

Hydrologic regime: a tool for floodplain restoration

North Delta Workshop

November 18, 2009

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(with special thanks to Andy Collison)

Overview

- Broad context
- Analysis of activated floodplains in the lower Sacramento Valley
- Key questions and uncertainties

Broad Context

Restoration of floodplain function

- Conceptual models (e.g., DRERIP)
 - Fill information gaps
 - Address key questions
- Key component: *Floodplain* hydrologic regime
 - Inform large-scale restoration planning
 - Contribute to restoration plan design
 - Aid in project-scale monitoring design
 - Supplies a programmatic-scale monitoring indicator

Broad context

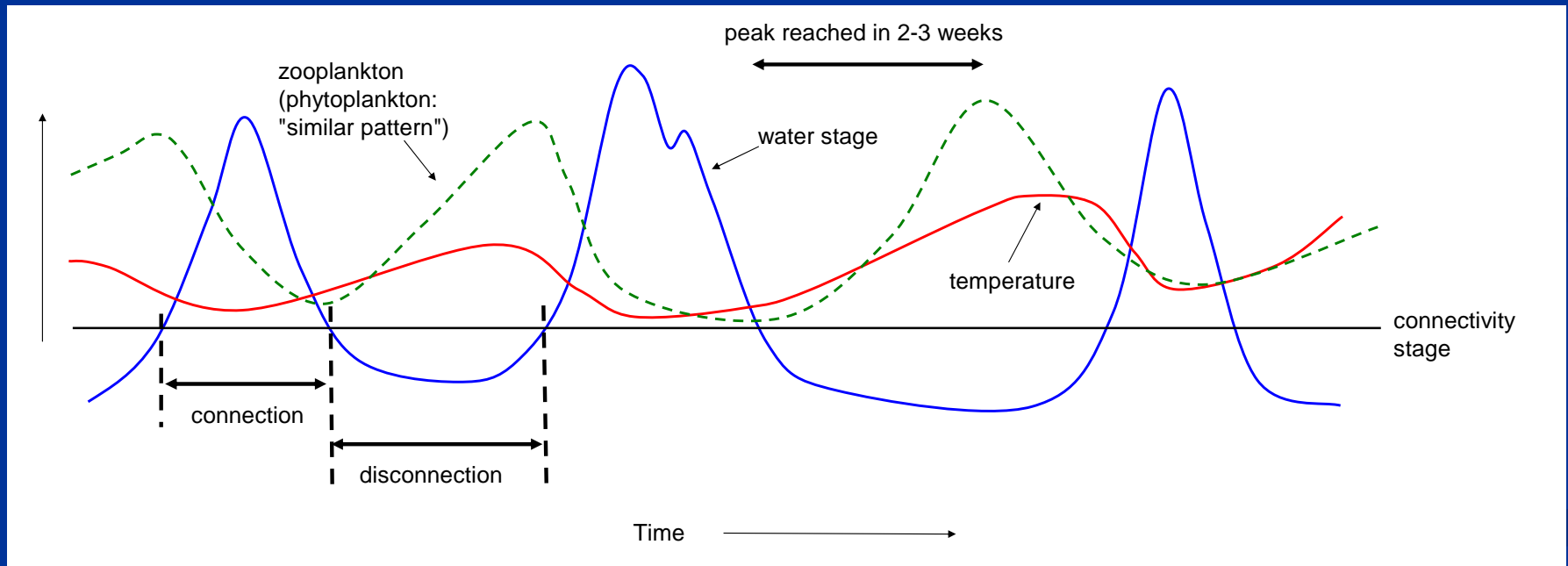
- Floodplains are not just a landscape.

They need a hydrologic regime supportive of their ecological functions to provide them.

Floodplains need floods.

Example: floodplain functions

Ahearn et al., 2006: showed the importance of disconnection for delivery of organic material from the floodplain to the river



graphic is a schematic of system function as described by Grosholz & Gallo (2006)

Activated Floodplains

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Quantifying activated floodplains on a lowland regulated river: its application to floodplain restoration in the Sacramento Valley

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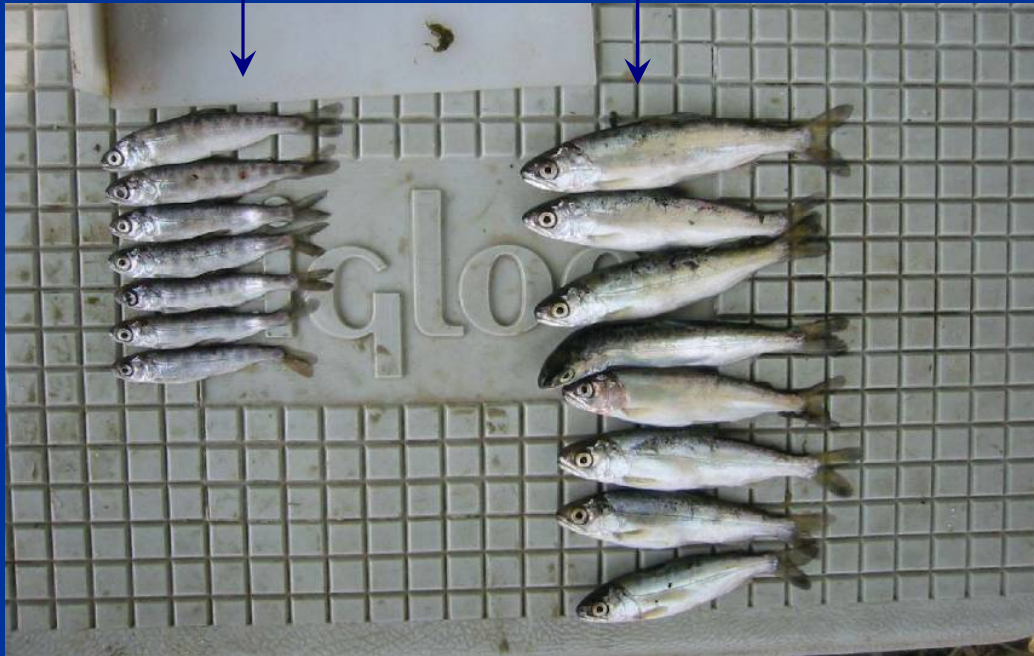
Activated Floodplains

- Activated floodplain \leq frequent, extended springtime inundation
 - Frequent:
 - at least once every 1-3 years (support for native fish population life cycle requirements, regular ecosystem benefits)
 - Extended:
 - long enough to provide a significant boost to food web support (2 days – 2 weeks minimum) and possibly native fish spawning ($> \sim 1$ wk for splittail) to as much as 6-8 weeks for rearing
 - Springtime:
 - Warm enough/ late enough to trigger growth of phytoplankton, zooplankton but not exceed temperatures tolerated by native fish;
 - Timing of opportunity for native fish use for spawning and/or rearing;
 - Timing of opportunity for establishment of seedbed conditions and flood-delivered native plant seeds or rooting material
 - February – May, March – April ideal

