

# Evaluating the effects of floodplain reconnection on flood risk and riparian ecosystems in the California Delta



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November 09, 2011

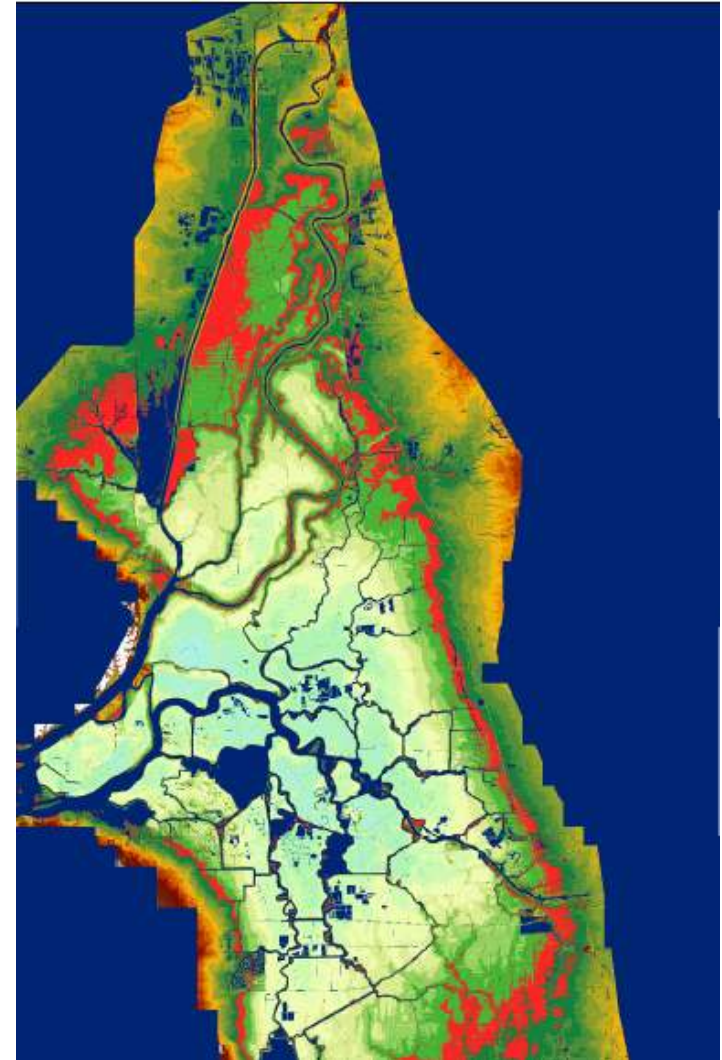
# The California Delta



- When it was first ‘discovered’ the Delta was an inland sea
- 1840-1850s: reclamation and farming began
- 1950s: headwater dams installed

# The California Delta

- 1,200 km of sloughs
- 57 Polders (we call them Islands)
- And the majority of the California Delta is below sea-level.



# The California Delta

In short, the problem in the delta is this:



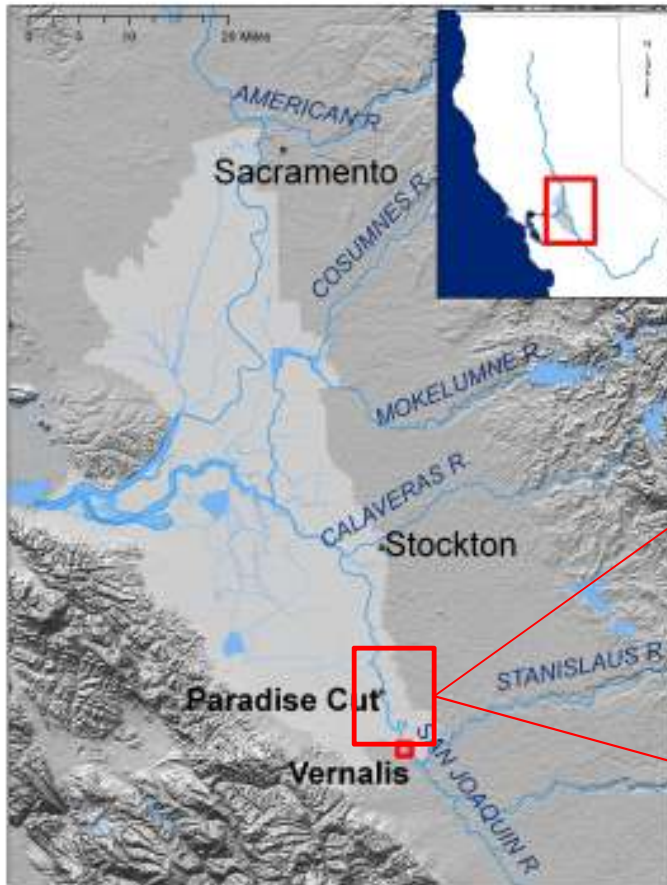
Too much water



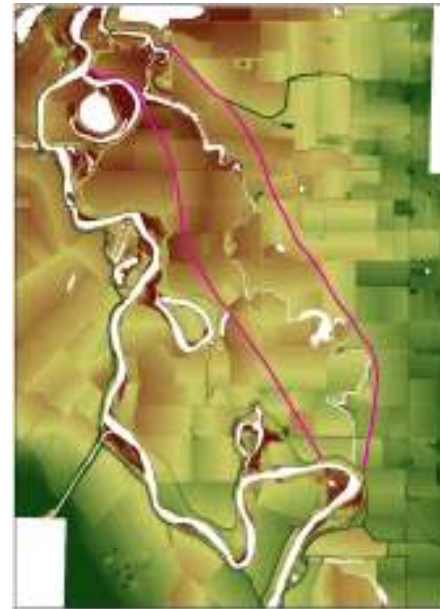
Not enough water

And we're trying to find solutions that address both.

# The floodplain:



Bypass



Levee  
Removal/  
Set back



# The starting question:

How do we QUANTIFY the benefits of floodplain reconnection for :

## 1) Flood Management



## 2) Riparian and Aquatic Habitat



## 3) Water Supply Reliability



# Metrics

## **Flood Risk Management**

- Probability of failure
- Annual expected damage



## **Riparian and Aquatic Habitat**

- Accessible habitat per species of concern
- Annual expected habitat area\*\*



## **Water Supply Reliability**

- Change in Flood Reservation\*\*



# Flood Risk Reduction



# Flood Risk

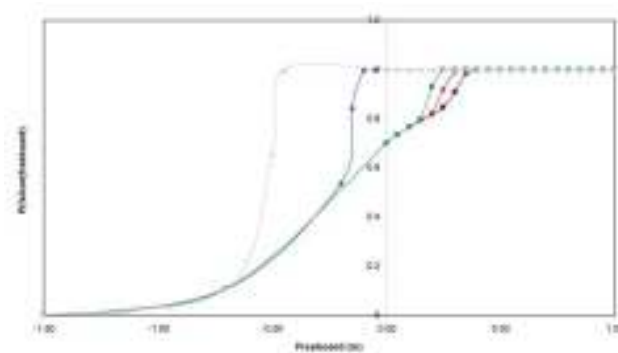
**Risk = Probability x Consequence**

Probability of Failure	Consequences
System was not built large enough	Dense urban development behind levees
Poorly constructed levees	Critical infrastructure
Subsidence, earthquake, sea-level rise	

