Are pelagic fisheries managed well?

A stock assessment scientists perspective

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Outline

1. A response to Myers and Worm (2003)
2. Are pelagic fisheries managed well?
3. EPO tuna Fisheries
4. Summary

Myers and Worm (2003)

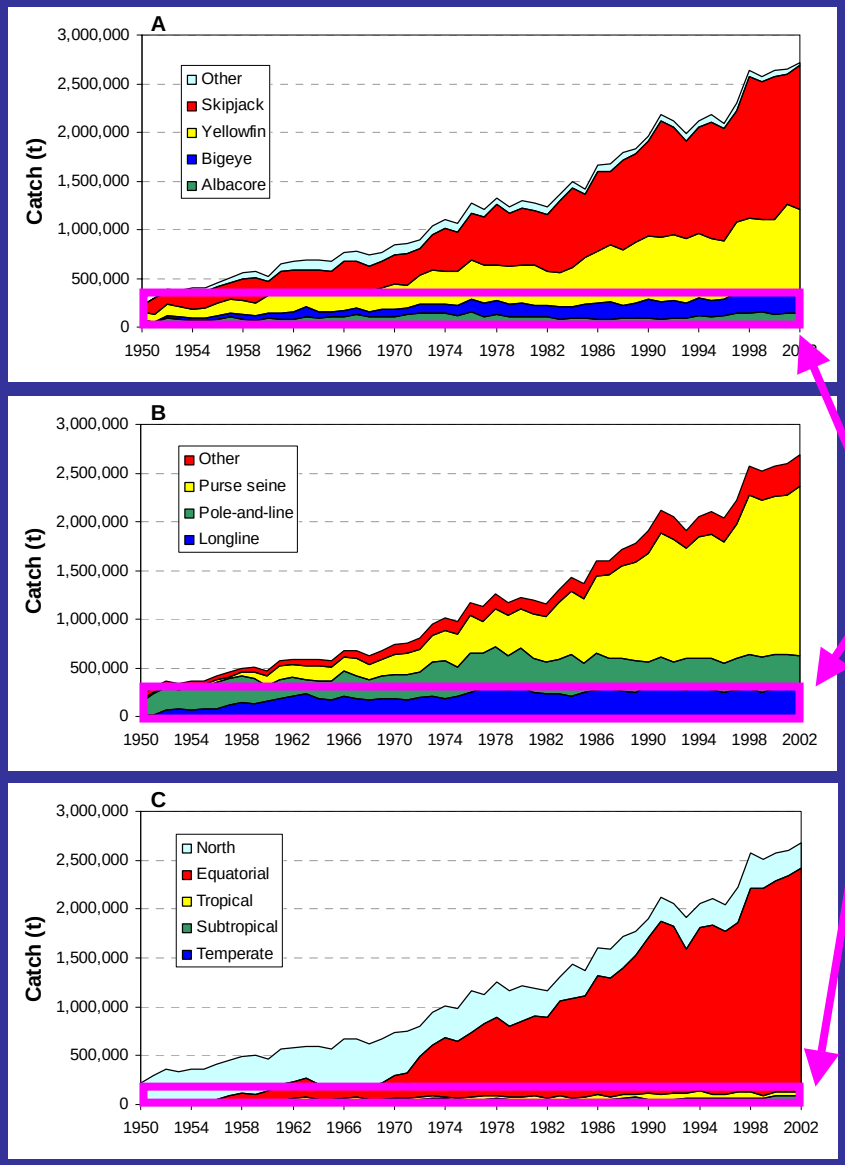
- “industrialized fisheries typically reduced community biomass by 80% during the first 15 years of exploitation”
- “large predatory fish biomass today is only about 10% of pre-industrial levels”.
- Most of the data was Japanese tuna longline catch and effort data
- I will argue that the analysis is flawed in several respects and illustrate this will data from the Pacific Ocean

