Summer/Fall Chinook Performance Potential Upstream of Chief Joseph and Grand Coulee Dams

Draft life-cycle modeling results of an ad-hoc workgroup of the UCUT fish committee

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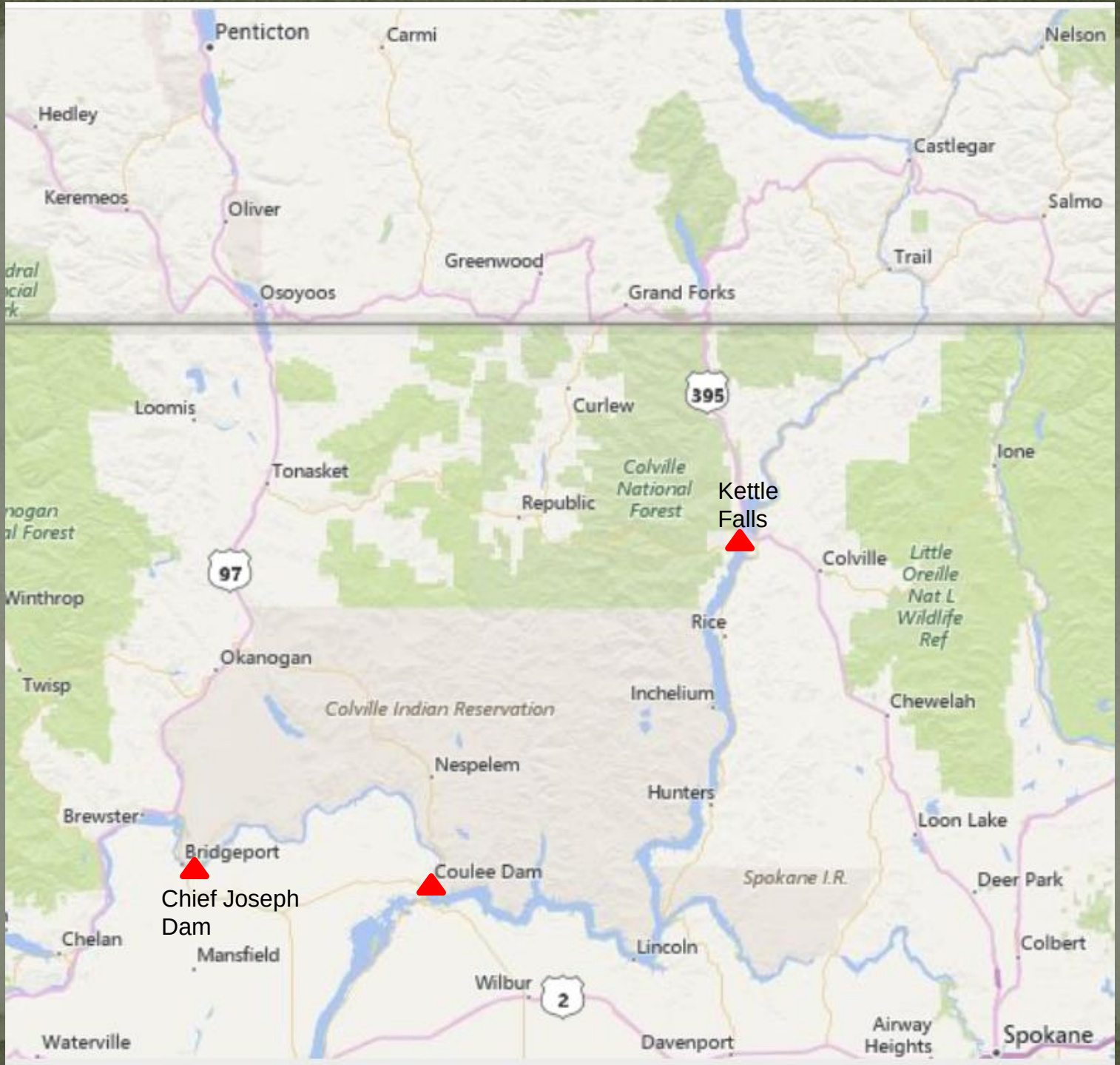
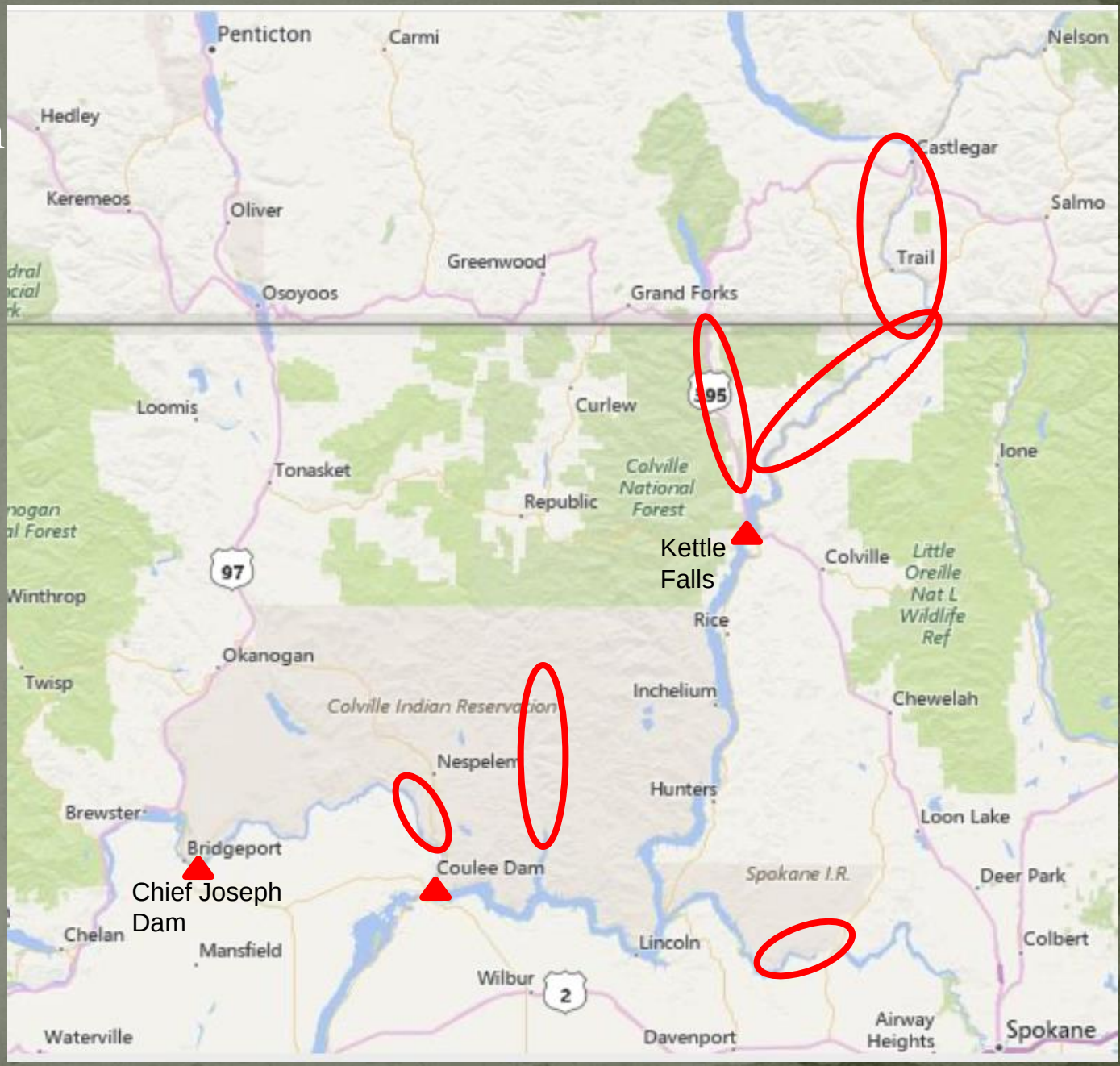

