A FIELD EVALUATION OF MINK AND RIVER OTTER ON THE LOWER COLUMBIA RIVER AND THE INFLUENCE OF ENVIRONMENTAL CONTAMINANTS

FINAL REPORT

Submitted to:

The Lower Columbia River Bi-State Water Quality Program

by:

Charles J. Henny, Robert A. Grove, and Olaf R. Hedstrom
National Biological Service
Forest and Rangeland Ecosystem Science Center
Northwest Research Station
3080 SE Clearwater Drive
Corvallis, OR 97333

Contract Numbers
ODEQ 143-94
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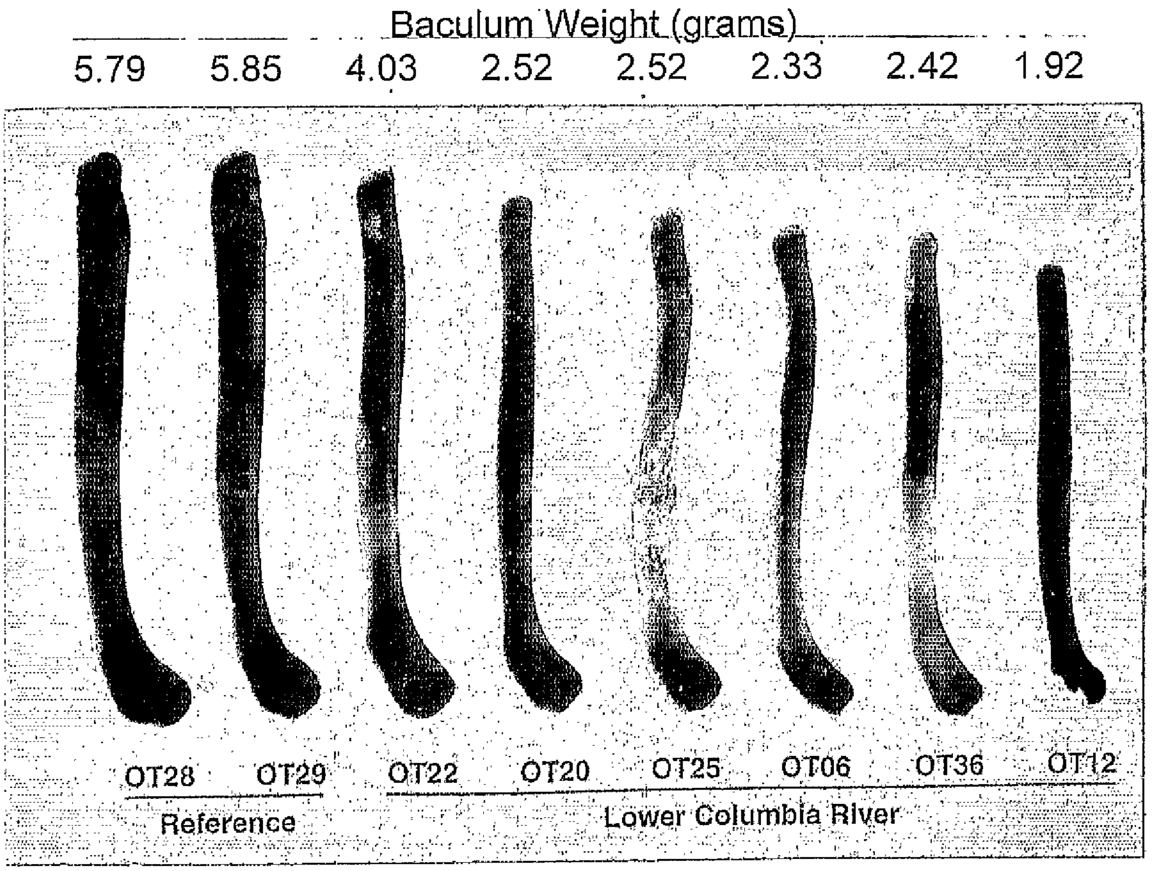
RIVER OTTER AGE CLASS 0



Frontispiece: Baculums from age class 0 male river otter from the Lower Columbia River and the ReferenceArea.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDIX TABLES

EXECUTIVE SUMMARY

Thirty-six river otter (Lutra canadensis) (30 from Lower Columbia River and 6 from Reference Area) and six mink (Mustela vison) (2 from Lower Columbia River and 4 from Reference Area) were trapped and used to evaluate organochlorine (OC) insecticides and their metabolites, polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins (dioxins), polychlorinated dibenzofurans (furans), and heavy metals contamination in the Lower Columbia River. Animals were aged using annual cementum layers of their canine teeth and summarized into three age classes: age class 0 (8-10 months old), age class 1, and age class 2+. Only two mink were captured along the Lower Columbia River which greatly restricted interpretation of mink residue accumulation. Therefore, findings were focused on river otter.

In age class 0 river otters, p,p'-DDE (DDE), β-hexachlorocyclohexane (HCH), heptachlor epoxide, dieldrin, mirex, nearly all PCB congeners, and many dioxin and furan congeners were already significantly higher in the Lower Columbia River than in the Reference Area. Contaminant concentrations in river otter livers were compared with River Mile (RM) of capture to evaluate their geographic distributions within the river. Geographical distributions were compared for all OC insecticides that met the mean liver concentration criteria of >1 ppb wet weight (ww) in age class 0, and Aroclor 1254:1260 represented all PCBs instead of evaluating each congener separately. These contaminants were rarely correlated with RM in age class 0 (only DDE), never correlated with RM in age class 1, but almost always correlated with RM in age class 2+ (the adults). In all significant relationships, concentrations decreased from Portland-Vancouver to the river mouth. The lack of significant relationships in age class 0 may be due to lower residue concentrations in young animals, while age class 1 are dispersers and wanderers that may have been captured at locations distant from their natal area where they spent their first year of life. Age class 2+ represents a relatively sedentary population that lives within an established home range. Dioxin-like compounds (co-planar PCBs, dioxins and furans) were evaluated with respect to RM in the same manner as OCs and PCBs. Two of the four co-planar PCBs (PCB 126 and PCB 169), only two dioxins (1,2,3,7,8,9-H6CDD and OCDD) and seven furans involving three furan families (PCDF, TCDF and H6CDF) showed significant relatinships with RM, and in each case, except age class 1, the concentrations were again higher near Portland-Vancouver and decreased downstream toward the mouth of the river. Known point sources of dioxins and furans, many of which were downstream from Portland-Vancouver, may have been responsible for the reduced numbers of significant dioxin and furan relationships with RM.

Body and organ weights, and measurements of river otter were compared between the Lower Columbia River and the Reference Area. Only baculum length and weight of Lower Columbia River age class 0 were significantly different (smaller or shorter) than the Reference Area animals of the same age class. Thus, only male reproductive organs in age class 0 were adversely effected, based on parameters measured in this study. Mean testes weight appeared to be less in river otters from the Lower Columbia River than the Reference Area, but the difference was not statistically significant. The seminiferous tubules in the age class 0 testes from the Lower Columbia River were lined with only a single layer of sertoli cells and there was no evidence of spermatogenesis. These effects in the Lower Columbia River seemed to result from delayed development and appeared to be temporary, because by age class 2+, the male reproductive organs were not significantly different in size from river otters in the Reference Area. However, we do not know if age class 2+ male reproductive organs were functioning normally. Most contaminants were inter-correlated making it extremely difficult to identify contaminants with respect to their potential for causing the observed effects. We evaluated age class 0 testes weight, baculum length, and baculum weight of individuals with respect to contaminant concentrations found in their livers (multiple regression). Heptachlor epoxide, 15 PCB congeners and 2,3,4,7,8-PCDF showed significant inverse relationships with testes weight. No testes were found in a 0 age class male from the Lower Columbia River. For most OCs and PCBs, this river otter had the highest concentrations in its age class. It also had the highest concentrations for about one-third of the dioxins and furans. Our regression equations (various contaminants vs. testes weight), excluding this animal, typically predicted no testes! More significant inverse relationships in age class 0 were found for baculum weight (6 OCs, 35 PCB congeners, 2 dioxins, and 5 furans) and baculum length (3 OCs, 16 PCB congeners, 1 dioxin, 2 furans, and chromium). It is known that PCBs cause liver enlargement and fatty deposition. Also, enlarged spleens were noted in some river otters during necropsy. Male river otters (the largest data set) in each age class were evaluated with respect to liver parameters, spleen weight and contaminant concentrations. A large number of significant direct relationships were found with liver and spleen weights and contaminants (including OCs, PCBs, dioxins and furans).

Spatial information showed that river otter collected at RM 119.5 (Portland-Vancouver) typically contained the highest concentrations of most contaminants (the exception being dioxins and furans), in addition to a few contaminants that were seldom found elsewhere. Three of the four animals collected at RM 119.5 showed gross abnormalities including a missing kidney and adrenal gland, a multilocular cystic abscess in the perineal region, and no testes found in a young male (the animal previously discussed).

Our river otter population estimating procedure was not rigorous, but provides an early autumn estimate of 286 ± 47 animals in the Lower Columbia River that were well distributed. There was no evidence for fewer animals in the Portland-Vancouver vicinity where the highest PCB and OC concentrations were found. No population estimates were made for mink; the population was extremely low. A mink Habitat Suitability Index (HSI) was determined for 25% of the Lower Columbia River, although its usefulness for river otter is unknown. The HSI scores for mink were excellent for many segments of the Lower Columbia River, but few mink were detected in July-August and only two were trapped during the trapping season.

Published reports of laboratory studies indicate that mink are extremely sensitive to PCBs and dioxin-like compounds. Based upon a series of published criteria developed for interpreting organ residue concentrations in mink, the few mink captured contained relatively low contaminant concentrations. River otter sometimes contained contaminants above threshold values (liver concentrations), and those from the Portland-Vancouver vicinity and immediately downstream were considered in the critical or almost critical category (scat concentrations), and gross pathological problems were encountered in 1994-95. These organ and scat criteria may not be appropriate for river otter because they were developed for mink (organ concentrations) and European otter (<u>Lutra lutra</u>) (scat concentrations) and we do not have an understanding of relative sensitivity among these species. Based upon river otter and mink contaminant data collected in 1978-79 from the Lower Columbia River, it becomes clear that total PCBs were much higher in the late 1970s when some individual mink contained PCB concentrations equivalent to those in adult female mink incapable of producing young in laboratory feeding studies. Therefore, the few mink observed now may be pioneering back into the Lower Columbia River in an attempt to recolonize.

River otter reproductive tract disorders found in age class 0 males from the Lower Columbia River were correlated with a number of contaminants, although all environmental contaminants were not evaluated (i.e., pthalate esters and alkylphenols). These reproductive tract disorders, with significant dose-response relationships shown for many OC, PCB, dioxin and furan contaminant, have not been previously reported for young free-living mammals. Tissue residue guidelines established for protecting wildlife from adverse reproductive effects (the mink data cited) pertained pimarily to the more toxic co-planar PCBs, dioxins, and furans, and may not be adequate for protecting river otters from the reproductive disorders we encountered with young males on the Lower Columbia River. In fact, this study provides some evidence that the more toxic dioxin-like contaminants may not be implicated in the young males plight. The disorders seem similar to abnormal gonadal morphology reported in juvenile alligators

mgmt section

(Alligator mississippienses) from Lake Apopka, Florida, where investigators hypothesized that xenobiotic compounds were modifying reproductive and endocrine development and function. Additional research is needed which includes continued studies with the contaminants initially investigated, plus other contaminants (e.g., pthalate esters and alkylphenols). This research also requires live-trapped river otters for evaluating general health, hormone concentrations, hormone receptor characteristics, gonadal morphology, and sperm counts.

1.0 INTRODUCTION

1.1 BACKGROUND

Biomagnification of organochlorine (OC) insecticides, polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins (dioxins), polychlorinated dibenzofurans (furans) and some heavy metals have been well documented in aquatic systems and high concentrations have been reported in predatory birds (e.g., bald eagle [Haliaeetus leucocephalus] and osprey [Pandion haliaetus]) at the top of aquatic food webs. Considerably less research has been conducted on wild predatory mammals associated with aquatic systems. Mink (Mustela vison) and river otter (Lutra canadensis) are both resident carnivores along the Lower Columbia River watershed; they feed largely on fish and other aquatic invertebrates and vertebrates and can therefore be exposed to relatively high levels of pollutants.

Concern about OC insecticides and their metabolites, PCBs, dioxins, and furans in the Columbia River is based on a variety of data: (1) black-crowned night-heron (Nycticorax nycticorax) eggs contained higher concentrations of both DDE and PCBs at Columbia River sites than adjacent sites in the Pacific Northwest (Henny et al. 1984), (2) bald eagles on the Lower Columbia River contained high concentrations of DDE and PCBs and elevated concentrations of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD, dioxin) in their eggs and exhibited low reproductive success compared to eagles in the remainder of Oregon (Anthony et al. 1993), (3) a pilot study of mink and river otter in Oregon in 1978-79 showed that PCBs were most frequently encountered in mink and river otter from the Lower Columbia River compared to other sites in Oregon (Henny et al. 1981). Also, PCB concentrations in several mink were within the range detected in ranch mink that survived long-term tests with a diet of 0.64 parts per million (ppm) PCBs, but were unable to successfully reproduce (i.e., only 1 of 12 females produced a litter [they died the first day] and 2 adult females died during the study) (Platonow and Karstad 1973). Aulerich and Ringer (1977) showed that mink receiving a dietary level of 1 ppm Aroclor 1254 had slightly depressed reproductive success compared to total reproductive failure for those receiving 2 ppm. Aroclor 1242 diets caused complete reproductive failure at levels as low as 5 ppm in the diet (Bleavins et al. 1980). Fish in the Columbia River above Portland in 1976-78 commonly contained PCBs (range 0.24-2.8 ppm) equivalent to or higher than the dietary dosage given in the laboratory studies (Henny et al. 1981). River otter and mink from the Lower Columbia River contained some of the highest PCB concentrations reported for the species in North America (Table 1 and 2). Exposure of animals to PCB mixtures produces a broad spectrum of effects including mortality, inhibition of body weight gain or body weight loss, porphyria, immunotoxicity, hepatotoxicity, neurotoxicity, thymus atrophy, dermal toxicity, carcinogenicity, endocrine disruption, and reproductive toxicity (Safe 1994).

Concern about dioxins and furans in the Lower Columbia River began when the EPA reported high concentrations in fish collected in 1987 (Table 3). The dioxin congener 2,3,7,8-TCDD and the furan congener 2,3,7,8-TCDF were detected in parts per trillion (ppt) wet weight (ww) in all 8 northern squawfish (Ptychocheilus oregonensis) and suckers analyzed. The toxic equivalency concentration (TEQ) (combined effective concentrations of all dioxins and similar chemicals relative to 2,3,7,8-TCDD toxicity) ranged from 2.80 to 8.50 ppt (ww). Mink are among the most sensitive species to the toxic effects of TCDD and related compounds such as PCBs. Hochstein et al. (1988) reported a 28-day LD50 for ranch mink of 4.2 micrograms per kilogram of body weight TCDD. A simple risk assessment conducted by the Canadian Wildlife Service indicated that mink fed a diet containing greater than 4.5 ppt of 2,3,7,8-TCDD could suffer reproductive impairment (Elliott and Whitehead 1989). This is within the range of concentrations reported in fish collected in the Lower Columbia River and does not take into account the contribution of PCBs and other contaminants known to be present in the food chain of the river. River otter in the Lower Columbia River contained even higher concentrations of PCBs than the mink (Henny et al. 1981), but their relative sensitivity to PCBs is not known. Several studies have reported that 2,3,7,8-TCDD and related toxic halogenated aromatics elicit a number of toxic responses similar to PCBs which include body weight loss, thymic atrophy, impairment of immune responses, hepatoxicity and porphyria, chloracne and related dermal lesions, tissue-specific hypo- and hyperplastic responses, carcinogenesis, teratogenicity, and reproductive toxicity (Safe 1990).

The percentage of Oregon's mink harvest in the two counties bordering the Lower Columbia River decreased from 15.4% in 1949-52 to 9.1% in 1973-76 (Henny et al. 1981). One trapper, who trapped the same area at the mouth of the Columbia River near Astoria, kept records since the 1963-64 trapping season. He always trapped within 13 km of his house and maintained generally constant effort over time. His data shows an 85% decrease in wild mink trapped from 1963-69 to 1985-89, as opposed to the overall 35% decrease in the 2-county area from 1965-68 to 1985-88 (Oregon Dept. Fish and Wildlife, [ODFW] files). Of course, a portion of the total mink harvested in the 2-county area are not directly associated with the Columbia River. Only 7 mink were taken in the 2-county area in 1992 (ODFW, files).

1.2 PURPOSE AND SCOPE

The present distribution and abundance of mink and river otter along the Lower Columbia River remains unknown. Likewise, the role of habitat change and the role of pollutants on the present distribution and abundance are unknown. The objectives of this study were:

(1) Collect mink and river otter and their scat along the Lower Columbia River and at a Reference Area to determine present contaminant burdens, and further evaluate contaminant accumulation in the Lower Columbia River by comparing residue concentrations among different age classes of mink and river otter.

(2) Evaluate contaminant distribution in the Lower Columbia River by comparing residue concentrations with River Mile (RM) of capture for the different age classes.

(3) Evaluate possible contaminant effects by comparing body and organ measurements and weights with contaminant concentrations (also compare concentrations with known effect levels based on laboratory studies).

(4) Develop a sampling framework and perform a late summer survey of the Lower Columbia River to provide a measure of the distribution and abundance of mink and river otter. Obtain an additional independent estimate of the number of mink and river otter in various river segments by obtaining information from knowledgeable trappers on the number of animals (family units) present and the number harvested.

(5) Evaluate mink and river otter habitat along the Lower Columbia River by collecting information for the Mink Habitat Suitability Index Model (Allen 1986).

1.3 ACKNOWLEDGMENTS

We appreciate the efforts of numerous individuals who participated in field activities on this project, including R. Breeden, M.McKinley, J. Culver, J. Nichols, J. Lederer, J. Shaw, D. Kilawitz, and G. Soukkala. L. Cooper and R. Green, ODFW provided information about mink and river otter trappers and properly extracted teeth for aging. C. Mack, Nez Perce Tribe, collected scat samples from the Clearwater River in Idaho. K. Patnode, Wisconsin Department of Natural Resources, offered advice in designing the study, and J. Hatfield, National Biological Service, provided statistical advice. The QA/QC was handled by the Canadian Wildlife Service, Hull, Quebec, Canada who regularly used the nearby Great Lakes Institute for Environmental Research (GLIER), University of Windsor, Windsor, Ontario, for contract chemical analyses. This project was partially funded by a Grant, administered through the Lower Columbia River Bi-State Water Quality Program. The manuscript was improved by the comments of T. Colborn, T. Kubiak, K. Patnode, and B. Rattner.

2.0 APPROACH AND METHODS

2.1 COLLECTION AND NECROPSY OF MINK AND RIVER OTTER

Mink and river otter were to be live-trapped during the late summer survey, but few mink were detected and river otters could not be live-trapped during the short stay at each location. Therefore, licensed trappers were contacted and skinned carcasses were obtained from them during the fall-winter 1994-95 trapping season. The carcasses were wrapped in aluminum foil and frozen by the trappers. We obtained 36 river otter carcasses (30 from within 400 meters of the Columbia River between RM 11.0 and 119.5 and 6 from a Reference Area in the Coast Range of Oregon [near headwaters Wilson and Trask Rivers]) and 2 mink from the Lower Columbia River and 4 from a Reference Area (Malheur National Wildlife Refuge in eastern Oregon). Mink collected at Malheur in the recent past showed low PCB, dioxin, and OC insecticide residues in their livers. Fresh scats were collected from both mink and river otter along the Lower Columbia River and placed in chemically cleaned jars. Also, Reference Area river otter scats were obtained from the Clearwater River in Idaho and the Wizard Falls Fish Hatchery on the Metolius River near Sisters in central Oregon.

A necropsy of each animal was conducted at the Veterinary Diagnostic Laboratory, College of Veterinary Medicine, Oregon State University, Corvallis, with a Board Certified Veterinary Pathologist (Hedstrom) present at all times. Small samples of all organs were preserved in 10% buffered formalin for possible later histology; all organs were weighed or measured with information recorded on a data form. Toes were checked for deformities, and a canine tooth was extracted for later use in aging the animal. Body condition and body measurements were recorded. Baculums were saved and later placed in a dermestid beetle colony at the Department of Fisheries and Wildlife, Oregon State University, for clean-up of non-bony tissue.

2.2 AGING TECHNIQUES AND CHEMICAL ANALYSES

Each animal was aged by counting cementum layers from a canine tooth (Stephenson 1977, Pascal and Delattre 1981, Matson 1981) at the Matson Laboratory, Milltown, Montana. Each cementum layer or annuli represents one year of age.

Frozen mink and river otter tissue samples and scat were sent to GLIER at the University of Windsor, Windsor, Ontario, Canada for contract chemical analyses. Quality Assurance/Quality Control was completed by the National Wildlife Research Centre of the Canadian Wildlife Service and Environment Canada, Hull, Quebec, Canada. Individuals mesentery fat and liver collected during the winter of 1994-95 were analyzed for OC insecticides and their metabolites, PCBs, dioxins and furans; liver and kidney in addition were analyzed for selected heavy metals. Regional trends in PCBs (based on Aroclor 1260 standard) and pesticide contamination in otter (L. lutra) from the United Kingdom have been determined using otter scats (feces or spraints) (e.g., Mason 1993, Mason and MacDonald 1993a, Mason and MacDonald 1994). Thus, the approach was used in this study to evaluate patterns of OCs and PCBs (lipid basis) in the Lower Columbia River and several Reference Areas, and to provide baseline information for future non-invasive monitoring. One scat sample was also analyzed for dioxins and furans to determine if they were present.

Chemical determination of organics followed the methods of Lazar et al. (1992). Organic and metals analyses for biological tissues are described in detail in the GLIER Methods and Procedures Quality Manual (1995). General procedures are briefly described below.

2.2.1 Organics

Moisture content was determined by oven-drying a 1 g aliquot of animal tissue sub-sample in a pre-weighed aluminum weighing boat for 24 hrs at 125°C. For organochlorine hydrocarbons, pesticides, and PCBs, a sample of animal tissue homogenate (1 g fat, 5 g liver) was ground with anhydrous Na_2SO_4 (5 fold the sample weight) using a glass mortar and pestle. The free-flowing powder obtained was extracted using dichloromethane (DCM)/hexane (50% V/V). The eluate collected was concentrated to approximately 5 ml after addition of 5 ml isooctane, and adjusted to 25 ml using hexane. Lipid determination was made by drying 2 ml of the sample eluate in a preweighed glass beaker at 105°C for 1 hr. The remaining 23 ml of extract was concentrated to ~2 ml after adding 5 ml of isooctane. If the lipid content of an extract was higher than 0.5 g/sample (i.e., fat samples), the extract was placed on a Gel Permeation Column (GPC) for bulk lipid separation after addition of 2 ml DCM. A total of 300 ml 50% DCM/hexane (v/v) was added to the gel permeation column and elution performed. The first 130 ml eluate containing the lipid was discarded. The last 170 ml of eluate containing the contaminants of interest was collected and 5 ml of isooctane added. The sample was concentrated to ~2 ml and transferred to a florisil column for additional cleanup. Samples containing less than 0.5 g fat/sample were also transferred to florisil column for additional cleanup. The first fraction from the florisil column was collected using 50 ml of hexane, with subsequent second and third fractions collected using 50 ml of 15% DCM/hexane (V/V) and 50 ml of 50% DCM/hexane (V/V), respectively. The 3 fractions were each concentrated to ~2 ml after addition of 5 ml of isooctane. The fractions were then adjusted to a suitable final volume in isooctane. The final dilutions of the sample were evaluated for the following:

Fraction 1

1,2,4,5-tetrachlorobenzene
1,2,3,4-tetrachlorobenzene
pentachlorobenzene (QCB)
hexachlorobenzene (HCB)
octachlorostyrene (OCS)
trans-nonachlor
p,p'-DDE (DDE)
photomirex
mirex
PCBs (including mono-orthosubstituted congeners)

Fraction 2

α-hexachlorocyclohexane (HCH)
β-HCH
γ-HCH
oxychlordane
trans-chlordane
cis-chlordane
p,p'-DDD (DDD)
cis-nonachlor
cis-nonachlor
p,p'-DDT (DDT)
PCBs (non-orthosubstituted congeners)

Fraction 3

heptachlor epoxide
dieldrin
trichlorophenylmethanol

A 5% carbon/silica gel mixture was used to separate the non-orthosubstituted PCBs from florisil fraction #2. An ~2 ml concentrated extract of fraction #2 was added to the top of a previously prepared carbon/silica column. The first fraction was eluted using 30 ml of hexane, followed by elution of a second fraction using 30 ml of DCM. The column was then inverted and a third fraction eluted using 30 ml of toluene. The third fraction (containing the non-orthosubstituted PCBs) was concentrated and reconstituted to an appropriate volume using isooctane. Fractions from the florisil and carbon/silica separations were run separately on a Hewlett Packard (HP) model 5890 Gas Chromatograph, equipped as follows:

^{63}Ni-electron capture detector (ECD)
HP-3396 Integrator
HP-7673A Autosampler
Column: 30 m x 0.25 mm I.D. x 0.25 μm DB-5 film thickness (J&W)
Injector temperature: 250°C; Detector temperature: 300°C
Carrier gas: helium at ~30 cm/sec - determined at 100°C (1 ml/min)
Make-up gas: argon/methane (95%/5%) at 50 ml/min
Oven temperature Program:
Initial temperature: 100°C Initial time: 1 min
Rate: 10°C/min to 150°C, then 3°C/min to 275°C
Final hold time: 5 min Equilibrium time: 3 min
2 μl sample injection using a splitless injection mode

Analyses were conducted for 20 organochlorine insecticides and 43 PCB congeners. Quantification was accomplished by comparing sample-peak area against standard-peak area of 3 standards supplied by the Canadian Wildlife Service. The detection limit for OC insecticides and PCBs was 0.1 parts per billion (ppb, ww). OCs and PCBs were confirmed using gas chromatograph/mass spectrometer.

Extraction of co-planar PCBs, dioxins, and furans was similar to the previously described extraction and cleanup method with a few exceptions. First, a 10g sample of liver homogenate was used instead, with the fat sample size remaining the same. Second, all sample extracts were run through bulk lipid separation by GPC. Third, during the florisil cleanup only 2 fractions were collected. The first fraction was collected using 50 ml hexane (fraction discarded), while the second fraction was collected using 100 ml toluene. The second fraction containing the contaminants of interest was concentrated and solvent exchanged into DCM to a final volume of 1 ml. The concentrated fraction was taken through a carbon chromatography cleanup process using a semi-automated high pressure liquid chromatography apparatus. Of four fractions collected, two fractions containing contaminants of interest were concentrated using DCM prior to analysis by high resolution gas chromatography/ mass spectrometry using a VG AutoSpec-Q mass spectrometer connected to a Hewlett Packard 5890 gas chromatograph. The detecting limit for co-planar PCBs, dioxins, and furans was 0.1 ppt (ww).

The concept of toxic equivalents or 2,3,7,8-TCDD equivalents (TEQs) was developed for application in risk assessment of dioxin-like compounds (PCBs, dioxins and furans), and converts residue data of complex mixtures into TEQs. 2,3,7,8-TCDD is generally recognized as the most toxic halogenated aryl hydrocarbon, and relative toxicities or toxic equivalency factors (TEFs) were developed for several PCBs, dioxins, and furans in relation to 2,3,7,8-TCDD based on in vivo studies and in vitro bioassays (Safe 1990). This approach is based on receptor-mediated mechanisms of action of phase 1 drug metabolizing enzymes (e.g., cytochrome P4501A1 induction) involving the Ah receptor. TEQs were calculated from PCB, dioxin, and furan residues in livers of river otter and mink using toxic equivalency factors (TEFs) reported by Safe (1994). TEQs were determined by conversion of river otter and mink liver residue data in which $\sum$(congener concentration) x (congener TEF) = TEQs for each separate sample. TEQs could then be compared among individuals. However, TEQs treat residue data as additive, not taking into account various possible interactions with mixtures which may be additive, antagonistic, or synergistic in nature. Therefore, care must be taken when interpreting TEQ information.

2.2.2 Metals

Analyses for 10 heavy metals were run on individual liver and kidney samples. For mercury analyses, a 1 g sample was digested in 15 ml of a 2:1 solution of sulphuric and nitric acids at 60°C. Once completely digested, 20 ml of 5% potassium permanganate was added, followed by a 20 ml addition of 5% potassium persulphate. Finally, 5 ml of 10% hydroxylamine hydrochloride-sodium chloride was added. The sample was adjusted to 100 ml using distilled water. Total mercury was determined using flameless atomic absorption spectrophotometry.

For other metal analyses (Al, Cd, Cr, Cu, Fe, Mn, Ni, Pb, V, and Zn), a 2 g sample was placed into a 50 ml beaker. At room temperature, 5 ml of a 1:1 mixture of concentrated sulfuric and nitric acids was added to the sample. The sample was heated up to 120°C for 1 hr and the beaker uncovered and heated at 120°C for 2 hrs or until the sample was charred. Another 5 ml of concentrated nitric acid was added and the sample heated at 120°C for 4 hrs. After cooling, 30% hydrogen peroxide was added and the sample heated. The nearly colorless solution was adjusted to 100 ml using distilled water. Atomic absorption spectrophotometry was used to determine metal concentrations in tissue preparations. The dry weight (dw) detection limits (ppm) for heavy metals were as follows:

Aluminum	0.90 ppm	Lead	0.47 ppm
Cadmium	0.02 ppm	Manganese	1.07 ppm
Chromium	0.13 ppm	Mercury	0.22 ppm
Copper	0.47 ppm	Nickel	0.44 ppm
Iron	12.50 ppm	Zinc	2.50 ppm
Vanadium	0.25 ppm		

2.2.3 Quality Assurance/Quality Control

Organic methodology for extraction and cleanup was checked by running a sample blank every 6th sample, a replicate sample run every 10th sample, a certified reference material sample provided by the Canadian Wildlife Service run every 9th sample for OCs and PCBs, and a ^{13}C-surrogate spike for each sample run for co-planar PCBs, dioxins, and furans. Instrumentation was checked daily using machine blanks, solvent blanks, method blanks, spiked blanks, and working standard solutions used for sample quantification. Inorganic methodology was checked using 3 method blanks, 2 samples in duplicate, an internal reference pool, and 2 certified reference material samples for every 25 samples run. Instrumentation was checked daily for calibration drift and zero verification for every eight samples run, and a sample extract re-reading every 25th and 40th sample run. Instrument readings are taken in duplicate accepting relative standard deviations no greater than 25%. Calibration is performed for each run made.

2.3 IN VITRO EXPOSURE OF RAT HEPATOMA CELLS TO RIVER OTTER LIVER EXTRACTS

H4IIE rat hepatoma cells, grown and cultured at 37°C as described by Tillitt et al. (1991), were grown to confluency on 96-well tissue culture microtiter plates. Mink and otter liver extracts held in isooctane were suspended in culture medium and mixed thoroughly prior to cell culture exposure, with a maximum 1% final solvent concentration. Cell cultures were exposed for 48 hours to the spiked cell culture medium. Following the exposure period, cells were washed with phosphate-buffered saline prior to ethoxyresorufin-O-deethylase (EROD) bioassay. The procedure used for monitoring EROD activity was a modification of the method described by Tillitt et al. (1991). Incubation medium with a final volume of 0.1 ml/well consisted of 50 mM $NaPO_4$, pH 8.0, containing 60 μM EDTA, 5 mM $MgSO_4$, and 10 μM dicoumarol. The cells were pre-incubated in this medium for 5 minutes with 40 μM digitonin (to permeabilize cells), glucose 6-phosphate dehydrogenase (to 0.5 μ/ml) and ethoxyresorufin (to 8 μM). The reaction is started by adding glucose 6-phosphate (to 5 mM) and NADPH (to 0.5 mM). Increased fluorescence as a result of ethoxyresorufin-O-deethylation was monitored using 96-well flourometric plate reader at 37°C, using excitation and emission filters with wavelength optima of 538 and 591 nm, respectively. Rates of resorufin production were determined using resorufin standards. Protein content was determined using the method described by Lowry et al. (1951).

2.4 MINK AND RIVER OTTER DISTRIBUTION AND ABUNDANCE

Initially, it was anticipated that the Lower Columbia River (below Bonneville Dam) would be divided into ecoregions and perhaps subecoregions that border the river. However, the usefulness of ecoregions and subregions to describe the 100 meter width of habitat along the Columbia River was untenable and had no utility for predicting the density of mink or river otter. Therefore, recognizing that the degree of tidal influence could also be a factor in animal density, we divided the lower 144 miles (not changed to metric because of its standard usage for river) of the Lower Columbia River into four equal strata of 36 river miles, and then randomly chose one 9-mile segment on each side of the river from each of the four strata (constrained so that the same river miles would not be surveyed on each side of the river). The home range of a river otter family (adult female and young) is about 5 to 16 km (Liers 1951), although adult males are known to move greater distances. Therefore, 72 river miles of the 288 (144 x 2) were surveyed, or 25% of the river. The stratified random sampling of the Lower Columbia River was conducted in July-August of 1994. With this approach (about 6 weeks on the river), a measure of the relative distribution and abundance of mink and river otter was obtained.

The field survey, by an expert trapper with 30 years of experience and National Biological Service biologists, used tracks, scat, scent markers, and other signs to estimate the minimal number of mink and river otter in each (pre-determined) 9-mile strata. Eight 9-mile segments were evaluated on the Lower Columbia River. In several studies, total numbers of mink inhabiting relatively small areas were estimated by intensive field observation (Errington 1943, McCabe 1949). Four days of intensive field work was completed at each 9-mile segment to evaluate tracks (adult females and young, and adult males), other sign (scat, etc.), and their distribution within each strata.

Mink family groups remain within an area of about 300 meters. Track boxes containing aluminum foil covered cardboard inserts coated with pine pitch soot and marked with mink anal gland scent were strategically placed in the strata to supplement mink track observations. Mink tracks alone or on the soot covered foil marked with anal gland extract may be considered an index to mink abundance (Humphrey and Zinn 1982). We believe numbers of animals determined by this approach were minimal.

Locations of all mink and river otter sign within a strata were plotted on maps, so that prey species sampling could be subsequently conducted to further evaluate contaminants in areas where animals were found. Available data from previous sampling of fish, sediment, and crayfish does not provide adequate information to determine a contaminant gradient for the river. Additional contaminant information for prey species could be obtained later, but we collected scat (from both river otter and mink) as an independent method to evaluate contaminant burdens (see Mason 1993).

2.5 MINK AND RIVER OTTER HABITAT

With respect to suitable mink and river otter habitat, the quality of habitat cannot be obtained from aerial photographs or maps. The availability of suitable denning habitat and food was evaluated for each 9-mile segment during the ground survey. Also, each 9-mile strata was evaluated for both mink and river otter suitability with the mink Habitat Suitability Index Model (Allen 1986). This included an evaluation of shoreline cover and canopy cover for 100 meters immediately adjacent to the river. No Habitat Suitability Index Model was available for river otter.

3.0 NECROPSY AND HISTOPATHOLOGY OF ORGANS AND TISSUES (RIVER OTTER)

3.1 GROSS NECROPSY FINDINGS

In all river otters there was moderate to extensive postmortem autolysis. Generally, river otter collected from the Lower Columbia River and Reference Area were found during necropsy to be in good body condition. Only one age class 1 male (No. 4), collected at River Mile (RM) 53.9, had low body fat reserves. Several gross pathological findings were noted. The baculum of an age class 0 male (No. 25) collected at RM 87.5 was previously broken, but healed completely (see Frontispiece). A 2 year old female (No. 37) collected at RM 119.5 had a multilocular cystic abscess in the perineal region which measured 8.9 cm long by 5 cm deep. A 3 year old male (No. 38) from the same area had left adrenal and renal agenesis. In the remaining organ systems of these river otters (Nos. 37 and 38), no significant gross lesions were observed. External or internal testes were not found in an age class 0 male (No. 36), also from RM 119.5. Therefore, 3 of 4 river otter collected from RM 119.5 had gross abnormalities. No external deformities of the toes were noted and no other significant gross lesions were observed in the remaining organ systems. The CNS system was not examined. About one-third of the river otter necropsied had enlarged spleens (a large lymphoid organ containing the largest collection of reticuloendothelial cells in the body).

3.2 HISTOPATHOLOGY

Mild granulomatous pneumonia with multifocal PAS positive fungal organisms within the center of the alveolar inflammatory foci were found in river otter No. 1 and No. 2 (both collected RM 73.1). In the testes of age class 0 river otters (Nos. 6, 12, 20, and 22) from the Lower Columbia River (RM 11.0 to 73.1), evidence of hypoplasia was found when compared with age-matched river otters (Nos. 28, 29) from the Reference Area (Figures 1 and 2). In the Lower Columbia River animals (B,C,D), the seminiferous tubules were small and they were usually lined by a single cell layer of sertoli cells; also, interstitial cells appeared more prominent and there was no evidence of spermatogenesis. In the testes obtained from the Reference Area river otters (Nos. 28,29), seminiferous tubules were large and tortuous and they were lined by several cell layers; spermatogenesis was observed. In river otter No. 37 from RM 119.5, a pyogranulomatous abscess and cellulitis was observed and an operculated parasite ova with a brown cell wall was found associated with the inflammatory reaction. In the remaining river otters, no significant histologic changes besides postmortem autolysis and freezing artifacts were observed in the lungs, liver, kidney, testes, uterus or ovary of the appropriate sex, spleen, thyroid gland, lymph node, and thymus.

4.0 ENVIRONMENTAL CONTAMINANTS IN LIVER, FAT, KIDNEY AND SCAT OF MINK AND RIVER OTTER

To show and interpret potential contaminant effects on wildlife in a study area (in this case the Lower Columbia River) several lines of evidence are required: (1) the contaminant of concern must be present and accumulated by the species studied, (2) spatial patterns in contaminant accumulation must be documented (e.g., RM) to further define problem areas, (3) contaminant relationships with body condition (e.g., organ weights, gross necropsy findings, histopathology) must be documented, (4) findings from the study must be evaluated with respect to published literature on known effect concentrations of individual contaminants (e.g., in prey species, in tissue or organ concentrations of animal itself, or in scat concentrations) on survival or productivity, and (5) items 1 through 4 must be evaluated with respect to the present distribution and abundance of each species in the study area.

4.1 CONTAMINANT ACCUMULATION (RIVER OTTER)

The 36 river otter form the largest data set (30 from Lower Columbia River and 6 from Reference Area) to evaluate contaminant exposure and accumulation in the Lower Columbia River. Exposure beyond background levels was determined by a comparison of residues from the Reference Area. Accumulation was evaluated by a comparison of residues for the age classes from the Lower Columbia River. Twenty-six of the river otters were males, and the data were summarized so that males alone and males plus females were both evaluated. Age class 0 represents animals less than one year old at the time of collection in the fall- winter trapping season, with age class 1 representing greater than 1 year, but less than 2 years of age. Age class 2+ for the Columbia River includes animals 2 to 5 years old. The six Reference Area animals shown in Tables 3 and 4 include all ages combined (actual ages 0, 0, 2, 3, 8, 9). Even though two animals were old, little organic residue accumulation occurred in the Reference Area, which provides the logic for combining the Reference Area age classes in this analysis. The addition of 10 females (1 Reference Area, 1 age class 0, 3 age class 1, and 5 age class 2+) did not change geometric means appreciably, but the increase in the sample size sometimes improved the ability to detect significant differences. Adult female mammals (age class 2+) are thought to reduce body burdens of lipophilic contaminants through placental and milk transfer of contaminants to young (e.g., Amdur et al. 1991:72). Therefore, in age class 2+ from the Lower Columbia River, we tested for significant differences in residue concentrations between males and females.

Ninety statistical tests (T-test, $\log_{10}$ transformed) of mean contaminant concentrations in livers or kidneys between 9 males and 5 females showed only 4 tests significant ($P \leq 0.05$). These included PCB 126, 1,2,3,7,8-PCDD, PCDD total, and 2,3,4,6,7,8-H6CDF; the mean female concentrations were unexpectedly higher than in males in all cases. These findings were contrary to the hypotheses of reduced concentrations in adult females because of contaminant elimination by placental and milk transfer to young. The period of carcass collection was long after the nursing period of young, which may account for these findings. We would expect 4.4 of the 90 tests to be significant as a random event with a $P=0.05$. Four tests were significant. Therefore, the combining of males and females seemed prudent.

4.1.1 PCBs and Organochlorine Insecticides and Metabolites

Liver was used to evaluate organochlorine and PCB concentrations (ppb, ww.) (Tables 4 and 5). The percent lipid and percent moisture in livers was not significantly different among age classes from the Lower Columbia River or the Reference Area (Table 4). Geometric means for contaminants were not computed unless at least 50% of the samples contained residues above the detection limit (0.10 ppb). For statistical purposes, a value of 0.05 ppb (half the detection limit) was assigned to samples in which the contaminant was not detected. Based on the largest data set (males and females combined), DDE, DDD, heptachlor epoxide, β-HCH, dieldrin, and mirex were already significantly higher in age class 0 from the Lower Columbia River than at the Reference Area. In river otter from the Lower Columbia River, a pattern of increased concentrations with age was apparent for all OC insecticides and metabolites, but the change was statistically significant for only oxychlordane.

PCBs in livers of males and females combined (Table 5) showed that nearly every PCB congener in age class 0 river otters from the Lower Columbia River was significantly higher than in river otters from the Reference Area. The only PCB congeners that did not show a significant increase when compared to the Reference Area were PCB 70 and PCB 151. These congeners were found at low concentrations in river otter from the Lower Columbia River, but were still at least twice as high as in those from the Reference Area. Of the 37 PCB congeners shown in Table 5, age class 0, male and female river otters from the Lower Columbia River contained concentrations that averaged 7.8-fold higher than those found in age class 0 otters from the Reference Area. PCB residues also showed a consistent pattern of increase with age in the river otters from the Lower Columbia River, but the increases were not statistically significant.

4.1.2 Co-planar PCBs, Dioxins and Furans

Liver was used to evaluate co-planar PCBs, dioxins and furans (ppt,ww) (Table 6). Geometric means were not computed unless at least 50% of the samples contained residues above the detection limit (0.10 ppt, ww). For statistical purposes, a value of 0.05 ppt (half the detection limit) was assigned to samples in which the contaminant was not detected. Based on the largest data set (males and females combined), 2,3,7,8-TCDD, TCDD total, 1,2,3,4,6,7,8-H7CDD, OCDD, 1,2,3,4,7,8-H6CDF, 1,2,3,4,6,7,8-H7CDF, and H7CDF total were significantly higher in all river otter age classes (0,1,2+) from the Lower Columbia River than the Reference Area. Six other dioxins and furans (1,2,3,6,7,8-H6CDD, H6CDD total, H7CDD total, 2,3,4,7,8,-PCDF, PCDF total, and H6CDF total) were significantly higher in age class 0 from the Lower Columbia River than the Reference Area. Of these six congeners, none in age class 1 and only four (H7CDD total, 2,3,4,7,8-PCDF, PCDF total, and H6CDF total) in age class

2+ were higher in river otter from the Lower Columbia River than those from the Reference Area. These differences between age classes do not appear related to sample size (age class 1 and 2+ had more animals). An inspection of the geometric means in Table 6 verifies the higher dioxin and furan concentrations in age class 0 for many of the congeners. Geometric means of the co-planar PCBs (PCB 77, PCB 81, PCB 126, and PCB 169) were generally higher in river otter from the Lower Columbia River than the Reference Area, but significantly higher only for PCB 81 in age class 2+.

PCB, dioxin and furan concentrations (ppt, ww) were also used to calculate a TEQ for each animal. One of the major applications of the TEQ approach involves the conversion of analytical data into toxic or 2,3,7,8-TCDD equivalents (TEQs). Therefore, TEQs reduce many individual congener concentrations of dioxin-like compounds that act in a similar manner (but with different potencies) to one value for evaluation purposes. TEQs were evaluated like residue concentrations in Table 6. Geometric mean TEQs were significantly higher in all river otter age classes from the Lower Columbia River than the Reference Area. However, as suggested earlier for some individual co-planar PCBs, dioxins and furans, the TEQs did not show a significant pattern of increase with age in the Lower Columbia River.

4.1.3 Heavy Metals

Heavy metals were analyzed in both the liver and the kidney of each animal collected. (Table 7). Cadmium increased significantly from age class 0 to age class 1 and age class 2+ in both the livers and the kidneys of river otters from the Lower Columbia River. Reference Area cadmium concentrations with all age classes combined, as might be expected, were intermediate between age class 0 and age class 2+ from the Lower Columbia River. Zinc in livers and kidneys showed no significant change with age along the Lower Columbia River (males + females combined), but zinc in livers was significantly higher in males from the Reference Area than in age class 2+ males from the Lower Columbia River. Chromium, copper, iron, manganese, mercury (analyzed liver only) and vanadium showed no significant differences between the Reference Area and the various age classes taken along the Lower Columbia River. Nickel in the kidney showed no significant differences between the Reference Area and Lower Columbia River, and it was seldom detected in the liver (only in 3 river otter from Lower Columbia River and 1 from Reference Area). Aluminum was detected in livers of 3 river otter and kidneys of 4 river otter from Lower Columbia River. The highest concentration (1.83 ppm, dw) was reported in a 3 year old male at RM 119.5 which is immediately downstream from an aluminum smelter. Lead was not detected (detection limit, 0.47 ppm) in any livers of river otter, but was found in 9 of 30 kidneys from the Lower Columbia River (range 0.48 to 1.63) and none (0 of 6) from the Reference Area. It is of interest that all four river otters taken at RM 119.5 contained lead in their kidneys (0.58, 1.63, 0.69, and 0.48 ppm).

Because cadmium increased significantly with age class (0,1,2+) in river otter from the Lower Columbia River (Table 7), the actual age of the animals was used to further evaluate the relationship. An ANOVA showed that cadmium in liver (F = 11.05, P = 0.003) and cadmium in kidney (F = 17.58, P = 0.0003) were related to actual age in years (Figure 3). However, the cadmium increase primarily occurred between age class 0 and age class 1.

4.2 CONTAMINANT ACCUMULATION (MINK)

With only two mink (adult male and adult female) trapped (both at RM 88 on the Oregon side) along the Lower Columbia River, the ability to discuss residue accumulation and concentration patterns within the river is greatly limited (Tables 8-11). The Reference Area mink (two males pooled and two females pooled) were trapped at Malheur National Wildlife Refuge in eastern Oregon, where some agricultural crops are planted (hence some potential insecticide use), but the refuge is mostly surrounded by rangeland and cattle. Agricultural insecticides were found in livers from both areas (Table 8), but were usually higher in the mink from the Lower Columbia River. PCB congeners were almost always higher in the two mink from the Lower Columbia River, and usually by 3 to 5-fold, and sometimes higher (Table 9).

The liver of only one mink from the Lower Columbia River was available for co-planar PCB, dioxin, and furan analysis (Table 10). The two pools of mink from the Reference Area provided evidence that some co-planar PCBs, dioxins, and furans were present in mink outside the Lower Columbia River system in the Pacific Northwest. Little can be said about the findings in one mink from the Lower Columbia River, but a number of congeners were present that were not found in the Reference Area, and several seemed to be considerably higher than in the Reference Area.

A brief review of the heavy metals concentrations show no obvious patterns between the Reference Area and the Lower Columbia River, except perhaps nickel in the kidney (Table 11). Nickel in the Lower Columbia River mink (2.77 and 4.82 ppm, dw) was considerably higher than in the Reference Area (0.52 and 0.82 ppm). For an additional point of comparison, river otter age classes (males and females) from the Lower Columbia River contained nickel concentrations (geometric means) of 0.58, 0.91, and 0.77 ppm (Table 7).

4.3 CONTAMINANTS RELATED TO RIVER MILE (RIVER OTTER)

Collection locations (RM) were used to evaluate residue concentrations for patterns throughout the Lower Columbia River study area. These animals were divided into three age classes (both sexes combined) (0,1, and 2+) as previously shown in Tables 4 and 5. A significant relationship (simple linear regression) was required for at least one age class (RM vs. contaminant concentration) before figures were presented, except for total dioxins and total furans.

4.3.1 PCBs and Organochlorine Insecticides and Metabolites

Rather than present all PCB congeners separately, we illustrate the PCB data with Aroclor 1254:1260 liver concentrations which include many PCB congeners. Age class 0, young animals still remaining in family groups with their mothers (Melquist and Hornocker 1983), showed no significant relationship between RM and Aroclor 1254:1260 concentrations in the liver. Age class 1, which is known for its dispersal and wandering (Melquist and Hornocker 1983), showed an even weaker relationship; however, age class 2+ showed a significant relationship between RM and Aroclor 1254:1260 concentrations (Figure 4). Only age classes with significant relationships are shown with an equation and line plotted.

In addition to PCBs, we evaluated all OC insecticides and metabolites in which age class 0 from the Lower Columbia River contained a geometric mean of at least 1 ppb (Table 4). These contaminants included HCB, DDE, DDD, dieldrin, oxychlordane, and trans-nonachlor.

HCB concentrations showed no relationships to RM for any of the age classes. DDE concentrations showed a significant relationship to RM in age class 0, no relationship in age class 1, but again a relationship in age class 2+ (Figure 5). The other metabolite of DDT, DDD showed the same pattern, a relationship with RM in age class 0, no relationship in age class 1, but a significant relationship in age class 2+ (Figure 6). Dieldrin showed no significant relationship between RM in age class 0 or age class 1, but a significant relationship in age class 2+ (Figure 7). Oxychlordane and trans-nonachlor followed a pattern similar to Aroclor 1254:1260 and dieldrin, no significant relationship in age class 0 or age class 1, but a significant relationship for age class 2+ (Figures 8 and 9).

The pattern observed shows that these contaminants were rarely related to RM in age class 0 (only DDE and DDD), never related to RM in age class 1, but almost always (only exception HCB) related to RM in age class 2+ (the adults). The lack of significant relationships in age class 0 may be due to lower residue concentrations in the younger age class, while, as mentioned earlier, age class 1 are dispersers and wanderers that may have been captured at locations distant from their natal area where they spent much of their first year of life. Age class 2+ represents a relatively sedentary population that lives within an established home range, although the home range is relatively large for adult males.

4.3.2 Co-planar PCBs, Dioxins and Furans

The dioxin-like compounds (see Table 6), including co-planar PCBs and furans, were evaluated with respect to RM in the same manner as the OC insecticides and PCBs. We evaluated all congeners except 1,2,3,4,7,8-H6CDD, 1,2,3,7,8-PCDF, and 1,2,3,7,8,9-H6CDF which had 50% or more of the samples below the detection limit (0.10 ppt, ww).

Two co-planar PCBs (PCB 126 and PCB 169) showed significant relationships with RM--age class 0 for PCB 126; age class 0 and age class 2+ for PCB 169 (Figures 10 and 11). Only two dioxins (1,2,3,7,8,9-H6CDD for age class 0 and OCDD for age class 0) showed significant relationships with RM (Figures 12 and 13). Only seven furans showed significant relationships with RM (Figures 14-20); however, only three families (H6CDF, PCDF, and TCDF) were involved and the family total was always one of the significant relationships. Therefore, the number of relationships could be considered biased, because congeners were counted twice (as a specific congener and again as part of a total). Five of the furan relationships (all age class 2+) were direct, much like those reported for OCs and PCBs. Two inverse relationships with RM were found (2,3,7,8-TCDF and TCDF total) which were contrary to all previous findings and involved age class 1 (the dispersing segment of the population). However, the majority (54 of 63) of the tests conducted with dioxins and furans showed no significant relationships to RM. The reduced number of significant dioxin and furan relationships with RM, which contrasts with the other contaminants, suggests additional important point sources of dioxins and furans downstream from Portland-Vancouver. Known point sources within the study area are shown in Figure 21. This figure also provides information on total dioxins and total furans found in the two more sedentary age classes (age class 0 and age class 2+). Age class 0 was included because dioxin and furan concentrations were nearly as high or higher than in age class 2+ (Table 6). It appears that some of the highest dioxin and furan concentrations appear to occur in river otters collected near known point sources (Figure 21).

4.3.3 Heavy Metals

Heavy metals were evaluated with respect to RM in the same manner as OC insecticides, PCBs, dioxins, and furans except relationships were evaluated with both liver and kidney concentrations. Because of the limited number of detections for some metals, no statistical analyses were attempted with aluminum, lead and nickel in the liver, or aluminum and lead in the kidney. The kidney was not chemically analyzed for mercury.

Liver concentrations of heavy metals showed no significant relationships with RM (cadmium, chromium, copper, iron, manganese, mercury, nickel, zinc, and vanadium) for any of the age classes. With kidney concentrations, manganese in age class 2+ showed a significant direct relationship with RM (Figure 22), and chromium in age class 1 showed a significant inverse relationship (Figure 23).

4.4 CONTAMINANTS IN RIVER OTTER SCAT

Only five pools of river otter scats were collected along the Lower Columbia River (Tables 12 and 13). The scats were collected at latrine sites and represented several animals at each location. One collection was made above Portland-Vancouver at RM 134, and the other four at various distances downstream. A consistent pattern emerged from the data with the sample from RM 87-108 showing higher OC and PCB concentrations than the sample above Portland-Vancouver (RM 134), then contaminant concentrations progressively decreased downstream from RM 87-108. PCB congener-specific residue concentrations are shown graphically in Figure 24. The same geographical residue pattern was shown from livers of age class 2+ river otters (Figures 4-11). The sample from RM 27 included (by chemist error) some scat (18.2% of total) from outside the Lower Columbia River system (Bear River in coastal Washington). The adjusted concentration presented (Tables 12 and 13) assumes that residue concentrations in the Bear River component of the sample equal the other two Reference Area concentrations. Since RM 27 findings were similar to Reference Area concentrations, the adjustment had little effect on the final concentration.

Wizard Falls Fish Hatchery on the Metolius River in central Oregon and the Clearwater River in northern Idaho were chosen as Reference Areas for comparative purposes. The scat samples at Wizard Falls were taken at the fish hatchery, while those on the Clearwater River were pooled and taken from the Upper and Lower reaches of the river (Kooskia, Ahsahka, Arrow Junction, Spalding and Orofino). Residue concentrations in scat samples from the two Reference Areas were always lower than at RM 87-108, and similar to or lower than at RM 27 (the lowest concentrations found in the Lower Columbia River). Interpretation of residue concentrations in scats from a toxicological perspective is found in section 6.3.3.

One pool of scat samples (RM 87-108) was analyzed for dioxins, furans and co-planar PCBs (Table 14). Dioxins, furans and co-planar PCBs were detected, thus, it seems possible that they could be monitored with scats.

4.5 CONTAMINANTS RELATED TO BODY AND ORGAN WEIGHTS AND MEASUREMENTS (RIVER OTTER)

Skinned carcass and organ measurements and weights were recorded during necropsy (Table 15). Tabor (1974) found that total body weight before skinning was about 120%

of the skinned carcass weight based on three river otter weighed before skinning and again after being skinned and stored in a freezer. Thus, the skinned carcass weight may be adjusted to a total body weight by multiplying by 1.2. Statistical comparisons (ANOVA) were made in two ways: (1) age class comparisons of only the Lower Columbia River males, and (2) comparisons of the Lower Columbia River and Reference Area males (no age class 1 animals were collected in Reference Area).

With respect to only the Lower Columbia River males, carcass weight, lungs, testes, baculum length, and baculum weight increased significantly with age (Table 15). Most other measurements or organ weights also increased with age, but the changes were not statistically significant.

When Lower Columbia River males were compared to Reference Area males (Table 15), only the baculum length and weight of Lower Columbia River age class 0 was significantly different (smaller or shorter) than those from the Reference Area animals of the same age class (see Frontispiece). The age class 2+ from the Lower Columbia River and the Reference Area showed no significant difference in baculum length or weight. The mean testes weight was also much smaller for the animals from the Lower Columbia River than the Reference Area (4.30 vs 21.10g), but the difference was not statistically significant. One river otter from the Lower Columbia River with no testes found (No. 36) was not included in the above mean. Basically, weights and measurements of the males from the Lower Columbia River were similar to those from the Reference Area except for the male reproductive organs in age class 0 (Table 16).

Before trying to understand if specific contaminants can be implicated in the reduced baculum length and weight and reduced testes weights from age class 0 river otters collected along the Lower Columbia River, it was important to determine if the various OCs and their metabolites, PCB congeners, dioxin-like compounds and heavy metals were correlated with each other. A series of two correlation matrices were prepared using residue concentrations ($\log_{10}$, ww) from the 30 river otter collected along the Lower Columbia River. One correlation matrix was developed for OCs and their metabolites, PCBs, and dioxin-like compounds including furans and co-planar PCBs in the liver (Table 17) and another for heavy metals in the liver (Table 18) and kidneys (Table 19). Many of the contaminants were highly correlated which makes it extremely difficult to evaluate contaminants with respect to their potential for causing observed effects.

Since the male reproductive organs were reduced in age class 0, testes weight, baculum length, and baculum weight were evaluated with respect to OCs and their metabolites, PCBs, dioxin-like compounds, and heavy metals concentrations found in their livers and kidneys (Table 20). A number of OCs and metabolites in addition to 25 of 38 PCB congeners plus ΣPCBs, Aroclor 1254:1260, and Aroclor 1260 showed significant inverse relationships with testes weight. Similar relationships in age class 0 were found for baculum weight and length. A graphical presentation is made for several of the significant relationships with testes weight (Figures 25-27) and baculum weight and length (Figures 28-33).

A few of the dioxin-like compounds also showed significant inverse relationships to testes weight, baculum weight, and baculum length (Table 20). These were: (1) testes weight PCB 126, 2,3,4,7,8-PCDF and PCDF total, (2) baculum weight PCB 126, 1,2,3,4,6,7,8-H7CDD, OCDD, 1,2,3,4,6,7,8-H7CDF and H7CDF total, and (3) baculum length PCB 126, OCDD, 1,2,3,4,6,7,8-H7CDF, H7CDF total and OCDF. Several of the congeners with significant relationships included both a dominant individual congener and the total for the family (Figures 34-41). TEQs were again used to evaluate the dioxin-like compounds collectively. With the age class 0 males, there was a significant relationship between TEQs and baculum weight, but not with testes weight or baculum length. The contribution of dioxins and furans vs. PCBs to the total TEQ is of special interest. On the average, 35 percent of Lower Columbia River river otter TEQ value was derived from dioxins and furans. All significant findings between male reproductive organs and organic contaminants were inverse relationships.

Heavy metals concentrations in liver and kidneys were not significantly related to testes weight (Table 20), but chromium in the liver showed a significant inverse relationship to baculum length (Figure 42). Iron in the liver showed a significant direct relationship for both baculum length and baculum weight, while vanadium in the kidney also showed a significant direct relationship with baculum weight (Figures 42 and 43).

The testes of mature males (2 years old and older) hypertrophy during late October for the reproductive cycle and remain enlarged through April (Liers 1960).. We suspected that some growth of testes may occur in age class 0 males during the trapping season (all age class 0 males collected between 16 December and 16 February) which could confound the linear regressions in Table 20. Therefore, we further investigated testes weight, but also baculum length and weight, using multiple regression techniques to better elucidate contaminant and potential collection date effects (Table 21). Collection date for age class 0 in the multiple regression was significantly related to testes weight in only 2 of 90 tests (1 positive, 1 negative) for the contaminants studied, but the additional variable reduced (from 36 to 18) the number of contaminants significantly related to testes weight and none of the heavy metals were related to testes weight with either the simple or multiple regressions (Tables 20 and 21). Similarly, collection date for age class 0 in the multiple regression was significantly related to baculum length for only two of the contaminants studied (both positive), but again the additional variable reduced (from 26 to 23) the number of contaminants inversely related to baculum length. With respect to baculum weight in age class 0, collection date was significant (always positive) in 22 instances, and resulted in an increase (from 40 to 49) in the number of contaminants significantly related inversely to baculum weight. In all above instances (with one exception), when significant relationships were found between specific organic contaminants and baculum length, baculum weight, and testes weight, the relationship was inverse or negative (a decreased male reproductive organ with increased contaminant concentrations in the liver).

Of the dioxin-like compounds, testes weight was inversely related to three compounds or totals (PCB 126, 2,3,4,7,8-PCDF and PCDF total) with the simple regression, but with the multiple regression an inverse relationship was found with only two compounds (PCB 81 and the same 2,3,4,7,8-PCDF). A direct relationship was found with testes weight and 1,2,3,7,8,9-H6CDD with the multiple regression. With baculum weight and the simple regression, five dioxin-like compounds showed an inverse relationship (PCB 126, 1,2,3,4,6,7,8-H7CDD, OCDD, 1,2,3,4,6,7,8-H7CDF, and H7CDF total), but with the multiple regression eight dioxin-like compounds showed an inverse relationship (PCB 126, 1,2,3,4,6,7,8-H7CDD, OCDD, 2,3,4,7,8-PCDF, PCDF total, 1,2,3,4,7,8-H6PCDF, 1,2,3,4,6,7,8-H7CDF and H7CDF total). The five significant compounds with the simple regression were significant again with the multiple regression and the significance level improved with the multiple regression. Baculum length was inversely related to five dioxin-like compounds with the simple regression (PCB 126, OCDD, 1,2,3,4,6,7,8-H7CDF, H7CDF total, and OCDF) and only three compounds with the multiple regression (OCDD, 1,2,3,4,6,7,8-H7CDF and H7CDF total). Again, TEQs were used to evaluate the dioxin-like compounds collectively. Based on age class 0 males using multiple regression, baculum weight again showed a significant relationship with total TEQs and the relationship was a little stronger than with the simple regression. Testes weight and baculum length again showed no significant relationship to TEQs.

Heavy metals showed no significant inverse relationships to testes weight or baculum weight with either the simple or multiple regressions, but two significant direct relationships (iron in liver with baculum weight and vanadium in kidney with baculum weight) using simple regressions were no longer significant using multiple regressions. Chromium in liver, the only heavy metal inversely related to baculum length in the simple regression (P=0.02), remained inversely related to baculum length in the multiple regression (P=0.05). The direct relationship between iron in liver and baculum length with the simple regression was no longer significant with the multiple regression. Among the heavy metals, it appears that only chromium may be adversely impacting baculum length.

4.6 CONTAMINANTS RELATED TO LIVER AND SPLEEN PARAMETERS (RIVER OTTER)

Although liver weights were not significantly different for age class 0 and age class 2+ between the Reference Area and the Lower Columbia River (Table 15), mean weights were higher in animals from the Lower Columbia River. Since hepatic effects of PCBs include possible hepatocellular damage, liver enlargement, and fat deposition (i.e., higher % lipid) (U.S. Dept. Health and Human Services 1993), it was decided to further evaluate several liver parameters. The gross necropsy also provided evidence of enlarged spleens in some animals. The mean spleen weights were also higher from Lower Columbia River, although the difference was again not statistically significant. Thus, the liver and spleen were both chosen for further evaluation with respect to contaminants. The river otter males (the largest data set, 26 animals) provide the best opportunity to evaluate liver lipid content (% lipid), liver weight, relative liver weight (liver wt./carcass wt.) and spleen weight in relationship to contaminants in the liver. The same three age classes of males (0,1,2+), as in earlier evaluations, were used. Liver concentrations for each contaminant ($\log_{10}$) were evaluated separately by ANOVA for each age class (Table 22).

For age class 0, the lipid in liver ranged from 2.48% to 4.21%, the liver weight ranged from 354 to 569g, the spleen ranged from 21 to 95g, and the liver/carcass weight ratio ranged from 0.052 to 0.075. Age class 0 river otter showed no significant relationships between OCs and liver or spleen parameters and only PCB 206 showed a direct relationship with liver size. Several dioxins and furans were directly related to liver parameters, but 7 were directly related to spleen weight.

Age class 1 findings were somewhat different and the lipid in the liver ranged from 2.27% to 4.94%, the liver weight ranged from 282 to 721g, the spleen ranged from 26 to 59g, and the liver/carcass weight ratio ranged from 0.041 to 0.084. There were few significant direct relationships with percent lipid in the liver (trans-chlordane and PCB 118), but cadmium in the liver and kidney was also significant. Several OCs and many PCB congeners showed significant direct relationships with liver weight, the liver/carcass weight ratio, or spleen weight. Dioxins and furans were not significantly related to any of the parameters, but both liver and kidney cadmium showed significant direct relationships with percent liver lipid.

Age class 2+ consisted of more animals, but fewer significant relationships. The lipid in the liver ranged from 2.97% to 5.26%, the liver weight ranged from 499 to 749g, the spleen ranged from 40 to 84g, and the liver/carcass weight ratio ranged from 0.060 to 0.069. All of the significant OC and PCB relationships were direct (6 of 6) and related to % lipid in the liver. Significant dioxin and furan effects (3 of 4 direct) pertained solely to spleen weight. Metals showed primarily inverse relationships (7 of 8) to both liver and spleen parameters.

The ability to detect significant relationships with the above data sets at least partially relates to the range of values for each parameter. For all measured weights in each age class, the maximum value was at least 1.5-fold higher than the minimum and averaged 2.2-fold higher. Examples of four of the most significant relationships (including a dioxin, a furan, a PCB, and an OC) are presented in Figures 44 and 45. Total TEQ was not related to any of the liver or spleen parameters.

4.7 PERSISTENCE OF PCB CONGENERS IN RIVER OTTERS FROM LOWER COLUMBIA RIVER

How are specific PCB congeners behaving over time in river otters? River otters from the Lower Columbia River provide a unique data set to evaluate patterns of accumulation or loss over time (age). We chose a chemically stable congener in the environment (PCB 153) as a basis for comparing expected values for other congeners (Table 23). The expected values for age class 1 or age class 2+ are based on the relationship for PCB 153 found between age class 0 and age class 1 (age class 0 x 2.0099) and age class 0 and age class 2+ (age class 0 x 2.1504). With the exceptions of PCB 138 and PCB 170/190, all PCB congener concentrations were below that expected for age class 1 (and sometimes as much as 50 to 80% below) which suggests some metabolism and excretion of most PCB congeners over time. PCB 138 and PCB 170/190 in age class 2+ continued to have higher concentrations than expected based on PCB 153; however, PCB 183 and PCB 180 also showed higher concentrations than expected. All other congeners in age class 2+ were below expected values.

4.8 RELATIONSHIP BETWEEN OC AND PCB CONCENTRATIONS IN RIVER OTTER LIVER AND FAT (LIPID ADJUSTED)

Both mesentery fat and liver were collected for analysis of organic compounds. Theoretically, if the lipid throughout an individuals body has equal concentrations of the contaminant of interest, the slope of the relationship between concentrations in individual animals (percent lipid adjusted in liver and fat) should be 1.00 and (P) should be highly significant. The 51 organics evaluated showed that tests were indeed significant ($P \leq 0.05$) and usually $P \leq 0.0001$ in all but four cases (β-HCH, PCB 28, PCB 44, and PCB 70; Table 24), where concentrations were extremely low in fat (all geometric means <10 ppb, lipid weight [lw]). Excluding the four contaminants above, liver contained higher concentrations than fat (slope significantly [$p \leq 0.05$] below 1.0) for 11 contaminants, the fat contained higher concentrations of 24 contaminants, and 12 contaminants were not significantly different from 1.0. The pattern was different for OCs and metabolites (7 liver, 3 fat, 2 similar) and PCBs (4 liver, 21 fat, 10 similar) (see Figures 46-54). PCB 138, PCB 153, and PCB 180 are the dominant congeners (highest geometric means) in river otter from the Lower Columbia River system and they show the same dominance in liver and fat (lipid adjusted) and in all three age classes (Figure 55).

Earlier (section 4.3) we showed that several OC insecticides and metabolites as well as PCB concentrations (based on Aroclor 1254:1260) in livers of river otters were correlated with RM of capture, although PCB congeners were not evaluated at that time. All significant patterns showed higher concentrations near Portland-Vancouver with decreases downstream. We now use the lipid adjusted fat and liver samples to further present congener specific PCB patterns associated with RM. Only age class 2+ showed a significant relationship with RM, therefore, all (male and female) age class 2+ animals from the Lower Columbia River were divided into three reaches because of natural gaps in collection sites (RM 11-41, RM 54-73, and RM 82-120). This approach yielded nearly equal sample sizes of 5, 6 and 3, respectively.

In general, the same three congeners predominate (PCB 138, PCB 153, and PCB 180) in all three reaches of the Lower Columbia River although concentrations were much higher in the Portland-Vancouver vicinity (Figure 56). Fat:liver ratios (lipid adjusted) for the PCB congeners in the lower two reaches were nearly 1:1, but for the upper reach (Vancouver-Portland, RM 82-120) concentrations in fat samples were substantially higher for several congeners. Reasons for the higher fat concentrations are uncertain. Elimination of PCBs in mink results from a combination of excretion via urine, feces and metabolism, in addition to lactation in females, but another elimination route is assumed to be secretion by the anal gland, which is present in all mustelids, including river otter. The gland is primarily used for territorial marking purposes. Concentrations of PCBs measured by Larsson et al. (1990) and Leonards et al. (1994) showed high levels in this secretory product of mustelids. Larsson et al. (1990) calculated a half-life of PCBs in mink of only 42 days, primarily due to this secretion route.

4.9 DIET AND CONTAMINANTS IN PREY SPECIES OF RIVER OTTER AND MINK

Food habits of river otter have been studied in a number of North American ecosystems. The river otter is primarily a fish predator, but also preys opportunistically on invertebrate, avian, amphibian, and mammalian species to varying extents in different aquatic ecosystems. River otters select prey items according to their relative availability, availability being a function of both local abundance and ease of detection and capture (Toweill and Tabor 1982, Melquist and Dronkert 1987). Tabor et al. (1980) studied wildlife along the Columbia River from Vancouver (RM 106.5) to Priest Rapids Dam (RM 397) and from the mouth of the Okanogan River (RM 535) to Grand Coulee Dam (RM 597). They noted that major foods of river otter (in the summer) within the study area were carp (Cyprinus carpio), crayfish (Pacifastacus leniusculus and P. trowbridgii), suckers, and centrarchid fishes. Waterfowl was identified as an important food in the John Day Pool only (outside our study area). Sculpins and American shad (Alosa sapidissima) were of minor importance only in The Dalles pool (again outside our study area). Other prey including northern squawfish (Ptychocheilus oregonensis), salmon, birds, mammals, insects, and mollusks were eaten infrequently and were judged by Tabor et al. (1980) to be of minor importance. Carp and crayfish were by far the most frequently eaten foods of river otter in the summer in all reaches studied including below Bonneville Dam (our study area), but no quantification of percentage contribution was made. Toweill (1974) presents the only other food habits data for river otter trapped in western Oregon from late November to early February. Contents of 75 digestive tracts (only 5 from Lower Columbia River) showed that fish were the main staple of the diet occurring in 80 percent of all tracts examined. Major fish families included Cottidae (31 percent), Salmonidae (24 percent), and Cyprinidae (24 percent). Crustaceans, amphibians, and birds were other important food items occurring in 33, 12, and 8 percent, respectively. The general river otter diet reported by Toweill (1974) does not deviate appreciably from diets reported elsewhere in North America (see Toweill and Tabor 1982, Melquist and Dronkert 1987); however, in another large river (Mississippi) a seasonal pattern in diet was apparent (Anderson and Woolf 1987). Fish were dominant in the fall, winter, and spring diet, but crayfish became very important in summer.

Crayfish remains were noted in almost every river otter scat sample we observed in the summer (July-August), but crayfish remains were infrequent in digestive tracts of river otter trapped in the fall-winter during this study. This suggests seasonality in the diet along the Lower Columbia River as reported from the Mississippi River.

Tabor et al. (1980) reported crayfish, fish, birds, and mammals as important foods of mink in their Columbia River study area. Reptiles and amphibians appeared to be eaten infrequently. Crayfish was the most important mink food in the study area as a whole. The most frequently eaten fish were sculpins, suckers, and centrarchids. Of the 7 taxa of mammals eaten by mink, bushy-tailed woodrats (Neotoma cinerea), microtines, and pocket mice were consumed most frequently.

The collection of river otter or mink prey species for contaminant evaluation was not part of this study. Published papers and unpublished information of others provide some useful contaminant information (e.g., Table 3). The National Contaminant Monitoring Program had fish collection sites on the Columbia River above Bonneville Dam at Cascade Locks (RM 149) and another on the Willamette River at Oregon City (Tables 25 and 26). Both of these sites were immediately outside the Lower Columbia River study area, but provide residue data from nearby fish between 1976 and 1984. PCBs were found in all pools of fish and concentrations ranged from 200 to 2800 ppb (ww) in the Columbia River and 100 to 2300 ppb on the Willamette River. Anthony et al. (1993) collected fish in the Lower Columbia River associated with a bald eagle study in 1986. The fish were collected between RM 19 and 26, and contained PCB concentrations (380 to 2100 ppb) similar to the two monitoring stations immediately outside the study area. DDT and its metabolites were also detected in the fish. The data were inadequate for statistical evaluation.

4.10 IN VITRO RAT HEPATOMA CELL LINE H4IIE BIOASSAY OF EXTRACTS FROM RIVER OTTER LIVERS

Assessment of complex mixtures with common toxic mechanisms can be achieved using the rat hepatoma cell line H4IIE bioassay which is a semi-quantitative technique used to evaluate dioxin-like toxicity and yields TEQs (Safe 1990). Assessments have been made with tern eggs, cormorant eggs, and eggs and flesh of chinook salmon (Oncorhynchus tshawytscha) from the Great Lakes region (Tillitt et al. 1993, Tillitt et al. 1992, Ankley et al. 1991), and black-crowned night-herons (Rattner et al. 1994).

Although use of 2,3,7,8-TCDD as the sole inducer showed the expected dose-response for EROD induction of the rat hepatoma cell line H4IIE, no induction was observed from extracts of river otter livers collected from the Lower Columbia River. Two possible reasons exist for the lack of induction: (1) interference by other less potent PCB congeners by competitive binding, or (2) concentrations of dioxin-like compounds were too low to induce EROD activity. A recent paper by Schmitz et al. (1995) reported that an equipotent mixture of PCBs 77, 105, 118, 126, 156, and 169 (non- and mono-ortho PCBs) showed perfect additive behavior of predicted TEFs in bioassays using both H4IIE rat hepatoma and primary Wistar rat hepatocyte cell cultures. However, a tenfold mixture addition of PCBs 28, 52, 101, 138, 153, and 180 (mono- and di-ortho PCBs) to the former mixture resulted in a almost threefold higher TEF than predicted. Their findings suggest a moderately synergystic induction enhancement of the more potent PCBs by less potent congeners. PCB congeners 138, 153, and 180 are the most common PCBs found in extracts of river otter livers collected in this study. With this fact in mind, contaminant concentrations may be too low to induce EROD activity. Further work with this assay technique is needed to fully understand why induction did not occur.

5.0 DISTRIBUTION AND ABUNDANCE

Time did not permit the use of a mark-recapture procedure to estimate the mink or river otter population size, and in fact, we were unable to live-trap animals in the summer for detailed histopathology investigations. We relied upon two types of data to generally assess mink and river otter populations: (1) a July-August count on only one side of the river at eight selected 9-mile strata, and (2) harvest data by trappers plus their assessment of size of the river otter populations (at the end of the trapping season) in the 9-mile strata they trapped or investigated.

5.1 NUMBERS OF MINK AND RIVER OTTER (LATE SUMMER 1994)

Only 4 days were available during the July-August counts to cover each 9-mile strata with only one side of the river covered, therefore, the counts provide minimum population numbers (i.e., and index). Mink sign was seldom located along the Lower Columbia River and only one mink family was documented in addition to four lone animals. These mink were found in five strata, while there were no observed signs of mink in three strata (Table 27).

At least one family of river otters was found in seven of the eight strata and two families were found in two strata. The average river otter family contained 2 adults, 2.28 young of year, and 1.53 1-year-olds (total of 5.81 for family). The estimated number of young of year and 1-year-olds were based on Tabor and Wight (1977). A simple calculation (1.125 families per strata x 5.81 animals in family x 16 strata = minimum population estimate) provides an estimate of 105 river otter in the Lower Columbia River that were well distributed among the strata. In addition to the visit to each sampled strata being short (4 days), the fact that only one side of the river was checked provides another reason for this estimate being minimal because animals, especially river otter, may switch back and forth to each side of the river and not be present on the side surveyed during the survey period.

5.2 NUMBERS OF MINK AND RIVER OTTER (FALL-WINTER 1994-95)

Trappers during the fall and winter trapping season spent many days on the river, and those individuals we worked with were accomplished knowledgeable trappers and understood the percentage of the population they were harvesting (i.e., knew initial size of population). We know that at least 42 river otter, but only 2 mink, were trapped on the Lower Columbia River during the 1994-95 trapping season. Population estimates by trappers of river otter present provide what we believe are more meaningful estimates. We have two independent estimates by different trappers (15 and 16 river otter) for RM 81-90. In addition to an estimate of 17 river otter for RM 9-18, we have another estimate for RM 0-36 of 40 to 50 river otters with the majority on the Oregon side of the river. The trappers provided estimates (both sides of river) for eight of the strata where they worked (Table 27). These estimates ranged from 11 to 24 animals per strata with a mean (±2 SE) of 15.25 ± 2.92 animals. These point estimates were not obtained by rigorous statistical methods and procedures and have limitations, but they were made by individuals with great knowledge of the species on the Lower Columbia River. The logic for essentially doubling the count from the 8 strata with population estimates by trappers to include those 8 strata without population estimates by trappers is as follows: the 8 strata with trapper estimates contained a minimum of 4 family groups in July-August and the 8 strata without trapper estimates contained a nearly identical 5 family groups in July-August (Table 27). Recognizing that the July-

August counts were minimal, they still provide a measure of variability within strata and suggest little difference between those with trapper estimates and those without trapper estimates. Assuming 15.25 ± 2.92 river otter per strata, the 16 strata which cover the Lower Columbia River would contain an estimated 244 ± 47 river otters alive at the end of the trapping season plus 42 animals harvested during the trapping season. The early autumn population was estimated at 286 ± 47 animals which is our best estimate. Clearly, a considerable number of river otter live in the Lower Columbia River. To further emphasize the abundance of river otter, nine nuisance animals were live-trapped along the Lower Columbia River near Portland by the Oregon Department of Fish and Wildlife in 1989 and transplanted in Colorado (ODFW, files).

To estimate the number of river otter in relation to river shoreline, the river length from Bonneville Dam to the ocean was estimated. The navigation channel is 235 km, but the shoreline on each side of the river averaged 309 km (31% more). The 309 km was based on tracing shoreline and large islands with a map wheel on USGS quadrangle maps at a scale of 1:24000. The shoreline estimate was considered conservative. We used 309 km of river shoreline as the base for further computations.

Although the July-August estimate of river otters in this study (105 animals or 34 per 100 km of river) was believed biased low because of limited effort, the early autumn population estimate based on much more effort by knowledgeable trappers (286 animals or 93 per 100 km of river) provides our best estimate and also suggests that about 15% (42 of 286) of the population was harvested by trappers. How do these population estimates compare with river otter populations from other locations? In a marine environment at Kelp Bay, Alaska, Woolington (1984) used the minimum number of animals known to inhabit the range of several family groups to estimate a density of 85 river otters per 100 km of coastline. An estimate of 50 per 100 km of shoreline was reported from Prince of Wales Island, Alaska (Larsen 1983, 1984). Testa et al. (1994) estimated 28 to 80 river otter per 100 km of coastline in Prince William Sound. A negative bias is likely for all of the Alaskan estimates, but the mark-recapture methods (Testa et al. 1994) are more nearly unbiased than what are essentially enumeration methods used in the studies in southeastern Alaska (Larsen 1983, 1984, Wollington 1984). Melquist and Hornocker (1983) provided an estimate of 27 animals per 100 km of river (enumeration method) in Idaho, although the rivers were much smaller than the Lower Columbia River. To our knowledge, no other estimates for river otter in riverine habitat are available. Our present Lower Columbia River population density estimate is the highest reported.

The mink population contrasts markedly with the river otter as only one family group and four singles were noted in July-August, and only two animals were captured by trappers during the trapping season. Of 219 mink scent box nights in the 8 strata in July-August, only one mink was attracted to a box at RM 108. Furthermore, 57 mink trap nights in the strata during the same time period yielded no mink captures. No population estimates were attempted.

5.3 MINK AND RIVER OTTER HABITAT

Habitat measurements for riverine mink (Allen 1986) were recorded at each half mile interval within the eight 9-mile strata sampled with the average values provided in Table 16. See Appendix 9 for a brief narrative and records for each sampling site. The mink habitat suitability index was slightly modified to include two types of canopy cover (high and low) although they both tended to parallel each other. The habitat suitability index (HSI) indeed was lower in urban industrial areas as expected, but too few mink detections were recorded to attempt any type of analysis. However, for many portions of the Lower Columbia River, the HSI was excellent, but few mink sign were found and few mink were trapped. The usefulness of the mink habitat suitability index model for river otters is unknown, but the river otter seemed well distributed throughout the Lower Columbia River.

6.0 DISCUSSION AND CONCLUSIONS

6.1 CONTAMINANT ACCUMULATION AND SPATIAL PATTERN

An evaluation of OC insecticides, PCBs, dioxins, furans and heavy metals in river otter (section 4.1) showed that nearly every OC insecticide including DDE, DDD, heptachlor epoxide, β-HCH, dieldrin and mirex were significantly higher in age class 0 from the Lower Columbia River that at the Reference Area which provides evidence of contaminant exposure and accumulation. A pattern of increased OC insecticide concentrations was also apparent with age, although all increases were not statistically significant. PCBs showed the same pattern with all but two congeners (PCB 70 and PCB 151, both found at low concentrations) from the Lower Columbia River showing a significant increase from the Reference Area. PCBs in river otter also showed a consistent pattern of increase with age in the Lower Columbia River, although all increases were not significant.

Dioxins and furans again showed the same pattern with age class 0 river otters having significantly higher concentrations in the Lower Columbia River than in the Reference Area. But, with dioxins and furans, a general pattern of increased concentrations with age was not apparent. In fact, age class 0 had higher concentrations of some congeners. Geometric means of co-planar PCBs were always higher in the Lower Columbia River than the Reference Area, but the difference was significant only for PCB 126 (age class 2+). TEQs, a method of combining all dioxin-like compounds, were significantly higher in all river otter age classes from the Lower Columbia River than the Reference Area. However, TEQs did not show a significant pattern of increase with age in the Lower Columbia River. Thus, the dioxin-like compounds behaved differently than OC insecticides and other PCBs which generally showed an increase in concentrations with age. Cadmium was the only heavy metal that increased with age in river otters along the Lower Columbia River.

The two mink from the Lower Columbia River provide limited information, but OC insecticides were usually higher in the Lower Columbia River animals and PCBs usually higher by 3 to 5-fold. Some co-planar PCBs, dioxins and furans were found in the Lower Columbia River that were not found in the Reference Area, and several were considerably higher than found in the Reference Area. Nickel was high in mink from the Lower Columbia River compared to Reference Area mink or the river otter from the Lower Columbia River (about 5-fold higher).

The river otter in age class 0 and 2+, which stay within a home range, showed many more significant relationships between RM and contaminant concentration. Age class 1, which disperses during this phase of their life, showed few relationships between RM and contaminant concentration. Age class 0 showed few significant relationships with RM for OC insecticides compared to age class 2+ (age class 0 contained lower residue concentrations). Aroclor 1254:1260 was evaluated with respect to RM instead of each individual PCB congener, and only age class 2+ showed a significant relationship with RM. For the dioxin-like compounds (including 4 co-planar PCBs, dioxins and furans), age class 0 sometimes contained higher residue concentrations than age class 2+ and both age classes showed an equal number of significant relationships with RM. The reduced number of significant correlations with RM may be the result of important additional sources of dioxins and furans downstream from Portland-Vancouver. Several of the highest dioxin and furan concentrations in river otter were reported between RM 86.9 and RM 88 with another at RM 39.1. Of the heavy metals in river otter, only manganese in kidneys (age class 2+) showed a significant relationship with RM.

When significant relationships existed between RM and contaminant concentrations, there was always (with the exception of 2 furans and chromium in the disperses [age class 1]) an increase in concentrations with an increase in RM. The highest concentrations were in the Portland-Vancouver vicinity (RM 119.5). Lead and aluminum were also found in a few animals, and they were usually those in the Portland-Vancouver vicinity. It appears that the Portland-Vancouver vicinity is the source of much contamination. Although no river otter were taken upstream from Portland-Vancouver, river otter scats from above Portland-Vancouver (RM 134) showed lower OC and PCB concentrations than samples taken at Portland-Vancouver or immediately downstream.

6.2 CONTAMINANT CONCENTRATIONS AND ANIMAL CONDITION

Basic weights, measurements and body condition were recorded during necropsy and tissues were collected for histopathology. Weights and measurements were evaluated with respect to age class (0,1,2+) and location of capture (Reference Area vs. Lower Columbia River). When Lower Columbia River males were analyzed together with Reference Area males, only the baculum length and baculum weight of Lower Columbia River age class 0 males was significantly different (smaller or shorter) than the Reference Area animals of the same age class. The older animals (age class 2+) from the Lower Columbia River showed no significant difference in baculum length or weight which suggests that the delayed development may be temporary. Mean testes weight was much smaller for age class 0 river otters from the Lower Columbia River than the Reference Area (4.30 vs. 21.10g), but the difference was not statistically significant. All of the weights and measurements of the males from the Lower Columbia River were similar to those from the Reference Area except for the male reproductive organs in age class 0. Testes of age class 0 river otters from the Lower Columbia River showed evidence of hypoplasia when compared to age-matched Reference Area animals. In the affected animals, the seminiferous tubules were small and they were lined by a single cell layer of sertoli cells; interstitial cells appeared more prominent and there was no evidence of spermatogenesis. In the Reference Area river otters, seminiferous tubules were large and tortuous, and they were lined by several cell layers; spermatogenesis was observed. Although not statistically significant, livers and spleens were generally larger in river otters from the Lower Columbia River. The enlarged spleens were also noted during necropsy. Four other gross pathological findings were noted: the baculum, which was much reduced in size, of an age class 0 male (RM 87.5) had been broken and healed, a 2 year old female (RM 119.5) had a multilocular cystic abscess, a 3 year old male (RM 119.5) had left renal agenesis and agenesis of the left adrenal, and no testes found in an age class 0 male (RM 119.5). Three of the 4 river otter collected at RM 119.5 (the Portland-Vancouver vicinity) had gross abnormalities.