Activated Floodplains

Fish reared
in-channel

Fish reared on
floodplain



Photographic image provided by Jeff Opperman

**= fish habitat & food
web support!**

e.g., a doubling of outmigrating
smolt weight = 20 times
greater escapement rate

Floodplain Activation Flow (FAF) Approach

Methodology, as applied in the lower Sacramento Valley pilot study:

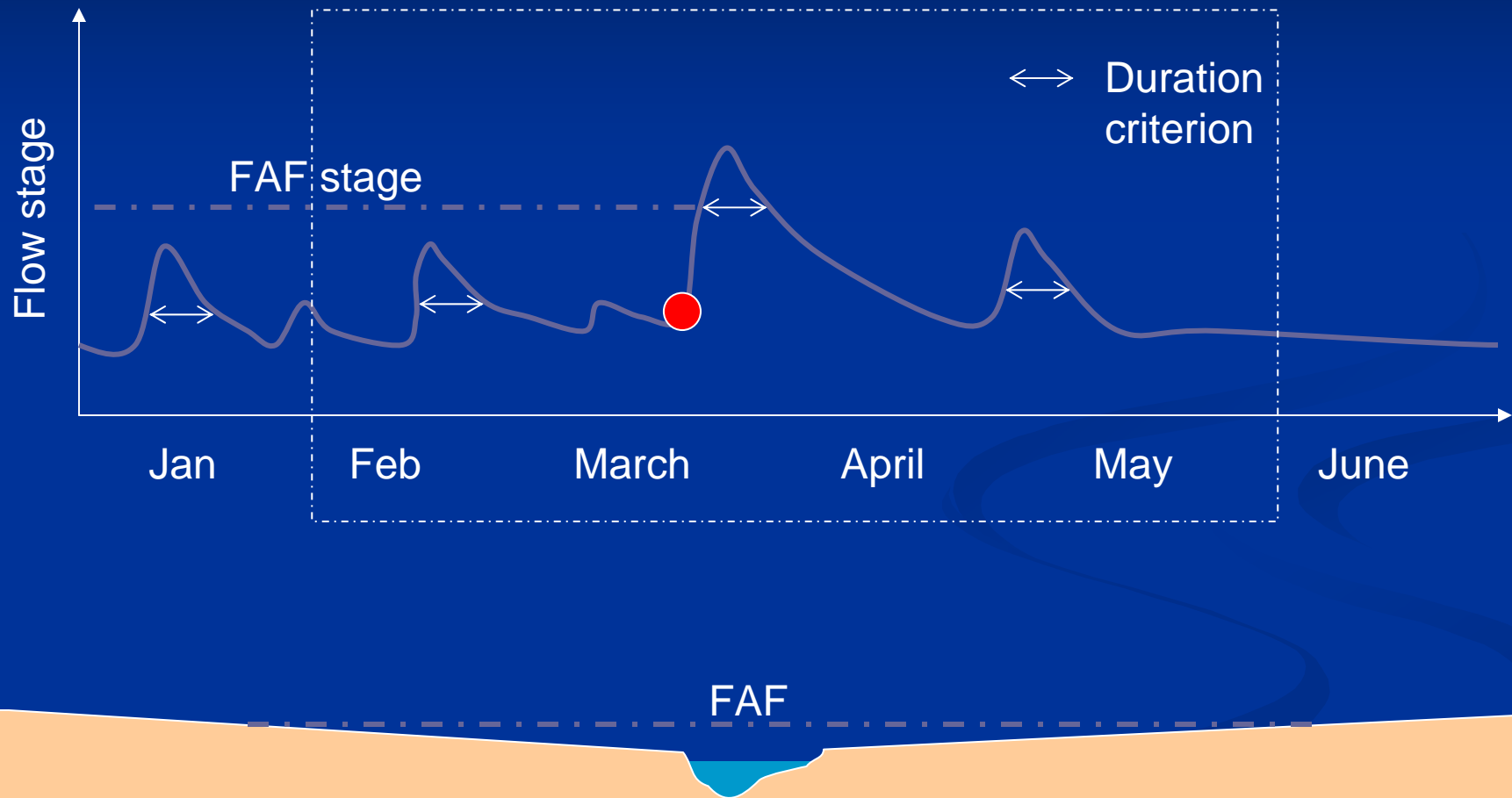
Identify the flood elevation that occurs frequently enough, and for long enough to trigger significant nutrient production for native fish, provide rearing habitat, and to allow splittail spawning... *if it inundates a floodplain.*

Approach

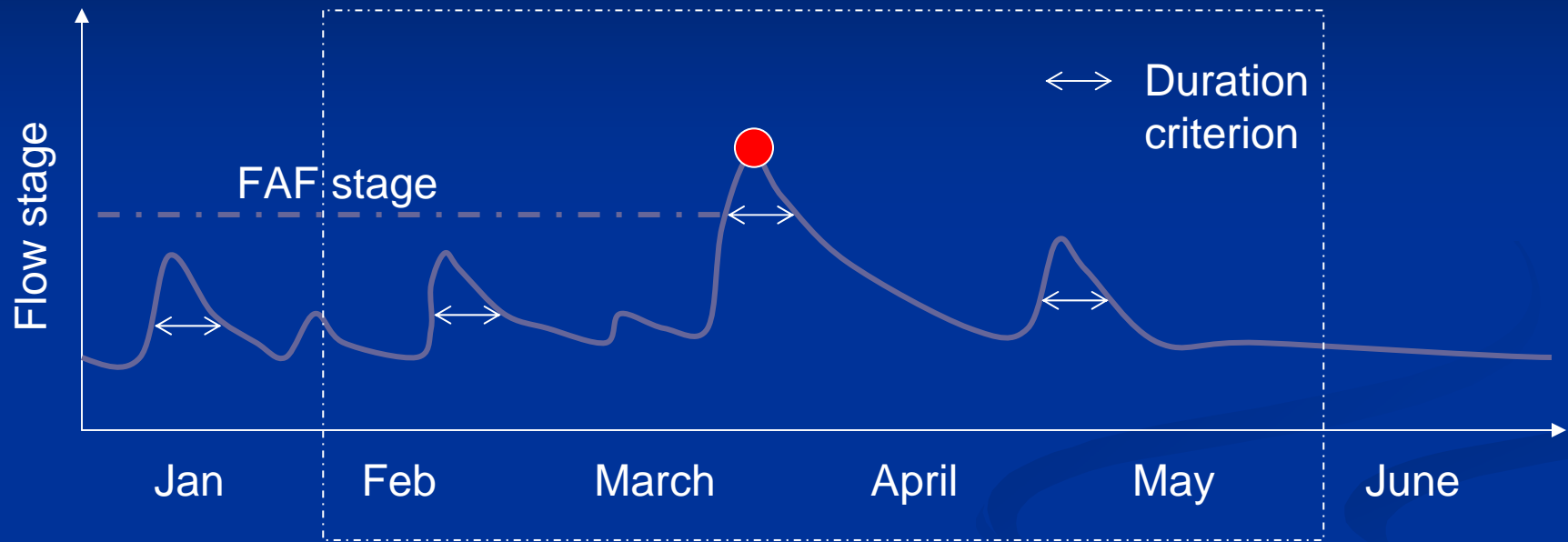
- Identify the stage associated with the representative flood condition sought –
- and then locate the floodplains inundated by it.