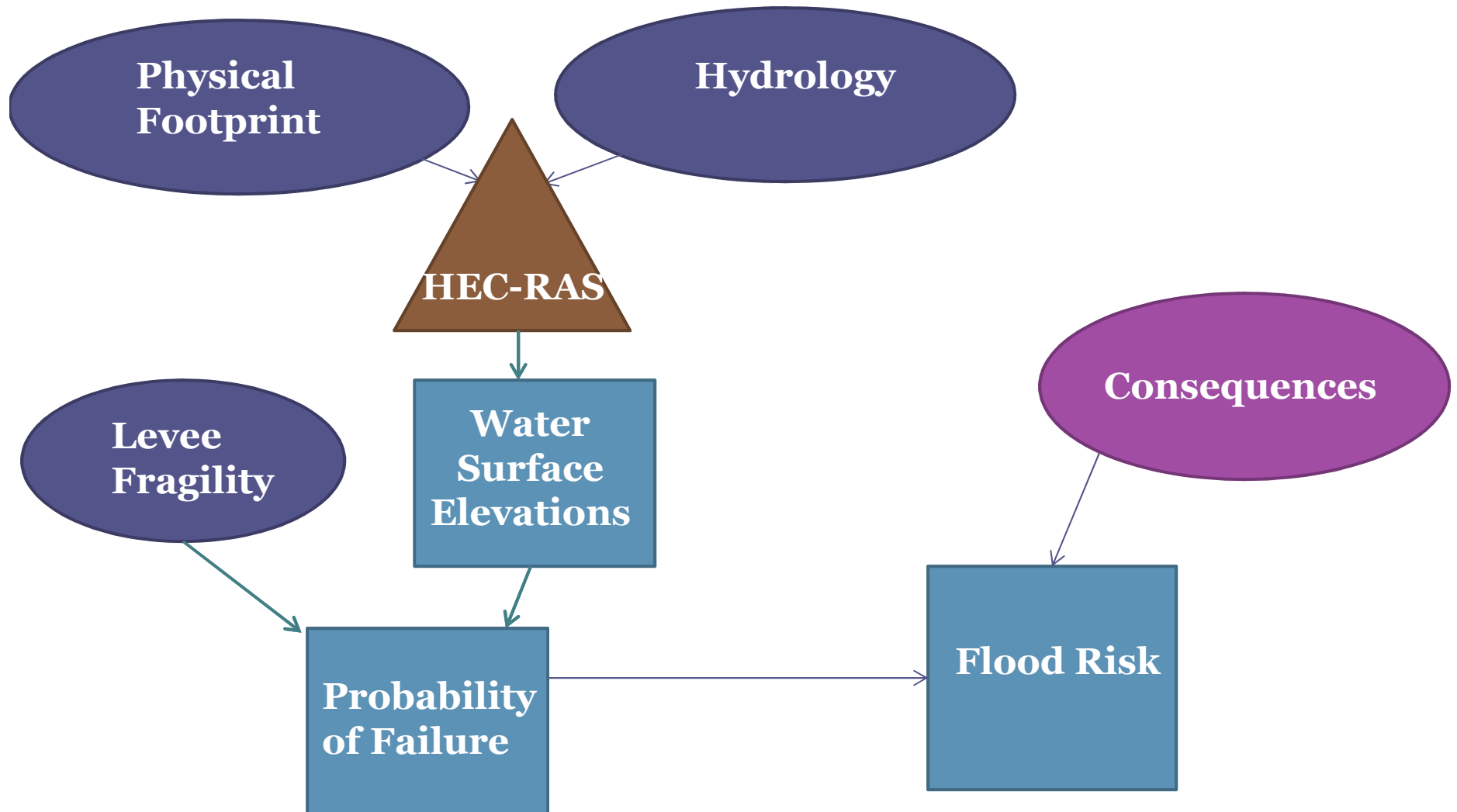
# Flood Risk

**Floodplain reconnections reduce risk by lowering both**

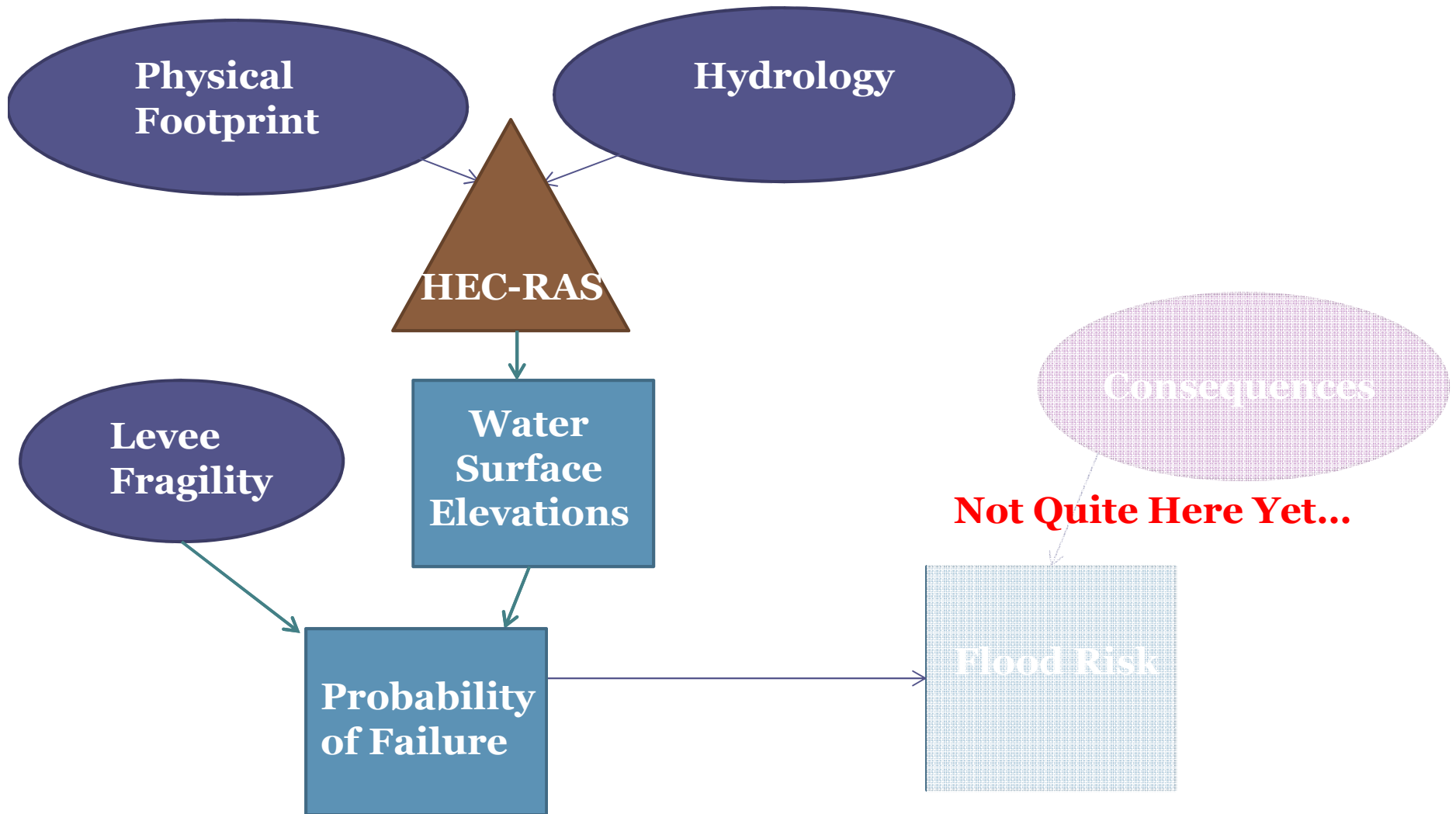
Probability of Failure	Consequences
Lower water surface elevations in the leveed system	Move water away from urban areas and critical infrastructure