Pacific Ocean Tuna Catch Data

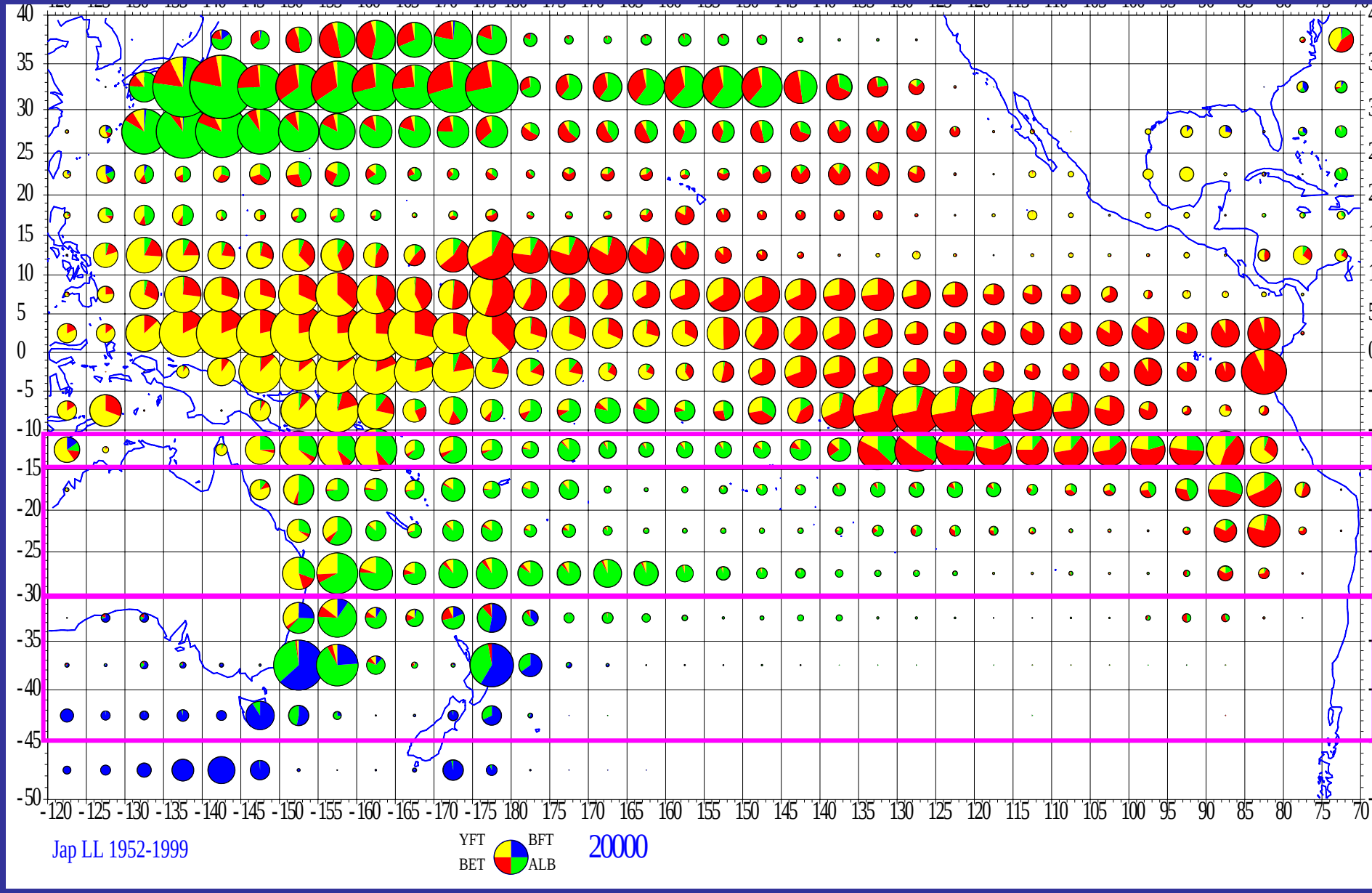
By species

By method

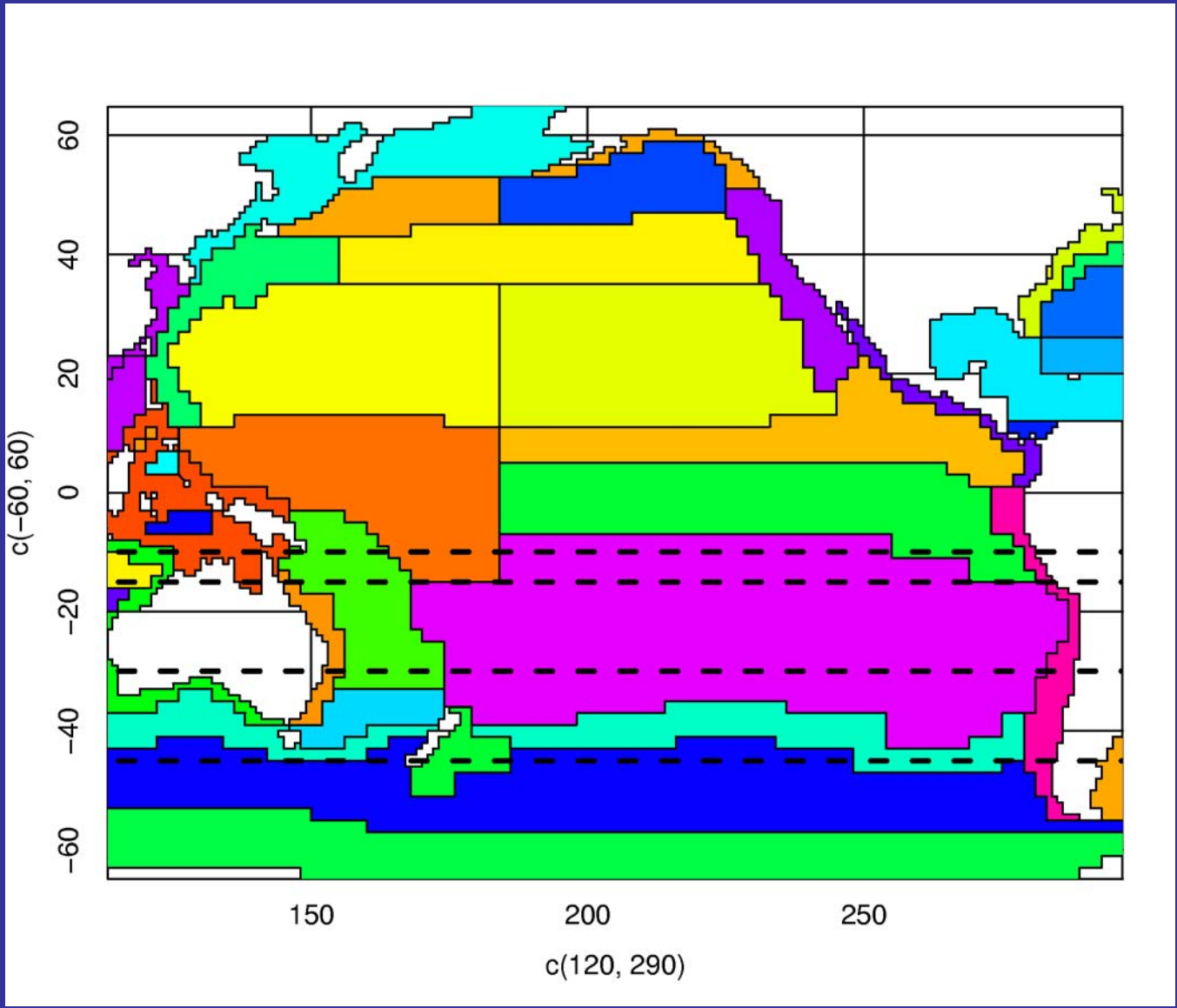
By area



Myers and Worm data


Jap LL 1952-1999
YFT
BET
BFT
ALB
20000

Longhurst Areas



Spatial expansion of the longline fishery

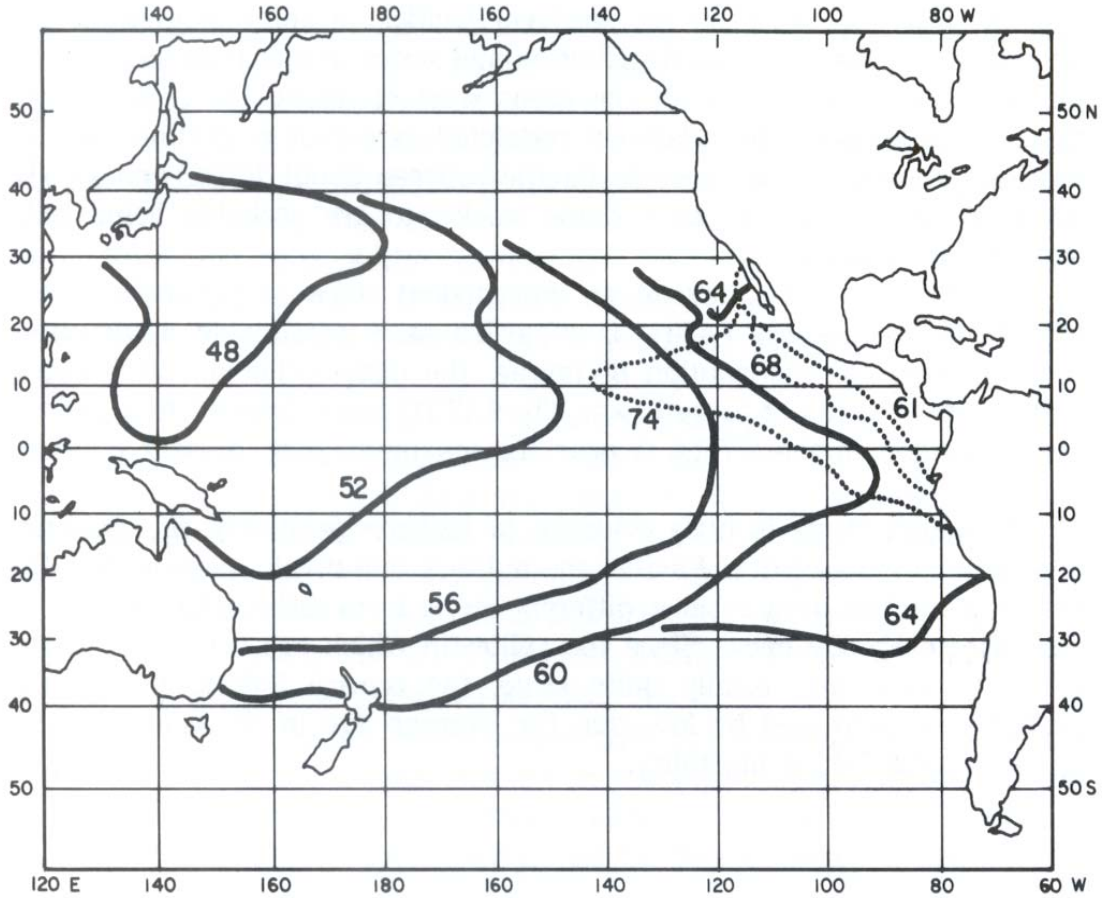
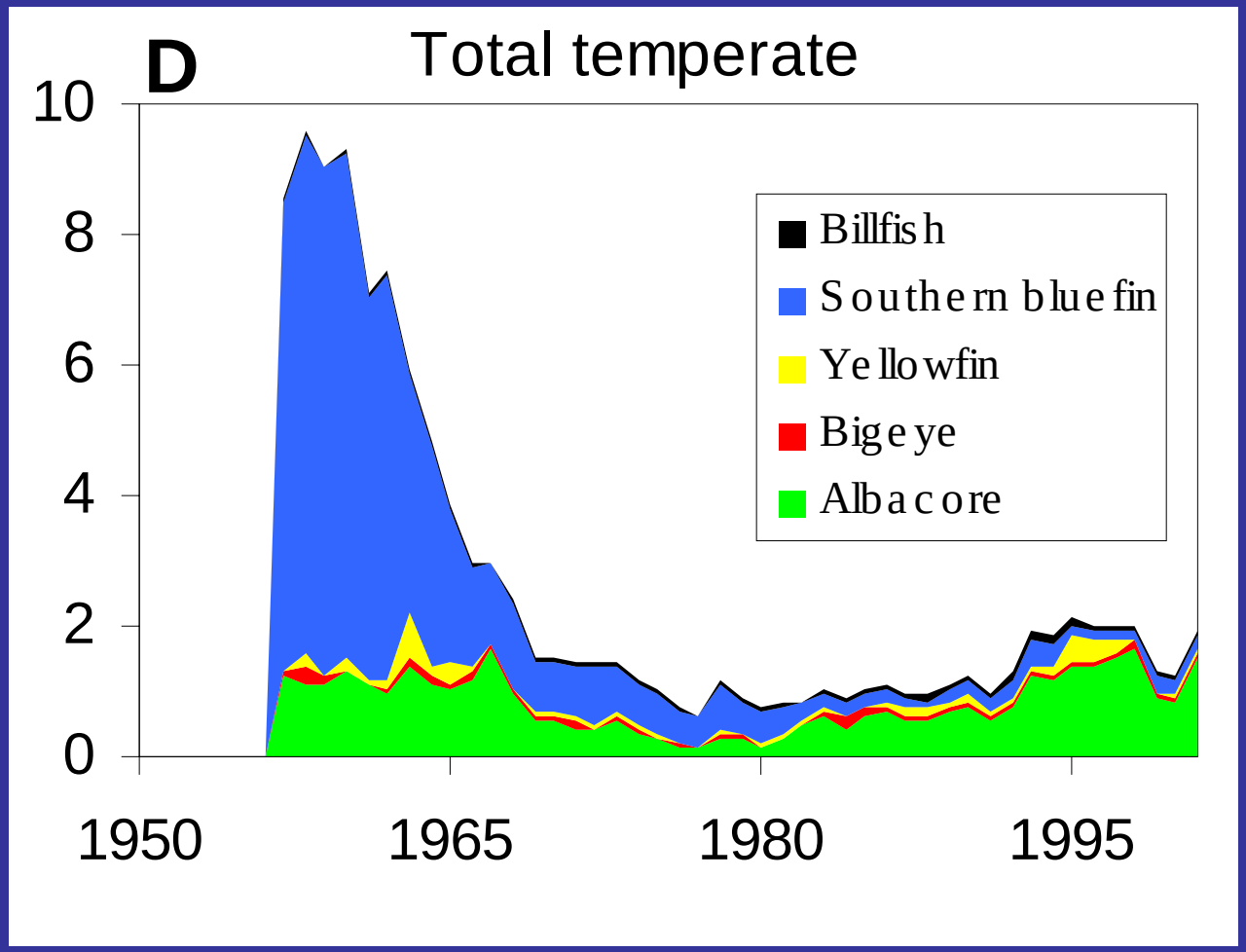


FIGURE 1. Geographical expansion of the Japanese longline fishery (solid curves) and the surface fishery in the eastern Pacific (dotted curves). Numerals denote calendar year.

