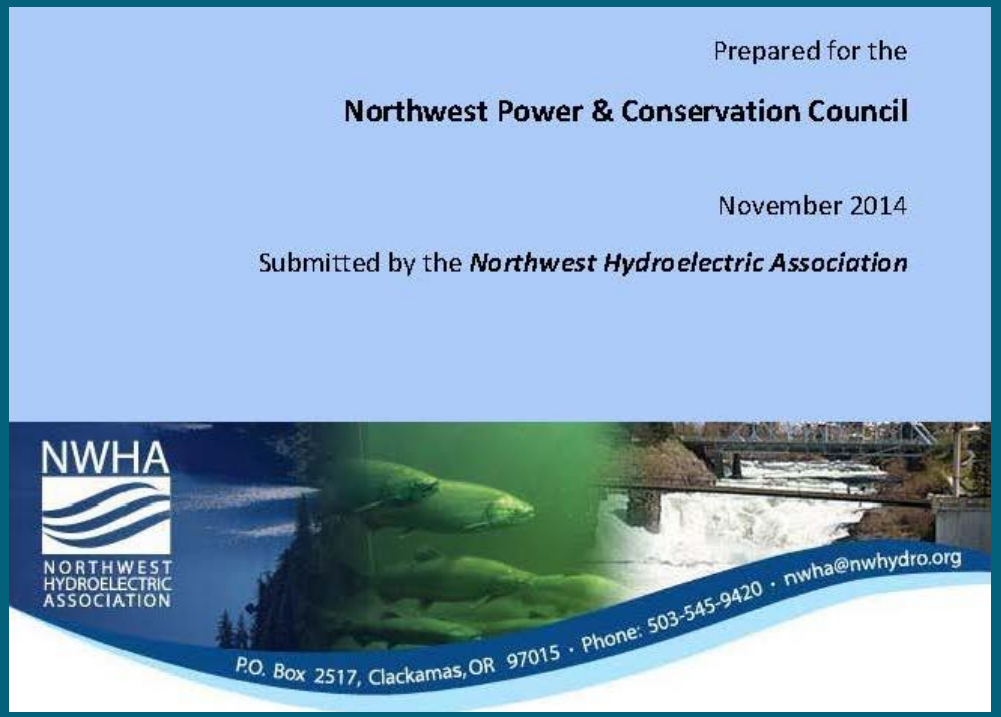
Regional Hydropower Potential Scoping Study



Hydropower Potential - Studies Reviewed for Scoping Study

- Twenty-four studies reviewed
- Grouped by categories
- Organized by chapters in report

Studies

	PROJECTS AT EXISTING UNPOWERED DAMS
A-1	Hydropower Resource Assessment at Non-Powered USACE Sites
A-2	An Assessment of Energy Potential at Non-Powered Dams in the United States
A-3	Hydropower Resource Assessment at Existing Reclamation Facilities
	CONDUIT AND KINETIC PROJECTS
B-1	Technical & Economic Feasibility Assessment of Small Hydropower Development in Deschutes River Basin
B-2	Integrated Basin-Scale Opportunity Assessment Initiative, FY 2011: Deschutes Basin
B-3	Feasibility Study on Five Potential Hydroelectric Power Generation Locations, North Unit Irrigation District
B-4	Power Extraction from Irrigation Laterals and Canals in the Columbia Basin Project
B-5	Site Inventory and Hydropower Energy Assessment of Reclamation Owned Conduits
B-6	Bureau of Reclamation Renewable Energy Update
B-7	Scoping Study of Hydropower Potential in Wallowa County, Oregon
	PUMPED STORAGE/ENERGY STORAGE PROJECTS
C-1	Assessment of Opportunities for New US Pumped Storage Hydroelectric Plants Using Existing Water Features
C-2	Appraisal Evaluation of Columbia River Mainstem Off-Channel Storage Options
C-3	Hydroelectric Pumped Storage for Enabling Variable Energy Resources within the FCRPS
C-4	Technical Analysis of Pumped Storage and Integration with Wind Power in the Pacific Northwest
	TIDAL AND WAVE ENERGY PROJECTS
D-1	Assessment of Energy Production Potential for Tidal Streams in the US
D-2	Mapping and Assessment of the US Ocean Wave Energy Resources
D-3	Assessment/Mapping of Riverine Hydroknetic Resource in the Contintental US
	GENERAL GENERATION PROJECT ASSESSMENTS:
E-1	New Stream-reach Development: Comprehensive Assessment of Hydropower Energy Potential in the US
E-2	Assessment of Natural Stream Sites for Hydroelectric Dams in the PNW Region
E-3	Irrigation Water Providers of Oregon: Hydropower Potential and Energy Savings Evaluation
E-4	Small Hydropower Technology and Market Assessment
E-5	Assessment of Waterpower Potential and Development Needs
E-6	Feasibility Assessment of the Water Energy Resources for the US for New Low Power & Small Hydro Classes
E-7	Estimation of Economic Parameters of US Hydropower Resources
	MODELS/DATABASES/TOOLS
F-1	Northwest Hydrosite Database
F-2	National Inventory of Dams
F-3	Hydropower Energy and Economic Analysis Tool
F-4	Virtual Prospector Tool
F-5	Tidal Stream Interactive Map
F-6	National Hydropower Asset Assessment Program (database)
	LEGISLATION AND RULEMAKING
G-1	Bureau of Reclamation Small Conduit Hydropower Development and Rural Jobs Act
G-2	Hydropower Regulatory Efficiency Act of 2013
G-3	EPA Rulemaking - Existing Power Plant Emissions

Report Chapters

- Chapter 1: Non-powered dams
- Chapter 2: Conduit/kinetic
- Chapter 3: Pumped storage/energy storage
- Chapter 4: Tidal and wave energy
- Chapter 5: General hydropower assessments
- Chapter 6: Tools – models and databases

Study Parameters

- Objective of study
- Model used to develop study
- Approach – how review conducted; area and number of sites
- Cost
- Capacity and energy value
- Site specific restrictions or environmental attributes
  - Protected lands (national/state parks, etc.)
  - Fish and wildlife species
  - Wild and Scenic Rivers
  - Water quality and quantity
  - Greenhouse gas compensation
  - Green incentives
  - Transmission access
- Potential in the Pacific Northwest

Chapter 1 – Non-powered dams

- Study A-1 “Hydropower Resource Assessment at Non-Powered USACE Sites
  - U.S. Army Corps of Engineers, July 2013
- Study A-2 “An Assessment of Energy Potential at Non-powered Dams in the United States
  - U.S. Department of Energy, Wind and Water Power Program, April 2012
- Study A-3 “Hydropower Resource Assessment at Existing Reclamation Facilities
  - U.S. Bureau of Reclamation, March 20011

Studies A-1 thru A-3 Potential Hydropower Capacity

Study	MWs	MWhs
A-1, USACE	116	168,778
A-2, USDOE	225	871,000
A-3, USBR	27	106,448

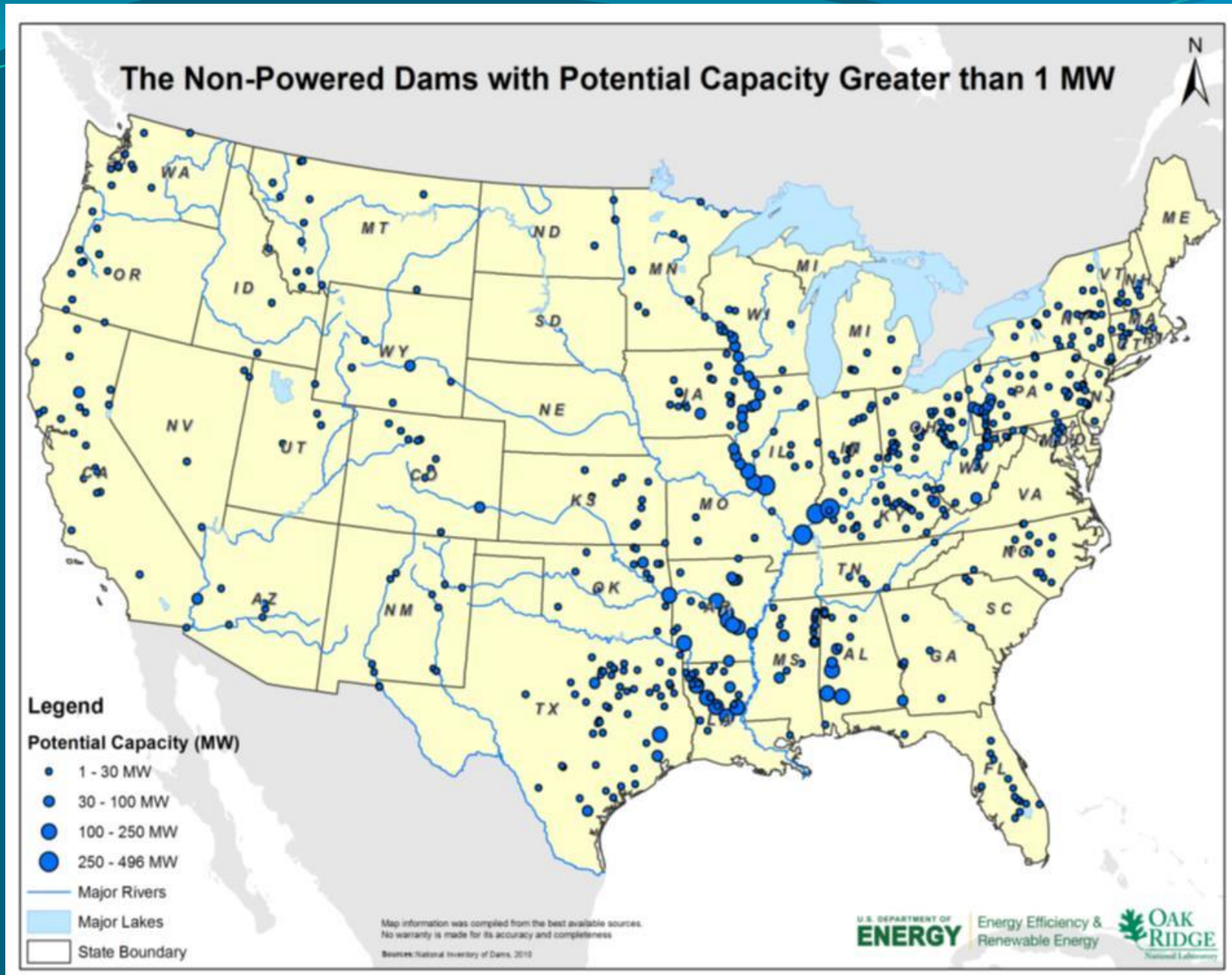
Note: Capacity at non-powered dams in Pacific Northwest. Values rounded.

Specific Sites in A-1 thru A-3

Study	Project Name	State	Capacity (MWs)	Generation (MWhs)
A-1	Blue River	OR	20.63	32,565.26
A-1	Cottage Grove	OR	8.41	12,048.79
A-1	Fern Ridge	OR	10.08	11,832.67
A-1	Hiram M. Chittenden Locks & Dam	WA	11.43	16,755.29
A-1	Howard A. Hanson Dam*	WA	65.58	95,576.38
A-2	Howard A. Hanson Dam (not included in total)*	WA	[26.3]	[101.62]
A-3	Arthur R. Bowman Dam	OR	3.293	18,282.00
A-3	Easton Diversion Dam	OR	1.057	7,400.00
A-3	Sunnyside Dam	WA	1.362	10,182.00
A-3	Scootney Wasteway	WA	2.276	11,238.00
A-3	Emigrant Dam	OR	.733	2,619.00
A-3	Wickiup Dam	OR	3.950	15,650.00
A-3	Cle Elum Dam	WA	7.249	14,911.00
A-3	Ririe Dam	ID	.993	3,778.00
A-3	Scoggins Dam	OR	.955	3,683.00
A-3	McKay Dam	OR	1.362	4,344.00
A-3	Keechelus Dam	WA	2.394	6,746.00
A-3	Haystack Dam	OR	.805	3,738.00
A-3	Kachess Dam	WA	1.227	3,877.00
A-3	TOTAL		143.786	275,226.39

Top USACE Sites in Oregon

Top USACE Sites in Washington


The Non-Powered Dams with Potential Capacity Greater than 1 MW
N
WA
OR
CA
ID
NV
MT
WY
UT
AZ
CO
NM
ND
SD
NE
KS
OK
TX
MN
IA
MO
AR
LA
WI
IL
MS
MI
IN
KY
TN
AL
OH
WV
GA
FL
SC
NC
VA
PA
NY
ME
VT
NH
MA
CT
RI
MD
DE
Legend
Potential Capacity (MW)
1 - 30 MW
30 - 100 MW
100 - 250 MW
250 - 496 MW
Major Rivers
Major Lakes
State Boundary
Map information was compiled from the best available sources.
No warranty is made for its accuracy and completeness
Sources: National Inventory of Dams, 2010
U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy
OAK RIDGE National Laboratory

