

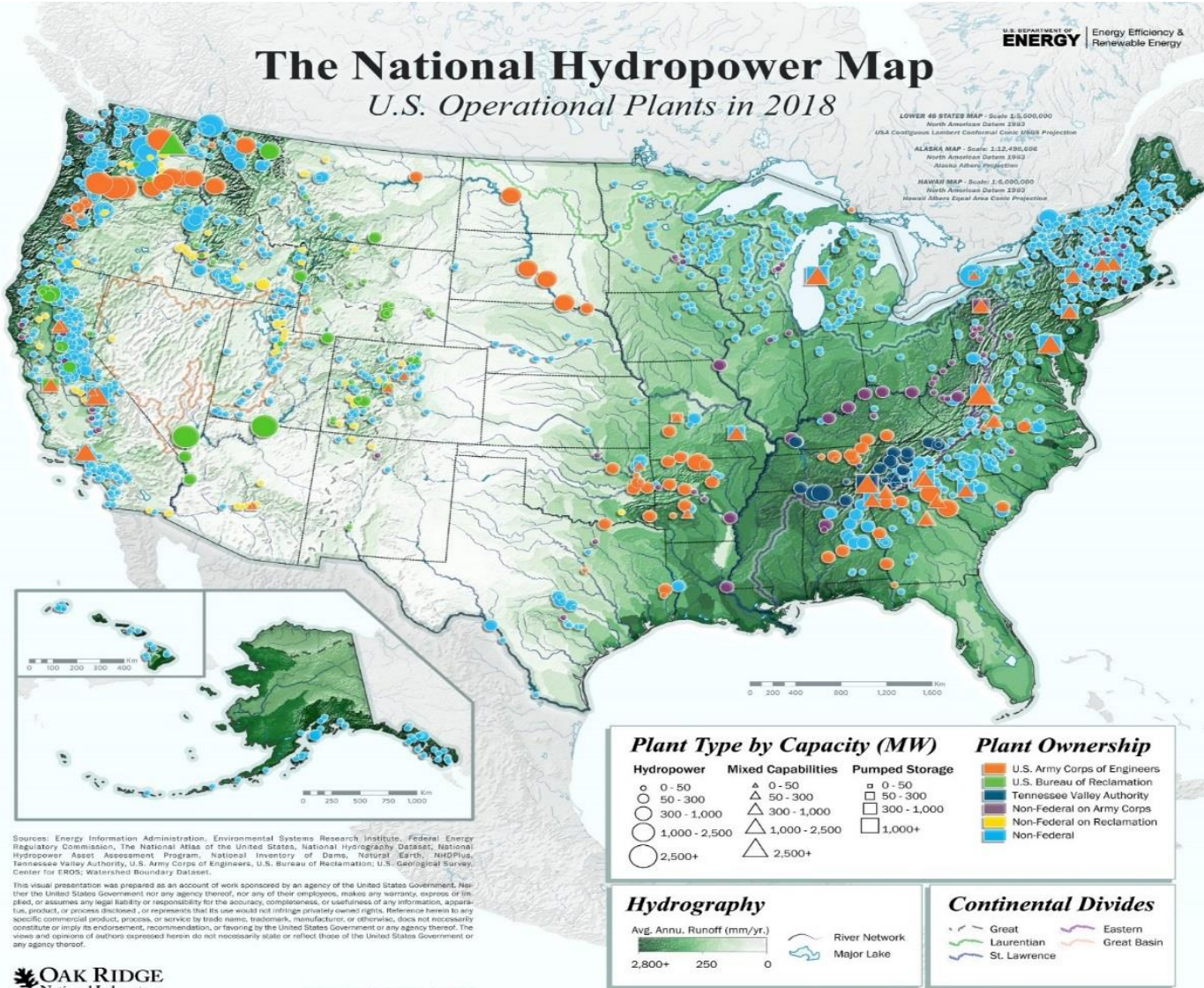


**Addressing the Challenge of Two-way Fish
Migration – *Fish Passage Technology R&D and
Standard Module Hydropower***

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Hydropower Summit Trondheim, Norway
February 5, 2020

- Summary of US Hydropower and Fish
 - US Hydropower basics
 - Species of Concern
 - Regulation and fish protection mitigation measures
- DOE R&D portfolio overview
- Fish passage challenge
 - Approaches
 - Current funded project examples (labs and industry/academia):
 - Standard Modular Hydropower
 - Technology R&D

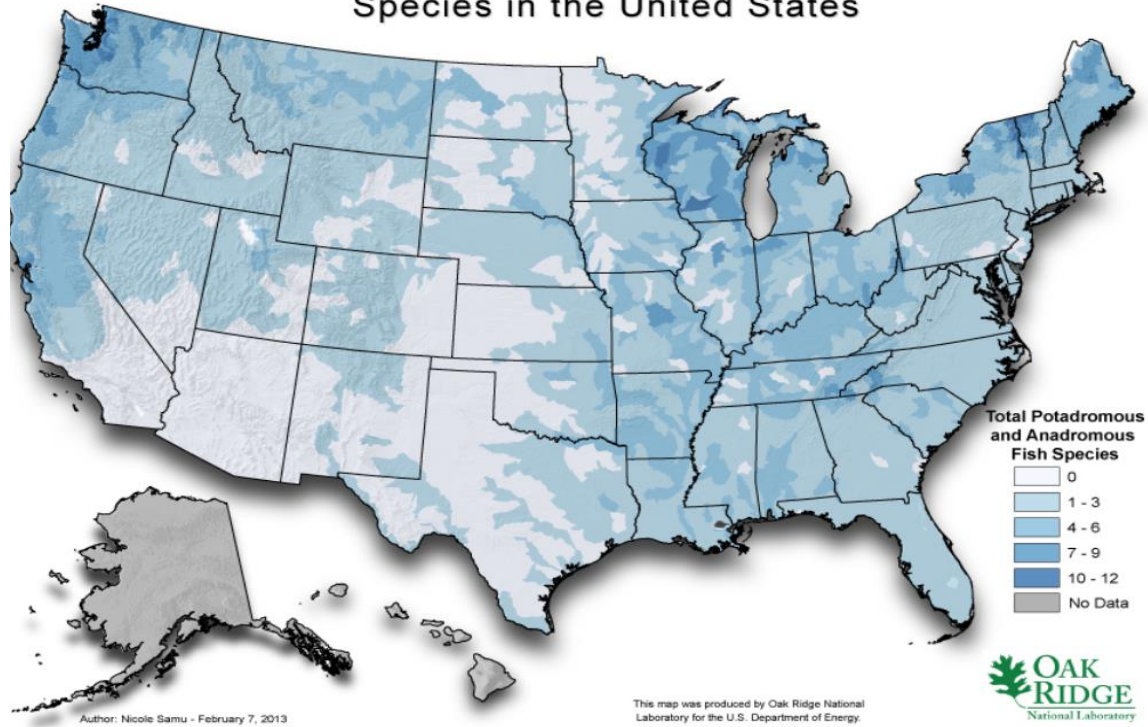
The National Hydropower Map U.S. Operational Plants in 2018