One species dominates



More often than not community CPUE declines faster than abundance

$$\frac{\partial B_i}{\partial t} = r_i\left(1-\frac{B_i}{K_i}\right)B_i - q_i E B_i$$

$$\frac{B_{SS}}{\sum_i K_i} < \frac{CPUE_{SS}}{\sum_i q_i K_i}$$

$$\frac{q_i}{q_j} < 1$$

$$\frac{\partial B_i}{\partial t} = 0$$

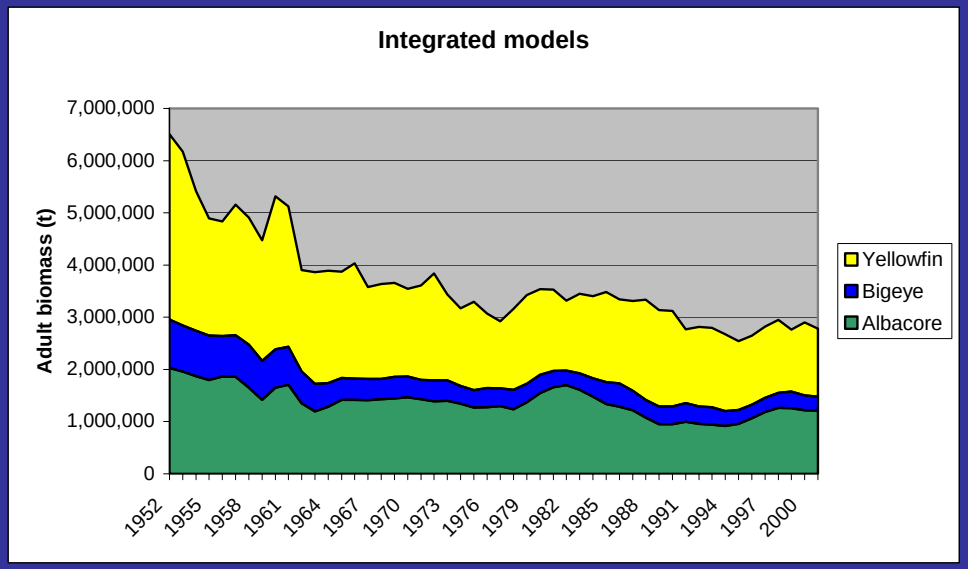
$$\left(\sum_i q_i K_i\right)^2 > \sum_i K_i \sum_i q_i^2 K_i$$

