Contributions of the Aquatic Environment to the Global Food Supply

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Three Questions from Stein Ove Østvik

1. The contribution of marine protein to the global food supply
2. The benefits of consuming marine proteins
3. Economic opportunities for marine proteins

1

The contribution of seafood to global food supply

The Current Global Food Situation

Human Food Requirements for Energy and Protein

Average per Person

Energy 2500 kcal/day
Protein 55 g

Johansson et al., AMBIO (2010)

Global Requirements for Energy and Protein

Annual needs of 6.7 billion people in 2010

Energy 7092 TWh
Protein 134 Mt

Johansson et al., AMBIO (2010)

Global Food Energy Budget

Parameter	Energy (TWh)
Gross energy	19900
Seeds	-700
Lost	-1300
Mould	-2700
Discarded	-360
Inedible	-1770
Feed (oil crop)	-690
Feed (peas & cereal)	-4545
Livestock	1183
Game, fish &seafood	217
Net Energy	**9265**

Johansson et al., AMBIO (2010)

Human Food Energy Need vs. Supply

Region	Population (10^9)	Demand (TWh)	Available (TWh)
World	6.7 (2010)	7092	9265
EU27	0.50 (2010)	526	431

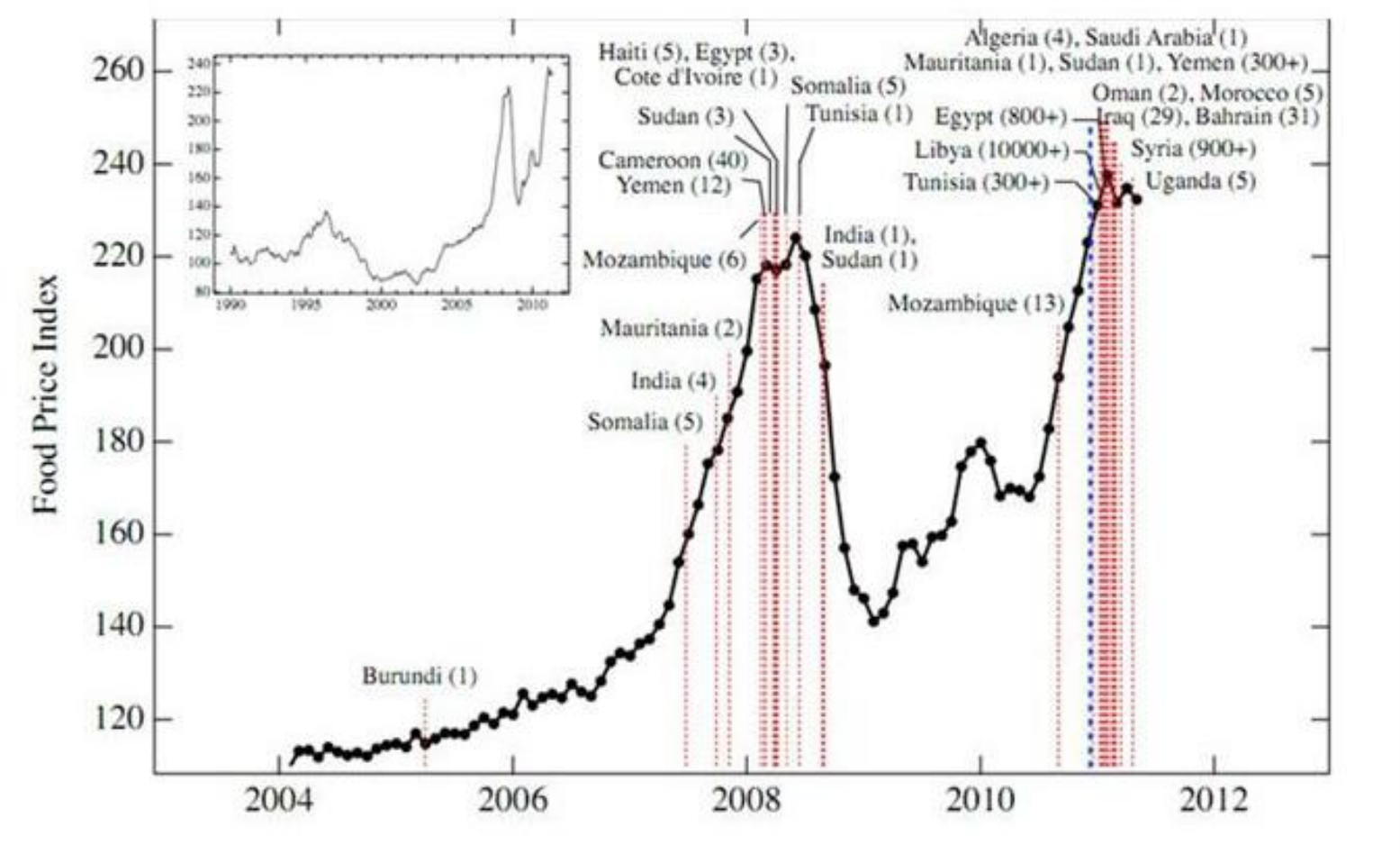
In 2010 we could feed 8.7 billion

Johansson et al., AMBIO (2010)

We can conclude that, at present, we have enough food to feed the global population.

Malnutrition (one billion people) is due to poverty.

FAO Global Food Price Index



Lagi et al., 2011

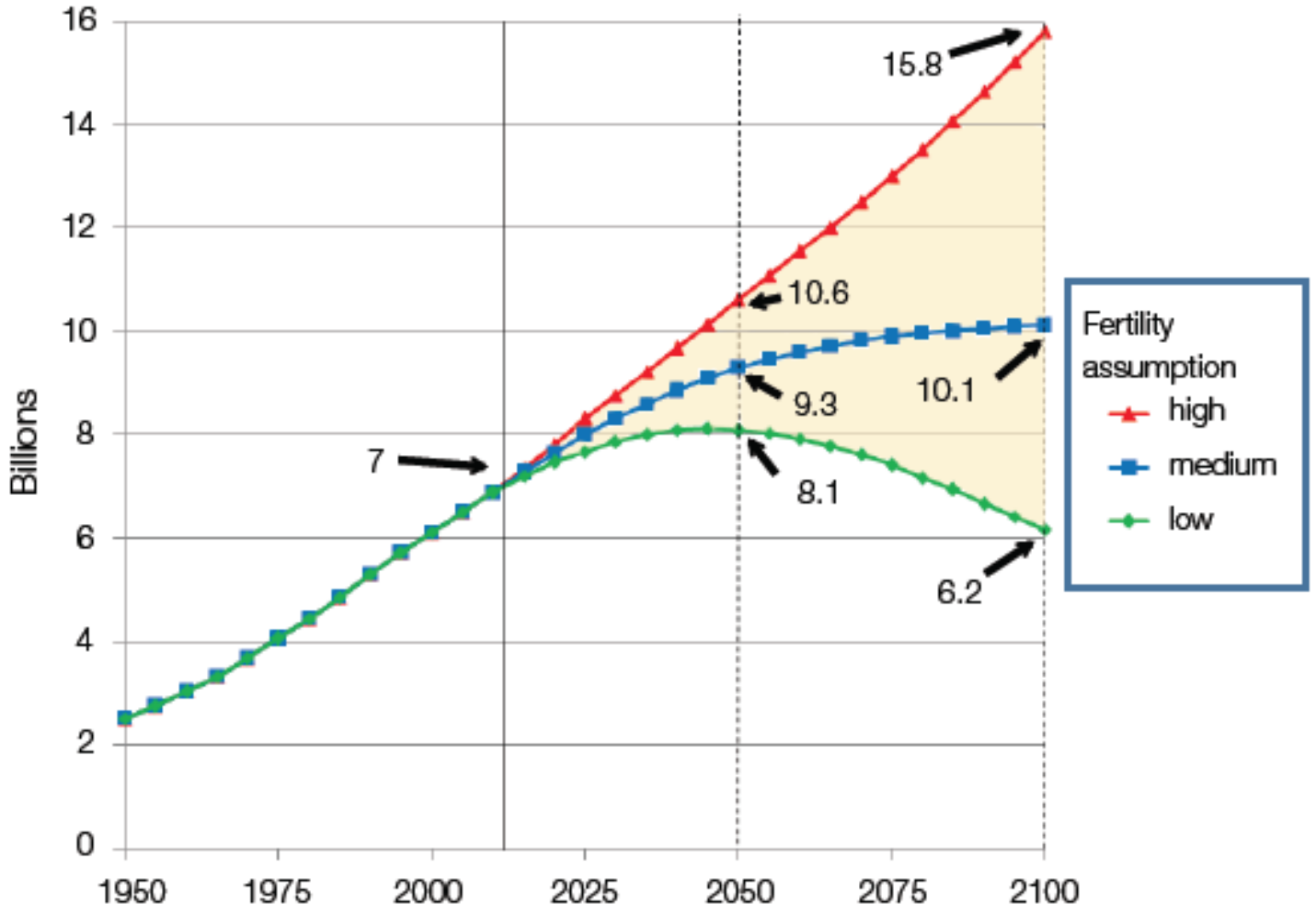
Future Food Demand and Supply

Increasing Food Demand

The Food and Agriculture Organization (FAO) projects that a 70% increase in the food supply will be required by 2050

Due to an increase in population and an increase in meat consumption

Projected Global Population Growth under 3 scenarios*



* United Nations Department of Economic and Social Affairs, Population Division (2011). World Population Prospects: The 2010 Revision

