ECOSYSTEM-BASED MANAGEMENT BEGINS AND ENDS WITH FORAGE FISH

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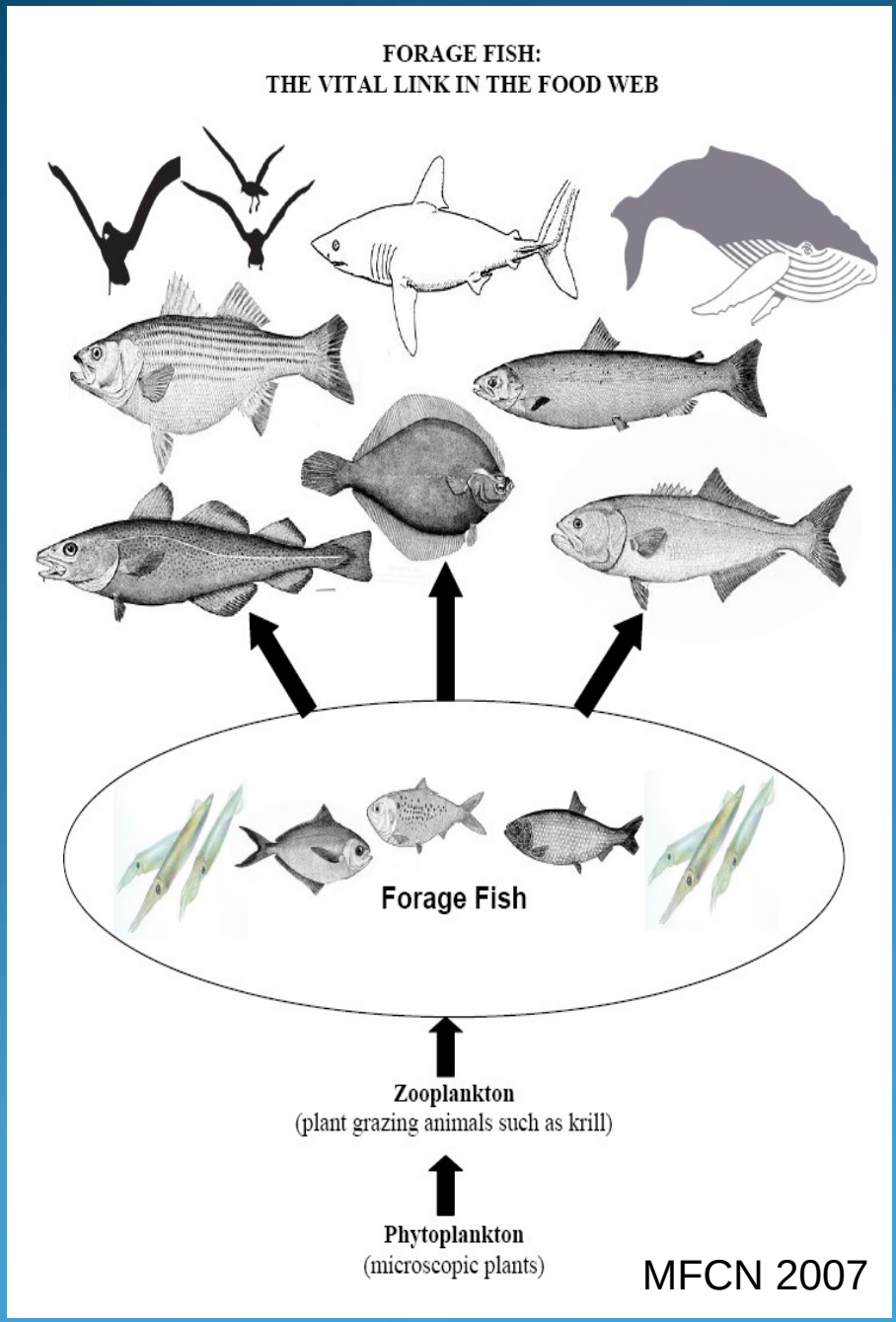
What Are Forage Fish?

