

Cod

- Bottom-dweller but stays relatively close to the surface (within a few hundred meters).
- Can reach up to 200 pounds and live 20 - 30 years
- Large females can lay 10 million eggs / year
- Eats anything that moves and is smaller than mouth

Cod Fishing

When Columbus sailed, “1000” Basque ships were fishing Georges Bank and Newfoundland.

If 1/2 of these were in Georges Bank and each ship pulled in 20 tons of cod, catch was about 10,000 tons / year.

By mid 1500's, 60% of fish eaten in Europe were cod.

Recipe book of Charles V in France

Salt cod is eaten with mustard sauce or with melted fresh butter over it.

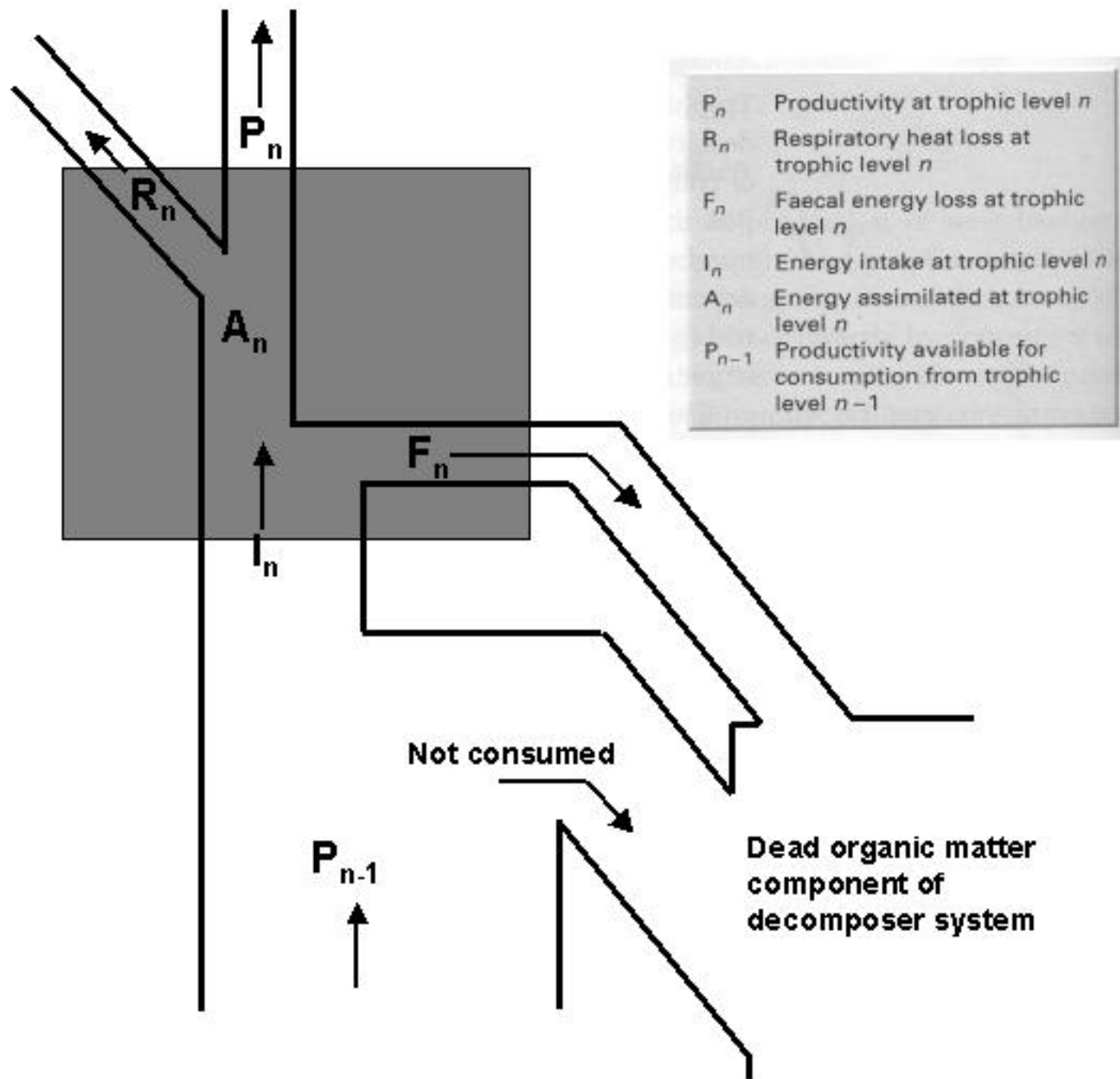
- Guillaume Tirel, Le Viandier, 1375

Cokkes of Kellyng

Take cokkes of kellyng; cut hem smalle. Do hit yn a brothe of fresch fysch or of fresh salmon; bowle hem well. Put to myllke and draw a lyour of bredde to hem with saundres, safferyn & sugure and poudyr of pepyr. Serve hit forth, & otheyr fysch amonge: turbut, pyke, saumon, chopped & hewn. Sesyn hem with venyger & salt.

-anonymous manuscript from fifteenth century

How Much Cod Can Be Caught?



