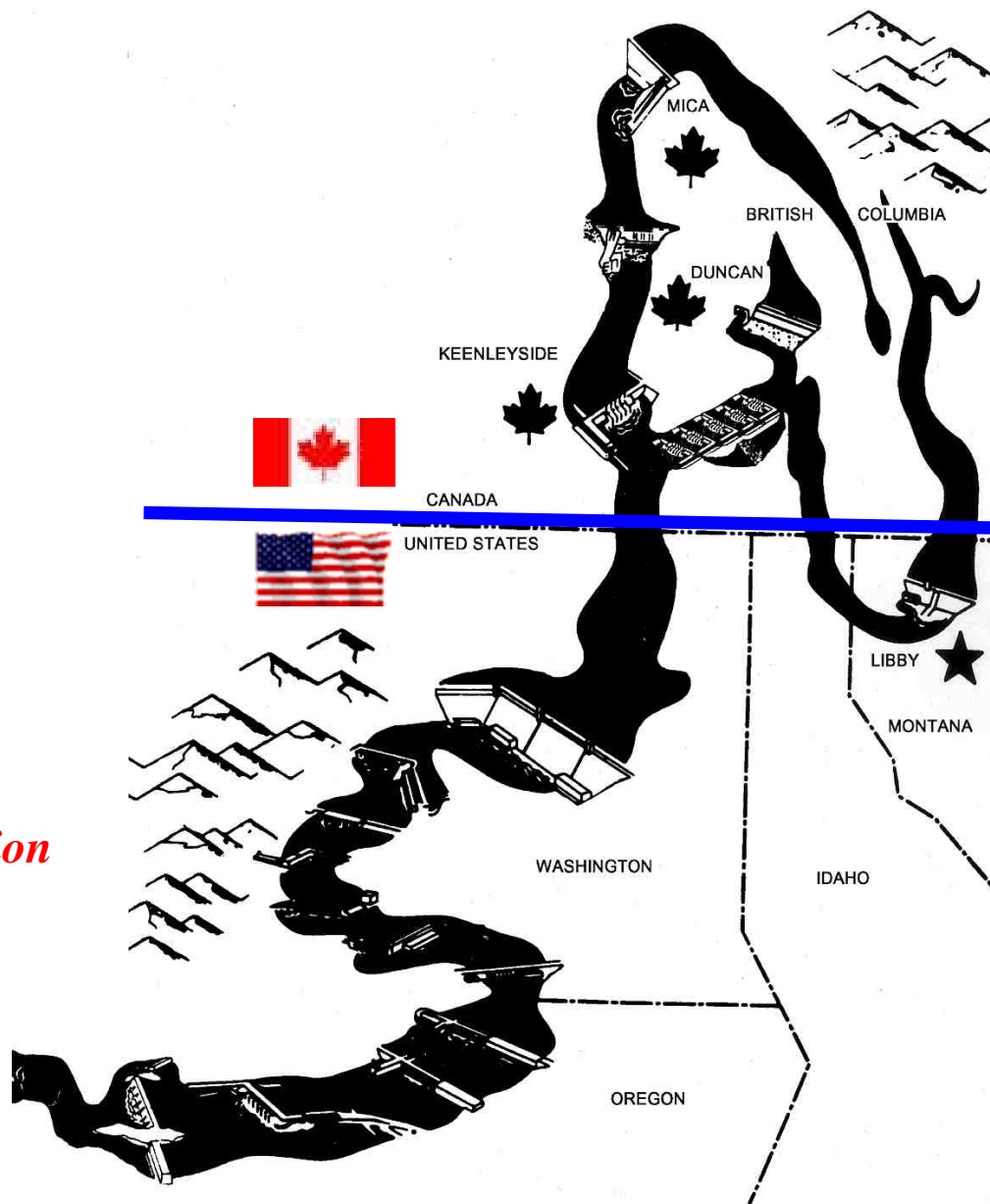




Columbia
River
Treaty

The Columbia River Treaty

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Presentation Outline

- ◆ Geography of the Pacific Northwest
- ◆ Bonneville Power Administration
- ◆ Stream flow characteristics of the Columbia River
- ◆ Dams in the Columbia River basin
- ◆ Typical reservoir regulation
- ◆ Need for Treaty
- ◆ Basic Treaty Requirements and Canadian and U.S. dams
- ◆ Treaty Entities and Permanent Engineering Board
- ◆ Treaty provisions for Flood Control
- ◆ Treaty provisions for Hydropower
- ◆ Lessons Learned



Columbia
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Pacific Northwest



- ♦ U.S.A. Pacific Northwest region consists of states of Oregon, Washington, Idaho, and Western Montana.
- ♦ Columbia River is 1954 km in length and basin size is 697,000 km², compared to Kyrgyzstan which is 198,500 km².
- ♦ About 15% of basin is in province of British Columbia, Canada.
- ♦ About 11 million people live in the four states, and about 4 million people in British Columbia.
- ♦ Coastal region is temperate with lots of rain. Region east of Cascade mountains is mostly dry, hot in the summer and cold in winter.





