Forage fish

Sustaining yields while safeguarding a critical ecosystem component

A REPORT FROM THE LENFEST FORAGE FISH TASK FORCE

A Reception and Discussion Hosted by Australia and Stony Brook University, U.S.

July 10, 2012

Mr. Gordon Neil, Assistant Secretary for Fisheries, Dept. of Agriculture, Fisheries and Forestry, Australia
Dr. Ellen Pikitch, Task Force Chair, Stony Brook University, U.S.A.
Dr. Keith Sainsbury, University of Tasmania, Australia
Dr. Philippe Cury, Centre de Recherche Halieutique Méditerranéenne et Tropicale, France

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- **Introduction - Task Force approach and case studies**

  Ellen Pikitch, Task Force chair, Stony Brook University, U.S.

- **Ecological importance of forage fish; Ecopath models**

  Philippe Cury, Centre de Recherche Halieutique Méditerranéenne et Tropicale, France

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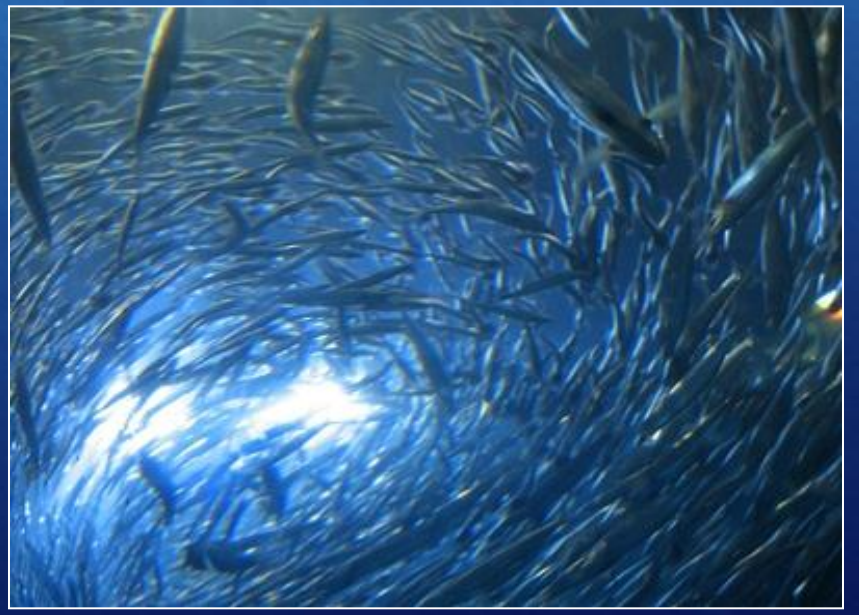
  Keith Sainsbury, University of Tasmania and SainSolutions Pty Ltd, Australia

- **Key recommendations and conclusions**

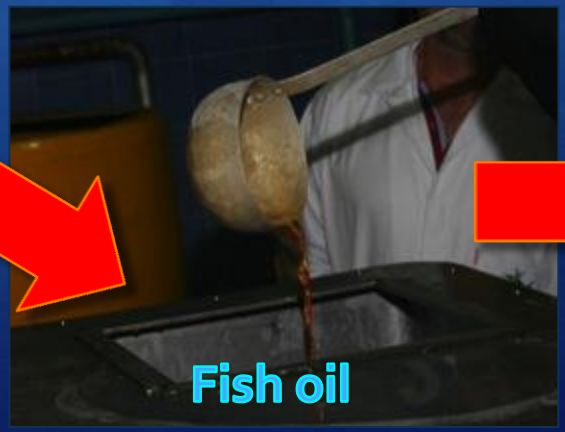
  Ellen Pikitch

What Are Forage Fish?

- Crucial species in food webs
- Small, often schooling pelagic species
- Sardines, anchovies, sand eels, krill, herring…
- Feed on plankton and transfer energy to upper trophic levels



37% of the world's marine catch is forage fish (Alder et al. 2008)



Anchoveta processing plant. *Paracas, Peru* 2011

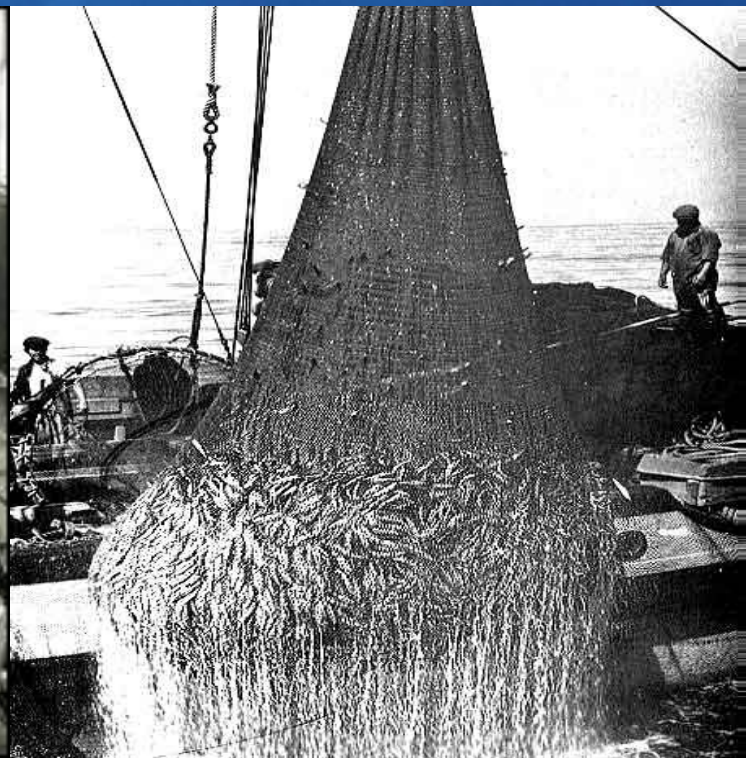
Collapses have occurred

California sardine- 1950s

Namibian sardine-1970s

Peruvian anchoveta- 1970s

Japanese sardine- 1990s



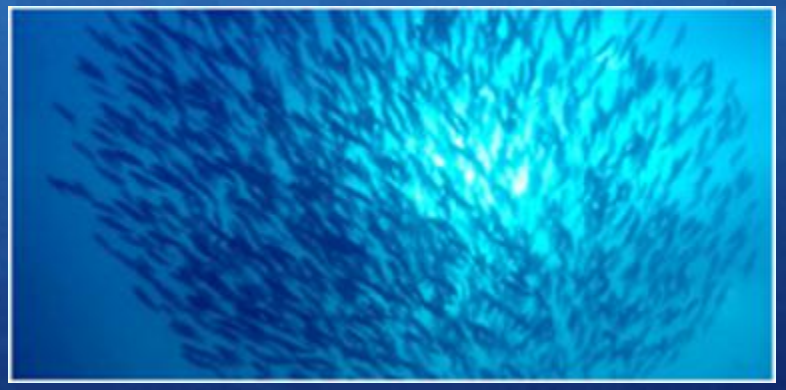
Lenfest Forage Fish Task Force

***Objective**: Develop consensus recommendations on sustainable management of forage fish which accounts for their vital role in ocean ecosystems.*

