A Quantitative Approach to Determine Cardiovascular and Neurodevelopment Risks and Benefits from Methylmercury and Omega 3 Fatty Acids in Fish Consumed in the Columbia River Basin

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Fish Consumption

Fish:

- important part of a nutritionally balanced diet
- excellent source of low fat protein
- contains *omega-3 polyunsaturated fatty acids*

Fish consumption: *Benefits*

- Omega 3s
  - Reduce CHD mortality
  - Improve blood lipid profiles
  - Enhances eye and brain development
  - Lowers blood pressure
  - Improve rheumatoid arthritis
  - Increase visual acuity in newborns
  - Better scores on neurodevelopment tests

Fish consumption: *Risks*

Methylmercury ingestion:

Children

- Brain and nervous system effects

Adults

- Cardiovascular endpoints
  - Coronary Heart Disease(CHD)
  - Blood pressure
  - Hypertension

Fish Consumption Advisories (FCAs)

- All U.S. states have issued advisories based on methylmercury levels in fish
  - However, most advisories based solely on risks.
- FCAs are perceived differently within a population
  - may cause women of child-bearing age to avoid fish completely (Oken et al 2005)
- Given the multitude of benefits to be gained from fish consumption, a continued trend away from this is cause for public health concern

Risk/benefit Analysis

Ginsberg and Toal (2009)

- Developed a quantitative approach that uses established dose-response relationships to weigh omega 3 fatty acid benefits and methylmercury risks for cardiovascular disease in adults and neurodevelopment in 6-month-old infants from previous studies

Location

- Columbia river basin:
  - High per capita fish consumption
  - Frequent fish consumption advisories

- Potentially significant public health impact

- Lack of quantitative studies examining risks/benefits of fish consumption in the CRB

Significance and Justification

- Due to concern regarding exposure to methylmercury through fish consumption, significant benefits may be foregone when policy advice is based solely on risks

- This approach has the potential to help guide future fish consumption advisories and to provide species-specific fish consumption advice for commonly consumed fish species within the Columbia River Basin.

Methods

Equation 1

The dose response has a hair mercury threshold of 0.51 ppm before any adverse effect is evident and is therefore included in the equation