- 84,000 dams in the US, only 2,400 produce power
- 80 GW of hydropower capacity (7% of renewable capacity)
 - 49% owned by the U.S. Government
- Nearly 1.5 GW of capacity added in the last decade
 - Regulations, high costs, and environmental concerns limit development
- Average age of hydropower dams is 64 years, constructed before the current US regulatory framework
- 15 federal US agencies have a role in hydropower
- \$8.9 billion in refurbishments & upgrades invested across 158 hydropower dams in the U.S. between 2007-2017
- Number of US dams with fish passage unknown
 - Performance is highly variable and has not been accessed at a national scale
- The United States has the most diverse temperate freshwater fish fauna with ~790 species
 - 1213 fish species in North America:
 - 28% migratory, 50% non-migratory, and 22% do not have their migration pattern described

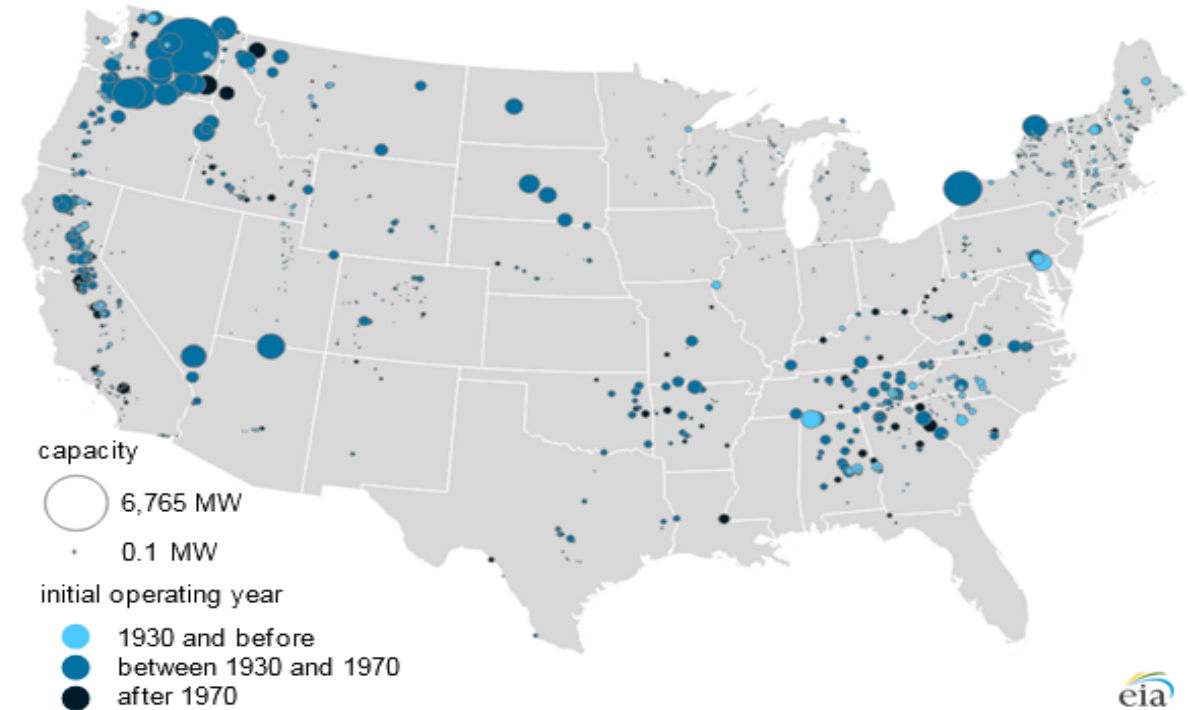
River connectivity for migratory fish

Potadromous and Anadromous Fish Species in the United States



Distribution of hydroelectric plants

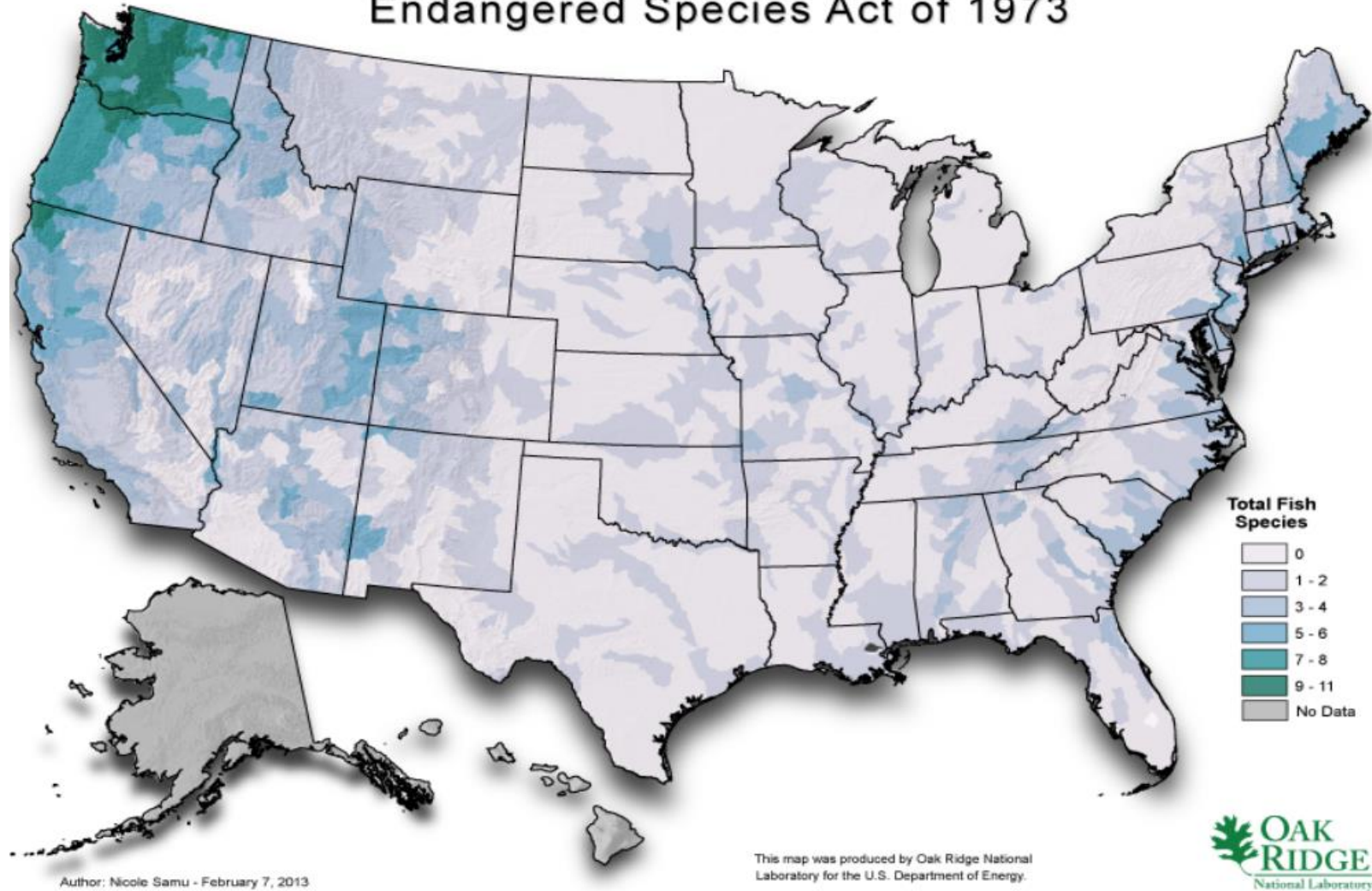
Distribution of conventional hydroelectric plants in the Lower 48 states