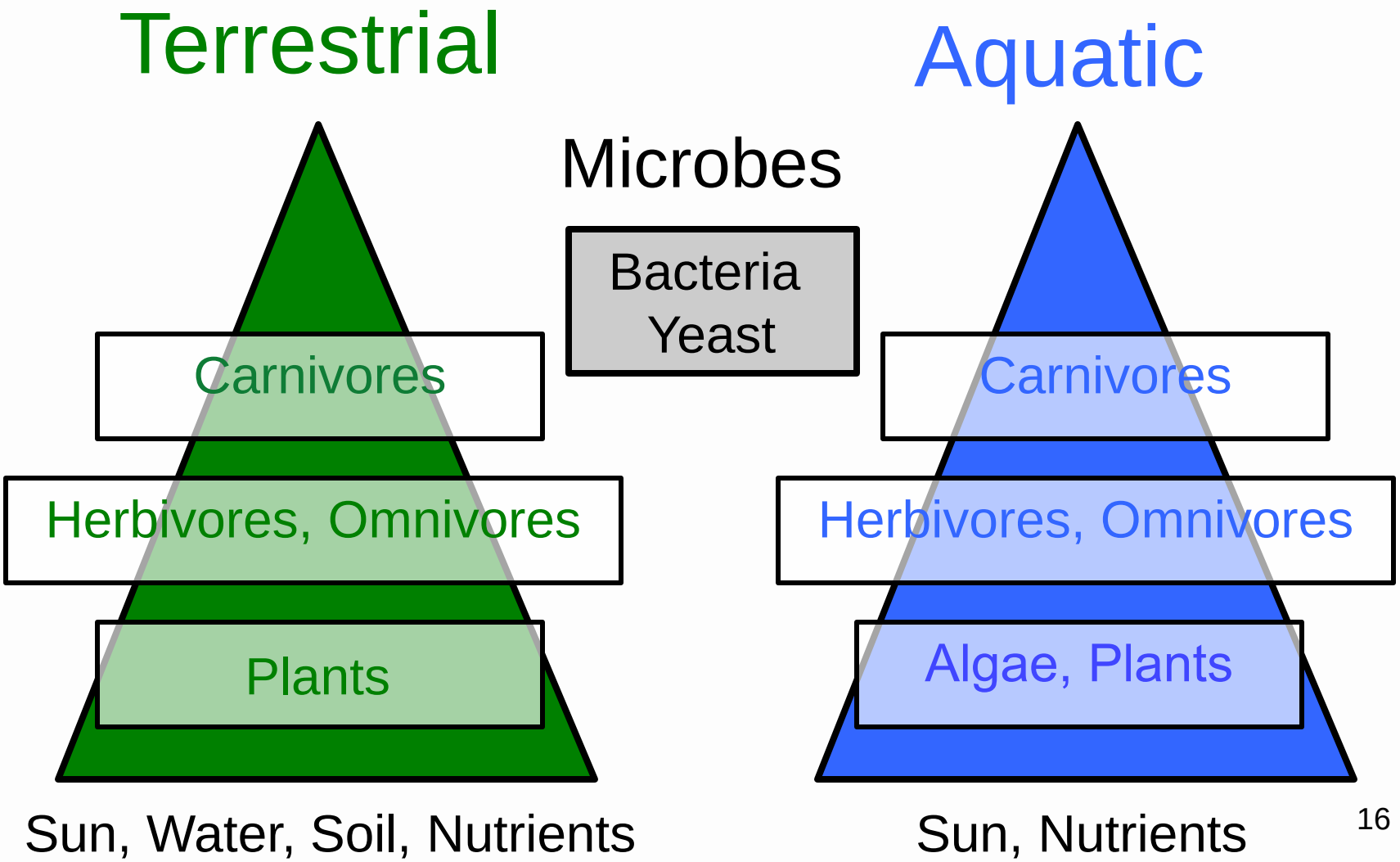
Human Food Energy Demand

Region	Population (10^9)	Demand (TWh)	Available (TWh)
World	6.7 (2010)	7092	9265
World	**10.1 (2100)**	**10690**	**+ 15%**
		+51%	

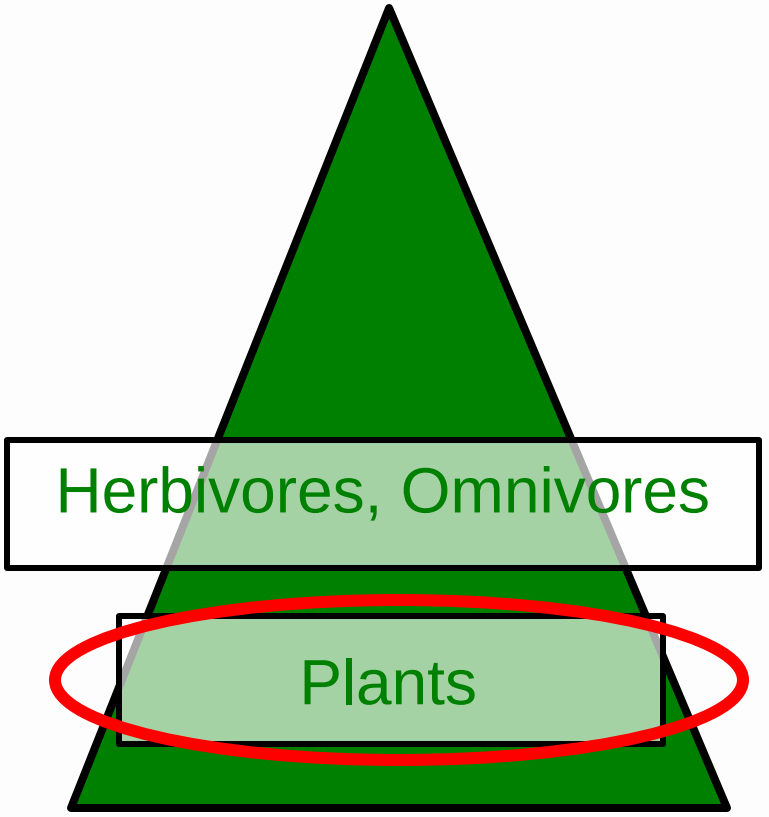
Johansson et al., AMBIO (in Press)

Where does our food come from?

