

Environmental Mitigation Prediction at Hydropower Projects

Background

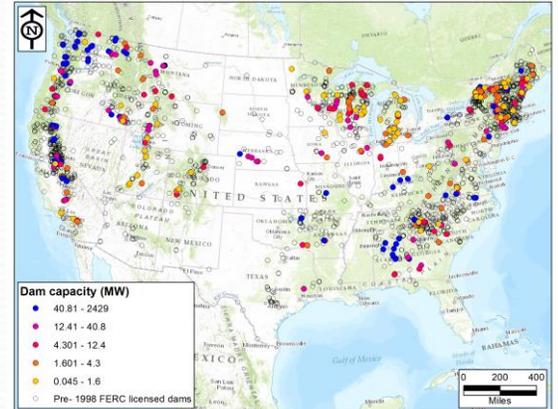
The future of hydropower in the US depends on being able to provide flexible, dependable power while minimizing environmental impact. Adequate environmental protection is difficult to predict or achieve without a comprehensive understanding of necessary mitigation across the US.

Project Objectives

To understand conservation and mitigation needs at existing and potential hydropower sites by:

- cataloging the environmental mitigation requirements at existing dams across the US and
- developing statistical models for predicting likely mitigation for new and existing projects.

Underscoring the importance of addressing the environmental mitigation data gap for hydropower projects are the significant numbers of projects approaching expiration of current FERC licenses.



Spatial distribution of hydropower plants with licenses issued since 1998 that were included in the mitigation database.

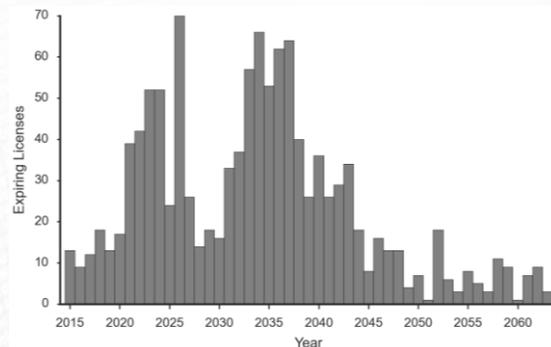
A hierarchical structure was used to easily classify mitigation requirements into different categories and provide a method to summarize mitigation information. Mitigation requirements were classified as one of six Tier I categories, 20 Tier II categories, and 132 Tier III requirements.

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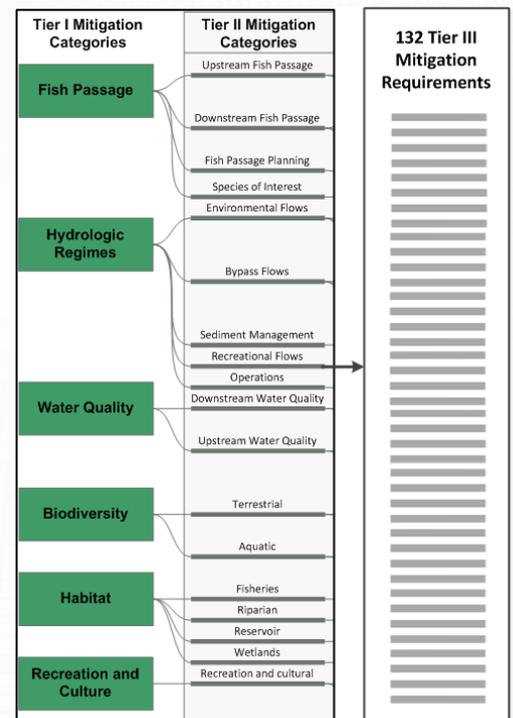
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The number of current FERC licenses expiring per year. Over 300 licenses are set to expire from 2016 through 2026.

Environmental Mitigation Database

Database design. The database we generated covers 309 FERC licenses issued between 1998 and 2013. These licenses govern operations at 447 hydropower plants and 414 dams in 40 states.

