

Problems with interpreting catch-per-unit-of-effort data to assess the status of individual stocks and communities: is integrated stock assessment, ecosystem modeling, management strategy evaluation, or adaptive management the solution?

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The importance of appropriate interpretation and analysis of data

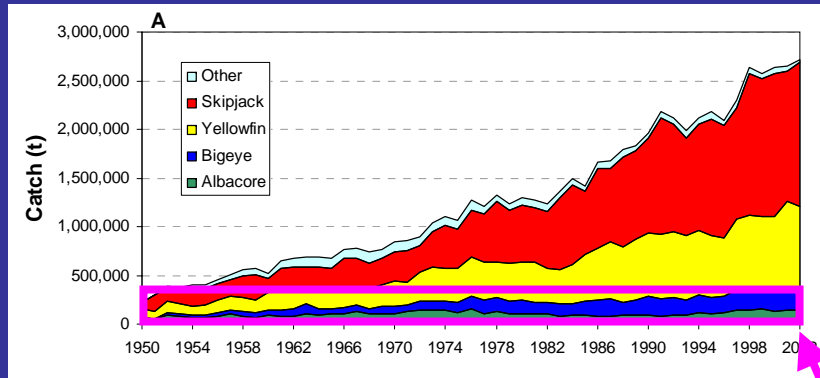
- “... by the illogic of the old paradigms ... yet another randomized trial ... was performed ... and resulted in 25 more infant deaths ...” Royal 1997

“...large predatory fish biomass today is only about 10% of pre-industrial levels.”