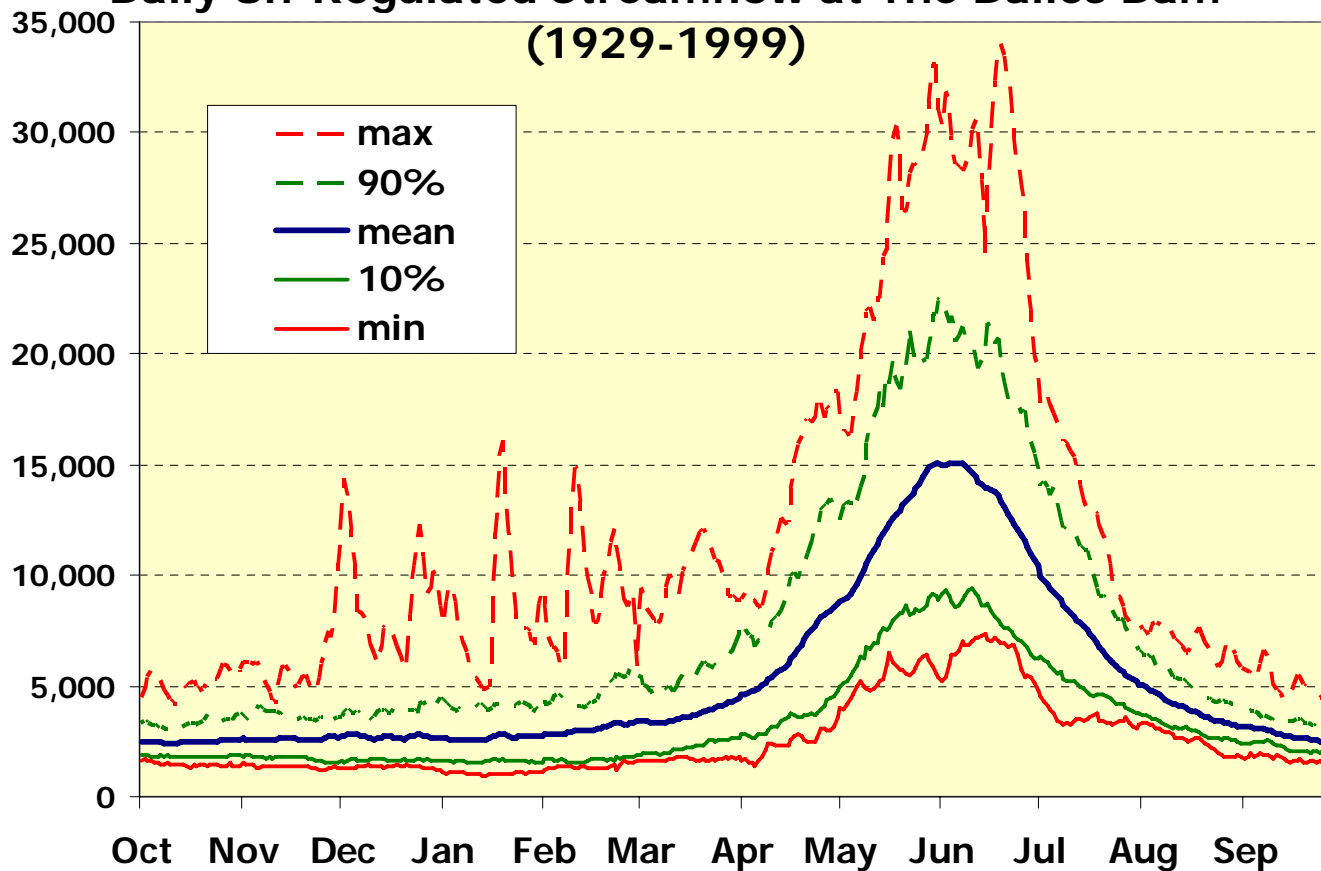
Bonneville Power Administration

- ◆ Self-funding federal agency established in 1937
- ◆ Sells power at cost from 31 federal dams and 1 nuclear plant – 45% of electricity used in Pacific Northwest
- ◆ Sells transmission services. Owns and operates 75% (24,000 km) of the high-voltage lines in Pacific Northwest.
- ◆ Protects, mitigates & enhances fish & wildlife in the Columbia River Basin by changing operation of federal dams and paying for improvements to the dams, fish hatcheries, and habitat improvements.
- ◆ About \$3.5 billion in annual revenues.
- ◆ About 3,000 employees located in Portland and throughout northwest.
- ◆ Size of 31 hydropower dams vary from 1.5 MW to 7,000 MW
