

Life-History Responses to Freshwater Flow



Wim Kimmerer
Romberg Tiburon Center for Environmental Studies
San Francisco State University

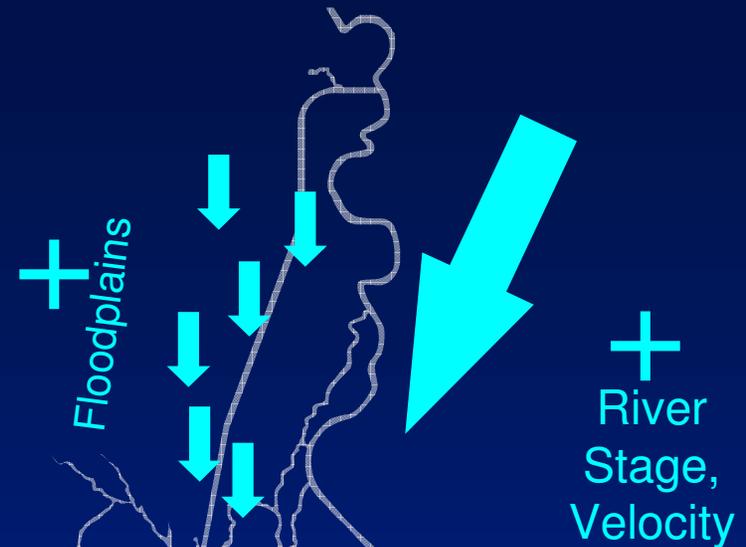


Main Points

- What does flow do in the ecosystem?
- Where does flow affect fish?
- How we learn about flow-fish relationships
- Interaction of flow with habitat and life history

What Changes As Flow Increases?

