Columbia Basin Operations and Flood Risk Management

Julie Ammann, PE  
Chief, Reservoir Control Center  
Northwestern Division USACE
The Columbia River Basin:

- Drainage area of 259,000 square miles, dams control only about 25% of basin area
- 2 countries and 7 states
- Over 80 dams operated by multiple organizations
- Operated as a coordinated system to meet multiple purposes
- Travel time of 10-20 days over 1200 miles
- About 15% of the basin is in Canada, and 35% of the average annual flow comes from Canada (as measured at The Dalles, Oregon)
Managing a Complex System

We work with other federal agencies (BPA, BOR, NWRFC, NOAA Fisheries, USFWS, EPA), Canadian partners, states, Tribes, PUDs, local agencies, non-federal dam operators, irrigators, navigators and the public.
Federal Columbia River Power System (FCRPS)

- The FCRPS comprises 14 Federal multi-purpose projects
- Operated in a coordinated manner to provide flood control, navigation, power, recreation, fish and wildlife, water quality, and water supply
- Corps operates and maintains 12 projects: 3 storage and 9 run-of-river
- US Bureau of Reclamation operates 2 storage projects
- Bonneville Power Administration markets and transmits power generated at the FCRPS projects
Columbia is the Most Powerful River in North America

- Hydropower is measured by river flow times change in elevation (called “head”)
- St. Lawrence and Mississippi have more flow, but much less head
- Grand Coulee has twice the head of Niagara Falls
Map of US Hydropower Capacity and Annual Runoff

Hydropower Generation by Region

Note: The central lines depict the median generation level for each month in each region during 2002-2013. The surrounding bands enclose all but the 10% highest and 10% lowest observations.

Navigation

- 485 miles of navigable waterways, serving 36 ports
- Approximately 12,000 commercial vessels and 100,000 recreational and charter vessels cross the Columbia River Bar each year
- Exports and imports annually exceed $18–20 billion
Water Supply

- Irrigation – total of approximately 5.3 million acres in the Columbia Basin
  - Over 1 million acres potentially impacted by Treaty operations
- M&I - Municipal and industrial water supply
- Instream Uses
  - Flows for fish and other aquatic species
  - Support for safe navigation
  - Support for recreational uses
Recreation & Cultural Resources

- Operational decisions impact recreation and cultural resources
- Recreation
  - Provides recreational and tourism opportunities throughout the region
- Cultural Resources
  - Native American historic sites are an important consideration in all reservoir operations
  - Monitored and protected
Coordination with Tribes

- Signed Fish Accords in 2008
- Treaty fishing
- Operations for fish
- Implementing the Biological Opinions
- Water quality standards and operations
- Shoreline protection
- ESA species
- Fish passage construction

Coordination with Tribes
Columbia River Basin Flood Storage

- Corps manages all flood control space – even for non-Corps projects
- Bulk of storage is in headwaters
- Treaty projects roughly doubled the storage capacity of the river
## Treaty Projects

<table>
<thead>
<tr>
<th></th>
<th>Completed</th>
<th>Treaty Storage</th>
<th>Non-Treaty Storage</th>
<th>Generator Capacity</th>
<th>Dam Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUNCAN</td>
<td>1967</td>
<td>1.4 Maf</td>
<td>None</td>
<td>None</td>
<td>130 ft.</td>
</tr>
<tr>
<td>ARROW</td>
<td>1968</td>
<td>7.1 Maf</td>
<td>0.25 Maf</td>
<td>185 MW</td>
<td>170 ft.</td>
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<tr>
<td>MICA</td>
<td>1973</td>
<td>7.0 Maf</td>
<td>5.0 Maf</td>
<td>~3000 MW</td>
<td>650 ft.</td>
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<tr>
<td>LIBBY</td>
<td>1973</td>
<td>5.0 Maf</td>
<td>None</td>
<td>604 MW</td>
<td>370 ft.</td>
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</tbody>
</table>
Columbia Basin reservoir storage is limited.
Runoff - Which Shape This Year?

1948 Maximum Storage Requirements:
- 1005.6 KCFs
- 29.4 MAF
- 1 APR FCST = 100 MAF

1954 Maximum Storage Requirements:
- 574 KCFs
- 9.5 MAF
- 1 APR FCST = 103 MAF
Flood Risk Management
Seasonal System Operations

- System operated per Flood Risk Operating Plan
- December through April end of month flood draft targets based on monthly water supply volume forecasts
- Storage projects meet both local and system requirements
- Refill start date dependent on runoff triggers
- Projects generally fill by June - August

End of month flood draft targets

Dec, Sep, Jun, Mar

Water Year
Evacuation Period

- Water Supply Forecasts (WSFs) estimate runoff volume expected in the spring and summer at key locations.
- WSFs are issued early in the month.
- Storage Reservation Diagrams are used at each reservoir to ensure flood control space is available before the flood event.
Initiation of Refill

