Responses of riparian vegetation to two contrasting managed flow regimes of the Colorado River in Grand Canyon, AZ

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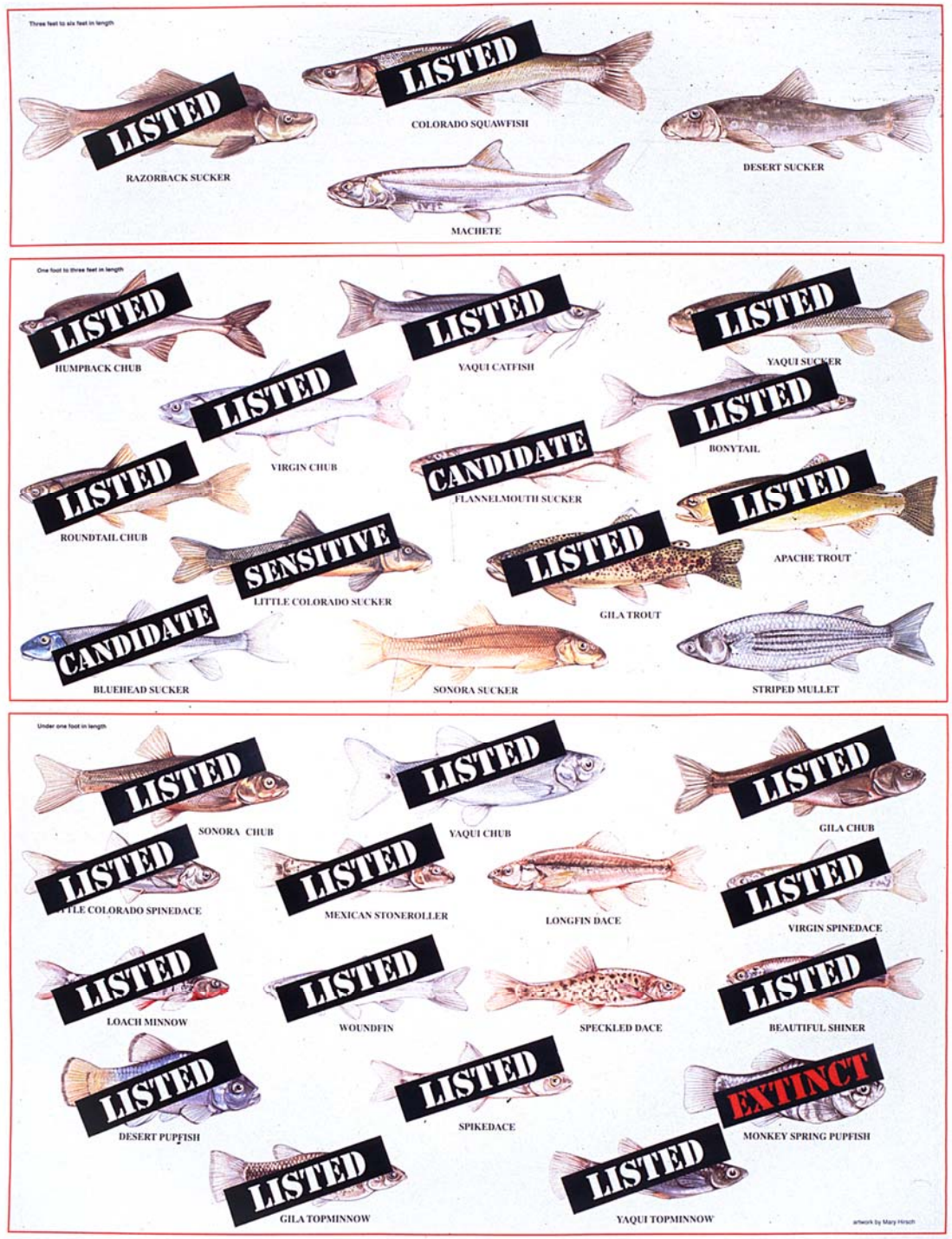
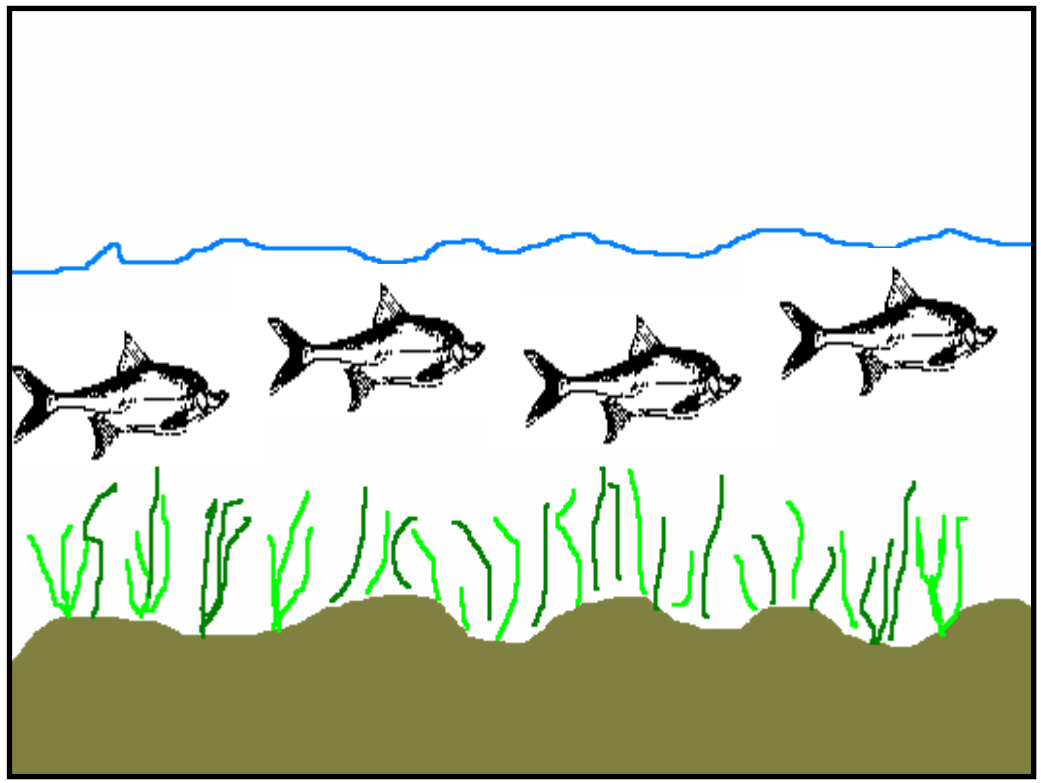

Three feet to six feet in length
LISTED
RAZORBACK SUCKER
LISTED
COLORADO SQUAWFISH
DESERT SUCKER
MACHETE
One foot to three feet in length
LISTED
HUMPBACK CHUB
LISTED
YAQUI CATFISH
LISTED
YAQUI SUCKER
LISTED
VIRGIN CHUB
LISTED
BONYTAIL
LISTED
ROUNDTAIL CHUB
CANDIDATE
FLANNELMOUTH SUCKER
LISTED
APACHE TROUT
SENSITIVE
LITTLE COLORADO SUCKER
LISTED
GILA TROUT
CANDIDATE
BLUEHEAD SUCKER
SONORA SUCKER
STRIPED MULLET
Under one foot in length
LISTED
SONORA CHUB
LISTED
YAQUI CHUB
LISTED
GILA CHUB
LISTED
LITTLE COLORADO SPINEDACE
LISTED
MEXICAN STONEROLLER
LONGFIN DACE
LISTED
VIRGIN SPINEDACE
LISTED
LOACH MINNOW
LISTED
WOUNDFIN
SPECKLED DACE
LISTED
BEAUTIFUL SHINER
LISTED
DESERT PUPFISH
LISTED
SPIKEDACE
EXTINCT
MONKEY SPRING PUPFISH
LISTED
GILA TOPMINNOW
LISTED
YAQUI TOPMINNOW
artwork by Mary Hirsch

