Instream Flow:

Why should we care about Fluvial Geomorphology? (Channel Shape)

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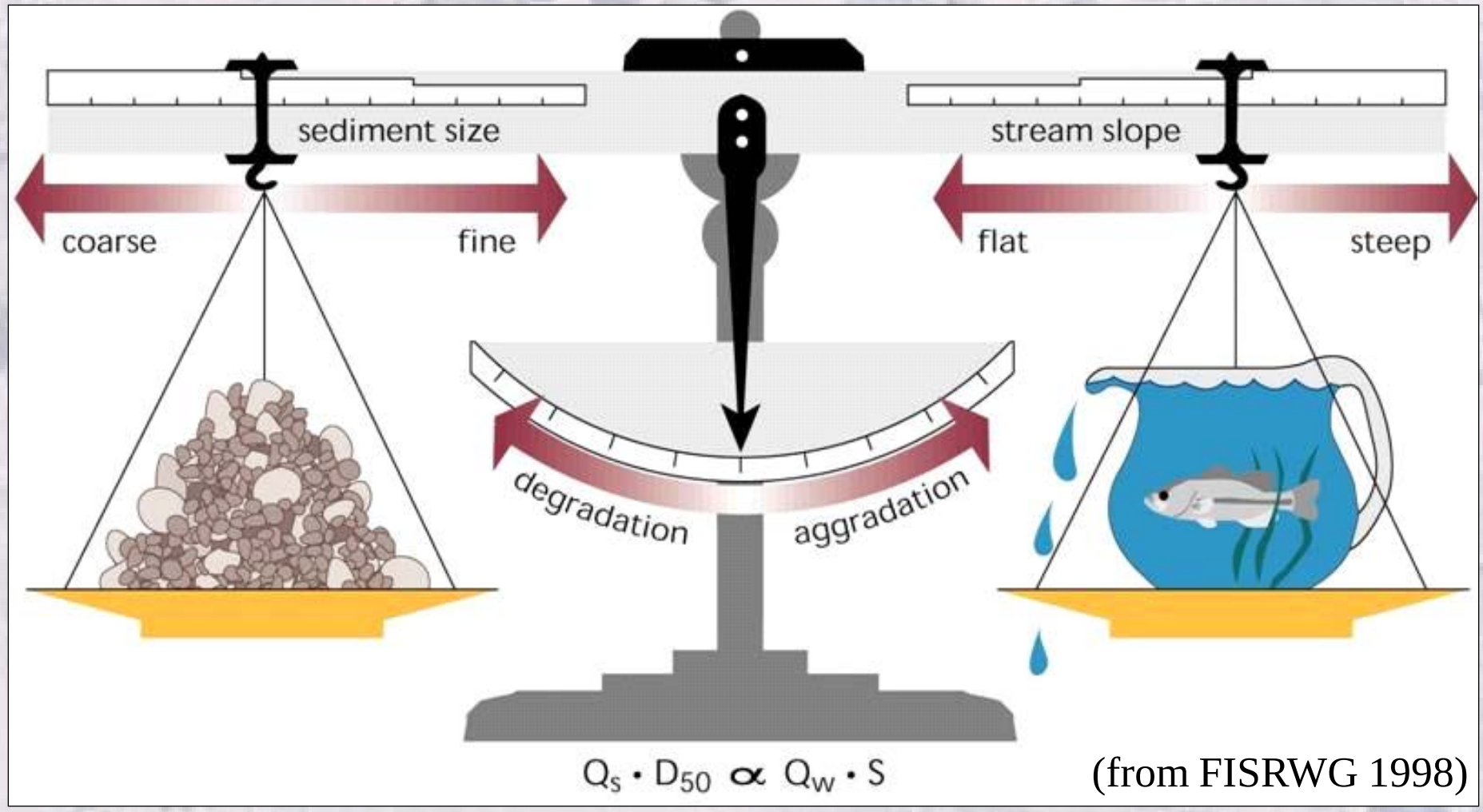
Hydrologist, TWDB

Lane's Diagram

A "stable" stream channel is a balance of sediment and discharge.

"The importance of fluvial morphology in **hydraulic engineering**" (Lane 1955)



(from FISRWG 1998)

Examples

(from Lane 1955)

↑Q

Figure 4. Waterfall on Five Mile Creek, Wyoming, Resulting from Grade Reduction Caused by Increase in Discharge

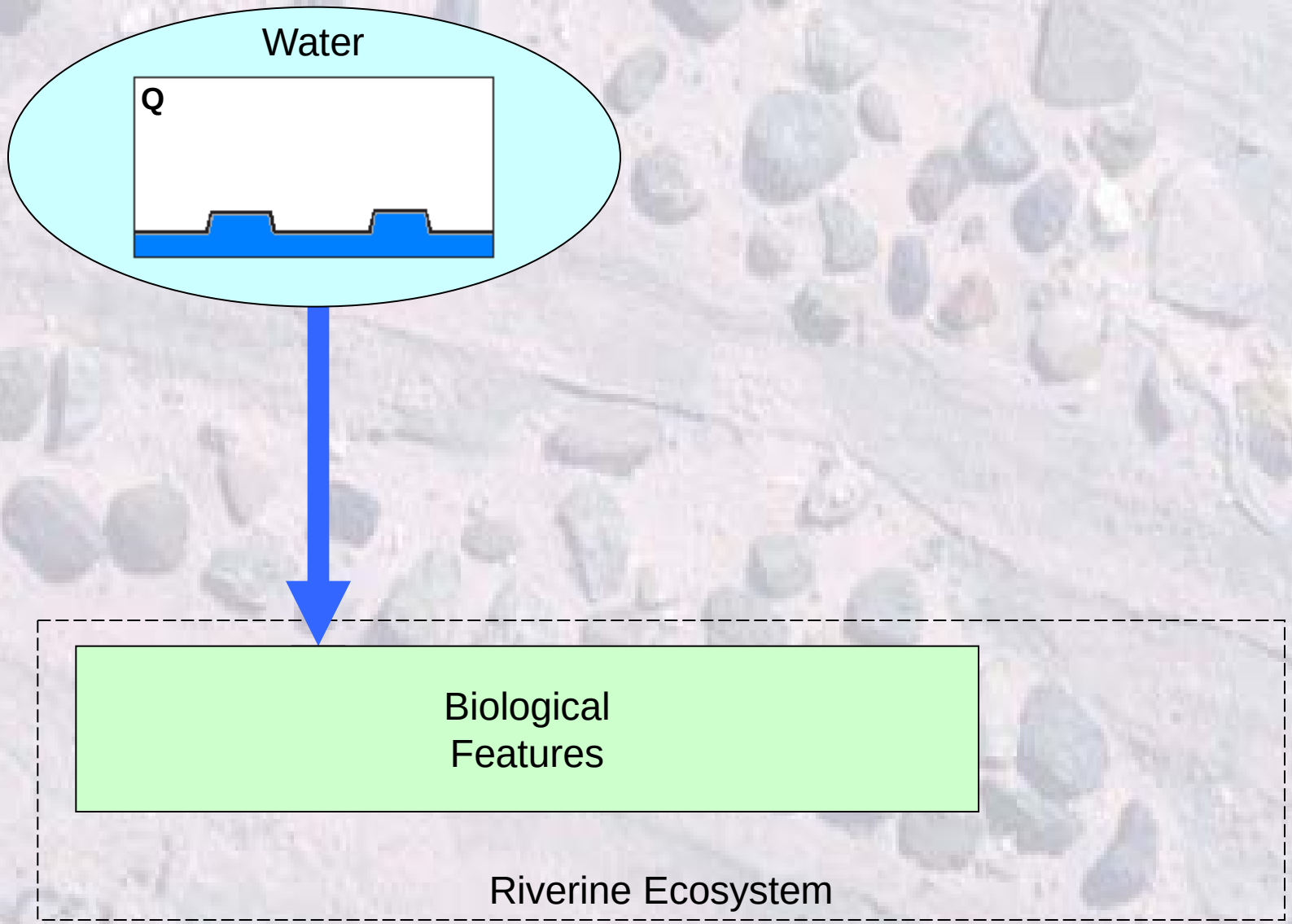
↓S

Figure 3. Degradation below Ft. Sumner Dam on Pecos River in New Mexico

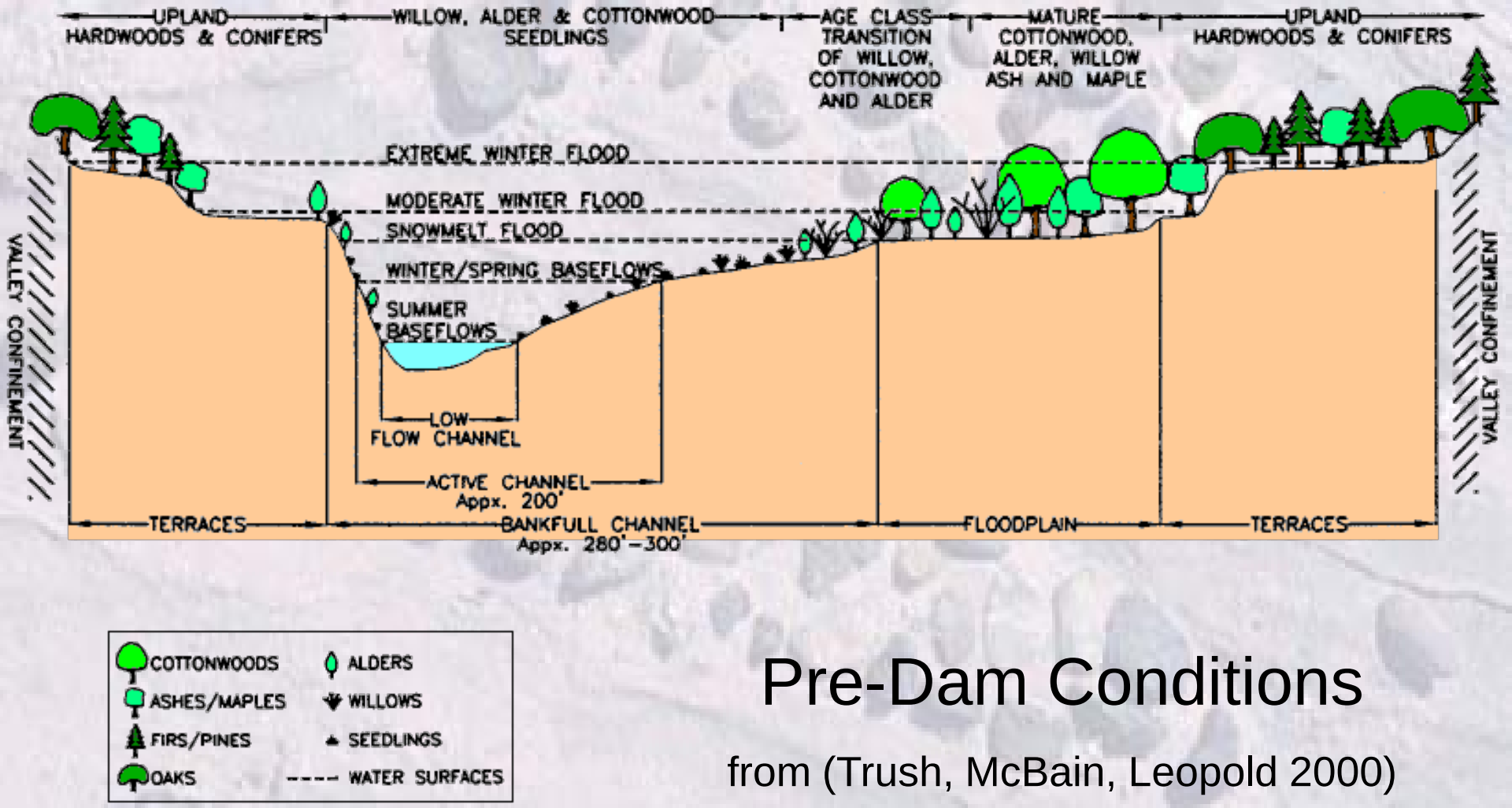
↓S

Figure 5. Bed Lowering in Cherry Creek, Denver, Colorado, Caused by Reduction of Sediment Load

