Atlas of the Columbia River Basin

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Oregon State University
Computer-Assisted Cartography Course 2013

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FOREWORD

Atlas of the Columbia River Basin

The Columbia River Basin is the social, ecological, and economic heart of the Pacific Northwest. Its tumultuous yet fascinating geologic history laid the foundation for a vibrant landscape and a diverse ecological web of flora and fauna.

As a source of food, trade, transportation, and culture, the Columbia River became the lifeblood of native Tribes and First Nations. Later, the powerful, snow-fed Columbia attracted Western settlers who harnessed the river's energy to fuel the region's economic development. Over its rich history, people increasingly managed the basin's lands and waters to achieve a wide array of values and uses, from timber harvest and agriculture to recreation and fishing.

However, this transformation of the basin also produced some negative social and ecological consequences, including important losses in fish and wildlife habitat and degradation of native peoples' cultural practices. Today, people across the Basin have begun to work together to restore and conserve the Basin's many uses for generations to come.

CHAPTER 1

INTRODUCTION

The Columbia River Basin is a vast and diverse landscape, encompassing the Canadian province of British Columbia and the U.S. states of Oregon, Washington, Idaho, Montana, Nevada, Wyoming, and Utah.

Encompassing an area of almost 300,000 acres along the border of Washington and Oregon, the Columbia River Gorge National Scenic Area is a landmark within the Pacific Northwest and Columbia River Basin.

COLUMBIA RIVER BASIN

Area
258,000 sq.mi.

Longest River
Columbia (1243 mi)

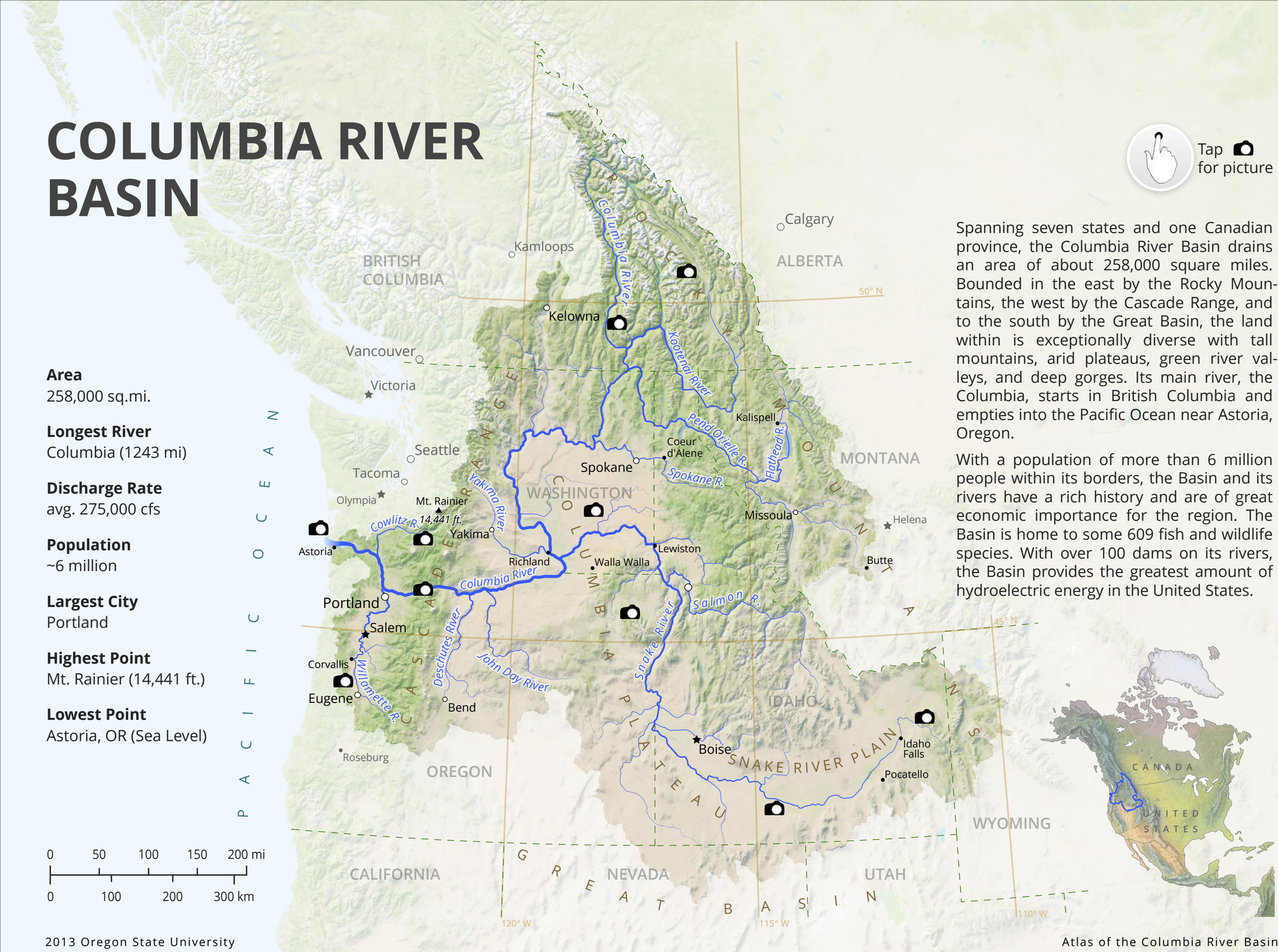
Discharge Rate
avg. 275,000 cfs

Population
~6 million

Largest City
Portland

Highest Point
Mt. Rainier (14,441 ft.)

Lowest Point
Astoria, OR (Sea Level)



Spanning seven states and one Canadian province, the Columbia River Basin drains an area of about 258,000 square miles. Bounded in the east by the Rocky Mountains, the west by the Cascade Range, and to the south by the Great Basin, the land within is exceptionally diverse with tall mountains, arid plateaus, green river valleys, and deep gorges. Its main river, the Columbia, starts in British Columbia and empties into the Pacific Ocean near Astoria, Oregon.

With a population of more than 6 million people within its borders, the Basin and its rivers have a rich history and are of great economic importance for the region. The Basin is home to some 609 fish and wildlife species. With over 100 dams on its rivers, the Basin provides the greatest amount of hydroelectric energy in the United States.

Tap maps to enlarge

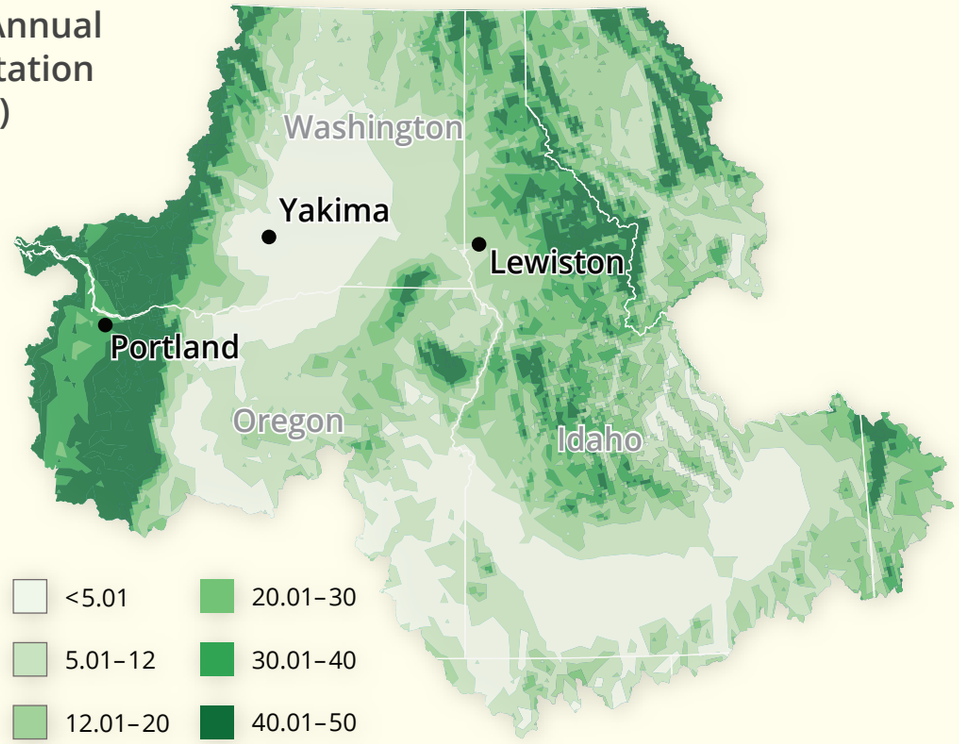
CLIMATE

The Columbia River Basin is home to a wide variety of climate types. It is subject to influences from the Cascade and Coast mountain ranges, the Pacific Ocean, and more.

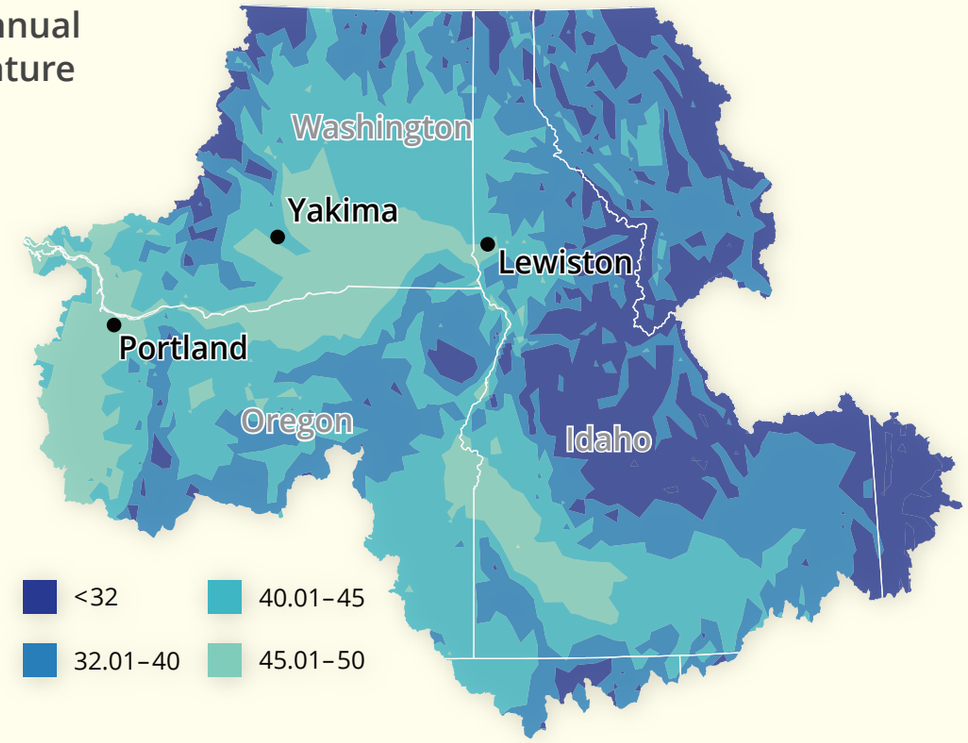
Precipitation and moisture from the Pacific Ocean moves inland and is forced upward by the Coast Range. This orographic effect produces significant precipitation in the Coast Range before slightly tapering off in the inland valleys, only to redevelop in the Cascade Range in Washington and Oregon. A rain shadow is created by the Cascade Range, leaving eastern Oregon and Washington much drier than the western side.

Much of the region west of the Cascades experiences a dry season during the summer and a wet season during the winter, constituting a cool-summer Mediterranean climate classification. Classified as a Marine West Coast climate, the coastal areas have a relatively consistent temperature profile and do not have a distinct dry season.