Use the flood to find the floodplain.

Defining the Floodplain Activation Flow



Defining the Floodplain Activation Flow

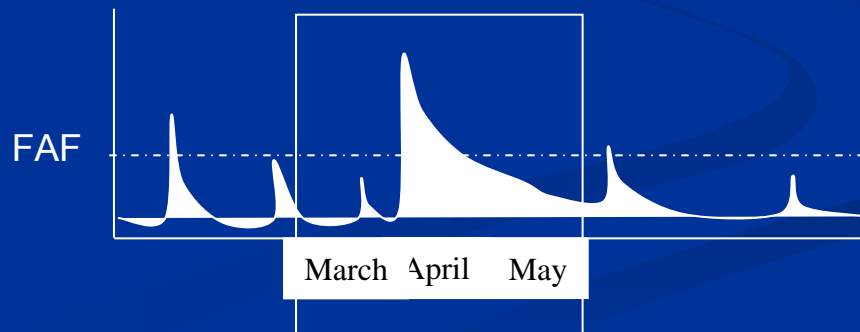


FAF

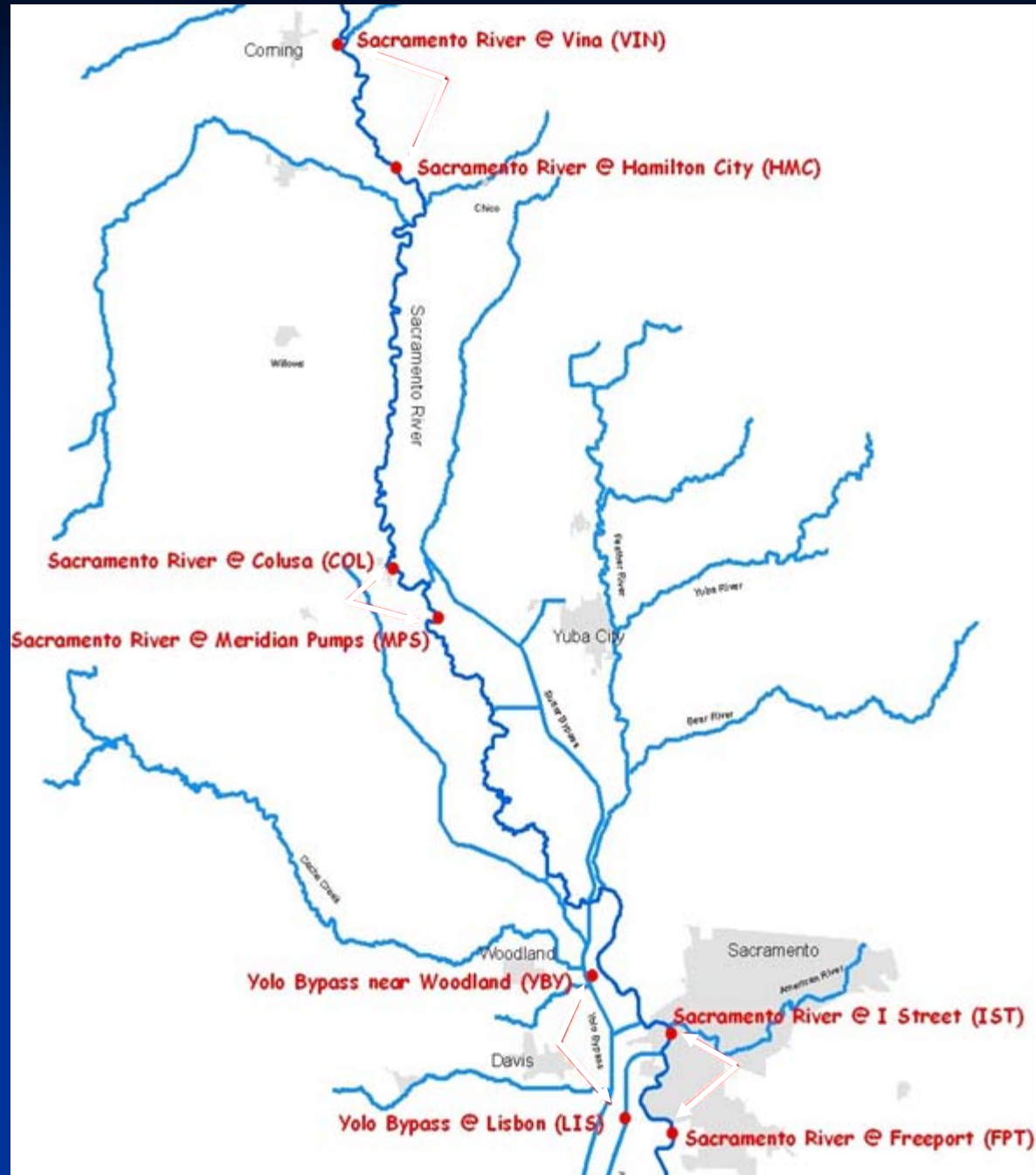
Floodplain Activation Flow (FAF) Approach

FAF pilot project criteria:

- **TIMING:** Occurs between March 15 - May 15
- **DURATION:** At least a 7-day duration of continuous connectivity
- **FREQUENCY:** Equaled or exceeded 2 out of 3 years



