

Is it working?

Quantifying Restoration Successes at the Physical Processes Level

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What does it all mean?



- Water surface elevation and water temperature are two of the most commonly collected metrics at restoration projects in the lower Columbia River

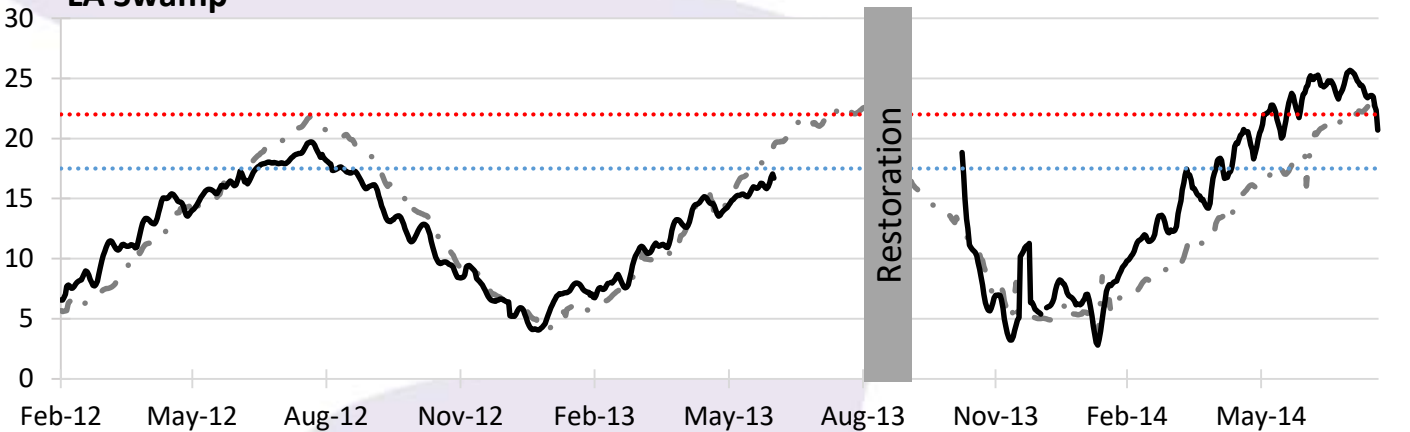
Metrics and Indicators

- **Water Temperature** – Monthly Average for the 7 day moving average maximum temperature (7-DMA)
- **Water Surface Elevation** - # of days site exceeded 2-year flood elevation



