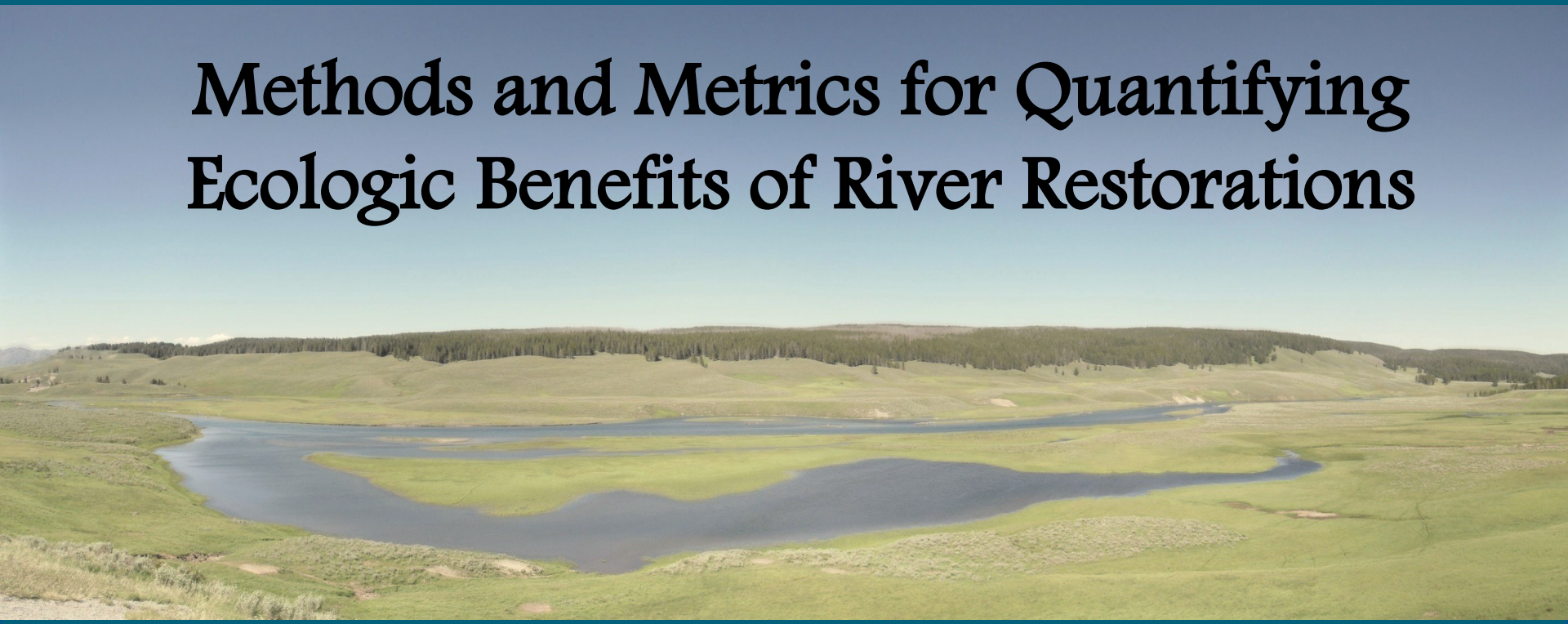
Methods and Metrics for Quantifying Ecologic Benefits of River Restorations



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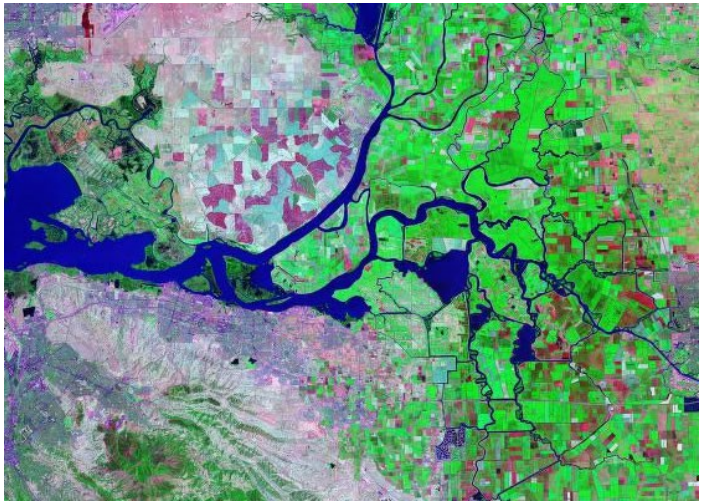
October 10, 2012

Goals for the metric

- Useful both as a screening and design tool.
- Adapted to measure habitat/benefit for a variety of species/objectives.
- Easily applied by any agency or consultant that uses standard tools and available data.
- Transparent and replicable i.e. not subject to distortion by hidden assumptions, qualitative indices, or weighting factors.



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Ecosystem Variables

Physical

- Area
- depth
- velocity
- cover
- vegetation
- connectivity

Hydrologic

- Duration
- Frequency
- Timing

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Borrowing Ideas ?

Intensity-Duration-Frequency Curves in Hydrology → Area-Duration-Frequency Curves for Habitat?

Estimated Annual Damage in Flood Risk Analysis → Estimated Annual Habitat

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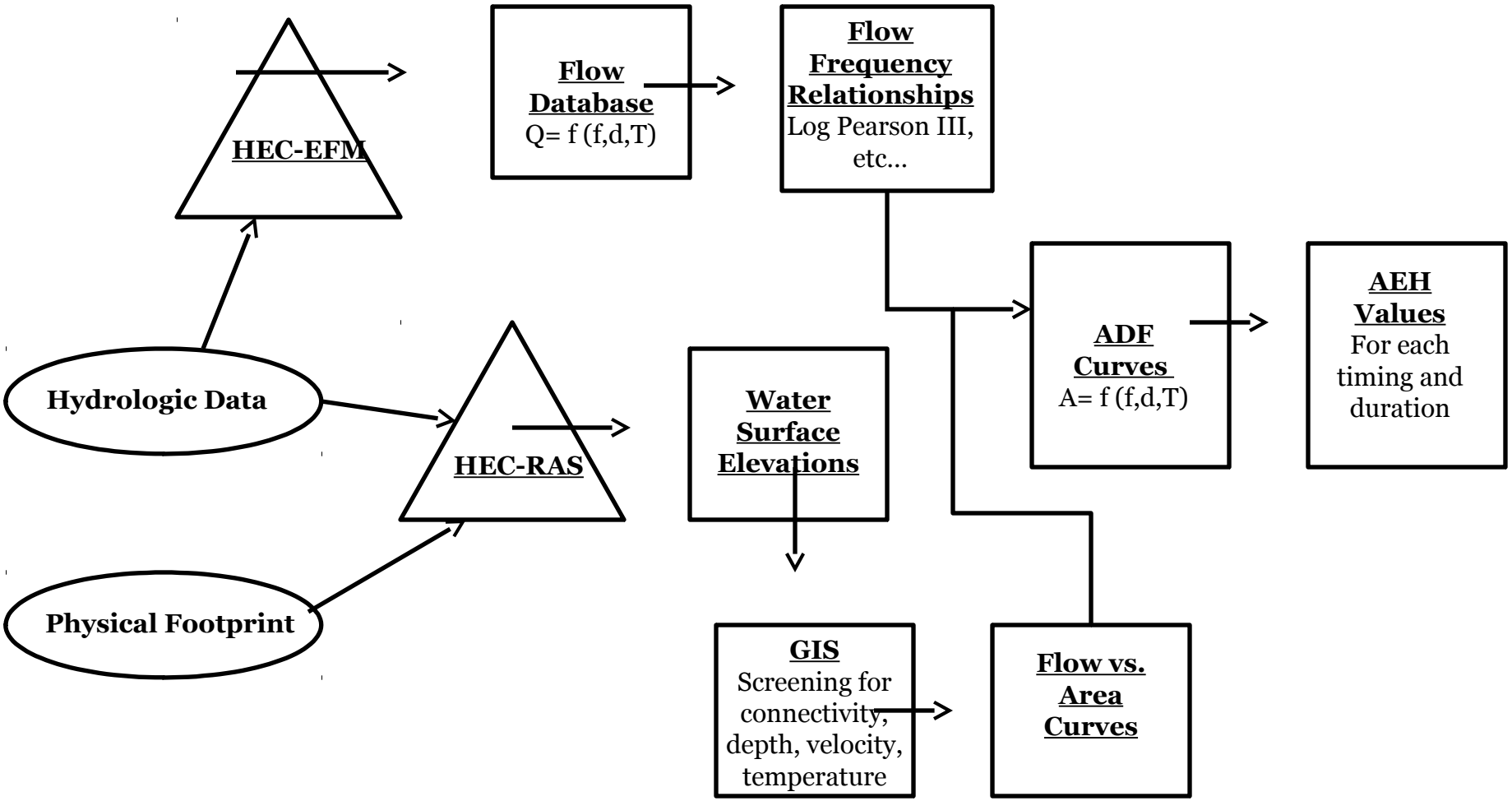
Method Flow



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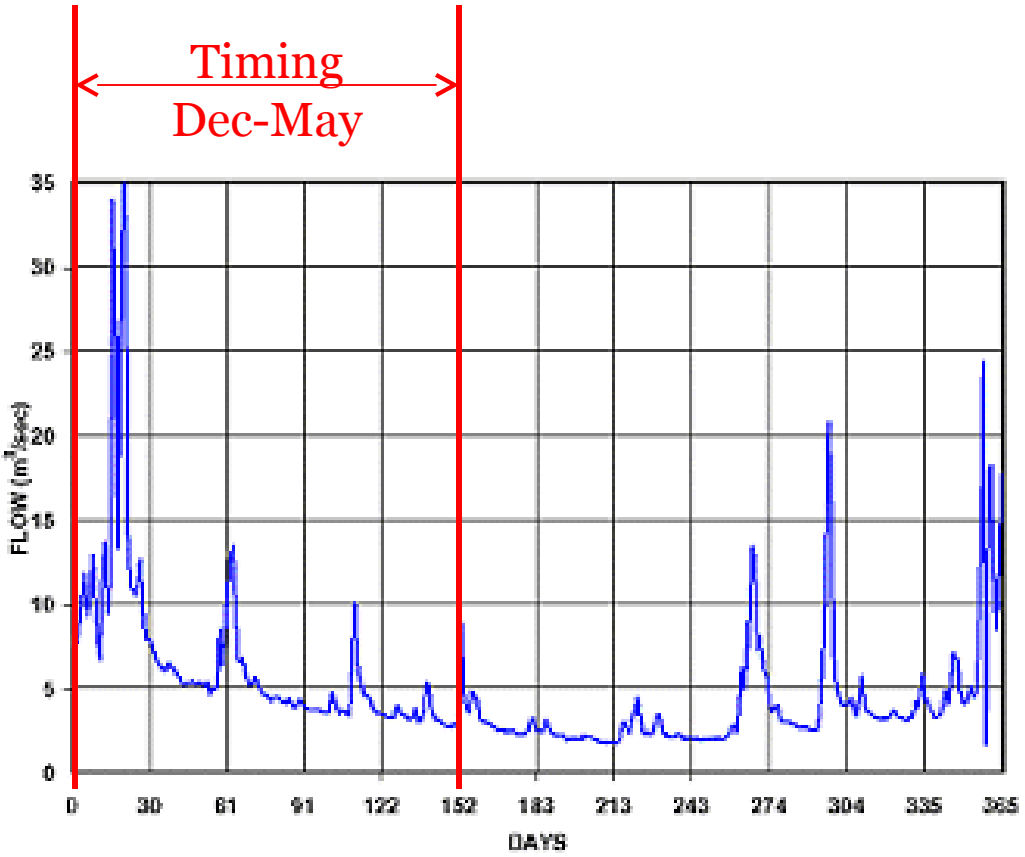
HEC-EFM