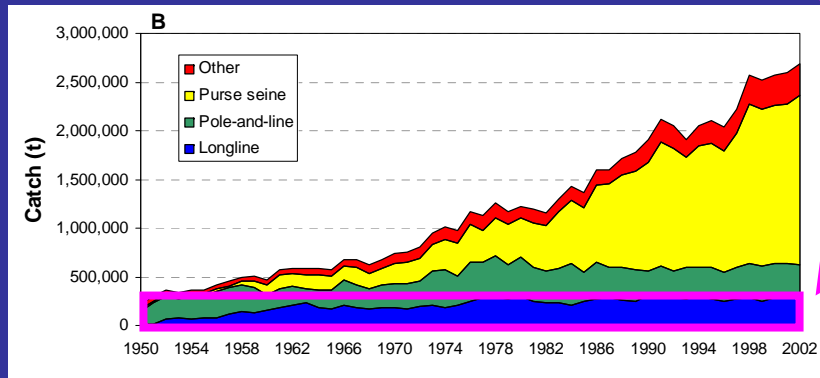
Myers and Worm 2003

Pacific Ocean Tuna Catch Data

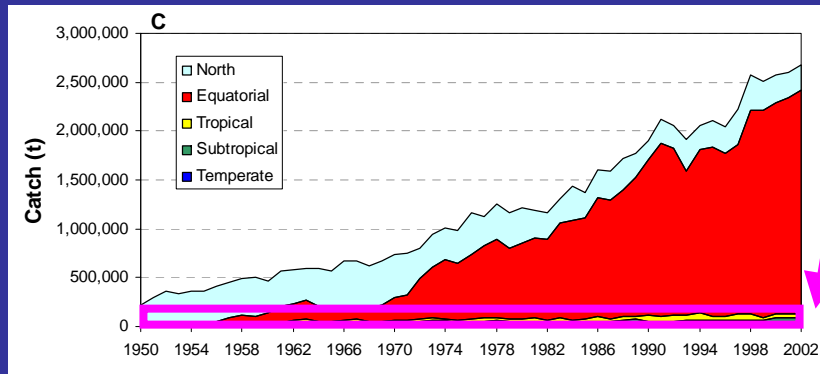
By species



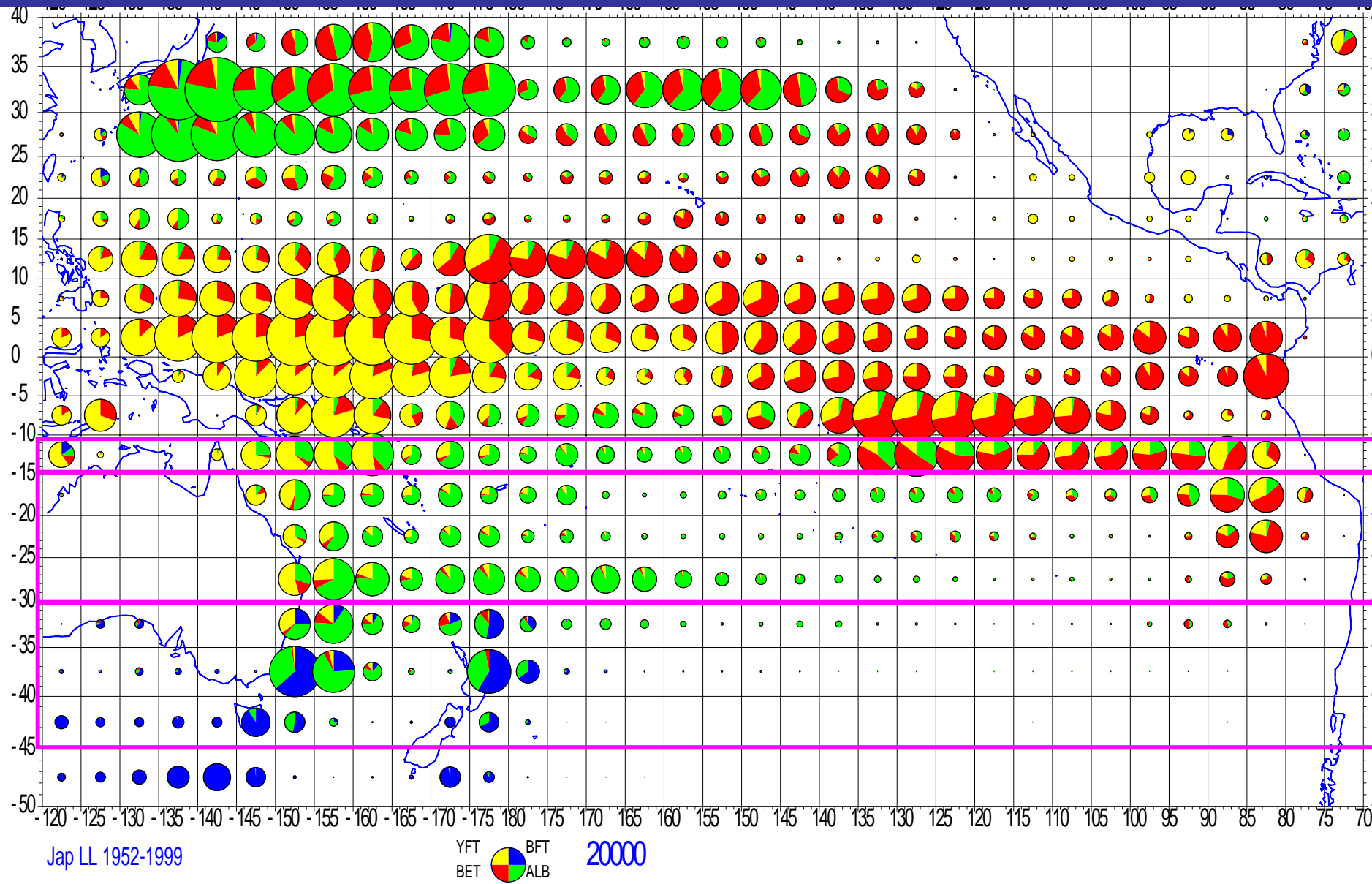
By method



