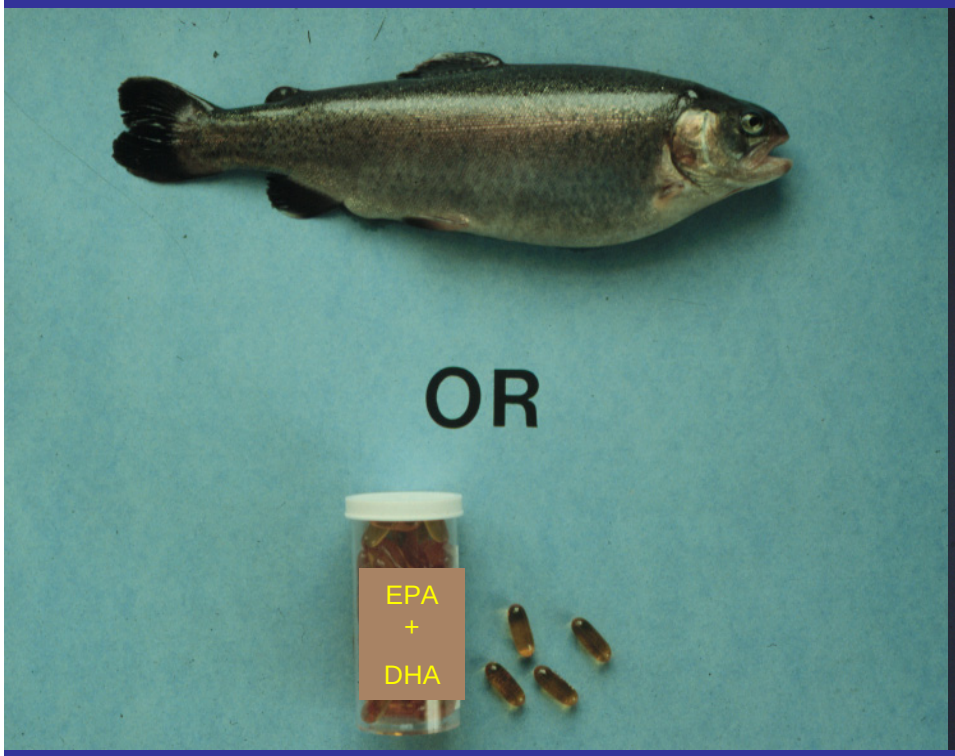
Omega-3 Levels in Fish: Data Quality, Quantity, and Future

2009 National Forum on Contaminants in Fish
Portland, Oregon
November 4th, 2009

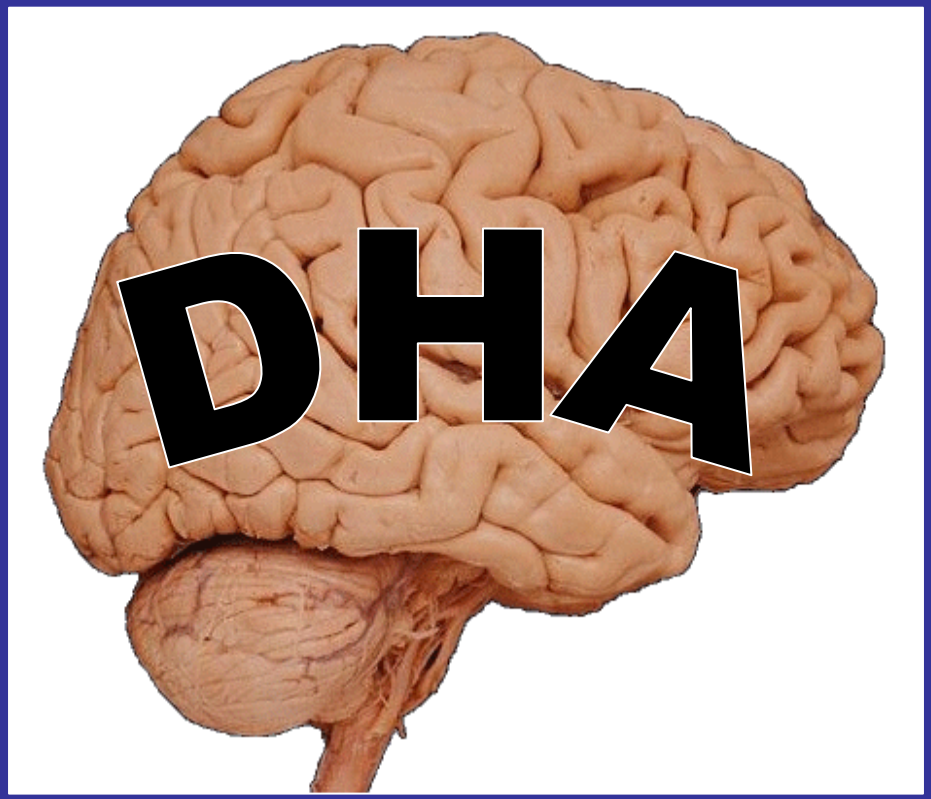
Bruce J. Holub, Ph.D.
University Professor Emeritus
Department of Human Health and Nutritional Sciences
University of Guelph
Guelph, ON Canada N1G 2W1
bholub@uoguelph.ca

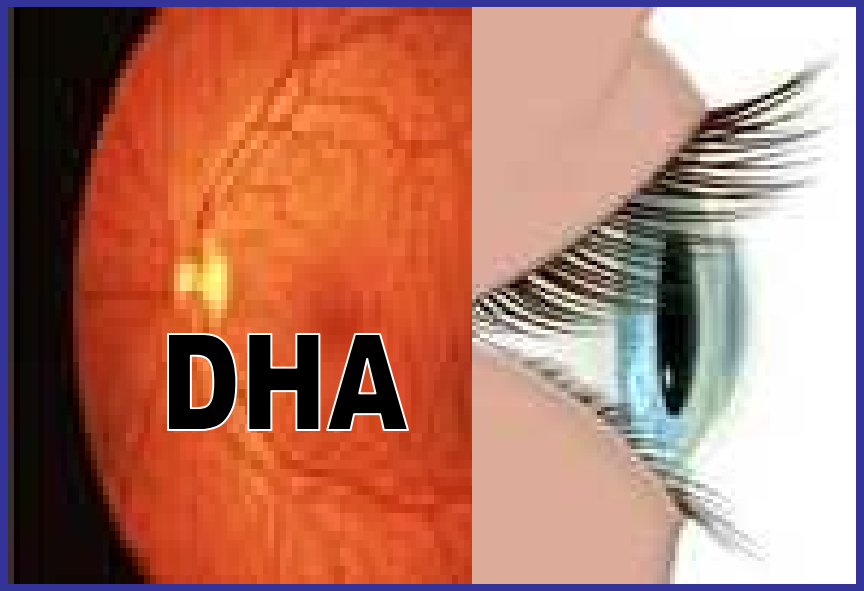
Fish-based Omega-3 Fatty Acids

(EPA – eicosapentaenoic acid plus DHA – docosahexaenoic acid)