Equation 2

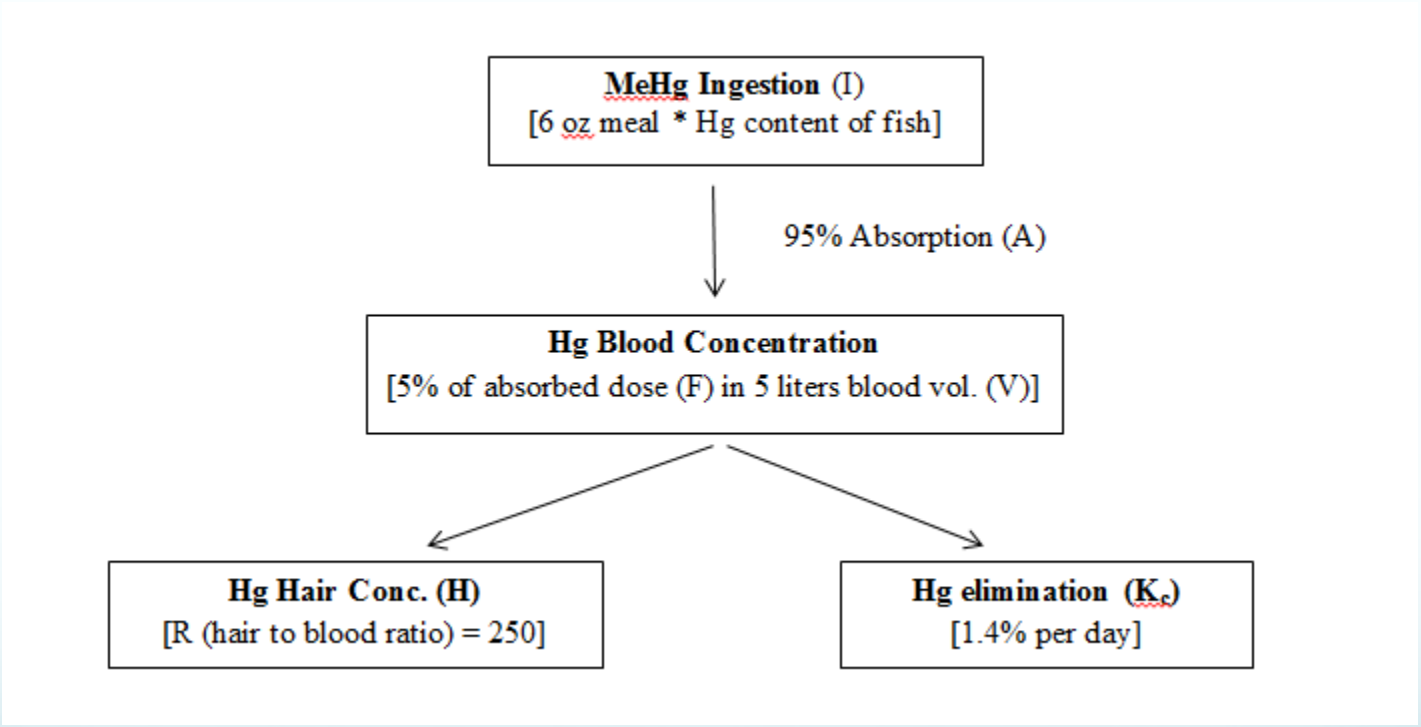
Methods-Fish Tissue Data

- data from EPA
- tissue samples being used in this analysis have been restricted to data from 1999 to 2006
- Mercury concentrations are presented in wet weight values as mg kg^{-1} (ppm; µg g^{-1})

Meals per week

# 6 oz Meals/week	Justification
1	State recommendation for some species of freshwater fish
2	Current EPA/FDA recommendation
7.2	Oregon's current fish consumption estimate 7 – 6 oz meals (175g/day)
25.53	CTUIR members who consume 620 g/day 25.53 – 6 oz meals

Figure 1. One-compartment pharmacokinetic model for methylmercury adapted from Ginsberg and Toal (2000)



Model equation: $H = \frac{(I*A*(1-K_e))*F*R}{V}$

Species	EPA (mg)	DHA (mg)	Total (mg)
Bridgelip Sucker	415	631	1046
Largescale Sucker	415	631	1046
Channel Catfish	170	233	403
Mountain Whitefish	690	2050	2740
Walleye	187	490	677
Sturgeon	423	202	625
Smallmouth Bass	518	779	1297
Rainbow Trout	796	884	1680
Chinook Salmon	1717	1236	2953