Instream Flow – Old Paradigm



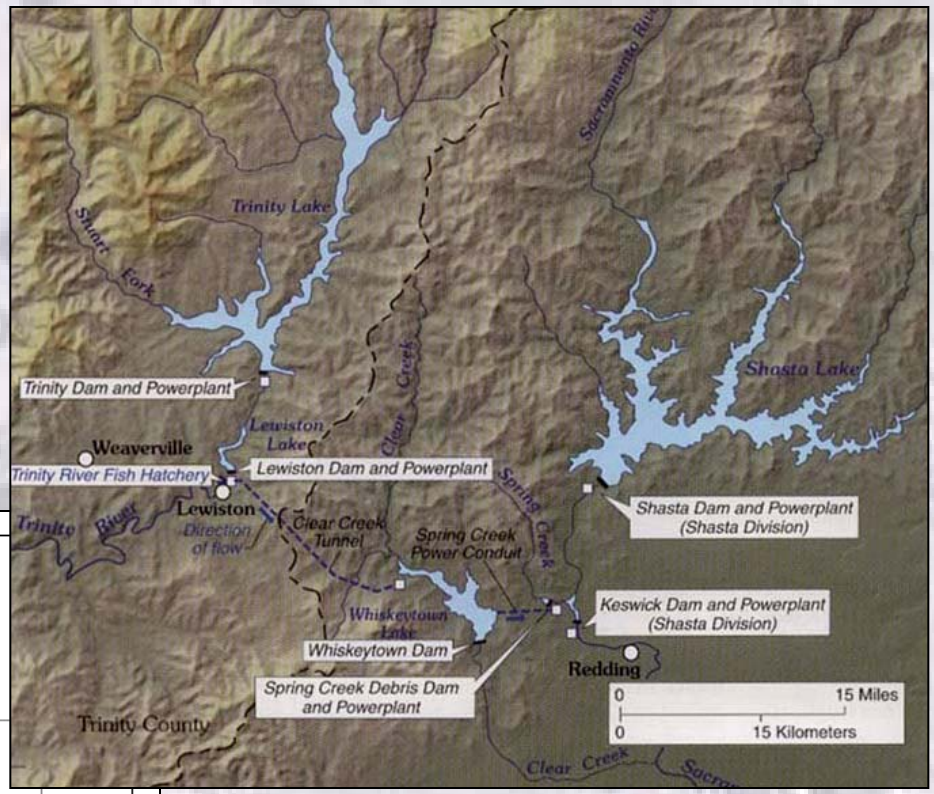
Trinity River Basin, CA



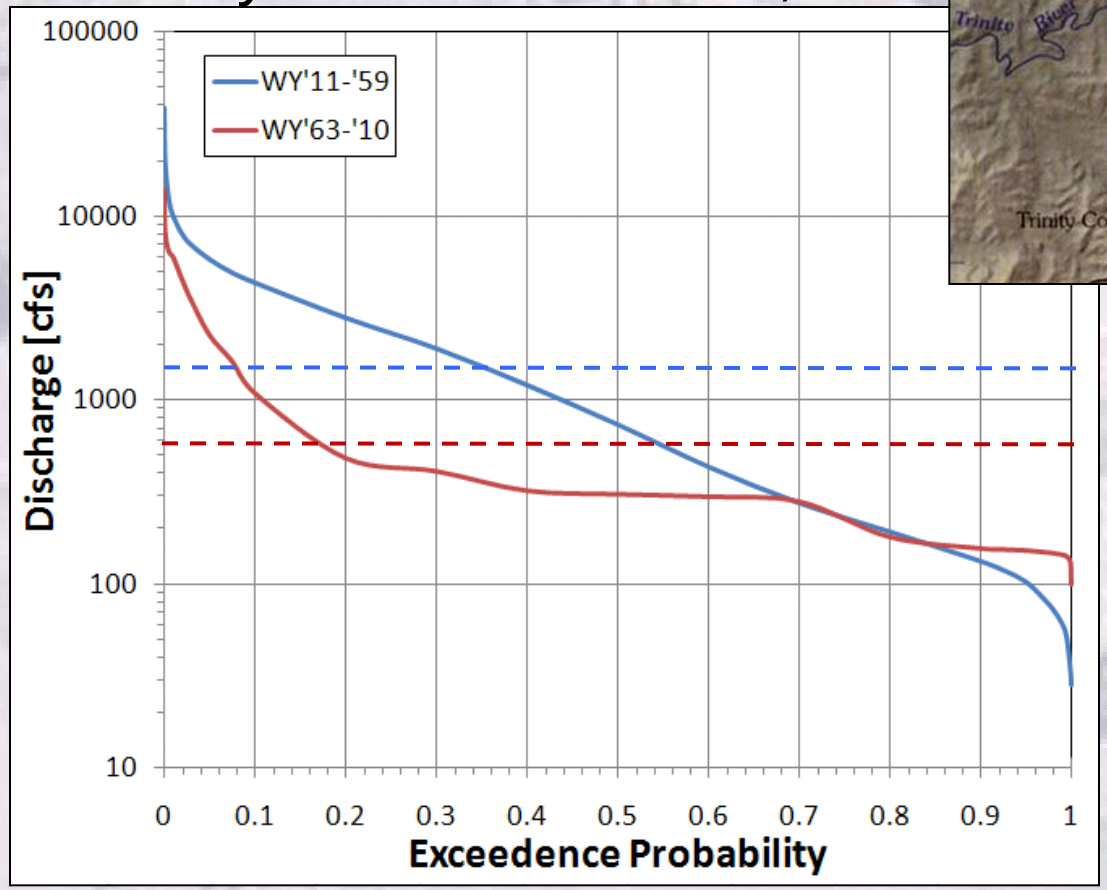
Pre-Dam Conditions

from (Trush, McBain, Leopold 2000)

