Aquaculture's Role in Sustainable and Healthy Food Systems: Public Health, Environment, and Policy Considerations

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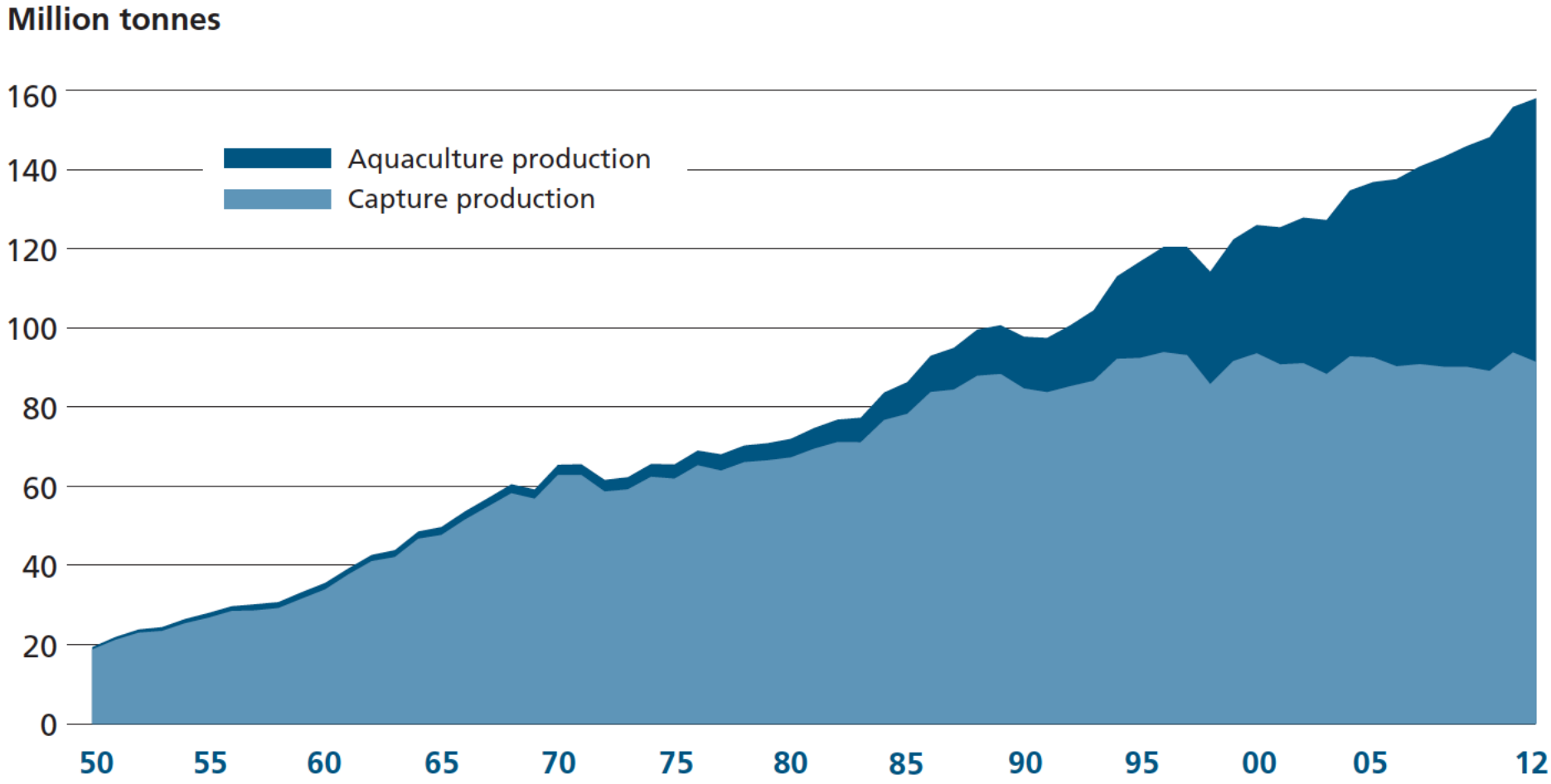
World Capture Fisheries and Aquaculture Production

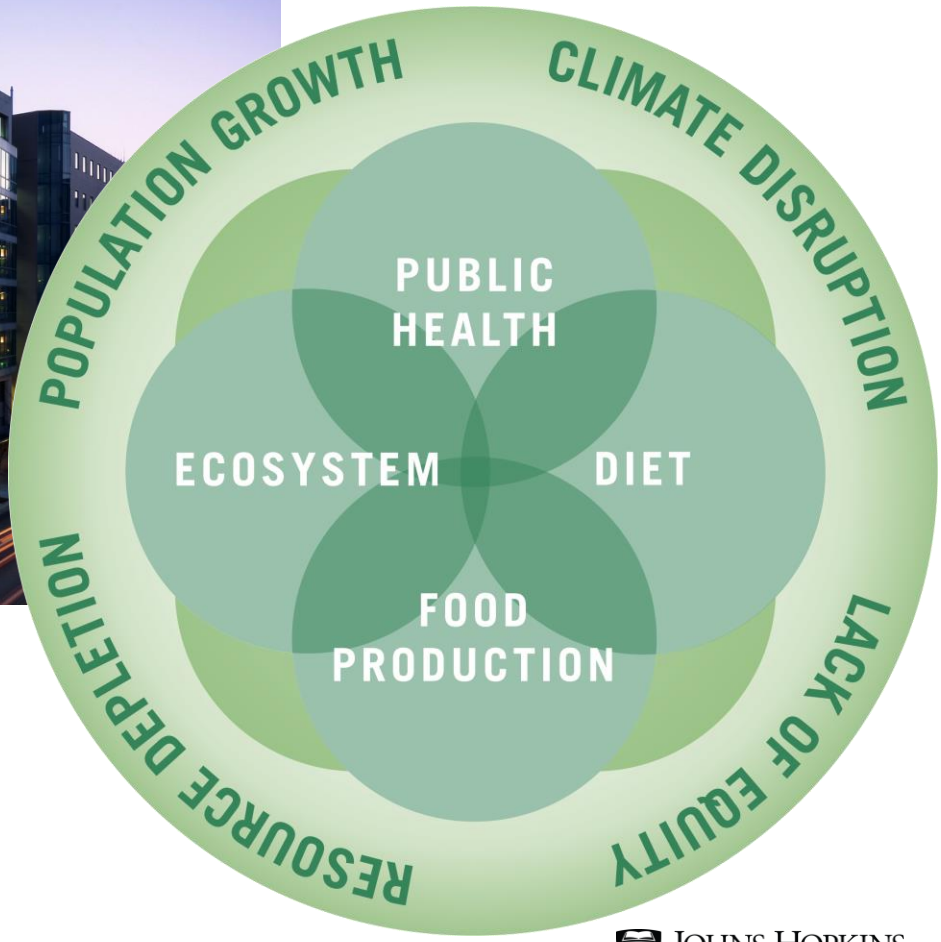


FAO State of the World Fisheries and Aquaculture 2014

Overview

- Johns Hopkins Center for a Livable Future
- Animal protein production
- Benefits and risks of seafood consumption
- Dietary guidelines
- Global trade
- Regulation of salmon aquaculture