© B. Holub 2009





Brain DHA

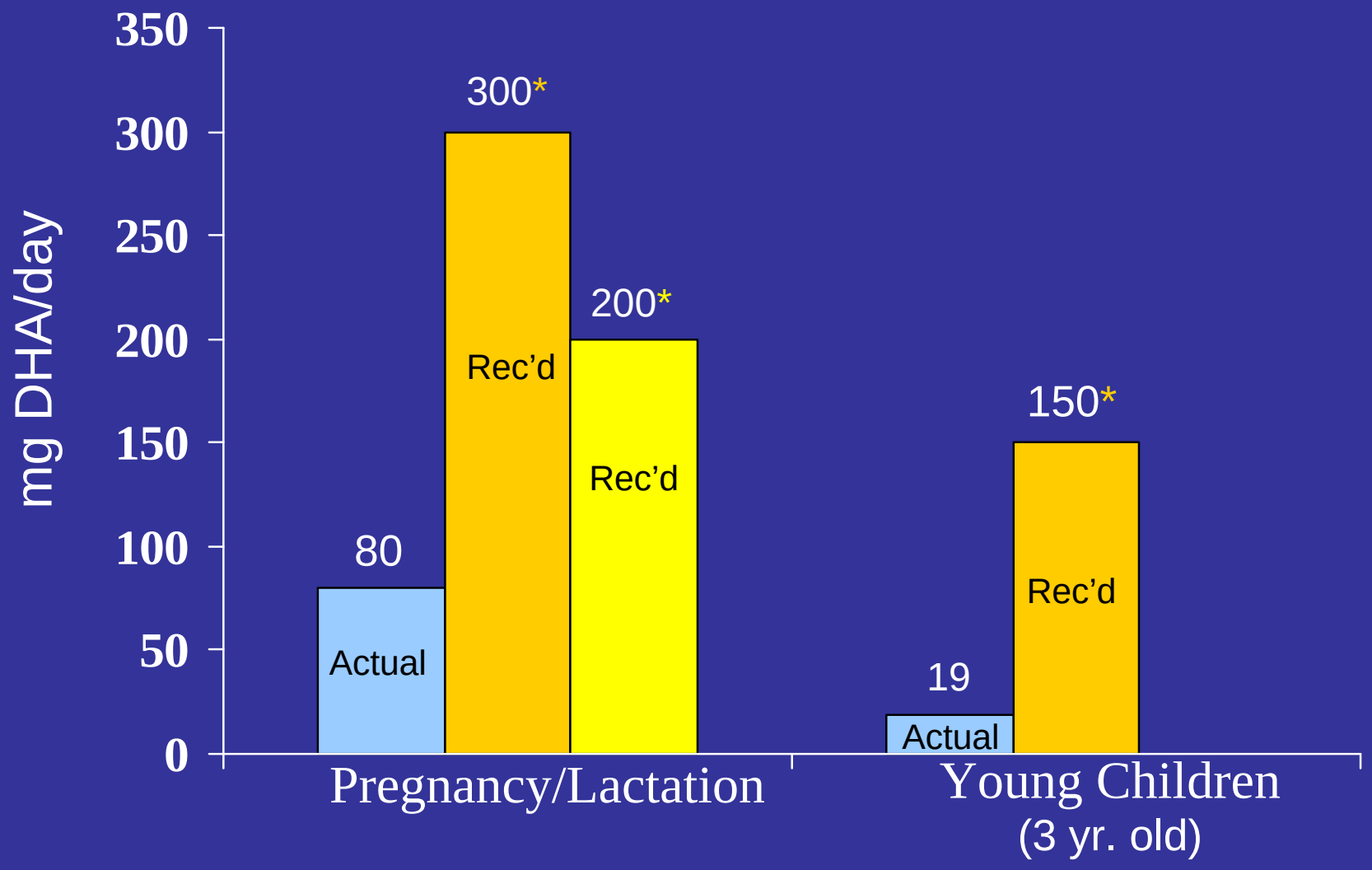
Retina (eye) DHA

NB: The amount of DHA in the brain increases approximately 30-fold from about 24 weeks gestation to about two years of age

(*Neonatal Network* 2007; **26**: 229-234).

BJ Holub

Actual vs. Recommended Intakes* of DHA (omega-3) for Women During Pregnancy and Lactation and in Young Children



*NIH Workshop (Bethesda, MD, USA, 1999)

*European Commission (PeriLip, 2007)

BJ Holub

Health Canada Santé Canada

Your health and safety... our priority. *Votre santé et votre sécurité... notre priorité.*

Prenatal Nutrition Guidelines for Health Professionals

Fish and Omega-3 Fatty Acids

Key Messages on Fish for Women of Childbearing Age

- Have at least 150 grams (5 ounces) of cooked fish each week (incl. salmon, trout, herring, canned light tuna, sole).

- Vary the types of fish you eat and follow advice from health Canada to limit your exposure to environmental contaminants such as mercury (caution- shark, swordfish, marlin, orange roughy, fresh and frozen tuna).

Personal Commentary:

- 150 grams Atlantic Salmon (farmed) weekly provides 312 mg DHA/day
- 150 grams sole weekly provides 55 mg DHA/day
- Problem : Fish advisories/ recommendations need to carefully consider target intakes of DHA omega-3 fatty acids based on amounts of DHA or DHA/EPA per fixed serving size (eg., 3.5 oz. or 100 gm).

The Journal of Nutrition
Nutrient Requirements and Optimal Nutrition

Direct Diet Quantification Indicates Low Intakes of (n-3) Fatty Acids in Children 4 to 8 Years Old[1,2]

Sarah M. M. Madden, Colin F. Garrioch, and Bruce J. Holub*

Department of Human Health and Nutritional Sciences, University of Guelph, Guelph, Ontario, Canada, N1G 2W1

J. Nutr. 139: 528–532, 2009.

TABLE 3 Intakes of (n-3) fatty acid by aged 4- to 8-y-old Canadian children in relation to recommendations from various international sources[1]

					% Meeting recommendation			
Source of recommendation	ALA	DHA	DHA+EPA	DHA+EPA+DPA	ALA	DHA	DHA+EPA	DHA+EPA+DPA
North America	900 mg	N/A[2]	Up to 90 mg	N/A	61%	N/A	22%	N/A
Australia/New Zealand	800 mg	N/A	N/A	55 mg	68%	N/A	N/A	51%
Netherlands	1% of energy	N/A	N/A	0.15–0.20 of energy	20%	N/A	N/A	20%
Belgium	0.45–1.50% of energy	0.10–0.40% of energy	N/A	N/A	83%	15%	N/A	N/A
ADA and DC	0.6–1.2% of energy	N/A	351 mg/d	N/A	68%	N/A	10%	N/A

Biological Role Claims

‘Omega-3 fatty acids contribute to good health and normal growth and development.’

