Are Lake Trout, *Salvelinus namaycush*, from Flathead Lake, MT "Safe" to Eat?

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Lake Trout

- Long living, predacious
- Largest native trout NA
- Introduced in 1905
- Population explosion
- 1990's 800,000 fish
- Extirpated Kokanee
- Now, 400,000 fish
- 2002 first Mack Days

Bob Orusa, Mo Fish Charters in Lakeside, MT. 43" 31.1 lbs

Why Mercury?

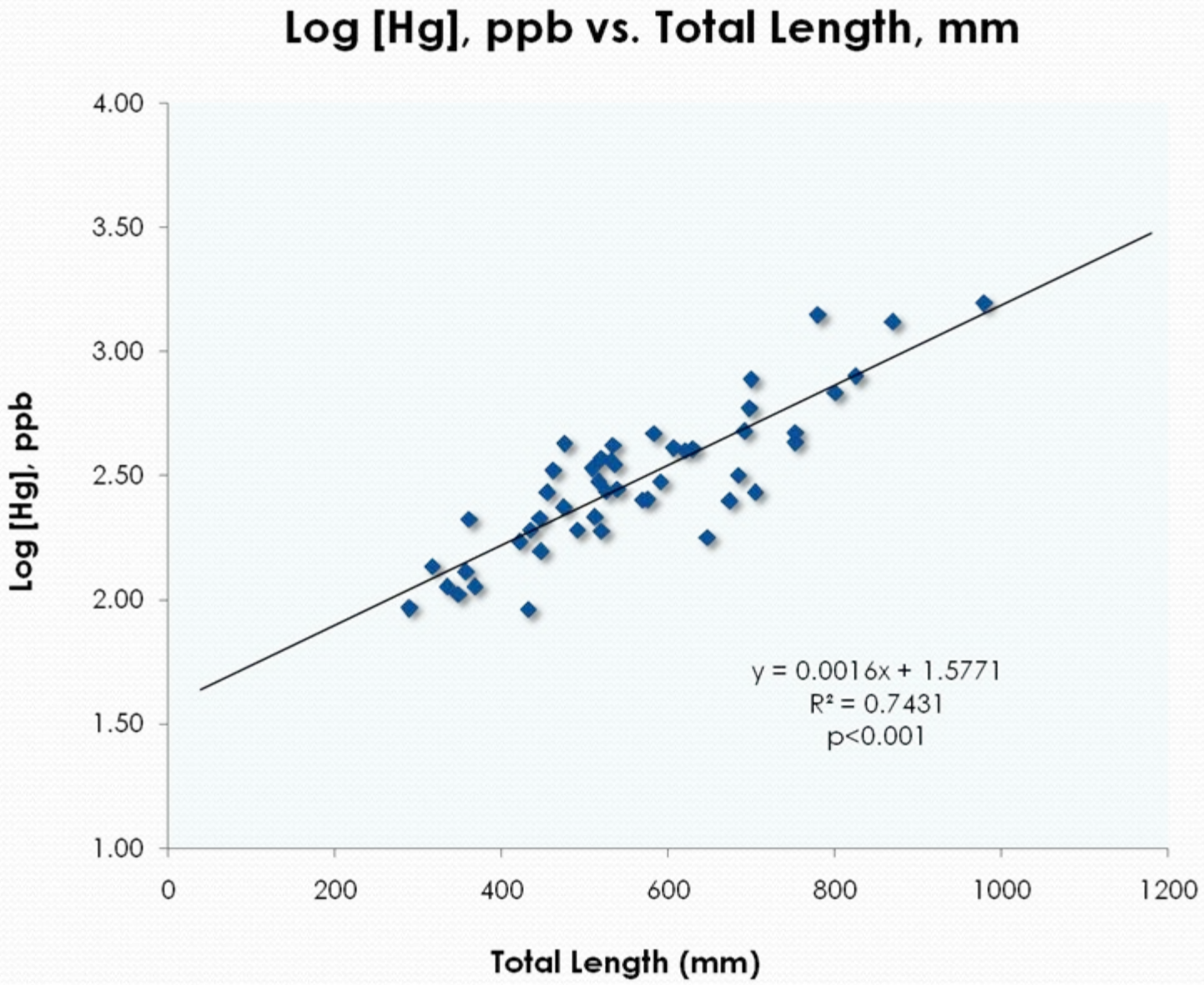
Mercury (Hg) is listed by the International Program of Chemical Safety as one of the **most dangerous chemicals** in the environment. [Gilbert and Grant-Webster 1995]