Ecosystems and Trophic Levels

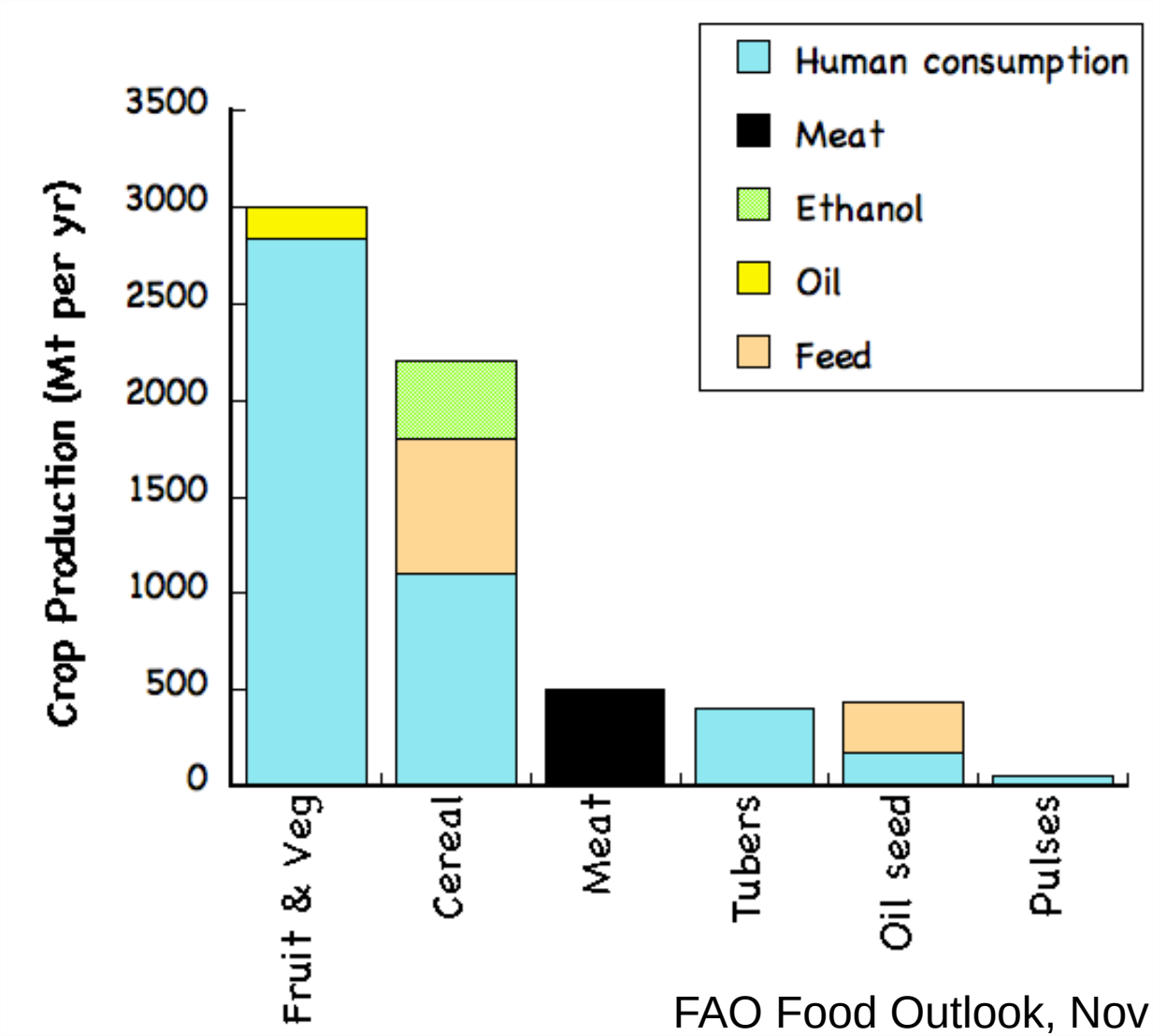


Terrestrial Crop Production



Sun, Water, Soil, Nutrients

Global Crop Production 2010



FAO Food Outlook, Nov 2012

Limits to Terrestrial Plant Production

Arable land is limited

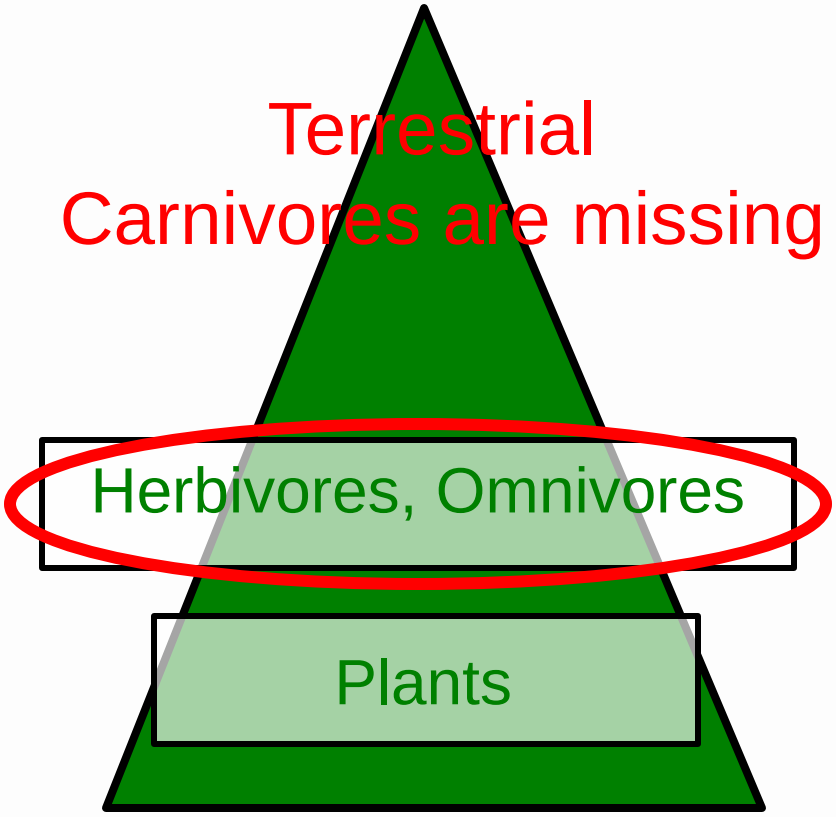
Topsoil loss

Water is limited

Phosphorus and potash

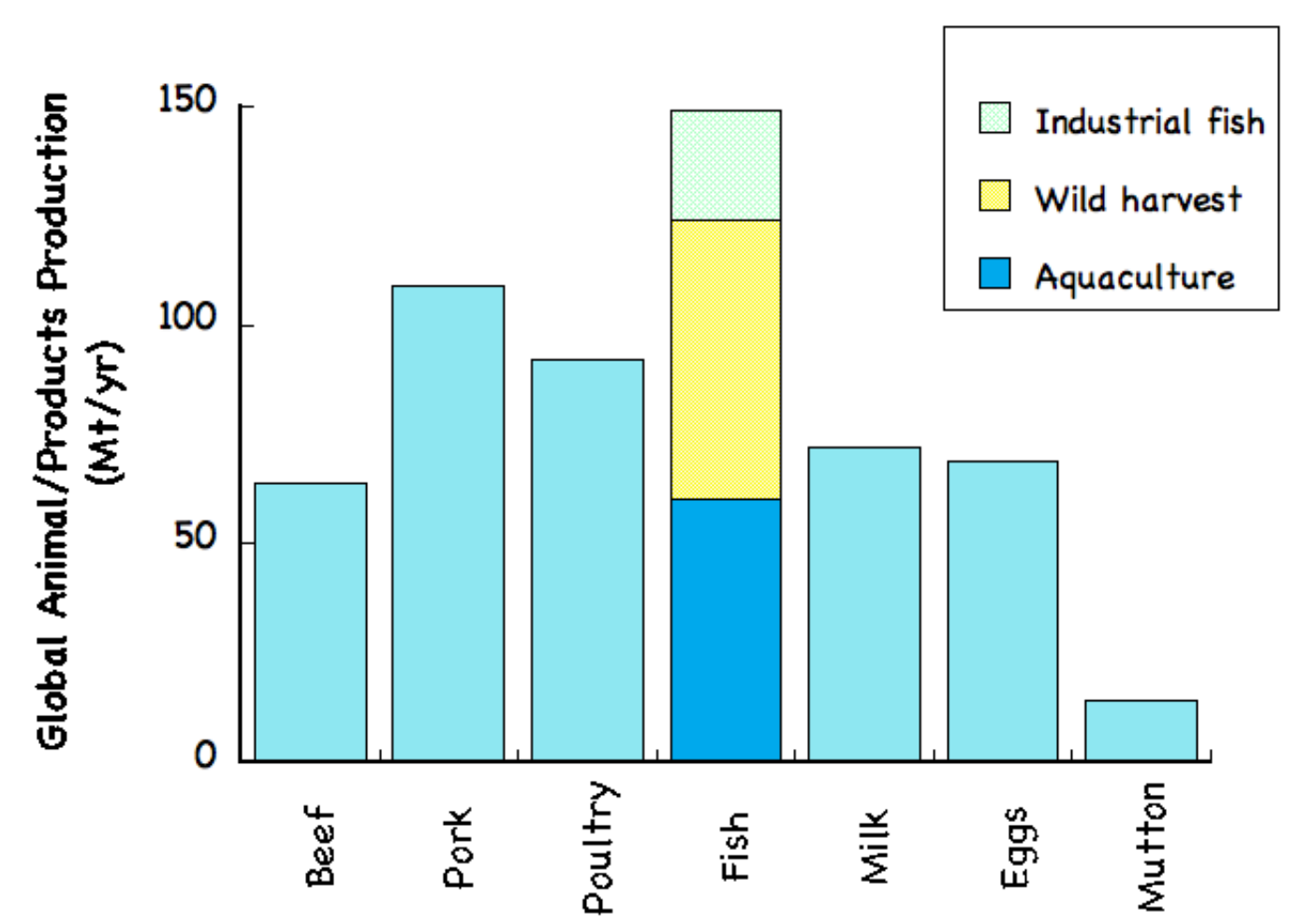
Salinization

Terrestrial Meat Production



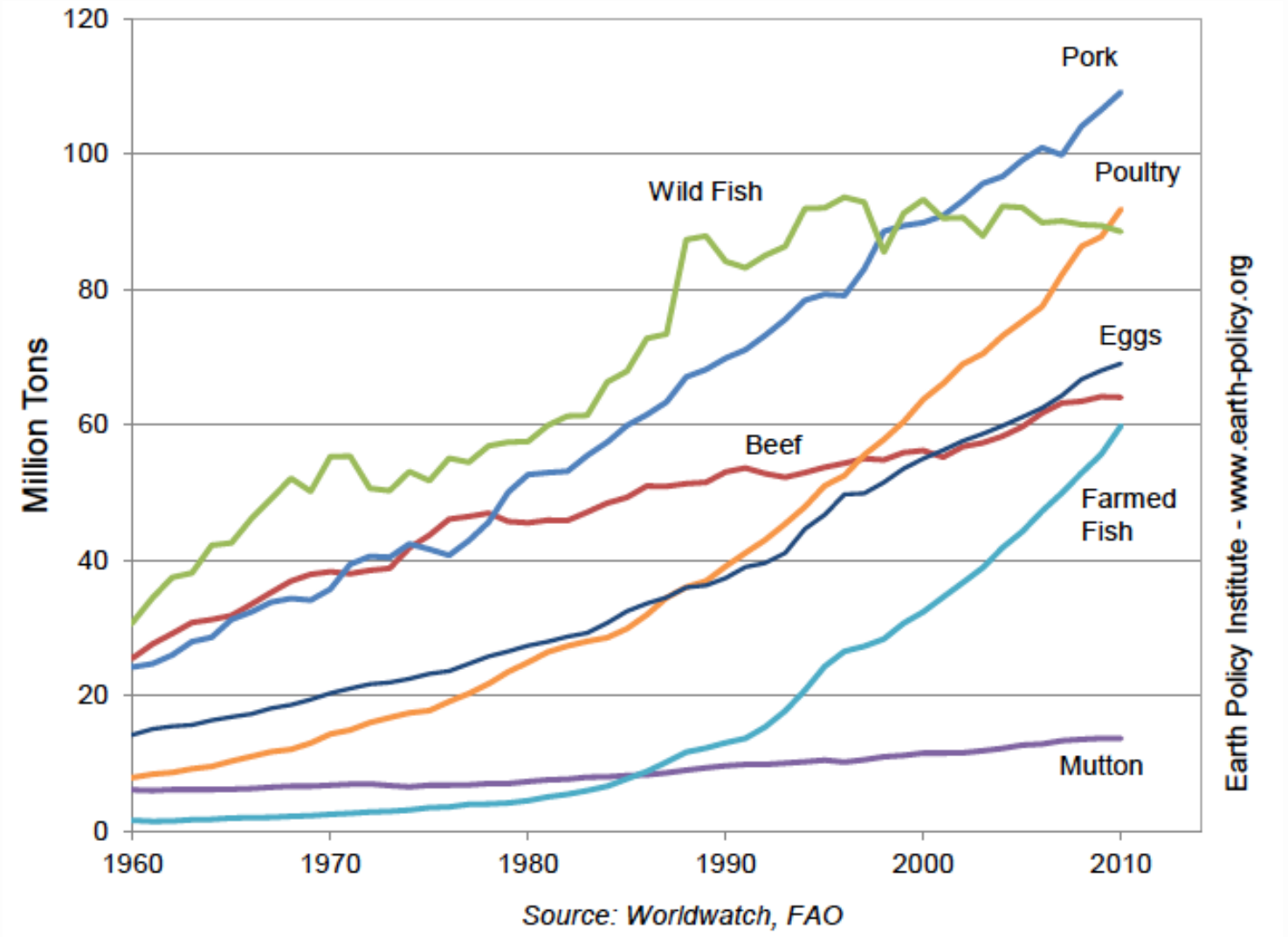
