Dietary Exposure of Mink (*Mustela vison*) to Fish from the Upper Hudson River, New York, USA: Effects on Reproduction, Offspring Growth and Mortality

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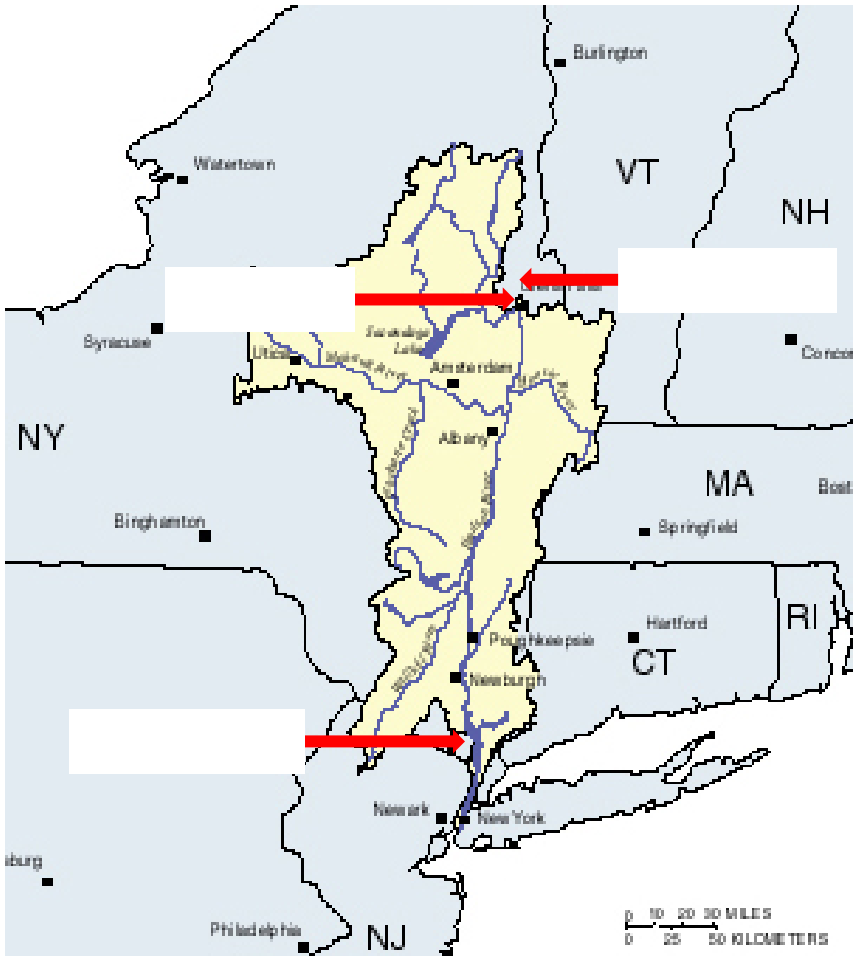
Introduction



- **Hudson River**
  - **Contaminated with PCBs from Ft. Edward to New York City**
- **Major sources of PCBs**
  - **Manufacturing facilities at Ft. Edward and Hudson Falls**

Introduction

- **Field studies**
  - **Wild mink have hepatic PCB concentrations suggesting risk of reproductive impairment**

Introduction

- Mink (*Mustela vison*) collected from PCB-contaminated sections of the Hudson River between Fort Edward and Troy between 1998 and 2001
  - Hepatic ∑PCBs concentrations (µg/g lipid)
    - Within 6 km (1 home range) = 13 (0.54 to 139)
    - Within 1 km of river = 33 (1.4 to 139)