Trinity River Basin, CA



Trinity River at Lewiston, CA

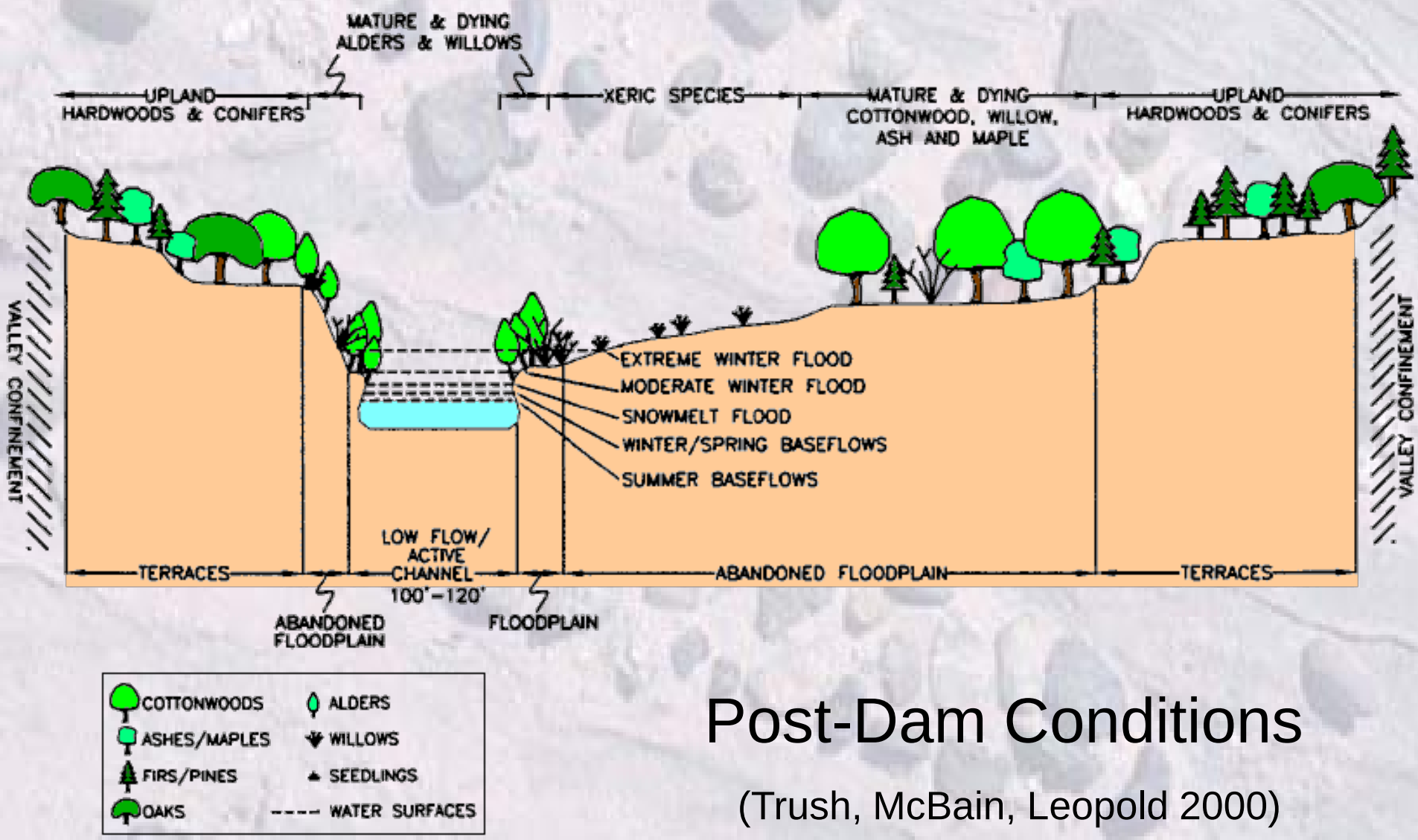


$\overline{Q}_{pre}$ = 1,650 cfs

$\overline{Q}_{post}$ = 590 cfs

$$\frac{\overline{Q}_{post}}{\overline{Q}_{pre}} = 36\%$$

Trinity River Basin, CA

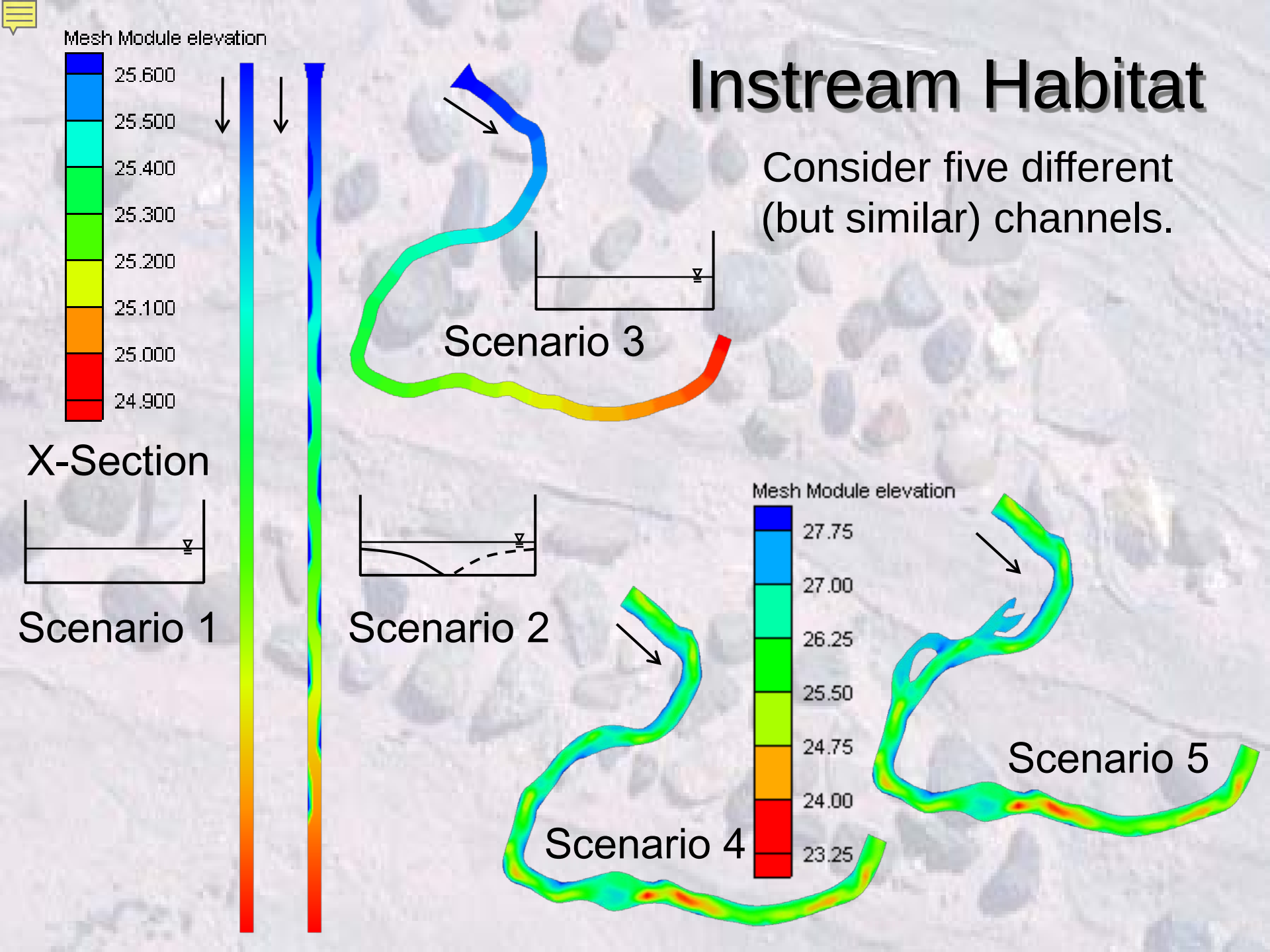


Post-Dam Conditions

(Trush, McBain, Leopold 2000)

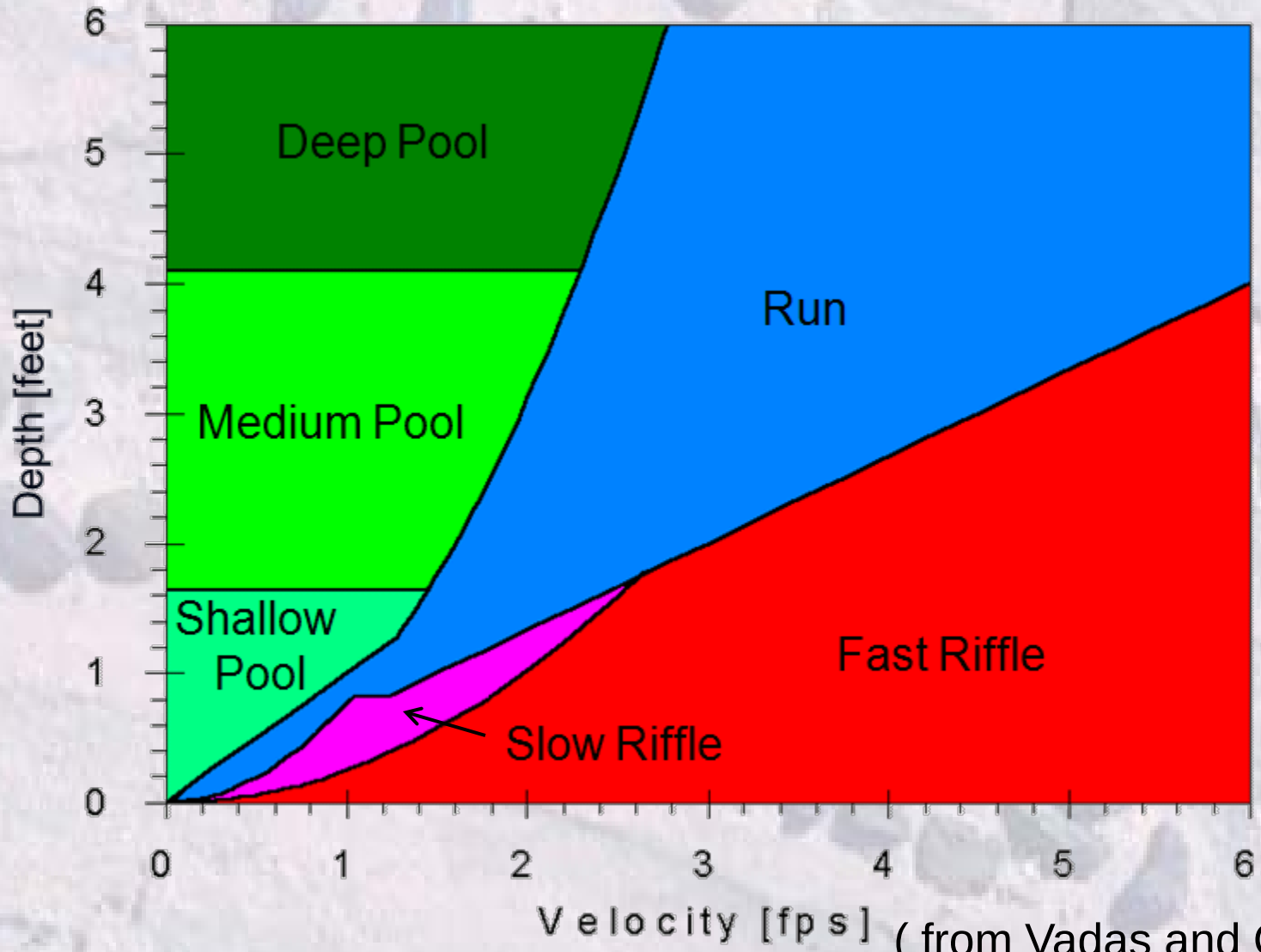
Instream Habitat

Consider five different (but similar) channels.



Instream Habitat

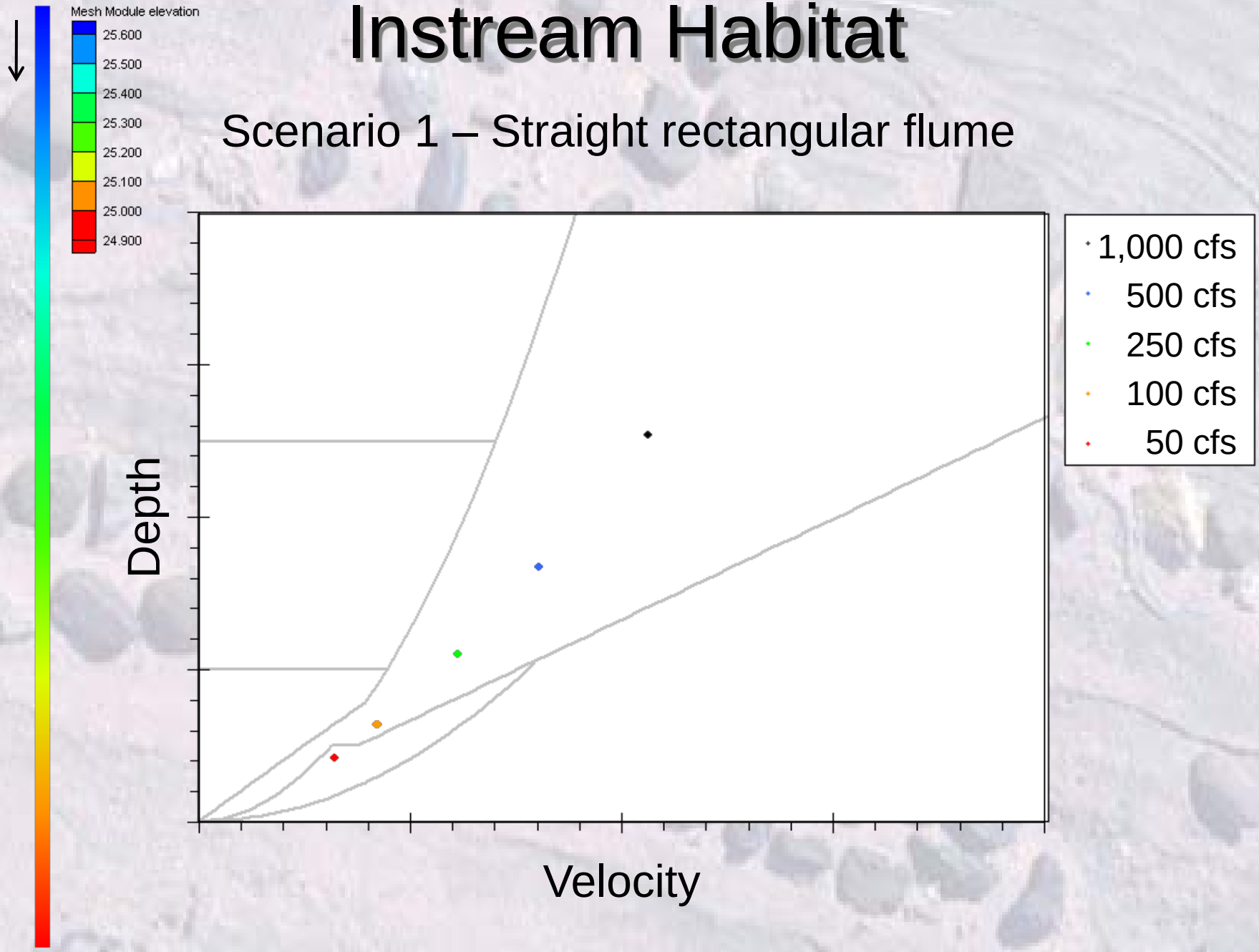
Habitat descriptions based on flow velocity and depth.



