

A REPORT FROM THE LENFEST FORAGE FISH TASK FORCE



little fish
BIG IMPACT

Managing a crucial link in ocean food webs

Task Force Members



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. Tim Essington

+ Dr. Éva Plagányi

+ Dr. P. Dee Boersma

+ Dr. Selina S. Heppell

+ Dr. Keith Sainsbury

+ Dr. Ian L. Boyd

+ Dr. Edward D. Houde

+ Dr. Robert S. Steneck

+ Dr. David O. Conover

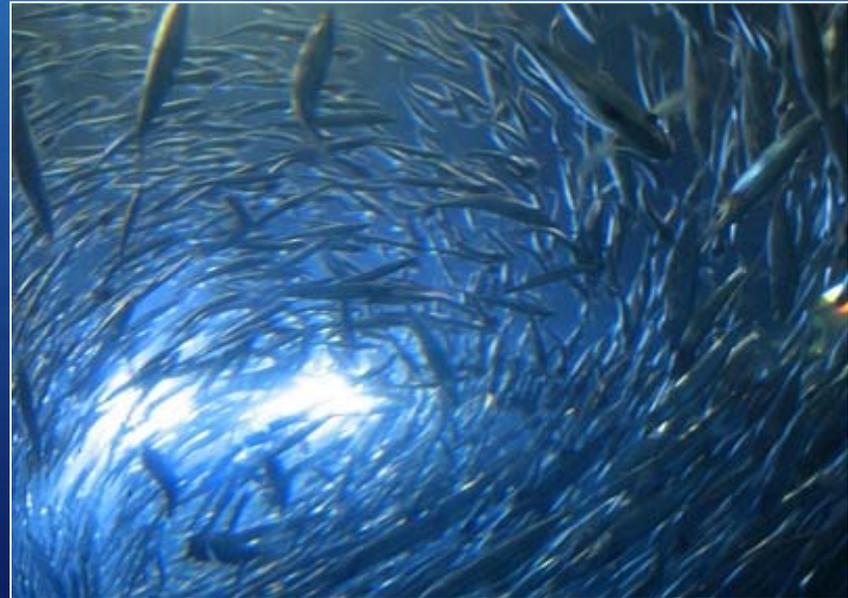
+ Dr. Marc Mangel

+ Dr. Philippe Cury

+ Dr. Daniel Pauly

What Are Forage Fish?

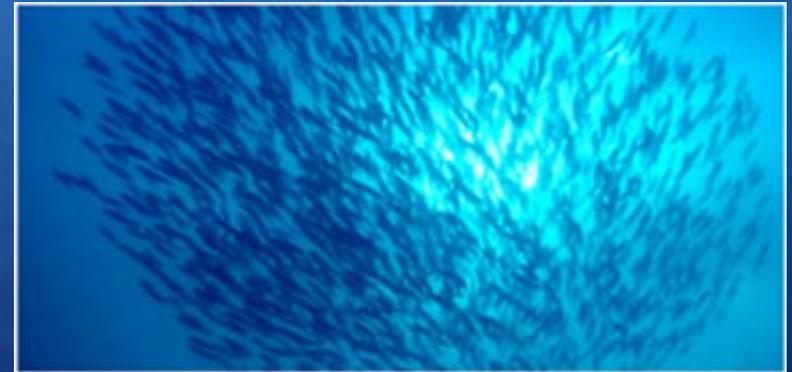
- Crucial species in food webs
- Small, often schooling pelagic species
- Sardines, anchovies, sand eels, krill, herring...
- Feed on plankton and transfer energy to upper trophic levels





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.