- Broad geographic extent of Hg accumulation
- Increasing global signal of Hg deposition
- Prior to 2003, global lacking of regulations to control the uses and disposal of Hg. [United Nations Environment Programme, 2003]
- After methylation in placid water systems, $MeHg^{+}$ becomes labile and readily moves through food web systems
- In terrestrial organisms, the presence of Hg has been correlated to decrease in reproductive processes, neurological damages/changes, abnormal behaviors, and ultimately, death.

THE SOURCES:

- Industrial sectors: Coal fired electric generators & mining
- Volcanoes, natural occurrence in soils as Mercuric Sulfide
- Mercury, gold, and silver mines
- Toxic waste sites
- Wastewater treatment plants/sewer
- Byproduct of chloralkali process
- Anti-fungal seed coatings

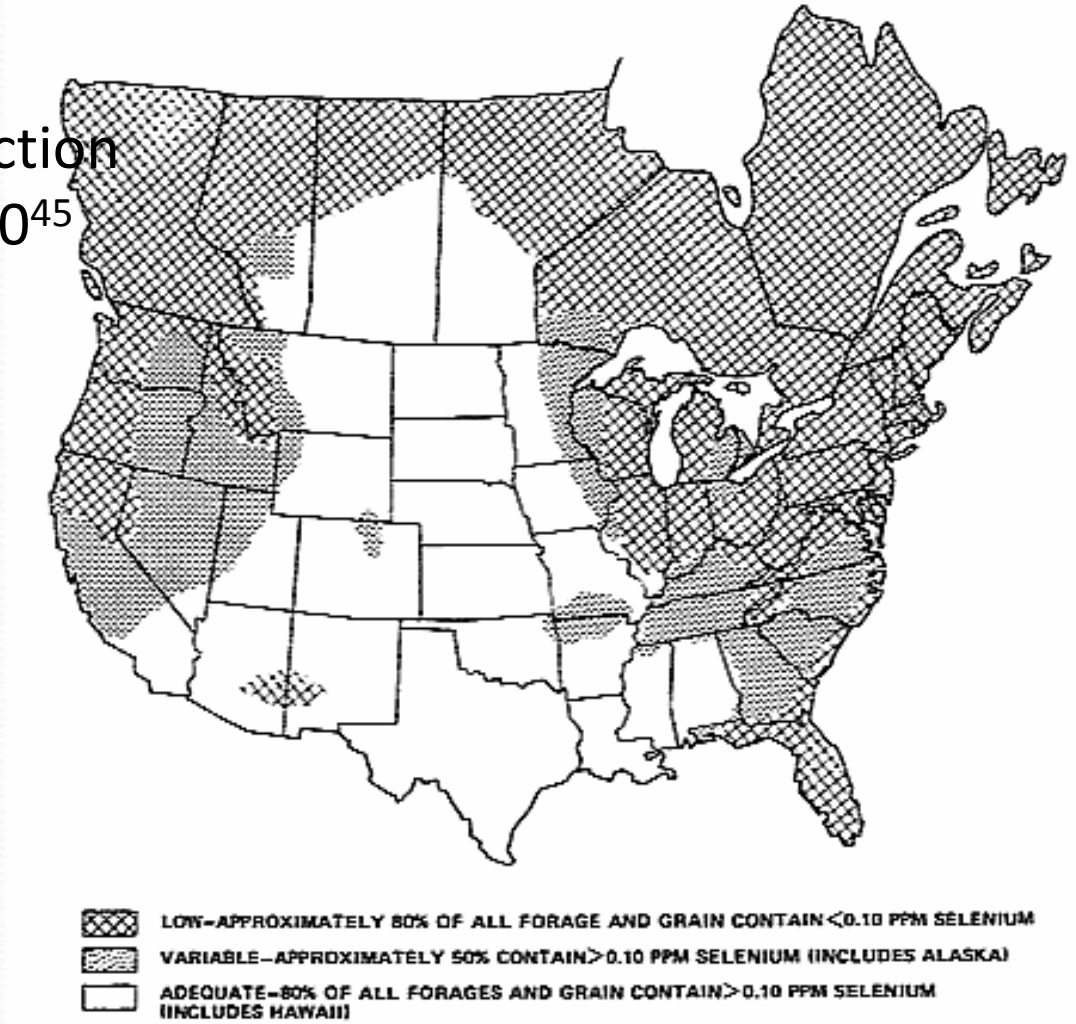
[Hg]


