

# Endocrine Disrupting Chemicals and Thyroid Outcomes

The Great Lakes Fish Consumption Study

Henry A. Anderson, Principal Investigator

Pamela Imm, Project Director

Wisconsin Department of Health and Family  
Services

WILL IT BE THE  
MAD COW BEEF,  
THE HORMONE CHICKEN,  
OR THE MERCURY FISH?

UM... I THINK  
I'LL GO WITH THE  
VEGETARIAN DISH.

PESTICIDE  
OR HEPATITIS?

TALS

©2004 THE WASHINGTON POST

MAYBE  
JUST  
WATER

POINT SOURCE, OR  
AGRICULTURAL  
RUNOFF?

# Endocrine Disrupters

- Problem statement: In the Great Lakes Basin, frequent consumption of large, predatory GL fish constitutes the single largest source of exposure to PCB and DDE. PBDE is present in GL fish and may be elevated in GL fish consumers.
- Research Objective: Investigate associations between fish consumption, contaminant levels and thyroid and reproductive hormone function.

# Goals of Study

- Characterize fish consumption and endocrine system status by analysis of self-administered questionnaires.
- Assess association between PCB, DDE and PBDE serum concentrations and endocrine health status by analysis of blood and urine specimens and survey responses to health status questions.

# Consortium/Contractual Partners

- Wisconsin Department of Health and Family Services, Bureau of Environmental and Occupational Health
- Michigan Department of Community Health
- University of Illinois-Chicago, Division of Epidemiology and Biostatistics
- University of Wisconsin-Madison, Wisconsin Survey Research Center
- Laboratories
  - Northwestern University: Shared Clinical Laboratories and the Division of Endocrinology, Metabolism and Molecular Medicine
  - Wisconsin State Laboratory of Hygiene
  - Quest Diagnostics

# Study Cohort

The 2004 Endocrine study enrolled participants from a 1993-4 GL fish consumption, PCB exposure and reproductive outcomes study cohort.

The 1993 cohort consisted of frequent GL sport fish consumers (charter boat captains & spouses with current 1992 charter licenses in WI, IL, IN, MI or OH and a 1988 cohort of WI anglers). Included was a control group of infrequent consumers (<6 meals of SF/yr for past 20 yrs) from the same communities as the frequent consumers.

# Specimen Analysis

WI State Laboratory of Hygiene

Chemical contaminants in serum

- PCB
  - 101 congeners
- PBDE
  - 24 congeners
- DDE

# Specimen Analysis

## **Northwestern University**

- urinary iodine
- thyroid hormones
- reproductive hormones

## **Quest Diagnostics**

- Lipid levels
- Hemoglobin A1C (marker for glucose metabolism)
- Thyroglobulin antibody levels



Preliminary results reported. QA/QC and blood results need to be completed.