- ◆ Annual Federal hydro firm generation ranges from 6,840 average megawatts (aMW) to 10,300 aMW, averaging 8,700 aMW.
- ◆ Generation is largely controlled by the need to move water for non-power purposes (mainly fish and flood control).
- ◆ Most hydro projects are interdependent, affected by upstream projects, and affecting downstream projects.



Columbia River Seasonal Variation in Unregulated Streamflows at The Dalles in cubic meters per second

Daily Un-Regulated Streamflow at The Dalles Dam (1929-1999)



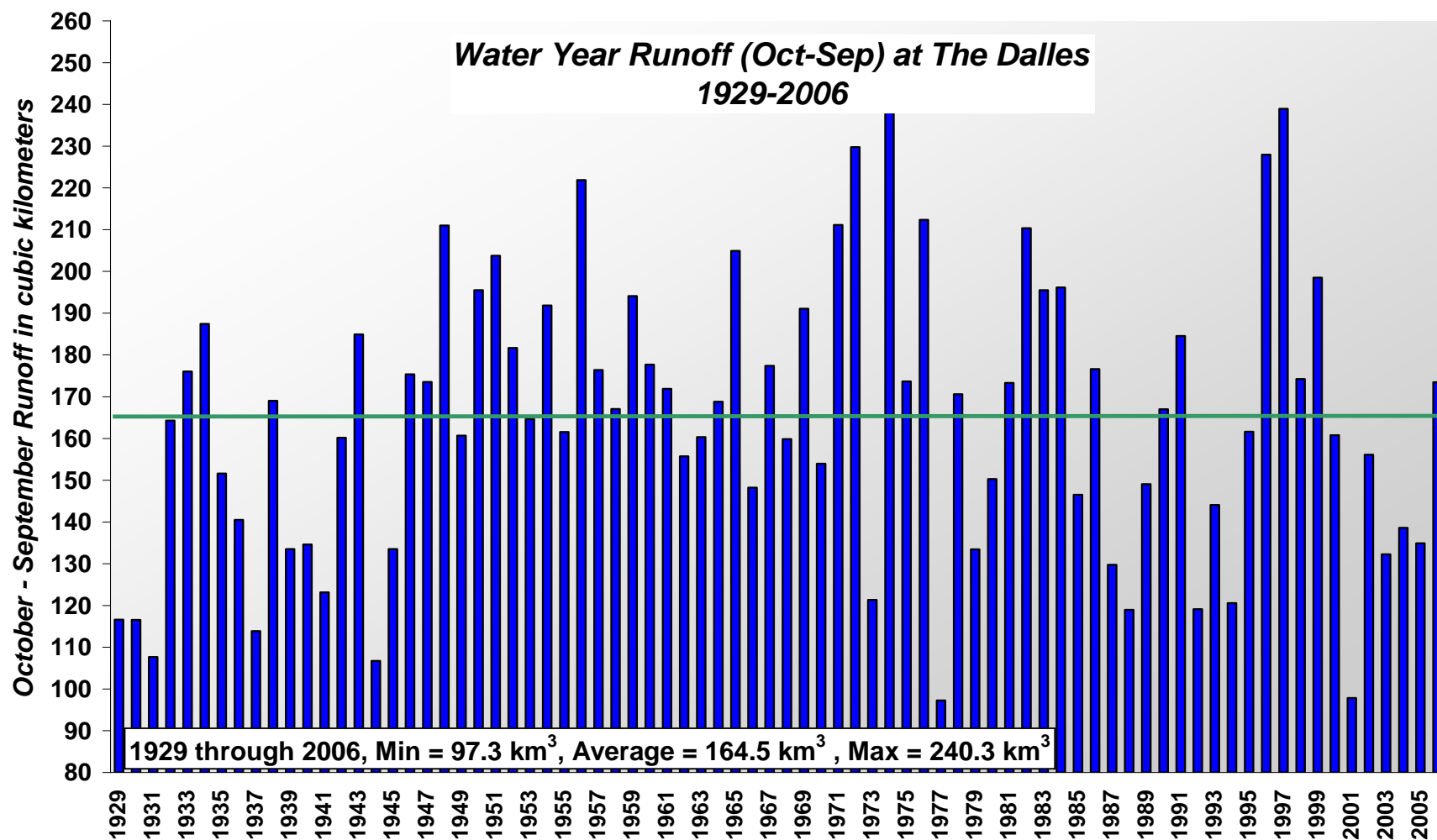
- ◆ Unregulated Columbia River stream flows vary greatly with low to high ratio of 1:34, much higher ratio compared to other large U.S. rivers (St. Lawrence=1:2 Mississippi=1:25).
- ◆ Columbia does not have enough reservoir storage to control most seasonal and annual variations.



