ABSTRACT

Title of Dissertation:	SUBLETHAL NARCOTIC IMPACTS OF DIETARY POLYCYCLIC AROMATIC HYDROCARBONS ON THE BIOENERGETICS OF AND POLYCHLORINATED BIPHENYL (PCB) BIOACCUMULATION IN *FUNDULUS HETEROCLITUS*
	Amy A. Merten, Doctor of Philosophy, 2005
Dissertation Directed By:	Professor Robert P. Mason University of Maryland, Chesapeake Biological Laboratory

Accumulation of non-polar narcotic chemicals in organisms alters their metabolic rates and therefore, their energetic demands. It is hypothesized that decreases in standard metabolic rate from accumulation of narcotics reduces feeding. Thus, exposure to and accumulation of narcotics may cause a negative feedback, reducing net bioaccumulation. Three experiments were conducted to examine the consequences of narcotic exposure on the bioenergetics and bioaccumulation rates of *Fundulus heteroclitus* continuously challenged with sublethal levels of hydrophobic organic chemicals (HOCs).

In the final experiment (120 days), fish were exposed to two concentrations of a model narcotic, 3-aminobenzoic acid ester methanesulfonate (MS-222) (0 and 50 mg/L), and four concentrations of PAH-contaminated food treatments sampled over five time points. All food treatments contained background concentrations of

polychlorinated biphenyl (PCB) congeners (40 ng/g Σ-PCBs w/w) and were used as a tracer of bioaccumulation. No statistically significant differences in weight, length, or condition factors among treatments, except on day 120 where MS-222 exposed fish were longer than non-MS-222 exposed fish ($p = 0.015$). Standard metabolic rate responded in a non-linear manner. At low PAH doses (835 ng/g Σ-PAH), SMR decreased significantly ($p = 0.093$, $\alpha = 0.10$). Fish fed 100% PAH-contaminated food (regardless of MS-222), had significantly elevated SMRs ($p = 0.02$). MS-222 did not affect PCB accumulation. PAH-contaminated food enhanced PCB accumulation measured in fish. There was an overall interaction between the food treatment and aqueous MS-222 exposures ($p = 0.004$). The results indicate that total chemical burden from the MS-222 plus PAH-contaminated food exposures masked the sublethal narcotic effect of MS-222, and produced a net increase in the standard metabolic rates of *Fundulus heteroclitus*, perhaps because of increased energetic costs associated with detoxification and bioactiviation processes.

The results of the experiments were subtle and non-linear with respect to dose of PAH-contaminated food. To explore whether small changes in SMR (± 5 – 10 %) may be important costs, a bioenergetics model was developed. The model tracks biomass (daily age classes) based on a balance of weight-specific consumption and bioenergetic costs (respiration, growth, and mortality). The model projects population biomass as the main output for comparing different "impacts."

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By

Amy Ann Merten

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Advisory Committee:
Professor Robert P. Mason, Chair
Associate Professor Thomas J. Miller
Associate Professor Peter A. Van Veld
Associate Professor Judd Nelson
Associate Professor Christopher Rowe
Assistant Professor Carys Mitchelmore

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Table of Contents

List of Tables

List of Figures

Chapter 1

Executive Summary

1.1 Introduction and Rationale

Enduring chronic contamination over the lifecycle of an organism imposes a physiological cost on its energetics, a cost that can be translated to the population (Calow, 1991). The research in this dissertation examines the above premise and the elusive question facing ecotoxicology and risk assessment today: can subtle, sublethal effects measured on individuals exposed continuously to chronic chemical stress be quantified in the laboratory and translated to ecologically relevant parameters? For example, studies in this dissertation use standard metabolic rate as a quantitative measurement of sublethal chemical stress that can be linked to population-level impacts. A population model is used to further investigate the laboratory results. This study adds to understanding long-term impacts on fish from low-level, chronic exposure to polycyclic aromatic hydrocarbons (PAHs) (Carls et al., 1999, Heintz et al., 1999, Johnson et al., 2002, Myers et al., 2003 and Incardona et al., 2004). Mixtures of chemicals, multiple routes of exposure, and several modes of toxicity complicate linking long-term cumulative PAH exposure to ecologically relevant, sublethal effects. Despite these complications, sediment quality guidelines deemed to be protective of fish populations are based on acute exposure models (Di Toro and McGrath, 2000) or weight of evidence approaches (Myers et al., 2003, and Johnson et al., 2002) where a suite of endpoints from multiple studies are examined to implicate PAHs. Therefore, PAHs continue to present a management challenge and are important chemicals to study further.

PAHs are a dominant class of chemicals contributing to chronic contamination of aquatic systems worldwide. PAHs are non-polar hydrophobic organic contaminants (HOCs) that persist in the environment through association with sedimentary particles and accumulation in invertebrate organisms that have reduced abilities to metabolize PAHs (Meador et al., 1995) providing a continuous source of PAHs to fish. PAHs enter estuaries from petrogenic and pyrogenic sources, and often co-exist with other contaminants of concern, such as polychlorinated biphenyls (PCBs) and trace metals (McGroddy et al., 1996, Ashley and Baker, 1999, Johnson et al., 2002). Although PAH inputs from large petroleum spills have decreased in the U.S. over the last decade, smaller spills and non-point sources continue to increase PAH loadings from land-use runoff and atmospheric deposition (NRC, 2003). Thus, PAHs continue to present risks to aquatic organisms.

Fish and other vertebrates possess monooxygenase enzyme systems capable of metabolizing PAHs (Varanasi et al., 1989). These enzyme systems provide a mechanism for eliminating PAHs and other contaminants by biotransforming compounds into polar metabolites that are readily excreted. However, the same enzyme systems can also activate the PAH producing harmful metabolites that can interfere with cellular function, bind to DNA, and ultimately lead to carcinogenic endpoints (Di Guilio et al., 1995, and van der Oost et al., 2003). A well-characterized example of activation is the biotransformation of benzo[a]pyrene into cytotoxic and mutagenic benzo[a]pyrene diol epoxides (Baird and Ralston, 1997). These activated products form adducts with DNA. If the DNA repair enzymes are ineffective in repairing adducts before replication occurs, point mutations can result. If these mutations occur in critical coding regions of proteins and enzymes involved in cell growth and regulation, normal controls of cell growth, division, and cell death may be altered (Di Guilio et al., 1995, and van der Oost et al., 2003). Metabolism of PAHs by fish impedes a direct assessment of PAH exposure through measurement of the parent compounds in fish tissue. The metabolic products of the enzymatic reaction can be quantified by measuring metabolites in the bile (e.g., fluorescent aromatic compounds in the bile correlates with the total level of PAH metabolites) (van der Oost et al., 2003). However, a physiologically-based approach can be used to assess cumulative impacts of contaminant stress (Widdows and Donkin, 1991, Adams et al., 1992, Congdon et al., 2001).

Standard metabolic rate (maintenance respiration) plus specific dynamic action set the minimum energetic requirements for survival (Calow and Sibly, 1990, and Congdon et al., 2001). Growth, reproduction, and activity compete for the remaining energy consumed, and/or provide energy compartments that can compensate for increased energetic stress from contamination. Standard metabolic rate is sensitive to contaminant stress, although whether it increases or decreases is contaminant-specific (Calow and Sibly, 1990) (See Chapter 2, Section 2.4). Using standard metabolic rate to assess chronic exposure to contaminants has the potential to connect costs incurred due to biotransformation and cellular repair activities to an individual level response that has direct relevance to population parameters, such as growth, reproductive and mortality rates (Calow and Sibly, 1990, Calow and Forbes, 1998, and Congdon et al., 2001).

This work uses wild-caught *Fundulus heteroclitus,* a model species for studying contaminant effects using environmentally relevant exposures (Matta et al., 2001). Multiple endpoints affected by contaminants have been studied in this species, including enzyme induction, reproduction, developmental, and survival across age classes (Munns et al., 1997). *Fundulus* provides sufficient biomass for performing multiple measurements on individual fish including standard metabolic rate assessments, contaminant analysis, and biomarker assays. It has a limited home range, low rates of larval dispersal, and high fecundity (Abraham, 1985). It feeds on benthic invertebrates, and is thus closely associated with contaminated sediment and benthos. *Fundulus* has some of the highest rates of production for estuarine species, thus they are a vital component of the food web (Valiela et al., 1977). *Fundulus* also acts as a vector for transporting contaminants from the benthic environment to higher trophic levels.

PAHs exert toxicity through multiple mechanisms including non-specific, reversible non-polar narcosis, and through enzyme-mediated pathways that lead ultimately to mutagenesis/carcinogenesis. The former is generally linked to mortality as an endpoint (van Wezel and Opperhuizen, 1995), whereas the latter results from biotransformation of parent PAHs into metabolites that initiate a cascade of effects such as developmental and reproductive impacts, formation of DNA-adducts and cancers (Johnson et al., 2002, Meyer et al., 2002, Myers et al., 2003, and van der Oost et al., 2003). The non-polar narcosis mechanism is discussed at length in Chapter 2. Briefly, as a fish accumulates PAH, the PAH interacts with the target site (lipid) in the biological membrane. Narcosis results from the accumulation of chemical in the membrane beyond a threshold concentration that destabilizes the membrane, resulting in loss of structure and function, ultimately leading to death (Sikkema et al., 1992, Rand, 1995, van Wezel and Opperhuizen, 1995, and NRC, 2005). However, most research on non-polar narcosis has been based on acute, high concentration aqueous exposures where accumulation occurs quickly, overwhelming the metabolic and detoxification capabilities of the test organism.

The traditional aqueous exposure approach (acute toxicity assays) portrays a situation where non-polar narcosis is the dominant mechanism, and mortality is the measured effect (“all or nothing”). These conditions assume steady state, and that a “critical body residue” is reached. At lower concentrations, the chemical still interacts with the membrane, but other mechanisms also affect the organism (Escher and Hermens et al., 2002). At lower exposure concentrations, it takes longer to reach an internal effects threshold to cause mortality. Also, a larger fraction of the exposure is biotransformed, therefore, metabolites contribute more to toxicity than under acute conditions (Escher and Hermens et al., 2002). In chronic exposures, metabolism controls net accumulation of the parent PAH, potentially preventing or delaying a mortality threshold (threshold accumulation in the membrane) from being obtained. Although sublethal narcosis (also termed “baseline toxicity”) is present, other mechanisms are operating in addition. The multiple mechanisms (the buildup of chemical in membranes plus enzyme induction and metabolite formation) are jointly controlling the expression of subsequent sublethal effects (Hallam et al., 1993, Jaworska et al., 1996, and Escher and Hermens, 2002). In all of the scenarios, the bioenergetic functions of the fish are taxed, thus a physiologically-based measurement such as standard metabolic rate could integrate the total effects of the different mechanisms.

This dissertation explores the consequences of sublethal non-polar narcosis on the bioenergetic and bioaccumulative processes of the estuarine fish *Fundulus heteroclitus* chronically exposed to several narcotic-inducing chemicals: a model narcotic MS-222 (3-aminobenzoic acid ester methanesulfonate), PCB-spiked trout chow, and a mixture of PAHs in an environmentally-contaminated diet. PAHs were chosen as the contaminant stressor in the last two experiments (Chapters 4 and 5) because:

1) PAHs are major contaminants of concern in estuaries,
2) PAHs have been previously categorized as non-polar narcotics that interact with the target site for narcosis (lipid membrane) (McCarty et al., 1986, McCarty and MacKay, 1993, Sikkema et al., 1994, Van Wezel and Opperhuizen, 1995, Di Toro et al., 2000, Di Toro and McGrath, 2000, and McGrath et al., 2004),
3) Narcosis is linked to a direct effect (mortality), and
4) The narcosis total lipid model is the regulatory tool employed in the U.S. for defining sediment quality guidelines specifically for Σ-PAHs (Di Toro and McGrath, 2000).

1.2 Objectives

The objectives of this research are to:

1) Define sublethal non-polar narcosis using standard metabolic rates of fish as the measured response;

2) Evaluate whether fish standard metabolic rates can be chemically lowered using a model narcotic, MS-222, and environmentally relevant contaminants, PCBs and PAHs;

3) Examine the consequences of sublethal non-polar narcosis on standard metabolic rates, growth, and survival of individual fish exposed to chronic doses of narcotics;

4) Assess differences in bioaccumulation using trace levels of poorly metabolized co-contaminants (PCBs) in concert with realistic levels of PAH-contaminated food resulting from altered standard metabolic rates as a surrogate measure of PAH exposure; and,

5) Using a modeling framework, compare population consequences of sublethal narcosis on standard metabolic rates with other energetic costs to evaluate whether it is an important stressor.

1.3 Overview of Chapters

1.3.1 Chapter 2:

Chapter 2 is a literature review of non-polar narcosis as it relates to PAH effects on fish. This chapter also discusses other mechanisms of PAH toxicity, compares narcosis models to alternative assessment models, and reviews the use of bioenergetics as a method for integrating multiple modes of toxicity. The chapter also summarizes and examines past work using standard metabolic rates to assess sublethal effects in fish species exposed to long-term chemical contamination.

There are limitations to extrapolating acute toxicity endpoints to chronic, sublethal ones. Both the critical body residue concept and the narcosis model are based on short, high dose, aqueous-only exposures that assume that steady state conditions are satisfied. The models use surrogates for membrane lipid target sites (octanol and whole-body lipid content) to approximate species differences and variations in chemical potencies. However, they do not account for chemical biotransformation, bioavailability or multiple toxicities. Despite these limitations, there is the potential that the synthesis of the existing short-term studies could be applied to longer-term experiments to develop a predictive model. Measures of individual standard metabolic rates hold promise as an endpoint that integrates cumulative contaminant stress at the individual level, yet also provide a physiological connection to both sub-organismal and population level parameters. However, a review of previous studies suggests that standard metabolic rates measured on several fish species are not as sensitive to chronic conditions as other organisms such as reptiles, amphibians and invertebrates (Rowe et al., 1998, Rowe, 1998 and 2003, Hopkins et al., 2000, and 2003). Yet, due to difficulties in comparing studies using different species, the use of standard metabolic rate of fish as a toxicity endpoint requires further investigation.

To examine the consequences of sublethal non-polar narcosis on the bioenergetics and PCB bioaccumulation processes, three laboratory experiments were conducted (Chapters 3 – 5).

1.3.2 Chapter 3:

Chapter 3 describes the first of three exposure experiments. This experiment set the foundation for the subsequent experiments in terms of establishing the experimental design, prototyping the flow-through MS-222 dosing system, and optimizing the sampling protocol for each measurement endpoint used. Experiment 1 (Spring/Summer, 2002) was a 93 day study where fish were exposed to a gradient of MS-222 (0, 0.1, 1, and 10 mg/L) and two levels of PCB-spiked trout chow (control trout chow with 30 ng/g of Σ-PCB, and trout chow spiked with 235 ng/g of Σ-PCB).

The main objectives of this first experiment were to:

1) Determine if SMRs were sensitive to sublethal concentrations of MS-222 (the model narcotic);
2) Ensure that background concentrations of Σ-PCB in the commercial trout chow did not produce confounding effects on SMR; and,
3) Calibrate and refine techniques. The study evaluated bioenergetic parameters (growth, lipid content, and standard metabolic rate) and bioaccumulation endpoints (total and congener-specific PCB tissue concentrations) on individual fish.

The major outcomes of this experiment were that:

1) SMRs were responsive to the highest concentration of MS-222 (10 mg/L) on day 56 ($p = 0.033$); however, a dose-response curve was not produced due to lack of response at the lower levels (0.1 and 1.0 MS-222).
2) MS-222 stimulated growth at the lowest level of MS-222 exposure (0.1 mg/L).
3) It was inconclusive whether PCB accumulation was influenced by MS-222 due to reduced bioavailability in the PCB-spiked trout chow, composite sampling of fish for chemical analysis, and no SMR measurements beyond day 56 because the respirometer was unavailable.

4) The background concentrations of PCBs in the trout chow did not appear to interfere with fish bioenergetics. However, the lower than expected bioaccumulation in fish fed the PCB-spiked diet led to using a different dietary exposure in the subsequent experiments.

1.3.4 Chapter 4:

Chapter 4 presents the results of the second experiment (30 day – Jun 4 – Jul 8, 2003). This was a pilot study and sought to address the following issues highlighted in the first experiment:

1) Repeat and validate the SMR response using a stronger MS-222 gradient (0, 10, 30, and 70 mg/L).

2) Test whether fish would eat and grow adequately on a diet composed of a mixture of clams and fish gel (control food = 180 ng/g Σ-PAH).

3) Compare fish growth, SMR and PCB accumulation results from Experiment 1 with results from feeding fish a different diet and contaminant source (clams environmentally contaminated with a mixture of bioavailable PAHs, (1630 ng/g Σ-PAH).

The significant results of the 30 day study were:

1) None of the treatments produced a significant response in SMR even though the fish fed the PAH-contaminated food and the fish exposed to the highest dose of MS-222 (70 mg/L) had significantly higher mortality than the other treatments.

2) The more relevant food was readily consumed by the fish, thus it was used in the final study.

3) There is a narrow range (10 – 70 mg/L) in which MS-222 produces sublethal responses and where it inhibits normal behavior. Thus, based on this experiment, the final experiment used 50 mg/L MS-222 as the exposure concentration.

1.3.5 Chapter 5:

Chapter 5 describes a long-term experiment (120 days, conducted August – December 2003) designed to test the sublethal narcosis hypotheses by integrating standard metabolic rates, bioaccumulation, and biomarker endpoints measured on *Fundulus heteroclitus* exposed to environmentally relevant concentrations of PAHs through dietary exposures. This experiment exposed *Fundulus heteroclitus* to two types of narcotic chemicals: MS-222 and PAHs. MS-222 was administered as an aqueous exposure as a positive control for sublethal narcosis. The dietary exposure was a gradient of PAH-contaminated food (bioavailable fraction of PAHs accumulated in clams caged in the Elizabeth River, VA, for approximately 30 days). The experiment was designed to test the following hypotheses:

1) Exposure to sublethal concentrations of narcotic chemicals depresses standard metabolic rates in fish relative to control fish.
2) Reduced standard metabolic rates in turn reduce consumption rates, resulting in reduced growth relative to control fish.
3) Reduced consumption reduces ingestion of contaminated prey, and therefore reduces accumulation of co-existing, trace concentrations of PCBs in the food exposures relative to control fish.

4) Cumulatively, the reduction in bioaccumulation increases time to reaching internal effects levels, but allows other mechanisms of PAH toxicity to develop relative to control fish.

The last experiment presented (Chapter 5) produced the following findings:

1) Standard metabolic rates were sensitive to a gradient of PAH-contaminated food.

2) Standard metabolic rates responded in a non-linear fashion indicating that multiple mechanisms of toxicity were operating across the gradient: sublethal narcosis that reduced SMRs at low level exposures of PAHs and other mechanisms that resulted in increased SMR at higher PAH exposures (> 900 ng/g-w/w Σ-PAHs in food exposures).

3) Hepatic ethoxyresorufin-O-deethlyase (EROD) activity measured on day 35 was elevated in fish exposed to the highest concentration of PAH-contaminated food.

4) PCB accumulation increased along the PAH-contaminated food gradient, consistent with the increased SMR and EROD activity.

5) Integration of multiple endpoints resulted in a more comprehensive understanding of sublethal exposures to PAHs. SMR provides a direct input for examining population level impacts through modeling.

1.3.6 Chapter 6:

Chapter 6 describes an age-structured, weight-specific bioenergetics model developed to explore further the results of the laboratory experiment which used standard metabolic rate as the primary link to examine effects of PAH exposure on *F. heteroclitus* populations. The goals of the modeling were:

1) To examine how sublethal changes in individual energetics (consumption and respiration) from multiple modes of toxicity affect *F. heteroclitus* population biomass.

2) To examine how changes in mortality rate affect population biomass.

3) To compare the population outcomes of altering age-specific consumption, respiration, and mortality rates.

The modeling exercise revealed that total population biomass after one year simulations that equivalent stress from consumption (reduced by 10%) and respiration (increased by 10%) resulted in similar effects on total population biomass and abundance. When mortality rates were increased by 10%, total population biomass was less sensitive than to the equivalent changes in consumption and respiration. The effect of simulated stress on mortality affected the relative distribution of age classes, which dampened the overall effect in total biomass. The modeling results illustrated that chemically-altered energetics are potentially as important as altered mortality probabilities. This has significant ramifications for populations exposed to sublethal levels of contaminants over long periods of time, and needs further investigation.

1.4 Conclusions and Implications

The results of the review presented in Chapter 2 revealed that acute exposure models cannot be realistically applied to sublethal, long term conditions. However, the meta-analysis associated with the narcosis total lipid model was valuable in that it synthesized data to statistically compare disparate studies. The approach could be emulated for longer term studies that are currently difficult to compare. The analysis suggested that a bioenergetics approach provides a framework on which comparisons of chemical stress may be made.

The most significant result of this research was that it demonstrated that standard metabolic rates measured on individual fish were sensitive to different mechanisms of toxicity: sublethal narcosis and metabolic induction of enzyme systems. At low PAH exposures (835 ng/g-w/w in the food exposures), standard metabolic rate was reduced, indicating that sublethal narcosis could be the mechanism whereas at higher PAH levels standard metabolic rates increased pointing to other mechanisms. The changes in metabolic rates were accompanied by enhanced bioaccumulation of trace levels of Σ-PCBs. In the environment, food availability will limit consumption, and activity levels will be higher, therefore a 5-10% change could have consequences on populations. In the simple model (Chapter 6), this small increase in respiration produced a 20% decrease in population biomass after a one year of constant exposure.

The direct implications of the laboratory and modeling results follow.

1) Increased maintenance costs: A 10% increase in maintenance costs of an individual fish leaves less energy available for growth and reproduction, evading predation, foraging, and combating other stressors in the environment such as fluctuations in salinity gradients, water temperatures, and limited food resources. Maintenance respiration and specific dynamic action account for as much as 70% of the total energy budget available (Valiela et al., 1977) for wild populations. A modest 10% increase in maintenance costs, potentially removes a third of the residual energy available for growth and survival; a significant impact even for a stress-

tolerant species. In the model, respiration accounts for about 40% of the total budget, thus the model is potentially underestimating the impact. *Fundulus* populations are some of the highest producers in the estuarine food web [up to160 kg/ha-year (Valiela et al., 1977)], potentially limiting food resources for top predators. Therefore, long term exposure to sublethal concentrations of PAHs changes the total energy available for moving carbon out of the benthos into the upper trophic levels.

2) Enhanced accumulation: Enhanced PCB accumulation from increased respiration rates provides a vector for shunting contaminants residing in sediments and benthic invertebrates to higher trophic levels. This phenomenon has also been reported by Weis (2002), however, she cites lack of enzyme induction as the mechanism. This is not the case in this study where hepatic EROD induction on day 35 occurred in response to the highest exposure of PAHs. One could speculate that under higher exposures the increased standard metabolic rates and enhanced accumulation would shorten times at which toxic effects are expressed.

3) Integrated assessment approach: The integrated methods of measuring biomarkers, bioenergetic parameters, and bioaccumulation endpoints on individual fish along with characterization of the chemical exposure, more fully elucidates the multiple mechanisms associated with PAH toxicity. Although standard metabolic rates may not be as universally sensitive because of masking effects of co-contaminants exerting different toxicities, it provides the physiological basis for measuring costs associated with chemical exposures, and affords a connection between biomarker responses and population level consequences. However, comparing the standard metabolic rate responses measured in this work with other

studies remains a challenge due to inconsistent characterization of chemical mixtures, exposure regimes, and test species (type and life stages).

4) The ultimate goal of the research was to provide a basis for using standard metabolic rate as a metric for linking effects measured in long-term exposures in the laboratory to population level effects. However, the experiments reported herein were not designed to measure some of the population parameters needed to make the full translation in the absence of modeling. In order to translate the results reported here, age-specific mortality and reproductive rates associated with altered metabolic rates are needed. Thus, future studies would need to increase the level of contaminant stress to delineate those endpoints. In doing so, changes in consumption rates resulting from increased chemical stress would need to be quantitatively measured. The work reported here sets a foundation for continuing to develop ecological assessments based on the bioenergetics, specifically standard metabolic rate measurements.

Despite the advantages of using SMR, there are several limitations to using it as a measurement for assessing sublethal contaminant stress from multiple contaminants. Although there were interesting results as discussed above, there was also a large part of this work where SMR was not as sensitive as desired. Future studies should consider using a more sensitive species or life stage. Studying effects from realistic exposures is important, however, SMR is influenced by the competing modes of toxicity from multiple contaminants that co-exist in the environment.

Chapter 2

Sublethal narcosis: an important mechanism of toxicity for fish populations exposed to polycyclic aromatic hydrocarbons

2.1 Introduction

Polycyclic aromatic hydrocarbons (PAHs) exert toxicity through multiple mechanisms including non-specific, reversible non-polar narcosis, and through enzyme-mediated pathways that lead to mutagenesis/carcinogenesis. The former is generally linked to mortality as an endpoint (van Wezel and Opperhuizen, 1995), whereas the latter results from enzymatic biotransformation of parent PAHs into metabolites that initiate a cascade of effects such as developmental and reproductive impacts, formation of DNA-adducts and cancers (Johnson et al., 2002, Meyer et al., 2002, Myers et al., 2003, and van der Oost et al., 2003). Narcosis and enzyme-mediated effects associated with PAHs are often assessed separately, hindering assessment of cumulative costs incurred to fish in chronically PAH-contaminated environments. At sublethal exposures, narcosis and enzyme-mediated mechanisms (e.g., induction of monooxygenase systems) interact and contribute to metabolic costs. The time scale and dose control whether one mechanism dominates over another, with longer time scales presenting conditions where the costs cannot easily be allocated to multiple mechanisms. Standard metabolic rate may thus be a useful endpoint for measuring cumulative effects from PAH exposure.

The term "toxicity" represents a broad spectrum of "effects" or "endpoints" across all levels of biological organization. Toxicity is defined as "the inherent potential or capacity of an agent or material to cause adverse effects in a living organism" (Rand et al., 1995). Although reversible if a narcotized organism is returned to a clean medium, toxicity associated with narcosis is generally linked to mortality as the measurement endpoint. Toxicity associated with the enzyme-mediated mechanisms can range from induction of the associated enzymes (a response) to a cascade of indirect effects, including cellular damage, neoplasia, developmental, reproductive, and immunotoxicological impacts. Multiple mechanisms impose a cumulative cost to the fish as it combats the multiple avenues of toxicity at the subcellular, cellular, and physiological levels. Thus, bioenergetics are influenced by multiple mechanisms over a life time, and may represent a framework for evaluating stress from mixtures of chemicals exerting multiple mechanisms.

Figure 2.1 conceptually describes the multiple mechanisms of toxicity and illustrates where some of the gaps in knowledge reside. The y-axis represents the dose of Σ-PAH or narcotic in the exposure medium. The x-axis represents the length of exposure. The left side of the graph represents the exposure and time regime where the narcosis is the dominant mode of toxicity for which mortality of 50% of the test organisms exposed for a short duration (less than 96 hours) is the typical effect. For longer exposures at lower concentrations, time becomes a major factor (sublethal exposures result in multiple effects) and other modes of action occur in addition to the initial narcosis. Mode of toxic action is defined as "a set of common physiological and behavioral signs that characterize an adverse biological response" (Rand et al., 1995). Figure 2.1 also highlights some of the complications encountered in comparing studies, including differences in exposure regimes and the characterization of the true exposures (nominal vs. measured concentrations, and measurement of only some of the chemicals contributing to toxicity). These complications will be discussed throughout the chapter.

The focus of this chapter is on non-polar narcosis and the historical development of the narcosis model for PAHs. The narcosis mode of action is examined for several reasons: (1) it represents the initial mechanism of toxicity as a PAH is accumulated in and transported across the biological membrane, (2) the mechanism for narcosis is linked to a direct effect (mortality), and (3) the narcosis model is the current regulatory tool used in the U.S. to evaluate sediment quality guidelines for Σ-PAHs concentrations (Di Toro et al., 2000, and Di Toro and McGrath, 2000). This chapter compares and contrasts the narcosis model with other models and methods for predicting PAH toxicity in fish. Because PAHs exert different levels of toxicity through multiple mechanisms, a bioenergetic-based approach for evaluating sublethal consequences of long-term exposure to PAHs is also highlighted.

2.2 Narcosis: a dominant toxicity mechanism for non-polar chemicals

2.2.1 Introduction to Non-polar Narcosis

Sixty to seventy percent of the non-polar chemicals measured in contaminated environments are classified as narcotic (van Wezel and Opperhuizen, 1995, Russom et al., 1997, Di Toro et al., 2000, Escher and Hermens, 2002). Assessing the effects of this broad class of chemicals on fish populations presents several challenges. First, the data used to define narcosis and derive predictive models for this mode of action have focused on acute, aqueous exposures (Veith et al., 1981, McCarty et al., 1991, Russom et al., 1997, Di Toro et al., 2000, and Escher and Hermens, 2002). More importantly, fish readily metabolize PAHs, inducing other enzyme-mediated modes of action. Although the narcosis total lipid model (Di Toro et al., 2000) states it was developed to predict chronic effects of PAHs, and to develop sediment quality guidelines to prevent those effects (Di Toro and McGrath, 2000, and Di Toro et al., 2000), it does not describe the area on the right side of the graph defined in Figure 2.1, where long-term, low-concentration exposures dominate.

Acute or chronic mortality from exposure to non-polar, hydrophobic organic compounds (HOCs) such as PAHs induces a mode of toxic action classified as “non-polar narcosis.” Mechanistically, narcosis occurs due to accumulation of chemical in the lipid bilayer of biological membranes beyond a threshold where the membrane integrity and function are disrupted. Symptoms of a narcotic mode of action in fish include loss of reactivity to stimuli, loss of muscle tone, erratic swimming, depression of metabolic and cardiac rates, and asphyxia and death (McKim et al., 1987, and Bowser, 2001). Recently, others have described narcosis as a depression of the central nervous system (Barron, 2002, Barron et al., 2004a, and Incardona et al., 2004) which is consistent with the broader syndrome, but the mechanism itself is chemical deposition within lipid of cells, including nerve cells (van Wezel and Opperhuizen, 1995 and Escher and Hermens, 2002).

MS-222 as a model narcotic (toxicant): MS-222 (3-aminobenzoic acid ethyl ester methanesulfonate) is a common fish anesthetic and has been used as a model toxicant (McKim et al., 1987, Sijm et al., 1993, and Kane et al., 2004). MS-222 is used routinely to alter cardiovascular and metabolic rates in fish and was used to establish the fish acute toxicity syndrome (FATS) for Type I (non-polar) narcotic chemicals (McKim et al., 1987). MS-222 has a lipophilic component (the tricaine is an isomer of benzocaine) and polar component (methane sulfonate), thus it is structurally different than a parent PAH. However, the polar end allows the compound to dissolve readily in water and to deliver the lipophilic end to the gill membrane, inducing narcosis. The tricaine is primarily eliminated as the parent chemical (through diffusion) but can also be metabolized by hydrolysis (Alpharma, 2001, and Kolanczyk et al., 2003). The chemical also acts as a sodium-channel blocker (Incardona et al., 2004), and prevents generation and conduction of nerve impulses (Alpharma, Animal Health Ltd., 2001, and Kane et al., 2004). Whether MS-222 acts upon the P-450 enzyme systems seems to be species-dependent (Kolanczyk et al., 2003). In rainbow trout, MS-222 does not affect induction over short time periods when used as an anesthetic (Kolanczyk, et al., 2003). Kane et al. (2004) exposed *Fundulus heteroclitus* to sublethal concentrations of MS-222 (60 mg/L) for 48 hours and found that MS-222 acted as a stimulant to behavior. Thus, MS-222 has multiple modes of toxicity. In the experiments described in Chapters 3 – 5, MS-222 was used a reference narcotic because of its use in defining the narcotic syndrome for fish acute toxicity and that it specifically lowered standard metabolic rate in rainbow trout (McKim et al., 1987), but the conflicting results in the literature and reported in later chapters corroborates its multiple mechanisms of effects.

Likewise, there are multiple modes of action that organic compounds can elicit depending on structure, hydrophobicity, break down products and includes three types of narcosis (Type I = non-polar, Type II = polar, and Type III = ester), achetocholinesterase inhibitors, oxidative phosphorylation inhibitors, respiratory inhibitors, central nervous system (CNS) seizure agents, and reactivity mechanisms (McCarty and Mackay, 1993, Rand, 1995, Russom et al., 1997, Escher and Hermens, 2002, and Barron et al., 2002). However, the focus of this dissertation is on non-polar, hydrophobic compounds (PAHs and PCBs) that have been classified as type I (non-polar narcotics) in acute toxicity models (McCarty et al., 1986, van Wezel et al., 1995, van Wezel and Opperhuizen, 1995, Di Toro et al., 2000, and McGrath et al., 2004). Thus, the main interest here is to induce sublethal narcosis (or sublethal chemical influence) using MS-222 and PAHs, and then examine the ramifications of sublethal exposure on standard metabolic rates and bioaccumulation processes. Since the studies described later in Chapters 3 – 5 are designed to evaluate sublethal exposures, other sublethal fates of MS-222 and PAHs will also occur as the organism processes the chemicals. But, the underlying assumption remains throughout this dissertation that sublethal narcosis (baseline toxicity) will operate (Escher and Hermens, 2002) as fish are continually challenged with PAH-contaminated food or MS-222 contaminated water.

Chemicals with octanol-water partitioning coefficients (log K_{OW}) greater than 1.5, low aqueous solubilities, and non-polar structures, such as PCBs and PAHs, are narcosis-inducing agents (McCarty et al., 1993, van Wezel and Opperhuizen, 1995, Di Toro et al., 2000, and McGrath et al., 2004). There are two main theories for the mechanism of narcosis. The critical volume hypothesis states that changes in the lipid component of cell membranes (caused by an increase in membrane volume from the toxic chemical dissolving in the lipid phase) results in membrane disruption and subsequent narcosis (Sikkema et al., 1992, van Wezel et al., 1996, van Wezel and Opperhuizen, 1995, and NRC 2005). This mechanism has also been linked to increased fluidity, which changes chemical equilibria conditions between different membrane lipids (van Wezel et al., 1996). The increase in fluidity theory has been studied for volatile compounds (chlorobenzenes) in model membrane systems where accumulation of the chemical changes the main phase transition temperature and affects the fluidity of the phospholipids. Prior to lethality, one could speculate that sublethal interactions between the chemical-membrane components are impacting the organism (baseline toxicity) (Escher and Hermens, 2002) or "sublethal narcosis."

Alternatively, the protein-binding hypothesis states that narcosis results from HOCs attaching to specific hydrophobic regions of protein molecules within the membrane (Abernethy et al., 1988), disrupting the electrical potential of the membrane. There is a less accepted hypothesis where the narcotic chemical inhibits functioning of membrane proteins by binding to the protein (van Wezel et al., 1996). McCarty et al. (1986) observed that the concentrations of chemicals in whole organisms resulting from short-term, aqueous exposures to high concentrations of narcotic chemicals were relatively constant across taxa [ranging from 2-5 mmol/kg for acute exposures (<96 hours) to 0.2-0.8 mmol/kg for chronic exposures (< 28 days)]. Thus, even over longer term exposures, there is an internal threshold within an organism ("critical body residue") beyond which it can no longer combat the accumulation of chemical through detoxification mechanisms such as metabolism.

2.2.2 Development of the critical body residue (CBR) concept and narcosis models

2.2.2.1 Synopsis

The motivations for developing the critical body residue (CBR) model were (1) to define toxicity (mortality) based on an internal concentration rather than on an external dose concentration, (2) to categorize chemicals according to modes of toxic action, and (3) to predict better mortality in the field from narcosis to improve risk assessments (McCarty and Mackay, 1993). The concept is based on the assumption that membrane lipid is the target site for a chemical to induce the narcosis. Thus, over short time periods, on a weight-specific molar concentration basis, accumulation to a critical threshold concentration in the lipid beyond which narcosis is induced is similar regardless of the chemical. Thus, the internal effects concentration for narcosis (mortality) should be constant across species. McCarty et al. (1991) combined data sets from studies that measured bioaccumulation factors (BCF) and separate studies that measured external exposure concentrations (concentrations causing mortality in 50% of the test organisms LC_{50}). They solved algebraically for log CBR by combining the regression equation for log BCF vs. log K_{OW} from Mackay (1982) and the regression for log LC_{50} – log K_{OW} (Table 2.1). This resulted in the relationship that log LC_{50} = log CBR – log K_{OW}. They tested this relationship using a limited data set obtained from the literature, and found the critical body residue was 4.4 mmol/Kg, with a range of an order of magnitude.

Van Wezel et al. (1995) found that lipid content explained 50% of the variability in the observed CBRs. Thus, Di Toro et al. (2000) reanalyzed a similar data set, included work by Sijm et al. (1993) and van Wezel et al. (1995), and revised the CBR model by adjusting for differences in species and chemical potencies. Their regression resulted in a lipid-normalized critical body residue (C_L^*) where log LC_{50} = log (C_L^*) – a_0 - 0.945 log K_{OW} (Table 2.1). The Di Toro et al. (2000) model differs from the McCarty et al. (1991) model in that it allows the intercept [log (C_L^*) – a_1] to vary in order to incorporate differences in species [log (C_L^*)] and chemical potency (-a_1).

The time scale of these models is determined by the classic acute bioassay (96 hour, aqueous exposures to relatively high concentrations of chemicals where mortality of 50% of the test organisms are the measurement endpoint). The chronic mortality CBRs are short time frames (28 day "chronic" exposure assays, where mortality of 50% of the test organisms is the most consistent endpoint measured) rather than sublethal effects concentrations. In Figure 2.1, the development of the CBR and narcosis models represents the extreme left end of the spectrum of understanding the cumulative effects of PAHs on biologically relevant and ecologically meaningful, "real-world", sublethal endpoints.

The details of each model are discussed in the subsequent sections. I will present examples of each model's application, and present alternative approaches for understanding long term impacts of PAH exposures to fish residing in contaminated environments. Table 2.2 also summarizes the historical progression of models that predict PAH effects on fish, from the critical body residue, which focuses on one mode of toxicity, to models that incorporate multiple and competing modes of action.

2.2.2.2 Derivation of the critical body residue model for non-polar narcotics

The derivation for the theoretical critical body residue (CBR) model originates from the single compartment first order kinetic model (1CFOK) (McCarty, 1986, and French-McCay, 2002). This assumes a fish can be modeled as a single compartment where rates of uptake and elimination of chemical are first order processes.

(1) $dC_{fish,t}/dt = k_1C_{w,t} - k_2C_{fish,t}$

The equation integrates to:

(2) $C_{fish,t}= C_{w,t}k_1/k_2*(1-e^{-k2t})$

where C_{fish} and C_w are molar concentrations of a chemical in fish tissue and water, respectively, and t = time. The first order rate constants are k_1 and k_2 for uptake and elimination, respectively. At steady state, the ratio of k_1 to k_2 equals the bioconcentration factor [BCF=($C_{fish}/C_{w,t}$)], then

(3) $C_{fish} = C_w*BCF*(1-e^{-k2t})$, and $C_{fish} = C_w*BCF$ at steady state.

So, when the LC_{50} equals the steady state water concentration, then the concentration in the fish equals the critical body residue. This is a major assumption of the model.

(4) CBR = $LC_{50\infty}$*BCF [mmol/Kg].

McCarty et al. (1991) used the regression derived from Mackay (1982), describing the relationship between log BCF vs. log K_{OW}.

(5) log BCF = log K_{OW} – 1.32 or BCF = 0.048(K_{OW}), where 0.048 is the lipid fraction. The relationship was parameterized using experimental data from Veith et al. (1979), where several non-polar narcotic (including several PAHs) compounds were exposed to fathead minnows.

McCarty et al. (1985) analyzed LC_{50} data from several experiments exposing fish to chlorobenzenes (Call et al., 1983) and to several other narcotic chemicals (Veith et al., 1983). McCarty et al. (1991) and (1992) used several fathead minnow bioassays from the literature, including those already mentioned, to test whether the hypothesized critical body residue relationship (CBR = $LC_{50\infty}$*BCF [mmol/Kg]) could be confirmed. The dataset consisted of 150 bioassays testing 124 narcotic chemicals, including cyclic and non-cyclic halogenated aliphatic hydrocarbons, ethers, alcohols, ketones, esters, and pthalates and substituted benzenes. Chemicals were chosen based on an apparent narcotic mode of action and non-polar character. They normalized the exposure time by curve fitting the data to the one-compartment, first order, kinetic (1CFOK) model described above.

The regression equation from this analysis is as follows:

(6) $\log LC_{50} = -0.90 \log K_{OW} + 1.71$ ($r^2 = 0.92$), generalized to

(7) $\log LC_{50} \cong 1.7 - \log K_{OW}$

Regardless of the chemical, the threshold CBR data associated with 50% mortality fits the following regression:

(8) $\log CBR = 0.099 \log K_{OW} + 0.41$ ($r^2 = 0.12$)

From this analysis, log K_{OW} had little influence on the lipid-based whole body residues, thus showing that in general, thus chemicals had similar potencies. The hydrophobicity data spanned seven orders of magnitude but the CBRs only spanned one order of magnitude (1.8 – 10 mmol/L of tissue).

So, by adding equations 5 and 7 together:

(9) $\log CBR \text{ (mmol/L)} = \log BCF + \log LC_{50}$

(10) $\log CBR = (\log K_{OW} - 1.3) + (-\log K_{OW} + 1.7)$

(11) $\log CBR = 0.4$ or $CBR = 2.5$ mmol/L

Thus, the CBR related to 50% mortality via aqueous exposure is predicted to be 2.5 mmol/L, or mmol/Kg. (If one assumes fish density to be 1.0 Kg/L then mmol/L and mmol/Kg are interchangeable.) Figure 2.2a (described in McCarty et al., 1986 and 1991) depicts the conceptual model for relating log LC_{50} (toxicity), log K_{OW}, bioaccumulation, and critical body residue by plotting the logLC_{50}–log K_{OW} and log BCF–log K_{OW} curves on the same graph. McCarty et al. (1992) concluded that chemicals with similar modes of action produce similar CBRs and can be treated as a constant, and are invariant with logK_{OW}. They verified the relationship with fish and invertebrate data, calculating a mean CBR of 4.4 mmol/L (Figure 2.2b). Other limited data with measured (and calculated) CBRs were compared to the study in McCarty et al. (1991, 1992). For PCBs and chlorobenzenes, concentrations measured in fish were similar to the values predicted from the quantitative structure-activity relationship (QSAR). PAH concentrations for crustaceans also fell within the range defined by McCarty et al. (1991).

McCarty et al. (1991) point out that lipid variability could account for some of the observed variability (Figure 2.2b). In a sensitivity analysis, they found that when lipid content ranged between 3% and 8%, the corresponding CBR values were 2.2 and 8.3 mmol/Kg or mmol/L. To account for lipid, McCarty et al. (1992) used an average of 5%, so the lipid-normalized CBR or C_L^* equals:

(12) $C_L^* = 2.5$ mmol/L /0.05 (fraction lipid) = 50 mmol/L

Relative to the variation in the data set, the variability from lipid was deemed low, thus a mean value of 5% was assumed with a range of 44 – 160 mmol/L for lipid-normalized CBRs (C_L^*).

Although the CBR was developed using LC_{50} data (an indicator of acute exposure), the concept can be applied to sublethal endpoints as well (McCarty et al., 1991) by linking sublethal effects with tissue concentrations. However, there are still relatively few studies that characterize exposure and measure body burdens linked to sublethal effects (van Wezel et al., 1995, van Wezel and Opperhuizen, 1995, Di Toro et al., 2000, Escher and Hermens, 2002, and Traas et al., 2004). This lack of data has prevented a progression to the right on the time axis in Figure 2.1.

2.2.2.3 Validating and challenging the CBR model

Van Wezel et al. (1995) designed an experiment to test the validity of the CBR model and its assumptions (Table 2.2, model 2). Specifically, they examined the influence of lipid concentrations and time to death on measured body residues for fish exposed to chlorinated benzenes and PCB mixtures (Aroclors 1242, 1254, 1260, and 1268). Within an experiment with limited classes of chemicals, Van Wezel et al. (1995) measured an order of magnitude variation in critical body residues for the same test species (fathead minnows). However, Van Wezel et al. (1995) demonstrated that lipid variability accounted for 50% of the observed variability. They also measured CBRs corresponding to time-to-death, and observed differences among the chemical classes. The chlorobenzene CBRs had no relationship to time-to-death, while the PCB body residues correlated to time-to-death. The researchers rejected chemical tolerance as an explanation based on the assumption that toxicants exerting the same mode of action would cause organisms to adapt in similar timeframes. They also cite slow distribution within the organism and local intoxication of the gills from high-concentration water exposures for the differences between the chlorobenzene and PCB time-to-death endpoints. Although not a focus in the particular study, van Wezel and Opperhuizen (1995) suggest induction of a secondary mode of action to explain the results in van Wezel et al. (1995).

The results of this study had direct bearing on development of the total lipid model (Di Toro et al., 2000) where lipid content of the test organism, interspecies variation, and relative chemical potencies were explicitly considered.

2.2.3 The Total Lipid Model (TLM) for acute and chronic narcosis

Di Toro et al. (2000) (Table 2.2, Model 4) refined the CBR model to account for differences among species and chemical potencies. The resulting model was the basis for setting U.S. EPA tissue and sediment quality guidelines specifically for PAHs. The TLM explicitly assumes that mortality occurs due to accumulation of a chemical concentration at the target site, the membrane lipid, and is related to the LC_{50} through the chemical's lipid-water partition coefficient (K_{LW}). The model also assumes the chemical is soluble enough to allow its water concentration to approach the LC_{50} value. Compounds with log $K_{OW} > 5$ may not be soluble enough to achieve a dissolved concentration sufficient to reach their LC_{50} concentrations.

The lipid-water partitioning coefficient (K_{LW}) accounts for the target site of the narcotic mechanism when dissolved concentrations (C_w) = LC_{50}. If the narcosis model is valid, that there is a constant lipid normalized critical body burden, then the LC_{50} can be calculated from C^*_L and the K_{LW}

(13) $K_{LW} = C_L/C_W$

(14) $C^*_L = K_{LW} * LC_{50}$

This can be re-arranged to:

(15) $LC_{50} = C^*_L/K_{LW}$ or $\log (LC_{50}) = \log (C^*_L) - \log K_{LW}$

To obtain a chemical-specific K_{LW}, Di Toro et al. (2000) used the following logic. For narcotic chemicals within the ranges of log K_{OW} 2 - 5, the partitioning coefficients between two liquids (i.e., octanol and water) can be related by a straight line:

(16) $\log(K_{LW}) = a_o + a_1 \log (K_{OW})$

They combine equations 15 and 16 to obtain equation 17:

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(17) $\log (LC_{50}) = \log (C^*_L) - a_o - a_1 \log (K_{OW})$

Where $\log (C^*_L) - a_o$ = y intercept and $- a_1$ is the slope. By arranging the above equation,

(18) $\log LC_{50} = \log C^*_L - \log BCF$ where ($\log BCF = a_1 \log K_{OW} - a_0$),

Di Toro et al. (2000) present their adjusted equation in the format of the CBR model. In the CBR model, McCarty et al. (1991 and 1992) assume a_o and a_1 are known and equal -1.3 and 1.0, respectively.

(19) $\log C^*_L = \log LC_{50} + \log BCF$.

DiToro et al. (2000) state that the TLM differentiates between chemical and biological parameters where the CBR does not. When a_o is not equal to 0, the y – intercept is [$\log (C^*_L) - a_o$]. The parameter a_0 accounts for the relationship between octanol and lipid, while the biological parameter [$\log (C^*_L)$] accounts for species differences in the y-intercept due to variation in lipid content. They assert that this is reasonable because the non-specific mechanism of narcosis affects the phospholipids of the cell membrane, thus the only relevant difference among species is phospholipid amount. The a_0 parameter is also the main difference between the two models. This parameter allowed Di Toro et al. (2000) to perform separate regressions for each species (n = 33) where for species k and chemical j, the $LC_{50k,j}$ is

(20) $\log LC_{50k,j} = \log (C^*_L(k)) – a_0 – a_1 \log K_{OW} (j)$

(21) $\log LC_{50k,j} = b_k - a_1 \log K_{OW} (j)$

Where $b_k = \log [C^*_L(k)] – a_0$

Di Toro et al. (2000) also had a species correction and a chemical class correction.

(22) $\log LC_{50i,j} = a_1 \log K_{OW} (j) + \Sigma b_k \delta_{k,j} + \Sigma \Delta c_l \, \xi_{l,j}$

$\Sigma b_k \delta_{k,j}$ accounted for the species adjustment. $\Sigma \Delta c_l \, \xi_{l,j}$ accounted for the chemical potency of a class of compounds (*l*) within the overall narcotic group. If only baseline narcotics are considered, the $\Delta c_l = 0$. The adjustment for PAHs = -0.263.

After conducting the regression and making corrections, for 145 chemicals and 33 species, the average universal slope a_1 = -0.945, regardless of species. For fish, the critical body burdens determined from the intercept parameters ranged from 62 to 227 μmol/g octanol. So, for *Oncorhynchus mykiss*, the most sensitive fish species exposed to PAHs, the regression equation is

(23) $\log LC_{50} = \log[C^*_L(i)] – 0.954 \log K_{OW}$, where $\log[C^*_L(i)] = b_i + \Delta c_l$ so

(24) $\log LC_{50} = (1.79 – 0.263) – 0.954 \log K_{OW}$.

DiToro et al. used an extensive database of 145 chemicals (10 were unsubstituted low molecular weight PAHs) with LC_{50} data for 33 species to validate the total lipid model. Their principal criteria for including a study was whether a number of chemicals had been tested on the same species in order to generate a log LC_{50} vs. log K_{OW} regression, and that the LC_{50} was less than the chemical solubility. The resulting general equation,

(25) $\log C^*_L = \log LC_{50} + 0.945 \log K_{OW}$

From this equation, they calculated fish PAH final acute and chronic values (critical body residues), as 19.3 and 3.79 μmol/g-lipid, respectively. Figure 2.3 (Figure 10 from Di Toro et al., 2000), shows the variation in the observed CBRs relative to the predicted values from the TLM model for five species, three of which were fish species. The highest variability in the data set is for *Poecilia reticulate* (guppy). Although the model predicts some of the variability, the data vary by an order of magnitude. The figure is a good illustration of both the strengths and weaknesses of applying the model to fish. There is variability in the data reflecting variability in chemical differences, species differences, and exposure conditions. The model tries to account for these differences, and despite the differences the model prediction does fall within the range (and standard error) of the data. However, the variability in the data reflects the fact that the exposures do not meet the steady-state criterion, and that fish metabolize narcotic chemicals. The fish data are from less than 96 hour acute water-only exposures to halogenated benzenes from Sijm et al. (1993) and van Wezel et al. (1995), and do not include PAHs. Fish have higher CBRs than crustaceans which are more sensitive. This is probably due to the metabolic capabilities of fish, for which the TLM cannot account adequately, and for the reasons discussed above.

Di Toro and McGrath (2000) validated the total lipid model for Σ-PAHs using field data where an amphipod (*Rhepoxynius*) was exposed to PAH-contaminated sediments (Elliott Bay, WA) for 10 days. The TLM demonstrated that a universal narcotic slope of approximately –1 is valid for that species (see Figure 2.4, lower right panel). The validation also includes comparison of the TLM fit to observed LC_{50} data for low molecular weight PAHs, most of which are halogenated. Three species used in the evaluation are fish (*Cyprinodon variegatus, Poecilia promelas, and Oncorhynchus. mykiss*) (Figure 2.4). The model also predicted single chemical (critical body residues) and Σ-PAH toxicity (total of 13 PAHs from Schwartz et al., 1995, Toxic Units approach) similar to the other predictive models (See Figure 2.5). The TLM model is the basis for the U.S. EPA's sediment and tissue quality guidelines for Σ-PAH (DiToro and McGrath, 2000) and thus establishes a baseline for applying the TLM to PAH-contaminated environments.

2.2.2.5 Applications of the narcosis models to acute toxicity

The narcosis models summarized in Table 2.2 (McCarty et al., 1991, Di Toro et al., 2000, Escher and Hermens, 2002, Escher and Schwarzenbach, 2002, and French-McCay, 2002) are all fundamentally the same models with slight modifications in partitioning coefficients to account for variability observed in empirical studies (van Wezel et al., 1995). Thus, it is not surprising that they all calculate similar (within an order of magnitude) critical body residues (Table 2.2). Because they are similar, they all share some limitations.

The primary limitation is that the models are derived and parameterized on short duration, high concentration, aqueous exposures (LC_{50}). The total lipid model

(DiToro et al., 2000) and baseline toxicity model (Escher and Hermens, 2002 and Escher and Schwarzenbach, 2002) were developed and validated on low molecular weight (LMW), volatile compounds. The Di Toro et al. (2000) total lipid model incorporates ten LMW unsubstituted PAHs into the regression, but the model is not fully validated (i.e., limited number of PAHs tested, and does not account for biotransformation) for predicting narcosis from PAHs for fish, especially for chronic endpoints (28 day tests and beyond). The Di Toro et al. (2000) model works well for predicting ∑-PAH narcosis in amphipods (*Rhepoxynius*), but the logistic-regression model (Lee et al., 2001) improved the predictability considerably for amphipods. French-McCay (2002) updated the regression for fish by adding additional studies. However, the TLM model is still limited because it assumes narcosis is the only mode of action resulting from exposure to PAHs with log K_{OW}s less than 5. It cannot accommodate for the complications that fish metabolize PAHs efficiently thereby inducing other modes of action (Varanasi et al., 1989, Meador et al., 1995, and Johnson et al., 2002). Finally, the CBR in the DiToro et al. (2000) model is a calculated value from LC_{50} bioassay data, not measured tissue concentrations. Figure 2.3 [Fig 10 (DiToro et al.)] shows predicted vs. observed CBRs from acute exposures (< 96 hours) in three fish species and two crustaceans. In the fish species, particularly *Pimephales promelas*, there is an order of magnitude of variability, and the observations are based on halogenated benzenes, not PAHs (data from Sijm et al., 1993, and van Wezel et al., 1995). The CBRs reviewed in Escher and Hermens (2002) compare the CBR model regression to the measured fish CBRs, but again use the same chlorobenzenes and PCB body residues data from Sijm et al., (1993) and van Wezel et al. (1995).

Barron et al. (2002) analyzed a database developed by Jarvinen and Ankley (1999) to examine the variability in reported and estimated CBRs for different species. Figure 2.6 (Fig 10 from Barron et al., 2002) compares their analysis with the McCarty and Mackay (1993) synthesis and reports a 50,000 fold range in CBRs for non-polar narcotics. Barron et al. (2002) excluded PAHs from their analysis, due to photo-enhanced toxicity issues associated with PAHs. However, their synthesis does point out some of the limitations of the narcosis model. Inclusion of lipid into the total lipid model (Di Toro et al., 2000) reduced variability of the McCarty et al. (1991) model from three orders of magnitude to one, but unexplained variability still exists for a variety of factors. Factors include exposure regime (time, concentration, and route of exposure), species sensitivity, and biotransformation.

PAHs provide a model class of compounds where multiple modes of toxicity are occurring, including from the same compounds at different concentrations or exposure durations. Sublethal narcosis (baseline toxicity) resulting from initial PAH accumulation may impact further accumulation of PAHs if the exposure continues. As the concentrations of PAHs within the cell approach concentrations where other specific, more potent, modes of action are induced, sublethal narcosis may be masked (Escher and Hermens, 2002). Multiple mechanisms exert stress on the metabolic system. Although PAHs present this complexity, mechanisms of toxicity are often assessed in isolation [e.g., Di Toro et al. (2000) just examined mortality due to narcosis], while studies assessing other mechanisms of PAH toxicity discount sublethal narcosis effects (e.g., Incardona et al., 2004).

2.3 Approaches for assessing sublethal PAH toxicity to fish

As we desire to understand sublethal effects, the temporal scale of exposure becomes a major factor in understanding narcosis and other modes of action that are produced by narcotics, such as PAHs. At longer exposure times, chemicals begin to challenge the organism at other target sites. As discussed, a prominent section of the PAH risk assessment literature focuses on PAHs as acute narcotics, and posits that narcosis is the dominate mode of action (McCarty et al., 1992, Swartz et al., 1995, McCarty and Mackay, 1993, DiToro et al., 2000, DiToro and McGrath, 2000, French-McCay, 2002, and Landrum et al., 2003). From the other end of the spectrum, researchers quantify environmental exposures using sublethal endpoints, or other modes of action associated with PAHs but linking specific compounds and mechanisms responsible for observed effects remain subjects of debate (Carls et al., 1999, Johnson et al., 2002, Barron et al., 2004a, and Incardona et al., 2004). Specifically, induction of enzyme systems (Cytochrome P-450 1A) and biotransformation of PAHs into toxic metabolites are necessary steps lead to other PAH toxicity endpoints (Meador et al., 1995, Di Giulio et al., 1995, and van der Oost, et al., 2003). These endpoints can operate on a different time scale than sublethal narcosis, but are not independent of it. Under continuous exposure, the mechanisms interact on the organism as a whole as the parent compounds and metabolites affect different target sites. Thus, there is a transition area where sublethal narcosis is influencing subsequent uptake of PAH, but other mechanisms are induced and become important in inducing sublethal effects (Figure 2.1).

At the other end of the spectrum (Figure 2.1), approaches have been employed to predict PAH effects in fish using incidence of multiple endpoints correlating with high PAH concentrations in sediments. For example, Johnson et al. (2002) developed "hockey-stick" regression relationships (two regressions, a zero slope regression where there is no relationship between effects and the PAH concentration in the sediment, and a regression with a slope, and high correlation with the measured ∑-PAH concentrations in sediments) were correlated to observed prevalence of DNA adducts and liver lesions in English sole (*Pleuronectes vertulus*). The goal of their assessment was to develop sediment quality thresholds for PAHs that were protective of estuarine benthic fish. While the Johnson et al. (2002) model predicts sublethal effects not included in the narcosis models, it does not account for sublethal narcosis, nor does it provide a link back to the narcosis models. The primary endpoints measured (DNA adducts, lesion prevalence) are associated with biotransformation of PAHs to toxic, reactive metabolites from induction of the Cytochrome P-450 1A (Cyp 1A) system. These endpoints were also linked to reduced growth and reproduction associated with PAH-contaminated sediments above 1000 ng/g-dry weight, but the study did not suggest probable mechanisms.

Barron et al. (2004a) attempted to compare the accuracy of the Di Toro et al. (2000) TLM model to evaluate multiple embryo toxicity endpoints observed in two fish species (herring and pink salmon) exposed to weathered oil (Alaska North Slope crude) (Carls et al., 1999 and Heintz et al, 1999). Embryo toxicity endpoints included mortality, hemorrhaging of yolk sac, pericardial sac, ocular and cranial tissues, skeletal deformities, and mortality. The narcosis model was also evaluated against two other distinct models defined by Barron et al. (2004a): the alkylated-phenanthrene toxicity model and the Arylhydrocarbon Receptor (Ah-R) agonist model. Barron et al. (2004a) attempted to normalize all of the models by calculating a Σ-Toxic Unit (TU) of Σ-PAH relative to the measured Σ-PAH tissue concentration in the herring and salmon eggs exposed to water accommodated fractions of crude oil. (A toxic unit is a ratio of the measured concentration to an effects concentration, usually on a molar basis.) The models were summed by adding toxic units from each respective model. The combined model was then compared to the performance of the three proposed mechanisms of PAH toxicity.

Barron et al. (2004a) calculated a narcosis TU by using the Di Toro et al. (2000) 3.79 μmol/g-lip final chronic value (FCV) for tissue derived from the total lipid model as the effects concentration for the TU ratio. They adjusted the value to take into account differences in lipid content for the two species of fish, herring embryos (1.36% lipid = 0.0516 μmol/g-lipid) and salmon (12.7% lipid = 0.4813 μmol/g-lipid). The FCV in the Di Toro et al. (2000) model is based on a mortality endpoint.

The alkylated-phenanthrene model discussed by Barron et al. (2004a) was based on work by Brinkworth et al. (2003). In this model, they linked observed toxicity (prevalence of blue-sac disease, hemorrhaging) to egg concentrations of 0.15 μg/g from exposure to retene at different times during development from fertilization to post hatch. Although yolk sac edema and mortality were measurement endpoints, the dissolved retene exposures (0, 9, and 32 μg/L) did not elicit these responses. However, Barron et al. (2004a) used the 0.15 μg/g egg burden as the effects concentration for calculating toxic units in the alkyl phenanthrene model. Thus, the toxic units being calculated are biased toward the alkyl phenanthrene model as being a better predictor of early life stage toxicity (e.g., blue-sac disease) observed in the Carls et al. (1999) and Heintz et al. (1999) studies.

The Ah-R agonist model also calculated toxic units using endpoints other than mortality. The effects concentrations for the TU calculation were based on "fish potency factors" for each PAH relative to the toxicity of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) for inducing the Ah receptor (See Barron et al., 2004b). The study in which Barron et al. (2004b) based the effects concentration (residue concentration) was based on a lowest observable effect (detection of induction) which is not a comparable endpoint to acute narcosis.

In the Barron et al. (2004a) analysis, the narcosis model (Di Toro et al., 2000) accurately predicted embryo mortality at the higher doses of PAH accumulation, but failed to accurately predict the sublethal endpoints (growth, yolk sac edema, jaw malformations, impaired swimming, and pericardial edema). They found that the alkylated-phenanthrene toxicity model better predicted most of these effects to an accuracy of 80%, however, the model underestimated yolk sac and jaw deformities and overestimated mortality and reduced growth in salmon. The Ah-R model underpredicted all of the toxicity endpoints, suggesting that other modes are present. In the combined toxicity model (addition of the other three models), overall accuracy improved, as one would expect.

The Barron et al. (2004a) study did not equally weight the narcosis model with the other models. Both the alkylated-phenanthrene and the Ah-R receptor models Barron et al. proposed were based on different toxic units (TU) than Di Toro and McGrath (2000). Barron et al. used sublethal effects concentrations as the denominator of the TU ratio, while the narcosis model uses a lethal effects concentration for calculating TUs. Thus, it is not surprising that the narcosis model only predicted the egg mortality endpoint. Nor is it surprising that the other models underpredicted the mortality endpoint.

Incardona et al. (2004) (Table 2.2, Approach 9) designed a study to examine effects of individual PAHs on the development of zebrafish (*Danio nerio*) embryos to determine if PAHs had specific modes of action. Incardona et al. (2004) dispute the narcosis model and assert that the effects they observed were not indicative of a narcotic mode of action. They support this claim by noting a minimal drop in heart rate in napthalene, chrysene, and anthracene only exposures. However, with fluorene and phenanthrene exposures there was a dose-dependent decline in heartrate, indicative of a narcotic response. In the exposures of a mixture of PAHs (phenanthrene, dibenzothiophene, fluorene, and naphthalene), there was a greater dose-dependent decline in heart-rate than with the fluorene or phenanthrene alone, indicating an additive narcotic effect.

All of the treatments induced yolk sac and pericardial edema, which also are indicative of a narcotic mode of action causing expansion of the membrane surfaces. Their study is interesting in that Incardona et al. (2004) did measure different responses which seemed to correlate to specific compounds. However, there are also some problems in extrapolating their findings outside of the laboratory. They used extremely high concentrations of PAHs (at or above solubility limits), all of which were nominal concentrations. At these concentrations, PAH crystallization likely occurred, and could have interfered with the surface structure and ionic exchange of the embryos independent of narcosis.

Although there still unanswered questions from this study, it provides a good illustration of competing between modes of action. Some of the modes of action compete, depending on the response being measured, and all of them demonstrate some baseline toxicity (i.e., sublethal narcosis). Escher and Hermens (2002), Barron et al. (2002 and 2004a), Incardona et al. (2004), and Traas et al. (2004) point out (1) the importance of understanding the mechanisms underlying the multiple responses and (2) the importance of elucidating the mechanism, along with a commensurate individual level response.

2.4 Bioenergetics as a method for linking the continuum and analyzing competing modes of toxicity from multiple chemicals.

Applying a bioenergetics approach to assessing long term effects from contaminants provides a framework which is ecologically relevant and integrates effects of multiple modes of toxicity and routes of exposures. Congdon et al. (2001) identified the disparity between individual and population level toxicological approaches. They proposed using resource-allocation based life histories as the method for bridging the gap between individual and population-level phenomenon. Using standard metabolic rate may be a method for bridging the gap between acute narcosis and long-term impacts from narcotic agents. As the time scale of exposure increases, multiple modes of toxicity manifest within an organism, and the narcosis model no longer adequately describes the total toxicity. Fish bioenergetics methods use energy units as currency that integrates chemical and biological interactions, allowing one to detect chemically-induced change in metabolic rate and examine energetic "costs" associated with that stressor. A bioenergetic parameter like standard metabolic rate (energy needed to meet normal maintenance requirements) may be sensitive to a narcotic endpoint, but also has been used to assess other modes of toxicity in a variety of organisms (Rowe et al., 1998), including fish (Beyers et al., 1999, Hopkins et al., 2001, Rowe, 2003) thus providing a measure for comparing studies.

Standard metabolic rate (SMR) is the portion of the energy budget that represents the maintenance requirements of an organism and has been used successfully to demonstrate costs of chemical stressors to fish (McKim et al., 1987, Beyers et al., 1999, and Rowe, 2003). A change in SMR causes a fish to adjust its energy budget in order to survive. A reduction in SMR could result in overall energy reduction where activity and specific dynamic action (energy required to assimilate and digest food) are reduced, which would indirectly reduce consumption, and ultimately impact growth. An increase in SMR reduces available energy for growth and reproduction (Rowe, 2003) unless the organism assimilates more energy to compensate which may not be possible in a food-limited environment. Also, if exposed to a suite of chemicals and some compounds lead to an increase in SMR, and some a decrease in SMR, then overall there may be little detectable change. This exposes the limitations of the experiments done with complex mixtures. Despite the theoretical foundation and potential sensitivity of the SMR measurement to some exposures, recent research efforts using SMR to assess chemical stress to fish populations have produced ambiguous results. Past studies demonstrated that the SMR endpoint was sensitive enough to be detected when fish were exposed both acutely and chronically to chemicals. In a hallmark study defining the narcosis syndrome, McKim et al. (1987) exposed rainbow trout to 50 mg/L of MS-222, a model narcotic. They demonstrated a 50% reduction in metabolic rate in a 96-hour assay. Therefore, SMR is reduced during short term exposures to MS-222.

Beyers et al. (1999), Hopkins et al. (2000), Rowe (2003), and Staub (2004) measured chemical stress on fish species using the same endpoint and method (SMR, using the Micro Oxymax^{TM}, Columbia Instruments), providing a potential set of studies on which to compare endpoints. All of these studies had a similar goal: to use SMR to quantify the cost of chemical exposure over months to years. Table 2.3 provides a summary of the studies and illustrates the challenges in trying to compare results of ecotoxicology studies. These studies tested different chemical mixtures, examined different routes of exposure, and used different life stages from different species. Therefore, results among studies using different contaminants and exposure regimes cannot be accurately compared.

Hopkins et al. (2000) exposed wild-caught lake chubsuckers (*Erimyzon sucetta*) from a reference site to coal fly ash-contaminated sediments over 124 day period. Fish were fed clean food and resided in aquaria with filtered, artificial soft water. There were no significant differences in standard metabolic rates on either days 84 or 124, despite measuring elevated tissue concentrations for Se, Sr, and V.

Fish living in the contaminated tanks exhibited a 25% mortality rate (although this was not statistically significant), poor growth rates (41% less than controls, with no growth for the last 16 days), and severe fin erosion. Hopkins et al. (2000) commented that contaminant mixture effects were likely, and that observed effects could not be linked specifically to an individual contaminant. Some of the effects could be associated with PAHs, as well as metal toxicity. They hypothesized that the lack of response in SMR was due to compensation in another portion of the energetic budget, such as specific dynamic action. This is plausible given that they did not observe reduced consumption, but they did measure reduced growth.

Rowe (2003) conducted a similar study using the same coal fly ash-contaminated sediment from the Savannah River Site, South Carolina. He exposed an estuarine fish species (*Cyprinodon variegatus*) to contaminated sediments for 374 days (laboratory-reared 1 day old hatchlings to adult year one). Fish were fed clean food and resided in 38-L aquaria in artificial seawater. Standard metabolic rates were measured eight times over the time course of the experiment. In the larval – juvenile stage (days 0 – 166), standard metabolic rates were reduced by 15% relative to the controls. After that time, standard metabolic rates were not significantly different between the control and exposed groups. Rowe reported reduced growth in the fish exposed to the contaminated sediments from day 200 through day 374. Eggs were smaller and contained less lipid in females exposed to the contaminated sediment. Growth trends between uncontaminated and contaminated fish did not diverge until after the standard metabolic rates became statistically indistinguishable, so SMR was not sensitive in the later life stage. Rowe (2003) concluded that reduction in energy assimilation efficiency could account for the lack of response in SMR and could explain the reduced growth and reproduction parameters. Individual contaminants could not be linked to specific effects, even though significant accumulation of As, Cd, Se, and V occurred. However, only the inorganic contaminants were measured. Similar to the Hopkins et al. (2000) study, multiple modes of action and joint toxicity masking effects on SMR cannot be ruled out.

Staub et al. (2004) collected the freshwater fish (*Gambusia holbrooki*) from two sites: a reference site in South Carolina and from the same coal fly ash-contaminated site where Hopkins et al. (2000) and Rowe (2003) obtained their contaminated sediments. They also found no significant differences between the fish from the contaminated and reference sites in standard metabolic rates or mass of male fish. Although they also measured brood size of the female fish, percent of live offspring at parturition, and trace element body burdens in females and offspring, those endpoints could not be linked to the male SMRs. The female fish from the contaminated site contained significantly higher body burdens of some of the trace elements, but none of the reproductive endpoints varied between sites. These researchers concluded that the mosquitofish is a tolerant species, however, they did not propose a mechanism for the tolerance.

There are several hypotheses as to why standard metabolic rate is a relatively insensitive endpoint. First, the species studied (*Gambusia holbrooki, Cyprinodon variietatus,* and *Erimyzon sucetta*) may be tolerant to chemical stress on maintenance costs, although several of the studies cited used naïve fish. Second, the mixture of contaminants in the exposure could be exerting competing modes of toxicity, hence masking the real effect. This latter hypothesis needs further examination before SMR can be ruled out as an effective metric for assessing multiple and competing modes of toxicity that a chronically contaminated environment imposes on individuals and populations. Individual modes of action need to be calibrated to a repeatable effect in SMR in a systematic manner analogous to the short term studies on separate modes of action before the cumulative effect on SMR can be fully elucidated.

2.5 Conclusions:

The Di Toro et al. (2000) Total Lipid Model (TLM) model provides an organized, well-synthesized method for predicting PAH toxicity for the upper bounds for setting sediment quality guidelines that are protective of several species from acute mortality effects. Regardless of the limitations, the TLM provides a sound example for others to emulate: thorough data synthesis, linkage of exposure concentration to an effects concentration using comparable studies, and basing the underlying assumptions of the model on a mechanism (chemical accumulating in the lipid membrane to a threshold concentration) responsible for the effect (mortality). Regardless of how far to the right we move on the curve (Figure 2.1), the longer term studies must characterize routes and durations of exposure, and define a mechanism linked to a demonstrable and relevant effect. The methodology could be used to develop models that incorporate sublethal endpoints. For example, can a bioenergetic parameter like standard metabolic rate (SMR) be used to compare and normalize exposures where multiple contaminants, variable exposure durations (months to years), and multiple mechanisms are interacting to produce multiple effects?

Sublethal narcosis may exist but it is measured indirectly, or discounted entirely as more specific modes of action become apparent or are easier to measure. Sublethal narcosis influences the rate at which other modes of action manifest themselves, and influences the physiology (bioenergetics) of individuals. It imposes an energetic cost on an organism and can mask or exacerbate other effects. Standard metabolic rate may provide a unifying metric for understanding sublethal narcosis and multiple modes of toxic action on fish. SMR responds to chemical stressors and also can be linked through models to population level ramifications. If SMR is altered, a loss must occur elsewhere in the individual's energy budget, potentially affecting production and survival.

Bioenergetics presents a framework for integrating sublethal narcosis and other modes of actions on a physiological, and hence, ecologically important level of biological organization. By accounting for the sublethal level of narcosis, a clearer understanding emerges of the total cost on the organism. Because fish have evolved enzyme systems and compensatory abilities due to constantly living in stressful environments (fluctuations in water temperature, salinity, dissolved oxygen and food availability), they have traits that enable them to adjust their energetics due to chemical stressors as well (Weis 2000, van Veld and Westbrook, 1995, Nacci et al., 1999). There is a cost, however, and the mechanistic impacts on these adjustments should be further examined. For example, there is still a great need to fully characterize exposures (inorganics and organics), account for several routes of exposure, and expand the range in which studies of similar types are conducted. The approach would help expand the zone from where the short term (narcosis) models provide satisfying results to regions of the curve where exposures (concentrations and durations) represent environmental relevance.

Like the narcosis models, the bioenergetics model is based on conservation of energy. Ecotoxicology could strive to build a database analogous to the acute toxicity literature. Currently, it is extremely difficult to compare studies where even the same methodologies for measuring SMR were employed. A metabolic cost to chemical stress has been demonstrated, however, it has not been translated into a system that provides a means for comparative assessments. SMR provides potential for an appropriate common measurement, but it needs to be paired consistently with complementary data to move from qualitative to quantitative comparisons between sites and among organisms, chemicals of concern, and exposure regimes.

