Fisheries Management and Governance

Daniel Pauly
Sea Around Us
University of British Columbia,
Vancouver, Canada

Ocean Conservation Masterclass
(Lecture 9 of 10)
University of Western Australia
Perth, May 26, 2017
d.pauly@oceans.ubc.ca
Sustainable Yield or Revenue

Maximum Economic Yield

Maximum Sustainable Yield

Open-Access Equilibrium

Total Cost (TC)

Total Revenue (TR)

Effective Fishing Effort

E1

E2

E3
When I was a student, the graph below was the picture we were taught of fisheries management.
Then came …

‘Co-management’

Government

Fisheries biologists

Fishers

Resource

Social scientists
Fisheries, when badly managed (by governments) tend to self-destroy, as shown in this graph, illustrating a Canadian tragedy that is being duplicated all over the world.
FAO’s invention…

…taken over by the *Sea Around Us*…

…continues to be used by FAO (source: SOFIA 2016)
... and finally:

‘New Governance’

- Fishers
- Other stakeholders
- Scientists
- Resource

Governments
The Toolkit of Fisheries Managers

1) Input controls (gear restrictions, spatial restrictions, overall effort limits, etc.) and their pros and cons;
2) Output controls (landing restriction, TAC/quotas, ‘catch shares’, ITQs), and their pros and cons.

Important here: C = F*B
How a Harvest Control Rule Works

The results of a fish stock assessment can be represented graphically by what is known as a Kobe plot. The example below shows a simple linear sliding HCR. The fishery’s ideal state is green, its cautionary state is yellow, and the state to avoid is red. In this example, the indicator of stock status is spawning stock biomass (SSB), as estimated by a stock assessment model. The HCR has the following specifications:

1. If SSB is below SSB_{limit}, suspend the fishery and institute a scientific monitoring quota until the limit is reached or exceeded.
2. If SSB is between the limit (SSB_{limit}) and the target (SSB_{target}), reduce fishing mortality in accordance with the rebuilding phase of the HCR.
3. If SSB is greater than or equal to the target (SSB_{target}), fish at the target mortality rate (F_{target}).
## Main Types of Harvest Control Rules

<table>
<thead>
<tr>
<th>HCR type</th>
<th>Description</th>
<th>What it looks like</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>Allows for a constant level of fishing based on one value, regardless of stock status. The single value could be mortality (F), total allowable catch, days at sea, etc.</td>
<td><img src="image" alt="Constant Chart" /></td>
</tr>
<tr>
<td>Threshold</td>
<td>Fishing is allowed at a single target level until a limit is reached, at which point fishing is stopped.</td>
<td><img src="image" alt="Threshold Chart" /></td>
</tr>
<tr>
<td>Step</td>
<td>Incorporates steps so higher fishing levels are permitted as the stock's status improves.</td>
<td><img src="image" alt="Step Chart" /></td>
</tr>
<tr>
<td>Sliding (simple linear)</td>
<td>A sliding rule allows for a continuous adjustment in fishing controls. Higher fishing levels are permitted with improved stock status.</td>
<td><img src="image" alt="Sliding (simple linear) Chart" /></td>
</tr>
<tr>
<td>Sliding (complex linear)</td>
<td>Same as above, but linear combinations can be complex, meaning that different responses may be triggered at different thresholds.</td>
<td><img src="image" alt="Sliding (complex linear) Chart" /></td>
</tr>
<tr>
<td>Sliding (nonlinear)</td>
<td>Similar to the sliding forms, but the adjustments are nonlinear. This may be logarithmic (i.e., a smooth increase in fishing levels as stock status improves, as shown) or logistic (more S-shaped—i.e., a smooth increase up to a constant control measure at larger stock sizes).</td>
<td><img src="image" alt="Sliding (nonlinear) Chart" /></td>
</tr>
</tbody>
</table>
There are numerous examples of rebuilt stocks, e.g., cod in the North Sea.
Median biomass relative to $B_{msy}$ in E.U. stocks

Analysis of 397 stocks in European Seas and adjacent waters (Froese et al. 2016; report to Oceana)
Top-down management, when consistent, can reduce fishing pressure, i.e., reduce F to $F_{msy}$, for example in the North Sea...

Analysis of 45 stocks in European Seas and adjacent waters (Froese et al. 2016; report to Oceana)
Another of fisheries governance is the setting of marine protected areas. Those that we have in the North Atlantic, at the onset on the 21st century, are shown in green …
Marine protected areas were early seen as part of the solution. There were many, but most of them were tiny, and their growth started from a small base…

1% of world ocean area (growth rate ~ 5% year⁻¹)

2,700 MPAs cover less than 1 km²

Wood et al. (Oryx, 2008)
Thus, the growth of the global MPA network was so slow that all targets would be missed...