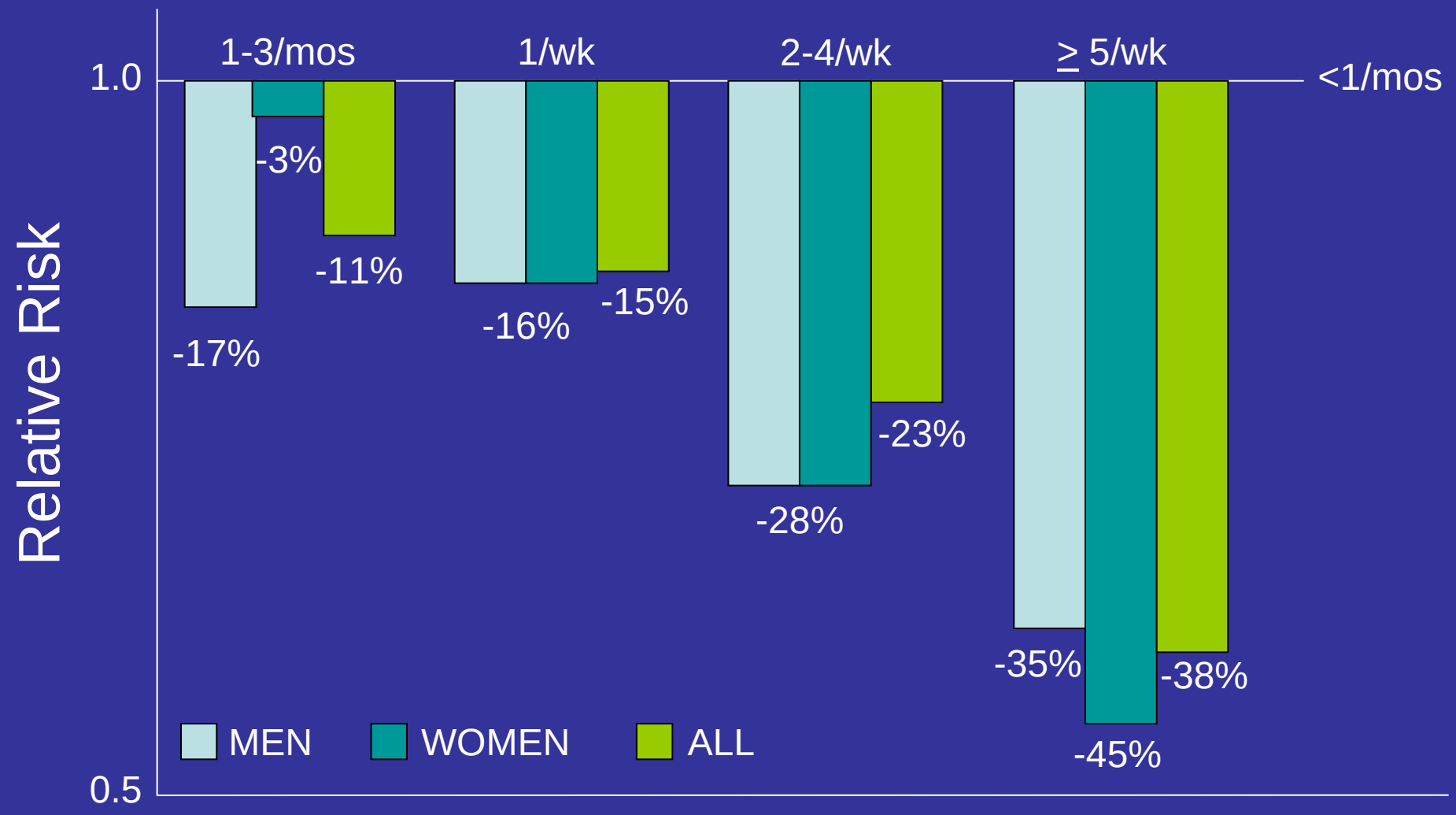
‘DHA, an Omega-3 fatty acid, supports normal development of the brain, eyes and nerves.’

Fish Intake in U.S. Children

16% of U.S. children consumed no fish or shellfish during a 12-month period and the average consumption rate among those who ate fish (the remaining 84%) was <1 meal per week.

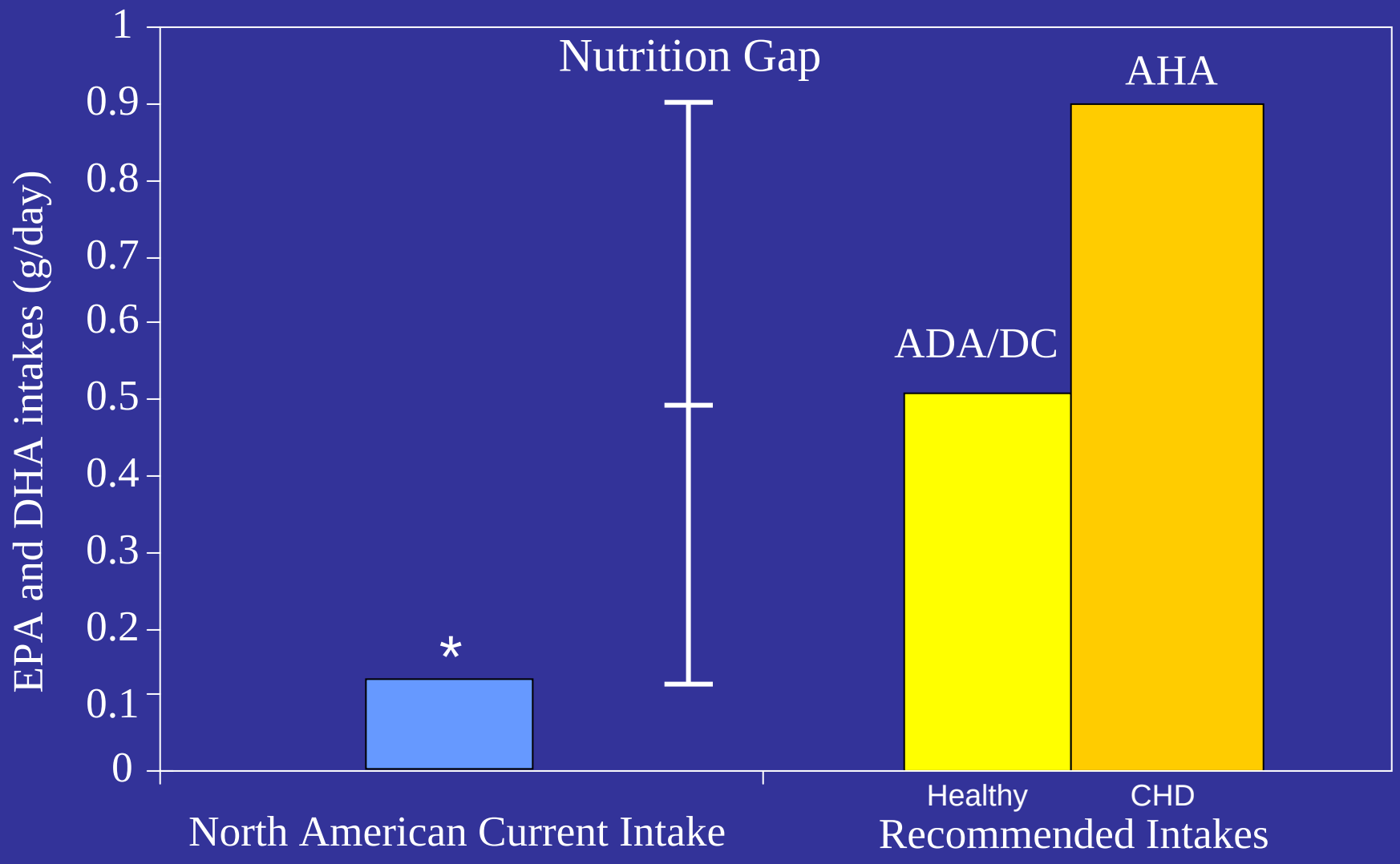
Ref: Imm *et al.*, Environ. Res., 103:198-209 (2007).

