Presentation of the Findings of the Chehalis River Fish Population Impact Study

Presented by

Paul Schlenger and Bob Montgomery

April 19, 2012

Overview of Presentation

- Review of Scope of Work and Process
- Results of Fish Study Analysis Components
  - Hydrology
  - Water Quality
  - Geomorphology
  - Fish Habitat Modeling (PHABSIM)
  - Fish Habitat Inventory of Upper Watershed (HEP)
  - Fish Population Modeling (SHIRAZ)
- Questions and Discussion

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Scope of Fish Study

- To characterize the magnitude of potential impacts that a flood storage facility on the upper mainstem Chehalis River could have on anadromous salmonid populations
- Study area defined as mainstem upstream from Porter (approximately river mile 33)
- Three salmonid species
  - Spring Chinook salmon
  - Coho salmon
  - Winter steelhead
- Scoped as a 9-month study

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Process

- Complete the analysis using available data or data that could be collected or modeled in one year
- Reached out to people who have worked in the basin for data on salmonid populations and habitat in the study area
- Draft report released in November 2011
- Comments received in January 2012
- Final report released in April 2012

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Organizations That Submitted Comments

- WA Dept. of Fish and Wildlife
- WA Dept. of Ecology
- WA Dept. of Transportation
- Confederated Tribes of the Chehalis Reservation
- City of Chehalis
- Wild Game Fish Conservation International
- Lewis County PUD
- Quinault Indian Nation

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General Comments Received

- A more detailed study would be necessary before a dam was approved and permits obtained
- Further refinement of dam configuration and operations would be necessary to avoid/minimize detrimental impacts and maximize beneficial impacts
- Fish passage survival rate estimates are too high
- Impacts of dam on fish populations are too low, especially for steelhead

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Study Approach

- To use applicable existing and new data to characterize habitat conditions in the basin that contribute to salmon viability and would potentially be impacted by a dam
  - Hydrology and Hydraulics (water flow)
  - Water Quality (temperature)
  - Geomorphology (sediment transport)
  - Physical Habitat Simulation (fish habitat)

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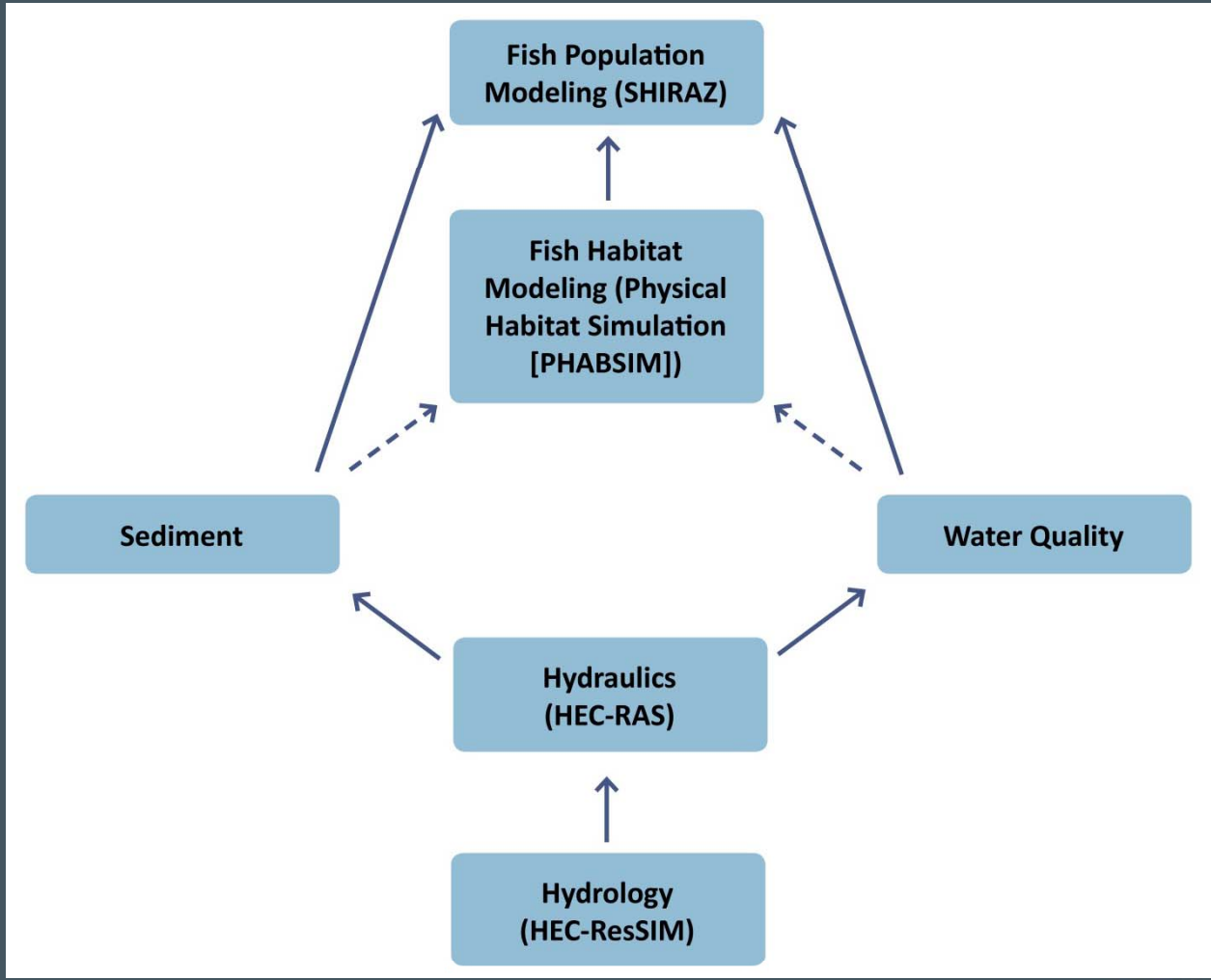
Study Approach



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Use of Hydrologic and Hydraulic Models

- Effect on flooding
- Reservoir water temperature modeling
- Chehalis River water temperature and dissolved oxygen modeling
- Sediment transport calculations
- Informs SHIRAZ fish population model

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Models Used

- HEC-ResSIM for hydrologic routing through reservoir and to Doty gage.
- HEC-RAS to route flow from Doty gage downstream to Porter. Also used for water quality modeling.
- Spreadsheet sediment transport calculations.
- DSS is data storage and visualization software to work with HEC models.
- Lots of spreadsheets used to create graphics for report.

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Dam Structure and Operations

Structure or Operational Element	Flood Storage Only (Single Purpose)	Multi-Purpose
Structure Location	2 miles south of Pe Ell (RM 108.3)	2 miles south of Pe Ell (RM 108.3)
Structure Height	238 feet	288 feet
Reservoir Surface Area (full)	1,000 acres	1,450 acres
Fish Passage Facilities	Yes	Yes
Sediment Transport Past Dam	No	No
Large Woody Debris Transport Past Dam	No	No

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Dam Structure and Operations

Structure or Operational Element	Flood Storage Only (Single Purpose)	Multi-Purpose
Total storage capacity (AF)	80,000	**145,000**
Bottom elevation (ft)	1432	**1432**
Spillway elevation (ft)	1650	**1700**
Dam crest elevation (ft)	1670	**1720**
Outlet capacity (cfs)	2,000	**2,000**
Power plant minimum operating elevation (ft)	NA	**1610**

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Revised Flood Release – Flood Storage Only Alternative

- In draft report, releases were a constant 2,000 cfs during floods.
- For final report, releases are reduced when large floods are encountered. When inflow greater than 10,000 cfs occurs, releases are ramped down to 200 cfs for 3 days. Flows are then increased to 2,000 cfs.
- The maximum rate of change in reservoir outflow is 200 cfs/hour to prevent sudden surges of water downstream or cause fish stranding issues.

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Flood Storage Reservoir Alternative

- Peak flows at Doty gage reduced by 60% for a 100-year flood event.
- Max. storage used in reservoir for 100-year flood is approximately 62,500 acre-feet.
- Flood levels in Chehalis-Centralia area are reduced by 1.6-2.0 ft for a 100-year flood.
- Flood levels in 1996 flood would have been reduced by 0.7–1.1 ft
- Flood levels in 2007 flood would have been reduced by 2.6-3.1 ft

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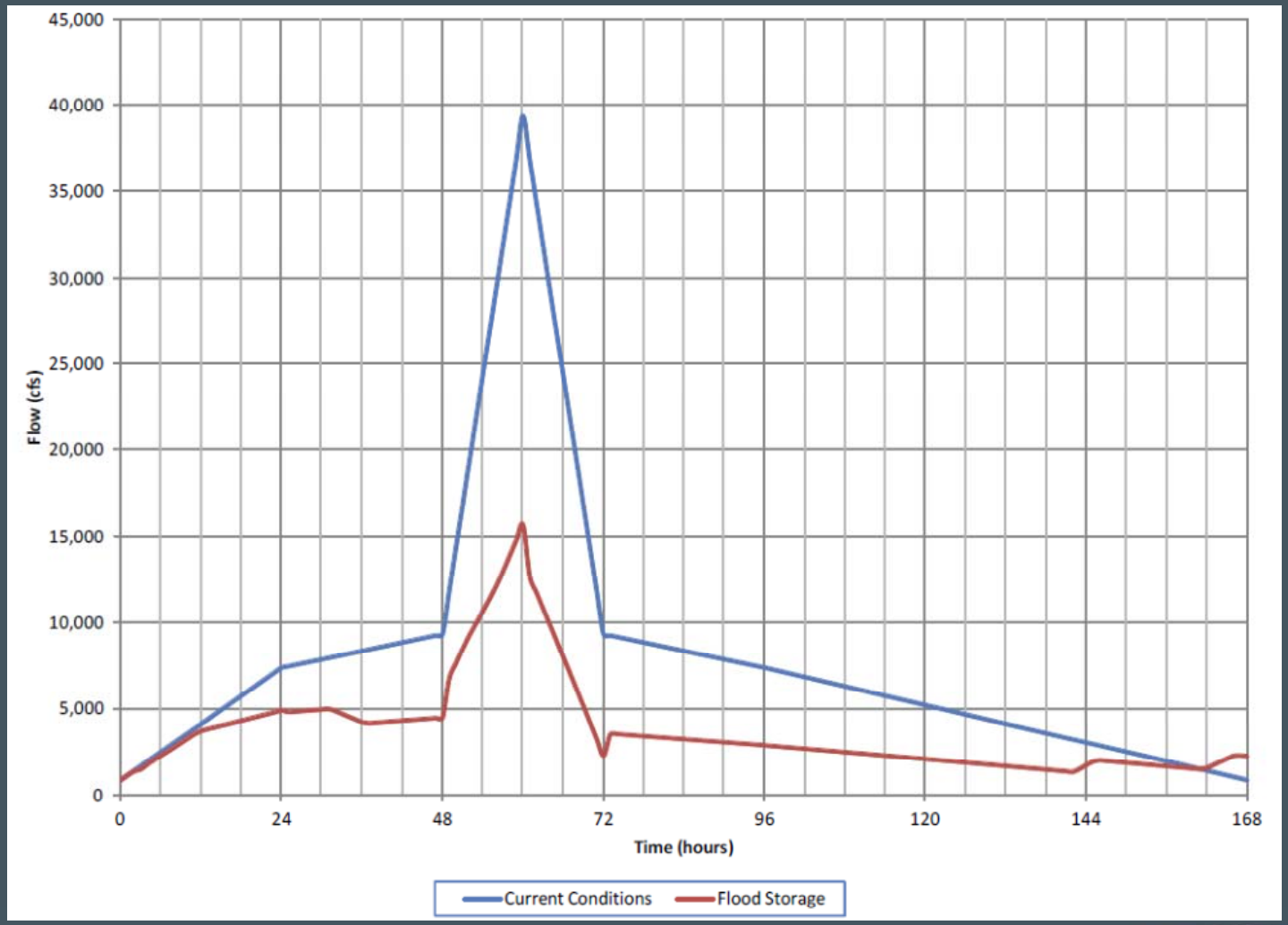
100-year Hydrograph at Doty gage



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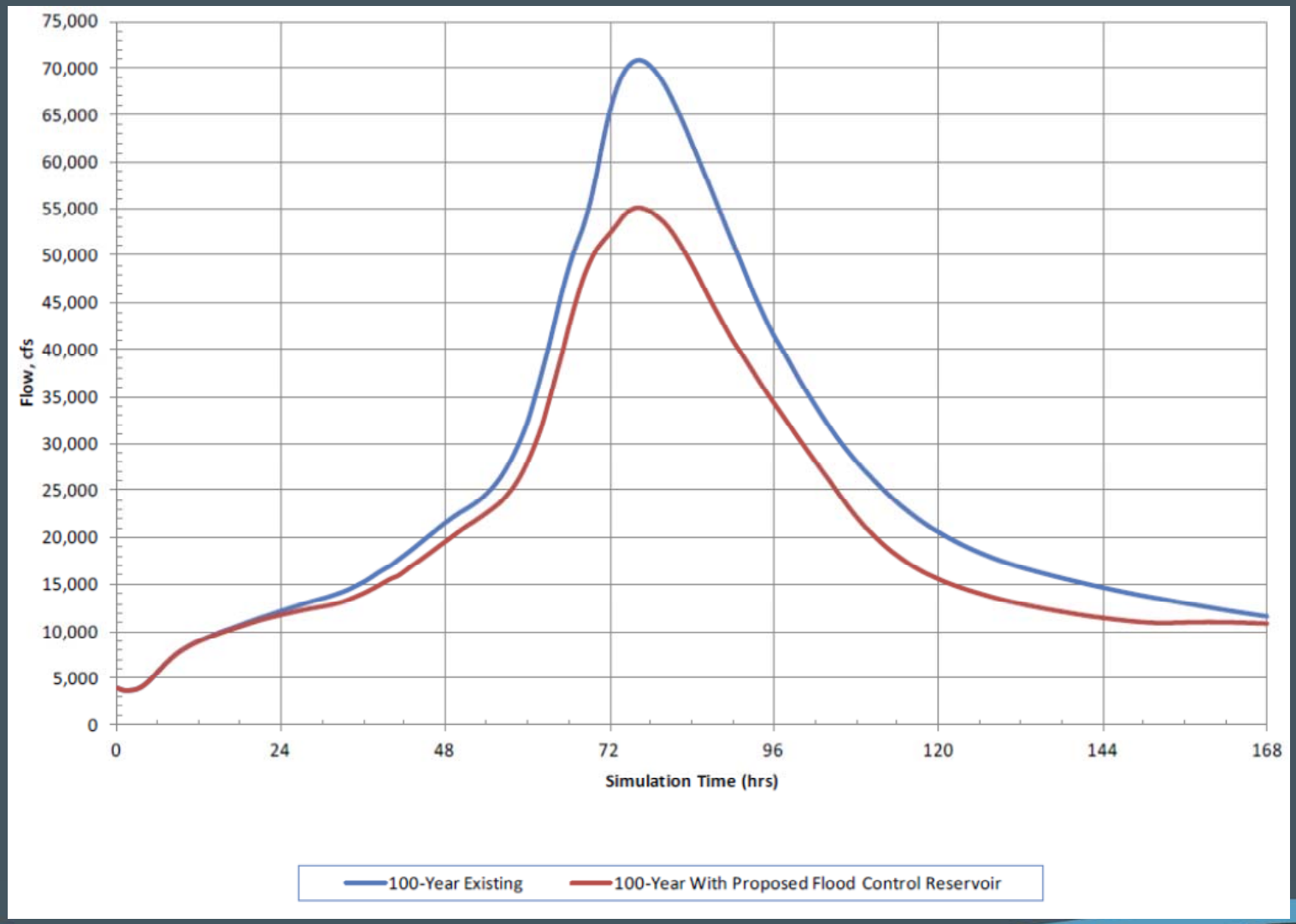
100-year Hydrograph at Mellen Street