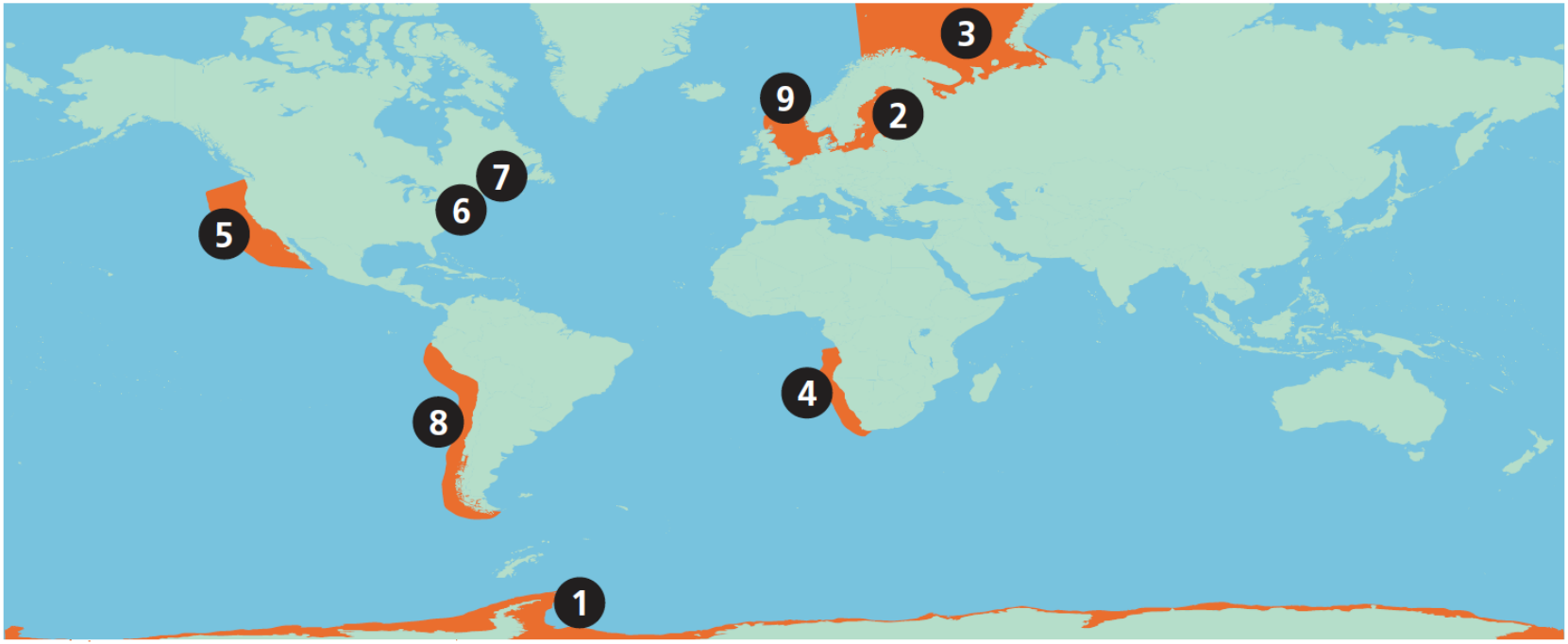
- Dr. Ellen K. Pikitch, Chair
- Dr. P. Dee Boersma
- Dr. Ian L. Boyd
- Dr. David O. Conover
- Dr. Philippe Cury
- Dr. Tim Essington
- Dr. Selina S. Heppell
- Dr. Edward D. Houde
- Dr. Marc Mangel
- Dr. Daniel Pauly
- Dr. Éva Plagányi
- Dr. Keith Sainsbury
- Dr. Robert S. Steneck

Task Force Approach

- Workshops and site visits
- Review of theory and practice
- Case studies
- New science
  - Ecopath models
  - Ecosim models
  - Predator Response to Exploitation of Prey (PREP) equation



Forage Fisheries Case Studies



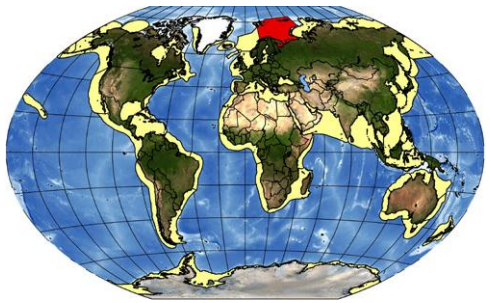
1. Antarctic
2. Baltic Sea
3. Barents Sea
4. Benguela Current
5. California Current
6. Chesapeake Bay
7. Gulf of Maine
8. Humboldt Current
9. North Sea

Case Study: Barents Sea

An Effective Threshold

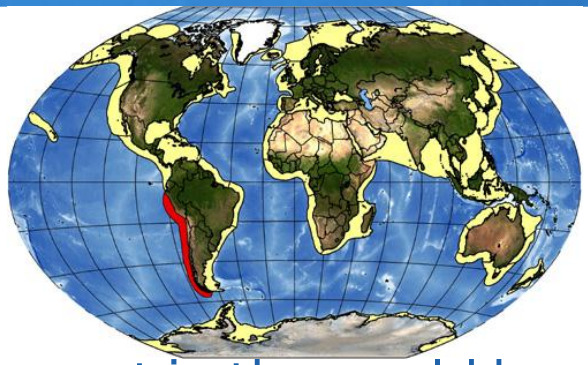
capelin

To protect the world's largest stock of cod, Norway and Russia prohibit fishing for capelin if its biomass falls below 200,000 tonnes. Since adopting this rule, capelin collapses attributable to fishing have not been repeated, and many fish stocks are now abundant.