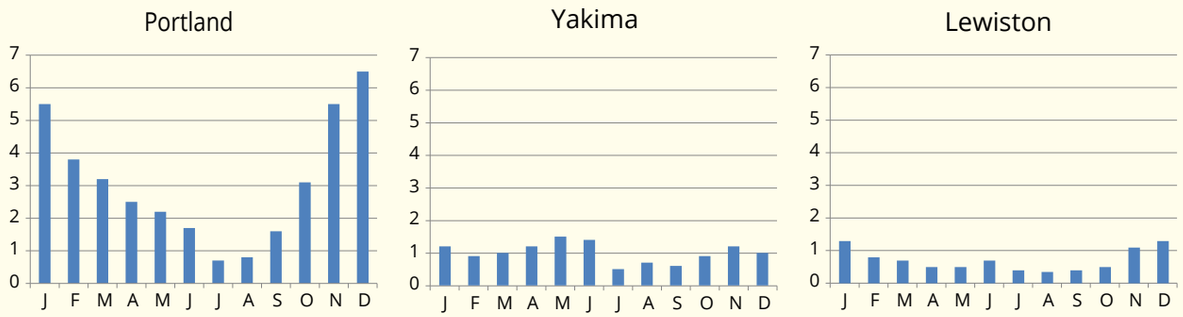
Mean Annual Precipitation (Inches)



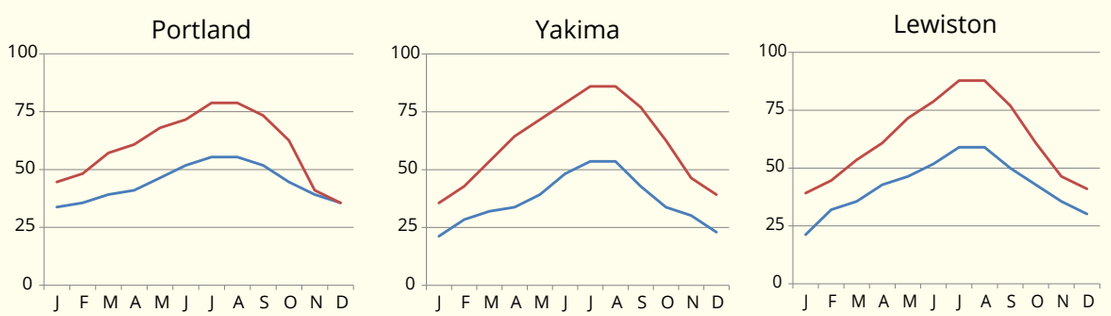
Mean Annual Temperature (°F)



Mean Monthly Precipitation (Inches)



Mean Monthly Temperature (°F)



LANDCOVER AND VEGETATION

The Columbia River Basin is home to a diversity of vegetation and land cover types. The extent of the drainage area covers land influenced not only by the topography of the Cascade Range to the west and the Rocky Mountains to the east, but by the Columbia River itself and its ecologically rich tributaries. The densely forested mountain ranges to the east and west give way to fertile valleys and agriculturally rich plateaus. The Basin is a mosaic of varying climates, topography, natural history, vegetation, and past and present human impact.

Industry such as forestry, agriculture, recreation, and hydro, wind, and solar power have altered the historical landscape and current land cover. A majority of the current Basin landscape consists of areas that are developed for urban growth; forested with natural, protected, or intensively managed tree stands; cultivated for agriculture or domestic animal use; utilized for natural desert shrubland or for unmanaged native grassland; and protected for wetlands.

POPULATION

The Columbia River Basin is home to over 6 million people in both Canada and the United States. Although much of the Basin is considered rural, there are several key urban centers, including Portland, which is the most economically important city and port in the Basin. Other large cities in the Basin include Boise, Idaho, and Spokane, Washington. Collectively, these cities make up approximately half of the Basin population.

The abundance of natural resources in the Basin has historically fueled population growth. With the high demand for industrial workers, the Basin population has grown more than ten-fold since 1900. As cities shift, economically, into the information era, people move from the rural areas into the cities to find work.

Population Per Dot

2,000 ·

20,000 •

200,000 ●

CHAPTER 2

GEOLOGY

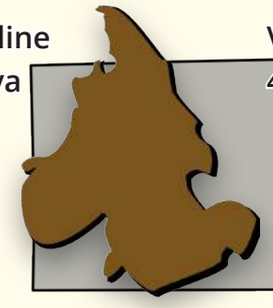
The Basin has undergone dramatic changes in the course of its geological history. Tectonic plate collisions, volcanic activity, glacial influence, and ancient floods have created an extremely diverse terrain within the basin.

Smith Rock State Park, located in central Oregon, draws many tourists, climbers, and vacationers annually for its world-class climbing, scenic river valleys, and incredible geology.

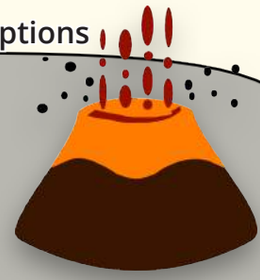
Tap images for more information

GEOLOGY OVERVIEW

Basin Outline
60 - 40 mya



Volcanic Eruptions
40 - 20 mya

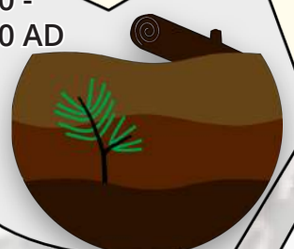


Missoula Floods
19,000 - 13,000 years ago

Cascade Uplift
2 mya - 700,000 years ago

Lava Flooding
17 - 6 mya

Landslides
1060 - 1760 AD



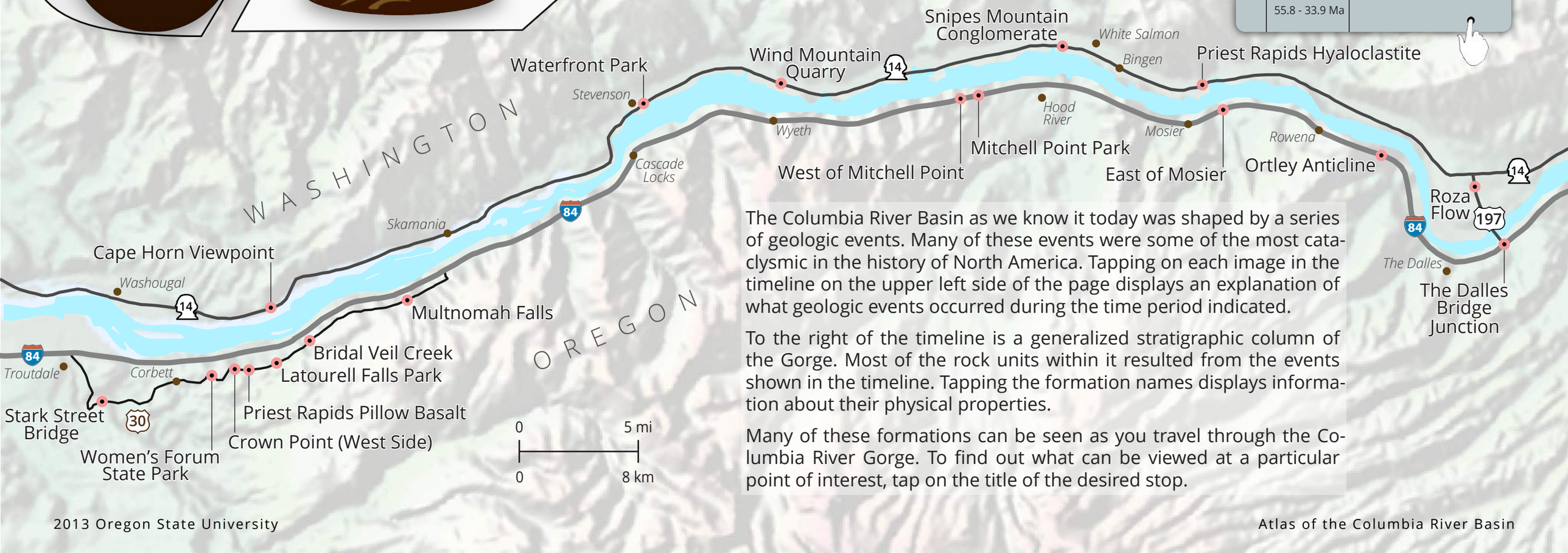
Mt. St. Helens Eruption
1980 AD

Gorge Stratigraphy

Time Period	Rock Unit
Quaternary 2.58 Ma - Present	Sedimentary Deposits
Tertiary: Pliocene 5.33 - 2.58 Ma	Boring and High Cascade Lavas
Tertiary: Miocene 23.03 - 5.33 Ma	Troutdale Formation
	Rhododendron Formation
	Columbia River Basalt Group
	Eagle Creek Formation
	Fifes Peak Formation
	Stevens Ridge Formation
Tertiary: Oligocene 33.9 - 23.03 Ma	
Tertiary: Eocene 55.8 - 33.9 Ma	Ohanapecosh Formation

Columbia River Gorge

Geologic Points of Interest



The Columbia River Basin as we know it today was shaped by a series of geologic events. Many of these events were some of the most cataclysmic in the history of North America. Tapping on each image in the timeline on the upper left side of the page displays an explanation of what geologic events occurred during the time period indicated.

To the right of the timeline is a generalized stratigraphic column of the Gorge. Most of the rock units within it resulted from the events shown in the timeline. Tapping the formation names displays information about their physical properties.

Many of these formations can be seen as you travel through the Columbia River Gorge. To find out what can be viewed at a particular point of interest, tap on the title of the desired stop.

FLOOD BASALT

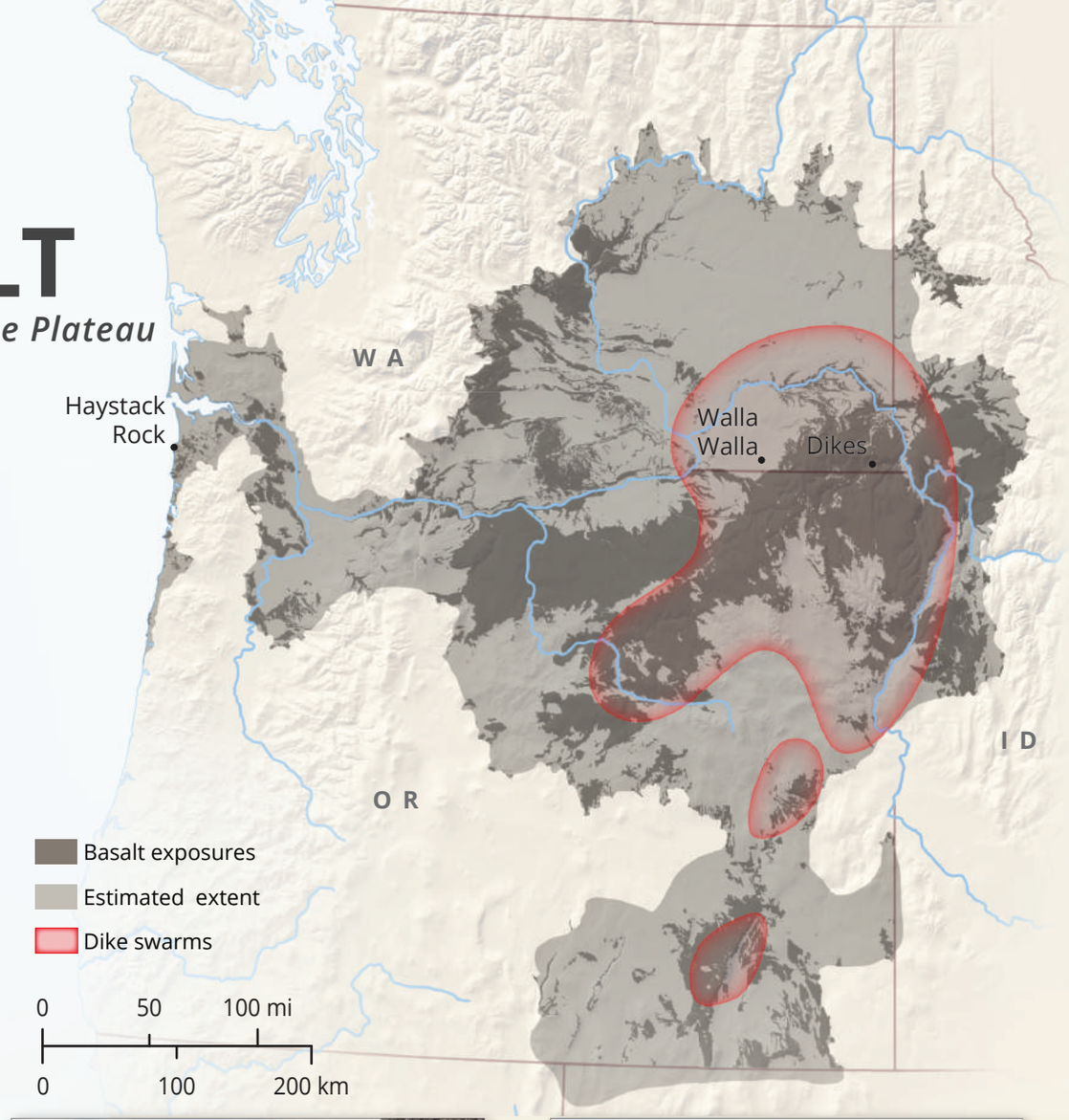
An Enormous Eruption Builds the Plateau

Flood basalts are catastrophic volcanic eruptions that, rather than building volcanic cones, simply inundate thousands of square miles of land with lava. 17 million years ago, a flood basalt eruption occurred in what is now the Pacific Northwest. Much of the lower Columbia River has shaped (and has been shaped by) the deposits of these eruptions.

Flood basalts are extremely rare; the Columbia River Basalts are the youngest known example in the world, deposited in a series of eruptions that occurred in several episodes from 17 million to 6 million years ago. They are thought to be the result of hot plumes of material which rise from near the earth's core and cause massive melting when they approach the upper mantle and crust.

The largest of the Columbia River eruptions produced 1,600 cubic kilometers of lava in about 1 week, which traveled over 500 kilometers. By contrast, the largest eruption of fluid lava ever witnessed by humans, at Iceland's Laki in 1783, produced 14 cubic kilometers of lava in 8 months.