Log [Hg], ppb vs. Total Length, mm
Log [Hg], ppb
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0
200
400
600
800
1000
1200
Total Length (mm)
y = 0.0016x + 1.5771
R² = 0.7431
p<0.001

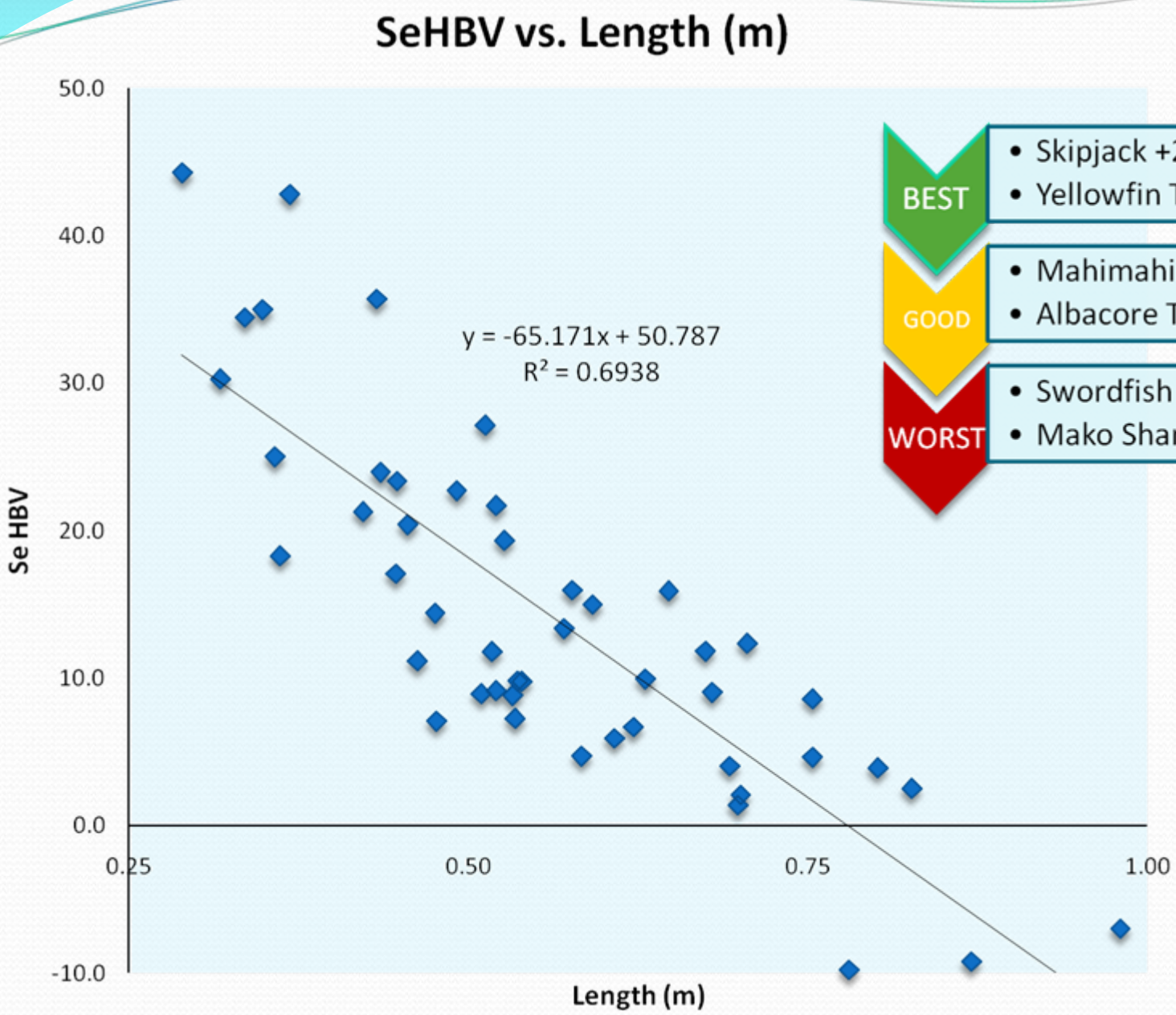
What factors can moderate $MeHg^+$ toxicity resulting from fish consumption?