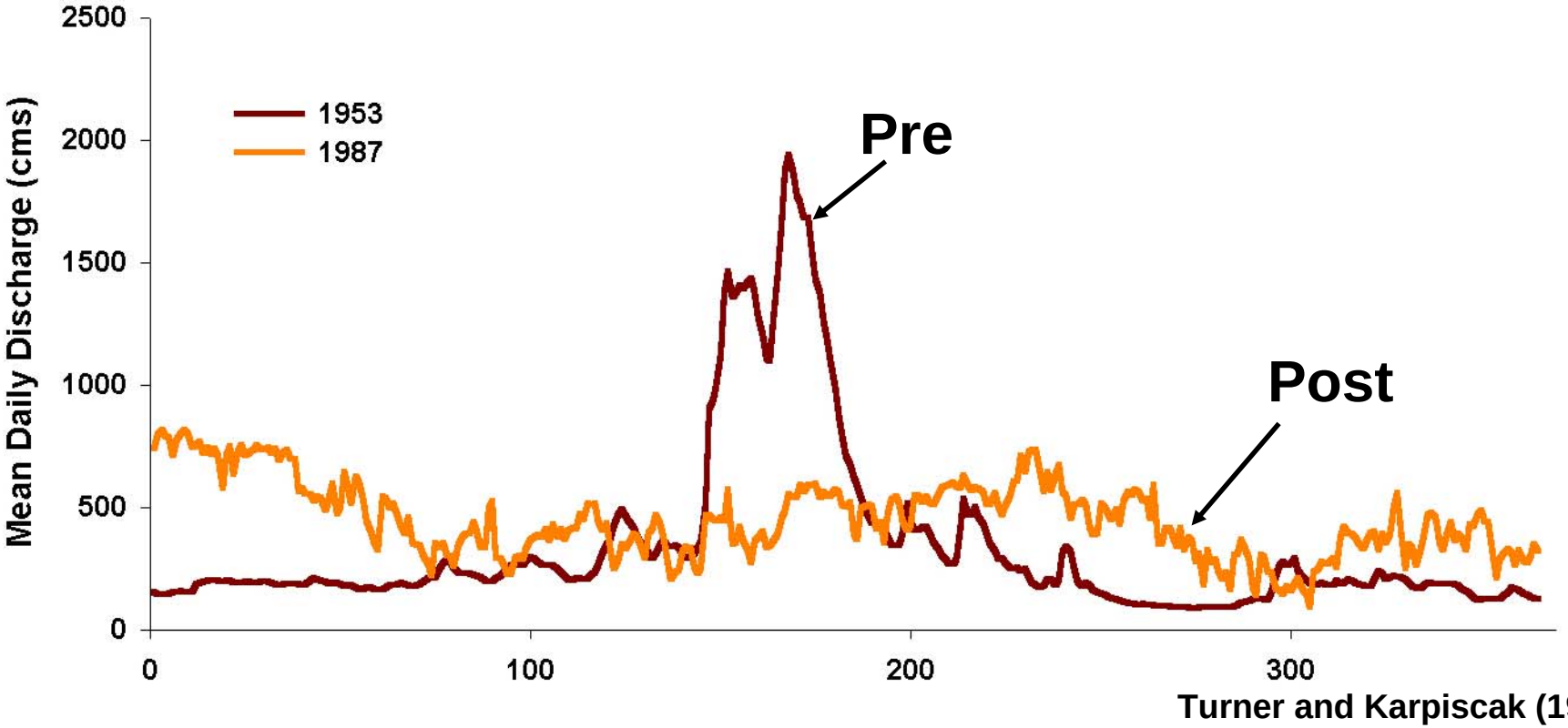
Purpose of 2000 Experimental Flows

- **To create habitat for native endangered juvenile fish**
  - **Backwaters & cobble bars**
  - **Warm the river water**
  - **Increase the food base**
  - **Vegetated shoreline habitat**

Why is vegetated shoreline habitat important?

- **Fish densities are greater**
  - **Micro-habitat warming**
  - **Food source**
  - **Predator free space**
- **Grow vegetation and inundate**



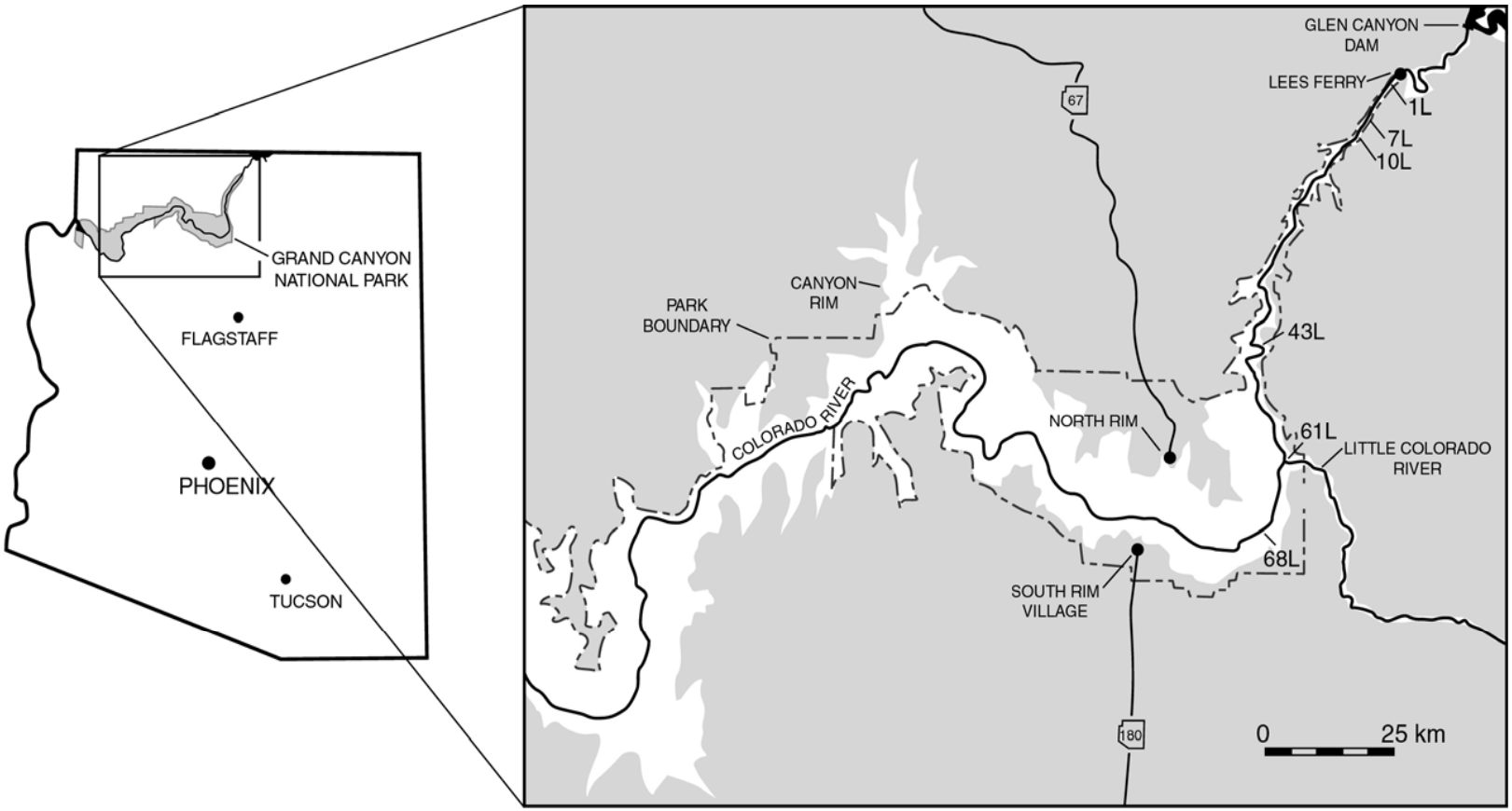


Turner and Karpiscak (1980)