(from Vadas and Orth 1998)

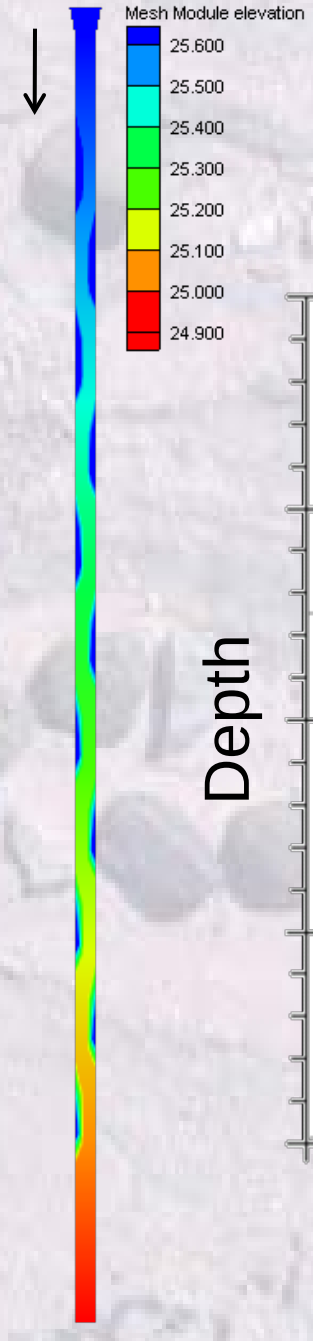
Instream Habitat

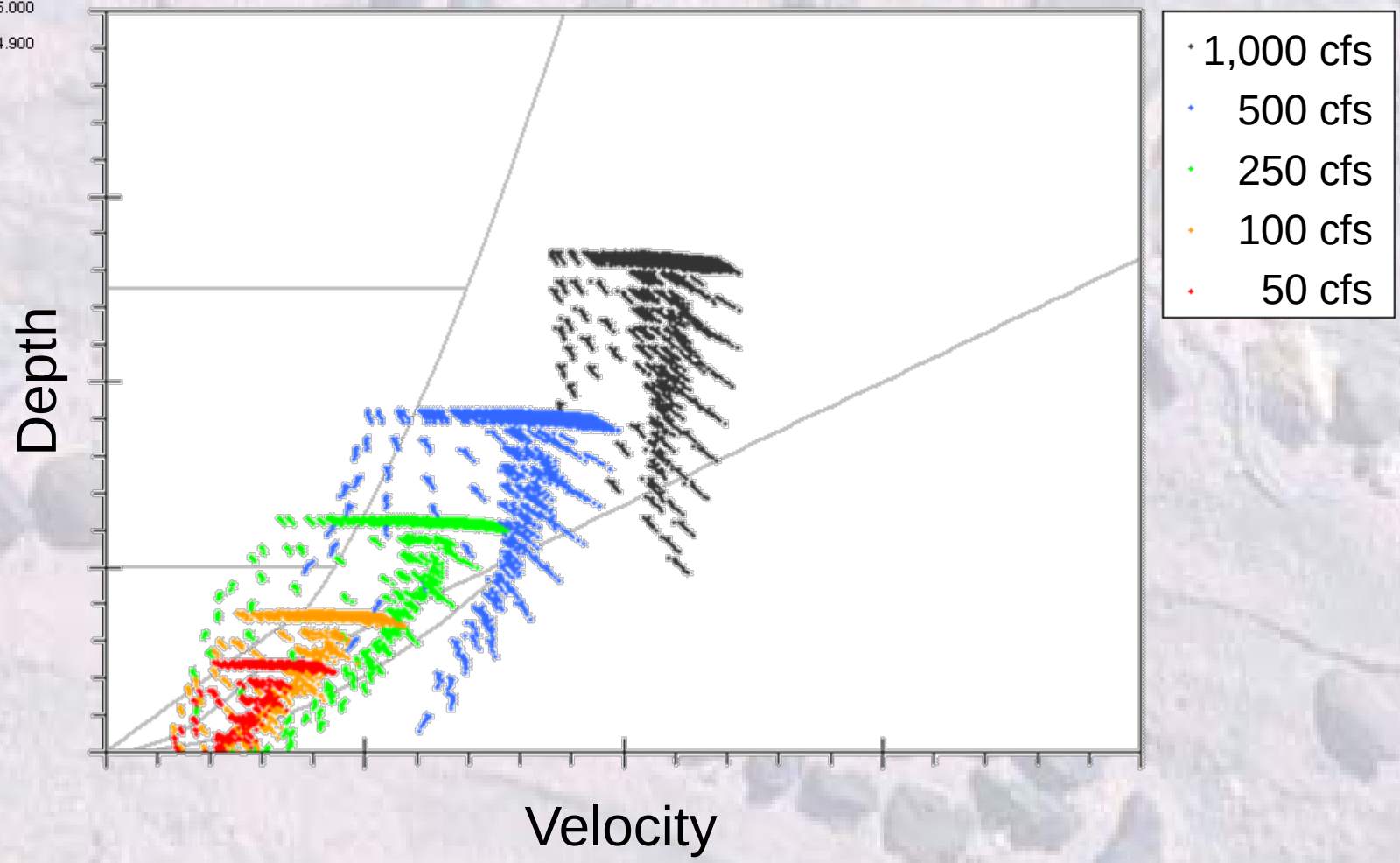
Scenario 1 – Straight rectangular flume



Instream Habitat

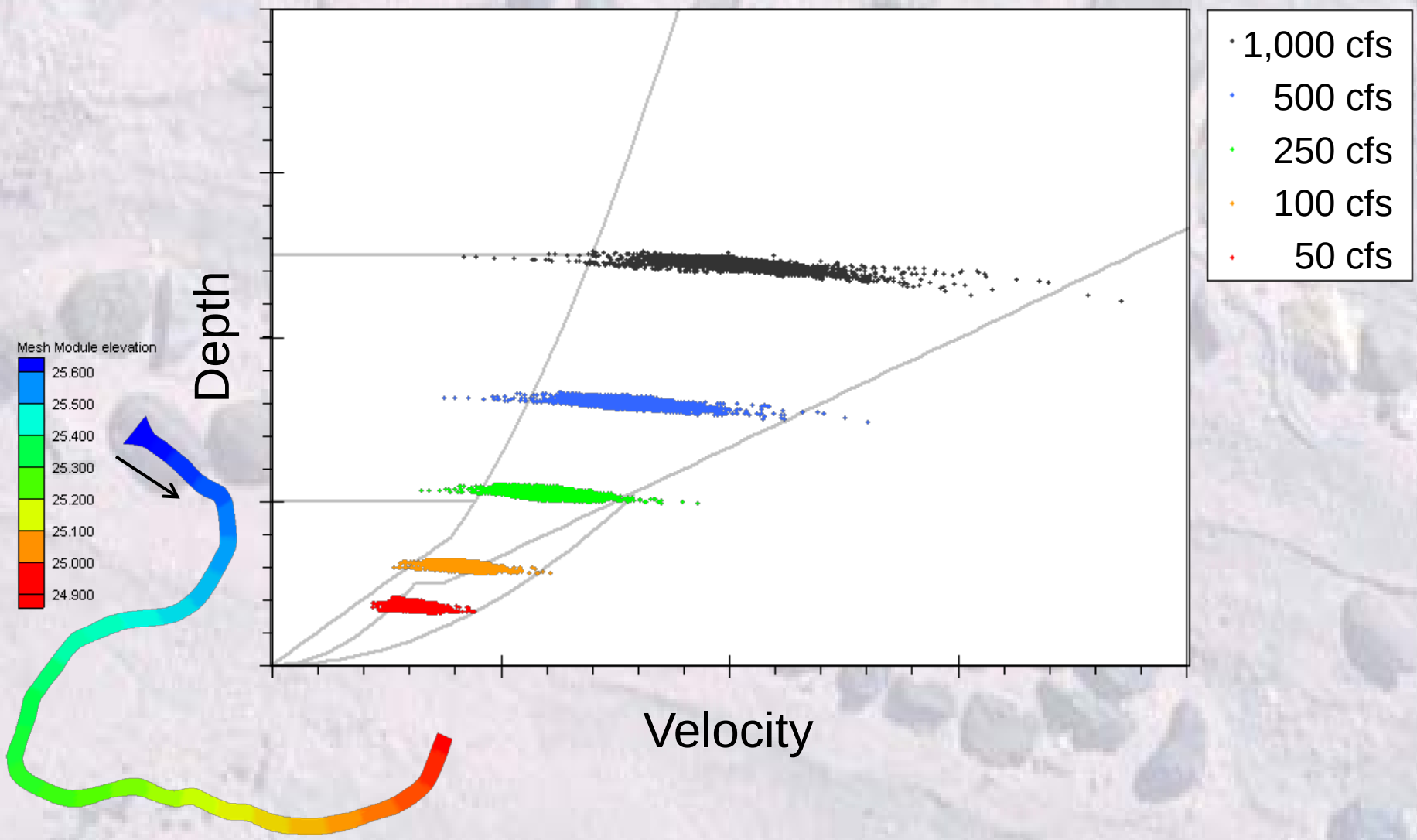
Scenario 2 – Straight rectangular flume with alternating bars