Penticton
Carmi
Nelson
Hedley
Castlegar
Keremeos
Oliver
Salmo
Greenwood
Trail
Osoyoos
Grand Forks
Loomis
Curlew
395
Tonasket
Colville National Forest
Republic
Kettle Falls
Ione
97
Colville
Little Oreille Nat L Wildlife Ref
Winthrop
Rice
Okanogan
Twisp
Inchelium
Chewelah
Colville Indian Reservation
Nespelem
Hunters
Brewster
Loon Lake
Bridgeport
Coulee Dam
Spokane I.R.
Deer Park
Chief Joseph Dam
Chelan
Mansfield
Lincoln
Colbert
Wilbur
2
Waterville
Davenport
Airway Heights
Spokane

Phase 1 Report includes……

Where	Habitat Assessment
Who	Donor Stock Assessment
Constraints	Risk Assessment
How	Reintroduction Strategies
How & Constraints	High Head Dam Fish Passage Facility Options
	★ Life Cycle Modeling
	Alternative Fish Passage Facility Configurations
	Key Uncertainties
	Cost and Financing Considerations
	Recommendations

Summer/Fall Chinook Salmon spawning areas

- Rufus Woods
- Sanpoil River
- Spokane River
- Kettle River
- Transboundary Reach



The Model

- Full life cycle (adult to adult)
- Spreadsheet based Beverton-Holt stage-specific survival model that accounts for density dependence during each freshwater life stage
- Productivity and carrying capacity parameters for each life stage
- Incorporates juvenile life history and origin-specific (hatchery or natural) assumptions about survival, harvest and return rate.

Go to Dashboard

Enter Natural Production Assumptions

Enter Migration and Passage Assumptions

Enter Hatchery and Harvest Assumptions

Go To Model Results

Go To Sensitivity Analysis

Biological assumptions….borrowed from adjacent populations.

Summer/Fall Chinook Assumptions **Fill in yellow cells only - green cells calculate automatically.**

Hatchery Fish Survival

In-Hatchery Survival

Adult pre-spawning survival (BY)	0.83
Percent females in hatchery brood (BY)	51%
Eggs per female (BY)	4,600
Egg to smolt survival	0.87

Hatchery Fish in Nature

Relative Post Release Survival:	
Subyearlings	1
Yearlings	1
Relative spawning success of HORs	0.8

Natural Spawning

	Spawner Age						
	1	**2**	**3**	**4**	**5**	**6**	
Age Composition	0.00%	0.79%	10.62%	61.87%	26.43%	0.28%	
Include? (1 or 0)	0	0	1	1	1	1	
Weight	0	0	0.1062	0.6187	0.2643	0.0028	
% Females	0	0	0.07	0.565	0.614	0.6	
Eggs/female	0	0	4,000	4,500	5,000	5,500	
Age weighted eggs/spawner (male and female)							2,443

	Juvenile life history pathway (%)
Fry to Spring Migrant	**85.0%**
Fry to Fall Migrant	**10.0%**
Fry to Yearling Migrant	**4.9%**
Fry to Age 2 Migrant	**0.1%**

Enter Natural Production Assumptions

Su/Fa Chinook

Natural Production Assumptions - Rufus Lake Population

Spawning-Rearing Area

Fill in yellow cells only - green cells calculate automatically.