Study reaches



Results – Vina to Hamilton City

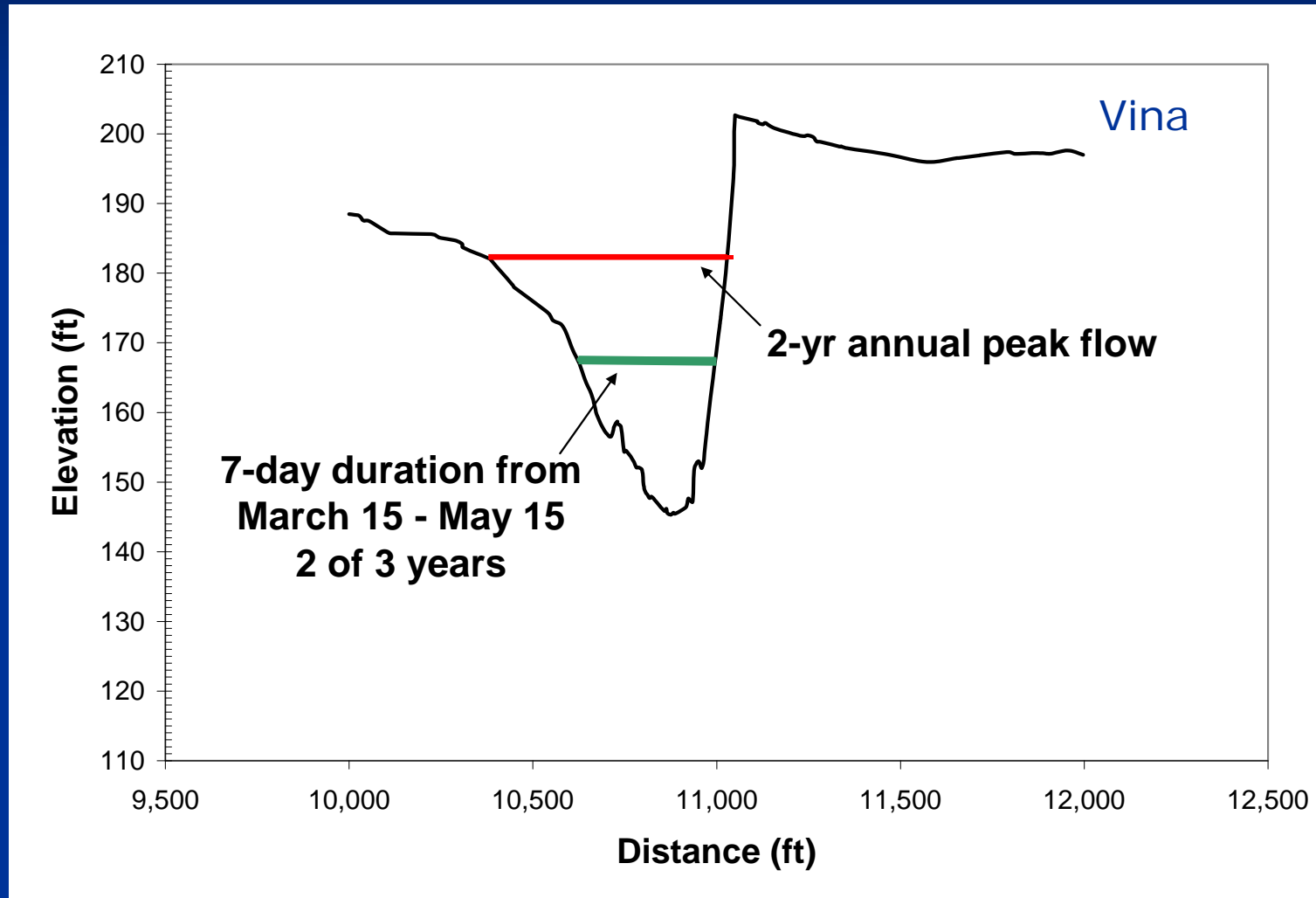


Area inundated by the FAF
(acres)

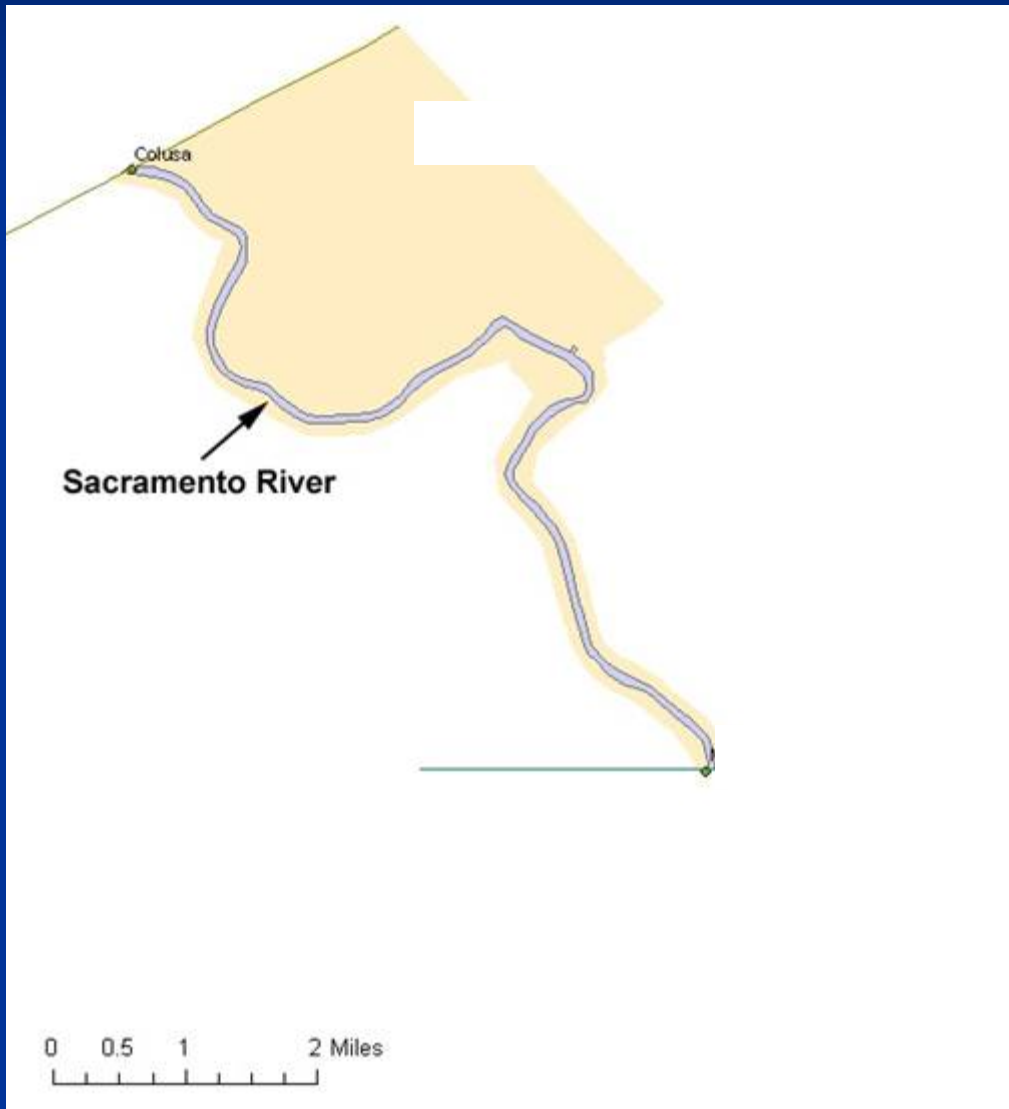
Total:	1380
Estimated:	
In channel	Out of channel
1160	220