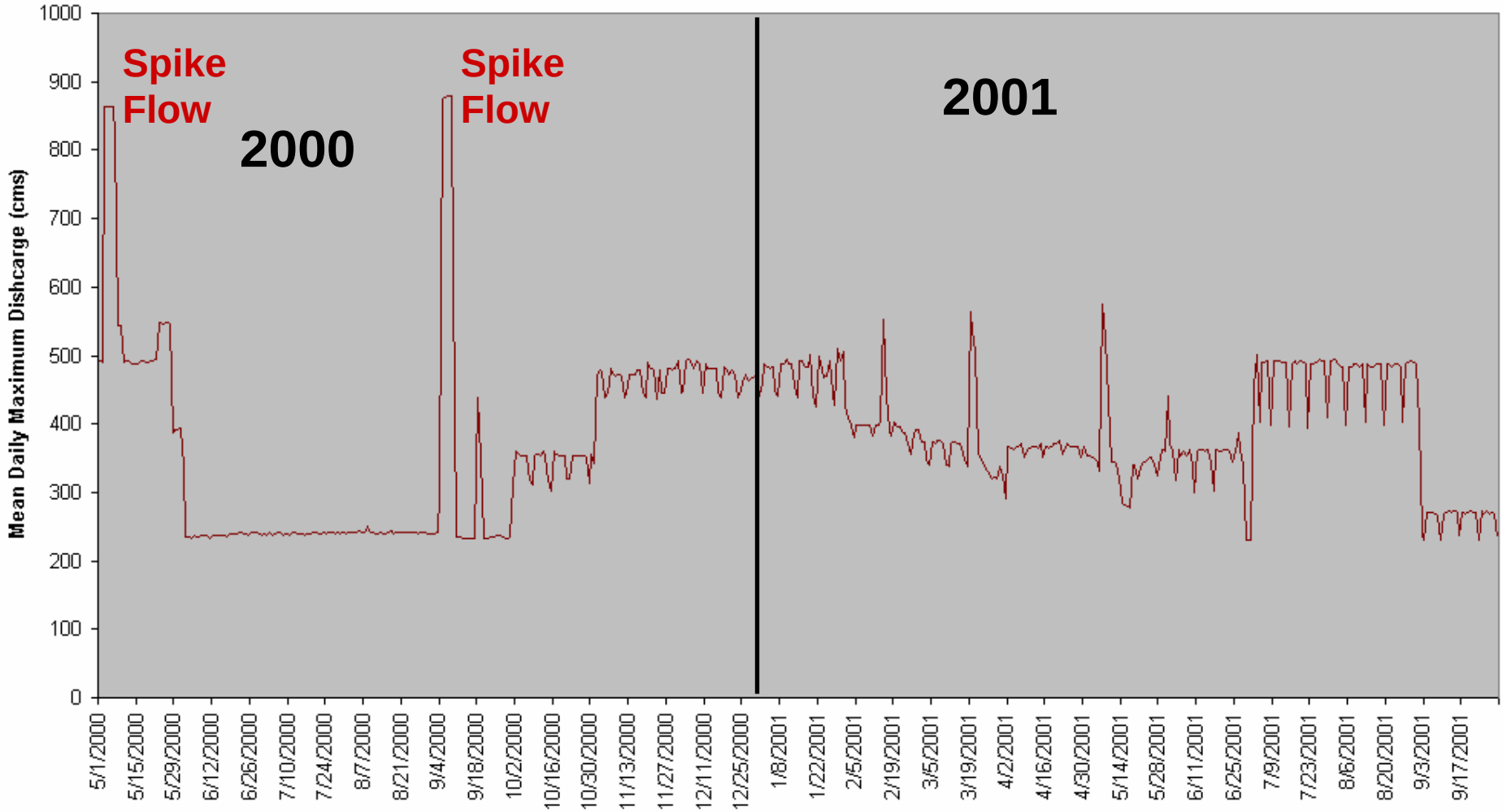
Research Questions

- **Do plants respond to different flow regimes?**
  - **Do plants colonize newly available habitat created?**
- **What is the nature of the colonist?**
  - **Are they native or exotic?**
- **What is the impact of a large spike flow?**
- **What are the effects of two flow regimes on extant vegetation?**

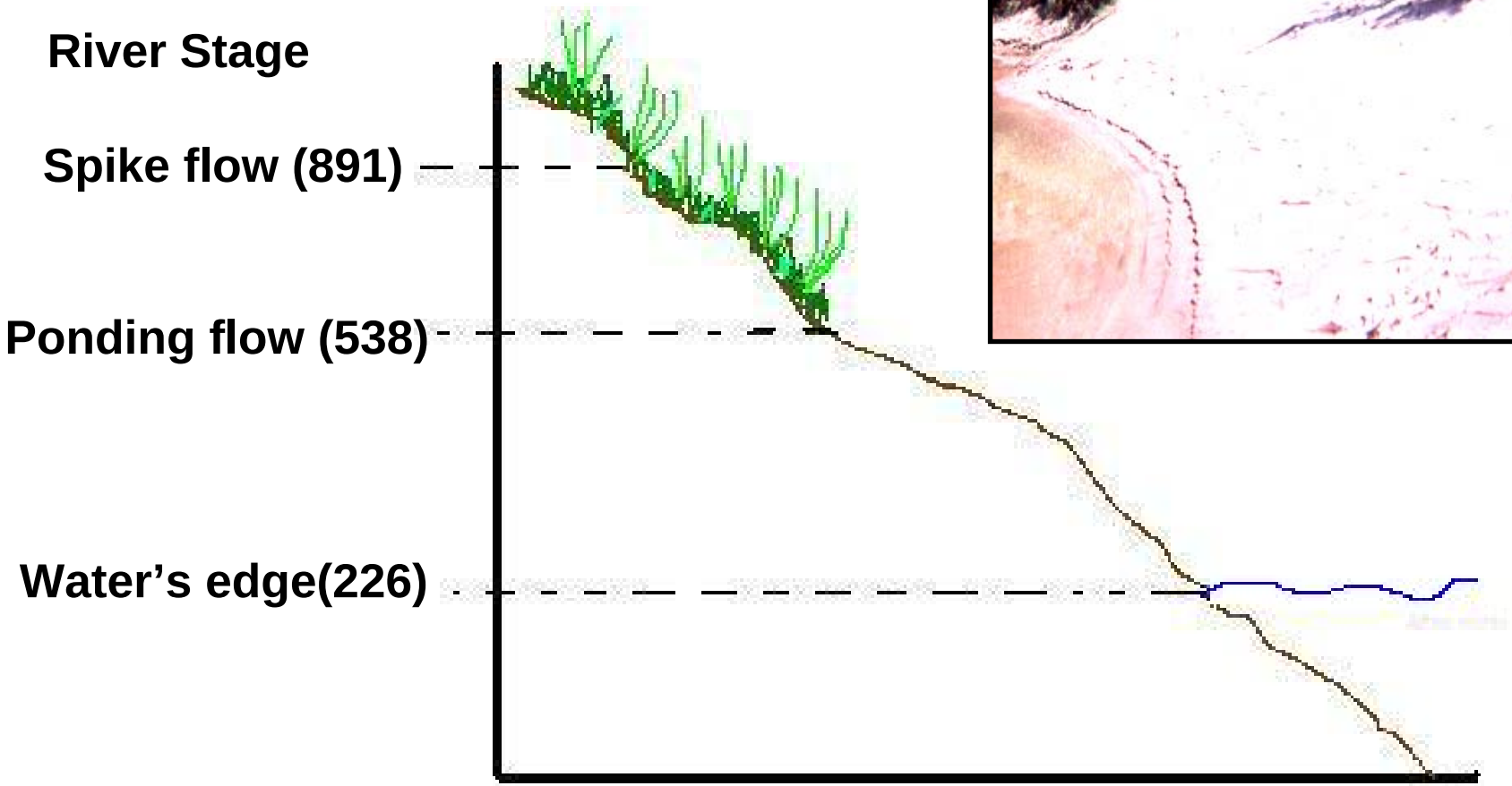
Near-shore Vegetation Study Sites



Hydrograph


Spike Flow
2000
Spike Flow
2001
Mean Daily Maximum Dishcarge (cms)
1000
900
800
700
600
500
400
300
200
100
0
5/1/2000
5/15/2000
5/29/2000
6/12/2000
6/26/2000
7/10/2000
7/24/2000
8/7/2000
8/21/2000
9/4/2000
9/18/2000
10/2/2000
10/16/2000
10/30/2000
11/13/2000
11/27/2000
12/11/2000
12/25/2000
1/8/2001
1/22/2001
2/5/2001
2/19/2001
3/5/2001
3/19/2001
4/2/2001
4/16/2001
4/30/2001
5/14/2001
5/28/2001
6/11/2001
6/25/2001
7/9/2001
7/23/2001
8/6/2001
8/20/2001
9/3/2001
9/17/2001

