

One Fish, Two Fish, Red Fish.... What Fish?

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What is industrial/commercial fisheries?



The German factory ship *Kiel NC 105*



What is industrial/commercial fisheries?



The German factory ship *Kiel NC 105*



Artisanal vs. Commercial



Can small scale be commercial?



Guanta y bagres



Cachama

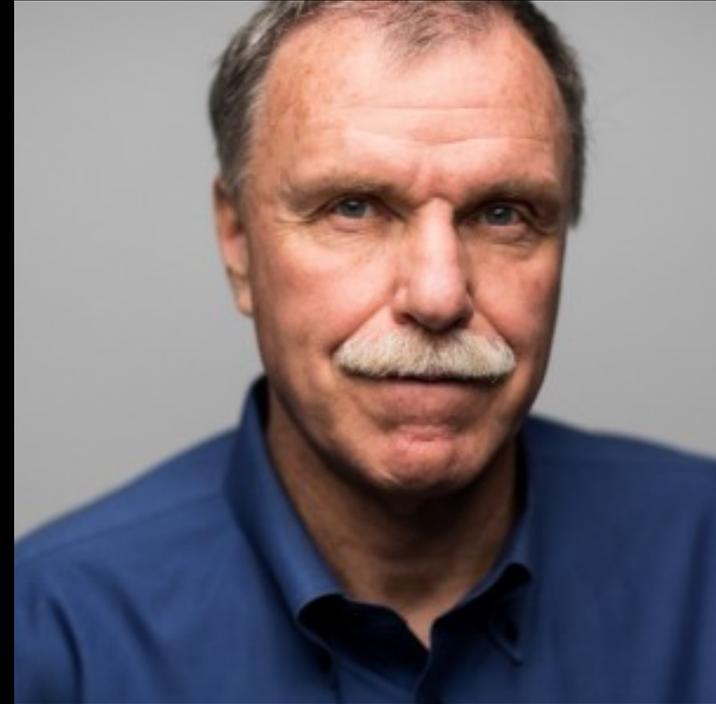


How are the fisheries doing?

That depends on who you ask...



Boris Worm
Marine Research Ecologist
Associate Professor
Dalhousie University, Canada



Ray Hilborn
Marine biologist and fisheries scientist,
Professor of aquatic and fishery science
University of Washington

How are the fisheries doing, according to Worm

letters to nature

Rapid worldwide depletion of predatory fish communities

Ransom A. Myers & Boris Worm

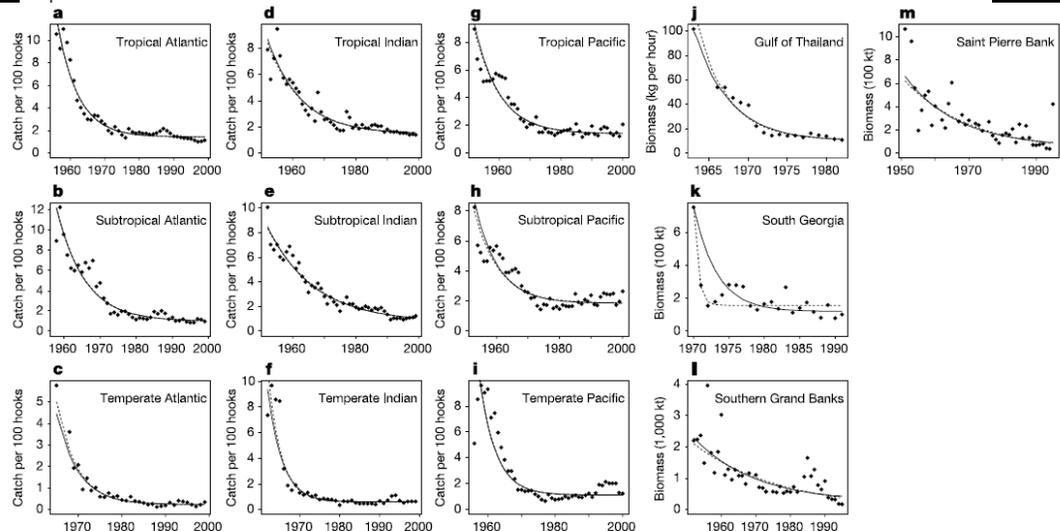


Figure 1 Time trends of community biomass in oceanic (a–i) and shelf (j–m) ecosystems. Relative biomass estimates from the beginning of industrialized fishing (solid points) are shown with superimposed fitted curves from individual maximum-likelihood fits (solid lines) and empirical Bayes predictions from a mixed-model fit (dashed lines).

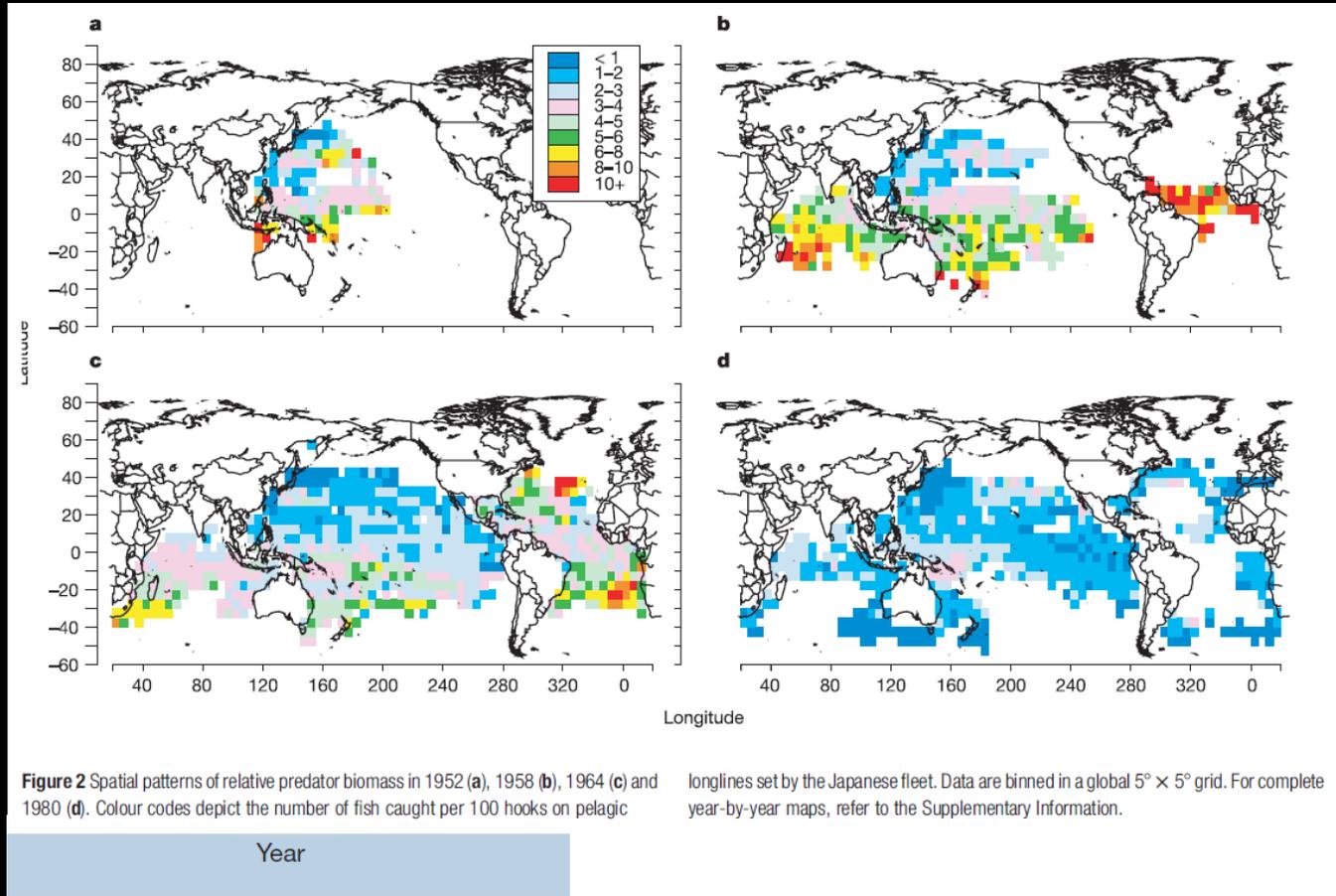


Figure 2 Spatial patterns of relative predator biomass in 1952 (a), 1958 (b), 1964 (c) and 1980 (d). Colour codes depict the number of fish caught per 100 hooks on pelagic longlines set by the Japanese fleet. Data are binned in a global $5^\circ \times 5^\circ$ grid. For complete year-by-year maps, refer to the Supplementary Information.

Myers, R., and B. Worm. 2003. Letters to Nature: Rapid Worldwide depletion of predatory fish communities. 423:280-283.