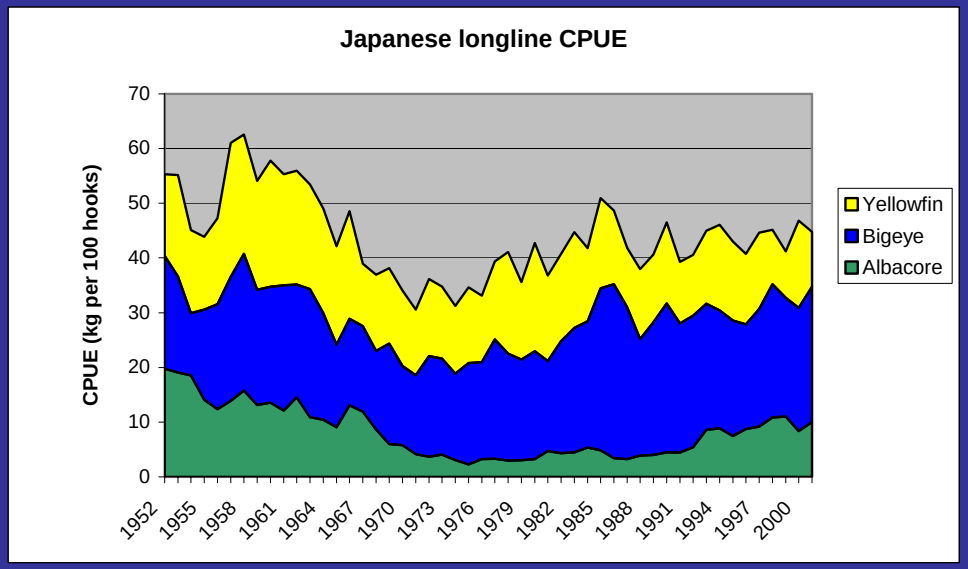
$$\frac{\sum_i \frac{q_i}{r_i} K_i}{\sum_i K_i} > \frac{\sum_i \frac{q_i^2}{r_i} K_i}{\sum_i q_i K_i}$$

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

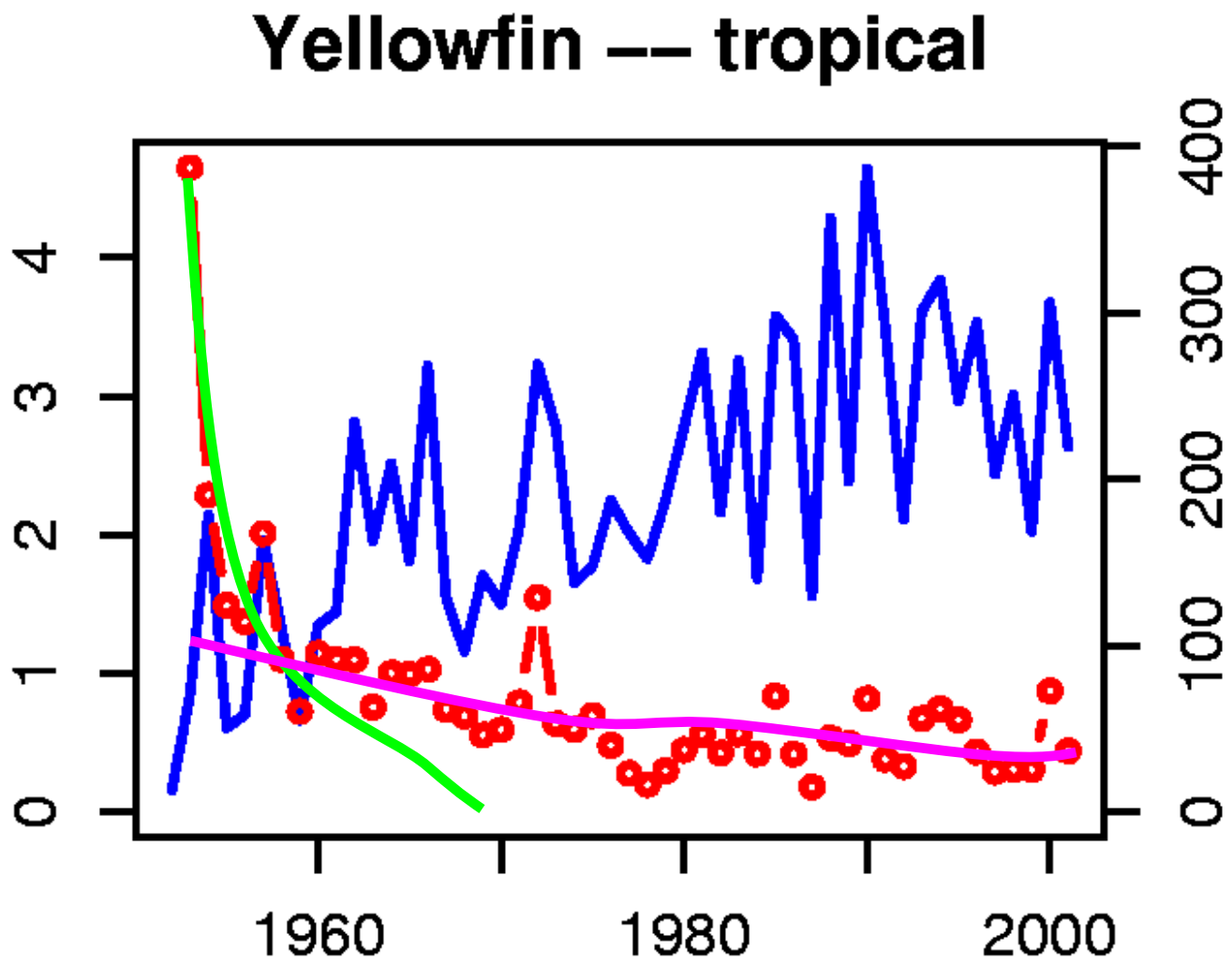
$$\frac{r_i}{r_j} < \frac{q_i}{q_j} < 1 \forall i, j \text{ pairs} \Rightarrow \text{Biomass declines faster than CPUE}$$

