilities in the US. It is an exclusive group. LIHI looks forward, however, to increasing the amount of LIHI Certified hydropower, and when LIHI Certified® hydropower is widely recognized in public policies and consumer purchasing. While facility size is often used as an indicator of hydropower's impact, our analysis did not identify a correlation between the size of a facility and its impact as demonstrated in the number of mitigation actions required or the ability to be LIHI Certified®. The determination of hydropower impacts is complex and varies based on regional and local conditions and stakeholder values, all of which are evaluated in the LIHI Certification process.

After twenty years, LIHI has defined Low Impact Hydropower through the LIHI Criteria. LIHI will continue to assess the Criteria over time to ensure that they reflect the best science and latest approaches to minimizing the impacts of hydropower operations. The LIHI Certification program is independent from the competing influences of industry and conservation groups, keeping its focus on the LIHI Criteria. But it is closely overseen by theses interests and the broader public.

While LIHI continues to meet the organization's mission, there are areas for continued improvement. First is to engage more with stakeholders so as to create greater confidence in the program even among those who do not look favorably upon hydropower as a whole. Such engagement, we hope, will lead to additional engagement in the application process, strengthening its rigor. Second is to improve the value of the LIHI Certificate such that there is greater demand for LIHI Certification in renewable markets and programs. Third is to continue to ensure that the increase in demand and LIHI Certification translates into river benefits.

2. EVOLUTION OF THE LIHI ORGANIZATION AND PROGRAM

2.1 Introduction

The Low Impact Hydropower Institute's (LIHI) bylaws include a provision that the governing board will periodically review the LIHI Certification program to ensure it remains relevant. To that end, over time the organization has written two papers. The first documented the creation of the organization and the certification program for Low Impact Hydropower. The second looked at the program's growth over the first 15 years. This paper seeks to reflect on the program, its evolution, and establish whether the organization is meeting its stated mission, including understanding whether the program is reducing the impacts of hydropower. The LIHI mission is to:

- set criteria for characterizing hydropower facilities as low impact,
- conduct a program to certify dams that meet these criteria with a goal of (1) reducing the environmental impacts of hydropower generation; by (2) creating a credible and accepted standard for consumers to use in evaluating hydropower, and
- make information about the environmental effects of power generation available to the public.

To evaluate the program in comparison to the mission, in this paper we review the program criteria's development and evolution over time, we look at the characteristics of LIHI Certified® facilities and ask whether improvements have been made to facilities, their operations, and/or to river systems as a result of LIHI Certification, and we ask stakeholders whether the program is considered a credible standard for evaluating hydropower. We also review our communications efforts to reflect on whether we are meeting the final piece of the mission – making information about the environmental effects of power generation available to the public.

It is challenging to compare LIHI Certified® facilities to non-certified facilities. As you will see, the available data is limited. It can be informative, but potentially lead to inaccurate conclusions. Therefore, we present the data and analysis, and offer our opinions on the results.

We hope that this document provides insight into the LIHI Certification program, its results, and its future.

2.2 Formation of LIHI

LIHI was established at the beginning of US electricity market deregulation. Consumer choice became increasingly possible, enabling a demand for "green power" (usually defined as generation from a renewable source and one that is understood to "present few significant adverse environmental impacts"[1]), Renewable Portfolio Standards[2] were on the rise, and the voluntary Green-e renewable energy credit market[3] was underway. Hydropower's role in these emerging frameworks was unclear as public skepticism around hydropower remained strong. While hydropower does rely on water, a renewable resource, instead of fossil fuels to generate electricity, it can cause significant environmental damage.

The following question was the seed of what became the Low Impact Hydropower Institute, or LIHI:

> "Hydropower generation typically requires a dam to impound or divert a river or stream into turbines. Individually and cumulatively, hydropower dams can cause significant adverse impacts to aquatic ecosystems, including the fish, wildlife, and human communities that depend on them. Not all hydropower dams create these impacts, but how can concerned consumers be sure that the hydropower they are buying in a green power market does not result in significant adverse environmental impacts?".[4]

American Rivers first began to explore this question in the late 1990s. Interest spread to other organizations including the Center for Resource Solutions, the parent organization of Green-e, and Green Mountain Energy Company, a power marketer. A standard seen and accepted as credible by consumers could serve to identify those hydropower projects that had the least possible impact on their environment. Through years of collaborative work, the LIHI

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[1] Lydia Grimm, *Certifying Hydropower for "Green" Energy Markets: The Development, Implementation, and Future of the Low Impact Hydropower Certification Program*, (2002), Page 1

[2] Renewable Portfolio Standards or "RPS" (also called Renewable Energy Standards, Clean Energy Standards and Alternative Energy Portfolio Standards) are government regulations or laws that impose an obligation, usually on load serving entities, to provide a certain percentage of their electricity supply portfolio from eligible renewable sources over a period of time. RPS programs focus on renewable generation while CES programs often include zero or low-carbon emission technologies such as nuclear and natural gas. Renewable energy certificates (RECs) are used to track the ownership of environmental attributes and are sometimes sold in bundled transactions with electricity sales while at other times sold separately or "unbundled" from the underlying electricity. In the case of unbundled REC sales, the electricity which is sold separately from the RECs is viewed as "null" energy with no environmental attributes, as if it were generated by non-renewable resources such as fossil generation (Definition from Page 7, Sale 2016).

[3] https://www.green-e.org/programs/energy

[4] Grimm, page 1

independent 501(c)(3) organization was established in 1999, criteria were created in 2000, and the certification program began the same year. This program was anticipated to "give positive recognition and economic reinforcement to hydropower owners who had taken steps to improve their facilities and invest in improvements in their local environment".[5]
As green power markets grew, American Rivers was not the only entity concerned about the risk of abuse of the term "green." The National Association of Attorneys General developed Environmental Marketing Guidelines for Electricity in 1999. The Guidelines said:

> "It is deceptive to misrepresent, directly or by implication, that any product or company is "green." "Green" is a term of general environmental benefit, and as such, every implied representation of significant environmental benefit or lack of significant environmental harm that the general assertion conveys to customers must be substantiated. Accordingly, use of "green" should be accompanied by clear and prominent disclosure of the sense in which the term is being used; and even where qualified, "green" may have some other, contextual meaning to consumers that must be substantiated".[6]

Such concerns highlighted the need for clear standards for environmental performance where hydropower was concerned.

Ideas on how to define "green" hydropower have often coalesced around size of the facility's capacity to generate power. The Public Utilities Regulatory Policy Act (PURPA) originally defined "small" hydropower in 1978 as facilities with an installed capacity of 30 MW or less. Since then, "small" hydropower has been used as a proxy for "low impact." One example is in New York where the RPS program allows hydropower that is "low impact, run-of-river" further defined as 10 MW or smaller for RPS Tier 2. LIHI has found that capacity size has little bearing on the size of a facility's environmental impact. Capacity size does not take into account the size of the dam or whether or how long a bypass reach is. A small dam could also have a devastating impact on the environment (such as when a small dam stops fish from migrating upstream), whereas a large dam may have a much smaller impact[7] for example, if there are no migratory fish species present, or if the facility provides flows that improve the quality of the water downstream. As stated in Grimm 2002, "A green standard should be used both to assure

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[5] Grimm, page 1
[6] https://www.epa.gov/greenpower/national-association-attorneys-general-environmental-marketing-guidelines-electricity
[7] Mattie, J.S., 1991. "Ecological effects of hydropower facilities," Chapter 8 in *Hydropower Engineering Handbook* edited by J.S. Gulliver and R.E.A. Arndt, McGraw-Hill, Inc., New York, NY. World Commission on Dams (WCD), 2000. "Dams and Development, A New Framework for Decision-Making", pp. 92-93, London and Sterling, VA. Earth scan Publications, Ltd. http://www.damsreport.org.

consumers that the facility is environmentally acceptable, and as a means to evaluate and even encourage better standards for the power generation source altogether. The 'small hydro' standard fails on both counts." In short, hydropower is complex, and determining whether it is "green" or "low impact" requires a thoughtful, comprehensive set of criteria and process for evaluation.

Another proxy that has been used to argue for any hydropower being "green" is the comprehensive Federal Energy Regulatory Commission's (FERC) hydropower licensing process. This proxy is inadequate for several reasons. First, not all hydropower projects are under the jurisdiction of FERC. Second, a FERC license is issued for 30-50 years, 40 being the new standard set in 2019[8], leaving long periods of time between opportunities to assess changes in an ecosystem. A FERC exemption lasts in perpetuity. Finally, and most significantly, FERC is mandated to provide "equal consideration"[9] to power and non-power benefits. In other words, FERC places equal value on "power production as it does on providing protection, mitigation or enhancement measures for the environment".[10] For these reasons, the founders of LIHI felt that an independent process would provide greater value to consumers looking for substantiation on the claim of "green" hydropower.

2.3 Establishment of the Criteria and Program

The original LIHI Criteria were drafted by American Rivers and commented on by utilities, marketers, and interested stakeholders. The criteria addressed fish passage, healthy fish populations, adequate river flows, controlled flow changes, water quality, and protection for flooded lands.[11, 12] In addition to ensuring that the criteria used to evaluate hydropower were comprehensive, the founding organizations understood that "the credibility of the program was its most important asset, and credibility demanded independent oversight, even if this added to the complexity and cost of certification."[13] Thus, LIHI was established as a nonprofit 501(c)(3) organization and independent reviewers (consultants) with technical expertise were hired to conduct the initial reviews.

The first set of comprehensive LIHI Criteria were put to public comment in 1998. The original letter introducing the criteria stated that the goal of the program was to "create a system to

[8] FERC Policy Statement on Hydropower License Terms: https://www.govinfo.gov/content/pkg/FR-2017-10-26/pdf/2017-23286.pdf
[9] Section 4(e) of the Federal Power Act (FPA) as amended by the Electric Consumers Protection Act of 1986 (ECPA)
[10] Grimm, page 7
[11] Grimm, page 8
[12] Threatened and endangered species and the requirement that a dam not be recommended for removal were added to the final criteria
[13] Grimm, page 9

identify hydropower plants with low environmental impacts." The system was designed to be credible with consumers; transparent and understandable; based on objective criteria; and easy to use.[14] The letter also included the following:

> "…Some environmental activists are sure to find facilities that gain certification which have adverse environmental impacts. Some hydropower generators are sure to identify facilities which do not pass but are doing a good job on environmental issues. The criteria are not designed to make a perfect in-depth assessment of every hydropower facility across the country. Rather they are designed to provide a simple, objective and transparent method of making a distinction between hydropower with low and high impacts.
>
> The Low Impact Hydropower criteria do not compare hydropower with other electricity sources because that judgment, we believe, is best left to consumers. They instead provide a method of comparing differing hydropower facilities.
>
> The goal of the Low Impact Hydropower criteria is to establish a standard for environmentally preferable hydropower…"

Thus, it was clear from the beginning that the program would not satisfy everyone. Comments on the original criteria reflected this. There were concerns about the "'all or nothing' aspects of the program, requiring compliance with all the criteria to obtain certification,"[15] on the part of hydropower owners. Owners also expressed a myriad of concerns with each criterion. On the part of environmental organizations, some felt that no hydropower should ever be qualified as "low impact" while others simply thought the criteria were not stringent enough. Some were concerned that the cumulative impact of multiple dams on a river were not fully considered.[16] An implementation task force was assembled to process the input received and make a recommendation.[17] The final set of criteria were issued for another round of public comment

[14] Grimm, page 10
[15] Grimm, page 13
[16] Grimm, page 13
[17] Participants included: Margaret Bowman (American Rivers), Bill Bradbury (For the Sake of the Salmon), Kirk Brown (Center for Resource Solutions), Sheryl Carter (Natural Resources Defense Council), Mark Crowdies (Green Mountain Energy), John Devine (Duke Engineering/President of the National Hydropower Association), Angus Duncan (Bonneville Environmental Foundation), Alec Geffen (Land and Water Associates), Gabriella Goldfarb (For the Sake of the Salmon), Corinne Grande (Seattle City Light), Jan Harming (Center for Resource Solutions), Rita Hayne (Wisconsin Electric), Nancy Hirsch (Northwest Energy Coalition), Cleve Kapala (US Generating), Debra Malin (Bonneville Power Administration), Steve Malloch (Consultant to American Rivers), Jan Mulder (Seattle City Light), Tom Rawls (Green Mountain Energy), Richard Roos-Collins (Natural Heritage Institute), Mike Sale (Oak Ridge National Laboratory), Frank Shrier (PacifiCorp), Johanna Thomas (Environmental Defense Fund).

in 1999. That same year LIHI was organized, as it was widely recognized that an independent organization would be necessary to oversee the program if it was to be impartial and credible.

> "The criteria were designed to be environmentally rigorous, yet achievable. The drafters recognized that if the level of environmental protection were set too high, an insufficient amount of power would be eligible for certification, and the program would be unable to attract participants. Without participants, the program could not be effective in its ultimate goal of encouraging reductions in the impacts of hydropower generation. They also recognized that if they were set too low, the program would lose environmental credibility, and thus lose the public and market value of the certification."[18]

These criteria were published in the original Certification Handbook and Questionnaire.

2.4 Evolution of the Criteria and Handbook

The organization's bylaws stipulate that the governing board will review the Program to ensure it is meeting its goals and objectives. Between 2006 and 2015, extensive efforts were undertaken to improve the program based on feedback from various stakeholders collected over the preceding years. In 2014, the governing board approved revisions to the criteria, mostly to the standards used to satisfy them. In 2016, the 2nd Edition Handbook was published. The improvements to the Handbook included the following new elements:

- the availability of a "Not applicable/De Minimis Effect" standard for each criterion,
- the opportunity for longer certificate terms of up to 10 years in length, when "PLUS" standards are achieved,
- a menu of alternative standards for applicants to use to satisfy each criterion, including best practices and best-available technologies, and
- providing conduit facilities and other very-low impact project types with simplified application forms and lower cost.

In addition, in the 2nd Edition Handbook:

- a new emphasis was placed on science-based standards to strengthen how criterion goals are satisfied,
- a new approach to contracting the use of the LIHI Certification Mark was introduced, and

[18] Grimm, page 17

- a new "Zone of Effect" concept was created to provide a more complete evaluation of the full environmental footprint of hydropower facilities.[19]

The eligibility criteria were not changed with two exceptions. In the 1st Edition Handbook, whether a dam was recommended for removal was a stand-alone criterion. In the 2nd Edition Handbook, recommendation for dam removal is a threshold eligibility requirement. Also, in the 2nd Edition Handbook, upstream and downstream fish passage were split into two separate criteria. A facility's size, or installed capacity, has never been a consideration for eligibility nor in evaluation of an application.

In keeping with the Organization's bylaws, the governing board has continued to evaluate the program, criteria, and handbook. Most recently, an ad hoc committee was convened in 2019 to discuss additional program improvements. The committee comprised a balance of environmental organizations and hydropower industry perspectives. That work has already led to clarifications published in the 2nd Edition Handbook Version 2.04 (April 2020), and additional improvements are being actively discussed and evaluated at this time. Based on this work, a proposal to improve the recertification process under the 2nd Edition Handbook was issued for public comment in October 2020.

At the direction of the board, LIHI has evaluated two eligibility requirements. LIHI requested comments on a proposal to change the definition of existing and new facilities from those with dams or diversions constructed before August 1998 to a rolling 5-year window prior to an application. More details on the proposal and comments received can be found on the LIHI website.[20] Based on comments received and an evaluation of the projects that would then be eligible for LIHI Certification, the board decided not to change the dam or diversion construction cutoff date. It was clear that an evaluation of the impacts of construction would be necessary, which would require a new criterion and associated standards. In addition, an analysis of dams built after August 1998 showed they were not plentiful. Given that LIHI is a small organization, it was decided that the number of potential new applicants did not outweigh the work necessary to accommodate the change. LIHI will, however, monitor hydropower construction activities to determine if such a change is warranted in the future. In particular, LIHI is interested in following projects that are currently in the conceptual phase, but if built, could possibly have a net benefit to certain river systems.[21]

[19] Mike Sale and Dana Hall, *The LIHI Experiment: Certifying "Green" Hydropower since 1999* (2016), Page 6
[20] https://lowimpacthydro.org/program-updates/
[21] As an example, see Natel Energy's restoration hydro concept: https://www.natelenergy.com/restoration-hydro/

LIHI also conducted internal pilot intake reviews of two Canadian facilities to evaluate whether facilities outside of the US could be considered under the current certification program. While there are facilities in Canada that, at least on the surface, could meet existing LIHI standards, the difference in environmental oversight presents difficulties. Canada does not have a federal oversight or licensing process for hydropower similar to the FERC process in the US. Provincial agencies are involved in project planning and initial licensing but do not conduct regular reevaluations once a project is operational. Many facilities are quasi-governmentally owned and thus are somewhat self-monitored. It was clear that the Agency Recommendation LIHI standard would not be applicable to almost any facility in Canada. Owners would therefore need to conduct studies to demonstrate compliance with the LIHI Criteria. Without independent agency oversight, LIHI would be placed in the position of judging whether a study was conducted correctly, and whether the results were acceptable.

For these reasons, LIHI will not be pursuing expansion into Canada at this time. However, as LIHI has been approached by numerous international entities looking for LIHI to certify facilities in their respective countries, or wanting to start a similar program, LIHI will look to develop a framework to assist in those endeavors in Canada and elsewhere.

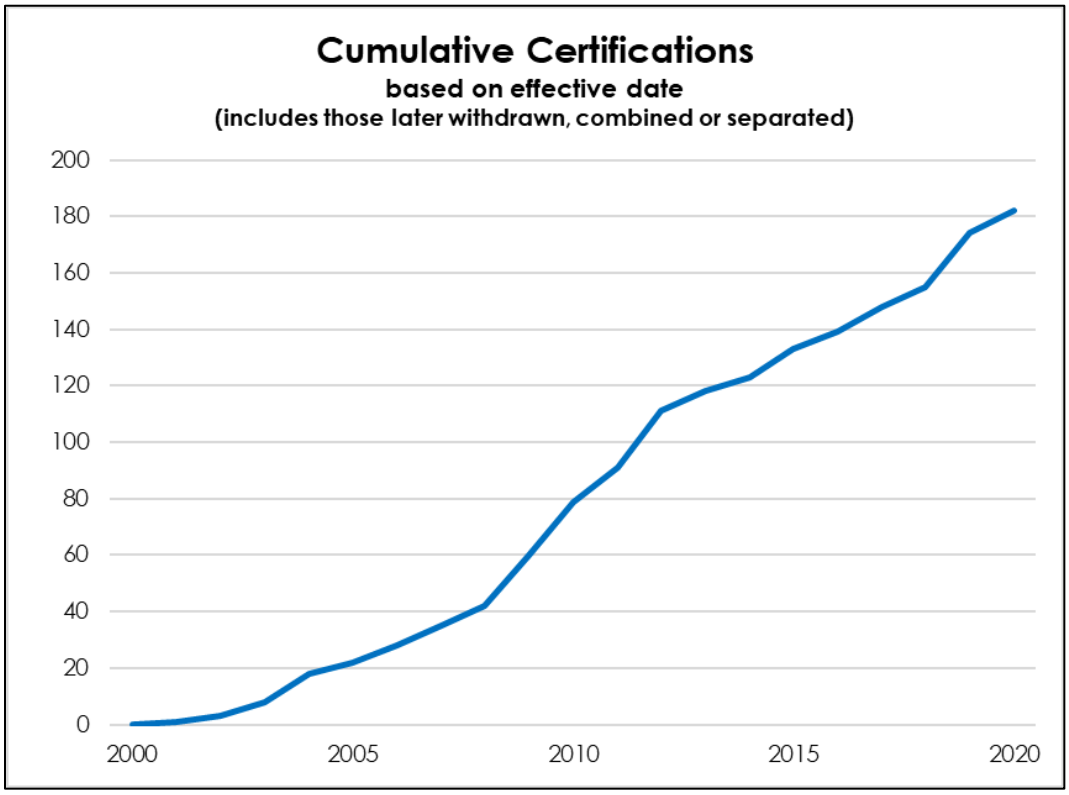
2.5 Certification Trends

The first Certificate was issued in 2001. In the 20 years since, LIHI has issued 182 Certificates. LIHI Certificates can encompass more than one powerhouse and/or dam, usually under a single FERC license. As of November 30, 2020, 162 Certificates are active, representing 276 individual powerhouses and dams, and 107 current Certificates have undergone at least one recertification. Fifteen chose not to recertify primarily due to valuation reasons, although five had recertified at least once prior to the decision to leave the program.[22] One certificate was revoked for non-compliance with the terms of LIHI certification.[23] Figure 1 shows the cumulative certifications over LIHI's history.

[22] To date, the primary reason for a Certificate holder to relinquish their Certificate is because they are unable to monetize the Certificate, including circumstances such as exceeding the eligibility window for Green-e, or not generating for significant time periods.

[23] If a Certificate holder is found to be violating a LIHI Criterion, or coming close to doing so, LIHI informs the owner and engages in an active dialogue with the goal of resolving the issue and thus keeping them certified – and keeping the criteria met and river resources protected.

Figure 1. Cumulative Certifications 2001 - 2020



LIHI Certified® hydropower as a percentage of non-federal US hydropower has grown over time. Today, approximately 11% of all FERC licensed and exempt facilities are certified. When considering only those FERC-regulated facilities that are eligible for LIHI certification, the percentage increases slightly to 12%.

In total, as of November 2020, LIHI Certified® facilities provide nearly 4,000 MW of capacity and generate over 16,000 gigawatt hours of electricity annually - enough to supply 1.4 million average US households[24] and avoid 11 million metric tons of carbon dioxide emissions, equivalent to 26 million barrels of oil.[25] LIHI Certified® facilities have stewardship of over 1,000 river miles and associated aquatic and terrestrial habitats. They collectively provide 160 fish passage structures, protect dozens of different threatened and endangered species, and provide over 1,100 recreation facilities and services.

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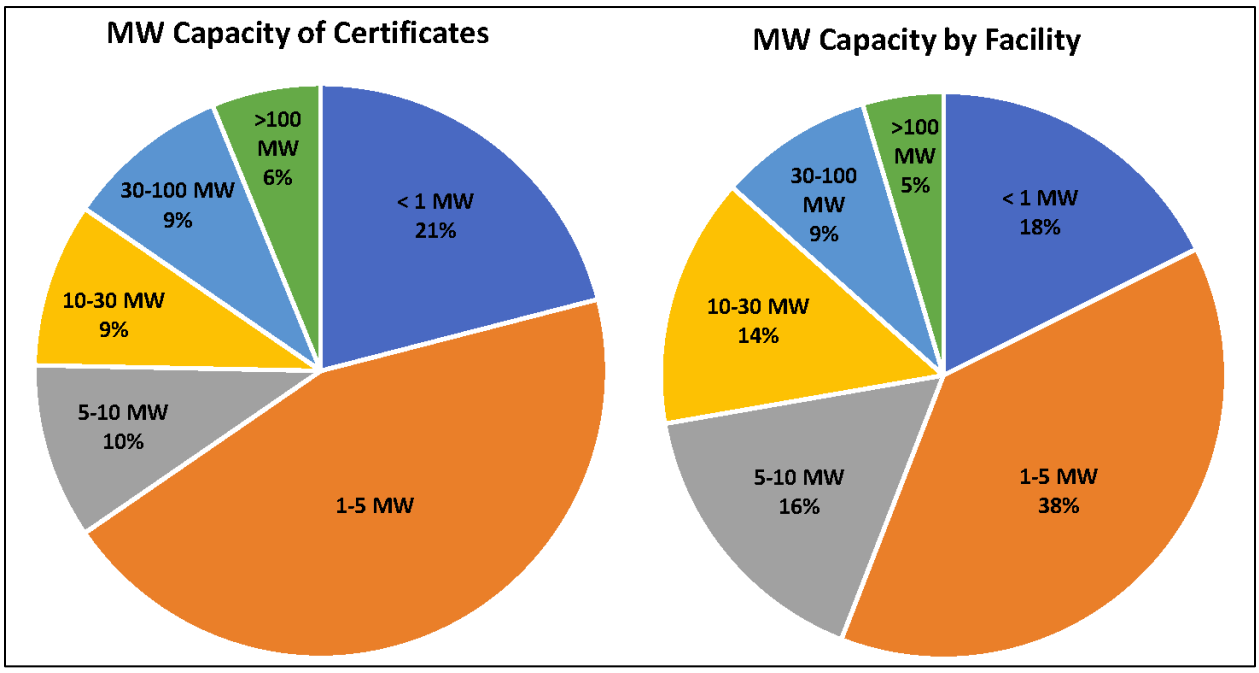
[24] https://www.eia.gov/tools/faqs/faq.php?id=97&t=3#:~:text=How%20much%20electricity%20does%20an,about%20914%20kWh%20per%20month.

[25] https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Figure 2 below shows the MW capacity for active LIHI Certificates and for all active certified facilities. As noted above, there are more individual powerhouses or dams (276) than there are Certificates (162) and because of that, the size distribution differs somewhat on each basis. For instance, 66% of all Certificates are less than 5 MW but a smaller number of all facilities (56%) are in that same category. Conversely, 19% of all Certificates are between 5 and 30 MW, but 30% of all facilities are in that category. For all Certificates, the average capacity is 24.5 MW and, on a facility basis, is 17 MW. The median in both cases is quite a bit smaller than the average at 3.3 MW for Certificates and 4.4 MW for facilities.

Figure 2. MW Capacity by Certificate and by Facility



Overall, LIHI Certified® facilities are located in 23 states, including southeast Alaska as shown in Figure 3.

Figure 3. Location of LIHI Certified® Facilities

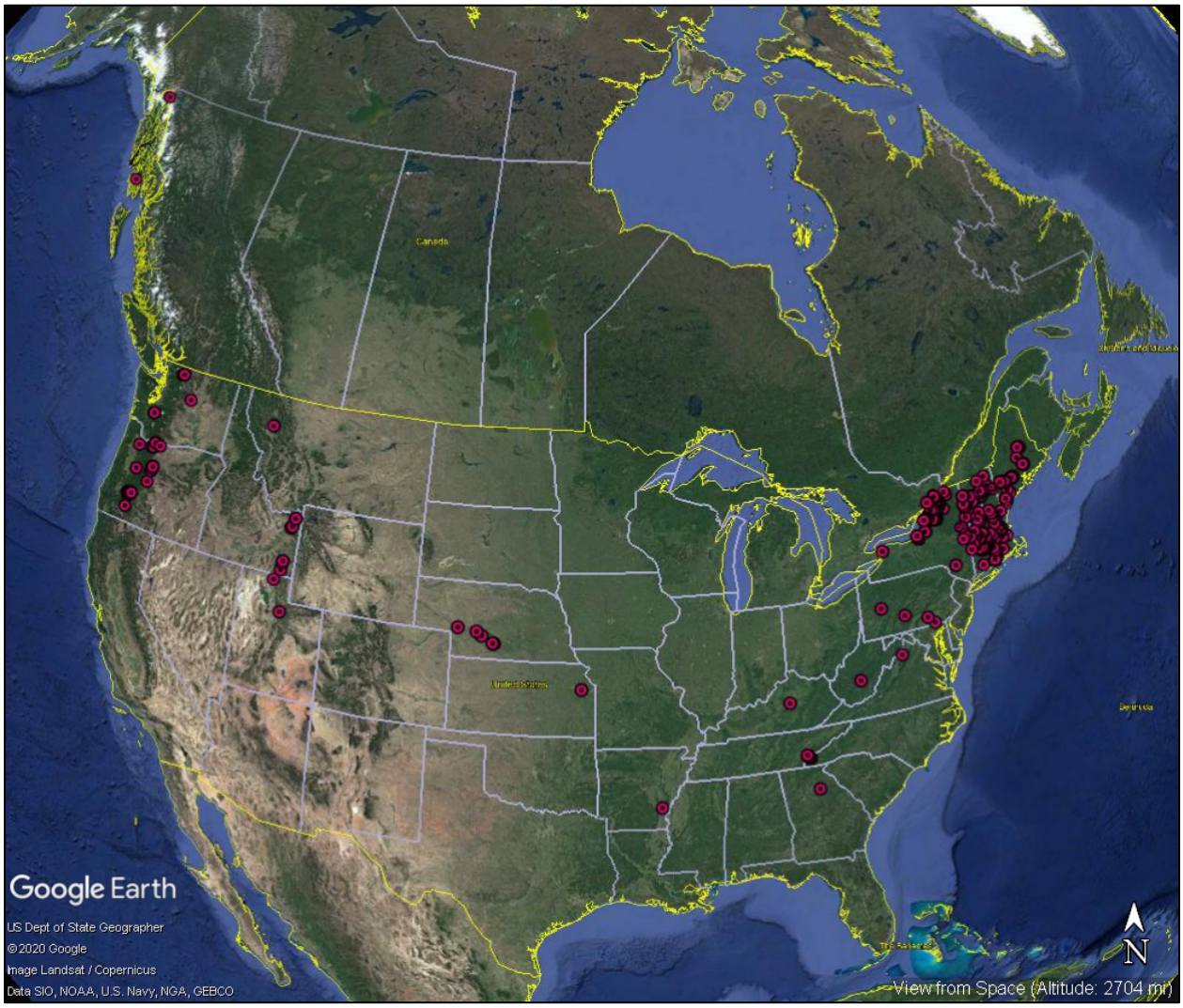
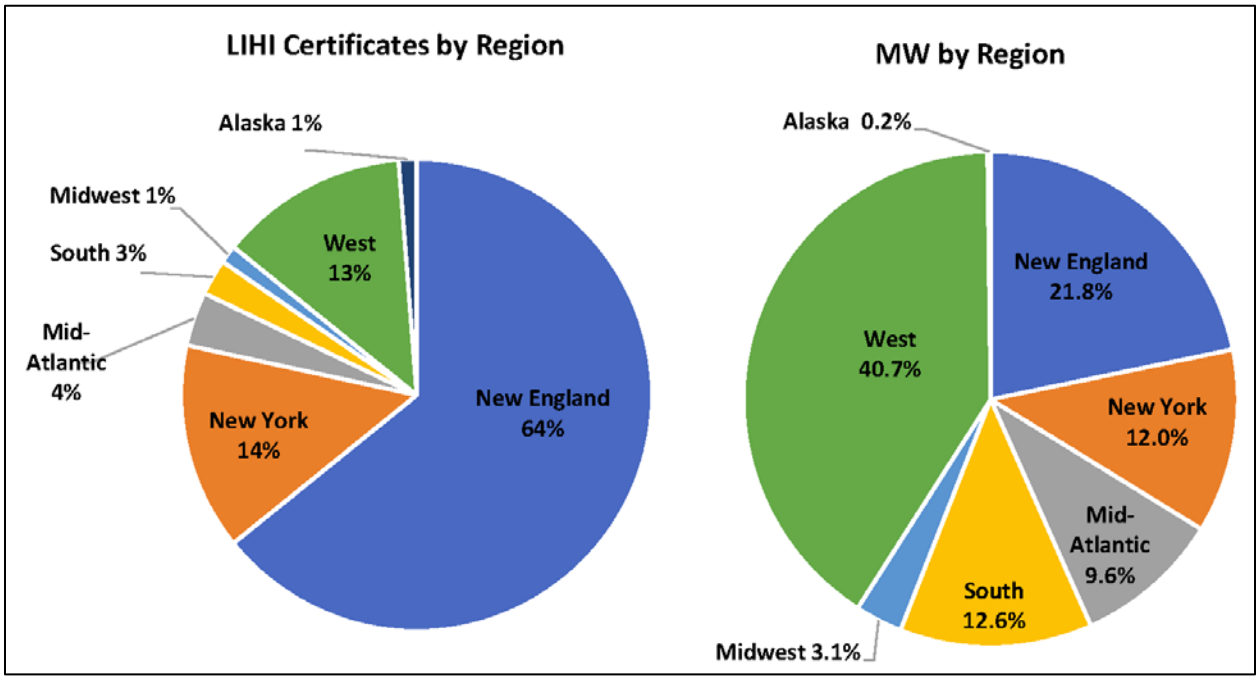


Figure 4 shows the distribution of Certificates across the US and the total MW capacity by region. The figure shows that a majority of Certified facilities are located in New England and over three quarters are in New England and New York combined. However, the most MWs are located in the West (40.7%) which reflects the fact that western projects tend to be larger than those in other parts of the country. Notably, New England and New York combined still account for fewer Certified MWs (33.8%) than the West. Similarly, LIHI Certified® facilities in the South and Mid-Atlantic are larger, and combined, they account for slightly more MW than New England (22.2% vs. 21.8%).