Were contaminants correlated with the observed reproductive tract developmental problems with the young males or the enlarged livers and spleens in river otters from the Lower Columbia River? Before trying to determine if specific contaminants may be implicated in the above phenomena, it was important to determine if the OCs and their metabolites, PCBs, dioxin-like compounds, and heavy metals were correlated with each other. Several large correlation matrices were constructed (section 4.5), and it is unfortunate that many of the contaminants were highly correlated. However, recognizing this limitation, all of the contaminants were evaluated (regression and multiple regression [adding capture date] techniques) with respect to age class 0 male reproductive organs. Also, contaminants in all males were evaluated (regression techniques) with respect to age class (0, 1, and 2+) and liver parameters (% lipid, weight, liver/carcass ratio) and spleen weights.

Two-thirds of the PCB congeners, a number of OCs and metabolites in addition to some dioxins and furans were inversely related to testes weight in age class 0 males (simple regression). TEQs, used for dioxin-like compounds, showed no significant relationship with testes weight. River otter No. 36 (age class 0), a male collected at RM 119.5, had the highest concentrations for its age class for most OCs and PCBs. It also had the highest concentrations for about one-third of the dioxins and furans. No external or internal testes were found in the animal during necropsy. Perhaps they were so small that they were not found, but based on the relationship in Figure 27, the 2864 ppb ($\log_{10}$=3.46) Aroclor 1254:1260 in its liver would project to no testes! The concentrations of heptachlor epoxide, PCB 101, PCB 149, and PCB 182/187 also project to no testes based on relationships reported. Not all contaminants significantly related to testes weight were evaluated with respect to projected testes weight in No. 36.

The multiple regression technique with male river otter reproductive organs included capture date which showed positive relationships for some of the tests (especially baculum weight). This indicates that growth was occurring as the trapping season progressed which was logical for age class 0. Testes weight (with multiple regression) was inversely related to 1 OC insecticide (heptachlor epoxide), 13 PCB congeners, and 1 furan (2,3,4,7,8-PCDF); baculum weight was inversely related to 6 OC insecticides (DDE, mirex, cis-chlordane, DDE, cis-nonachlor, and dieldrin), 32 PCB congeners, 2 dioxins (1,2,3,4,6,7,8-H7CDD, OCDD) and 5 furans (2,3,4,7,8-PCDF, PCDF total, 1,2,3,4,7,8-H6CDF, 1,2,3,4,6,7,8-H7CDF, and H7CDF total); baculum length was inversely related to 3 OC insecticides (DDE, DDD, dieldrin), 16 PCB congeners, 1 dioxin (OCDD), and 2 furans 1,2,3,4,6,7,8-H7CDF, H7CDF total). TEQ was used to evaluate dioxin-like compounds collectively. Only baculum weight was inversely related to TEQs. In general, use of multiple regression reduced the number of contaminants inversely related to testes weight from 36 to 18, and baculum length from 26 to 23 contaminants, but increased the number of contaminants related to baculum weight from 40 to 49. PCBs provided some of the strongest inverse relationships with testes weight and baculum weight. Although PCBs provide some strong inverse relationships with baculum length, OCDD, 1,2,3,4,6,7,8-H7CDF, and H7CDF total also provide strong relationships. Metals, with the exception of chromium in the liver and baculum length, did not show significant inverse relationships with reproductive organs of young male river otter.

Concern about enlarged livers and spleens led to a series of regression analyses by age class. The % lipid in liver showed a general increase with age, and several OC insecticides and PCB congeners, in addition to iron, cadmium and TCDF total, were directly related to % lipid in the liver. These relationships were more frequently found in the older age class. Liver weight and the liver weight/carcass weight ratio showed similar findings since they were two approaches for evaluating liver size. Most of the direct relationships occurred in age class 1, with none in age class 2+, and only a few in age class 0. The direct relationships were dominated by PCB congeners, but included a few OC insecticides. The only significant dioxin and furan relationships were in age class 0. The pattern of significant direct relationships with spleen weight was different. Seven dioxins and furans showed significant direct relationships with spleen weight in age class 0; however, no dioxins and furans in age class 1 were directly related to spleen weight, but there were several OC insecticides and PCB congeners. Then, in age class 2+ the only significant direct relationships with spleen weight were two furans and a dioxin. In general, it seems that dioxins and furans seem to primarily affect the spleen in river otters, while the PCBs primarily affect liver. The liver and spleen weights varied widely which improved the ability to detect significant relationships.

Finally, the spatial information shows that the river otter collected at RM 119.5 (Portland-Vancouver) contained the highest concentrations of most contaminants (the exception was dioxins and furans), in addition to a few contaminants (e.g., lead and aluminum) that were seldom found elsewhere. These were also the animals that showed three of the four gross abnormalities discovered.

6.3 OTHER CONSIDERATIONS

Historically, environmental guideline development has focused on water quality guidelines to protect different water uses from water-borne contaminants. For hydrophobic chemicals, which tend to partition to sediments and accumulate in aquatic organisms, water quality guidelines are of limited use since these types of chemicals are difficult to measure in water with current analytical techniques. These substances are more likely detected in the tissues of aquatic organisms or sediments than in water. Hydrophobic and lipophilic organic substances (e.g., dioxins, furans, and PCBs) and some chemical forms of metals, primarily organometallic species tend to accumulate in aquatic organisms because of their high affinity for fat relative to water and typically low metabolism and excretion rates.

Recently, the Canadian Council of Ministers of the Environment Task Group on Water Quality Guidelines initiated the development of environmental quality guidelines for other media (e.g., sediment, soil, prey species) to address contamination of these compartments. For bioaccumulative contaminants, one major route of exposure for predatory species in aquatic food webs is the consumption of contaminated aquatic prey species. Also, of concern is the significance of body residues of contaminants to the aquatic biota themselves. In order for environmental managers to make scientifically defensible decisions to protect the different uses of the aquatic environment, tissue residue guidelines (TRGs) for the protection of wildlife and aquatic life have been proposed as useful tools for aquatic resource managers to assess the significance of contaminant levels in tissues of aquatic biota. However, federal TRGs are not in place at this time, but some TRGs have been developed in New York and British Columbia and the concept is receiving more attention in Canada (see Appendix 10), The Netherlands (Leonards et al. 1994), and the United States (Tillitt et al. 1996).

The goal of TRGs in aquatic biota is to: (1) protect wildlife predators from exposure to contaminants in their aquatic prey species; and (2) protect the aquatic biota themselves from contaminant concentrations in their tissues. TRGs for the protection of wildlife are mainly targeted at those substances that are persistent and bioaccumulative. Following the above line of reasoning, it is our intention to: (1) review contaminant concentrations in the tissues and organs of mink and river otter themselves with respect to published effect concentrations, and (2) review contaminant concentrations in prey species of mink and river otter with respect to available TRGs and other similar information, and (3) review contaminant concentrations in scat in relation to published findings. Mustelids, seals, and cormorants are some of the most sensitive species for PCBs (Giesy et al. 1994).

6.3.1 Contaminants in Organs and Tissues

Organ and tissue residue concentrations from laboratory studies allow the field investigator to relate laboratory effects to concentrations in the field and permit simple comparisons with concentrations from wild populations. A recent series of papers where laboratory mink were fed graded amounts (10, 20, 40%) of carp (Cyprinus carpio) from Saginaw Bay, Michigan (Heaton et al. 1995a, 1995b, Tillitt et al. 1996), provides useful information for interpreting the residue concentrations found in mink and river otter from the Lower Columbia River. Several points were unique about this laboratory feeding study: (1) environmentally degraded contaminants (i.e., contaminated fish), which may be a more realistic diet, were used, (2) the laboratory reproductive study was followed by detailed analyses of the liver for contaminant concentrations, and (3) the contaminants in the diet and livers were both evaluated by TEQs. Therefore, we can evaluate the survival and reproductive performance of the mink in relationship to TEQs in the liver (this section) as well as TEQs in the diet or prey species (section 6.3.2). The study emphasized reproductive effects and the dioxin-like compounds (co-planar PCBs, dioxins and furans) which showed a strong correlation with reproductive success. The estimated threshold dose (TEQ) for reproduction effects, based on liver concentrations was 60 (ppt, ww), and based on H4IIE rat hepatoma cell bioassay was 70 (Tillitt et al. 1996). Their calculated TEQ was based on International values assigned each congener, (Ahlborg et al. 1992, Ahlborg et al. 1994) while our study used values from Safe (1994) which yields slightly higher TEQs. The control mink in their study had a calculated liver TEQ of 18 ppt (ww) and based on rat hepatoma cell bioassay <10 ppt (ww), while the 10% carp group (lowest treatment) had TEQs of 207 and 495 ppt (ww), respectively. The 10% carp diet fed to females for two months prior to breeding resulted in decreased body weights and survival of kits to three to six weeks of age. The 10% carp diet was equivalent to 0.72 ppm (ww) PCBs, while Hornshaw et al. (1983) fed female mink a diet containing 1.5 ppm (ww) PCBs from Saginaw Bay carp for about seven months prior to breeding. Hornshaw's mink failed to whelp any live kits. In our study, the TEQ in the liver for the only mink from the Lower Columbia River was 17.67 ppt (ww), while the two from the Reference Area were 12.09 and 1.68. The TEQs from our study were all below controls (18 ppt, ww) in the Heaton et al. (1995a, 1995b) and Tillitt et al. (1996) studies.

Although we do not know the relative sensitivity of mink and river otters to the groups of contaminants of concern, the geometric mean TEQs from river otters in age class 0, 1, and 2+ (both sexes) from the Lower Columbia River were 19.79, 22.37, and 27.94 ppt (ww), respectively. These means were far below the estimated threshold 60-70 ppt (ww) of Tillitt et al. (1996); however, some individuals including No. 34 (2 year old male) from RM 88 (TEQ 82.72), No. 37 (2 year old female) from RM 119.5 (TEQ 83.17), and No. 38 (3 year old male) from RM 119.5 (TEQ 115.24) had TEQs exceeding the calculated threshold. The generally low TEQs calculated for the river otter from the Lower Columbia River may be responsible for the lack of induction observed with the rat hepatoma cell line H4IIE bioassay.

In summary, although possible adverse effects on reproduction of river otter are suggested for some individuals, it is important to recognize that the criteria were established for mink and not for river otter and that relative sensitivity of the two species to the same contaminants is unknown. Another point also needs to be made. PCB and DDE concentrations in river otter were much higher in the Lower Columbia River in 1978-79 (Henny et al. 1981). It seems logical to assume that contaminant concentrations were also much higher in mink 15 years ago, although we have sparse information about present concentrations. Therefore, estimated effects on kit survival and productivity based on the residue criteria presently available most likely underestimates effects in the past.

Synergistic and antagonistic effects between PCB congeners and dioxins and furans in combination with PCBs on reproduction and kit survival of minks is poorly understood. The tendency at the moment is to calculate and report only TEQs for PCBs, dioxins and furans using an additive model. Valuable information might be lost with this approach, therefore, we have included all congener-specific concentrations in the report, but recognize that a more complete interpretation of the data may become available at a later date.

It is important to recognize that the under-development or delayed development of the male reproductive tract of young river otter observed in this study has not been previously documented in any free-living mammals, where significant dose-response relationships were shown for many chlorinated hydrocarbon contaminants. Many of these contaminants have been reported to reduce litter size and kit survival in mink by Heaton et al. (1995a, 1995b) and Tillitt et al. (1996). However, recent laboratory studies with rats have shown that some of these contaminants such as p,p'-DDE also compete for the androgen receptor, disrupting normal androgen physiology, resulting in under-developed male gonads and reduced sperm counts (Chapin et al. 1995, Gray et al. 1995). In this study, many strong relationships between baculum size and weight and testes weight were not associated with the more toxic co-planar PCBs, dioxins, and furans, but with other less toxic OCs, PCBs, dioxins, and furans. Thus, the criteria established for mink reproductive affects is probably not relevant to what was found with young male otters.

6.3.2 Contaminants in Prey Species

As mentioned in the previous section, the laboratory reproductive study of Tillitt et al. (1996) provides TEQs in the diet responsible for various degrees of reproductive problems in mink. TRGs are also shown in Appendix 10 and include three tissue residue estimates for PCBs in fish eaten by aquatic wildlife. More recently Leonards et al. (1994) evaluated current available PCB toxicity data for mink. They extrapolated risk levels expressed on the basis of mink tissue residues to concentrations in prey organisms (fish). Congener specific effect levels were extrapolated to concentrations expressed as different cumulative indices (total PCBs, PCB 153, TEQs). Extrapolated to concentrations in prey organisms (fish) (Table 28), the no-effect level for litter size for total PCB in the diet was 145 ppb (ww). For kit survival, the PCB level was higher (399 ppb, ww). The diet based no-effect levels expressed as TEQs were 50 ppt (ww) (relative litter size, TEQ System of Safe 1993) and 17 ppt TEQ (ww) (kit survival).

Residue concentrations in fish from areas immediately adjacent to the study area (upstream in the Lower Columbia River and the lower Willamette River) are shown in Table 25, but unfortunately PCB information for the Lower Columbia River is limited and usually based on Aroclor 1254 or 1260. The limited fish data from the study area do not warrant an analysis at this time, but criteria mentioned above is available for interpreting information when it becomes available. As mentioned in the previous section, the assumption that toxicokinetics and sensitivity to PCBs, dioxins, and furans for river otter and mink are comparable is highly speculative. From the literature it is known that large differences may exist in sensitivity for PCBs between closely related species. So caution is again warranted in extrapolation effect levels from mink to river otter. More research regarding the sensitivity and toxicokinetics of PCBs for the river otter in comparison to the mink is needed.

6.3.3 Contaminants in Scat

To assess the significance of contaminant concentrations in scats, Mason and MacDonald (1993b) developed a hierarchy of concentrations:

(a) critical levels
concentrations in scats (lw) >16 mg/kg (ppm) of PCBs (based on Aroclor 1260 standard) and dieldrin, singly or combined, or concentrations of total organochlorines (OCs) >20 ppm;

(b) levels of concern
concentrations in scats 9-16 ppm of PCBs and dieldrin singly or combined, or concentrations of total OCs >16-20 ppm;

(c) maximum allowable concentration;
concentration less than the level of concern but greater than the no effects level; and

(d) no effects level
less than 4 ppm for all individual contaminants, as described above.

Their approach was based on a single compartment model relating PCB concentrations in scats to tissue concentrations (Mason et al. 1992, Mason and MacDonald 1993b). They adopted a compliance level of 90% of the samples within a catchment falling below levels (a) and (b), in a manner analogous to that of regulatory authorities protecting water resources from polluting discharges.

Although congener specific information was available in this study, PCB concentrations based on the Aroclor 1260 standard were obtained (Table 13). The small series of scat data from the Lower Columbia River would be interpreted, according to criteria of Mason and colleagues as follows: RM 134 (10.3 ppm, ww) level of concern; RM 87-108 (27.2 ppm) critical; RM 63-69 (15.6 ppm) level of concern (almost critical); RM 28-33 (6.7) maximum allowable concentration; RM 27 (2.9 or 3.1 ppm) no effects level. The two Reference Areas (Wizard Falls, OR and Clearwater River, ID) showed Aroclor 1260 concentrations of 1.1 and 2.4 ppm which were both at the no effects level. Again, a caveat must be made. Lutra lutra from Europe and Lutra canadensis from North America are not the same otter. Therefore, criteria established for one species may not be directly comparable to another.

6.4 CONTAMINANTS AND PRESENT DISTRIBUTION AND ABUNDANCE

The two mink captured along the Lower Columbia River contained relatively low contaminant concentrations compared to criteria available for interpreting findings. However, based upon river otter and mink residue data collected in 1978-79 from the Lower Columbia River, it becomes clear that PCB concentrations are not nearly as high now as they were in the late 1970s. An important point here is that PCB concentrations in some Lower Columbia River mink in the late 1970s were equivalent to mink that survived long-term PCB tests, but failed to produce any kits that survived (Henny et al. 1981). Little can be said about the mink population along the Lower Columbia River except, that few animals were present in 1994-95 (size of population could not be estimated) although large numbers were present in earlier years, and PCBs were present in the two animals trapped. Mink are extremely sensitive to PCBs and perhaps the most sensitive mammalian wildlife species(Platonow and Karstad 1973, Aulerich and Ringer 1977, Jensen et al. 1977, Tillitt et al. 1992). Therefore, it seems conceivable that PCBs nearly extirpated the mink over the last several decades and that the few mink seen in 1994-95 may be animals pioneering back into the Lower Columbia River System in an attempt to recolonize it. We have too few data to determine if their attempts will fail (a population sink) or be successful.

The river otter in 1994-95 have a relatively dense population that seems well distributed throughout the Lower Columbia River, including the most polluted (at least from a PCB perspective) Portland-Vancouver vicinity. Three of the four river otter collected within the area at RM 119.5 had gross abnormalities in addition to the highest PCB concentrations, and several other contaminants that seemed unique to the area. Unless some other unknown factor (e.g., disease) has nearly extirpated the mink from the Lower Columbia River over the last three or four decades, we can only account for the numbers of river otter seen and the lack of mink by their different sensitivities to the contaminants in the river. Henny et al. (1981) reported that river otter contained higher PCB concentrations than mink at that time, so we can only infer that river otters are less sensitive. Despite river otter being relatively abundant in the Lower Columbia River, the adverse effects documented with the reproductive system of age class 0 males (reduced baculum size and reduced testes weight, including the apparent lack of testes found in the young male from RM 119.5 with the highest PCB concentrations) causes great concern. Baculum size and testes weight were inversely correlated with a number of OCs, PCBs, dioxins, and furans. The development of the male genitalia is apparently completed later as age class 2+ males seemed to have normal sized testes and baculums, although we do not know at this time if they function normally.

Many xenobiotic compounds introduced into the environment by human activity have been shown to modify normal biological function in various wildlife species. The ubiquitous distribution of many contaminants and the nonlethal, multigenerational effects of such contaminants on reproductive, endocrine, and immune systems have led to concerns that wildlife worldwide may be affected (Colborn et al. 1993, Hose and Guillette 1995). The reproductive disorders reported to date in wildlife exposed to xenobiotic compounds involve such factors as reduced fertility, reduced hatchability, reduced viability of offspring, impaired endocrine function, and modified adult sexual behavior (Guillette et al. 1995). Of special interest to this Lower Columbia River study are the observations of Guillette et al. (1994) who reported that juvenile alligators (Alligator mississippiensis) from Lake Apopka, Florida, exhibited abnormal gonadal morphology and plasma sex steroid concentrations. Male alligators 6 months old from Lake Apopka had poorly organized testes with unique, aberrant structures of unknown origin within the seminiferous tubules. Both male and female alligators exhibited abnormal plasma sex steroid concentrations, with males from Lake Apopka having greatly reduced plasma testosterone (T) concentrations similar to that of females from either the contaminated lake (Lake Apopka) or control lakes. In contrast, males from the control lake had plasma T concentrations four times that observed in the juvenile males from Lake Apopka. Guillette et al. (1995) hypothesized that xenobiotic compounds are modifying reproductive and endocrine development and function in alligators exposed in ovo, and suggest that the changes in the reproductive and endocrine systems are the result of modifications in gonadal steroidogenic activity, hepatic degeneration of steroids, and synthesis of plasma sex steroid binding proteins. In our study on the Lower Columbia River, age class 0 river otter males showed significantly smaller baculums, and much smaller testes compared to Reference Area animals in the same age class. Unfortunately, animals were not live-captured during our study which eliminated the option of collecting blood to evaluate steroid concentrations, as well as the option for histopathology of unaltered (non-frozen) organs and tissue.

7.0 CONSIDERATION FOR FUTURE RESEARCH ACTIVITIES

Conclusions drawn from data collected during this study make it abundantly clear that additional research is needed to better characterize the current status of river otter on the Lower Columbia River in relation to contaminant exposure and accumulation. Research effort should be focused on the Portland-Vancouver area along the Lower Columbia River where the highest PCB residues were found in river otter tissue collected during this study, and where 3 of 4 otter collected in the general vicinity had obvious physiological or pathological abnormalities. Effort should be made to live-trap about 15 river otter in this location, as well as about 15 from a Reference Area. The Reference Area animals provide baseline values for comparative purposes. Proposed field research should be conducted over a 2-year period with consideration given to seasonal effects which influence reproductive readiness which may complicate data interpretation. Live-trapping should be done in accordance with current animal care and use guidelines, thus minimizing stress and suffering of captured animals. Live-traps should be monitored in such a way to immediately identify when river otters are caught in order to reduce trap time.

Proposed research would focus on six areas:

(1) Blood samples will be taken prior to euthanasia to determine cell populations and biochemical indices. Cell assessments include RBC, WBC, and differential counts to characterize general animal condition and immunological competence, while serum chemistry reflects liver and kidney function. Concentrations of serum progesterone, 17β-estradiol, testosterone, and protection will be quantified.

(2) A complete necropsy will be performed to obtain general morphometric data. Samples of liver, kidney, and reproductive tissues will be immediately removed and frozen in liquid nitrogen for enzyme activity and hormone receptor analyses. Samples of liver, kidney, spleen, thymus, adrenal glands, lung, reproductive tracts will be fixed in buffered formalin for histopathological evaluation. Samples of liver kidney, fat, and perhaps other tissue will be frozen and stored for subsequent contaminant analyses.

(3) Disease and parasite incidence will be evaluated from tissues collected for histopathology, potentially providing some evidence of immunocompetence. Tissue examined microscopically will be categorized by lesion when discovered. Gonadal morphology of male river otter will be characterized and correlated with sperm count and contaminant concentrations.

(4) Cytochrome P450 biomarkers of contaminant exposure will be determined in liver and kidney tissue by fluorometric monooxygenase assays and by western blotting to quantify exposure to P450 inducing contaminants (Rattner et al. 1994). Progesterone, 17β-estradiol, and glucocorticoid receptor density (R_t) and dissociation contents (Kd) in the uterine cytosolic and nuclear subcellular fractions will be estimated by competitive binding assays (Patnode and Curtis 1994).

(5) Analyze fat, kidney, and liver samples for OCs, total PCBs and congeners, other coplanar polyhalogenated hydrocarbons, pthalate esters, alkylphenols, and inorganics.

(6) Fecal samples taken from river otter during necropsy will be assessed for hormone concentrations as a potential bio-marker that could be compared to hormone levels in blood.

Responses (hormonal, steroid receptor, gonadal and other morphological lesions, etc.) will be categorized by age, sex, reproductive state, study site and degree of contaminant exposure (as evidenced by P450 induction responses or actual contaminant burdens). Apparent effects of PCBs and other persistent contaminants on endocrine regulation of reproduction, morphology of reproductive tissues, sexual differentiation and fertility of adults will be evaluated by parametric statistical analysis (analysis of variance and correlation techniques). Intensive research effort conducted on river otter as proposed above would lead to a better understanding of its current physiological status in the Lower Columbia River with respect to present contaminant exposure. Furthermore, data collected on river otter in the Lower Columbia River may help to understand the dramatic decline of mink in the same area.

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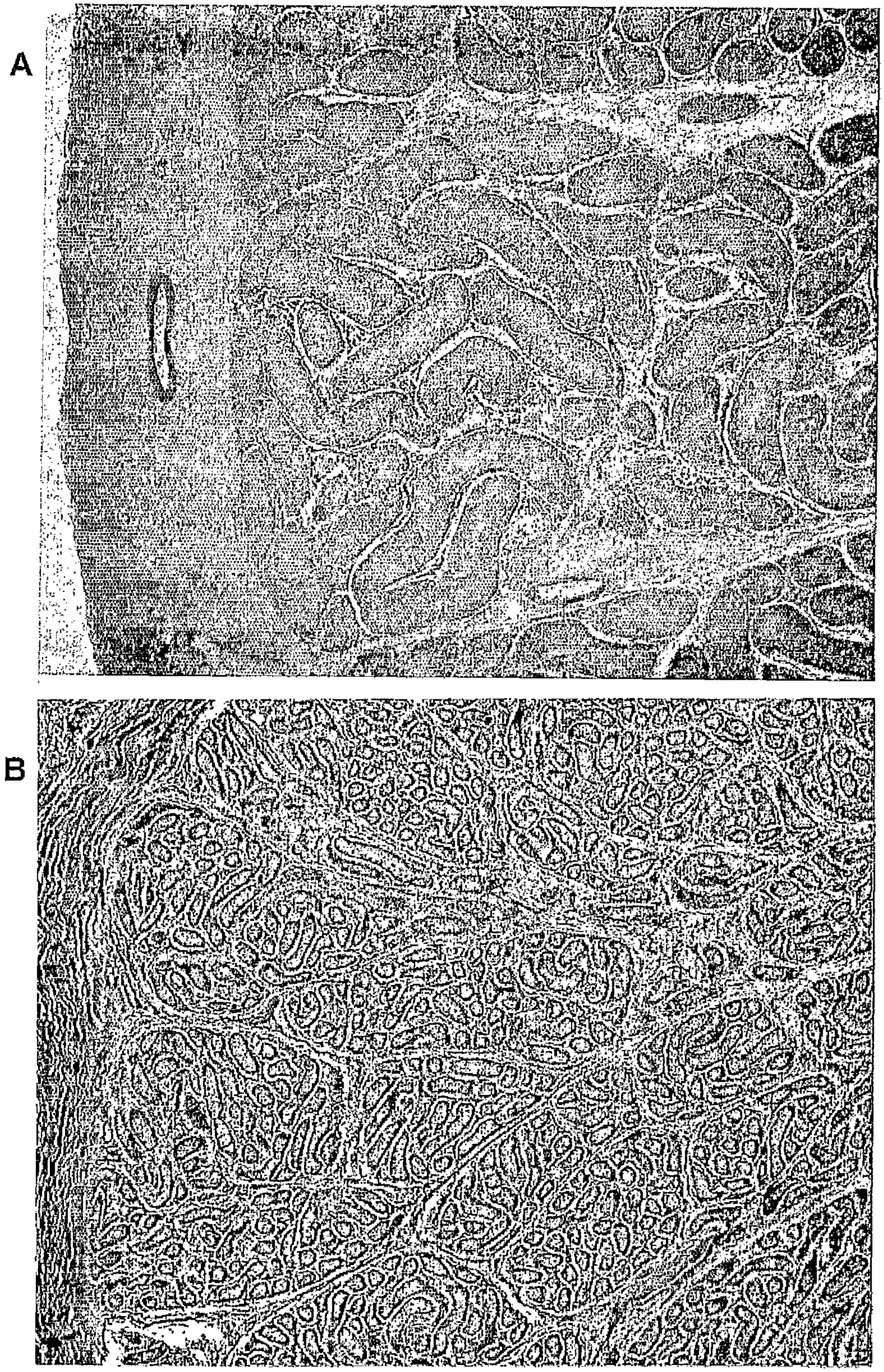


Figure 1. Low magnification (25X) hematoxylin and eosin stained micrographs of testes from age class 0 river otters obtained at a Reference Area (**A**, river otter No. 29) and the Lower Columbia River (**B**, river otter No. 6).

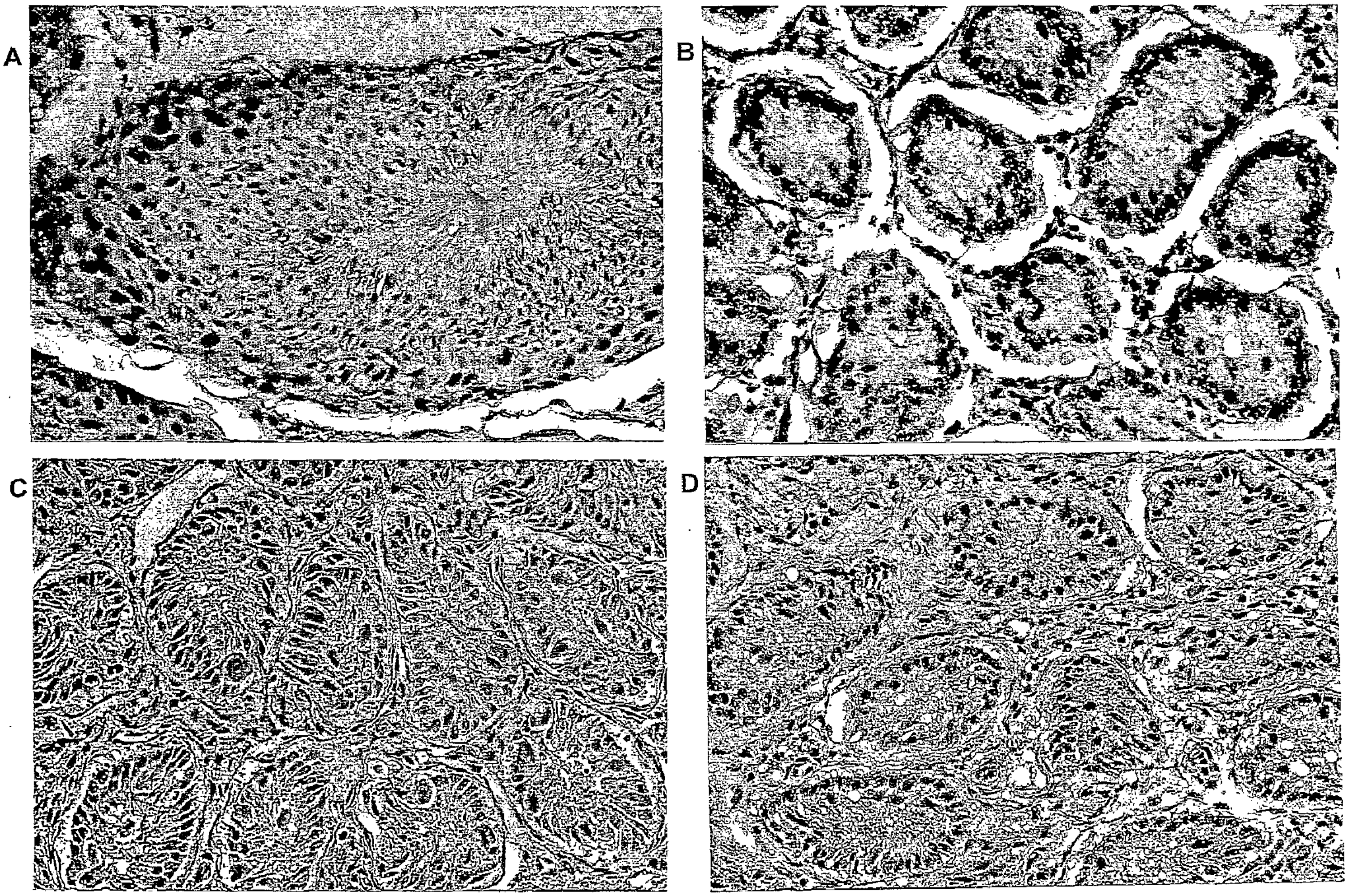
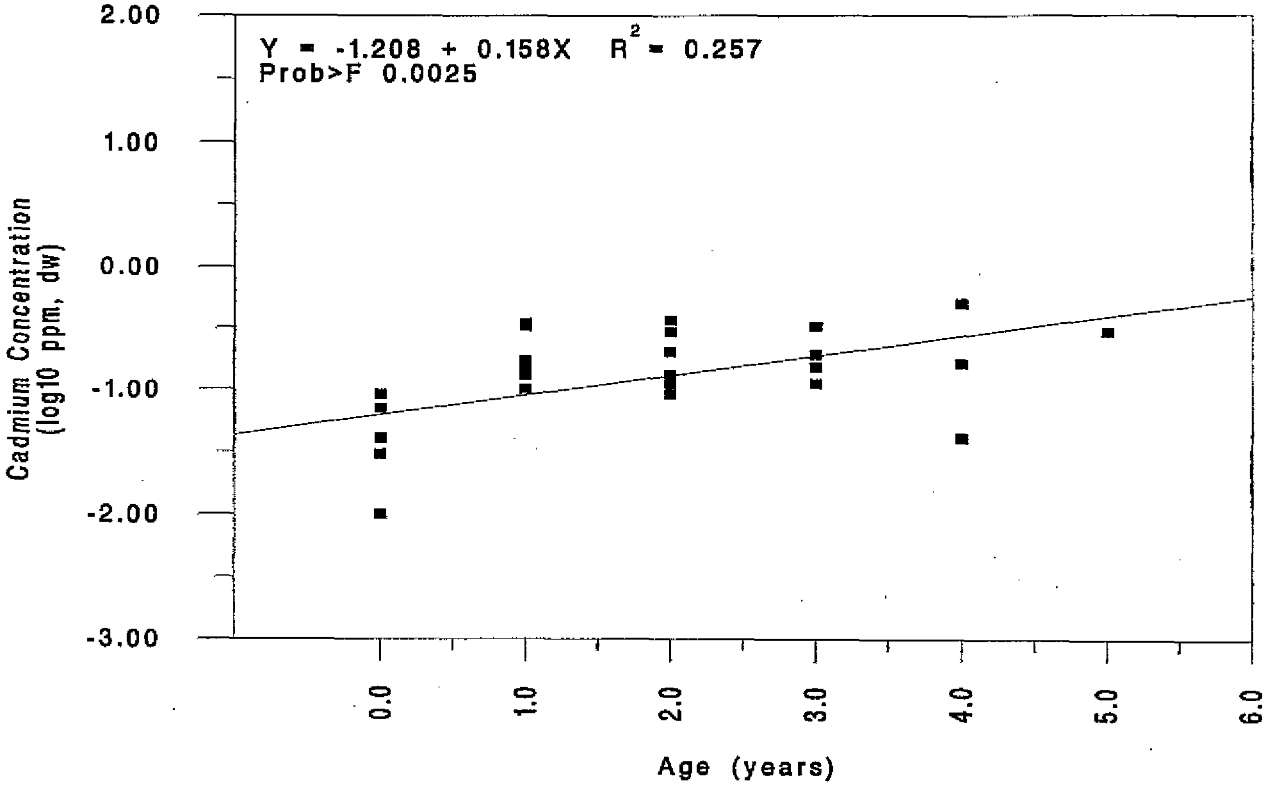


Figure 2. High magnification (250X) hematoxylin and eosin stained micrographs of testes from age class 0 river otters obtained at a Reference Area (**A**, river otter No. 29) and the Lower Columbia River (**B**, river otter No. 6; **C**, No. 12; **D**, No. 20).



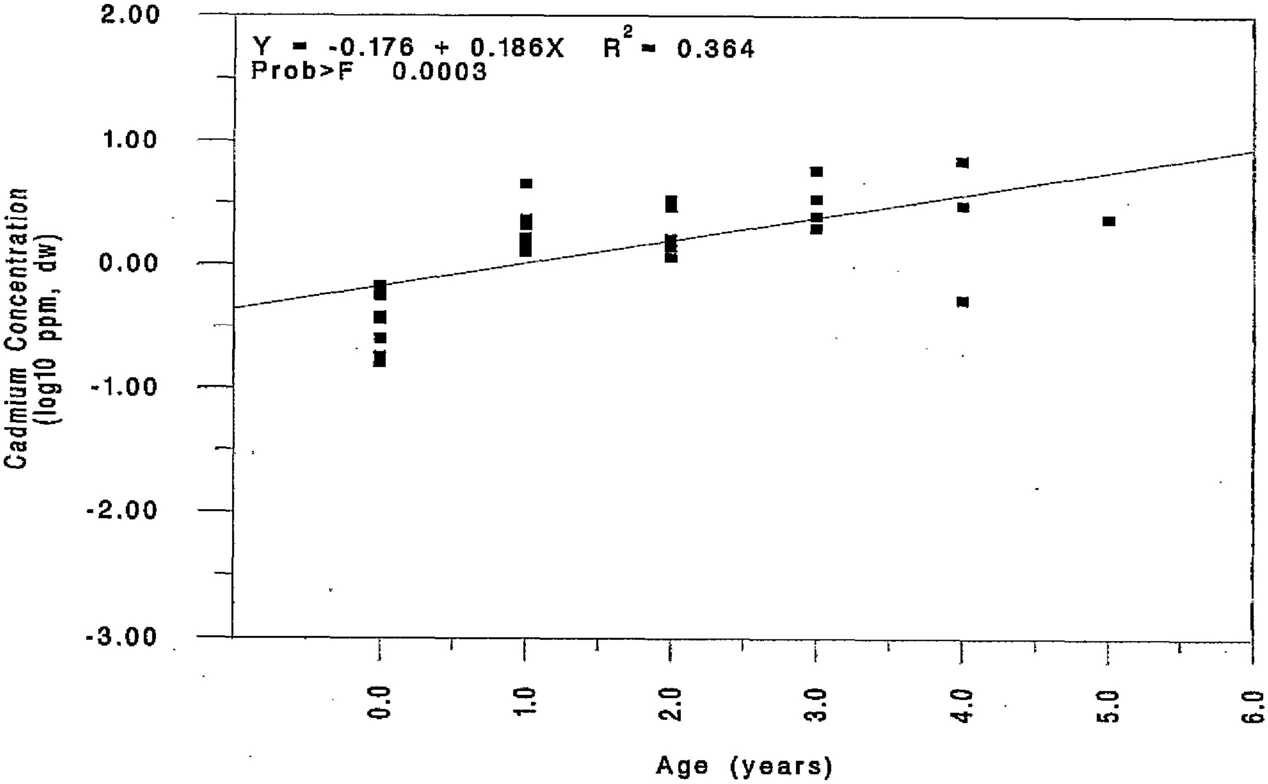


Figure 3. Relationship between age and cadmium concentrations in livers (top) and kidneys (bottom) of male and female river otter from the Lower Columbia River.

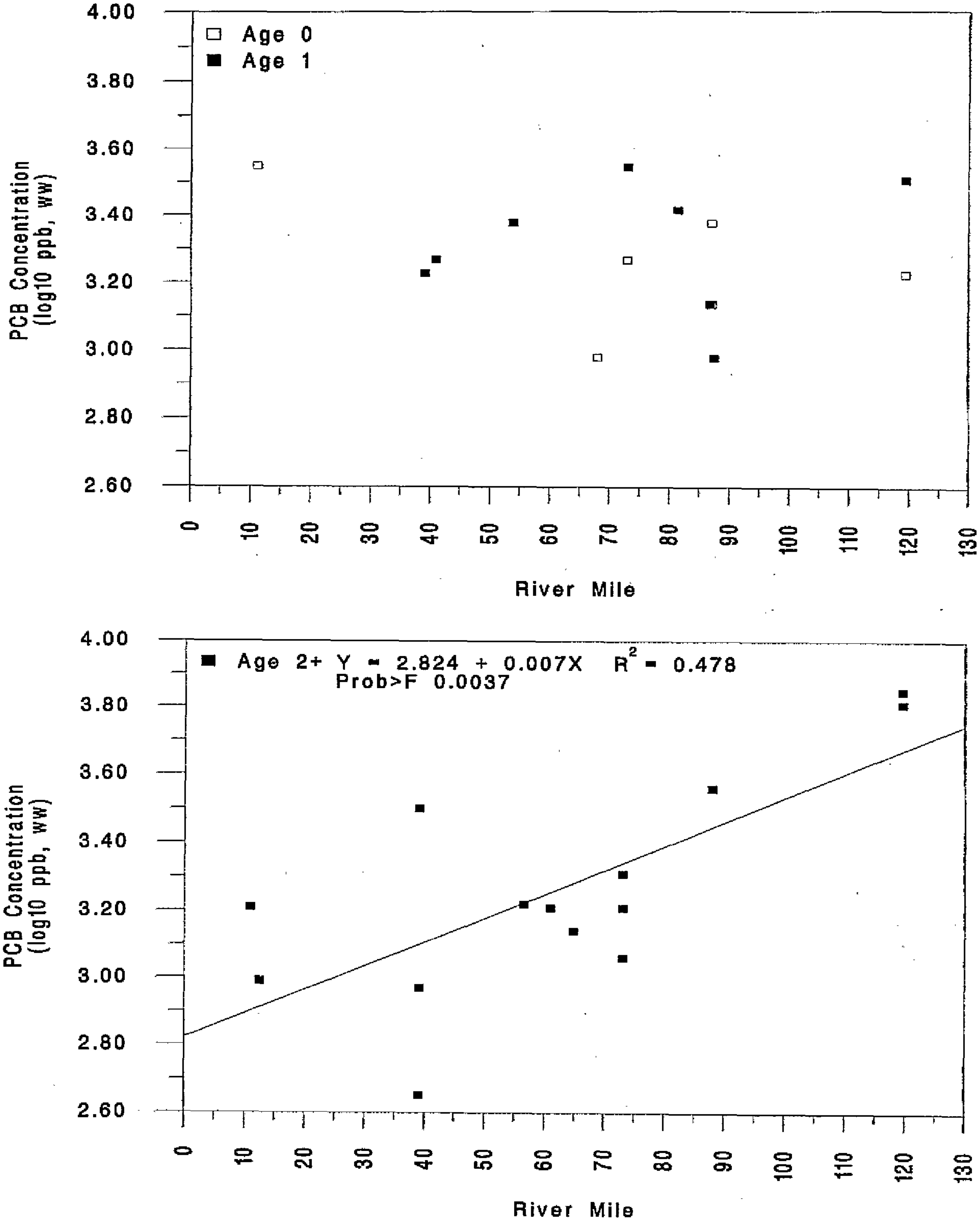


Figure 4. Relationship between River Mile and Aroclor 1254:1260 concentrations in livers of river otter (age class 0, 1, 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.

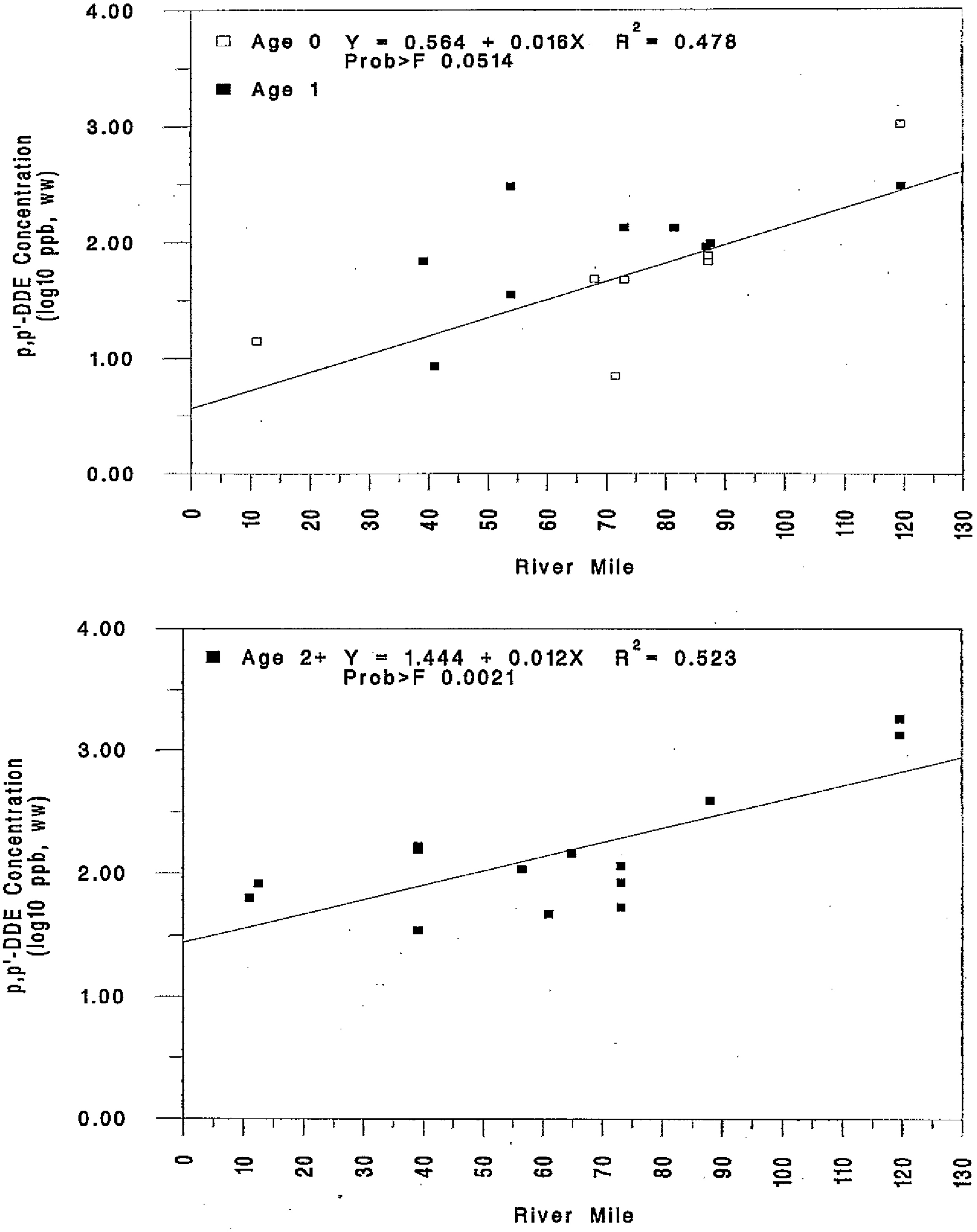


Figure 5. Relationship between River Mile and p,p'-DDE concentrations in livers of river otter (age class 0, 1, 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.

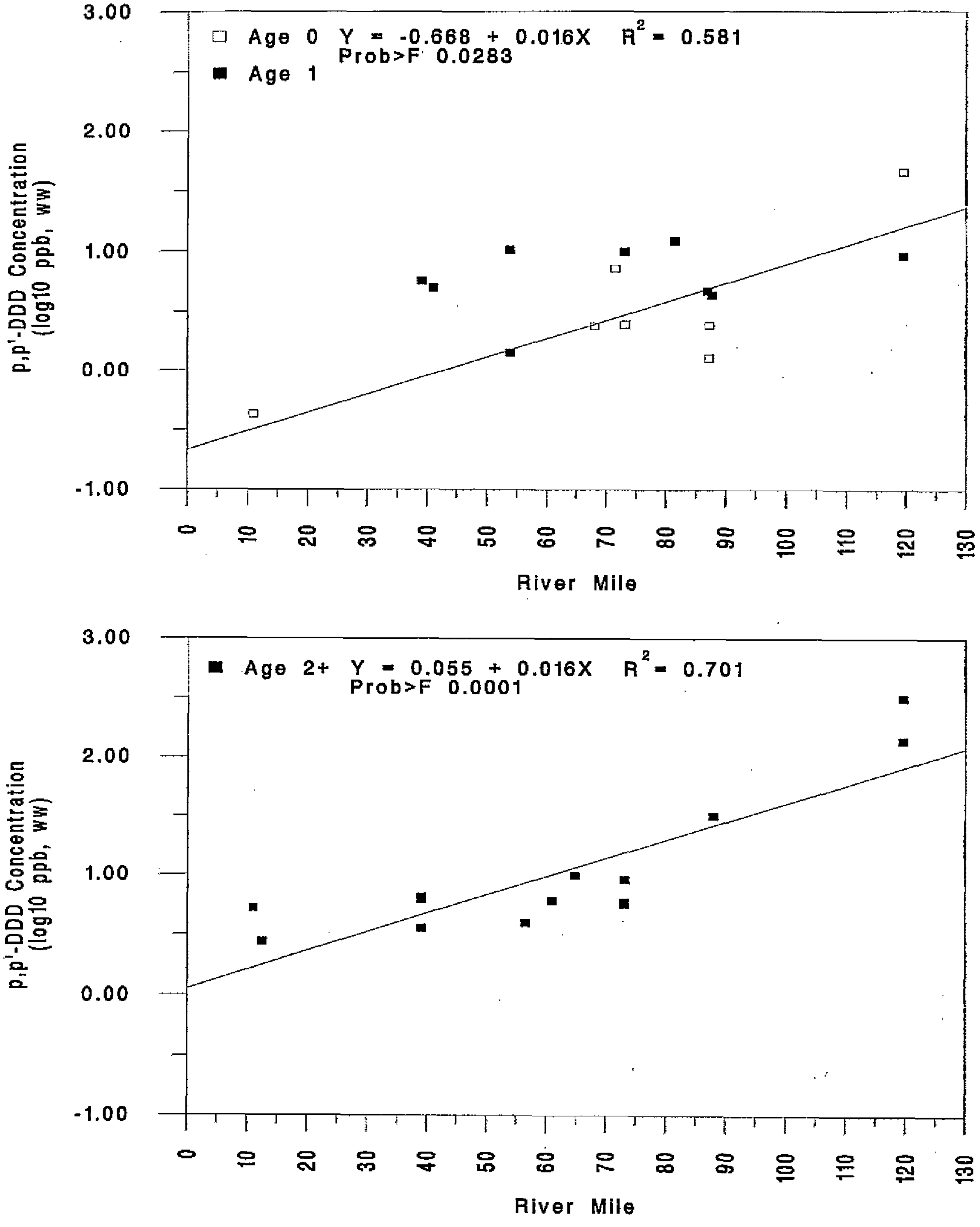
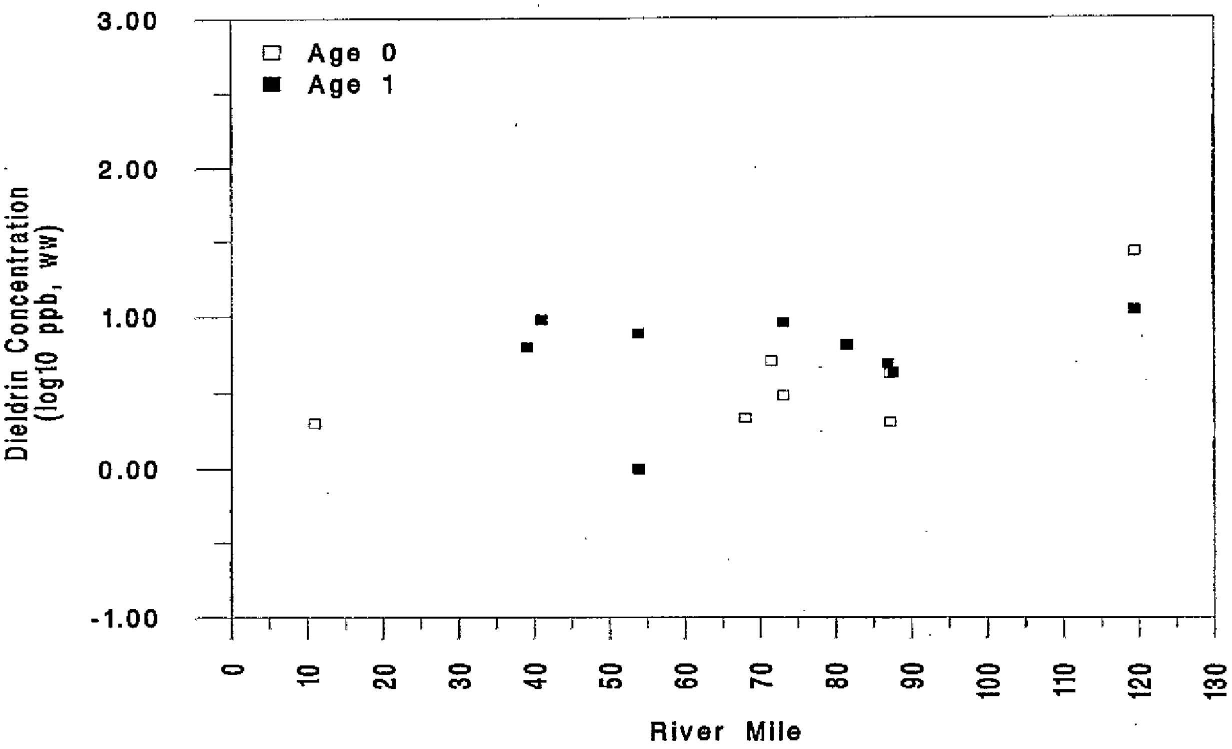


Figure 6. Relationship between River Mile and p,p'-DDD concentrations in livers of river otter (age class 0, 1, 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.



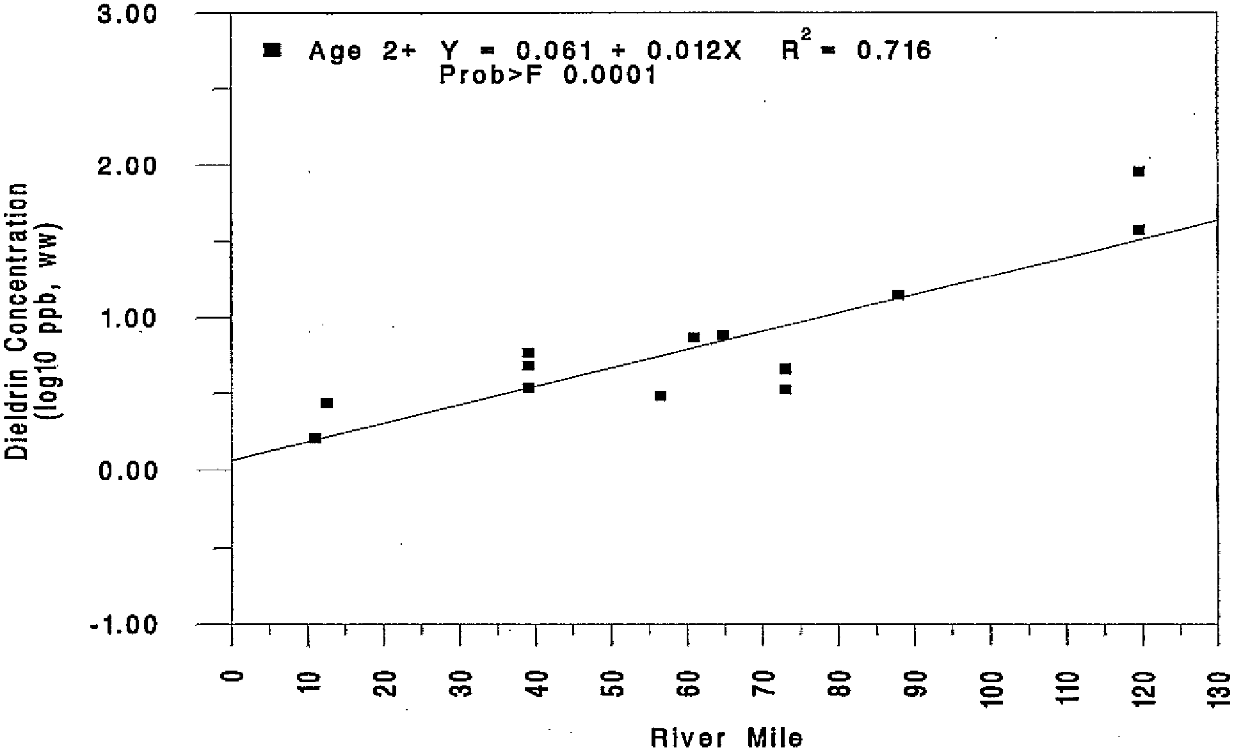
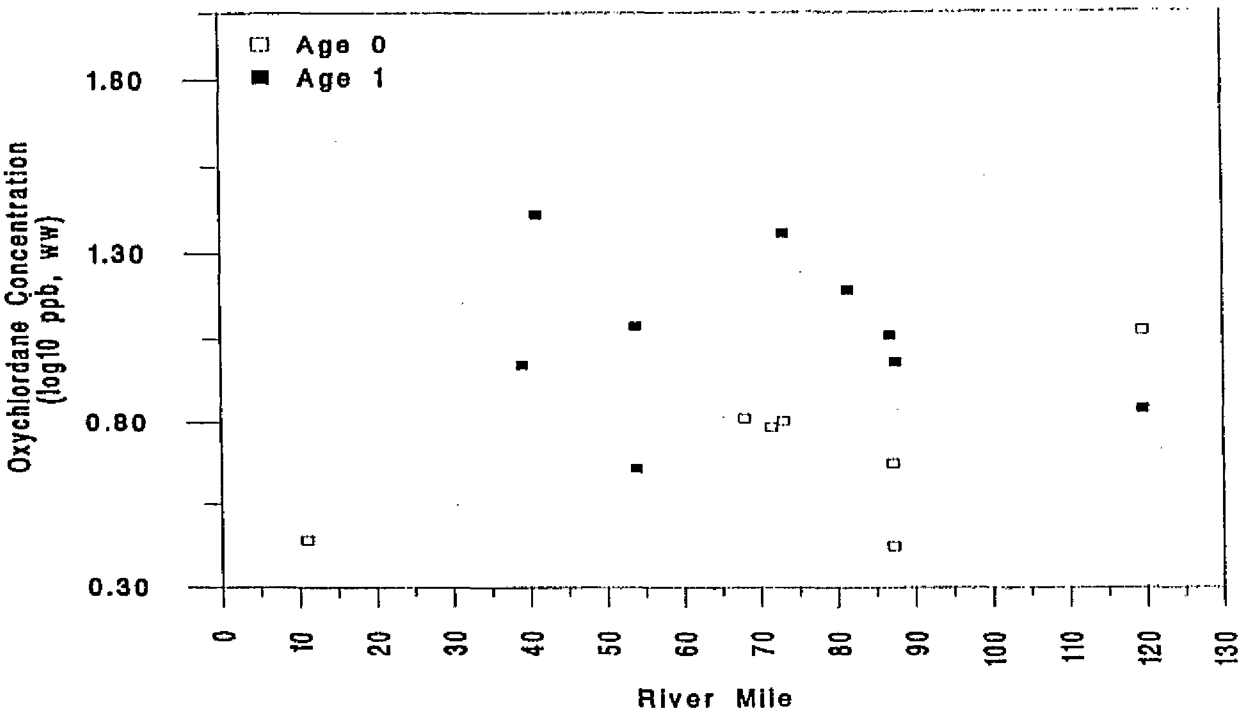


Figure 7. Relationship between River Mile and dieldrin concentrations in livers of river otter (age class 0, 1, 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.



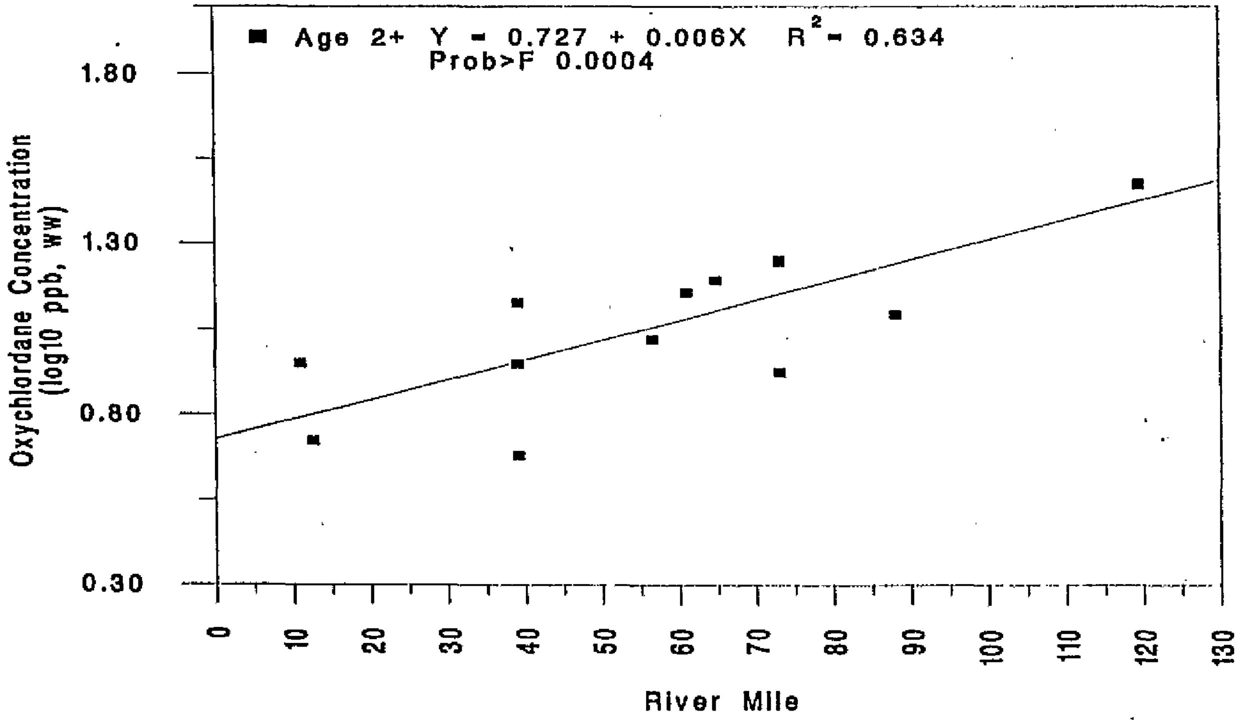


Figure 8. Relationship between River Mile and oxychlordane concentrations in livers of river otter (age class 0, 1, 2+) from Lower Columbia River. No line was plotted when the relationship was not significant.

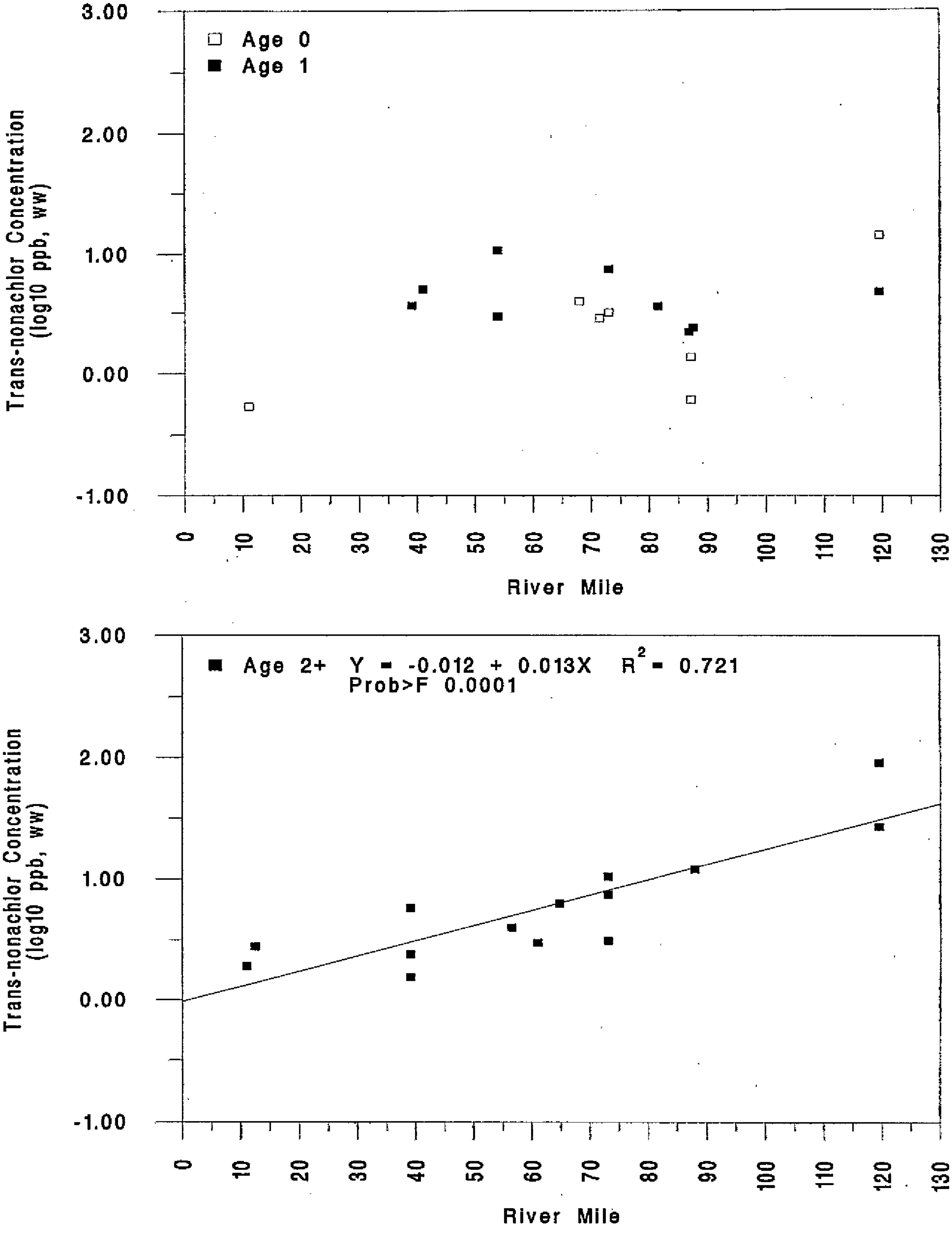


Figure 9. Relationship between River Mile and trans-nonachlor concentrations in livers of river otter (age class 0, 1, 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.

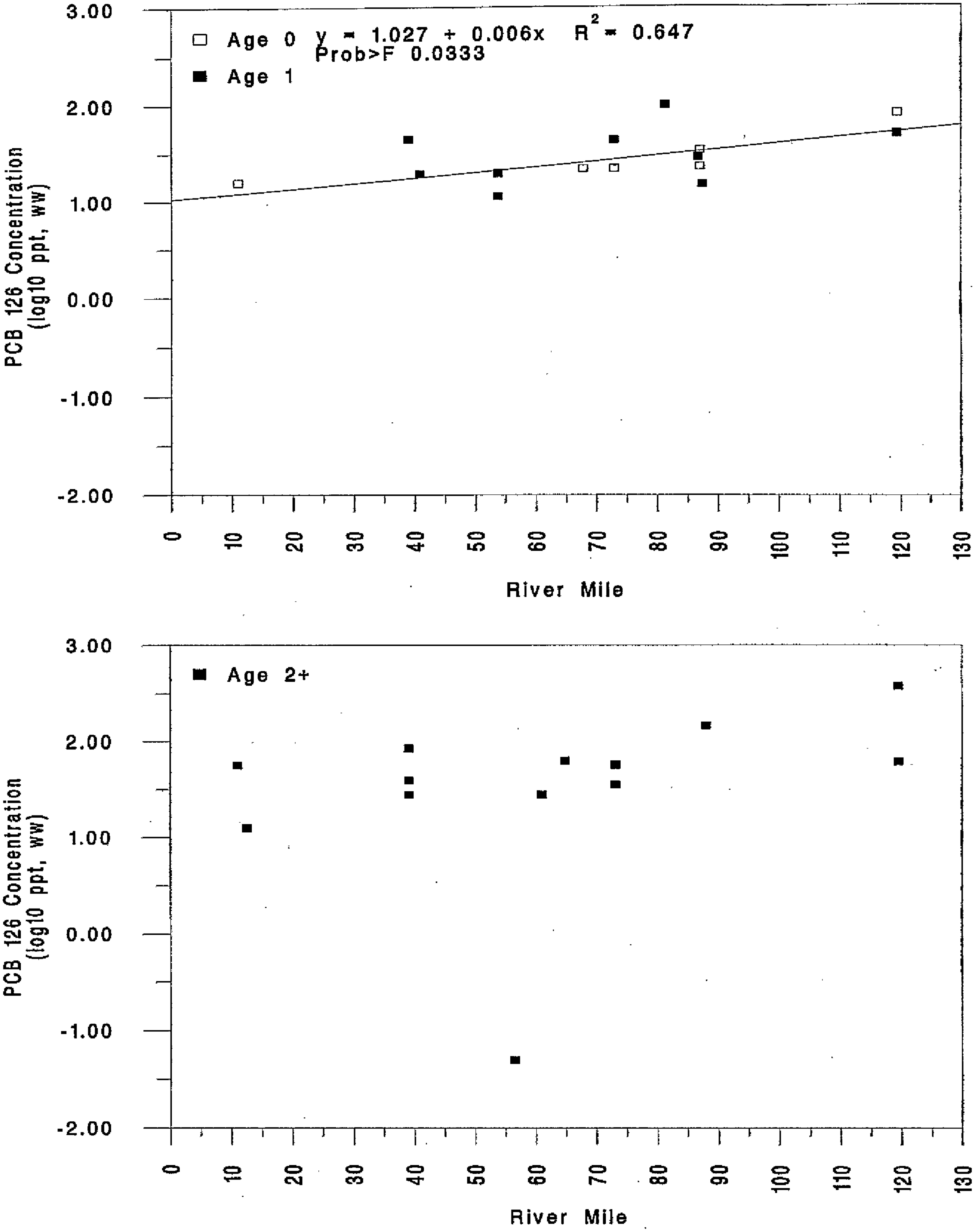
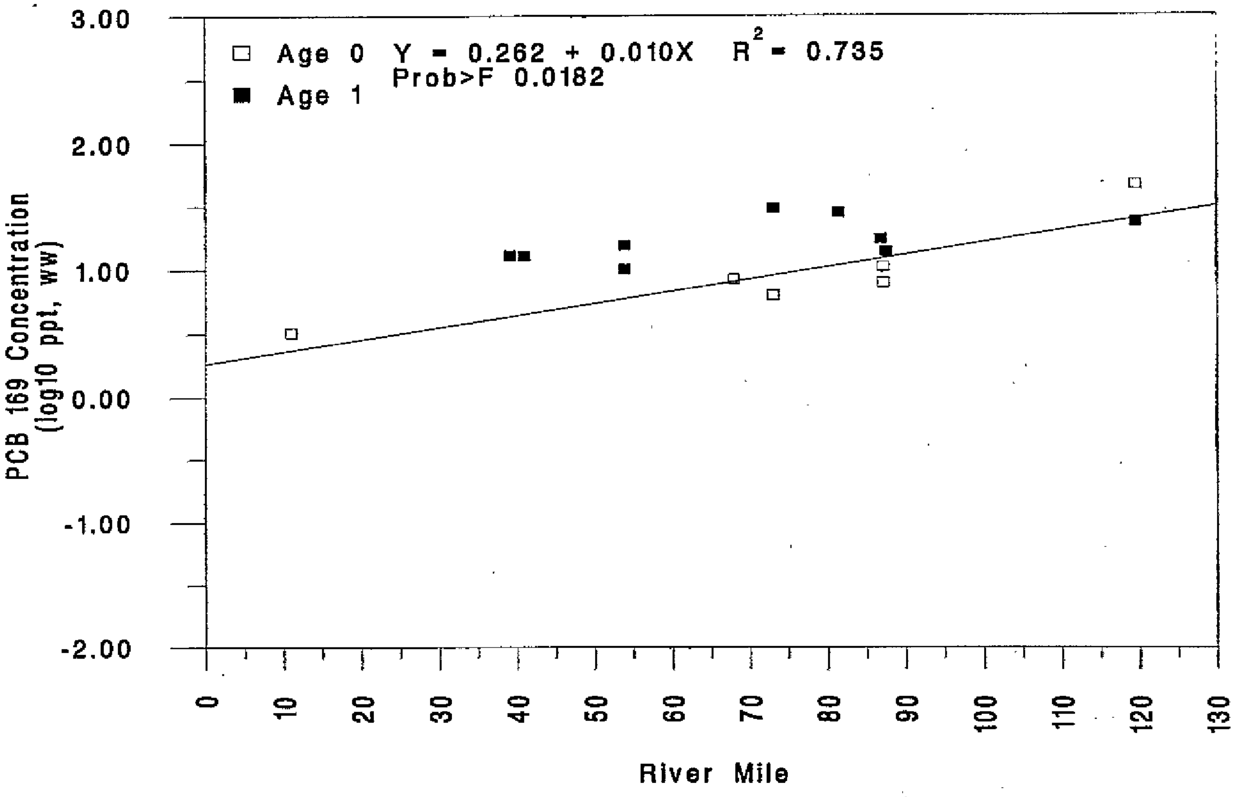


Figure 10. Relationship between River Mile and PCB 126 concentrations in livers of river otter (age class 0, 1 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.



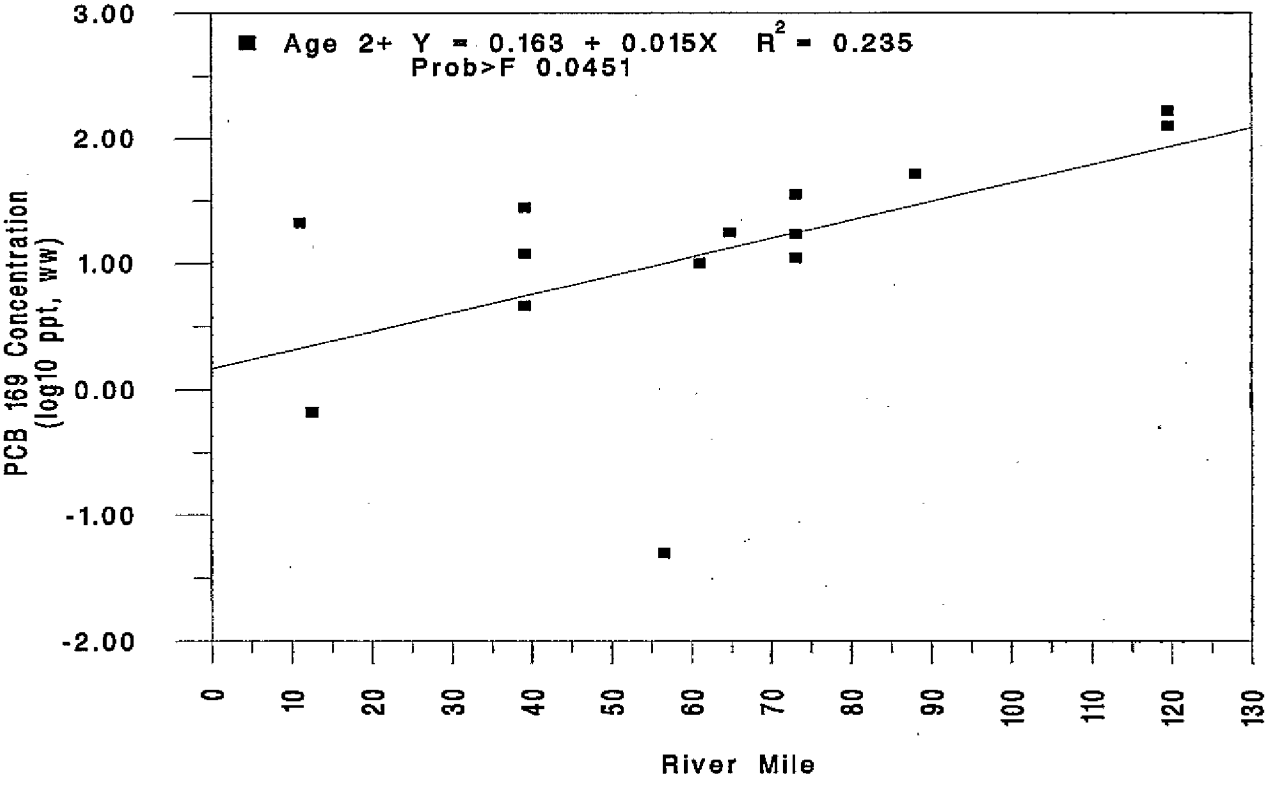


Figure 11. Relationship between River Mile and PCB 169 concentrations in livers of river otter (age class 0, 1, 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.

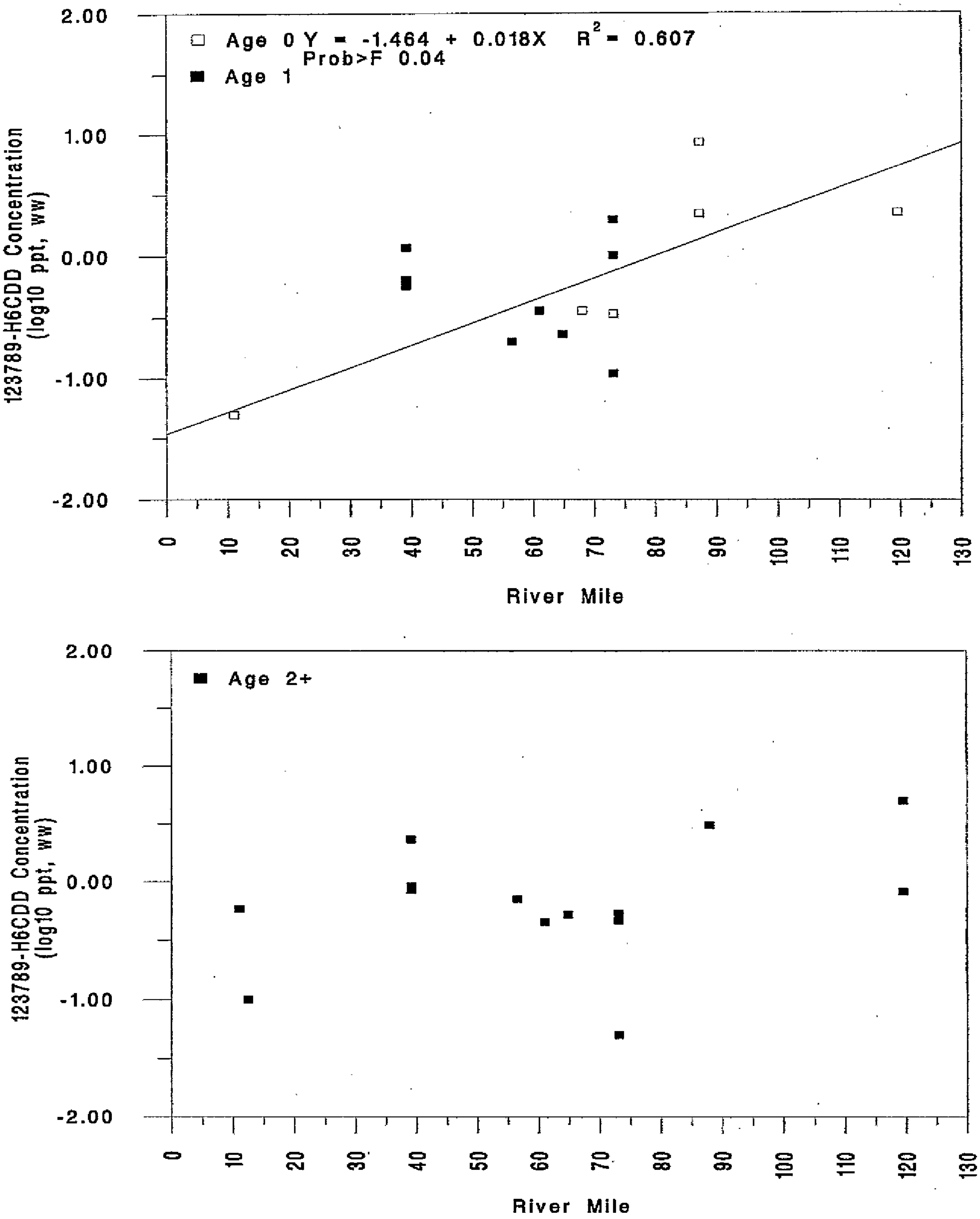
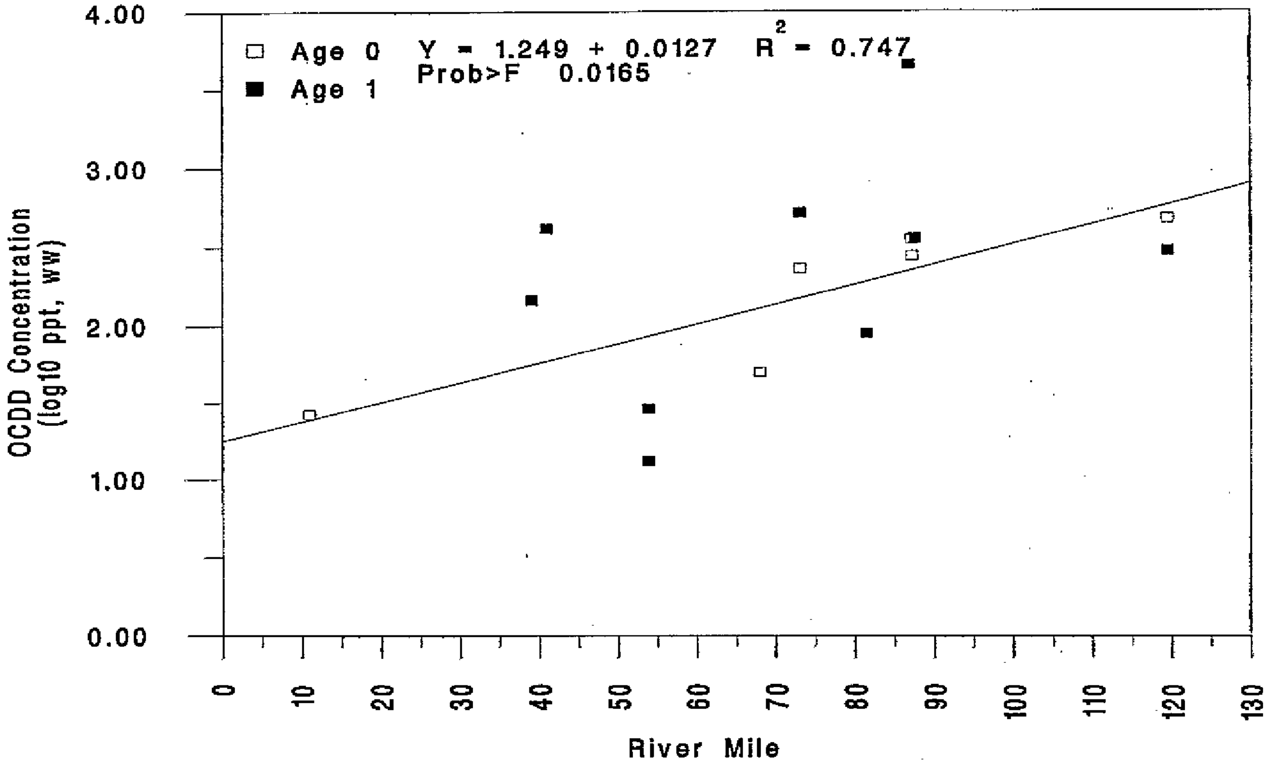


Figure 12. Relationship between River Mile and 123789-H6CDD concentrations in livers of river otter (age class 0, 1, 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.



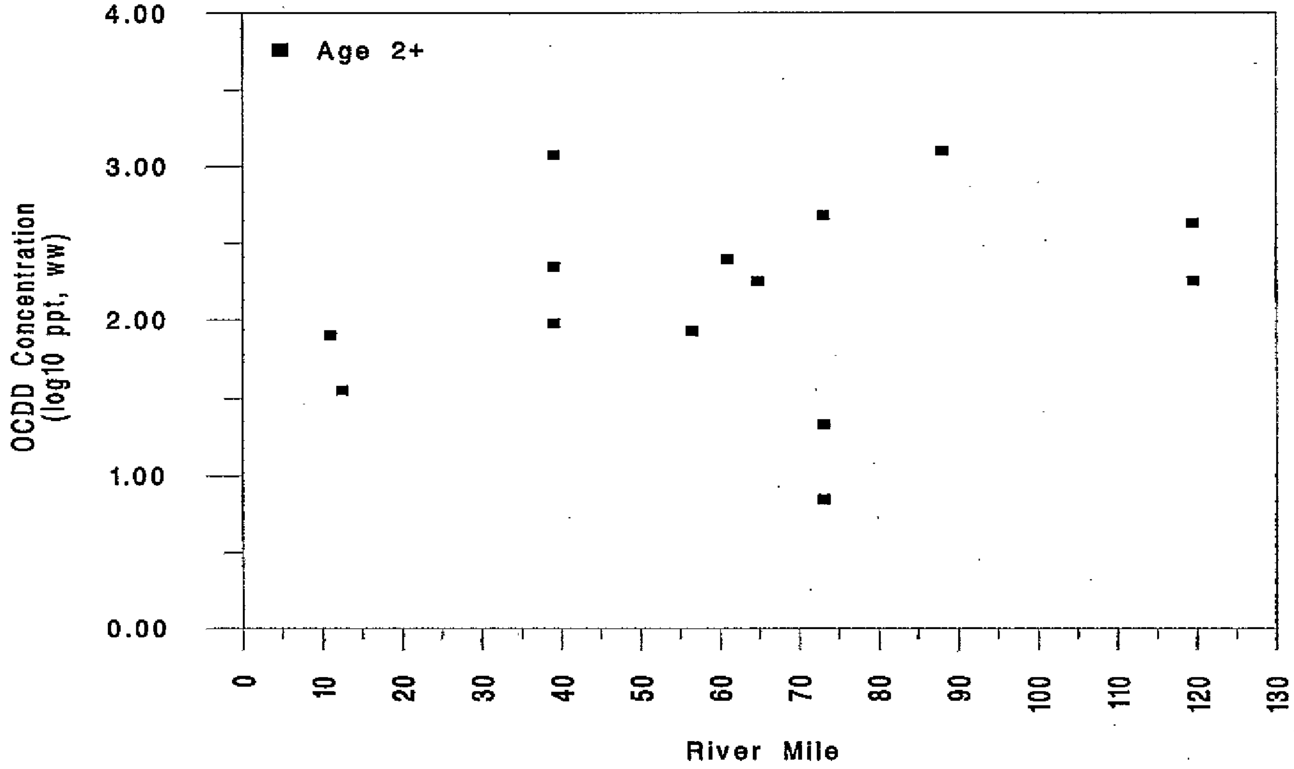


Figure 13. Relationship between River Mile and OCDD concentrations in livers of river otter (age class 0, 1, 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.