Source: Begon (1996)

From Pauly and Christensen
See text 546-547

TABLE 2 Global estimates of primary production (PP), of PPR to sustain world fisheries (mean for 1988-1991, net weight), and of the mean trophic levels (TL) of the catches, by ecosystem type							
							PPR (catches +discards)
Ecosystem type	Area (10 ⁶ km ²)	PP (gC m ⁻² yr ⁻¹)	Catch (g m ⁻² yr ⁻¹)	Discards (g m ⁻² yr ⁻¹)	TL of the catch	Mean (%)	95% Confidence interval
Open ocean	332.0	103	0.01	0.002	4.0	1.8	1.3-2.7
Upwellings	0.8	973	22.2	3.36	2.8	25.1	17.8-47.9
Tropical Shelves	8.6	310	2.2	0.671	3.3	24.2	16.1-48.8
Non-tropical shelves	18.4	310	1.6	0.706	3.5	35.3	19.2-85.5
Coastal/reef systems	2.0	890	8.0	2.51	2.5	8.3	5.4-19.8
Rivers and lakes	2.0	290	4.3	n.a.	3.0	23.6	11.3-62.9
Weighted means (or total)	(363.8)	126	0.26	0.07	2.8	8.0	6.3-14.4

Assimilation Efficiencies (A/I) for different types of organisms

	Herbivore	Carnivore	Microbivore	Saprotroph
Invertebrates	40%	80%	30%	20%
Vertebrates	50%	80%	--	--

From Heal and Mac Lean, 1975

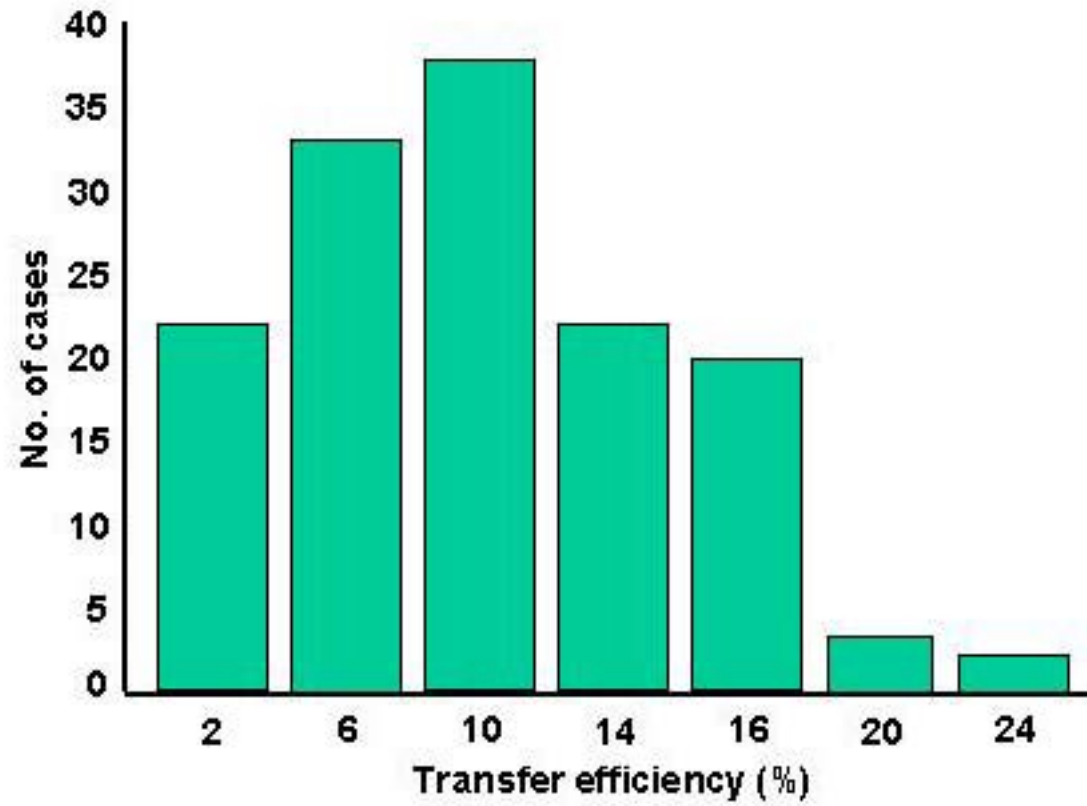
The more similar you are to your food, the more efficient you are at assimilating it