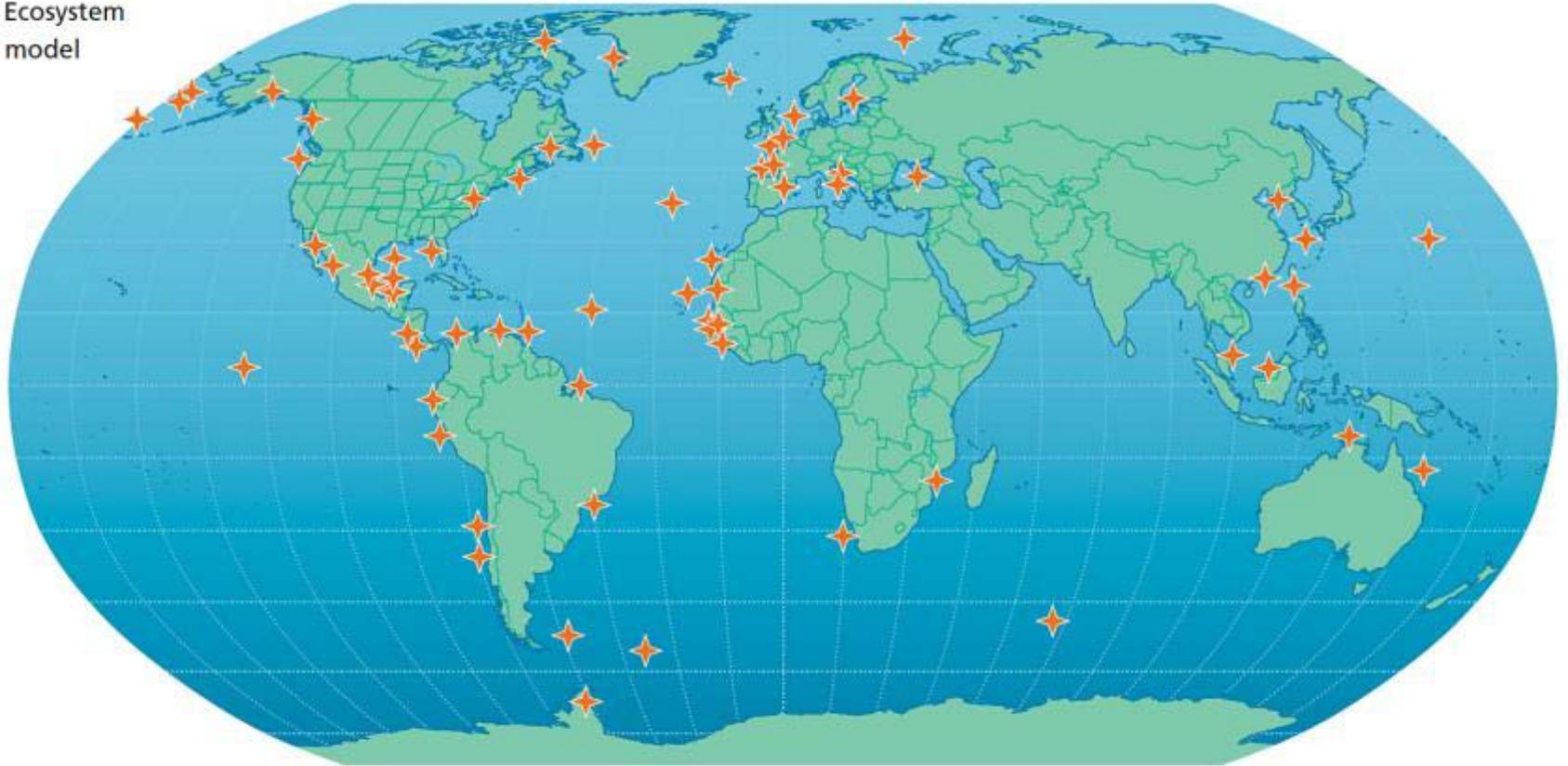


Norway

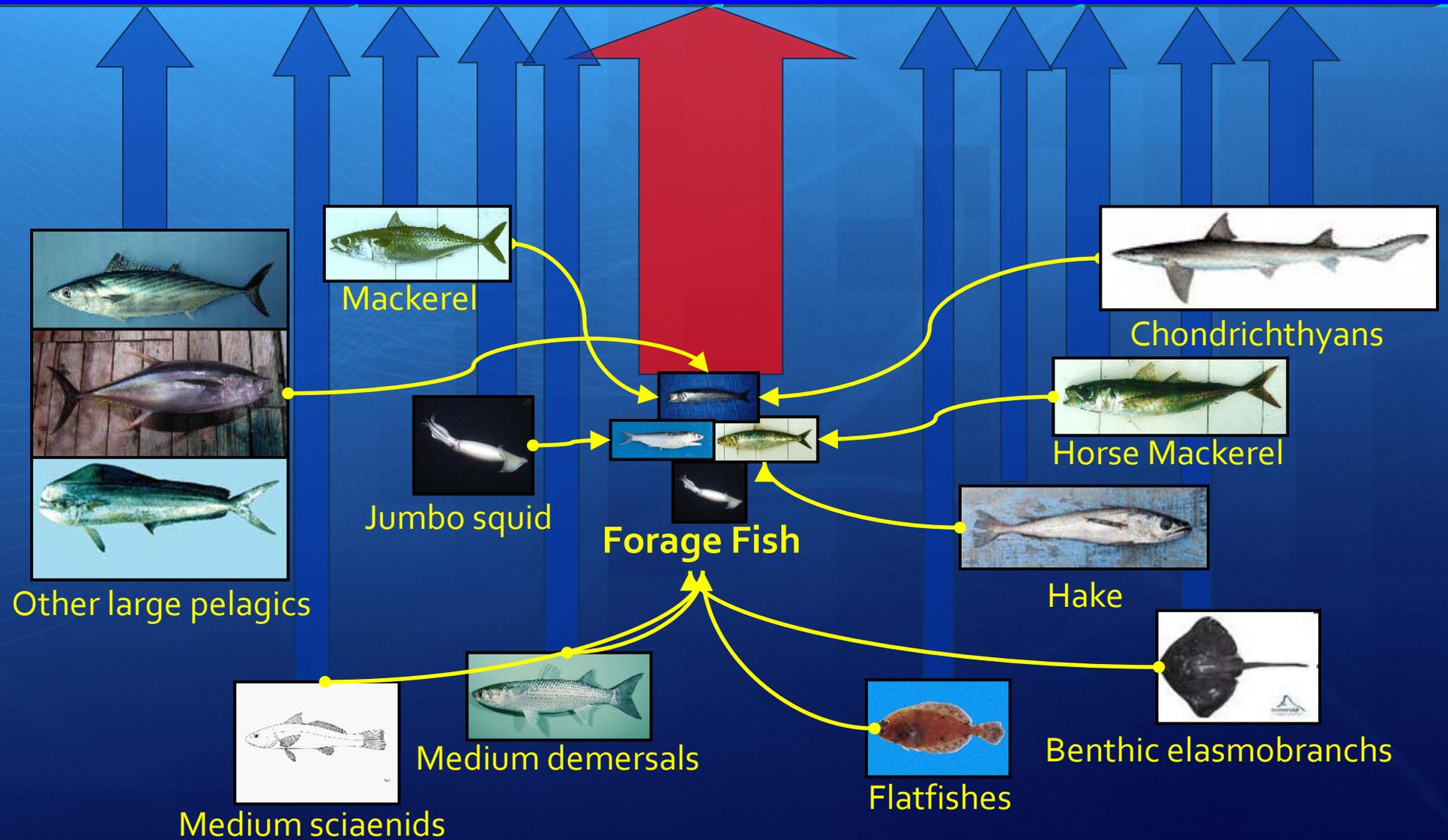
Russia

Approximate locations of the 72 Ecopath models used in this analysis

✦ Ecosystem
model



