X2 reflects many ecosystem factors

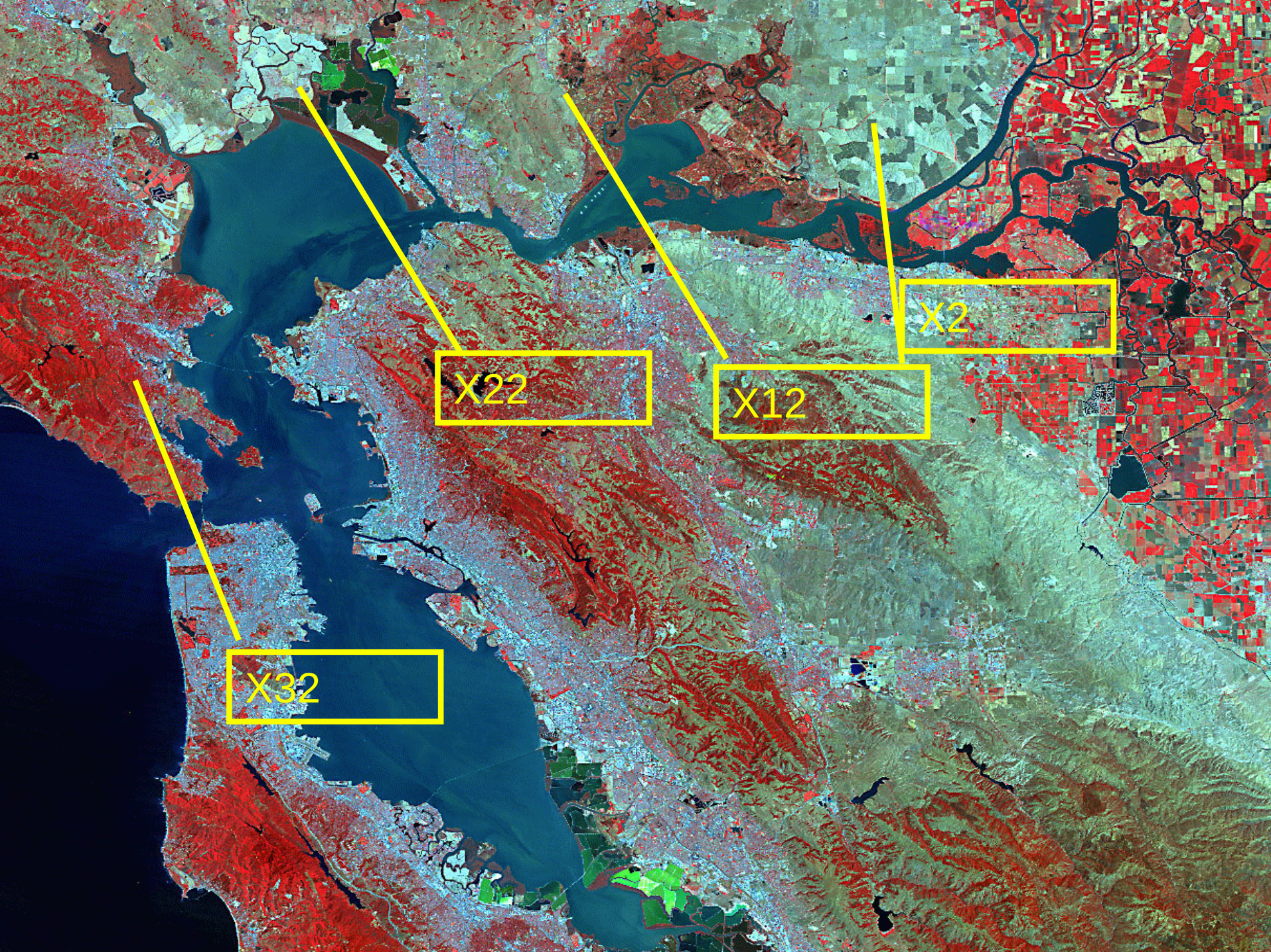
Physical Habitat changes

Water Quality

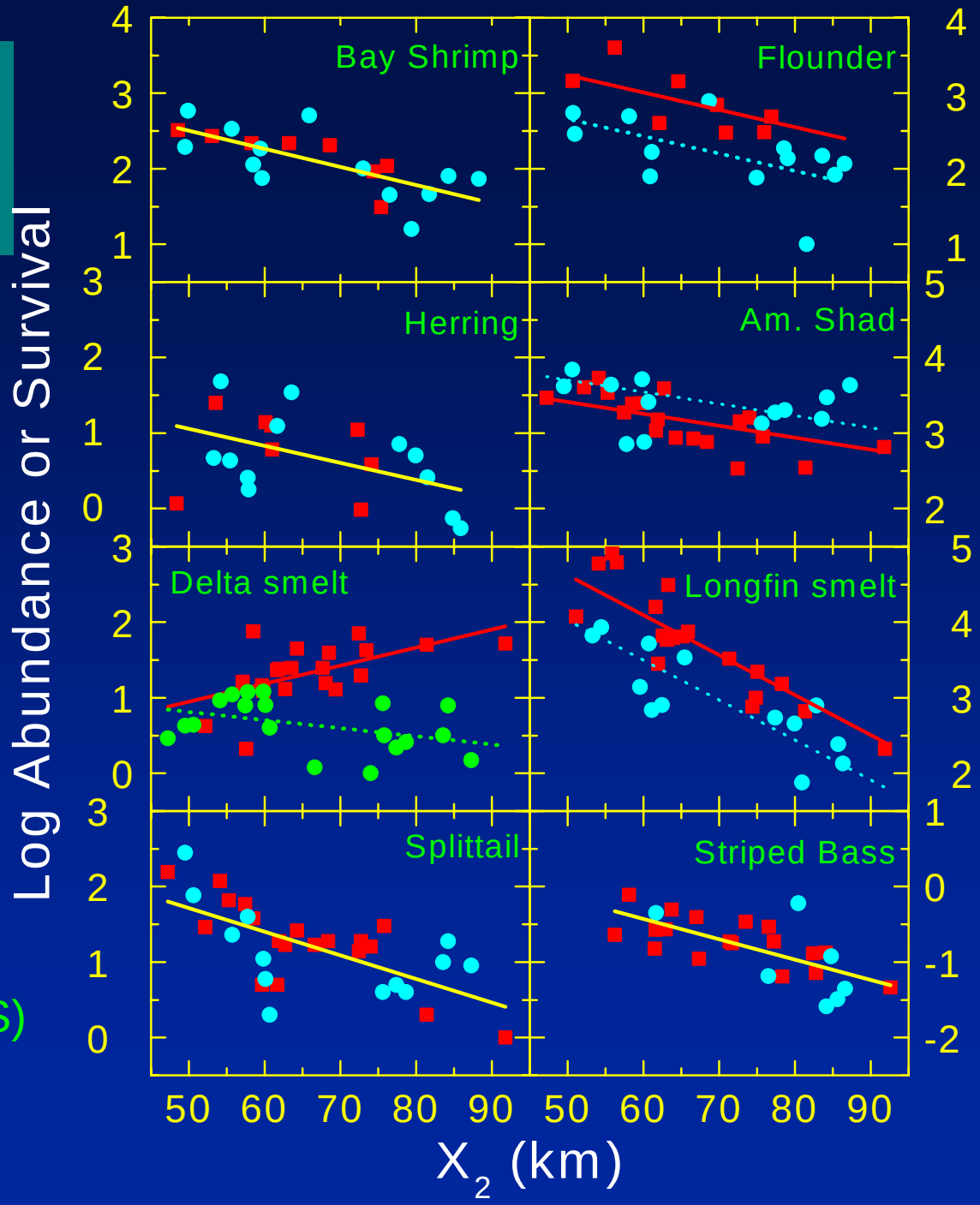
Contaminant effects

Larval dispersal

Adult migration and spawning


X2
X22
X12
X32

Fish- X_2 Relationships From Kimmerer 2002



X2 observations

Fish:X2 Relationships maintained across 35 years of data

Massive change in food web had little impact on relationships

Mechanisms remain unclear and probably diverse

Future Directions

- Research strategy under development (CBDA grant to Kimmerer and Bennett)
  - Limited ability to test mechanisms
  - Reduced funding likely to restrict studies
- Discussion with local biologists suggest that, for many possible mechanisms, variability is likely important (Estuarine Ecology Team July 2004)

Conclusions

- X2 seems to be working to protect aquatic resources from reductions in estuarine habitat quality
- Protecting both mean and variance of X2 seem important
- Unlikely that more effective ways to protect resources will be found soon
- Continued data collection is vital for meaningful review

Main references

- Kimmerer, W.J. 2002. Physical, biological, and management responses to variable freshwater flow into the San Francisco estuary. Estuaries 25:1275-1290

- Jassby, A.D., W. J. Kimmerer, S.G. Monismith, C. Armor, J.E. Cloern, T.M. Powell, J.R. Schubel, and T.J. Vendlinski. 1995. Isohaline position as a habitat indicator for estuarine populations. Ecological Applications 5:272-289