Columbia River

Year to Year Variation in Unregulated Flow

About +/- 50% of Average

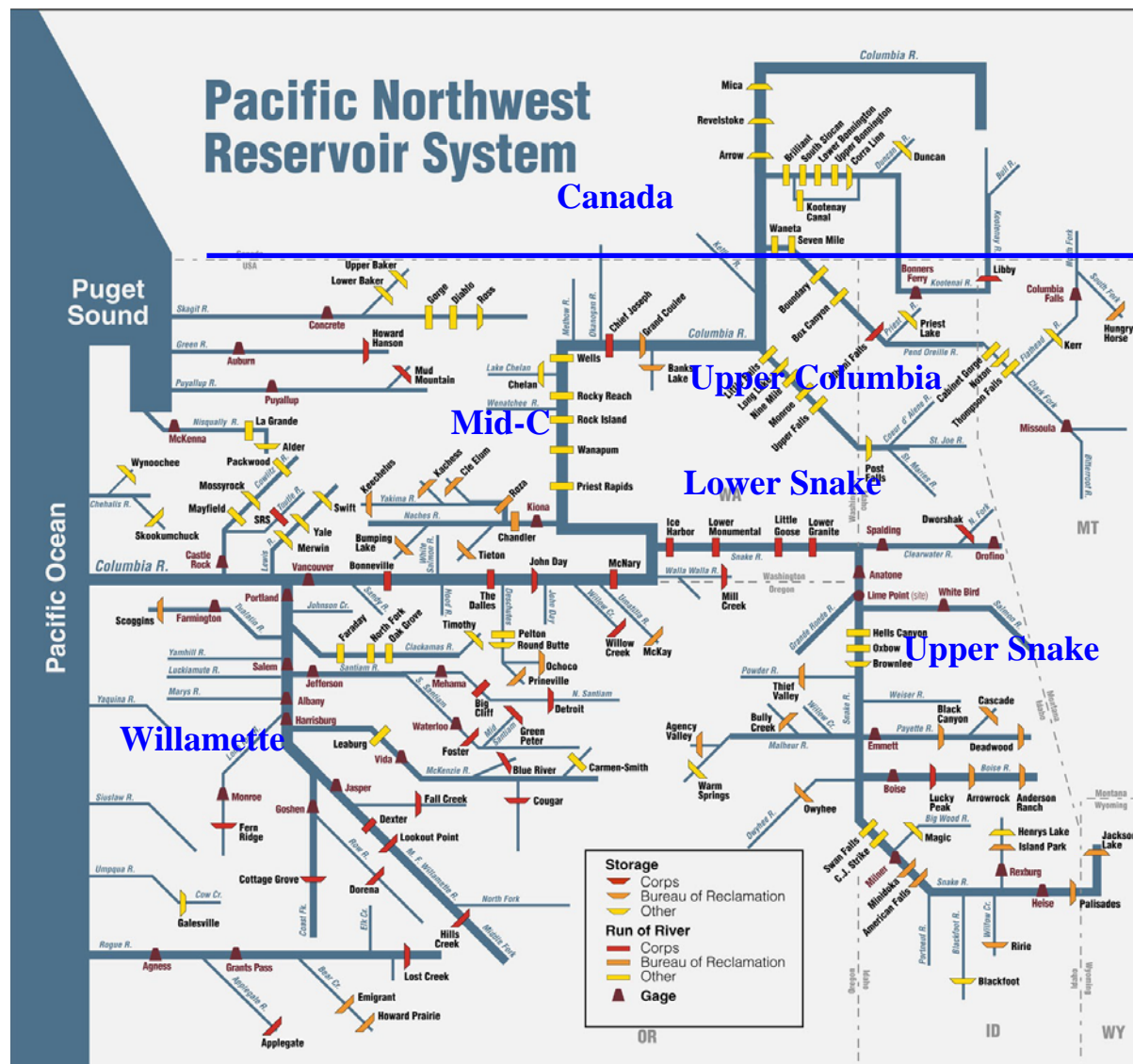


16 Oct 2006



Dams on the Columbia River

- ◆ Over 250 dams
- ◆ 31 federal government dams with power generation
- ◆ Many dams constructed by cities, counties, and private companies.
- ◆ Most dams built for irrigation, flood control, power, or navigation. Now also operated for fish, recreation, and municipal water supply.