Case Study: Humboldt Current

Impoverished but productive



The Peruvian anchoveta fishery, the largest in the world by volume, has recovered from collapses in 1972 and 1983. Managers now halt fishing if biomass falls below 5 million tonnes, but earlier anchoveta declines and other human activity have left the ecosystem greatly impoverished.

Peruvian Anchoveta

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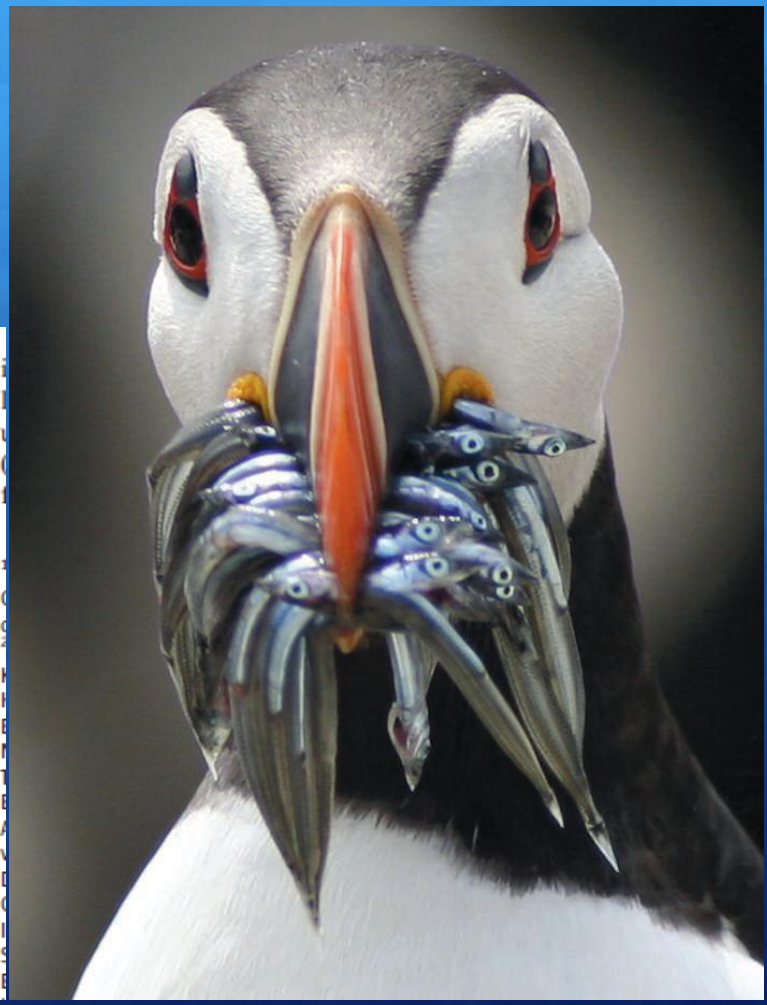
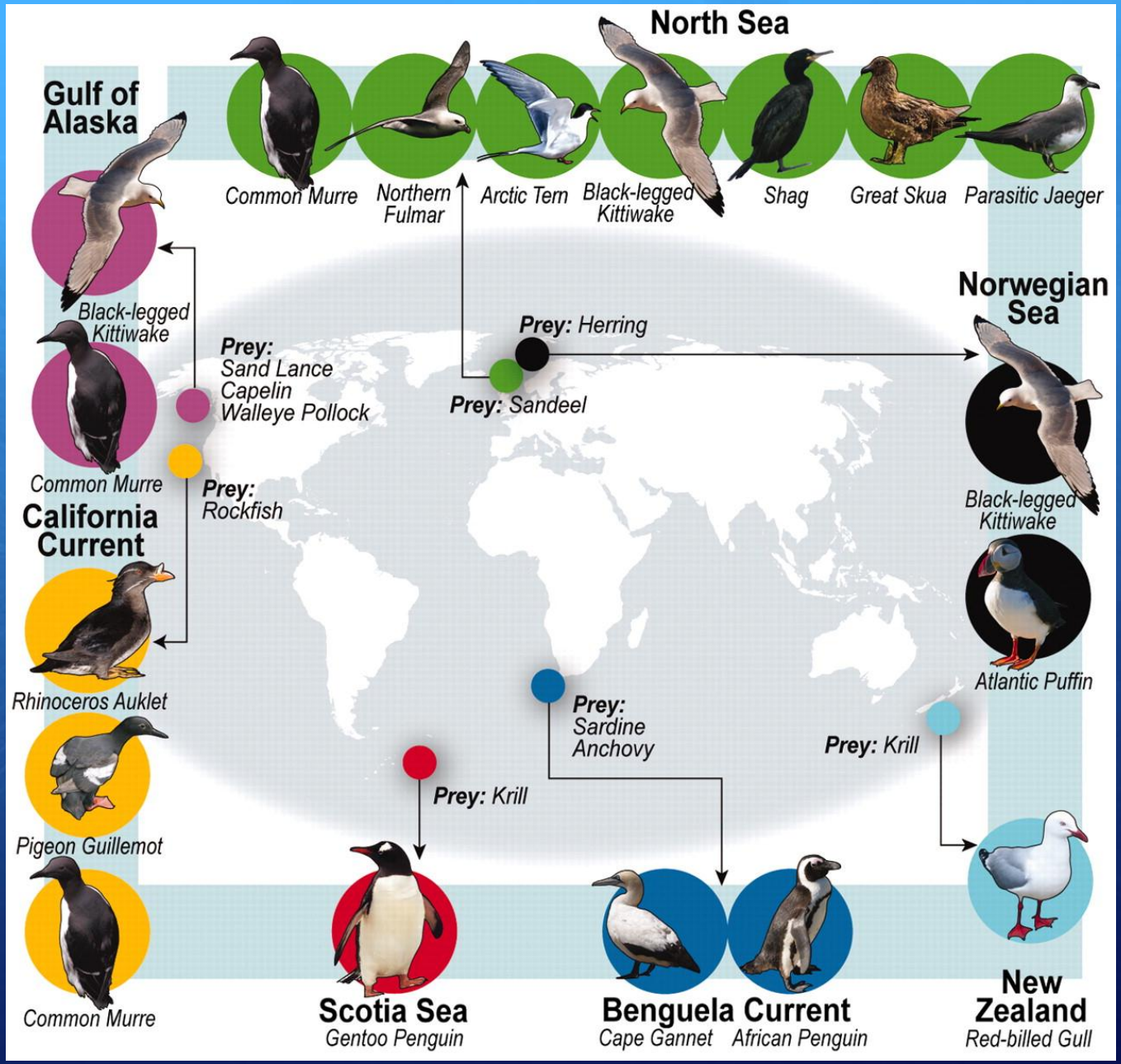
Global Seabird Response to Forage Fish Depletion—One-Third for the Birds