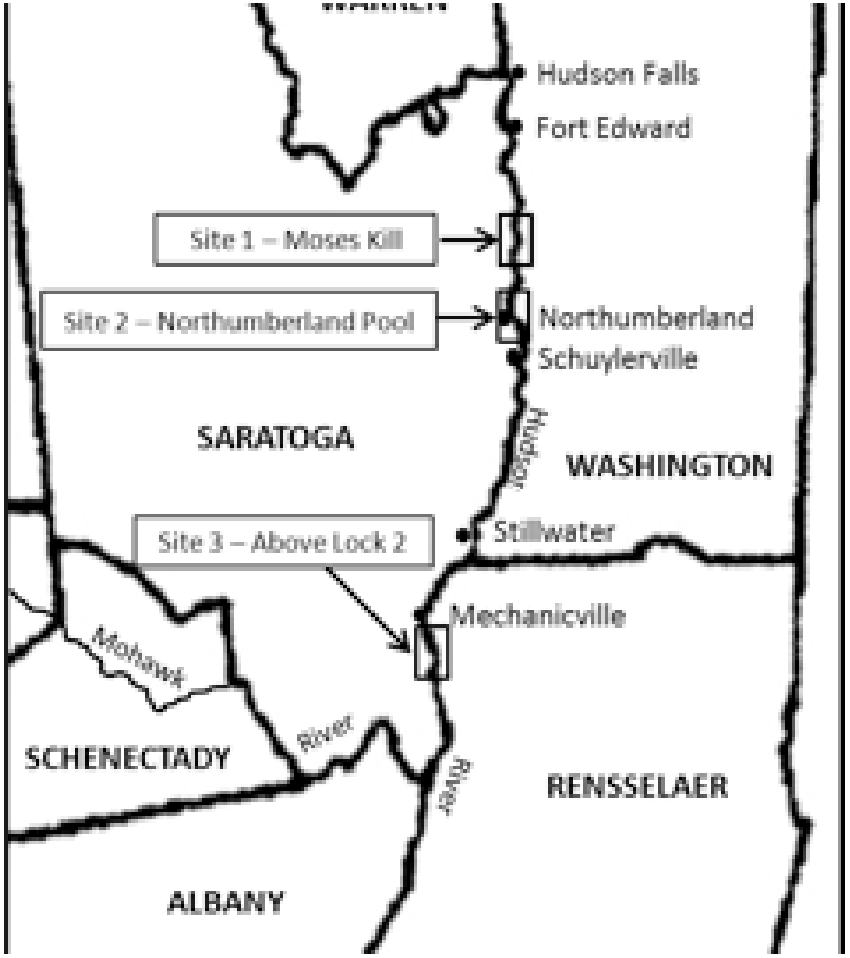
- LOAECs for reduced kit survival
  - 45 µg/g lipid (Heaton et al.,1995; Saginaw Bay)
  - 29 µg/g lipid (Bursian et al., 2006; Housatonic River)

Objective

- To evaluate health effects of feeding ranch mink diets containing PCB-contaminated fish from the Hudson River
  - Reproductive performance
  - Offspring survival
  - Organ mass and tissue pathology (WP114)

Methods

- Carp collected from upper Hudson River
- Ground fish incorporated into feed at a rate of 20%



Dietary Concentrations of ∑PCBs and TEQs

Total TEQs (pg TEQs/g feed)	0.72	5.4	10	20	28	38

Number of Female and Male Mink per Treatment Group

	[illegible]					
	Control	0.72	1.5	2.8	4.5	6.1

Methods

- Animals housed singly in an open-sided pole barn
- Test diets fed from 8 weeks prior to breeding through weaning of kits (≈ 160 days)
- Kits weighed at 24 hr post-partum and at 3 and 6 wk of age

Methods

- Adults and a sample of kits were necropsied when kits were ≈ 6 wk old
- Liver, brain, heart, kidneys, spleen, thyroid gland, adrenal glands, testes/uterus, mandible/maxilla removed, weighed, fixed for histology
- Portion of liver frozen for contaminant analysis

Methods

- Remaining kits maintained on dietary treatment until ~ 31 wk old
  - Control - 47 kits
  - 0.72 µg ΣPCBs/g - 24 kits
  - 1.5 µg ΣPCBs/g - 13 kits
  - 2.8 µg ΣPCBs/g - 9 kits
  - 4.5 µg ΣPCBs/g - 12 kits
  - 6.1 µg ΣPCBs/g - 2 kits
- Necropsied juveniles (30 controls and 23 in 0.72 µg ΣPCBs/g feed group)