Sun, Water, Soil, Nutrients

Global Meat Production 2010



FAO Food Outlook, Nov 2012

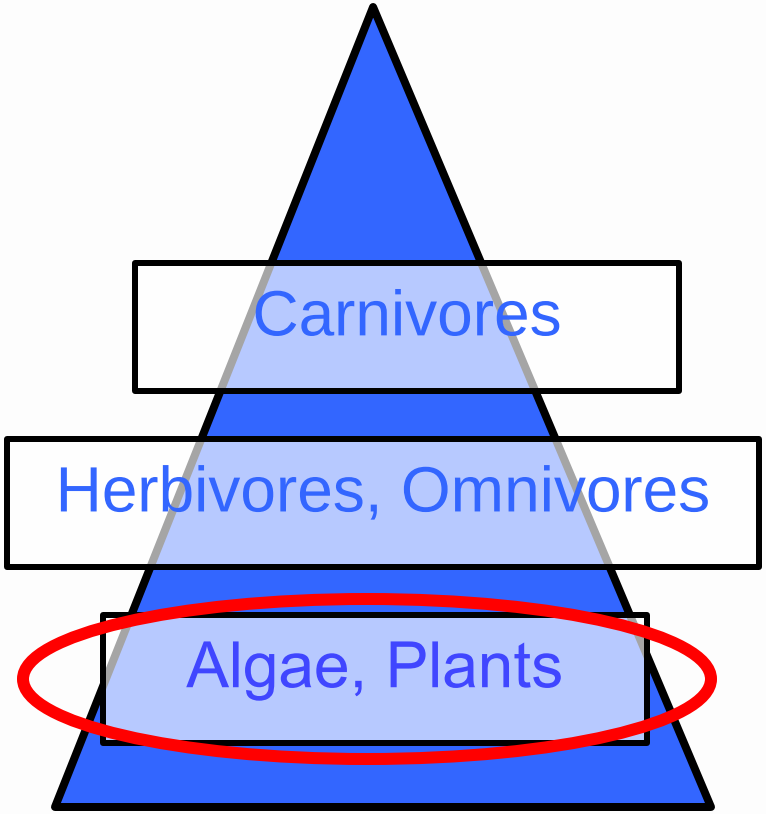
Global Meat Production 1960-2010



Limits to Terrestrial Animal Production

Feed costs
Ethical considerations

Aquatic Plant Production



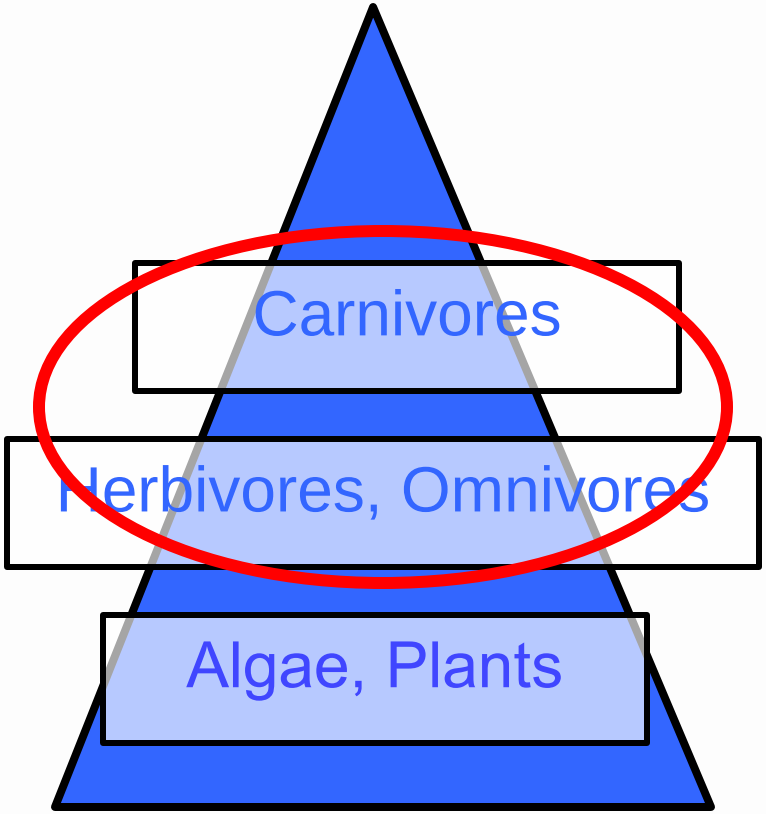
Sun, Nutrients

Wild Aquatic Plant Harvest

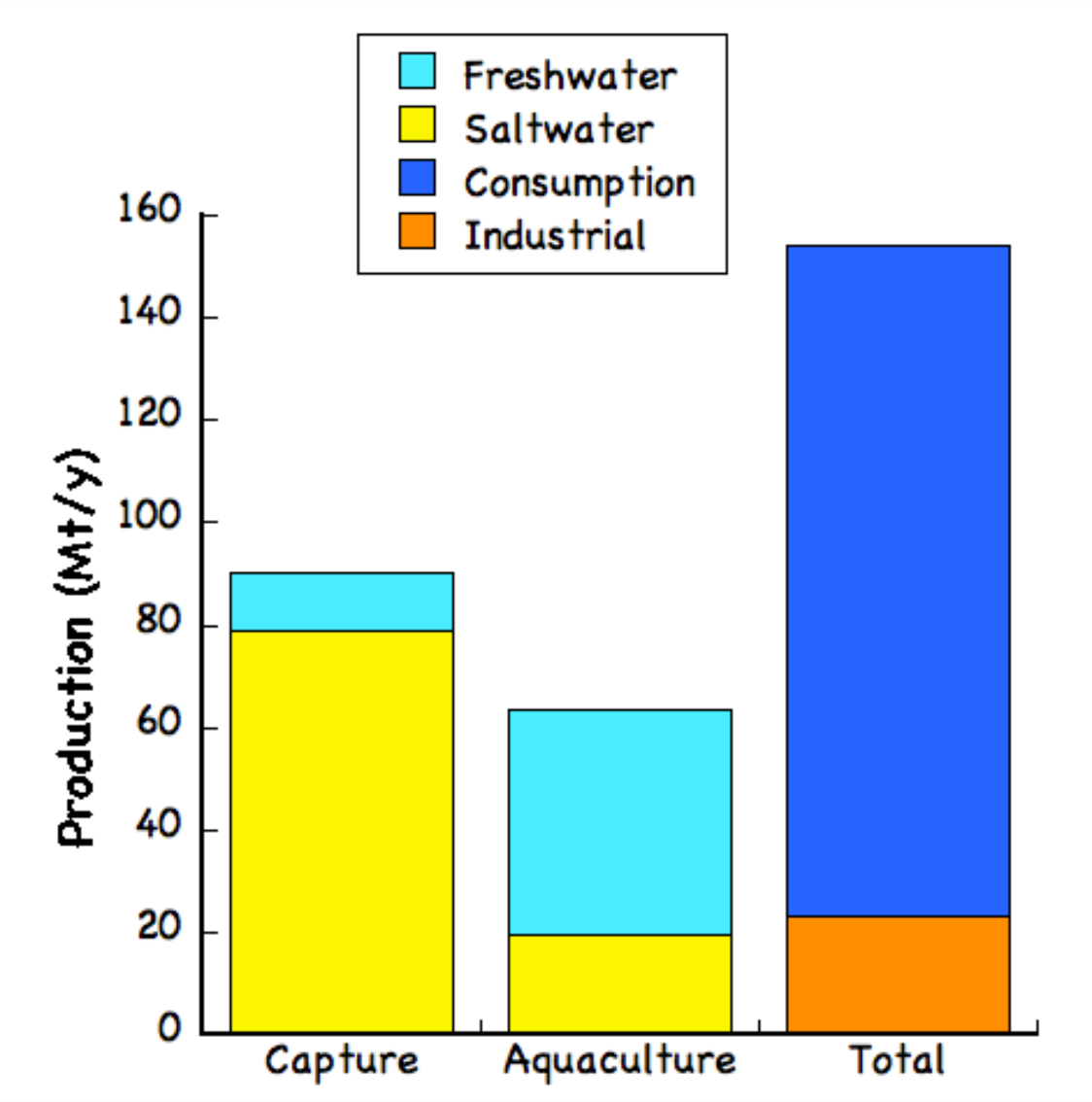
Harvest of aquatic plants is about 3.5 Mt wet weight