area estimated to be
inundated during a FAF
event is shown in blue

Results – Vina to Hamilton City



Results – Colusa to Meridian Pumps

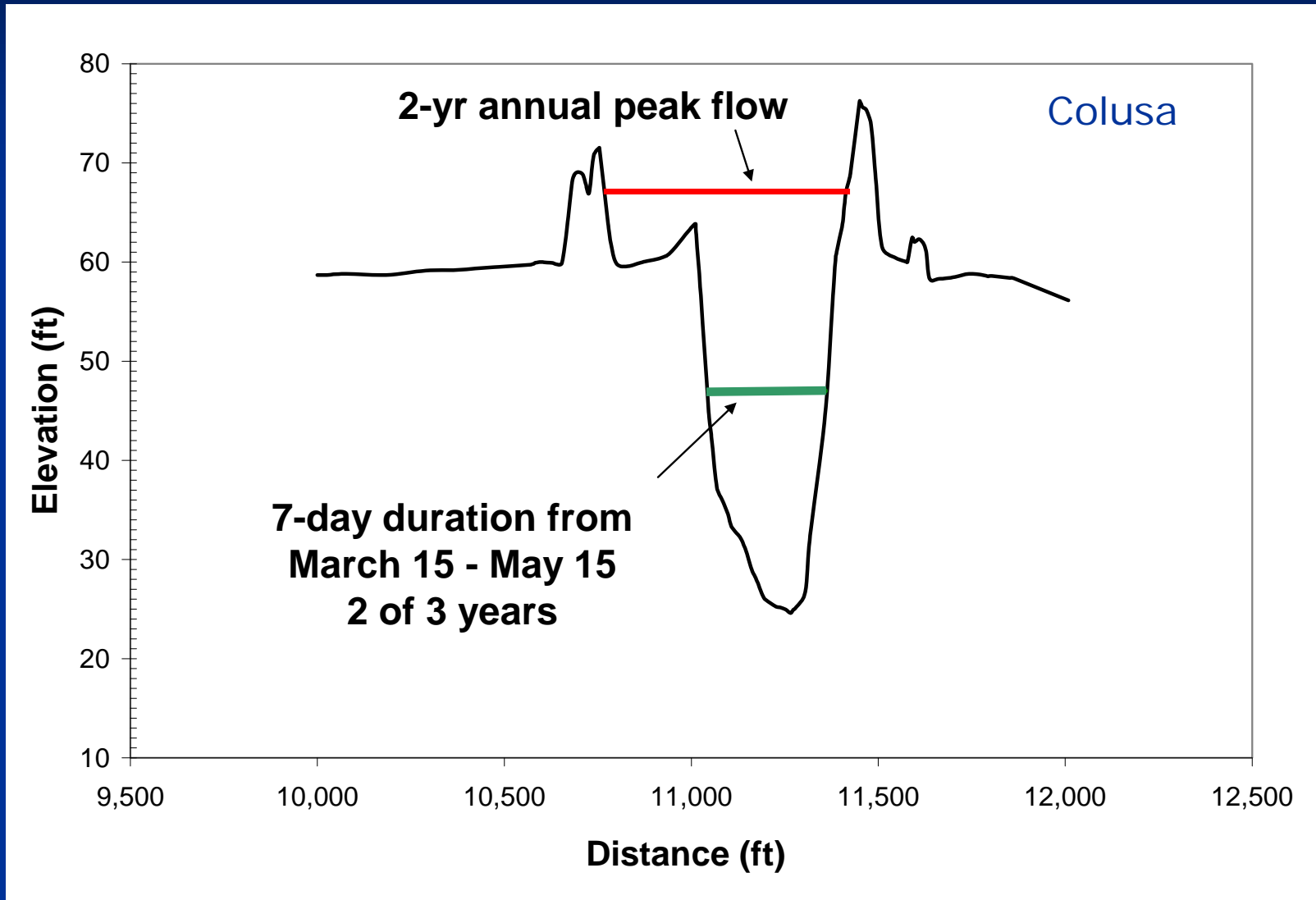


Area inundated by the FAF

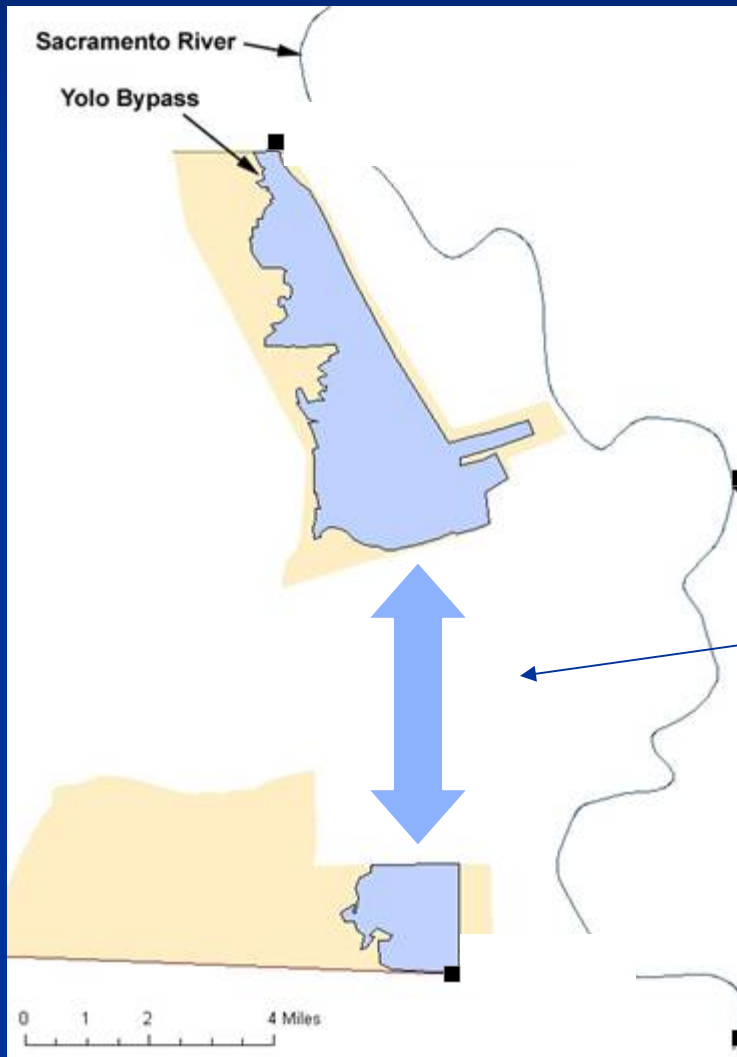
(acres)