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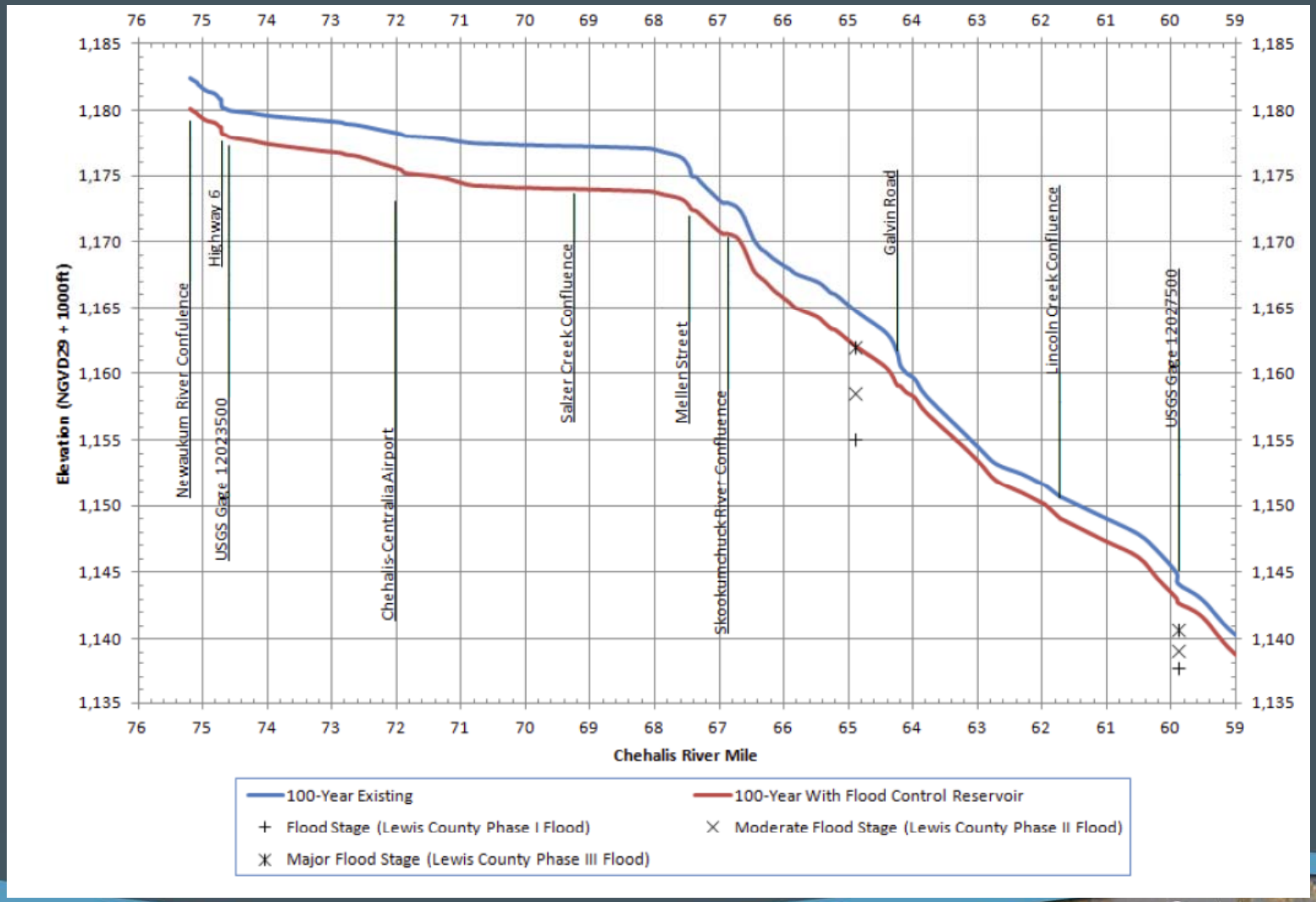
100-year Flood Profile, Newaukum River to Grand Mound Gage



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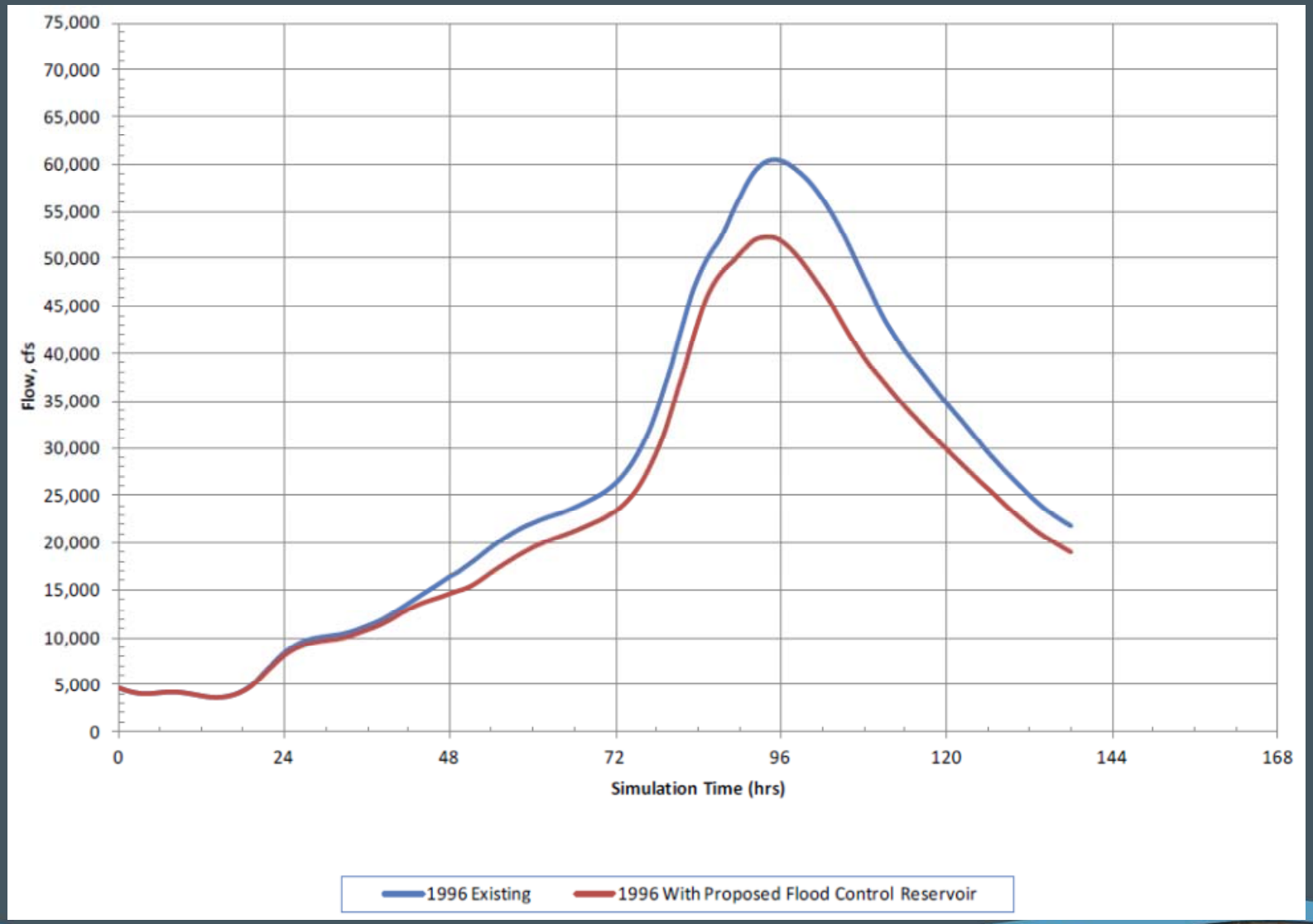
1996 Flood Hydrograph at Mellen Street



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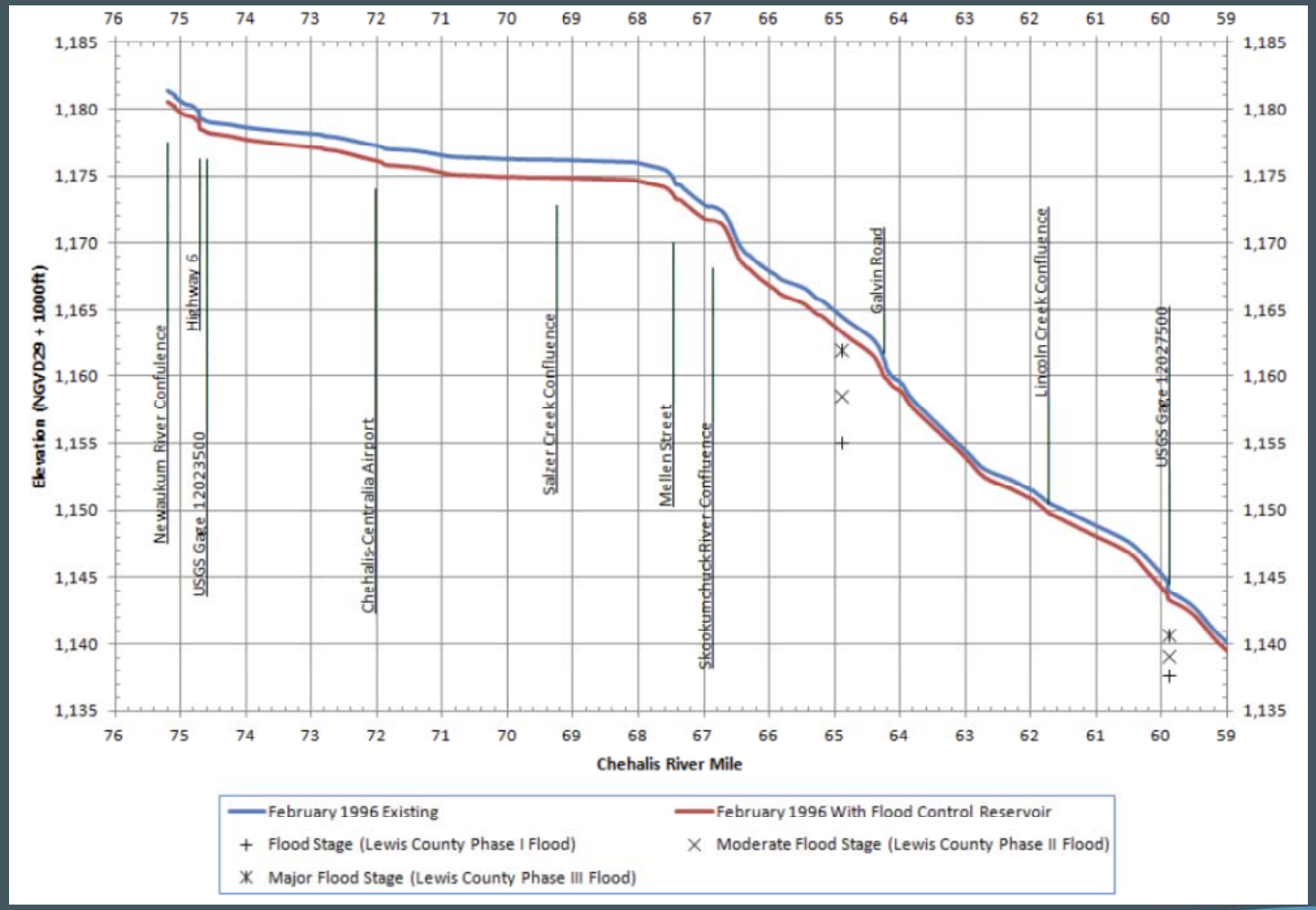
1996 Flood Profile, Newaukum River to Grand Mound Gage



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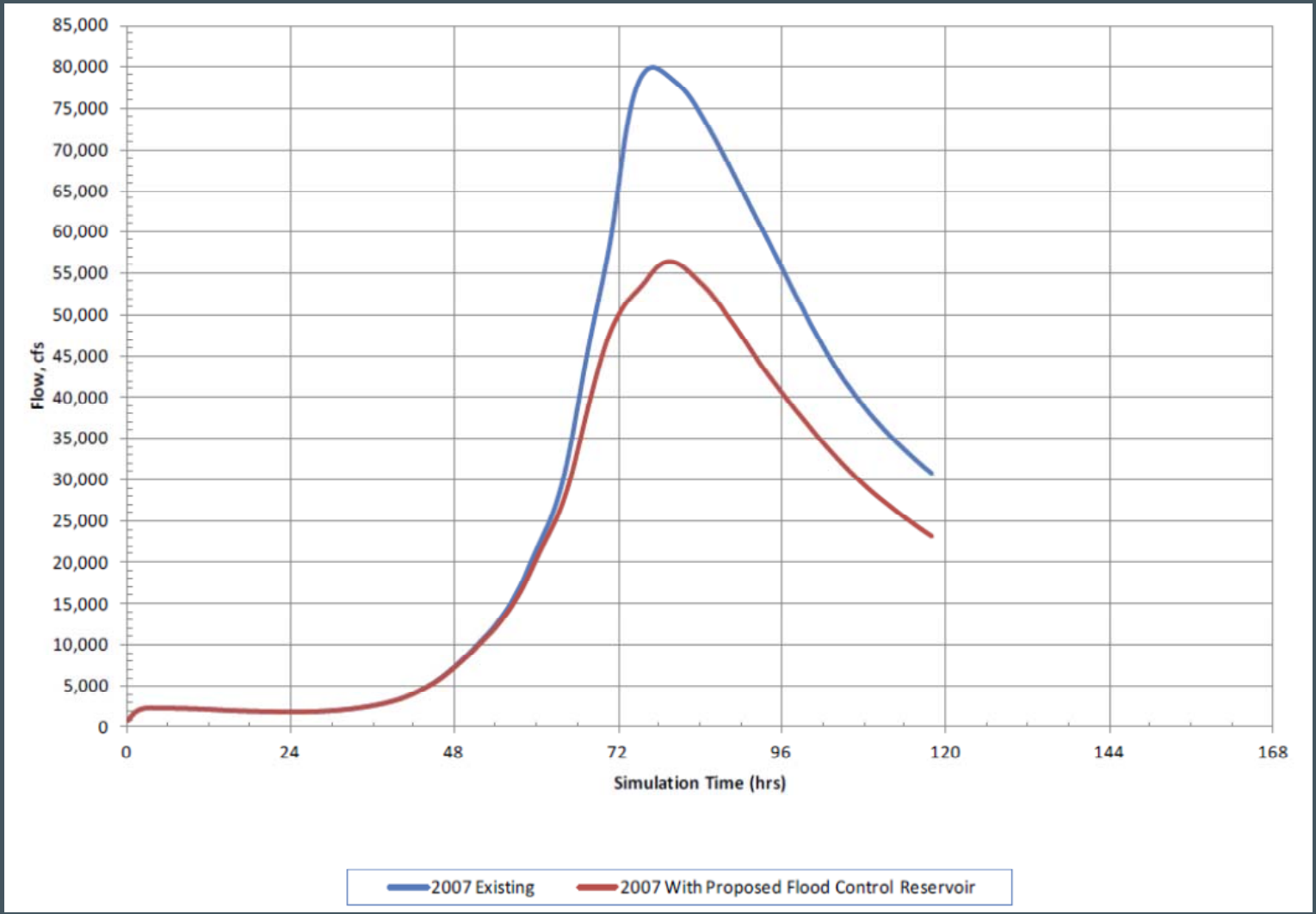
2007 Flood Hydrograph at Mellen Street



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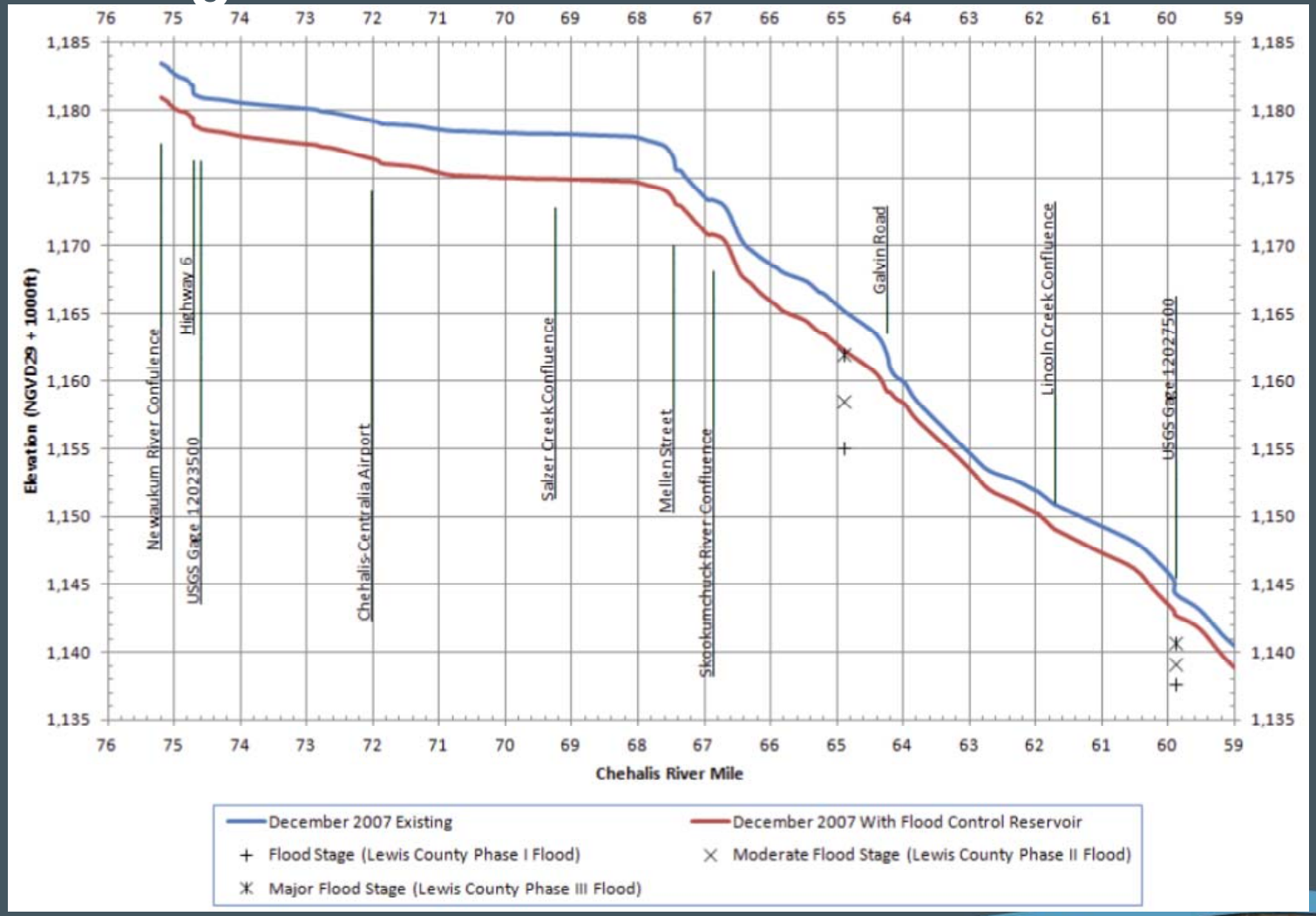
2007 Flood Profile, Newaukum River to Grand Mound Gage



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Multi-purpose Reservoir Alternative

- Similar operation of flood storage will provide same flood reduction benefits as flood storage only reservoir alternative.
- Additional 65,000 acre-feet of storage is used for controlled release for instream flow augmentation and water temperature benefits. A fish flow release schedule was prepared based upon instream flow measurements taken for this study.
- Hydroelectric generation is a secondary purpose under this alternative.