Water Temperature

LA Swamp



Duration of Pre/Post WSE Monitoring

— Wetland Max 7DMA

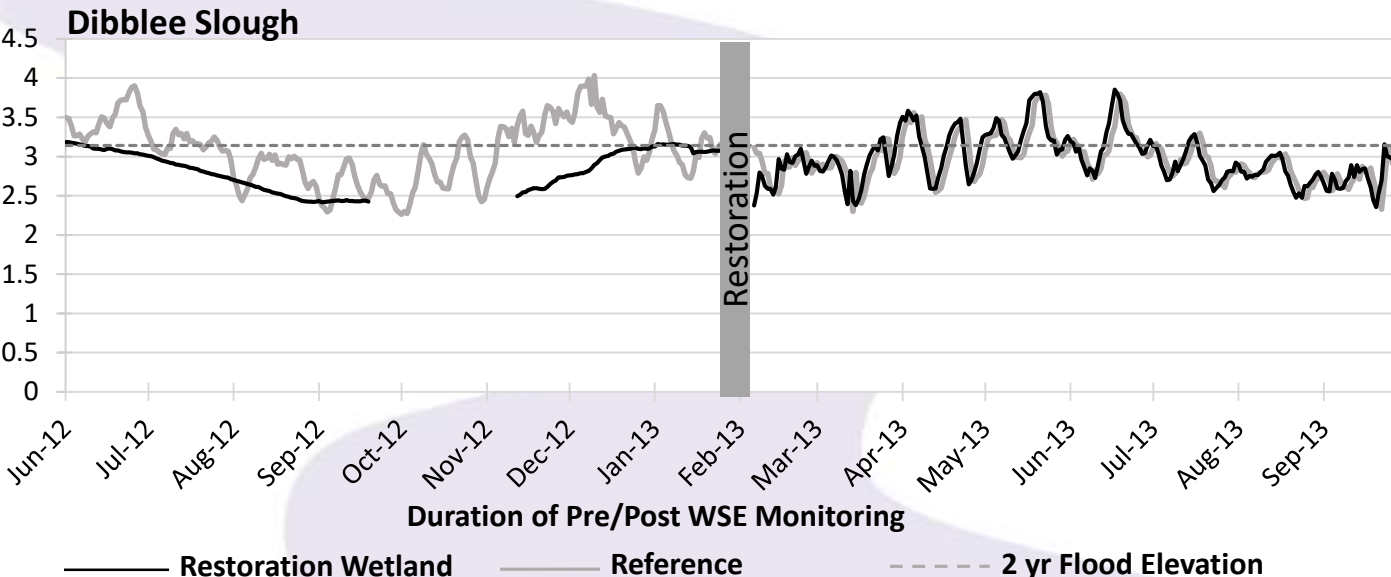
- - - Mainstem Max 7DMA

..... 17.5 °C Reference Temp

..... 22 °C Reference Temp

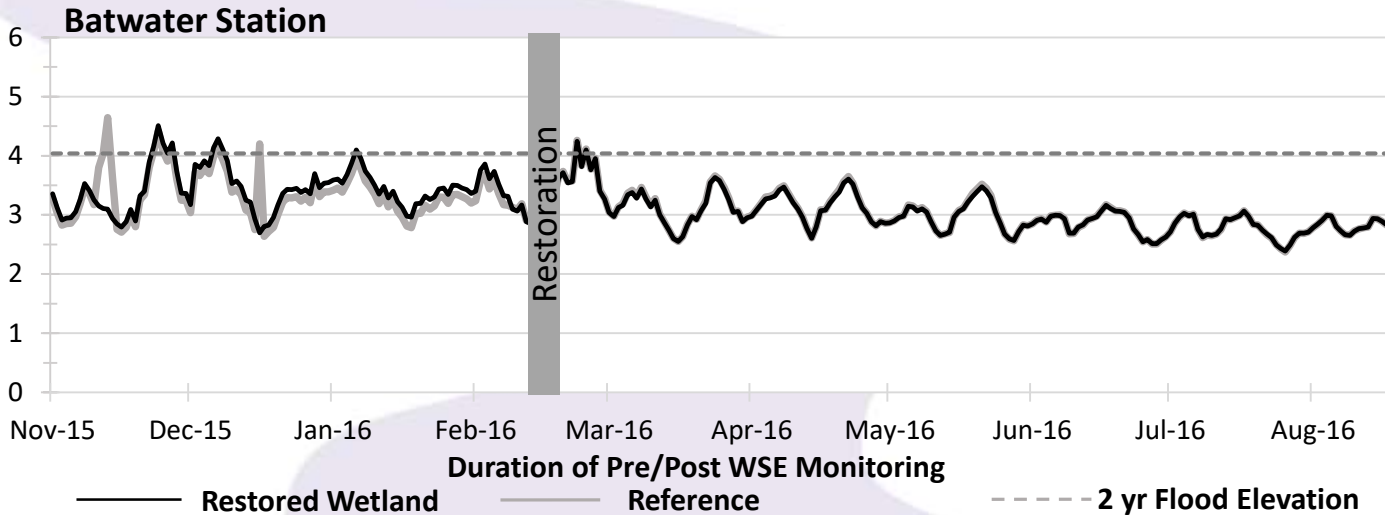
Year		2013											2014								
Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Restored	Mean	5.0	7.3	8.4	11.6	14.2	15.7					9.7	6.5	6.9	6.8	11.9	15.3	19.0	22.2	24.6	23.9
	SE	0.1	0.1	0.2	0.2	0.1	0.1					0.7	0.5	0.1	0.4	0.2	0.3	0.2	0.2	0.1	0.3
Main Stem	Mean	4.9	5.7	7.4	10.5	14.2	17.3	20.7	22.0	Restoration	14.9	10.6	5.8	5.5	5.9	8.1	11.0	14.7	17.5	20.7	22.4
	SE	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1		0.2	0.4	0.2	0.1	0.2	0.1	0.2	0.2	0.1	0.2	0.1

Water Surface Elevation