CHD Mortality and Fish Consumption



Meta-analysis of cohort studies (222,364 subjects with 11.8 yr. follow-up)
He *et al.*, Circ., 109: 2705-2711, 2004.

© B. Holub 2009



* Denomme, Stark, and Holub. J. Nutr., 135: 206-211, 2005

© B. Holub 2009

Are dietary recommendations for the use of fish oils sustainable?

Ref: Jenkins *et al.*, CMAJ 180:633-637 (2008).

Conclusions:

‘Until renewable sources of long-chain omega-3 fatty acids – derived from plant, algae, yeast or other unicellular organisms – become more generally available, it would seem responsible to refrain from advocating to people in developed countries that they increase their intake of long-chain omega-3 fatty acids through fish consumption.’

‘Half of the fish consumed globally is now raised on farms, study finds’

"Aquaculture is set to reach a landmark in 2009, supplying half of the total fish and shellfish for human consumption," the authors wrote.

"The huge expansion is being driven by demand," said lead author Rosamond L. Naylor, a professor of environmental Earth system science at Stanford University and director of the Stanford Program on Food Security and the Environment. "As long as we are a health-conscious population trying to get our most healthy oils from fish, we are going to be demanding more of aquaculture and putting a lot of pressure on marine fisheries to meet that need."

Ref: Naylor *et al.*, Proc. Nat. Acad. Sci. Sept,8 (2009).

Quantitative analysis of the benefits and risks of consuming farmed and wild salmon

Ref: Foran *et al.*,J. Nutr. 135: 2639-2643 (2005).

‘Recommended levels of (n-3) fatty acid intake, as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), may be achieved by consuming farmed or wild salmon while maintianing and acceptable level of noncarcinogenic risk.’

‘However, the recommended level of EPA+DHA intake cannot be achieved solely from farmed or wild salmon while maintaining an acceptable level of carcinogenic risk.’

NUTRA
ingredients-usa.com

Breaking News on Supplements & Nutrition - North America

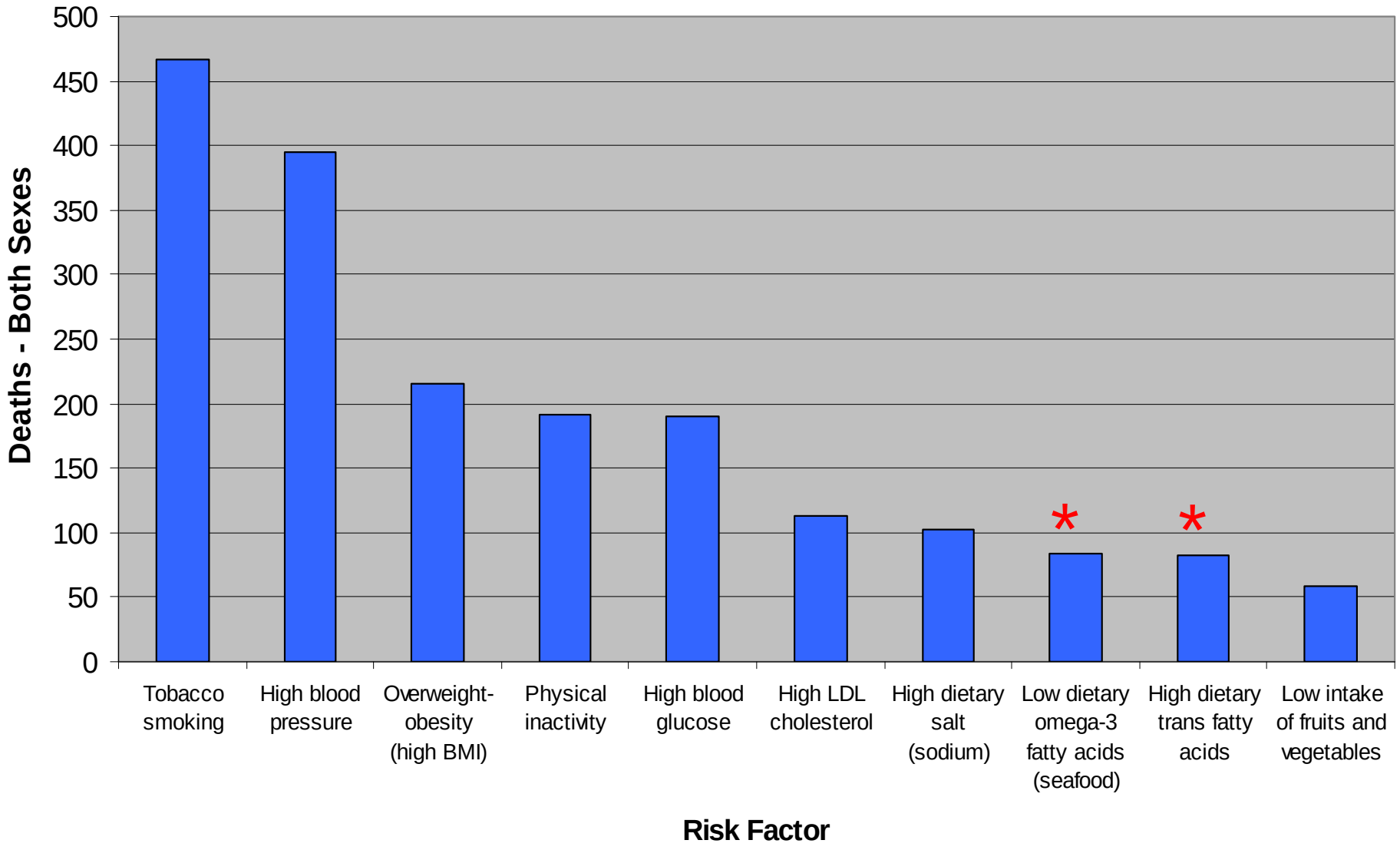
Omega-3 deficiency causes 96,000 US deaths per year, say researchers

By Shane Starling, 26-Jun-2009

Related topics: Nutritional lipids and oils, Cardiovascular health, Cognitive and mental function

Omega-3 deficiency is the sixth biggest killer of Americans and more deadly than excess trans fat intake, according to a new study.