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Multi-purpose Reservoir Operations – Proposed Fish Flow Releases

Dates	Minimum Release (cfs) - Reservoir WSE above 1610 ft	Minimum Release (cfs) - Reservoir WSE below 1610 ft
November-February (coho spawning)	250	250
March-June (steelhead spawning)	200	200
July (juvenile rearing)	200	160
August-October (Chinook spawning)	200	160

Notes: Minimum releases provide 80-90% of maximum Weighted Usable Area in Chehalis River between dam and the Newaukum River. WSE 1610 ft is minimum operating level for hydropower and equals 49,500 acre-feet of storage

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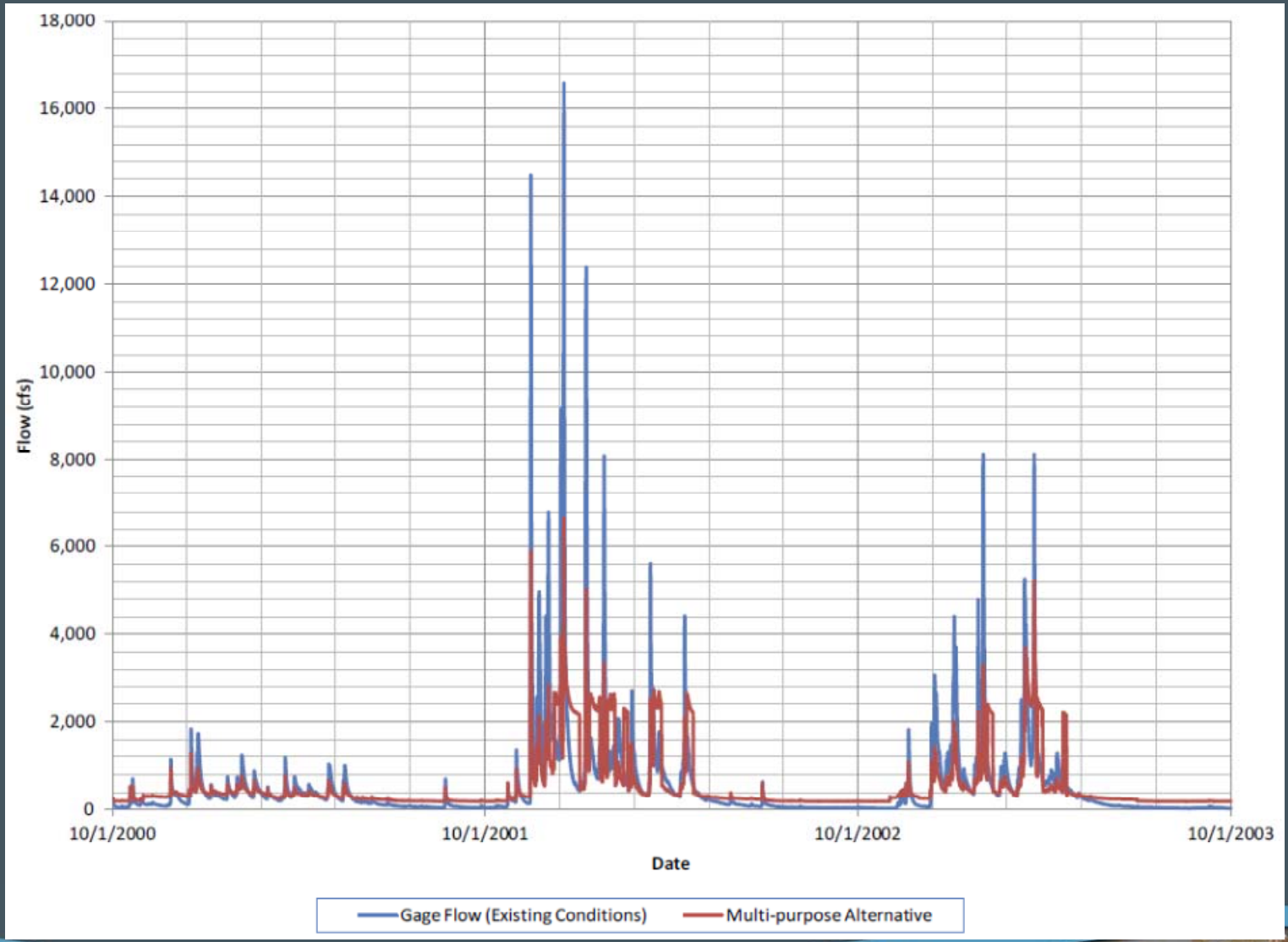
Predicted flow at Doty gage



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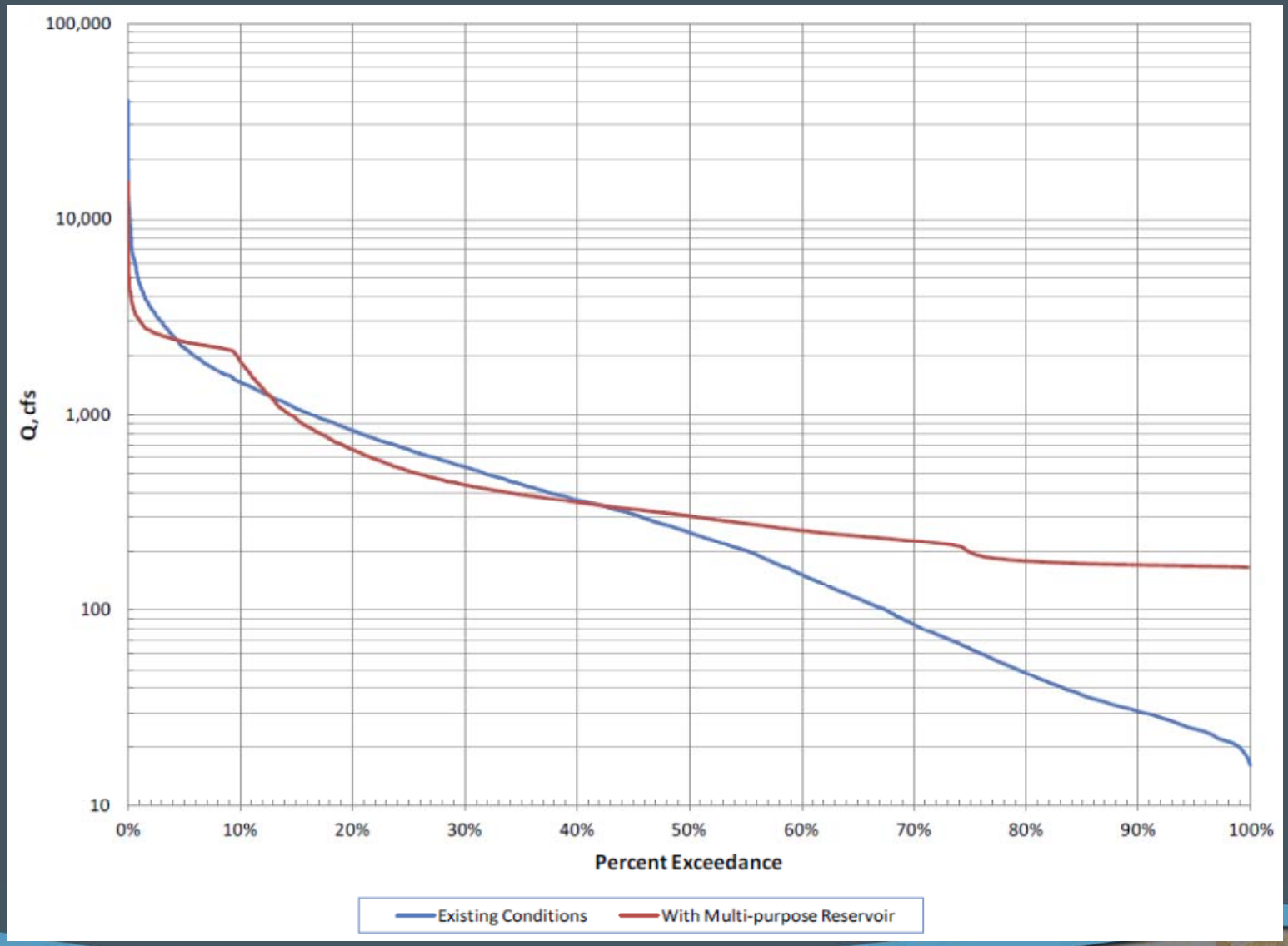
Flow Exceedance Curves at the Doty Gage



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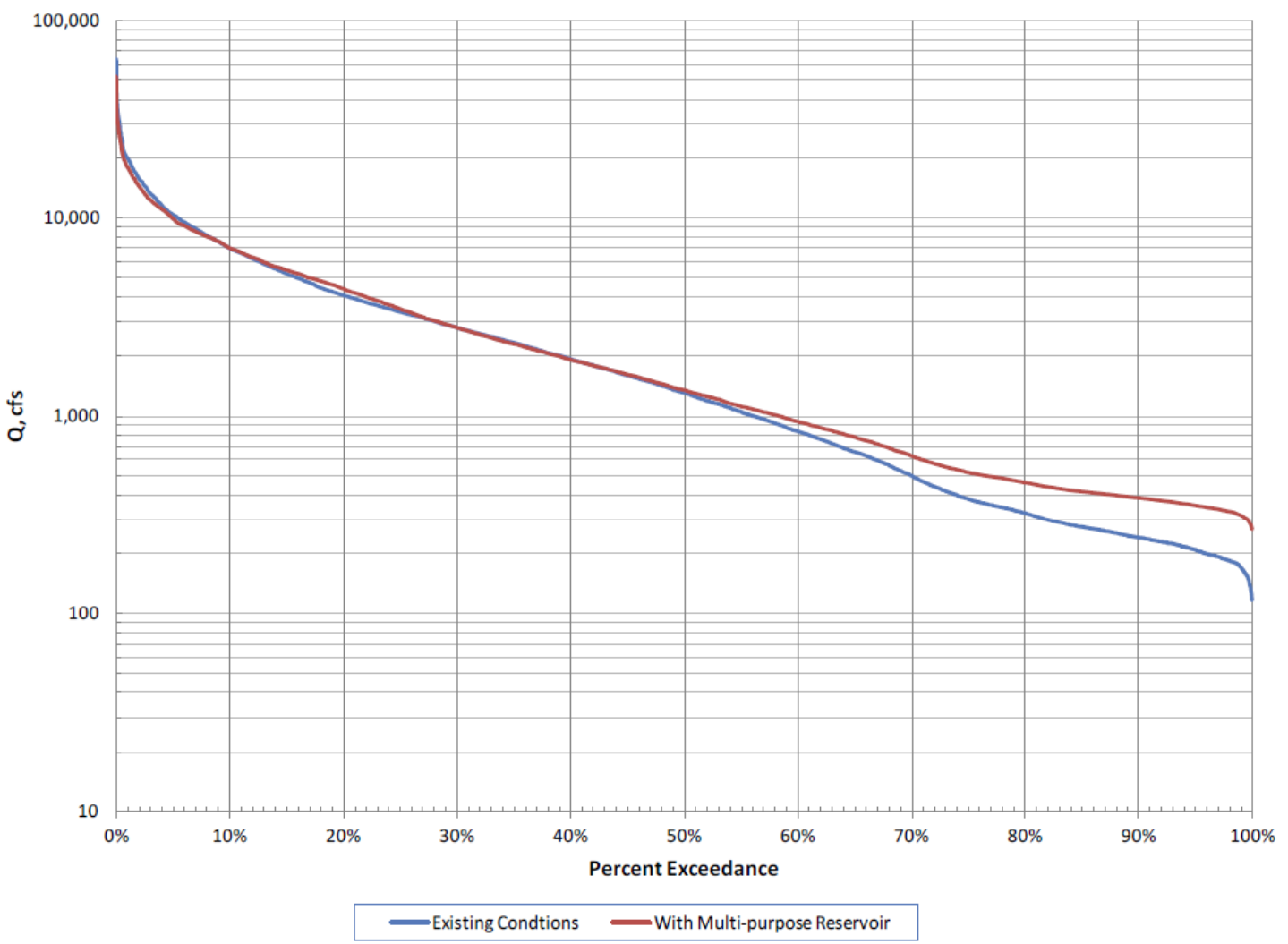
Flow Exceedance Curves at Grand Mound Gage



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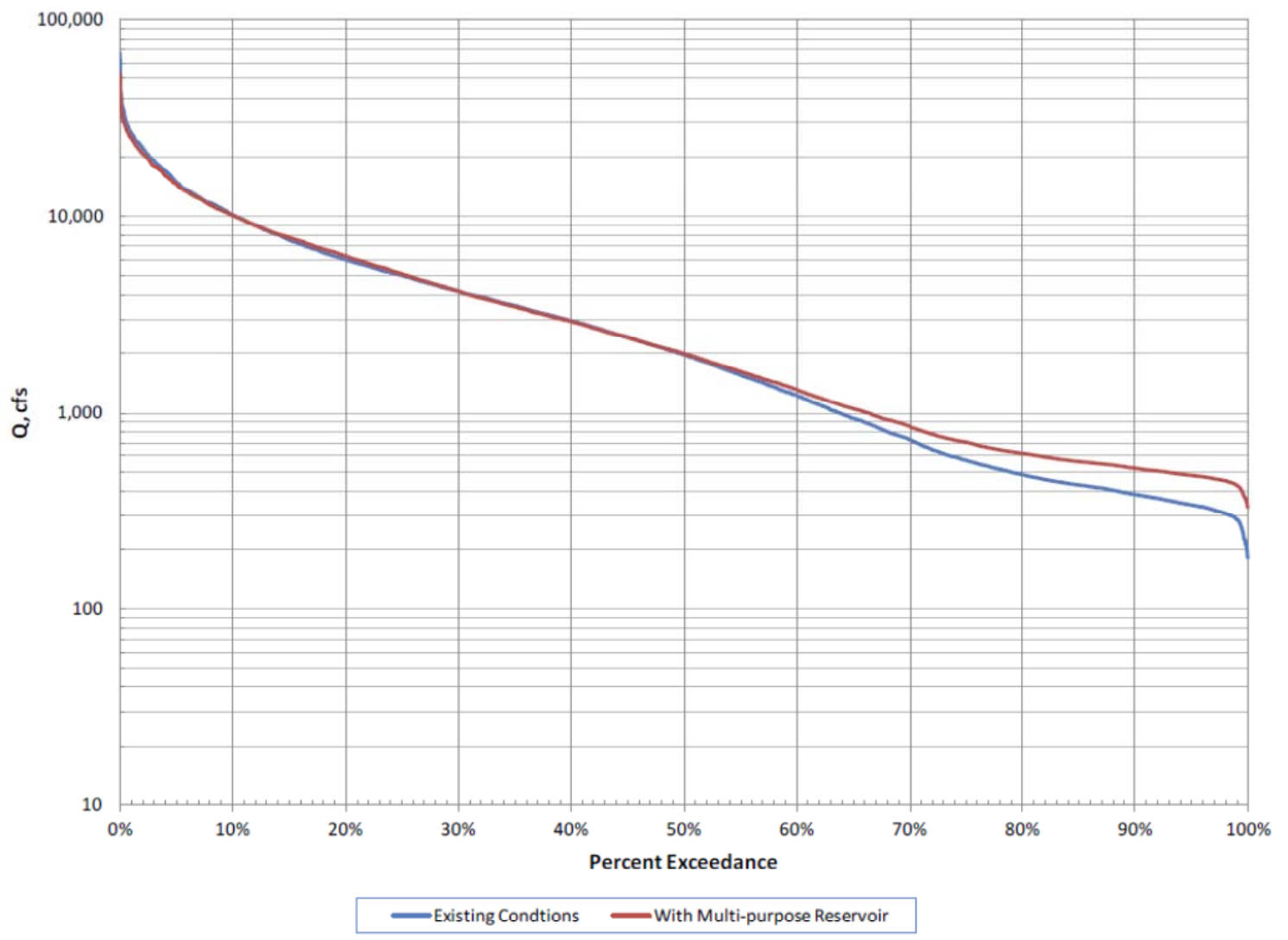
Flow Exceedance Curve at Porter Gage



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Reliability of Fish Flows with Multi-purpose Reservoir Alternative

Dates	Fish Flow Provided	% of Days Flow Met or Exceeded at Reservoir	% of Days Flow Met or Exceeded at Doty Gage
November-February (coho spawning)	250	98.8%	99.6%
March-June (steelhead spawning)	200	95.5%	100%
July (juvenile rearing)	200	100%	100%
August-October (Chinook spawning)	200	100%	100%

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Modeling Limitations

- Hydrology – uncertainty in USGS estimated peak flow for 2007 event and volume estimated by NHC creates uncertainty in the estimates of smaller floods
- Hydraulics – HEC-RAS model cross-sections are old
- A different configuration of the reservoir or a different release schedule may change the results.