Figure 4. Certificates and Capacity by Region

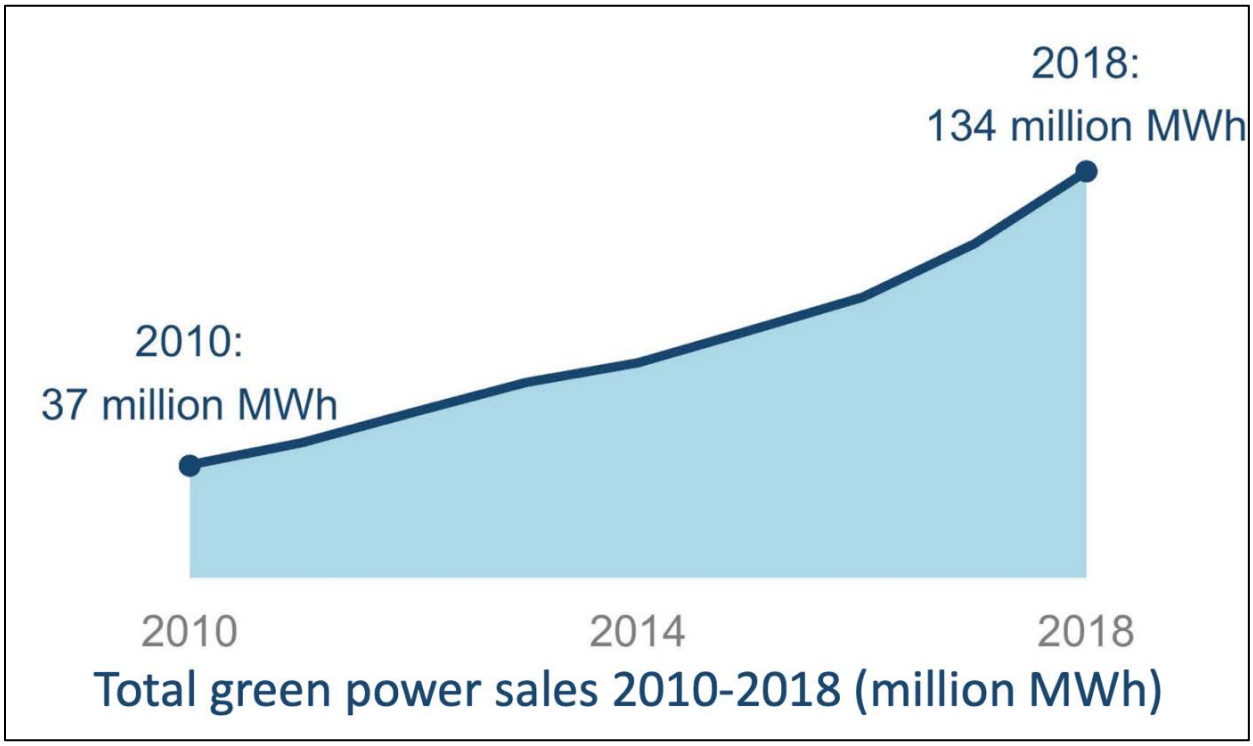


3. MARKETS

Environmental attributes associated with renewable energy generation have been an important, and often critical, source of revenue for developers and operators. The environmental attributes are most often characterized in markets as RECs – renewable energy credits. There are various instruments that allow purchases of RECs, either with or without the associated electricity. As stated earlier, LIHI Certification was founded on the presumption that consumers would want or should have access to a third-party evaluation of hydropower to ensure that those RECs are as green as expected.

The first markets for renewable energy were compliance programs like renewable portfolio standards (RPS) and now clean energy standards (CES). Other mechanisms for consumers to purchase green power include Green-e, green tariff programs, green pricing programs, consumer choice aggregation (CCAs) and long-term contracts in the form of power purchase agreements (PPAs) or virtual power purchase agreements (VPPAs). Consumers are also building and using their own generation ranging from residential roof-top solar to corporate ownership of utility scale projects. Figure 5 illustrates the large growth in green power sales, increasing over 3 ½ times in less than ten years.

Figure 5. US Green Power Sales, 2010-2018



Source: NREL and Clean Kilowatts LLC, "Status and Trends in Green Power Markets (2018 Data)", presented at the Renewable Energy Markets Conference 2019 (Septmber4-6, 2019), available at https://www.nrel.gov/docs/fy20osti/74862.pdf.

Renewable Portfolio Standards / Regulatory Markets

Renewable portfolio standards regulatory programs have continued to evolve over the past 20 plus years. These compliance programs were originally created to stimulate new renewable development, drive down the cost of renewable energy, and often to stimulate local economies through local renewable energy development.[26] Public policy continues to support renewable portfolio programs but have also begun to broaden eligibility as they contemplate how to attain a carbon-free future, in some cases leading to embracing a clean energy standard format.

Clean Energy Standard programs focus on lowering greenhouse gas emissions using a broader array of low-carbon energy generation including nuclear energy in the case of New York, and large hydropower with no environmental restrictions in the case of Massachusetts.

[26] Stori, Val, "The Role of Hydropower in State Clean Energy Policy: How States Include Hydropower in Renewable Portfolio Standards and Energy Storage Mandates" (2020), Clean Energy States Alliance and Pacific Northwest National Laboratory. Page 7

The Clean Energy States Alliance (CESA) released a study in 2020 on hydropower's inclusion in state RPS programs.[27] It found that hydropower is included in all 30 RPS state programs but to varying degrees.

With the broadening of focus embraced by clean energy standards, a loosening of eligibility restrictions followed, particularly for hydropower. For example, the Massachusetts RPS requires hydropower to meet certain environmental characteristics[28] and meet deliverability requirements as well as size restrictions (7.5 MW cap in Tier 2 and 30 MW cap in Tier 1).[29] In 2016, however, the State passed an Act Relative to Energy Diversity[30] which enabled the procurement of hydropower of any size, any operating type, regardless of environmental standards. In 2020, the State of New York passed the Climate Leadership and Community Protection Act, which set aggressive goals of 70% renewable energy by 2030 and 100% carbon-free electricity by 2040.[31] It also allows any hydropower regardless of size or impact to qualify, unlike the RPS which caps hydropower's eligibility to "low-impact run-of-river" facilities that are less than 10 MW in Tier 2.

In 2008, Massachusetts adopted LIHI Certification as a proxy for demonstrating compliance with the statutory environmental requirements for hydropower under the RPS program. Additional states followed suit including Pennsylvania, Oregon, Delaware, Connecticut and Vermont. Connecticut subsequently omitted all hydropower. As stated in the CESA report (page 19), "LIHI has had a positive influence on RPS programs beyond those that require certification. Four states require hydropower facilities to either meet the LIHI standards or standards modeled on LIHI's. New Jersey in effect requires LIHI certification, even though its rules do not explicitly name LIHI; the state's Class I allows for small-scale hydropower that has been certified to meet low-impact criteria by a nationally recognized low-impact hydropower organization. Ohio, Delaware, and New York Tier I's hydropower eligibility requirements include meeting environmental criteria identical to LIHI's, as does Utah's voluntary RPS."

Where actual LIHI Certification is required for participation in a state renewable incentive program, LIHI Certified® hydropower enjoys significant monetary support through the sale of

[27] Stori, Val. Page 7

[28] The *Massachusetts Green Communities Act* set out specific environmental criteria for hydropower. The regulations implementing the Act specified that having LIHI Certification would be one method to meet those criteria. https://www.mass.gov/regulations/225-CMR-14-renewable-energy-portfolio-standard-class-i and https://www.mass.gov/regulations/225-CMR-15-renewable-energy-portfolio-standard-class-ii

[29] In the case of Massachusetts, the size caps for hydropower were not a reflection of environmental impact but instead were intended to limit supply. Policy makers wanted to ensure adequate demand for newer and emerging technologies such as wind and solar.

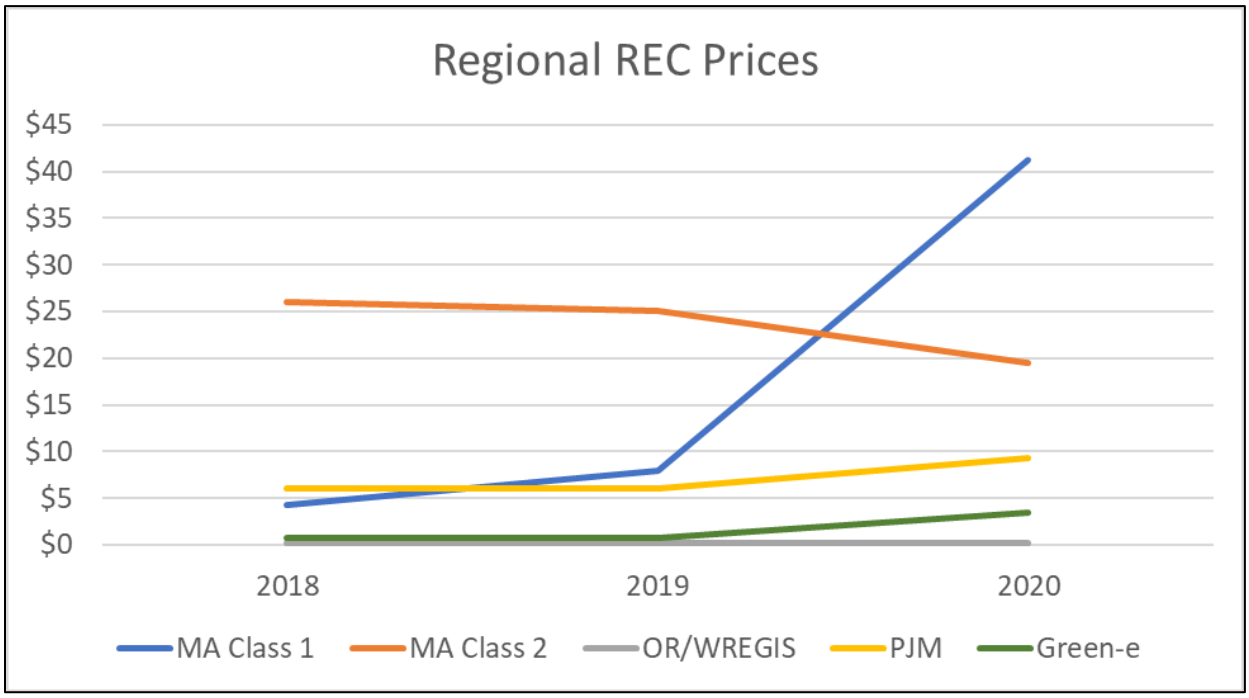
[30] Chapter 188 of the Acts of 2016

[31] https://climate.ny.gov/

RECs. Eighty-nine percent of certified facilities participate in RPS programs. Certified facilities are expected to receive REC revenue totaling over $64 million dollars in 2020. That is a simple average of over $14 per MWh (Figures 6, 7).

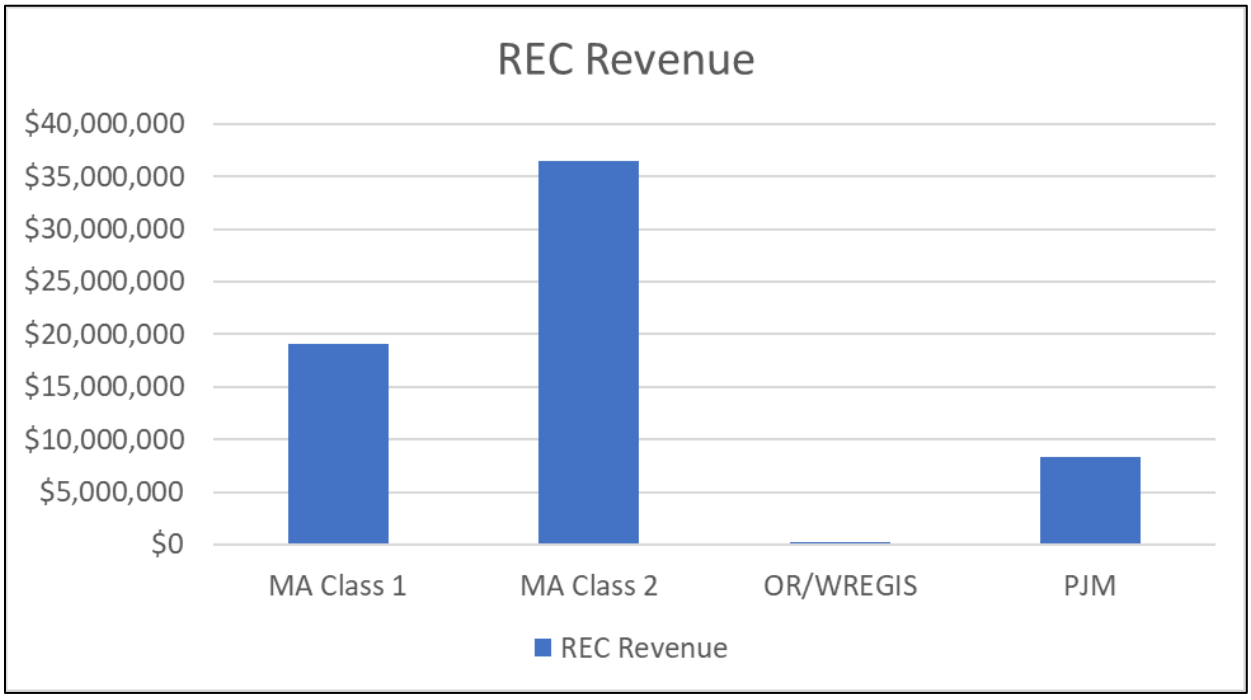
The majority of those sales are in New England where the Massachusetts RPS program has offered consistently robust prices. REC revenue from Massachusetts RPS participation is approximately $55.5 million in 2020, or nearly $23 per MWh (Figure 7).

Figure 6. Renewable Energy Credit Price Trends in Different Markets, 2018 - 2020



MA = Massachusetts, OR/WREGIS = Oregon and the West, PJM = the Mid-Atlantic, Green-e is nationwide. REC prices provided by Karbone.

Figure 7. LIHI Certified® Facility Renewable Energy Credit Revenues, 2020



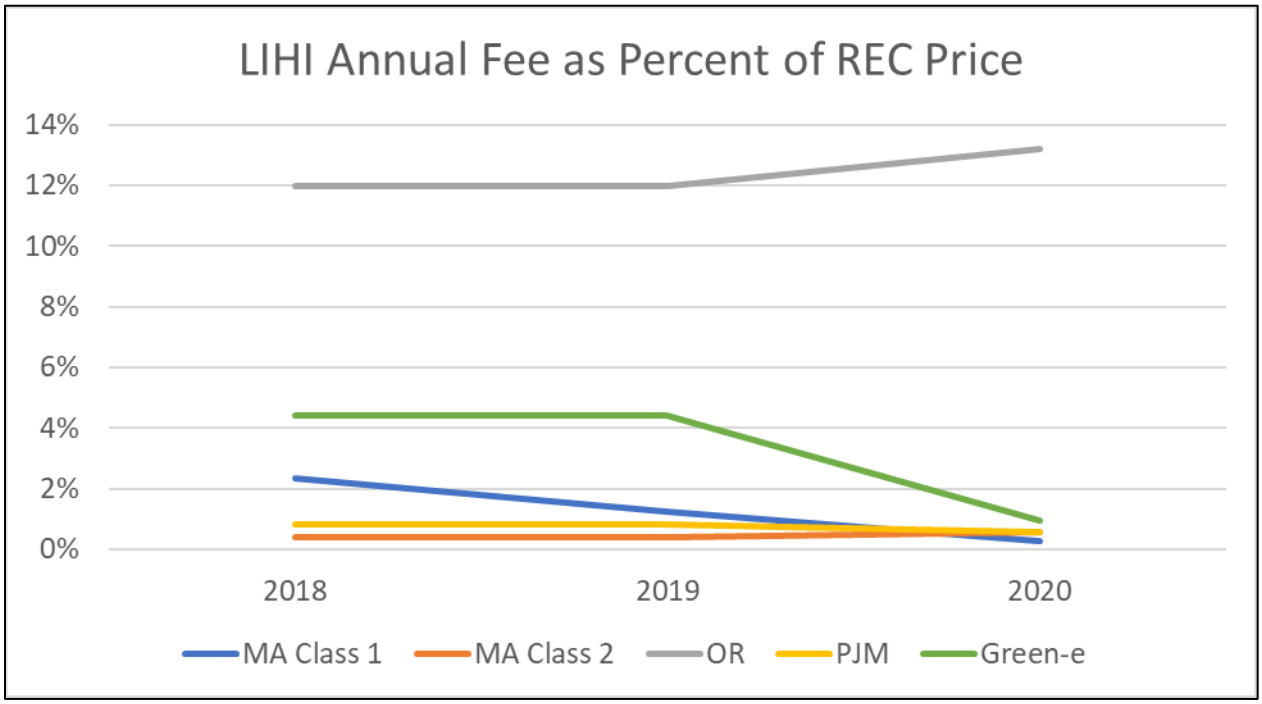
Note: based on reported average annual generation in applications. REC price data provided by Karbone.

As acknowledged in the CESA report, there is a cost to LIHI Certification and to improvements that may be necessary to gain Certification. The report states, "…even though LIHI certification improves hydropower's environmental performance, many states have not opted for making certification a requirement due to the high cost of certification for generators."

Countering this observation is the cost of LIHI Certification relative to REC revenue received by certified facilities. LIHI's average annual fee is 3% (Figure 8) as a percent of average annual REC revenue using 2020 pricing.[32] The region where LIHI is the most expensive as compared to REC revenue is in Oregon, where LIHI annual fees are 13% of REC revenue. It is lowest in Massachusetts where the fee is 0.27% for Class I and 0.56% for Class II. If the annualized average cost of a LIHI application is included, the overall average percentage increases from 3% to 7%. We do not have visibility into the exact costs of improvements made to certified facilities as a result of Certification, however, presumably owners conduct cost-benefit analyses and are still electing to pursue Certification, as demonstrated by the increase year-over-year in the number of certified facilities and the very limited number of non-renewals (see Section 2), even in Oregon where the relative cost for Certification is highest.

[32] REC prices for analysis were provided by Karbone Inc. (www.karbone.com)

Figure 8. LIHI Annual Fees Relative to REC Prices



Voluntary Renewable Energy Procurement Programs

Around the same time that renewable portfolio standards became common, voluntary markets created additional opportunities for REC purchases and sales – energy consumers had increasing options to ensure their supply was met with renewable sources. An overview of these various mechanisms follows. Fifty percent of LIHI Certificates participate in voluntary REC markets.

Utility Programs

In vertically integrated regions (regions without consumer choice of supply) consumers can elect to receive electricity from renewable sources through green tariff or green pricing programs. In a green tariff program, customers sign up for a multi-year commitment, pay a renewable energy charge on their bill, and receive credits on the regular supply charges. Customers using green tariffs are usually large corporate customers. In a green pricing program, retail customers make monthly commitments to receive renewable energy, pay a renewable energy charge on their bill, and do not receive credits for regular energy supply. Utilities may elect to procure RECs independent of the supply.[33] The availability of, and

[33] https://www.nrel.gov/docs/fy19osti/74211.pdf

participation in utility green programs has steadily increased from 2010 to 2018 but growth is outpaced by other mechanisms such as unbundled RECs, community choice aggregation and competitive suppliers.[34]

While we do not have data on the volume of LIHI Certified® hydropower in utility programs, 20% of certified facilities are owned by utilities.

Retail Sales

Retail REC sales are renewable energy procurements made by retail (large or small) customers outside of utility programs. These can include various mechanisms such as long-term contracts with a generator for both the power and the RECs or the purchase of unbundled RECs. Long term contracts can be "physical" or "financial". Physical power purchase agreements, or PPAs, are long-term contracts for both the energy and RECs from a specific renewable energy generator located within the power grid of the customer or "offtaker." Virtual PPAs (VPPAs) include energy and RECs but the energy is not expected to be delivered to or consumed by the offtaker. This allows for the purchase of energy and RECs from generators outside of the offtaker's electricity market.[35] PPAs and VPPAs are typically entered into by large corporate entities. For small entities and individual home owners, Community Choice Aggregators (CCAs) and competitive choice suppliers are the typical options. Competitive choice suppliers are not utilities but are third parties that provide electricity to retail customers. Typically, these third party choices provide an energy supply mix that has a greater portion of renewable energy than that provided by the utility.[36] CCAs are entities that pool together small offtakers such as municipalities, to purchase renewable energy and/or RECs, comprising the largest growing segment of renewable energy purchasers in the US.[37]

Green-e

RECs sold in a voluntary market are independently verified through third parties to ensure they actually represent the renewable attributes of a qualified renewable generation source. Green-e is the largest certifier of RECs in the US.[38] Hydropower is included in the Green-e voluntary REC market. However, Green-e requires that participating generation

[34] https://www.nrel.gov/docs/fy20osti/74862.pdf
[35] M.J. Bradley & Associates, LLC, MJB&A Issue Brief, September 5, 2019 (Updated November 5, 2019)
[36] Ibid.
[37] https://www.nrel.gov/docs/fy20osti/74862.pdf
[38] https://resource-solutions.org/g2019/

resources be "new", or less than 15 years old.[39] It also requires that hydropower meet certain requirements, including that it be LIHI Certified®. In 2019, Green-e amended its definition of qualified hydropower in order to better align with its unique physical components.[40] Even with this amendment, due to the requirement that any new generation be less than 15 years old, only a small amount of hydropower is currently qualified.

The voluntary market is significant and growing but primarily available to wind and solar. In 2018, wind accounted for 87% of Green-e certified supply, solar 6%, non-gaseous biomass 6%, gaseous biomass 1%, hydropower 0.5%, and geothermal 0.1%.

By the number of facilities, Low Impact hydropower represented 0.75% of Green-e suppliers, while solar made up 50% and wind 40%.

Voluntary Green-e certified sales have increased 13% per year over the past four years and 4% from 2017 to 2018. This growth was driven by CCAs. CCAs are not available in all states[41] but CCAs purchased 15% more generation in 2018 than in 2017. Most Green-e certified sales were REC sales either through stand-alone transactions or in PPAs or VPPAs. Direct procurement grew 15% from 2017 to 2018. Retail customers increased their purchases by 15% and non-residential customers by 3%. Non-residential sales accounted for the vast majority of overall sales.[42]

As noted above, non-residential procurement is the largest driver of PPAs and VPPAs. Green-e certified transactions were 76.6 million MWh in 2018 with 49.7 million for non-residential, 742,000 for residential and 14.5 million for wholesale transactions. PPAs and VPPAs represent 85% of sales, followed by utility green pricing programs. Retail customers primarily purchase through green pricing programs while non-retail customers purchase through PPAs and VPPAs.[43]

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[39] https://www.green-e.org/docs/energy/framework/Green-e%20Framework%20for%20Renewable%20Energy%20Certification.pdf, page 7

[40] Ibid, page 3. For example, in order for repowered facilities to qualify as new, 80% of repowering cost has to be for the generation equipment. The extensive physical components including the dam structure of a hydropower plant would rarely if ever meet this requirement. Hydropower now has its own set of criteria to qualify as repowered in Green-e.

[41] Community Choice Aggregation is available in California, Illinois, Massachusetts, New Jersey, New York, Ohio, Rhode Island, Virginia. https://www.energysage.com/other-clean-options/community-choice-aggregation/where-are-ccas-available/

[42] 2019 Green-e Verification Report (2018 Data), (2020). https://resource-solutions.org/g2019/

[43] Center for Resource Solutions

Direct Corporate Contracting

Large electric load customers also evolved from simply utility customers to sophisticated independent buyers. Through corporate sustainability goals, increasing sophistication in their electricity use, and recognition of cost savings opportunities, large and small corporations and universities have increased their use of bi-lateral contracts to reduce their own carbon footprints. These contracts are primarily with solar and wind facilities. Direct corporate procurement of renewable energy increased from 1.2 gigawatts (GW) in 2015 to 6.53 GW in 2018, with transactions doubling from 2017 to 2018.[44] Corporate procurement has focused primarily on wind developments and increasingly on solar. Corporate buyers are also getting more specific in their purchasing goals. Google, for example, found that their procured renewable generation does not always coincide with their need.[45] Google may have purchased enough renewable energy to meet their overall usage, but they have found that there are times when their instantaneous electricity demand cannot be met with renewables alone, and is powered by fossil generation instead. This awareness presents an opportunity for Low Impact Certified hydropower as its generation is more reliably available at all hours of the day.

While we do not have information on the amount of LIHI Certified® hydropower included in long term contracts, at least 30% of LIHI Certified® facilities have long-term contracts.

3.2 Interest in LIHI Certified® Hydropower

As discussed above, the opportunities for LIHI Certified® hydropower outside of RPS programs is still somewhat limited. However, over the course of the past few years, LIHI has received inquiries from a number of power marketers looking to match interested corporate buyers with hydropower they can feel confident in procuring, or who are interested in possibly aggregating LIHI Certified® hydropower generation into an amount of generation in which larger offtakers would be interested.

According to the LIHI Certificate Holder survey conducted in the summer of 2020, 49% of Certificates are participating in PPAs and most of those include RECs that need LIHI Certification to qualify. Eighty percent of respondents indicated strong interest in entering into a long-term contract for their generation.

[44] https://businessrenewables.org/corporate-transactions/

[45] https://storage.googleapis.com/gweb-sustainability.appspot.com/pdf/24x7-carbon-free-energy-data-centers.pdf

4. SURVEYS

4.1 Certificate Holder Survey

In the summer of 2020, LIHI surveyed Certificate holders in an effort to understand the primary drivers of undertaking LIHI Certification as well as to attempt to quantify improvements to watersheds as part of the process. Requests were emailed to Certificate holders who were asked to complete one survey per Certificate. Seventy surveys were completed representing 45% of all Certificates. All respondents are current LIHI Certificate holders.

Respondent Overview

All current and former Certificate holders were invited to participate, and respondents generally mirrored the geographic distribution of LIHI Certificates. Facility sizes also mirrored the distribution of the sizes of facilities within the portfolio with the exception of those between 30 and 100 MW. Twenty percent of respondents fell into this size category while only 12% of Certificates fall into this category.

69% of respondents report employing less than 30 people at the facility. However, 60% report that more than 50 people are also indirectly employed there. Other industries listed as being dependent on the facilities include:

- Construction
- Water supply
- Recreation (e.g., fishing, camping)
- White water rafting
- Agricultural irrigation
- Canal operations
- Municipalities or utilities using generation to meet 100% renewable goals
- NGOs
- Other businesses dependent on the local generation

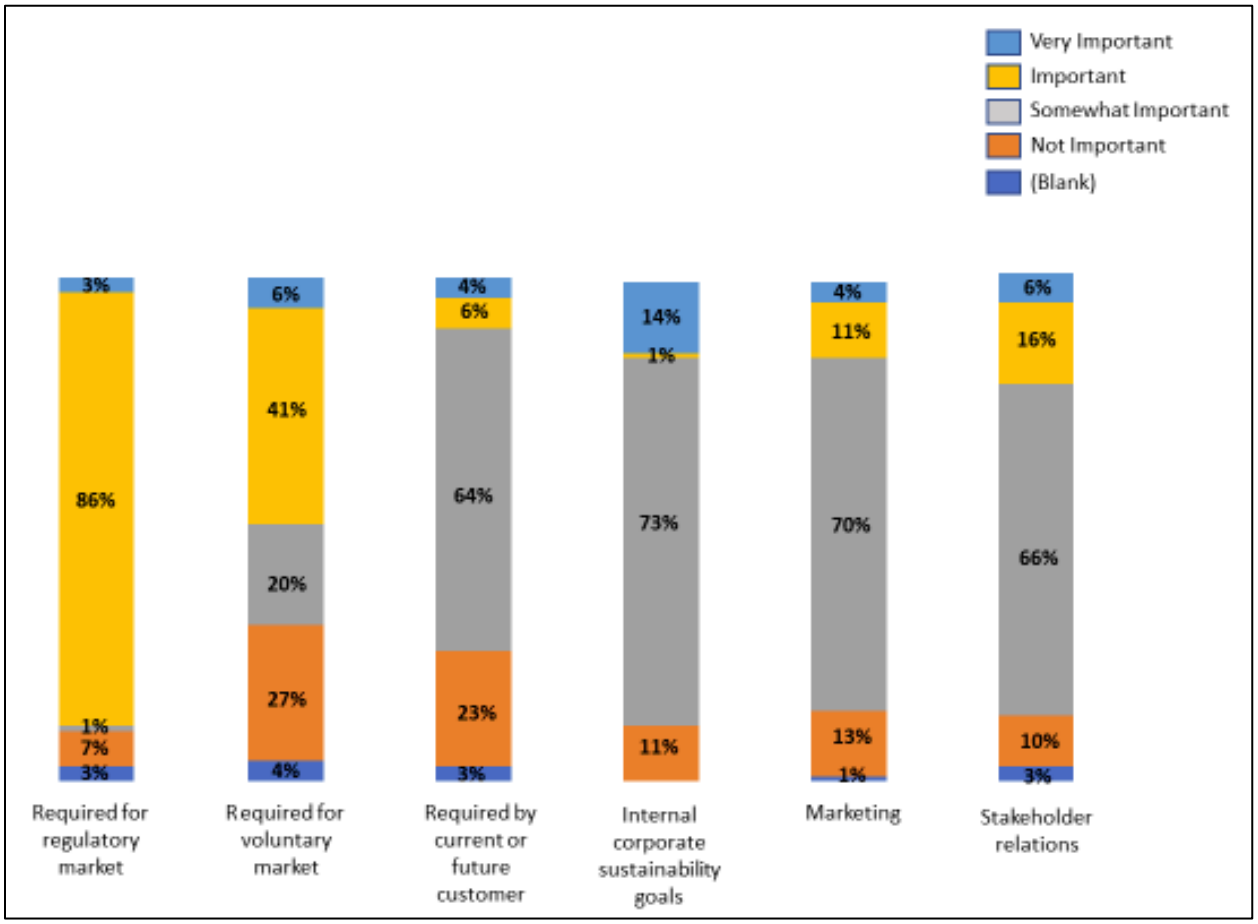
Most respondents declined to answer questions about revenue and taxes. However, those that did respond (10), 40% said that the facilities earn less than $500,000 in annual revenue and 30% earn between $500,000 and $1,000,000. Of the 25 who responded about state and local taxes, 64% pay between $0 and $100,000 per year. The rest pay greater than $100,000 with one respondent report paying more than $2,000,000.