Economic Importance



Economic Value of Forage Fish

Direct value of commercial catch = \$5.6 billion

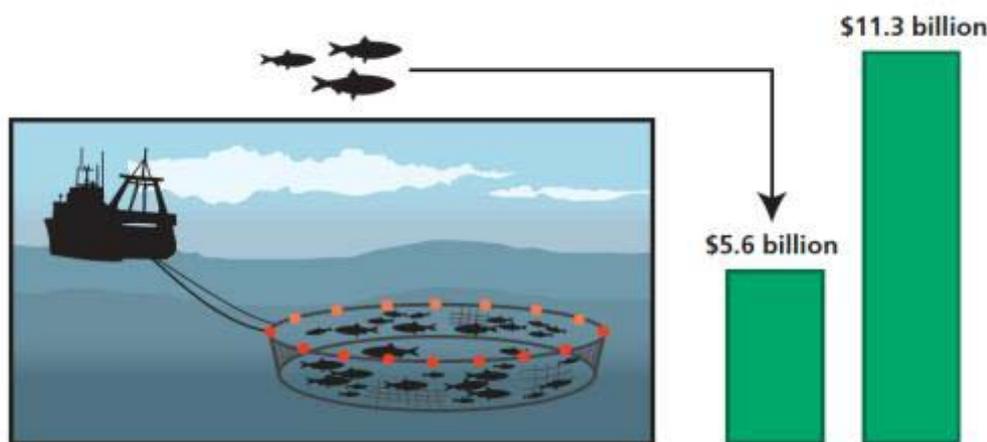
Supportive commercial value = \$11.3 billion

