

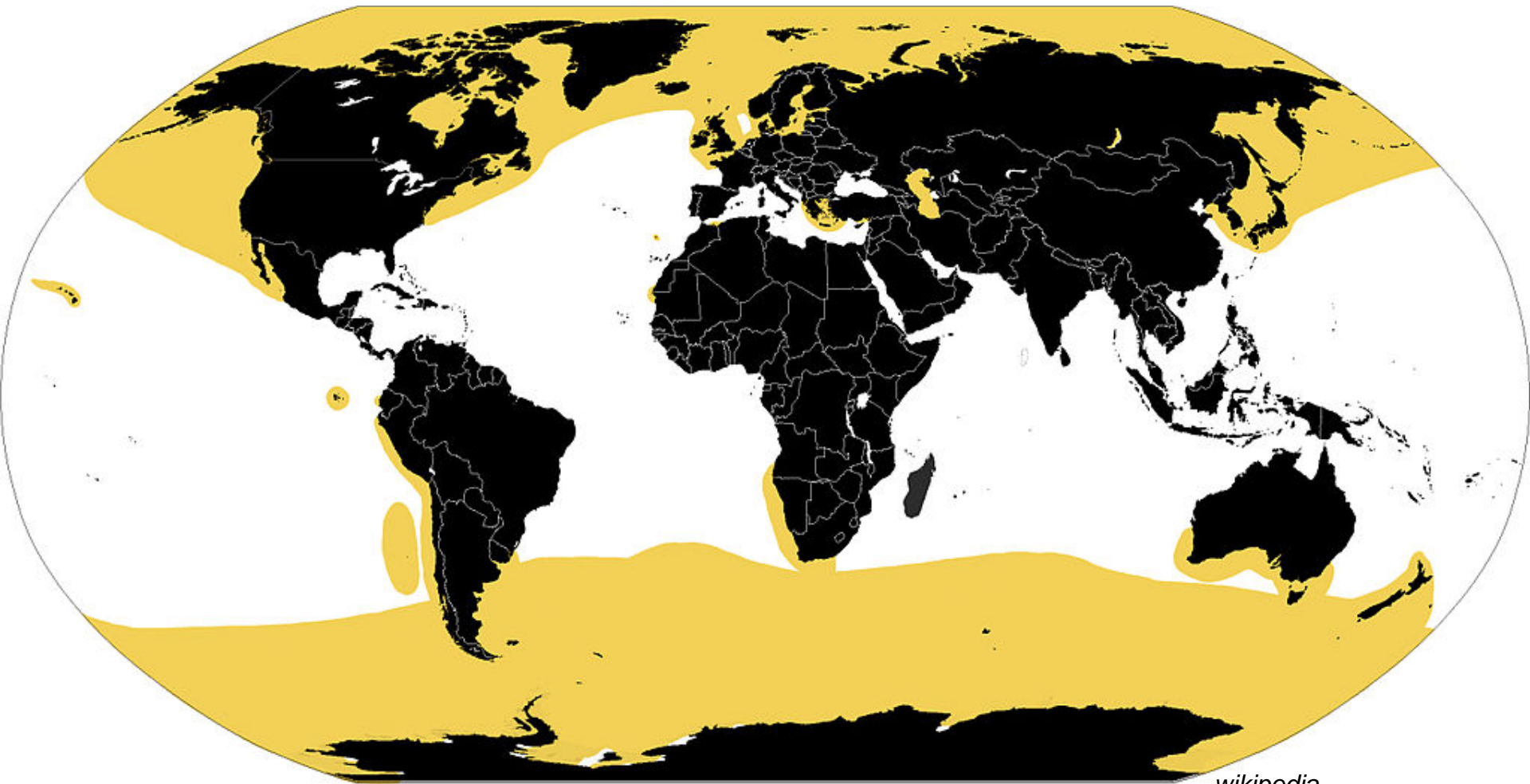
The Role of Pinnipeds in Marine Ecosystems



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World-wide pinniped distribution



wikipedia

What do we mean by “role in an ecosystem”?

Interaction w/ biological & non-biological components

Trophic interactions – simple answer; seals are...

Predators



Competitors



Prey



Bowen 1997- Role of marine mammals....