Over millions of years, many thick sheets of basaltic lava were deposited by these eruptions. Basalt is a hard rock and will often outlast surrounding rock or protect softer rock beneath it from erosion. It thus forms many of the plateaus in the eastern parts of the Columbia Basin, as well as the cliffs and waterfalls of the Columbia Gorge.



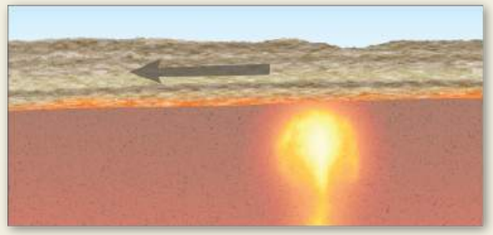
From the Canyon...

When an eruption ends, magma that hasn't erupted can solidify below ground and may remain when the surrounding terrain is eroded away. These dikes are just north of the Washington–Oregon

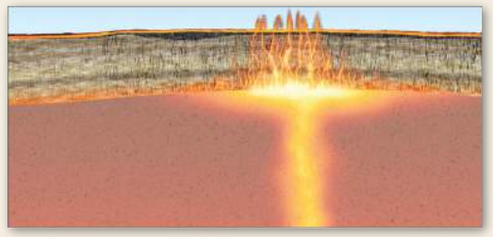
...to the Coast

Many Grande Ronde and Wanapum flows were quite large and reached the northern Oregon coast, forming many of its famous cliffs and seastacks. Haystack Rock, pictured above, is a

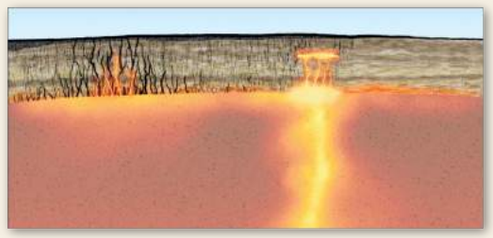
Life Cycle of a Mantle Plume



Mantle plumes form in the lower mantle near the Earth's core. The mantle is solid but soft enough to flow on long timescales, so the plume rises through it as a column of hot rock that remains roughly stationary relative to the



When the head of the plume reaches the crust, it causes uplift and fracturing, while the heat of the plume causes massive melting in the upper mantle. Flood basalts occur when this magma flows up through the fractures.



After millions of years, the head is exhausted and may be carried off by the drifting crustal plate. The remnant of the head can continue to cause "small" eruptions like those of Newberry Volcano. The tail persists as a "hot spot",

MISSOULA FLOODS

About 15,000 years ago, toward the end of the Ice Age, an extension of the Cordilleran Ice Sheet dammed the North Clark River in present-day northern Idaho. Glacial Lake Missoula, a vast lake stretching hundreds of miles across, formed behind the ice dam. Rising water weakened the dam until the water finally burst through in a cataclysmic flood that inundated much of the Pacific Northwest. Raging floodwaters eroded landforms, transported sediment and glacial erratics from Montana to the Pacific Coast, created new landforms such as the Channeled Scablands in eastern Washington, and carved out the Columbia River Gorge. Over centuries, as the Cordilleran Ice Sheet advanced and retreated dozens of times, Glacial Lake Missoula filled and emptied in similar large flood events.

Crown Point, Columbia River Gorge

Palouse Falls

Channeled Scablands

Geologic Discovery

Two geologists in the 1920s, J. Harlen Bretz and Joseph T. Pardee, were instrumental in solving the mystery of the Ice Age flood. Bretz studied the Channeled Scablands in eastern Washington and recognized evidence of catastrophic flooding. Bretz's theory was initially disregarded because it ran against prevailing views of the time. Parsdee identified the source of the flood, proposing the theory of Glacial Lake Missoula and the failing ice dam. Parsdee's findings lent credibility to Bretz's theories. The multiple flood hypothesis, now the most widely accepted theory, was first proposed by R. B. Waitt, Jr. in 1980. This theory suggests there were 40 or more separate floods instead of a single flood as Bretz and Pardee believed.

Effects on the Landscape

Floodwaters carved out 50 cubic miles of rock, transporting sediment and boulders long distances and depositing them as new landforms or onto the floor of the Pacific Ocean. Gravel bars reached 400 feet tall. In Oregon's Willamette Valley, floodwaters deposited fertile soil. The walls of the Columbia River Gorge were scoured and steepened. Creek junctions with the Columbia River were destroyed, leaving creeks to drop over the lip of the gorge as spectacular waterfalls. The Channeled Scablands in Washington along with the Grand Coulee riverbed, Dry Falls, Palouse Falls, and many other features were created by the Missoula Floods. Today, erratics with origins in Montana and British Columbia can be found in the Willamette Valley.

Significance

Scientific study of the Missoula Ice Age Floods contributes to understanding cyclical climate change. The Ice Age Floods have been considered an analog to understanding geologic processes on Mars, where landforms similar to those in eastern Washington's Channeled Scablands have been discovered. Outburst floods similar to the Missoula Floods will likely recur in the Columbia River Basin in the future, as long-term climate cycles will cause large ice sheets to engulf the landscape once again.

CHAPTER 3

HISTORY

Originally inhabited by Native American tribes, the social landscape started to diversify as European Americans expanded westward in search of fur trade and resources in the Basin.

The site of the earliest inhabited community in North America, Celilo Falls, located mid-way up the Columbia River, was one of the most important indigenous fishing grounds along the Columbia River.

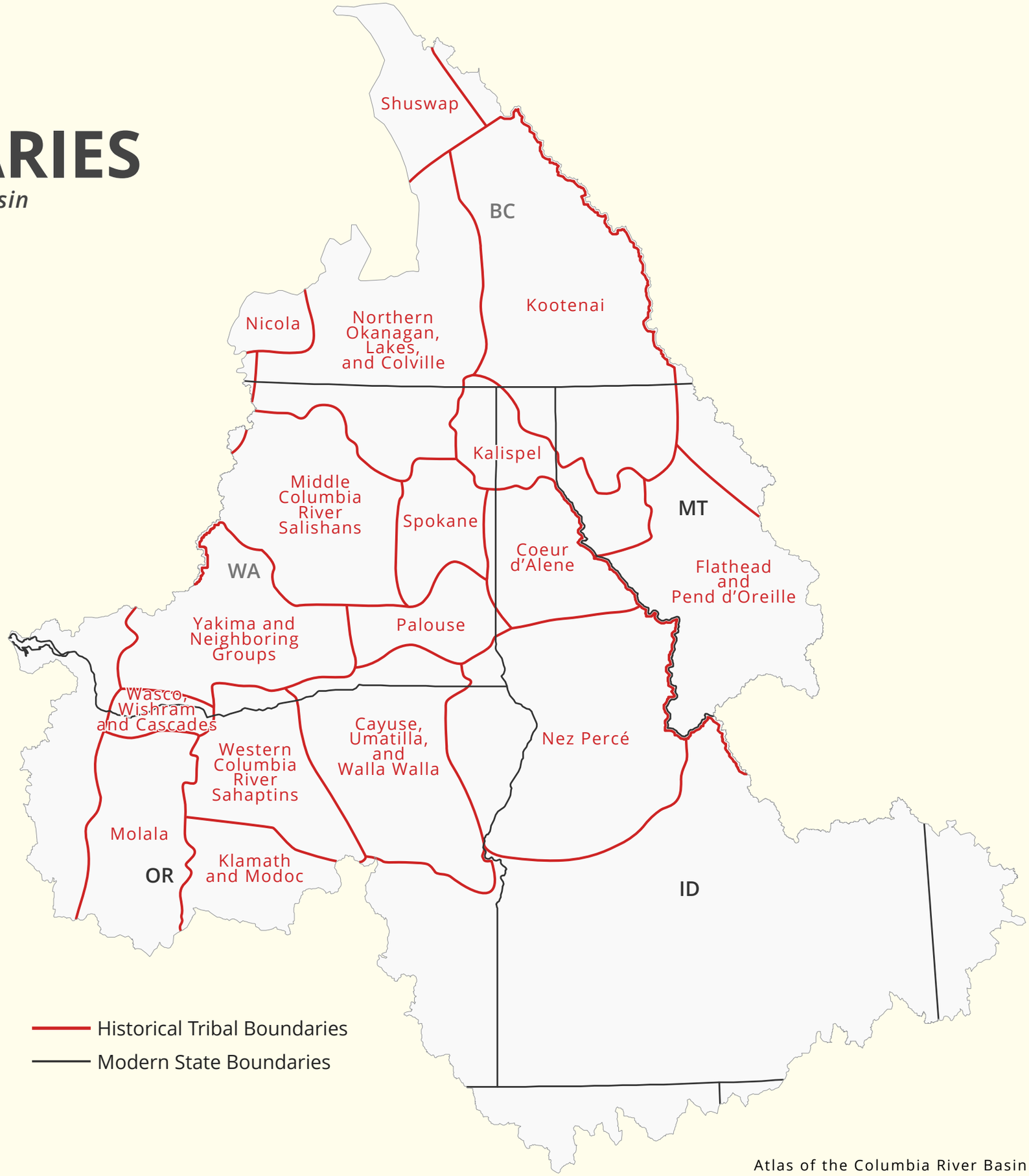
TRIBAL BOUNDARIES

Native Peoples of the Columbia River Basin

Native American communities residing in the Columbia River Basin flourished until the migration of the American Pioneers. Much of Native American's culture was lost during this time, making it difficult to gather information about their previous lifestyles.

Many Native American tribes inhabit the Columbia River Basin. It is unknown how the native people of the region originally traveled here. There is evidence to support the theory of traveling by way of land bridge that existed between Northeast Russia and Alaska during the late Pleistocene epoch. It is known that humans have inhabited the region for as many as 14,500 years. Native Americans have likely fished the Columbia River Basin since their first arrival here.

The simplified ranges shown are a generalization of the situation in the early- to mid-19th century. Since the map depicts the situation at the earliest periods for which evidence is available, the ranges mapped for different groups often refer to different periods; there may have been intervening movements, extinctions, and changes in range that are not shown. Groups that came into existence later than the mapped period are not shown. This map it is not an authoritative depiction of territories for several reasons: sharp boundaries have been drawn and no area is unassigned; groups mapped are in some cases arbitrarily defined; subdivisions are not indicated; no joint or disputed occupations are show; and different kinds of land use are not distinguished.



TRIBAL RESERVATIONS

In 1846, the Oregon Treaty resolved the dispute over the international boundary between the United States and Canada. With the treaty came a new set of changes to the Native American tribes of the area. Massive immigration and settlement by Euro-Americans of the Columbia River Basin occurred. The Oregon Treaty ignored all tribal land claims, interests, and native involvement in the settlement discussions. Native Americans were removed from their aboriginal territory and relocated on reservations. The Dawes Severalty Act, the Homestead Act, rights of way and roads, and the sale of patented Indian lands contributed to the diminishing acreage of reservations over time.

By 1855, treaty making in the northwestern U.S. created different conditions for U.S. tribes from those in Canada. U.S. treaties reserved large land areas for tribes and contained reserved rights language and guarantees. Tribal governments in the U.S. initiated legal actions to affirm treaty rights that included fishing and hunting on traditional tribal lands, as well as rights to tax and legal jurisdiction. In Canada, tribal governments operate under provincial, rather than federal, authority which prohibits tribal challenges to regulatory authority. The U.S. Native American policy in the Northwest has allowed for the creation of stronger tribal governments than in Canada.

British Columbia
Alberta
Montana
Washington
Oregon
Idaho
Salmon River 1
Enderby 2
Otter Lake 2
Okanagan 1
Harris 3
Swan Lake 4
Priest's Valley 6
Shuswap
Columbia Lake 3
One Mile 6
Tsinstikeptum 10
Duck Lake 7
Nine Mile Creek 4
Tsinstikeptum 9
Medicine Creek 12
Vermilion Forks 1
Medicine Hill 11
Penticton
Wolf Creek 3
Mission Creek 8
Kootenay 1
Bummers Flat 6
Isidore's Ranch 4
Lulu 5
Keremeos Forks 12 & 12A
St. Mary's 1A
Cassimayooks 5
Chuchuwayha 2
Blind Creek 6
Chuchuwayha 2C
Osoyoos 1
Lower Kootenay
Tobacco Plains 2
Ashnola 10
Alexis 9
Osoyoos 3
Range 13
Lower Similkameen 2
Kootenai
Narcisse's Farm 4
Chopaka 7 & 8
Kalispel
Colville
Spokane
Coeur d'Alene
Flathead
Yakima
Nez Percé
Warm Springs
Celilo Village
Umatilla
The Dalles Unit
Grande Ronde
Warm Springs
Fort Hall
Duck Valley
Fort McDermitt

HISTORIC EXPLORATION AND TRAVEL

Voyages, Trails, and Trade Routes

Surveys

European interest in the Columbia River began with the search for the Northwest Passage, a theoretical route through North America to the trade markets in Asia. The location of the river mouth was first correctly described in 1775, but no expedition reached the river itself until the voyage of the the American Captain Robert Gray in the Columbia Rediviva in 1792. Later that year, the British investigated the first 100 miles of the river under Commander George Vancouver, stopping at the point that would later be the site of Fort Vancouver. In 1805 and 1806, Meriwether Lewis and William Clark mapped the lower river and part of the Snake as they made their way to the Pacific Coast in search of "the most direct & practicable water communication across this continent, for the purposes of commerce." The full river was mapped in 1811 and 1812 by David Thompson, a British-Canadian fur trader and consummate surveyor, who laid claim to the site at the confluence of the Snake and the Columbia that would later become the well-situated Fort Nez Percé (later US military Fort Walla Walla).