+
Stratification
Gravitational Circulation



Location of Any Salinity Range

-
X2

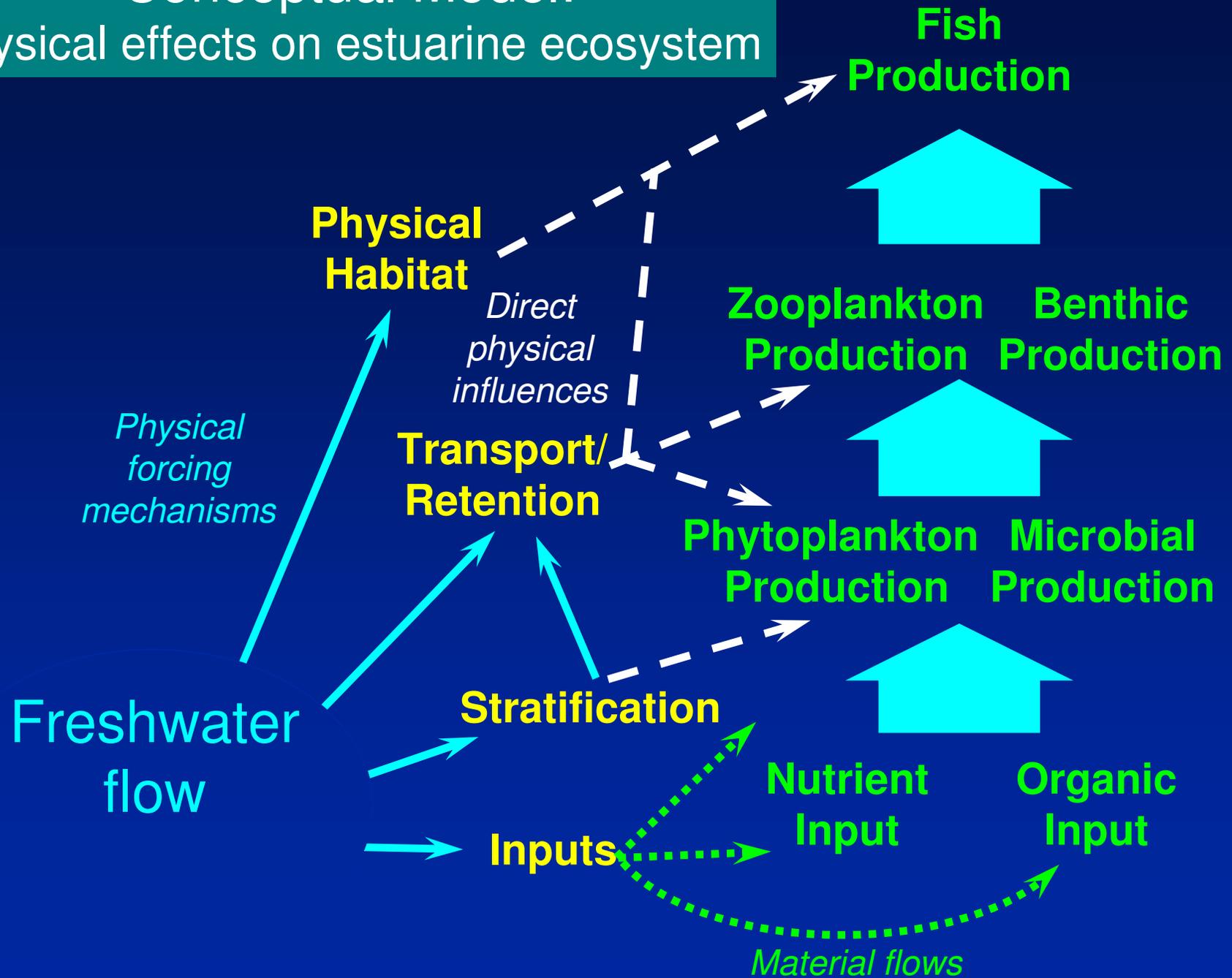
-
Salinity At a Point

-
Delta Residence Time

-
Proportion Diverted

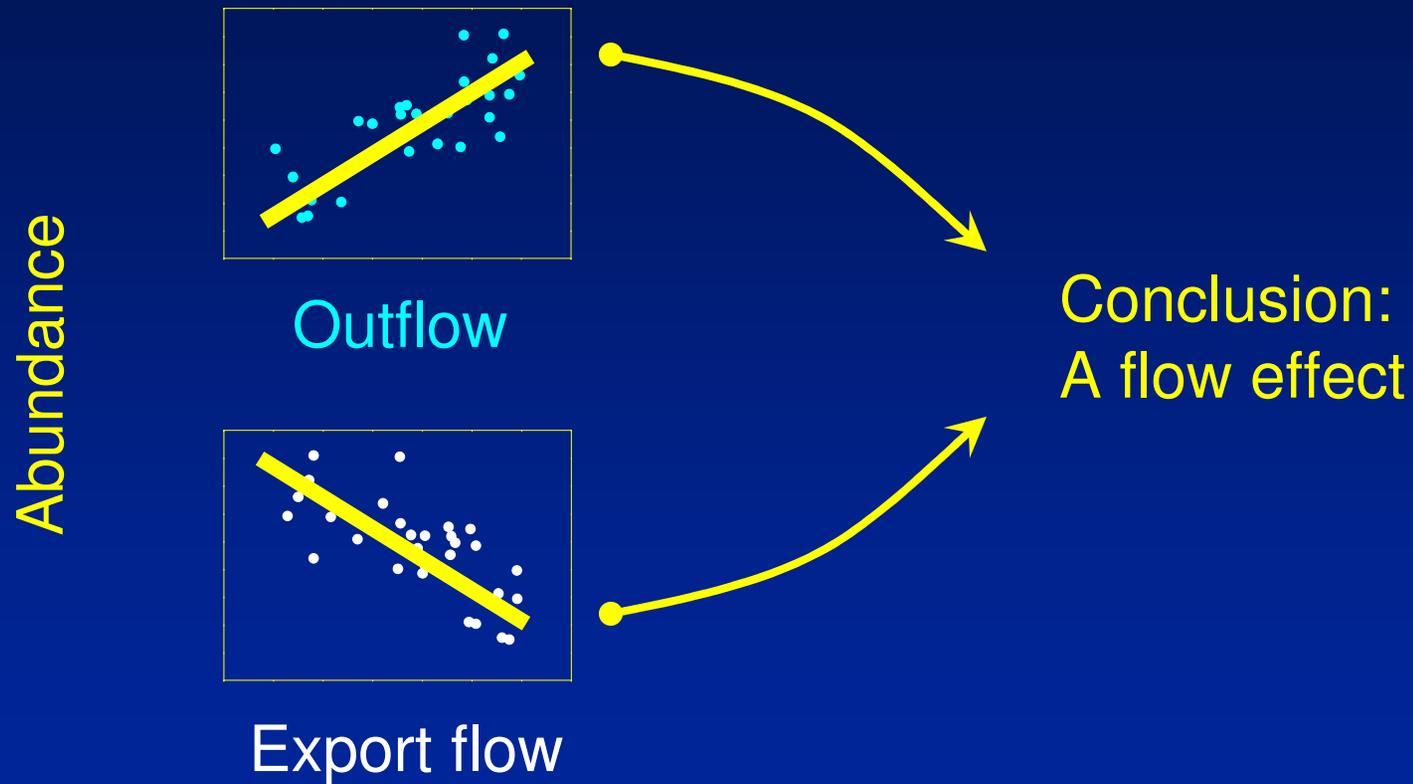
Nutrients
Organic matter
Sediment
Contaminants
Fish