		Productivity	Capacity	Cum. Productivity	Cum Capacity
	Spawning	0.72	20,000	0.72	20,000
Density Independent Survival Rate Egg-to-	Incubation	0.63	100,000,000	1108	23,536,507
47.3%	Fry Colonization	0.75	100,000,000	831	15,003,844
42.1%	Fry to Spring Migrant	0.89	100,000,000	740	11,780,343
25.2%	Fry to Fall Migrant	0.6	100,000,000	499	8,258,822
2.5%	Fry to Yearling Migrant	0.1	100,000,000	83	1,478,206
0.0%	Fry to Age 2 Migrant	0.001	100,000,000	1	15,002

From Harnish et al. 2014, Hanford Reach Fall Chinook

Assumption: Not capacity limited life stages, (subyearling migrants spend limited time in a big space)

Enter Migration and Passage Assumptions

	Juvenile Passage (Mainstem Columbia River)	Estuary/ Ocean Survival		
	CJD to Bonneville Dam (BON)	BON to BON SAR	CJD to CJD SAR NORs	CJD to CJD SAR HORs
Spring Migrants	27.0%	1.98%	0.44%	0.44%
Fall Migrants	36.3%	2.53%	0.76%	0.76%

Enter Migration and Passage Assumptions

Go to Reservoir Rearing

Fill in yellow cells only - green cells calculate automatically.

			Destination of fish arriving at Chief Joseph Dam					
	Percent migrating to CJD	Percent of arriving fish collected	Percent transported	Transport survival	Percent in Bypass	Bypass survival	Percent spill/turbine	Spill/Turbine Survival
Spring Migrants	100.0%	85.0%	0.0%	99.0%	85.0%	99.0%	15.0%	88.0%
Fall Migrants	100.0%	87.0%	0.0%	99.0%	87.0%	99.0%	13.0%	44.0%
Yearling Migrants	100.0%	70.0%	0.0%	99.0%	70.0%	99.0%	30.0%	88.0%
Age 2 Migrants	100.0%	70.0%	0.0%	99.0%	70.0%	99.0%	30.0%	88.0%

<u>Spring migrants</u>
85% are bypassed (*e.g.*, FSC)
bypassed fish have 99% survival

15% go through spill
88% survival

<u>Fall migrants</u>
87% are bypassed (*e.g.*, FSC)
bypassed fish have 99% survival

13% go through turbines
44% survival

Enter Hatchery and Harvest Assumptions

Rufus Woods baseline: Release 1,000 hatchery origin adults to spawn in the river

Lake Roosevelt baseline: Release 2,000 hatchery origin adults and 1.5 million Subyearling smolts

Harvest Rates

Fill in yellow cells only - green cells calculate automatically.

	Ocean	Estuary to Bonneville Dam	Bonneville to Wells	Upstream of Wells		Exploitation Rate
HORs	30.5%	7.2%	26.9%	19.3%		61.9%
NORs	30.5%	7.2%	26.2%	10.9%		57.6%

The harvest split for fisheries located between Wells Dam and Chief Joseph Dam, and upstream of Chief Joseph Dam are defined for HORs and NORs to the right.

HORs	Wells to Chief Joseph	5.0%
	Upstream Chief Joseph Dam	15.0%
NORs	Wells to Chief Joseph	1.0%
	Upstream Chief Joseph Dam	10.0%

Preliminary LCM for the reach between CJD and GCD (Rufus Woods Reservoir)

- The Baseline Scenario includes:
  - Floating surface collector (FSC) and exclusion nets in front of the powerhouse cul de sac (85%) (—)
  - Out-planting 1,000 hatchery-origin adults above the dam.
    - Passage of natural-origin adults resulting from spawning in Rufus Woods Reservoir

Preliminary LCM for the reach between CJD and GCD (Rufus Woods Reservoir)