Chapter 2 – Conduit / Kinetic

- B-1 Technical & Economic Feasibility of Small Hydropower Development in the Deschutes River Basin"
  - June 2013, Department of Energy
- B-2 The Integration Basin-Scale Opportunity Assessment Initiative, FY 2011 Year-End Report
  - Sept. 2011, Pacific Northwest National Laboratory
- B-3 Feasibility Study on Five Potential Hydroelectric Power Generation Locations in the North Unit Irrigation District
  - August 2009, Energy Trust of Oregon

Chapter 2 – Conduit / Kinetic

- B-4 Power Extraction from Irrigation Laterals and Canals in the Columbia Basin Project
  - University of Washington, 2009
- B-5 Site Inventory and Hydropower Energy Assessment of Reclamation Owned Conduits
  - USBR, March 2012
- B-6 Bureau of Reclamation Renewable Energy Update, FY 2014 Q3
  - USBR, July 2014
- B-7 Scoping Study of Hydropower Potential in Wallowa County, OR
  - Energy Trust of Oregon, Nov 2010

Conduit Projects

Photos of Swalley Irrigation District
Bend, OR

Kinetic Projects

Photos of Kinetic Projects, courtesy of Instream Energy and Hydrovolts

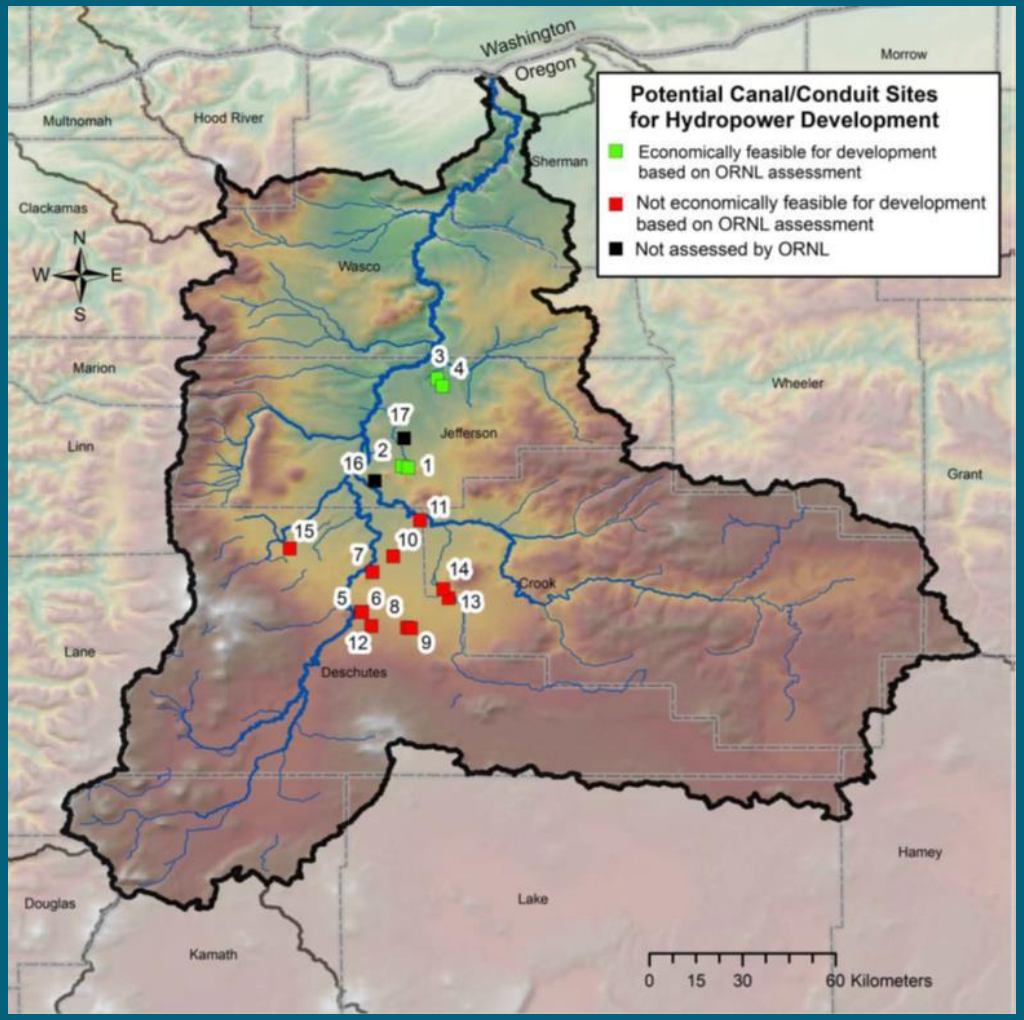
Specific Sites in B-1 thru B-7

Study	Project Name	Capacity (MWs)	Generation (MWhs)
B-1	Wickiup Dam	7.118	29,010
B-1	Bowman Dam	5.959	19,587
B-1	North Canal Dam	1.135	5,145
B-1	Ochoco Dam	.366	2,992
B-1	Mile 45 conduit site	2.700	12,565
B-1	Haystack canal site	1.730	8,078
B-1	Lateral 58-11 canal site	.137	560
B-1	Lateral 58-9 canal site	.750	305
B-3	Brinson Boulevard canal site	.969	4,214
B-3	Smith Rock Drop canal site	.610	1,958
B-5	Pacific NW Regional canal sites	34.000	116,597
B-6	18 Reclamation Facilities	50.750	91,243
B-7	22 conduit sites	1.02	3,391
	TOTAL	**92.616**	**295,645**

B-1 Feasible Projects Oak Ridge Lab

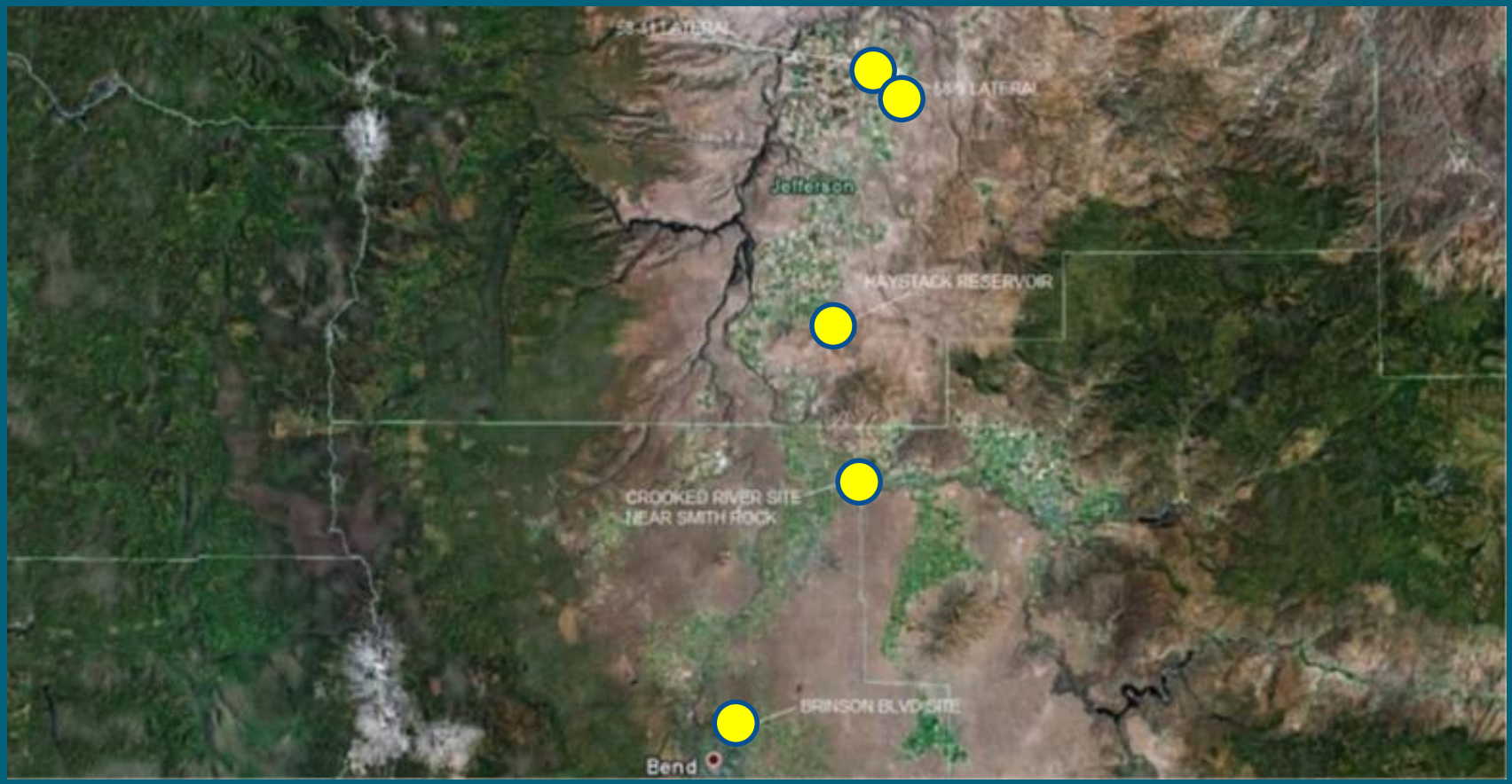
Project Name	Project No. on Map	Capacity (MWs)	Generation (MWhs)
Wickiup Dam		7.118	29,010
Bowman Dam		5.959	19,587
North Canal Dam		1.135	5,145
Ochoco Dam		.366	2,992
Mile 45 conduit site	1	2.700	12,556
Haystack canal site	2	1.730	8,078
Lateral 58-11 site	3	.137	560
Lateral 58-9 site	4	.075	305
TOTAL		**19.895**	**78,242**

B-1 Canal and Conduit Sites, Central OR



Map of Potential Canal and Conduit Sites in the Deschutes and Crooked River Basins, Central Oregon

B-3 North Unit Irrigation Dist. Sites



B-5 Hydropower Resource Assessments at Existing Reclamation Facilities

STATE	CANAL SITES	POTENTIAL INSTALLED CAPACITY MW	POTENTIAL ANNUAL ENERGY MWH
ID	9	2.77	11,451.81
MT	32	9.88	26,316.56
OR	68	20.40	75,943.04
WA	2	1.05	2,885.36
TOTAL	111	34.00	116,596.77

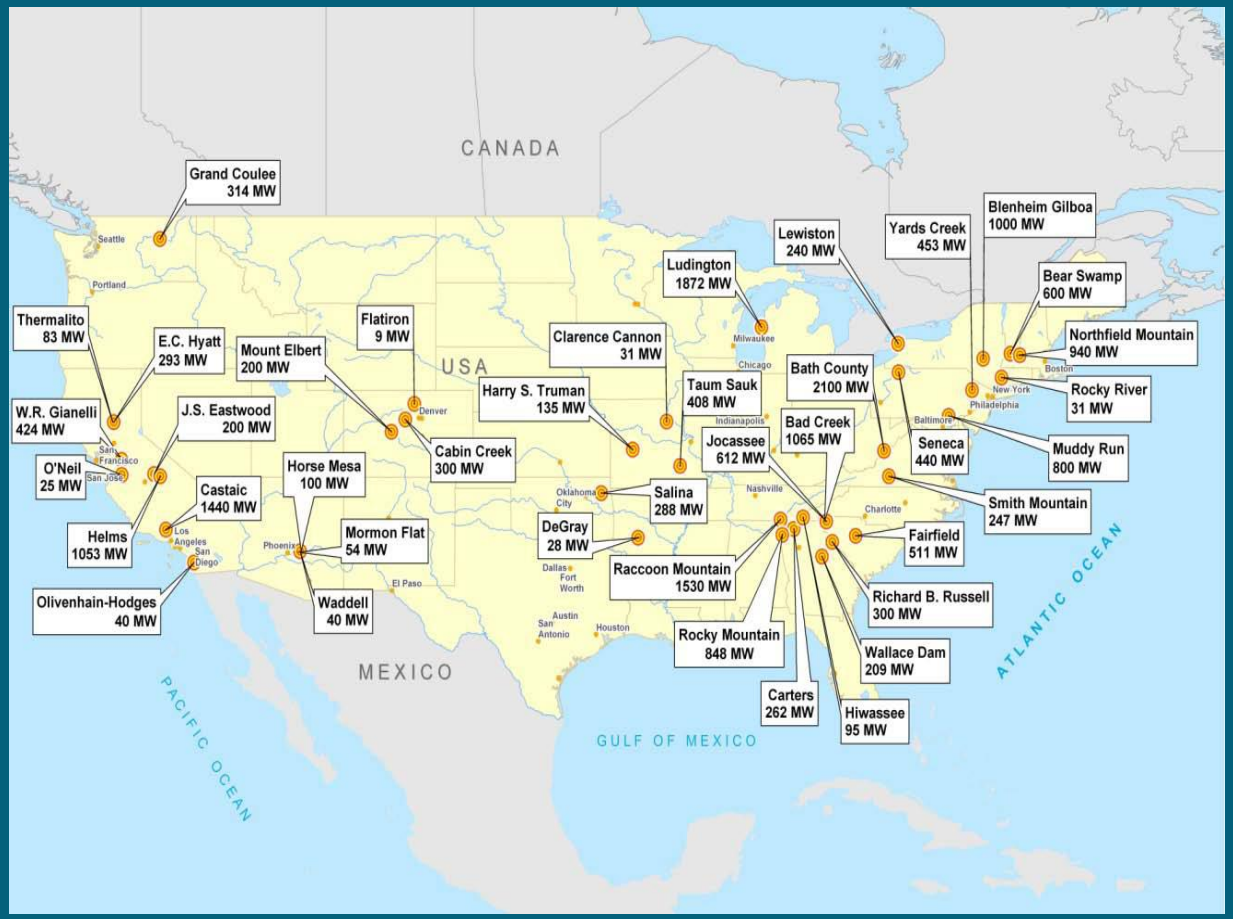
B-6FERC & LOPP
Non-Federal Hydroelectric Projects