How are the fisheries doing, according to Worm

Impacts of Biodiversity Loss on Ocean Ecosystem Services

Boris Worm,^{1*} Edward B. Barbier,² Nicola Beaumont,³ J. Emmett Duffy,⁴ Carl Folke,^{5,6} Benjamin S. Halpern,⁷ Jeremy B. C. Jackson,^{8,9} Heike K. Lotze,¹ Fiorenza Micheli,¹⁰ Stephen R. Palumbi,¹⁰ Enric Sala,⁸ Kimberley A. Selkoe,⁷ John J. Stachowicz,¹¹ Reg Watson¹²

Human-dominated marine ecosystems are experiencing accelerating loss of populations and species, with largely unknown consequences. We analyzed local experiments, long-term regional time series, and global fisheries data to test how biodiversity loss affects marine ecosystem services across temporal and spatial scales. Overall, rates of resource collapse increased and recovery potential, stability, and water quality decreased exponentially with declining diversity. Restoration of biodiversity, in contrast, increased productivity fourfold and decreased variability by 21%, on average. We conclude that marine biodiversity loss is increasingly impairing the ocean's capacity to provide food, maintain water quality, and recover from perturbations. Yet available data suggest that at this point, these trends are still reversible.

Worm, B., E. B. Barbier, N. Beaumont, E. Duffy, B.S. Halpern, J. B. C. Jackson, H. K. Lotze, F. Micheli, S. R. Palumbi, E. Sala, K. A. Selkoe, J. J. Stachowicz, R. Watson. 2006. Impacts of Biodiversity Loss on Ocean Ecosystem Services. *Science*. 314:787-790

Fig. 3. Global loss of species from LMEs. (A) Trajectories of collapsed fish and invertebrate taxa over the past 50 years (diamonds, collapses by year; triangles, cumulative collapses). Data are shown for all (black), species-poor (<500 species, blue), and species-rich (>500 species, red) LMEs. Regression lines are best-fit power models corrected for temporal autocorrelation. (B) Map of all 64 LMEs, color-coded according to their total fish species richness. (C) Proportion of collapsed fish and invertebrate taxa, (D) average productivity of noncollapsed taxa (in percent of maximum catch), and (E) average recovery of catches (in percent of maximum catch) 15 years after a collapse in relation to LME total fish species richness. (F) Number of fished taxa as a function of total species richness. (G) Coefficient of variation in total catch and (H) total catch per year as a function of the number of fished taxa per LME.

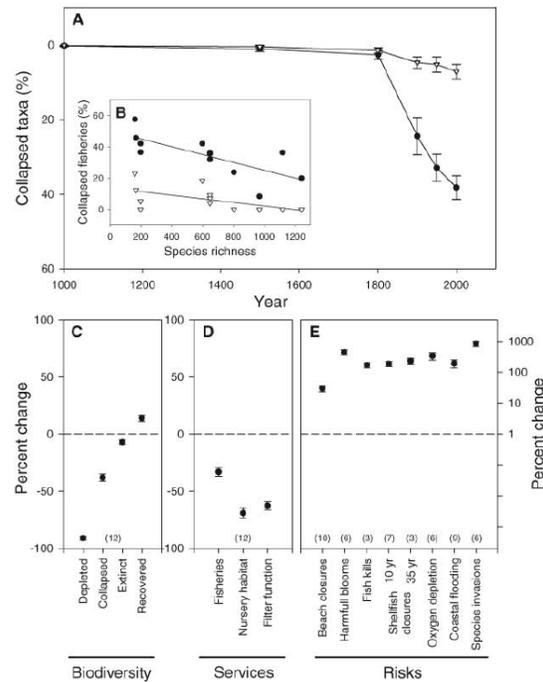


Fig. 2. Regional loss of species diversity and ecosystem services in coastal oceans. (A) Trends of collapse (circles, >90% decline) and extinction (triangles, 100% decline) of species over the past 1000 years. Means and standard errors are shown ($n = 12$ regions in Europe, North America, and Australia). (B) Percentage of collapsed (circles) and extinct (triangles) fisheries in relation to regional fish species richness. Significant linear regression lines are depicted ($P < 0.01$). (C to E) Relative losses or gains in (C) biodiversity, (D) ecosystem services, and (E) risks that are associated with the loss of services. The number of studies is given in parentheses; error bars indicate standard errors.

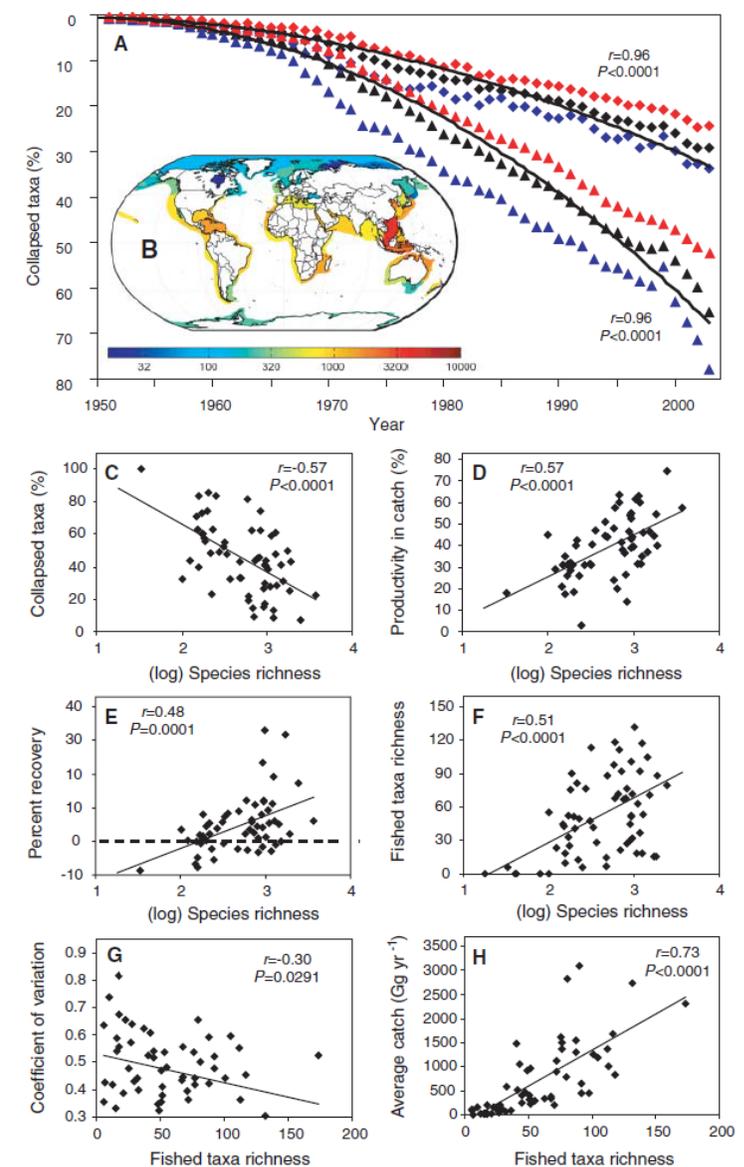


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Seafood could collapse by 2050, experts warn

Overfishing, pollution, warming are destroying stocks, study finds

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WASHINGTON — Clambakes, crabcakes, swordfish steaks and even humble fish sticks could be little more than a fond memory in a few decades.

If current trends of overfishing and pollution continue, by 2050 the populations of just about all seafood face collapse, defined as 90 percent depletion, a team of ecologists and economists warns in a study published in Friday's issue of the journal *Science*.

"Whether we looked at tide pools or studies over the entire world's ocean, we saw the same picture emerging. In losing species we lose the productivity and stability of entire ecosystems," said lead author Boris Worm of Dalhousie University in Halifax, Canada.

"I was shocked and disturbed by how consistent these trends are — beyond anything we suspected," Worm said.

When ocean species collapse, it makes the ocean itself weaker and less able to recover from shocks like global climate change, Worm said.



ENVIRONMENT

Like Seafood? Enjoy It Now: Commercial Seafood Set to Disappear from Oceans in 2048

Scientists and economists are concerned that commercial seafood harvesting may end within three decades.

By [Cliff Weathers / AlterNet](#) | November 28, 2014



1.7K



49 COMMENTS

A prominent marine research ecologist says that commercial seafood could disappear from our oceans within the next three decades if humans don't take action immediately.

Boris Worm of Dalhousie University in Halifax, Canada said the oceans are quickly losing biodiversity and that nearly 30% of seafood species humans consume are already too small to harvest. If the long-term trend continues, there will be little or no seafood available for a sustainable harvest by 2048.



Photo Credit: withGod/Shutterstock

CORRECTION TO THIS ARTICLE

One of the headlines for a Nov. 3 article about endangered fish incorrectly described the conclusions. The researchers warned of the danger of the world's seafood supply running out, not of fish disappearing entirely.

World's Fish Supply Running Out, Researchers Warn

By Juliet Eilperin
Washington Post Staff Writer
Friday, November 3, 2006

An international group of ecologists and economists warned yesterday that the world will run out of seafood by 2048 if steep declines in marine species continue at current rates, based on a four-year study of catch data and the effects of fisheries collapses.

Seafood May Be Gone by 2048, Study Says

John Roach
for National Geographic News
November 2, 2006

Unless humans act now, seafood may disappear by 2048, concludes the lead author of a new study that paints a grim picture for ocean and human health.

According to the study, the loss of ocean biodiversity is accelerating, and 29 percent of the seafood species humans consume have already crashed. If the long-term trend continues, in 30 years there will be little or no seafood available for sustainable harvest.