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Sediment Transport and LWD

- Work included:
  - Gravel sampling
  - Aerial photo review
  - Estimating sediment transport capacity
  - Estimating sediment input from landslide data
  - Inventory of LWD

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Sediment Transport and LWD

- Most coarse sediment and wood would be trapped by reservoir
- Peak flows reduced downstream of reservoir
- Bedload transport capacity substantially reduced between reservoir and confluence with South Fork Chehalis River, may result in aggradation in that reach and perhaps fining
- Effects muted in downstream direction, reset at RM 61.7 at bedrock grade control

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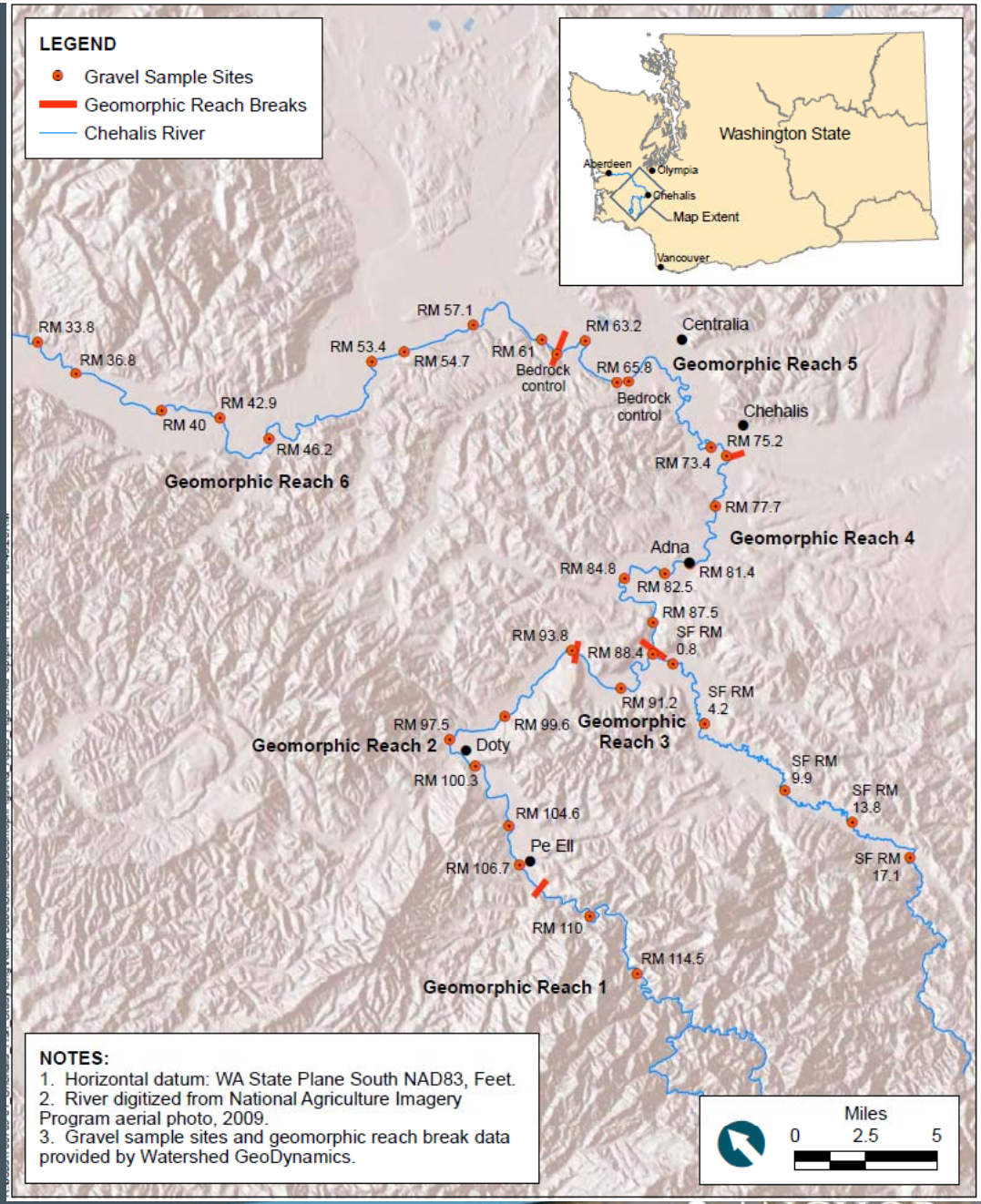
Geomorphic Reaches



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Bedload Transport Calculations

Geomorphic Reach	River Mile	Approximate Flow to Initiate Bedload Transport (cfs)	Existing Conditions	Flood Control Alternative		Multi-Purpose Alternative	
			Bedload Transport Capacity (tons)	Bedload Transport Capacity (tons)	Change from Existing	Bedload Transport Capacity (tons)	Change from Existing
2	101.8	7,000	16,900	1,100	-93%	1,100	-93%
	100.76	6,500	8,530	150	-98%	135	-96%
	100.44	4,300	29,700	460	-98%	410	-97%
	100.16	9,400	1,590	0.1	-100%	0.2	-100%
	99.77	4,900	36,700	5,600	-85%	5,560	-80%
	98.47	2,000	6,550	2,560	-61%	2,050	-66%
	97.49	1,700	34,800	14,600	-58%	15,400	-49%
3	93.03	2,700	136,000	37,700	-72%	38,600	-67%
	90.11	35,700	3.7	0.1	-97%	0.1	-97%
	88.28	1,900	9,830	7,200	-27%	7,380	-24%
4	87.18	9,000	39,000	20,700	-47%	20,500	-41%
	85.05	59,000	82	4	-95%	5	-96%
	82.58	22,000	23,700	20,000	-16%	20,000	-97%
5	74.95	22,400	4,440	3,500	-21%	3,400	-17%
	69.52	37,400	5.2	1.9	-63%	1.4	-60%
6	60.51	17,600	5.2	4.5	-13%	4.8	-4.9%
	46.94	17,000	3,330	3,100	-7%	3,200	-2.50%
	34	22,000	5,630	4,600	-18%	4,700	-14%

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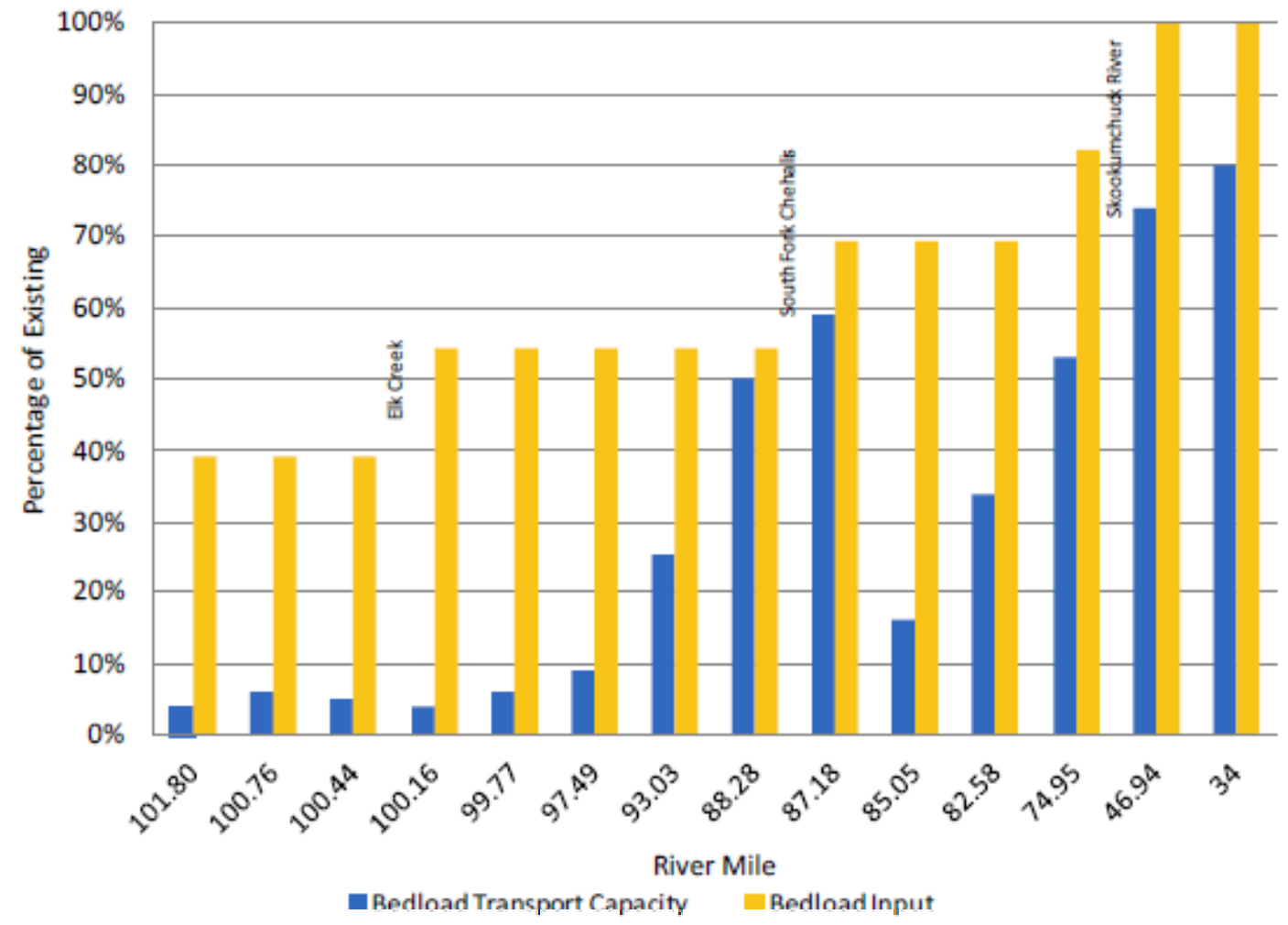
Bedload Input and Transport Relative to Existing



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Water Quality Studies

- Field sampling:
  - Temperature data loggers deployed at 10 locations
  - Low flow surveys conducted on Sep 13-14 and Oct 19-20 (Q < 650 cfs at Porter for both events)
  - Two high flow sampling completed on Dec 2 and Feb 17 (Q > 8000 cfs at Porter on both dates)
  - Tidbit data downloaded on May 31, 2011
  - Control of tidbits passed over to Ecology
- Modeling:
  - CE-QUAL-W2 model (reservoir temperature and DO)
  - HEC-RAS model (downstream temperature and DO)

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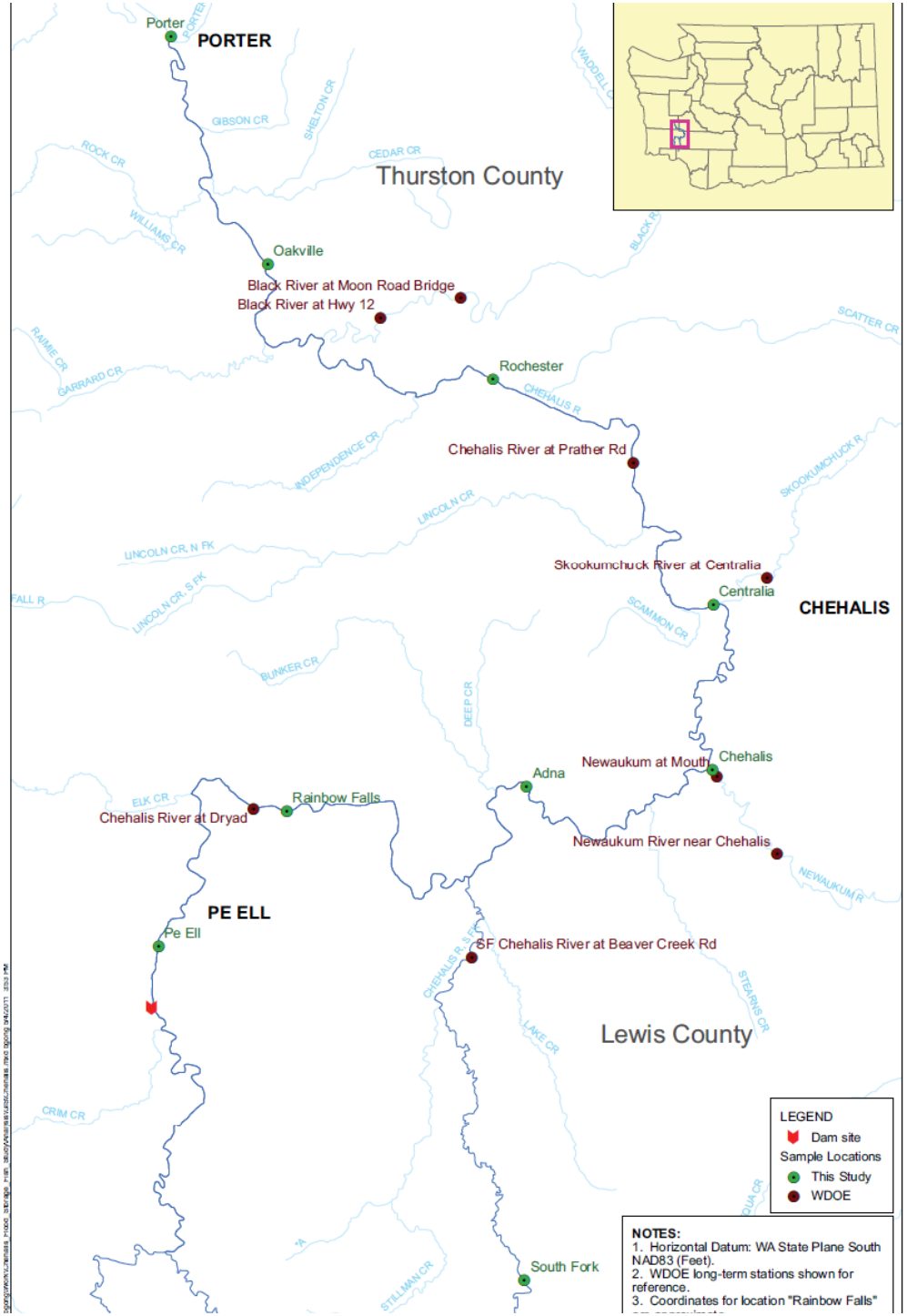
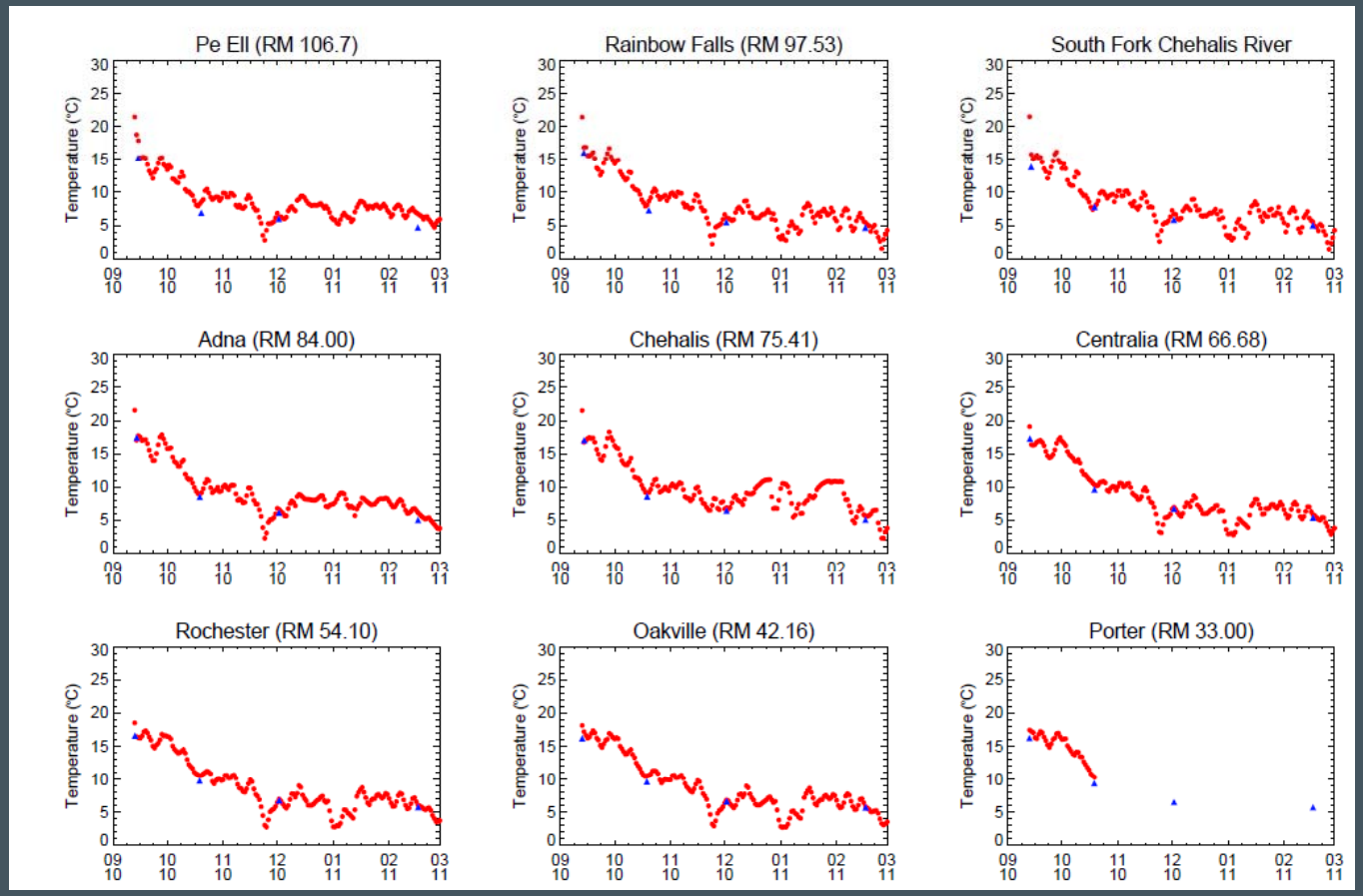
Locations of Temperature/Water Quality Probes



