

Sacramento
River



Suisun
Bay

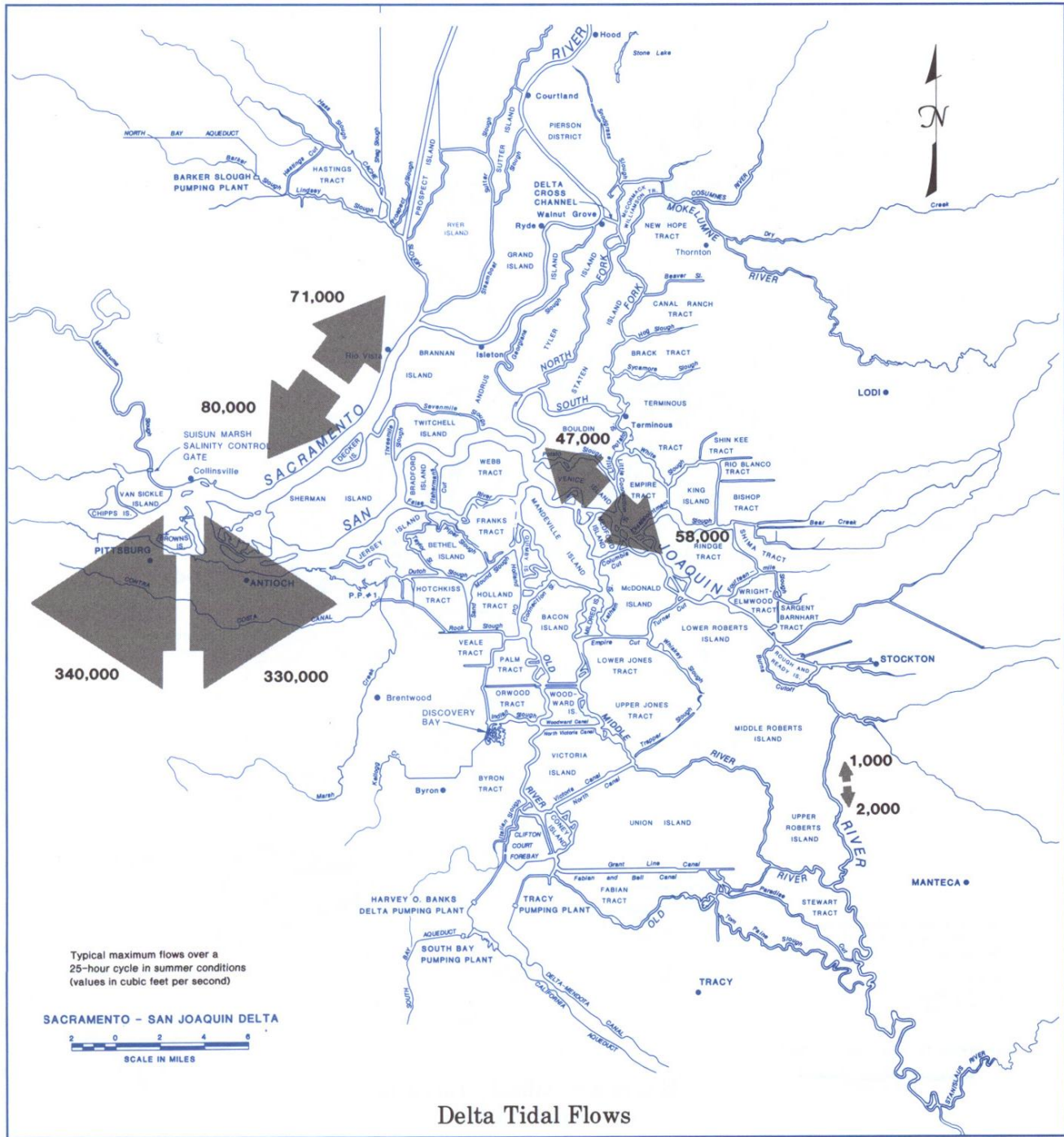
Sacramento-
San Joaquin
Delta

San Joaquin
River



San
Francisco

Digital Map from
Dr. William Bowen California
State University Northridge



Delta Tidal Flows