By area



Myers and Worm data



Spatial expansion of the longline fishery

300

SUZUKI, TOMLINSON AND HONMA

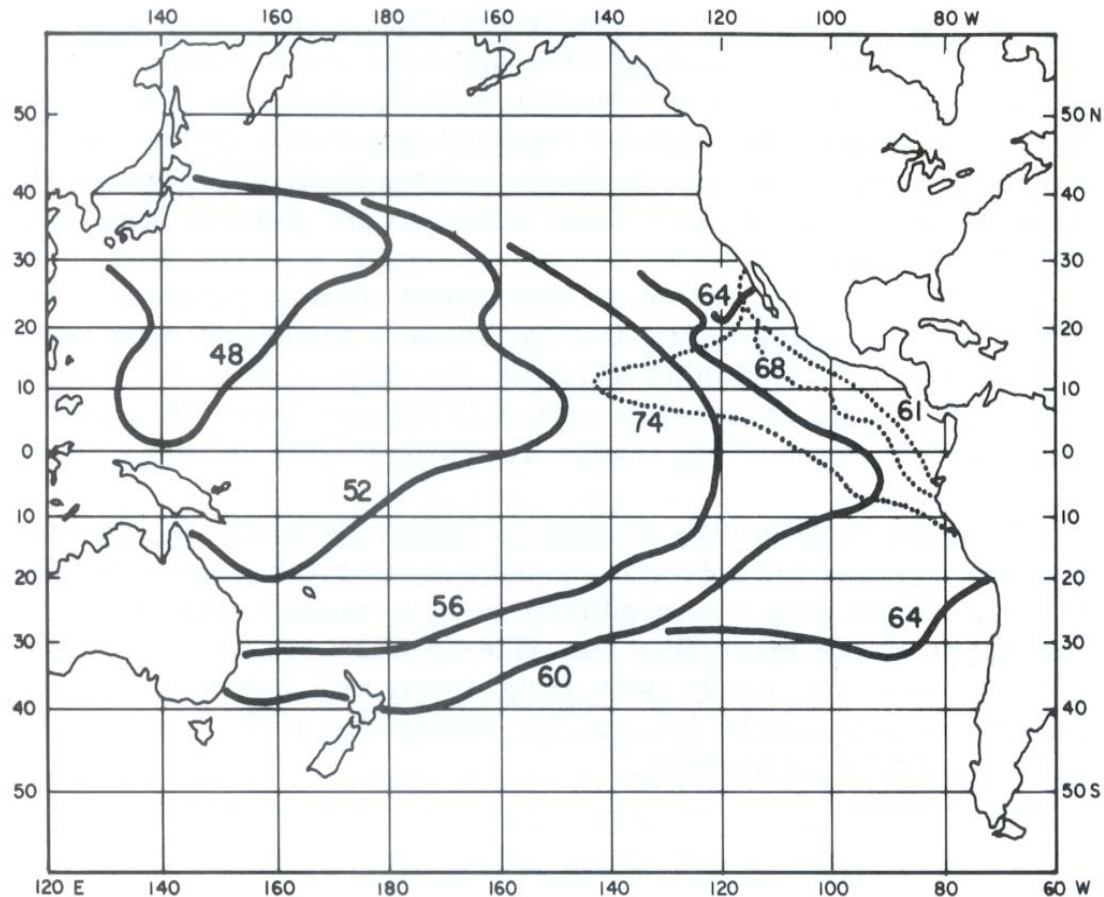
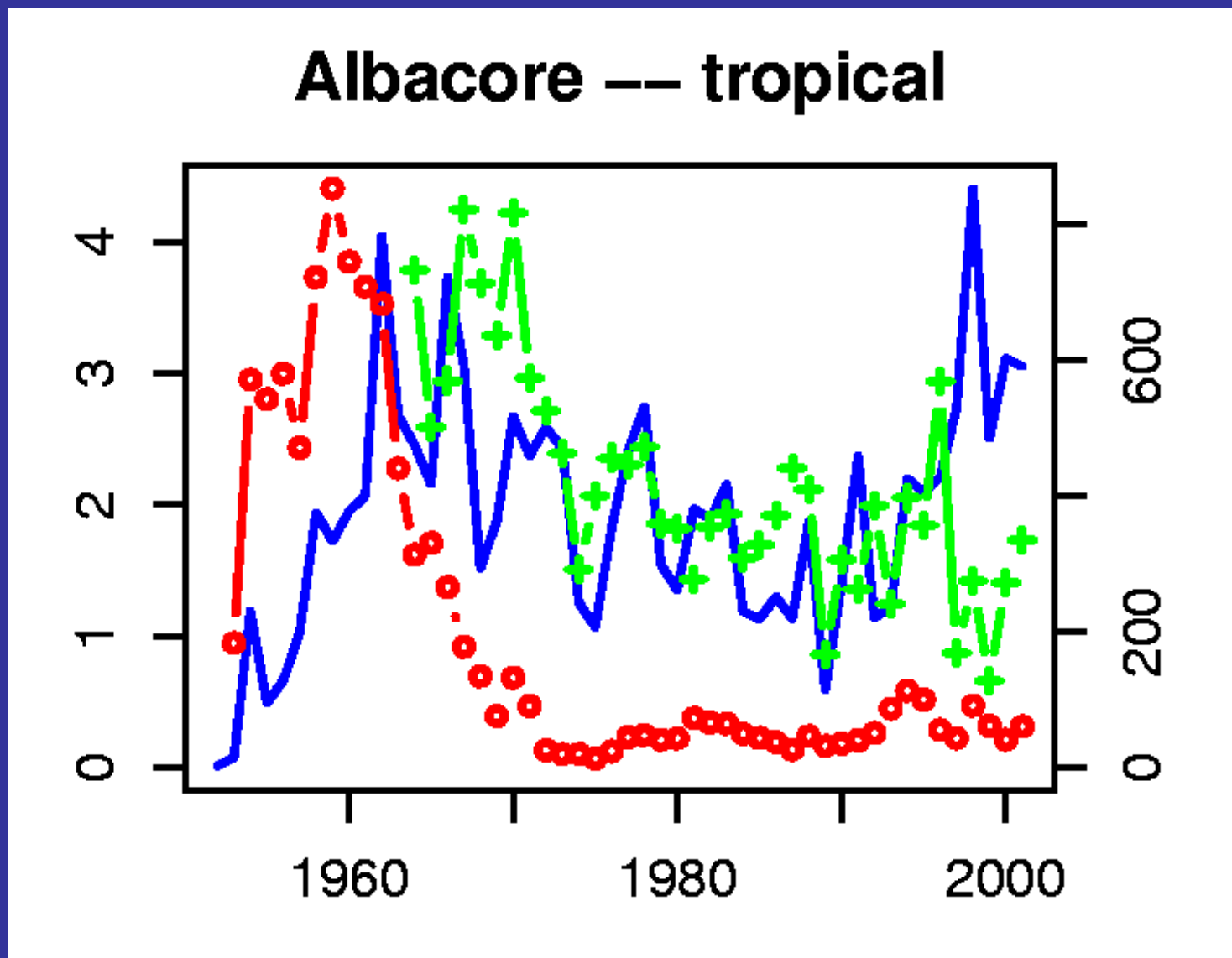