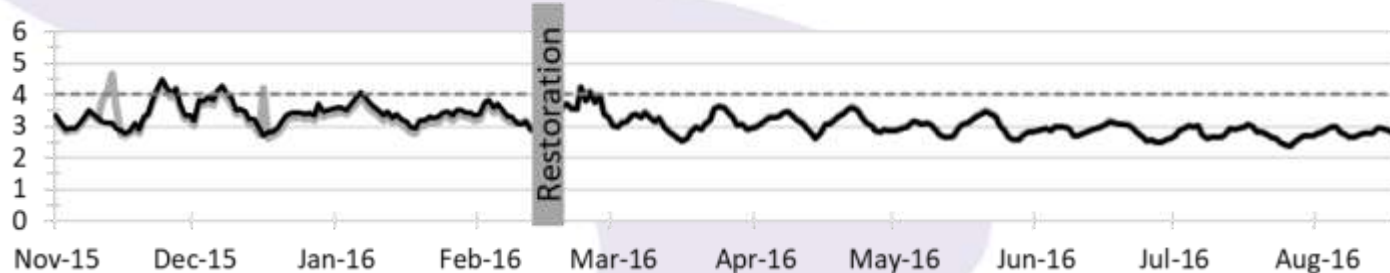
Year		2012								2013								
Month		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Restoration	n (days)	23	31	31	26		12	31	31	Restoration	31	30	31	30	31	31	30	3
	Mean	3.12	2.92	2.61	2.43		2.57	2.89	3.11		2.85	3.15	3.27	3.19	2.97	2.79	2.70	2.99
	SE	0.01	0.02	0.02	0.00		0.01	0.03	0.01		0.04	0.06	0.06	0.05	0.04	0.03	0.03	0.01
	Days Exceeded 2 yr Flood Elevation	0	0	0	0	0	0	0	0		0	10	9	6	0	0	0	0
Reference	n (days)	23	31	31	30	31	30	31	31	Restoration	31	30	31	30	31	31	30	3
	Mean	3.43	3.30	2.90	2.64	2.70	3.14	3.56	3.10		2.83	3.12	3.25	3.17	3.01	2.80	2.67	3.01
	SE	0.03	0.05	0.04	0.04		0.06	0.04	0.05		0.04	0.06	0.06	0.05	0.03	0.02	0.02	0.06
	Days Exceeded 2 yr Flood Elevation	11	6	0	0	0	4	24	4		0	7	9	4	0	0	0	0