Drivers for and Outcomes of LIHI Certification

The survey listed six potential reasons to get certified and asked how important each was to the Certificate applicant. Figure 9 shows that the requirement for RPS program participation was by far the most important reason, followed by requirement for voluntary REC market, and internal sustainability goals. The least important reason was that it was required by a current or future customer. Other reasons added by respondents include employee morale and perception of the project. When asked if certification was helpful with stakeholder relationships, 89% believed it was at least somewhat helpful. 35% said helpful or extremely helpful.

Comments to this question illustrated recurring themes. While certification could be helpful, some thought agencies used the process as a second chance, outside of formal proceedings, to ask for additional mitigation. Other comments included that the applicant would not have otherwise known about new threatened and endangered species at the project, and that it was useful for discussions on fish passage, or with specific agencies. When asked if LIHI Certification was a factor in a FERC relicensing, 93% said no. LIHI strives for independence and autonomy from the FERC process so this result was consistent with that effort. Interestingly, one respondent who said yes, said LIHI Certification was a condition of their license.

Figure 9. Reasons to Become Certified



Voluntary Changes

LIHI hopes to encourage improvements to river systems impacted by hydropower. Therefore, certificate holders were asked if they made voluntary changes in order to get certified, either before applying or as a result of certification (see Sections 5.1 and 6.3). Overall, 23%[46] of Certificates included in survey responses implemented voluntary changes to operations, facilities, or communications as a result of certification. Ten percent made changes before applying and 17% made changes after certification. The majority of those changes were in relation to fish passage, communications and stakeholder relations, and recreation (Table 1). Section 6.3 discusses the 29% of all LIHI Certified® facilities that have taken actions that go above and beyond the LIHI Criteria and/or have implemented voluntary measures.

[46] Many certificate surveys reflected changes made before as well as after the application process. These are only counted once in the overall changes figure of 23%.

Table 1. Voluntary Changes Made for LIHI Certification

Criterion	Facility / Before	Operations / Before	Accelerated License / Before	Facility / After	Operations / After	Total
Water Quality	1					**1**
Flows				2	1	**3**
Upstream Fish passage		1		4	1	**6**
Downstream Fish passage		1		2	3	**6**
Threatened and Endangered Species					1	**1**
Shoreline protection						**0**
Cultural and historic resources			1	1	1	**3**
Recreation		1		5	2	**8**
Other (e.g., communications, stakeholder relations)	2	2	2	4	2	**12**
Total	**3**	**5**	**3**	**18**	**11**	**40**

4.2 Stakeholder Survey

As stakeholder involvement is important to the application process, (see also Section 5.1 - Public Comments), it was important to understand how the program is perceived by them. This effort is also key to understanding whether LIHI Certification is a credible standard. LIHI's goals and objectives seek to provide information to consumers so that they have the information available to be informed on a hydropower facility's impact. LIHI's goals and objectives do not include changing the minds of the public on hydropower overall. As is demonstrated below, there is a correlation between survey respondent perceptions of hydropower and their perceptions of the LIHI Certification program. Complicating this analysis further, the sample size was very small. Therefore, these results are informative but cannot be considered statistically significant.

LIHI sent survey requests to 610 individuals across the country. Recipients were all subscribed to the LIHI communication list and Certificate holders, news outlets, and board members were

removed from the original list. In the end, only 30 people responded despite multiple reminders and extensions to the deadline. As stated above, given the 5% response rate, these results are informative but not representative.

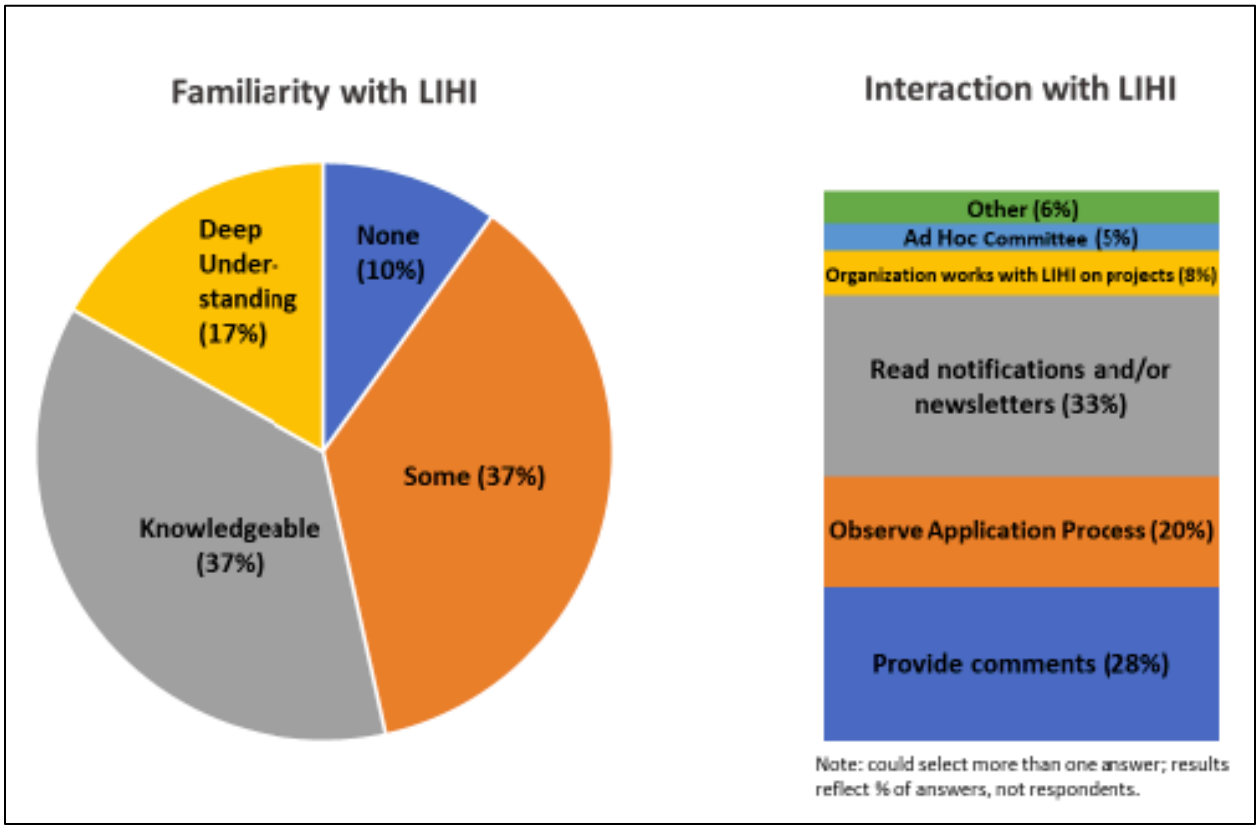
Respondent Overview

Twenty-six percent of respondents selected Federal as their area of engagement. New England was the region represented the most by respondents (42%) followed by New York (10%), and the west (which includes the pacific northwest and California) (9%). Forty-seven percent were stakeholders versus 34% who were government employees.

Participants were pretty equally distributed in terms of their organizational affiliation but 22% lived in a certified facility watershed and 37% worked or volunteered for an NGO (non-government organization or nonprofit) or watershed organization. Thirty-eight percent were engaged at the state or local level while 45% were engaged at the regional or federal level.

Most respondents were familiar with LIHI and 28% had provided comments on applications. 44% have been engaged with LIHI for less than 5 years and 23% for more than a decade. Providing comments, reading notifications, and observing the application process accounted for more than 80% of participation activities (Figure 10). Sixty-seven percent were familiar with the use of LIHI Certification for a regulatory market (RPS), while 57% were aware of its use in other corporate marketing activities.

Figure 10. Stakeholder Familiarity and Interaction with LIHI

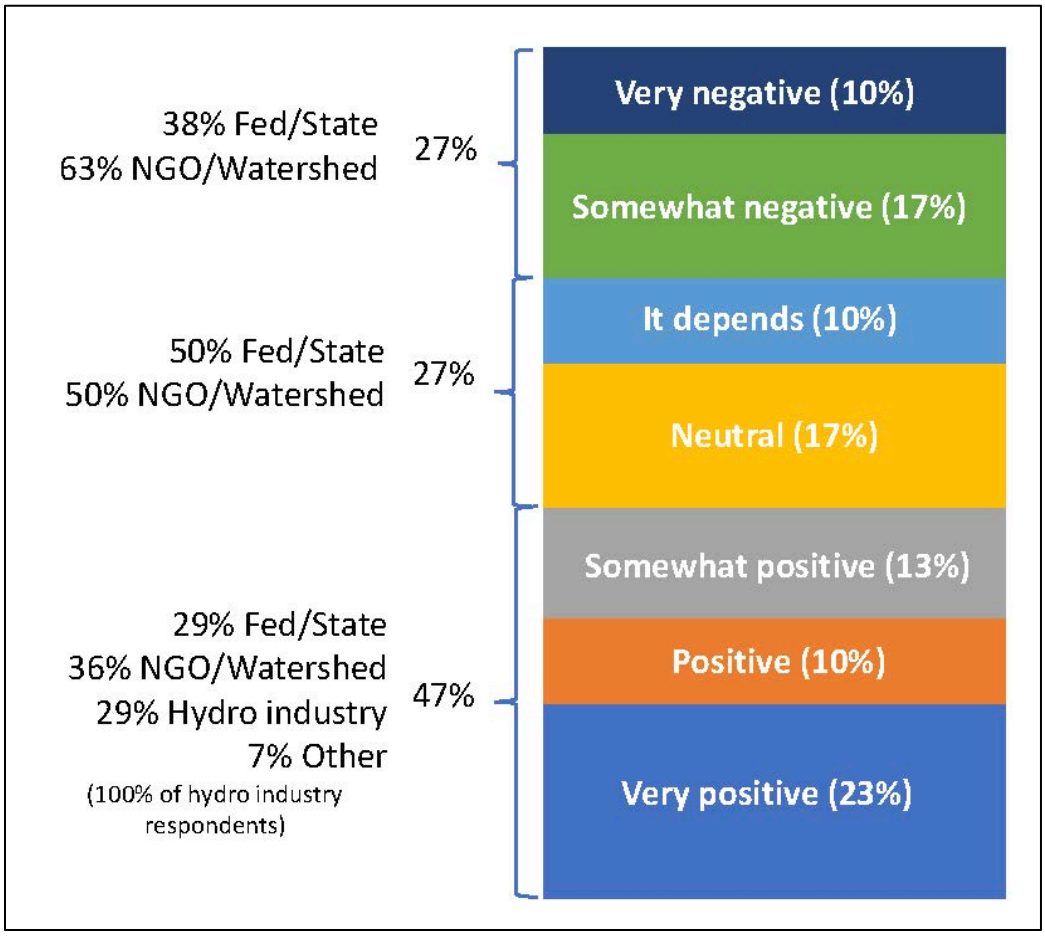


Perceptions of Hydropower

Respondents were asked to indicate whether their perceptions of hydropower in general were positive or negative (Figure 11). Twenty-seven percent had negative perceptions of hydropower while 47% were positive. NGOs and agencies were generally split on their perceptions while all of those related in some way to the hydropower industry were positive.

Respondents were also asked about their organization's perception of hydropower. Views here were also split with 37% skeptical or opposed to hydropower, while 44% supported its use in getting to a 100% renewable grid, or for its grid and ancillary services.

Figure 11. Stakeholder Perceptions of Hydropower



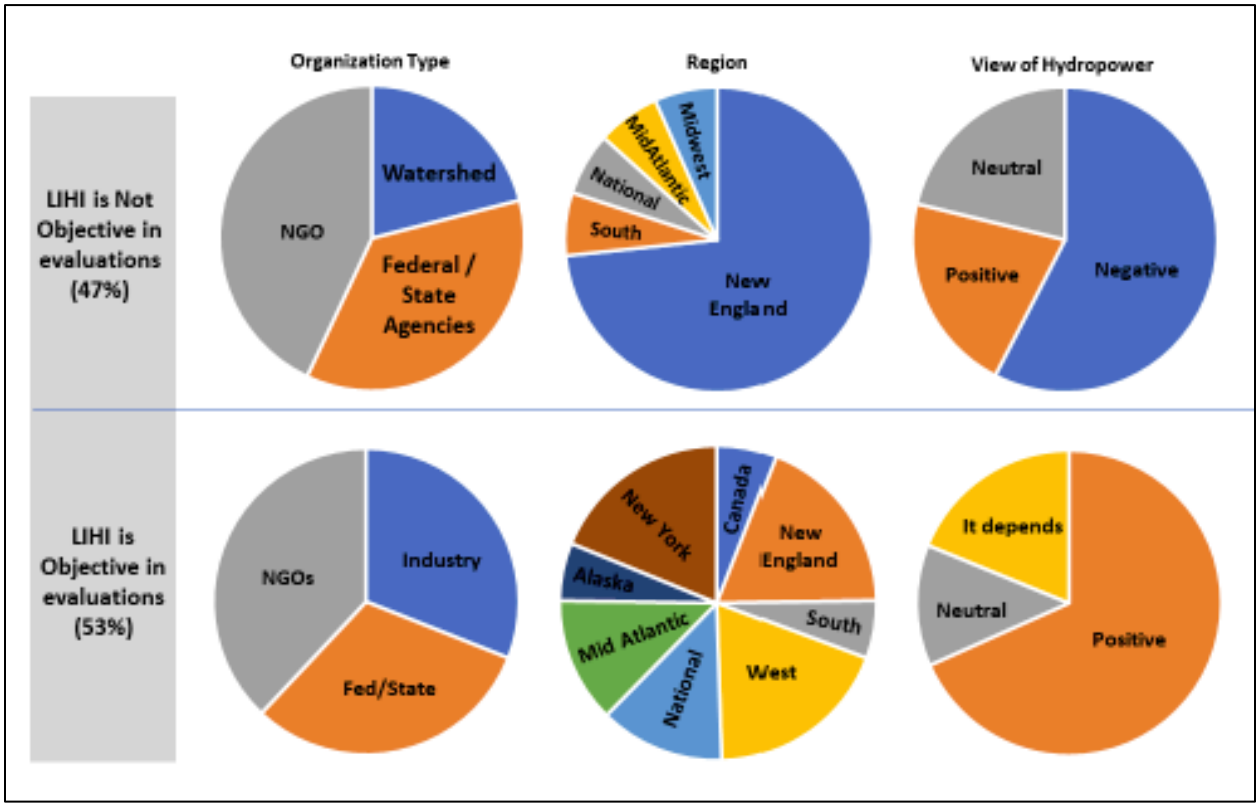
The comments on these questions were representative of comments and results overall. In fact, the results overall reflect Lydia Grimm's characterization (see page 4 of this report) that LIHI would never make everyone happy and in fact would be unacceptable by some in both industry and conservation. Generally, some believe all hydropower is inherently not worth its impacts. Others believe hydropower's benefits (low carbon energy) more than outweigh its well mitigated impacts.

Perceptions of LIHI Program

Respondents were asked about their perceptions of the LIHI Certification program (Figure 12). Responses were split here as well. Fifty-three percent believe LIHI is objective in its evaluations and 53% had at least some confidence in the LIHI Certified® designation, with 37% saying it depends on the specific facility. Only 10% had no confidence in objectivity of the program.

The majority of those who did not believe LIHI was objective were located in New England (71%) and were watershed groups or NGOs (64%). All of those with a negative perception of hydropower had a negative view of LIHI.

Figure 12. Stakeholder Perceptions of LIHI (N=30 respondents)



Comments on these questions included the following:

Not Objective	Objective
Not enough transparency	Trust in LIHI's experience
Side with industry/industry influence	New handbook improved confidence
Outcomes do not go above and beyond license requirements or are driven by license requirements	Consistency
Applications are not rejected	Recognition of impacts
	FERC exempt projects show improvements

To some extent the stakeholder comments reflected the nature of LIHI's approach to rejecting applications. As discussed further in Section 5.2, 11.9% of applications are not approved. Other applicants decide not to submit an application based on pre-application consultation with LIHI staff that identified potential barriers to meeting the LIHI Criteria. Still more never approach LIHI knowing that their project will not meet the LIHI Criteria. Rejections are not typically shared by any certification program. However, the misperception that LIHI approves all applications is likely a factor in negative views of the program.

The 2nd Edition Handbook improved the confidence in the program for 20% of stakeholder respondents. Forty-eight percent of respondents believe LIHI Certified® hydropower is more trustworthy, environmentally sound, does more to safeguard the environment, and inspires more confidence than non-certified hydropower. Thirty percent think there is no difference. Only 17% were aware that improvements were made at the certified facilities with which they are familiar while 40% feel that the hydropower facilities are up to status quo.

Survey respondents who have a negative view of LIHI also have a negative view of hydropower overall. Respondents with negative views on LIHI, either that the decisions are not objective or that the LIHI Certified® distinction is not credible, were most likely to have a negative view of hydropower. Local watershed groups were also more skeptical of the program. Those with positive views were far more likely to be positive about hydropower. Industry was more favorable toward the program.

The transparency provided by the LIHI Certification process provides more accessible operations information than does the FERC e-library. LIHI also provides information for projects that are FERC-exempt, or FERC non-jurisdictional (e.g., federally owned projects), for which there is less likely to be transparent information. However, as comments reflected, LIHI can do more to provide additional transparency and information, including publishing LIHI's responses to application comments.

4.3 Survey Take-Aways

Using the data collected in the stakeholder survey we can draw the conclusion that if one is predisposed to disliking hydropower, LIHI Certification has not changed that opinion. However, from the Certificate holder survey, we know that facility improvements that benefit river systems are being made as a result of Certification. The data also show that stakeholders in the Northeast are more critical of the program than those in the rest of the country. REC sales drive LIHI Certification. Likely because of the Massachusetts RPS, Certificate holders in the Northeast stand to earn significant revenue from REC sales, creating a greater focus on revenue derived in part from LIHI Certification, and thus greater expectations for performance that may exceed the LIHI Criteria.

The difference in survey response rates may indicate how much more important LIHI Certification is to those who have earned it, or to a larger part of their regular business, than it is for stakeholders. The relatively large voluntarily subscribed LIHI stakeholder list, coupled with website traffic (see Section 7), indicates that the information provided by LIHI does have value for interested individuals and organizations across the country.

5. CURRENT LIHI PROGRAM

Since its founding in 1999, LIHI has developed and reviewed its criteria, evolving as the program has matured. As noted earlier, a major update to the handbook, primarily effecting standards, was issued in 2016. Since then, the governing board has approved incremental changes to clarify where necessary. Below is a description of the status of the current program, including an overview of LIHI Certified® facilities.

5.1 LIHI Certification under the 1st Edition and 2nd Edition Handbooks

The 1st Edition LIHI Handbook was originally issued in 2000. The first LIHI application was received in August 2000 and the first LIHI Certificate was issued on March 27, 2001. Periodic minor revisions to the 1st Edition Handbook were made until 2016 when the 2nd Edition Handbook was published. Subsequent minor revisions have been made to the 2nd Edition in 2016, 2018, and 2020.

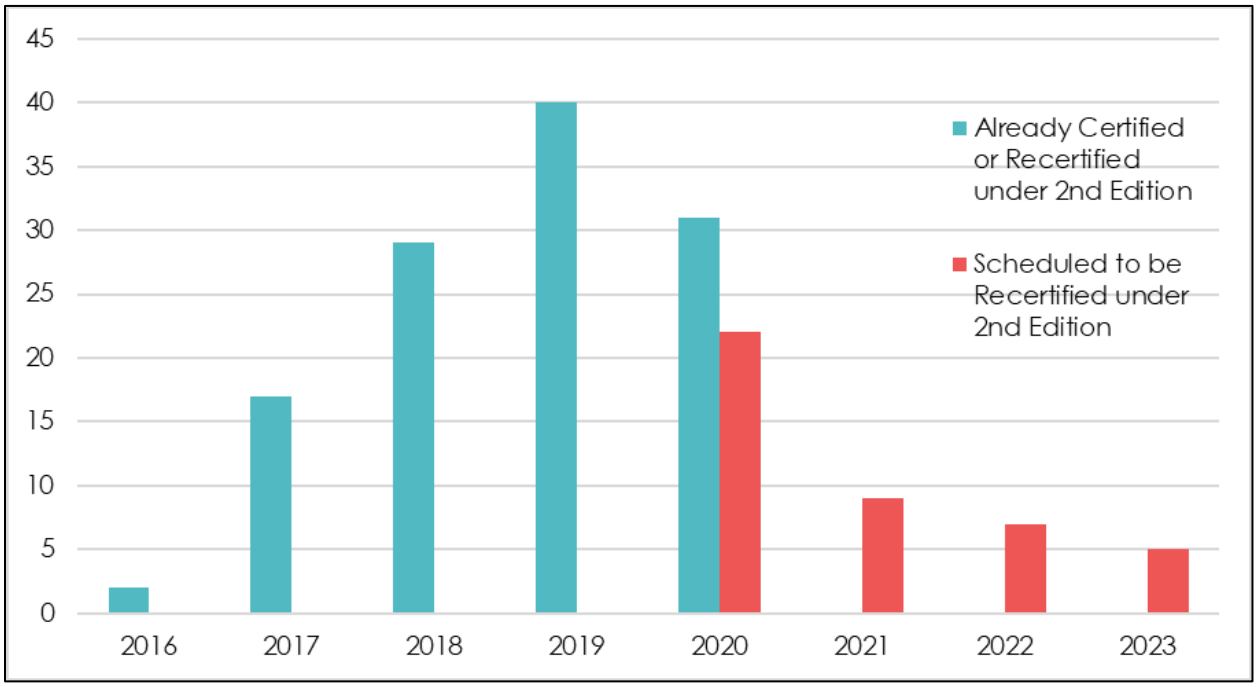
The 2nd Edition incorporated several new aspects that have substantially improved the certification program. LIHI introduced the concept of Zones of Effect to distinguish between different amounts of impact that may occur in different facility zones (e.g., impoundment, bypassed reach, downstream reach). This approach allows for a much more detailed and granular evaluation of impacts. Alternative standards were also introduced (discussed below) and PLUS standards are now available for all eight criteria. In the 1st Edition, PLUS was only available for the shoreline and watershed protection criterion. Very Low Impact status can now be granted where impacts are determined to be “not applicable” or “de minimis” (Standard 1) in all criteria and in all zones. This results in a 10-year Certificate term and reduced fees.

Current Status of Certifications

Forty-three current Certificates or 27%, have not yet been renewed under the 2nd Edition Handbook, although most had been recertified at least once under the 1st Edition Handbook. Given the newness of the 2nd Edition, no facilities originally certified under that edition have been recertified yet although recertification processes will begin for some Certificates expiring in early 2021.

During the transition from the 1st to 2nd Edition Handbooks some applications were grandfathered and able to use the 1st Edition Handbook for applications received through 2016 and early 2017. Most Certificates not yet renewed will expire in 2020 or have expired and have been extended to cover the current recertification application processing period. By 2023 all Certified facilities that choose to apply for recertification will have gone through the process under the 2nd Edition Handbook (Figure 13).

Figure 13. Certified Facility Status under the 2nd Edition Handbook



Use of Alternative Standards in the 2nd Edition Handbook

The primary difference between the two handbooks is that the 1st Edition relied almost exclusively on a facility's compliance with formal resource agency recommendations and/or concurrence of resource agencies on the lack of facility impacts related to the LIHI Criteria. The 2nd Edition retains agency recommendations as Standard 2 for each criterion. One or more alternative standards can also be used to satisfy each criterion, as follows.

A. Ecological Flow Regimes:
- Standard 1 – Not applicable / de minimis effect
- Standard 2 – Agency recommendation
- Standard 3 – Limited storage
- Standard 4 – Site-specific studies

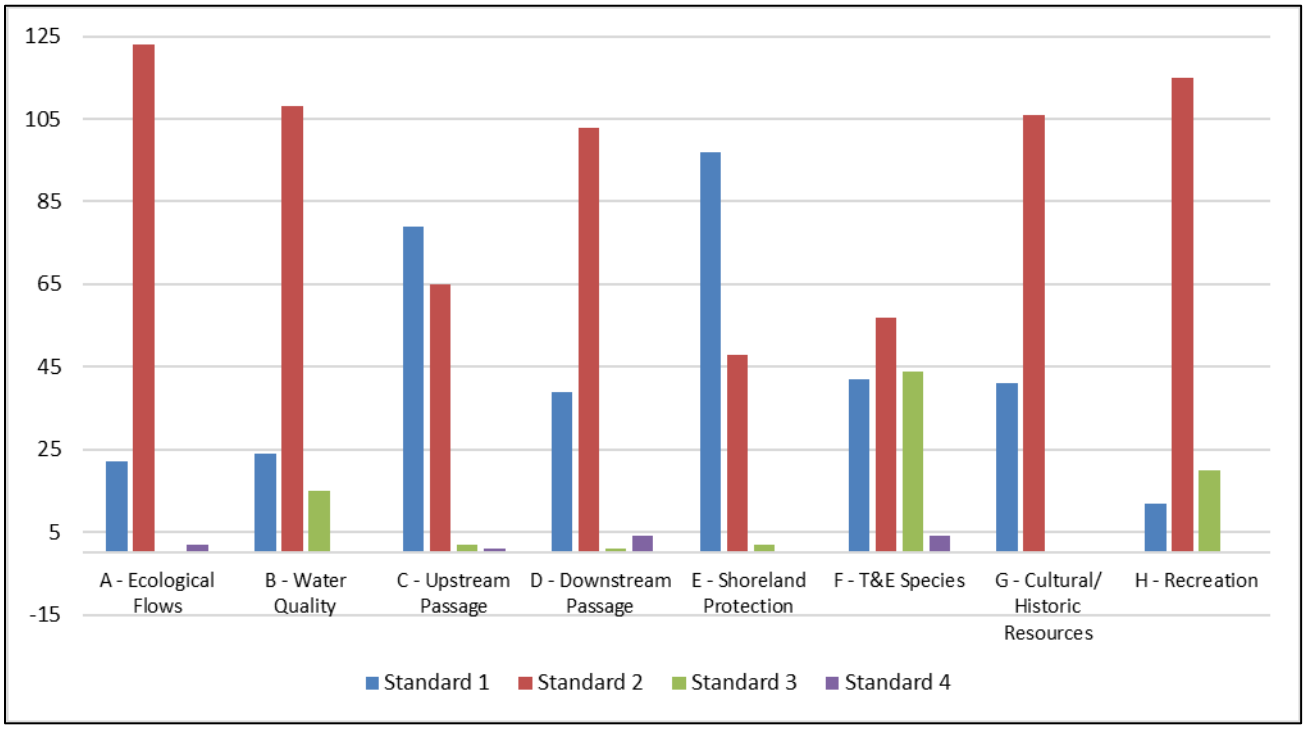
B. Water Quality:
    Standard 1 – Not applicable / de minimis effect
    Standard 2 – Agency recommendation
    Standard 3 – Site-specific studies
C. and D. Upstream and Downstream Fish Passage:
    Standard 1 – Not applicable / de minimis effect
    Standard 2 – Agency recommendation
    Standard 3 – Best practice / best available technology
    Standard 4 – Acceptable mitigation
E. Shoreline and Watershed Protection:
    Standard 1 – Not applicable / de minimis effect
    Standard 2 – Agency recommendation
    Standard 3 – Enforceable protection
F. Threatened and Endangered Species Protection:
    Standard 1 – Not applicable / de minimis effect
    Standard 2 – Finding of no negative effect
    Standard 3 – Recovery planning and action
    Standard 4 – Acceptable mitigation
G. Cultural and Historic Resource Protection:
    Standard 1 – Not applicable / de minimis effect
    Standard 2 – Approved plan
H. Recreational Resources:
    Standard 1 – Not applicable / de minimis effect
    Standard 2 – Agency recommendation
    Standard 3 – Assured Accessibility and Use

One benefit of this approach to resource agency staff is that their LIHI-related workload has decreased since applicants and LIHI reviewers do not need to reach out to agencies if enough information exists to determine a facility's satisfaction of the criteria. Agencies also no longer need to submit letters of concurrence for every application.

Agency and stakeholder contacts on LIHI's email list and those listed in applications are notified when a full application has been received and the 60-day public comment period has begun. Those individuals listed in the application's contact table are told who the reviewer is and informed that the reviewer may contact them for additional input. They are also invited to submit public comments on the application. Reviewers are copied on that notification and agencies and stakeholders continue to provide comments and/or informal input as they see fit.

Figure 14 shows the frequencies of the highest standard used for each criterion across all Zones of Effect for all currently certified facilities. Most facilities still select Standard 2, Agency Recommendation to satisfy most criteria (red bars), but the 2nd Edition Handbook allows better identification of the facility's actual level of impacts through the use of alternative standards.

Figure 14. Standards Used under the 2nd Edition Handbook[47]



Note: Standards 3 and 4 are not available for criterion G - cultural and historic resource protection. Standard 4 is not available for criterion B - water quality, criterion E - shoreline and watershed protection, and criterion H - recreation.

In practice, agency recommendations (Standard 2, red bars) are often based on things like site-specific studies so the applicant often selects the agency recommendation standard even if another standard could also apply. Notably, the figure shows that Standard 1 – not applicable/de minimis effect (blue bars) is now used more often for upstream fish passage[48] and for shoreline and watershed protection than Standard 2. For threatened and endangered species (criterion F), Standard 1 and Standard 3 (recovery planning and action) are used nearly as frequently as Standard 2 which for this criterion is a finding of no negative effect - either from an agency recommendation, or based on the expected presence of the species or lack of habitat within the facility's influence. For instance, in an urban setting it is unlikely that a facility could impact Northern long-eared bat, or at a facility with only limited riparian lands

[47] Figure 14 represents Standards selections for each Zone of Effect at a facility, which can range from 1 zone for a conduit project to 25 for a multi-facility application.

[48] The upstream passage criterion allows for most impoundments to qualify for Standard C-1 since once above a dam there is typically no further facility-related barrier to continued passage. Conversely, the downstream passage criterion allows for downstream reaches to typically qualify for Standard D-1.

there is unlikely to be habitat for the small-whorled pogonia, a plant species found in mixed-deciduous/coniferous forests.