Johns Hopkins Center for a Livable Future



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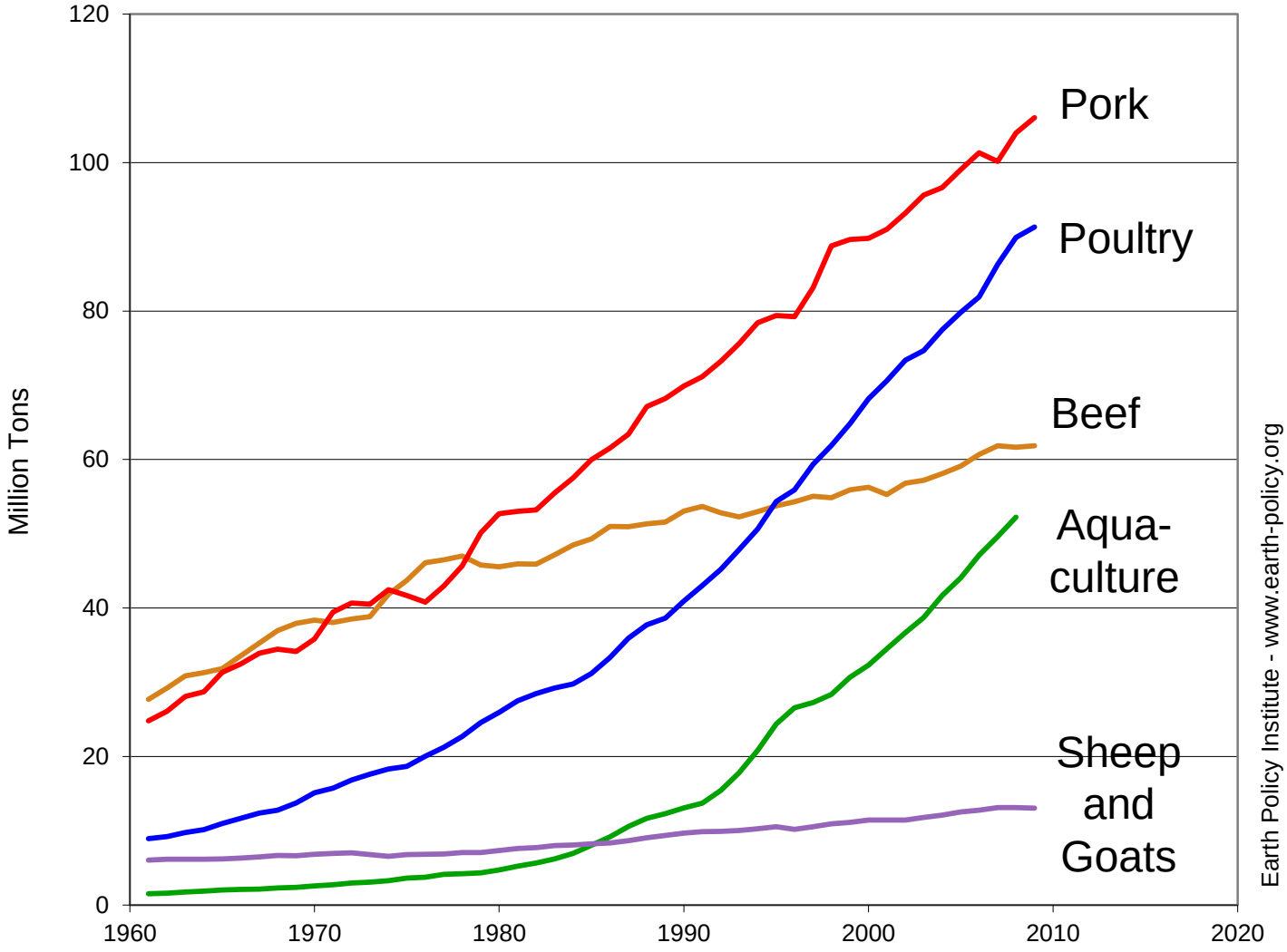
Global Food Animal Production, 1961-2009



Source: EPI from FAO

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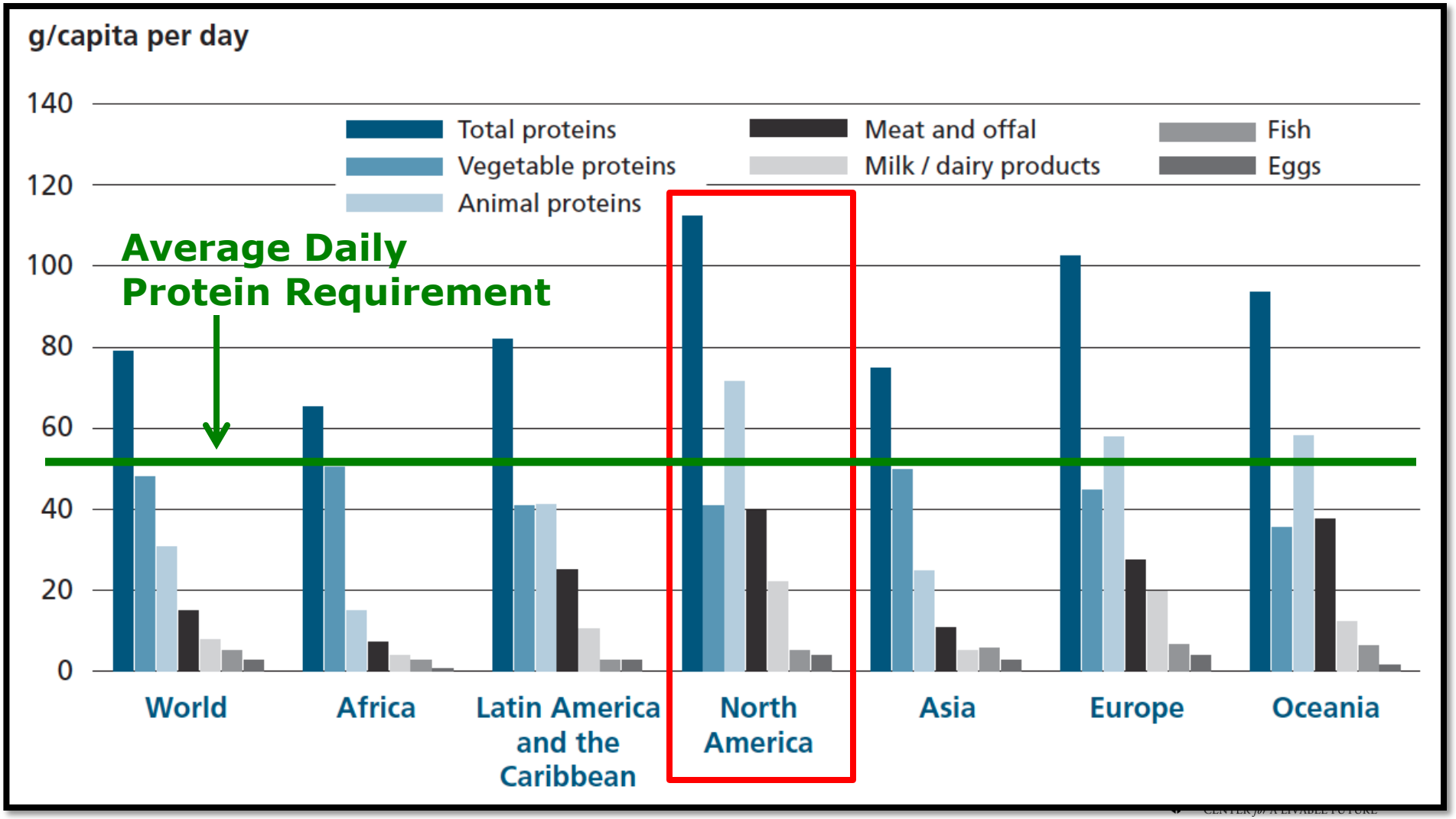
Protein Supply by Continent and Food Group (2008-10)