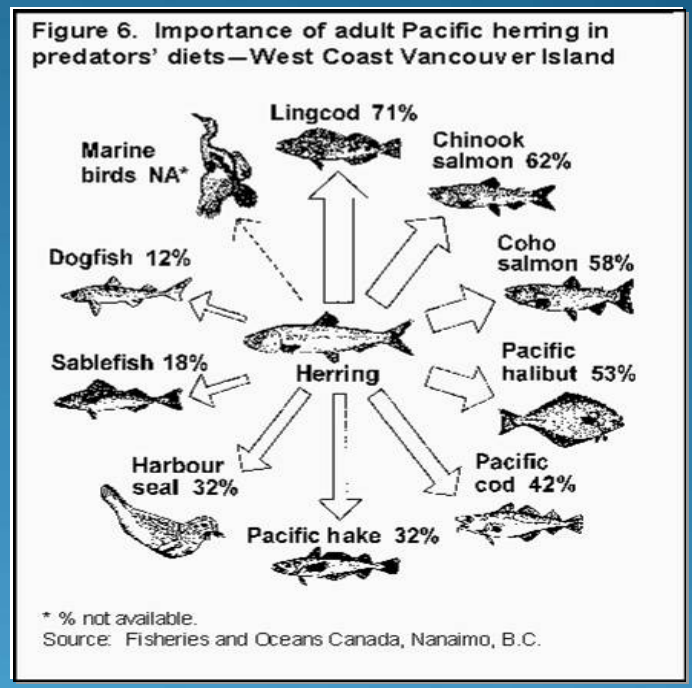
Forage fish include “baitfish” like menhaden, sardine, anchovy, capelin, and sandlance, but also squid and tiny shrimp-like krill. Medium-sized pelagic species such as Pacific hake, Alaska pollock, herring and mackerel are also major forage fish species at all life stages in their respective ecosystems.

Common characteristics of forage fish worldwide:

1. they travel in large schools which may number in the millions, making them easy prey for both predators and fishing nets;
2. they are fast-growing and prolific, but their abundance is influenced by changing ocean conditions and prone to fluctuations;
3. they are dominant prey species in their respective ecosystems, sustaining top predator fish, seabirds and marine mammals;
4. they are targets of some of the largest commercial fisheries in the world.



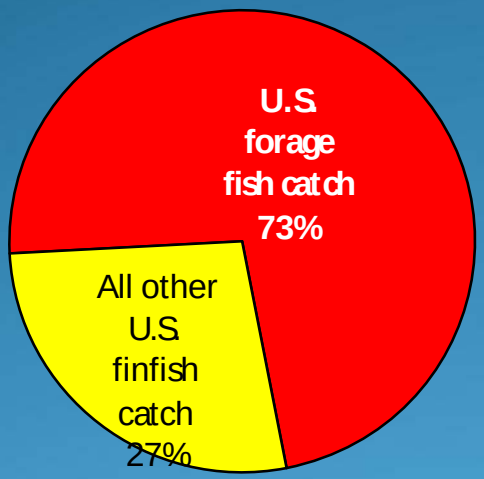
A simplified illustration: forage fish are the means by which energy is transferred to higher trophic level predators



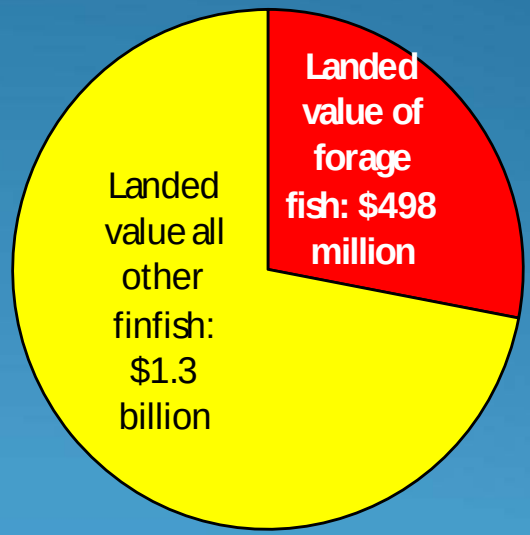
In "wasp-waist" food webs dominated by one major forage species, overfishing of that species can have widespread effects on dependent predators

Based on reported landings in 2005, six major commercial forage fish fisheries accounted for more than 70 percent of all marine finfish landed in the United States by weight...

Forage fish fisheries as a percent of total U.S. catch by weight (excluding shellfish), 2005