Significance inferred from size and abundance

Little evidence of suspected roles

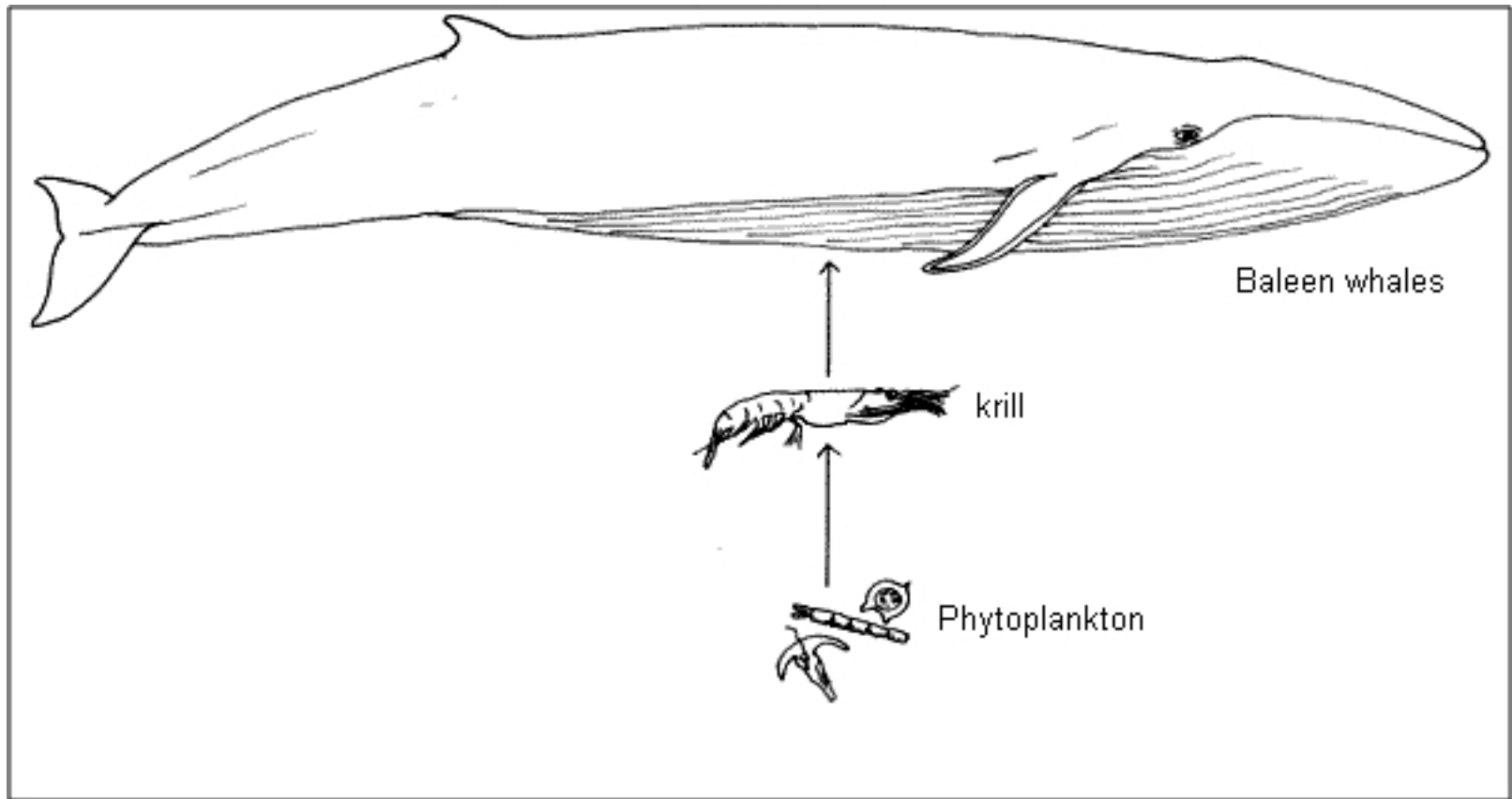
Why?