Reshaping

Then in 1825, Hudson's Bay Company established its Columbia District headquarters at Fort Vancouver, rerouting many of its shipments down the river. This led rapidly to further interior exploration of the Basin by trappers and fur traders, and the expansion of existing Native American trails into major routes for overland trade such as the York Factory Express and the Okanogan Trail. Other routes created by natives and fur trappers were merged to form the Oregon Trail, which brought thousands of American settlers to the Basin. This prompted the construction of additional forts for both trade and protection as hostilities with native peoples increased. In 1877 the conflict between Americans and the Nez Percé ended with the U.S. cavalry forcing the Nez Percé from their lands in Oregon, Washington, and Idaho along what is now the Nez Percé National Historic Trail to Montana and Canada. Conflicts also arose between the Americans and the British, who jointly controlled the area by treaty after the War of 1812. The vast numbers of Americans settling in the region eventually undermined the British presence, leading to the Oregon Treaty, which divided the territory at the 49th parallel, the modern border between the US and Canada.

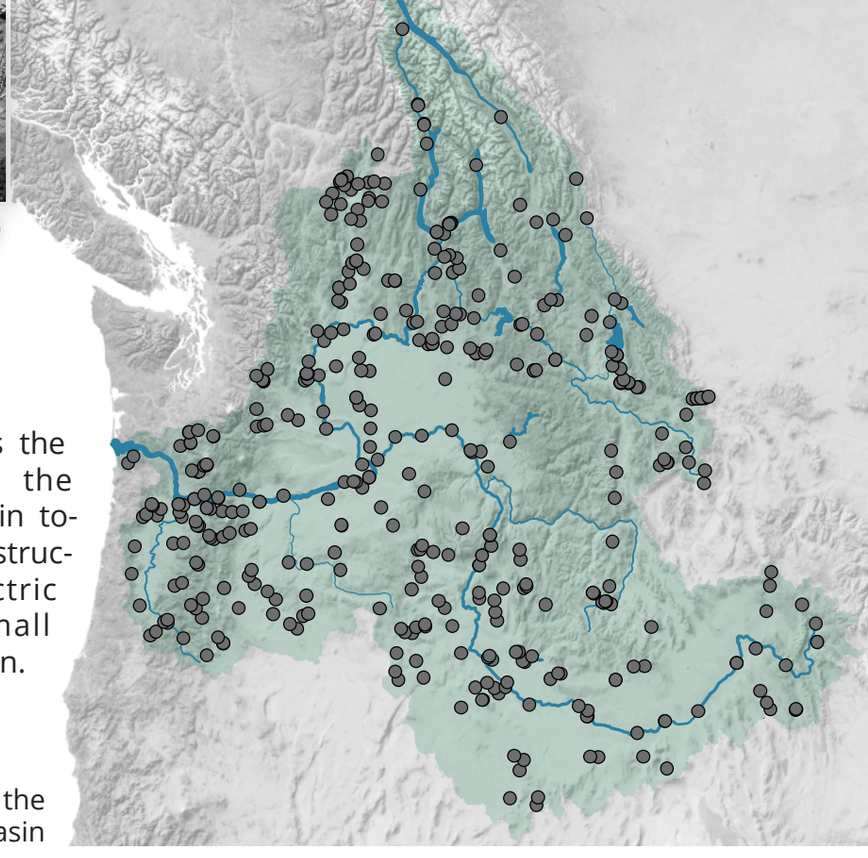
DEVELOPMENT OF THE RIVER

Changing the Face of the Basin

Major dams (50 feet tall with a storage capacity of at least 5,000 acre-feet, or of any height with a storage capacity of 25,000 acre-feet) listed by the U.S. Corps of Engineers are shown in the map above. They are displayed by date of completion, with older dams represented by darker colors. Tap the image to view as an animation.

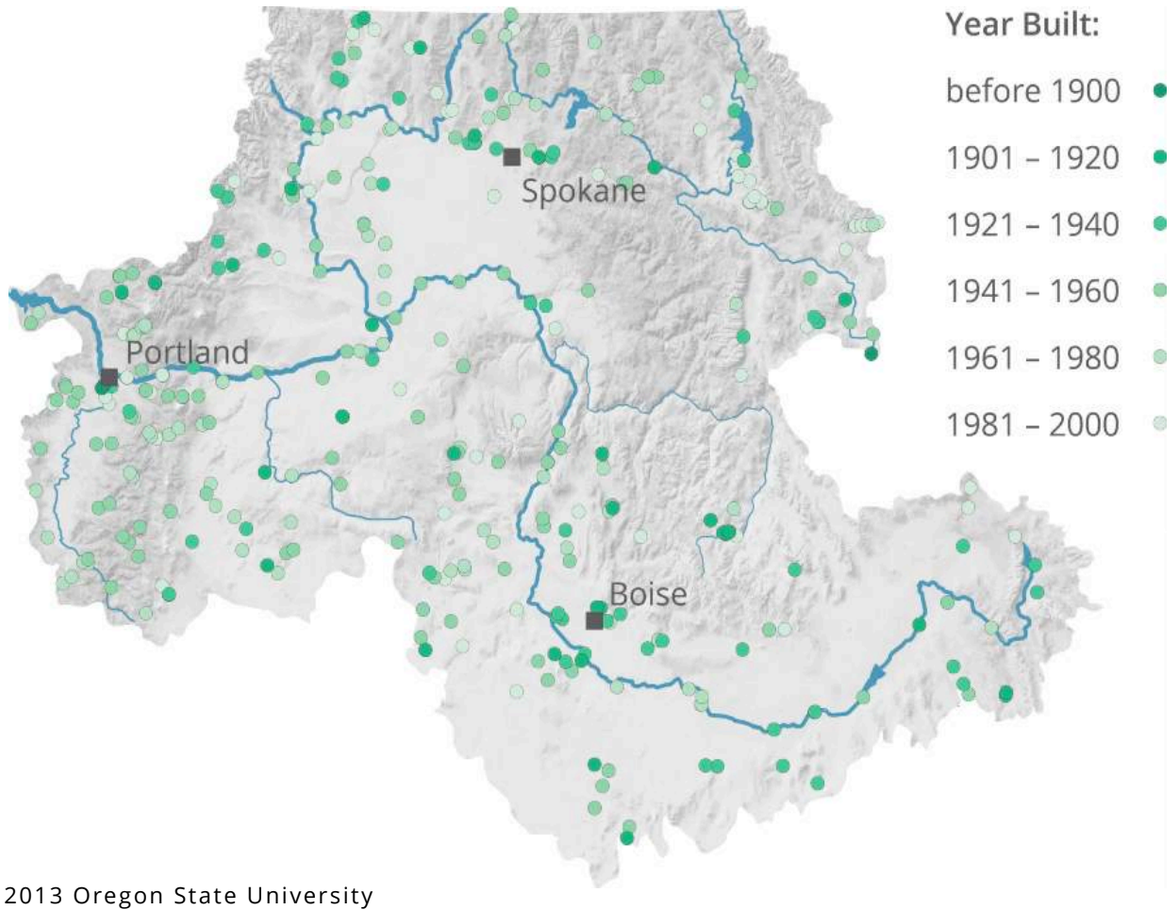
The first hydroelectric dam in the Pacific Northwest was built in 1885 in Spokane, Washington. In 1933, Rock Island Dam in Washington, the first spanning the main stem of the river was completed. Since then, ten more dams across the main river and hundreds of smaller dams have been built in the United States on the Columbia and its tributaries.

The Columbia River Basin is the most dammed system in the world, with over 450 dams in total. These range from huge structures used for hydroelectric power generation, to small earthen ones used in irrigation.



Major Dams of the Columbia River Basin

Date of Construction of U.S. Major Dams



Early Modification

Around the turn of the 20th century, industrialists began giving their attention to the unruly waters of the Columbia and its tributaries. The Columbia was dredged to enhance navigability, locks and canals were installed to bypass the Cascades Rapids and Celilo Falls, and jetties were constructed at the river mouth to make travel near the Columbia Bar less treacherous. Still, none of these alterations can compare to the hydrological changes that came as a result of the dams that were installed over the course of the 21st century. Federal dam projects were initially aimed at providing irrigation to the nutrient rich but dry regions of eastern Washington, but as demands for electricity increased, hydropower became the foremost consideration.

Altered Course

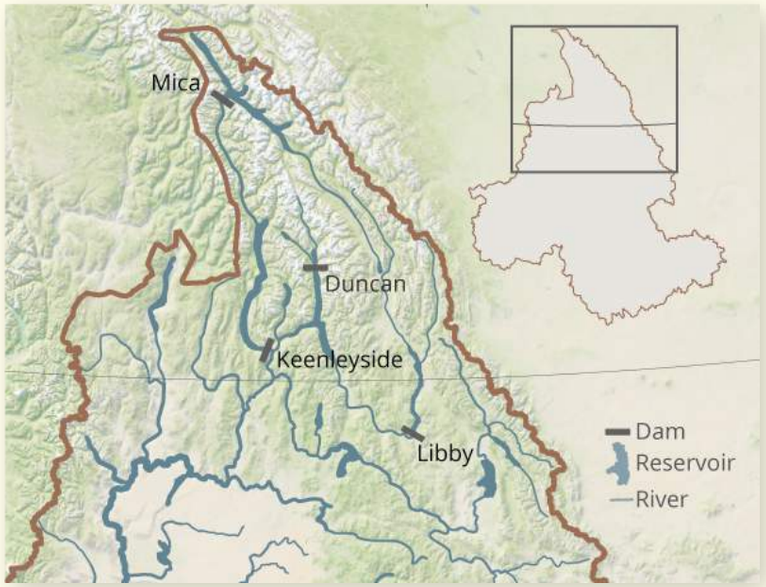
Eight dams spanning the main stem of the Columbia River were built between 1937 and 1961, including Grand Coulee Dam, the largest in North America. In 1961, the Columbia River Treaty was signed by the U.S. and Canada, laying out an agreement between the two nations on the operations and development of the Upper Columbia River and providing for the construction of additional dams. Today, dams of the Basin provide 40 percent of the Pacific Northwest's electricity in addition to substantial amounts exported to other areas. Their construction greatly altered the river, flooding places such as Celilo Falls—once a native fishery—while also regulating extreme flows.

COLUMBIA RIVER TREATY

Trans-boundary Management of the River

History and Provisions of the Treaty

In 1948, severe flooding in the Columbia River Basin caused multiple deaths and extensive property damage in both Canada and the U.S.. In response to such flood events, as well as to foster hydroelectric development, the U.S. and Canada ratified the Columbia River Treaty in 1964. Treaty provisions include flood control measures and river usage guidelines for power generation. The Treaty initiated the construction of three dams in Canada (Mica, Duncan, and Keenleyside) and one dam in the U.S. (Libby). The U.S. paid Canada $64.4 million for dam construction and expected avoidance of flood damages through 2024. The U.S. also pays Canada 50% of the projected U.S. power benefits each year, known as the "Canadian Entitlement."



Treaty Dams

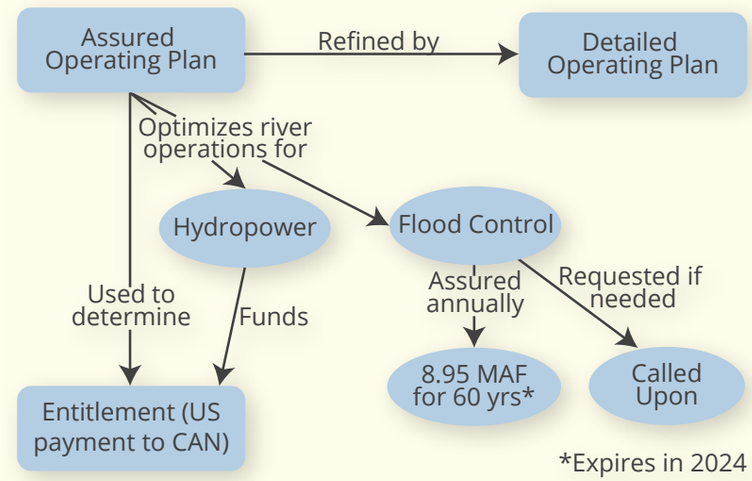
The Future of the Treaty

While the Treaty continues indefinitely, some flood control provisions will expire in 2024 and two other major provisions others will come into effect. First, flood control provisions shift from assured flood control of 8.95 million acre feet (MAF) of storage in Canada to "Called Upon" flood control, where the U.S. can request and pay for emergency storage after it has utilized its own storage. Second, both nations can unilaterally terminate the Treaty, given ten years notice. Therefore, if either nation wanted to terminate the Treaty in 2024 (the earliest date to do so), the U.S. or Canada would need to give notice of its intent in 2014. To understand what the future management of the river may look like and what decisions they want to make, both nations are conducting reviews of the Treaty.