Source: U.S. Energy Information Administration, *Preliminary Monthly Electric Generator Inventory*
 Note: [Click to enlarge.](#)



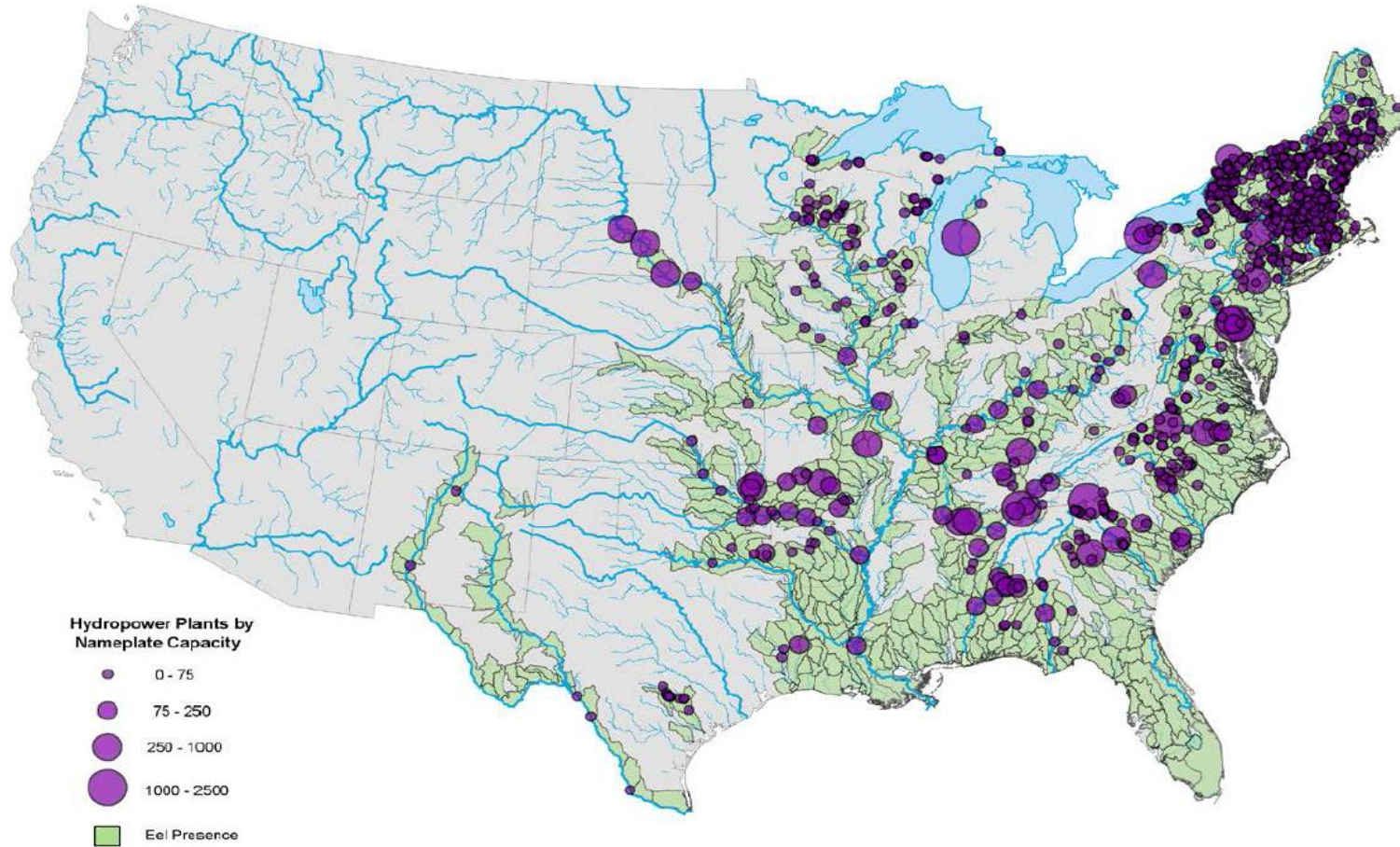
Fish Species Recognized under the Endangered Species Act of 1973



Author: Nicole Samu - February 7, 2013

This map was produced by Oak Ridge National Laboratory for the U.S. Department of Energy.