Expense

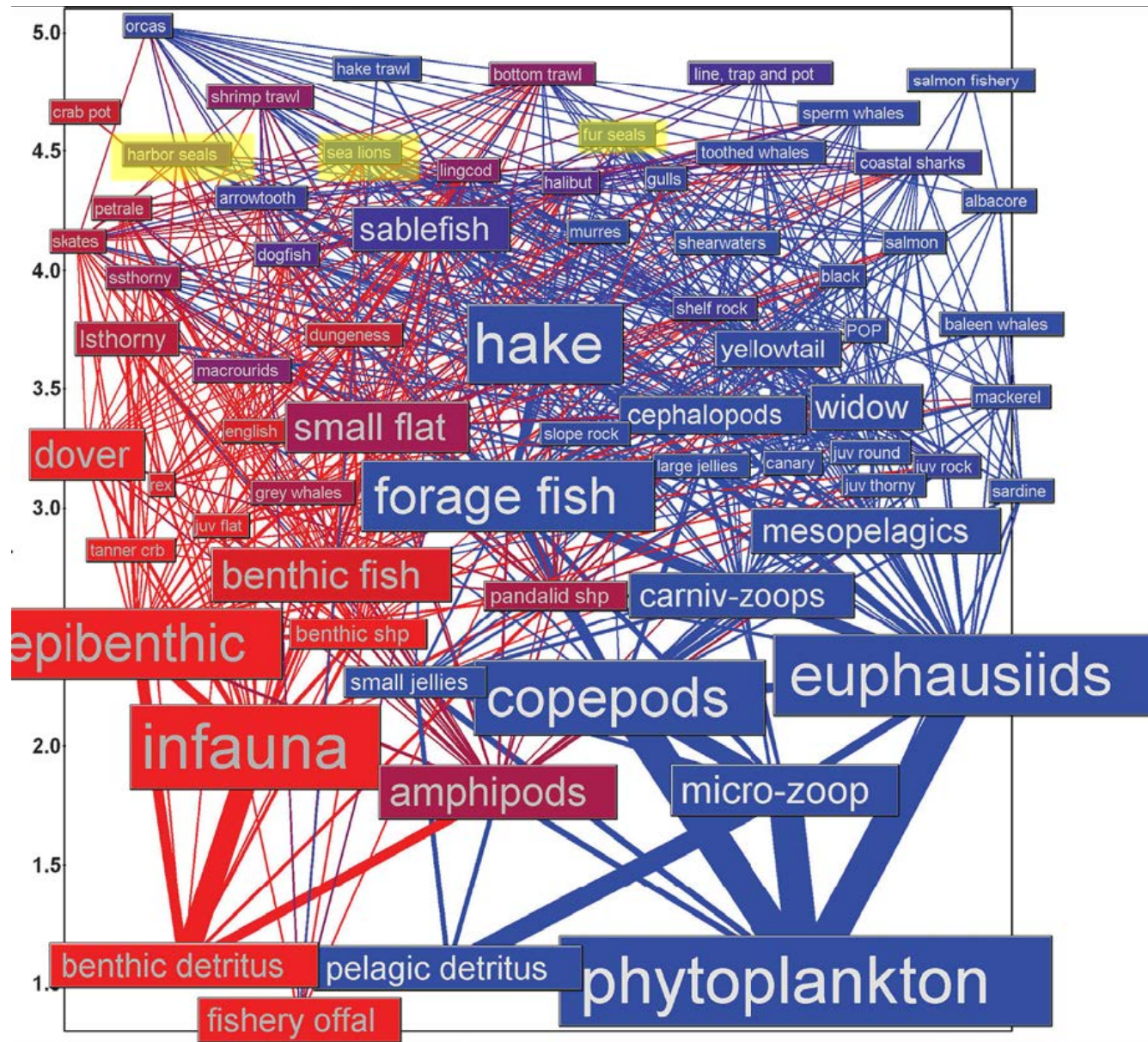
Interactions occur at various time and spatial scales

Indeterminacy of complex systems

Simple Food Web



Northern California Current Food web, Field et al. 2006



How do we analyze trophic dynamics?

Data

Biomass, diet, physiology, etc.

