Methylmercury in Freshwater Fish

Sublethal and reproductive effects at environmentally relevant exposures

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1979: *"Fish became contaminated with methylmercury to levels dangerous to consumers. There is little evidence to show what levels of mercury contamination in the fish may be lethal to the creatures themselves."*

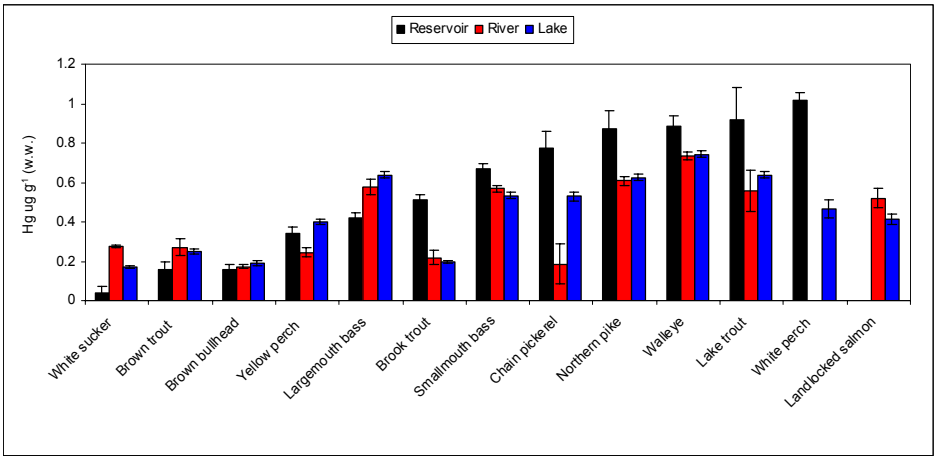
F. A. J. Armstrong

1996: *"…..relatively scant progress has been made……. Armstrong's statement ……remains applicable 15 years later."*

J. G. Wiener & D. J. Spry

Objective: Evaluate recent laboratory and field evidence of effects of methylmercury at environmentally relevant concentrations

Mean Hg concentrations in fillets of standard-length freshwater fish species across northeastern North America



Kamman et al. (2005)

Ecotoxicology

Molecular

Biochemical

Cellular

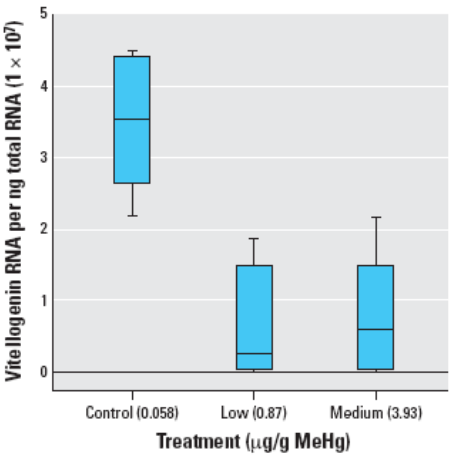
Tissue

Individual

Molecular (laboratory)

Altered gene expression

- Apoptosis
- Reproduction
- Sugar metabolism
- Calcium regulation



Klaper et al. 2006

Molecular (field)

Altered gene expression

- Stress (oxidative)
- Reproduction
- Immune function
- General cellular maintenance
- Metabolism and growth

Expression of glutathione peroxidase increased 1300%

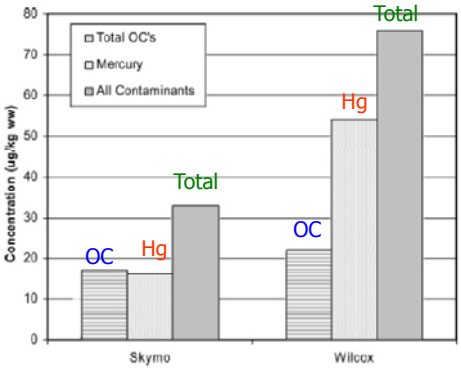
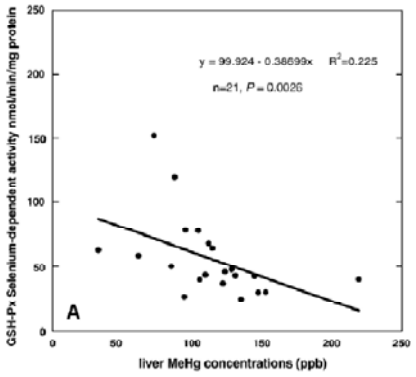


FIGURE 3. Two-year average contaminant levels from five fish composite samples, collected from Skymo and Wilcox Lakes. Transcriptional responses in fish liver between these lakes were performed using trout cDNA microarray.