Total:	360
Estimated:	
In channel	Out of channel
360	0

Results – Colusa to Meridian Pumps



Results – Yolo Bypass



Area inundated by the FAF

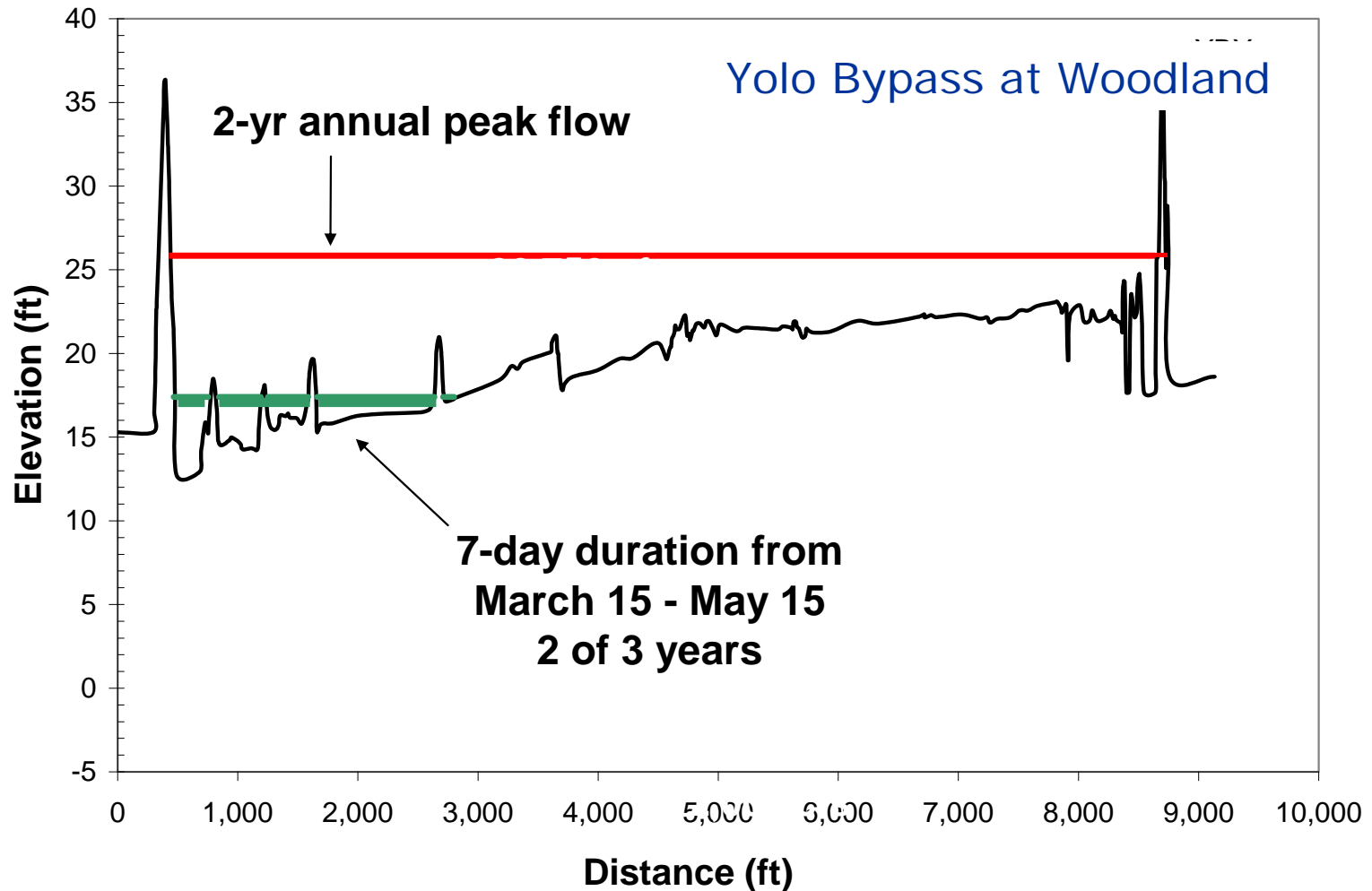
(acres)

Total:

8,500+

topography was not yet available for this reach

Results



Sensitivity analysis

Sensitivity test of criteria as applied at Colusa

	Period	Frequency	FAF Stage Elevation (m)
7-Day Duration	March 15 - May 15	2 out of 3 years	14.3
7-Day Duration	March 15 - May 15	<i>1 out of 3 years</i>	16.2
7-Day Duration	<i>January - June</i>	2 out of 3 years	16.5
<i>3-Day Duration</i>	March 15 - May 15	2 out of 3 years	15.6
<i>14-Day Duration</i>	March 15 - May 15	2 out of 3 years	13.9

Conclusions

1. Under present conditions there is negligible FAF (activated) floodplain along the Sacramento River in the study reaches, while significantly more is present in the Yolo Bypass study reach.
2. There is tremendous physical potential to increase activated floodplain area within the Yolo Bypass.
3. Floodplain restoration projects within and between the Sacramento study reaches would likely require flow releases, changes to hydraulic control structures, levee modification, and/or floodplain excavation to increase the extent of the FAF floodplain.

Key questions and uncertainties: activated floodplain

- How much activated floodplain is needed for fishery and foodweb support to help put listed aquatic species on pathways to recovery?
- What are the appropriate hydrologic regime criteria for floodplain activation? Do these differ significantly by location?
- Where in the landscape *should* activated floodplain be restored?
- Are there other readily accessible criteria that should also be used to assess expected functionality?
- How will future modified operations and flood system configuration change our opportunities to restore activated floodplain?

Key questions and uncertainties: activated floodplain

Possible strategies to address questions:

1. Broaden the geographic area of analysis to identify the best opportunities and use hydraulic models to interpolate between available gauge locations.
2. Include experimental design within floodplain restoration sites and monitor for comparative productivity under differing hydrologic regimes.
3. To the extent we have data to construct them, use models (hydrodynamic, water quality, foodweb, fish population) to better understand the relationships between these ecosystem components.

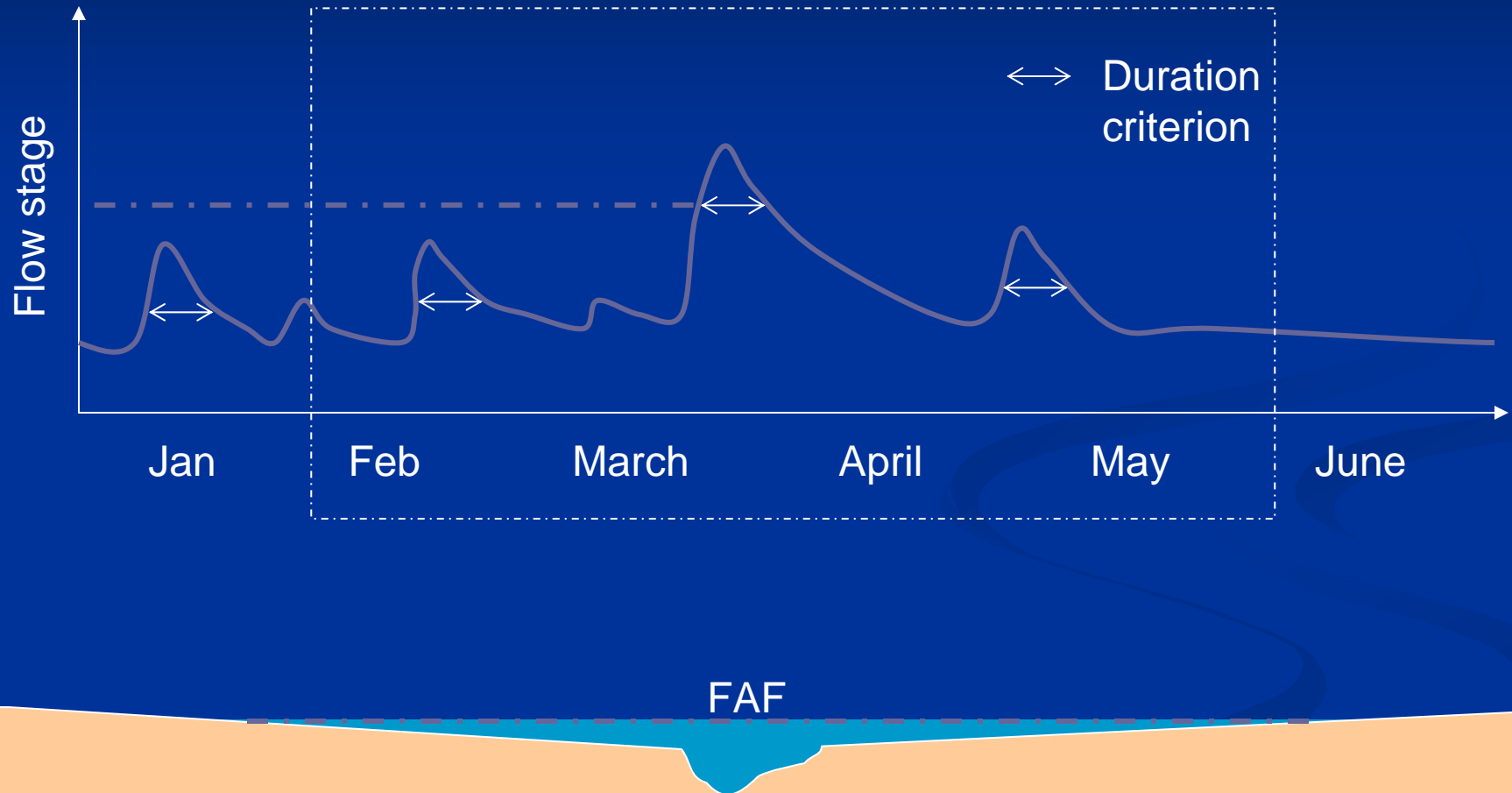
Key questions and uncertainties: activated floodplain