Beach Cross-section



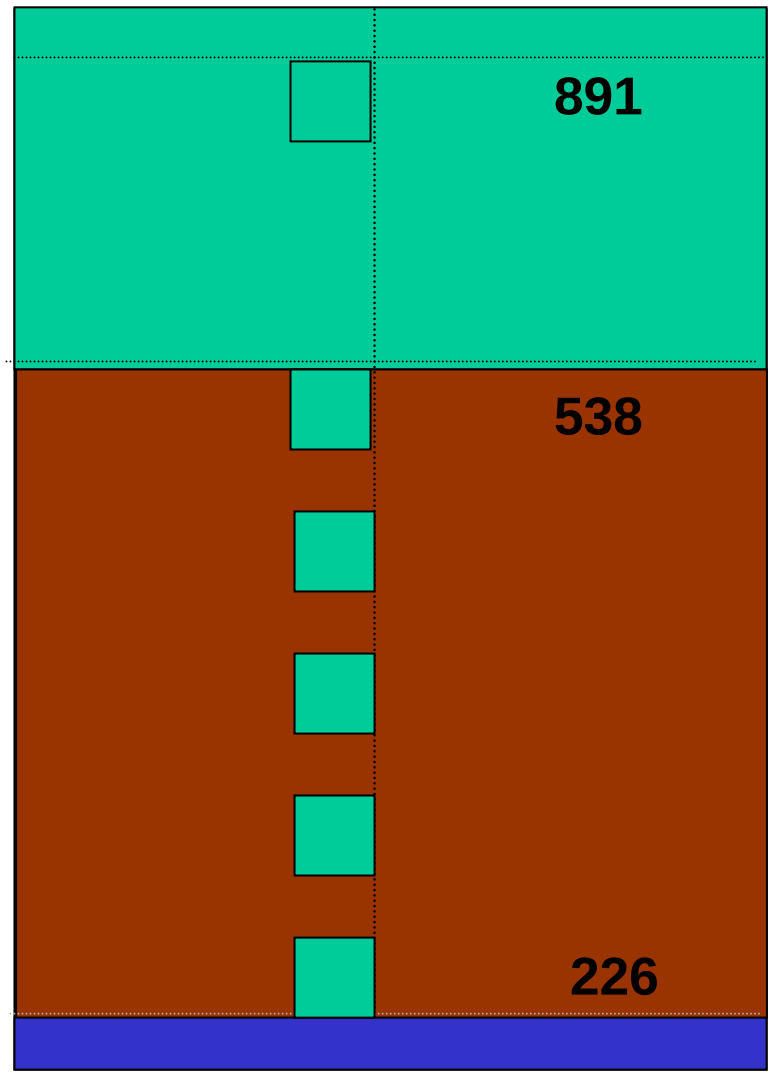
Sampling Transect Design

= 0.25 m² Plot

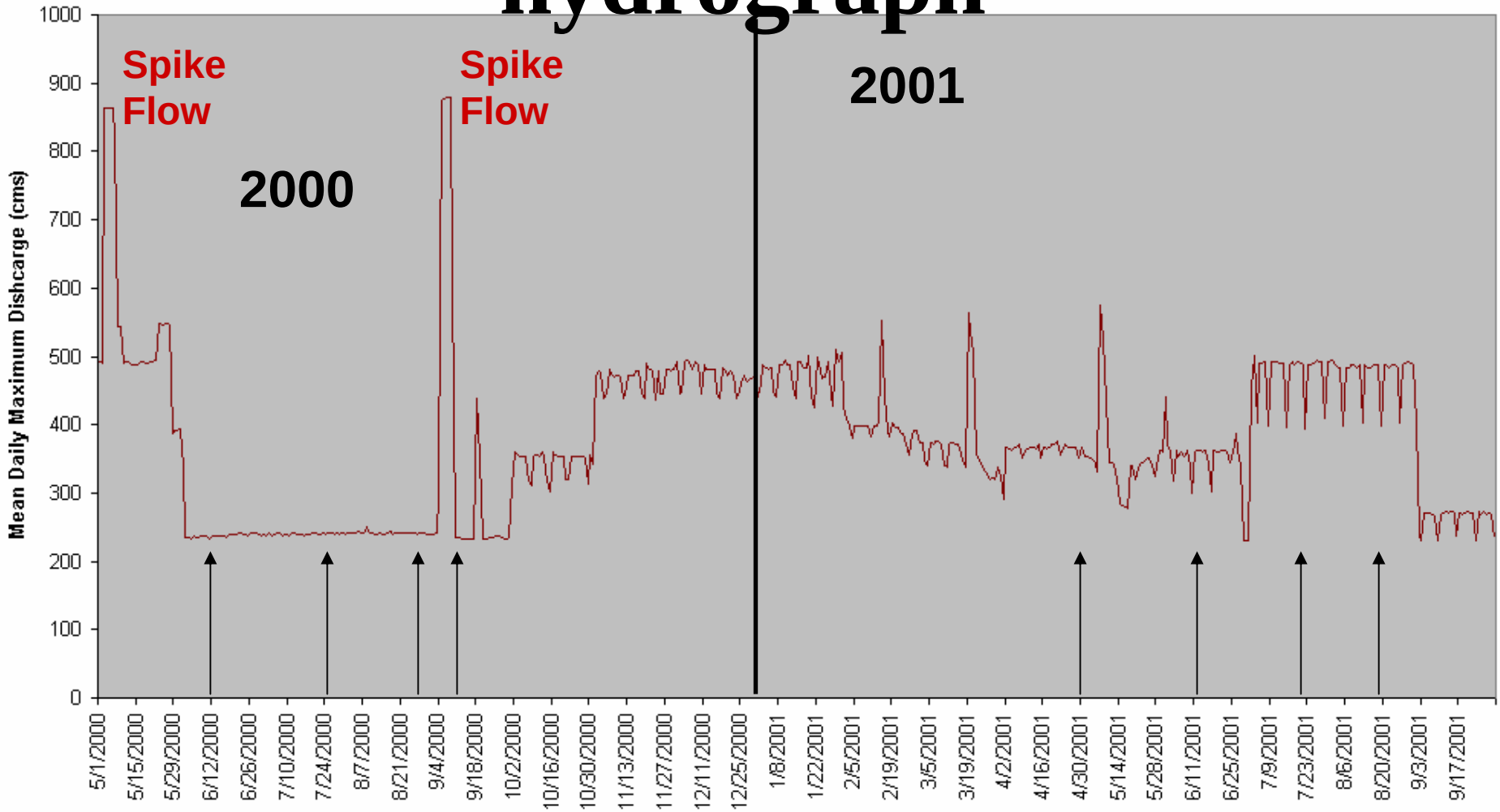
Species surveyed

Equisetum

Tamarix



Sample dates on hydrograph



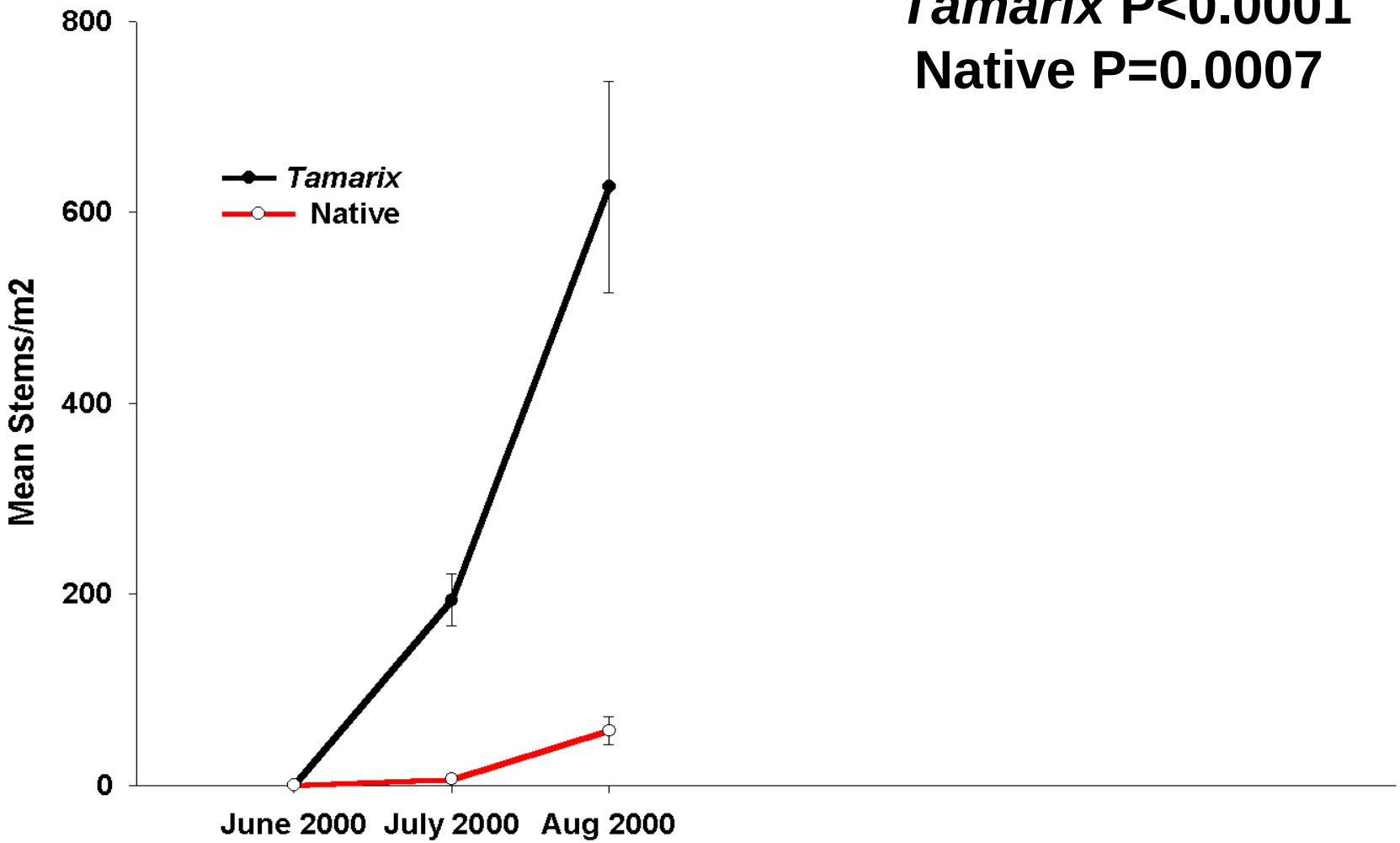
Tamarix establishment for low steady flows in 2000

July

August

What is the nature of the colonist? Are they native or exotic?