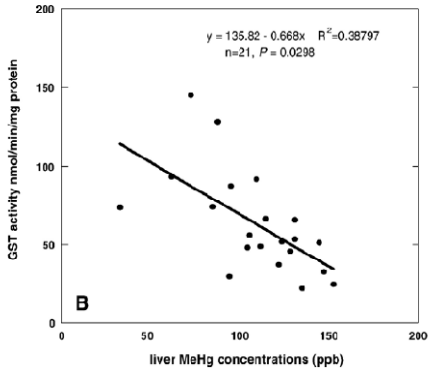
Moran et al. 2007

Biochemical (field)

Glutathione peroxidase selenium dependent activity

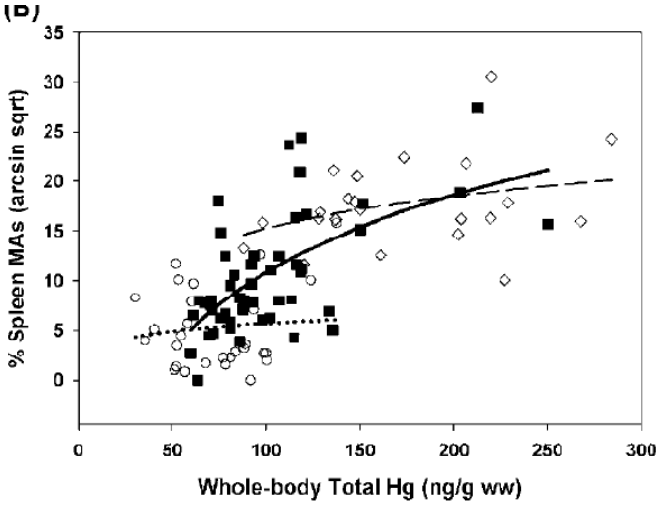


Glutathione s-transferase activity

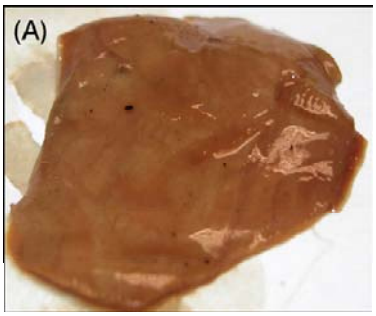


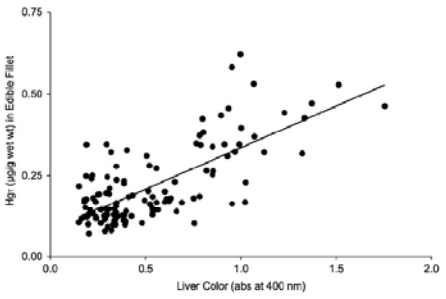
Larose et al. 2007

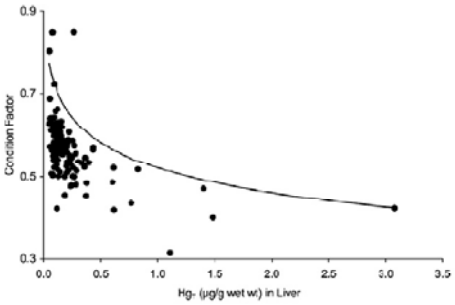
Cellular (field)
macrophage aggregates



Schwindt et al. 2008







Drevnick et al. 2008

Cellular (Laboratory)