Philippe M. Cury,[1*] Ian L. Boyd,[2*] Sylvain Bonhommeau,[3] Tycho Anker-Nilssen,[4] Robert J. M. Crawford,[5] Robert W. Furness,[6] James A. Mills,[7] Eugene J. Murphy,[8] Henrik Österblom,[9] Michelle Paleczny,[10] John F. Piatt,[11] Jean-Paul Roux,[12,13] Lynne Shannon,[14] William J. Sydeman[15]

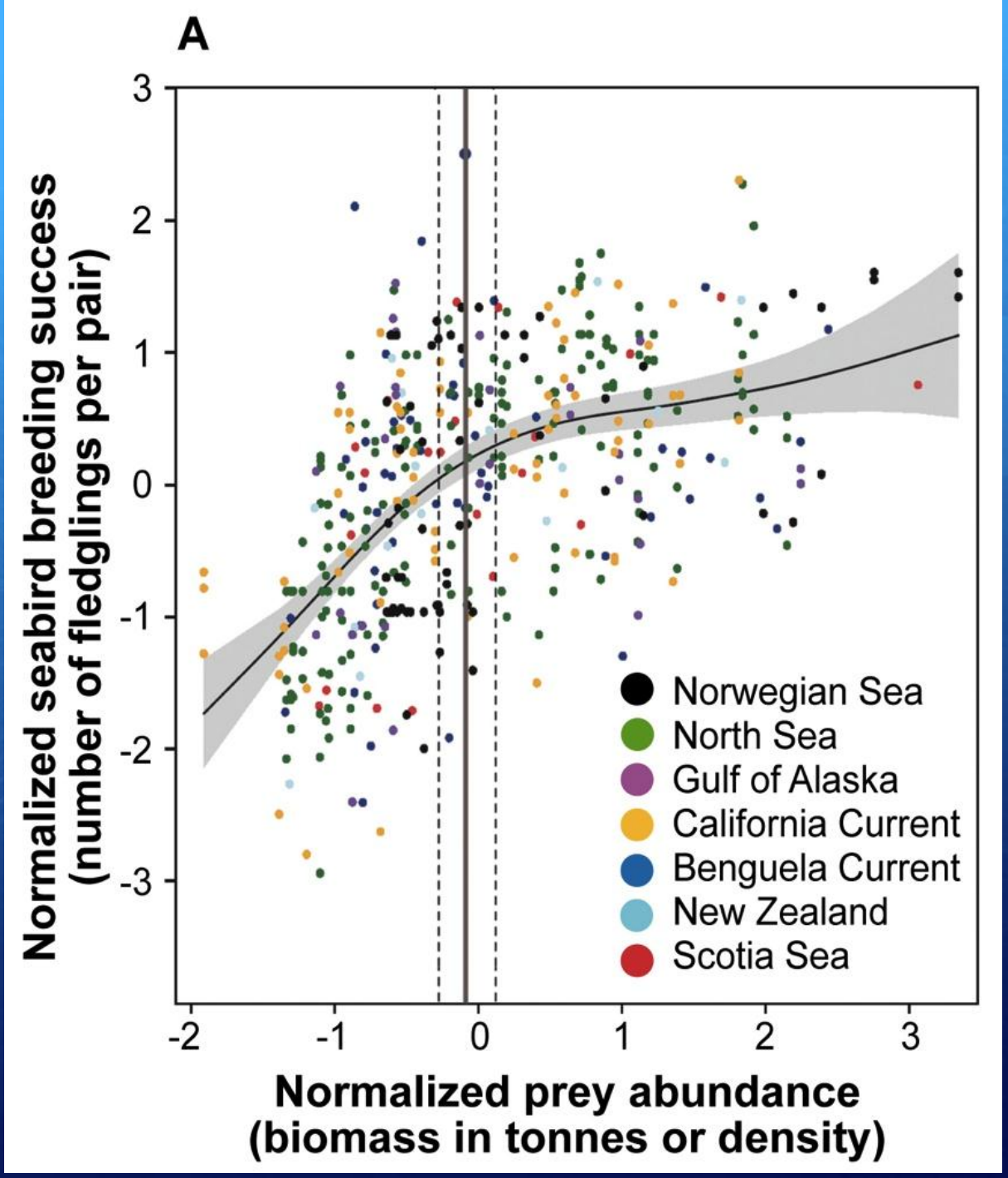
Determining the form of key predator-prey relationships is critical for understanding marine ecosystem dynamics. Using a comprehensive global database, we quantified the effect of fluctuations in food abundance on seabird breeding success. We identified a threshold in prey (fish and krill, termed "forage fish") abundance below which seabirds experience consistently reduced and more variable productivity. This response was common to all seven ecosystems and 14 bird species examined within the Atlantic, Pacific, and Southern Oceans. The threshold approximated one-third of the maximum prey biomass observed in long-term studies. This provides an indicator of the minimal forage fish biomass needed to sustain seabird productivity over the long term.



