Global Fishery Prospects: Modeling & Management

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6 December, 2016
Roadmap for this talk

- Current status and trends in global fisheries
- Timing-to-recovery
- Prospects: Food, livelihoods, conservation
- Research ideas and next steps
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Global fishery prospects under contrasting management regimes

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Edited by James A. Estes, University of California, Santa Cruz, CA, and approved February 26, 2016 (received for review October 14, 2015)

Data from 4,713 fisheries worldwide, representing 78% of global reported fish catch, are analyzed to estimate the status, trends, and benefits of alternative approaches to recovering depleted fisheries. For each fishery, we estimate current biological status and forecast the impacts of contrasting management regimes on catch, profit, and biomass of fish in the sea. We estimate unique recovery targets and trajectories for each fishery, calculate the year-by-year effects of alternative recovery approaches, and model how alternative institutional reforms affect recovery outcomes. Current status is highly heterogeneous—the median fishery is in poor health (overfished, with further overfishing occurring), although 32% of fisheries are in good biological, although not necessarily economic, condition. Our business-as-usual scenario projects further divergence and continued collapse for many of the world’s fisheries. Applying sound management reforms to global fisheries in our dataset could generate annual increases exceeding 16 million metric tons (MMT) in catch, $53 billion in profit, and 619 MMT in biomass relative to business as usual. We also find that, with appropriate reforms, recovery can happen quickly, with the median fishery taking under 10 y to reach recovery targets. Our results show that commonsense reforms to fishery management would dramatically improve overall fish abundance while increasing food security and profits.

Recent advances in our understanding of global fishery status (1–4) provide a foundation for estimating the targets for, and potential benefits from, global fishery recovery. Although existing aggregate estimates make a compelling general case for reform (5–6), new data, models, and methods allow for more

Global Fishery Prospects

Significance

Bioeconomic theory provides some predictions for the trade-offs of contrasting management regimes. Indeed, emerging empirical evidence shows that effective policy interventions.

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The authors declare no conflict of interest.


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Global fishery prospects under contrasting
management regimes

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Rights based fishery managem

Rights-based fishery management (NEI) category (SI Appendix, Appendix 3) is among the most effective policy interventions for recovering overfished fishery. It emphasizes the welfare of fishers and the conservation of fish and marine ecosystems. Other social objectives such as employment, equity, or biodiversity conservation are clearly important, and may be correlated with these outcomes, but are not explicitly modeled here. Aggregating across fisheries provides country and global estimates of the consequences and trade-offs of alternative policies for recovering fisheries. A strength of our approach is the ability to forecast effects for fisheries in the Food and Agriculture Organization (FAO) “not elsewhere included” (NEI) category (SI Appendix).

Bioeconomic theory provides some predictions for the trade-offs across alternative societal objectives of food, profit, and
Global wild fish production

Wild Fish Production

Year


$10^7$
Biology: fish growth

![Graph showing the relationship between sustainable food and fish stock (B/Bmsy). The graph includes a curve labeled 'Catch.'](image-url)
Fishery status: 1800

- No Fishing

- Sustainable Food

- Fish Stock (B/Bmsy)
Bioeconomics: low fishing

Small Fishing

Sustainable Food

Fish Stock (B/Bmsy)
Bioeconomics: medium fishing

Medium Fishing

Sustainable Food

Fish Stock (B/Bmsy)
Bioeconomics: over-fishing

High Fishing

Sustainable Food

Fish Stock (B/Bmsy)
Bioeconomics: extreme over-fishing

Extreme Fishing

Sustainable Food

Fish Stock (B/Bmsy)
Bioeconomics: optimal condition

![Graph showing the relationship between revenue/cost and fish stock. The graph has a peak indicating the optimal fish stock (B/Bmsy) where revenue equals cost.](image)
Bioeconomics: current condition

![Graph showing revenue, cost, fish stock, and optimal fishing]

- Revenue, Cost
- Fish Now
- Fish Opt.
- Fish Stock (B/Bmsy)
Food upside

- Food
- Old Food
- New Food
- Fish Stock (B/Bmsy)
Fish upside
Profit upside

![Graph showing profit vs. fish stock (B/Bmsy)]
Institutional reforms

Profit

Old Profit

New Profit

Fish Stock (B/Bmsy)
A model of global fishery reform

- Stock-by-stock analysis (4,713 fisheries worldwide)
- Economics data, ecological data, dynamic models
- Current status & projections
  - BAU, Fmsy, Rights-based fishery management
- Triple-bottom-line outcomes
  - Food, Profits, Conservation
Data-poor ecosystems in worst shape

- 95% of fisheries *lack formal assessment*
- How to design/prioritize reforms without data?
- Develop new methods for global data-poor assessment

![Graph showing stock assessed, unassessed, and 95% confidence intervals from 1979 to 2009.](chart.png)
“Conservation Concern:” 77% of global stocks
Global snapshot, highlighting China

China
Country-level effects: RBFM vs. BAU

Change in Catch (MMT)

Change in Annual Profit ($ Billion)

Change in Biomass (MMT)

- China
- Indonesia
- India
- Japan
- Philippines
- Thailand
- Malaysia
- Viet Nam
- Taiwan
- S. Korea
- Taiwan

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Global Fishery Prospects
Global effects: Today

Policy applied to stocks of conservation concern
Policy applied to all stocks

Biomass (MMT)
Annual Profit ($ Billions)

Today 62.4

Policy applied to stocks of conservation concern
Policy applied to all stocks
Global effects: Conservation Concern stocks

- Biomass (MMT)
  - BAU: 58.2
  - Fmsy: 64.1
  - RBFM: 64.1
  - Today: 62.4

- Annual Profit ($ Billions)
  - Policy applied to stocks of conservation concern
  - Policy applied to all stocks
Global effects: All stocks

- **BAU**
  - Initial: 58.2
  - Final: 54.6

- **FMSY**
  - Initial: 73.1
  - Final: 64.1

- **RBFM**
  - Initial: 70.6
  - Final: 64.1

Policy applied to stocks of conservation concern

Policy applied to all stocks
Conclusions

- Global fisheries are in poor average health
  - Compromises food provision, livelihoods, conservation

- Business-as-usual shows continued declines

- Fishery management alternatives show tremendous promise:
  - Recovery in just 10 years
  - Catch increases 20%

- Models and approaches to jointly consider production and conservation
New frontiers and unanswered questions

1. Restoring ecosystems & food webs
   - Timing, policies, areas, resilience

2. Ocean enhancement
   - Effects, for production, for restoration

3. Role of pollution
   - Pollution vs. overfishing - which to fix first?

4. Climate change
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4. Climate change
Climate change and fisheries (preliminary results)

- 800 species - model productivity changes over time
  - Status quo management
  - Optimize under current conditions
  - Fully adaptive management anticipating climate change

- Cost of climate change

- Value of adaptation
Climate change alters productivity

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Global Fishery Prospects

Time (yrs)

Carrying Capacity (scaled)

2020 2040 2060 2080 2100

0 50 100 150
Can fishery management be *naturally adaptive*?
Fishery management effect >> Climate effect

No Management Effect (Loss) vs. Climate Effect (Loss)

Δ in K

50%
25%
25%
0%

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Thank You
Questions?

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