SEARCH

The New York Times

That Keeps
earth-size
Colliding



TRILOBITES
Baby Louie, the Dinosaur
Orphan, Finds Its Species
at Last



A Light for Science, and
Cooperation, in the Middle
East



Stay In or Leave the Paris
Climate Deal? Lessons
From Kyoto

SCIENCE

Study Sees 'Global Collapse' of Fish Species

By CORNELIA DEAN NOV. 3, 2006

If fishing around the world continues at its present pace, more and more species will vanish, marine ecosystems will unravel and there will be "global collapse" of all species currently fished, possibly as soon as midcentury, fisheries experts and ecologists are predicting.

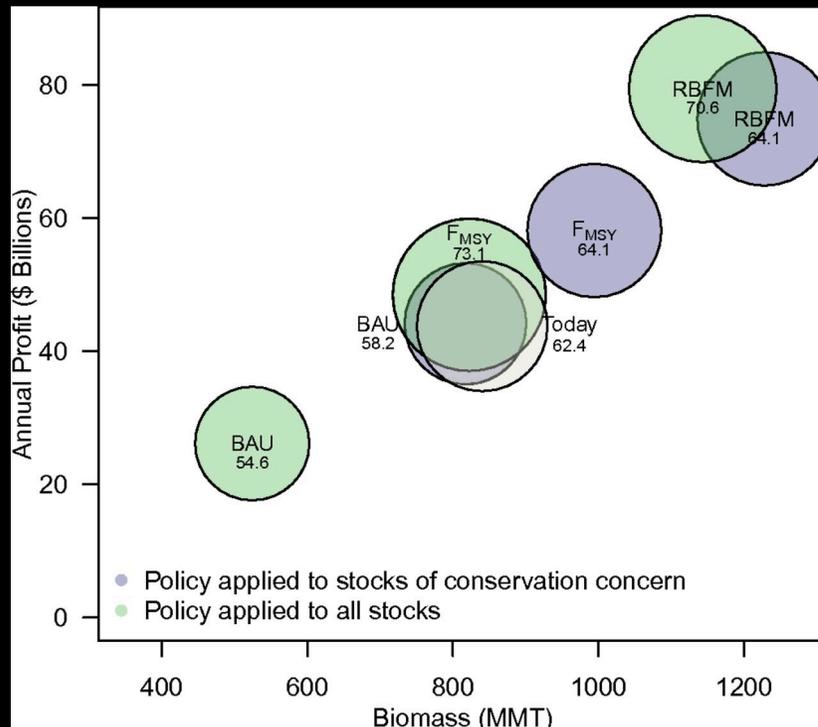
The scientists, who report their findings today in the journal *Science*, say it is not too late to turn the situation around. As long as marine ecosystems are still biologically diverse, they can recover quickly once overfishing and other threats are reduced, the researchers say.

But improvements must come quickly, said Boris Worm of Dalhousie University in Nova Scotia, who led the work. Otherwise, he said, "we are seeing the bottom of the barrel."

"When humans get into trouble they are quick to change their ways," he continued. "We still have rhinos and tigers and elephants because we saw a clear trend that was going down and we changed it. We have to do the same in the oceans."

How are the fisheries doing, according to Hilborn

Aggregate global effects on projected 2050 profit and biomass of alternative policies applied to fisheries in our dataset.



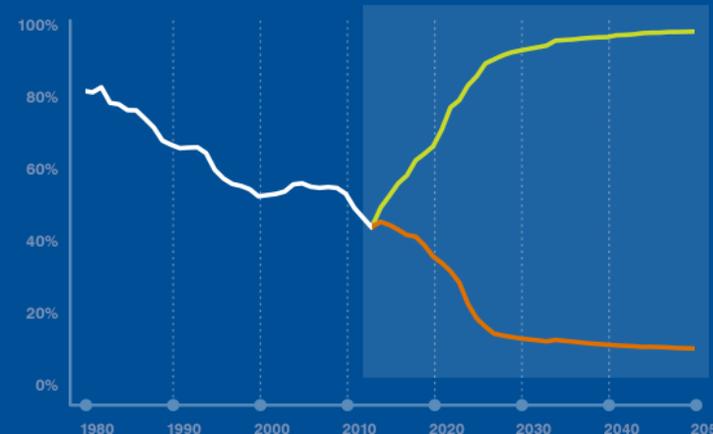
Global fishery prospects under contrasting management regimes

Christopher Costello^{a,1}, Daniel Ovando^a, Tyler Clavelle^a, C. Kent Strauss^b, Ray Hilborn^c, Michael C. Melnychuk^c, Trevor A. Branch^c, Steven D. Gaines^a, Cody S. Szuwalski^a, Reniel B. Cabral^a, Douglas N. Rader^b, and Amanda Leland^b

^aBren School of Environmental Science and Management, University of California, Santa Barbara, CA 93106; ^bEnvironmental Defense Fund, New York, NY 10010; and ^cSchool of Aquatic and Fishery Sciences, University of Washington, Seattle, WA 98195

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

Percent of fisheries that are healthy, under **sustainable fishing** and **business as usual**



Compared to this “business-as-usual” scenario, the long-term potential of the oceans is even more striking: By 2050 sustainably managed fisheries could produce 16 million metric tons (or 29%) more wild fish, generate \$53 billion USD (or 204%) more profits, and boost the amount of fish left in the water for conservation by 118%.

How are the fisheries doing, according to Hilborn

“mean trophic level in the world’s catch was rising, not falling, and that the decline Pauly had shown was due primarily to two species, the rebuilding of the Peruvian anchovetta stock (low trophic level), and the decline of catches of Atlantic “cod. Worldwide the mean trophic level of the catch was rising, not falling.”

Ray Hilborn @hilbornr Following

An updated map of fish stock abundance coverage in the RAM Legacy Database. Shaded area shows proportion in data.

Mean Catch (10 ⁶ tons)	Proportion Reported
12	100%
5	67%
1	33%

RETWEETS 15 LIKES 6

7:28 AM - 1 Oct 2015

Ray Hilborn @hilbornr · 1 Oct 2015
Replying to @hilbornr
Size of circle indicates average catch from country, shaded area proportion of catch in assessed stocks.

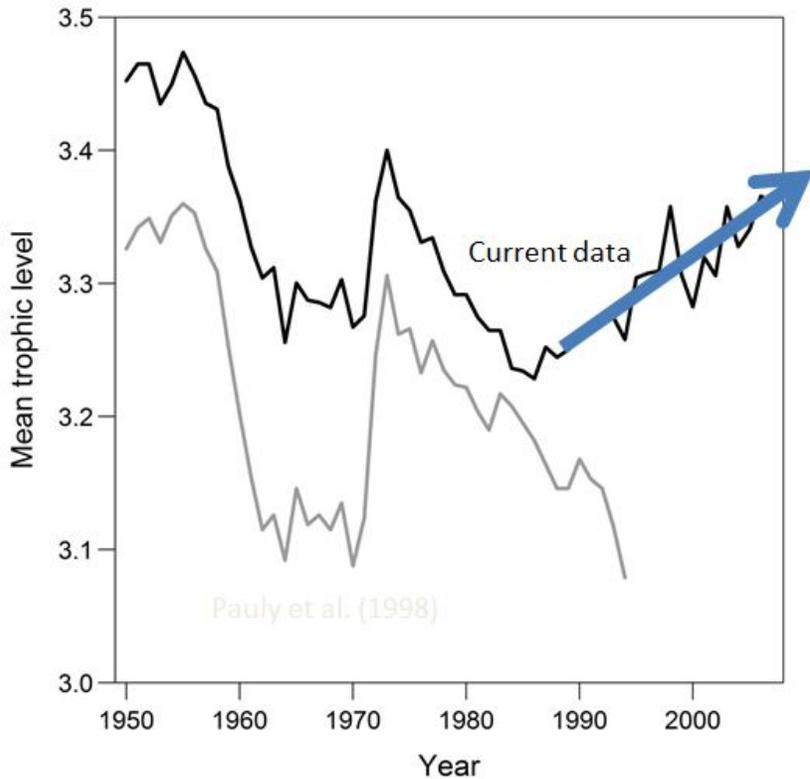
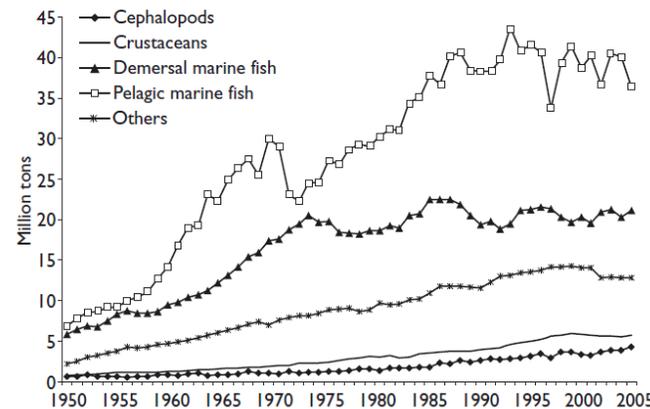


Figure 1.1 Catch of Selected Species Groups in Marine Fisheries



Source: FAO FishStat Plus.