Summary of Study Endpoints, Data Types and Statistical Analysis Methods

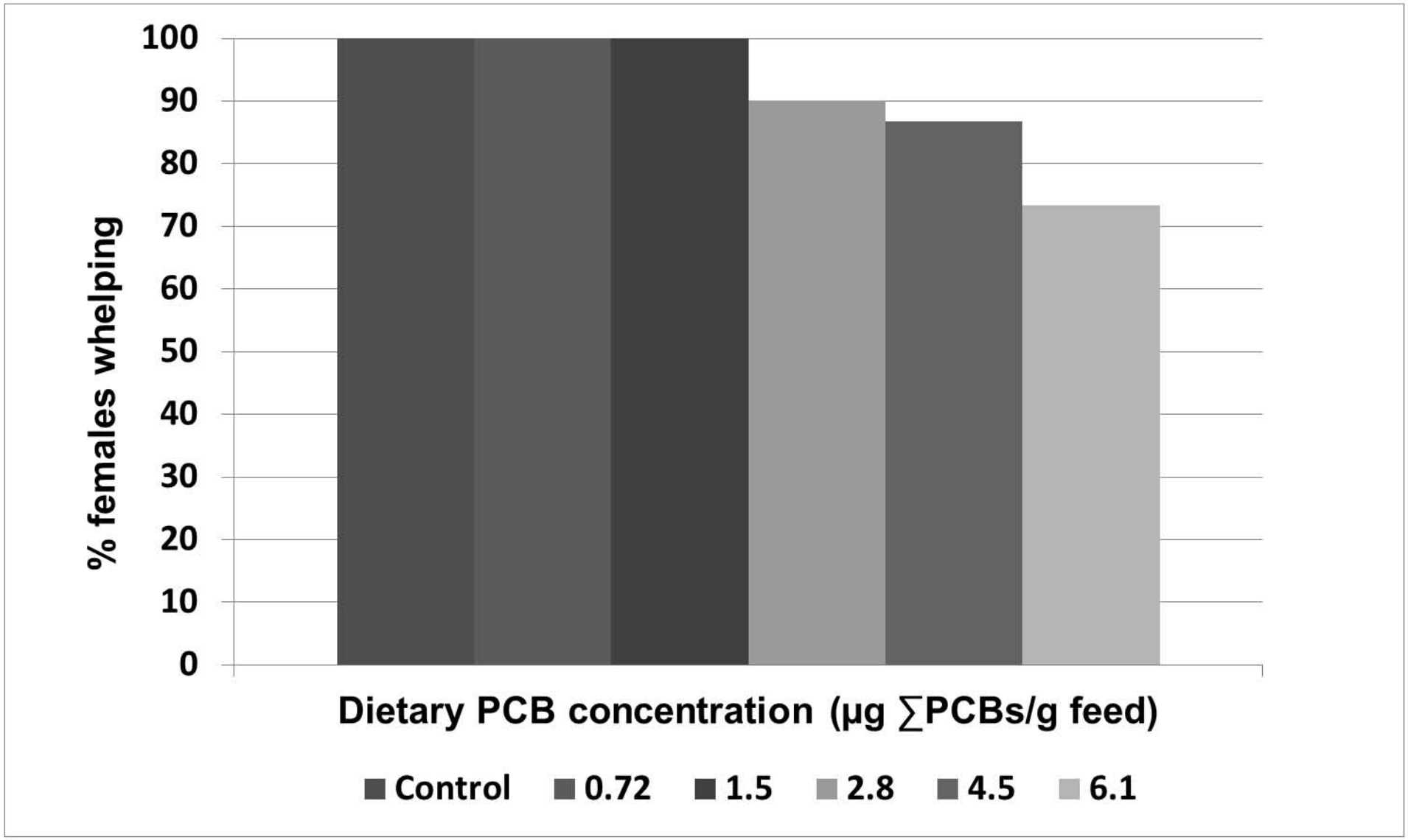
Endpoint	Data Type	Statistical Methods
Adult body weight	Continuous	Generalized Estimating Equations Regression for Repeated Measures
Adult feed consumption	Continuous	Generalized Estimating Equations Regression for Repeated Measures
Number of females mated	Binary	Logistic Regression / Fisher's Exact Test
Length of gestation	Continuous	ANOVA / Linear Regression
Number of females whelping	Binary	Logistic Regression / Fisher's Exact Test
Number whelped per female	Count	Negative Binomial Regression
Number whelped live per female	Count	Negative Binomial Regression
Average litter weight	Continuous	ANOVA / Linear Regression
Kit weight at birth, three and six weeks	Continuous	Linear Generalized Estimating Equation Regression
Kit mortality at three and six weeks	Binary	Beta-Binomial Regression
Monthly body weights of seven-month-old juveniles	Continuous	Linear Generalized Estimating Equation Regression