Selenium

- Ocean fish are rich in Se
- Essential nutritional trace element
- 25-35 essential enzymes
  - Brain & endocrine system
  - Antioxidant/cellular protection
- High binding affinity for Hg ~10^{45}



Se HBV



BEST
- Skipjack +232.7
- Yellowfin Tuna +201.7

GOOD
- Mahimahi +78.4
- Albacore Tuna +45.4

WORST
- Swordfish +0.1
- Mako Shark -11.1

Ralston et al. 2008

FISH FATTY ACIDS

Omega-3 Fatty Acids:

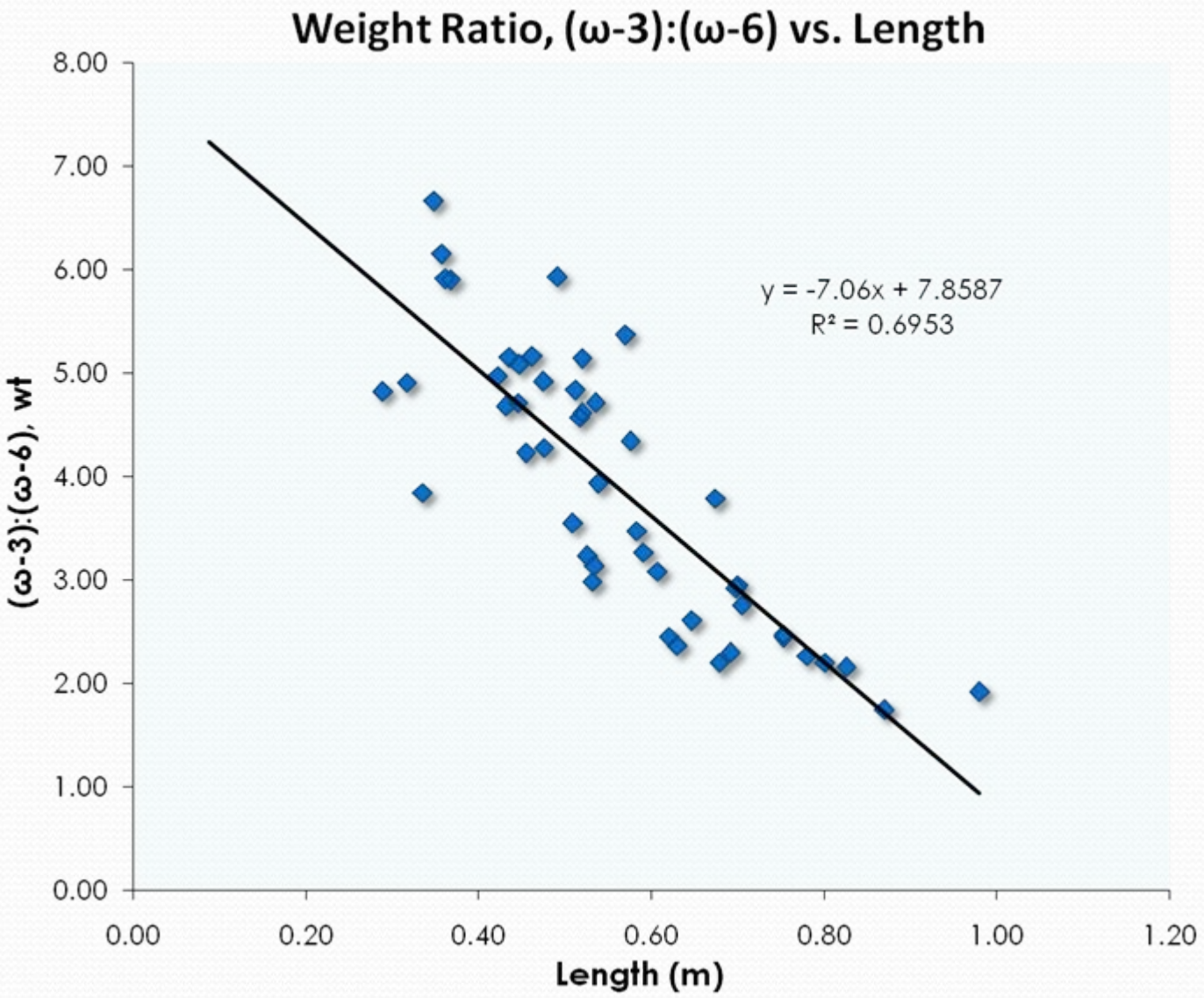
- Beneficial neurological effects on developing fetuses
- Improvement in neurologic and psychological disorders
- Enhanced eye and brain development in early life
- Decrease risk of arrhythmias
- Decrease triglyceride levels
- Decrease growth rate of atherosclerotic plaque
- Lower blood pressure (slightly)
- Improvement in rheumatoid arthritis
- Lower risk of type 2 Diabetes