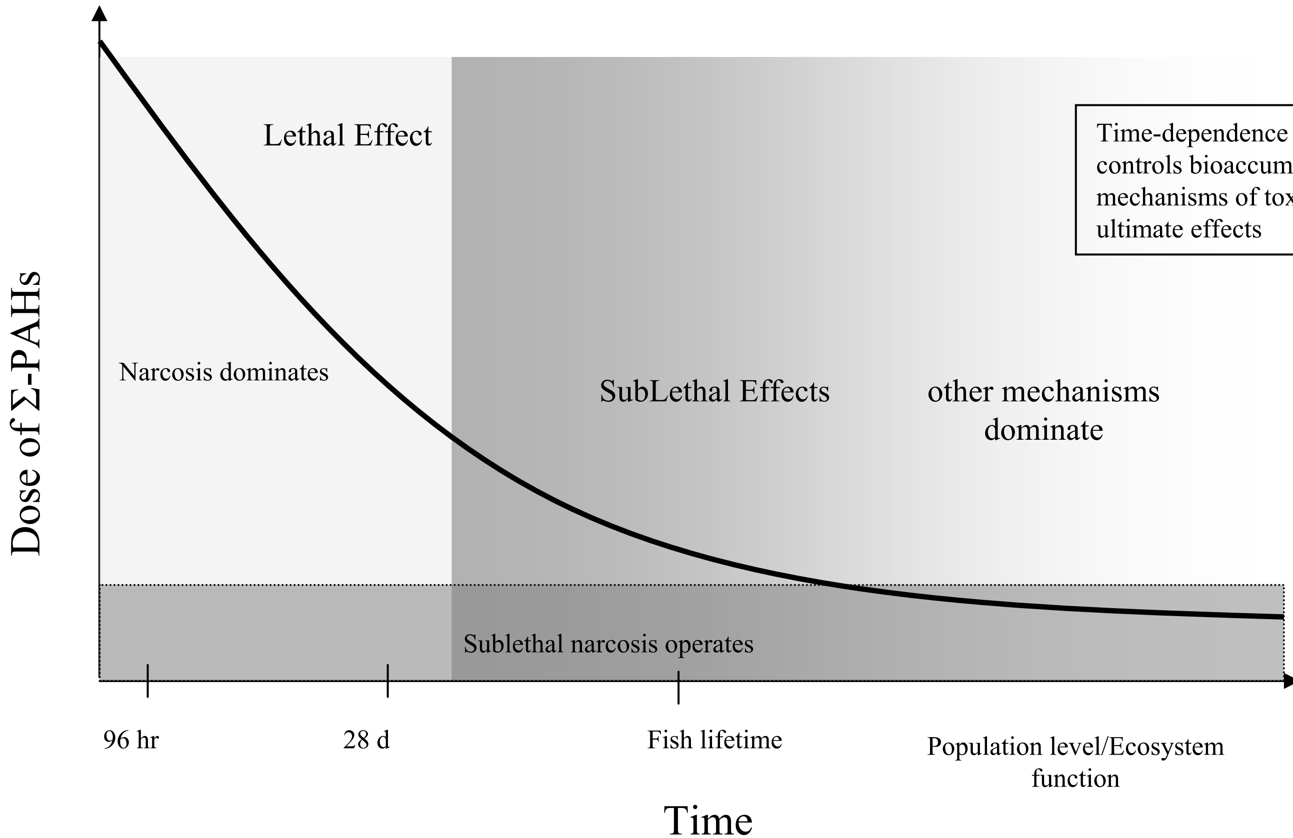

Figure 2.1. Idealized concept for linking acute and chronic narcosis with other mechanisms.

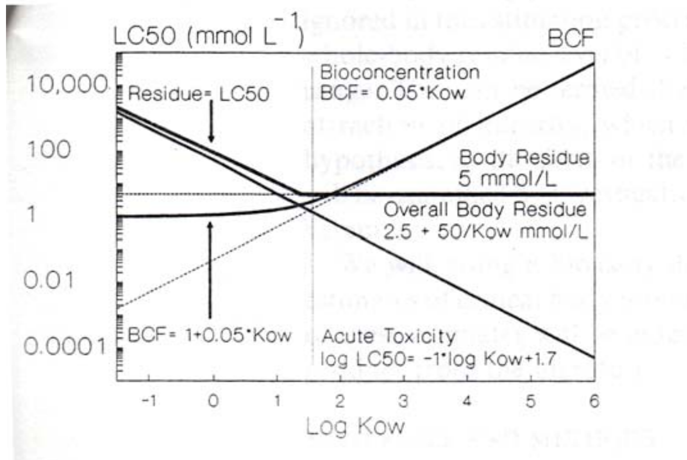

Figure 2.2a. From McCarty et al., 1991. Idealized model for critical body residue concept where the logistical equations are added together to develop the hypothesized critical body residue. From McCarty et al., 1991, "Fig. 1. Idealized relationships between acute toxicity, bioconcentration, critical body residue and log K_{ow} for small aquatic organisms exposed to narcotic chemicals. Fro log $K_{ow} \leq 1.5$ (the vertical dotted line), deviations from linearity in bioconcentration are expected as the level of toxicant in the water phase of the organism becomes the controlling factor. To account for this the bioconcentration factor relationship changes to $1 + 0.05K_{ow}$. Thus, over this range the body residue should be similar to the LC_{50} values. Over the entire log K_{ow} range (-2 to 6), whole-body residue should be described by 2.5 + $50/K_{ow}$mmol kg^{-1}."

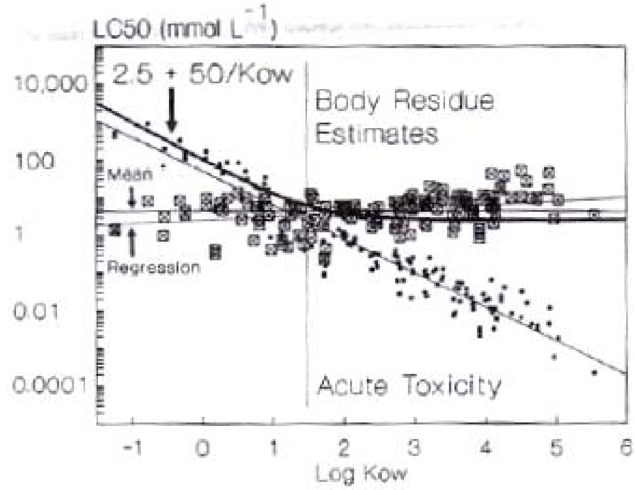

Figure 2.2b. From McCarty et al., 1991. Idealized model with data overlaid verifying the relationships. From McCarty et al., 1991, “Fig. 2. Acute toxicity and body residue QSARs for fathead minnows exposed to narcotic organic chemicals. Toxicity data are from the US EPA-Duluth data base. The estimated critical body residue associated with mortality derived from these two QSARs is also included. The average residue value and a linear regression fitted to all data points ($n = 150$) are indicated. The body residue relationship estimated by the overall residue equation presented in Fig. 1 ($2.5 + 50/K_{ow}$ mmol kg^{-1}) is also presented for comparison.”

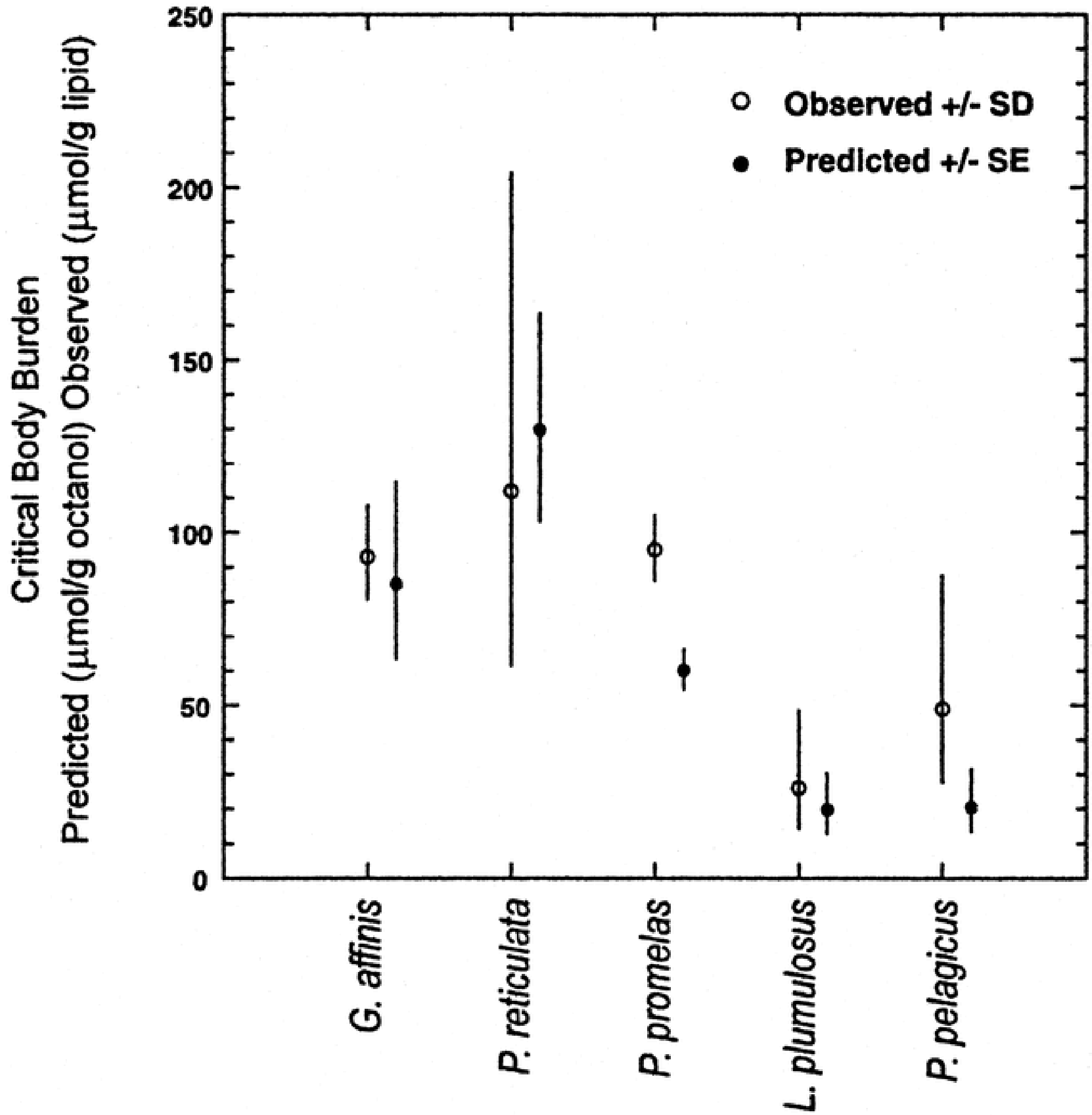

Figure 2.3. From Di Toro et al., 2000, “Fig. 10. Predicted and measured body burdens for five species.”

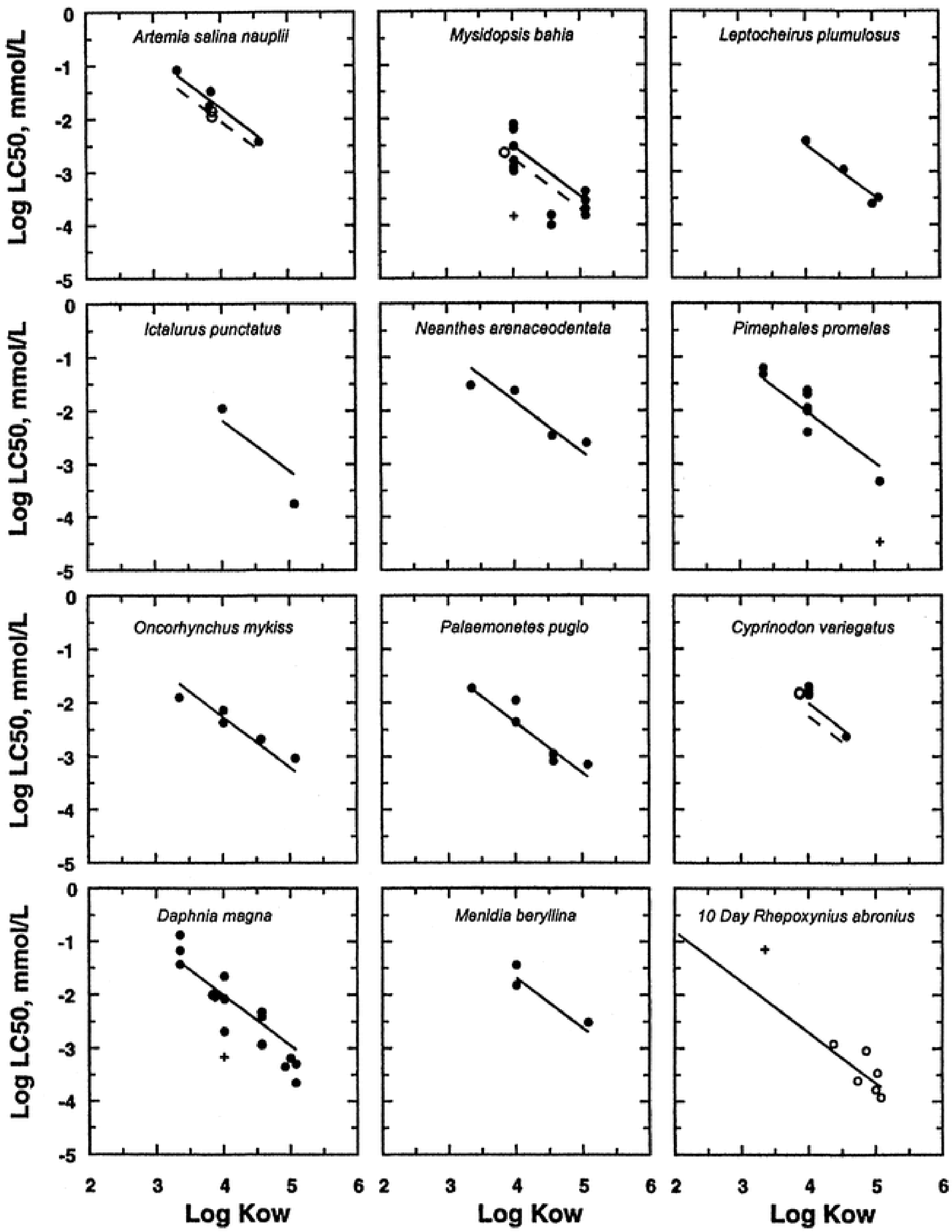

Figure 2.4. From Di Toro and McGrath, 2000, "Fig. 3. Comparison of target lipid model fit and observed LC50 data for polycyclic aromatic hydrocarbons (PAHs) and the indicated species. The PAHs included are naphthalene (3.36), 1-methylnaphthalene (3.84), 2-methylnaphthalene (3.86), 2-chloronaphthalene (3.88), 1-chloronaphthalene (3.88), acenaphthene (4.01), phenanthrene (4.57), pyrene (4.92), 9-methylanthracene (5.01), fluoranthene (5.08). Number in parentheses is $\log(K_{OW})$. Solid line and filled symbols for nonhalogenated PAHs. Dotted line and unfilled symbols for the halogenated (i.e., chlorinated) PAHs: + denotes outliers.")

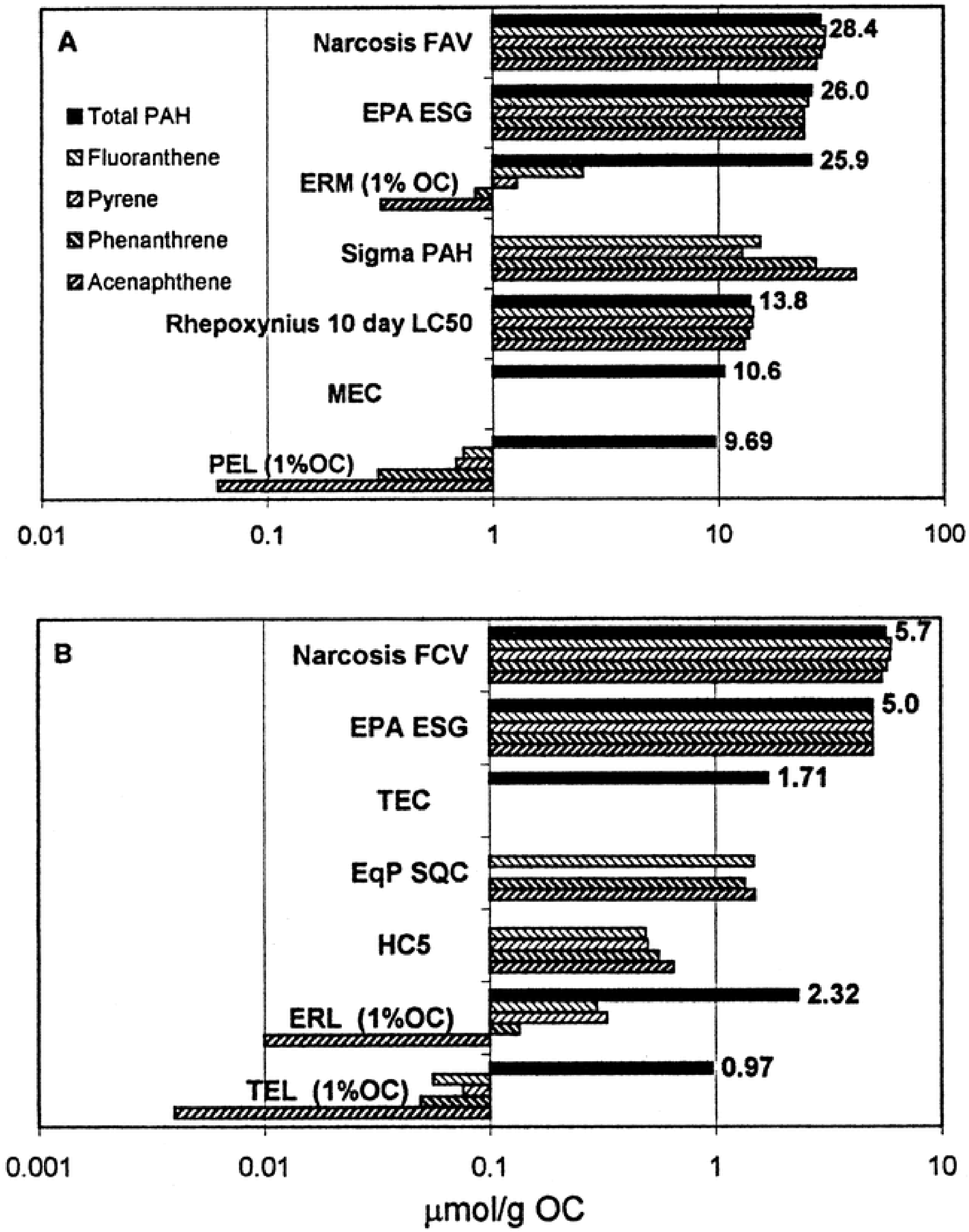

Figure 2.5. From Di Toro and McGrath, 2000. "Fig. 6. Comparison of various estimates of sediment effects concentrations. The effects range low (ERLs) and effects range median (ERMs) from Long and Morgan [25]; threshold effects level (TELs) and probable effects level (PELs) from MacDonald et al. [26]; HC_5 from Van Leeuwen et al. [27]; ΣPAH from Swartz et al. [3]: EPA SQC from [28–30]; threshold effects concentration (TEC) and median effects concentration (MEC) from Swartz [31]; *Rhepoxynius* 10-d LC50 from Swartz et al. [18]; EPA ESG from [20]; narcosis final acute value (FAV) and final chronic value (FCV) from this work."

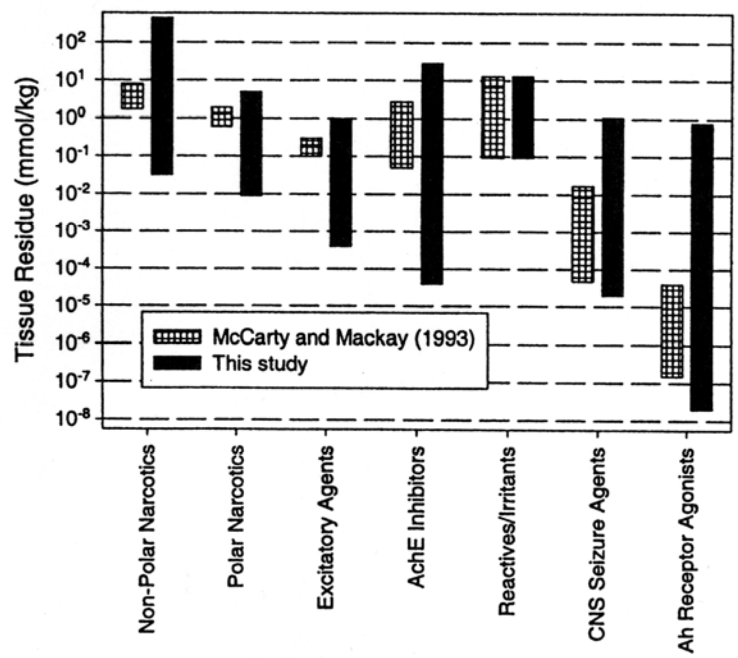

Figure 2.6. From Barron et al., 2002. “Fig. 10. Comparison of CBRs reported by McCarty and Mackay (1993) with CBR ranges determined in the current study.”

Table 2.1. Acute Partitioning of nonpolar organics from water to target site (lipid membrane)

Study	QSARs	y =	m	x	+ b	References and comments
McCarty et al., 1992	1. log BCF vs. log K_{OW}	log BCF	1	log K_{OW}	-1.32	Mackay, 1982
	2. log LC_{50} vs. log K_{OW}	log LC_{50}	-1	log K_{OW}	1.7	Veith et al., 1983, McCarty et al., 1985, and 1986
	3. Add equations 1 and 2 for CBR model	log CBR	1	log LC_{50}	log BCF	
		log CBR	0.4 mmol/L			Or CBR = 2.5 mmol/L, assumed to be constant
Di Toro et al., 2000	4. Rearrange equation 3; replace CBR with lipid-normalized CBR (C_L^*)	log LC_{50}	- a_1	log K_{OW}	log (C_L^*) – a_0	a_0 = -1.3 and a_1 = 1 are constant in McCarty et al. model. Di Toro el al. allow a_0 and log (C_L^*) to vary by chemical potency and species, respectively
	5. Total Lipid Model	log LC_{50}	- 0.945	log K_{OW}	log (C_L^*) – a_0	Calculated C_L^* = 19.3 μmol/g lip (acute), and 3.79 μmol/g lip (chronic) for Σ-PAHs
French-McCay, 2002	6. oil spill application	log LC_{50}	- 1.09	log K_{OW}	log (C_L^*) – a_0	Calculated C_L^* = 4.4 (average) for Σ-PAHs when more studies exposing organisms to PAH < log K_{OW} = 5 included in the regression.

Table 2.2. Development of critical body residue concept for the narcosis mode of action. The list has been expanded to include other assessments of PAHs on fish where narcosis, and the narcosis model, were acknowledged and/or refuted.										
Study	**QSAR and/or advancement**	**Data Sources**		**Validation**		**Exposure**	**Duration**	**Mode of Action**	**Limitations**	**CBR (µmol/L or g)**
		Chemicals tested	**Test Species**	**Chemicals tested**	**Test Species**					
1. McCarty et al., 1991	Original CBR narcosis model	124 narcotics (few LMW PAHs)	Fathead minnow Flagfish guppies	Chloro-benzenes, PCBs, PAHs	150 assays fish (chl-benzenes and PCBs) crustaceans (PAHs)	LC50 (only used studies w/ measured exposures	< 96 hour	Acute narcosis	Calculated LC50s based on mortality data, compared to measured.	4.4 (range 1.8 – 10), 50 for lipid normalized average
						LC 50, growth	85 days	Chronic narcosis	No PAHs tested	0.2 – 0.8
2. van Wezel et al., 1995	Challenged CBR assumptions Variation in % lipid Differences in time to death	Chloro-benzenes PCB Aroclors	Fathead minnow			LC50	< 96 hour	Acute and chronic (28 day) narcosis	No PAH tested, no adjustment in QSAR	4-23 fold variation in CBR
3. Schwartz et al., 1995	∑-PAH additivity model – Toxic Unit (TU Approach)	13 PAHs	amphipod	13 PAHs	Amphipod (4 species)	LC50	10 day	Acute narcosis	Doesn't account for species sensitivities	Not calculated or measured
4. Di Toro et al., 2000	Adapted CBR model → Total Lipid Model	145 narcotics, 10 unsubstituted LMW PAHs, mixtures	33 species, 3 species of fish	Elliott Bay sediments	Amphipod (R. abronius)	LC50	<96 hour	Acute narcosis	Calculated CBR from LC50 Limited PAHs (LMW) Used calculated CBR to develop final acute and chronic water quality values. Used those values to calculate sediment QG. Only validated on one species with limited data.	19.3 (acute) 3.79 (chronic) for PAHs

5. Escher and Hermens, 2002 and Escher and Schwarzen-bach 2002.	Baseline toxicity model Allows for time-dependence toxicity Measured CBRs (used van Wezel et al., 1995 and Sijm et al. 1993) Separates lipid type	Nonpolar narcotics	Guppies and fathead minnows	15 Nonpolar narcotics (chloroben-zenes and PCBs), no PAHs	Guppies and fathead minnows	EC50 (external conc.) Usually aqueous	Until IEC is reached, most data on < 96 hours	Acute narcosis	DiToro et al also used the same data set in calibrating the TLM model.	IC50 (3.4 – 30.5) ILC memLip (65 – 400) ILCstorageLip(70-680)
6. Lee et al., 2001	Logistic Model for ∑-PAH Tested the species-specific QSAR from Di Toro et al. 2000 Included exposure time in model	PAHs, mixtures	amphipods	∑-PAH = 33 PAHs	Amphipod (H. azteca)	Compar-ed water only LC50 data to sediment toxicity tests	10 and 14 day	Acute narcosis	Only developed for amphipods	CBRs time dependent patterns
7. French-McCay, 2002	Applied Total Lipid Model for oil spills Measured slope of –1.09 using the TLM from adding more datasets	PAHs, mixtures	Multiple species, including fish	LMW PAHs	Lobster	Oil spills (aqueous)	< 96 hour	Acute narcosis	Calculated CBR from LC50 Limited PAHs (LMW)	4.0 (average for all species)
8. Johnson et al., 2002, Myers et al., 2003	Hockey-stick regression model	PAHs, ∑-PAH mixtures	English sole	Weight of evidence approach	English sole	sediment	Long term, field exposure	Background + carcinogen-icity precursors Growth, reproduction, Liver lesions, DNA adducts	Focuses on deleterious effects	Not measured
9. Barron et al., 2003	Recalculation of CBRs using Jarvinen and Ankley CBR database	Narcotics, no PAHs	Multiple	NA	NA	LC50s, dietary	Mostly short-term (<96 hour)		Explicitly excluded PAHs	50,000 fold variation in CBRs

10. Incardona et al., 2004	Specific toxicities for PAH compounds	Parent PAHs	Zebrafish embryos			Aqueous, nominal, high levels, above solubility limits	6 days	Developmental, reduced heart beat Narcosis, multiple modes	Nominal, high level exposures	Not measured
11. Barron et al. 2004	Combined toxicity model (narcosis, alkylated-phenanthrene toxicity, AhR agonist)	EVOS weathered mixtures	Herring and salmon embryos				16 and 35 day	Multiple modes		herring embryos (1.36% lipid = 0.0516 µmol/g-lipid) and salmon (12.7% lipid = 0.4813 µmol/g-lipid)
12. Multiple studies: Meador et al., 995, van Veld et al., 1992, Weis, 2000 Bello et al., 2001	Other AhR agonist studies	PAH mixtures	Fundulus and others			Dietary, aqueous, IP injections	Short to long term	EROD induction, liver lesions, tolerance	Precusor to effects Induction alone is not an effect Mechanism for developing tolerance Mult chems compete for target site (AhR)	Not measured
13. Traas et al., 2004	Partitioned modes of toxicity Used ERED database to develop food web model	Nonpolar narcotics, 2 PAHs (Pyr and FluAn)	Fish spp.	3 fish species	PCBs only	LC50 and EC100	<96 hour, some chronic	Multiple modes of toxicity including narcosis	Also used the same fish CBR data used in 4 and 5 Calculated PCB tissue levels from sediment measurements for BCF and BMF calculations	Median = 5.75

Chapter 3

Aqueous 3-aminobenzoic acid ester methanesulfonate (MS-222) and dietary polychlorinated biphenyl impacts on bioenergetics and bioaccumulation in *Fundulus heteroclitus*

3.1 Introduction and Background

A series of three exposure studies were conducted to examine the effects of sublethal narcosis on the bioenergetics of and bioaccumulation in fish. This chapter reports the findings of the first of the three experiments. The results reported here influenced and directed the revised hypotheses and experimental designs of the later experiments (Chapters 4 and 5). The major components of each experiment are summarized below. All of the experiments used *Fundulus heteroclitus* collected from the same reference site, Paxtuxent River, MD.

Experiment 1 (93 day exposure duration) was designed as a preliminary study to address the following questions:

1. Are fish standard metabolic rates (SMR) sensitive to low level exposures of a narcotic chemical, MS-222 (3-aminobenzoic acid ethyl ester methanesulfonate)?
2. Does a measurable change in SMR induce a detectable change in PCB tissue concentration measured in exposed fish?
3. Do measured "background" concentrations of PCBs in commercially available fish food ("trout chow") interfere with fish bioenergetics?
4. Does commercially available fish food ("trout chow") provide a realistic response in accumulation in order to justify using it in future

dietary exposure studies in which trout chow was spiked with neat standards of contaminants (e.g., PAHs and PCBs)?

Experiment 2 (Chapter 4) was a smaller pilot study (30 day exposure duration) designed to:

1. Repeat the 10 mg/L MS-222 exposure to validate the SMR responses measured in Experiment 1.
2. Increase the MS-222 exposure gradient to concentrations that stress the fish's ability to maintain visibly normal behavior.
3. Compare fish growth, SMR and PCB accumulation results of Experiment 1 with Experiment 2 results where fish were fed a different diet (uncontaminated clams), and a different source of contaminant (environmentally contaminated clams).

Experiment 3 (Chapter 5) was the main study (120 days) which led directly from the previous two studies and was designed to:

1. Compare the effects of MS-222 on SMR after exposure of environmentally relevant concentrations of narcotic chemicals (PAHs).
2. Assess whether altered SMRs due to a PAH-contaminated diet affects PCB accumulation.

3.1.1 Effects of chemical stressors on fish bioenergetics

Several studies have posed the metabolic cost hypothesis for organisms exposed to chronic chemical stress (Moore et al., 1987, Calow and Sibly, 1990, Calow, 1991, Beyers et al., 1999, and Rowe, 2003). Mixtures of environmental chemicals may affect maintenance respiration in organisms by either increasing or decreasing standard metabolic rate (SMR). However, few studies have examined the consequences of an altered SMR on bioaccumulation of hydrophobic organic compounds (HOCs), particularly in the context of sublethal narcosis from realistic dietary exposures. Theoretically, decreasing an organism's SMR will reduce consumption, which in turn will reduce dietary HOC exposure and accumulation. One consequence of this impact would be an increase in time to reach critical body residues (defined as the internal concentration of a chemical that causes mortality to 50% of the test population, McCarty et al., 1992). Alternatively, sublethal narcosis could slow the rate of uptake to a point where elimination processes prevent mortality thresholds from being obtained, thus indirectly controlling bioaccumulation. However, maintenance costs imposed on the organism increase with increasing SMR, forcing an organism to compensate by adjusting other portions of its bioenergetic budget (e.g., growth, reproduction, or activity) (Moore et al., 1987, Beyers et al., 1999, and Rowe, 2003). Either way there is a metabolic cost associated with a chemically induced change in SMR.

3.1.2 Implications of sublethal narcosis

Exposure to narcotics affects cellular function, reduces activity, depresses SMR, and decreases consumption of carbon and associated contaminants. Through this process, the time to reach a critical, or effects level, body residue may be increased substantially, even to the point where such a level is avoided althogher. Earlier evidence that narcotics reduced SMRs was reported by McKim et al., (1987), where rainbow trout were exposed to 50 mg/L of MS-222 for 96 hours. Metabolic rates were depressed by up to 50% relative to controls. In a chronic study where *Cyprinodon* was exposed to sediments contaminated with coal ash residue over a life cycle, SMR was depressed by 12% in the early life stage (75 – 160 days post hatch) (Rowe, 2003). Thus, based on acute exposure (96 hour) and early life stage studies, there is some evidence to suggest that SMR will decrease in the presence of long-term exposure to sublethal concentrations of narcotic chemicals.

3.1.3 *Fundulus heteroclitus* as a model species

Fundulus heteroclitus is distributed ubiquitously throughout eastern North American estuaries. The species has a limited home range (100 m^2) (Black et al., 1998), is an opportunistic feeder, and feeds in numerous habitats (benthic, pelagic, and marsh intertidal). *Fundulus* is primarily carnivorous (Abraham, 1985), and thus likely is exposed to contaminants primarily through its diet. Major prey items include fiddler crabs, polychaetes, amphipods and other small crustacea (Kneib et al., 1980), small clams, fish, zooplankton and fish larvae, and carcasses of larger organisms (Abraham, 1985). In the Chesapeake Bay and other East Coast estuaries, *Fundulus* is an important secondary producer and a vector for transferring carbon and contaminants from the benthic environment to higher trophic levels (Weis, 2002).

Fundulus heteroclitus is commonly used to examine sublethal effects of chemical contaminants due to its life history (Black et al., 1998, Gutahr-Gobell et al., 1999, and Matta et al., 2001). The species is short-lived (2-4 years), matures early (100 days), is iteroparous (2-5 times per year) with clutch sizes from 10-300 eggs, and requires little parental care (Abraham, 1985). For bioaccumulative and energetic studies, *Fundulus* are large enough (1.5 – 7 g, subadults – 1 year olds) that SMRs and PCB tissue residues may be measured on individual fish.

3.2 Objectives

The objectives of this chapter are to present the results of a long-term (93 days) exposure study where *Fundulus heteroclitus* was exposed to dissolved MS-222 and a diet of PCB-spiked food and to discuss experimental changes for subsequent studies. This is the first in a series of three experiments that attempted to chemically alter fish standard metabolic rates, and to assess the consequences of those changes on bioaccumulation. Therefore, the results of this chapter have direct bearing on the experimental design and sampling protocol used in the subsequent experiments (Chapters 4 and 5).

The main objectives of this first experiment were: 1) to determine if SMRs were sensitive to sublethal concentrations of MS-222 (the model narcotic); 2) to ensure that background concentrations of Σ-PCB in the commercial trout chow did not produce confounding effects on SMR; and 3) to calibrate techniques. The study evaluated bioenergetic parameters (growth, lipid content, and standard metabolic rate) and bioaccumulation endpoints (total and congener-specific PCB tissue residues).

This experiment was designed to address the following hypotheses relative to controls:

- H_1 = Low level, chronic exposure to MS-222 will depress SMR of *F. heteroclitus*
- H_2 = Low level, chronic exposure to MS-222 will depress growth rates and biomass
- H_3 = Low level, chronic exposure to MS-222 will reduce lipid content and change lipid composition

- H_4 = Low level, chronic exposure to MS-222 will reduce consumption levels and lipid content leading to reduced PCB bioaccumulation measured in fish tissue
- H_5 = No significant differences will be detected in growth rates, fecundity, lipid content or cytochrome P4501a induction between test treatments due to different PCB concentrations.

3.3 Methods and Materials

3.3.1 Experimental design

The experiment followed a 2x4x3 factorial, random block design. Fish were exposed to four levels of dissolved MS-222 (0, 0.1, 1.0 and 10 mg/L), two levels of food treatments [1) control food = commercial trout chow containing background concentrations of total PCBs (30 ng/g d/w) and, 2) trout chow spiked with Aroclors 1232, 1248, and 1262 (235 ng/g dw total Aroclors)]. Sampling (see section 3.3.3) occurred on days 0, 7, 14, 28, 42, 56, 80 and 93. Each treatment was run in triplicate for a total of twenty-four aquaria. Subadult and adult fish were seined from a wild population at a reference site on the Patuxent River, MD. Fish were held in the experiment laboratory (same water and light conditions) in 100-L circular flow-through tanks for approximately one week prior to the start of the experiment, and were acclimated to the diet of pellet fish food (Zeigler's trout chow, Gardner, PA) twice a day. This was the same food used in the contaminant-amended food treatments. While in the holding tanks, fish were formalin-dipped to prevent bacterial growth or infection.

A week prior to day 0, aquaria were randomly placed on two racks (12 on the top, 12 on the bottom), and filled with filtered (< 0.5 μm), 20^{o}C ambient seawater. Salinity ranged from eight to twelve parts per thousand (ppt) throughout the course of the experiment. The flow-through system was allowed to flush the aquaria until the start of the experiment. On day 0, 24 fish were randomly placed into each 38-L aquaria (total number of fish = 576 at the start of the experiment). On day 1, fish were switched to the experimental diets and fed at a rate of 5% body weight per day. During the experiment, water was delivered to each aquarium at a flow rate of 200 mL/min. Each aquarium was aerated using air-stones. The experiment was conducted under 16 hours of fluorescent light and 8 hours of darkness. Aquaria were also loosely covered with black plastic on the sides of the racks of aquaria to minimize disturbance. Aquaria were periodically cleaned by suctioning debris off of the bottom, brushing down the side walls, and cleaning the exit weirs. Tubing that delivered water to each aquarium was replaced as needed.

3.3.2 Exposure treatments

3.3.2.1 *Food Treatment Preparations*

Food was prepared following the methods used by Gutahr-Gobell et al. (1999), and Matta et al. (2001). Two batches of 1000 g of trout chow (Zeigler's trout chow, Gardner, PA) were weighed and the control batch was spiked with 200 mL of methanol. The PCB-spiked batch was spiked with Aroclors 1232, 1248, and 1262 standards (Ultra Scientific, North Kingstown, RI) dissolved in 200 mL of methanol. Each batch was mixed thoroughly for 10 minutes under the laboratory venting hoods in pre-cleaned, solvent-rinsed steel bowls with steel spatulas. The batches were loosely covered with aluminum foil and allowed to dry under the hood overnight with occasional stirring to enhance evaporation of the methanol. After drying for 16 hours in the dark, the batches were placed in Ziploc bags and placed in the freezer until feeding. Prior to each feeding, the ration for each aquarium based on the number of fish was weighed. Across the course of the experiment, the ration was adjusted to account for growth and removal of biomass from previous sampling periods to maintain the ration of 5% body weight per fish (wet weight basis).

3.3.2.2 *MS-222 Treatments*

MS-222 (3-aminobenzoic acid ethyl ester methanesulfonate), purchased from Argent Laboratories (Redmond, WA), was used as a model narcotic chemical. MS-222 is used routinely to alter cardiovascular and metabolic rates in fish (McKim et al., 1987). MS-222 was used to establish the fish acute toxicity syndrome (FATS) for Type I (non-polar) narcotic chemicals (McKim et al., 1987). The chemical also acts as a sodium-channel blocker (Incardona et al., 2004), and prevents generation and conduction of nerve impulses (Alpharma, Animal Health Ltd., 2001). MS-222 is metabolized through the gills and kidney (Alpharma, Animal Health Ltd., 2001). The impact of MS-222 on the P450 enzyme systems seems to be species-dependent (Kolanczyk et al., 2003). In rainbow trout, MS-222 does not induce EROD or Cyp 1a over short time periods when used as an anesthetic (Kolanczyk, et al., 2003). Thus, MS-222 was used as a positive control of narcosis for examining whether it would affect fish standard metabolic rate at sublethal, chronic levels.

The MS-222 delivery system was a gravity-fed, flow-through system controlled with a header tank and clamp valves on flexible tubing. Seawater flowed into the header tank through four chemical-mixing reservoirs and finally into six separate aquaria. Opaque, food-grade, color-coded polyurethane tubing (1.6 mm ID, 3.2 mm OD tubing, Cole-Parmer, Vernon Hills, IL) fed each aquarium from the chemical mixing reservoirs. Opaque tubing was used to retard algal growth and photo-degradation of MS-222.

Stock solutions 0, 10, 1000, 10,000 mg/L of MS-222 were bled into the mixing reservoirs via silicon pump tubing (Masterflex L/S, Cole Parmer, Vernon Hills, IL) at 0.3 mL/min controlled with a multiple channel pump system (Masterflex L/S system, Cole-Parmer, Vernon Hills, IL), and then delivered to respective aquaria at concentrations of 0, 0.1, 1.0, and 10 mg/L (100 mL/min). Refrigerated DI water was delivered to the other set of aquaria at the same flow rate as experimental control. Stock solutions of MS-222 and control DI water were stored in 1-L glass amber jars held under constant refrigeration, and replenished every few days. Under these conditions, parent MS-222 remains stable in solution for approximately a month according to the manufacturer (Argent Laboratories).

3.3.3 Sampling procedures

On day 0, 15 fish were removed from the holding tank at the same time that experimental fish were placed into each aquarium. Ten individuals underwent baseline standard metabolic rate (SMR) evaluation. A composite of three fish (whole body) were used for the baseline PCB tissue analysis. The approved animal care protocol was followed for euthanizing fish humanely. On each subsequent sampling day (7, 14, 28, 42, 56, 80, and 93), three fish were removed from each aquarium. Each fish was used to evaluate standard metabolic rates. Afterwards, two fish were composited for chemical analysis (lipid and congener-specific PCB analysis), and one fish was used to evaluate cytochrome P450 induction on day 14 only.

3.3.3.1 Procedure for measuring standard metabolic rate

To evaluate chemical-induced stress, standard metabolic rate was measured on individual fish following methods previously described by Rowe (2003). Briefly, three fish from each aquarium were randomly captured and placed into individual 0.5 L plastic incubation containers with ~ 300 mL of their respective aquarium water. Fish were placed into the respirometry incubator (25 ^{o}C, dark), and held unfed for 24 hours to minimize activity and specific dynamic action respiration in preparation for measuring resting, or standard, metabolic rates. Following incubation, fish were transferred to 1 L glass test chambers with 300 mL of strained (to remove feces and bulk particulate matter) test water, and connected to the Micro Oxymax^{TM} respirometer system (Columbus Instruments). Oxygen depletion (minimum O_2 consumption rates or VO_{2min} or the minimum rate of oxygen consumption by individual fish at rest and after 24 hours of fasting) was measured by a computer-controlled, closed circuit mircrorespirometer at 1 hour intervals. Each chamber was sampled approximately seven times over a 24 - 36 hour period. The chambers refresh O_2 so the organisms have adequate oxygen throughout the experiment.

After SMR was measured, each fish was removed from the test chamber and anesthetized with an overdose of MS-222 (500 mg/L) in a seawater bath. Fish were measured for body length to nearest 0.5 mm, and weighed to the nearest 0.001 g and sexed. Two fish were then placed in pre-cleaned glass jars and frozen until extraction for lipid and PCB-congener analyses (each sample consisted of a composite of two fish, whole bodies).

3.3.3.4 *Procedure for biomarker (CYP1a P450) analysis*

The remaining fish was used to measure CYP1a P450 production in liver tissue following the methods of Van Veld et al. (1992). Briefly, fish were placed in a seawater ice bath until anesthetized. Then, they were quickly weighed, measured, sexed, and then decapitated. The liver was quickly removed, separated from the gall bladder, dipped in a 1.15% KCl buffer solution, placed in 2 mL cryovials, and flash-frozen in liquid nitrogen. Samples were maintained in a –80^{o}C freezer until analysis. CYP1a was measured on day 14 only. These fish were fasted and rested for 24 hours prior to removing livers.

3.3.4 PCB chemical analyses

In this preliminary study, two fish (whole body) from each tank were composited to reduce the number of chemistry samples analyzed for PCB and lipid content. An aliquot from each of the food treatments was also analyzed for PCB and lipid content. Each sample was homogenized and dried with sodium sulfate, and extracted using 24 hour Soxhlet extraction with dichloromethane (Baker et al., 1997). Prior to extraction, each sample was spiked with surrogates 3,5-dichlorobiphenyl and 2,3,4,4',5,6'-hexachlorobiphenyl (PCB IUPAC congeners 14 and 166, respectively). Recoveries of PCB 14 and 166 averaged 83% (± 27 %) and 70% (± 27 %) respectively. All chromatographic peaks were hand-integrated to accurately assess recoveries. Blank sodium sulfate samples were run in parallel with each Soxhlet extraction to quantify laboratory background contamination. Contamination was minimal, and thus reported congeners were not blank-corrected. Σ-PCBs reported are the sum of 95% of the congener peaks (individual PCB congeners or unresolved congener groups).

Samples were concentrated to approximately 1 mL via roto-evaporation, and lipids removed via gel permeation chromatography (GPC). A subsample of approximately 0.5 ml was removed for gravimetric determination of tissue lipid content prior to GPC injection. Samples were concentrated to 1 ml for final cleanup using Florisil solid:liquid chromatography. Samples were concentrated and transferred to amber auto-sampler vials (ASVs), and internal standards 2,4,6-trichlorobiphenyl and 2,2',3,4,4',5,6,6'-octachlorobiphenyl (PCBs 30 and 204, respectively) were added to each sample prior to PCB quantification using gas chromatography with electron capture detection (GC/ECD).

A 2 ul portion of the concentrated sample extract was eluted with hydrogen through a 60 m x 0.320 mm I.D. capillary column with a 0.25um 5% diphenyl/95% dimethylpolysiloxane film (J&W Scientific #1235062 DB5). On exiting the column, the eluting compounds passed through a ^{63}Ni electron capture detector, generating responses for compounds identified using a calibration standard. PCBs were quantified on an individual congener basis following Mullin et al. (1984). Congeners were identified by retention time relative to two internal standards (PCBs 30 and 204). Sample congeners were quantified using relative response factors (RRF), the product of mass:response ratio of the congener in the calibration standard and the response:mass ratio of the internal standard in the calibration standard. The mass of the congener in each sample was then calculated as the product of the RRF, the internal standard mass in the sample, and the congener response:internal standard response ratio for the sample. Concentrations were calculated as the quotient of the mass in the sample extract divided by the mass extracted (corrected gravimetrically for subsampling).

3.3.5 Data analyses

For each sampling day, all measured responses [weight, length, standard metabolic rate (SMR), gonad-somatic indices (% egg mass per female pass), fraction lipid, and total PCB bioaccumulation] were analyzed by analysis of variance (ANOVA) (Minitab, 2000). For SMR, fish body weight (g wet weight) was analyzed as a covariate (ANCOVA). Data were tested for normality prior to analyses allowing for non-transformed data, and the use of parametric tests. The analysis tested two fixed factors: MS-222 (i) and PCB(j), and their interactions (ij). The MS-222 factor tested 4 levels (1 = 0, 2 = 0.1, 3 = 1.0, and 4 = 10 mg/L MS-222). The PCB factor tested two levels (0 = control food, 1 = PCB-spiked food). All tests employed the ANOVA general linear model (GLM) for each time point where Response(ijk) =μ + ai + bj + abij + εk(ij) (Minitab, 2000).

Standard metabolic rates ($V_{O2\ min}$, the minimum rate of oxygen consumption by individual fish at rest and after 24 hours of fasting) were measured as a physiological response to chronic exposure to narcotic chemicals. In the respirometer chambers, periods of hyperactivity affect sample means. All of the data presented here are averages of the lower 50% of measurements for each individual per sampling event to eliminate the confounding influence of measurements during periods of activity

(Rowe, 2003). Reported results in SMR are reported in J/g-d by converting the measured $V_{O2\ min}$ by assuming 1 mL O_2 consumed equals 20.08 J (Rowe, 2003).

3.4 Results

3.4.1 PCBs in the Food

The two food treatments were characterized for individual PCB congeners to verify and quantify dietary exposures to fish. Figure 3.1 depicts the PCB profiles of 43 congeners (chromatographic peaks) measured in the food batches. The control food treatment contained 30 ng/g w/w (n = 1) and 11% lipid. For the PCB-spiked treatment, the Σ-PCB concentration was 235 ng/g (n = 1) with 14% lipid, one order of magnitude above the control food.

3.4.2 Impacts on survival, growth and reproductive parameters

Fish survival throughout the experiment was above 90% in all of the treatments. (See Table 3.1 for aquarium and treatment survival.) Curiously, all of the treatments with MS-222 had statistically higher survival rates than the control groups ($p = 0.008$). For the treatments fed the control food, survival rates were 93, 100, 100, and 99% for the 0, 0.1, 1.0, and 10 mg/L MS-222 exposures, respectively. For the treatments fed the PCB-spiked food, survival rates were 92, 99, 100, and 97% for the 0, 0.1, 1.0, and 10 mg/L MS-222 exposures, respectively.

Fish weight and length measurements were not statistically different among the treatments (see Tables 3.2 and 3.3 and Figures 3.2 and 3.3 for ANOVA results). However, there were some exceptions. On day 93, median fish weight and length significantly decreased in the control group (0 MS-222 and control food, $p = 0.003$)

and in the group fed PCB-spiked food and exposed to the lowest concentration of MS-222 (0.1 MS-222 and PCB spiked food, $p < 0.0001$). See Tables 3.2 and 3.3 for the full hypothesis testing using Tukey's pairwise comparisons (at the 95% confidence interval, Minitab, 2000).

The focus of the study was not on reproductive endpoints. However, the percentage of gravid females was documented for each time point (See Table 3.4). Also, the gonad-somatic index (GSI) (egg mass per female mass * 100) was calculated on days 28, 42, 56 and 93. The number of individuals from each treatment was pooled in order to have numbers available for conducting statistical analysis, and thus, limited inference will be drawn from the results of the reproductive output (See Table 3.4). Figure 3.4 plots the percent gravid females per treatment per time point. There was no statistical difference ($p >> 0.05$) in GSI across treatments on any of the time points measured (see Table 3.4 for ANOVA results). Because reproductive output was not the primary assessment, the experimental design was not adequate (i.e., too few females per tank) to adequately address whether there were treatment effects on percent gravid females and on GSI.

3.4.3 Impacts on Standard Metabolic Rate

Standard metabolic rates (SMR) of individual fish were measured on days 0, 14, 28, 42 and 56. Unfortunately, the oxygen sensor on the Oxymax Respirometer was being serviced for the day 80 and 93 time points, and was one of the reasons for repeating the MS-222 exposures in Experiments 2 (Chapter 4) and 3 (Chapter 5). Figure 3.5 depicts SMR (J/g-d) versus time. (See Table 3.5 for the ANOVA results.) Due to lack of differences among the groups fed the control and PCB-spiked food, the groups were pooled according to MS-222 levels. On days 42 and 56, there was a significant main effect from the MS-222 ($p = 0.035$ and 0.018, respectively). On days 42 and 56 SMR were reduced between the highest MS-222 level (10 mg/L) and the control level (0 mg/L), $p = 0.0595$ and $p = 0.0329$, respectively. On day 42, the highest MS-222 level (10 mg/L) was significantly lower ($p = 0.0411$) relative to the lowest MS-222 (0.1 mg/L) (see Table 3.5).

3.4.4 Impacts on lipid and PCB bioaccumulation

Figure 3.6 plots the Σ-PCB concentrations in fish tissue across the course of the experiment. From day 14 forward, more PCBs accumulated in the treatments fed the PCB-spiked food (see Table 3.6). However, there was no MS-222 induced effect on PCB accumulation. Although not statistically significant, in both the food treatments MS-222 seemed to increase the variability in PCB body burdens. There were no significant differences detected in lipid content among the treatments (Figure 3.7, Table 3.7).

There was no overall significant correlation between fraction lipid and PCB concentrations. There were weak correlations on days 56, 80 and 93 when the Pearson's coefficients were 0.233, 0.388 and 0.276, respectively. Corresponding p-values were 0.28, 0.074, and 0.20. Due to the general lack of correlation, PCB concentrations were not lipid-normalized overall. However, on day 93, Figure 3.8 plots the lipid-normalized bioaccumulation factors (BAF) [(PCB congener in tissue/fraction lipid)/(PCB congener in food/fraction lipid)] vs. log K_{OW}. In the control food, there is no difference in bioaccumulation (top panel). In the treatments exposed to the highest levels of MS-222 (10 mg/L), BAFs were consistently higher than the treatments exposed to 0 MS-222. With the added contaminant, MS-222 enhanced PCB accumulation. (This also occurs in Chapter 5 when fish are exposed to MS-222 and polycyclic aromatic hydrocarbons.) Overall, the spiked food was not a good representation of reality where the spiked food is seven fold higher than the control food, yet the fish body burdens are only a factor of 2-3 fold. .

3.4.5 Biomarker Induction

Livers extracted on day 14 were analyzed for Cytochrome P4501A induction by Van Veld and Rutan. There were no significant differences detected (See Table 3.8). The other time points were not analyzed due to lack of replication, and because this endpoint was not the focus of the research.

3.5 Discussion

The main objectives of this study were to examine whether sublethal levels of a known narcotic agent (MS-222) would depress standard metabolic rates in fish at detectable levels, to demonstrate that low concentrations of PCBs (30 ng/g-d/w) in commercial trout chow would not influence test parameters, and to evaluate whether spiking commercially available trout chow produced realistic bioaccumulation of PCBs in exposed fish. The general lack of significant differences among the control treatments and experimental treatments for survival, growth (weight and length), and reproductive parameters demonstrate that the fish were behaving and growing adequately and that the PCBs in the control food did not affect these endpoints. The MS-222 did result in higher survival rates than the control, but all of the survival rates were above 90%.

The one exception to the lack of effects was in the treatment groups exposed to the lowest level of MS-222 on day 93. The group fed the control food was statistically heavier and longer than the other treatments fed the control food. This group was statistically similar to the treatments fed the PCB-spiked food and exposed to 0, 1.0 and 10 MS-222. See Table 3.2 and 3.3 for specific p values using Tukey's comparisons (95% confidence level). The group exposed to the lowest level of MS-222 and fed the PCB-spiked diet, was statistically smaller (on average 30% lighter and 10% shorter) than the other groups exposed to MS-222 within this treatment. This group was also 35% lighter and 13% shorter than the group exposed to the same MS-222 level and fed the control food. Low dose of MS-222 with background contaminants seems to stimulate growth. However, with higher concentrations of co-contaminants (e.g., PCBs), the low dose of MS-222 seems to have a depressed growth. Except for this MS-222 level (0.1 mg/L), the groups fed the PCB-spiked food were larger than the groups fed the control food on day 93 (Figures 3.2 and 3.3). The lipid data support these trends but are not statistically different in any of the sampling events, including that on day 93. This is partly because the lipid data are composite samples of two fish per lipid extraction making the endpoint less sensitive than the weight or length endpoint.

On days 42 and 56, the fish exposed to highest level of MS-222 (10 mg/L) exhibited statistically significant depressed standard metabolic rates relative to control fish (0 mg/L MS-222). These results partially supported the hypothesis that low level exposures of MS-222 would depress SMR. However, there was not a gradient effect as anticipated, thus the primary objective of demonstrating a gradient-induced depression of SMR was not met. The obvious thought was that the MS-222 gradient was too low, and that 10 mg/L was the lowest observable effect concentration. In this study, 10 mg/L was chosen as the highest dose level because others had reported anesthetizing *Fundulus* at 15 – 50 mg/L (Matta et al., 2001). McKim et al. (1987) significantly depressed respiration in rainbow trout at MS-222 exposure concentrations of 50 mg/L. Additionally, I had conducted some preliminary beaker studies to corroborate that 50 mg/L altered the swimming behavior of *Fundulus*. The water concentrations of MS-222 were not measured, so the degradation of MS-222 in the water column could have been faster than predicted, and exposures lower than reported. After the day 56 sampling event, the Oxymax respirometer was out of service, thus it was impossible to determine whether this effect would continue or if the lower level exposures would diverge from the control after longer exposures without conducting another test.

There were no statistical differences in PCB body burdens of the fish over the course of the experiment due to the influence of MS-222. The groups fed the PCB-spiked diet accumulated statistically higher levels of PCBs than the groups fed the control fed, as expected. Thus, the main objective of controlling for PCB effects in the control food was satisfactorily met. The fish fed the trout chow spiked with PCB Aroclors resulting in a diet with PCB concentrations an order of magnitude higher than background concentrations did not exhibit demonstrable PCB-induced effects.

However, the PCB body burdens reported here resulted in changes in the dietary exposures and chemical analyses in subsequent studies. First of all, since this was intended to be a pilot study, composite fish samples (2 fish per aquarium per sampling event) were analyzed for lipid and PCB concentrations in order to minimize the number of chemistry samples. This resulted in variability and diminished statistical power. This potentially masked any effects the MS-222 may have had on accumulation. Secondly, although the fish fed the PCB-spiked diet accumulated more PCBs than the fish fed the control food, the differences were less than expected. The two food levels were different by one order of magnitude but the body burdens only varied by a factor of two suggesting that the artificially spiked-diet had reduced bioavailability compared to the "naturally contaminated" diet consisting of background concentrations of PCBs.

Figure 3.8 shows the difference in bioavailability between the two sources of PCB to the fish at the end of the experiment. Although there is variability in the lipid normalized bioaccumulation factors in both exposures, the fish fed the control food have an order of magnitude higher BAFs than the fish fed the diet spiked with PCBs. Additionally, MS-222 influenced accumulation in the artificially spiked diet by enhancing accumulation of PCBs relative to the group fed the PCB-spiked diet with no MS-222 exposure. Given the lack of influence from the MS-222 on PCB accumulation and the error associated with composite samples, all that can be concluded is that MS-222 potentially affects accumulation and that the two different forms of PCBs presented to the fish are reflected in the differences in bioaccumulation factors. Additionally, "naturally contaminated diets" are a more labile source of contaminant than the artificially contaminated diet. The results here led to using a naturally contaminated diet in the next two studies (Chapters 4 and 5) and in the larger Chesapeake Ecotoxicology Research Program experiments.

3.6 Conclusions and next steps

The results of this study guided the experimental designs for the experiments described in Chapters 4 and 5. Not all of the questions regarding the influence of MS-222 on standard metabolic rates were answered satisfactorily, and the choice food had some complicating factors. Thus, the following elements are addressed in the subsequent experiments:

1. Increase MS-222 gradient: the gradient of MS-222 used in this study seemed to be too low to induce a dose-response curve for standard metabolic rate as originally intended.
2. Validate observation that MS-222 (10 mg/L) reduces SMR: the apparent reduction of SMR detected on days 42 and 56 should be validated as real effects at the 10 mg/L exposure concentration before conducting another long term study investing in SMR as a metric for assessing sublethal narcosis.
3. Change food source: the lower than expected accumulation of PCBs in the fish fed the PCB-spiked diet and the lower bioaccumulation factors suggest that in future studies that use diet as a source of contaminant exposures should use a naturally contaminated food source rather than an artificially spiked food.
4. Analyze individual fish tissues rather than composites: chemical analysis should be conducted on individuals rather than composite samples in order to increase statistical power. Additionally, the number of sampling events could be reduced to increase the number of fish analyzed from each aquarium in

order to maintain a manageable experiment in terms of numbers of fish needed, tank size, and food needed.

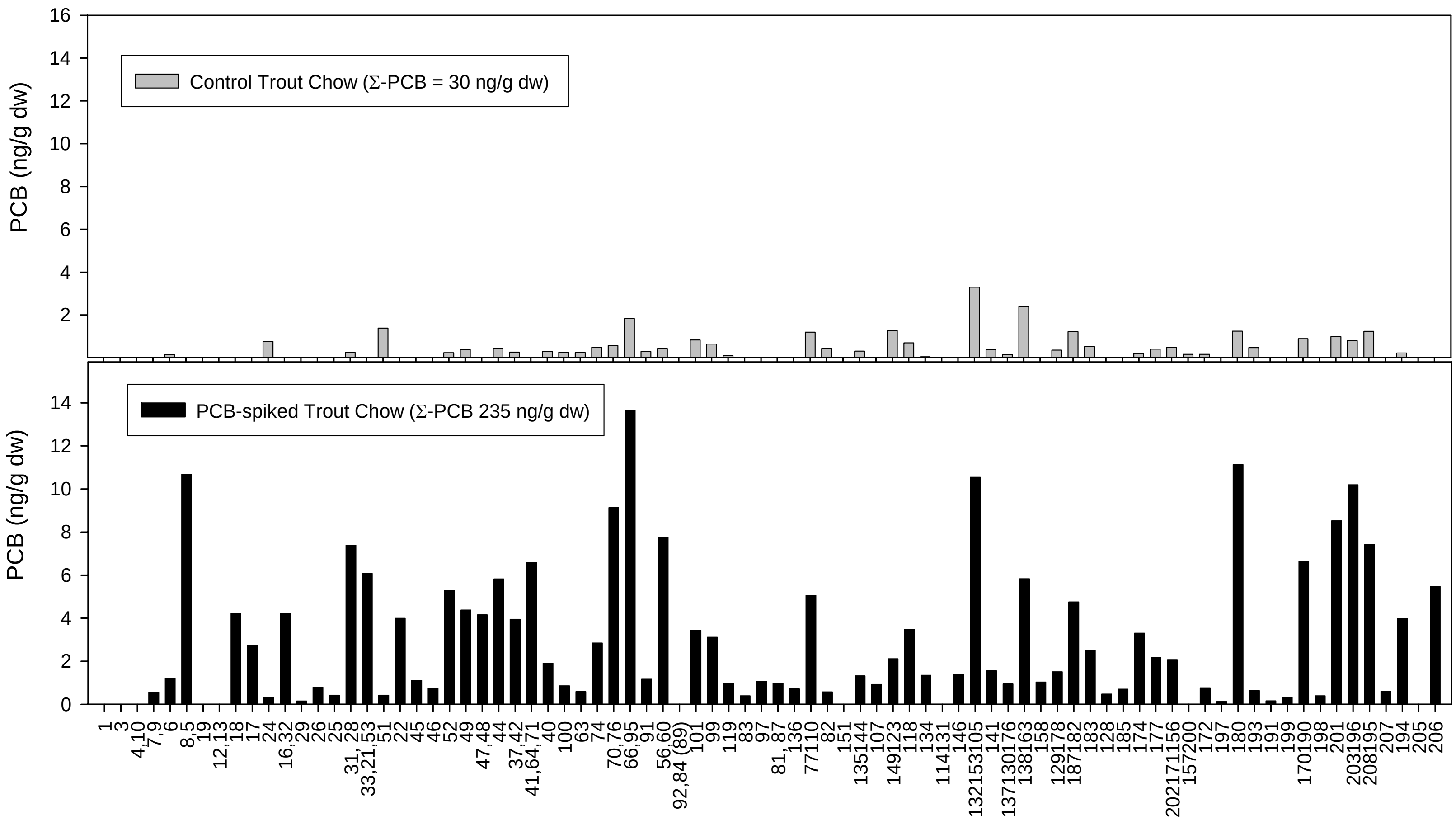

Figure 3.1. PCB food profiles for the two food treatments. The control trout chow contains background concentrations of Σ-PCBs of 30 ng/g d/w (% lipid = 11%, n = 1). The PCB-spiked trout chow was spiked with Aroclors 1232, 1248, and 1262 and contains Σ-PCBs of 235 ng/g d/w (% lipid = 14%, n = 1).

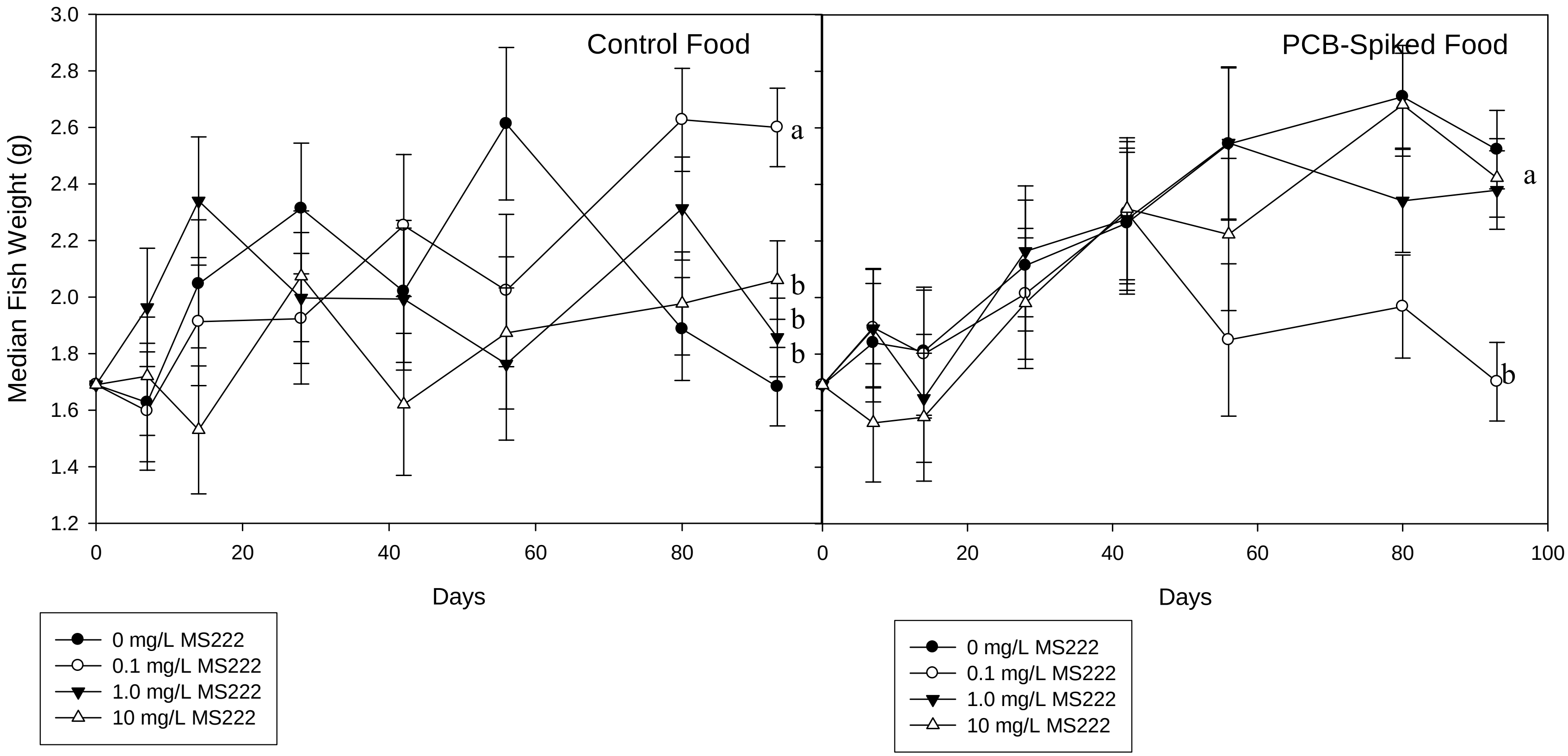

Figure 3.2. Median fish weight (g) of fish exposed to aqueous MS-222 concentrations of 0, 0.1, 1.0 and 10 mg/L for 93 days. Error bars represent ± 1 standard error of the least square means from ANOVA general linear model. N = 3 tanks medians (each tank contained n = 3 fish/tank). Different letters denote significant differences ($p < 0.05$). See Table 3.2 for p-values in Tukey comparisons.

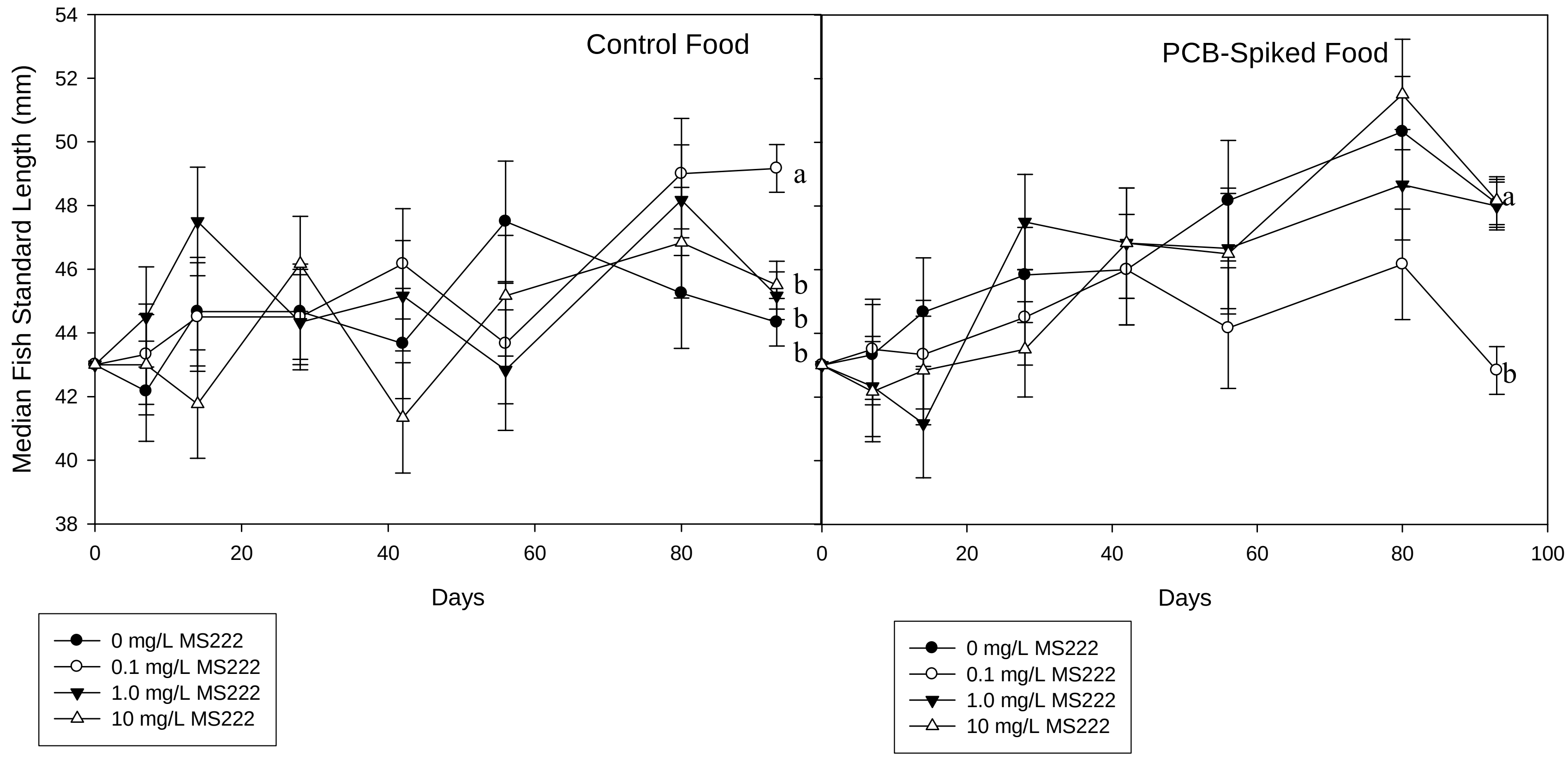

Figure 3.3. Median fish length (g) of fish exposed to aqueous MS-222 concentrations of 0, 0.1, 1.0 and 10 mg/L for 93 days. Error bars represent ± 1 standard error of the least square means from ANOVA general linear model. N = 3 tanks medians (each tank contained n = 3 fish/tank). Different letters denote significant differences ($p < 0.05$). See Table 3.2 for p-values in Tukey comparisons.

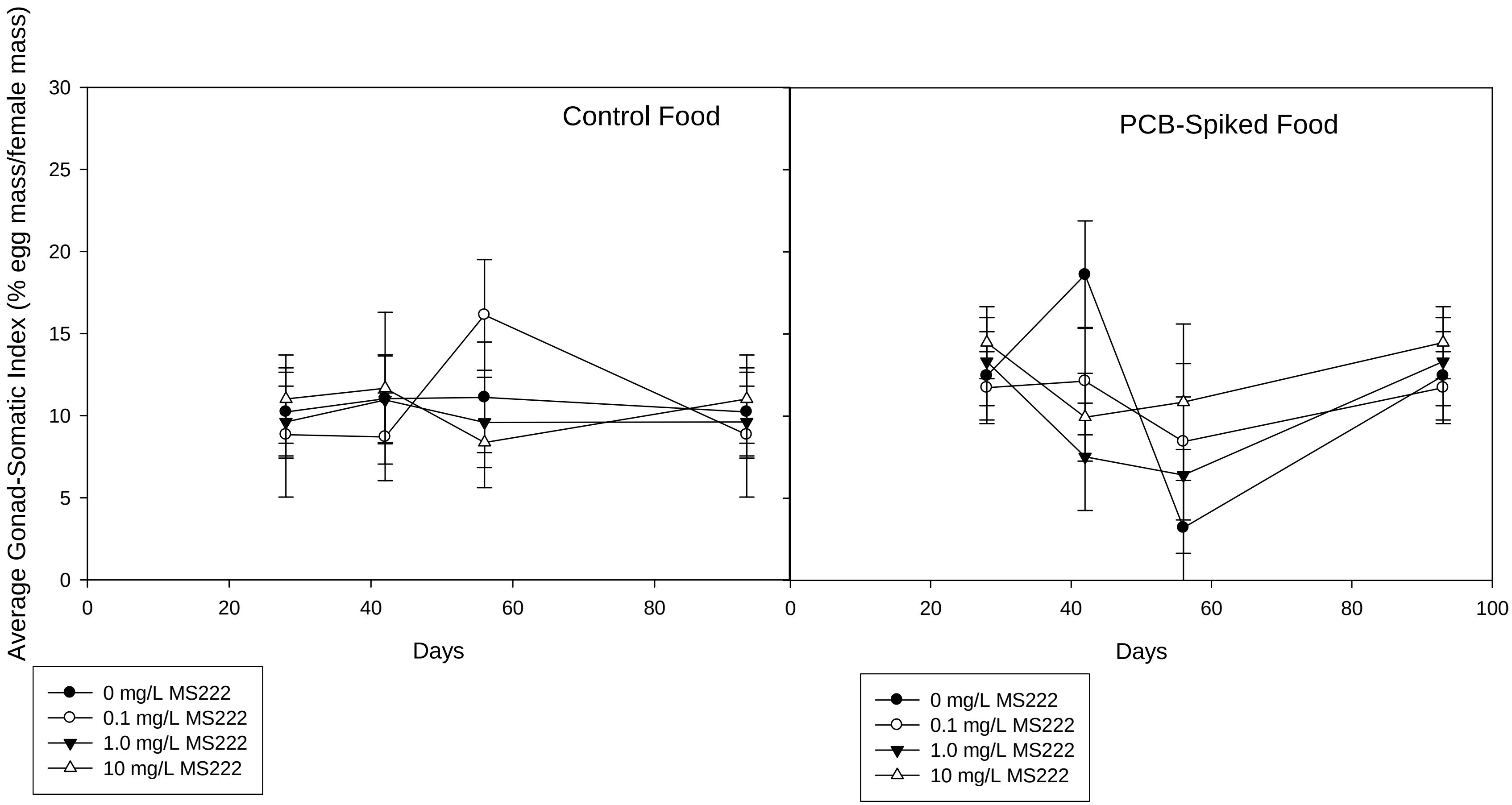

Figure 3.4. Average gonad-somatic index of fish exposed to aqueous MS-222 concentrations of 0, 0.1, 1.0 and 10 mg/L for 93 days. Error bars represent ± 1 standard error of the least square means from ANOVA general linear model. See Table 3.4 for n values and statistical results.