Water Surface Elevation



Year		2015				2016						
Month		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Restoration	n (days)	14	31	31	Restoration	31	30	31	30	31	31	2
	Mean Max	3.15	3.60	3.44		3.31	3.12	3.04	2.96	2.83	2.76	2.86
	SE	0.05	0.09	0.06		0.07	0.05	0.05	0.04	0.04	0.03	0.03
	Days Exceeded 2 yr Flood Elevation	0	8	1		2	0	0	0	0	0	0
Reference	n (days)	14	31	31	Restoration	31	30	31	30	31	31	2
	Mean Max	3.37	3.48	3.33		3.32	3.13	3.05	2.97	2.83	2.76	2.86
	SE	0.14	0.09	0.06		0.07	0.05	0.05	0.05	0.04	0.03	0.03
	Days Exceeded 2 yr Flood Elevation	1	5	1		2	0	0	0	0	0	0

Water Surface Elevation= Habitat Access



Water Temperature = Habitat Quality

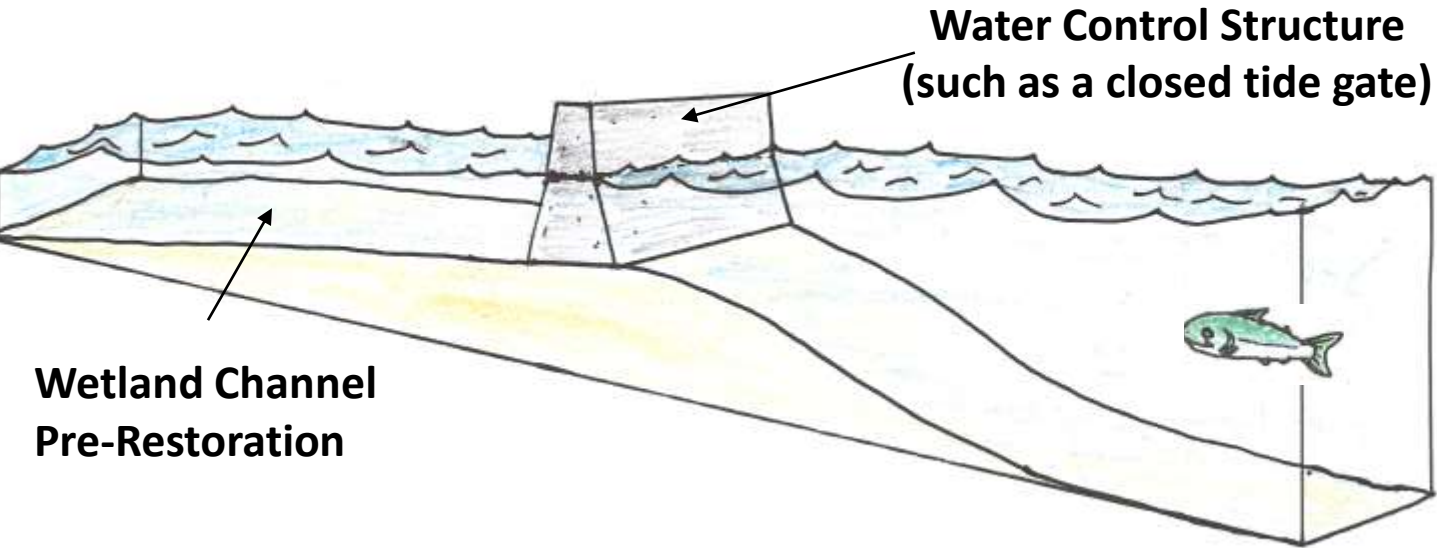


Habitat Access + **Habitat Quality** = **Opportunity***

Water surface elevation and water temperature used together tells a more complete story