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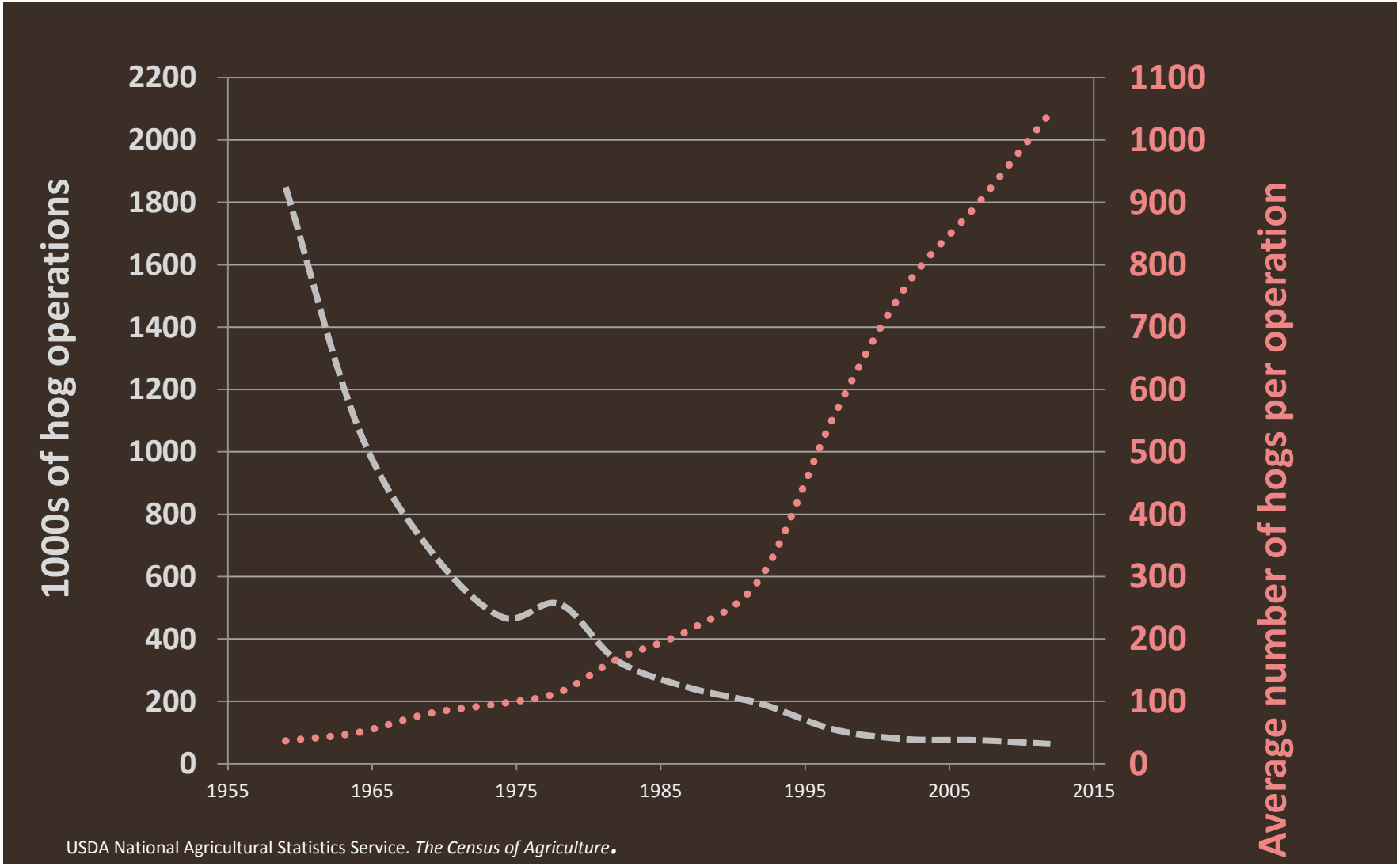
Terrestrial Animal Agriculture

Changes in hog industry structure, 1959 - 2012



USDA National Agricultural Statistics Service. *The Census of Agriculture*.

Photo credit: SRA Project www.sraproject.org

Photo credit: Farm Sanctuary

Waste

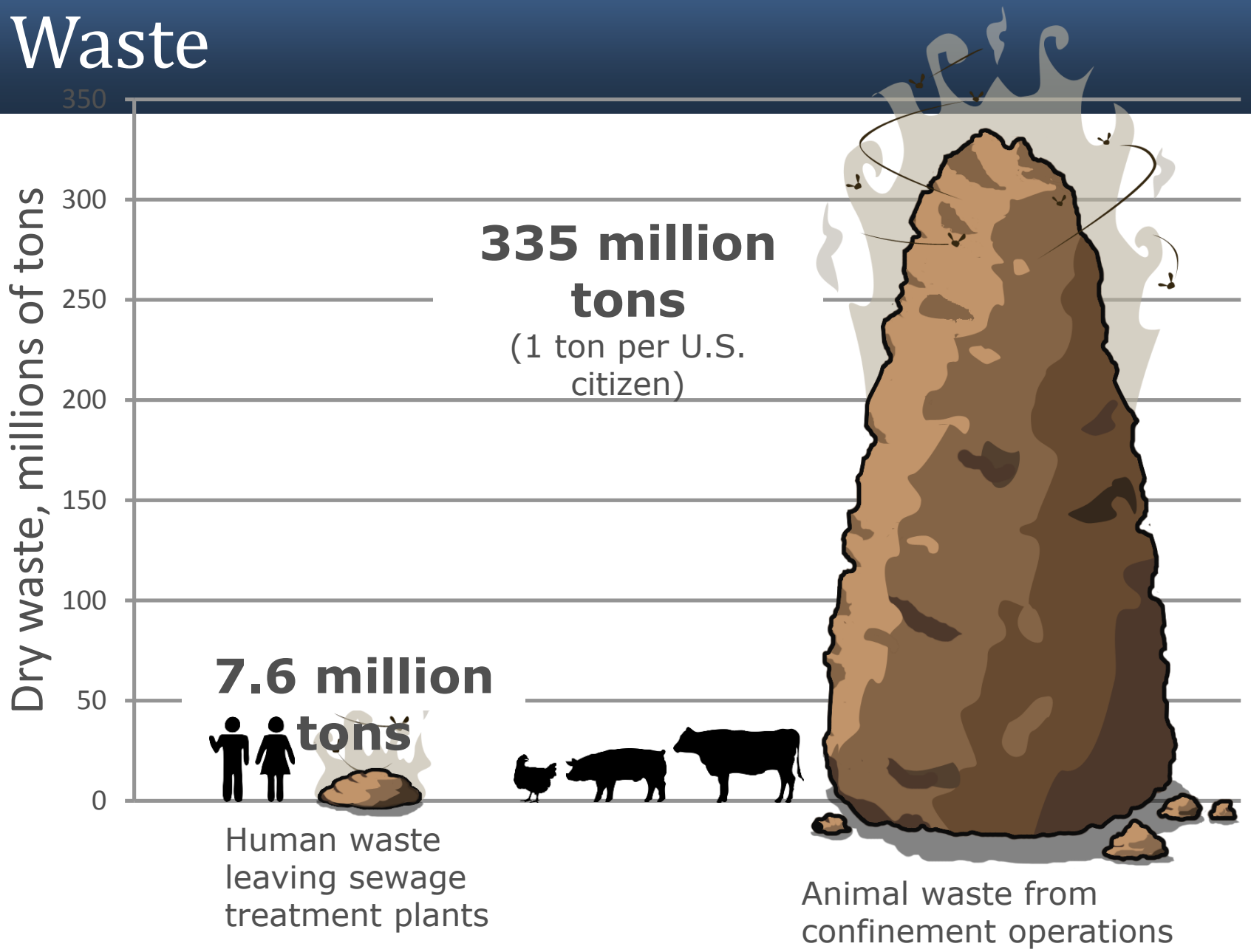


Image credit: Brent Kim, Johns Hopkins Center for a Livable Future.