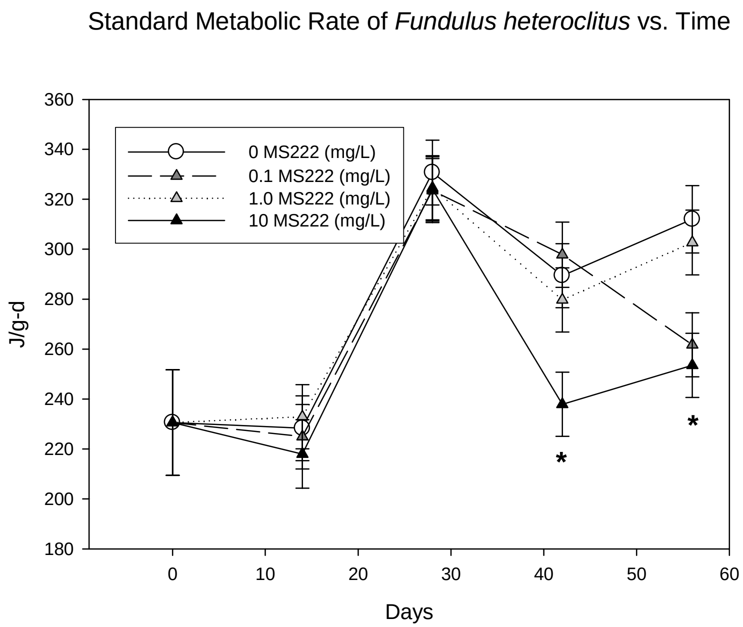

Figure 3.5. Average standard metabolic rates (J/g-d) of fish exposed to aqueous MS-222 concentrations of 0, 0.1, 1.0 and 10 mg/L for 56 days. Error bars represent ± 1 standard error of the least square means from ANOVA general linear model. * denotes a significant difference from control treatments ($p < 0.05$). See Table 3.6 for p-values in Tukey comparisons.

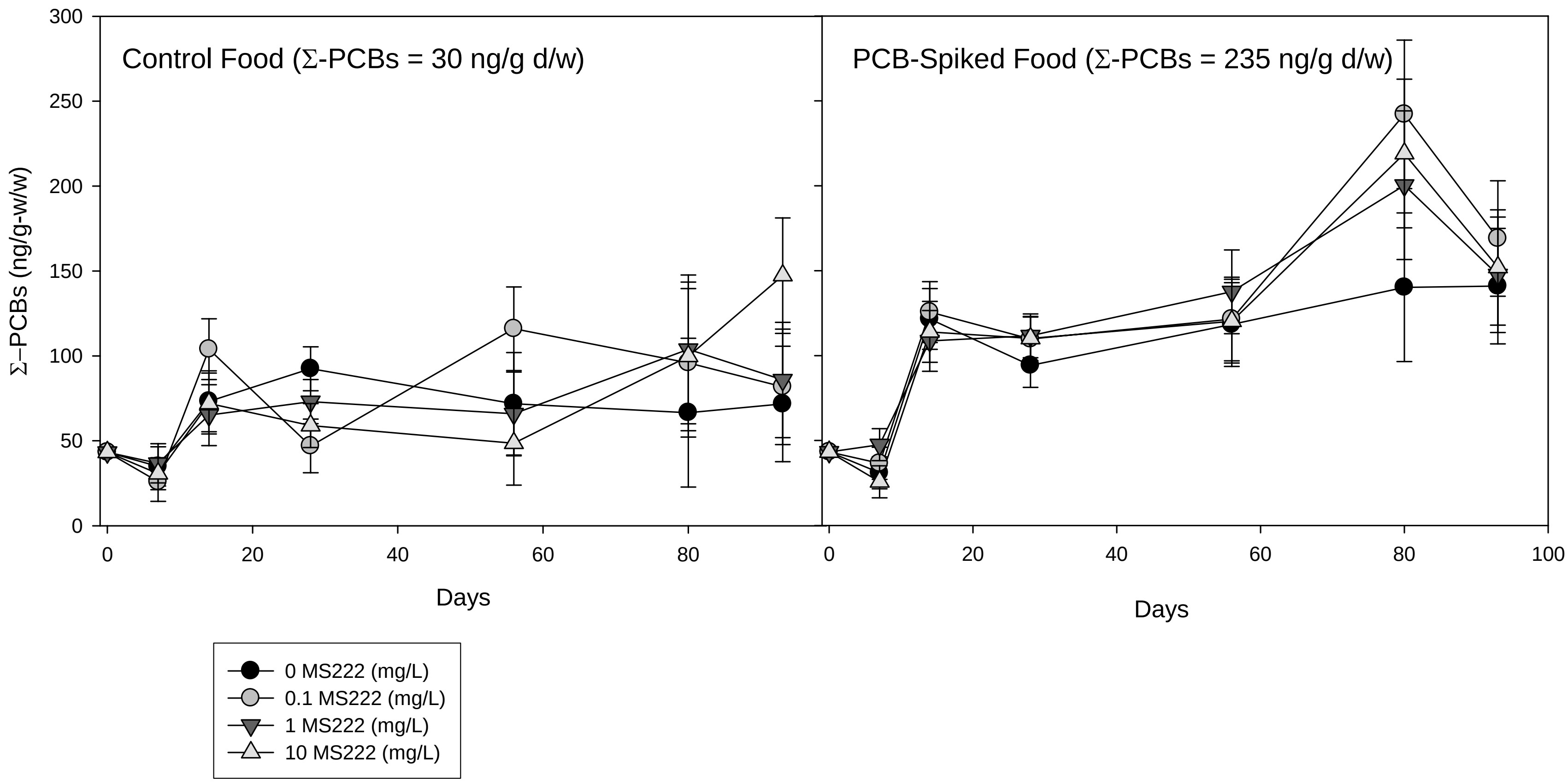

Figure 3.6. Average tissue concentrations of Σ-PCBs ng/g w/w of fish exposed to aqueous MS-222 concentrations of 0, 0.1, 1.0 and 10 mg/L for 93 days. Error bars represent ± 1 standard error of the least square means from ANOVA general linear model. N = 3 tanks means (each tank contained composites of 2 fish/tank).

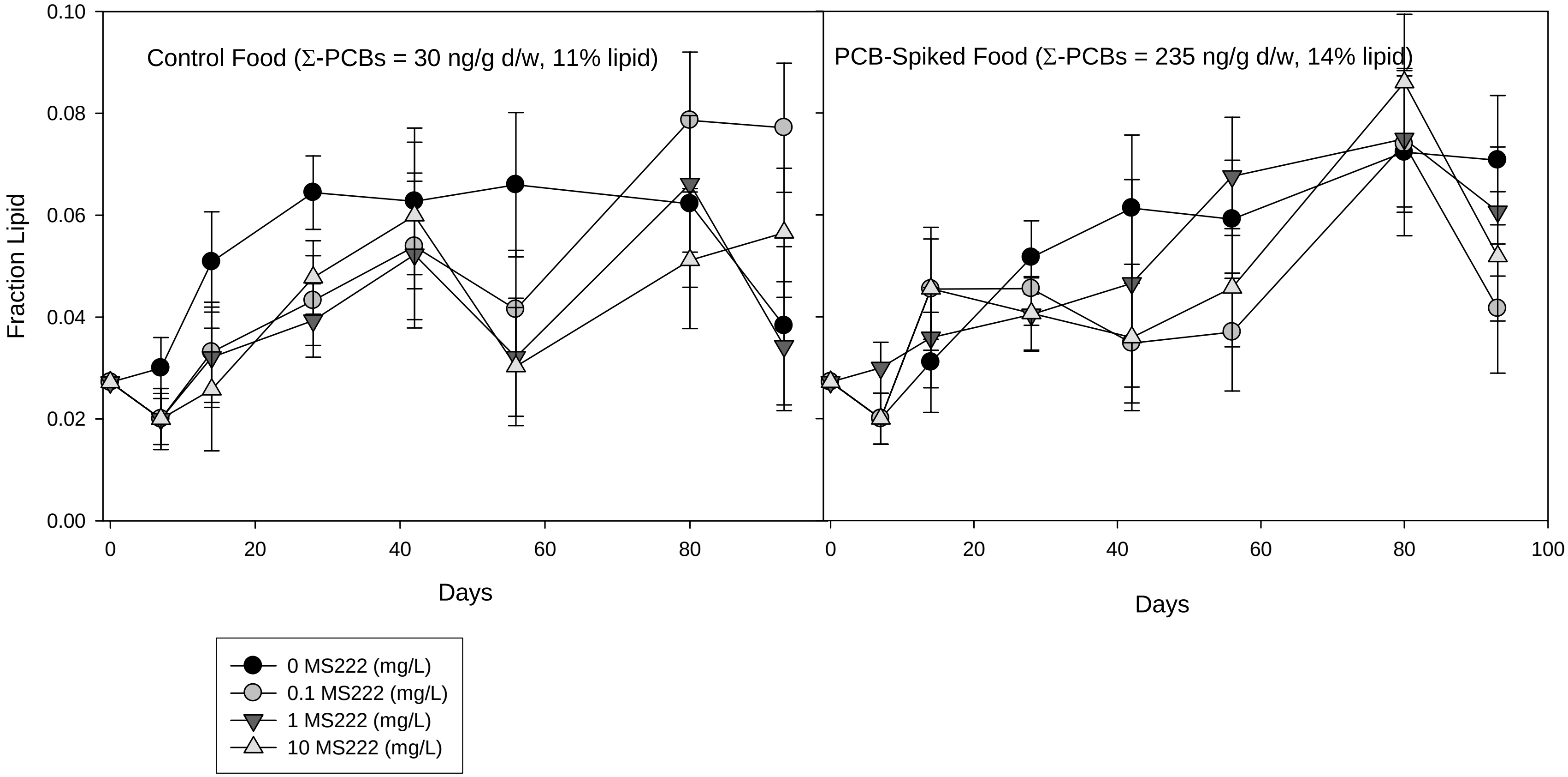

Figure 3.7. Average fractions of lipid of fish exposed to aqueous MS-222 concentrations of 0, 0.1, 1.0 and 10 mg/L for 93 days. Error bars represent ± 1 standard error of the least square means from ANOVA general linear model. N = 3 tanks means (each tank contained composites of 2 fish/tank).

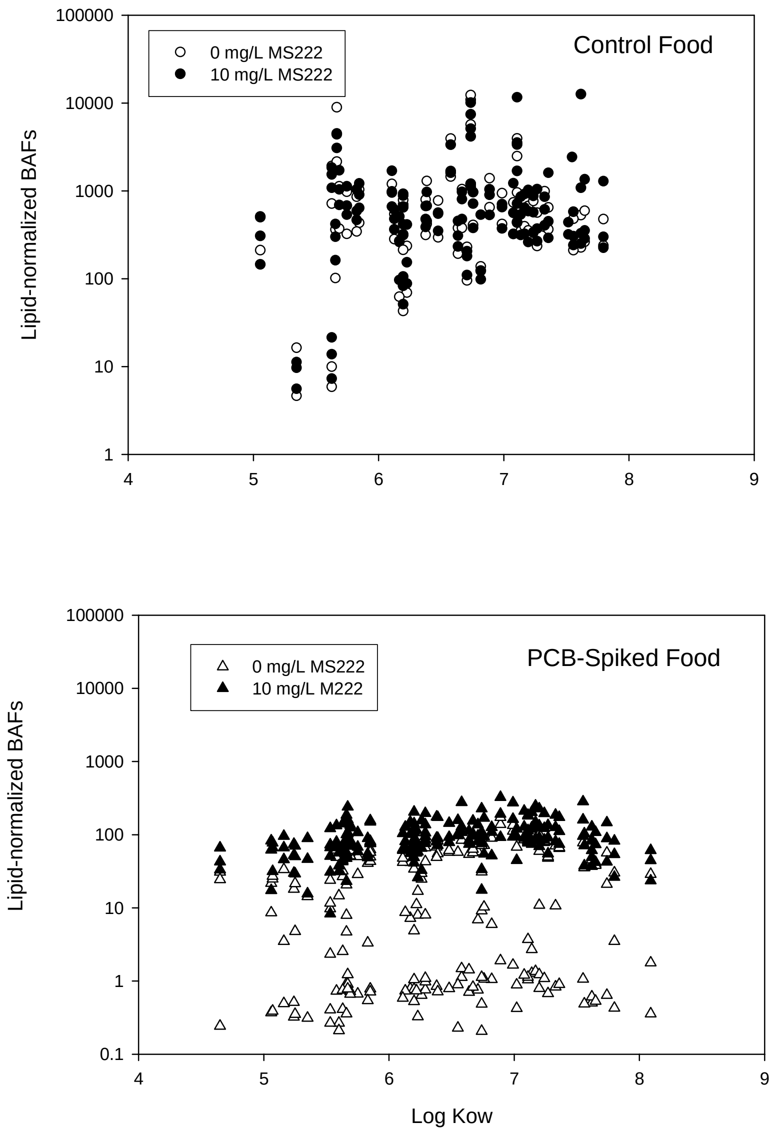

Figure 3.8. PCB-congener lipid-normalized bioaccumulation factors (BAFs). BAF = (concentration of PCB_i in fish/fish lipid fraction)/ (concentration of PCB_i in food/food lipid fraction) for Day 93. The BAFs from the control food are an order of magnitude higher than from the PCB-spiked food.

TABLE 3.1 Survival

Treatments for 93 day Exposure Experiment

MS222 concentration in tank water		**PCB concentration in food (ng/g d/w)**		
1 =	**0 mg/L**	**Control Food**	**0 =**	**30**
2 =	**0.1 mg/L**	**PCB-Spiked Food**	**1 =**	**235**
3 =	**1.0 mg/L**			
4 =	**10 mg/L**			

Tank counts - Survival

Tank	tank count	MS222	PCB	MS222	PCB	trt count	% survival
1	24	2	0	1	0	67	93
2	24	4	0	2	0	72	100
3	24	3	0	3	0	72	100
4	21	1	0	4	0	71	99
5	23	1	1	1	1	66	92
6	22	4	0	2	1	71	99
7	24	2	0	3	1	73	100
8	24	3	1	4	1	70	97
9	23	4	1				
10	24	2	1				
11	24	3	0				
12	24	3	1				
13	24	3	0				
14	23	4	1				
15	22	1	0				
16	25	4	0				
17	24	4	1				
18	23	2	1				
19	24	3	1				
20	24	2	0				
21	22	1	1				
22	24	2	1				
23	21	1	1				
24	24	1	0				

MS222 significantly ($p = 0.008$) enhanced survival

TABLE 3.2

Analysis of Variance for Median Fish Weight (g)

Factor	Type	Levels	Values
MS222	Fixed	4	1 2 3 4
PCB	Fixed	2	0 1

Treatments for 93 day Exposure Experiment

MS222 concentration in tank wa		PCB concentration in food (ng/g d/w)		
1 =	0 mg/L	Control Food	0 =	30
2 =	0.1 mg/L	PCB-Spiked Food	1 =	235
3 =	1.0 mg/L			
4 =	10 mg/L			

n = number of tanks (avg of 3 fish/tank)

Day	Source	DF	F	P	MS222	PCB	Anaylyzed median Weight (g)	SE	n
7	MS222	3	0.66	0.587	1	0	1.627	0.209	3
	PCB	1	0.21	0.65	2	0	1.597	0.209	3
	MS222*PCB	3	0.56	0.649	3	0	1.963	0.209	3
	Error	16			4	0	1.720	0.209	3
	Total	23			1	1	1.840	0.209	3
					2	1	1.893	0.209	3
					3	1	1.890	0.209	3
					4	1	1.557	0.209	3
14	MS222	3	2.44	0.138	1	0	2.047	0.227	3
	PCB	1	1.47	0.261	2	0	1.913	0.227	3
	MS222*PCB	3	0.99	0.42	3	0	2.340	0.227	3
	Error	16			4	0	1.530	0.227	3
	Total	23			1	1	1.810	0.227	3
					2	1	1.800	0.227	3
					3	1	1.643	0.227	3
					4	1	1.577	0.227	3
28	MS222	3	0	0.956	1	0	2.313	0.231	3
	PCB	1	0.41	0.748	2	0	1.923	0.231	3
	MS222*PCB	3	0.26	0.851	3	0	1.997	0.231	3
	Error	16			4	0	2.073	0.231	3
	Total	23			1	1	2.113	0.231	3
					2	1	2.013	0.231	3
					3	1	2.163	0.231	3
					4	1	1.980	0.231	3
42	MS222	3	3.19	0.093	1	0	2.020	0.251	3

Day	Source	DF	F	P	MS222	PCB	Weight (g)	SE	n		
	PCB	1	0.51	0.681	2	0	2.253	0.251	3		
	MS222*PCB	3	0.59	0.632	3	0	1.993	0.251	3		
	Error	16			4	0	1.620	0.251	3		
	Total	23			1	1	2.263	0.251	3		
					2	1	2.300	0.251	3		
					3	1	2.277	0.251	3		
					4	1	2.314	0.251	3		
56	MS222	3	1.36	0.26	1	0	2.613	0.269	3		
	PCB	1	2.17	0.132	2	0	2.023	0.269	3		
	MS222*PCB	3	1.32	0.304	3	0	1.763	0.269	3		
	Error	16			4	0	1.873	0.269	3		
	Total	23			1	1	2.543	0.269	3		
					2	1	1.850	0.269	3		
					3	1	2.547	0.269	3		
					4	1	2.223	0.269	3		
80	MS222	3	3.04	0.1	1	0	1.887	0.182	3		
	PCB	1	0.02	0.996	2	0	2.627	0.182	3		
	MS222*PCB	3	7.07	0.003	3	0	2.313	0.182	3		
	Error	16			4	0	1.977	0.182	3		
	Total	23			1	1	2.710	0.182	3		
					2	1	1.968	0.182	3		
					3	1	2.342	0.182	3		
					4	1	2.682	0.182	3		
										Hypothesis Tests	p value
93	MS222	3	4.45	0.051	1	0	1.683	0.139	3	1*0 < 1*1	0.0104
	PCB	1	0.4	0.756	2	0	2.600	0.139	3	1*0 < 2*0	0.0049
	MS222*PCB	3	15.1	0	3	0	1.857	0.139	3	1*0 < 3*1	0.0426
	Error	16			4	0	2.060	0.139	3	1*0 < 4*1	0.028
	Total	23			1	1	2.523	0.139	3	2*0 > 2*1	0.0059
					2	1	1.702	0.139	3	2*0 > 3*0	0.0271
					3	1	2.380	0.139	3	2*1 < 1*1	0.0125
					4	1	2.423	0.139	3	2*1 < 4*1	0.0335

TABLE 3.3

Analysis of Variance for median Fish Length (mm)

Factor	Type	Levels	Values
MS222	**Fixed**	**4**	**1 2 3 4**
PCB	**Fixed**	**2**	**0 1**

Treatments for 93 day Exposure Experiment

MS222 concentration in tank water	
1 =	**0 mg/L**
2 =	**0.1 mg/L**
3 =	**1.0 mg/L**
4 =	**10 mg/L**

PCB concentration in food (ng/g d/w)		
Control Food	**0 =**	**30**
PCB-Spiked Food	**1 =**	**235**

n = number of tanks (avg of 3 fish/tank)

Day	Source	DF	F	P	MS222	PCB	Length (mm)	SE	n
7	MS222	3	0.16	0.925	1	0	42.17	1.5734	3
	PCB	1	0.14	0.713	2	0	43.33	1.5734	3
	MS222*PCB	3	0.41	0.748	3	0	44.5	1.5734	3
	Error	16			4	0	43	1.5734	3
	Total	23			1	1	43.33	1.5734	3
					2	1	43.5	1.5734	3
					3	1	42.33	1.5734	3
					4	1	42.17	1.5734	3
14	MS222	3	1.78	0.201	1	0	44.6667	1.70453	3
	PCB	1	0.76	0.534	2	0	44.5	1.70453	3
	MS222*PCB	3	1.85	0.179	3	0	47.5	1.70453	3
	Error	16			4	0	41.7667	1.70453	3
	Total	23			1	1	44.6667	1.70453	3
					2	1	43.3333	1.70453	3
					3	1	41.1667	1.70453	3
					4	1	42.8333	1.70453	3
28	MS222	3	0.16	0.70	1	0	44.6667	1.4942	3
	PCB	1	0.33	0.80	2	0	44.5	1.4942	3
	MS222*PCB	3	1.33	0.30	3	0	44.3333	1.4942	3
	Error	16			4	0	46.1667	1.4942	3
	Total	23			1	1	45.8333	1.4942	3
					2	1	44.5	1.4942	3
					3	1	47.5	1.4942	3
					4	1	43.5	1.4942	3
42	MS222	3	3.63	0.075	1	0	43.667	1.7321	3

Day	Source	DF	F	P	MS222	PCB	Length (mm)	SE	n		
	PCB	1	0.62	0.612	2	0	46.167	1.7321	3		
	MS222*PCB	3	0.93	0.449	3	0	45.167	1.7321	3		
	Error	16			4	0	41.333	1.7321	3		
	Total	23			1	1	46	1.7321	3		
					2	1	46	1.7321	3		
					3	1	46.833	1.7321	3		
					4	1	46.833	1.7321	3		
56	MS222	3	1.4	0.254	1	0	47.5	1.893	3		
	PCB	1	1.6	0.229	2	0	43.667	1.893	3		
	MS222*PCB	3	0.33	0.802	3	0	42.833	1.893	3		
	Error	16			4	0	45.167	1.893	3		
	Total	23			1	1	48.167	1.893	3		
					2	1	44.167	1.893	3		
					3	1	46.667	1.893	3		
					4	1	46.5	1.893	3		
80	MS222	3	2.28	0.15	1	0	45.25	1.73481	3		
	PCB	1	0.34	0.799	2	0	49	1.73481	3		
	MS222*PCB	3	2.33	0.113	3	0	48.167	1.73481	3		
	Error	16			4	0	46.833	1.73481	3		
	Total	23			1	1	50.333	1.73481	3		
					2	1	46.167	1.73481	3		
					3	1	48.667	1.73481	3		
					4	1	51.5	1.73481	3		
										Hypothesis Tests	p value
93	MS222	3	1.9	0.187	1	0	44.333	0.74826	3	1*0 < 1*1	0.0429
	PCB	1	0.5	0.689	2	0	49.167	0.74826	3	1*0 < 2*0	0.0059
	MS222*PCB	3	20	0	3	0	45.167	0.74826	3	1*0 < 3*1	0.0498
	Error	16			4	0	45.5	0.74826	3	1*0 < 4*1	0.037
	Total	23			1	1	48.083	0.74826	3	2*0 > 2*1	0.0004
					2	1	42.833	0.74826	3	2*0 > 3*0	0.0274
					3	1	48	0.74826	3	2*0 > 4*0	0.0498
					4	1	48.167	0.74826	3	2*1 < 1*1	0.0028
										2*1 < 3*1	0.0032
										2*1 < 4*1	0.0024

TABLE 3.4

Analysis of Variance for mean Gonad-Somatic Index

Factor	Type	Levels	Values
MS222	Fixed	4	1 2 3 4
PCB	Fixed	2	0 1

Treatments for 93 day Exposure Experiment

MS222 concentration in tank water

1 =	0 mg/L
2 =	0.1 mg/L
3 =	1.0 mg/L
4 =	10 mg/L

PCB concentration in food (ng/g d/w)

Control Food	0 =	30
PCB-Spiked Food	1 =	235

n1 = number of females per treatment
n2 = number of gravid per treatment

Day	Source	DF	F	P	MS222	PCB	GSI	SE	n1	n2	% gravid
28	MS222	3	0.27	0.844	1	0	10.228	2.688	4	4	100
	PCB	1	2.61	0.137	2	0	8.844	3.801	2	1	50
	MS222*PCB	3	0.03	0.992	3	0	9.611	2.194	4	4	100
	Error	10			4	0	11.013	2.688	3	3	100
	Total	17			1	1	12.457	2.688	3	3	100
					2	1	11.73	2.194	5	5	100
					3	1	13.324	2.688	3	3	100
					4	1	14.474	2.194	4	4	100
42	MS222	3	1.31	0.32	1	0	11.035	2.672	4	4	100
	PCB	1	0.41	0.534	2	0	8.71	2.672	7	6	86
	MS222*PCB	3	1.33	0.314	3	0	10.961	2.672	7	7	100
	Error	11			4	0	11.676	4.627	6	3	50
	Total	18			1	1	18.613	3.272	3	2	67
					2	1	12.132	3.272	5	3	60
					3	1	7.524	3.272	6	4	67
					4	1	9.935	2.672	6	5	83
56	MS222	3	0.61	0.634	1	0	11.115	3.368	2	2	100
	PCB	1	2.07	0.2	2	0	16.136	3.368	3	3	100
	MS222*PCB	3	0.75	0.559	3	0	9.598	2.75	4	3	75
	Error	6			4	0	8.367	2.75	5	4	80
	Total	13			1	1	3.199	4.763	1	1	100
					2	1	8.444	4.763	2	1	50
					3	1	6.407	4.763	2	2	100
					4	1	10.85	4.763	2	1	50

Day	Source	DF	F	P	MS222	PCB	GSI	SE	n1	n2	% gravid
93	MS222	3			1	0	10.228	2.688	4	1	25
	PCB	1			2	0	8.844	3.801	*	*	*
	MS222*PCB	3			3	0	9.611	2.194	5	2	40
	Error				4	0	11.013	2.688	4	3	75
	Total				1	1	12.457	2.688	5	3	60
					2	1	11.73	2.194	4	2	50
					3	1	13.324	2.688	6	6	100
					4	1	14.474	2.194	4	2	50

TABLE 3.5

Analysis of Variance for mean Standard Metabolic Rate (J/g-d)

Factor	**Type**	**Levels**	**Values**
MS222	**Fixed**	**4**	**1 2 3 4**
PCB	**Fixed**	**2**	**0 1**

Treatments for 93 day Exposure Experiment

MS222 concentration in tank water

1 =	**0 mg/L**
2 =	**0.1 mg/L**
3 =	**1.0 mg/L**
4 =	**10 mg/L**

PCB concentration in food (ng/g d/w)

Control Food	**0 =**	**30**
PCB-Spiked Food	**1 =**	**235**

Day	**Source**	**DF**	**F**	**P**	**MS222**	**PCB**	**SMR**	**SE**	**n**	
14	Weight (covar)	1	2.91	0.108	1	0	234	17	3	
	MS222	3	0.38	0.77	2	0	221	17	3	
	PCB	1	2.35	0.146	3	0	211	19	3	
	MS222*PCB	3	1.16	0.356	4	0	221	17	3	
	Error	15			1	1	235	17	3	
	Total	23			2	1	241	17	3	
					3	1	268	17	3	
					4	1	220	17	3	
28	Weight (covar)	1	0.17	0.684	1	0	323	21	3	
	MS222	3	0.02	0.997	2	0	333	20	3	
	PCB	1	0.61	0.448	3	0	323	21	3	
	MS222*PCB	3	0.98	0.43	4	0	301	20	3	
	Error	15			1	1	333	21	3	
	Total	23			2	1	314	20	3	
					3	1	326	21	3	
					4	1	350	21	3	
42	Weight (covar)	1	0.17	0.683	1	0	290	18	3	4 < 2 p=0.0411
	MS222	3	3.73	0.035	2	0	297	18	3	4 < 1 p=0.0595
	PCB	1	0.08	0.786	3	0	268	18	3	
	MS222*PCB	3	0.21	0.889	4	0	234	19	3	
	Error	15			1	1	286	18	3	
	Total	23			2	1	290	18	3	
					3	1	287	18	3	
					4	1	242	18	3	
56	Weight (covar)	1	3.85	0.069	1	0	304	20	3	4<1 p = 0.0329

Day	Source	DF	F	P	MS222	PCB	SMR	SE	n	
	MS222	3	4.57	0.018	2	0	281	19	3	
	PCB	1	0.39	0.54	3	0	326	20	3	4*1<1*1 p = 0.049
	MS222*PCB	3	3.51	0.042	4	0	224	19	3	3*0>2*1 p = 0.0476
	Error	15			1	1	320	19	3	
	Total	23			2	1	233	20	3	
					3	1	275	21	3	
					4	1	274	19	3	

TABLE 3.6

Analysis of Variance for mean PCB accumulation

Factor	Type	Levels	Values
MS222	Fixed	4	1 2 3 4
PCB	Fixed	2	0 1

Treatments for 93 day Exposure Experiment

MS222 concentration in tank water

1 =	0 mg/L
2 =	0.1 mg/L
3 =	1.0 mg/L
4 =	10 mg/L

PCB concentration in food (ng/g d/w)

Control Food	0 =	30
PCB-Spiked Food	1 =	235

n= no. tanks (composite of 2 fish/tank)

Day	Source	DF	F	P	MS222	PCB	tPCBs	SE	n
7	MS222	3	0.69	0.572	1	0	34.94	11.56	2
	PCB	1	0.19	0.673	2	0	25.89	11.56	2
	MS222*PCB	3	0.37	0.776	3	0	36.73	11.56	2
	Error	13			4	0	30.64	9.43	3
	Total	20			1	1	31.01	9.43	3
					2	1	36.56	9.43	3
					3	1	47.55	9.43	3
					4	1	25.65	9.43	3
14	MS222	3	0.9	0.465	1	0	73.26	17.91	3
	PCB	1	9.41	0.007	2	0	103.97	17.91	3
	MS222*PCB	3	0.22	0.883	3	0	65.11	17.91	3
	Error	16			4	0	71.97	17.91	3
	Total	23			1	1	121.56	17.91	3
					2	1	125.58	17.91	3
					3	1	108.64	17.91	3
					4	1	113.96	17.91	3
28	MS222	3	0.53	0.667	1	0	92.41	12.92	3
	PCB	1	16.78	0.001	2	0	46.95	15.83	2
	MS222*PCB	3	1.97	0.162	3	0	73.09	12.92	3
	Error	15			4	0	58.93	12.92	3
	Total	22			1	1	94.25	12.92	3
					2	1	109.75	12.92	3
					3	1	111.61	12.92	3
					4	1	110.10	12.92	3

Day	Source	DF	F	P	MS222	PCB	tPCBs	SE	n
42	MS222	3	0.17	0.916	1	0	181.86	63.54	2
	PCB	1	2.03	0.192	2	0	137.36	63.54	3
	MS222*PCB	3	1.26	0.351	3	0	82.92	63.54	3
	Error	8			4	0	40.76	63.54	3
	Total	15			1	1	112.94	63.54	3
					2	1	197.95	51.88	3
					3	1	184.64	89.86	3
					4	1	213.97	63.54	3
56	MS222	3	0.68	0.58	1	0	71.8	30.2	3
	PCB	1	7.39	0.06	2	0	115.98	24.66	3
	MS222*PCB	3	0.8	0.512	3	0	65.84	24.66	3
	Error	15			4	0	48.55	24.66	3
	Total	22			1	1	118.31	24.66	3
					2	1	121.52	24.66	3
					3	1	137.59	24.66	3
					4	1	120.24	24.66	3
80	MS222	3	0.89	0.467	1	0	66.56	43.78	3
	PCB	1	12.37	0.003	2	0	95.91	43.78	3
	MS222*PCB	3	0.25	0.859	3	0	103.85	43.78	3
	Error	16			4	0	99.69	43.78	3
	Total	23			1	1	140.22	43.78	3
					2	1	242.07	43.78	3
					3	1	200.3	43.78	3
					4	1	219	43.78	3
93	MS222	3	0.59	0.63	1	0	71.67	33.99	2
	PCB	1	5.37	0.034	2	0	81.79	33.99	2
	MS222*PCB	3	0.55	0.655	3	0	85.81	33.99	2
	Error	16			4	0	147.27	33.99	2
	Total	23			1	1	140.94	33.99	2
					2	1	168.96	33.99	3
					3	1	147.57	33.99	1
					4	1	151.92	33.99	2

TABLE 3.7

Analysis of Variance for mean Fraction Lipid

Factor	Type	Levels	Values
MS222	Fixed	4	1 2 3 4
PCB	Fixed	2	0 1

Treatments for 93 day Exposure Experiment

MS222 concentration in tank water

1 =	0 mg/L
2 =	0.1 mg/L
3 =	1.0 mg/L
4 =	10 mg/L

PCB concentration in food (ng/g d/w)

Control Food	0 =	30
PCB-Spiked Food	1 =	235

n= no. tanks (composite of 2 fish/tank)

Day	Source	DF	F	P	MS222	PCB	fraction lipid	SE	n
7	MS222	3	0.94	0.447	1	0	0.030	0.006	2
	PCB	1	0.03	0.876	2	0	0.020	0.006	2
	MS222*PCB	3	0.93	0.456	3	0	0.020	0.006	2
	Error	13			4	0	0.020	0.005	3
	Total	20			1	1	0.020	0.005	3
					2	1	0.020	0.005	3
					3	1	0.030	0.005	3
					4	1	0.020	0.005	3
14	MS222	3	0.2	0.893	1	0	0.051	0.010	3
	PCB	1	0.3	0.594	2	0	0.033	0.010	3
	MS222*PCB	3	1.36	0.294	3	0	0.032	0.010	3
	Error	14			4	0	0.026	0.012	2
	Total	21			1	1	0.031	0.010	3
					2	1	0.045	0.010	3
					3	1	0.036	0.010	3
					4	1	0.046	0.012	2
28	MS222	3	2.38	0.111	1	0	0.064	0.007	3
	PCB	1	0.62	0.445	2	0	0.043	0.009	2
	MS222*PCB	3	0.46	0.713	3	0	0.039	0.007	3
	Error	15			4	0	0.048	0.007	3
	Total	22			1	1	0.052	0.007	3
					2	1	0.046	0.007	3
					3	1	0.040	0.007	3
					4	1	0.041	0.007	3

Day	Source	DF	F	P	MS222	PCB	fraction lipid	SE	n
42	MS222	3	0.17	0.916	1	0	0.063	0.014	2
	PCB	1	2.03	0.192	2	0	0.054	0.014	3
	MS222*PCB	3	1.26	0.351	3	0	0.052	0.014	3
	Error	8			4	0	0.060	0.014	3
	Total	15			1	1	0.061	0.014	3
					2	1	0.035	0.012	3
					3	1	0.047	0.020	3
					4	1	0.036	0.014	3
56	MS222	3	1.7	0.21	1	0	0.066	0.014	2
	PCB	1	1.37	0.261	2	0	0.042	0.012	3
	MS222*PCB	3	1.38	0.287	3	0	0.032	0.012	3
	Error	15			4	0	0.030	0.012	3
	Total	22			1	1	0.059	0.012	2
					2	1	0.037	0.012	3
					3	1	0.068	0.012	3
					4	1	0.046	0.012	3
80	MS222	3	0.16	0.921	1	0	0.062	0.016	2
	PCB	1	1.49	0.242	2	0	0.079	0.013	3
	MS222*PCB	3	0.76	0.537	3	0	0.066	0.013	3
	Error	14			4	0	0.051	0.013	3
	Total	21			1	1	0.072	0.016	3
					2	1	0.074	0.013	3
					3	1	0.075	0.013	3
					4	1	0.086	0.013	3
93	MS222	3	0.3	0.826	1	0	0.038	0.016	2
	PCB	1	0.25	0.623	2	0	0.077	0.013	2
	MS222*PCB	3	2.89	0.07	3	0	0.034	0.013	2
	Error	15			4	0	0.057	0.013	2
	Total	22			1	1	0.071	0.013	2
					2	1	0.042	0.013	3
					3	1	0.061	0.013	1
					4	1	0.052	0.013	2

TABLE 3.8

Analysis of Variance for mean Standard Metabolic Rate (J/g-d)

Treatments for 93 day Exposure Experiment

Factor	**Type**	**Levels**	**Values**
MS222	**Fixed**	**4**	**1 2 3 4**
PCB	**Fixed**	**2**	**0 1**

MS222 concentration in tank water

1 =	**0 mg/L**
2 =	**0.1 mg/L**
3 =	**1.0 mg/L**
4 =	**10 mg/L**

PCB concentration in food (ng/g d/w)

Control Food	**0 =**	**30**
PCB-Spiked Food	**1 =**	**235**

n = 3 tanks with 1 fish from each tank

Day	**Source**	**DF**	**F**	**P**	**MS222**	**PCB**	**Cyp1a**	**SE**	**n**
14	Weight (covar)	1	0.75	0.539	1	0	7.8	2.2	3
	MS222	3	0.5	0.492	2	0	9.5	3.5	3
	PCB	1	0.69	0.575	3	0	10.8	7.6	3
	MS222*PCB	3			4	0	19.8	6.3	3
	Error	14			1	1	8.5	5.9	3
	Total	21			2	1	7.1	6.9	3
					3	1	13.0	17.7	3
					4	1	9.0	5.5	3

Chapter 4

Comparison of polycyclic aromatic hydrocarbon (PAH)-contaminated food and aqueous MS-222 exposures on bioenergetic and bioaccumulation rates of *Fundulus heteroclitus*

4.1 Introduction and Background

This chapter reports the findings of the second of the three experiments. The results reported here influenced and directed the revised hypotheses and experimental designs of Experiment 3 (Chapter 5).

Experiment 1 (93 days) (Chapter 3) revealed that:

1) Standard metabolic rates (SMR) measured in *F. heteroclitus* may be sensitive to low level exposures of a narcotic chemical, MS-222 (3-aminobenzoic acid ethyl ester methanesulfonate), but validation of the response was necessary.

2) It was inconclusive whether changes in SMR would lead to a detectable change in bioaccumulation of PCBs from an artificially contaminated diet ("trout chow" spiked with PCBs). Several factors contributed to the inconclusive results, including low bioavailability in the PCB-spiked trout chow, composite sampling of fish exposed to the test diets, and instrumentation problems with the respirometer during Experiment 1.

3) The background concentrations of PCBs quantified in commercially available fish food did not appear to interfere with fish bioenergetics. However, the lower than expected bioaccumulation of PCBs in fish tissue fed commercially available fish food ("trout chow") spiked with neat

Aroloclor standards led to experimenting with more realistic fish diets that contained naturally contaminated concentrations of hydrophobic organic contaminants (e.g., PAHs).

Due to all of the above factors the experiment reported in this chapter was designed to address the following:

4. Repeat and increase the MS-222 exposure gradient to validate the SMR responses measured in Experiment 1.
5. Compare fish growth, SMR and PCB accumulation results of Experiment 1 with results from feeding fish a different diet and source of contaminant (environmentally contaminated clams).

4.2 Objectives

The objectives of this chapter are to present the results of a pilot study (30 days) where *Fundulus heteroclitus* was exposed to a stronger dissolved MS-222 gradient (0, 10, 30 and 70 mg/L of MS-222) than tested in Chapter 3, and to test a diet based on naturally contaminated food. The source of contamination originated from clams caged in the Elizabeth River, VA, for approximately 30 days to accumulate contaminants, primarily PAHs. Both control and contaminated clams were mixed with a fish gel additive to enhance nutrient levels, provide bulk and to dilute PAH-concentrations.

The test hypotheses were:

H_1 = SMR will be reduced due to the higher exposure of MS-222

H_2 = Fish will consume the PAH-contaminated diet and grow similarly to fish fed control food

H_3 = Dietary exposure of PAH-contaminated food will produce an equivalent response in SMR as the MS222 exposures.

4.3 Methods and Materials

4.3.1 Experimental design

The experiment consisted of exposing fish to four concentrations of MS-222 (0, 10, 30 and 70 mg/L) for 30 days. Fish exposed to MS-222 were fed control food (control clams purchased from a commercial seafood company and mixed with a fish gel additive). At the same time, fish were fed contaminated food which consisted of a mixture of control clams caged in the Elizabeth River (a PAH-contaminated sited) for approximately 30 days, and a fish gel additive. Thus, the experiment consisted of five treatments replicated three times for a total of 15 aquaria randomly arranged. Sampling occurred on days 0 and 30. Subadult and adult fish were seined from a wild population at a reference site on the Patuxent River, MD. Fish were held in the laboratory (same water and light conditions) in 100-L circular flow-through tanks for approximately one week prior to the start of the experiment, and were fed pellet fish food (Zeigler's trout chow, Gardner, PA) twice a day. While in the holding tanks, fish were formalin-dipped to prevent bacterial growth or infection.

One week prior to day 0, aquaria were randomly placed on two racks (8 on the top, 7 on the bottom), and filled with filtered (< 0.5 μm), 20°C ambient seawater. The flow-through system was allowed to flush the aquaria until the start of the experiment. Salinity ranged from eight to twelve parts per thousand (ppt) throughout the course of the experiment. On day 0, nine fish were randomly placed into each 38-

L aquaria (total number of fish = 135 at the start of the experiment). On day 1, fish were switched to the experimental diets and fed at a rate of 5% body weight per day. The experiment was conducted under 16 hours of fluorescent light and 8 hours of darkness. Aquaria were also loosely covered with black plastic on the sides of the racks of aquaria to minimize disturbance. Aquaria were periodically cleaned by suctioning debris off of the bottom, brushing down the side walls, and cleaning the exit weirs. Tubing that delivered water to each aquarium was replaced as needed.

4.3.2 Exposure treatments

4.3.2.1 *Food Treatment Preparations*

Food treatments consisted of control and contaminated clams (*Mercenaria mercenaria*) homogenized with a fish gel (Gel Fish Food, Aquatic Ecosystems, Inc., Apopka, FL). Fish gel was used as an additive to the clams to provide more nutrients than the clams would alone. The fish gel also was used to provide bulk in order to reduce the amount of biomass needed from caged clams, and to dilute the contaminant concentrations accumulated in the clams caged in the Elizabeth River, VA. Food treatments were prepared by mixing “control clams” with fish gel and “contaminated clams.” “Control clams” purchased from a local commercial fisher were collected from the Chester River, MD, and the Ware River, NC. (Control clams were purchased at different times and hence reflect the two different sources.) Control clams were split into two groups. One group was frozen until the experiment. One group was kept alive, transported, and caged at a PAH-contaminated site on the Elizabeth River, VA (Van Veld et al., 1992) to accumulate environmentally relevant, and bioavailable, hydrophobic organic contaminants (HOCs) for the exposure experiments. A consequence of contaminating clams in the environment is that other contaminants such as trace metals, and uncharacterized HOCs were also present. Clams were caged for approximately 30 days, transported live to the laboratory, and then frozen. Both sets of clams were shucked and homogenized separately in separate food processors. Clams were mixed with equal parts of reconstituted fish gel to provide additional nutrients and bulk to the food treatments. The fish gel was reconstituted with heated deionized water at a 50:50 ratio of powdered gel to water, per the manufacturer's instructions. Pre-cleaned, solvent-rinsed steel bowls and spatulas were used for all mixing procedures.

Both batches were frozen until feeding. Samples from each batch of food were collected for chemical analysis. For daily feedings, each aquarium received an equally measured ration of food at a rate of 5% of total fish biomass in the aquarium on a wet-weight basis.

4.3.2.2 *MS-222 Treatments*

MS-222 (3-aminobenzoic acid ethyl ester methanesulfonate), purchased from Argent Laboratories (Redmond, WA), was used as a model narcotic chemical. The narrow test gradient was chosen so that the lowest exposure concentration (10 mg/L MS222) would be comparable to the dose where fish SMR was reduced in Experiment 1. 70 mg/L was the highest exposure concentration attainable where fish still visually behaved normally. At exposure levels above 70 mg/L fish lost equilibrium and exhibited an acute response from the MS-222 exposure.

The MS-222 delivery system was the same as described in Experiment 1. Stock solutions 0, 10, 30, and 70 g/L of MS-222 were bled into the mixing reservoirs via silicon pump tubing (Masterflex L/S, Cole Parmer, Vernon Hills, IL) at 0.3 mL/min controlled with a multiple channel pump system (Masterflex L/S system, Cole-Parmer, Vernon Hills, IL), and then delivered to respective aquaria at concentrations of 0, 10, 30, and 70 mg/L (100 mL/min). Refrigerated DI water was delivered to the other set of aquaria at the same flow rate as experimental control. Stock solutions of MS-222 and control DI water were stored in 1-L glass amber jars held under constant refrigeration, and replenished every few days. Under these conditions, parent MS-222 remains stable in solution for approximately one month according to the manufacturer (Argent Laboratories).

4.3.3 Sampling procedures

On day 0, nine fish were randomly placed into each aquarium. Also on day 0, four fish were removed from the holding tank at the same time that experimental fish were placed into each aquarium. These individuals underwent baseline standard metabolic rate (SMR) evaluation. One composite of four fish (whole bodies) was used for the day 0 PCB tissue analysis. On day 30, all fish were removed from each aquarium. Three fish was used to evaluate standard metabolic rates. Afterwards, one fish from each aquarium was frozen for chemical analysis (lipid and congener-specific PCB analysis). All fish were killed with an overdose of MS-222 per the approved animal care protocol.

4.3.3.1 Procedure for measuring standard metabolic rate

To evaluate chemical-induced stress, standard metabolic rate was measured on individual fish following methods previously described by Rowe (2003). Briefly, three fish from each aquarium were randomly captured and placed into individual 0.5

L plastic incubation containers with ~ 300 mL of their respective aquarium water. Fish were placed into the respirometry incubator (25 ^{o}C, dark), and held unfed for 24 hours to minimize activity and specific dynamic action respiration in preparation for measuring resting, or standard, metabolic rates. Following incubation, fish were transferred to 1 L glass test chambers with 300 mL of strained (to remove feces and bulk particulate matter) test water, and connected to the Micro Oxymax^{TM} respirometer system (Columbus Instruments). Oxygen depletion (minimum O_2 consumption rates or VO_{2min} or the minimum rate of oxygen consumption by individual fish at rest and after 24 hours of fasting) was measured by a computer-controlled, closed circuit mircrorespirometer at 1 hour intervals. Each chamber was sampled approximately seven times over a 24 - 36 hour period. The chambers refresh O_2 so the organisms have adequate oxygen throughout the experiment.
After SMR was measured, each fish was removed from the test chamber and anesthetized with an overdose of MS-222 (500 mg/L) in a seawater bath. Fish were measured for body length to nearest 0.5 mm, and weighed to the nearest 0.001 g and sexed. Fish were then placed in pre-cleaned glass jars and frozen until extraction for lipid and PCB-congener analyses.

4.3.4 PAH and PCB chemical analyses

4.3.4.1 Chemical analysis of PCB congeners in fish tissue

In this preliminary study, each chemistry sample consisted of a one fish (whole body) from each aquarium (n = 15) to minimize the number of samples analyzed for PCB and lipid content. An aliquot from each of the food treatments was also analyzed for PCB and lipid content. Each sample was homogenized and dried with sodium sulfate, and extracted using 24 hour Soxhlet extraction with dichloromethane (Baker et al., 1997). Prior to extraction, each sample was spiked with surrogates 3,5-dichlorobiphenyl and 2,3,4,4',5,6'-hexachlorobiphenyl (PCB IUPAC congeners 14 and 166, respectively). Recoveries of PCB 14 and 166 averaged 91% (± 20 %) and 95% (± 10 %) respectively. All chromatographic peaks were hand-integrated to accurately assess recoveries. Blank sodium sulfate samples were run in parallel with each Soxhlet extraction to quantify laboratory background contamination. Contamination was minimal, and thus reported congeners were not blank-corrected. Σ-PCBs reported are the sum of 95% of the congener peaks (individual PCB congeners or unresolved congener groups).

Samples were concentrated to approximately 1 mL via roto-evaporation, and lipids removed via gel permeation chromatography (GPC). A subsample of approximately 0.5 ml was removed for gravimetric determination of tissue lipid content prior to GPC injection. Samples were concentrated to 1 ml for final cleanup using Florisil solid:liquid chromatography. Samples were concentrated and transferred to amber auto-sampler vials (ASVs), and internal standards 2,4,6-trichlorobiphenyl and 2,2',3,4,4',5,6,6'-octachlorobiphenyl (PCBs 30 and 204, respectively) were added to each sample prior to PCB quantification using gas chromatography with electron capture detection (GC/ECD).

A 2 ul portion of the concentrated sample extract was eluted with hydrogen through a 60 m x 0.320 mm I.D. capillary column with a 0.25um 5% diphenyl/95% dimethylpolysiloxane film (J&W Scientific #1235062 DB5). On exiting the column, the eluting compounds passed through a ^{63}Ni electron capture detector, generating responses for compounds identified using a calibration standard. PCBs were quantified on an individual congener basis following Mullin et al. (1984). Congeners were identified by retention time relative to two internal standards (PCBs 30 and 204). Sample congeners were quantified using relative response factors (RRF), the product of mass:response ratio of the congener in the calibration standard and the response:mass ratio of the internal standard in the calibration standard. The mass of the congener in each sample was then calculated as the product of the RRF, the internal standard mass in the sample, and the congener response:internal standard response ratio for the sample. Concentrations were calculated as the quotient of the mass in the sample extract divided by the mass extracted (corrected gravimetrically for subsampling).

4.3.4.2 Chemical analysis of PAH and PCB concentrations in food treatments

Aliquots of each food treatment were analyzed for both PAHs and PCBs. Samples were extracted and cleaned up via the same procedures identified above for fish. Perdeuterated surrogate compounds (d_8-napthalene, d_{10}-fluorene, d_{10}-fluoranthene, d_{12}-perylene) were used to assess analytical recoveries. Recoveries averaged 11 ± 7%, 50 ± 6%, 74 ± 4%, and 122 ± 26% d_8-napthalene, d_{10}-fluorene, d_{10}-fluoranthene, and d_{12}-perylene, respectively. For all of the samples, recoveries for the low molecular PAHs were below acceptable limits, speculatively due to evaporating samples too quickly. However, since this was a pilot study, and the primary goal was to determine if the fish would eat contaminated food, the samples were not re-analyzed. Recoveries of PCB 14 and 166 averaged 130% (± 0.1 %) and

90% (± 0.1 %), respectively. Prior to the Florisil cleanup step described for PCB analysis, samples were purified by placing the 1 mL sample onto the head of a deactivated alumina [6% (w/w) water] column and eluted with 35 mL petroleum ether. After concentrating, the extracts were spiked with a perdeuterated PAH mixture (d_{10}-acenapthene, d_{10}-phenanthrene, d_{12}-benz[*a*]anthracene, d_{12}-benzo[*a*]pyrene, d_{12}-benzo[*ghi*]perylene) for quantification of PAHs. PAH analytes were identified and quantified using a capillary gas chromatograph (Hewlett Packard 5890) and a mass spectrometer (5970A) (GC/MS) operated in Selective Ion Monitoring (SIM) mode (Baker et al., 1997). Following GC/MS analysis, samples were processed in the same manner as the fish samples for subsequent individual PCB congener analysis.

Other contaminants such as trace metals, pesticides, and other constituents in creosote were not quantified.

4.3.5 Data analyses

On day 30, all measured responses [weight, length, standard metabolic rate (SMR), fraction lipid, and total PCB bioaccumulation] were analyzed by analysis of variance (ANOVA) (Minitab, 2000). For SMR, fish body weight (g wet weight) was analyzed as a covariate (ANCOVA). The analysis tested one fixed factor: MS-222 (i). The MS-222 factor tested 5 levels (0 = 0, 1 = 10, 2 = 30, 3 = 70 mg/L MS-222, and 4 = 0 MS-222 plus PAH-contaminated food). All tests employed the ANOVA general linear model (GLM) for each time point where Response(ik) $=\mu + ai + \varepsilon k(i)$ (Minitab, 2000).

Standard metabolic rates ($V_{O2\ min}$, the minimum rate of oxygen consumption by individual fish at rest and after 24 hours of fasting) were measured as a physiological response to chronic exposure to narcotic chemicals. In the respirometer chambers, periods of hyperactivity affect sample means. All of the data presented here are averages of the lower 50% of measurements for each individual per sampling event to eliminate the confounding influence of measurements during periods of activity (Rowe, 2003). Reported results in SMR are reported in J/g-d by converting the measured $V_{O2\ min}$ by assuming 1 mL O_2 consumed equals 20.08 J (Rowe, 2003).

4.4 Results

4.4.1 PAH and PCB Concentrations in the Food

The two food treatments were characterized for individual PAH analytes and PCB congeners to verify and quantify dietary exposures to fish. Figure 4.1 depicts the PAH profiles of the individual PAH analytes in the food batches. The control food contained 180 ng/g w/w Σ-PAH (n = 1, 3% lipid). The PAH-contaminated food contained 1630 ± 80 ng/g w/w Σ-PAH (n = 2, 3% lipid) Figure 4.2 depicts the PCB profiles of 43 congeners (chromatographic peaks) measured in the food batches. The control food treatment contained 54 ng/g w/w Σ-PCB (n = 1) and 3% lipid. For the PAH-contaminated treatment, the Σ-PCB concentration was 60 ± 0.7 ng/g w/w (n = 2) with 3% lipid, similar to the control food. Thus, the Elizabeth River was not a major source of PCBs to the clams, and the PCB concentrations reflect background in the commercially purchased clams and in the fish gel. Previously analyzed clams without the gel additive contained Σ-PAH concentrations of 11.2 ± 0.1 (n = 2) and

3640 ± 485 (n = 2) from the control and contaminated clams, respectively. Previously analyzed clams without the gel additive contained Σ-PCB concentrations of 9.4 ± 0.1 (n = 2, % lipid < 1 %) and 29.2 ± 3.5 (n = 2, % lipid < 1 %) from the control and contaminated clams, respectively.

4.4.2 Impacts on survival, growth and reproductive parameters

Fish survival was significantly affected by the MS-222 gradient ($p = 0.021$) in the ANOVA. (See Table 4.1 for aquarium and treatment survival.) In Tukey's comparisons ($\alpha = 0.10$), fish exposed to the 70 mg/L MS-222 had significantly lower survival rates (85 ± 3%, n = 3 aquaria) compared to the control fish (100% survival, n = 3 aquaria), fish exposed to 10 mg/L MS-222 (100% survival, n = 3 aquaria), and fish exposed to PAH-contaminated food (100% survival, n = 3 aquaria) ($p = 0.0611$). Fish exposed to 30 mg/L MS-222 had 89 ± 3% survival (n = 3 aquaria). These observations on survival in the study resulted in the choice of 50 mg/L MS-222 exposure for Experiment 3 (Chapter 5).

On day 0, average fish weight and length measurements were 3.2 ± 1.2 g (n = 4) and 51.75 ± 6.3 mm (n = 4), respectively. On day 30, fish weight and fish length were not significantly affected among the different treatments in the ANOVA general linear model (Tables 4.2 and 4.3). Average fish weight was not significantly affected by the exposures (0 = 0, 1 = 10, 2 = 30, 3 = 70 mg/L MS-222, and 4 = 0 MS-222 plus PAH-contaminated food) ($p = 0.327$). Also, see Figure 4.3 for average fish weight versus treatment. Aquarium averages (n = 7 – 9 fish) were calculated. Thus, the average of the replicates for each treatment (n = 3, ± 1 SE) were analyzed by ANOVA and graphed in Figure 4.3. Average fish length (Table 4.3) was not significantly affected by the exposures (0 = 0, 1 = 10, 2 = 30, 3 = 70 mg/L MS-222, and 4 = 0 MS-222 plus PAH-contaminated food) ($p = 0.137$). Aquarium averages (n = 7 – 9 fish) were calculated. Thus, the average of the replicates for each treatment (n = 3, ± 1 SE) were analyzed by ANOVA.

4.4.3 Impacts on Standard Metabolic Rate

Standard metabolic rates (SMR) of individual fish were measured on days 0 and 30. On day 0, baseline SMR measurements were 163.7 ± 23 (n = 4 fish, ± 1 SD). On day 30, SMR measurements were not significantly affected by the exposures (0 = 0, 1 = 10, 2 = 30, 3 = 70 mg/L MS-222, and 4 = 0 MS-222 plus PAH-contaminated food) ($p = 0.509$). Also, see Figure 4.4 for average fish standard metabolic rates versus treatment. Aquarium averages (n = 3 fish) were calculated. Thus, the average of the replicates for each treatment (n = 3, ± 1 SE) were analyzed by ANOVA and graphed in Figure 4.4.

4.4.4 Impacts on PCB bioaccumulation and lipid content

Total and congener-specific PCB concentrations and % lipid measurements were measured for individual fish on days 0 and 30. On day 0, the Σ-PCB concentration in fish tissue was 36 ng/g (n = 1, composite of four fish, 5% lipid). On day 30, Σ-PCB concentrations measured in fish tissue were significantly lower in fish exposed to 70 mg/L MS-222 compared to the fish fed PAH-contaminated food ($p = 0.0385$, Tukey's Comparison, 95% CI). Also, see Figure 4.5 for average fish total PCB concentrations (ng/g) versus treatment. One fish from each treatment (n = 3 aquaria, ± 1 SE, per treatment) were analyzed in the ANOVA and graphed in Figure 4.5.

Lipid contents of fish were not significantly affected by the exposures ($p = 0.496$, Table 4.6). One fish from each treatment ($n = 3$ aquaria, $\pm$ 1 SE, per treatment) were analyzed in the ANOVA.

4.5 Discussion and next steps

One of the main purposes of this experiment was to replicate the depression in fish standard metabolic rates observed on days 42 and 56 in Experiment 1 (Chapter 3) by repeating the exposure to 10 mg/L MS-222 and also increasing the MS-222 exposure gradient (0, 10, 30 and 70 mg/L MS-222). Growth parameters (fish weight, length, and lipid content) were unaffected by the 30 day exposures of the MS-222 gradient or the PAH-contaminated diet. However, the range of MS-222 concentrations was necessarily narrow. Beyond 70 mg/L MS-222, fish were unable to maintain equilibrium. The lower survival rates in the fish exposed to the 70 mg/L MS-222 relative to all of the other treatments may reflect the limit in dose of MS-222 needed to maintain sublethal narcosis. However, the narrow range in the MS-222 gradient may limit separation of subtle differences in growth parameters or in standard metabolic rates. Given that fish could not tolerate higher MS-222 concentrations in order to span an order of magnitude in concentration range, 30 days may not have been long enough to separate out impacts on standard metabolic rates, or other growth parameters. Other reasons for the lack of response in SMR may be due to unmeasured co-contaminants interacting with MS-222 and PAHs, the insensitivity of fish SMR to sublethal concentrations of chemicals, or the biological variability among individual fish within each treatment.

Counter to the results discussed above, another goal of this study was to evaluate whether *Fundulus* would readily consume a diet of clams mixed with fish gel, and accumulate PCBs similarly from the diet treatments. The lack of differences in fish weight, length, % lipid detected among treatments demonstrates that the diet was appropriate.

Fish did not accumulate PCBs in their tissues above the background concentrations (36 ng/g) compared to accumulation by day 28 in Experiment 1 except for in the fish exposed to PAH-contaminated food. This was primarily due to the fact that the trout chow contained higher lipid content (11%) versus the clam:fish gel mixtures (3% lipid). However, there was a significant difference in accumulation between the fish exposed to the 70 mg/L MS-222 and fed the control food compared to the fish exposed to control water (0 MS-222) and fed the PAH-contaminated food. But, the significant accumulation is proportional with individual PCB congeners measured in fish tissue were normalized to the individual PCB congener measured in the food. Figure 4.6 plots the bioaccumulation factors (BAFs) versus log K_{OW} and shows that the BAFs are similar between the fish exposed to the 70 mg/L MS-222 fed the control food and the fish exposed to control water (0 MS-222) and fed the PAH-contaminated food.

In visually examining the trends in fish weight (Figure 4.4) and PCB accumulation (Figure 4.5) in fish exposed to MS-222, in general fish weight and PCB accumulation decreases as MS-222 concentration increases. Although this did not statistically bear out in the ANOVA tests, these results left the question of whether the test was just not long enough.

The observations made in this pilot study led to the experimental design in Experiment 3 (Chapter 5). First, the naturally contaminated diet was readily consumed by fish, and was preferred as a more environmentally relevant food exposure compared to spiking trout chow. Second, the MS-222 exposure was set at 50 mg/L for the last experiment due to the differences in mortality observed in this short experiment when fish were exposed to 70 mg/L MS-222. Third, the results of the SMR measurements remain equivocal. The lack of response may be due to insufficient exposure duration, however, mortality was observed thus perhaps the test is not appropriate. Therefore, the next study lengthens the exposure time to 120 days. Fourth, PCB and lipid analyses need to be conducted on multiple individuals from each aquarium over time.

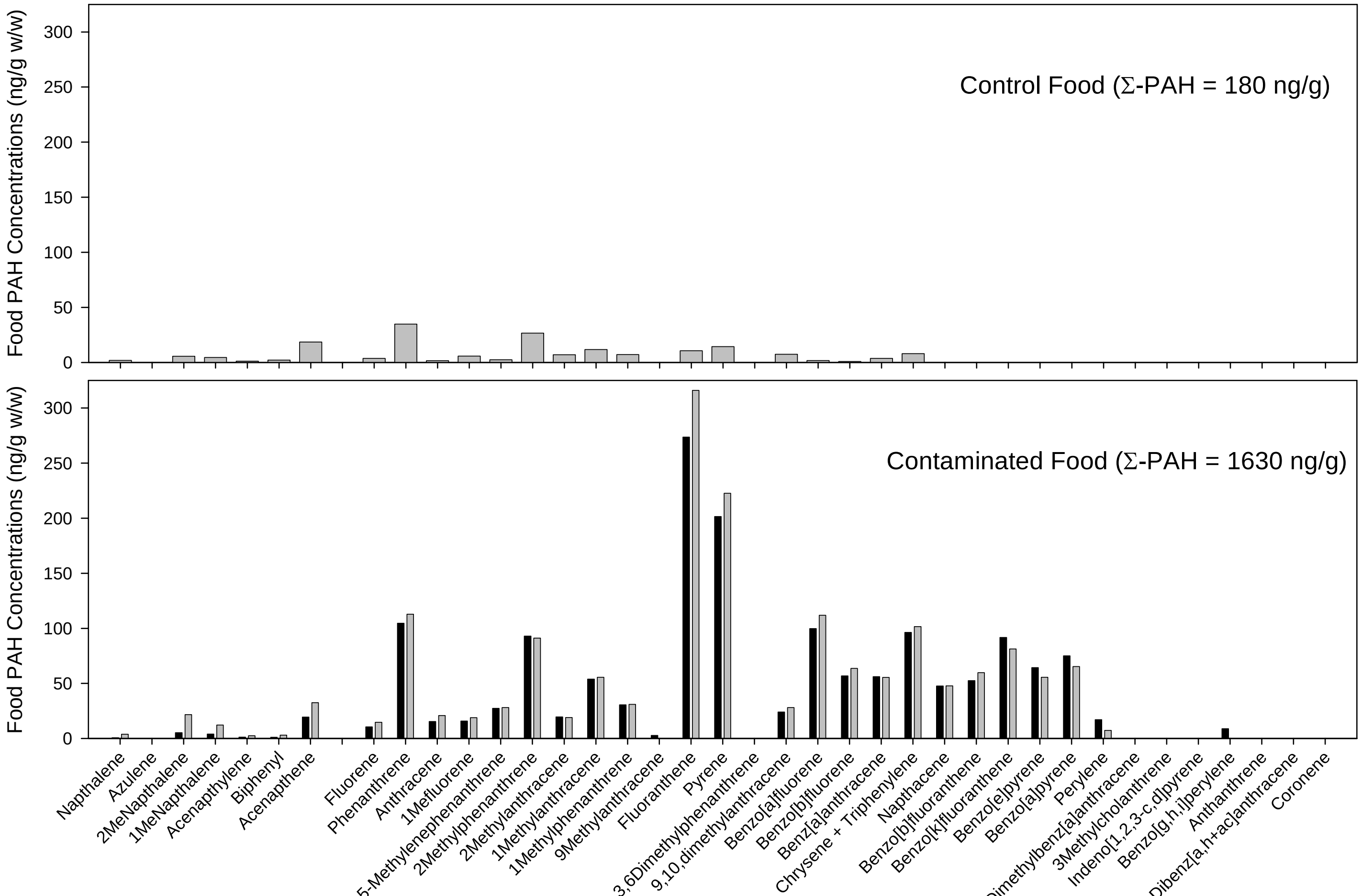

Figure 4.1. PAH profiles in the two food treatments. The control food contains background concentrations of Σ-PAHs of 180 ng/g w/w (% lipid = 3%, n = 1). The PAH-contaminated food contains 1630 ± 80 ng/g w/w Σ-PAH (% lipid = 3%, n = 2).

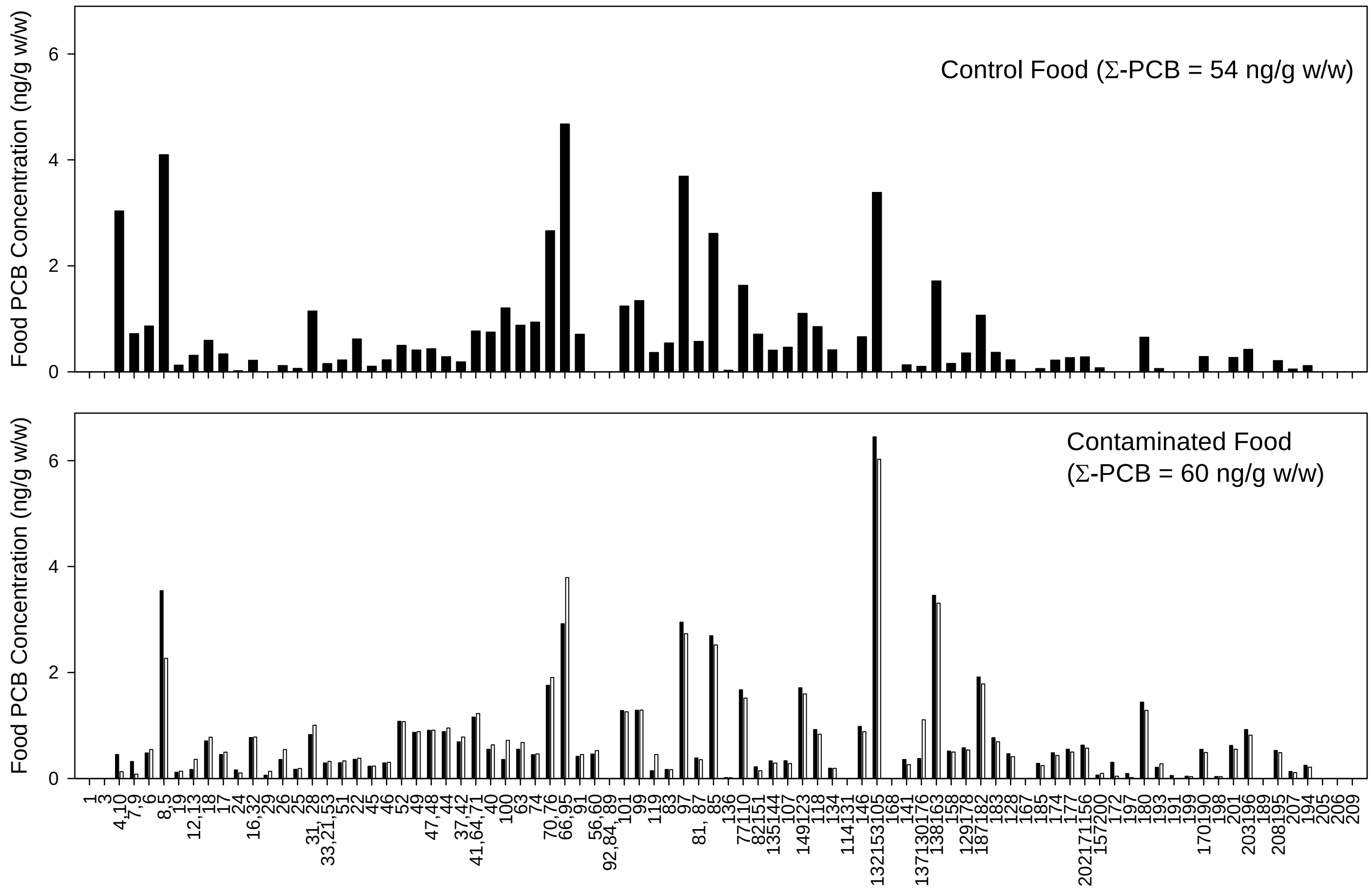

Figure 4.2. PCB profiles in the two food treatments. The control food contains background concentrations of Σ-PCBs of 54 ng/g w/w (% lipid = 3%, n = 1). The PAH-contaminated food contains 60 ± 0.7 ng/g w/w Σ-PCB (% lipid = 3%, n = 2).

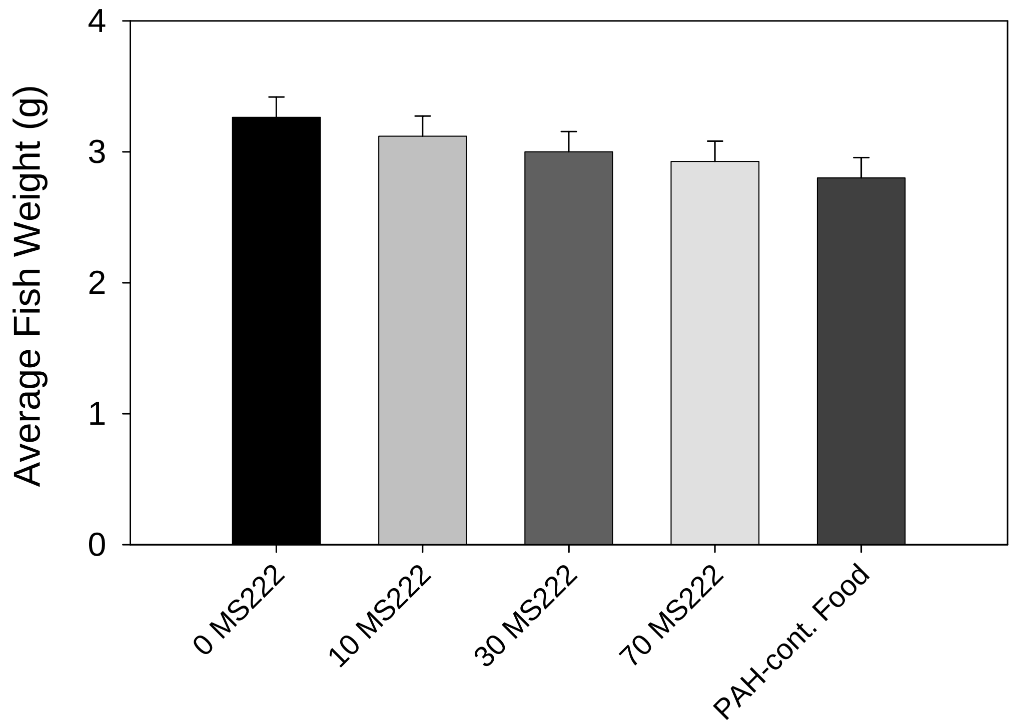

Figure 4.3. Average fish weight (g) after 30 days of exposure to 0, 10, 30 and 70 mg/L MS-222 and fed control food compared to fish fed PAH-contaminated food (0 MS-222). Each bar represents an average ± 1 SE of three aquaria (n = 3 aquaria, with 7-9 fish per aquarium).