The Signing of the Columbia River Treaty, 1961, John Diefenbaker (left) and Dwight Eisenhower (right)

Coordination of River Management

Six years prior to a given year, the US and Canada prepare an Assured Operating Plan for river operations. This plan dictates how dams and reservoirs will be operated in order to meet flood risk management objectives and maximize hydropower production. It also determines the amount the US will pay to Canada in the Canadian Entitlement. Detailed Operating Plans can be developed closer to the actual operating year in order to increase benefits for both countries and may address benefits other than power production and flood control. The two countries also produce Flood Control Operating Plans for each of the Treaty dams. These plans lay out the procedures for how the dams will provide flood control to downstream communities.



Planning River Operations

CHAPTER 4

LAND USE

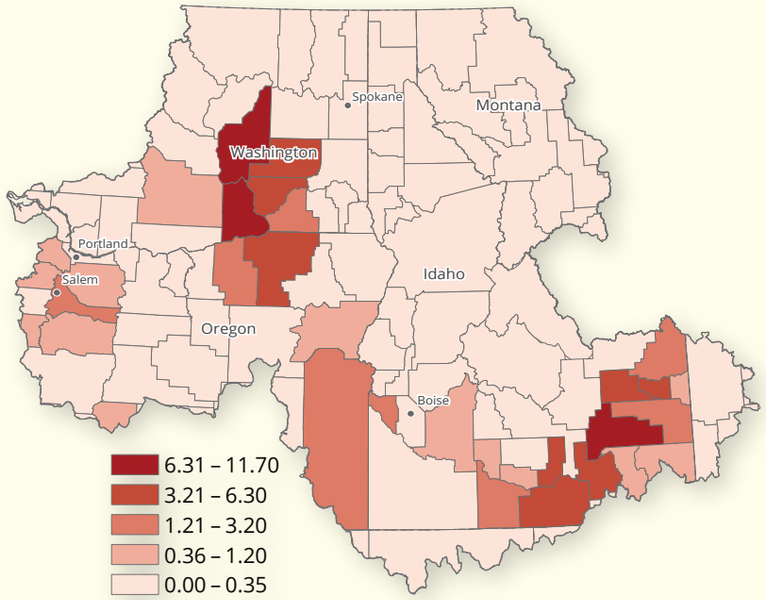
The unique geologic history, topography and hydrology of the Columbia River Basin provide natural resources that have been instrumental to the use and development of the Basin.

With a total generating capacity of nearly 7,000 megawatts, and responsible for the irrigating over 600,000 acres, the Gand Coulee Dam is the most important water control and distribution utility on the Columbia River.

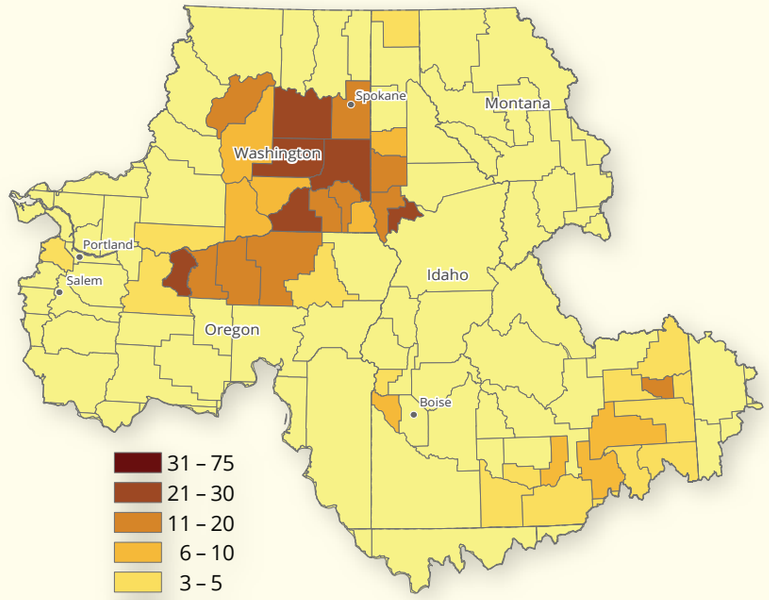
AGRICULTURE

Tap maps to enlarge

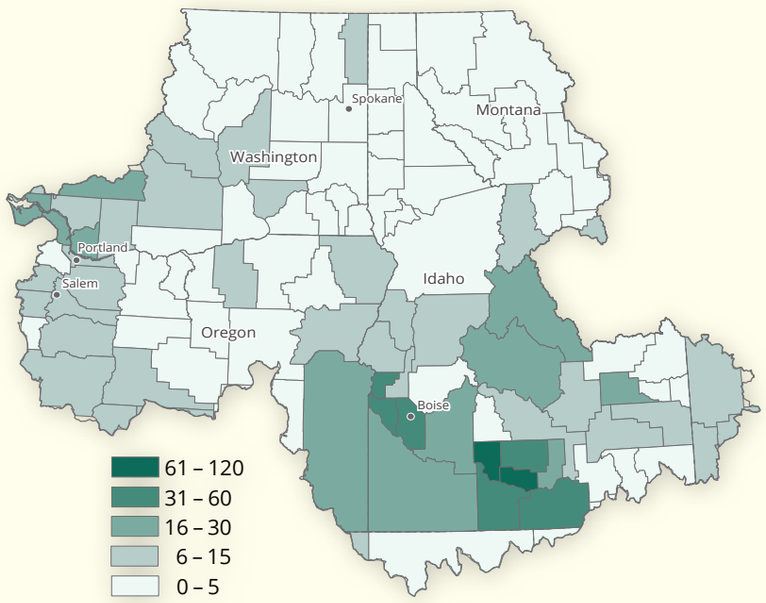
Percent of County Acreage Harvested for Vegetables



Percent of County Acreage Harvested for Wheat



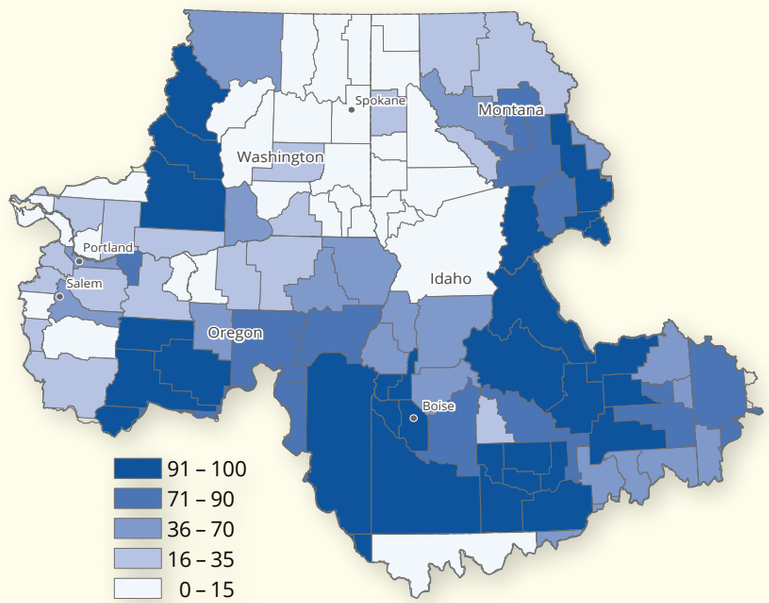
Average Number of Cattle per 100 Acres



Agriculture in the Columbia River Basin began with indigenous people over several thousand years ago. Modern agriculture practices took root during the Lewis and Clark Expedition. Irrigation of crops with water from the Columbia River, an economic activity that today consumes millions of acre-feet each year, originated with the first settlements. Irrigation continues to be a benefit that stems directly from the unique nature of the Columbia River Basin; it is the largest non-hydropower use of water. Farmers in arid parts of eastern Washington, northeastern Oregon, and southern Idaho depend on irrigation to support crops such as wheat, corn, potatoes, peas, alfalfa, apples, and grapes.

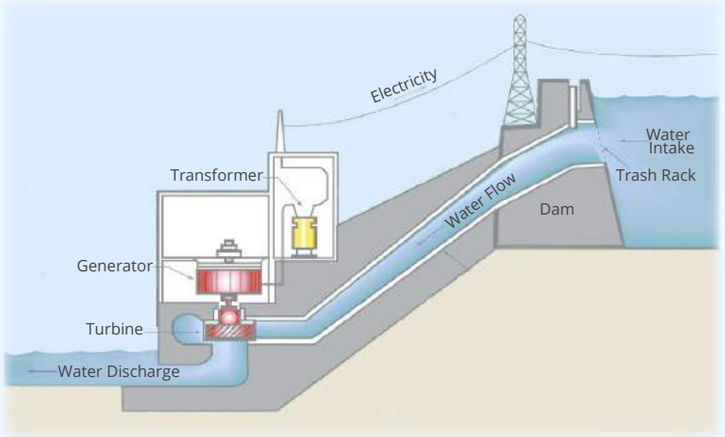
Central Washington supports a variety of crops and the Yakima River Basin in south central Washington is one of the most productive fruit and vegetable regions in the United States. In the Willamette Valley of Oregon more than 170 different crops are grown, making it one of the most diverse agricultural areas on Earth. Idaho is the fourth largest agricultural state in the West and dominant vegetable crops are dry beans, potatoes, and wheat. Agriculture is a culturally relevant and economically important industry in the states of the Columbia River Basin.

Percent of Irrigated County Cropland



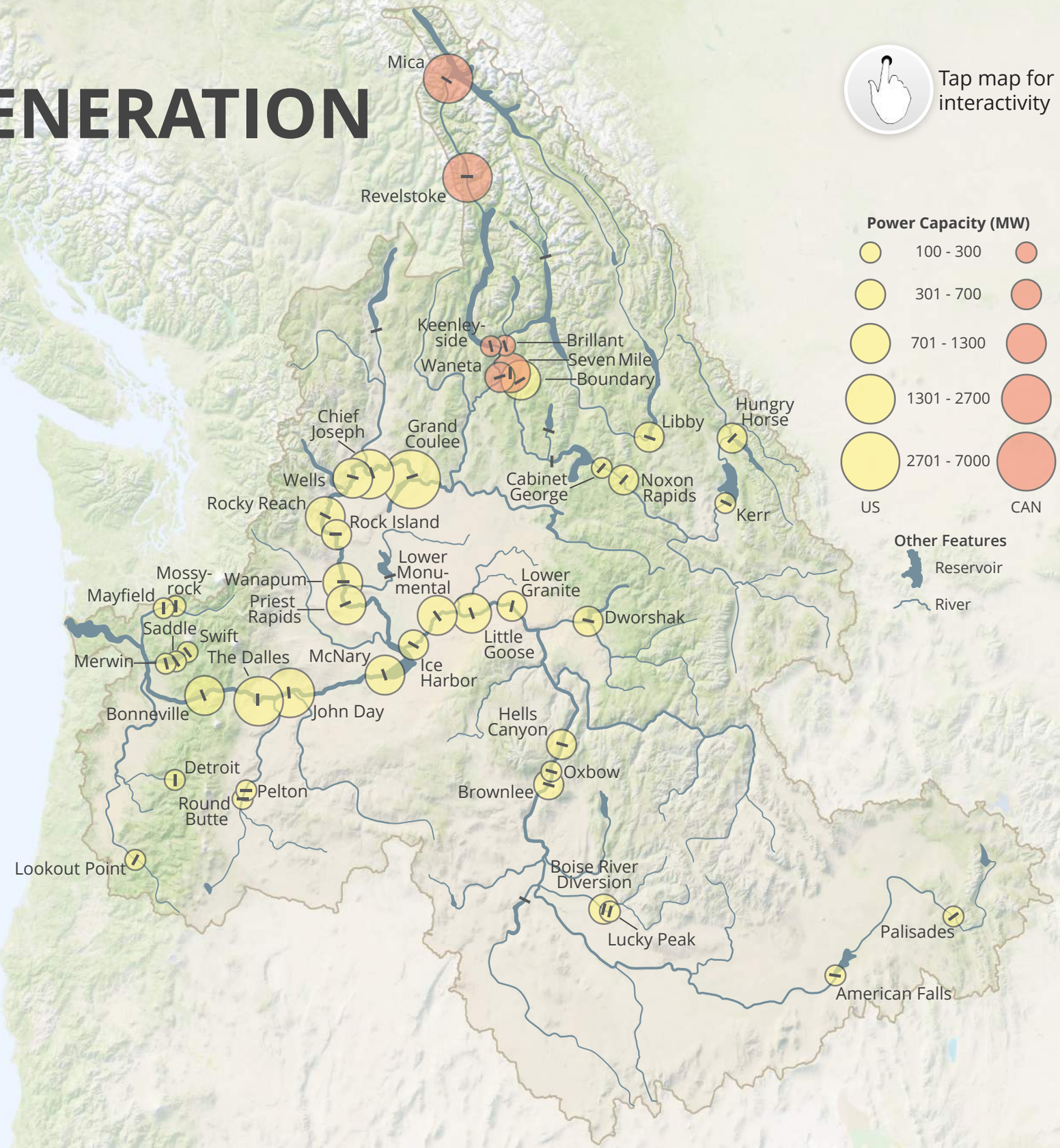
HYDROPOWER GENERATION

Forty percent of the United States' hydroelectricity and thirty-five percent of British Columbia's hydroelectricity is produced in the Columbia River Basin. In an average year, dams in the basin produce 16,604 megawatts (MW) of electricity. In the Columbia River Basin, power generation on the main stem of the river is coordinated through the Columbia River Treaty. The U.S. and Canada work together to optimize the amount of power produced (along with flood risk management) by coordinating dam releases and storage in reservoirs.