Total global commercial value = \$16.9 billion

Value in 2006 dollars

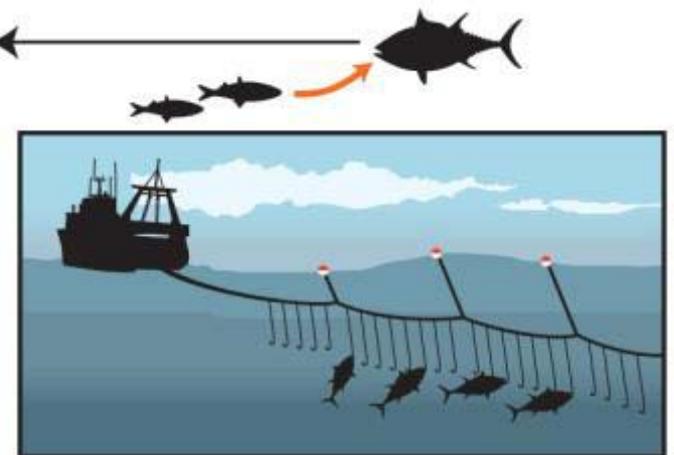
FORAGE FISH DIRECT VALUE

The commercial catch of forage fish was \$5.6 billion.



FORAGE FISH SUPPORTIVE VALUE

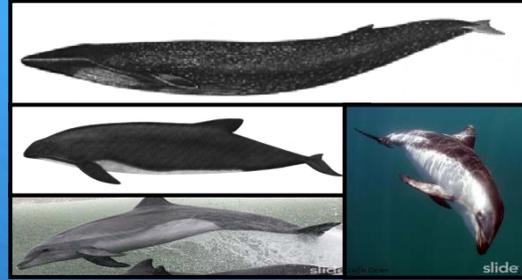
Forage fish added \$11.3 billion in value to commercial catch of predators.