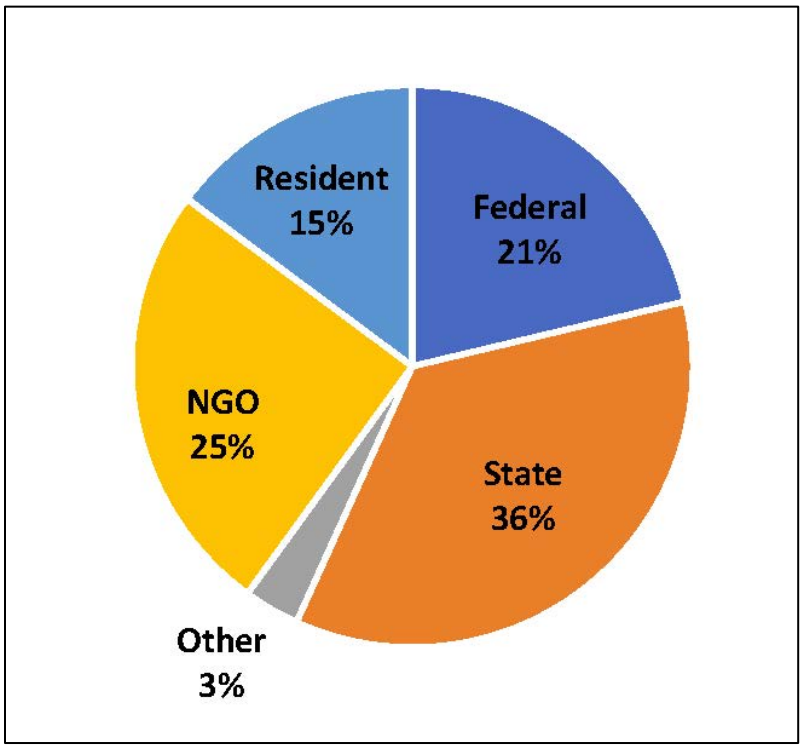
For the other criteria Standards 3 and 4, where available, differ among the criteria and are geared toward special cases, thus these standards are rarely used.

Public Comments

Public comments received by LIHI that are posted on the LIHI website for original and recertification applications were reviewed and analyzed. The sample includes 157 comment letters submitted on 101 individual applications. Of all current Certificates, 50% have received comment letters and 8% have received comments on multiple applications (the original application and/or one or more recertification applications).

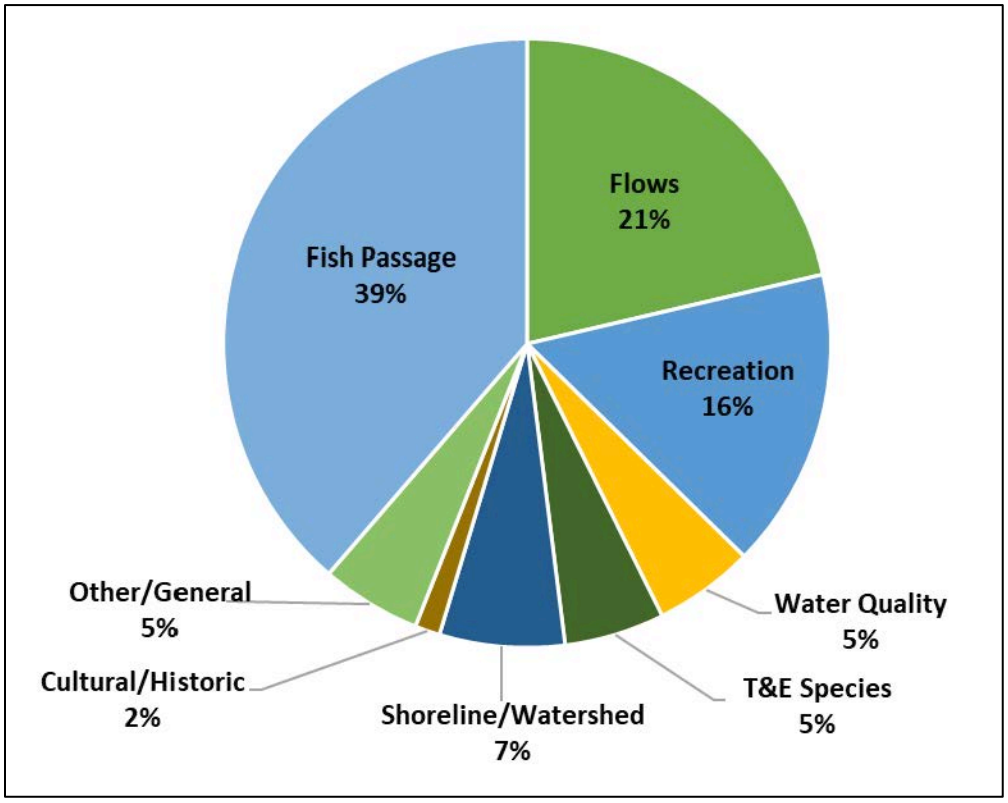
Comments came primarily from state and federal resource agencies (57% combined), followed by environmental NGOs (25%) and then by local residents (Figure 15). The preponderance of agency letters is due in part to facilities certified under the 1st Edition Handbook that required more formal agency input.

Figure 15. Percentage of Public Comments by Stakeholder Category



Commenters often, but not always make specific recommendations or list specific reasons for their comments. A breakdown of those reasons and recommendations by LIHI Criterion is shown in Figure 16. Comments include both positive and negative viewpoints with fish passage being the most frequent criteria addressed (39%) followed by flows (21%) and recreation (16%).

Figure 16. Percentage of Specific Comments by LIHI Criteria



A majority of applications with comments received only positive or neutral comments (63%) while 37% received negative or opposing comments. Two other applications received both positive and negative comments. Neutral comments typically either corrected information in applications or made general statements about, or recommendations for, the facility. Some applications received neutral comments, either as the only comments or in addition to positive or negative comments from other stakeholders. In 55% of cases where negative comments were received, the applicant provided responses to the comments, letters that are also posted on the website.

In all cases, the application reviewer summarized all comments and applicant responses, and determined whether the comments necessitated a Certificate condition in the review report.[49] Overall, two-thirds of applications with adverse or neutral comments resulted in conditions related to the comment. In another 14% of cases, conditions codified voluntary actions and/or include PLUS awards or PLUS options (see below and Section 6.3) to further encourage continued facility and operational improvements recommended by commenters.

Use of Conditions

Forty-three Certificates (27%) have original certifications under the 2nd Edition Handbook and 76 Certificates (47%) have been renewed under the 2nd Edition Handbook. As noted above, the remaining forty-three Certificates have not yet been recertified under the new handbook. Conditions have been used throughout LIHI's history, although their use has declined slightly under the 2nd Edition Handbook. Revision 2.04 of the 2nd Edition Handbook issued in April 2020 clarified the use of conditions. Conditions are now being applied more consistently across facilities on the same river system, and condition language has been made more concise and consistent. Conditions are typically imposed to:

- satisfy a criterion where additional confirming data is or will be collected,
- reflect anticipated changes to the facility's structures, operations, or capacity,
- incorporate FERC relicensing or other regulatory outcomes,
- address agency reservations of authority to require additional measures,
- respond to stakeholder or agency comments, and/or
- ensure that planned or in-progress studies, mitigation measures, agreements between the applicant and stakeholders, or compliance matters are completed in a timely manner.

Conditions are also used to ensure that existing voluntary measures remain in place (e.g., enhanced minimum flows, fish passage season extensions, or renewal of a third-party Memoranda of Agreement between owner and agencies).

Conditions often increase the likelihood that certification will achieve its goal of reducing the environmental impacts of hydropower generation, which is a core mission of LIHI. Without conditions on certificates, there may be no certification issued and thus no reduction in impacts and no additional benefits to river ecosystems. However, if an application cannot be approved

[49] Negative comments have contributed to an application's withdrawal but have not necessarily prevented certification. In cases where negative comments were received and the decision was to certify, the standards were proven adequately met.

without conditions and the owner/operator of the facility cannot agree to meet the conditional requirements, then the application would not be approved.

Table 2 summarizes the use of conditions over time for: a) Certificates issued only under the 1st Edition; b) Certificates issued only under the 2nd Edition; and c) Certificates originally issued under the 1st Edition and later recertified under the 2nd Edition.

Table 2. Breakdown of Conditions under 1st and 2nd Handbook Editions

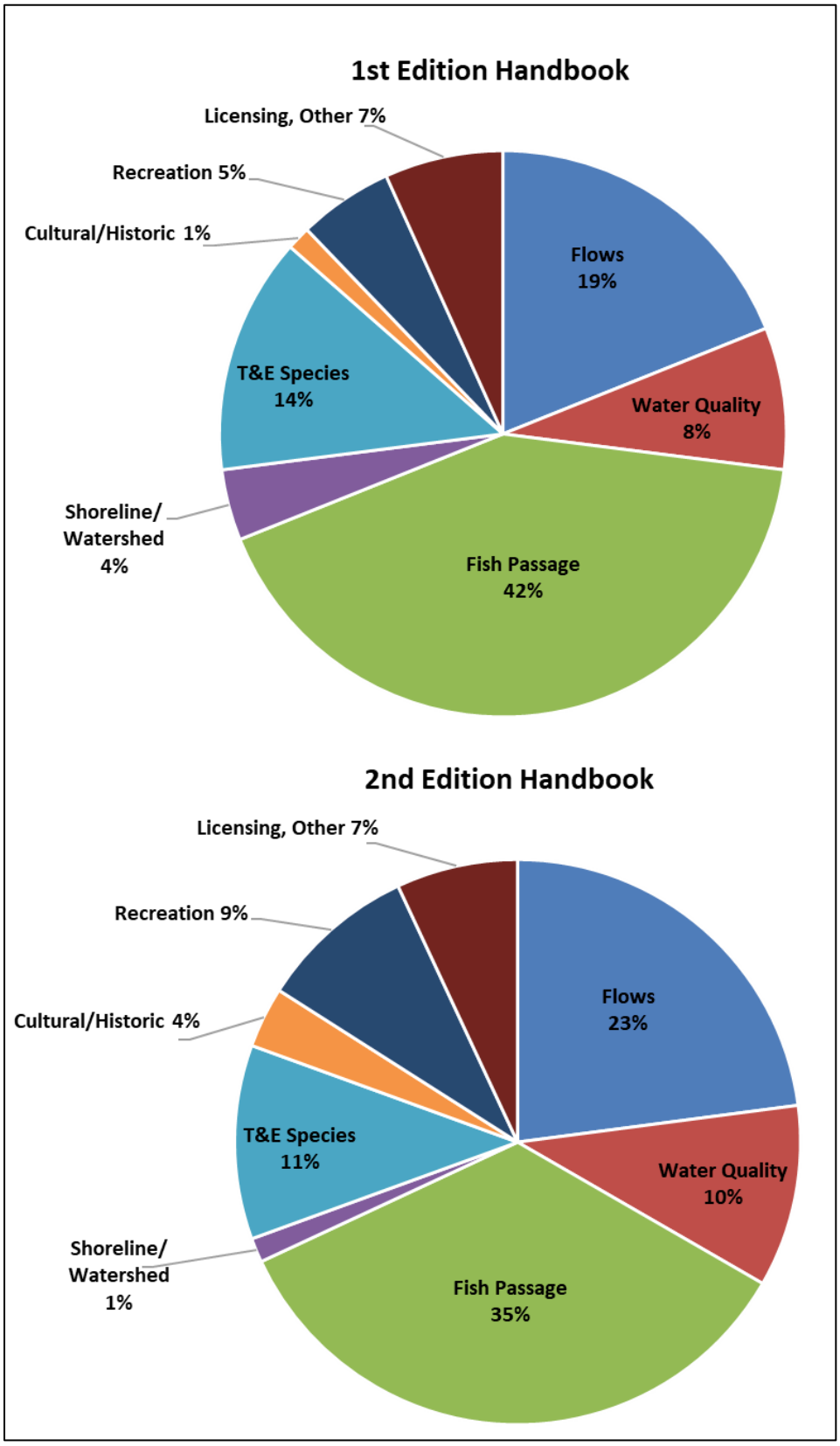
	1st Edition Only	2nd Edition Only	Both 1st and 2nd Editions
Number of Certificates	43	43	76
% with conditions	86%	60%	70%
Average # of conditions	1.86	1.77	1.89

The table shows that the frequency with which conditions are placed on Certificates has decreased under the 2nd Edition Handbook. This is primarily due to the alternative standards that allow LIHI to consider additional information beyond agency recommendations alone, such as demonstrated de minimis impacts, results of site-specific studies, acceptable mitigation measures, or the use of best available technologies. The average number of conditions on a Certificate is similar regardless of the handbook used.

Seventy-nine percent of Certificates in New England have conditions. This may be due in part to more comment letters with recommendations received for those applications. Outside of New England, 60% of Certificates have conditions. In addition, 65% of all recertifications include new or modified conditions.

Figure 17 shows that the percentage of all conditions imposed by criterion differ only slightly between handbooks. Overall, conditions apply most often to the upstream and downstream fish passage criteria (in the old handbook upstream and downstream passage were considered as a single criterion), followed by the ecological flows criterion, threatened and endangered species, and water quality.

Figure 17. Conditions Issued under the 1st and 2nd Edition Handbooks



Use of PLUS Awards

Under the original handbook, an extra three years of certification was available to facilities with a buffer zone extending 200 feet from the river high water mark, or with an approved watershed enhancement fund that could achieve the ecological and recreational equivalent to the buffer zone and with agreement of appropriate stakeholders and resource agencies.

In the new handbook, this award is called a PLUS award and is available for all eight criteria. A numbered standard must be satisfied in all Zones of Effect before a PLUS standard can be awarded for the same criterion. One PLUS award provides an extra three years of certification and two or more PLUS awards provide another two extra years, for a maximum Certificate term of ten years. The PLUS standards differ by criterion as follows:

Criterion A – Ecological Flow Regimes: Adaptive management program or significant, non-flow habitat enhancements with demonstrated net benefits to fish and wildlife resources affected by the facility.

Criterion B – Water Quality: Advanced technology to enhance ambient water quality or an adaptive management program.

Criterion C – Upstream Fish Passage: Advanced technology, part of a basin-scale redevelopment strategy, or an adaptive management program.

Criterion D – Downstream Fish Passage and Protection: Advanced technology, part of a basin-scale redevelopment strategy, or an adaptive management program.

Criterion E – Shoreline and Watershed Protection: Site-specific shoreline buffer or watershed land protection plan that includes at least 50% of the undeveloped shoreline around the reservoir, or equivalent along its riverine zones; or a watershed enhancement fund designed to achieve the ecological and recreational equivalent of the 50% buffer zone.

Criterion F – Threatened and Endangered Species Protection: Enforceable agreement with resource agencies to support rare and endemic species, proactive measures to substantively minimize impacts on species at risk, or significant participation in a species recovery effort.

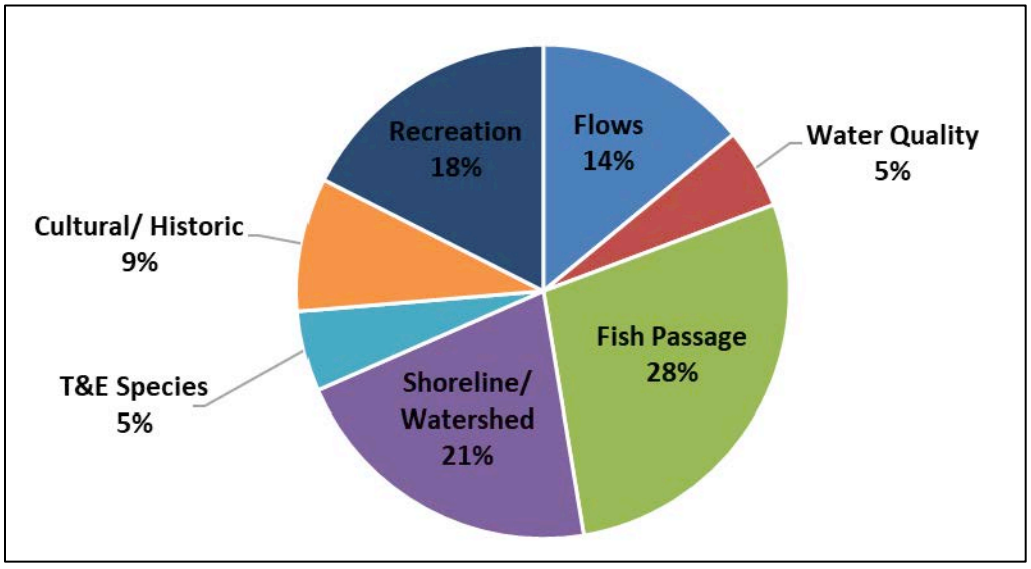
Criterion G – Cultural and Historic Resource Protection: Restoration of significant cultural or historical resources beyond what is required in existing plans, or significant new educational opportunities about cultural or historical resources in the area have been created.

Criterion H – Recreational Resources: Significant new public recreational opportunities are provided beyond those otherwise required and which do not create unmitigated impacts to other resources.

Fourteen current Certificates under the 1st Edition Handbook (33%) were awarded the extra years for shoreline and watershed protection. Under the 2nd Edition Handbook, thirteen Certificates have been awarded one PLUS and seven have been awarded two PLUS. Another seven Certificates include the option of one PLUS and another two Certificates with one PLUS award also have the option for a second PLUS - in both cases the optional PLUS would be awarded only if certain conditions are met during the Certificate term. Overall, 23% of all Certificates under the new handbook have a PLUS or PLUS option award, a smaller percentage than under the old handbook. For all Certificates combined, 25% have at least one PLUS award.

The breakdown by criterion of PLUS and PLUS option awards in the 2nd Edition Handbook is shown in Figure 18. As with conditions, more PLUS awards are made for fish passage (28%) than for the other criteria. This award is often for voluntary actions in the absence of formal agency recommendations to support restoration efforts such as providing upstream American eel passage, making operational changes to enhance passage, or providing flows to support extended passage seasons. Shoreline and watershed protection PLUS standards (21%) are the next most frequent PLUS award for actions such as contributing to watershed enhancement funds or direct land protections; followed by recreation (18%) for actions such as voluntarily developing a river paddling guide, collaborating with stakeholders on non-facility owned access points, or providing significant new recreational amenities and services on facility property beyond FERC requirements.

Figure 18. PLUS, or PLUS Option Awards under the 2nd Edition Handbook



Certified facilities also undertake voluntary actions (see also Section 4.1) that may not rise to the level of a PLUS award, or that cannot be awarded a PLUS standard if two have already been granted. As noted above, Certificates typically include a condition to ensure that voluntary actions continue throughout the Certificate term. In some cases, these actions are taken to support a LIHI Certification decision and some are taken as a result of Certification, including:

- maintaining higher than required minimum flows,
- limiting impoundment fluctuations,
- engaging in voluntary collaboration with resource agencies on fish passage needs,
- coordination of land use protection efforts with surrounding public properties,
- engaging in voluntary collaboration with stakeholders on recreation needs and providing recreation enhancements outside of regulatory requirements, or
- conducting facility site tours and educational program to school children and others.

5.2 LIHI Applications Withdrawn for Criteria Issues

LIHI is sometimes asked about the rate of application rejection. LIHI does not formally deny applications since it is a voluntary program and there is no need to publicly "shame" an applicant for a facility that simply does not meet the LIHI Criteria. Rather, applicants can choose to withdraw an application without prejudice at any time prior to a certification decision being made. This may occur when LIHI discovers potentially significant issues that would preclude certification even with conditions attached. Staff provides general guidance on ways to resolve those issues and encourages unsuccessful applicants to reapply or reactivate a stalled application when the issues have been resolved.

It is important to recognize that applicants self-select facilities they believe can become certified. Often a pre-application consultation with LIHI staff confirms that the facility is or is not a good candidate for certification. Further, we are not aware of any other certification programs that publish data on denied applications. For instance, Green-e, Wildlife Habitat Council, Forest Stewardship Council, and LEED do not publish such data. But like LIHI, they have published standards, robust processes for certification, and compliance monitoring and/or audits to ensure that once certified, facilities continue to meet the program's goals.

LIHI has processed 252 applications since program inception, resulting in a total of 182 certifications over the program's history. A number of potential applicants have chosen not to even submit an intake application when the pre-application consultation identifies that the application is not yet ready for review or there are potentially significant criteria issues. LIHI historically has not tracked information on pre-consultation meeting outcomes.

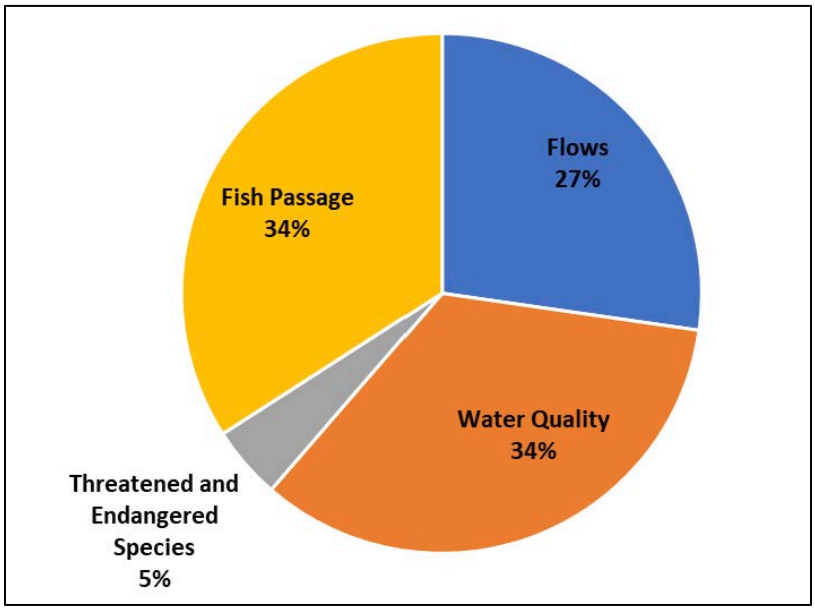
Based on available historical LIHI documentation, at least 30 applications, or 11.9% of all applications received since program inception, were withdrawn or put on hold due to criteria concerns before a certification decision was made.[50] In these cases, either:

- LIHI found significant issues that would preclude certification,
- resource agencies and/or stakeholders did not support certification,
- there was insufficient data to determine if the criteria were met, or
- the facility was in relicensing and there was insufficient current information upon which to base a certification decision at that time.

Some facilities have reapplied when able to demonstrate that they meet the criteria. In other cases, applications have remained pending while the facility obtains additional data, receives agency concurrence on specific mitigation measures, or receives a new FERC license or water quality certificate with final agency terms and conditions.

In many withdrawn applications there were multiple criteria issues identified that precluded certification. The highest number of issues across all 30 projects were related to water quality and fish passage, followed by flow issues. Threatened and endangered species concerns were a much smaller percentage. The other criteria – shoreland and watershed protection, cultural and historic resources and recreation typically did not pose issues significant enough to preclude certification. The data is summarized in Figure 19.

Figure 19. Criterion Issues Precluding LIHI Certification



[50] Another 39 applications (15.5%) were withdrawn due to certification cost, operational problems, or other reasons.

5.3 LIHI Certification Requirements

During the term of their LIHI Certificates, all facility owners/operators are required to operate their hydroelectric facilities in a manner that complies with the Certificate terms and all program rules. LIHI maintains the integrity and credibility of Low Impact Certification by verifying annual compliance with the criteria and with facility-specific requirements. Changes to a facility or its requirements do not necessarily represent a violation of the LIHI Criteria, nonetheless LIHI verifies compliance in order to maintain a complete and accurate record of the operations at each certified facility. Certificate holders must notify LIHI as soon as possible when a violation of the terms of the LIHI Certificate has or may have occurred and must also summarize those instances and their resolution in annual compliance statements submitted to LIHI. Triggers to required notification include:

- a violation of the LIHI Criteria or associated site-specific conditions included in the LIHI Certificate,
- a violation of the LIHI marketing guidelines,
- a material change in the facility, its operations, or in regulatory requirements relevant to the Certification that may impact compliance, or
- receipt of a notice of permit or license violation or formal notice of non-compliance from any government agency relevant to the facility's Certification, LIHI Criteria, or facility-specific conditions.

Any other party may also notify LIHI of the occurrence of one or more of these triggering events. If a facility falls out of compliance, staff first attempts to work with them to resolve the issues and return to compliance. Generally, this involves more frequent compliance reporting and/or new conditions to ensure that progress toward issue resolution continues. Some Certifications have been suspended during the non-compliance period and reinstated when the issue is resolved. LIHI has revoked one certification for flagrant violation of the Certificate terms and Certification Mark License Agreement (CMLA).[51]

[51] Applicants are required to sign a formal contract with LIHI prior to issuance of the LIHI Certificate. This is called the Certification Mark License Agreement (CMLA) which requires the facility to abide by all aspects of the LIHI program for the duration of the Certificate term. The CMLA entitles the Certificate holder to use the LIHI Certification Mark to market energy and the associated green attributes from the facility as "Low Impact Certified" or "LIHI Certified®". The CMLA also requires strict, ongoing adherence to all program rules, LIHI marketing guidelines, and all compliance requirements specified in the LIHI Handbook.

6. COMPARISON OF CERTIFIED FACILITIES TO NON-CERTIFIED FACILITIES

To understand whether LIHI facilities are structurally different from non-certified facilities, LIHI analyzed the only datasets available – the FERC lists of licensed, exempt, and qualifying conduit projects, and the Oak Ridge National Lab HydroSource and Mitigation databases. While there were significant data limitations the effort was informative, nonetheless. We set out to answer the following three questions:

- Are there discernible differences between LIHI Certified® projects and non-certified projects?
- Are there discernible differences between LIHI Certified® projects under the 1st and 2nd Handbooks?
- Are any differences quantifiable or qualitative only?

6.1 Comparison of LIHI and Non-LIHI Facilities Under FERC Jurisdiction

Several data sources were used to compare LIHI facilities to other facilities within the broader context of all FERC-regulated facilities:

1. Oak Ridge National Lab (ORNL) Hydro Source Database[52] published 04/07/2020
2. FERC license and exemption lists published as of 02/19/2020
3. FERC qualified conduit list published as of 01/15/2020
4. LIHI Master List of certified facilities as of 11/30/2020
5. LIHI Attributes Database as of 11/30/2020
6. FERC elibrary searches and general web searches for project information

Data Preparation and Classification

The ORNL and FERC databases were combined, and the following facilities were excluded:

1. Duplicates found in one or more datasets
2. LIHI ineligible projects (pumped storage, new construction, hydrokinetics)
3. FERC licensed transmission and storage-only projects, although Carry Falls was kept for some comparisons (part of FERC No. P-2060 and part of LIHI #14A – Upper Raquette River)
4. FERC non-jurisdictional projects[53] including the two LIHI non-jurisdictional projects (#29 – Jordanelle Dam, #86 – Open Square)

[52] https://hydrosource.ornl.gov/node/250
[53] https://www.ferc.gov/jurisdiction-determination

5. Projects that were never built, are being removed, or the FERC license/exemption has been surrendered or revoked
6. Projects with unknown operational status, but suspected to be non-operational
7. Projects in Hawaii (all are FERC non-jurisdictional) and the one licensed project in Puerto Rico.

Facilities with missing data were identified and where available, that data (e.g., MW capacity) was added from the FERC elibrary and other public sources. The resulting consolidated dataset includes 1,968 individual facilities of which 250 (12.7%) are LIHI facilities (some LIHI Certificates include multiple facilities, and some of which are considered a single facility by FERC). Of those, 17% are FERC licensed and 6% are FERC exempt.

Facilities were then classified by type/mode of operation. Discrepancies between databases were resolved where possible by conducting FERC elibrary document reviews or web searches. For purposes of this analysis three categories were defined:

1. **Conduits** as defined by LIHI rather than by FERC. FERC considers conduits to include those that discharge to natural waters while LIHI considers conduits to be facilities that do not discharge directly to natural waters, for instance those in water supply pipes or irrigation canals.
2. **Run-of-river** projects including those modified with ramping rates, minimum bypass flows or required base flows; those that do not control inflow (e.g., "run-of-release" facilities at federal dams); and those that receive inflow from an upstream storage dam that is not part of the FERC project. In all cases, where this information was known or could be confirmed.
3. **Store/release** projects including those commonly referred to as peaking projects and reregulating facilities downstream of associated store/release facilities, where that information was known.

Operation type could not be accurately determined in all cases, particularly for older FERC exemptions, either the data was not included in the available datasets, or relevant documents were not available electronically on the FERC elibrary. Therefore, some level of uncertainty remains in project type. Some projects categorized as store/release may be modified run-of-river. Unless otherwise verified, very small projects (less than 0.5 MW) were assumed to be run-of-river. Projects owned by water supply or irrigation systems were assumed to be conduits unless otherwise verified through staff research.

Facilities were then categorized for comparison by:

- Operation type
- MW size range
- FERC license year range
- Hydrologic unit code (e.g., watershed) at the region level (HUC 02)
- State

HUC units were identified where not included in the ORNL Hydro Source dataset using EPA's GIS Waters Layer[54] in Google Earth and using either geographic coordinates where available, or the nearest town listed in FERC exemption applications. The EPA Waters Layer does not include HUC 08 level data for Alaska, so all facilities in that state have only the HUC 02 designation (HUC Region 19).

Analysis

LIHI facilities represent 12.7% of all LIHI-eligible FERC jurisdictional facilities but comprise a larger percentage of FERC licensed facilities (17%) than exempt facilities (6%). This may be due to applicant expectations that FERC licenses more easily demonstrate compliance with LIHI Criteria since many older exemptions do not include enough recent information to fully evaluate current facility impacts without additional documentation (including new studies). However, 16% of all LIHI facilities (26% of all Certificates) under FERC jurisdiction are exempt with the majority of those exemptions (86% of all exempt Certificates) issued prior to 1999, showing that these older small projects can be certified.

Operation Type

Table 3 shows that LIHI facilities are less likely to be conduit facilities if exempt (3%), but much more likely to be conduits if FERC licensed (35%). Conversely, LIHI facilities are more likely to be store/release facilities if exempt. The majority of LIHI facilities are run-of-river.

[54] https://www.epa.gov/waterdata/viewing-waters-data-using-google-earth

Table 3. LIHI Representation by Operation Type

Operation Type	LIHI	% of All LIHI	Non-LIHI	% of All Non-LIHI	% LIHI of All Licensed	% LIHI of All Exempt
Conduit	27	11%	380	22%	35%	3%
Run of River	148	59%	960	56%	15%	9%
Store/Release	75	30%	378	22%	17%	11%
Total	**250**	**100%**	**1718**	**100%**	**17%**	**6%**

Capacity

Table 4 shows that overall, LIHI facilities are less likely to be less than 1 MW than non-LIHI facilities. For licensed facilities, LIHI facilities are less likely to be greater than 30 MW. This may be due to factors such as the cost to certify very small projects relative to the financial benefits of certification, as well as the fact that many states limit the size of facilities that can qualify in their RPS programs to less than 30 MW. No FERC exempt facilities are 30 MW or larger. The average LIHI facility is 17 MW and the median is 4.4 MW. The average licensed LIHI facility is 19.5 MW while the non-LIHI average is 31.8 MW, although medians are the same (4.8 MW). The average exempt LIHI facility is slightly larger than the non-LIHI facility (1.8 MW vs. 1.1 MW, median = 1.3 MW vs. 0.4 MW).