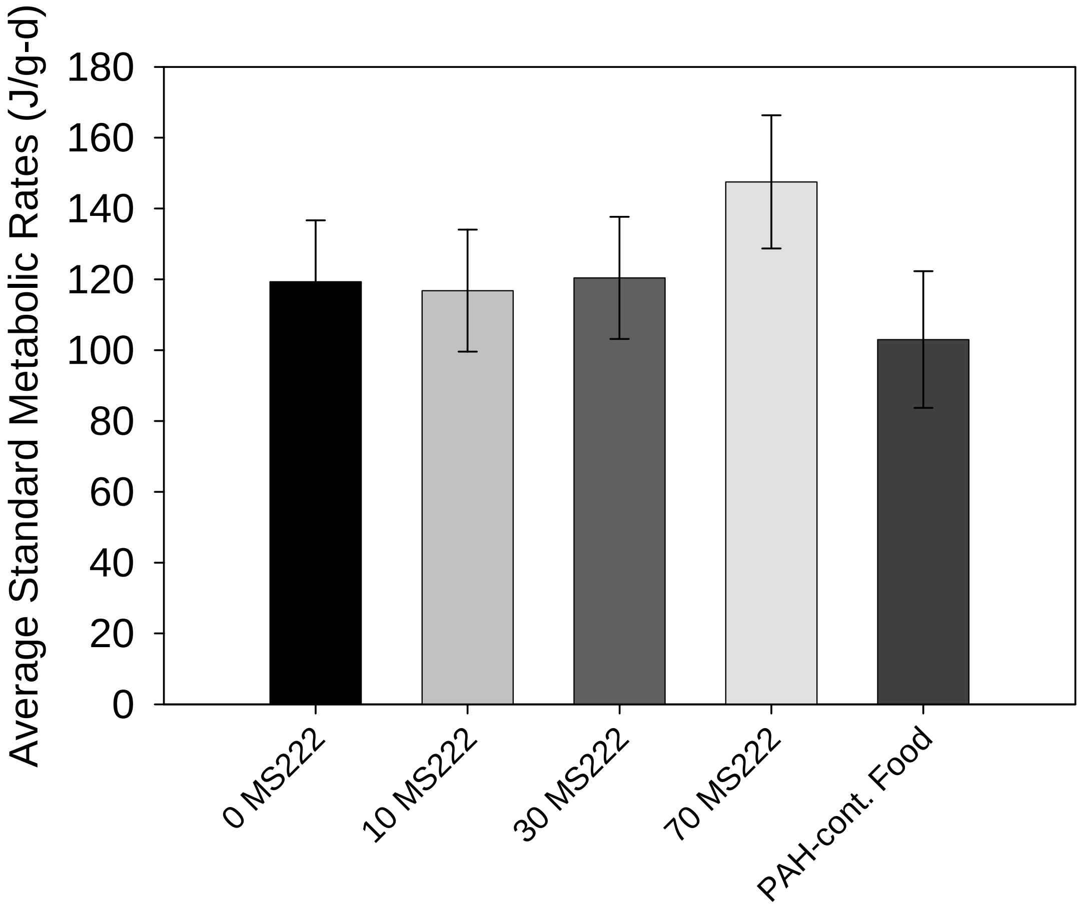

Figure 4.4. Average standard metabolic rates measured in fish tissue after 30 days of exposure to 0, 10, 30 and 70 mg/L MS-222 and fed control food compared to fish fed PAH-contaminated food (0 MS-222). Each bar represents an average ± 1 SE of three aquaria (n = 3 aquaria, with 2 fish per aquarium).

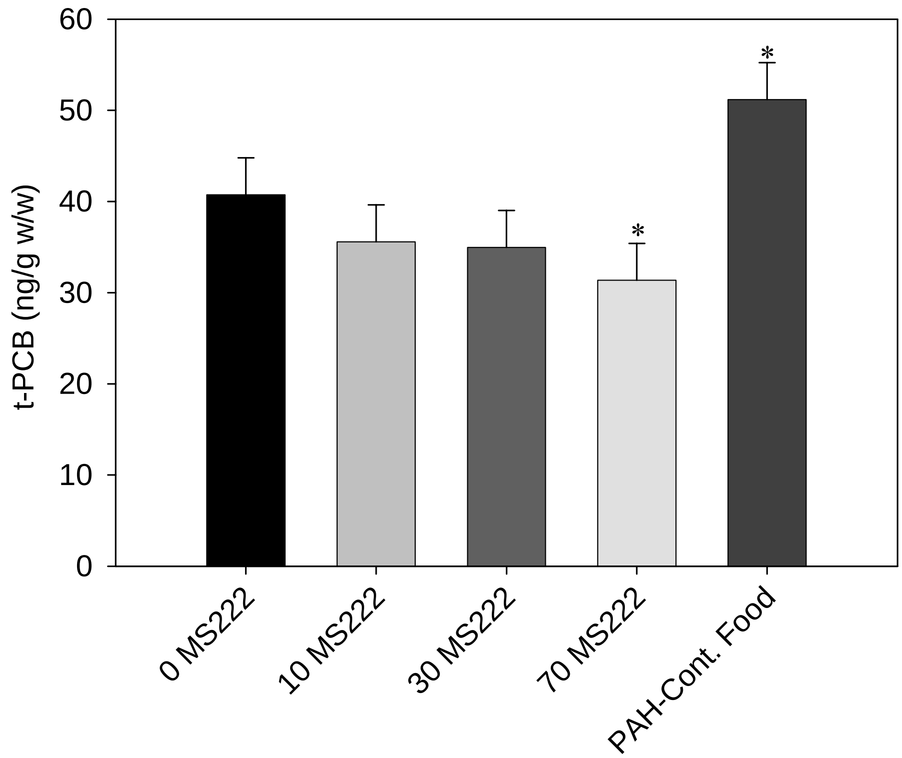

Figure 4.5. Average total PCB concentrations measured in fish tissue after 30 days of exposure to 0, 10, 30 and 70 mg/L MS-222 and fed control food compared to fish fed PAH-contaminated food (0 MS-222). Each bar represents an average ± 1 SE of three aquaria (n = 3 aquaria, with 1 fish per aquarium). * denotes significance ($p = 0.0385$).

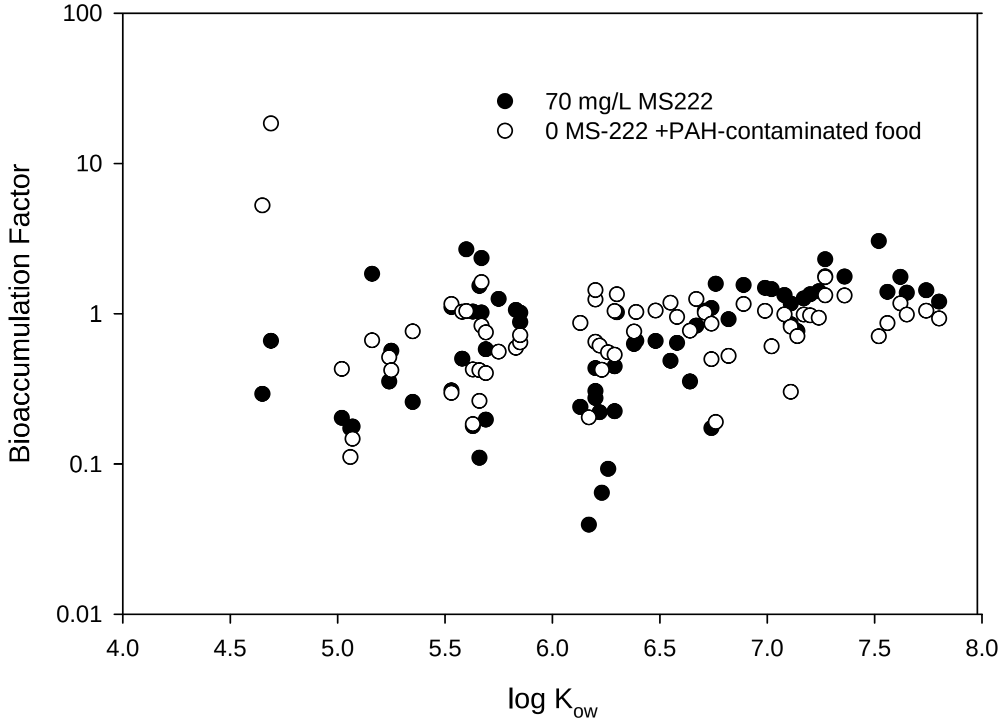

Figure 4.6. Bioaccumulation factors (PCB congener$_i$ in fish tissue/ PCB congener$_i$ in food) versus log K_{OW}. The food normalized concentrations do not retain the difference in accumulation seen in Figure 4.5. Each point is an average of three fish.

TABLE 4.1 Survival

Treatments for 30 day Exposure Experiment

MS222 concentration in tank water		**PCB concentration in food (ng/g d/w)**		
0 =	**0 mg/L**	**Control Food**	**0 =**	**180**
1 =	**10 mg/L**	**PAH-Contaminated F**	**1 =**	**1630**
2 =	**30 mg/L**			
3 =	**70 mg/L**			
4 =	**0 mg/L * PAH-contaminated food**			

Tank counts - Survival

Tank	tank count	MS222	PAH	Mortality	% survival
4	9	0	0	0	100%
7	9	0	0	0	100%
11	9	0	0	0	100%
3	9	1	0	0	100%
6	9	1	0	0	100%
10	9	1	0	0	100%
5	9	2	0	0	100%
12	9	2	0	1	89%
14	9	2	0	2	78%
2	9	3	0	2	78%
8	9	3	0	1	89%
9	9	3	0	1	89%
1	9	4	1	0	100%
13	9	4	1	0	100%
15	9	4	1	0	100%

Source	DF	F	P	MS222	PAH	% Survival	SE	n = 3 aquaria
MS222	4	4.75	0.021	0	0	100%	3%	3
Error	10			1	0	100%	3%	3
Total	14			2	0	89%	3%	3
				3	0	85%	3%	3
				4	1	100%	3%	3

MS222	p value
0, 1, and 4 > 3	0.061

TABLE 4.2

Analysis of Variance for Fish Weight (g)

Factor	**Type**	**Levels**	**Values**
MS222	**Fixed**	**5**	**0 1 2 3 4**

Treatments for 30 day Exposure Experiment

MS222 concentration in tank water

0 =	**0 mg/L**
1 =	**10 mg/L**
2 =	**30 mg/L**
3 =	**70 mg/L**
4 =	**0 mg/L * PAH-contaminated food**

PCB concentration in food (ng/g d/w)

Control Food	**0 =**	**180**
PAH-Contaminated F	**1 =**	**1630**

n = number of tanks (7-9 fish/tank)

Day									
30	**Source**	**DF**	**F**	**P**	**MS222**	**PAH**	**Analyzed average Weight (g)**	**SE**	**n**
	MS222	4	1.32	0.327	0	0	3.263	0.154	3
	Error	10			1	0	3.118	0.154	3
	Total	14			2	0	2.999	0.154	3
					3	0	2.926	0.154	3
					4	1	2.801	0.154	3

TABLE 4.3

Analysis of Variance for Fish Length (mm)

Factor	Type	Levels	Values
MS222	Fixed	5	0 1 2 3 4

Treatments for 30 day Exposure Experiment

MS222 concentration in tank water

0 =	0 mg/L
1 =	10 mg/L
2 =	30 mg/L
3 =	70 mg/L
4 =	0 mg/L * PAH-contaminated food

PCB concentration in food (ng/g d/w)

Control Food	0 =	180
PAH-Contaminated F	1 =	1630

n = number of tanks (7-9 fish/tank)

Day	Source	DF	F	P	MS222	PAH	Analyzed average Length (mm)	SE	n
30	MS222	4	2.24	0.137	0	0	56.1	0.6	3
	Error	10			1	0	55.8	0.6	3
	Total	14			2	0	54.5	0.6	3
					3	0	56.0	0.6	3
					4	1	54.1	0.6	3

TABLE 4.4

Analysis of Variance for Standard Metabolic Rates

Factor	Type	Levels	Values
MS222	Fixed	5	0 1 2 3 4

Treatments for 30 day Exposure Experiment

MS222 concentration in tank water

0 =	**0 mg/L**
1 =	**10 mg/L**
2 =	**30 mg/L**
3 =	**70 mg/L**
4 =	**0 mg/L * PAH-contaminated food**

PCB concentration in food (ng/g d/w)

Control Food	**0 =**	**180**
PAH-Contaminated F	**1 =**	**1630**

Day

30	Source	DF	F	P
	W avg	1	0.47	0.509
	MS222	4	0.64	0.649
	Error	9		
	Total	14		

n = number of tanks (2 fish/tank)

MS222	PAH	Analyzed average SMR (J/g-d)	SE	n
0	0	119.3	17.3	3
1	0	116.8	17.2	3
2	0	120.4	17.2	3
3	0	147.5	18.8	3
4	1	103.0	19.3	3

TABLE 4.5

Analysis of Variance for Total PCB concentrations

Factor	Type	Levels	Values
MS222	Fixed	5	0 1 2 3 4

Treatments for 30 day Exposure Experiment

MS222 concentration in tank water		PCB concentration in food (ng/g d/w)		
0 =	0 mg/L	Control Food	0 =	180
1 =	10 mg/L	PAH-Contaminated F	1 =	1630
2 =	30 mg/L			
3 =	70 mg/L			
4 =	0 mg/L * PAH-contaminated food			

Day	Source	DF	F	P
30	MS222	4	3.62	0.045
	Error	10		
	Total	14		

n = number of tanks (1 fish/tank)

MS222	PAH	Analyzed average tPCB	SE	n
0	0	40.7	4.1	3
1	0	35.6	4.1	3
2	0	35.0	4.1	3
3	0	31.4	4.1	3
4	1	51.2	4.1	3

Comparison	p value
4 > 3	0.0385

TABLE 4.6
Analysis of Variance for % lipid

Factor	Type	Levels	Values
MS222	Fixed	5	0 1 2 3 4

Treatments for 30 day Exposure Experiment

MS222 concentration in tank wa	
0 =	0 mg/L
1 =	10 mg/L
2 =	30 mg/L
3 =	70 mg/L
4 =	0 mg/L * PAH-contaminated food

PCB concentration in food (ng/g d/w)		
Control Food	0 =	180
PAH-Contaminated F	1 =	1630

n = number of tanks (1 fish/tank)

Day	Source	DF	F	P	MS222	PAH	Analyzed average % lipid	SE	n
30	MS222	4	0.91	0.496	0	0	0.028	0.003	3
	Error	10			1	0	0.023	0.003	3
	Total	14			2	0	0.021	0.003	3
					3	0	0.023	0.003	3
					4	1	0.021	0.003	3

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Chapter 5

Polycyclic aromatic hydrocarbon (PAH) impacts on bioenergetics and polychlorinated biphenyls (PCBs) accumulation in *Fundulus heteroclitus*

5.1 Introduction and Background

This chapter reports the findings of the final experiment, and the experimental design is a direct result of observations and results from Experiments 1 (Chapter 3) and 2 (Chapter 4).

Fish are exposed to narcotic chemicals associated with contaminated sediments via direct uptake from the water and sediment, as well as from feeding on contaminated prey. Consumption of contaminated prey is an important vector for moving contaminants from the sediment to benthic fish (Varanasi et al., 1989, Meador et al., 1995, and Johnson et al., 2002). Littoral zone fish such as *Fundulus heteroclitus* living in contaminated environments are continuously challenged by low-level exposures to multiple chemicals that exert baseline toxicity, or narcosis (Weis, 2002). Narcosis is defined as a nonspecific, reversible disturbance of membrane function due to the accumulation of hydrophobic chemicals in the lipids of membranes (McCarty et al., 1991, Van Wezel and Opperhuizen, 1995, DiToro et al., 2000). Acute narcosis depresses physiological and behavioral responses in exposed organisms (Rand, 1995, and Van Wezel and Opperhuizen, 1995). At lower exposure levels, the fish combats "sublethal narcosis" as the chemical builds up in the lipid membrane (Escher and Hermens, 2002, DiToro et al., 2000, and Van Wezel and

Opperhuizen, 1995). This may impose a bioenergetic cost on the fish leaving less energy available for growth and reproduction (Calow, 1991, and Beyers et al., 1999).

Ingestion of contaminated prey is a dominant route for exposure to non-polar, hydrophobic organic compounds for fish (Thomann and Connolly, 1984, Sijm et al., 1992, and Weis, 2002). Therefore, the food source for a fish living in a contaminated environment is a direct pathway for narcotics to affect its metabolic processes. However, some chemicals, such as polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs), which initially may exert a narcotic impact, also have additional specific modes of action that may counterbalance the narcotic effect on standard metabolic rate.

5.2.1 Effects of chemical stressors on fish bioenergetics

Several studies have posed the metabolic cost hypothesis for organisms exposed to chronic chemical stress (Moore et al., 1987, Calow and Sibly, 1990, Calow, 1991, Beyers et al., 1999, and Rowe, 2003). Mixtures of environmental chemicals may affect maintenance respiration in organisms by either increasing or decreasing standard metabolic rate (SMR). However, few studies have examined the consequences of an altered SMR on bioaccumulation of hydrophobic organic compounds (HOCs), particularly in the context of sublethal narcosis from realistic dietary exposures. Theoretically, decreasing an organism's SMR will reduce consumption, which in turn will reduce dietary HOC exposure and accumulation. One consequence of this impact could be an increase in time to reach critical body residues (defined as the internal concentration of a chemical that causes mortality to 50% of the test population, McCarty et al., 1992). Alternatively, sublethal narcosis could slow the rate of uptake to a point where elimination processes prevent mortality thresholds from being obtained, thus indirectly controlling bioaccumulation. Maintenance costs imposed on the organism increase with increasing SMR, forcing an organism to compensate by adjusting other portions of its bioenergetic budget (e.g., growth, reproduction, or activity) (Moore et al., 1987, Beyers et al., 1999, and Rowe, 2003). Either way there is a metabolic cost associated with a chemically induced change in SMR.

5.2.2 Competing modes of toxic action

Sublethal narcosis occurs as the membrane changes permeability (Van Wezel and Opperhuizen, 1995, Jaworska et al., 1996, and Escher and Hermens, 2002). There is substantial experimental evidence that narcotic chemicals increase fluidity of the phospholipids, and that ion permeability of the lipid bilayer is increased by narcotics. More specifically, nonpolar narcotics interfere with membrane integrity by disrupting the electrical potential and pH gradient (Sikkema et al., 1994). Enhanced chemical transport due to increased membrane fluidity and subsequent bioaccumulation of hydrophobic compounds (even of the narcotic itself) may be an indirect consequence of sublethal narcosis. At an acute level, the disturbance in the membrane from narcotic compounds decreases physical activity and diminishes the ability to react to outside stimuli (Van Wezel and Opperhuizen, 1995). At low-level, constant exposure to narcotics, the organism's processes including standard metabolic rate start to slow down as the membrane interacts with the chemical. When concentrations of the chemical within the cell reach concentrations that induce detoxification and cellular repair mechanisms, standard metabolic rate may be stimulated as maintenance requirements are stressed (Moore et al., 1987, and Penttinen and Kukkonen, 1998) and as a specific mode of action competes with the nonspecific response (Escher and Hermens, 2002). The net result is an idealized u-shaped curve (Figure 5.1).

5.2.3 PAH and PCB fates under the influence of competing modes of action

PAHs and PCBs present classic examples of chemicals that are effective at exerting baseline toxicity through the narcotic mode of action (Van Wezel et al., 1995, Di Toro et al., 2000, and Escher et al, 2002). However, these chemicals have multiple modes of action, including concentration- and time-dependent specific toxicities. For example, a well studied mechanism of PAH metabolism is the induction of the Cytochrome P450 1A system. This is a precursor process for carcinogenic or other developmental modes of action associated with PAH exposures in fish species (Meador et al., 1995, Johnson et al., 2002, and Incardona et al., 2004). These secondary modes of action may counterbalance or synergistically affect the metabolic rates of a fish. In past research on fish bioenergetics, exposure to contaminants (e.g., dieldrin and heavy metals) that act through other specific modes of toxic action has been shown to increase maintenance costs in fish (Beyers et al., 1999) as hypothesized in Figure 5.1. Similar responses have been seen in other organisms (Rowe et al., 1998).

5.2.4 Assessment of PAH exposure on fish

Sediments contaminated with PAHs continue to be of major concern for managing fish resources (US EPA, 2000 and Johnson et al., 2002). However, there are complications associated with directly assessing the impact of PAH exposures to fish because fish efficiently biotransform PAHs (Varanasi et al., 1989, and van der Oost et al., 2003). Therefore methods for assessing PAH exposure other than measuring tissue residues of parent compounds must be employed.

PAH and PCB contamination often co-occur (Ashley and Baker, 1999, Johnson et al., 2002, and Smith et al., 2003). Relative to PAHs, PCBs are poorly metabolized by fish but are subject to the same environmental and biological processes. PAHs and PCBs of similar log K_{ow}s are assimilated into tissue via similar routes of uptake. Sites that pose chemical risk to fish often are dominated by PAHs, but also have PCB concentrations at background concentrations (e.g., the creosote-contaminated site in the Elizabeth River, VA). In these areas, PCBs can be used as convenient tracers for monitoring chemical exposure and uptake. Additionally, measures for assessing PAH metabolism such as PAH metabolites in bile or EROD activity in liver tissue as a result of induction of the Cytochrome P450 1A (CYP1a) system can also be used to assess exposure of both classes of chemicals (Van Veld et al., 1992, Meador et al., 1995, and van der Oost., et al., 2003). In this study, standard metabolic rate is used to assess PAH exposure. PCB accumulation is used as a tracer of changes in bioaccumulation due to PAH exposure. EROD activity is also measured to assess the level of biotransformation and to compare to the response in standard metabolic rate.

5.2.5 Objectives

The objectives of this study are to quantify the impacts of a long-term exposure to dissolved and dietary narcotics on *Fundulus heteroclitus*. The experiment sought to infer the implications of sublethal narcosis on fish bioenergetics and bioaccumulation. The study evaluated bioenergetic parameters (growth, fraction of lipid, and standard metabolic rate) and bioaccumulation endpoints (total and congener-specific PCB tissue residues) to correlate chronic exposure to dietary PAHs with changes in bioenergetics and bioaccumulation.

The experiment was designed to test the following hypotheses:

H_1 Long-term exposure to narcotic chemicals (MS-222 and/or PAHs) reduces standard metabolic rate (SMR) in *Fundulus heteroclitus*.

H_2 Reduction in SMR reduces consumption of contaminated food.

H_3 If consumption is reduced, total PCB (Σ-PCB) bioaccumulation will be reduced, altering time to reach critical body residues.

Overall, if narcotics reduce SMR, then net Σ-PCB accumulation should be reduced.

5.3 Methods and Materials

5.3.1 Experimental design

The experiment followed a 2x4x3 factorial, random block design. Fish were exposed to two concentrations of MS-222 (0 and 50 mg/L), and four food treatments [1) control food, 2) 10% contaminated food:90% control food, 3) 50% contaminated food:50% control food, and 4) 100% contaminated control food] sampled over five time points (0, 32, 65, 90, 120 days). Each treatment was run in triplicate for a total of twenty-four aquaria. Subadult and adult fish were seined (July 2003) from a wild population at a control site on the Patuxent River, MD. Fish were held in the same experiment laboratory (same seawater system and light conditions) in 100-L circular flow-through tanks for approximately one week prior to the start of the experiment, and were fed pellet fish food (Zeigler's trout chow, Gardner, PA) twice a day. While in the holding tanks, fish were formalin-dipped to prevent bacterial growth or infection. On day 1, fish were switched to the experimental diets and fed at a rate of 5% body weight per day. During a 30-day pilot study (Chapter 4) conducted prior to this experiment, it was found that *Fundulus* readily consumed and adequately grew on this diet.

One week prior to day 0, aquaria were randomly placed on two racks (12 on the top, 12 on the bottom), and filled with filtered (< 0.5 um), 20^{o}C ambient seawater. The flow-through system was allowed to flush the aquaria until the start of the experiment. On day 0, 24 fish were randomly placed into each 38-L aquaria (total number of fish = 576 at the start of the experiment). During the experiment, water was delivered to each aquarium at a flow rate of 200 mL/min. Salinity ranged from eight to twelve parts per thousand (ppt) throughout the course of the experiment. Each aquarium was aerated using air-stones. The experiment was conducted under 16 hours of light and 8 hours of darkness. Aquaria were also loosely covered with black plastic to reduce photo-degradation of MS-222, and to minimize disturbance. Aquaria were periodically cleaned by suctioning debris off of the bottom, brushing down the side walls, and cleaning the exit weirs. Tubing that delivered water to each aquarium was replaced as needed. Aquaria were periodically monitored for temperature, pH, dissolved oxygen and nitrogen concentrations.

5.3.2 Exposure treatments

5.3.2.1 *Food Treatment Preparations*

Food treatments consisted of control and contaminated clams (*Mercenaria mercenaria*) homogenized with a fish gel (Gel Fish Food, Aquatic Ecosystems, Inc., Apopka, FL). Fish gel was used as an additive to the clams to provide more nutrients than the clams would alone. The fish gel also was used to provide bulk in order to reduce the amount of biomass needed from caged clams, and to dilute the contaminant concentrations accumulated in the clams caged in the Elizabeth River, VA. Food treatments were prepared by mixing “control clams” with fish gel, and “contaminated clams” in specific ratios to create four PAH exposure concentrations (Table 1 and Figures 5.2 and 5.3). “Control clams” purchased from a local commercial fisher were collected from the Chester River, MD, and the Ware River, NC. (Control clams were purchased at different times and hence reflect the two different sources.) Control clams were split into two groups. One group was frozen until the experiment. One group was kept alive, transported, and caged at a PAH-contaminated site on the Elizabeth River, VA (Van Veld et al., 1992) to accumulate environmentally relevant, and bioavailable, hydrophobic organic contaminants (HOCs) for the exposure experiments. A consequence of contaminating clams in the environment is that other contaminants such as trace metals, and uncharacterized HOCs were also present. Clams were caged for approximately 30 days, transported live to the laboratory, and then frozen. Both sets of clams were shucked and homogenized separately in separate food processors. Clams were mixed with equal parts of reconstituted fish gel to provide additional nutrients and bulk to the food treatments. The fish gel was reconstituted with heated deionized water at a 50:50

ratio of powdered gel to water, per the manufacturer's instructions. Pre-cleaned, solvent-rinsed steel bowls and spatulas were used for all mixing procedures.

Food treatments reflecting a composite of clams and fish gel were then prepared as follows: 1) control food only, 2) 10%, contaminated food to 90 % control clams, 3) 50% contaminated food: 50% control food, and 4) contaminated food only. All batches were frozen until feeding. Samples from each batch of food were collected for chemical analysis. For daily feedings, each aquarium received an equally measured ration of food at a rate of 5% of total fish biomass in the aquarium on a wet-weight basis. Fish rapidly consumed the food ration while it was in the water column of the aquarium. It was assumed that the food ration per fish averaged out over the course of the experiment.

5.3.2.2 *MS-222 Treatments*

MS-222 (3-aminobenzoic acid ethyl ester methanesulfonate), purchased from Argent Laboratories (Redmond, WA), was used as a model narcotic chemical. MS-222 is used routinely to alter cardiovascular and metabolic rates in fish (McKim et al., 1987). MS-222 was used to establish the fish acute toxicity syndrome (FATS) for Type I (non-polar) narcotic chemicals (McKim et al., 1987). MS-222 and PAHs also have similar critical body residues (McKim and Schmieder, 1991) under acute exposure regimes. The log K_{ow} (1.96) of MS-222 is lower than the major suite of chemicals of interest (PAHs) (log K_{ow}'s range from 3.3 (naphthalene) to 7.64 (coronene)). Russom et al. (1997) reclassified MS-222 as a Type III narcotic to account for the ester group, but maintained the behavior syndrome classification. MS-222's non-polar end is lipophillic (Kolanczyk et al., 2003), and will interact with the target lipid in the membrane similarly to exert the same mode of action initially as a PAH. The chemical also acts as a sodium-channel blocker (Incardona et al., 2004), and prevents generation and conduction of nerve impulses (Alpharma, Animal Health Ltd., 2001). MS-222 is metabolized through the gills and kidney. The impact of MS-222 on the P450 systems seems to be species-dependent (Kolanczyk et al., 2003). In rainbow trout, MS-222 does not affect induction over short time periods when used as an anesthetic (Kolanczyk, et al., 2003). Thus, MS-222 was used as a positive control of narcosis, recognizing that its chemical structure, and ultimate fate, is different than that of PAHs.

The MS-222 delivery system was a gravity-fed, flow-through system controlled with a header tank and clamp valves on flexible tubing. Seawater flowed into the header tank through four chemical-mixing reservoirs and finally into six separate aquaria. Opaque, food-grade, color-coded polyurethane tubing (1.6 mm ID, 3.2 mm OD tubing, Cole-Parmer, Vernon Hills, IL) fed each aquarium from the chemical mixing reservoirs. Opaque tubing was used to retard algal growth and photo-degradation of MS-222.

A stock solution of 25,000 mg/L of MS-222 was bled into the mixing reservoirs via silicon pump tubing (Masterflex L/S, Cole Parmer, Vernon Hills, IL) at 0.4 mL/min controlled with a multiple channel pump system (Masterflex L/S system, Cole-Parmer, Vernon Hills, IL), and then delivered to respective aquaria at a concentration of 50 mg/L (200 mL/min). Refrigerated DI water was delivered to the other set of aquaria at the same flow rate as the experimental control. Stock solutions of MS-222 and control DI water were stored in 2-L glass amber jars held under constant refrigeration and replenished every few days. Under these conditions, parent MS-222 remains stable in solution for approximately a month according to the manufacturer (Argent Laboratories).

5.3.3 Sampling procedures

On Day 0, 15 fish were removed from the holding tank at the same time that experimental fish were placed into each aquarium. Nine individuals underwent baseline standard metabolic rate evaluation, and subsequent PCB tissue analysis. Six individuals were killed, and their livers analyzed for Cytochrome P450-1A (Cyp 1A) protein induction via the enzyme activity of Ethoxyresorufin-*O*-deethylase (EROD). On each subsequent sampling day (35, 62, 90 and 120), six fish were removed from each aquarium; three fish were used to evaluate standard metabolic rates and PCB accumulation in tissue, and three fish were used to evaluate EROD activity. Fish were maintained in test water and fasted for 24 hours prior to any analysis in order to allow time to clear gut contents.

5.3.3.1 Procedure for measuring standard metabolic rate

To evaluate narcotic-induced stress, standard metabolic rate was measured on individual fish following methods previously described by Rowe (2003). Briefly, three fish from each aquarium were randomly captured and placed into individual 0.5 L plastic incubation containers with ~ 300 mL of their respective aquarium water. Fish were placed into the respirometry incubator (25 ^{o}C, dark), and held unfed for 24 hours to minimize activity and specific dynamic action respiration in preparation for measuring resting, or standard, metabolic rates. Following incubation, fish were transferred to 1 L glass test chambers with 300 mL of strained (to remove feces and bulk particulate matter) test water, and connected to the Micro Oxymax™ respirometer system (Columbus Instruments). Oxygen depletion (minimum O_2 consumption rates or VO_{2min} or the minimum rate of oxygen consumption by individual fish at rest and after 24 hours of fasting) was measured by a computer-controlled, closed circuit mircrorespirometer at 1 hour intervals in the headspace overlying the test water. Each chamber was sampled approximately seven times over a 24 - 36 hour period.

After SMR was measured, each fish was removed from the test chamber and anesthetized with an overdose of MS-222 (500 mg/L) in a seawater bath. Fish were measured for body length to nearest 0.5 mm, and weighed to the nearest 0.001 g. The sex of the fish was determined. Fish were then placed in clean foil pouches and frozen until extraction for lipid and PCB-congener analyses.

5.3.3.4 ***Procedure for biomarker (EROD) analysis***

Three additional fish were randomly captured from each aquarium and processed for subsequent analysis of EROD activity in liver tissue following the methods of Van Veld et al. (1992). Briefly, fish were placed in a seawater ice bath until anesthetized. Then, they were quickly weighed, measured, sexed, and then decapitated. The liver was quickly removed, dipped in a 1.15% KCL buffer solution, placed in 2 mL cryovials, and flash-frozen in liquid nitrogen. Samples were maintained in a –80°C freezer until analysis. EROD was measured on days 0 and 35 and results reported herein.

5.3.4 Chemical analyses

5.3.4.1 Chemical analysis of PCB congeners in fish tissues

Individual fish were homogenized and dried with sodium sulfate, and extracted using 24 hour Soxhlet extraction with dichloromethane (Baker et al., 1997). Prior to extraction, each sample was spiked with surrogates 3,5-dichlorobiphenyl and 2,3,4,4',5,6'-hexachlorobiphenyl (PCB IUPAC congeners 14 and 166, respectively). In 75% of the samples, recoveries of PCB 14 and 166 averaged 96% (± 20 %) and 94% (± 20 %) respectively. Twenty-five percent of the samples either had recoveries below 70% or above 130% for either congener. All chromatographic peaks were hand-integrated to accurately assess recoveries, and final congener masses were surrogate corrected. Blank sodium sulfate samples were run in parallel with each Soxhlet extraction to quantify laboratory background contamination. Contamination was minimal, and thus reported congeners were not blank-corrected. Σ-PCBs reported are the sum of 95% of the congener peaks (individual PCB congeners or unresolved congener groups).

Samples were concentrated to approximately 1 mL via roto-evaporation, and lipids removed via gel permeation chromatography (GPC). A subsample of approximately 0.5 ml was removed for gravimetric determination of tissue lipid content prior to GPC injection. Samples were concentrated to 1 ml for final cleanup using Florisil solid:liquid chromatography. Samples were concentrated and transferred to amber auto-sampler vials (ASVs), and internal standards 2,4,6-trichlorobiphenyl and 2,2',3,4,4',5,6,6'-octachlorobiphenyl (PCBs 30 and 204, respectively) were added to each sample prior to PCB quantification using gas chromatography with electron capture detection (GC/ECD).

A 2 μl portion of the concentrated sample extract was eluted with hydrogen through a 60 m x 0.320 mm I.D. capillary column with a 0.25um 5% diphenyl/95% dimethylpolysiloxane film (J&W Scientific #1235062 DB5). On exiting the column, the eluting compounds passed through a ^{63}Ni electron capture detector, generating responses for compounds identified using a calibration standard. PCBs were quantified on an individual congener basis following Mullin et al. (1984). Congeners were identified by retention time relative to two internal standards (PCBs 30 and 204). Sample congeners were quantified using relative response factors (RRF), the product of mass:response ratio of the congener in the calibration standard and the response:mass ratio of the internal standard in the calibration standard. The mass of the congener in each sample was then calculated as the product of the RRF, the internal standard mass in the sample, and the congener response:internal standard response ratio for the sample. Concentrations were calculated as the quotient of the mass in the sample extract divided by the mass extracted (corrected gravimetrically for subsampling).

5.3.4.2 Chemical analysis of PAH and PCB concentrations in food treatments

Aliquots of each food treatment were analyzed for both PAHs and PCBs. Samples were extracted and cleaned up via the same procedures identified above for fish. Perdeuterated surrogate compounds (d_8-napthalene, d_{10}-fluorene, d_{10}-fluoranthene, d_{12}-perylene) were used to assess analytical recoveries. Recoveries averaged 70 ± 12%, 100 ± 14%, 110 ± 14%, and 110 ± 14% d_8-napthalene, d_{10}-fluorene, d_{10}-fluoranthene, and d_{12}-perylene, respectively. Prior to the Florisil cleanup step described for PCB analysis, samples were purified by placing the 1 mL sample onto the head of a deactivated alumina [6% (w/w) water] column and eluted with 35 mL petroleum ether. After concentrating, the extracts were spiked with a perdeuterated PAH mixture (d_{10}-acenapthene, d_{10}-phenanthrene, d_{12}-benz[*a*]anthracene, d_{12}-benzo[*a*]pyrene, d_{12}-benzo[*ghi*]perylene) for quantification of PAHs. PAH analytes were identified and quantified using a capillary gas chromatograph (Hewlett Packard 5890) and a mass spectrometer (5970A) (GC/MS) operated in Selective Ion Monitoring (SIM) mode (Baker et al., 1997). Following GC/MS analysis, samples were processed in the same manner as the fish samples for subsequent individual PCB congener analysis.

Other contaminants such as trace metals, pesticides, and other constituents in creosote were not quantified.

5.3.5 Data analyses

For each sampling day, all measured responses [percent survival, weight, length, Fulton's condition factor ($K = g/cm^3$), standard metabolic rate (SMR), percent lipid, total PCB bioaccumulation, and P450 biomarkers] were analyzed by analysis of variance (ANOVA) (Minitab, 2000). For SMR, fish body weight (g wet weight) was analyzed as a covariate (ANCOVA). The analysis tested two fixed factors: MS-222(i) and PAH Food(j), and their interactions (ij). The MS-222 factor tested 2 levels (1= 0, 2 = 1). The PAH Food factor tested four levels (1 = 0, 2 = 0.1, 3 = 0.5, and 4 = 1). All tests employed ANOVA general linear model (GLM) for each time point where Response (ijk) = μ + ai + bj + abij + εk(ij). Each response was also analyzed by repeated measures ANOVA with "day" as a fixed variable in the general linear model (Minitab, 2000).

Standard metabolic rates ($V_{O2\ min}$, the minimum rate of oxygen consumption by individual fish at rest and after 24 hours of fasting) were measured as a physiological response to chronic exposure to narcotic chemicals. In the respirometer chambers, periods of hyperactivity affect sample means (Rowe, 2003). All of the data presented here are averages of the lower 50% of measurements for each individual per sampling event to eliminate the confounding influence of measurements during periods of activity (Rowe, 2003).

Rates of survival were not significantly different across treatments ($p > 0.3$ for all factors) (Table 5.1). However, fish from five aquaria, [1 control aquarium (control food * no MS-222)(#15), 1 aquarium (no MS-222 * 0.1 food)(#7), 1 aquarium (no MS-222 * 0.5 food)(#11),1 aquarium (50 mg/L MS-222 * 0.1 food)(#18), and 1 aquarium (50 mg/L MS-222 * 1.0 food)(#2)] died before the end of the experiment (Table 5.1), potentially from disease introduced to the test system through the main laboratory supply of seawater. Data analyses were conducted with and without these aquaria for the repeated measures analysis, and for earlier time points in the univariate analysis. For all of the within day analyses, reported values include all of the aquaria. For the repeated measures analysis, the aquaria were removed to have a balanced time-series. Reported results in SMR are reported in J/g-d by converting the measured $V_{O2\ min}$ by assuming 1 mL O_2 consumed equals 20.08 J (Rowe, 2003).

5.4 Results

5.4.1 PAH and PCBs measured in the Food

All batches of food were characterized for individual PAH analytes and PCB congeners to verify and quantify dietary exposures to fish and to correlate narcotic dose to sublethal responses in *Fundulus heteroclitus.* Figure 5.2 depicts the PAH profiles of forty-two PAH analytes measured in the food batches and the PAH gradient. Figure 5.3 depicts the average concentrations of Σ-PAHs of each treatment. The control food treatment contained an average Σ-PAH concentration of 600 ng/g w/w (± 20, n = 4). For the contaminated treatments, the average Σ-PAH concentrations were 840 (± 270, n = 4), 2400 (± 1300, n = 4), and 2800 (± 2200, n = 6) for the 10% contaminated, 50% contaminated, and 100% contaminated treatments, respectively. (Averages were obtained by combing all batches within a treatment, thus it represents the integrated exposure for the treatment.) The contaminated treatments represent an environmentally relevant mixture and the bioavailable fraction of PAHs accumulated from a contaminated estuarine system (Elizabeth River, a sub-estuary of the Chesapeake Bay) where PAHs are the dominant chemical class of concern. However, other unmeasured contaminants are also present. The variability in the contaminated food batches is due to two different caging periods, and thus reflects different environmental conditions of the Elizabeth River at times of clam deployments. The different concentrations resulted from not making enough food at the start of the experiment, and reflect batch differences, not analytical error.

PCB patterns and overall concentrations did not vary significantly across food treatments. (See Figure 5.4). Figure 5.4 depicts the PCB profiles of 43 congeners (chromatographic peaks) measured in the food batches. Figure 5.5 depicts the average concentrations of Σ-PCBs of each treatment. The control food treatment contained an average of 40 ng/g w/w (± 10, n = 4). For the contaminated treatments, the average Σ-PCB concentrations were 40 (± 6, n = 4), 40 (± 8, n = 4), and 40 (± 25, n = 6) for the 10% contaminated, 50% contaminated, and 100% contaminated treatments, respectively. (Averages were obtained by combing all batches within a treatment, thus it represents the integrated exposure for the treatment.)

Although the PAH concentrations increased along a gradient as designed, the PCB concentrations remained invariant across treatments due to mixing the clams with fish gel which contained background PCB concentrations. The "control clams" contained background concentrations of PCBs, thus the Elizabeth River was not an important source of PCBs to the "contaminated clams." Relative to PAHs, PCBs are poorly metabolized by fish and provide a convenient chemical tracer for assessing changes in bioaccumulation of hydrophobic contaminants over time. Because the PCB concentrations did not vary among food treatments, comparison of PCB bioaccumulation across treatments is simplified, and directly reflects differences in bioaccumulation.

5.4.2 Impacts on survival and growth parameters

Exposures of aqueous MS-222 and PAH-contaminated food did not significantly affect fish survival ($p > 0.32$ for main and interaction effects) (Table 5.1 and Figure 5.6). Fish survival ranged from 64 – 82%. All treatments suffered from lower survival after day 90, as previously discussed.

In general, there were not significant treatment effects on fish weight (g), length (mm), or Fulton's condition factors {K = [mass of fish (g)/(length of fish (cm))^3]}between treatments, suggesting that fish were not dramatically affected by the contaminant exposures per the experimental design. However, there were some exceptions. Figure 5.7 plots median fish weight versus time for each treatment. For the growth parameters, two to six fish were used to calculate medians for each aquarium to obtain a median for each treatment ($n = 3$ aquaria per treatment). (See Table 5.1 for number of fish (n) for each aquarium.) On days 90 and 120, three to five treatments average only two aquaria, and are designated on the graphs. Median fish weight (g) was not sensitive to the treatment effects when analyzed within each time point (Table 5.2) by ANOVA GLM. Time significantly affected fish weight in the repeated measures analysis ($p < 0.001$) when day was included as a factor whereas the PAH-contaminated food ($p = 0.749$) and the MS-222 ($p = 0.07$) did not significantly affect weight ($\alpha = 0.05$). On day 120, fish weight was significantly less than on days 35, 62, and 90 ($p < 0.002$) for all treatments.

Median fish length was not affected by the PAH-contaminated food or MS-222 exposures until day 120 (Figure 5.8). On day 120, MS-222 positively affected length where fish exposed to 50 mg/L MS-222 were significantly longer than the non-exposed fish ($p = 0.015$). In the repeated measures analysis, day was a significant factor ($p = 0.009$), as was MS-222 ($p = 0.036$). Fish on day 120 were shorter than those on day 90 ($p = 0.018$), and the MS-222 exposed fish were longer than the non-exposed treatments (0.0359). The PAH-contaminated food treatments did not affect fish length ($p = 0.67$).

Given the effects observed in the weight and length measurements, Fulton's condition factor was calculated as (fish weight (g) / (fish standard length (cm))^3 to examine whether there was a treatment effect on fish health. Condition factor did not vary significantly due to the treatments in either the univariate or repeated measures analysis (Figure 5.9, Table 5.4). However condition factor significantly declined over time ($p < 0.0001$) where day 120 fish had reduced condition factors relative to the other days ($p = 0.02$).

Sex ratios did not vary significantly among treatments, $p = 0.127$ in a one-way ANOVA with food treatment as the response variable. Reproductive endpoints were not measured. However, during dissections it was observed that 15% of the females were gravid on Day 90 while on Day 120 none were gravid. There was not a sufficient number of females within treatments to make any assessment of treatment effects on fecundity, which was not part of the experimental design.

5.4.3 Impacts on Bioenergetics

Standard metabolic rate responded in a non-linear manner to the exposure treatments. MS-222, the PAH-contaminated food, and time (day) all had significant effects and interactions in univariate and repeated measures analyses. Figure 5.10 shows standard metabolic rate (SMR) versus the PAH-contaminated food gradient for each sampling period (univariate analysis). For day 62, where food treatments were compared (Tukey's Comparisons, 95% CI), the PAH-contaminated food increased SMRs between the control food concentrations (600 ng/g Σ-PAH), and the 10% contaminated food concentration (835 ng/g Σ-PAH) ($p = 0.0592$). The fish fed the 50% contaminated food and 100% contaminated food had higher standard metabolic rates than the fish fed the control food ($p = 0.0256$ and 0.0711, respectively). (See Table 5.5.)

On Day 62, MS-222-exposed fish fed control food exhibited significantly reduced SMRs compared to the other MS-222-exposed fish fed the 10% ($p = 0.0236$), 50% ($p = 0.0191$) and 100% ($p = 0.0165$) contaminated food. The other sampling days (35, 90, and 120) did not demonstrate detectable differences among treatments. Thus, a repeated measures ANCOVA was performed and results reported below.

Figure 5.11 presents all of the standard metabolic rate data analyzed by the repeated measures ANCOVA general linear model. The data points represent the least square means (± 1 SE) on the aquarium means (n = 3 aquaria/treatment). (See Tables 5.1 and 5.5.) The aquarium means comprise 3 fish per aquarium on day 35. On day 62, only 2 fish from each aquarium were measured due to problems with the respirometer, but the treatment mean is comprised of (n = 3 aquaria).

On Day 120, as previously stated, 5 aquaria were not included in the repeated measures analysis. In the repeated measures analysis, all factors produced significant effects. MS-222 exposure stimulates SMR relative to the non-exposed (0 mg/L MS-222) fish ($p = 0.021$). There is an interaction effect between the MS-222 and the PAH-contaminated food (0.004). Time also affects SMR ($p = 0.006$). The general trend here is that MS-222 stimulates SMR except in the control food (uncontaminated food) treatments where MS-222 depresses SMR over time (see Figure 5.11).

Figure 5.12 depicts the mean SMR by treatment from the ANOVA GLM where MS-222 is crossed with the PAH-contaminated food to examine the cumulative response over the entire study. When examining the effects of MS-222, there is no significant difference in SMRs between the fish fed the control food (control food, Σ-

PAH = 600 ng/g w/w) due to MS-222 ($p = 0.5213$), Tukey's comparison, 95% confidence intervals).

In comparing the effects of the contaminated food gradient, the 100% contaminated food produces a significant increase in SMRs relative to control food treatments (0.0139). In treatments with no MS-222 (white bars), standard metabolic rates of fish fed the 10% contaminated food are depressed (at the $\alpha = 0.10$ level) compared to the fish fed the 100% contaminated food ($p = 0.0925$). In treatments with MS-222 (black bars), the SMRs of the fish exposed to the 50 mg/L MS-222 and control food are significantly depressed compared to he MS-222-exposed fish fed the 10% contaminated food ($p = 0.0199$) and the 100% contaminated food ($p = 0.0189$). This group also has significantly depressed SMRs compared to the fish exposed to 0 mg/L MS-222 and 100% contaminated food ($p = 0.0189$). There is an overall interaction effect between the food treatment and aqueous MS-222 exposures ($p = 0.004$). The results indicate that total chemical burden from the MS-222 plus PAH-contaminated food exposures masked the sublethal narcotic effect of MS-222, and produced a net increase in the standard metabolic rates of *Fundulus heteroclitus*.

5.4.4 Impacts on PCB bioaccumulation

Figure 5.13 plots mean Σ-PCB concentrations measured in the tissues for each treatment by sampling period. There are no MS-222 effects on PCB accumulation for any time point (day 35, $p = 0.35$, day 62, $p = 0.07$, day 90, $p = 0.698$, and day 120, $p = 0.404$ for MS-222 main effect, Table 5.6). However, the PAH-contaminated food significantly increases accumulation between the control food treatments and the 10% contaminated food treatment ($p = 0.0307$, Figure 5.12) in the ANOVA general linear model analysis. On day 120, the PCB accumulation from the PAH-contaminated food is not significant ($p = 0.092$ in the ANOVA general linear model) among the treatments. However, since MS-222 is not inducing an effect in PCB accumulation, in a one-way ANOVA, there is a significant food effect ($p = 0.038$) (Figure 5.14) when MS-222 is not analyzed as a separate factor.

Figure 5.15 presents all of the Σ-PCBs data across the time course of the experiment. Data points are the averages (± 1 SE) and are aquarium averages (n = 3 fish/aquarium and n=3 aquaria/treatment) (Table 5.6). Toward the end of the experiment, statistical power diminishes due to five aquaria experiencing mortality after day 90 due to a systemic laboratory-wide issue with the water source unrelated to the experimental design. The increased mortality was not treatment-specific. For this reason, the data set for days 35 – 90 are analyzed for a repeated measures analysis through an ANOVA general linear model with "MS-222", "Food", and "Day" as fixed factors. Through this procedure, the food treatment was a significant factor ($p = 0.056$, at the $\alpha = 0.10$ level) for the PCB accumulation endpoint. (Day 120 was excluded from the repeated measures analysis because of mortality presenting an imbalance in the time series data.) In the treatments fed PAH-contaminated food, PCB accumulation increased above the control concentrations after day 62, despite being exposed to the same PCB concentrations. The dashed lines (Figure 5.15) designate the Σ-PCB concentrations in the food treatments.

5.4.5 Impacts on fish lipid content

Figure 5.16 presents all of the fraction lipid content measured in fish tissue across the time course of the experiment. Data points are the averages (± 1 SE) and are aquarium averages (n = 3 fish/aquarium and n=3 aquaria/treatment) (Table 5.7), and were analyzed in the same fashion as the PCB data. On day 62, MS-222 affected lipid content where MS-222 exposed fish contained more lipid than the MS-222 unexposed fish ($p = 0.017$). However, there were no significant differences in lipid content due to treatment effects detected after that time point. In the repeated measures analysis, no significant differences were detected for MS-222 ($p = 0.108$), PAH-contaminated food ($p = 0.498$), and day ($p = 0.296$).

The lipid contents measured in fish were inconsistently correlated to PCB concentrations. On days 35 and 120, the two variables were not correlated [Pearson's correlation (-0.043 and 0.208 with respective p values of 0.717 and .132)]. On days 62 and 90, there were significant correlations [Pearson's correlation (0.554 and 0.384 with respective p values of < 0.001 and 0.005)]. In testing for a correlation across time, there is a significant correlation (Pearson's correlation, 0.170, $p = 0.007$); however, there was a poor r^2 (0.029) in a linear regression of Σ-PCB versus percent lipid. Because of the inconsistencies within time points, and the poor relationship in the regression, PCB tissue concentrations were not lipid-normalized.

5.4.6 Enzyme activity

Livers removed on Day 35 were analyzed for enzyme activity. In Figure 5.17, mean Ethoxyresorufin-*O*-deethylase (EROD) activity (pmol/mg protein/min) is plotted versus the PAH-contaminated food gradient. In treatments with no MS-222 (white bars), EROD activity increased with the PAH dose, however, there was no distinction among the control concentration and the intermediate concentrations. MS-222 inhibited EROD activity relative to Day 0 (grey bar, (*) $p = 0.048$) and in treatments without MS-222. Only the control concentration and the highest concentration of PAH-contaminated food treatments with MS-222 (black bars) and PAH showed a statistically significant inhibition in EROD activity relative to the treatments without MS-222 ($p < 0.001$). There is no distinction between the intermediate concentrations (Mitchelmore and Benedict, unpublished data). Although there is a response in EROD activity, it may be lower than expected due to biotransformation in the intestine, thus limiting biotransformation in the liver tissue (Van Veld et al., 1997).

5.5 Discussion

The results of the experiment are complex and different from the alternative hypotheses: 1) exposure to aqueous MS-222 and dietary PAH treatments would induce sublethal narcosis, and in doing so, depress standard metabolic rates (SMRs); and 2) if SMR decreases, PCB accumulation would also decrease. Figure 5.1 shows the hypothetical response in standard metabolic rates. It was expected that the treatments with control water (no MS-222) to demonstrate reduced metabolic rates as the PAH load increased (the solid line). In keeping with narcosis theory, chemicals that exert the same mode of action should act in an additive fashion (Schwartz et al., 1995 and Di Toro et al., 2000). Thus, if another narcotic is added to the PAH load, a further depression in metabolic rate was anticipated. Under acute situations, this may apply; however, in long-term exposures other mechanisms are induced. The results of the study suggest that sublethal narcosis can be induced. However, there is a threshold where other modes of action may interact with and mask the sublethal narcosis effect by increasing SMR (the dotted line) in Figure 5.1.

Comparing the hypothetical response (Figure 5.1) with the data (Figure 5.12, cumulative effect on SMR) suggests that at PAH concentrations in the control food, the added narcotic (50 mg/L MS-222) depressed SMR, however, not to a statistically significantly level ($p > 0.05$). There is a 10% increase in SMR between the MS-222 exposed fish fed the control food and the MS-222-exposed fish fed the 10% and 100% contaminated food. There are likely several factors interacting to produce these results including competing modes of toxicity, including sublethal narcosis.

The control fish exposed to the MS-222 were exhibiting the expected response according to the hypothesis: SMR was depressed relative to the fish exposed to higher concentrations of PAHs. However, the non-MS-222 exposed fish fed the control food were not significantly different from any group. This could be due to several reasons: to non-measured contaminants (e.g., trace metals, pesticides, and other creosote-associated contaminants) interacting in the other treatments, to other PAH-associated toxicities, to non-chemical stressors, and/or to the insensitivity of SMR as a method for quantifying sublethal chemical stress in fish.

1. Complications with non-measured co-contaminants. The Elizabeth River, VA, Atlantic Woods site where the caged clams were contaminated is a well studied site due to its high concentrations of PAHs associated with creosote contamination (Vogelbein et al., 1990, and Van Veld et al., 1991 and 1992). Although PAHs are the dominant contaminant class of concern, other contaminants (e.g., metals, pesticides, and other creosote-associated compounds) co-exist. These chemicals were not measured in the food exposure. Therefore, integrated response of the known exposure to the PAHs, PCBs, and MS-222, along with these non-quantified

compounds may be counter-acting sublethal narcosis and acting synergistically to induce the stimulated metabolic rates.

2. Other toxicities associated with PAHs. As discussed in Chapter 2, PAHs cause a multitude of toxicities depending on the duration of exposure, the type of exposure, and the endpoints measured. Regardless of the potential for other contaminants to influence the SMR endpoint measured here, different PAHs and their metabolites are producing other effects in addition to the sublethal narcosis effect. As the PAH load increased above 835 ng/g w/w Σ-PAH, SMRs are stimulated, indicative a different mode of action. Similar results were found in a study where dieldrin increased largemouth bass standard metabolic rates (Beyers et al., 1999) and coal fly ash increased amphibian SMRs (Rowe et al., 1998).

3. Laboratory stresses unrelated to the experimental design. There were not profound treatment effects with regard to the other parameters measured (fish weight, length, and % lipid), however, toward the end of the experiment fish mortality increased and weight, length and condition factor parameters decreased across all treatments over time indicating a stressed environment. The suspected cause was due to compounds in the water from a toxic algae bloom in the Patuxent River that entered the filtered, laboratory seawater system. This was not confirmed, but other concurrent experiments experienced problems during this time as well. Regardless, the added stress may have diluted the SMR response in the main control group (0 mg/L MS-222 and control food).

Others have demonstrated that for some species of fish SMR is not sensitive to contaminant stress (Hopkins et al., 2000, Rowe 2003, and Staub et al., 2004). One of the reasons for this is due to the complications associated with chemical mixtures, and therefore competing toxicities that dampen out the SMR response. Additionally, all of the studies used relatively hardy fish species (*Erimyzon sucetta*, Hopkins et al., 2000, *Cyprinodon variegatus*, Rowe 2003, and *Gambusia holbrooki*, Staub et al., 2004) to examine contaminant mixture effects. *Fundulus heteroclitus* is also an inherently hardy species given that it thrives in a wide range of salinities and temperatures. Thus, SMR may not be an appropriate method for assessing effects of contaminant stress from mixtures. The results reported here were influenced by the choice of species and exposure methods, however, the discernable impacts have relevance in understanding long-term, sublethal impacts of environmentally relevant exposures on fish bioenergetics.

Fish in all treatments were exposed to the same concentrations of PCBs across treatments and across time (same dose). Despite this, fish fed the PAH-contaminated food, accumulated higher concentrations of PCBs over the course of the experiment. In this study, MS-222 did not influence PCB accumulation. In order to increase PCB tissue levels above the control groups, fish fed the contaminated food had to ingest more PCB, assimilate PCBs more efficiently, or decrease rates of elimination and biotransformation. Fish could not ingest more PCB because consumption was controlled throughout the course of the experiment. There was no visual evidence of the control fish reducing their consumption rates, thus it seems unlikely that the fish fed the PAH-contaminated food ingested more mass of PCB. The PAH-contaminated food treatments did not affect fish weight, length, condition factors or lipid content, thus it does not seem likely that assimilation efficiency was altered due to the food exposures. Likewise, if elimination processes were affected, other growth parameters would probably have been affected.

PCBs and PAHs with similar K_{ow}s should transport into tissues through the same mechanism at similar rates for similarly sized molecules (i.e., diffusion across the digestive tract). Both PCBs and PAHs induce the P450 systems (van der Oost et al., 2003). Whether metabolized in the intestine (Van Veld et al., 1997), or after assimilated into tissue, PAHs are readily metabolized in fish relative to PCBs, and PAH accumulation may interfere with the elimination of PCBs through competition for enzyme binding sites. Concentrations of PAHs in the food treatments were one to two orders of magnitude above the invariant PCB concentrations, thus there would be more available PAH substrate available for binding as the PAH-contaminated food increased. The net result of this would be higher PCB concentrations in the fish fed the more PAH-contaminated food. Treatment-dependent differences in PCB patterns would be expected where fish challenged with higher PAH exposures would develop PCB profiles dominated with lighter molecular weight congeners due to reduced degradation of PCBs through biotransformation. This was not observed. However, since the PAHs were much higher than the PCB concentrations in the food, perhaps there was not a high enough source of PCB for effects to separate out in a congener-specific manner.

Metabolism of PAHs was not directly assessed in this study by measuring PAH metabolites in bile, for example. EROD activity was measured on day 35 as an indirect measure of PAH metabolism, but this only provides an indicator early in the study when neither SMR nor PCB accumulation were affected by any of the treatment factors. PAH metabolism was not the focus of this study. The goal of the experimental design was to use a combination of standard metabolic rates and PCB accumulation as a way of assessing the consequences of PAH and MS-222 exposure on bioenergetics and PCB bioaccumulation. It is an important finding that PAH exposure enhances PCB accumulation, but the mechanism for such a result needs further elucidation in future research.

5.6 Implications and conclusions

There are several important implications of this study. First, this study demonstrated that exposure to narcotic chemicals (MS-222 and PAHs) modifies standard metabolic rates of fish. At higher concentrations of PAH exposure, a shift in mode of toxicity is indicated where standard metabolic rates are stimulated, thus masking the sublethal narcosis (depressed metabolic rate). Secondly, exposure to increasing concentrations of PAHs enhanced bioaccumulation of other hydrophobic organic compounds (e.g., PCBs).

From a bioenergetics standpoint, stimulated metabolic rates impose a cost on the fish, leaving less energy available for other processes (e.g., growth and reproduction) (Calow, 1991). The population level consequences of these interactions are explored in Chapter 6.

From a bioaccumulation standpoint, there are potentially three main implications. First, at sites where PAHs and PCBs co-exist, enhanced accumulation provides a mechanism for moving contaminants from the benthos to higher trophic levels. Second, through maternal transfer of PCBs and other contaminants, a simultaneous exposure to PAHs (and/or other non-measured contaminants) may increase PCB transfer to eggs and larvae. Third, at sites where concentrations of PCBs are of concern, stimulated metabolic rates due to PAH exposure could reduce the time to reaching internal effects concentrations. This second indirect effect has potential ramifications on population level parameters. For example, if it takes less time to achieve a threshold for a deleterious effect, the probability of reaching maturation could be compromised. Alternatively, sublethal narcosis may control the time to reaching a critical effects concentration by allowing the rate of biotransformation to be such that the bioaccumulation threshold for producing a critical body residue is not reached.

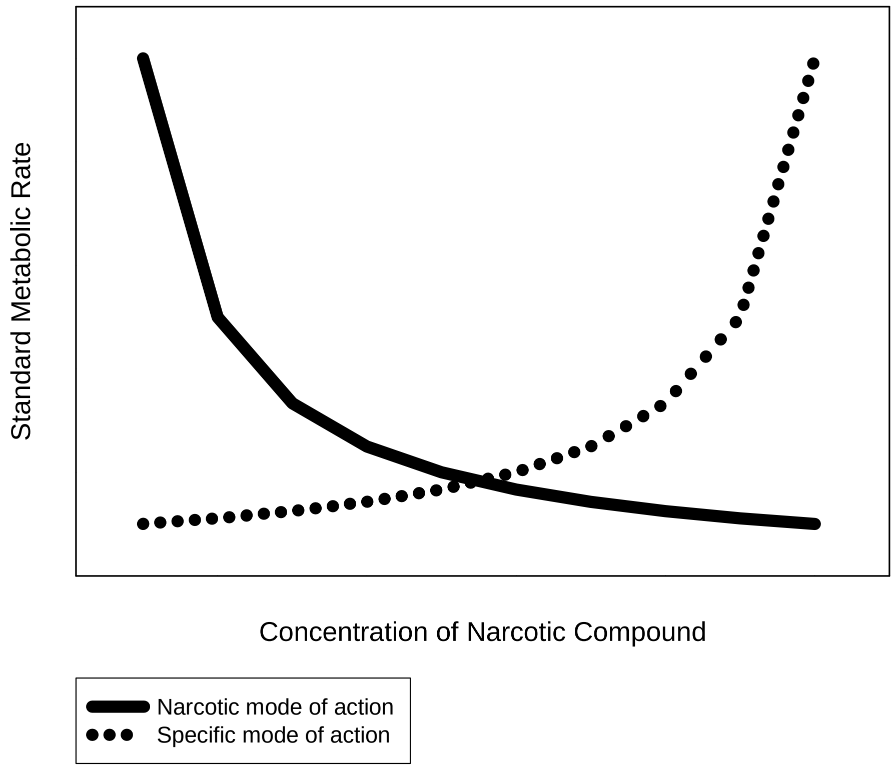

Figure 5.1. Conceptual model for the impacts competing modes of action on fish standard metabolic rates. The slopes are not precise but are for illustration purposes only.

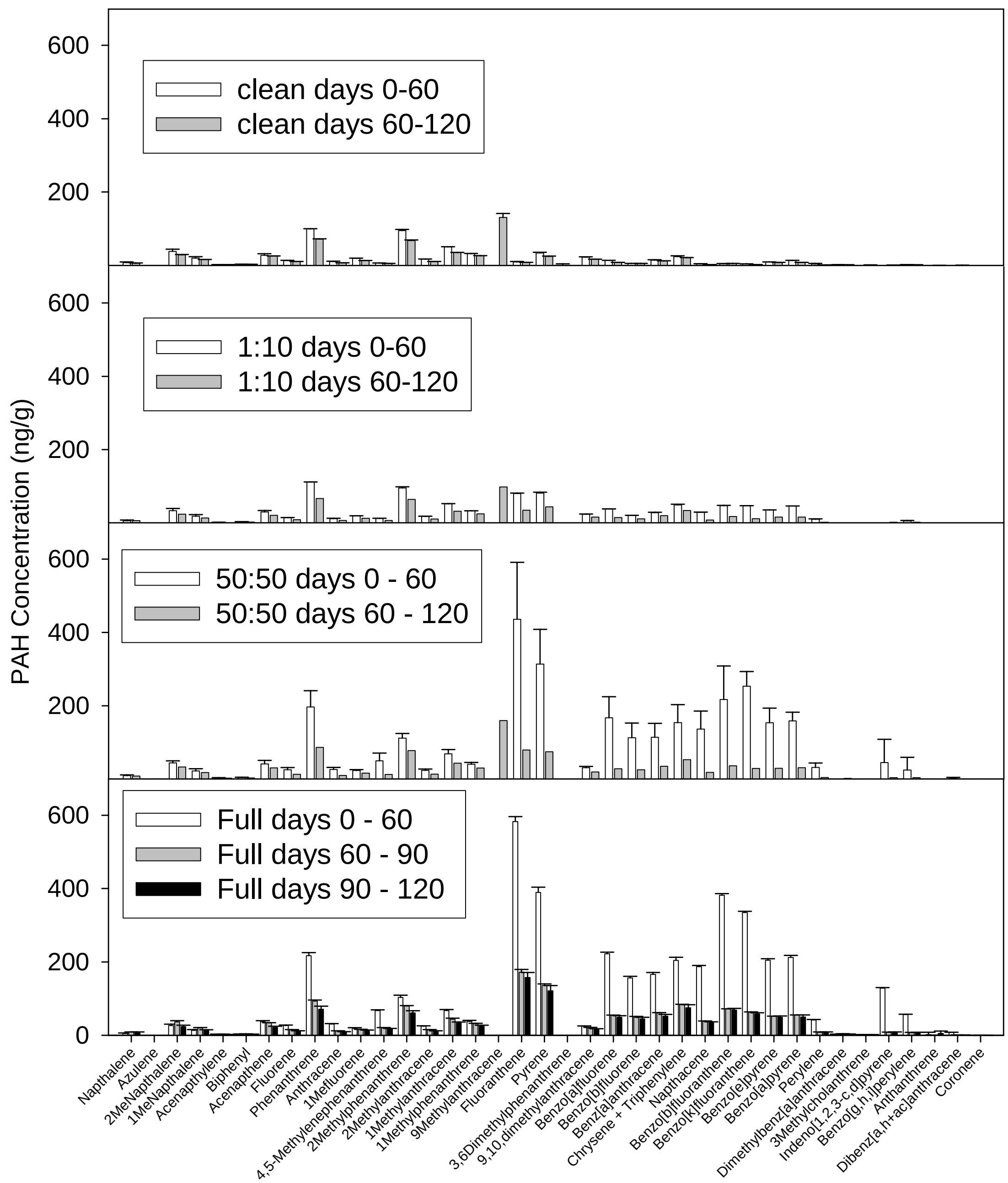

Figure 5.2. PAH analyte (ng/g) profiles quantified in the in food treatments. Different batches reflect different time periods when clams were in the Elizabeth River to bioaccumulate PAHs. Error bars represents ± 1 SD from replicates of the respective food batch.

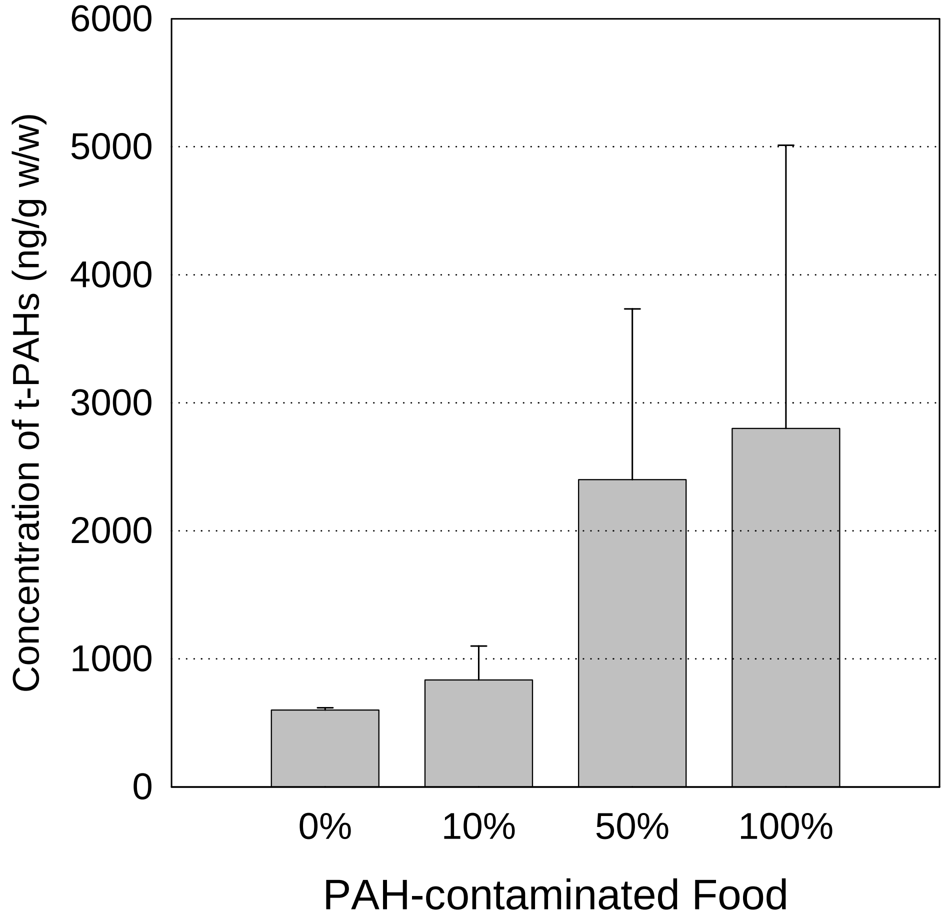

Figure 5.3. Average Σ-PAH concentrations measured in food treatments. All batches for each treatment were averaged together to obtain an integrated average for each treatment.

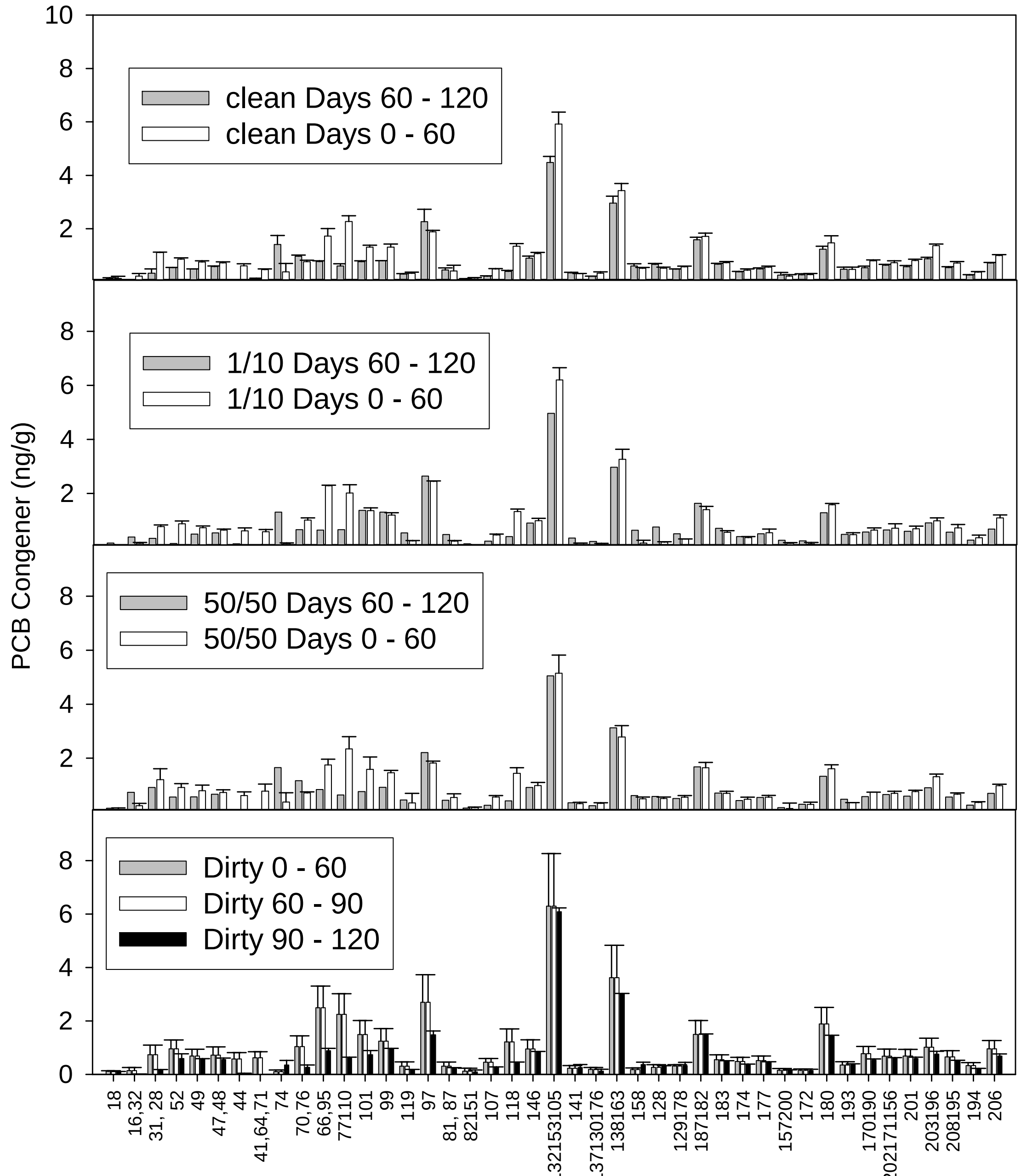

Figure 5.4. PCB analyte (ng/g) profiles quantified in the in food treatments. Different batches reflect different time periods when clams were in the Elizabeth River to bioaccumulate PAHs. Error bars represents ± 1 SD from replicates of the respective food batch.

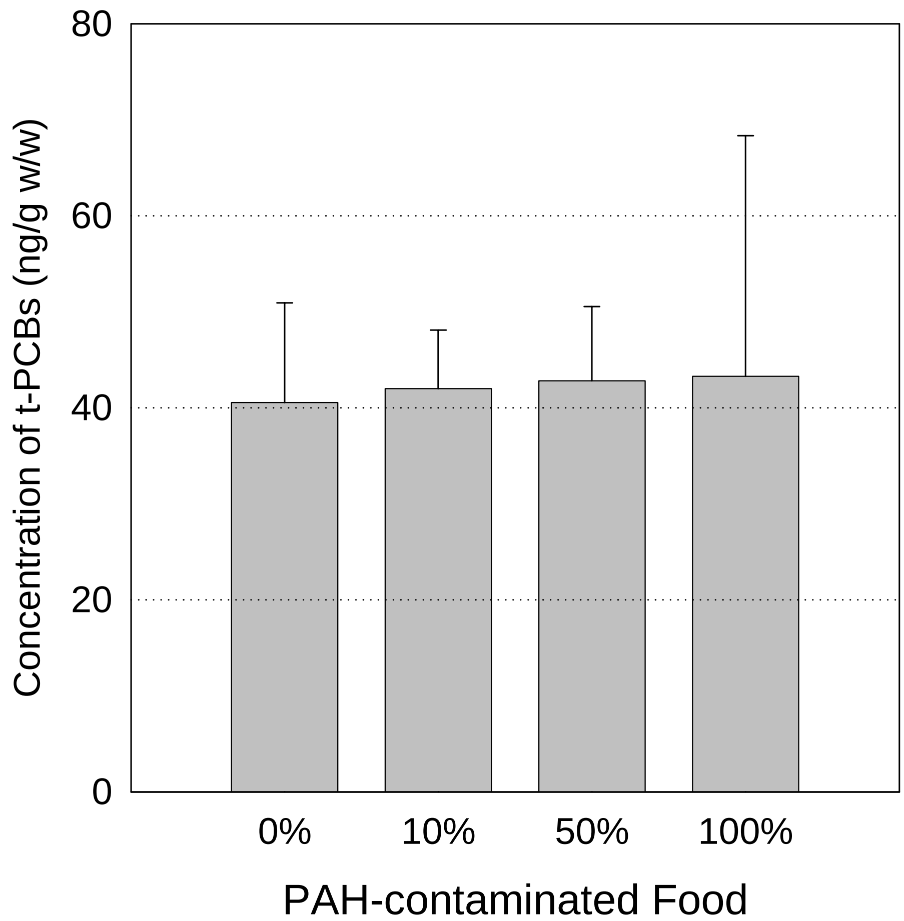

Figure 5.5. Average Σ-PAH concentrations measured in food treatments. All batches for each treatment were averaged together to obtain an integrated average for each treatment.