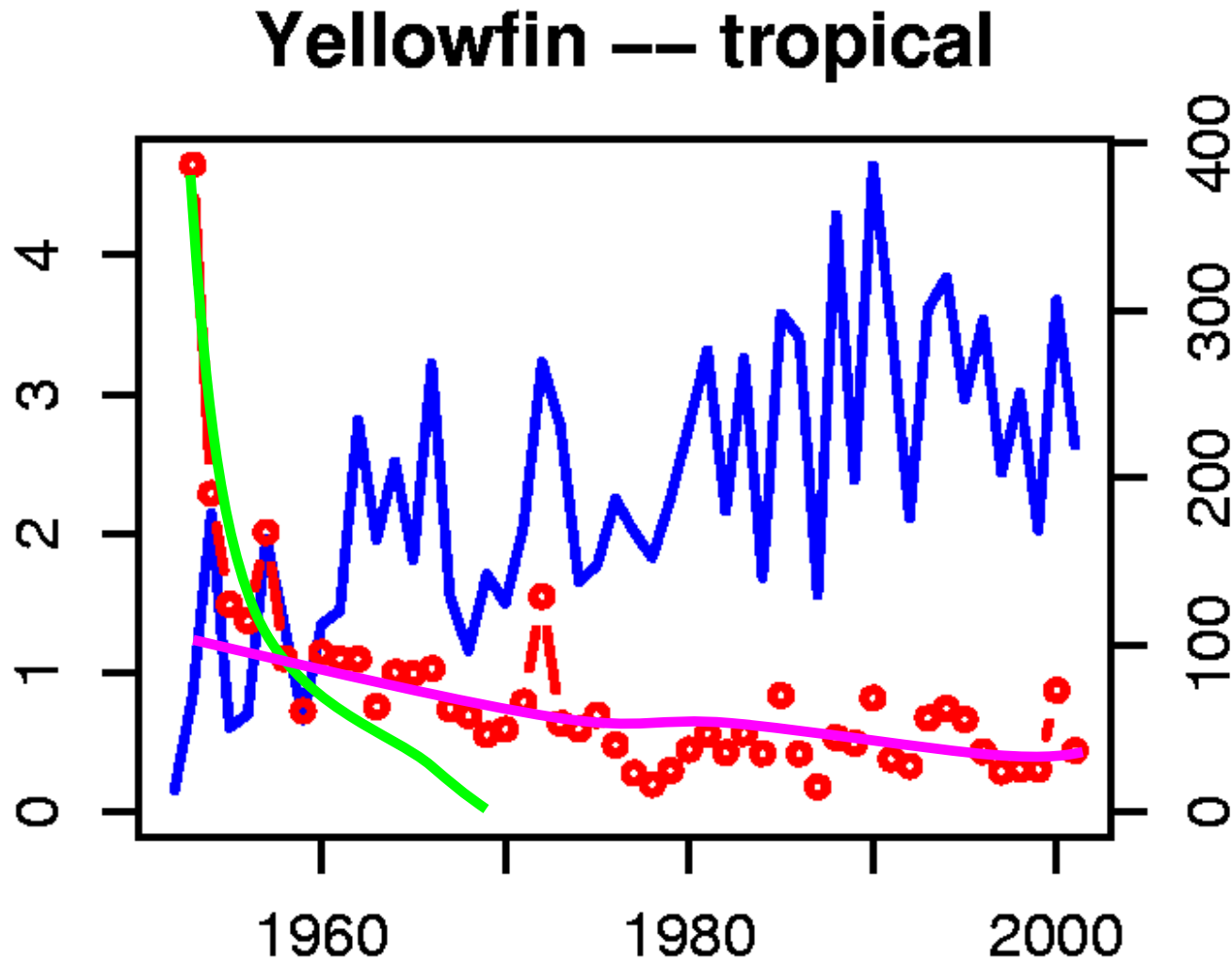
FIGURE 1. Geographical expansion of the Japanese longline fishery (solid curves) and the surface fishery in the eastern Pacific (dotted curves). Numerals denote calendar year.