# Flood Risk

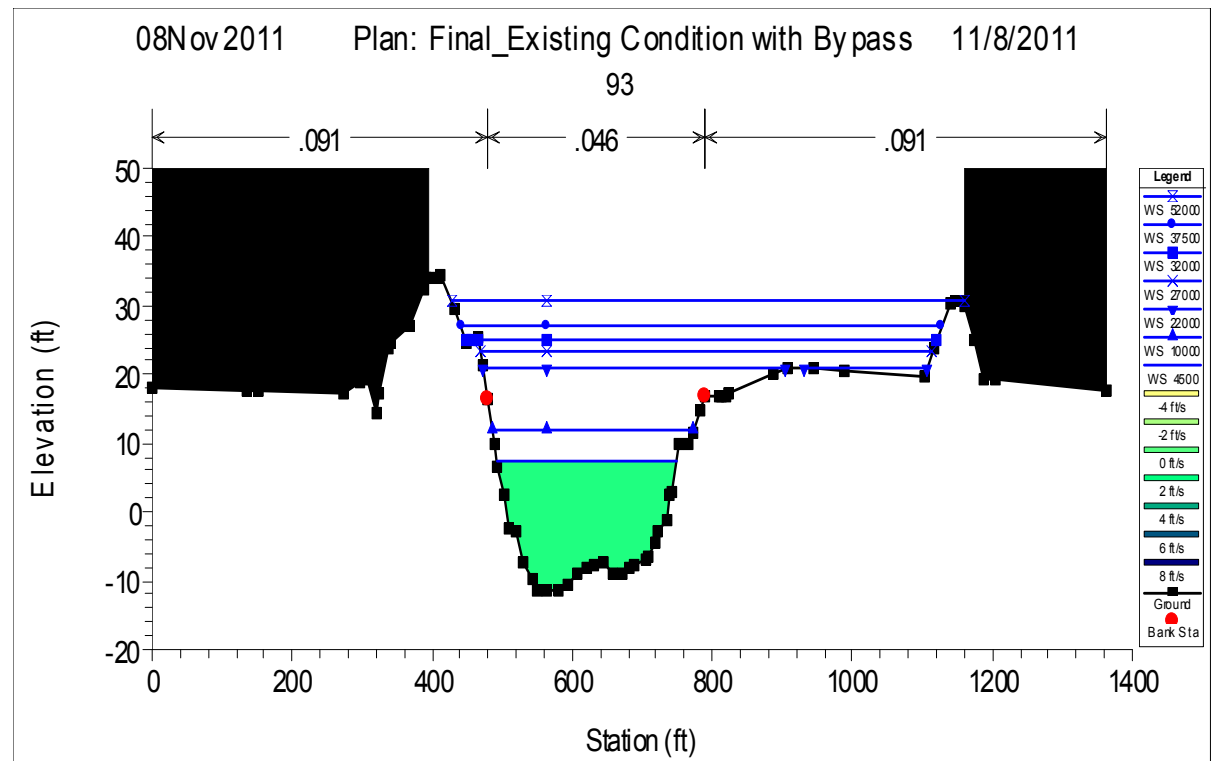


# Flood Risk

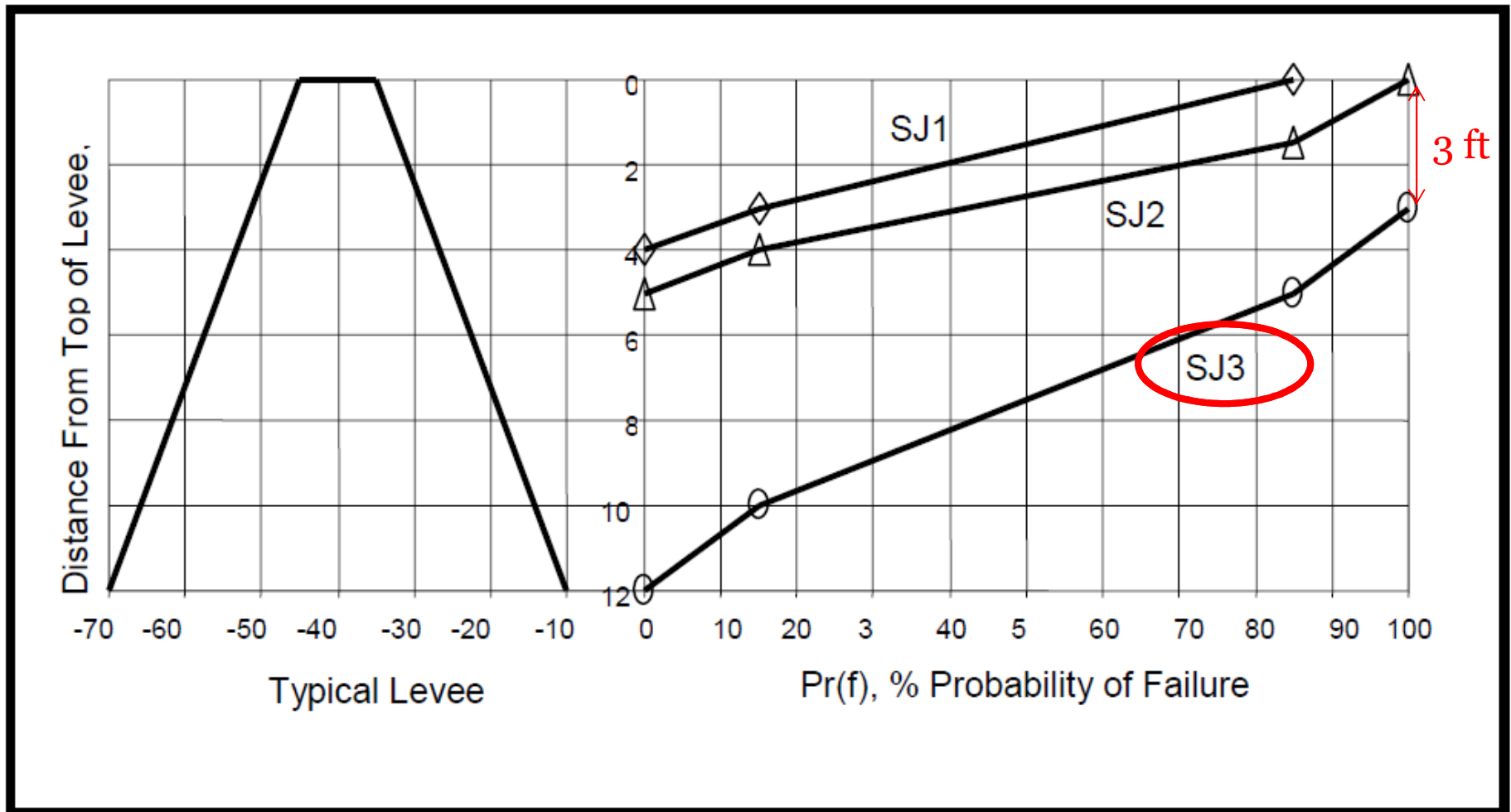


# Flood Risk

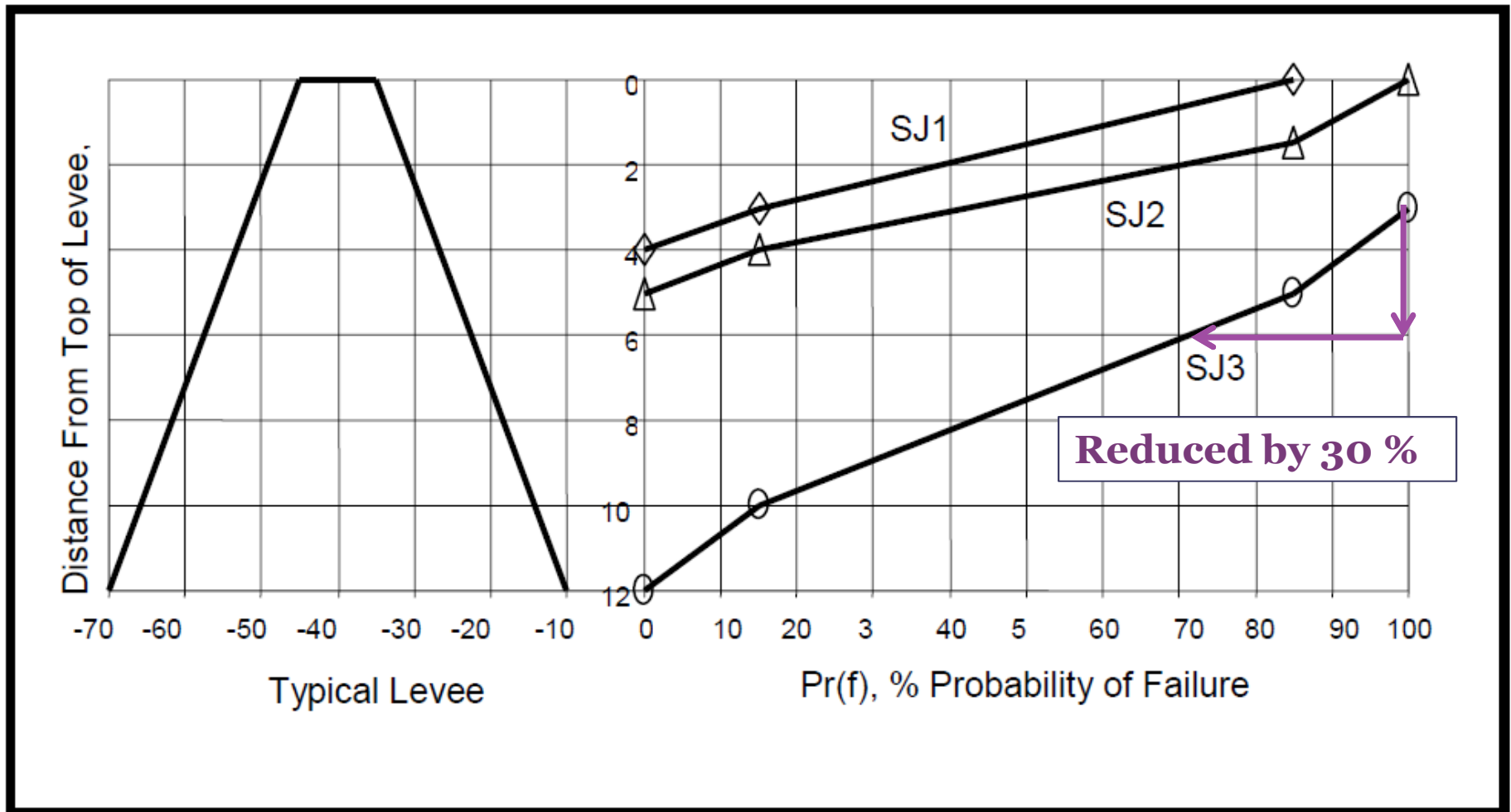
RI	Flow (cfs)
50 yr	54,615
10 yr	37,500
5 yr	32,800
4 yr	26,200
3 yr	21,800
2 yr	9,920
1.3 yr	4,510



# Flood Risk



# Flood Risk



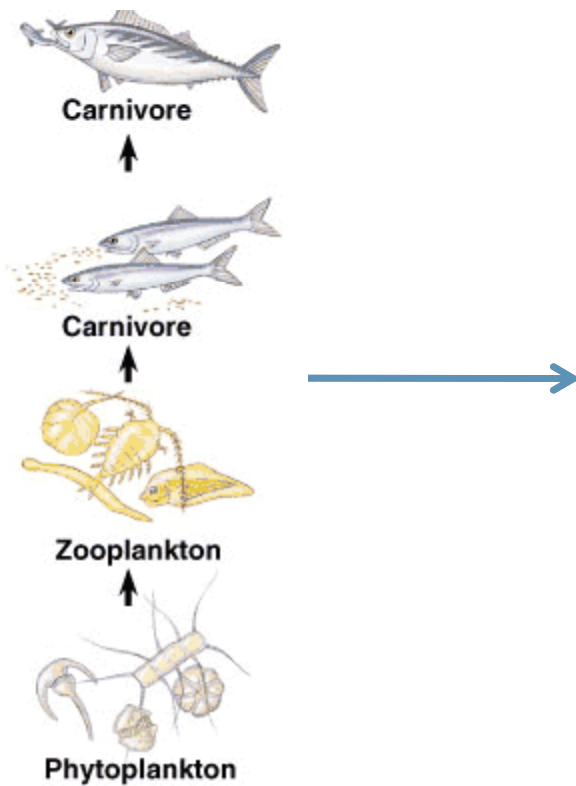
# Flood Risk Conclusions

1. Floodplain reconnections in the Lower San Joaquin Basin may be able to reduce water surface elevations by 2-4 feet for large events.
2. Because the levees in the Lower San Joaquin are so fragile, these water surface reductions translate into substantial increases in safety.