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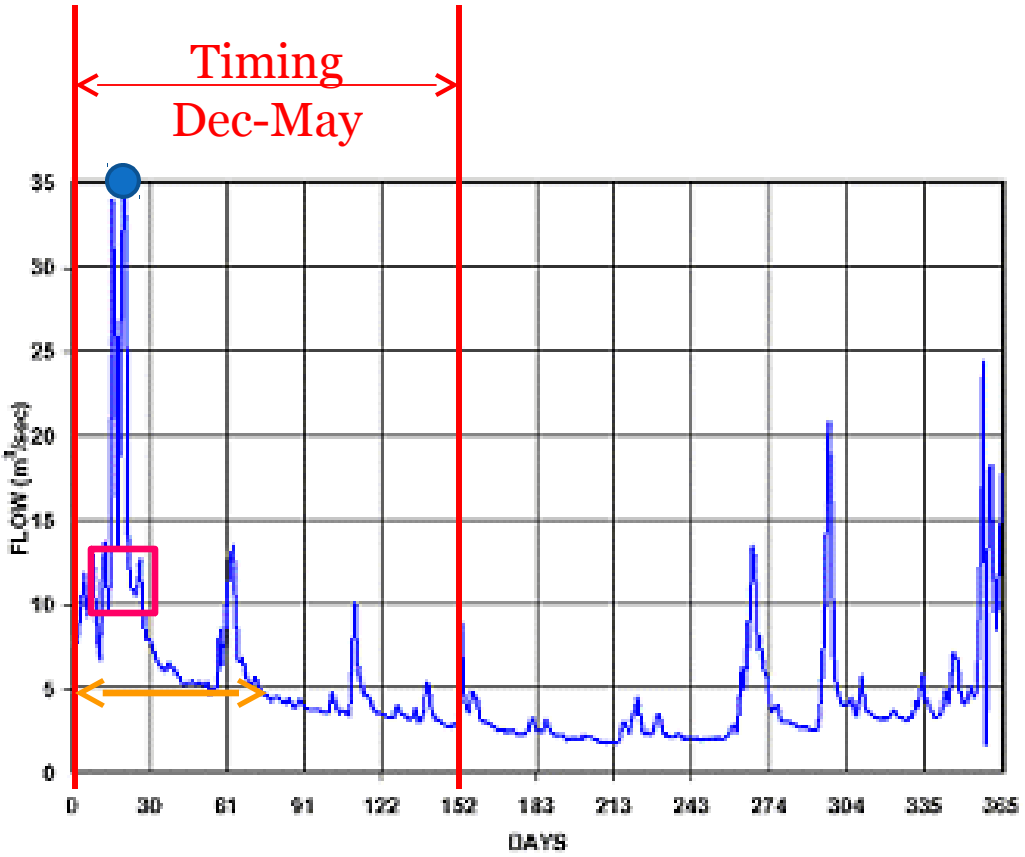

Durations

1-Day

3-Day

7-Day

14-Day

21-Day

28-Day

60-Day

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Durations

1-Day

3-Day

7-Day

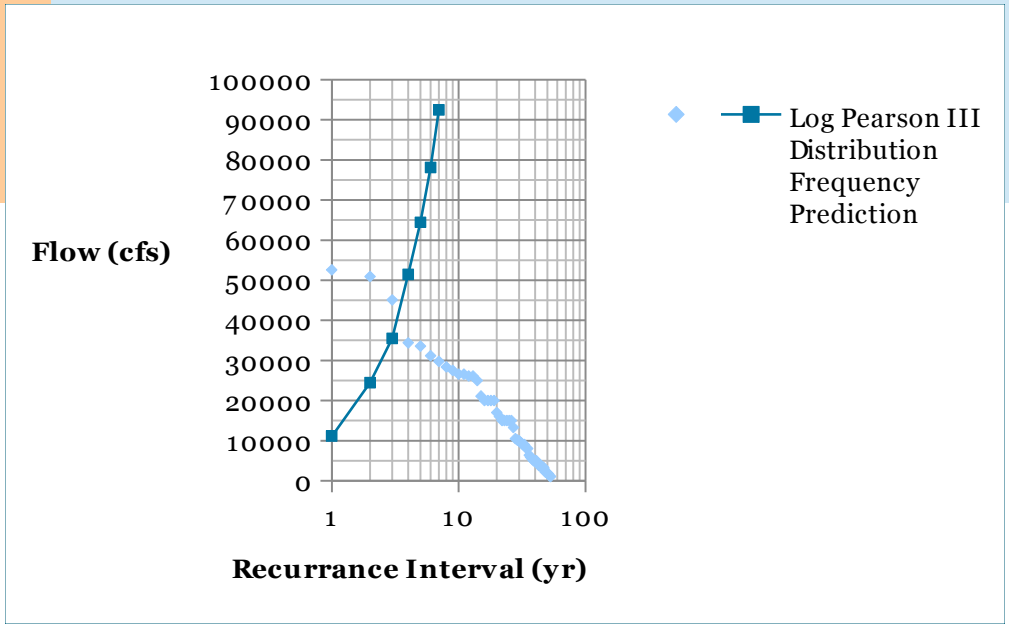
14-Day

21-Day

28-Day

60-Day

RANK	PEAK_FLOW_VALUE_Q(cfs)	LOGQ_cfs	(log Q – avg(logQ))^2	(log Q – avg(logQ))^3	Return Period (n+1)/m	Exceedence Probability (1/Tr)
1	52,600	4.721	0.4959	0.3492	54.00	0.019
2	50,900	4.707	0.4760	0.3284	27.00	0.037
3	45,100	4.654	0.4063	0.2589	18.00	0.056
4	34,400	4.537	0.2702	0.1404	13.50	0.074
5	33,598	4.526	0.2596	0.1323	10.80	0.093
6	31,201	4.494	0.2279	0.1088	9.00	0.111
7	29,800	4.474	0.2092	0.0957	7.71	0.130
8	28,400					
9	27,500					
10	26,599					
11	26,599					



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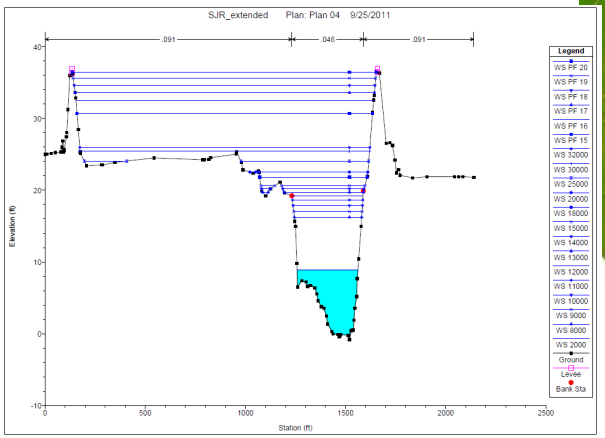
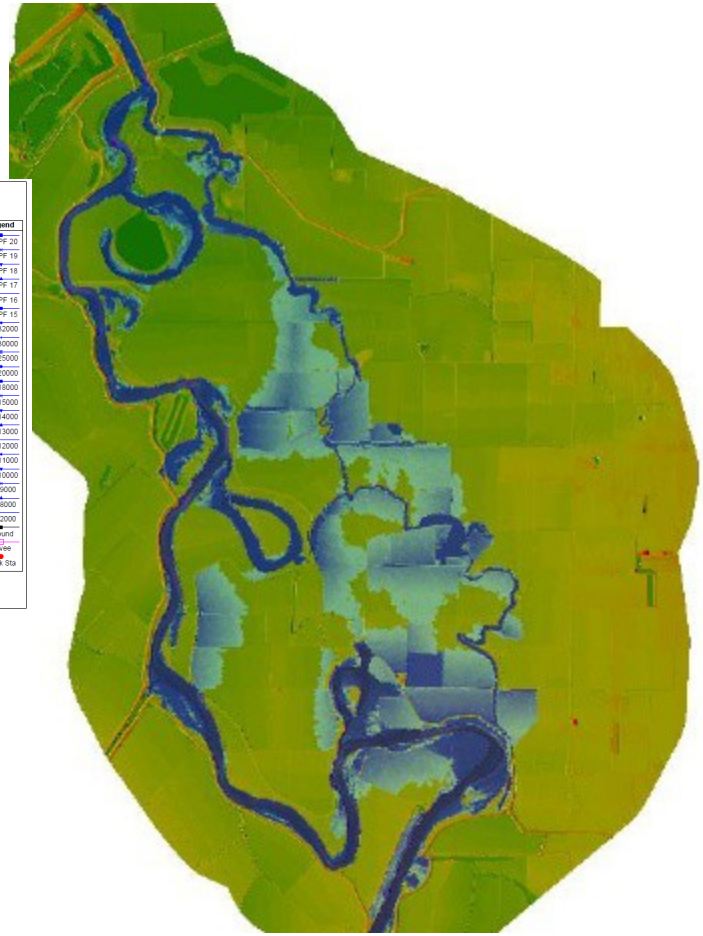
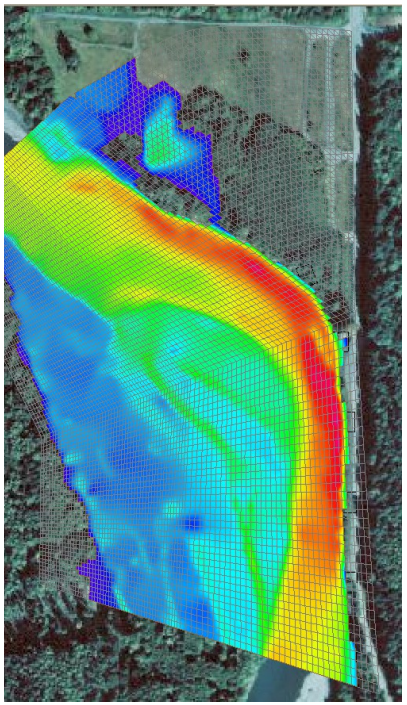
HEC-RAS and other hydraulic models