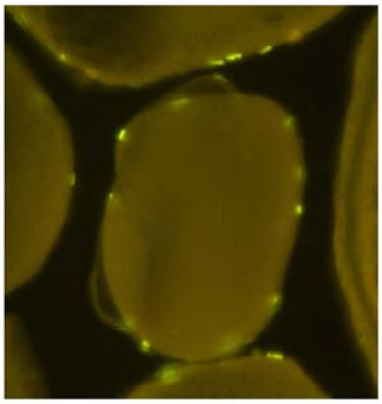
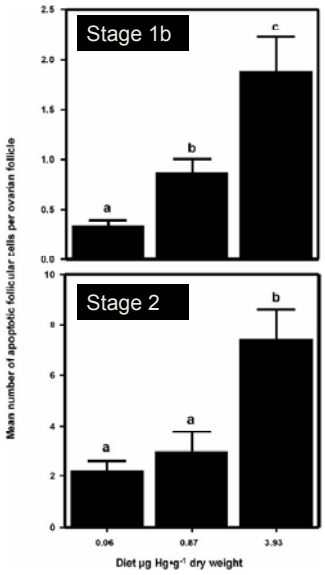
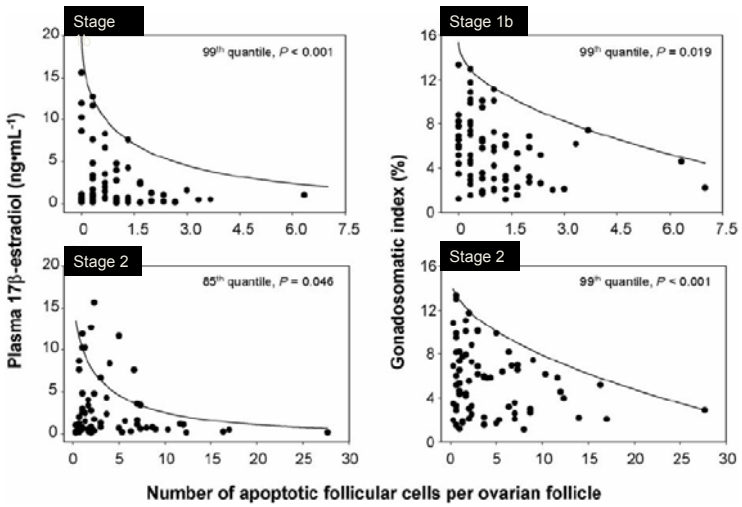


Fig. 1. Ovarian follicles with apoptotic (green) follicular cells at 400× magnification (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of the article.)



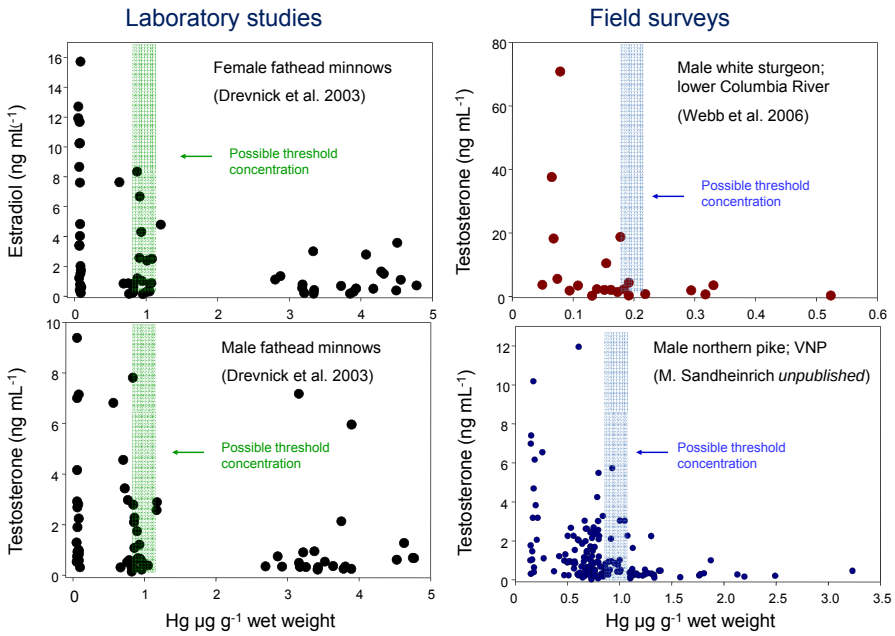
Drevnick et al. 2006

Cellular (Laboratory)