Cury, Boyd et al 2011, *Science*



Cury et al. Science 2011;334:1703-1706



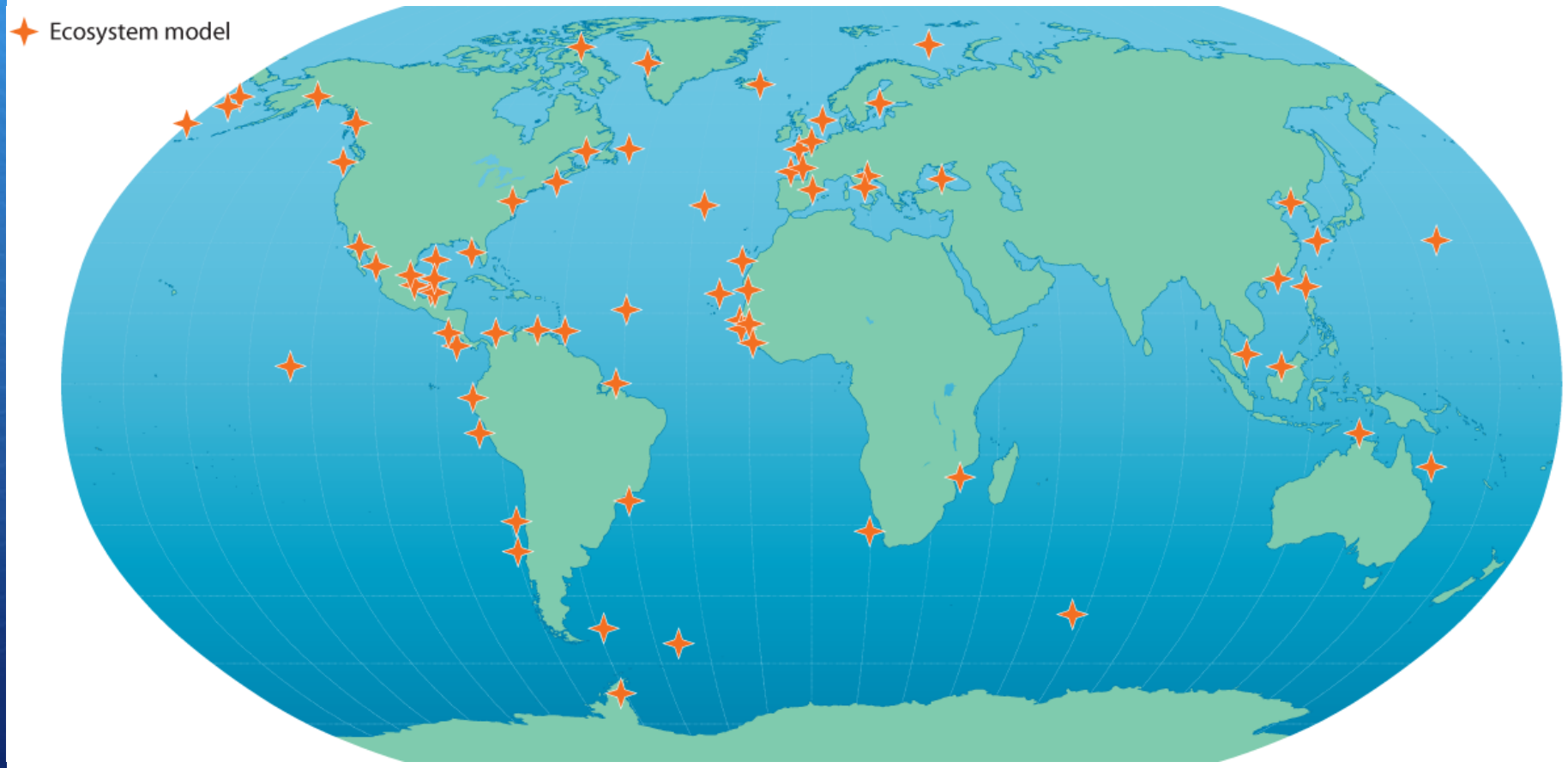
Meta-analysis: one third for the birds

7 marine ecosystems

14 seabird species

438 years of observation

Approximate locations of the 72 Ecopath models used in this analysis



Ecological Importance

Seabirds

95%

Cetaceans

10%

Pinnipeds

39%

Other large pelagics

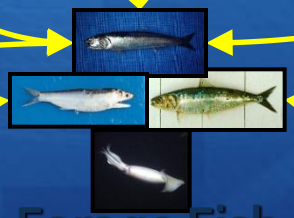
Mackerel

62%

83%

Jumbo squid

15%



Forage Fish

Chondrichthyans

33%

Horse Mackerel

3%

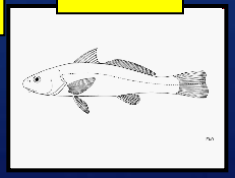
Hake

29%

Sea robin

22%

28%



Medium sciaenids

Medium demersals

3%

Flatfishes

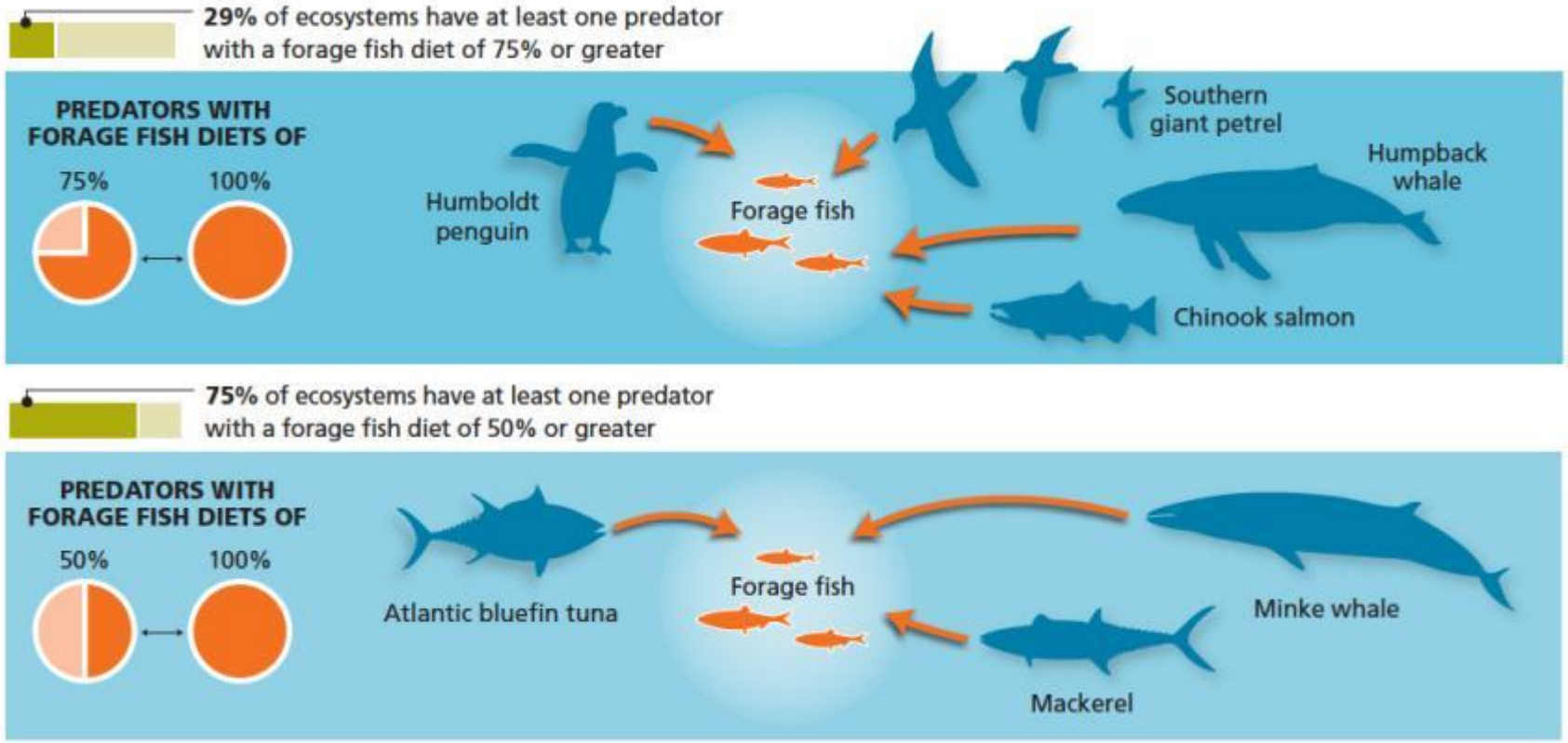
46%

Benthic elasmobranchs

12%

Ecological Importance of Forage Species

The Task Force found that 75% of the ecosystems studied have at least one highly or extremely dependent predator.



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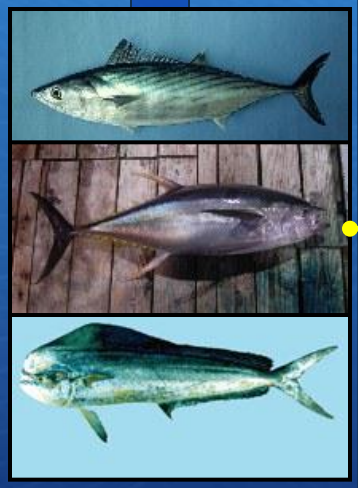
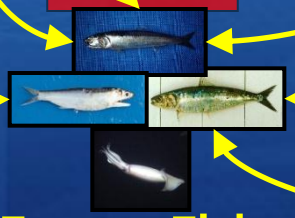
Economic Importance