Strategy to address uncertainty

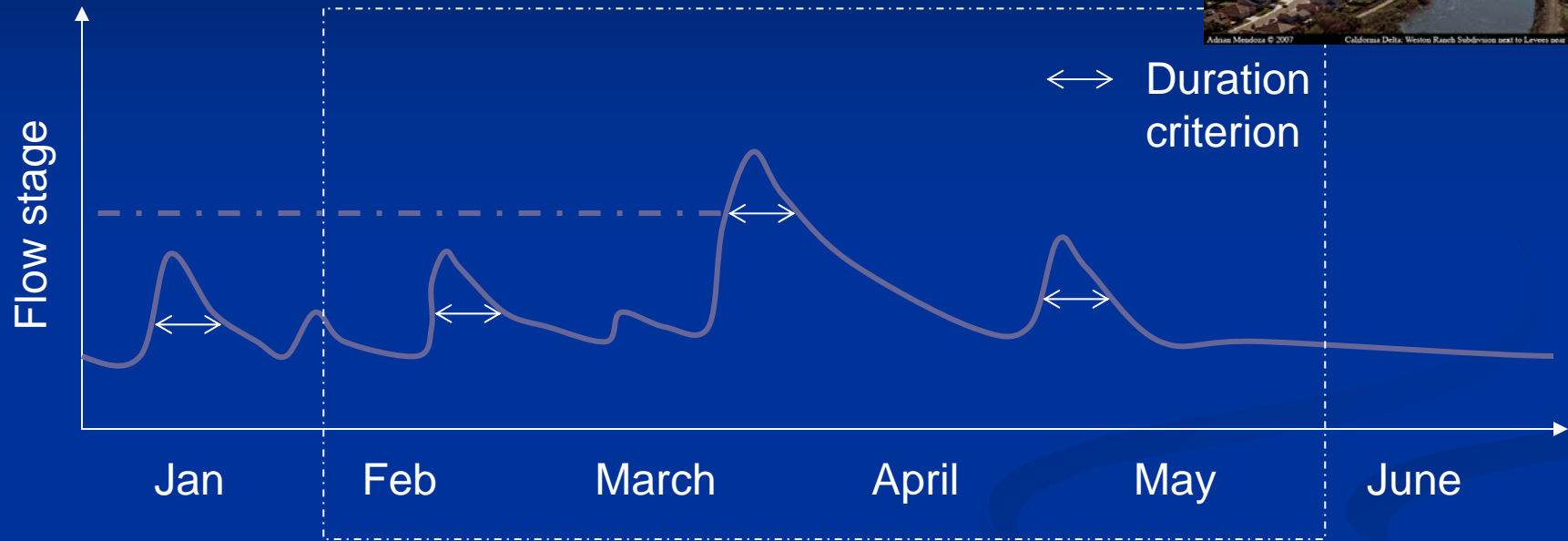
- Develop design approaches that are resilient: they assume we don't know exactly what the needed hydrologic regime is or what future hydrologic conditions will be, or what conditions fish prefer.

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Loss of active floodplain due to...