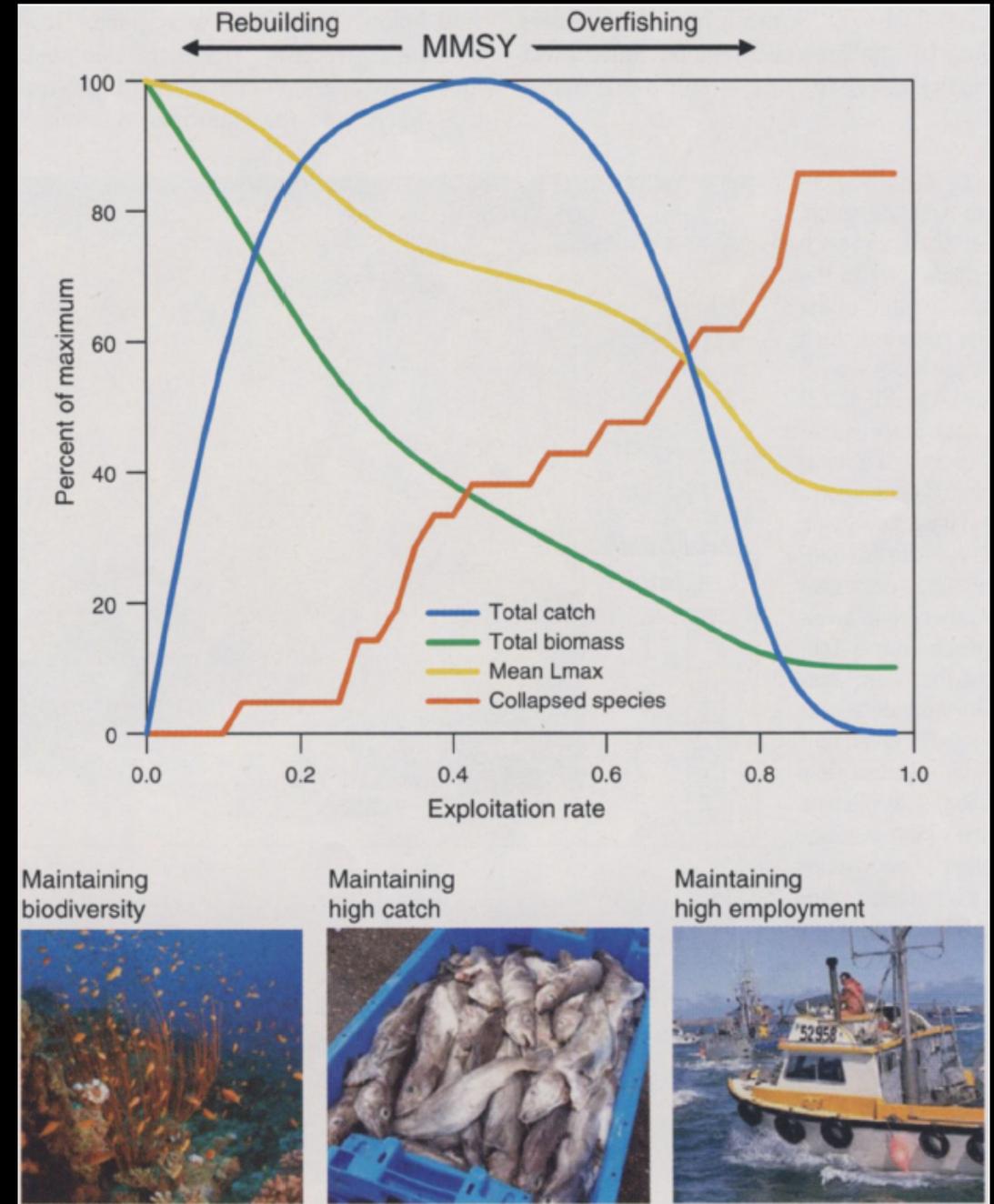
Worm and Hilborn

RESEARCH ARTICLES

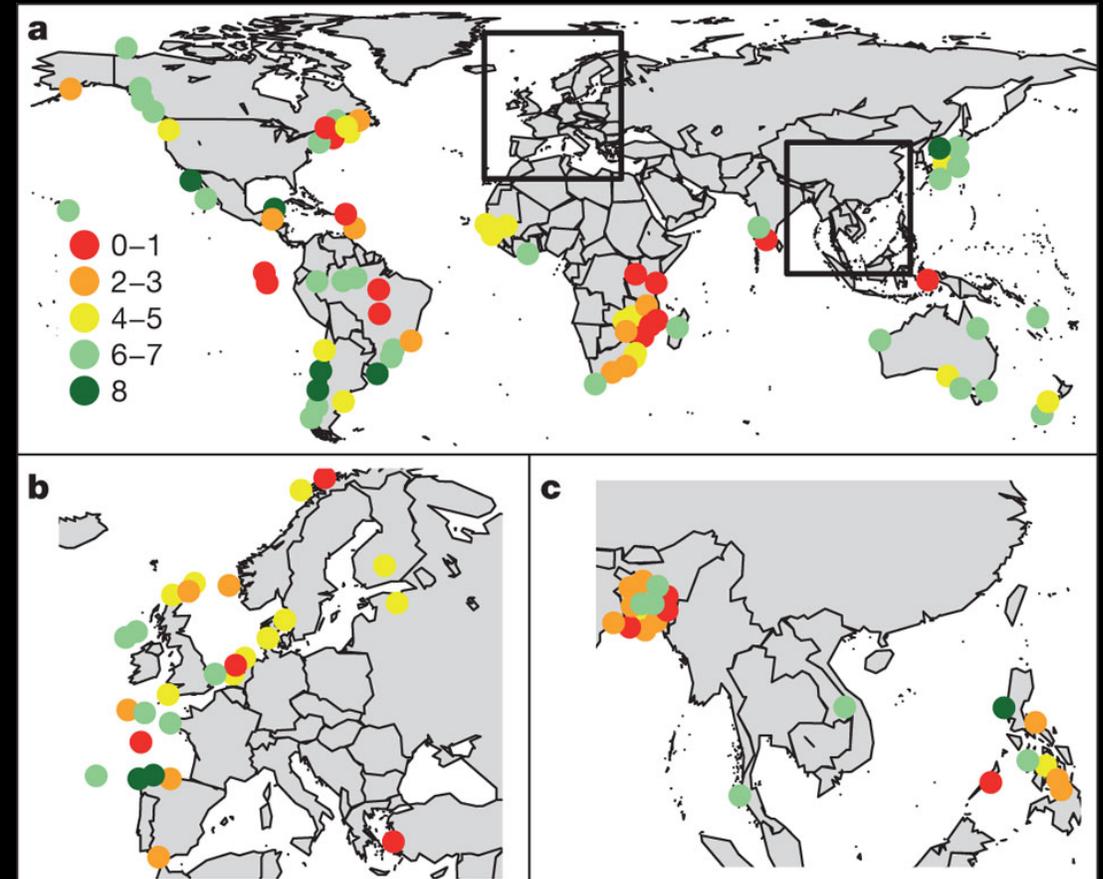
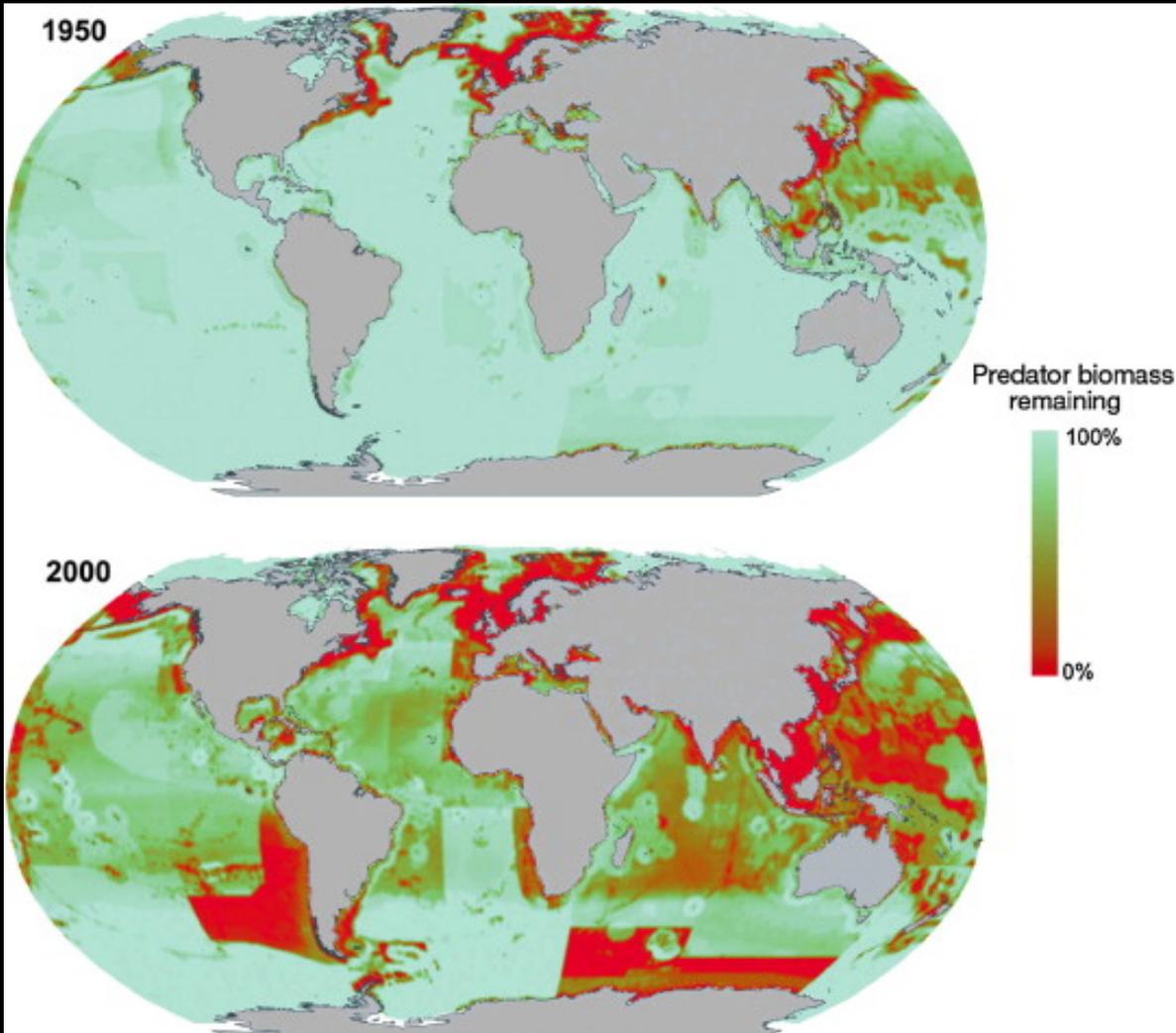
Rebuilding Global Fisheries