Other large pelagics

Mackerel

Jumbo squid



Forage Fish

Chondrichthyans

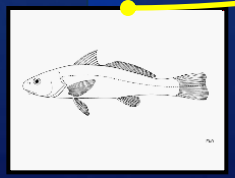
Horse Mackerel

Hake

Benthic elasmobranchs

Flatfishes

Medium demersals



Medium sciaenids

Economic Value of Forage Fish

Direct value of commercial catch = $5.6 billion

Supportive commercial value = $11.3 billion

Total global commercial value = $16.9 billion

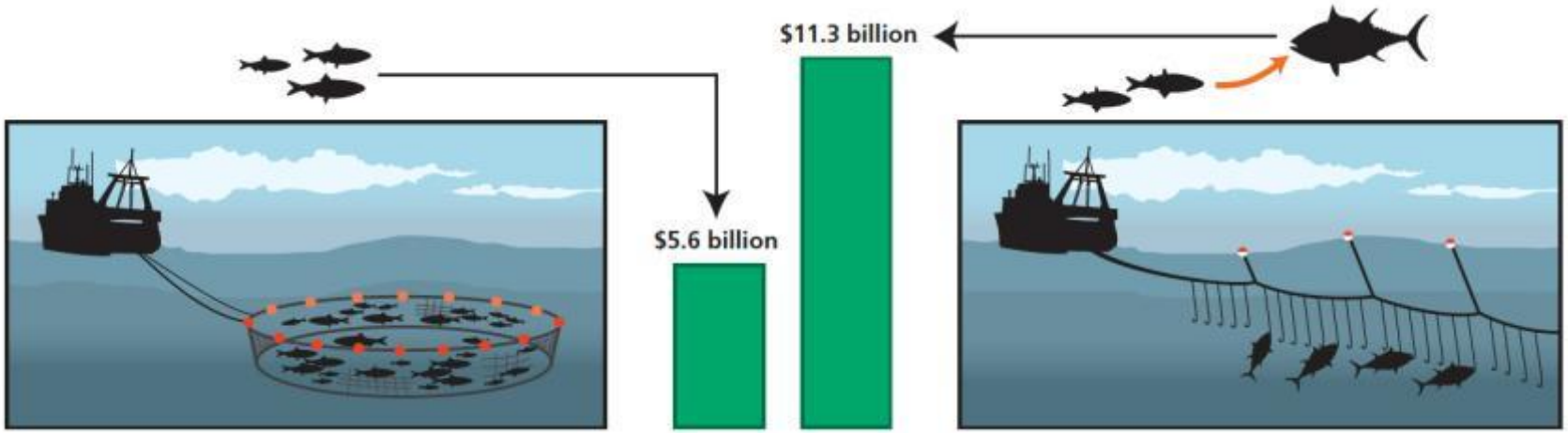
Value in 2006 dollars

FORAGE FISH DIRECT VALUE

The commercial catch of forage fish was $5.6 billion.

FORAGE FISH SUPPORTIVE VALUE

Forage fish added $11.3 billion in value to commercial catch of predators.



Predator Criterion

"Dependent Predator Performance Criterion"

- **Adopt harvest strategies and management measures so that there is a greater than 95 percent chance that fishing on forage fish will not deplete any dependent predator population to levels that would meet the IUCN "vulnerable" criteria.**

Results: Critical biomass levels

Critical forage fish biomass needed to avoid a 50% decline in predators.