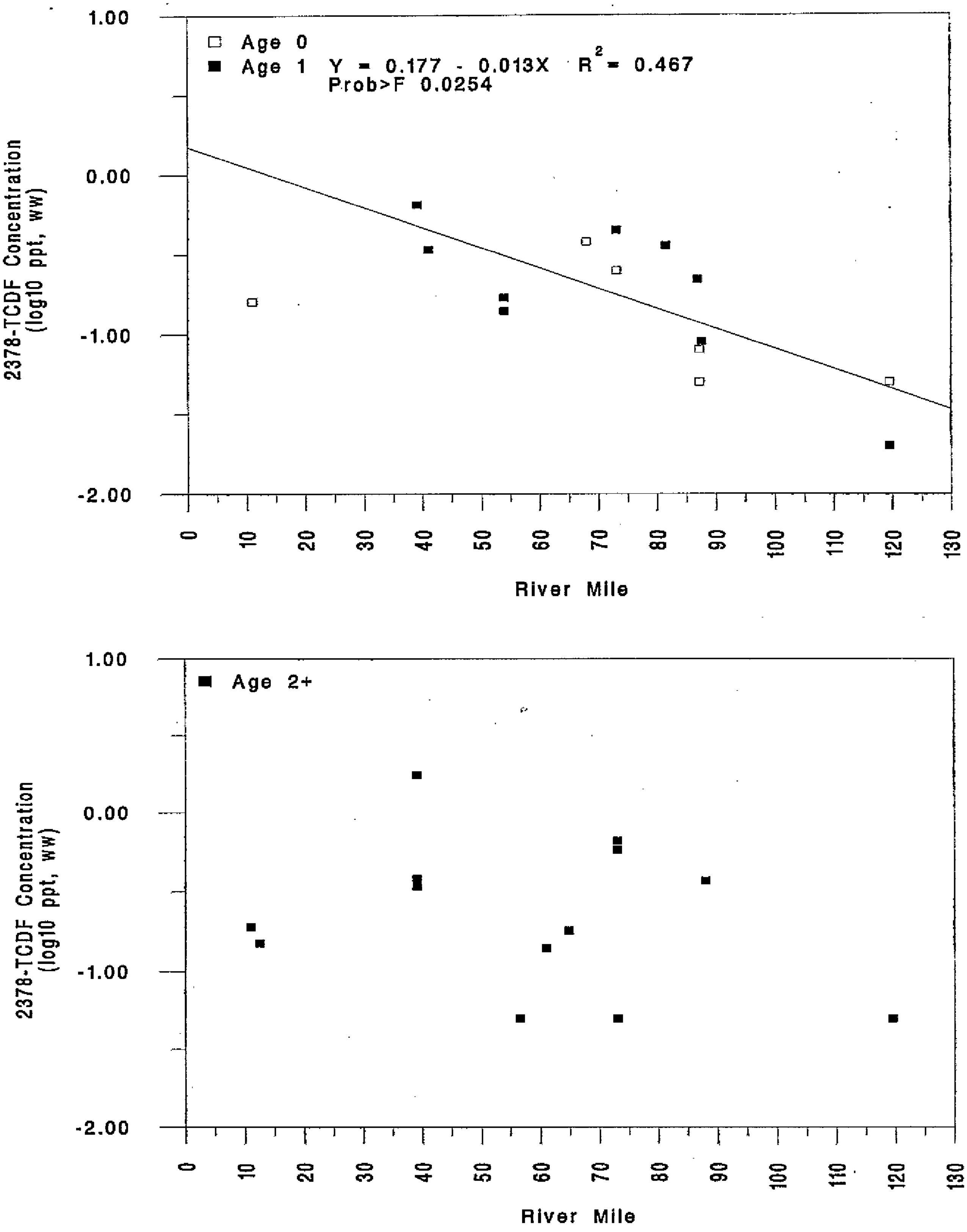


Figure 14. Relationship between River Mile and 2378-TCDF concentrations in livers of river otter (age class 0, 1, 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.

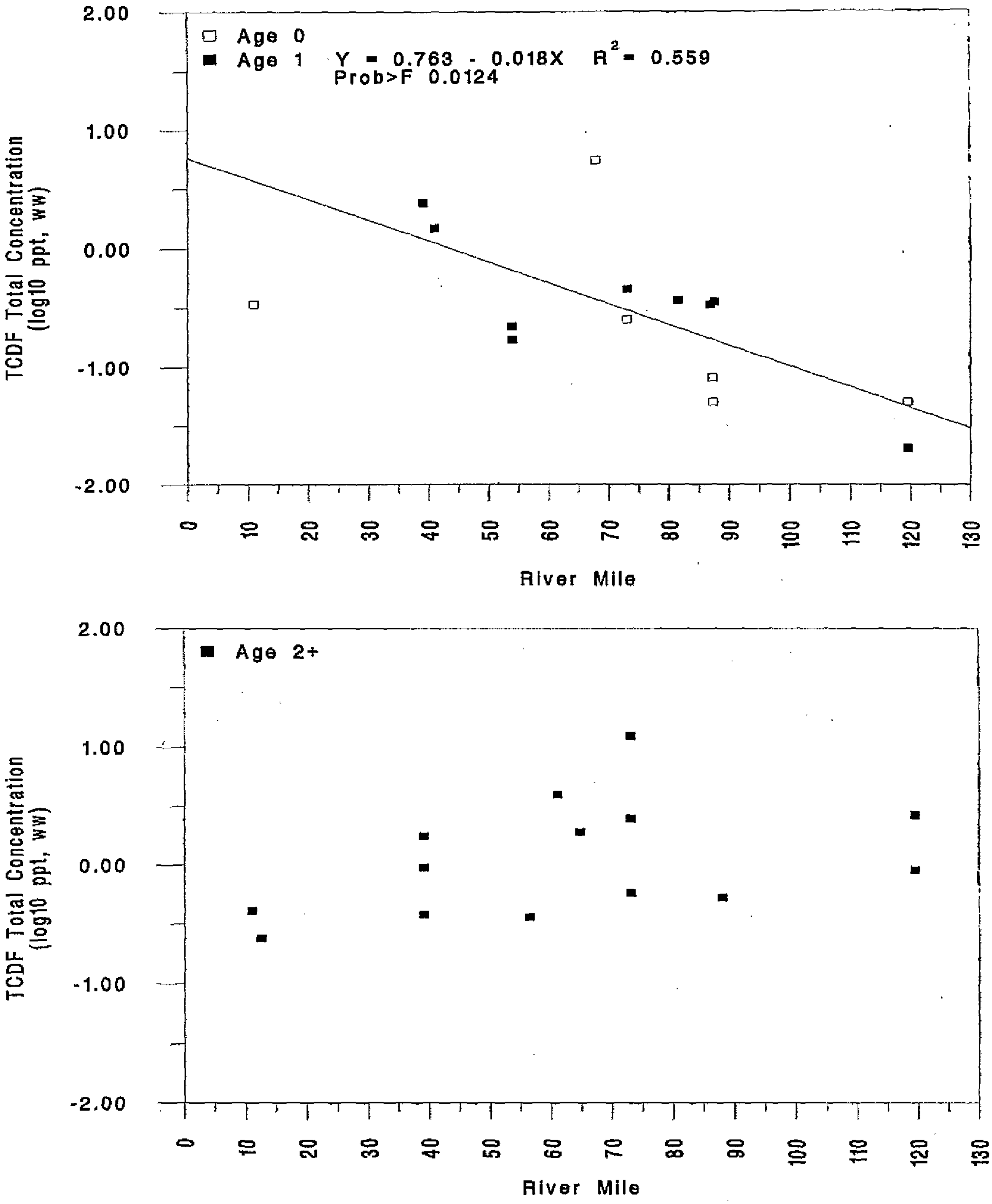


Figure 15. Relationship between River Mile and TCDF total concentrations in livers of river otter (age class 0, 1, 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.

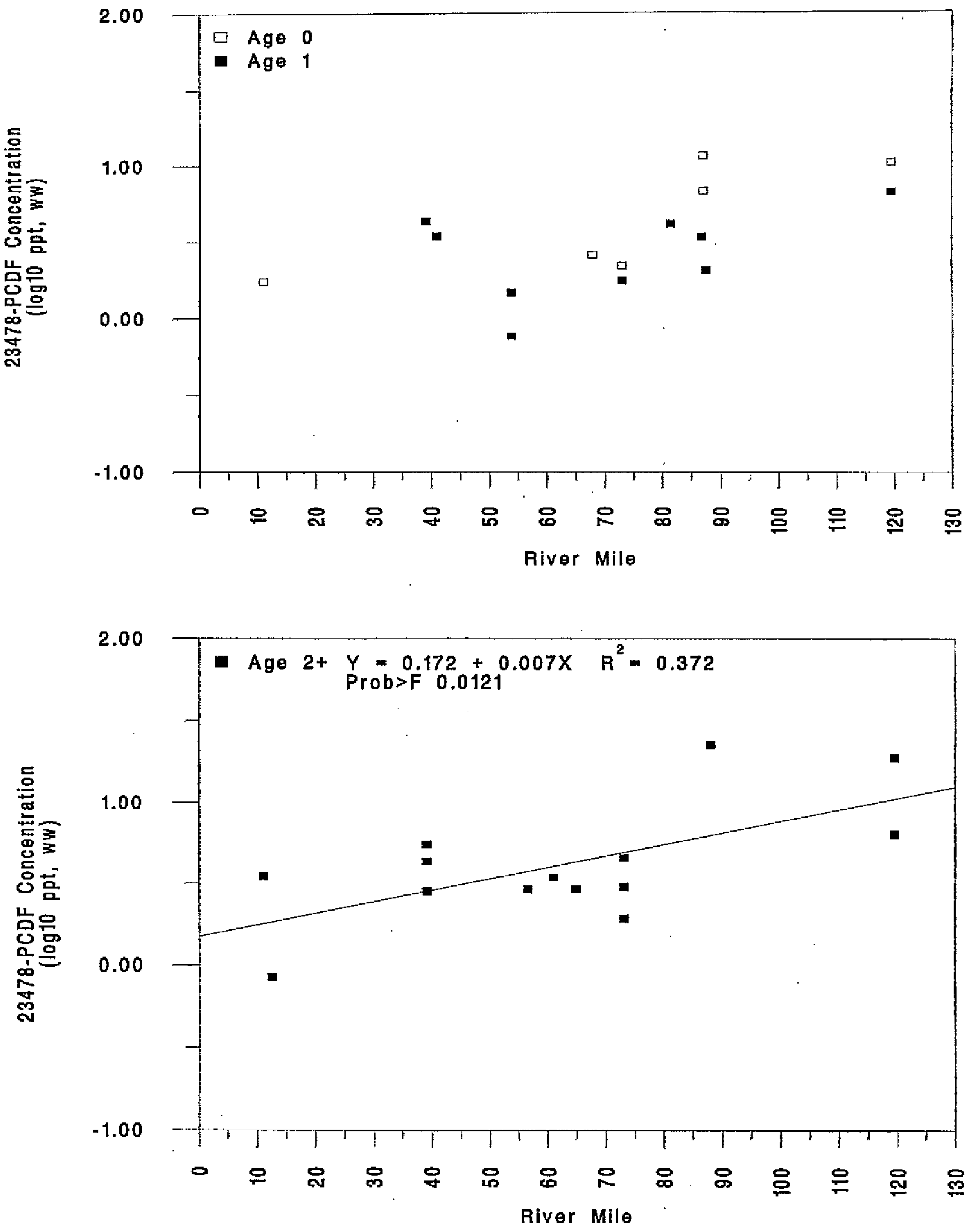


Figure 16. Relationship between River Mile and 23478-PCDF concentrations in livers of river otter (age class 0, 1, 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.

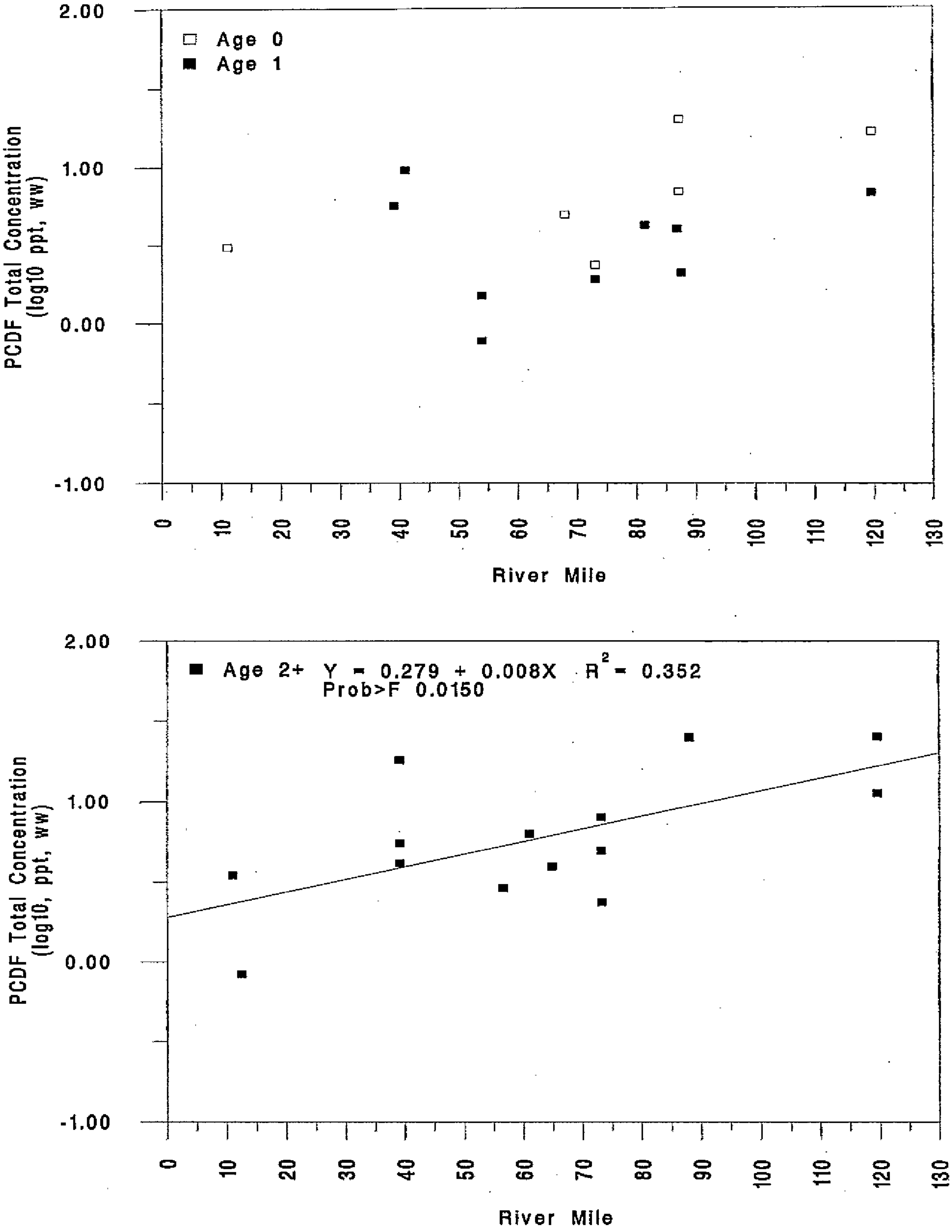


Figure 17. Relationship between River Mile and PCDF total concentrations in livers of river otter (age class 0, 1, 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.

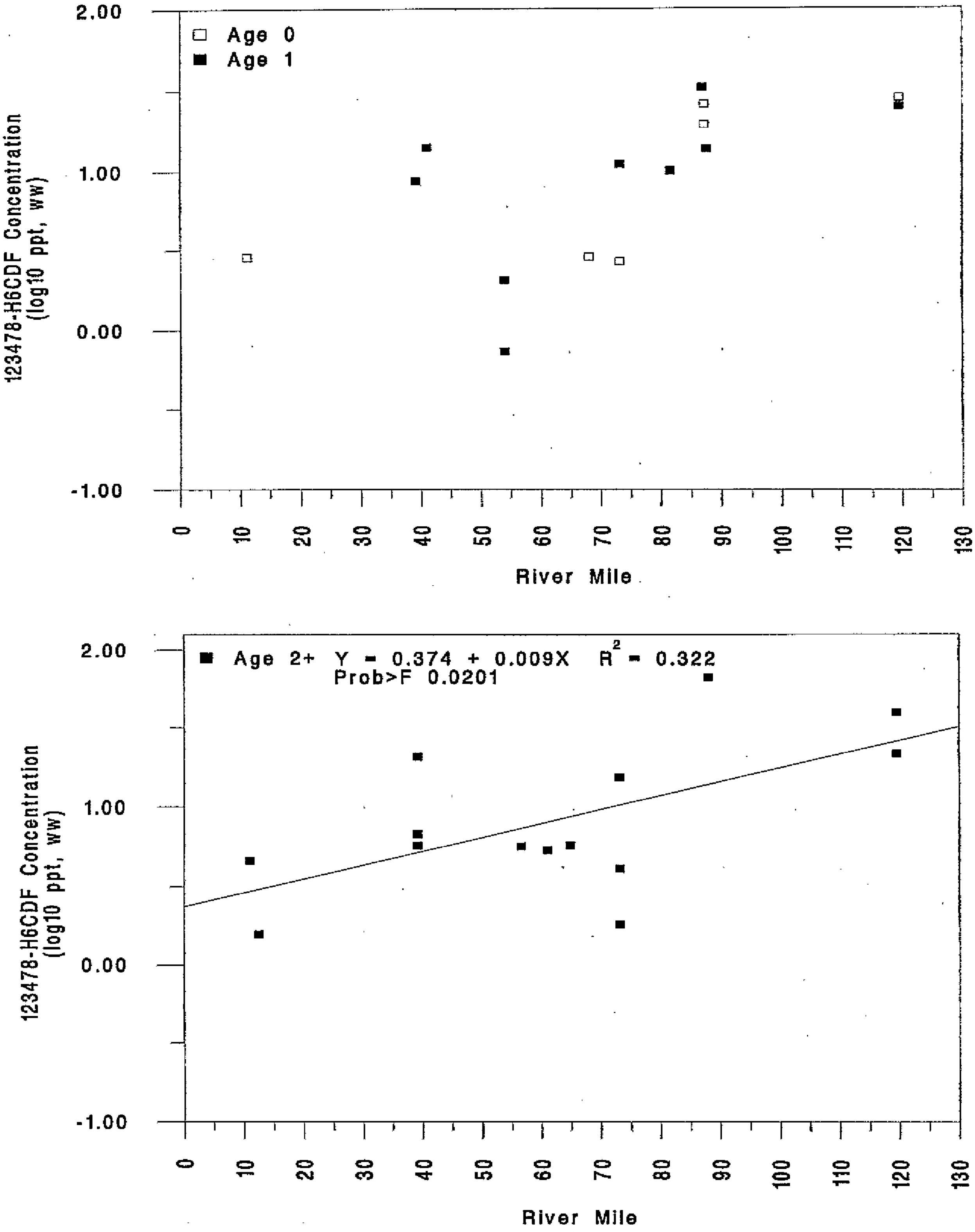
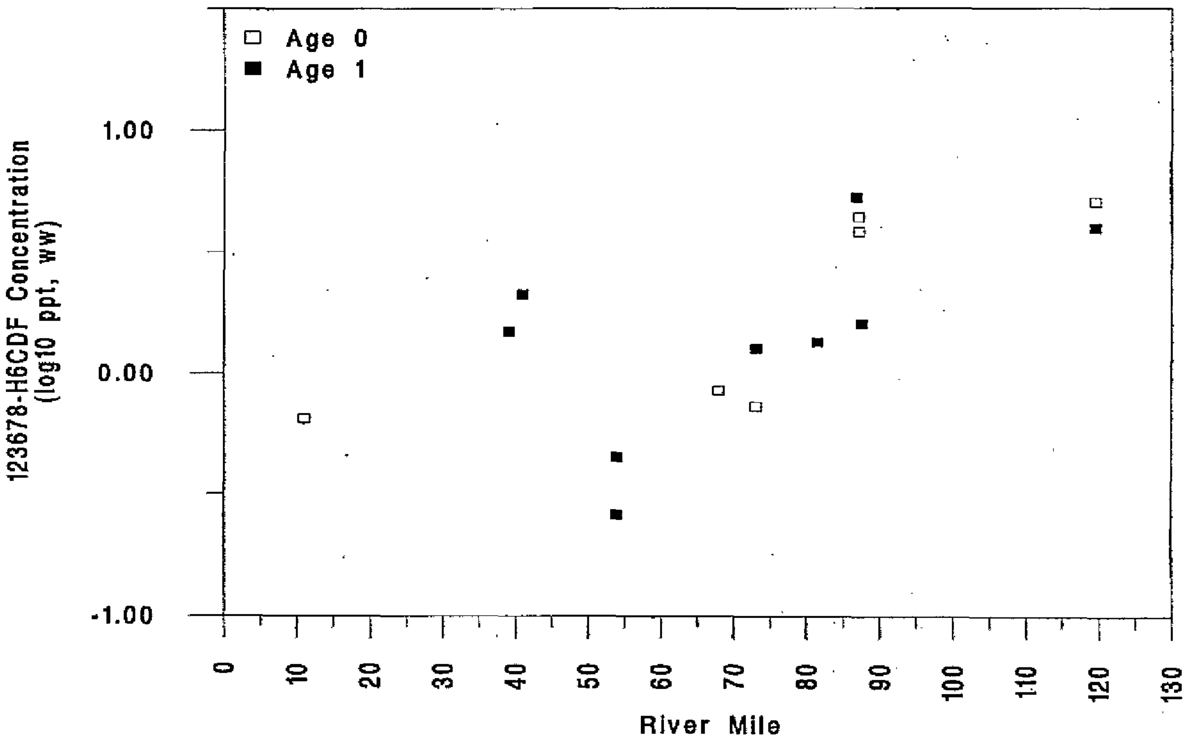


Figure 18. Relationship between River Mile and 123478-H6CDF concentrations in livers of river otter (age class 0, 1, 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.



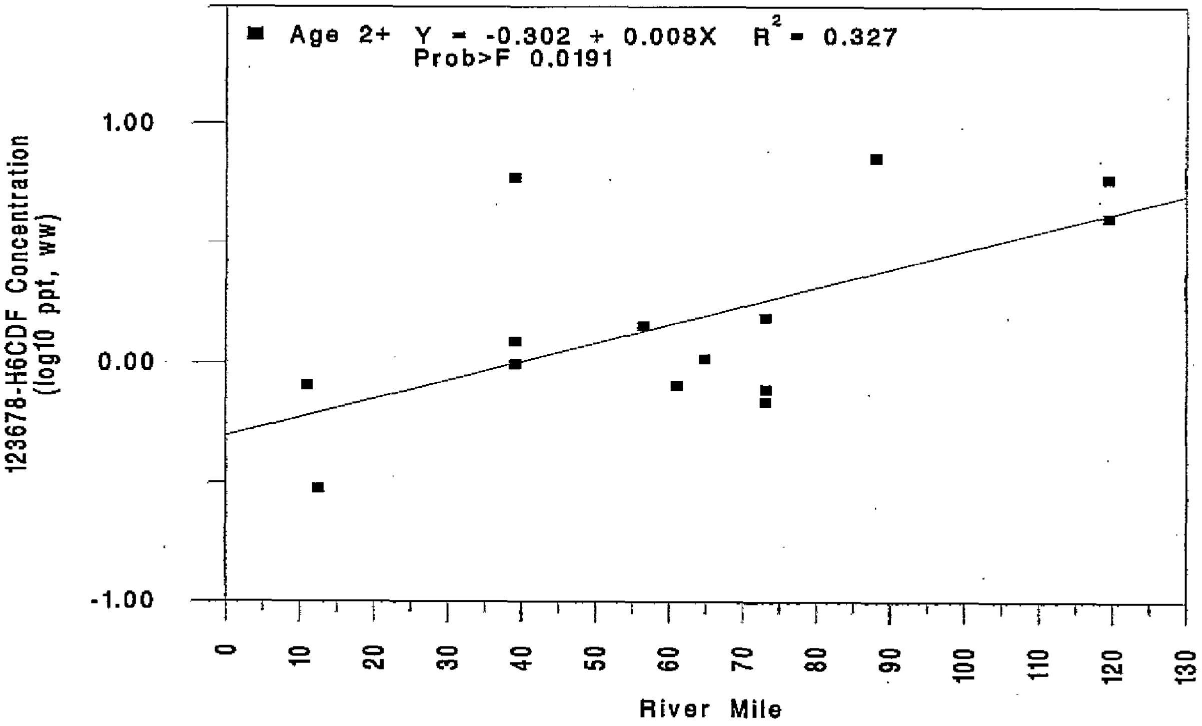


Figure 19. Relationship between River Mile and 123678-H6CDF concentrations in livers of river otter (age class 0, 1, 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.

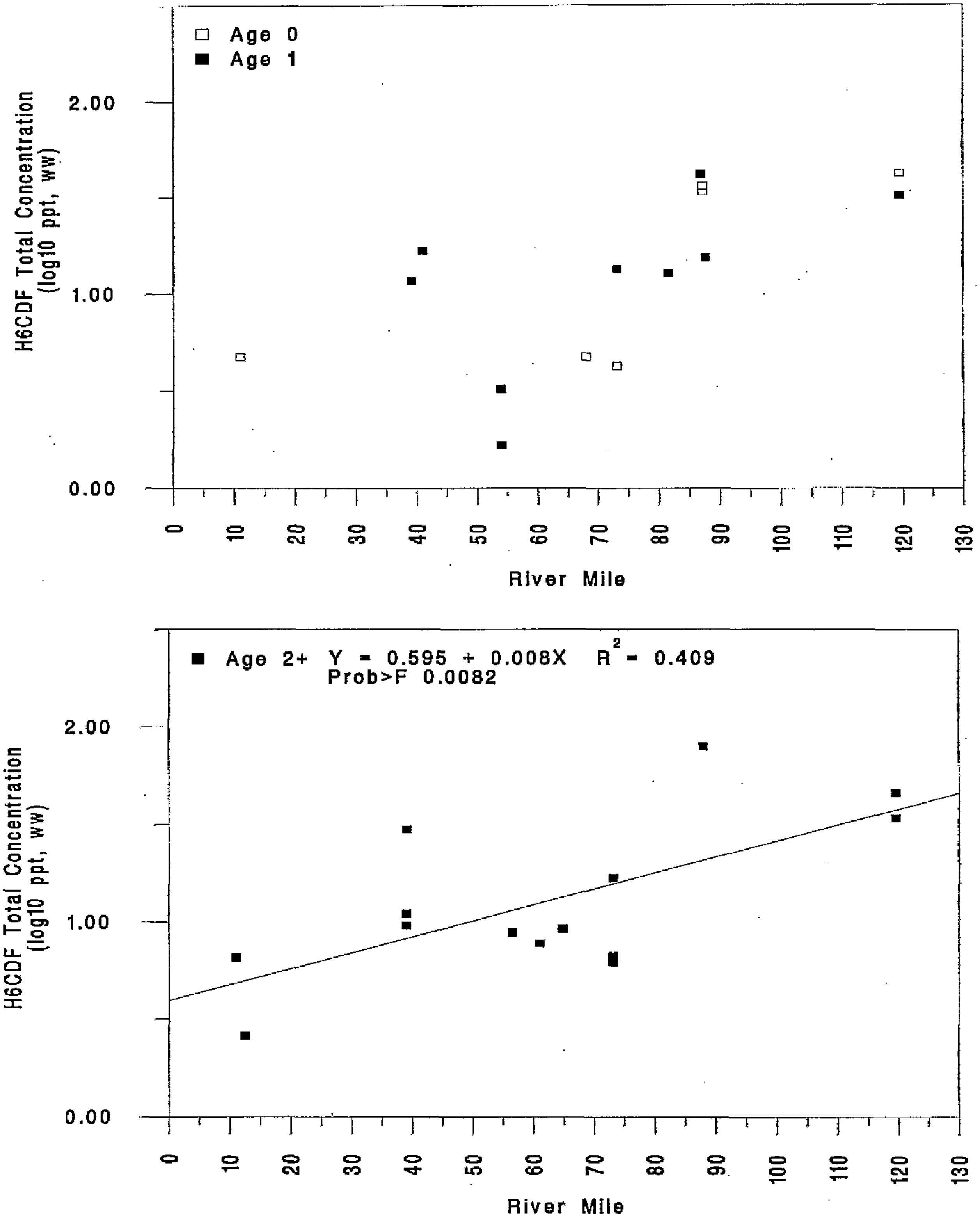
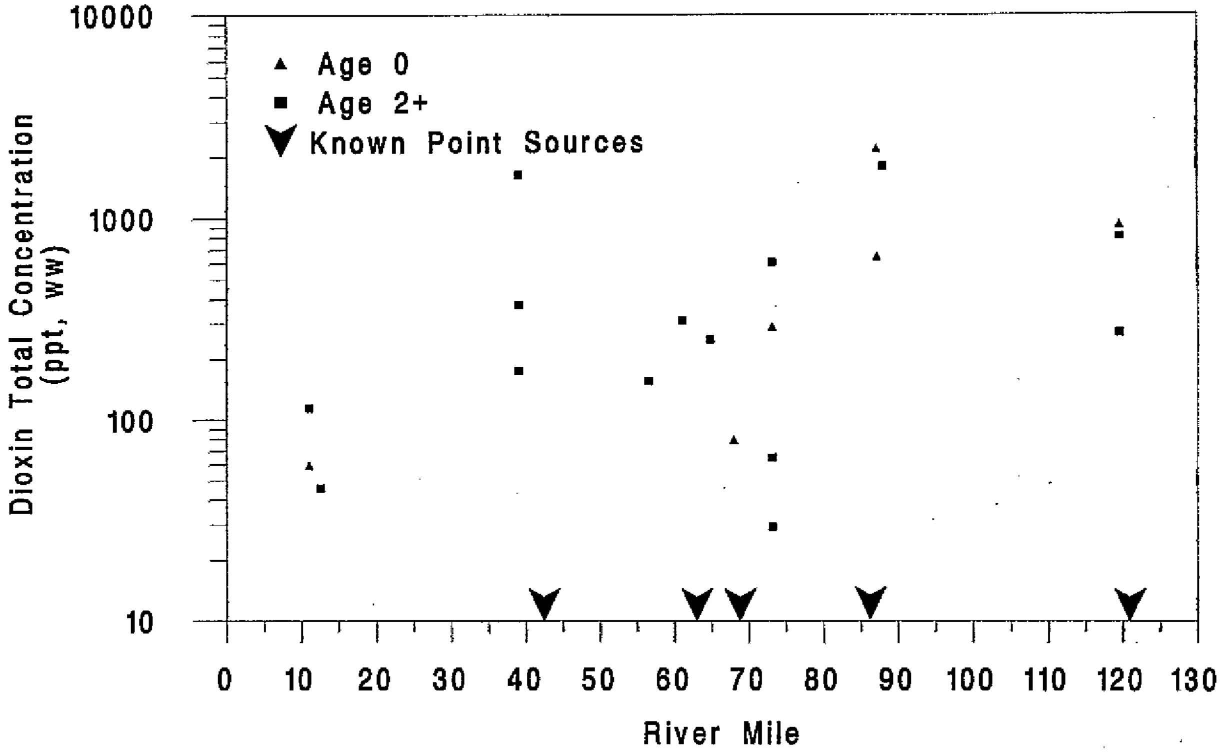


Figure 20. Relationship between River Mile and H6CDF total concentrations in livers of river otter (age class 0, 1, 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.



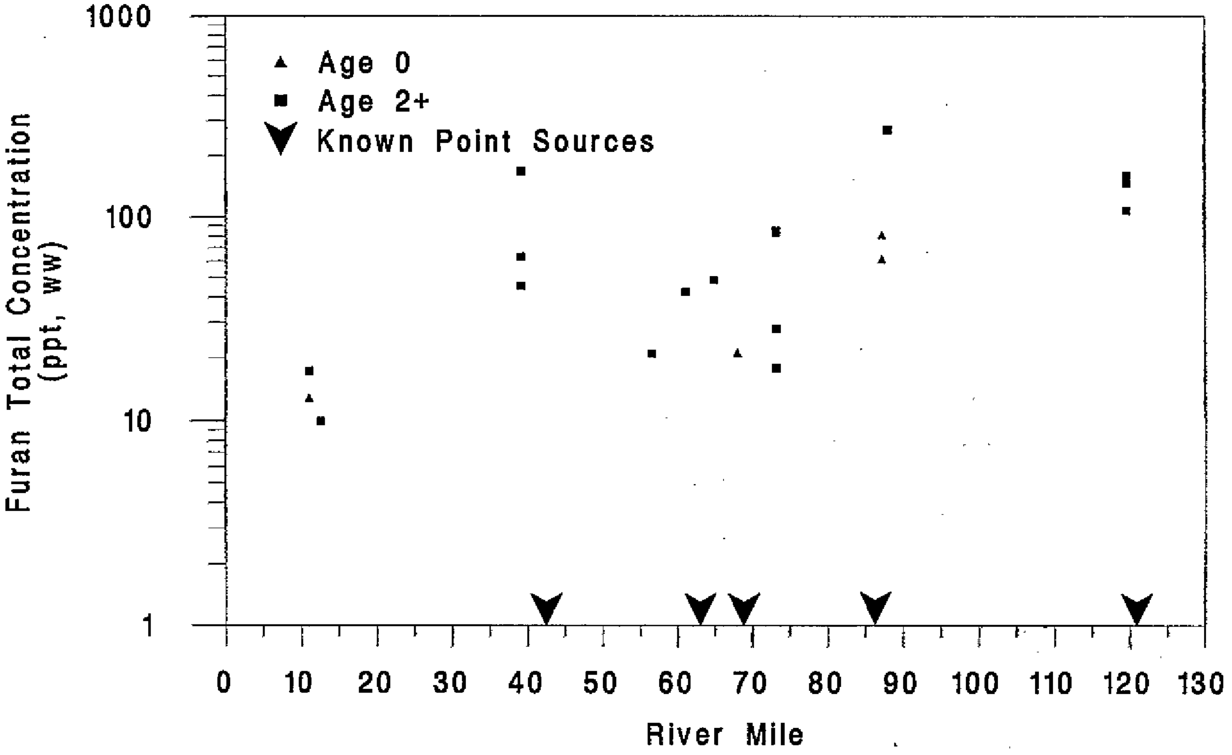


Figure 21. Relationship between River Mile, known point sources, and dioxin total and furan total concentrations in livers of river otter (age class 0 and 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.

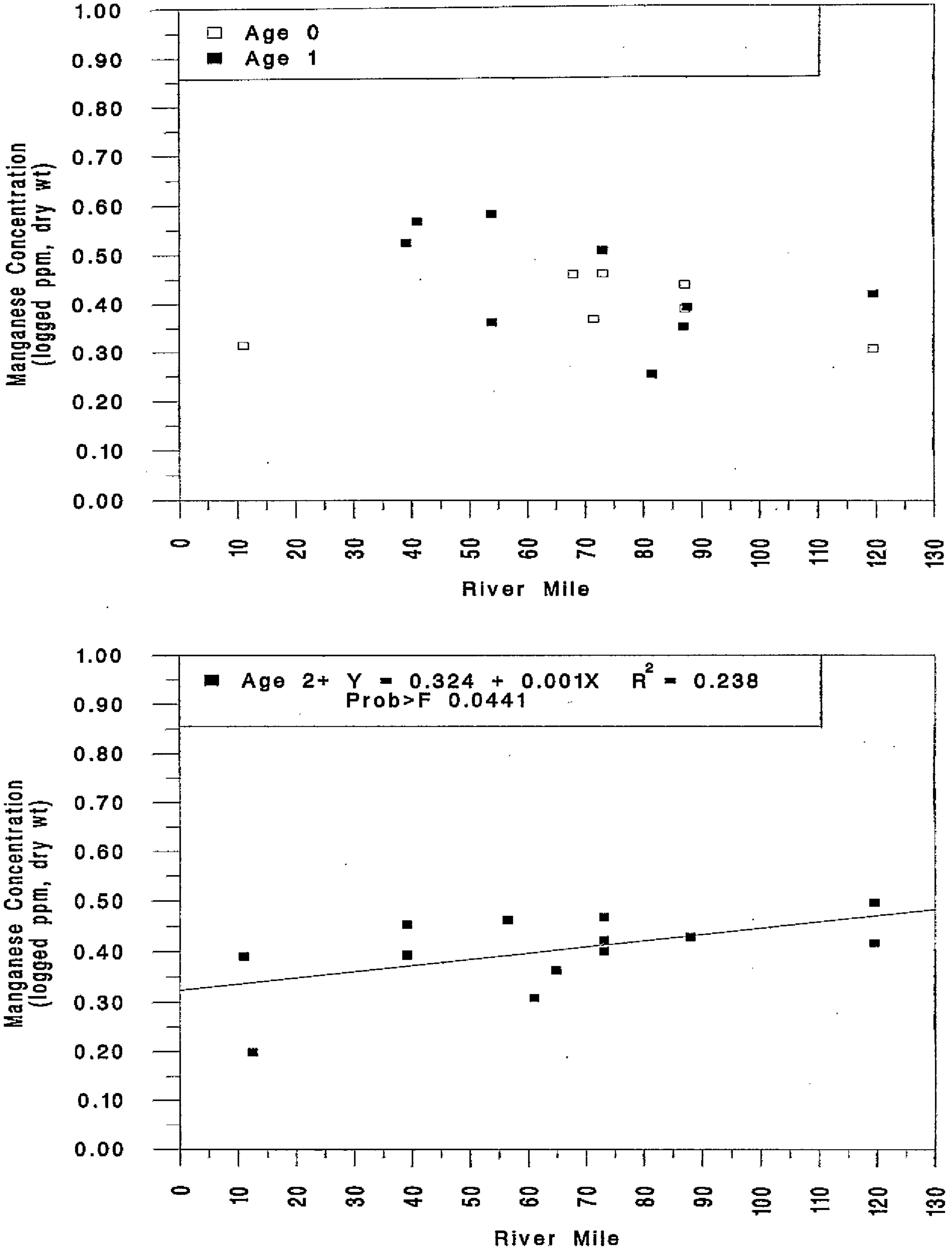


Figure 22. Relationship between River Mile and manganese concentrations in kidneys of river otter (age class 0, 1, 2+) from the Lower Columbia River. No line is plotted when the relationship is not significant.

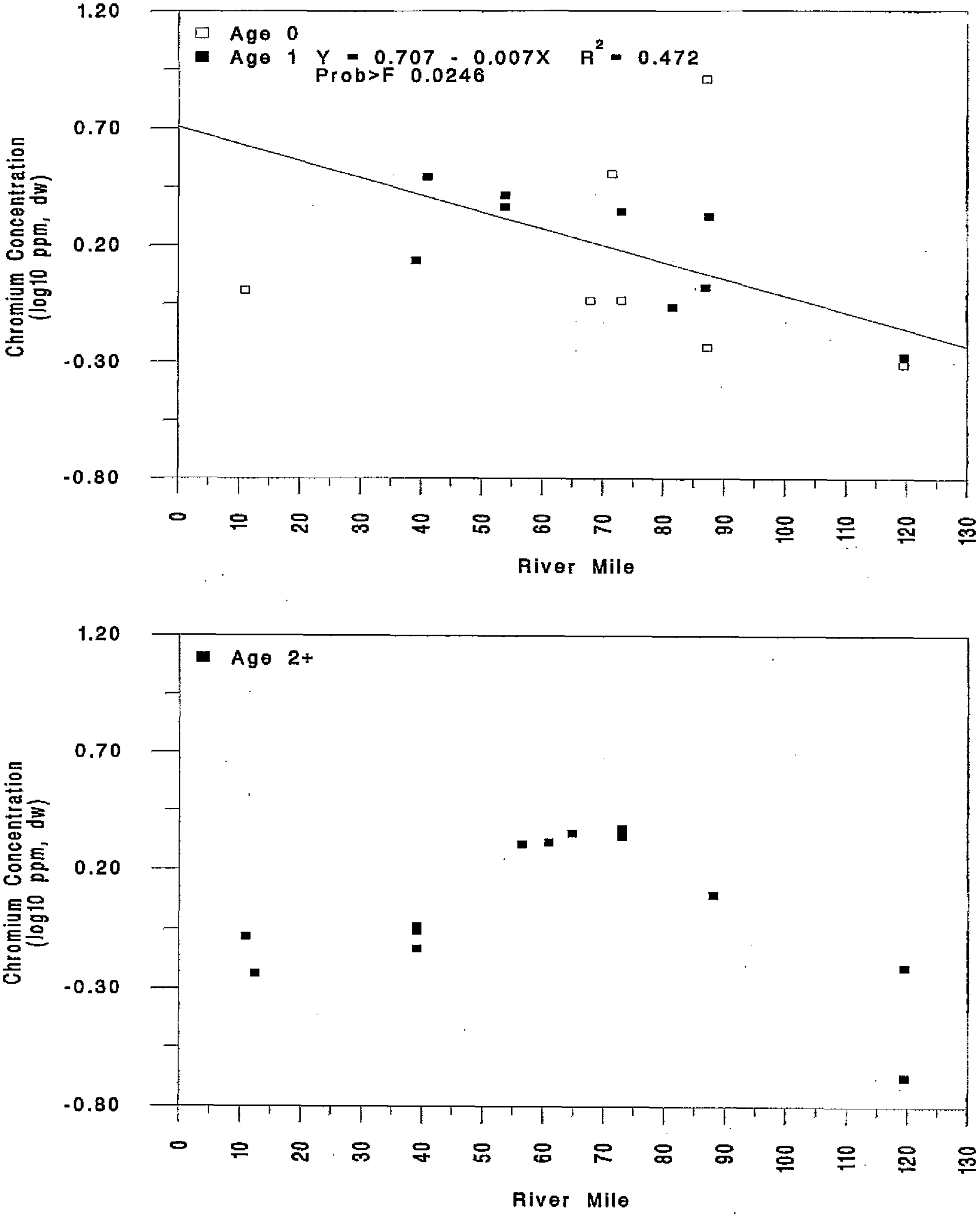


Figure 23. Relationship between River Mile and chromium concentrations in kidneys of river otter (age class 0, 1, 2+) from the Lower Columbia River. No line was plotted when the relationship was not significant.

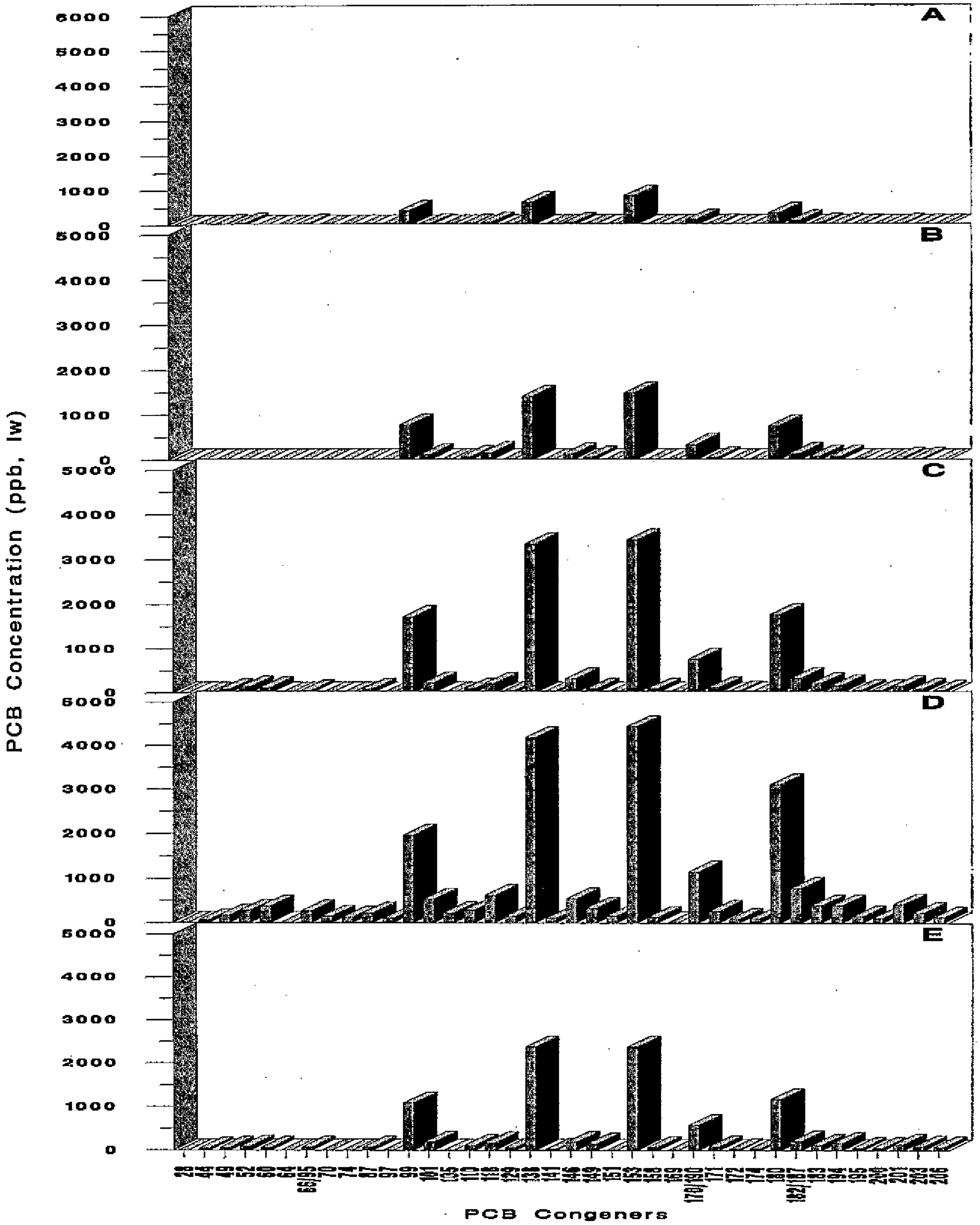


Figure 24. Congener specific PCB concentrations (ppb, lw) in river otter scat collected from the Lower Columbia River (A=River Mile 27; B=River Mile 28-33; C=River Mile 63-69; D=River Mile 87-108; E=River Mile 134).

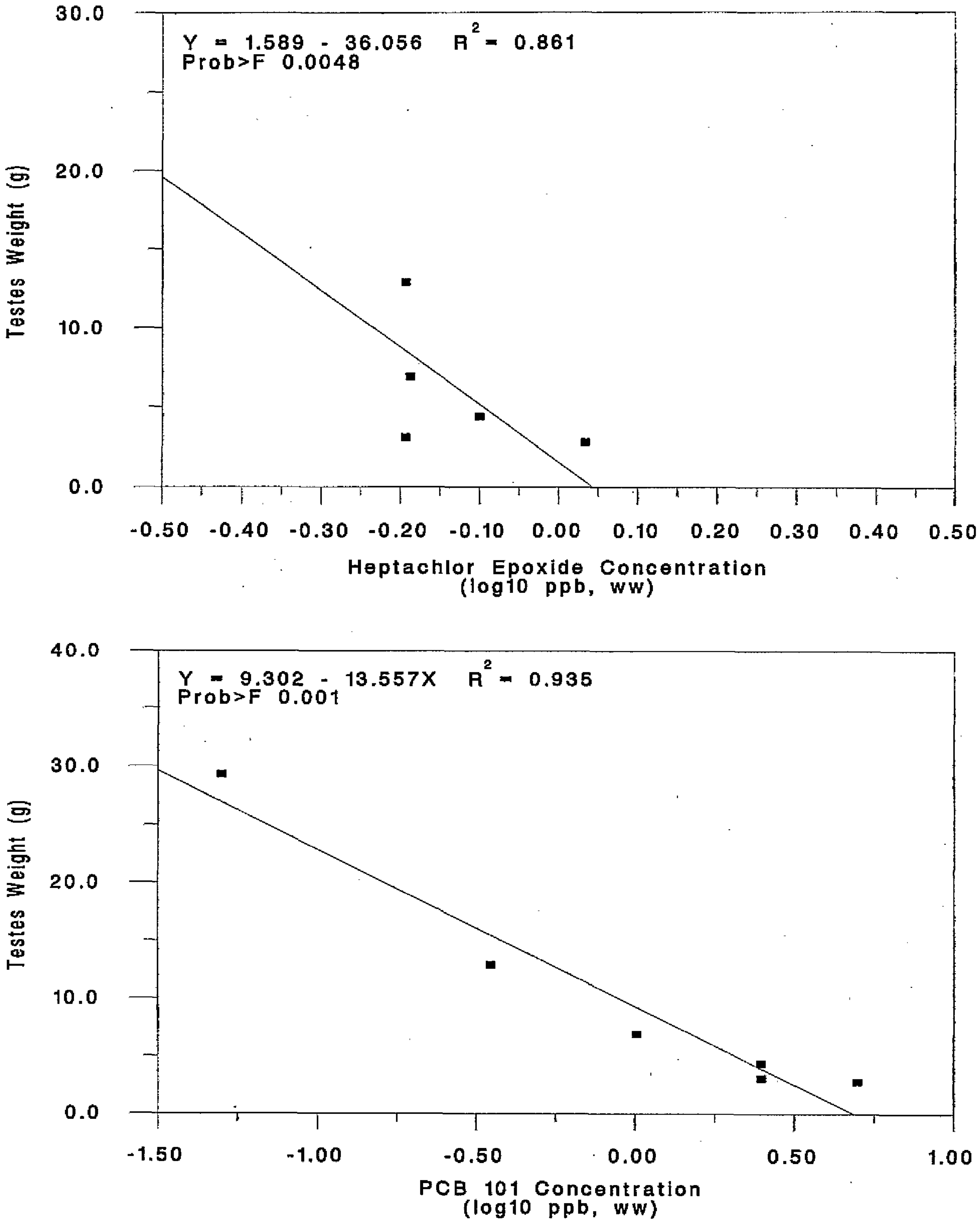


Figure 25. Relationship between testes weight and heptachlor epoxide (top) or PCB 101 (bottom) concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.

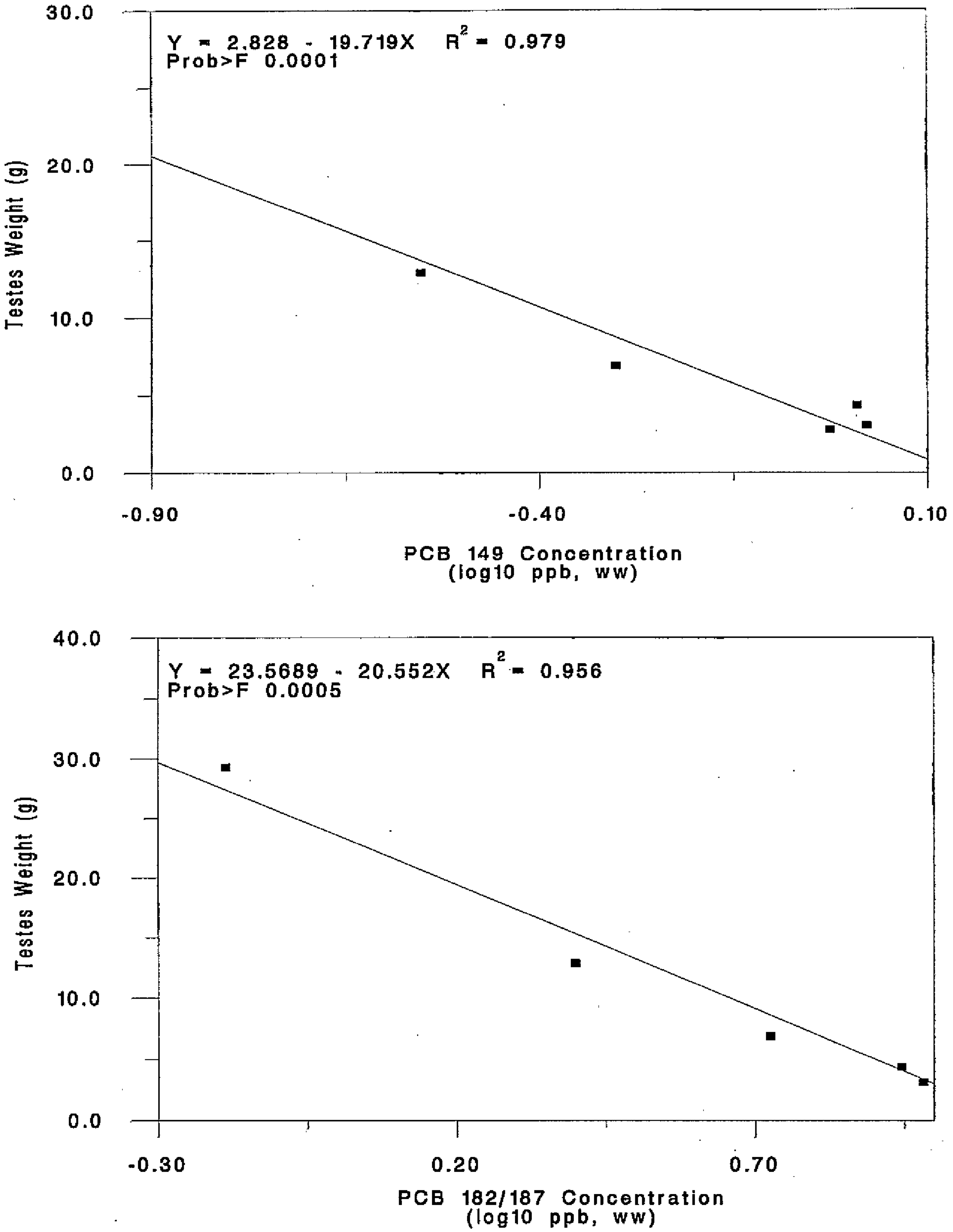


Figure 26. Relationship between testes weight and PCB 149 (top) or PCB 182/187 (bottom) concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.

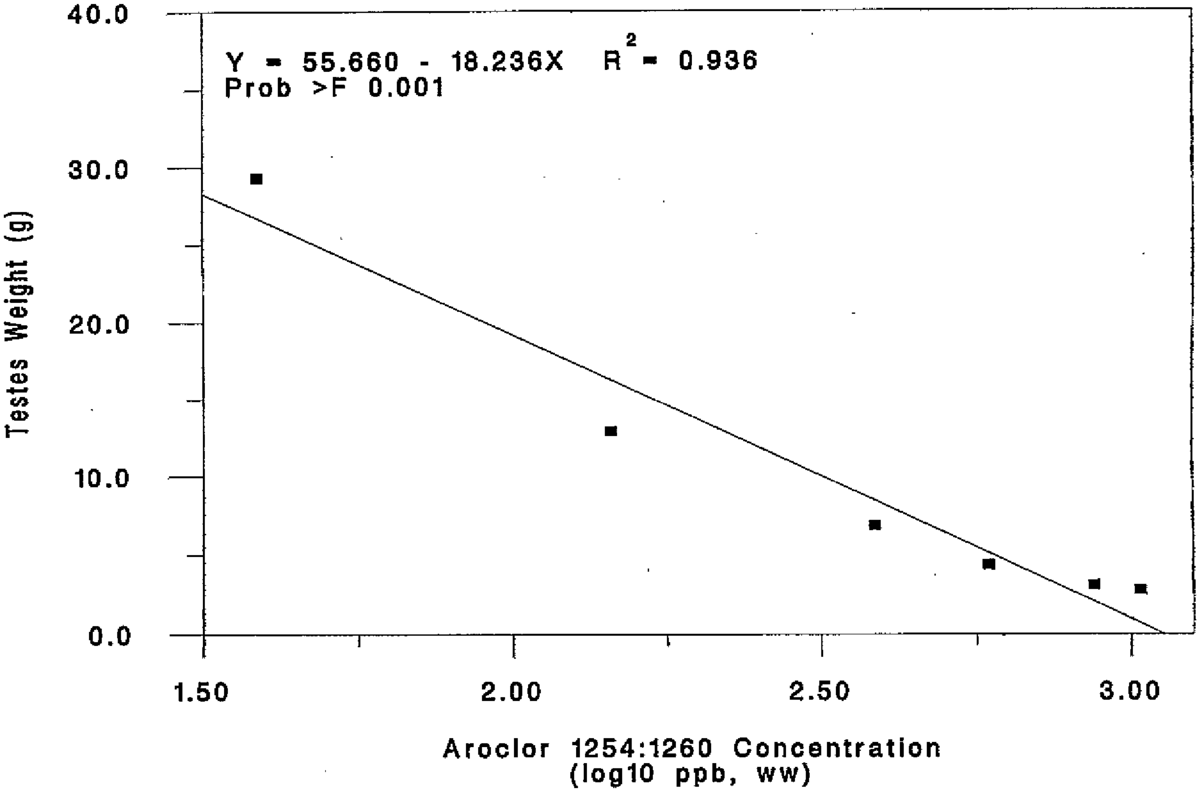


Figure 27. Relationship between testes weight and Aroclor 1254:1260 concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.

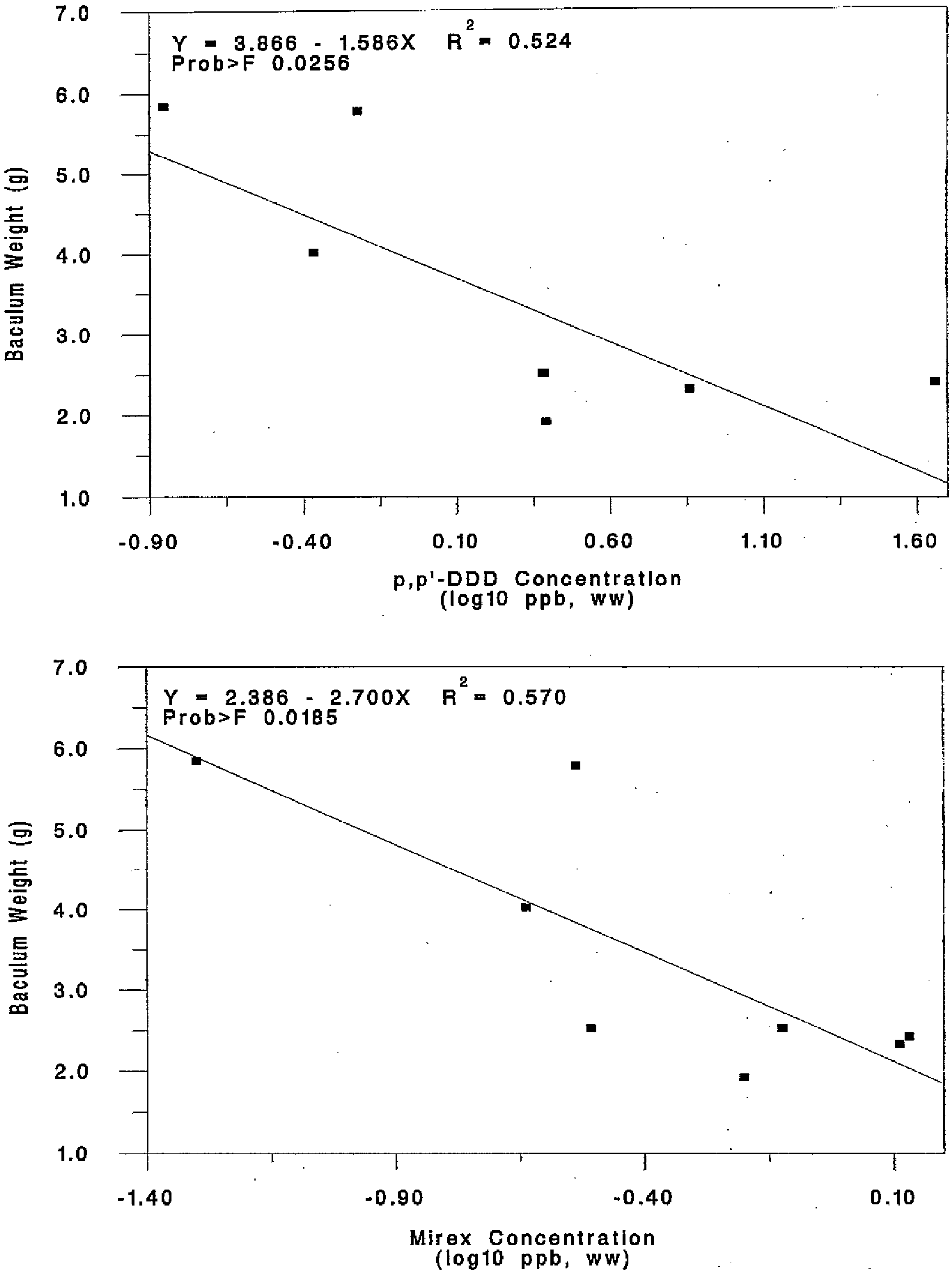
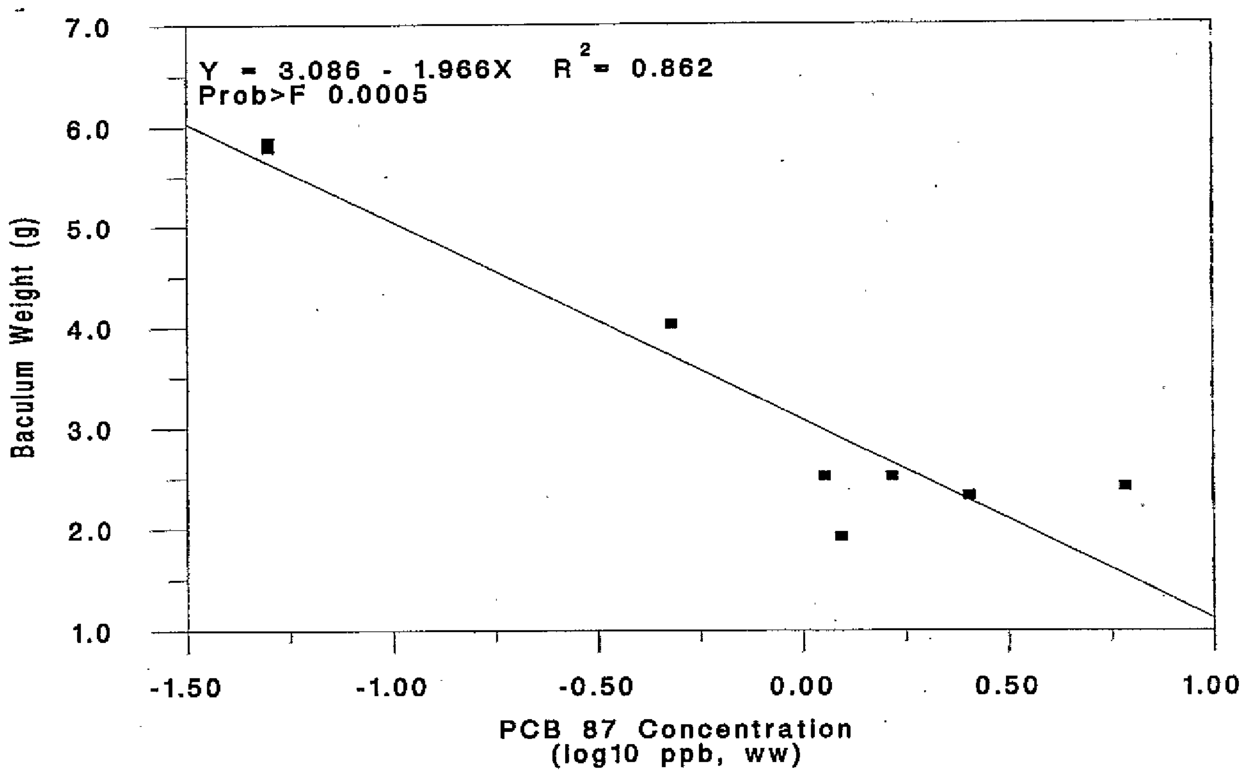


Figure 28. Relationship between baculum weight and p,p'-DDD (top) or mirex (bottom) concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.



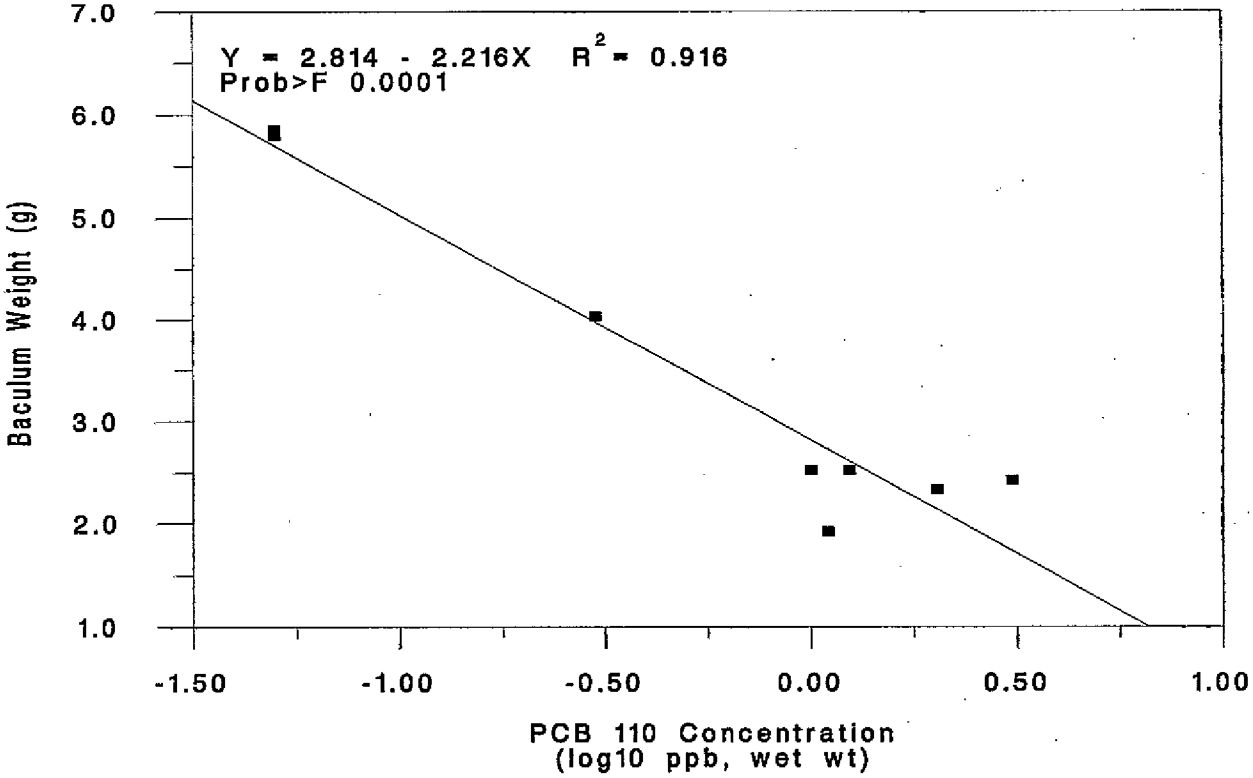
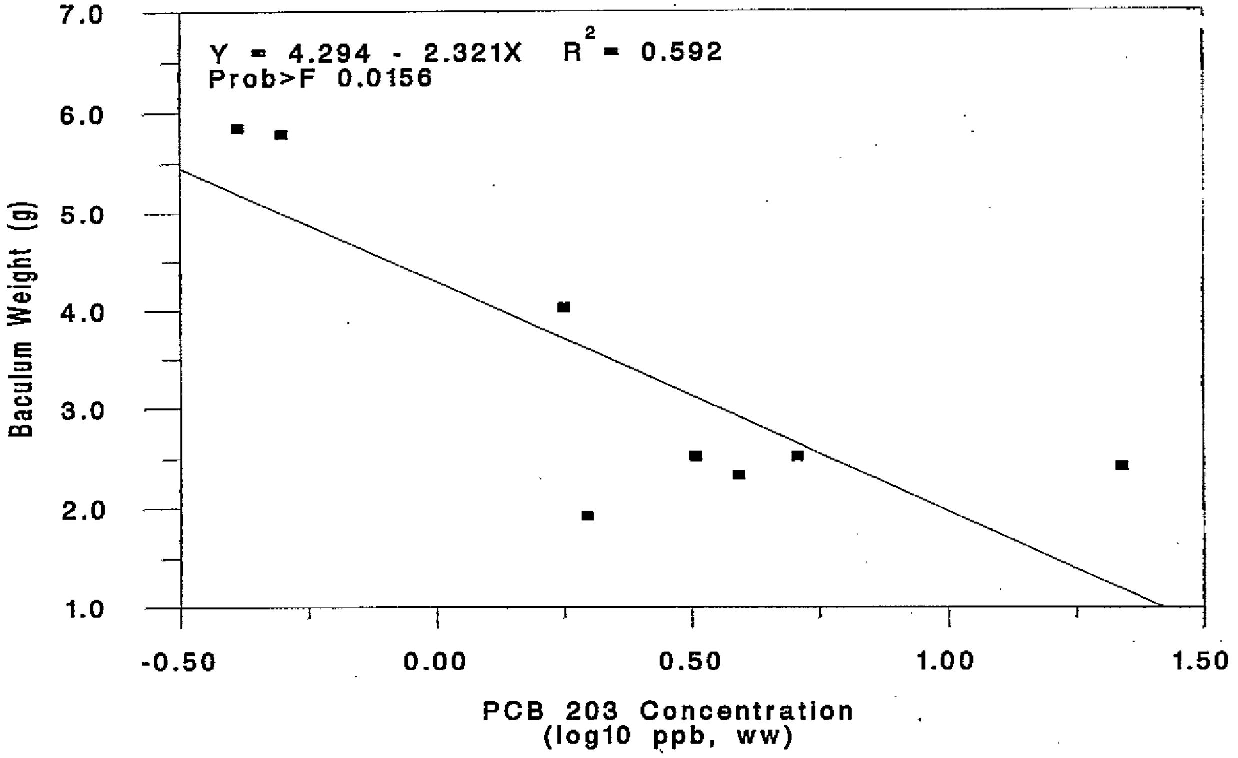


Figure 29. Relationship between baculum weight and PCB 87 (top) or PCB 110 (bottom) concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.



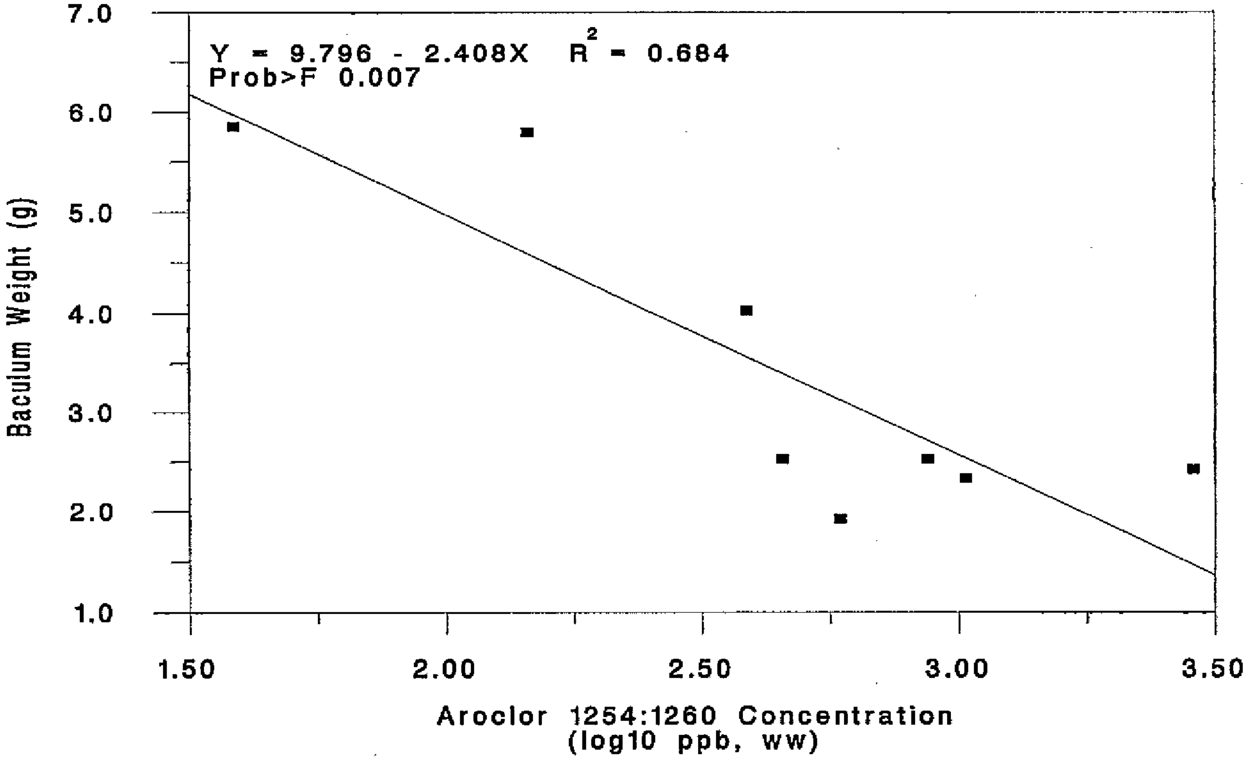
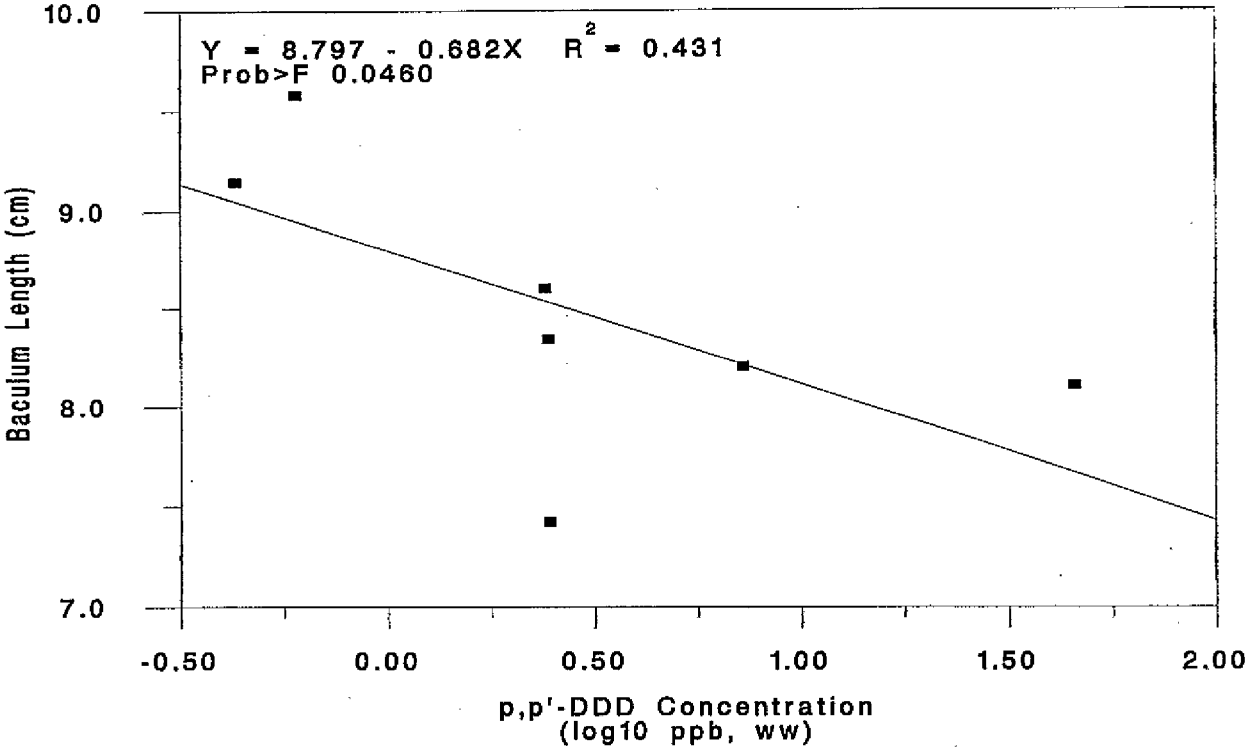


Figure 30. Relationship between baculum weight and PCB 203 (top) or Aroclor 1254:1260 (bottom) concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.



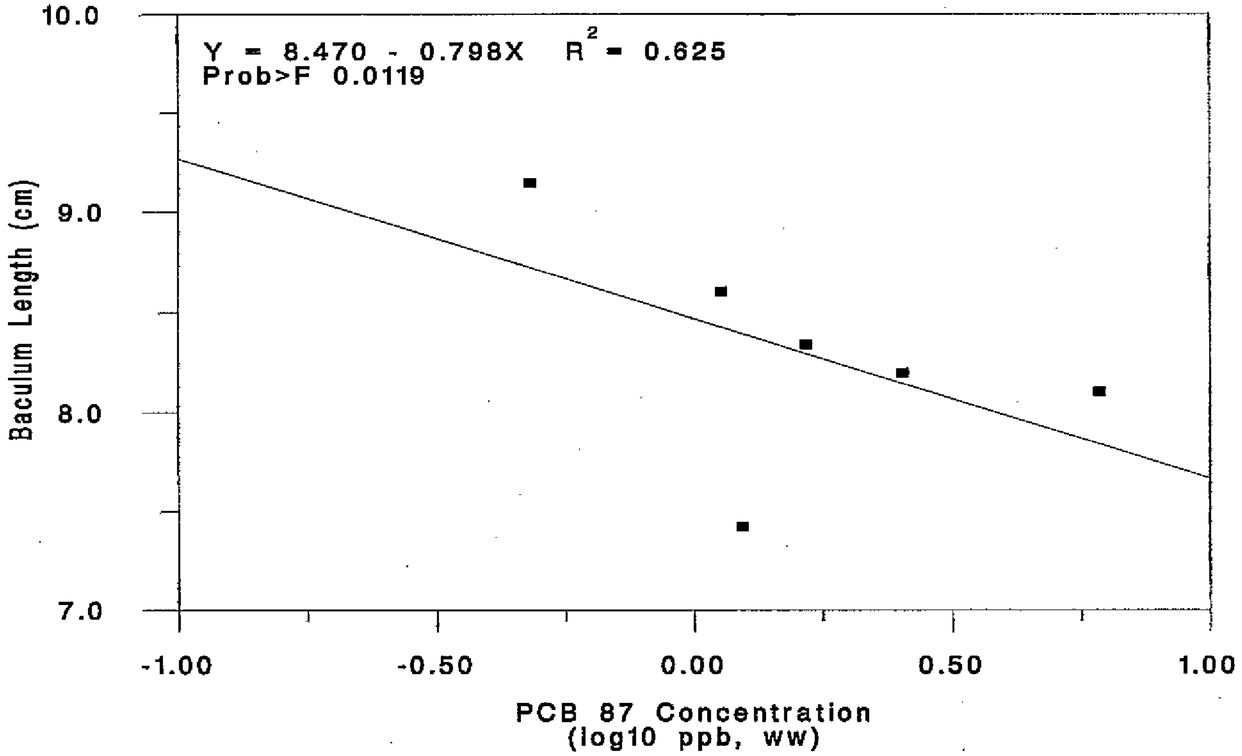
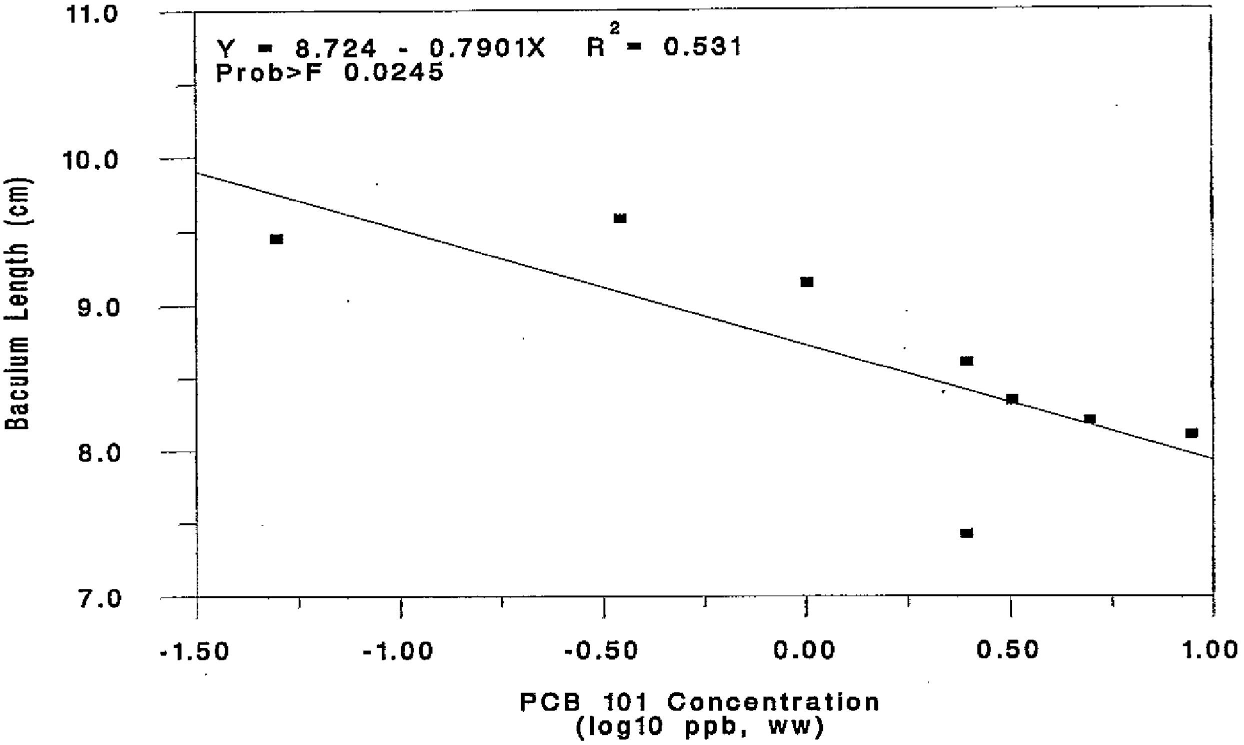


Figure 31. Relationship between baculum length and p,p'-DDD (top) or PCB 87 (bottom) concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.



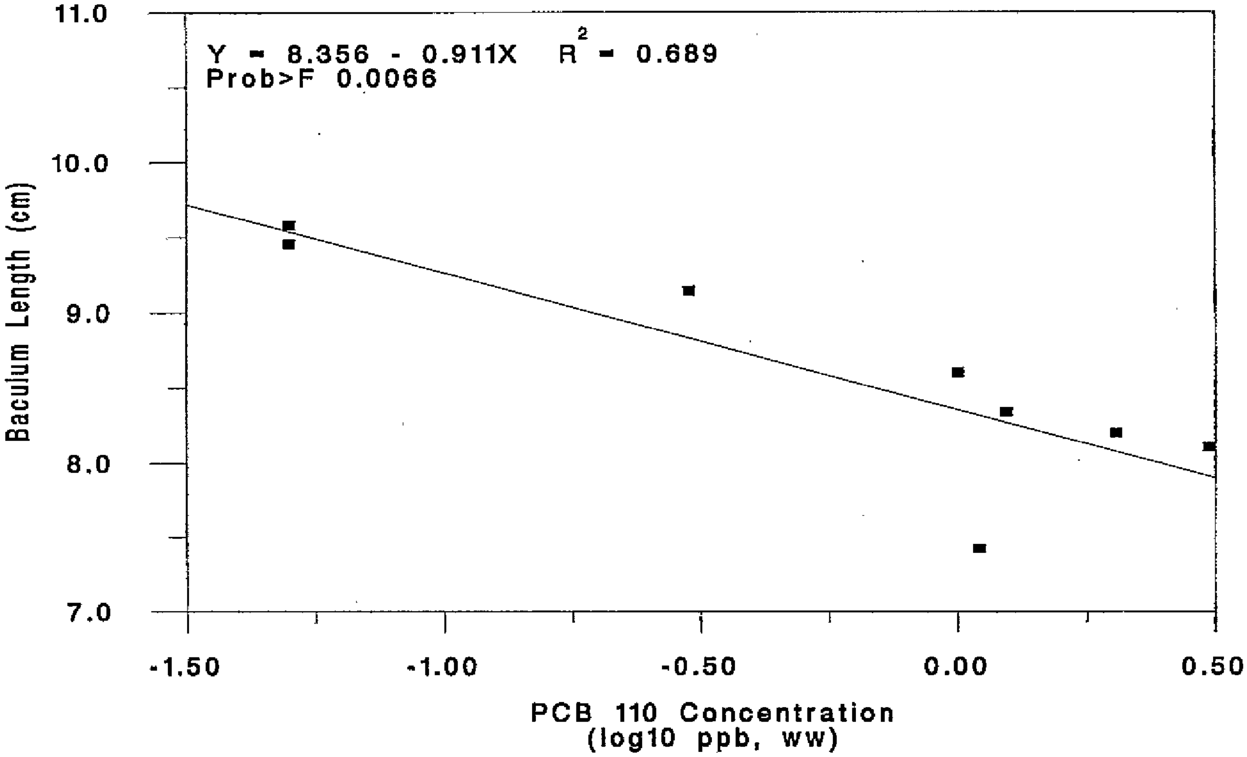


Figure 32. Relationship between baculum length and PCB 101 (top) or PCB 110 (bottom) concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.