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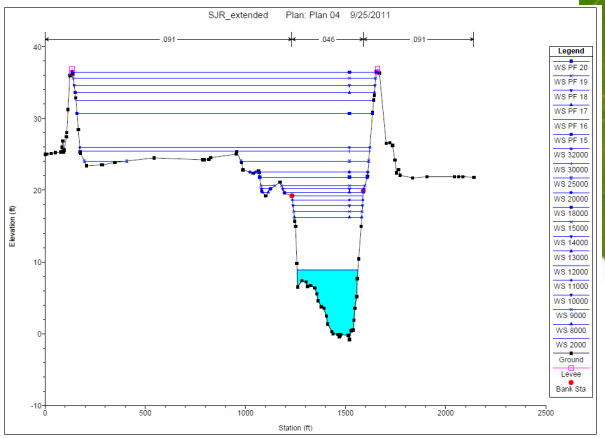
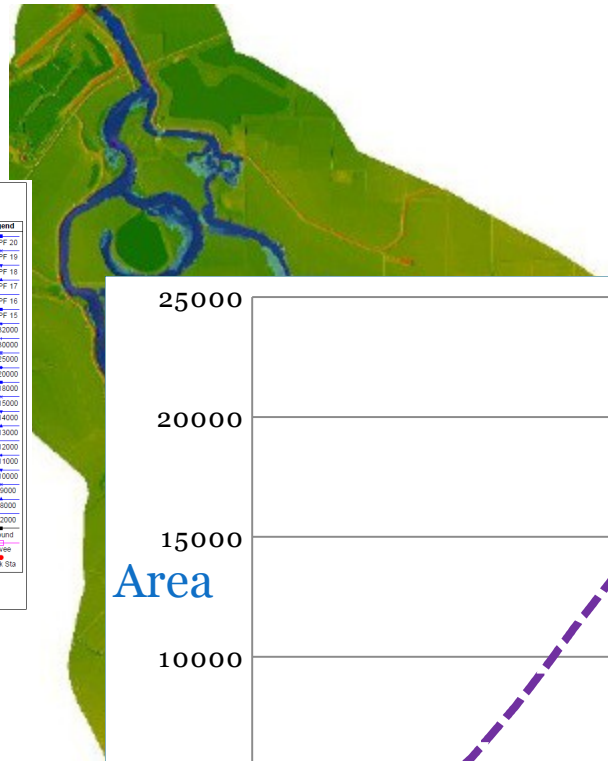
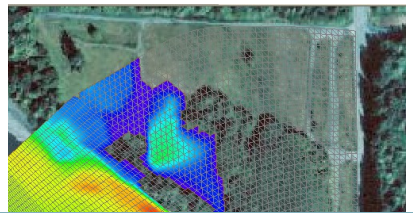
HEC-RAS and other hydraulic models







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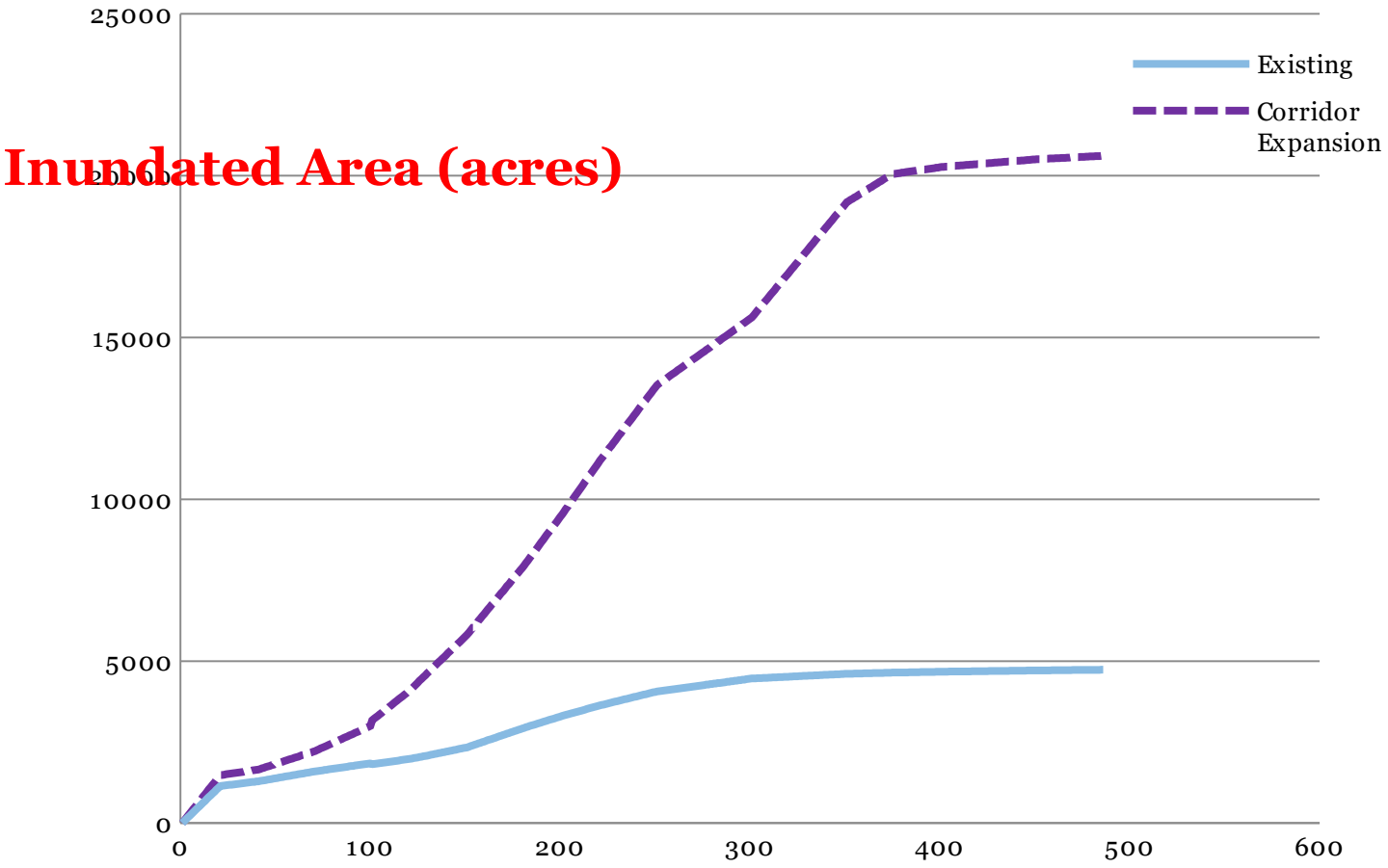
ADF Curve Development



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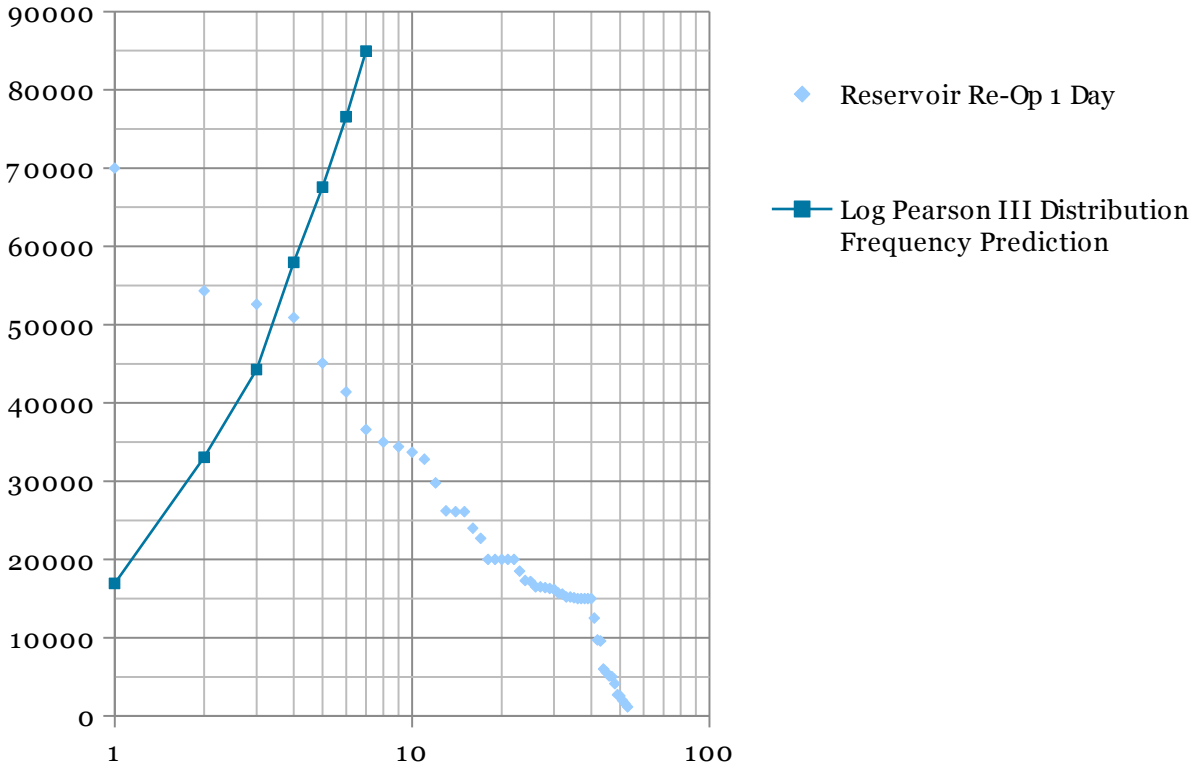
ADF Curve Development

Flow (cfs)



Probability (given as Recurrence Interval)