Change in targeting: from albacore to bigeye



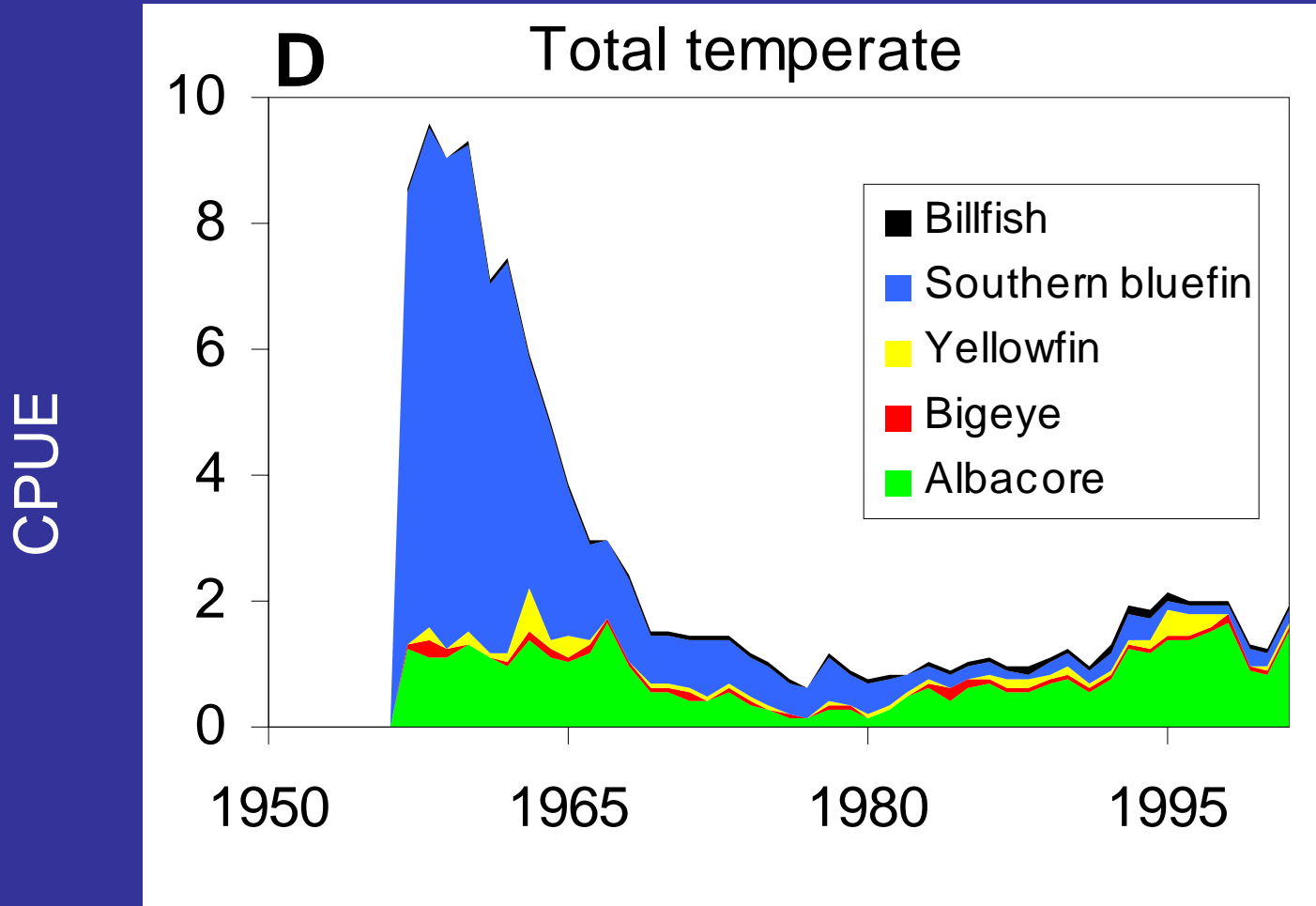
Blue is total catch, green is Taiwan CPUE, red is Japan CPUE

CPUE is inconsistent with catch and population dynamics



Blue is total catch, red is CPUE

One species dominates



More often than not community CPUE declines faster than abundance

$$\frac{\partial B_i}{\partial t} = r_i \left(1 - \frac{B_i}{K_i} \right) B_i - q_i E B_i \quad \frac{B_{SS}}{\sum_i K_i} < \frac{CPUE_{SS}}{\sum_i q_i K_i}$$

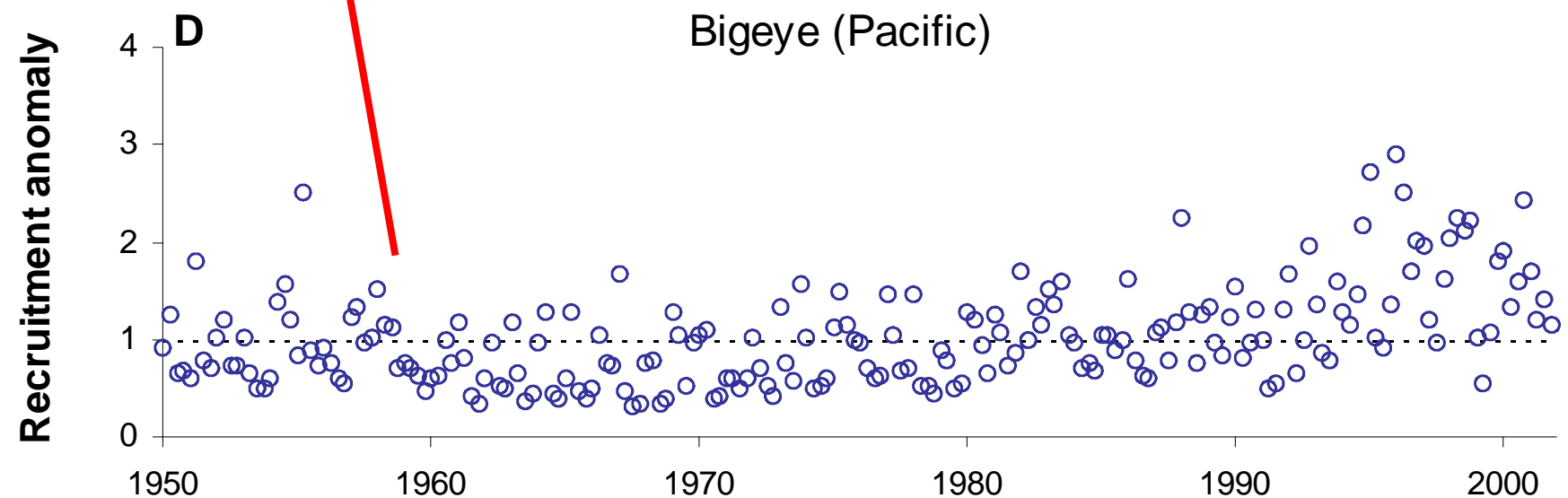
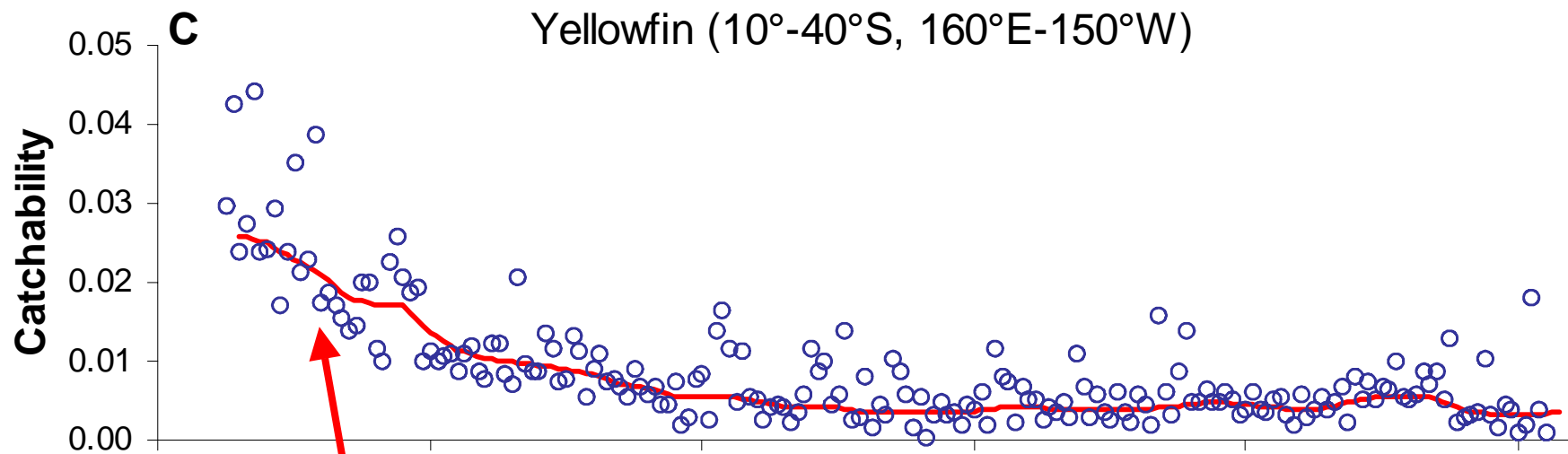
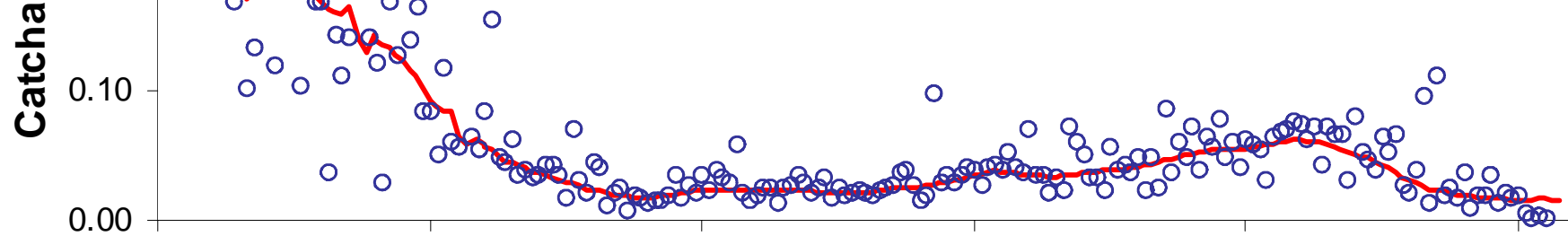
$$\frac{q_i}{q_j} < 1 \quad \frac{\partial B_i}{\partial t} = 0 \quad \left(\sum_i q_i K_i \right)^2 > \sum_i K_i \sum_i q_i^2 K_i \quad \frac{\sum_i \frac{q_i}{r_i} K_i}{\sum_i K_i} > \frac{\sum_i \frac{q_i^2}{r_i} K_i}{\sum_i q_i K_i}$$