Ecological Importance



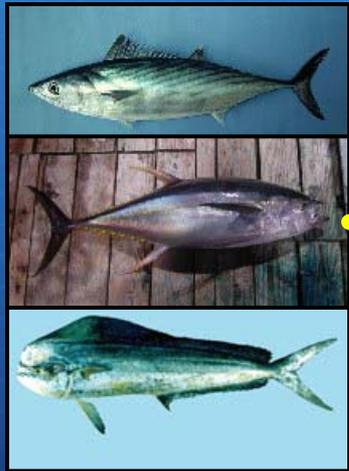
Seabirds



Cetaceans



Pinnipeds



Other large pelagics



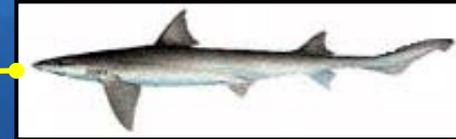
Mackerel



Jumbo squid



Forage Fish



Chondrichthyans



Horse Mackerel



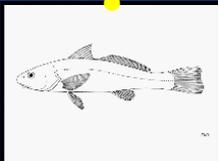
Hake



Benthic elasmobranchs



Sea robin



Medium sciaenids



Medium demersals

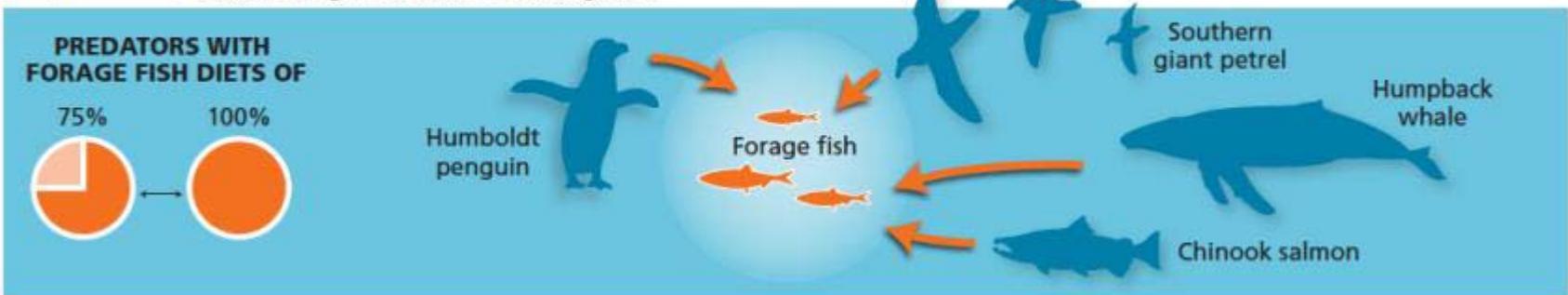


Flatfishes

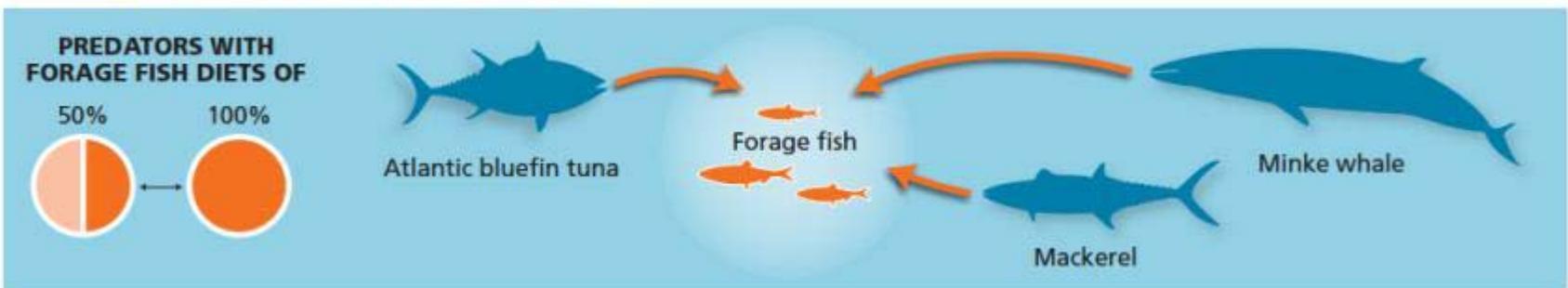
Ecological Importance of Forage Species

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

29% of ecosystems have at least one predator with a forage fish diet of 75% or greater