* Adapted from Bottom et al. 2011 - Estuarine Habitat and Juvenile Salmon: Current and Historical Linkages in the Lower Columbia River and Estuary

Salmonid Habitat Opportunity

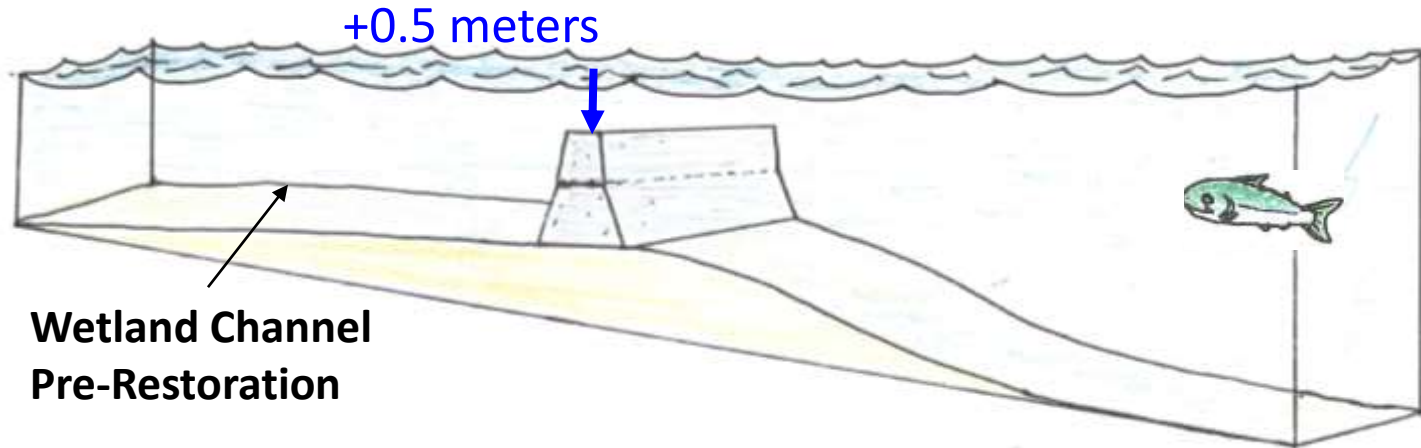


Wetland Channel
Pre-Restoration

Opportunity Depth = Top WCS Elevation
+ 0.5 m

Opportunity Temp = Optimal ≤ 17.5 C
Marginal 17.5-22 C

Salmonid Habitat Opportunity



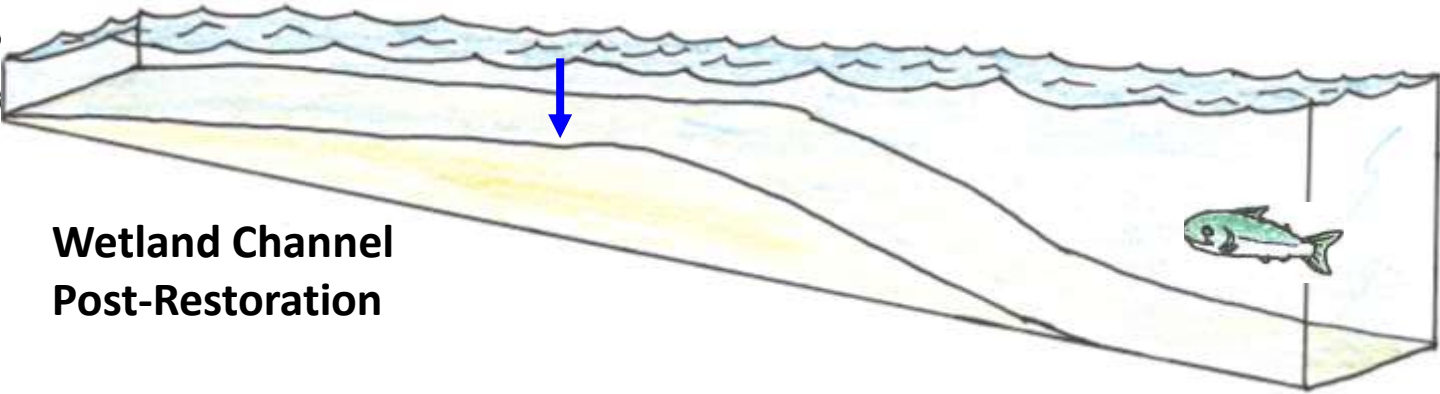
Wetland Channel
Pre-Restoration

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Salmonid Habitat Opportunity