Wood et al. (Oryx, 2008)
However, the declaration of very large marine reserves has changed the trend…

<table>
<thead>
<tr>
<th>Name of MPA/Marine reserve</th>
<th>Country</th>
<th>Area (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phoenix Islands Protected Area</td>
<td>Kiribati</td>
<td>408,342</td>
</tr>
<tr>
<td>Great Barrier Reef Marine Park</td>
<td>Australia</td>
<td>343,480</td>
</tr>
<tr>
<td>Papahanaumokuakea Marine National Monument</td>
<td>United States</td>
<td>334,154</td>
</tr>
<tr>
<td>Mariana Trench Marine National Monument</td>
<td>United States</td>
<td>247,179</td>
</tr>
<tr>
<td>Pacific Remote Islands Marine National Monument</td>
<td>United States</td>
<td>212,788</td>
</tr>
<tr>
<td>Prince Edward Islands Marine Protected Area</td>
<td>South Africa</td>
<td>180,633</td>
</tr>
<tr>
<td>Kermadec Benthic Protection Area</td>
<td>New Zealand</td>
<td>164,840</td>
</tr>
<tr>
<td>Macquarie Island Commonwealth Marine Reserve</td>
<td>Australia</td>
<td>161,895</td>
</tr>
<tr>
<td>Galapagos Marine Reserve</td>
<td>Ecuador</td>
<td>137,975</td>
</tr>
<tr>
<td>Franz Josef Land Zakaznik</td>
<td>Russia</td>
<td>123,877</td>
</tr>
<tr>
<td>Antipodes Transect Benthic Protection Area</td>
<td>New Zealand</td>
<td>110,565</td>
</tr>
</tbody>
</table>
Global Distribution of Marine Protected Areas

Wood et al. (Oryx, 2008, with updates)
Understanding the cost of establishing marine protected areas

Ashley McCrea-Strub a,*, Dirk Zeller a, Ussif Rashid Sumaila a, Jay Nelson b, Andrew Balmford c, Daniel Pauly a
Then there is Ray Hilborn, who can always be counted on to argue that we don’t need MPAs. Here, in *Nature* no less, he writes that we don’t need marine protection because we have ‘fisheries management’- as if fisheries management was meant to protect biodiversity…

**Marine biodiversity needs more than protection**

To sustain the seas, advocates of marine protected areas and those in fisheries management must work together, not at cross purposes, urges Ray Hilborn.

On 1 September, government leaders, directors of non-governmental organizations (NGOs) and others will meet in Hawaii at the International Union for Conservation of Nature’s World Conservation Congress to discuss environmental and development challenges. Twenty-three NGOs, including the Pew Charitable Trusts and the Natural Resources Defense Council, are calling on the IUCN to make 30% of the world’s coastal and marine areas fully protected from fishing and other forms of exploitation by 2030.

Fishing is either banned outright or tightly restricted. Many conservationists see the establishment of these marine protected areas (MPAs) as the only way to protect biodiversity. Others — me included — argue that the protection of biodiversity at sea can include recreational and industrial fishing and other uses of ocean resources. In fact, we think that closing waters to some kinds of fishing gear and restricting the catch of named species can offer much more protection than cordonning off even 30% of an area. We are concerned that MPAs may simply sea-bed mining and ocean acidification, are not being addressed in standard fisheries management.

The seas face myriad problems — climate change, development and the nutritional and other needs of a growing human population. To tackle them, conservationists and those involved in fisheries management must work together and answer to the same governing bodies.

**RISE OF PROTECTION**

Calls for MPAs began in earnest during the
Trends in the observed and projected global coverage of marine protected areas (MPAs). (a) Data from Wood et al. (1960-2006), showing the observed and projected increase; (b) Observed (1960-2014) and accelerated increases, then back to 4.6% per year growth rate; (c) hypothetical increase of global marine protected areas in the Sargasso Sea, (d) the High Arctic and the area of the Southern Ocean managed by the CCMLAR, and (e) the global high seas.

The argument that even large marine reserves would fail to protect migratory fish such as tuna doesn’t hold, because the simulation models so far used to test the effect of closures did not include evolution, i.e., that more sedentary fish will be suffering less from fishing, and thus, over time, will tend to become more abundant (Mee, J., S. Otto and D. Pauly 2016).
Finally:

This graph highlights the crucial role of small-scale fisheries, so far often neglected.

Indeed, we would achieve most stated aims of fisheries management plans (particularly their social aims) by dedicated access arrangements for small-scale fisheries, and termination of industrial subsidies.