- ◆ All coordinated, either hourly, daily, or weekly.
- ◆ About 62 km³ of total usable reservoir storage:
 - 26 km³ in Canada (19 treaty)
 - 20 km³ in Upper Columbia
 - 1 km³ in Mid-C
 - 3 km³ in lower Col. & Snake
 - 10 km³ in Upper Snake
 - 2 km³ in Willamette

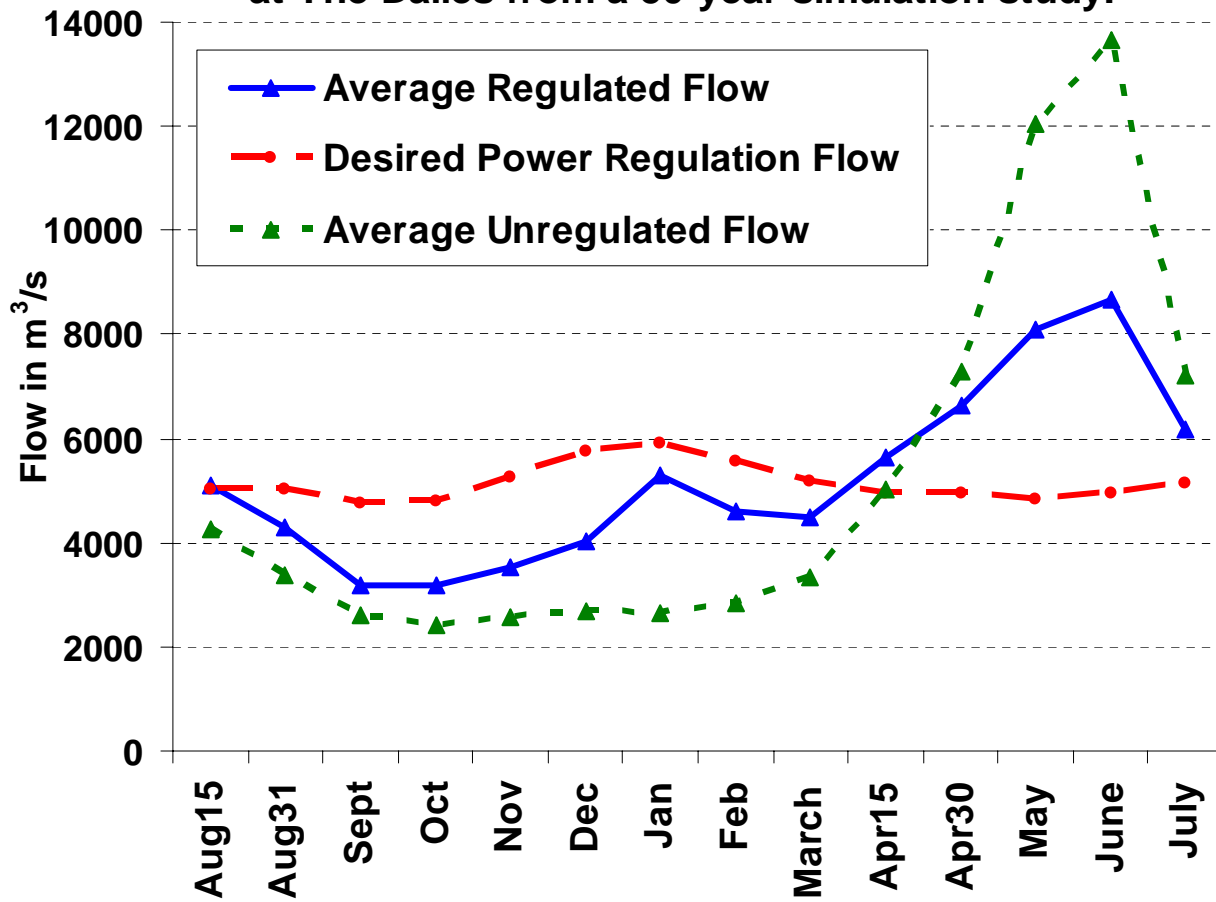


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Columbia River reservoir regulation

Comparison of Average Columbia River Streamflows at The Dalles from a 50-year simulation study.