Conceptual Model: Physical effects on estuarine ecosystem

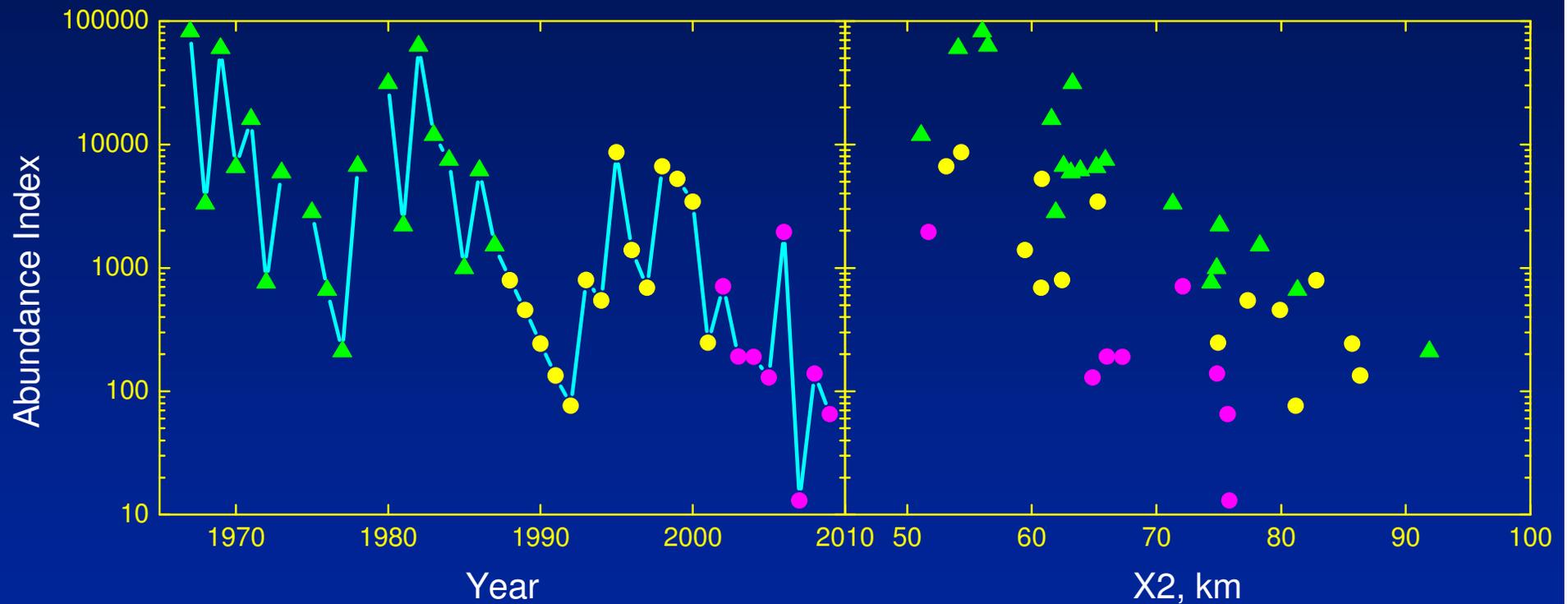


How do we detect flow effects?

1. Correlation with abundance



Longfin Smelt: Abundance Index and X2



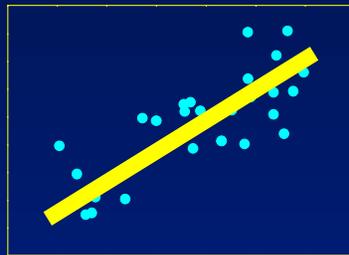
Source:

Kimmerer et al.
2009 (Estuaries & Coasts)

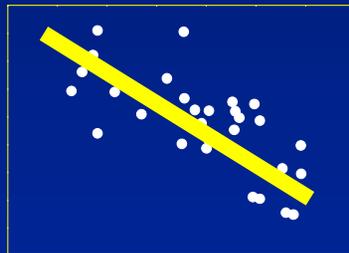
How do we detect flow effects?

2. Correlation with habitat

Habitat area or volume



Outflow



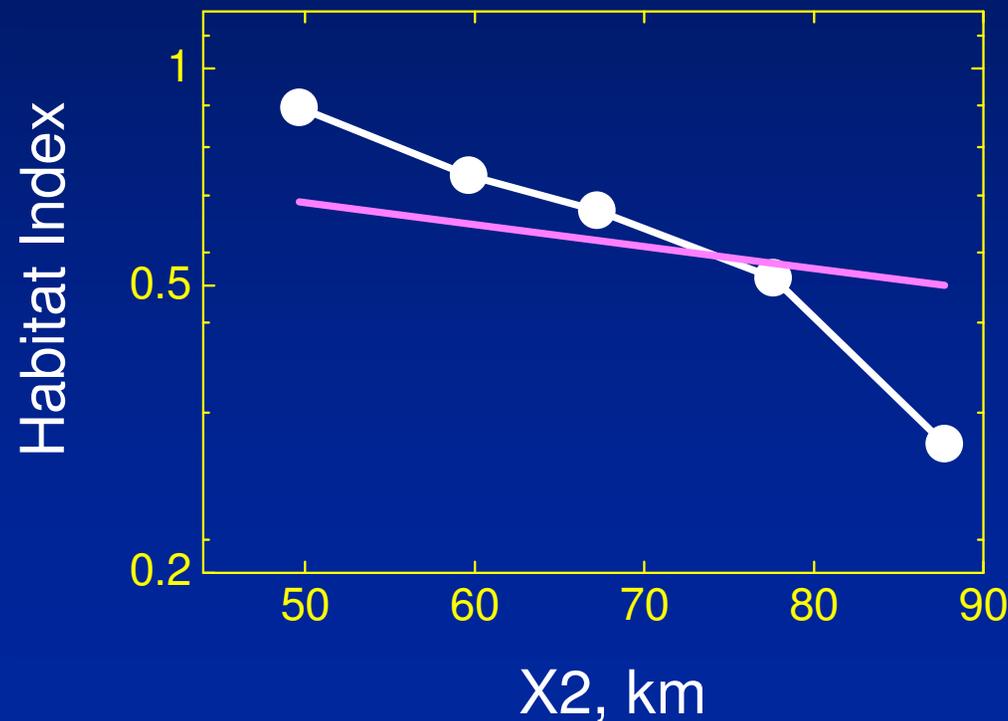
Export flow

Is habitat limiting?

