

# Science & Technology Needs for Hydropower

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## New Resource Assessments are becoming available

***Existing Hydropower assets are a mix of federal and non-federal projects.***

	<i>Number of Projects</i>	<i>Number of Units</i>	<i>Total Capacity (GW)</i>	<i>Average Project Size (MW)</i>	<i>Average Units per Project</i>	<i>Average Unit Size (MW)</i>
Corps of Engineers	74	350	20.4	276	4.7	58
Bureau of Reclamation	58	194	14.8	255	3.3	76
TVA	29	109	3.9	134	3.8	36
<b><i>Total Federal</i></b>	<b><i>161</i></b>	<b><i>653</i></b>	<b><i>39.1</i></b>	<b><i>243</i></b>	<b><i>4.1</i></b>	<b><i>60</i></b>
FERC Licenses *	1012	n/a	53.5	53	n/a	n/a
FERC Exemptions	595	n/a	0.8	1.4	n/a	n/a
<b><i>Total Nonfederal *</i></b>	<b><i>1607</i></b>		<b><i>54.3</i></b>	<b><i>34</i></b>		

## Technically feasible resources are larger than previously considered

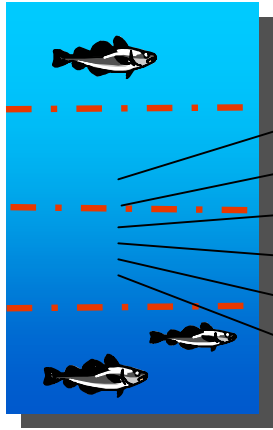
- New estimates have not been screened yet for costs or environmental issues
- New technologies can overcome (some of) those challenges

Potential Areas for Increased Capacity	Potential Capacity Available
Efficiency/Capacity Upgrades (non-federal facilities)	4.4 -12.4 GW
Efficiency/Capacity Upgrades (federal facilities)	3.6 GW
Powering Non-Powered Dams (federal and non-federal facilities)	63 GW
New Small Hydro Development	255 GW
<b>Total</b>	<b>326 – 334 GW</b>
Pumped Storage	34 GW

# Hydropower Science and Technology Themes

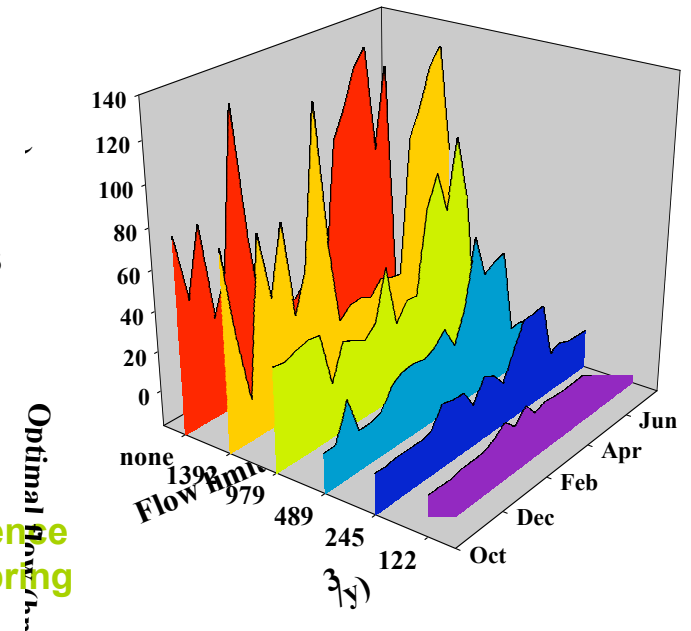
- **Unresolved Environmental Science**
  - Fish response to hydropower systems
  - Ecosystem response to flow releases
- **Hydropower in Electric Power Systems and Markets**
  - Capability and value of hydropower for grid services
- **Holistic Decision Support Systems for Hydropower**
  - Multiple objectives and horizons for scheduling and planning
  - Joint variability of hydro and intermittent renewables
- **Hydropower Machine Technology**
  - Pumped storage construction costs, variable speed technology
  - “Smaller” hydro technologies