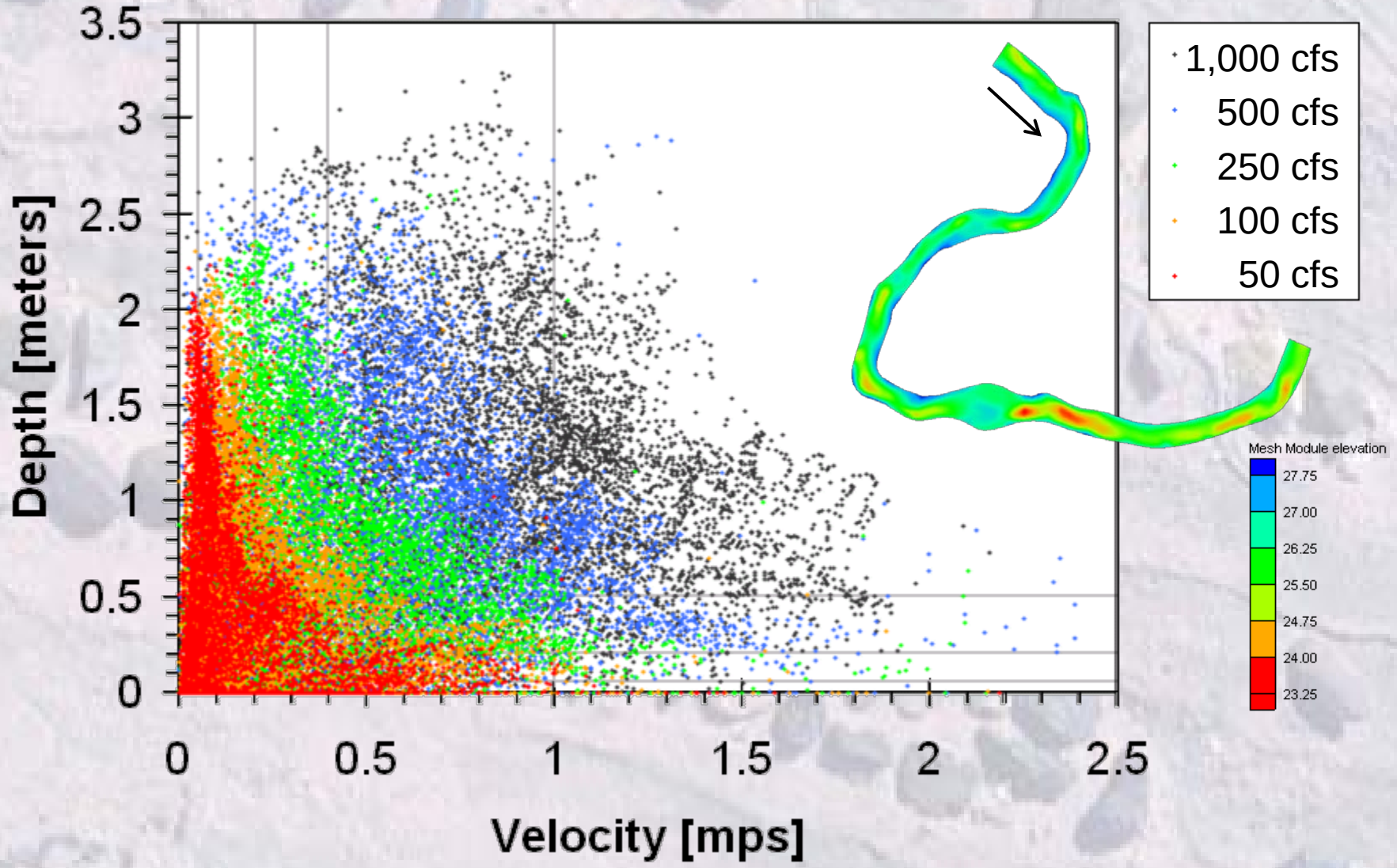
Instream Habitat

Scenario 3 – Meandering rectangular flume



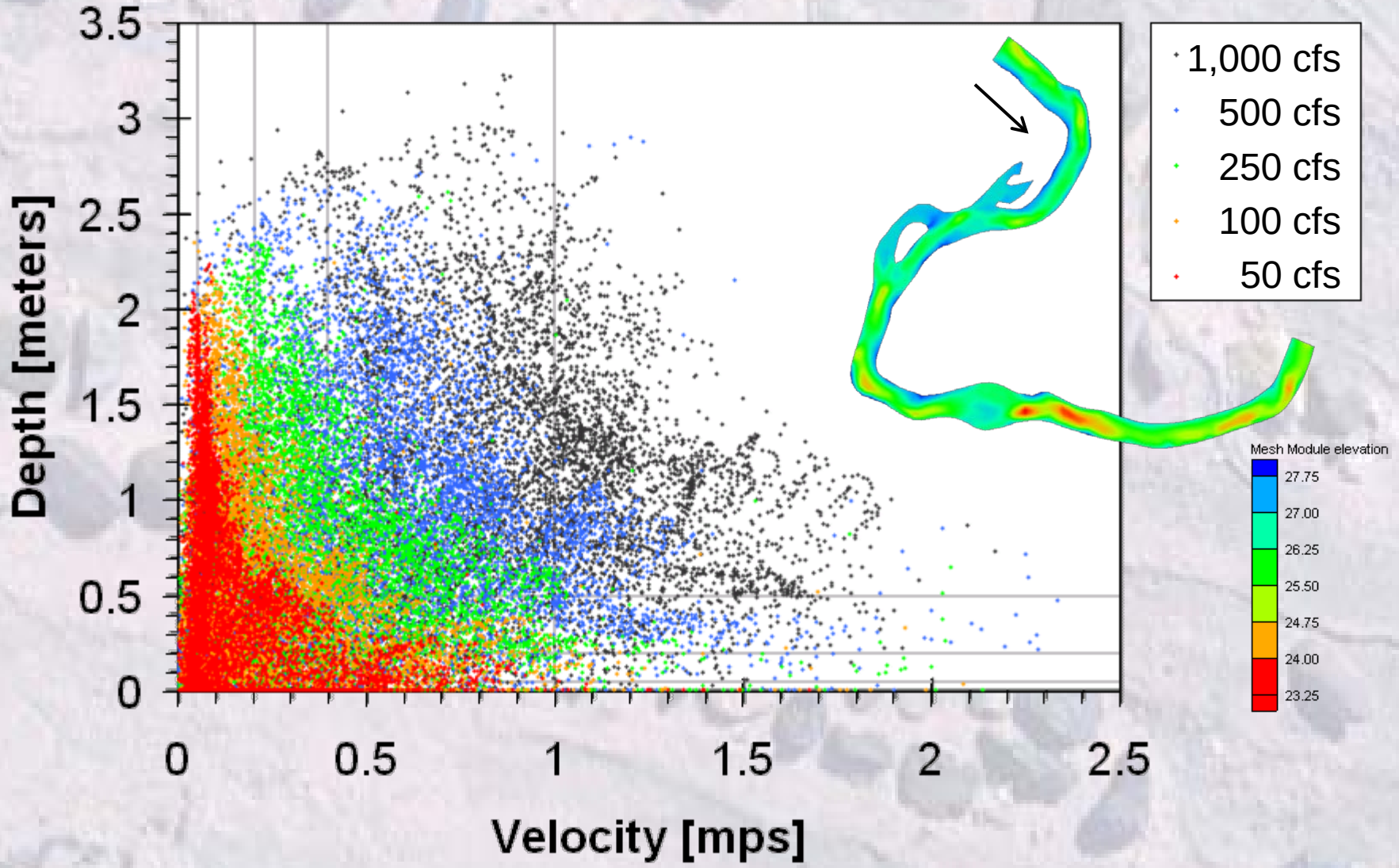
Instream Habitat

Scenario 4 – Main channel with natural form



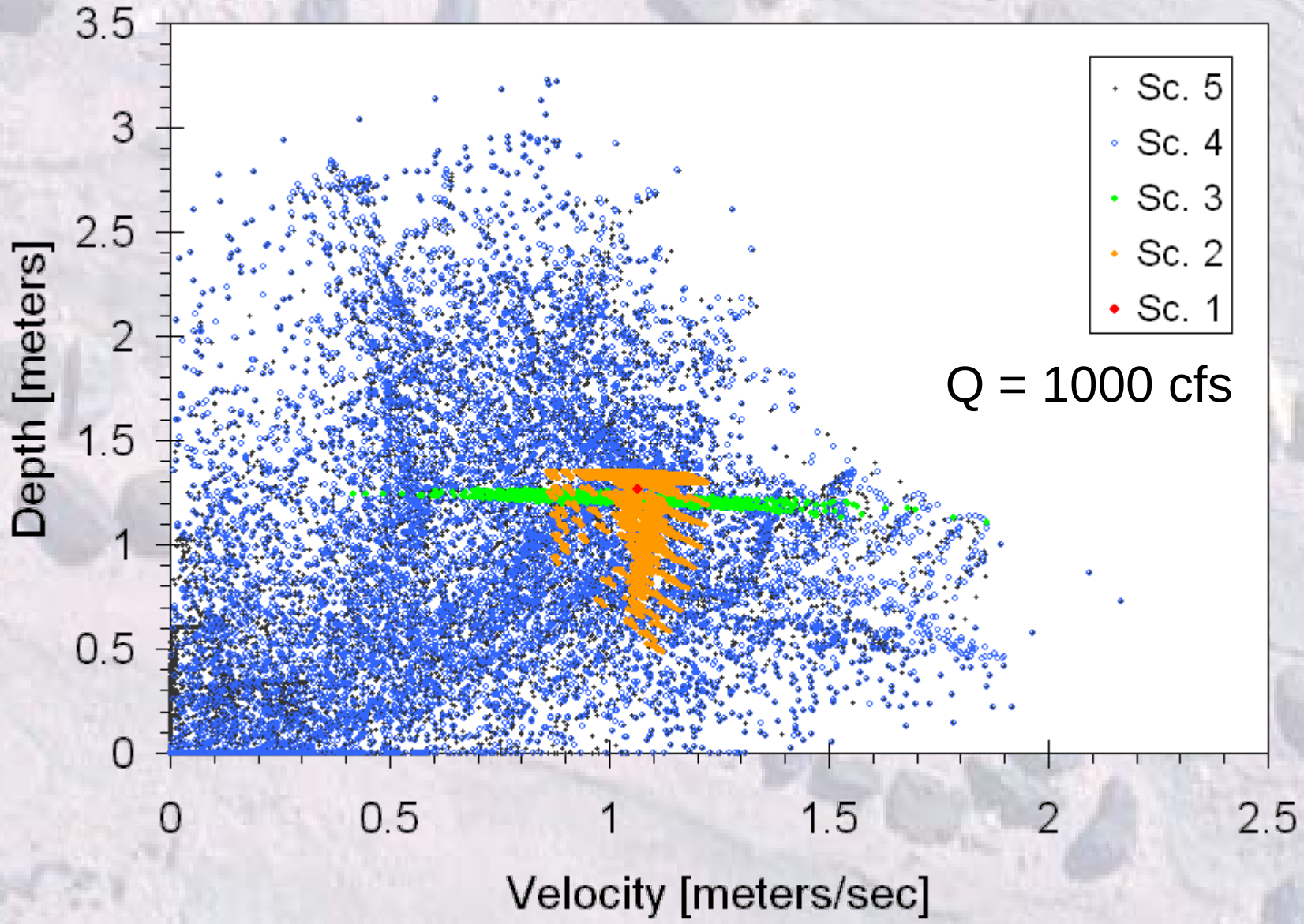
Instream Habitat

Scenario 5 – Main and side channels with backwater area

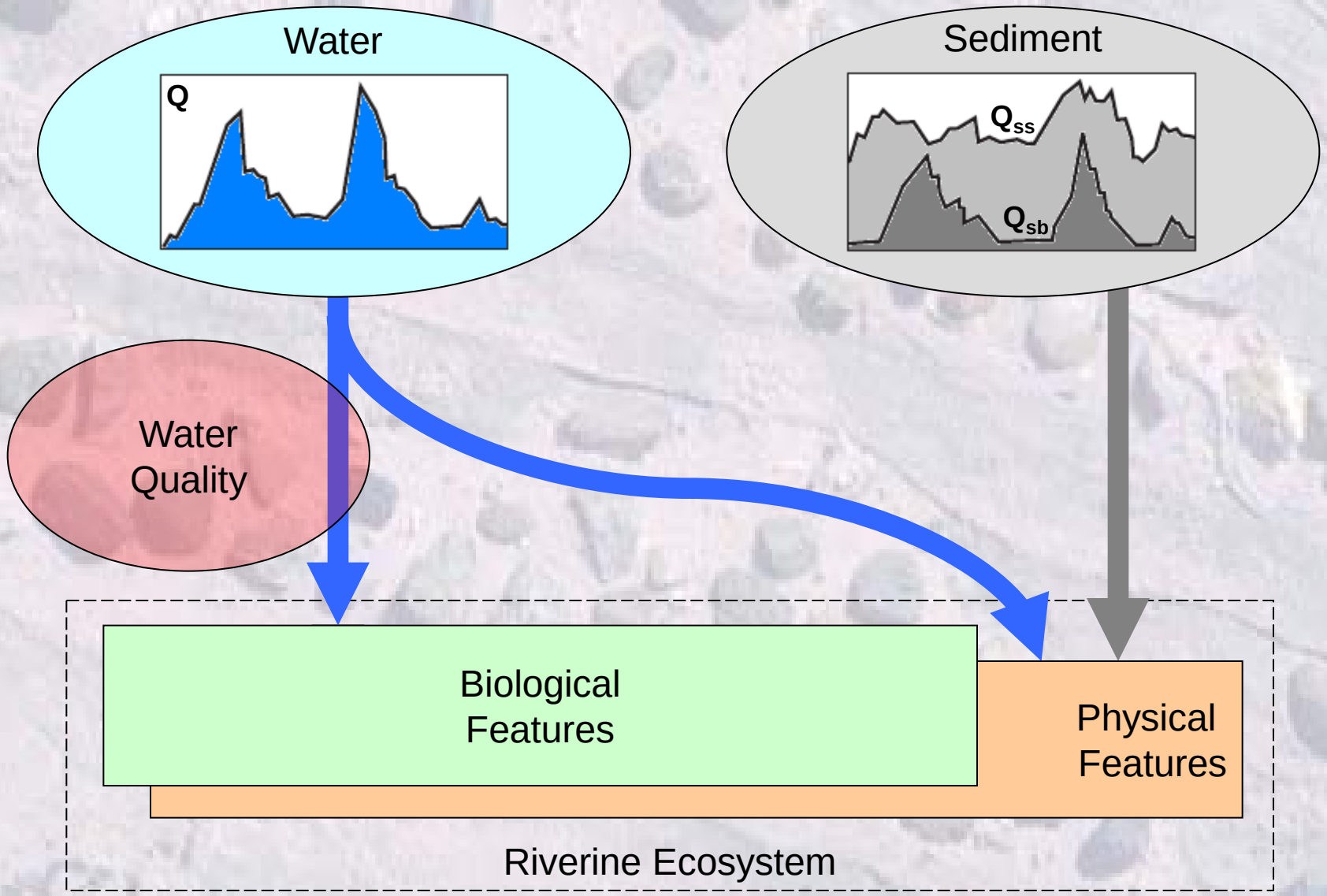


Instream Habitat

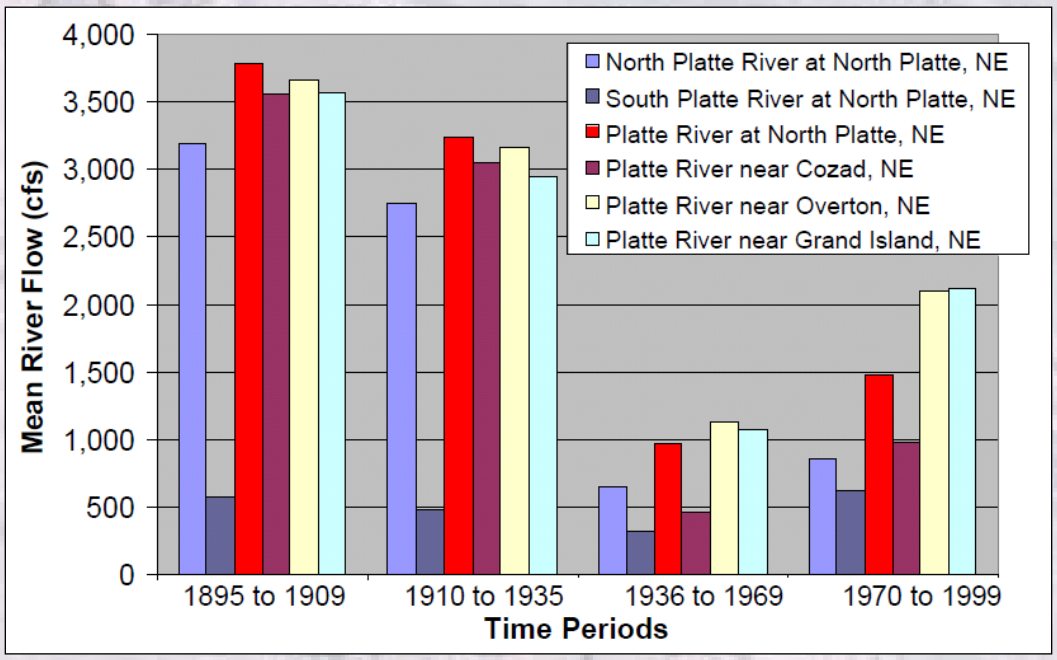
Aquatic habitat is a function of **flow** <u>and</u> **channel shape**.