Preventable Causes of Death (all-cause) in the United States (thousands per year)



Ref: PLoS Med., 6(4), (2009).

© B. Holub 2009

Risk/Benefit Assessment of Health Risk Parameters (End- Points) ?

Eg., ‘Acceptable’ carcinogenic risk (1 in 100,000 or 0.001%) due to contaminants in fish vs. 30% higher risk of cardiovascular disease due to insufficient intakes of DHA/EPA from fish.

USDA ars Agricultural Research Service

NUTRIENT DATA LABORATORY

Search the USDA National Nutrient Database for Standard Reference

http://www.nal.usda.gov/fnic/foodcomp/search/index.html

The content of favorable and unfavorable polyunsaturated fatty acids found in commonly eaten fish

Ref: Weaver *et al.*, J. Am. Dietetic Assoc., 108:1178-1185 (2008).

'…tilapia (the fastest growing and most widely farmed fish) and catfish have much lower concentrations of n-3 PUFA, very high ratios of long chain n-6 to long chain n-3 PUFAs, and high saturated fatty acid plus monounsaturated fatty acid to PUFA ratios.'

'For individuals who are eating fish as a method to control inflammatory diseases such as heart disease, it is clear from these numbers that tilapia is not a good choice.'

Globe Life

Farmed tilapia may be no better for you than a doughnut

CARLY WEEKS

From Wednesday's Globe and Mail Published on Wednesday, Aug. 06, 2008 9:00AM EDT Last updated on Tuesday, Mar. 31, 2009 8:27PM EDT

'…eating farmed tialpia, a widely consumed fish that has been steadily growing in popularity, may be no better than dining on bacon, hamburgers or doughnuts.'

'New U.S. research has found that farmed tilapia have low levels of omega-3 fatty acids – and surprisingly high levels of potentially detrimental omega-6 fatty acids.'

'It is a finding that could have serious implications for people who suffer from arthritis, asthma and other illnesses or allergies because the omega-6 fatty acids may cause inflammation, which can damage blood vessels and vital organ tissue, according to the findings, published in last month's Journal of American Dietetic Association.'

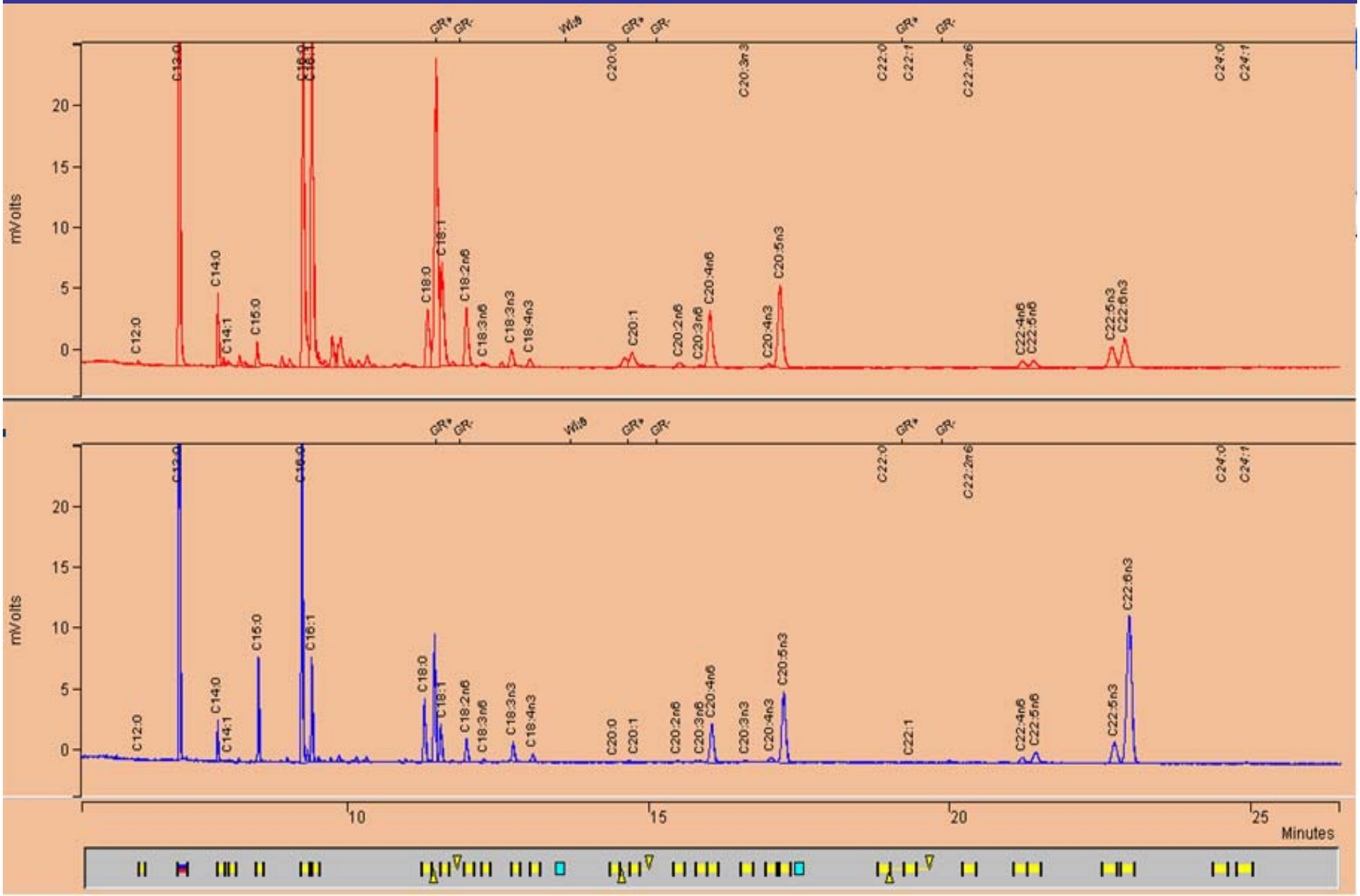
'But consuming too much omega-6 can contribute to cancer, asthma, depression and heart disease, among other ailments.'

‘Omega-6 Fatty Acids and Risk for Cardiovascular Disease’:

A Science Advisory From the American Heart Association Nutrition Subcommittee of the Council on Nutrition, Physical Activity, and Metabolism; Council on Cardiovascular Nursing; and Council on Epidemiology and Prevention Ref: Harris *et al.*, Circ., 119:902-907 (2009).