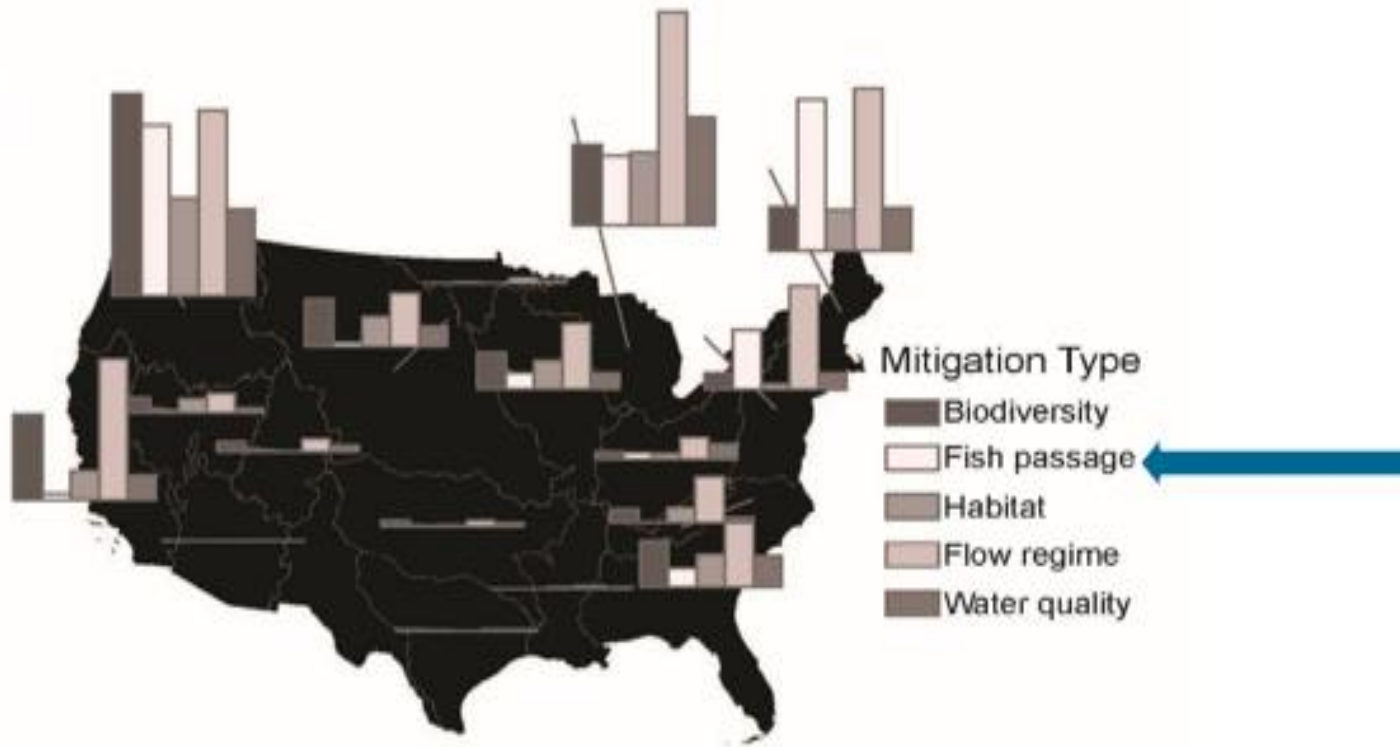




American eel and Hydropower

Fig. 3. ESA listing the American eel could impact 32,719 MW of nameplate capacity at 939 US hydropower plants. "Eel presence" identifies 8-digit USGS US river subbasins where eels are currently present or where they were historically present.

Jager et al. 2013



- Private dams are regulated by the Federal Energy Regulatory Commission
- Federal resource agencies can prescribe mitigation requirements become part of private hydropower licenses
 - Endangered Species Act
 - Section 7: Consultation to avoid adverse modification of critical habitat
 - Section 18: prescription of fishway maintenance and operations
 - National Environmental Policy Act, Federal Power Act, Clean Water Act, etc.
- Other stakeholders: states, tribes, special interest groups, local residents can provide input into the process

- Frequency and location of mitigation types ordered on private hydropower project licenses.
- Size of bar graphs are relative to the number of licenses ordering mitigations by region.

(Oak Ridge National Lab - Schramm et al. (2016))

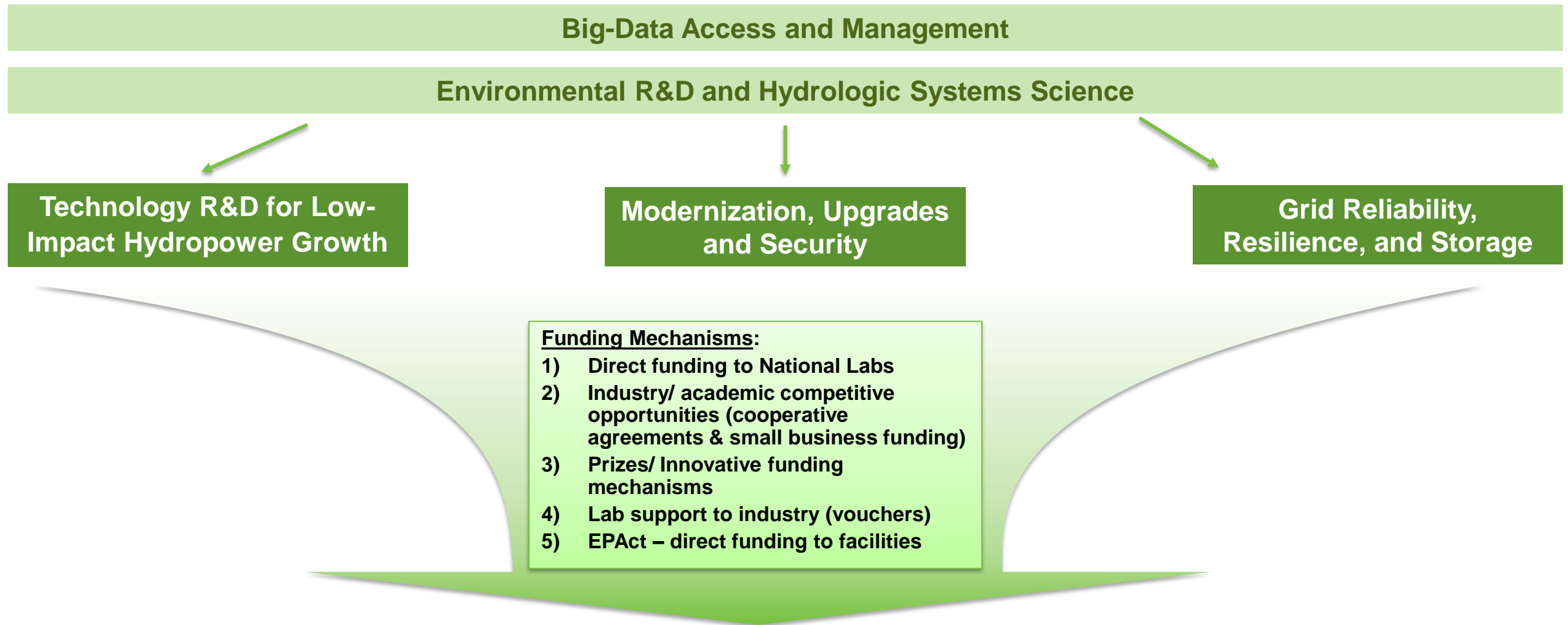
OUR GUIDING PRINCIPLES

DEPARTMENT OF ENERGY MISSION

To enhance U.S. security and economic growth through **transformative science**, **technology innovation**, and **market solutions** to meet the nation's energy and environmental challenges