+0.5 meters

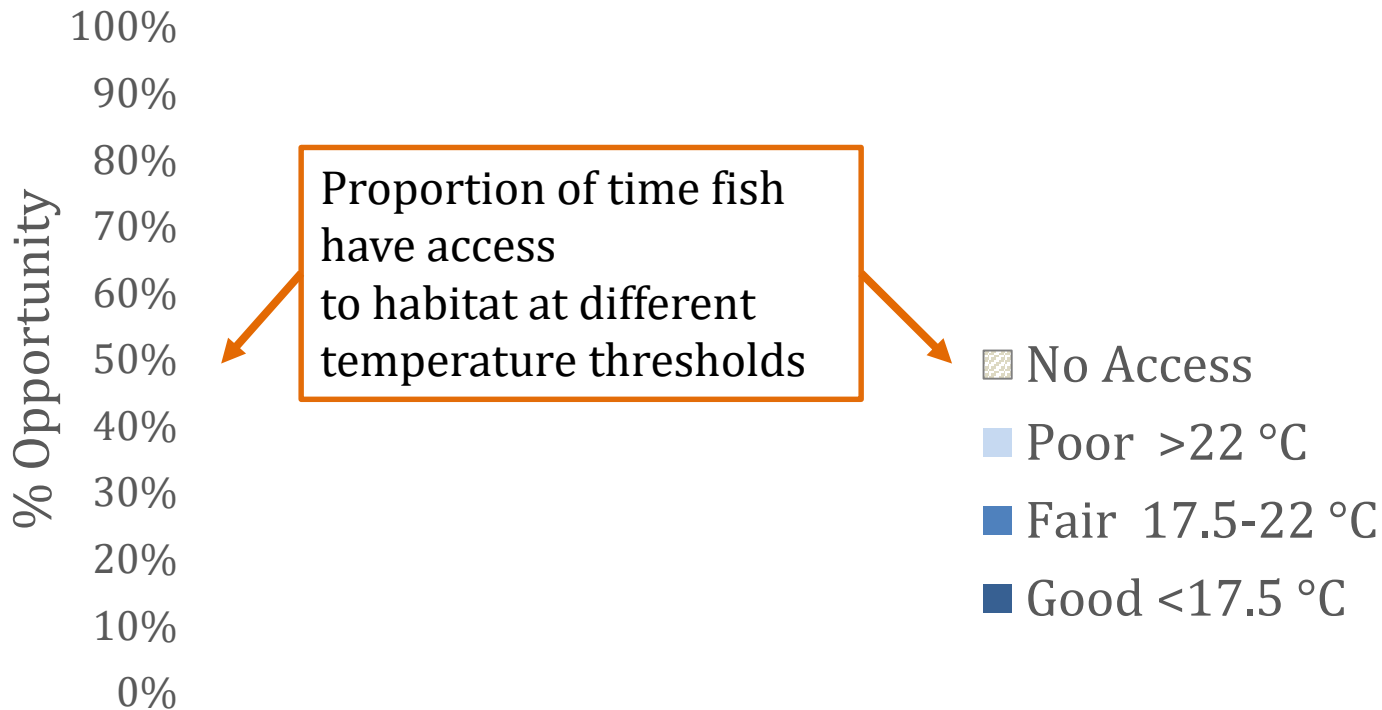


Wetland Channel
Post-Restoration

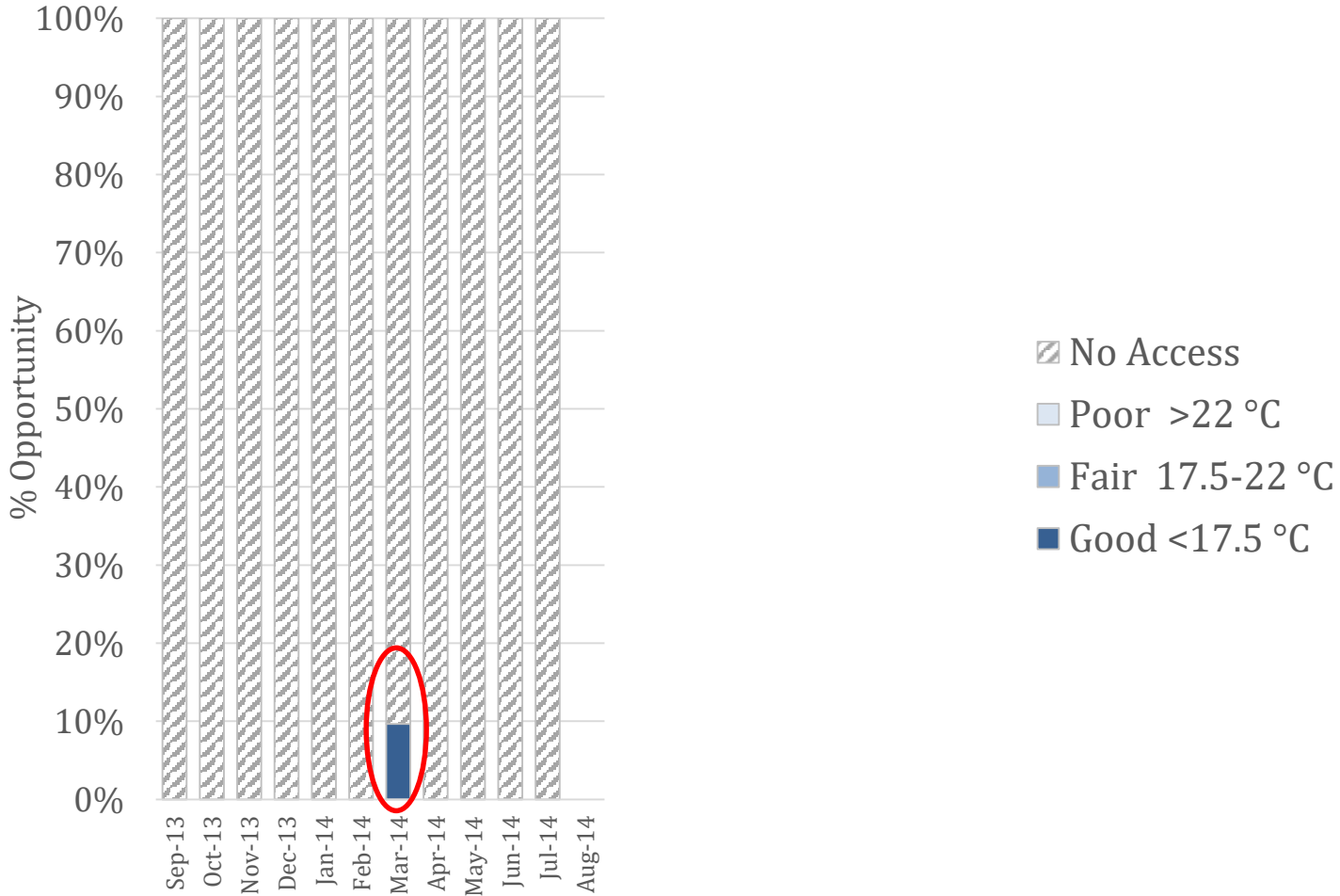
Opportunity Depth = Channel Elevation
+ 0.5 m