National Nutrient Database for Standard Reference Release 26

http://ndb.nal.usda.gov/ndb/search/list

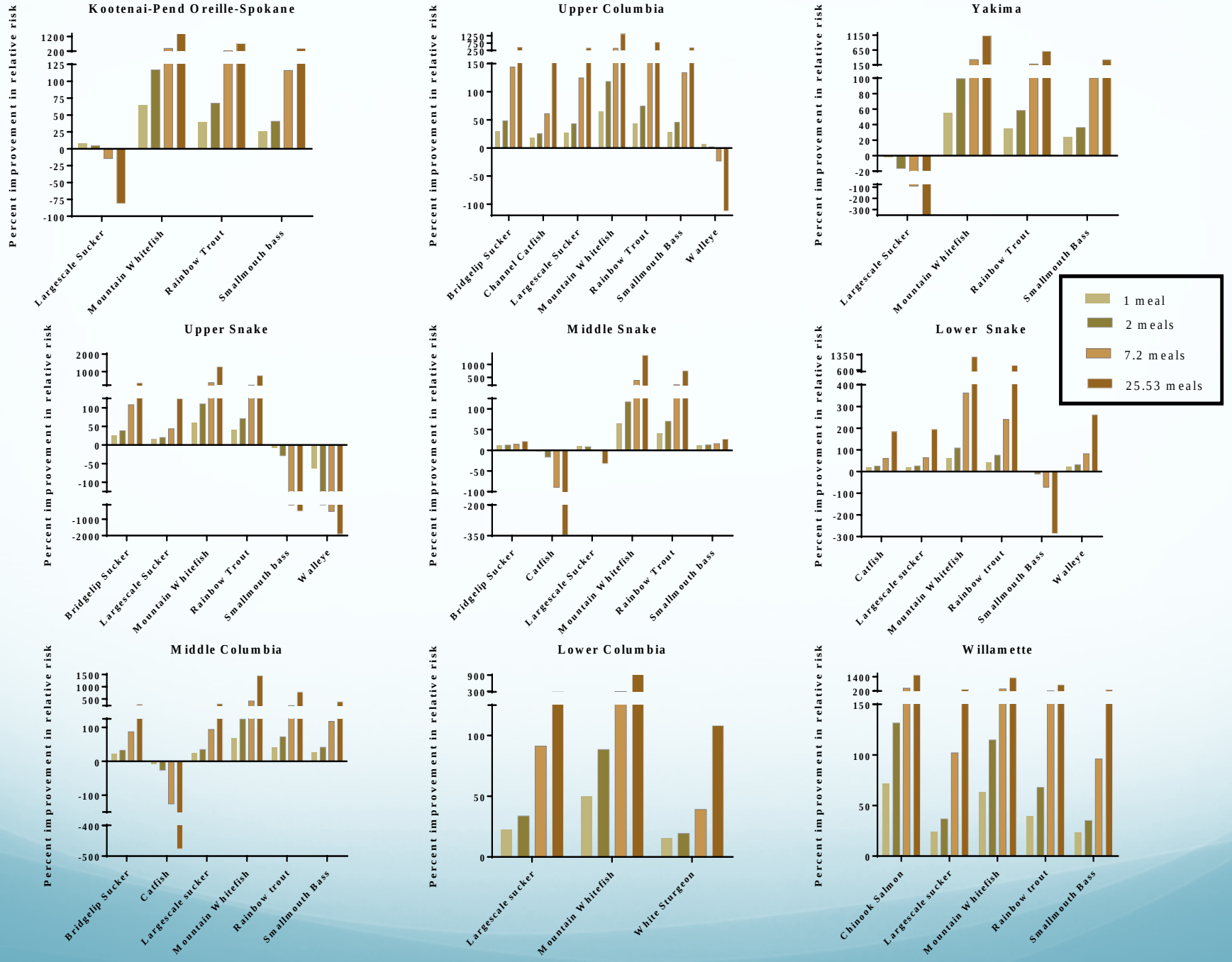
Omega 3s
EPA - Eicosapentaenoic acid
DHA - Docosahexaenoic acid

Fish Species

- chinook salmon
- rainbow trout
- mountain whitefish
- sturgeon
- walleye
- bridgelip sucker
- largescale sucker
- channel catfish
- smallmouth bass