Long time series

Math/statistical models

Variety of types, simple to complex

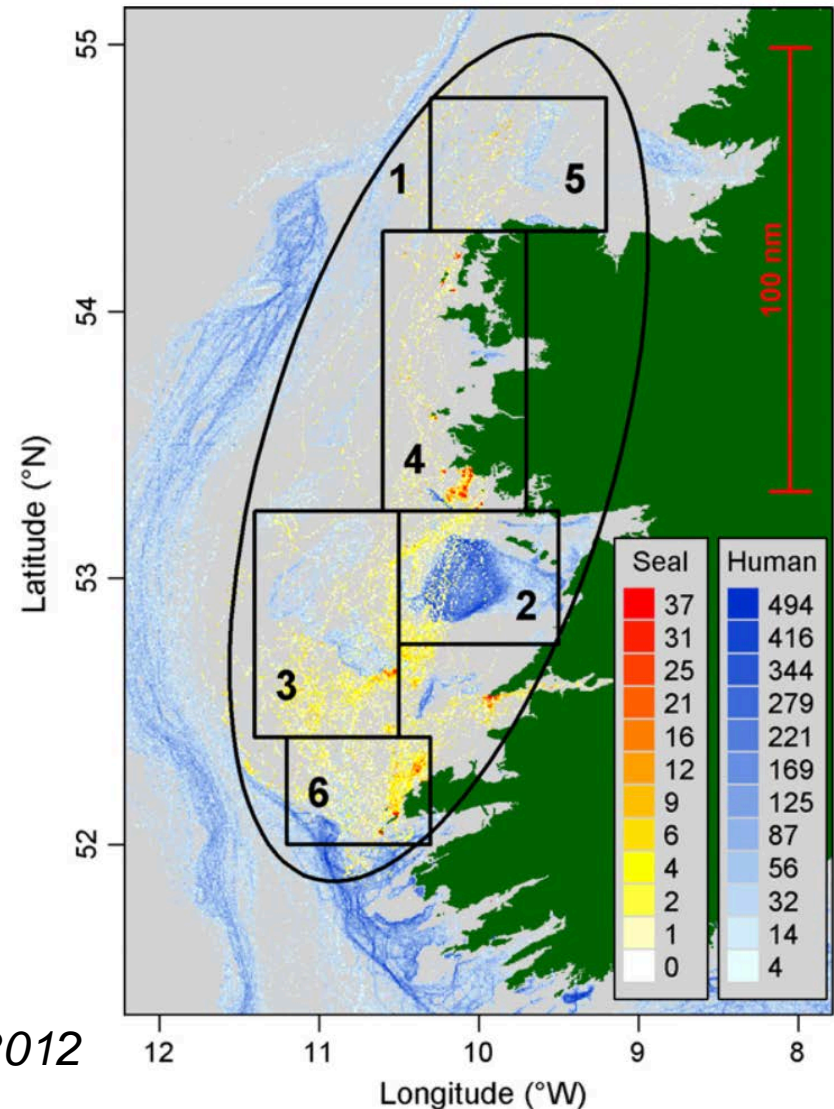
Conclusions often elusive, owing to

Model structure

Uncertainty (process and parameter)

Additional Complexity of Marine Mammal - Fishery Competition (Matthiopoulos et al. 2008)

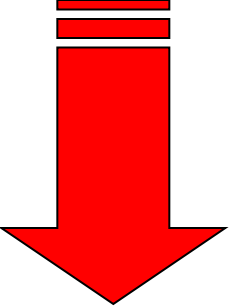
- Spatial heterogeneity
- Individual variation
- Multi-species interactions
- Long-term dynamics



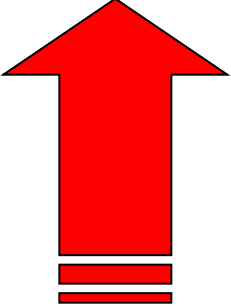
Estimated annual loss of fish to predation in six marine ecosystems (*Bax 1991*)

ECOSYSTEM	Annual fish loss (tons/km ²)			
	Birds	Mammals	Fish	Fisheries
Benguela current	0.3	2.6	56.5	1.6
Georges Bank	2.0	5.4	42.5	6.1
Balsfjord	0.0	0.0	14.1	1.5
East Bering Sea	0.2	1.5	11.0	1.4
North Sea	0.6	0.1	7.0	4.4
Barents Sea	0.0	3.0	5.1	1.8

