Incubation Flow Analysis

Presented to the
Aquatic Subcommittee
January 29-30, 2008

Issues

- Moving the outage to August 15 – September 15 with or without a drawdown may result in spill.
- This spill may allow Chinook salmon to spawn at higher flows and higher on the stream margins
- Spawning in these areas may require additional water to protect incubating Chinook eggs.

Objectives

- Determine the duration and magnitude, if any, of spills under various operational scenarios.
- If spill does occur, determine the flows present in Study Site 1 (anadromous zone)
- Determine the flows necessary to protect incubating Chinook eggs if/when spill occurs

Methods

- Analyze operational scenarios to determine if/when spill occurs:
  - No drawdown
  - Using 20 year record (1987-2007)
  - During low (1992), median (1988) and high (1999) inflow years
  - Instream Flows Scenarios
    - 15 cfs in August, 20 cfs in September
    - 15 cfs August 1 – 15; 20 cfs August 16 – September 15; 15 cfs September 16-30
  - Assumes outage from August 15 – Sept 14

Methods, cont'd

- Once spill is determined, calculate flows (release + spill + accretion) that occurs in Study Site 1.
- Determine Incubation Flows required in SS1, and back-calculate releases from the drop structure using:
  - Using site-specific sensitivity analysis
  - Prior analysis used 1 transect (T7); this analysis includes two additional transects (T1 – run and T3 run with enhanced gravel)

Results

Analysis of scenarios

		August		September		Starting	Days	Spill		
Lake Elevation	Inflow Level	1-15	16-31	1-15	16-30	Date	Spill	Peak	Mean	Min
2856.50	Low	15	20	20	15	N/A	0	0	0	0
2856.50	Low	15	15	20	20	N/A	0	0	0	0
2856.50	Med	15	20	20	15	8-Sep	8	13	8	3
2856.50	Med	15	15	20	20	3-Sep	13	18	11	4
2856.50	High	15	20	20	15	22-Aug	26	119	45	17
2856.50	High	15	15	20	20	21-Aug	27	119	44	4

No drawdown, Median Inflows
Split Flows (15/20/15)

		August		September		Starting	Days		Spill	
Lake Elev	Level	1-15	16-31	1-15	16-30	Date	Spill	Peak	Mean	Min
2856.50	**Median**	**15**	**20**	**20**	**15**	8-Sep	8	13	8	3

Month	Release	Spill	Total at Top	Inflow	SS1 Flow
Sep	20	8	28	8	36
Oct	10		10	8	18
Nov	7		7	16	23
Dec	4		4	30	34

No drawdown, Median Inflows
15 cfs –Aug/20 cfs Sept

		August		September		Starting	Days		Spill	
Lake Elev	Level	1-15	16-31	1-15	16-30	Date	Spill	Peak	Mean	Min
2856.50	**Median**	**15**	**15**	**20**	**20**	3-Sep	13	18	11	4

Month	Release	Spill	Total at Top	Inflow	SS1 Flow	70%	Addt'l required
Sep	20	11	31	8	39		
Oct	10		10	8	18		
Nov	7		7	16	23		
Dec	4		4	30	34		

No drawdown, High Inflows
Split Flows (15/20/15)

		August		September		Starting	Days	Spill		
Lake Elev	Level	1-15	16-31	1-15	16-30	Date	Spill	Peak	Mean	Min
2856.50	**High**	**15**	**20**	**20**	**15**	22-Aug	26	119	45	17

Month	Release	Spill	Total at Top	Inflow	SS1 Flow
Aug	20	45	65	9	74
Sep	20		20	8	28
Oct	10		10	8	18
Nov	7		7	16	23
Dec	4		4	30	34

No drawdown, High Inflows
15 cfs –Aug/20 cfs Sept

		August		September						
Lake Elev	Level	1-15	16-31	1-15	16-30	Date	Spill	Peak	Mean	Min
2856.50	**High**	**15**	**15**	**20**	**20**	21-Aug	27	119	44	4