Table 4. LIHI Representation by Capacity

Capacity (MW)	LIHI	% of All LIHI	Non-LIHI	% of All Non-LIHI	% LIHI of All Licensed	% LIHI of All Exempt
< 1	48	19%	731	43%	11%	4%
1 - 5	98	39%	458	27%	20%	12%
5 - 10	39	16%	165	10%	20%	11%
10 - 30	33	13%	170	10%	17%	0%
30 - 100	21	8%	120	7%	15%	n/a
> 100	11	4%	74	4%	13%	n/a
Total	**250**	**100%**	**1718**	**100%**	**17%**	**6%**

FERC Vintage

Tables 5 shows the most recent FERC license, relicense, or exemption issuance year. The license year break point between 2005 and 2006 was chosen to be consistent with the breakpoint used in Section 6.2 below, and because FERC changed its default licensing process to

the Integrated Licensing Process (ILP) in 2005. Many projects licensed or relicensed since that time have used the ILP, particularly larger or more complex projects. The table shows that LIHI facilities are more likely than non-LIHI facilities to have licenses, relicenses, or exemptions issued between 1990 and 2005, and less likely to have issuances prior to 1990 or later than 2013 although 61% of all LIHI FERC-licensed facilities have licenses older than 1999. This may be partly due to the timing of RPS program implementation in different states. It may also simply reflect the number of facilities approaching license expiration in the Northeast (about 100 licenses in the region have expired and are in relicensing now or will expire by 2029).

Table 5. LIHI Representation by FERC Vintage

FERC Issuance	LIHI	% of All LIHI	Non-LIHI	% of All Non-LIHI	% LIHI of All Licensed	% LIHI of All Exempt
< 1980	2	1%	92	5%	1%	0%
1980-1989	61	24%	793	46%	15%	67%
1990-1999	90	36%	258	15%	40%	18%
2000-2005	60	24%	192	11%	29%	2%
2006-2013	25	10%	203	12%	11%	7%
2014-2020	12	5%	180	10%	4%	7%
Total	**250**	**100%**	**1718**	**100%**	**17%**	**6%**

Location

LIHI facilities are present in 23 states, while there are FERC jurisdictional hydropower facilities in 45 states. State RPS programs strongly influence applicants' desire to become certified (see Section 4.1). There are no LIHI facilities in California where 18% of all FERC regulated facilities are located. The California RPS program allows all hydro less than 30 MW and no hydro 30 MW or larger so there is no RPS program reason to become LIHI Certified®. Conversely, Massachusetts, Oregon, and Pennsylvania all require LIHI certification and LIHI facilities in those states comprise 64%, 21%, and 16% of all FERC regulated facilities in those states, respectively (see Table 6 below).

Figure 20 below shows the number of FERC-regulated LIHI facilities in each state. The most individual LIHI facilities are in New York (N=58) where many of the 22 LIHI Certificates cover multiple facilities. As the figure shows, most LIHI facilities are concentrated in New York and the New England states since Massachusetts allows imports of renewable energy from surrounding states in its RPS program.

Figure 20. LIHI Facilities by State

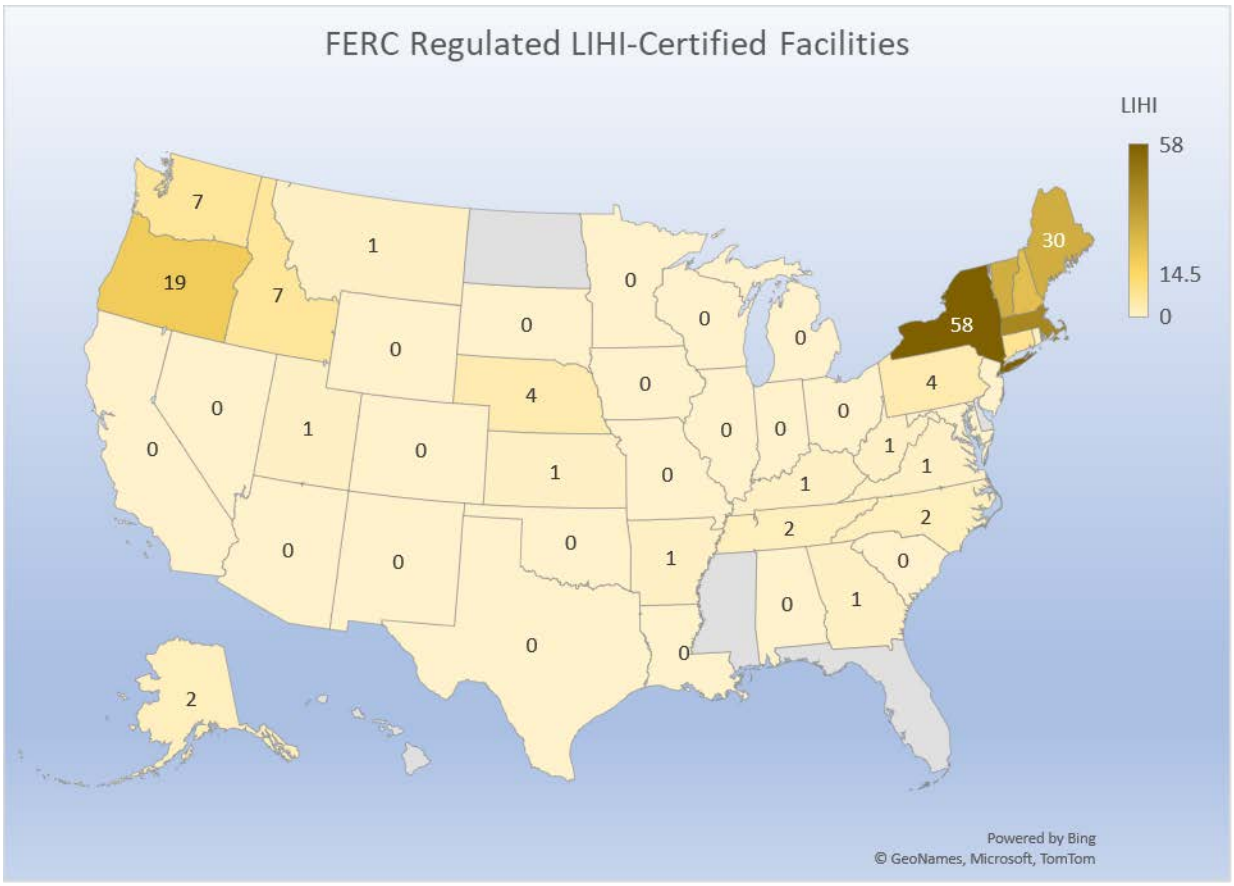


Table 6 shows the number and percentage of LIHI facilities in each state. The list is sorted from highest to lowest number of certified facilities. Most individual LIHI facilities are located in New York (23%) representing 29% of all FERC facilities in the state, while only 14% of all LIHI Certificates are in New York since many LIHI Certificates cover multiple facilities. Interestingly, while some states have only a few LIHI facilities, they can represent a very large fraction of all FERC-regulated facilities in the state. For instance, Tennessee's two FERC facilities are certified and a majority of facilities in Nebraska and Massachusetts are certified (57% and 64%, respectively).

Table 6. FERC-regulated LIHI Facilities by State

State	LIHI	% of All LIHI	Non-LIHI	% of All Non-LIHI	Total	% LIHI of all FERC
NY	58	23%	144	8%	202	29%
MA	44	18%	25	1%	69	64%
VT	30	12%	49	3%	79	38%
ME	30	12%	72	4%	102	29%
NH	24	10%	71	4%	95	25%
OR	19	8%	70	4%	89	21%
CT	8	3%	23	1%	31	26%
ID	7	3%	135	8%	142	5%
WA	7	3%	72	4%	79	9%
PA	4	2%	21	1%	25	16%
NE	4	2%	3	0%	7	57%
NC	2	1%	50	3%	52	4%
AK	2	1%	33	2%	35	6%
TN	2	1%	0	0%	2	100%
UT	1	0%	66	4%	67	1%
MT	1	0%	38	2%	39	3%
VA	1	0%	31	2%	32	3%
GA	1	0%	24	1%	25	4%
WV	1	0%	13	1%	14	7%
AR	1	0%	8	0%	9	11%
KY	1	0%	5	0%	6	17%
RI	1	0%	5	0%	6	17%
KS	1	0%	1	0%	2	50%
CA	0	0%	354	21%	354	0%
WI	0	0%	99	6%	99	0%
CO	0	0%	82	5%	82	0%
MI	0	0%	75	4%	75	0%
MN	0	0%	31	2%	31	0%
SC	0	0%	27	2%	27	0%
AL	0	0%	17	1%	17	0%
WY	0	0%	11	1%	11	0%
IL	0	0%	9	1%	9	0%
NV	0	0%	7	0%	7	0%
TX	0	0%	7	0%	7	0%
IN	0	0%	6	0%	6	0%
NM	0	0%	6	0%	6	0%
OH	0	0%	6	0%	6	0%
IA	0	0%	5	0%	5	0%

State	LIHI	% of All LIHI	Non-LIHI	% of All Non-LIHI	Total	% LIHI of all FERC
OK	0	0%	5	0%	5	0%
AZ	0	0%	3	0%	3	0%
MO	0	0%	3	0%	3	0%
MD	0	0%	2	0%	2	0%
NJ	0	0%	2	0%	2	0%
LA	0	0%	1	0%	1	0%
SD	0	0%	1	0%	1	0%
Total	**250**	**100%**	**1718**	**100%**	**1968**	**12.7%**

Summary of FERC Comparison

The distribution of LIHI Certifications indicates that state policies have played a significant role in driving LIHI Certification applications. The greatest saturation of Certified facilities is in Massachusetts and the other New England states, increasing more when New York is included as New York facilities are eligible in the Massachusetts RPS program. So, while saturation is highest in this region, there are many more facilities that could be Certified. From discussions with owners and in reviews of FERC e-library information on the non-certified facilities in the region, many would need to make changes in order to meet the LIHI Criteria. Policies are also driving the size distribution. Massachusetts' Class 2 caps eligible hydropower at 7.5 MW, explaining at least in part why more FERC facilities are certified between 1 and 10 MWs. The analysis also highlights that LIHI Certified® hydropower comprises an elite group of facilities. LIHI Certification is not yet a common occurrence within the hydropower industry.

6.2 ORNL Mitigation Database Comparison

The Oak Ridge National Lab (ORNL) Mitigation Database[55] includes the subset of FERC licensed facilities that were licensed or relicensed between 1998 and 2013. The database contains 5,130 individual mitigation records for 447 facilities representing 309 FERC licenses.[56] Mitigations are defined in the database as the specific protection, mitigation, and enhancement (PM&E) measures required in FERC license orders. They are broadly categorized into six areas: fish passage, hydrology, water quality, biodiversity, habitat and recreation. Examples include modifying operations to ensure adequate river flows or water quality, construction of fish passage structures, evaluation of passage effectiveness, shoreline or habitat protection plans,

[55] For this analysis, the Excel version of the database was used but the Microsoft Access version contains more detail. https://hydrosource.ornl.gov/node/18.

[56] Schramm, M.P., M. Bevelhimer, and C. DeRolph. 2016. A synthesis of environmental and recreational mitigation requirements at hydropower projects in the United States. Environmental Science and Policy 61, (2016), 87-96. https://www.sciencedirect.com/science/article/abs/pii/S1462901116300752?via%3Dihub

construction of recreational facilities, provision of whitewater boating opportunities, or evaluation of recreational needs (see Table 10 below).

As noted in the previous section, a majority of LIHI Certified® facilities have licenses dating earlier than 1999. Therefore, the certified facilities included in the ORNL database are not necessarily representative of certified facilities overall. Even so, the comparisons outlined below show that overall, hydropower is very site specific and Certified facilities have a similar number of overall mitigations as non-certified facilities.

Data Preparation and Classification

LIHI staff researched project status in the FERC elibrary and culled the database to eliminate facilities for which:

- the FERC license was later revoked or surrendered,
- The project is known or planned to be decommissioned or removed,
- The project is not built yet, or the operational status is uncertain, and
- projects not eligible for LIHI certification including:
  - Pumped storage, including PS/Conventional combinations where the ORNL database did not separate those facilities
  - Original licenses for new construction after August 1998

The resulting mitigation dataset used for this report's analysis[57] contains 406 individual facilities representing 276 FERC licenses. Included in the dataset are 100 LIHI facilities (25% of the dataset), representing 51 FERC licenses and 50 LIHI Certificates.[58] There are 306 non-certified facilities representing 225 FERC licenses. As in Section 6.1, facilities were then categorized for comparison by:

- Operation type
- MW size range
- FERC license year range
- Hydrologic unit code (e.g., watershed) at the region level (HUC 02)
- State

[57] Based on the number LIHI Certifications when the analysis was conducted. Two facilities in the dataset were LIHI Certified® after the analysis was completed.

[58] Holyoke, LIHI #89 includes nine FERC licenses with only two of those included in the ORNL mitigation database.

Facility Analysis

Breakdowns of LIHI versus non-LIHI facilities in the different categories within the mitigation dataset and in the larger LIHI-eligible FERC license dataset are shown in Tables 7 – 9 and Figure 21 below.

Operation Type

Table 7 shows that LIHI conduit facilities are over-represented in the mitigation dataset. Since not all project types could be accurately determined, a small level of uncertainty remains in project type. For instance, there may be some store/release facilities that could be considered modified run-of-river or vice versa. Modified run-of-river facilities (e.g., "run-of-release") that do not control inflows, such as those at US Army Corps of Engineer dams, were included with the run-of-river facilities; however, known re-regulating facilities were categorized as store/release. When compared to all LIHI-eligible FERC licensed facilities, LIHI conduits are grossly over-represented in the mitigation dataset relative to the FERC license dataset (83% vs. 35%) and non-conduit facilities are only slightly over-represented in the mitigation dataset.

Table 7. Operation Types in the ORNL Mitigation Dataset

Operation Type	LIHI	Non-LIHI	Total	% of LIHI in ORNL	% of LIHI all Licenses
Conduit	10	2	12	83%	35%
Run of River	48	158	206	23%	15%
Store/Release	42	146	188	22%	17%
Total	**100**	**306**	**406**	**25%**	**17%**

Capacity

Table 8 shows that LIHI facilities within the mitigation dataset are more likely to be less than 30 MW, and less likely to be smaller than 1 MW or greater than 30 MW. This also holds true in the FERC license dataset. Average size of a LIHI facility is 20 MW, while non-LIHI facility average is 55 MW.

Table 8. Capacity Ranges in the ORNL Mitigation Dataset

Capacity (MW)	LIHI	Non-LIHI	Total	% of LIHI in ORNL	% of LIHI all Licenses
< 1	8	54	62	13%	11%
1 - 5	40	80	120	33%	19%
5 - 10	14	36	50	28%	20%
10- 30	20	55	75	27%	16%
30 - 100	12	47	59	20%	14%
> 100	6	34	40	15%	13%
Total	**100**	**306**	**406**	**25%**	**17%**

FERC License Vintage

Table 9 below shows that LIHI facilities in the mitigation dataset are more likely than non-LIHI facilities to have received a license or relicense prior to 2006. As noted in Section 6.1, the license year break point of 2005/2006 was chosen since FERC rules were changed to require use of the Integrated Licensing Process (ILP) as the default process effective July 23, 2005. The ILP requires pre-application stakeholder and agency consultation and studies, and often results in more mitigation actions based on agency recommendations and study results. This breakdown also provides a convenient breakpoint of seven years in each license vintage category.

In both datasets, LIHI facilities are slightly more likely to have older licenses than non-LIHI facilities. As noted in Section 6.1, the majority of LIHI Certified® facilities are in New England. There are 100 facilities in that region whose licenses expire within the next ten years. The age of certified facility licenses is a reflection of greater demand for LIHI Certification in regions where there are many old FERC licenses. License age itself does not have any bearing on LIHI Certification decisions.

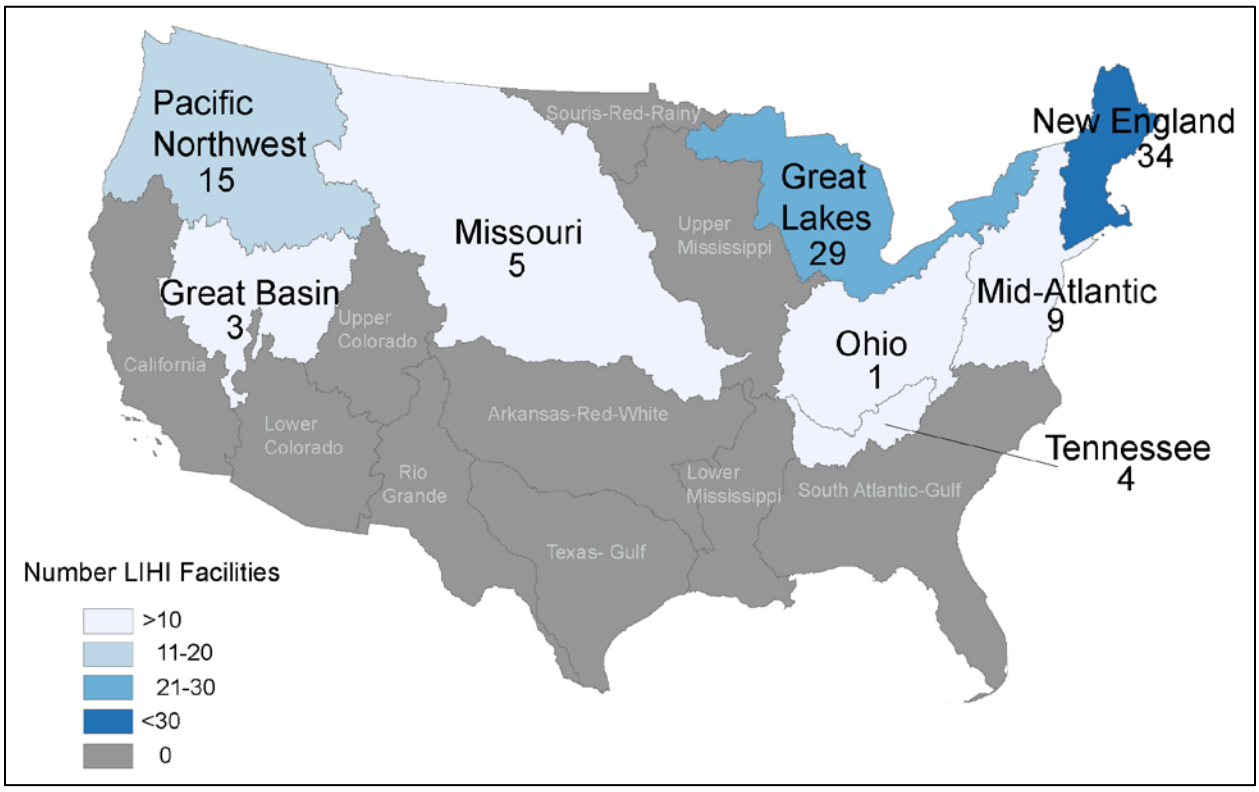
Table 9. FERC License Vintage in the ORNL Mitigation Dataset

FERC License Year	LIHI	Non-LIHI	Total	% of LIHI in ORNL	% of LIHI all Licenses
1998 - 2005	79	195	274	29%	17%
2006 - 2013	21	111	132	16%	15%
Total	**100**	**306**	**406**	**25%**	**17%**

Location

LIHI facilities are located in 23 states, but in only 14 states within the ORNL mitigation dataset. Within the FERC license dataset, LIHI facilities are in 20 states (LIHI facilities in the other 3 states - MT, RI, VA, are FERC exempt). Water resource hydrologic regions do not correspond to state boundaries, but they can reflect general differences in regional approaches to FERC licensing and the level of resource agency and stakeholder involvement in licensing. LIHI facilities are not widely dispersed geographically throughout hydrologic regions (8 of 19 regions in the mitigation dataset and 11 of 19 in the FERC license dataset). This is not surprising since a primary driver for many facilities to become certified is their ability to qualify in state RPS programs. In fact, 77% of all currently certified LIHI facilities (licensed and exempt) are in the New England (HUC 01) and Great Lakes - New York (HUC 04) regions, and those licensed facilities are also over-represented in the mitigation dataset. In the New England region, there are more LIHI facilities than non-LIHI facilities in the mitigation dataset. Overall, in states where LIHI has certified projects, LIHI is over-represented in the ORNL database, with the exception of Alaska. However, as pointed out earlier, 60% of all Certified facilities are not represented in the ORNL database at all.

Figure 21. Watershed Location of LIHI Facilities in the ORNL Mitigation Dataset



License Mitigation Analysis

The ORNL mitigation database categorized FERC license mitigation requirements into six Tier 1 categories and twenty Tier 2 categories, described in Table 10.

Table 10. ORNL Mitigation Categories[59]

Tier 1 Classification	Tier 2 Classification	Some Examples of Mitigation
1. Fish Passage	0101. Downstream Fish Passage	Surface collector
	0102. Upstream Fish Passage	Fish ladder
	0103. Passage Planning	Passage feasibility assessment
	0104. Entrainment	Guidance net
2. Hydrology	0205. Flow Mitigation	Ramping rates
	0206. Tailrace Minimum Flow	Run of river
	0207. Bypass Minimum Flow	Year round
	0208. Sediment	Sediment/erosion plan
	0209. Recreation Flow	Recreational flow releases
	0210. Operations	Compliance monitoring plan
3. Water Quality	0311. Downstream Water Quality	Forebay aeration
	0312. Upstream Water Quality	Water quality monitoring
4. Biodiversity	0413. Terrestrial	Critical habitat conservation
	0414. Aquatic	Stocking fish species of concern
5. Habitat	0515. Fisheries	Downstream gravel restoration
	0516. Riparian	Establish riparian buffer zones
	0517. Reservoir	Noxious plant control
	0518. Wetlands	Wetland protection
6. Recreation	0619. Resources and Mitigation	Shoreline access
	0620. Planning	Recreational plans or studies

[59] Adapted from Table 1 in Schramm, M.P., M. Bevelhimer, and C. DeRolph. 2016. See footnote 2.

The ORNL mitigation categories do not align directly with LIHI Criteria categories as shown in Table 11. Cultural and historic resource mitigations fall under ORNL's recreation category, but those resources do not seem to be fully represented in the dataset. Only 18 of over 5,000 records mention these resources, and based on experience, there are likely to be many more facilities subject to cultural and historic resource protection mitigations.

Table 11. Relationship Between LIHI Criteria and ORNL Categories

LIHI Criterion	ORNL Tier 1 Category(ies)
A. Ecological Flows	2. Hydrology
B. Water Quality	3. Water Quality
C. Upstream Fish Passage	1. Fish Passage
D. Downstream Fish Passage and Protection	1. Fish Passage
E. Shoreline and Watershed Protection	4. Biodiversity, 5. Habitat
F. Threatened and Endangered Species Protection	4. Biodiversity, 5. Habitat
G. Cultural and Historic Resources Protection	6. Recreation (limited)
H. Recreational Resources	6. Recreation

LIHI conducted various analyses to compare LIHI facilities to non-LIHI facilities within the ORNL mitigation dataset. Four key variables were analyzed: mode of operation, installed capacity (MW), FERC license vintage, and hydrologic region (HUC02 level).

It is important to note that these comparisons are based only on mitigations included in FERC licenses and only those portions of agency recommendations[60] that FERC adopts and codifies in licenses. The database does not reflect whether a mitigation was completed. For example, if a license mitigation such as fish passage was appealed and overturned, the requirement for the fish passage remains in the database. The mitigation comparisons are also completely unrelated to LIHI Certification which is not a consideration in licensing. In rare cases, license settlement agreements or side agreements made during relicensing include LIHI Certification. LIHI applicants also make voluntary improvements in advance or as a result of LIHI Certification, often in consultation with resource agencies. Further, LIHI evaluates facilities based, in part, on resource agency recommendations and WQC conditions even if they are not incorporated into a FERC license. These actions are not included in the mitigation database comparison.

[60] Including agency requirements under Federal Power Act Section 18, Section 10(j), and Section 10(a)(2)(A); Clean Water Act Section 401, Section 307(c)(3) of the Coastal Zone Management Act, and Section 106 of the National Historic Preservation Act.

Also, a small and large facility both may be required to pursue the same mitigation actions and a store/release facility may have greater impacts and more mitigation requirements than a run-of-river facility. However, the scale of the mitigation action is likely to be larger for the larger facility or store/release facility. This analysis does not consider the scale of mitigation, rather only whether on average, the mitigation action took place or not. Said another way, the analysis does not consider the quality of mitigations, only the number.

Overall, the total number of mitigation actions required are comparable between LIHI facilities and non-LIHI facilities. LIHI facilities have an average of 11.4 actions, a median of 10, and minimum and maximum of 2 and 29, respectively. Non-LIHI facilities have an average of 12 actions, a median of 11, and minimum and maximum of 1 and 36, respectively.

Figure 22 below shows the overall average number of mitigation actions by facility in each Tier 1 category for LIHI and non-LIHI facilities. The figure shows that LIHI facilities overall tend to have more fish passage mitigations and fewer mitigations in all other categories. For all facilities, hydrology and recreation have the highest average number of mitigations, and the lowest for water quality and habitat.

Given the propensity for LIHI facilities in the Northeast, it is useful to compare those facilities (Figure 23). It is important to note that there are nearly twice as many LIHI facilities than non-LIHI facilities in the dataset in the Northeast. It is also important to note that all facilities in the dataset located in Massachusetts (N=9) are LIHI Certified®. Figure 23 below shows that LIHI facilities in those states have, on average, fewer fish passage mitigations than non-LIHI facilities but slightly more hydrology, water quality, and biodiversity mitigations, which also differs from the whole dataset comparison shown in Figure 22.

Figure 22. Average Number of Tier 1 Mitigations

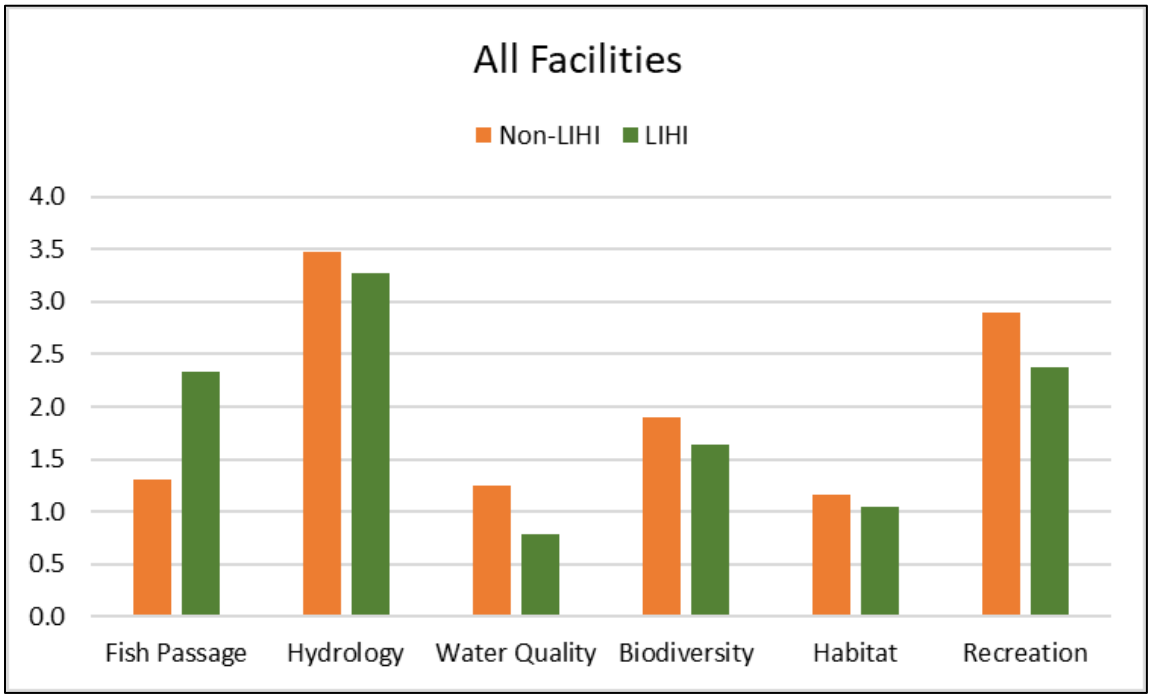
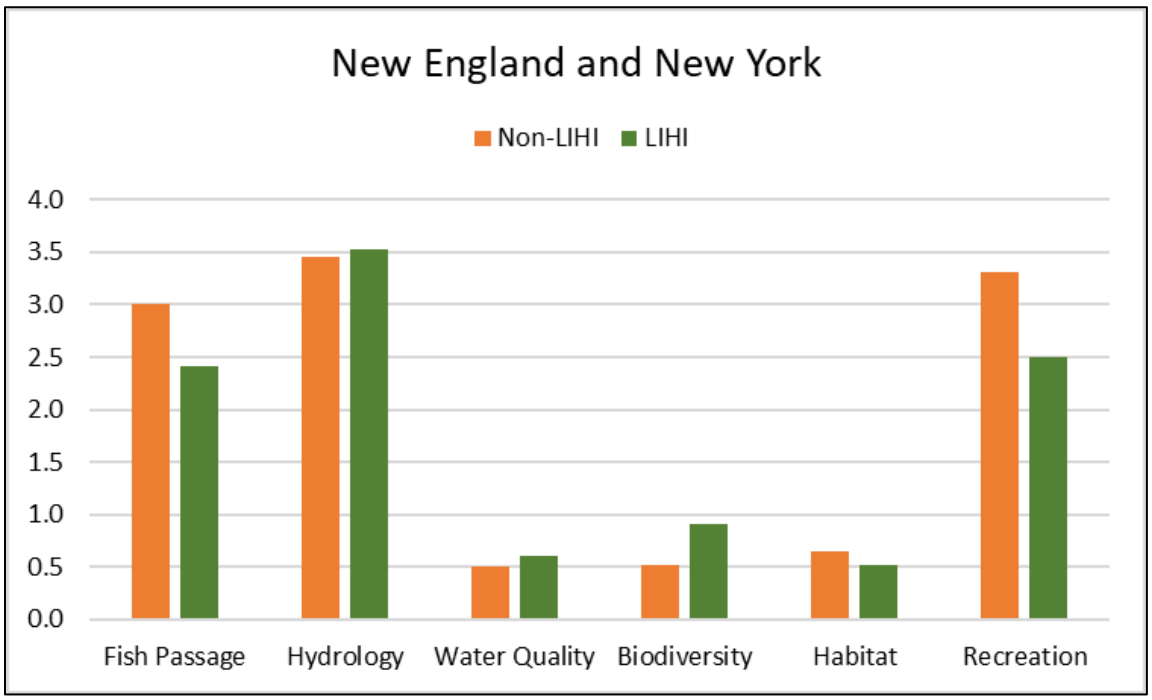


Figure 23. Average Number of Tier 1 Mitigations in New England and New York



More gradation can be seen at the Tier 2 category level (Figures 24 and 25 below). While LIHI facilities have slightly fewer hydrology mitigations overall in Figure 22, they have slightly more flow mitigation and minimum flow requirements than non-LIHI facilities. Somewhat surprisingly, LIHI facilities have more riparian habitat and recreation planning mitigations than non-LIHI facilities.

LIHI facilities in New England and New York have slightly more entrainment mitigations and fewer flow requirements for bypass reach minimum flows, recreation flows, and operational flows (e.g., plans or monitoring for operations and/or flow management) than non-LIHI facilities. The LIHI facilities in the region are more likely to be run-of-river facilities. It is likely that recreation flows, such as whitewater releases, are less common because of the run-of-river operational restrictions. LIHI facilities also have more upstream water quality and fewer downstream water quality requirements (Figure 25).