ENERGY EFFICIENCY AND RENEWABLE ENERGY (EERE) STRATEGIC OBJECTIVES





More cost-effective hydro & more flexible, valuable hydro and pumped storage

Environmental R&D:

- Monitoring technologies to evaluate impacts
- *Technologies and strategies to avoid, minimize, or mitigate effects*
- Develop better metrics for sustainability evaluations
- Assess impacts of long-term hydrologic variations
- Improve ability to assess reservoir emissions
- Identify opportunities for basin scale assessments

Technology R&D for Low-Impact Hydropower Growth:

- *Standard Module Hydropower Technologies*

Modernization, Upgrades:

- Develop advanced sensor suites to empower data driven decisions

Grid Reliability, Resilience:

- Gather data to assess the true costs and constraints to flexible operations

Fish Passage:

- Existing hydropower
- Low impact new hydro

Challenges:

System-level:

- Populations, abiotic/water quality, habitat, connectivity, etc.

Facility-level:

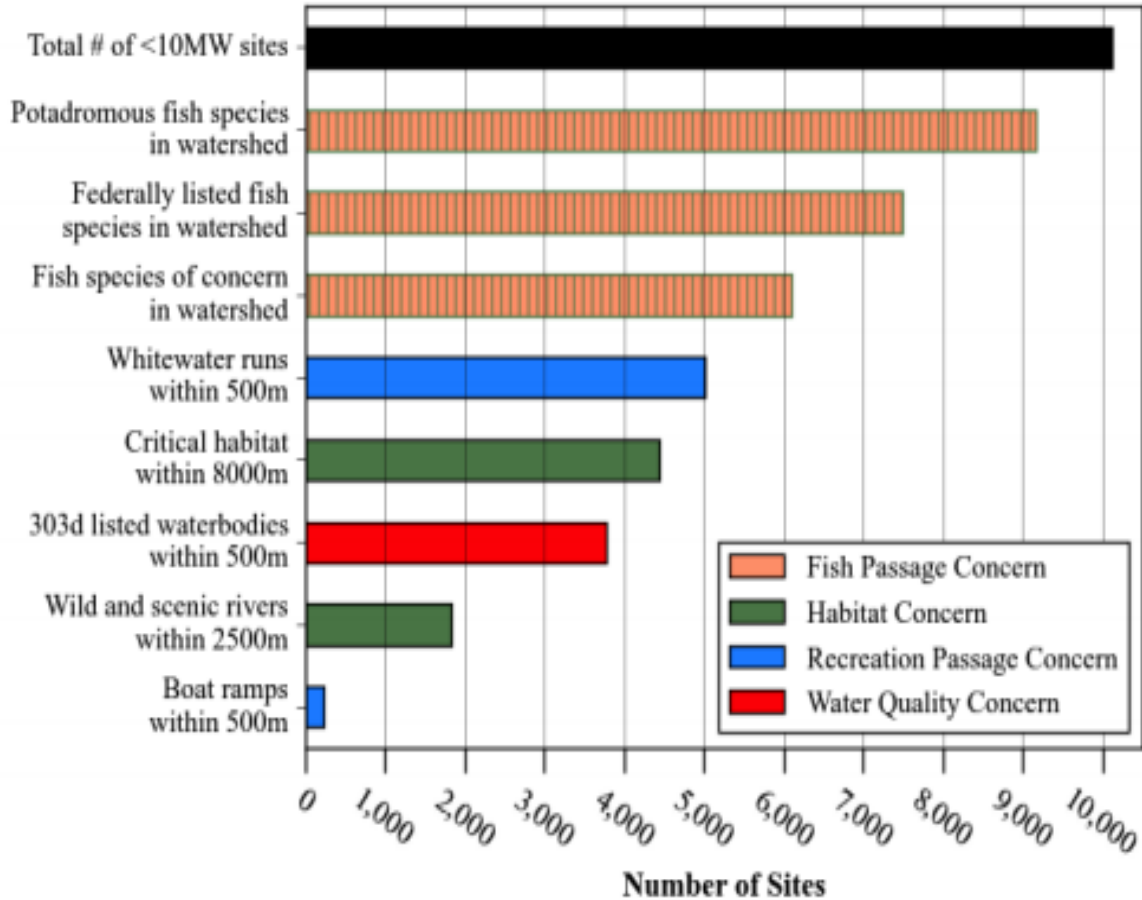
- Upstream
- Downstream passage
 - Turbine
 - Other routes/methods: fish exclusion, fishways, spillways, etc.

Research and Development Processes: Monitoring, modeling, technology development, risk/stakeholders, mitigation/management, etc.