Stationary Habitat ---Geometry



Dynamic Habitat ---
Hydrodynamics, ocean conditions, weather

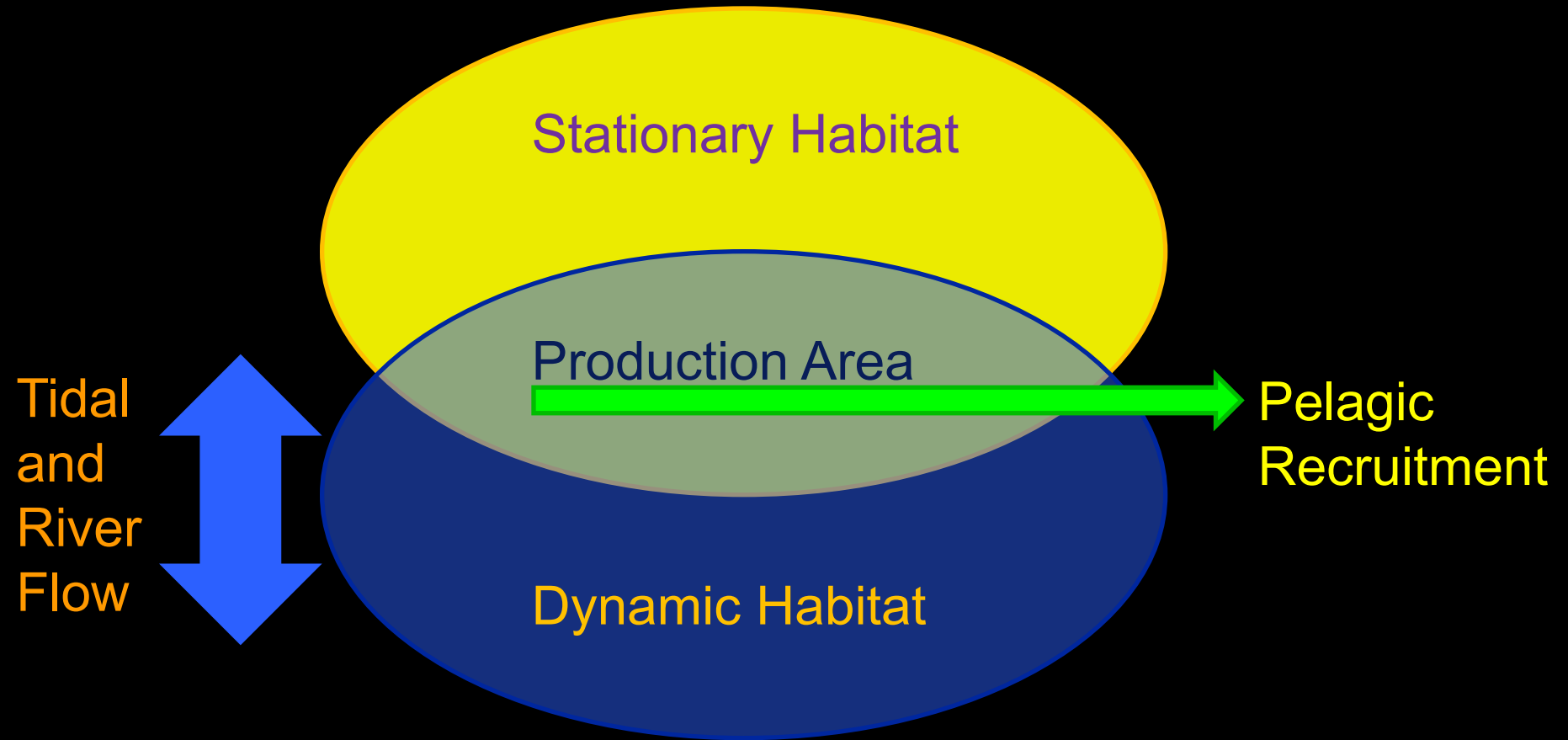


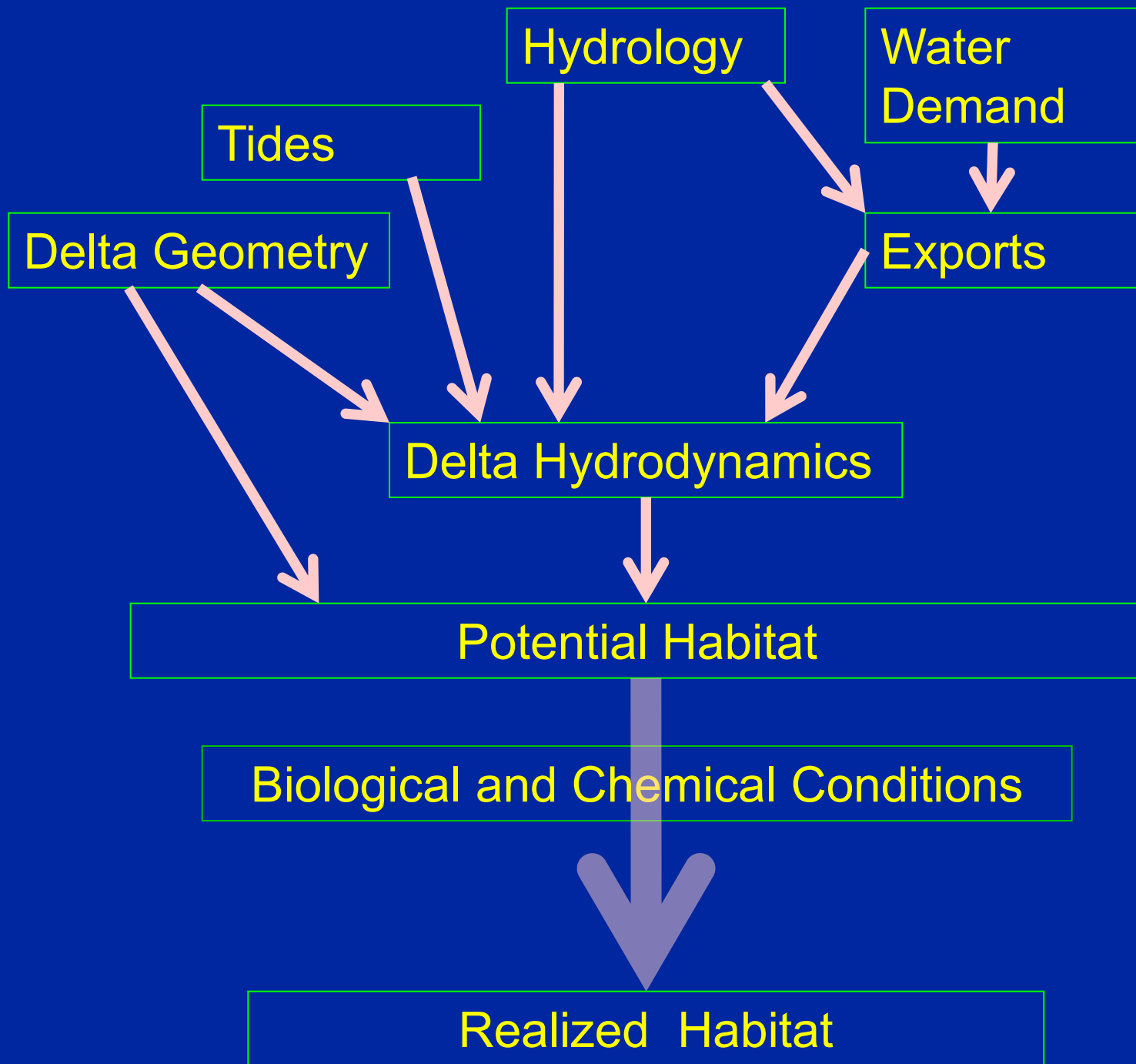
Biological Conditions



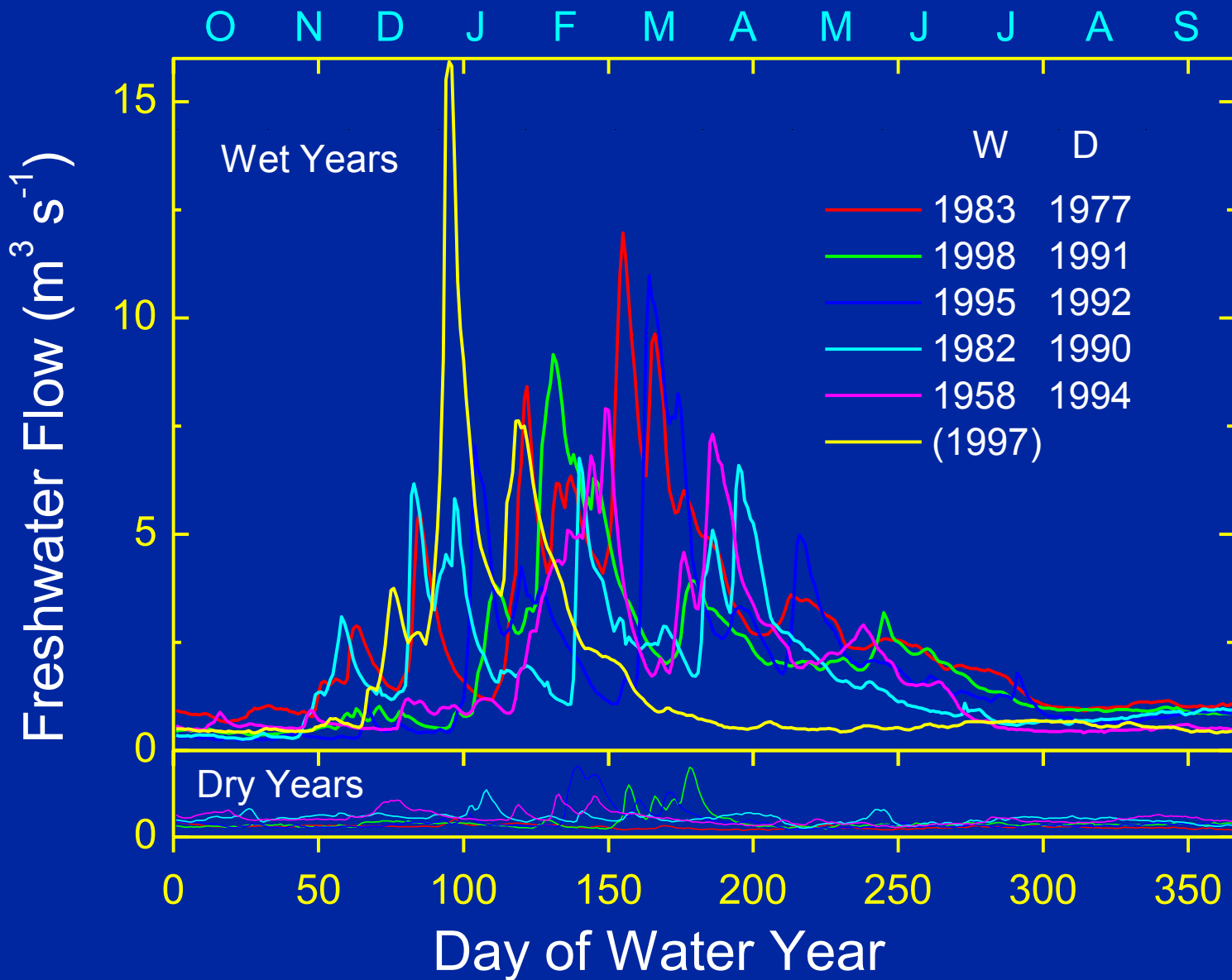