State	Type	Facility Type	Status	Type	Project Name	FERC	Operating Entity	Capacity (kW)	Pump Generation Capacity (kW)	Estimated Annual Generation (kWh)	Project Initiation	Preliminary Permit/ Lease Date
WA	FERC	Conduit	Preliminary	Conventional	16.4 Wasteway	14349	Grand Coulee Project H. Authority	1,750			7/29/2011	3/26/2013
OR	FERC	Conduit	Exemption	Conventional	45-Mile	13817	Earth by Design (Exemption: 12/17/2010)	5,000			7/16/2010	
WA	FERC	Conduit	Preliminary	Conventional	46A Wasteway	14351	Grand Coulee Project H. Authority	1,600			7/29/2011	3/26/2013
WA	FERC	Dam	Preliminary	Pump Storage	Banks Lake Pumped Storage Project	14329	Grand Coulee Project H. Authority		1,000,000	2,263,000,000	11/30/2011	8/22/2013
OR	FERC	Dam	Preliminary	Pump Storage	Bryant Mountain Pumped Storage	13680	Bryant Mountain LLC	-	1,250,000	2,409,000,000	3/1/2010	9/24/2010
MT	FERC	Conduit	Exemption	Conventional	Mary Taylor Drop	14294	Turnbull Hydro, LLC (Exemption: 6/28/2012)	890		1,840,000	9/23/2011	
WA	FERC	Dam	Preliminary	Conventional	McKay Dam	14546	Houtama Hydropower, LLC	2,300			8/13/2013	2/6/2014
OR	FERC	Conduit	Preliminary	Conventional	Monroe Drop	14430	Natel	300		1,733,511	7/2/2012	3/28/2013
WA	FERC	Conduit	Preliminary	Conventional	PEC 1973 Drop	14316	Grand Coulee Project H. Authority	2,200			11/8/2011	3/26/2013
WA	FERC	Dam	Preliminary	Conventional	Pinto Dam	14380	Grand Coulee Project H. Authority	3,400			4/4/2012	10/10/2012
WA	FERC	Conduit	Preliminary	Conventional	Rocky Coulee Wasteway	14372	Grand Coulee Project H. Authority	12,000			3/13/2012	7/11/2012
WA	FERC	Conduit	Preliminary	Conventional	Scooteney Outlet Drop	14317	Grand Coulee Project H. Authority	1,300			5/31/2011	3/26/2013
WA	FERC	Conduit	Preliminary	Conventional	Scooteney Wasteway	14352	Grand Coulee Project H. Authority	1,110			7/28/2011	3/26/2013
WA	FERC	Conduit	Preliminary	Conventional	Scootney Inlet Drop	14318	Grand Coulee Project H. Authority	1,700			5/31/2011	3/26/2013
OR	FERC	Dam	Preliminary	Conventional	Unity Dams/Warm Springs Hydro	14576	Warm Springs Hydro, LLC	800		3,400,000	1/13/2014	6/16/2014
MT	LOPP	Conduit	Request	Conventional	A Drop	n/a	Turnbull Hydro, LLC	1,000		2,500,000	6/1/2014	
MT	LOPP	Dam	Request	Conventional	Helena Valley Pumping Plant	n/a	Helena Valley Irrigation District	4,800		9,608,000	9/13/2013	
MT	LOPP	Conduit	Request	Conventional	Johnson Drop	n/a	Turnbull Hydro, LLC	700		1,700,000	6/1/2014	
MT	LOPP	Conduit	Request	Conventional	Woods Drop	n/a	Turnbull Hydro, LLC	900		2,200,000	6/1/2014	
MT	LOPP	Dam	Request	Conventional	Yellowtail Afterbay	n/a	Crow Tribe	9,000		68,261,000	1/11/2012	

Chapter 3 -Hydroelectric Pumped Storage

1095-MW Rocky Mountain Pumped Storage Project

Pumped Storage is Proven and Prolific

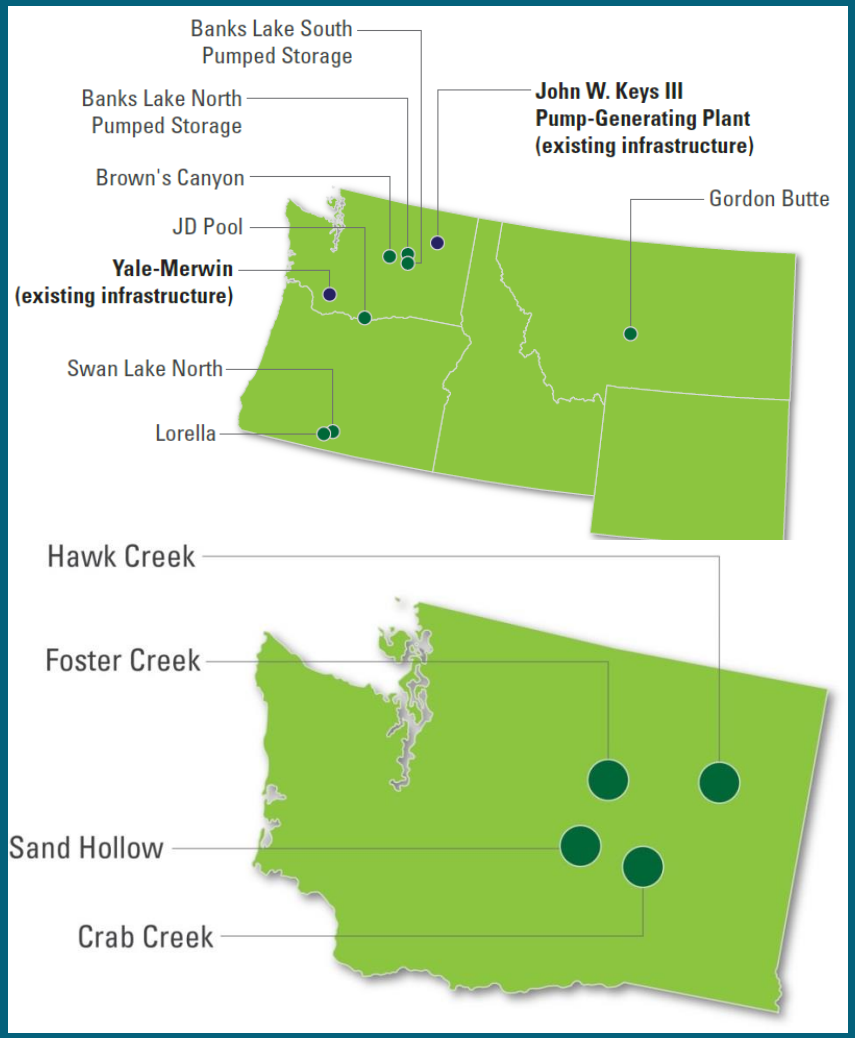


Today, there are 40 pumped storage projects operating in the U.S. that provide more than 20 GW, or nearly 2 percent, of the capacity for our nation's energy supply system (Energy Information Admin, 2007).

Pumped Storage Studies Reviewed

- **C-1: "Assessment of Opportunities for New US Pumped Storage Hydroelectric Plants Using Existing Water Features as Auxiliary Reservoirs"**
  - Department of Energy, Idaho National Lab, March 2014
- **C-2: "Technical Analysis of Pumped Storage and Integration with Wind Power in the Pacific Northwest"**
  - MWH for US Army Corps of Engineers, August 2009
- **C-3: "Appraisal Evaluation of Columbia River Mainstem Off-Channel Storage Options**
  - CH2MHill for US Bureau of Reclamation, May 2007
- **C-4: "Hydroelectric Pumped Storage for Enabling Variable Energy Resources within Federal Columbia Power System**
  - *HDR for Bonneville Power Administration, September 2010*

Summary of Capacity Identified in Studies C-1 through C-4



Study	Project Name	State	Capacity (MW)
C-1	See Report, Large Number of Studies Nationwide	N/A	-----
C-2	John Day Pool	WA	1300
C-2	Swan Lake	OR	600
C-3	Crab Creek (varies by size)	WA	69-392
C-3	Sand Hollow Creek	WA	285
C-3	Hawk Creek (varies by size)	WA	237-1136
C-3	Foster Creek	WA	300-1100
C-4	John Day Pool (duplicate, also cited in C-2)	WA	-----
C-4	Swan Lake North	OR	600
C-4	Brown's Canyon	WA	1000
C-4	Banks Lake Pumped Storage – North Banks Lake	WA	1000
C-4	Banks Lake Pumped Storage – South Banks Lake	WA	1040
C-4	Lorella (Klamath County)	OR	1000
C-4	Gordon Butte	MT	400
C-4	Yale-Merwin	WA	255

Pumped Storage Projects with FERC Preliminary Permits

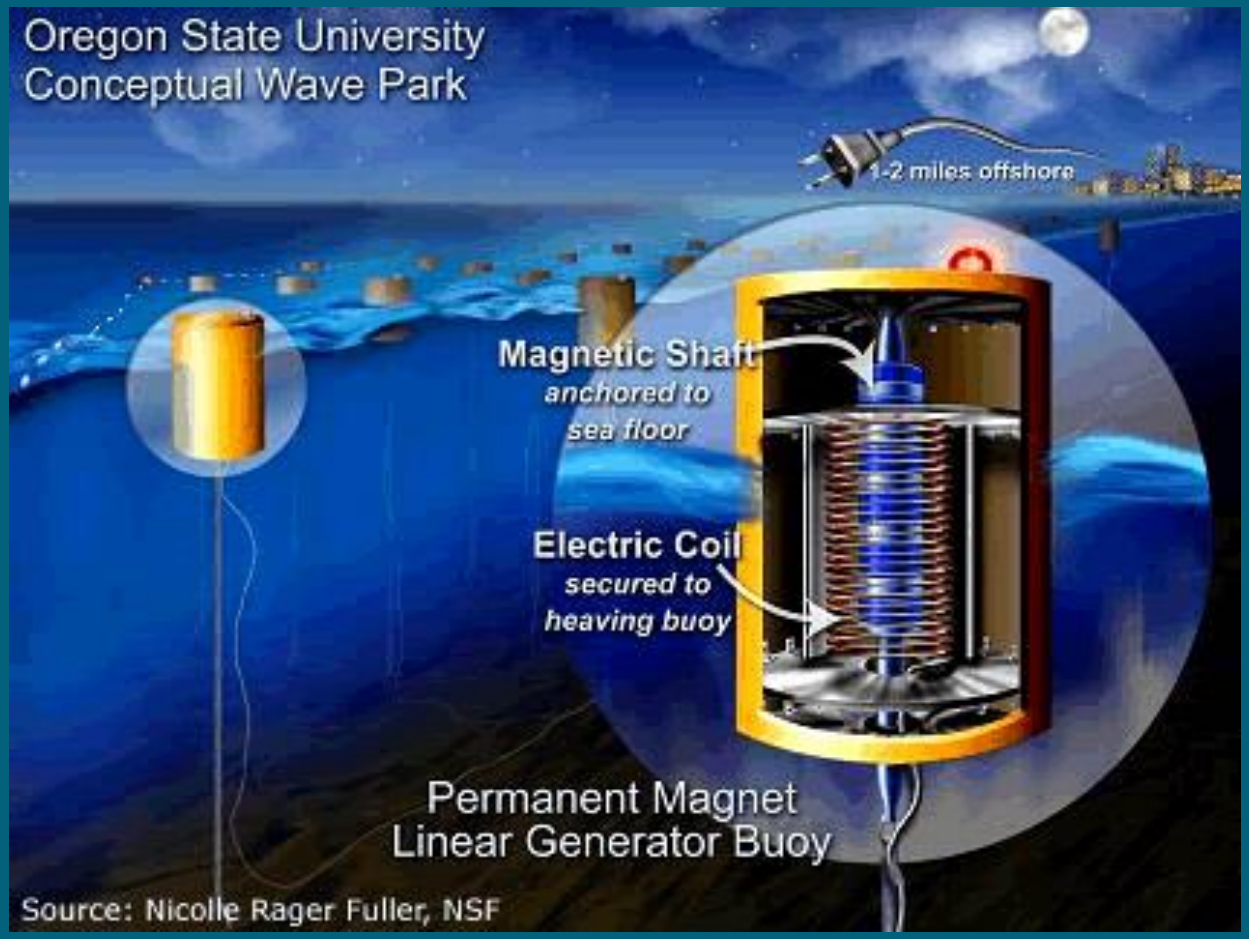
FERC Docket Number	Project Name	Licensee/Permit Holder/Applicant	State	Capacity (MW)	Closed Loop?	L/H Ratio	Estimated Energy Storage (MWh)
13333	John Day Pool	PUD No.1 of Klickitat County	WA	1000	Yes	4.58	15000
13318	Swan Lake North	Swan Lake North Hydro, LLC	OR	600	Yes	4.98	10000
14329	Banks Lake Pumped Storage (Alternative 1 – North Banks Lake)	Grand Coulee Hydro Authority	WA	1000	No	28.29	8000
14329	Banks Lake Pumped Storage (Alternative 2 – South Banks Lake)	Grand Coulee Hydro Authority	WA	1040	No	3.18	8084
14416	Lorella (Klamath County)	FFP Project 111, LLC	OR	1000	Yes	4.81	15625
13642	Gordon Butte	GB Energy Park, LLC	MT	400	Yes	3.88	3422