- Trigger for refill is based on unregulated flows at The Dalles, OR
- Once unregulated flows are projected to hit the *Initial Control Flow* (ICF), refill is triggered
- Projects switch from drafting to filling
Flow Management Effects

- Regulation (storing and releasing water) reduces the spring flow and increases winter flows.
- Lower spring flows improve flood risk management.
- Higher winter flows are beneficial for power.
Two Types of High Water Events

- **Spring Freshet** -- Snow Melt; Function of temperature and precipitation

- **Rain Events** – Generally sustained rain (atmospheric river)
  
  - Willamette Basin and uncontrolled Lower Columbia flows play major role in winter floods
## Storage Operations Timeline

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<thead>
<tr>
<th></th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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<tbody>
<tr>
<td><strong>Libby</strong></td>
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<td></td>
<td></td>
<td>END OF DECEMBER VARIABLE DRAFT LIMITS</td>
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<td></td>
<td>MINIMUM FLOW OR FRM</td>
<td>OPERATE TO VARQ FRM</td>
<td>OPERATE TO BULL TROUT FLOW OBJECTIVES</td>
<td>OPERATE TO STURGEON AND SALMON FLOW OBJECTIVES</td>
<td>OPERATE TO SALMON FLOW OBJECTIVES</td>
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<td><strong>Hungry Horse</strong></td>
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<tr>
<td></td>
<td>MINIMUM FLOW OR FRM</td>
<td>OPERATE TO VARQ FRM</td>
<td>VARIABLE DRAFT LIMITS</td>
<td>OPERATE TO MCNARY SPRING FLOW OBJECTIVES</td>
<td>OPERATE TO MCNARY SUMMER FLOW OBJECTIVES</td>
<td>MINIMUM OUTFLOW FOR COLUMBIA FALLS (BULL TROUT)</td>
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<tr>
<td><strong>Albeni Falls</strong></td>
<td>WINTER ELEVATION</td>
<td>REFILL</td>
<td>FULL FOR SUMMER RECREATION</td>
<td>DRAFT TO WINTER ELEVATION</td>
<td>WINTER ELEVATION</td>
<td>BULL TROUT AND CHUM</td>
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<tr>
<td><strong>Grand Coulee</strong></td>
<td>OPERATE FOR CHUM AND VERNITA BAR FLOW OBJECTIVES</td>
<td>OPERATE TO PRIEST RAPIDS AND MCNARY FLOW OBJECTIVES</td>
<td>OPERATE TO MCNARY FLOW OBJECTIVES</td>
<td>MINIMUM FLOW OR FRM</td>
<td>OPERATE FOR CHUM AND VERNITA BAR FLOW OBJECTIVES</td>
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<tr>
<td><strong>Dworshak</strong></td>
<td>FRM DRAFT AND REFILL</td>
<td>OPERATE TO LOWER GRANITE SPRING FLOW OBJECTIVES</td>
<td>OPERATE TO LOWER GRANITE SUMMER FLOW &amp; TEMPERATURE OBJECTIVES</td>
<td>TREATY OPERATIONS (INCLUDING PROPORTIONAL DRAFT IN DRY YEARS)</td>
<td>OPERATE TO MCNARY SPRING FLOW OBJECTIVES</td>
<td>OPERATE TO MCNARY SUMMER FLOW OBJECTIVES</td>
<td>MINIMUM FLOW OR FRM</td>
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<tr>
<td><strong>Canadian Treaty Projects</strong></td>
<td>ARROW WHITEFISH FLOWS</td>
<td>ARROW TROUT SPAWNING FLOWS</td>
<td>RELEASE FLOW AUGMENTATION</td>
<td>TREATY OPERATIONS (INCLUDING PROPORTIONAL DRAFT IN DRY YEARS)</td>
<td>DUNCAN TO MEET DOWNSTREAM FLOW REQUIREMENTS FOR FISH</td>
<td>DUNCAN DRAFT TO EMPTY IN APRIL AND REFILL BY EARLY AUGUST</td>
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### Legend:
- **FISH OPERATION**
- **FRM or POWER OPERATION**
- **OTHER PURPOSES**


Operations for Fish

Spring and Summer Spill

Juvenile Fish Transport

Flow Augmentation Temperature

Surface Passage
Special Operation Coordination

- Generally includes requests for flows, tailwater elevation, forebay elevation, specific outlets, etc…
- Must consider fish impacts (compliance with BiOps)
- Can conflict with other operations – must be coordinated!
- Safety considerations
- Seasonal timing
- Contingencies and unexpected events, etc.
In Summary

- Multiple purposes & interests
  - Flood Risk Management
  - Fish & Wildlife
  - Hydropower
  - Water Supply
  - Recreation
  - Navigation
  - Cultural Resources/Tribes

USACE works with our partners to strike a balance among these interests
Questions?