Pollution of Air, Water, and Soil

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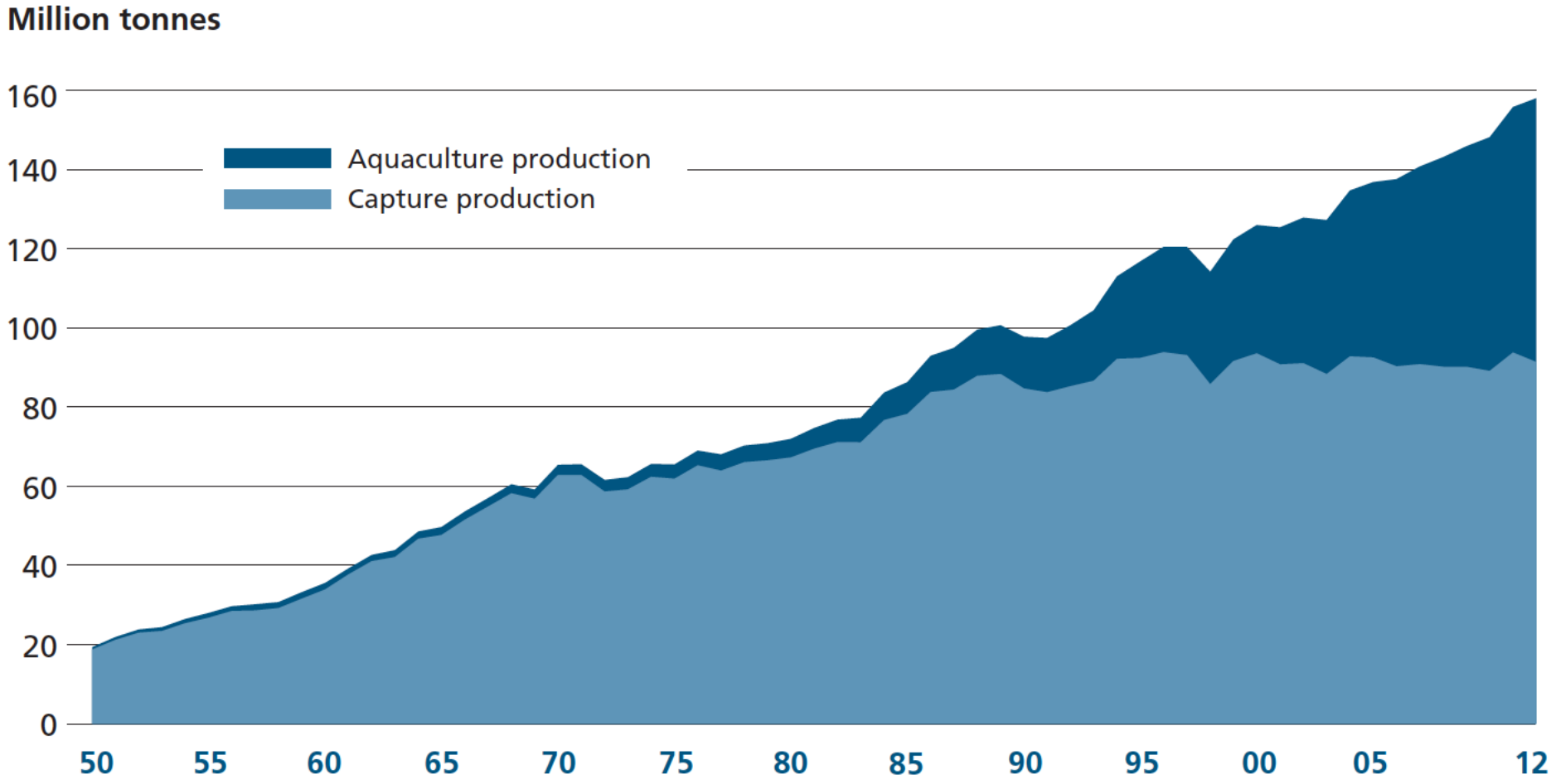
Terrestrial Animal Agriculture

- Resource Use (varies by species)
  - Feed: 4-7 kg to produce 1 kg of pork, beef
    - Land, water, fertilizer, fossil fuel resources
  - 35% global cropland used for animal feed
  - 27% global water footprint: animal production
- Greenhouse gas emissions
  - FAO: 18% of all GHG emissions (CO_2 equivalent)

Foley et al., (2011) Solutions for a Cultivated Planet. *Nature*.
Hoekstra AY, Mekonnen MM. (2012) The Water Footprint of Humanity. *PNAS USA*.

World Capture Fisheries and Aquaculture Production



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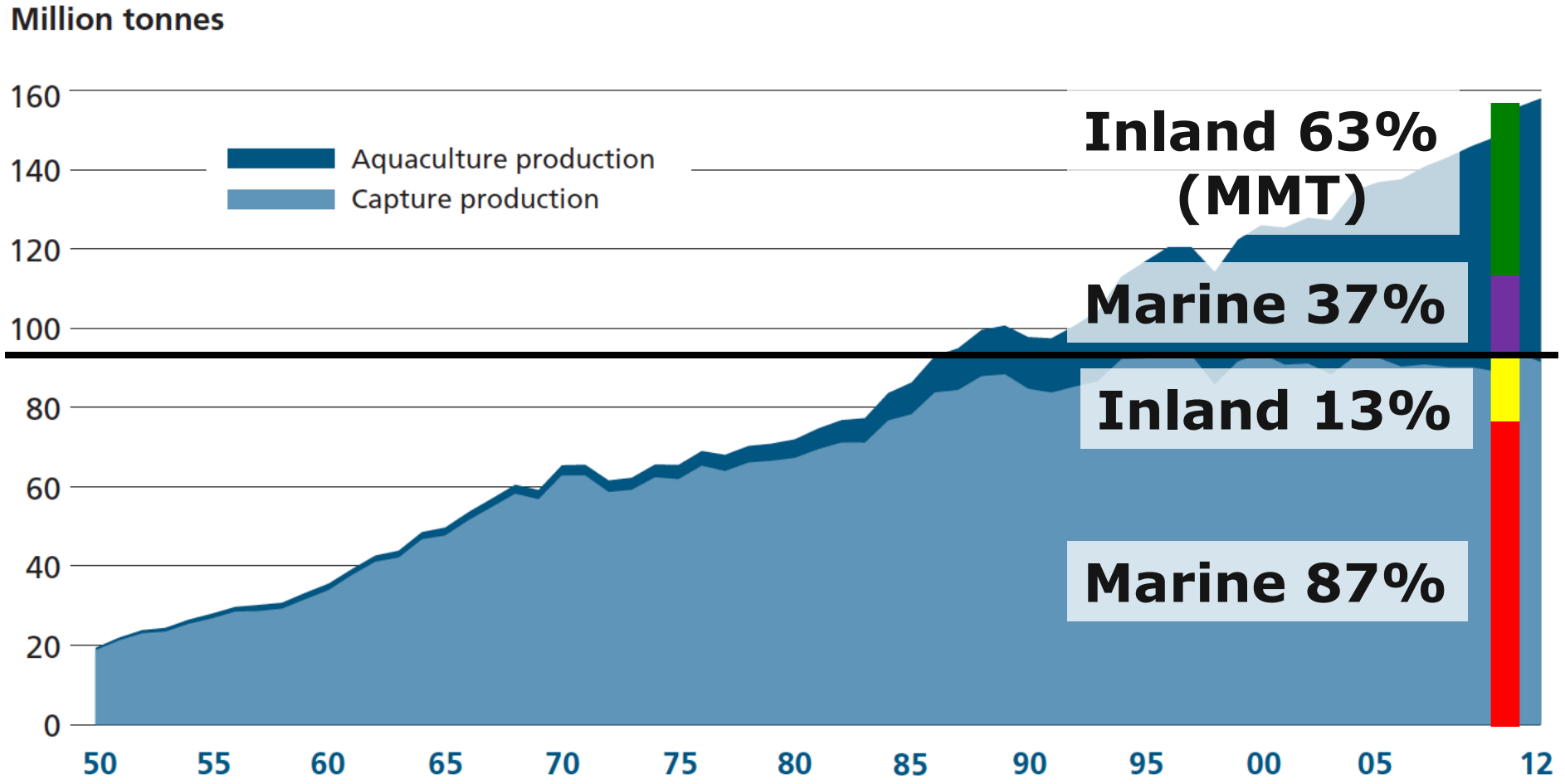