Summary of Study Endpoints, Data Types and Statistical Analysis Methods

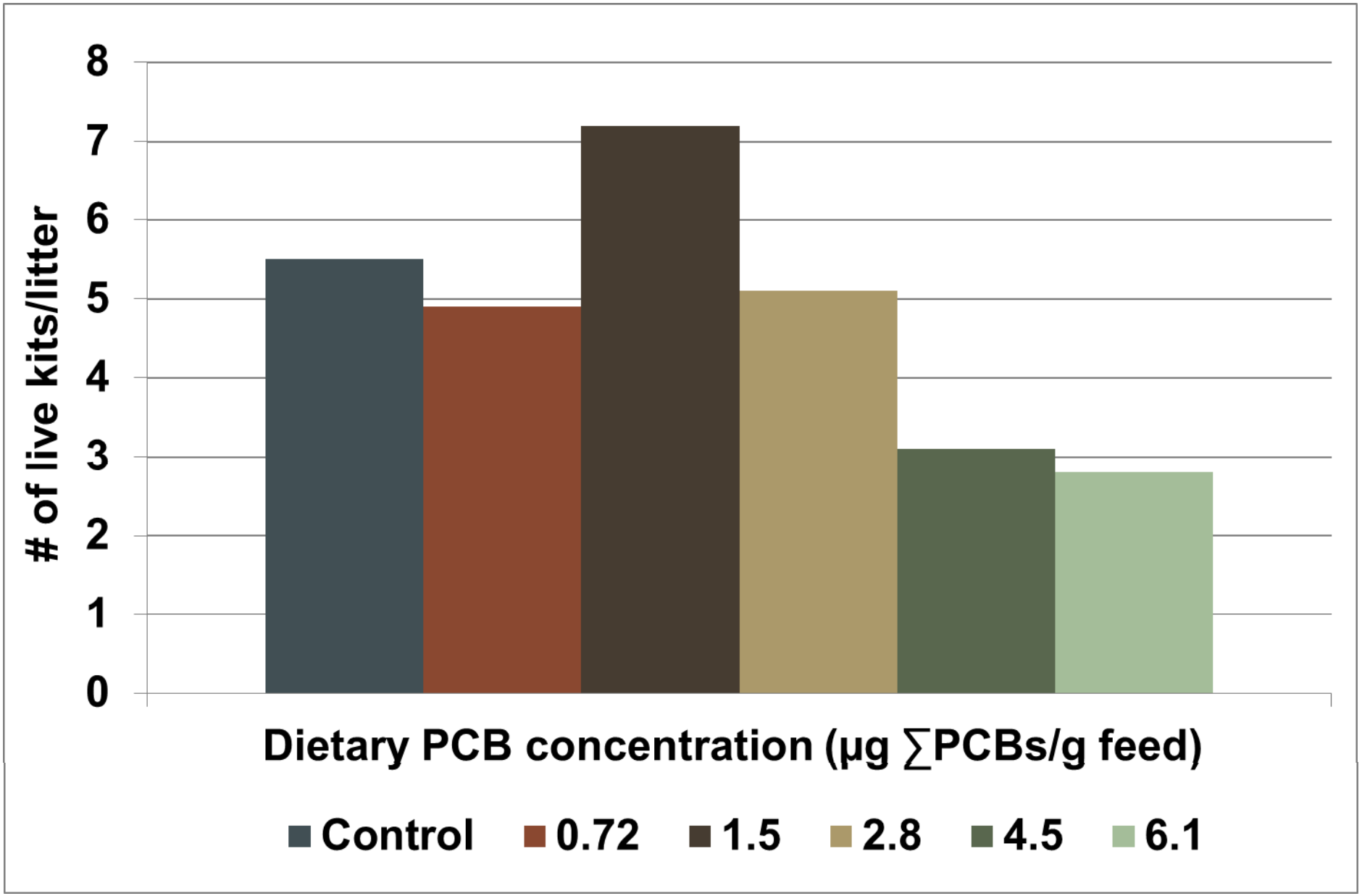
Adult organ weights	Continuous	ANOVA / Linear Regression
Six-week-old kit organ weight	Continuous	Linear Generalized Estimating Equation Regression
Seven-month-old juvenile organ weight	Continuous	Linear Generalized Estimating Equation Regression
Total PCB and Total TEQs in adult livers	Continuous	ANOVA / Linear Regression
Total PCB and Total TEQs in six-week-old kit livers	Continuous	Linear Generalized Estimating Equation Regression
Total PCB and Total TEQs in seven-month-old juveniles livers	Continuous	Linear Generalized Estimating Equation Regression
Histopathology of adult organs and jaws	Binary	Logistic / Fisher's Exact Test
Histopathology of six-week-old kit organs and jaws	Binary	Beta-Binomial Regression / Fisher's Exact Test
Histopathology of seven-month-old juvenile organ and jaws	Binary	Beta-Binomial Regression / Fisher's Exact Test