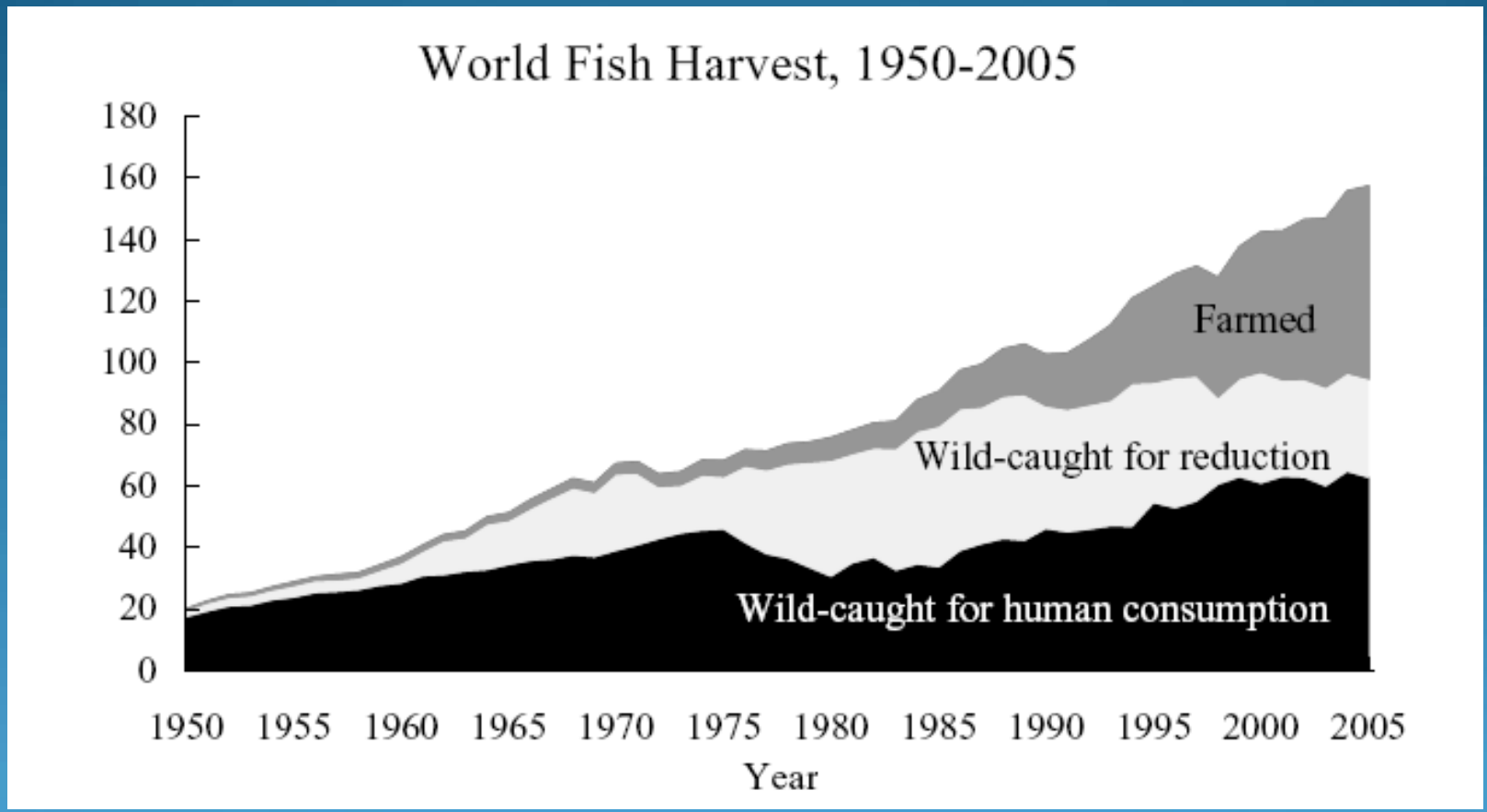


Forage fish fisheries as a percent of total U.S. landed value of fish (excluding shellfish), 2005