Environment

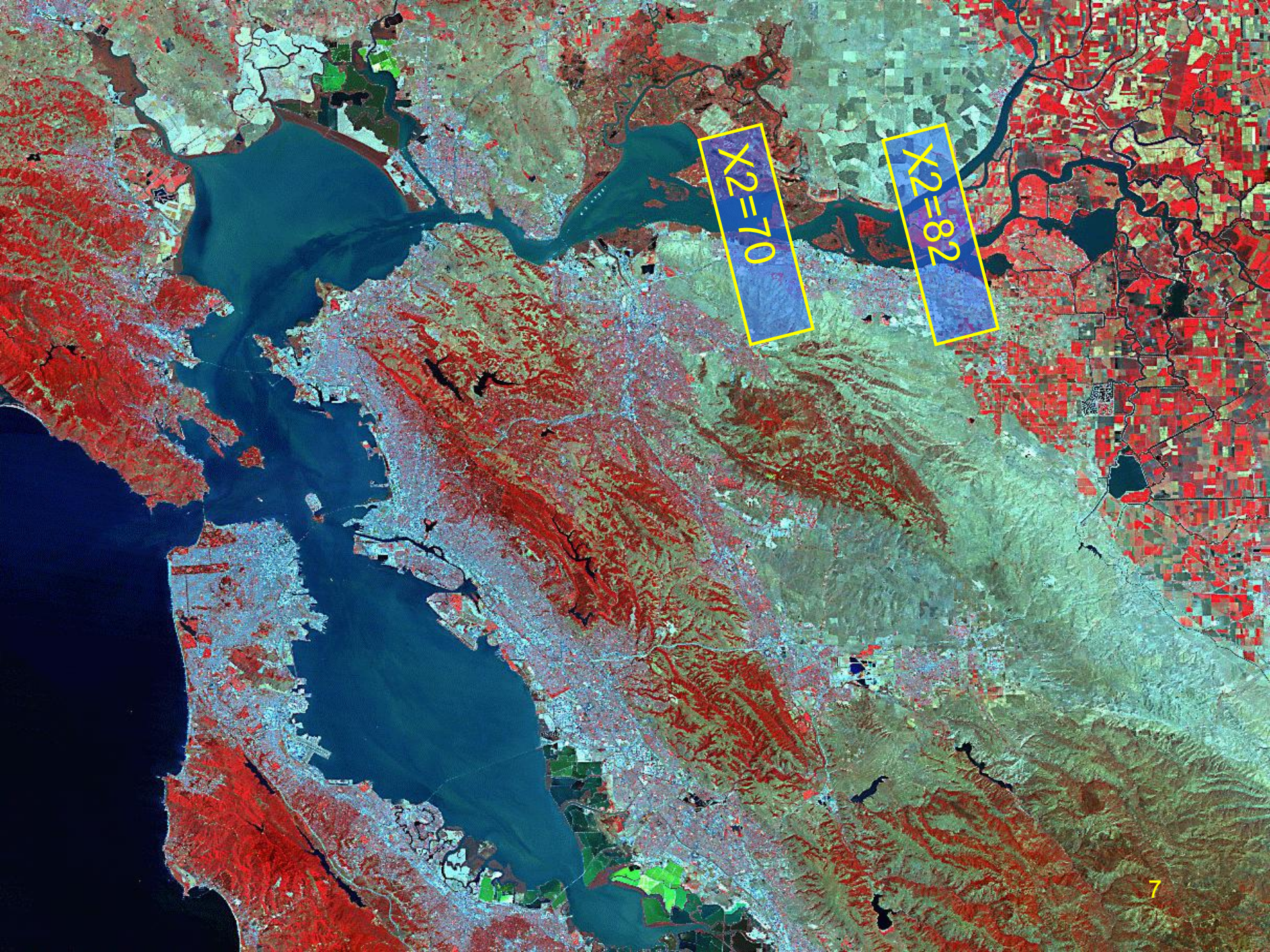
Estuarine habitat conceptual model (Peterson 2003)





Variability of Freshwater Delta Inflow

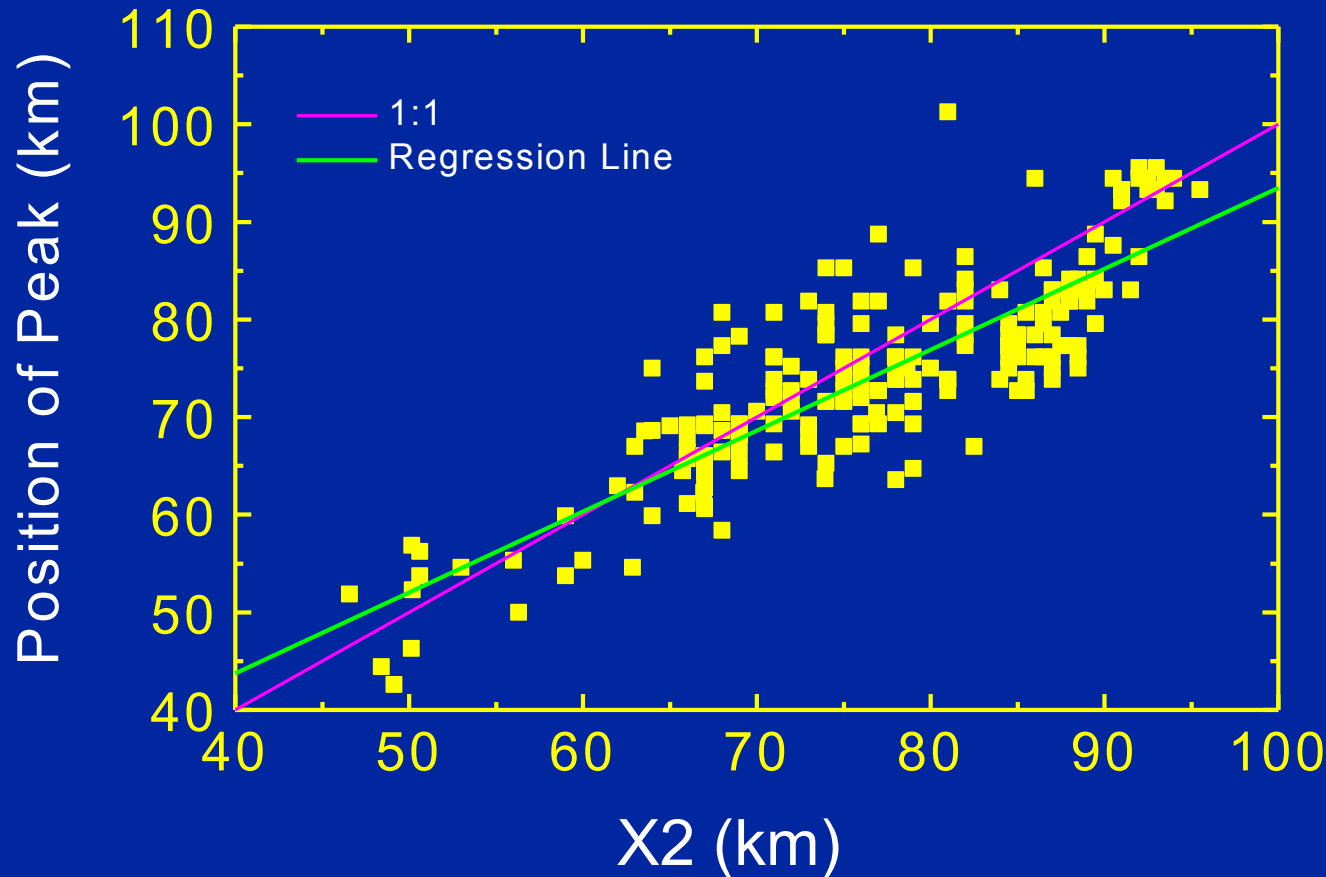
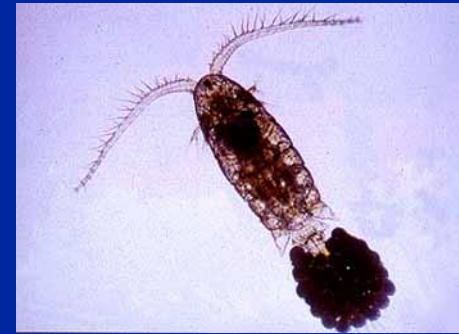