- ♦ Columbia River has insufficient reservoir storage to shape streamflows to desired power regulation.
- ♦ New objectives to help migrating salmon require increased streamflows in spring-summer and bypassing powerhouse (spilling) large portion of stream flows.
- ♦ Fishery requirements have reduced power generation by over 2000 MW in the winter. Average annual loss about 1290 MW.



About 1/3 of the Columbia River water comes from Canada.



- ♦ Canada has 15% of the basin area, but 30% of 165 km³ average annual flow at The Dalles on the lower river.
- ♦ 50% of worst Columbia flood flows (1894) at The Dalles came from Canada.
- ♦ Columbia River flow at Canada/U.S. border varies from a low of 368 m³/s to a high of 19,250 m³/s, a 1:52 ratio.



Development of the Treaty: U.S. and Canadian Objectives

- ◆ The 1948 Columbia River flood killed about 60 people and left about 35,000 people homeless in U.S. and Canada. Both governments recognized that storage dams in Canada were necessary to control future floods.
- ◆ U.S. objectives:
 - Flood Control and regulation to shape hydropower generation to meet regional power loads in the winter and increase stream flows in low flow years, and
 - U.S. expected to pay Canada only for a portion of the cost of Canadian dams.
- ◆ Canadian objectives:
 - Power and Flood Control benefits in Canada,
 - U.S. must pay Canada for one-half of U.S. benefits, and
 - Wanted up front payment for first 30 years of power benefits to pay for construction of Canadian dams.
- ◆ Negotiations from 1954 to 1964 were not successful until the U.S. accepted the Canadian objectives.



Basic Treaty Requirements

- ♦ Canada must construct and operate 19.1 cubic kilometers (km^3) of reservoir storage in the Columbia River basin in Canada for optimum power generation and flood control benefits downstream in Canada and the U.S. (This doubled the amount of reservoir storage on the Columbia River).
- ♦ The U.S. paid Canada \$254 million in 1964 for 30 years of power benefits. Since 2003 the U.S. must deliver to Canada an amount of electrical power equal to one-half of the estimated increased power generated at U.S. dams.
- ♦ The U.S. paid Canada \$64 million for one-half of the estimated value of future flood damages prevented in the U.S. until 2024.
- ♦ The Treaty also allowed the U.S. to construct and operate the Libby dam with 6.2 km^3 storage on a tributary to the Columbia for flood control and power. The reservoir backs up into Canada and downstream flows return to Canada and then the U.S., creating benefits in both countries.
- ♦ Canada and the U.S. each have the option to terminate the Treaty after 60 years (2024), otherwise the Treaty continues.