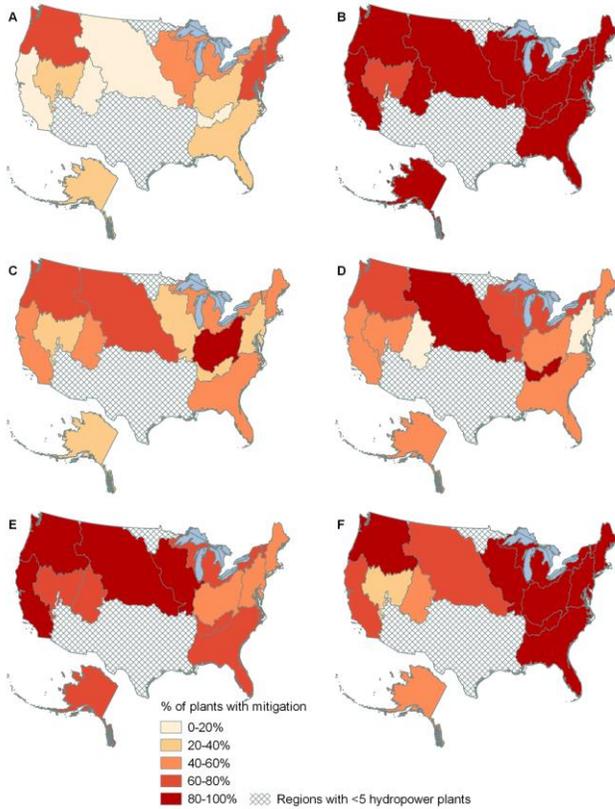


Conceptual mitigation database schema

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License data mining results. We identified 132 mitigation types and 5,130 total mitigation requirements. Nationally, there was a mean of 11.5 mitigation requirements per hydropower plant (n=447, SD=6.0, table 1). The mean values ranged from 6.7 (SE=2.1) in the Great Basin to 15.7 (SE=0.9) in the Pacific Northwest. The largest mean values were categorized as hydrology (3.3, SE=0.1), and recreation (2.6, SE=0.1).

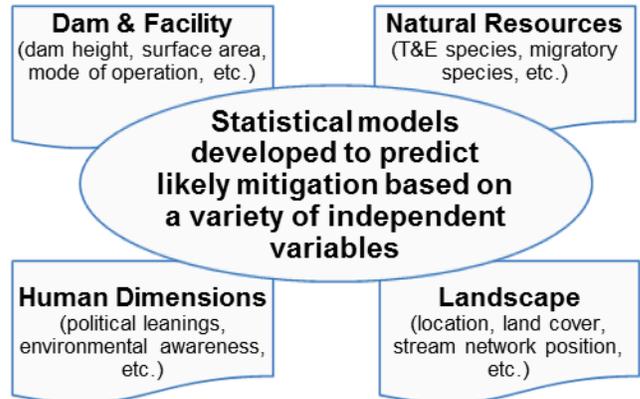


Frequency of plants (percentage) with mitigation requirements: (a) fish passage, (b) hydrology, (c) water quality, (d) habitat, (e) biodiversity, (f) recreation.

Predicting Environmental Mitigation Requirements

Mitigation requirements are issued by FERC through licenses on a plant-by-plant basis. Linkages in the National Hydropower Asset Assessment Program (NHAAP) database from plants to the associated dams and from dams to the associated NHD stream segment allow for integration of stream network features, landscape characteristics, and fish species distributions into the dataset used to build the predictive models.

Candidate predictor variables were selected to represent elements thought to be linked to hydropower mitigation requirements, and they fall into four broad categories: hydropower facility characteristics, landscape characteristics, natural resources, and human dimensions.



Categories of candidate predictor variables used in model development

Since there are 20 Tier II mitigation categories and 132 Tier III mitigation requirements, a subset of these was selected to evaluate whether mitigation requirements issued by FERC were predictable and whether mitigation requirements were predictable at different levels of the hierarchical classification system. Based on our preliminary findings, it appears that predictive models can be fit for mitigation requirements that have sufficient data available and can be predicted using hydropower facility characteristics, human dimensions metrics, landscape characteristics, and fish species information.

Potential model applications. Many of the predictive models created thus far include at least one hydropower facility characteristic predictor variable. These hydropower facility characteristics exist in the NHAAP database for existing powered dams, non-powered dams, and potential new development sites. Thus the predictive models can be applied to:

- existing powered dams,
- existing non-powered dams,
- potential new sites identified in a recent ORNL analysis, or
- stream reaches lacking any previous consideration.

Products:

- Publicly accessible and queryable database of hydropower environmental mitigation requirements
- Decision support tool for predicting mitigation at new and existing hydropower projects

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