Results


Pacific Ocean
Upper Columbia
Kootenai-Pend Oreille-Spokane
Lower Columbia
Yakima
Willamette
Middle Columbia
Lower Snake
Middle Snake
Upper Snake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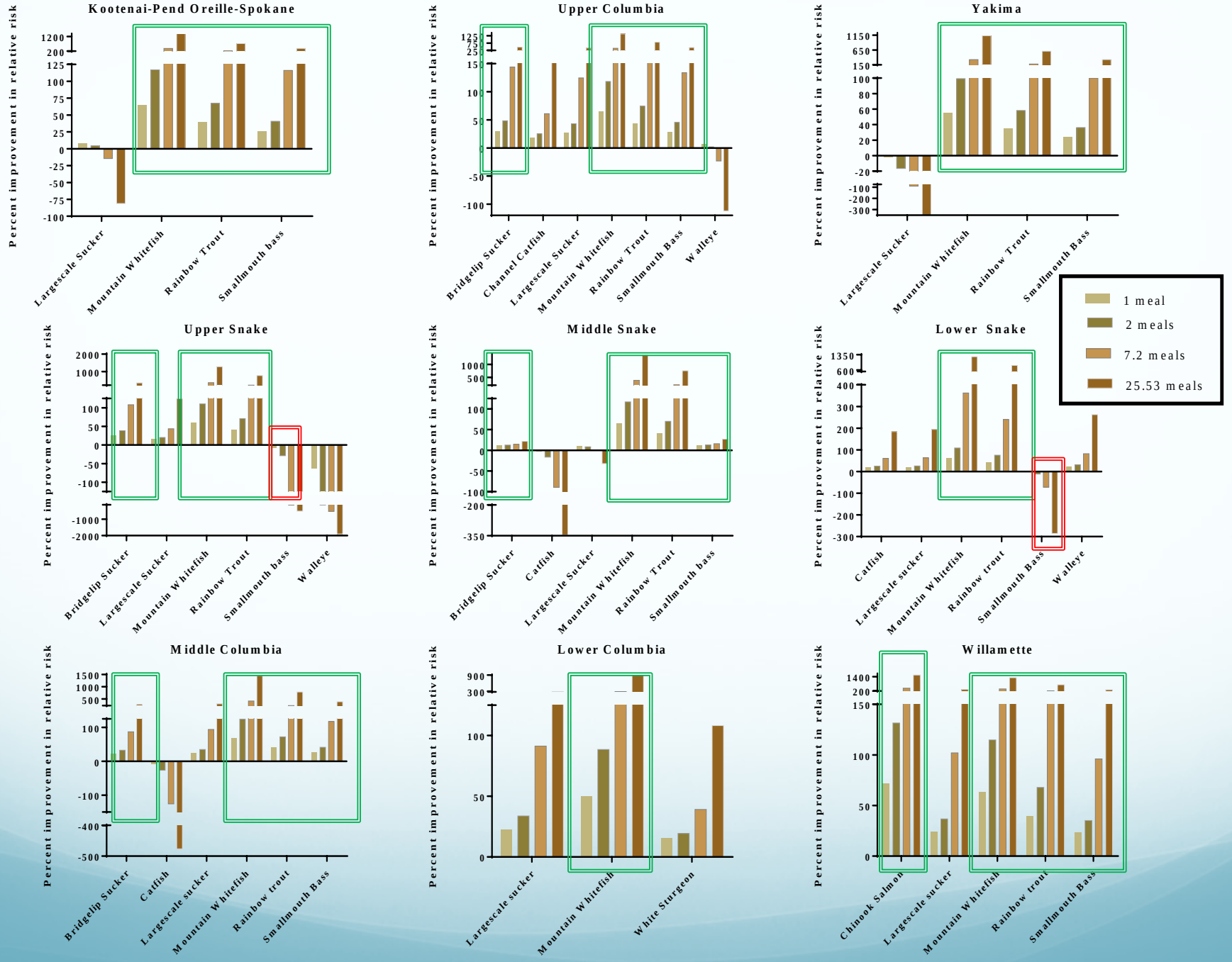
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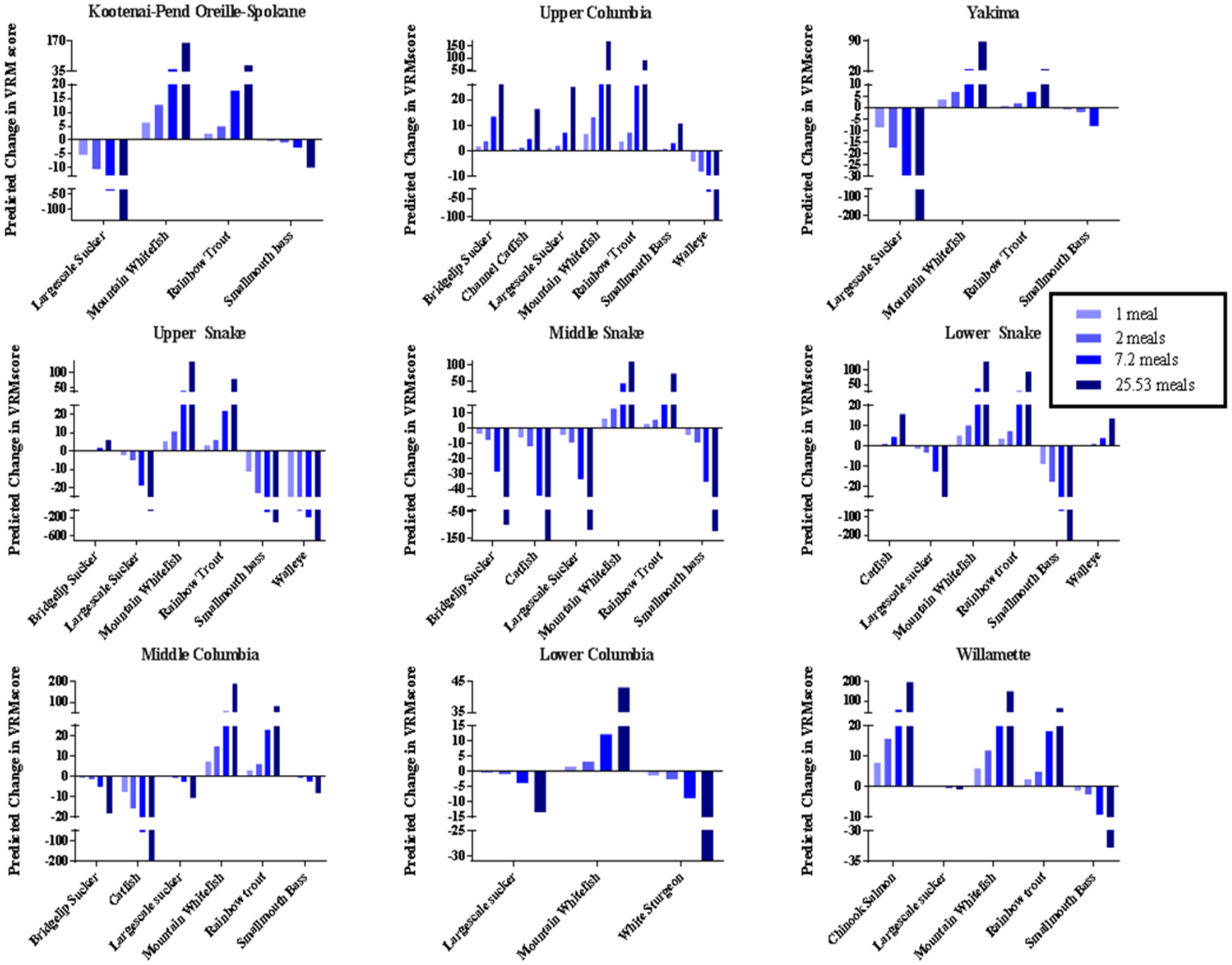
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