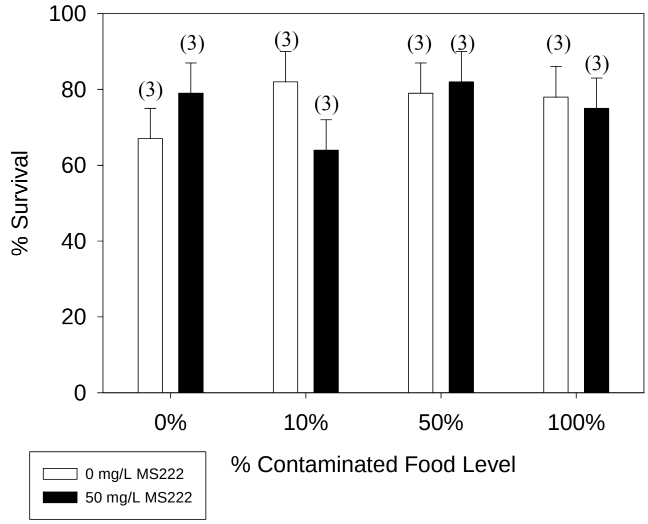

Figure 5.6. % Survival of fish exposed for 120 days to 0 mg/L (white bars) and 50 mg/L MS-222 (black bars) versus a gradient of PAH-contaminated food (0% = control food, 10% = 10% contaminated food:90%control food, 50% contaminated food:50% control food, and 100% contaminated food. Numbers in parentheses represent number of aquaria. Survival was not significantly different between treatments ($p > 0.3$ for all factors).

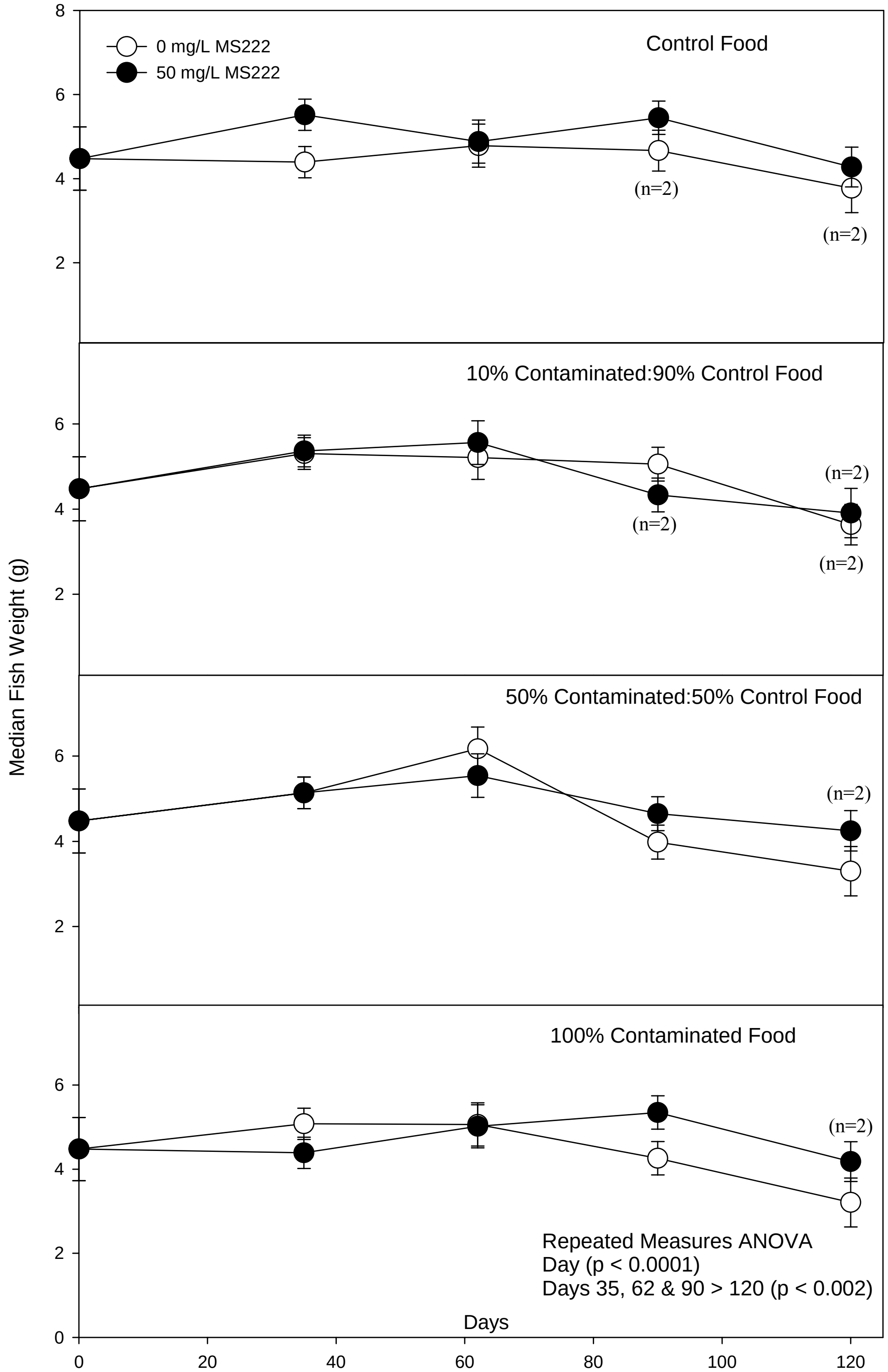

Figure 5.7. Median fish weight (g) (± 1 SE) vs. time analyzed by ANOVA, general linear model (univariate and repeated measures). The food gradient proceeds from top to bottom: Control food, 10% contaminated:90% control, 50% contaminated:50% control, 100% contaminated food. MS-222 concentrations 0 and 50 mg/L are represented by white and black symbols, respectively, where n = 3 aquaria, unless designated otherwise.

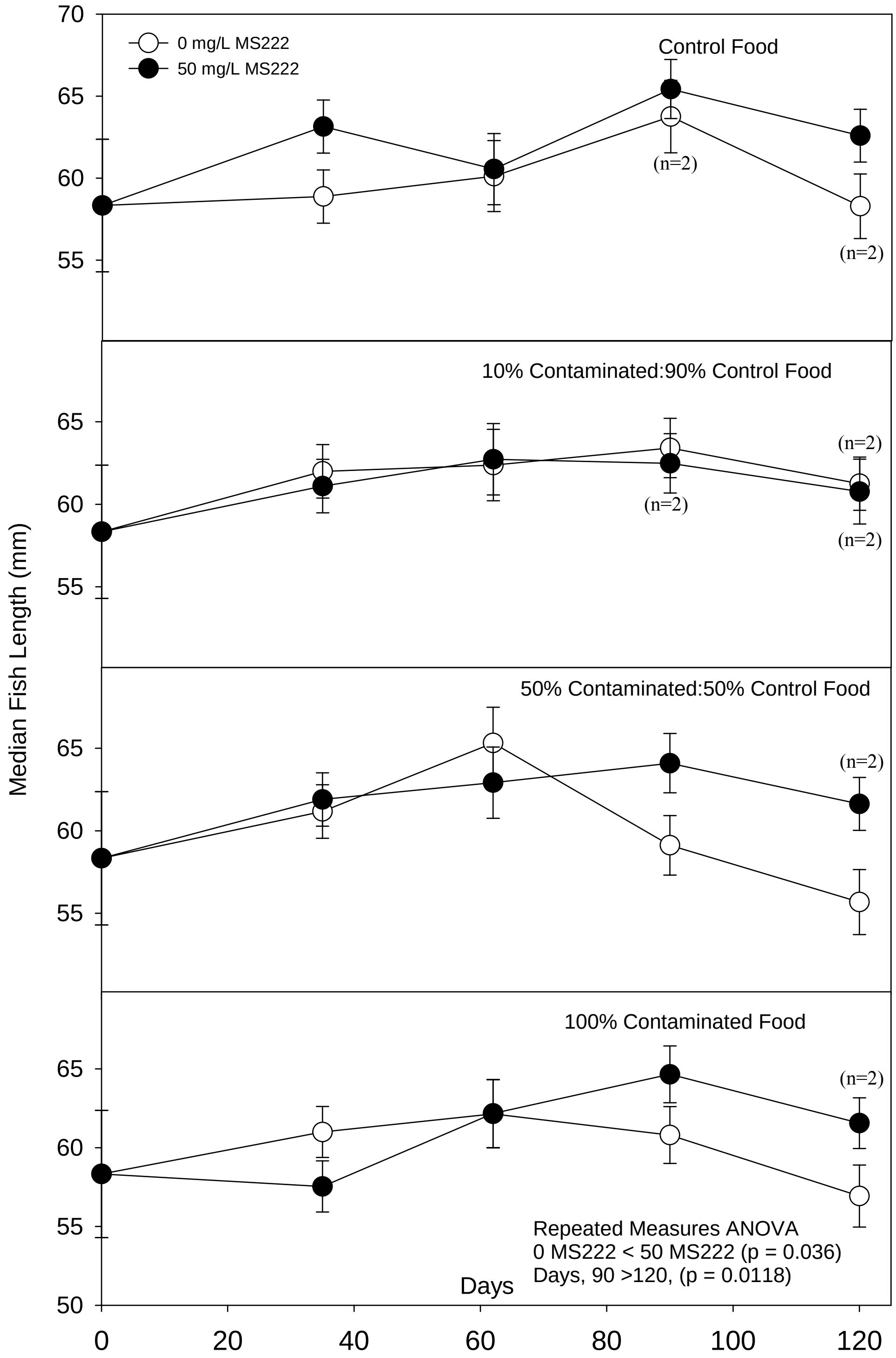

Figure 5.8. Median fish length (g) (± 1 SE) vs. time analyzed by ANOVA, general linear model (univariate and repeated measures). The food gradient proceeds from top to bottom: Control food, 10% contaminated:90% control, 50% contaminated:50% control, 100% contaminated food. MS-222 concentrations 0 and 50 mg/L are represented by white and black symbols, respectively, where n = 3 aquaria, unless designated otherwise.

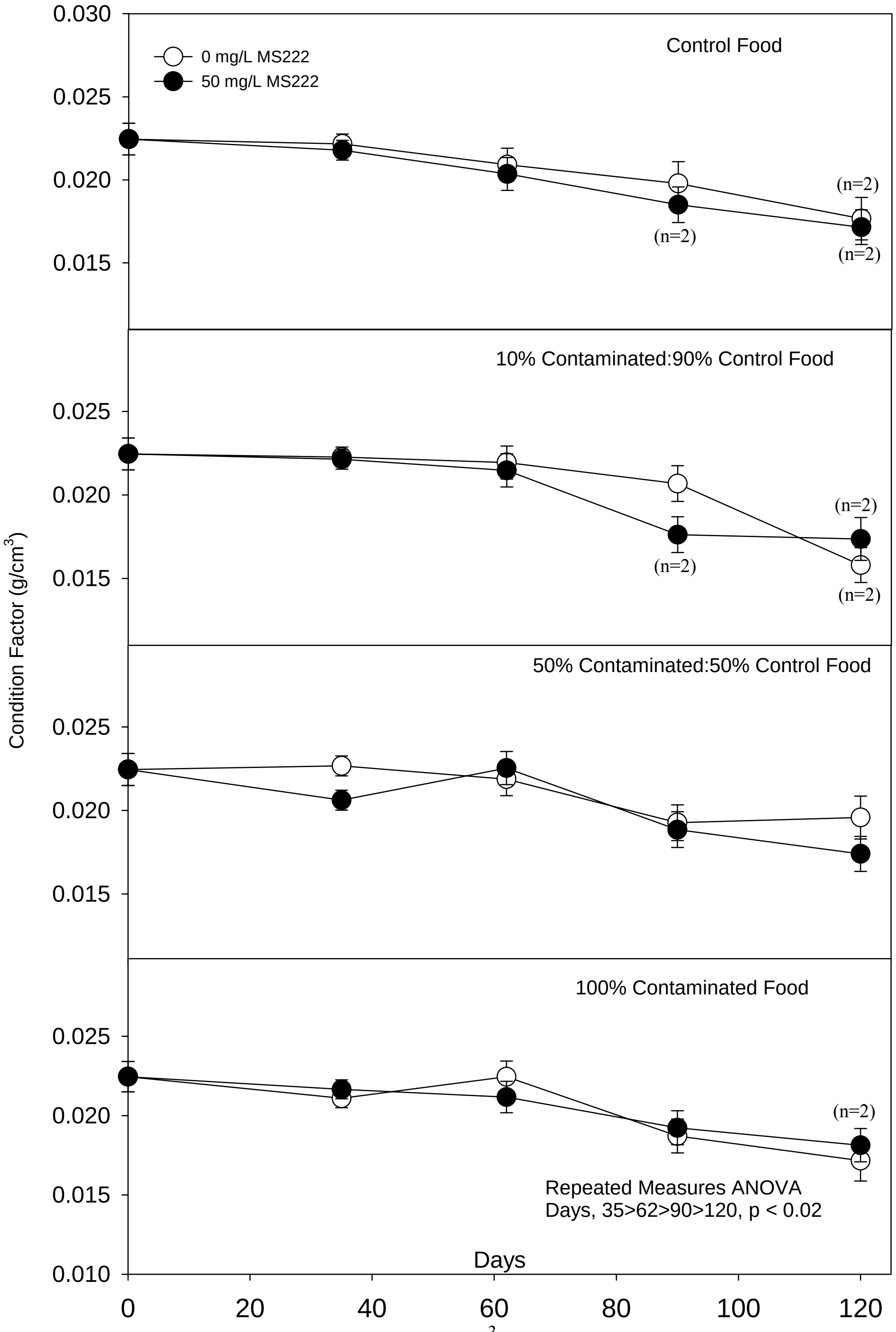

Figure 5.9. Median Condition Factor (g/cm^3) (± 1 SE) vs. time analyzed by ANOVA, general linear model (univariate and repeated measures). The food gradient proceeds from top to bottom: Control food, 10% contaminated:90% control, 50% contaminated:50% control, 100% contaminated food. MS-222 concentrations 0 and 50 mg/L are represented by white and black symbols, respectively, where n = 3 aquaria, unless designated otherwise.

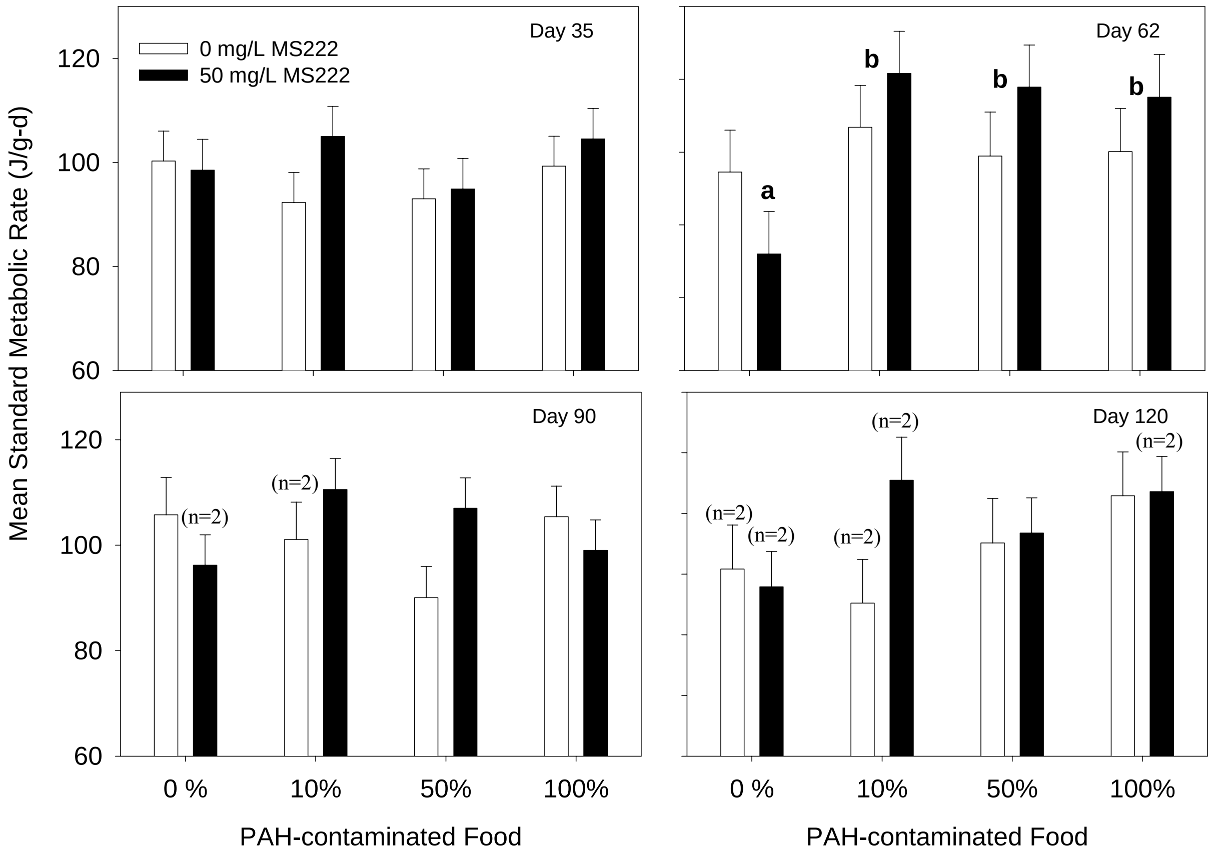

Figure 5.10. Mean standard metabolic rates (J/g-d) by treatment for each sampling day in ANCOVA with fish weight as a co-variate. Error bars represent ± 1 S.E. 0 % = Control food, 10% = 10% contaminated:90% control, 50% = 50% contaminated:50% control, and 100%= 100% contaminated food. 0 and 50 mg/L MS-222 are represented by white and black bars, respectively, where n = 3 aquaria, unless designated otherwise.

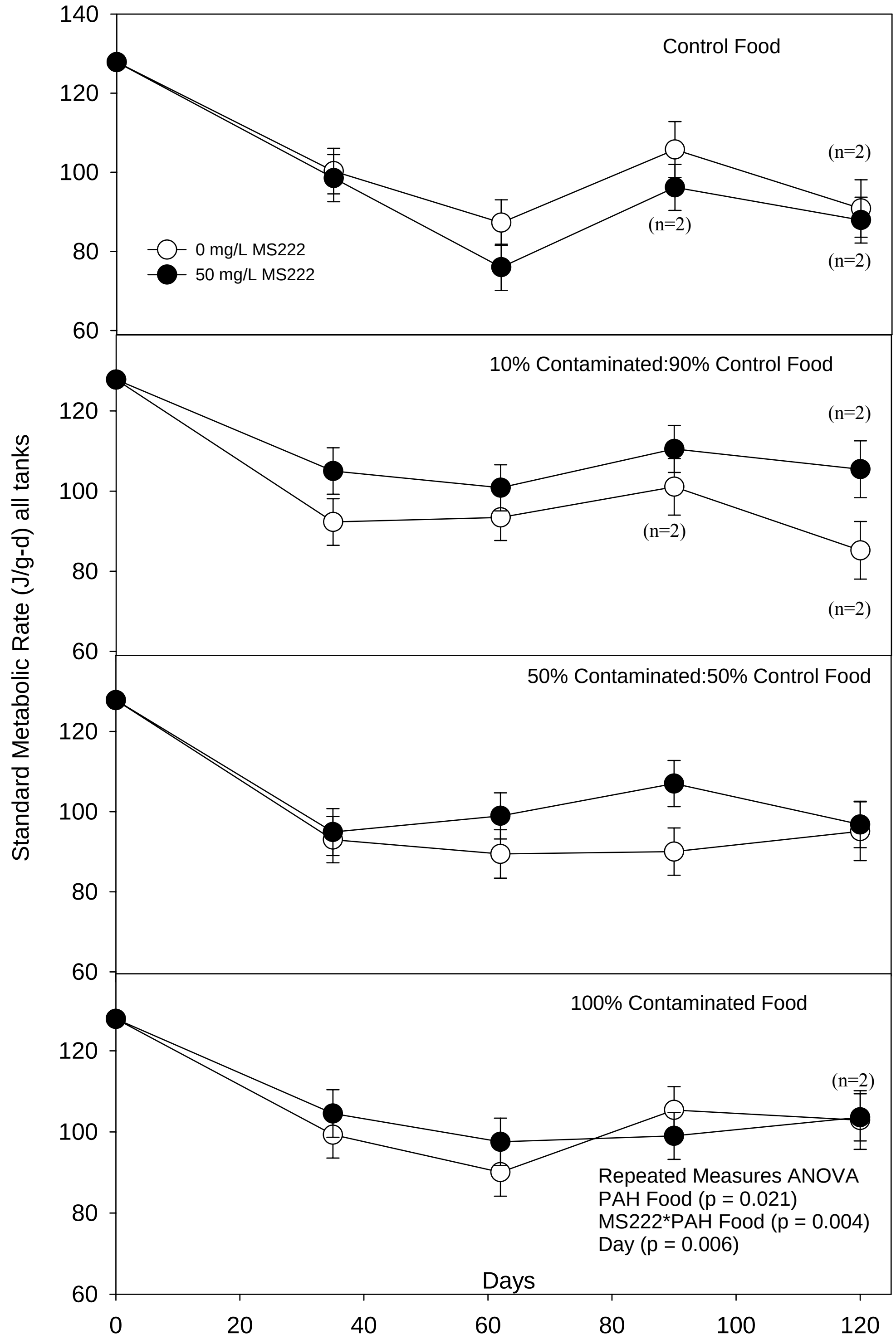

Figure 5.11. Mean standard metabolic rate (J/g-d) (± 1 SE) vs. time analyzed by ANCOVA, general linear model (univariate and repeated measures). The food gradient proceeds from top to bottom: Control food, 10% contaminated:90% control, 50% contaminated:50% control, 100% contaminated food. MS-222 concentrations 0 and 50 mg/L are represented by white and black symbols, respectively, where n = 3 aquaria, unless designated otherwise.

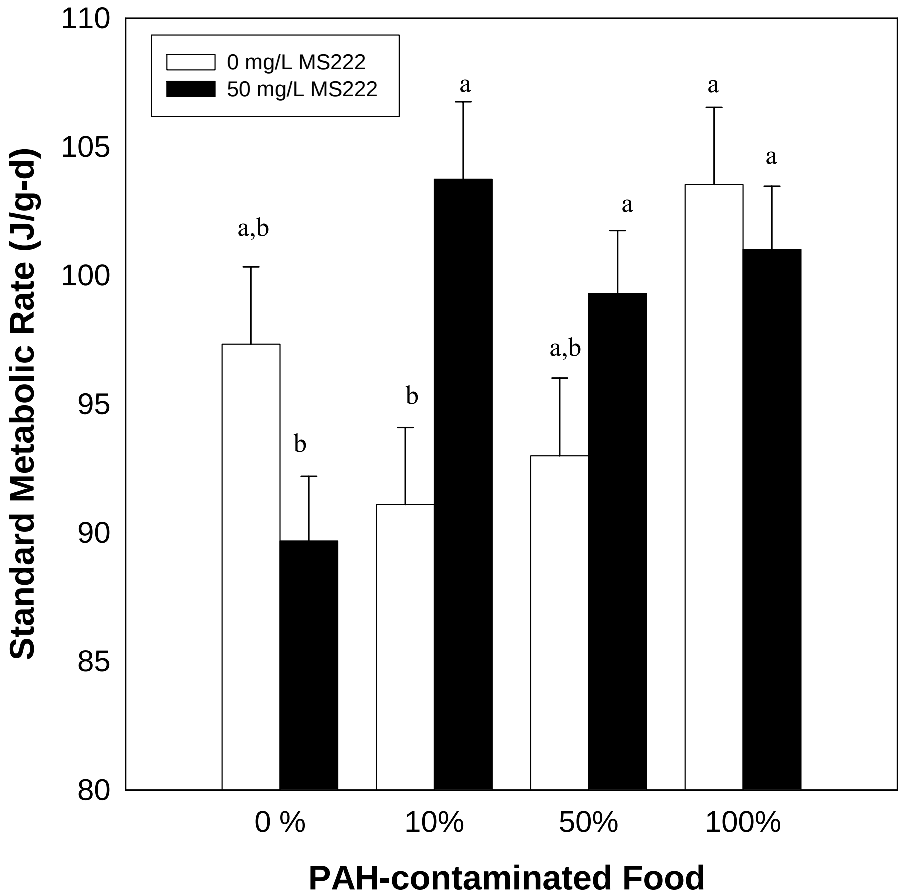

Figure 5.12. Cumulative mean standard metabolic rates (J/g-d) versus PAH-contaminated food gradient in ANCOVA with fish weight as a co-variate. Error bars represent ± 1 S.E. 0 % = Control food, 10% = 10% contaminated:90% control, 50% = 50% contaminated:50% control, and 100%= 100% contaminated food. 0 and 50 mg/L MS-222 are represented by white and black bars, respectively, where n = 3 aquaria. Different letters depict statistically significant differences ($p < 0.05$, Tukey's comparisons).

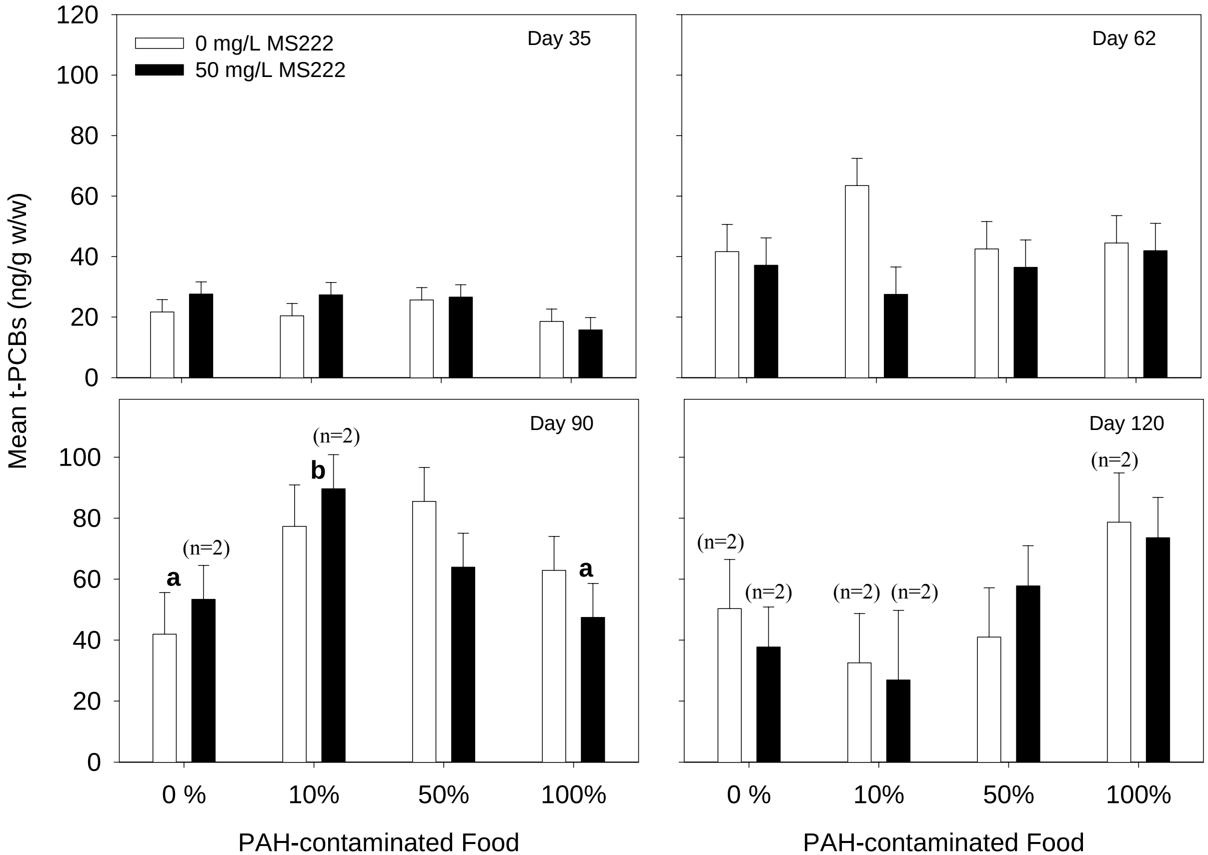

Figure 5.13. Mean Σ-PCB by treatment for each sampling day in ANOVA. Error bars represent ± 1 S.E. 0 % = Control food, 10% = 10% contaminated:90% control, 50% = 50% contaminated:50% control, and 100%= 100% contaminated food. 0 and 50 mg/L MS-222 are represented by white and black bars, respectively, where n = 3 aquaria, unless designated otherwise

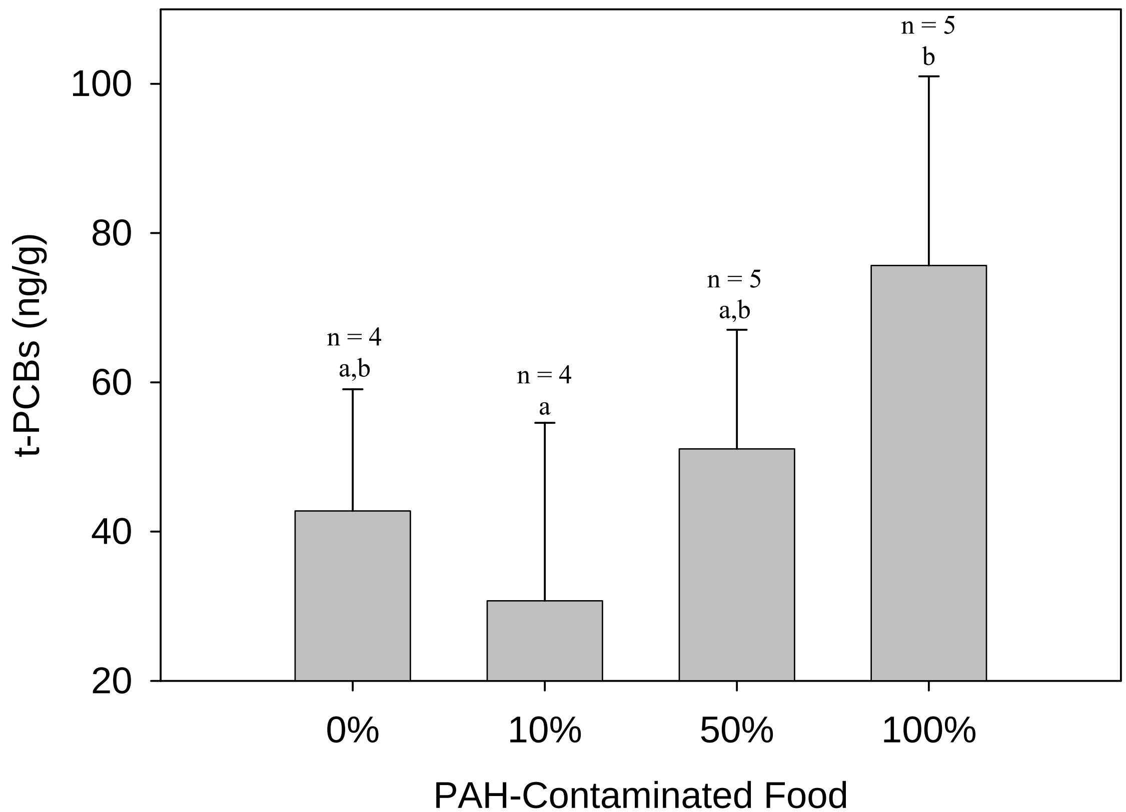

Figure 5.14. Change in Σ-PCBs (Day 120 – Day 0) in Fish. Error bars represent ± 1 standard deviation of the means from a one-way analysis of variance ($p = 0.038$ for significant food effect). N values represent number of aquaria. Letters represent significance at $\alpha = 0.10$ ($p = 0.0940$).

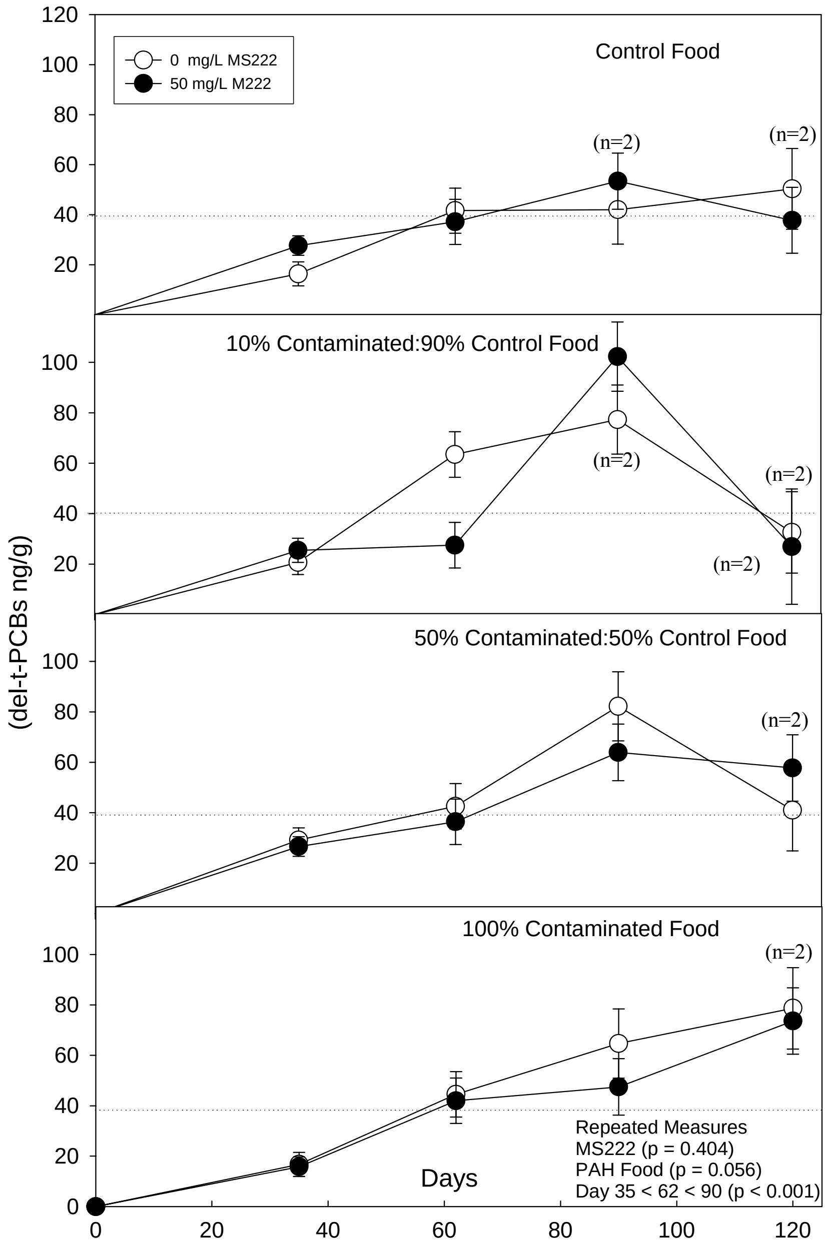

Figure 5.15. Σ-PCB concentrations in fish tissue (± 1 SE) vs. time analyzed by ANOVA, general linear model (univariate and repeated measures). The food gradient proceeds from top to bottom: Control food, 10% contaminated:90% control, 50% contaminated:50% control, 100% contaminated food. MS-222 concentrations 0 and 50 mg/L are represented by white and black symbols, respectively, where n = 3 aquaria, unless designated otherwise. Dashed line is Σ-PCB concentrations in food treatments.

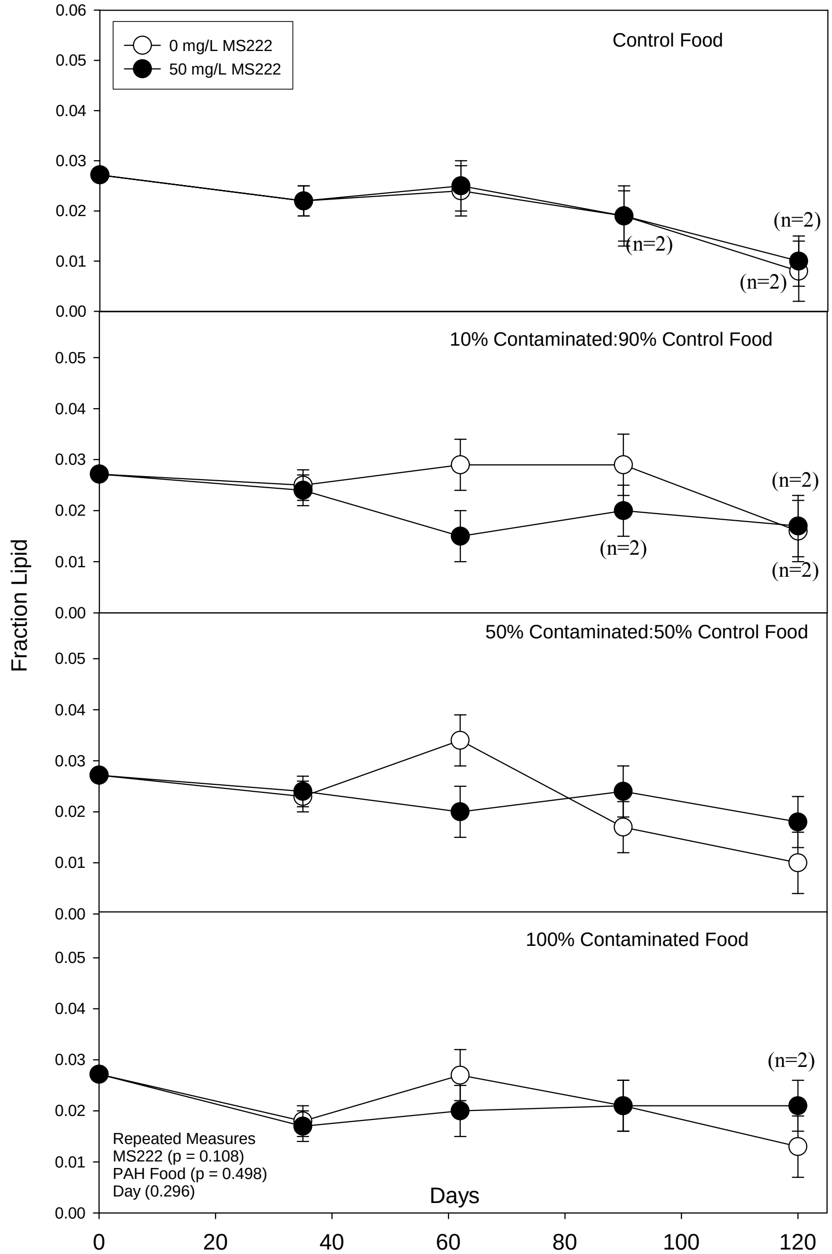

Figure 5.16. Mean fraction lipid (g lipid/g fish) (± 1 SE) vs. time analyzed by ANOVA, general linear model (univariate and repeated measures). The food gradient proceeds from top to bottom: Control food, 10% contaminated:90% control, 50% contaminated:50% control, 100% contaminated food. MS-222 concentrations 0 and 50 mg/L are represented by white and black symbols, respectively, where n = 3 aquaria, unless designated otherwise

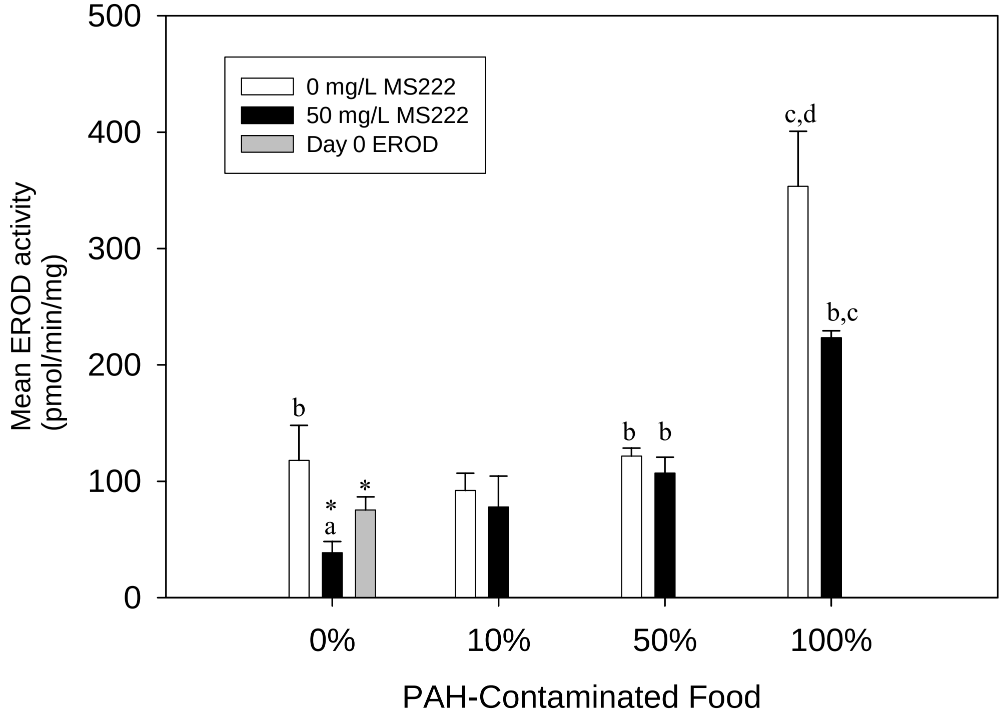

Figure 5.17. Mean Ethoxyresorufin-O-deethylase (EROD) activity (pmol/min/mg) by treatment for day 35 in ANOVA. Error bars represent ± 1 S.E. 0 % = Control food, 10% = 10% contaminated:90% control, 50% = 50% contaminated:50% control, and 100%= 100% contaminated food. 0 and 50 mg/L MS-222 are represented by white and black bars, respectively, where n = 3 aquaria. Letters represent significance at $\alpha = 0.05$ ($p < 0.001$ for PAH Food, and 0.016 for MS-222). * designates significant difference between Day 0 EROD and Day 35 MS-222*PAH food at the control level.

TABLE 5.1 Survival

Treatments for 120 day Exposure Experiment					**Treatments for 93 day Exposure Experiment**					
MS222 concentration in tank water		**PCB concentration in food (ng/g d/w)**			**MS222 concentration in tank water**		**PAH concentration in food (ng/g d/w)**			
1 =	**0 mg/L**	**Control Food**	**0 =**	**30**	**0 =**	**0 mg/L**	**Control Food**	**0 =**	**600**	
2 =	**0.1 mg/L**	**PCB-Spiked Food**	**1 =**	**235**	**1 =**	**50 mg/L**	**10% Contaminated:90% Co**	**0.1 =**	**835**	
3 =	**1.0 mg/L**						**50% Contaminated:50% Co**	**0.5 =**	**2400**	
4 =	**10 mg/L**						**Contaminated**	**1.0 =**	**2800**	

Source	DF	F	P	MS222	PAH	% Survival	SE	% Survival of Control
MS222	1	0.06	0.81	0	0	67	8	100%
PAH	3	0.41	0.749	0	0.1	82	8	123%
MS222*Food	3	1.26	0.32	0	0.5	79	8	119%
Error				0	1	78	8	117%
Total				1	0	79	8	119%
				1	0.1	64	8	96%
				1	0.5	82	8	123%
				1	1	75	8	112%

Tank counts - Survival

Tank	tank count	trt	MS222	PAH	% Total survival	Day 35	Day 62	Day 90	Day 120
4	20	1	0	0	83	6	5	6	3
15	11	1	0	0	46	6	5	0	0
24	17	1	0	0	71	6	5	3	3
1	24	2	0	0.1	100	6	5	5	8
7	15	2	0	0.1	63	6	5	3	1
20	20	2	0	0.1	83	6	5	3	6
3	24	3	0	0.5	100	6	5	5	8
11	14	3	0	0.5	58	6	5	3	0
13	19	3	0	0.5	79	6	5	3	5
2	17	4	0	1	71	6	5	6	0
6	21	4	0	1	88	6	5	6	4
16	18	4	0	1	75	6	5	2	5
5	19	5	1	0	79	6	5	4	4
21	17	5	1	0	71	6	5	2	4
23	21	5	1	0	88	6	5	3	7
10	19	6	1	0.1	79	6	5	2	6
18	12	6	1	0.1	50	6	5	1	0
22	15	6	1	0.1	63	6	5	3	1
8	21	7	1	0.5	88	6	5	6	4
12	19	7	1	0.5	79	6	5	2	6
19	19	7	1	0.5	79	6	5	3	5
9	18	8	1	1	75	6	5	3	4
14	19	8	1	1	79	6	5	2	6
17	17	8	1	1	71	6	5	3	3
	436					144	120	79	93

TABLE 5.2

Analysis of Variance for Median Fish Weight (g)

Factor	Type	Levels	Values
MS222	**Fixed**	**2**	**0 1**
Food	**Fixed**	**4**	**0 .1 .5 1**
Day	**Fixed**	**4**	**35 62 90 120**

Treatments for 93 day Exposure Experiment

MS222 concentration in tank water	
0 =	**0 mg/L**
1 =	**50 mg/L**

PAH concentration in food (ng/g d/w)		
Control Food	**0 =**	**600**
10% Contaminated:90% Control	**0.1 =**	**835**
50% Contaminated:50% Control	**0.5 =**	**2400**
Contaminated	**1.0 =**	**2800**

n = number of tanks (avg of 6 fish/tank)

Day	Source	DF	F	P	MS222	PAH	Anaylyzed median Weight (g)	SE	n
35	MS222	1	0.22	0.645	0	0	4.394	0.3713	3
	PAH	3	0.95	0.439	0	0.1	5.304	0.3713	3
	MS222*Food	3	2.03	0.15	0	0.5	5.135	0.3713	3
	Error	16			0	1	5.079	0.3713	3
	Total	23			1	0	5.517	0.3713	3
					1	0.1	5.364	0.3713	3
					1	0.5	5.139	0.3713	3
					1	1	4.387	0.3713	3
62	MS222	1	0.02	0.879	0	0	4.785	0.5121	3
	PAH	3	1.53	0.246	0	0.1	5.209	0.5121	3
	MS222*Food	3	0.33	0.803	0	0.5	6.172	0.5121	3
	Error	16			0	1	5.063	0.5121	3
	Total	23			1	0	4.882	0.5121	3
					1	0.1	5.563	0.5121	3
					1	0.5	5.543	0.5121	3
					1	1	5.018	0.5121	3
90	MS222	1	2.46	0.138	0	0	4.667	0.4869	2
	PAH	3	1.1	0.38	0	0.1	5.055	0.3976	2
	MS222*Food	3	2.02	0.154	0	0.5	3.98	0.3976	3
	Error	15			0	1	4.258	0.3976	3
	Total	22			1	0	5.447	0.3976	3
					1	0.1	4.333	0.3976	3
					1	0.5	4.65	0.3976	3
					1	1	5.348	0.3976	3

Day	Source	DF	F	P	MS222	PAH	Weight (g)	SE	n
120	MS222	1	3.23	0.097	0	0	3.771	0.5808	2
	PAH	3	0.15	0.93	0	0.1	3.636	0.4742	2
	MS222*Food	3	0.21	0.888	0	0.5	3.299	0.5808	2
	Error	12			0	1	3.207	0.5808	2
	Total	19			1	0	4.276	0.4742	3
					1	0.1	3.908	0.5808	2
					1	0.5	4.246	0.4742	3
					1	1	4.179	0.4742	3

Repeated Measures

					MS222	p	**day**	p
	MS222	1	3.41	0.07	1 < 0	0.067	35 > 120	0
	PAH	3	0.041	0.749			62 > 120	0
	Day	3	14.59	0			90 > 120	0.0019
	MS222*Food	3	0.64	0.59				
	MS222*Day	3	1	0.401				
	Food*Day	9	1.12	0.364				
	MS222*Food*Day	9	1.02	0.432				
	Error	59						
	Total	90						

TABLE 5.3

Analysis of Variance for Median Fish Length (mm)

Factor	Type	Levels	Values
MS222	Fixed	2	0 1
Food	Fixed	4	0 .1 .5 1
Day	Fixed	4	35 62 90 120

Treatments for 93 day Exposure Experiment

MS222 concentration in tank water

0 =	0 mg/L
1 =	50 mg/L

PAH concentration in food (ng/g d/w)

Control Food	0 =	600
10% Contaminated:90% Co	0.1 =	835
50% Contaminated:50% Co	0.5 =	2400
Contaminated	1.0 =	2800

n = number of tanks (avg of 6 fish/tank)

Day	Source	DF	F	P	MS222	PAH	Anaylyzed median Length (mm)	SE	n
35	MS222	1	0.02	0.89	0	0	58.878	1.6202	3
	PAH	3	0.88	0.472	0	0.1	61.992	1.6202	3
	MS222*Food	3	1.99	0.156	0	0.5	61.163	1.6202	3
	Error	16			0	1	60.998	1.6202	3
	Total	23			1	0	63.143	1.6202	3
					1	0.1	61.098	1.6202	3
					1	0.5	61.893	1.6202	3
					1	1	57.542	1.6202	3
62	MS222	1	0.07	0.797	0	0	60.123	2.1634	3
	PAH	3	1.03	0.406	0	0.1	62.37	2.1634	3
	MS222*Food	3	0.19	0.898	0	0.5	65.32	2.1634	3
	Error	16			0	1	62.15	2.1634	3
	Total	23			1	0	60.553	2.1634	3
					1	0.1	62.727	2.1634	3
					1	0.5	62.913	2.1634	3
					1	1	62.173	2.1634	3
90	MS222	1	3.33	0.088	0	0	63.753	2.2046	2
	PAH	3	0.82	0.502	0	0.1	63.41	1.8001	2
	MS222*Food	3	1.04	0.402	0	0.5	59.113	1.8001	3
	Error	15			0	1	60.802	1.8001	3
	Total	22			1	0	65.428	1.8001	3
					1	0.1	62.477	1.8001	3
					1	0.5	64.093	1.8001	3
					1	1	64.653	1.8001	3

Day	Source	DF	F	P	MS222	PAH	Length (mm)	SE	n
120	MS222	1	8.02	0.015	0	0	58.288	1.9689	2
	PAH	3	0.72	0.559	0	0.1	61.243	1.6076	2
	MS222*Food	3	1.22	0.343	0	0.5	55.673	1.9689	2
	Error	11			0	1	56.93	1.9689	2
	Total	18			1	0	62.59	1.6076	3
					1	0.1	60.763	1.9689	2
					1	0.5	61.627	1.6076	3
					1	1	61.555	1.6076	3

Repeated Measures	DF	F	P	MS222	p	Day	p
MS222	1	4.61	0.036	1 > 0	0.0359	90 > 120	0.0118
PAH	3	0.52	0.67				
Day	3	4.24	0.009				
MS222*Food	3	1.12	0.349				
MS222*Day	3	1.91	0.138				
Food*Day	9	1	0.449				
MS222*Food*Day	9	0.9	0.527				
Error	57						
Total	88						

TABLE 5.4

Analysis of Variance for Condition Factors (g/cm^3)

Factor	Type	Levels	Values
MS222	**Fixed**	**2**	**0 1**
Food	**Fixed**	**4**	**0 .1 .5 1**
Day	**Fixed**	**4**	**35 62 90 120**

Treatments for 93 day Exposure Experiment

MS222 concentration in tank water	
0 =	**0 mg/L**
1 =	**50 mg/L**

PAH concentration in food (ng/g d/w)		
Control Food	**0 =**	**600**
10% Contaminated:90% Control	**0.1 =**	**835**
50% Contaminated:50% Control	**0.5 =**	**2400**
Contaminated	**1.0 =**	**2800**

n = number of tanks (avg of 6 fish/tank)

Day	**Source**	**DF**	**F**	**P**	**MS222**	**PAH**	**Anaylyzed median CF (g/cm^3))**	**SE**	**n**
35	MS222	1	1.4	0.254	0	0	0.022	0.001	3
	PAH	3	0.74	0.542	0	0.1	0.022	0.001	3
	MS222*Food	3	1.72	0.204	0	0.5	0.023	0.001	3
	Error	16			0	1	0.021	0.001	3
	Total	23			1	0	0.022	0.001	3
					1	0.1	0.022	0.001	3
					1	0.5	0.021	0.001	3
					1	1	0.022	0.001	3
62	MS222	1	0.35	0.565	0	0	0.021	0.001	3
	PAH	3	0.93	0.449	0	0.1	0.022	0.001	3
	MS222*Food	3	0.33	0.805	0	0.5	0.022	0.001	3
	Error	16			0	1	0.022	0.001	3
	Total	23			1	0	0.020	0.001	3
					1	0.1	0.021	0.001	3
					1	0.5	0.023	0.001	3
					1	1	0.021	0.001	3
90	MS222	1	1.85	0.194	0	0	0.020	0.001	2
	PAH	3	0.01	0.998	0	0.1	0.021	0.001	2
	MS222*Food	3	1.01	0.415	0	0.5	0.019	0.001	3
	Error	15			0	1	0.019	0.001	3
	Total	22			1	0	0.019	0.001	3
					1	0.1	0.018	0.001	3
					1	0.5	0.019	0.001	3
					1	1	0.019	0.001	3

Day	Source	DF	F	P	MS222	PAH	CF (g/cm^3))	SE	n
120	MS222	1	0	0.964	0	0	0.018	0.001	2
	PAH	3	0.9	0.468	0	0.1	0.016	0.001	2
	MS222*Food	3	1.02	0.418	0	0.5	0.020	0.001	3
	Error	12			0	1	0.017	0.001	2
	Total	19			1	0	0.017	0.001	3
					1	0.1	0.017	0.001	2
					1	0.5	0.017	0.001	3
					1	1	0.018	0.001	3

Repeated Measures

	DF	F	P	Day	p
MS222	1	2.14	0.149	90 < 35	0
PAH	3	0.51	0.679	120 < 35	0
Day	3	34.48	0	90 < 62	0
MS222*Food	3	0.55	0.653	120 < 62	0
MS222*Day	3	0.36	0.783	120 < 90	0.0164
Food*Day	9	0.68	0.726		
MS222*Food*	9	1.06	0.405		
Error	59				
Total	90				

TABLE 5.5

Analysis of Co-Variance for Standard Metabolic Rate

Factor	**Type**	**Levels**	**Values**
MS222	**Fixed**	**2**	**0 1**
Food	**Fixed**	**4**	**0 .1 .5 1**
Day	**Fixed**	**4**	**35 62 90 120**

Treatments for 93 day Exposure Experiment

MS222 concentration in tank water	
0 =	**0 mg/L**
1 =	**50 mg/L**

PAH concentration in food (ng/g d/w)		
Control Food	**0 =**	**600**
10% Contaminated:90% C	**0.1 =**	**835**
50% Contaminated:50% C	**0.5 =**	**2400**
Contaminated	**1.0 =**	**2800**

n = number of tanks (avg of 3 fish/tank)

Day	**Source**	**DF**	**F**	**P**	**MS222**	**PAH**	**SMR (J/g-d)**	**SE**	**n**
35	Weight	1	0.23	0.641	0	0	100.3	5.8	3
	MS222	1	0.77	0.395	0	0.1	92.3	5.8	3
	PAH	3	0.9	0.465	0	0.5	93.0	5.8	3
	MS222*Food	3	0.75	0.538	0	1	99.3	5.8	3
	Error	15			1	0	98.5	6.0	3
	Total	23			1	0.1	105.0	5.8	3
					1	0.5	94.9	5.9	3
					1	1	104.5	5.9	3
62	Weight	1	20.88	0	0	0	87.3	5.8	3
	MS222	1	0.79	0.388	0	0.1	93.4	5.8	3
	PAH	3	6.54	0.005	0	0.5	89.5	6.0	3
	MS222*Food	3	2.15	0.036	0	1	90.1	5.9	3
	Error	15			1	0	76.0	5.8	3
	Total	23			1	0.1	100.8	5.8	3
					1	0.5	99.0	5.8	3
					1	1	97.6	5.9	3
90	Weight	1	2.51	0.137	0	0	105.7	7.1	2
	MS222	1	0.25	0.623	0	0.1	101.1	7.1	2
	PAH	3	0.41	0.745	0	0.5	90.0	5.9	3
	MS222*Food	3	1.73	0.21	0	1	105.4	5.8	3
	Error	13			1	0	96.2	5.8	3
	Total	21			1	0.1	110.5	5.9	3
					1	0.5	107.0	5.8	3
					1	1	99.0	5.8	3

Tukey's comparisons	**p values**
Food	
0 < 0.1	0.0592
0 < 0.5	0.0256
0 < 1.0	0.711
MS222*Food	
1*0 < 1*0.1	0.0236
1*0< 1*0.5	0.0191
1*0 < 1*1	0.0165

Day	Source	DF	F	P	MS222	PAH	SMR (J/g-d)	SE	n
120	Weight	1	1.88	0.2	0	0	90.8	7.3	2
	MS222	1	0.86	0.376	0	0.1	85.2	7.2	2
	PAH	3	1.53	0.267	0	0.5	95.1	7.3	2
	MS222*Food	3	1.12	0.387	0	1	102.9	7.2	2
	Error	10			1	0	87.9	5.8	3
	Total	18			1	0.1	105.5	7.1	2
					1	0.5	96.8	5.8	3
					1	1	103.6	5.8	3

Repeated Measures

Source	DF	F	P	Food	p	MS222*Food	p
Weight	**1**	12.34	0.001	0 < 1.0	0.0139	0*0.1 < 0*1	0.0925
MS222	1	1.22	0.275			0*0.1 < 1*1	0.0811
PAH	3	3.58	0.021			1*0 < 0*1	0.0189
Day	3	4.7	0.006			1*0 < 1*1	0.0492
MS222*Food	3	5.03	0.004			1*0 < 1*0.1	0.0199
MS222*Day	3	0.57	0.641				
Food*Day	9	1.77	0.102				
MS222*Food*Day	9	1.36	0.237				
Error	43						
Total	75						

TABLE 5.6

Analysis of Variance for average PCB concentrations

Factor	**Type**	**Levels**	**Values**
MS222	**Fixed**	**2**	**0 1**
Food	**Fixed**	**4**	**0 .1 .5 1**
Day	**Fixed**	**3**	**35 62 90**

Treatments for 93 day Exposure Experiment

MS222 concentration in tank water	
0 =	**0 mg/L**
1 =	**50 mg/L**

PAH concentration in food (ng/g d/w)		
Control Food	**1 =**	**600**
10% Contaminated:90% Con	**2 =**	**835**
50% Contaminated:50% Con	**3 =**	**2400**
Contaminated	**4 =**	**2800**

n = number of tanks (avg of 3 fish/tank)

Day	**Source**	**DF**	**F**	**P**	**MS222**	**PAH**	**PCB (ng/g)**	**SE**	**n**			
35	MS222	1	0.93	0.35	0	0	21.69	4.06	3	One Way ANOVA	p	
	PAH	3	1.92	0.167	0	0.1	20.43	4.06	3	Food		0.14
	MS222*Food	3	0.62	0.612	0	0.5	25.68	4.06	3			
	Error	16			0	1	18.55	4.06	3			
	Total	23			1	0	27.62	4.06	3			
					1	0.1	27.37	4.06	3			
					1	0.5	26.62	4.06	3			
					1	1	15.79	4.06	3			
62	MS222	1	3.7	0.072	0	0	41.61	9.027	3	One Way ANOVA	p	
	PAH	3	0.22	0.881	0	0.1	63.48	9.027	3	Food		0.908
	MS222*Food	3	1.55	0.241	0	0.5	42.55	9.027	3			
	Error	16			0	1	44.52	9.027	3			
	Total	23			1	0	37.14	9.027	3			
					1	0.1	27.51	9.027	3			
					1	0.5	36.43	9.027	3			
					1	1	41.99	9.027	3			
90	MS222	1	0.16	0.698	0	0	41.97	13.61	2	One Way ANOVA	p	
	PAH	3	3.8	0.035	0	0.1	77.33	13.61	2	Food		0.024
	MS222*Food	3	1.13	0.37	0	0.5	85.48	11.113	3			
	Error	14			0	1	62.89	11.113	3	Food		
	Total	21			1	0	53.39	11.113	3	0<.1		0.0307
					1	0.1	89.66	11.113	3	.1 > 1.0		0.0683
					1	0.5	63.94	11.113	3			
					1	1	47.47	11.113	3			

Day	Source	DF	F	P	MS222	PAH	PCB (ng/g)	SE	n			
120	MS222	1	0.02	0.889	0	0	50.32	16.154	2	One Way ANOVA	p	
	PAH	3	2.85	0.092	0	0.1	32.57	16.154	2	Food		0.038
	MS222*Food	3	0.37	0.779	0	0.5	41.04	16.154	2			
	Error	10			0	1	78.68	16.154	2	Food		
	Total	17			1	0	37.72	13.19	3	0.1 < 1.0		0.094
					1	0.1	26.95	22.845	2			
					1	0.5	57.77	13.19	3			
					1	1	73.62	13.19	3			

Repeated measures

Source	DF	F	P	Food	p	day	p	MS222*day	p
MS222	1	0.71	0.404	.1 > 0	0.0339	35 < 62	0.0049	0*35 < 0*62	0.041
PAH	3	2.74	0.056			35 < 90	0	0*35 < 0*90	0.0002
Day	2	26.67	0			62 < 90	0.0003	0*35 < 1*90	0.0001
MS222*Food	3	0.09	0.967					0*62 < 1*35	0.0328
MS222*Day	2	0.8	0.458					0*90 < 1*35	0.0001
Food*Day	6	0.94	0.48					0*90 < 1*62	0.0066
MS222*Food*Day	6	2.02	0.087						
Error	38							**Food*Day**	
Total	61							0*35 < 0.5*90	0.0179
								0*35 < 1.0*90	0.0105
								0*62 < 0.1*90	0.0082
								0.1*62<0.1*90	0.0317
								0.1*90 > 0.5*35	0.0005
								0.1 > 1.0*62	0.0196
								0.1*90>1.0*35	0.0001
								1.0*90 > 0.5*35	0.0424
								1*35 < 0.5*90	0.0152

TABLE 5.7

Analysis of Variance for fish fraction lipid

Factor	**Type**	**Levels**	**Values**
MS222	**Fixed**	**2**	**0 1**
Food	**Fixed**	**4**	**0 .1 .5 1**
Day	**Fixed**	**4**	**35 62 90 120**

Treatments for 93 day Exposure Experiment

MS222 concentration in tank water	
0 =	**0 mg/L**
1 =	**50 mg/L**

PAH concentration in food (ng/g d/w)		
Control Food	**0 =**	**600**
10% Contaminated:90% C	**0.1 =**	**835**
50% Contaminated:50% C	**0.5 =**	**2400**
Contaminated	**1.0 =**	**2800**

n = number of tanks (avg of 3 fish/tank)

Day	**Source**	**DF**	**F**	**P**	**MS222**	**PAH**	**fraction lipid**	**SE**	**n**		
35	MS222	1	0.02	0.884	0	0	0.022	0.003	3		
	PAH	3	1.7	0.207	0	0.1	0.025	0.003	3		
	MS222*Food	3	0.04	0.99	0	0.5	0.023	0.003	3		
	Error	16			0	1	0.018	0.003	3		
	Total	23			1	0	0.022	0.003	3		
					1	0.1	0.024	0.003	3		
					1	0.5	0.024	0.003	3		
					1	1	0.017	0.003	3		
62	MS222	1	7.06	0.017	0	0	0.024	0.005	3	1 < 0	0.0172
	PAH	3	0.4	0.754	0	0.1	0.029	0.005	3		
	MS222*Food	3	1.32	0.303	0	0.5	0.034	0.005	3		
	Error	16			0	1	0.027	0.005	3		
	Total	23			1	0	0.025	0.005	3		
					1	0.1	0.015	0.005	3		
					1	0.5	0.020	0.005	3		
					1	1	0.020	0.005	3		
90	MS222	1	0.03	0.858	0	0	0.019	0.006	3		
	PAH	3	0.41	0.749	0	0.1	0.029	0.006	2		
	MS222*Food	3	0.78	0.526	0	0.5	0.017	0.005	3		
	Error	14			0	1	0.021	0.005	3		
	Total	21			1	0	0.019	0.005	3		
					1	0.1	0.020	0.005	3		
					1	0.5	0.024	0.005	3		
					1	1	0.021	0.005	3		

Day	Source	DF	F	P	MS222	PAH	fraction lipid	SE	n
120	MS222	1	1.7	0.218	0	0	0.008	0.006	2
	PAH	3	0.9	0.473	0	0.1	0.016	0.006	2
	MS222*Food	3	0.26	0.854	0	0.5	0.010	0.006	2
	Error	11			0	1	0.013	0.006	2
	Total	18			1	0	0.010	0.005	3
					1	0.1	0.017	0.006	2
					1	0.5	0.018	0.005	3
					1	1	0.021	0.005	3

	Correlation to PCBs		
	Pearson	p value	
35	-0.043	0.717	
62	0.554	0	
90	0.384	0.005	
120	0.208	0.132	
Overall	0.17	0.007	Regression of PCB vs % lipid = r2 of 0.029

Repeated measures

Source	DF	F	P
MS222	1	2.69	0.108
PAH	3	0.8	0.498
Day	2	1.25	0.296
MS222*Food	3	0.65	0.584
MS222*Day	2	1.86	0.168
Food*Day	6	0.51	0.798
MS222*Food*Day	6	0.8	0.576
Error	38		
Total	61		

TABLE 5.8

Analysis of Variance Biomarkers

Factor	Type	Levels	Values
MS222	**Fixed**	**2**	**0 1**
Food	**Fixed**	**4**	**0 .1 .5 1**
Day	**Fixed**	**4**	**35 62 90 120**

Treatments for 93 day Exposure Experiment

MS222 concentration in tank water		PAH concentration in food (ng/g d/w)		
0 =	**0 mg/L**	**Control Food**	**0 =**	**600**
1 =	**50 mg/L**	**10% Contaminated:90% Control**	**0.1 =**	**835**
		50% Contaminated:50% Control	**0.5 =**	**2400**
		Contaminated	**1.0 =**	**2800**

n = number of tanks (avg of 3 fish/tank)

Day	**Source**	**DF**	**F**	**P**			**EROD**	**SE**	**n**	1 < 0	0.0165
35	MS222	1	7.17	0.016	0	0	100.1	28.6	3	1.0>0	0
	PAH	3	24.61	0	0	0.1	93.9	28.6	3	1.0>.1	0
	MS222*Food	3	1.88	0.173	0	0.5	121.6	28.6	3	1>.5	0.0001
	Error	16			0	1	353.3	28.6	3	0*1>0*0	0.0003
	Total	23			1	0	38.7	28.6	3	0*1>0*.1	0.0002
					1	0.1	84.8	28.6	3	0*1 > 0*.05	0.0007
					1	0.5	105.2	28.6	3	1*0<0*1	0
					1	1	223.3	28.6	3	1*.1<0*1	0.0001
										1*.5<0*1	0.0003

							mRNA			mRNA tests	
35	MS222	1	2.88	0.109	0	0	0.057	0.01	3	.1 < 0	0.0322
	PAH	3	9.18	0.001	0	0.1	0.027	0.01	3	1<0.1	0.0005
	MS222*Food	3	0.22	0.884	0	0.5	0.053	0.01	3	1<0.5	0.0322
	Error	16			0	1	0.08	0.01	3	0*1>0*.1	0.0225
	Total	23			1	0	0.05	0.01	3	1*.01<0*1	0.0088
					1	0.1	0.02	0.01	3	1*.5<0*1	0.0566
					1	0.5	0.033	0.01	3	1*1>1*0.1	0.0566
					1	1	0.067	0.01	3		

Chapter 6

Development of a bioenergetics model to assess the consequences of chemical stress on *Fundulus heteroclitus* populations

6.1 Introduction

Chapter 2 discussed the narcosis model for predicting acute toxicity of PAHs on aquatic organisms, and explored whether it could be extended to populations. Likewise, the experiments described in Chapter 5 raised questions regarding the long-term population-level consequences of chemically altered bioenergetics in *Fundulus heteroclitus*. Under acute conditions where narcosis is the main mode of toxicity, mortality rates increase. Under longer term exposures, other modes of toxicity become important. Depending on the dominant modes of toxicity under sublethal conditions, standard metabolic rates (SMRs) may increase or decrease. Affected organisms must compensate by repartitioning energy otherwise used for other processes, including growth and reproduction. The relative effects of altered SMR, mortality and consumption rates will be further evaluated using an age-structured weight-specific bioenergetics model.

6.1.1 Objectives

The objectives of this chapter are:

1. To examine how sublethal changes in individual energetics (consumption and respiration) from multiple modes of toxicity affect *F. heteroclitus* population biomass.
2. To examine how changes in mortality rate affect population biomass.
3. To compare the population outcomes of altering age-specific consumption, respiration, and mortality rates.

Linking contaminant-induced, sublethal effects on individual to population level risks remains a challenge for resource management efforts (Myers et al., 2003, and Johnson et al., 2002). Physiological parameters at different life stages provide individual-level measurements with population relevance (Calow, 1991, Adams et al., 1992, and Forbes et al., 2001). Previous studies used models to link individual physiological responses from chemical stress to population-level consequences. There are two main approaches to modeling population-level effects of chemical stress: (1) life tables, or Leslie Matrix, population projection models (Caswell, 1989, Munns et al., 1997, Forbes et al., 2001, and Spromberg and Meador, 2005) and (2) individual-based bioenergetics models (Hallam, 1990, Jaworska et al., 1997, Beyers et al., 1999, and Sherwood et al., 2000).

Munns et al. (1997) developed a stage-based population model to evaluate changes in population growth based on dioxin- and PCB-induced effects on individual reproduction rates and survivorship probabilities measured in the laboratory and in the field for *Fundulus heteoclitus*. Spromberg and Meador (2005) also used this approach to evaluate effects of sublethal exposures to PCBs on age-class distributions and other population level parameters of wild Chinook salmon populations. The Leslie matrix models require quantification of how contaminants affect rates of fecundity and survivorship probabilities for each stage class within the lifecycle. Those parameters were not measured in Experiment 3 (Chapter 5). Although data are available from the literature for the base (no chemical stressor) case (Valiela et al., 1977 and Weisberg and Lotrich, 1982), no information is available describing how each process is affected by PAH exposure.

Hallam et al. (1993) developed a bioenergetics population model exploring the consequences of sublethal narcosis on the population dynamics of *Daphnia.* Jaworska et al. (1997) developed an individual-based model using the basic bioenergetic equations (Kitchell et al., 1977 and Hanson et al., 1997) to compare the consequences of PCBs on mortality versus fluctuations in water temperatures on largemouth bass populations in southeastern U.S. lakes. Beyers et al. (1999) used the Wisconsin bioenergetics model (Hanson et al., 1997) to assess whether increased standard metabolic rates (SMRs) from dieldrin exposures were important relative to water temperature fluctuations on populations of largemouth bass in Colorado reservoirs.

Since PAH-induced changes in SMRs were explicitly measured on *F. heteroclitus* (Chapters 5), an age-structured, weight specific bioenergetics model was developed to investigate potential impacts on population biomass. The model was developed to simulate the sublethal effects of PAH exposure on the standard metabolic rates of *F. heteroclitus,* to simulate chemically-induced mortality, and to simulate chemically induced changes in consumption rates. The model projects population biomass by balancing energy input (consumption) with energy outputs (respiration and reproduction). The model also tracks changes in biomass due to mortality. The model provides a basic starting point for comparing projected growth of population biomass from the different stressors relative to a base-case stable population. Outputs from the model include total population biomass, proportion of stage-class biomass, proportions of total population respiration, growth, reproduction, and mortality rates, and stage-class abundance.

6.2 Methods and Materials

6.2.1 Description of the *Fundulus heteroclitus* population model

The *Fundulus heteroclitus* bioenergetics model calculates age-specific biomass (B) and is based on the 4-year lifecycle of *Fundulus heteroclitus* with a daily time step. Thus, the main matrix B (a,t) is the age-specific biomass, where a = age (days) and t = elapsed simulation time (days). The model calculates daily change in age-class biomass (B) from a_1 to a_{1460}, using a forward difference scheme to solve the ordinary differential equation. Model input parameters for consumption, mortality, reproduction and respiration are age-specific. The derivation of each input parameter is discussed in detail below (Section 6.2.2). The daily input parameters ('BioData' file in the Matlab code) can be found in Appendix I.