# Ecological Optimization: Chinook Salmon Model



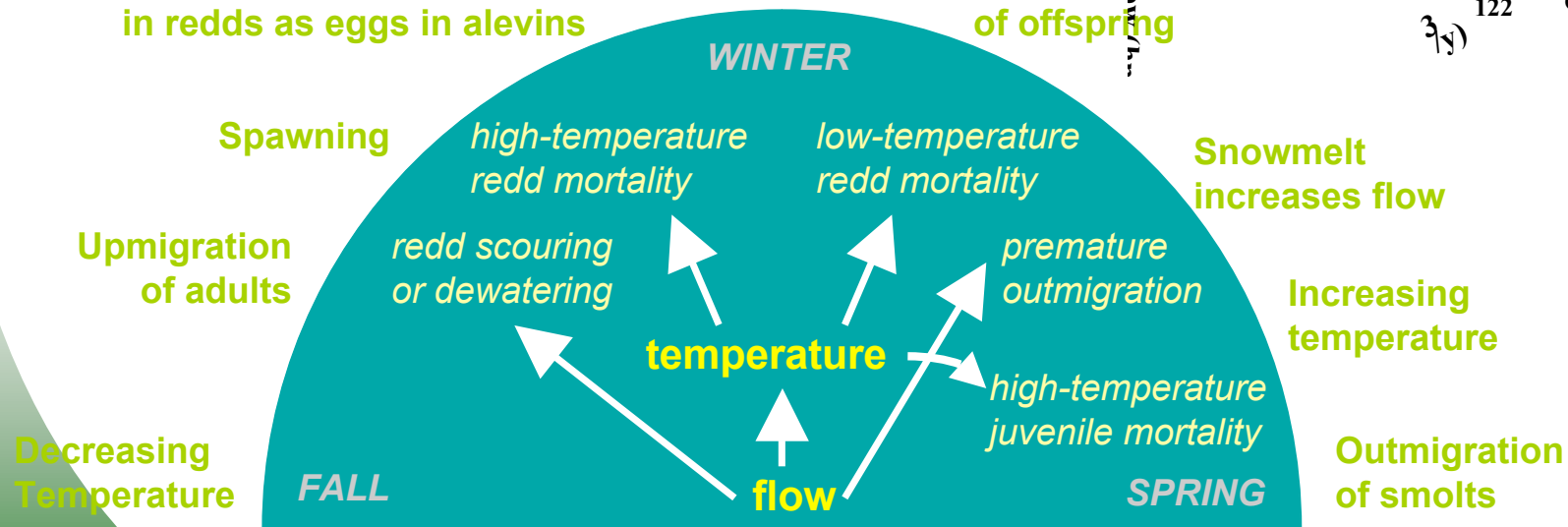
Water volume attributes:

- % pool vs. riffle
- number of predators
- number of overlapping spawners
- number of larger Chinook competitors
- weighted usable area
- temperature and flow