$$\sum_i q_i^2 K_i^2 + 2 \sum_{i < j} q_i q_j K_i K_j > \sum_i q_i^2 K_i^2 + \sum_{i < j} (q_i^2 + q_j^2) K_i K_j$$

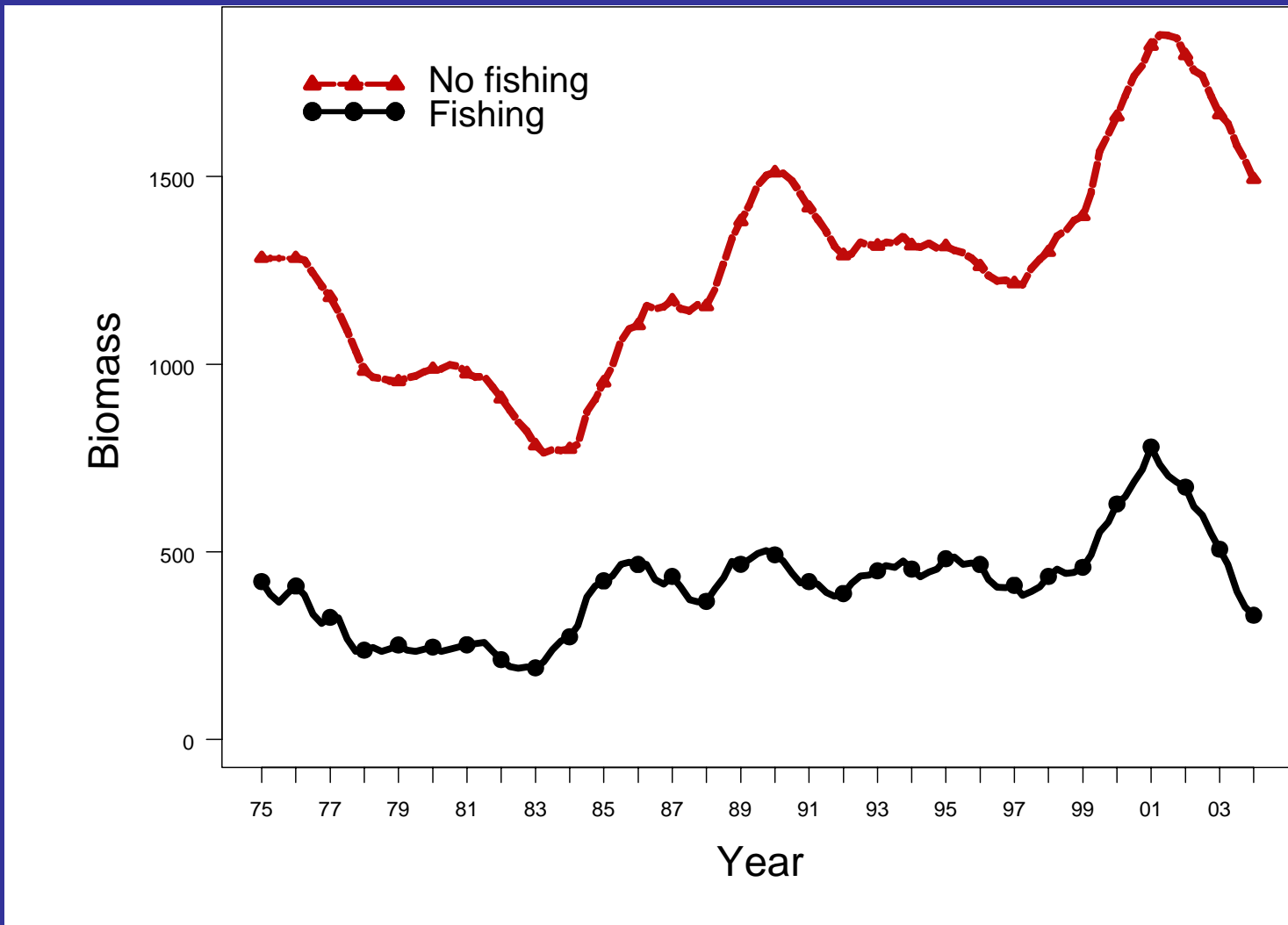
$$\frac{r_i}{r_j} < \frac{q_i}{q_j} < 1 \forall i, j \text{ pairs} \Rightarrow \text{Biomass declines faster than CPUE}$$