Opportunity Temp = Optimal ≤ 17.5 C
Marginal 17.5-22 C

Salmonid Habitat Opportunity



Salmonid Habitat Opportunity

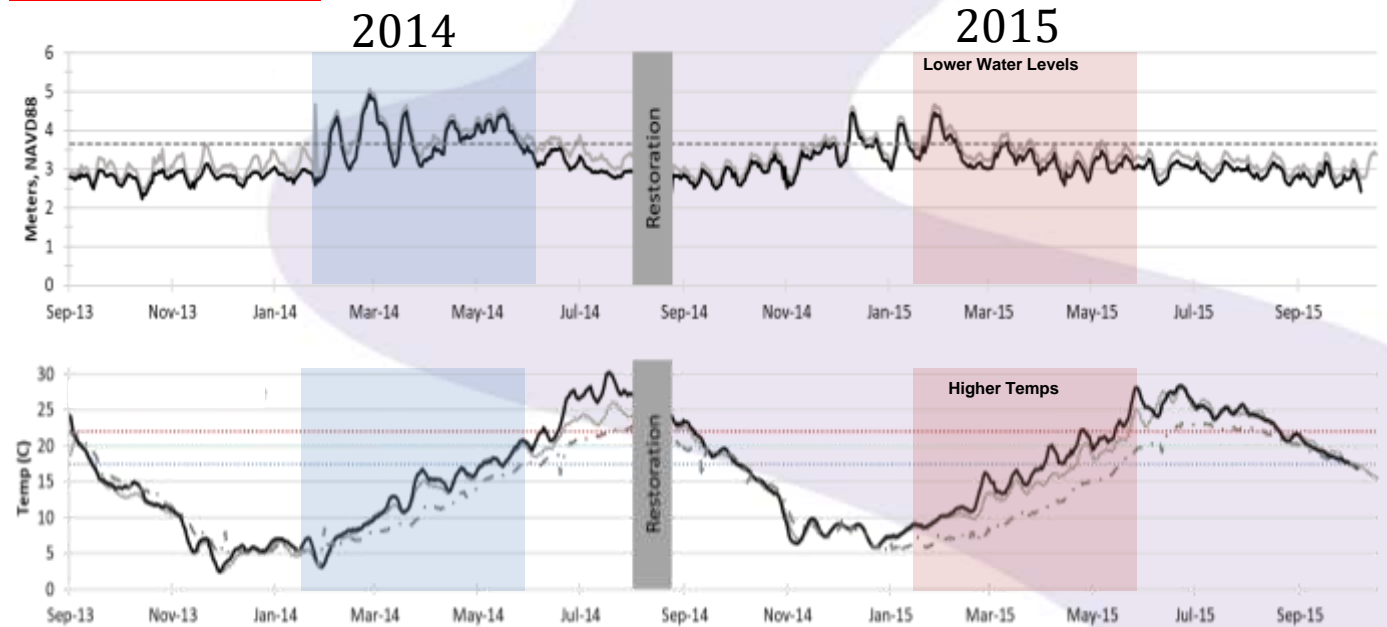


Salmonid Habitat Opportunity

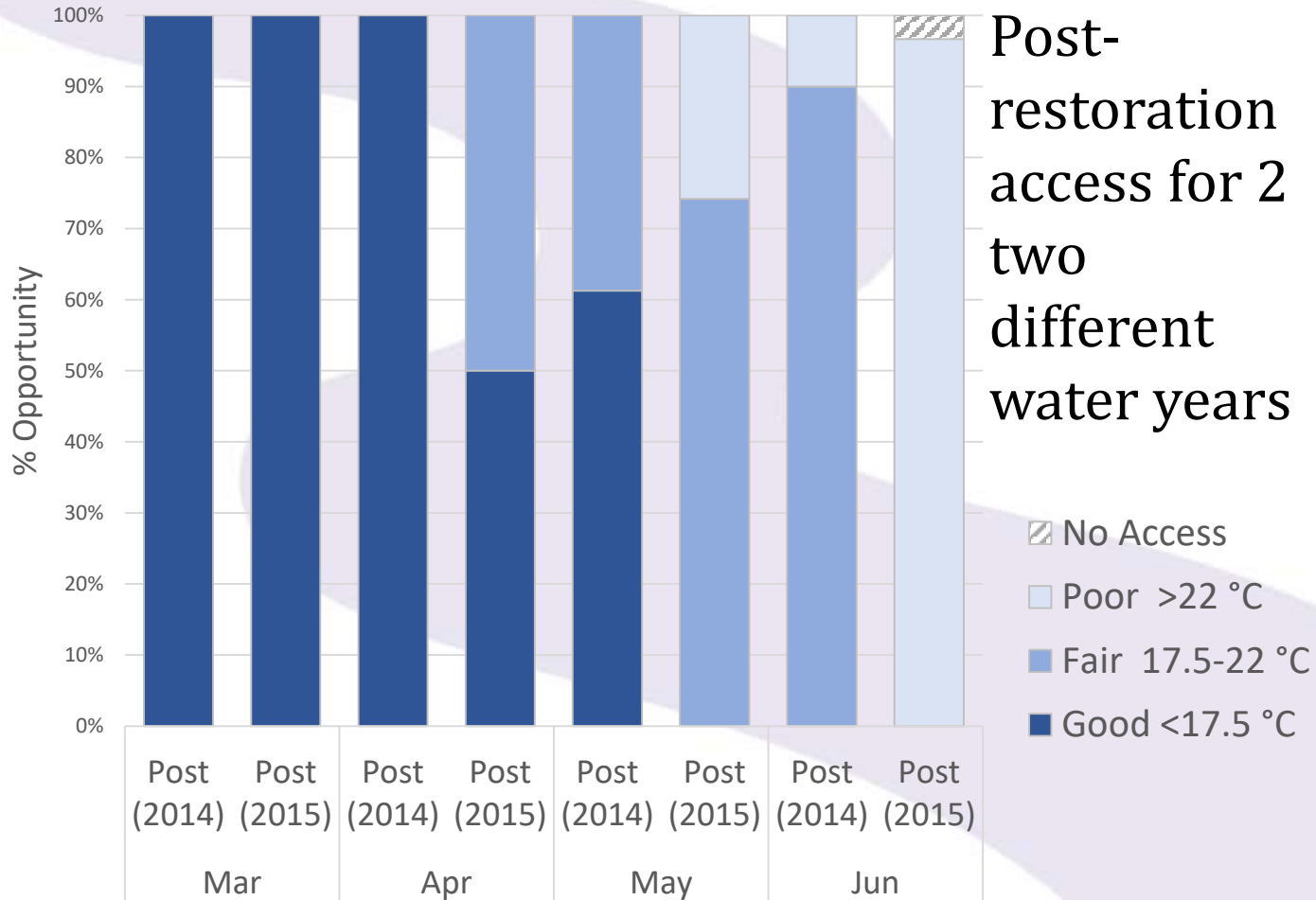
North Unit Millionaire Opportunity (% Access)																									
Years	2013			2014										2015											
Months	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Sum of <17.5 Pre	0	0	0	0	0	10	0	0	0	0	Restoration	0	48	90	100	100	100	100	50	0	0	0	0	0	24
Sum of 17.5-22 Pre	0	0	0	0	0	0	0	0	0	0		46	42	0	0	0	0	0	50	74	0	0	0	100	76
Sum of >22 Pre	0	0	0	0	0	0	0	0	0	0		50	0	0	0	0	0	0	0	26	97	100	100	0	0
No Access	100	100	100	100	100	90	100	100	100	100		4	10	10	0	0	0	0	0	0	0	3	0	0	0