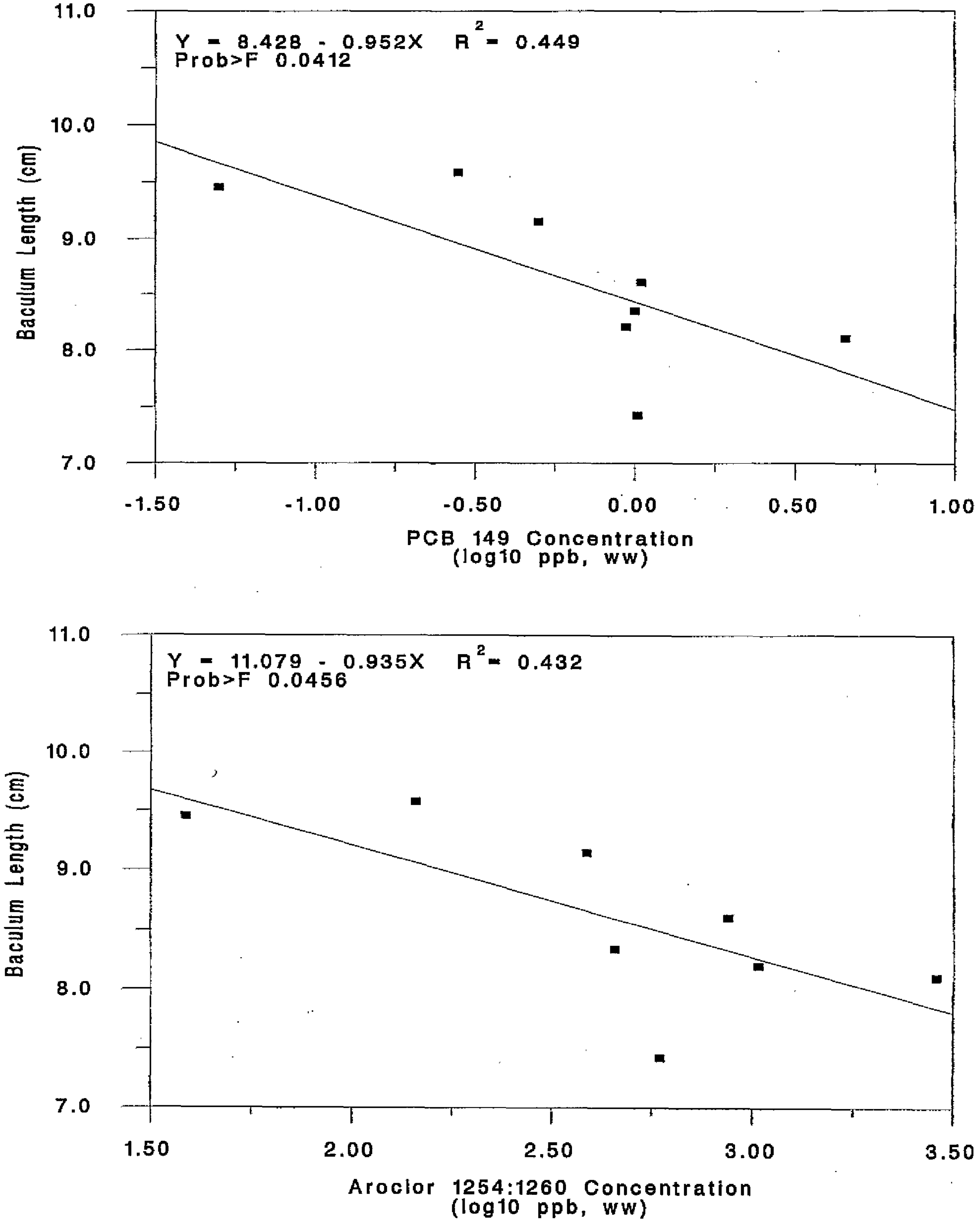


Figure 33. Relationship between baculum length and PCB 149 (top) or Aroclor 1254:1260 (bottom) concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.

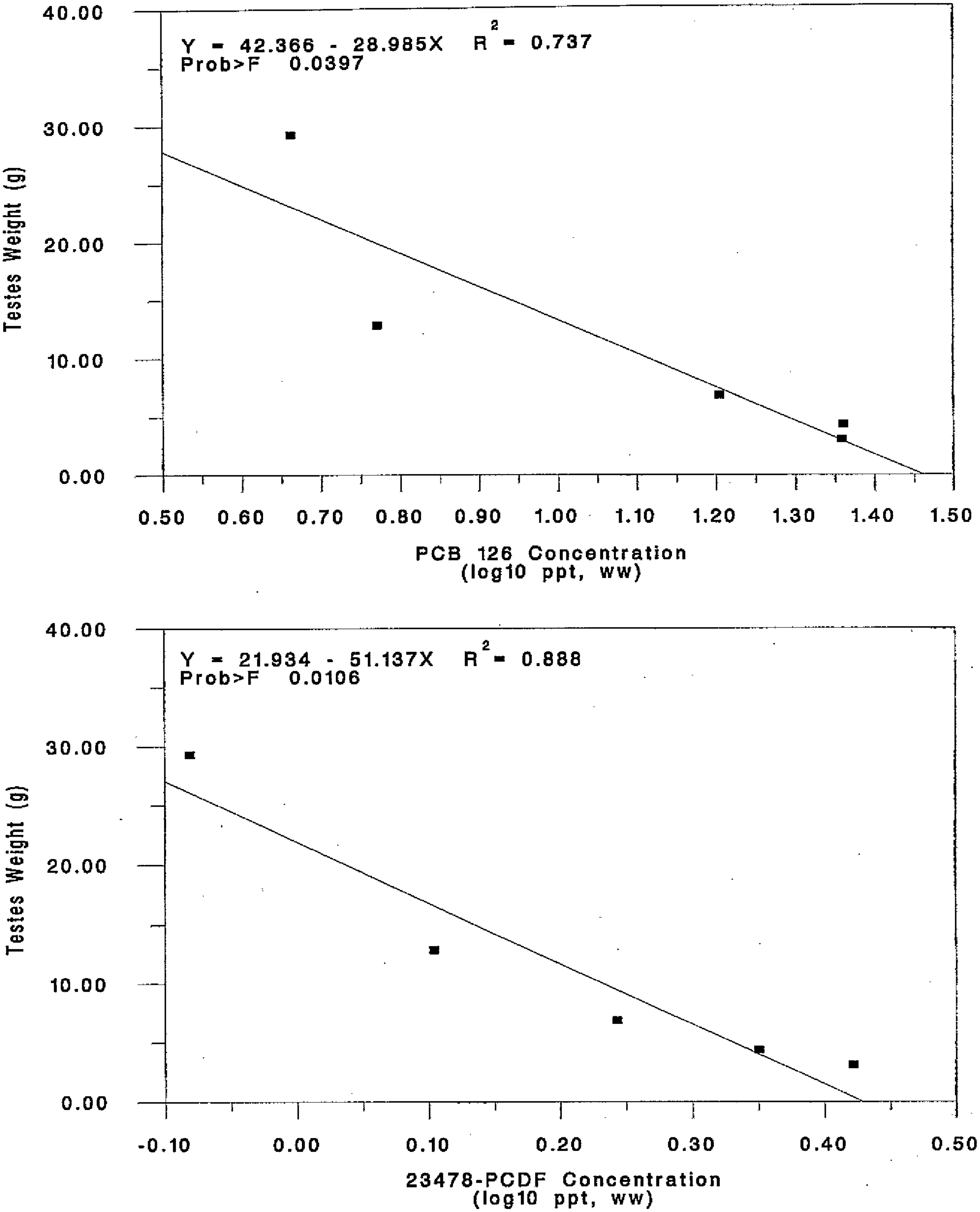


Figure 34. Relationship between testes weight and PCB 126 (top) or 23478-PCDF (bottom) concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.

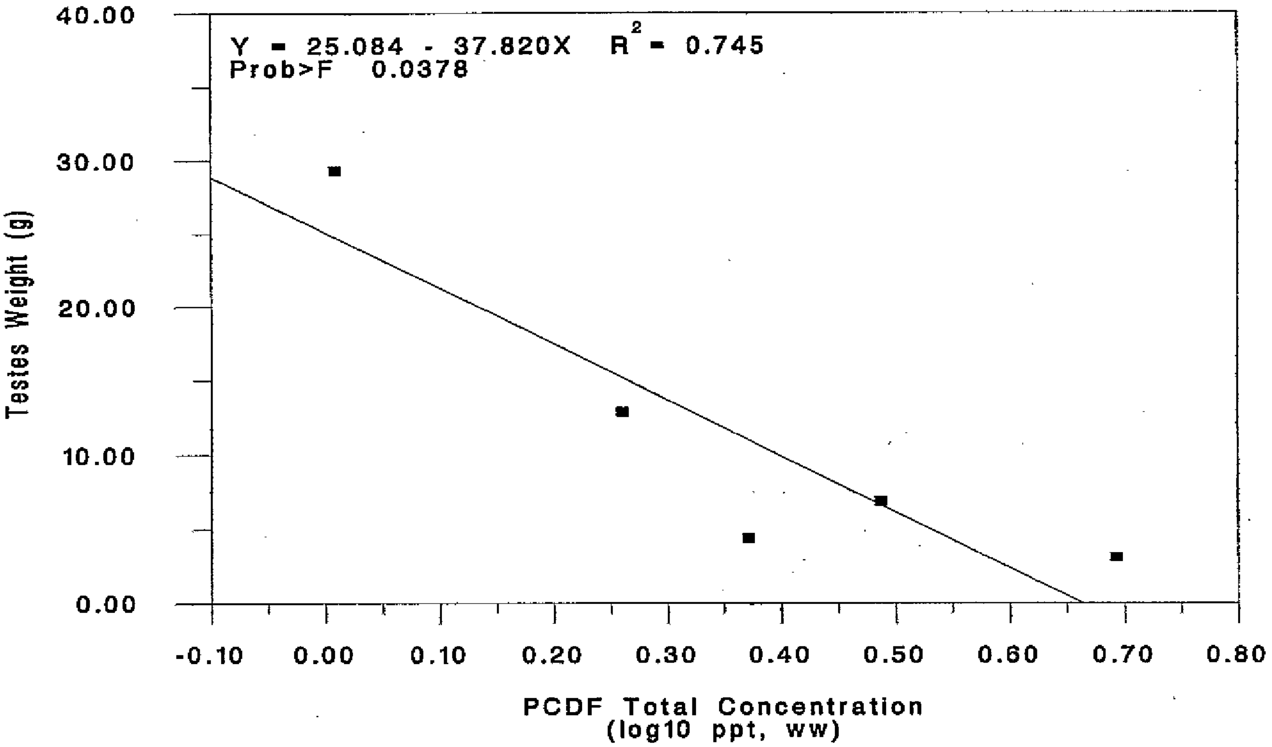
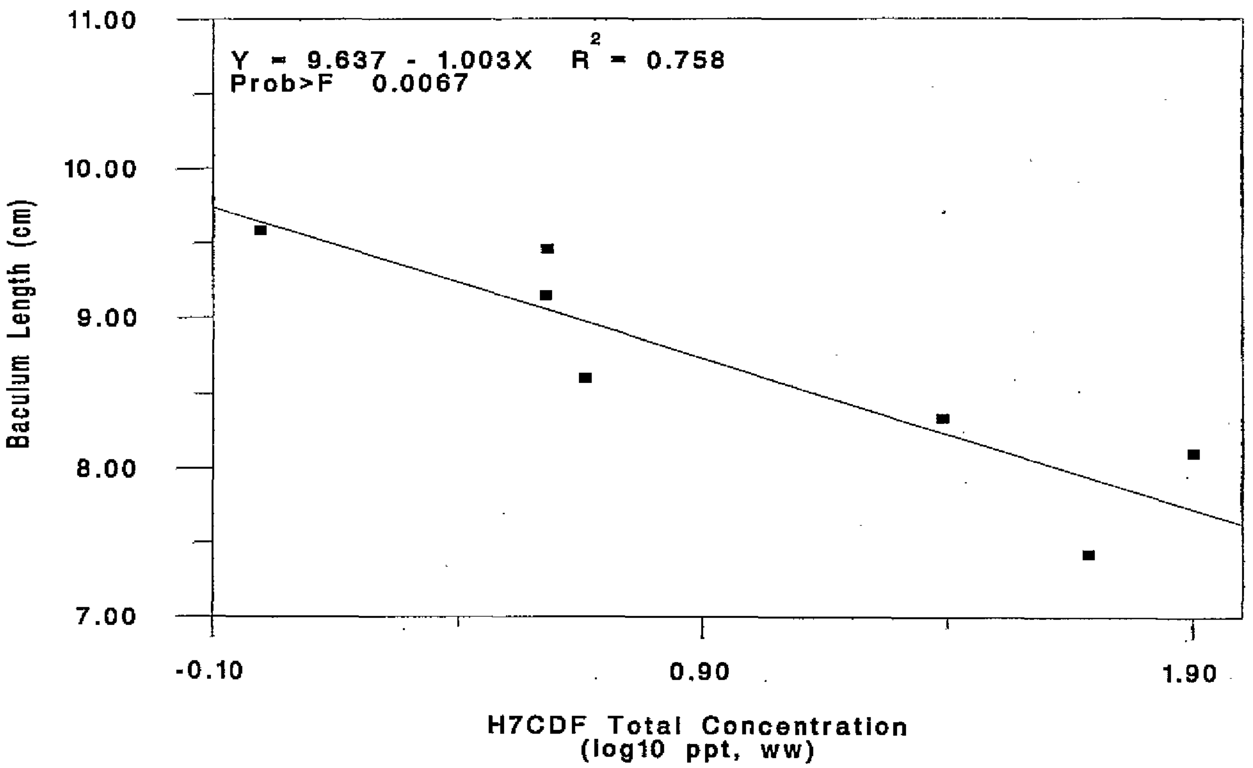


Figure 35. Relationship between testes weight and PCDF total concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.



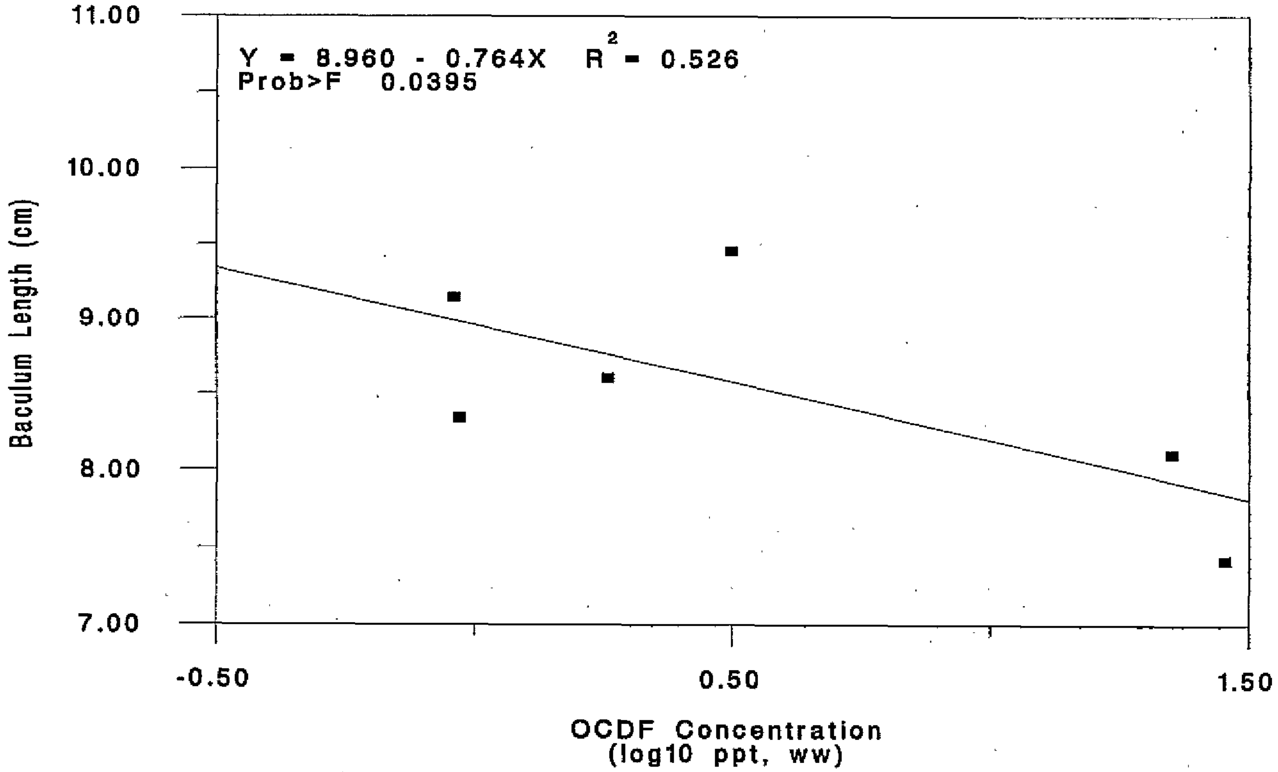


Figure 36. Relationship between baculum length and H7CDF total (top) or OCDF (bottom) concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.

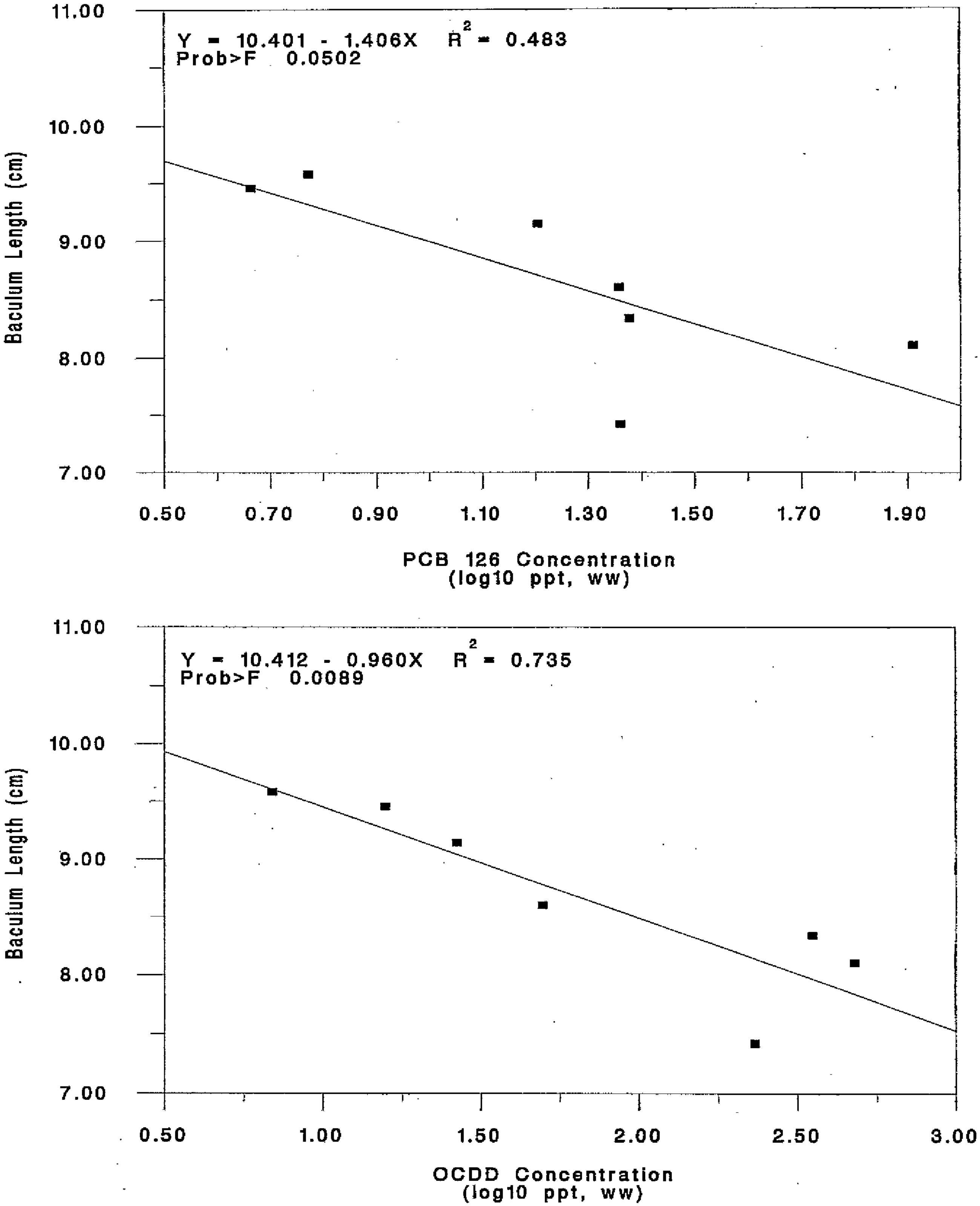


Figure 37. Relationship between baculum length and PCB 126 (top) or OCDD (bottom) concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.

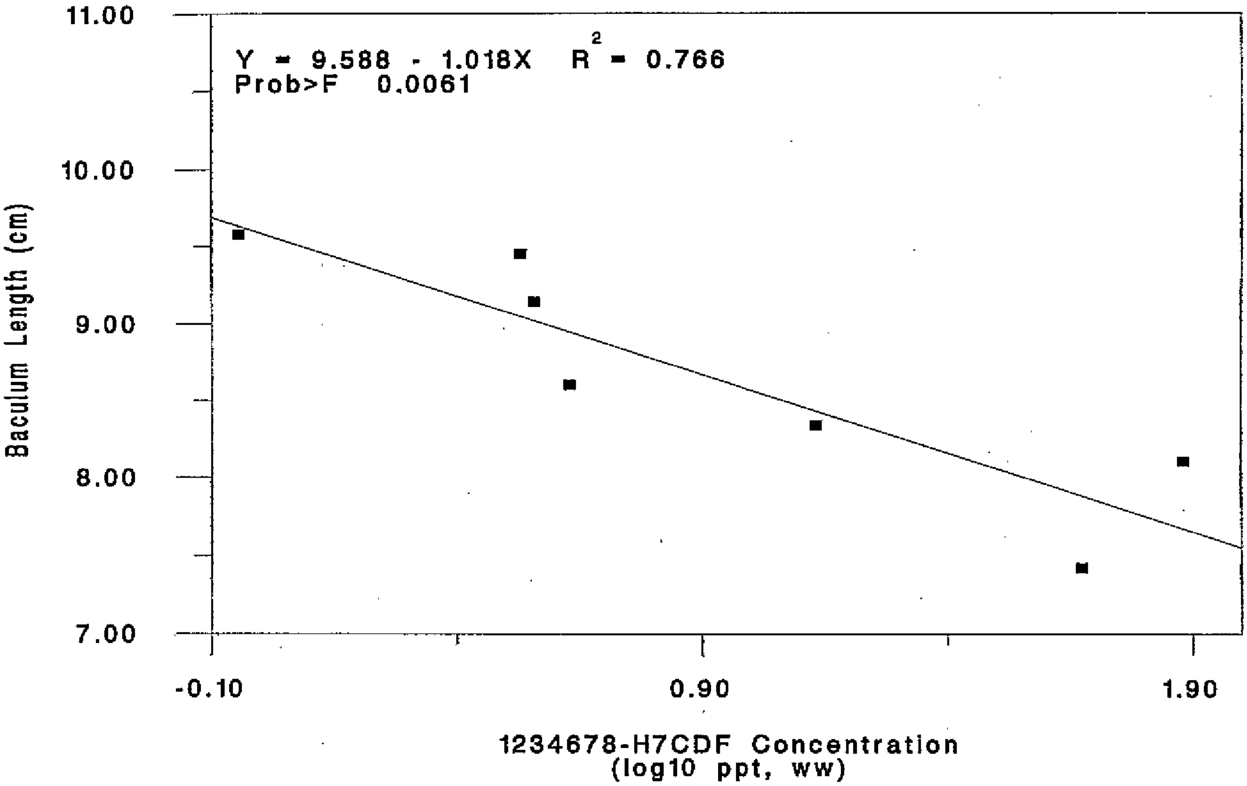


Figure 38. Relationship between baculum length and 1234678-H7CDF concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.

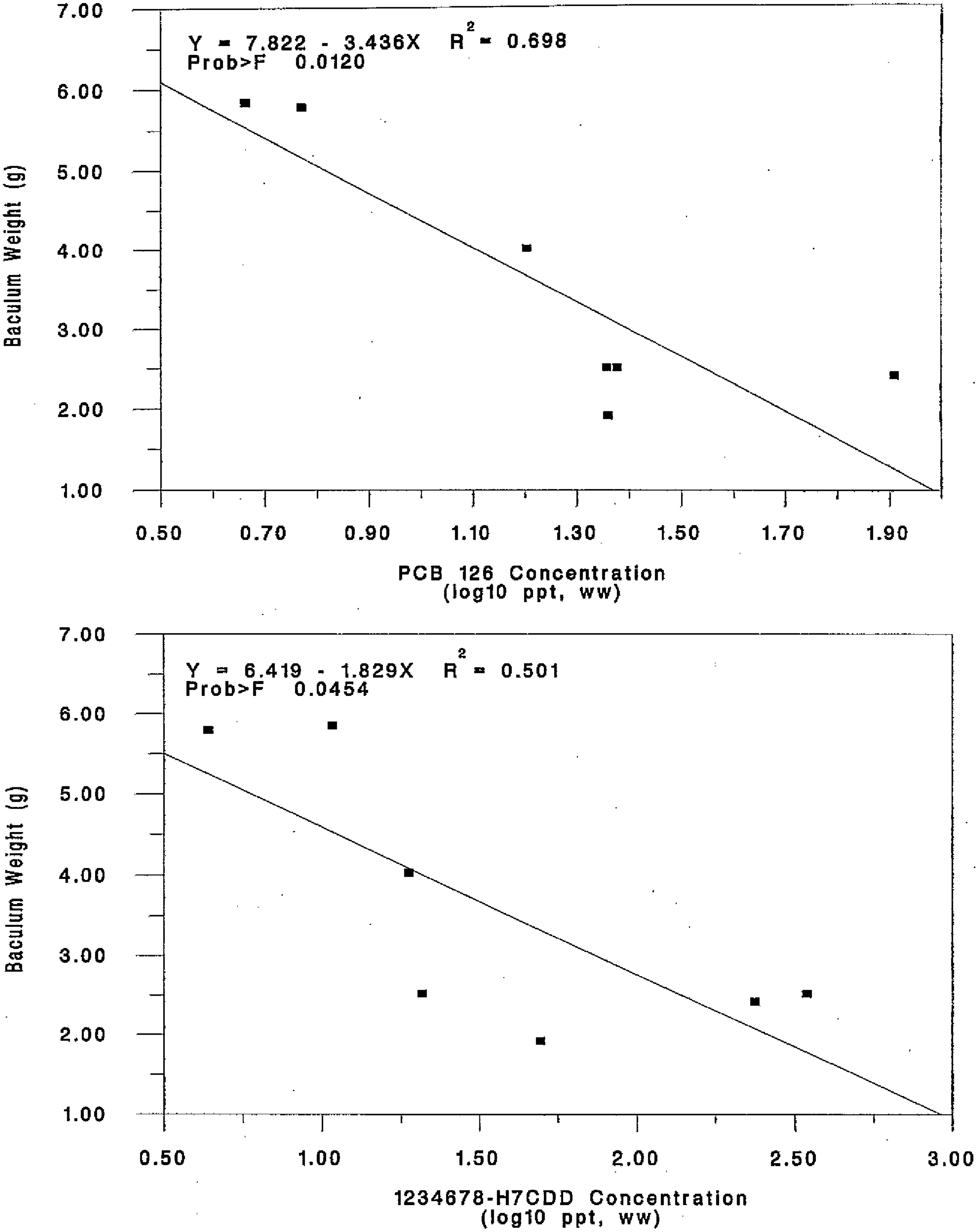
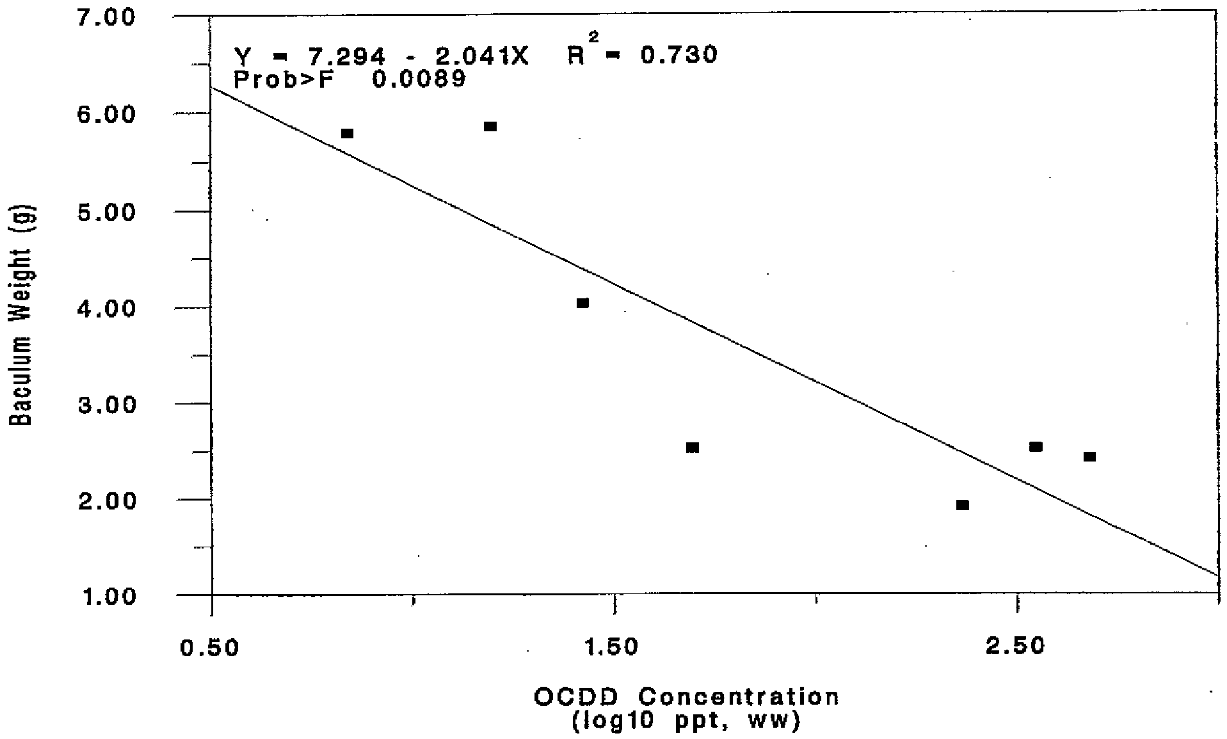


Figure 39. Relationship between baculum weight and PCB 126 (top) or 1234678-H7CDD (bottom) concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.



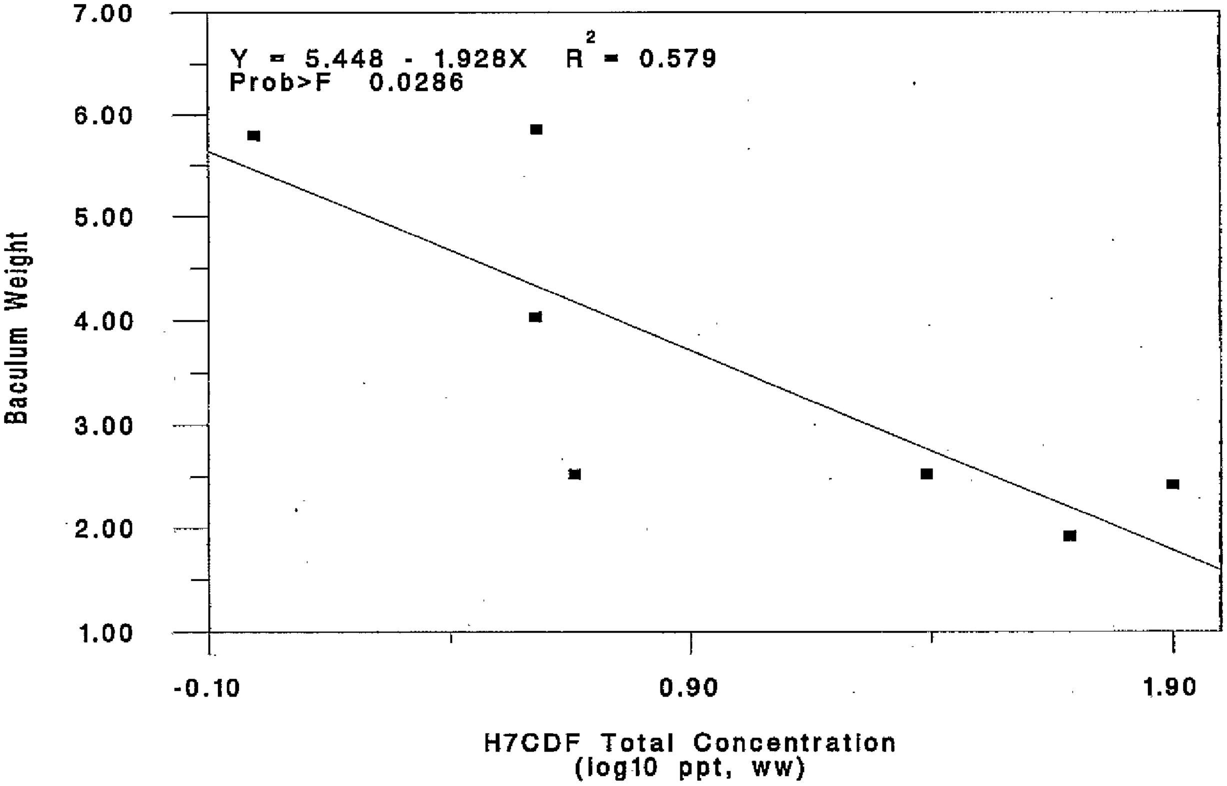


Figure 40. Relationship between baculum weight and OCDD (top) or H7CDF total (bottom) concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.

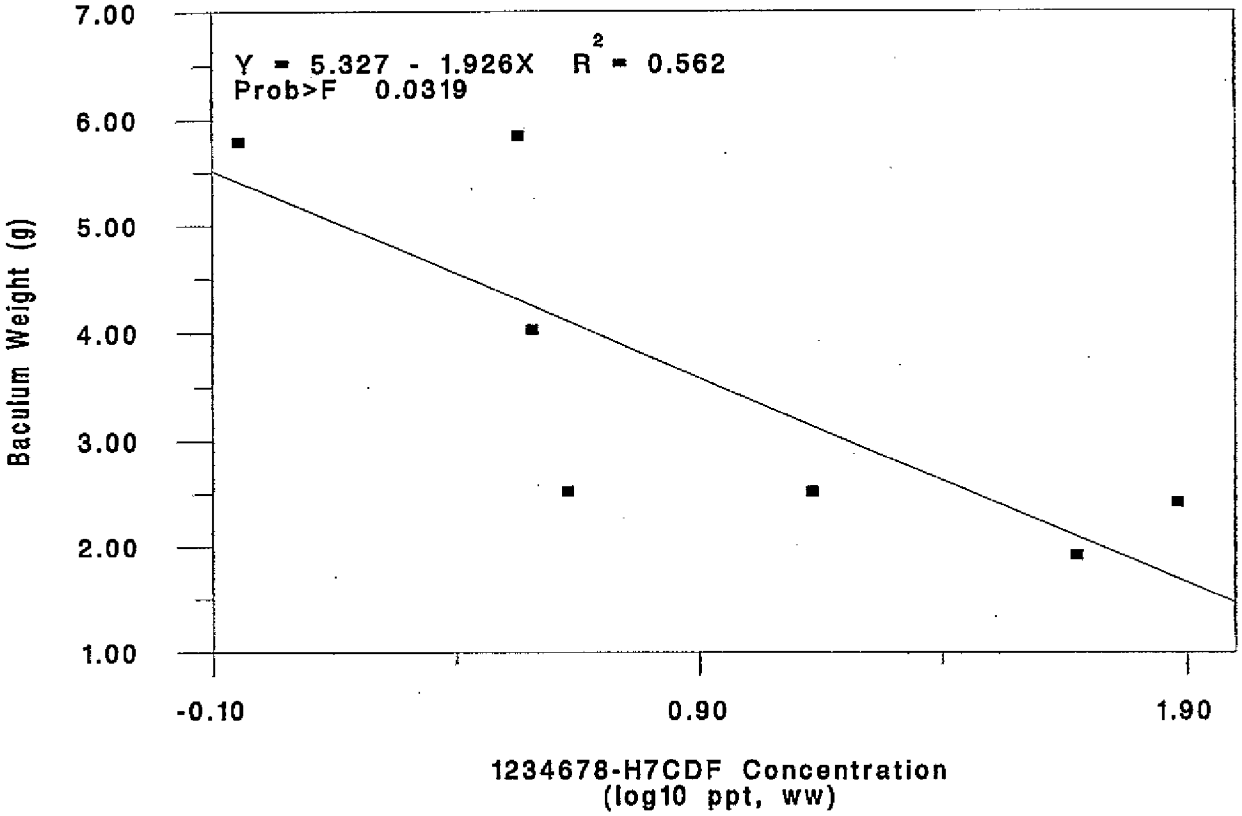
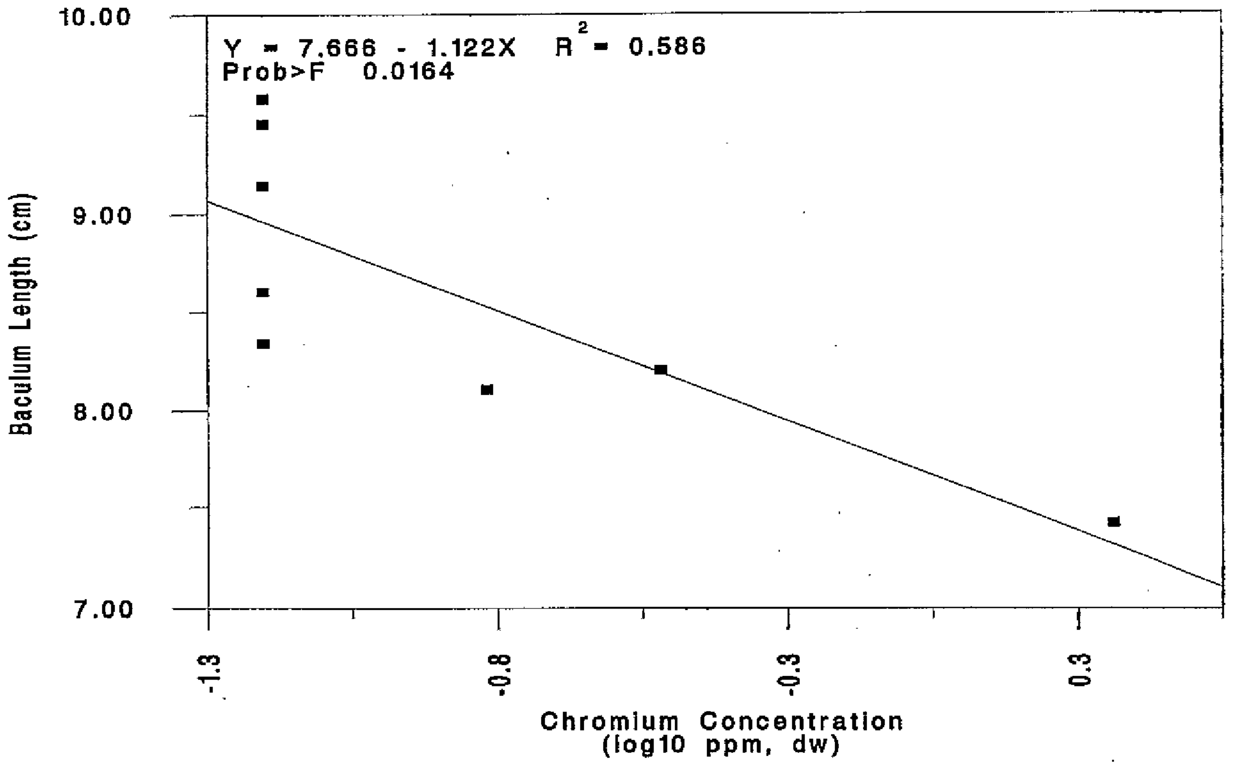


Figure 41. Relationship between baculum weight and 1234678-H7CDF concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.



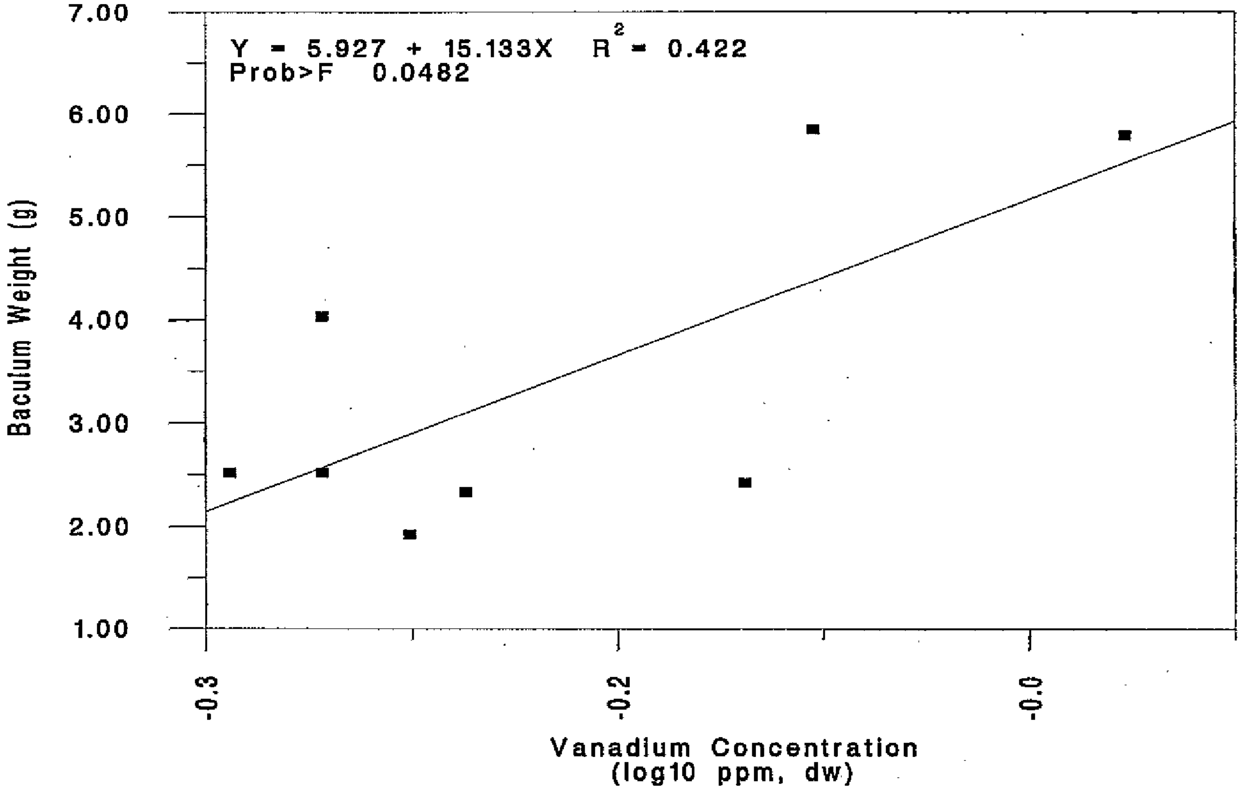


Figure 42. Relationship between baculum length and Chromium concentration in livers (top) or baculum weight and vanadium concentrations in kidneys (bottom) of age class 0 river otter from the Lower Columbia River and Reference Area

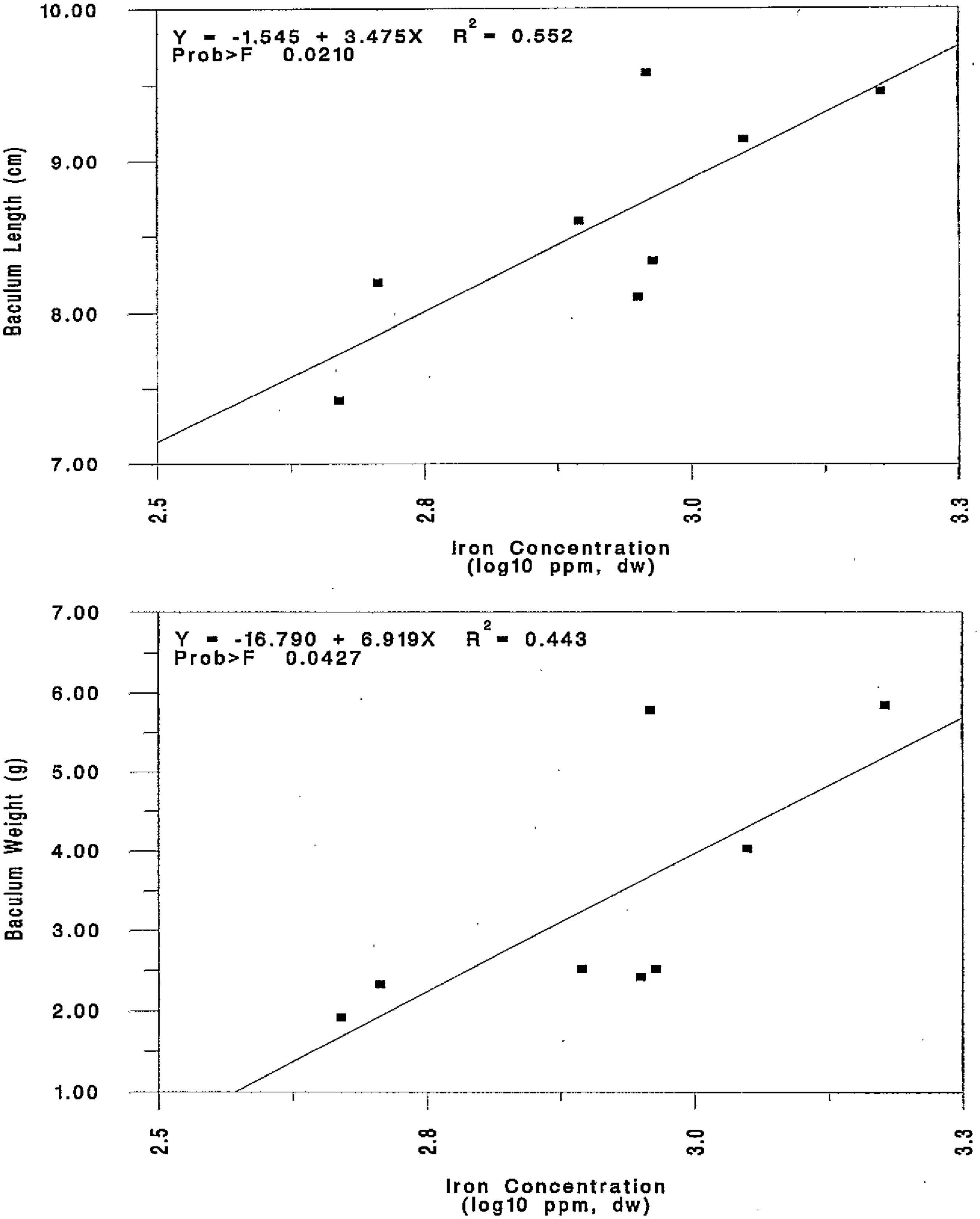


Figure 43. Relationship between baculum length (top) or baculum weight (bottom) and iron concentrations in livers of age class 0 river otter from the Lower Columbia River and Reference Area.

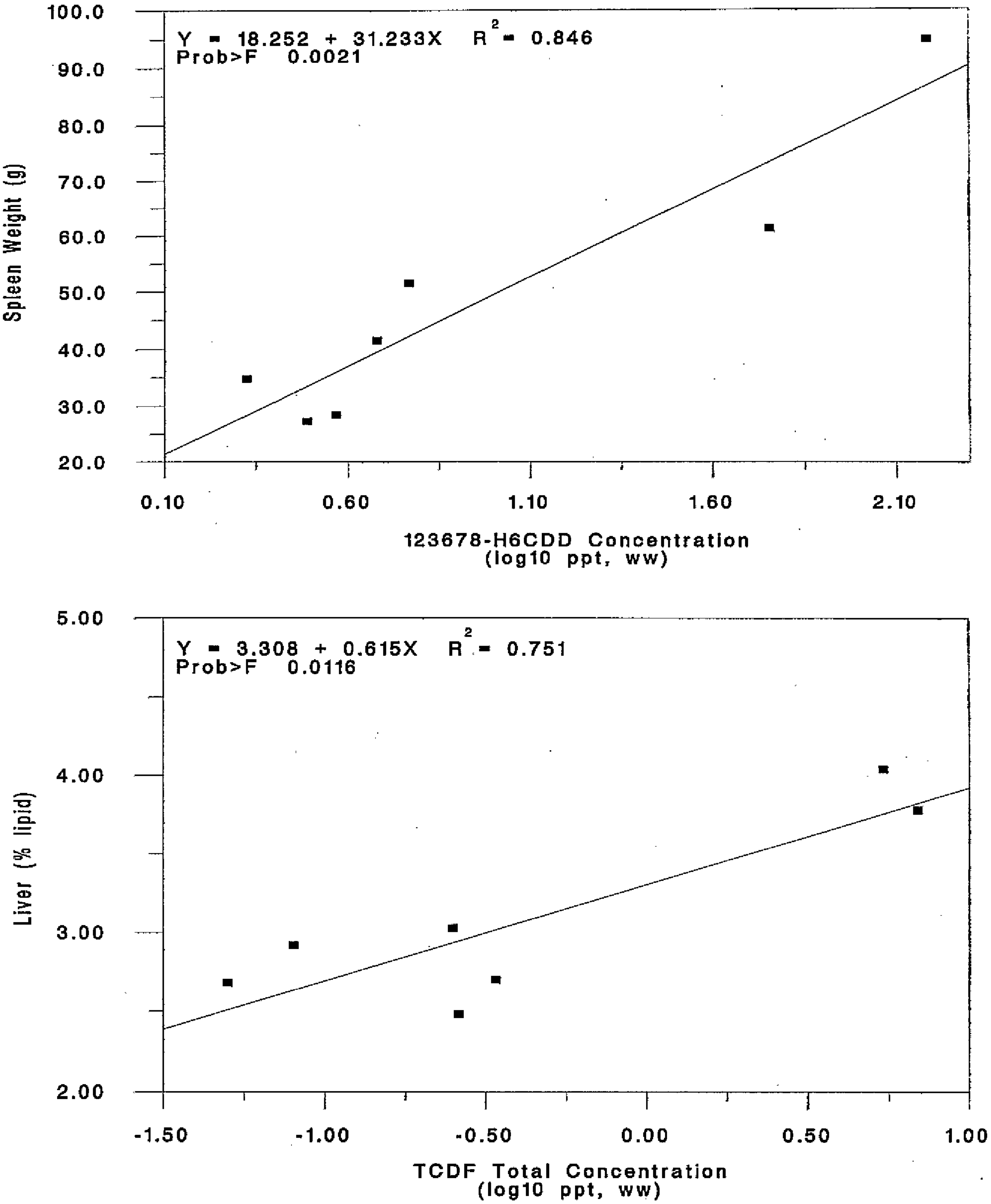


Figure 44. Relationship between spleen weight and 123678-H6CDD concentrations (top) or liver (% lipid) and TCDF total (bottom) of age class 0 river otter from the Lower Columbia River and Reference Area.

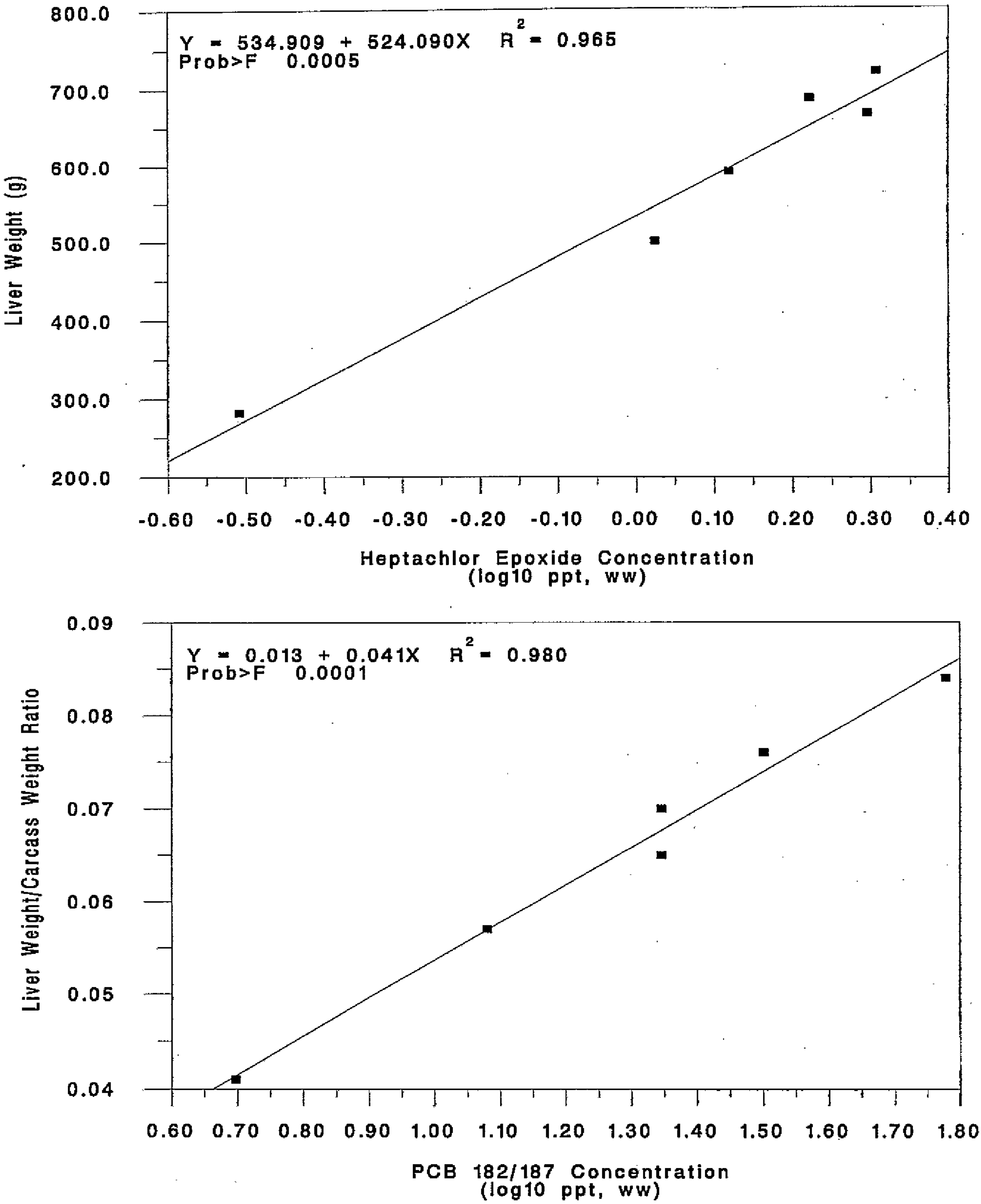
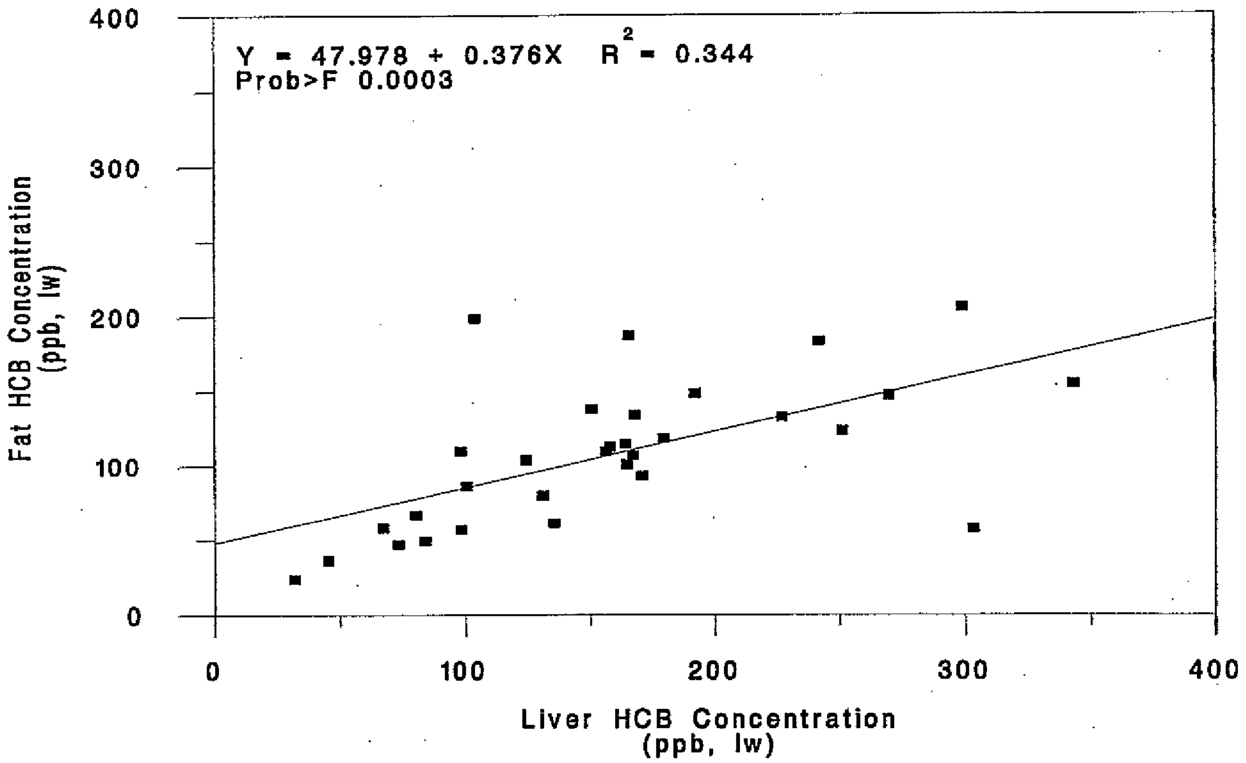


Figure 45. Relationship between liver weight and heptachlor epoxide concentrations (top) or liver weight/carcass weight ratio and PCB 182/187 concentrations (bottom) in livers of age class 1 river otter from the Lower Columbia River and Reference Area.



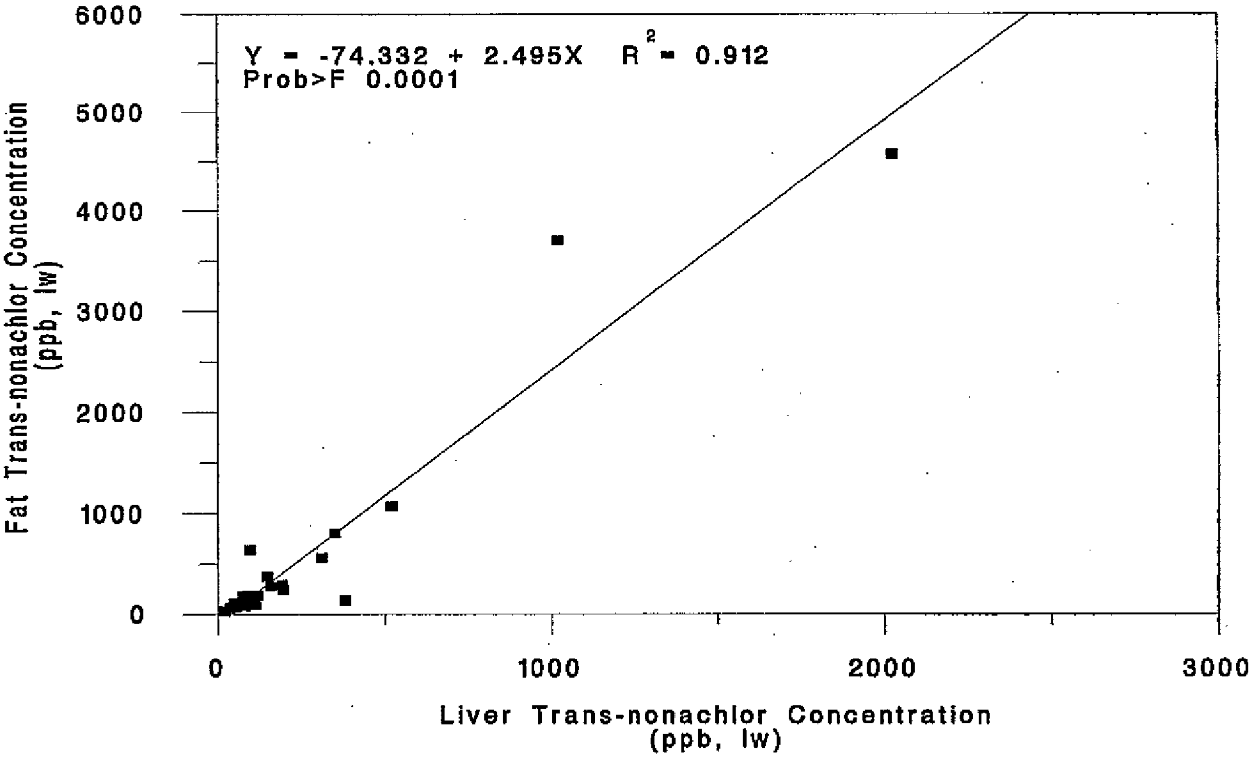


Figure 46. Relationship between concentrations of HCB (top) or trans-nonachlor (bottom) in lipid adjusted river otter fat and liver samples collected from the Lower Columbia River and Reference Area.

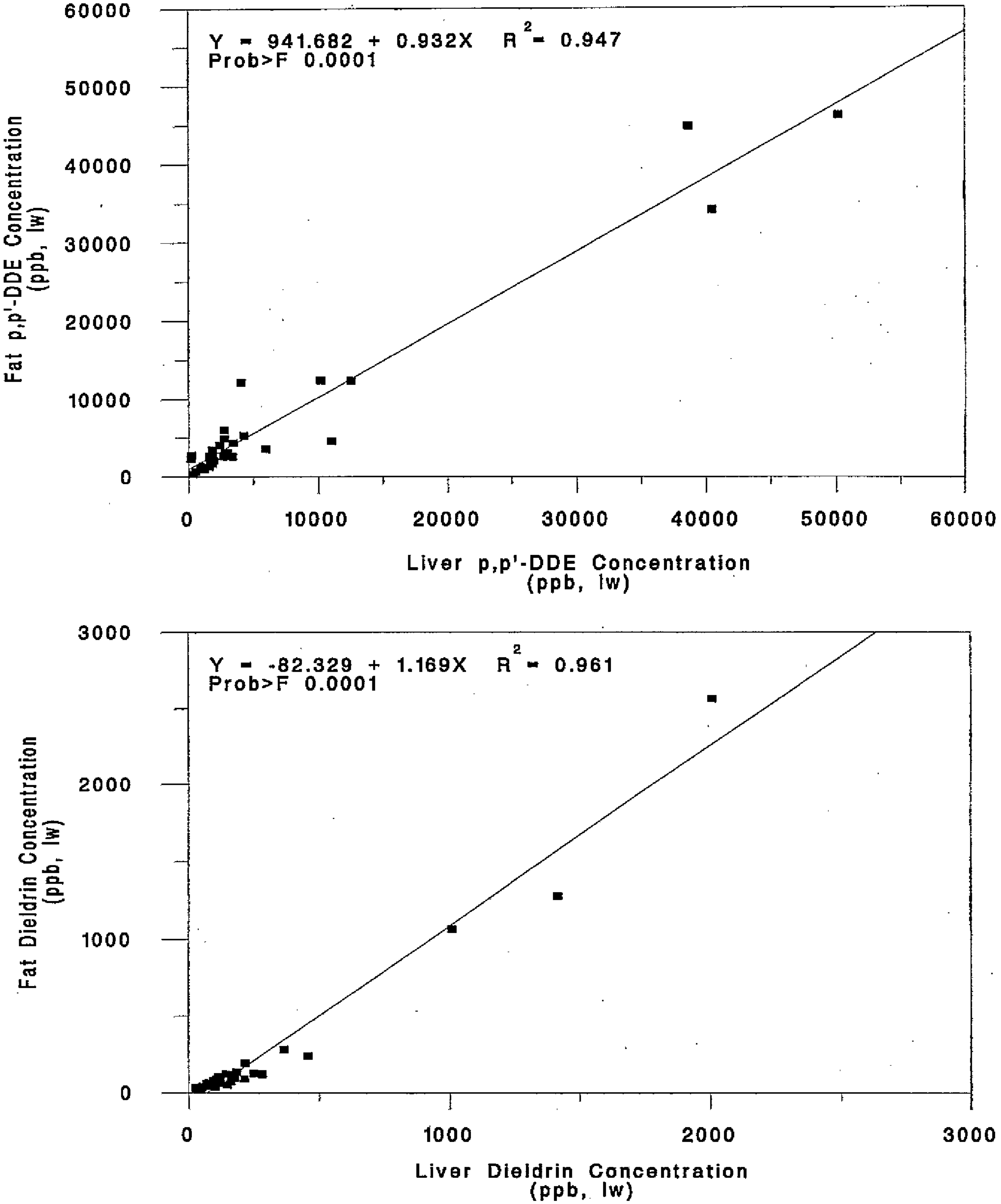
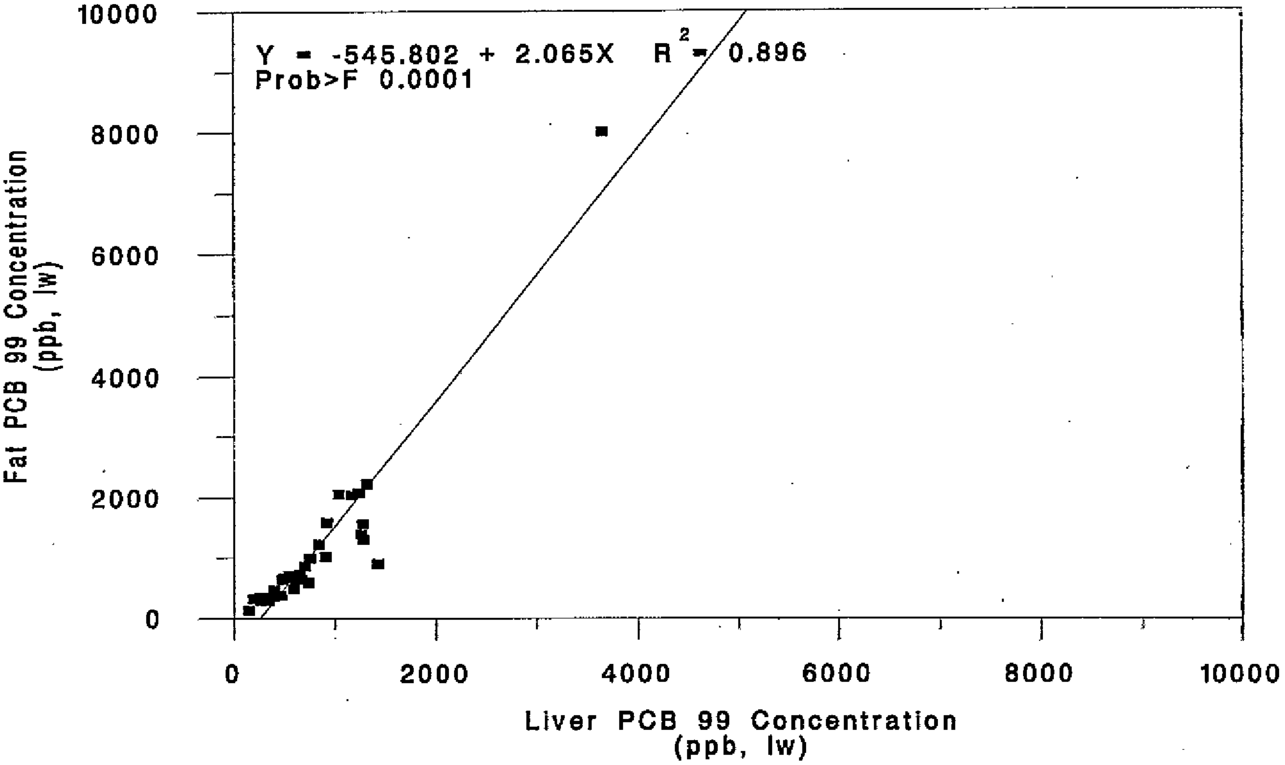


Figure 47. Relationship between concentrations of p,p'-DDE (top) or dieldrin (bottom) in lipid adjusted river otter fat and liver samples collected from the Lower Columbia River and Reference Area.



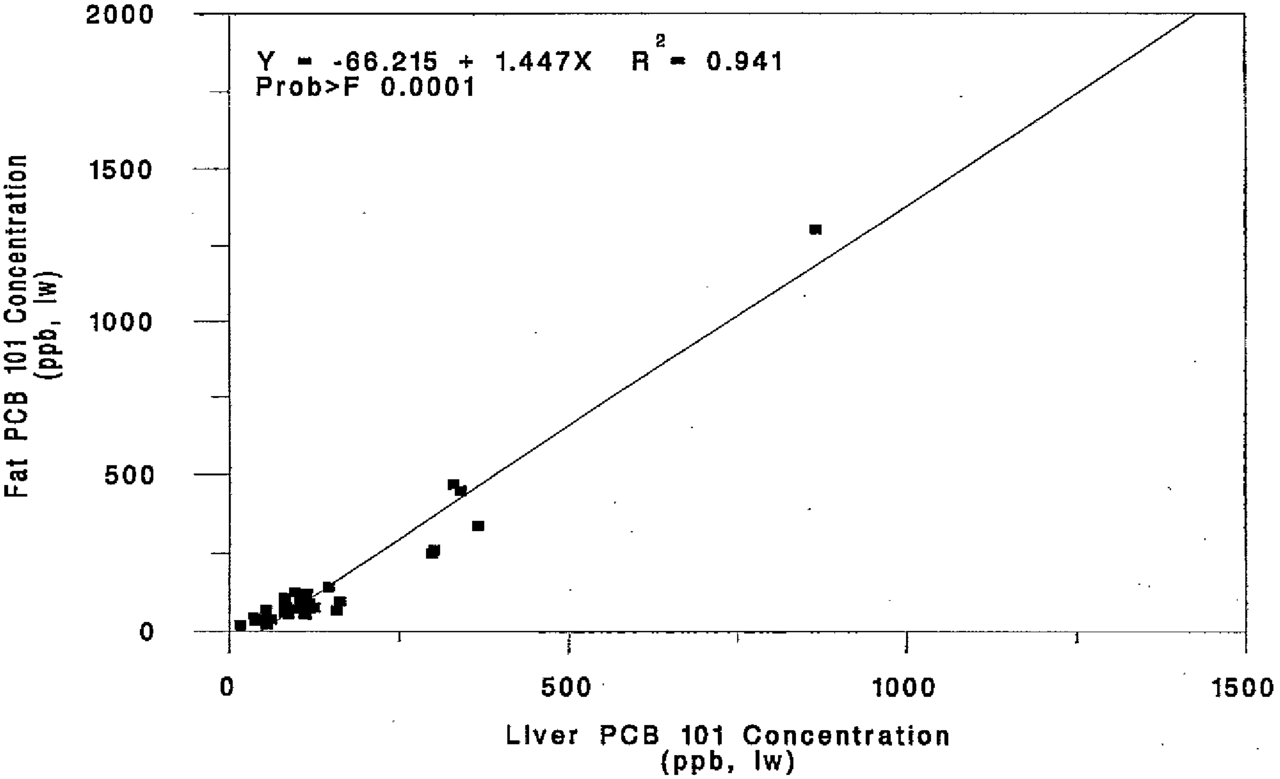
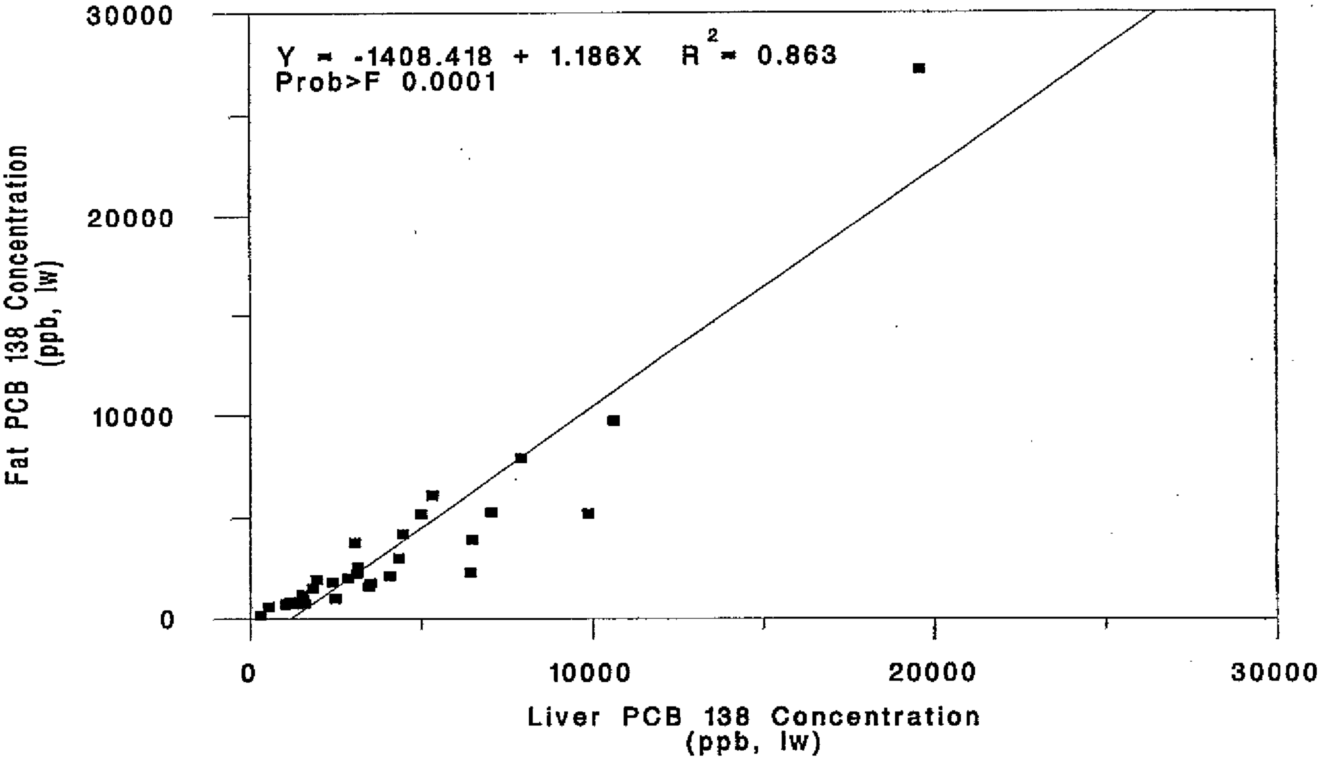


Figure 48. Relationship between concentrations of PCB 99 (top) or PCB 101 (bottom) in lipid adjusted river otter fat and liver samples collected from the Lower Columbia River and Reference Area.



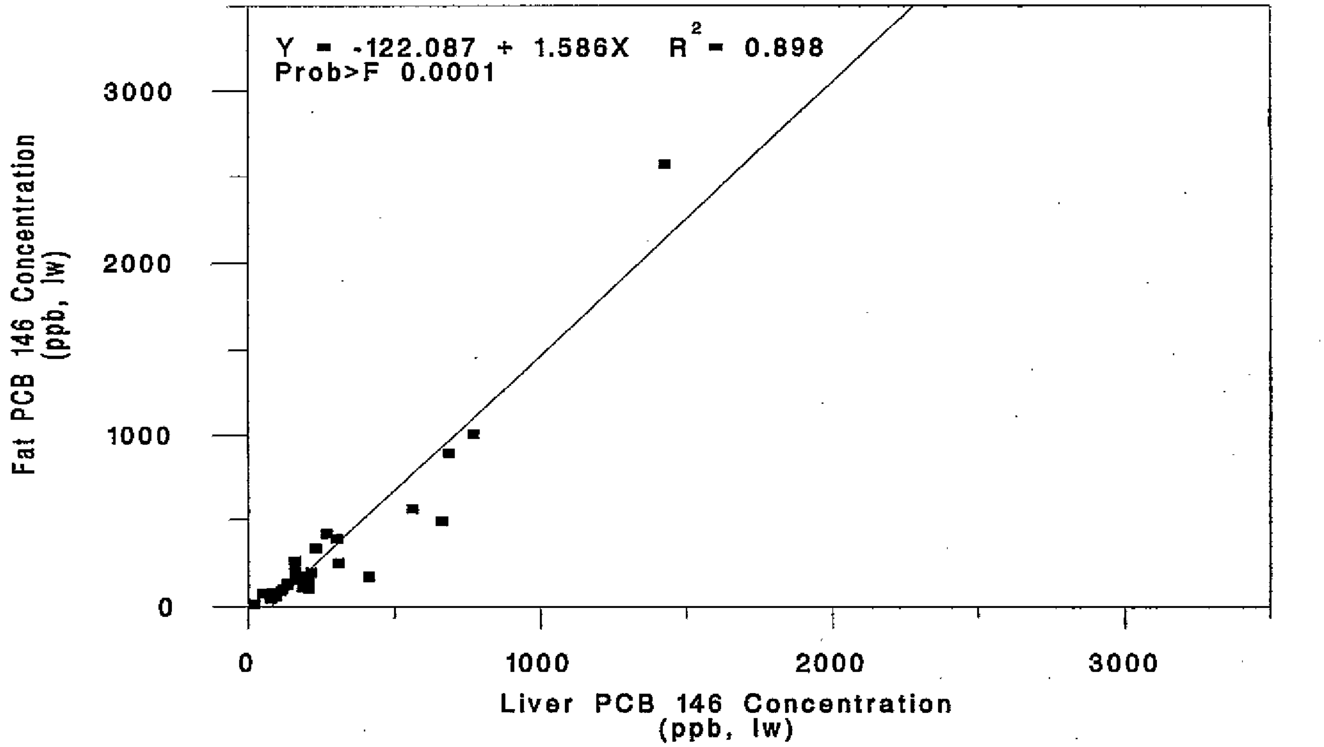


Figure 49. Relationship between concentrations of PCB 138 (top) or PCB 146 (bottom) in lipid adjusted river otter fat and liver samples collected from the Lower Columbia River and Reference Area.

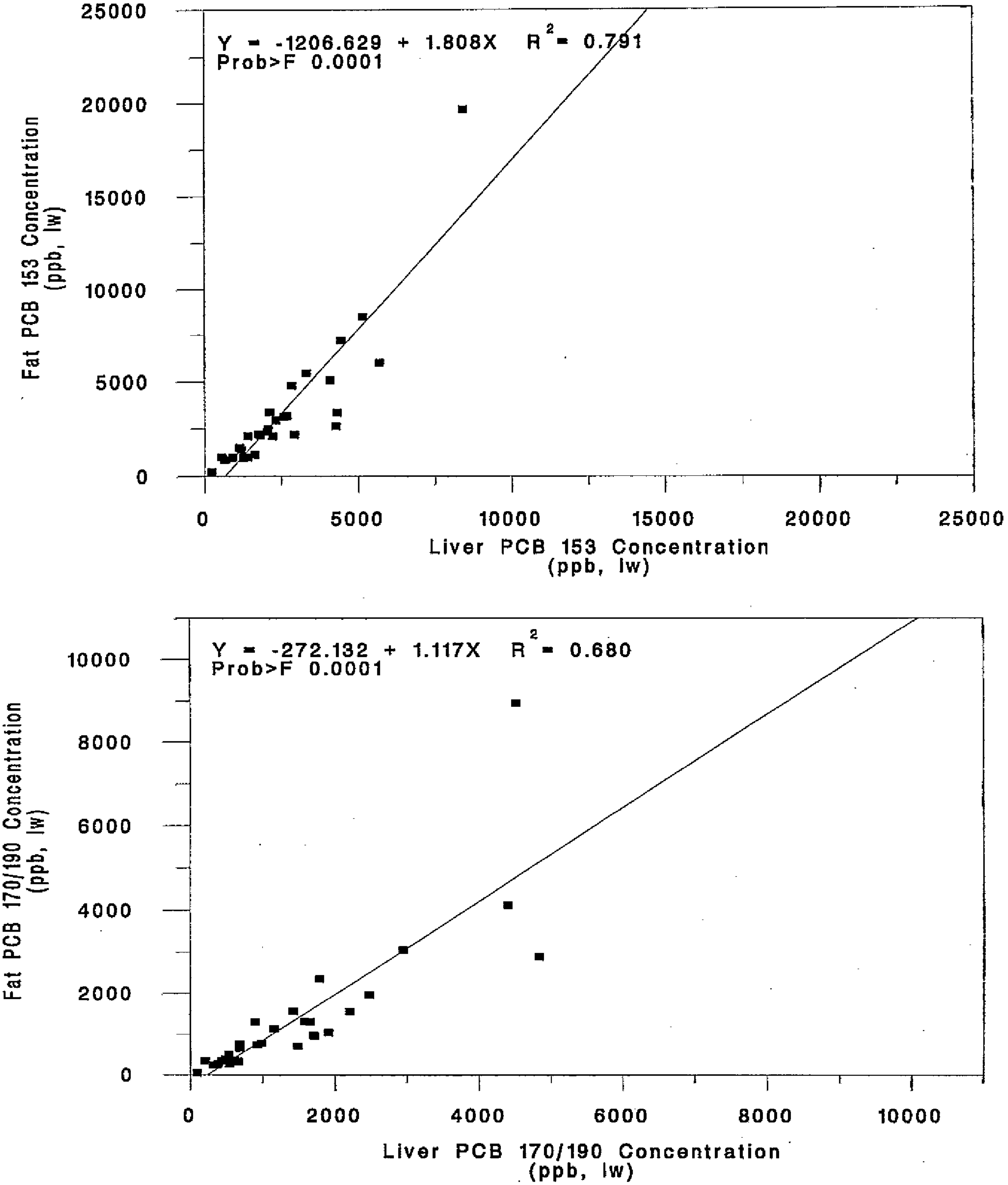
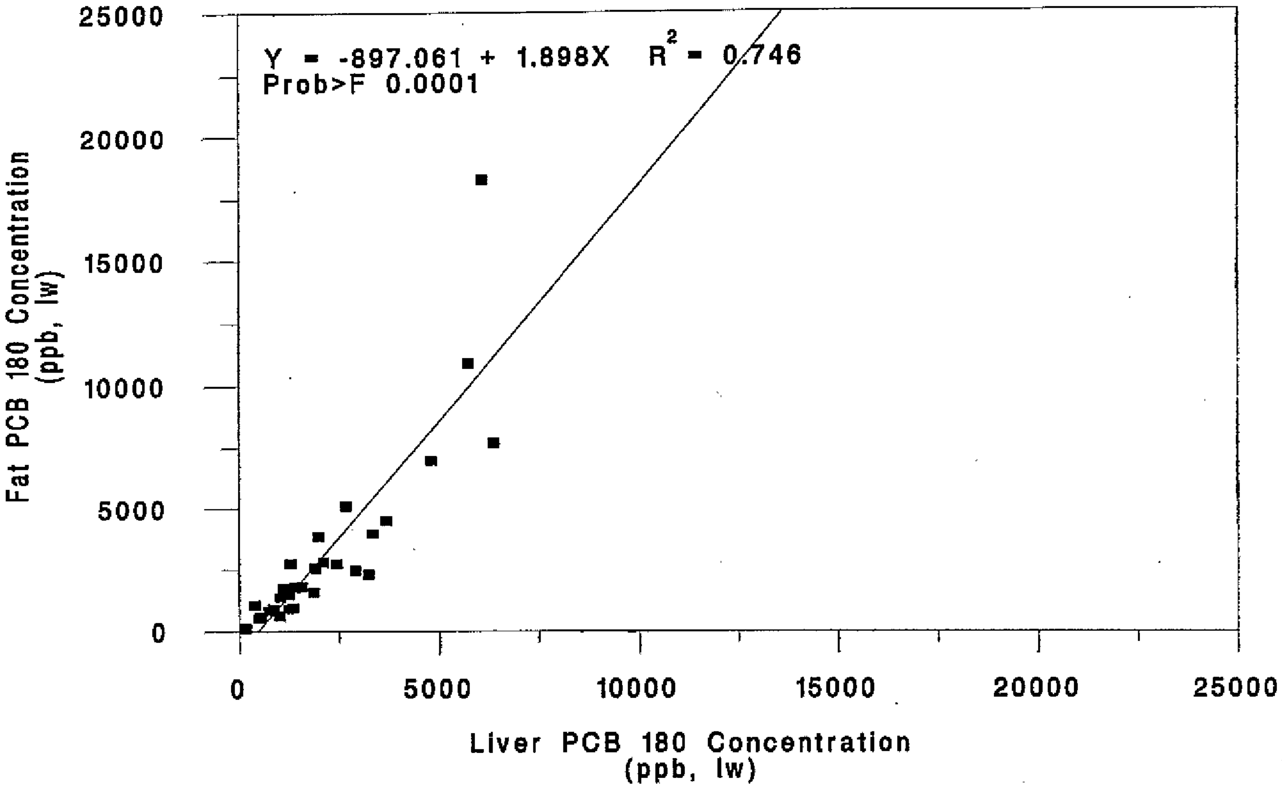


Figure 50. Relationship between concentrations of PCB 153 (top) or PCB 170/190 (bottom) in lipid adjusted river otter fat and liver samples collected from the Lower Columbia River and Reference Area.