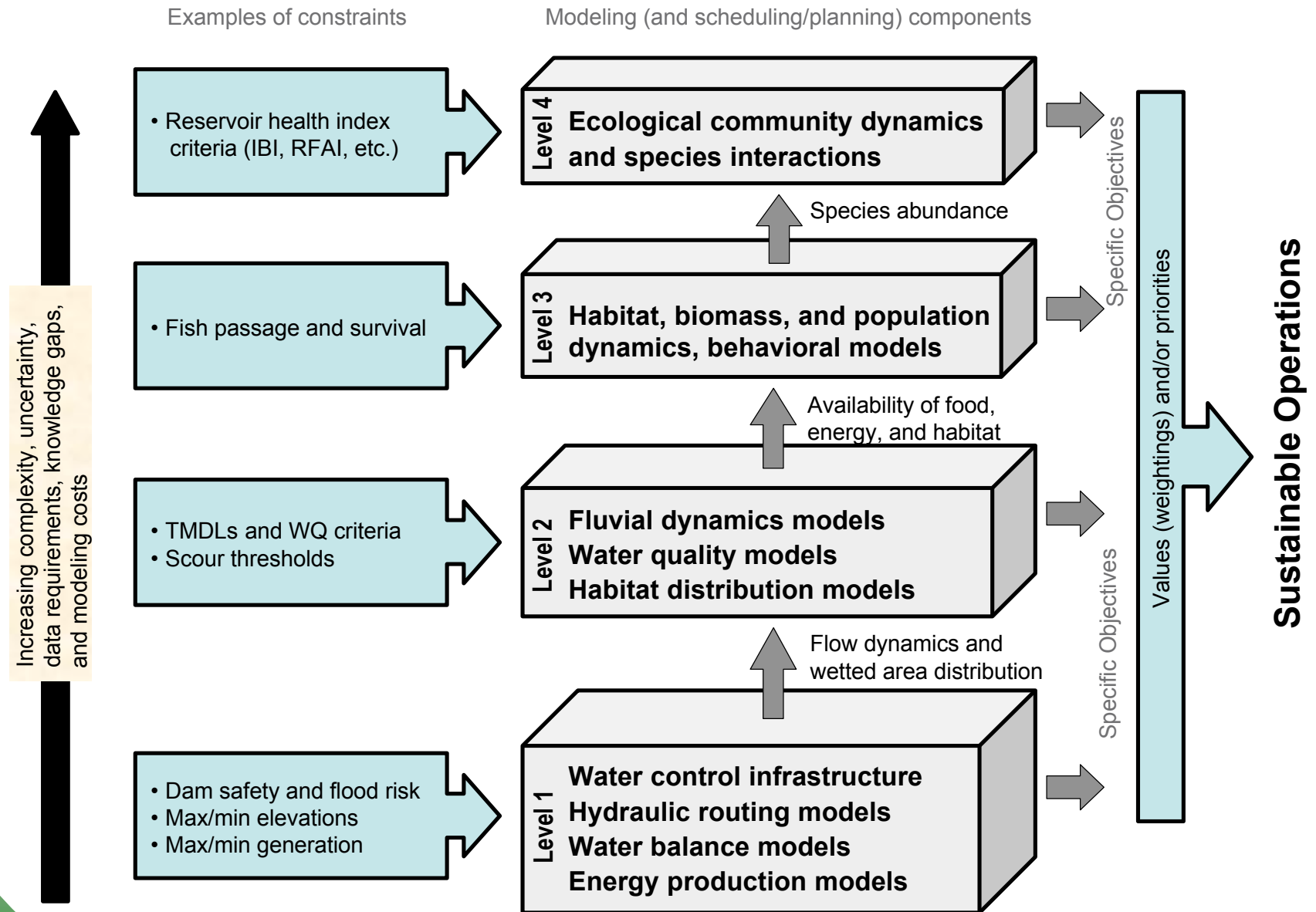


Rearing of offspring,  
in redds as eggs in alevins

Emergence  
of offspring

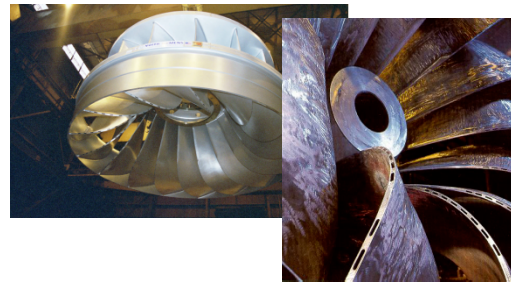
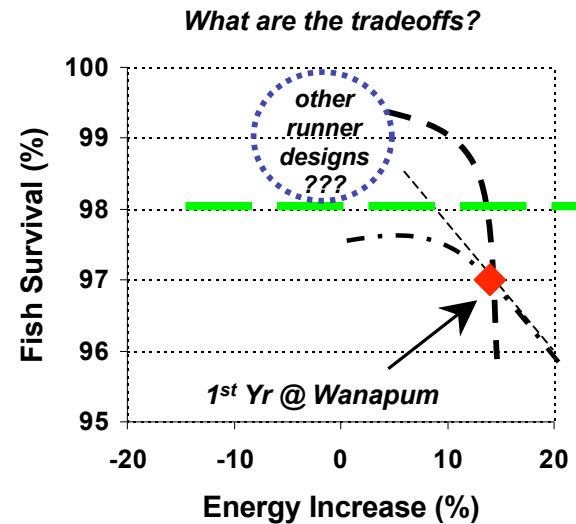


# Advanced Scheduling for Environmental Targets



# New technologies have been developed to improve performance

- Fish-friendly turbines
- Aerating turbines
- Reregulating weirs
- Siphon designs
- Automated controls



# Energy-Water-Use Optimization