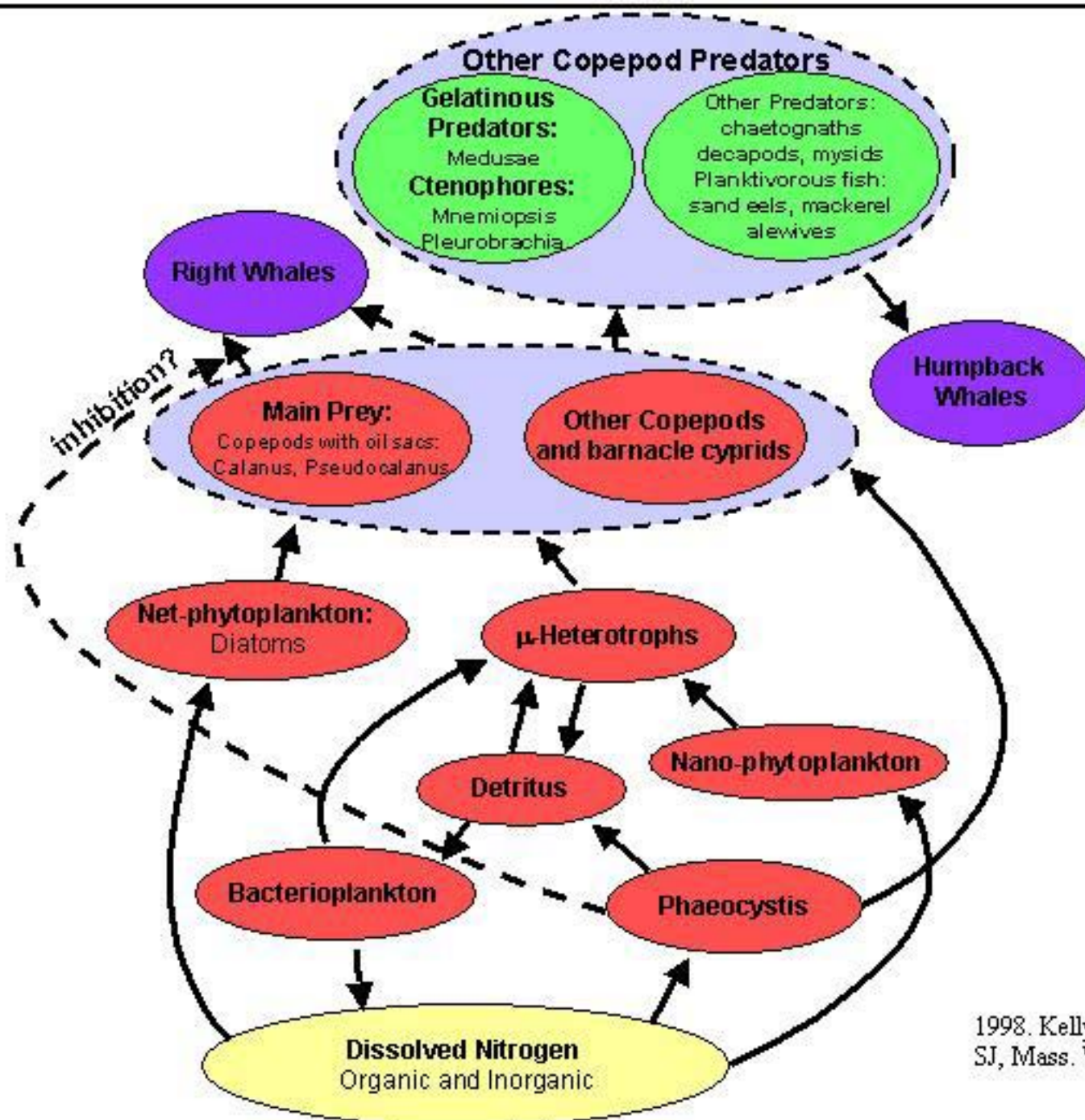
Production Efficiency of Various Animal Groups (ranked in order of increasing efficiency)