‘In summary, the AHA supports an omega-6 PUFA intake of at least 5% to 10% of energy in the context of other AHA lifestyle and dietary recommendations. To reduce omega-6 PUFA intakes from their current levels would be more likely to increase than to decrease risk for CHD.’

GLC Top = Round Sheepshead, Bottom = Round Pickerel



Lake Erie Fish: Absolute Amounts of n-3 PUFA (mg/100 gm)

Fatty Acids	Jumbo Pickerel Filet	Round Yellow Perch	Yellow Perch Filet	Round Smelt
DHA	188.5	225.6	146.9	265.9
EPA	64.6	92.0	43.8	121.4
DHA + EPA	253.1	317.6	190.7	387.3
All n-3	294.3	361.6	211.7	464.5

© B. Holub 2009

Lake Erie Fish: Absolute Amounts of n-3 PUFA (mg/100 gm)

Fatty Acids	Bass Filet	Round Bass	Round Pickerel	Round Sheepshead
DHA	217.9	306.9	286.5	78.8
EPA	95.3	186.6	102.9	168.8
DHA + EPA	313.2	493.5	389.4	247.6
All n-3	395.5	676.0	465.1	345.1

© B. Holub 2009

Omega-3 Contents of Siscowet Lake Trout*

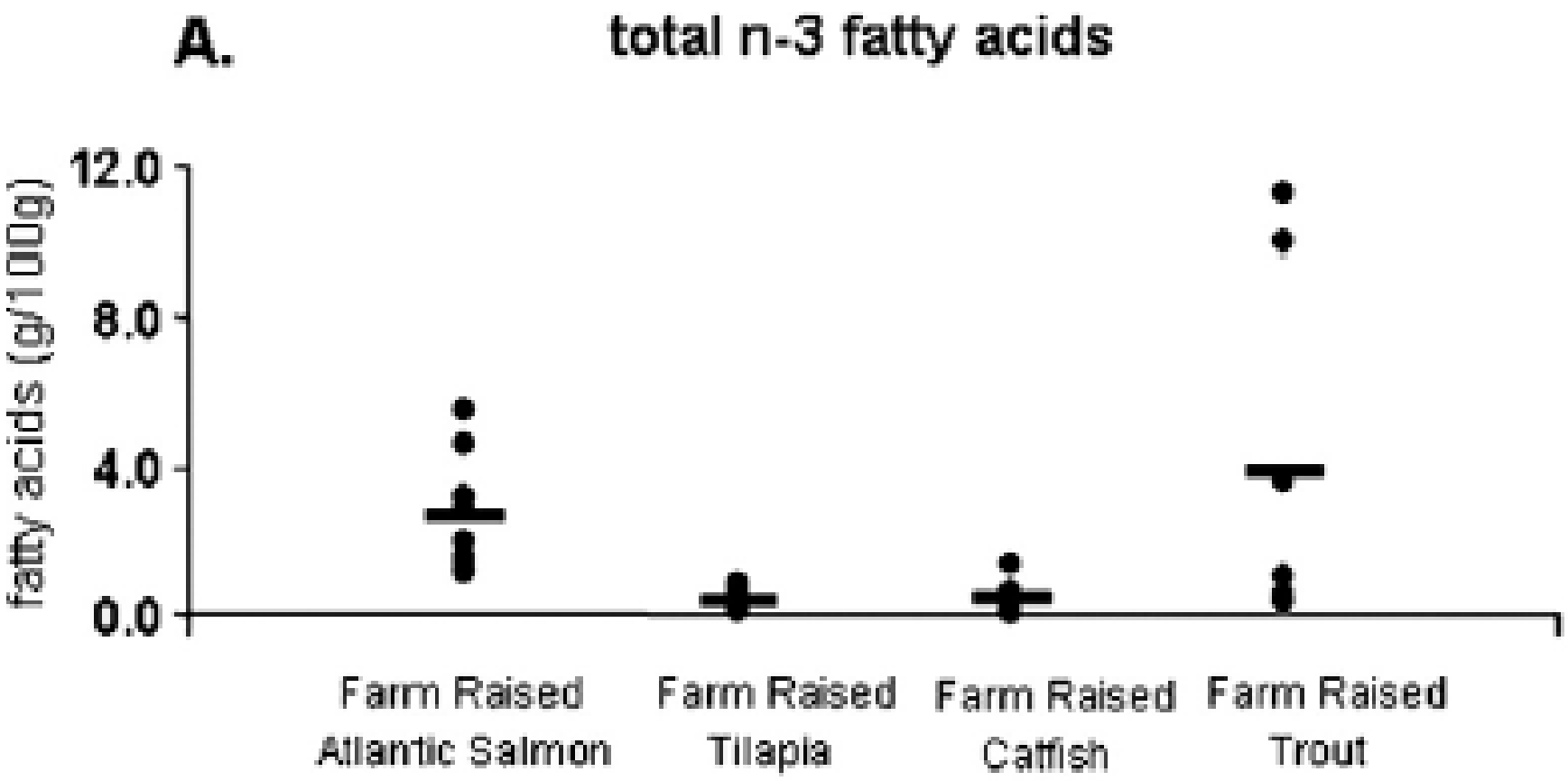
Omega-3 Fatty Acid	mg/100 gm	Relative % of Total Fatty Acids
DHA	1476	11.2
EPA	792	6.0
DHA + EPA	2268	17.2
All n-3**	4664	35.3

*Sent to our lab for fatty acid analysis (July/09) by Dr. Ron Kinnunen. Total fatty acid content was 13,212 mg/100 gm (i.e., 13.2% by wt. as summed fatty acids).