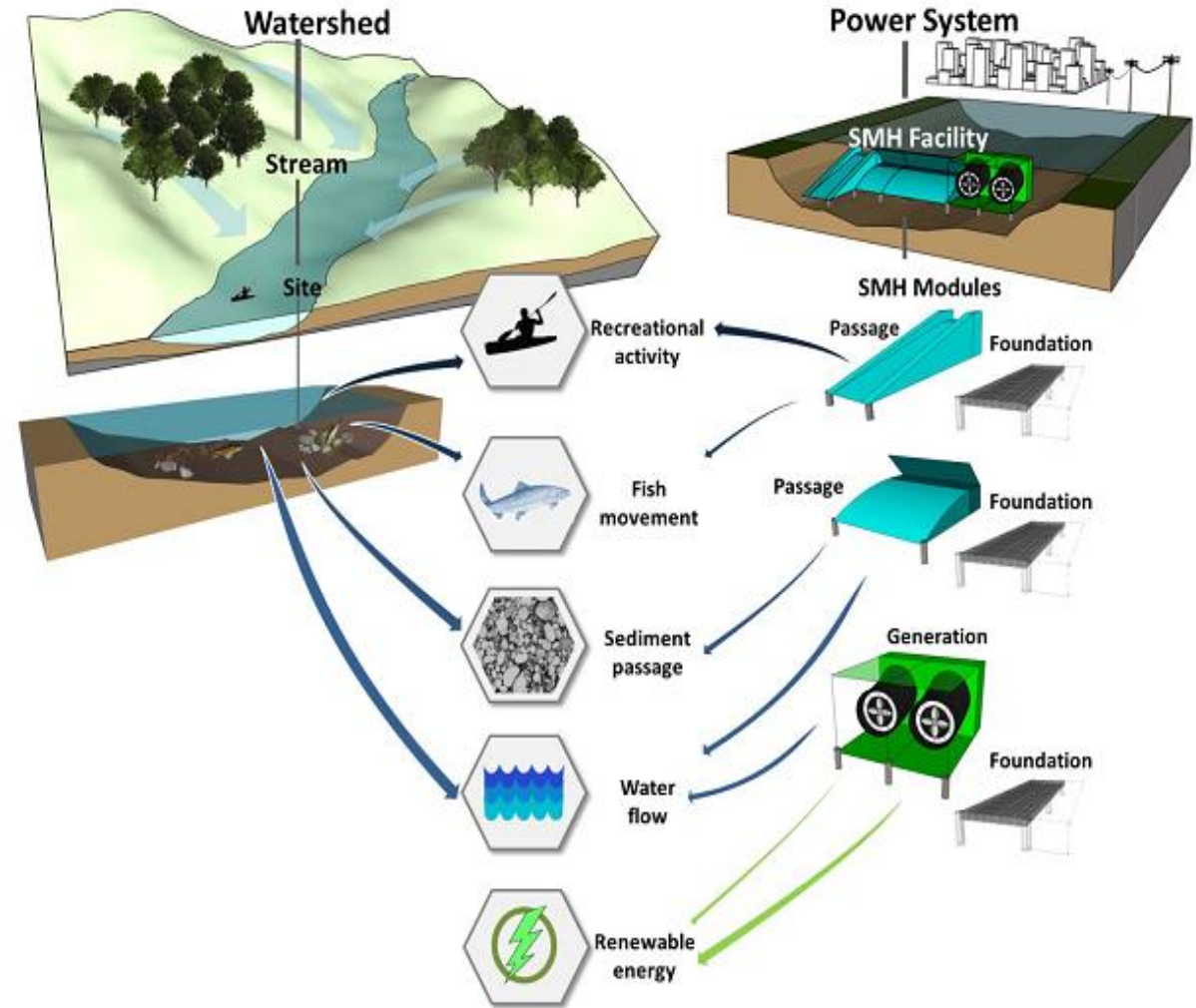
New Stream Reach Development

Environmental Attributes of NSD Sites with <10MW Potential



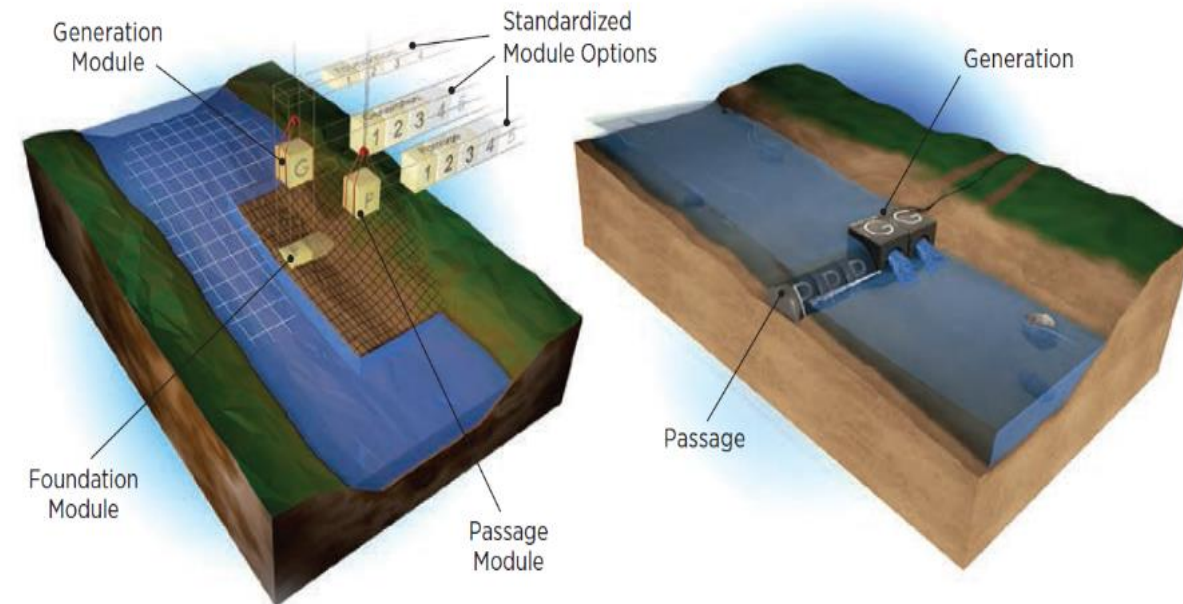
- Majority of sites in US with hydro resource potential have < 30 feet of hydraulic head

New Approaches to Designing and Developing New Hydro



2019 Competitive Funding for the Development of Standard Module Hydropower (SMH) Modules:

- Recently awards for module development for integration into an SMH facility
 - Two passage modules & one fish-friendly generation module
 - Other awards: on generation & sediment modules
- Utilize the Oak Ridge National Laboratory Design Envelop
- Reduce costs
 - Utilize advanced manufacturing



Develop a novel fish passage module for low head hydropower based on Archimedes screw principles

Percheron Power, LLC

Develop a fish passage module that can be used to accommodate multiple species simultaneously

Littoral Power Systems

Advance the design of a fish-friendly horizontal axial-flow low head generation module of a compact bulb