# Ecosystem Benefits



# Ecosystems in the Delta





# Ecosystem Variables

## Physical

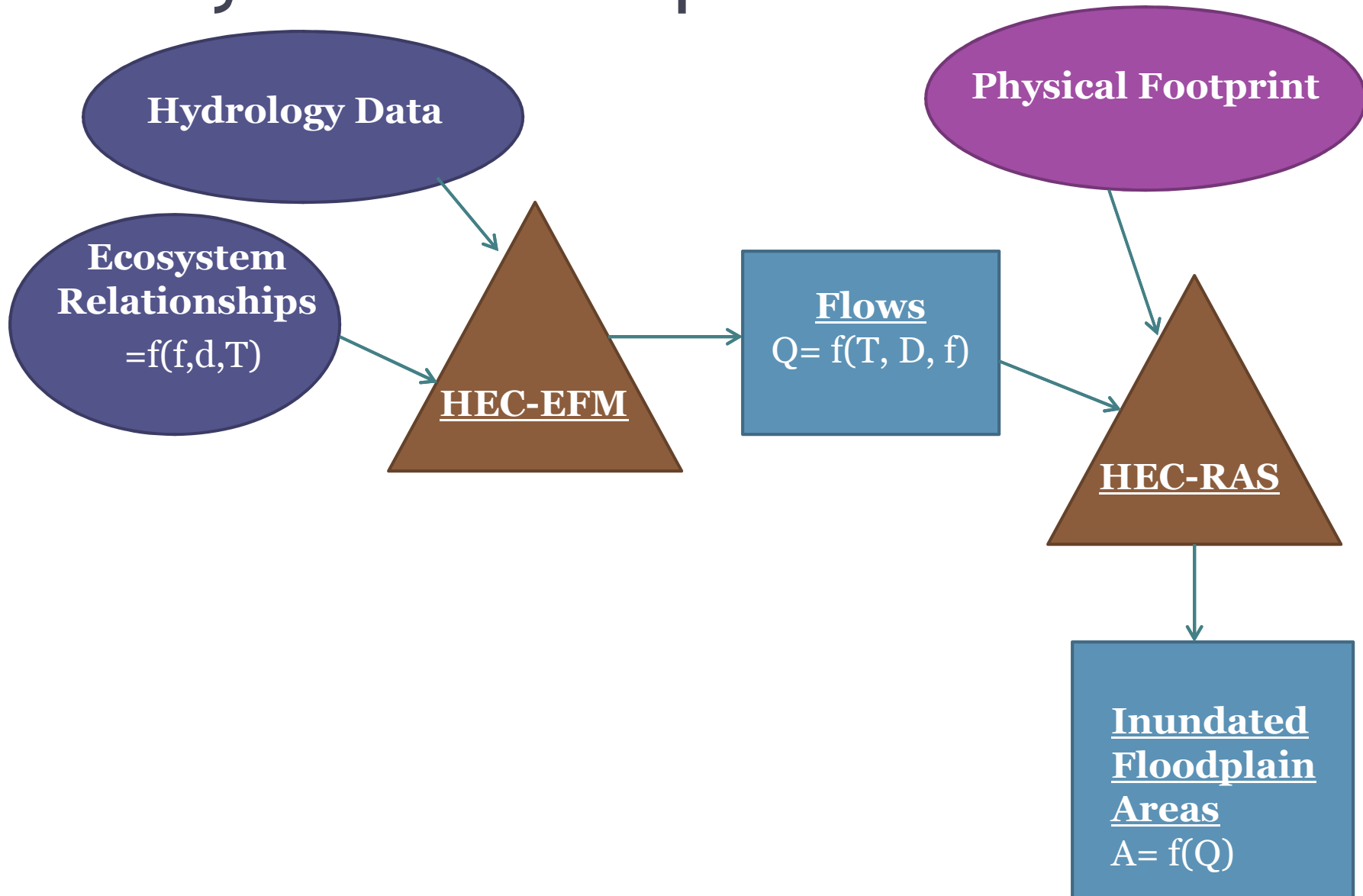
- Area
  - ✓ depth
  - ✓ velocity
  - ✓ cover
  - ✓ vegetation
  - ✓ connectivity

## Hydrologic

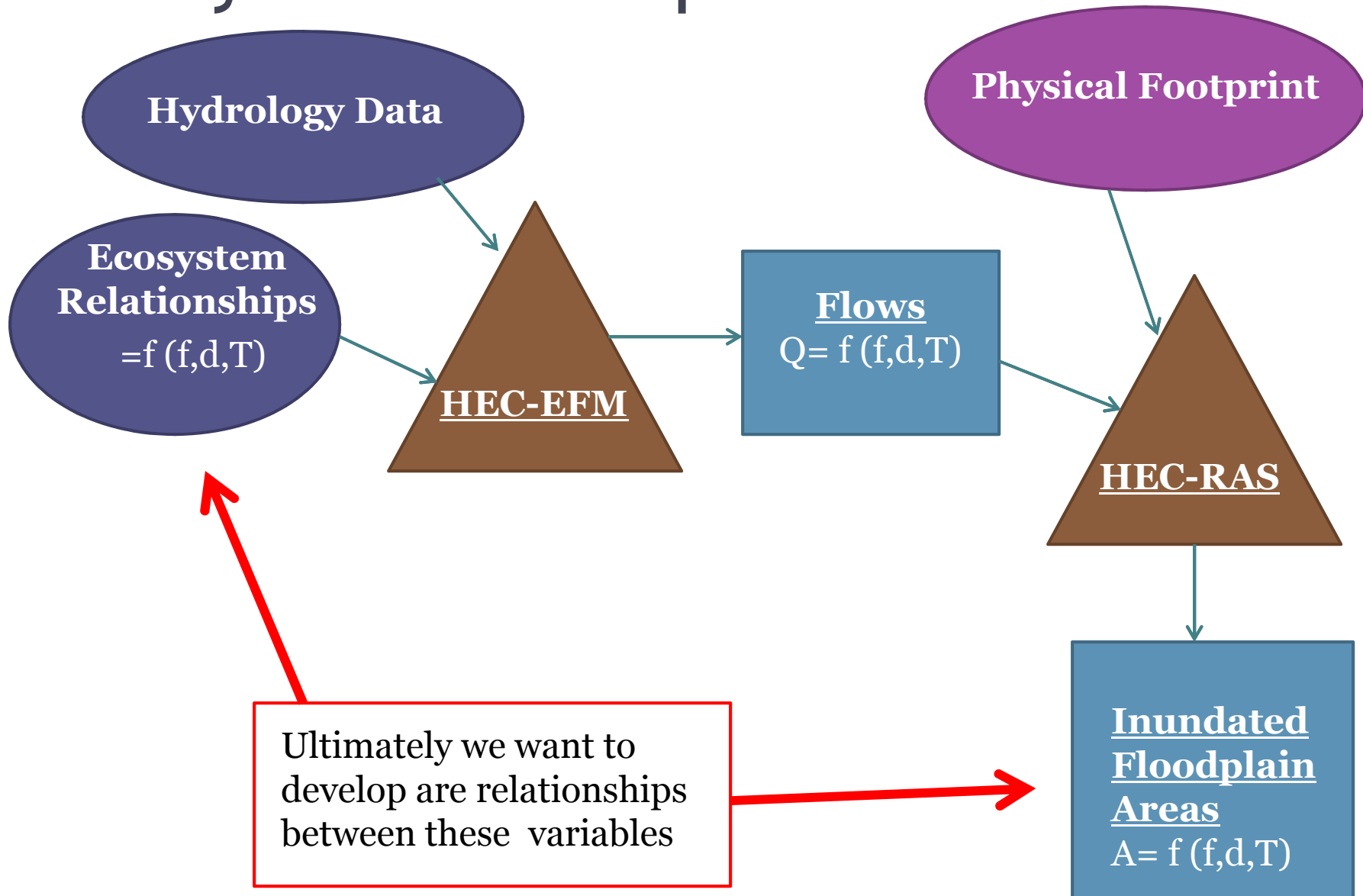
- Duration
- Frequency
- Timing



# Ecosystem Concept



# Ecosystem Concept



# Hydrology

- Historic Record (average daily flows)
  - Pre-Dam
  - Post-Dam
- Climate Change Scenarios (downscaled monthly flows)
  - B1PCM: Warm and Wet (Low Emissions)
  - A2GFDL: Hot and Dry (High Emissions)