X2=70

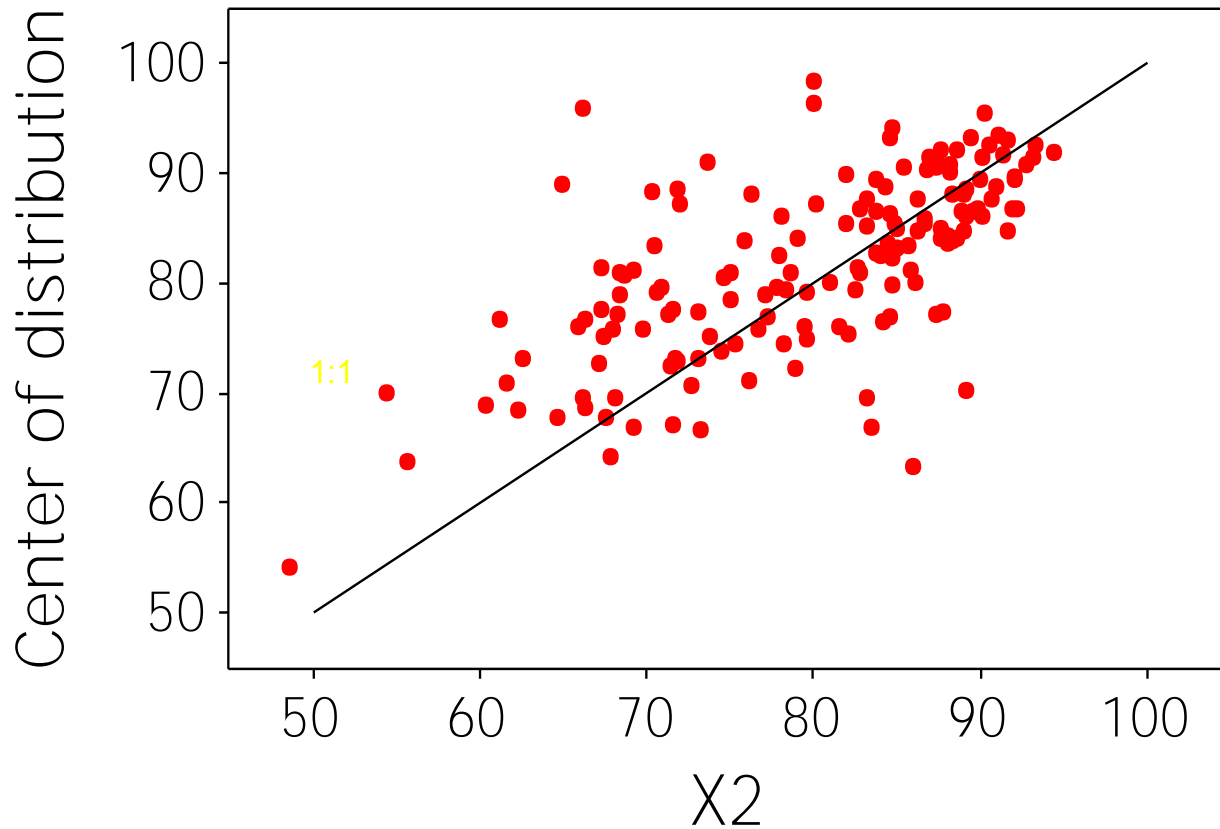
X2=82

Pelagic organisms follow salinity:
The copepod *Eurytemora affinis*

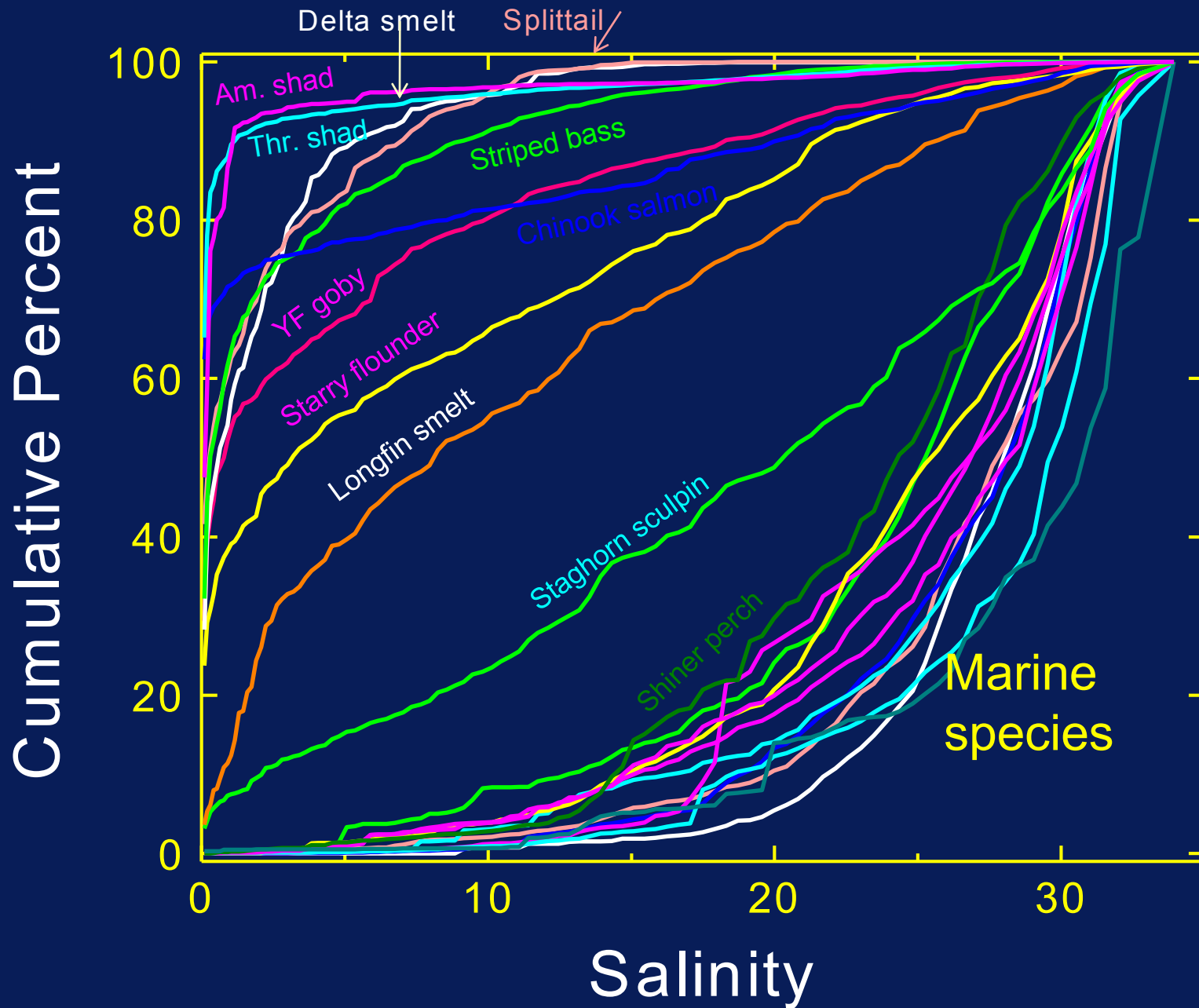


Kimmerer 1998

Pelagic organisms follow salinity: Delta smelt