***Tamarix* P<0.0001**
Native P=0.0007




AIG

What is the nature of the colonist? Are they native or exotic?

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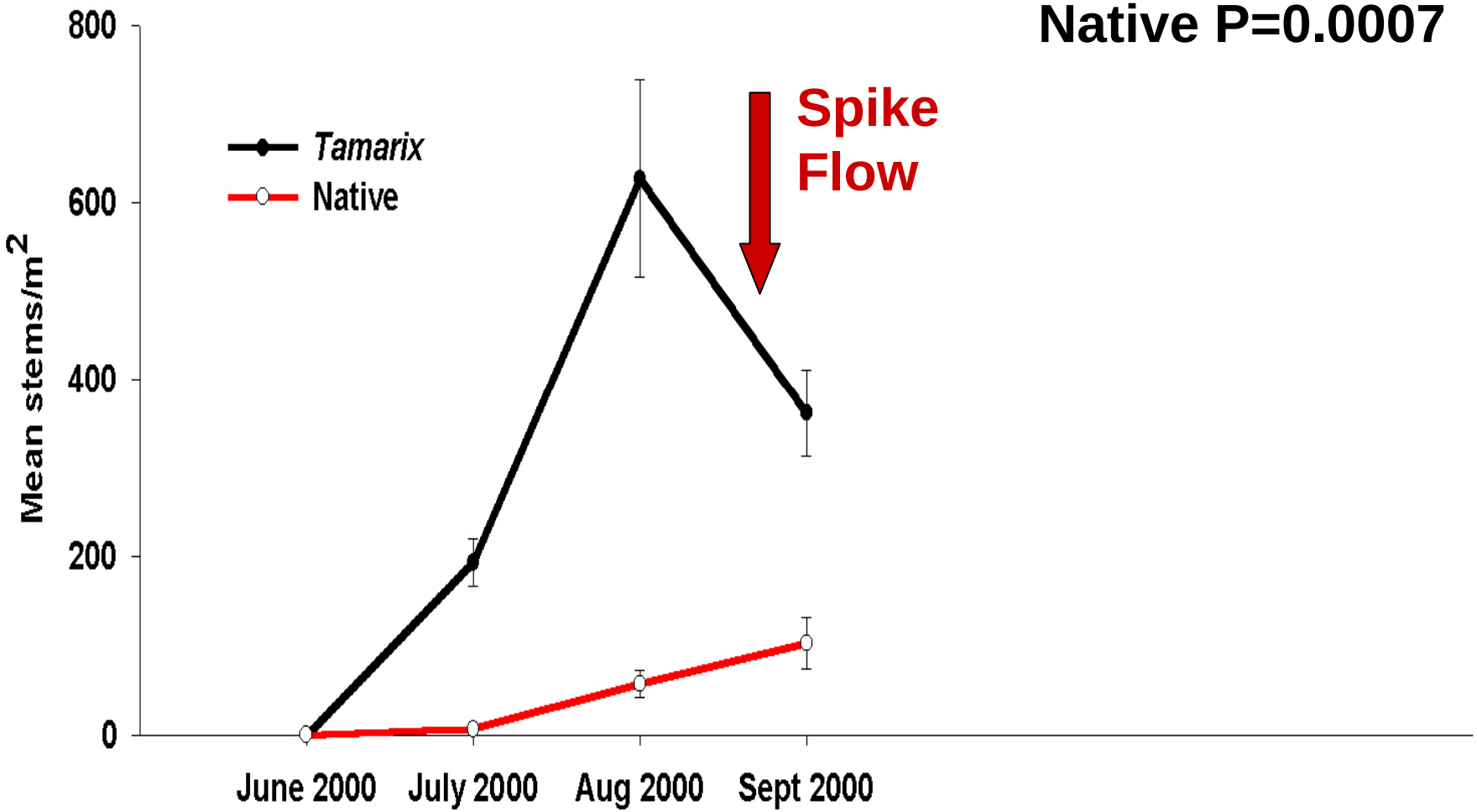