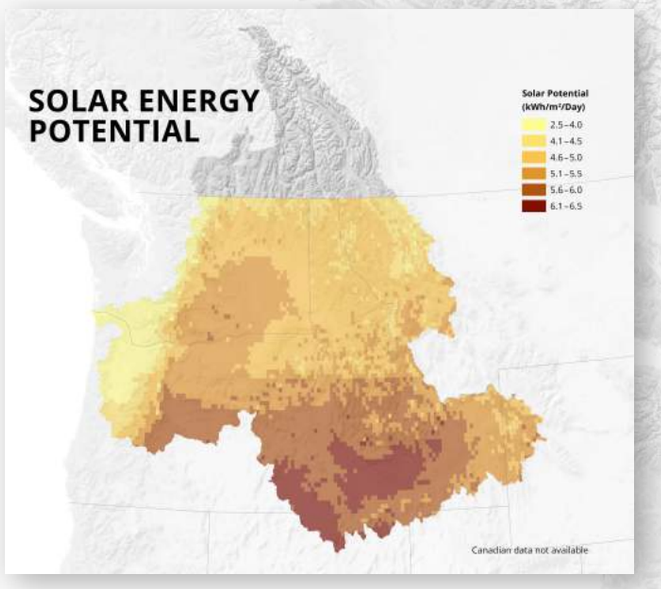


Dams generate power by passing water through one or more turbines , which turn a shaft connected to a generator. This creates an electric charge that transformers convert into electricity. Dam operators regulate the amount of power produced by controlling the flow of water through the turbines. Some dams use reservoirs to store water until it is needed. Run-of-the-river dams, on the other hand, cannot store water and operators rely on storage from dams upstream or spill water over the top of the dam to reduce production and not overwhelm the power grid. "Pumped storage" dams pump water to a reservoir when power demand is low and then release it to produce power when demand is higher.

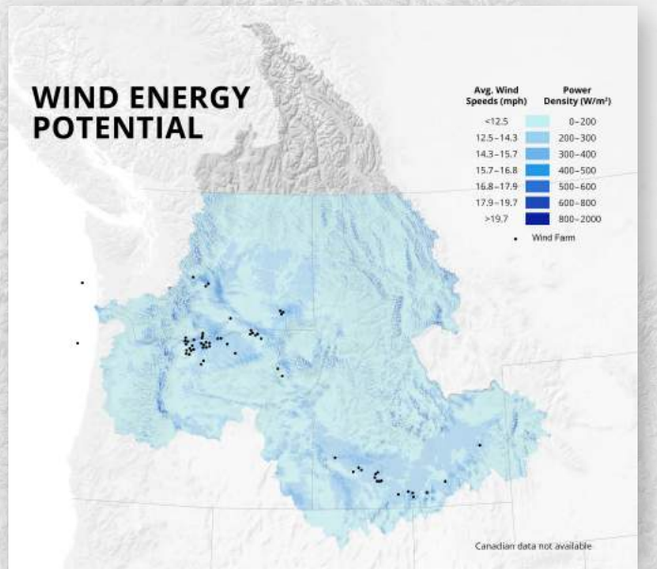
Tap map for interactivity



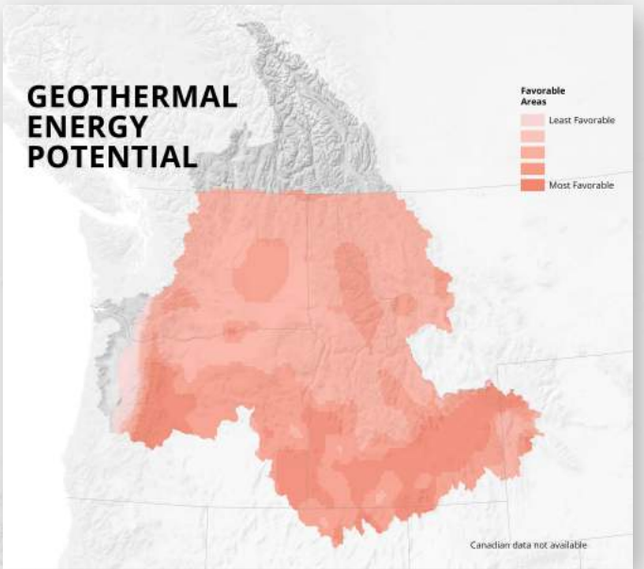
ALTERNATIVE ENERGY SOURCES



Solar technology converts the sun's rays into useful forms of energy like electricity. The rays are captured by solar farms, which are giants plots of solar panels. The amount of solar radiation a location receives depends on its geographic location, time of year, time of day, weather, and landscape. Areas in the southern portion of the Columbia River Basin tend to have a higher solar energy potential compared to the rest of the area.



Wind energy is a fast growing renewable resource. Wind power is converted into electricity, usually with the help of large wind turbines. Geographic location, elevation, season, and time of day influence the wind potential. Many of the wind farms in the Basin are along the Columbia River Gorge and along the Snake river. Many of the high potential areas shown on the map coincide with mountain ranges, where it isn't feasible to build wind farms.



Geothermal energy is derived from the heat that is produced in the interior of the Earth. The Columbia River Basin is on top of a subduction zone, which gives the region a boost in geothermal potential. Electricity production from geothermal energy is expected to reach 100,000 megawatt within the next 50 years.

Baldock Safety Rest Area Near Wilsonville

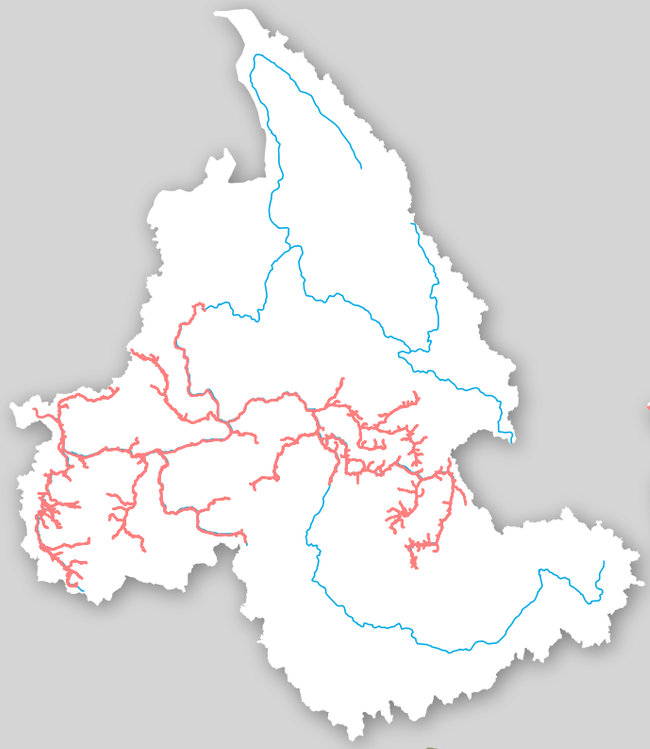
Wind Farm in Columbia Hills

Neal Springs Geothermal Project

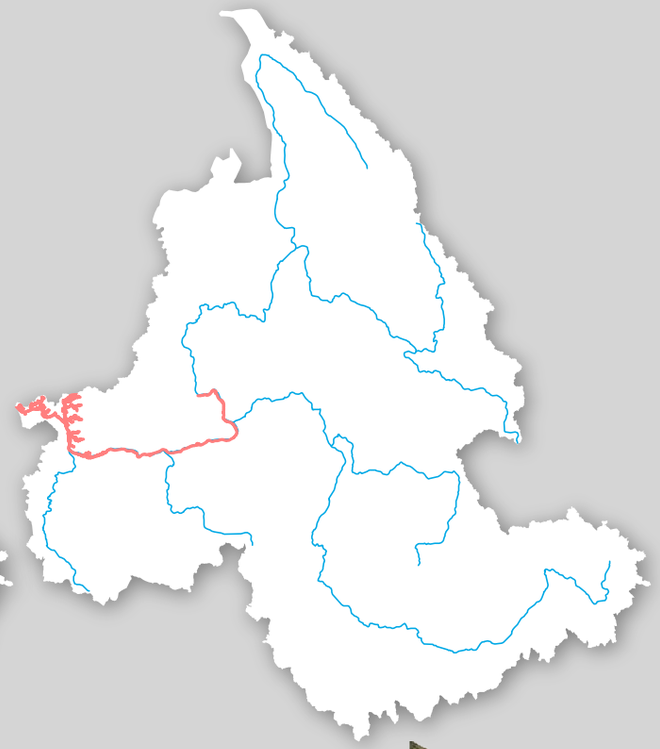
SALMON

Fish Migration

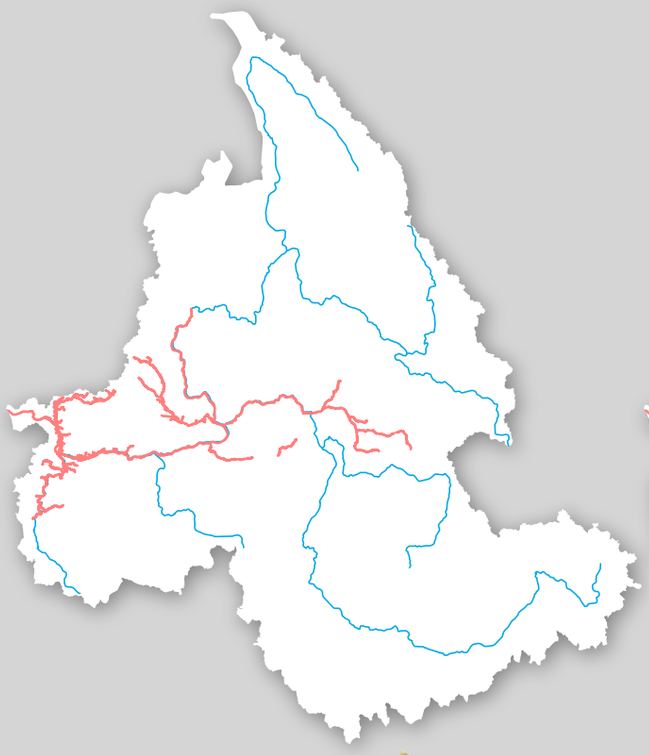
The Columbia River Basin is home to a variety of anadromous fish. Common species include salmon and steelhead. Anadromous fish spend portions of their lives in both freshwater and saltwater. The salmon and steelhead in the Columbia River Basin hatch in freshwater rivers and streams. They migrate to the Pacific Ocean as juveniles and spend most of their adult lives in the sea. Once matured, they return to the Columbia River and travel to the tributary where they hatched to spawn.