Project Storage Projects Under Significant Development

- Klickitat PUD's **JD Pool Project** – Notice of Intent, Traditional Licensing Process request and Pre-Application Document filed with FERC on 3 NOV 14; expect to file a Draft License Application October 2015.

- EDF Renewable Energy's **Swan Lake Project** – ongoing geo-tech investigation with deep borehole drilling of the escarpment where the main shaft and powerhouse location; expect to file a Final License Application in October 2015.

Chapter 4 – Tidal & Wave Energy



Chapter 4 – Tidal & Wave Energy

- There are three types of wave energy technologies:
  - Floats, buoys or other pitching devices to generate electricity, driving hydraulic pumps by using the rise and fall of swells
  - Oscillating water column (OWC) devices to generate near the shore using the rise and fall of water in a cylindrical shaft
  - Overtopping device or tapered channel, which may be used either near the shore or offshore

Chapter 4 – Tidal & Wave Energy

- D-1 Assessment of Energy Production Potential from Tidal Streams in the US
  - Funded by Wind and Water Program, U.S. Dep't of Commerce
  - Prepared by Georgia Tech Research Corporation
  - June 29, 2011
- D-2 Mapping and Assessment of the United States Ocean Wave Energy Resource
  - Electric Power Research Institute (EPRI), 2011
- D-3 Assessment and Mapping of the Riverine Hydrokinetic Resource in the Continental United States
  - Electric Power Research Institute (EPRI), 2012

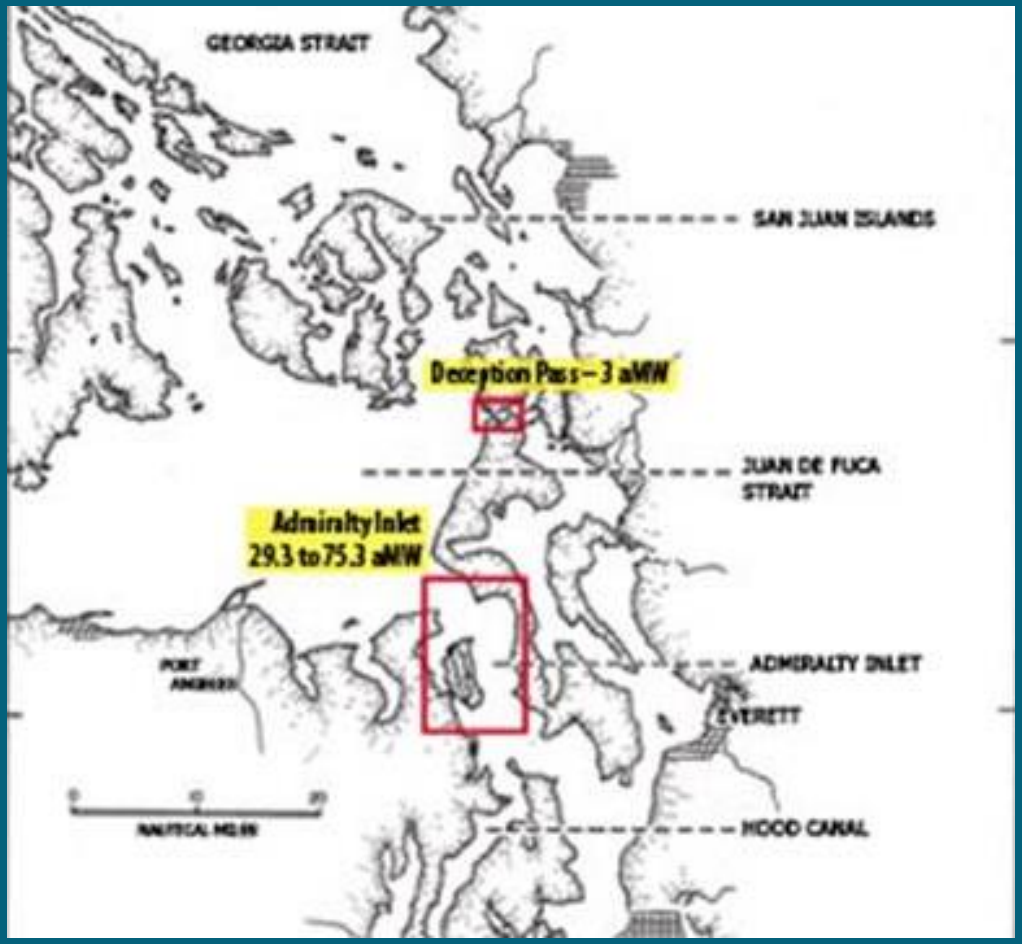
Chapter 4 – EPRI Estimates

	Inner Shelf TWh/yr	Outer Shelf TWh/yr
West Coast (CA, OR, WA)	440	590
Washington	72	116
Oregon	143	179

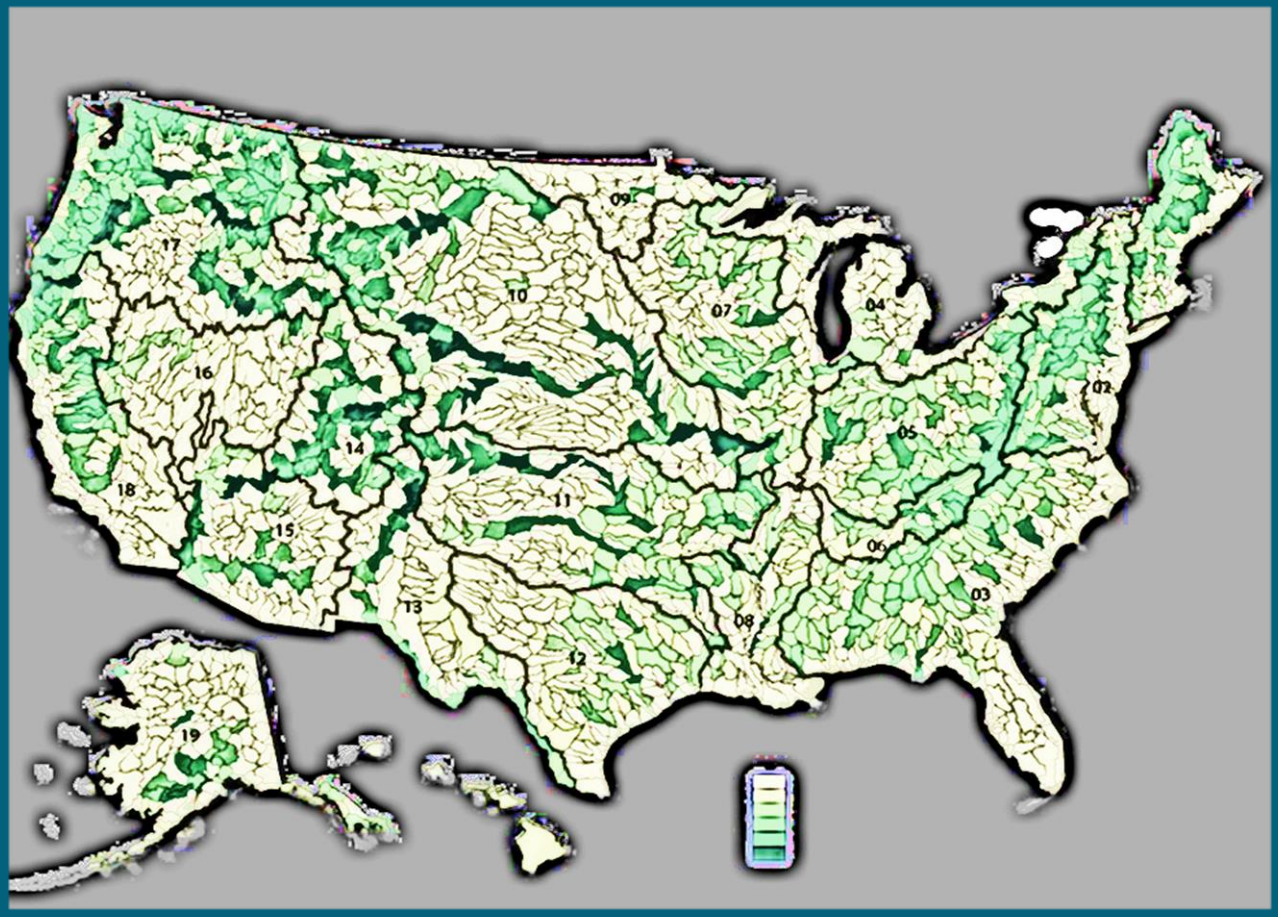
*Terrawatt hours per year

*A terawatt hour is one million megawatt hours or one trillion kilowatt hours.

Chapter 4 – Tidal & Wave Energy



Chapter 5 – General Hydropower Project Assessments



Chapter 5 – General Hydropower Project Assessments

- E-1 New Stream-reach Development: A Comprehensive Assessment of Hydropower Energy Potential in the US
  - U.S. Department of Energy, Wind and Water Power Technologies Office, April 2014
- E-2 Assessment of Natural Stream Sites for Hydroelectric Dams in the PNW Region
  - Idaho National Lab, March 2012
- E-3 Hydropower Potential & Energy Savings Evaluation – Irrigation Water Provides of Oregon
  - Energy Trust of Oregon, 2011, Black Rock Consulting

Chapter 5 – General Hydropower Project Assessments

- E-4 Small Hydropower Technology and Market Assessment
  - Energy Trust of Oregon, January 2009, Summit Blue Consulting
- E-5 Assessment of Waterpower Potential & Development Needs
  - Electric Power Research Institute, March 2007
- E-6 Feasibility Assessment of the Water Energy Resources of the US for New Lower Power and Small Hydro Classes of Hydroelectric Plants
  - U.S. Department of Energy, Wind and Water Power Technologies Office, January 2006, Idaho National Lab