Group	P / A %
1 Insectivores	0.86
2 Birds	1.29
3 Small Mammal Communities	1.51
4 Other Mammals	3.14
5 Fish and social insects	9.77
6 Non-insect invertebrates	25.0
7 Non-social insects	40.7
<i>Non-insect invertebrates</i>	
8 Herbivores	20.8
9 Carnivores	27.6
10 Detritivores	36.2
<i>Non-social insects</i>	
11 Herbivores	38.8
12 Detritivores	47.0
13 Carnivores	55.6

Source: Begon (1996)

Krebs Fig 26.4



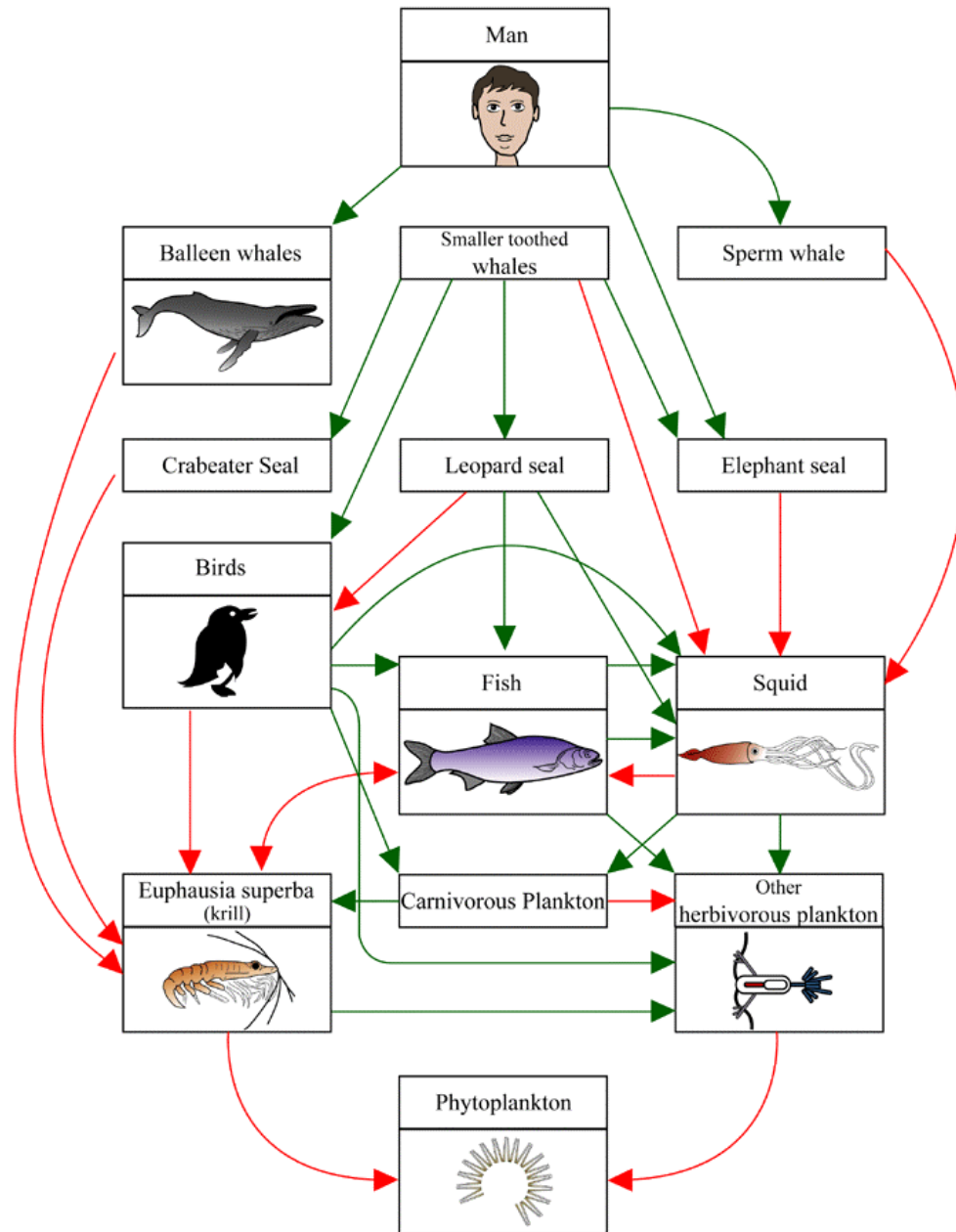


1998. Kelly, JR, Davis CS, Cibir SJ, Mass. Water Resources Auth.

118 Secondary Production

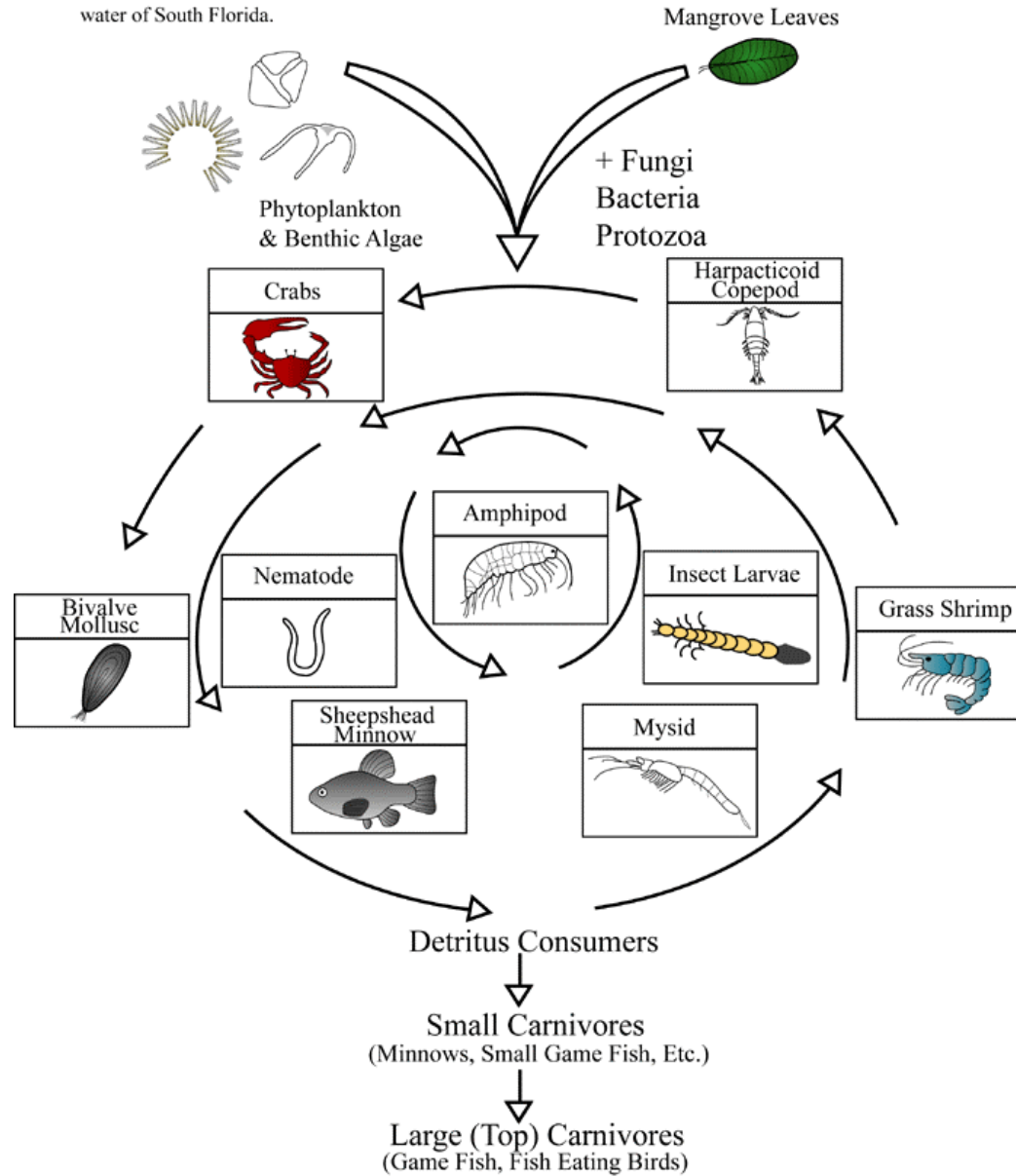
Table 6.1 A simple taxonomic-trophic categorization of heterotrophic organisms. For each category the characteristic assimilation (A/C) and growth (P/A) efficiencies are given. (From Heal and Maclean, 1975.)