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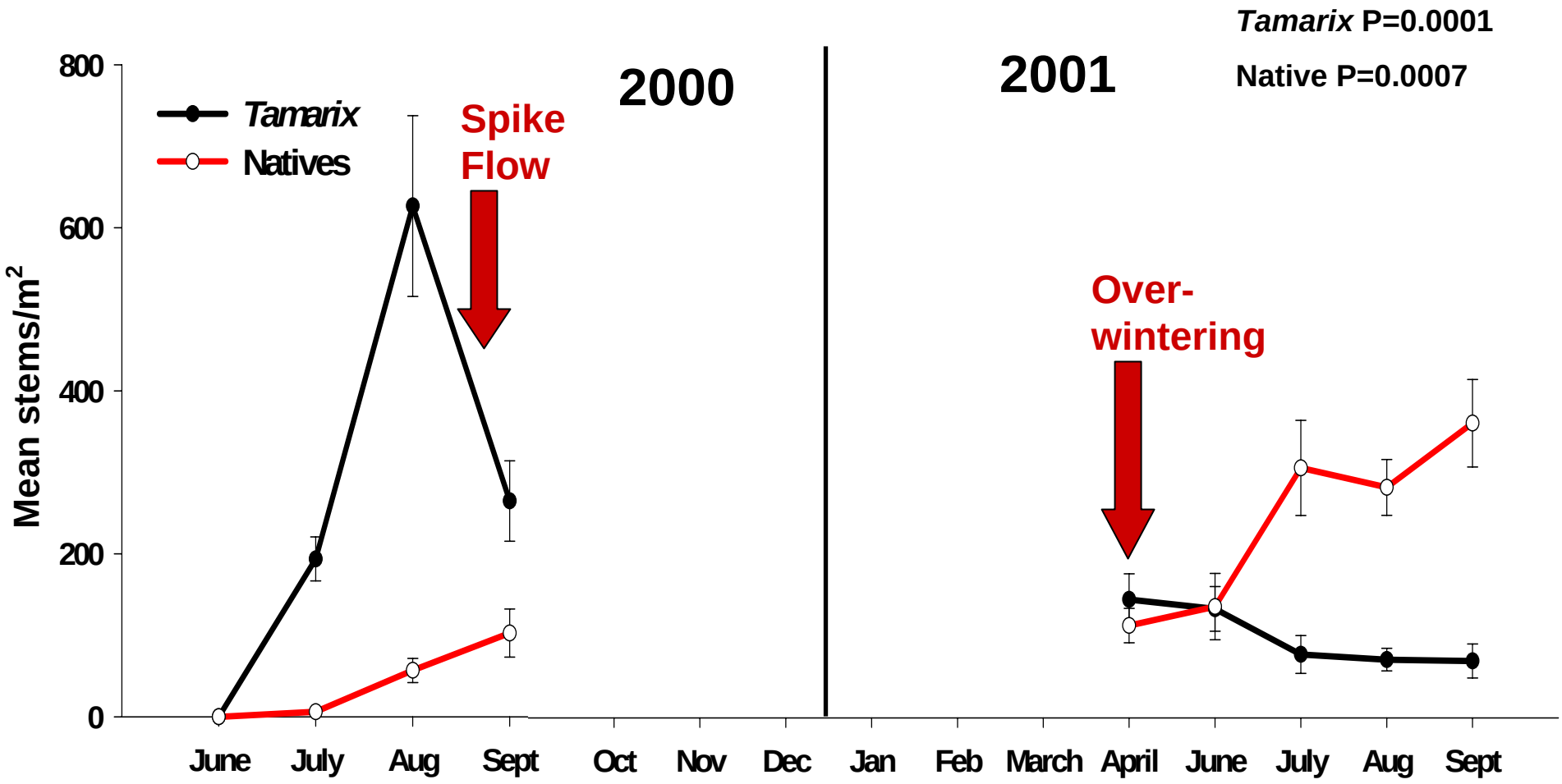
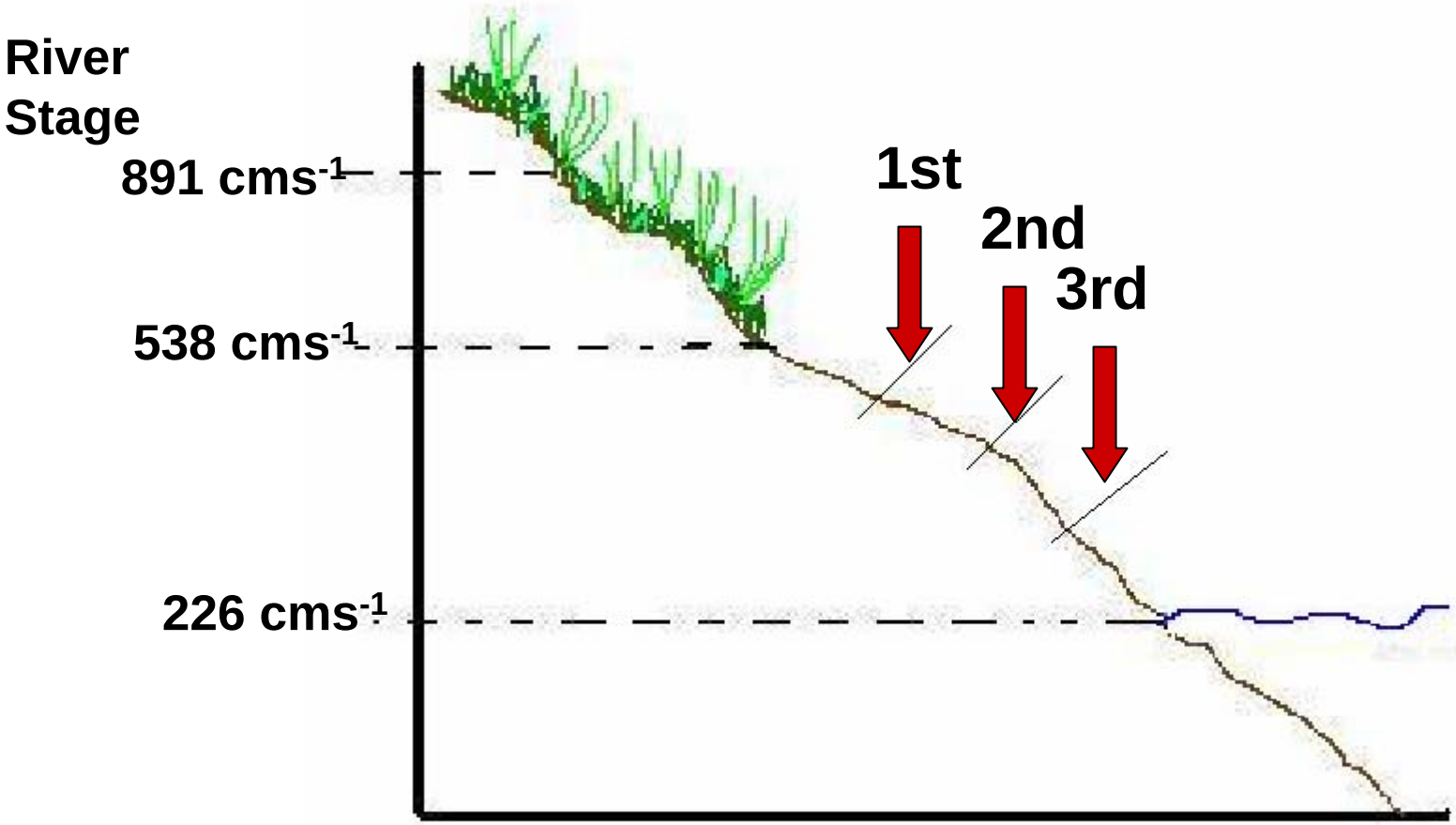
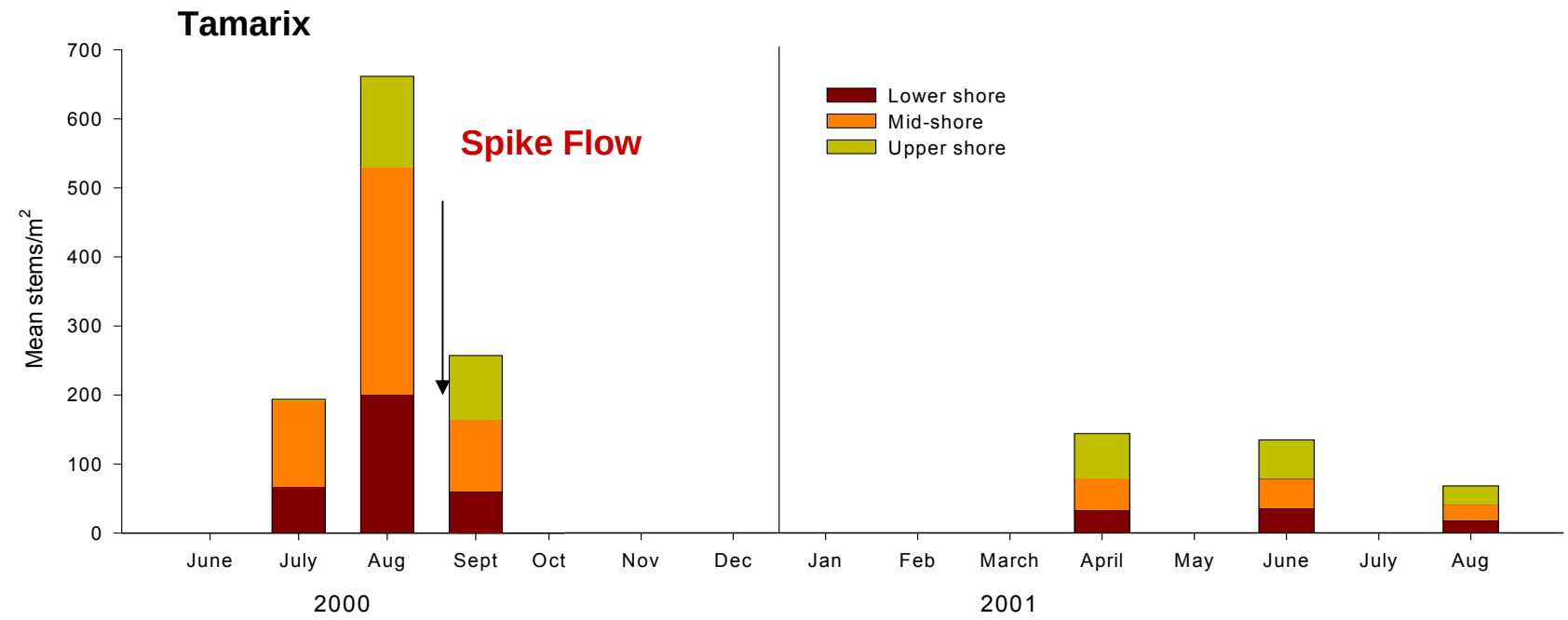
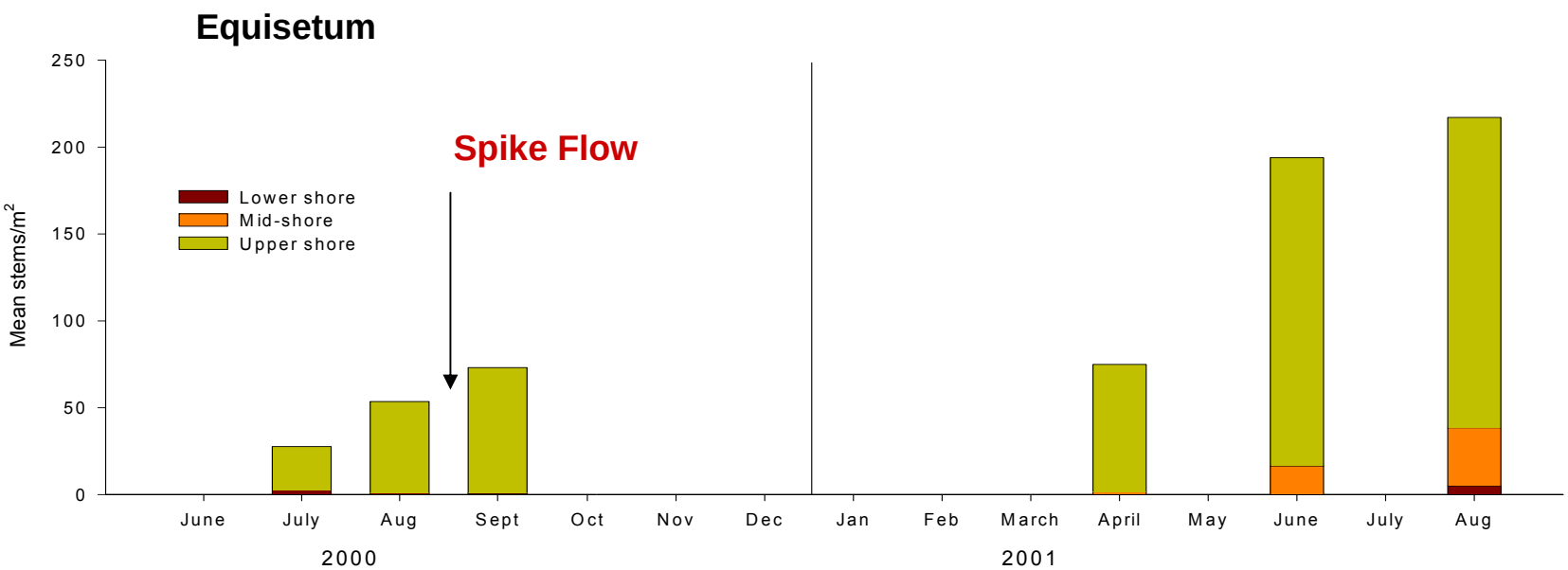