Community Dynamics

TOP

DOWN

OR

UP

BOTTOM

In marine systems, bottom up (e.g., climate forcing) well-documented, but growing recognition of top-down (Baum and Worm 2009)



Ron Niebrugge

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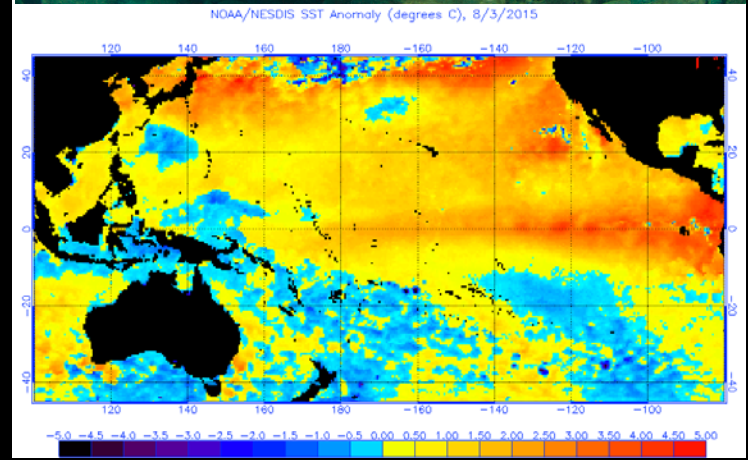


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Octavio Aburto

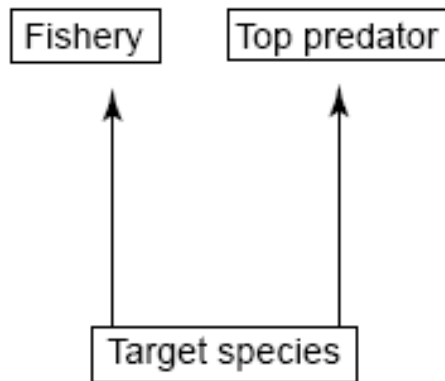
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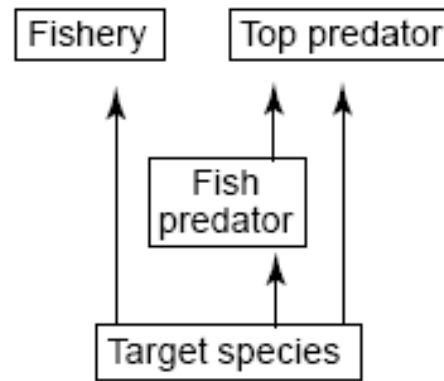
Benguela Cape fur seal culling example

Yodzis 2001

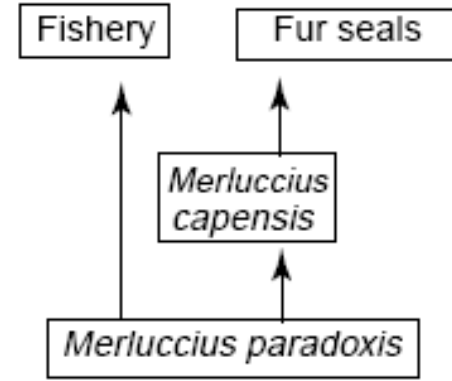
I (a)



(b)



(c)