Conclusion:
A flow effect

Delta Smelt: Physical Habitat

Is habitat limiting?

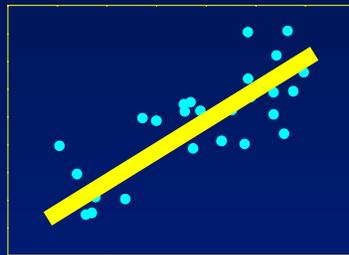


Abundance relationship much flatter – unresponsive to physical habitat as defined by salinity

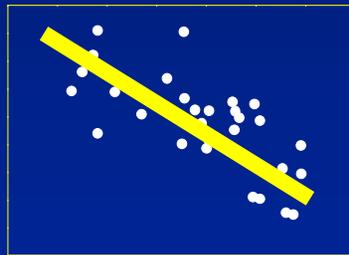
How do we detect flow effects?

3. Life history processes

Survival, birth rate, ...



Outflow

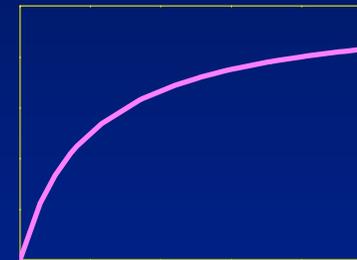


Export flow



Density dependence

Later Abun.

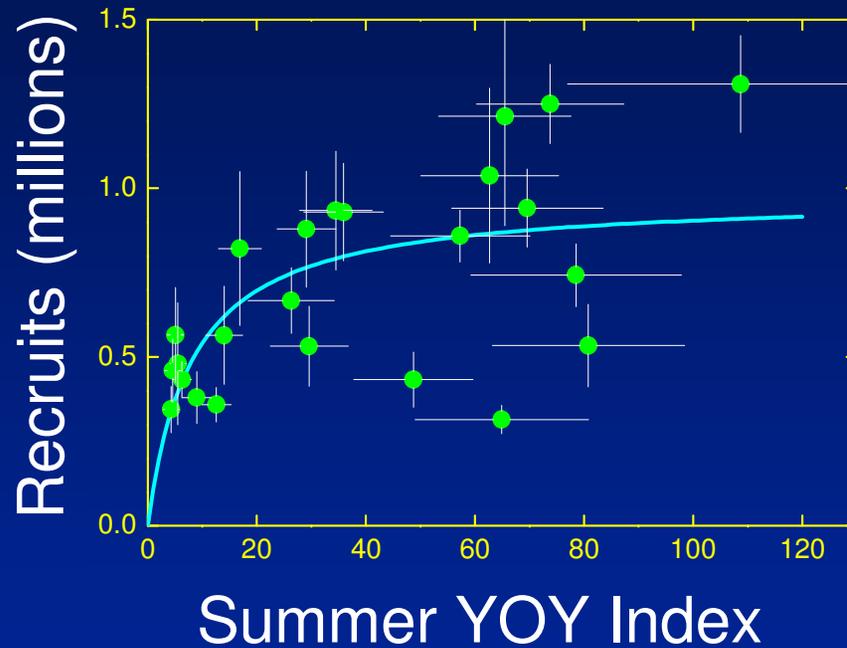


Early abundance



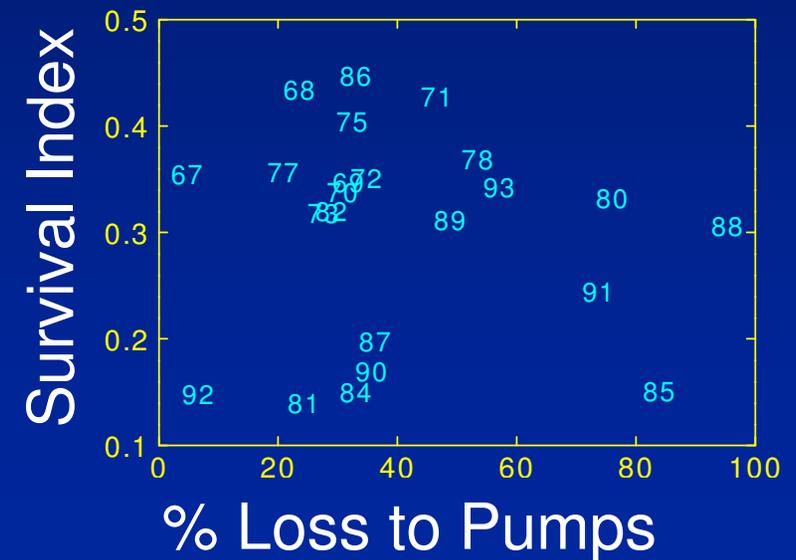
Conclusion:
Little or no flow effect

Effect of export pumping on young striped bass



Density
Dependence
erases export signal

(Numbers are
years)