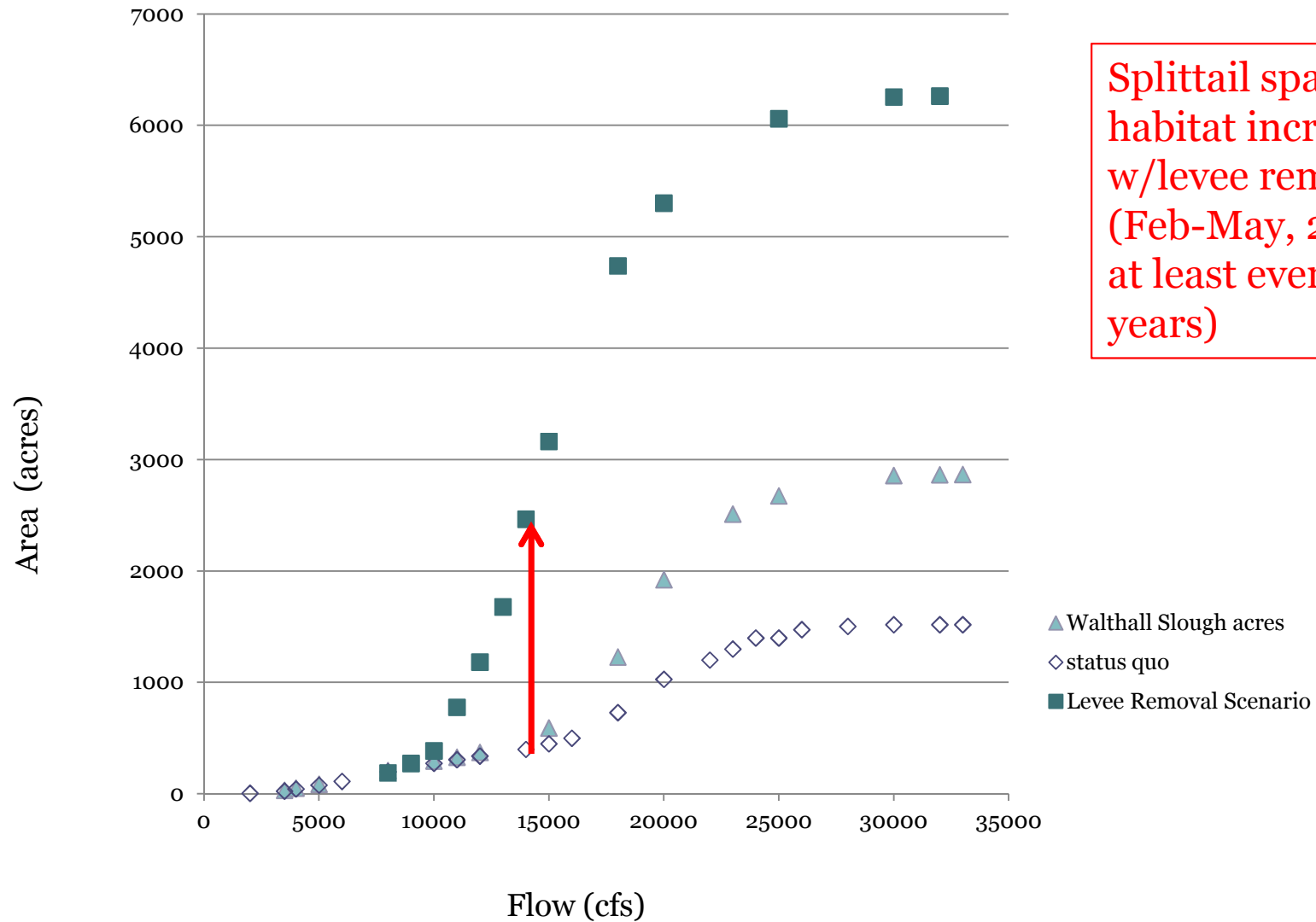
# Ecosystem Relationships

<b>Ecological Relevance</b>	<b>Season</b>	<b>Duration</b>	<b>Frequency</b>
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

# EFM Results

Relationship/ Threshold	USGS Gage 1930-2010		A2GFDL scenario		B1PCM scenario	
	Stage, ft	Flow, cfs	Stage, ft	Flow, cfs	Stage, ft	Flow, cfs
a) Benthic macroinvert.	17.4	9,888	18.0	11,124	14.8	6,710
b) Splittail spawning	20.3	14,762	16.4	8,687	15.1	7,063
c) 10 yr seasonal flood	29.9	37,398	29.2	36,198	23.6	20,553

# Species Specific Results



Splittail spawning habitat increase w/levee removal (Feb-May, 21 Day, at least every 4 years)

# Is there a concise way to visualize the variables in eco-benefits?

- Area
  - ✓ depth
  - ✓ velocity
  - ✓ cover
  - ✓ vegetation
  - ✓ connectivity
- Duration
- Frequency
- Timing

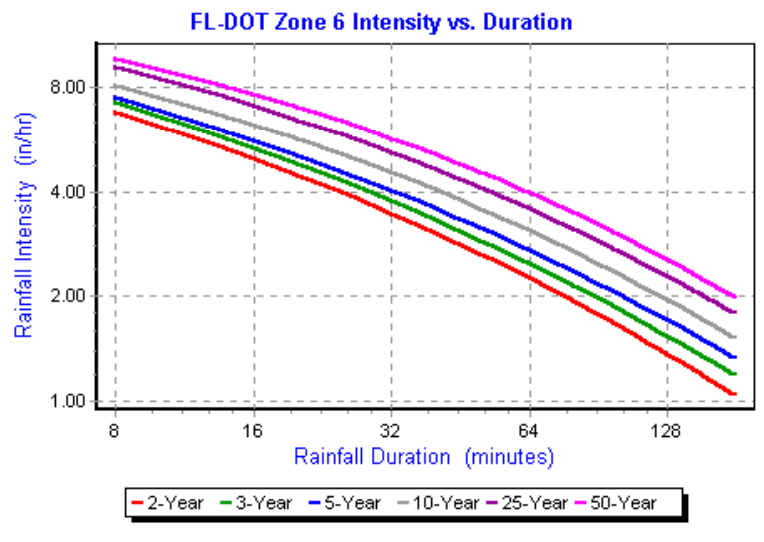


# Borrowing Ideas ?

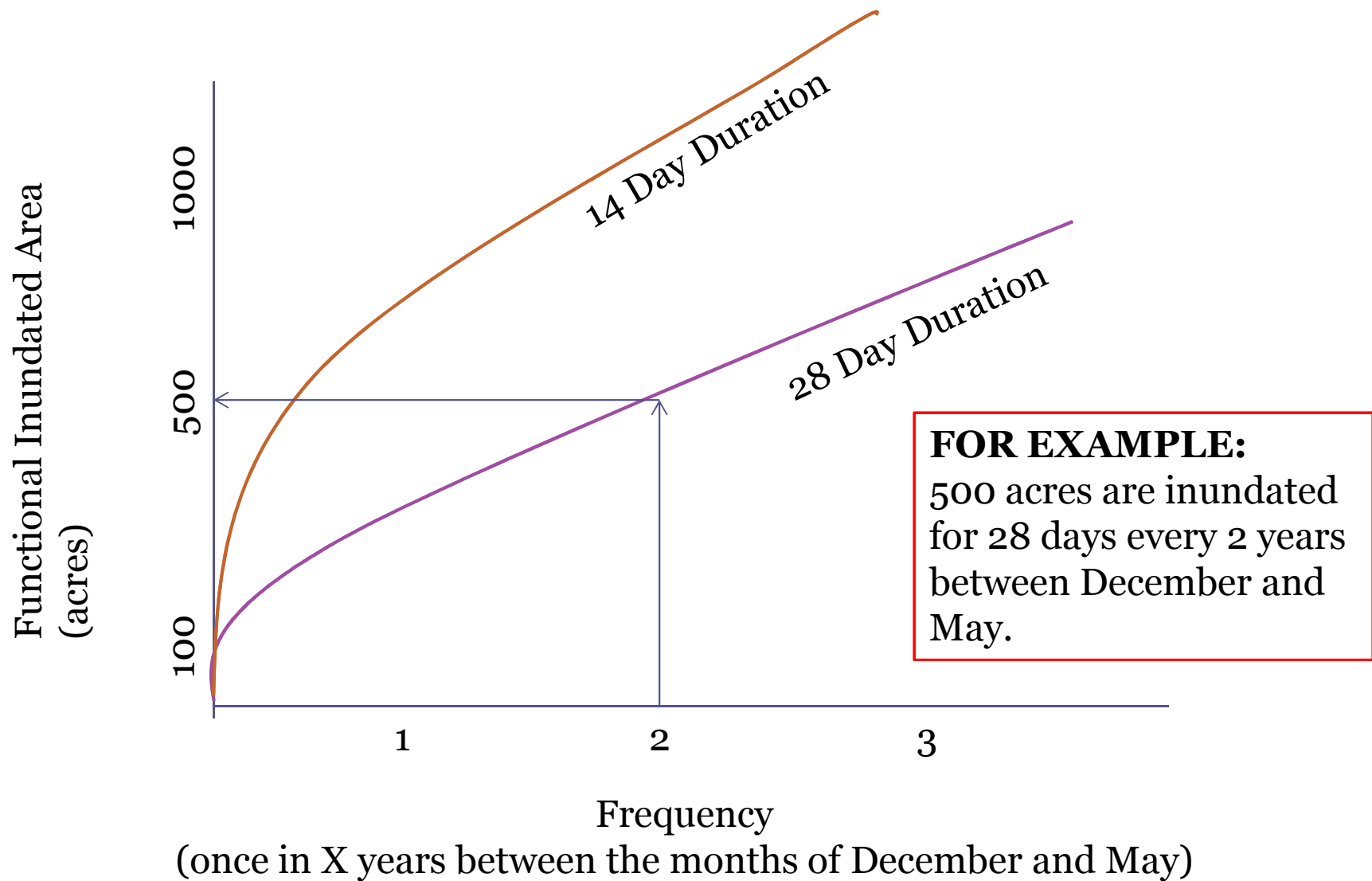
Intensity-Duration-Frequency Curves in Hydrology