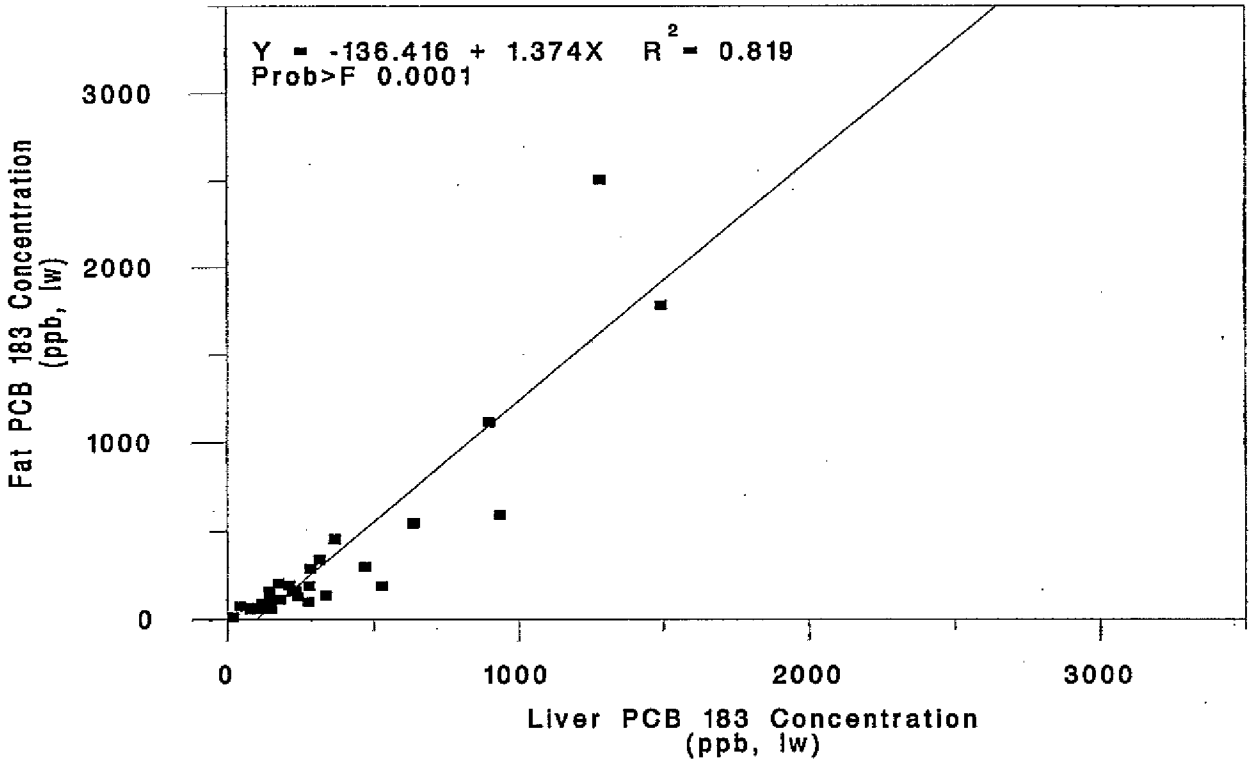


Figure 51. Relationship between concentrations of PCB 180 (top) or PCB 183 (bottom) in lipid adjusted river otter fat and liver samples collected from the Lower Columbia River and Reference Area.

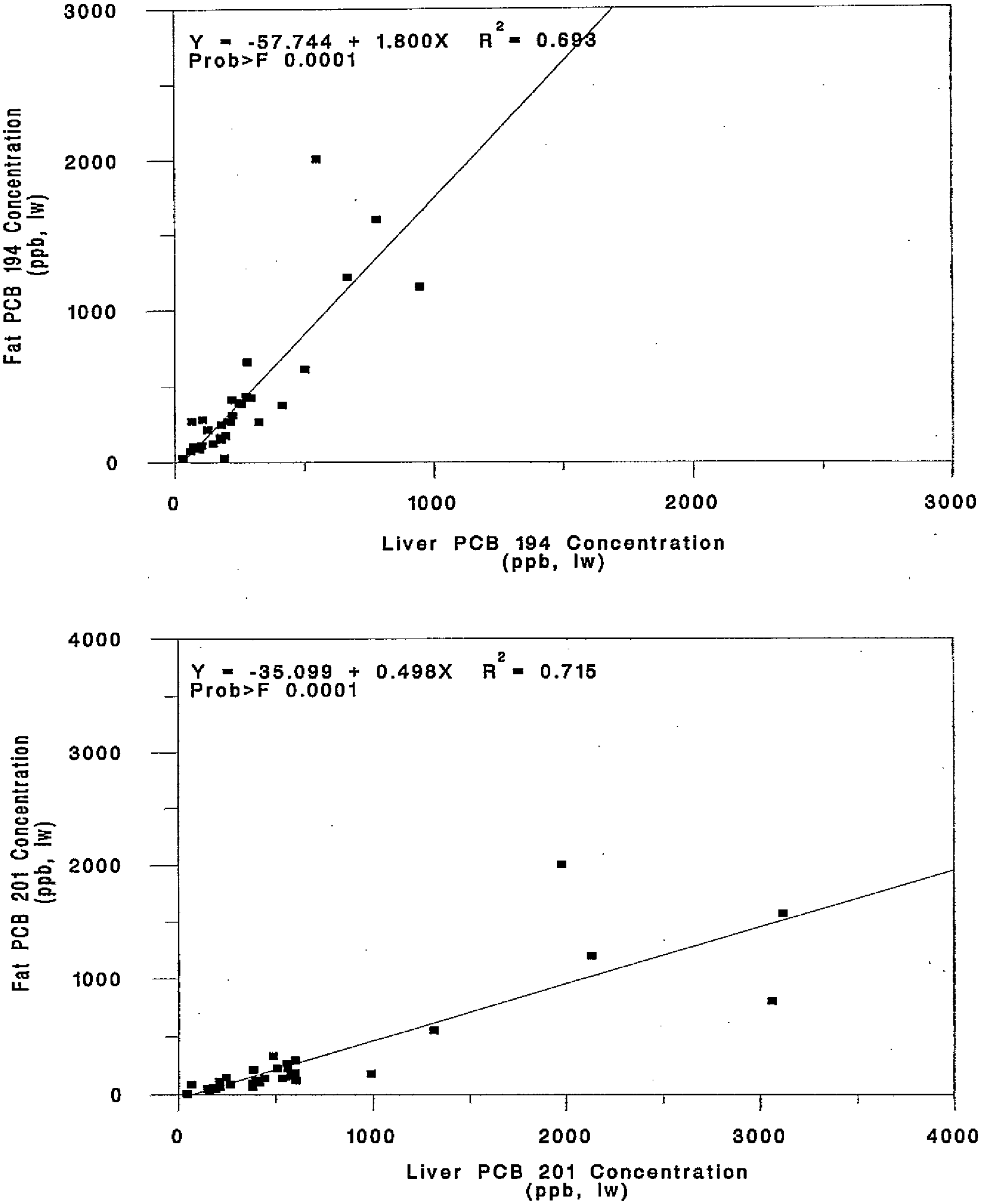
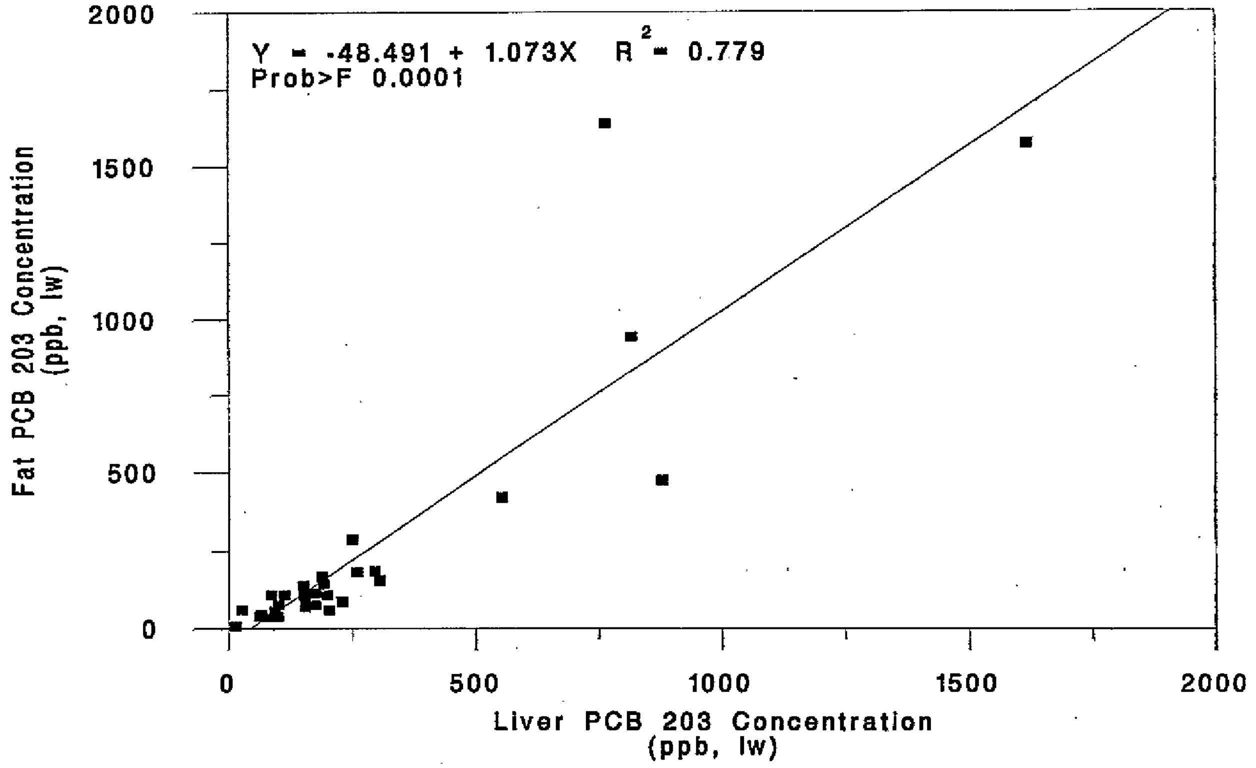


Figure 52. Relationship between concentrations of PCB 194 (top) or PCB 201 (bottom) in lipid adjusted river otter fat and liver samples collected from the Lower Columbia River and Reference Area.



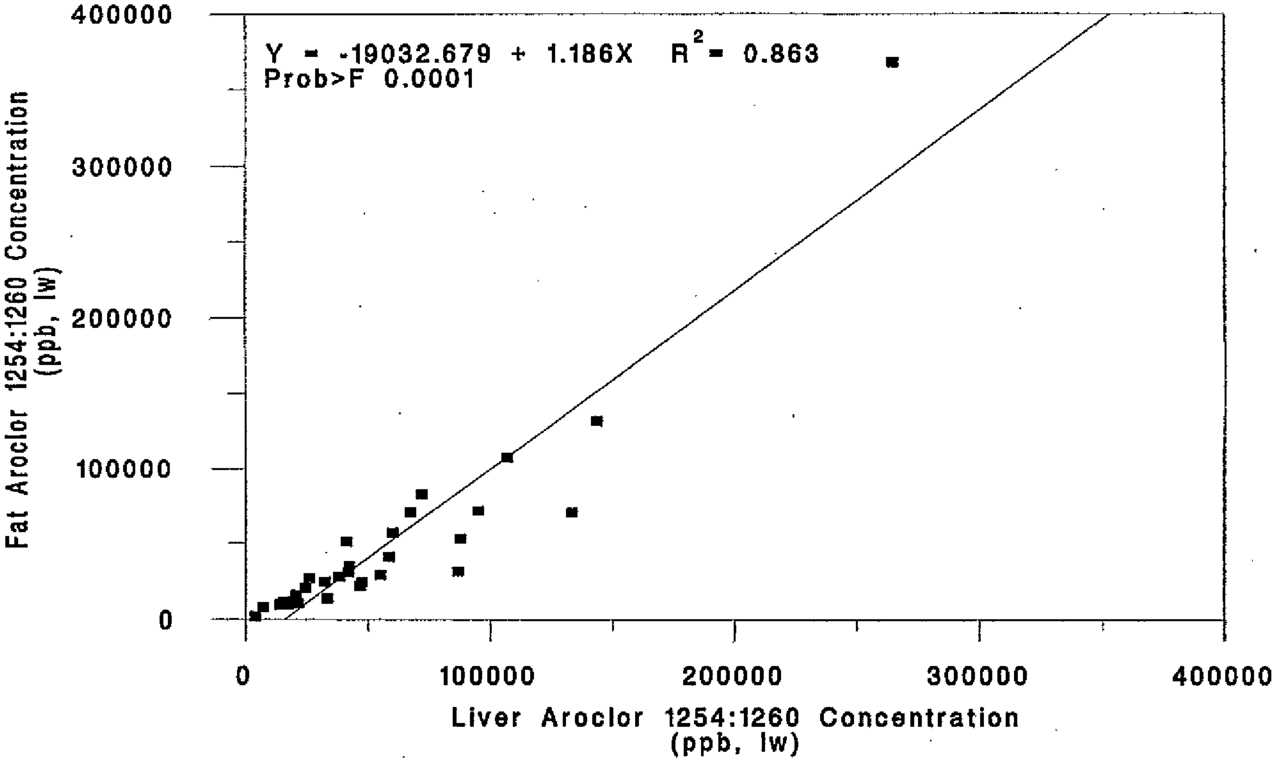
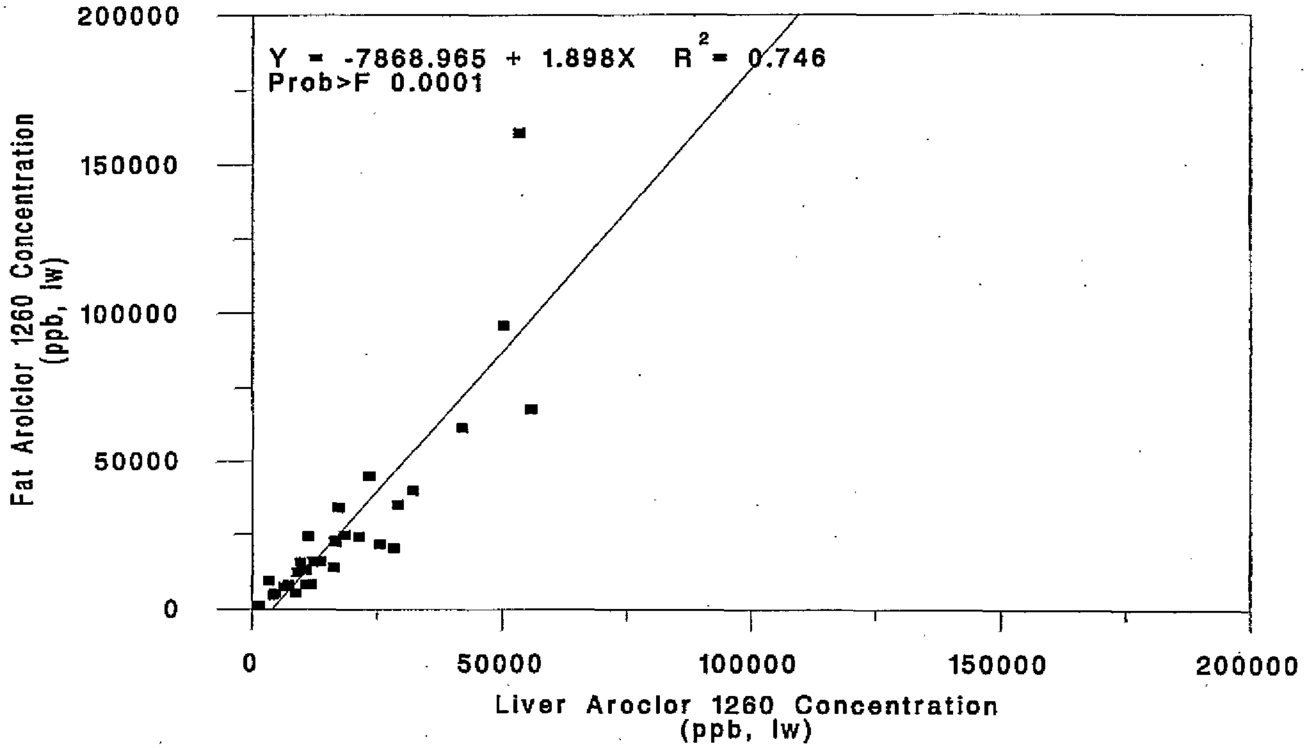


Figure 53. Relationship between concentrations of PCB 203 (top) or Aroclor 1254:1260 (bottom) in lipid adjusted river otter fat and liver samples collected from the Lower Columbia River and Reference Area.



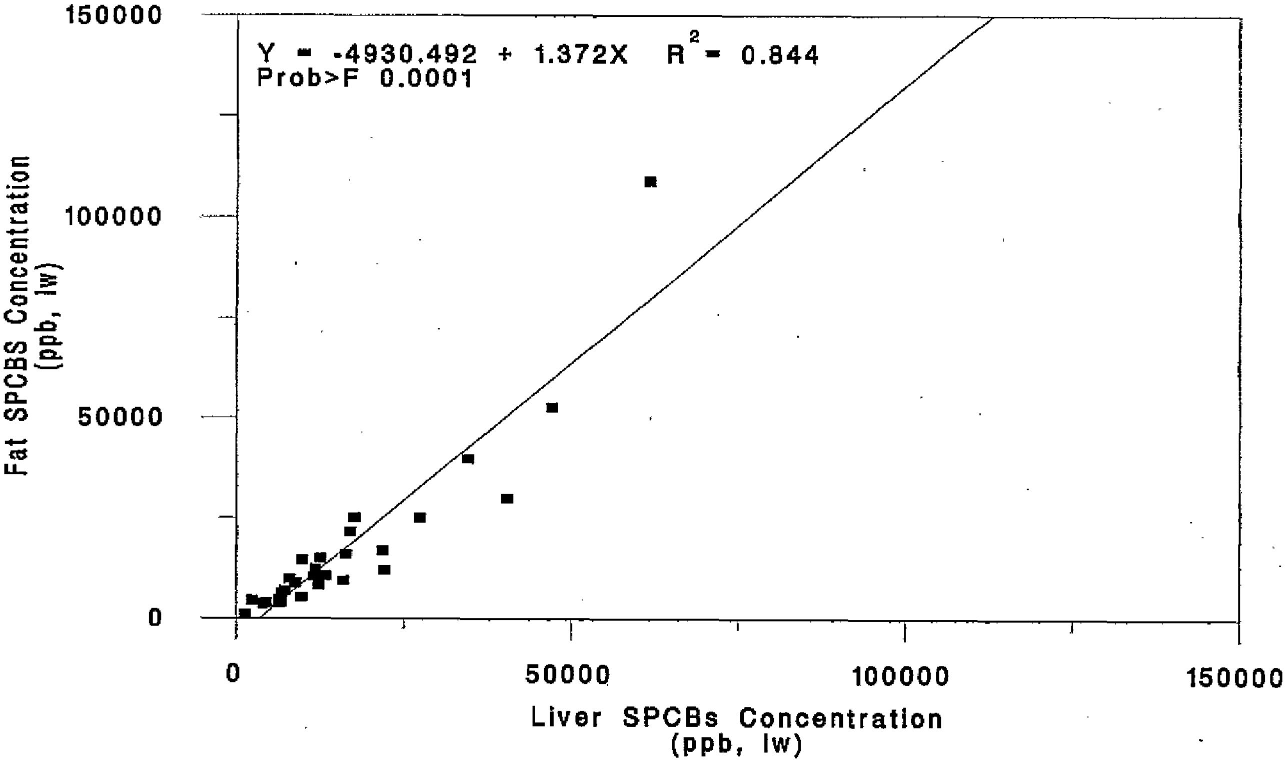


Figure 54. Relationship between concentrations of Aroclor 1260 (top) or the sum of PCBs (SPCBs)(bottom) in lipid adjusted river otter fat and liver samples collected from the Lower Columbia River and Reference Area.

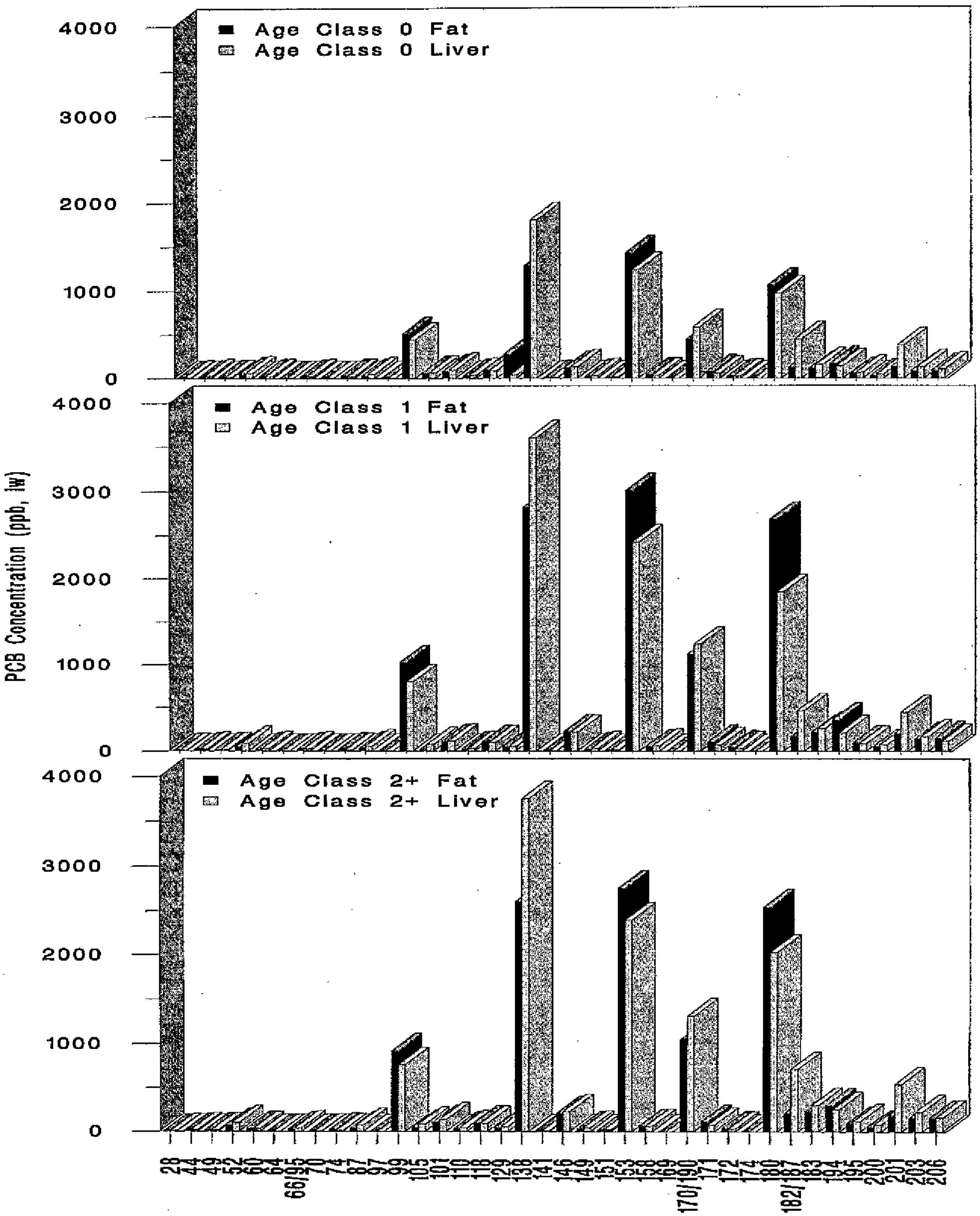


Figure 55. Geometric mean concentrations (ppb, lw) of congener specific PCBs in livers and mesentary fat of three age classes of river otter collected from the Lower Columbia River.

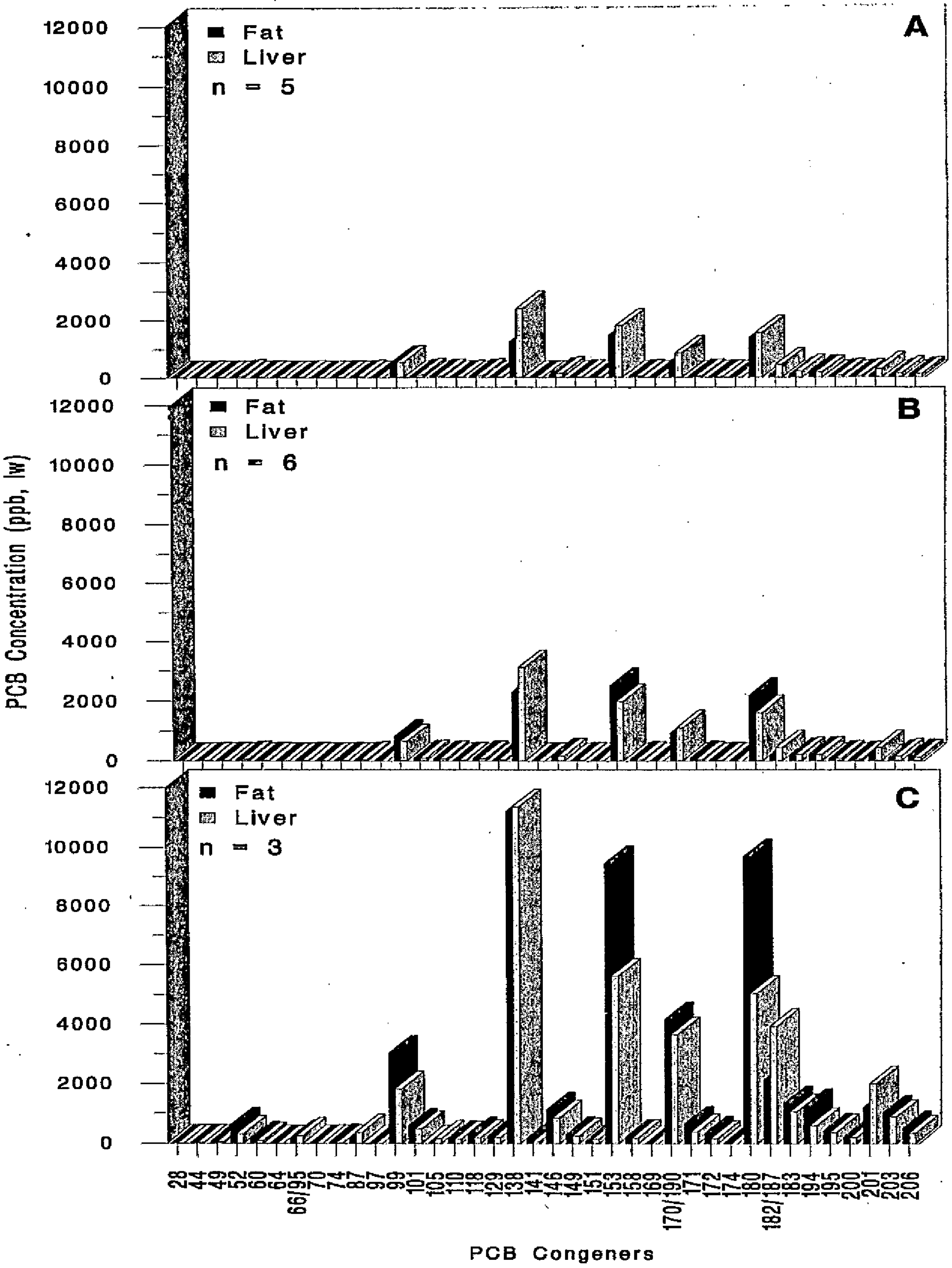


Figure 56. Congener specific PCB concentrations (ppb, lw) in fat and liver of age class 2+ river otters collected from the Lower Columbia River (A=River Mile 11-41; B=River Mile 54-73; C=River Mile 82-120).

Table 1. Concentrations of PCBs (ppm, ww) in river otter tissues from North America.

	Liver			Muscle			Fat				
Area	Mean[a]	Range	n	Mean	Range	n	Mean	Range	n	Detection Limit	Reference
USA: Oregon Lower Columbia River	9.4 (7.0)	1.7 - 23	7	4.0 (3.3)	1.1 - 8.3	7				0.5	Henny et al. 1981
USA: Louisiana	0.11	nd - 0.83	57							0.5	Fleming et al. 1985
USA: Alabama				0.36	nd - 2.5	19				0.01	Hill and Lovett 1975
USA: Georgia							3.5	nd - 66.7	128	0.2	Halbrook et al. 1981
USA: New York										0.1	Foley et al. 1988
Eastern Lake Plains							(1.7)	-	-		
West Adirondaks							(3.5)	-	-		
Northeastern Adirondaks							(3.6)	-	-		
Hudson River Valley							(19.9)	-	-		
USA: New York	(0.40)	nd - 7.3	63							0.05	Foley et al. 1991
USA: Virginia	0.02	nd - 0.07	7	0.003	nd - 0.01	6	0.01	nd - 0.04	3	-	Anderson 1981
USA: Michigan	0.30	0.1 - 4.4	50				3.2	0.4 - 38.5	39	0.1	Stuht 1981
Canada: Alberta	0.02	nd - 2.3	88				0.38	nd - 2.34	58	0.002	Somers et al. 1987

[a] Arithmetic means with non-detections treated as "0" in all calculations although the detections limits varied; when geometric means, they are shown in parenthesis ( ) and use half the detection limit for non-detections.

nd = not detected

Table 2. Concentrations of PCBs (ppm, ww) in mink tissues from North America.

	Liver			Muscle			Fat				
Area	Mean[a]	Range	n	Mean	Range	n	Mean	Range	n	Detection Limit	Reference
USA: Oregon										0.5	Henny et al. 1981
Lower Columbia	0.74 (0.63)	nd - 2.1	9	0.50 (0.48)	nd - 1.6	9					
USA: Maryland	[b]	nd - 2.4	82							0.25	O'Shea et al. 1981
USA: New York		0.03 - 7.9						0.4 - 95.0		0.05 L, 0.10 F	Foley et al. 1988
West Appalachian Plateau	(0.1)		6				(0.8)		6		
East Appalachian Plateau	(0.3)		5				(2.0)		5		
West Adirondaks	(0.3)		16				(2.4)		15		
Northeast Adirondaks	(0.2)		7				(2.4)		6		
Eastern Lake Plains	(0.3)		15				(3.4)		15		
Lake Ontario	(0.30)		8				(2.4)		9		
South Hudson River	(0.40)		11				(3.5)		12		
North Hudson River	(0.60)		7				(4.4)		6		
Canada:											
Northwest Territories	0.01 (0.004)	nd - 0.03	90							0.00002	Poole et al. 1995
Ontario				0.27	-	20				-	Frank et al. 1979

[a] Arithmetic means with non-detections treated as "0" in all calculations although the detection limits varied; when geometric means, they are shown in parenthesis ( ) and use half the detection limit for non-detections.

[b] Eight of 82 mink collected in counties of Maryland had detectable PCB concentrations. PCB values for the 8 mink were 0.62, 0.74, 1.1, 1.1, 1.4, 2.0, 2.2, and 2.4 ppm.

nd = not detected

Table 3. Dioxins, furans and TEQs (ppt, ww) in fish collected from the Lower Columbia River in 1987 and reported by the Environmental Protection Agency[a].

Location (RM)[b]	Species	Part[c]	2378-TCDD	2378-TCDF	TEQ
Camas (120)	no. squawfish	PF	1.14	11.95	2.36
	sucker	WB	2.28	15.95	4.08
St. Helens (86)	no. squawfish	PF	1.28	9.03	2.80
	sucker	WB	2.29	10.83	3.79
Longview (66)	no. squawfish	PF	1.62	20.43	3.82
	sucker	WB	5.23	28.34	8.50
Wauna (42)	no. squawfish	PF	1.73	21.63	4.38
	sucker	WB	2.78	16.39	4.45

[a] Environmental Protection Agency, Unpublished data.

[b] Estimated River Mile (RM).

[c] PF = fillet, WB = whole body.

Table 4. Geometric mean organochlorine insecticide residue concentrations (ppb, ww) in livers for male and male + female (combined) river otters collected in the Reference Area (all age classes combined) and Lower Columbia River (0,1,2+ age classes). Moisture and lipid content of livers are arithmetic means.

	Males				Males + Females			
Age Class	Ref	0	1	2+	Ref	0	1	2+
n	5	6	6	9	6	7	9	14
Lipid(%)	3.10A	3.26A	3.36A	3.83A	3.13A	3.33A	3.46A	3.71A
Moisture(%)	70.33A	70.51A	70.41A	69.92A	70.12A	70.29A	70.66A	70.26A
Hexachlorobenzene	5.28A	3.21A	4.62A	6.27A	4.38A	2.92A	5.26A	5.84A
p,p'-DDE	9.18B	51.22AB	131.62A	142.72A	7.15B	53.43A	88.00A	144.61A
Oxychlordane	3.45C	5.28BC	10.74AB	12.93A	3.21B	5.20B	11.50A	12.27A
p,p'-DDD	0.68B	3.56AB	6.52A	10.27A	0.58B	3.08A	5.96A	10.50A
Heptachlor epoxide	0.35B	0.90AB	1.20A	1.30A	0.34B	0.87A	1.26A	1.30A
Dieldrin	1.08B	3.91AB	5.38A	6.82A	1.02B	3.96A	5.69A	6.51A
Octachlorostyrene	0.24A	0.25A	0.43A	0.57A	0.18B	0.26AB	0.47AB	0.51A
Trans-nonachlor	1.18B	2.33AB	4.50AB	7.15A	0.90B	2.16AB	4.14A	5.88A
Mirex	0.27B	0.62AB	0.85AB	1.23A	0.20B	0.56A	0.86A	1.13A
Cis-chlordane	0.08A	0.21A	0.22A	0.51A	0.07B	0.18AB	0.20AB	0.44A
Cis-nonachlor	0.13B	0.31AB	0.59AB	0.88A	0.11B	0.27AB	0.49A	0.80A
β-Hexachlorocyclohexane	0.05B	0.14A	0.07AB	0.10AB	0.05B	0.12A	0.08AB	0.10AB
Trans-chlordane	0.05A	0.08A	0.07A	0.12A	0.05A	0.07A	0.07A	0.11A

One-way ANOVA, General Linear Models Procedure, Tukey's Studentized Range Test, Alpha = 0.05. Males and males + females tested separately. Rows of these categories sharing same letter are not significantly different.

Note: 1,2,4,5-tetrachlorobenzene; 1,2,3,4-tetrachlorobenzene and gamma hexachlorocyclohexane were not detected. Pentachlorobenzene had 7 detections (high 1.03 ppb), photo-mirex 10 detections (high 1.19 ppb), alpha hexachlorocyclohexane 10 detections (high 0.15 ppb), p,p'-DDT 16 detections (high 0.78 ppb).

Table 5. Geometric mean polychlorinated biphenyl (congener specific and estimated total) residue concentrations (ppb, ww) in livers for male and male + female (combined) river otters collected in the Reference Area (all age classes combined) and Lower Columbia River (0,1,2+ age classes).

	Males				Males + Females			
Age Class	Ref	0	1	2+	Ref	0	1	2+
n	5	6	6	9	6	7	9	14
PCB 99	3.94B	14.49A	27.51A	29.34A	3.36B	14.53A	26.75A	27.63A
PCB 118	0.54B	2.94A	3.82A	3.41A	0.36B	2.95A	3.26A	3.47A
PCB 146	0.59B	4.38A	8.11A	8.66A	0.53B	4.38A	7.25A	8.39A
PCB 153	6.85B	39.83A	85.41A	98.45A	5.91B	40.43A	81.26A	86.94A
PCB 138	8.94B	59.33A	128.59A	154.67A	8.03B	58.94A	120.67A	136.11A
PCB 182/187	2.22B	14.63A	19.56A	27.59A	1.88B	14.73A	15.55A	25.92A
PCB 183	0.60B	5.10A	9.64A	12.43A	0.52B	5.08A	8.68A	11.11A
PCB 180	5.02B	30.62A	68.31A	85.04A	4.41B	31.59A	62.07A	73.72A
PCB 170/190	2.90B	19.27A	45.59A	57.15A	2.60B	19.36A	41.65A	47.65A
PCB 201	1.35B	11.51A	18.22A	21.90A	1.33B	12.53A	14.90A	19.68A
PCB 194	0.92B	4.28A	8.53A	10.59A	0.81B	4.56A	7.13A	9.35A
PCB 206	0.70B	3.17A	4.69A	6.72A	0.70B	3.52A	3.89A	5.88A
PCB SPCB	40.96B	240.77A	474.13A	563.64A	35.73B	244.51A	434.31A	508.98A
Aroclor 1254-1260	120.73B	801.68A	1737.40A	2089.78A	108.47B	796.34A	1630.42A	1839.08A
Aroclor 1260	44.00B	268.60A	599.24A	745.93A	38.65B	277.08A	544.50A	646.70A
PCB 28	0.05B	0.24A	0.20AB	0.21AB	0.07B	0.25A	0.22AB	0.21AB
PCB 52	0.33B	1.82A	3.69A	3.12A	0.24B	1.96A	2.96A	3.73A
PCB 49	0.05B	0.40A	0.62A	0.63A	0.05B	0.46A	0.53A	0.69A
PCB 44	0.13B	0.94A	0.77A	0.78A	0.18B	0.80A	0.75A	0.73A
PCB 74	0.07B	0.71A	0.35AB	0.28AB	0.07B	0.78A	0.31A	0.40A
PCB 70	0.07A	0.19A	0.14A	0.29A	0.07B	0.15AB	0.12AB	0.24A
PCB 66/95	0.15B	0.72AB	1.12A	1.42A	0.13B	0.77A	0.90A	1.52A
PCB 60	0.21B	0.71AB	1.17A	1.31A	0.17B	0.82A	0.98A	1.18A
PCB 101	0.40B	3.10A	4.59A	4.89A	0.28B	3.09A	3.81A	4.96A
PCB 87	0.17B	1.61A	2.28A	2.58A	0.14B	1.58A	1.83A	2.71A
PCB 110	0.14B	1.17A	1.29A	1.67A	0.12B	1.15A	1.11A	1.64A
PCB 151	0.31A	0.64A	0.92A	0.79A	0.23A	0.58A	0.57A	0.86A
PCB 149	0.25B	1.15A	1.23A	1.86A	0.19B	1.04A	1.02A	1.66A
PCB 105	0.35B	1.97A	2.78A	3.04A	0.25B	2.00A	2.64A	3.16A

Table 5. (continued).

PCB 141	0.05B	0.37A	0.48A	0.58A	0.05B	0.28A	0.36A	0.54A
PCB 158	0.05B	1.19A	2.29A	2.56A	0.05B	1.15A	2.03A	2.30A
PCB 129	0.18B	1.28A	2.05A	2.33A	0.15B	1.34A	1.80A	2.18A
PCB 171	0.34B	2.12A	3.03A	2.75A	0.25B	1.97A	2.51A	2.87A
PCB 200	0.32B	1.68A	2.65A	3.08A	0.23B	1.68A	2.59A	2.95A
PCB 172	0.08B	0.76A	1.32A	1.29A	0.08B	0.81A	1.10A	1.26A
PCB 203	0.49B	4.13A	6.79A	9.51A	0.48B	4.32A	5.68A	8.26A
PCB 195	0.14B	2.17A	3.36A	4.98A	0.12B	2.23A	3.02A	4.35A

One-way ANOVA, General Linear Models Procedure, Tukey's Studentized Range Test, Alpha = 0.05. Males and males + females tested separately. Rows of these categories sharing same letter are not significantly different.

Note: PCB 31and PCB 42 were not detected. PCB 64 had 14 detections (high 0.10 ppb), PCB 97 had 7 detections (high 0.38 ppb), PCB 185 had 3 detections (high 5.97 ppb), PCB 174 had 7 detections (high 0.99 ppb).

Table 6. Geometric mean co-planar polychlorinated biphenyl (PCB 77, PCB 81, PCB 126, and PCB 169), dioxin, and furan residue concentrations (ppt, ww) in livers for male and male+female (combined) river otters collected in the Reference Area (all age classes combined) and Lower Columbia River (0, 1, 2+ age classes). Total TEQ is also presented (geometric mean) for each age class.

	Males				Males + Females			
Age Class	Ref	0	1	2+	Ref	0	1	2+
n	5	5	6	9	6	6	9	14
PCB 77	2.07A	2.39A	3.72A	2.69A	1.77A	2.21A	3.26A	2.61A
PCB 81	0.07A	0.23A	0.22A	0.37A	0.07B	0.18AB	0.20AB	0.43A
PCB 126	8.64A	27.66A	34.31A	25.47A	6.93A	28.81A	30.54A	33.65A
PCB 169	4.65A	9.10A	19.54A	9.31A	4.11A	9.34A	17.17A	12.03A
2378-TCDD	0.12B	1.03A	0.52A	0.83A	0.10B	1.01A	0.57A	0.90A
TCDD Total	**0.22B**	**1.03A**	**0.57AB**	**0.90A**	**0.18B**	**1.01A**	**0.62A**	**0.95A**
12378-PCDD	0.19A	0.41A	0.42A	0.38A	0.22A	0.52A	0.27A	0.48A
PCDD Total	**0.19A**	**0.41A**	**0.42A**	**0.38A**	**0.22A**	**0.52A**	**0.27A**	**0.49A**
123678-H6CDD	2.74A	14.22A	7.88A	11.01A	3.01B	19.16A	8.34AB	11.33AB
123789-H6CDD	0.15A	0.65A	0.47A	0.56A	0.18A	0.80A	0.49A	0.66A
H6CDD Total	**3.23A**	**16.48A**	**8.73A**	**12.92A**	**3.54B**	**21.76A**	**9.13AB**	**13.30AB**
1234678-H7CDD	7.77A	69.06A	46.89A	43.81A	8.58B	86.58A	53.28A	54.33A
H7CDD Total	**7.84A**	**113.95A**	**47.09A**	**59.81A**	**8.65B**	**131.40A**	**54.14AB**	**68.98A**
OCDD	**11.07B**	**138.55AB**	**169.36A**	**111.79AB**	**12.20B**	**155.42A**	**199.71A**	**144.88A**
2378-TCDF	0.11A	0.14A	0.16A	0.21A	0.09A	0.12A	0.19A	0.20A
TCDF Total	**1.00A**	**0.28A**	**0.18A**	**1.35A**	**0.61A**	**0.21A**	**0.33A**	**0.91A**
23478-PCDF	1.48A	4.18A	2.53A	4.19A	1.29B	4.55A	2.73AB	4.11A
PCDF Total	**1.74A**	**6.50A**	**2.51A**	**6.34A**	**1.47B**	**6.56A**	**3.12AB**	**5.87A**
123478-H6CDF	1.45A	6.55A	7.17A	7.10A	1.42B	8.24A	8.48A	8.25A
234678-H6CDF	0.90A	1.95A	1.42A	1.07A	0.92A	2.14A	0.67A	1.24A
123678-H6CDF	0.62A	1.51A	1.27A	1.32A	0.61A	1.81A	1.41A	1.50A
H6CDF Total	**3.25A**	**10.80A**	**10.38A**	**11.59A**	**3.30B**	**13.06A**	**11.57AB**	**12.76A**
1234678-H7CDF	1.47A	14.95A	19.99A	13.30A	1.63B	15.27A	27.21A	17.21A
H7CDF Total	**1.53A**	**17.46A**	**20.17A**	**13.99A**	**1.69B**	**17.77A**	**27.37A**	**17.90A**
OCDF	**0.39A**	**3.96A**	**5.45A**	**2.11A**	**0.39B**	**3.34AB**	**5.58A**	**3.36AB**
Total TEQ[a]	**3.90B**	**18.12A**	**24.28A**	**27.03A**	**3.56B**	**19.79A**	**22.37A**	**27.94A**

One-way ANOVA, General Linear Models Procedure, Tukey's Studentized Range Test, Alpha = 0.05. Males and males + females tested separately. Rows of these categories sharing same letter are not significantly different.

NOTE: 3478-H6CDD, 12378-PCDF, and 123789-H6CDF were detected (≥0.10 ppt) in less than 50% of the samples (geometric means not presented and statistical tests not performed). Totals in bold.

[a] Total TEQ based on Safe (1990, 1994), and includes PCB congeners in Table 5.

Table 7. Geometric mean heavy metal concentrations (ppm, dw) in livers and kidneys for male and male + female (combined) river otters collected in the Reference Area (all age classes combined) and Lower Columbia River (0,1,2+ age classes).

	Males				Males + Females			
Age Class	Ref.	0	1	2+	Ref.	0	1	2+
Livers (n)[a,b,c]	5	6	6	9	6	7	9	14
Moisture (%)	70.33A	70.51A	70.41A	69.92A	70.12A	70.29A	70.66A	70.26A
Cadmium	0.07AB	0.03B	0.16A	0.15A	0.07B	0.03B	0.16A	0.17A
Chromium	0.07A	0.19A	0.12A	0.16A	0.13A	0.28A	0.17A	0.15A
Copper	26.77A	31.37A	21.44A	25.07A	28.22A	29.05A	25.18A	28.01A
Iron	971A	745A	1013A	1025A	1015A	733A	1053A	1043A
Manganese	7.38A	6.81A	7.46A	6.54A	7.16A	6.77A	7.47A	6.83A
Zinc	79.29A	70.56AB	70.95AB	60.95B	76.51A	70.39A	71.01A	64.75A
Mercury	5.60A	3.62A	3.34A	3.46A	5.38A	3.65A	3.33A	3.39A
Vanadium	0.66A	0.67A	0.70A	0.66A	0.64A	0.63A	0.70A	0.67A
Kidneys (n)[d,e]	5	6	6	9	6	7	9	14
Moisture (%)	70.51A	71.73A	72.40A	70.92A	71.09A	72.01A	72.47A	71.24A
Cadmium	0.74AB	0.30B	2.01A	2.12A	0.66B	0.32B	1.89A	2.27A
Chromium	2.24A	1.49A	1.40A	1.36A	3.09A	1.30A	1.57A	1.12A
Copper	34.65A	31.87A	36.82A	38.15A	38.42A	34.18A	39.50A	35.32A
Iron	573A	567A	612A	600A	607A	567A	599A	594A
Manganese	3.34A	2.47A	2.60A	2.45A	3.38A	2.47A	2.76A	2.51A
Nickel	1.91A	0.69A	0.92A	0.87A	2.13A	0.58B	0.91AB	0.77AB
Zinc	60.33A	56.19A	59.94A	54.02A	60.88A	56.03A	60.32A	56.29A
Vanadium	0.76A	0.63A	0.62A	0.76A	0.76A	0.64A	0.63A	0.67A

One way ANOVA, General Linear Models Procedure, Tukey's Studentized Range Test, Alpha = 0.05. Males and males + females tested separately. Rows of these categories showing same letter are not significantly different.

[a] Aluminum found in livers (above detection limit, 0.90 ppm) of 3 animals from Lower Columbia River (Nos. 1,11,24) 0.91 ppm, 1.21 ppm, 1.77 ppm, respectively.

[b] Nickel found in livers (above detection limit, 0.44 ppm) of 3 animals from Lower Columbia River (Nos. 4,12,24) 0.72 ppm, 0.92 ppm, and 1.22 ppm, respectively and 1 animal from Reference Area (No. 26) 1.00 ppm.

[c] No detection of lead in livers (detection limit, 0.47 ppm).

[d] Aluminum found in kidney (above detection limit, 0.90 ppm) of 4 animals from Lower Columbia River (Nos. 1,2,16, 38) 0.98 ppm, 1.28, 0.94, 1.83 ppm, respectively.

[e] Lead found in kidney (above detection limit, 0.47 ppm) of 9 animals from Lower Columbia River (Nos. 3,9,12,14,18,35,36,37,38) 0.65 ppm, 0.52 ppm, 0.53 ppm, 0.57 ppm, 0.61 ppm, 0.58 ppm, 1.63 ppm, 0.69 ppm, 0.48 ppm, respectively.

Table 8. Organochlorine insecticide residues concentrations (ppb, ww) in livers of male and female mink collected from the Lower Columbia River and a Reference Area.

	Reference Area		Lower Columbia River	
Sex	Male	Female	Male	Female
n	2	2	1	1
Age (years)	2,2[a]	5,1[a]	3	2
Sample No.	MK 39	MK 40	MK 30	MK 31
Lipid (%)	4.81	4.38	5.14	3.18
Moisture (%)	70.88	70.86	71.89	73.69
Pentachlorobenzene	ND	ND	0.53	ND
Hexachlorobenzene	0.73	0.44	2.13	0.58
Octachlorostyrene	0.13	ND	0.55	0.20
Trans-nonachlor	0.10	0.12	0.67	ND
p,p'-DDE	281.59	14.59	151.72	47.41
Photo-mirex	1.17	ND	0.52	0.23
Mirex	1.27	ND	1.49	0.68
β-Hexachlorocyclohexane	0.08	0.12	ND	0.10
Oxychlordane	26.27	3.71	58.37	36.84
Cis-chlordane	ND	0.08	ND	ND
p,p'-DDD	1.22	0.59	6.56	2.83
Cis-nonachlor	ND	0.08	ND	ND
Heptachlor epoxide	0.32	0.08	2.30	0.43
Dieldrin	3.30	0.81	33.69	8.40

Note: alpha HCH, gamma-HCH, trans-chlordane, and p,p'-DDT were not detected.

[a] Two animals of the same sex were pooled for residue analysis.

Table 9. Polychlorinated biphenyl (congener specific and estimated total) residue concentrations (ppb, ww) in livers of male and female mink collected from the Lower Columbia River and a Reference Area.

	Reference Area		Lower Columbia River	
Sex	Male	Female	Male	Female
n	2	2	1	1
Age (years)	2,2[a]	5,1[a]	3	2
Sample No.	MK 39	MK 40	MK 30	MK 31
PCB 28	0.14	ND	0.51	ND
PCB 52	ND	ND	ND	0.29
PCB 44	0.39	0.17	1.22	ND
PCB 74	0.74	ND	3.05	0.62
PCB 66/95	0.21	ND	1.16	0.46
PCB 60	0.49	ND	3.84	0.89
PCB 101	0.26	ND	2.08	0.60
PCB 99	4.56	0.18	19.96	5.69
PCB 87	0.21	ND	0.81	0.35
PCB 110	ND	ND	ND	0.14
PCB 118	7.09	0.84	21.73	6.10
PCB 146	2.73	0.20	10.50	2.60
PCB 153	23.97	4.83	59.49	21.49
PCB 105	1.74	ND	5.28	1.77
PCB 138	29.72	4.90	109.30	28.93
PCB 158	0.68	ND	1.82	0.66
PCB 129	0.38	ND	1.22	0.38
PCB 182/187	ND	1.40	67.16	23.34
PCB 183	2.29	0.37	6.20	3.07
PCB 185	ND	ND	8.74	1.79

Table 9. (continued).

Sample No.	MK 39	MK 40	MK 30	MK 31
PCB 171	1.48	0.36	7.85	1.60
PCB 200	0.38	ND	1.79	0.33
PCB 172	0.16	ND	0.81	0.25
PCB 180	19.95	11.70	98.46	22.48
PCB 170/190	8.59	4.12	47.93	9.21
PCB 201	3.47	0.46	16.99	5.57
PCB 203	2.64	0.64	8.77	3.88
PCB 195	1.34	0.45	6.26	1.51
PCB 194	2.89	2.35	20.18	3.61
PCB 206	2.29	1.14	15.78	3.41
SPCBs	118.83	34.11	548.87	151.02
Aroclor 1254:1260	401.66	66.25	1477.02	390.99
Aroclor 1260	174.99	102.67	863.66	197.19

Note: PCB 31, PCB 49, PCB 42, PCB 64, PCB 70, PCB 97, PCB 151, PCB 149, PCB 141, and PCB 174 were not detected.

[a] Two animals of the same sex were pooled for residue analysis.

Table 10. Co-planar PCBs, dioxin and furan concentrations (ppt, ww) in livers of male and female mink collected from the Lower Columbia River and a Reference Area.

	Reference Area		Lower Columbia River[a]
Sex	Male	Female	Female
n	2	2	1
Age (years)	2,2[b]	5,1[b]	2
Sample No.	MK 39	MK 40	MK 31
Lipid (%)	4.81	4.38	3.18
Moisture (%)	70.88	70.86	73.69
PCB 77	0.80	0.60	2.20
PCB 81	0.40	ND	0.70
PCB 126	58.60	6.40	56.50
PCB 169	8.70	1.60	2.30
2378-TCDD	ND	ND	0.19
TCDD Total	**ND**	**ND**	**0.19**
12378-PCDD	ND	ND	ND
PCDD Total	**ND**	**ND**	**ND**
123478-H6CDD	ND	ND	1.23
123678-H6CDD	2.77	ND	6.84
123789-H6CDD	ND	ND	0.80
H6CDD Total	**2.77**	**ND**	**8.87**
1234678-H7CDD	2.07	3.11	35.25
H7CDD Total	**2.07**	**3.11**	**35.25**
OCDD	**3.22**	**13.37**	**66.95**
2378-TCDF	ND	ND	0.30
TCDF Total	**ND**	**ND**	**0.30**

Table 10. (continued).

12378-PCDF	ND	ND	ND
23478-PCDF	2.86	ND	6.24
PCDF Total	**2.86**	**ND**	**6.24**
123478-H6CDF	0.23	ND	1.17
234678-H6CDF	0.90	0.66	2.09
123678-H6CDF	0.36	ND	1.55
123789-H6CDF	ND	ND	0.04
H6CDF Total	**1.51**	**0.66**	**5.16**
1234678-H7CDF	0.21	1.08	0.52
H7CDF Total	**0.21**	**1.16**	**0.66**
OCDF	**0.22**	**ND**	**1.15**

ND = not detected (detection limit, 0.10 ppt), totals are bold.

[a] Another mink (MK 30) from Lower Columbia River did not have adequate amount of liver for this analysis.

[b] Two animals of the same sex were pooled for residue analysis.

Table 11. Heavy metal residue concentrations (ppm, dw) in livers and kidneys of male and female mink collected from the Lower Columbia River and a Reference Area.

	Reference Area		Lower Columbia River	
Sex	Male	Female	Male	Female
n	2	2	1	1
Age (years)	2,2[a]	5,1[a]	3	2
Sample No.	MK39	MK40	MK30	MK31
Liver				
Moisture (%)	70.88	70.86	71.89	73.69
Cadmium	0.04	0.09	0.08	0.06
Chromium	ND	0.15	0.35	ND
Copper	16.32	30.69	12.63	25.83
Iron	992	1368	904	1215
Mercury	3.42	0.86	1.95	2.21
Manganese	6.49	8.73	4.29	4.77
Vanadium	0.58	0.82	0.47	0.76
Zinc	106.1	91.7	81.6	84.5
Kidney				
Moisture (%)	72.70	67.51	71.25	68.89
Aluminum	ND	ND	ND	1.55
Cadmium	0.15	0.10	0.44	0.34
Chromium	0.52	0.33	0.32	0.24
Copper	26.49	24.24	19.18	24.93
Iron	519	466	470	654
Lead	ND	0.63	ND	ND
Manganese	2.99	2.53	3.11	3.39
Nickel	0.82	0.52	2.77	4.82
Vanadium	1.14	0.66	0.98	0.64
Zinc	64.7	45.7	68.7	59.8

NOTE: Aluminum (detection limit, 0.90 ppm), lead (0.47 ppm), and nickel (0.44 ppm) in liver were not detected.

[a] Two animals of the same sex were pooled for residue analysis.

Table 12. Organochlorine insecticide and metabolite residue concentrations (ppb, lw) in pools of river otter scats from the Lower Columbia River and Reference Areas[a].

River Mile	% Lipid	% Moisture	HCB	OCS	TRNO	DDE	MIREX	γHCH	OXY	TRCH	CICH	DDD	CINO	DDT	HE	Dieldrin
RM 134	0.37	60.20	273	nd	274	6095	nd	nd	351	17	47	285	85	nd	69	132
RM 87-108	0.35	7.15	209	29	585	9230	42	22	1388	69	224	765	339	nd	200	561
RM 63-69	0.37	33.81	281	29	465	6942	40	nd	517	16	39	168	91	nd	110	321
RM 28-33	0.23	68.57	222	nd	211	2457	75	36	724	20	79	122	nd	nd	128	253
RM 27[b]	0.70	57.64	131	nd	95	1290	nd	nd	214	7	16	72	35	nd	39	106
RM 27(Adj.)[b]	—	—	(151)	(nd)	(101)	(1352)	(nd)	(nd)	(242)	(7)	(17)	(74)	(35)	(nd)	(43)	(119)
Reference Areas																
Wizard Falls, OR	1.52	52.53	23	nd	62	644	13	nd	36	4	13	71	41	nd	7	21
Clearwater River, ID[c]	0.91	22.31	53	nd	69	1371	nd	nd	134	6	7	55	32	5	31	69

Note: HCB = hexachlorobenzene, OCS = octachlorostyrene, TRNO = trans-nonachlor, γHCH = gamma hexachlorocyclohexane, OXY = oxychlordane, TRCH = trans-chlordane, CICH = cis-chlordane, CINO = cis-nonochlor, HE = heptachlor epoxide, TCB = tetrochlorobenzene, QCB = pentachlorobenzene.

[a] 1,2,4,5-TCB; 1,2,3,4-TCB; QCB; photo-mirex; alpha-HCH; and beta-HCH; and beta-HCH were not detected.

[b] Scat from Bear River in coastal Washington was included by error with the scat from RM 27. It amounted to 18.2% of the sample. The adjusted estimate assumes residue concentrations in the Bear River component of the sample were equal to the Reference Area concentrations.

[c] Arithmetic mean for % lipid and % moisture (n=3); geometric mean for residue concentrations.

Table 13. This is a large table placed in a packet in the back of the report.

Table 13. Congener specific PCB concentrations (ppb, lw) in pools of river otter scats from the Lower Columbia River and Reference Areas.

			PCB Congeners[a]																
Lower Columbia River River Mile	% Lipid	% Moisture	52	49	44	74	70	66/95	60	101	99	97	87	110	151	149	118	146	153	105
RM 134	0.37	60.20	88	60	47	nd	nd	68	60	184	1086	nd	72	111	nd	141	168	180	2374	nd
RM 87-108	0.35	7.15	278	166	58	115	141	261	376	533	1956	92	215	286	152	331	621	542	4444	221
RM 63-69	0.37	33.81	142	82	nd	nd	nd	61	127	233	1728	nd	87	92	nd	92	219	329	3431	nd
RM 28-33	0.23	68.57	nd	nd	nd	nd	nd	nd	nd	116	779	nd	nd	74	nd	61	154	132	1498	nd
RM 27	0.70	57.64	63	24	nd	nd	nd	33	nd	54	390	nd	nd	32	nd	29	84	68	778	nd
RM 27(Adj.)[b]	—	—	(68)	(28)	(nd)	(nd)	(nd)	(35)	(nd)	(46)	(429)	(nd)	(nd)	(26)	(nd)	(18)	(84)	(75)	(850)	(nd)
Reference Areas																				
Wizard Falls, OR	1.52	52.53	20	nd	18	14	20	29	46	87	85	17	27	60	29	88	83	34	231	nd
Clearwater, ID[c]	0.91	22.31	60	9	27	nd	nd	16	nd	95	336	nd	42	59	nd	66	86	40	674	nd

	PCB Congeners[a]																			
Lower Columbia River River Mile	141	138	158	129	182/187	183	174	171	200	172	180	170/190	201	203	195	194	206	77	∑PCBs	Aroclor 1254:1260	Aroclor 1260
RM 134	25	2372	67	61	203	120	38	86	53	25	1172	572	129	86	52	162	75	nd	9937	32055	10280
RM 87-108	98	4181	119	139	781	388	88	256	106	76	3099	1142	415	223	138	390	120	13	22545	56495	27184
RM 63-69	42	3344	92	57	335	221	nd	123	62	39	1775	770	155	99	65	176	54	nd	14031	45186	15573
RM 28-33	nd	1421	nd	nd	142	83	nd	50	nd	nd	759	343	43	39	nd	82	nd	nd	5776	19200	6659
RM 27	nd	633	nd	22	117	43	nd	29	nd	nd	326	158	33	20	13	39	14	nd	3002	8557	2863
RM 27(Adj.)[b]	(nd)	(671)	(nd)	(25)	(131)	(46)	(nd)	(31)	(nd)	(nd)	(353)	(169)	(34)	(20)	(14)	(39)	(13)	(nd)	(3166)	(9077)	(3101)
Reference Areas																					
Wizard Falls, OR	20	220	nd	11	69	26	23	17	11	9	129	54	30	17	11	27	30	nd	1576	2966	1133
Clearwater, ID[c]	nd	696	nd	nd	36	32	15	27	nd	nd	276	160	28	19	nd	54	6	nd	2929	9408	2423

[a] PCB31, PCB28, PCB42, PCB64, PCB185, PCB126 and PCB169 were not detected.

[b] Scat from Bear River in coastal Washington was included by error with the scat from RM 27. It amounted to 18.2% of the sample. The adjusted estimate assumes residue concentrations in the Bear River component of the sample were equal to the Reference Area concentrations.

[c] Arithmetic mean for % lipid and % moisture (n=3); geometric mean for residue concentrations.

Table 14. Dioxin, furan, and co-planar PCB residue concentrations (ppt, lw) in a pool of river otter scats from River Mile 87-108 along the Lower Columbia River.

% Lipid	PCB 77	PCB 81	PCB 126	PCB 169	2378-TCDD	TCDD Total
0.35	39.80	1.10	13.60	2.42	ND	ND
12378-PCDD	PCDD Total	123478-H6CDD	123678-H6CDD	123789-H6CDD	H6CDD Total	1234678-H7CDD
ND	ND	0.15	2.47	ND	6.84	58.80
H7CDD Total	OCDD	2378-TCDF	TCDF Total	12378-PCDF	23478-PCDF	PCDF Total
93.48	552.00	3.73	7.80	ND	1.42	3.55
123478-H6CDF	234678-H6CDF	123678-H6CDF	123789-H6CDF	H6CDF Total	1234678-H7CDF	H7CDF Total
0.62	0.94	0.22	0.27	8.87	4.18	11.06
OCDF						
5.27						

ND= Not detectable

Table 15. A comparison of body and organ measurements (arithmetic mean) for river otter males of different age classes (0,1,2+) in the Lower Columbia River alone and including two age classes (0 and 2+) from a Reference Area.

	Only Columbia River			Columbia River + Reference Area				
Age Class	0	1	2+	Ref 0	0	1	2+	Ref 2+
n	6	6	9	2	6	6	9	3
Carcass (kg)	7.27B	8.66A	9.83A	7.40B	7.27B	8.66AB	9.83A	8.95AB
Total length (cm)	110.45A	121.30A	116.33A	115.00A	110.45A	121.30A	116.33A	112.17A
Tail length (cm)	45.25A	45.50A	46.77A	47.25A	45.25A	46.77A	45.50A	44.17A
Messentary fat (g)	18.47A	23.55A	30.28A	18.85B	18.47B	23.55AB	30.28AB	42.23A
Thymus (g)	13.90A	9.43A	8.86A	5.20AB	13.90A	9.43AB	8.86AB	4.13B
Lungs (g)	174.07B	205.38AB	234.08A	182.80A	174.07A	205.38A	234.08A	200.43A
Liver (g)	478.32A	575.45A	624.24A	421.90A	478.32A	575.45A	624.24A	596.03A
Spleen (g)	47.32A	48.50A	56.39A	38.15A	47.32A	48.50A	56.39A	43.70A
Pancreas (g)	35.02A	38.23A	44.61A	34.85B	35.02B	38.23AB	44.61AB	52.90A
Testes (g)	4.30B	26.62A	39.31A	21.10AB	4.30B	26.62AB	39.31A	40.13A
Thyroids (g)	0.77A	0.74A	0.81A	0.62A	0.77A	0.74A	0.81A	0.65A
Kidneys (g)	97.65A	97.77A	124.27A	92.10A	97.65A	97.77A	124.27A	111.43A
Adrenals (g)	1.02A	1.26A	1.30A	1.01A	1.02A	1.26A	1.30A	1.06A
Baculum								
length (cm)	8.30B	9.82A	9.80A	9.52A	8.30B	9.82A	9.80A	9.52A
weight (g)	2.62B	6.18A	7.08A	5.82A	2.62B	6.18A	7.08A	6.48A

Note: For testes, thyroid, kidney, and adrenal, the values are the combined weight of left and right.

Table 16. A comparison of body and organ measurements of male river otter (age class 0) between six river otter from the Lower Columbia River and two from a Reference Area.

Category	Columbia River Mean (Range)	Reference Area No. 28	 No. 29
Carcass (kg)	7.27 (6.12-8.39)	7.06	7.74
Total length (cm)	110.5 (104.8-114.6)	115.9	114.1
Tail length (cm)	45.3 (40.0-48.3)	46.7	47.8
Messentary fat (g)	18.5 (14.3-25.5)	20.6	17.1
Thymus (g)	13.9 (7.4-23.3)	4.9	5.5
Lung (g)	174.1 (106.4-215.1)	185.0	180.6
Liver (g)	478.3 (353.6-569.3)	443.0	400.8
Spleen (g)	47.3 (21.0-94.7)	34.8	41.5
Pancreas (g)	35.0 (26.3-47.6)	34.6	35.1
Testes (g)	4.3 (2.8-6.9)	12.9	29.3
Thyroids (g)	0.77 (0.35-0.97)	0.62	0.62
Kidneys (g)	97.7 (71.1-132.1)	92.9	91.3
Adrenals (g)	1.02 (0.74-1.45)	0.97	1.05
Baculum			
length (cm)	8.30 (7.42-9.14)	9.58	9.46
weight (g)	2.62 (1.92-4.03)	5.79	5.85

Note: For testes, thyroid, kidney, and adrenal, the values are the combined weight of left and right.

Table 17. A large table placed in a packet in the back of the report.

Table 17. Correlation matrix between OC insecticides and their metabolites, PCB congeners, dioxins, and furans found in the 1994-95 trapping season (*P<0.05, **P<0.01, #P<0.001, ##P<0.0001).

	HCB	OCS	Trans-nonachlor	DDE	Mirex	Oxy-chlordane	Cis-chlordane	DDD	Cis-nonachlor	Heptachlor	Dieldrin	PCB 28	PCB 52	PCB 49	PCB 44	PCB 74	PCB 70	PCB 66/95
OCS	## 0.890																	
Trans-Nonaclor	## 0.665	** 0.479																
DDE	* -0.405	0.300	## 0.704															
Mirex	## 0.805	## 0.650	## 0.788	** 0.549														
Oxychlor	## 0.673	** 0.517	## 0.806	** 0.473	## 0.708													
Cis-chlordane	* 0.398	0.180	## 0.776	# 0.582	## 0.645	## 0.649												
DDD	** 0.536	0.311	## 0.873	## 0.785	## 0.746	## 0.732	## 0.843											
Cis-nonachlor	# 0.576	0.345	## 0.937	## 0.743	## 0.784	## 0.747	## 0.899	## 0.954										
Heptachlor	** 0.531	0.318	## 0.845	## 0.693	## 0.669	## 0.754	## 0.722	## 0.863	## 0.865									
Dieldrin	** 0.486	0.279	## 0.819	## 0.709	# 0.635	## 0.714	## 0.771	## 0.897	## 0.883	## 0.963								
PCB28	0.043	0.058	-0.306	-0.364	0.004	-0.121	-0.081	-0.262	-0.261	-0.197	-0.161							
PCB52	* 0.366	0.249	## 0.686	## 0.774	# 0.575	# 0.591	## 0.632	## 0.880	## 0.767	## 0.763	## 0.791	-0.226						
PCB49	0.307	0.247	** 0.498	# 0.584	** 0.533	** 0.515	** 0.555	## 0.727	# 0.617	# 0.581	## 0.669	0.064	## 0.843					
PCB44	0.089	0.063	0.073	-0.125	0.004	-0.075	-0.089	-0.022	-0.016	-0.185	-0.232	-0.242	-0.171	-0.292				
PCB74	-0.012	-0.081	0.039	0.087	0.197	0.109	* 0.402	0.200	0.204	0.175	0.226	0.249	0.152	0.311	-0.341			
PCB70	0.179	0.117	0.179	0.151	0.299	0.160	** 0.504	* 0.368	0.334	0.054	0.185	0.279	0.242	** 0.523	0.148	0.309		
PCB66/95	0.324	0.235	## 0.678	## 0.754	# 0.605	** 0.532	## 0.713	## 0.862	## 0.774	## 0.652	## 0.705	-0.204	## 0.917	## 0.865	-0.108	0.220	** 0.475	
PCB60	0.238	0.213	** 0.566	# 0.623	** 0.478	* 0.426	** 0.545	## 0.676	# 0.599	* 0.405	** 0.521	-0.131	## 0.700	## 0.782	-0.082	0.178	** 0.490	## 0.837
PCB101	* 0.398	0.311	## 0.724	## 0.763	## 0.652	# 0.621	## 0.698	## 0.893	## 0.798	## 0.734	## 0.775	-0.193	## 0.938	## 0.855	-0.078	0.209	* 0.419	## 0.942
PCB99	## 0.641	** 0.541	## 0.766	# 0.633	## 0.770	## 0.830	# 0.630	## 0.800	## 0.757	## 0.767	## 0.755	-0.039	## 0.797	## 0.719	-0.152	0.211	0.230	## 0.747
PCB87	0.358	0.237	## 0.717	## 0.757	# 0.601	# 0.634	## 0.724	## 0.894	## 0.797	## 0.755	## 0.789	-0.236	## 0.938	## 0.823	-0.098	0.237	* 0.379	## 0.920
PCB110	0.332	0.277	# 0.627	## 0.643	** 0.566	** 0.555	## 0.690	## 0.803	## 0.709	# 0.618	## 0.674	-0.152	## 0.844	## 0.864	-0.043	0.231	# 0.573	## 0.927
PCB151	0.164	0.106	** 0.551	** 0.546	* 0.411	0.301	## 0.655	## 0.686	## 0.680	* 0.449	** 0.557	-0.270	# 0.626	# 0.581	0.050	0.295	** 0.526	## 0.734
PCB149	* 0.342	0.283	## 0.744	## 0.773	# 0.615	** 0.512	## 0.735	## 0.841	## 0.798	## 0.693	## 0.707	* -0.376	## 0.771	# 0.603	0.096	0.165	* 0.368	## 0.850
PCB118	0.324	0.315	** 0.558	** 0.426	** 0.504	** 0.488	# 0.573	# 0.627	## 0.604	** 0.466	** 0.475	-0.148	## 0.646	# 0.601	0.223	0.214	** 0.474	## 0.737
PCB146	** 0.562	* 0.435	## 0.814	## 0.785	## 0.734	## 0.738	## 0.708	## 0.911	## 0.864	## 0.857	## 0.883	-0.179	## 0.899	## 0.782	-0.161	0.181	0.261	## 0.834
PCB153	# 0.591	** 0.518	## 0.767	## 0.687	## 0.741	## 0.777	# 0.619	## 0.796	## 0.765	## 0.741	## 0.741	-0.122	## 0.767	## 0.701	-0.144	0.130	0.247	## 0.750
PCB105	** 0.467	0.337	## 0.675	** 0.490	# 0.616	## 0.758	## 0.684	## 0.805	## 0.728	## 0.713	## 0.746	-0.022	## 0.838	## 0.760	-0.151	0.189	* 0.363	## 0.770
PCB141	* 0.411	0.247	## 0.767	## 0.678	## 0.660	# 0.608	## 0.757	## 0.874	## 0.846	## 0.667	## 0.691	-0.345	## 0.751	## 0.669	0.248	0.196	** 0.525	## 0.843
PCB138	** 0.567	* 0.450	## 0.786	## 0.701	## 0.729	## 0.804	## 0.689	## 0.851	## 0.817	## 0.810	## 0.823	-0.137	## 0.813	## 0.737	-0.168	0.161	0.263	## 0.771
PCB158	# 0.622	** 0.493	## 0.856	## 0.724	## 0.803	## 0.806	## 0.750	## 0.900	## 0.884	## 0.848	## 0.854	-0.156	## 0.842	## 0.754	-0.099	0.175	0.318	## 0.806
PCB129	** 0.483	* 0.363	## 0.816	## 0.740	## 0.668	## 0.689	## 0.732	## 0.910	## 0.873	## 0.824	## 0.893	-0.228	## 0.877	## 0.800	-0.184	0.175	0.303	## 0.819
PCB182/187	* 0.397	0.265	## 0.795	## 0.861	## 0.671	** 0.561	## 0.753	## 0.899	## 0.877	## 0.810	## 0.859	-0.252	## 0.851	## 0.744	-0.166	0.184	0.291	## 0.837
PCB183	** 0.508	* 0.401	## 0.794	## 0.809	## 0.731	## 0.705	## 0.725	## 0.880	## 0.852	## 0.812	## 0.839	-0.173	## 0.828	## 0.762	-0.193	0.180	0.305	## 0.828
PCB171	** 0.485	0.345	## 0.754	## 0.753	## 0.673	** 0.567	# 0.633	## 0.847	## 0.805	## 0.829	## 0.837	-0.141	## 0.811	## 0.660	0.028	0.202	0.240	## 0.753
PCB200	** 0.523	* 0.429	## 0.697	## 0.664	## 0.714	## 0.733	## 0.689	## 0.825	## 0.752	## 0.753	## 0.770	-0.011	## 0.820	## 0.743	-0.191	0.272	0.326	## 0.787
PCB172	* 0.385	0.296	## 0.713	## 0.812	# 0.584	# 0.599	## 0.641	## 0.861	## 0.788	## 0.794	## 0.853	-0.219	## 0.891	## 0.810	-0.203	0.204	0.249	## 0.827
PCB180	**	*	##	##	##	##	#	##	##	##	##		##	##				##

	0.499	0.437	0.720	0.725	0.667	0.691	0.617	0.784	0.749	0.701	0.725	-0.132	0.751	0.718	-0.190	0.128	0.305	0.756
PCB170/190	** 0.511	* 0.422	## 0.737	## 0.697	## 0.664	## 0.730	## 0.643	## 0.802	## 0.773	## 0.739	## 0.770	-0.152	## 0.746	## 0.705	-0.185	0.127	0.291	## 0.726
PCB201	0.280	0.199	## 0.645	## 0.760	** 0.511	** 0.547	# 0.614	## 0.795	## 0.732	## 0.736	## 0.812	-0.155	## 0.807	## 0.822	-0.260	0.188	0.315	## 0.774
PCB203	* 0.392	0.293	## 0.743	## 0.820	## 0.648	# 0.604	## 0.717	## 0.851	## 0.825	## 0.777	## 0.833	-0.159	## 0.807	## 0.797	-0.227	0.193	* 0.366	## 0.829
PCB195	* 0.367	0.261	## 0.671	## 0.750	# 0.601	# 0.606	## 0.650	## 0.812	## 0.757	## 0.756	## 0.814	-0.105	## 0.788	## 0.823	-0.263	0.192	* 0.377	## 0.796
PCB194	* 0.389	0.352	## 0.661	## 0.746	# 0.571	** 0.568	** 0.561	## 0.754	## 0.705	# 0.635	## 0.689	-0.180	## 0.734	## 0.749	-0.182	0.124	* 0.371	## 0.759
PCB206	0.213	0.219	** 0.527	## 0.717	* 0.428	* 0.395	** 0.511	## 0.647	# 0.601	** 0.542	# 0.614	-0.141	# 0.631	## 0.697	-0.235	0.164	* 0.389	## 0.689
SPCB	** 0.520	* 0.418	## 0.770	## 0.753	## 0.714	## 0.737	## 0.687	## 0.859	## 0.815	## 0.800	## 0.826	-0.113	## 0.831	## 0.776	-0.203	0.185	0.299	## 0.808
Aroclor 1254:1260	** 0.567	* 0.450	## 0.786	## 0.701	## 0.729	## 0.804	## 0.689	## 0.851	## 0.817	## 0.810	## 0.823	-0.137	## 0.813	## 0.737	-0.168	0.161	0.263	## 0.771
Aroclor 1260	** 0.499	* 0.437	## 0.720	## 0.725	## 0.667	## 0.691	# 0.617	## 0.784	## 0.749	## 0.702	## 0.725	-0.132	## 0.751	## 0.718	-0.190	0.128	0.305	## 0.756
PCB 77	0.302	0.338	-0.016	-0.127	0.138	0.082	0.072	-0.039	0.009	-0.204	-0.174	-0.050	-0.175	-0.092	0.169	0.197	0.286	-0.109
PCB 81	0.106	0.029	0.086	0.229	0.222	0.111	0.144	0.178	0.138	-0.111	-0.086	-0.018	0.154	0.203	0.345	-0.063	* 0.388	0.222
PCB 126	0.166	0.184	0.338	* 0.369	0.290	0.272	** 0.574	** 0.477	* 0.469	* 0.376	** 0.471	-0.065	0.392	* 0.458	-0.137	* 0.434	** 0.508	** 0.508
PCB 169	0.431	0.334	## 0.692	## 0.678	** 0.567	## 0.660	## 0.689	## 0.794	## 0.751	## 0.672	## 0.731	-0.230	## 0.752	## 0.674	0.014	0.198	0.299	## 0.709
2378-TCDD	0.197	0.164	0.218	* 0.451	0.316	0.117	0.263	* 0.396	0.303	0.344	* 0.383	0.240	* 0.452	** 0.512	0.023	0.084	0.278	0.421
Total TCDD	0.214	0.182	0.220	* 0.449	0.319	0.115	0.272	* 0.402	0.309	0.318	* 0.375	0.227	* 0.445	** 0.488	0.056	0.058	0.295	* 0.404
12378-PCDD	-0.149	-0.209	0.211	** 0.556	0.103	-0.005	0.390	** 0.486	* 0.396	0.280	* 0.399	-0.191	** 0.564	# 0.623	-0.172	0.148	* 0.405	# 0.604
Total PCDD	-0.156	-0.221	0.201	** 0.547	0.093	-0.016	0.386	** 0.480	* 0.391	0.252	* 0.392	-0.184	** 0.556	# 0.617	-0.177	0.147	* 0.405	# 0.597
123478-H6CDD	-0.160	-0.255	0.198	* 0.445	0.063	-0.049	0.272	* 0.405	0.304	0.231	0.359	-0.094	* 0.426	* 0.396	0.015	-0.097	0.284	** 0.492
123678-H6CDD	-0.176	-0.217	0.105	* 0.423	0.010	0.038	0.289	* 0.386	0.274	0.315	* 0.465	0.007	** 0.502	# 0.639	-0.271	0.121	0.298	** 0.477
123789-H6CDD	-0.124	-0.222	0.182	* 0.408	0.074	0.120	0.345	* 0.447	0.338	0.287	* 0.447	0.003	** 0.519	# 0.639	-0.189	0.131	0.354	** 0.513
Total H6CDD	0.018	-0.013	0.278	** 0.512	0.148	0.216	* 0.391	** 0.508	* 0.420	** 0.486	# 0.613	-0.020	# 0.617	## 0.711	-0.307	0.103	0.269	** 0.540
1234678-H7CDD	-0.139	-0.226	-0.005	0.272	-0.110	0.045	0.209	0.295	0.183	0.254	* 0.393	0.050	* 0.406	** 0.547	-0.257	0.161	0.256	0.329
Total H7CDD	-0.178	-0.283	-0.030	0.279	-0.112	0.011	0.216	0.279	0.157	0.215	* 0.368	0.085	* 0.375	** 0.549	-0.262	0.177	0.321	0.335
OCDD	0.056	-0.035	0.048	0.272	0.027	0.194	0.248	0.350	0.229	0.328	* 0.439	0.131	* 0.441	# 0.579	-0.262	0.246	0.282	* 0.372
2378-TCDF	0.127	0.147	-0.122	* -0.377	0.005	0.074	0.057	-0.186	-0.122	-0.276	-0.255	0.288	-0.296	-0.166	0.258	0.097	* 0.379	-0.179
Total TCDF	* 0.435	0.279	0.307	-0.144	0.339	** 0.481	0.347	0.150	0.225	0.104	0.092	0.296	-0.125	-0.062	0.111	0.115	0.297	-0.048
12378-PCDF	-0.080	-0.187	0.129	0.281	0.145	0.012	0.228	0.236	0.196	0.058	0.183	-0.125	0.087	0.205	0.197	0.266	* 0.392	0.215
23478-PCDF	0.104	0.029	0.364	** 0.558	0.283	0.255	** 0.496	# 0.580	** 0.484	** 0.484	# 0.620	0.040	# 0.616	## 0.728	-0.245	0.094	* 0.419	# 0.623
Total PCDF	0.102	-0.008	0.356	* 0.424	0.267	0.304	** 0.493	** 0.517	* 0.439	* 0.461	# 0.593	0.103	** 0.490	# 0.591	-0.217	0.129	0.380	** 0.493
123478-H6CDF	0.023	-0.047	0.217	** 0.482	0.090	0.269	0.367	** 0.530	* 0.377	** 0.487	# 0.601	-0.040	## 0.687	## 0.722	-0.264	0.110	0.266	# 0.594
234678-H6CDF	-0.224	-0.264	0.129	** 0.473	-0.021	-0.113	0.277	0.235	0.243	0.178	0.253	0.102	0.343	* 0.402	-0.258	0.100	0.287	0.356
123678-H6CDF	0.020	-0.070	0.232	** 0.508	0.115	0.213	* 0.373	* 0.509	* 0.388	** 0.479	# 0.589	-0.014	# 0.645	## 0.692	-0.289	0.122	0.235	** 0.545
Total H6CDF	0.028	-0.052	0.240	** 0.524	0.117	0.264	* 0.393	** 0.542	* 0.396	** 0.488	# 0.610	-0.028	## 0.689	## 0.739	-0.287	0.115	0.299	# 0.606
1234678-H7CDF	0.135	0.010	0.160	0.314	0.042	0.258	0.289	* 0.417	0.313	* 0.419	** 0.510	-0.032	** 0.482	** 0.507	-0.173	0.169	0.201	0.364
Total H7CDF	0.106	-0.027	0.139	0.313	0.025	0.237	0.286	* 0.409	0.299	* 0.403	** 0.500	-0.023	** 0.476	** 0.515	-0.181	0.179	0.220	0.367
OCDF	0.0.72	-0.046	0.063	0.177	-0.076	0.133	0.210	0.285	0.216	0.276	0.348	0.009	0.320	0.330	-0.125	0.203	0.166	0.195

livers (ppb, ww) of 30 river otters collected from the Lower Columbia River during

PCB 60	PCB 101	PCB 99	PCB 87	PCB 110	PCB 151	PCB 149	PCB 118	PCB 146	PCB 153	PCB 105	PCB 141	PCB 138	PCB 158	PCB 129	PCB 182/187	PCB 183	PCB 171	PCB 200	PCB 172
## 0.760																			
# 0.587	## 0.847																		
## 0.705	## 0.979	## 0.814																	
## 0.753	## 0.937	## 0.731	## 0.934																
## 0.646	## 0.700	** 0.474	## 0.637	## 0.679															
## 0.653	## 0.885	## 0.695	## 0.876	## 0.841	## 0.715														
** 0.562	## 0.775	# 0.630	## 0.756	## 0.776	** 0.550	## 0.717													
## 0.641	## 0.924	## 0.931	## 0.893	## 0.798	## 0.647	## 0.802	# 0.636												
# 0.615	## 0.833	## 0.965	## 0.771	## 0.704	** 0.543	## 0.725	# 0.581	## 0.935											
** 0.549	## 0.853	## 0.834	## 0.873	## 0.807	** 0.488	## 0.640	## 0.698	## 0.826	## 0.741										
## 0.677	## 0.866	## 0.705	## 0.842	## 0.850	## 0.793	## 0.877	## 0.752	## 0.795	## 0.721	## 0.682									
# 0.583	## 0.864	## 0.962	## 0.831	## 0.757	** 0.566	## 0.746	# 0.585	## 0.966	## 0.977	## 0.807	## 0.759								
# 0.618	## 0.897	## 0.944	## 0.867	## 0.802	# 0.621	## 0.799	## 0.648	## 0.973	## 0.942	## 0.831	## 0.818	## 0.971							
## 0.703	## 0.904	## 0.827	## 0.872	## 0.804	## 0.700	## 0.782	# 0.592	## 0.950	## 0.843	## 0.800	## 0.781	## 0.890	## 0.919						
## 0.691	## 0.887	## 0.755	## 0.869	## 0.776	## 0.689	## 0.858	** 0.561	## 0.916	## 0.798	## 0.677	## 0.787	## 0.836	## 0.878	## 0.922					
## 0.676	## 0.883	## 0.896	## 0.837	## 0.766	## 0.645	## 0.819	# 0.571	## 0.962	## 0.950	## 0.715	## 0.787	## 0.958	## 0.946	## 0.906	## 0.930				
** 0.511	## 0.851	## 0.794	## 0.832	## 0.725	# 0.604	## 0.798	## 0.657	## 0.893	## 0.779	## 0.744	## 0.763	## 0.820	## 0.867	## 0.820	## 0.856	## 0.834			
# 0.569	## 0.893	## 0.952	## 0.864	## 0.790	** 0.545	## 0.770	## 0.658	## 0.936	## 0.934	## 0.838	## 0.722	## 0.952	## 0.931	## 0.847	## 0.803	## 0.908	## 0.828		
## 0.694	## 0.918	## 0.831	## 0.884	## 0.790	## 0.669	## 0.800	# 0.602	## 0.956	## 0.862	## 0.729	## 0.757	## 0.892	## 0.890	## 0.953	## 0.936	## 0.935	## 0.852	## 0.872	
##	##	##	##	##	#	##	**	##	##	##	##	##	##	##	##	##	##	##	##