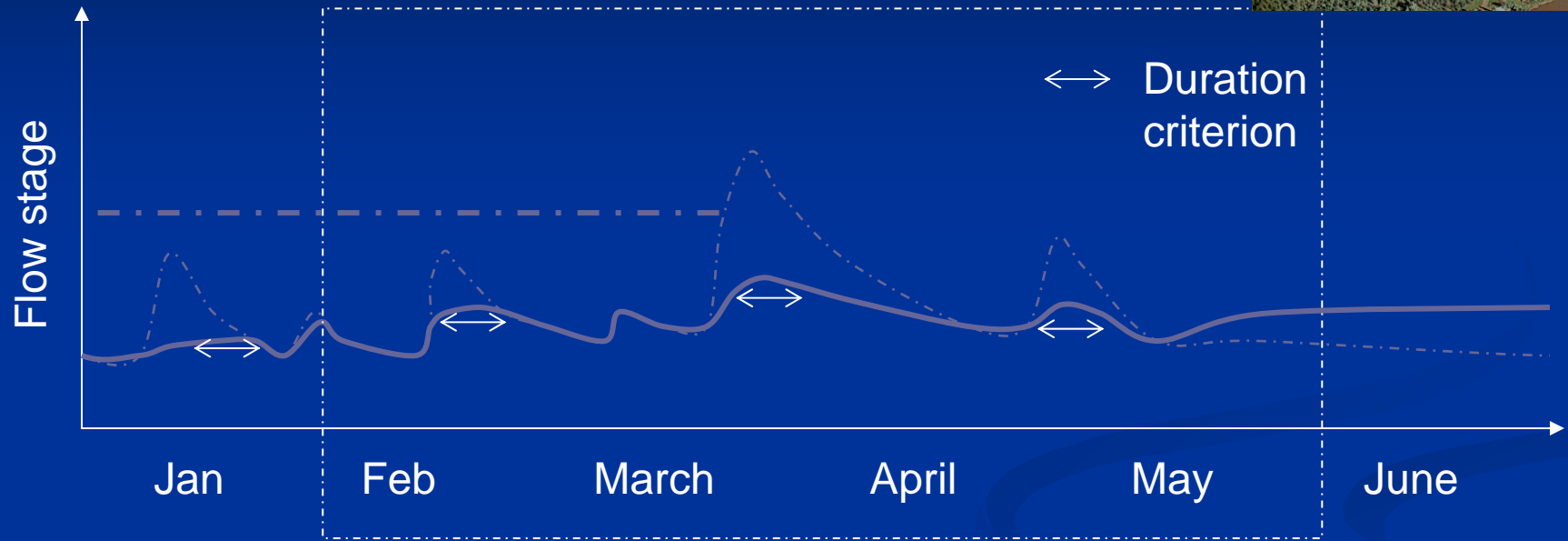
levees,



FAF

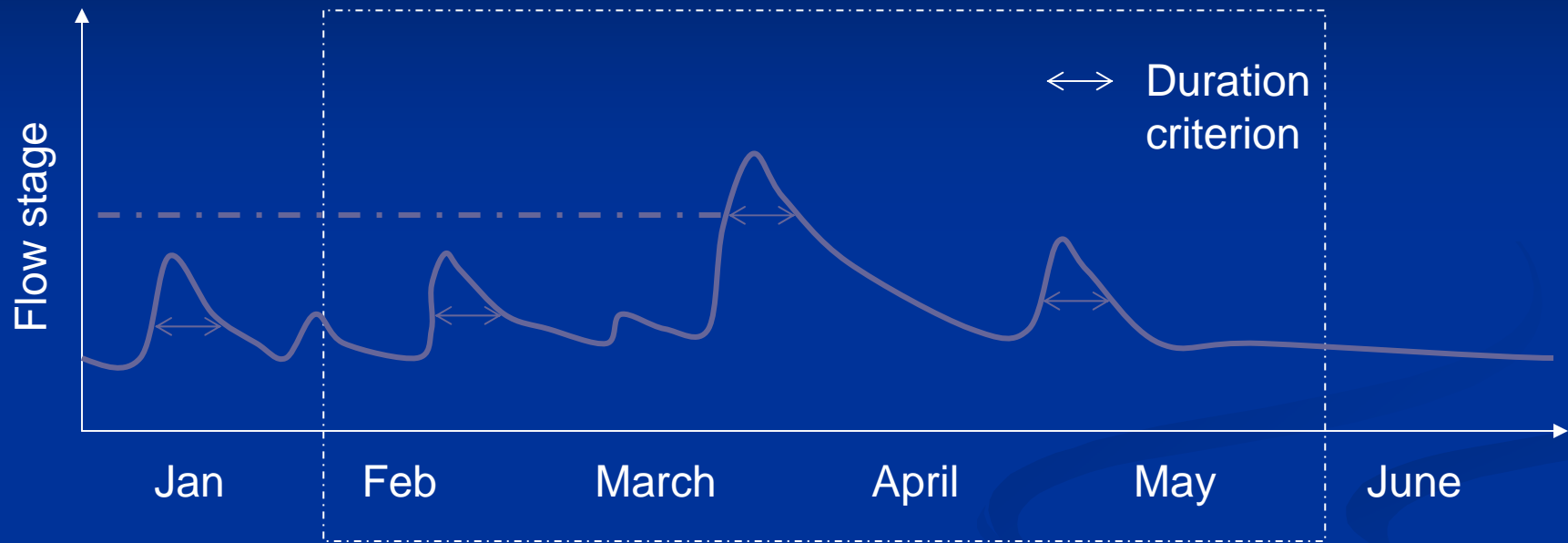
A cross-sectional diagram of a levee. The levee is shown as a raised embankment with a flat top. The water level is indicated by a dashed line labeled 'FAF' (Freeboard Above Flood). The water level is shown to be below the FAF line, but the levee has a breach in the center, with water flowing through it. The ground below the levee is shown in a light brown color.

flow regulation,



FAF

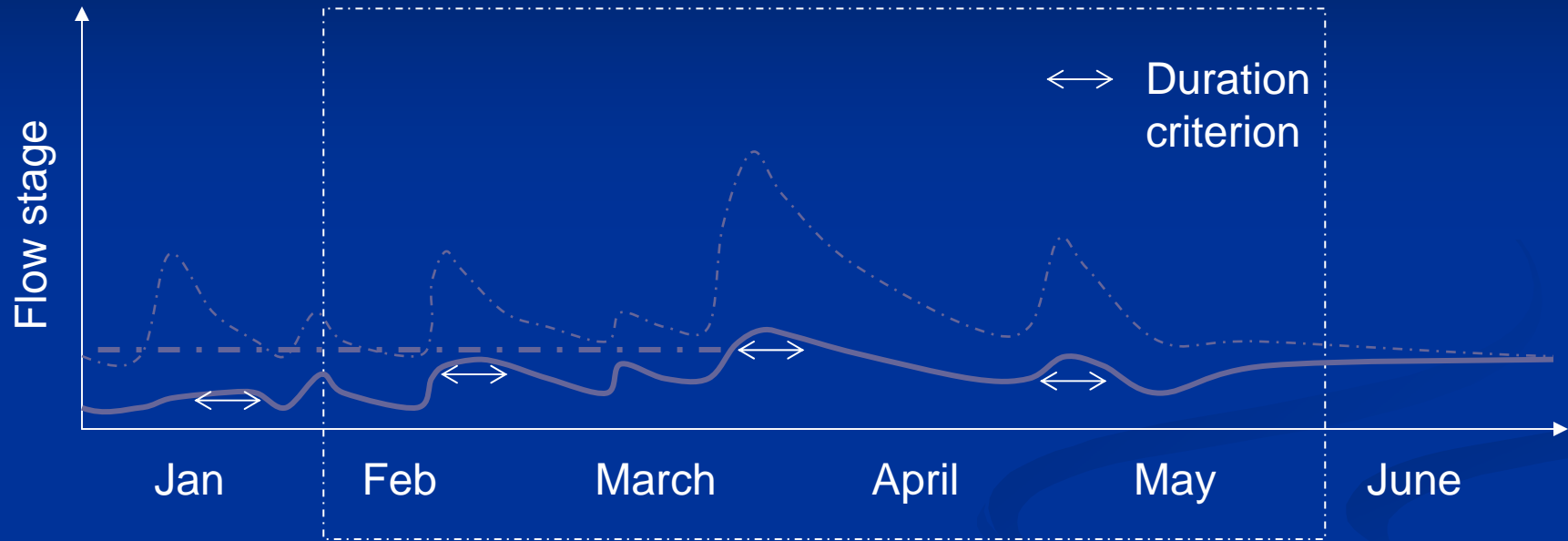
channel incision,



FAF

A cross-sectional diagram of a channel bed. The channel bed is shown in a light orange color. A dashed horizontal line represents the original bed level. A solid horizontal line, labeled 'FAF', represents the current bed level. The channel bed has eroded downwards in the center, forming a V-shape. The water level is shown as a blue area at the bottom of the channel.

...or all three



FAF