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Intensive Aquaculture: Ecologic & Public Health Implications

- Significant variability
- Main ecologic and public health concerns:
  - Benthic effects/pollution
  - Use of antibiotics, paracitides, pesticides
  - Marine feed ingredients
  - Disease transmission to wild species
  - Escapes
  - Habitat loss
- Currently uses ~4% of global animal feed

Gormaz JG, Fry JP, Erazo M, Love DC. (2014) Public Health Perspectives on Aquaculture. *Current Environmental Health Reports*.
Troell et al. (2014) Does aquaculture add resilience to the global food system? *PNAS USA*.

Aquaculture vs. Terrestrial Animal Agriculture

- Use of resources and GHG emissions
  - Small fraction of land-based animal agriculture
  - Not only due to scale
  - Increasingly efficient use of marine feed inputs
- Antibiotic use
  - Use of vaccines
  - Not used for growth promotion in aquaculture

Implications for high-income countries?

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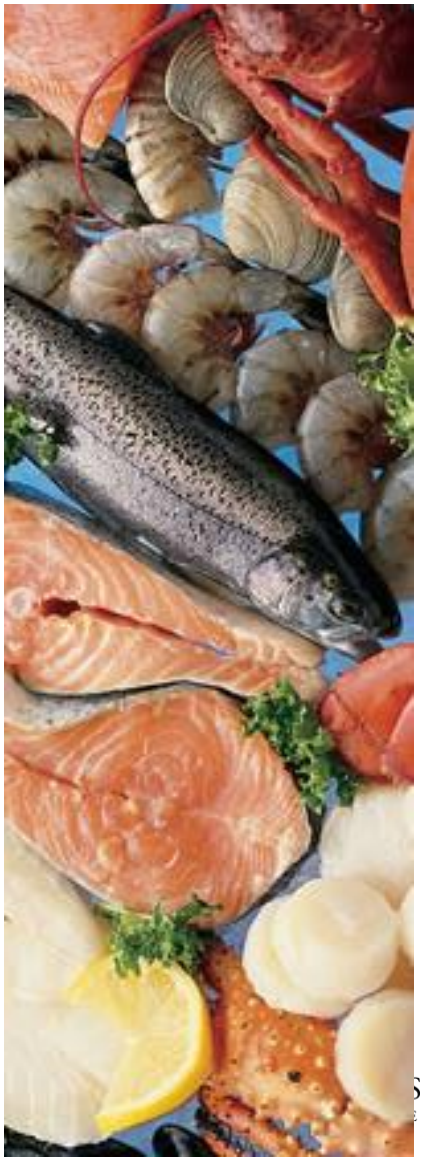
Seafood Consumption- Benefits

Benefits:

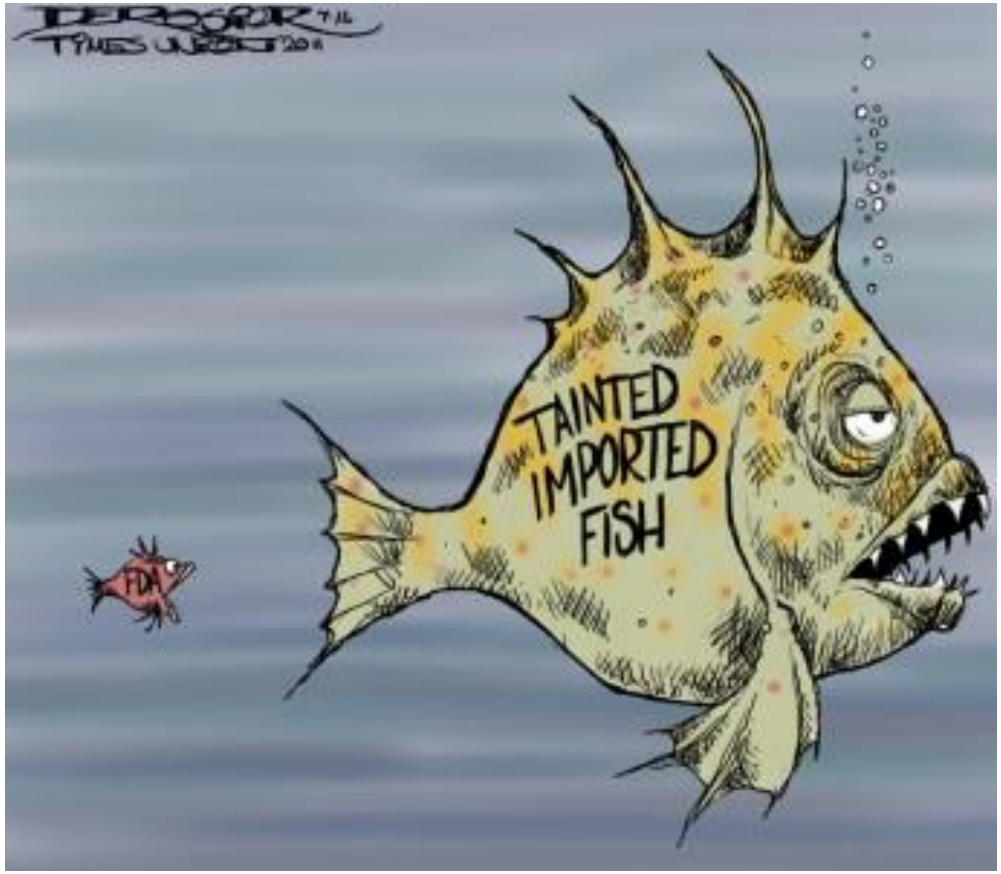
- Protein, marine omega-3 fatty acids, vitamins (D) and minerals (selenium)
- Replaces other meat
- Brain and eye health
- Protection against heart disease & stroke



Seafood Consumption- Risks

- Metals: e.g., methylmercury
- Persistent Organic Pollutants: e.g., PCBs and dioxins
- Pathogens & toxins
- Drug residues

Outbreaks from Imported Food



- Top globally traded food commodity
- 44% of outbreaks in US from imported food caused by seafood (2005-2010)
- US FDA inspects 2% of seafood imports
- Testing is not transparent

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Love et al., 2011 Veterinary Drug Residues in Seafood Inspected by the EU, US, Canada, and Japan, 2000-09 *ES&T*

Balancing Risks & Benefits

- Benefits outweigh specific risks of seafood consumption
- Policies and consumer behavior can reduce risks

Mahaffrey et al., (2011) Balancing the benefits of n-3 polyunsaturated fatty acids and the risks of methylmercury exposure from fish consumption. *Nutrition Reviews*.