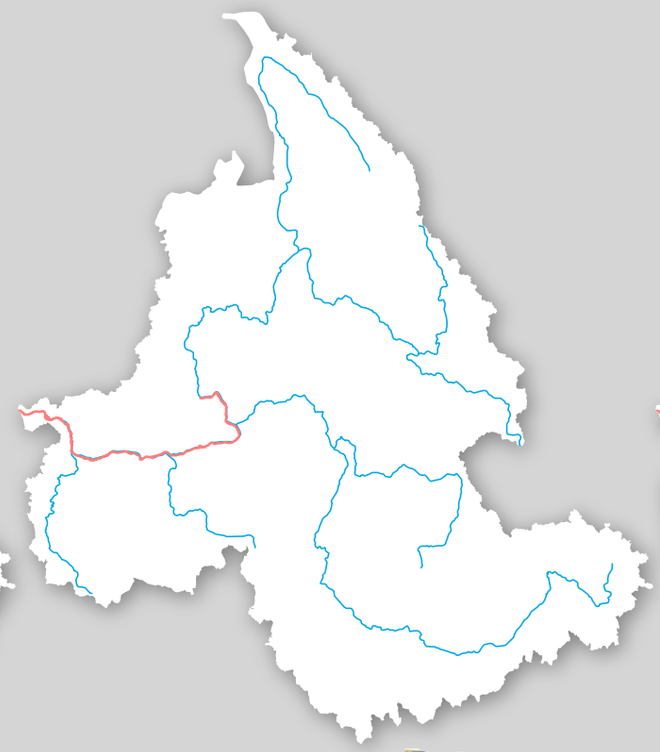
Chinook Salmon



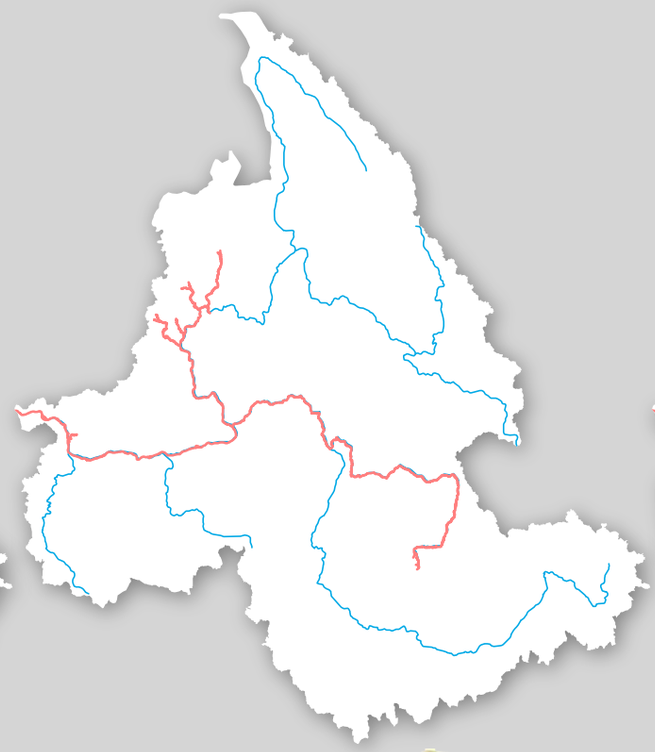
Chum Salmon



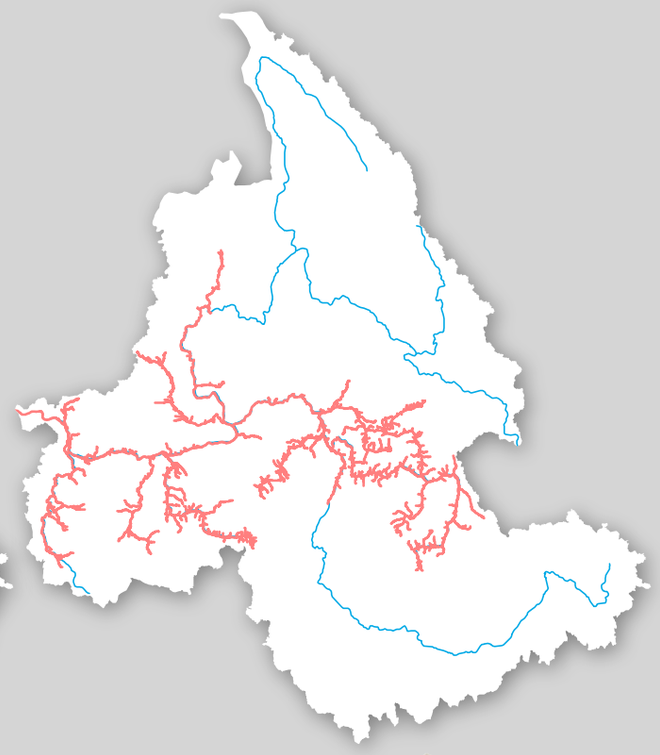
Coho Salmon



Pink Salmon



Sockeye Salmon



Steelhead

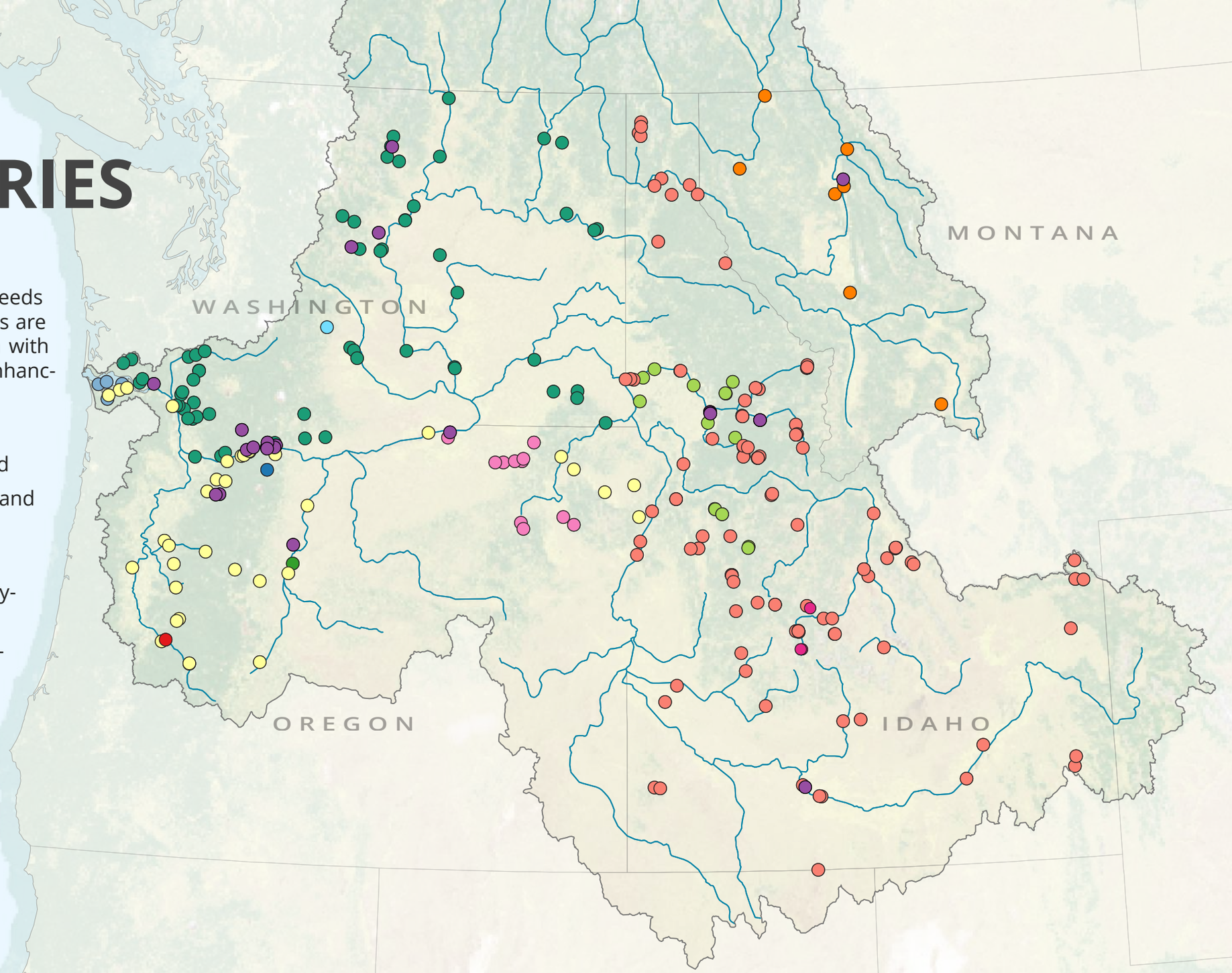
FISH HATCHERIES

A fish hatchery is a facility that artificially breeds and hatches various species of fish. Hatcheries are located throughout the Columbia River Basin with the purpose of conserving, protecting, and enhancing fish and their habitats.

Conservation efforts include:

- Restoring fish populations that have declined
- Protecting threatened and endangered fish and restoring them to their native waters
- Providing fish health services
- Preserving the genes of wild and hatchery-raised fish
- Making up for loss of fish as a result of water projects
- Providing education and research stations

In the United States, the National Fish Hatchery System was established by the U.S. Fish and Wildlife Service. The Service has worked with state governments, Native American tribes, and federal agencies to build hatcheries in vital areas throughout the country.



Fishery Management Agency

- U.S. Fish and Wildlife Service
- Oregon Department of Fish and Game
- Washington Department of Fish and Wildlife
- Idaho Department of Fish and Game
- Montana Fish, Wildlife, and Parks
- Clatsop Economic Development Committee
- Portland General Electric
- U.S. Army Corps of Engineers
- Nez Pierce Tribe of Idaho
- Confederated Tribes of the Umatilla Indian Reservation
- Shosone-Bannock Tribes Fisheries Department
- Confederated Tribes of the Warm Springs Reservation of Oregon
- Yakama Indian Nation

PUBLIC LANDS

Lands managed by U.S. or Canadian Federal Agencies, Tribes, and First Nations

The U.S. Forest Service

The U.S. Bureau of Land Management

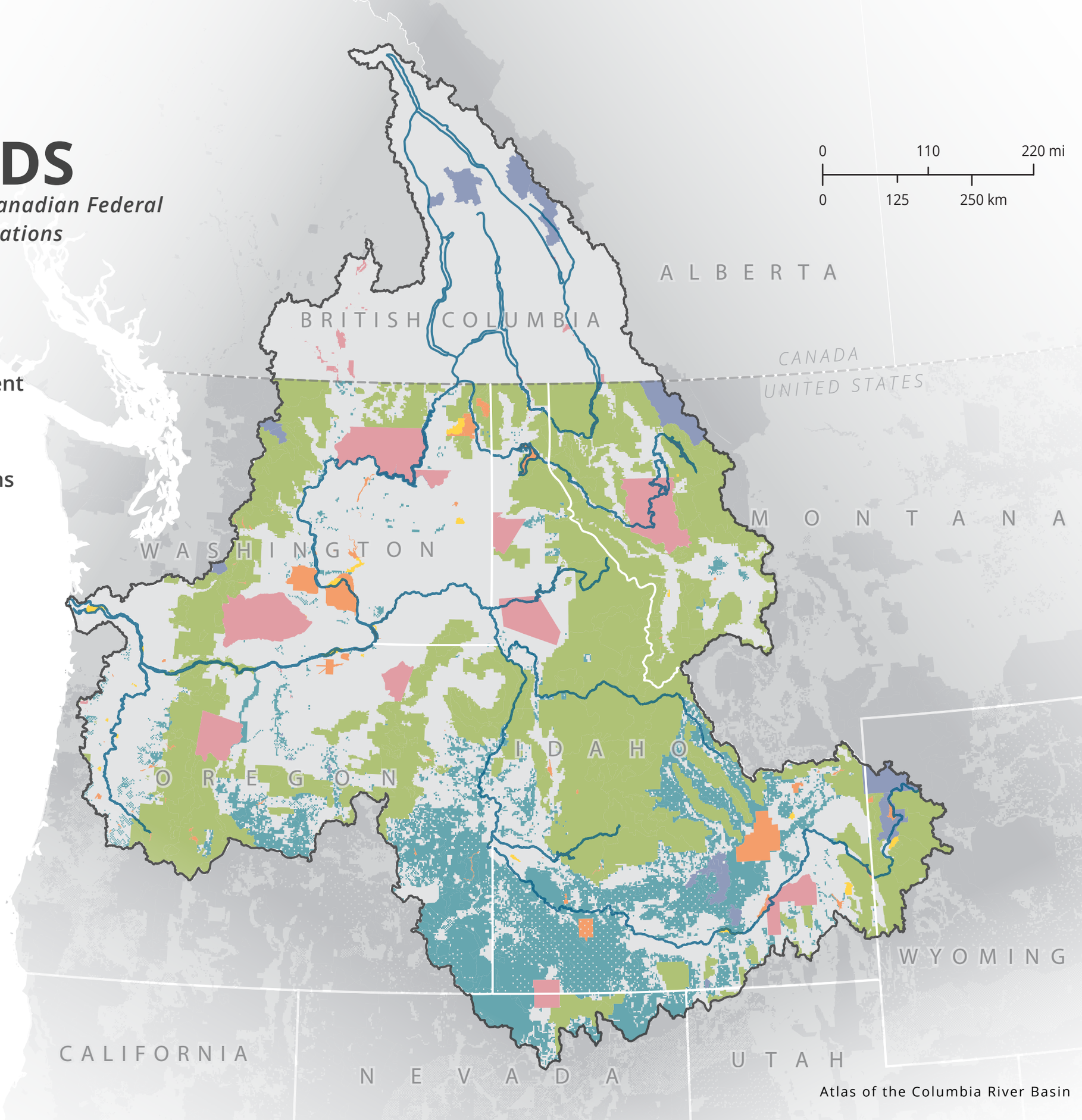
Tribal and First Nations Reservations

U.S. and Canadian National Parks

U.S. Fish & Wildlife Service

Other

Outside Columbia River Basin



COLUMBIA RIVER GORGE

National Scenic Area

The Columbia River Gorge National Scenic Area (CRGNSA) was established in 1986. National scenic areas are created with a mission of protecting and enhancing the scenic, natural, cultural, and recreational resources of a specific area. The area of CRGNSA is 295,000 acres; it extends for nearly 85 miles through the Columbia River Gorge. There is an elevation gradient of approximately 4,000 feet at the deepest point. Almost 2 million people visit the area each year, taking advantage of the wide range of cultural, recreational, and ecological experiences that the area has to offer.