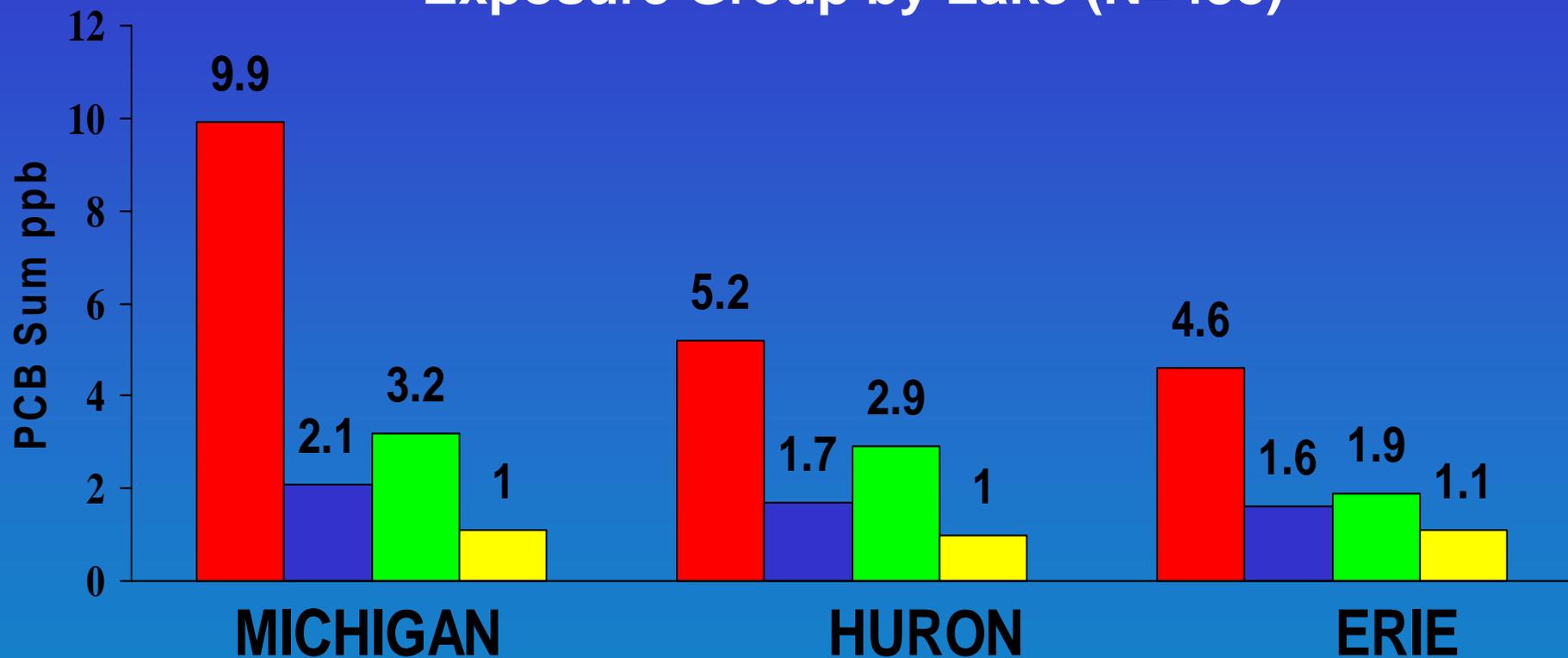
# PCBs in Great Lakes Top Predator Whole Fish\*



# Does Eating Sport Fish Matter?

## Human Tissue Profiles

Exposure Group by Lake (N=438)