**Includes (EPA + DHA) + other 18-carbon plus 20-carbon plus 22-carbon fatty acids of the omega-3 (n-3) family.

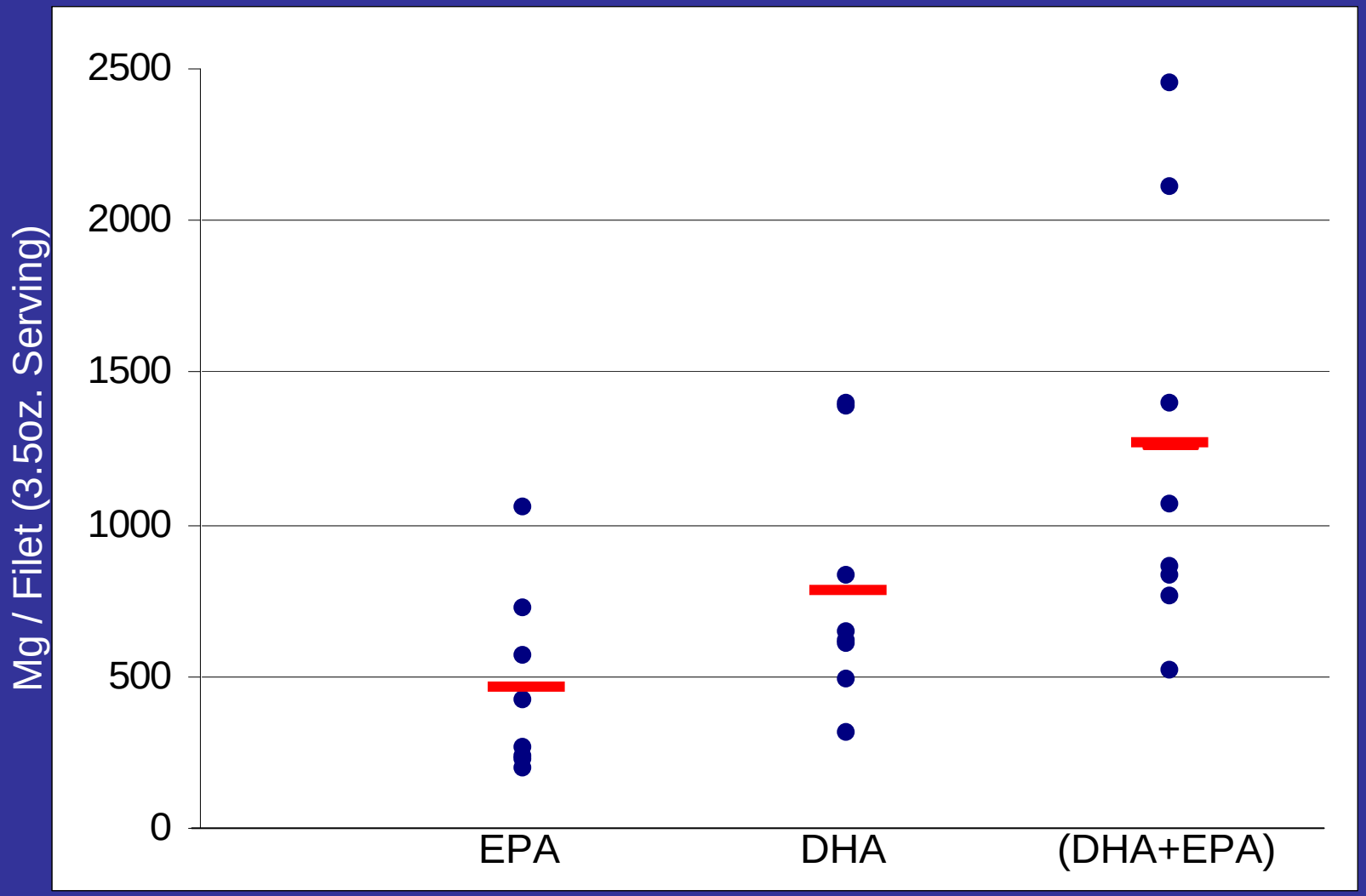
Data provided by: Prof. Bruce Holub, Univ. of Guelph

Email: bholub@uoguelph.ca



Ref: Weaver *et al.*, J. Am. Dietetic Assoc., 108:1178-1185 (2008).

Siscowet Lake Trout (off Grand Marais, Lake Superior)



Note: Samples (different age, size, sex, depth) provided by Mike Ripley (Inter-Tribal Fisheries Assessment Pgm., Sault Ste. Marie, MI) to Prof. B Holub for analyses (Aug., 2009).

© B. Holub 2009

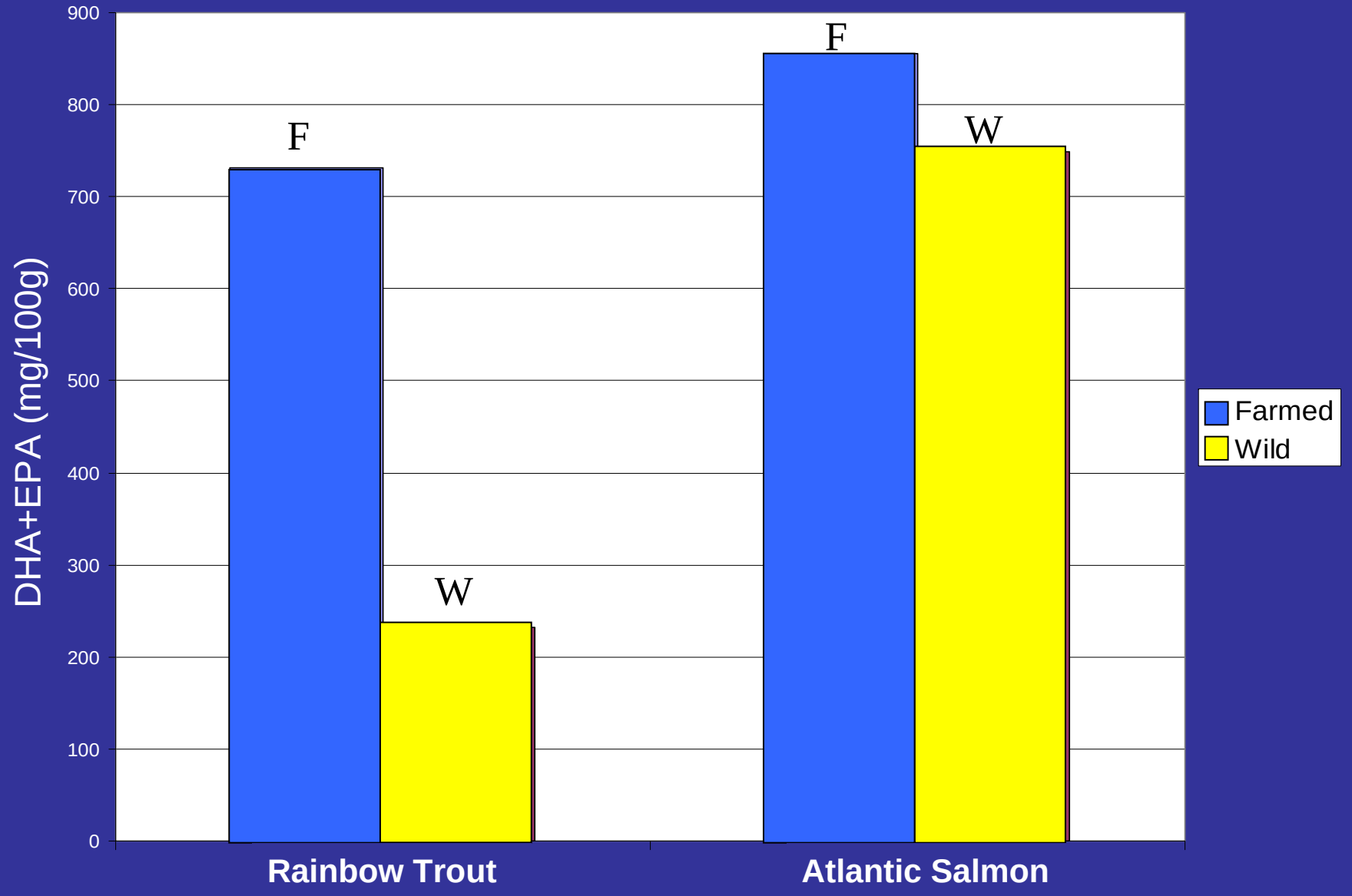
Monday, January 23, 2006 Issue 58 VOLUME 3 ISSUE 58