Figure 24. Average Number of Tier 2 Mitigations

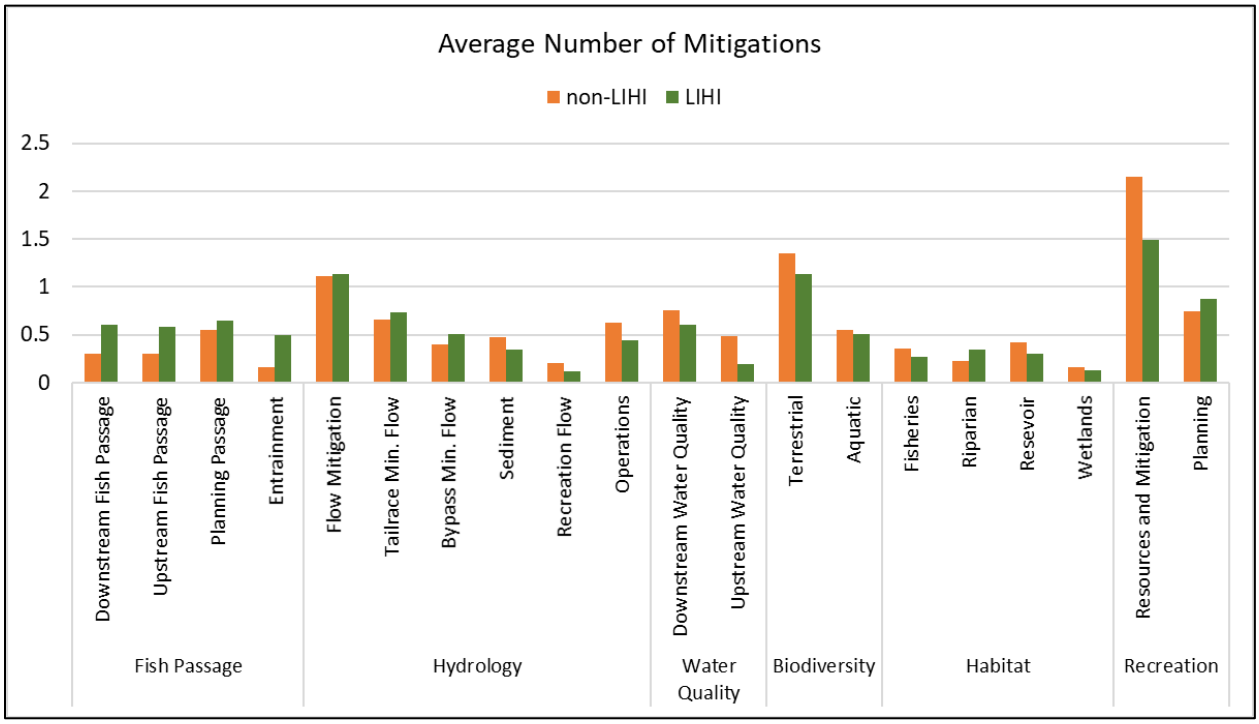


Figure 25. Average Number of Tier 2 Mitigations in New England and New York

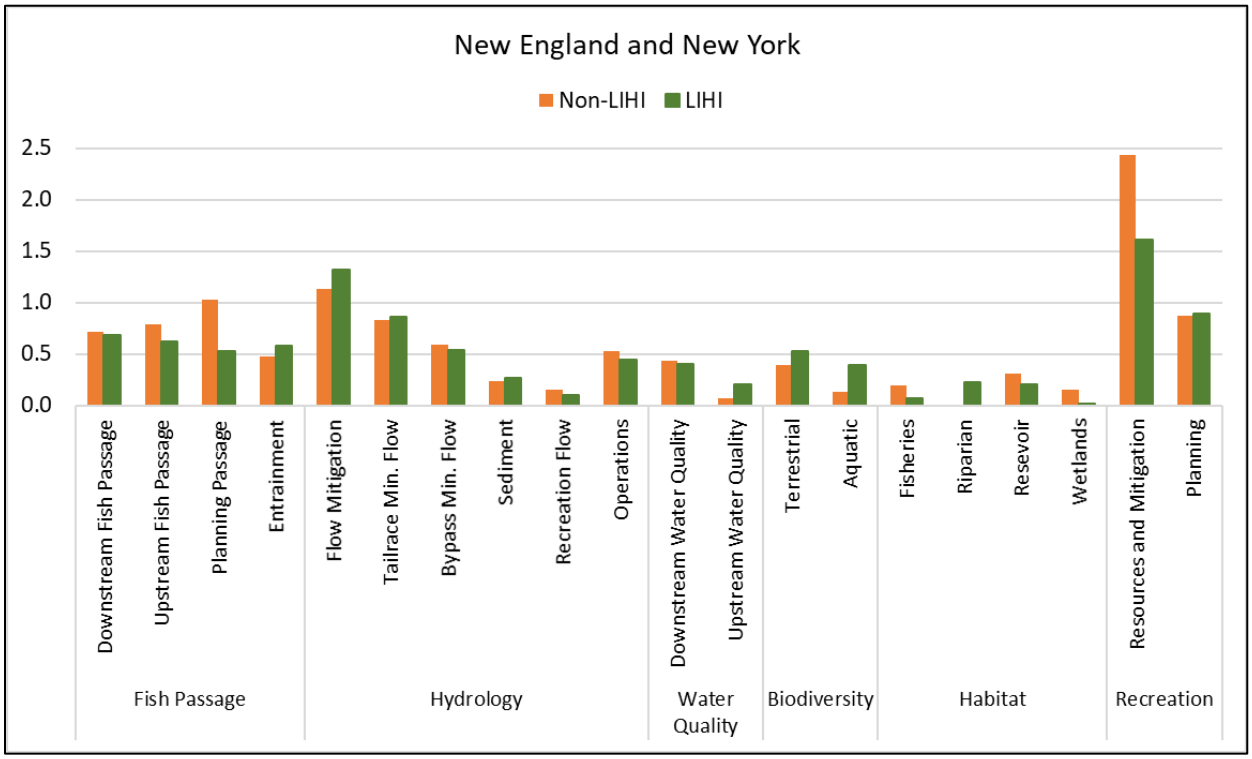
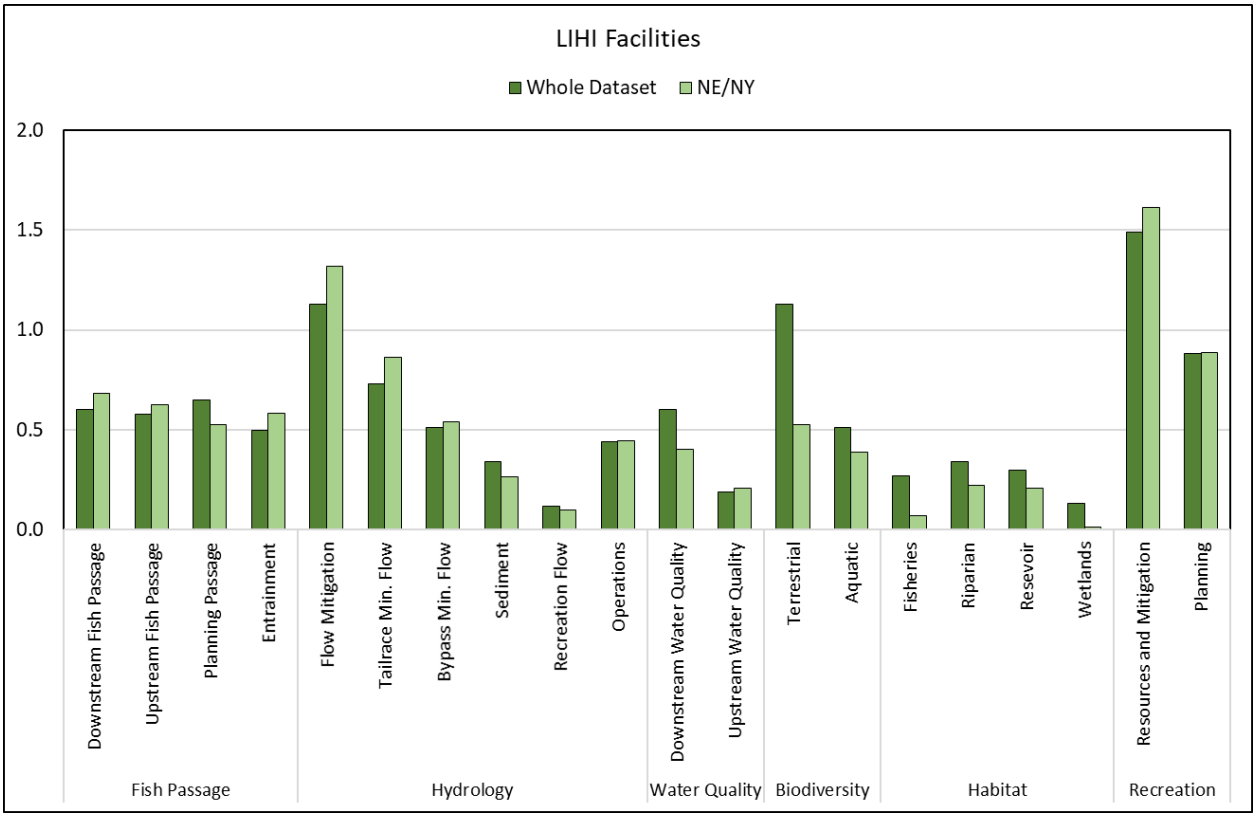


Figure 26 below shows mitigations for LIHI facilities in the Northeast in relation to all LIHI facilities in the dataset. Overall, facilities in the Northeast tend to have slightly more fish passage requirements (except for passage planning), more hydrology requirements (except sediment and recreation flows), and fewer biodiversity and habitat requirements.

Figure 26. Average Number of Tier 2 Mitigations at LIHI Facilities



Operation Type

Mitigations were compared based on facility operation type. Conduit projects were excluded due to the small sample size - there are only two non-LIHI and eight LIHI conduit facilities in the dataset.

Figures 27 and 28 compare the relative percentage of Tier 1 mitigation actions in each category for run-of-river and store/release facilities, respectively. Figure 27 shows that LIHI run-of-river facilities have 79% of all their mitigations in the recreation, fish passage and hydrology categories while non-LIHI facilities have 67% of their mitigations in those categories. For store/release facilities the proportion of mitigations in those three categories combined is more similar for LIHI and non-LIHI facilities (64% vs. 62%). Both LIHI run-of-river and store/release facilities have more fish passage requirements and fewer water quality, biodiversity and habitat requirements as a percentage of all mitigation requirements than their non-LIHI counterparts.

Figure 27. Average Number of Tier 1 Mitigations, Run-of-river Facilities

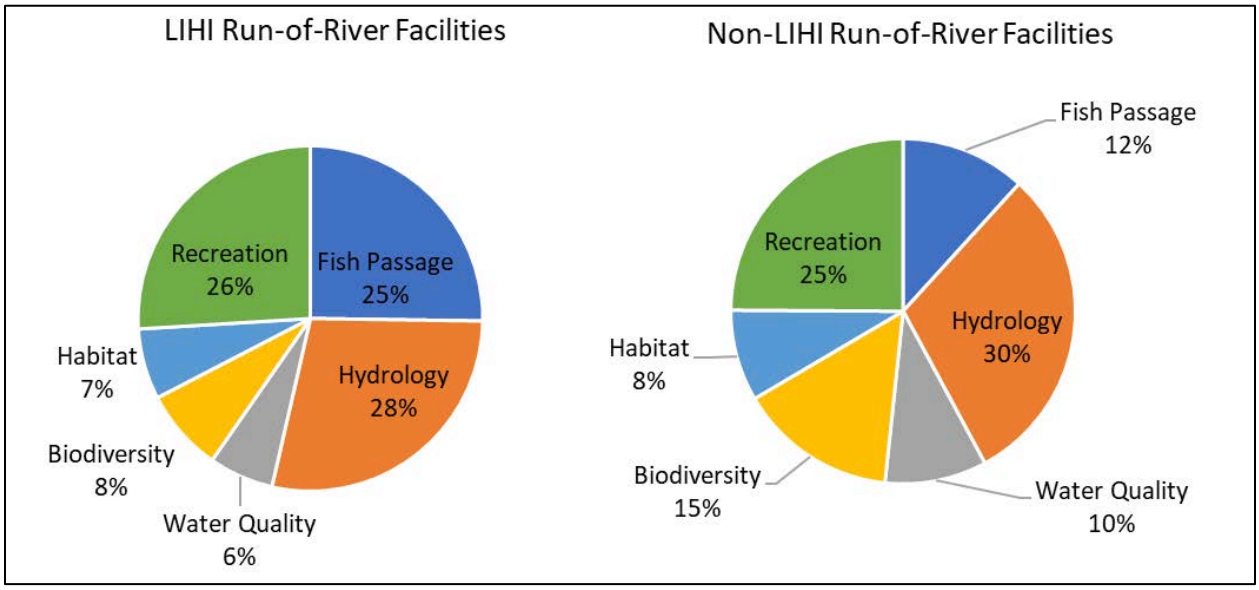
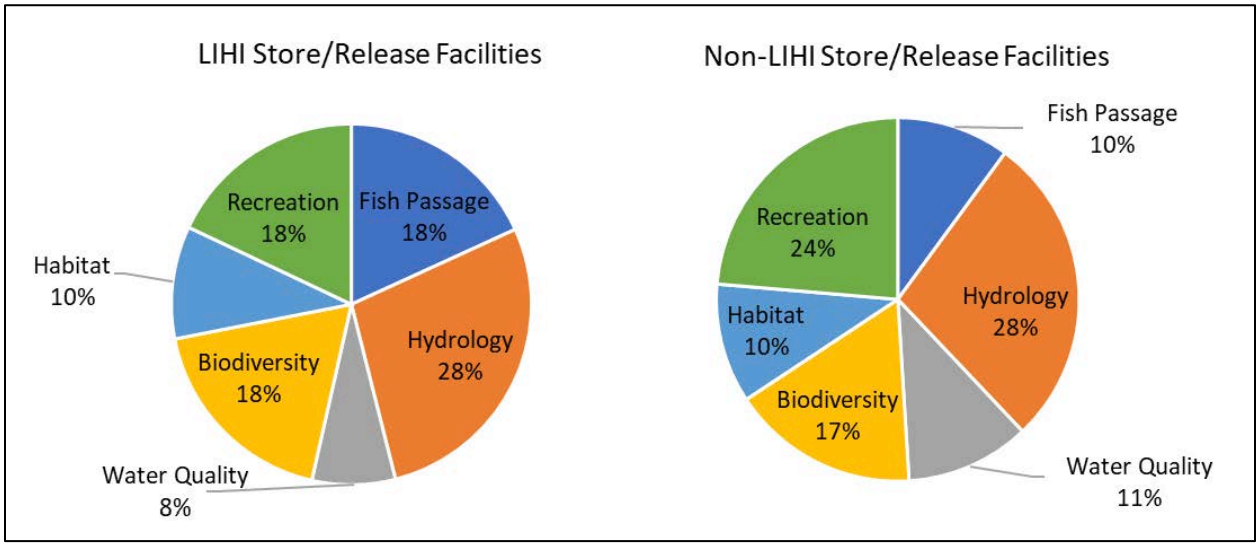


Figure 28. Average Number of Tier 1 Mitigations, Store/release Facilities



Graphs of Tier 2 mitigations are provided in Appendix A Figures 1 and 2. For run-of-river facilities, the only difference compared to Figure 24 above is that LIHI facilities have slightly fewer tailrace minimum flow mitigations. For store/release facilities, LIHI facilities as a whole have fewer flow mitigation and riparian habitat mitigations, and more terrestrial biodiversity and fisheries habitat mitigations.

Capacity

To examine the data in more detail, facilities were separated by MW capacity range. LIHI facilities in the dataset tend to be smaller with an average capacity of 20.3 MW versus 54.9 MW for non-LIHI facilities. The median MW size is much closer, 6 MW for LIHI facilities and 7.4 MW for non-LIHI facilities.

Figure 29 shows that for small facilities, LIHI facilities have 81% of all their mitigations in the recreation, fish passage and hydrology categories while non-LIHI facilities have only 66% of their mitigations in those categories. LIHI facilities have more fish passage requirements, slightly more recreation and hydrology requirements, and fewer water quality, biodiversity, and habitat mitigations than non-LIHI facilities.

Figure 29. Average Number of Tier 1 Mitigations, < 5 MW

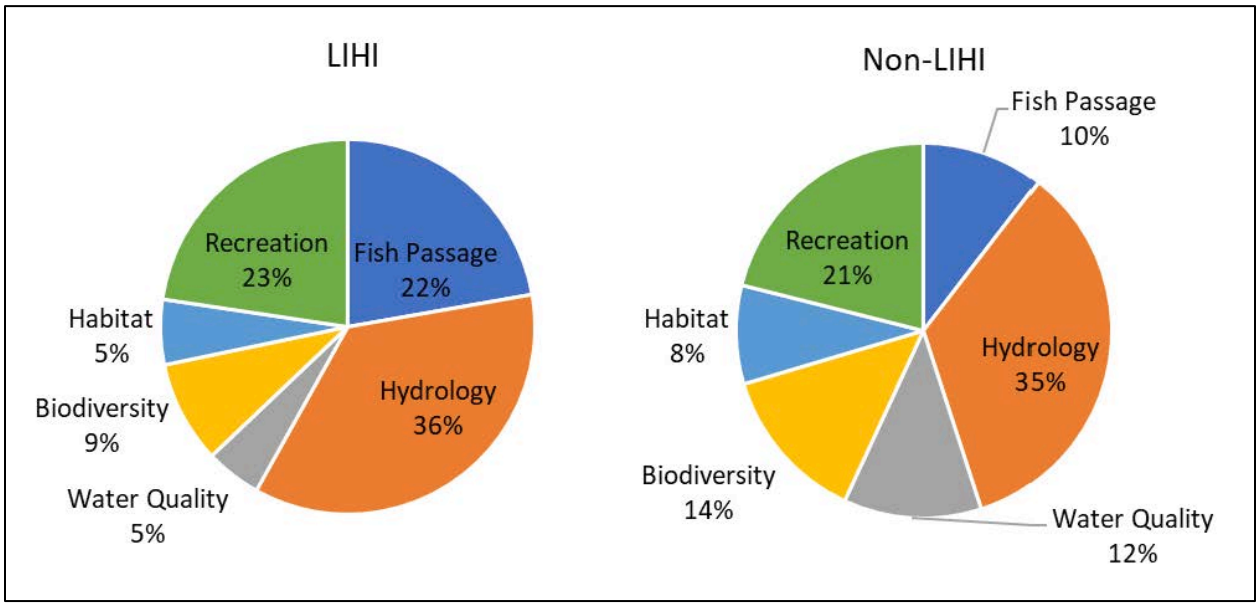


Figure 30 below shows that both LIHI and non-LIHI facilities between 5 and 30 MW have the same overall proportion of their mitigations in the recreation, fish passage and hydrology categories (67%). LIHI facilities overall have more fish passage mitigations, and somewhat fewer hydrology and recreation mitigations than non-LIHI facilities, while water quality, biodiversity and habitat requirements are similar for all facilities. This is also generally true for facilities greater than 30 MW (Figure 31).

Figure 30. Average Number of Tier 1 Mitigations, 5 to 30 MW

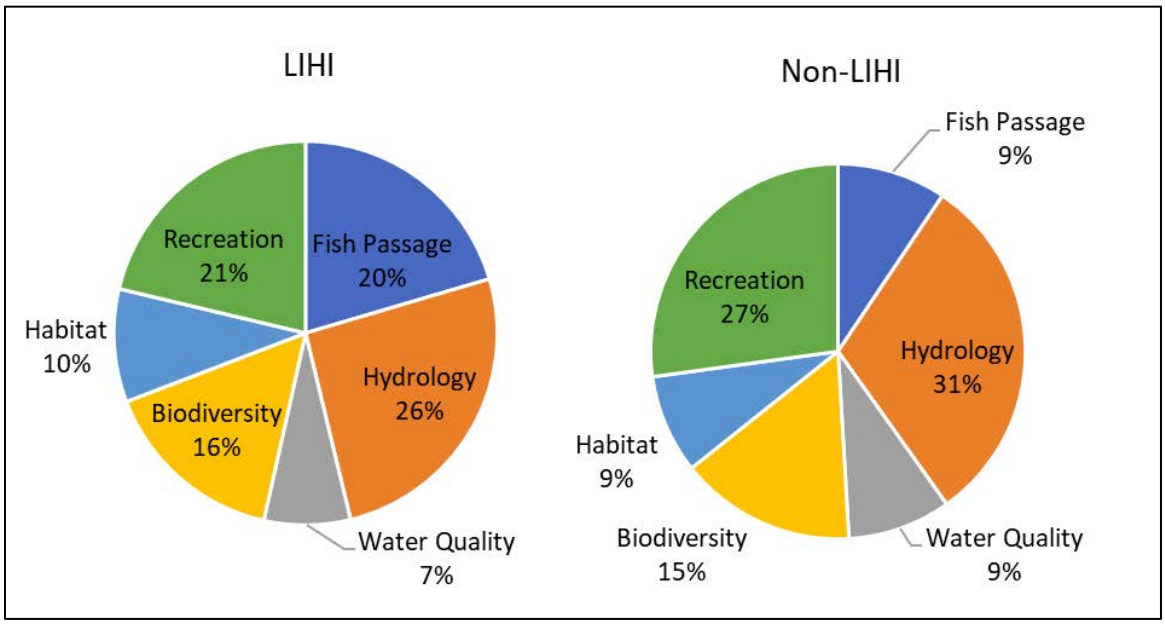
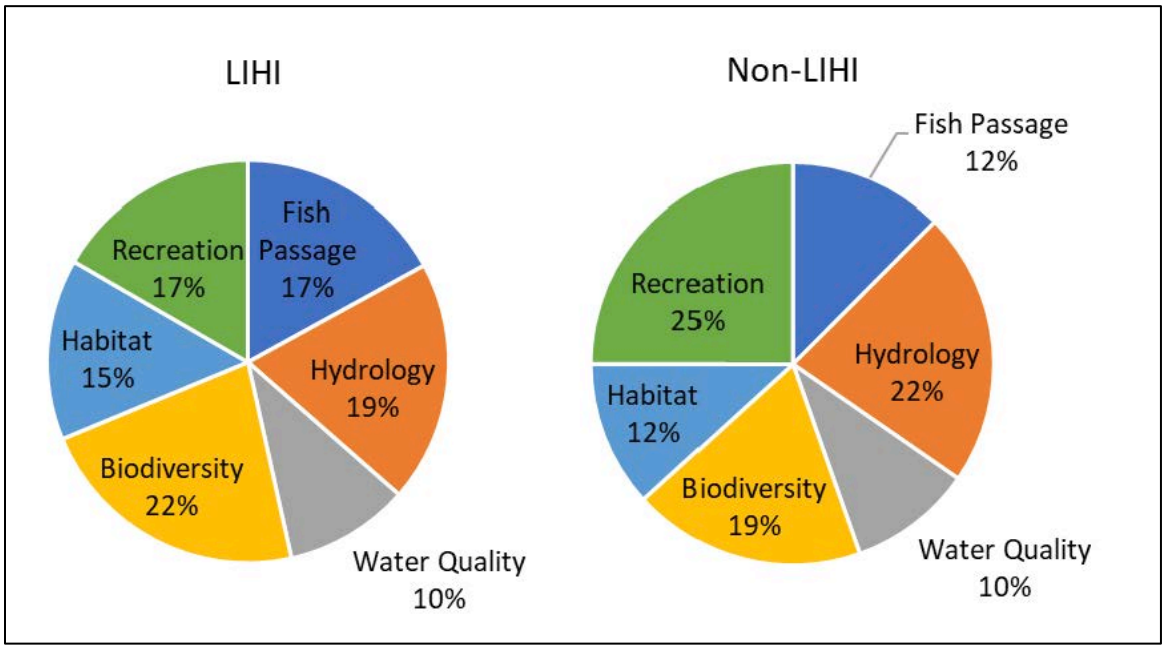


Figure 31. Average Number of Tier 1 Mitigations, > 30 MW



Tier 2 graphs are provided in Appendix A Figures 3 – 6, for MW ranges less than 1 MW, 1 to 5, 5 to 30, and greater than 30 MW, respectively. Compared to Figure 24 above, the Appendix graphs show some relative differences between LIHI and non-LIHI facilities based on capacity. Most notably, LIHI facilities less than 5 MW have more mitigations related to aquatic

biodiversity and nearly as many related to recreation resources and mitigation as non-LIHI facilities. In the 5 – 30 MW range, LIHI facilities have slightly fewer mitigations for fish passage planning, flow mitigation and minimum flows, and slightly more mitigations for terrestrial biodiversity, and fisheries and wetlands habitat.

LIHI facilities greater than 30 MW have fewer mitigations for upstream fish passage, flow mitigation, tailrace minimum flows, and recreation planning but more for operations, terrestrial biodiversity and fisheries habitat. For these larger facilities, the average number of mitigations for water quality and reservoir habitat are the same for LIHI and non-LIHI facilities.

FERC License Vintage

Facility mitigations were compared based on FERC license issuance from 1998 to 2005, and from 2006 to 2013. Overall, there are fewer mitigation requirements before 2006 than after 2006 for both LIHI and non-LIH facilities; however, there are slightly more fish passage and water quality mitigation actions under older licenses than newer licenses.

Figure 32 shows that for older licenses and relicenses, LIHI and non-LIHI facilities have similar proportions of their mitigations in the recreation, fish passage and hydrology categories combined, but again LIHI facilities have more fish passage and somewhat fewer hydrology, water quality, and recreation mitigations than non-LIHI facilities while biodiversity and habitat requirements are generally similar for all facilities.

Figure 32. Average Number of Tier 1 Mitigations, Licensed from 1998 to 2005

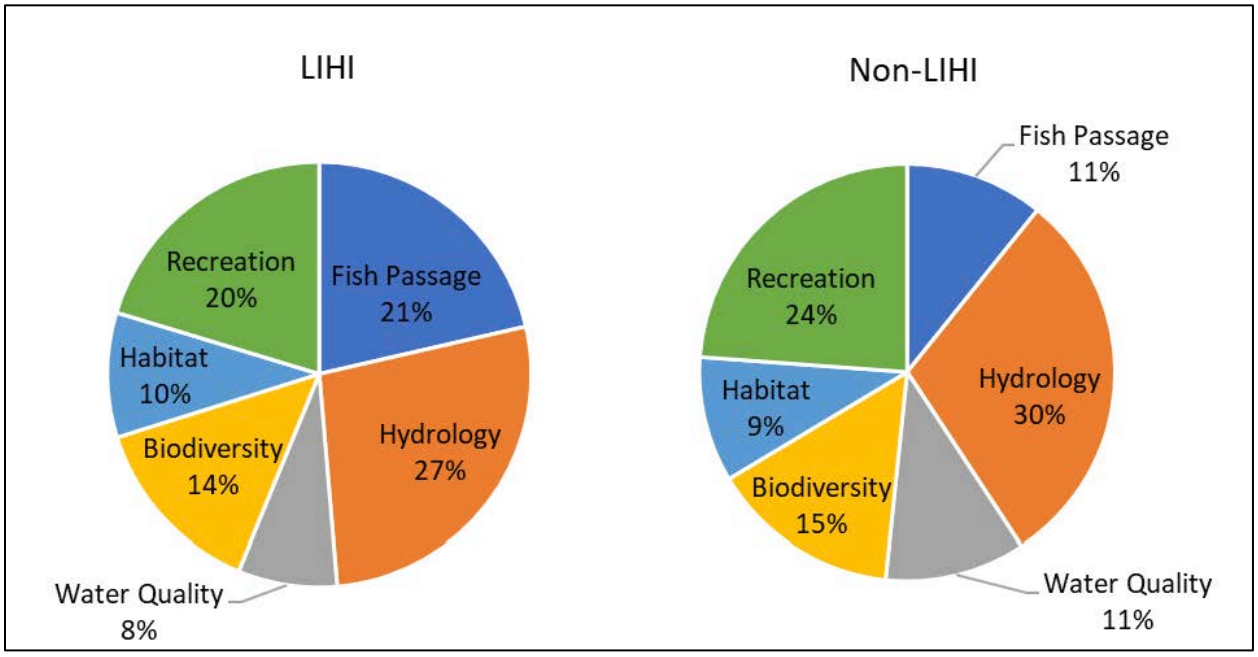
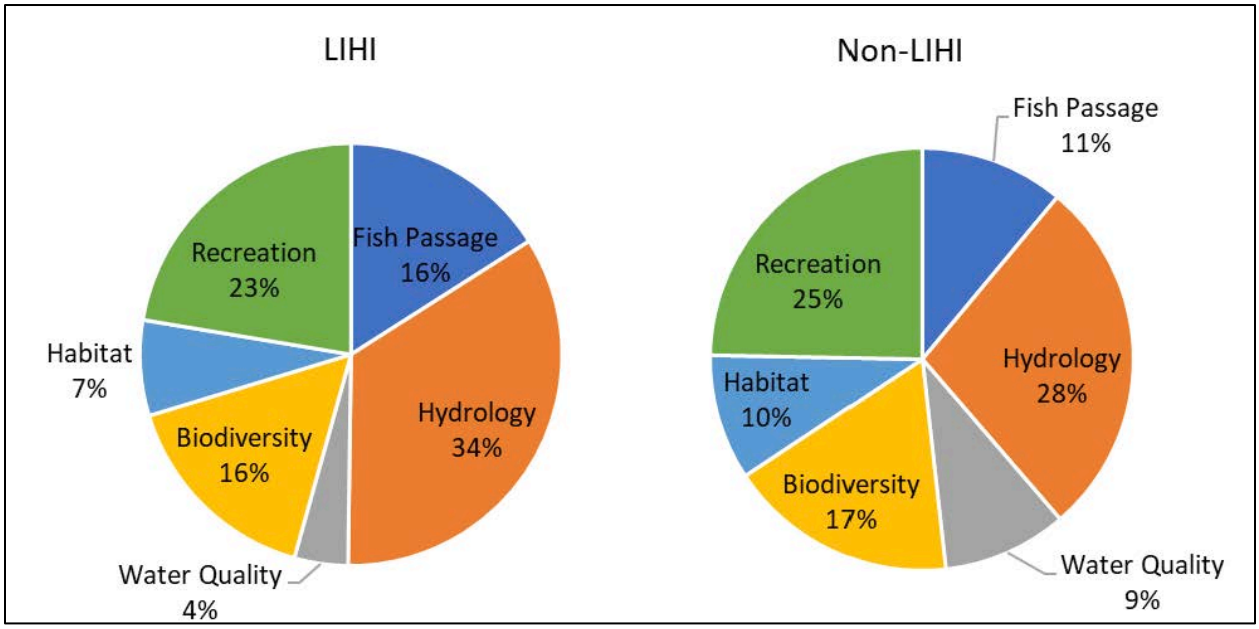


Figure 33 shows that LIHI facilities licensed or relicensed after 2005 have 73% of their mitigations in the recreation, fish passage, and hydrology categories combined, compared to non-LIHI facilities with only 64% of their mitigations in those categories. LIHI facilities have somewhat more fish passage and hydrology mitigations and somewhat fewer in the other categories than non-LIHI facilities. Comparing LIHI facilities in Figures 32 and 33 shows that newer licenses tend to have fewer fish passage, water quality, and habitat requirements while they also have more hydrology, biodiversity and recreation requirements.