■ Freq - Male

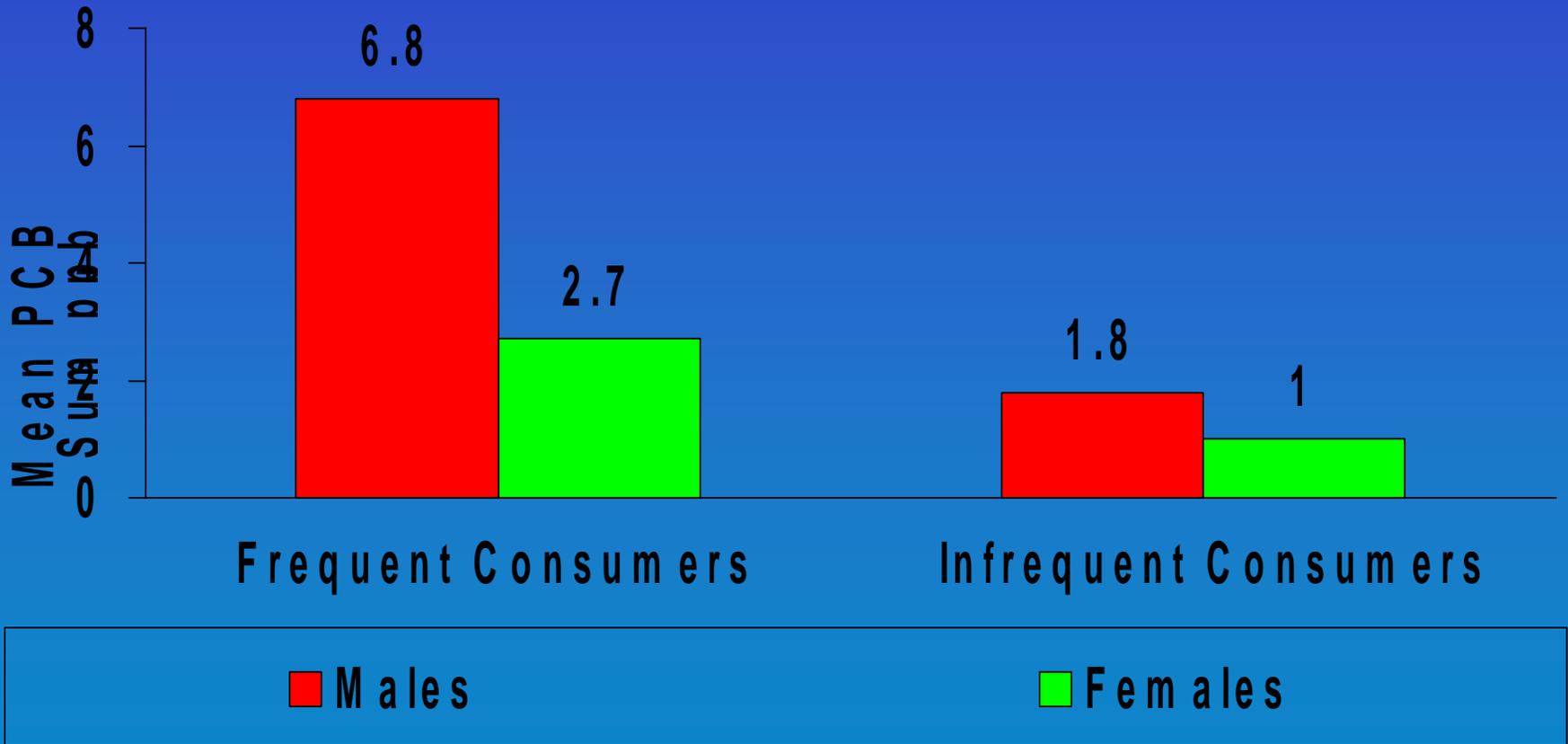
■ Infreq - Male

■ Freq - Female

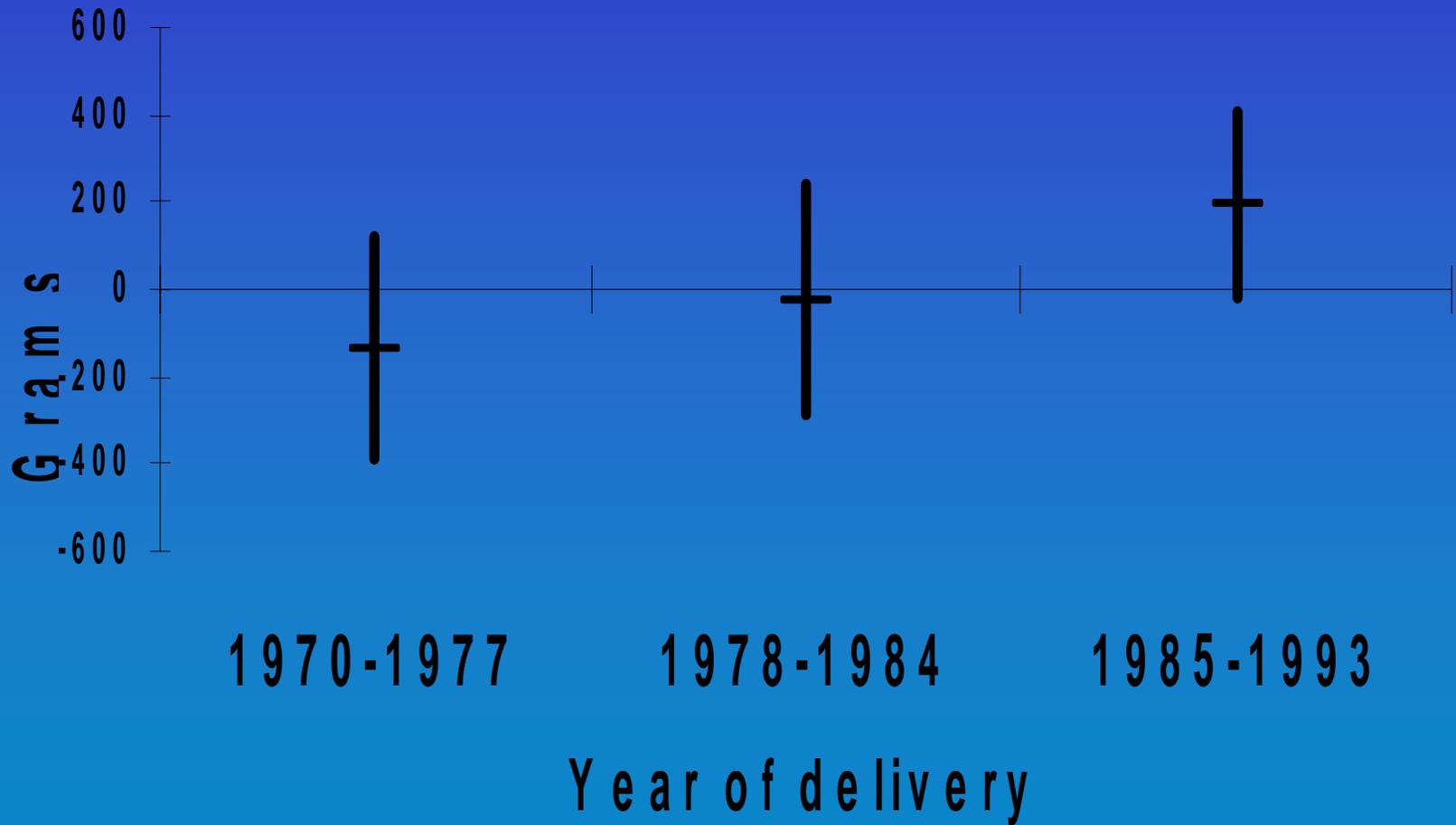
■ Infreq - Female

# PCB Mean Congener Sum

## Great Lakes Consortium Cohorts



# Adjusted Mean Differences in Birthweight High” vs None GLSCF Consumption, by Delivery Years



# Number of Study Participants

<b>Study</b>	<b>N</b>
Participants in 1993 and 2005 Surveys	1778
Participants in 1994 Original Biomarker and 2005 Endocrine Blood Testing	299*
Participants in 1994 Endocrine Blood Study and 2005 Endocrine Blood Testing	143**

\*Includes 93 Repeat Biomarker participants who gave blood in 2002 ATSDR Study but not the 2005 Endocrine Study. \*\* Includes 48 Repeat Biomarker participants who gave blood in 2002 but not in 2005.

# Questionnaire

- A 10 page questionnaire was sent by mail.
- Topics included:
  - fish consumption
  - medical history
  - reproductive health
  - tobacco and alcohol use
  - demographic information.
- Sample size=3,865; 1,799 returned, CASRO=49%.

# Clinical Phase

- Respondents were invited to participate in the clinical second phase (additional questionnaires, and blood and urine collection) by providing their contact information.
- 531 respondents from WI, IL, IN, MI and OH participated (target was 500).

# Clinical Phase

- 12 page questionnaire. Topics included:
  - medical history
  - medication use
  - weekly food consumption/diet
  - occupational exposure to various chemicals.
- Blood and urine specimens were collected by phlebotomists and nurses in WI, IL, IN, MI and OH.

# Average Fish Consumption\* by Type and Gender

	<b>Male</b>	<b>Female</b>
Mean shellfish meals/yr	45	25
Mean commercial meals/yr	53	34
Mean sportfish meals/yr	44	21
Mean Great Lakes SF meals/yr	24	16

Means calculated only for those who reported consuming the type of fish reported and did not answer “don’t know” or “refused.”