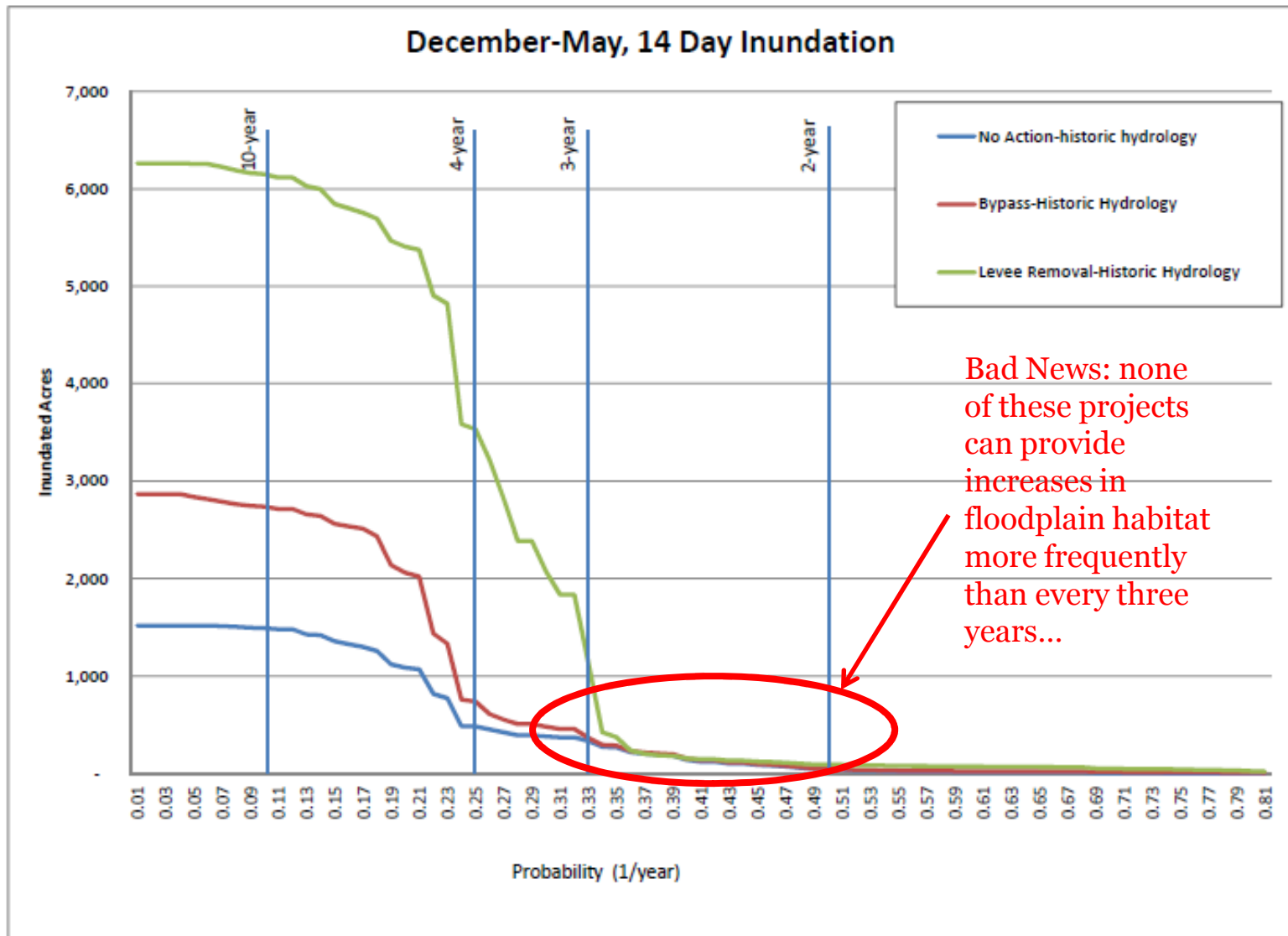
Area-Duration-Frequency Curves for Habitat?