In This Issue

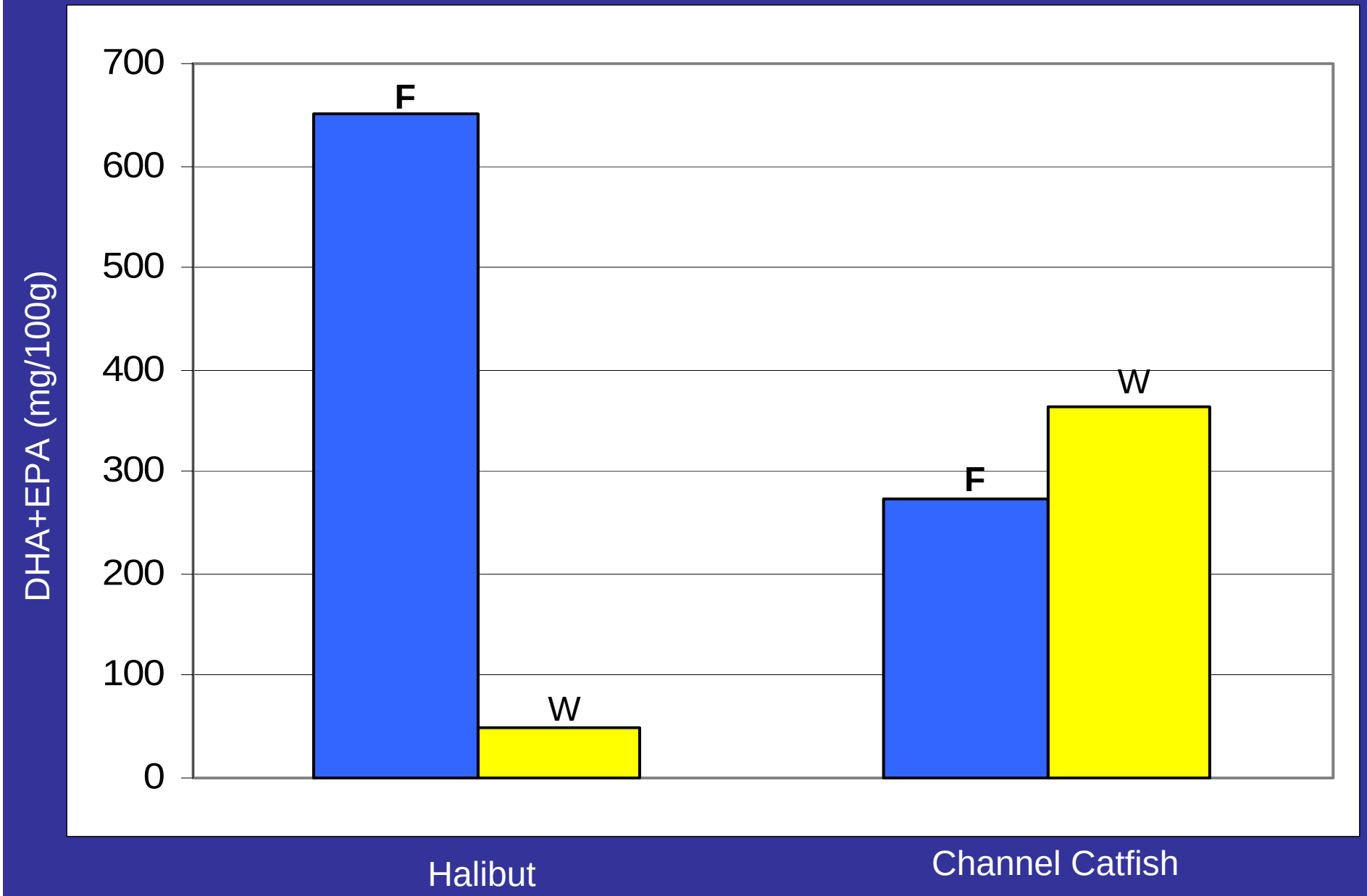
Farmed Salmon's Diet Yields Unhealthful Cardiovascular Effects

Fish doctors find plant oils in standard feed regimen may slash heart benefits of farmed salmon

Farmed vs. Wild Fish (Canada)



Dewailly et al. Food & Chem. Tox., 45:1343-1348 (2007)



Ref: Olsson *et al.*, Aquaculture, 217: 191-205 (2003).

USDA

Number of Fish Servings (3.5oz.) needed per week to meet target intake for DHA or (DHA+EPA)

	Servings per Week		
Fish	Pregnancy/Lactation (EU-200 mg DHA/day)	Child (4-8 yrs.) (N.Am. – 90 mg (DHA+EPA)/day)	Adult (ADA/DC – 500 mg (DHA/EPA)/day)
Salmon (Wild Atlantic)	1.0	0.3	1.9
Rainbow Trout (Farmed)	1.7	0.5	3.0
Cod (Pacific)	8.1	2.3	12.7
Tilapia	10.8	4.7	25.9
Round Pickerel (Lake Erie)	4.9	1.6	9.0
(S. Lake Trout (Lake Superior)	0.9	0.3	1.5

© B. Holub 2009

Overall Recommendations:

1) Much more extensive compositional data on the fatty acid contents (omega-3 plus others) of the numerous fish options available to consumers are needed to support the important role that fish containing DHA/DPA/EPA can play in enhancing human health throughout the life cycle and to fill the 'nutrition gap' between actual and target / recommended intakes.

2) Fish advisories / recommendations need to be based upon the known amounts of DHA, (DHA+EPA), or total long-chain omega-3 fatty acids (DHA+DPA+EPA) per specific serving size(s) as well as considering target intakes of omega-3 fatty acids for sectors within the population (pregnacy / lactation, children, healthy adults, those with various chronic disorders, and others) in conjunction with consideration of known contaminants (types / levels).

3) Due to the extremely wide variance in the amounts of DHA and EPA per serving of a given fish species (due to numerous factors), nutritional information on these omega-3 amounts should be made available at point-of-purchase for fresh / frozen fish as well as processed fish products. Such content declarations should be based on the minimal amount of DHA/EPA present per serving (with 95% confidence) or 'typical' values if such are within variance limits of 15-20% of actual amounts.

© B. Holub 2009

DHA/EPA OMEGA-3 INSTITUTE

www.DHAomega3.org

- Overview of Omega-3 fatty acids
- DHA/EPA and life stages
- DHA/EPA news and latest research
- DHA/EPA and health conditions

© B. Holub 2009