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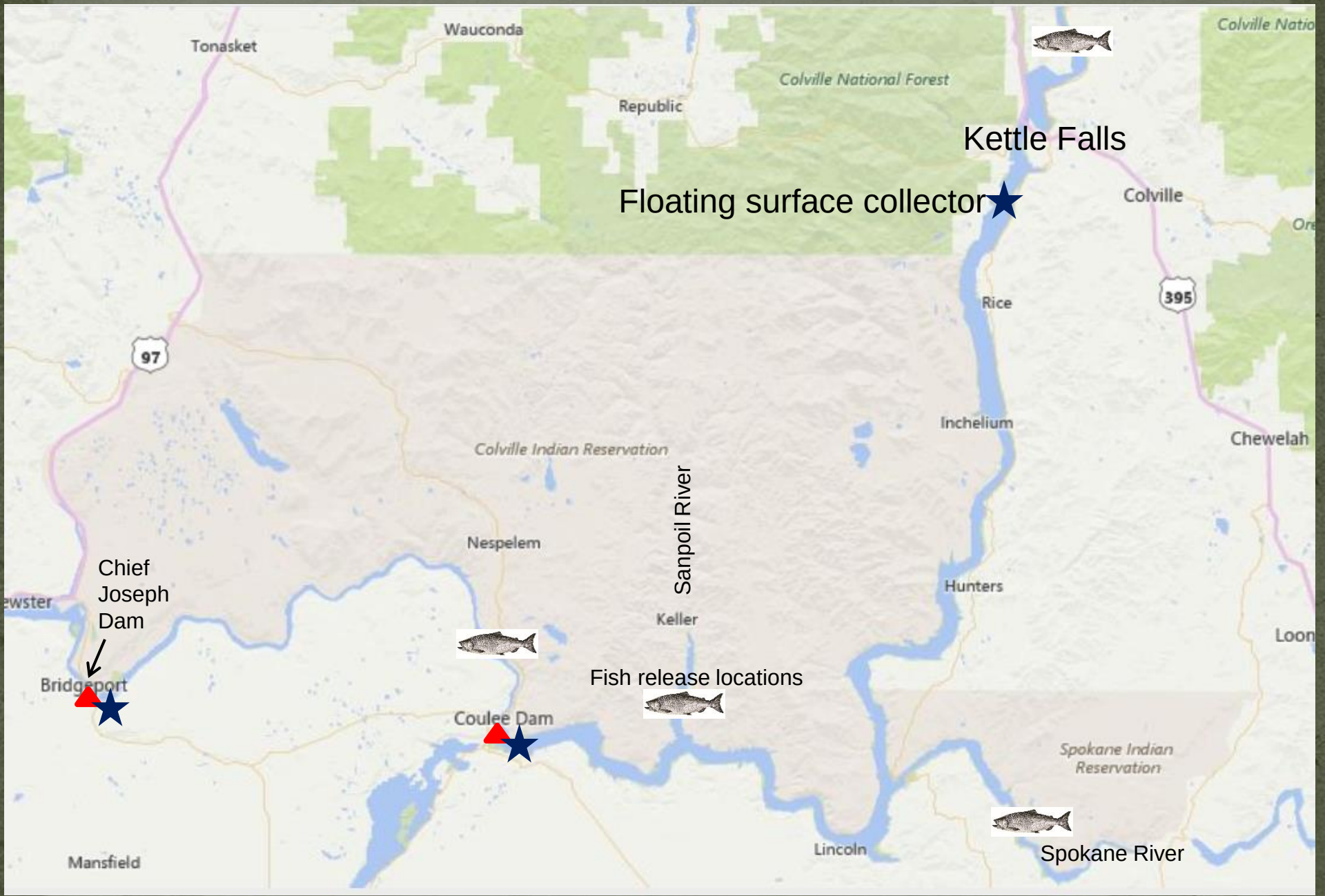
  - Out-planting 1,000 hatchery-origin adults above the dam.
    - Passage of natural-origin adults resulting from spawning in Rufus Woods Reservoir
- Variant scenarios include:
  - (±) 25% and 50% juvenile productivity assumptions
  - No floating surface collector
  - Add 500k juvenile fish release

Preliminary LCM for upstream of GCD (Lake Roosevelt)