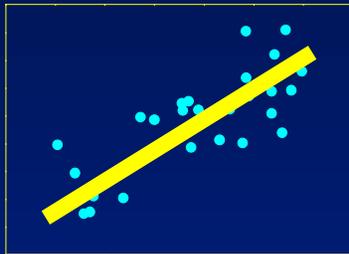
Source:

Kimmerer et al.
2000 (CJFAS)

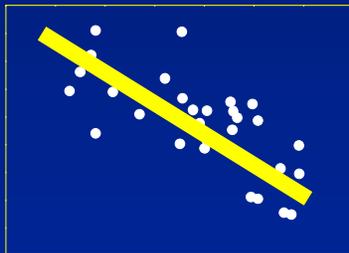
How do we detect flow effects?

3. Life history processes

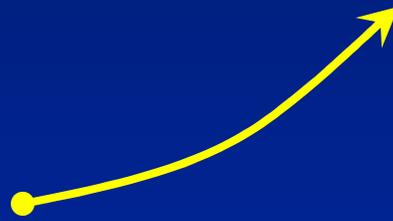
Survival, birth rate, ...



Outflow

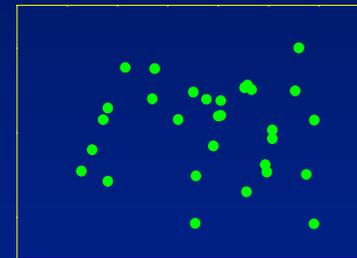


Export flow



Random
Noise or
Other
Process

Abundance

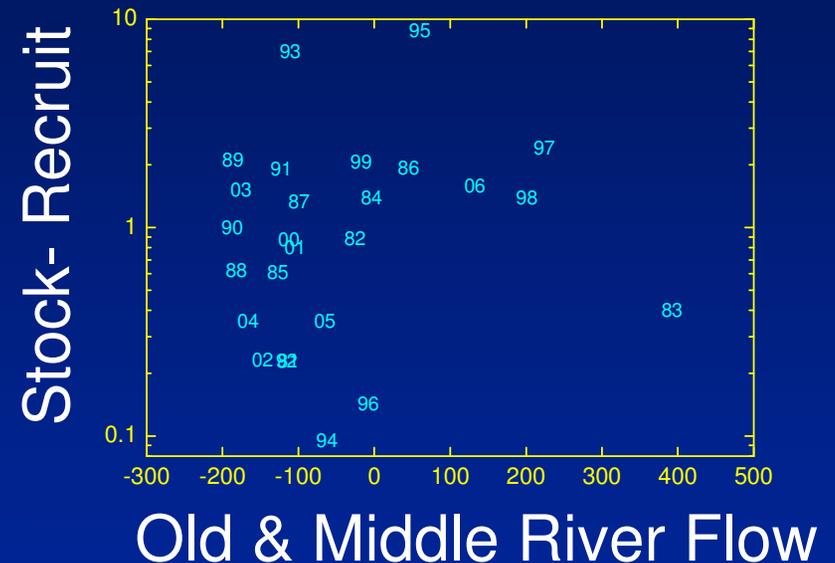
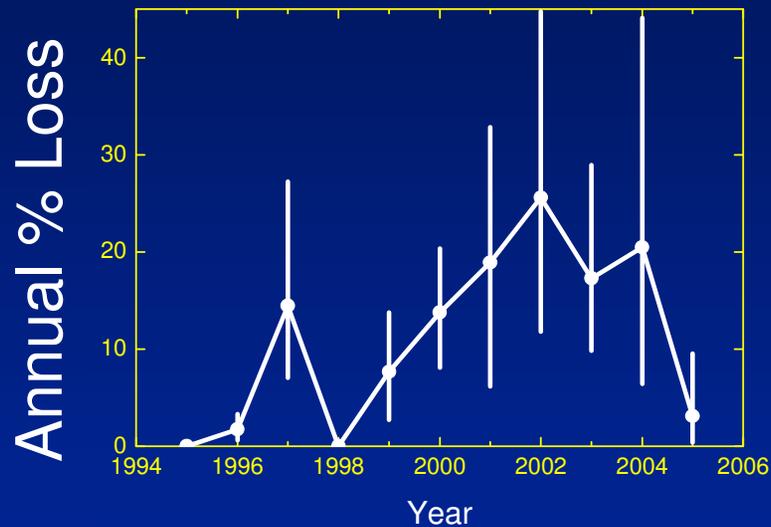


Survival, birth, ...