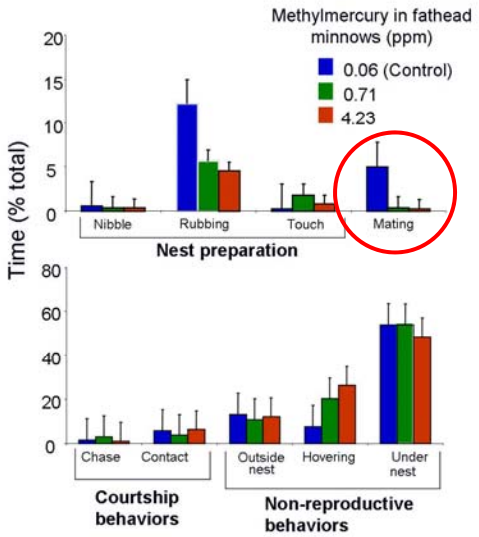


Drevnick et al. 2006

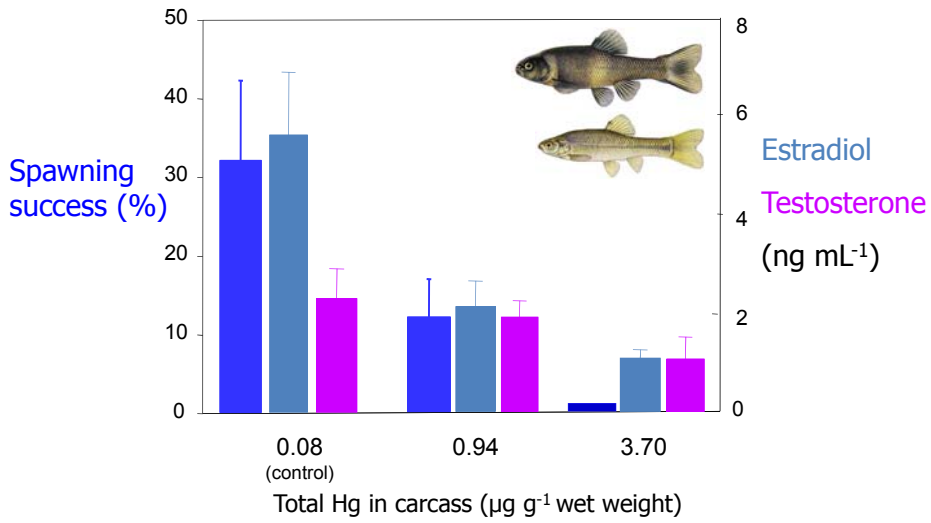
Suppression of Steroidogenesis by Methylmercury



Behavior (laboratory)



Sandheinrich & Miller 2006



From Drevnick & Sandheinrich 2003

Fathead minnow illustrations by Joseph Tomelleri

Evidence of Altered Reproduction in Fish with ≤ 1 ppm Methylmercury

	Supporting Evidence	
	Laboratory	Field
Reduced gonad size	fathead minnows[1]	white sturgeon[2]
Altered gonad histology linked to production of sex hormones	fathead minnows[3]	*not assessed*
Suppressed sex hormones	fathead minnows[4]	northern pike[5] white sturgeon[2]
Altered reproductive behavior	fathead minnows[6]	*not assessed*
Reduced reproductive success	fathead minnows[1,4,6] mummichog[7]	*not assessed*

[1]Hammerschmidt et al. 2002. *Environ. Sci. Technol.* 36:877-883.