# Comparison\* of Great Lakes Sportfish Consumption in Past Year by Gender

	<b>Male (N=1229)</b>	<b>Female (N=549)</b>
1993 Survey	68%	50%
2005 Endocrine Survey	69%	53%

\*Comparison of respondents who participated in both surveys.

# Comparison of Mean Number of GL Sportfish Meals/Year\*

	<b>Male</b> <b>Mean Meals/yr (N)</b>	<b>Female</b> <b>Mean Meals/yr (N)</b>
1993 Survey	38 (834)	40 (263)
2005 Endocrine Survey	24 (829)	16 (291)

\*Among those who ate GLSF in past year.

Comparison of respondents who participated in BOTH surveys. Number of participants are slightly different because participants who answered with unknown responses were excluded from this analysis.

# Reported Changes in Great Lake Sportfish consumption since 1994

	<b>Male (N=1104)</b>	<b>Female (N=451)</b>
Increase	13%	11%
Stay same	45%	43%
Decrease	40%	43%
Don't know/refused	3%	3%

Among those who EVER ate GL sportfish. Based on self-report in Endocrine Survey.

# 2005 Mean Contaminant Levels

<b>Test</b>	<b>Male (N=246) (Min, Max)</b>	<b>Female (N=107) (Min, Max)</b>
DDE ug/l	3.2 (0, 24.0)	2.1 (0.3, 9.9)
PCB* ug/l	3.5 (0, 28.0)	1.6 (0, 9.5)
PBDE** ug/l	0.4 (0, 10.1)	0.4 (0, 8.8)

\*Based on sum of all congeners. \*\* Based on sum of all congeners except values were not added to total if sample detected congener below <2x blank value or if sample may have contained PBB and could not be separated from PBDE 154.

# PBDE Congeners Detected 2005

<b>Congener</b>	<b>Detected in sample</b>	<b>Congener</b>	<b>Detected in sample</b>
47	84%	28	10%
99	45%	138	3%
100	34%	85	2%
153	33%	49	<1%

Note: a specific congener is not noted if it was only detected below <2x blank value or if sample may have contained PBB and could not be separated from PBDE 154.

# Changes in Contaminant Levels

	<b>Gender</b>	<b>1994</b>	<b>2005</b>
PCB*, ug/L Mean	Male	5.7	3.4
	Female	2.4	1.7
DDE, ug/L Mean	Male	6.6	3.2
	Female	3.4	2.0

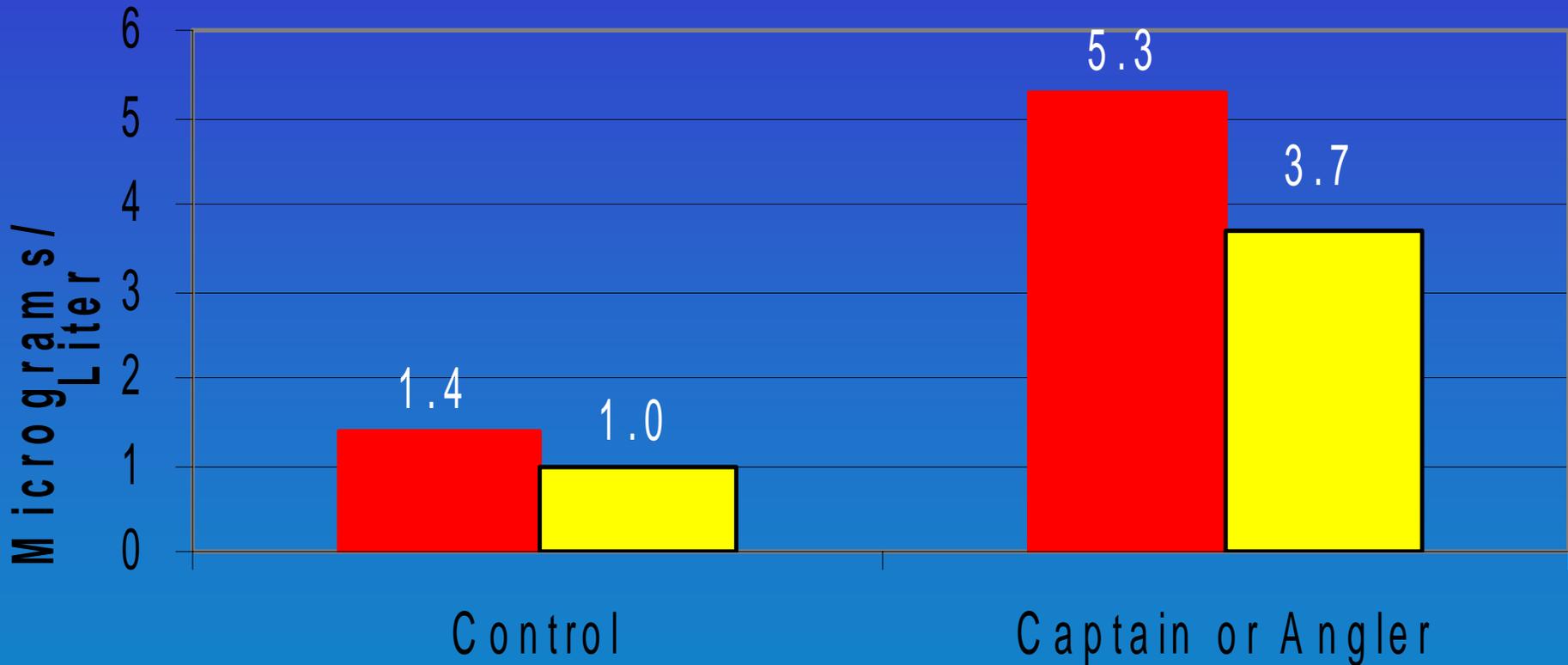
Based on 85 paired samples: 46 men, 39 women.