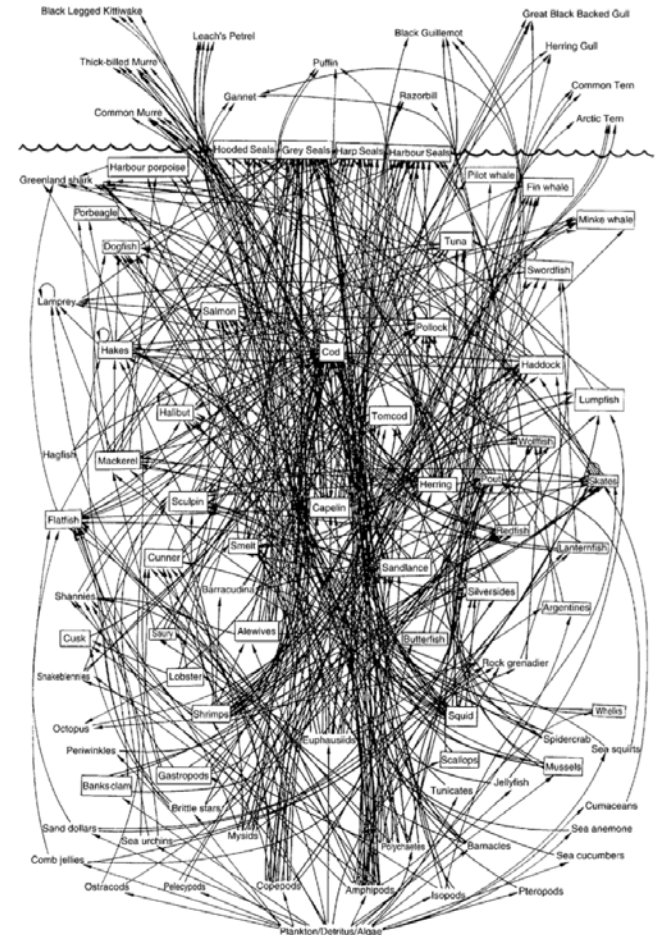
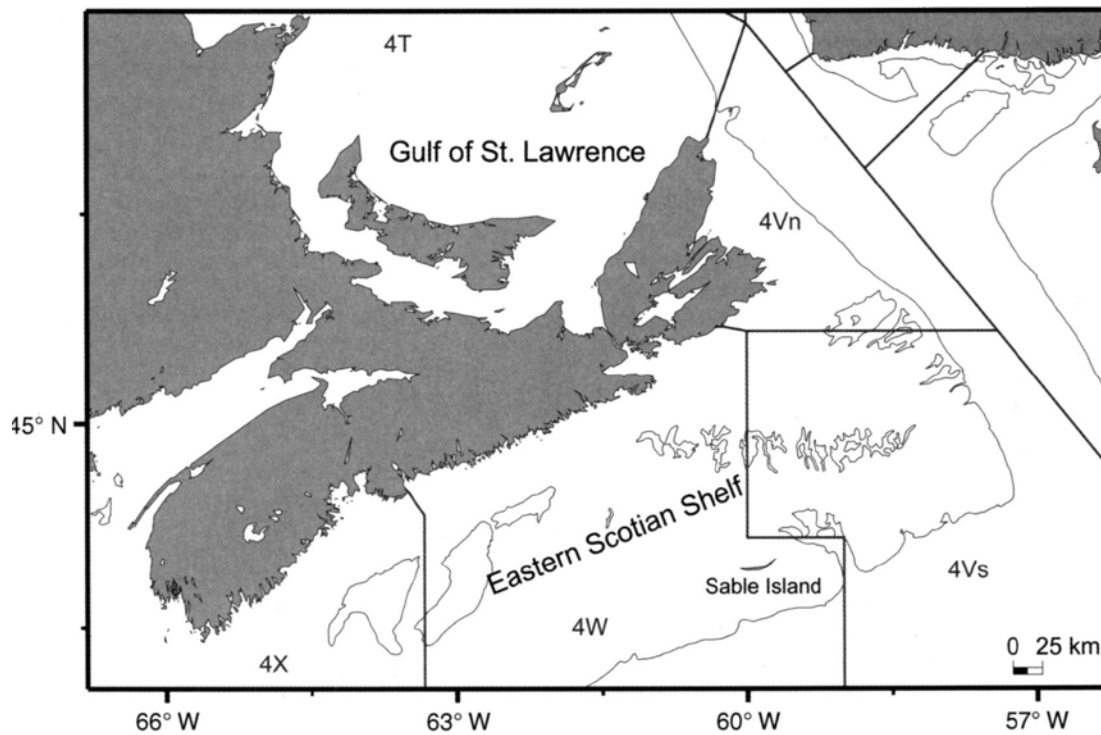


