Are pelagic fisheries managed well?

A stock assessment scientists perspective

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Outline

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 with data from the Pacific Ocean
Pacific Ocean Tuna Catch Data

By species

By method

By area

Myers and Worm data
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

![Graph showing CPUE for different species across years]

- Billfish
- Southern bluefin
- Yellowfin
- Bigeye
- Albacore
More often than not community CPUE declines faster than abundance

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

\[
\frac{\partial B_i}{\partial t} = 0 \quad q_i < 1
\]

\[
q_j < 1
\]

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

\[
\frac{r_i}{r_j} < \frac{q_i}{q_j} < 1 \forall i, j \text{ pairs} \Rightarrow \text{Biomass declines faster than CPUE}
\]
Abundance of tunas in the Pacific Ocean

**Integrated models**

- *Yellowfin*
- *Bigeye*
- *Albacore*

**Japanese longline CPUE**

- *Yellowfin*
- *Bigeye*
- *Albacore*
CPUE is inconsistent with catch and population dynamics

Yellowfin -- tropical

Blue is total catch, red is CPUE
Change in targeting: from albacore to bigeye

Albacore --- tropical

Blue is total catch, green is Taiwan CPUE, red is Japan CPUE
<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Current depletion level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>More</td>
</tr>
<tr>
<td>Regime change</td>
<td>x</td>
</tr>
<tr>
<td>Ecosystem</td>
<td>x</td>
</tr>
<tr>
<td>Spatial distribution</td>
<td>x</td>
</tr>
<tr>
<td>Gear depth</td>
<td>x</td>
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<tr>
<td>Stupid fish</td>
<td>x</td>
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<tr>
<td>Size-specific vulnerability</td>
<td>x</td>
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<tr>
<td>Multiple stocks</td>
<td></td>
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<tr>
<td>Fraction of stock</td>
<td></td>
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<tr>
<td>Interference</td>
<td></td>
</tr>
<tr>
<td>Increased power</td>
<td>x</td>
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<tr>
<td>Targeting</td>
<td>Depends</td>
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<tr>
<td>Age-specific M</td>
<td>x</td>
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<tr>
<td>Fishing regulations</td>
<td>x</td>
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<tr>
<td>Soaktime</td>
<td>x</td>
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<tr>
<td>Shark damage</td>
<td>x</td>
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<tr>
<td>Hook saturation</td>
<td>x</td>
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</tbody>
</table>
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/S₀)
Bigeye tuna Spawning Biomass Ratio ($S/S_0$)
Fishery Impact on EPO bigeye tuna

![Graph showing fishery impact on EPO bigeye tuna over the years. The graph indicates the trend of fishery impact on various types of fishing methods, including longline, floating object, and small discards. The impact is measured on a scale from 0.0 to 1.0.]
<table>
<thead>
<tr>
<th>Year of assessment</th>
<th>Stock assessment conclusion</th>
<th>Staff recommendation (includes actions for all species)</th>
<th>Adopted conservation measures</th>
<th>Change in fishing mortality from comparison year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>Assuming a moderate spawner-recruitment relationship, fishing mortality should be kept at 1999 levels.</td>
<td>No recommendation for bigeye Catch quota for yellowfin</td>
<td>Three month closure of the floating-object fishery</td>
<td>Fishing mortality increased 54% from 1999 levels.</td>
</tr>
<tr>
<td>2001</td>
<td>Assuming a moderate spawner-recruitment relationship, fishing mortality should be reduced (10%) from 2000 levels.</td>
<td>Fishing effort should not be allowed to increase beyond current levels.</td>
<td>Closure of floating-object fishing if catches of small bigeye reach 1999 levels, but not before November 2001. No closure occurred.</td>
<td>Fishing mortality increased 11% from 2000 levels.</td>
</tr>
<tr>
<td>2003</td>
<td>Fishing mortality needs to be reduced substantially (20-50%) from levels observed in 2000 and 2001.</td>
<td>Complete EPO closure for two months plus two month closure of an area of high bigeye catches. Longline catches reduced to 2000 levels</td>
<td>Closure of a smaller region (than proposed) for December 2003. Longline catches reduced to 2001 levels</td>
<td>Fishing mortality increased 60% from 2000-2001 levels.</td>
</tr>
<tr>
<td>2004</td>
<td>Fishing mortality needs to be reduced substantially (30-60%) from levels observed in 2001 and 2002</td>
<td>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</td>
<td>Complete closure of the EPO for six weeks (This resolution was agreed upon in October 2003). Longline catches reduced to 2001 levels.</td>
<td></td>
</tr>
</tbody>
</table>
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)