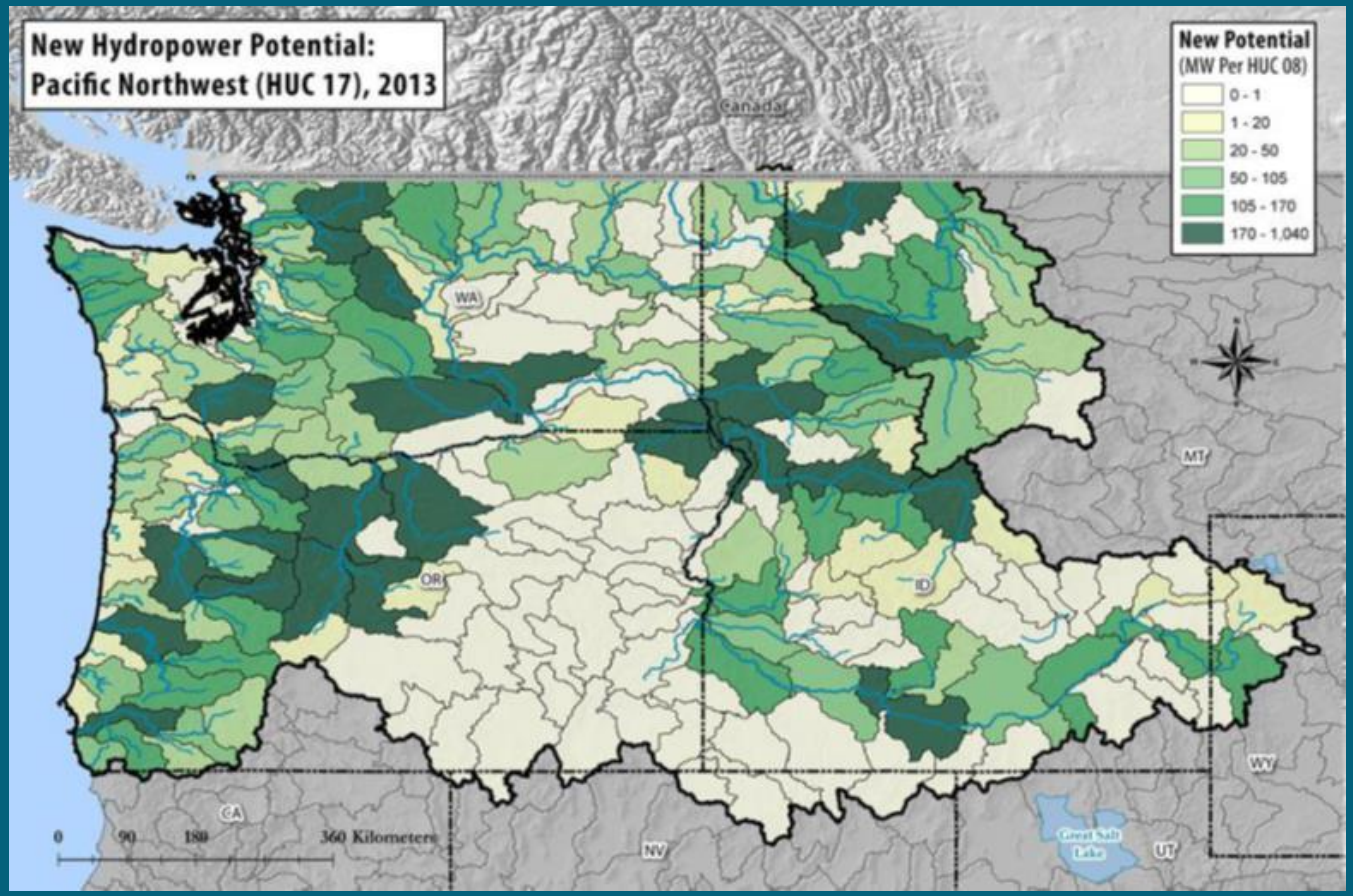
Chapter 5 – General Hydropower Project Assessments

Study	Project Name	Capacity (MWs)	Generation
E-1	Northwest Projects < 1 MW	15,997.00	96,756,000 MWh
E-1	Northwest Projects > 1 MW	9,228.00	52,244,000 MWh
E-2	Northwest Projects (5,439 sites)	15,021.00	n/a
E-3	Irrigation Projects (30 sites)	20.61	5,823 MWh
E-6	Northwest Projects	n/a	9,969 MWa

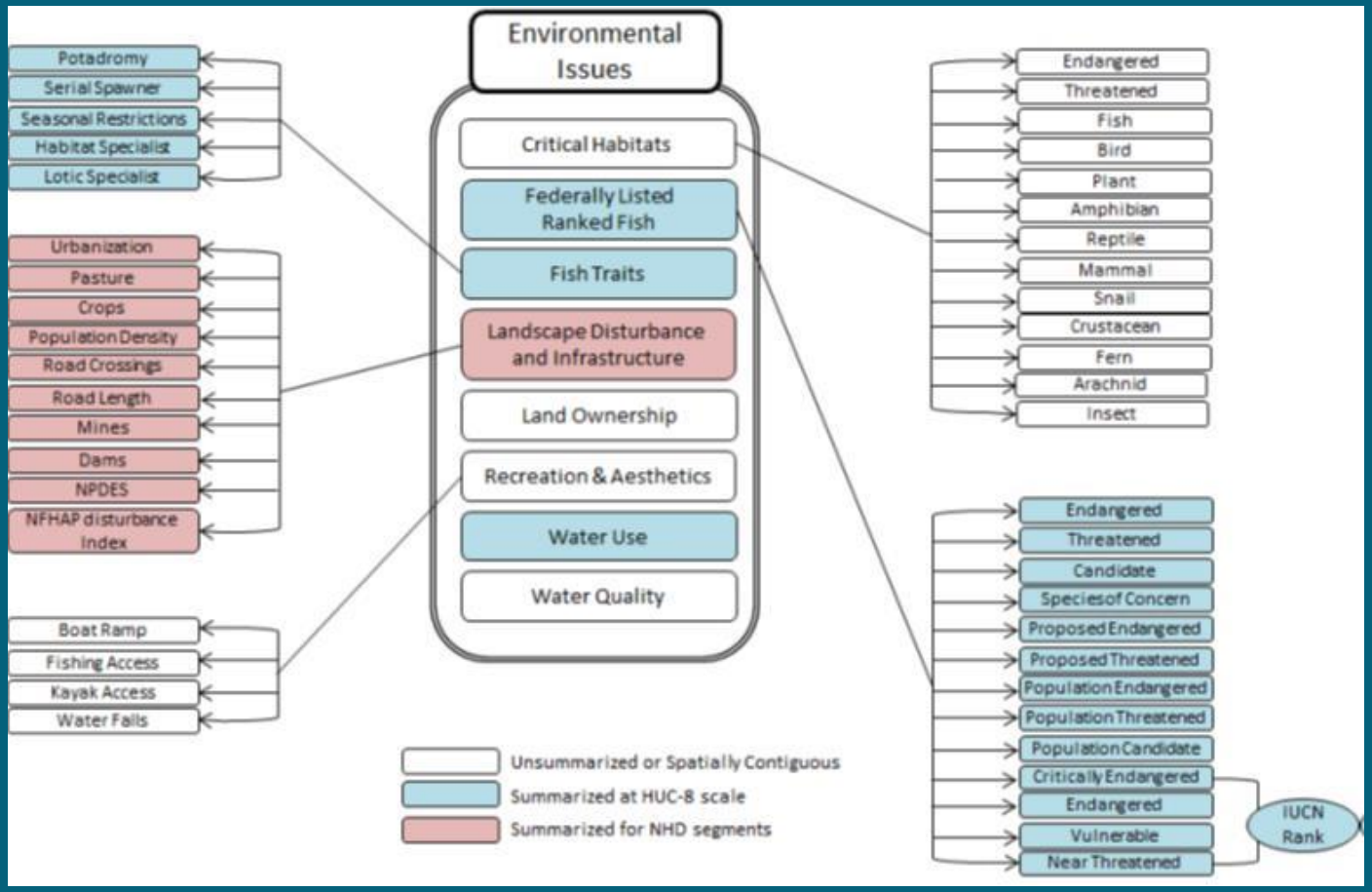
E-1 – PNW New Hydropower Potential

State	Capacity (MW)	Energy (MWhs/year)
Idaho	7,018	41,015,000
Montana	4,763	28,201,000
Oregon	8,920	53,353,000
Washington	7,381	43,788,000
TOTAL	28,082	166,357,000