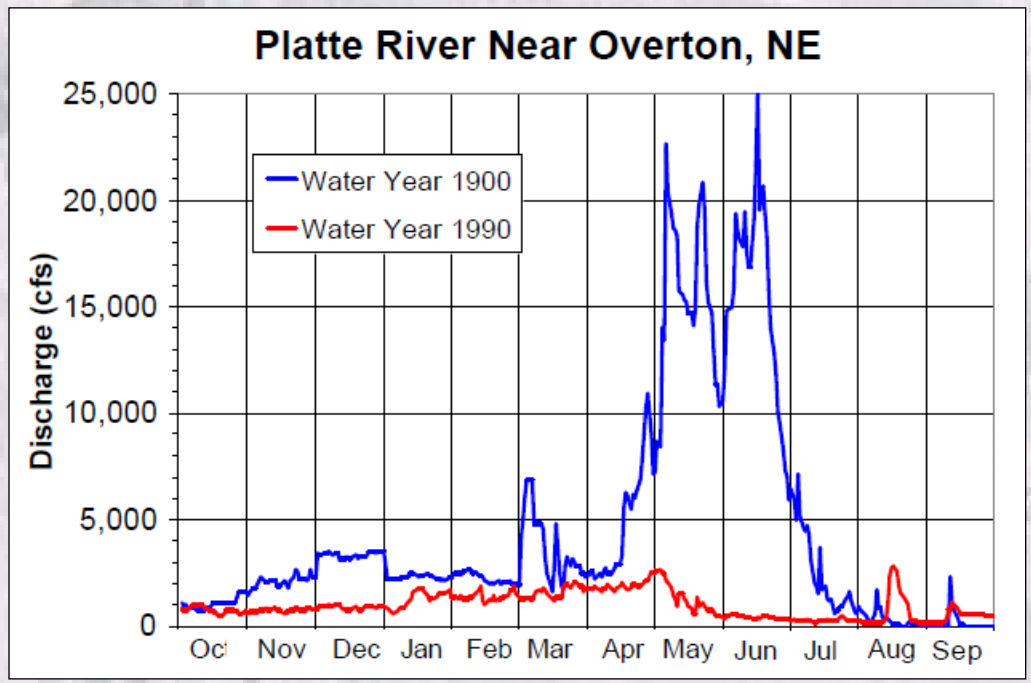


Environmental Flow – New Paradigm



Example – Central Platte River, NE

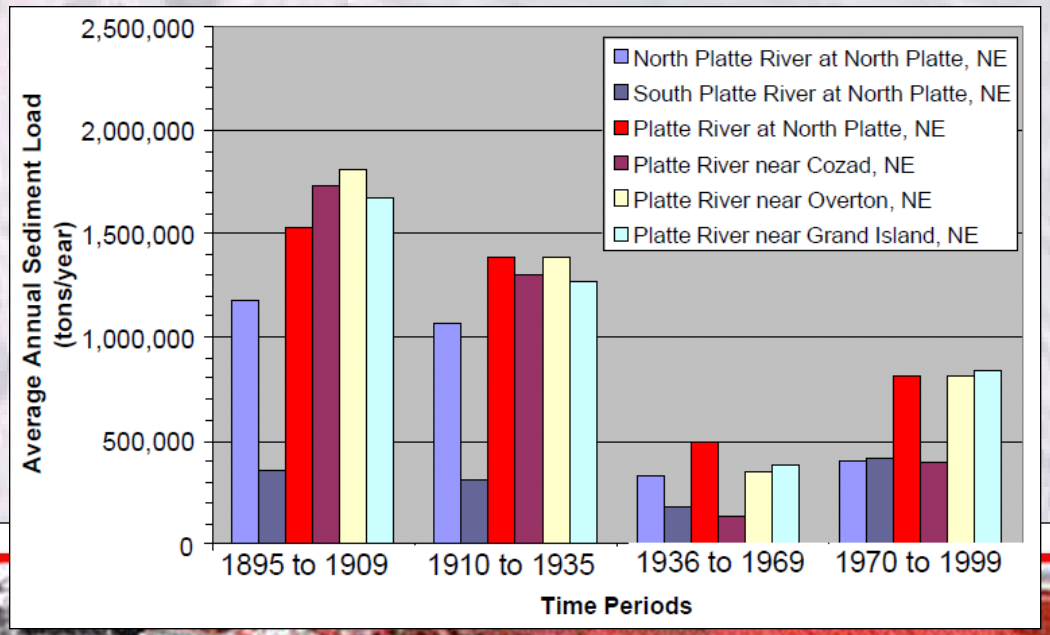




$$\frac{\bar{Q}_{70\text{-}99}}{\bar{Q}_{10\text{-}35}} = \frac{2{,}100 \text{ cfs}}{3{,}150 \text{ cfs}} = 67\%$$

(Murphy et. al 2004)

Example – Central Platte River, NE



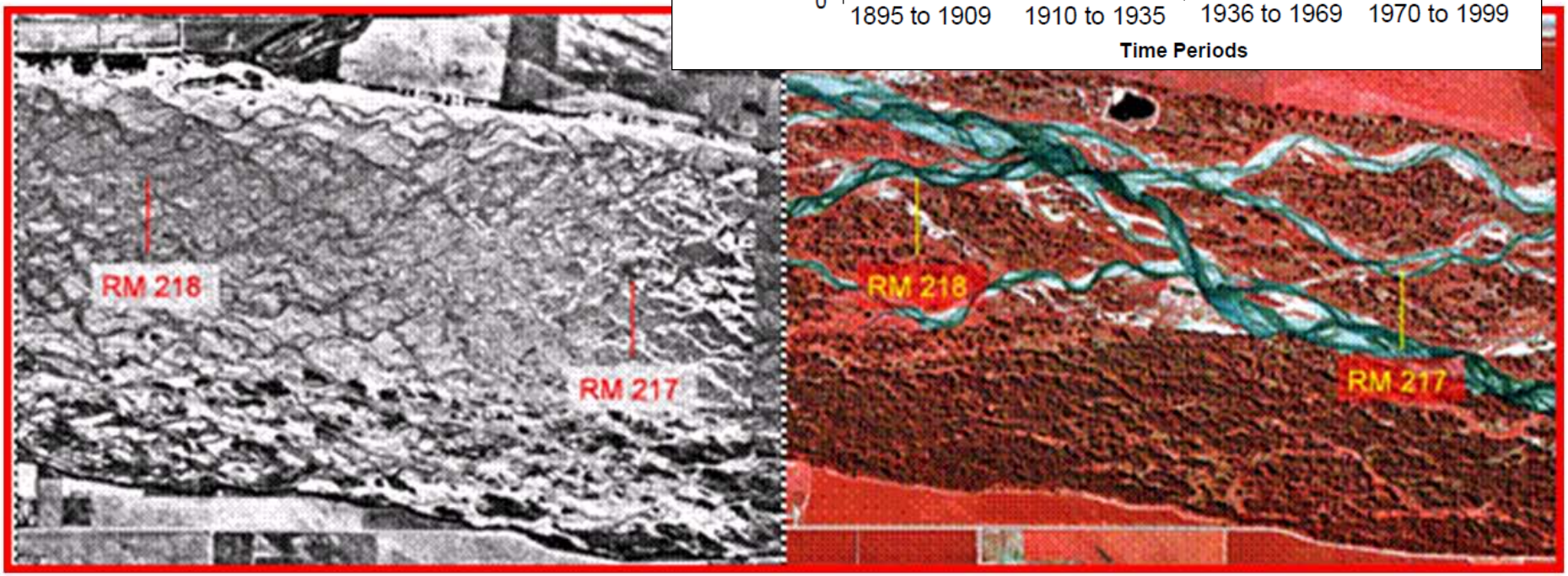
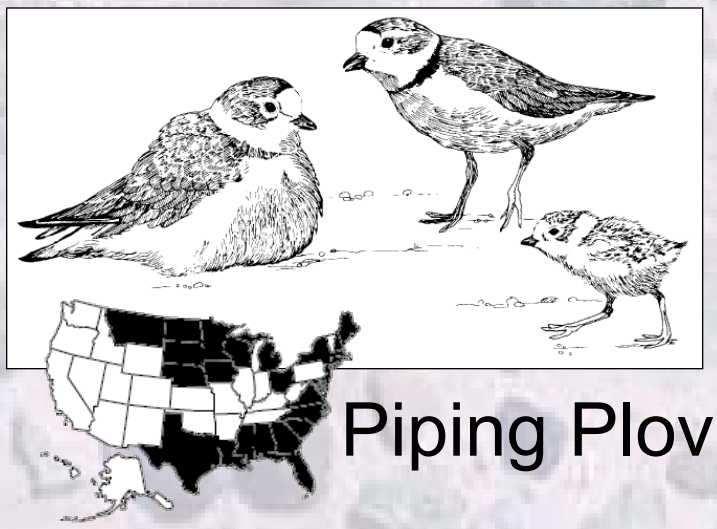
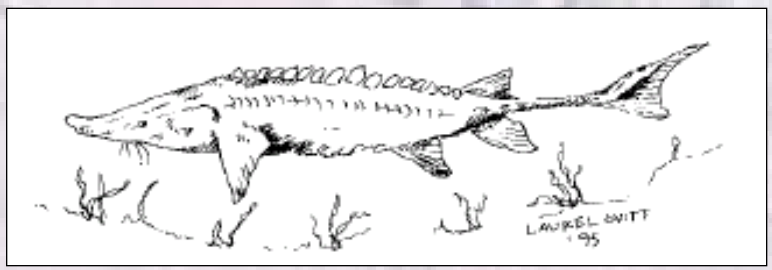


Figure 3. Comparison of plan form from 1938 (FWS, 1938) to 1998 (Friessen et al, 2000) at a location upstream of Kearney. The 1938 braided channel, with small vegetated islands on the south bank, is in 1998 a multi-thread, anastomosed channel with large vegetated islands throughout.