[2]Webb et al. 2006. *Arch. Environ. Contam. Toxicol.* 50:443-451

[3]Drevnick et al. 2006. *Aquat. Toxicol. 79:49-54.*

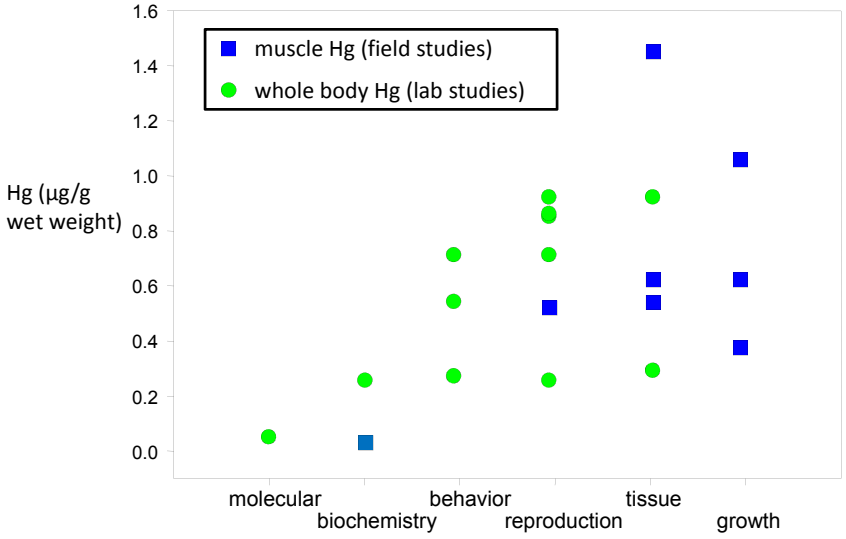
[4]Drevnick & Sandheinrich. 2003. *Environ. Sci. Technol.* 37:4390-4396.

[5]Sandheinrich et al. *In prep*

[6]Sandheinrich & Miller. 2006. *Environ. Tox. Chem.* 25:3053-3057

[7]Matta et al. 2001. *Environ. Toxicol Chem.* 20:327-335

Concentrations associated with effects on fish



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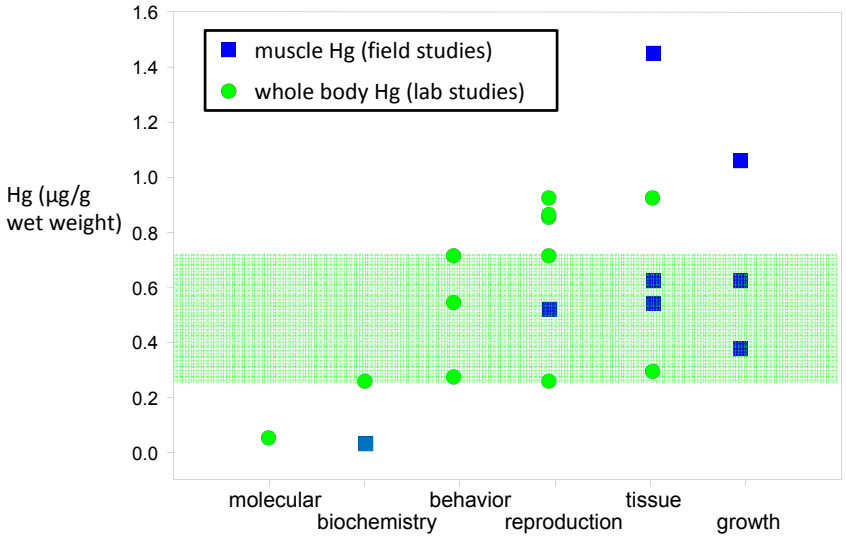