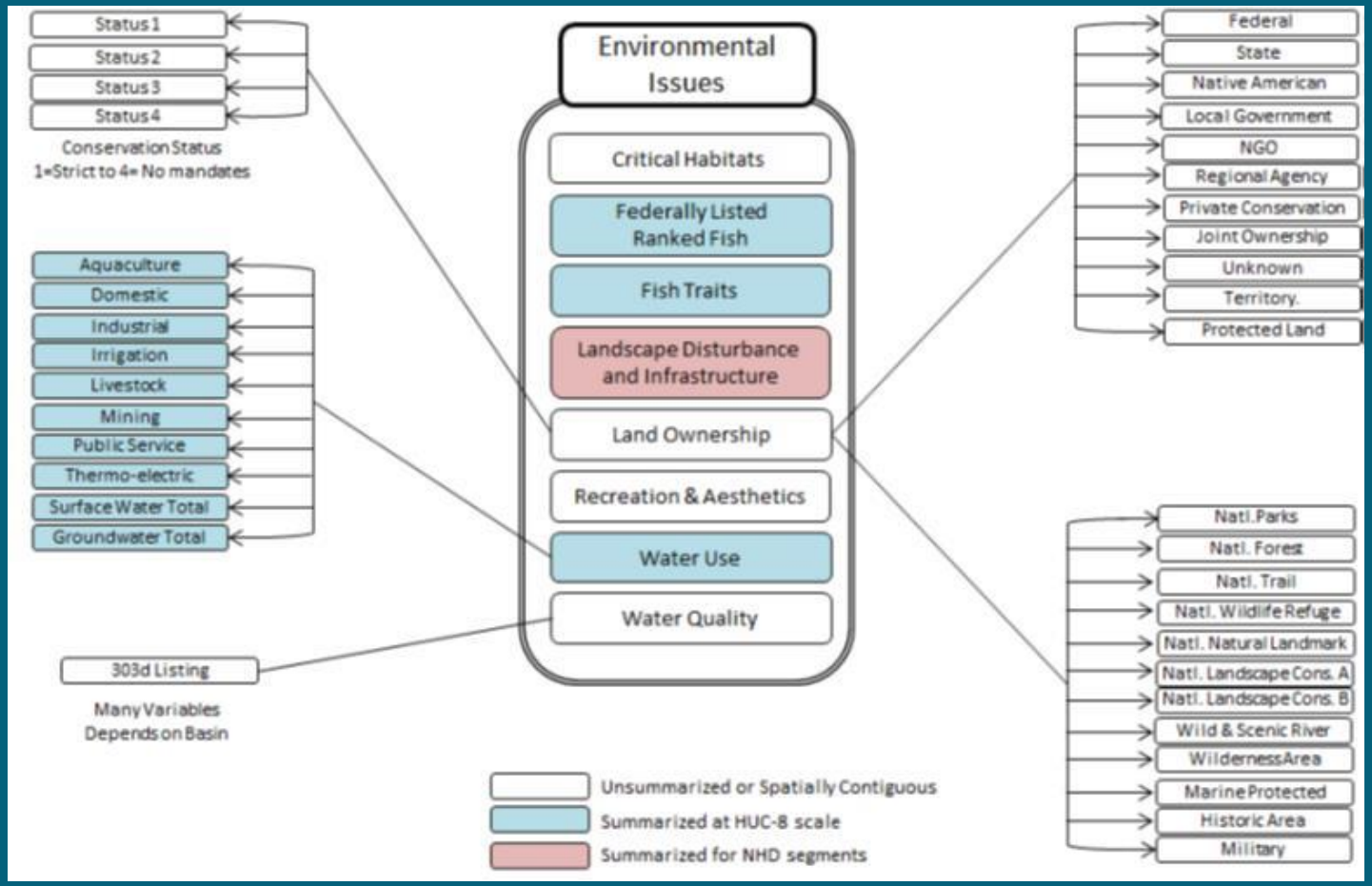
E-1 PNW New Hydropower Potential



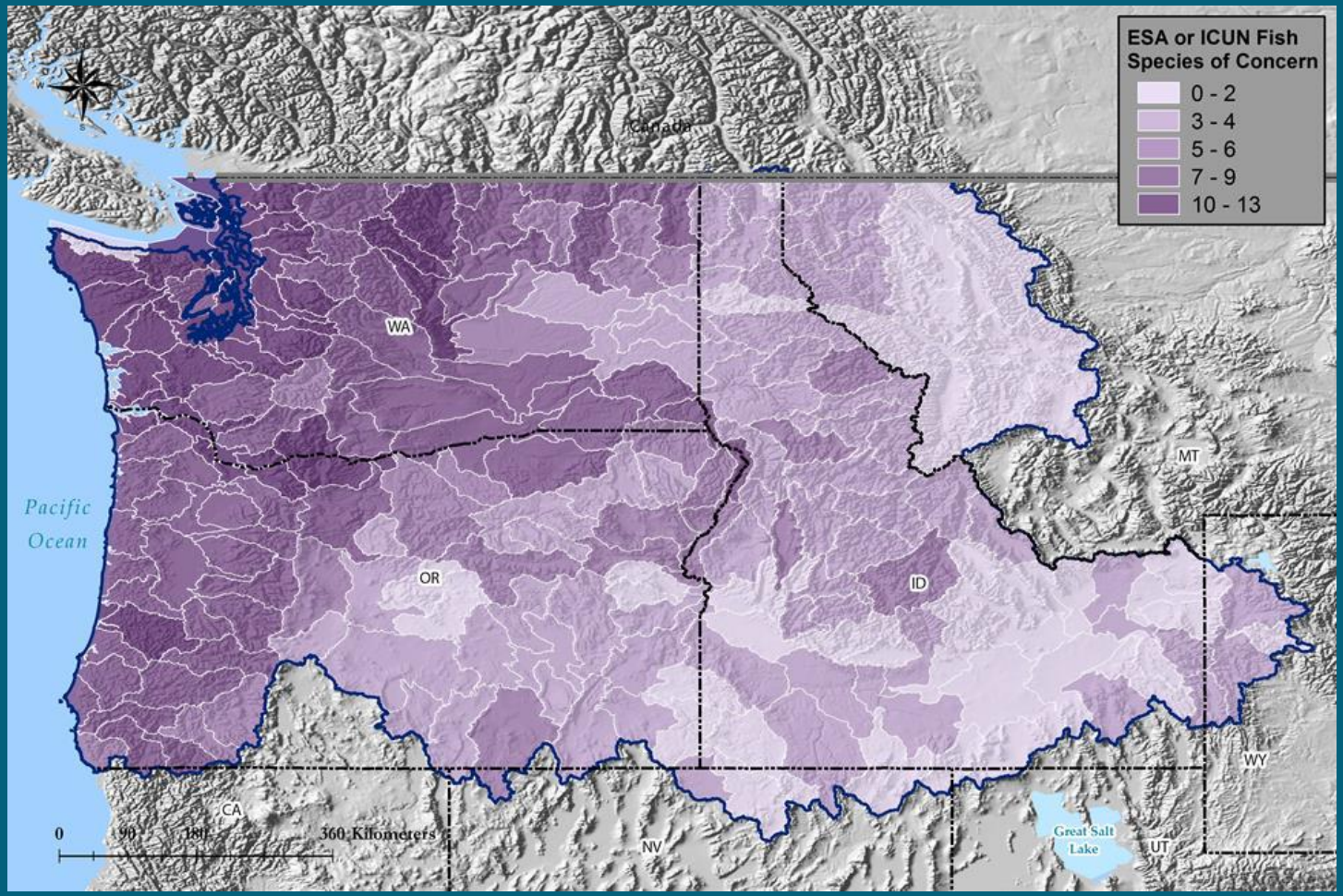
E-1 Environmental Constraints (Chart 1, DOE)



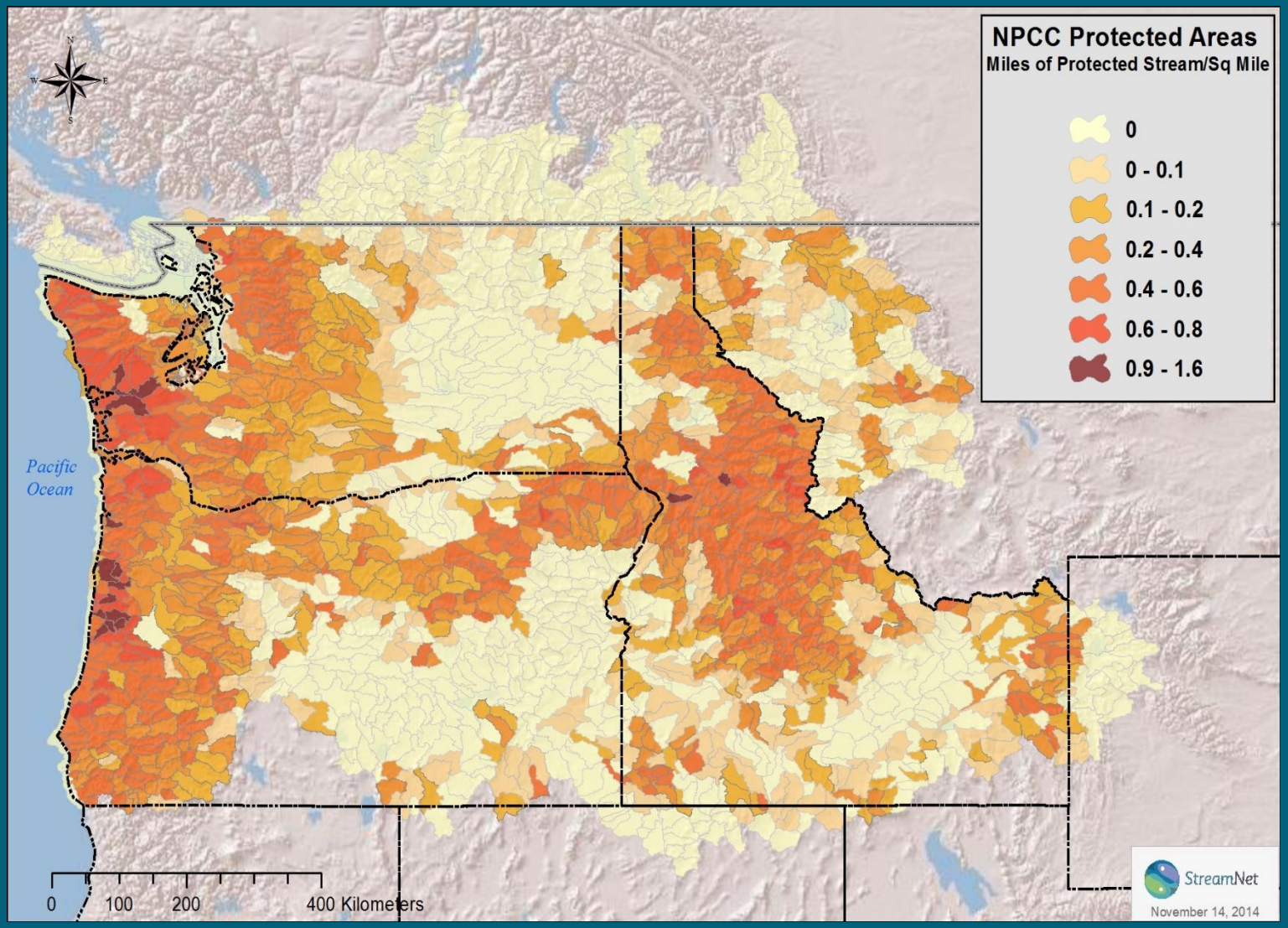
E-1 Environmental Constraints (Chart 2, DOE)



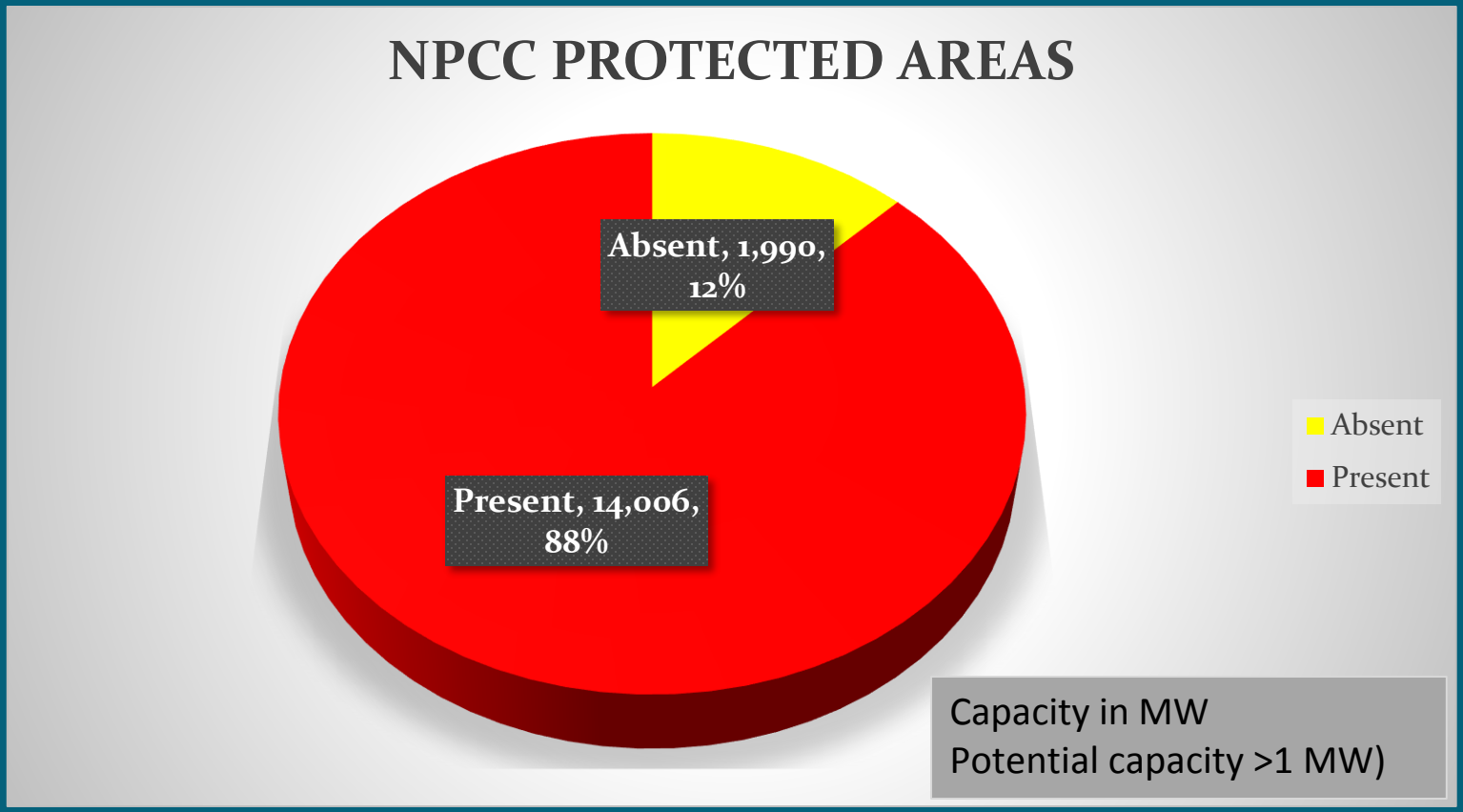
E-1 Fish Species of Concern, DOE



Northwest Power and Conservation Council's Protected Areas dataset designating stream reaches protected from hydropower development. map illustrates relative density of protected stream segments in the Pacific Northwest by normalizing the miles of NPCC protected streams by watershed area (miles/square mile).