The majority is consumed directly

Aquatic Meat Production



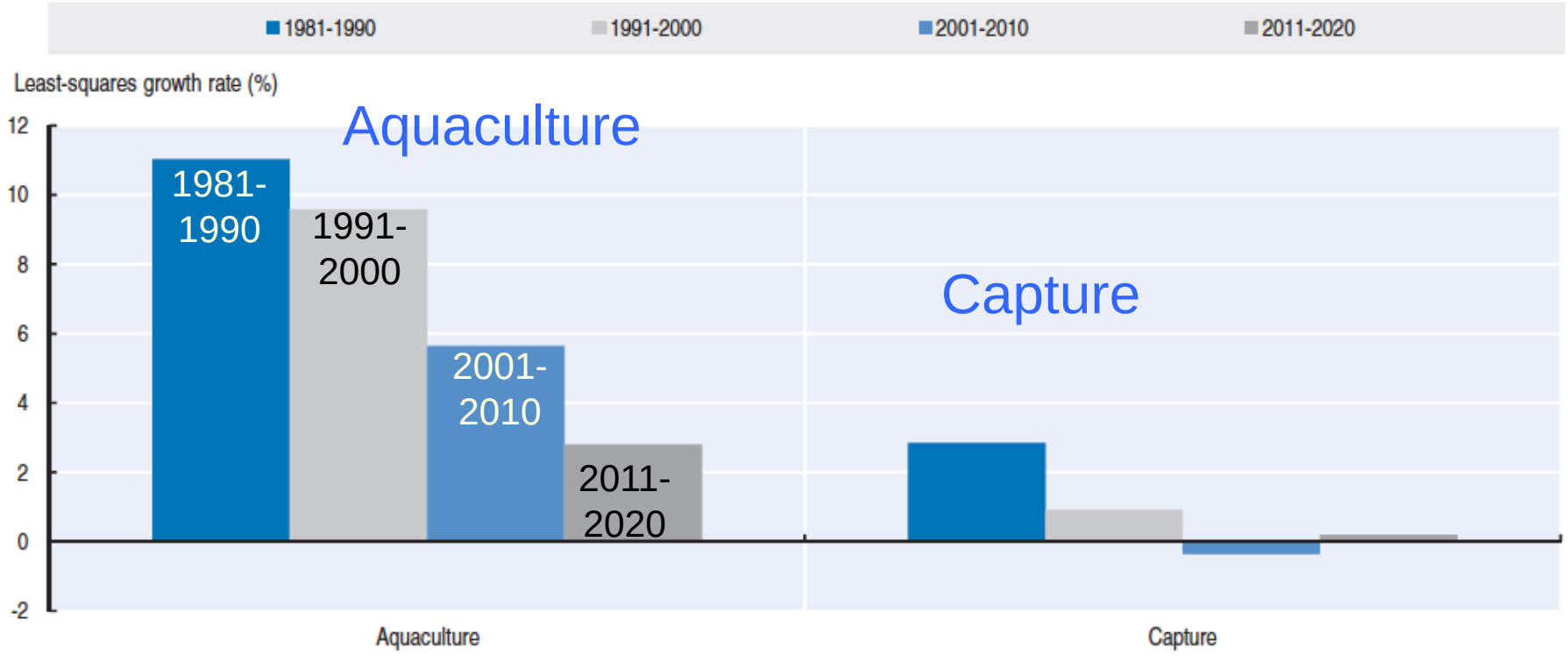
Global Fish Production



Trends Growth in Global Fish Production

Figure 8.1. **Declining growth rate of fish production**

Growth rate of capture and aquaculture fish production by decades



Source: OECD and FAO Secretariats.

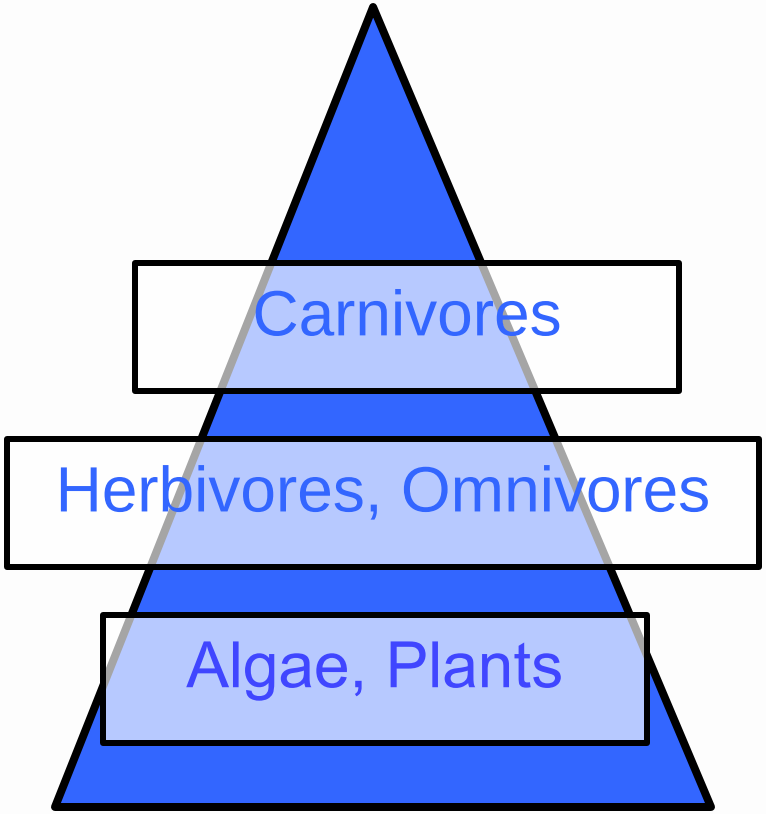
StatLink http://dx.doi.org/10.1787/888932427151

Limits to Harvest of Wild Marine Resources

Over fishing
Climate change
Pollution
Ocean acidification
Introduced species

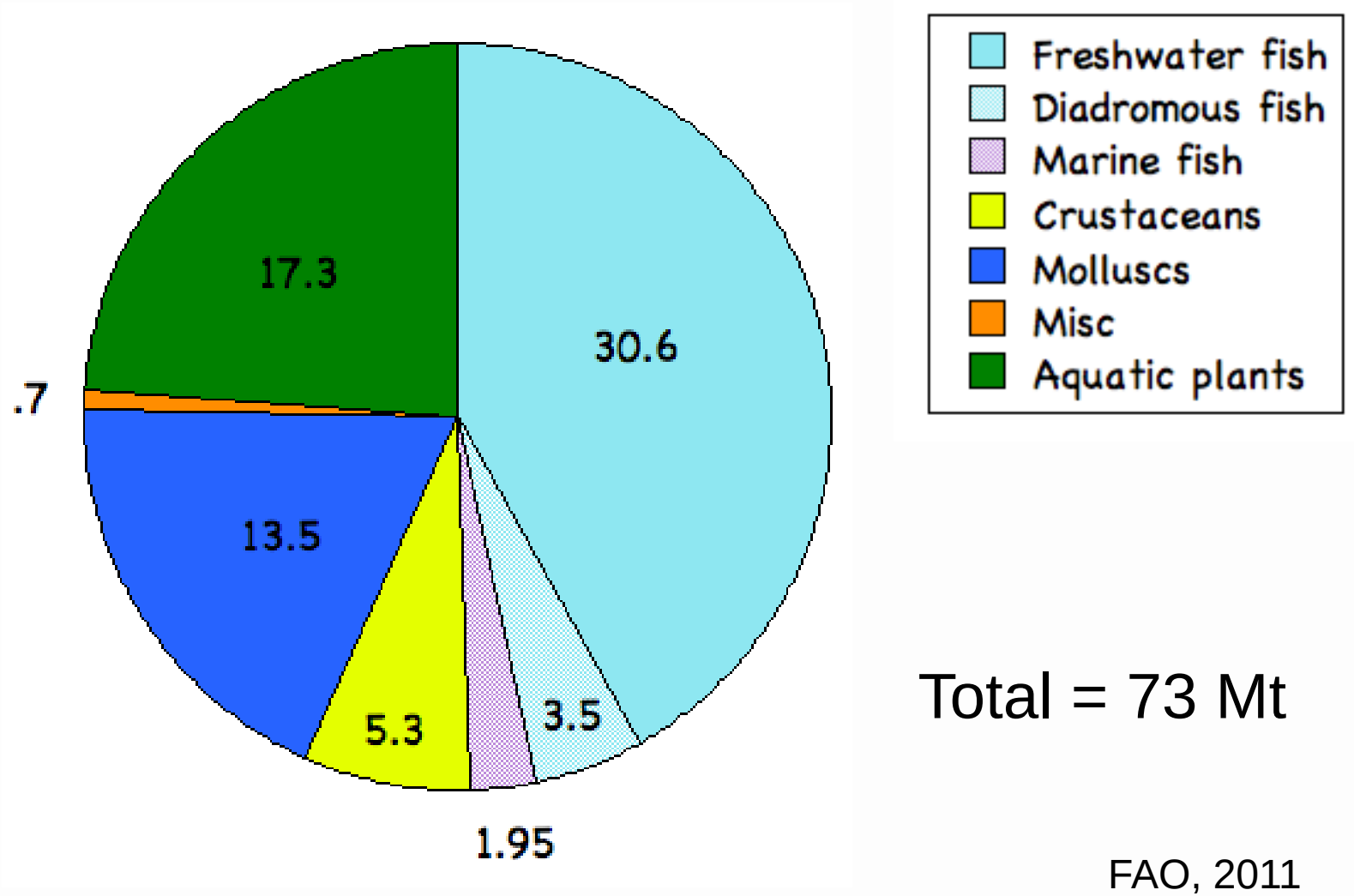
Aquaculture

Aquaculture



Sun, Nutrients

Global Aquaculture Production 2009



Total = 73 Mt

FAO, 2011

Classification of Aquaculture

Trophic level	Degree of Control
Plants	Extensive
Herbivore	Extensive
Omnivore	Semi-intensive
Carnivore	Intensive

Concentrated Aquatic Animal Feeding Operation (CAAFO)

Global Aquaculture Production 2009

Group	Production (Mt)	Value (US$ billion)	Value ($ per kg)
Freshwater fishes	30.64	44.19	1.44
Diadromous fishes	3.53	14.00	3.96
Marine fishes	1.95	7.10	3.64
Crustaceans	5.30	24.13	4.55
Molluscs	13.52	13.13	0.97
Miscellaneous aquatic animals	0.73	2.75	3.77
Aquatic plants	17.34	4.82	0.28
Total aquaculture production	73.02	110.12	1.51

FAO 2011

2

The benefits of consuming marine proteins

Seafood and Human Health

The benefits and risks of seafood consumption are examined:

1. Measuring the levels of nutrients and known risk factors
2. In a clinical trial (short term, variables, mechanisms))
3. An epidemiological study (long term, associations)

Measuring Seafood Composition

NIFES

National Institute of Nutrition and Seafood Research

Nutrient Composition of Seafood

Undesirable Substances

Clinical trial

An Example

(A) Increased Omega-3 intake reduces (B) Blood triglycerides

(B) Reducing triglycerides improves (C) Cardiovascular health

Therefore

(A) Increased Omega-3 intake improves (C) cardiovascular health

Clinical Trial

(A) Increased Omega-3 intake reduces (B) Blood triglycerides

(B) Reducing triglycerides may improve (C) Cardiovascular health

Therefore

(A) Increased Omega-3 intake may improve (C) Cardiovascular health

Rizos, E. C. et al., Association Between Omega-3 Fatty Acid Supplementation and Risk of Major Cardiovascular Disease Events: A systematic Review and Meta-Analysis. Sept 2012. 308 (10) 1024-1033.