Many communities are nestled in the Gorge. On the Oregon side, Hood River lies at the confluence of the Hood River and the Columbia River. It is located 30 miles from Mt. Hood, the tallest peak in Oregon. White Salmon, Washington, is located across the Gorge from Hood River. The area is famous for agriculture and viticulture.

There are 63 waterfalls in the area. Multnomah Falls is on the Oregon side of the river, and is located along the Historic Columbia River Highway. At 620 feet the falls are the tallest in Oregon and they are often credited as the second tallest year-round waterfall in the United States.

Multnomah Falls

Recreational opportunitles are plentiful in the gorge. Hiking trails and wonderful views abound. Trails offer visitors a variety of options, ranging from short interpretive walks to longer day and overnight hikes.

Mount Hood

RECREATION

Wilderness Activities

Tap icons on map for more information

Rafting and Kayaking

There are hundreds of scenic rivers within the Basin that are wonderful to float or navigate, ranging in level of difficultly. Among these rivers a few stand out as world-class. The Snake, Salmon, Deschutes, Kootenay, and Yakima draw travelers from around the region to test their waters

Fishing

The Basin may be one of best places in the world to fish. Historically, the Columbia River had one of the largest runs of salmon and steelhead in the world and continues to produce every year. Along with salmon, the Basin hosts fantastic trout fishing that rivals any trout fishery worldwide.

Windsurfing

There are only a handful of places in North America where one can windsurf in a river with great conditions; the Columbia River Gorge is one of them. The Gorge is a must for any windsurfer, with activity centered at the city of Hood River, Oregon.

Hiking and Rock Climbing

Where the Basin lacks in rock climbing, it makes up in hiking. There are a number of rock climbing spots but, hiking is the main tourist draw. Places like the Columbia River Gorge and Glacier National Park are unique environments to explore.

Skiing and Snowboarding

Skiing in the Basin is very diverse. It varies from volcanos in Oregon and Washington to high-elevation skiing in the Rockies. Some of the most popular areas include Sun Valley, Mt. Hood, Mt. Bachelor, Big Mountain, and Big White.

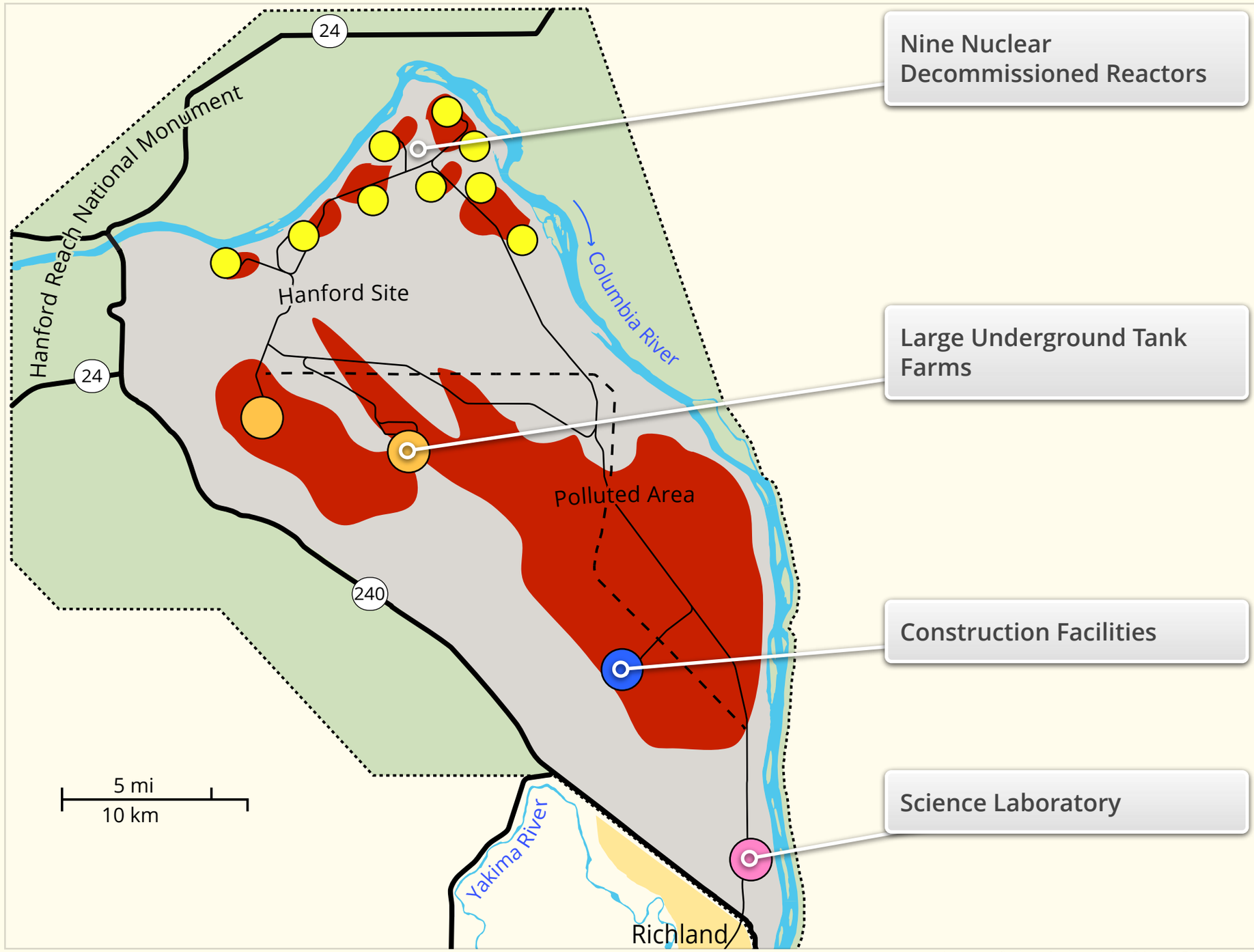
HANFORD NUCLEAR RESERVATION

Areas designated by the Department of Energy

The 565-square mile Hanford nuclear site was built in the 1940s to research and produce atomic weapons to be used in World War II. The site was extended during the Cold War to expand U.S. nuclear weapon capability. It is the most contaminated nuclear site in the United States and the focus of the nation's largest remediation effort.

The Hanford Story

Internet connection required



FACILITIES OF HANFORD SITE

The Hanford Nuclear Reservation is an artifact of the World War II and Cold War eras. The facility was established for the sole purpose of producing atomic weapons to be used in World War WII. The site was expanded after the war to include nuclear reactors and plutonium processing during the Cold War era (1950s through the 1970s). The site today is the most contaminated nuclear site in the U.S.

Government records indicate that safety and disposal practices were poorly conducted in the the early years. Significant amounts of radioactive materials were released directly into the Columbia River. Deliberate release into the air occurred as well. The result of past actions continue to threaten the health of residents and the surrounding ecosystem.

The high priority of clean-up involves a variety of technologies and strategies to address the problems. This includes removing radioactive soil, treating contaminated groundwater, removing dumpsites, emptying and removing leaking storage tanks, and demolishing site structures. One technology—called pump and treat—removes contaminants and returns the treated water to the aquifer (pumps system shown below).

100-HX Groundwater Facility

Massive Hanford Works in the Early 1940s

Double-shell Tanks under Construction

Data Sources and Authors

Students	Kimberly L. Ogren Steven R. Schuetz Charles A. Preppernau Brooke E. Marston Nicholas D. Arnold Jane E. Darbyshire Julie E. Watson John R. Speece Darrell A. McGie Ellen M. Pesek Lara D. Heitmeyer Thomas G. Hood Nicholas P. Maslen Margaret K. Giraud Chase M. Bains Kyle H. Mc Farland Aaron C. Mallon
Production Assistant	Sebastian Hennig
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The Atlas of the Columbia River Basin was created by students in the Geo 445/545 Computer-assisted Cartography course at Oregon State University during the winter term 2013.

Oregon State University OSU

CARTO GROUP GRAPHY & GEOVISUALIZATION

www.cartography.oregonstate.edu

ABOUT THIS ATLAS

The authors of this atlas are both undergraduate and graduate students enrolled in Computer-Assisted Cartography, a course offered through the College of Earth, Ocean, and Atmospheric Sciences at Oregon State University. This atlas of the Columbia River Basin's geology, history, uses, and environmental problems was jointly produced by the authors during the Winter 2013 academic term.

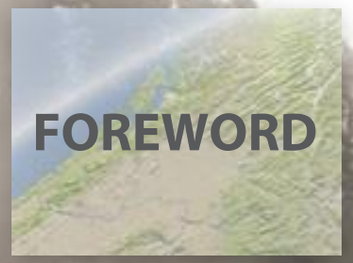
A major goal of this atlas was to explore new opportunities for constructing, designing, and formatting an atlas. Ongoing developments in digital technology have led to a world that is now driven by digital communication, where information is no longer shared primarily through print media. Cartography is transitioning and evolving in conjunction with these new technological advancements, resulting in the ability of cartographers to expand the scope of their work to include new software and mediums. The authors of this atlas wanted to explore the potential of these technologies for the advancement of cartographic design.

The second goal of creating this atlas was to educate others about the Columbia River Basin through geography and cartography. Using map-based storytelling with interactive features, the authors hope to showcase some of the most important aspects of the Columbia River. The authors believe this new approach to atlas design will produce a unique product that will be more engaging and accessible to readers.

DATA SOURCES AND REFERENCES

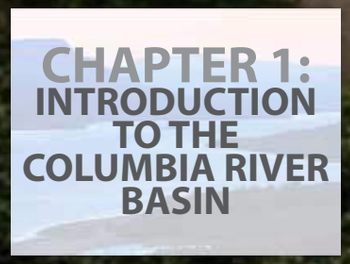
Tap thumbnails for information

Charles A. Preppernau

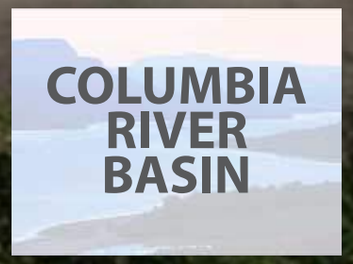


Julie E. Watson

Introduction to the Columbia River Basin



Ellen M. Pesek



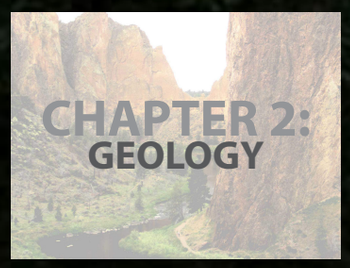
Steven R. Schuetz

Kyle H. Mc Farland, Steven R. Schuetz

Ellen M. Pesek

Nicholas D. Arnold, Aaron C. Mallon

Geology



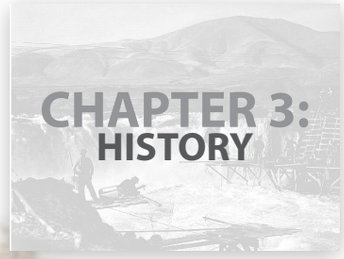
Ellen M. Pesek

Jane E. Darbyshire

Charles A. Preppernau

Brooke E. Marston

History



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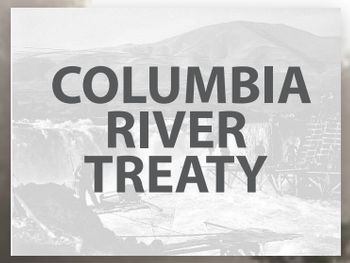


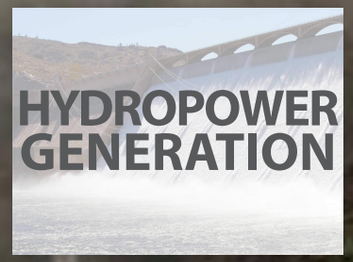
Kimberly L. Ogren

Tap thumbnails for information

Land Use

Ellen M. Pesek,
John R. Speece

John R. Speece



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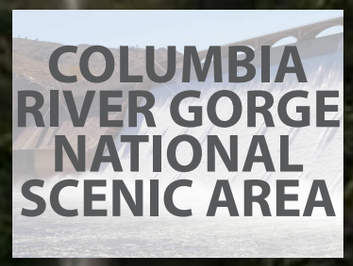
Nicholas P. Maslen,
Steven R. Schuetz

Margaret K. Giraud

Margaret K. Giraud

Julie E. Watson



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