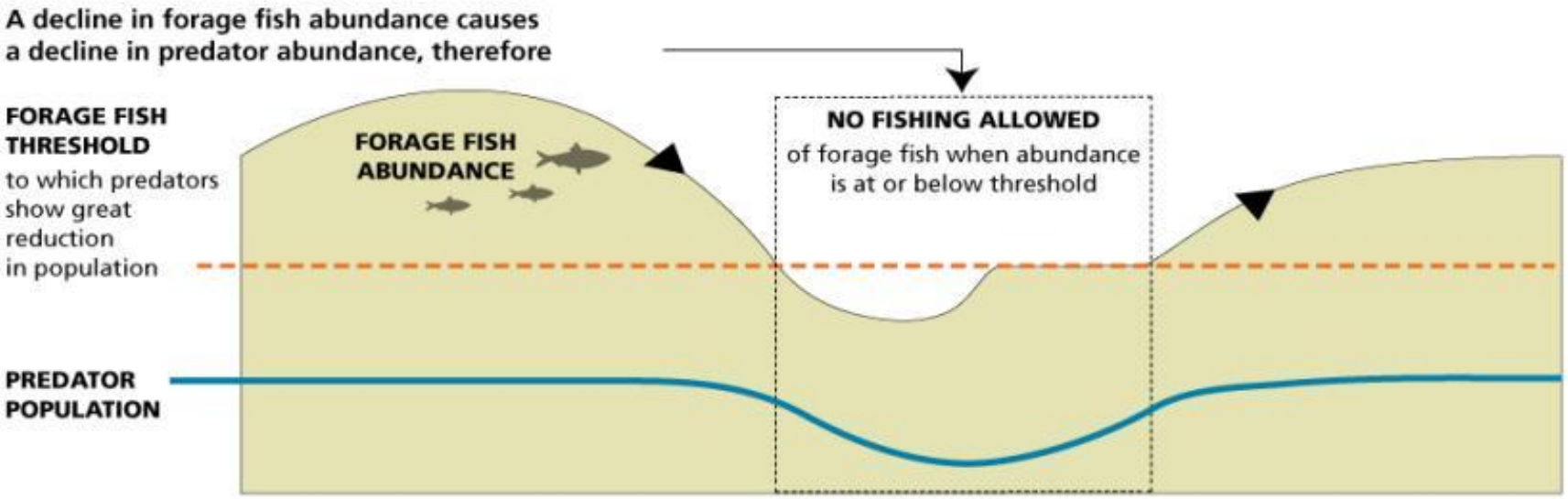
Predator Diet (% forage fish)	Biomass needed (proportion of B_0) for 95% confidence of success	
	All groups	Seabirds
25%	0.79	0.74
50%	0.85	0.88
75%	0.88	0.90
Max	0.90	0.91

Results from PREP Equation (Predator Response to Exploitation of Prey):

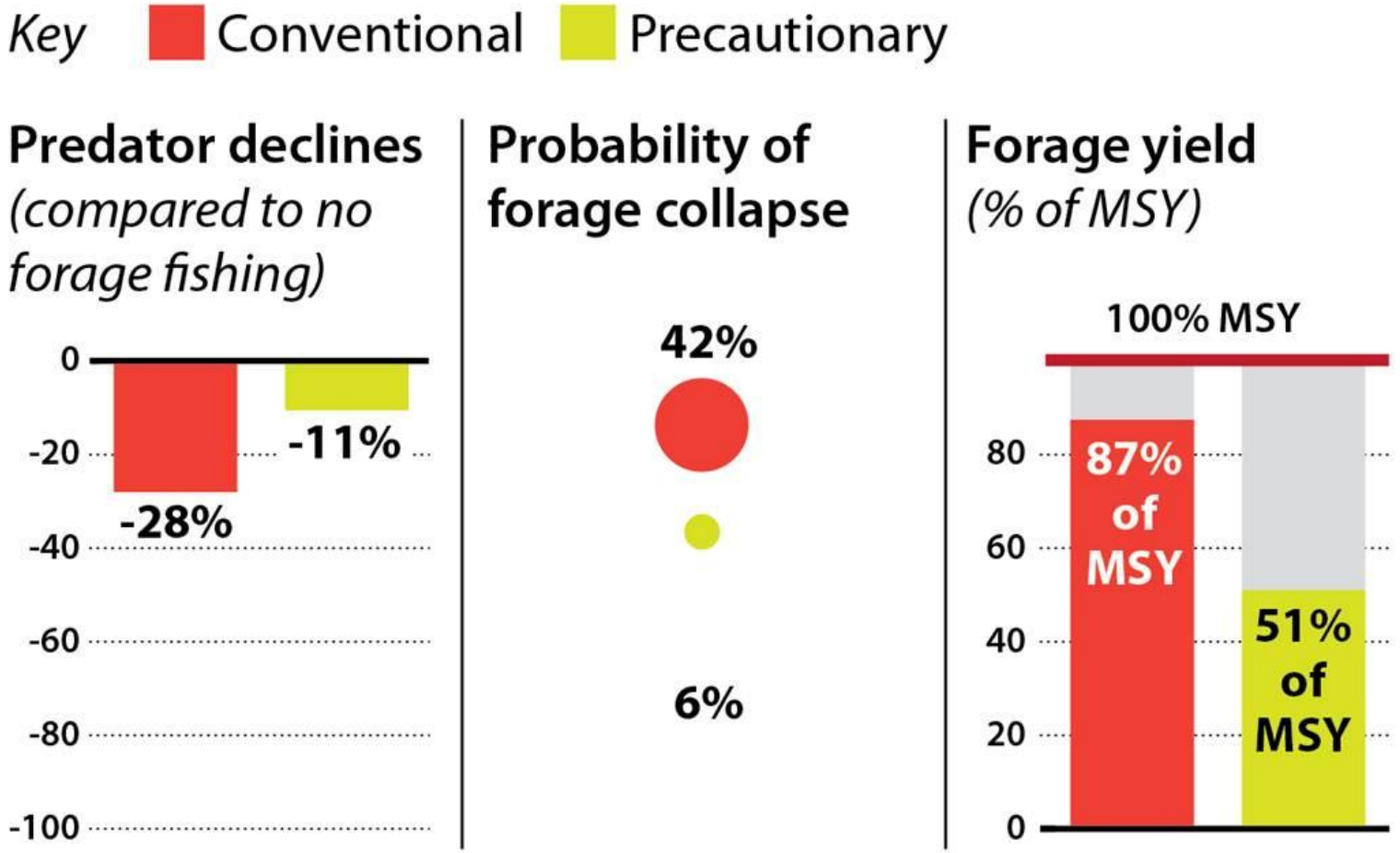
$$R = \rho D^{\alpha}\left(1-\frac{B}{B_0}\right)^{\beta}$$

R = Predator Decline (as %); D = Diet Dependency (as a fraction of the total diet); B = Forage Fish Biomass

Minimum Biomass Threshold



Only Precautionary Management Protects Predators and Fisheries



Key Recommendations

- Context of Task Force recommendations is a "Tiered Approach"– action depends on how much you know about forage fish, **and** the ecosystem.
- Focus on predators
- Cut forage fishing in half and leave twice as much fish in the ocean in many ecosystems (compared with conventional management).
- Include spatial and temporal management