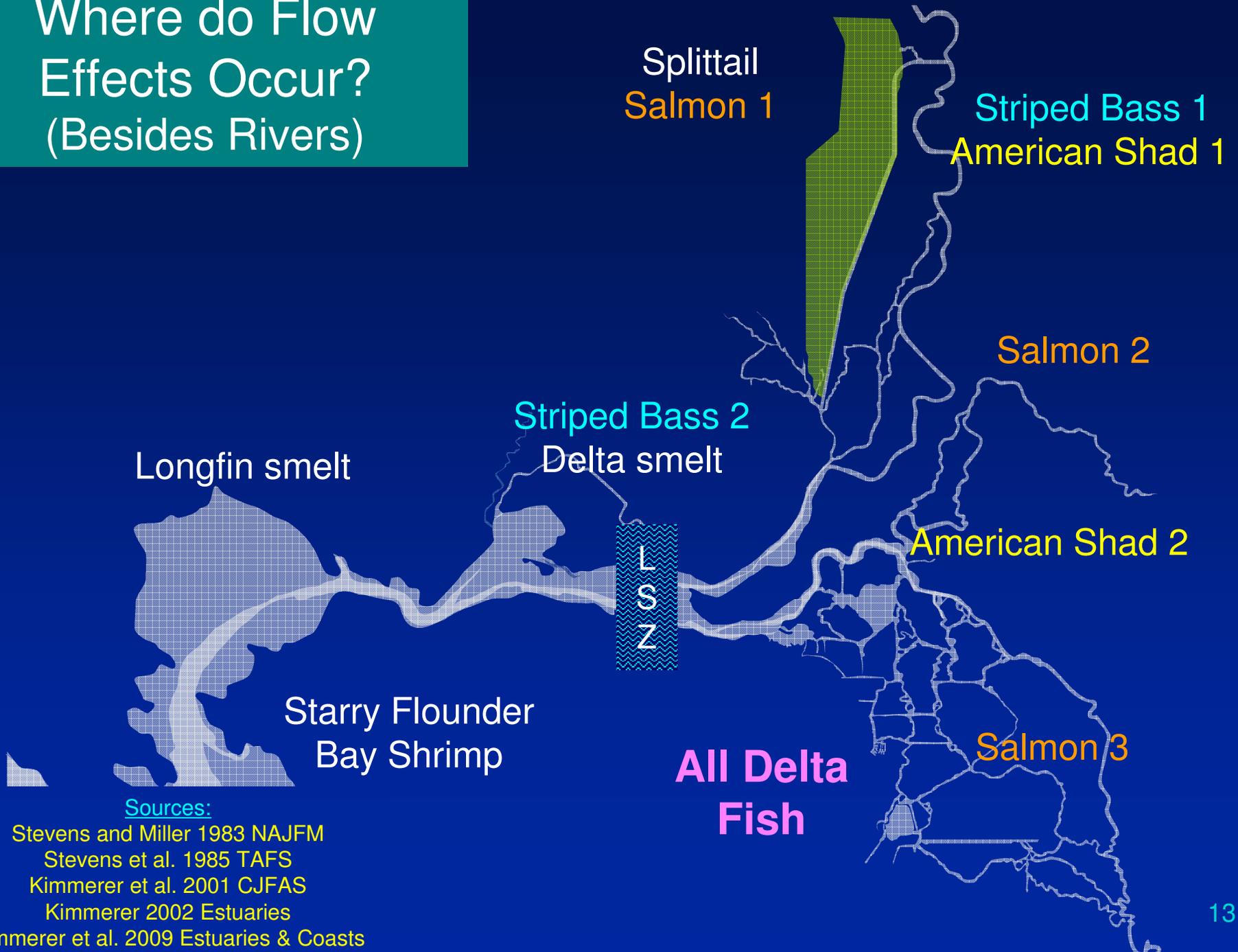
Conclusion:
Likely flow effect

Effect of export losses on young delta smelt

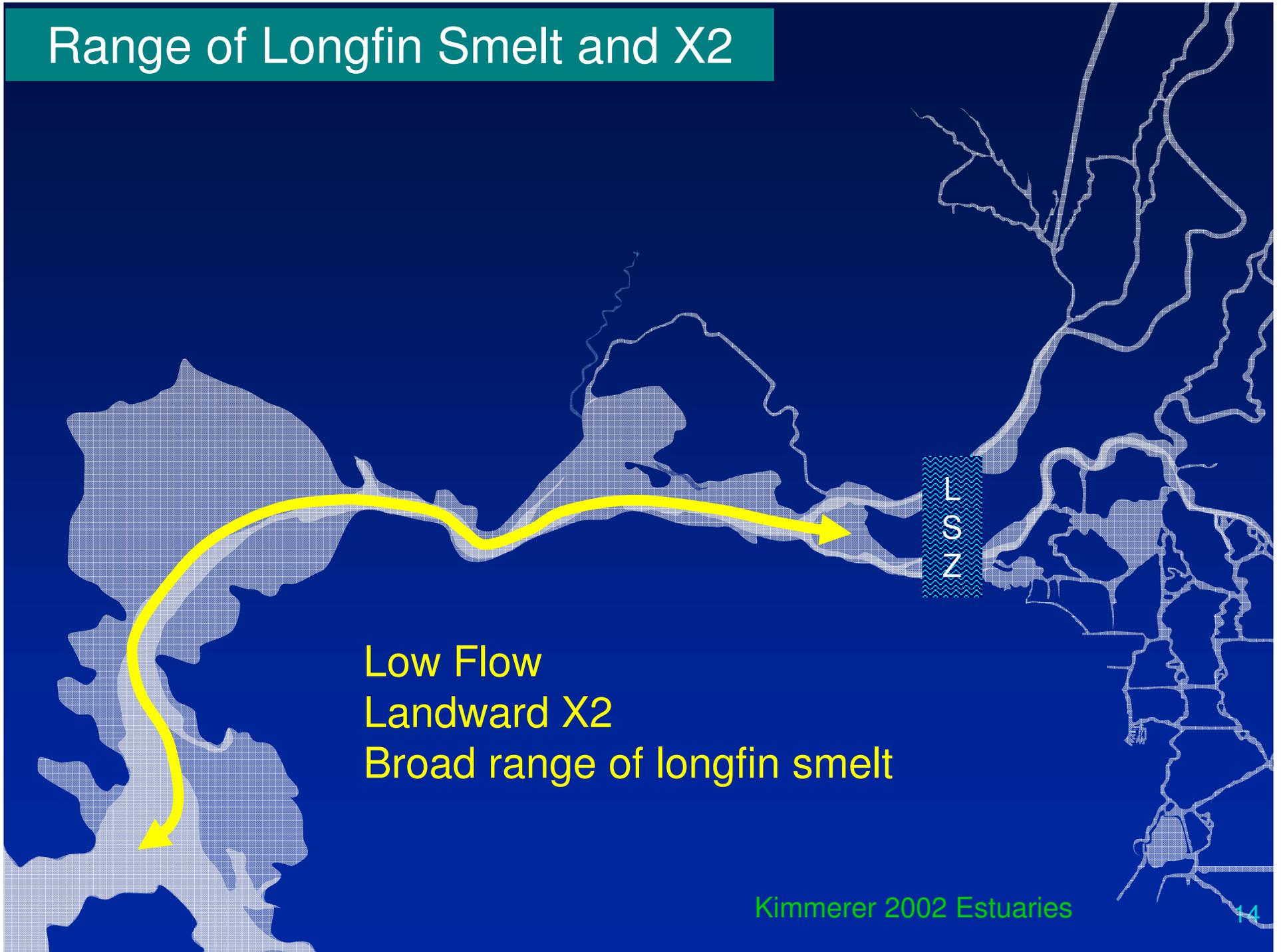