Continuous Temperature Data Collected on the Chehalis River



- Modeling efforts completed in March
- Only data downloaded through October 2010 was used in modeling

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Water Quality Modeling

- CE-QUAL-W2 model
  - Developed to include the anticipated inundation area
  - Used to simulate reservoir temperature and DO under a multi-purpose
  - A range of withdrawal elevations were evaluated
- HEC-RAS model
  - Developed from Chehalis River at Doty (RM 101.8) to Chehalis River at Porter (RM 32.28)
  - Model developed for April 2010 to March 2011 conditions
  - Calibrated to Ecology and Tidbit data from this project
  -

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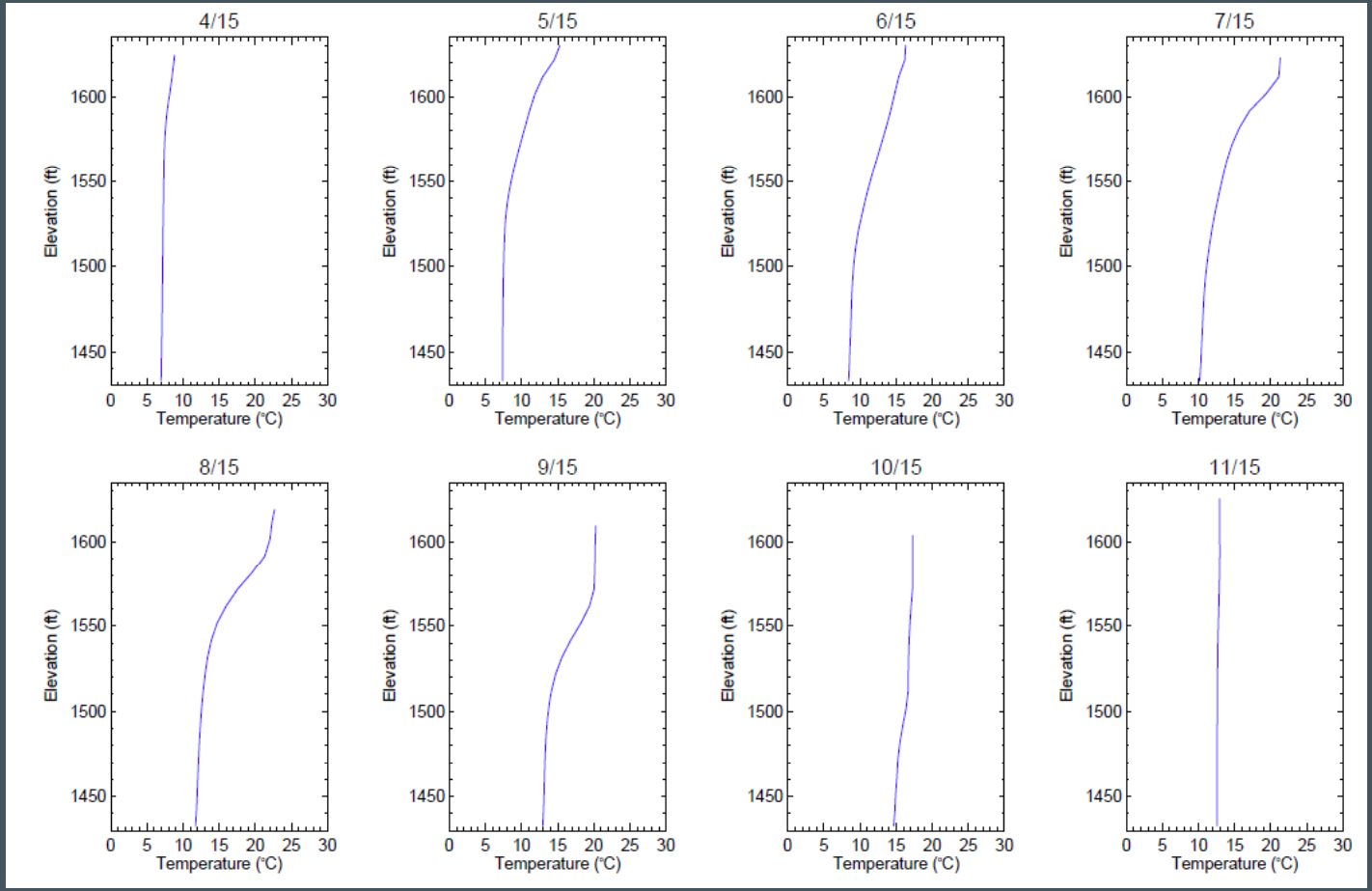
Reservoir Water Temperature Profiles



- Model simulated the dynamics of thermal stratification successfully

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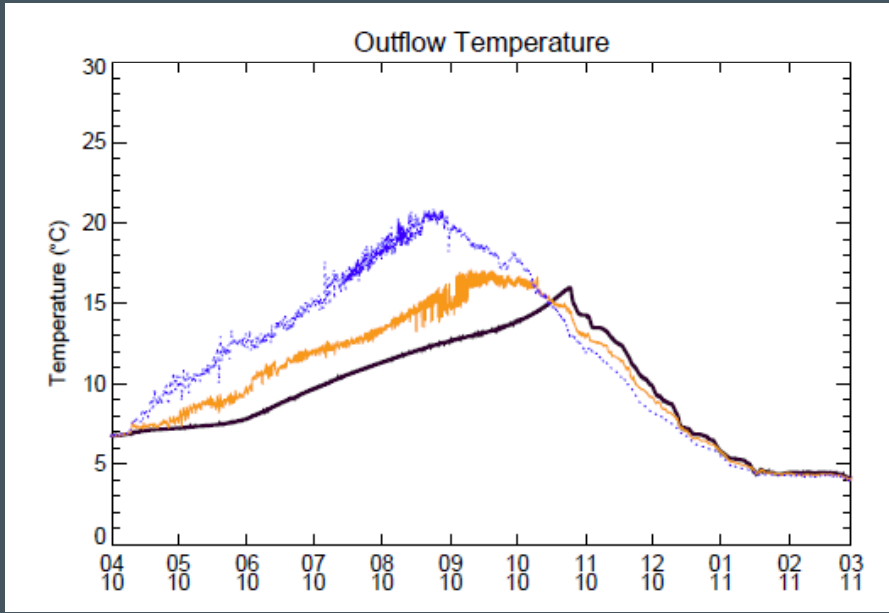
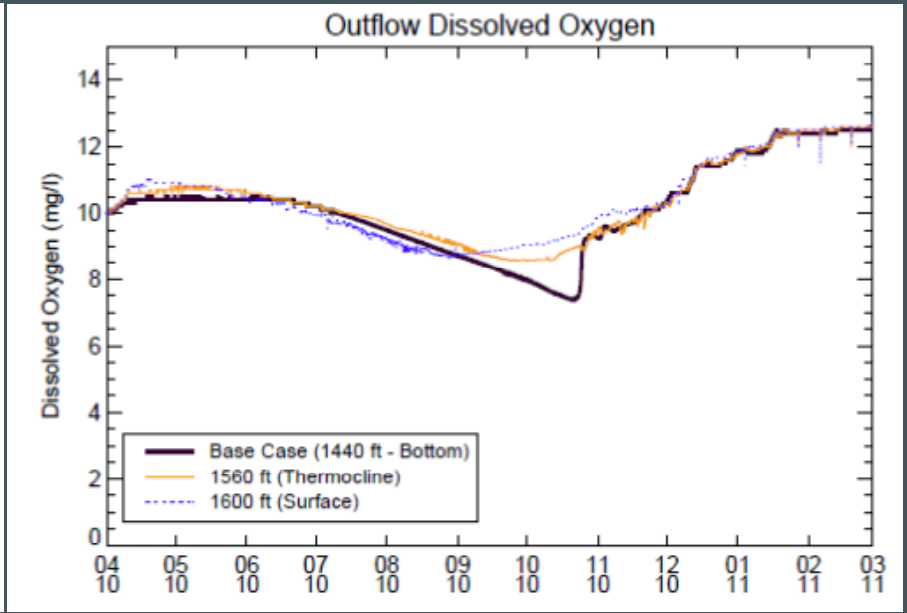
Outflow Temperature and DO: Effect of Withdrawal Elevation





- Outputs from CE-QUAL model provided the upstream boundary temperature and DO in HEC-RAS model
- Withdrawal elevation affects the temperature and DO

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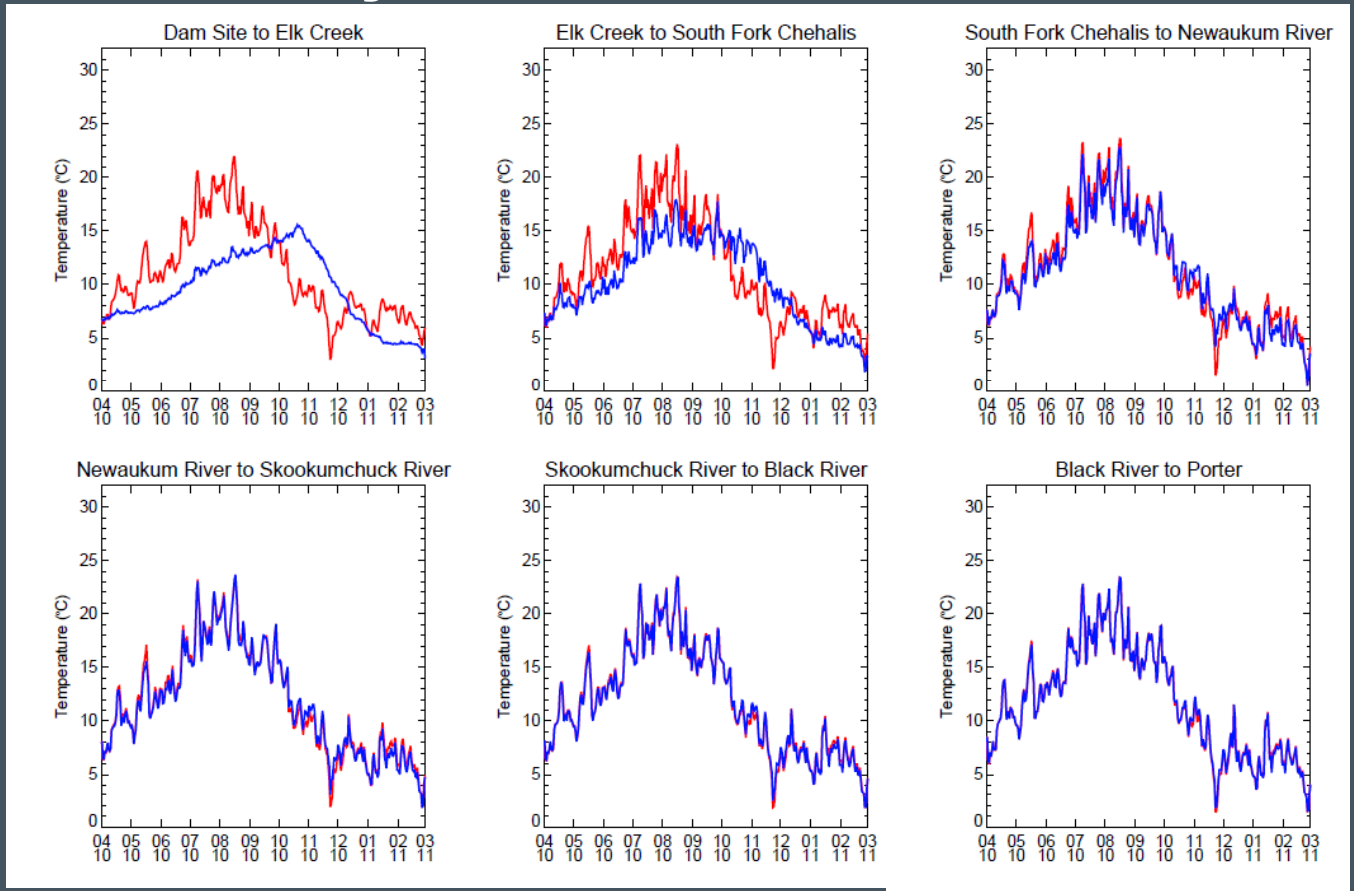
Downstream Temperatures with and without Project



- Substantial improvements in downstream temperature in summer for base case withdrawal (from 1440 ft)
- Improvements in water temperature generally declined downstream

Base Case
Multi-purpose Scenario

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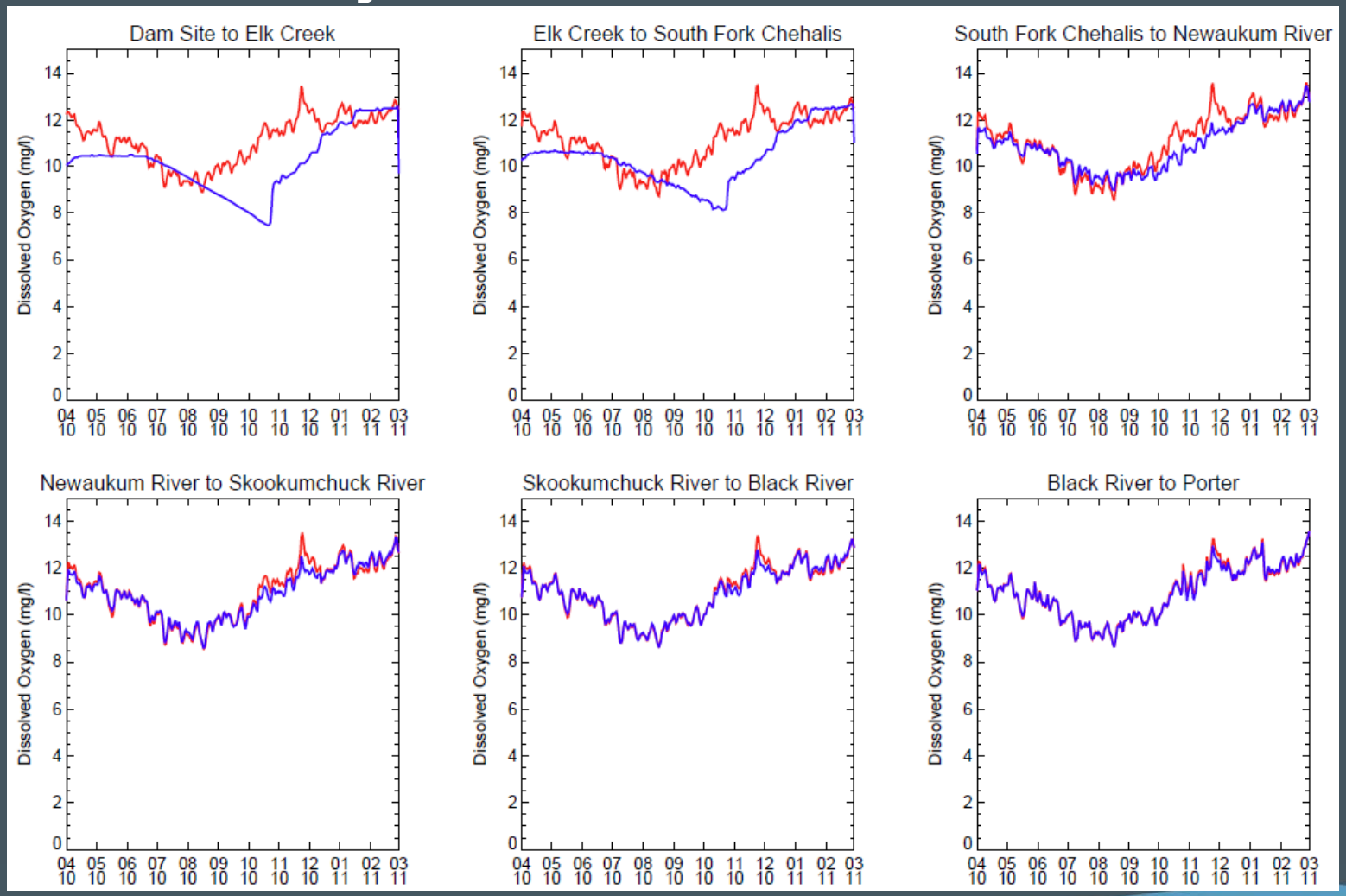
Downstream Dissolved Oxygen with and without Project