0.639	0.825	0.897	0.757	0.701	0.586	0.735	0.532	0.913	0.975	0.675	0.709	0.950	0.903	0.848	0.831	0.963	0.756	0.904	0.887
# 0.586	## 0.824	## 0.906	## 0.770	## 0.710	# 0.587	## 0.726	** 0.522	## 0.931	## 0.970	## 0.713	## 0.726	## 0.974	## 0.927	## 0.879	## 0.828	## 0.957	## 0.770	## 0.917	## 0.894
## 0.681	## 0.859	## 0.757	## 0.827	## 0.765	# 0.617	## 0.744	** 0.510	## 0.892	## 0.819	## 0.661	## 0.703	## 0.856	## 0.836	## 0.914	## 0.918	## 0.916	## 0.778	## 0.812	## 0.963
## 0.714	## 0.873	## 0.802	## 0.835	## 0.781	## 0.652	## 0.817	** 0.559	## 0.916	## 0.871	## 0.665	## 0.767	## 0.890	## 0.887	## 0.903	## 0.957	## 0.972	## 0.811	## 0.840	## 0.940
## 0.661	## 0.856	## 0.815	## 0.815	## 0.781	# 0.608	## 0.748	** 0.516	## 0.911	## 0.881	## 0.684	## 0.732	## 0.909	## 0.880	## 0.884	## 0.904	## 0.956	## 0.790	## 0.862	## 0.931
## 0.701	## 0.825	## 0.788	## 0.754	## 0.712	# 0.608	## 0.736	** 0.553	## 0.862	## 0.890	# 0.617	## 0.698	## 0.860	## 0.826	## 0.850	## 0.847	## 0.922	## 0.725	## 0.817	## 0.899
## 0.667	## 0.732	## 0.621	## 0.667	## 0.638	** 0.560	## 0.700	* 0.462	## 0.736	## 0.749	** 0.465	# 0.597	## 0.718	## 0.684	## 0.750	## 0.815	## 0.840	# 0.630	## 0.688	## 0.832
## 0.652	## 0.892	## 0.940	## 0.845	## 0.769	# 0.603	## 0.781	# 0.591	## 0.971	## 0.976	## 0.773	## 0.760	## 0.982	## 0.956	## 0.909	## 0.888	## 0.984	## 0.840	## 0.951	## 0.937
# 0.583	## 0.864	## 0.962	## 0.831	## 0.757	** 0.566	## 0.746	# 0.585	## 0.966	## 0.977	## 0.807	## 0.759	## 1.000	## 0.971	## 0.890	## 0.836	## 0.958	## 0.820	## 0.952	## 0.893
## 0.639	## 0.825	## 0.897	## 0.757	## 0.701	# 0.586	## 0.735	** 0.532	## 0.913	## 0.975	## 0.675	## 0.709	## 0.950	## 0.903	## 0.848	## 0.831	## 0.963	## 0.756	## 0.904	## 0.887
-0.024	-0.063	-0.034	-0.032	0.035	-0.051	-0.023	0.144	-0.126	-0.101	0.044	0.062	-0.090	-0.027	-0.086	-0.194	-0.169	-0.112	-0.062	-0.203
0.163	0.256	0.120	0.252	0.274	0.073	0.192	* 0.375	0.113	0.116	0.183	0.331	0.131	0.130	0.095	0.149	0.117	0.093	0.179	0.112
* 0.441	* 0.466	0.292	** 0.485	# 0.579	# 0.641	** 0.533	* 0.402	* 0.397	0.279	* 0.416	** 0.501	0.340	* 0.404	* 0.443	* 0.447	* 0.407	* 0.426	0.366	* 0.398
# 0.632	## 0.773	## 0.702	## 0.805	## 0.746	** 0.557	## 0.702	# 0.617	## 0.772	## 0.656	## 0.743	## 0.707	## 0.720	## 0.765	## 0.789	## 0.757	## 0.723	## 0.733	## 0.705	## 0.760
0.280	** 0.488	* 0.380	* 0.457	* 0.426	0.233	* 0.424	0.307	** 0.471	* 0.383	0.321	0.331	* 0.399	* 0.413	* 0.408	** 0.560	** 0.483	** 0.554	** 0.483	** 0.534
0.276	** 0.484	* 0.377	* 0.450	* 0.412	0.257	* 0.422	0.303	** 0.475	* 0.386	0.325	0.328	* 0.402	* 0.415	* 0.425	** 0.561	** 0.479	** 0.552	** 0.491	** 0.540
# 0.604	** 0.548	0.145	** 0.521	** 0.540	# 0.586	* 0.446	* 0.389	* 0.406	0.206	0.289	* 0.464	0.256	0.307	** 0.539	# 0.584	* 0.410	0.319	0.279	** 0.570
# 0.596	** 0.536	0.131	** 0.511	** 0.530	# 0.580	* 0.432	* 0.377	* 0.395	0.192	0.285	* 0.454	0.244	0.295	** 0.527	** 0.574	* 0.397	0.312	0.266	** 0.556
** 0.542	** 0.480	0.178	** 0.470	* 0.446	* 0.439	** 0.495	0.294	0.361	0.216	0.243	* 0.416	0.250	0.250	* 0.415	** 0.521	* 0.386	0.360	0.279	** 0.490
** 0.504	* 0.447	0.211	* 0.446	* 0.432	* 0.369	0.327	0.173	* 0.410	0.258	0.278	0.280	0.317	0.307	** 0.483	** 0.556	* 0.445	0.342	0.308	** 0.575
# 0.602	* 0.443	0.206	* 0.417	* 0.423	** 0.522	0.284	0.135	* 0.399	0.250	0.290	0.367	0.302	0.310	** 0.497	** 0.520	* 0.418	0.290	0.271	** 0.535
** 0.491	# 0.540	0.360	** 0.537	** 0.507	* 0.420	* 0.399	0.229	** 0.557	* 0.404	* 0.432	0.347	** 0.472	** 0.470	# 0.627	## 0.658	** 0.570	** 0.475	* 0.433	## 0.679
0.335	0.271	0.097	0.288	0.288	0.298	0.102	-0.005	0.276	0.116	0.198	0.193	0.205	0.178	0.347	0.337	0.279	0.172	0.143	* 0.406
* 0.389	0.277	0.077	0.309	0.318	0.255	0.122	-0.011	0.248	0.084	0.186	0.189	0.174	0.152	0.321	0.352	0.266	0.156	0.134	0.391
0.307	0.325	0.266	0.321	0.345	0.317	0.135	0.042	0.373	0.270	0.289	0.271	0.349	0.287	* 0.376	0.312	* 0.368	0.225	0.285	* 0.436
-0.165	-0.232	-0.053	-0.263	-0.104	0.111	-0.246	-0.013	-0.184	-0.076	-0.052	-0.010	-0.079	-0.076	-0.273	-0.323	-0.182	-0.220	-0.093	-0.341
-0.064	-0.014	0.201	0.040	0.076	-0.082	0.008	0.056	0.030	0.113	0.266	0.107	0.143	0.137	0.022	-0.056	0.027	0.006	0.165	-0.133
* 0.413	0.194	0.095	0.180	0.191	0.330	0.240	0.089	0.176	0.153	0.028	0.322	0.150	0.159	0.182	0.323	0.252	0.249	0.122	0.245
# 0.609	# 0.636	* 0.391	# 0.645	## 0.664	* 0.457	** 0.539	0.313	** 0.572	* 0.397	** 0.491	* 0.469	** 0.474	** 0.504	## 0.660	## 0.717	# 0.581	** 0.509	** 0.494	## 0.684
** 0.499	** 0.530	* 0.391	** 0.560	** 0.559	* 0.383	* 0.458	0.187	** 0.515	* 0.375	** 0.481	* 0.395	* 0.457	** 0.473	** 0.576	# 0.639	** 0.524	** 0.479	** 0.474	# 0.584
** 0.477	** 0.571	* 0.420	** 0.590	** 0.560	* 0.406	* 0.393	0.288	** 0.569	* 0.423	** 0.512	* 0.388	** 0.504	* 0.466	## 0.581	** 0.556	** 0.543	* 0.457	** 0.486	## 0.657
0.344	* 0.371	0.039	* 0.369	0.359	0.363	0.280	0.248	0.249	0.073	0.157	0.251	0.117	0.168	0.346	0.472	0.264	0.258	0.148	* 0.406
** 0.478	** 0.524	0.340	** 0.551	** 0.500	* 0.371	* 0.372	0.206	** 0.517	0.340	* 0.418	0.348	* 0.421	* 0.416	** 0.567	# 0.589	** 0.507	* 0.418	* 0.398	# 0.633
** 0.527	# 0.588	* 0.416	# 0.618	# 0.581	* 0.389	* 0.417	0.283	** 0.570	* 0.414	** 0.514	* 0.392	** 0.494	* 0.470	# 0.598	## 0.601	** 0.555	* 0.463	** 0.479	## 0.670
0.276	0.342	0.292	0.351	0.327	0.359	0.173	0.080	* 0.414	0.287	0.334	0.326	* 0.371	0.330	* 0.423	0.330	* 0.372	0.281	0.284	* 0.454
0.295	0.340	0.275	0.353	0.333	0.351	0.171	0.072	* 0.399	0.267	0.322	0.323	0.354	0.313	* 0.413	0.330	0.362	0.266	0.271	* 0.450
0.117	0.180	0.131	0.179	0.165	0.351	0.037	-0.080	0.257	0.138	0.178	0.232	0.217	0.188	0.288	0.182	0.212	0.142	0.123	0.294

PCB 180	PCB 170/190	PCB 201	PCB 203	PCB 195	PCB 194	PCB 206	SPCB	Aroclor 1254:1260	Aroclor 1260	PCB 77	PCB 81	PCB 126	PCB 169	2378-TCDD	Total TCDD	12378-PCDD	Total PCDD	123478-H6CDD	123678-H6CDD

## 0.983																			
## 0.879	## 0.887																		
## 0.919	## 0.908	## 0.963																	
## 0.927	## 0.930	## 0.968	## 0.975																
## 0.955	## 0.926	## 0.923	## 0.934	## 0.932															
## 0.658	## 0.808	## 0.902	## 0.907	## 0.889	## 0.953														
## 0.977	## 0.979	## 0.912	## 0.943	## 0.949	## 0.924	## 0.818													
## 0.950	## 0.974	## 0.856	## 0.890	## 0.909	## 0.860	## 0.718	## 0.982												
## 1.000	## 0.983	## 0.879	## 0.919	## 0.927	## 0.955	## 0.858	## 0.977	## 0.950											
-0.143	-0.093	-0.240	-0.202	-0.251	-0.144	-0.218	-0.145	-0.090	-0.143										
0.125	0.127	0.137	0.138	0.137	0.155	0.142	0.125	0.131	0.125	0.152									
0.303	0.324	* 0.379	* 0.439	* 0.378	0.318	0.325	0.357	0.340	0.303	0.291	-0.226								
# 0.633	## 0.668	## 0.698	## 0.713	## 0.653	# 0.605	** 0.504	## 0.716	## 0.720	# 0.633	0.171	0.096	## 0.658							
* 0.425	* 0.391	** 0.559	** 0.536	** 0.545	* 0.441	** 0.512	** 0.474	* 0.399	* 0.425	* -0.367	* 0.377	0.085	0.366						
* 0.432	* 0.404	** 0.556	** 0.528	** 0.534	* 0.447	** 0.509	** 0.475	* 0.402	* 0.432	-0.329	0.410	0.082	* 0.388	## 0.990					
0.307	0.293	# 0.592	** 0.532	** 0.504	* 0.466	** 0.545	0.350	0.256	0.307	-0.219	0.300	0.287	0.350	* 0.417	* 0.418				
0.293	0.279	# 0.580	** 0.520	** 0.493	* 0.453	** 0.532	0.337	0.244	0.293	-0.217	0.297	0.285	0.341	* 0.414	* 0.414	## 0.999			
0.285	0.277	** 0.516	** 0.492	* 0.459	* 0.398	* 0.463	0.340	0.250	0.285	-0.333	0.126	0.264	0.362	* 0.422	* 0.424	# 0.638	# 0.636		
0.351	0.336	## 0.657	** 0.574	# 0.582	* 0.457	# 0.583	* 0.402	0.317	0.351	* -0.432	0.085	0.261	* 0.401	# 0.643	# 0.632	## 0.745	## 0.744	# 0.642	
0.326	0.311	# 0.580	** 0.509	** 0.516	* 0.399	* 0.470	* 0.373	0.302	0.326	* -0.431	0.142	0.265	* 0.390	** 0.523	** 0.524	## 0.786	## 0.786	# 0.587	## 0.896
** 0.482	** 0.479	## 0.745	## 0.670	## 0.674	** 0.555	# 0.642	** 0.535	** 0.472	** 0.482	* -0.390	0.049	0.318	** 0.506	## 0.666	## 0.658	## 0.687	## 0.685	** 0.490	## 0.946
0.186	0.199	** 0.470	* 0.372	* 0.402	0.250	0.341	0.242	0.205	0.186	-0.313	0.015	0.247	0.289	* 0.429	* 0.411	# 0.629	# 0.631	* 0.412	## 0.869
0.162	0.170	** 0.476	* 0.384	* 0.413	0.247	0.359	0.225	0.174	0.162	-0.302	0.044	0.267	0.313	* 0.457	* 0.440	# 0.629	# 0.631	** 0.526	## 0.903
0.305	0.327	* 0.464	* 0.393	* 0.456	0.297	0.323	0.353	0.349	0.305	-0.245	-0.029	0.265	0.275	0.356	0.332	* 0.466	* 0.466	0.282	## 0.692
-0.150	-0.120	-0.355	-0.275	-0.224	-0.281	-0.362	-0.176	-0.079	-0.150	0.205	0.114	0.152	-0.115	-0.148	-0.128	-0.295	-0.290	-0.361	-0.264
0.053	0.104	-0.109	-0.033	-0.021	-0.060	-0.150	0.069	0.143	0.053	0.305	0.266	0.126	0.157	-0.042	-0.019	* -0.401	* -0.398	-0.230	-0.364
0.200	0.179	0.300	0.323	0.319	0.281	0.349	0.203	0.150	0.200	-0.097	0.154	0.209	0.249	0.254	0.278	0.245	0.243	* 0.371	* 0.410
* 0.466	** 0.474	## 0.743	## 0.693	## 0.684	** 0.539	# 0.611	** 0.547	** 0.474	* 0.466	-0.269	0.162	* 0.440	## 0.618	## 0.710	## 0.709	## 0.696	## 0.693	## 0.681	## 0.856
* 0.421	* 0.444	## 0.651	# 0.612	# 0.623	* 0.446	** 0.503	** 0.505	* 0.457	* 0.421	-0.288	0.098	* 0.421	# 0.594	## 0.663	## 0.671	* 0.455	* 0.454	# 0.594	## 0.752
* 0.464	** 0.475	## 0.670	# 0.593	# 0.628	** 0.488	** 0.512	** 0.532	** 0.504	* 0.464	-0.346	0.008	0.355	** 0.533	** 0.534	** 0.522	# 0.615	# 0.612	** 0.513	## 0.873
0.187	0.164	** 0.476	* 0.421	* 0.373	0.336	* 0.459	0.226	0.117	0.187	-0.276	0.273	0.172	0.206	* 0.413	* 0.407	## 0.676	## 0.675	** 0.496	** 0.508
* 0.395	* 0.396	## 0.665	# 0.591	# 0.588	* 0.445	** 0.511	** 0.472	* 0.421	* 0.395	-0.352	0.047	0.336	** 0.529	# 0.601	# 0.586	## 0.669	## 0.665	** 0.547	## 0.921
* 0.463	* 0.468	## 0.699	# 0.628	# 0.646	** 0.508	** 0.551	** 0.536	** 0.494	* 0.463	-0.320	0.037	* 0.378	** 0.575	** 0.566	** 0.555	# 0.636	# 0.632	** 0.571	## 0.908
0.297	0.337	* 0.438	* 0.372	* 0.411	0.279	0.265	0.357	* 0.371	0.297	-0.158	-0.077	0.298	0.345	0.265	0.250	* 0.428	* 0.427	0.239	# 0.612
0.282	0.321	* 0.441	* 0.373	* 0.413	0.274	0.269	0.345	0.354	0.282	-0.164	-0.068	0.301	0.346	0.272	0.256	* 0.450	* 0.449	0.283	# 0.642
0.167	0.211	0.279	0.203	0.242	0.149	0.136	0.201	0.217	0.167	-0.069	-0.142	0.245	0.181	0.114	0.103	0.335	0.339	0.074	* 0.399

123789-H6CDD	Total H6CDD	1234678-H7CDD	Total H7CDD	OCDD	2378-TCDF	Total TCDF	12378-PCDF	23478-PCDF	Total PCDF	123478-H6CDF	234678-H6CDF	123678-H6CDF	Total H6CDF	1234678-H7CDF	Total H7CDF

## 0.842															
## 0.859	## 0.851														
## 0.865	## 0.834	## 0.964													
## 0.716	## 0.712	## 0.916	## 0.848												
-0.081	-0.240	-0.083	-0.118	0.045											
-0.260	-0.281	-0.310	-0.261	-0.209	* 0.405										
* 0.434	0.280	0.243	* 0.388	0.145	0.127	-0.022									
## 0.790	## 0.857	## 0.666	## 0.745	** 0.526	-0.263	-0.042	0.347								
## 0.699	## 0.751	** 0.553	## 0.670	* 0.428	-0.108	0.154	** 0.487	## 0.927							
## 0.794	## 0.898	## 0.886	## 0.858	## 0.846	-0.163	-0.276	0.185	## 0.757	# 0.645						
** 0.495	** 0.475	0.350	* 0.413	0.157	-0.308	-0.234	0.158	# 0.591	* 0.460	0.297					
## 0.845	## 0.936	## 0.909	## 0.901	## 0.797	-0.260	-0.265	0.203	## 0.837	## 0.712	## 0.954	* 0.435				
## 0.810	## 0.919	## 0.876	## 0.886	## 0.797	-0.217	-0.244	0.258	## 0.830	## 0.730	## 0.983	* 0.383	## 0.974			
## 0.654	## 0.674	## 0.872	## 0.775	## 0.945	0.054	-0.205	0.084	* 0.465	* 0.367	## 0.828	0.110	## 0.760	## 0.774		
## 0.678	## 0.684	## 0.892	## 0.811	## 0.953	0.036	-0.209	0.120	** 0.494	* 0.398	## 0.840	0.134	## 0.799	## 0.795	## 0.997	
** 0.518	** 0.479	## 0.750	# 0.621	## 0.854	0.122	-0.192	-0.033	0.257	0.171	# 0.608	0.113	** 0.572	** 0.540	## 0.914	## 0.902

Table 18. Correlation matrix between heavy metals found in livers (ppm, dw) of 30 river otters collected from the Lower Columbia River during the 1994-95 trapping season.

	Cadmium	Chromium	Copper	Iron	Manganese	Mercury	Vanadium
Chromium	0.063						
Copper	0.148	** 0.547					
Iron	0.149	# -0.565	## -0.717				
Manganese	0.256	** 0.532	## 0.753	## -0.671			
Mercury	0.019	0.284	0.185	-0.295	0.230		
Vanadium	0.074	0.026	* 0.366	-0.150	0.301	0.009	
Zinc	-0.090	0.346	0.323	-0.216	# 0.564	0.147	0.237

Significance: * = P≤0.05, ** = P≤0.01, # = P≤0.001, ## = P≤0.0001

Table 19. Correlation matrix between heavy metals found in kidneys (ppm, dw) of 30 river otters collected from the Lower Columbia River during the 1994-95 trapping season.

	Cadmium	Chromium	Copper	Iron	Manganese	Nickel	Vanadium
Chromium	0.070						
Copper	0.227	## 0.806					
Iron	0.033	-0.031	-0.082				
Manganese	0.253	0.241	0.334	0.289			
Nickel	0.271	** 0.496	0.292	0.221	0.140		
Vanadium	0.095	** -0.464	-0.342	** 0.535	0.258	0.060	
Zinc	0.208	0.197	0.344	* 0.412	## 0.730	0.206	0.343

Significance: * = P≤0.05, ** = P≤0.01, # = P≤0.001, ## = P≤0.0001

Table 20. Linear regression (probability of F) for age class 0 river otter between contaminants ($\log_{10}$) and testes weight, baculum weight and baculum length.

	testes wt.	bac wt.	bac lg.
Contaminant (n)	6	8	8
Hexachlorobenzene	NS	NS	NS
Octachlorostyrene	NS	NS	NS
Trans-nonachlor	-0.04	NS	NS
p,p'-DDE	NS	NS	NS
Mirex	-0.007	-0.02	NS
Oxychlordane	-0.05	NS	NS
Cis-chlordane	NS	NS	NS
p,p'-DDD	-0.03	-0.03	-0.05
Cis-nonachlor	NS	NS	NS
Heptachlor epoxide	-0.005	NS	NS
Dieldrin	-0.01	NS	NS
PCB 28	NS	NS	NS
PCB 52	-0.01	-0.01	-0.03
PCB 49	NS	-0.01	-0.04
PCB 44	-0.01	-0.002	-0.04
PCB 74	-0.03	-0.0009	-0.03
PCB 70	NS	NS	NS
PCB 66/95	NS	-0.006	-0.02
PCB 60	NS	NS	NS
PCB 101	-0.001	-0.002	-0.02
PCB 99	-0.0008	-0.03	NS
PCB 87	-0.03	-0.0005	-0.01
PCB 110	-0.04	-0.0001	-0.007
PCB 151	NS	-0.05	NS
PCB 149	-0.0001	-0.01	-0.04
PCB 118	-0.003	-0.001	-0.03
PCB 146	-0.0002	-0.01	-0.05
PCB 153	-0.001	-0.006	-0.05

Table 20. (continued).

PCB 105	-0.0008	-0.02	NS
PCB 141	NS	-0.003	-0.003
PCB 138	-0.001	-0.007	-0.05
PCB 158	-0.03	-0.002	-0.02
PCB 129	-0.001	-0.02	-0.05
PCB 182/187	-0.0005	-0.02	NS
PCB 183	-0.001	-0.007	-0.05
PCB 171	-0.03	-0.04	NS
PCB 200	NS	-0.008	NS
PCB 172	-0.007	-0.009	-0.04
PCB 180	-0.03	-0.01	NS
PCB 170/190	-0.02	-0.01	NS
PCB 201	-0.03	-0.02	NS
PCB 203	-0.02	-0.02	NS
PCB 195	-0.02	-0.009	NS
PCB 194	NS	NS	NS
PCB 206	NS	NS	NS
S PCB	-0.004	-0.01	NS
Aroclor 1254:1260	-0.001	-0.007	-0.05
Aroclor 1260	-0.03	-0.01	NS
PCB 77	NS	NS	NS
PCB 81	NS	NS	NS
PCB 126	-0.04	-0.01	-0.05
PCB 169	NS	NS	NS
2378-TCDD	NS	NS	NS
TCDD Total	NS	NS	NS
12378-PCDD	NS	NS	NS
PCDD Total	NS	NS	NS
123678-H6CDD	NS	NS	NS
123789-H6CDD	NS	NS	NS

Table 20. (continued).

H6CDD Total	NS	NS	NS
1234678-H7CDD	NS	-0.05	NS
H7CDD Total	NS	NS	NS
OCDD	NS	-0.009	-0.009
2378-TCDF	NS	NS	NS
TCDF Total	NS	NS	NS
23478-PCDF	-0.01	NS	NS
PCDF Total	-0.04	NS	NS
123478-H6CDF	NS	NS	NS
234678-H6CDF	NS	NS	NS
123678-H6CDF	NS	NS	NS
H6CDF Total	NS	NS	NS
1234678-H7CDF	NS	-0.03	-0.006
H7CDF Total	NS	-0.03	-0.007
OCDF	NS	NS	-0.04
Total TEQ[a]	**NS**	**-0.03**	**NS**
Cadmium (liver)	NS	NS	NS
Cadmium (kidney)	NS	NS	NS
Copper (liver)	NS	NS	NS
Copper (kidney)	NS	NS	NS
Chromium (liver)	NS	NS	-0.02
Chromium (kidney)	NS	NS	NS
Iron (liver)	NS	+0.04	+0.02
Iron (kidney)	NS	NS	NS
Manganese (liver)	NS	NS	NS
Manganese (kidney)	NS	NS	NS
Zinc (liver)	NS	NS	NS
Zinc (kidney)	NS	NS	NS
Mercury (liver)	NS	NS	NS
Vanadium (liver)	NS	NS	NS
Vanadium (kidney)	NS	+0.05	NS
Nickel (kidney)	NS	NS	NS

NS = Not Significant P>0.05

[a] = Total TEQ based on Safe (1990, 1994).

Table 21. Multiple regression (probability of T) for age class 0 river otter between capture date and contaminants ($\log_{10}$) and testes weight, baculum weight, baculum length.

	testes wt.		baculum wt.		baculum length	
Contaminant	Date	Residue	Date	Residue	Date	Residue
Hexachlorobenzene	NS	NS	NS	NS	NS	NS
Octachlorostyrene	NS	NS	NS	NS	NS	NS
Trans-nonachlor	NS	NS	NS	NS	NS	NS
p,p'-DDE	NS	NS	+0.01	-0.007	NS	-0.04
Mirex	NS	NS	NS	-0.03	NS	NS
Oxychlordane	NS	NS	NS	NS	NS	NS
Cis-chlordane	NS	NS	NS	-0.04	NS	NS
p,p'-DDD	NS	NS	+0.03	-0.006	NS	-0.03
Cis-nonachlor	NS	NS	NS	-0.05	NS	NS
Heptachlor epoxide	NS	-0.02	NS	NS	NS	NS
Dieldrin	NS	NS	+0.03	-0.02	NS	-0.05
PCB 28	NS	NS	NS	NS	NS	NS
PCB 52	NS	NS	NS	-0.005	NS	-0.03
PCB 49	NS	NS	NS	-0.01	NS	NS
PCB 44	NS	NS	NS	-0.009	NS	NS
PCB 74	NS	NS	NS	-0.003	NS	NS
PCB 70	NS	NS	NS	NS	NS	NS
PCB 66/95	NS	NS	NS	-0.005	NS	-0.03
PCB 60	NS	NS	NS	NS	NS	NS
PCB 101	NS	-0.005	NS	-0.002	NS	-0.04
PCB 99	NS	-0.01	NS	-0.03	NS	NS
PCB 87	NS	NS	+0.02	-0.0002	NS	-0.02
PCB 110	NS	NS	+0.05	-0.0001	NS	-0.02
PCB 151	NS	NS	NS	-0.05	NS	NS
PCB 149	NS	-0.0009	+0.02	-0.002	NS	-0.04
PCB 118	NS	-0.02	NS	-0.005	NS	NS
PCB 146	NS	-0.001	NS	-0.004	NS	-0.05
PCB 153	NS	-0.005	NS	-0.005	NS	NS
PCB 105	NS	-0.009	NS	-0.04	NS	NS
PCB 141	NS	NS	NS	-0.004	NS	-0.006
PCB 138	NS	-0.003	NS	-0.004	NS	NS

Table 21. (continued).

PCB 158	NS	NS	NS	-0.002	NS	-0.04
PCB 129	NS	-0.02	NS	-0.008	NS	-0.05
PCB 182/187	NS	-0.002	+0.004	-0.0005	NS	-0.03
PCB 183	NS	-0.004	+0.02	-0.001	NS	-0.04
PCB 171	NS	NS	NS	-0.02	NS	NS
PCB 200	NS	NS	NS	-0.008	NS	NS
PCB 172	NS	-0.02	+0.002	-0.0002	NS	-0.02
PCB 180	NS	NS	+0.03	-0.004	NS	NS
PCB 170/190	NS	NS	+0.03	-0.003	NS	NS
PCB 201	NS	NS	+0.004	-0.0006	NS	-0.04
PCB 203	NS	NS	+0.004	-0.0005	NS	-0.04
PCB 195	NS	NS	+0.008	-0.0006	NS	-0.05
PCB 194	NS	NS	+0.02	-0.01	NS	NS
PCB 206	NS	NS	+0.01	-0.008	NS	NS
S PCB	NS	-0.02	+0.03	-0.003	NS	NS
Aroclor 1254:1260	NS	-0.003	NS	-0.004	NS	NS
Aroclor 1260	NS	NS	+0.03	-0.004	NS	NS
PCB 77	NS	NS	NS	NS	NS	NS
PCB 81	-0.05	-0.04	NS	NS	NS	NS
PCB 126	NS	NS	+0.008	-0.001	NS	NS
PCB 169	NS	NS	NS	NS	NS	NS
2378-TCDD	NS	NS	NS	NS	NS	NS
TCDD Total	NS	NS	NS	NS	NS	NS
12378-PCDD	NS	NS	NS	NS	NS	NS
PCDD Total	NS	NS	NS	NS	NS	NS
123678-H6CDD	NS	NS	NS	NS	NS	NS
123789-H6CDD	+0.004	+0.007	NS	NS	NS	NS
H6CDD Total	NS	NS	NS	NS	NS	NS
1234678-H7CDD	NS	NS	NS	-0.02	NS	NS
H7CDD Total	NS	NS	NS	NS	NS	NS
OCDD	NS	NS	NS	-0.004	NS	-0.006
2378-TCDF	NS	NS	NS	NS	NS	NS
TCDF Total	NS	NS	NS	NS	NS	NS

Table 21. (continued).

23478-PCDF	NS	-0.01	+0.04	-0.01	NS	NS
PCDF Total	NS	NS	NS	-0.03	NS	NS
123478-H6CDF	NS	NS	+0.04	-0.02	NS	NS
234678-H6CDF	NS	NS	NS	NS	NS	NS
123678-H6CDF	NS	NS	NS	NS	NS	NS
H6CDF Total	NS	NS	NS	NS	NS	NS
1234678-H7CDF	NS	NS	NS	-0.02	+0.03	-0.001
H7CDF Total	NS	NS	NS	-0.02	+0.04	-0.002
OCDF	NS	NS	NS	NS	NS	NS
Total TEQ[a]	NS	NS	+0.02	-0.01	NS	NS
Cadmium (liver)	NS	NS	NS	NS	NS	NS
Cadmium (kidney)	NS	NS	NS	NS	NS	NS
Copper (liver)	NS	NS	NS	NS	NS	NS
Copper (kidney)	NS	NS	NS	NS	NS	NS
Chromium (liver)	NS	NS	NS	NS	NS	-0.05
Chromium (kidney)	NS	NS	NS	NS	NS	NS
Iron (liver)	NS	NS	NS	NS	NS	NS
Iron (kidney)	NS	NS	NS	NS	NS	NS
Manganese (liver)	NS	NS	NS	NS	NS	NS
Manganese (kidney)	NS	NS	NS	NS	NS	NS
Zinc (liver)	NS	NS	NS	NS	NS	NS
Zinc (kidney)	NS	NS	NS	NS	NS	NS
Mercury (liver)	NS	NS	NS	NS	NS	NS
Vanadium (liver)	NS	NS	NS	NS	NS	NS
Vanadium (kidney)	NS	NS	NS	NS	NS	NS
Nickel (kidney)	NS	NS	NS	NS	NS	NS

NS = Not Significant P>0.05.

[a] Total TEQ based on Safe (1990, 1994).

Table 22. Significant regression relationships between contaminant concentrations ($\log_{10}$) in the liver of male river otter (Reference Area and Lower Columbia River combined) and liver parameters and spleen weight.

	Contaminant (P value)			
Category	**Liver (% Lipid)**	**Liver wt. (g)**	**Liver wt.(g)/Carcass wt.(g)**	**Spleen wt. (g)**
Age Class 0 (n=8)				
OCs				
PCBs		PCB206 +0.04	PCB206 +0.03	
Dioxins		2378-TCDD +0.05		123678-H6CDD +0.002
		TCDD Total +0.002	TCDD Total +0.03	H6CDD Total +0.003
				H7CDD Total +0.02
Furans	TCDF Total +0.01	PCDF Total +0.02	PCDF Total +0.02	123478-H6CDF +0.05
			23478-PCDF +0.05	234678-H6CDF +0.03
				123678-H6CDF +0.04
				H6CDF Tota l +0.02
Metals				
Total TEQ				
Age Class 1 (n=6)				
OCs	Trans-Chlor +0.04	p,p'-DDE +0.007	p,p'-DDE +0.0008	p,p'-DDE +0.03
		p,p'-DDD +0.005	p,p'-DDD +0.03	p,p'-DDD +0.04
		Heptachlor epoxide +0.0005	Heptachlor epoxide +0.005	Heptachlor epoxide +0.006
		Dieldrin +0.003	Dieldrin +0.007	Dieldrin +0.01
		Cis-Nonachlor +0.01		
PCBs	PCB118 +0.05	PCB99 +0.007	PCB206 +0.05	PCB99 +0.05
		PCB146 +0.003	PCB146 +0.005	
		PCB153 +0.001	PCB153 +0.01	PCB153 +0.04
		PCB138 +0.003	PCB138 +0.02	PCB138 +0.03
		PCB182/187 +0.01	PCB182/187 +0.001	
		PCB183 +0.002	PCB183 +0.003	PCB183 +0.03
		PCB180 +0.007	PCB180 +0.008	PCB180 +0.04
		PCB170/190 +0.009	PCB170/190 +0.008	PCB170/190 +0.04
		PCB194 +0.04	PCB201 +0.02	PCB49 +0.05
		∑PCBs +0.004	∑PCBs +0.009	∑PCBs +0.03
		Aroclor 1254:1260 +0.003	Aroclor 1254:1260 +0.02	Aroclor 1254:1260 +0.02
		Aroclor 1260 +0.007	Aroclor 1260 +0.008	Aroclor 1260 +0.04
		PCB44 -0.03	PCB44 -0.03	PCB44 -0.004
		PCB66/95 +0.03	PCB52 +0.04	
		PCB60 +0.04		PCB60 +0.04
		PCB158 +0.005	PCB158 +0.03	
		PCB129 +0.02	PCB129 +0.003	
		PCB171 +0.03	PCB171 +0.02	
		PCB200 +0.03		

Table 22. (continued).

			PCB172	+0.03	PCB172	+0.007		
			PCB203	+0.01	PCB203	+0.005	PCB203	+0.03
			PCB195	+0.01	PCB195	+0.008	PCB195	+0.02
Dioxins								
Furans								
Total TEQ								
Metals	Cd	+0.03	Cr	-0.02			Cr	-0.003
	Cd (K)	+0.05					V	-0.03
Age Class 2+ (n=12)								
OCs	p,p'-DDE	+0.03						
	β-HCH	+0.02						
PCBs	PCB180	+0.04						
	PCB194	+0.04						
	PCB206	+0.02						
	Aroclor 1260	+0.04						
Dioxins							OCDD	+0.01
Furans							234678-H6CDF	-0.05
							H7CDF Total	+0.02
							OCDF	+0.02
Total TEQ								
Metals	Fe	+0.007	Zn	-0.03			Zn	-0.03
	Mn	-0.004	Mn(k)	-0.02				
	Cr(k)	-0.008	Zn(k)	-0.01				
	Ni(k)	-0.03						

NOTE: Organic contaminants (ww), heavy metals (dw). For heavy metals, concentrations in kidneys (k) were also evaluated (except mercury).

Table 23. A comparison of expected PCB liver concentrations (ppb,ww) in age class 1 and 2+ river otter males and females from the Lower Columbia River with.observed PCB concentrations. Expected PCB concentrations are based on findings for PCB 153 which is relatively stable.

	Males + Females (Lower Columbia River)						
PCB#	Obs"O"	Exp."1"[a]	Obs"1"	Obs"1"-Exp."1"(%)[b]	Exp."2"[c]	Obs"2"	Obs"2"-Exp."2"(%)[b]
153	40.43	81.26	81.26	0	86.94	86.94	0
99	14.53	29.20	26.75	-2.45(-8)	31.25	27.63	-3.62(-12)
118	2.95	5.93	3.26	-2.67(-45)	6.34	3.47	-2.87(-45)
146	4.38	8.80	7.25	-1.55(-18)	9.42	8.39	-1.03(-11)
138	58.94	118.46	120.67	+2.21(+2)	126.74	136.11	+9.37(+7)
182/187	14.73	29.61	15.55	-14.06 (-47)	31.68	25.92	-5.76(-18)
183	5.08	10.21	8.68	-1.53(-15)	10.92	11.11	+0.19(+2)
180	31.59	63.49	62.07	-1.42(-2)	67.93	73.72	+5.79(+9)
170/190	19.36	38.91	41.65	+2.74(+7)	41.63	47.65	+6.02(+14)
201	12.53	25.18	14.90	-10.28(-41)	26.94	19.68	-7.26(-27)
194	4.56	9.17	7.13	-2.04(-22)	9.81	9.35	-0.46(-5)
206	3.52	7.07	3.89	-3.18(-45)	7.57	5.88	-1.69(-22)
28	0.25	0.50	0.22	-0.28(-56)	0.54	0.21	-0.33(-61)
52	1.96	3.94	2.96	-0.98(-25)	4.21	3.73	-0.48(-11)
49	0.46	0.92	0.53	-0.39(-42)	0.99	0.69	-0.30(-30)
44	0.80	1.61	0.75	-0.86(-53)	1.72	0.73	-0.99(-58)
74	0.78	1.57	0.31	-1.26(-80)	1.68	0.40	-1.28(-76)
70	0.15	0.30	0.12	-0.18(-60)	0.32	0.24	-0.08(-25)
66/95	0.77	1.55	0.90	-0.65(-42)	1.66	1.52	-0.14(-8)
60	0.82	1.65	0.98	-0.67(-41)	1.76	1.18	-0.58(-33)
101	3.09	6.21	3.81	-2.40(-39)	6.64	4.96	-1.68(-25)
87	1.58	3.18	1.83	-1.35(-.42)	3.40	2.71	-0.69(-20)
110	1.15	2.31	1.11	-1.20(-52)	2.47	1.64	-0.83(-34)
151	0.58	1.17	0.57	-0.60(-52)	1.25	0.86	-0.39(-31)
149	1.04	2.09	1.02	-1.07(-51)	2.24	1.66	-0.58(-26)
105	2.00	4.02	2.64	-1.38(-34)	4.30	3.16	-1.14(-27)
141	0.28	0.56	0.36	-0.20(-36)	0.60	0.54	-0.06(-10)
158	1.15	2.31	2.03	-0.28(-12)	2.47	2.30	-0.17(-7)
129	1.34	2.69	1.80	-0.89(-33)	2.88	2.18	-0.70(-24)
171	1.97	3.96	2.51	-1.45(-37)	4.24	2.87	-1.37(-32)
200	1.68	3.38	2.59	-0.79(-23)	3.61	2.95	-0.66(-18)
172	0.81	1.63	1.10	-0.53(-33)	1.74	1.26	-0.48(-28)
203	4.32	8.68	5.68	-3.00(-35)	9.29	8.26	-1.03(-11)
195	2.23	4.48	3.02	-1.46(-33)	4.80	4.35	-0.45(-9)
SPCB	244.51	491.44	434.31	-57.13(-12)	525.79	508.98	-16.81(-3)
Aroclor 1254:1260	796.34	1600.56	1630.42	+29.86(+2)	1712.45	1839.08	+126.63(+7)

Table 23. (continued).

Aroclor 1260	277.08	556.90	544.50	-12.40(-2)	595.83	646.70	+50.87(+9)

[a] Expected "1" is calculated by observation "0" x 2.0099 (the increase from the geometric mean for PCB 153 in age class 0 to age class 1.

[b] % (change from expected)

[c] Expected "2" follows the same logic, i.e., observation "0" x 2.1504 (the increase from the geometric means for PCB 153 in age class 0 to age class 2.

Table 24. Regression equations showing the relationships between OCs in liver and fat and PCBs in liver and fat (adjusted to lipid weight) for 30 river otter from the Lower Columbia River plus 1 pooled Reference Area sample (n=31).

Contaminant	Equation	R^2	Prob>F	Slope [a]
Hexachlorobenzene	Y = 47.978 + 0.376X	0.344	0.0003	-
Octachlorostyrene	Y = 5.532 + 0.619X	0.334	0.0004	-
Cis-nonachlor	Y = 1.237 + 1.133X	0.932	0.0001	+
Trans-nonachlor	Y = -74.332 + 2.495X	0.912	0.0001	+
p,p'-DDE	Y = 941.682 + 0.932X	0.947	0.0001	NS
p,p'-DDD	Y = -19.613 + 0.848X	0.988	0.0001	-
Mirex	Y = 6.500 + 0.518X	0.254	0.0023	-
β-HCH	Y = 1.413 + 0.356X	0.086	0.0599	
Oxychlordane	Y = -95.277 + 1.177X	0.709	0.0001	NS
Cis-chlordane	Y = 6.084 + 0.694X	0.978	0.0001	-
Trans-chlordane	Y = -0.160 + 0.876X	0.981	0.0001	-
Heptachlor Epoxide	Y = -1.429 + 0.840X	0.925	0.0001	-
Dieldrin	Y = -82.329 + 1.169X	0.961	0.0001	+
PCB 28	Y = 2.572 + 0.110X	0.052	0.1150	
PCB 44	Y = 8.897 + 0.128X	-0.010	0.4036	
PCB 49	Y = -4.246 + 1.201X	0.832	0.0001	+
PCB 52	Y = -22.289 + 1.000X	0.991	0.0001	NS
PCB 60	Y = -4.758 + 1.261X	0.736	0.0001	NS
PCB 64	Y = -0.956 + 1.477X	0.462	0.0001	NS
PCB 66/95	Y = -2.634 + 0.750X	0.950	0.0001	-
PCB 70	Y = 5.331 + 0.238X	0.068	0.0848	
PCB 74	Y = 13.413 + 0.685X	0.275	0.0015	NS
PCB 87	Y = -33.593 + 1.109X	0.966	0.0001	+
PCB 99	Y = -545.802 + 2.065X	0.896	0.0001	+
PCB 105	Y = 17.975 + 0.660X	0.449	0.0001	-

Table 24. (continued)

Contaminant	Equation	R^2	Prob>F	Slope
PCB 101	Y = -66.215 + 1.447X	0.941	0.0001	+
PCB 110	Y = -16.566 + 1.225X	0.843	0.0001	+
PCB 118	Y = -27.731 + 1.431X	0.747	0.0001	+
PCB 129	Y = -23.032 + 1.302X	0.865	0.0001	+
PCB 138	Y = -1408.418 + 1.186X	0.863	0.0001	+
PCB 141	Y = -11.157 + 2.119X	0.929	0.0001	+
PCB 146	Y = -122.087 + 1.586X	0.898	0.0001	+
PCB 149	Y = -20.772 + 1.392X	0.950	0.0001	+
PCB 151	Y = -4.081 + 0.887X	0.817	0.0001	NS
PCB 153	Y = -1206.629 + 1.808X	0.791	0.0001	+
PCB 158	Y = -11.881 + 1.378X	0.731	0.0001	+
PCB 170/190	Y = -272.132 + 1.117X	0.680	0.0001	NS
PCB 171	Y = 28.957 + 1.613X	0.384	0.0001	NS
PCB 172	Y = -30.747 + 2.188X	0.862	0.0001	+
PCB 180	Y = -897.061 + 1.898X	0.746	0.0001	+
PCB 182/187	Y = -120.212 + 0.548X	0.914	0.0001	-
PCB 183	Y = -136.146 + 1.374X	0.819	0.0001	+
PCB 194	Y = -57.744 + 1.800X	0.693	0.0001	+
PCB 195	Y = -15.268 + 1.052X	0.742	0.0001	NS
PCB 200	Y = -44.204 + 1.329X	0.887	0.0001	+
PCB 201	Y = -35.099 + 0.498X	0.715	0.0001	-
PCB 203	Y = -48.491 + 1.073X	0.779	0.0001	NS
PCB 206	Y = 3.577 + 1.078X	0.681	0.0001	NS
Aroclor 1254:1260	Y = -19032.679 + 1.186X	0.863	0.0001	+
Aroclor 1260	Y = -7868.965 + 1.898X	0.746	0.0001	+
SPCBS	Y = -4930.492 + 1.372X	0.844	0.0001	+

* Slope significantly different ($P \leq 0.05$) if 2SE of slope does not overlap 1.00; - (liver has higher concentrations), + (fat has higher concentrations), and NS (slope not significantly different from 1.00). Note: liver (X) and fat (Y) in the equations.

Table 25. Fish collected in 1970, 1971, 1972, 1973, 1974, 1976, 1978, 1981, and 1984 and analyzed as part of the National Contaminant Monitoring Program (after Schmitt et al. 1981, Schmitt et al. 1983, Schmitt et al. 1985, Schmitt et al. 1990) and 1986 (after Anthony et al. 1993) for organochlorine contaminants (ppb ww, total carcass).

Species[a]	DDE	DDD	DDT	Cis-chlor	Trans-chlor	Cis-non	Trans-non	Oxy-chlor	Hepta-chlor	Endrin	Dieldrin	HCB	α-BHC	γ-BHC	Toxa-phene	PCBs
Columbia River at Cascade Locks, RM-149																
1970																
largescale sucker	220.0	120.0	80.0	-[b]	-	-	-	-	ND[c]	ND	10.0	-	10.0	-	-	440.0
northern squawfish	1410.0	510.0	230.0	-	-	-	-	-	ND	ND	10.0	-	10.0	-	-	2080.0
northern squawfish	930.0	340.0	180.0	-	-	-	-	-	ND	ND	10.0	-	10.0	-	-	1410.0
1971																
carp	110.0	30.0	20.0	-	-	-	-	-	ND	10.0	10.0	-	-	-	ND	130.0
carp	250.0	100.0	30.0	-	-	-	-	-	ND	ND	10.0	-	-	-	ND	250.0
largescale sucker	320.0	220.0	200.0	-	-	-	-	-	ND	ND	10.0	-	-	-	ND	290.0
largescale sucker	470.0	370.0	270.0	-	-	-	-	-	ND	ND	10.0	-	-	-	ND	950.0
northern squawfish	940.0	240.0	80.0	-	-	-	-	-	ND	ND	10.0	-	-	-	ND	980.0
northern squawfish	850.0	190.0	60.0	-	-	-	-	-	ND	10.0	10.0	-	-	-	ND	830.0
1972																
carp	500.0	180.0	ND	-	-	-	-	-	ND	ND	ND	-	-	-	ND	100.0
largescale sucker	470.0	380.0	240.0	-	-	-	-	-	ND	ND	ND	-	-	-	ND	1400.0
1973																
carp	230.0	ND	ND	-	-	-	-	-	ND	ND	ND	-	-	-	ND	ND
largescale sucker	280.0	110.0	ND	-	-	-	-	-	ND	ND	ND	-	-	-	ND	800.0
largescale sucker	220.0	170.0	ND	-	-	-	-	-	ND	ND	ND	-	-	-	ND	930.0
northern squawfish	240.0	ND	ND	-	-	-	-	-	ND	ND	ND	-	-	-	ND	500.0

Table 25. (continued).

Species	DDE	DDD	DDT	Cis-chlor	Trans-chlor	Cis-non	Trans-non	Oxy-chlor	Hepta-chlor	Endrin	Dieldrin	HCB	α-BHC	γ-BHC	Toxa-phene	PCBs
Columbia River at Cascade Locks, RM-149																
1974																
carp	320.0	120.0	ND	-	-	-	-	-	ND	ND	ND	-	-	-	ND	180.0
largescale sucker	2000.0	ND	ND	-	-	-	-	-	ND	ND	ND	-	-	-	ND	ND
largescale sucker	20.0	ND	ND	-	-	-	-	-	ND	ND	ND	-	-	-	ND	ND
northern squawfish	1200.0	280.0	ND	-	-	-	-	-	ND	ND	ND	-	-	-	ND	2600.0
1976																
largescale sucker	180.0	40.0	10.0	20.0	10.0	10.0	20.0	-	ND	ND	10.0	10.0	70.0	10.0	ND	600.0
largescale sucker	90.0	70.0	30.0	50.0	10.0	ND	ND	-	ND	ND	10.0	10.0	70.0	20.0	ND	2800.0
northern squawfish	270.0	120.0	20.0	320.0	190.0	ND	ND	-	ND	10.0	20.0	ND	10.0	ND	100.0	2000.0
1978																
largescale sucker	230.0	140.0	30.0	20.0	ND	ND	10.0	ND	ND	10.0	10.0	ND	ND	ND	ND	240.0
largescale sucker	350.0	210.0	40.0	30.0	10.0	10.0	20.0	ND	ND	ND	10.0	ND	10.0	ND	100.0	400.0
northern squawfish	360.0	30.0	ND	10.0	ND	10.0	20.0	ND	ND	ND	ND	ND	ND	ND	100.0	800.0
1981																
largescale sucker	470.0	220.0	70.0	20.0	20.0	10.0	20.0	ND	ND	ND	10.0	10.0	ND	ND	100.0	200.0
largescale sucker	610.0	200.0	30.0	10.0	20.0	10.0	10.0	ND	ND	ND	10.0	10.0	10.0	ND	200.0	400.0
northern squawfish	640.0	140.0	ND	10.0	20.0	10.0	30.0	ND	ND	ND	10.0	ND	ND	ND	100.0	500.0
1984																
largescale sucker	730.0	230.0	50.0	10.0	10.0	10.0	20.0	10.0	ND	ND	10.0	10.0	10.0	ND	100.0	500.0
northern squawfish	560.0	120.0	ND	10.0	10.0	10.0	10.0	ND	ND	ND	10.0	ND	ND	ND	100.0	600.0

Table 25. (continued).

Species	DDE	DDD	DDT	Cis-chlor	Trans-chlor	Cis-non	Trans-non	Oxy-chlor	Hepta-chlor	Endrin	Dieldrin	HCB	α-BHC	γ-BHC	Toxa-phene	PCBs
Columbia River, RM 18-22																
1986																
largescale sucker	70.0	80.0	20.0	-	-	-	-	-	-	-	-	-	-	-	-	850.0
peamouth	410.0	150.0	ND	-	-	-	-	-	-	-	-	-	-	-	-	2100.0
american shad	70.0	100.0	50.0	-	-	-	-	-	-	-	-	-	-	-	-	380.0
northern squawfish	200.0	210.0	80.0	-	-	-	-	-	-	-	-	-	-	-	-	1700.0
Willamette River, Oregon City, OR																
1970																
carp	340.0	350.0	110.0	-	-	-	-	-	ND	ND	70.0	-	60.0	-	-	1250.0
largescale sucker	570.0	720.0	810.0	-	-	-	-	-	ND	ND	40.0	-	60.0	-	-	2400.0
largescale sucker	640.0	770.0	440.0	-	-	-	-	-	ND	ND	40.0	-	40.0	-	-	4580.0
1971																
largescale sucker	250.0	320.0	210.0	-	-	-	-	-	ND	ND	10.0	-	-	-	ND	1670.0
largescale sucker	250.0	350.0	180.0	-	-	-	-	-	ND	ND	20.0	-	-	-	ND	1350.0
northern squawfish	370.0	410.0	140.0	-	-	-	-	-	ND	ND	10.0	-	-	-	ND	2370.0
northern squawfish	330.0	240.0	210.0	-	-	-	-	-	ND	ND	10.0	-	-	-	ND	2600.0
1972																
largescale sucker	400.0	160.0	ND	-	-	-	-	-	ND	ND	20.0	-	-	-	ND	2800.0
largescale sucker	500.0	290.0	510.0	-	-	-	-	-	ND	ND	ND	-	-	-	ND	5400.0
channel catfish	570.0	280.0	150.0	-	-	-	-	-	ND	ND	60.0	-	-	-	ND	4400.0
northern squawfish	570.0	130.0	ND	-	-	-	-	-	ND	ND	20.0	-	-	-	ND	3000.0

Table 25. (continued).

Species	DDE	DDD	DDT	Cis-chlor	Trans-chlor	Cis-non	Trans-non	Oxy-chlor	Hepta-chlor	Endrin	Dieldrin	HCB	α-BHC	γ-BHC	Toxa-phene	PCBs
Willamette River, Oregon City, OR																
1973																
carp	350.0	ND	ND	-	-	-	-	-	ND	ND	ND	-	-	-	ND	200.0
largescale sucker	310.0	150.0	ND	-	-	-	-	-	ND	ND	ND	-	-	-	ND	2400.0
largescale sucker	210.0	110.0	ND	-	-	-	-	-	ND	ND	ND	-	-	-	ND	1600.0
northern squawfish	530.0	140.0	ND	-	-	-	-	-	ND	ND	ND	-	-	-	ND	2800.0
1974																
carp	880.0	330.0	ND	-	-	-	-	-	ND	ND	ND	-	-	-	ND	100.0
largescale sucker	150.0	30.0	20.0	-	-	-	-	-	ND	ND	ND	-	-	-	ND	1300.0
largescale sucker	500.0	150.0	170.0	-	-	-	-	-	ND	ND	ND	-	-	-	ND	2700.0
northern squawfish	190.0	60.0	ND	-	-	-	-	-	ND	ND	ND	-	-	-	ND	2300.0
1976																
smallmouth bass	60.0	30.0	20.0	40.0	10.0	ND	ND	-	10.0	ND	40.0	ND	10.0	20.0	ND	600.0
chiselmouth	70.0	70.0	ND	60.0	20.0	ND	ND	-	ND	ND	20.0	ND	160.0	20.0	ND	2300.0
chiselmouth	120.0	40.0	ND	30.0	10.0	ND	20.0	-	ND	ND	20.0	10.0	80.0	20.0	ND	700.0
1978																
northern squawfish	420.0	ND	120.0	40.0	10.0	30.0	50.0	ND	ND	ND	ND	ND	ND	ND	ND	830.0
chiselmouth	90.0	50.0	ND	30.0	10.0	10.0	20.0	ND	ND	ND	20.0	ND	ND	10.0	ND	600.0
chiselmouth	90.0	60.0	ND	30.0	10.0	10.0	20.0	ND	ND	ND	20.0	ND	ND	10.0	ND	600.0
1981																
largescale sucker	150.0	50.0	10.0	20.0	10.0	10.0	30.0	ND	10.0	ND	20.0	10.0	ND	ND	ND	700.0

Table 25. (continued).

Species	DDE	DDD	DDT	Cis-chlor	Trans-chlor	Cis-non	Trans-non	Oxy-chlor	Hepta-chlor	Endrin	Dieldrin	HCB	α-BHC	γ-BHC	Toxaphene	PCBs
Willamette River, Oregon City, OR																
1981																
largescale sucker	210.0	50.0	20.0	10.0	10.0	10.0	20.0	ND	ND	ND	10.0	ND	ND	ND	100.0	1200.0
northern squawfish	280.0	30.0	ND	10.0	10.0	10.0	30.0	ND	ND	ND	10.0	ND	ND	ND	100.0	800.0
1984																
northern squawfish	130.0	20.0	10.0	10.0	ND	10.0	10.0	ND	ND	ND	ND	ND	ND	ND	ND	300.0
peamouth	30.0	10.0	10.0	10.0	ND	ND	10.0	ND	ND	ND	10.0	ND	ND	ND	ND	200.0
peamouth	30.0	10.0	ND	10.0	ND	ND	10.0	ND	ND	ND	ND	ND	ND	ND	ND	100.0

NOTE: **Abbreviations:** DDE = p,p'-DDE, DDD = p,p'-DDD, DDT = p,p'-DDT, Cis-chlor = cis-chlordane, Trans-chlor = trans-chlordane, Cis-non = cis-nonachlor, Trans-non = trans-nonachlor, Oxy-chlor = oxychlordane, Hepta-chlor = heptachlor epoxide, HCB = hexachlorobenzene, α-BHC = alpha-benzene hexachloride, γ-BHC = gamma-benzene hexachloride.

Scientific names: largescale sucker (Catostomus macrocheilus), northern squawfish (Ptychocheilus oregonensis), carp (Cyprinus carpio), peamouth (Mylocheilus caurinus), American shad (Alosa sapidissima), channel catfish (Ictalurus punctatus), smallmouth bass (Micropterus dolomieui), chiselmouth (Acrocheilus alutaceus).

[a] Each value is a composite of 3 to 5 adult specimens of a single species; 2 pools representing bottom-feeding species and 1 representative of a predator species. Level of quantification was 10.0 ppb for organochlorine contaminants, except for toxaphene and PCBs (based on Aroclor mixtures) which was set at 100.0 ppb.

[b] A dash = not analyzed.

[c] ND = not detected.

Table 26. Fish collected in 1971, 1972, 1973, 1976-77, 1978, and 1981 as part of the National Contaminant Monitoring Program (after Walsh et al. 1977, May and McKinney 1981, Lowe et al. 1985), and 1986 (after Anthony et al. 1993) for heavy metal contaminants (ppm ww, total carcass).

Species[a]	Arsenic	Cadmium	Copper	Lead	Mercury	Selenium	Zinc
Columbia River, RM 149							
1971							
carp	0.15	0.11	-[b]	ND[c]	0.05	-	-
largescale sucker	0.12	ND	-	0.11	0.21	-	-
northern squawfish	ND	ND	-	ND	0.84	-	-
1972							
carp	0.15	0.16	-	0.58	0.08	0.31	-
largescale sucker	ND	0.16	-	0.10	0.23	0.14	-
northern squawfish	0.11	0.42	-	0.30	0.06	0.11	-
carp	0.12	1.80	-	0.20	0.12	0.40	-
1973							
largescale sucker	ND	0.13	-	0.32	0.32	0.13	-
northern squawfish	ND	ND	-	0.24	0.85	0.20	-
carp	0.08	ND	-	0.24	0.06	0.20	-
1976-77							
northern squawfish	ND	ND	-	ND	0.23	-	-
largescale sucker	0.87	0.15	-	ND	0.05	-	-
1978							
largescale sucker	0.42	0.06	1.3	0.23	0.05	0.43	21.4
largescale sucker	0.25	0.05	1.1	0.27	0.11	0.41	23.6
northern squawfish	0.11	0.01	0.7	0.10	1.09	0.49	18.5
1981							
largescale sucker	0.47	0.03	0.8	0.10	0.05	0.29	17.4
largescale sucker	0.40	0.03	1.0	0.10	0.10	0.23	19.4
northern squawfish	0.10	0.02	0.8	0.10	0.37	0.17	14.2

Table 26. (continued).

Species	Arsenic	Cadmium	Copper	Lead	Mercury	Selenium	Zinc
Willamette River, Oregon City, OR							
1971							
largescale sucker	0.05	ND	-	ND	0.28	-	-
northern squawfish	ND	ND	-	ND	1.10	-	-
1972							
channel catfish	ND	ND	-	0.10	0.29	0.06	-
northern squawfish	ND	0.13	-	0.20	0.04	0.04	-
largescale sucker	0.14	ND	-	0.10	0.24	0.12	-
1973							
largescale sucker	-	-	-	-	0.08	0.09	-
northern squawfish	-	-	-	-	0.65	ND	-
carp	-	-	-	-	0.15	0.18	-
1976-77							
smallmouth bass	ND	ND	-	0.12	0.13	-	-
chiselmouth	1.15	0.20	-	0.85	ND	-	-
1978							
northern squawfish	0.05	0.01	0.7	0.10	0.52	0.13	23.2
chiselmouth	0.13	0.03	1.2	0.23	0.04	0.17	31.9
chiselmouth	0.16	0.03	1.6	0.54	0.03	0.14	42.2
1980							
largescale sucker	0.07	0.01	0.9	0.15	0.15	0.20	22.4
largescale sucker	0.07	0.02	1.0	0.13	0.23	0.23	22.6
northern squawfish	0.06	0.01	1.2	0.10	0.77	0.45	17.6

Table 26. (continued).

Species	Arsenic	Cadmium	Copper	Lead	Mercury	Selenium	Zinc
Columbia River, RM 18-22							
1986							
largescale sucker	-	0.052	-	0.10	0.094	-	-
peamouth	-	0.061	-	0.16	0.120	-	-
american shad	-	0.054	-	ND	0.039	-	-
northern squawfish	-	0.170	-	ND	0.190	-	-

[a] Each value is a composite of 3 to 5 adult specimens of a single species for the Columbia River, RM 149 and Willamette River sampling sites. The level of quantification for arsenic, cadmium, copper, lead, mercury selenium and zinc were 0.05, 0.01, 0.25, 0.10, 0.01,0.05, and 1.0 ppm (ww, whole carcass). A composite of 2 to 4 fish were collected for the Columbia River, RM 18-22, with the level of quantification for cadmium, lead, and mercury at 0.01, 0.08, and 0.03 ppm (ww, whole carcsss).

[b] A dash = not analyzed.

[c] ND = not detected.

Table 27. The harvest of mink and river otter along the Lower Columbia River during the 1994-95 trapping season together with July 1994 population estimates (minimum) and March 1995 river otter population estimates based on trapper information.

	Side of River							
	Oregon			Washington				
River Mile (RM)	Suitability Index Lo[1]	Suitability Index Hi[2]	July Count	Suitability Index Lo	Suitability Index Hi	July Count	Harvest[3]	River Otter Pop. Est.[4]
0-9				0.826	0.091	M-none O-1 family		[5]
9-18							O-8	O-17[5]
18-27								[5]
27-36	0.946	0.783	M-1 family O- 2 families					[5]
36-45							O-5	O-15
45-54				0.752	0.716	M-none O-1 family	O-2	O-11
54-63							O-2	O-12
63-72	0.573	0.506	M-none O-2 families				O-3	O-12
72-81							O-5	O-16
81-90	0.418	0.343	M-one O-1 family				M-2 O-6	O-15
90-99								
99-108				0.226	0.126	M-one O-1 family		
108-117								
117-126				0.715	0.566	M-one O-none	O-4	O-24
126-135	0.678	0.552	M-one O-1 family					
136-144								

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[1] Based on low canopy index.

[2] Based on high canopy index.

[3] 1994-95 trapping season. Number of river otters (O) and mink (M) harvested on both sides of the river within 0.25 miles of Columbia River. An additional 6 to 8 river otters (assume 7) were taken between RM 36 and RM 90, but carcasses were not obtained and could not be assigned to a RM.

[4] Population estimate by trappers working in each segment.

[5] One trapper estimated 40-50 river otter between RM 0 and RM 36, while another estimated 17 between RM 9 and RM 18.

Table 28. Proposed critical (EC_{50}) and safe levels (EC_1) of total PCBs, PCB153 and TEQs for mink diet which was calculated with a one-compartment bioaccumulation model in combination with a dose-effect model (from Leonards et al. 1994).

	Mink Diet	
	Litter Size	Kit Survival
Critical level		
Total PCB ppm (ww)	0.371	0.730
PCB153 ppm (ww)	0.051	0.068
TEQ_{tot} AHH ppt (ww)[a]	38	72
TEQ_{tot} S ppt (ww)[b]	77	96
No-effect level		
Total PCB ppm (ww)	0.145	0.399
PCB153 ppm (ww)	0.026	0.049
TEQ_{tot} AHH ppt (ww)[a]	38	0.02
TEQ_{tot} S ppt (ww)[b]	50	17

[a] Predicted toxic equivalent concentration with the TEF-AHH system (see Leonards et al. 1994:38).

[b] Predicted toxic equivalent concentration with TEF system (Safe 1993).

Appendix 1. Morphometrics of river otter and mink collected during the winter of 1994-95 from the Lower Columbia River and Reference Area.

Sample Number	Species	Date Collected	River Mile	Sex	Age in Years	Body Weight (kg)	Total Length (cm)	Tail Length (cm)	Neck Girth (cm)	Mesentery Fat (g)	Thymus Weight (g)	Lung Weight (g)
OT#1	Otter	12/18/94	73.1	M	5	9.53	119.4	47.6	25.4	25.7	7.7	223.7
OT#2	Otter	12/21/94	73.1	M	3	9.75	114.9	48.3	30.5	17.0	14.2	246.3
OT#3	Otter	12/21/94	64.8	F	2	7.94	118.1	50.8	24.8	23.8	6.6	164.9
OT#4	Otter	12/16/94	53.9	M	1	6.80	111.8	46.4	24.8	8.9	2.5	137.8
OT#5	Otter	12/22/94	61.0	M	2	11.11	126.4	48.3	29.2	44.4	8.1	230.3
OT#6	Otter	12/16/94	71.5	M	0	6.12	104.8	43.2	22.2	16.4	7.4	153.0
OT#7	Otter	12/23/94	41.0	F	1	7.94	113.7	44.5	25.4	12.6	10.4	209.7
OT#8	Otter	12/21/94	73.1	M	4	9.30	116.8	41.9	27.3	33.8	12.0	245.5
OT#9	Otter	12/26/94	56.5	M	3	8.16	111.8	43.2	24.4	13.9	5.9	210.4
OT#10	Otter	12/20/94	39.1	M	2	10.44	114.6	42.2	30.5	20.6	12.0	237.8
OT#11	Otter	12/27/94	87.6	F	1	7.48	107.9	40.0	24.8	13.8	6.7	202.7
OT#12	Otter	12/18/94	73.1	M	0	6.80	105.4	40.0	26.0	25.5	8.0	106.4
OT#13	Otter	12/16/94	73.1	M	1	9.75	127.6	55.2	26.7	23.0	12.0	249.3
OT#14	Otter	12/14/94	39.1	F	4	8.62	111.1	44.4	26.7	22.0	10.5	208.0
OT#15	Otter	12/29/94	86.9	M	1	8.85	115.6	46.0	27.9	25.9	13.4	220.1
OT#16	Otter	12/23/94	53.9	M	1	9.53	117.5	47.3	27.6	17.5	12.4	228.9
OT#17	Otter	12/14/94	39.1	F	1	7.94	111.9	47.1	24.8	16.2	5.3	206.3
OT#18	Otter	12/14/94	39.1	F	3	7.94	107.2	43.0	26.4	23.7	7.7	177.4
OT#19	Otter	12/27/94	81.5	M	1	9.07	144.0	43.8	26.0	31.9	9.8	236.1
OT#20	Otter	12/16/94	68.0	M	0	8.39	114.6	48.3	27.9	22.2	23.3	178.2
OT#21	Otter	01/02/95	11.0	F	2	6.45	109.2	45.7	24.1	17.0	2.2	177.7
OT#22	Otter	01/15/95	11.0	M	0	7.29	112.7	46.7	24.8	16.7	19.0	206.1
OT#23	Otter	01/30/95	12.5	M	4	10.01	112.4	47.0	29.2	42.1	9.3	277.8
OT#24	Otter	01/29/95	87.2	F	0	6.69	106.0	45.4	25.4	14.2	12.6	173.5
OT#25	Otter	01/13/95	87.2	M	0	7.26	113.0	47.6	26.0	15.7	17.7	185.6
OT#26	Otter	01/11/95	--	F	3	6.83	109.2	42.2	25.1	20.2	5.7	145.9
OT#27	Otter	02/20/95	--	M	2	7.74	109.2	41.4	26.5	49.9	4.3	181.6
OT#28	Otter	01/29/95	--	M	0	7.06	115.9	46.7	24.4	20.6	4.9	185.0
OT#29	Otter	01/21/95	--	M	0	7.74	114.1	47.8	23.5	17.1	5.5	180.6
MK#30	Mink	02/03/95	88.0	M	3	1.13	63.1	23.2	14.6	9.6	0.3	23.6
MK#31	Mink	02/15/95	88.0	F	2	0.57	21.4	18.1	11.4	4.8	0.3	16.2
OT#32	Otter	02/20/95	--	M	9	8.19	110.5	46.0	24.1	45.8	5.6	199.4
OT#33	Otter	--	--	M	8	10.92	116.8	45.1	27.3	31.0	2.5	220.3
OT#34	Otter	03/10/95	88.0	M	2	11.09	--	--	29.8	39.2	4.6	235.4
OT#35	Otter	01/09/95	119.5	M	1	7.97	111.3	41.9	24.8	34.1	6.5	160.1
OT#36	Otter	02/16/95	119.5	M	0	7.74	112.2	45.7	26.4	14.3	8.0	215.1
OT#37	Otter	12/28/94	119.5	F	2	8.65	112.1	43.3	28.9	23.3	6.3	252.2
OT#38	Otter	01/23/95	119.5	M	3	9.10	114.3	--	26.7	35.8	5.9	199.5

Appendix 1 (continued).

Sample Number	Liver Weight (g)	Spleen Weight (g)	Pancreas Weight (g)	Gonad Weight (g)	Uterus Weight (g)	Thymus Weight (g)	Kidney Weight (g)	Adrenals Weight (g)	Baculum Length (cm)	Baculum Weight (g)
OT#1	634.3	83.7	43.4	30.60	--	0.58	137.4	1.16	10.132	7.36
OT#2	642.1	42.5	50.2	32.50	--	1.13	103.2	1.34	9.734	6.45
OT#3	482.4	27.1	37.6	0.52	5.6	0.49	96.4	0.98	--	--
OT#4	281.8	25.6	28.2	24.20	--	0.42	74.9	0.83	9.363	5.04
OT#5	684.6	62.4	38.8	19.70	--	0.68	138.7	1.55	9.990	6.42
OT#6	377.3	21.0	26.3	2.80	--	0.35	80.2	0.75	8.202	2.33
OT#7	448.0	38.2	26.8	0.96	1.5	0.63	97.8	0.73	--	--
OT#8	558.8	45.6	39.4	28.50	--	0.68	106.8	1.42	9.432	6.41
OT#9	498.8	52.2	31.7	27.40	--	0.65	93.8	1.12	10.148	6.00
OT#10	626.0	60.9	52.4	43.70	--	0.88	136.6	1.68	9.805	7.92
OT#11	463.2	45.6	34.1	0.69	1.6	0.77	78.8	0.98	--	--
OT#12	353.6	27.3	27.3	4.40	--	0.97	71.1	1.00	7.423	1.92
OT#13	686.8	51.8	46.4	39.60	--	1.05	121.2	1.22	10.252	7.27
OT#14	515.7	40.8	44.2	1.57	4.9	0.77	118.8	1.31	--	--
OT#15	502.6	54.2	33.8	33.00	--	0.71	94.1	0.94	9.730	5.16
OT#16	720.7	58.7	42.4	14.60	--	0.73	107.5	1.77	9.418	5.69
OT#17	501.9	35.0	36.9	0.90	3.0	0.83	105.2	1.12	--	--
OT#18	470.7	37.4	46.8	1.37	5.2	1.17	101.5	1.20	--	--
OT#19	593.5	48.1	38.0	24.80	--	1.00	91.9	1.49	9.779	6.30
OT#20	516.2	28.4	47.6	3.10	--	0.75	101.1	1.07	8.602	2.52
OT#21	313.1	38.3	37.5	1.01	3.7	0.78	97.0	1.02	--	--
OT#22	509.6	51.4	31.4	6.90	--	0.87	102.8	0.74	9.144	4.03
OT#23	654.0	54.1	43.7	49.40	--	0.80	141.9	1.15	9.523	9.25
OT#24	382.9	36.4	35.3	0.15	0.9	0.59	97.6	1.38	--	--
OT#25	543.9	94.7	39.9	--	--	0.70	132.1	1.45	8.340	2.52
OT#26	402.8	32.0	36.3	0.47	8.1	0.60	106.3	1.30	--	--
OT#27	503.3	49.6	48.1	37.90	--	0.66	104.0	0.79	9.184	5.17
OT#28	443.0	34.8	34.6	12.90	--	0.62	92.9	0.97	9.579	5.79
OT#29	400.8	41.5	35.1	29.30	--	0.62	91.3	1.05	9.455	5.85
MK#30	65.2	6.0	1.4	7.2	--	0.07	14.7	0.13	--	--
MK#31	46.9	5.6	4.8	0.39	1.2	0.16	7.4	0.14	--	--
OT#32	535.9	41.5	52.2	40.80	--	0.40	97.5	0.88	9.169	5.94
OT#33	748.9	40.0	58.4	41.70	--	0.90	132.8	1.50	10.215	8.32
OT#34	708.4	57.6	45.0	56.90	--	1.38	148.7	1.42	10.364	8.79
OT#35	667.3	52.6	40.6	23.50	--	0.54	97.0	1.32	10.364	7.59
OT#36	569.3	61.1	37.6	--	--	0.96	98.6	1.11	8.106	2.42
OT#37	498.6	58.4	40.6	0.36	6.5	1.02	112.2	1.13	--	--
OT#38	611.2	48.5	56.9	65.10	--	0.53	111.3	0.90	9.032	5.13

Appendix 2. Organochlorine insecticides and metabolites and PCB concentrations (ppb, ww) in livers of river otter and mink collected from the Lower Columbia River and Reference Area, 1994-95. Detection limit = 1.0 ppb (ww). ND = not detectable. A,B = 2 replicates of the same sample. SPCBs = The sum of PCBs.

Sample Number	% Lipid	% Moisture	1,2,4,5 -TCB	1,2,3,4 -TCB	QCB	HCB	OCS	trans-Nonachlor	pp'-DDE	photo-Mirex	Mirex	a-HCH	b-HCH	g-HCH	oxy-Chlordane
OT#1-LIVER	3.52	70.95	ND	ND	ND	5.51	0.53	3.09	84.01	ND	0.95	ND	ND	ND	8.38
OT#2-LIVER	2.97	71.65	ND	ND	ND	2.49	0.20	10.42	53.96	ND	0.66	ND	ND	ND	17.55
OT#3-LIVER	5.31	71.29	ND	ND	ND	10.20	0.95	6.26	145.60	ND	1.14	ND	0.19	ND	15.50
OT#4-LIVER	3.84	71.61	ND	ND	ND	3.77	0.42	2.93	35.56	0.35	0.41	ND	ND	ND	4.54
OT#5-LIVER	2.97	69.85	ND	ND	ND	4.70	0.40	2.98	47.33	ND	0.72	ND	0.14	ND	14.34
OT#6-LIVER	4.21	70.03	ND	ND	ND	3.38	0.21	2.83	6.97	ND	1.29	ND	0.49	ND	6.09
OT#7-LIVER	4.48	73.06	ND	ND	ND	7.52	0.66	4.97	8.53	ND	1.00	ND	0.14	ND	25.86
OT#8-LIVER	3.87	69.38	ND	ND	ND	11.58	1.11	7.40	115.25	1.19	2.08	ND	0.23	ND	17.76
OT#9-LIVER	3.90	71.19	ND	ND	ND	6.41	0.45	3.99	108.69	ND	1.05	ND	0.12	ND	10.48
OT#10-LIVER	3.65	69.40	ND	ND	ND	6.55	0.70	5.77	155.33	ND	1.52	ND	0.05	ND	13.35
OT#11-LIVER	2.93	70.53	ND	ND	ND	7.09	0.72	2.37	98.45	ND	0.78	ND	0.18	ND	9.53
OT#12-LIVER	3.03	70.41	ND	ND	ND	4.57	0.44	3.16	47.81	0.32	0.63	ND	0.13	ND	6.36
OT#13-LIVER	4.94	70.07	ND	ND	ND	8.18	0.68	7.29	134.98	ND	1.27	0.05	0.07	ND	22.62
OT#14-LIVER A	3.41	70.72	ND	ND	ND	3.09	0.15	1.52	33.72	ND	0.41	ND	ND	ND	4.56
OT#14-LIVER B	3.01	70.72	ND	ND	ND	3.32	0.17	1.58	35.92	ND	0.40	ND	0.10	ND	4.94
OT#15-LIVER	2.27	70.87	ND	ND	0.14	2.36	0.16	2.19	91.77	ND	0.28	0.15	0.06	ND	11.44
OT#16-LIVER	2.76	70.31	ND	ND	ND	8.37	0.77	10.50	303.36	0.89	2.63	0.05	0.12	ND	12.20
OT#17-LIVER	3.57	69.91	ND	ND	ND	5.97	0.37	3.62	69.29	ND	0.88	ND	0.09	ND	9.36
OT#18-LIVER	2.79	69.23	ND	ND	ND	7.00	0.63	2.39	165.35	ND	1.64	0.05	0.11	ND	8.87
OT#19-LIVER	3.91	68.07	ND	ND	ND	4.87	0.59	3.57	133.92	ND	1.35	0.09	0.07	ND	15.56
OT#20-LIVER A	4.05	71.48	ND	ND	0.16	5.31	0.50	3.95	47.99	0.56	0.74	ND	0.15	ND	6.47
OT#20-LIVER B	4.03	71.48	ND	ND	0.16	5.28	0.44	3.90	48.44	0.54	0.75	ND	0.15	ND	6.49
OT#21-LIVER	3.49	72.07	ND	ND	ND	3.43	0.52	1.92	63.57	ND	0.86	ND	0.07	ND	8.91
OT#22-LIVER	2.70	70.20	ND	ND	ND	1.98	0.20	0.54	14.06	ND	0.23	ND	0.13	ND	2.76
OT#23-LIVER	5.26	70.10	ND	ND	ND	3.53	0.38	2.76	82.54	0.48	0.75	ND	0.20	ND	5.26
OT#24-LIVER	3.71	68.93	ND	ND	ND	1.68	0.34	1.35	68.86	ND	0.31	0.05	ND	ND	4.71
OT#25-LIVER	2.92	69.14	ND	ND	ND	0.93	ND	0.61	77.12	ND	0.31	0.05	0.05	ND	2.65
OT#26-LIVER	3.24	69.06	ND	ND	ND	1.71	ND	0.23	2.05	ND	ND	ND	ND	ND	2.22
OT#27-LIVER	3.24	70.25	ND	ND	ND	5.01	0.31	2.07	16.38	0.53	0.68	ND	0.10	ND	4.40
OT#28-LIVER	3.78	71.88	ND	ND	ND	12.16	0.49	3.08	18.74	0.39	0.29	ND	ND	ND	6.46
OT#29-LIVER	2.48	70.10	ND	ND	ND	2.18	ND	0.12	1.18	ND	ND	ND	ND	ND	1.36
MINK#30-LIVER	5.14	71.89	ND	ND	0.53	2.13	0.55	0.67	151.72	0.52	1.49	ND	ND	ND	58.37
MINK#31-LIVER	3.18	73.69	ND	ND	ND	0.58	0.20	ND	47.41	0.23	0.68	ND	0.10	ND	36.84
OT#32-LIVER	3.03	69.93	ND	ND	ND	5.14	0.23	1.72	14.09	0.28	0.49	ND	ND	ND	2.76
OT#33-LIVER A	3.06	69.47	ND	ND	ND	6.17	0.51	1.80	13.37	0.36	0.30	ND	ND	ND	4.61
OT#33-LIVER B	2.92	69.47	ND	ND	ND	5.90	0.38	1.66	12.20	0.33	0.29	ND	ND	ND	4.54
OT#34-LIVER	3.85	68.29	ND	ND	0.38	13.21	1.92	11.95	391.75	ND	1.34	0.05	0.07	ND	12.42
OT#35-LIVER	2.43	71.55	ND	ND	0.47	3.30	0.32	4.73	303.94	ND	0.72	ND	ND	ND	6.89
OT#36-LIVER	2.68	71.82	ND	ND	1.03	7.23	0.52	13.94	1036.26	ND	1.35	ND	0.11	ND	11.83
OT#37-LIVER	2.66	71.08	ND	ND	0.68	4.55	0.24	27.12	1335.72	ND	1.34	0.07	ND	ND	29.78
OT#38-LIVER	4.50	68.44	ND	ND	0.74	10.22	0.59	91.13	1821.36	ND	4.37	0.07	0.17	ND	29.44
MINK#39-LIVER	4.81	70.88	ND	ND	ND	0.73	0.13	0.10	281.59	1.17	1.27	ND	0.08	ND	26.27
MINK#40-LIVER	4.38	70.86	ND	ND	ND	0.44	ND	0.12	14.59	ND	ND	ND	0.12	ND	3.71

Appendix 2 (continued).

Sample Number	trans-Chlordane	cis-Chlordane	pp'-DDD	cis-Nonachlor	pp'-DDT	HC Epox	Dieldrin	PCB #31	PCB #28	PCB #52	PCB #49	PCB #44	PCB #42	PCB #64	PCB #74
OT#1-LIVER	0.11	0.34	9.12	0.54	0.18	0.61	3.34	ND	ND	3.25	0.66	1.03	ND	ND	1.13
OT#2-LIVER	0.06	0.57	5.64	0.81	0.14	1.28	4.54	ND	ND	1.51	0.35	1.24	ND	0.06	ND
OT#3-LIVER	0.08	0.08	9.86	0.48	ND	1.50	7.63	ND	0.24	3.34	1.06	0.97	ND	0.05	1.42
OT#4-LIVER	ND	0.06	1.41	0.19	0.16	0.31	0.99	ND	ND	0.77	ND	1.56	ND	ND	ND
OT#5-LIVER	0.06	0.37	6.02	0.44	0.37	1.06	7.39	ND	0.37	1.83	0.40	0.52	ND	ND	0.29
OT#6-LIVER	0.13	0.44	7.24	0.56	0.24	1.08	5.08	ND	0.87	3.88	1.15	1.11	ND	0.05	0.98
OT#7-LIVER	ND	0.19	4.96	0.39	0.09	1.94	9.48	ND	0.40	1.73	0.39	0.54	ND	ND	0.44
OT#8-LIVER	0.05	0.45	5.91	0.65	0.78	1.19	4.63	ND	0.36	2.15	0.73	0.45	ND	0.10	0.55
OT#9-LIVER	ND	ND	3.92	0.31	ND	0.91	3.04	ND	0.23	2.67	0.45	0.91	ND	ND	ND
OT#10-LIVER	0.06	0.32	6.46	0.58	0.15	1.02	5.85	ND	0.39	2.50	0.51	0.86	ND	ND	0.40
OT#11-LIVER	ND	ND	4.35	0.20	ND	1.20	4.29	ND	0.16	2.15	0.28	1.31	ND	ND	ND
OT#12-LIVER	ND	0.12	2.46	0.30	0.25	0.80	3.02	ND	ND	1.31	0.22	1.00	ND	0.05	0.53
OT#13-LIVER	0.20	1.08	9.95	1.66	0.22	1.67	9.07	ND	0.27	3.43	1.03	0.71	ND	0.06	1.37
OT#14-LIVER A	0.06	0.20	3.41	0.33	ND	0.70	3.58	ND	0.44	1.47	0.34	0.49	ND	ND	0.40
OT#14-LIVER B	0.08	0.20	3.68	0.34	ND	0.64	3.27	ND	0.46	1.56	0.36	0.56	ND	ND	0.33
OT#15-LIVER	ND	0.28	4.69	0.30	ND	1.06	4.89	ND	0.49	3.55	0.83	0.64	ND	ND	0.75
OT#16-LIVER	0.06	0.32	10.31	1.06	0.19	2.03	7.73	ND	0.49	4.26	0.58	0.64	ND	0.08	0.59
OT#17-LIVER	0.09	0.51	5.68	0.52	0.22	1.21	6.27	ND	0.30	1.85	0.47	0.51	ND	ND	0.59
OT#18-LIVER	0.07	0.33	6.20	0.54	ND	1.17	4.83	ND	0.39	3.94	0.71	0.50	ND	ND	0.74
OT#19-LIVER	0.09	0.42	12.24	0.61	ND	1.32	6.47	ND	0.34	7.86	1.92	0.82	ND	0.07	1.19
OT#20-LIVER A	ND	0.20	2.40	0.31	0.13	0.63	2.08	ND	0.73	1.40	0.33	1.23	ND	0.06	0.61
OT#20-LIVER B	ND	0.17	2.40	0.28	0.12	0.65	2.21	ND	0.74	1.33	0.33	1.19	ND	0.05	0.65
OT#21-LIVER	0.05	0.21	5.21	0.31	ND	0.49	1.61	ND	0.18	2.84	0.86	0.82	ND	ND	0.64
OT#22-LIVER	ND	ND	0.43	0.06	ND	0.65	2.00	ND	0.44	0.28	ND	0.92	ND	ND	0.57
OT#23-LIVER	0.05	0.21	2.75	0.28	ND	0.82	2.73	ND	0.29	1.28	0.22	0.53	ND	ND	0.71
OT#24-LIVER	ND	0.08	1.28	0.12	ND	0.70	4.21	ND	0.33	3.09	1.13	0.30	ND	ND	1.10
OT#25-LIVER	ND	0.11	2.44	0.11	ND	0.35	2.02	ND	0.30	1.57	0.63	0.76	ND	ND	0.77
OT#26-LIVER	ND	ND	0.25	ND	ND	0.31	0.77	ND	0.30	ND	ND	0.70	ND	ND	ND
OT#27-LIVER	0.06	0.31	1.79	0.25	0.19	0.31	0.94	ND	ND	0.91	ND	0.20	ND	ND	0.34
OT#28-LIVER	ND	0.07	0.60	0.14	0.36	0.64	2.15	ND	ND	0.33	ND	0.18	ND	0.08	ND
OT#29-LIVER	ND	ND	0.14	ND	ND	0.18	0.48	ND	ND	ND	ND	0.13	ND	ND	ND
MINK#30-LIVER	ND	ND	6.56	ND	ND	2.30	33.69	ND	0.51	ND	ND	1.22	ND	ND	3.05
MINK#31-LIVER	ND	ND	2.83	ND	ND	0.43	8.40	ND	ND	0.29	ND	ND	ND	ND	0.62
OT#32-LIVER	ND	0.06	1.13	0.15	ND	0.38	1.22	ND	ND	0.71	ND	ND	ND	ND	ND
OT#33-LIVER A	ND	0.10	0.85	0.14	ND	0.38	1.20	ND	ND	0.36	ND	0.19	ND	ND	ND
OT#33-LIVER B	ND	0.09	0.91	0.16	ND	0.35	1.31	ND	ND	0.32	ND	ND	ND	ND	ND
OT#34-LIVER	0.30	0.99	31.82	1.61	ND	1.78	14.05	ND	0.55	13.92	2.56	0.99	ND	0.05	ND
OT#35-LIVER	ND	ND	9.25	0.66	ND	1.98	11.09	ND	ND	7.98	1.25	0.54	ND	ND	ND
OT#36-LIVER	0.29	1.54	45.61	2.82	ND	4.29	27.02	ND	ND	11.71	1.51	0.72	ND	0.09	0.93
OT#37-LIVER	0.45	3.23	137.60	4.95	ND	6.49	37.64	ND	ND	61.66	1.43	0.60	ND	0.06	0.84
OT#38-LIVER	4.85	23.22	314.46	30.83	0.19	7.79	90.34	ND	0.14	12.35	1.84	0.85	ND	0.10	1.92
MINK#39-LIVER	ND	ND	1.22	ND	ND	0.32	3.30	ND	0.14	ND	ND	0.39	ND	ND	0.74
MINK#40-LIVER	ND	0.08	0.59	0.08	ND	0.08	0.81	ND	ND	ND	ND	0.17	ND	ND	ND

Appendix 2 (continued).