TRENDS in Ecology & Evolution

E. Scotian Shelf gray seal-cod example

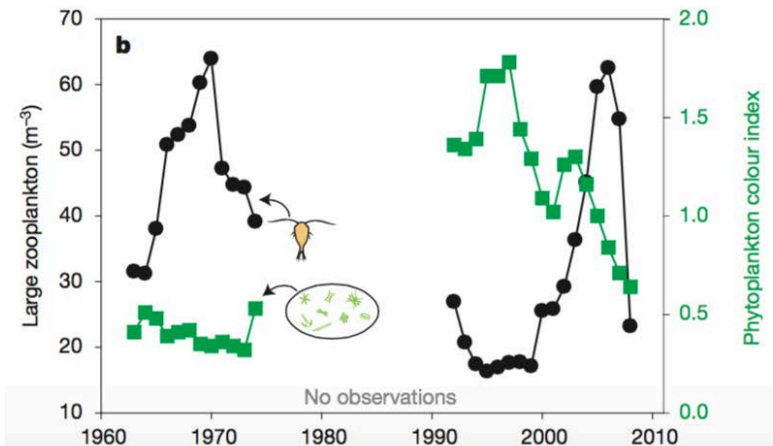
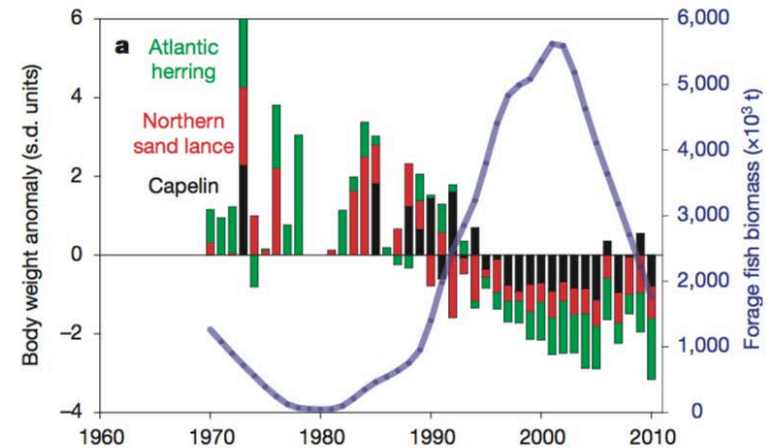
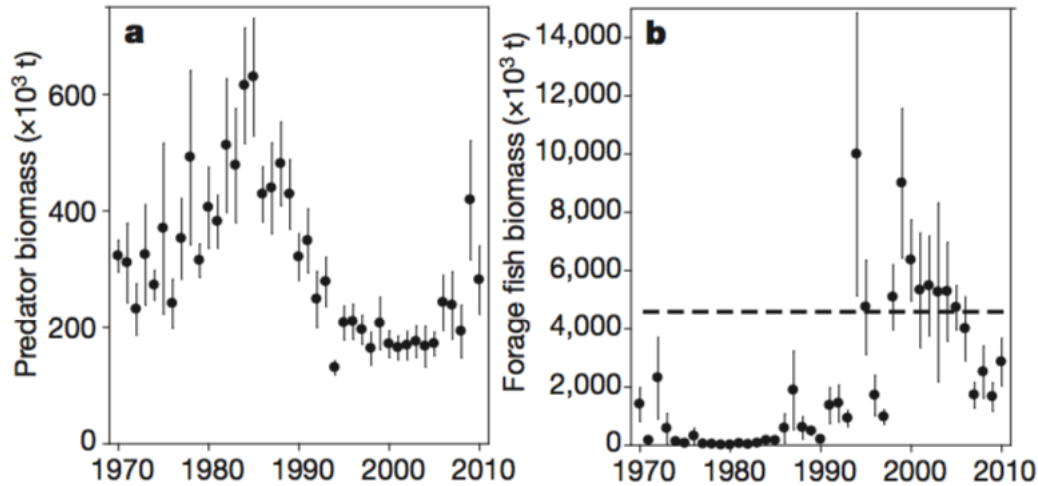
Many studies published –seals affecting cod recovery?

No consensus; most concluded likely limited effect



E. Scotian Shelf gray seal-cod example

Frank et al. 2011 trophic cascade



But the debate continues...
Sinclair et al 2016, Jech & McQuinn 2016

Summary

Trophic dynamics are complex, not intuitive

Models are necessary but always flawed

Conclusions and predictions often ambiguous

Fish are primary predators of fish

Top-down and bottom-up control

Getting less ambiguous answers demands much data for long time spans