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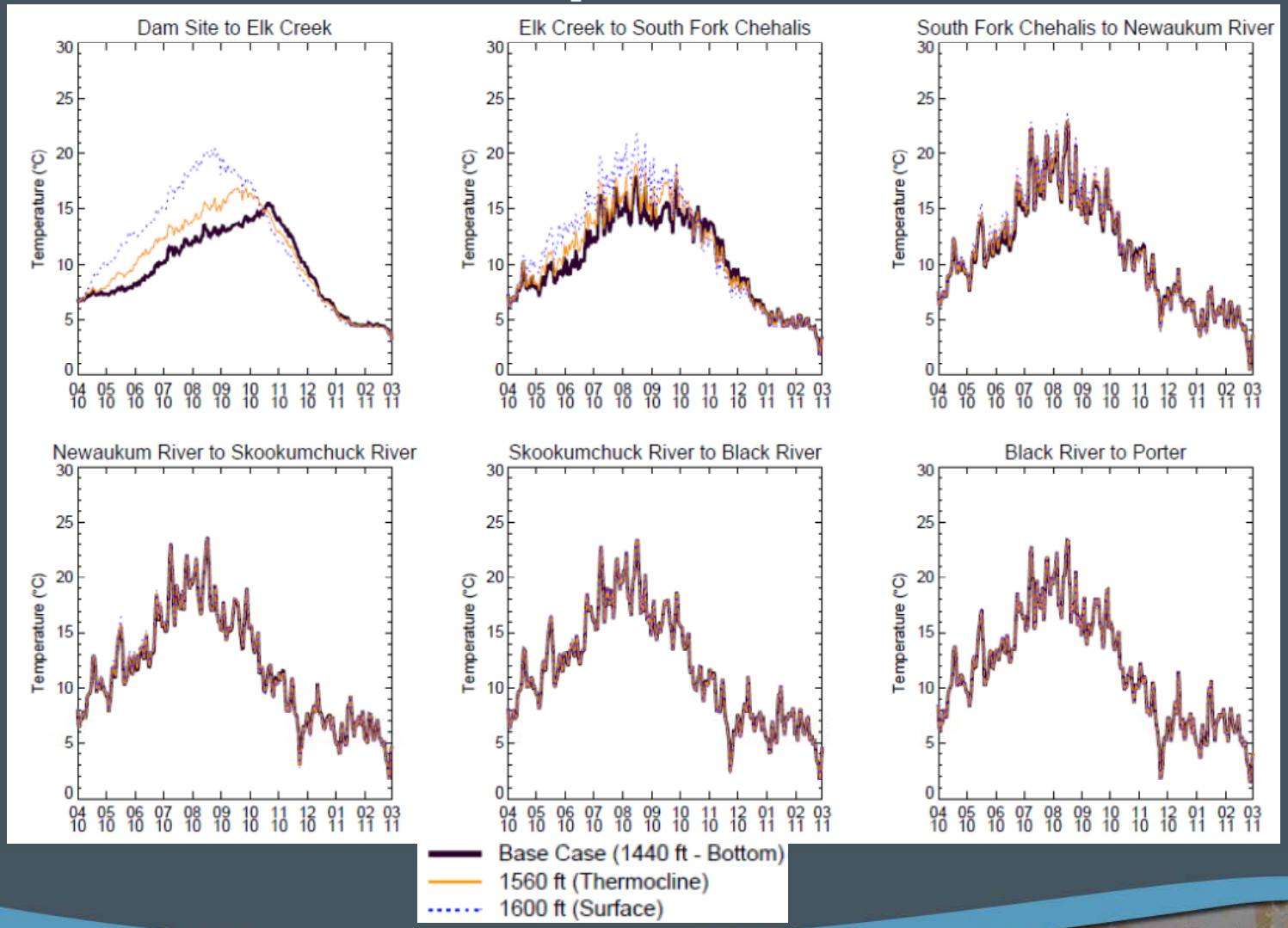
Effect of Withdrawal Elevations on Downstream Temperature



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Summary

- Model simulations indicate that there is a potential for improvements in downstream temperature from multi-purpose reservoir alternative
  - Downstream temperatures are sensitive to withdrawal elevation
  - Bottom waters from reservoir result in cooler downstream temperatures
- Model simulated temperature used for developing inputs to Shiraz Model

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Fish Habitat Availability

- Used Physical Habitat Simulation (PHABSIM) methods
  - Part of Instream Flow Incremental Methodology (IFIM) procedures
  - Followed guidelines developed by WA Dept. of Fish and Wildlife and WA Dept. of Ecology
  - WDFW and Ecology biologists participated in study site selection and study plan review
- PHABSIM predicts changes in habitat availability with changes in flow

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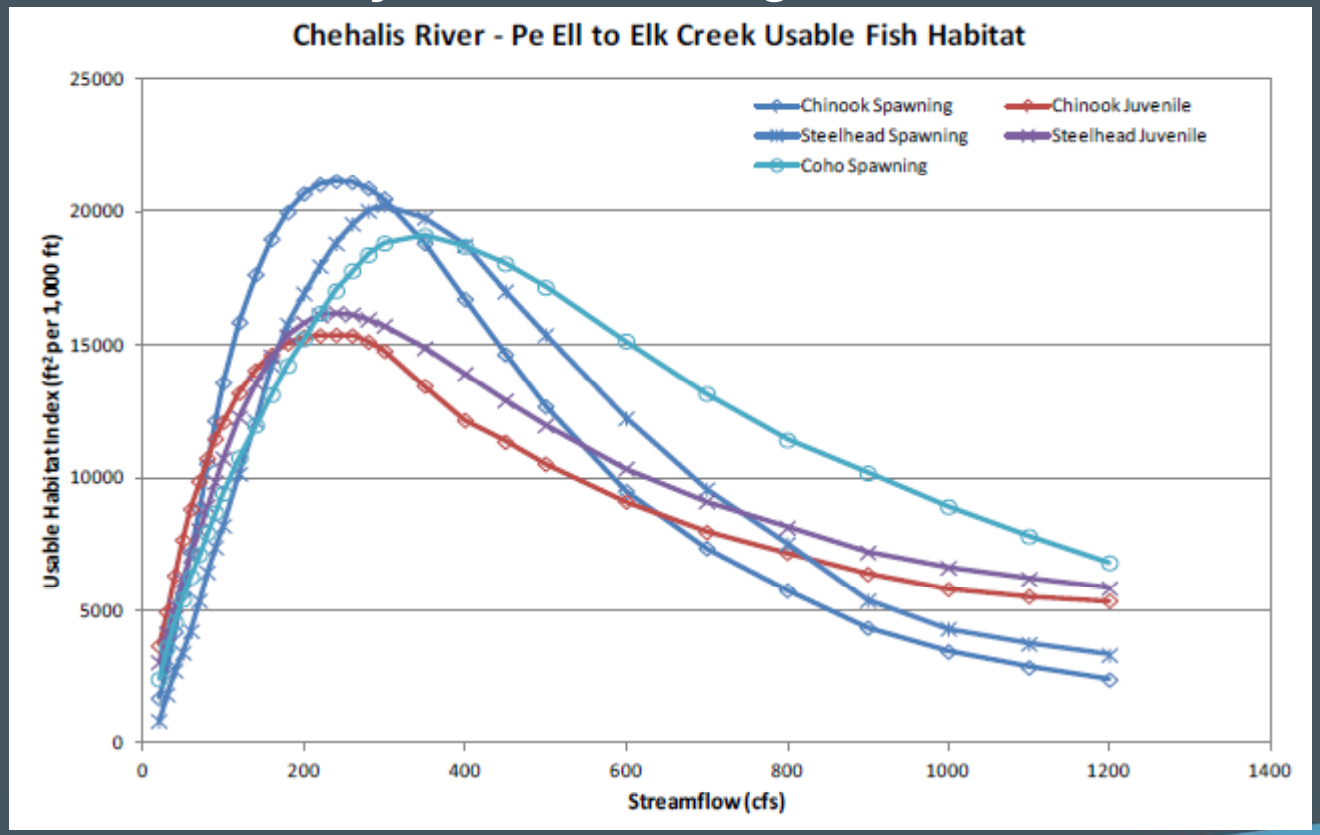
Fish Habitat Modeling Using PHABSIM

- PHABSIM predicts changes in habitat availability with changes in flow



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Fish Habitat Availability In Upper Watershed

- Used Habitat Equivalency Protocols to estimate habitat above proposed dam site
- Collected data on habitat types, fine sediment, substrate sizes, and availability of cover

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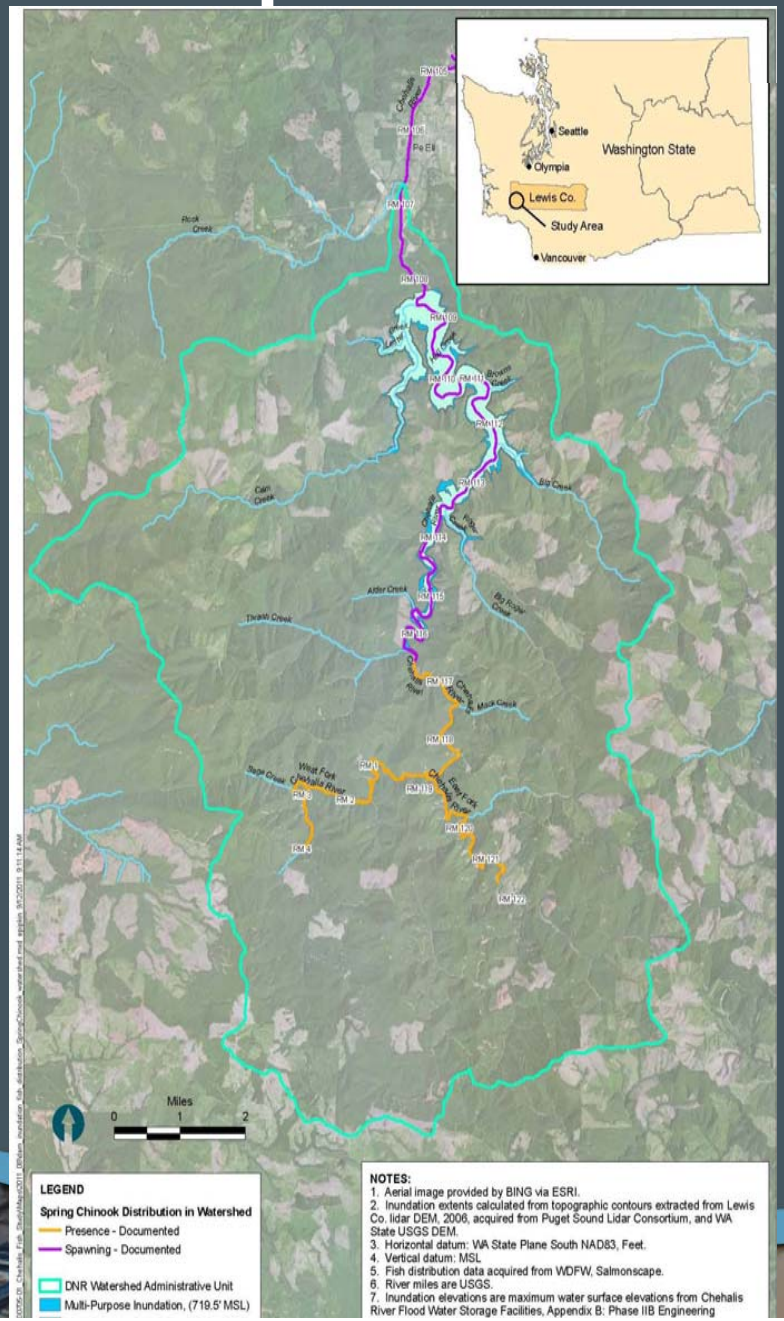
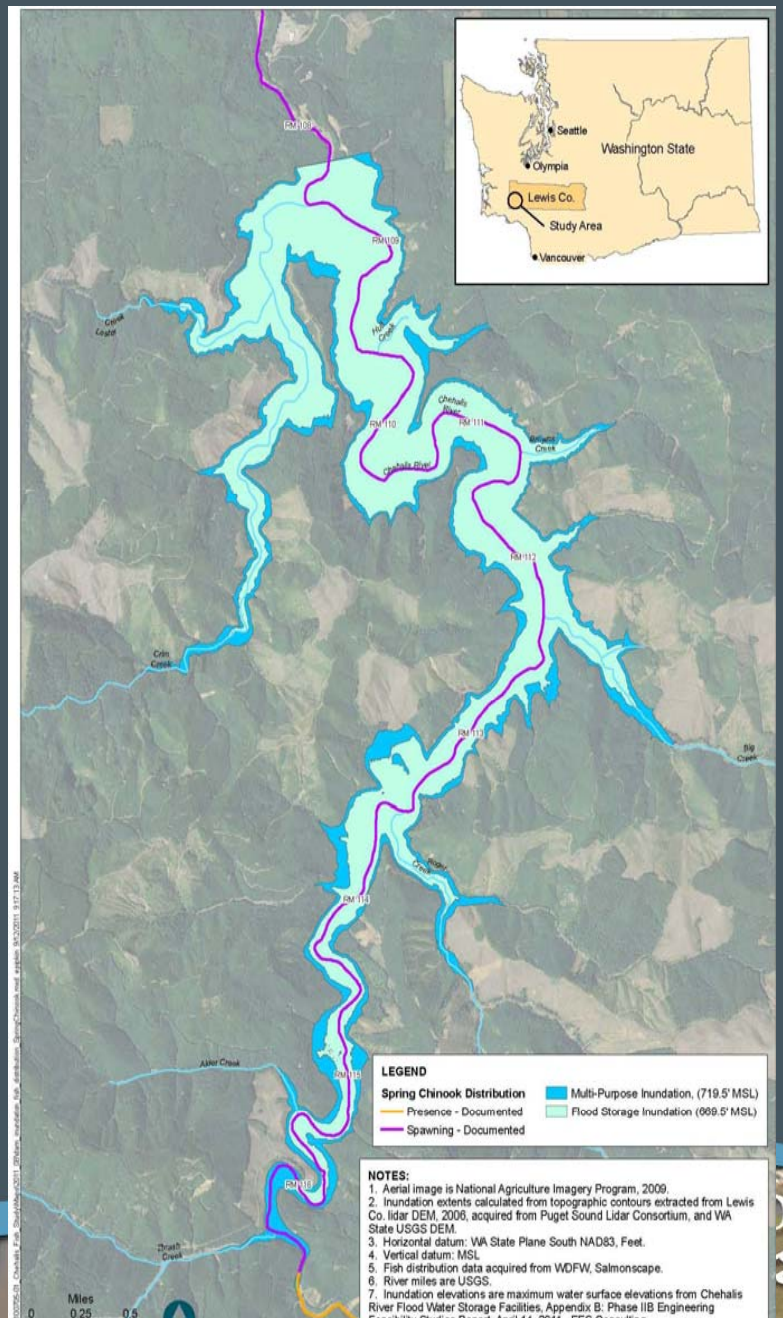
Example of Salmonid Distribution





Fish Habitat Remaining In Upper Watershed above Proposed Dam Site

Species and Life Stage	Percent of Existing Habitat Area Remaining	
	Flood Storage Only Dam	Multi-Purpose Dam
Spring Chinook spawning	4	0
Spring Chinook rearing	51	48
Winter Steelhead spawning	45	42
Winter Steelhead rearing	59	54
Coho spawning	52	46
Coho rearing	50	45

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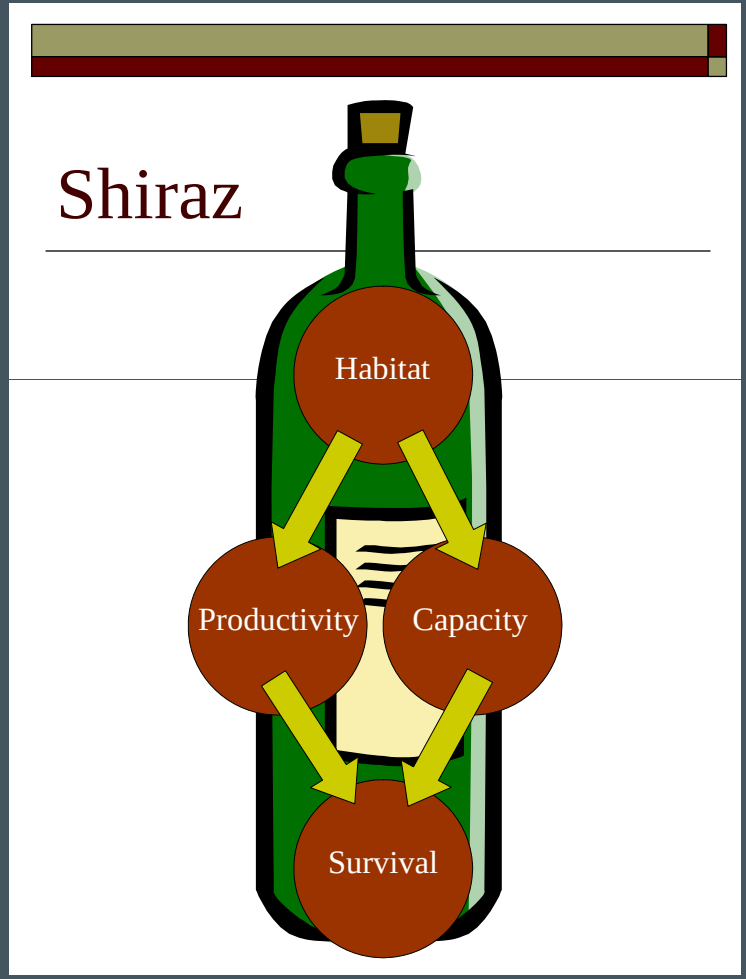
Fish Population Modeling Using SHIRAZ