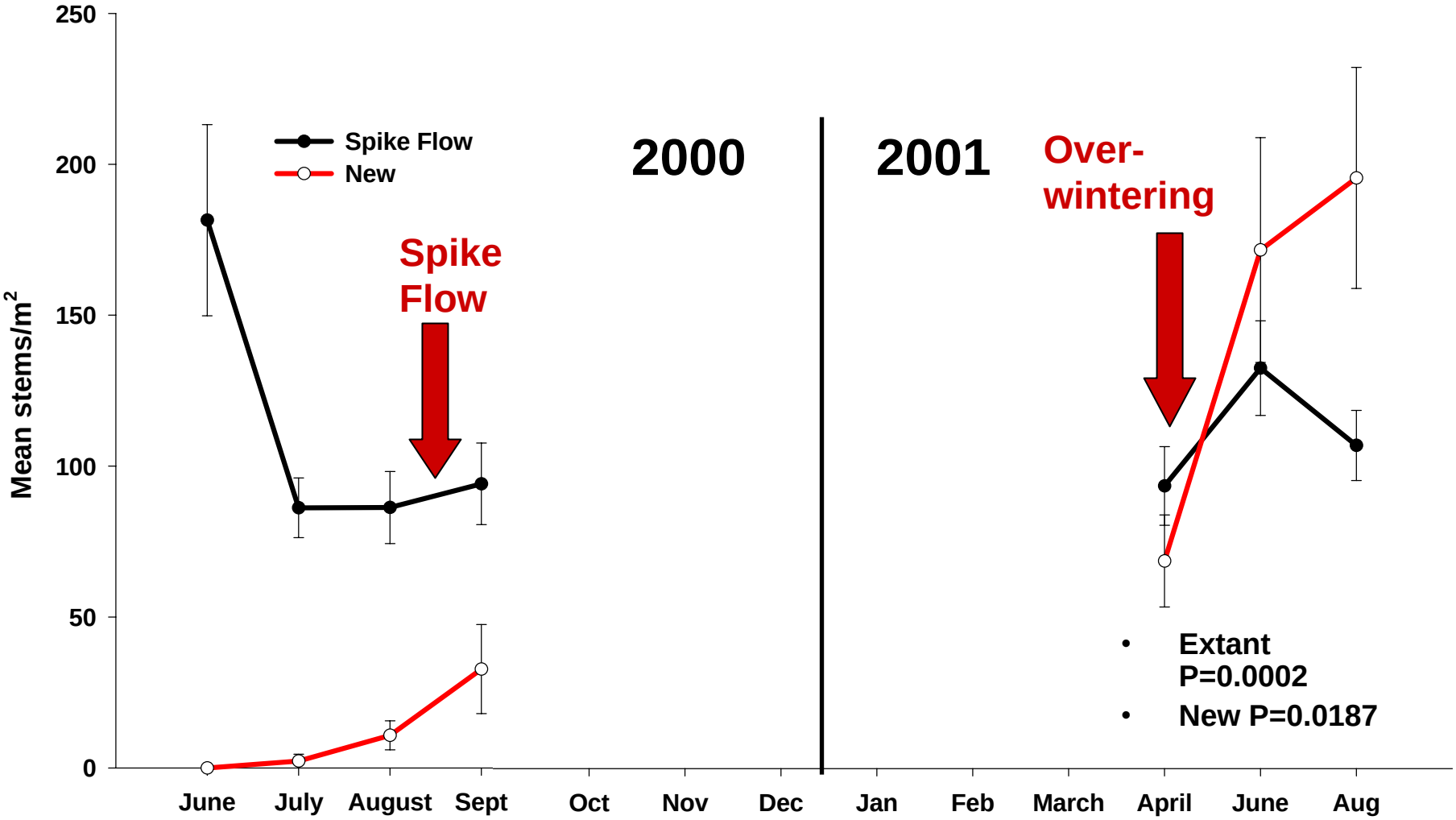
Schematic of transect divisions




Tamarix
Mean stems/m2
700
600
500
400
300
200
100
0
Spike Flow
Lower shore
Mid-shore
Upper shore
June
July
Aug
Sept
Oct
Nov
Dec
Jan
Feb
March
April
May
June
July
Aug
2000
2001


Equisetum
Mean stems/m2
250
200
150
100
50
0
Spike Flow
Lower shore
Mid-shore
Upper shore
June
July
Aug
Sept
Oct
Nov
Dec
Jan
Feb
March
April
May
June
July
Aug
2000
2001

What are the effects of flows on extant vegetation?
Equisetum responses for 2000 & 2001



Greenhouse Experiment

The Goal: Experimentally change the water table!

-We wanted to mimic water table decline on the Colorado River.

-Can we experimentally see the same mortality seen in the field?

Water table decline on dam regulated rivers is often very rapid causing extensive water stress and mortality (Mahoney and Rood 1998; Horton and Clark 2000).

The Rhizopods

- Plant *Equisetum* plug in peripheral tube
- Allow 7 days to establish
- Drain main reservoir
- Run at low water levels for 50 days
- Harvest