Month	Release	Spill	Total at Top	Inflow	SS1 Flow
Aug	20	44	64	9	73
Sep	20		20	8	28
Oct	10		10	8	18
Nov	7		7	16	23
Dec	4		4	30	34

Site Specific Transect Analysis

- Used Transect 7 from Instream Flow Study (Pool Tailout) with enhanced substrate
- Added Transects 1 and 3 from Instream Flow Study, Study Site 1 with enhanced substrates
- Let model determine HSI at each cell for the following flows at SS1:
  - 36 cfs - 39 cfs
  - 73 cfs - 74 cfs

Transect Analysis, cont'd

- Protect those cells that had quality habitat values
  - S (depth) * S (velocity) * S (substrate) $\geq$ 0.4
  - Since S (substrate) = 1,
    - S (depth) * S (velocity) $\geq$ 0.4

Chinook Spawning HSI

Velocity	HSI	Depth	HSI
0.00	0.00	0.00	0.00
0.50	0.00	0.50	0.00
1.00	0.10	1.20	1.00
1.30	0.70	3.40	1.00
1.75	1.00	5.00	0.00
3.00	1.00	99.99	0.00
4.00	0.00		
99.99	0.00		

Methods

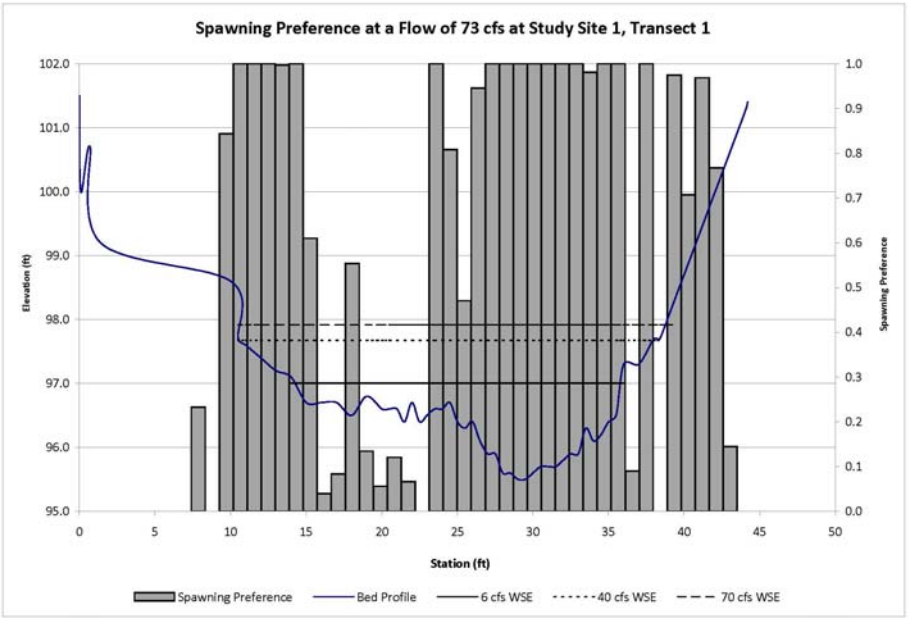
- RHABSIM used for
  - Bed elevations
  - Stage/Discharge Relationship
  - Combined Suitability Value (0.0 – 1.0) for each cell at the modeled flows.
- If Suitability Value $\geq$ 0.40
  - The width of that cell was counted
- If Suitability Value < 0.40
  - The width of that cell was given a value of 0.0