The main equations are two nested loops with the age loop nested inside of the time loop. Within the age loop, daily biomass is calculated as the balance of consumption (energy ingested in terms of biomass per day) with reproduction, respiration, and mortality (energy lost in terms of grams of biomass per day), using the age-specific energetic parameters. The Matlab code is as follows:

```
for t=2:TDays-1
        for a=2:Age
              B(a,t)=B(a-1,t-1);
               NetGrowthI(a,t)=(Cons(a)-(Repro(a)+Resp(a))*B(a,t));
               MortB(a,t)=B(a,t)*Mort(a);
               PopRepro(t)=PopRepro(t)+Repro(a)*B(a,t);
               PopResp(t)=PopResp(t)+Resp(a)*B(a,t);
               PopGrowth(t)=PopGrowth(t)+(NetGrowthI(a,t));
               PopMort(t)=PopMort(t)+MortB(a,t);
               B(a,t)=B(a,t)+(NetGrowthI(a,t)-MortB(a,t));
               TotalBiomass(t)=TotalBiomass(t)+B(a,t);
        end
    B(1,t+1)=PopRepro(t);
end
```

Lines 2 to 11 calculate each parameter for each day class from a_2 until a_{1460}. Line 3 calculates the change in biomass (g) for day by 'ageing' the biomass of the one day younger fish from the previous model day. Line 4 calculates the net growth per day (g/d) of individual biomass of each age class at time t where (consumption – (respiration + reproduction)) * B(a,t) equals net growth (g/d) (NetGrowthI(a,t)). Line 5 calculates biomass per day lost to mortality (MortB(a,t)). Lines 6 through 9 aggregate population parameters by calculating the individual day class energetic parameters, and then adding them to the total to accumulate population levels of reproduction, respiration, growth, and mortality. For example, line 6 calculates reproduction by multiplying the age-specific reproduction rate (1/d) from the 'BioData' input file by biomass (B) for age a at time t. The product is added to PopRepro(t), which aggregates across the age classes to calculate the total population reproductive output on day t. Line 10 adjusts biomass due to net growth by subtracting biomass lost due to mortality (MortB(a,t)). Line 11 accumulates the individual biomass for each $B_{a,t}$ into the total population biomass at time t.

The nested calculation occurs for each of the 1459 daily age classes for each model simulation day. The outside loop (simulation time loop) accumulates all of the parameters from the nested loop (age loop) on a daily basis and continues until Tdays – 1.

Line 13 accumulates new biomass (1 day old biomass) lost from reproduction of each age class (a_{366} – a_{1460}), and is added into the total biomass for 1 day olds B(1,t+1). The calculation is based on the assumption that all the biomass lost from reproduction from the adults generates 1 day-old biomass. This represents the maximum amount that could go into reproduction. I do not account for the cost of reproduction on respiration. (The full MatLab code can be found in Table 6.1.)

6.2.2 Determining bioenergetic parameters for *Fundulus heteroclitus*

The bioenergetic parameters (consumption, age-specific weight, and reproduction) were derived from literature values. Respiration parameters were obtained from measurements of control fish in Experiment 3 (Chapter 5). Population level parameters such as mortality and fecundity probabilities were based on literature values for *F. heteroclitus* (Valiela et al., 1977, Weisburg and Lotrich, 1982, Abraham, 1985, and Munns et al., 1997), and then converted to rate constants in order to track biomass lost due to mortality and reproductive probabilities. The main bioenergetics equations used were adapted from the Wisconsin Fish Bioenergetics Model 3.0 (Hanson et al., 1997). For example, consumption was not measured in Experiment 3, however, the modeled growth is constrained by weight-specific consumption. Thus, if exposure to contaminants affects rates of consumption (Calow, 1991, and Black et al., 1999), the model can project biomass due to changes in consumption rates. The will be discussed in more detail below.

As a starting point, Hanson et al. (1997) suggested that in a balanced energetic budget for a carnivorous fish, the expenditures should be roughly 44%, 27%, and 29% for respiration, waste, and growth, respectively. For *Fundulus,* respiration has been reported as high as 69% of its daily budget, and growth as little as 12% (Weisberg and Lotrich, 1982). Out of the respiration (standard, active, and specific dynamic action) budget, about half of it is devoted to standard metabolic rate, and as much as 30% to specific dynamic action (Valiela et al., 1977). In other models, the activity term is generally scaled to the standard metabolic rate, although this assumption is controversial (Hanson et al., 1997 and Essington and Houser, 2003). These were used as general guidelines when parameterizing consumption, respiration, reproduction, and mortality rates.

Munns et al. (1997) defined six stages (egg, larval, juvenile, one year old, two year old, and three year old) for their staged-based *Fundulus heteroclitus* demographic model. These were based on age-class demarcations from healthy populations of *Fundulus* where age-length relationships were determined (Fritz and Garside, 1975, Valiela et al., 1977 and Abraham, 1985). The stage classes used to define the model were based on life cycle stages and the age-length relationships from these studies.

The life cycle is broken down into the following five stage classes:

1. Larval stage (4 – 12 mm, hatchling though juvenile, 1 – 28 days)
2. Juvenile stage (<12 - 35 mm, 29 – 365 days)
3. 2 year old adults (35 – 50 mm, 366 – 730 days)
4. 3 year old adults (50 – 62 mm, 731– 1095 days)
5. 4 year old adults (62 –72 mm, 1096 – 1460 days)

The model is based on a daily time step, thus all of the parameters that are inputs into the model are rate constants of gram of fish biomass consumed or produced per gram of fish biomass per day (1/d). Yearly stage (age) classes were converted to daily classes based on the yearly life cycle described above.

Although growth was measured in the experiment described in Chapter 5, by design the fish in the experiments spanned a relatively narrow range of size (55 – 65 mm). Therefore, the experimental data did not have a large enough size distribution to describe the complete age-growth relationship. Age-specific growth rates were based on the field measurements of *Fundulus heterclitus* living in a "clean" environment (Valiela et al., 1977). A regression of the log-transformed weight (g) (W) and length (cm) (L) data from the Valiela et al. (1977) study was performed to obtain a length to weight relationship in order to calculate daily growth rates (Figure 6.1). I started with an initial weight of 0.01 g for a 1 day old fish. The initial weight was based on mummichog larval weights reported by Kneib and Parker, 1991. The final weight on day 1460 (~ 18 g) was consistent with field measurements under "clean" conditions (Valiela et al., 1977). Each subsequent age-specific weight was calculated from the length-based year classes using the regression equation of $W = 0.0117*L^{3.51}$. I then calculated the daily growth rate using the equation:

(1) $G = (\ln W_2 - \ln W_1)/t_2\text{-}t_1$ for each year class.

To establish a daily growth rate and a daily weight, a regression was performed on the calculated growth rates for each year class to obtain the equation:

(2) $G_a = 3.97a^{-1.11}$ where a = age in days

(See Figure 6.2).

I then re-arranged equation 1 to calculate the change in weight from growth for each daily time step, starting with an initial weight of 0.01 g for the day 1 old fish, so that the weight of an a+1 day old fish equals:

3) $W_{a+1} = W_{a1} * e^{Ga*((t+1)-t)}$

The final weight of the fish on Day 1460 was 17.96 g. See Figure 6.2 for the weight vs. age curve used to generate weight-specific first order rate constants as inputs for the model. To avoid excessively high growth rates in young age classes, the daily growth rate was capped at 0.02 g/g-d from age 1 to 118 days. This was consistent with the larval growth rates reported for *Fundulus* (Kneib and Parker, 1991), and with growth rates for other larval species reported in Houde (1997).

6.2.2.1 Mortality

Yearly mortality probabilities reported in the literature were used as the starting point for calculating daily mortality rates. The yearly mortality rates reported for *Fundulus* were 99.5%, 54%, and 54% for larval through juvenile stages, two year olds, and three year olds, respectively (Valiela et al., 1977, Abraham, 1985, and Munns et al., 1997). Age-specific mortality rates were calculated using an approach similar to that used for the growth rates. First order rate constants were calculated using the exponential equation (Jaworska et al., 1997):

(4) $B_{365} = B_1 * e^{(-Ma*t)}$

where M_a is the rate of mortality, the probability of biomass surviving from age 1 day (B_1) to age 365 days (B_{365}) = 1 - 0.995, so that $B_{365}/B_1 = 0.005 = e^{(-Ma*365)}$, or ln (0.005)/(-365) = M_a. I then interpolated among these annual mortality rates (using the mid-points of the age class) to estimate age-specific daily mortality rates via two regressions of mortality rates vs. age where (Figure 6.4):

(5a) $M_a = -0.00003a + 0.0209$ for ages 1 – 550 days

(5b) $M_a = -0.000002a + 0.0036$ for ages 550 – 1460 days

Day 550 was used in both of the regressions, and represents the breakpoint. The reason for this was based on the limited data available and the shape of the curve.

6.2.2.2 Reproduction

Reproduction parameters were characterized first in terms of the biomass lost by each age class per day and then in terms of the amount of one day-old biomass generated by reproduction daily. Biomass lost from spawning fish was calculated from the amount of adult biomass transferred to egg biomass measured for a representative sample of females in each age class (Valiela et al., 1977). The total biomass lost to eggs was multiplied by number of spawns per age class, normalized to the body weight of females within each age class, and then divided by 365 to obtain an weight-specific reproduction rate constant (1/d). By converting reproduction to a rate constant, it can be used as a loss term in the mass balance equation. For the base-case model, only fish older than one year reproduce. One, two, and three year olds spawn four, three, and two times per year, respectively, thus the highest rate of daily reproduction occurs in fish between one and two years (366 and 729 days) old, consistent with the literature (Valiela et al., 1977, Abraham, 1985, and Munns et al., 1997).

6.2.2.3 Respiration

The respiration rate constant (Resp (a)) calculated for each aged fish is based on the summation of standard metabolic rate (SMR), active metabolic rate (ACT), and specific dynamic action (S). SMR is based on laboratory measurements of control fish from the experiment described in Chapter 5. A regression of the log-transformed SMR (g O_2/d) vs. weight data was performed to obtain the following equation:

(6) $\text{Log SMR} = 0.86*\text{LogW} - 2.06$, $r^2 = 0.57$, or

(7) $\text{SMR} = 0.008*W^{0.86}*f(T)*\text{ACT}$,

(See Figure 6.5).

The calculations for ACT and S are scaled in accordance with equations and multipliers described in the Wisconsin Fish Bioenergetics Model (Hanson et al., 1997). Some of the parameters for juvenile age classes were adjusted based on the study by Madon et al., 2001, using *Fundulus parvipinnis* (See Appendix I for parameters and equations from the Wisconsin Model and the Madon et al., 2001 study). I used the temperature-dependent calculations described in the Wisconsin model. (Temperature was held constant at 20^{o}C in this model.) ACT = Active metabolic rate is a multiplier of SMR, ACT was set at 2 for age classes greater than 28 days, and 4 for the age classes less than 28 days. The respiration budget was approximately 45, 45, and 10% for SMR, Activity, and SDA, respectively. f(T) is the temperature-dependent function of respiration, and was taken from the Wisconsin model. Temperature was constant at 20^{o}C, and thus f(T) is approximately 1 in the calculation in equation 7.

To calculate specific dynamic action, I used the following equation from the Wisconsin model:

(8) S = SDA*AE

where SDA is the proportion of energy lost through digestion (set at 0.2) (Hanson et al. 1997 recommend an SDA range of (0.1 – 0.2), and AE is the assimilation efficiency (consumption - egestion), which for *Fundulus* ranges from 0.8-0.9 (Weisburg and Lotrich, 1982). So,

(9) S = (SMR*(0.2))*(0.8)

(10) Total Respiration (Resp) = R+ S which is then normalized to the age-specific biomass to obtain the rate constant for Respiration (1/d).

6.2.2.4 Consumption Rates

The model projects growth based on weight-specific consumption so that net growth (NetGrowthI(a,t)) is a mass balance of energy input minus energy outputs. Both equations 11 and 12 below are from the Wisconsin Model (Handon et al., 1997) where weight-specific consumption was calculated from maximum consumption (C_{max}):

(11) $C_{max} = CA*W^{CB}$

CA is the intercept of the allometric mass function for 1 gram of fish at optimum temperature for growth (25^{o}C), and CB is the slope. These were calculated for larval, juvenile, and adult stages of *Fundulus* using parameters reported in Madon et al. (2001). The weights for each day old fish used to calculate consumption rates (g/g-d) for each class were discussed early in this chapter. Weight-specific consumption (C) for each daily age class was calculated as:

(12) C (g/g-d) = C_{max} * p * f(T)

where p = proportion of maximum consumption (set to 20% for adults and juveniles, and to 10% for larvae). For f(T), Equation 2 from the Wisconsin Model (Kitchell et al., 1977) for warm water species was used.

Figure 6.6 plots all of the age-specific (daily) rate constant curves used as inputs for consumption, mortality, reproduction, and respiration rates (1/d). These parameters were read into the Matlab model (through the “BioData” file; see Appendix I), and then multiplied to the maximum values of each parameter. For the base case, the maximum values were set to 1 for consumption, mortality and respiration. Reproduction was set to 10. The maximum values are multipliers that allow scenarios to be run without changing the original age-specific input data. (See Table 6.1 for the Matlab code.)

The base-case model was initialized with a starting age distribution in a two step process. First, a Leslie Matrix population projection model was developed based on daily fecundity rates (number of offspring/individual) and survival probabilities (1 – mortality probabilities) for *Fundulus heteroclitus* to analyze the stable age distribution at steady state. Daily rates were calculated based on the yearly rates reported in the literature. The output from the Leslie Matrix then became the initialization input to start the base-case run to start from a stable population.

6.2.3 Leslie Matrix Population Projection Model

A Leslie Matrix model (Caswell, 1989) was developed for *Fundulus heteroclitus* from life table parameters for yearly age classes. Table 6.2a depicts the survivorship schedule (l(x)); birth rates per individual (b(x)); survival probabilities (P_i) of moving from one age class into the next one, and rates of fecundity for each year class (P_i*b(x) (Gotelli, 2001). These values were then transferred into the Leslie Matrix model (Table 6.2b) for *Fundulus heteroclitus* (Table 6.2c). This was used to calculate the relative distribution of age classes in numbers of individuals. I then converted number of individuals to weight, totaled the biomass, and multiplied by 10^5 to generate a starting biomass scaled to the relative distribution of a stable population. This became the input to initialize the biomass matrix B(a,t).

The model was then run for 20 years to obtain a 20 year age distribution of biomass. This biomass age distribution was then used as the starting distribution for the base-case. This double initialization of the model was employed to ensure a stable base-case model.

6.3 Results

6.3.1 Base-case model

The base-case model was run for a 10 year simulation and presents a steady state population where net growth is zero, and thus total biomass (g) does not change across the ten-year model simulation (Figure 6.7). Biomass projections are relative to starting biomass age distributions, however, the base case apportions biomass realistically to stage-class biomass (Figure 6.8, base case curve) and abundance (Figure 6.9, base case). In Figure 6.8, the greatest rates of biomass accumulation (grams of biomass produced per day) are in the youngest age classes (less than 150 days) and then there is an even distribution of biomass accumulation across the older age classes. In terms of abundance (numbers of individuals), most of the population is in the larval and juvenile stages (See base case in Figures 6.9 and 6.10, respectively). In terms of abundance and age-specific production (g/d), the model is projecting a realistic output when compared to Valiela et al., 1977. However, this results needs to be validated using another data set since the Valiela et al. data were used to parameterize inputs of age-specific weight and reproductive rates.

6.3.2 Scenarios

6.3.2.1 Chemically-induced changes in standard metabolic rates

These scenarios simulate chemically-induced changes in standard metabolic rates by changing the respiration parameter across time and in all age classes by ± 5%, 10% and 25% relative to the base model. The laboratory experiment in Chapter 5 reported PAH-induced changes in standard metabolic rates ranging from ±5-7%. These results were used as the basis for choosing the scenarios. Figure 6.7 demonstrates the effect on total biomass due to a small change on respiration. The increase in respiration rate depletes total population biomass and the decrease in respiration rate allows biomass to increase. The change in respiration rate does not change the relative contribution of each age class among scenarios because the change is applied equally to all ages. Because the model is constrained by consumption, the biomass returns to a stable state.

Figure 6.11 depicts the change in total population and stage-class biomass (g) after one year versus the changes in respiration rates. An increase in metabolic rates causes biomass to decrease, whereas a decrease in metabolic rate increases biomass. Except for the larval stage, each stage-class contributes equally to the total population biomass.

In terms of age-distribution, a change in respiration results in a vertical shift of the age-distribution curve, but it does not change the shape of the curve (see Figure 6.8). In terms of stage-class abundance at the end of a one year simulation, total abundance changes, but the relative distribution of each stage-class changes proportionally to the change in total biomass (Figures 6.10 and 6.11).

6.3.2.2 Simulation of chemical stress on mortality rates

To simulate a chemical stressor on mortality rates, the mortality parameter was increased by 10%, 25% and 50%. 10% was chosen as a common perturbation factor applied in population models (Forbes et al., 2001, and Spromberg and Meador, 2005). Figure 6.12 shows the resulting stage-class biomass for each simulation. Over a one year period, total population biomass is reduced by 3%, 5%, and 9%, for the respective 10%, 25% and 50% increases in mortality rates.

In terms of the age-distribution of rates of biomass (g/d), the shape of the curve does change with increases in mortality rates (Figure 6.13). However, the age-classes affected are buffered by the lack of response in the later age-classes and the earliest age classes where biomass and abundance contribute the most to population totals.

6.3.2.3 Simulation of chemical stress on consumption rates

Consumption rates were also altered by ± 5, 10, 25 %. Because the main equation of the model is constrained by balancing consumption with loss processes, a change in consumption returns the mathematical response is biomass. So, if consumption is decreased by 10%, growth is reduced by 10%. See Figure 6.14. The advantage to this approach is that the model is stable, and does not allow the population to crash or explode as it did in a previous version of this model.

In order to compare the simulated "effects" on stage-class biomass, Figure 6.15 shows the deviation from base case for a 10% increase in mortality, a 10% increase in respiration, and a 10% decrease in consumption. In this comparison, the "equivalent energetic impact" on consumption and respiration translate into higher costs to total population biomass than mortality. Respiration and consumption decrease the total biomass by 10%, where the same decrease in mortality reduces biomass by only 5%.

6.4 Discussion and Implications

The results discussed in Chapter 5 led to the development of an age-structured, weight specific bioenergetics model for *Fundulus heteroclitus* to explore whether effects on individual respiration rates from PAH exposure might have important effects at the population level. Secondly, the model was used to compare simulations from chemically-induced changes in respiration, consumption and mortality rates to investigate whether small changes in respiration were potentially important for populations.

Under the scenarios where respiration rates were altered, the model projected resulting changes in population biomass. Decreases in respiration rates led to systematic increases in biomass. In the model, a reduction in respiration causes the increase in biomass because there is more energy available for growth in the mass balance. A decrease in respiration in the model does not also reduce consumption, a limitation of the current model.

The resulting losses in biomass from the scenarios where respiration rates were increased also have implications. Intuitively, the model results for the increased respiration rate scenarios are more realistic than the results from the depressed respiration rates. Increased respiration rates reduced total population biomass of a major component of the estuarine food web. Under these sets of scenarios, carbon flow from the benthos to the upper trophic levels would be reduced.

In comparing increased respiration rates with increased mortality rates (to simulate exposures where a fraction of the population reached lethal body burdens of toxicant), biomass depletion was more sensitive to changes in respiration than to changes in mortality. A 10% increase in respiration rate led to a 10% reduction in population biomass, whereas the same increase in mortality led to a 5% reduction in total biomass after a one year simulation period. Thus, the model revealed that chemically-altered energetics are potentially as important as altered mortality probabilities. This has significant ramifications for populations exposed to sublethal levels of contaminants over long periods of time, and needs further investigation.

Consumption rates in the experiment in Chapter 5 were not quantitatively measured; however, there is a non-linear relationship between respiration and consumption that is not completely incorporated in the model. There are examples in the literature where consumptions rates are reduced when *Fundulus* is exposed to high levels of PCBs (20 μg/g of Σ-PCB) (Gutjar-Gobell et al., 1998). As expected, reduced consumption from high-level exposure, also reduced growth and increased mortality significantly in that study. At lower exposure levels, as in the levels simulated in this modeling effort, one would expect consumption to be reduced as respiration is reduced from exposure. If respiration is reduced in the Matlab code, it only reduces the weight-specific respiration array being pulled into the model. Both consumption and respiration can be changed, however, this just results in an additive change in total biomass lost.

The scenarios described here were chosen to demonstrate the basic framework and functioning of the model, and to assess whether the observations from Chapter 5 could have consequences at the population level. The “chemical impacts” exerted on the respiration and mortality rates were constant across age classes. However, age-specific impacts could be simulated by changing the age-specific parameters (e.g., mortality or reproductive rates) in the input file. The model provides an initial framework based on fish bioenergetics to evaluate effects of long-term exposure of chemicals operating under different and multiple modes of action. The use of this simple approach illustrated that small changes in fish standard metabolic rates are similar to changes in consumption and mortality in terms of total biomass of the population. These findings provide a foundation for future modeling studies where density-dependence may be incorporated and bioaccumulation can be added.

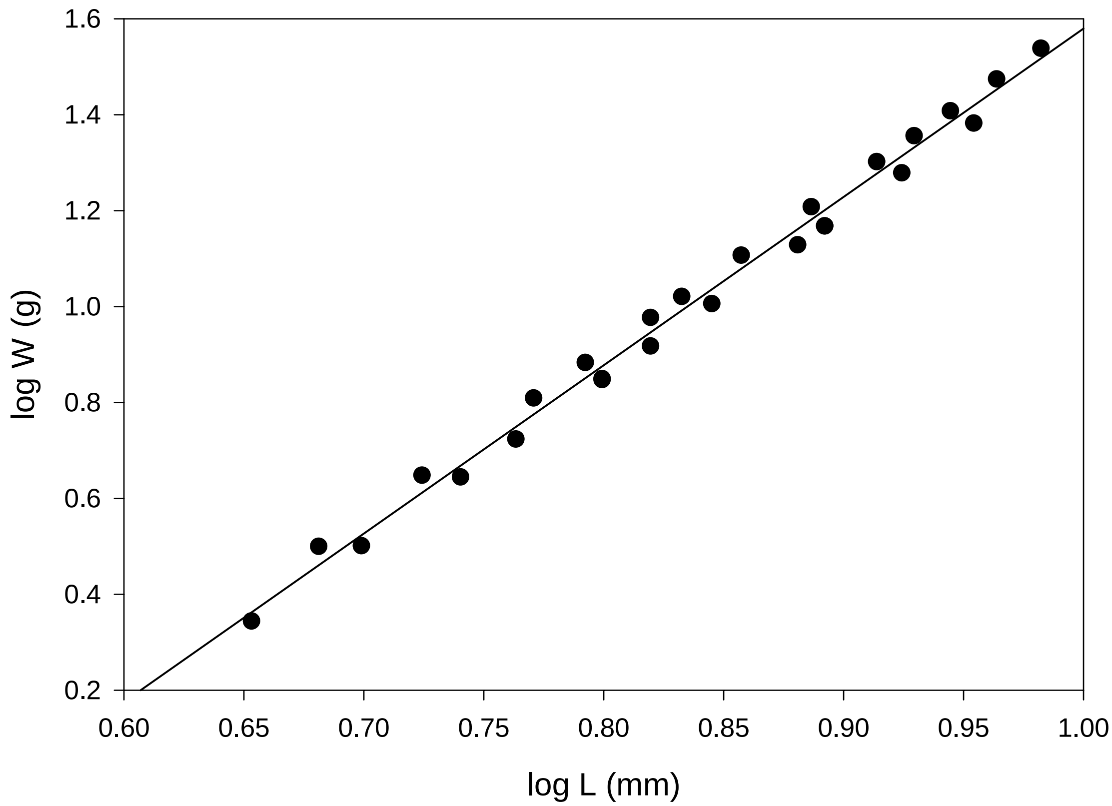

Figure 6.1. Linear regression of log-transformed *F. heteroclitus* weight-length data from Valiela et al., 1977. The allometric function W (g) = a L(cm)^b where a = 0.0117 and b = 3.51. R^2 = 0.99.

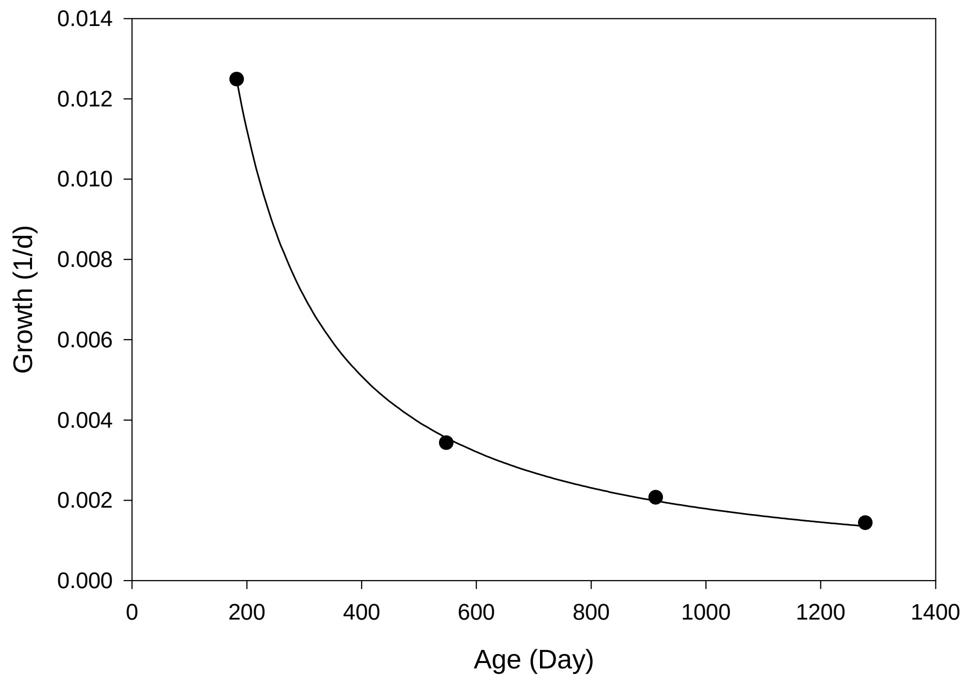

Figure 6.2. Power function regression of day versus growth rate (1/d) of calculated growth rates of year classes of *F. heteroclitus* to establish a weight specific growth rate for each daily time step. $G_a = 3.97a^{-1.11}$. R^2=0.99

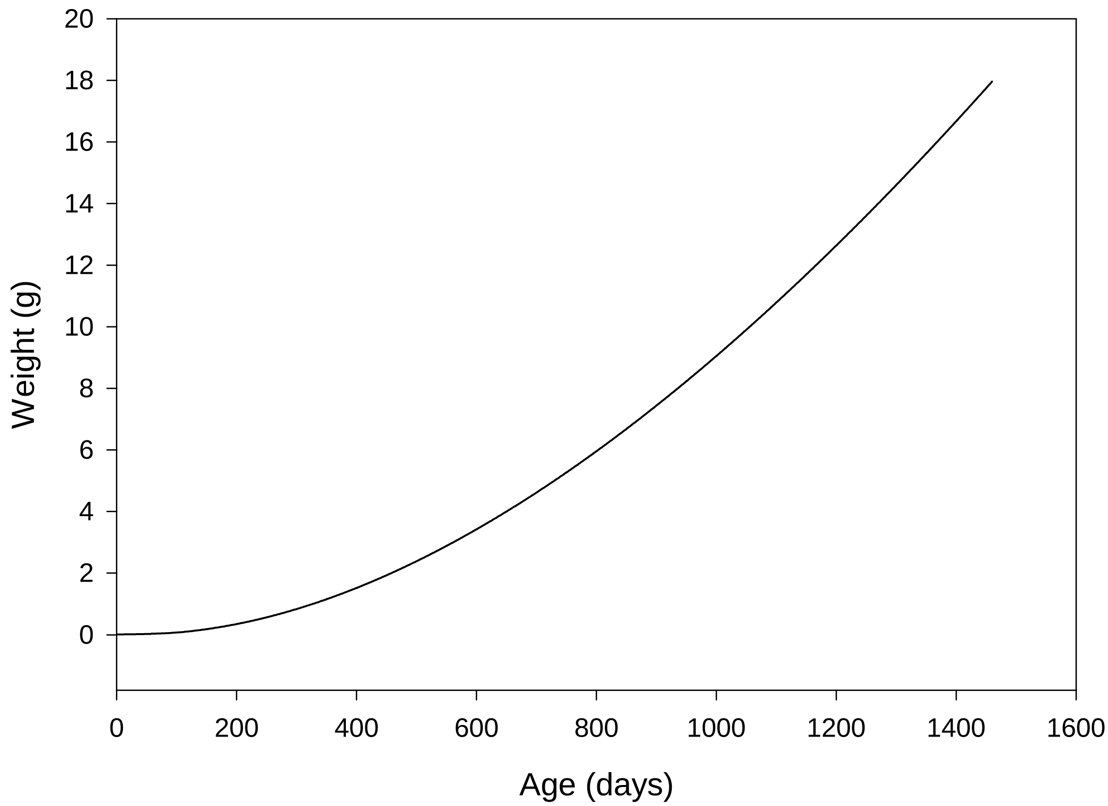

Figure 6.3. The fish weight curve used to define daily weights of fish from age 1 day to age 1460 days.

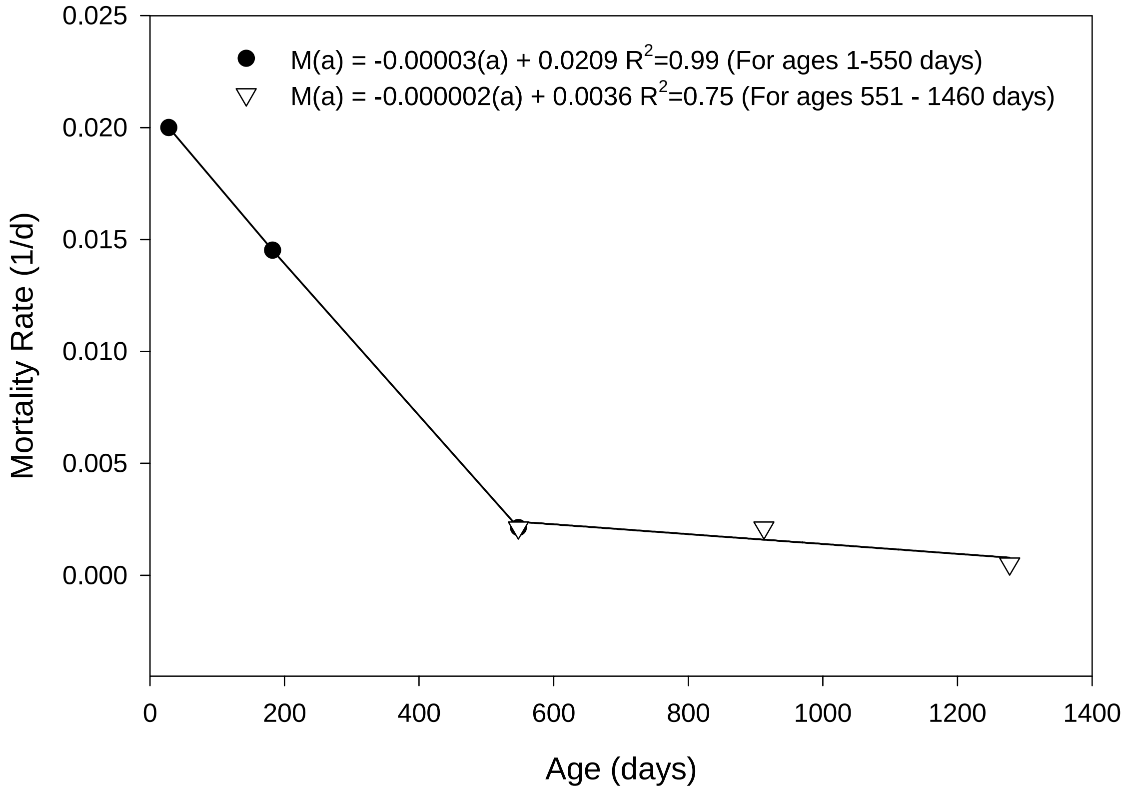

Figure 6.4. Mortality rates based on a yearly probability vs. time to generate a weight-specific daily mortality rate (g/g-d).

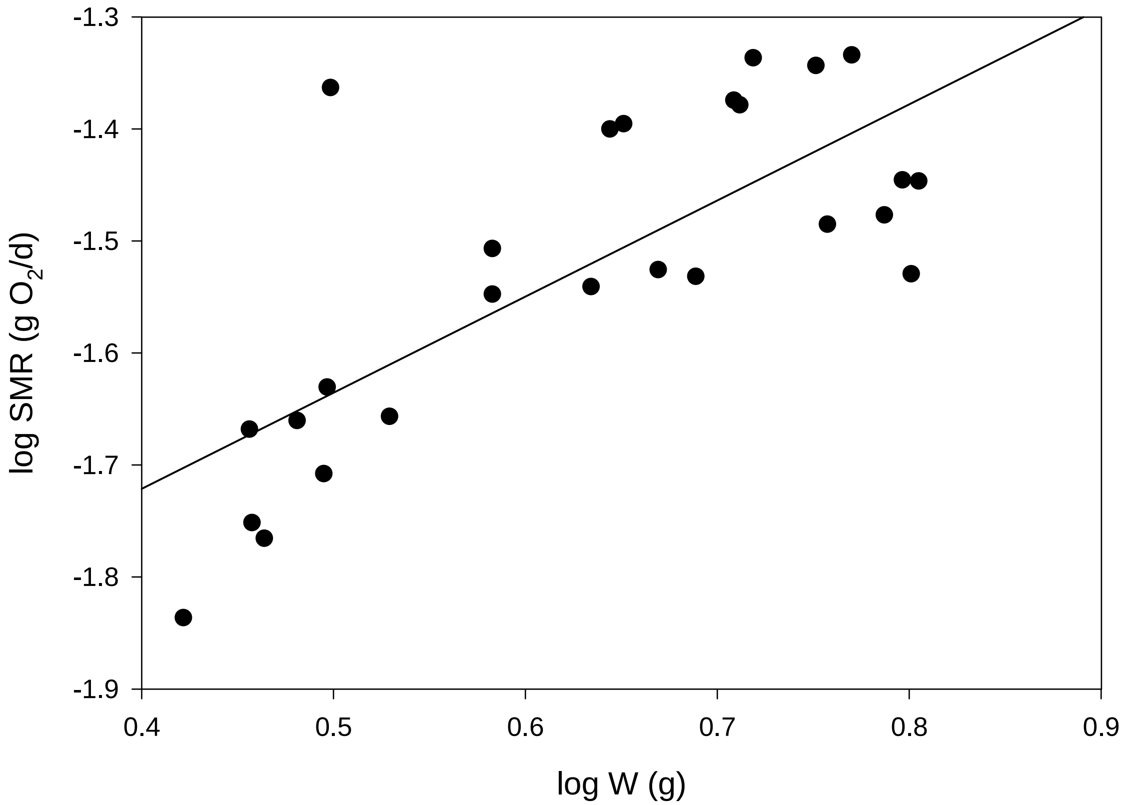

Figure 6.5. Log transformed linear regression of standard metabolic rates (gO_2/d) (SMR) vs. log Weight where SMR = $0.008*W^{0.86}$ (R^2=0.57) for *Fundulus heteroclitus.* Data are from the control fish in Chapter 5.

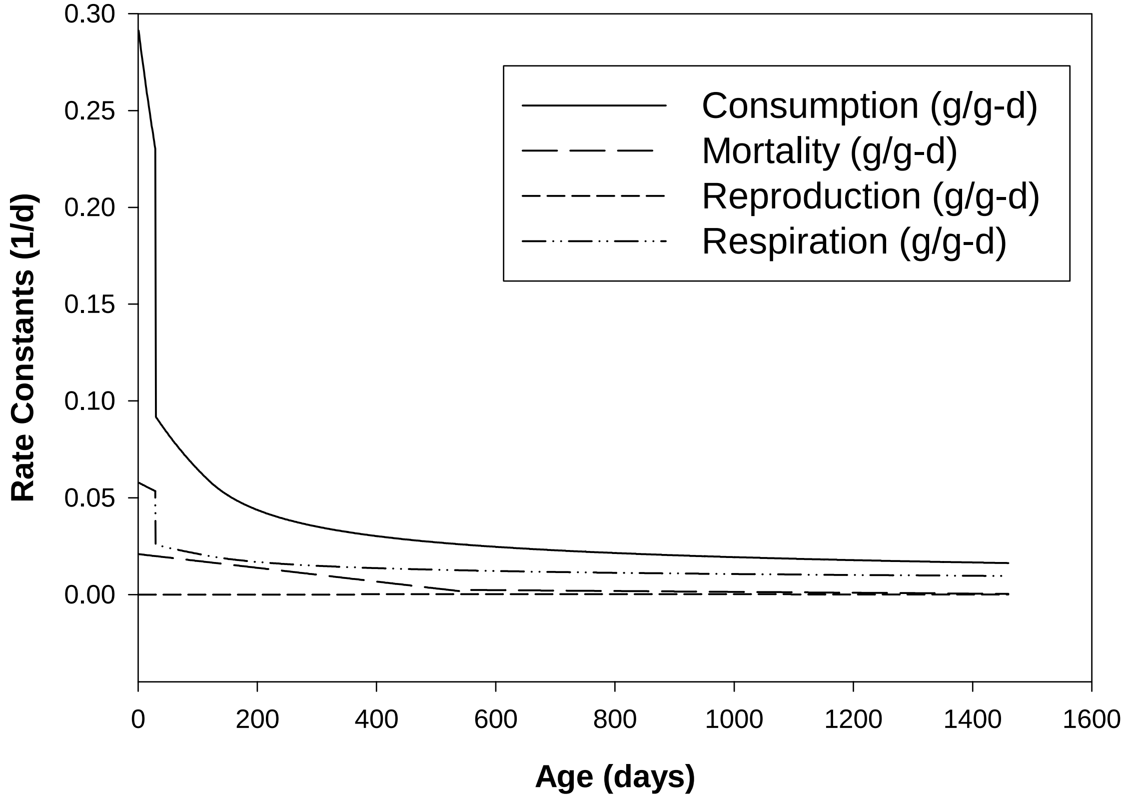

Figure 6.6. Rate constants for each age-specific parameter used as inputs into the *Fundulus* model in Matlab.

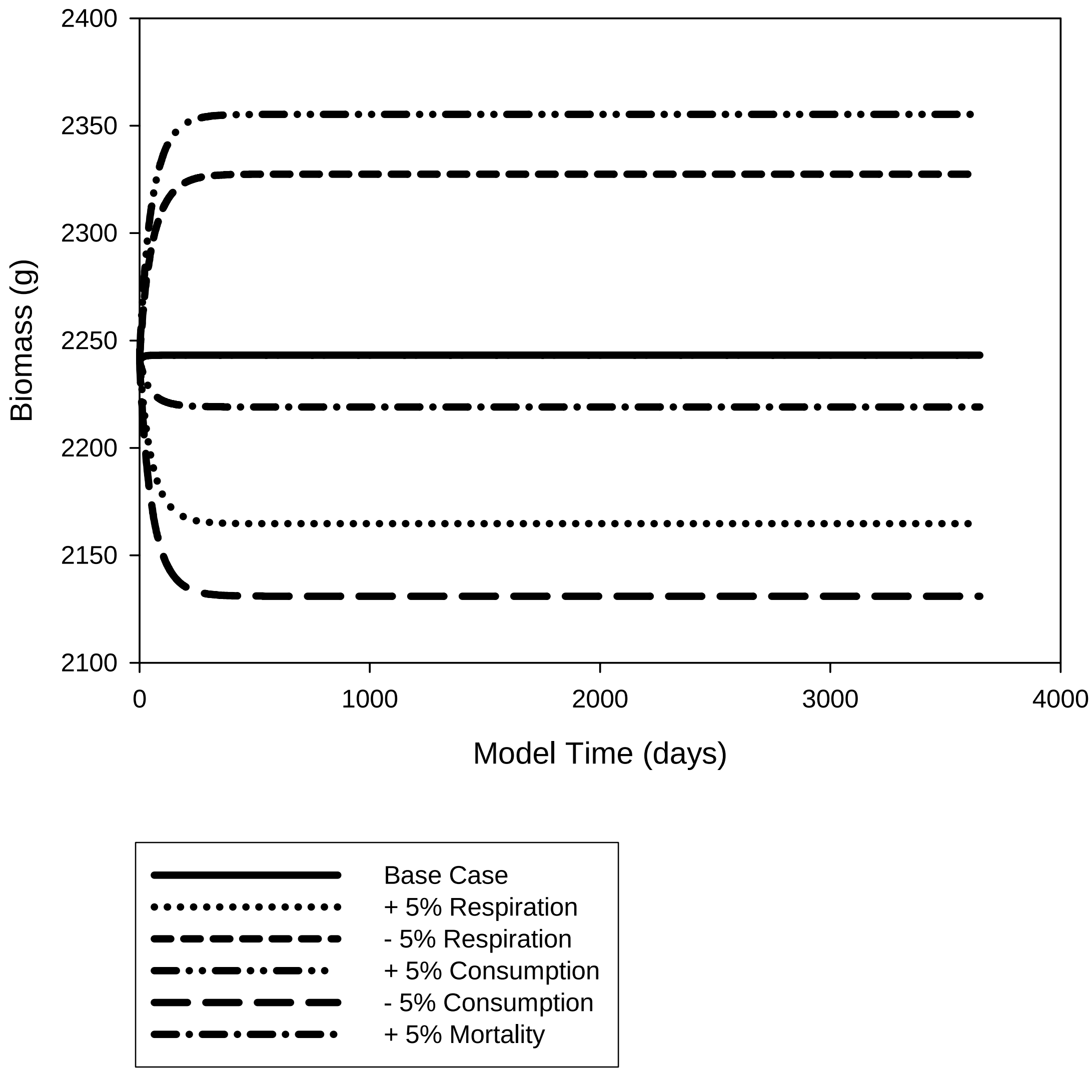

Figure 6.7. Total biomass in each scenario (1: base-case, 2: 5% increase in Respiration, and 3: 5% decrease in Respiration, 4: 5% increase in Consumption, 5: 5% decrease in Consumption, and 6: 5% increase in Mortality).

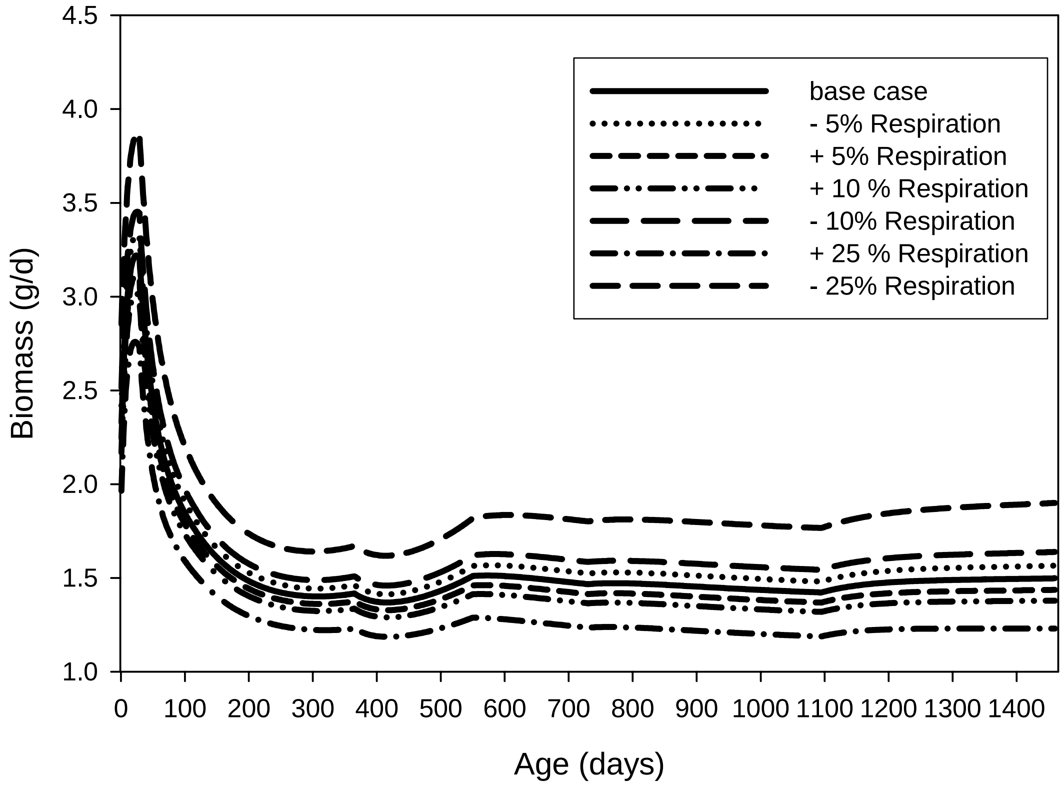

Figure 6.8. Age distribution of biomass rates (g/d) for base case conditions (solid line), and the response due to ± 5, 10, and 25% changes in respiration. The curve adjusts vertically and changes the total magnitude of biomass but the relative distribution does not change.

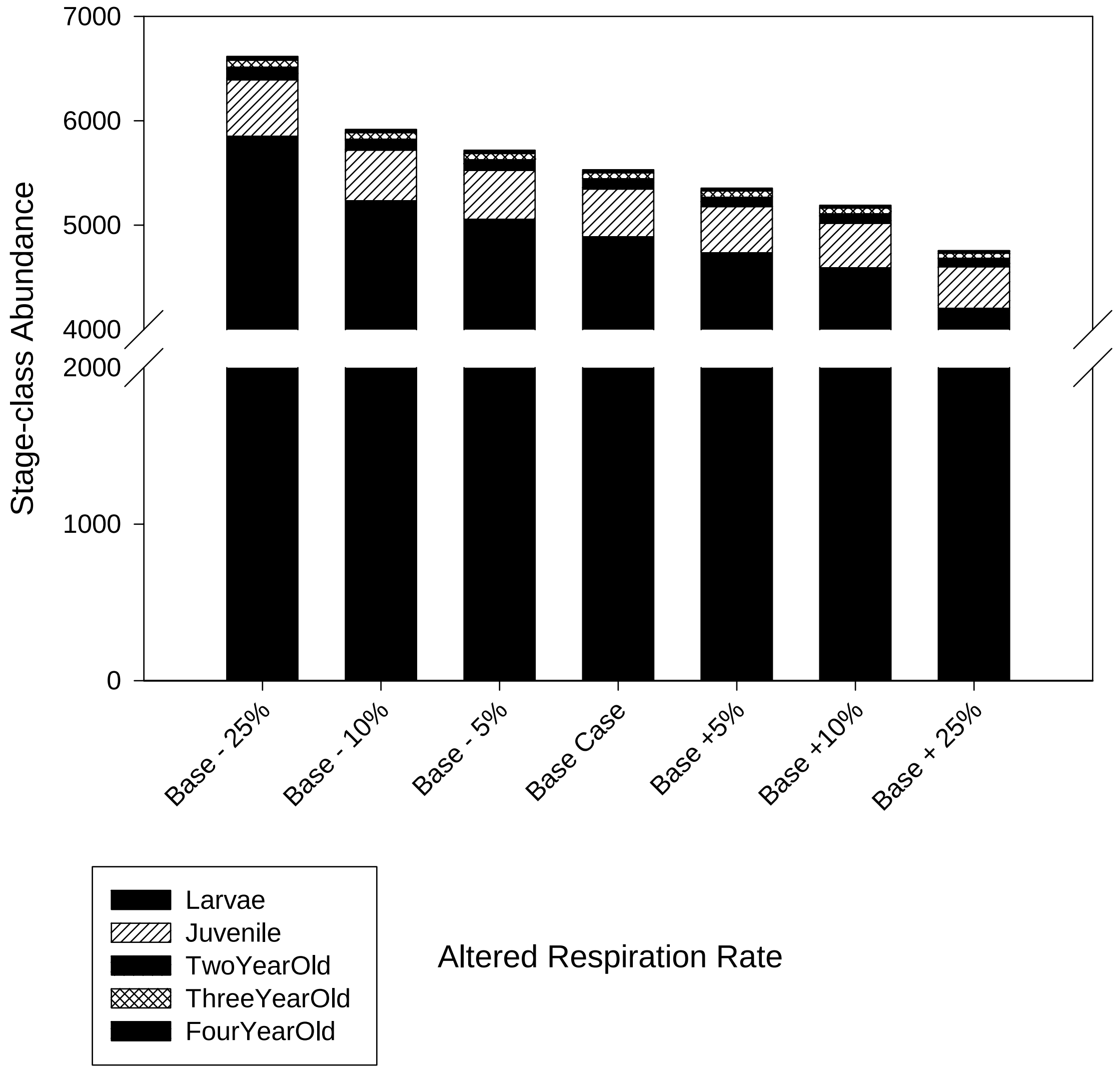

Figure 6.9. Stage-class abundance versus ± 5, 10, and 25% changes in respiration.

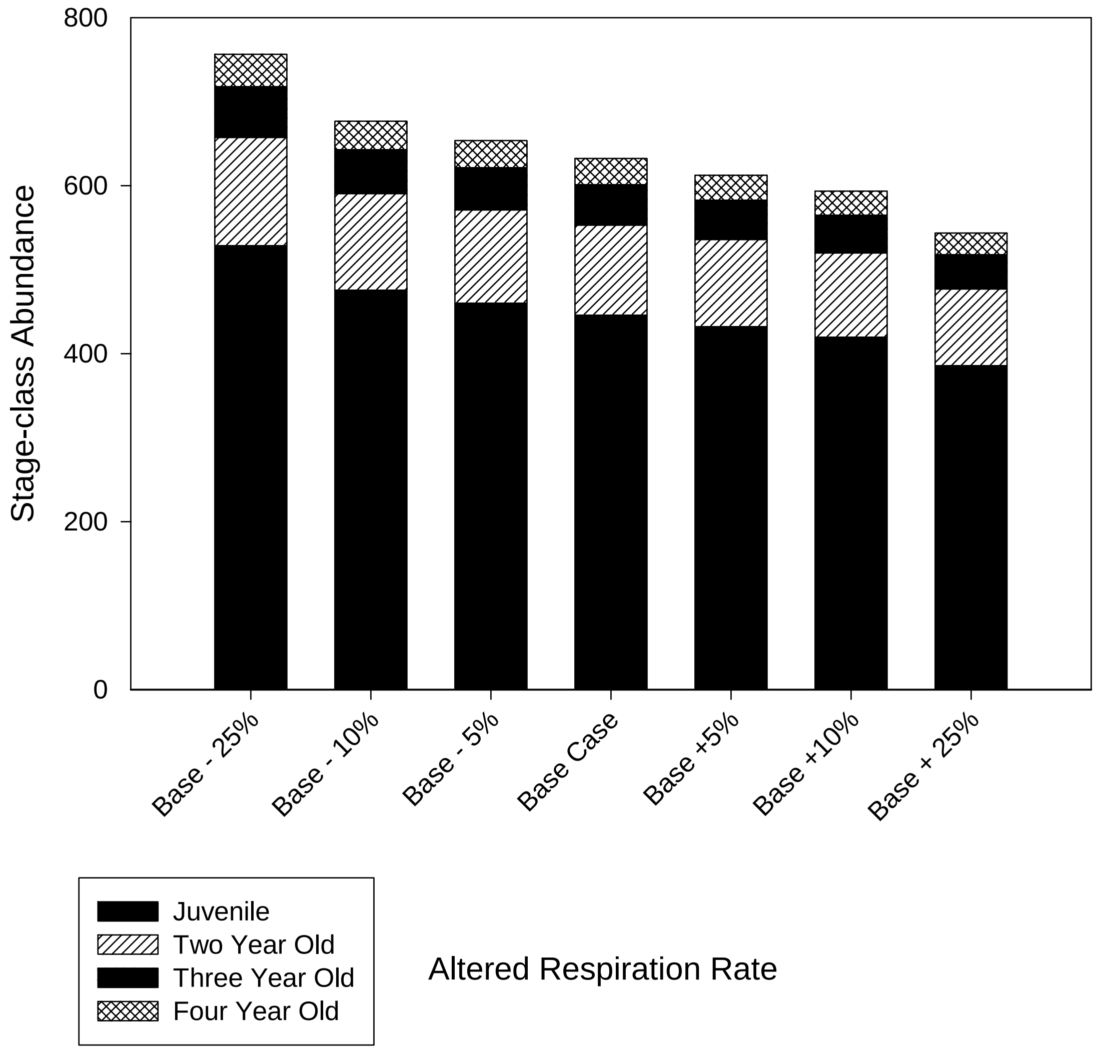

Figure 6.10. Stage-class abundance versus ± 5, 10, and 25% changes in respiration without the larval stage class in order to show the relative abundance of the older stage-classes.

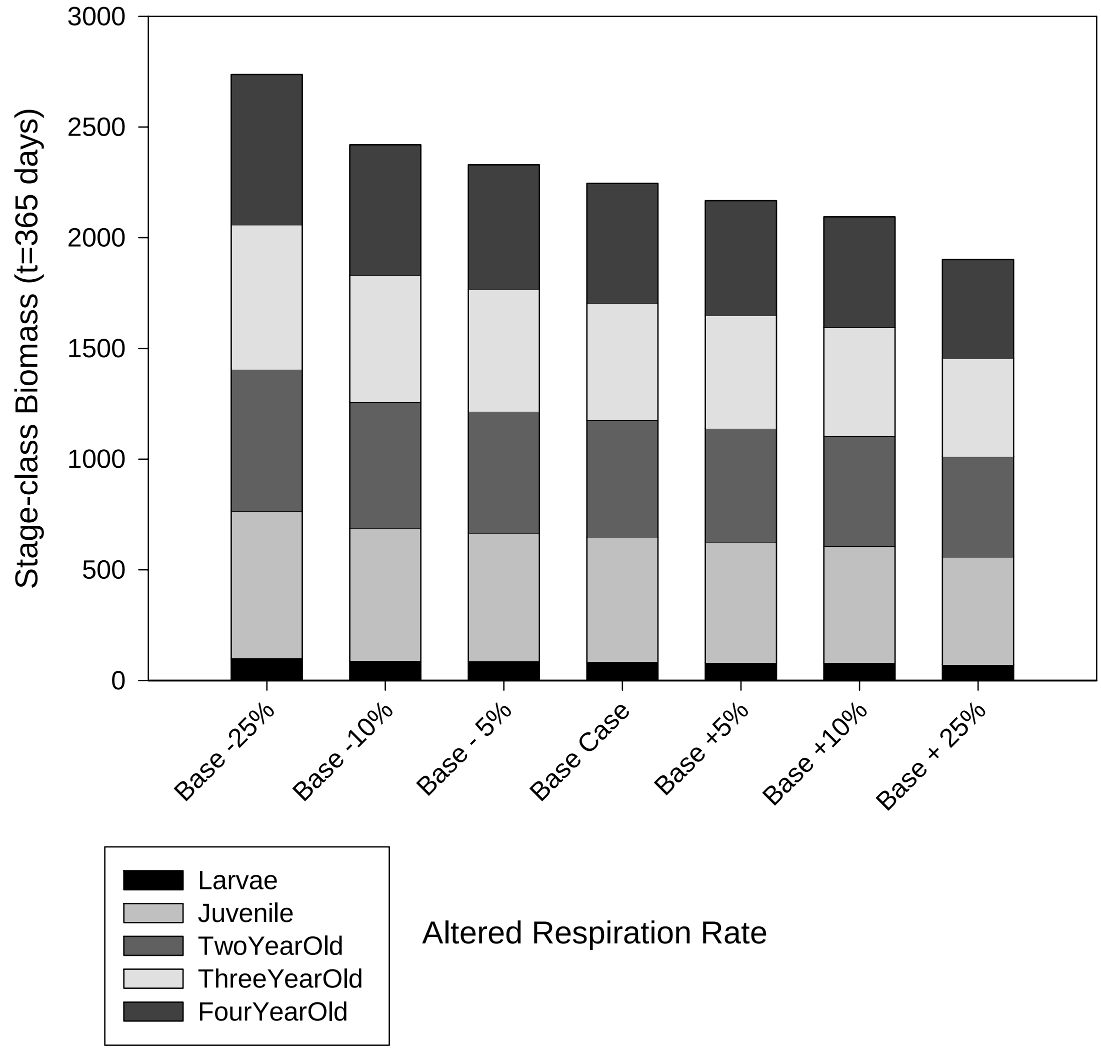

Figure 6.11. Stage-class biomass after 365 day runs simulating chemically altered respiration rates. Base-case relative to changes in ± 5, 10, and 25% from base-case.

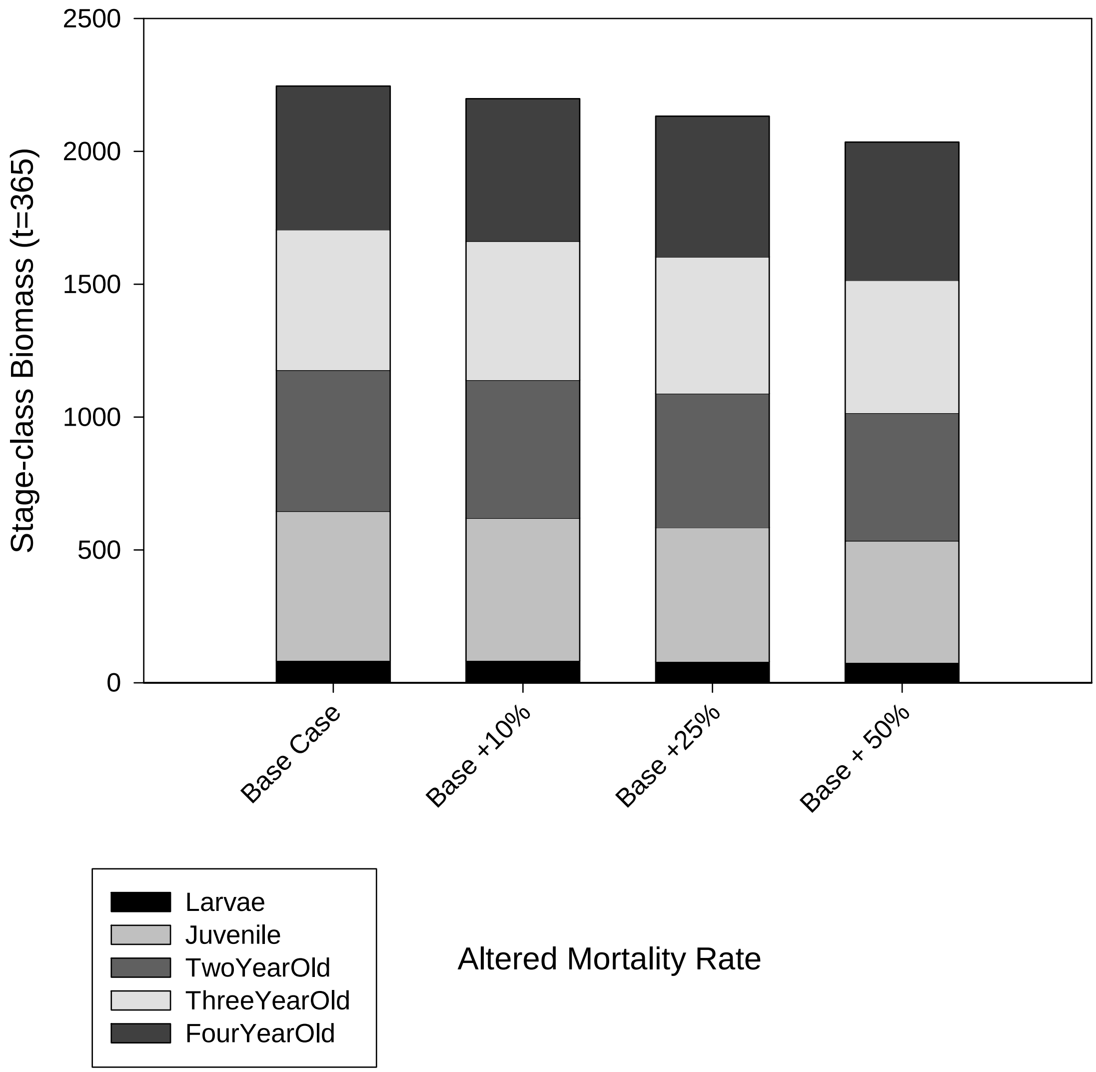

Figure 6.12. Stage-based biomass after 365 day model runs simulating chemical stressor affecting mortality rates. Base-case relative to increases of 10%, 25% and 50% in mortality rates.

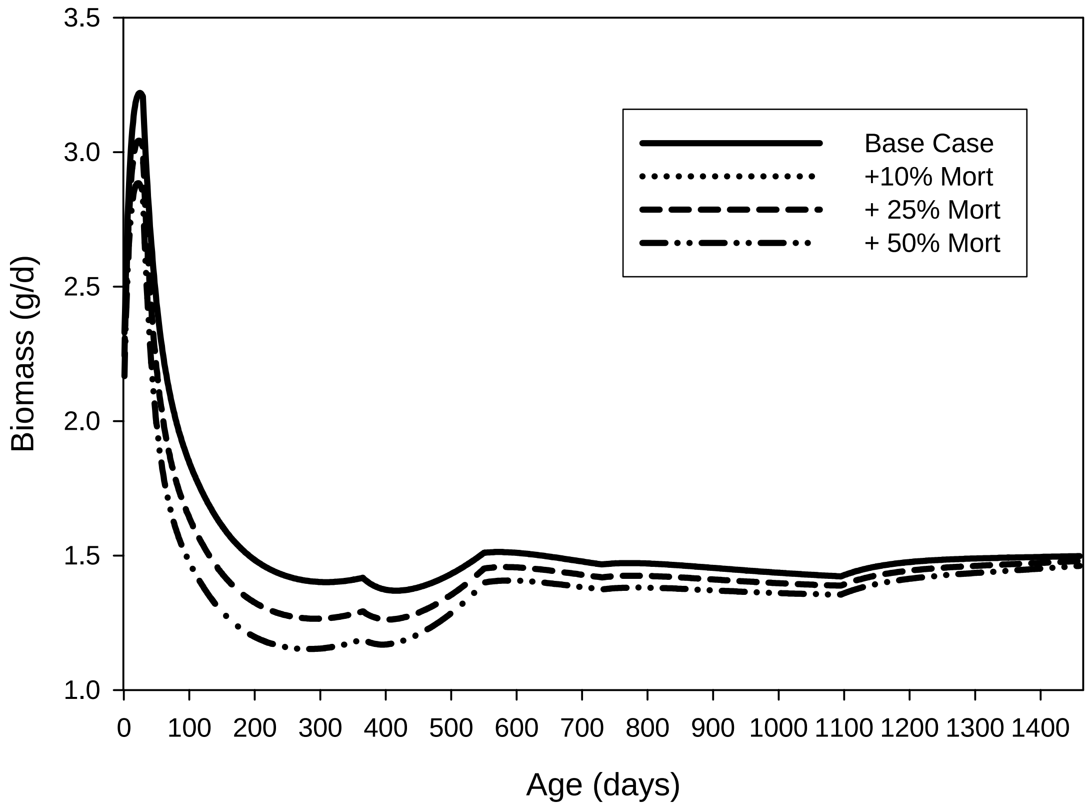

Figure 6.13. Age-distribution of biomass rates (g/d) after 365 day model runs simulating increases of 10, 25 and 50%. Changes in mortality affect biomass production in the juvenile daily age classes, but are dampened by lack of responses in the other age classes.

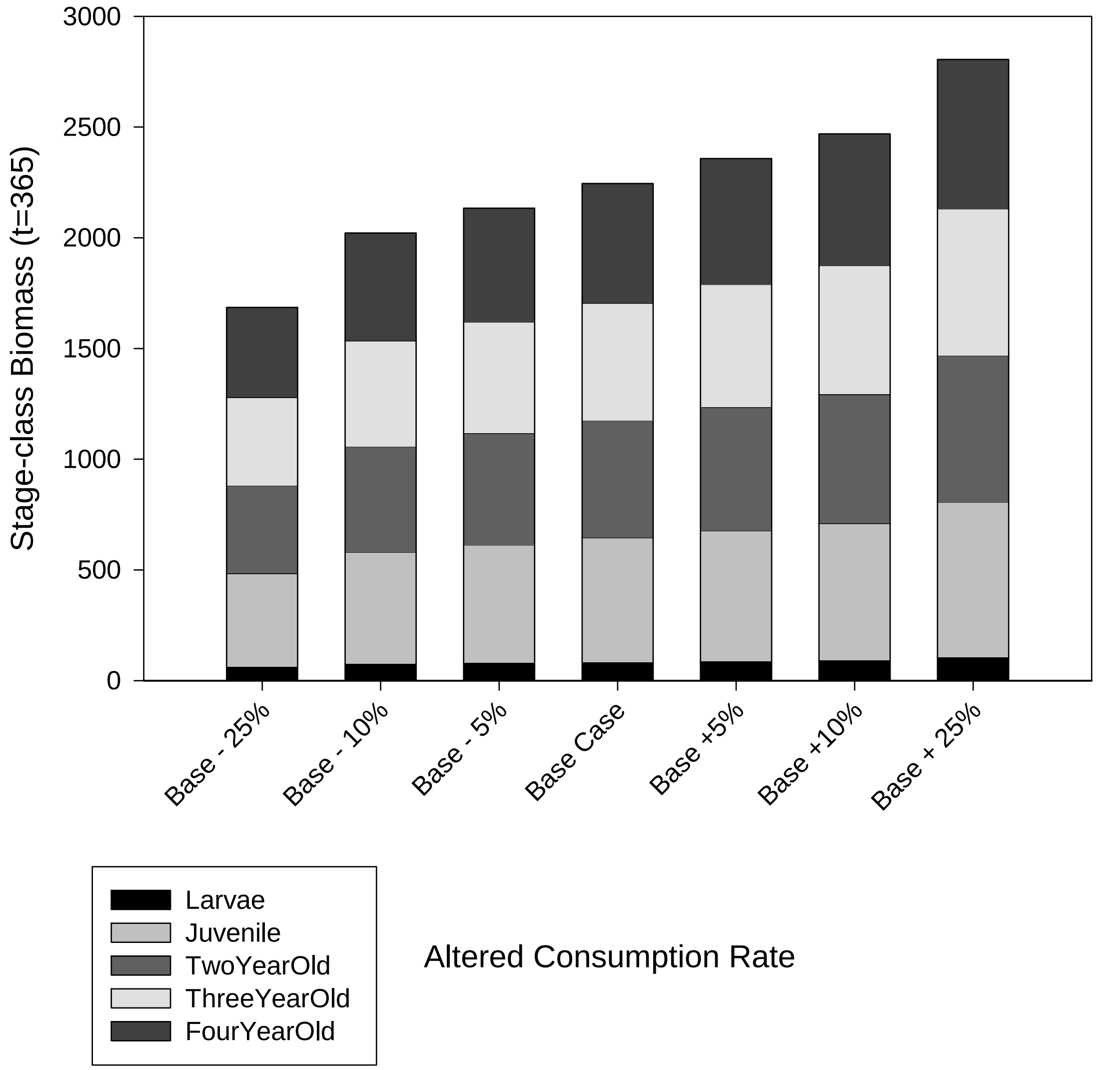

Figure 6.14. Stage-based biomass after 365 day model runs simulating chemical stressor affecting mortality rates. Base-case relative to ± 5, 10, and 25 base-case.

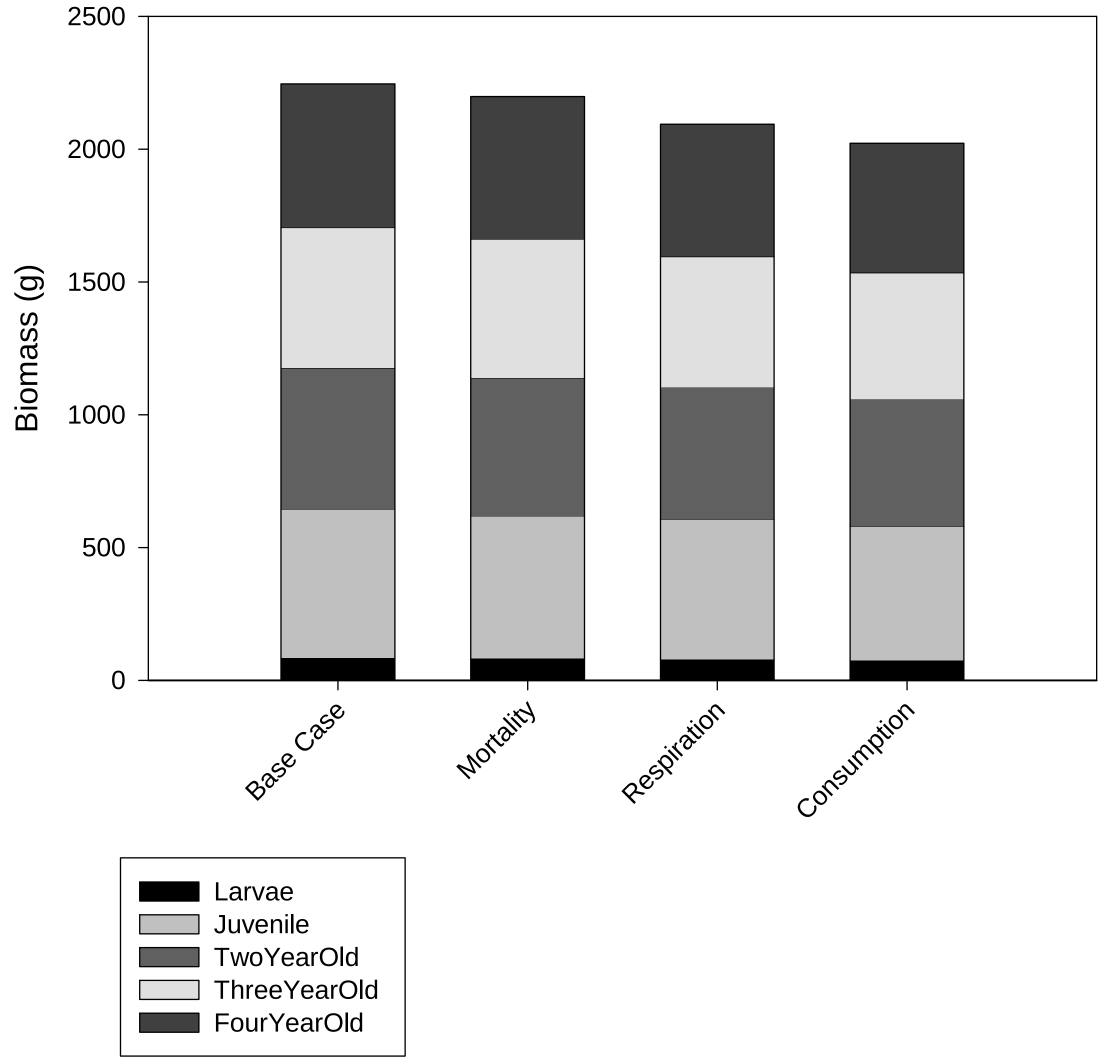

Figure 6.15. Comparison of resulting population biomass resulting from simulated stressors on mortality and respiration rates (+10% of base-case for each parameter).