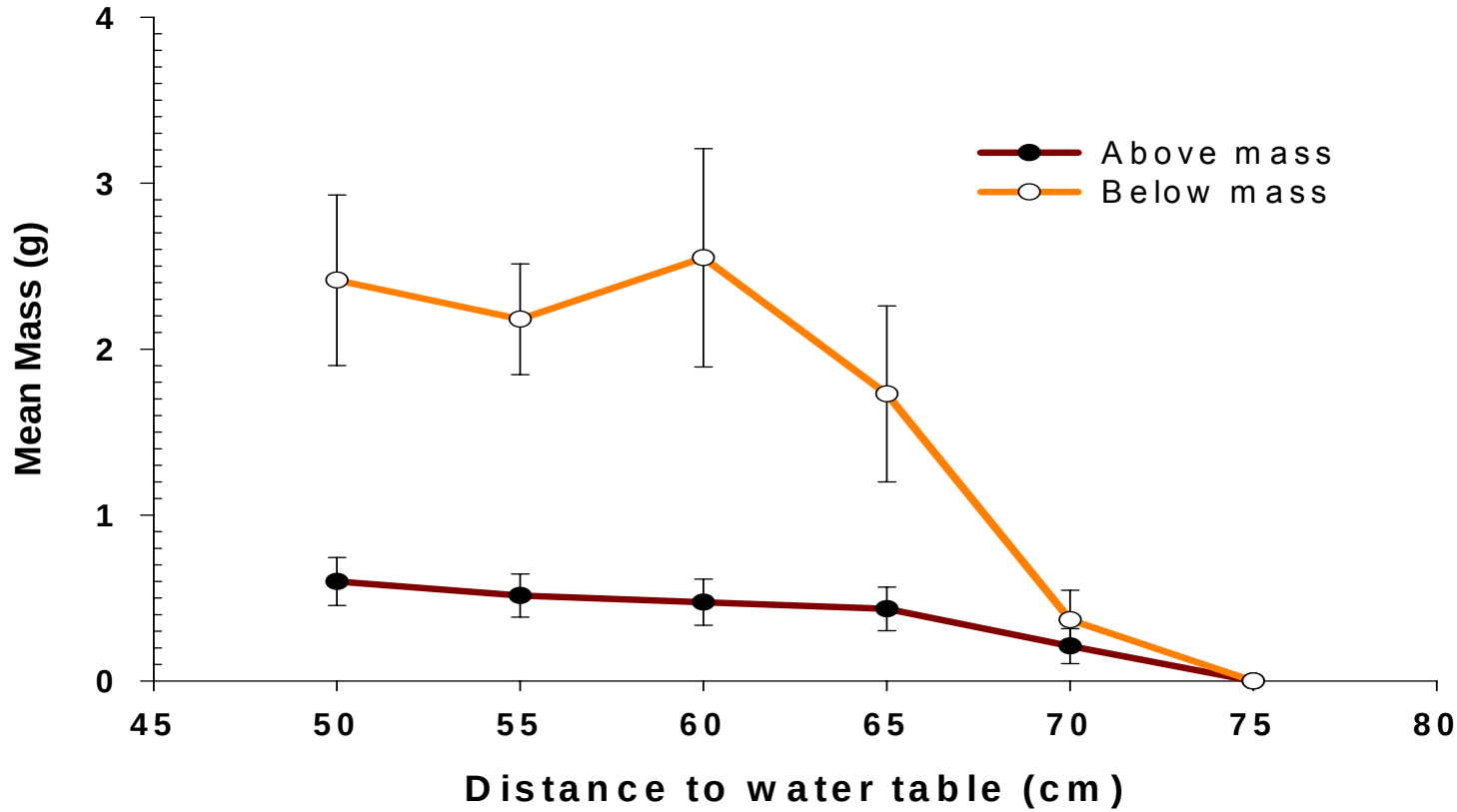
Rhizopod Questions

- **What is the *Equisetum* threshold for drastic water changes?**
  - **How do the above and below ground biomasses of *Equisetum* respond to water limitation?**
  - **What differences in *Equisetum* stem mortality are found in water stressed situations?**

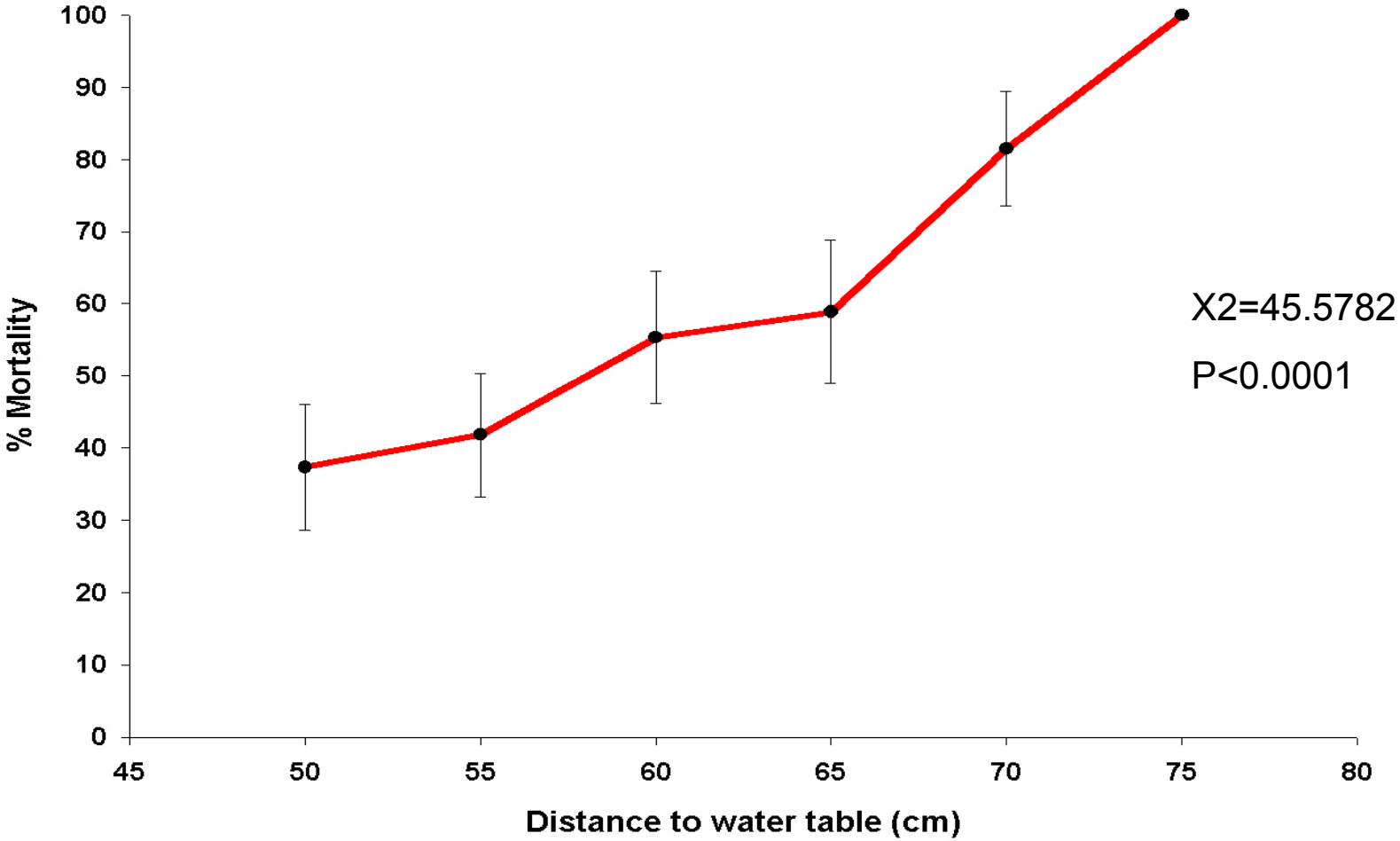
Above vs below ground biomass

Above $\chi 2=14.0268$; $P<0.0154$

Below $\chi 2= 33.8486$; $P<0.0001$

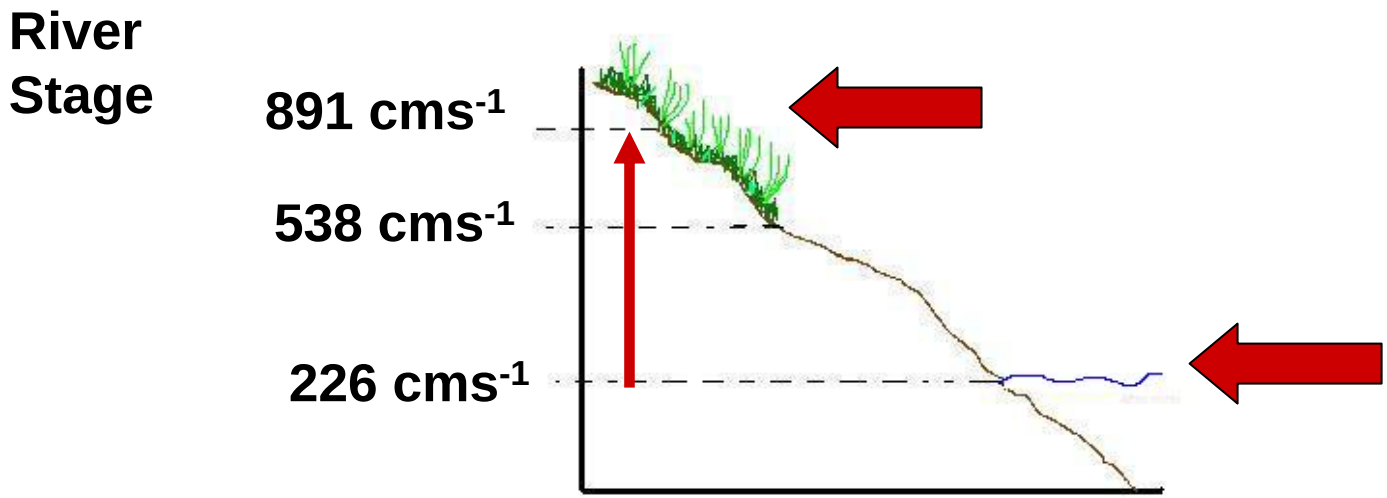


% Stem Mortality



Field Analogs to Greenhouse distance from water table

- **The vertical distance to the water table for Equisetum during the low steady flows ranged from 75 cm to 285 cm.**



Conclusions

- ***Equisetum*** **does appear to have a survival threshold for rapid changes in the water table.**

The Big Picture

- **Plants are able to colonize the new habitat.**
- **Low steady flows favor Tamarix establishment.**
- **Low fluctuating flows favor native clonal plant establishment.**
- **Potential fish habitat is created.**

Management Implications

-Vegetation provides habitat for native endangered fishes (Converse et al. 1998)

-Recreation effects

- **Loss of camping area(Kearsley et al. 1999)**
- **Fishing**

Future Research

Multi-year research plans

---1st Year: Establishment

---2nd Year: Inundation

Conclusions change in second year

Thanks to:

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