- Microsoft Excel-based modeling platform to relate habitat conditions to salmon production
  - Capacity (spawning and rearing habitat using PHABSIM and hydrology results)
  - Productivity (using water quality, geomorphology, sediment transport results)



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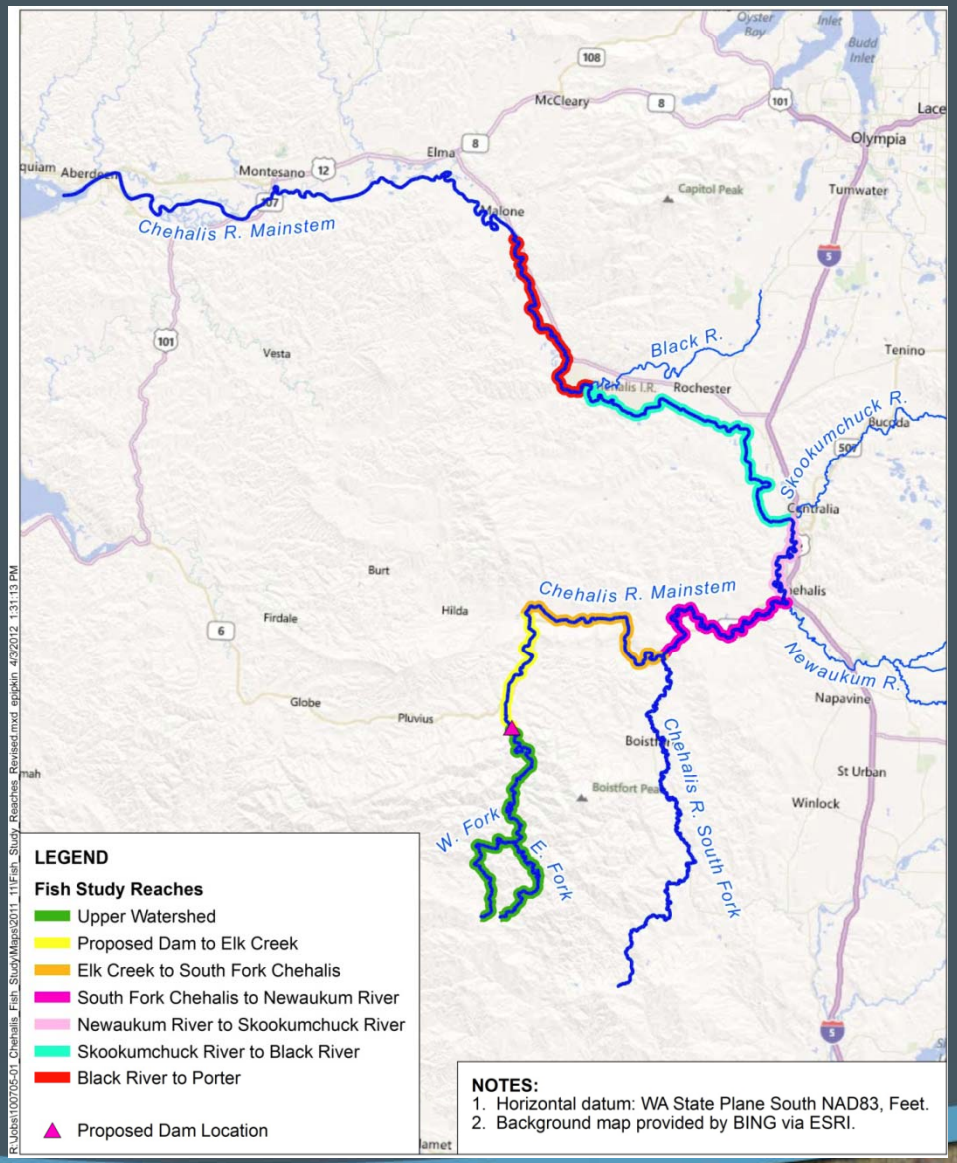
Assessment Reaches



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Changes Incorporated to Final Analysis

- Adjusted spawning distributions of coho salmon
- Incorporated stray rate estimates
- Used median flows instead of average flows
- Used peak periods rather than full life stage periodicity
- Adjusted functional relationships used for each species
- Removed "tributary" reach from model framework
- Removed spawning habitat capacity from those reaches the fish have not been documented spawning in

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Changes Incorporated to Final Analysis

- Increased number of simulations to 50
- Analyzed 3 survival rate scenarios past dam: target, poor, and no survival
- Multi-purpose analysis refined to be based on water release schedule that maximizes fish habitat

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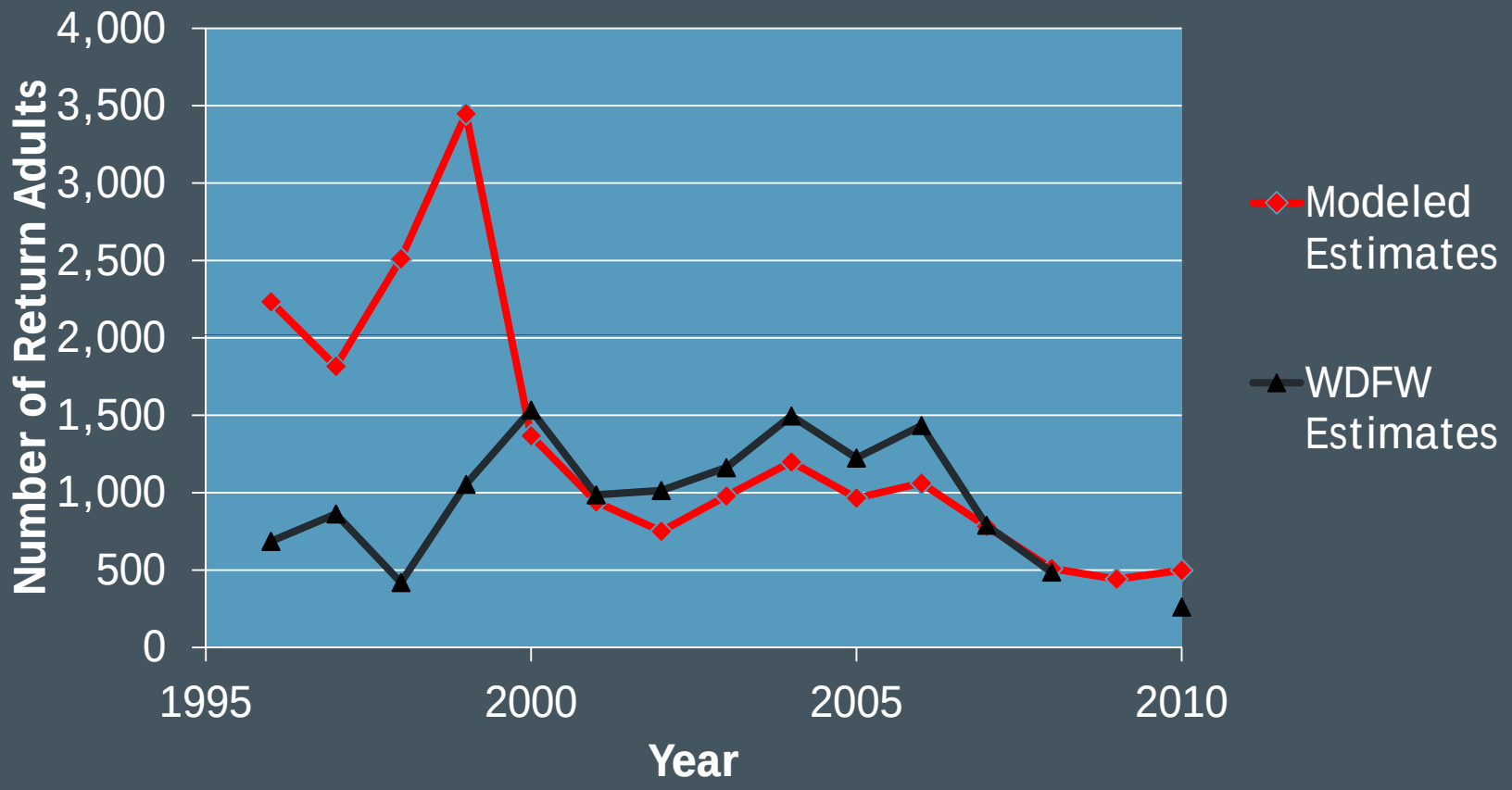
Calibrated Model – Winter Steelhead



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Future Scenarios Analyzed for Each Species

- Continuation of Existing Conditions (no dam)
- Flood Storage Only Dam
  - Assuming target fish passage survival rates
  - Assuming poor fish passage survival
  - Assuming no fish passage
- Multi-Purpose Dam with Optimized Flow Releases for Fish
  - Assuming target fish passage survival rates
  - Assuming poor fish passage survival
  - Assuming no fish passage

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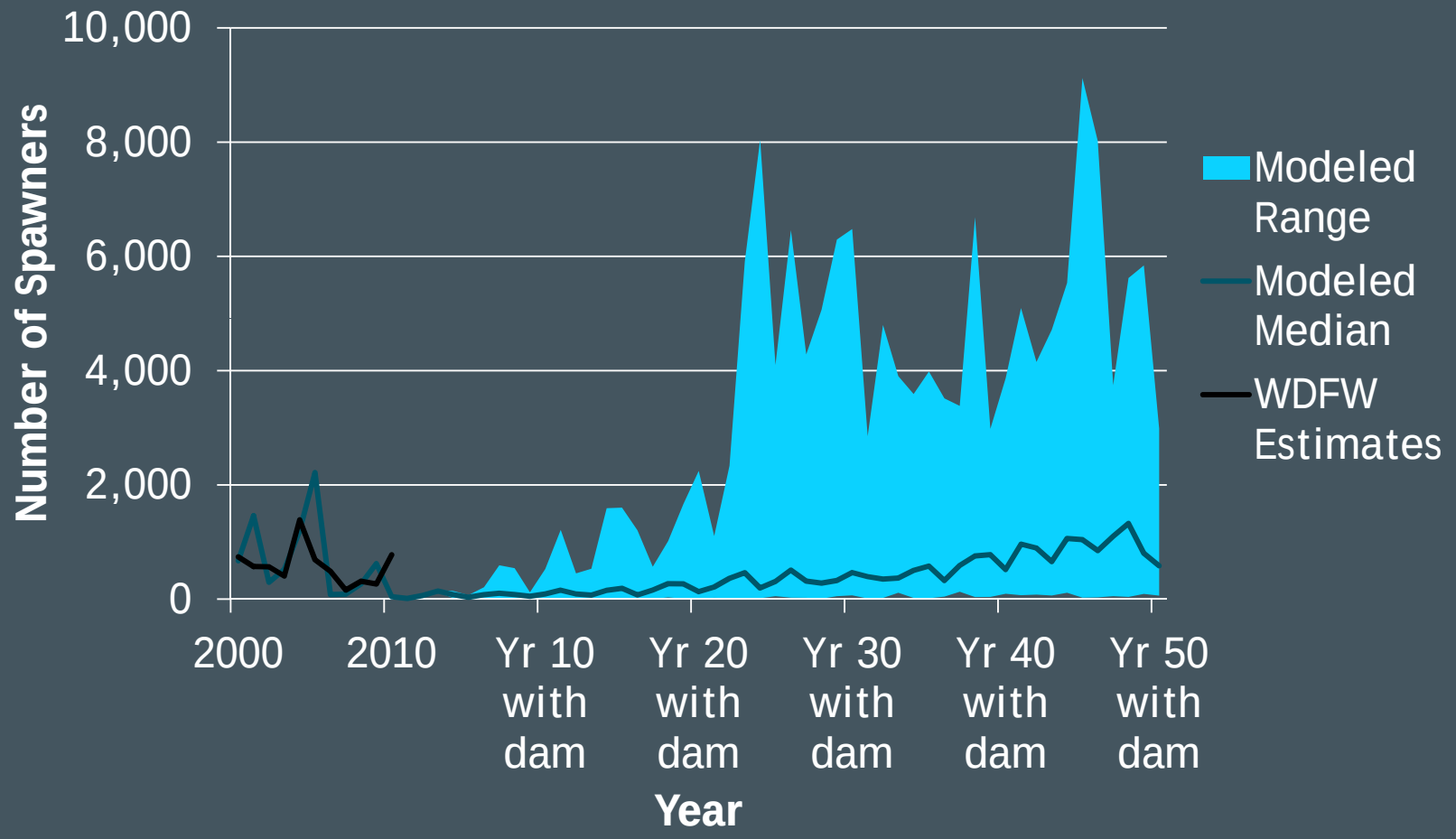
Predicted Future Conditions – Chinook Assuming Existing Conditions (no dam)



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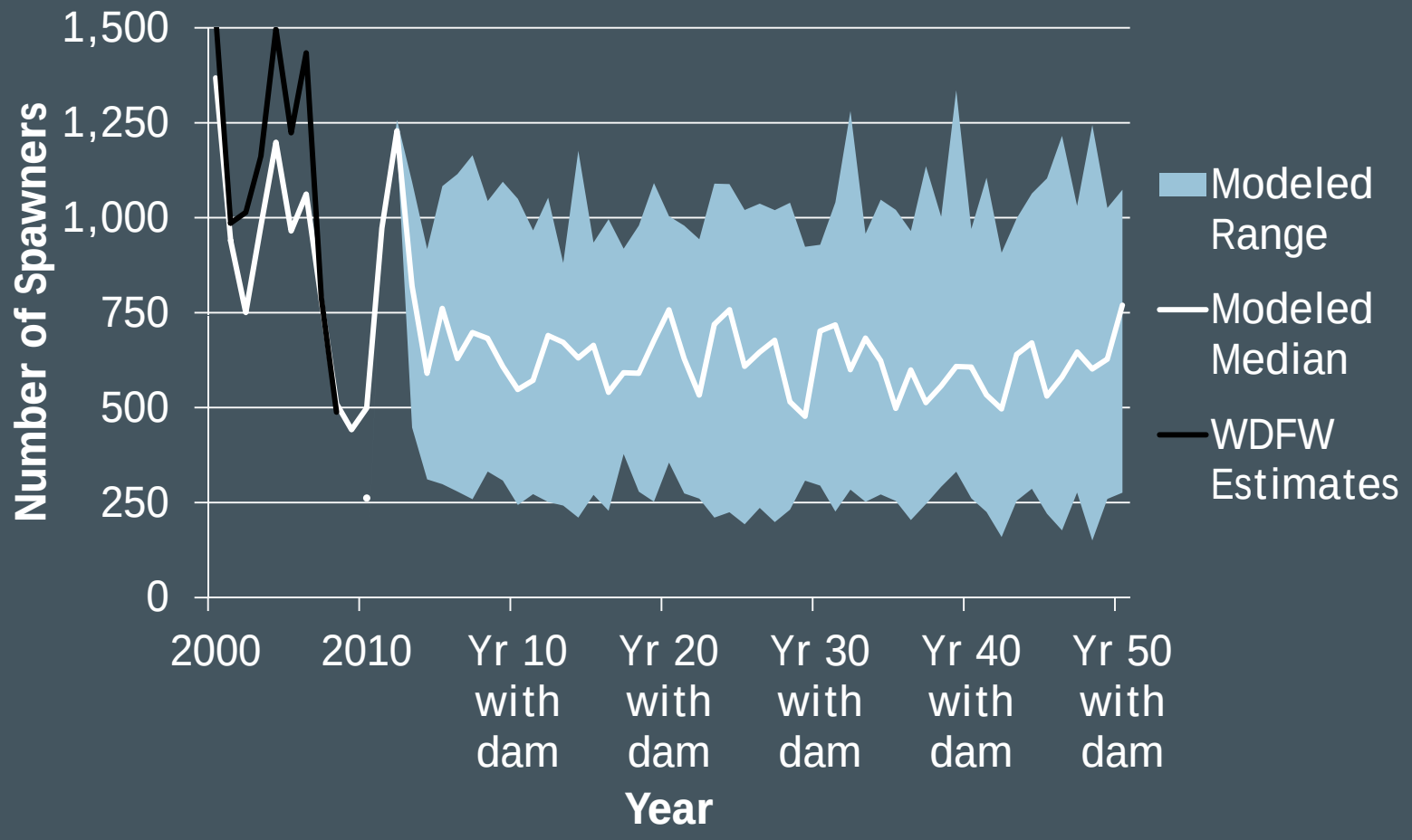
Predicted Future Conditions – Steelhead Assuming Existing Conditions (no dam)