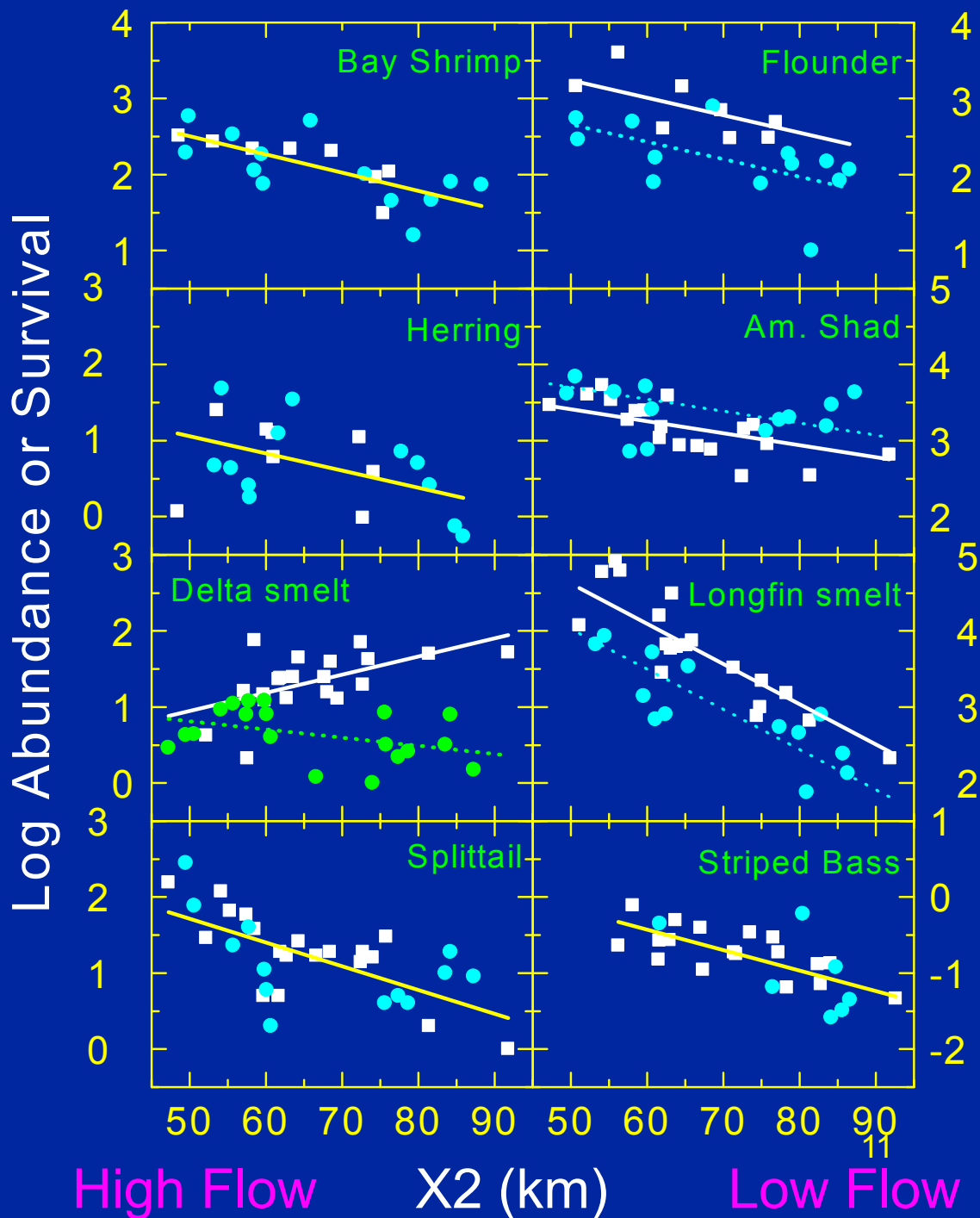


Most fishes follow salinities



[Kimmerer 2004](#)

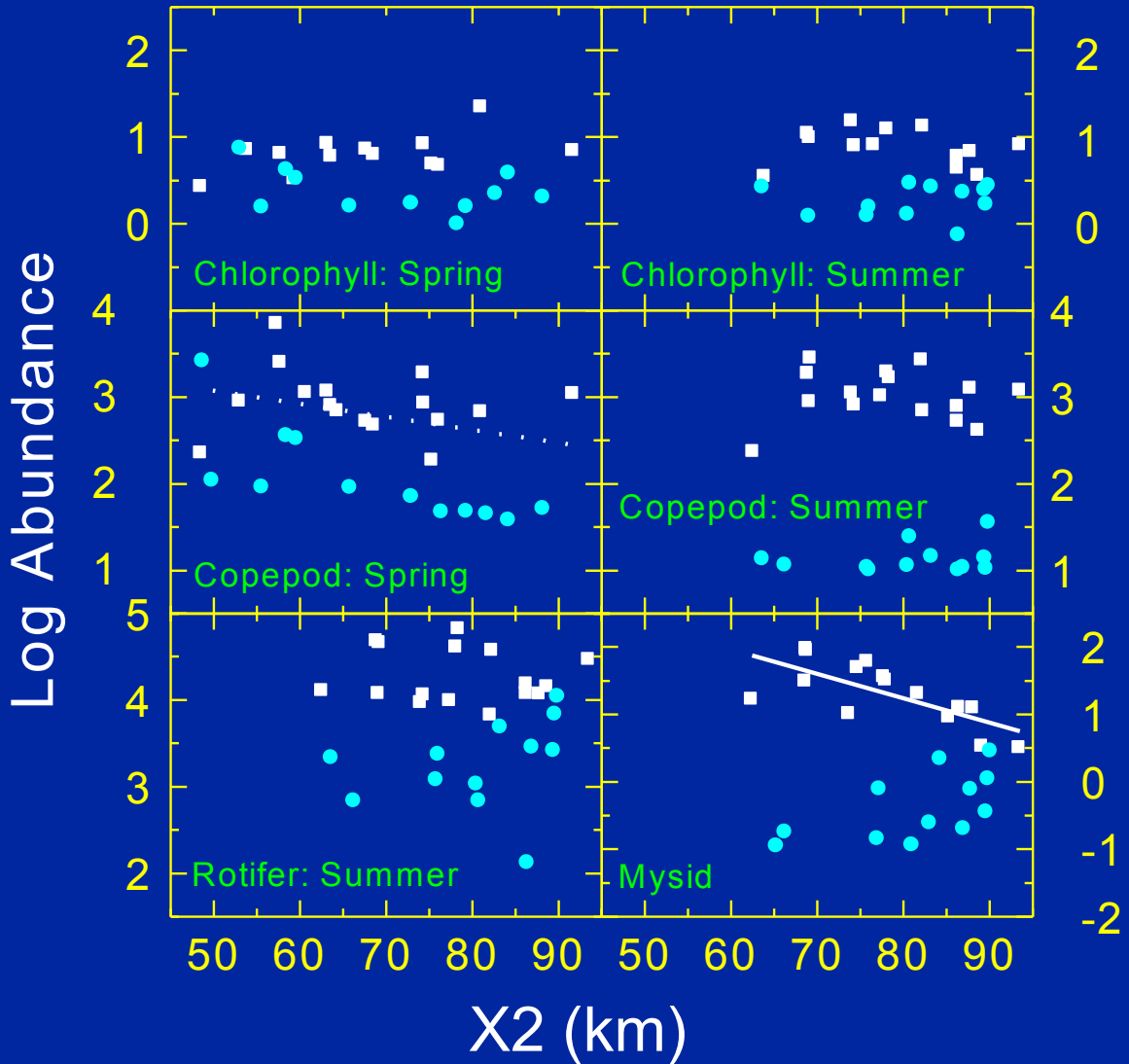
Higher trophic levels
show many
relationships of
abundance to
freshwater flow