Example – Central Platte River, NE

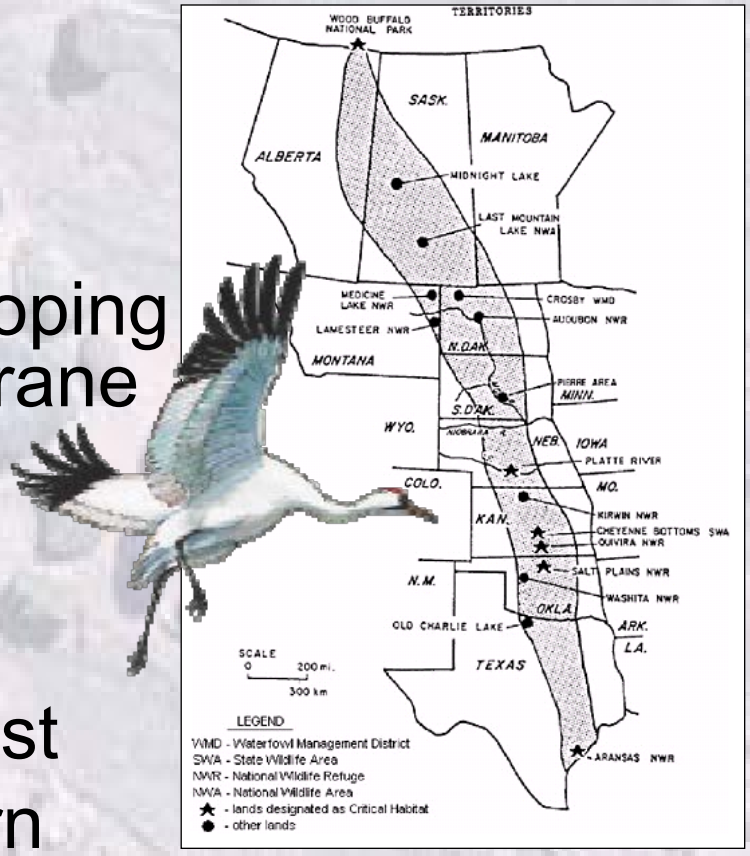


Piping Plover



Pallid Sturgeon

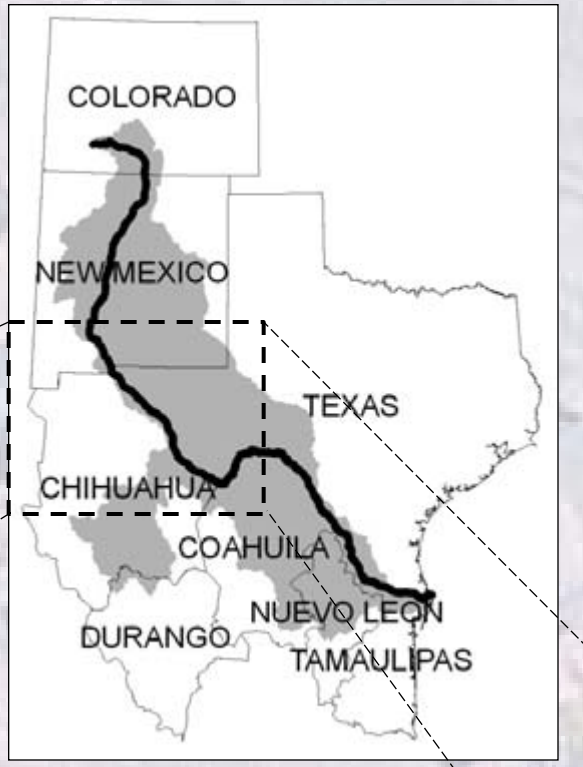
Whooping Crane



Least Tern

(NRC2004)

Example – Rio Grande, TX



Pre-1915 | 1930-1940 | 1995-2005

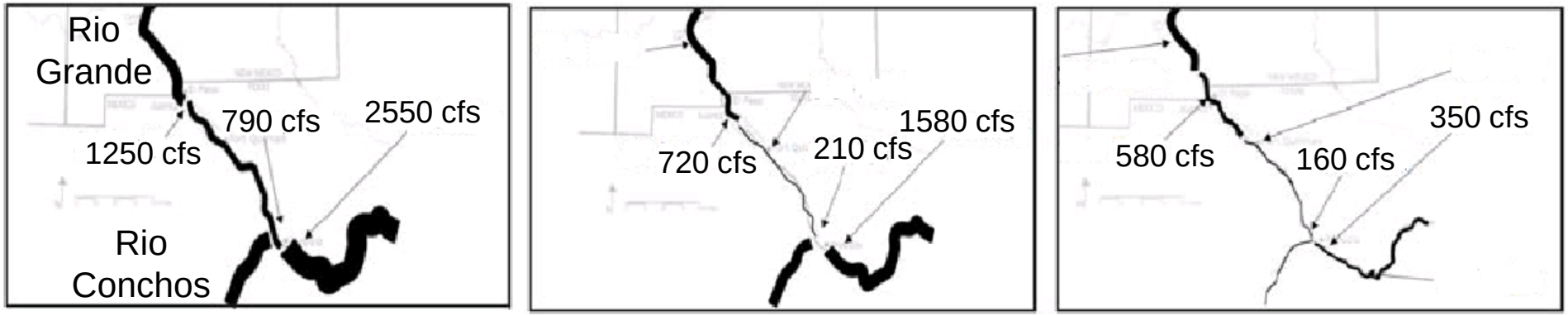
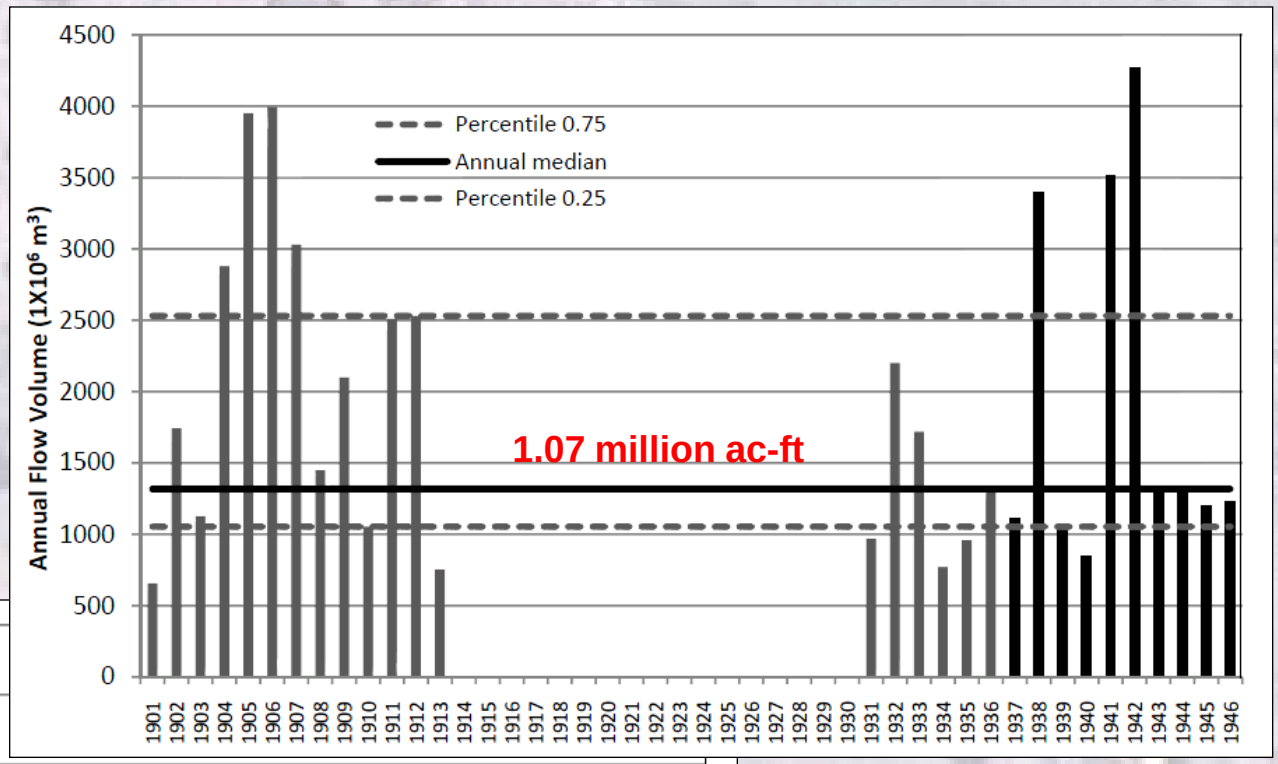


Fig. 2.5: Mean annual flow of segments of the Rio Grande (a) prior to 1915, (b) between 1930 and 1940, and (c) between 1995 and 2005. The thickness of the lines are proportional to the mean annual flow. (modified from Dean 2009)

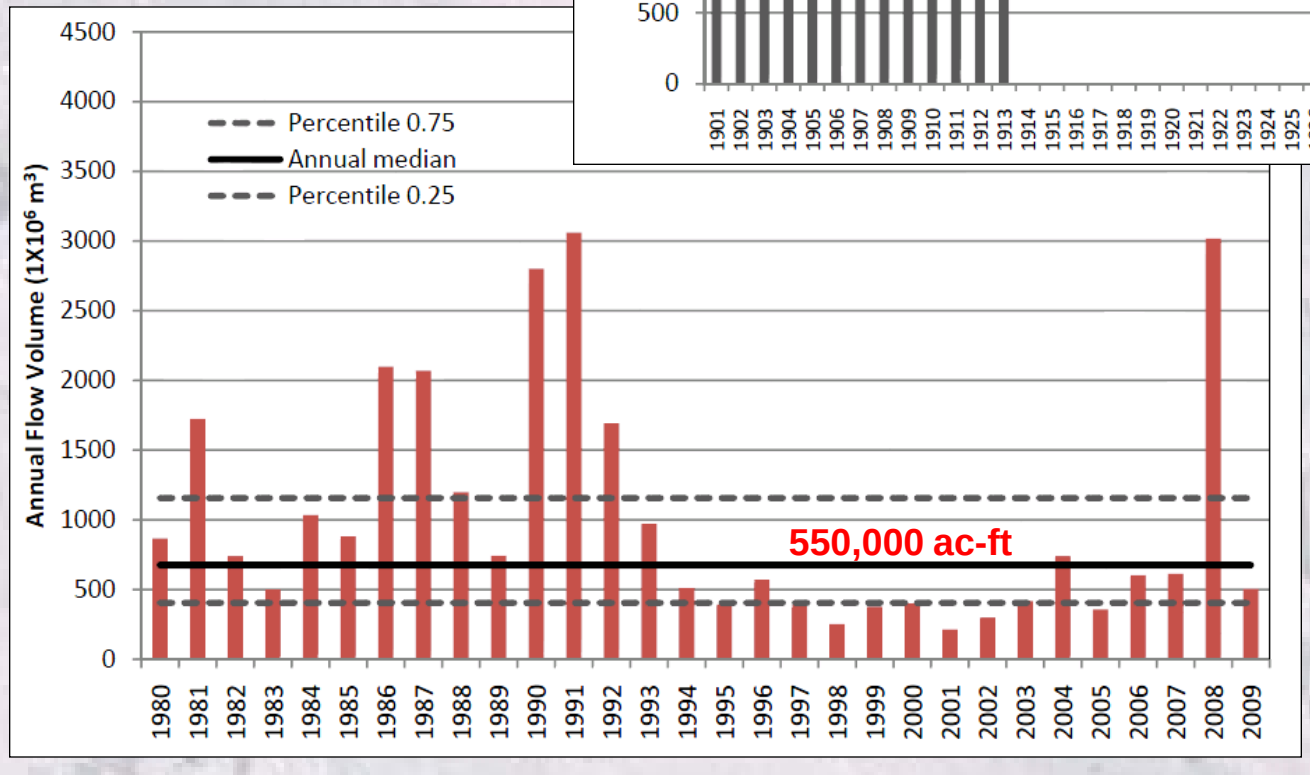
Example – Rio Grande

Annual Stream Flow Volume at Johnson Ranch

(from Solis 2010)