Figure 33. Average Number of Tier 1 Mitigations, Licensed from 2006 to 2013



Tier 2 graphs are provided in Appendix A Figures 7 and 8. Relative to Figure 24 above, LIHI facilities with older licenses or relicenses have more aquatic biodiversity mitigations than non-LIHI facilities and about equal mitigations for fisheries and wetlands habitat. LIHI facilities with newer licenses or relicenses have fewer fish passage planning and flow mitigations, and more sediment related mitigations than non-LIHI facilities. Somewhat surprisingly, none of the newer licensed LIHI facilities have any upstream water quality mitigations although the sample size is small (21 facilities).

Location

As noted in Figure 21 above, most LIHI facilities in the mitigation dataset are located in New England and New York, followed by Oregon, Washington and Idaho. Figures 22 – 25 above compare facilities in New England and New York to their non-LIHI counterparts. Here they are

compared by Tier 1 mitigation categories in Figure 34, and in relation to facilities in the Pacific Northwest states in Figure 35.

Figure 34 shows that in the Northeast, LIHI facilities have slightly more of their mitigation requirements in hydrology, water quality, and biodiversity and slightly fewer in fish passage and recreation than non-LIHI facilities. Figure 35 shows that LIHI facilities in the Pacific Northwest have far fewer recreation requirements and more habitat requirements than non-LIHI facilities in that region.

Comparing only LIHI facilities in these two regions shows that Northeast facilities have far more recreation and hydrology requirements as well as more fish passage requirements, and facilities in the Northwest have more water quality, biodiversity and habitat requirements.

Figure 34. Average Number of Tier 1 Mitigations, New England and New York

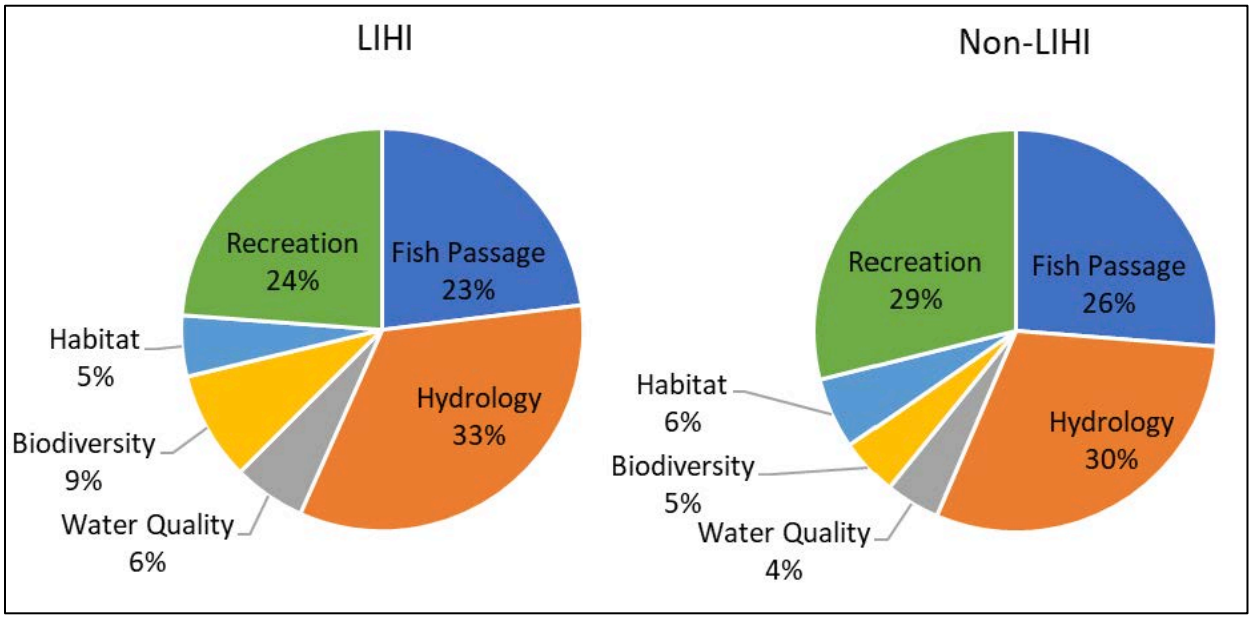
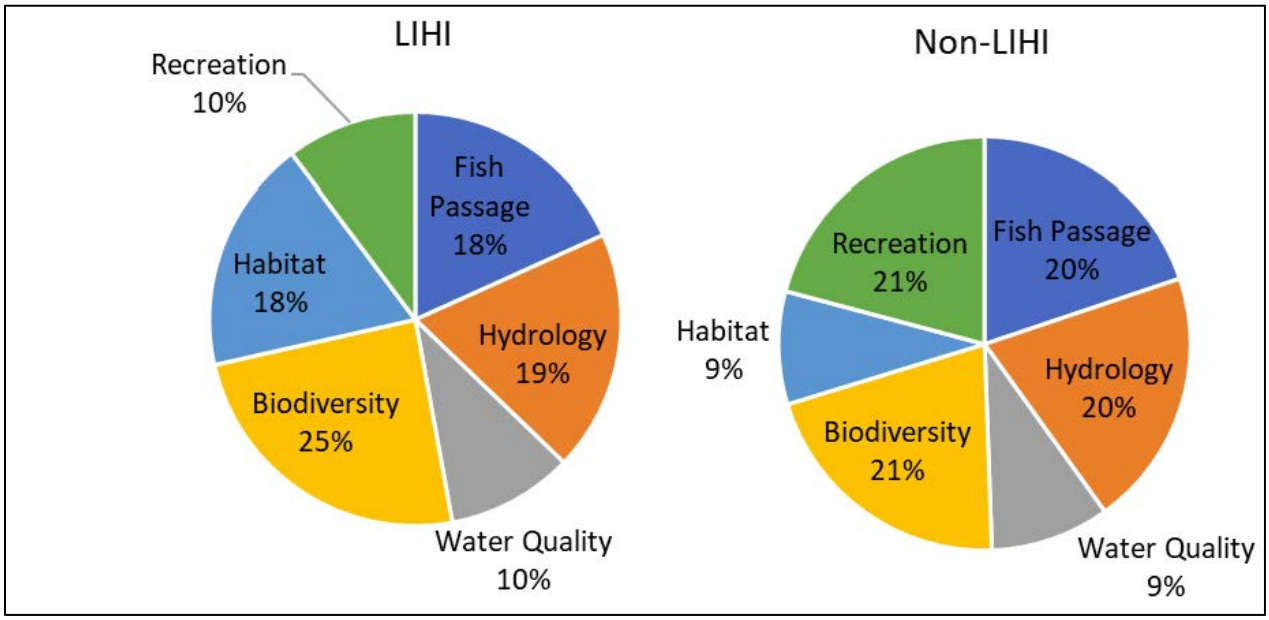


Figure 35. Average Number of Tier 1 Mitigations, Oregon, Washington and Idaho



Direct LIHI to Non-LIHI Facility Comparisons

Comparable LIHI and non-LIHI facilities were identified in the mitigation dataset for more in-depth qualitative analysis using operation type, MW capacity, FERC license vintage, and location (either HUC 08 sub-basin, or on the same river, or within the same state where possible). Thirteen comparisons were made directly among facilities in the mitigation dataset or where one facility was included in the dataset and the comparison facility was not (e.g., "indirect" comparison). For facilities not in the dataset, the comparison included a review of FERC license articles to identify mitigation actions. All comparisons included a review of LIHI PLUS awards, voluntary measures taken by facility owners, and conditions placed on the Certificate.

Example 1

Three small store/release LIHI facilities on one river in Maine were compared to a comparable non-LIHI facility on another river, both tributaries to the Kennebec River. The LIHI facilities were certified under the 1st Edition Handbook and will be undergoing recertification later this year. Overall, they have fewer license mitigation requirements but also shared some of those with the non-LIHI facility including requirements for flow management, water quality, and recreation. These LIHI facilities had no requirements for fish passage, but a Certificate condition was imposed to conduct upstream and downstream passage investigations for American eel.

Example 2

Two very small run-of-river facilities (≤ 0.25 MW) in Idaho were compared. Both shared mitigation requirements for flow monitoring, upstream fish passage monitoring, downstream passage protection, and downstream passage/entrainment monitoring. The LIHI facility also had requirements for threatened and endangered species protection and recreation including interpretative signage. The LIHI facility was first certified in 2006 and subsequently recertified under the 1st Edition handbook. The Certificate also includes a condition related to verification of flow requirements.

Example 3

Two store/release facilities associated with irrigation systems were compared. Both are located on the same river and had licenses/relicenses issued in 1998. The 50-MW LIHI facility had more mitigation requirements in its license than did the 29 MW non-LIHI facility (6 vs. 4), although both had similar requirements for terrestrial wildlife management and sensitive species habitat monitoring. The LIHI facility was first certified in 2008 and twice recertified, most recently under the 2nd Edition Handbook. The Certificate includes a condition related to erosion control (not a FERC mitigation requirement) as well as a PLUS award for voluntary recreational enhancements including voluntary construction of an eagle viewing building at the impoundment that is visited by more than 1,000 people annually.

Indirect LIHI to Non-LIHI Comparisons

Indirect comparisons were also made among facilities that were not well represented or present in the dataset including conduits, facilities located in other regions of the country, those at Army Corps locks and dams, and FERC exempt facilities. Six indirect comparisons were made, and each included a review of FERC license or exemption articles and LIHI PLUS awards, voluntary measures, and Certificate conditions.

Example 4

Two large facilities (> 100 MW) with licenses issued in 1982-1983 and located at US Army Corps locks and dams in the Lower Mississippi HUC 02 region were compared. Both had very few mitigation requirements. Both shared a requirement for conducting recreational needs assessments. The non-LIHI facility also had requirements for sediment and wildlife management plans. The LIHI facility had flow management and monitoring requirements. It was first certified in 2009 and recertified under the 1st Edition Handbook. The Certificate also included a condition to cooperate with resource agencies on their fish passage

feasibility studies. This project has just been recertified under the 2nd Edition Handbook with the same condition remaining in place for the new Certificate term.

Example 5

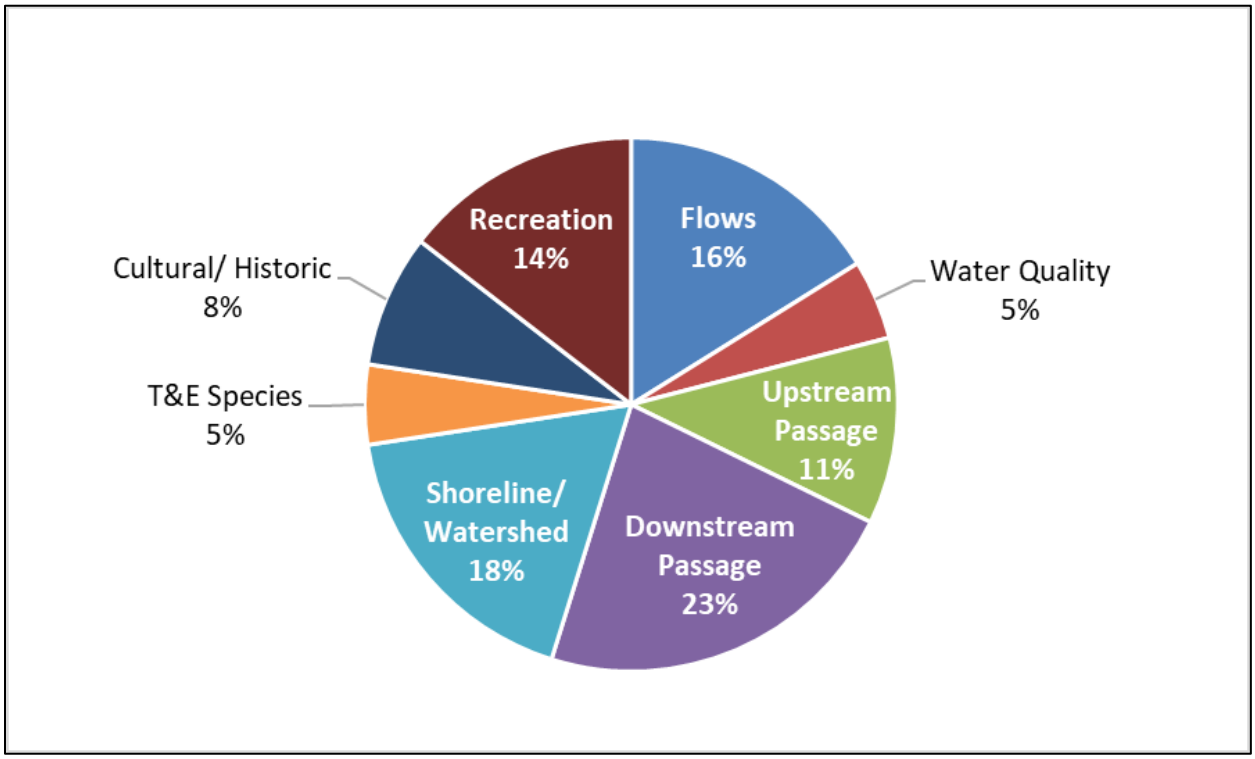
Two small (< 1 MW) FERC exempt run-of-river facilities in Connecticut were compared. Both were new exemptions issued in 2012 or later. In this case, both facilities shared requirements for an operations plan, water quality monitoring, upstream American eel passage, and recreational access. The LIHI facility had additional requirements for upstream and downstream passage, benthic macroinvertebrate surveys, and invasive species control. The LIHI facility was certified in 2019 under the 2nd Edition Handbook. Its Certificate includes conditions related to upcoming water quality and downstream passage studies. A PLUS award was also given for use of advanced technology used for downstream passage, but only pending results of the passage studies and resource agency concurrence.

6.3 Voluntary Measures

Section 4.1 discusses voluntary measures reported in the Certificate Holder survey results. Based on those responses, 23% of that sample included voluntary changes to operations, facilities, or stakeholder communications for purposes of certification with some actions taken before Certification and some after Certification. Many survey non-respondents have also taken voluntary actions, most of which are codified in Certificate conditions.

Overall, 29% of certified facilities have PLUS awards, PLUS options, or have implemented voluntary measures as part of LIHI Certification. Figure 36 shows the breakdown of these by criterion. Most such measures are for downstream passage and 34% of all measures are related to upstream and/or downstream passage. Some voluntary actions apply to more than one criterion. For instance, a facility that manages flows or increases dissolved oxygen in its discharge for the benefit of threatened or endangered aquatic species. Actions that apply to more than one facility in a multiple-facility Certificate are counted for each facility. Two case studies are provided below to illustrate these efforts within the context of LIHI Certification.

Figure 36. PLUS, PLUS Options, and Voluntary Measures



Case Study 1

Four facilities under a single ownership applied for LIHI Certification in 2014-2015. The facilities are in the Merrimack River watershed in New Hampshire - one was FERC licensed in 1982 and the others were exempted in 1983. All are run-of-river facilities, each less than 3.5 MW capacity. These facilities were not captured in the Certificate holder survey results nor in the mitigation dataset.

Under the 1st Edition Handbook, the applicant needed resource agency concurrence and support for LIHI Certification. The US Fish and Wildlife Service (FWS) agreed to endorse LIHI Certification "in return for commitments and progress to address flow and fish passage concerns". The owner and FWS negotiated a binding Memorandum of Agreement (MOA) that established a plan and schedule to implement specific measures to protect aquatic life at all facilities. Specified measures included establishment of minimum flows in the bypasses, operational flow monitoring plans, and downstream passage facilities for American eel and river herring. In consultation with the federal and state resource agencies, the owner conducted flow tests to determine adequate minimum flows for habitat needs and developed fish passage designs and fish passage operational plans. Measures were implemented during

the initial LIHI Certification period in accordance with site-specific conditions to ensure the MOA provisions were satisfied in a timely manner.

All four of the certified facilities were recertified in 2020 with new conditions related to ongoing work under the MOA. Annual agency site visits continue to occur to monitor compliance with the MOA and evaluate the effectiveness of the measures. Upstream passage measures have not yet been required but are included in the MOA and are scheduled for agency review this year. The owner's collaboration with agencies and the voluntary MOA agreement allowed these facilities to become and remain certified. Most important, these measures have positively affected the rivers in ways that would not have happened in the absence of LIHI Certification and would not have been captured in the mitigation database.

Case Study 2

A 30 MW store/release facility in Utah applied for certification in 2009 and was recertified in 2014. As part of relicensing in the mid-1990's the facility developed a Resource Management Plan (RMP) in consultation with resource agencies. The RMP was designed to improve water quality, wildlife habitat, and scenic resources as well as retaining and improving agricultural uses of facility's waters and creating or improving recreation access to facility waters.

The owner has protected 189 miles of shoreline (99.6% of the undeveloped shoreline) with a buffer extending at least 200 feet from the shore. The remaining 0.4% or less than 1 mile is characterized by steep terrain along a canyon at the top of the impoundment but even that area has a minimum 25-foot buffer and up to 199 feet in some places. The FERC license required only 125 acres of shoreline buffer, but 1,440 acres have been protected.

The RMP also included a vegetation management program that protected and created habitat for wildlife on over 1,225 acres with twelve distinct areas ranging from 0.5 to 3 acres set aside for sensitive species habitats. An agricultural lease program was instituted to better manage agricultural practices which included converting over 600 acres from agriculture to grassland while the RMP required only 50 acres to be converted. Shoreline tilling buffers were created, herbicide restrictions were instituted, and 21 miles of fencing was installed to keep livestock away from the shorelines, while the RMP required only 6 miles.

Wetland mitigations were completed on six acres and 30 fish habitat structures were installed (only 4 – 6 were required), and water quality and flow monitoring were conducted. Collectively the measures not only protect lands but also the river from agricultural runoff. These activities remain ongoing and the RMP requires periodic monitoring and 5-year reports that summarize activities and describe future needs over the next 5-year period.

In addition, the facility has received awards from numerous national organizations including National Audubon Society, The Nature Conservancy, and the American Society of Landscape Architects for contributing to biodiversity and conservation, non-point source pollution reduction, and ecological restoration under the RMP.

6.4 Summary of LIHI Facility Comparisons

Overall, there was no clear relationship found between the number and types of mitigation actions for comparable LIHI and non-LIHI facilities at the macro level. These results are not surprising since the number and type of FERC license mitigation requirements differ in relation to each facility's unique characteristics. In addition to the variables analyzed above, other variables that come into play but were not captured in the mitigation dataset include, among others:

- the river's unique hydrology, geomorphology, and ambient water quality conditions,
- the amount of land within the FERC project boundary that can influence the need for shoreline and watershed protection or the potential to make recreation enhancements,
- the presence of migratory fish, threatened and endangered species, or special habitats, and
- the facility's location on the river in relation to upstream and/or downstream dams that can determine a need for fish passage improvements.

The most obvious distinguishing feature between LIHI and non-LIHI facilities may be the fact that LIHI Certified® facilities meet all eight of LIHI's Low Impact Hydropower criteria. As noted in Section 5.1, LIHI application reviews include consideration of requirements that are not ultimately incorporated into a FERC license or exemption, as well as criteria not fully captured in the mitigation database (e.g., cultural and historic resources). LIHI also considers whether a mitigation requirement was completed. LIHI Certificates often impose site-specific conditions, and LIHI's annual compliance reviews provide much more frequent oversight than does FERC to ensure that requirements continue to be met. Voluntary measures and PLUS awards indicate actions that go above and beyond standard regulatory requirements and the basic LIHI standards. None of these additional actions are included in the mitigation database.

Evaluating hydropower is very site specific, as the case studies illustrate. The limited number of comprehensive hydropower datasets is also important. We compared LIHI Certified® facilities to non-certified facilities within the data sets and have provided additional information where possible, from our own data. LIHI provides a specific reference point, the LIHI Criteria, that prioritizes the environment over power production, and provides in depth analysis for stakeholders and the public to use to make their own decisions. The number of mitigations should not be taken as an indicator of impact. A large number could reflect a greater impact

with more actions required to mitigate for them. A small number could reflect that the facility itself does not have negative impacts that need to be mitigated for. Or, it could mean the opposite. Facility by facility review would be necessary to truly understand the impact for any given facility.

7. OUTREACH AND EDUCATION

The third leg of LIHI's mission is to provide information to the public on the impacts of hydropower. LIHI approaches this in three ways: providing all application materials and project descriptions on its website; presenting information to interested groups and at conferences; and facilitating and conducting educational discussions and visits for students. LIHI also advises on several US Department of Energy (DOE) funded project boards and serves as reviewer on DOE funded projects and papers in development.

The LIHI website is the primary source of information to the public. Each Certificate has its own project page with the full history of applications, decisions, and conditions. In addition, there are photos of the projects and a written description of the project's location and operations. There is also a table with key data about the project including size, ownership, and location. The website receives an average of 1,400 visits per month and nearly 6,000 page views. For context, according to the Source Engine Journal, only 20% of businesses receive 1,500 website visits per month and 55% receive fewer than 500 visits. 11% of LIHI site visits are international. In 2020, LIHI updated its website platform and encountered a few technical glitches. During the few days those glitches occurred, we received numerous calls and emails from individuals unable to properly access the site. Although anecdotal, it reinforced the importance of the information provided there. As noted in earlier sections, there are two main data sources for hydropower facilities in the US – the FERC lists of facilities, and HydroSource databases. There is also the national inventory of dams maintained by the USACE. The next most comprehensive set of information available on hydropower in the US is the LIHI website.

Every year LIHI staff present at conferences and participate in calls and conversations about hydropower in general and about our program. One or more of LIHI's staff has presented at 44 conferences since 2013, an average of six per year. LIHI often has an information table and presents at regional and national meetings of the hydropower industry (e.g., National Hydropower Association, Hydrovision International, Northwest Hydropower Association), renewable markets industry (e.g., Renewable Energy Markets, PJM Markets), dam safety organizations (e.g., US Society on Dams, VT Dam Safety task force), agencies (e.g., US Department of the Interior, US Forest Service), and NGOs (e.g., NRDC, Hydropower Reform Coalition).

LIHI is involved in the Uncommon Dialogue led by Stanford University and Energy Futures Initiative, working with hydropower leaders and national stakeholders over two years to find common ground on key issues facing the US, including climate change and hydropower's role in addressing it. LIHI staff has participated with the Department of Energy's Waterpower Technologies Office on the Hydropower Vision Report [61] and development of tools for use in relicensing, as well as consulted in the development of new standard modular hydropower. The LIHI Criteria are used as a benchmark by developers to help them design projects that would meet our standards. Although small in size, LIHI dedicates significant time and resources to participate in local and national discussions about hydropower, its role in a carbon free future, and its impacts and benefits.

LIHI provides a PLUS standard for educational efforts within the cultural and historic resources criterion. For multiple years, LIHI has facilitated visits to hydropower facilities by fourth grade classes studying energy. LIHI staff has led learning opportunities for extracurricular clubs such as the hydro dynamics LEGO Challenge in 2019. LIHI has also visited classrooms to talk about energy, renewable energy, and hydropower specifically. LIHI is also available to speak with agencies, nonprofits, and other stakeholders to explain our program and answer questions about its process and impact. LIHI most recently presented to the US Department of the Interior and other state and federal agencies, and before that to the US Forest Service.

These educational activities also include providing information to public officials so that policies can be developed with full information. On the international front, LIHI has been contacted by parties around the world about the LIHI program and the possibilities of either certifying facilities outside of the US or starting a similar international program, or programs. In 2019, LIHI had the honor of hosting a delegation of small hydropower interests from China. The visit included multiple LIHI Certified® facility site tours and a conference to exchange information between the delegation, LIHI Certificate holders, and other hydropower stakeholders regarding hydropower regulations and market incentives in the US.

Education and outreach are key components of the LIHI mission. LIHI will seek to find more opportunities to engage with the nonprofit stakeholders across the country and ensure that information on LIHI Certified® hydropower is included in discussions of possible national renewable or clean energy standards. Although we are seeing that local ecosystems are losing many protections they have benefited from over the past decades, these ecosystems are essential for a healthy climate, and hydropower owners that are actively working to limit their impacts and safeguard the environment should receive recognition.

[61] https://www.energy.gov/eere/water/downloads/hydropower-vision-report-full-report

8. CONCLUSION

LIHI provides the most comprehensive definition of low impact hydropower generation as demonstrated by the global interest in the program and LIHI's influence on public policy, especially within the context of renewable portfolio standards. As demonstrated in the cases of Massachusetts and New York, where RPS policies have higher standards for hydropower than their clean energy standards, public policy is increasingly prioritizing commitments to 100% carbon-free resource mixes over other policy aims, such as valuing low impact hydropower. In contrast, some corporations and individual consumers have not fully embraced any hydropower as a green source as evidenced by the dramatic increase in green power programs, CCAs, and long-term contracts for wind and solar and not hydropower. As awareness of the reliance on fossil fuels to cover periods of low wind and sun increases, LIHI Certified® hydropower can play a critical role in achieving a 100% renewable grid while also protecting local river ecosystems. LIHI Certification remains the most comprehensive, independent, and accessible source of whether that protection is occurring.

The comparison between LIHI Certified® and non-certified facilities in ORNL's mitigation database demonstrated no statistical difference between the number of mitigations. Instead, the comparison highlighted the information not included as well as the importance of understanding specific site characteristics. There is no apparent correlation between the number of mitigations and overall impact illustrated by the data. Physical characteristics of certified versus non-certified facilities within the FERC database highlighted the role that public policy plays in encouraging LIHI Certification. There is significant difference in the consideration of actions taken outside of FERC licensing, and the transparency, regular evaluation, and accountability of LIHI Certified® facilities. Although in public policy debates, FERC licensing is held up as a comparable litmus test, the limitation of the information available through that process is demonstration enough that it is insufficient alone for determining a hydropower project's impacts. Meeting the LIHI Criteria is the main and most important distinction.

Through its website, application process, and outreach activities, LIHI has opened the door to digestible, independent information on at least a portion of hydropower in the United States. LIHI's use, either directly or indirectly, in defining eligible hydropower in state RPS programs demonstrates its influence in shaping public policy, even without direct lobbying efforts.

RPS programs that require LIHI Certification fund improvements, or the improvements at LIHI Certified® facilities may earn the facilities additional revenue. Regardless, we do know that improvements are being made at certified facilities, and that most LIHI facilities are in areas where RPS programs require it. This is a demonstration of win-win-win policies that should be replicated across the country.

Hydropower is arguably the most site-specific, dynamic, and unique renewable generation source. It provides myriad benefits which have not been explored fully in this report. Hydropower has varied impacts that are directly related to sensitive ecosystems, project designs, and ownership values. By conducting the certification program, LIHI provides detailed information and comprehensive analysis to neighbors, stakeholders, purchasers, marketers, and acquirers of hydropower facilities. The willingness of hydropower owners to go through the LIHI Certification process and provide detailed information about their projects and be annually assessed demonstrates a commitment to transparency and sustainability that may not be matched by those unwilling or unable to do the same.

Over the past twenty years, the LIHI Certification program has consistently met the LIHI mission – to define Low Impact Hydropower, to conduct a certification program to evaluate hydropower based on that definition, and to educate the public about the impacts of hydropower. As with any program, we strive to be better and to make a bigger impact. Through program enhancements, including continual assessment of our criteria and standards, and expansion of our outreach efforts, we hope to increase the amount and positive impact of improvements, increase the number of facilities in the program, and provide high quality information to stakeholders.

Knowing how important state and voluntary programs have been in driving LIHI Certifications, our next challenge will be to develop more and stronger relationships with stakeholders to ensure LIHI Certified® hydropower is properly and fairly compensated for its additional activities. We must convince public policy makers that local ecosystem preservation can happen in tandem with lowering carbon emissions. We can attract greater stakeholder participation and interest. Our mission will truly be accomplished when all of the hydropower in the US can be considered Low Impact. Until then, we will keep evaluating each individual facility that applies to the program, and we will continue to hold them accountable to the Low Impact standards. We will also continue to support them in monetizing and leveraging the value of Certification. Finally, we will continue to reach out to the public with comprehensive information and opportunities to participate in this process for stakeholder input is now and will always be a critical part of the LIHI Certification program and oversight of the organization itself.

APPENDIX A – MITIGATION DATASET COMPARISON GRAPHS

NOTE: The Y-axis scale varies between the following graphs

Figure 1.

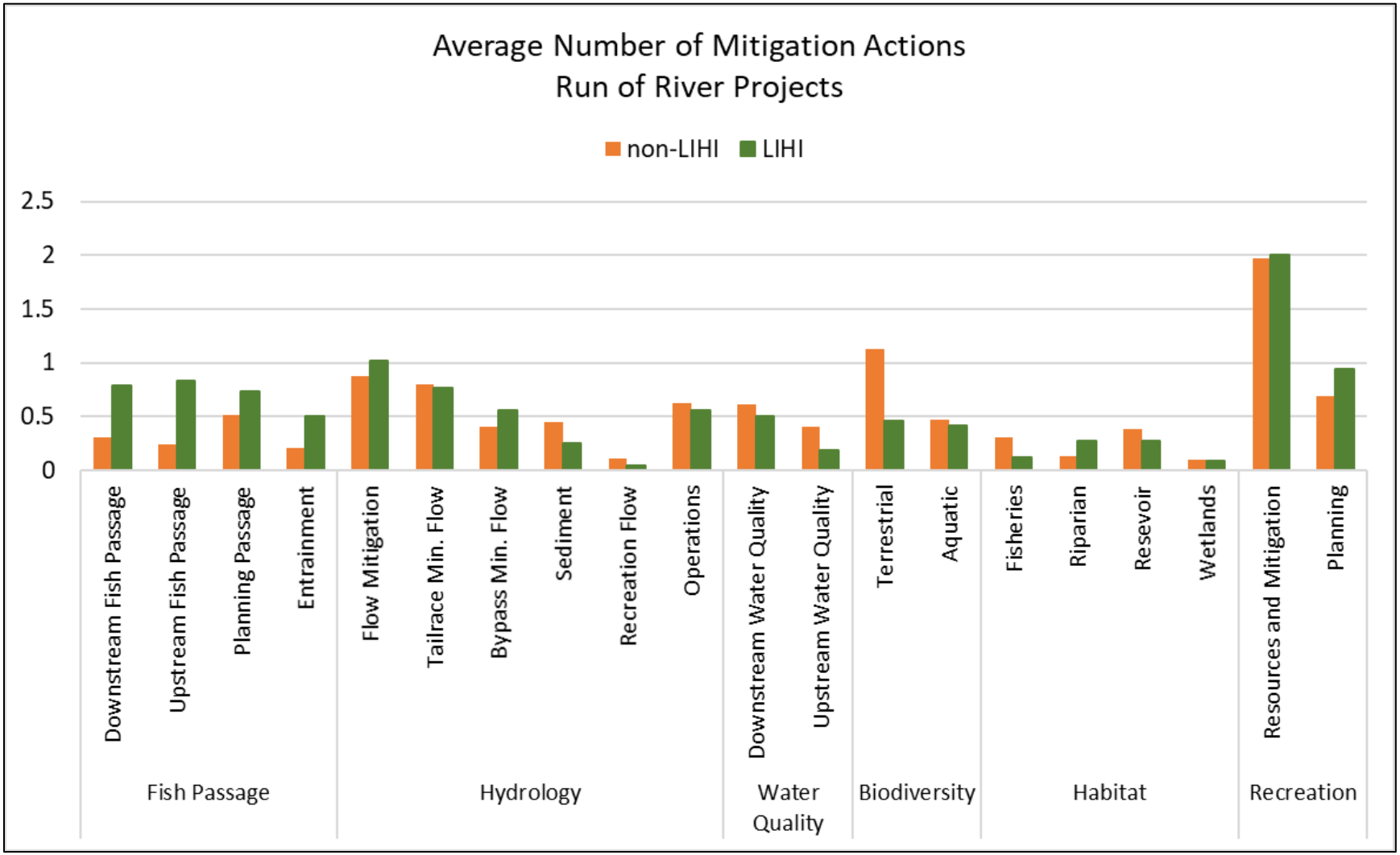


Figure 2.