Omega-6 Fatty Acids:

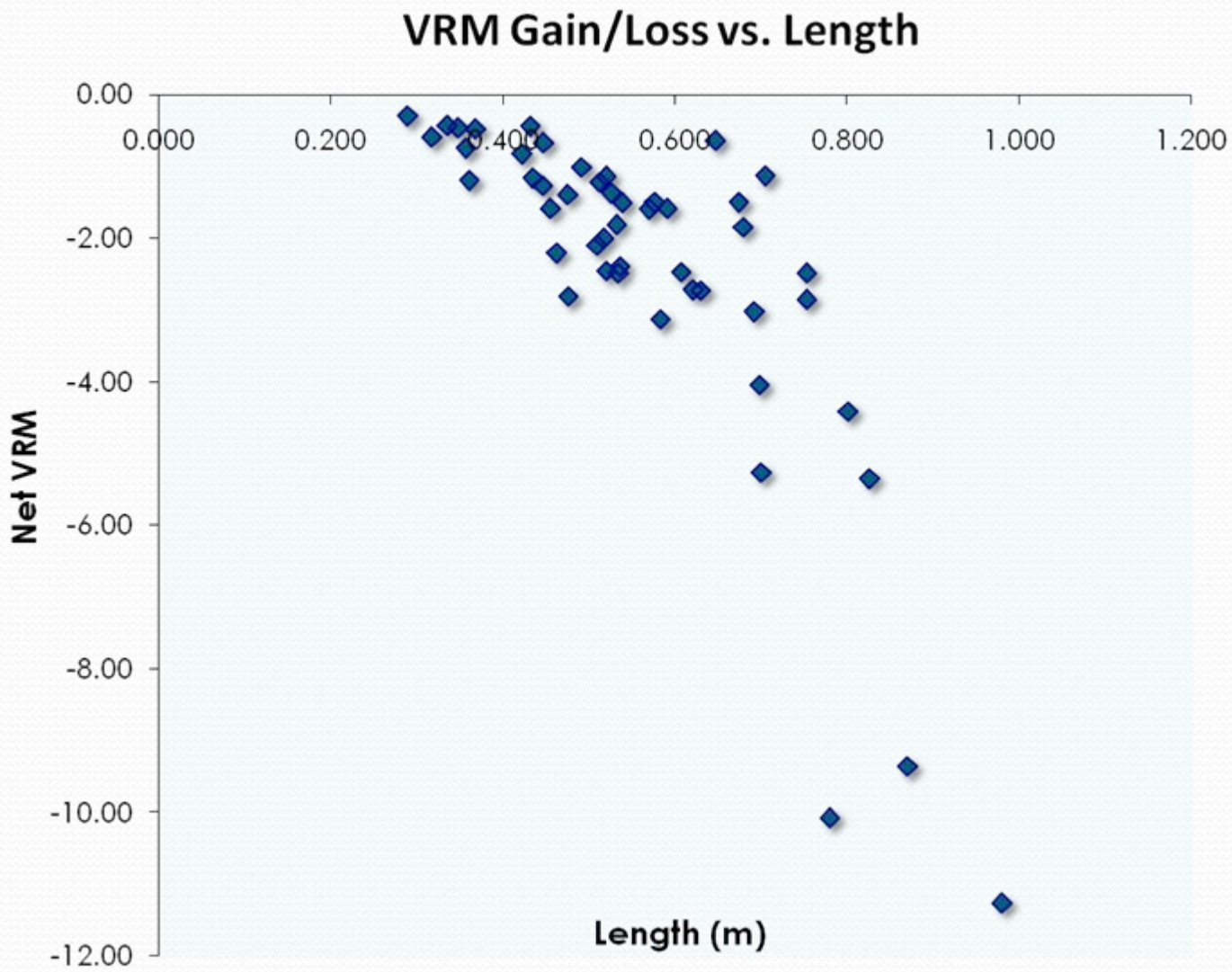
- Increase inflammation
- Increase risk of asthma
- Increase risk for rheumatoid arthritis
- Increase risk for atherosclerosis