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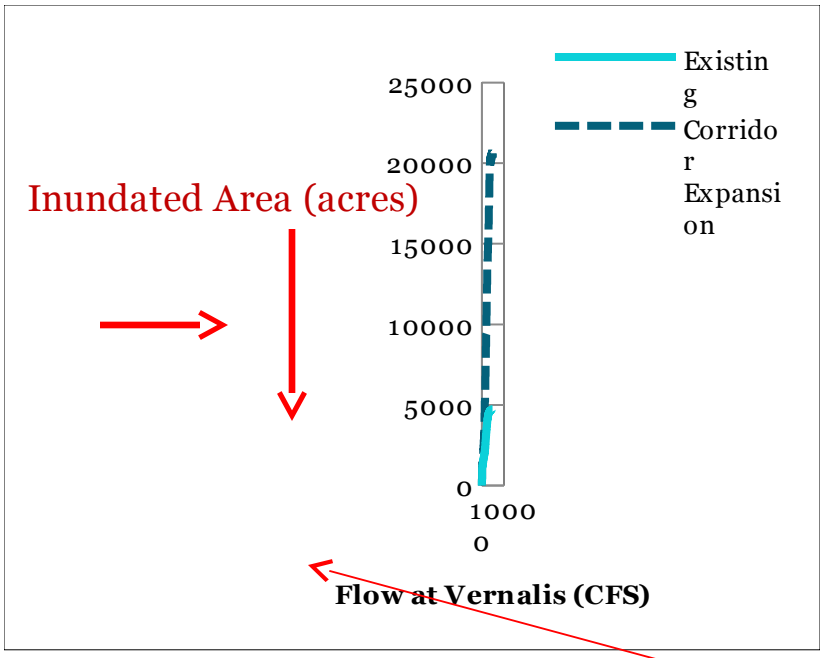
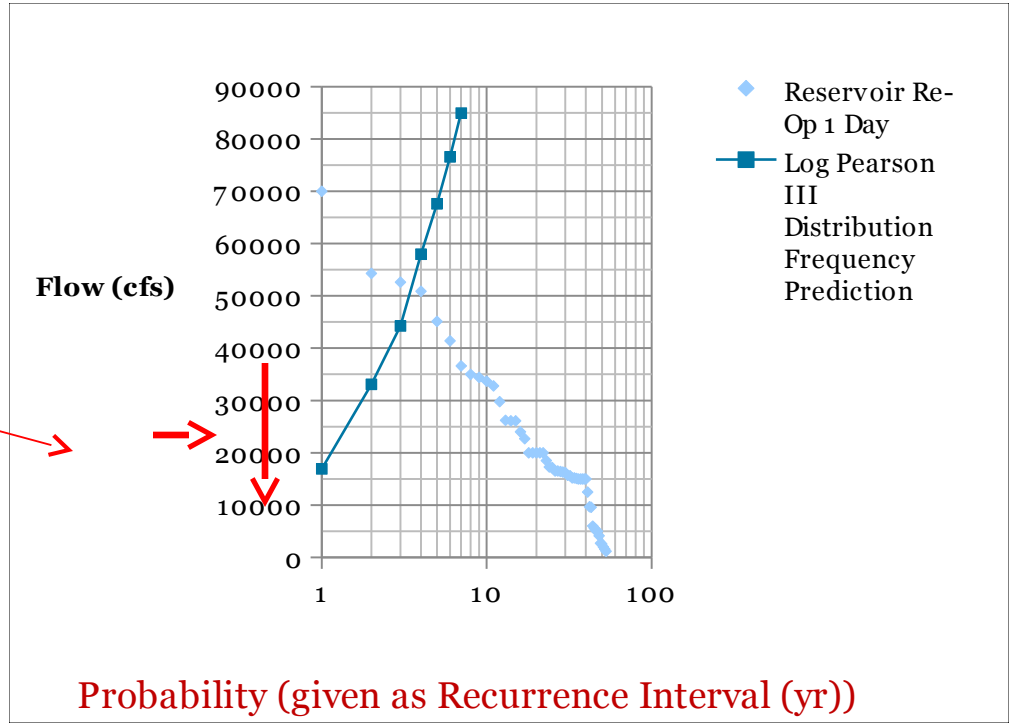
Develop ADF Curves

Q vs Area Curves



Recurrence Interval Curves for each duration—in total there are 28 of these curves.



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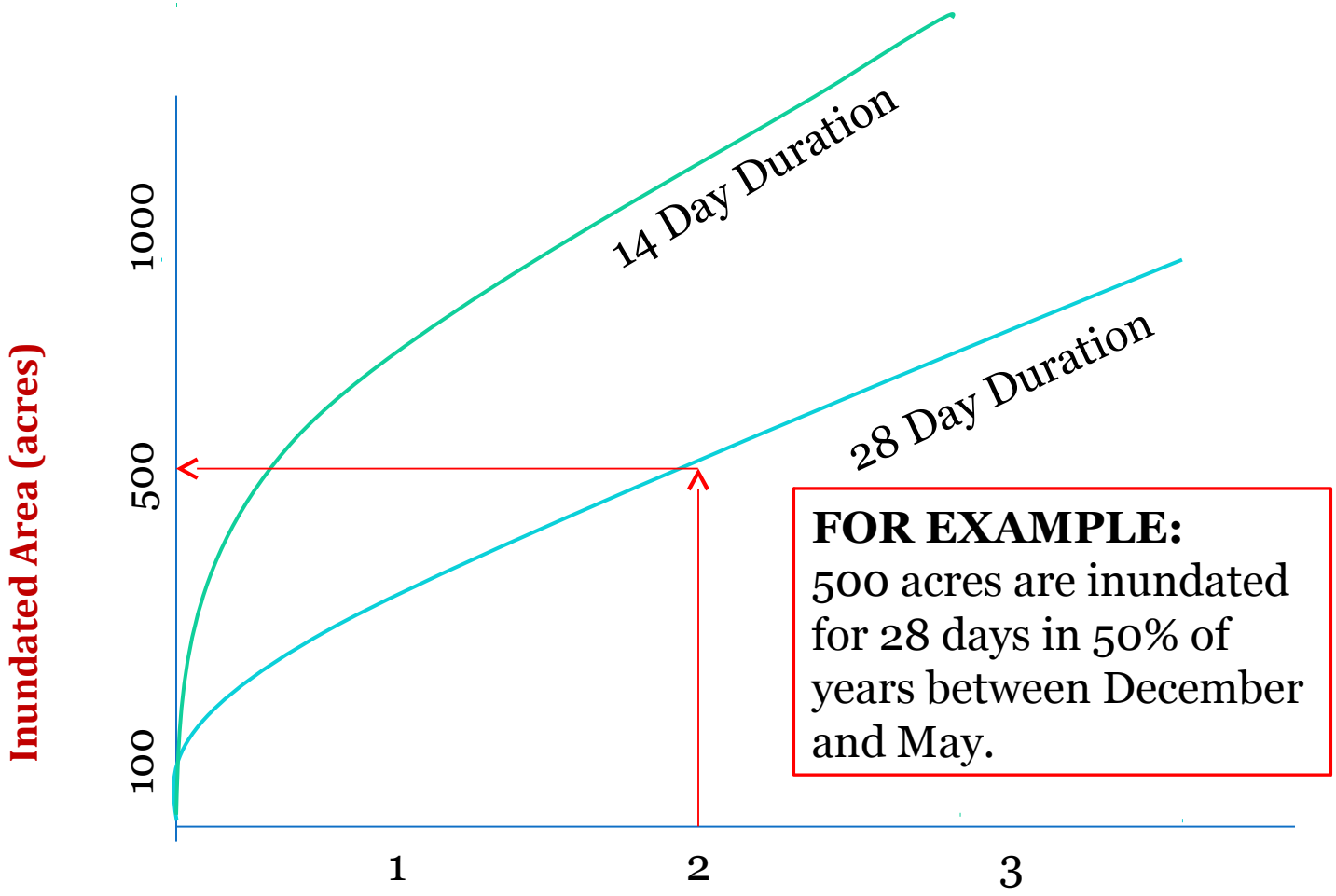
Develop ADF Curves



FOR EXAMPLE:
500 acres are inundated for 28 days in 50% of years between December and May.

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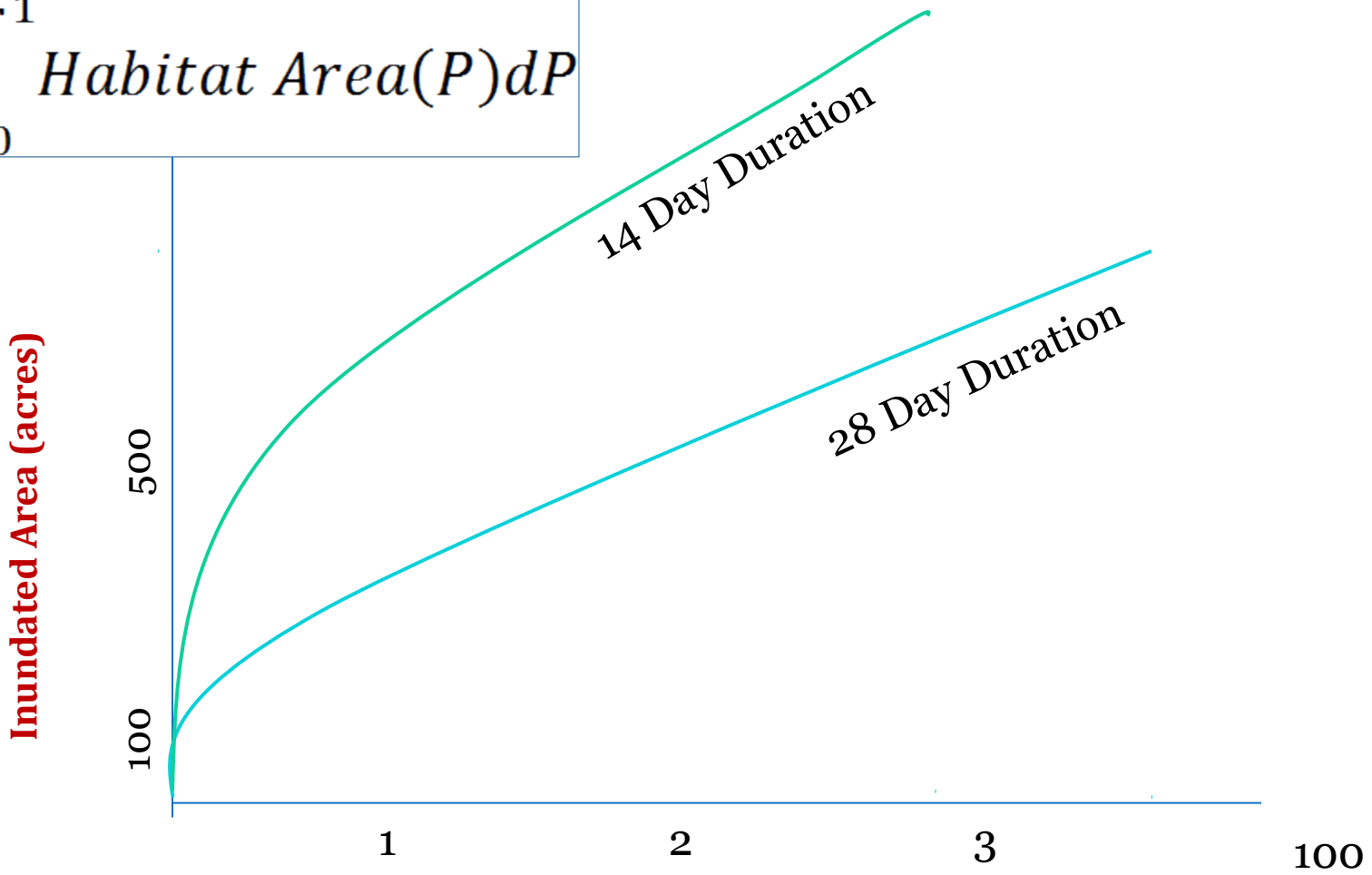
Develop EAH