Natel Energy

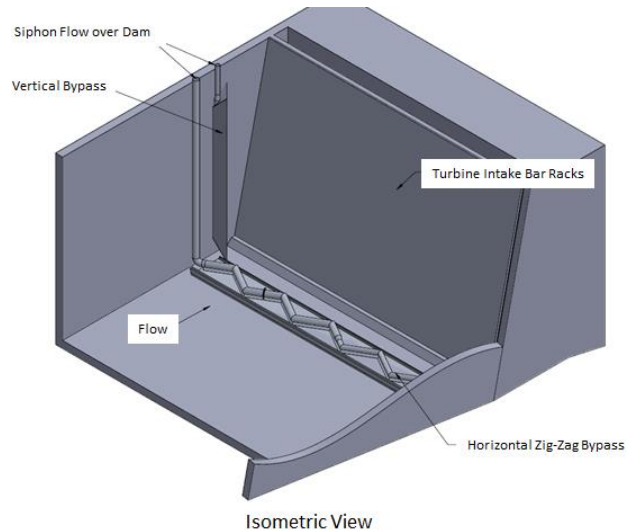
Fish Passage Modules

Generation Module

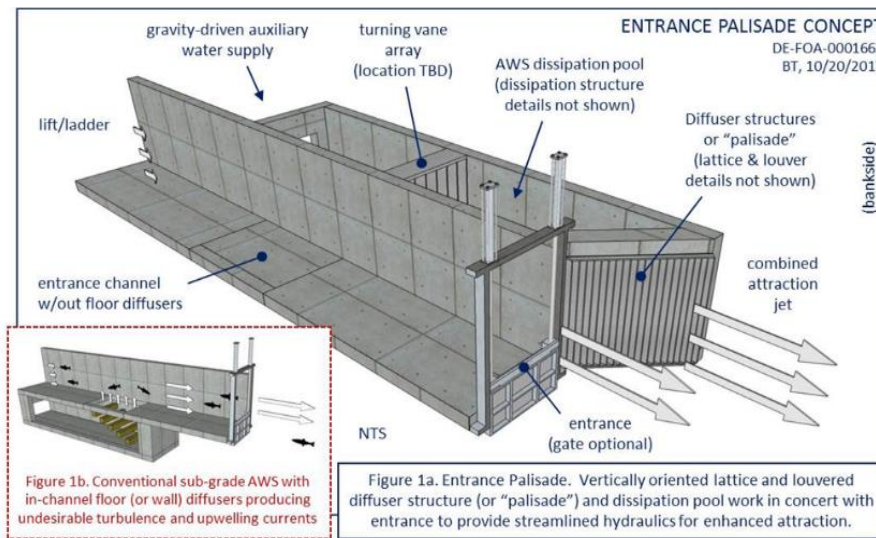
New Technology Development – Approach for New and Existing Hydro

2017 Competitive Funding for the Development of Innovative New Fish Passage Technologies:

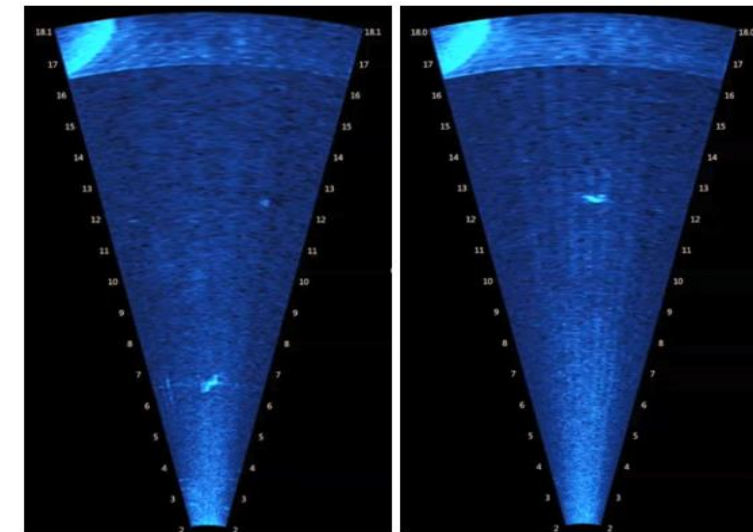
- Increase and verify performance of passage (safe, timely, effective) compared to best available tech
- Reduce costs:
 - Construction, operation, maintenance goals
 - Manufacturing - utilize standard, modular, scalable elements