Integrated stock assessment models

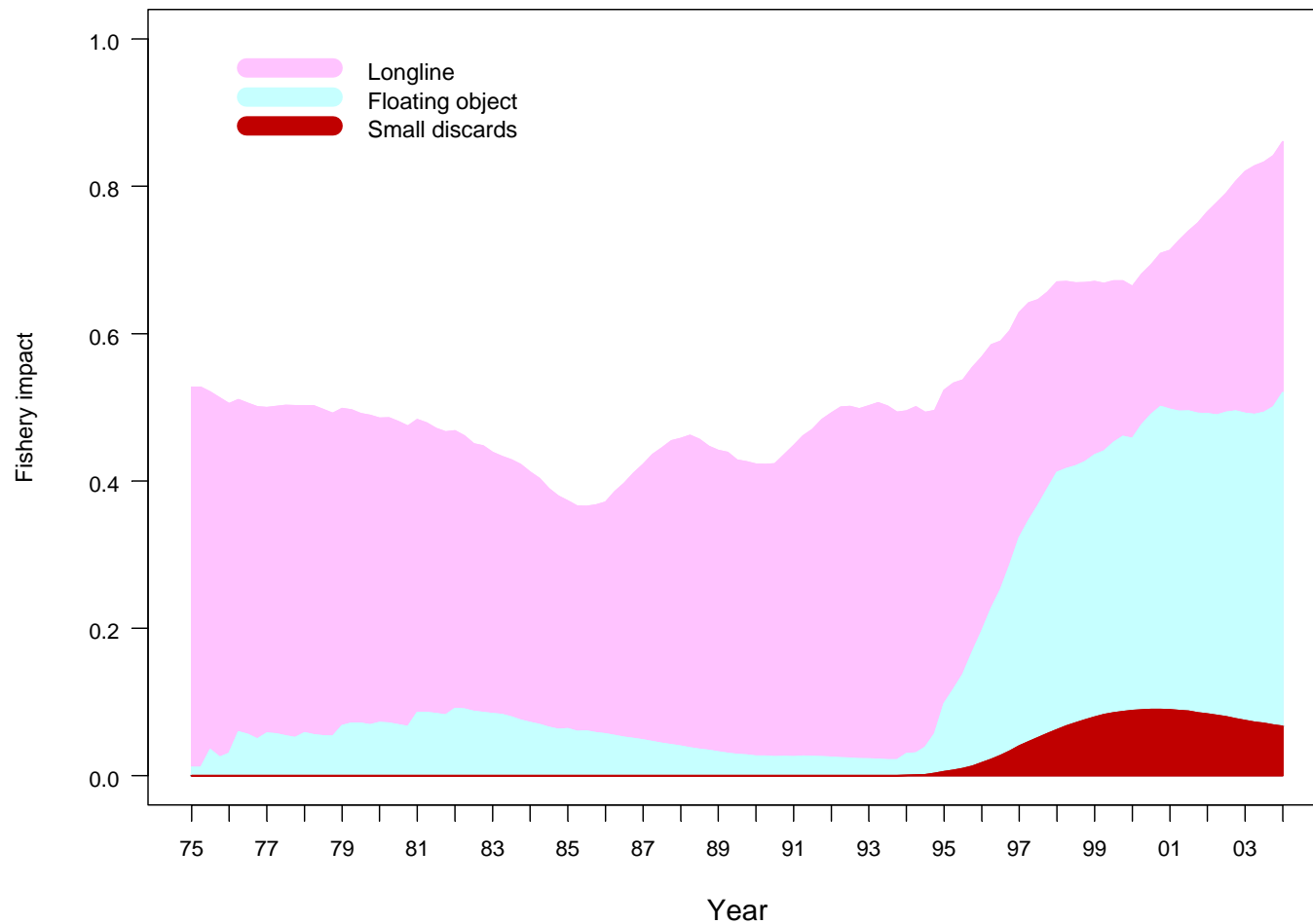
- Uses all data
- Determine if data is consistent
- Fishery versus environment
- Fishery impact by gear
- Use more information for longer predictions
- Estimate management quantities
- Determine yield efficiency of gear
- Investigate management options
- Can be combined to calculate community abundance



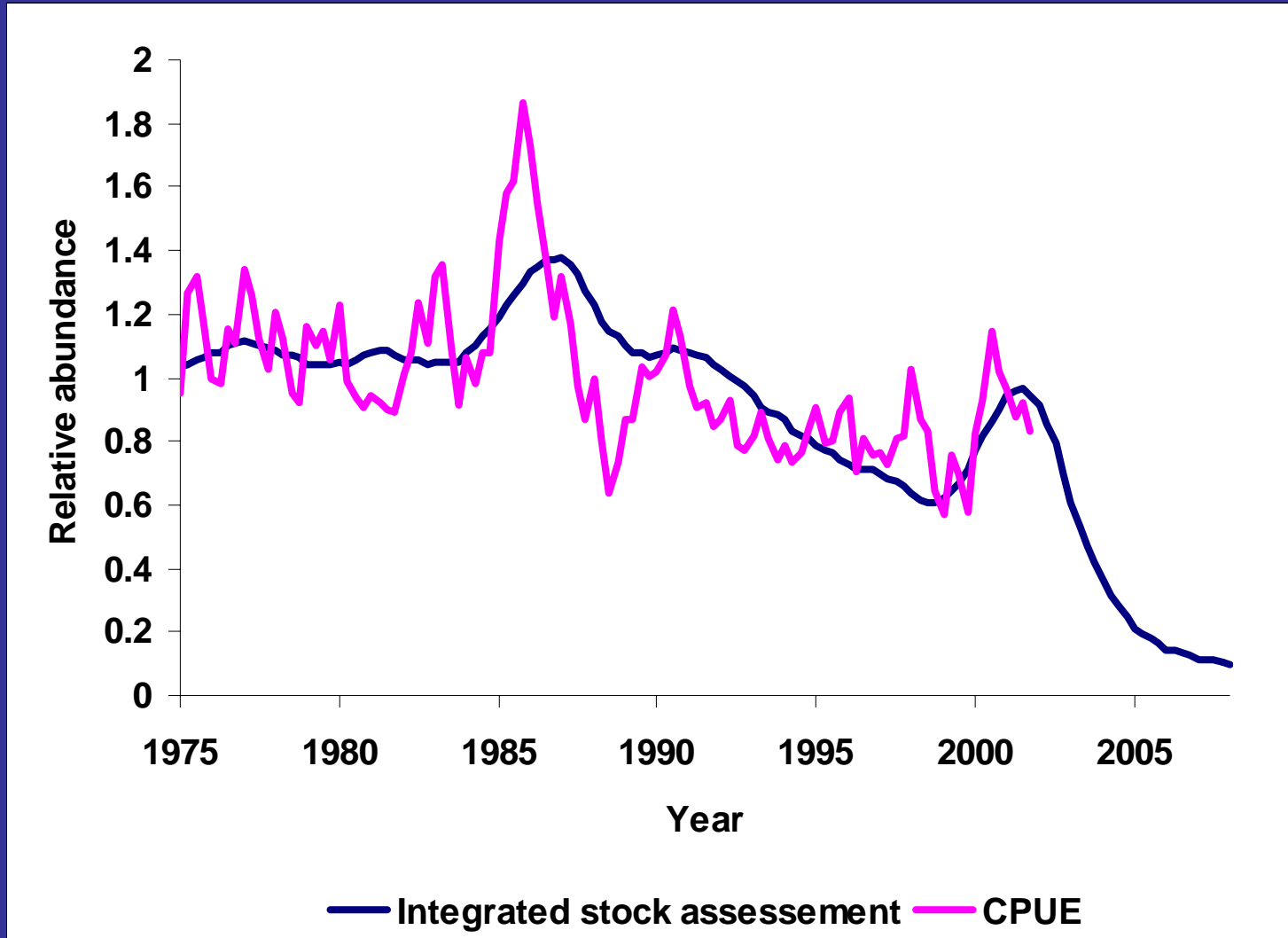
Fishery versus environment for yellowfin tuna in the EPO