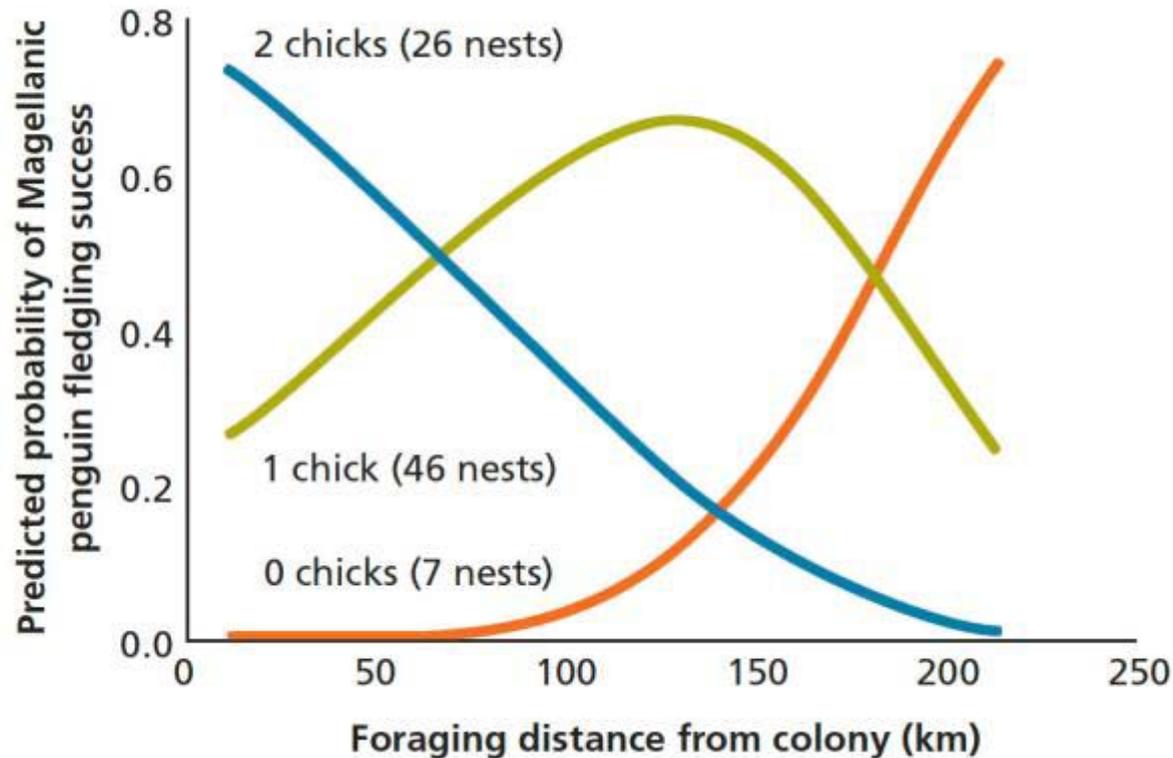


75% of ecosystems have at least one predator with a forage fish diet of 50% or greater



Foraging Distance & Magellanic Penguins

Foraging-trip distance predicted Magellanic penguin reproductive success in Punta Tombo, Argentina. (Boersma and Rebstock 2009)



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

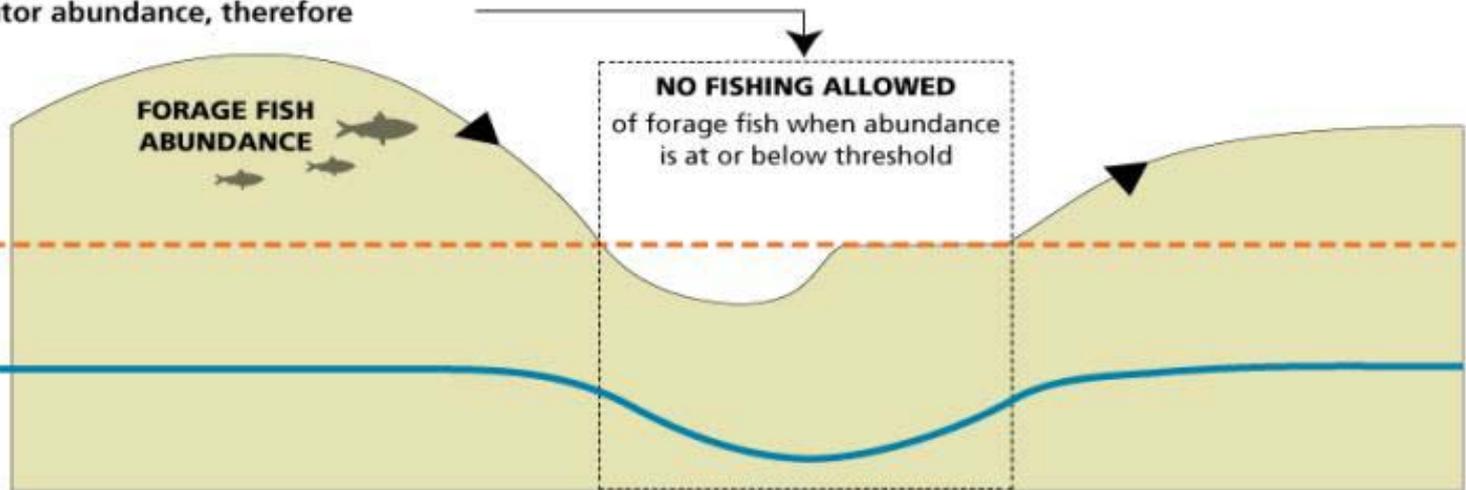
Minimum Biomass Threshold

A decline in forage fish abundance causes a decline in predator abundance, therefore