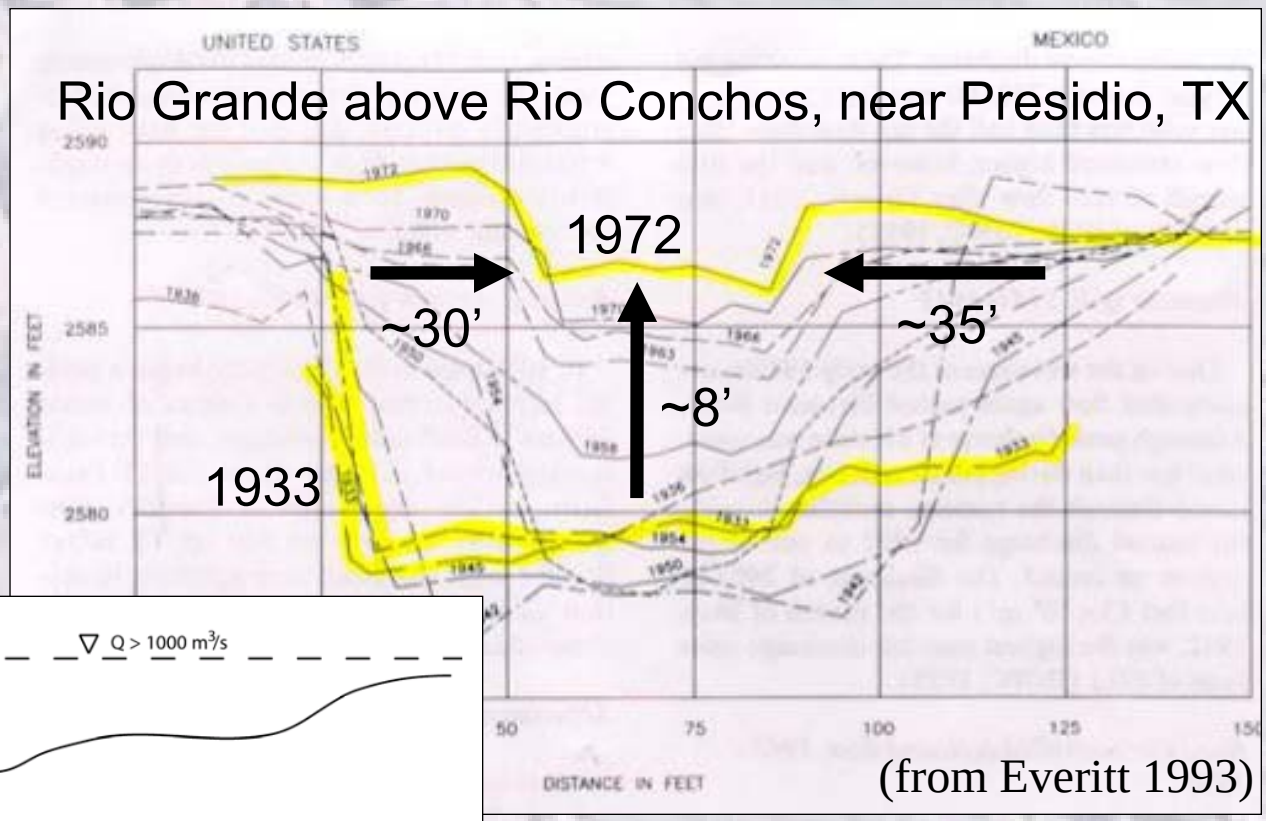
(Pre-1946)



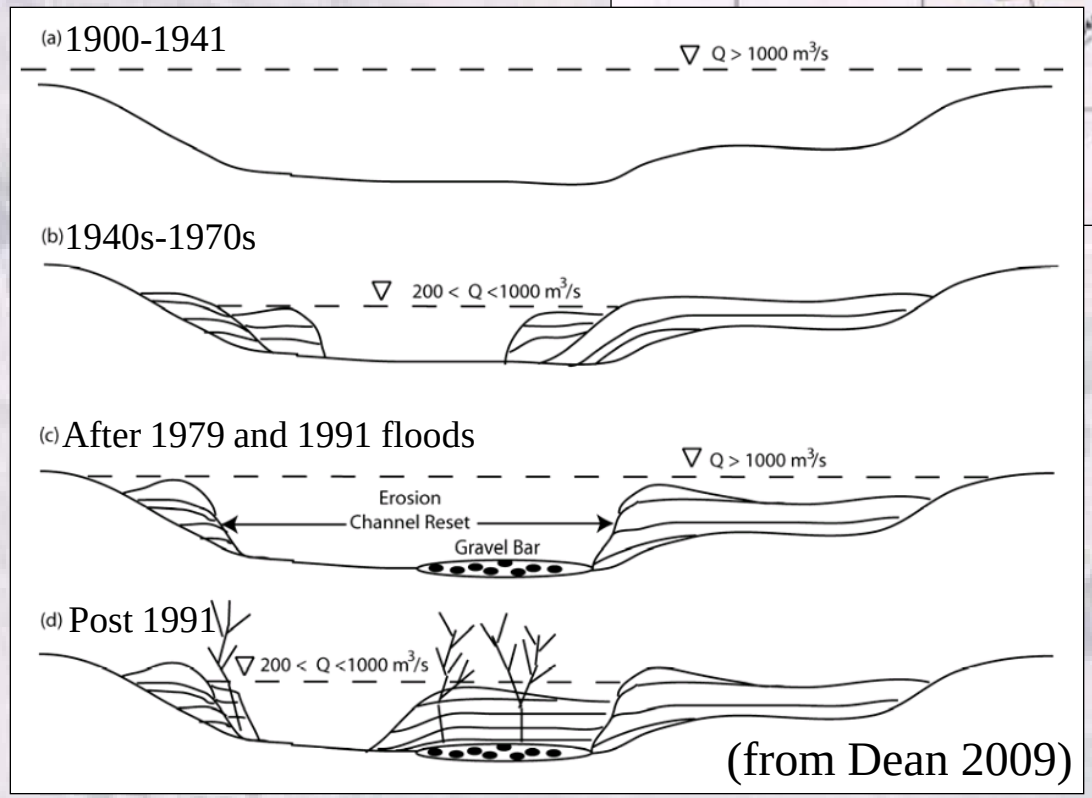
$$\frac{\overline{Q}_{post}}{\overline{Q}_{pre}} = 51\%$$

(Post 1946, 1980-2009 shown)

Example – Rio Grande



(from Everitt 1993)



(from Dean 2009)

Example – Rio Grande, TX

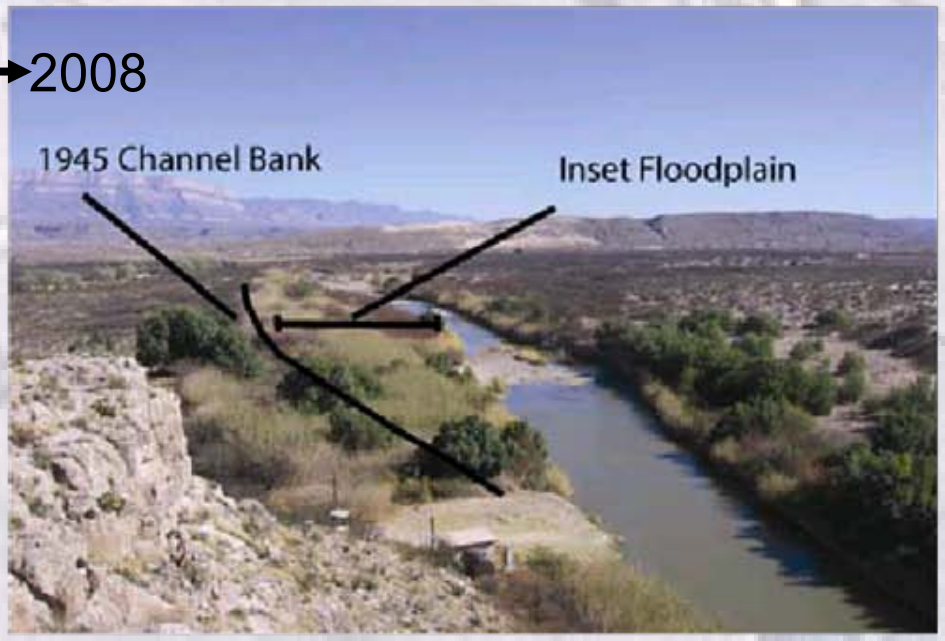
(from Dean 2009 and Bennett 2010)

Rio Grande at Black Dike

1933 → 2010

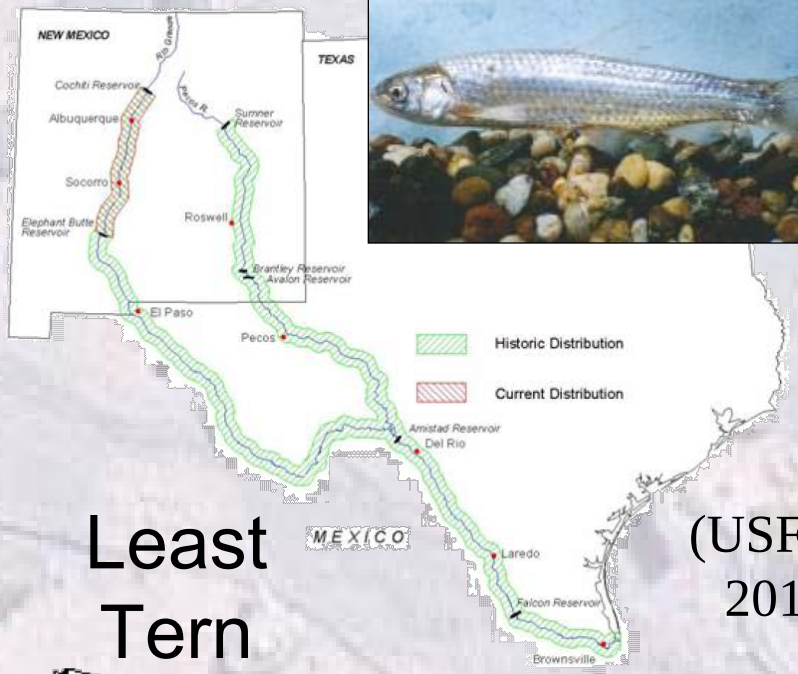
Rio Grande near
Hot Spring Canyon

1945 → 2008



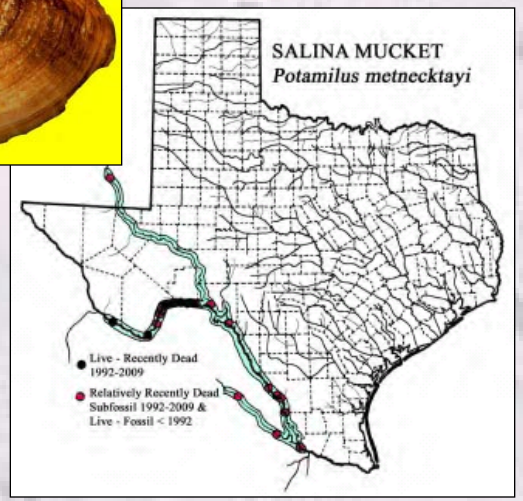
Example – Rio Grande, TX

Silvery Minnow



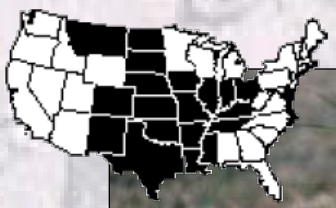
(USFWS 2010)

Salina Mucket



(Howells 2010)

Least Tern



Questions?