- The Baseline Scenario includes:
  - Floating surface collector (FSC) and exclusion nets
    - in front of the 3rd powerhouse cul de sac (75%)
    - at the 'head of reservoir' (~160 km upstream of GCD)(70%)
  - Out-planting 2,000 hatchery-origin adults above the dam and 1.5 million subyearling smolts
    - Whooshh or trap and haul of natural-origin adults resulting from spawning upstream of GCD

Grand Coulee Dam (GCD)


Tonasket
Wauconda
Colville National Forest
Republic
Kettle Falls
Floating surface collector
Colville
Rice
395
97
Inchelium
Chewelah
Colville Indian Reservation
Sanpoil River
Nespelem
Chief Joseph Dam
Hunters
Keller
Fish release locations
Bridgeport
Coulee Dam
Spokane Indian Reservation
Lincoln
Mansfield
Spokane River

LCM for upstream of GCD (Lake Roosevelt)

- Variant scenarios include:
  - Add an additional FSC on left side of GCD (+10% efficiency)
  - No floating surface collectors (44% turbine/spill survival)
  - No hatchery production
  - More hatchery production? (2x? 3x?)

L. Roosevelt 'head of reservoir' and GCD floating surface collector assumptions

	w/collection and bypass
% to HoR collector	90%
collection efficiency	70%
% transported	80%
transport survival	98%
% bypassed	95%
bypass survival	99%
	46%

L. Roosevelt 'head of reservoir' and GCD floating surface collector assumptions

	w/collection and bypass			In-reservoir, no bypass
% to HoR collector	90%			90%
collection efficiency	70%	27% →		
% transported	80%	14% →	41%	
transport survival	98%		25%	25%
% bypassed	95%		75%	
bypass survival	99%		99%	44%
	46%	+	8% = 54%	10%

In-reservoir survival assumption = 25%

GCD spillway/turbine survival assumption = 44%

Results

Model Results (after 100 generations)				
Juvenile Production	Rufus	Sanpoil	Mainstem	Total
Natural Fry Production (before Passage)	3,751,969	292,850	4,319,256	8,364,075
Hatchery releases - Subyearlings	0	500,000	1,000,000	1,500,000
Hatchery releases - Yearlings	0	0	0	0
Natural Spring Migrants below CJD	2,673,861	74,503	2,414,011	5,162,375
Natural Fall Migrants below CJD	200,090	11,452	219,279	430,821
Natural Yearling Migrants below CJD	17,026	4,023	18,597	39,646
Natural Age 2 Migrants below CJD	3	0	5	9
Hatchery subyearlings below CJD	0	482,705	925,539	1,408,244
Hatchery yearlings below CJD	0	69	1,429	1,497
Total Juveniles below CJD	2,890,980	572,753	3,578,860	7,042,593
Total Juveniles below BON	802,340	156,488	994,778	1,953,606

Results

Adult Production	Rufus	Sanpoil	Mainstem	Total
Adult Runsize (before Harvest and Passage)	16,329	3,132	20,278	39,739
Adult Runsize (before Harvest and Passage) - NORs	16,329	550	15,134	32,012
Adult Runsize (before Harvest and Passage) - HORs	0	2,582	5,145	7,727
Adult Runsize to below CJD	6,451	1,228	7,992	15,670
Total Adult Loss to Passage	1,705	428	2,808	4,941
Broodstock Removal - NORs	0	73	59	132
Broodstock Removal - HORs	0	221	529	750
Adult Outplants - NORs	0	0	0	0
Adult Outplants - HORs	1000	0	2000	3000
Spawning Escapement - NORs	5,220	79	4,123	9,422
Spawning Escapement - HORs	1,000	447	2,803	4,250

Harvest	Rufus	Sanpoil	Mainstem	Total
Ocean Harvest	4,980	955	6,185	12,120
Estuary to Bonneville	817	157	1,015	1,989
Bonneville to Wells	2,759	541	3,450	6,750
Upstream of Wells	847	92	382	1,321
Upstream Grand Coulee	0	139	925	1,063
Above Waneta	0	0	0	0
Above Sevenmile	0	0	0	0
Above Hugh L. Keenleyside	0	0	0	0
Above Brilliant Dam	0	0	0	0
Total Harvest	9,404	1,883	11,956	23,243