FORAGE FISH THRESHOLD

to which predators show great reduction in population

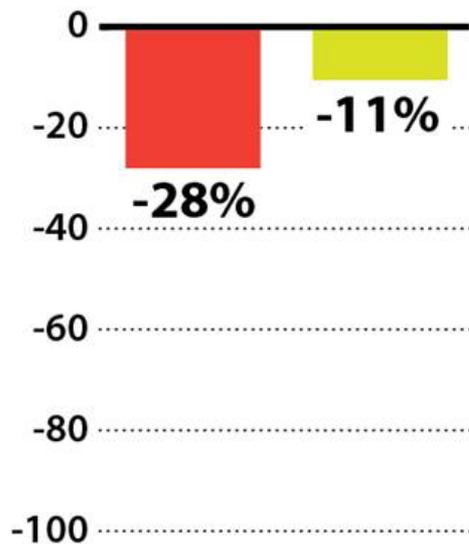
PREDATOR POPULATION



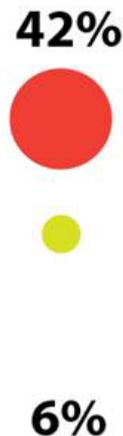
Only Precautionary Management Protects Predators and Fisheries

Key ■ Conventional ■ Precautionary

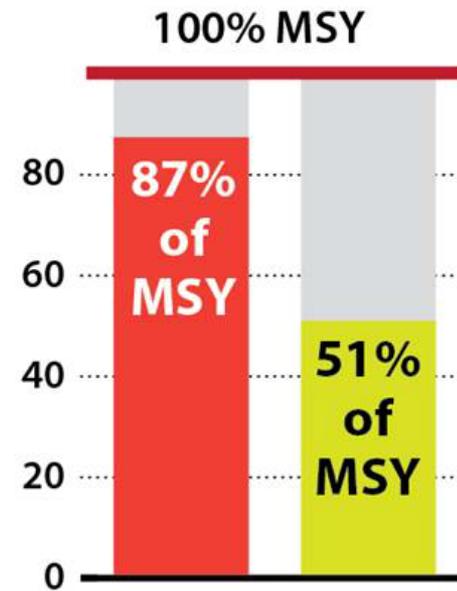
Predator declines
(compared to no forage fishing)



Probability of forage collapse



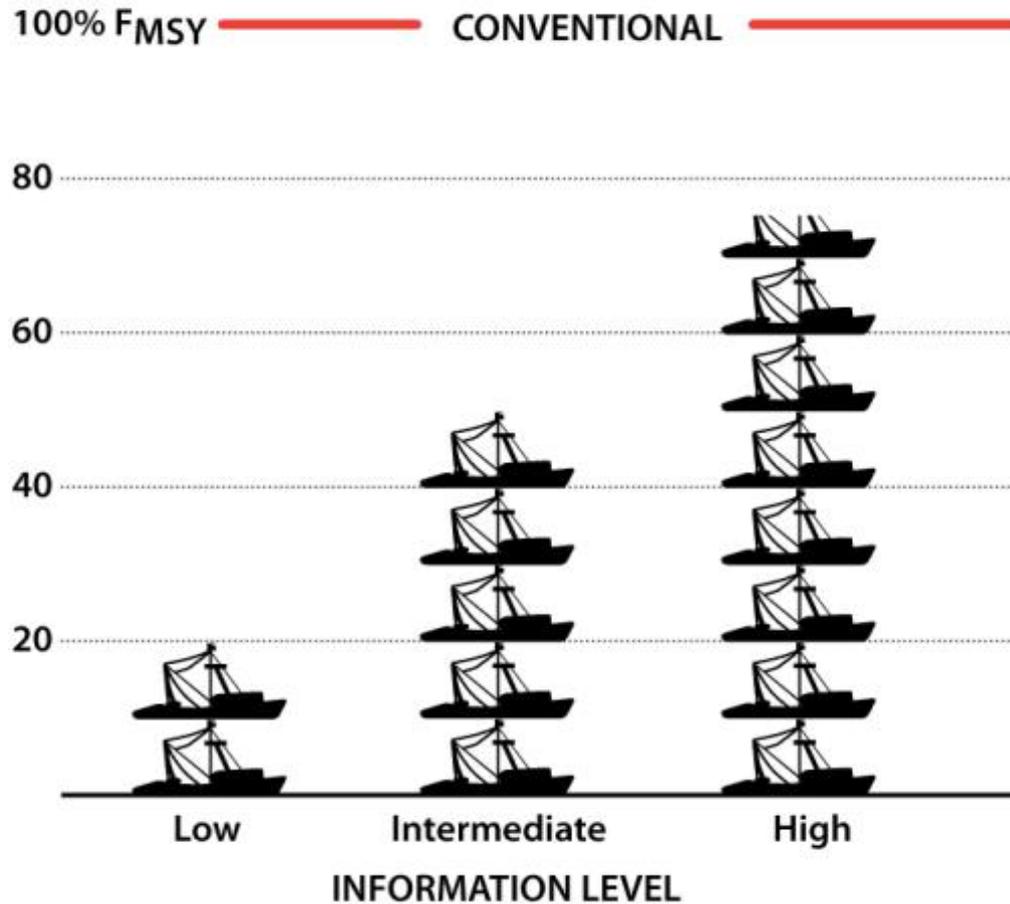
Forage yield
(% of MSY)