Boris Worm,^{1*} Ray Hilborn,^{2*} Julia K. Baum,³ Trevor A. Branch,² Jeremy S. Collie,⁴ Christopher Costello,⁵ Michael J. Fogarty,⁶ Elizabeth A. Fulton,⁷ Jeffrey A. Hutchings,¹ Simon Jennings,^{8,9} Olaf P. Jensen,² Heike K. Lotze,¹ Pamela M. Mace,¹⁰ Tim R. McClanahan,¹¹ C il n Minto,¹ Stephen R. Palumbi,¹² Ana M. Parma,¹³ Daniel Ricard,¹ Andrew A. Rosenberg,¹⁴ Reg Watson,¹⁵ Dirk Zeller¹⁵

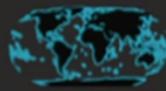
After a long history of overexploitation, increasing efforts to restore marine ecosystems and rebuild fisheries are under way. Here, we analyze current trends from a fisheries and conservation perspective. In 5 of 10 well-studied ecosystems, the average exploitation rate has recently declined and is now at or below the rate predicted to achieve maximum sustainable yield for seven systems. Yet 63% of assessed fish stocks worldwide still require rebuilding, and even lower exploitation rates are needed to reverse the collapse of vulnerable species. Combined fisheries and conservation objectives can be achieved by merging diverse management actions, including catch restrictions, gear modification, and closed areas, depending on local context. Impacts of international fleets and the lack of alternatives to fishing complicate prospects for rebuilding fisheries in many poorer regions, highlighting the need for a global perspective on rebuilding marine resources.



In actuality it depends....



Gutierrez, Nicolas L.A.U - Hilborn, RayAU - Defeo, OmarTI - Leadership, social capital and incentives promote successful fisheries. 2011



World EEZs

70M

ANNUAL METRIC TONS LANDED

\$69B

REAL VALUE (USD)

161M

SQUARE KILOMETERS

99.9%

WORLD'S CORAL REEFS



High Seas

10M

ANNUAL METRIC TONS LANDED

\$16B

REAL VALUE (USD)

202M

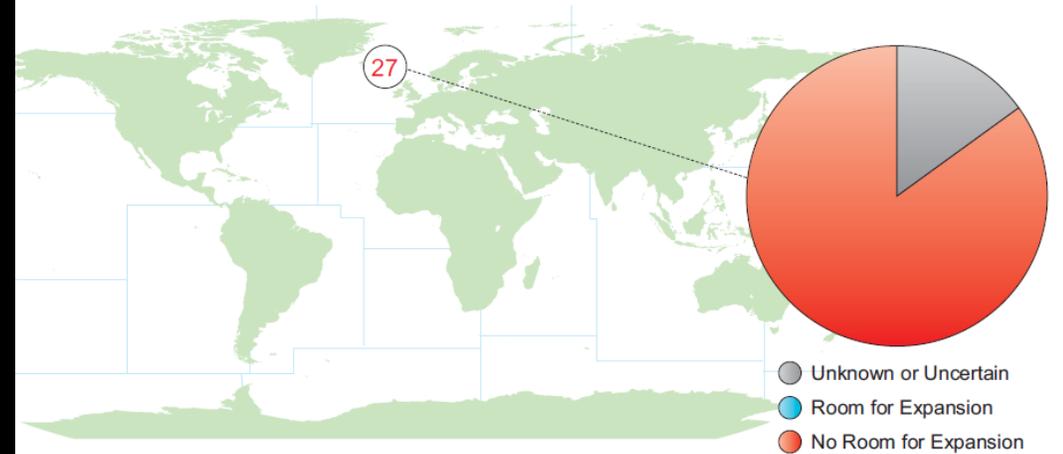
SQUARE KILOMETERS

0.10%

WORLD'S CORAL REEFS

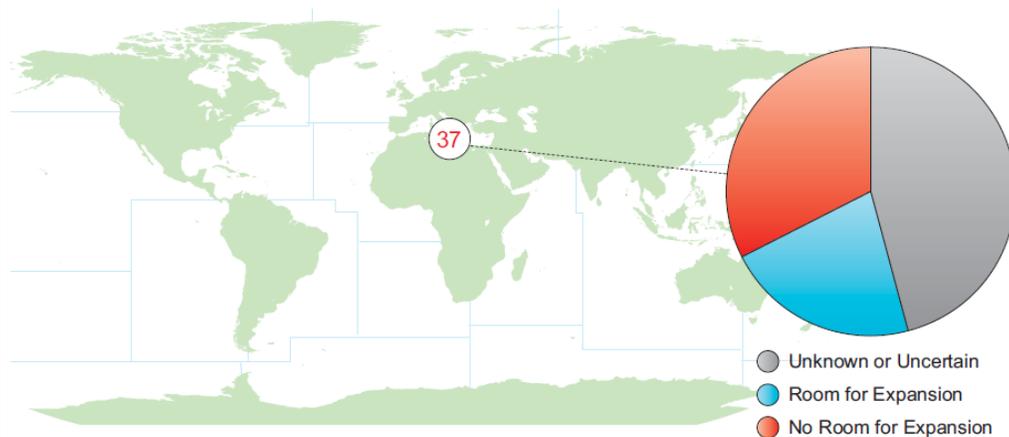
Northeast Atlantic (FAO statistical area 27)

The Northeast Atlantic accounted for 11.5% of global landings in 2005. In the Northeast Atlantic, 89% of fish stocks have no room for further expansion and the status of 11% is unknown. No stocks have room for expansion.



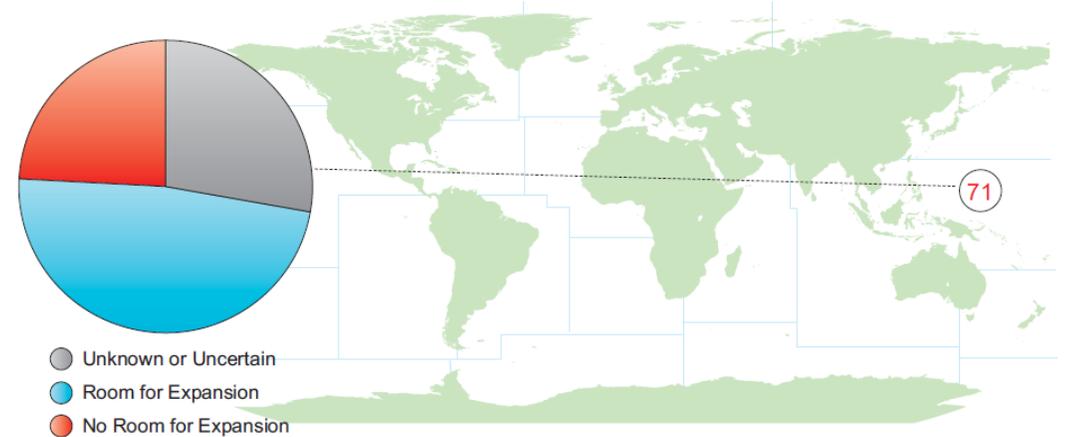
Mediterranean and Black Sea (FAO statistical area 37)

The Mediterranean and Black Sea accounted for 1.7% of global landings in 2005. In the Mediterranean and Black Sea, 48% of fish stocks have no room for further expansion, 17% have some room for further expansion, and the status of 35% is unknown.