Noise and other processes hide export signal

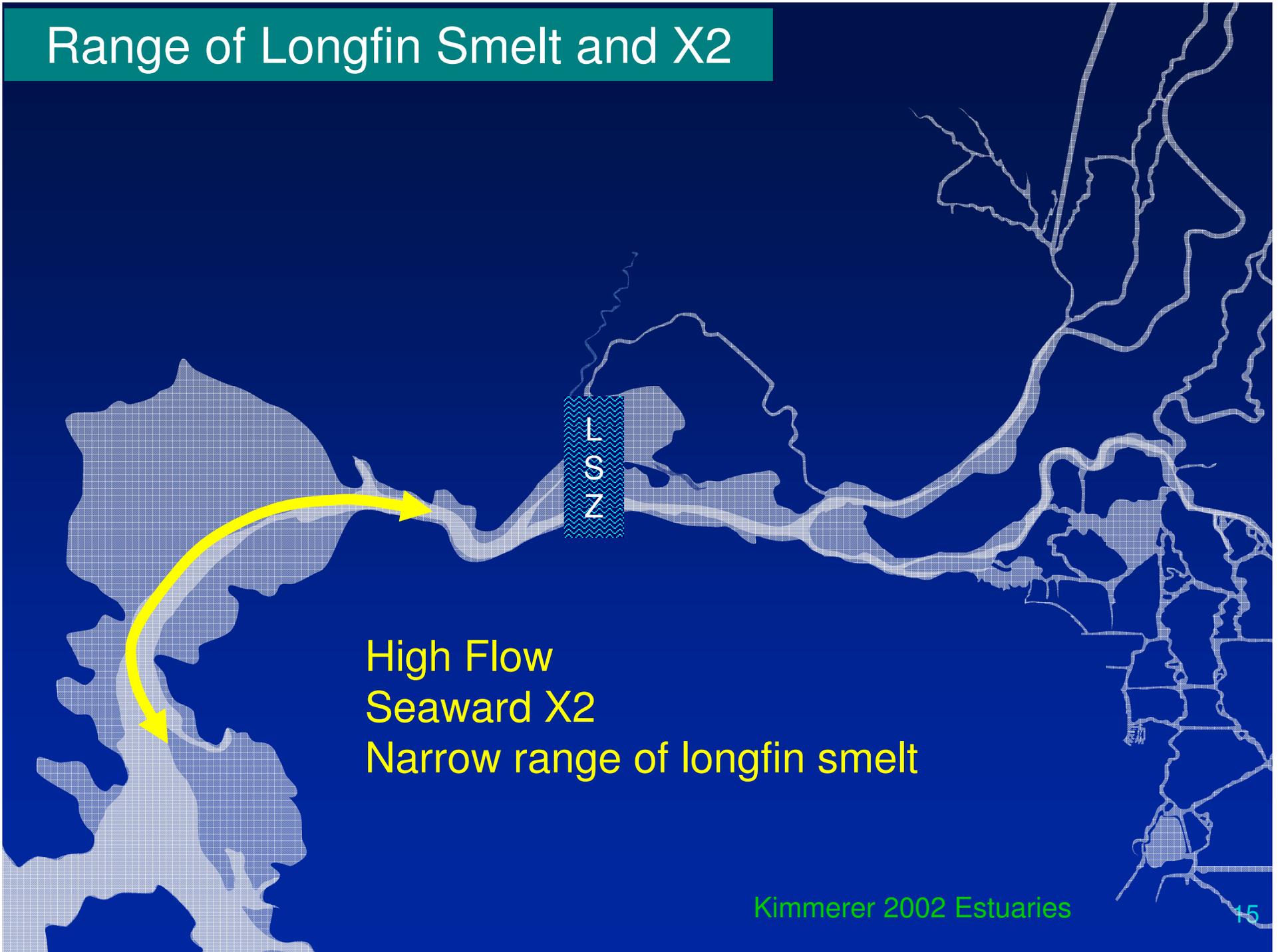
Where do Flow Effects Occur? (Besides Rivers)