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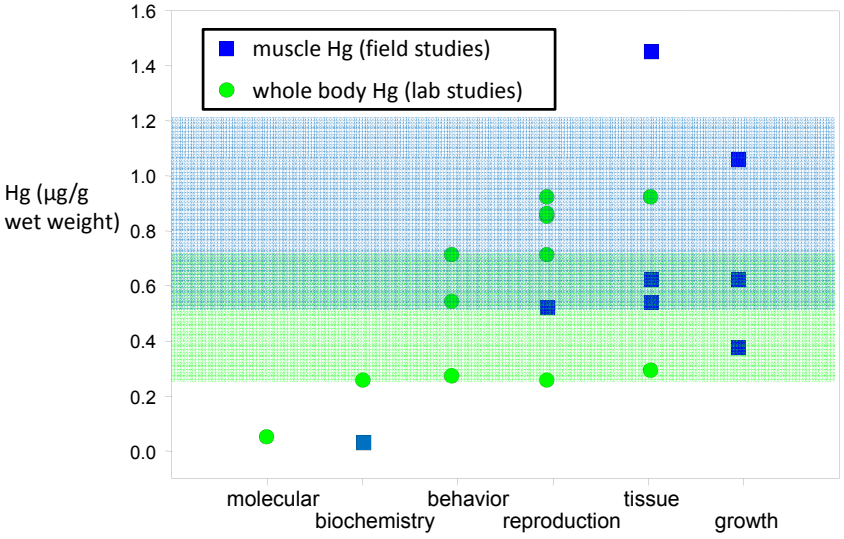
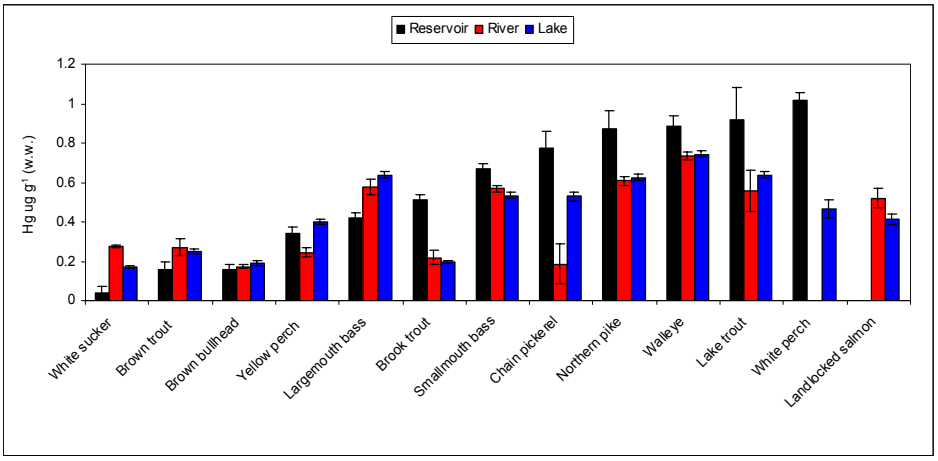


Mean Hg concentrations in fillets of standard-length freshwater fish species across northeastern North America



Kamman et al. (2005)

Ecotoxicology

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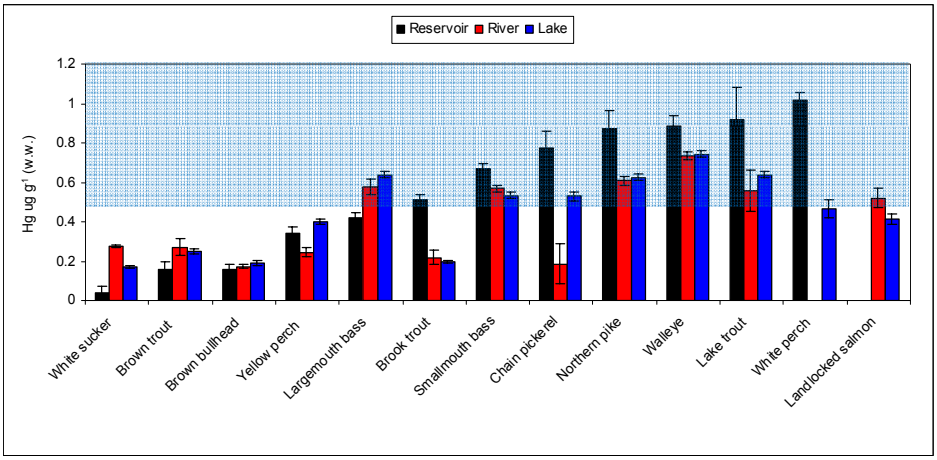

Kamman et al. (2005)

Ecotoxicology

Information in this presentation is part of a forthcoming chapter to be published in 2010.

Sandheinrich, M. B., and J. G. Wiener. In press. Methylmercury in fish—advances in assessing toxicity of environmentally relevant exposures. Book chapter in W. N. Beyer and J. P. Meador (editors), Environmental Contaminants in Biota: Interpreting Tissue Concentrations, 2nd edition. CRC Press/Taylor and Francis, Boca Raton, Florida.