Abundance of tunas in the Pacific Ocean



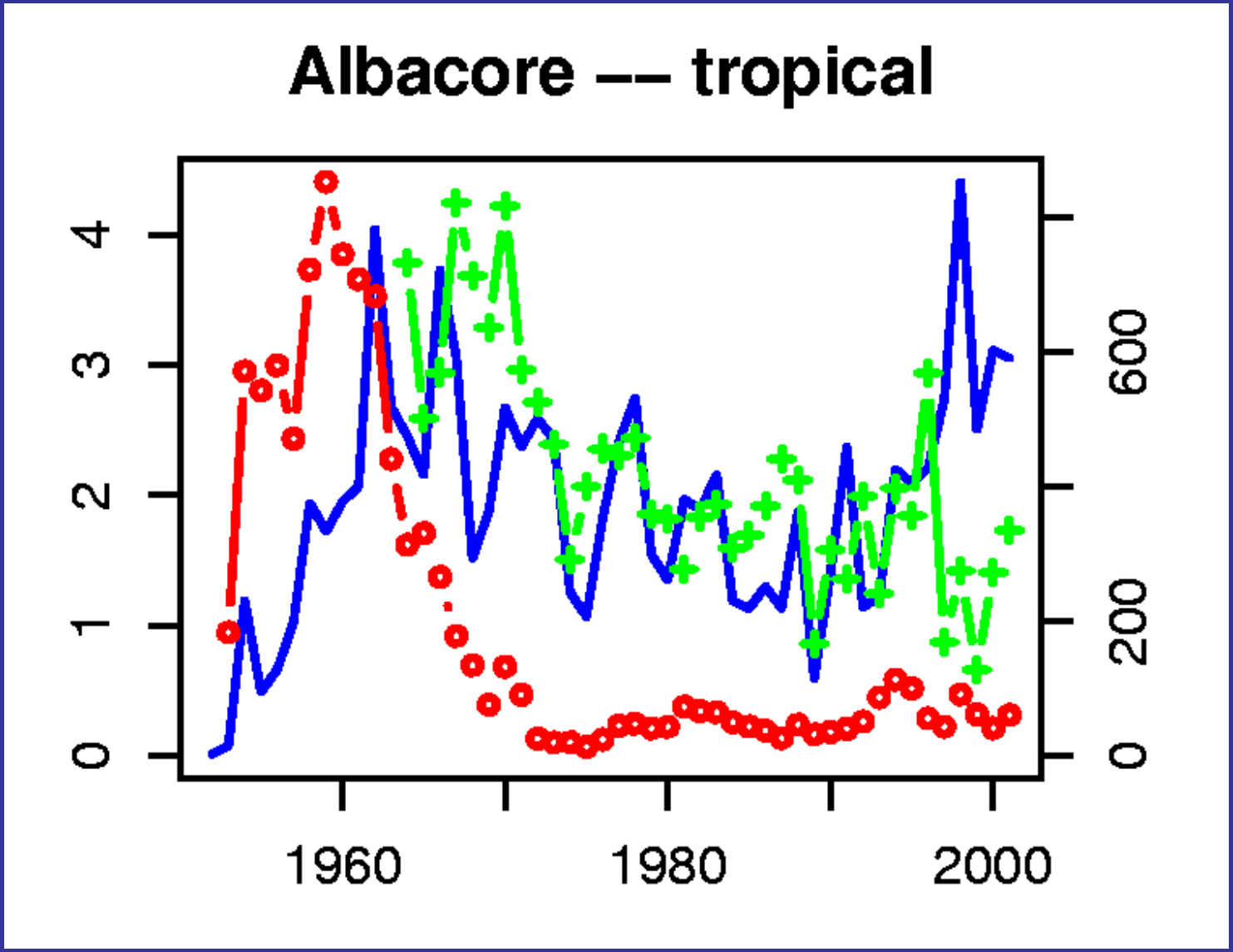


CPUE is inconsistent with catch and population dynamics



Blue is total catch, red is CPUE

Change in targeting: from albacore to bigeye



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

Single Species

Hypothesis	Current depletion level			
	More	Same	Less	Unknown
Regime change		x		
Ecosystem		x		
Spatial distribution		x		
Gear depth			x (most)	
Stupid fish			x	
Size-specific vulnerability			x	
Multiple stocks				x
Fraction of stock				x
Interference			x	
Increased power	x			
Targeting				Depends
Age-specific M				x
Fishing regulations				x
Soaktime	x			
Shark damage	x			
Hook saturation	x			

Are pelagic fisheries managed well?

1. What are the management objectives?
2. Are the management objectives reasonable?
3. Can we determine if the management objectives have been achieved?

What are the management objectives? Don’t really know

- International commissions
- Individual country jurisdictions
- Over-arching objective
  - Maintain stocks at levels capable of producing MSY
  - Modified by other factors
  - Precautionary approach
- Most specific objectives vary by user/country and are unrecorded

Are the management objectives reasonable? Yes, but too vague to be useful

- Stated management objectives are vague
  - Need to have something that covers the diverse goals of users
  - Are the specific interpretations reasonable?
- MSY
  - Reasonable given difficulty determining other factors
  - More useful as an indicator than an objective
  - Negative aspects of MSY covered by “modifying factors” and precautionary approach
  - Depletion to around 30% of unexploited
- But these are not the real objectives
  - Social, economic, cultural, ….
  - Bycatch only important if causes a penalty

Considerations

- Multiple species
  - Can’t get MSY for each simultaneously
  - Sustainable overexploitation of some species may be required
- Different gears
  - Yield
  - Economics
  - Bycatch
- Different countries
  - Economic and social dependence
- Different users have different objectives

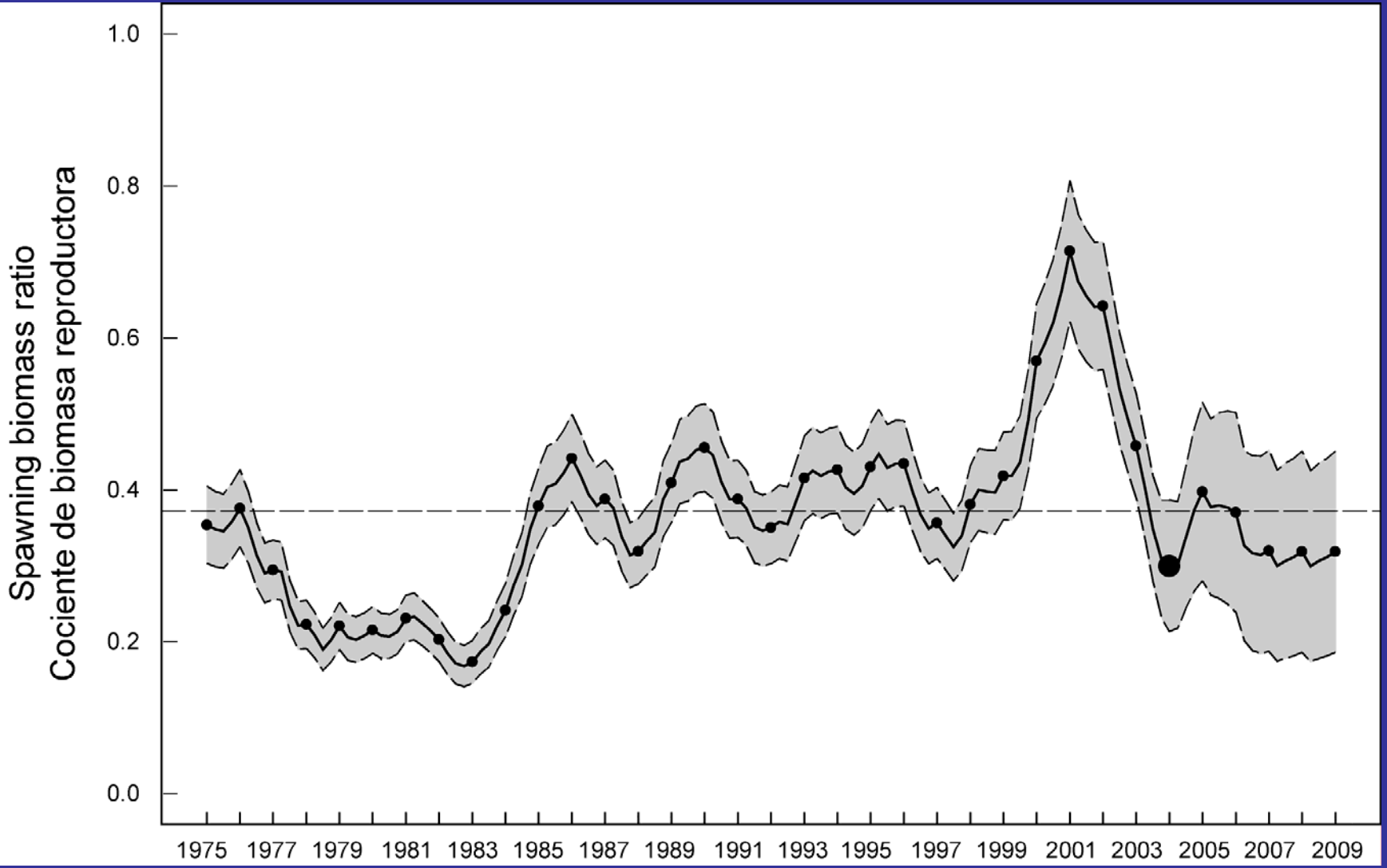
Can we determine if the management objectives have been achieved? Depends