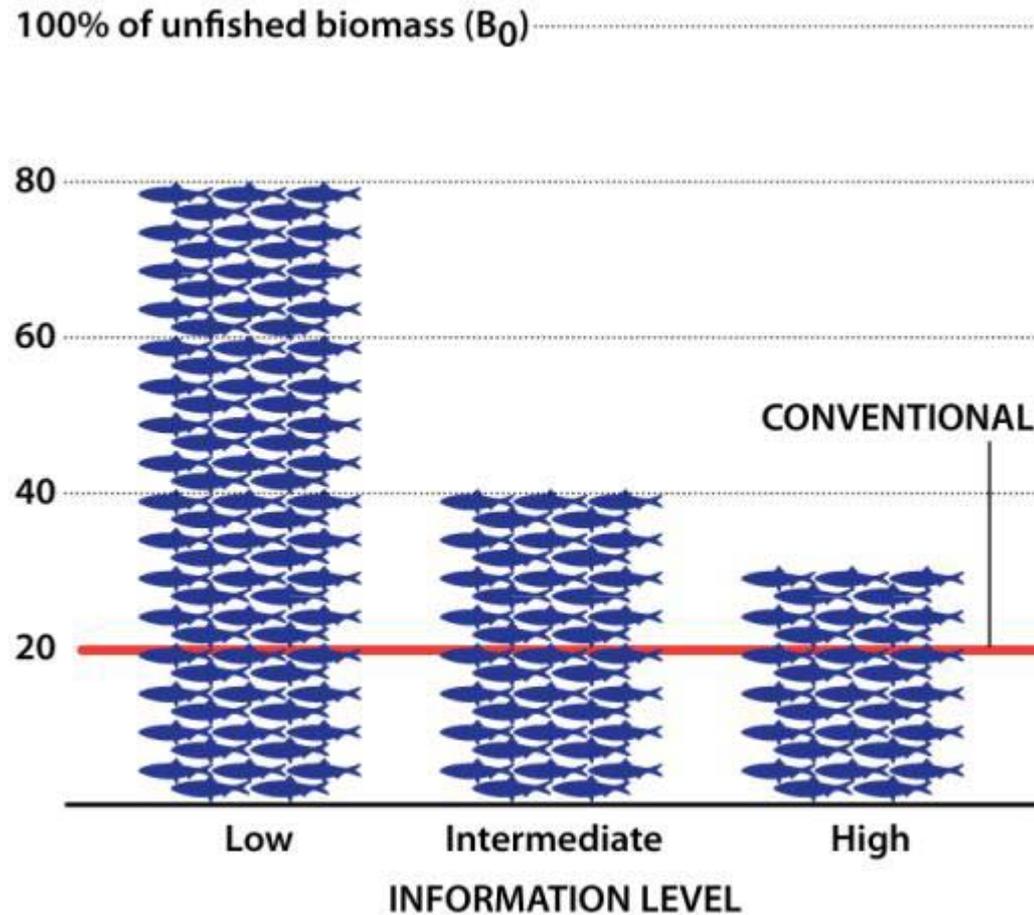
Key Recommendations

- + Focus on predators
- + Consider spatial & temporal management
- + Cut forage fishing in half and leave twice as much fish in the ocean in many ecosystems.
- + Tailor management to available information

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



Managing a crucial link in ocean food webs

A report from the Lenfest Forage Fish Task Force