Organ mass and histopathology: WP114

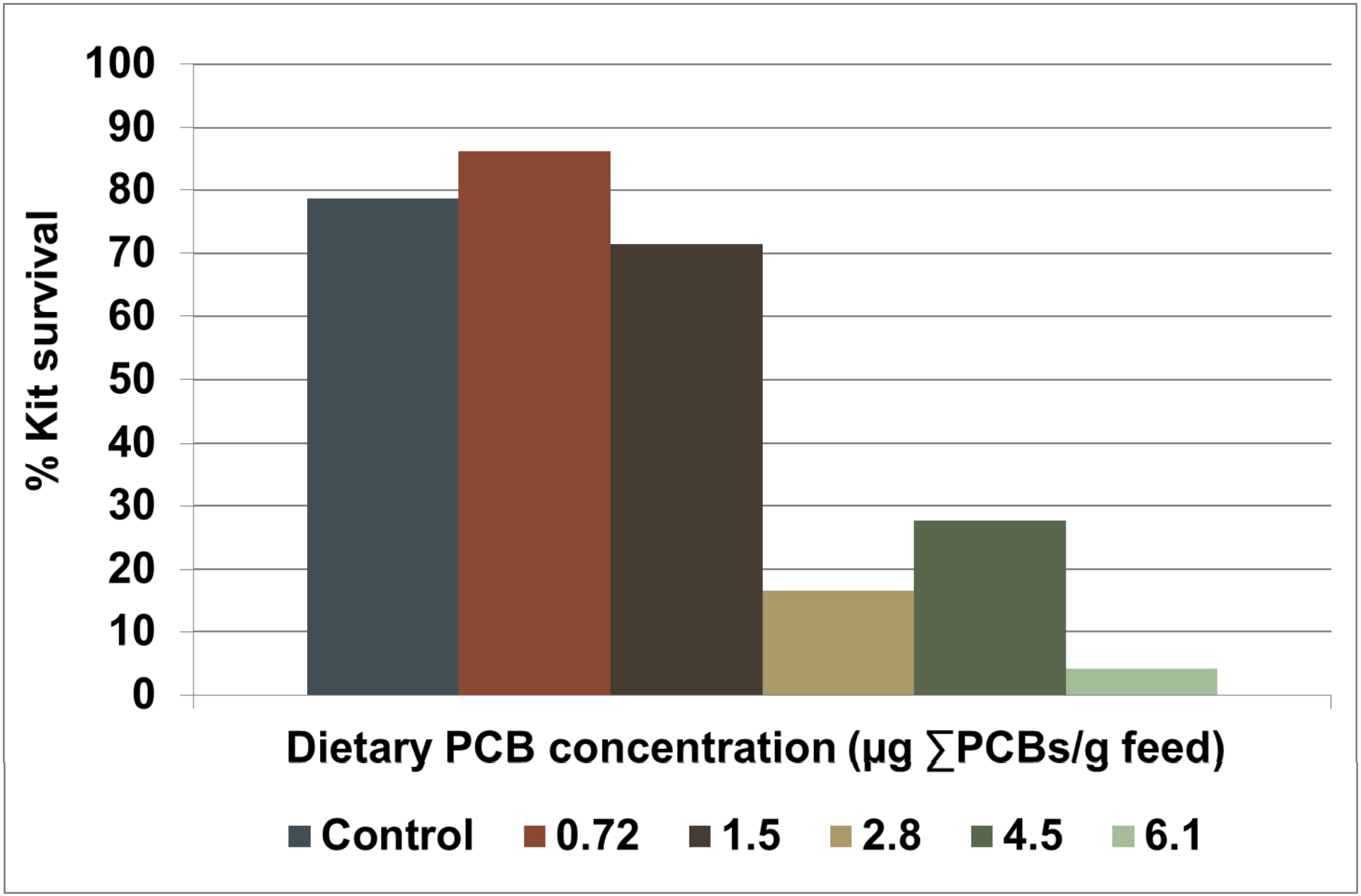
Percent of Females Whelping



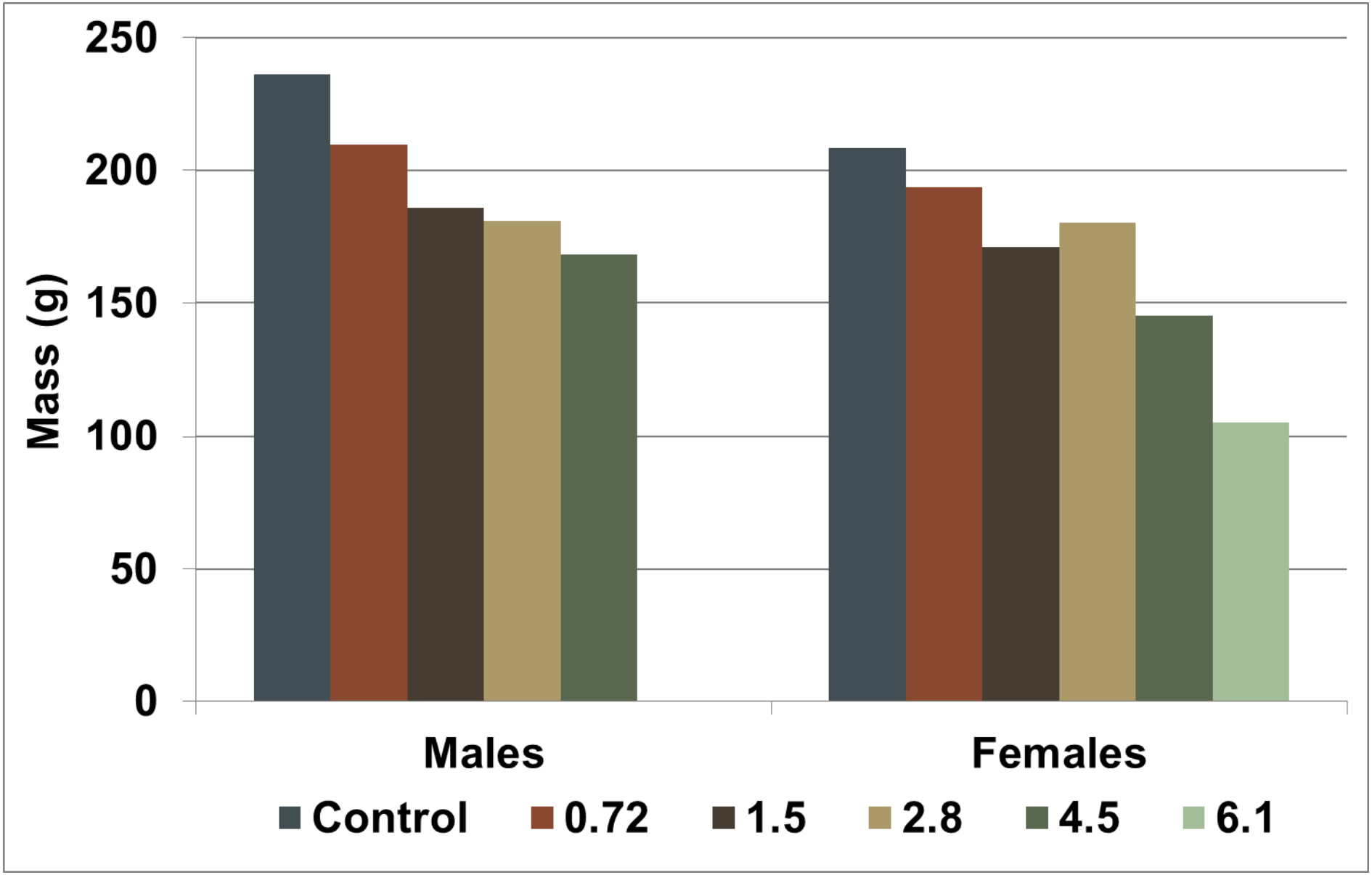
Live Kits Per Litter



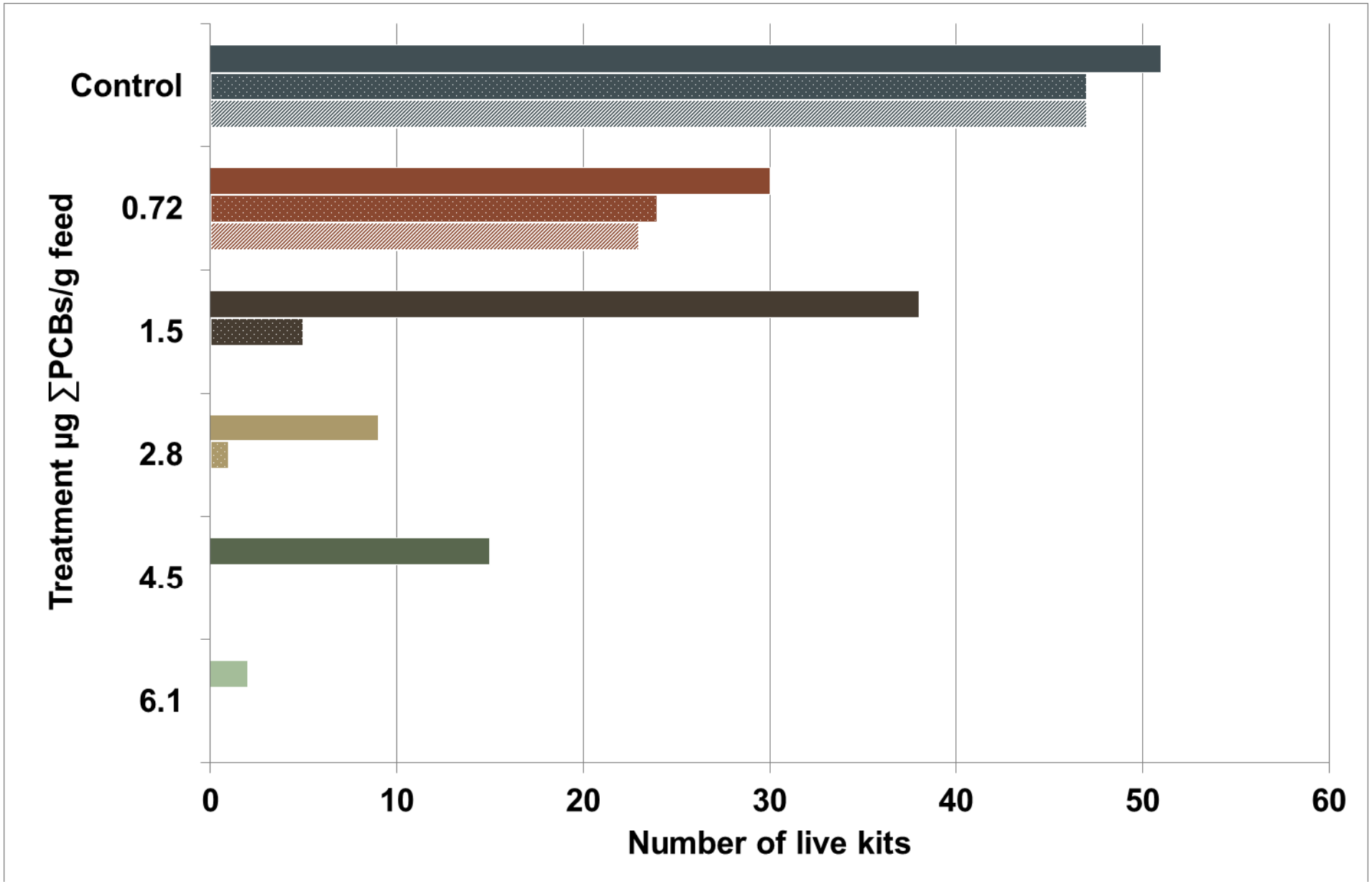
Percent Survival of Six-Week-Old Kits



Mass of Six-Week-Old Kits



Offspring Mortality Between 6 and 31 Weeks of Age

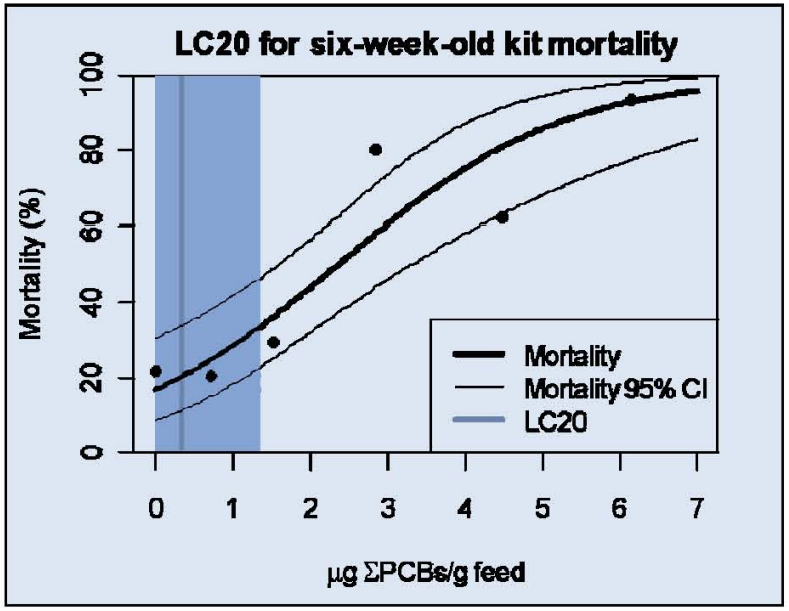


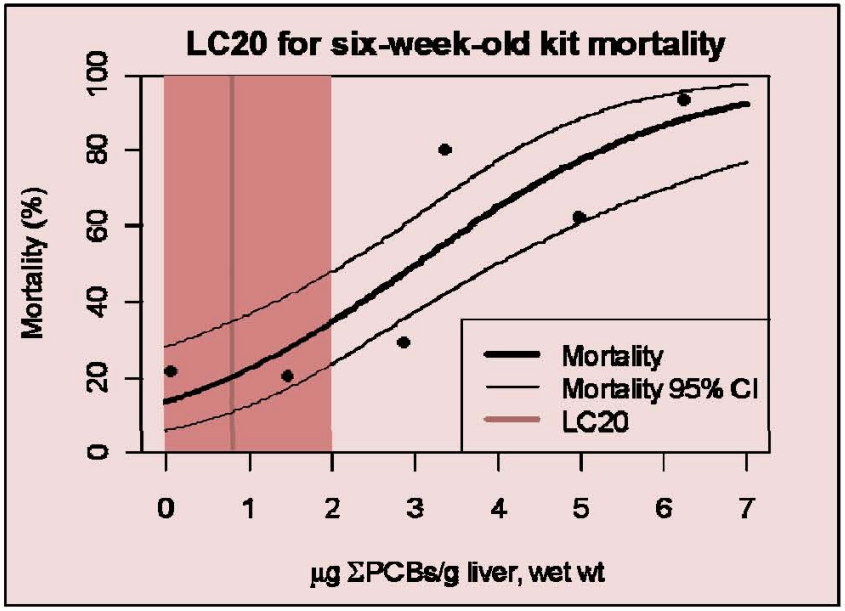
Dietary and Maternal Hepatic

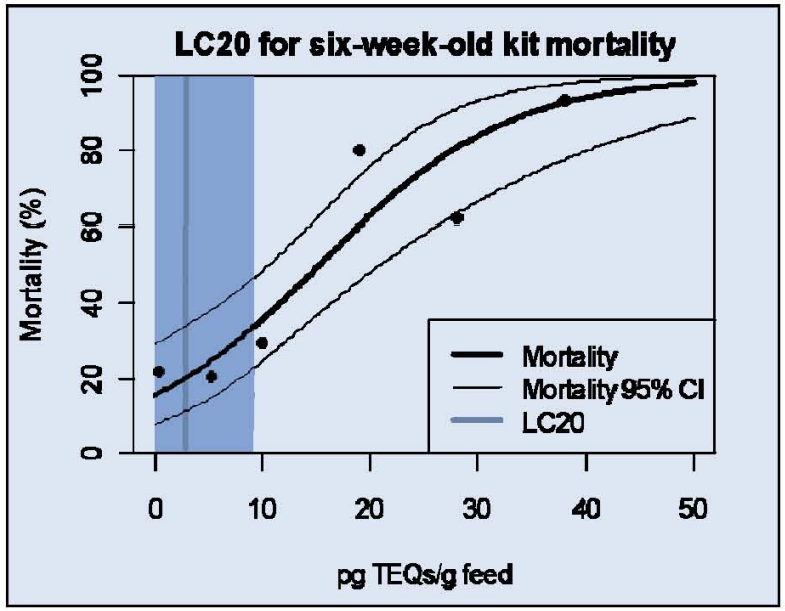
(pg TEQs/g feed)						

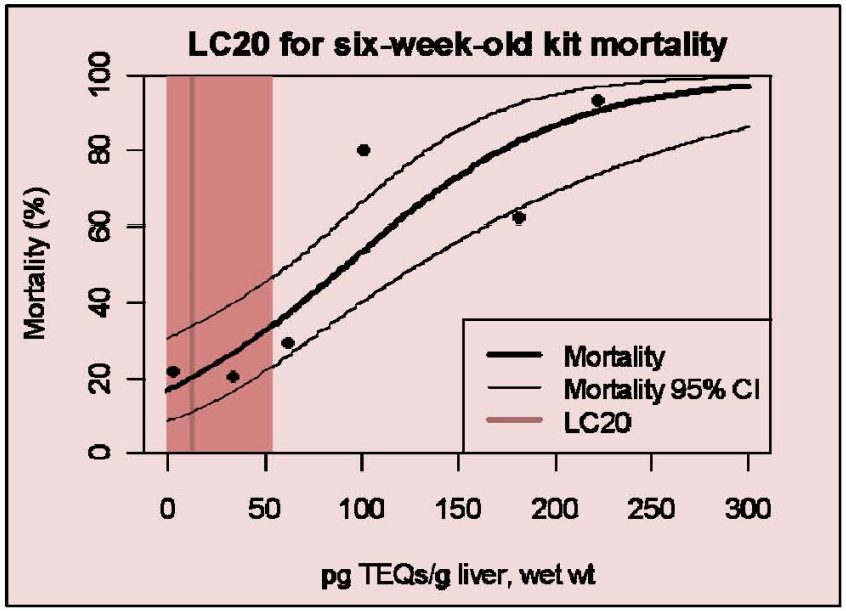
Dietary ΣPCBs/TEQs Associated with 20% Mortality of 6-wk-old Kits