Fishery Impact on EPO bigeye tuna

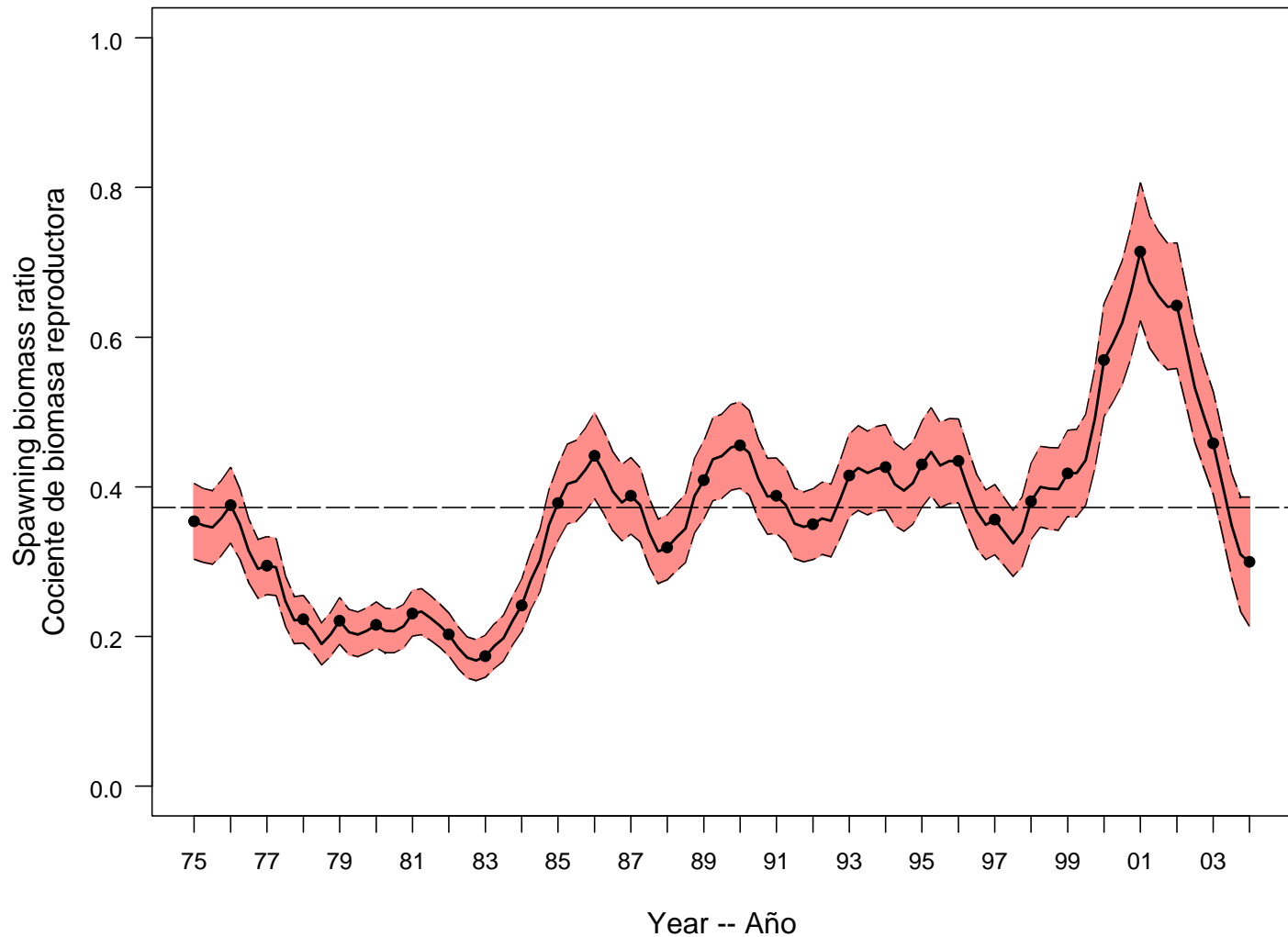


Relative abundance of bigeye tuna in the EPO



Estimate management quantities

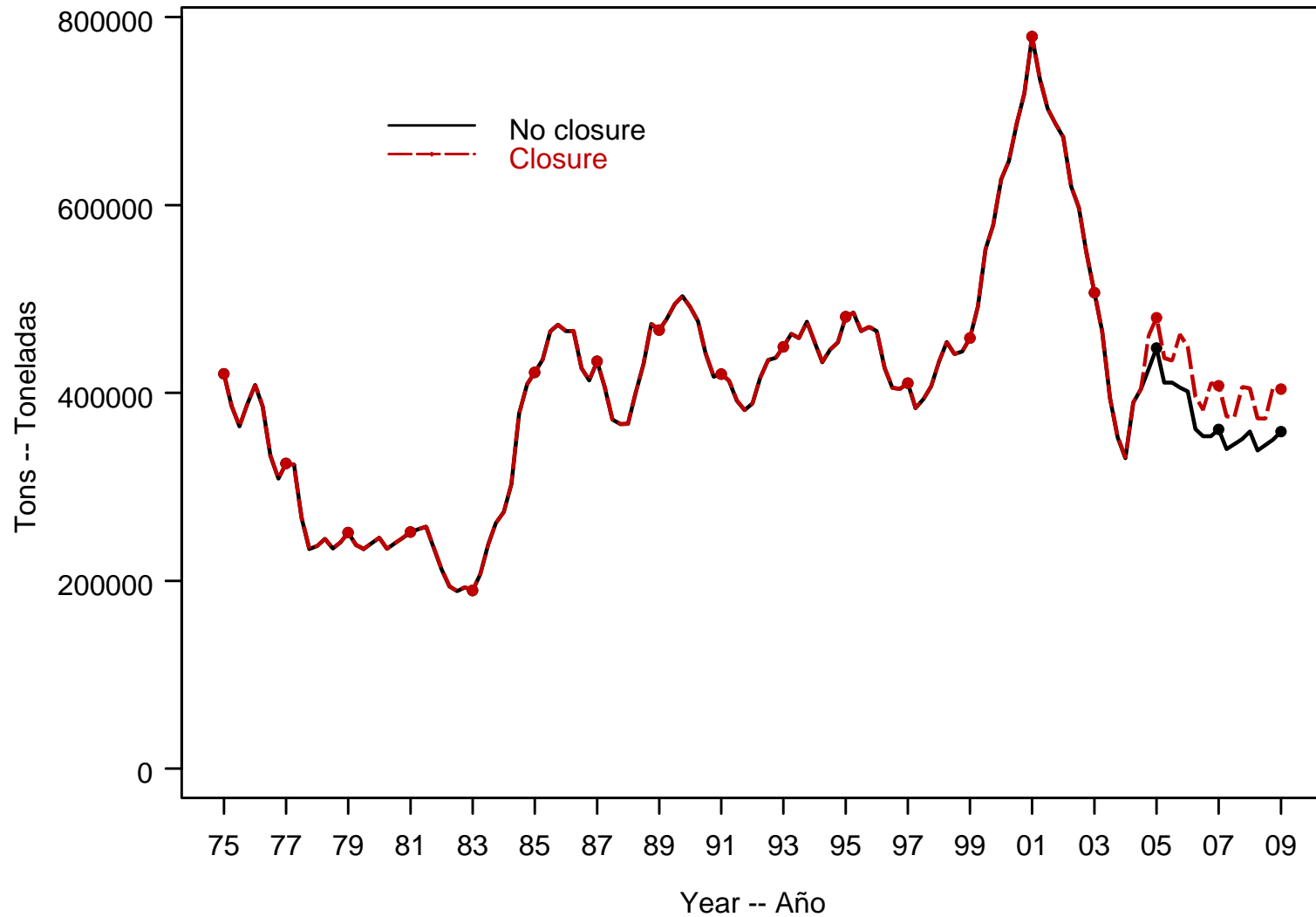
(how useful they are?)



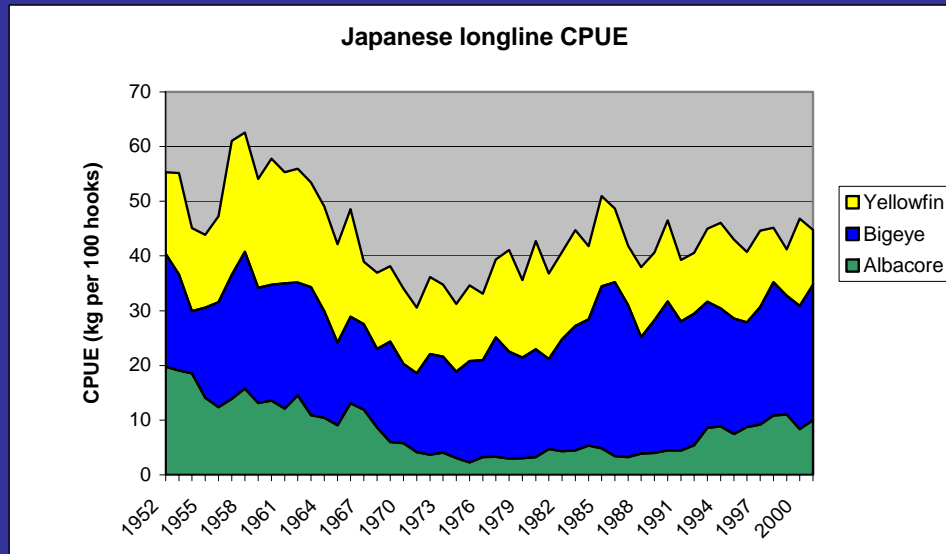
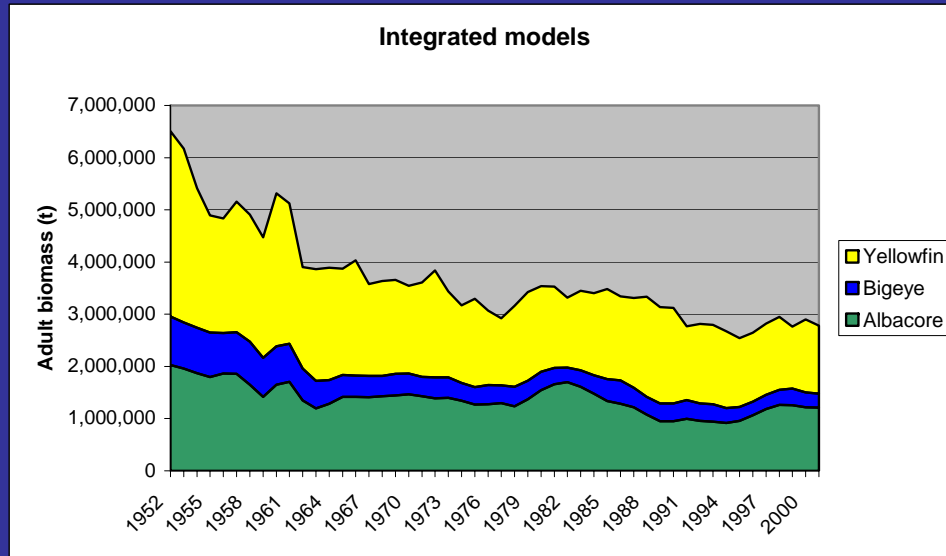
Determine increase in yield by changing fishing methods: Yellowfin tuna in the EPO

Method	MSY (´000 t)
All	285
Floating Object	194
Unassociated	243
Dolphin associated	320
longline	386

Predict effects of management



Abundance of tunas in the Pacific Ocean



Management of fish stocks

- Sustainable fisheries management is based on surplus production
- Surplus production increases as the abundance falls towards B_{MSY}
- B_{MSY} is often much less than half the unexploited level
- B_{MSY} and MSY are dependent on many factors
- CPUE alone tells us nothing about the above

Management of communities and ecosystems

- Cannot maximize yield of two species caught simultaneously by the same gear because their productivities and catchabilities differ
- What would be the impact on the ecosystem if all commercially valuable stocks were fished at their single species MSY

Adaptive management, management strategy evaluation, and ecosystem models

- Adaptive management provides information for integrated stock assessments and has been used for yellowfin tuna in the EPO
- Management strategy evaluation can be used to compare integrated stock assessments to other approaches (e.g. raw CPUE). Operating model is often based on integrated stock assessment
- Multispecies and ecosystem models can be used to investigate how species interactions may influence single species integrated stock assessments and management

Conclusions

- Integrated stock assessment provides a much broader picture than simple CPUE
- Integrated stock assessment can provide many insights into managing a fishery
- Integrated stock assessment is not the answer to everything, other methods may provide alternative perspectives
- Management strategy evaluation provides a method to compare Integrated stock assessment with alternatives

The End