Sample Number	PCB #70	PCB #66/95	PCB #60	PCB #101	PCB #99	PCB #97	PCB #87	PCB #110	PCB #151	PCB #149	PCB #118	PCB #146	PCB #153	PCB #105	PCB #141
OT#1-LIVER	0.46	1.54	1.17	4.18	26.32	ND	2.41	1.75	1.89	1.80	3.29	7.55	90.81	2.68	0.70
OT#2-LIVER	0.26	1.06	0.92	3.02	14.08	0.33	1.72	1.75	0.75	1.56	3.97	4.00	51.93	2.50	0.81
OT#3-LIVER	0.33	1.01	1.41	5.14	28.67	ND	2.61	1.66	0.89	0.91	4.60	8.48	74.79	3.47	0.62
OT#4-LIVER	ND	0.18	0.64	1.42	7.33	ND	0.55	0.29	0.45	0.55	2.83	1.91	21.88	1.42	0.12
OT#5-LIVER	0.20	0.48	0.55	3.10	19.20	ND	1.56	1.17	0.59	0.75	1.87	6.13	60.39	3.15	0.22
OT#6-LIVER	0.60	1.53	0.96	4.98	20.64	ND	2.54	2.02	0.91	0.94	4.69	5.58	47.54	4.14	0.62
OT#7-LIVER	ND	0.35	0.70	2.43	37.58	ND	1.08	0.60	0.23	0.53	1.82	7.14	94.62	3.16	0.14
OT#8-LIVER	0.23	1.08	1.37	4.41	34.96	0.38	3.36	2.03	ND	1.48	3.24	6.24	79.99	3.54	0.25
OT#9-LIVER	ND	0.48	0.55	3.28	27.13	ND	1.41	0.61	ND	0.52	2.67	6.94	90.18	2.30	0.19
OT#10-LIVER	0.23	0.98	1.44	4.55	45.81	ND	2.00	1.18	1.24	1.32	2.63	11.26	157.00	3.22	0.50
OT#11-LIVER	ND	0.73	0.66	2.40	18.00	0.19	1.11	0.80	ND	0.94	2.68	3.95	53.27	1.93	0.21
OT#12-LIVER	ND	0.54	0.67	2.48	11.84	0.29	1.24	1.10	0.74	1.02	2.66	3.37	28.02	1.64	0.58
OT#13-LIVER	0.36	1.89	1.33	5.13	51.21	ND	2.55	1.58	1.46	1.15	7.82	13.26	163.03	3.57	1.01
OT#14-LIVER A	0.19	0.51	0.47	1.60	7.79	ND	0.80	0.54	0.37	0.25	1.70	2.56	20.36	2.43	0.12
OT#14-LIVER B	0.22	0.57	0.40	1.69	8.22	ND	0.84	0.57	0.32	0.28	1.84	2.68	21.66	2.62	0.09
OT#15-LIVER	0.21	0.69	1.21	3.32	20.81	ND	1.99	1.09	0.34	0.55	2.05	5.24	60.63	2.46	0.29
OT#16-LIVER	ND	1.30	1.26	4.51	39.21	0.20	1.89	1.16	0.54	1.23	3.03	11.36	117.86	2.42	0.36
OT#17-LIVER	0.24	0.76	0.68	3.11	23.91	ND	1.40	1.13	0.91	0.67	2.76	6.89	79.00	2.20	0.30
OT#18-LIVER	0.20	1.02	0.56	3.13	16.45	ND	1.60	0.93	0.81	0.85	2.36	5.74	45.33	2.24	0.26
OT#19-LIVER	0.74	3.36	1.61	11.78	45.46	0.17	7.43	4.52	1.86	3.66	8.84	11.77	110.36	5.47	1.45
OT#20-LIVER A	0.24	0.74	0.68	2.47	18.90	ND	1.11	0.92	1.07	1.02	2.66	3.86	51.10	1.70	0.35
OT#20-LIVER B	0.22	0.74	0.81	2.50	18.58	ND	1.15	1.05	1.09	1.08	2.68	3.80	50.37	1.68	0.31
OT#21-LIVER	0.29	1.87	1.42	5.50	25.53	ND	2.29	1.98	1.43	2.05	4.00	6.44	101.42	2.42	0.63
OT#22-LIVER	ND	ND	ND	1.01	7.01	ND	0.48	0.30	ND	0.50	2.15	1.92	19.06	1.19	ND
OT#23-LIVER	0.24	1.04	0.88	2.90	18.03	ND	1.03	0.80	0.87	1.67	2.66	4.06	73.99	1.72	0.27
OT#24-LIVER	ND	1.08	1.87	3.03	14.75	ND	1.43	1.09	0.34	0.58	3.02	4.39	44.19	2.21	ND
OT#25-LIVER	0.47	1.21	2.98	3.21	8.72	0.15	1.65	1.24	0.69	1.00	2.62	2.78	26.11	1.44	0.31
OT#26-LIVER	ND	ND	ND	ND	1.52	ND	ND	ND	ND	ND	ND	0.31	2.81	ND	ND
OT#27-LIVER	0.27	0.46	ND	1.23	7.20	ND	0.57	0.50	0.92	0.61	0.89	1.05	12.57	0.57	ND
OT#28-LIVER	ND	ND	0.58	0.35	7.18	ND	ND	ND	0.38	0.28	0.66	0.87	7.77	0.76	ND
OT#29-LIVER	ND	ND	ND	ND	0.58	ND	ND	ND	ND	ND	0.26	0.14	2.08	ND	ND
MINK#30-LIVER	ND	1.16	3.84	2.08	19.96	ND	0.81	ND	ND	ND	21.73	10.50	59.49	5.28	ND
MINK#31-LIVER	ND	0.46	0.89	0.60	5.69	ND	0.35	0.14	ND	ND	6.10	2.60	21.49	1.77	ND
OT#32-LIVER	ND	0.19	0.63	0.86	4.49	ND	0.39	0.16	0.49	0.42	0.63	0.77	6.52	0.41	ND
OT#33-LIVER A	ND	ND	0.48	0.56	7.31	ND	0.28	0.31	0.40	0.28	0.46	0.73	11.95	0.61	ND
OT#33-LIVER B	ND	0.35	0.48	0.54	6.75	ND	0.25	0.26	0.23	0.27	0.48	0.66	10.91	0.52	ND
OT#34-LIVER	1.56	7.53	4.00	14.08	49.02	ND	7.86	6.65	4.13	5.01	7.06	21.61	157.18	5.28	1.48
OT#35-LIVER	ND	1.93	1.25	7.24	31.13	ND	3.57	1.75	2.75	2.26	2.55	16.05	138.00	2.82	0.69
OT#36-LIVER	0.26	3.85	1.79	8.85	33.12	ND	6.09	3.07	2.67	4.52	3.42	18.37	118.73	2.97	1.35
OT#37-LIVER	ND	14.27	1.82	23.04	97.30	ND	28.73	5.65	2.84	10.19	7.79	37.98	224.42	9.39	2.41
OT#38-LIVER	0.56	7.36	5.17	15.31	59.01	ND	10.12	3.65	13.52	15.00	5.98	34.59	231.62	4.45	5.88
MINK#39-LIVER	ND	0.21	0.49	0.26	4.56	ND	0.21	ND	ND	ND	7.09	2.73	23.97	1.74	ND
MINK#40-LIVER	ND	ND	ND	ND	0.18	ND	ND	ND	ND	ND	0.84	0.20	4.83	ND	ND

Appendix 2 (continued).

Sample Number	PCB #138	PCB #158	PCB #129	PCB #182/187	PCB #183	PCB #185	PCB #174	PCB #171	PCB #200	PCB #172	PCB #180	PCB #170/190	PCB #201	PCB #203	PCB #195
OT#1-LIVER	152.48	2.28	1.97	16.73	9.85	ND	0.24	1.94	2.90	1.01	73.89	55.51	15.47	6.15	3.74
OT#2-LIVER	84.16	1.70	1.32	14.92	6.62	ND	0.20	1.24	1.37	0.48	40.78	27.41	11.73	5.70	3.07
OT#3-LIVER	102.38	1.89	2.34	16.49	7.62	ND	ND	4.86	2.44	1.52	58.14	36.09	20.39	5.95	3.97
OT#4-LIVER	20.57	0.53	0.79	4.98	1.68	ND	ND	0.67	0.71	0.27	14.73	7.85	2.54	1.02	0.30
OT#5-LIVER	120.73	1.63	2.44	11.79	6.62	ND	ND	1.26	2.75	0.98	56.37	50.82	17.08	4.63	3.26
OT#6-LIVER	76.43	1.70	1.91	13.34	4.97	ND	ND	3.02	2.21	0.73	30.85	20.35	11.15	3.91	2.17
OT#7-LIVER	136.71	2.28	1.86	10.05	7.84	ND	ND	1.36	2.84	0.84	56.89	39.91	10.97	3.88	2.58
OT#8-LIVER	120.43	2.31	1.73	21.67	9.01	ND	ND	1.74	2.90	0.74	59.94	38.26	14.72	7.68	3.30
OT#9-LIVER	121.95	1.80	1.68	17.69	8.26	ND	ND	1.73	2.47	1.15	73.44	45.23	19.79	5.86	3.86
OT#10-LIVER	236.37	3.34	1.93	32.95	17.19	ND	ND	5.59	3.98	1.40	121.26	80.45	21.74	10.78	5.91
OT#11-LIVER	70.19	1.01	0.76	6.51	5.20	ND	ND	2.32	1.72	0.50	35.71	19.87	6.10	2.94	1.49
OT#12-LIVER	43.54	0.94	1.12	8.81	3.11	ND	ND	0.93	0.96	0.48	14.91	11.26	5.37	1.97	0.93
OT#13-LIVER	262.68	3.67	2.50	22.18	18.14	3.89	ND	3.79	3.92	1.89	131.62	88.29	23.95	12.30	6.18
OT#14-LIVER A	32.05	0.66	0.75	7.62	2.50	ND	ND	1.45	0.92	0.26	15.16	9.73	4.54	1.92	1.16
OT#14-LIVER B	34.31	0.72	0.82	8.25	2.71	ND	ND	1.59	1.01	0.30	17.89	10.50	4.93	2.06	1.13
OT#15-LIVER	100.99	1.44	1.57	12.02	7.16	ND	ND	1.11	1.89	1.06	55.08	37.63	22.50	5.88	3.25
OT#16-LIVER	177.18	3.59	2.23	31.72	14.60	5.97	ND	5.04	3.54	1.37	80.14	52.76	16.54	8.41	4.37
OT#17-LIVER	125.05	1.78	1.88	14.52	8.56	ND	ND	1.61	3.11	1.03	66.26	52.99	14.82	5.54	3.75
OT#18-LIVER	69.03	1.48	1.36	21.11	7.73	ND	ND	1.36	1.79	0.77	34.41	18.40	10.58	5.66	2.27
OT#19-LIVER	194.89	4.30	2.52	22.18	11.13	ND	0.53	7.58	6.10	1.79	76.79	55.63	21.73	7.38	4.44
OT#20-LIVER A	64.63	1.22	0.98	9.60	4.82	ND	ND	2.42	1.86	0.52	35.65	21.62	7.60	3.22	1.55
OT#20-LIVER B	64.07	1.20	0.95	9.58	4.80	ND	ND	2.44	1.84	0.52	44.63	21.72	7.72	3.21	1.57
OT#21-LIVER	120.89	1.74	1.65	20.34	11.75	ND	0.28	1.51	3.35	1.30	112.51	59.36	21.01	7.99	4.41
OT#22-LIVER	28.60	0.50	0.46	5.32	2.13	ND	ND	1.45	1.13	0.30	14.23	10.25	5.70	1.78	1.01
OT#23-LIVER	72.66	1.12	0.91	10.48	7.82	ND	ND	1.20	2.04	0.53	70.54	32.01	8.33	5.21	2.57
OT#24-LIVER	56.61	0.91	1.78	15.39	5.34	ND	ND	1.26	1.66	1.19	38.04	19.89	20.80	5.65	2.66
OT#25-LIVER	33.61	0.58	0.91	14.88	4.31	ND	ND	0.92	1.29	0.78	24.45	12.74	15.58	5.10	2.87
OT#26-LIVER	4.70	ND	ND	0.83	0.26	ND	ND	ND	ND	ND	2.31	1.49	1.24	0.43	ND
OT#27-LIVER	15.17	ND	0.48	4.27	1.13	ND	ND	0.47	0.35	0.10	6.58	3.72	1.73	0.55	0.22
OT#28-LIVER	10.67	ND	0.42	2.51	0.65	ND	ND	0.37	0.21	0.09	4.22	2.46	1.21	0.50	0.16
OT#29-LIVER	2.86	ND	ND	0.65	0.19	ND	ND	0.27	0.36	ND	3.66	1.98	1.17	0.41	0.11
MINK#30-LIVE	109.30	1.82	1.22	67.16	6.20	8.74	ND	7.85	1.79	0.81	98.46	47.93	16.99	8.77	6.26
MINK#31-LIVE	28.93	0.66	0.38	23.34	3.07	1.79	ND	1.60	0.33	0.25	22.48	9.21	5.57	3.88	1.51
OT#32-LIVER	8.41	ND	0.16	3.23	0.61	ND	ND	0.30	0.35	0.08	4.15	2.33	1.37	0.33	ND
OT#33-LIVER A	15.29	ND	0.14	2.46	0.96	0.37	ND	0.33	0.39	0.10	7.87	5.10	1.39	0.73	0.28
OT#33-LIVER B	13.97	ND	0.12	2.30	0.88	ND	ND	0.30	0.33	ND	7.17	4.68	1.26	ND	0.27
OT#34-LIVER	270.76	5.27	5.42	71.78	24.52	ND	0.28	6.63	5.54	3.79	141.11	95.29	50.65	21.29	11.14
OT#35-LIVER	239.77	3.36	4.26	59.99	22.71	ND	ND	7.18	3.03	4.01	154.65	117.36	74.34	21.34	12.41
OT#36-LIVER	211.90	5.09	5.07	109.68	24.09	ND	0.25	10.00	3.93	4.35	128.34	78.96	57.08	21.90	11.30
OT#37-LIVER	521.48	7.26	6.40	118.47	34.05	ND	ND	18.40	10.92	6.53	162.01	120.09	52.56	20.34	10.28
OT#38-LIVER	478.30	9.19	11.45	331.00	67.12	ND	0.99	22.45	7.06	8.42	257.67	198.08	140.15	72.82	23.22
MINK#39-LIVE	29.72	0.68	0.38	ND	2.29	ND	ND	1.48	0.38	0.16	19.95	8.59	3.47	2.64	1.34
MINK#40-LIVE	4.90	ND	ND	1.40	0.37	ND	ND	0.36	ND	ND	11.70	4.12	0.46	0.64	0.45

Appendix 2 (continued).

Sample Number	PCB #194	PCB #206	SPCBs	Aroclor 1254:1260	Aroclor 1260	Total PCB TEQs
OT#1-LIVER	9.04	4.80	442.54	2060.49	648.18	0.012355
OT#2-LIVER	5.64	3.85	261.75	1137.27	357.72	0.007731
OT#3-LIVER	11.72	6.25	423.73	1383.49	509.99	0.015028
OT#4-LIVER	2.52	1.43	88.80	277.96	129.21	0.003068
OT#5-LIVER	6.37	3.64	393.12	1631.54	494.45	0.011134
OT#6-LIVER	4.34	2.48	285.28	1032.83	270.61	NS
OT#7-LIVER	4.80	2.46	439.15	1847.45	498.99	0.012292
OT#8-LIVER	7.89	4.98	444.19	1627.43	525.81	0.011846
OT#9-LIVER	9.61	5.72	460.75	1647.91	644.23	0.010024
OT#10-LIVER	10.66	6.19	797.76	3194.24	1063.65	0.015057
OT#11-LIVER	3.70	2.28	251.06	948.47	313.22	0.007012
OT#12-LIVER	1.86	1.16	135.75	588.31	130.82	0.004007
OT#13-LIVER	13.83	6.89	867.93	3549.69	1154.53	0.030115
OT#14-LIVER A	2.46	1.53	125.52	433.13	132.98	0.003205
OT#14-LIVER B	2.15	1.71	135.35	463.69	156.96	
OT#15-LIVER	7.36	5.21	371.29	1364.74	483.20	0.008766
OT#16-LIVER	7.63	3.39	611.41	2394.26	703.00	0.009533
OT#17-LIVER	6.97	3.40	438.98	1689.86	581.26	0.008836
OT#18-LIVER	4.11	3.25	271.10	932.87	301.83	0.006808
OT#19-LIVER	8.60	4.63	660.91	2633.60	673.63	0.015844
OT#20-LIVER A	3.86	2.46	253.18	873.38	312.73	0.004240
OT#20-LIVER B	3.88	2.49	260.97	865.81	391.47	
OT#21-LIVER	14.43	9.85	554.98	1633.69	986.90	0.012356
OT#22-LIVER	2.17	2.21	113.08	386.52	124.85	0.002700
OT#23-LIVER	9.42	7.79	345.82	981.94	618.81	0.007276
OT#24-LIVER	6.67	6.58	268.36	765.00	333.71	0.006208
OT#25-LIVER	5.08	5.06	186.75	454.21	214.46	0.004481
OT#26-LIVER	0.42	0.71	18.03	63.52	20.22	0.000332
OT#27-LIVER	0.59	0.51	64.13	205.02	57.70	0.001277
OT#28-LIVER	0.90	0.73	44.53	144.22	37.02	0.000790
OT#29-LIVER	1.73	1.11	17.69	38.62	32.15	0.000345
MINK#30-LIVER	20.18	15.78	548.87	1477.02	863.66	NS
MINK#31-LIVER	3.61	3.41	151.02	390.99	197.19	0.005650
OT#32-LIVER	0.52	0.43	38.94	113.64	36.41	0.000877
OT#33-LIVER A	1.68	0.98	61.99	206.58	69.07	0.001176
OT#33-LIVER B	1.08	0.90	55.28	188.74	62.85	
OT#34-LIVER	19.33	11.21	1054.53	3658.86	1237.85	0.026975
OT#35-LIVER	22.96	13.24	982.37	3240.10	1356.58	0.017832
OT#36-LIVER	17.83	12.69	926.46	2863.51	1125.80	0.017828
OT#37-LIVER	14.55	6.46	1640.22	7046.98	1421.18	0.058338
OT#38-LIVER	35.10	27.11	2119.55	6463.56	2260.29	0.037999
MINK#39-LIVER	2.89	2.29	118.83	401.66	174.99	0.003900
MINK#40-LIVER	2.35	1.14	34.11	66.25	102.67	0.000834

Appendix 3. Organochlorine insectide and metabolites and PCB concentrations (ppb, lw) in livers of river otter and mink collected from the Lower Columbia River and Reference Area, 1994-95. Detection limit is adjusted for % fat. A,B = 2 replicates of the same sample. SPCBs = the sum of PCBs.

Sample Number	% Lipid	% Moisture	1,2,4,5 -TCB	1,2,3,4 -TCB	QCB	HCB	OCS	trans-Nonachlor	pp'-DDE	photo-Mirex	Mirex	a-HCH	b-HCH	g-HCH	oxy-Chlordane
OT#1-LIVER	3.52	70.95	0.00	0.00	0.00	156.44	15.19	87.81	2386.55	0.00	27.01	0.00	0.00	0.00	238.10
OT#2-LIVER	2.97	71.65	0.00	0.00	0.00	83.99	6.74	350.92	1816.83	0.00	22.31	0.00	0.00	0.00	590.83
OT#3-LIVER	5.31	71.29	0.00	0.00	0.00	192.14	17.85	117.97	2742.03	0.00	21.50	0.00	3.52	0.00	291.99
OT#4-LIVER	3.84	71.61	0.00	0.00	0.00	98.18	11.05	76.21	926.07	9.09	10.59	0.00	0.00	0.00	118.18
OT#5-LIVER	2.97	69.85	0.00	0.00	0.00	158.14	13.36	100.50	1593.56	0.00	24.14	0.00	4.58	0.00	482.78
OT#6-LIVER	4.21	70.03	0.00	0.00	0.00	80.32	5.08	67.18	165.66	0.00	30.65	0.00	11.71	0.00	144.76
OT#7-LIVER	4.48	73.06	0.00	0.00	0.00	167.91	14.68	110.98	190.51	0.00	22.42	0.00	3.16	0.00	577.24
OT#8-LIVER	3.87	69.38	0.00	0.00	0.00	299.18	28.57	191.19	2978.06	30.78	53.75	0.00	5.84	0.00	459.04
OT#9-LIVER	3.90	71.19	0.00	0.00	0.00	164.26	11.64	102.27	2787.01	0.00	26.99	0.00	2.97	0.00	268.61
OT#10-LIVER	3.65	69.40	0.00	0.00	0.00	179.51	19.16	158.09	4255.65	0.00	41.67	0.00	1.35	0.00	365.76
OT#11-LIVER	2.93	70.53	0.00	0.00	0.00	241.82	24.48	80.96	3360.23	0.00	26.53	0.00	6.15	0.00	325.23
OT#12-LIVER	3.03	70.41	0.00	0.00	0.00	150.70	14.62	104.14	1577.76	10.43	20.92	0.00	4.32	0.00	209.93
OT#13-LIVER	4.94	70.07	0.00	0.00	0.00	165.50	13.68	147.49	2732.45	0.00	25.68	0.99	1.32	0.00	457.93
OT#14-LIVER A	3.41	70.72	0.00	0.00	0.00	90.76	4.30	44.44	988.96	0.00	12.06	0.00	0.00	0.00	133.75
OT#14-LIVER B	3.01	70.72	0.00	0.00	0.00	110.41	5.50	52.63	1193.51	0.00	13.27	0.00	3.18	0.00	164.19
OT#15-LIVER	2.27	70.87	0.00	0.00	6.18	103.90	6.83	96.67	4042.75	0.00	12.42	6.45	2.45	0.00	503.91
OT#16-LIVER	2.76	70.31	0.00	0.00	0.00	303.31	28.05	380.46	10991.16	32.40	95.37	1.84	4.52	0.00	441.93
OT#17-LIVER	3.57	69.91	0.00	0.00	0.00	167.18	10.50	101.45	1940.87	0.00	24.54	0.00	2.45	0.00	262.11
OT#18-LIVER	2.79	69.23	0.00	0.00	0.00	251.06	22.53	85.49	5926.52	0.00	58.66	1.82	3.95	0.00	318.06
OT#19-LIVER	3.91	68.07	0.00	0.00	0.00	124.43	15.19	91.35	3425.16	0.00	34.58	2.23	1.66	0.00	397.85
OT#20-LIVER A	4.05	71.48	0.00	0.00	3.93	131.17	12.39	97.61	1184.95	13.73	18.18	0.00	3.72	0.00	159.67
OT#20-LIVER B	4.03	71.48	0.00	0.00	4.01	130.90	10.93	96.74	1201.89	13.52	18.58	0.00	3.71	0.00	161.11
OT#21-LIVER	3.49	72.07	0.00	0.00	0.00	98.31	14.91	55.11	1821.50	0.00	24.51	0.00	2.05	0.00	255.23
OT#22-LIVER	2.70	70.20	0.00	0.00	0.00	73.32	7.55	19.91	520.92	0.00	8.44	0.00	4.84	0.00	102.39
OT#23-LIVER	5.26	70.10	0.00	0.00	0.00	67.19	7.28	52.50	1569.21	9.03	14.18	0.00	3.76	0.00	99.93
OT#24-LIVER	3.71	68.93	0.00	0.00	0.00	45.30	9.21	36.34	1856.17	0.00	8.24	1.29	0.00	0.00	127.01
OT#25-LIVER	2.92	69.14	0.00	0.00	0.00	31.98	0.00	20.85	2641.06	0.00	10.56	1.64	1.55	0.00	90.89
OT#26-LIVER	3.24	69.06	0.00	0.00	0.00	52.83	0.00	7.03	63.29	0.00	0.00	0.00	0.00	0.00	68.56
OT#27-LIVER	3.24	70.25	0.00	0.00	0.00	154.70	9.65	63.78	505.53	16.41	20.90	0.00	3.07	0.00	135.71
OT#28-LIVER	3.78	71.88	0.00	0.00	0.00	321.66	12.88	81.41	495.84	10.29	7.58	0.00	0.00	0.00	170.90
OT#29-LIVER	2.48	70.10	0.00	0.00	0.00	87.97	0.00	4.66	47.65	0.00	0.00	0.00	0.00	0.00	54.76
MINK#30-LIVER	5.14	71.89	0.00	0.00	10.22	41.52	10.73	13.00	2951.75	10.20	28.99	0.00	0.00	0.00	1135.68
MINK#31-LIVER	3.18	73.69	0.00	0.00	0.00	18.09	6.43	0.00	1490.87	7.23	21.37	0.00	3.15	0.00	1158.49
OT#32-LIVER	3.03	69.93	0.00	0.00	0.00	169.69	7.56	56.81	465.12	9.11	16.15	0.00	0.00	0.00	90.95
OT#33-LIVER A	3.06	69.47	0.00	0.00	0.00	201.67	16.80	58.77	436.78	11.84	9.68	0.00	0.00	0.00	150.56
OT#33-LIVER B	2.92	69.47	0.00	0.00	0.00	202.05	13.10	56.75	417.72	11.21	10.04	0.00	0.00	0.00	155.41
OT#34-LIVER	3.85	68.29	0.00	0.00	9.94	343.19	49.90	310.42	10175.39	0.00	34.91	1.25	1.79	0.00	322.47
OT#35-LIVER	2.43	71.55	0.00	0.00	19.40	135.61	13.36	194.64	12508.01	0.00	29.74	0.00	0.00	0.00	283.38
OT#36-LIVER	2.68	71.82	0.00	0.00	38.39	269.64	19.26	520.03	38666.60	0.00	50.48	0.00	4.05	0.00	441.49
OT#37-LIVER	2.66	71.08	0.00	0.00	25.74	170.95	8.85	1019.58	50215.21	0.00	50.48	2.61	0.00	0.00	1119.40
OT#38-LIVER	4.50	68.44	0.00	0.00	16.52	227.00	13.04	2025.17	40474.76	0.00	97.06	1.52	3.68	0.00	654.32
MINK#39-LIVER	4.81	70.88	0.00	0.00	0.00	15.26	2.73	2.18	5854.16	24.33	26.44	0.00	1.69	0.00	546.23
MINK#40-LIVER	4.38	70.86	0.00	0.00	0.00	9.99	0.00	2.71	333.08	0.00	0.00	0.00	2.77	0.00	84.70

Appendix 3 (continued).

Sample Number	trans-Chlordane	cis-Chlordane	pp'-DDD	cis-Nonachlor	pp'-DDT	HC Epox	Dieldrin	PCB #31	PCB #28	PCB #52	PCB #49	PCB #44	PCB #42	PCB #64
OT#1-LIVER	3.03	9.71	259.17	15.47	5.23	17.47	94.88	0.00	0.00	92.29	18.80	29.28	0.00	0.00
OT#2-LIVER	1.99	19.35	180.03	27.20	4.72	42.95	152.85	0.00	0.00	50.77	11.78	41.69	0.00	2.07
OT#3-LIVER	1.55	1.50	185.62	9.08	0.00	28.27	143.68	0.00	4.53	62.98	19.94	18.24	0.00	0.91
OT#4-LIVER	0.00	1.61	36.69	5.00	4.28	7.99	25.69	0.00	0.00	19.99	0.00	40.51	0.00	0.00
OT#5-LIVER	2.13	12.35	202.70	14.96	12.43	35.83	248.82	0.00	12.35	61.64	13.46	17.53	0.00	0.00
OT#6-LIVER	2.99	10.43	171.87	13.26	5.77	25.76	120.71	0.00	20.69	92.08	27.33	26.26	0.00	1.12
OT#7-LIVER	0.00	4.29	110.72	8.68	2.09	43.29	211.70	0.00	8.95	38.69	8.62	11.97	0.00	0.00
OT#8-LIVER	1.37	11.51	152.80	16.69	20.27	30.73	119.61	0.00	9.22	55.65	18.93	11.74	0.00	2.49
OT#9-LIVER	0.00	0.00	100.50	7.91	0.00	23.30	77.97	0.00	5.98	68.44	11.42	23.21	0.00	0.00
OT#10-LIVER	1.77	8.90	177.11	16.00	4.04	27.83	160.16	0.00	10.58	68.51	14.01	23.54	0.00	0.00
OT#11-LIVER	0.00	0.00	148.61	6.70	0.00	40.93	146.49	0.00	5.32	73.31	9.44	44.56	0.00	0.00
OT#12-LIVER	0.00	3.99	81.23	9.80	8.30	26.30	99.68	0.00	0.00	43.39	7.28	33.01	0.00	1.52
OT#13-LIVER	4.09	21.91	201.33	33.57	4.54	33.85	183.58	0.00	5.40	69.46	20.92	14.32	0.00	1.14
OT#14-LIVER A	1.72	5.95	99.92	9.54	0.00	20.39	104.80	0.00	12.89	42.99	10.06	14.24	0.00	0.00
OT#14-LIVER B	2.51	6.81	122.15	11.22	0.00	21.14	108.79	0.00	15.41	51.79	12.10	18.52	0.00	0.00
OT#15-LIVER	0.00	12.20	206.79	13.11	0.00	46.54	215.36	0.00	21.70	156.39	36.53	28.40	0.00	0.00
OT#16-LIVER	2.22	11.62	373.42	38.25	6.88	73.58	280.07	0.00	17.68	154.22	21.16	23.06	0.00	2.80
OT#17-LIVER	2.45	14.23	159.16	14.63	6.03	33.80	175.74	0.00	8.47	51.77	13.27	14.27	0.00	0.00
OT#18-LIVER	2.34	11.78	222.07	19.26	0.00	41.94	173.23	0.00	14.01	141.38	25.55	17.96	0.00	0.00
OT#19-LIVER	2.31	10.64	312.93	15.50	0.00	33.67	165.48	0.00	8.72	201.10	49.13	21.08	0.00	1.68
OT#20-LIVER A	0.00	4.94	59.16	7.60	3.30	15.55	51.37	0.00	18.10	34.48	8.20	30.26	0.00	1.48
OT#20-LIVER B	0.00	4.24	59.51	7.06	2.87	16.15	54.72	0.00	18.38	32.92	8.22	29.61	0.00	1.28
OT#21-LIVER	1.46	6.08	149.18	8.81	0.00	13.91	46.23	0.00	5.18	81.24	24.63	23.39	0.00	0.00
OT#22-LIVER	0.00	0.00	15.85	2.15	0.00	23.90	74.10	0.00	16.37	10.22	0.00	34.13	0.00	0.00
OT#23-LIVER	0.88	3.93	52.26	5.26	0.00	15.65	51.83	0.00	5.56	24.27	4.11	10.16	0.00	0.00
OT#24-LIVER	0.00	2.08	34.49	3.12	0.00	18.92	113.47	0.00	8.97	83.32	30.51	8.00	0.00	0.00
OT#25-LIVER	0.00	3.71	83.55	3.84	0.00	12.15	69.24	0.00	10.13	53.79	21.57	25.96	0.00	0.00
OT#26-LIVER	0.00	0.00	7.84	0.00	0.00	9.62	23.90	0.00	9.41	0.00	0.00	21.68	0.00	0.00
OT#27-LIVER	1.97	9.43	55.23	7.62	5.93	9.54	29.00	0.00	0.00	27.99	0.00	6.04	0.00	0.00
OT#28-LIVER	0.00	1.83	15.74	3.67	9.40	17.02	57.00	0.00	0.00	8.80	0.00	4.79	0.00	1.99
OT#29-LIVER	0.00	0.00	5.52	0.00	0.00	7.33	19.45	0.00	0.00	0.00	0.00	5.18	0.00	0.00
MINK#30-LIVER	0.00	0.00	127.72	0.00	0.00	44.66	655.37	0.00	9.83	0.00	0.00	23.65	0.00	0.00
MINK#31-LIVER	0.00	0.00	89.00	0.00	0.00	13.56	264.07	0.00	0.00	9.20	0.00	0.00	0.00	0.00
OT#32-LIVER	0.00	1.86	37.21	4.80	0.00	12.46	40.12	0.00	0.00	23.57	0.00	0.00	0.00	0.00
OT#33-LIVER A	0.00	3.42	27.80	4.66	0.00	12.57	39.24	0.00	0.00	11.62	0.00	6.37	0.00	0.00
OT#33-LIVER B	0.00	3.19	31.19	5.60	0.00	12.08	44.77	0.00	0.00	11.11	0.00	0.00	0.00	0.00
OT#34-LIVER	7.75	25.79	826.54	41.83	0.00	46.31	365.04	0.00	14.17	361.55	66.61	25.65	0.00	1.30
OT#35-LIVER	0.00	0.00	360.64	27.02	0.00	81.61	456.32	0.00	0.00	328.53	51.54	22.30	0.00	0.00
OT#36-LIVER	10.67	57.52	1701.73	105.04	0.00	160.11	1008.05	0.00	0.00	436.85	56.26	26.79	0.00	3.30
OT#37-LIVER	16.95	121.60	5172.75	185.98	0.00	243.85	1415.13	0.00	0.00	2318.20	53.67	22.43	0.00	2.12
OT#38-LIVER	107.79	515.97	6987.98	685.07	4.25	173.12	2007.66	0.00	3.13	274.38	40.80	18.98	0.00	2.12
MINK#39-LIVER	0.00	0.00	25.45	0.00	0.00	6.64	68.52	0.00	2.85	0.00	0.00	8.15	0.00	0.00
MINK#40-LIVER	0.00	1.90	13.38	1.76	0.00	1.93	18.55	0.00	0.00	0.00	0.00	3.86	0.00	0.00

Appendix 3 (continued).

Sample Number	PCB #74	PCB #70	PCB #66/95	PCB #60	PCB #101	PCB #99	PCB #97	PCB #87	PCB #110	PCB #151	PCB #149	PCB #118	PCB #146	PCB #153
OT#1-LIVER	32.23	12.95	43.79	33.32	118.79	747.84	0.00	68.37	49.59	53.70	51.16	93.39	214.50	2579.74
OT#2-LIVER	0.00	8.74	35.81	31.08	101.65	474.03	11.23	58.07	58.88	25.14	52.55	133.78	134.85	1748.40
OT#3-LIVER	26.81	6.28	19.08	26.63	96.82	539.88	0.00	49.14	31.26	16.82	17.19	86.63	159.71	1408.55
OT#4-LIVER	0.00	0.00	4.67	16.65	37.07	190.76	0.00	14.35	7.48	11.75	14.27	73.58	49.69	569.81
OT#5-LIVER	9.93	6.81	16.02	18.58	104.53	646.57	0.00	52.45	39.24	19.71	25.13	62.86	206.43	2033.45
OT#6-LIVER	23.28	14.18	36.40	22.91	118.19	490.23	0.00	60.42	47.94	21.64	22.24	111.44	132.65	1129.21
OT#7-LIVER	9.90	0.00	7.81	15.59	54.15	838.89	0.00	24.18	13.47	5.17	11.93	40.63	159.32	2112.15
OT#8-LIVER	14.20	5.98	27.78	35.33	114.03	903.30	9.82	86.87	52.37	0.00	38.37	83.60	161.12	2066.85
OT#9-LIVER	0.00	0.00	12.20	14.11	84.08	695.60	0.00	36.17	15.71	0.00	13.43	68.34	177.85	2312.29
OT#10-LIVER	10.92	6.34	26.74	39.32	124.71	1255.15	0.00	54.77	32.37	34.06	36.19	71.98	308.44	4301.32
OT#11-LIVER	0.00	0.00	24.79	22.60	81.77	614.32	6.54	37.86	27.28	0.00	32.05	91.58	134.98	1818.19
OT#12-LIVER	17.51	0.00	17.93	22.10	81.74	390.91	9.51	40.76	36.34	24.36	33.53	87.83	111.31	924.64
OT#13-LIVER	27.70	7.27	38.34	26.92	103.76	1036.67	0.00	51.68	32.01	29.65	23.30	158.33	268.41	3300.16
OT#14-LIVER A	11.65	5.61	14.94	13.76	46.92	228.37	0.00	23.42	15.75	10.85	7.39	49.71	75.13	597.21
OT#14-LIVER B	11.11	7.14	18.96	13.14	55.99	273.20	0.00	27.88	19.01	10.56	9.37	61.10	89.00	719.53
OT#15-LIVER	33.13	9.17	30.56	53.46	146.45	916.87	0.00	87.50	48.22	15.17	24.07	90.14	230.70	2670.71
OT#16-LIVER	21.39	0.00	46.96	45.76	163.26	1420.72	7.23	68.36	42.12	19.44	44.42	109.73	411.48	4270.35
OT#17-LIVER	16.51	6.84	21.24	19.12	87.16	669.85	0.00	39.18	31.63	25.54	18.87	77.33	193.12	2212.90
OT#18-LIVER	26.68	7.32	36.56	19.94	112.12	589.64	0.00	57.45	33.25	29.07	30.35	84.53	205.66	1624.74
OT#19-LIVER	30.55	18.88	86.02	41.18	301.40	1162.60	4.36	189.91	115.66	47.50	93.54	226.17	301.06	2822.47
OT#20-LIVER A	15.02	5.98	18.28	16.89	61.06	466.69	0.00	27.48	22.73	26.41	25.11	65.74	95.28	1261.82
OT#20-LIVER B	16.01	5.34	18.36	20.07	62.06	461.13	0.00	28.49	26.10	26.98	26.76	66.48	94.41	1249.92
OT#21-LIVER	18.28	8.45	53.56	40.82	157.66	731.49	0.00	65.58	56.73	41.10	58.75	114.58	184.58	2906.12
OT#22-LIVER	21.10	0.00	0.00	0.00	37.49	259.64	0.00	17.95	11.16	0.00	18.52	79.68	71.17	705.93
OT#23-LIVER	13.57	4.48	19.70	16.64	55.21	342.75	0.00	19.50	15.17	16.63	31.75	50.53	77.20	1406.71
OT#24-LIVER	29.67	0.00	29.01	50.43	81.63	397.47	0.00	38.43	29.49	9.12	15.71	81.51	118.32	1191.09
OT#25-LIVER	26.46	16.05	41.31	102.07	109.95	298.48	5.28	56.37	42.36	23.53	34.38	89.86	95.10	894.06
OT#26-LIVER	0.00	0.00	0.00	0.00	0.00	47.04	0.00	0.00	0.00	0.00	0.00	0.00	9.49	86.87
OT#27-LIVER	10.47	8.30	14.12	0.00	37.92	222.16	0.00	17.46	15.43	28.36	18.76	27.43	32.26	387.96
OT#28-LIVER	0.00	0.00	0.00	15.38	9.13	190.06	0.00	0.00	0.00	10.11	7.39	17.38	23.10	205.63
OT#29-LIVER	0.00	0.00	0.00	0.00	0.00	23.42	0.00	0.00	0.00	0.00	0.00	10.58	5.78	83.73
MINK#30-LIVER	59.33	0.00	22.58	74.64	40.45	388.25	0.00	15.69	0.00	0.00	0.00	422.76	204.29	1157.41
MINK#31-LIVER	19.36	0.00	14.41	27.97	18.98	178.78	0.00	10.89	4.35	0.00	0.00	191.71	81.85	675.73
OT#32-LIVER	0.00	0.00	6.13	20.79	28.27	148.19	0.00	12.90	5.43	16.28	13.81	20.81	25.53	215.11
OT#33-LIVER A	0.00	0.00	0.00	15.54	18.45	238.78	0.00	9.14	10.02	13.02	9.03	14.90	23.77	390.59
OT#33-LIVER B	0.00	0.00	11.99	16.31	18.56	231.09	0.00	8.44	8.94	8.02	9.26	16.47	22.63	373.80
OT#34-LIVER	0.00	40.53	195.51	103.90	365.69	1273.31	0.00	204.06	172.80	107.36	130.15	183.47	561.19	4082.53
OT#35-LIVER	0.00	0.00	79.48	51.29	298.09	1281.07	0.00	146.96	71.88	113.02	93.15	104.79	660.45	5678.86
OT#36-LIVER	34.59	9.65	143.55	66.84	330.13	1235.99	0.00	227.30	114.52	99.70	168.60	127.43	685.34	4430.13
OT#37-LIVER	31.76	0.00	536.59	68.31	866.12	3658.06	0.00	1079.93	212.35	106.68	383.09	293.01	1427.92	8436.83
OT#38-LIVER	42.74	12.52	163.53	114.87	340.14	1311.43	0.00	224.90	81.13	300.39	333.30	132.97	768.73	5147.12
MINK#39-LIVER	15.40	0.00	4.35	10.27	5.36	94.87	0.00	4.34	0.00	0.00	0.00	147.40	56.70	498.35
MINK#40-LIVER	0.00	0.00	0.00	0.00	0.00	4.17	0.00	0.00	0.00	0.00	0.00	19.14	4.49	110.21

Appendix 3 (continued).

Sample Number	PCB #105	PCB #141	PCB #138	PCB #158	PCB #129	PCB #182/187	PCB #183	PCB #185	PCB #174	PCB #171	PCB #200	PCB #172	PCB #180	PCB #170/190
OT#1-LIVER	76.12	19.80	4331.72	64.76	56.09	475.41	279.95	0.00	6.83	55.18	82.34	28.69	2099.23	1577.00
OT#2-LIVER	84.22	27.30	2833.60	57.09	44.46	502.38	222.91	0.00	6.84	41.59	46.11	16.01	1373.08	922.82
OT#3-LIVER	65.28	11.67	1928.03	35.56	43.99	310.60	143.44	0.00	0.00	91.51	45.97	28.67	1094.90	679.69
OT#4-LIVER	37.04	3.17	535.65	13.71	20.46	129.71	43.67	0.00	0.00	17.53	18.45	6.97	383.59	204.46
OT#5-LIVER	106.07	7.41	4065.11	54.91	82.05	396.95	222.78	0.00	0.00	42.55	92.51	33.02	1897.88	1711.13
OT#6-LIVER	98.33	14.80	1815.43	40.43	45.34	316.93	117.96	0.00	0.00	71.72	52.60	17.25	732.77	483.31
OT#7-LIVER	70.56	3.10	3051.59	50.79	41.54	224.41	175.08	0.00	0.00	30.43	63.29	18.64	1269.76	890.85
OT#8-LIVER	91.43	6.40	3111.88	59.63	44.66	559.98	232.69	0.00	0.00	45.04	74.99	19.22	1548.89	988.60
OT#9-LIVER	59.05	4.78	3126.81	46.12	43.19	453.67	211.92	0.00	0.00	44.29	63.41	29.39	1883.13	1159.86
OT#10-LIVER	88.25	13.67	6475.99	91.55	52.90	902.81	471.01	0.00	0.00	153.02	109.10	38.43	3322.09	2204.09
OT#11-LIVER	65.77	7.04	2395.45	34.45	25.99	222.25	177.51	0.00	0.00	79.30	58.64	16.91	1218.66	678.29
OT#12-LIVER	54.07	19.06	1436.81	30.87	37.11	290.92	102.54	0.00	0.00	30.69	31.70	15.71	492.19	371.51
OT#13-LIVER	72.25	20.50	5317.35	74.26	50.67	449.00	367.14	78.73	0.00	76.73	79.32	38.21	2664.30	1787.21
OT#14-LIVER A	71.19	3.60	939.92	19.48	21.98	223.50	73.45	0.00	0.00	42.40	26.92	7.50	444.56	285.36
OT#14-LIVER B	86.90	3.13	1139.96	23.81	27.35	274.20	89.88	0.00	0.00	52.96	33.57	10.00	594.47	348.91
OT#15-LIVER	108.32	12.66	4448.92	63.51	69.28	529.41	315.39	0.00	0.00	48.69	83.47	46.68	2426.62	1657.51
OT#16-LIVER	87.62	12.97	6419.40	129.94	80.77	1149.37	528.91	216.18	0.00	182.68	128.19	49.76	2903.69	1911.47
OT#17-LIVER	61.62	8.52	3502.78	49.75	52.78	406.86	239.72	0.00	0.00	45.04	87.10	28.80	1856.14	1484.35
OT#18-LIVER	80.39	9.44	2474.29	53.09	48.75	756.74	276.93	0.00	0.00	48.79	64.18	27.60	1233.29	659.58
OT#19-LIVER	139.98	37.19	4984.30	109.96	64.37	567.34	284.61	0.00	13.63	193.79	156.13	45.88	1964.04	1422.76
OT#20-LIVER A	41.94	8.62	1595.81	30.18	24.19	236.95	118.98	0.00	0.00	59.71	45.94	12.91	880.28	533.70
OT#20-LIVER B	41.78	7.74	1589.83	29.71	23.68	237.64	119.09	0.00	0.00	60.62	45.73	12.97	1107.40	539.02
OT#21-LIVER	69.24	17.95	3463.98	50.00	47.25	582.69	336.63	0.00	8.15	43.37	95.88	37.12	3223.68	1700.91
OT#22-LIVER	44.07	0.00	1059.35	18.58	16.89	196.97	78.91	0.00	0.00	53.82	41.75	11.15	527.14	379.45
OT#23-LIVER	32.72	5.12	1381.43	21.38	17.33	199.25	148.72	0.00	0.00	22.89	38.77	9.99	1341.15	608.47
OT#24-LIVER	59.63	0.00	1525.88	24.55	48.00	414.79	143.91	0.00	0.00	33.95	44.77	32.09	1025.42	536.04
OT#25-LIVER	49.18	10.77	1151.08	19.84	31.06	509.67	147.54	0.00	0.00	31.63	44.04	26.82	837.27	436.23
OT#26-LIVER	0.00	0.00	145.08	0.00	0.00	25.62	8.08	0.00	0.00	0.00	0.00	0.00	71.14	45.97
OT#27-LIVER	17.70	0.00	468.26	0.00	14.78	131.94	34.80	0.00	0.00	14.45	10.70	3.20	203.01	114.75
OT#28-LIVER	20.02	0.00	282.33	0.00	11.13	66.29	17.24	0.00	0.00	9.81	5.66	2.49	111.65	65.17
OT#29-LIVER	0.00	0.00	115.24	0.00	0.00	26.06	7.71	0.00	0.00	10.99	14.70	0.00	147.77	79.80
MINK#30-LIVER	102.64	0.00	2126.45	35.33	23.71	1306.71	120.53	170.06	0.00	152.70	34.90	15.70	1915.51	932.55
MINK#31-LIVER	55.79	0.00	909.85	20.62	12.10	734.03	96.62	56.19	0.00	50.45	10.23	7.99	706.92	289.66
OT#32-LIVER	13.47	0.00	277.54	0.00	5.28	106.48	20.18	0.00	0.00	10.01	11.54	2.62	136.97	76.79
OT#33-LIVER A	20.03	0.00	499.58	0.00	4.62	80.50	31.34	12.11	0.00	10.88	12.83	3.25	257.31	166.76
OT#33-LIVER B	17.83	0.00	478.32	0.00	4.26	78.80	29.99	0.00	0.00	10.16	11.32	0.00	245.38	160.20
OT#34-LIVER	137.05	38.55	7032.62	136.89	140.74	1864.52	636.96	0.00	7.34	172.17	143.80	98.34	3665.31	2475.14
OT#35-LIVER	116.17	28.34	9866.97	138.17	175.30	2468.81	934.65	0.00	0.00	295.37	124.69	165.11	6364.19	4829.76
OT#36-LIVER	110.79	50.50	7906.70	190.10	189.21	4092.54	898.88	0.00	9.16	372.98	146.75	162.30	4788.85	2946.29
OT#37-LIVER	353.04	90.68	19604.37	273.07	240.63	4453.61	1280.00	0.00	0.00	691.60	410.43	245.49	6090.78	4514.67
OT#38-LIVER	98.90	130.65	10628.97	204.31	254.40	7355.63	1491.51	0.00	21.97	498.79	156.84	187.10	5726.08	4401.68
MINK#39-LIVER	36.16	0.00	617.93	14.17	7.90	0.00	47.68	0.00	0.00	30.84	7.84	3.41	414.75	178.49
MINK#40-LIVER	0.00	0.00	111.92	0.00	0.00	31.96	8.51	0.00	0.00	8.30	0.00	0.00	267.23	94.00

Appendix 3 (continued).

Sample Number	PCB #201	PCB #203	PCB #195	PCB #194	PCB #206	SPCBs	Aroclor 1254:1260	Aroclor 1260
OT#1-LIVER	439.52	174.63	106.38	256.73	136.33	12572.26	58536.72	18414.26
OT#2-LIVER	394.96	191.81	103.52	189.95	129.65	8812.97	38291.92	12044.55
OT#3-LIVER	384.03	111.96	74.86	220.77	117.63	7979.94	26054.41	9604.39
OT#4-LIVER	66.16	26.59	7.93	65.50	37.22	2312.60	7238.53	3364.87
OT#5-LIVER	574.94	155.80	109.73	214.40	122.60	13236.51	54933.89	16648.10
OT#6-LIVER	264.84	92.93	51.49	103.05	58.91	6776.28	24532.77	6427.76
OT#7-LIVER	244.96	86.60	57.57	107.06	54.89	9802.53	41237.68	11138.26
OT#8-LIVER	380.34	198.44	85.34	203.85	128.63	11477.65	42052.44	13586.75
OT#9-LIVER	507.50	150.31	98.93	246.41	146.59	11814.19	42254.23	16518.71
OT#10-LIVER	595.75	295.45	161.84	291.95	169.53	21856.37	87513.36	29141.15
OT#11-LIVER	208.30	100.25	50.90	126.32	77.91	8568.53	32370.95	10689.98
OT#12-LIVER	177.18	65.02	30.84	61.22	38.45	4480.30	19416.29	4317.48
OT#13-LIVER	484.81	249.01	125.05	279.89	139.51	17569.37	71856.09	23371.02
OT#14-LIVER A	133.22	56.27	33.99	72.09	44.74	3681.06	12701.66	3899.63
OT#14-LIVER B	163.80	68.50	37.40	71.33	56.74	4496.74	15404.88	5214.65
OT#15-LIVER	991.07	259.04	143.03	324.23	229.37	16356.39	60120.53	21286.16
OT#16-LIVER	599.36	304.74	158.16	276.37	122.78	22152.51	86748.61	25471.01
OT#17-LIVER	415.20	155.23	104.96	195.17	95.38	12296.47	47334.90	16281.89
OT#18-LIVER	379.33	202.76	81.31	147.47	116.57	9716.74	33436.34	10818.35
OT#19-LIVER	555.81	188.72	113.48	219.83	118.31	16903.13	67355.41	17228.46
OT#20-LIVER A	187.71	79.43	38.17	95.19	60.72	6251.43	21565.04	7721.72
OT#20-LIVER B	191.45	79.77	38.86	96.22	61.75	6475.78	21484.22	9714.01
OT#21-LIVER	602.07	228.96	126.38	413.39	282.37	15902.15	46810.53	28277.86
OT#22-LIVER	211.16	65.86	37.59	80.22	81.81	4188.08	14315.52	4624.03
OT#23-LIVER	158.31	99.05	48.93	179.10	148.04	6574.59	18667.97	11764.49
OT#24-LIVER	560.54	152.37	71.70	179.76	177.25	7233.33	20619.96	8994.95
OT#25-LIVER	533.46	174.54	98.40	174.05	173.27	6395.57	15555.08	7344.46
OT#26-LIVER	38.16	13.14	0.00	12.82	21.98	556.48	1960.50	624.05
OT#27-LIVER	53.47	16.93	6.92	18.16	15.72	1979.44	6327.84	1780.81
OT#28-LIVER	31.97	13.19	4.33	23.77	19.34	1178.17	3815.28	979.41
OT#29-LIVER	47.06	16.36	4.31	69.79	44.75	713.24	1557.26	1296.24
MINK#30-LIVER	330.51	170.65	121.82	392.69	306.97	10678.32	28735.79	16802.72
MINK#31-LIVER	175.08	121.87	47.58	113.59	107.15	4748.96	12295.22	6201.08
OT#32-LIVER	45.17	11.03	0.00	17.13	14.21	1285.23	3750.59	1201.52
OT#33-LIVER A	45.46	23.91	9.13	55.06	31.98	2025.97	6751.08	2257.09
OT#33-LIVER B	43.07	0.00	9.17	37.05	30.88	1893.04	6463.76	2152.50
OT#34-LIVER	1315.48	553.04	289.38	502.13	291.21	27390.43	95035.36	32151.84
OT#35-LIVER	3059.07	878.15	510.79	944.72	544.92	40426.59	133337.45	55826.19
OT#36-LIVER	2129.90	817.09	421.76	665.22	473.36	34569.35	106847.34	42007.44
OT#37-LIVER	1975.79	764.53	386.45	547.13	242.97	61662.30	264923.95	53427.93
OT#38-LIVER	3114.41	1618.15	516.10	779.93	602.39	47101.00	143634.70	50228.77
MINK#39-LIVER	72.14	54.99	27.82	60.18	47.53	2470.44	8350.45	3638.13
MINK#40-LIVER	10.43	14.56	10.29	53.70	26.06	778.83	1512.44	2344.15

Appendix 4. Organochlorine insecticides and metabolites and PCB concentrations (ppb, ww) in mesentary fat of river otter and mink collected from the Lower Columbia River and Reference Area, 1994-95. River otter fat samples 26-29 and 32-33 from the Reference Area were pooled. Detection limit = 1.00 ppb (ww), A,B = 2 replicates of the same sample, SPCBs = the sum of PCBs.

Sample Number	% Lipid	% Moisture	1,2,4,5 -TCB	1,2,3,4 -TCB	QCB	HCB	OCS	trans-Nonachlor	pp'-DDE	photo-Mirex	Mirex	a-HCH	b-HCH	g-HCH
OT#1-FAT	67.24	20.93	ND	ND	1.47	73.81	8.00	104.17	2702.39	ND	8.68	1.21	1.02	ND
OT#2-FAT	62.23	n.d.	ND	ND	1.14	30.63	5.31	501.12	2118.58	5.77	11.34	1.76	0.77	ND
OT#3-FAT	63.93	26.92	ND	ND	1.86	94.83	12.94	117.00	3125.71	6.64	8.93	1.06	2.46	ND
OT#4-FAT	7.21	n.d.	ND	ND	ND	7.91	1.28	12.49	83.13	2.42	2.06	ND	ND	ND
OT#5-FAT	76.88	18.37	ND	ND	1.91	86.42	11.88	128.62	2005.37	ND	11.38	1.37	1.42	ND
OT#6-FAT	59.88	31.89	ND	ND	1.38	40.08	3.16	51.73	1351.17	ND	9.41	1.19	ND	ND
OT#7-FAT	38.35	41.57	ND	ND	ND	51.42	2.83	36.17	1039.95	ND	5.73	1.39	1.14	ND
OT#8-FAT A	42.76	44.03	ND	ND	ND	90.52	11.53	133.81	1378.05	19.47	13.43	ND	1.75	ND
OT#8-FAT B	48.85	44.03	ND	ND	ND	98.00	11.59	132.61	1473.11	20.49	14.39	ND	2.19	ND
OT#9-FAT	52.87	38.00	ND	ND	2.10	60.68	7.48	88.22	1628.99	7.46	9.11	0.81	0.97	ND
OT#10-FAT	47.17	42.91	ND	ND	ND	55.90	9.49	131.16	2493.77	8.69	13.16	ND	ND	ND
OT#11-FAT	35.19	52.35	ND	ND	ND	64.49	2.23	26.65	901.20	3.52	2.92	0.66	3.16	ND
OT#12-FAT	57.24	39.96	ND	ND	1.60	78.94	7.78	94.53	1148.90	9.33	7.40	ND	3.40	ND
OT#13-FAT	31.29	58.90	ND	ND	ND	58.51	7.93	116.77	1879.25	ND	10.98	ND	ND	ND
OT#14-FAT	42.39	47.22	ND	ND	ND	36.67	3.36	46.13	583.94	ND	3.87	0.62	ND	ND
OT#15-FAT A	50.22	38.31	ND	ND	ND	97.45	17.24	316.46	5935.99	18.61	20.88	1.28	2.61	ND
OT#15-FAT B	54.74	38.31	ND	ND	1.29	111.16	18.69	351.70	6855.42	21.43	23.58	1.36	2.72	ND
OT#16-FAT	60.48	33.91	ND	ND	2.83	34.89	3.88	80.71	2745.06	ND	5.15	5.10	1.36	ND
OT#17-FAT	63.32	37.76	ND	ND	1.37	67.77	6.42	80.32	1306.57	ND	7.59	0.87	1.58	ND
OT#18-FAT	51.72	46.14	ND	ND	1.41	63.86	7.06	64.32	1820.84	ND	4.94	0.72	2.08	ND
OT#19-FAT	57.24	38.16	ND	ND	1.39	59.49	11.25	107.08	2480.73	ND	10.24	1.01	1.33	ND
OT#20-FAT	45.82	42.27	ND	ND	1.22	36.62	4.35	52.10	433.47	5.36	5.42	1.25	1.86	ND
OT#21-FAT	69.60	45.72	ND	ND	ND	39.70	7.14	46.81	1164.64	6.90	6.24	ND	1.14	ND
OT#22-FAT	51.64	42.83	ND	ND	1.27	24.26	1.51	12.52	326.29	ND	2.05	1.15	3.46	ND
OT#23-FAT A	80.83	12.72	ND	ND	1.39	46.93	5.21	51.48	1019.00	5.86	5.95	2.00	4.05	ND
OT#23-FAT B	83.19	12.72	ND	ND	1.50	48.36	5.45	52.72	1063.82	6.14	6.15	2.15	3.89	ND
OT#24-FAT	57.35	38.78	ND	ND	1.64	20.79	2.97	33.20	1615.34	ND	5.87	2.31	1.14	ND
OT#25-FAT	50.37	42.62	ND	ND	1.23	11.79	1.91	16.55	1297.29	ND	2.99	3.10	0.86	ND
OT-FAT POOL(#26,27,28,29,32,33)	65.17	41.20	ND	ND	1.14	65.87	5.07	46.85	224.98	6.24	3.29	ND	ND	ND
MINK#30 FAT	52.44	39.81	ND	ND	1.50	8.12	2.41	2.92	552.27	ND	ND	ND	ND	ND
MINK#31 FAT	67.63	26.46	ND	ND	1.52	10.72	3.28	3.53	890.62	ND	ND	ND	1.37	ND
OT#34-FAT	44.73	45.76	ND	ND	2.46	69.28	20.82	249.99	5555.46	ND	12.73	0.89	ND	ND
OT#35-FAT	61.95	36.42	ND	ND	8.09	37.91	7.47	147.07	7668.88	ND	10.65	0.76	ND	ND
OT#36-FAT	38.24	46.90	ND	ND	11.89	56.25	9.64	408.46	17156.51	ND	28.08	ND	1.11	ND
OT#37-FAT	47.45	39.85	ND	ND	10.30	44.25	7.90	1757.38	21910.29	ND	38.50	0.76	0.88	ND
OT#38-FAT A	55.76	30.19	ND	ND	8.40	74.19	10.49	2556.43	20756.45	ND	51.36	1.00	1.87	1.94
OT#38-FAT B	71.25	30.19	ND	ND	10.66	94.15	14.61	3243.21	22273.38	ND	61.04	1.03	2.45	2.41

Appendix 4 (continued).

Sample Number	oxy-Chlordan	trans-Chlordane	cis-Chlordane	pp'-DDD	cis-Nonachlor	pp'-DDT	HC Epox	Dieldrin	PCB #31	PCB #28	PCB #52	PCB #49	PCB #44	PCB #42
OT#1-FAT	107.08	1.06	7.45	72.07	11.84	29.10	13.28	52.50	ND	ND	36.59	10.86	3.73	ND
OT#2-FAT	501.12	2.00	24.52	108.81	43.39	8.52	19.72	74.29	ND	1.02	24.53	6.38	3.93	ND
OT#3-FAT	106.78	0.94	5.68	101.70	13.96	23.67	18.33	76.14	ND	1.62	49.21	19.55	6.33	ND
OT#4-FAT	12.29	ND	ND	2.91	0.71	ND	0.75	2.16	ND	ND	ND	ND	1.50	ND
OT#5-FAT	259.11	0.97	6.79	49.96	11.58	20.70	20.07	96.17	ND	2.49	43.98	11.56	4.56	ND
OT#6-FAT	29.79	0.48	4.76	52.73	8.05	27.75	14.01	35.44	ND	2.80	42.22	12.67	5.91	ND
OT#7-FAT	15.40	ND	2.85	33.01	6.93	22.61	13.99	33.98	ND	2.17	14.95	4.02	4.82	ND
OT#8-FAT A	129.88	ND	3.94	30.82	6.35	20.02	12.04	33.96	ND	3.78	19.94	10.31	7.50	ND
OT#8-FAT B	122.47	0.41	4.57	35.19	7.72	19.78	14.30	33.51	ND	3.07	21.08	11.12	5.48	ND
OT#9-FAT	131.45	ND	3.20	47.37	7.71	4.78	10.03	34.22	ND	2.50	25.36	6.05	4.65	ND
OT#10-FAT	165.36	0.55	3.72	42.39	9.17	6.38	12.52	33.92	ND	2.15	21.11	4.75	5.47	ND
OT#11-FAT	8.73	ND	2.52	32.44	5.44	21.64	7.81	18.21	ND	2.29	16.75	3.35	5.51	ND
OT#12-FAT	54.82	ND	4.69	32.44	9.05	24.67	9.83	20.77	ND	2.42	18.94	4.79	5.92	ND
OT#13-FAT	165.27	0.60	4.76	27.15	8.55	15.12	11.33	41.84	ND	2.82	22.46	4.62	4.61	ND
OT#14-FAT	66.99	ND	2.88	22.00	5.40	11.68	8.65	37.54	ND	2.45	13.78	3.94	4.27	ND
OT#15-FAT A	250.44	1.02	10.62	135.15	25.79	61.68	30.54	102.73	ND	1.68	46.01	9.41	6.02	ND
OT#15-FAT B	251.35	1.11	10.29	137.91	26.03	79.33	33.39	98.33	ND	1.62	51.78	10.81	5.88	ND
OT#16-FAT	185.75	1.08	6.06	85.85	9.60	5.50	15.62	72.39	ND	2.97	49.40	16.69	5.63	ND
OT#17-FAT	130.23	0.62	4.72	29.64	7.82	20.76	14.93	60.37	ND	2.54	23.25	5.53	3.43	ND
OT#18-FAT	115.33	0.70	4.38	31.50	9.93	13.79	13.64	52.71	ND	2.25	25.41	7.58	2.85	ND
OT#19-FAT	233.64	0.81	4.70	69.40	9.29	8.32	15.04	58.08	ND	3.10	104.97	24.79	10.23	ND
OT#20-FAT	77.61	ND	3.66	15.38	4.59	10.22	6.55	16.96	ND	2.80	11.28	2.88	4.14	ND
OT#21-FAT	109.42	ND	1.62	35.84	5.62	6.15	4.95	13.26	ND	ND	15.18	5.34	2.08	ND
OT#22-FAT	10.49	ND	3.41	10.02	2.86	ND	6.88	22.31	ND	ND	5.58	2.22	1.18	ND
OT#23-FAT A	84.56	0.46	3.56	25.72	5.47	14.25	10.77	31.79	ND	ND	8.50	1.73	1.36	ND
OT#23-FAT B	89.14	0.52	2.48	24.33	5.50	20.94	10.63	32.28	ND	ND	8.82	1.91	2.73	ND
OT#24-FAT	92.65	ND	2.12	38.04	4.36	1.75	9.75	59.48	ND	2.28	27.31	12.46	7.02	ND
OT#25-FAT	61.56	ND	1.35	46.50	2.99	ND	5.20	29.61	ND	1.27	13.50	7.37	3.03	ND
OT-FAT POOL(#26,27,28,29,32,33)	67.65	ND	3.66	9.77	4.01	12.10	4.61	12.00	ND	ND	6.70	1.54	1.84	ND
MINK#30 FAT	58.35	ND	ND	25.44	ND	6.14	2.04	19.60	ND	1.18	3.97	1.81	2.14	ND
MINK#31 FAT	57.94	ND	ND	28.47	ND	11.91	2.31	25.46	ND	1.50	7.62	3.36	3.44	ND
OT#34-FAT	232.95	3.14	16.23	344.36	34.19	16.61	16.58	125.62	ND	1.15	135.79	34.24	11.97	ND
OT#35-FAT	104.85	4.56	17.94	268.32	25.84	4.78	22.97	147.26	ND	2.49	119.48	31.04	16.87	ND
OT#36-FAT	113.48	7.09	21.21	750.62	69.32	9.10	52.89	407.95	ND	1.26	196.80	33.66	11.61	ND
OT#37-FAT	673.26	8.57	57.65	1888.90	15.56	61.54	90.82	606.31	ND	0.96	1091.89	34.81	13.56	ND
OT#38-FAT A	532.68	51.72	203.34	3371.63	448.87	71.72	97.48	1385.69	ND	0.56	174.97	32.94	6.19	ND
OT#38-FAT B	709.13	66.42	246.93	4340.95	587.98	65.92	130.76	1884.46	ND	1.17	217.08	41.06	6.89	ND

Appendix 4 (continued).

Sample Number	PCB #64	PCB #74	PCB #70	PCB #66/95	PCB #60	PCB #101	PCB #99	PCB #97	PCB #87	PCB #110	PCB #151	PCB #149	PCB #118	PCB #146
OT#1-FAT	0.73	16.18	5.22	12.20	17.79	50.04	663.74	1.46	21.81	16.88	4.20	13.00	52.05	129.85
OT#2-FAT	0.85	8.33	2.03	8.62	24.86	45.93	393.39	2.04	15.50	12.89	8.70	13.47	45.68	77.37
OT#3-FAT	1.25	27.18	9.77	21.08	29.01	79.79	448.62	2.46	29.65	26.45	5.49	18.55	89.48	126.78
OT#4-FAT	ND	ND	ND	ND	ND	3.23	23.01	ND	ND	ND	ND	ND	6.13	5.37
OT#5-FAT	0.82	15.62	6.15	15.76	14.52	60.07	556.05	1.55	21.18	15.84	16.04	15.96	61.33	124.12
OT#6-FAT	0.37	20.49	5.36	12.50	12.79	54.50	394.49	ND	19.65	15.08	1.21	8.28	67.24	75.07
OT#7-FAT	0.38	6.18	ND	3.37	8.44	26.23	467.17	ND	9.58	4.13	1.49	5.99	27.10	98.04
OT#8-FAT A	1.38	10.83	6.99	16.29	23.53	54.91	471.75	6.03	21.84	26.72	24.66	20.68	55.30	65.99
OT#8-FAT B	1.94	11.43	6.18	15.22	24.55	57.51	452.19	6.34	23.07	28.25	23.13	21.80	57.70	69.73
OT#9-FAT	0.54	7.94	1.34	5.29	15.13	41.93	453.46	2.01	12.93	9.69	2.16	9.93	39.64	90.66
OT#10-FAT	0.45	7.38	1.89	5.82	16.45	36.48	653.20	2.30	11.43	9.22	8.45	12.26	31.47	116.63
OT#11-FAT	0.70	9.79	4.84	9.20	12.99	38.55	226.80	6.21	17.30	22.18	5.48	18.22	53.51	46.65
OT#12-FAT	0.58	9.99	3.39	7.49	9.20	34.25	205.56	2.31	10.25	8.05	17.65	8.00	36.89	52.02
OT#13-FAT	0.23	6.52	ND	5.71	6.75	31.93	643.47	ND	10.39	4.83	6.47	10.41	26.84	129.89
OT#14-FAT	ND	8.59	ND	4.87	5.95	17.62	143.99	ND	6.98	3.92	2.04	2.83	29.38	32.99
OT#15-FAT A	1.39	12.85	3.20	13.75	28.72	69.98	779.15	4.55	26.41	17.74	28.98	25.65	45.45	163.12
OT#15-FAT B	1.34	10.56	2.75	14.53	31.37	79.12	882.08	5.11	29.99	20.19	33.43	28.00	52.10	184.69
OT#16-FAT	0.98	23.52	7.56	13.81	33.66	59.00	546.03	3.38	25.26	20.79	3.06	14.67	57.56	101.69
OT#17-FAT	0.47	8.77	2.76	8.27	8.02	34.89	405.32	2.03	11.84	9.64	7.79	10.62	38.40	90.59
OT#18-FAT	0.35	18.12	4.17	9.71	9.48	28.29	251.82	ND	10.80	6.05	7.20	6.84	47.93	54.04
OT#19-FAT	1.11	25.59	8.55	30.85	15.66	149.35	1163.91	3.84	77.45	56.78	13.02	27.19	149.98	221.15
OT#20-FAT	0.52	4.90	ND	4.23	1.28	17.37	171.20	1.64	5.68	5.49	9.14	6.31	20.07	27.51
OT#21-FAT	0.38	8.82	3.07	7.83	14.38	48.27	408.73	4.06	16.25	18.96	6.00	17.03	60.07	77.38
OT#22-FAT	ND	5.28	ND	2.83	4.62	17.32	150.09	ND	4.48	3.78	ND	2.59	40.78	35.92
OT#23-FAT A	0.37	4.36	ND	3.22	14.52	17.84	233.41	ND	4.78	3.59	8.03	6.57	20.20	37.26
OT#23-FAT B	0.39	4.51	ND	3.80	15.26	18.66	241.04	ND	4.92	3.80	8.43	7.22	21.43	38.77
OT#24-FAT	0.75	23.64	9.16	17.10	26.10	49.74	268.08	4.59	23.02	23.87	3.97	15.59	72.87	58.88
OT#25-FAT	0.60	13.69	3.72	8.24	43.40	28.58	172.83	1.40	10.85	8.12	1.28	5.09	37.93	36.97
OT-FAT POOL(#26,27,28,29,32,33)	0.40	2.97	0.54	3.61	10.72	13.25	85.39	2.46	4.49	6.04	18.17	10.65	16.55	10.55
MINK#30 FAT	ND	19.29	5.71	13.18	15.23	27.07	75.02	5.60	14.18	21.30	4.00	15.58	121.45	27.08
MINK#31 FAT	0.25	18.92	8.45	18.79	13.46	37.67	84.08	8.83	19.89	32.01	5.85	23.10	134.88	25.07
OT#34-FAT	0.86	20.79	6.57	38.00	35.41	151.38	696.90	3.85	7.17	60.60	21.34	49.52	99.31	250.99
OT#35-FAT	1.84	23.37	9.91	33.89	43.92	154.75	804.28	3.78	59.81	46.85	22.88	55.51	95.90	303.47
OT#36-FAT	1.79	21.67	6.74	56.52	34.74	179.28	793.73	4.31	85.54	51.00	37.06	85.22	92.97	341.40
OT#37-FAT	1.68	22.00	2.54	194.40	60.35	619.34	3801.17	3.17	574.17	150.98	50.72	274.50	229.98	1221.56
OT#38-FAT A	2.04	30.30	5.42	83.93	114.29	255.71	1241.92	3.80	106.24	49.18	171.82	234.88	111.37	570.77
OT#38-FAT B	2.60	34.37	4.03	93.59	140.84	313.19	1580.00	4.92	131.56	62.36	211.99	289.94	137.94	704.87

Appendix 4 (continued).

Sample Number	PCB #153	PCB #105	PCB #141	PCB #138	PCB #158	PCB #129	PCB #182/187	PCB #183	PCB #185	PCB #174	PCB #171	PCB #200	PCB #172
OT#1-FAT	2110.53	45.88	7.13	2026.70	45.37	21.28	76.59	127.53	ND	1.08	1099.84	37.82	20.22
OT#2-FAT	1373.98	34.04	5.93	1261.72	32.40	10.46	81.62	104.10	ND	1.05	19.67	19.85	10.69
OT#3-FAT	1343.88	64.80	10.35	1251.07	39.21	35.27	92.34	104.28	ND	3.86	76.72	30.03	28.99
OT#4-FAT	72.25	ND	ND	41.89	ND	1.22	7.47	5.22	ND	ND	3.26	1.84	1.04
OT#5-FAT	1800.18	47.19	8.30	1637.11	40.99	31.54	77.69	123.32	ND	1.22	63.53	28.36	21.84
OT#6-FAT	888.59	39.12	4.49	900.05	27.44	14.81	51.55	54.17	ND	ND	42.21	20.34	11.47
OT#7-FAT	1295.46	32.69	1.73	1444.40	38.19	19.26	40.10	79.59	ND	ND	46.27	28.65	17.20
OT#8-FAT A	1111.74	29.59	6.57	1002.10	26.61	10.10	52.96	74.62	ND	2.32	12.72	18.86	8.84
OT#8-FAT B	1165.96	30.94	7.38	1060.11	30.98	15.53	56.62	78.15	ND	2.40	14.25	20.17	9.27
OT#9-FAT	1563.08	39.79	7.14	1352.35	32.16	26.40	92.42	103.05	ND	2.42	22.07	27.18	21.87
OT#10-FAT	1576.74	42.05	3.45	1851.12	48.71	25.75	106.21	141.68	ND	1.20	31.25	34.55	20.96
OT#11-FAT	757.57	33.57	8.07	634.81	17.60	9.30	35.38	39.66	ND	4.08	34.92	16.85	9.53
OT#12-FAT	557.81	22.51	3.79	496.81	16.42	12.26	44.50	38.64	ND	ND	27.45	10.59	8.36
OT#13-FAT	1702.28	29.56	2.85	1913.20	50.17	25.07	81.51	142.43	ND	ND	60.56	31.80	24.64
OT#14-FAT	361.58	21.29	1.50	294.90	10.34	6.32	27.32	26.64	ND	ND	20.67	6.49	4.61
OT#15-FAT A	1607.32	44.82	6.96	2061.15	60.75	29.75	139.47	166.63	ND	1.76	73.52	32.67	23.56
OT#15-FAT B	1714.20	43.87	7.83	2343.92	63.97	27.46	155.50	190.35	ND	2.04	85.23	40.55	28.13
OT#16-FAT	1596.09	56.27	10.44	1396.52	34.33	31.54	83.88	114.40	ND	3.96	65.58	25.43	23.78
OT#17-FAT	1337.98	28.64	3.19	1117.82	29.32	21.14	59.22	83.38	ND	ND	16.19	22.25	12.28
OT#18-FAT	578.25	31.30	3.14	516.71	19.45	12.18	53.94	51.56	ND	ND	31.10	11.44	7.21
OT#19-FAT	2738.80	113.32	20.36	2979.62	90.07	33.48	106.11	164.81	ND	1.82	143.57	77.89	31.30
OT#20-FAT	445.15	13.96	1.57	350.76	11.21	7.29	23.19	26.58	ND	ND	16.57	8.32	3.61
OT#21-FAT	1517.40	43.04	12.19	1114.06	28.73	21.89	80.40	96.87	ND	4.63	47.96	29.61	16.65
OT#22-FAT	459.28	24.98	3.73	385.83	13.06	7.52	30.61	30.59	ND	ND	27.16	11.59	5.36
OT#23-FAT A	795.69	14.97	1.05	578.91	14.44	8.02	30.30	48.67	ND	ND	20.35	13.10	4.74
OT#23-FAT B	824.52	15.03	1.37	602.40	15.09	8.35	31.62	50.61	ND	ND	21.76	13.90	4.75
OT#24-FAT	775.30	41.52	11.45	667.61	17.84	22.43	63.99	61.96	ND	4.11	49.28	15.94	17.06
OT#25-FAT	487.74	24.14	5.24	409.96	11.71	12.36	45.60	41.46	ND	1.68	29.09	9.84	9.55
OT-FAT POOL(#26,27,28,29,32,33)	144.59	7.63	3.37	104.83	ND	3.75	9.27	7.75	ND	ND	4.99	4.04	1.55
MINK#30 FAT	254.00	29.33	7.62	277.61	9.78	7.73	32.48	21.26	ND	3.83	24.41	11.05	5.61
MINK#31 FAT	280.48	33.24	10.85	286.89	11.60	5.24	31.54	24.50	ND	5.36	28.55	8.69	4.94
OT#34-FAT	2268.29	77.41	28.09	2365.40	70.16	53.57	341.69	243.51	ND	11.86	119.36	45.54	59.97
OT#35-FAT	3715.82	ND	30.23	3234.78	83.43	88.76	346.84	366.70	ND	15.11	139.56	37.31	102.33
OT#36-FAT	2761.13	74.61	47.12	3034.13	108.93	78.12	744.50	427.34	ND	19.81	193.76	62.44	104.13
OT#37-FAT	9314.73	103.67	91.83	12919.18	245.86	198.54	1612.99	1188.60	ND	8.59	721.99	273.21	329.93
OT#38-FAT A	4864.57	ND	155.91	5559.34	58.22	162.53	2105.26	1010.66	13.41	77.11	380.45	94.05	205.50
OT#38-FAT B	5911.61	ND	194.16	6787.23	74.89	199.75	2569.85	1246.69	16.50	94.92	470.45	113.84	253.09

Appendix 4 (continued).

Sample Number	PCB #180	PCB #170/190	PCB #201	PCB #203	PCB #195	PCB #194	PCB #206	SPCBs	Aroclor 1254:1260	Aroclor 1260
OT#1-FAT	1890.02	879.58	94.78	76.72	58.87	260.08	96.54	10032.87	27387.80	16579.10
OT#2-FAT	1116.86	458.63	78.29	89.69	48.36	16.35	80.24	5539.45	17050.25	9796.98
OT#3-FAT	1135.60	485.09	135.30	69.35	50.75	198.98	81.22	6229.36	16906.31	9961.38
OT#4-FAT	77.59	24.10	6.13	4.36	2.03	19.46	13.16	320.27	566.13	680.58
OT#5-FAT	1975.33	740.23	120.95	73.87	52.77	208.05	75.01	8115.06	22123.10	17327.45
OT#6-FAT	502.22	232.60	53.63	34.33	20.73	65.86	29.34	3743.57	12162.82	4405.41
OT#7-FAT	1053.90	497.39	55.72	41.86	34.52	107.30	44.42	5562.70	19518.89	9244.73
OT#8-FAT A	806.19	346.76	44.58	48.58	28.47	119.66	62.23	4661.95	13541.95	7071.87
OT#8-FAT B	855.58	367.02	46.30	50.79	29.63	126.88	64.57	4872.32	14325.84	7505.07
OT#9-FAT	1367.93	599.39	119.22	73.35	49.45	207.84	100.61	6538.91	18275.04	11999.37
OT#10-FAT	1882.77	731.69	86.31	86.87	58.55	201.85	84.47	7963.07	25015.11	16515.55
OT#11-FAT	523.86	229.78	38.30	27.30	19.44	74.90	35.06	3050.27	8578.54	4595.27
OT#12-FAT	299.71	138.09	33.44	22.19	12.53	41.40	18.77	2242.99	6713.72	2629.08
OT#13-FAT	1598.48	733.46	102.97	89.92	60.68	207.27	79.81	7854.64	25854.11	14021.73
OT#14-FAT	250.63	102.21	20.49	16.75	11.53	42.74	23.41	1533.03	3985.14	2198.50
OT#15-FAT A	1343.15	632.88	88.35	88.90	53.32	131.42	45.22	7915.64	27853.37	11781.98
OT#15-FAT B	1540.56	731.46	100.05	101.47	61.08	149.30	51.07	8883.37	31674.59	13513.67
OT#16-FAT	1494.49	628.05	177.50	94.32	65.23	263.83	125.56	7276.89	18871.92	13109.59
OT#17-FAT	1010.69	446.05	66.20	44.14	34.98	110.07	39.20	5156.89	15105.64	8865.68
OT#18-FAT	479.54	168.63	34.84	30.47	18.68	64.77	32.44	2638.53	6982.61	4206.53
OT#19-FAT	2212.42	891.57	151.20	95.76	68.61	235.45	90.87	12334.55	40265.17	19407.15
OT#20-FAT	285.48	123.46	22.40	16.82	9.95	39.78	16.92	1719.43	4740.00	2504.18
OT#21-FAT	1617.86	678.37	84.15	60.92	45.80	264.12	112.24	6590.73	15054.93	14191.73
OT#22-FAT	310.67	135.61	35.81	24.08	13.02	54.22	33.09	1882.92	5213.91	2725.19
OT#23-FAT A	708.30	291.14	29.13	30.89	20.96	118.57	68.49	3163.45	7823.14	6213.13
OT#23-FAT B	853.68	303.68	29.91	32.24	21.63	125.00	71.59	3408.85	8140.51	7488.39
OT#24-FAT	802.37	290.30	127.63	61.06	38.28	142.06	92.65	3949.27	9021.81	7038.29
OT#25-FAT	462.62	172.12	71.25	39.00	23.21	82.45	53.72	2390.60	5540.00	4058.07
OT-FAT POOL(#26,27,28,29,32,33)	82.12	28.69	5.15	4.26	1.97	17.06	11.53	638.44	1416.62	720.36
MINK#30 FAT	369.76	178.49	18.74	18.84	19.33	96.43	46.88	1806.99	3751.51	3243.50
MINK#31 FAT	342.67	126.04	13.64	20.58	16.86	60.25	35.11	1794.21	3876.88	3005.88
OT#34-FAT	2026.13	875.55	249.55	187.85	104.79	275.01	111.29	11140.84	31964.92	17773.04
OT#35-FAT	4779.05	1784.99	500.31	293.46	179.16	715.05	252.17	18495.08	43713.25	41921.50
OT#36-FAT	2670.66	1164.92	459.87	360.13	171.15	465.84	251.28	15235.17	41001.74	23426.86
OT#37-FAT	8693.38	4245.12	953.07	776.32	358.01	952.84	298.24	51633.87	174583.51	76257.72
OT#38-FAT A	6187.53	2340.13	896.33	892.60	311.73	913.07	432.10	29856.82	75126.21	54276.60
OT#38-FAT B	7690.69	2878.12	1096.01	1096.97	381.87	1116.26	525.19	36696.48	91719.30	67462.22

Appendix 5. Organochlorine insecticides and metabolites and PCB concentrations (ppb,lw) in mesentary fat of river otter and mink collected from the Lower Columbia River and Reference Area, 1994-95. River otter fat samples 26-29 and 32-33 from the Reference Area were pooled. Detection limit is adjusted for % fat. A,B = 2 replicates of the same sample. SPCBs = sum of PCBs.

Sample Number	% Lipid	% Moisture	1,2,4,5 -TCB	1,2,3,4 -TCB	QCB	HCB	OCS	trans-Nonachlor	pp'-DDE	photo-Mirex	Mirex	a-HCH	b-HCH
OT#1-FAT	67.24	20.93	0	0	2.18	109.78	11.89	154.92	4019.02	0.00	12.91	1.80	1.52
OT#2-FAT	62.23	n.d.	0	0	1.83	49.21	8.53	805.27	3404.44	9.27	18.23	2.83	1.23
OT#3-FAT	63.93	26.92	0	0	2.91	148.34	20.25	183.01	4889.27	10.39	13.96	1.65	3.85
OT#4-FAT	7.21	n.d.	0	0	0.00	109.75	17.81	173.25	1153.01	33.62	28.64	0.00	0.00
OT#5-FAT	76.88	18.37	0	0	2.48	112.40	15.45	167.30	2608.44	0.00	14.81	1.78	1.85
OT#6-FAT	59.88	31.89	0	0	2.30	66.94	5.27	86.40	2256.47	0.00	15.71	1.98	0.00
OT#7-FAT	38.35	41.57	0	0	0.00	134.07	7.39	94.31	2711.74	0.00	14.95	3.62	2.98
OT#8-FAT A	42.78	44.03	0	0	0.00	211.58	26.95	312.78	3221.24	45.51	31.39	0.00	4.09
OT#8-FAT B	48.85	44.03	0	0	0.00	200.61	23.73	271.46	3015.58	41.95	29.45	0.00	4.49
OT#9-FAT	52.87	38.00	0	0	3.98	114.76	14.15	166.87	3081.12	14.11	17.23	1.53	1.84
OT#10-FAT	47.17	42.91	0	0	0.00	118.50	20.11	278.07	5286.77	18.42	27.89	0.00	0.00
OT#11-FAT	35.19	52.35	0	0	0.00	183.26	6.34	75.72	2560.97	10.01	8.29	1.88	8.99
OT#12-FAT	57.24	39.96	0	0	2.79	137.91	13.60	165.14	2007.17	16.30	12.92	0.00	5.94
OT#13-FAT	31.29	58.90	0	0	0.00	186.98	25.33	373.20	6005.91	0.00	35.08	0.00	0.00
OT#14-FAT	42.39	47.22	0	0	0.00	86.51	7.92	108.82	1377.55	0.00	9.14	1.46	0.00
OT#15-FAT A	50.22	38.31	0	0	0.00	194.04	34.33	630.14	11819.97	37.05	41.78	2.54	5.21
OT#15-FAT B	54.74	38.31	0	0	2.35	203.06	34.14	642.48	12523.60	39.16	43.08	2.48	4.97
OT#16-FAT	60.48	33.91	0	0	4.67	57.70	6.42	133.45	4538.79	0.00	8.52	8.43	2.24
OT#17-FAT	63.32	37.76	0	0	2.17	107.03	10.14	126.85	2063.44	0.00	11.99	1.37	2.49
OT#18-FAT	51.72	46.14	0	0	2.72	123.47	13.65	124.36	3520.56	0.00	9.55	1.39	4.02
OT#19-FAT	57.24	38.16	0	0	2.42	103.93	19.66	187.07	4333.90	0.00	17.89	1.76	2.32
OT#20-FAT	45.82	42.27	0	0	2.67	79.93	9.49	113.72	946.02	11.70	11.84	2.73	4.05
OT#21-FAT	69.60	45.72	0	0	0.00	57.05	10.26	67.26	1673.34	9.92	8.96	0.00	1.63
OT#22-FAT	51.64	42.83	0	0	2.47	46.98	2.91	24.25	631.86	0.00	3.96	2.22	6.70
OT#23-FAT A	80.83	12.72	0	0	1.72	58.05	6.44	63.69	1260.67	7.25	7.36	2.47	5.01
OT#23-FAT B	83.19	12.72	0	0	1.80	58.13	6.55	63.38	1278.79	7.38	7.39	2.59	4.68
OT#24-FAT	57.35	38.78	0	0	2.86	36.26	5.17	57.89	2816.63	0.00	10.24	4.03	1.99
OT#25-FAT	50.37	42.62	0	0	2.45	23.40	3.78	32.85	2575.52	0.00	5.94	6.15	1.70
OT-FAT POOL(#26,27,28,29,32,33)	65.17	41.20	0	0	1.75	101.08	7.79	71.88	345.21	9.57	5.05	0.00	0.00
MINK#30 FAT	52.44	39.81	0	0	2.85	15.48	4.59	5.56	1053.16	0.00	0.00	0.00	0.00
MINK#31 FAT	67.63	26.46	0	0	2.25	15.85	4.84	5.22	1316.91	0.00	0.00	0.00	2.02
OT#34-FAT	44.73	45.76	0	0	5.50	154.89	46.55	558.88	12420.00	0.00	28.45	1.98	0.00
OT#35-FAT	61.95	36.42	0	0	13.06	61.20	12.05	237.40	12379.14	0.00	17.20	1.23	0.00
OT#36-FAT	38.24	46.90	0	0	31.09	147.09	25.21	1068.16	44865.35	0.00	73.42	0.00	2.91
OT#37-FAT	47.45	39.85	0	0	21.71	93.27	16.64	3703.65	46175.53	0.00	81.14	1.60	1.85
OT#38-FAT A	55.76	30.19	0	0	15.06	133.05	18.80	4584.70	37224.62	0.00	92.11	1.79	3.36
OT#38-FAT B	71.25	30.19	0	0	14.97	132.14	20.51	4551.87	31260.89	0.00	85.67	1.45	3.44

Appendix 5 (continued).