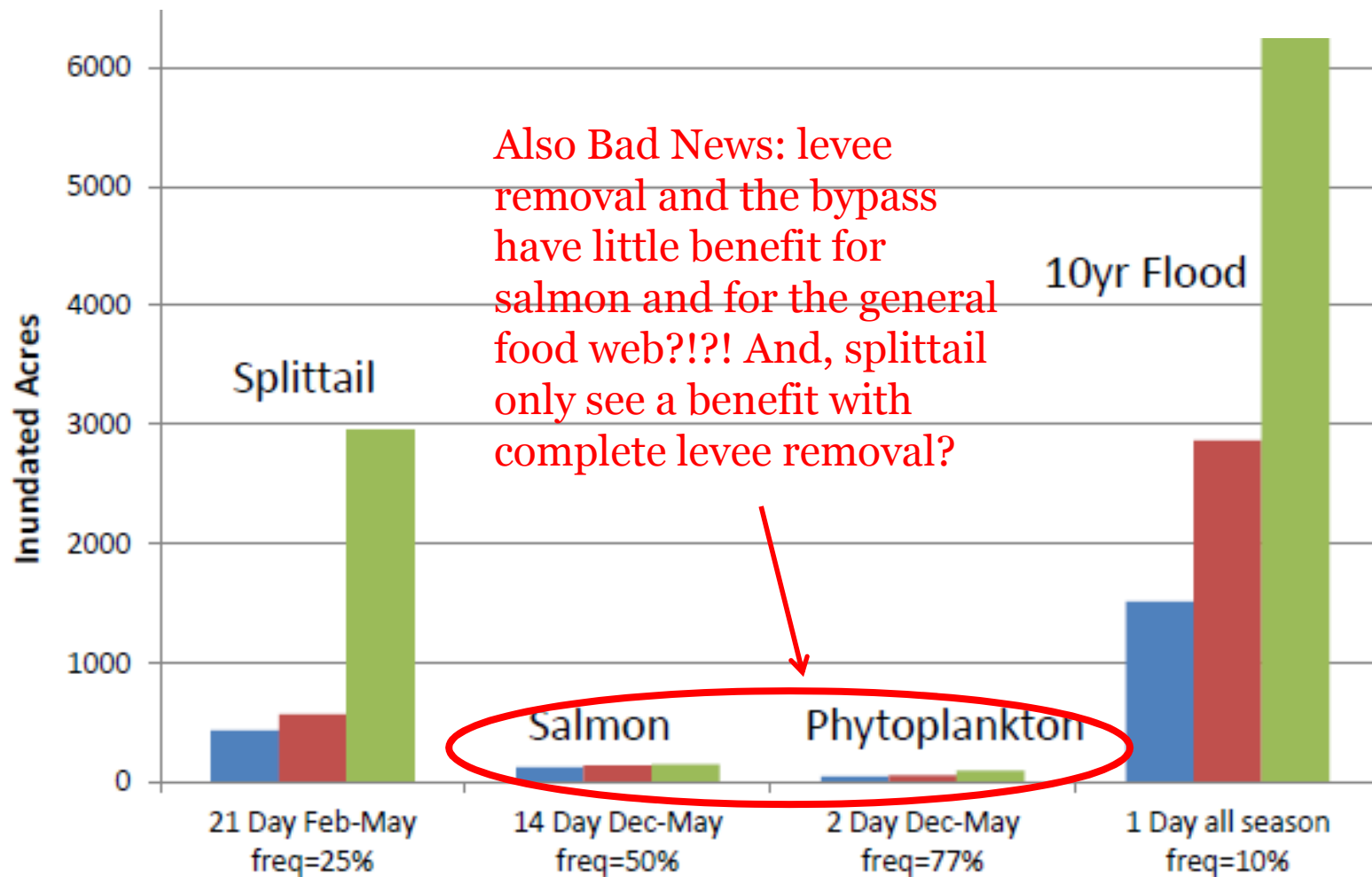
# Develop ADF Curves



# Comparing Alternatives: Ecosystem Results

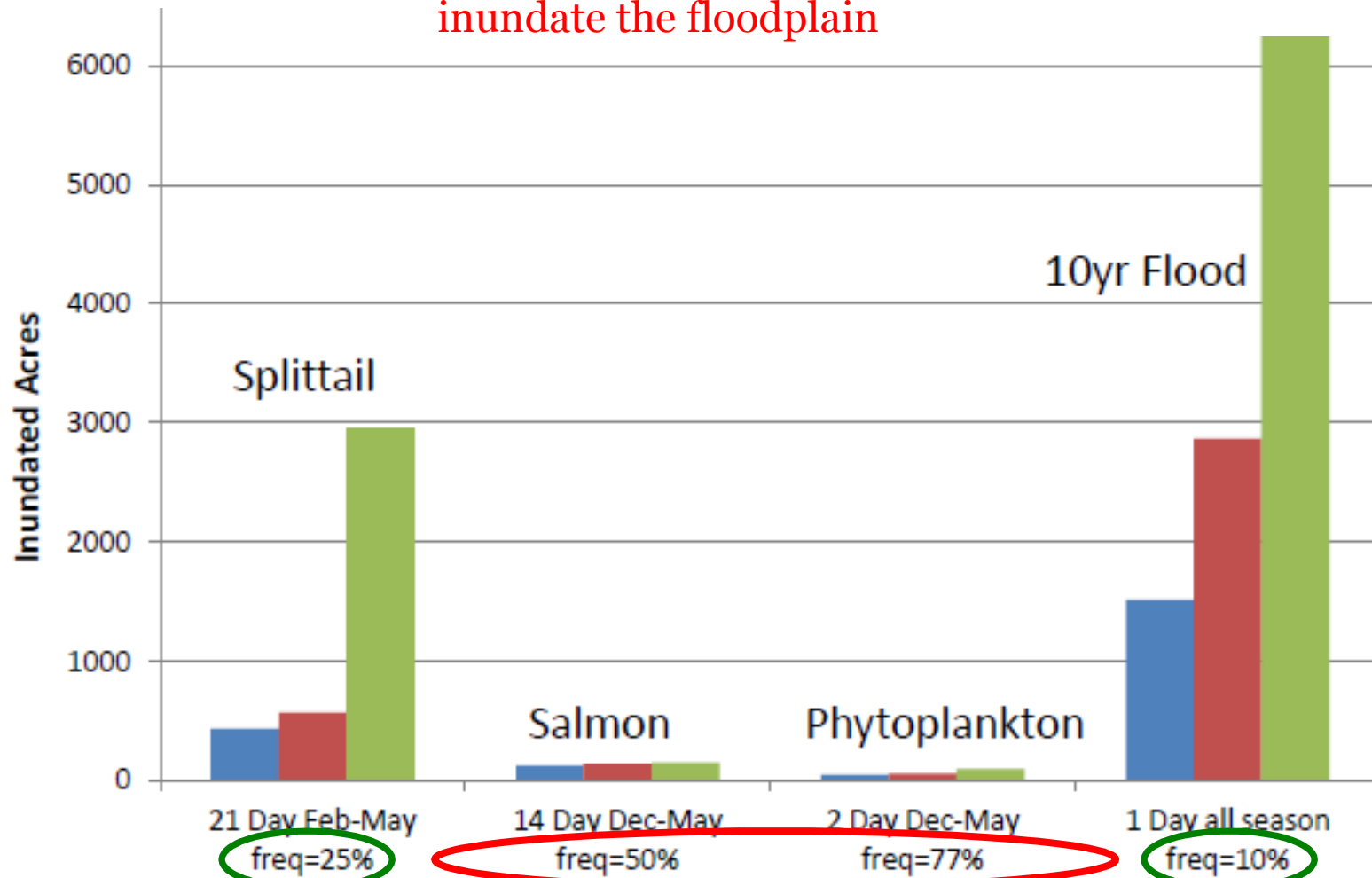


# Ecosystem Results



# WHY?!?!?

The answer is the  
**FREQUENCY** of flows that  
inundate the floodplain



# Eco-Benefit Conclusions

1. Under existing hydrology, the project does not provide substantial habitat benefits more frequent than every two years.\*\*\*
2. While changing the physical footprint of the river and floodplain is important, so is changing the inflow hydrology.

\*\*\*This is really important

# Can We Change Hydrology?



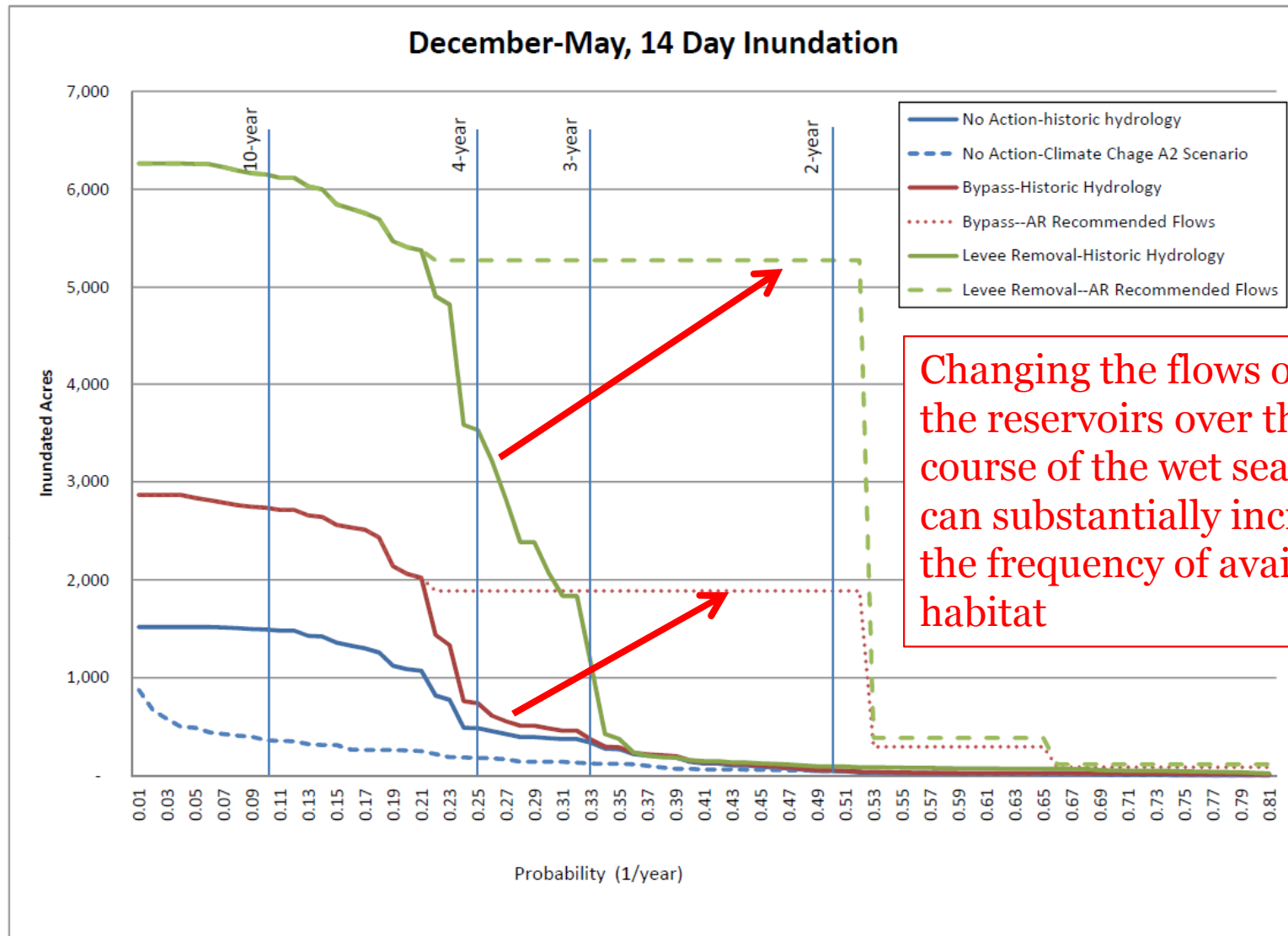
Yes, because the entire Lower San Joaquin River system is regulated by reservoirs.

And if we do, what possible changes do we make to water supply reliability?

And how might our increased flood conveyance impact the flood reservation in the reservoirs?