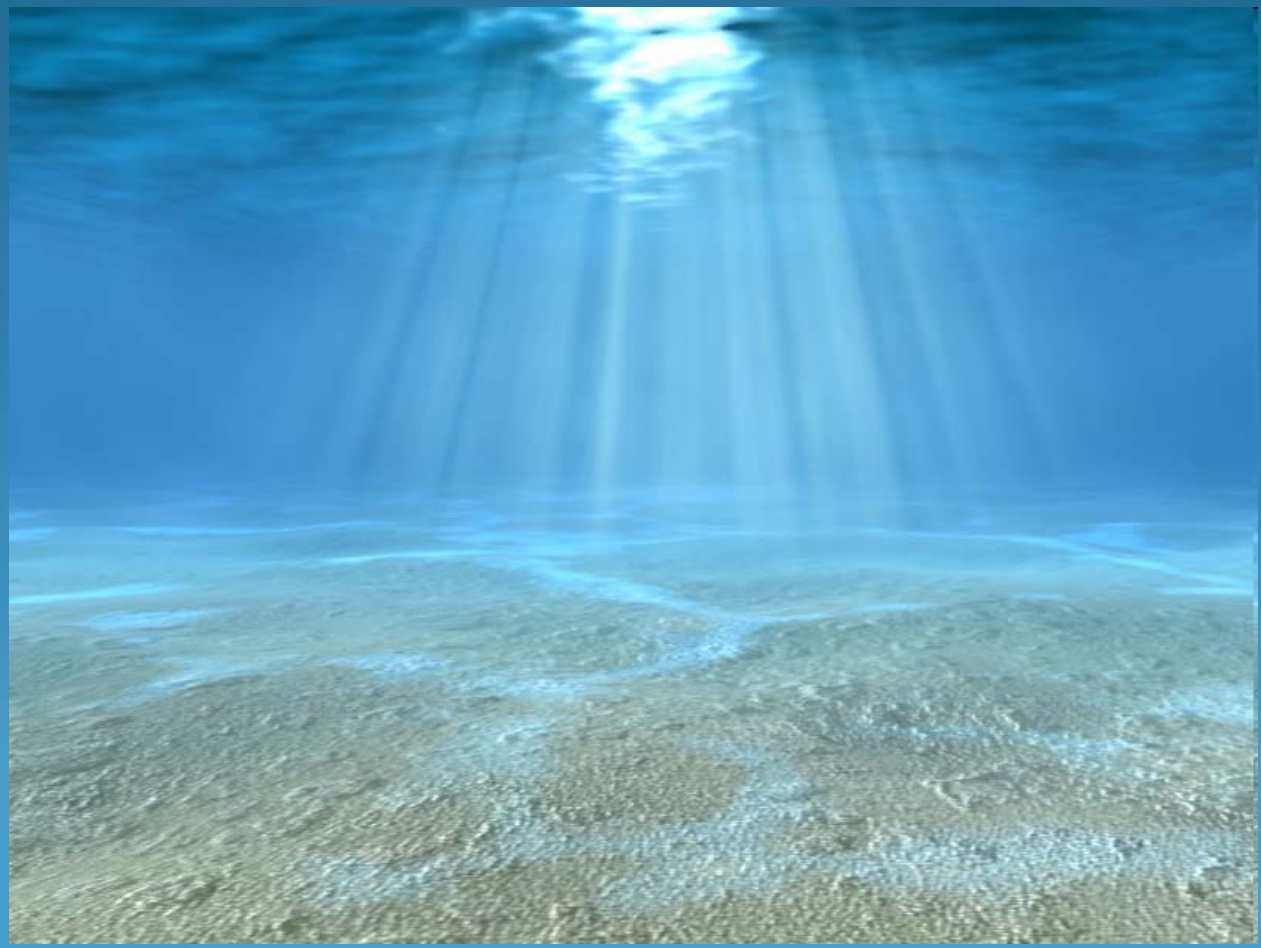
...but less than 30 percent of the total value of commercial landings nationally

Explosive growth of global aquaculture puts added pressure on heavily exploited forage fish