- Estimate MSY quantity e.g B_{MSY} or F_{MSY}
  - Age-specific F
  - Age-specific Natural mortality
  - Steepness of the stock-recruitment relationship
  - What years to average recruitment
- Comparison quantity B_{cur} or F_{cur}
  - Most recent B and F uncertain
- Ratios (e.g. F/F_{MSY}) are more precisely estimated and should be estimated inside the assessment model
- Problems with estimating unexploited biomass (Myers and Worm debate, shifting baselines)

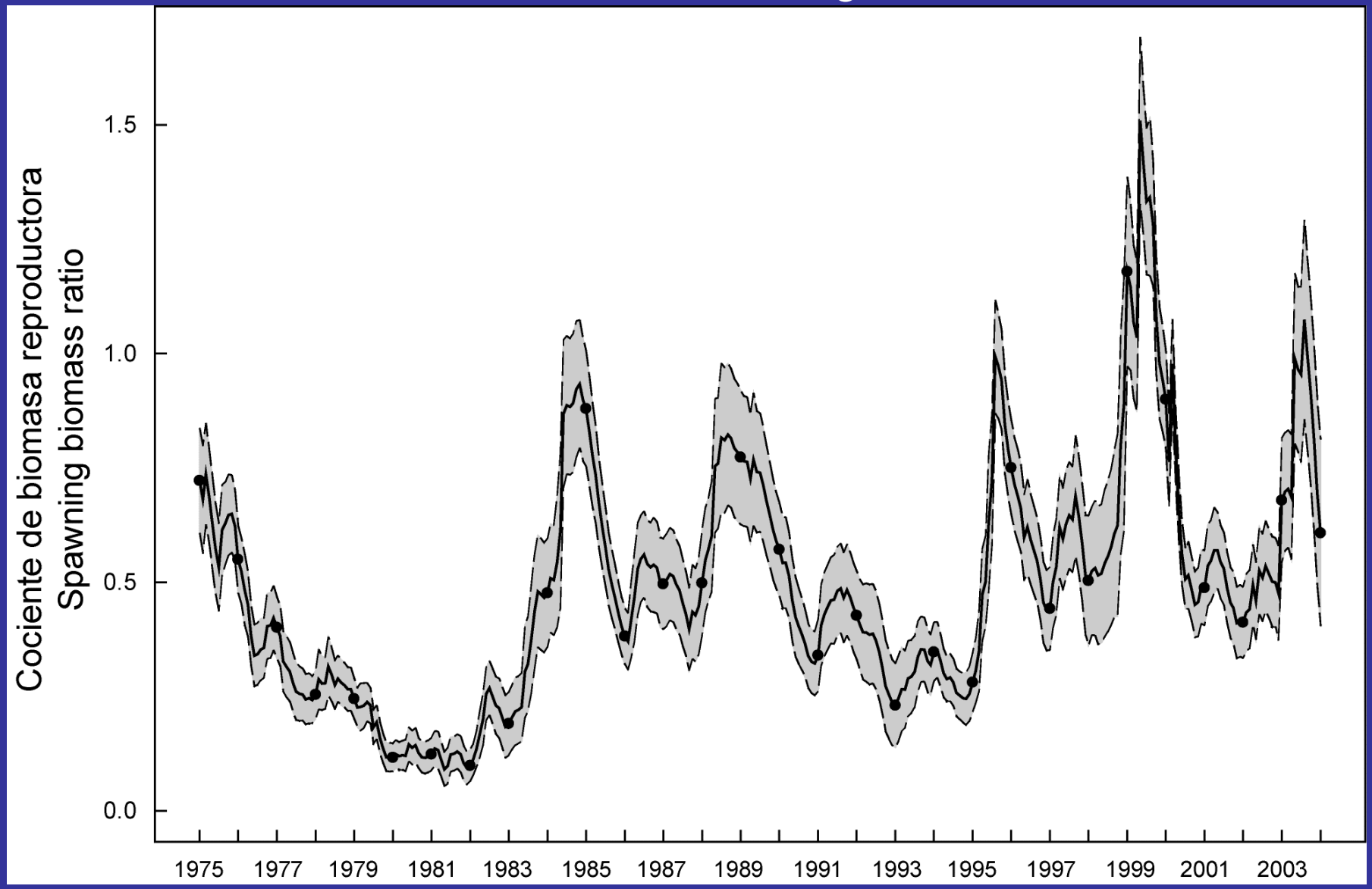
EPO Tuna Stocks

- Inter-American Tropical Tuna Commission - governing body
- Yellowfin, skipjack, bigeye
- Longline
  - Distant water nations
  - Large bigeye
  - Sharks, Turtles
- Purse seine on floating objects
  - Ecuador, EU
  - Skipjack, small bigeye
  - Sharks and other fish
- Purse seine on unassociated schools
  - Opportunistic
  - Skipjack, small yellowfin
  - Similar but less than Floating objects
- Purse seine on dolphin associated schools
  - Mexico, Venezuela
  - Large yellowfin
  - Dolphins