$$EAH = \int_0^1 Habitat\ Area(P)dP$$



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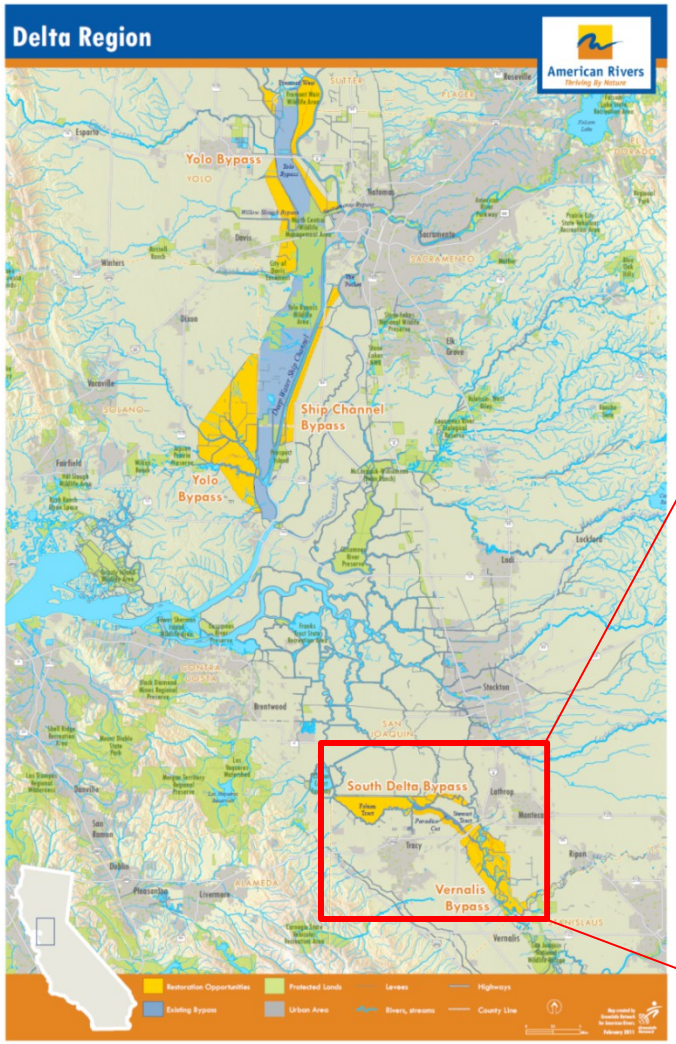
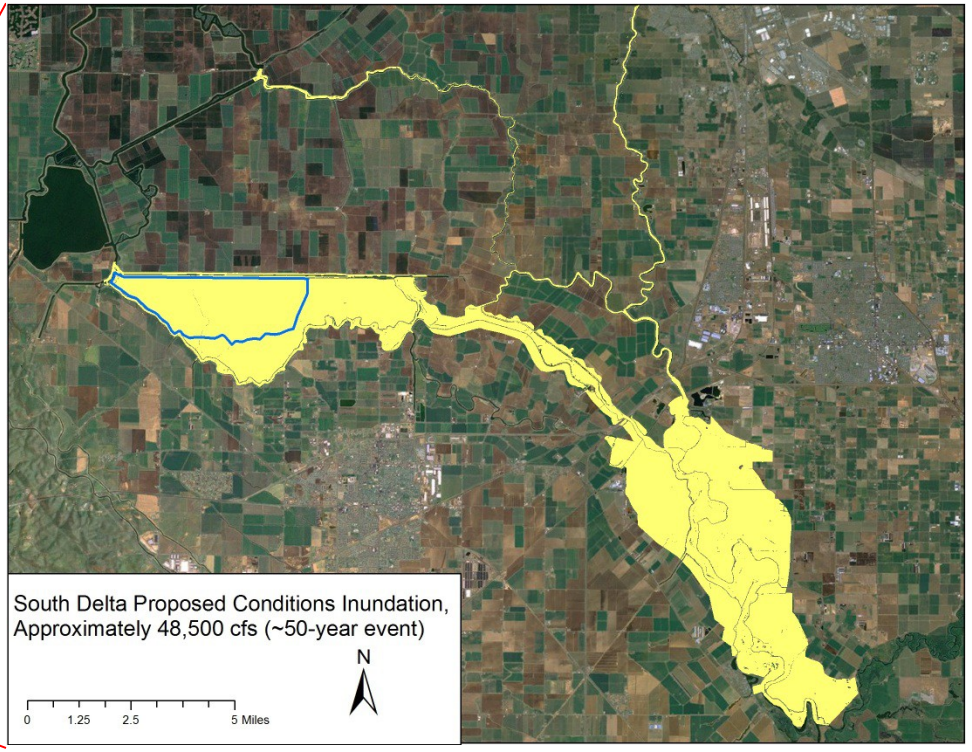
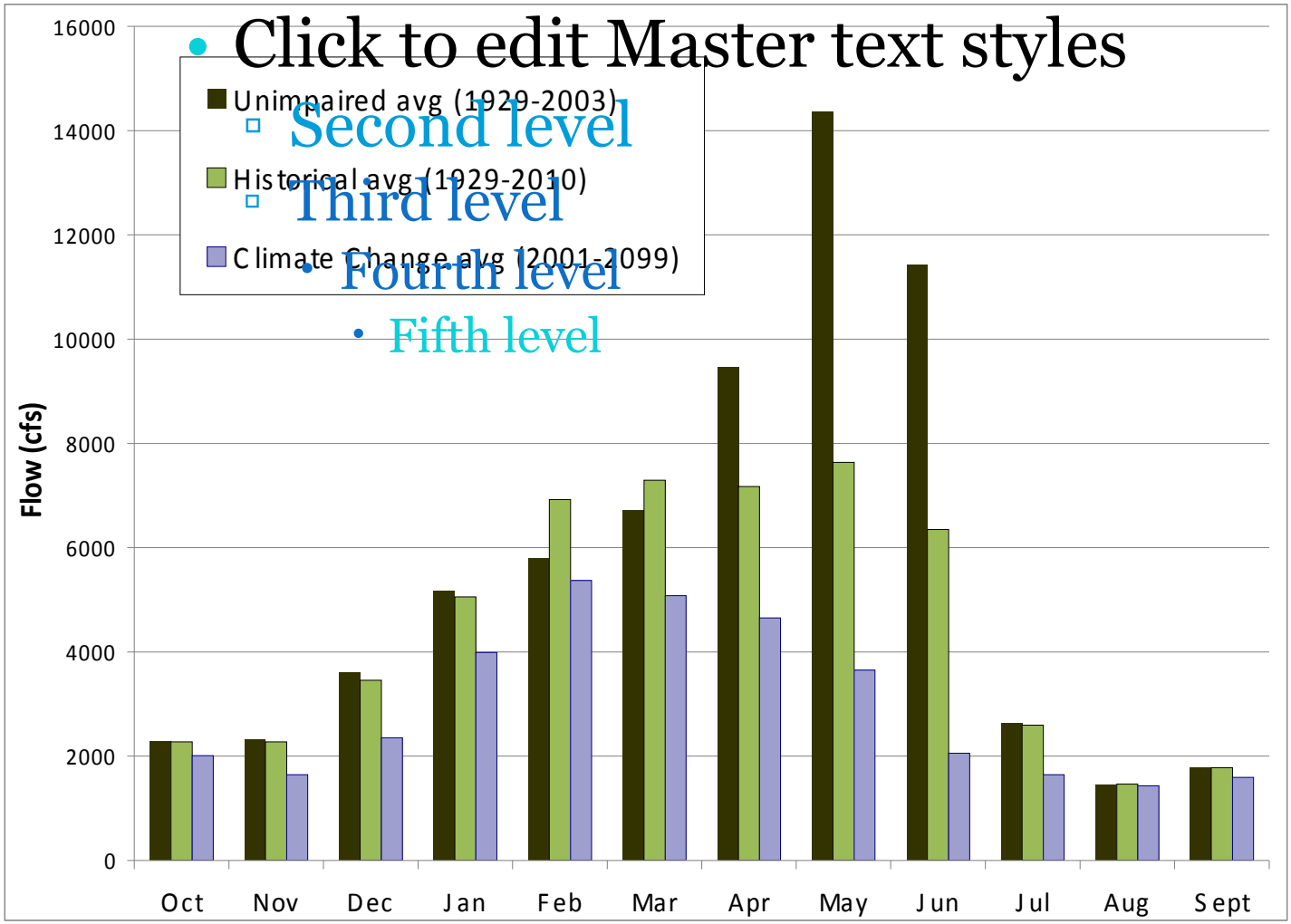
Corridor Expansion Test Reach



Remove levees between Vernalis and Hwy 5, Expand Paradise Cut, Convert Fabian Tract to Floodway