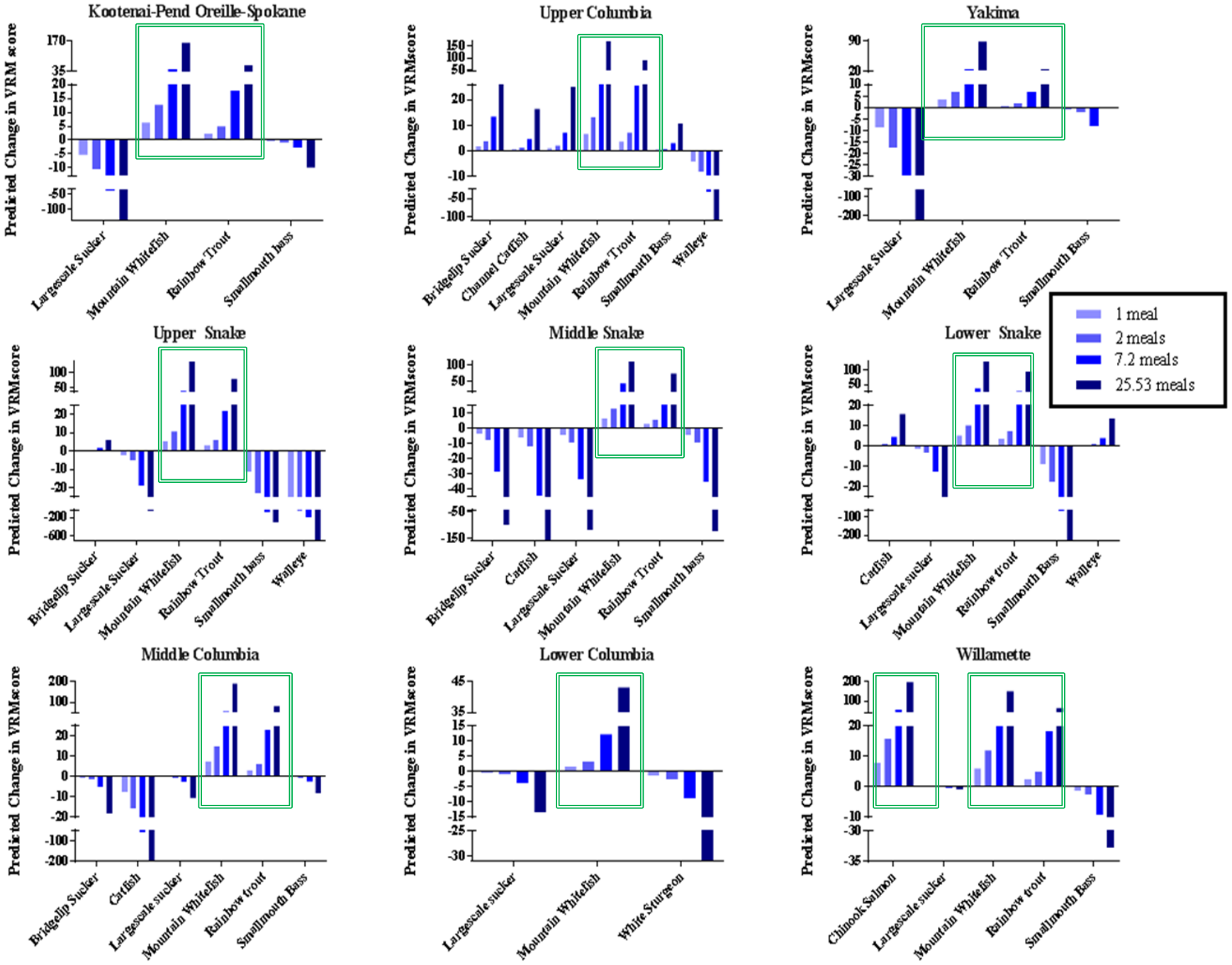
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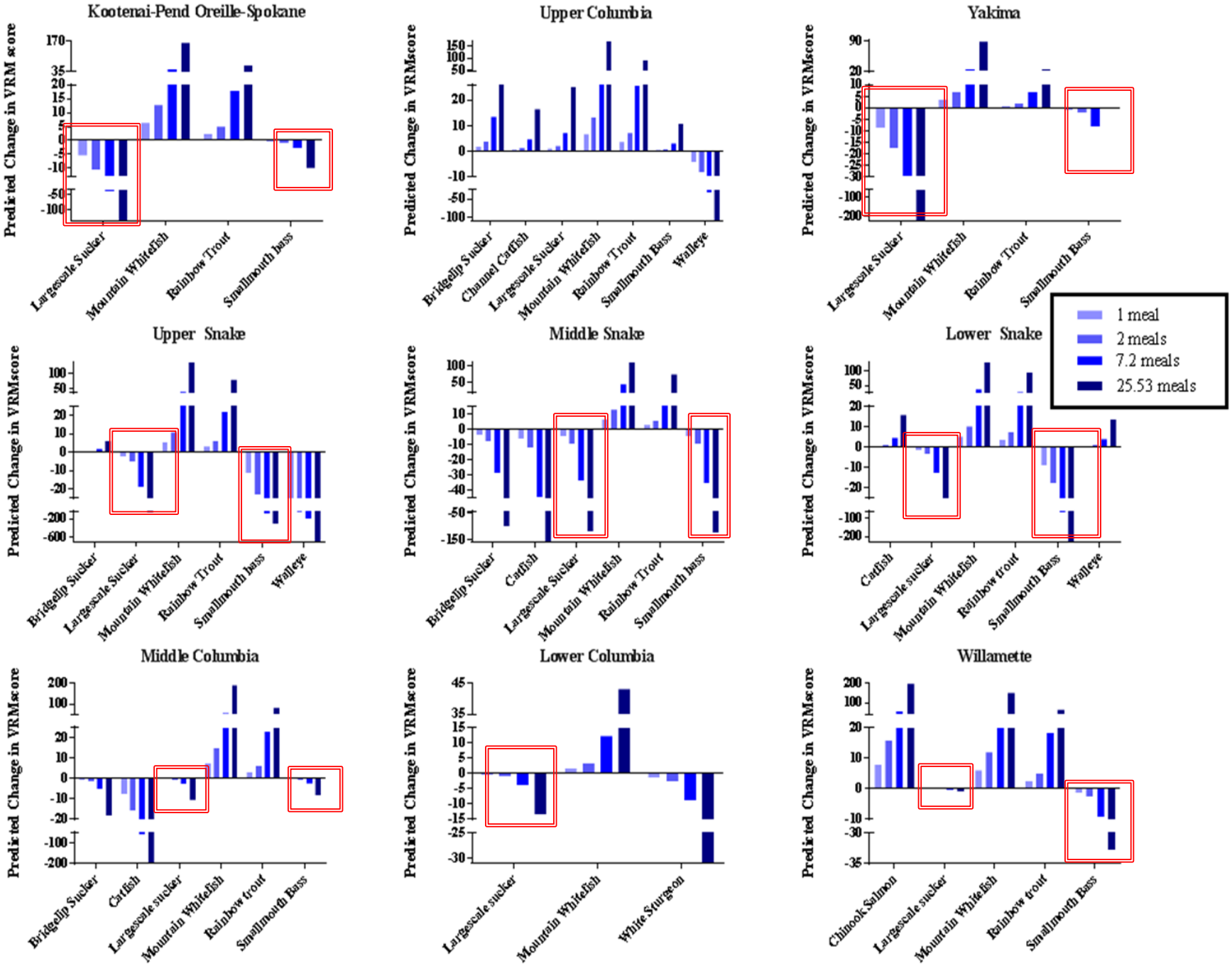
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Discussion