Source:
 Kimmerer 2002MEPS

Lower trophic levels
show few relationships
of abundance to
freshwater flow

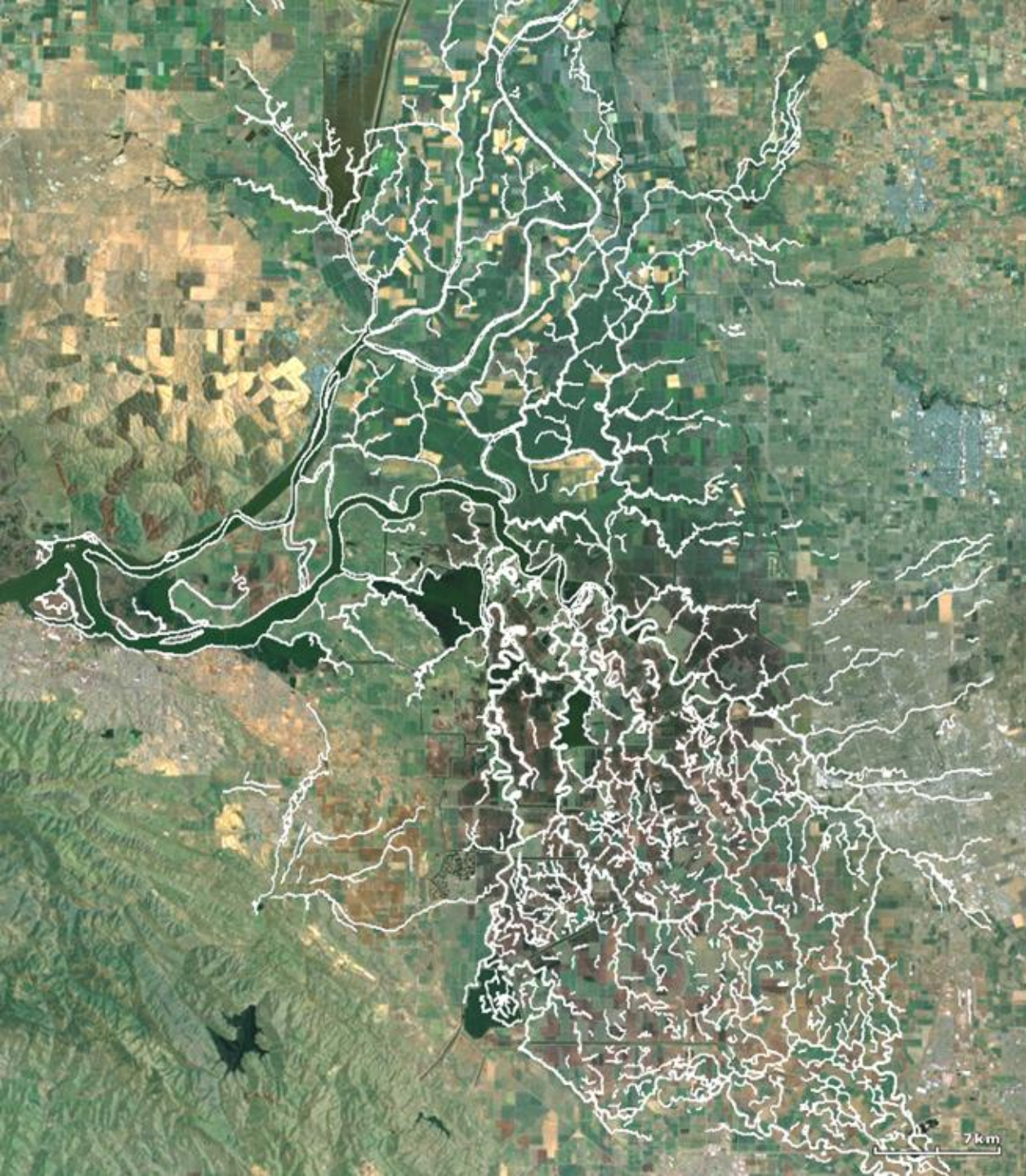
■ ——— 1972-1987
● 1988-2000



Source:
Kimmerer 2002 MEPS

High Flow

12
Low Flow



1873 Delta:

Long residence time

Marsh connections

Two rivers connect
to bay

Waterways dendritic



Modern delta

Short residence times

Rip-rapped

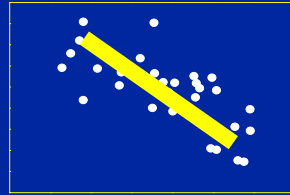
Cross Delta flows

Rare San Joaquin
connection to bay

Waterways web-like

What Changes As Flow Increases?