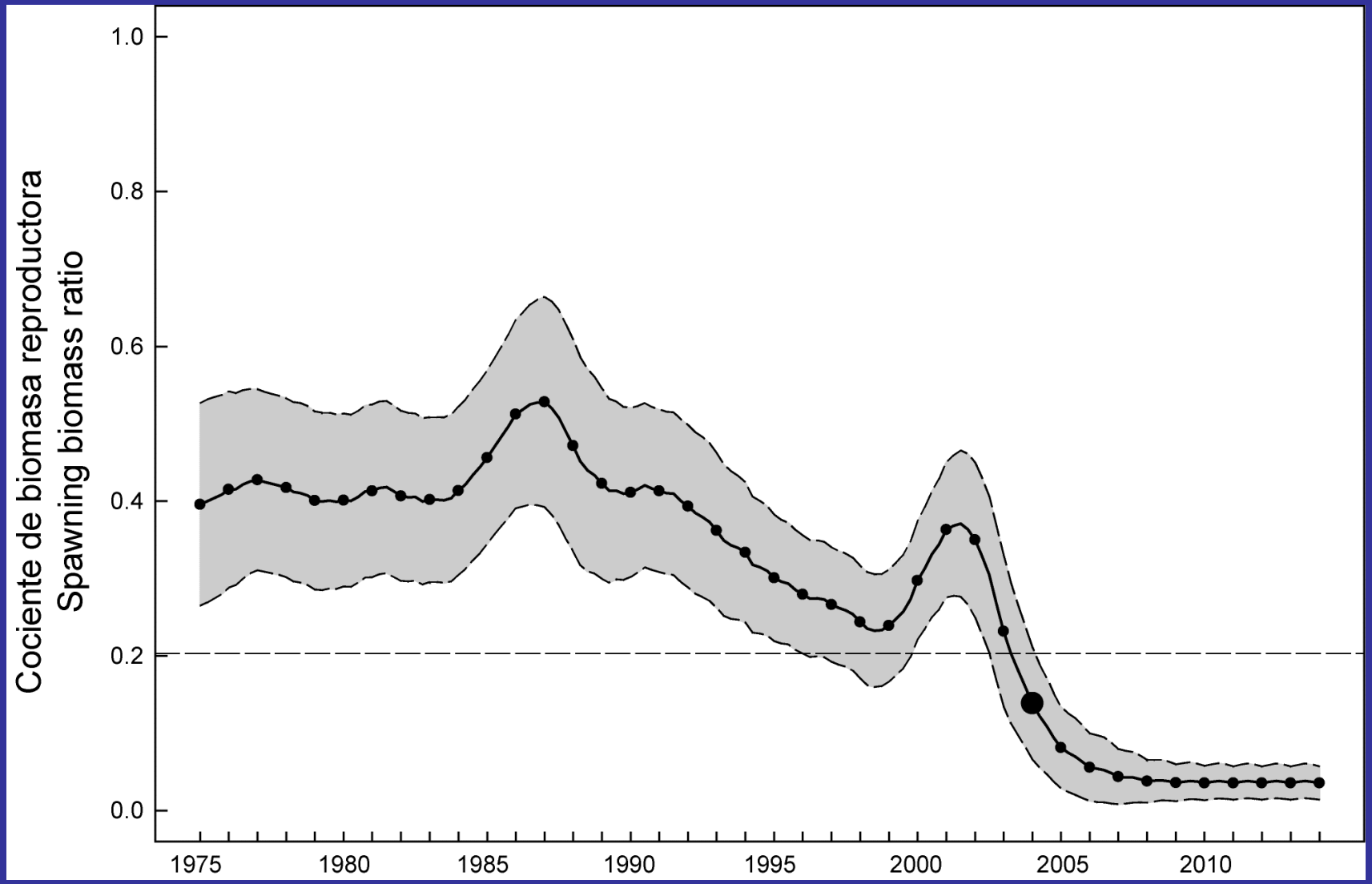
Yellowfin Tuna Spawning Biomass Ratio (S/S_0)



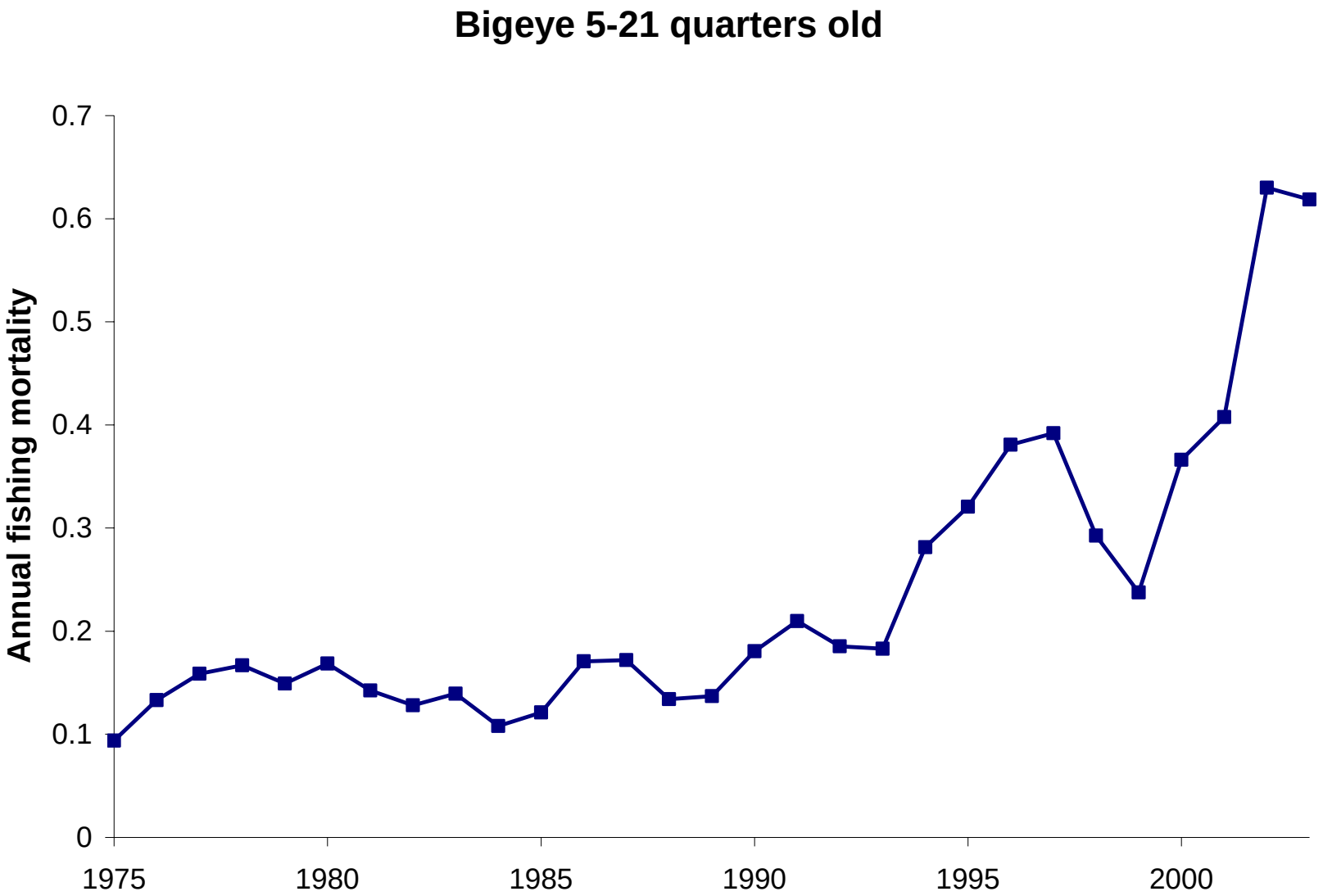
Skipjack Tuna Spawning Biomass Ratio (S/S_0)