Alden Research Lab



University of Massachusetts Amherst

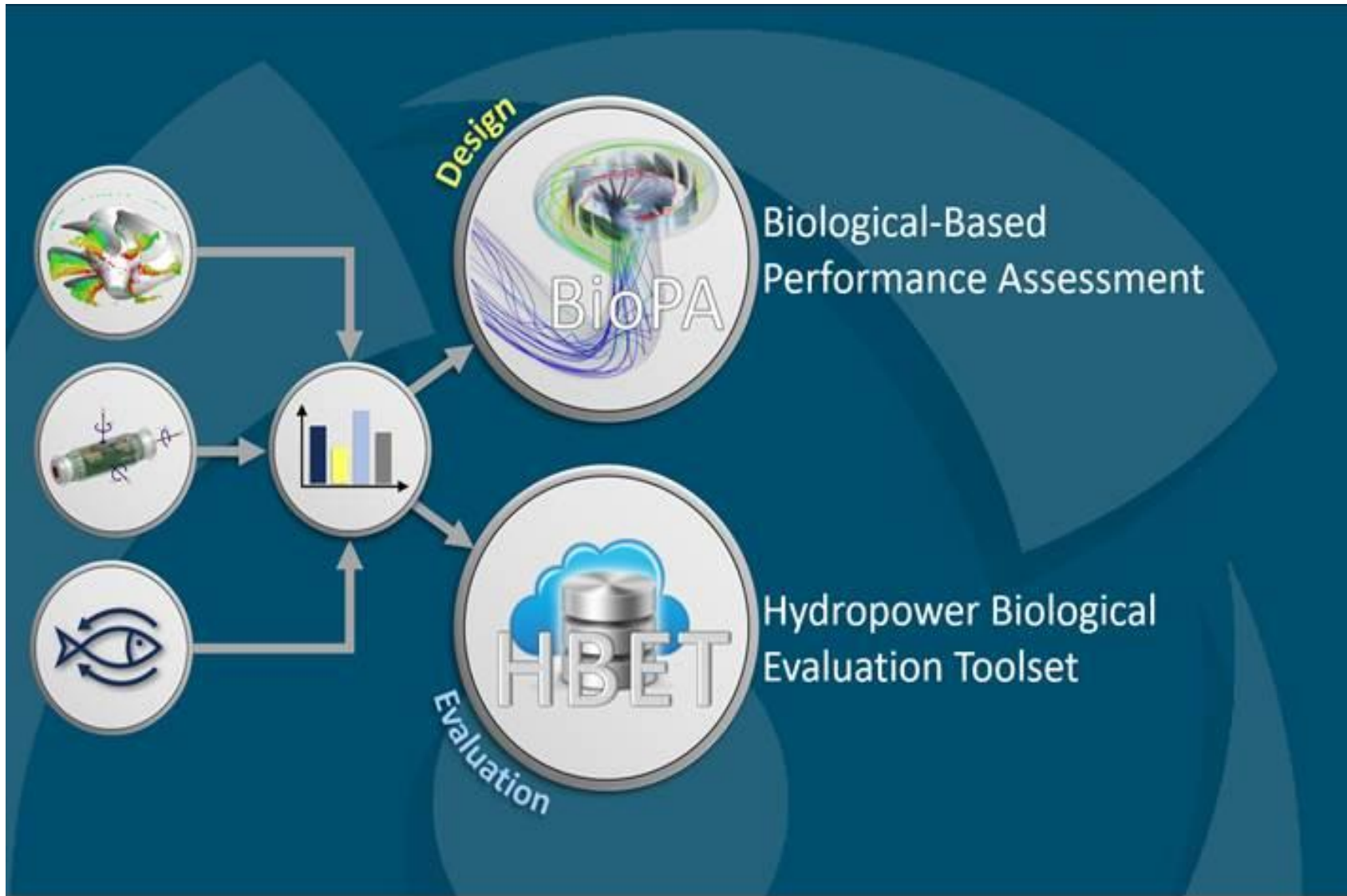


Electric Power Research Institute

Testing the Effects of Innovative Fish Passage Technologies

Advancing Innovative Methods and Technologies to Improve Fish Passage

Instruments, Data, and Tools (HydroPASSAGE Project) – *Approach for New and Existing Hydro*



- HydroPASSAGE is delivering tools to support turbine design and evaluation processes – to improve downstream fish passage
- Software packages work with either CFD models or hydraulic measurements from the Sensor Fish
 - BioPA Tool
 - HBET
- This information is related to biological response data on different fish species to produce an Passage Quality Index (probability of impacts)
- Blade strike, rapid decompression, shear and turbulence can all be analyzed
- Data on over 26 species of fish is available – including salmon, eel, and shad.

Innovative Funding (Fish Protection Prize) – Approach for New and Existing Hydro

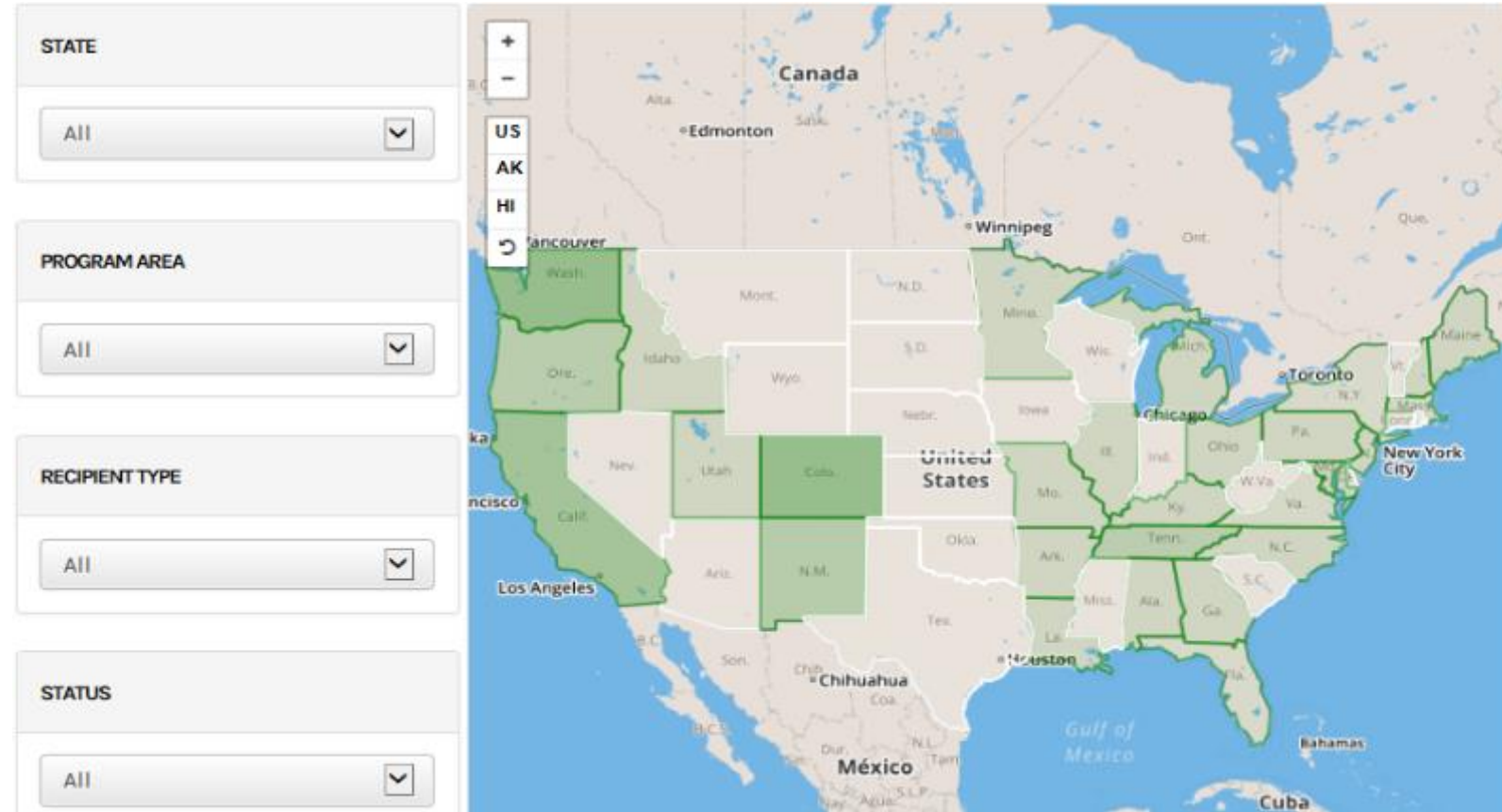
- Identify and advance innovative technologies for fish exclusion for water diversions and intakes
- New partnership with the US Department of Reclamation and WPTO, with support from Pacific Northwest National Lab and the National Renewable Energy Lab.
- Funding to advance radically new ideas and ready to commercialize improvements to existing technologies
- Phased competition is crowd sourcing innovation and drawing ideas from other industries and the general public



<https://www.herox.com/FishProtection>



- Interactive map
- Provides information on WPTO's R&D portfolio
- Features multiple filters to isolate specific details
- Contains historical information on completed projects with associated materials, research findings, and publication links



<https://energy.gov/eere/water/water-power-technologies-office-projects-map>

Questions?

<https://www.energy.gov/eere/water/water-power-technologies-office>



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