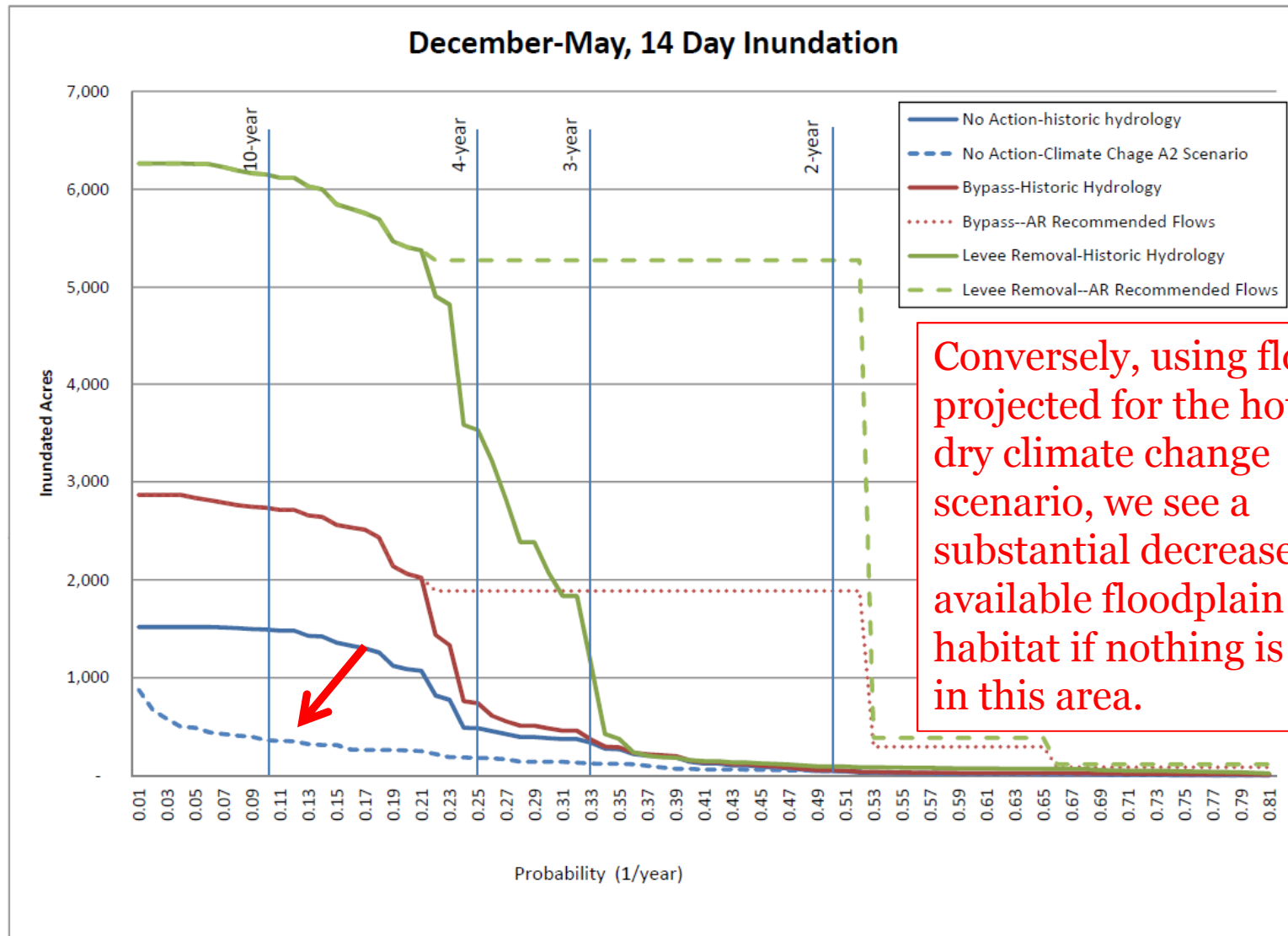
HEC-EFM

# Changing the hydrology



Changing the flows out of the reservoirs over the course of the wet season can substantially increase the frequency of available habitat

# Changing the hydrology

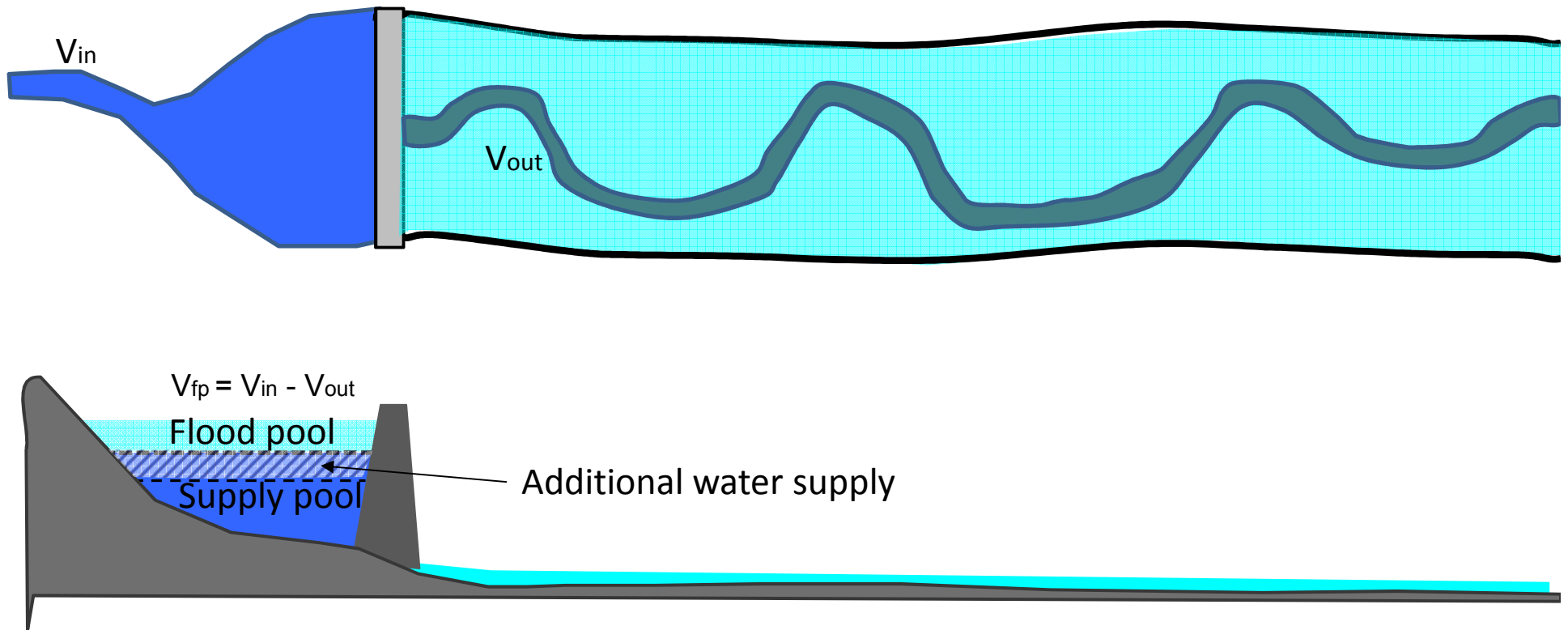


# Water Supply Benefits

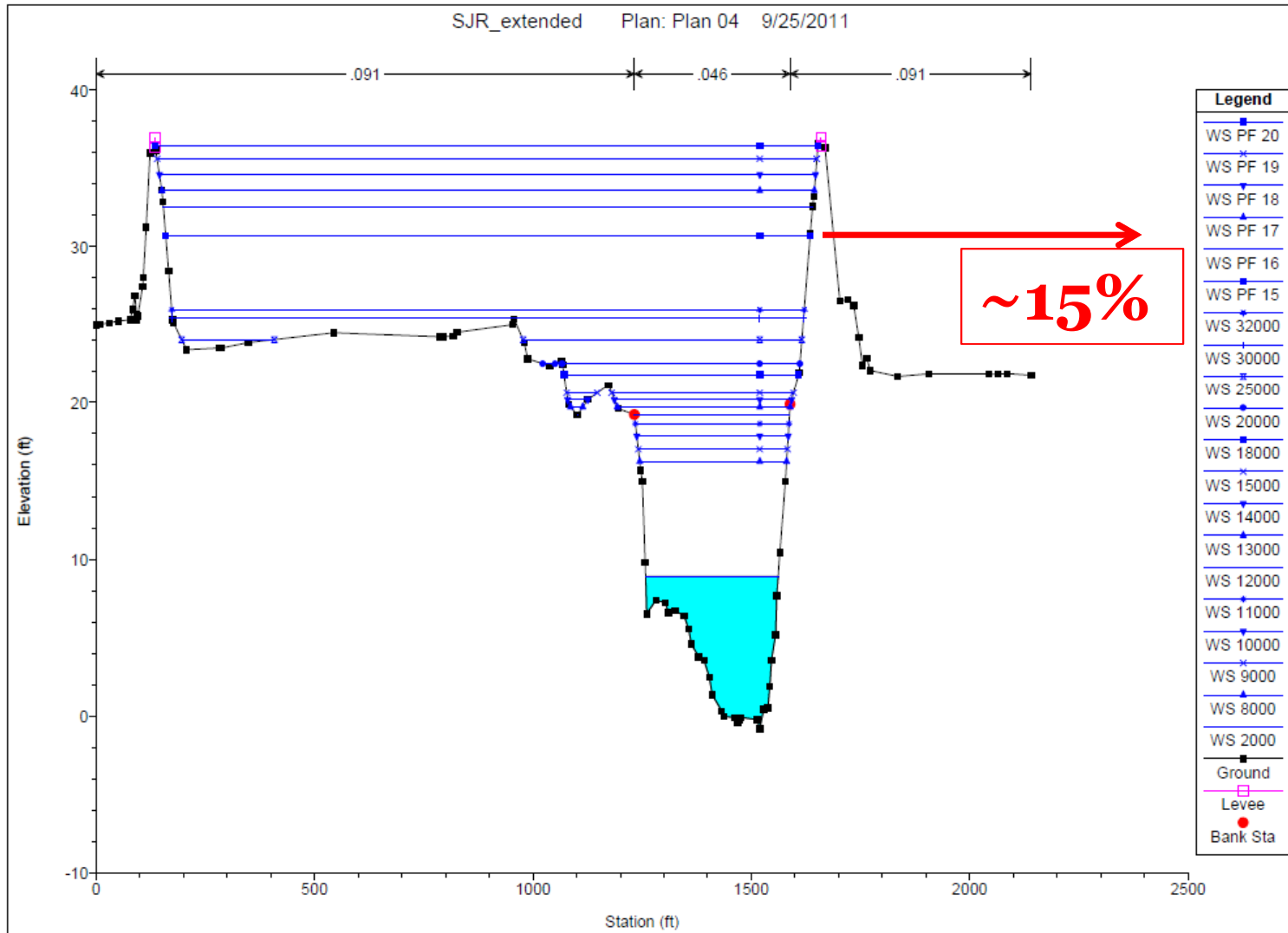


# Water Supply Benefits

If downstream capacity allows larger releases, the flood pool can be smaller -- leaving more water in the supply pool



# Increased conveyance ?



# Conclusions

1. Study in Method (issues with hydrologic timescales)
2. Duration and frequency must be considered in habitat analysis
3. In this case, floodplain restoration must also include changes to the inflow hydrology
4. Need way to assess process based restoration
5. In do-nothing scenario, flood risk increases and ecosystem function decreases perpetually into the future

# Thank You

Especially to Mary Matella, John Cain, Mark Tompkins & Eric Ginney