Source: Jacquet, 2008

SHORTCOMINGS OF CONVENTIONAL MSY-BASED FISHING STRATEGIES IN AN ECOSYSTEM CONTEXT



Source: NOAA

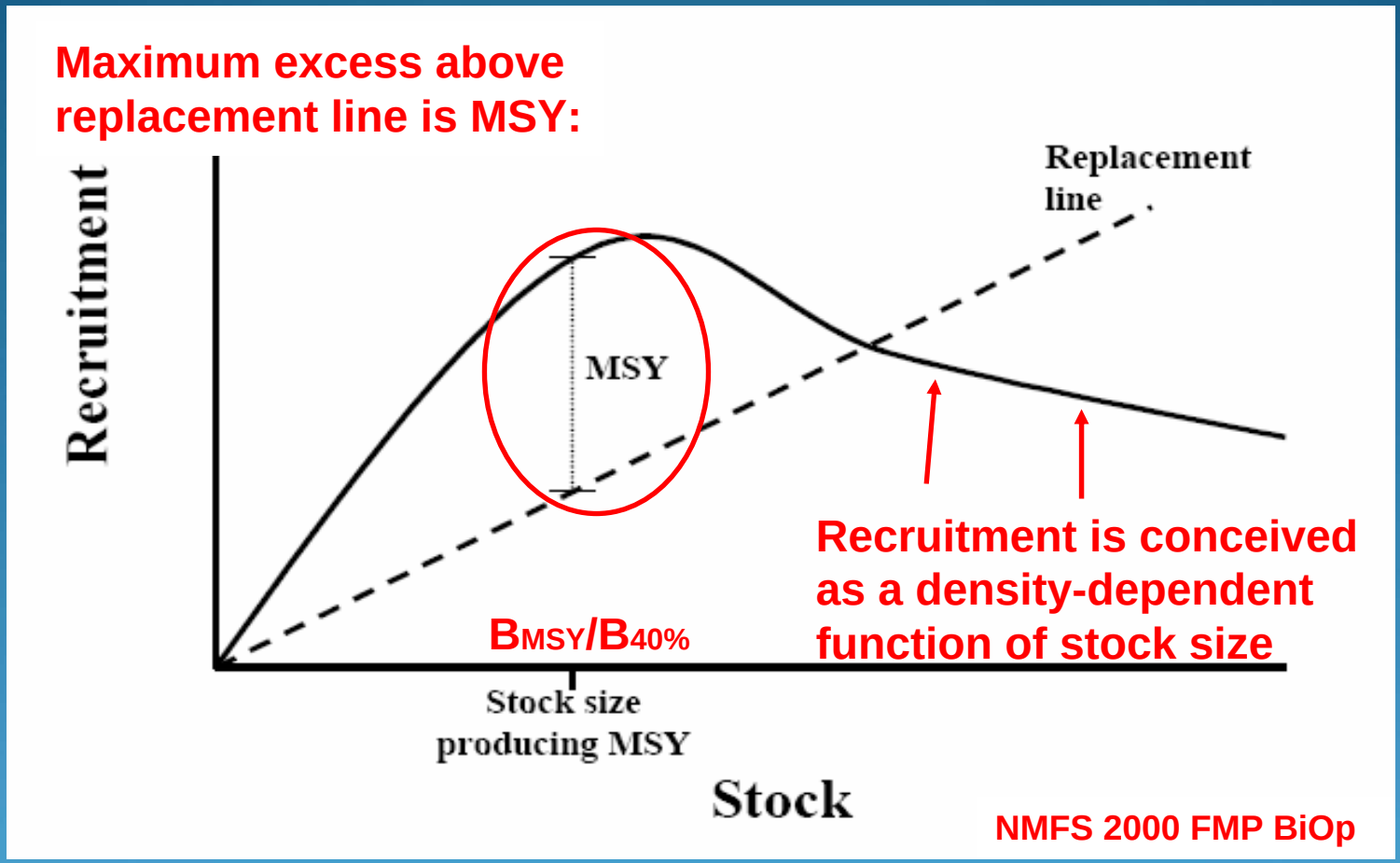
MSY has become the benchmark of fishery sustainability

F_{MSY} was designated as an upper bound to fishing mortality. It is premised on the assumption of a density-dependent stock-recruitment relationship whereby production of new recruits to the adult spawning stock can be maximized at lower abundances of spawning-aged fish.

Gabriel and Mace (1999)

Source: Getty Images

Theoretical Ricker curve illustrating 'surplus' above replacement line available to fishery



The positive difference between recruitment and the replacement line indicates recruitment in excess of that needed to replace the stock and is considered surplus in a single-species context

Assumptions of the single-species FMSY or proxy (e.g., F_{MAX}, $F_{40\%}$) fishing strategies

- Density dependence is the main regulating factor in population dynamics.
- If one simply knows enough about the vital information of the stock, then it is possible to fully control the trajectory of the stock.
- Stocks can be assessed and managed outside of their role in the ecosystem.

Goodman et al. (2002)

Margins of safety in the $F_{40\%}$ policy:
Is the approach considerate of ecosystem needs?

"[I]*t is not clear how much of the margin between* $F_{35\%}$ *and* $F_{40\%}$ *was 'allocated' to ecosystem considerations [or] whether the margin between fishing at* $F_{35\%}$ *and* $F_{40\%}$ *supplies this amount*."

"*A harvest management strategy, such as* $F_{40\%}$*, that by design reduces the biomass of the target stock by a large fraction, will, all other things being equal, reduce the total consumption by higher trophic levels by a similar large fraction, and we would expect the predator populations to be reduced accordingly.*"

Goodman et al. (2002)

Major findings of National Research Council, Committee on Ecosystem Effects of Fishing, Phase II (2006)