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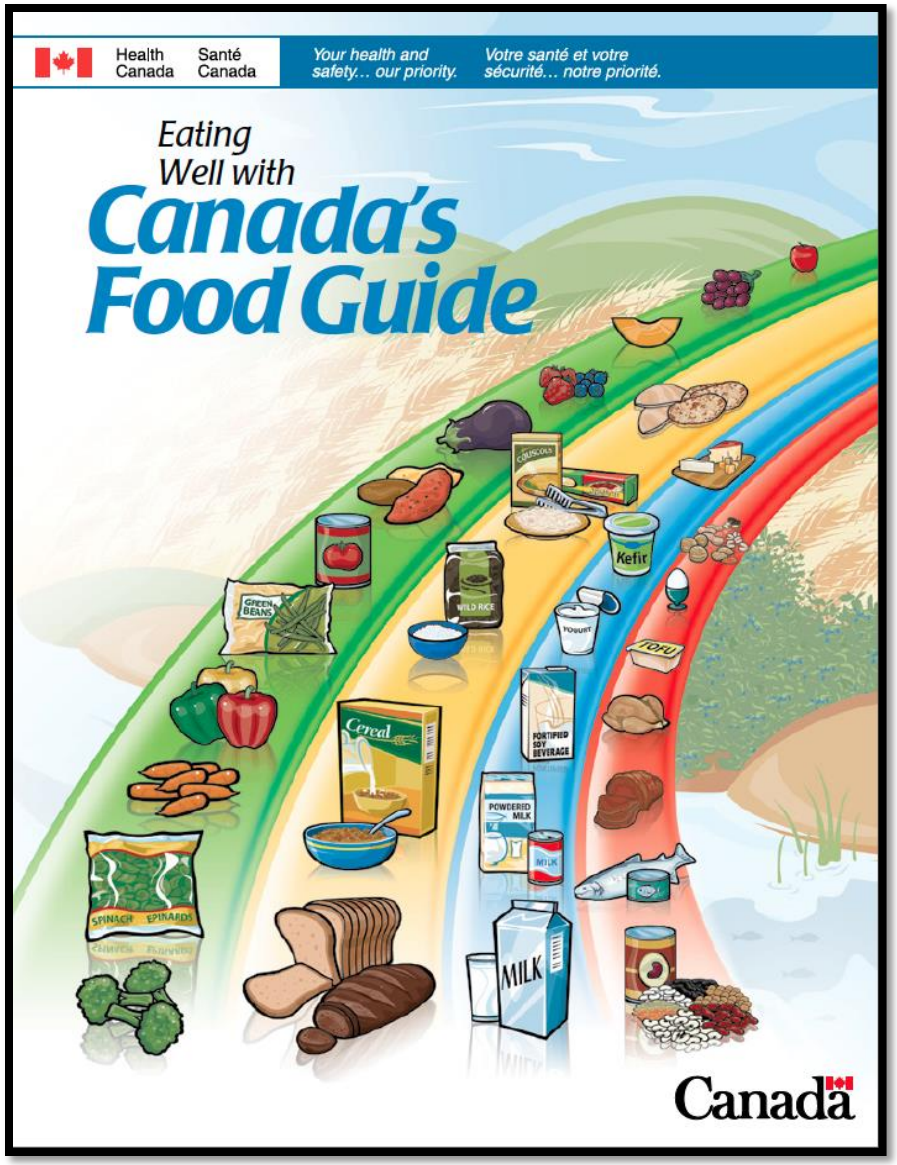
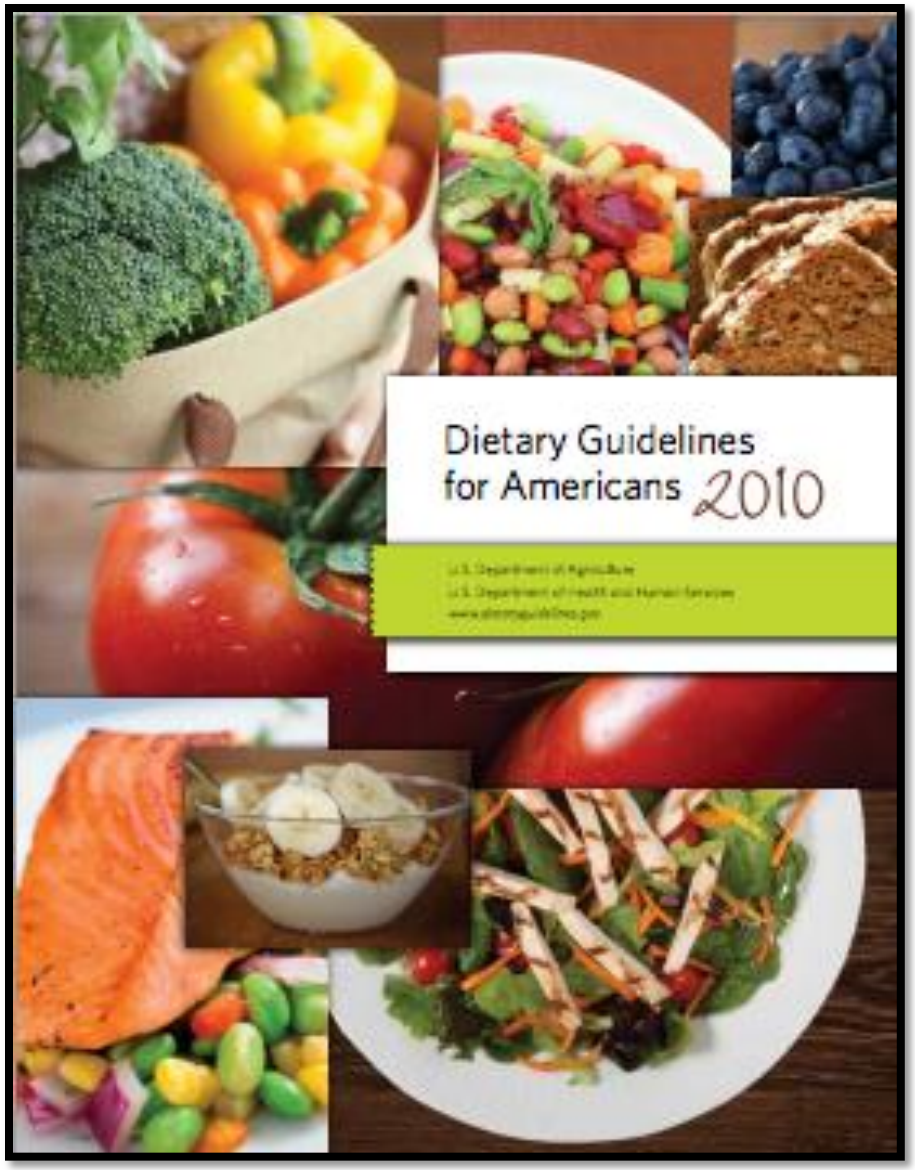
Dietary Guidelines: Canada and US