Higher ratios of ω-3:ω-6 are more desirable

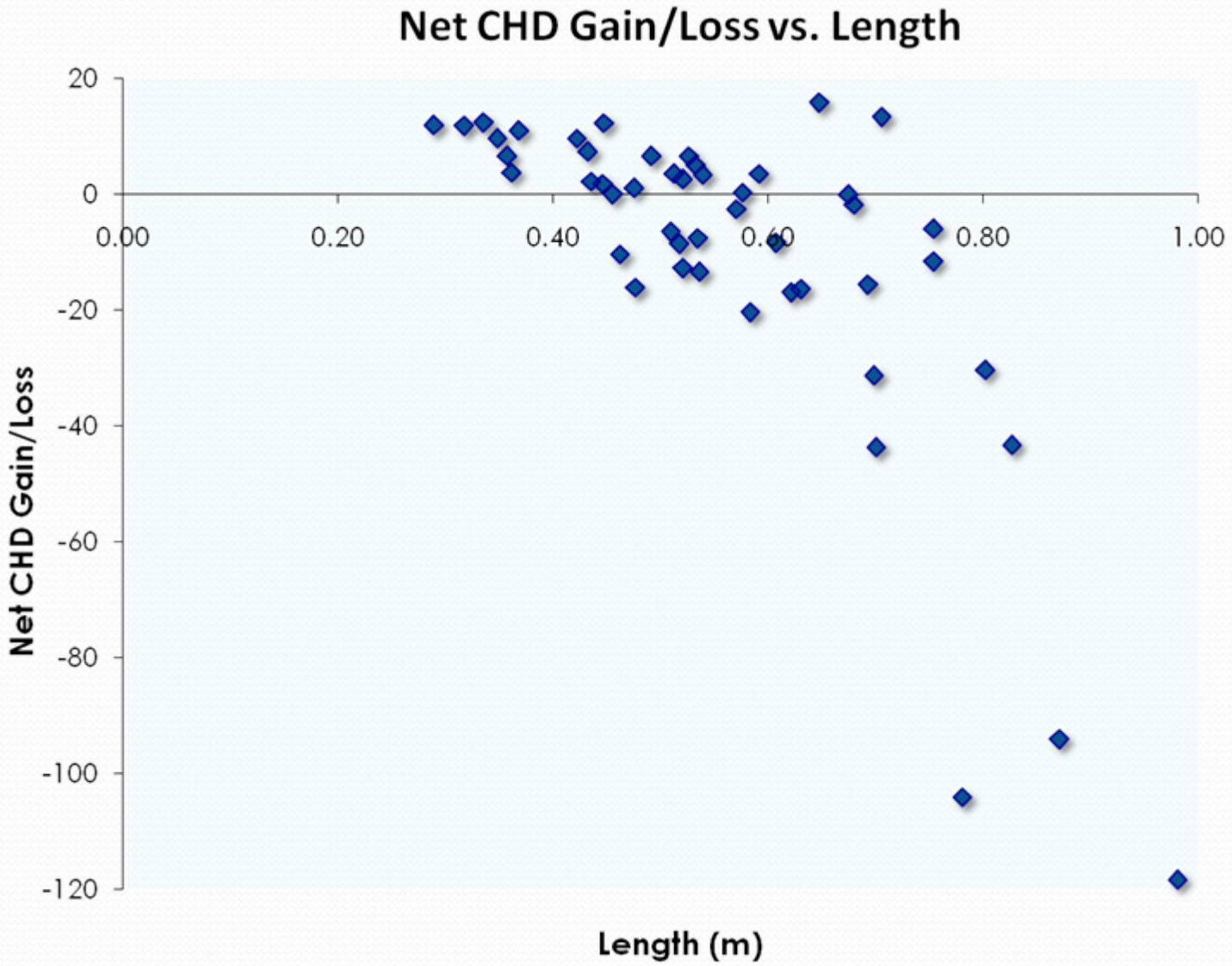
[ω-3:ω-6]