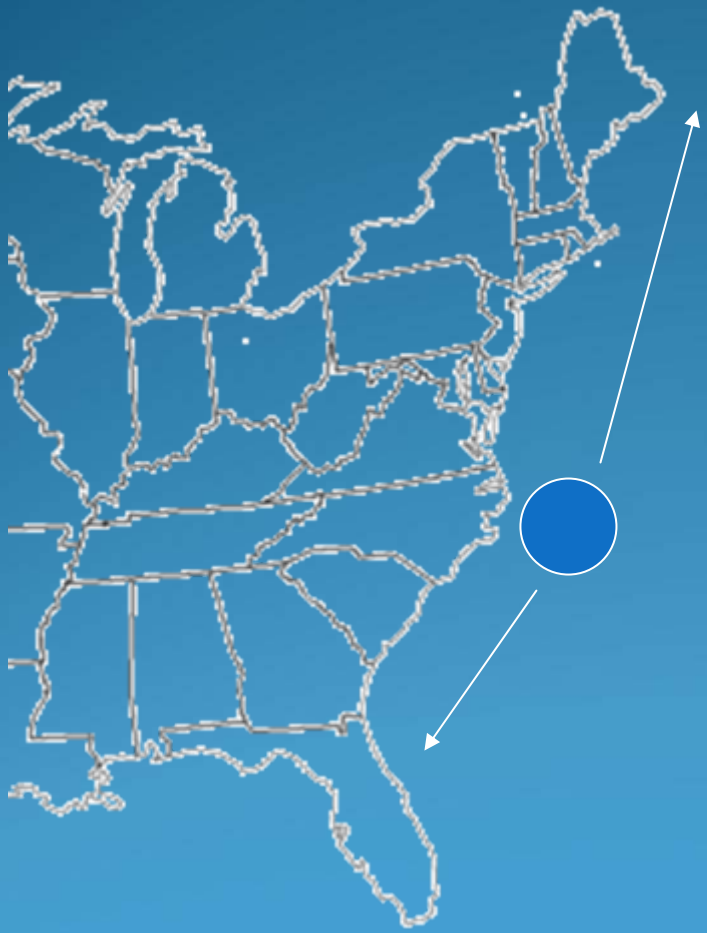
- Managing fisheries within an ecosystem context will require accounting for food web interactions and trophic effects and making tradeoffs between species or among fisheries and other uses.
- Single-species MSY policies are unlikely to be sufficient for future management because these measures do not take into account species interactions and food web effects nor do they consider non-consumptive ecosystem services.
- A variety of new regulatory mechanisms and institutions ought to be considered to help implement ecosystem-based management approaches.
- Existing laws and agency structures will need to be examined against a wider mandate to implement an ecosystem approach to management.

Case Study: Menhaden

Effects of MSY harvest policy

- The goal of the MSY-based harvest policy is to remove fish before they are “lost” to natural mortality by other ecosystem consumers.
- Menhaden would have to be fished to below 27% of it’s biomass to be considered overfished in a single-species context.
- This long-term reduction is reasonably likely to reduce significantly the availability of prey to other components of the ecosystem, such as weakfish, cobia, mackerel and tuna
- This stock-wide reduction in biomass effectively diminishes carrying capacity of essential habitats for predator species.

Menhaden Spawn and Overwinter off the North Carolina Coast



- The South Atlantic no longer has any economic interest in the reduction fishery.
- Demand for Omega-3 and aquaculture feed are driving fisheries off the coast and outward.
- There once were reduction plants as far south as North Florida.

Important predator fish rely heavily on menhaden

- Atlantic menhaden constitute up to 90% of a young weakfish's diet (Hartman and Brandt, 1995)
- Menhaden are up to 35% of a king mackerel's diet
- (Hartman and Brandt, 1995)
- Species like bluefish and striped bass rely primarily on menhaden for food source (Hartman and Brandt, 1995)
- Sharks are often seen following schools of menhaden.
- Pollock, cod, silver hake, bluefish, weakfish, tuna and swordfish all consume great numbers.

Scientific consensus statement on Atlantic Menhaden underscores the ecological importance of menhaden in coastal waters of the eastern seaboard

- ✓ Atlantic menhaden play a unique role transforming primary productivity directly into fish biomass.
- ✓ Menhaden are important prey for large predators. Historically menhaden were the dominant prey species in places such as Chesapeake Bay and North Carolina.
- ✓ Menhaden continue to serve an important ecological role although that role has diminished in modern times as menhaden abundance has been reduced.
- ✓ Menhaden may be the last major abundant inshore clupeid.

Atlantic Menhaden Workshop Report and Proceedings, Atlantic States Marine Fisheries Commission, October 12-14, 2004, Alexandria, VA.