Monthly Average Flow



Reservoir Re-operation Scenarios

Scenario	Description
'Current Rules'	• No changes to operations
'Reservoir Re-Operation'	• Modify reservoir rules curves (New Melones, Don Pedro, McLure): 1. Additional fall drawdown: Combined 221 TAF in Nov and 151 TAF in Dec for three reservoirs 2. Reduced flood reservation : Combined -121 TAF (-11%) in Feb, -323 TAF (-32%) in Mar, -569 TAF (-82%) in Apr, -123 TAF (-98%) in May for three reservoirs • Groundwater banking: Added 333 TAF storage capacity each for Stanislaus, Tuolumne, and Merced River riparian water users.
'Reservoir Re-Operation + Floodplain inundation'	• Modified rule curves as above • Groundwater banking operations as above • 2-weeks floodplain inundation between Feb-May in 80% of years

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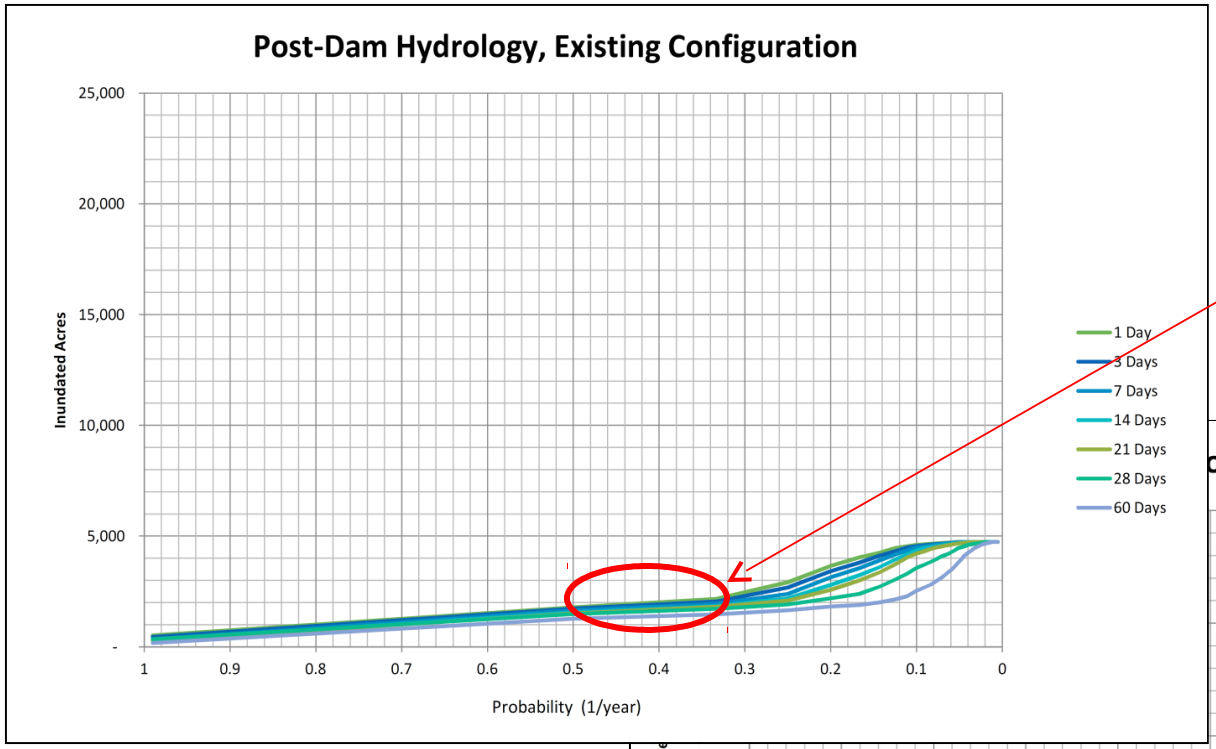
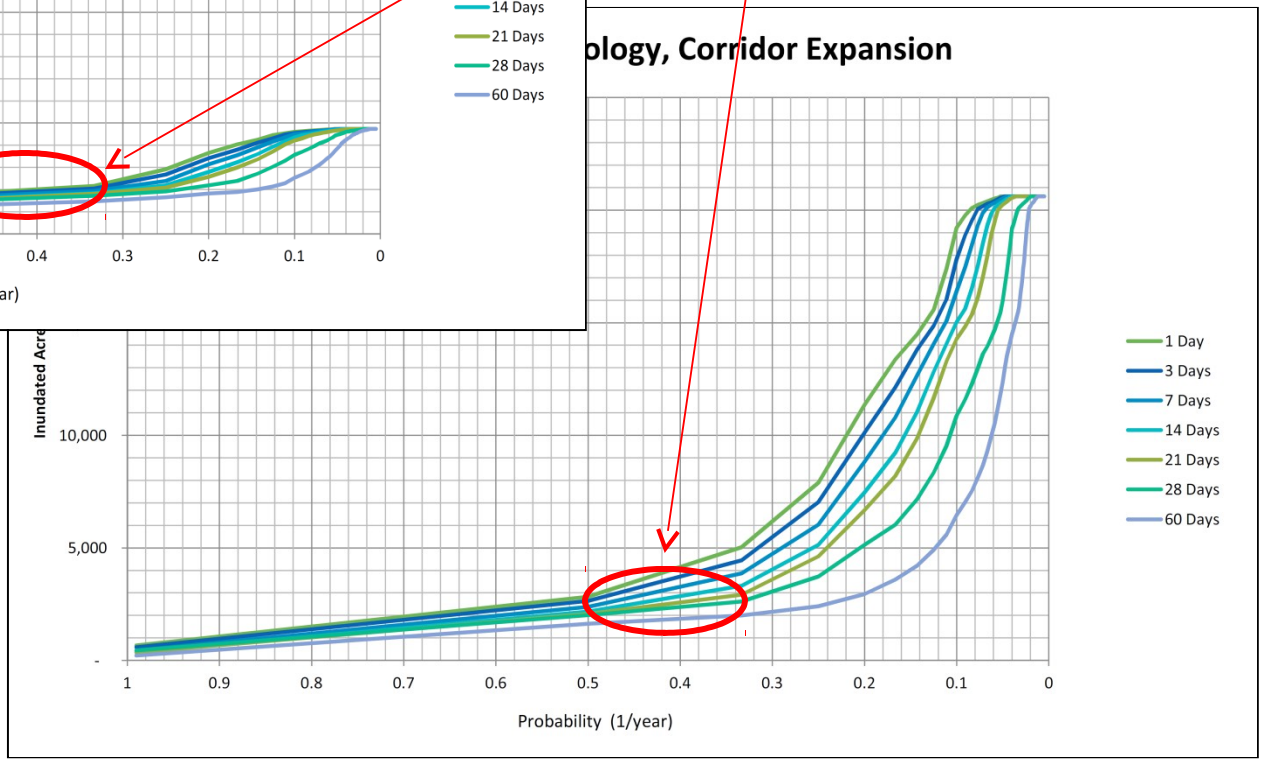
Ecosystem Relationships

Ecological Relevance	Season	Duration	Frequency
Splittail spawning and rearing	Feb – May	At least 21 days	At least 4 yr return period
Chinook salmon rearing	Dec – May	At least 14 days	At least 2 yr return period
Phytoplankton production	Dec – May	At least 2 days	1.3 yr return period
Zooplankton production	Dec – May	At least 14 days	1.3 yr return period
Benthic macroinvertebrate production	Dec – Sep	At least 1 day	2 yr return period

ADF Curves: Results



Some noticeable Benefit from Corridor Expansion



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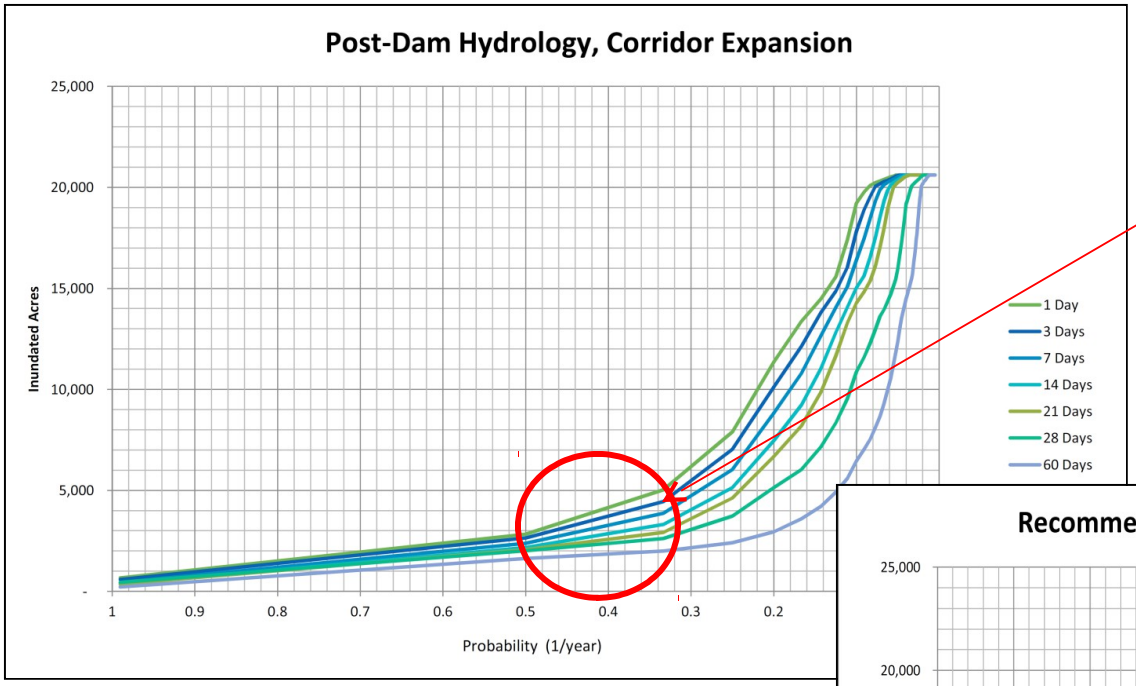
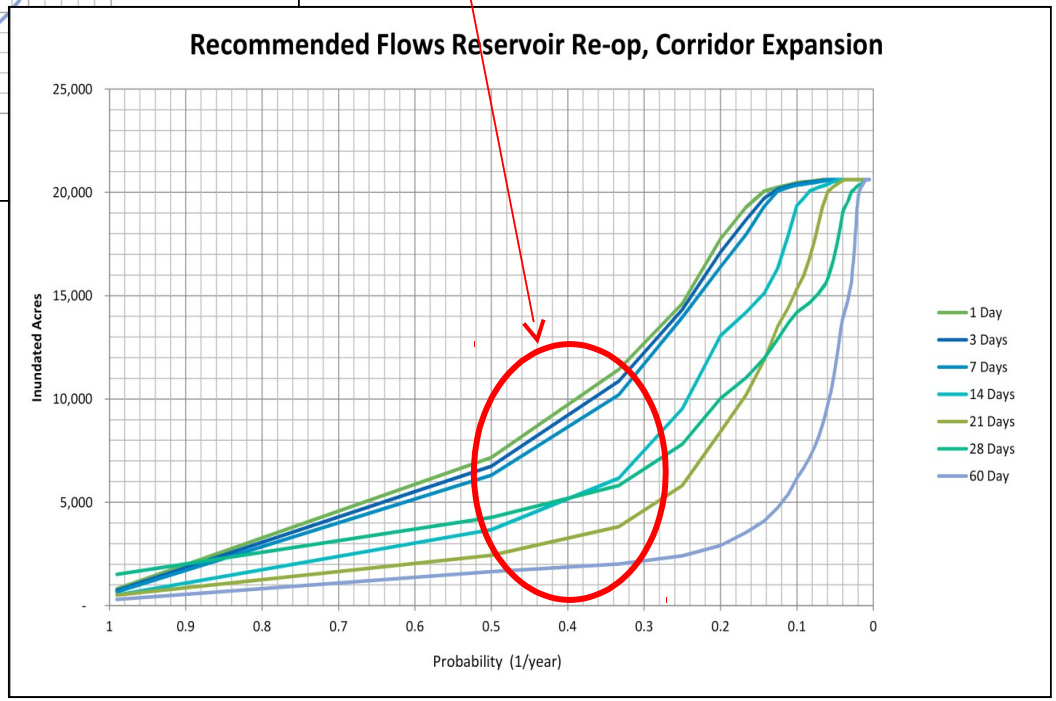