Salinity
and X2



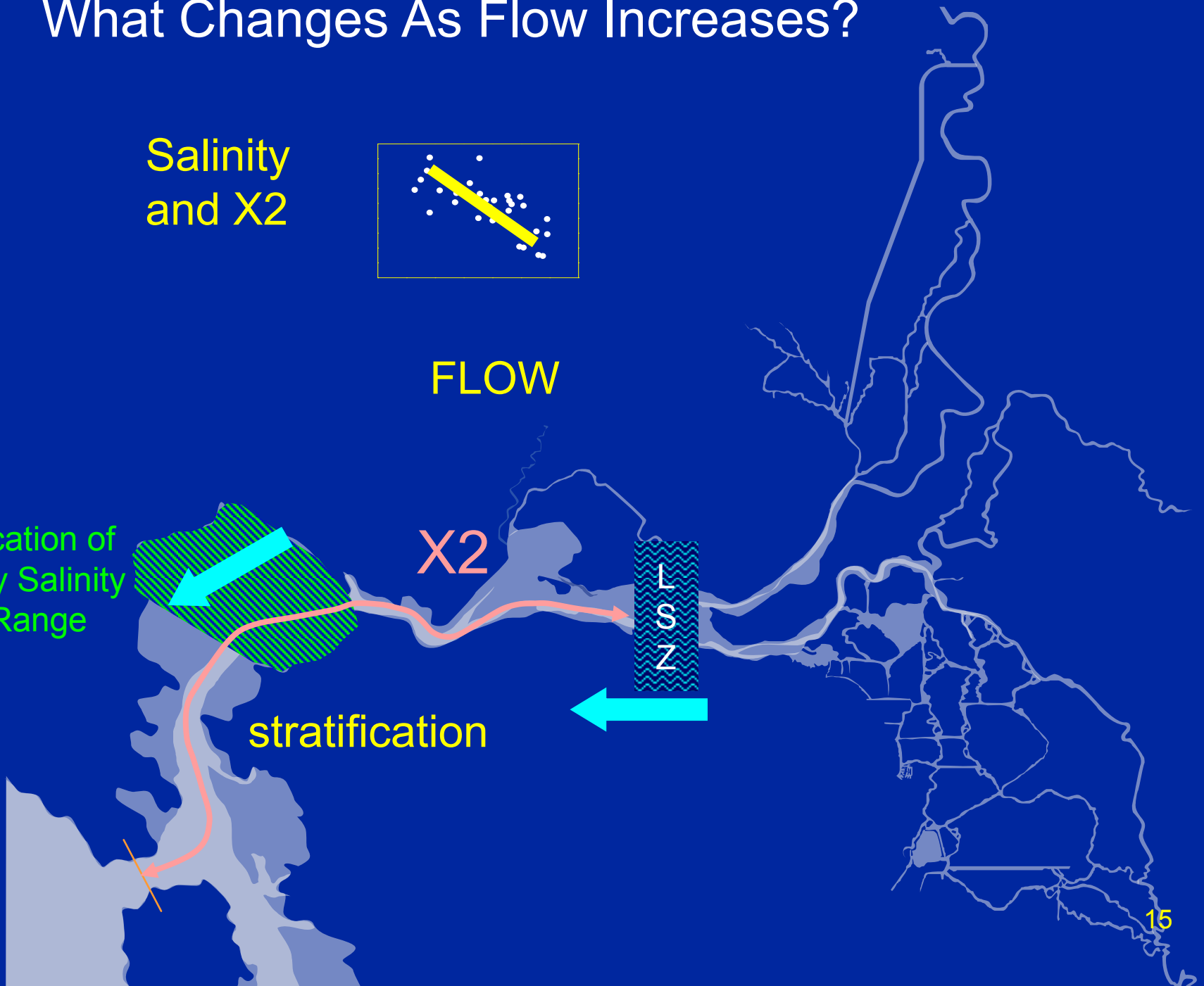
FLOW

Location of
Any Salinity
Range

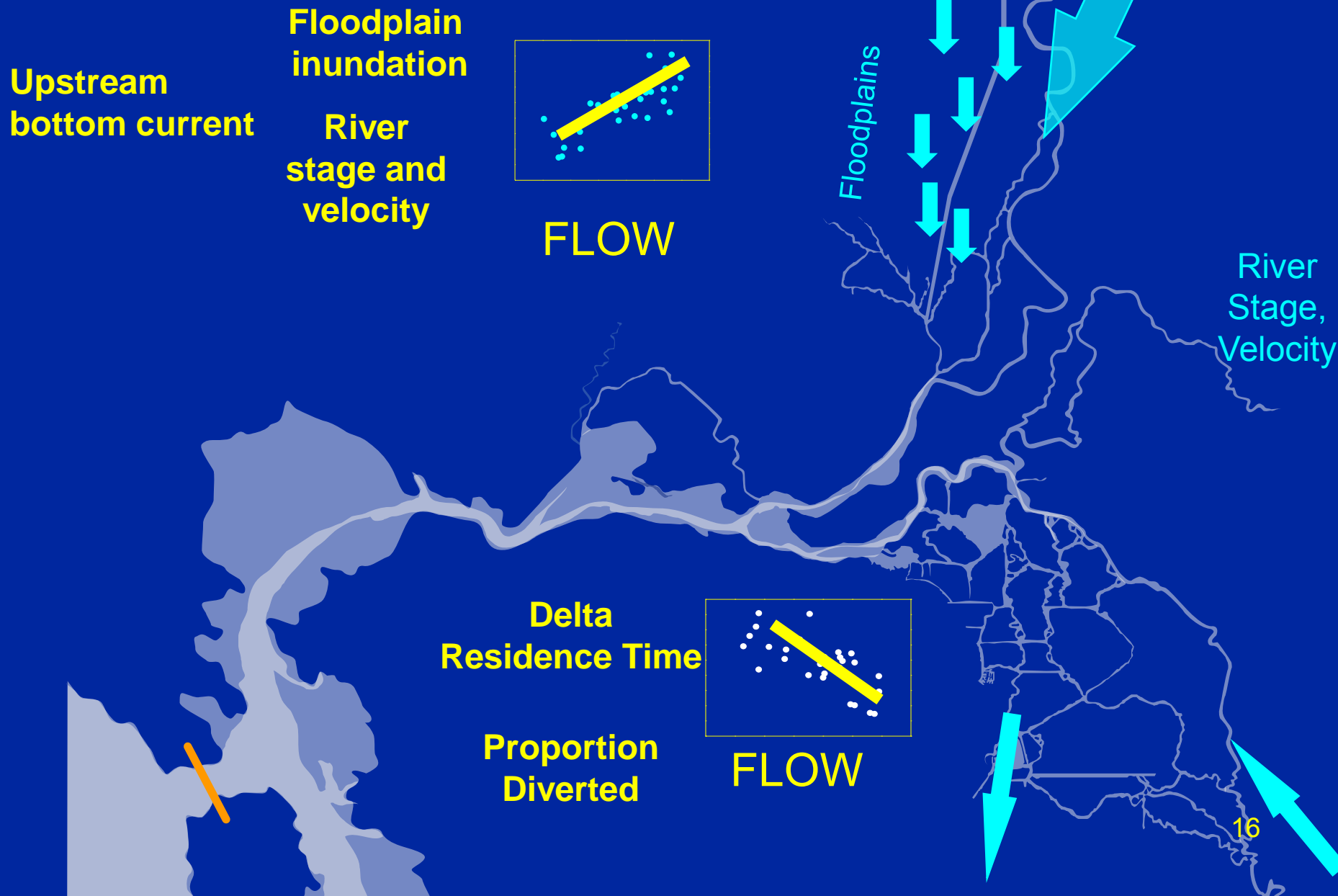
X2

L
S
Z

stratification

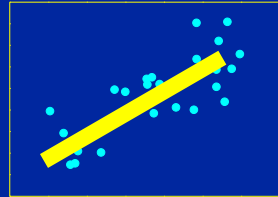


What Changes As Flow Increases?



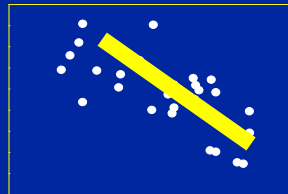
What Changes As Flow Increases?

Loadings



FLOW

Concentrations



FLOW

Nutrients
Contaminants
Organic matter
Sediment

What Changes As Flow Increases?

Adult spawners move up:

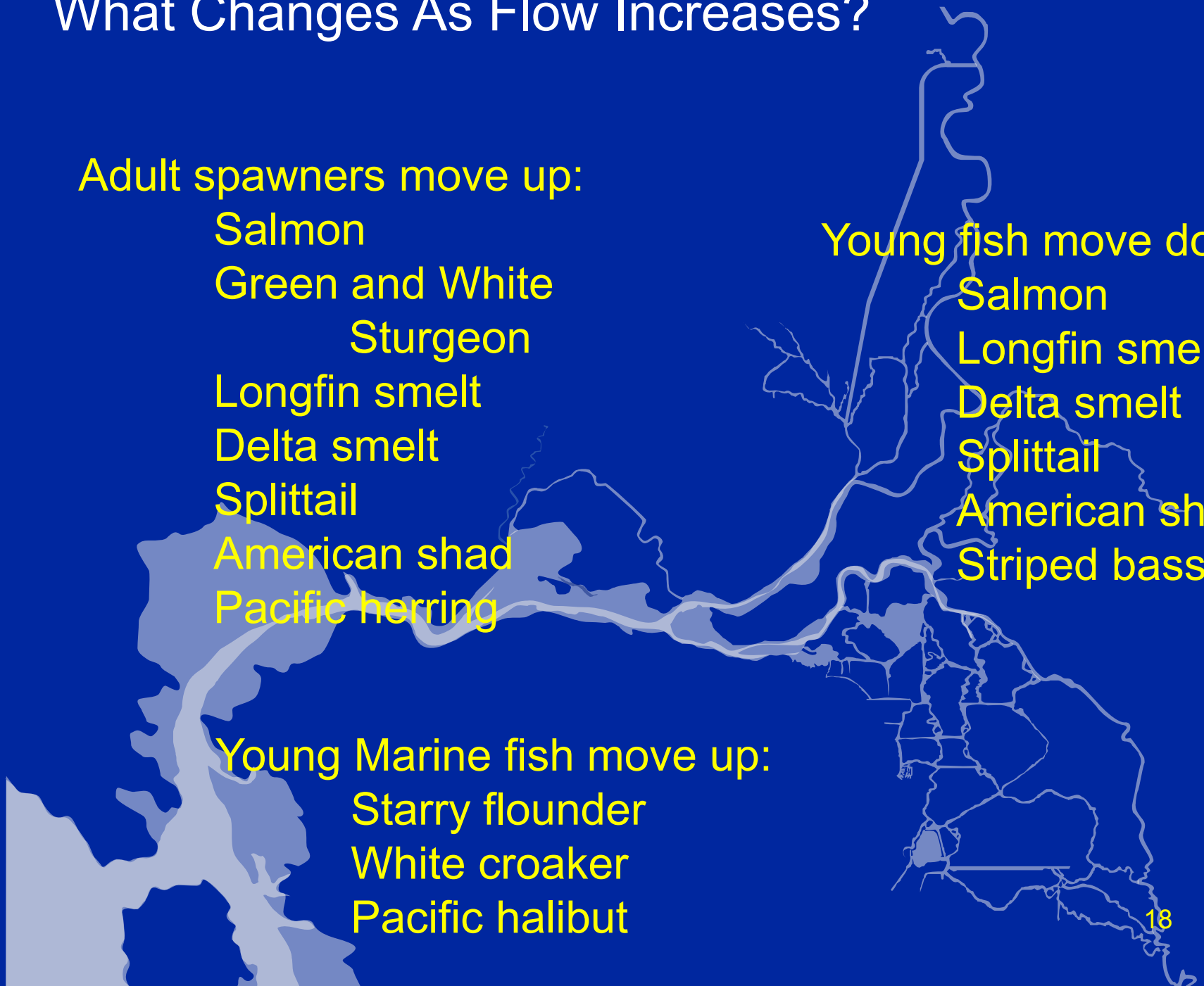
Salmon
Green and White
Sturgeon
Longfin smelt
Delta smelt
Splittail
American shad
Pacific herring

Young fish move down:

Salmon
Longfin smelt
Delta smelt
Splittail
American shad
Striped bass

Young Marine fish move up:

Starry flounder
White croaker
Pacific halibut



Flows are important
but so is geometry



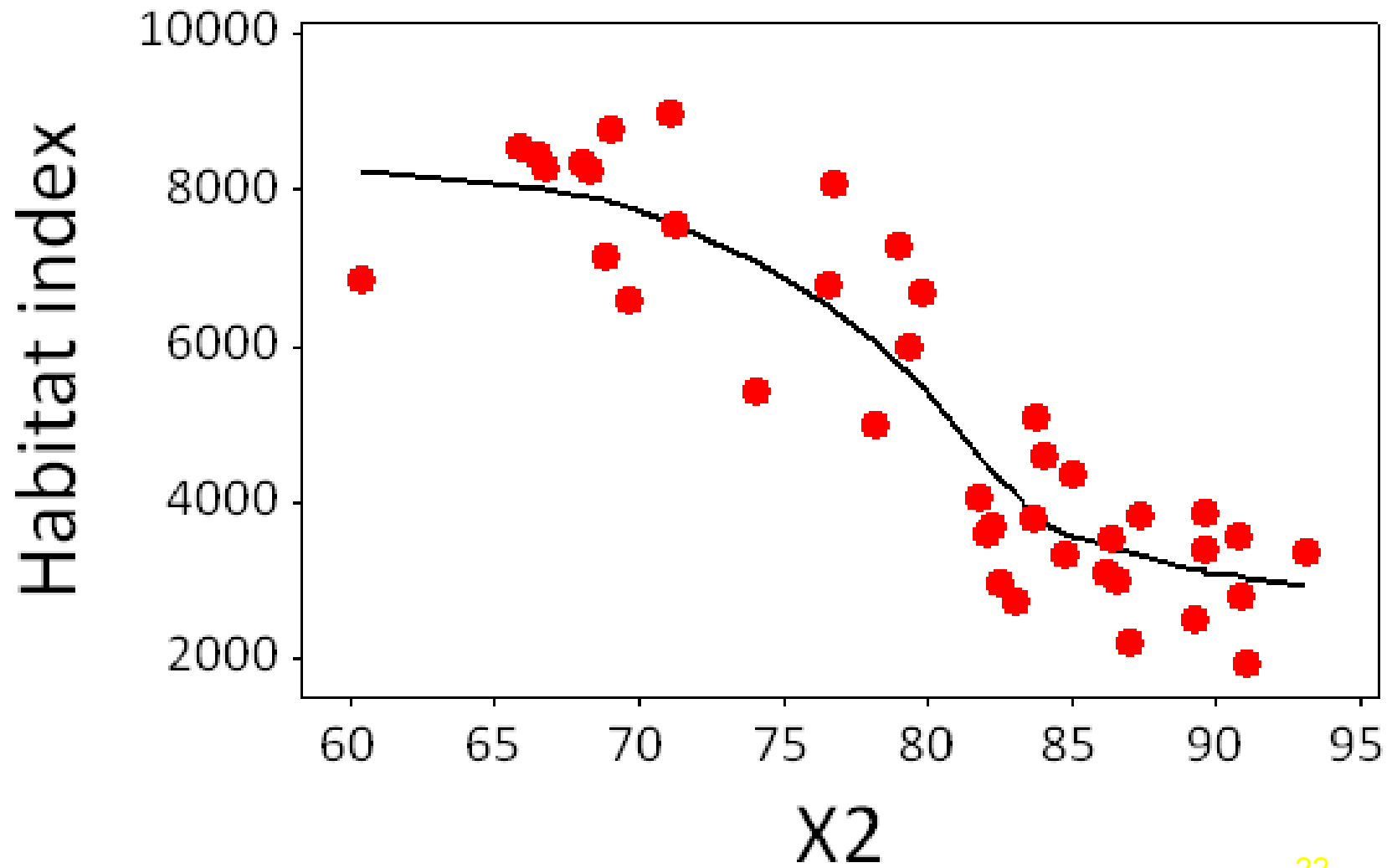
Head of Old River Barrier

Five Key Points

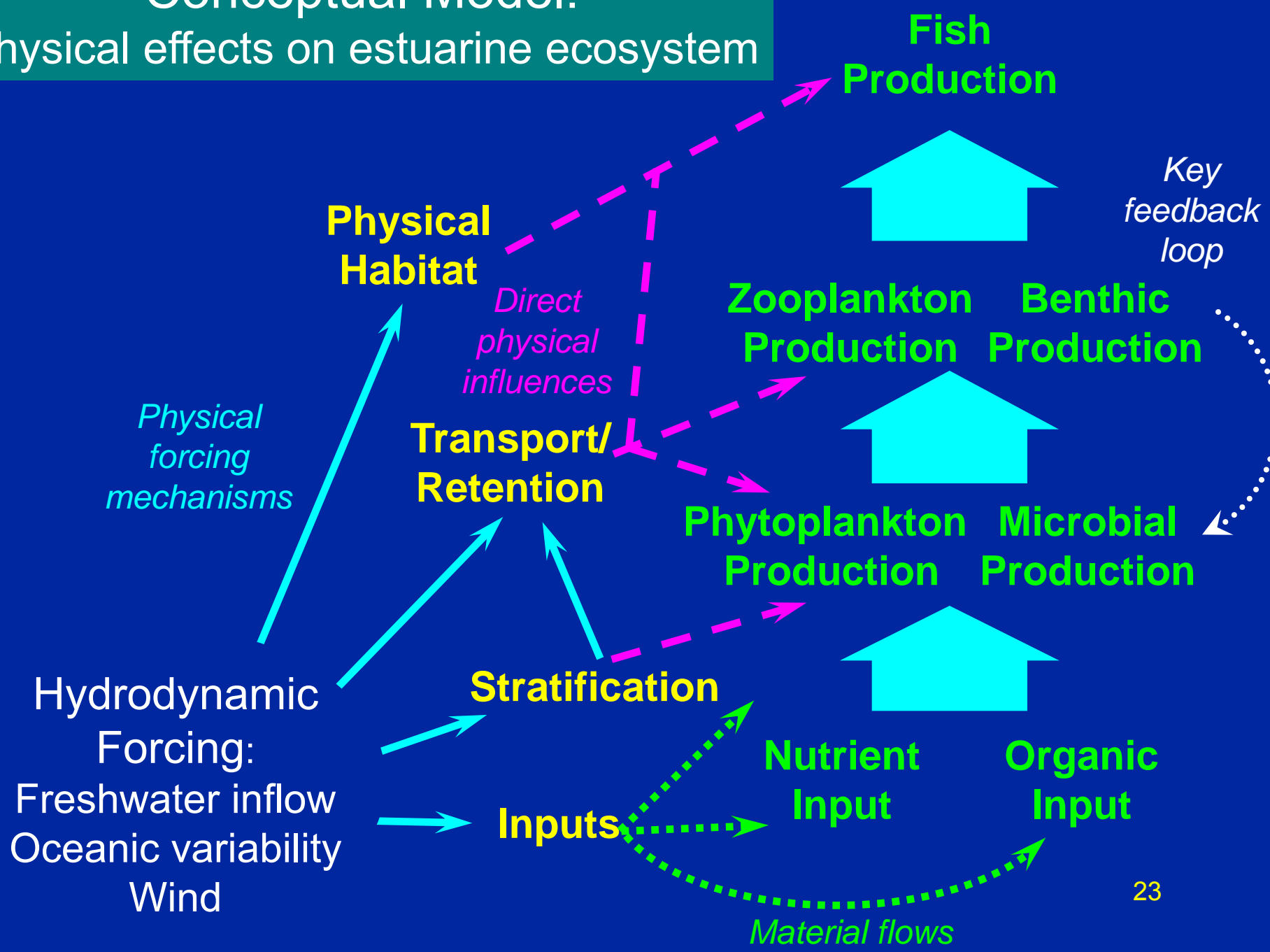
1. Environmental flows are more than just volumes of inflows and outflows
2. Recent flow regimes both harm native species and encourage non-native species
3. Flow is a major determinant of habitat and transport
4. Recent Delta environmental flows are insufficient to support native Delta fishes for today's habitats
5. A strong science program and a flexible management regime are essential to improving flow criteria



Delta smelt habitat abundance in relation to X2



Conceptual Model: Physical effects on estuarine ecosystem



How much water do fish need?