Water Year Matters

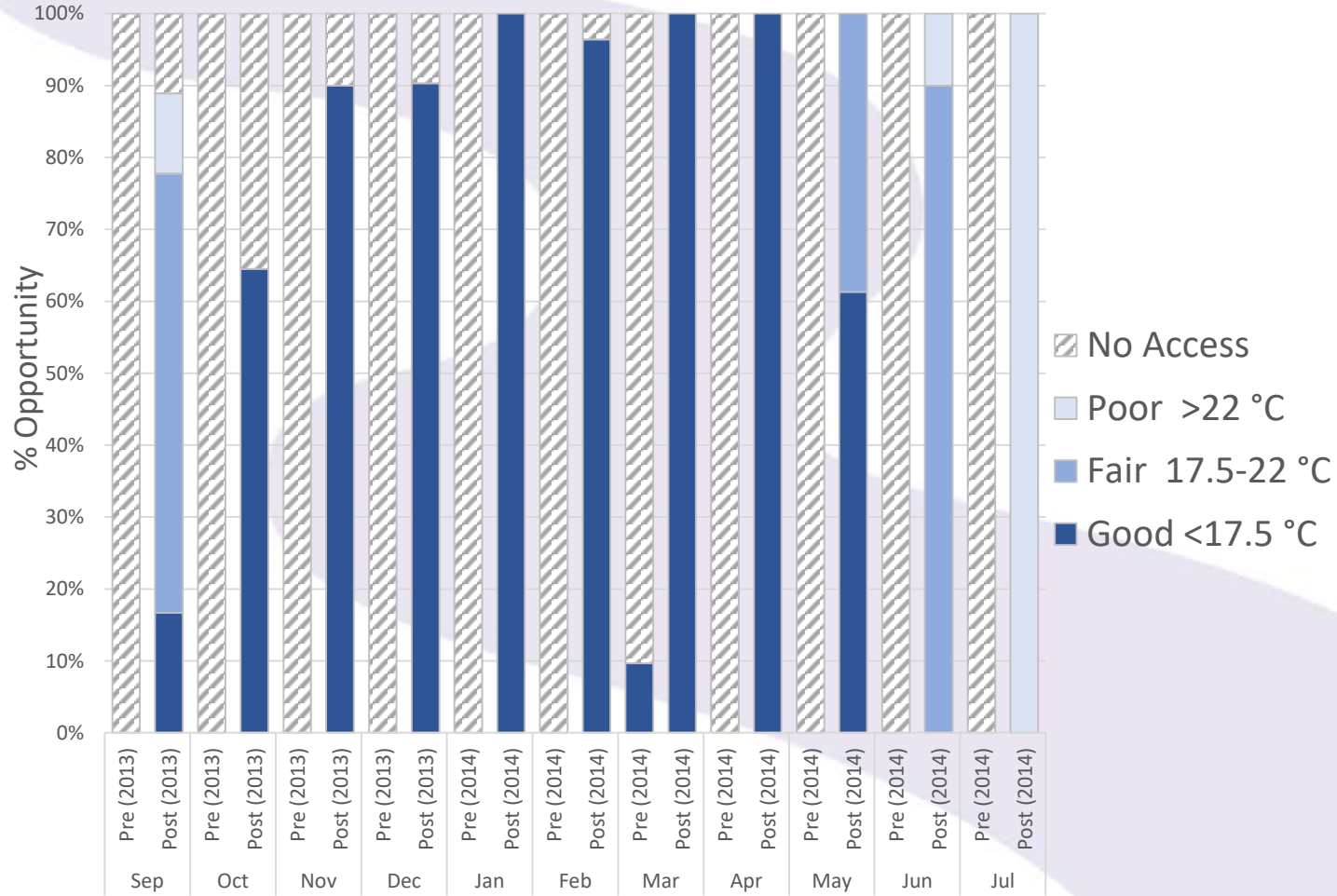
- Example Looking at Pre/Post Data from 2014 and 2015
- Important when determining what is the result of restoration actions vs different climatic conditions



Salmonid Habitat Opportunity



Salmonid Habitat Opportunity



Conclusion

- Two year flood elevation is a good footprint for a project and 7 day moving average maximum temperature is a useful regulatory indicator, but do not answer questions about site opportunity
- Water surface elevation and water temperature used together tells a more complete story

Next Steps

- Deploy additional loggers in the floodplain to begin to define the functional floodplain at restoration sites and quantify additional hydrologic inputs
- Couple the opportunity indicator with ecological modeling to predict ecological inundation extent to better quantify impact of restoration projects

Questions



Thank you!

BONNEVILLE
POWER ADMINISTRATION



Columbia
LAND TRUST



COLUMBIA RIVER ESTUARY
STUDY TASKFORCE



COWLITZ INDIAN TRIBE



Pacific Northwest
NATIONAL LABORATORY

THANK YOU FOR LISTENING!

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