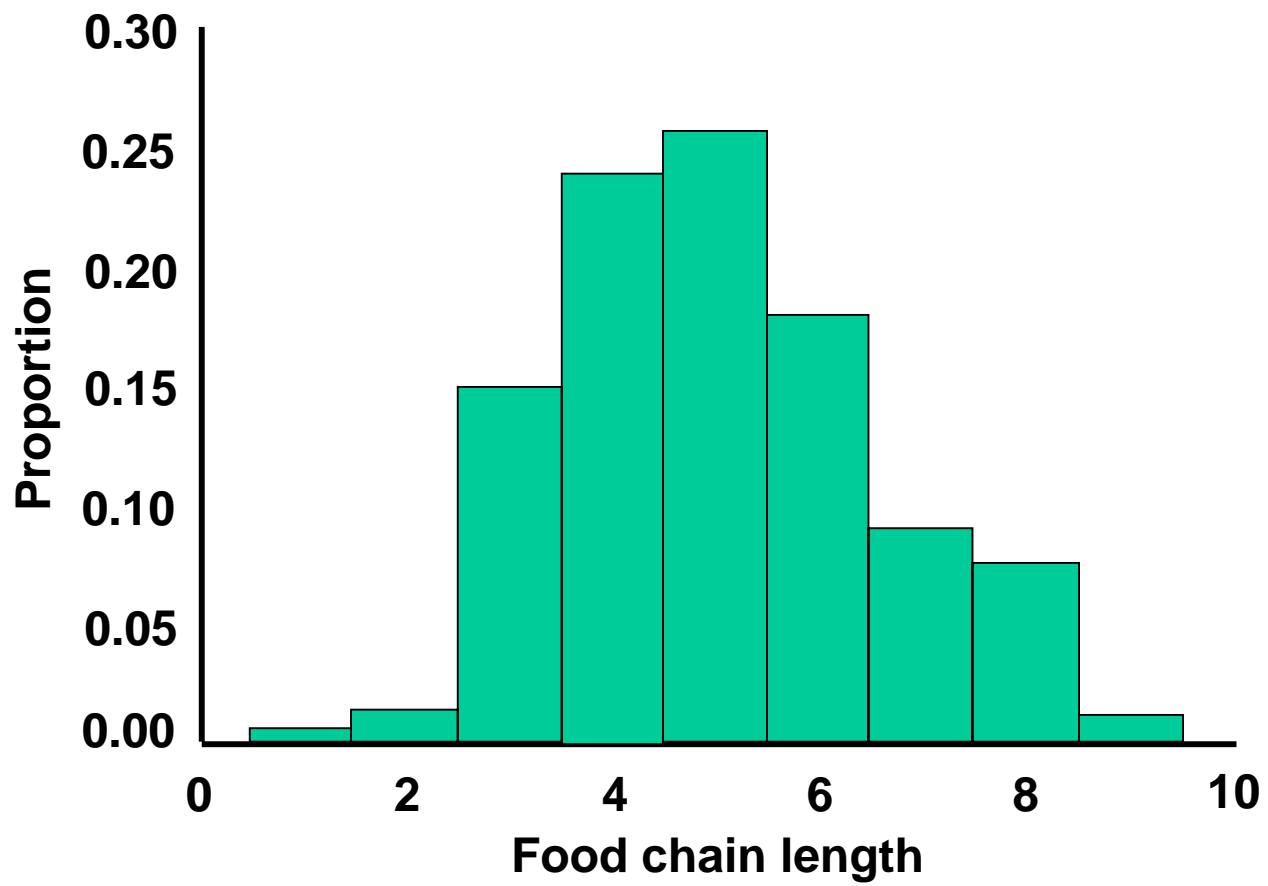
Trophic Function								
	Herbivore		Carnivore		Microbivore		Saprotroph	
	A/C	P/A	A/C	P/A	A/C	P/A	A/C	P/A
Micro organisms	-	-	-	-	-	-	-	0.40
Invertebrates	0.40	0.40	0.80	0.30	0.30	0.40	0.20	0.40
Vegetate homotherms	0.50	0.02	0.80	0.02	-	-	-	-
Vegetate heterotherms	0.50	0.10	0.80	0.10	-	-	-	-