No reduction in cardiovascular outcomes and omega-3 supplementation

Clinical Trials

Correlation vs. Causation

We need to understand the mechanisms

e.g.
How do omega-3s affect cardiovascular health?

Epidemiological Study

Searching for correlations
Between variables

Chowdhury, R. et al. BMJ 2012; 345

Association between fish consumption, long chain omega 3 fatty acids, and risk of cerebrovascular disease: systematic review and meta-analysis

Meta-analysis
38 studies
794,000 people
People consumed fish
- 0 or 1 times/week
- 2-4 times/week
- 5 or more times/week

Input Variables A1, A2, A3

A1 

A2 

A3 

Statistics

Examine the correlation between the input variables A1, A2, A3

and
the response in

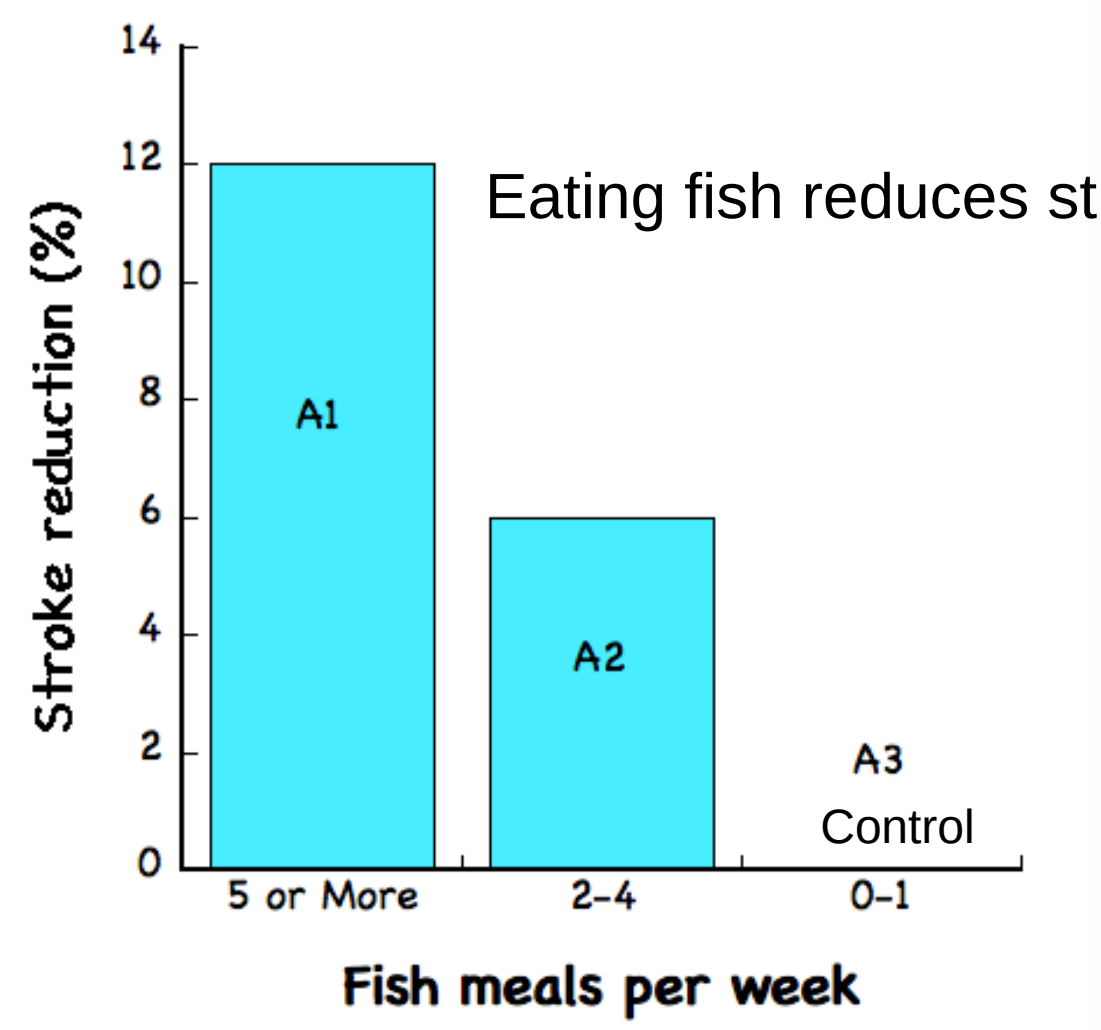
Variable C (Incidence of stroke)

Results of the Analysis

The were a total of 34817 strokes (C)

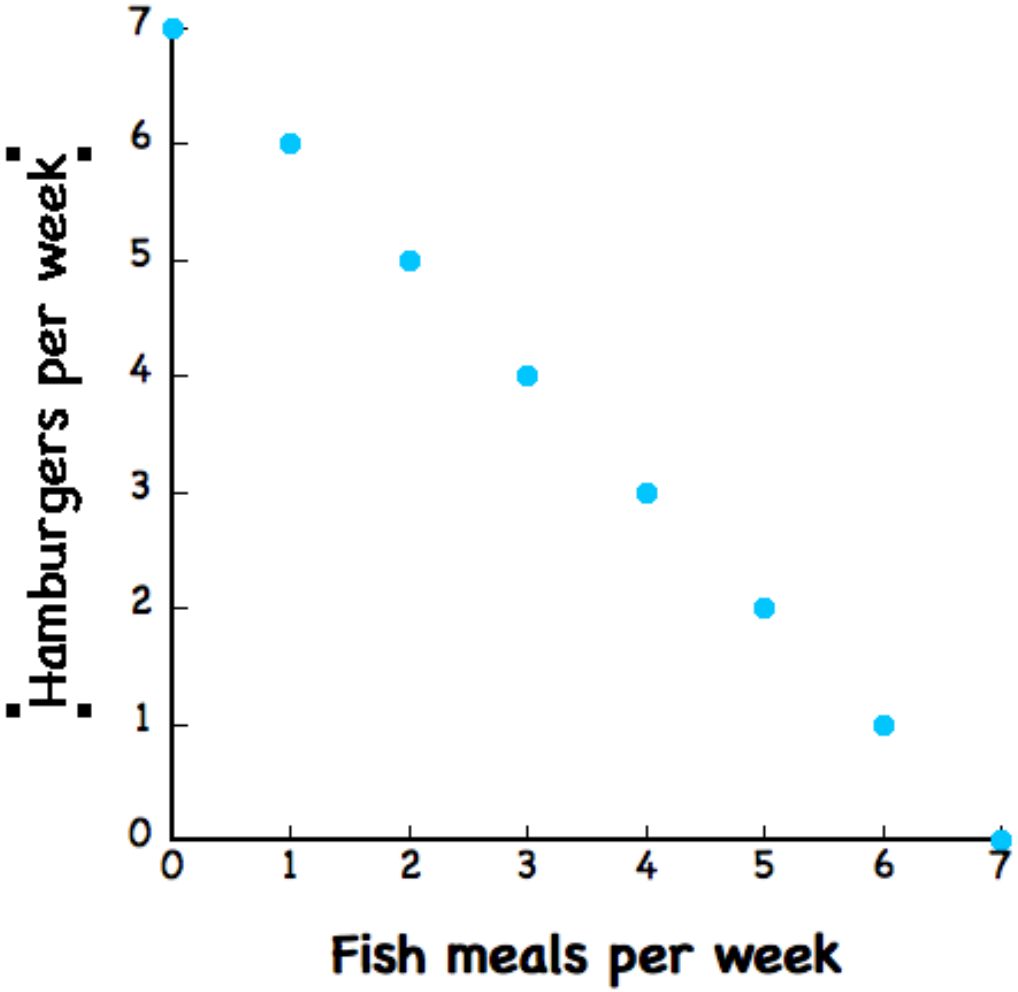
A3	Fish 0-1 times/week	12057	strokes
A2	Fish 2-4	11334	-6%
A1	Fish 5 or more	10610	-12%
		34817	