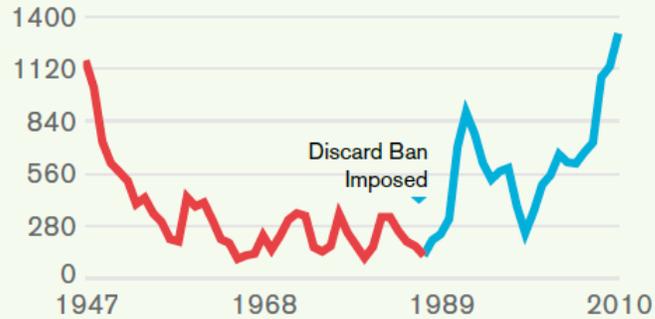
Western Central Pacific (FAO statistical area 71)

The Western Central Pacific Ocean accounted for 12.9% of global landings in 2005. In the Western Central Pacific, 24% of fish stocks have no room for further expansion, 48% have some room for further expansion, and the status of 28% is unknown.



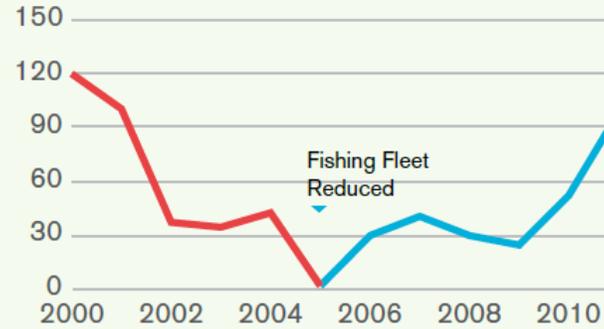
Norway Arctic Cod Recovers After Discards Reduced

Spawning biomass in 1000 metric tons



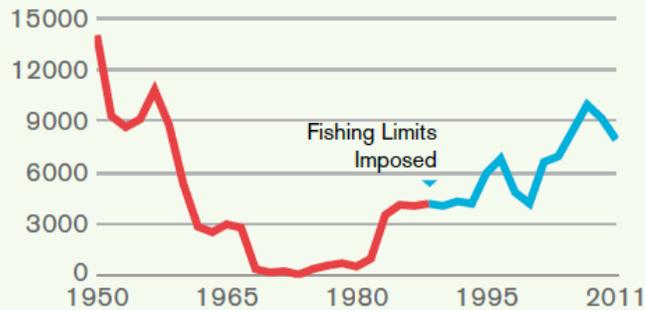
EU Bay of Biscay Anchovy Recovers After Fishing Limited

Spawning biomass in 1000 metric tons



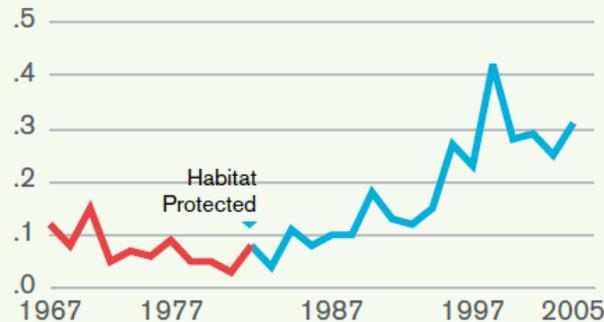
Norway Herring Recovers After Fishing Limited

Spawning biomass in 1000 metric tons



Japan Snow Crab Recovers After Habitat Protected

CPUE in metric tons per day



Recovered fisheries after sustainable fisheries practices implemented

- Setting Quotas
- Reducing bycatch (eliminating waste)
- Protect essential fish habitat

Sources: ICES 2011; Brooks. "B. Georges bank haddock". 2008; Diamond and Beukers-Stewart. Norway IMR. 2011; New Zealand Ministry of Fisheries, 2011.

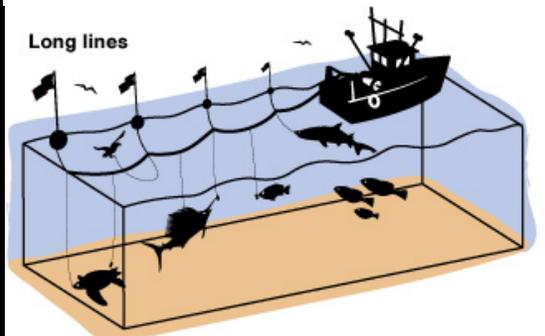
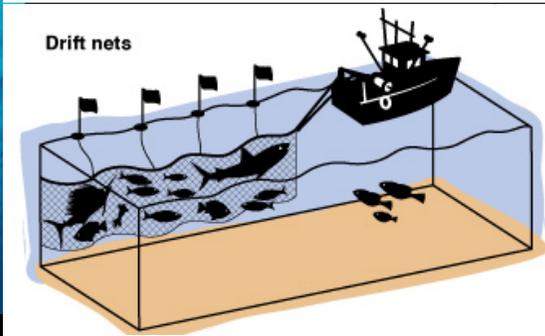
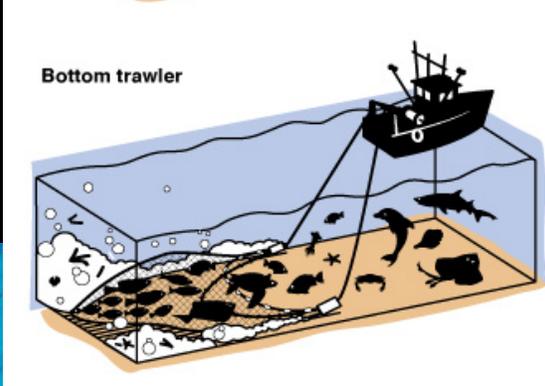
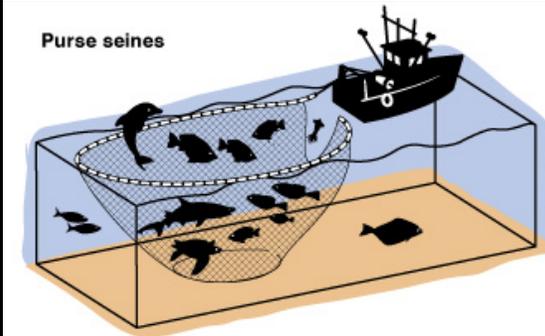
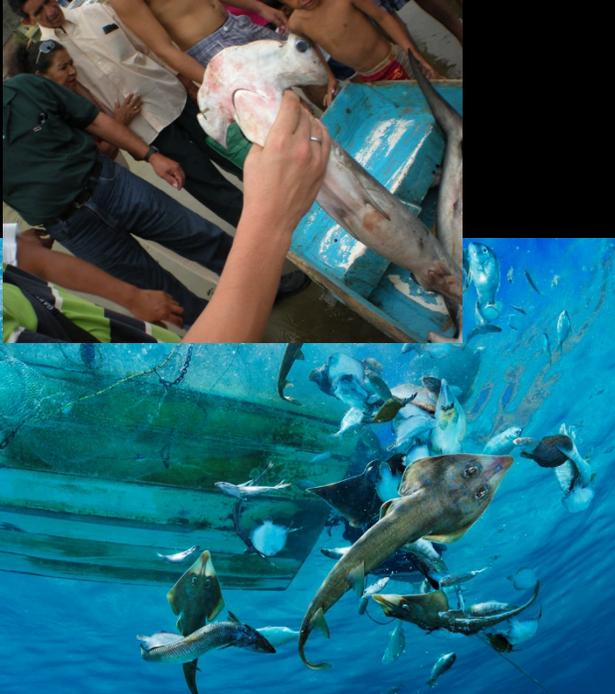
Tools of Sustainable Management from FAO

- **Rights:** The granting of secure rights to resource users (individually or collectively) for use of a portion of the catch, space, or other relevant aspects of the fishery.
- **Transparent, participatory management:** The granting of a meaningful role to stakeholders in the full range of management (e.g., planning, science, legislation, implementation).
- **Support to science, planning, and enforcement:** Providing the resources necessary for all aspects of management of the fishery.
- **Benefit distribution:** Using economic tools to distribute benefits from the fishery to address community and economic sustainability.
- **Integrated policy:** Planning fisheries, including setting explicit objectives that address all the dimensions of sustainability and the interactions among the factors of unsustainability.
- **Precautionary approach:** Application according to FAO guidance.
- **Capacity building and public awareness rising:** Development and application of programs to better inform policy makers and the public at large about main fisheries issues.
- **Market incentives:** Using market tools in situations in which they are appropriate for addressing factors of unsustainability.