Menhaden fishery increasing catch in the EEZ

Landings by Distance from U.S. Shores, 2006, State of Virginia			
	0 - 3 Miles	3 - 200 Miles	High Seas
Species	Pounds (000)	Pounds (000)	Pounds (000)
Menhaden	325,702	45,287	-

Landings by Distance from U.S. Shores, 2006, State of North Carolina			
	0 - 3 Miles	3 - 200 Miles	High Seas
Species	Pounds (000)	Pounds (000)	Pounds (000)
Menhaden	947	16	-

Only Virginia and North Carolina currently allow menhaden reduction in state waters, but the EEZ is not currently regulated

National legislation declaring a moratorium on Atlantic menhaden reduction fishing introduced in 2007

- **H.R. 3840** introduced by Rep. Saxton (R-NJ), 10/16/2007:

  Imposes a fishing moratorium on commercial harvest of Atlantic menhaden that are reduced to meal and oil in state waters of each coastal state north of South Carolina. Makes it unlawful to engage in reduction fishing of Atlantic menhaden in the Exclusive Economic Zone (EEZ).
- **H.R. 3841** introduced by Rep. Gilchrest (R-MD), 10/16/2007:

  Makes it unlawful to engage, or to attempt to engage, in commercial harvesting of Atlantic menhaden for reduction purposes in Atlantic coastal waters or in the Exclusive Economic Zone (EEZ).

  Both bills referred to House Natural Resources Subcommittee on Fisheries, Wildlife, and Oceans, 10/19/2007

  May 8, 2008 hearings held: status uncertain

Recommendation:
Ban the Reduction Fishery for Menhaden in the South Atlantic EEZ

- There are no menhaden reduction plants or fishermen in the South Atlantic
- Such a ban would secure the spawning and wintering grounds for a coast-wide species
- Menhaden are more valuable as forage for species like mackerel and weakfish than for aquaculture and industrial products.

NEEDED:

A NEW FRAMEWORK FOR THE CONSERVATION AND MANAGEMENT OF FORAGE FISH

Source: NOAA

Ecosystem-based fisheries management : from theory to practice in forage fish conservation

- The goal of ecosystem-based fisheries management in the MSA is to put ecosystem principles into *practice* (MSA, Sec. 406).
- Perfect knowledge of the ecosystem is not realistic: most management actions are taken in the face of considerable uncertainty; we know enough to begin acting now.
- To compensate for the ecological deficiencies of MSY, overfishing criteria should be modified to account explicitly for needs of predators and leave more fish in the water.
- Quantifying the ‘right’ amount is inherently problematic; precautionary approach more realistic in short-term.

Regulatory Guidance
National Standard 1 – Optimum Yield

Regulatory guidance on factors used in reducing MSY to obtain OY:

> *In determining the greatest benefit to the Nation, these values that should be weighed are food production, recreational opportunities, and protection afforded to marine ecosystems. They should receive serious attention when considering the economic, social, or ecological factors used in reducing MSY to obtain OY*.
>
> 50 CFR 600.310(f)(2))