Decomposer Food Web

Detritus food chain based on mangrove leaves which fall into shallow estuarine water of South Florida.





Georges Bank Cod Summary

Georges Bank 240 x 120 km in size

Primary productivity 0.9 kg C / m² / year

Cod range from trophic level 4 - 6

Transfer efficiencies ~ 10% between trophic levels

What is a guess at sustainable harvest?

Digression - Confidence Limits and Sensitivity Analysis

What if energy transfer was 8% instead of 10%?

What if less of Georges Bank was suitable habitat?

What about other species of bottom fish?

Ecological calculations are almost worthless without some measure of the confidence boundaries. Often confidence is assessed through sensitivity analysis - how much difference would mistakes in the input values make to the final result?

Columbus and Cabot

In 1492, Columbus sailed the ocean blue.

In 1497 John Cabot “discovers” Cape Cod and the Basque fishing vessels

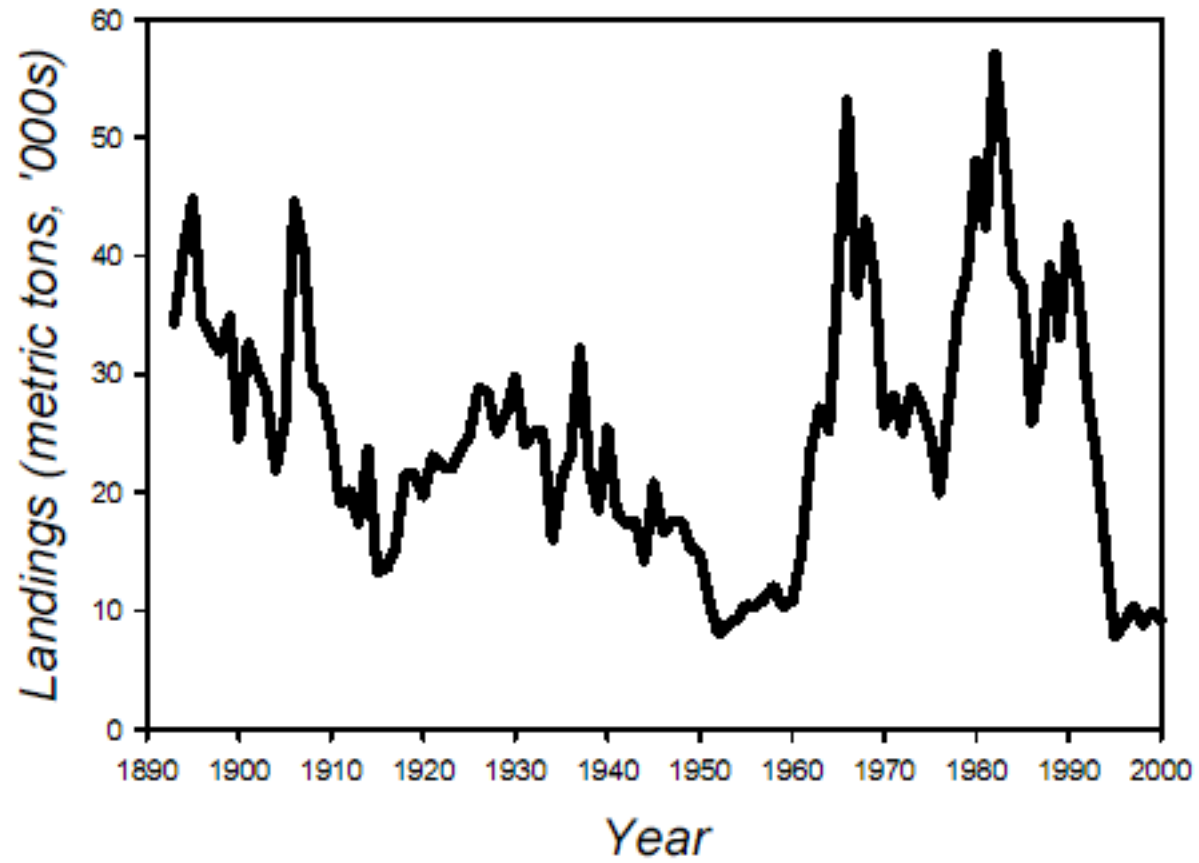
In 1500’s there is a cod rush to Massachusetts up to Newfoundland