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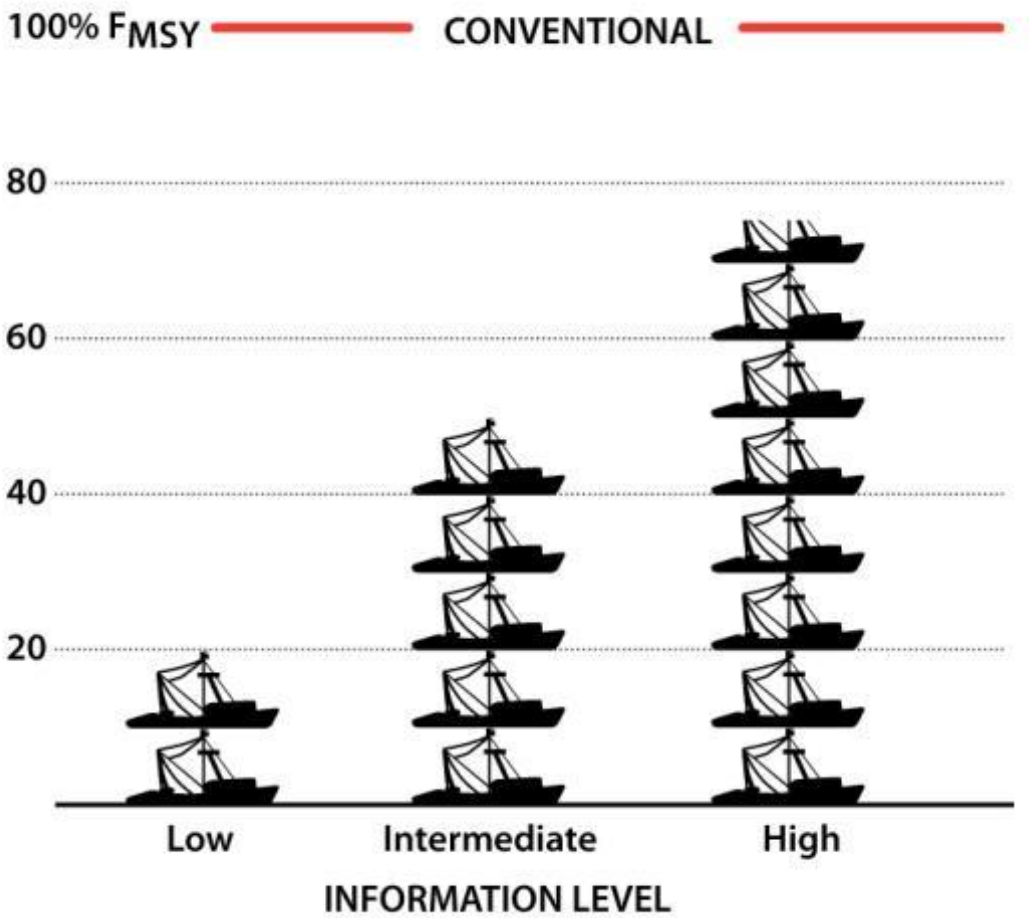
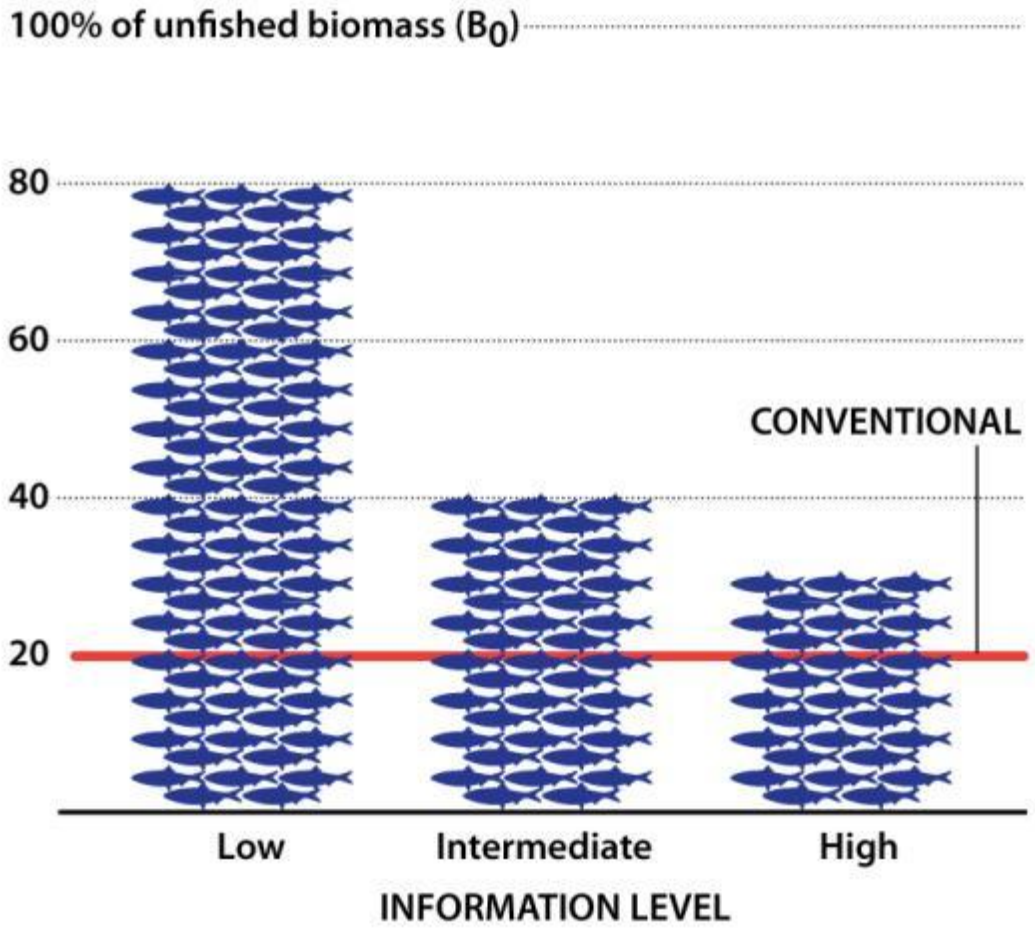
A Lower Ceiling on Forage Fishing



A Higher Floor on Forage Fish Biomass



Concluding Remarks

- Step toward ecosystem-based management
- Benefits both the ecosystem and fisheries
  - Maintains ecological roles and support services
  - Reduces risk of forage fishery collapse
  - May increase catch of commercially valuable fish

www.lenfestocean.org
http://www.oceanconservationscience.org/foragefish