Conclusion

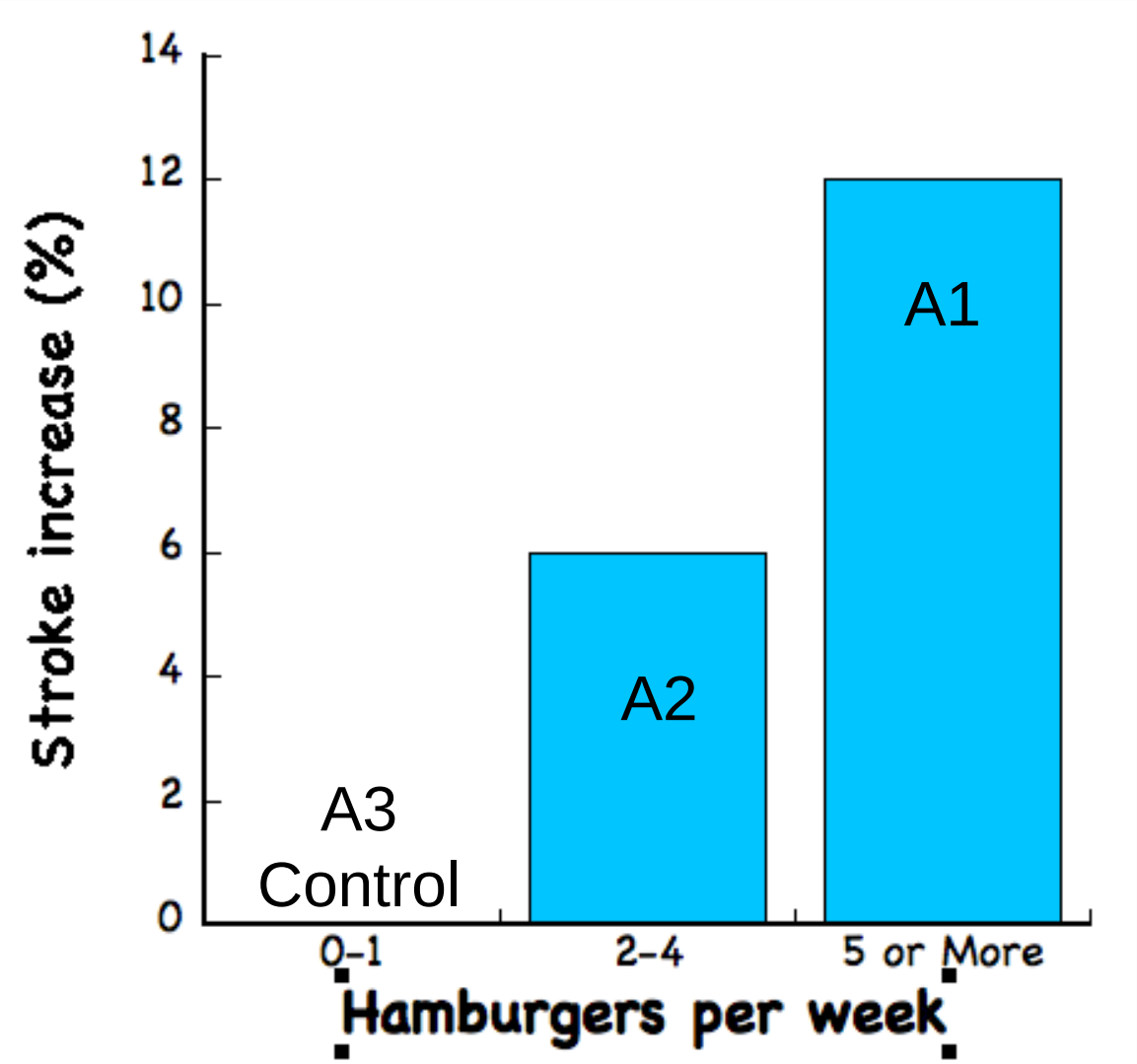


Eating fish reduces strokes

Correlation vs Causation



The Alternative Explanation



Seafood and Human Health

Contaminant free seafood is a good source of nutrients,

but

many studies examining the benefits or risks of consuming seafood have flaws and that additional studies are required.

The Salt Scare of the 90's

FINANCIAL POST

Junk Science Week: Salt scare lacks solid evidence

3

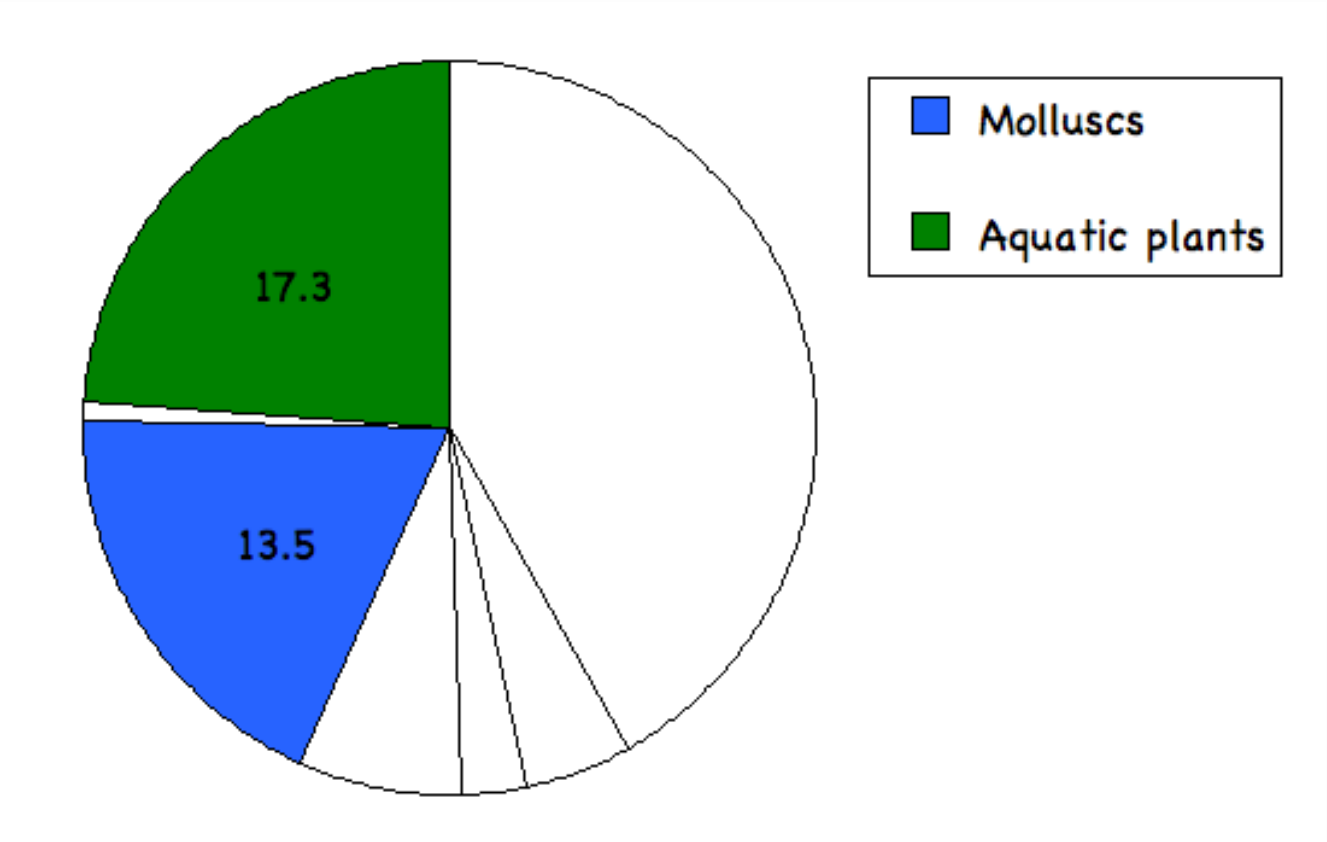
Opportunities associated with seafood

Wild Harvest

It is unlikely that the total wild harvest will increase significantly

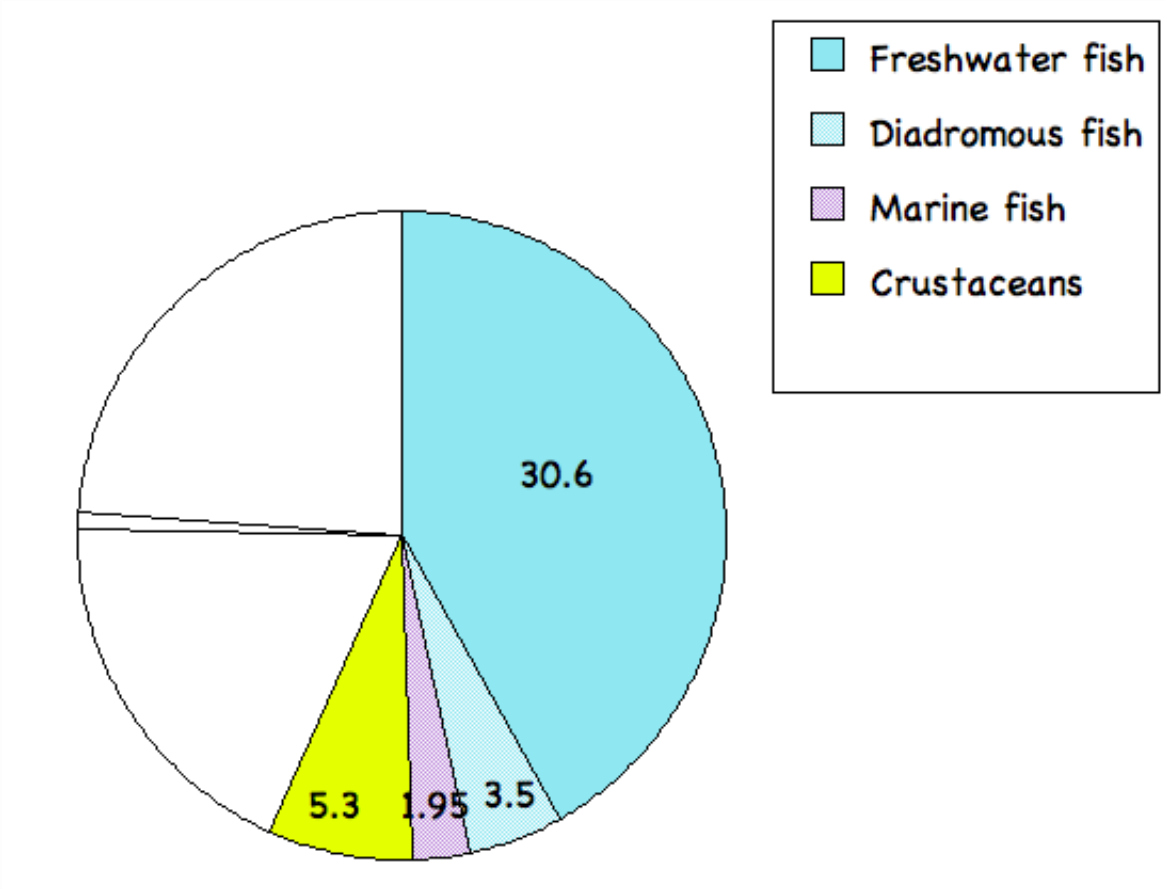
Aquaculture Opportunities

Extensive Aquaculture Production (Mt) 2009



This is as close as we can get to a free lunch

Intensive & Semi-intensive Aquaculture Production (Mt) 2009



Concentrated Aquatic Animal Feeding Operations

Animal production, both terrestrial and aquatic, is moving, increasingly, toward concentrated feeding operations CAFOs and CAAFOs