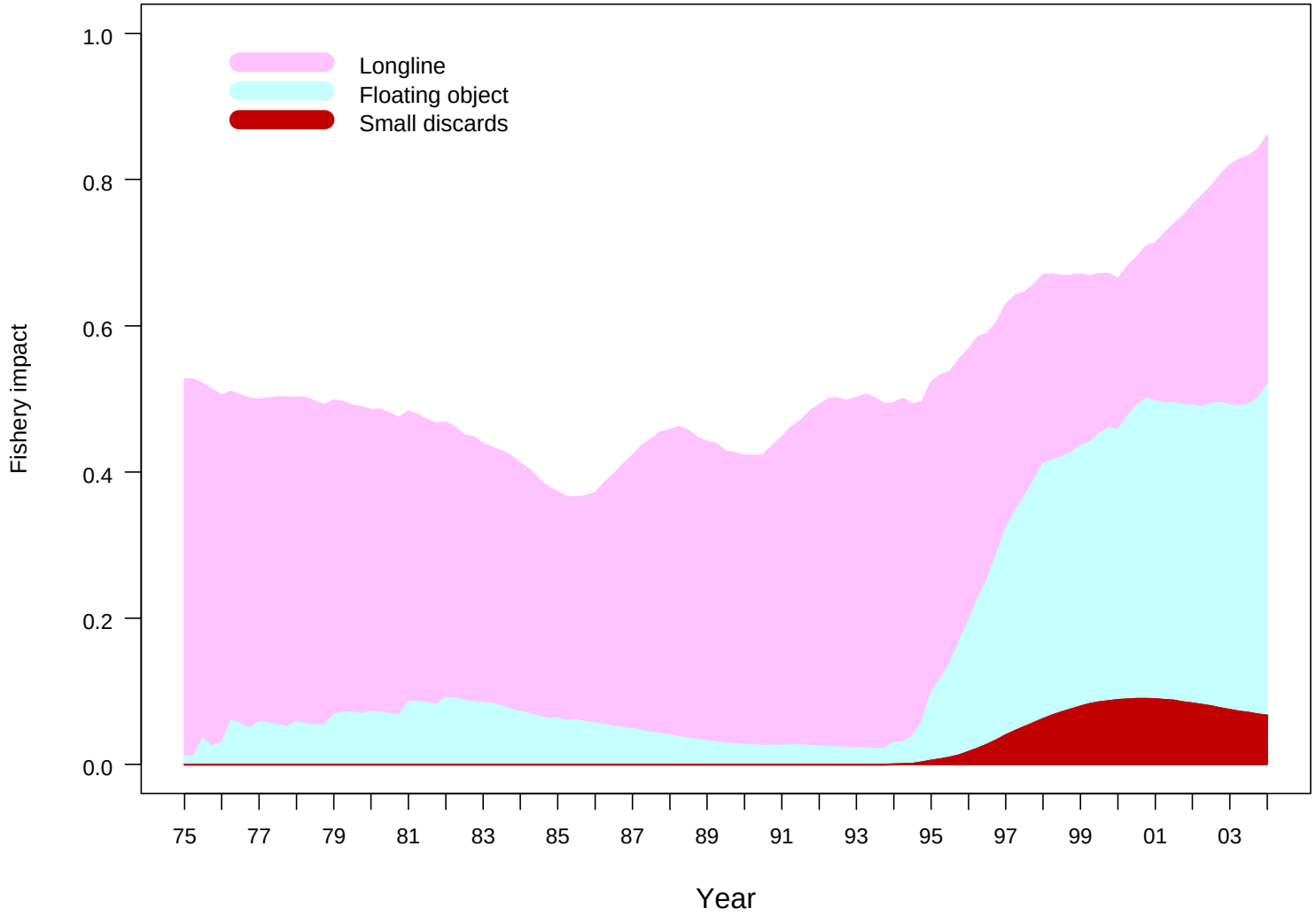
Bigeye tuna Spawning Biomass Ratio (S/S_0)



Bigeye Fishing Mortality



Fishery Impact on EPO bigeye tuna



Year of assessment	Stock assessment conclusion	Staff recommendation (includes actions for all species)	Adopted conservation measures	Change in fishing mortality from comparison year
2000	Assuming a moderate spawner-recruitment relationship, fishing mortality should be kept at 1999 levels.	No recommendation for bigeye Catch quota for yellowfin	Three month closure of the floating-object fishery	Fishing mortality **increased 54%** from 1999 levels.
2001	Assuming a moderate spawner-recruitment relationship, fishing mortality should be **reduced (10%)** from 2000 levels.	Fishing effort should not be allowed to increase beyond current levels.	Closure of floating-object fishing if catches of small bigeye reach 1999 levels, but not before November 2001. No closure occurred.	Fishing mortality **increased 11%** from 2000 levels.
2002	Assuming a moderate spawner-recruitment relationship, fishing mortality should be kept at 2001 levels.	Close the floating-object fishery if small bigeye catches reach 1999 levels **and** a complete EPO closure for December 2002.	Complete closure of the EPO for December 2002	Fishing mortality **increased 55%** from 2001 levels.
2003	Fishing mortality needs to be **reduced substantially (20-50%)** from levels observed in 2000 and 2001.	Complete EPO closure for two months **plus** two month closure of an area of high bigeye catches. Longline catches reduced to 2000 levels	Closure of a smaller region (than proposed) for December 2003. Longline catches reduced to 2001 levels	Fishing mortality **increased 60%** from 2000-2001 levels.
2004	Fishing mortality needs to be **reduced substantially (30-60%)** from levels observed in 2001 and 2002	Complete EPO closure for two months **plus** either a six month closure of a area of high bigeye catches **or** a six month closure of an area for floating-object sets **or** 500t individual vessel catch limits. Longline catches to be reduced to levels of 2000	Complete closure of the EPO for six weeks (This resolution was agreed upon in October 2003). Longline catches reduced to 2001 levels.	

Bycatch research in the EPO

- IATTC bycatch database 100% observers on large purse seine vessels
- IATTC resolution to collect data on turtles
- IATTC collaboration with WWF to reduce turtle mortality
- The reduction in dolphin mortality in the EPO purse seine fisheries
- IATTC protected species modeling

Summary

- Myers and Worm (2003) analysis
  - Flawed
  - Should not be used to determine the status of large predatory fish biomass
- Are pelagic fisheries managed well?
  - Difficult to answer
  - We don’t know what the management objectives are
  - We don’t know what the management objectives should be
  - Even if we did, we might not be able to determine if they have been met
- Tuna stocks
  - Some stocks appear to be poorly managed (e.g. bigeye tuna in the EPO)
  - Some stocks appear to be healthy, but the associated fisheries have management problems (e.g. skipjack tuna in the EPO)
  - Some stocks appear to be well managed, but with other issues (e.g. yellowfin tuna in the EPO)
  - The status of many stocks are uncertain (e.g. billfish in the EPO)

Aquavest