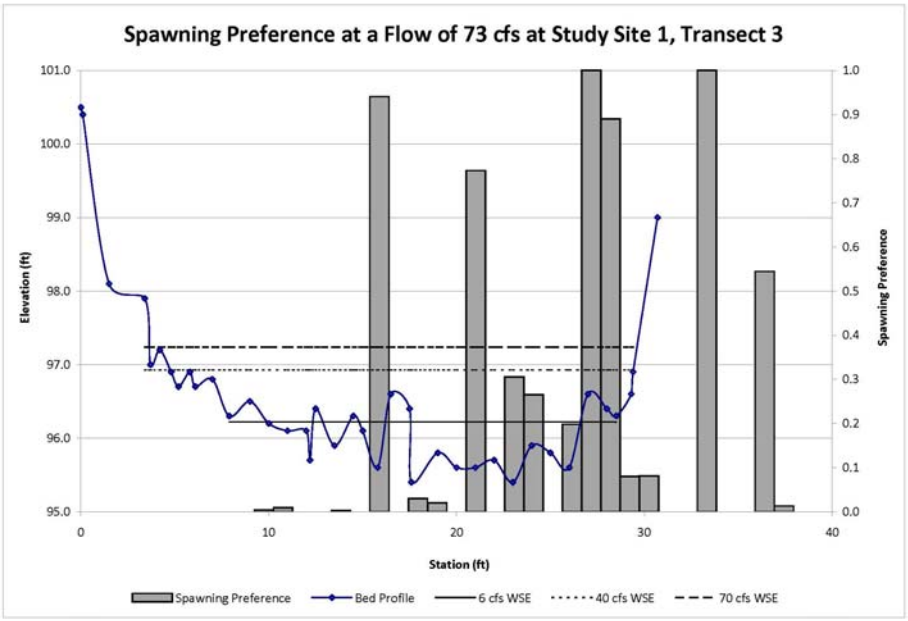
Methods, cont'd

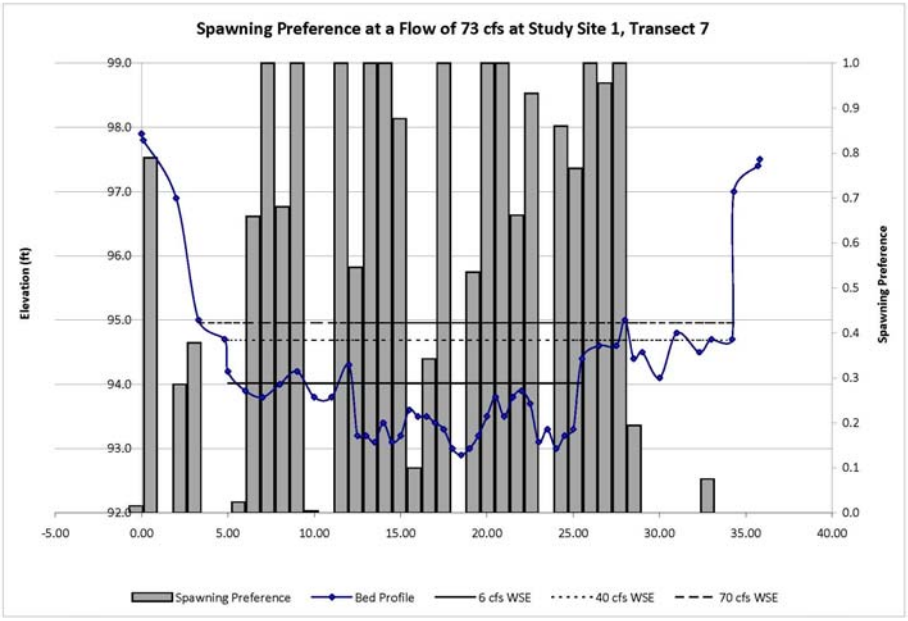
- The water surface elevation was calculated for each modeled flow
- For each modeled flow, the depth of the water over each cell was calculated
- If the water depth $\geq$ 0.10 ft, the value of the width was assigned; otherwise a 0 was used.
- Flows were modeled in 5 cfs increments down from the spawning flow at SS1.

Methods, cont'd

- Analysis was continued until incubation cells no longer had 0.1 ft of water; then flows were modeled in 1 cfs increments to find the flow at which the 0.1 cfs depth was not present.