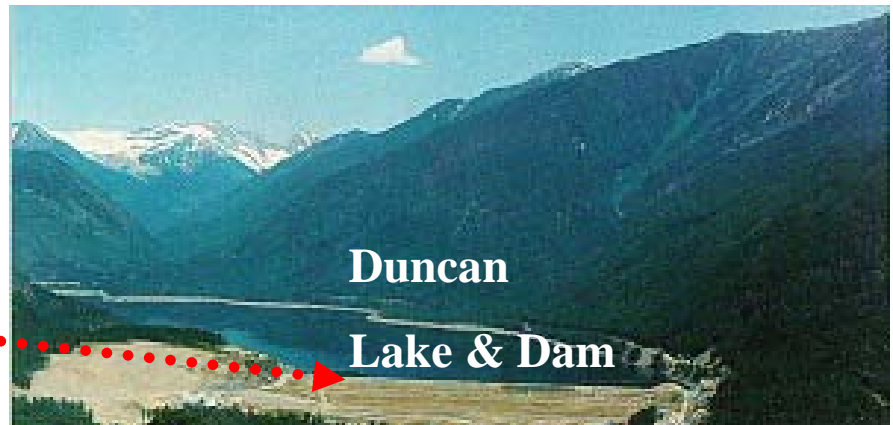
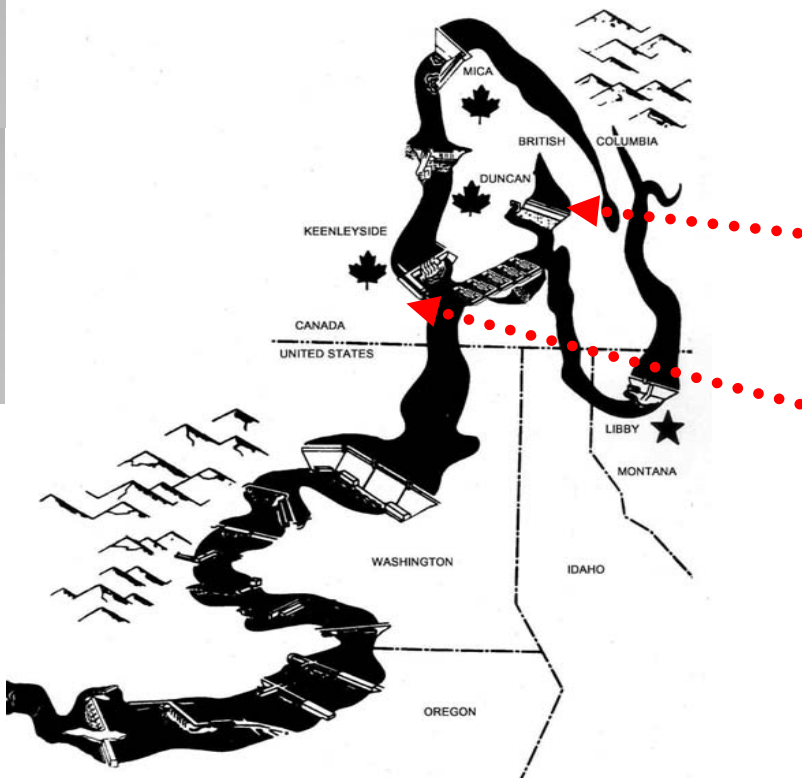
Treaty Entities and Permanent Engineering Board

- ♦ Treaty directs Canada and U.S. to appoint Entities responsible for implementing most of the Treaty requirements
- ♦ Canada appointed the British Columbia Hydro and Power Authority (a government owned electric utility) to be the Canadian Entity, and
- ♦ U.S. appointed the managers of the Bonneville Power Administration and the Army Corps of Engineers to be the U.S. Entity.
- ♦ Treaty also created a Permanent Engineering Board, consisting of senior Canadian and U.S. officials to review activities of the Entities, report results annually to the governments, and assist the Entities with resolving disputes.