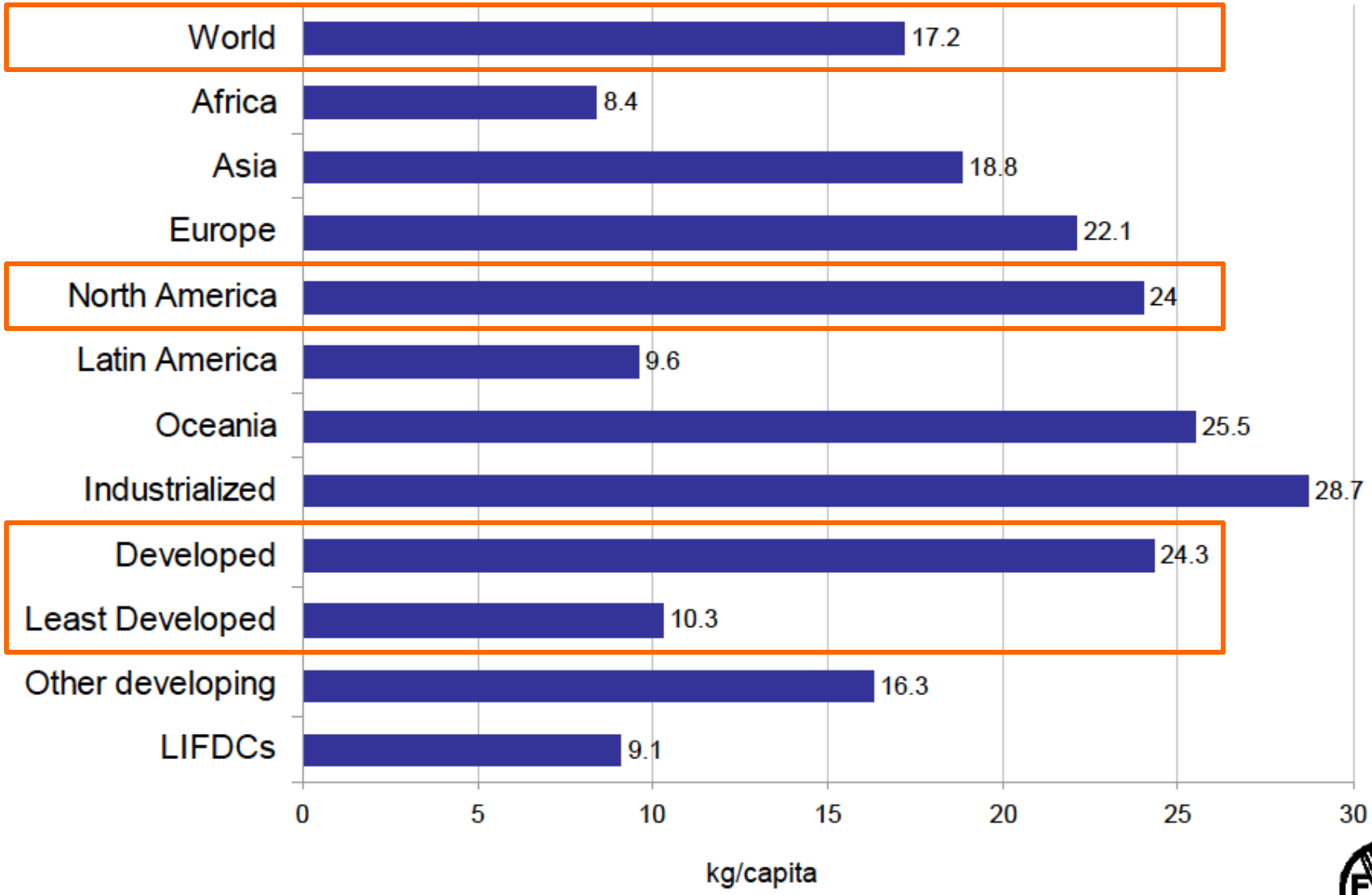




Guidelines vs. Consumption

	Canada	US
Recommended servings	At least two per week	Two per week
Serving size	75 g	113 g (4 oz.)
Recommended consumption	150 g per week	227 g (8 oz.) per week
Actual Consumption	148 g per week	99 g per week

How does seafood supply vary?



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Top 10 Importers: Fish and Fishery Products

	2002	2012	APR
	(US$ millions)		*(Percentage)*
Japan	13 646	17 991	2.8
United States of America	10 634	17 561	5.1
China	2 198	7 441	13.0
Spain	3 853	6 428	5.3
France	3 207	6 064	6.6
Italy	2 906	5 562	6.7
Germany	2 420	5 305	8.2
United Kingdom	2 328	4 244	6.2
Republic of Korea	1 874	3 739	7.2
China, Hong Kong SAR	1 766	3 664	7.6
TOP TEN SUBTOTAL	44 830	77 998	5.7
REST OF WORLD TOTAL	17 323	51 390	11.5
WORLD TOTAL	**62 153**	**129 388**	**7.6**

Note: APR refers to the average annual percentage growth rate for 2002–2012.

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Top 10 Exporters: Fish and Fishery Products

	2002	2012	APR
	(US$ millions)		*(Percentage)*
EXPORTERS			
China	4 485	18 228	15.1
Norway	3 569	8 912	9.6
Thailand	3 698	8 079	8.1
Viet Nam	2 037	6 278	11.9
United States of America	3 260	5 753	5.8
Chile	1 867	4 386	8.9
Canada	3 044	4 213	3.3
Denmark	2 872	4 139	3.7
Spain	1 889	3 927	7.6
Netherlands	1 803	3 874	7.9
TOP TEN SUBTOTAL	28 525	67 788	9.0
REST OF WORLD TOTAL	29 776	61 319	7.5
WORLD TOTAL	**58 301**	**129 107**	**8.3**

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Aquaculture Production

Producer	Finfish		Crustaceans	Molluscs	Other species	National total	Share in world total
	Inland aquaculture	Mariculture					
	(Tonnes)			(Tonnes)			(Percentage)
China	23 341 134	1 028 399	3 592 588	12 343 169	803 016	41 108 306	61.7
India	3 812 420	84 164	299 926	12 905	...	4 209 415	6.3
Viet Nam	2 091 200	51 000	513 100	400 000	30 200	3 085 500	4.6
Indonesia	2 097 407	582 077	387 698	...	477	3 067 660	4.6
Bangladesh	1 525 672	63 220	137 174	...	...	1 726 066	2.6
Norway	85	1 319 033	...	2 001	...	1 321 119	2.0
Thailand	380 986	19 994	623 660	205 192	4 045	1 233 877	1.9
Chile	59 527	758 587	...	253 307	...	1 071 421	1.6
Egypt	1 016 629	...	1 109	...	...	1 017 738	1.5
Myanmar	822 589	1 868	58 981	...	1 731	885 169	1.3
Philippines	310 042	361 722	72 822	46 308	...	790 894	1.2
Brazil	611 343	...	74 415	20 699	1 005	707 461	1.1
Japan	33 957	250 472	1 596	345 914	1 108	633 047	1.0
Republic of Korea	14 099	76 307	2 838	373 488	17 672	484 404	0.7
United States of America	185 598	21 169	44 928	168 329	...	420 024	0.6
Top 15 subtotal	**36 302 688**	**4 618 012**	**5 810 835**	**14 171 312**	**859 254**	**61 762 101**	**92.7**
Rest of world	2 296 562	933 893	635 983	999 426	5 288	4 871 152	7.3
World	**38 599 250**	**5 551 905**	**6 446 818**	**15 170 738**	**864 542**	**66 633 253**	**100**