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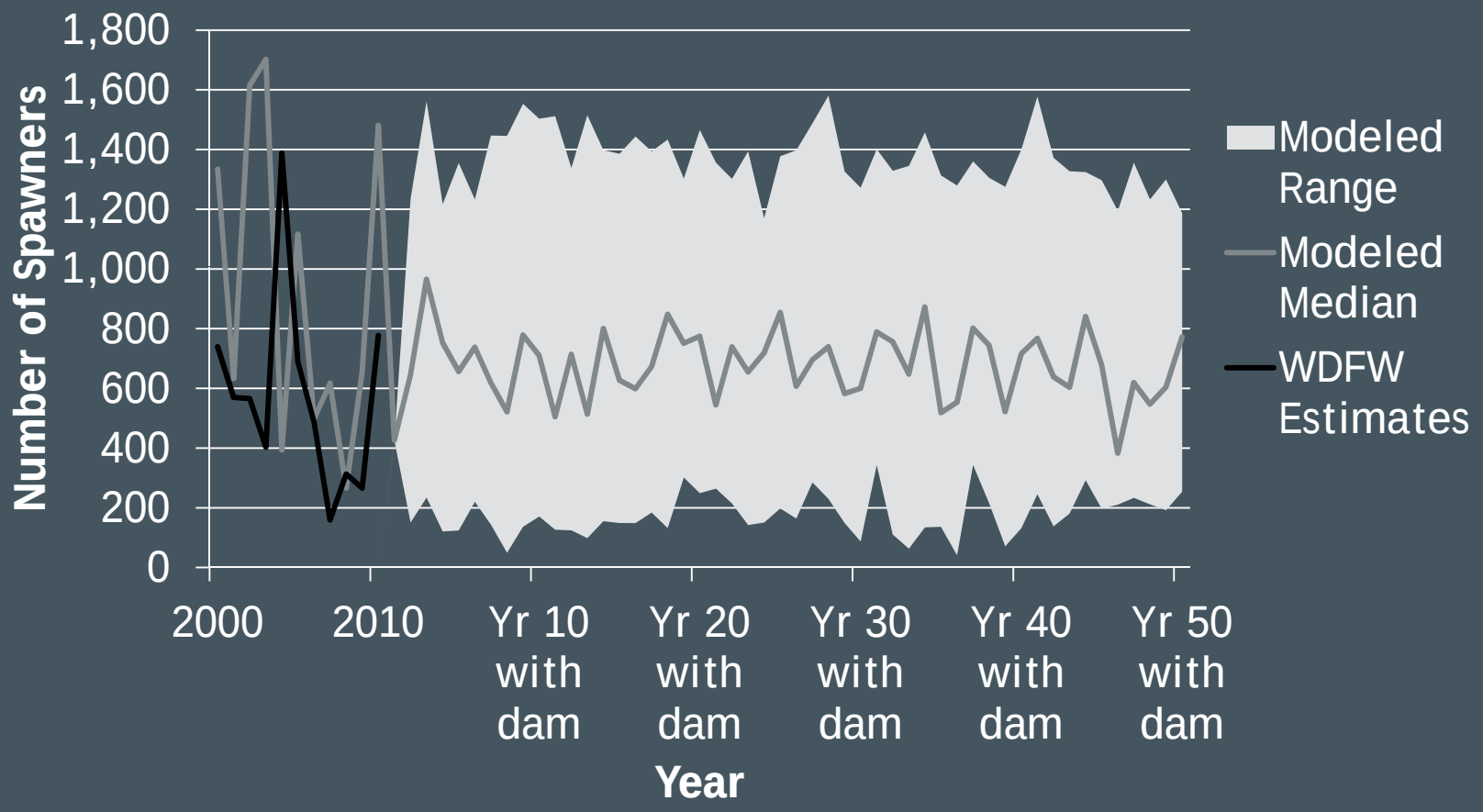
Predicted Future Conditions – Coho Assuming Existing Conditions (no dam)



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Changes to Scenarios with Dams

Model Input Changed	Flood Storage Only	Multi-Purpose
Decreased frequency and magnitude of high flow events	✓	✓
Decreased quantity of habitat available in the upper watershed	✓	✓
Decreased habitat quantity to account for loss of sediment bedload and large wood	✓	✓
Increased percent fine sediments in the downstream of the dam	✓	✓
Increased base flows in the lower river		✓
Altered water temperatures downstream of dam		✓

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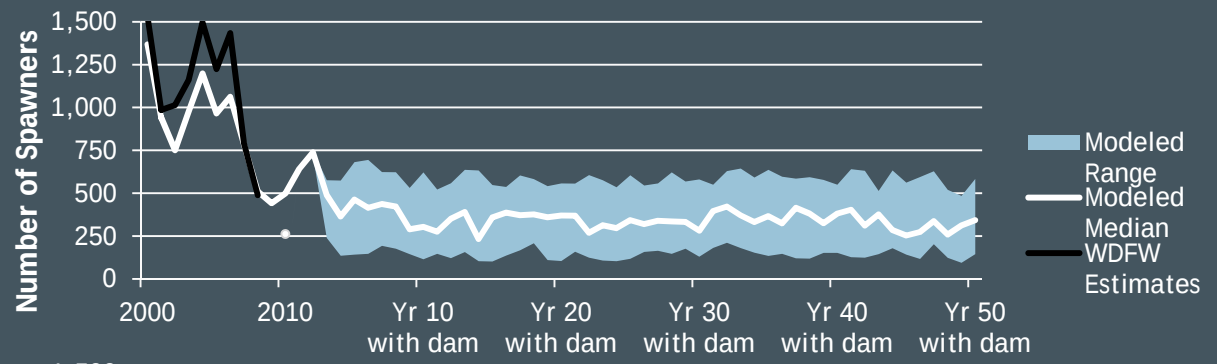
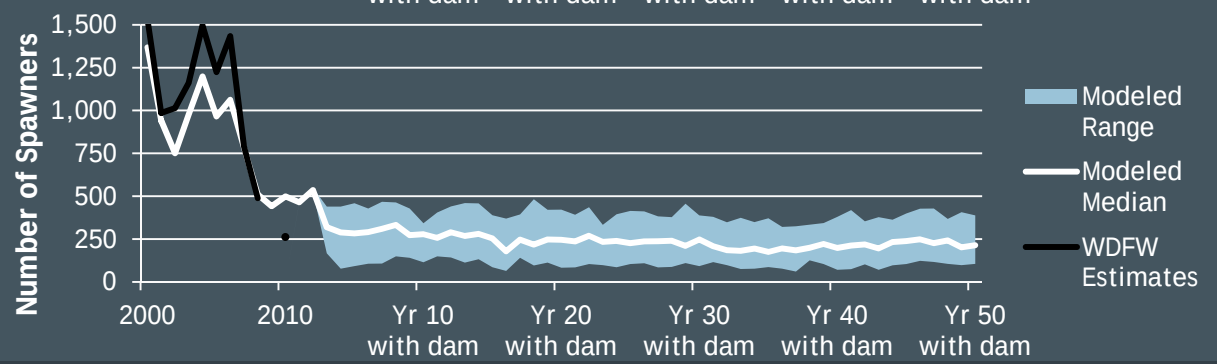
Predicted Winter Steelhead Spawners with Flood Storage Only Dam

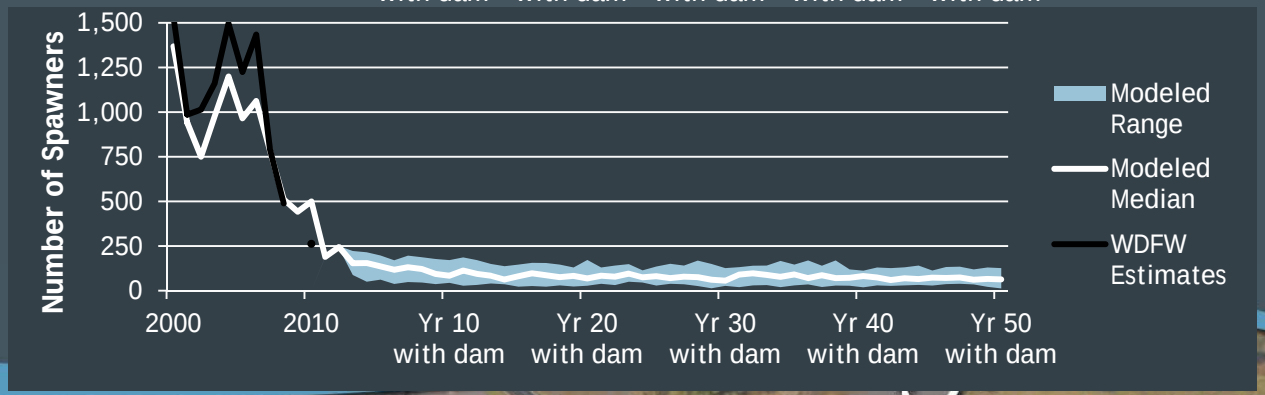
- Target fish passage survival



- Poor fish passage survival



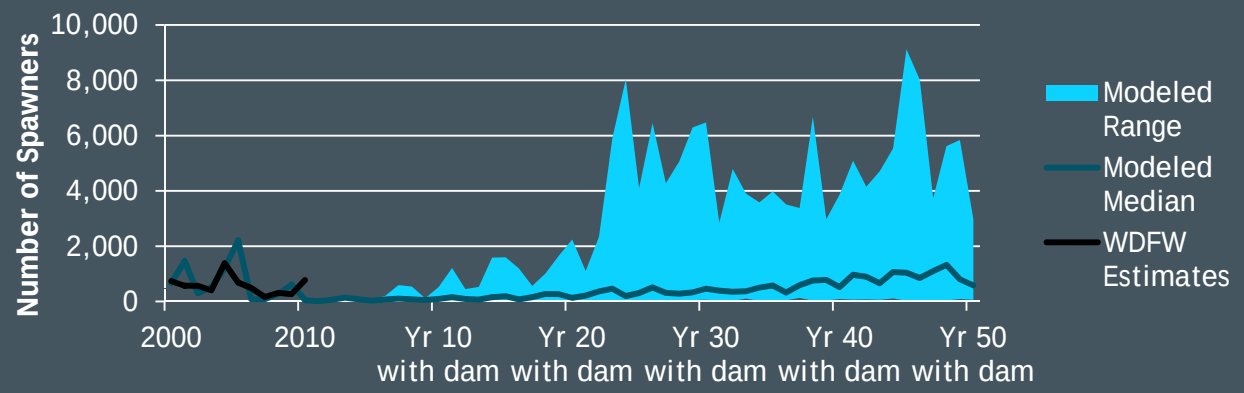
- No fish passage survival



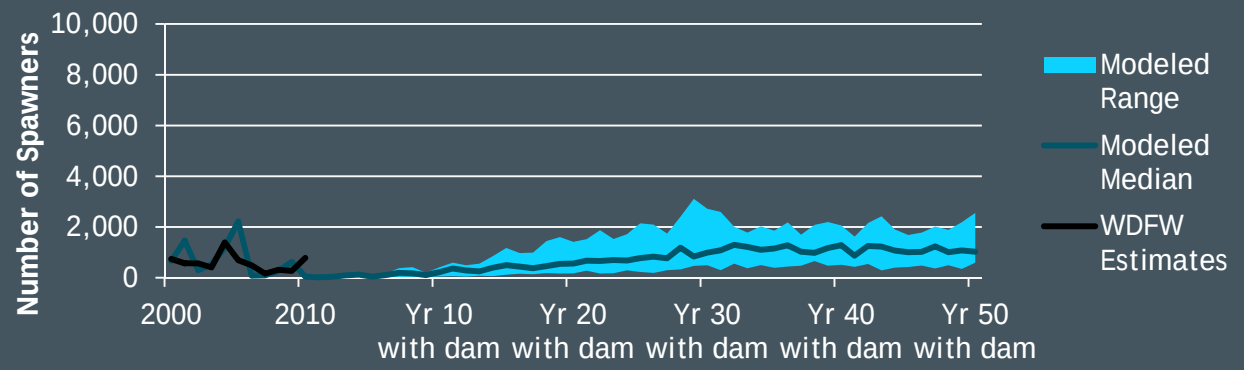
QEA

Comparison of Predicted Spring Chinook Spawners Between Existing Conditions and with Optimized Multi-Purpose Dam

- Continuation of Existing Conditions (no dam)



- Optimized Multi-Purpose Dam



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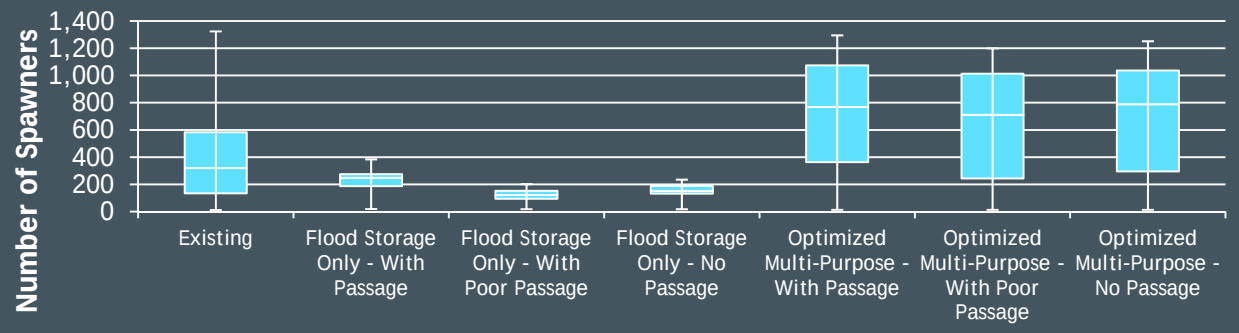
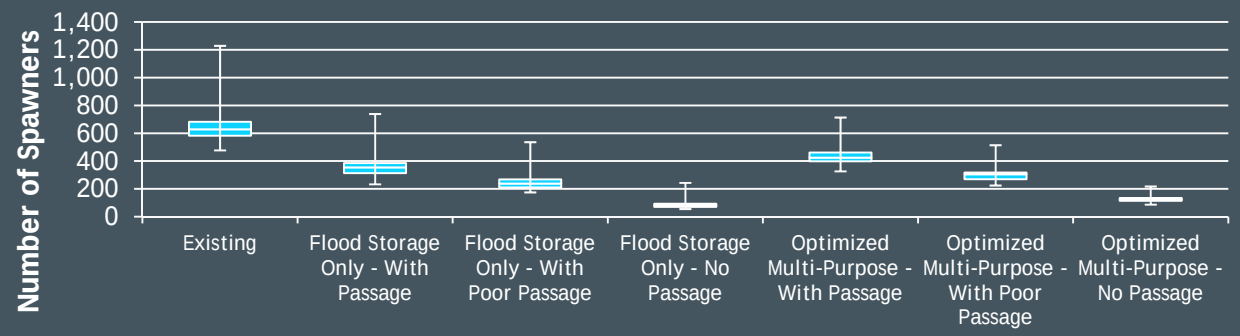
Predicted Salmonid Abundance In Modeled Scenarios

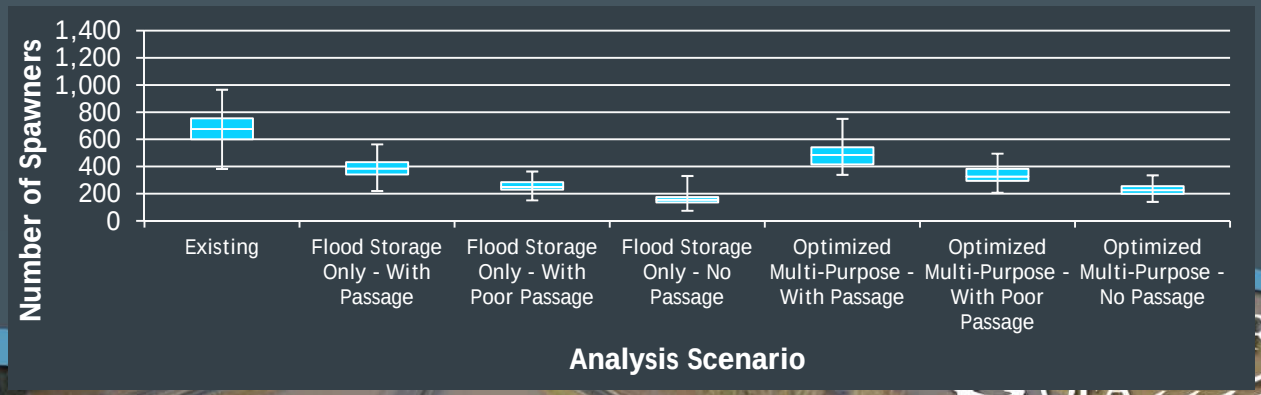
- Spring Chinook Salmon



- Winter Steelhead



- Coho Salmon



Summary of Predicted Population Effects

Dam Type	Fish Passage Analysis Scenario	Spring Chinook Salmon	Winter Steelhead	Coho Salmon
No Dam – Continuation of Existing Conditions		0%	0%	0%
Flood Storage Only Dam	Target Survival	-22%	-43%	-43%
	Poor Survival	-62%	-62%	-63%
	No Survival	-52%	-87%	-77%
Optimized Multi-Purpose Dam	Target Survival	140%	-32%	-28%
	Poor Survival	122%	-52%	-52%
	No Survival	146%	-81%	-67%

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Summary Points

- Winter steelhead and coho salmon populations were predicted to be substantially reduced in either dam configuration
- Spring Chinook abundance was predicted to more than double (median) with Multi-Purpose Dam operated to maximize fish habitat through water releases. Any alterations to this would decrease predictions.

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Questions and Discussion

- Report available at:

https://projects.anchorqea.com/sites/chehalisfishstudy
username: chehalisfish
password: upstream-4

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