Duncan and Arrow

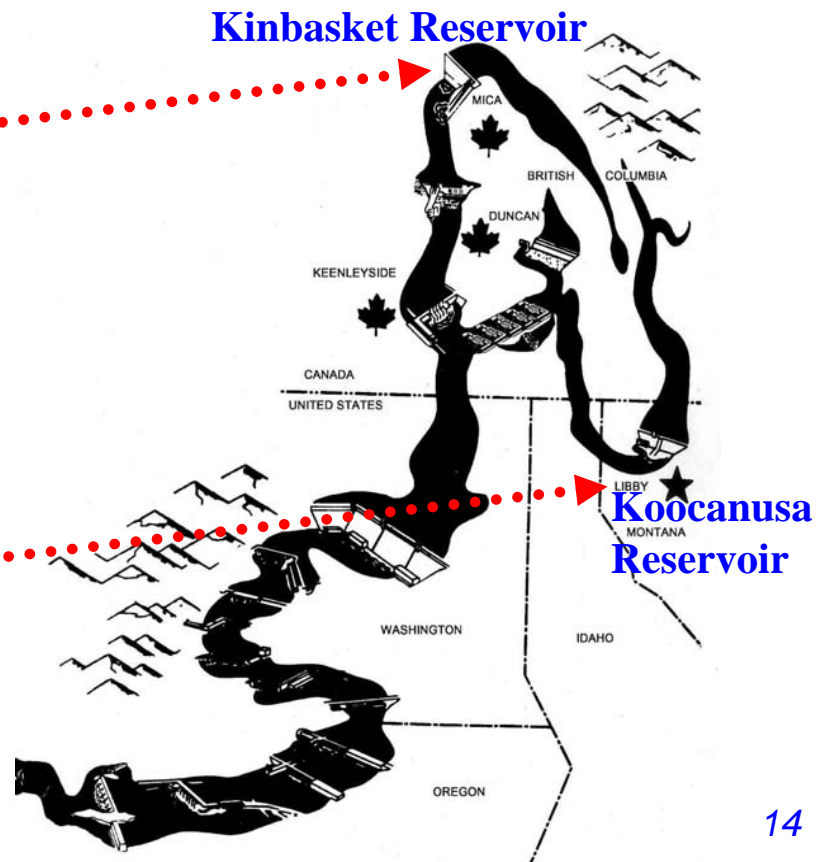
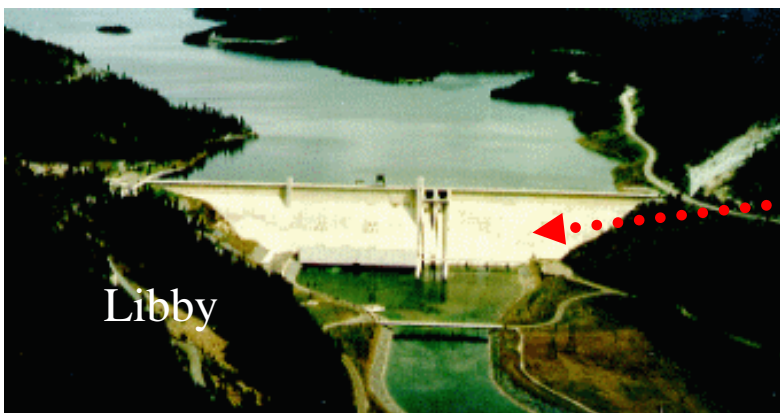
	<u>Completed</u>	<u>Treaty Storage</u>	<u>Non-Treaty Storage</u>	<u>Generator Capacity</u>	<u>Dam Height</u>
DUNCAN	1967	1.7 km ³	None	None	40 meters
ARROW	1968	8.8 km ³	0.3 km ³	185 MW	52 meters





Mica and Libby

	<u>Completed</u>	<u>Treaty Storage</u>	<u>Non-Treaty Storage</u>	<u>Generator Capacity</u>	<u>Turbine Capacity</u>	<u>Dam Height</u>
MICA	1973	8.6 km ³	6.2 km ³	1740 MW	1133 m ³ /s	198 m.
LIBBY	1973	6.2 km ³	None	604 MW	708 m ³ /s	112 m.





Treaty Provisions for Flood Control

- ◆ 10.4 km³ of Canadian storage at Arrow, Duncan, and Mica dams is allocated for flood control benefits in the U.S. and Canada.
- ◆ Flood control operating plans draft a portion of Canadian flood control storage by March each year based on a forecast of April through August unregulated flow at The Dalles.
- ◆ Operation during April-August controls flows to non-damaging levels as much as possible.
- ◆ We estimate that Treaty Storage prevented over \$200 million of flood damages in each year for 1972, 1974, and 1997.





Treaty Provisions for Hydropower



- ◆ 19.1 km³ of Canadian storage is operated for optimum power generation in Canada and the U.S., limited only by flood control needs.
- ◆ Operating Plan for Canadian Storage is prepared six years in advance only for power and flood control benefits.
- ◆ Treaty allows Entities to modify plan annually for mutual benefits.
- ◆ Canada is entitled to receive one-half of the estimated increased power generating capability at downstream U.S. dams due to the operation of Canadian Treaty storage.
- ◆ Power benefits are delivered to Canada in equal amounts of average monthly energy, but shaped on an hourly basis as Canada desires.
- ◆ Canada does not pay the U.S. for the power and flood control benefits in Canada from the operation of Libby dam.



Columbia River Treaty lessons learned that have helped the U.S. and Canada

- ◆ Sharing processes to collect and distribute hydro-meteorological data (e.g. weather, forecasts, stream flows, and reservoir elevations) is essential.
- ◆ Sharing the analysis and planning of alternative dams and reservoir operating plans is essential.
- ◆ Need competent staff to analyze and negotiate agreements. Requires training and computer support.
- ◆ Must coordinate with all groups of people affected by the dams.
- ◆ Must respect the needs of each side and have excellent working relationships.
- ◆ Look for solutions with mutual benefits.
- ◆ Objectives for Treaty and the value of the expected benefits may change over the long term. Need flexibility for managers to respond to changing values and objectives.