Even more benefit with reservoir re-operations



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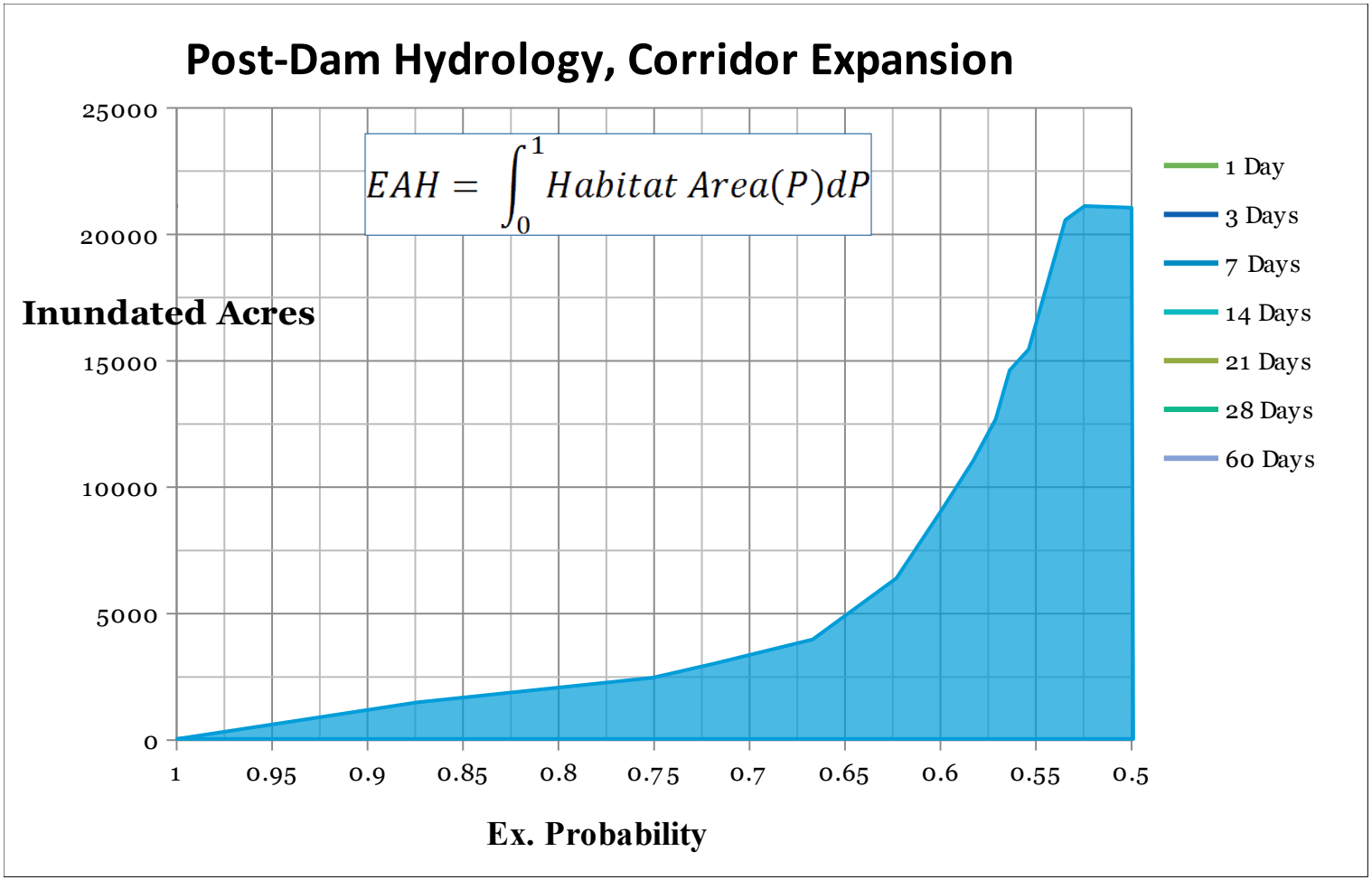
EAH Development



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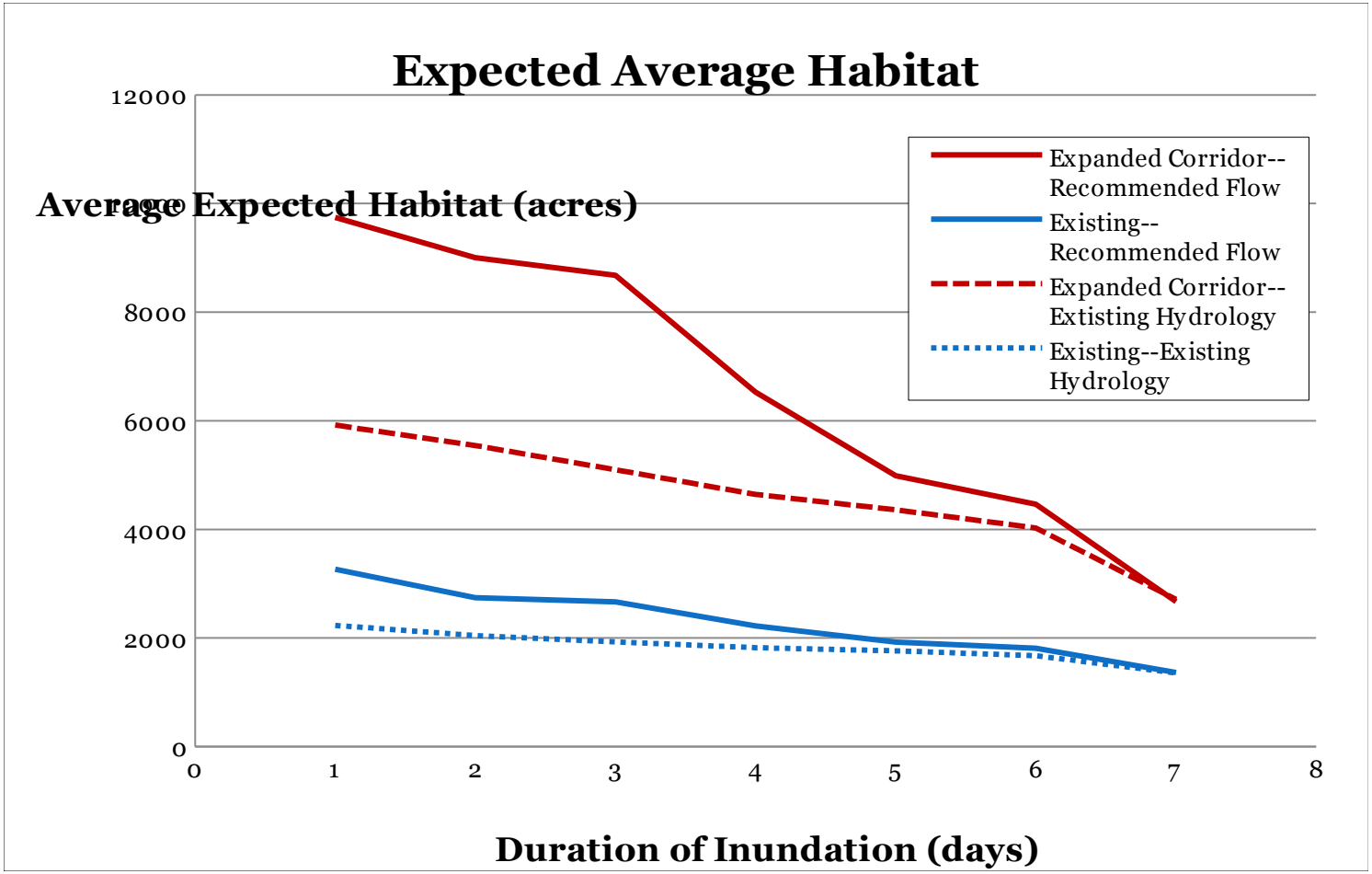
EAH Results