Table 6.1. MatLab 7.0 code for Fundulus heteroclitus Model (FM_9.m)

```
clear
%Simulation Time and Age Structure

TYears=5;                    %total simulation time, years
TDays=round(TYears*365);       %total simulation time, days
AgeClass=4;                  %age classes, years
Age=round(AgeClass*365);       %total number of age classes, days

BioData=xlsread('BioData.xls');

%Initial Matrices
B=BioData(:,12);             %using, 'FMOut2'from Tdays-1 from 20 year run after changing biodata file

InitialBiomass=0;
for i=1:Age
InitialBiomass=InitialBiomass+B(i,1);
end

%Define Maximum Energetic Terms

WeightMax=1;
ConsMax=1;
MortMax=1;
ReproMax=10;
RespMax=1;

% Age-Specific Energetic and Biomass Terms (From BioData file)

Weight=WeightMax*BioData(:,2);
Cons=ConsMax*BioData(:,14);
Mort=MortMax*BioData(:,4);
Repro=ReproMax*BioData(:,5);
Resp=RespMax*BioData(:,6);

%  Initialize Population-Level Statistics

PopRepro=zeros(1,TDays);
PopResp=zeros(1,TDays);
PopGrowth=zeros(1,TDays);
PopMort=zeros(1,TDays);
NetGrowthI=zeros(1,TDays); %individiual net growth C-(Res+Repr)(a,t)
MortB=zeros(1,TDays); % biomass lost to mortality
NetGrowthP=zeros(1,TDays); %population net growth Sum(a,t)
TotalBiomass=zeros(1,TDays);
TotalBiomass(1)=InitialBiomass;

for t=2:TDays-1
   for a=2:Age
      B(a,t)=B(a-1,t-1);
      NetGrowthI(a,t)=(Cons(a)-(Repro(a)+Resp(a))*B(a,t));
      MortB(a,t)=B(a,t)*Mort(a);
      PopRepro(t)=PopRepro(t)+Repro(a)*B(a,t);
      PopResp(t)=PopResp(t)+Resp(a)*B(a,t);
      PopGrowth(t)=PopGrowth(t)+(NetGrowthI(a,t));
      PopMort(t)=PopMort(t)+MortB(a,t);
      B(a,t)=B(a,t)+(NetGrowthI(a,t)-MortB(a,t));
      TotalBiomass(t)=TotalBiomass(t)+B(a,t);
   end
   NetGrowthP(t)=TotalBiomass(t)-TotalBiomass(t-1); % check for PopGrowthP and for plot

  B(1,t+1)=PopRepro(t);
```

```
  %tscreen=t/TDays
end

% transpose matrices routines for population statistics
for t=1:TDays
    PopTrans(t,1)=PopRepro(1,t);
    PopTrans(t,2)=PopResp(1,t);
    PopTrans(t,3)=PopGrowth(1,t);
    PopTrans(t,4)=PopMort(1,t);
    PopTrans(t,5)=TotalBiomass(t);
    PopTrans(t,6)=NetGrowthP(t);
end

% summing year class parameters
Larvae=zeros(TDays,6);
Juvenile=zeros(TDays,6);
TwoYearOld=zeros(TDays,6);
ThreeYearOld=zeros(TDays,6);
FourYearOld=zeros(TDays,6);
for t=1:TDays-1
    for a=1:28
        Larvae(t,1)=Larvae(t,1)+Repro(a)*B(a,t);
        Larvae(t,2)=Larvae(t,2)+Resp(a)*B(a,t);
        Larvae(t,3)=Larvae(t,3)+NetGrowthI(a,t);
        Larvae(t,4)=Larvae(t,4)+MortB(a,t);
        Larvae(t,5)=Larvae(t,5)+B(a,t);
        Larvae(t,6)=(Larvae(t,5)/BioData(a,2));
    end
    for a=29:365
        Juvenile(t,1)=Juvenile(t,1)+Repro(a)*B(a,t);
        Juvenile(t,2)=Juvenile(t,2)+Resp(a)*B(a,t);
        Juvenile(t,3)=Juvenile(t,3)+NetGrowthI(a,t);
        Juvenile(t,4)=Juvenile(t,4)+MortB(a,t);
        Juvenile(t,5)=Juvenile(t,5)+B(a,t);
        Juvenile(t,6)=(Juvenile(t,5)/BioData(a,2));
    end
    for a=366:730
        TwoYearOld(t,1)=TwoYearOld(t,1)+Repro(a)*B(a,t);
        TwoYearOld(t,2)=TwoYearOld(t,2)+Resp(a)*B(a,t);
        TwoYearOld(t,3)=TwoYearOld(t,3)+NetGrowthI(a,t);
        TwoYearOld(t,4)=TwoYearOld(t,4)+MortB(a,t);
        TwoYearOld(t,5)=TwoYearOld(t,5)+B(a,t);
        TwoYearOld(t,6)=(TwoYearOld(t,5)/BioData(a,2));
    end
     for a=731:1095
        ThreeYearOld(t,1)=ThreeYearOld(t,1)+Repro(a)*B(a,t);
        ThreeYearOld(t,2)=ThreeYearOld(t,2)+Resp(a)*B(a,t);
        ThreeYearOld(t,3)=ThreeYearOld(t,3)+NetGrowthI(a,t);
        ThreeYearOld(t,4)=ThreeYearOld(t,4)+MortB(a,t);
        ThreeYearOld(t,5)=ThreeYearOld(t,5)+B(a,t);
        ThreeYearOld(t,6)=(ThreeYearOld(t,5)/BioData(a,2));
      end
       for a=1096:1460
        FourYearOld(t,1)=FourYearOld(t,1)+Repro(a)*B(a,t);
        FourYearOld(t,2)=FourYearOld(t,2)+Resp(a)*B(a,t);
        FourYearOld(t,3)=FourYearOld(t,3)+NetGrowthI(a,t);
        FourYearOld(t,4)=FourYearOld(t,4)+MortB(a,t);
        FourYearOld(t,5)=FourYearOld(t,5)+B(a,t);
        FourYearOld(t,6)=(FourYearOld(t,5)/BioData(a,2));
      end
end
```

Table 6.2a: Life table parameters derived for the *Fundulus heteroclitus* Leslie matrix population projection model. The values are based on yearly age classes (i). l(x) = the survivorship schedule for each age class. b(x) = the birth rates for each individual within an age class. P_i = the probability of surviving age $class_{i-1}$ and moving into the next age $class_i$. F_i = rate of fecundity of age class (i), or birth rate * survival probability.

Age Class (i)	l(x)	b(x)	Pi = L(i)/l(i-1)	Fi = b(i)Pi
0	1	0		
1	0.005	150	0.005	0.75
2	0.0023	250	0.46	115
3	0.001058	200	0.46	92
4	0	0	0	0

Table 6.2b: Leslie Matrix Model Structure.

	F1	F2	F3	F4
A =	P1	0	0	0
	0	P3	0	0
	0	0	P3	0

Table 4.2c: Leslie Matrix Model for *Fundulus heteroclitus* with a yearly time step defining age classes.

	0.75	115	92	0
A =	0.005	0	0	0
	0	0.46	0	0
	0	0	0.46	0

Table 6.3: Wisconsin Bioenergetics Model Processes and Equations

Process	Equations	Parameters	Values for Fundulus - Adult	References
Consumption (C)	a. $C = C_{max} \cdot p \cdot f(T)$ b. $C_{max} = CA \cdot W^{CB}$ f(T) – Equation 2 (Kitchell et al., 1977) useful for warm water species and known lab optimum T. c. $f(T) = V^X \cdot e^{(X \cdot (1-V))}$ d. $V = (CTM – T)/(CTM – CTO)$ e. $X = (Z^2 \cdot (1 + ((1 + 40/4)^{0.5})^2)/400)$ f. $Z = LN(CQ) \cdot (CTM – CTO)$ g. $Y = LN(CQ) \cdot (CTM – CTO + 2)$	C = specific consumption rate (g/g day) C_{max} = maximum specific feeding rate (g/g day) P = proportion of max consumption f(T) = temperature dependence function T = water temperature °C W = fish mass (g) CA = intercept of allometric mass function for 1 gram fish at optimum T CB = slope of allometric mass function CTO = lab optimum water temperature CTM = max water temperature above which consumption ceases CQ = approximates Q_{10}	C = C_{max} = 0.10*W P = 0.5 (prey/pred ratio) f(T) = T = 20 CA = 0.20 CB = -0.25 CTO = 25 °C CTM = 34 °C CQ = 2.22	1 1 Chapter 5 Chapter 5 2 2 2 2 2
Respiration (R)	a. $R = RA \cdot W^{RB} \cdot f(T) \cdot Activity + SDA$ b. $S = SDA \cdot (AE)$ f(T) – Respiration Equation 2 (Kitchell et al., 1977) c. $f(T) = V^X \cdot e^{(X \cdot (1-V))}$ d. $V = (RTM – T)/(RTM – RTO)$ e. $X = (Z^2 \cdot (1 + ((1 + 40/4)^{0.5})^2)/400)$ f. $Z = LN(RQ) \cdot (RTM – RTO)$ g. $Y = LN(RQ) \cdot (RTM – RTO + 2)$	R = specific rate of respiration (g/g day) RA = intercept of the allometric mass function (g/g day) RB = slope of the allometric mass function (g/g day) ACT = activity multiplier S = proportion of assimilation energy lost to SDA (typical values 0.15 – 0.2) SDA, C, F are all specific rates AE = (C – F) is the assimilation efficiency RA = # of grams O_2 (g/g d) consumed by 1 gram of fish at RTO RTO = lab optimum water temperature RTM = max water temperature above which consumption ceases RQ = approximates Q_{10}	RA = 0.008 RB = -0.14 RQ = 2.0 RTO = 29 °C RTM = 34 °C S = 0.1 ACT = 1.0 AE = 0.8	Chapter 5 Chapter 5 2 2 2 2 2 2

1. Hanson et al., 1997.
2. Madon et al., 2001.

Table A-1: Experiment 1 - Fish Growth Parameters

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Eggs	MS222	PCB	GSI	CF
0	1		A	1.90	43.0	M					0.024
0	2		B	1.70	43.0	M					0.021
0	3		C	1.43	41.0	F					0.021
0	4		D	1.12	39.0	M					0.019
0	5		E	1.57	42.0	M					0.021
0	6		F	1.34	41.0	M					0.019
0	7		G	1.52	42.0	M					0.021
0	8		H	1.87	46.0	F					0.019
0	9		I	2.31	49.5	M					0.019
0	10		J	2.10	44.0	M					0.025
0	11		K	1.42	40.0	M					0.022
0	12		L	1.57	44.5	M					0.018
0	13		M	1.54	42.0	M					0.021
0	14		N	1.60	39.5	M					0.026
0	15		O	2.28	49.5	M					0.019
7	F07-01A	1	A	1.20	36.0	F		2	0		0.026
7	F07-01B	1	B	2.82	48.0	FG		2	0		0.025
7	F07-01C	1	C	1.77	47.0	M		2	0		0.017
7	F07-02A	2	A	2.40	47.0	M		4	0		0.023
7	F07-02B	2	B	0.93	34.0	M		4	0		0.024
7	F07-02C	2	C	1.67	43.0	F		4	0		0.021
7	F07-03A	3	A	1.89	47.0	M		3	0		0.018
7	F07-03B	3	B	1.86	45.0	F		3	0		0.020
7	F07-03C	3	C	1.58	40.5	FG		3	0		0.024
7	F07-04A	4	A	1.55	41.0	M		1	0		0.022
7	F07-04B	4	B	1.25	40.0	F		1	0		0.020
7	F07-04C	4	C	1.92	46.0	FG		1	0		0.020
7	F07-05A	5	A	1.94	43.5	FG		1	1		0.024
7	F07-05B	5	B	2.47	48.0	FG		1	1		0.022
7	F07-05C	5	C	1.30	41.0	M		1	1		0.019
7	F07-06A	6	A	2.11	45.0	M		4	0		0.023
7	F07-06B	6	B	2.37	51.0	M		4	0		0.018
7	F07-06C	6	C	1.72	44.5	M		4	0		0.020
7	F07-07A	7	A	2.48	45.0	FG		2	0		0.027
7	F07-07B	7	B	1.53	40.0	M		2	0		0.024

* Fish Died

Table A-1: Experiment 1 - Fish Growth Parameters

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Eggs	MS222	PCB	GSI	CF
7	F07-07C	7	C	1.47	41.0	F		2	0		0.021
7	F07-08A	8	A	4.41	51.0	M		3	1		0.033
7	F07-08B	8	B	2.58	47.0	M		3	1		0.025
7	F07-08C	8	C	1.47	41.0	FG		3	1		0.021
7	F07-09A	9	A	1.60	40.0	M		4	1		0.025
7	F07-09B	9	B	1.32	40.0	FG		4	1		0.021
7	F07-09C	9	C	1.95	48.0	M		4	1		0.018
7	F07-10A	10	A	1.91	44.0	FG		2	1		0.022
7	F07-10B	10	B	2.14	48.0	M		2	1		0.019
7	F07-10C	10	C	1.23	38.0	M		2	1		0.022
7	F07-11A	11	A	2.92	49.0	FG		3	0		0.025
7	F07-11B	11	B	1.59	42.5	F		3	0		0.021
7	F07-11C	11	C	1.10	39.0	M		3	0		0.019
7	F07-12A	12	A	1.34	39.0	M		3	1		0.023
7	F07-12B	12	B	0.87	35.5	M		3	1		0.019
7	F07-12C	12	C	2.73	49.0	FG		3	1		0.023
7	F07-13A	13	A	2.44	48.0	F		3	0		0.022
7	F07-13B	13	B	2.50	46.0	FG		3	0		0.026
7	F07-13C	13	C	1.43	41.0	M		3	0		0.021
7	F07-14A	14	A	2.14	48.0	M		4	1		0.019
7	F07-14B	14	B	1.35	43.0	M		4	1		0.017
7	F07-14C	14	C	1.35	39.0	F		4	1		0.023
7	F07-15A	15	A	1.86	44.0	FG		1	0		0.022
7	F07-15B	15	B	1.16	38.5	M		1	0		0.020
7	F07-15C	15	C	1.98	44.0	F		1	0		0.023
7	F07-16A	16	A	2.46	48.5	M		4	0		0.022
7	F07-16B	16	B	0.86	34.0	M		4	0		0.022
7	F07-16C	16	C	1.38	41.0	M		4	0		0.020
7	F07-17A	17	A	1.42	43.5	M		4	1		0.017
7	F07-17B	17	B	1.86	45.5	F		4	1		0.020
7	F07-17C	17	C	1.72	42.0	M		4	1		0.023
7	F07-18A	18	A	2.51	47.0	M		2	1		0.024
7	F07-18B	18	B	1.35	43.0	M		2	1		0.017
7	F07-18C	18	C	2.26	46.5	F		2	1		0.022
7	F07-19A	19	A	2.52	46.0	FG		3	1		0.026

* Fish Died

Table A-1: Experiment 1 - Fish Growth Parameters

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Eggs	MS222	PCB	GSI	CF
7	F07-19B	19	B	1.39	39.0	M		3	1		0.023
7	F07-19C	19	C	1.75	41.0	FG		3	1		0.025
7	F07-20A	20	A	1.94	43.0	M		2	0		0.024
7	F07-20B	20	B	1.49	42.0	F		2	0		0.020
7	F07-20C	20	C	1.02	37.0	M		2	0		0.020
7	F07-21A	21	A	1.71	43.0	M		1	1		0.022
7	F07-21B	21	B	2.42	48.0	F		1	1		0.022
7	F07-21C	21	C	2.07	46.0			1	1		0.021
7	F07-22A	22	A	1.76	43.0	F		2	1		0.022
7	F07-22B	22	B	1.51	40.0	M		2	1		0.024
7	F07-22C	22	C	1.29	39.0	FG		2	1		0.022
7	F07-23A	23	A	1.51	42.0	M		1	1		0.020
7	F07-23B	23	B	1.15	40.5	M		1	1		0.017
7	F07-23C	23	C	1.57	40.0	F		1	1		0.025
7	F07-24A	24	A	1.32	39.0	F		1	0		0.022
7	F07-24B	24	B	1.61	41.5	FG		1	0		0.023
7	F07-24C	24	C	1.47	42.0	FG		1	0		0.020
14	F14-01A	1	A	2.39	50.0	F		2	0		0.019
14	F14-01B	1	B	1.71	40.0	F		2	0		0.027
14	F14-01C	1	C	2.00	45.0	M		2	0		0.022
14	F14-02A	2	A	1.22	40.0	MM		4	0		0.019
14	F14-02B	2	B	1.61	41.0	M		4	0		0.023
14	F14-02C	2	C	2.40	48.0	F		4	0		0.022
14	F14-03A	3	A	2.27	49.0	F		3	0		0.019
14	F14-03B	3	B	2.13	44.5	M		3	0		0.024
14	F14-03C	3	C	1.33	41.0	F		3	0		0.019
14	F14-04A	4	A	2.70	46.0	F		1	0		0.028
14	F14-04B	4	B	2.41	44.5	M		1	0		0.027
14	F14-04C	4	C	1.71	41.5	M		1	0		0.024
14	F14-05A	5	A	1.31	39.0	M		1	1		0.022
14	F14-05B	5	B	1.66	44.5	*		1	1		0.019
14	F14-05C	5	C	2.39	48.0	F		1	1		0.022
14	F14-06A	6	A	2.44	48.0	M		4	0		0.022
14	F14-06B	6	B	1.67	44.3	F		4	0		0.019
14	F14-06C	6	C	1.11	40.0	F		4	0		0.017

* Fish Died

Table A-1: Experiment 1 - Fish Growth Parameters

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Eggs	MS222	PCB	GSI	CF
14	F14-07A	7	A	1.49	40.0	F		2	0		0.023
14	F14-07B	7	B	2.34	48.0	M		2	0		0.021
14	F14-07C	7	C	1.47	41.0	M		2	0		0.021
14	F14-08A	8	A	1.51	39.0	F		3	1		0.025
14	F14-08B	8	B	2.03	45.0	F		3	1		0.022
14	F14-08C	8	C	2.01	44.0	F		3	1		0.024
14	F14-09A	9	A	1.70	42.0	F		4	1		0.023
14	F14-09B	9	B	1.55	41.0	M		4	1		0.022
14	F14-09C	9	C	2.14	46.0	F		4	1		0.022
14	F14-10A	10	A	1.86	42.0	F		2	1		0.025
14	F14-10B	10	B	1.87	45.0	F		2	1		0.021
14	F14-10C	10	C	2.46	46.0	F		2	1		0.025
14	F14-11A	11	A	1.06	37.0	M		3	0		0.021
14	F14-11B	11	B	1.76	45.0	M		3	0		0.019
14	F14-11C	11	C	2.56	46.0	M		3	0		0.026
14	F14-12A	12	A	1.02	35.0	F		3	1		0.024
14	F14-12B	12	B	1.27	38.0	F		3	1		0.023
14	F14-12C	12	C	2.62	50.5	M		3	1		0.020
14	F14-13A	13	A	3.13	48.0	F		3	0		0.028
14	F14-13B	13	B	3.55	53.5	M		3	0		0.023
14	F14-13C	13	C	2.74	53.0	F		3	0		0.018
14	F14-14A	14	A	1.41	38.0	F		4	1		0.026
14	F14-14B	14	B	1.68	42.5	F		4	1		0.022
14	F14-14C	14	C	1.31	41.5	M		4	1		0.018
14	F14-15A	15	A	1.41	39.0	M		1	0		0.024
14	F14-15B	15	B	2.55	48.5	F		1	0		0.022
14	F14-15C	15	C	2.31	56.5	F		1	0		0.013
14	F14-16A	16	A	1.31	40.0	F		4	0		0.020
14	F14-16B	16	B	1.52	41.5	F		4	0		0.021
14	F14-16C	16	C	1.27	40.0	M		4	0		0.020
14	F14-17A	17	A	1.62	45.0	F		4	1		0.018
14	F14-17B	17	B	0.75	33.0	M		4	1		0.021
14	F14-17C	17	C	2.19	48.0	M		4	1		0.020
14	F14-18A	18	A	1.10	37.0	F		2	1		0.022
14	F14-18B	18	B	1.95	44.0	F		2	1		0.023

* Fish Died

Table A-1: Experiment 1 - Fish Growth Parameters

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Eggs	MS222	PCB	GSI	CF
14	F14-18C	18	C	1.51	41.0	M		2	1		0.022
14	F14-19A	19	A	1.96	45.5	F		3	1		0.021
14	F14-19B	19	B	1.65	41.5	M		3	1		0.023
14	F14-19C	19	C	1.22	39.0	M		3	1		0.021
14	F14-20A	20	A	2.40	52.5	M		2	0		0.017
14	F14-20B	20	B	2.03	47.5	M		2	0		0.019
14	F14-20C	20	C	2.25	46.5	M		2	0		0.022
14	F14-21A	21	A	1.90	45.0	M		1	1		0.021
14	F14-21B	21	B	1.76	41.0	F		1	1		0.026
14	F14-21C	21	C	2.20	46.5	F		1	1		0.022
14	F14-22A	22	A	2.02	44.0	M		2	1		0.024
14	F14-22B	22	B	2.60	48.0	M		2	1		0.024
14	F14-22C	22	C	1.34	39.0	M		2	1		0.023
14	F14-23A	23	A	2.06	44.5	M		1	1		0.023
14	F14-23B	23	B	1.17	33.5	M		1	1		0.031
14	F14-23C	23	C	1.87	45.5	M		1	1		0.020
14	F14-24A	24	A	1.40	41.0	F		1	0		0.020
14	F14-24B	24	B	1.42	41.0	F		1	0		0.021
14	F14-24C	24	C	1.76	43.5	F		1	0		0.021
28	F28-01A	1	A	2.32	47.0	F		2	0		0.022
28	F28-01B	9	A	2.14	46.5	M		4	1		0.021
28	F28-01C	17	A	2.31	46.0	F	0.564	4	1	24.429	0.024
28	F28-02A	1	B	1.49	41.0	M		2	0		0.022
28	F28-02B	9	B	2.10	43.0	F	0.372	4	1	17.705	0.026
28	F28-02C	17	B	1.99	45.5	F	0.257	4	1	12.899	0.021
28	F28-03A	1	C	1.55	42.0	M		2	0		0.021
28	F28-03B	9	C	1.51	41.5	M		4	1		0.021
28	F28-03C	17	C	1.63	42.5	M		4	1		0.021
28	F28-04A	2	A	1.82	43.5	M		4	0		0.022
28	F28-04B	10	A	1.97	45.0	F	0.166	2	1	8.437	0.022
28	F28-04C	18	A	1.37	41.0	M		2	1		0.020
28	F28-05A	2	B	2.87	49.0	M		4	0		0.024
28	F28-05B	10	B	2.35	50.5	F	0.377	2	1	16.030	0.018
28	F28-05C	18	B	1.83	44.0	M		2	1		0.021
28	F28-06A	2	C	2.21	47.5	F	0.178	4	0	8.050	0.021

* Fish Died

Table A-1: Experiment 1 - Fish Growth Parameters

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Eggs	MS222	PCB	GSI	CF
28	F28-06B	10	C	1.68	44.5	M		2	1		0.019
28	F28-06C	18	C	1.45	40.5	F	0.156	2	1	10.786	0.022
28	F28-07A	3	A	1.79	42.5	F	0.273	3	0	15.257	0.023
28	F28-07B	11	A	1.52	42.0	F	0.146	3	0	9.612	0.021
28	F28-07C	19	A	2.51	46.5	M		3	1		0.025
28	F28-08A	3	B	1.69	41.0	M		3	0		0.025
28	F28-08B	11	B	2.25	47.0	M		3	0		0.022
28	F28-08C	19	B	1.83	43.0	M		3	1		0.023
28	F28-09A	3	C	1.87	49.5	F	0.131	3	0	6.979	0.015
28	F28-09B	11	C	2.27	46.0	M		3	0		0.023
28	F28-09C	19	C	2.20	47.5	F	0.217	3	1	9.882	0.021
28	F28-10A	4	A	2.66	45.5	M		1	0		0.028
28	F28-10B	12	A	2.04	48.0	M		3	1		0.018
28	F28-10C	20	A	1.09	38.0	M		2	0		0.020
28	F28-11A	4	B	2.27	45.5	M		1	0		0.024
28	F28-11B	12	B	3.17	48.0	F	0.832	3	1	26.233	0.029
28	F28-11C	20	B	1.61	43.0	M		2	0		0.020
28	F28-12A	4	C	2.12	45.5	M		1	0		0.023
28	F28-12B	12	C	1.70	43.5	F	0.124	3	1	7.300	0.021
28	F28-12C	20	C	3.21	51.5	F	0.284	2	0	8.844	0.024
28	F28-13A	5	A	2.02	46.0	M		1	1		0.021
28	F28-13B	13	A	2.36	48.0	M		3	0		0.021
28	F28-13C	21	A	1.23	43.0	M		1	1		0.015
28	F28-14A	5	B	3.36	51.5	F	0.474	1	1	14.119	0.025
28	F28-14B	13	B	1.46	41.5	F	0.118	3	0	8.103	0.020
28	F28-14C	21	B	1.62	41.5	F	0.246	1	1	15.185	0.023
28	F28-15A	5	C	2.82	49.5	M		1	1		0.023
28	F28-15B	13	C	1.95	44.5	M		3	0		0.022
28	F28-15C	21	C	3.67	54.5	F	0.235	1	1	6.403	0.023
28	F28-16A	6	A	1.12	38.0	M		4	0		0.020
28	F28-16B	14	A	1.85	42.0	M		4	1		0.025
28	F28-16C	22	A	3.05	51.5	F	0.413	2	1	13.548	0.022
28	F28-17A	6	B	1.73	42.5	M		4	0		0.023
28	F28-17B	14	B	1.90	44.0	F	0.134	4	1	7.053	0.022
28	F28-17C	22	B	1.89	44.0	F	0.204	2	1	10.794	0.022

* Fish Died

Table A-1: Experiment 1 - Fish Growth Parameters

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Eggs	MS222	PCB	GSI	CF
28	F28-18A	6	C	2.20	49.0	M		4	0		0.019
28	F28-18B	14	C	1.36	39.0	M		4	1		0.023
28	F28-18C	22	C	2.62	47.5	M		2	1		0.024
28	F28-19A	7	A	2.61	48.5	M		2	0		0.023
28	F28-19B	15	A	2.85	51.0	M		1	0		0.021
28	F28-19C	23	A	2.31	47.0	M		1	1		0.022
28	F28-20A	7	B	2.30	47.0	M		2	0		0.022
28	F28-20B	15	B	2.20	43.0	F	0.256	1	0	11.618	0.028
28	F28-20C	23	B	1.90	45.0	M		1	1		0.021
28	F28-21A	7	C	2.77	54.5	M		2	0		0.017
28	F28-21B	15	C	1.31	38.5	F	0.171	1	0	13.015	0.023
28	F28-21C	23	C	1.42	40.0	M		1	1		0.022
28	F28-22A	8	A	1.63	43.5	M		3	1		0.020
28	F28-22B	16	A	1.37	39.0	F	0.193	4	0	14.095	0.023
28	F28-22C	24	A	2.22	38.0	F	0.109	1	0	4.910	0.040
28	F28-23A	8	B	2.25	48.0	M		3	1		0.020
28	F28-23B	16	B	2.28	48.5	M		4	0		0.020
28	F28-23C	24	B	2.55	49.5	M		1	0		0.021
28	F28-24A	8	C	2.46	48.5	M		3	1		0.022
28	F28-24B	16	C	2.93	49.5	F	0.406	4	0	13.857	0.024
28	F28-24C	24	C	2.47	45.5	F	0.281	1	0	11.368	0.026
42	F42-01A	1	A	2.53	47.0	F	0.312	2	0	12.348	0.024
42	F42-01B	1	B	1.50	41.0	M		2	0		0.022
42	F42-01C	1	C	2.07	45.0	M	0.138	2	0	6.671	0.023
42	F42-02A	2	A	1.97	40.0	M		4	0		0.031
42	F42-02B	2	B	1.37	37.0	M		4	0		0.027
42	F42-02C	2	C	1.59	41.5	F		4	0		0.022
42	F42-03A	3	A	2.57	48.0	F	0.115	3	0	4.482	0.023
42	F42-03B	3	B	3.09	48.0	F	0.391	3	0	12.667	0.028
42	F42-03C	3	C	1.77	43.5	M	0.344	3	0	19.435	0.022
42	F42-04A	4	A	2.12	42.0	F	0.456	1	0	21.505	0.029
42	F42-04B	4	B	2.85	50.0	M		1	0		0.023
42	F42-04C	4	C	2.12	42.5	F	0.161	1	0	7.575	0.028
42	F42-05A	5	A	2.12	45.0	M		1	1		0.023
42	F42-05B	5	B	1.58	41.0	M		1	1		0.023

* Fish Died

Table A-1: Experiment 1 - Fish Growth Parameters

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Eggs	MS222	PCB	GSI	CF
42	F42-05C	5	C	2.09	44.5	F	0.411	1	1	19.679	0.024
42	F42-06A	6	A	2.03	44.0	F	0.119	4	0	5.882	0.024
42	F42-06B	6	B	2.76	51.0	M		4	0		0.021
42	F42-06C	6	C	1.68	42.5	F	0.294	4	0	17.470	0.022
42	F42-07A	7	A	1.53	42.0	M		2	0		0.021
42	F42-07B	7	B	2.93	48.0	F	0.149	2	0	5.072	0.026
42	F42-07C	7	C	1.91	44.0	F		2	0		0.022
42	F42-08A	8	A	2.28	45.0	F	0.186	3	1	8.171	0.025
42	F42-08B	8	B	2.23	46.0	M		3	1		0.023
42	F42-08C	8	C	2.70	49.0	F	0.139	3	1	5.152	0.023
42	F42-09A	9	A	3.05	51.0	M		4	1		0.023
42	F42-09B	9	B	2.10	45.0	M		4	1		0.023
42	F42-09C	9	C	2.75	50.0	F	0.233	4	1	8.465	0.022
42	F42-10A	10	A	3.11	60.0	M		2	1		0.014
42	F42-10B	10	B	2.99	51.0	F	0.146	2	1	4.890	0.023
42	F42-10C	10	C	2.46	49.5	F		2	1		0.020
42	F42-11A	11	A	2.86	50.0	F	0.212	3	0	7.427	0.023
42	F42-11B	11	B	1.46	45.0	M		3	0		0.016
42	F42-11C	11	C	2.08	45.0	F	0.018	3	0	0.865	0.023
42	F42-12A	12	A	2.05	45.0	M		3	1		0.022
42	F42-12B	12	B	1.93	47.0	F		3	1		0.019
42	F42-12C	12	C	1.93	45.0	F		3	1		0.021
42	F42-13A	13	A	0.87	38.0	M		3	0		0.016
42	F42-13B	13	B	2.14	44.5	F	0.370	3	0	17.280	0.024
42	F42-13C	13	C	1.33	42.5	F	0.210	3	0	15.805	0.017
42	F42-14A	14	A	2.01	41.0	F	0.307	4	1	15.256	0.029
42	F42-14B	14	B	1.98	43.5	F	0.069	4	1	3.485	0.024
42	F42-14C	14	C	2.20	45.5	F		4	1		0.023
42	F42-15A	15	A	2.02	45.0	M		1	0		0.022
42	F42-15B	15	B	1.27	37.5	F	0.110	1	0	8.661	0.024
42	F42-15C	15	C	1.93	43.5	M		1	0		0.023
42	F42-16A	16	A	2.18	45.0	F		4	0		0.024
42	F42-16B	16	B	1.20	37.5	F		4	0		0.023
42	F42-16C	16	C	1.24	40.0	F	0.505	4	0	40.750	0.019
42	F42-17A	17	A	2.18	48.0	M		4	1		0.020

* Fish Died

Table A-1: Experiment 1 - Fish Growth Parameters

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Eggs	MS222	PCB	GSI	CF
42	F42-17B	17	B	1.96	42.5	F	0.429	4	1	21.888	0.026
42	F42-17C	17	C	2.44	47.0	F	0.050	4	1	2.053	0.024
42	F42-18A	18	A	1.66	40.0	M		2	1		0.026
42	F42-18B	18	B	2.63	49.5	F	0.256	2	1	9.734	0.022
42	F42-18C	18	C	1.33	39.0	F	0.386	2	1	29.015	0.022
42	F42-19A	19	A	2.00	45.0	M		3	1		0.022
42	F42-19B	19	B	2.62	49.5	F	0.236	3	1	9.004	0.022
42	F42-19C	19	C	3.12	51.0	F	0.242	3	1	7.769	0.024
42	F42-20A	20	A	2.94	50.0	F	0.323	2	0	10.986	0.024
42	F42-20B	20	B	2.78	49.5	F	0.494	2	0	17.763	0.023
42	F42-20C	20	C	2.32	46.5	F	0.137	2	0	5.897	0.023
42	F42-21A	21	A	2.66	50.0	M		1	1		0.021
42	F42-21B	21	B	2.26	46.5	M		1	1		0.022
42	F42-21C	21	C	1.98	45.0	F		1	1		0.022
42	F42-22A	22	A	2.17	46.0	F		2	1		0.022
42	F42-22B	22	B	2.56	50.0	M		2	1		0.020
42	F42-22C	22	C	2.25	47.0	M		2	1		0.022
42	F42-23A	23	A	1.59	41.0	M		1	1		0.023
42	F42-23B	23	B	3.79	56.0	F	0.665	1	1	17.546	0.022
42	F42-23C	23	C	2.44	47.0	M		1	1		0.024
42	F42-24A	24	A	2.10	45.0	F	0.208	1	0	9.905	0.023
42	F42-24B	24	B	2.01	47.0	M		1	0		0.019
42	F42-24C	24	C	1.64	42.5	M		1	0		0.021
56	F56-01A	1	A	1.42	40.0	M		2	0		0.022
56	F56-01B	1	B	2.77	51.0	M		2	0		0.021
56	F56-01C	1	C	1.85	43.5	M		2	0		0.022
56	F56-02A	2	A	1.17	38.0	F		4	0		0.021
56	F56-02B	2	B	1.77	44.5	F	0.120	4	0	6.780	0.020
56	F56-02C	2	C	1.63	42.5	M		4	0		0.021
56	F56-03A	3	A	1.77	44.0	M		3	0		0.021
56	F56-03B	3	B	1.82	44.0	F	0.126	3	0	6.901	0.021
56	F56-03C	3	C	3.04	51.5	M		3	0		0.022
56	F56-04A	4	A	1.74	42.5	M		1	0		0.023
56	F56-04B	4	B	1.49	41.5	M		1	0		0.021
56	F56-04C	4	C	1.99	44.5	F	0.269	1	0	13.518	0.023

* Fish Died

Table A-1: Experiment 1 - Fish Growth Parameters

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Eggs	MS222	PCB	GSI	CF
56	F56-05A	5	A	2.08	46.5	M		1	1		0.021
56	F56-05B	5	B	2.73	47.0	M		1	1		0.026
56	F56-05C	5	C	2.52	48.5	M		1	1		0.022
56	F56-06A	6	A	1.76	42.5	F	0.117	4	0	6.648	0.023
56	F56-06B	6	B	2.53	49.0	M		4	0		0.022
56	F56-06C	6	C	1.86	46.5	F	0.102	4	0	5.457	0.018
56	F56-07A	7	A	3.03	50.0	F	0.273	2	0	9.020	0.024
56	F56-07B	7	B	1.52	41.0	F	0.149	2	0	9.796	0.022
56	F56-07C	7	C	1.95	44.5	M		2	0		0.022
56	F56-08A	8	A	2.40	46.0	M		3	1		0.025
56	F56-08B	8	B	5.30	54.0	M		3	1		0.034
56	F56-08C	8	C	1.87	43.5	M		3	1		0.023
56	F56-09A	9	A	2.44	47.5	M		4	1		0.023
56	F56-09B	9	B	2.31	48.0	M		4	1		0.021
56	F56-09C	9	C	1.44	41.5	M		4	1		0.020
56	F56-10A	10	A	1.75	45.0	M		2	1		0.019
56	F56-10B	10	B	1.63	43.0	M		2	1		0.021
56	F56-10C	10	C	1.53	40.0	F	0.129	2	1	8.444	0.024
56	F56-11A	11	A	1.52	40.0	F	0.166	3	0	10.928	0.024
56	F56-11B	11	B	1.63	42.0	M		3	0		0.022
56	F56-11C	11	C	1.17	38.5	M		3	0		0.021
56	F56-12A	12	A	1.37	40.0	M		3	1		0.021
56	F56-12B	12	B	3.81	53.5	M		3	1		0.025
56	F56-12C	12	C	3.39	52.5	M		3	1		0.023
56	F56-13A	13	A	1.38	42.5	F		3	0		0.018
56	F56-13B	13	B	2.32	47.0	M		3	0		0.022
56	F56-13C	13	C	1.95	44.5	F	0.214	3	0	10.964	0.022
56	F56-14A	14	A	1.85	44.0	M		4	1		0.022
56	F56-14B	14	B	2.53	48.0	F	0.275	4	1	10.850	0.023
56	F56-14C	14	C	2.33	47.0	M		4	1		0.022
56	F56-15A	15	A	3.19	55.0	M		1	0		0.019
56	F56-15B	15	B	2.88	48.5	F	0.251	1	0	8.712	0.025
56	F56-15C	15	C	2.21	46.0	M		1	0		0.023
56	F56-16A	16	A	2.91	51.0	M		4	0		0.022
56	F56-16B	16	B	2.13	46.5	M		4	0		0.021

* Fish Died

Table A-1: Experiment 1 - Fish Growth Parameters

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Eggs	MS222	PCB	GSI	CF
56	F56-16C	16	C	1.85	44.5	F	0.227	4	0	12.270	0.021
56	F56-17A	17	A	1.36	40.5	F		4	1		0.020
56	F56-17B	17	B	2.35	49.5	M		4	1		0.019
56	F56-17C	17	C	2.03	45.0	M		4	1		0.022
56	F56-18A	18	A	1.73	43.0	M		2	1		0.022
56	F56-18B	18	B	1.42	40.5	M		2	1		0.021
56	F56-18C	18	C	0.91	34.5	M		2	1		0.022
56	F56-19A	19	A	1.50	41.0	M		3	1		0.022
56	F56-19B	19	B	2.82	49.5	F	0.143	3	1	5.057	0.023
56	F56-19C	19	C	1.85	41.5	F	0.144	3	1	7.757	0.026
56	F56-20A	20	A	4.16	55.0	M		2	0		0.025
56	F56-20B	20	B	2.27	43.0	F	0.519	2	0	22.863	0.029
56	F56-20C	20	C	1.61	41.5	M		2	0		0.023
56	F56-21A	21	A	2.71	49.0	F	0.087	1	1	3.199	0.023
56	F56-21B	21	B	2.68	48.0	M		1	1		0.024
56	F56-21C	21	C	2.35	46.5	M		1	1		0.023
56	F56-22A	22	A	1.65	42.0	F		2	1		0.022
56	F56-22B	22	B	3.09	51.5	M		2	1		0.023
56	F56-22C	22	C	2.50	49.0	M		2	1		0.021
56	F56-23A	23	A	2.85	50.5	M		1	1		0.022
56	F56-23B	23	B	2.43	49.5	M		1	1		0.020
56	F56-23C	23	C	1.15	37.5	M		1	1		0.022
56	F56-24A	24	A	3.22	51.5	M		1	0		0.024
56	F56-24B	24	B	3.19	50.0	M		1	0		0.026
56	F56-24C	24	C	3.29	51.5	M		1	0		0.024
80	F80-01A	1	A	2.65	47.0	M		2	0		0.026
80	F80-01B	1	B	1.49	41.0	M		2	0		0.022
80	F80-01C	1	C	2.33	46.0	M		2	0		0.024
80	F80-01D	1	D	2.92	50.0	M		2	0		0.023
80	F80-01E	1	E	2.24	49.0	M		2	0		0.019
80	F80-01F	1	F	1.84	46.0	F		2	0		0.019
80	F80-02A	2	A	1.94	47.0	M		4	0		0.019
80	F80-02B	2	B	1.87	48.0	M		4	0		0.017
80	F80-02C	2	C	1.31	40.0	M		4	0		0.020
80	F80-02D	2	D	3.62	58.0	M		4	0		0.019

* Fish Died

Table A-1: Experiment 1 - Fish Growth Parameters

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Eggs	MS222	PCB	GSI	CF
80	F80-02E	2	E	2.80	48.0	M		4	0		0.025
80	F80-02F	2	F	1.78	47.0	F		4	0		0.017
80	F80-03A	3	A	2.71	50.0	M		3	0		0.022
80	F80-03B	3	B	1.57	44.0	M		3	0		0.018
80	F80-03C	3	C	1.90	45.0	F		3	0		0.021
80	F80-03D	3	D	2.95	55.0	M		3	0		0.018
80	F80-03E	3	E	3.07	57.0	F		3	0		0.017
80	F80-03F	3	F	3.07	54.0	M		3	0		0.019
80	F80-04A	4	A	1.81	46.5	F		1	0		0.018
80	F80-04B	4	B	2.05	46.0	M		1	0		0.021
80	F80-04C	4	C	*	*	*		1	0		*
80	F80-05A	5	A	2.25	47.0	M		1	1		0.022
80	F80-05B	5	B	4.03	61.0	M		1	1		0.018
80	F80-05C	5	C	2.95	57.0	F		1	1		0.016
80	F80-05D	5	D	4.67	63.0	M		1	1		0.019
80	F80-05E	5	E	3.14	54.0	M		1	1		0.020
80	F80-06A	6	A	2.25	47.0	M		4	0		0.022
80	F80-06B	6	B	2.16	45.0	F		4	0		0.024
80	F80-06C	6	C	2.38	48.0	F		4	0		0.022
80	F80-06D	6	D	1.81	44.0	M		4	0		0.021
80	F80-07A	7	A	2.47	50.0	M		2	0		0.020
80	F80-07B	7	B	2.08	44.0	M		2	0		0.024
80	F80-07C	7	C	3.06	53.0	M		2	0		0.021
80	F80-07D	7	D	2.65	48.0	F		2	0		0.024
80	F80-07E	7	E	4.03	48.0	F	1.640	2	0	40.695	0.036
80	F80-07F	7	F	2.61	51.0	F		2	0		0.020
80	F80-08A	8	A	2.46	47.0	F		3	1		0.024
80	F80-08B	8	B	2.19	46.0	F		3	1		0.022
80	F80-08C	8	C	2.61	50.0	F		3	1		0.021
80	F80-08D	8	D	4.87	61.0	M		3	1		0.021
80	F80-08E	8	E	2.58	59.0	F		3	1		0.013
80	F80-08F	8	F	3.74	59.0	M		3	1		0.018
80	F80-08G	8	G	2.47	48.0	M		3	1		0.022
80	F80-09A	9	A	1.63	45.0	M		4	1		0.018
80	F80-09B	9	B	2.29	47.0	M		4	1		0.022

* Fish Died

Table A-1: Experiment 1 - Fish Growth Parameters

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Eggs	MS222	PCB	GSI	CF
80	F80-09C	9	C	2.89	55.0	F		4	1		0.017
80	F80-09D	9	D	3.96	59.0	M		4	1		0.019
80	F80-09E	9	E	4.70	60.0	M		4	1		0.022
80	F80-10A	10	A	1.24	36.0	M		2	1		0.027
80	F80-10B	10	B	1.60	40.0	F		2	1		0.025
80	F80-10C	10	C	1.90	45.0	F		2	1		0.021
80	F80-10D	10	D	2.99	52.0	M		2	1		0.021
80	F80-10E	10	E	3.36	56.0	M		2	1		0.019
80	F80-10F	10	F	1.98	47.0	M		2	1		0.019
80	F80-11A	11	A	2.04	45.0	M		3	0		0.022
80	F80-11B	11	B	2.34	38.0	F		3	0		0.043
80	F80-11C	11	C	1.75	42.0	F		3	0		0.024
80	F80-11D	11	D	3.55	55.0	M		3	0		0.021
80	F80-11E	11	E	2.70	52.0	F		3	0		0.019
80	F80-11F	11	F	2.30	48.0	M		3	0		0.021
80	F80-12A	12	A	3.26	52.0	M		3	1		0.023
80	F80-12B	12	B	2.62	50.0	F		3	1		0.021
80	F80-12C	12	C	2.34	47.0	M		3	1		0.023
80	F80-12D	12	D	2.39	47.0	M		3	1		0.023
80	F80-12E	12	E	2.73	53.0	M		3	1		0.018
80	F80-12F	12	F	2.41	49.0	M		3	1		0.020
80	F80-13A	13	A	1.51	44.0	F		3	0		0.018
80	F80-13B	13	B	1.66	45.0	M		3	0		0.018
80	F80-13C	13	C	1.71	47.0	F		3	0		0.016
80	F80-13D	13	D	1.87	45.0	M		3	0		0.021
80	F80-13E	13	E	2.95	52.0	M		3	0		0.021
80	F80-13F	13	F	2.27	52.0	M		3	0		0.016
80	F80-14A	14	A	2.66	49.0	F		4	1		0.023
80	F80-14B	14	B	2.37	47.0	M		4	1		0.023
80	F80-14C	14	C	1.65	42.0	M		4	1		0.022
80	F80-14D	14	D	3.37	57.0	M		4	1		0.018
80	F80-14E	14	E	3.47	55.0	M		4	1		0.021
80	F80-15A	15	A	1.93	45.0	M		1	0		0.021
80	F80-15B	15	B	1.16	40.0	F		1	0		0.018
80	F80-15C	15	C	1.55	40.0	F		1	0		0.024

* Fish Died

Table A-1: Experiment 1 - Fish Growth Parameters

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Eggs	MS222	PCB	GSI	CF
80	F80-15D	15	D	3.66	55.0	M		1	0		0.022
80	F80-16A	16	A	1.97	47.0	M		4	0		0.019
80	F80-16B	16	B	1.82	46.0	F		4	0		0.019
80	F80-16C	16	C	1.42	41.0	F		4	0		0.021
80	F80-16D	16	D	3.38	57.0	M		4	0		0.018
80	F80-16E	16	E	1.82	46.0	M		4	0		0.019
80	F80-16F	16	F	1.77	47.0	M		4	0		0.017
80	F80-16G	16	G	1.72	47.0	M		4	0		0.017
80	F80-17A	17	A	2.68	50.0	M		4	1		0.021
80	F80-17B	17	B	2.25	48.0	M		4	1		0.020
80	F80-17C	17	C	1.50	43.0	F		4	1		0.019
80	F80-17D	17	D	2.49	51.0	M		4	1		0.019
80	F80-17E	17	E	3.11	53.0	M		4	1		0.021
80	F80-17F	17	F	2.50	52.0	F	0.210	4	1	8.400	0.018
80	F80-18A	18	A	1.78	45.0	F		2	1		0.020
80	F80-18B	18	B	1.50	41.0	F		2	1		0.022
80	F80-18C	18	C	1.78	43.0	M		2	1		0.022
80	F80-18D	18	D	2.99	57.0	M		2	1		0.016
80	F80-18E	18	E	2.50	52.0	M		2	1		0.018
80	F80-19A	19	A	1.49	45.0	M		3	1		0.016
80	F80-19B	19	B	1.52	41.0	F		3	1		0.022
80	F80-19C	19	C	2.02	47.0	F		3	1		0.019
80	F80-19D	19	D	2.57	51.0	F		3	1		0.019
80	F80-19E	19	E	2.02	48.0	M		3	1		0.018
80	F80-19F	19	F	1.84	46.0	F		3	1		0.019
80	F80-20A	20	A	2.69	51.0	F		2	0		0.020
80	F80-20B	20	B	2.59	50.0	M		2	0		0.021
80	F80-20C	20	C	3.24	55.0	M		2	0		0.019
80	F80-20D	20	D	3.31	52.0	M		2	0		0.024
80	F80-20E	20	E	2.27	49.0	M		2	0		0.019
80	F80-20F	20	F	3.26	55.0	M		2	0		0.020
80	F80-21A	21	A	2.63	48.0	F		1	1		0.024
80	F80-21B	21	B	2.49	45.0	F		1	1		0.027
80	F80-21C	21	C	1.88	42.0	F		1	1		0.025
80	F80-21D	21	D	3.94	52.0	F	0.840	1	1	21.320	0.028

* Fish Died

Table A-1: Experiment 1 - Fish Growth Parameters

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Eggs	MS222	PCB	GSI	CF
80	F80-22A	22	A	1.59	41.0	F		2	1		0.023
80	F80-22B	22	B	2.63	53.0	M		2	1		0.018
80	F80-22C	22	C	2.12	47.0	M		2	1		0.020
80	F80-22D	22	D	2.51	50.0	F	0.060	2	1	2.390	0.020
80	F80-22E	22	E	2.25	48.0	F	0.040	2	1	1.778	0.020
80	F80-22F	22	F	1.94	47.0	F	0.020	2	1	1.031	0.019
80	F80-23A	23	A	3.47	55.0	M		1	1		0.021
80	F80-23B	23	B	1.39	40.0	F		1	1		0.022
80	F80-23C	23	C	*	*	*		1	1		*
80	F80-24A	24	A	1.79	43.0	M		1	0		0.023
80	F80-24B	24	B	2.11	47.0	M		1	0		0.020
80	F80-24C	24	C	1.50	42.0	F		1	0		0.020
80	F80-24D	24	D	2.60	51.0	M		1	0		0.020
80	F80-24E	24	E	1.89	47.0	M		1	0		0.018
80	F80-24F	24	F	2.09	48.0	M		1	0		0.019
93	F93-01A	1	A	2.60	52.5	M		2	0		0.018
93	F93-01B	1	B	2.30	48.0	M		2	0		0.021
93	F93-01C	1	C	1.48	43.0	M		2	0		0.019
93	F93-02A	2	A	1.86	47.0	M		4	0		0.018
93	F93-02B	2	B	1.34	41.0	M		4	0		0.019
93	F93-02C	2	C	1.98	48.0	M		4	0		0.018
93	F93-03A	3	A	2.71	48.5	M		3	0		0.024
93	F93-03B	3	B	1.79	45.0	F		3	0		0.020
93	F93-03C	3	C	1.66	43.0	M		3	0		0.021
93	F93-04A	4	A	2.01	44.5	M		1	0		0.023
93	F93-04B	4	B	1.83	46.5	F		1	0		0.018
93	F93-04C	4	C	*	*	*		1	0		*
93	F93-05A	5	A	2.36	47.5	M		1	1		0.022
93	F93-05B	5	B	4.03	56.5	M		1	1		0.022
93	F93-05C	5	C	2.72	50.0	F		1	1		0.022
93	F93-06A	6	A	2.57	46.0	F	0.220	4	0	8.549	0.026
93	F93-06B	6	B	2.27	46.0	F		4	0		0.023
93	F93-06C	6	C	2.47	48.0	M		4	0		0.022
93	F93-07A	7	A	2.64	49.0	M		2	0		0.022
93	F93-07B	7	B	3.25	52.5	M		2	0		0.022

* Fish Died

Table A-1: Experiment 1 - Fish Growth Parameters

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Eggs	MS222	PCB	GSI	CF
93	F93-07C	7	C	2.32	45.5	M		2	0		0.025
93	F93-08A	8	A	2.33	47.0	F	0.128	3	1	5.502	0.022
93	F93-08B	8	B	2.88	49.0	F	0.424	3	1	14.705	0.024
93	F93-08C	8	C	2.50	49.5	F	0.130	3	1	5.196	0.021
93	F93-09A	9	A	1.57	40.5	M		4	1		0.024
93	F93-09B	9	B	2.85	53.5	F		4	1		0.019
93	F93-09C	9	C	2.44	49.0	M		4	1		0.021
93	F93-10A	10	A	1.96	43.5	F	0.178	2	1	9.077	0.024
93	F93-10B	10	B	1.69	42.5	M		2	1		0.022
93	F93-10C	10	C	*	*	*		2	1		*
93	F93-11A	11	A	2.32	46.5	F	0.229	3	0	9.858	0.023
93	F93-11B	11	B	2.04	46.5	M		3	0		0.020
93	F93-11C	11	C	1.68	42.5	F	0.049	3	0	2.899	0.022
93	F93-12A	12	A	2.53	48.0	F	0.106	3	1	4.190	0.023
93	F93-12B	12	B	3.11	51.0	M		3	1		0.023
93	F93-12C	12	C	2.32	47.0	M		3	1		0.022
93	F93-13A	13	A	1.78	44.5	F		3	0		0.020
93	F93-13B	13	B	1.74	44.0	M		3	0		0.020
93	F93-13C	13	C	1.51	43.0	F		3	0		0.019
93	F93-14A	14	A	1.77	44.0	M		4	1		0.021
93	F93-14B	14	B	2.44	48.0	F	0.220	4	1	9.004	0.022
93	F93-14C	14	C	3.01	50.0	F		4	1		0.024
93	F93-15A	15	A	1.11	39.0	F	0.323	1	0	29.108	0.019
93	F93-15B	15	B	1.26	42.5	F		1	0		0.016
93	F93-15C	15	C	1.76	48.0	M		1	0		0.016
93	F93-16A	16	A	1.85	43.5	F	0.150	4	0	8.124	0.022
93	F93-16B	16	B	2.02	46.0	M		4	0		0.021
93	F93-16C	16	C	1.55	42.0	F	0.153	4	0	9.845	0.021
93	F93-17A	17	A	1.58	43.0	F	0.108	4	1	6.835	0.020
93	F93-17B	17	B	2.94	50.5	M		4	1		0.023
93	F93-17C	17	C	2.39	47.5	M		4	1		0.022
93	F93-18A	18	A	1.54	40.5	F	0.136	2	1	8.818	0.023
93	F93-18B	18	B	1.66	43.0	F		2	1		0.021
93	F93-18C	18	C	1.65	43.5	M		2	1		0.020
93	F93-19A	19	A	2.11	47.0	M		3	1		0.020

* Fish Died

Table A-1: Experiment 1 - Fish Growth Parameters

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Eggs	MS222	PCB	GSI	CF
93	F93-19B	19	B	2.33	48.5	F	0.077	3	1	3.322	0.020
93	F93-19C	19	C	1.58	40.0	F	0.160	3	1	10.146	0.025
93	F93-20A	20	A	3.41	54.5	M		2	0		0.021
93	F93-20B	20	B	2.76	49.5	M		2	0		0.023
93	F93-20C	20	C	2.86	50.5	M		2	0		0.022
93	F93-21A	21	A	1.88	44.0	F	0.318	1	1	16.894	0.022
93	F93-21B	21	B	2.43	47.0	F	0.235	1	1	9.667	0.023
93	F93-21C	21	C	2.43	50.0	F	0.415	1	1	17.066	0.019
93	F93-22A	22	A	1.38	41.0	F		2	1		0.020
93	F93-22B	22	B	1.63	42.5	M		2	1		0.021
93	F93-22C	22	C	2.39	46.0	M		2	1		0.025
93	F93-23A	23	A	1.32	40.5	F		1	1		0.020
93	F93-23B	23	B	3.52	54.0	M		1	1		0.022
93	F93-23C	23	C	*	*	*		1	1		*
93	F93-24A	24	A	1.65	41.0	F		1	0		0.024
93	F93-24B	24	B	1.87	45.0	M		1	0		0.021
93	F93-24C	24	C	2.16	46.5	M		1	0		0.021

* Fish Died

Table B-1: Experiment 1- Fish Standard Metabolic Rates

Day	Tank	Replicate	Weight (g)	Length (mm)	Sex	MS222	PCB Treatment	ul O2/min (avg)	SMR (J/g-d)
14	1	A	2.39	50.0	F	2	0	9.7	195.6
14	1	B	1.71	40.0	F	2	0	6.0	168.3
14	1	C	2.00	45.0	M	2	0	11.8	283.5
14	2	A	1.22	40.0	M	4	0	6.3	248.1
14	2	B	1.61	41.0	M	4	0	8.2	244.0
14	2	C	2.40	48.0	F	4	0	9.2	185.0
14	3	A	2.27	49.0	F	3	0	9.8	208.9
14	3	B	2.13	44.5	M	3	0	9.0	203.2
14	3	C	1.33	41.0	F	3	0	5.5	200.8
14	4	A	2.70	46.0	F	1	0	9.5	170.1
14	4	B	2.41	44.5	M	1	0	12.3	246.7
14	4	C	1.71	41.5	M	1	0	7.8	218.5
14	5	A	1.31	39.0	M	1	1	7.8	285.3
14	5	B	1.66	44.5	*	1	1	6.6	191.5
14	5	C	2.39	48.0	F	1	1	9.2	185.2
14	6	A	2.44	48.0	M	4	0	13.3	263.6
14	6	B	1.67	44.3	F	4	0	9.1	262.3
14	6	C	1.11	40.0	F	4	0	5.2	225.4
14	7	A	1.49	40.0	F	2	0	4.8	155.1
14	7	B	2.34	48.0	M	2	0	12.3	253.0
14	7	D	1.47	41.0	M	2	0	7.2	236.8
14	8	A	1.51	39.0	F	3	1	13.8	439.9
14	8	B	2.03	45.0	F	3	1	10.8	257.2
14	8	D	2.01	44.0	F	3	1	8.3	198.8
14	9	A	1.70	42.0	F	4	1	6.0	170.2
14	9	B	1.55	41.0	M	4	1	9.2	287.1
14	9	D	2.14	46.0	F	4	1	12.3	275.9
14	10	A	1.86	42.0	F	2	1	7.8	203.2
14	10	B	1.87	45.0	F	2	1	7.2	184.5
14	10	D	2.46	46.0	F	2	1	8.5	166.6
14	11	A	1.06	37.0	M	3	0	4.7	215.1
14	11	B	1.76	45.0	M	3	0	7.8	213.7
14	11	D	2.56	46.0	M	3	0	11.5	216.5
14	12	A	1.02	35.0	F	3	1	6.5	305.8
14	12	B	1.27	38.0	F	3	1	7.2	271.8

* Fish Died

Table B-1: Experiment 1- Fish Standard Metabolic Rates

Day	Tank	Replicate	Weight (g)	Length (mm)	Sex	MS222	PCB Treatment	ul O2/min (avg)	SMR (J/g-d)
14	12	D	2.62	50.5	M	3	1	9.7	179.1
14	13	A	3.13	48.0	F	3	0	8.3	127.4
14	13	C	3.55	53.5	M	3	0	11.9	162.2
14	13	D	2.74	53.0	F	3	0	12.4	217.5
14	14	A	1.41	38.0	F	4	1	6.2	212.2
14	14	C	1.68	42.5	F	4	1	8.6	247.3
14	14	D	1.31	41.5	M	4	1	7.6	279.1
14	15	A	1.41	39.0	M	1	0	5.3	182.0
14	15	C	2.55	48.5	F	1	0	8.7	163.7
14	15	D	2.31	56.5	F	1	0	11.0	229.1
14	16	A	1.31	40.0	F	4	0	6.3	232.5
14	16	C	1.52	41.5	F	4	0	4.8	152.3
14	16	D	1.27	40.0	M	4	0	6.6	252.1
14	17	A	1.62	45.0	F	4	1	7.4	219.2
14	17	C	0.75	33.0	M	4	1	3.0	190.8
14	17	D	2.19	48.0	M	4	1	8.3	183.6
14	18	A	1.10	37.0	F	2	1	6.4	279.3
14	18	C	1.95	44.0	F	2	1	10.8	266.7
14	18	D	1.51	41.0	M	2	1	8.0	254.2
14	19	B	1.96	45.5	F	3	1	10.1	248.6
14	19	C	1.65	41.5	M	3	1	7.6	220.8
14	19	D	1.22	39.0	M	3	1	8.7	343.0
14	20	B	2.40	52.5	M	2	0	7.8	156.2
14	20	C	2.03	47.5	M	2	0	11.3	268.0
14	20	D	2.25	46.5	M	2	0	10.6	226.1
14	21	B	1.90	45.0	M	1	1	13.3	336.5
14	21	C	1.76	41.0	F	1	1	7.6	207.1
14	21	D	2.20	46.5	F	1	1	10.1	220.7
14	22	B	2.02	44.0	M	2	1	10.9	259.9
14	22	C	2.60	48.0	M	2	1	11.6	215.6
14	22	D	1.34	39.0	M	2	1	9.4	339.5
14	23	B	2.06	44.5	M	1	1	9.2	215.2
14	23	C	1.17	33.5	M	1	1	5.8	238.7
14	23	D	1.87	45.5	M	1	1	9.5	245.7
14	24	B	1.40	41.0	F	1	0	8.8	301.9

* Fish Died

Table B-1: Experiment 1- Fish Standard Metabolic Rates

Day	Tank	Replicate	Weight (g)	Length (mm)	Sex	MS222	PCB Treatment	ul O2/min (avg)	SMR (J/g-d)
14	24	C	1.42	41.0	F	1	0	8.1	273.4
14	24	D	1.76	43.5	F	1	0	10.3	281.7
28	1	A	2.32	47.0	F	2	0	11.5	239.1
28	1	B	1.49	41.0	M	2	0	11.6	374.6
28	1	D	1.55	42.0	M	2	0	9.7	300.8
28	2	A	1.82	43.5	F	4	0	10.7	283.3
28	2	B	2.87	49.0	F	4	0	16.8	282.3
28	2	D	2.21	47.5	F	4	0	11.7	254.5
28	3	A	1.79	42.5	M	3	0	7.9	211.7
28	3	B	1.69	41.0	M	3	0	14.5	412.7
28	3	D	1.87	49.5	F	3	0	12.2	314.7
28	4	A	2.66	45.5	M	1	0	20.8	376.7
28	4	B	2.27	45.5	M	1	0	13.1	277.3
28	4	D	2.12	45.5	M	1	0	18.2	413.8
28	5	A	2.02	46.0	M	1	1	16.5	392.6
28	5	B	3.36	51.5	F	1	1	20.4	292.4
28	5	D	2.82	49.5	M	1	1	20.1	343.9
28	6	A	1.12	38.0	M	4	0	4.8	207.2
28	6	B	1.73	42.5	M	4	0	12.6	350.9
28	6	D	2.20	49.0	M	4	0	17.9	391.0
28	7	A	2.61	48.5	M	2	0	19.8	366.4
28	7	B	2.30	47.0	M	2	0	10.2	214.6
28	7	C	2.77	54.5	M	2	0	20.7	359.6
28	8	A	1.63	43.5	M	3	1	15.1	445.3
28	8	B	2.25	48.0	M	3	1	14.4	308.5
28	8	C	2.46	48.5	M	3	1	17.0	333.2
28	9	A	2.14	46.5	M	4	1	17.3	389.7
28	9	B	2.10	43.0	F	4	1	13.6	311.2
28	9	C	1.51	41.5	M	4	1	15.0	479.3
28	10	A	1.97	45.0	F	2	1	12.5	305.3
28	10	B	2.35	50.5	M	2	1	11.6	238.9
28	10	C	1.68	44.5	M	2	1	12.2	349.9
28	11	A	1.52	42.0	F	3	0	7.0	223.4
28	11	B	2.25	47.0	F	3	0	13.4	286.8
28	11	C	2.27	46.0	M	3	0	20.6	436.3

* Fish Died

Table B-1: Experiment 1- Fish Standard Metabolic Rates

Day	Tank	Replicate	Weight (g)	Length (mm)	Sex	MS222	PCB Treatment	ul O2/min (avg)	SMR (J/g-d)
28	12	A	2.04	48.0	M	3	1	14.3	336.7
28	12	B	3.17	48.0	F	3	1	14.1	214.6
28	12	C	1.70	43.5	F	3	1	9.6	271.5
28	13	A	2.36	48.0	M	3	0	18.8	382.9
28	13	C	1.46	41.5	F	3	0	10.4	343.3
28	13	D	1.95	44.5	M	3	0	12.7	315.0
28	14	A	1.85	42.0	M	4	1	15.9	414.9
28	14	C	1.90	44.0	F	4	1	10.0	252.5
28	14	D	1.36	39.0	M	4	1	8.8	310.7
28	15	A	2.85	51.0	M	1	0	20.9	352.8
28	15	C	2.20	43.0	F	1	0	15.7	344.7
28	15	D	1.31	38.5	F	1	0	8.3	306.0
28	16	A	1.37	39.0	F	4	0	8.8	308.6
28	16	C	2.28	48.5	M	4	0	16.8	355.3
28	16	D	2.93	49.5	F	4	0	16.7	274.8
28	17	A	2.31	46.0	M	4	1	16.6	347.2
28	17	C	1.99	45.5	F	4	1	13.0	313.7
28	17	D	1.63	42.5	M	4	1	12.1	358.3
28	18	A	1.37	41.0	M	2	1	6.6	231.0
28	18	C	1.83	44.0	M	2	1	13.9	365.3
28	18	D	1.45	40.5	F	2	1	10.4	345.0
28	19	B	2.51	46.5	M	3	1	17.1	329.0
28	19	C	1.83	43.0	M	3	1	15.0	395.5
28	19	D	2.20	47.5	F	3	1	13.3	292.0
28	20	B	1.09	38.0	M	2	0	8.7	385.3
28	20	C	1.61	43.0	M	2	0	14.2	423.7
28	20	D	3.21	51.5	F	2	0	22.1	331.4
28	21	B	1.23	43.0	M	1	1	7.3	287.3
28	21	C	1.62	41.5	F	1	1	11.3	334.8
28	21	D	3.67	54.5	F	1	1	19.5	256.0
28	22	B	3.05	51.5	F	2	1	16.5	261.0
28	22	C	1.89	44.0	F	2	1	18.6	474.8
28	22	D	2.62	47.5	M	2	1	14.3	262.5
28	23	B	2.31	47.0	M	1	1	15.6	325.1
28	23	C	1.90	45.0	M	1	1	11.8	300.2

* Fish Died

Table B-1: Experiment 1- Fish Standard Metabolic Rates

Day	Tank	Replicate	Weight (g)	Length (mm)	Sex	MS222	PCB Treatment	ul O2/min (avg)	SMR (J/g-d)
28	23	D	1.42	40.0	M	1	1	13.2	449.5
28	24	B	2.22	38.0	F	1	0	13.9	301.3
28	24	C	2.55	49.5	M	1	0	10.8	204.7
28	24	D	2.47	45.5	F	1	0	15.7	306.5
42	1	A	2.53	47.0	F	2	0	11.5	218.8
42	1	B	1.50	41.0	M	2	0	11.1	358.1
42	1	C	2.07	45.0	M	2	0	15.3	356.5
42	2	A	1.97	40.0	M	4	0	8.7	213.6
42	2	B	1.37	37.0	M	4	0	5.4	189.8
42	2	C	1.59	41.5	F	4	0	8.7	264.3
42	3	A	2.57	48.0	F	3	0	13.8	259.4
42	3	B	3.09	48.0	F	3	0	14.0	218.3
42	3	C	1.77	43.5	M	3	0	12.7	347.1
42	4	A	2.12	42.0	F	1	0	7.7	174.8
42	4	B	2.85	50.0	M	1	0	20.0	337.6
42	4	C	2.12	42.5	F	1	0	9.3	210.6
42	5	A	2.12	45.0	M	1	1	12.7	289.3
42	5	B	1.58	41.0	M	1	1	13.1	399.3
42	5	C	2.09	44.5	F	1	1	12.2	281.5
42	6	A	2.03	44.0	F	4	0	7.8	186.2
42	6	B	2.76	51.0	M	4	0	11.9	207.7
42	6	C	1.68	42.5	F	4	0	9.5	272.3
42	7	A	1.53	42.0	M	2	0	7.4	232.0
42	7	B	2.93	48.0	F	2	0	17.4	285.6
42	7	C	1.91	44.0	F	2	0	12.5	315.1
42	8	A	2.28	45.0	F	3	1	10.1	214.5
42	8	B	2.23	46.0	M	3	1	12.5	271.0
42	8	C	2.70	49.0	M	3	1	16.4	292.3
42	9	A	3.05	51.0	M	4	1	20.4	322.9
42	9	B	2.10	45.0	M	4	1	11.9	274.1
42	9	C	2.75	50.0	F	4	1	11.9	209.0
42	10	A	3.11	60.0	M	2	1	17.4	269.3
42	10	B	2.99	51.0	F	2	1	18.7	301.5
42	10	C	2.46	49.5	F	2	1	12.0	235.5
42	11	A	2.86	50.0	F	3	0	16.7	281.1

* Fish Died

Table B-1: Experiment 1- Fish Standard Metabolic Rates

Day	Tank	Replicate	Weight (g)	Length (mm)	Sex	MS222	PCB Treatment	ul O2/min (avg)	SMR (J/g-d)
42	11	B	1.46	45.0	M	3	0	9.3	307.3
42	11	C	2.08	45.0	M	3	0	14.1	325.6
42	12	A	2.05	45.0	M	3	1	14.0	328.0
42	12	B	1.93	47.0	F	3	1	9.0	224.8
42	12	C	1.93	45.0	F	3	1	12.4	308.8
42	13	A	0.87	38.0	M	3	0	4.0	222.4
42	13	B	2.14	44.5	F	3	0	10.1	228.6
42	13	C	1.33	42.5	M	3	0	6.5	235.7
42	14	A	2.01	41.0	F	4	1	7.8	186.4
42	14	B	1.98	43.5	F	4	1	8.6	208.3
42	14	C	2.20	45.5	F	4	1	11.6	253.1
42	15	A	2.02	45.0	M	1	0	12.6	300.3
42	15	B	1.27	37.5	F	1	0	7.9	298.2
42	15	C	1.93	43.5	M	1	0	13.4	333.8
42	16	A	2.18	45.0	F	4	0	13.4	296.8
42	16	B	1.20	37.5	F	4	0	6.5	261.9
42	16	C	1.24	40.0	F	4	0	6.3	243.2
42	17	A	2.18	48.0	M	4	1	13.6	301.1
42	17	B	1.96	42.5	F	4	1	7.3	178.3
42	17	C	2.44	47.0	F	4	1	11.7	231.1
42	18	A	1.66	40.0	M	2	1	10.4	303.0
42	18	B	2.63	49.5	F	2	1	12.0	219.0
42	18	C	1.33	39.0	F	2	1	9.6	348.5
42	19	A	2.00	45.0	M	3	1	17.3	416.9
42	19	B	2.62	49.5	F	3	1	14.4	265.7
42	19	C	3.12	51.0	F	3	1	16.0	247.1
42	20	A	2.94	50.0	F	2	0	16.6	271.3
42	20	B	2.78	49.5	F	2	0	15.9	275.6
42	20	C	2.32	46.5	F	2	0	16.7	347.9
42	21	A	2.66	50.0	M	1	1	16.2	294.0
42	21	B	2.26	46.5	M	1	1	12.4	264.1
42	21	C	1.98	45.0	F	1	1	9.9	239.8
42	22	A	2.17	46.0	F	2	1	10.4	230.2
42	22	B	2.56	50.0	M	2	1	16.9	317.4
42	22	C	2.25	47.0	M	2	1	17.4	372.3

* Fish Died

Table B-1: Experiment 1- Fish Standard Metabolic Rates

Day	Tank	Replicate	Weight (g)	Length (mm)	Sex	MS222	PCB Treatment	ul O2/min (avg)	SMR (J/g-d)
42	23	A	1.59	41.0	M	1	1	8.1	245.4
42	23	B	3.79	56.0	F	1	1	19.3	244.9
42	23	C	2.44	47.0	M	1	1	15.4	303.2
42	24	A	2.10	45.0	F	1	0	13.4	307.4
42	24	B	2.01	47.0	M	1	0	13.0	312.4
42	24	C	1.64	42.5	M	1	0	11.7	344.5
56	1	A	1.42	40.0	M	2	0	8.7	293.9
56	1	B	2.77	51.0	M	2	0	19.6	340.8
56	1	C	1.85	43.5	M	2	0	8.1	211.4
56	2	A	1.17	38.0	F	4	0	5.8	239.4
56	2	B	1.77	44.5	F	4	0	8.1	221.0
56	2	C	1.63	42.5	M	4	0	7.8	229.3
56	3	A	1.77	44.0	M	3	0	14.7	400.0
56	3	B	1.82	44.0	F	3	0	7.8	206.5
56	3	C	3.04	51.5	M	3	0	21.5	341.1
56	4	A	1.74	42.5	M	1	0	11.8	326.3
56	4	B	1.49	41.5	M	1	0	12.5	405.3
56	4	C	1.99	44.5	F	1	0	10.4	251.2
56	5	A	2.08	46.5	M	1	1	15.3	353.7
56	5	B	2.73	47.0	M	1	1	16.0	283.3
56	5	C	2.52	48.5	M	1	1	20.2	385.4
56	6	A	1.76	42.5	F	4	0	8.2	225.6
56	6	B	2.53	49.0	M	4	0	13.6	258.3
56	6	C	1.86	46.5	F	4	0	8.0	207.2
56	7	A	3.03	50.0	F	2	0	17.1	271.6
56	7	B	1.52	41.0	F	2	0	6.6	208.6
56	7	C	1.95	44.5	M	2	0	13.4	331.3
56	8	A	2.40	46.0	M	3	1	13.7	274.1
56	8	B	5.30	54.0	M	3	1	19.8	179.6
56	8	C	1.87	43.5	M	3	1	15.0	385.9
56	9	A	2.44	47.5	M	4	1	13.7	270.8
56	9	B	2.31	48.0	M	4	1	13.1	272.5
56	9	C	1.44	41.5	M	4	1	8.5	283.5
56	10	A	1.75	45.0	M	2	1	7.9	217.3
56	10	B	1.63	43.0	M	2	1	10.5	310.6

* Fish Died

Table B-1: Experiment 1- Fish Standard Metabolic Rates

Day	Tank	Replicate	Weight (g)	Length (mm)	Sex	MS222	PCB Treatment	ul O2/min (avg)	SMR (J/g-d)
56	10	C	1.53	40.0	F	2	1	8.6	270.9
56	11	A	1.52	40.0	F	3	0	6.4	203.1
56	11	B	1.63	42.0	M	3	0	8.7	256.5
56	11	C	1.17	38.5	M	3	0	19.6	809.1
56	12	A	1.37	40.0	M	3	1	9.7	342.6
56	12	B	3.81	53.5	M	3	1	23.8	301.1
56	12	C	3.39	52.5	M	3	1	5.6	78.9
56	13	A	1.38	42.5	F	3	0	9.7	338.0
56	13	B	2.32	47.0	M	3	0	13.6	281.5
56	13	C	1.95	44.5	F	3	0	8.3	205.8
56	14	A	1.85	44.0	M	4	1	12.4	322.3
56	14	B	2.53	48.0	F	4	1	12.2	232.9
56	14	C	2.33	47.0	M	4	1	11.7	241.1
56	15	A	3.19	55.0	M	1	0	17.0	256.8
56	15	B	2.88	48.5	F	1	0	17.1	285.8
56	15	C	2.21	46.0	M	1	0	13.2	287.9
56	16	A	2.91	51.0	M	4	0	16.2	268.3
56	16	B	2.13	46.5	M	4	0	11.3	256.1
56	16	C	1.85	44.5	F	4	0	7.1	184.0
56	17	A	1.36	40.5	F	4	1	7.9	281.2
56	17	B	2.35	49.5	M	4	1	12.9	264.1
56	17	C	2.03	45.0	M	4	1	14.1	334.2
56	18	A	1.73	43.0	M	2	1	6.9	192.6
56	18	B	1.42	40.5	M	2	1	9.4	317.6
56	18	C	0.91	34.5	M	2	1	5.8	308.5
56	19	A	1.50	41.0	M	3	1	6.9	220.5
56	19	B	2.82	49.5	F	3	1	14.3	244.8
56	19	C	1.85	41.5	F	3	1	11.3	294.7
56	20	A	4.16	55.0	M	2	0	26.5	307.5
56	20	B	2.27	43.0	F	2	0	10.4	219.9
56	20	C	1.61	41.5	M	2	0	10.7	320.9
56	21	A	2.71	49.0	F	1	1	18.9	336.2
56	21	B	2.68	48.0	M	1	1	15.2	273.2
56	21	C	2.35	46.5	M	1	1	16.0	328.5
56	22	A	1.65	42.0	F	2	1	4.4	128.5

* Fish Died

Table B-1: Experiment 1- Fish Standard Metabolic Rates

Day	Tank	Replicate	Weight (g)	Length (mm)	Sex	MS222	PCB Treatment	ul O2/min (avg)	SMR (J/g-d)
56	22	B	3.09	51.5	M	2	1	15.2	237.4
56	22	C	2.50	49.0	M	2	1	12.3	236.2
56	23	A	2.85	50.5	M	1	1	19.6	331.3
56	23	B	2.43	49.5	M	1	1	10.3	204.1
56	23	C	1.15	37.5	M	1	1	7.8	325.1
56	24	A	3.22	51.5	M	1	0	14.2	212.6
56	24	B	3.19	50.0	M	1	0	16.5	249.6
56	24	C	3.29	51.5	M	1	0	23.4	343.4