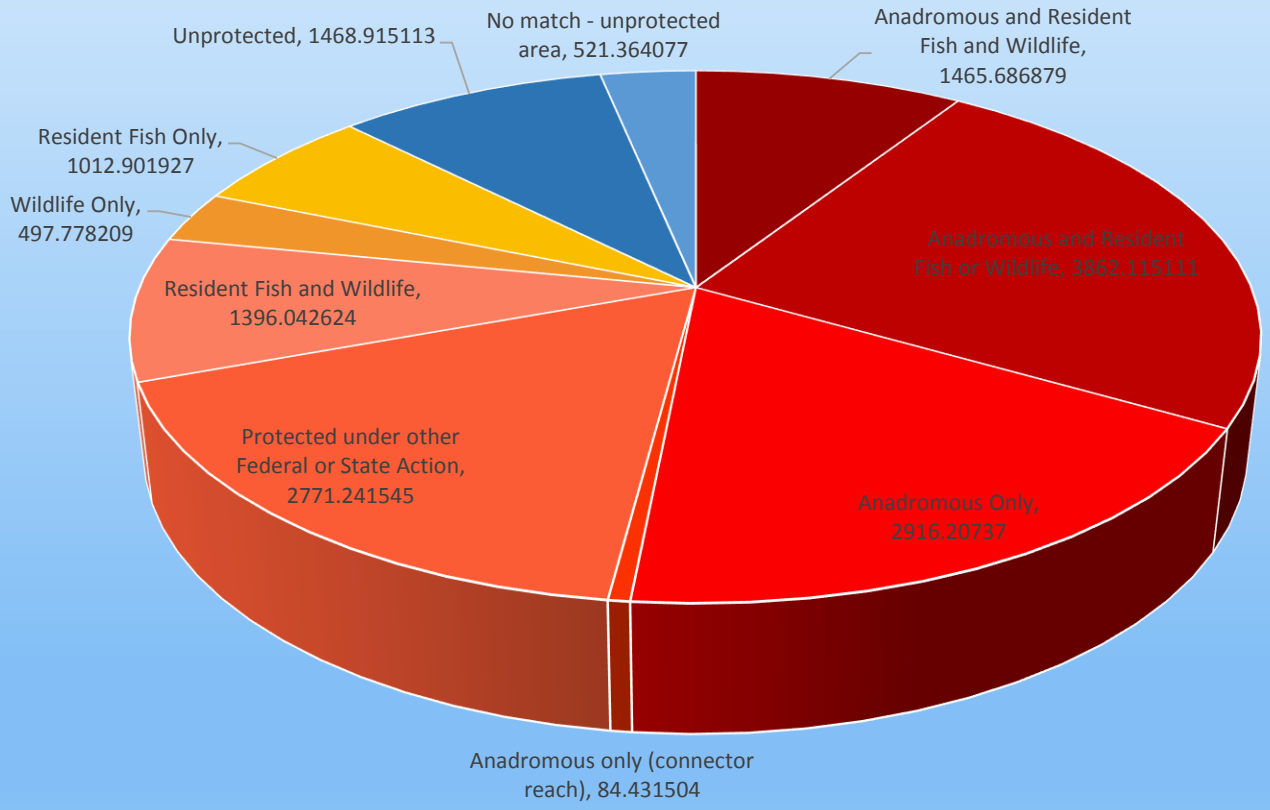


Potential Capacity Associated with NPCC Protected Areas in Region 17

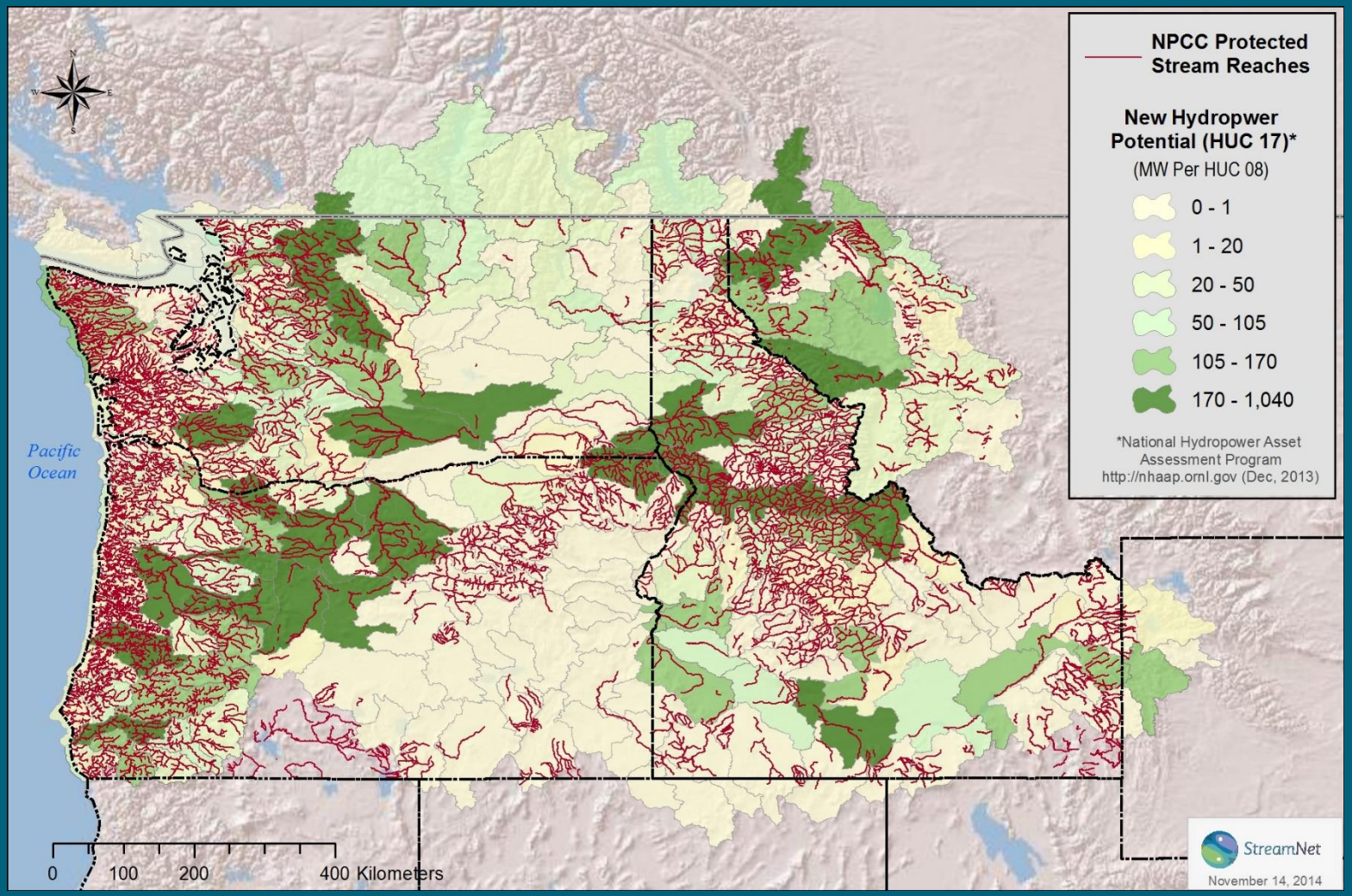


Potential Capacity Associated with NPCC Protected Areas in Region 17

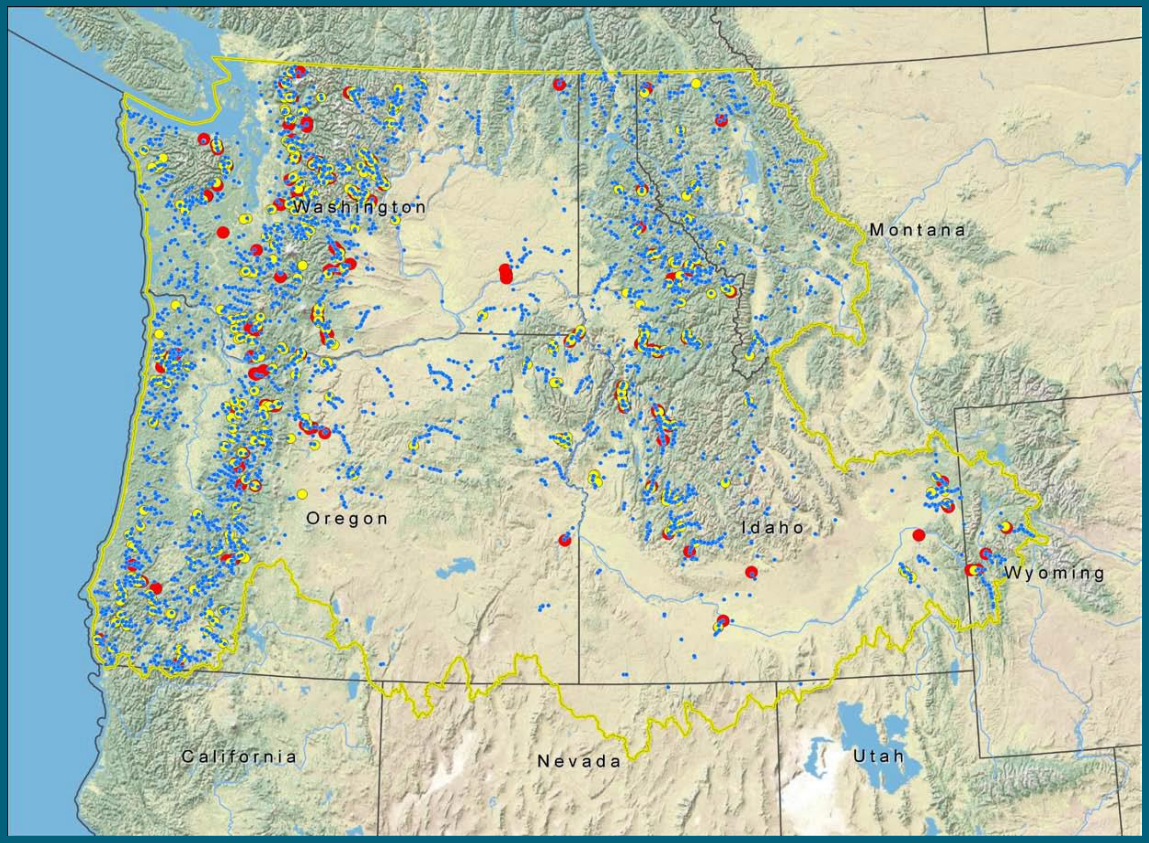
T



Protected Areas stream reaches overlaid on map layer of new hydropower potential (MW) existing in Pacific Northwest (Hydrologic Region 17) at the HUC08 level (4th level HUC) based on study conducted by the National Hydropower Asset Assessment Program (Kao, S. et. al, 2014), US DOE.



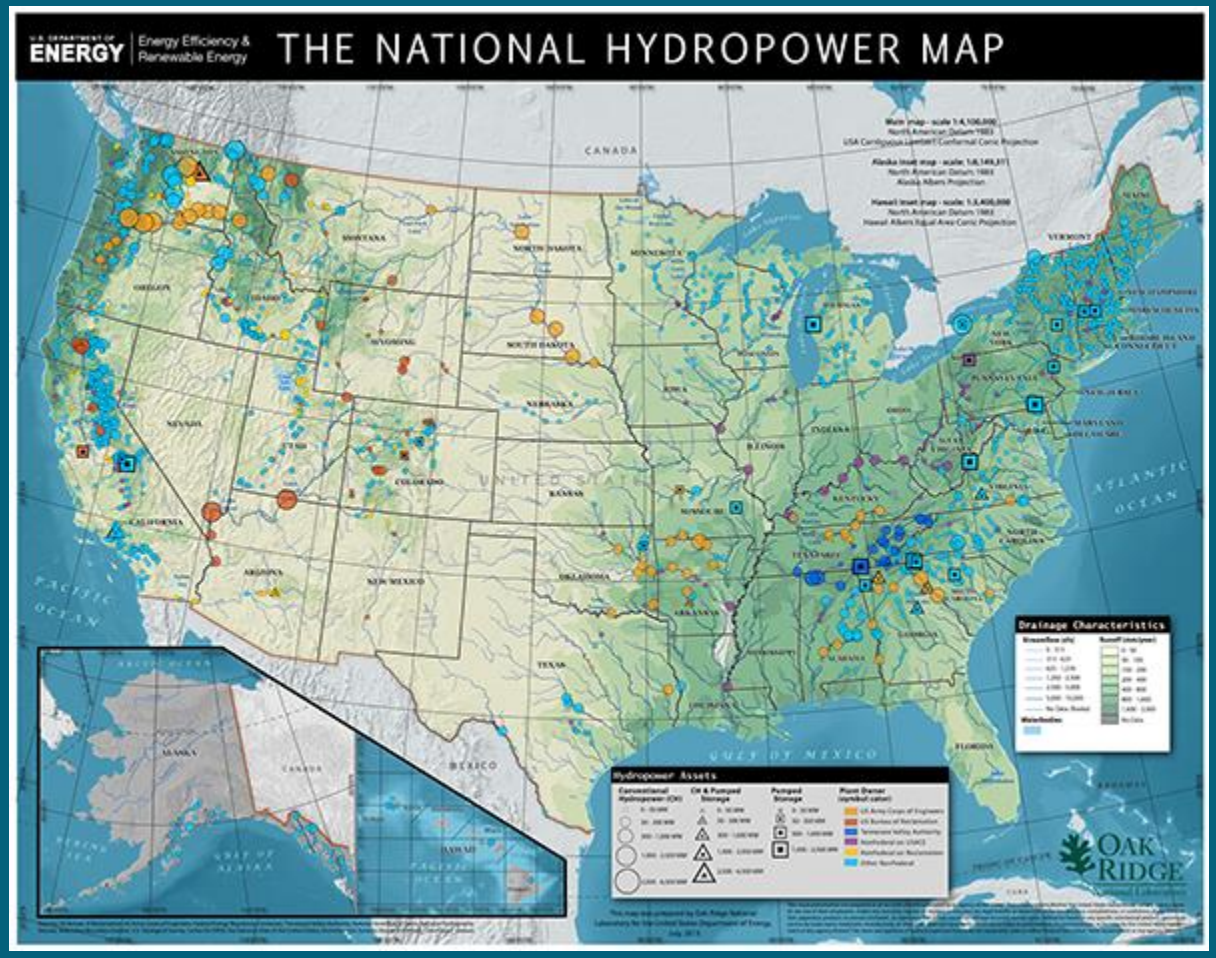
E-2 Locations of Small Hydropower Sites, Idaho National Lab



E-2 Stream Reaches Identified with Potential Hydropower Projects

Reaches	Number of Reaches	Capacity (MWs)
All reaches	231,747	211,666
Capacity potential less than 1 MW	29,580	185,485
Small hydropower reaches: 2 MW – 60 MW	24,489	73,934
Available small hydropower reaches	15,676	42,835
Candidate reach sites for further assessment	5,439	15,021

