The Trophic Fingerprint of Fishing on Marine Ecosystems

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Photo: G.M. Branch
“Overfishing has slashed stocks—especially of large predator species—to an all-time low worldwide... If we don’t manage this resource, we will be left with a diet of jellyfish and plankton stew”

Pauly & Watson (2003)
NCEAS group: global catches, 25 ecosystem models, 29 long-term trawl surveys, 242 stock assessments
Global catch MTL

Pauly et al. (1998)
Global catch MTL

Branch et al. in press
Global catch MTL

![Graph showing mean trophic levels over time. The graph compares current data with Pauly et al. (1998) data and FishBase 97 trophic levels for top 25 species as noted by Branch et al. in press.](image-url)
Exclude Peruvian anchoveta

Global catch MTL

Branch et al. in press
Exclude South American pilchard

Branch et al. in press
Exclude Atlantic cod

Mean trophic level

Year

Catch amount

Branch et al. in press
Global catch MTL

Apex predators only

Trophic levels $\geq 3.5$

Branch et al. in press
Apex predators only

Mean trophic level

Year

Trophic levels >= 3.5

Exclude Atlantic cod

Branch et al. in press
Global catch MTL

Catch at each trophic level:

1. Marine fishes
2. Ghost shrimps
3. Capelin
4. Japanese anchovy
5. Pacific snow crabs
6. Marine molluscs
7. Gulf menhaden
8. American oyster
9. S. American sardine
10. Anchoveta
11. Cape anchovy
12. Chub mackerel
13. Brems and porgies
14. Alaskan pollock
15. Bigeye tuna
16. Atlantic cod
17. Skipjack tuna
18. Japanese squid
19. Squids
20. Blue whiting
21. Common squids
22. Argentine squid
23. Redfishes
24. Scads
25. Flatfishes


Branch et al. in press
Predicted: fishing **down** marine food webs

Observed: fishing **increasing** at all levels of marine food webs

Branch et al. in press
25 Ecopath with Ecosim models

Decline in catch MTL does not imply decline in ecosystem MTL; negative correlation in 38% of fishing-down models

MTL trend not a good indicator of fraction collapsed
Global data

All indices increasing in recent decades

Catch MTL unrelated to survey MTL \((r = -0.55)\)

Catch MTL unrelated to assessment MTL \((r = -0.31)\)
Apples-to-apples comparison (223 stock assessments, $r = -0.41$)

Branch et al. in press
Ecosystem comparisons (16 LMEs)

- Catch and survey MTL negatively correlated in 13 of 29 surveys
- Catch and assessment MTL negatively correlated in 4 of 9 ecosystems

Branch et al. in press
Catch vs. biomass

Gulf of Alaska

Mean trophic level vs. Year


Catches
Small mesh survey

Branch et al. in press
Catch vs. biomass

Gulf of Thailand

Branch et al. in press
Catch vs. biomass

Scotian Shelf

Branch et al. in press
Summary

- Catch trend diverges from Pauly et al. 1998
- Fishing pressure increasing at all levels of marine food webs
- Increases in recent survey and assessment MTL
- Catch trend often opposite to ecosystem trend
- Increasing collapses possible even if MTL constant
- Greater focus needed on biomass trends
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• FishBase trophic levels, maximum lengths, and depths
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NCEAS working group: Finding common ground in marine conservation and management
Rebuilding global fisheries

WHOA! HALF EMPTY! DEFINITELY HALF EMPTY!!

CHOKING GASP!

JUST LISTEN TO YOU! ALWAYS THE PESSIMIST!
Fishery development

\[ p = 0.82 \]

Fishery development

Development year (first year catch > 25% of max)

Development of new fisheries continues...

Per year

Cumulative

But new fisheries are low volume

and new fisheries are low value

25 Ecopath with Ecosim models

Branch et al. in press
Ecosystem models

When catches unevenly impact food webs, negative correlations between catch MTL and ecosystem MTL in 35-38% of models.

When catches evenly impact food webs, catch MTL closely correlated with ecosystem MTL (sampling slight shifts in ecosystems).

Correlation between catch MTL and ecosystem MTL

Branch et al. in press