- First study to conduct risk/benefit analysis in this region
- Methylmercury varies by region: unwise to provide advice for the entire CRB
- Some species generally lower in MeHg and high in omega 3s and can safely be consumed more than the recommended twice per month

Discussion

- Mountain whitefish, rainbow trout and chinook salmon provide net benefit for CHD and VRM

- Attributed to high omega 3s and low average MeHg
  - Whitefish 2740 mg/g 0.078 µg/g
  - Rainbow trout 1680 mg/g 0.066 µg/g
  - Chinook salmon 2953 mg/g 0.013 µg/g

Discussion

- There are limitations to this approach yet there is also great utility for public health officials

- Using this approach will enable us to place species that are commonly consumed by both recreational fishermen as well as many Native American tribes that reside within the Columbia River Basin into different consumption categories

Limitations

- Uncertainty in dose/response relationships that serve as the basis for conclusions
- Methylmercury not the only contaminant
- National estimates were used for omega 3 concentrations

Conclusions

- Mountain whitefish, rainbow trout and chinook salmon provide net benefit in terms of CHD and VRM in all regions
- Some species which provide benefits in one area may not in another
- Species which provide a net benefit for CHD may not for VRM
- Generating general fish consumption advice may be difficult
- Future work should include other benefits and other contaminants in equation

Questions?