Hepatic ΣPCBs/TEQs Associated with 20% Mortality of 6-wk-old Kits









Conclusions

- Reproductive performance of adult female mink and offspring survival and growth were adversely affected by consumption of feed containing PCBs derived from fish collected from the Hudson River

Conclusions

- **Reproductive Performance**
  - The number of stillborn kits per litter was significantly increased by dietary concentrations of 4.5 µg ∑PCBs/g feed (28 pg TEQs/g feed) and greater
- **Kit Survivability**
  - Dietary LC20 based on kit survivability at 6 wk of age = 0.34 µg ∑PCBs/g feed (2.9 pg TEQs/g feed)
  - Hepatic LC20 based on kit survivability at 6 wk of age = 0.80 µg ∑PCBs/g liver, ww (13 pg TEQs/g liver, ww)
- **Kit Growth**
  - Average body masses in the 1.5, 2.8 and 4.5 µg ∑PCBs/g feed groups (10, 19 and 28 TEQs/g feed, respectively) were less than controls at six weeks of age

Conclusions (WP114)

- **Organ Mass**
  - ↑ thyroid mass of adult females, ↓ heart mass of 6-wk-old kits, ↑ adrenal gland mass of juvenile mink

- **Tissue histopathology**
  - Development of a jaw lesion in adult mink characterized as mandibular and maxillary squamous epithelial proliferation
    - Dietary EC20 = 2.3 µg ∑PCBs/g (15 pg TEQs/g)
    - Dietary EC50 = 3.9 µg ∑PCBs/g (25 pg TEQs/g)
    - Hepatic EC20 = 2.8 µg ∑PCBs/g (89 pg TEQs/g)
    - Hepatic EC50 = 4.4 µg ∑PCBs/g (151 pg TEQs/g)

Conclusions

- EC20 based on the jaw lesion is 6-fold greater than LC20 based on kit survivability
- EC50 based on the jaw lesion is 1.7-fold greater than LC50 based on kit survivability

The conclusions and opinions presented here are those of the authors, they do not represent the official position of any of the funding agencies, the Hudson River Trustees or the United States. Funding provided by the Hudson River Trustees.

QUESTIONS?