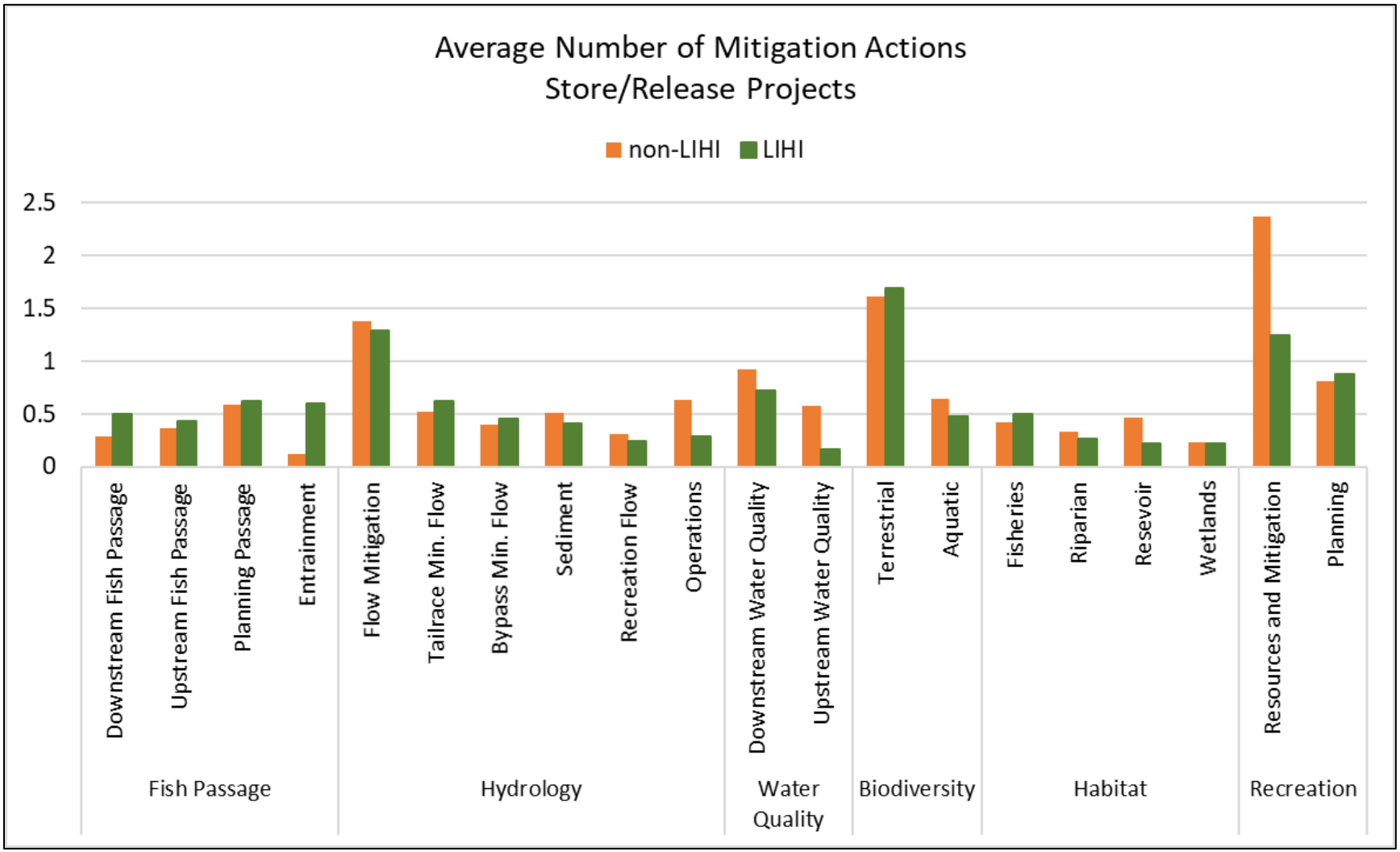

Average Number of Mitigation Actions
Store/Release Projects
non-LIHI
LIHI
2.5
2
1.5
1
0.5
0
Downstream Fish Passage
Upstream Fish Passage
Planning Passage
Entrainment
Flow Mitigation
Tailrace Min. Flow
Bypass Min. Flow
Sediment
Recreation Flow
Operations
Downstream Water Quality
Upstream Water Quality
Terrestrial
Aquatic
Fisheries
Riparian
Resevoir
Wetlands
Resources and Mitigation
Planning
Fish Passage
Hydrology
Water Quality
Biodiversity
Habitat
Recreation

Figure 3.

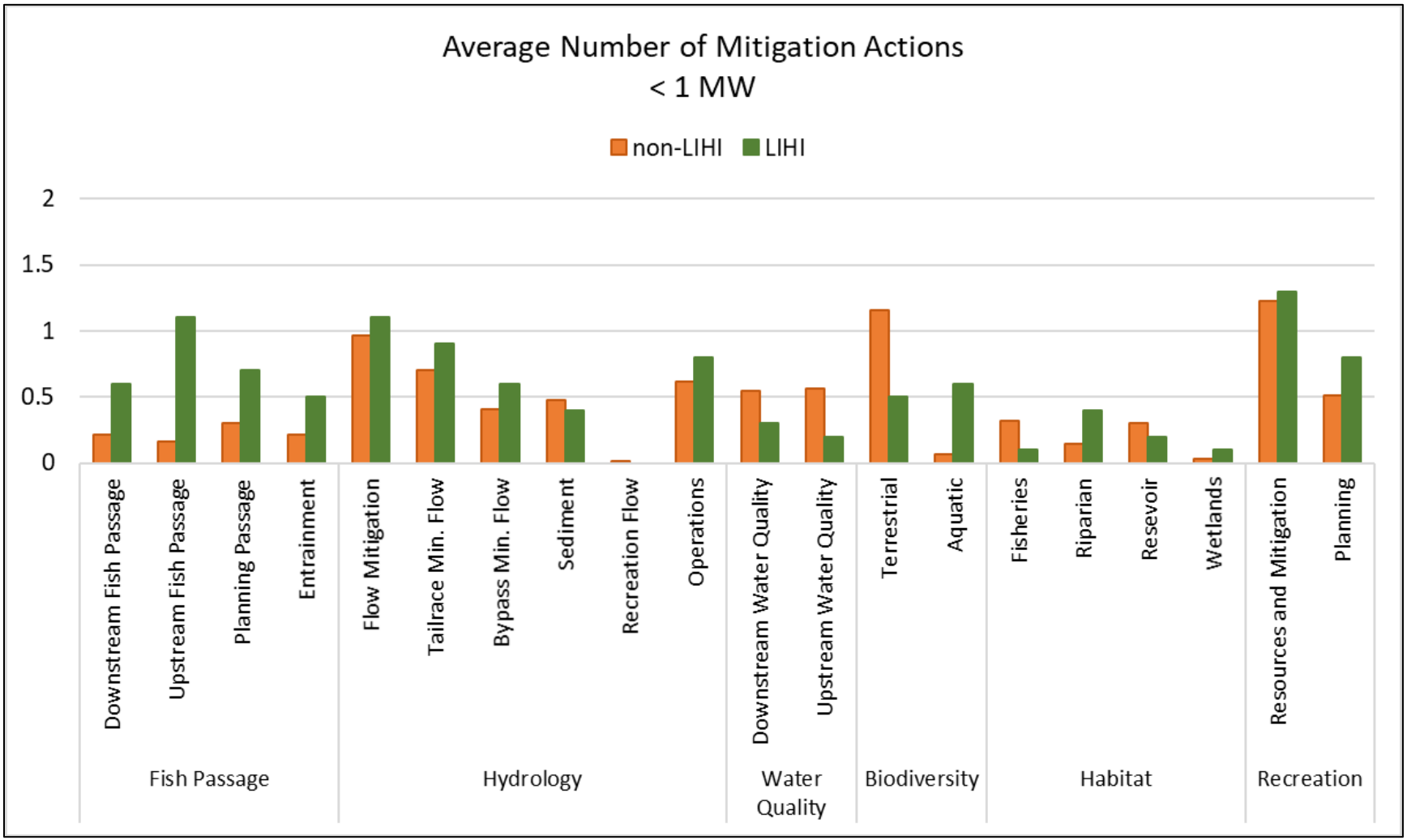

Average Number of Mitigation Actions
< 1 MW
non-LIHI
LIHI
2
1.5
1
0.5
0
Downstream Fish Passage
Upstream Fish Passage
Planning Passage
Entrainment
Flow Mitigation
Tailrace Min. Flow
Bypass Min. Flow
Sediment
Recreation Flow
Operations
Downstream Water Quality
Upstream Water Quality
Terrestrial
Aquatic
Fisheries
Riparian
Resevoir
Wetlands
Resources and Mitigation
Planning
Fish Passage
Hydrology
Water Quality
Biodiversity
Habitat
Recreation

Figure 4.

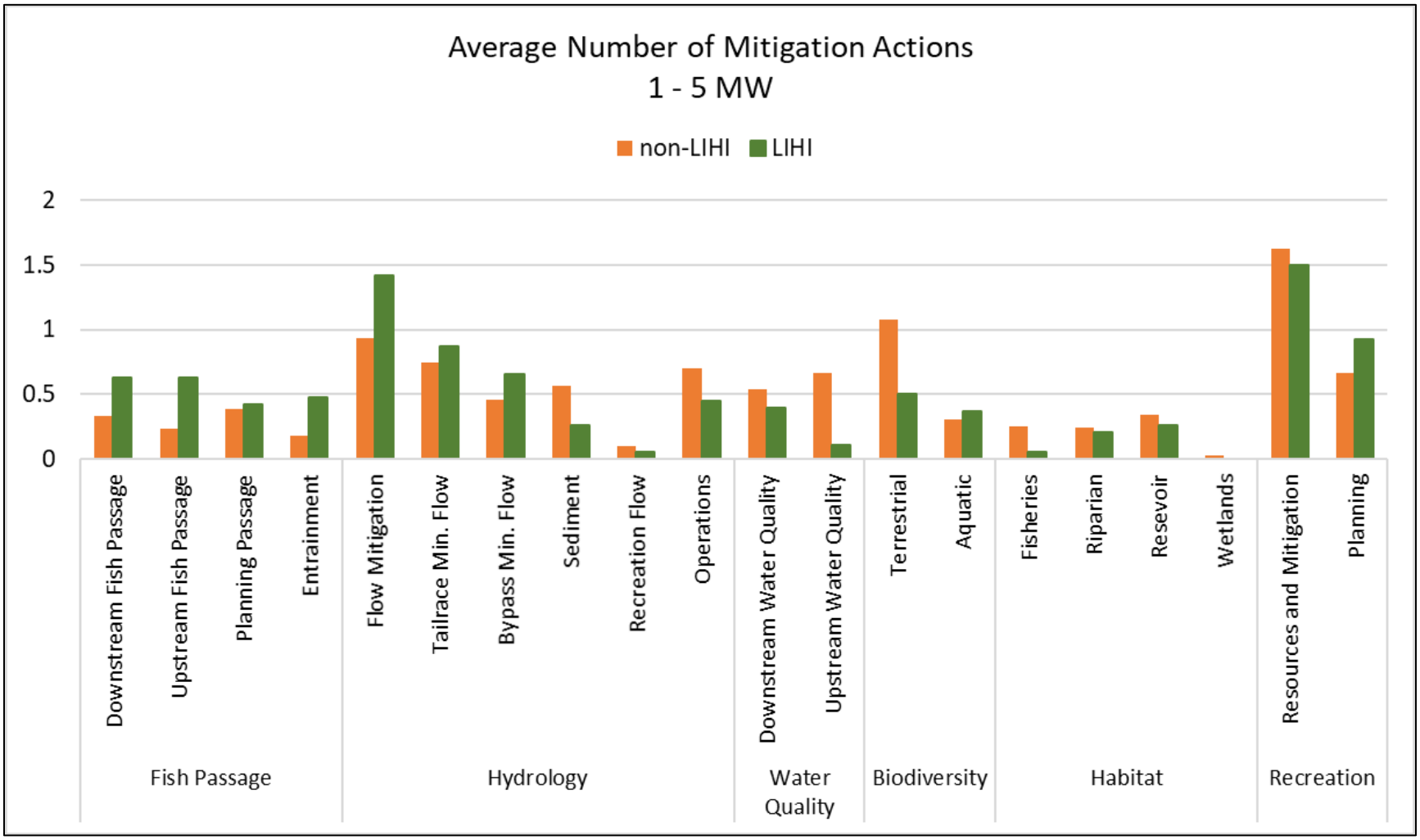

Average Number of Mitigation Actions
1 - 5 MW
non-LIHI
LIHI
2
1.5
1
0.5
0
Downstream Fish Passage
Upstream Fish Passage
Planning Passage
Entrainment
Flow Mitigation
Tailrace Min. Flow
Bypass Min. Flow
Sediment
Recreation Flow
Operations
Downstream Water Quality
Upstream Water Quality
Terrestrial
Aquatic
Fisheries
Riparian
Resevoir
Wetlands
Resources and Mitigation
Planning
Fish Passage
Hydrology
Water Quality
Biodiversity
Habitat
Recreation

Figure 5.

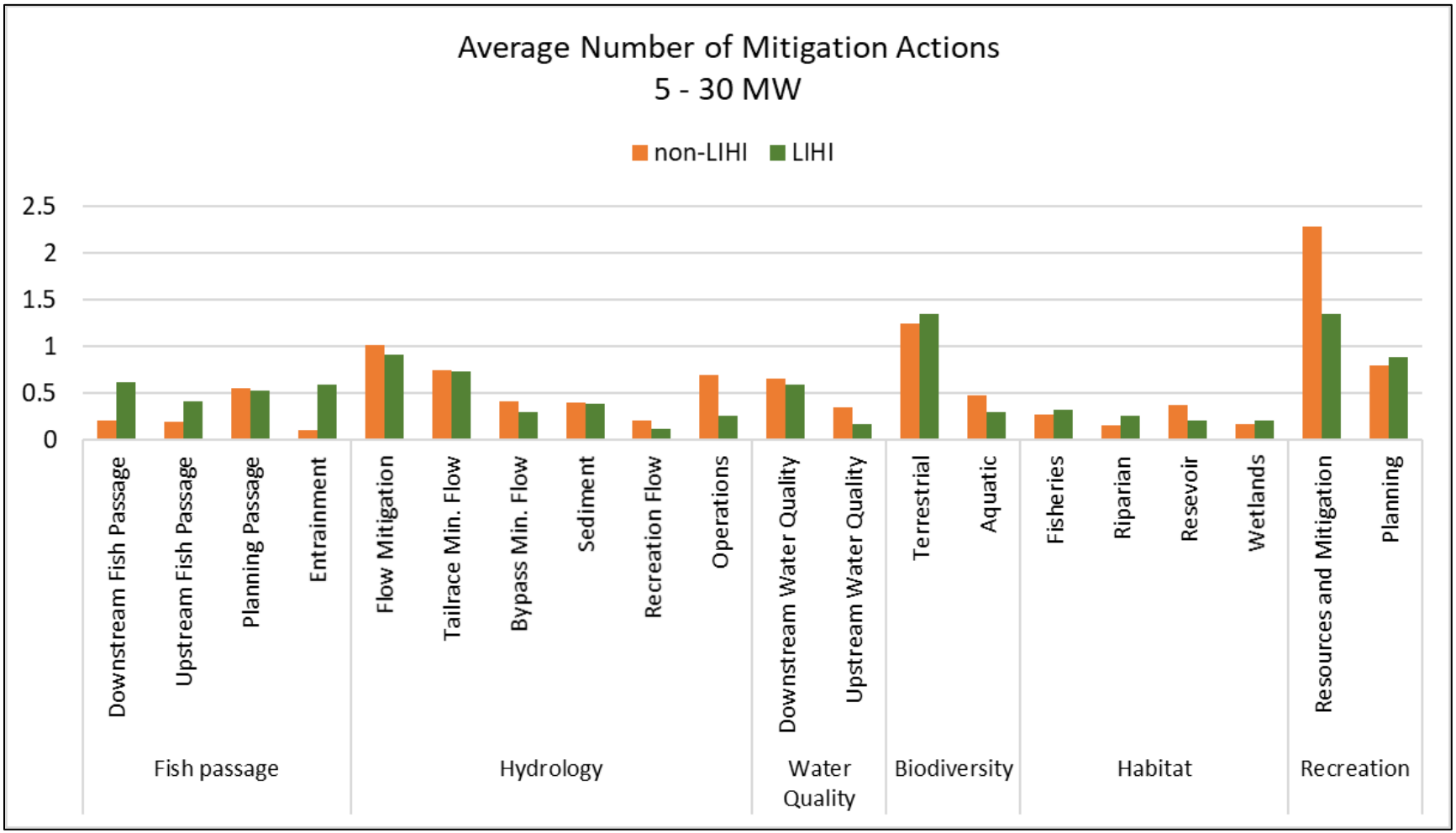

Average Number of Mitigation Actions
5 - 30 MW
non-LIHI
LIHI
2.5
2
1.5
1
0.5
0
Downstream Fish Passage
Upstream Fish Passage
Planning Passage
Entrainment
Flow Mitigation
Tailrace Min. Flow
Bypass Min. Flow
Sediment
Recreation Flow
Operations
Downstream Water Quality
Upstream Water Quality
Terrestrial
Aquatic
Fisheries
Riparian
Resevoir
Wetlands
Resources and Mitigation
Planning
Fish passage
Hydrology
Water Quality
Biodiversity
Habitat
Recreation

Figure 6.

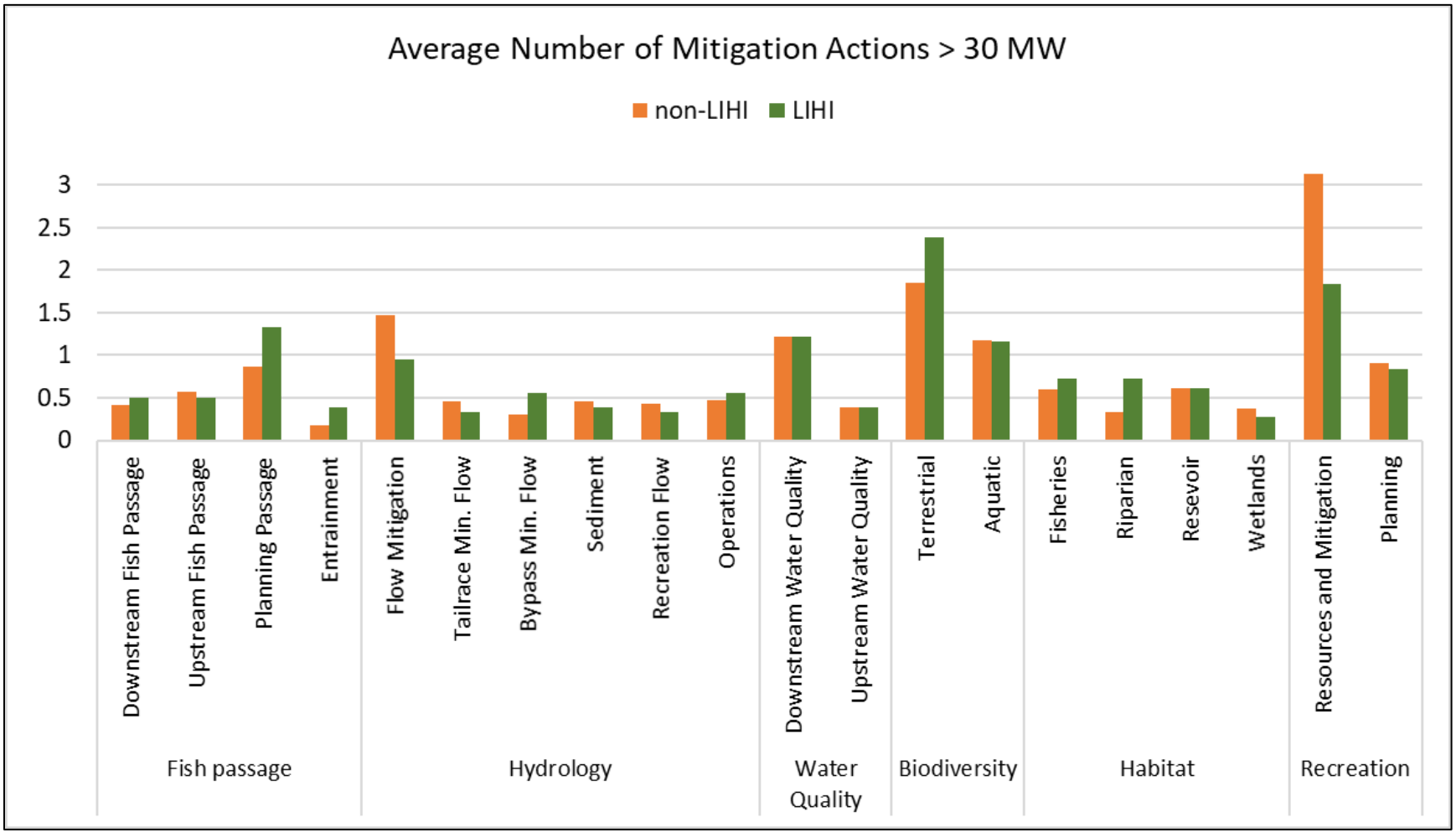

Average Number of Mitigation Actions > 30 MW
non-LIHI
LIHI
3
2.5
2
1.5
1
0.5
0
Downstream Fish Passage
Upstream Fish Passage
Planning Passage
Entrainment
Flow Mitigation
Tailrace Min. Flow
Bypass Min. Flow
Sediment
Recreation Flow
Operations
Downstream Water Quality
Upstream Water Quality
Terrestrial
Aquatic
Fisheries
Riparian
Resevoir
Wetlands
Resources and Mitigation
Planning
Fish passage
Hydrology
Water Quality
Biodiversity
Habitat
Recreation

Figure 7.

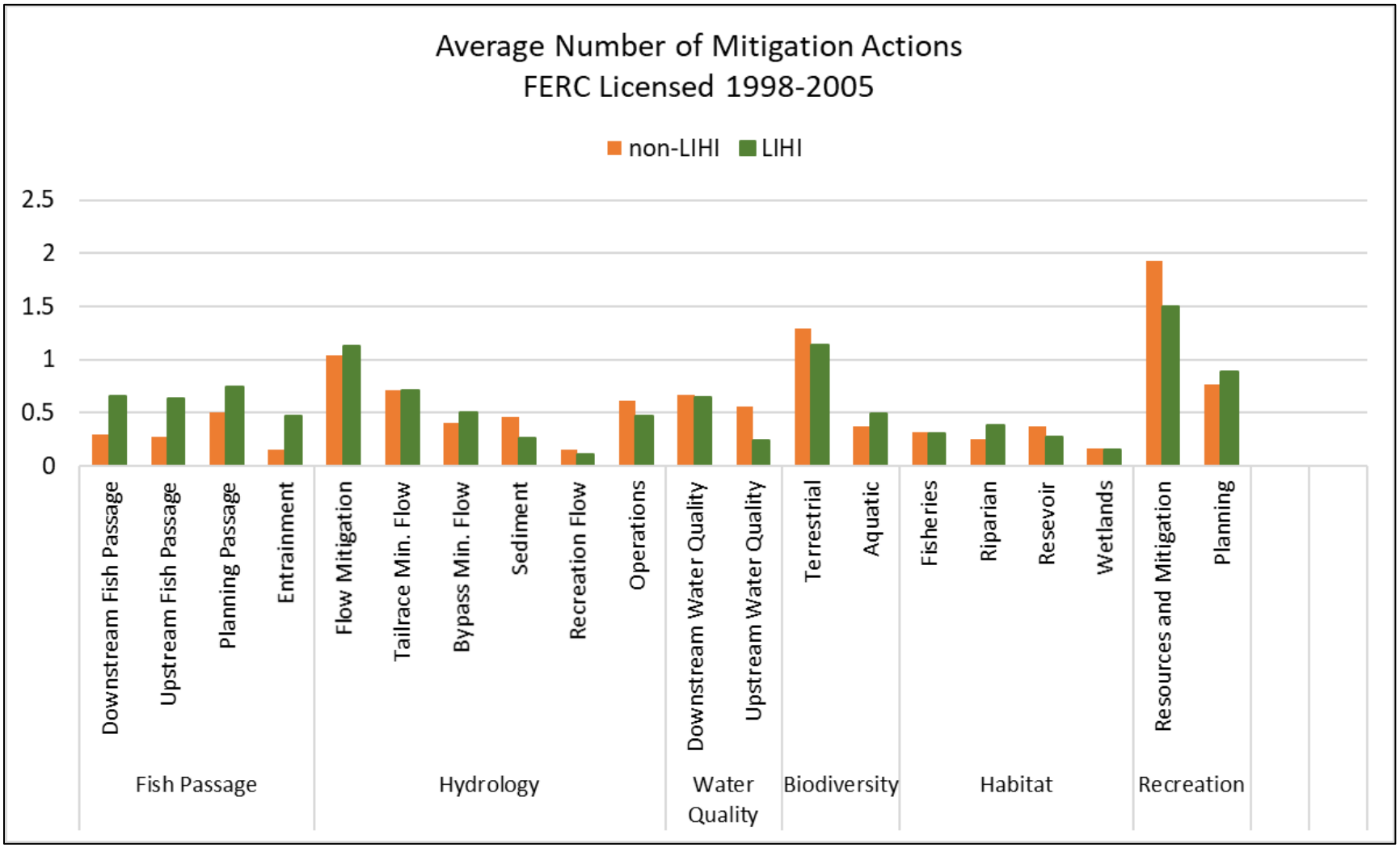
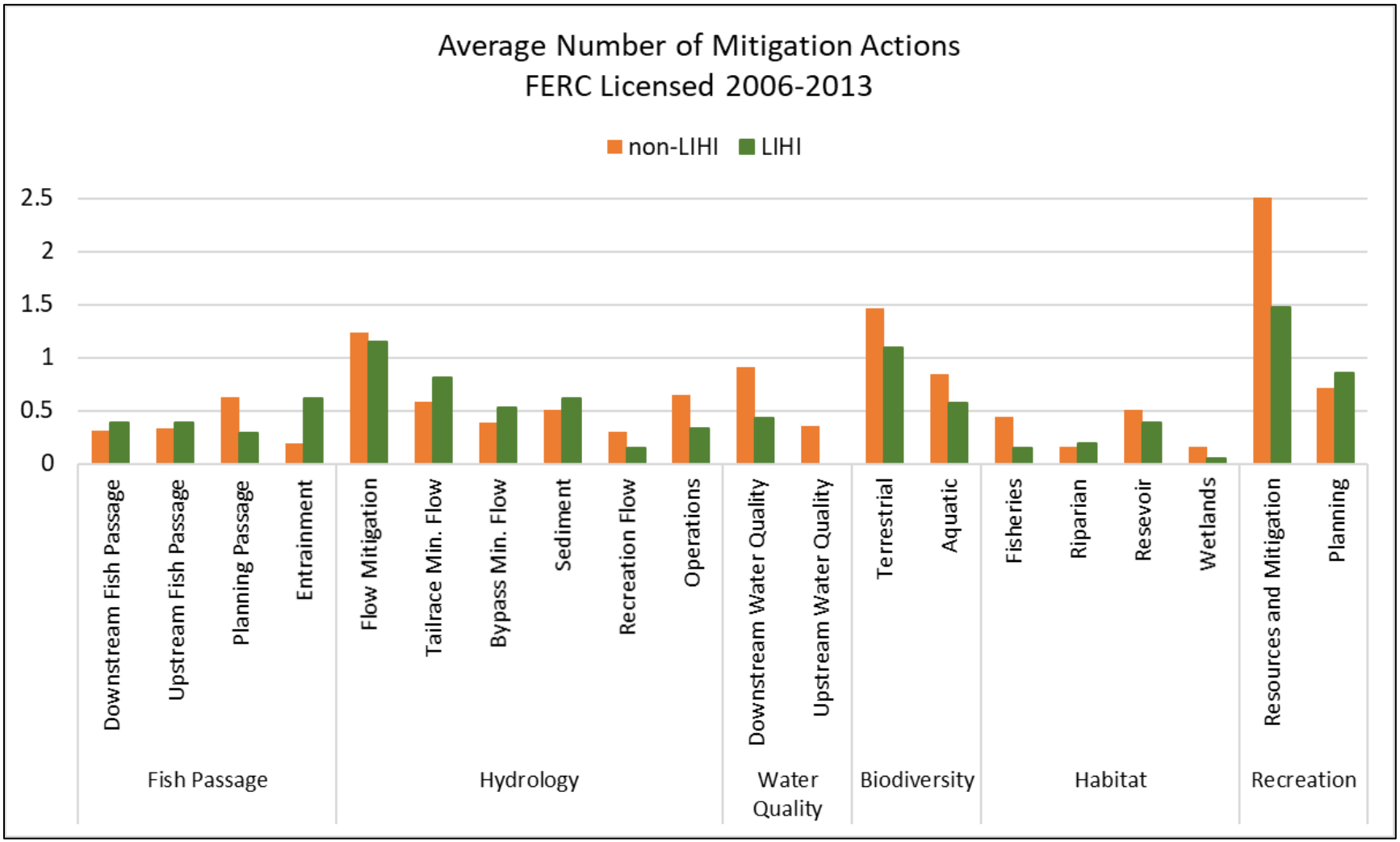

Average Number of Mitigation Actions
FERC Licensed 1998-2005
non-LIHI
LIHI
2.5
2
1.5
1
0.5
0
Downstream Fish Passage
Upstream Fish Passage
Planning Passage
Entrainment
Flow Mitigation
Tailrace Min. Flow
Bypass Min. Flow
Sediment
Recreation Flow
Operations
Downstream Water Quality
Upstream Water Quality
Terrestrial
Aquatic
Fisheries
Riparian
Resevoir
Wetlands
Resources and Mitigation
Planning
Fish Passage
Hydrology
Water Quality
Biodiversity
Habitat
Recreation

Figure 8.


Average Number of Mitigation Actions
FERC Licensed 2006-2013
non-LIHI
LIHI
2.5
2
1.5
1
0.5
0
Downstream Fish Passage
Upstream Fish Passage
Planning Passage
Entrainment
Flow Mitigation
Tailrace Min. Flow
Bypass Min. Flow
Sediment
Recreation Flow
Operations
Downstream Water Quality
Upstream Water Quality
Terrestrial
Aquatic
Fisheries
Riparian
Resevoir
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Fish Passage
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Water Quality
Biodiversity
Habitat
Recreation