Chapter 6
Tools for Assessing Hydropower Potential

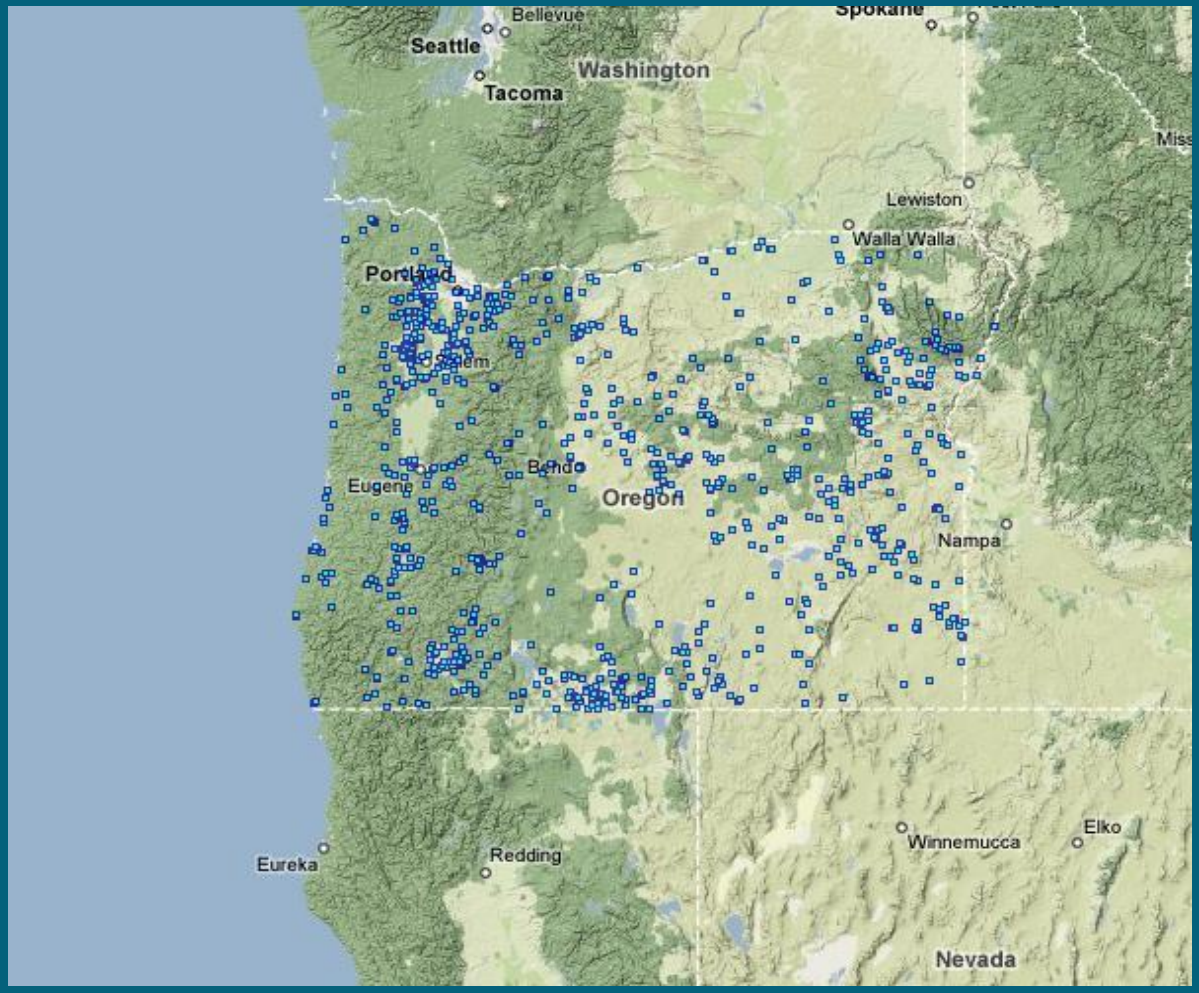


Map From F-6

Chapter 6 – Tool F-6

- F-1 Northwest Subbasin Databrowser
  - Developed by GIS Support Division and Environment, Fish and Wildlife Group, BPA, 2014
- F-2 National Inventory of Dams
  - Maintained by the USACE, May 2013 Update
- F-3 Hydropower Energy & Economic Analysis Tool
  - USBR, 2014
- F-4 Virtual Hydropower Prospector
  - Idaho National Laboratory, 2011
- F-5 Tidal Stream Interactive Map
  - Georgia Institute, June 2011
- F-6 National Hydropower Asset Assessment Program
  - Oakridge National Lab

F-2 National Inventory of Dams



Chapter 6 – Tool F-6

- NHAAP GIS Team at Oak Ridge National Laboratory (ORNL) Interactive Mapping Site
- Navigation system access to data and map products for:
  - Existing hydropower assets
  - Non-powered dams
  - New stream-reach development
  - Environmental attribution
  - Ecological research
  - Stream classification

Chapter 7 – Legislative/Rulemaking

- Hydropower Regulatory Efficiency Act of 2013
  Public Law 113-23 (H.R. 267) Enacted August 9, 2013
  - Capacity Exemption increased to 10 MW
  - Streamlining of Conduit Exemption, raise capacity threshold
  - Extensions allowable for preliminary permits
  - Pilot 2 year licensing process

- Bureau of Reclamation Small Conduit Hydropower Development and Rural Jobs Act , Public Law 113-24
  - Authorizes Lease of Power Privilege
  - Categorical Exclusion from NEPA
  - BOR processes “small conduit hydropower” up to 5 MW

Rulemaking

- EPA 111d Rule - June 24, 2014
  under "President's Climate Action Plan"
  - Lower carbon emissions by 30% below 2012 levels by 2030
  - Each state defines its own plan
    - Or addresses a regional solution
    - Plans due by June 2016
  - Pacific NW Goal – 60% Reduction Average
    - Idaho – 33%
    - Montana – 21%
    - Oregon 48%
    - Washington 72%

Summary of Findings

Pacific NW Potential for 2015-2035

- 3,200 MW Capacity
- 23,000,000 MWhs

Potential Cost

- Non-powered dams $1,889 to $5,075 per kW - $3,518 average
- Conduit projects $2,140 to $11,867 per kW - $4,391 average*
- Pumped storage $5,000 to $7,000 per kW - $6,000 average
- Run-of-river $2,487 to $21,062 per kW - $8,464 average

- *includes development of pipeline infrastructure for non-power purposes

Potential Hydropower 2015-2035

Non-Powered Dams	FERC No.	Study #	Date Opr.	Developer	State	Project Information	River	Capacity MW
Identified in Survey and FERC Applications								
Tongue River Dam	P-14602		N/A	State of Montana, DNR	MT	Add capacity	Ruby	2.200
Gibson Dam	P-12478		2016	Tollhouse Energy/Greenfield I.D.	MT	New project at existing dam	Sun	15.000
Mason Dam	P-12686		N/A	Baker County	OR	New project at existing dam	Powder	3.400
Pinto Dam	P-14380		2019	GCHPA*	WA	New project at existing dam	Columbia	2.929
Warmsprings Dam Hydro	P-13570		N/A	Warmsprings Irrigation District	OR	New project at existing dam	Malheur	2.700
Studies A-1, A-2, A-3 & FERC Applications								
McKay Dam	P-14205	A-3	N/A	McKay Dam Hydropower	OR	New project at existing dam	Umatilla	3.000
Howard A. Hanson Dam	P-14594	A-1, 2	N/A	Howard A. Hanson Power, LLC	WA	New project at existing dam	Green	5.000
Scooteney Wasteway	P-14352	A-3	2019	GCHPA	WA	New project at existing dam	Columbia	1.100
Easton Diversion Dam	P-13850	A-3	N/A	Qualified Hydro 15 LLC	WA	New project at existing dam	Yakima	1.200
Blue River Dam	P-14381	A-1	N/A	Qualified Hydro 15 LLC	OR	New project at existing dam	Blue	20.630
NON-POWERED DAMS POTENTIAL							**10 Projects:**	**57.159**
Conduit Exemptions & Hydrokinetic Projects								
Studies B-1 and B-2		B-2	N/A	Various irrigation districts	OR	4 Conduit projects	Deschutes	5.317
Study B-3		B-3	N/A	Various irrigation districts	OR	2 Conduit projects	Deschutes	1.579
Stiudy B-5		B-5	N/A	Various canal sites	NW	111 Conduit projects	NW Rivers	34.000
Survey Responses		SR	N/A	Various canal/pipeline sites	NW	15 Conduit projects	NW Rivers	14.627
Hydrokinetic Demo Project		SR	2015	Hydrokinetic unit in canal	WA	1 Hydrokinetic conduit project	Yakima	0.01
FERC apps. Issued		FERC	N/A	Approved projects/canals	NW	7 Conduit projects	NW Rivers	2.099
FERC approved NOIs		FERC	N/A	Approved projects/canals	NW	3 Conduit projects	NW Rivers	6.065
CONDUIT EXEMPTIONS AND HYDROKINETIC PROJECTS							**143 Projects:**	**63.697**
Pumped Storage Projects								
John Day Pool		C-2	N/A	Klickitat PUD	WA	Pumped storage	Columbia	1,000.000
Swan Lake		C-2	N/A	EDF Renewable Energy	OR	Pumped storage	Klamath	600.000
Banks Lake		SR	2019	*Grand Coulee Hydroelectric Power Agency (GCHPA)	WA	Pumped storage	Columbia	1,040.000
PUMPED STORAGE PROJECTS								**2,640.000**

Potential Hydropower 2015-2035

General Assessments	FERC No.	Study #	Date Opr.	Developer	State	Project Information	River	Capacity MW
Identified in Survey and FERC Applications								
Various canal or small reservoir		E-3	N/A	Various irrigation districts	OR	30 Conduit exemptions	Oregon Rivers	20.630
Oak Springs		SR	N/A	Oregon Dept. Fish/Wildlife	OR	Exemption at existing diversion	Deschutes	0.085
Unidentified Location		SR	N/A	Portland General Electric	OR	New traditional project	Clackamas	2.800
Identified in FERC Applications only								
Go with the Flow	P-14538	FERC	N/A	Go with the Flow Hydropower	OR	Traditional hydro exemption	Umatilla	1.200
Weiser-Galloway	P14608	FERC	N/A	Idaho Water Resources Board	ID	Traditional hydro project	Weiser	60.000
Two Girls Creek	P-14626	FERC	N/A	Green Volt Hydro Inc.	OR	Traditional hydro	Two Girls Creek	5.000
GENERAL ASSESSMENTS							**35 Projects:**	**89.7**

Upgrades								
These projects were identified in the survey:								
Blind report as requested		SR	2020	Unidentified utility	WA	Add equipment	NW	7.000
Box Canyon Dam	P-2042	SR	2017	Pend Oreille PUD	WA	Add equipment	Pend Oreille	30.000
North Wasco PUD Plant	P-7076	OR	2018	North Wasco PUD	OR	Add capacity at Dalles Dam	Columbia	5.000
Shoshone Falls	P-2778	ID	2022	Idaho Power Company	ID	Add capacity	Snake	52.000
Blind report as requested		SR	2015	Unidentified utility	WA	Add energy	NW	0.000
Grand Coulee Dam		SR	2018+	Bureau of Reclamation	WA	Add units 19-21	Columbia	200.000
Boundary Dam		SR	2015-2035	Seattle City Light	WA	Add equipment	Pend Oreille	40.000
Packwood Lake Hydro		SR	2015	Energy Northwest	WA	Add energy	Cowlitz	0.000
Black Canyon Dam		SR	2018	Bureau of Reclamation	ID	Add third unit	Payette	12.000
Hungry Horse Dam		SR	2019+	Bureau of Reclamation	MT	Replace turbines/efficiency	Flathead	0.000
Lower Baker		SR	N/A	Puget Sound Energy	WA	New powerhouse		30.000
Little Falls		SR	2015-2018	Avista Corporation	WA	4 new units	Spokane	4.000
Nine Mile		SR	2015	Avista Corporation	WA	Upgrade	Spokane	8.000
Palisades Dam		SR	2016	Bureau of Reclamation	ID	Replace turbines +7.5 efficiency	Snake	0.000
							14 Projects:	**388.000**

TOTAL OF ALL PROJECTS OF EACH TECHNOLOGY:	3,238.56

Contributors & Acknowledgments

- Principal Author: NWHA Executive Director, Jan LEE
- NWHA board and members contribution:
  - B&V - Frances Brinkman
  - HDR - Lisa Larson, Rick Miller, Rachel Darany
  - MWH - Nathan Sandvig, Michael Manwaring
- Map development contribution:
  - Pacific State Marine Fisheries Commission - Van Hare
  - Oak Ridge National Laboratory – Nicole Samu