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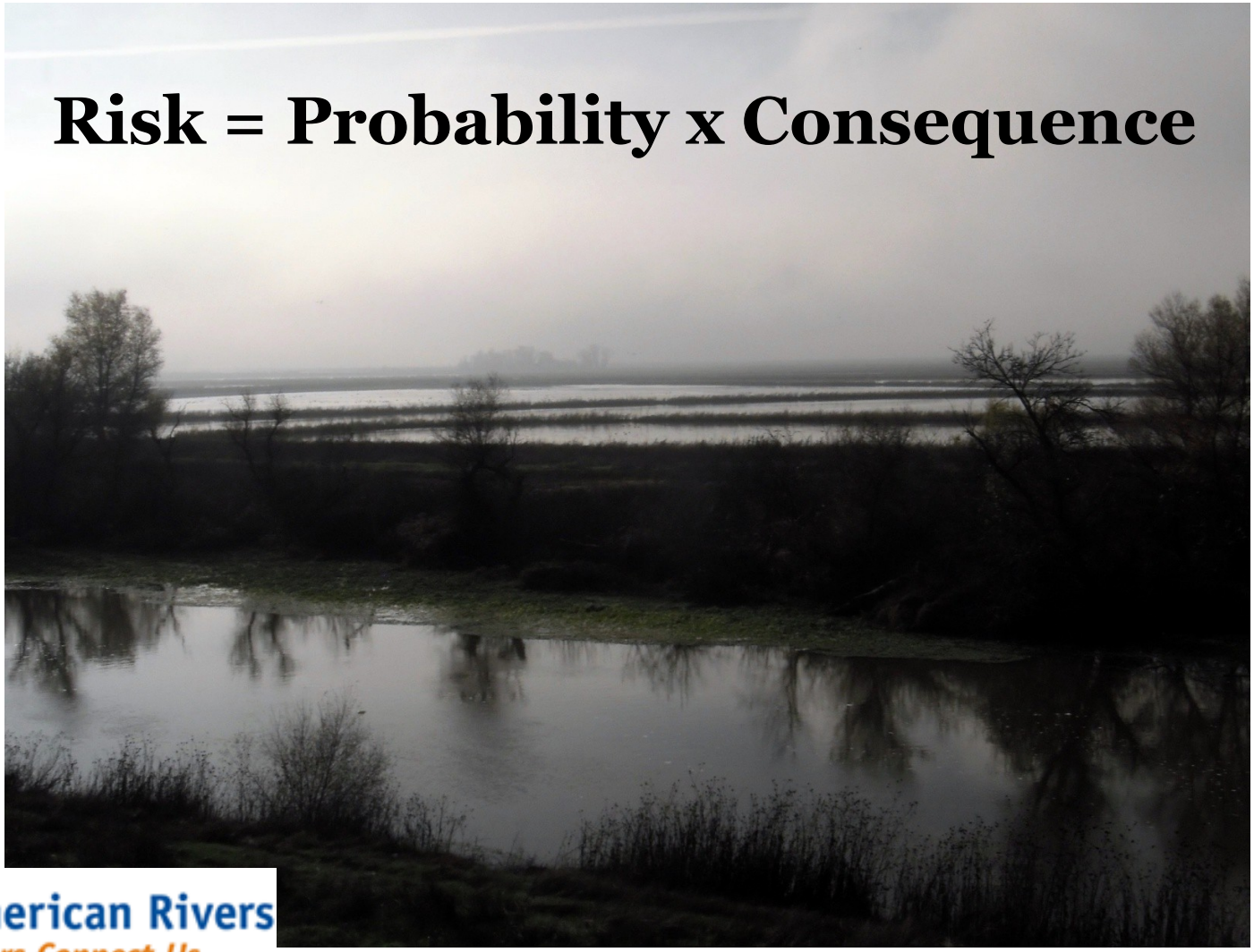
Benefits as Risk



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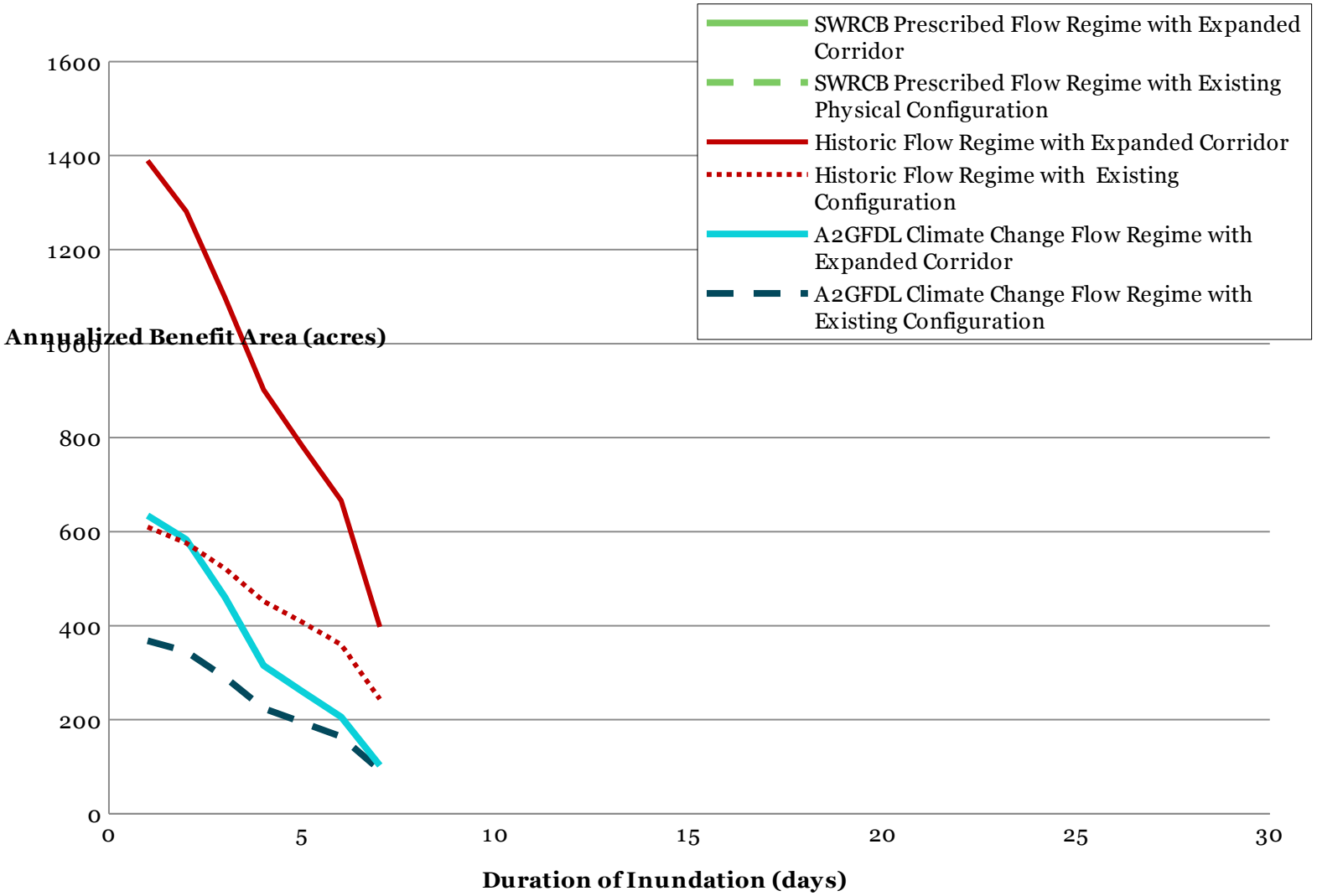
Climate Change



Conclusions

1. Study in method and development of new and transparent metrics

2. In this case, restoration must also include changes to the hydrology

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Questions?

ESA PWA

NEWFIELDS

FULBRIGHT

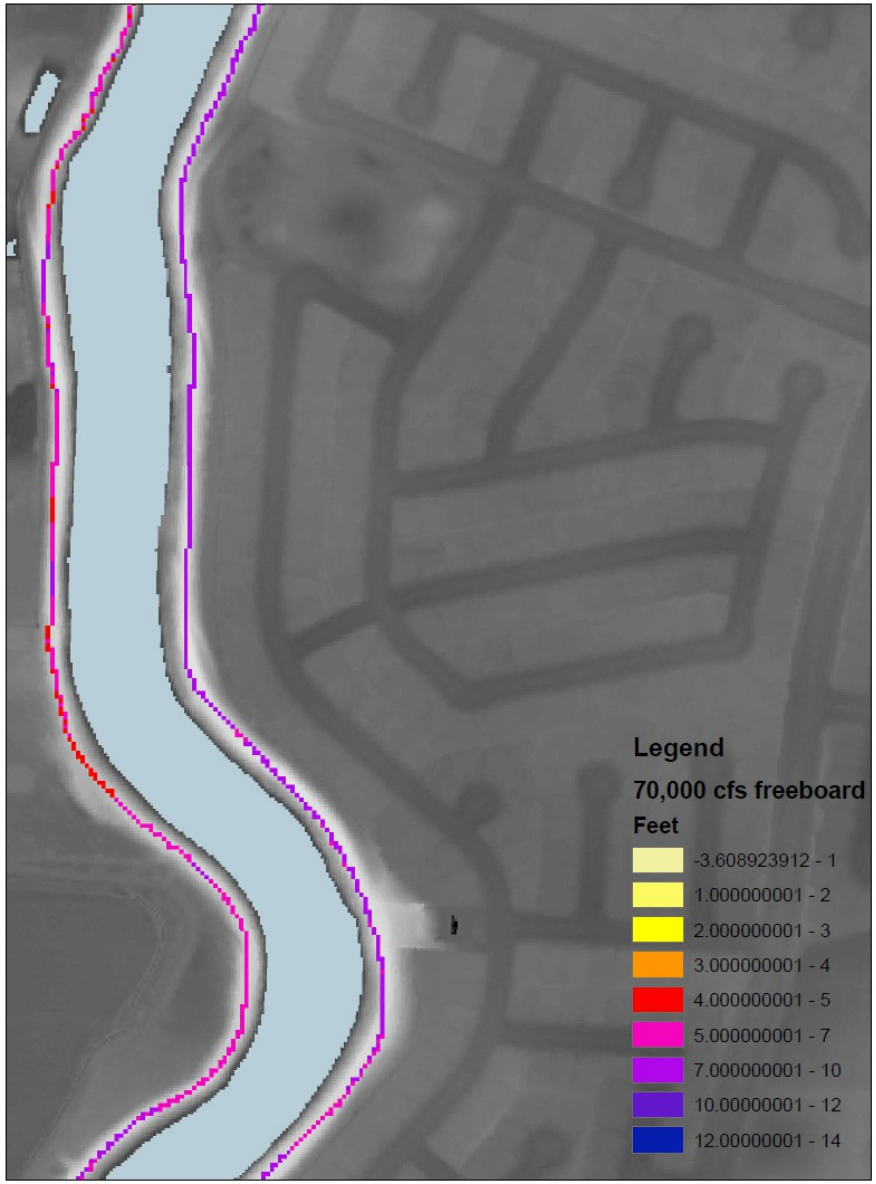
TU Delft Delft University of Technology

THE UNIVERSITY OF CALIFORNIA 1868

Flood Risk Results

Annualized Risk of Failure between Mossdale and Stockton, right bank.

	Recommended	Post-Dam
Existing	14.56	9.24
Proposed	2.32	1.74
Percent Change	-84.08	-81.18



75 % reduction in annualized probability of levee failure.