Weight Ratio, (ω-3):(ω-6) vs. Length
y = -7.06x + 7.8587
R² = 0.6953
(ω-3):(ω-6), wt
Length (m)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
0.20
0.40
0.60
0.80
1.00
1.20

VRM RESULTS (Visual Recognition Memory Assessment)



CHD RESULTS (Coronary Heart Disease Mortality)



FISH CONSUMPTION ADVISORIES

MONTANA CONSUMPTION LIMITS FOR WOMEN OF CHILDBEARING AGE

FISH [Hg], ppm[1]	EPA meals/mo	Size (in)[2]	MT meals/mo[3]	VRM	Se-HBV
>0.078 - 0.12	8	8 - 12	NA	0	++
>0.12 - 0.23	4	12 - 19	7	0 to -	+
>0.23 - 0.31	3	19 - 22	3	-	+ to 0
>0.31 - 0.47	2	22 - 26	3	--	0
>0.47 - 0.94	1	26 - 34	1	---	-

[1] = Taken from Table 4-3, EPA (2000)

[2] = Based on SKC data

[3] = Taken from MT Sport Fish Consumption Guidelines 2009, available at http://www.dphhs.mt.gov/PHSD/Food-consumer/food-safe-index.shtml

RESEMBLE SHARK

NEW GUIDELINES

PROPOSED NEW CONSUMPTION GUIDELINES FOR LAKE TROUT FROM FLATHEAD LAKE, MT

Size (inches)	6 - 10	10 - 14	14 - 18	18 - 22	22 - 26	26 - 30	30+
WC[1]	NA	NA	**7**	3	3	1	1
WC[2]	NA	6	**4**	3	2	0	0
Size (cm)	15 - 25	25 - 36	36 - 46	46 - 56	56 - 66	66 - 76	76+

NA = Spp. and size category not analyzed

WC = Women of childbearing age and children

[1] = Existing Montana 2009 guidelines

[2] = SKC recommendations

Discussion

Clearly the smaller fish are more beneficial to consume

- The most devastating effects of mercury are seen in pre- and postnatal brain development. These populations require conservative consumption limits whereas the effects on the remaining population are less dramatic.

- The state and tribal consumption advisories are liberal enough that they are not adequately protective. Our data indicate that length limits should be lowered, hence the proposed new guideline table.

- Current risk assessment models for $MeHg^{+}$ lack sufficient study data to provide precise limits. Therefore, **more study is needed before a safe $MeHg^{+}$ exposure can be determined.**
  - Local consumption
    - -Local fish spp. consumption?
    - -Lake Trout frequency & portion
    - -Commercial fish supplementation?
    - -Commercial fish frequency & portion

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RAIDERS
Montana
GRIZZLIES
ACE
pepsi