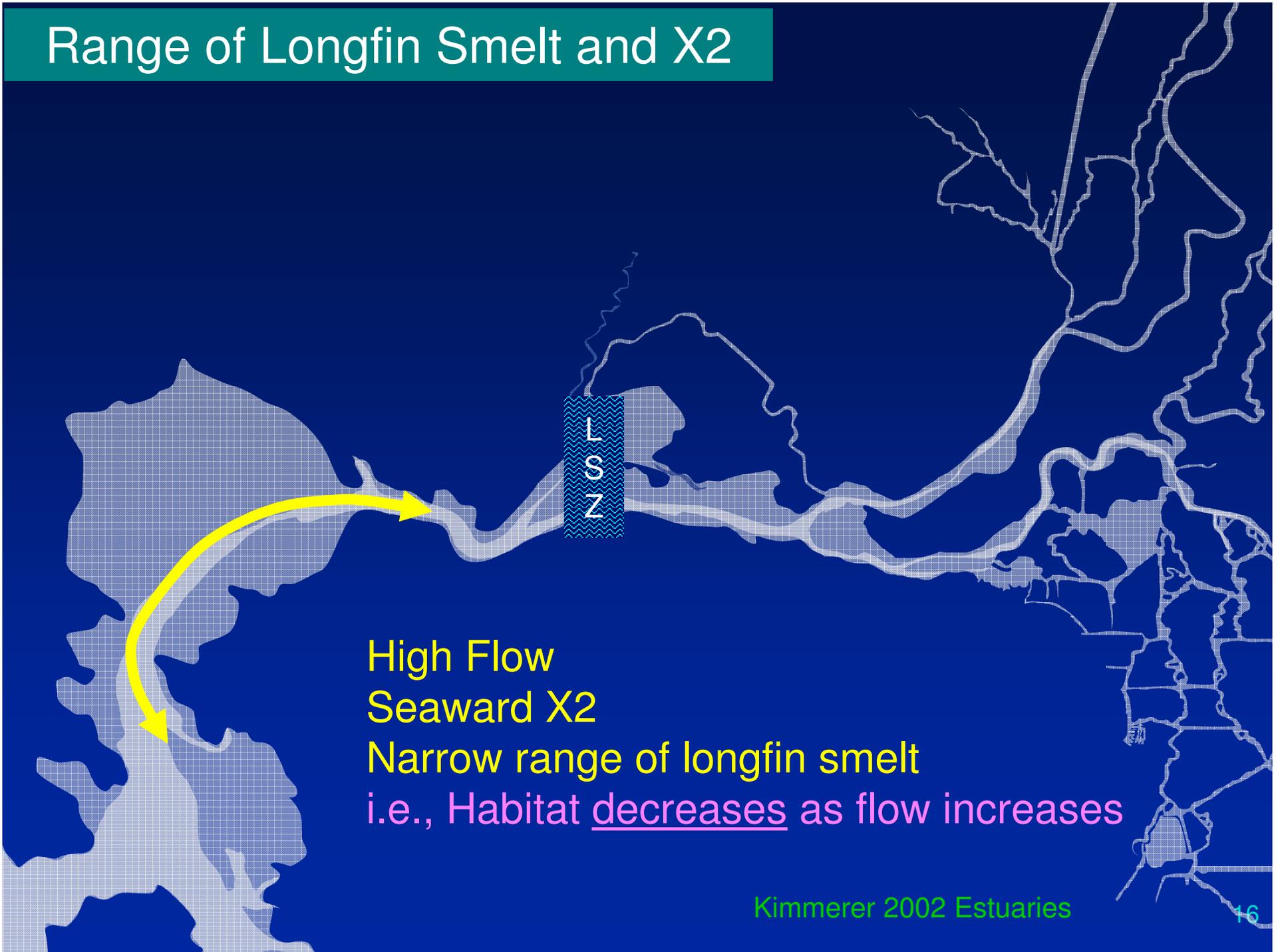
Range of Longfin Smelt and X2



Range of Longfin Smelt and X2



Range of Longfin Smelt and X2



Summary

- Wide variety of mechanisms
- Mechanisms operate in different places
- The overall picture is quite complex
- Simplistic analyses can be misleading
- Must consider life histories