Sample Number	g-HCH	oxy-Chlordane	trans-Chlordane	cis-Chlordane	pp'-DDD	cis-Nonachlor	pp'-DDT	HC Epox	Dieldrin	PCB #31	PCB #28	PCB #52
OT#1-FAT	0.00	159.25	1.57	11.09	107.19	17.61	43.28	19.75	78.08	0.00	0.00	54.42
OT#2-FAT	0.00	805.28	3.21	39.41	174.85	69.72	13.70	31.69	119.38	0.00	1.64	39.42
OT#3-FAT	0.00	167.02	1.47	8.88	159.08	21.83	37.02	28.68	119.10	0.00	2.53	76.98
OT#4-FAT	0.00	170.47	0.00	0.00	40.34	9.82	0.00	10.39	29.98	0.00	0.00	0.00
OT#5-FAT	0.00	337.03	1.26	8.84	64.99	15.06	26.93	26.11	125.10	0.00	3.24	57.21
OT#6-FAT	0.00	49.76	0.81	7.95	88.06	13.44	46.34	23.40	59.19	0.00	4.67	70.51
OT#7-FAT	0.00	40.15	0.00	7.43	86.06	18.07	58.96	36.48	88.61	0.00	5.65	39.00
OT#8-FAT A	0.00	303.60	0.00	9.20	72.04	14.85	46.80	26.15	79.39	0.00	8.83	46.60
OT#8-FAT B	0.00	250.71	0.85	9.36	72.05	15.81	40.50	29.26	68.59	0.00	6.29	43.15
OT#9-FAT	0.00	248.64	0.00	6.06	89.59	14.59	9.05	18.98	64.72	0.00	4.73	47.96
OT#10-FAT	0.00	350.56	1.16	7.89	89.88	19.43	13.53	26.54	71.90	0.00	4.55	44.76
OT#11-FAT	0.00	24.82	0.00	7.15	92.19	15.47	61.50	22.20	51.76	0.00	6.51	47.60
OT#12-FAT	0.00	95.77	0.00	8.20	56.68	15.81	43.10	17.18	36.28	0.00	4.23	33.08
OT#13-FAT	0.00	528.18	1.91	15.22	86.76	27.33	48.31	36.21	133.72	0.00	9.01	71.79
OT#14-FAT	0.00	158.04	0.00	6.79	51.91	12.74	27.56	20.40	88.55	0.00	5.79	32.50
OT#15-FAT A	0.00	498.68	2.03	21.15	269.12	51.36	122.81	60.81	204.56	0.00	3.35	91.62
OT#15-FAT B	0.00	459.17	2.02	18.80	251.94	47.56	144.91	60.99	179.63	0.00	2.96	94.58
OT#16-FAT	0.00	307.13	1.79	10.02	141.95	15.88	9.09	25.83	119.70	0.00	4.91	81.68
OT#17-FAT	0.00	205.67	0.98	7.46	46.81	12.35	32.79	23.57	95.35	0.00	4.01	36.72
OT#18-FAT	0.00	222.98	1.35	8.47	60.90	19.20	26.66	26.37	101.91	0.00	4.35	49.12
OT#19-FAT	0.00	408.18	1.41	8.21	121.25	16.22	14.53	26.28	101.47	0.00	5.42	183.39
OT#20-FAT	0.00	169.39	0.00	7.98	33.56	10.02	22.30	14.30	37.02	0.00	6.11	24.62
OT#21-FAT	0.00	157.21	0.00	2.33	51.49	8.08	8.83	7.10	19.05	0.00	0.00	21.81
OT#22-FAT	0.00	20.32	0.00	6.61	19.41	5.54	0.00	13.32	43.21	0.00	0.00	10.80
OT#23-FAT A	0.00	104.61	0.57	4.41	31.82	6.76	17.63	13.32	39.33	0.00	0.00	10.52
OT#23-FAT B	0.00	107.16	0.62	2.99	29.24	6.61	25.17	12.78	38.80	0.00	0.00	10.61
OT#24-FAT	0.00	161.56	0.00	3.70	66.32	7.61	3.06	17.00	103.72	0.00	3.98	47.62
OT#25-FAT	0.00	122.22	0.00	2.68	92.32	5.94	0.00	10.33	58.78	0.00	2.52	26.79
OT-FAT POOL(#26,27,28,29,32,33)	0.00	103.81	0.00	5.61	14.99	6.15	18.57	7.07	18.41	0.00	0.00	10.27
MINK#30 FAT	0.00	111.27	0.00	0.00	48.51	0.00	11.71	3.89	37.37	0.00	2.26	7.57
MINK#31 FAT	0.00	85.67	0.00	0.00	42.10	0.00	17.61	3.42	37.64	0.00	2.22	11.27
OT#34-FAT	0.00	520.79	7.01	36.28	769.86	76.44	37.13	37.07	280.83	0.00	2.58	303.57
OT#35-FAT	0.00	169.24	7.36	28.95	433.12	41.71	7.72	37.08	237.70	0.00	4.01	192.86
OT#36-FAT	0.00	296.75	18.55	55.47	1962.91	181.26	23.79	138.32	1066.81	0.00	3.29	514.65
OT#37-FAT	0.00	1418.88	18.07	121.49	3980.83	32.79	129.70	191.40	1277.79	0.00	2.03	2301.13
OT#38-FAT A	3.47	955.30	92.75	364.67	6046.68	805.01	128.63	174.82	2485.09	0.00	1.00	313.79
OT#38-FAT B	3.38	995.27	93.22	346.58	6092.56	825.23	92.53	183.53	2644.85	0.00	1.64	304.68

Appendix 5 (continued).

Sample Number	PCB #49	PCB #44	PCB #42	PCB #64	PCB #74	PCB #70	PCB #66/95	PCB #60	PCB #101	PCB #99	PCB #97	PCB #87	PCB #110
OT#1-FAT	16.15	5.55	0.00	1.08	24.07	7.76	18.14	26.45	74.42	987.12	2.17	32.43	25.10
OT#2-FAT	10.25	6.32	0.00	1.37	13.39	3.26	13.85	39.95	73.81	632.15	3.27	24.91	20.72
OT#3-FAT	30.58	9.90	0.00	1.96	42.52	15.28	32.97	45.38	124.81	701.74	3.85	46.37	41.38
OT#4-FAT	0.00	20.78	0.00	0.00	0.00	0.00	0.00	0.00	44.84	319.18	0.00	0.00	0.00
OT#5-FAT	15.03	5.94	0.00	1.07	20.32	7.99	20.49	18.89	78.13	723.27	2.02	27.55	20.60
OT#6-FAT	21.16	9.86	0.00	0.61	34.21	8.96	20.87	21.36	91.01	658.80	0.00	32.82	25.18
OT#7-FAT	10.48	12.57	0.00	0.99	16.11	0.00	8.79	22.02	68.39	1218.18	0.00	24.98	10.76
OT#8-FAT A	24.11	17.54	0.00	3.22	25.33	16.35	38.07	55.01	128.35	1102.74	14.10	51.06	62.46
OT#8-FAT B	22.76	11.21	0.00	3.97	23.39	12.65	31.16	50.26	117.74	925.67	12.98	47.22	57.83
OT#9-FAT	11.45	8.79	0.00	1.03	15.01	2.53	10.00	28.62	79.32	857.68	3.80	24.45	18.34
OT#10-FAT	10.07	11.60	0.00	0.95	15.65	4.02	12.33	34.87	77.34	1384.77	4.88	24.24	19.55
OT#11-FAT	9.51	15.65	0.00	1.99	27.81	13.74	26.14	36.90	109.54	644.49	17.65	49.16	63.02
OT#12-FAT	8.37	10.34	0.00	1.02	17.45	5.92	13.08	16.08	59.83	359.12	4.04	17.91	14.07
OT#13-FAT	14.75	14.74	0.00	0.75	20.85	0.00	18.25	21.58	102.06	2056.47	0.00	33.22	15.43
OT#14-FAT	9.29	10.08	0.00	0.00	20.27	0.00	11.50	14.04	41.57	339.69	0.00	16.46	9.24
OT#15-FAT A	18.74	11.98	0.00	2.76	25.58	6.37	27.37	57.19	139.35	1551.47	9.07	52.60	35.32
OT#15-FAT B	19.75	10.74	0.00	2.45	19.28	5.02	26.54	57.32	144.54	1611.39	9.34	54.79	36.88
OT#16-FAT	27.59	9.30	0.00	1.62	38.90	12.51	22.84	55.66	97.56	902.83	5.59	41.76	34.38
OT#17-FAT	8.74	5.42	0.00	0.75	13.85	4.35	13.06	12.66	55.10	640.11	3.20	18.70	15.23
OT#18-FAT	14.65	5.50	0.00	0.68	35.04	8.06	18.77	18.33	54.70	486.89	0.00	20.87	11.70
OT#19-FAT	43.31	17.86	0.00	1.94	44.71	14.93	53.89	27.36	260.92	2033.38	6.70	135.31	99.20
OT#20-FAT	6.28	9.04	0.00	1.13	10.70	0.00	9.23	2.80	37.91	373.65	3.57	12.40	11.99
OT#21-FAT	7.67	2.99	0.00	0.54	12.67	4.40	11.25	20.67	69.35	587.26	5.84	23.35	27.24
OT#22-FAT	4.30	2.29	0.00	0.00	10.23	0.00	5.48	8.95	33.54	290.65	0.00	8.67	7.32
OT#23-FAT A	2.14	1.68	0.00	0.45	5.40	0.00	3.98	17.97	22.08	288.76	0.00	5.91	4.44
OT#23-FAT B	2.30	3.29	0.00	0.46	5.42	0.00	4.56	18.35	22.44	289.75	0.00	5.92	4.56
OT#24-FAT	21.73	12.24	0.00	1.30	41.21	15.97	29.82	45.51	86.72	467.45	8.00	40.14	41.62
OT#25-FAT	14.64	6.01	0.00	1.20	27.19	7.38	16.35	86.17	56.75	343.11	2.78	21.53	16.12
OT-FAT POOL(#26,27,28,29,32,33)	2.36	2.82	0.00	0.61	4.56	0.82	5.53	16.45	20.34	131.03	3.78	6.89	9.26
MINK#30 FAT	3.45	4.09	0.00	0.00	36.79	10.89	25.14	29.04	51.62	143.07	10.68	27.04	40.62
MINK#31 FAT	4.97	5.08	0.00	0.38	27.98	12.49	27.79	19.91	55.69	124.33	13.05	29.41	47.33
OT#34-FAT	76.54	26.76	0.00	1.92	46.47	14.68	84.96	79.17	338.44	1558.02	8.60	16.02	135.48
OT#35-FAT	50.11	27.23	0.00	2.97	37.72	16.00	54.70	70.90	249.80	1298.27	6.09	96.54	75.62
OT#36-FAT	88.02	30.37	0.00	4.67	56.68	17.63	147.82	90.85	468.82	2075.66	11.27	223.70	133.38
OT#37-FAT	73.36	28.57	0.00	3.53	46.37	5.36	409.70	127.18	1305.25	8010.89	6.69	1210.04	318.19
OT#38-FAT A	59.07	11.11	0.00	3.65	54.34	9.72	150.52	204.97	458.59	2227.26	6.82	190.52	88.21
OT#38-FAT B	57.62	9.67	0.00	3.65	48.24	5.66	131.36	197.67	439.56	2217.54	6.91	184.65	87.52

Appendix 5 (continued).

Sample Number	PCB #151	PCB #149	PCB #118	PCB #146	PCB #153	PCB #105	PCB #141	PCB #138	PCB #158	PCB #129	PCB #182/187	PCB #183	PCB #185
OT#1-FAT	6.25	19.34	77.41	193.11	3138.80	68.24	10.61	3014.12	67.47	31.65	113.90	189.66	0.00
OT#2-FAT	13.98	21.64	73.40	124.33	2207.91	54.70	9.53	2027.51	52.06	16.81	131.16	167.29	0.00
OT#3-FAT	8.58	29.02	139.97	198.31	2102.11	101.35	16.20	1956.93	61.33	55.17	144.44	163.12	0.00
OT#4-FAT	0.00	0.00	85.02	74.55	1002.10	0.00	0.00	581.05	0.00	16.93	103.65	72.38	0.00
OT#5-FAT	20.86	20.76	79.77	161.45	2341.54	61.38	10.80	2129.43	53.31	41.03	101.06	160.41	0.00
OT#6-FAT	2.02	13.82	112.29	125.37	1483.96	65.34	7.50	1503.09	45.82	24.74	86.09	90.47	0.00
OT#7-FAT	3.90	15.61	70.66	255.65	3377.98	85.23	4.51	3766.36	99.59	50.23	104.56	207.53	0.00
OT#8-FAT A	57.64	48.33	129.26	154.25	2598.74	69.18	15.36	2342.46	62.20	23.60	123.79	174.43	0.00
OT#8-FAT B	47.36	44.63	118.12	142.75	2386.82	63.34	15.10	2170.14	63.42	31.79	115.92	159.97	0.00
OT#9-FAT	4.08	18.79	74.98	171.48	2956.46	75.26	13.50	2557.88	60.83	49.93	174.80	194.91	0.00
OT#10-FAT	17.91	26.00	66.72	247.26	3342.67	89.14	7.32	3924.35	103.26	54.59	225.16	300.35	0.00
OT#11-FAT	15.56	51.78	152.06	132.57	2152.81	95.39	22.93	1803.96	50.03	26.42	100.54	112.69	0.00
OT#12-FAT	30.83	13.98	64.45	90.89	974.51	39.33	6.61	867.95	28.69	21.41	77.75	67.50	0.00
OT#13-FAT	20.68	33.26	85.77	415.12	5440.34	94.48	9.12	6114.43	160.32	80.13	260.51	455.20	0.00
OT#14-FAT	4.82	6.68	69.31	77.83	852.99	50.21	3.54	695.68	24.40	14.91	64.44	62.84	0.00
OT#15-FAT A	57.71	51.07	90.49	324.82	3200.55	89.26	13.87	4104.24	120.97	59.25	277.73	331.80	0.00
OT#15-FAT B	61.07	51.15	95.17	337.40	3131.53	80.14	14.29	4281.91	116.86	50.16	284.07	347.73	0.00
OT#16-FAT	5.06	24.26	95.17	168.13	2639.04	93.04	17.27	2309.06	56.77	52.16	138.69	189.16	0.00
OT#17-FAT	12.30	16.77	60.64	143.07	2113.04	45.23	5.03	1765.35	46.30	33.39	93.52	131.69	0.00
OT#18-FAT	13.92	13.22	92.67	104.49	1118.03	60.53	6.08	999.06	37.61	23.54	104.29	99.68	0.00
OT#19-FAT	22.75	47.51	262.01	386.35	4784.76	197.98	35.57	5205.49	157.36	58.48	185.38	287.93	0.00
OT#20-FAT	19.95	13.78	43.81	60.03	971.52	30.47	3.42	765.52	24.45	15.91	50.61	58.00	0.00
OT#21-FAT	8.63	24.47	86.31	111.18	2180.18	61.84	17.51	1600.67	41.28	31.45	115.52	139.19	0.00
OT#22-FAT	0.00	5.02	78.97	69.55	889.39	48.38	7.23	747.15	25.28	14.56	59.29	59.23	0.00
OT#23-FAT A	9.93	8.13	25.00	46.10	984.40	18.51	1.30	716.21	17.87	9.92	37.49	60.22	0.00
OT#23-FAT B	10.14	8.68	25.76	46.61	991.13	18.07	1.65	724.12	18.14	10.04	38.01	60.84	0.00
OT#24-FAT	6.93	27.19	127.05	102.67	1351.88	72.39	19.97	1164.11	31.10	39.11	111.58	108.03	0.00
OT#25-FAT	2.54	10.10	75.30	73.39	968.31	47.93	10.40	813.90	23.26	24.54	90.52	82.31	0.00
OT-FAT POOL(#26,27,28,29,32,33)	27.88	16.35	25.40	16.19	221.87	11.71	5.18	160.86	0.00	5.76	14.22	11.90	0.00
MINK#30 FAT	7.63	29.72	231.59	51.65	484.37	55.94	14.54	529.39	18.64	14.73	61.93	40.54	0.00
MINK#31 FAT	8.65	34.16	199.43	37.08	414.73	49.15	16.04	424.20	17.15	7.74	46.64	36.22	0.00
OT#34-FAT	47.70	110.72	222.02	561.13	5071.06	173.05	62.79	5288.18	156.85	119.76	763.90	544.40	0.00
OT#35-FAT	36.94	89.60	154.80	489.86	5998.09	0.00	48.80	5221.60	134.68	143.27	559.87	591.93	0.00
OT#36-FAT	96.92	222.85	243.12	892.79	7220.52	195.10	123.23	7934.44	284.86	204.28	1946.91	1117.53	0.00
OT#37-FAT	106.90	578.51	484.68	2574.41	19630.63	218.49	193.52	27226.93	518.15	418.41	3399.35	2504.95	0.00
OT#38-FAT A	308.15	421.24	199.73	1023.62	8724.11	0.00	279.61	9970.12	104.41	291.48	3775.57	1812.52	24.04
OT#38-FAT B	297.53	406.93	193.59	989.29	8297.00	0.00	272.51	9525.93	105.10	280.35	3606.80	1749.74	23.16

Appendix 5 (continued).

Sample Number	PCB #174	PCB #171	PCB #200	PCB #172	PCB #180	PCB #170/190	PCB #201	PCB #203	PCB #195	PCB #194	PCB #206	SPCBs	Aroclor 1254:1260	Aroclor 1260
OT#1-FAT	1.61	1635.69	56.24	30.07	2810.85	1308.13	140.96	114.09	87.56	386.79	143.58	14920.98	40731.41	24656.60
OT#2-FAT	1.69	31.61	31.89	17.18	1794.72	736.99	125.80	144.12	77.72	26.28	128.94	8901.58	27398.76	15743.19
OT#3-FAT	6.05	120.01	46.97	45.34	1776.31	758.78	211.64	108.48	79.39	311.24	127.05	9744.03	26445.03	15581.70
OT#4-FAT	0.00	45.18	25.56	14.41	1076.10	334.22	85.03	60.43	28.13	269.95	182.52	4442.01	7851.99	9439.45
OT#5-FAT	1.59	82.63	36.89	28.41	2569.37	962.84	157.32	96.08	68.64	270.62	97.57	10555.48	28776.14	22538.30
OT#6-FAT	0.00	70.49	33.97	19.16	838.71	388.45	89.57	57.33	34.62	109.98	49.00	6251.79	20311.99	7357.07
OT#7-FAT	0.00	120.65	74.71	44.84	2748.11	1296.96	145.29	109.16	90.01	279.78	115.83	14505.08	50896.72	24106.20
OT#8-FAT A	5.43	29.73	44.09	20.66	1884.51	810.57	104.22	113.56	66.55	279.70	145.46	10897.49	31654.86	16530.79
OT#8-FAT B	4.91	29.17	41.30	18.98	1751.44	751.32	94.77	103.96	60.65	259.73	132.17	9974.04	29326.18	15363.49
OT#9-FAT	4.58	41.74	51.41	41.37	2587.34	1133.70	225.49	138.73	93.52	393.11	190.29	12367.89	34565.99	22695.99
OT#10-FAT	2.53	66.24	73.24	44.44	3991.46	1551.19	182.97	184.16	124.12	427.92	179.07	16881.65	53031.81	35012.84
OT#11-FAT	11.59	99.24	47.90	27.08	1488.66	652.97	108.83	77.58	55.24	212.84	99.63	8668.00	24377.78	13058.44
OT#12-FAT	0.00	47.96	18.51	14.61	523.61	241.24	58.42	38.76	21.90	72.32	32.79	3918.56	11729.06	4593.07
OT#13-FAT	0.00	193.55	101.63	78.76	5108.59	2344.08	329.09	287.36	193.92	662.42	255.06	25102.73	82627.39	44812.16
OT#14-FAT	0.00	48.76	15.30	10.89	591.24	241.13	48.33	39.51	27.21	100.82	55.22	3616.50	9401.14	5186.35
OT#15-FAT A	3.50	146.39	65.05	46.91	2674.52	1260.22	175.93	177.01	106.17	261.68	90.05	15761.92	55462.70	23460.74
OT#15-FAT B	3.73	155.70	74.07	51.40	2814.32	1336.24	182.78	185.36	111.58	272.74	93.29	16228.29	57863.70	24687.01
OT#16-FAT	6.55	108.44	42.04	39.32	2471.05	1038.45	293.49	155.96	107.86	436.23	207.61	12031.90	31203.57	21675.92
OT#17-FAT	0.00	25.57	35.13	19.39	1596.16	704.44	104.55	69.71	55.25	173.83	61.91	8144.18	23856.03	14001.39
OT#18-FAT	0.00	60.13	22.12	13.93	927.19	326.04	67.37	58.92	36.12	125.23	62.72	5101.57	13500.80	8133.27
OT#19-FAT	3.19	250.82	136.08	54.68	3865.16	1557.60	264.16	167.29	119.86	411.34	158.76	21548.83	70344.46	33904.87
OT#20-FAT	0.00	36.16	18.16	7.88	623.04	269.45	48.88	36.70	21.71	86.82	36.92	3752.58	10344.84	5465.25
OT#21-FAT	6.66	68.91	42.54	23.92	2324.51	974.67	120.91	87.53	65.80	379.48	161.27	9469.44	21630.64	20390.42
OT#22-FAT	0.00	52.60	22.45	10.39	601.61	262.61	69.35	46.64	25.22	104.99	64.09	3646.24	10096.65	5277.29
OT#23-FAT A	0.00	25.17	16.20	5.86	876.28	360.19	36.04	38.21	25.94	146.69	84.74	3913.71	9678.51	7686.66
OT#23-FAT B	0.00	26.16	16.71	5.71	1026.18	365.05	35.95	38.76	26.00	150.26	86.06	4097.67	9785.44	9001.55
OT#24-FAT	7.17	85.93	27.80	29.75	1399.07	506.19	222.55	106.46	66.76	247.70	161.55	6886.26	15731.15	12272.52
OT#25-FAT	3.34	57.76	19.53	18.96	918.44	341.71	141.45	77.43	46.08	163.70	106.64	4746.08	10998.62	8056.53
OT-FAT POOL(#26,27,28,29,32,33)	0.00	7.66	6.20	2.39	126.01	44.02	7.91	6.54	3.02	26.18	17.70	979.65	2173.73	1105.36
MINK#30 FAT	7.29	46.54	21.07	10.70	705.11	340.36	35.74	35.93	36.85	183.89	89.40	3445.81	7153.90	6185.17
MINK#31 FAT	7.93	42.22	12.85	7.31	506.68	186.37	20.17	30.42	24.93	89.08	51.91	2652.98	5732.48	4444.59
OT#34-FAT	26.51	266.85	101.81	134.07	4529.68	1957.41	557.91	419.96	234.27	614.83	248.80	24906.87	71461.93	39734.05
OT#35-FAT	24.39	225.28	60.22	165.18	7714.37	2881.34	807.60	473.71	289.20	1154.24	407.06	29854.86	70562.15	67669.89
OT#36-FAT	51.81	506.69	163.28	272.30	6983.95	3046.33	1202.60	941.76	447.57	1218.19	657.10	39840.92	107222.13	61262.70
OT#37-FAT	18.11	1521.57	575.78	695.32	18321.14	8946.50	2008.58	1636.08	754.49	2008.09	628.54	108817.43	367931.52	160711.74
OT#38-FAT A	138.29	682.30	168.67	368.55	11096.72	4196.79	1607.48	1600.78	559.05	1637.50	774.92	53545.23	134731.37	97339.68
OT#38-FAT B	133.23	660.28	159.77	355.21	10793.96	4039.47	1538.25	1539.61	535.96	1566.69	737.11	51503.83	128728.84	94683.82

Appendix 6. Co-planar PCB, dioxin, and furan concentrations (ppt, ww) in livers of river otter and mink collected from the Lower Columbia River and Reference Area, 1994-95. Detection limit = 0.1 ppt (ww). ND = not detectable. A,B = 2 replicates of the same sample.

Sample Number	% Lipid	PCB #77	PCB #81	PCB #126	PCB #169	2378-TCDD	TCDD Total	12378-PCDD	PCDD Total	123478-H6CDD	123678-H6CDD	123789-H6CDD	H6CDD Total	1234678-H7CDD	H7CDD Total	OCDD	2378-TCDF
OT#1-LIVER	3.52	7.10	0.70	57.00	17.10	0.47	0.57	0.41	0.41	ND	11.96	0.46	12.42	104.65	104.65	477.01	0.58
OT#2-LIVER	2.97	15.20	0.70	35.60	11.00	0.36	0.36	0.33	0.33	ND	7.40	0.53	8.77	25.60	33.45	21.57	0.66
OT#3-LIVER	5.31	3.30	0.40	63.20	17.50	0.79	0.79	0.42	0.42	ND	6.11	0.52	8.03	48.41	62.08	177.16	0.18
OT#4-LIVER	3.84	7.00	0.20	11.60	10.10	0.17	0.26	0.17	0.17	ND	1.11	0.11	1.22	3.49	3.49	13.17	0.14
OT#5-LIVER	2.97	3.50	0.30	28.00	10.00	0.29	0.42	0.22	0.22	ND	4.55	0.45	6.23	44.34	55.30	246.79	0.14
OT#7-LIVER	4.48	1.70	ND	19.90	12.90	0.64	0.64	ND	ND	ND	14.62	1.02	16.06	96.88	106.44	413.85	0.34
OT#8-LIVER	3.87	11.40	0.50	57.90	35.20	0.55	0.55	ND	ND	ND	2.79	ND	3.59	5.37	18.11	7.01	ND
OT#9-LIVER	3.90	1.23	ND	25.30	22.20	2.21	2.21	0.60	0.60	ND	15.22	0.71	15.93	51.76	51.76	84.93	ND
OT#10-LIVER	3.65	2.40	0.70	39.20	27.70	1.49	1.69	ND	ND	ND	11.69	0.85	15.03	34.19	63.24	94.89	1.76
OT#11-LIVER A	2.93	4.10	0.30	16.60	14.10	0.83	0.83	ND	ND	ND	6.65	0.40	7.05	65.16	65.18	360.63	0.12
OT#11-LIVER B	2.93	1.70	0.10	14.90	13.70	0.73	0.73	ND	ND	ND	6.52	ND	6.52	63.61	63.61	349.81	ND
OT#12-LIVER	3.03	4.80	0.40	22.90	6.30	0.36	0.36	0.38	0.38	ND	3.08	0.34	3.42	49.33	49.33	231.75	0.25
OT#13-LIVER	4.94	4.10	0.30	44.90	30.30	0.43	0.47	0.25	0.25	ND	8.60	0.36	8.96	71.74	71.74	519.88	0.45
OT#14-LIVER	3.41	3.40	0.20	27.90	4.60	0.68	0.68	0.59	0.78	ND	10.10	0.91	11.63	129.05	136.23	220.94	0.34
OT#15-LIVER	2.27	3.40	0.20	29.80	17.50	0.50	0.50	0.53	0.53	ND	26.82	1.97	28.79	982.95	982.95	4517.97	0.22
OT#16-LIVER	2.76	2.20	ND	20.50	15.50	0.51	0.51	0.27	0.27	ND	2.26	0.20	2.99	7.71	7.91	28.69	0.17
OT#17-LIVER A	3.57	3.30	0.50	44.40	13.10	0.68	0.75	0.66	0.66	ND	8.29	0.60	8.89	51.36	51.36	146.06	0.65
OT#17-LIVER B	3.57	3.10	0.60	45.90	12.90	0.68	0.81	0.70	0.70	ND	8.71	0.68	9.39	53.01	57.11	145.34	0.65
OT#18-LIVER	2.79	2.10	0.90	85.10	11.90	1.28	1.28	1.16	1.16	ND	30.34	2.32	32.66	409.51	409.51	1182.69	0.38
OT#19-LIVER	3.91	7.70	3.30	100.40	28.30	1.22	1.22	0.91	0.91	ND	10.28	0.57	10.85	35.85	35.85	89.24	0.36
OT#20-LIVER	4.05	2.00	0.40	22.60	8.40	1.42	1.42	ND	ND	ND	3.70	0.36	4.05	20.74	24.04	49.50	0.38
OT#21-LIVER	3.49	3.20	1.40	56.50	21.10	1.50	1.50	0.80	0.80	ND	8.12	0.58	8.70	23.82	23.82	79.59	0.19
OT#22-LIVER	2.70	2.50	0.10	16.00	3.20	1.27	1.27	ND	ND	ND	5.85	ND	5.85	18.88	25.52	26.49	0.16
OT#23-LIVER	5.26	1.90	ND	12.50	0.67	0.29	0.29	0.14	0.14	ND	1.90	0.10	2.00	7.45	7.45	35.65	0.15
OT#24-LIVER	3.71	1.50	ND	35.30	10.60	0.89	0.89	1.76	1.76	ND	85.15	2.21	87.36	268.12	268.12	276.07	ND
OT#25-LIVER A	2.92	1.50	0.80	24.60	8.30	1.16	1.16	6.70	7.25	32.67	159.00	9.06	225.81	360.30	2473.88	394.13	ND
OT#25-LIVER B	2.92	1.30	0.90	23.10	7.60	1.13	1.13	6.50	6.50	30.33	148.33	8.13	190.22	327.98	1040.04	308.83	0.10
OT#26-LIVER	3.24	0.80	ND	2.30	2.20	ND	ND	0.44	0.44	0.46	4.84	0.35	5.65	14.11	14.11	19.85	ND
OT#27-LIVER	3.24	2.80	0.30	16.10	3.90	ND	0.42	0.21	0.21	ND	3.00	0.20	4.05	12.93	13.15	20.44	0.10
OT#28-LIVER	3.78	0.90	ND	5.90	4.70	0.13	0.40	0.22	0.22	0.14	2.11	ND	2.25	4.37	4.37	6.91	ND
OT#29-LIVER	2.48	3.20	ND	4.60	7.20	0.36	0.36	0.57	0.57	0.48	4.79	0.53	5.80	10.80	10.80	15.69	0.26
MK#31-LIVER	3.18	2.20	0.70	56.50	2.30	0.87	1.04	0.83	0.83	1.23	6.84	0.80	8.87	35.25	35.25	66.95	0.30
OT#32-LIVER	3.03	6.50	ND	16.80	3.60	0.19	0.19	ND	ND	ND	2.75	ND	2.75	12.28	12.28	17.24	0.16
OT#33-LIVER A	3.06	ND	ND	6.70	5.00	ND	ND	ND	ND	0.23	1.90	0.31	2.44	4.13	4.13	4.92	ND
OT#33-LIVER B	2.92	1.40	ND	6.40	4.20	ND	ND	0.34	0.34	0.25	1.80	0.33	2.38	3.43	3.64	3.78	0.08
OT#34-LIVER	3.85	2.30	0.70	147.20	51.40	2.99	2.99	4.28	4.28	5.39	75.05	3.08	89.63	293.39	426.06	1255.35	0.37
OT#35-LIVER	2.43	1.60	ND	50.20	23.70	0.86	0.86	0.95	0.95	1.78	40.30	1.17	43.25	156.25	156.25	297.96	0.02
OT#36-LIVER	2.68	2.30	ND	81.30	46.40	1.59	1.59	1.82	1.82	ND	56.82	2.25	72.05	236.29	361.28	478.08	ND
OT#37-LIVER	2.66	1.20	0.50	62.50	124.90	1.17	1.17	0.87	0.87	0.95	15.97	0.83	20.42	53.83	68.40	178.74	ND
OT#38-LIVER A	4.50	3.10	1.20	355.40	154.80	2.28	2.28	5.94	5.94	ND	79.82	4.78	91.74	235.71	285.04	406.04	ND
OT#38-LIVER B	4.50	3.40	1.20	405.00	176.70	2.75	2.75	6.79	6.79	4.66	86.37	5.25	100.57	246.40	254.56	443.82	ND
MK#39-LIVER	4.81	0.80	0.40	58.60	8.70	ND	ND	ND	ND	ND	2.77	ND	2.77	2.07	2.07	3.22	ND
MK#40-LIVER	4.38	0.80	ND	6.40	1.60	ND	ND	ND	ND	ND	ND	ND	ND	3.11	3.11	13.37	ND

Appendix 6 (continued).

Sample Number	TCDF Total	12378-PCDF	23478-PCDF	PCDF Total	123478-H6CDF	234678-H6CDF	123678-H6CDF	123789-H6CDF	H6CDF Total	1234678-H7CDF	H7CDF Total	OCDF	Dioxin TEQs	Total TEQs
OT#1-LIVER	0.58	0.31	1.91	2.36	15.30	ND	1.55	ND	16.85	54.55	54.55	10.98	13.337	25.691
OT#2-LIVER	2.49	0.14	2.99	4.94	4.11	1.14	0.78	ND	6.69	3.29	3.52	0.30	8.062	15.793
OT#3-LIVER	1.91	0.35	2.90	3.95	5.80	1.10	1.04	ND	9.25	25.84	26.85	6.72	12.097	27.125
OT#4-LIVER	0.22	ND	0.77	0.77	0.73	0.69	0.26	ND	1.68	0.97	0.97	0.29	2.757	5.825
OT#5-LIVER	3.96	ND	3.44	6.29	5.38	1.02	0.81	ND	7.78	16.05	16.92	7.43	7.648	18.682
OT#7-LIVER	1.45	ND	3.50	9.53	13.98	ND	2.12	ND	16.64	60.85	60.85	10.27	10.251	22.543
OT#8-LIVER	12.41	ND	4.55	7.98	1.82	1.05	0.69	ND	6.21	0.89	1.18	ND	11.194	23.040
OT#9-LIVER	0.36	ND	2.90	2.90	5.68	1.76	1.43	ND	8.87	8.45	8.62	1.05	7.128	17.152
OT#10-LIVER	1.76	3.56	4.29	18.18	5.74	0.90	0.99	0.25	10.99	12.89	12.89	1.58	11.927	26.984
OT#11-LIVER A	0.64	ND	2.42	2.42	14.00	ND	1.61	ND	15.61	53.33	53.33	3.37	8.273	15.221
OT#11-LIVER B	ND	ND	1.76	1.76	13.43	ND	1.61	ND	15.04	52.64	52.64	3.32	7.474	14.549
OT#12-LIVER	0.25	ND	2.24	2.35	2.68	0.87	0.73	ND	4.28	47.11	48.39	28.39	6.343	10.350
OT#13-LIVER	0.45	0.11	1.79	1.90	11.04	1.06	1.27	ND	13.37	54.44	54.44	8.89	11.570	41.685
OT#14-LIVER	0.95	ND	2.82	4.12	6.78	1.39	1.23	ND	9.58	27.52	28.29	20.14	9.321	12.526
OT#15-LIVER	0.33	ND	3.47	4.00	32.95	3.21	5.31	ND	41.56	683.79	706.72	920.09	35.543	44.308
OT#16-LIVER	0.17	ND	1.49	1.49	2.05	0.75	0.45	ND	3.25	2.58	2.58	0.74	4.967	14.490
OT#17-LIVER A	0.65	ND	3.73	3.73	8.51	1.37	1.54	ND	11.42	39.41	39.41	5.33	11.158	19.354
OT#17-LIVER B	4.09	ND	4.98	7.55	8.86	1.33	1.43	ND	11.84	40.09	40.09	6.06	12.034	21.510
OT#18-LIVER	0.38	ND	5.51	5.51	20.63	2.88	5.90	ND	29.89	109.38	110.85	21.42	26.379	32.987
OT#19-LIVER	0.36	ND	4.22	4.22	10.02	1.39	1.35	ND	12.76	13.07	13.07	1.47	18.294	33.938
OT#20-LIVER	5.40	ND	2.64	4.93	2.87	1.07	0.85	ND	4.77	4.25	4.56	1.61	6.664	10.904
OT#21-LIVER	0.41	ND	3.49	3.49	4.60	1.14	0.81	ND	6.55	4.55	4.55	2.28	12.292	24.648
OT#22-LIVER	0.34	ND	1.75	3.07	2.85	1.08	0.65	ND	4.76	3.60	3.79	0.91	5.241	7.941
OT#23-LIVER	0.24	ND	0.84	0.84	1.57	0.72	0.30	ND	2.59	4.69	4.69	1.58	2.715	9.991
OT#24-LIVER	ND	ND	6.92	6.92	25.94	3.39	4.42	ND	33.75	18.97	19.38	1.42	24.564	30.772
OT#25-LIVER A	ND	6.12	12.01	25.89	19.89	7.05	3.80	0.38	39.76	14.65	27.64	ND	41.040	45.362
OT#25-LIVER B	0.10	1.06	11.55	13.77	18.89	7.00	3.87	ND	32.33	12.48	21.40	1.81	38.291	42.930
OT#26-LIVER	ND	ND	0.65	0.65	1.29	0.99	0.56	ND	3.56	2.75	2.75	0.42	1.931	2.263
OT#27-LIVER	0.10	ND	1.96	1.96	2.49	0.87	0.64	ND	4.00	2.52	2.52	0.53	3.823	5.100
OT#28-LIVER	6.91	0.11	1.27	1.82	0.74	0.74	0.40	ND	2.10	0.90	0.99	0.17	2.187	2.977
OT#29-LIVER	0.26	0.19	0.83	1.02	1.99	1.21	0.94	0.31	4.45	3.37	3.82	3.14	3.133	3.478
MK#31-LIVER	0.30	ND	6.24	6.24	1.17	2.09	1.55	0.04	5.16	0.52	0.66	1.15	12.020	17.670
OT#32-LIVER	3.46	ND	2.45	2.78	2.58	0.96	0.77	ND	4.31	3.07	3.07	0.60	4.233	5.110
OT#33-LIVER A	ND	ND	1.29	1.29	0.72	0.83	0.55	ND	2.10	ND	ND	ND	2.065	3.226
OT#33-LIVER B	3.12	ND	1.47	1.83	0.63	0.78	0.41	ND	2.38	0.52	0.52	ND	2.240	3.430
OT#34-LIVER	0.53	ND	22.60	25.08	66.79	6.03	7.17	ND	79.99	139.88	142.04	22.00	55.741	82.716
OT#35-LIVER	0.02	ND	6.75	6.75	25.00	3.32	3.97	ND	32.29	52.48	53.48	10.10	20.882	38.714
OT#36-LIVER	ND	0.58	10.51	16.39	28.33	4.00	5.09	ND	42.04	76.19	79.20	22.35	31.531	49.359
OT#37-LIVER	0.90	ND	6.35	11.29	39.80	2.26	4.03	ND	46.25	43.59	44.19	4.28	24.828	83.166
OT#38-LIVER A	2.70	1.03	18.39	30.02	20.62	3.84	5.64	ND	33.95	68.11	70.06	11.23	72.733	109.453
OT#38-LIVER B	2.57	ND	19.14	20.58	22.79	4.76	6.16	ND	34.43	74.16	74.16	11.80	81.744	121.022
MK#39-LIVER	ND	ND	2.86	2.86	0.23	0.90	0.38	ND	1.51	0.21	0.21	0.22	8.187	12.087
MK#40-LIVER	ND	ND	ND	ND	ND	0.66	ND	ND	0.66	1.08	1.18	ND	0.849	1.683

Note: Total TEQs include TEQs from Appendix 1 (converted to ppt) PCBs and TEQs from co-planar PCBs, dioxins and furans from this Appendix.

Appendix 7. Co-planar PCB, dioxin, and furan concentrations (ppt, ww) in mesentary fat of river otter and mink collected from the Lower Columbia River and Reference Area, 1994-95. Detection Limit = 0.1 ppt (ww). ND = not detectable. A,B = replicates of the same sample.

Sample Number	% Lipid	PCB #77	PCB #81	PCB #126	PCB #169	2378-TCDD	Total TCDD	12378-PCDD	TOTAL PCDD	123478-H6CDD	123678-H6CDD	123789-H6CDD	Total H6CDD	1234678-H7CDD	Total H7CDD
OT#1-FAT	75.50	74.90	2.70	45.00	156.90	ND	ND	ND	ND	ND	10.09	ND	36.52	19.58	270.29
OT#2-FAT	62.23	43.30	0.70	43.70	126.30	ND	ND	ND	ND	ND	9.07	ND	9.07	7.62	7.62
OT#3-FAT	66.54	62.50	ND	96.80	165.30	4.58	7.07	ND	4.00	ND	13.05	ND	127.72	16.71	896.38
OT#4-FAT	7.21	13.00	1.20	13.50	29.80	ND	ND	ND	ND	ND	2.26	ND	2.26	2.85	25.35
OT#5-FAT	76.88	90.90	4.50	55.00	129.80	ND	ND	ND	ND	ND	7.06	0.62	7.68	12.81	12.81
OT#6-FAT A	59.88	46.90	ND	49.10	57.80	ND	ND	ND	ND	ND	ND	ND	ND	13.59	14.47
OT#6-FAT B	59.88	45.00	2.70	51.80	58.40	2.83	2.83	ND	ND	ND	ND	ND	ND	7.51	7.51
OT#7-FAT	38.35	67.10	ND	36.40	183.10	2.71	2.71	ND	ND	ND	15.66	ND	32.27	24.74	152.17
OT#8-FAT	45.82	61.08	ND	52.00	281.80	ND	ND	ND	ND	ND	ND	ND	ND	5.35	9.93
OT#9-FAT	52.87	14.80	ND	27.90	150.00	6.64	6.64	ND	ND	ND	11.28	ND	11.28	10.33	10.33
OT#10-FAT	47.17	41.50	1.70	37.40	304.10	4.50	4.50	ND	ND	ND	9.96	ND	35.04	8.32	227.04
OT#11-FAT	35.19	68.60	ND	41.30	146.40	ND	ND	ND	ND	ND	10.74	ND	30.21	23.25	182.53
OT#12-FAT	57.24	21.60	2.40	39.90	102.60	ND	ND	ND	ND	ND	5.37	ND	5.37	24.29	31.14
OT#13-FAT	31.29	17.70	ND	20.10	130.80	ND	ND	ND	ND	ND	5.00	ND	5.00	12.55	12.55
OT#14-FAT	42.39	21.60	ND	33.60	45.00	ND	ND	ND	ND	ND	ND	ND	2.45	14.92	89.13
OT#15-FAT	52.48	25.90	ND	51.90	206.00	2.47	2.47	ND	ND	ND	ND	ND	2.20	2.94	20.62
OT#16-FAT	60.48	78.40	6.80	73.90	387.20	ND	ND	ND	ND	ND	44.99	9.56	150.45	406.88	2917.34
OT#17-FAT	63.32	75.50	6.80	54.00	167.90	4.07	4.07	ND	ND	ND	7.82	ND	7.82	15.40	17.42
OT#18-FAT	51.72	45.90	7.10	82.80	94.60	ND	ND	ND	ND	ND	16.69	ND	17.74	68.98	75.67
OT#19-FAT A	57.24	64.60	6.30	62.00	269.70	ND	ND	ND	ND	ND	9.31	ND	55.08	10.48	555.33
OT#19-FAT B	57.24	63.70	5.90	61.00	269.60	ND	ND	ND	ND	ND	7.03	ND	22.08	6.32	28.85
OT#20-FAT	45.82	24.10	2.40	35.40	101.30	6.37	6.95	ND	ND	ND	4.99	ND	8.11	ND	ND
OT#21-FAT	69.60	36.30	ND	55.00	165.60	3.46	3.46	ND	ND	ND	ND	ND	67.33	3.39	334.51
OT#22-FAT	51.64	31.00	ND	67.40	114.10	6.36	6.36	ND	ND	ND	11.80	ND	11.80	9.46	10.37
OT#23-FAT	82.01	27.20	ND	33.30	155.70	2.02	2.02	ND	ND	1.36	4.46	2.20	8.02	8.18	8.18
OT#24-FAT	57.35	110.20	9.80	136.20	396.20	3.23	10.43	ND	ND	ND	35.18	ND	268.16	32.35	2100.44
OT#25-FAT	50.37	90.00	5.00	70.10	166.10	4.01	4.01	ND	ND	ND	98.87	ND	189.08	82.63	4040.95
MK#30-FAT	52.44	139.30	ND	62.60	124.40	ND	ND	9.01	9.01	13.43	65.95	ND	79.38	54.33	54.33
MK#31-FAT	67.63	79.70	7.70	209.50	40.90	3.60	3.60	ND	ND	ND	23.84	ND	54.68	25.53	456.35
OT#34-FAT	44.73	180.00	16.10	259.40	50.10	4.43	4.43	ND	ND	ND	16.14	0.91	19.05	23.33	23.33
OT#35-FAT A	61.95	61.80	6.20	85.80	250.80	4.46	4.46	ND	ND	2.52	19.60	ND	22.12	23.31	30.78
OT#35-FAT B	61.95	109.40	9.30	139.20	423.20	4.26	4.26	ND	ND	ND	29.00	0.77	29.77	34.52	34.52
OT#36-FAT	38.24	68.00	5.90	84.90	271.40	3.16	3.16	ND	ND	ND	14.01	ND	15.06	26.59	27.75
OT#37-FAT	47.45	27.80	ND	77.40	1053.50	ND	ND	ND	ND	ND	13.47	10.09	587.00	ND	3954.15
OT#38-FAT	63.51	32.40	ND	382.70	1199.80	6.69	6.69	10.32	10.32	4.04	30.52	3.33	40.63	29.52	44.67
OT-FAT POOL A(#26,27,28,29,32,33)	65.17	27.50	ND	23.60	56.70	ND	ND	ND	ND	ND	3.76	ND	3.76	5.52	5.52
OT-FAT POOL B(#26,27,28,29,32,33)	65.17	20.50	1.20	20.10	51.30	ND	ND	ND	ND	ND	ND	ND	4.73	4.70	25.04

Appendix 7 (continued).

Sample Number	OCDD	2378-TCDF	Total TCDF	12378-PCDF	23478-PCDF	Total PCDF	123478-H6CDF	234678-H6CDF	123678-H6CDF	123789-H6CDF	Total H6CDF	1234678-H7CDF	Total H7CDF	OCDF
OT#1-FAT	50.82	2.89	2.89	2.99	4.52	27.35	2.35	6.32	ND	ND	16.11	4.81	10.68	2.16
OT#2-FAT	7.49	ND	ND	ND	ND	ND	0.88	5.63	ND	ND	6.51	ND	ND	ND
OT#3-FAT	46.44	3.03	3.03	29.78	10.24	115.36	ND	8.80	ND	4.91	58.12	ND	7.92	ND
OT#4-FAT	9.40	ND	2.60	ND	ND	ND	ND	5.76	ND	ND	9.74	ND	ND	ND
OT#5-FAT	31.65	ND	ND	ND	ND	ND	1.21	5.73	ND	ND	6.94	1.85	1.85	ND
OT#6-FAT A	79.23	3.56	4.37	ND	ND	ND	1.53	6.59	ND	ND	8.12	6.22	6.22	3.32
OT#6-FAT B	18.37	2.83	2.83	ND	ND	ND	ND	6.27	0.45	ND	6.72	1.42	1.42	ND
OT#7-FAT	56.93	ND	1.27	ND	ND	ND	ND	6.38	ND	ND	6.38	7.15	7.15	2.11
OT#8-FAT	35.66	ND	ND	ND	ND	ND	ND	6.99	ND	ND	6.99	ND	ND	ND
OT#9-FAT	15.46	ND	ND	ND	ND	ND	ND	6.69	ND	ND	6.69	ND	ND	ND
OT#10-FAT	22.75	3.76	21.87	ND	17.03	17.03	ND	6.83	ND	ND	13.07	ND	8.45	ND
OT#11-FAT	119.15	3.93	7.53	ND	ND	ND	2.97	7.56	ND	ND	16.83	7.88	11.38	ND
OT#12-FAT	42.09	1.70	4.62	ND	ND	ND	ND	6.70	ND	ND	7.77	6.64	6.64	ND
OT#13-FAT	41.50	ND	ND	ND	ND	ND	ND	6.55	ND	ND	6.55	3.28	3.28	ND
OT#14-FAT	31.54	ND	ND	ND	ND	13.01	1.67	8.30	ND	ND	13.48	ND	ND	ND
OT#15-FAT	12.25	ND	2.30	ND	ND	ND	ND	5.27	1.00	ND	6.27	ND	ND	ND
OT#16-FAT	1083.18	ND	ND	ND	5.89	80.43	9.04	8.34	ND	1.38	61.28	110.58	205.01	184.75
OT#17-FAT	28.81	ND	ND	ND	ND	6.21	2.56	8.96	ND	ND	17.01	4.26	4.26	ND
OT#18-FAT	129.01	ND	ND	ND	ND	ND	2.26	7.24	ND	ND	10.97	7.83	9.12	3.08
OT#19-FAT A	44.59	ND	ND	ND	5.84	5.84	ND	6.34	ND	ND	22.15	2.53	24.44	5.60
OT#19-FAT B	20.86	ND	ND	ND	ND	ND	0.74	6.96	ND	ND	7.70	ND	ND	2.10
OT#20-FAT	13.30	ND	ND	ND	ND	ND	ND	6.32	ND	ND	6.32	ND	ND	ND
OT#21-FAT	9.58	ND	0.82	ND	ND	3.91	ND	5.03	ND	ND	24.38	ND	10.73	ND
OT#22-FAT	9.59	ND	ND	ND	ND	ND	ND	6.25	ND	ND	6.25	1.12	1.12	ND
OT#23-FAT	37.34	2.12	2.12	ND	ND	ND	1.99	7.77	2.41	1.83	14.00	8.81	11.87	25.98
OT#24-FAT	69.58	ND	2.42	ND	ND	144.04	6.37	6.66	2.57	ND	88.14	ND	22.64	ND
OT#25-FAT	137.28	2.99	2.99	ND	ND	40.30	6.91	7.45	1.33	ND	28.86	ND	53.91	ND
MK#30-FAT	49.02	3.46	3.46	ND	ND	ND	4.51	6.90	ND	ND	11.41	ND	ND	ND
MK#31-FAT	70.73	3.80	3.80	ND	ND	ND	2.36	7.43	ND	1.17	10.96	ND	12.98	ND
OT#34-FAT	37.24	7.19	7.19	ND	5.88	5.88	3.84	8.35	ND	ND	12.19	1.95	1.95	ND
OT#35-FAT A	63.38	1.54	1.54	ND	1.78	1.78	2.36	6.55	ND	ND	9.90	4.79	4.79	4.55
OT#35-FAT B	35.91	1.94	1.94	ND	ND	ND	3.46	6.96	ND	ND	10.42	5.43	5.43	1.76
OT#36-FAT	40.78	1.13	4.39	ND	ND	ND	2.50	6.55	ND	ND	9.05	4.63	6.27	4.23
OT#37-FAT	37.92	ND	ND	108.84	22.68	1112.33	11.56	7.95	2.07	5.13	240.77	ND	63.91	2.04
OT#38-FAT	32.43	ND	6.25	ND	ND	ND	3.38	10.06	ND	ND	13.44	ND	ND	ND
OT-FAT POOL A(#26,27,28,29,32,33)	9.15	ND	ND	ND	ND	ND	ND	6.99	ND	ND	6.99	0.82	0.82	ND
OT-FAT POOL B(#26,27,28,29,32,33)	13.46	ND	32.08	ND	ND	8.24	ND	6.05	ND	ND	11.25	ND	ND	ND

Appendix 8. Heavy metal concentrations (ppm, dw) in livers and kidneys of river otter and mink collected from the Lower Columbia River and Reference Area, 1994-95.
ND = not detectable.

Detection Limit		0.90	0.02	0.13	0.47	12.50	1.07	0.44	0.47	2.50	0.22	0.10
Sample Number	% Moisture	Aluminum	Cadmium	Chromium	Copper	Iron	Manganese	Nickel	Lead	Zinc	Mercury	Vanadium
OT#1-LIVER	70.95	0.91	0.29	0.99	45.70	737.40	7.58	ND	ND	54.60	5.46	0.86
OT#2-LIVER	71.65	ND	0.11	0.27	37.82	944.70	7.63	ND	ND	64.70	4.10	0.75
OT#3-LIVER	71.29	ND	0.36	0.50	73.19	805.40	8.85	ND	ND	72.80	8.14	0.67
OT#4-LIVER	71.61	ND	0.14	1.40	35.89	668.30	12.81	0.72	ND	112.50	5.12	0.85
OT#5-LIVER	69.85	ND	0.13	0.38	42.31	759.40	7.55	ND	ND	63.10	1.91	0.68
OT#6-LIVER	70.03	ND	0.09	0.34	68.85	508.40	8.15	ND	ND	67.50	3.11	0.59
OT#7-LIVER	73.06	ND	0.15	0.29	42.03	1004.40	8.80	ND	ND	66.40	1.30	0.66
OT#8-LIVER	69.38	ND	0.16	0.39	38.03	1058.00	6.42	ND	ND	69.70	5.11	0.64
OT#9-LIVER	71.19	ND	0.15	ND	27.62	1032.80	7.90	ND	ND	64.20	4.77	0.55
OT#10-LIVER	69.40	ND	0.20	ND	15.18	981.50	6.17	ND	ND	60.50	4.17	0.61
OT#11-LIVER	70.53	1.21	0.10	0.53	41.01	969.10	8.83	ND	ND	75.40	12.56	0.65
OT#12-LIVER	70.41	ND	0.04	2.05	50.83	467.40	9.96	0.92	ND	76.90	6.23	0.78
OT#13-LIVER	70.07	ND	0.34	ND	33.75	702.50	10.17	ND	ND	64.70	6.05	0.65
OT#14-LIVER	70.72	ND	0.49	0.18	35.20	844.10	7.55	ND	ND	62.00	1.72	0.61
OT#15-LIVER	70.87	ND	0.13	ND	17.20	1380.60	6.65	ND	ND	68.30	1.26	0.68
OT#16-LIVER	70.31	ND	0.13	ND	19.31	1071.40	6.15	ND	ND	70.10	4.74	0.57
OT#17-LIVER	69.91	ND	0.32	0.28	24.29	1520.10	5.41	ND	ND	71.90	2.26	0.76
OT#18-LIVER	69.23	ND	0.19	ND	33.83	1030.30	6.91	ND	ND	66.70	2.43	0.80
OT#19-LIVER	68.07	ND	0.17	ND	11.22	1325.70	4.76	ND	ND	53.90	6.59	0.76
OT#20-LIVER	71.48	ND	ND	ND	37.67	785.00	6.60	ND	ND	70.50	5.19	0.93
OT#21-LIVER	72.07	ND	0.29	ND	16.64	1590.20	6.79	ND	ND	79.30	5.32	0.64
OT#22-LIVER	70.20	ND	ND	ND	12.53	1119.80	4.30	ND	ND	64.90	3.63	0.49
OT#23-LIVER	70.10	ND	0.04	ND	13.94	1293.40	5.03	ND	ND	54.90	1.93	0.63
OT#24-LIVER	68.93	1.77	0.07	3.43	18.30	965.00	6.50	1.22	ND	69.40	3.75	0.43
OT#25-LIVER	69.14	ND	0.03	ND	17.80	920.90	5.82	ND	ND	69.20	3.38	0.59
OT#26-LIVER	69.06	ND	0.06	2.75	36.69	1267.00	6.13	1.00	ND	64.00	4.37	0.59
OT#27-LIVER	70.25	ND	0.10	ND	24.43	1095.20	6.48	ND	ND	79.20	5.80	0.84
OT#28-LIVER	71.88	ND	0.03	ND	33.02	909.50	8.14	ND	ND	104.80	5.00	0.68
OT#29-LIVER	70.10	ND	0.04	ND	46.14	1502.90	8.63	ND	ND	77.20	3.63	0.35
MK#30-LIVER	71.89	ND	0.08	0.35	12.63	903.50	4.29	ND	ND	81.60	1.95	0.47
MK#31-LIVER	73.69	ND	0.06	ND	25.83	1214.50	4.77	ND	ND	84.50	2.21	0.76
OT#32-LIVER	69.93	ND	0.15	ND	18.70	831.10	6.95	ND	ND	76.20	11.28	0.89
OT#33-LIVER	69.47	ND	0.07	ND	19.75	694.40	6.93	ND	ND	64.20	4.65	0.68
OT#34-LIVER	68.29	ND	0.11	ND	14.93	1359.50	5.79	ND	ND	55.30	3.03	0.59
OT#35-LIVER	71.55	ND	0.13	ND	21.54	1176.90	6.80	ND	ND	67.90	1.13	0.72
OT#36-LIVER	71.82	ND	0.03	0.17	32.40	891.20	7.47	ND	ND	75.10	1.85	0.74
OT#37-LIVER	71.08	ND	0.09	ND	32.26	1303.40	7.03	ND	ND	82.10	2.11	0.80
OT#38-LIVER	68.44	ND	0.32	ND	16.10	1252.80	5.51	ND	ND	63.40	2.77	0.69
MK#39-LIVER	70.88	ND	0.04	ND	16.32	991.90	6.49	ND	ND	106.10	3.42	0.58
MK#40-LIVER	70.86	ND	0.09	0.15	30.69	1368.20	8.73	ND	ND	91.70	0.86	0.82

Appendix 8 (continued).

		0.90	0.02	0.13	0.47	12.50	1.07	0.44	0.47	2.50	0.10
Sample Number	% Moisture	Aluminum	Cadmium	Chromium	Copper	Iron	Manganese	Nickel	Lead	Zinc	Vanadium
OT#1-KIDNEY	71.08	0.98	2.38	2.36	41.34	559.50	2.65	0.83	ND	51.10	0.56
OT#2-KIDNEY	69.91	1.28	1.98	2.24	53.27	552.30	2.52	1.04	ND	55.40	0.48
OT#3-KIDNEY	71.93	ND	3.39	2.26	56.01	420.40	2.31	1.03	0.65	65.80	0.50
OT#4-KIDNEY	74.43	ND	1.66	2.33	56.94	921.90	3.84	1.11	ND	99.30	0.68
OT#5-KIDNEY	68.30	ND	1.42	2.07	43.62	439.60	2.04	0.96	ND	44.10	0.55
OT#6-KIDNEY	70.87	ND	0.67	3.21	49.64	513.10	2.34	1.46	ND	52.40	0.65
OT#7-KIDNEY	74.81	ND	1.57	3.13	63.74	639.40	3.71	1.42	ND	68.70	0.70
OT#8-KIDNEY	72.78	ND	3.04	2.19	58.34	578.60	2.94	1.10	ND	61.20	0.76
OT#9-KIDNEY	75.68	ND	3.45	2.03	43.85	631.40	2.90	1.18	0.52	66.50	0.73
OT#10-KIDNEY	72.21	ND	2.95	0.92	33.80	646.30	2.47	0.60	ND	56.10	0.70
OT#11-KIDNEY	73.21	ND	1.29	2.13	45.29	573.70	2.48	1.04	ND	60.90	0.79
OT#12-KIDNEY	72.02	ND	0.38	0.92	29.77	366.50	2.91	ND	0.53	64.50	0.63
OT#13-KIDNEY	73.07	ND	4.49	2.22	49.58	521.40	3.24	1.17	ND	55.30	0.59
OT#14-KIDNEY	72.68	ND	7.03	0.88	32.25	537.20	2.84	0.49	0.57	59.70	0.63
OT#15-KIDNEY	73.20	ND	1.26	1.05	31.75	589.60	2.26	0.56	ND	55.70	0.67
OT#16-KIDNEY	74.79	0.94	2.26	2.61	45.41	621.90	2.30	1.11	ND	60.90	0.53
OT#17-KIDNEY	69.86	ND	2.33	1.37	32.54	513.70	3.35	0.50	ND	54.50	0.48
OT#18-KIDNEY	71.36	ND	2.49	0.74	25.05	607.40	2.48	3.25	0.61	59.80	0.78
OT#19-KIDNEY	67.21	ND	2.08	0.86	27.67	461.00	1.80	0.44	ND	46.00	0.50
OT#20-KIDNEY	70.95	ND	0.18	0.92	26.07	513.50	2.90	ND	ND	55.90	0.60
OT#21-KIDNEY	70.96	ND	1.62	0.83	28.91	667.50	2.46	ND	ND	55.00	0.75
OT#22-KIDNEY	71.89	ND	0.16	1.02	27.92	726.40	2.06	0.48	ND	51.90	0.60
OT#23-KIDNEY	67.64	ND	0.52	0.58	26.20	535.20	1.58	ND	ND	41.40	0.54
OT#24-KIDNEY	73.70	ND	0.56	0.58	51.94	570.30	2.46	ND	ND	55.10	0.67
OT#25-KIDNEY	71.04	ND	0.25	8.08	46.83	809.60	2.76	1.85	ND	57.80	0.57
OT#26-KIDNEY	73.98	ND	0.38	15.53	64.39	806.70	3.60	3.69	ND	63.70	0.77
OT#27-KIDNEY	68.81	ND	1.05	4.29	38.26	560.00	3.14	0.94	ND	59.80	0.51
OT#28-KIDNEY	75.74	ND	0.49	2.20	35.85	470.20	7.73	0.96	ND	71.30	0.94
OT#29-KIDNEY	70.80	ND	0.12	2.11	33.93	1107.00	3.46	5.00	ND	65.20	0.79
MK#30-KIDNEY	71.25	ND	0.44	0.32	19.18	469.50	3.11	2.77	ND	68.70	0.98
MK#31-KIDNEY	68.89	1.55	0.34	0.24	24.93	654.20	3.39	4.82	ND	59.80	0.64
OT#32-KIDNEY	68.22	ND	2.16	1.91	33.09	498.00	2.54	3.25	ND	58.20	0.88
OT#33-KIDNEY	69.00	ND	1.63	1.47	32.45	425.20	1.94	1.73	ND	49.40	0.77
OT#34-KIDNEY	68.77	ND	1.40	1.25	31.77	639.30	2.69	2.62	ND	54.50	0.66
OT#35-KIDNEY	71.67	ND	1.51	0.53	22.11	646.10	2.63	1.68	0.58	54.10	0.78
OT#36-KIDNEY	73.58	ND	0.36	0.49	20.81	583.40	2.03	1.69	1.63	55.50	0.76
OT#37-KIDNEY	72.15	ND	1.15	0.21	20.99	734.40	3.14	ND	0.69	63.40	1.00
OT#38-KIDNEY	71.93	1.83	5.83	0.62	24.75	920.50	2.62	0.80	0.48	60.90	0.97
MK#39-KIDNEY	72.70	ND	0.15	0.52	26.49	518.80	2.99	0.82	ND	64.70	1.14
MK#40-KIDNEY	67.51	ND	0.10	0.33	24.24	465.50	2.53	0.52	0.63	45.70	0.66

Appendix 9. A summary of river otter and mink habitat characteristics for each 0.5 mile interval in the randomly chosen 9-mile strata (shoreline cover, canopy cover, and general assessment), 1994. Percent canopy cover was measured in 25 m increments from the shoreline inland.

		Percent Canopy Cover								
		0-25 m		26-50 m		51-75 m		76-100 m		
River Mile	% Shoreline Cove	Low	High	Low	High	Low	High	Low	High	General Assessment
Ilwaco Strata										
0.0	100	100	0	100	0	0	0	0	0	Ocean jetty - poor habitat
0.5	100	100	0	100	0	100	10	100	10	Ocean/State Park, heavy human traffic - poor habitat
1.0	0	100	0	100	0	100	5	100	5	Ocean/State Park, heavy human traffic - poor habitat
1.5	100	0	0	-	-	-	-	-	-	75m vertical cliff - no habitat
2.0	100	100	0	100	0	100	100	100	100	Tidewater marsh (76m cliff) - good habitat
2.5	100	100	0	100	0	100	0	100	0	Large riprap jetty/brushy field - good habitat
3.0	100	100	0	100	0	100	0	100	100	Salt marsh estuary/brushy hillside - good habitat
3.5	100	100	0	100	0	100	0	100	0	Salt marsh estuary/flooded at high tide - good habitat
4.0	100	100	0	100	0	100	0	100	0	Salt marsh estuary/flooded at high tide - good habitat
4.5	100	100	0	100	0	100	0	100	0	Salt marsh estuary/flooded at high tide - good habitat
5.0	100	100	0	100	0	100	0	100	0	Salt marsh estuary/flooded at high tide - good habitat
5.5	100	100	0	100	0	100	0	100	0	Salt marsh estuary/flooded at high tide - good habitat
6.0	100	100	0	100	0	100	0	100	0	Salt marsh estuary/near mouth of Chinook River - good habitat
6.5	100	100	0	100	0	100	0	100	0	Salt marsh estuary/flooded at high tide - good habitat
7.0	100	100	0	100	0	100	0	100	0	Salt marsh estuary/flooded at high tide - good habitat
7.5	100	100	0	100	0	100	0	100	0	Salt marsh estuary/riprap-residential - good habitat
8.0	100	100	0	100	0	100	0	100	0	Salt marsh estuary/riprap-residential, otter den in jetty - good habitat
8.5	0	0	0	100	5	-	-	-	-	Mud flats/riprap and tree cover/residential
9.0	0	0	0	0	0	100	50	50	50	Mud flats/riprap and tree cover/residential - good habitat
Welsh Island Strata										
27.0	100	100	100	100	100	100	100	100	100	Thick conifer cover, undercut banks - good habitat
27.5	100	100	100	100	100	100	100	100	100	Thick conifer cover, undercut banks, creeks, pilings/dolphins - good habitat
28.0	100	100	100	100	100	60	0	60	0	Undercut banks, grass/cottonwood, pasture - good habitat
28.5	100	100	0	100	0	100	100	60	0	Grass cover, mud banks/ tall trees/ pasture - good habitat
29.0	100	100	0	100	0	100	100	100	100	Mud banks with grass/ dense willow, muskrat runs - good habitat
29.5	100	100	100	100	100	100	100	100	100	Dense alder stand with overhangs/ dense alder - good habitat
30.0	100	100	0	60	0	60	0	60	0	Small riprap, blackberry / pasture, grass cover
30.5	100	100	50	100	0	100	0	100	0	Grass, cottonwoods, old dock/ meadow, pasture
31.0	100	80	80	100	100	100	100	100	100	Pilings, rocks/ alder/ forested hillside - good habitat
31.5	100	100	50	100	75	100	100	100	100	Undercut banks, grass/ grass, willow - good habitat
32.0	100	100	50	100	50	100	80	100	100	Undercut banks, grass/ willow, marsh, grass - good habitat
32.5	100	80	100	100	100	100	100	100	100	Marsh, alder, pilings/ thickly forested hillside - good habitat
33.0	100	80	20	100	100	100	100	100	100	Shallow water marshgrass, logs/ steeply forested hillside - good habitat
33.5	100	75	30	100	100	100	100	100	100	Deep water, riprap, grass/ railroad, thickly forested hillside - good habitat
34.0	100	100	15	100	50	100	100	100	100	Pilings, deep water, grass/ alder, willow, cottonwood - good habitat
34.5	100	80	50	100	100	100	100	100	100	Pilings, riprap/ alder, vines, residential housing - good habitat
35.0	100	80	50	100	100	100	100	100	100	Deep water, dolphins, riprap/ maple, vines, forest - good habitat
35.5	25	50	50	100	100	100	100	100	100	Cottonwood saplings, reeds/ thick cottonwood grove - good habitat
36.0	100	80	50	100	100	100	100	100	100	Piling, riprap, railroad/ maple, dense understory - good habitat

Appendix 9 (continued).

		Percent Canopy Cover								
		0-25 m		26-50 m		51-75 m		76-100 m		
River Mile	Shoreline Cover	Low	High	Low	High	Low	High	Low	High	General Assessment
Cathlamet Strata										
45.0	100	100	100	100	100	100	100	100	100	Rock, roots, brush, maple/ fir salal, blackberry - good habitat
45.5	100	35	0	100	100	100	100	100	100	Large riprap, roadside, culverts/ fir, madrone, brush
46.0	100	30	0	100	100	100	100	100	100	Large riprap, roadside, culverts/ fir, madrone, brush
46.5	100	30	0	100	100	100	100	100	100	Large riprap, roadside, culverts/ fir, madrone, brush
47.0	100	35	0	100	100	100	100	100	100	Large riprap, roadside, culverts/ fir, madrone, brush
47.5	0	0	0	0	0	50	50	50	50	Shallow water, sandy beach/ residential, human activity
48.0	0	0	0	0	0	100	100	100	100	Sandy beach/ steep hillside, fir, maple, cliffs
48.5	100	50	0	0	0	0	0	100	100	Riprap, cliffs/ resident/ dense forest
49.0	75	100	100	100	100	100	100	100	100	Sandy beach, rocks/ steep hillside, fir, maple, madrone, cliffs
49.5	100	100	100	100	100	100	100	100	100	Deep water, rocks/ alder, fir,maple, coves - good habitat
50.0	100	100	100	100	100	100	100	100	100	Deep water, rocks/ alder, fir,maple, coves - good habitat
50.5	100	100	100	100	100	100	100	100	100	Sandy beach, rocks/ steep hillside, fir, maple, madrone, cliffs
51.0	65	100	100	100	100	100	100	100	100	Sandy beach, pilings/ logs, alder, cottonwood, maple - good habitat
51.5	100	15	10	0	0	0	0	0	0	Riprap, small cottonwood/ parking lot, highway - poor habitat
52.0	100	35	0	100	100	100	100	100	100	Riprap, small cottonwood/ parking lot, highway/ steeply forested cliffs - poor habi
52.5	100	30	0	100	100	100	100	100	100	Large riprap, roadside, culverts/ fir, madrone, brush
53.0	100	50	0	100	100	100	100	100	100	Large riprap, roadside, culverts/ fir, madrone, brush/ sheer cliffs - poor habitat
53.5	100	20	0	100	100	100	100	100	100	Large riprap, roadside, culverts/ fir, madrone, brush/ sheer cliffs - poor habitat
54.0	100	5	0	50	0	25	25	25	25	Deep water, rock, roadway/ cliff/ clear cut - good habitat
Rainier Strata										
63.0	100	100	100	100	100	100	100	100	100	Pilings, undercut bank, cottonwood/ marsh, grass - good habitat
63.5	100	100	100	100	100	100	100	100	100	Pilings, undercut bank, cottonwood/ marsh, grass - good habitat
64.0	100	100	100	100	100	100	100	100	100	Pilings, undercut bank, cottonwood/ marsh, grass - good habitat
64.5	100	100	100	100	100	100	100	100	100	Pilings, undercut bank, cottonwood/ marsh, grass - good habitat
65.0	0	0	0	0	0	50	100	50	100	Sandy beach/cottonwood, trampled cover via ATV activity - poor habitat
65.5	0	0	0	0	5	0	5	0	5	Sandy beach/ small cottonwood trampled by ATV activity - poor habitat
66.0	5	25	10	25	10	100	50	0	0	Sandy beach/ riprap/ parking lot, human activity - poor habitat
66.5	5	75	0	0	0	0	0	0	0	Small riprap, scotch broom/ lumber yard - poor habitat
67.0	50	100	0	0	0	0	0	0	0	Riprap, scotch broom/ lumber yard - fair habitat on end
67.5	50	50	25	0	0	0	0	0	0	Sand bank, grass, blackberry/ Streets of the city Rainier
68.0	100	100	65	100	100	100	100	100	100	Log booms, pilings, grass, undercut bank, forest - good habitat
68.5	100	100	70	100	100	100	100	100	100	Large riprap, grass/ cottonwood, blackberry, fir - good habitat
69.0	100	100	10	100	100	100	100	100	100	Large riprap, grass/ dense cottonwood, maple, understory - good habitat
69.5	90	80	5	100	100	100	100	100	100	Riprap, logs, railroad/ logs, fir, maple forests - good habitat
70.0	50	50	10	100	100	100	100	100	100	Brush, cottonwood/ dense maple, a few houses - good habitat
70.5	100	100	5	100	100	100	100	100	100	Large riprap, railroad/ dense maple forest - good habitat
71.0	0	0	0	0	0	50	100	50	100	Sandy beach, trampled cover, parking lot/ cottonwood, human activity - poor hab
71.5	0	0	0	0	0	0	0	25	75	Sandy beach, trampled cover, parking lot/ cottonwood, human activity - poor hab
72.0	50	5	50	50	5	0	0	75	50	Rocks, logs/ lanscaped/ house/ maple forest

Appendix 9 (continued).

		Percent Canopy Cover								
		0-25 m		26-50 m		51-75 m		76-100 m		
River Mile	Shoreline Cover	Low	High	Low	High	Low	High	Low	High	General Assessment
St. Helens Strata										
81.0	40	100	40	100	100	100	100	100	100	Logs, grass, scotch broom /dense cottonwood grove - good habitat
81.5	5	50	10	50	0	50	0	0	0	Trees, grassy meadow/slough - good habitat
82.0	5	40	5	40	15	40	25	40	50	Sandy shore, logs grass/a few trees, recreational activity
82.5	85	100	100	100	100	100	100	100	100	Beach, dense brush/ cottonwood, scotch broom, willow - good habitat
83.0	5	50	0	0	0	0	0	0	0	Large riprap, logs, scotch broom/ lumber yard
83.5	100	100	100	100	100	0	0	0	0	Blackberry, maple, cottonwood/ lumber yard 1st 50m - good habitat
84.0	100	100	50	100	50	0	0	0	0	Pilings, riprap, grass, blackberry/ residential - good habitat
84.5	100	100	100	100	100	100	100	100	100	Pilings, undercut bank, grass, cottonwood, shrubs - good habitat
85.0	100	100	100	100	100	0	0	0	0	Logs, saplings, cottonwood, grass/ residential - good habitat for 1st 50m
85.5	100	100	100	0	0	0	0	0	0	Riprap, pilings, docks, grass - narrow bands of good habitat
86.0	90	95	0	0	0	0	0	0	0	Pilings, large riprap/ log storage - narrow bands of good habitat
86.5	2	0	0	0	0	0	0	0	0	Old log booms, rocks/ parking, mill, hunt area - narrow bands of good habitat
87.0 a	100	100	100	100	100	0	0	0	0	Undercut bank, dense cottonwood, willow,blackberry - good habitat
87.0 b	0	20	10	100	100	100	100	100	100	Sandy beach, grass,recreational area/ cottonwood, brush - good habitat for >30
87.5 a	100	100	0	0	0	0	0	0	0	Grass, blackberry/ chip mill - poor habitat
87.5 b	15	100	100	100	100	100	100	100	100	Logs, undercut bank, sapling/ dense brush, forest - good habitat
88.0 a	100	100	50	0	0	0	0	0	0	Pilings, undercut bank, grass, blackberry/ lumber yard - fair habitat
88.0 b	20	100	100	100	100	100	100	100	100	Logs, undercut bank, sapling/ dense brush, forest - good habitat
88.5	50	100	50	100	100	75	65	75	65	Sandy beach, cliff/ dense understory/ trees cattle pasture, human activity
89.0	0	15	0	90	100	90	100	90	100	Sandy beach/ recreational use of area, understory tramped - poor habitat
89.5	0	0	0	50	50	90	90	90	90	Sandy beach/recreational use of forest, trails, cattle - poor habitat
90.0	0	0	0	5	5	15	0	25	0	Sandy beach/recreational use, parking, tramped - poor habitat
Vancouver Strata										
99.0	0	10	25	100	100	100	100	100	100	Sandy beach/ cottonwood, blackberry, willow, human traffic
99.5	0	5	0	0	0	0	5	0	0	Pilings, sandy beach, small logs/ tramped grass, cows
100.0	0	5	0	0	0	-	-	0	0	Pilings, sandy beach, small logs/ tramped grass, cows, barn
100.5	0	0	0	5	10	5	50	5	50	Sandy beach/ willow/ browsed willows, cows
101.0	0	5	1	20	15	50	40	50	40	Sandy beach/saplings/trees, meadow, blackberry, human activity
101.5	0	15	5	30	15	100	100	100	100	Sandy beach/ grass, vines/ forest, blackberry, human activity
102.0	5	75	50	100	100	100	100	100	100	Sandy beach, logs/ dense brush/ forest, blackberry - good habitat
102.5	100	100	45	0	0	0	0	0	0	Undercut bank, dense low vegetation, logs, cliff/ agriculture field
103.0	5	5	0	0	0	0	0	0	0	Tight riprap/ industrial, parking lot - poor habitat
103.5	10	15	0	0	0	0	0	0	0	Bricks, logs, very little vegetation/ developed area - poor habitat
104.0	0	25	5	0	0	0	0	0	0	Sandy beach/ logs, small low vegetation, few cottonwood/ industrial - poor habit
104.5	100	100	50	0	0	0	0	0	0	Pilings, large riprap, blackberry/ concrete wall/ industrial - fair habitat
105.0	100	100	100	0	0	0	0	0	0	Dock, pier, riprap/ industrial
105.5	100	100	50	0	0	0	0	0	0	Large riprap, blackberry/ highway - good habitat 1st 25m
106.0	100	100	50	0	0	0	0	0	0	Large riprap, blackberry/ industrial - poor habitat
106.5	0	0	0	0	0	0	0	0	0	Vertical concrete wall/industrial - poor habitat
107.0	100	100	30	0	0	0	0	0	0	Large riprap, cottonwood/ road, human recreation - poor habitat
107.5	100	100	0	0	0	0	0	0	0	Piling, large riprap, low grass/ construction - good habitat <25m
108.0	100	100	0	0	0	0	0	0	0	Piling, large riprap, low grass/ construction - good habitat <25m

Appendix 9 (continued).

		Percent Canopy Cover								
		0-25 m		26-50 m		51-75 m		76-100 m		
River Mile	Shoreline Cover	Low	High	Low	High	Low	High	Low	High	General Assessment
Camas Slough Strata										
117.0	15	60	50	100	100	100	100	100	100	Logs, Blackberry/dense cottonwood, cows, good habitat
117.0 c	15	25	0	100	100	100	100	100	100	Sandy beach, sparse vegetation/cottonwood, dense understory, good habitat
117.5	50	50	0	30	0	30	0	30	0	Docks, rocks, blackberry/houses, fair habitat
118.0	100	100	0	100	100	100	100	100	100	Rocks, shrubs, grass/ cottonwood forest, logs - good habitat
118.5	100	100	75	100	100	100	100	100	100	Reeds/ grass/ cottonwood, willow/ beaver pond, logs - good habitat
119.0	100	100	100	100	100	100	100	100	100	Dense forest, blackberry, shrubs
119.5	100	100	100	100	100	100	100	100	100	Dense forest, blackberry, shrubs
120.0	100	100	100	0	0	0	0	0	0	Cliff, blackberry, grass, shrub/ mill yard, <25 m good habitat
120.5	100	100	100	0	0	0	0	0	0	Cliff, blackberry, grass, shrub/ mill yard, <25 m good habitat
121.0	100	100	0	100	0	0	0	0	0	Rock, grass, willow, blackberry/ cleared for development
121.5	100	100	0	100	100	100	100	0	0	Rock, grass, reeds/ deciduous forest/ residential
122.0	100	100	50	100	100	100	100	100	100	Rock, grass, logs/ cottonwood forest - good habitat
122.5	100	100	15	0	0	0	0	0	0	Rock, grass, willow/ willow/ residential
123.0	100	100	0	0	0	0	0	0	0	Large riprap, grass/ road, development - good habitat
123.5	100	100	100	100	100	100	100	100	100	Undercut bank, log, grass, willow/ beaver pond/ trees good habitat
124.0	10	40	20	100	100	100	100	50	0	Sandy beach, willow, undercut bank/ forest/meadow/recreational area - good ha
124.5	100	100	0	100	100	100	100	100	100	Reeds, grass, saplings, logs/ human activity, dogs
125.0	100	100	0	100	60	10	0	10	0	Riprap, reeds,grass,shrubs/ trees/ agricultural field
125.5	100	100	100	100	100	100	100	100	100	Riprap, reeds,grass,shrubs/ old beaver lodge/ agricultural field
126.0	100	100	50	100	100	0	0	0	0	Deep water, undercut bank, grass, logs/ forest/ road
Rooster Rock Strata										
126.0 d	100	100	75	100	75	100	75	100	75	Logs, grass, willow, cottonwood - good habitat
126.5	30	50	30	0	0	0	0	0	0	Millfoil, rocks, sparse vegetation & trees/ freeway
127.0	50	50	50	0	0	0	0	0	0	Rocks, sparse vegetation & grass/ freeway
127.5	50	100	20	0	0	0	0	0	0	Rocks, grass, shrubs, sparse cottonwood/ freeway
128.0	100	100	15	0.	0	0	0	0	0	Rocks, grass, shrubs, sparse cottonwood/ freeway
128.5	75	100	100	100	100	100	100	100	100	Rocks, veg./dense blackberry, grass, cottonwood, human activity - good habitat
129.0	100	100	0	0	50	0	50	0	50	Riprap, vegetation/ parking lot, lawn,recreational area
129.5	0	0	0	0	0	100	0	30	50	Sandy beach/ large riprap, grass/ parking lot, park
130.0	80	90	80	70	100	70	100	70	100	Reeds, grass/ willow, sparse understory, recreation
130.5	100	100	50	100	100	100	100	100	100	Reeds, rocks, grass/ willow, heavy human use
131.0	90	90	0	100	100	50	0	50	50	Reeds, rocks/ cottonwood, willow/ meadow/ sparse trees - poor habitat
131.5	50	75	0	100	100	0	0	100	100	Grass, vegetation/ cottonwood, logs, understory/ highway/ forest
132.0	100	100	0	100	0	100	75	100	100	Reeds/ grass, young cottonwoods, willow - good habitat
132.5	100	100	0	100	50	100	100	0	0	Grass/ willow, cottonwood/ fir, shrubs/ highway
133.0	75	50	0	100	75	100	100	100	100	Reeds, grass/ willow, poplar/ willow, cottonwood
133.5	100	100	0	100	100	100	100	100	100	Reeds/ cottonwood, willows, blackberry
134.0	50	80	0	100	0	100	0	100	0	Rock/ short willow, human activity
134.5	50	100	100	100	100	100	100	100	100	Mudflat/ willow, cottonwood, vegetation
135.0	100	85	50	100	100	100	100	100	100	Mudflat, willow, cottonwood/ willow, cottonwood, vegetation

a) Main land, not island
b) Sauvie Island, Columbia River side of the island
c) Sand Island
d) Rooster Rock

Appendix 10. A summary of tissue residue guidelines for the protection of piscivorous wildlife.

Substance	Tissue Residue Guideline (ww)	Rationale	Jurisdiction	Reference
Aldrin/Dieldrin	0.02 ppm	Carcinogenic (1 in 100 cancer risk level) fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
	0.12 ppm	Non-carcinogenic fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
Benzo (a) Pyrene	1 ppm	Maximum level in fish food organisms.	British Columbia	Pommen 1989
Chlordane	0.37 ppm	Carcinogenic (1 in 100 cancer risk level) fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
	0.5 ppm	Non-carcinogenic fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
DDT + DDE	0.27 ppm	Carcinogenic (1 in 100 cancer risk level) fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
	0.2 ppm	Non-carcinogenic fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
Dioxin-2,3,7,8-TCDD	2.3 ppt	Carcinogenic (1 in 100 cancer risk level) fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
	3.0 ppt	Non-carcinogenic fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
Endrin	0.025 ppm	Non-carcinogenic fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
Heptachlor and Heptachlor Epoxide	0.21 ppm	Carcinogenic (1 in 100 cancer risk level) fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
	0.2 ppm	Non-carcinogenic fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
Hexachlorobenzene	0.2 ppm	Carcinogenic (1 in 100 cancer risk level) fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
	0.33 ppm	Non-carcinogenic fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987

Appendix 10. (continued).

Substance	Tissue Residue Guideline (ww)	Rationale	Jurisdiction	Reference
Hexachlorobutadiene	4.5 ppm	Carcinogenic (1 in 100 cancer risk level) fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
	1.3 ppm	Non-carcinogenic fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
Lindane (gamma HCH)	0.51 ppm	Carcinogenic (1 in 100 cancer risk level) fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
	0.1 ppm	Non-carcinogenic fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
Hexachloroethane	14.1 ppm	Non-carcinogenic fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
Mirex	0.37 ppm	Carcinogenic (1 in 100 cancer risk level) fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
	0.33 ppm	Non-carcinogenic fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
Octachlorostyrene	0.02 ppm	Non-carcinogenic fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
PCBs	0.1 ppm	Maximum level in whole fish to protect wildlife.	British Columbia	Nagpal 1992
	0.11 ppm	Carcinogenic (1 in 100 cancer risk level) fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
	0.13 ppm	Non-carcinogenic fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
Pentachlorophenol	2 ppm	Non-carcinogenic fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
Tetrachlorophenol	0.67 ppm	Non-carcinogenic fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987
Trichlorobenzenes	1.3 ppm	Non-carcinogenic fish flesh criterion for piscivorous wildlife.	New York	Newell et al. 1987