In 1930’s, factory trawlers arrive.

In 1960’s, U.S. and Canada increase fishing effort

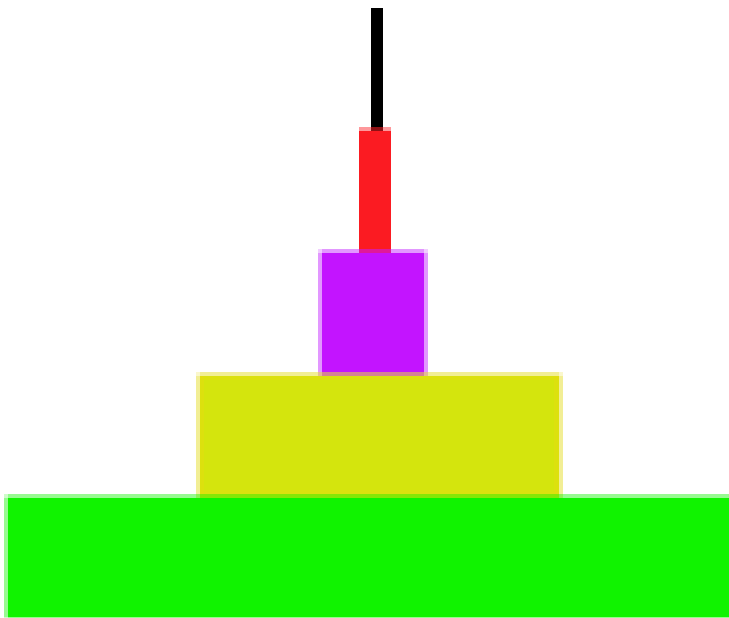
In 1990’s ...

Georges Bank Cod

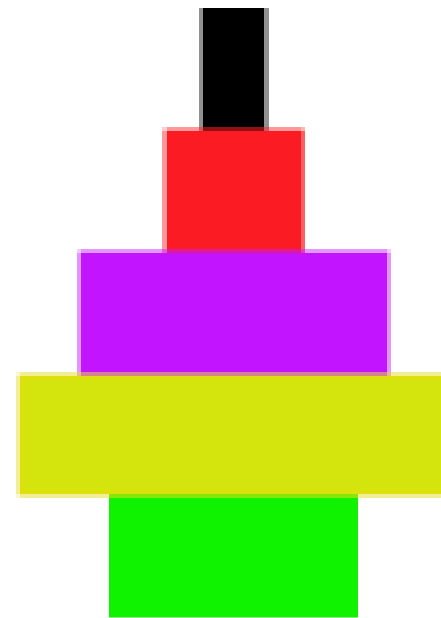


How could catch be at 50,000 tons for years?

Productivity



Biomass
(Standing Stock)



What happens to system when cod are removed?

Trophic cascades

Brooks, J. L. and S. I. Dodson, 1965. Predation, body size, and composition of plankton. *Science* 150: 28-35

Keystone Species

Paine, R. T., 1966. Food web complexity and species diversity. *The American Naturalist* 100: 65 - 75.

Question: What controls the diversity of and relative abundance of different species in the intertidal community?

First careful observations of the community

Transplant different species and find which ones are competitively dominant (dominance hierarchy)

Construct food web for predatory species

What will happen if one of the species is removed?

The answer ...

is in your next EcoBeaker lab

Wrap-up

Ecology can make some general predictions about what might happen to Georges Bank system.

Ecology can also make some predictions about whether and how long it might take cod populations to recover.

More on the first topic at the end of the course, when discussing communities.

More on the second topic in a couple weeks, when talking about population growth.