Results: scenario variants
(Rufus Woods Reservoir)

Rufus Woods population, sensitivity analysis on juvenile productivity assumptions (±) 25% and 50%

ario	Baseline	Scenario (±)25%		
		Mean	Minimum	Maximum
Spawning Productivity	0.72	0.72	0.72	0.72
Spawning Capacity	20,000	20,000	20,000	20,000
Incubation Productivity	0.63	0.63	0.47	0.72
Incubation Capacity	100,000,000	100,000,000	100,000,000	100,000,000
Fry Colonization Productivity	0.75	0.75	0.56	0.81
Fry Colonization Capacity	100,000,000	100,000,000	100,000,000	100,000,000
Fry to Spring Migrant Productivity	0.89	0.89	0.67	0.92
Fry to Spring Migrant Capacity	100,000,000	100,000,000	100,000,000	100,000,000
Fry to Fall Migrant Productivity	0.60	0.60	0.45	0.70
Fry to Fall Migrant Capacity	100,000,000	100,000,000	100,000,000	100,000,000
Fry to Yearling Migrant Productivity	0.10	0.10	0.08	0.12
Fry to Yearling Migrant Capacity	100,000,000	100,000,000	100,000,000	100,000,000
Fry to Age 2 Migrant Productivity	0.00	0.00	0.00	0.00

-50% productivity still resulted in 1,800 natural origin adults from 1,000 hatchery fish

Results: scenario variants
(Rufus Woods Reservoir)

CJD, no floating surface collector

- Reduce smolts by ~5 million
- Reduce returning adults by ~30 thousand
- Overall benefits reduced by ~75%

CJD, add 500,000 smolt release

- > 800k smolts to below CJD
- > returning adults by 4,000
- > harvest by 3,000
- > spawners by 1,000

Results: scenario variants

Lake Roosevelt / Grand Coulee Dam

GCD, no head of reservoir FSC

- results not available, still working on reservoir survival assumptions

GCD, no dam FSC

- Reduce smolts by 47%
- Reduce total adult production by 19,000
- Reduce harvest by 11,000 fish
- Reduce spawners by 5,100 fish
- Sanpoil population failure
- < 1:1 replacement rate for mainstem population (2,000 hatchery outplants results in 690 returning natural origin adults)

Results: scenario variants

Floating surface collector efficiency

	Baseline	-25%	-50%	+25%
Chief Joseph Dam	85%	64%	43%	89%
Grand Coulee Dam	75%	56%	38%	81%
Head of Reservoir	70%	53%	35%	78%
~ Response across metrics		-15%	-30%	5%
(smolts)				
(adult returns)				
(harvest)				

Conclusions/Recommendations

It's early and results are preliminary, BUT….

- Translocating hatchery adults appears productive
- Hatchery production is critical given high exploitation
- Harvest and natural-origin returns show 'meaningful' increases
- Juvenile bypass facilities appear important
- Engineering and financial considerations are not yet part of this
- Need to develop list of critical uncertainties for Phase 2…..
  - Migration behavior and spawning success of transplanted adults
  - Juvenile reservoir reach survival (will determine how important the head of reservoir collector is)
  - Approach and passage routes at dams


The ~~End~~ Beginning

Extra slides

Results: scenario variants

Lake Roosevelt / Grand Coulee Dam

GCD, add FSC on left bank of GCD

- > collection from 75% to 85%
- Results in only 100k additional smolts
- Very small benefits to adult returns

Lack of response due to high percentage of upstream fish entering the head of reservoir collector

May become more important if other FSCs are less efficient

Need juvenile migration/approach information to verify routes (left bank or right)