Spawning Preference at a Flow of 73 cfs at Study Site 1, Transect 1
Elevation (ft)
Spawning Preference
Station (ft)
Spawning Preference
Bed Profile
6 cfs WSE
40 cfs WSE
70 cfs WSE


Spawning Preference at a Flow of 73 cfs at Study Site 1, Transect 3
Elevation (ft)
Spawning Preference
Station (ft)
Spawning Preference
Bed Profile
6 cfs WSE
40 cfs WSE
70 cfs WSE



Results

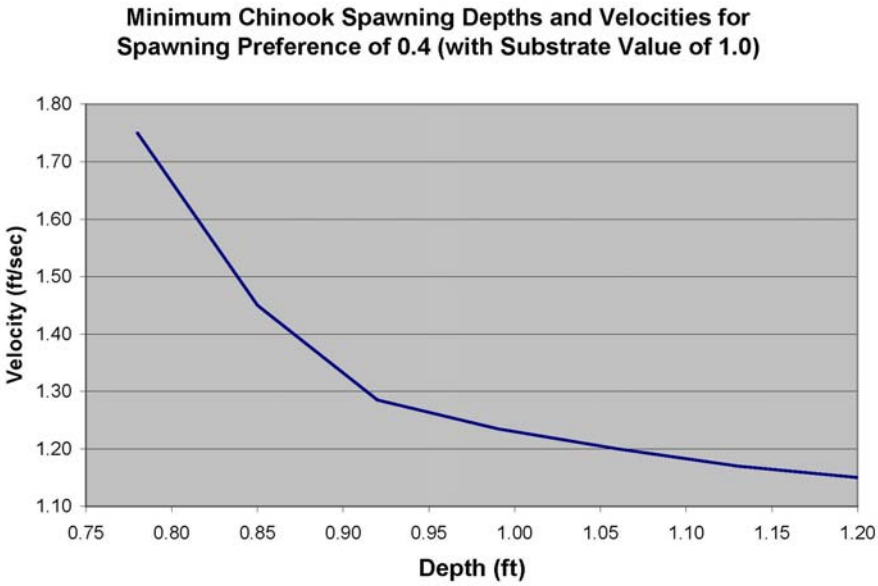
- Flows that protected incubating eggs were less than 70% of the spawning flows across each spawning flow in SS1 resulting from spill

Results, SS1 Spawning and Incubation Flows

Spawning Flow (SS1)	Incubation Flow Required at SS1		
	Trans 1	Trans 3	Trans 7
36 cfs	5 cfs	5 cfs	6 cfs
39 cfs	5 cfs	5 cfs	6 cfs
73 cfs	5 cfs	11 cfs	6 cfs
74 cfs	5 cfs	11 cfs	6 cfs

Why Is This?

- Spawning depth criteria for Chinook requires a ***minimum*** depth of 0.51 ft before there is a value;
- Chinook spawning required to have a ***minimum*** depth of 0.78 ft to have a HSI value of 0.4
- A change in stage of 0.68 ft (at a flow of 74 cfs, leaving a depth of 0.1 ft) equates to a change in flow of:
  - 55 cfs (Transect 1)
  - 60 cfs (Transect 3)
  - 59 cfs (Transect 7)



Conclusion

- Using site-specific data, incubation flows required for spawning flows in Study Site 1 [(release + spill at drop structure) + inflow] can be met with the existing proposed flow regime;
- Additional flow releases are not required to meet incubation needs for Chinook eggs.

Results, SS1 Spawning and Incubation Flows

Spawning Flow (SS1)	Incubation Flow Required at SS1		
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Month	Release	Spill	Total at Top	Inflow	SS1 Flow
August	15		15	9	24
Sep	20		20	8	28
Oct	10		10	8	18
Nov	7		7	16	23
Dec	4		4	30	34
Jan	4		4	41	45
Feb	4		4	36	40
Mar	4		4	30	34