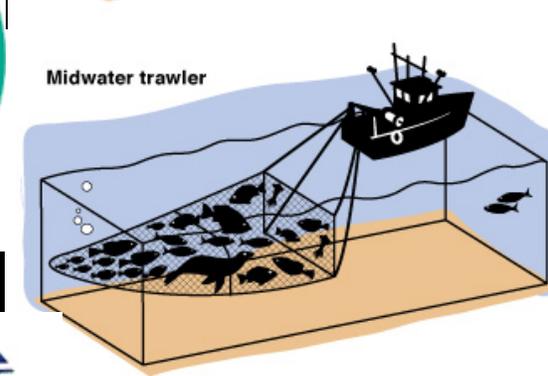
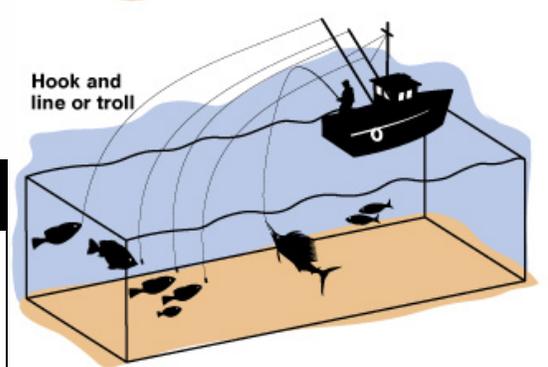
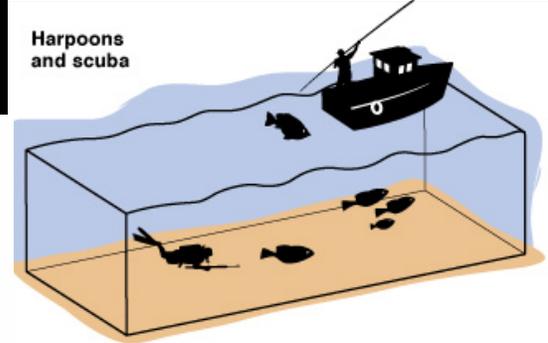
Is there a future for fisheries?



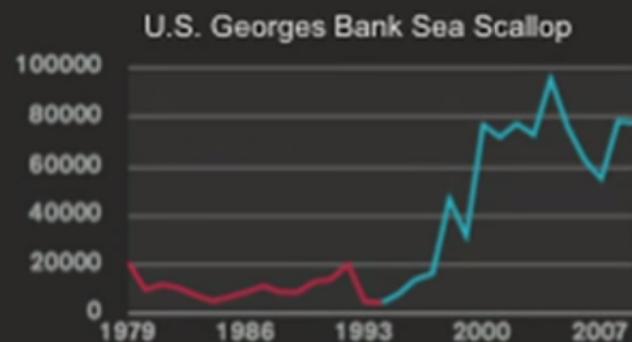
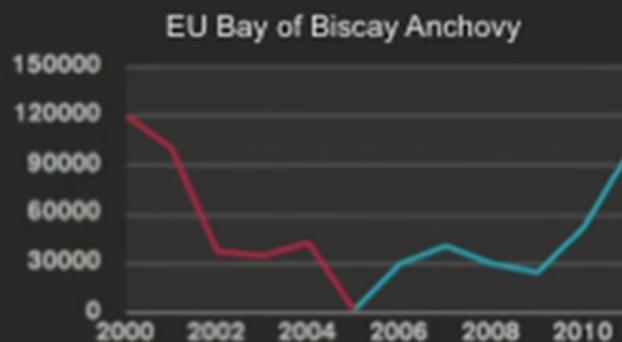
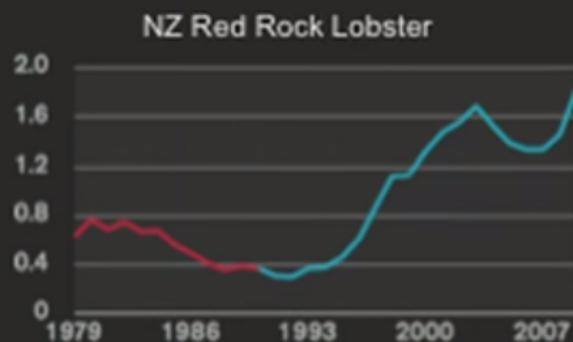
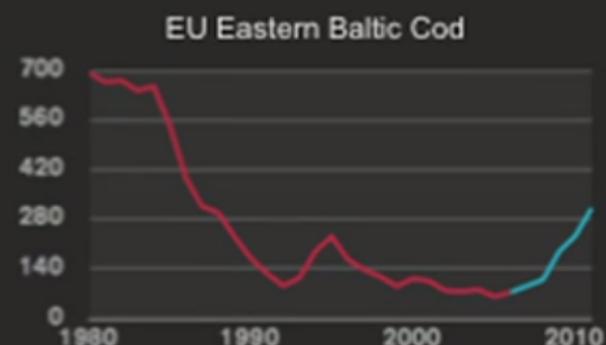
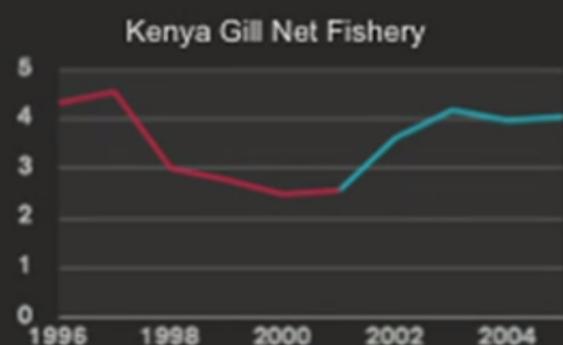
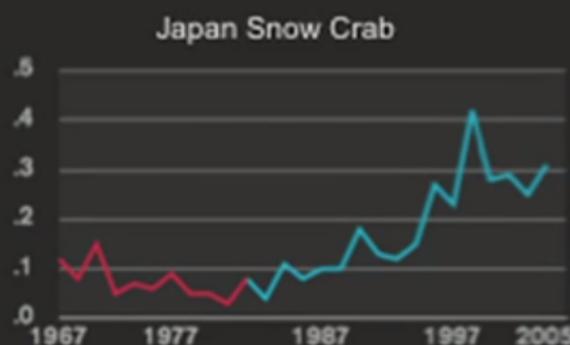
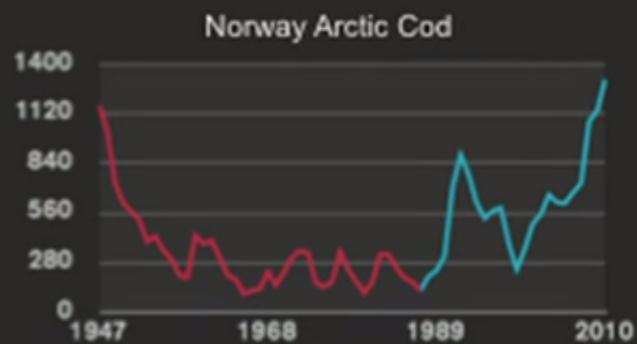
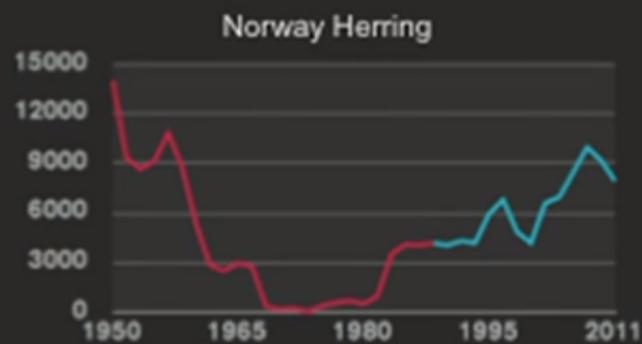
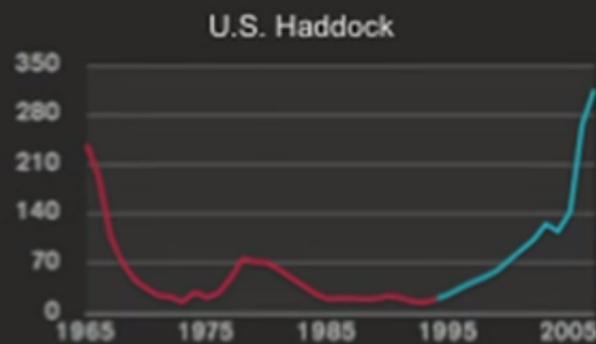
Unsustainable



Sustainable



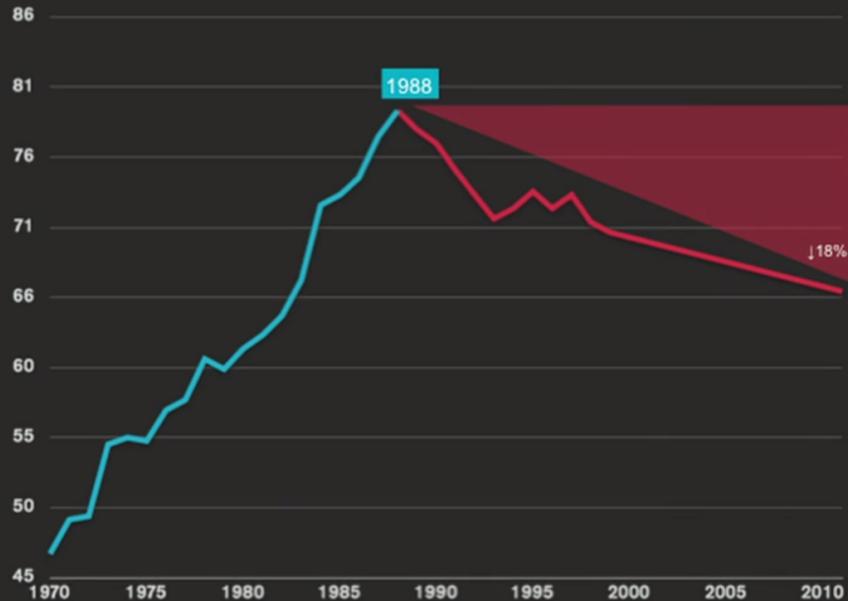
Recovery Examples Can Be Found Worldwide



We can do better!