\*Based on sum of all congeners.

# PCB Level in 1993 vs 2005

Unadjusted Means

Captain/angler N = 193, Control N = 29



■ Mean 1992 PCB Level ■ Mean 2005 PCB Level

# Diagnosis of Disease by Gender\*

	<b>Told by Doctor has Thyroid condition**</b>	<b>Diagnosed with any type of Cancer</b>
Male (N=1237)	5%	14%
Female (N=562)	17%	10%

\*Reported in 2005 survey. \*\*Includes benign tumor, Hashimoto's, Graves, underactive and overactive thyroid, goiter and other unspecified.

# Thyroid Levels in 1994

<b>Test</b>	<b>Gender</b>	<b>Mean (N)</b>	<b>% out of range</b>
T3 (ng/dL)	Female	108.1 (51)	1.3
	Male	129.5 (155)	3.2
T4 (ug/dL)	Female	6.8 (51)	6.9
	Male	7.2 (159)	8.4
TSH (uIU/mL)	Female	2.1 (51)	7.1
	Male	1.7 (170)	7.9

The 1994 study excluded participants on thyroid medications and other meds that affect thyroid function.

# Thyroid Levels for 2005 Study

<b>Test</b>	<b>Gender</b>	<b>Mean (N)</b>	<b>% out of range</b>
T3 (ng/dL)	Female	99.2 (196)	4.6
	Male	98.4 (410)	2.9
T4 (ug/dL)	Female	7.9 (197)	3.0
	Male	7.2 (412)	2.4
TSH (uIU/mL)	Female	1.9 (193)	7.3
	Male	1.8 (409)	5.7

No participants were excluded from analysis.

# Strengths of Study

- Longitudinal data on fish consumption and contaminant body burdens are available for subsets of the study cohort.
- Diverse cohort: men, women, frequent and infrequent Great Lakes sport fish consumers.
- Cohort members live in several Great Lakes states so findings have applicability within the region and are not state or lake-specific.

# Weaknesses of Study

- Not a controlled study where fish intake and other contaminant sources are regulated.
- Controlling for chronic effect of medication on health and hormone status may be difficult.
- Collection of accurate fish consumption subject to recall biases.

# Next Steps

- All laboratory analyses to be completed by end of year.
- Result levels sent to participants.
- Analysis of correlations between lab results and survey responses.
- Comparisons with earlier study results.