Global Compound Feed Production

Table 1: World Compound Feed Production by region 2011
(million metric tons)

Region	Million Metric Tons
Asia	305
Europe	200
North America	185
Latin America	125
Middle East / Africa	47
Other	11
Total	873

Source: Alltech 2012 Global Feed Survey

Compound Feed by Species

Table 2: Global Feed Tonnage by Species 2011
(million metric tons)

Region	Pig	Poultry	Ruminant	Aqua	Other**
Asia	81	116	80.12	24.4	4.03
Europe*	63.09	70.25	57.11	1.33	8
North America	31.23	91.07	45.5	0.286	17.09
Middle East / Africa	0.87	27.71	17.04	0.60	0.72
Latin America	24.80	71.26	22.34	1.88	4.46
Other	2	4.60	3.49	0.20	0.86
Total	202.99	380.89	225.6	28.696	35.16

**EU27 & Non-EU Europe and former Soviet Union / **Other includes Horse (9.24M) and Pets (25.6M)*
Source: Alltech 2012 Global Feed Survey

Salmon Feed

Until recently,
was composed primarily
of things people did not eat.

But now
We are feeding fish human food.

Plant Protein and Oil in Norwegian Salmon Feeds

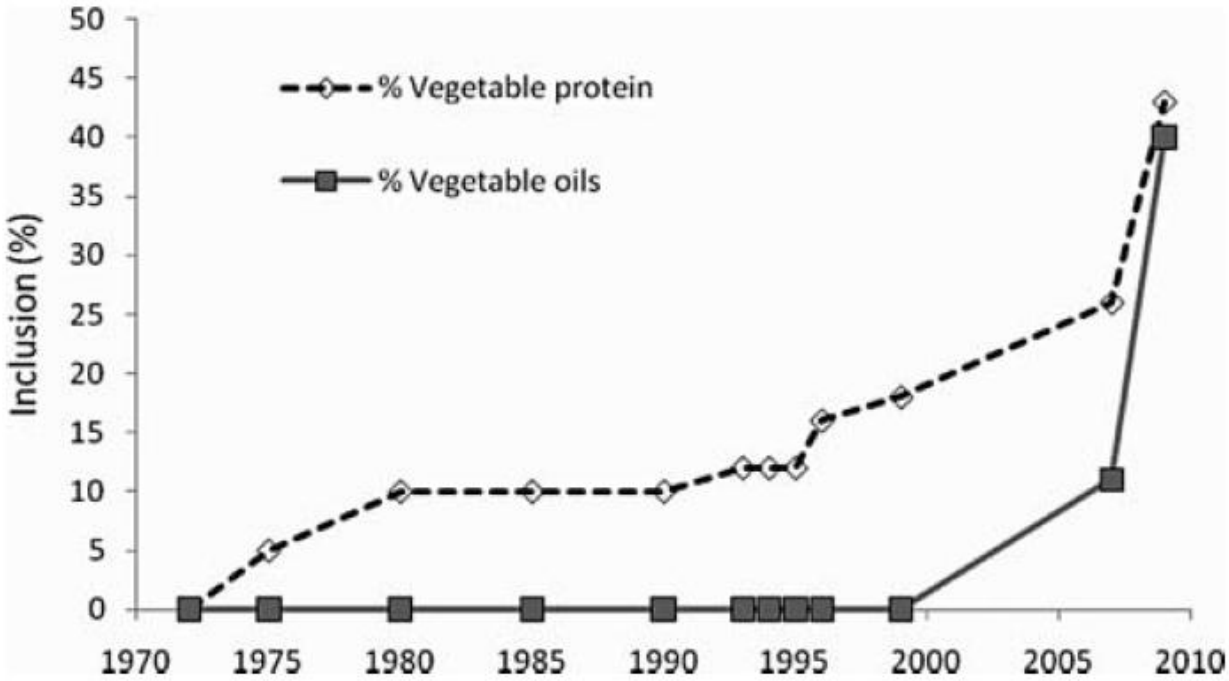


Figure 3 Inclusion levels of vegetable proteins and oils in Norwegian salmon diets; information provided by the major feed producers in Norway and calculated on the basis of information from Norwegian Seafood Federation (FHL), Norway (www.fhl.no).

Torrissen et al. 2011

Atlantic Salmon Feed in Norway

This would require (as plant ingredients)

270,000 t wheat (United States) = 75,000 ha
1,560,000 t soy (Brazil) = 675,000 ha
950,000 t canola (Europe) = 320,000 ha
2,780000 t 1,070,000 ha

Torrissen et al. 2011

Nutrient Composition of Norwegian Salmon Feed

Component	**Feed**
Mass (tons)	1,137,120
Protein (tons)	460,850
EPA+DHA (kg)	49,373
Phosphorus (tons)	12,046

(Ytrestøyl et al., 2011)

Norwegian Atlantic Salmon Nutrient Budget

Component	Feed	Fillet	% Retained in fillet
Mass (tons)	1,236,000	612,097	49% (16%)*
Energy (MJ)	31,000	6,646	21%
Protein (tons)	460,850	121,807	26%
EPA+DHA (kg)	49,373	12,909	26%

* Dry basis

(Ytrestøyl et al., 2011)

Food In : Food Out

1 kg feed

=

550 g fillet

450 g protein

110 g protein

Aquaculture and Human Protein Needs

Feeding Norwegian Salmon for 1 Year

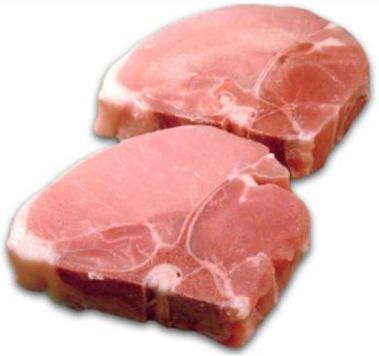
Protein in the feed could supply 19.5 million people for 1 year

Protein recovered can supply 4.9 million people for 1 year

Protein lost could supply 14.6 million people for 1 year

Price ($/lb) of Seafood in Seattle

$ 0.88



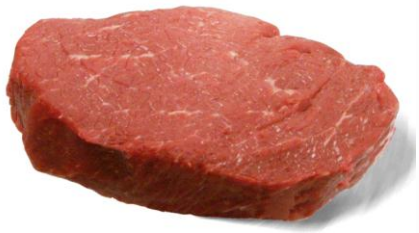
$ 4.49

$ 5.99-
7.99

$ 3.39

$ 4.99

$ 3.99

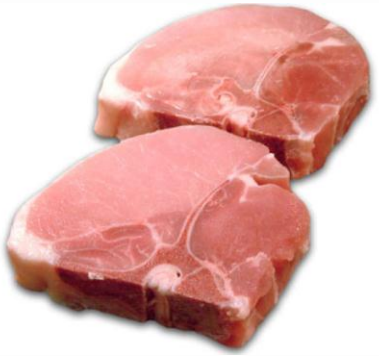


$ 5.99

$ 8.99

Price (NOK/kg) of Seafood in Seattle

12.0



61.4

81.9-
109

46.3

68.3

54.5

81.9

123

($1 = 5.7 NOK)

Palanco, F. et al., 2012. Globfish Research Program #106. FAO

Global Initiative for Life & Leadership through Seafood

Impact of Crisis on Seafood consumption: The case of Spain

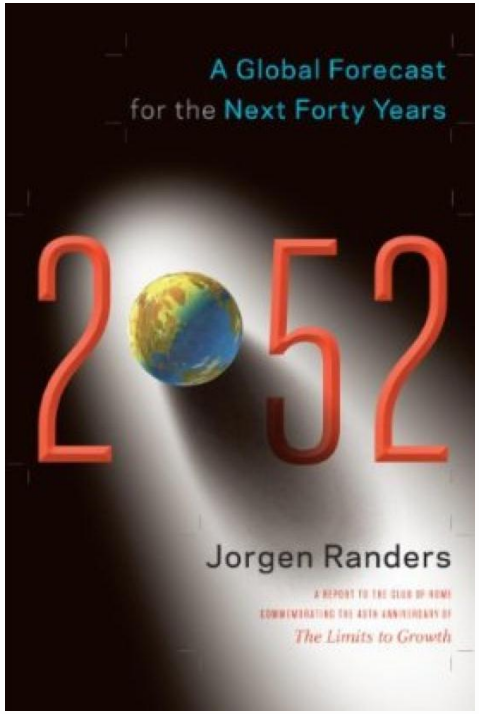
Prof. José Fernández Polanco
Department of Business,
Univesity of Cantabria, Spain

UC UNIVERSIDAD DE CANTABRIA

GILLS
Global Initiative for Life & Leadership through Seafood

Ethical Issues

"The rich will consume the high quality protein and the poor will eat lower quality protein because that is all they can afford."



Jorgen Randers

Aquaculture

Has the potential to increase significantly

Feed cost, disease and escapement are major issues

Recirculation systems will increase

Seafood must compete with with terrestrial meat in price

Meat consumption my become an ethical issue

Summary

The human food supply is comprised mainly of terrestrial plants

Plant production is becoming constrained by limited natural resources

Demand for animal protein is increasing due to population increase and changes in diet preferences

Meat production, both terrestrial and aquatic, rely on terrestrial feed ingredients

Meat production has a large negative impact on the total food supply