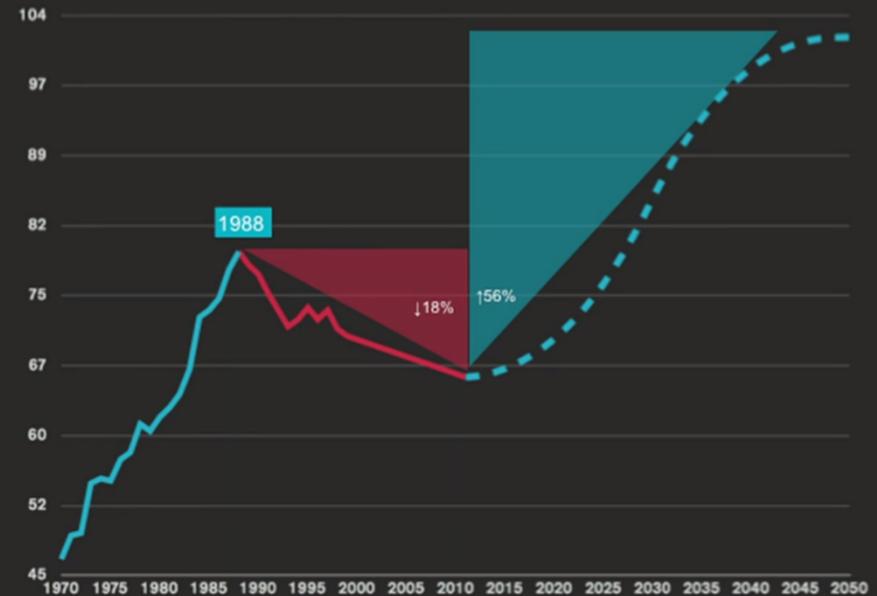
Global Catch Has Steadily Grown Until Peak in 1988

Global Catch (Million Metric Tons)



Better Management Can Increase Catch

Global Catch (Million Metric Tons)



Food Security

925M
PEOPLE DO NOT HAVE ENOUGH TO EAT

400M+
HUNGRY PEOPLE LIVE IN MAJOR FISHING COUNTRIES

Source: World Food Programme

±3 BILLION PEOPLE
RELY ON FISH AS A MAJOR SOURCE OF ANIMAL PROTEIN*

12% OF THE WORLD'S POPULATION DEPENDS ON FISHERIES

>90% ARE SMALL-SCALE FISHERS
♀ (ABOUT HALF ARE WOMEN)

Wild Fish is Most Cost Effective Animal Protein

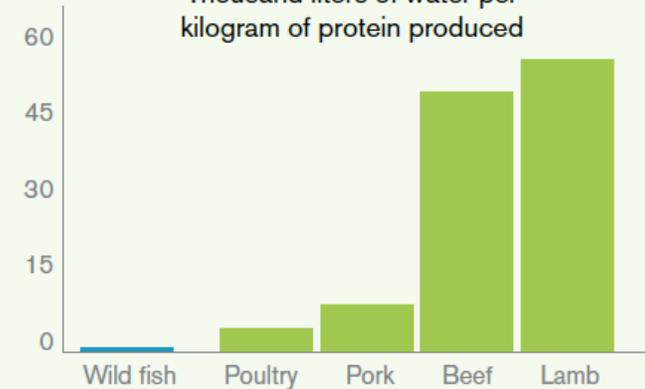
Metric tons per \$100,000



Source: FAO / Sea Around Us Project

Wild Fish Uses Minimal Water in Production

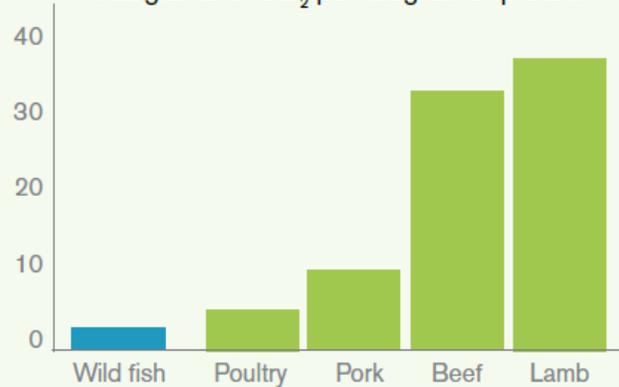
Thousand liters of water per kilogram of protein produced



Source: Pimentel 2004

Wild Fish is Lowest Producer of CO₂

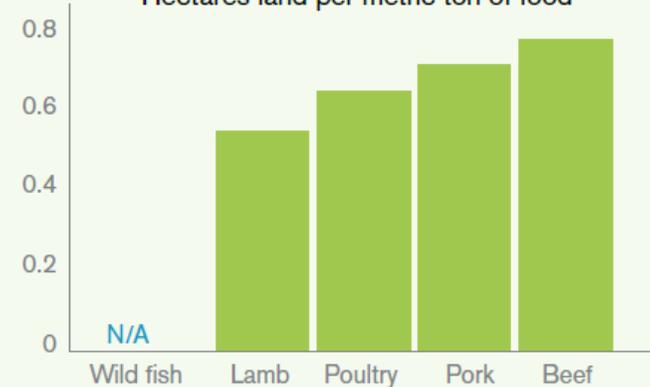
Kilograms of CO₂ per kilogram of protein



Source: Environmental Working Group / SINTEF

Wild Fish Requires No Arable Land

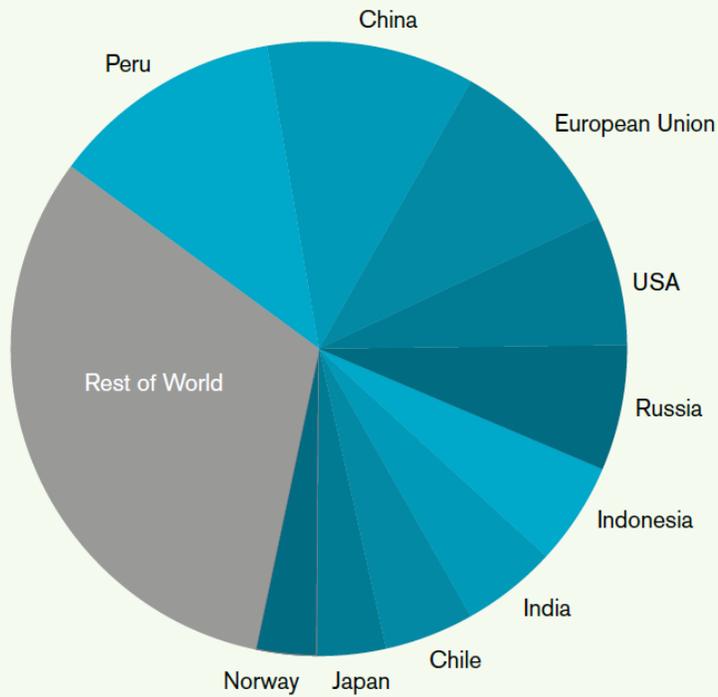
Hectares land per metric ton of food



Source: DEFRA 2006

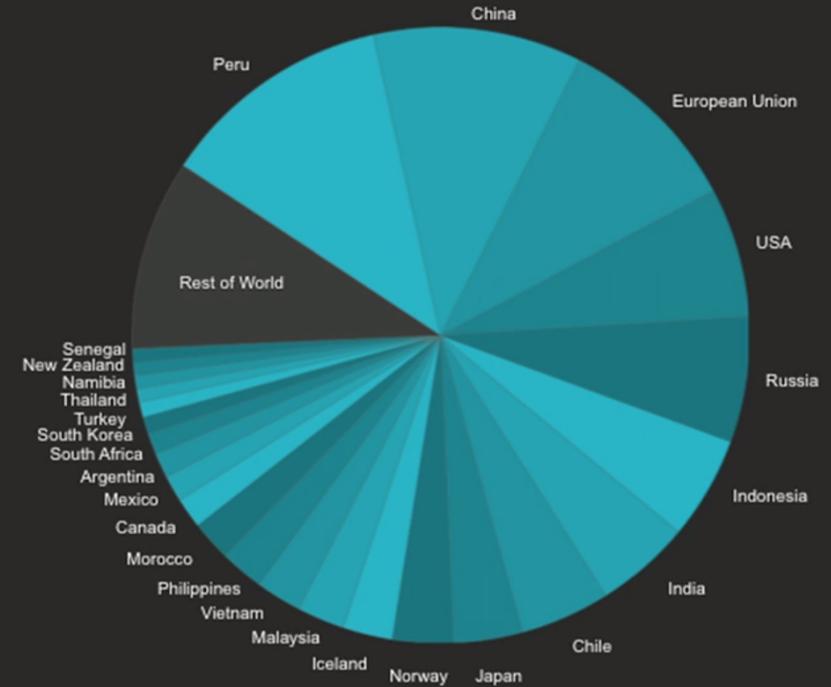
It is doable!

Nine Countries and the EU Catch 68 Percent of the World's Wild Ocean Fish



Source: Sea Around Us Project

24 Countries and the EU Catch 90% of the World's Wild Ocean Fish



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Questions?



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