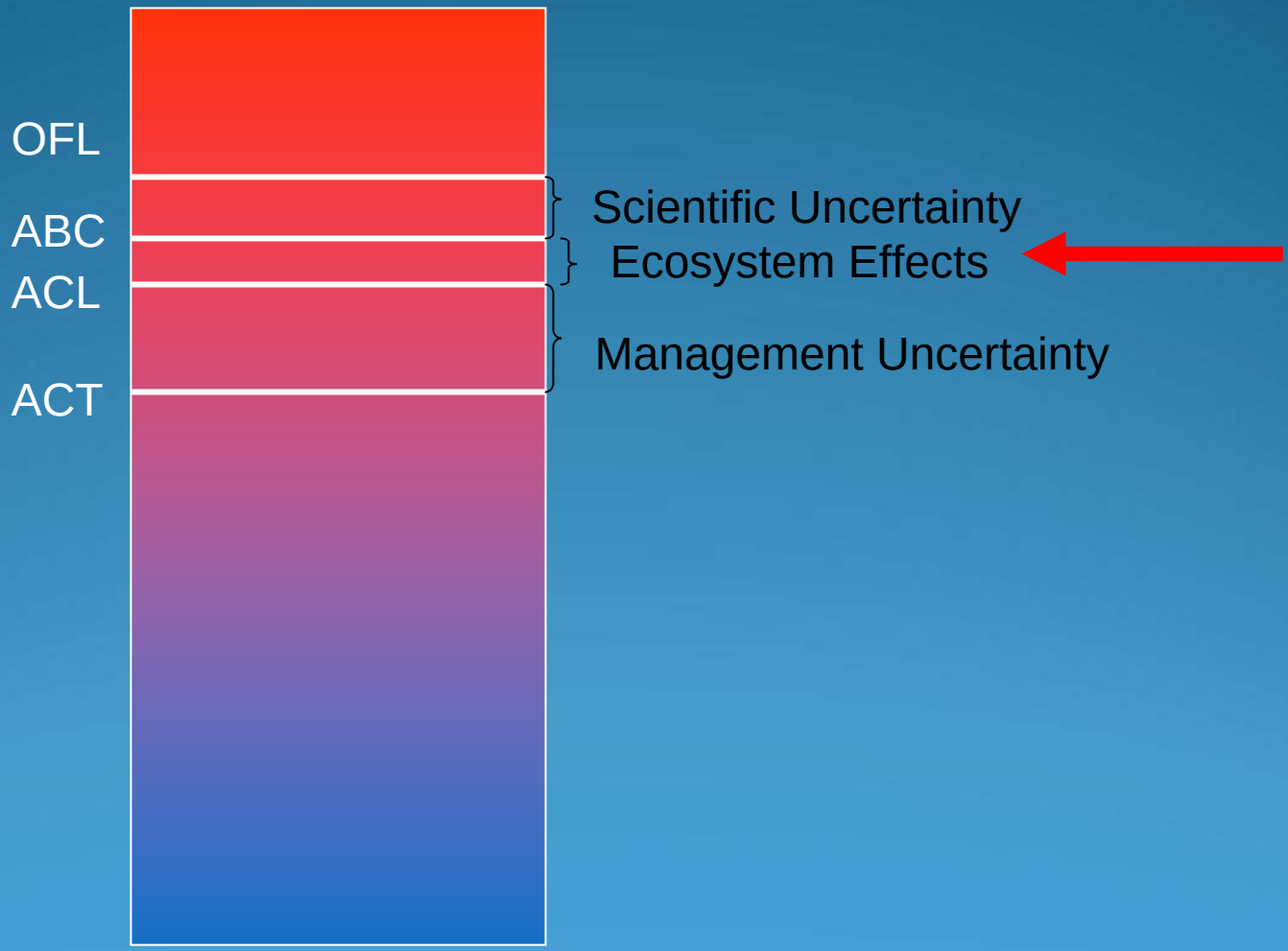
Specific ecological factors used in reducing ABC to obtain ACL include:

- stock size and age composition
- the vulnerability of incidental or unregulated stocks in a mixed-stock fishery
- predator-prey or competitive interactions
- dependence of marine mammals and birds or endangered species on a stock of fish
- natural and manmade changes in wetlands or nursery grounds
- effects of pollutants on habitat and stocks

  50 CFR 600.310(f)(3)(iii))

Example (from NMFS presentation)

Buffer to Account for Ecosystem Effects



Recommendation:
Designate menhaden, herring as Essential Fish Habitat

Importance of conserving prey species in EFH regulations:

Prey species. Loss of prey may be an adverse effect on EFH and managed species because the presence of prey makes waters and substrate function as feeding habitat, and the definition of EFH includes waters and substrate necessary to fish for feeding. Therefore, actions that reduce the availability of a major prey species, either through direct harm or capture, or through adverse impacts to the prey species' habitat that are known to cause a reduction in the population of the prey species, may be considered adverse effects on EFH if such actions reduce the quality of EFH. FMPs should list the major prey species for the species in the fishery management unit and discuss the location of prey species' habitat.

50 CFR 600.815 (a)(7)

Specific Network recommendations

- Identify and define “forage fish” through existing FMPs or new Forage Fish Plans.
- Ban the reduction fishery of Menhaden in Federal Waters
- Establish menhaden and other forage fish as part of EFH
- Set optimum yield (OY) for forage fish with aim of maintaining stock biomass well above B_{MSY} to account for ecological role as prey.
- Account for sources of uncertainty in data and stock assessment advice.
- Address the spatial impacts of fishing on forage fish and predators explicitly by apportioning the annual catch limit by areas, seasons, fishing gears, or by a specified amount of fishing effort to avoid localized depletions and serial depletions of forage stock.

Conservation of forage fish requires an ecosystem approach that accounts explicitly for their role as prey and mandates more precautionary approach

- Establish forage fish category and require regional fishery management councils to identify and protect major forage species through existing fishery management plans or new forage fish plans.
- Set target fishing rate at conservative proxy for ecosystem considerations and establish a more precautionary threshold for classifying forage fish as overfished in order to leave more fish in the water and start rebuilding sooner.
- Address the spatial-temporal impacts of fishing with measures such as area-specific and seasonal catch limits to distribute fishing effort and avoid localized depletions of forage fish.

www.conservefish.org
www.foragefish.org

marine fish conservation network

ACHIEVING HEALTHY OCEANS & PRODUCTIVE FISHERIES

Thanks!

Source: NOAA