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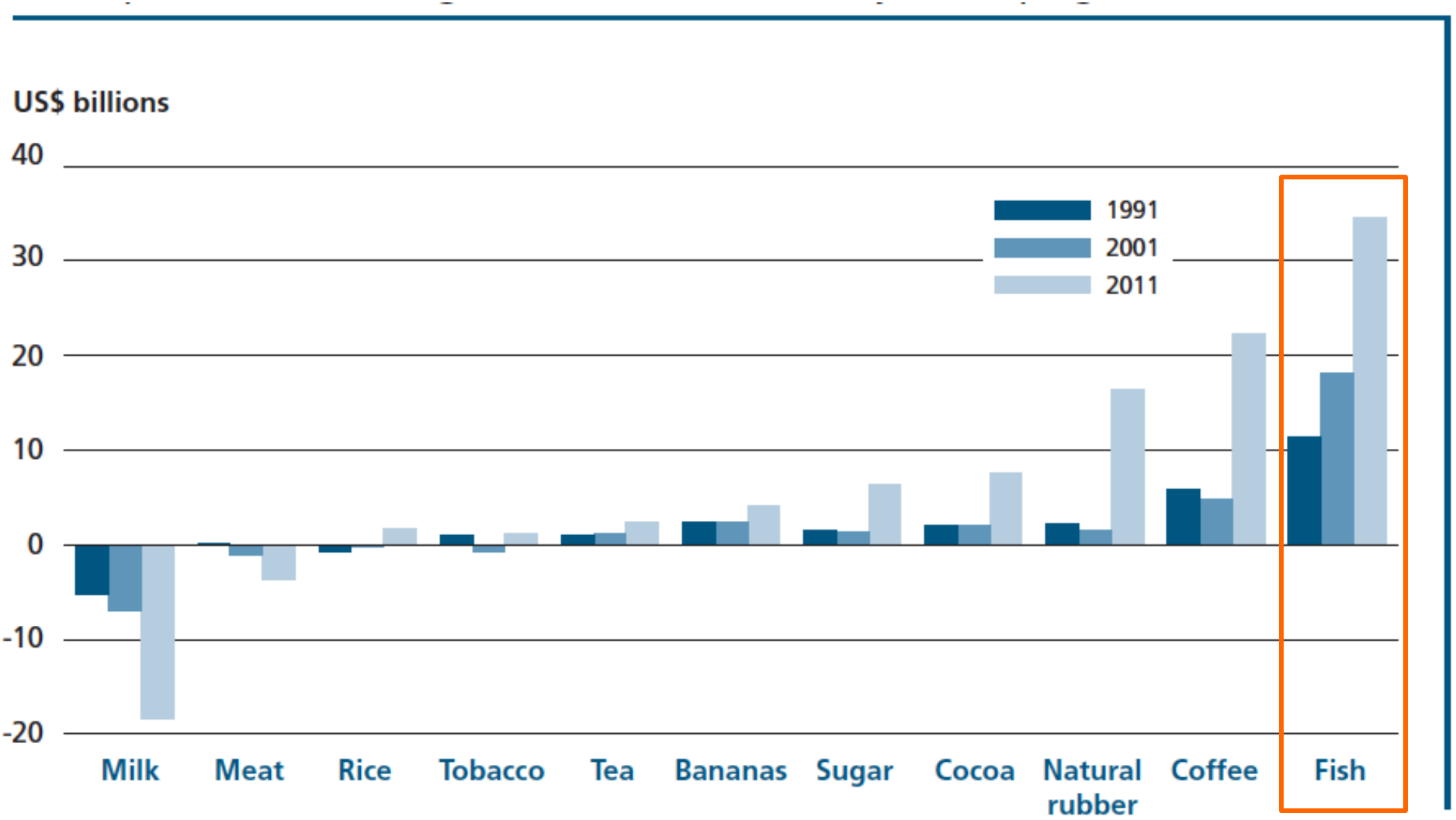
Net Exports of Agriculture Products from Developing Countries



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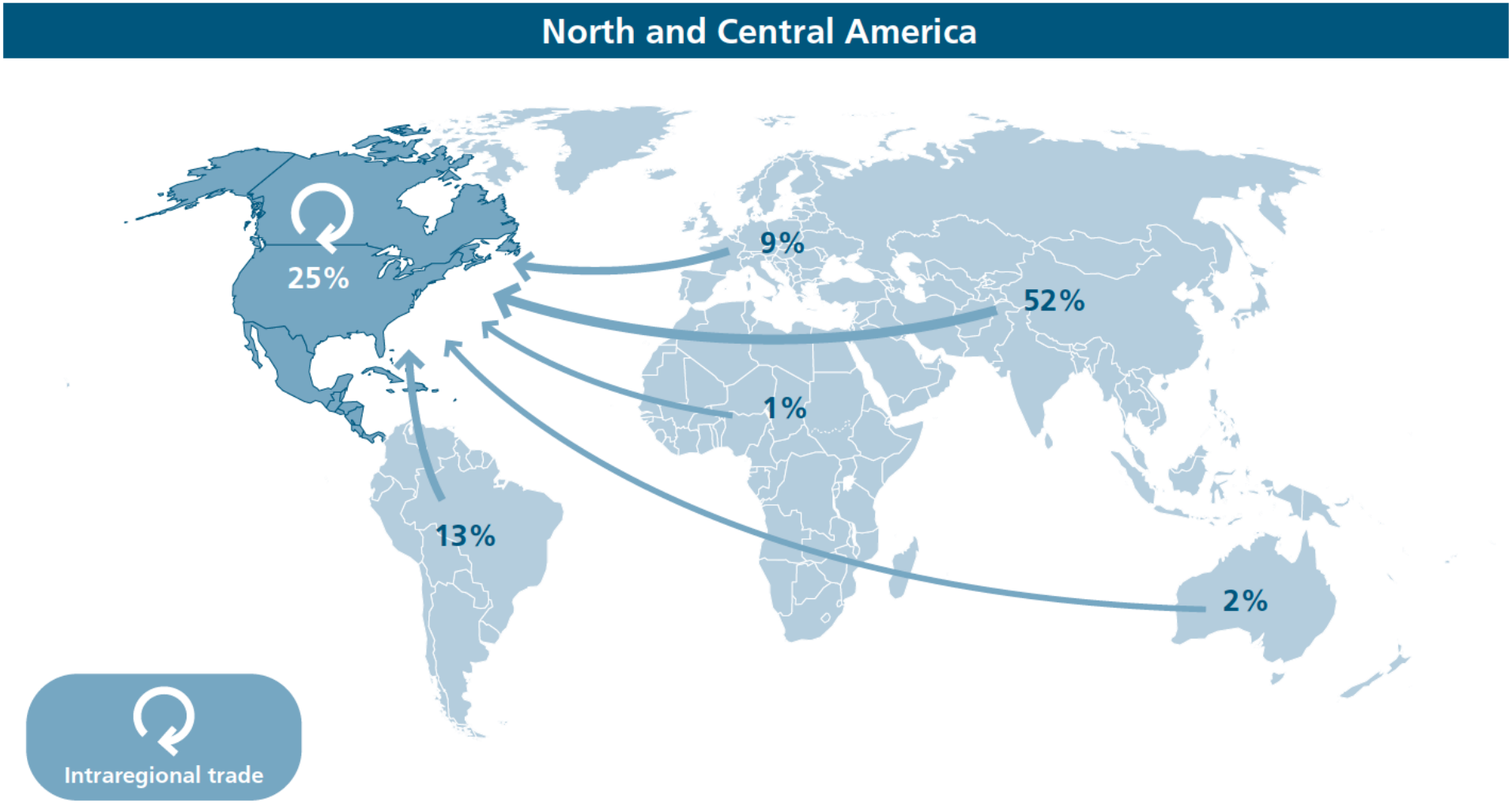
Trade Flows, 2010-2012



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Study of Salmon Farming Regulations

- Canadian and US governments working to expand aquaculture production
- How is salmon production currently regulated?
- Study:
  - Document review
  - Qualitative interviews
    - Purposeful, stratified, and snowball sampling methods

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Study of Salmon Farming Regulations

- Industry in both countries advocating for:
  - Streamlining- federal legislation
  - Longer leases/permits
- Regulations similar- involve states/provinces and federal agencies
  - Changing in BC
  - Access to veterinary health products in Canada vs. US
  - Other forms of government involvement vary

Study of Salmon Farming Regulations

- US agencies trying to develop offshore industry for finfish
  - Occupational safety regulatory gaps in US
- Strong focus on innovation and research
  - Role of third party certification in Canada
- Regulations for closed-containment operations differ due to limited interaction with the environment and current size of industry

Conclusion

- Favorable comparison to land-based animal agriculture
  - Contained systems reduce interaction with environment
- Dietary health: Benefits outweigh specific risks
- Food safety and trade are important

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Conclusion

- Role in healthy and sustainable food systems:
  - Replace other sources of animal protein
  - Produce food at low price point and/or teach people how to produce it
  - Focus on innovation, transparency to protect the environment and public health

THE ATLANTIC SALMON.

Salmo salar, L. (p. 468.)

Drawing by H. L. Todd, from specimen in the U. S. National Museum, taken in the Delaware River.

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