* Fish Died

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F0	F7T01	F7T02	F7T03	F7T04	F7T05	F7T06	F7T07	F7T08	F7T09	F7T10	F7T11	F7T12	F7T13	F7T14
Sample Extracted g	4.40	3.86	3.40	3.65	3.31	3.82	4.43	3.80	6.63	4.11	4.65	4.32	3.45	5.26	3.44
% Lipid	0.027	0.023	0.016	0.019	0.018	0.013	0.030	0.014	0.039	0.027	0.020	0.020	0.023	0.026	0.012
Day	0	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Tank		1	2	3	4	5	6	7	8	9	10	11	12	13	14
MS222		2	4	3	1	1	4	2	3	4	2	3	3	3	4
PCB Treatment		0	0	0	0	1	0	0	1	1	1	0	1	0	1
PCBs Congeners	nd = non-detect														
1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4,10	nd	2.30	1.49	1.60	nd	0.68	1.59	0.94	3.02	3.97	0.96	1.18	0.33	nd	1.98
7,9	0.41	0.05	0.07	0.09	0.12	0.03	0.07	0.14	0.05	0.09	0.08	0.18	0.06	0.06	0.04
6	nd	nd	0.05	0.16	nd	0.09	0.03	0.17	0.11	0.08	0.07	0.44	0.04	nd	0.11
8,5	0.42	0.22	0.58	0.55	nd	0.95	0.55	0.45	1.18	0.75	0.69	1.91	0.51	nd	0.86
19	nd	nd	nd	nd	nd	nd	nd	nd	0.12	nd	0.10	0.18	nd	nd	nd
12,13	nd	nd	nd	nd	nd	nd	nd	nd	0.02	nd	nd	0.15	0.32	nd	nd
18	0.06	0.10	0.12	0.16	nd	0.16	0.21	0.08	0.28	nd	0.22	0.13	0.15	nd	0.26
17	0.03	0.08	0.06	0.09	nd	0.11	0.09	0.05	0.28	0.02	0.13	0.13	0.12	nd	0.15
24	0.02	0.01	0.02	0.01	nd	0.02	0.02	0.01	0.04	0.01	0.01	nd	0.01	nd	0.02
16,32	0.09	0.14	0.14	0.21	nd	0.29	0.20	0.19	0.45	0.36	0.45	0.33	0.24	nd	0.33
29	0.01	nd	nd	nd	nd	nd	0.00	0.02	0.00	nd	0.01	0.09	0.01	0.01	nd
26	0.06	0.04	0.04	0.05	nd	0.06	0.04	0.03	0.10	0.06	0.06	0.24	0.05	nd	0.08
25	0.07	0.06	0.08	0.11	nd	0.07	0.07	0.08	0.14	0.08	0.09	0.25	0.05	nd	0.08
31, 28	0.53	0.51	0.63	0.79	0.29	1.54	0.61	0.87	1.63	1.28	1.67	0.76	0.85	nd	0.70
33,21,53	0.11	0.09	0.11	0.16	nd	0.27	0.18	0.09	0.56	0.35	0.43	0.10	0.22	nd	0.35
51	nd	0.02	0.02	nd	nd	0.03	0.04	0.40	0.05	0.02	0.03	0.15	0.02	nd	0.02
22	0.29	0.10	0.16	0.20	nd	0.35	0.16	0.21	0.49	0.31	0.42	0.68	0.32	nd	0.30
45	0.03	0.07	0.08	0.08	0.06	0.15	0.03	0.56	0.20	0.11	0.15	0.47	0.10	0.01	0.13
46	nd	nd	nd	nd	nd	0.07	0.01	nd	0.04	0.02	0.02	0.43	0.02	nd	0.01
52	0.43	0.24	0.16	0.32	nd	0.53	0.26	0.15	0.58	0.47	0.45	0.21	0.28	nd	0.41
49	0.47	0.19	0.20	0.26	0.04	0.43	0.21	0.16	0.46	0.38	0.43	0.30	0.34	0.02	0.34
47,48	0.79	0.23	0.28	0.36	0.15	0.46	0.23	0.25	0.46	0.42	0.49	0.37	0.44	0.09	0.34
44	0.45	0.14	0.21	0.23	nd	0.60	0.22	0.17	0.54	0.42	0.50	0.50	0.38	nd	0.41
37,42	0.29	0.06	0.10	0.14	nd	0.77	0.13	0.11	0.31	0.26	0.31	0.11	0.26	0.01	0.27
41,64,71	0.67	0.17	0.31	0.30	nd	0.86	0.22	0.27	0.61	0.45	0.74	0.54	0.57	nd	0.44
40	0.28	0.04	0.08	0.05	nd	0.27	0.04	0.03	0.12	0.09	0.11	0.35	0.09	nd	0.08
100	0.55	0.02	0.09	0.05	nd	0.32	0.02	0.05	0.03	0.04	0.04	0.37	0.04	nd	0.04
63	0.32	0.04	0.06	0.03	nd	0.18	0.05	0.08	0.03	0.02	0.03	0.39	0.03	nd	0.02
74	0.64	0.05	0.14	0.17	nd	0.53	0.10	0.11	0.32	0.22	0.37	0.39	0.27	nd	0.19
70,76	0.80	0.14	0.32	0.29	nd	1.03	0.25	0.22	0.78	0.60	0.89	0.63	0.73	nd	0.55

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F0	F7T01	F7T02	F7T03	F7T04	F7T05	F7T06	F7T07	F7T08	F7T09	F7T10	F7T11	F7T12	F7T13	F7T14
Sample Extracted g	4.40	3.86	3.40	3.65	3.31	3.82	4.43	3.80	6.63	4.11	4.65	4.32	3.45	5.26	3.44
% Lipid	0.027	0.023	0.016	0.019	0.018	0.013	0.030	0.014	0.039	0.027	0.020	0.020	0.023	0.026	0.012
Day	0	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Tank		1	2	3	4	5	6	7	8	9	10	11	12	13	14
MS222		2	4	3	1	1	4	2	3	4	2	3	3	3	4
PCB Treatment		0	0	0	0	1	0	0	1	1	1	0	1	0	1
PCBs Congeners	nd = non-detect														
66,95	1.90	0.45	0.81	0.91	nd	2.07	0.61	0.59	1.47	1.11	1.56	1.19	1.23	nd	1.02
91	0.52	0.06	0.12	0.13	nd	0.43	0.10	0.09	0.15	0.13	0.15	0.36	0.14	nd	0.12
56,60	1.55	0.33	0.71	0.72	nd	0.76	0.46	0.50	0.52	0.81	0.54	4.54	0.48	nd	0.80
92,84 (89)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
101	0.76	0.28	0.38	0.52	0.01	0.71	0.38	0.31	0.54	0.50	0.45	0.57	0.32	nd	0.45
99	0.81	0.32	0.58	0.74	nd	0.83	0.44	0.48	0.64	0.53	0.66	1.26	0.47	nd	0.53
119	0.64	0.12	0.22	0.27	nd	0.78	0.16	0.18	0.22	0.17	0.21	0.43	0.17	0.01	0.21
83	0.22	0.03	0.06	0.05	nd	0.37	0.03	0.04	0.05	0.04	0.05	0.29	0.04	nd	0.08
97	0.29	0.05	0.07	0.10	nd	0.40	0.06	0.04	0.13	0.11	0.13	0.14	0.11	nd	0.13
81, 87	0.33	0.06	0.11	0.14	nd	0.47	0.08	0.09	0.18	0.14	0.21	0.16	0.21	nd	0.23
136	0.14	0.02	0.03	0.04	nd	0.14	0.02	0.02	0.06	0.05	0.06	0.11	0.04	nd	0.05
77,110	1.11	0.31	0.54	0.80	nd	1.02	0.45	0.49	0.79	0.66	0.83	0.73	0.64	nd	0.65
82	0.40	0.01	0.02	0.04	nd	0.04	0.02	0.03	0.04	0.03	0.05	0.08	0.02	nd	0.02
151	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
135,144	0.30	0.05	0.08	0.11	nd	0.12	0.07	0.09	0.14	0.12	0.15	0.27	0.12	nd	0.10
107	0.58	0.07	0.13	0.20	nd	0.12	0.11	0.21	0.17	0.15	0.19	0.38	0.13	nd	0.12
149,123	0.36	0.12	0.20	0.29	0.04	0.25	0.17	0.21	0.32	0.29	0.33	0.17	0.26	nd	0.24
118	1.57	0.29	0.58	1.06	0.34	0.59	0.45	1.03	0.78	0.64	0.83	0.80	0.61	0.23	0.65
134	0.50	0.15	0.12	0.16	nd	0.06	0.12	0.23	0.16	0.11	0.13	0.49	0.11	nd	0.10
114,131	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
146	0.77	0.34	0.34	0.59	0.06	0.30	0.25	0.34	0.45	0.34	0.51	0.53	0.29	0.03	0.39
132,153,105	3.42	2.31	2.34	4.40	0.03	2.35	1.68	2.12	3.26	2.48	3.75	2.22	2.05	nd	2.75
141	0.12	0.07	0.04	0.09	nd	0.11	0.04	0.04	0.15	0.10	0.17	0.15	0.11	nd	0.12
137,130,176	0.13	0.06	0.07	0.11	nd	0.07	0.07	0.05	0.13	0.08	0.13	1.05	0.08	0.11	0.08
138,163	1.54	1.20	1.12	1.93	nd	1.16	0.82	1.11	1.58	1.16	1.74	1.22	1.05	nd	1.39
158	0.21	nd	0.11	0.18	nd	0.10	0.08	0.12	0.16	0.12	0.18	nd	0.10	nd	0.14
129,178	0.22	0.13	0.15	0.23	nd	0.18	0.11	0.12	0.23	0.17	0.27	0.29	0.16	nd	0.19
187,182	1.03	0.84	0.87	1.28	0.02	1.05	0.60	0.80	1.04	0.88	1.27	0.65	0.89	0.01	1.16
183	0.45	0.33	0.36	0.52	nd	0.48	0.25	0.34	0.41	0.38	0.51	0.30	0.40	nd	0.50
128	0.13	0.12	0.14	0.22	nd	0.09	0.10	0.13	0.11	0.11	0.10	0.14	0.12	nd	0.15
185	0.05	0.03	0.04	0.10	nd	0.10	0.04	0.06	0.07	0.06	0.08	0.04	0.08	nd	0.08
174	0.17	0.14	0.13	0.21	nd	0.37	0.10	0.12	0.40	0.27	0.47	0.09	0.31	nd	0.32

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F0	F7T01	F7T02	F7T03	F7T04	F7T05	F7T06	F7T07	F7T08	F7T09	F7T10	F7T11	F7T12	F7T13	F7T14
Sample Extracted g	4.40	3.86	3.40	3.65	3.31	3.82	4.43	3.80	6.63	4.11	4.65	4.32	3.45	5.26	3.44
% Lipid	0.027	0.023	0.016	0.019	0.018	0.013	0.030	0.014	0.039	0.027	0.020	0.020	0.023	0.026	0.012
Day	0	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Tank		1	2	3	4	5	6	7	8	9	10	11	12	13	14
MS222		2	4	3	1	1	4	2	3	4	2	3	3	3	4
PCB Treatment		0	0	0	0	1	0	0	1	1	1	0	1	0	1
PCBs Congeners	nd = non-detect														
177	0.25	0.17	0.20	0.32	nd	0.31	0.15	0.18	0.37	0.24	0.43	0.16	0.26	nd	0.29
202,171,156	0.31	0.23	0.24	0.40	nd	0.28	0.18	0.22	0.37	0.27	0.42	0.20	0.25	nd	0.30
157,200	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
172	0.01	nd	nd	nd	nd	nd	0.05	0.01	0.06	0.05	0.06	nd	0.03	nd	0.01
197	0.01	nd	0.02	0.04	nd	0.02	0.02	nd	0.03	0.03	0.04	0.02	0.00	nd	nd
180	1.31	0.63	0.74	1.75	nd	1.52	0.54	0.63	1.69	1.34	2.12	0.59	1.13	nd	1.50
193	nd	0.20	0.30	0.90	0.02	nd	0.30	0.27	nd	nd	nd	0.22	nd	0.02	nd
191	0.03	nd	nd	nd	nd	0.01	nd	nd	0.02	0.03	0.04	nd	0.02	nd	nd
199	0.01	nd	0.01	0.02	nd	0.03	0.00	0.04	0.03	0.02	0.03	nd	0.02	nd	0.02
170,190	0.72	0.46	0.55	0.95	nd	0.81	0.42	0.76	0.88	0.72	1.13	0.43	0.56	nd	0.76
198	0.02	nd	nd	0.02	nd	0.03	0.01	nd	0.03	0.01	0.04	nd	0.02	nd	0.03
201	0.72	0.51	0.57	0.91	nd	0.84	0.44	0.48	0.92	0.80	1.21	0.35	0.60	nd	0.80
203,196	0.67	0.49	0.50	0.85	nd	0.86	0.43	0.46	0.90	0.81	1.16	0.44	0.61	nd	0.79
208,195	0.81	0.69	0.65	1.09	nd	0.68	0.55	0.61	0.77	0.81	0.98	0.64	0.47	nd	0.72
207	0.09	0.08	0.08	0.12	nd	0.07	0.07	0.07	0.09	0.09	0.10	0.09	0.05	nd	0.09
194	0.15	0.15	0.12	0.22	nd	0.21	0.12	0.11	0.19	0.24	0.27	0.15	0.12	nd	0.19
205	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
206	0.38	13.92	1.95	1.87	nd	1.28	1.37	1.09	0.85	1.90	1.31	7.44	0.91	nd	0.97
Total PCBs	33.54	30.96	21.98	32.08	1.17	33.34	18.17	20.82	34.56	29.99	35.02	41.38	22.68	0.61	27.78
Surrogate Recoveries															
PCB 14		0.92	0.81	1.09	0.01	0.78	0.54	0.94	0.88	0.34	0.75	0.85	0.64	0.01	1.17
PCB 166		0.69	0.61	0.80	-	0.58	0.39	0.67	0.65	0.26	0.58	0.57	0.52	-	0.89

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F7T15	F7T16	F7T17	F7T18	F7T19	F7T20	F7T21	F7T22	F7T23	F7T24	F14T01	F14T02	F14T03	F14T04
Sample Extracted g	3.73	3.42	3.56	4.48	5.00	3.93	5.55	3.84	3.81	3.84	3.04	3.90	3.36	4.24
% Lipid	0.028	0.016	0.013	0.010	0.031	0.022	0.038	0.018	0.014	0.022	0.025	0.037	0.027	0.062
Day	7	7	7	7	7	7	7	7	7	7	14	14	14	14
Tank	15	16	17	18	19	20	21	22	23	24	1	2	3	4
MS222	1	4	4	2	3	2	1	2	1	1	2	4	3	1
PCB Treatment	0	0	1	1	1	0	1	1	1	0	0	0	0	0
PCBs Congeners														
1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4,10	0.23	4.67	0.05	4.33	0.50	nd	1.21	0.46	0.32	0.76	4.77	12.49	7.33	12.74
7,9	0.06	0.33	0.01	0.11	0.09	nd	0.04	0.03	0.14	0.04	0.17	0.42	0.17	0.18
6	nd	0.32	0.01	0.05	0.16	nd	0.08	0.16	0.21	nd	0.38	0.41	0.16	0.17
8,5	0.69	1.45	0.00	1.12	1.98	nd	1.44	0.66	0.59	0.17	0.84	1.40	0.59	1.23
19	nd	nd	nd	nd	nd	nd	nd	nd	0.17	nd	nd	0.05	nd	0.18
12,13	nd	nd	nd	nd	nd	nd	nd	nd	0.09	nd	nd	0.66	nd	nd
18	0.05	0.36	0.04	0.24	0.20	nd	0.14	0.32	0.21	0.06	0.21	0.57	0.18	0.46
17	0.04	0.16	0.01	0.17	0.17	nd	0.12	0.20	0.45	0.07	0.10	0.37	0.16	0.47
24	nd	0.01	0.00	0.01	0.01	nd	0.01	0.02	0.04	nd	0.01	0.02	0.01	0.03
16,32	0.20	0.36	0.00	0.41	0.45	nd	0.38	0.33	0.36	0.09	0.29	0.56	0.32	0.69
29	0.01	0.04	nd	nd	nd	nd	0.03	nd	0.04	nd	nd	0.09	nd	0.04
26	0.07	0.13	0.01	0.07	0.07	nd	0.16	0.08	0.09	0.03	0.07	0.21	0.08	0.25
25	0.13	0.14	0.01	0.08	0.09	nd	0.20	0.08	0.10	0.04	0.12	0.21	0.15	0.41
31, 28	0.87	0.85	0.08	1.59	2.19	nd	1.83	1.30	0.99	0.43	1.22	1.27	1.60	2.69
33,21,53	0.22	0.40	0.11	0.27	0.35	nd	0.51	0.31	0.36	0.07	0.14	0.48	0.24	0.98
51	nd	nd	0.00	0.03	0.03	nd	0.03	0.02	0.03	0.01	nd	0.02	nd	0.12
22	0.22	0.30	0.14	0.36	0.52	nd	0.50	0.30	0.30	0.10	0.26	0.47	0.48	1.07
45	0.09	0.19	0.01	0.15	0.16	nd	0.15	0.11	0.18	0.07	0.14	0.22	0.19	0.28
46	nd	nd	nd	0.03	0.02	nd	0.05	0.03	0.04	nd	nd	0.06	0.04	0.27
52	0.14	0.33	0.08	0.51	0.50	nd	0.45	0.51	0.45	0.16	0.38	0.94	0.38	1.64
49	0.19	0.33	0.07	0.42	0.41	nd	0.43	0.38	0.31	0.13	0.44	0.72	0.48	1.28
47,48	0.30	0.54	0.02	0.41	0.30	nd	0.52	0.36	0.33	0.18	0.67	0.93	0.71	1.39
44	0.22	0.41	0.14	0.53	0.62	nd	0.54	0.43	0.33	0.10	0.47	0.66	0.39	1.29
37,42	0.15	0.27	nd	0.26	0.35	nd	0.30	0.22	0.23	0.08	0.33	0.58	0.25	1.66
41,64,71	0.33	0.45	0.08	0.58	0.75	nd	0.67	0.46	0.42	0.15	0.76	0.83	0.58	2.10
40	0.11	0.13	0.01	0.11	0.13	nd	0.13	0.10	0.08	0.02	0.31	0.23	0.11	0.89
100	0.10	0.14	0.01	0.04	0.04	nd	0.06	0.04	0.04	0.02	0.46	0.13	0.06	1.37
63	0.06	0.19	0.00	0.03	0.03	nd	0.04	0.02	0.06	0.04	0.24	0.11	0.05	0.88
74	0.16	0.13	0.06	0.25	0.39	nd	0.27	0.23	0.22	0.06	0.52	0.48	0.28	1.77
70,76	0.43	0.28	0.11	0.62	0.97	nd	0.73	0.56	0.46	0.11	0.96	1.03	0.65	2.59

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F7T15	F7T16	F7T17	F7T18	F7T19	F7T20	F7T21	F7T22	F7T23	F7T24	F14T01	F14T02	F14T03	F14T04
Sample Extracted g	3.73	3.42	3.56	4.48	5.00	3.93	5.55	3.84	3.81	3.84	3.04	3.90	3.36	4.24
% Lipid	0.028	0.016	0.013	0.010	0.031	0.022	0.038	0.018	0.014	0.022	0.025	0.037	0.027	0.062
Day	7	7	7	7	7	7	7	7	7	7	14	14	14	14
Tank	15	16	17	18	19	20	21	22	23	24	1	2	3	4
MS222	1	4	4	2	3	2	1	2	1	1	2	4	3	1
PCB Treatment	0	0	1	1	1	0	1	1	1	0	0	0	0	0
PCBs Congeners														
66,95	0.81	0.68	0.00	1.14	1.81	nd	1.41	1.13	1.02	0.39	2.05	2.47	1.71	5.37
91	0.25	0.55	0.02	0.14	0.21	nd	0.24	0.12	0.14	0.07	0.59	0.45	0.27	1.45
56,60	0.85	2.44	0.11	0.35	0.65	nd	0.65	0.80	0.66	0.31	1.79	2.07	1.39	4.61
92,84 (89)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
101	0.39	0.94	0.03	0.38	0.52	nd	0.46	0.50	0.45	0.23	0.86	1.41	0.70	2.58
99	0.71	1.22	0.02	0.46	0.70	nd	0.51	0.53	0.47	0.32	1.31	1.72	1.01	2.58
119	0.37	0.64	0.04	0.16	0.25	nd	0.34	0.20	0.16	0.13	0.59	0.78	0.39	1.49
83	0.22	0.36	0.01	0.03	0.05	nd	0.07	0.06	0.03	0.03	0.31	0.39	0.09	0.54
97	0.13	0.16	nd	0.09	0.12	nd	0.07	0.11	0.06	0.04	0.17	0.38	0.15	0.60
81, 87	0.14	0.15	0.01	0.14	0.20	nd	0.18	0.20	0.10	0.10	0.22	0.53	0.27	0.71
136	nd	0.04	0.01	0.05	0.06	nd	0.05	0.05	0.03	0.02	0.12	0.16	0.06	0.32
77,110	0.90	0.58	0.01	0.54	0.87	nd	0.75	0.64	0.52	0.34	1.33	2.09	1.14	2.91
82	0.35	0.03	0.01	0.02	0.03	nd	0.04	0.02	0.02	0.01	0.35	0.37	0.06	0.25
151	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
135,144	0.25	0.08	0.01	0.09	0.15	nd	0.14	0.11	0.09	0.05	0.31	0.50	0.19	0.51
107	0.35	0.12	0.00	0.11	0.17	nd	0.17	0.13	0.12	0.07	0.55	0.76	0.36	0.74
149,123	0.21	0.19	0.05	0.22	0.34	nd	0.28	0.24	0.22	0.11	0.38	0.61	0.44	0.96
118	0.75	0.46	0.06	0.52	0.80	nd	0.52	0.56	0.76	0.29	1.55	2.13	1.68	2.14
134	0.82	0.30	0.02	0.17	0.30	nd	0.07	0.08	0.11	0.14	1.69	0.97	0.38	0.19
114,131	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
146	0.64	0.45	0.03	0.53	0.65	nd	0.46	0.33	0.45	0.23	1.10	1.20	0.82	1.42
132,153,105	2.60	2.80	2.31	4.02	4.76	nd	3.01	2.42	3.35	1.55	5.34	7.00	5.30	9.39
141	0.15	0.07	0.00	0.21	0.25	nd	0.13	0.12	0.10	0.04	0.14	0.17	0.11	0.21
137,130,176	0.64	0.02	0.01	0.13	0.18	nd	0.14	0.07	0.10	0.05	0.20	0.21	0.16	0.33
138,163	1.38	1.52	0.15	1.77	2.25	nd	1.59	1.19	1.53	0.79	2.53	3.52	2.73	4.60
158	0.25	nd	0.01	0.18	0.23	nd	0.23	0.12	0.15	0.08	0.33	0.38	0.25	0.46
129,178	0.22	0.20	0.04	0.28	0.34	nd	0.29	0.17	0.21	0.09	0.33	0.46	0.33	0.61
187,182	0.85	0.99	0.03	1.44	1.58	nd	1.09	0.93	1.25	0.51	1.50	2.07	1.61	2.68
183	0.32	0.37	0.11	0.62	0.71	nd	0.44	0.41	0.55	0.19	0.62	0.91	0.67	1.12
128	0.16	0.13	0.01	0.13	0.18	nd	0.15	0.13	0.17	0.09	0.24	0.39	0.30	0.48
185	0.07	0.04	0.00	0.12	0.14	nd	0.08	0.07	0.07	0.02	0.12	0.13	0.12	0.16
174	0.14	0.14	0.10	0.47	0.60	nd	0.32	0.28	0.32	0.09	0.25	0.38	0.31	0.54

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F7T15	F7T16	F7T17	F7T18	F7T19	F7T20	F7T21	F7T22	F7T23	F7T24	F14T01	F14T02	F14T03	F14T04
Sample Extracted g	3.73	3.42	3.56	4.48	5.00	3.93	5.55	3.84	3.81	3.84	3.04	3.90	3.36	4.24
% Lipid	0.028	0.016	0.013	0.010	0.031	0.022	0.038	0.018	0.014	0.022	0.025	0.037	0.027	0.062
Day	7	7	7	7	7	7	7	7	7	7	14	14	14	14
Tank	15	16	17	18	19	20	21	22	23	24	1	2	3	4
MS222	1	4	4	2	3	2	1	2	1	1	2	4	3	1
PCB Treatment	0	0	1	1	1	0	1	1	1	0	0	0	0	0
PCBs Congeners														
177	0.20	0.23	0.10	0.43	0.51	nd	0.30	0.26	0.33	0.12	0.43	0.64	0.44	0.75
202,171,156	0.27	0.31	0.10	0.44	0.53	nd	0.33	0.26	0.34	0.17	0.59	0.75	0.53	0.90
157,200	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
172	0.02	nd	nd	0.24	0.04	nd	nd	0.04	0.06	nd	0.34	0.04	0.02	0.06
197	nd	nd	nd	0.04	0.04	nd	nd	0.00	0.03	nd	0.11	0.05	0.05	0.08
180	0.70	0.75	0.05	2.26	2.75	nd	1.25	0.87	1.69	0.44	1.75	1.80	1.22	1.99
193	0.41	0.37	0.10	nd	nd	nd	nd	nd	nd	0.14	0.63	0.42	0.40	0.43
191	nd	nd	nd	0.03	0.03	nd	nd	0.01	0.01	nd	0.10	0.04	nd	0.05
199	0.03	nd	0.00	0.04	0.04	nd	nd	0.02	0.02	nd	0.10	0.02	0.01	0.02
170,190	0.61	0.57	0.09	1.19	1.53	nd	0.58	0.63	0.90	0.35	1.20	1.69	0.82	1.41
198	nd	nd	nd	0.03	0.05	nd	nd	0.02	0.03	nd	0.05	0.05	0.03	0.05
201	0.94	0.70	0.10	1.45	1.61	nd	0.66	0.65	0.98	0.37	1.21	1.59	0.80	1.36
203,196	0.80	0.68	0.08	1.50	1.68	nd	0.60	0.65	0.90	0.34	1.12	1.46	0.69	1.19
208,195	0.83	0.82	0.04	1.47	1.53	nd	0.56	0.55	0.88	0.48	1.47	1.92	0.83	1.39
207	1.02	0.10	0.01	0.18	0.18	nd	nd	0.06	0.12	0.06	0.18	0.23	0.09	0.14
194	4.29	4.05	3.45	0.57	1.43	nd	0.12	0.14	0.19	0.10	3.47	0.38	0.09	0.18
205	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
206	10.85	14.61	10.80	12.95	42.85	nd	1.78	0.95	1.29	16.99	64.11	9.35	1.50	0.45
Total PCBs	40.94	51.77	19.18	50.13	85.40	0.00	31.06	24.53	28.63	28.94	117.99	81.65	46.17	99.53
Surrogate Recoveries														
PCB 14	0.60	0.61	0.58	0.81	0.96	0.00	0.65	0.60	1.51	0.37	0.92	0.81	1.09	0.01
PCB 166	0.54	0.56	0.48	0.60	0.78	0.00	0.61	0.49	1.23	0.28	0.69	0.61	0.80	-

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F14T05	F14T06	F14T07	F14T08	F14T09	F14T10	F14T11	F14T12	F14T13	F14T14	F14T15	F14T16	F14T17
Sample Extracted g	3.86	1.74	3.67	3.88	3.54	4.12	4.12	3.67	6.05	2.87	4.66	2.61	2.81
% Lipid	0.032	0.010	0.027	0.050	0.069	0.041	0.020	0.027	0.049	0.009	0.068	0.015	0.022
Day	14	14	14	14	14	14	14	14	14	14	14	14	14
Tank	5	6	7	8	9	10	11	12	13	14	15	16	17
MS222	1	4	2	3	4	2	3	3	3	4	1	4	4
PCB Treatment	1	0	0	1	1	1	0	1	0	1	0	0	1
PCBs Congeners													
1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4,10	3.58	5.54	15.44	6.34	2.87	11.41	4.25	1.67	2.18	0.50	2.55	7.84	3.80
7,9	0.18	0.12	0.27	0.17	0.09	0.25	0.17	0.31	0.09	0.23	0.60	0.24	0.57
6	0.19	nd	0.35	0.23	0.20	0.18	0.16	0.18	0.08	0.17	0.72	0.05	0.29
8,5	2.37	0.25	1.24	2.03	3.42	3.87	1.70	2.67	0.87	2.59	2.31	1.52	2.63
19	0.22	nd	0.21	0.13	nd	nd	0.26	0.05	0.13	0.46	0.34	nd	0.10
12,13	nd	nd	nd	0.09	nd	nd	nd	nd	nd	nd	0.31	nd	nd
18	0.93	0.12	0.87	0.77	0.33	0.63	0.51	1.25	0.26	1.81	0.46	0.55	1.55
17	0.53	0.25	0.34	0.65	0.29	0.82	0.40	0.69	0.21	0.88	0.38	0.37	0.79
24	0.03	nd	0.16	0.12	0.02	0.13	0.13	0.04	0.07	0.16	0.15	0.03	0.05
16,32	1.12	0.40	1.25	1.10	0.90	1.88	0.98	1.32	0.50	1.24	0.89	0.99	1.42
29	0.04	0.18	0.09	0.12	0.07	0.20	nd	0.01	nd	1.03	0.28	0.55	0.02
26	0.26	0.17	0.49	0.38	0.38	0.59	0.40	0.28	0.20	0.49	0.53	0.70	0.38
25	0.25	0.20	nd	0.42	0.47	0.44	0.58	0.28	0.30	0.16	0.54	0.55	0.38
31, 28	4.38	2.20	2.48	2.64	4.34	8.04	4.08	3.32	2.09	5.69	2.90	4.52	3.41
33,21,53	0.98	0.78	2.13	0.49	1.20	0.87	0.51	0.99	0.26	6.38	0.72	1.08	1.34
51	0.07	0.22	nd	0.11	0.08	0.19	0.14	0.12	0.07	nd	0.34	0.29	0.07
22	1.05	0.70	0.71	1.51	1.18	1.56	1.35	1.37	0.69	2.59	2.08	1.23	1.53
45	0.33	0.31	0.20	0.46	0.34	0.46	0.25	0.40	0.13	0.10	0.56	0.33	0.42
46	0.14	nd	0.07	0.30	0.12	0.11	0.27	0.26	0.14	0.08	0.49	nd	0.26
52	2.16	0.56	0.57	1.36	1.06	3.09	1.13	2.43	0.58	1.81	0.88	0.89	2.17
49	1.56	0.42	0.53	1.06	1.02	2.49	1.09	1.88	0.56	1.28	1.09	0.85	1.71
47,48	1.50	0.98	0.35	0.94	1.24	2.19	1.24	1.87	0.64	1.08	2.10	1.14	1.92
44	2.01	nd	0.64	1.46	1.28	2.99	0.98	2.48	0.50	2.06	0.61	0.84	2.12
37,42	1.52	2.18	0.15	0.75	0.72	1.65	0.54	1.85	0.28	0.71	0.43	0.64	1.11
41,64,71	2.47	0.41	0.66	1.56	1.58	3.16	1.57	3.36	0.81	1.58	2.07	1.23	2.66
40	0.73	0.06	0.23	0.42	0.31	0.59	0.48	1.20	0.24	0.43	nd	0.25	0.80
100	0.77	0.03	0.02	0.20	0.14	0.26	0.40	1.49	0.20	0.03	1.47	0.58	0.81
63	0.57	0.02	0.10	0.22	0.10	0.24	0.45	1.08	0.23	0.08	0.75	0.45	0.67
74	1.72	0.24	0.36	0.86	0.65	1.79	1.08	2.55	0.55	1.17	1.66	0.90	1.75
70,76	3.16	0.43	0.73	1.77	1.74	3.51	1.68	4.52	0.86	2.52	1.60	1.70	3.53

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F14T05	F14T06	F14T07	F14T08	F14T09	F14T10	F14T11	F14T12	F14T13	F14T14	F14T15	F14T16	F14T17
Sample Extracted g	3.86	1.74	3.67	3.88	3.54	4.12	4.12	3.67	6.05	2.87	4.66	2.61	2.81
% Lipid	0.032	0.010	0.027	0.050	0.069	0.041	0.020	0.027	0.049	0.009	0.068	0.015	0.022
Day	14	14	14	14	14	14	14	14	14	14	14	14	14
Tank	5	6	7	8	9	10	11	12	13	14	15	16	17
MS222	1	4	2	3	4	2	3	3	3	4	1	4	4
PCB Treatment	1	0	0	1	1	1	0	1	0	1	0	0	1
PCBs Congeners													
66,95	6.41	1.47	1.62	1.75	3.34	7.03	4.10	8.52	2.10	4.15	3.86	3.09	5.81
91	1.03	0.20	0.93	0.37	0.56	0.75	0.61	1.58	0.31	3.01	0.96	0.78	0.80
56,60	2.15	0.69	1.45	1.53	1.53	2.45	3.18	3.48	1.63	6.92	1.36	2.39	2.55
92,84 (89)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
101	1.98	0.91	0.91	1.06	1.09	2.11	1.88	2.53	0.96	1.66	1.40	1.27	2.02
99	1.76	1.09	1.12	0.83	1.21	1.69	2.27	2.45	1.16	1.81	2.14	1.01	1.86
119	0.80	1.38	0.31	0.44	0.81	0.80	1.13	1.46	0.58	0.46	1.32	nd	0.97
83	0.26	0.06	0.10	0.06	0.17	0.03	0.42	0.62	0.21	0.13	0.73	0.13	0.28
97	0.39	0.15	0.11	0.25	0.16	0.41	0.38	0.73	0.20	0.26	0.35	0.15	0.36
81, 87	0.55	0.23	0.41	0.35	0.43	0.63	0.60	0.82	0.31	0.74	0.70	0.28	0.55
136	0.25	nd	0.01	0.14	0.12	0.30	0.23	0.43	0.12	nd	0.34	0.07	0.23
77,110	2.09	1.12	1.06	1.38	1.77	2.66	2.52	2.94	1.29	2.06	2.41	4.13	1.99
82	0.12	0.02	0.01	0.09	0.10	0.19	0.18	0.22	0.09	0.03	1.04	0.07	0.07
151	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
135,144	0.41	0.19	0.20	0.26	0.34	0.51	0.38	0.61	0.19	0.37	0.68	0.72	0.41
107	0.42	0.25	0.18	0.28	0.40	0.57	0.60	0.67	0.31	0.16	1.23	0.48	0.56
149,123	0.86	0.47	0.34	0.50	0.67	1.09	0.79	1.01	0.41	0.84	0.81	0.54	0.85
118	2.06	1.15	0.81	1.31	1.43	2.32	2.82	2.62	1.39	1.45	3.89	2.60	2.16
134	0.16	0.09	1.72	0.33	0.21	0.26	0.49	0.43	0.24	0.48	2.00	2.91	nd
114,131	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
146	1.18	0.49	5.33	1.64	1.26	1.65	2.64	1.94	1.30	25.24	2.82	5.48	1.73
132,153,105	8.96	4.43	8.71	11.15	8.32	11.89	17.83	14.45	8.77	10.45	14.00	9.59	12.12
141	0.50	0.03	0.09	0.69	0.36	0.63	0.29	1.01	0.14	0.23	0.27	0.47	0.69
137,130,176	0.36	0.11	10.50	0.58	0.39	0.43	0.48	0.56	0.24	18.87	0.42	4.04	0.42
138,163	4.24	2.44	4.76	5.01	4.40	5.65	7.54	6.60	3.71	3.58	6.18	4.36	5.27
158	0.46	0.20	0.07	0.33	0.63	0.60	0.64	0.73	0.31	10.29	0.30	0.87	0.49
129,178	0.71	0.29	0.31	0.72	0.81	0.94	0.88	1.11	0.43	0.30	0.70	0.64	0.80
187,182	3.27	1.86	1.67	3.01	3.01	4.05	3.78	4.86	1.86	2.62	3.17	2.49	3.68
183	1.55	0.84	0.50	1.20	1.21	1.60	1.46	2.21	0.72	0.96	1.30	0.95	1.59
128	0.39	0.31	0.17	0.34	0.40	0.26	0.47	0.60	0.23	0.17	0.59	0.42	0.45
185	0.27	0.16	0.03	0.24	0.22	0.35	0.11	0.42	0.06	0.42	0.13	0.14	0.27
174	1.35	0.28	0.20	1.21	0.88	2.00	0.59	1.96	0.29	1.12	0.52	0.35	1.19

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F14T05	F14T06	F14T07	F14T08	F14T09	F14T10	F14T11	F14T12	F14T13	F14T14	F14T15	F14T16	F14T17
Sample Extracted g	3.86	1.74	3.67	3.88	3.54	4.12	4.12	3.67	6.05	2.87	4.66	2.61	2.81
% Lipid	0.032	0.010	0.027	0.050	0.069	0.041	0.020	0.027	0.049	0.009	0.068	0.015	0.022
Day	14	14	14	14	14	14	14	14	14	14	14	14	14
Tank	5	6	7	8	9	10	11	12	13	14	15	16	17
MS222	1	4	2	3	4	2	3	3	3	4	1	4	4
PCB Treatment	1	0	0	1	1	1	0	1	0	1	0	0	1
PCBs Congeners													
177	1.06	0.49	0.27	0.95	0.84	1.53	1.03	1.45	0.51	0.69	0.83	0.48	0.98
202,171,156	0.98	0.51	0.36	0.91	0.92	1.41	1.24	1.32	0.61	0.47	0.96	0.58	0.93
157,200	nd	nd	3.97	nd	nd	nd	nd	nd	nd	16.10	nd	nd	nd
172	0.11	nd	nd	0.35	nd	0.81	0.16	0.10	0.08	nd	0.10	nd	0.11
197	0.08	0.02	0.14	0.09	nd	0.16	0.12	0.12	0.06	nd	0.08	nd	0.08
180	3.39	1.73	0.90	1.59	3.44	5.49	3.02	4.25	1.48	3.55	1.69	1.12	2.04
193	0.40	0.66	0.56	0.34	nd	0.81	0.58	0.92	0.29	nd	0.48	0.25	0.32
191	0.09	nd	nd	nd	nd	0.19	0.02	0.11	0.01	nd	0.11	0.07	nd
199	0.09	0.02	0.03	0.10	nd	0.16	0.02	0.12	0.01	0.10	0.03	nd	0.09
170,190	2.24	0.72	0.60	0.98	1.60	3.59	1.78	2.18	0.87	1.63	1.10	0.88	1.30
198	0.08	nd	nd	0.04	nd	0.15	0.06	0.08	0.03	nd	nd	0.28	nd
201	2.44	0.89	0.47	1.06	1.82	4.18	1.54	2.35	0.76	1.71	1.02	0.93	1.35
203,196	2.42	0.80	0.50	1.11	1.65	4.32	1.41	2.28	0.69	2.12	0.96	0.67	1.25
208,195	1.78	0.93	1.26	1.20	1.54	3.35	1.43	1.50	0.70	0.61	1.16	0.95	0.95
207	0.19	0.11	0.48	0.14	nd	0.42	0.15	0.18	0.07	0.51	0.19	0.16	0.12
194	0.47	0.43	0.09	0.19	0.32	1.16	0.21	0.40	0.10	0.40	0.14	0.11	0.22
205	nd	nd	nd	0.08	nd	nd	nd	nd	nd	nd	nd	nd	nd
206	0.49	1.80	nd	1.05	4.92	1.47	0.54	0.48	0.27	nd	2.95	0.27	0.29
Total PCBs	96.02	46.80	83.89	75.90	79.40	136.60	99.36	125.32	49.82	164.02	97.20	87.45	98.44
Surrogate Recoveries													
PCB 14	0.78	0.37	0.54	0.94	0.88	0.34	0.75	0.85	0.64	0.01	1.17	0.60	0.61
PCB 166	0.58	0.28	0.39	0.67	0.65	0.26	0.58	0.57	0.52	-	0.89	0.54	0.56

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F14T18	F14T19	F14T20	F14T21	F14T22	F14T23	F14T24	F28T01	F28T02	F28T03	F28T04	F28T05	F28T06
Sample Extracted g	3.29	2.67	4.14	3.82	3.76	2.91	3.05	2.93	4.77	3.29	4.24	5.50	3.80
% Lipid	0.045	0.030	0.047	0.044	0.050	0.017	0.023	0.036	0.070	0.040	0.058	0.067	0.039
Day	14	14	14	14	14	14	14	28	28	28	28	28	28
Tank	18	19	20	21	22	23	24	1	2	3	4	5	6
MS222	2	3	2	1	2	1	1	2	4	3	1	1	4
PCB Treatment	1	1	0	1	1	1	0	0	0	0	0	1	0
PCBs Congeners													
1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4,10	6.50	4.08	3.29	7.97	8.82	5.39	0.48	nd	3.67	3.93	2.33	3.37	1.21
7,9	0.15	0.30	0.36	0.33	0.47	0.20	0.08	nd	0.34	0.15	0.19	0.18	0.32
6	0.08	0.10	0.33	nd	0.79	nd	nd	nd	0.11	nd	0.15	0.19	0.09
8,5	3.57	3.28	2.40	1.48	6.74	1.43	0.15	nd	0.94	0.98	1.07	2.60	1.26
19	0.35	nd	0.09	nd	0.30	nd	nd	nd	0.18	nd	0.09	0.10	0.04
12,13	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
18	0.15	0.19	0.91	0.07	1.99	0.86	0.02	nd	0.21	0.07	0.35	0.89	0.54
17	0.24	0.28	0.50	0.17	0.92	0.42	0.06	nd	0.20	0.05	0.22	0.41	0.29
24	0.02	nd	0.04	nd	0.06	0.03	nd	nd	0.01	0.01	0.02	0.03	0.03
16,32	1.24	1.11	0.89	1.27	1.67	0.86	0.08	nd	0.47	0.41	0.53	1.21	0.63
29	0.01	nd	0.06	nd	nd	nd	nd	nd	0.03	0.03	0.04	0.02	0.01
26	0.17	0.26	0.33	0.07	0.31	0.21	0.08	nd	0.17	0.19	0.19	0.19	0.18
25	0.36	0.35	0.31	0.35	0.31	0.19	0.07	nd	0.24	0.27	0.28	0.23	0.24
31, 28	8.35	6.52	3.15	9.20	4.28	4.08	0.62	nd	1.46	2.63	2.40	3.69	2.42
33,21,53	1.58	0.66	0.83	0.46	1.22	0.68	0.07	nd	0.52	0.28	0.52	0.86	0.65
51	0.23	0.18	nd	0.16	0.06	0.05	0.03	nd	0.04	0.03	0.04	0.08	0.05
22	2.33	1.70	0.72	2.03	0.83	0.83	0.13	nd	0.59	0.60	0.62	1.35	0.81
45	0.60	0.54	0.15	0.35	0.20	0.27	0.04	nd	0.08	0.07	0.11	0.26	0.15
46	0.15	0.30	0.21	nd	0.08	0.11	nd	nd	0.10	nd	0.07	0.06	0.14
52	1.31	1.10	1.14	0.50	1.51	1.93	0.27	nd	0.81	0.37	0.75	1.41	0.99
49	1.91	1.90	1.06	1.72	1.06	1.51	0.24	nd	0.72	0.67	0.72	1.36	0.77
47,48	1.91	2.10	1.33	2.22	0.92	1.41	0.27	nd	0.78	0.81	0.77	1.55	0.81
44	2.42	2.15	1.20	1.96	1.21	1.72	0.17	nd	0.67	0.57	0.68	1.65	0.84
37,42	1.70	1.02	1.03	1.40	0.60	0.96	0.12	nd	0.48	0.35	0.48	1.03	0.67
41,64,71	3.94	3.23	2.11	4.16	1.12	1.91	0.19	nd	0.87	0.82	0.93	2.54	1.15
40	0.86	0.67	0.83	0.55	0.21	0.35	0.04	nd	0.26	0.12	0.27	0.42	0.46
100	0.85	0.69	0.54	0.47	0.05	0.25	0.03	nd	0.19	0.08	0.17	0.20	0.29
63	0.65	0.56	0.63	0.38	0.03	0.30	0.02	nd	0.20	0.05	0.20	0.30	0.39
74	2.41	1.94	1.53	2.48	0.39	1.18	0.14	nd	0.60	0.42	0.58	1.52	0.83
70,76	4.93	3.90	2.20	5.22	1.04	2.46	0.26	nd	1.14	0.96	1.10	3.10	1.40

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F14T18	F14T19	F14T20	F14T21	F14T22	F14T23	F14T24	F28T01	F28T02	F28T03	F28T04	F28T05	F28T06
Sample Extracted g	3.29	2.67	4.14	3.82	3.76	2.91	3.05	2.93	4.77	3.29	4.24	5.50	3.80
% Lipid	0.045	0.030	0.047	0.044	0.050	0.017	0.023	0.036	0.070	0.040	0.058	0.067	0.039
Day	14	14	14	14	14	14	14	28	28	28	28	28	28
Tank	18	19	20	21	22	23	24	1	2	3	4	5	6
MS222	2	3	2	1	2	1	1	2	4	3	1	1	4
PCB Treatment	1	1	0	1	1	1	0	0	0	0	0	1	0
PCBs Congeners													
66,95	7.71	7.02	4.02	9.35	2.03	5.17	0.77	nd	2.47	2.41	2.55	5.26	2.56
91	1.25	0.71	1.13	1.23	0.27	0.69	0.14	nd	0.52	0.39	0.43	0.65	0.63
56,60	3.67	2.69	3.65	3.46	0.58	1.58	0.55	nd	1.95	1.82	1.91	2.26	2.24
92,84 (89)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
101	1.84	1.94	1.83	1.77	0.63	2.03	0.45	nd	1.10	0.99	1.06	1.20	1.12
99	2.25	2.35	2.02	2.66	0.46	1.91	0.40	nd	1.09	1.21	1.05	1.21	1.17
119	1.08	1.04	1.23	1.09	0.20	0.70	0.19	nd	0.63	0.74	0.62	0.61	0.83
83	0.28	0.52	0.61	0.16	0.04	0.09	0.03	nd	0.07	0.08	0.10	0.09	0.26
97	0.44	0.50	0.49	0.64	0.12	0.30	0.05	nd	0.18	0.23	0.19	0.29	0.19
81, 87	0.73	0.80	0.67	0.86	0.14	0.51	0.12	nd	0.24	0.31	0.26	0.41	0.35
136	0.33	0.33	0.35	0.40	0.10	0.19	0.03	nd	0.10	0.14	0.11	0.23	0.14
77,110	2.99	2.60	2.41	3.80	0.58	2.17	0.50	nd	1.29	1.63	1.32	1.83	1.27
82	0.23	0.17	0.46	0.11	nd	0.08	0.02	nd	0.06	0.08	0.06	0.13	0.13
151	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
135,144	0.62	0.53	0.66	0.72	0.11	0.36	0.07	nd	0.21	0.28	0.24	0.41	0.24
107	0.58	0.57	1.06	0.70	0.07	0.54	0.13	nd	0.34	0.41	0.34	0.35	0.36
149,123	1.23	1.11	0.69	1.56	0.24	0.93	0.19	nd	0.46	0.57	0.45	0.73	0.35
118	2.46	2.98	2.93	2.91	0.32	2.24	0.71	nd	1.31	1.24	0.97	1.50	1.00
134	0.40	0.59	1.37	0.52	0.38	0.26	0.13	nd	0.18	0.25	0.18	0.35	0.17
114,131	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
146	2.35	2.33	2.18	2.85	1.65	3.24	0.88	nd	1.32	1.80	1.23	1.72	1.19
132,153,105	17.18	16.82	9.31	21.31	12.65	24.04	5.58	nd	8.02	10.80	7.13	12.22	6.88
141	1.41	1.21	0.44	1.39	1.06	0.71	0.09	nd	0.13	0.30	0.20	1.18	0.17
137,130,176	0.72	0.68	0.42	0.88	0.61	0.72	0.16	nd	0.29	0.38	0.26	0.55	0.19
138,163	7.59	7.42	4.46	9.42	5.37	9.35	2.39	nd	3.89	4.95	3.43	5.52	3.24
158	0.80	0.62	0.69	0.99	nd	0.92	0.22	nd	0.38	0.46	0.39	0.60	0.31
129,178	1.32	1.29	0.71	1.64	0.94	1.29	0.27	nd	0.47	0.59	0.45	1.07	0.39
187,182	5.31	5.60	2.45	6.98	4.53	5.82	1.40	nd	1.99	2.51	1.73	4.06	1.72
183	2.18	2.55	1.10	3.18	1.88	2.15	0.55	nd	0.78	0.97	0.69	1.88	0.66
128	0.52	0.64	0.50	0.76	0.40	0.39	0.22	nd	0.30	0.37	0.29	0.36	0.27
185	0.44	0.48	0.20	0.59	0.31	0.30	0.07	nd	0.09	0.13	0.14	0.43	0.10
174	2.47	2.16	0.53	2.91	1.82	1.63	0.22	nd	0.39	0.45	0.34	2.12	0.29

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F14T18	F14T19	F14T20	F14T21	F14T22	F14T23	F14T24	F28T01	F28T02	F28T03	F28T04	F28T05	F28T06
Sample Extracted g	3.29	2.67	4.14	3.82	3.76	2.91	3.05	2.93	4.77	3.29	4.24	5.50	3.80
% Lipid	0.045	0.030	0.047	0.044	0.050	0.017	0.023	0.036	0.070	0.040	0.058	0.067	0.039
Day	14	14	14	14	14	14	14	28	28	28	28	28	28
Tank	18	19	20	21	22	23	24	1	2	3	4	5	6
MS222	2	3	2	1	2	1	1	2	4	3	1	1	4
PCB Treatment	1	1	0	1	1	1	0	0	0	0	0	1	0
PCBs Congeners													
177	1.74	1.53	0.71	2.03	1.17	1.51	0.27	nd	0.56	0.64	0.49	1.43	0.44
202,171,156	1.52	1.41	0.91	1.82	1.11	1.38	0.33	nd	0.75	0.80	0.61	1.27	0.56
157,200	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
172	0.19	0.11	0.08	0.15	nd	0.05	0.01	nd	nd	0.11	0.06	0.17	0.04
197	0.12	0.13	0.07	0.05	nd	0.03	nd	nd	0.08	nd	nd	0.03	0.02
180	4.19	4.01	2.27	6.77	5.20	3.33	0.80	nd	1.27	1.76	1.34	5.55	1.33
193	0.57	0.54	0.52	nd	nd	0.27	nd	nd	0.42	0.37	0.32	0.45	0.50
191	0.11	nd	0.01	0.12	nd	0.15	nd	nd	nd	nd	nd	nd	nd
199	0.15	0.13	0.02	0.17	0.14	0.09	nd	nd	nd	nd	nd	0.15	nd
170,190	2.53	2.18	1.96	2.98	2.69	1.79	0.34	nd	1.21	1.19	0.93	2.96	0.89
198	0.10	0.09	0.06	0.11	nd	nd	nd	nd	nd	nd	nd	0.14	nd
201	2.65	2.38	2.11	3.36	3.16	1.83	0.31	nd	1.17	1.18	0.91	3.43	0.92
203,196	2.62	2.30	2.07	3.32	3.33	1.72	0.27	nd	1.09	1.07	0.92	3.64	0.85
208,195	1.72	1.47	2.69	2.24	3.10	1.13	0.31	nd	1.39	1.44	1.13	2.49	1.08
207	0.20	0.13	0.33	0.22	nd	0.12	0.03	nd	0.18	nd	0.15	0.31	0.13
194	0.52	0.41	0.89	0.68	1.24	0.31	0.06	nd	0.27	0.30	0.23	1.09	0.22
205	nd	nd	0.13	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
206	0.65	0.51	18.44	0.81	5.34	0.40	0.15	nd	0.93	1.09	0.85	1.41	0.75
Total PCBs	138.93	124.70	110.03	154.64	101.21	114.02	23.06	0.00	55.64	61.36	51.91	104.53	53.82
Surrogate Recoveries													
PCB 14	0.58	0.81	0.96	0.00	0.65	0.60	1.51	0.00	1.07	1.14	0.81	1.18	1.41
PCB 166	0.48	0.60	0.78	0.00	0.61	0.49	1.23	0.00	0.82	1.13	0.65	1.05	1.29

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F28T07	F28T08	F28T09	F28T10	F28T11	F28T12	F28T13	F28T14	F28T15	F28T16	F28T17	F28T18	F28T19
Sample Extracted g	4.90	4.57	3.23	3.85	4.11	3.72	3.16	3.02	2.94	4.65	3.24	2.94	3.64
% Lipid	0.043	0.055	0.052	0.040	0.050	0.040	0.027	0.029	0.064	0.035	0.041	0.043	0.026
Day	28	28	28	28	28	28	28	28	28	28	28	28	28
Tank	7	8	9	10	11	12	13	14	15	16	17	18	19
MS222	2	3	4	2	3	3	3	4	1	4	4	2	3
PCB Treatment	0	1	1	1	0	1	0	1	0	0	1	1	1
PCBs Congeners													
1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4,10	4.70	5.43	1.90	4.29	4.93	1.66	0.88	0.99	0.28	0.66	0.97	2.20	4.53
7,9	0.28	0.39	0.62	0.23	0.40	0.11	0.09	0.14	0.22	0.21	0.26	0.15	0.18
6	0.16	0.41	0.57	0.30	0.24	0.09	0.06	0.17	nd	0.12	0.23	0.25	0.05
8,5	1.60	3.90	4.50	3.59	1.19	1.20	1.07	2.72	nd	1.41	3.60	4.46	2.80
19	0.13	0.16	nd	0.09	0.28	0.15	nd	0.08	nd	0.13	0.22	0.13	nd
12,13	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
18	0.36	1.87	0.26	1.26	0.07	0.36	0.50	0.86	0.52	0.44	0.98	1.17	0.22
17	0.19	0.91	0.34	0.68	0.12	0.18	0.30	0.57	nd	0.24	0.48	0.74	0.35
24	0.01	0.08	0.01	0.04	0.02	0.02	0.03	0.04	nd	0.02	0.03	0.05	0.01
16,32	0.69	1.83	0.80	1.38	0.38	0.86	0.58	1.10	0.25	0.61	1.17	1.57	1.04
29	0.02	nd	nd	0.01	0.13	0.01	0.01	nd	nd	0.02	nd	nd	nd
26	0.18	0.44	0.35	0.32	0.19	0.14	0.14	0.27	0.20	0.16	0.35	0.46	0.26
25	0.32	0.37	0.31	0.27	0.29	0.19	0.23	0.24	0.26	0.24	0.33	0.40	0.28
31, 28	3.58	4.18	2.92	3.38	1.10	3.38	3.75	4.20	3.36	2.84	5.94	7.26	7.43
33,21,53	0.45	2.01	0.57	1.24	0.19	0.39	0.36	0.81	nd	0.60	0.67	1.81	0.77
51	0.01	0.12	0.07	0.07	0.06	0.07	0.05	0.08	nd	0.06	0.09	0.13	0.09
22	0.66	1.92	1.39	1.28	0.61	1.23	0.51	1.37	0.44	0.74	1.75	1.83	1.72
45	0.05	0.37	0.37	0.32	0.11	0.21	0.18	0.27	0.49	0.14	0.15	0.40	0.25
46	0.01	0.18	0.31	0.08	0.13	0.05	0.02	0.06	nd	0.02	0.02	0.11	0.16
52	0.55	2.46	1.58	2.12	0.52	1.34	0.72	1.99	0.35	0.54	1.23	2.45	1.55
49	0.54	1.85	1.59	1.70	0.63	1.40	0.61	1.58	0.40	0.51	1.23	1.91	1.51
47,48	0.54	1.78	1.28	1.63	0.69	1.34	0.61	1.39	0.45	0.48	1.19	1.70	1.10
44	0.56	2.43	1.75	1.99	0.50	1.45	0.73	1.96	0.34	0.47	1.69	2.35	1.96
37,42	0.23	1.73	0.78	0.98	0.26	0.83	0.56	1.38	0.22	0.22	0.71	1.24	0.90
41,64,71	0.81	2.91	2.27	2.16	0.81	2.08	0.98	2.45	0.66	0.70	2.17	2.56	2.17
40	0.11	0.71	0.54	0.30	0.24	0.23	0.34	0.30	nd	0.12	0.20	0.35	0.28
100	0.08	0.37	0.72	0.14	0.30	0.10	0.50	0.42	nd	0.10	0.06	0.12	0.10
63	0.07	0.48	0.51	0.15	0.23	0.14	0.30	0.32	nd	0.06	0.16	0.14	0.17
74	0.36	1.84	1.44	1.24	0.53	1.27	0.77	1.36	0.24	0.30	1.14	1.41	1.34
70,76	0.98	3.84	2.93	2.83	0.95	2.87	1.18	3.09	0.55	nd	2.70	3.28	2.93

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F28T07	F28T08	F28T09	F28T10	F28T11	F28T12	F28T13	F28T14	F28T15	F28T16	F28T17	F28T18	F28T19
Sample Extracted g	4.90	4.57	3.23	3.85	4.11	3.72	3.16	3.02	2.94	4.65	3.24	2.94	3.64
% Lipid	0.043	0.055	0.052	0.040	0.050	0.040	0.027	0.029	0.064	0.035	0.041	0.043	0.026
Day	28	28	28	28	28	28	28	28	28	28	28	28	28
Tank	7	8	9	10	11	12	13	14	15	16	17	18	19
MS222	2	3	4	2	3	3	3	4	1	4	4	2	3
PCB Treatment	0	1	1	1	0	1	0	1	0	0	1	1	1
PCBs Congeners													
66,95	1.91	6.04	4.81	4.93	2.19	4.90	2.28	4.94	1.53	1.56	4.21	5.50	4.27
91	0.26	0.91	0.66	0.45	0.32	0.46	0.67	0.53	0.24	0.18	0.37	0.49	0.29
56,60	1.27	2.84	2.11	1.97	0.72	2.01	1.27	2.58	1.30	0.62	2.16	2.73	2.40
92,84 (89)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
101	0.80	1.85	1.39	1.44	0.99	1.13	nd	nd	nd	nd	nd	nd	nd
99	0.80	1.60	1.43	1.04	1.07	1.19	1.23	1.43	0.79	0.79	1.21	1.59	1.26
119	0.44	0.75	0.79	0.51	0.67	0.60	1.40	nd	0.87	0.77	0.90	1.14	1.12
83	0.08	0.21	0.37	0.08	0.21	0.05	1.41	0.49	0.58	0.52	0.45	0.63	0.65
97	0.15	0.43	0.34	0.34	0.21	0.24	0.50	0.08	0.06	0.03	0.06	0.06	0.07
81, 87	0.19	0.48	0.47	0.40	0.29	0.44	0.61	0.31	0.13	0.15	0.38	0.37	0.30
136	0.06	0.26	0.23	0.22	0.12	0.24	2.52	3.17	2.34	2.85	3.13	3.43	3.40
77,110	1.25	1.96	1.43	1.61	1.11	1.86	nd	0.17	nd	0.07	0.14	0.24	0.14
82	0.03	0.14	0.07	0.10	0.05	0.11	0.92	1.56	0.68	0.94	1.58	1.78	1.65
151	nd	nd	nd	nd	nd	nd	0.56	0.10	3.79	0.05	0.11	0.14	0.10
135,144	0.21	0.42	0.30	0.34	0.19	0.39	nd	nd	nd	nd	nd	nd	nd
107	0.27	0.36	0.22	0.28	0.28	0.34	0.66	0.28	0.08	0.15	0.30	0.38	0.33
149,123	0.44	0.81	0.55	0.64	0.37	0.70	1.09	0.28	nd	0.24	0.27	0.29	0.47
118	1.30	1.33	0.96	1.07	0.84	1.22	0.29	0.53	0.25	0.34	0.58	0.58	0.62
134	0.19	0.31	0.31	0.30	0.21	0.38	0.59	0.89	0.56	0.75	0.97	0.91	1.19
114,131	nd	nd	nd	nd	nd	nd	4.00	0.40	nd	0.30	0.44	0.58	0.39
146	1.35	1.55	1.42	1.54	1.37	1.96	nd	nd	nd	nd	nd	nd	nd
132,153,105	8.57	11.70	10.61	11.25	8.06	13.71	6.13	1.91	1.86	1.73	2.07	1.96	2.43
141	0.20	0.99	0.87	0.80	0.22	1.09	13.67	13.23	9.40	10.02	14.91	14.03	17.21
137,130,176	0.30	0.58	0.44	0.44	0.27	0.51	1.32	0.67	0.52	0.24	0.79	1.22	1.09
138,163	3.81	5.06	4.31	4.81	3.62	5.70	2.87	0.53	nd	0.29	0.58	0.61	0.65
158	0.38	0.59	0.28	0.46	0.31	0.54	5.50	5.23	3.57	4.16	5.78	5.51	6.44
129,178	0.50	0.97	0.71	0.84	0.44	1.01	1.89	0.49	nd	0.34	0.42	0.55	0.63
187,182	1.95	3.51	3.17	3.29	1.80	4.04	15.03	10.90	8.21	7.22	10.68	9.86	9.59
183	0.81	1.50	1.29	1.30	0.71	1.77	2.43	3.62	1.87	1.98	3.89	4.03	4.68
128	0.34	0.24	0.24	0.24	0.31	0.37	1.19	1.75	0.82	0.81	1.83	1.99	2.23
185	0.11	0.32	0.27	0.30	0.09	0.36	1.13	1.26	nd	1.10	1.13	1.22	1.29
174	0.33	1.61	1.39	1.53	0.31	1.78	nd	0.34	nd	0.12	0.42	0.38	0.38

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F28T07	F28T08	F28T09	F28T10	F28T11	F28T12	F28T13	F28T14	F28T15	F28T16	F28T17	F28T18	F28T19
Sample Extracted g	4.90	4.57	3.23	3.85	4.11	3.72	3.16	3.02	2.94	4.65	3.24	2.94	3.64
% Lipid	0.043	0.055	0.052	0.040	0.050	0.040	0.027	0.029	0.064	0.035	0.041	0.043	0.026
Day	28	28	28	28	28	28	28	28	28	28	28	28	28
Tank	7	8	9	10	11	12	13	14	15	16	17	18	19
MS222	2	3	4	2	3	3	3	4	1	4	4	2	3
PCB Treatment	0	1	1	1	0	1	0	1	0	0	1	1	1
PCBs Congeners													
177	0.47	1.11	0.96	1.09	0.40	1.29	0.25	1.41	nd	0.32	1.51	1.66	1.68
202,171,156	0.56	0.98	0.91	1.01	0.59	1.20	0.31	0.95	0.36	0.45	0.99	1.09	1.25
157,200	nd	nd	nd	nd	nd	nd	0.41	0.84	nd	0.55	0.89	0.95	1.11
172	0.25	0.10	0.09	0.11	0.12	0.19	15.78	12.76	77.70	10.79	22.00	11.28	15.21
197	0.07	0.06	0.09	0.04	0.04	0.10	nd	0.09	nd	0.07	0.08	0.10	0.11
180	1.00	2.90	3.36	4.28	1.36	4.96	nd	0.06	nd	nd	0.05	0.06	0.08
193	0.30	0.37	0.31	0.37	0.38	0.47	0.84	3.13	1.04	1.12	3.06	3.63	4.18
191	nd	0.01	nd	nd	nd	nd	nd	0.05	nd	0.23	0.08	0.20	0.35
199	0.02	0.09	0.12	0.12	nd	0.13	nd	nd	nd	nd	nd	nd	nd
170,190	0.58	1.30	1.86	2.23	0.88	2.63	nd	0.07	nd	nd	0.08	0.09	0.08
198	nd	0.05	nd	nd	nd	0.12	0.56	1.79	nd	0.80	1.76	1.80	2.31
201	0.55	1.48	2.23	2.53	0.88	3.09	nd	nd	nd	nd	nd	nd	nd
203,196	0.49	1.46	2.36	2.63	0.90	3.14	0.58	2.03	nd	0.74	2.05	2.11	2.66
208,195	0.58	0.95	1.83	1.84	1.15	2.35	0.59	2.15	nd	0.70	2.14	2.25	2.68
207	0.06	0.10	nd	nd	nd	0.26	nd	1.75	nd	0.88	1.59	1.67	2.07
194	0.08	0.32	0.76	0.93	0.24	0.98	nd	nd	nd	nd	nd	nd	nd
205	nd	nd	nd	nd	nd	nd	nd	0.78	nd	0.21	0.83	0.78	0.93
206	0.29	0.42	1.05	1.23	1.00	1.35	nd	nd	nd	nd	nd	nd	nd
Total PCBs	51.85	106.00	88.03	94.99	51.38	94.72	106.54	115.70	127.76	67.32	126.57	130.50	134.11
Surrogate Recoveries													
PCB 14	1.13	1.14	0.53	0.82	1.06	0.69	0.92	1.17	0.50	1.30	0.79	1.31	0.79
PCB 166	1.07	1.21	0.48	0.83	1.02	0.73	1.25	1.25	0.44	1.22	0.87	1.42	0.91

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F28T20	F28T21	F28T22	F28T23	F28T24	F42T01	F42T02	F42T03	F42T04	F42T05	F42T06	F42T07	F42T08
Sample Extracted g	4.30	4.51	3.94	3.15	4.56	3.37	2.67	4.30	4.43	3.29	3.66	4.13	4.77
% Lipid	0.044	0.049	0.053	0.039	0.072	0.052	0.033	0.079	0.067	0.054	0.087	0.056	0.047
Day	28	28	28	28	28	42	42	42	42	42	42	42	42
Tank	20	21	22	23	24	1	2	3	4	5	6	7	8
MS222	2	1	2	1	1	2	4	3	1	1	4	2	3
PCB Treatment	0	1	1	1	0	0	0	0	0	1	0	0	1
PCBs Congeners													
1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4,10	0.87	0.43	3.83	0.76	2.80	nd	nd	nd	nd	nd	nd	nd	nd
7,9	0.26	0.20	0.51	0.16	0.36	0.25	nd	0.18	0.33	0.19	0.10	0.18	0.17
6	0.07	0.13	0.32	0.14	0.13	0.18	nd	0.22	0.27	0.37	0.31	0.28	0.50
8,5	0.68	2.44	4.26	1.73	1.84	1.81	nd	1.71	3.59	2.56	2.35	1.98	4.18
19	nd	0.07	0.07	0.08	0.03	nd	nd	nd	nd	nd	nd	nd	nd
12,13	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.03
18	0.23	0.44	1.54	0.49	0.18	0.96	nd	0.66	1.04	0.68	0.40	0.25	2.17
17	0.15	0.53	0.78	0.32	0.27	0.46	nd	0.38	0.72	0.36	0.30	0.20	1.11
24	0.01	0.04	0.05	0.02	0.01	0.04	nd	0.04	0.05	0.03	0.02	0.01	0.13
16,32	0.33	0.91	1.50	0.92	0.93	0.96	nd	0.87	1.55	1.20	0.76	0.57	2.23
29	nd	nd	0.00	0.01	0.00	0.03	nd	0.05	0.07	nd	0.03	nd	0.03
26	0.12	0.26	0.41	0.19	0.23	0.33	nd	0.28	0.50	0.29	0.29	0.18	0.55
25	0.19	0.22	0.38	0.22	0.29	0.48	nd	0.38	0.70	0.31	0.42	0.30	0.49
31, 28	1.80	4.76	3.91	5.00	5.42	6.40	nd	2.90	6.15	5.71	3.74	3.30	7.40
33,21,53	0.46	0.75	1.97	0.64	0.78	1.23	nd	0.47	1.31	0.79	0.63	0.33	1.78
51	0.04	0.09	0.13	0.06	0.10	0.14	nd	0.07	0.11	0.10	0.03	0.03	0.13
22	0.57	1.11	1.77	0.90	1.06	1.30	nd	0.59	1.55	1.71	1.12	0.90	2.18
45	0.06	0.24	0.38	0.15	0.14	0.26	nd	0.06	0.24	0.14	0.24	0.11	0.27
46	0.08	0.07	0.20	0.03	0.06	0.27	nd	0.11	0.06	0.13	0.14	0.03	0.11
52	0.79	2.29	2.61	1.14	1.11	1.79	nd	1.14	2.12	1.63	0.69	0.73	2.04
49	0.86	1.75	2.10	1.20	1.36	1.41	nd	0.77	1.71	1.60	0.84	0.75	1.55
47,48	2.02	1.86	3.23	1.05	1.19	1.45	nd	0.61	1.48	1.26	0.73	0.63	1.22
44	0.59	1.95	2.37	1.42	1.58	1.39	nd	0.79	1.63	1.89	0.85	0.72	2.24
37,42	0.43	1.13	1.55	0.70	0.91	1.18	nd	0.33	0.89	0.96	0.42	0.35	0.68
41,64,71	0.85	2.16	2.82	1.84	1.73	2.07	nd	0.84	1.75	2.76	1.24	0.86	2.48
40	0.24	0.27	0.60	0.20	0.21	0.79	nd	0.15	0.33	0.42	0.36	0.18	0.39
100	0.32	0.07	0.54	0.10	0.11	0.54	nd	0.08	0.18	0.20	0.27	0.14	0.07
63	0.20	0.11	0.41	0.10	0.08	0.69	nd	0.10	0.12	0.32	0.32	0.10	0.15
74	0.59	1.22	1.71	0.98	0.92	1.52	nd	0.46	0.91	1.63	0.77	0.51	1.33
70,76	0.98	2.66	3.79	2.15	2.13	2.37	nd	1.11	2.02	3.12	1.38	0.99	3.14

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F28T20	F28T21	F28T22	F28T23	F28T24	F42T01	F42T02	F42T03	F42T04	F42T05	F42T06	F42T07	F42T08
Sample Extracted g	4.30	4.51	3.94	3.15	4.56	3.37	2.67	4.30	4.43	3.29	3.66	4.13	4.77
% Lipid	0.044	0.049	0.053	0.039	0.072	0.052	0.033	0.079	0.067	0.054	0.087	0.056	0.047
Day	28	28	28	28	28	42	42	42	42	42	42	42	42
Tank	20	21	22	23	24	1	2	3	4	5	6	7	8
MS222	2	1	2	1	1	2	4	3	1	1	4	2	3
PCB Treatment	0	1	1	1	0	0	0	0	0	1	0	0	1
PCBs Congeners													
66,95	2.35	5.18	6.28	3.72	3.83	4.90	nd	2.89	5.41	5.72	2.66	2.38	4.52
91	0.48	0.47	0.88	0.32	0.35	1.28	nd	0.38	0.78	0.49	0.44	0.33	0.37
56,60	1.79	1.68	2.76	1.68	2.01	1.47	nd	1.28	1.40	2.49	1.18	0.21	2.74
92,84 (89)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
101	1.11	1.58	2.07	nd	nd	1.75	nd	1.60	2.64	1.33	1.11	1.06	1.43
99	1.04	1.12	1.64	1.05	1.22	1.24	nd	1.47	2.39	1.24	1.32	1.08	0.97
119	0.52	0.48	0.77	0.82	1.09	1.06	nd	1.02	1.65	0.68	0.96	0.74	0.57
83	0.06	0.03	0.18	0.38	0.75	0.14	nd	0.15	0.15	0.20	0.26	0.12	0.26
97	0.18	0.36	0.50	0.07	0.11	0.42	nd	0.31	0.48	0.36	0.27	0.20	0.43
81, 87	0.25	0.41	0.51	0.27	0.36	0.22	nd	0.36	0.56	0.50	0.34	0.28	0.51
136	0.10	0.24	0.31	2.97	4.27	0.11	nd	0.15	0.26	0.25	0.12	0.11	0.26
77,110	1.30	1.91	2.31	0.07	0.15	1.67	nd	1.71	2.87	1.76	1.14	1.21	1.79
82	0.16	0.14	0.18	1.42	1.77	0.19	nd	0.09	0.15	0.11	0.05	0.06	0.13
151	nd	nd	nd	0.06	0.09	nd	nd	nd	nd	nd	nd	nd	nd
135,144	0.29	0.42	0.58	nd	nd	0.30	nd	0.30	0.50	0.37	0.17	0.20	0.37
107	0.56	0.37	0.66	0.30	0.31	0.21	nd	0.44	0.69	0.27	0.25	0.28	0.33
149,123	0.52	0.86	1.05	0.26	0.34	0.48	nd	0.53	0.92	0.65	0.34	0.38	0.65
118	1.23	1.14	1.90	0.46	0.41	0.91	nd	1.47	1.81	1.20	0.76	0.96	1.28
134	0.51	0.31	0.71	0.70	0.71	1.77	nd	0.83	1.13	0.67	0.40	0.47	0.77
114,131	nd	nd	nd	0.52	0.44	nd	nd	nd	nd	nd	nd	nd	nd
146	1.05	1.28	1.53	nd	nd	4.31	nd	4.09	5.33	2.54	2.10	2.50	2.85
132,153,105	5.70	9.55	10.49	1.91	2.07	24.30	nd	21.97	30.38	18.55	12.18	14.11	19.98
141	0.16	0.77	1.00	12.98	13.11	0.68	nd	0.63	0.89	1.74	0.30	0.42	1.54
137,130,176	0.21	0.42	0.51	1.07	0.73	1.01	nd	0.93	1.07	0.80	0.40	0.51	1.08
138,163	2.54	4.07	4.73	0.61	0.54	9.50	nd	9.38	12.43	7.17	5.04	5.98	8.30
158	0.23	0.39	0.50	5.14	5.24	0.38	nd	0.90	1.04	0.64	0.33	0.54	0.74
129,178	0.33	0.76	0.84	0.53	0.52	1.09	nd	1.15	1.44	1.27	0.55	0.70	1.53
187,182	1.36	3.04	3.12	10.13	6.90	4.01	nd	4.19	5.75	5.02	2.31	2.66	5.72
183	0.54	1.40	1.29	3.54	3.08	4.37	nd	1.81	2.38	2.28	0.95	0.91	2.97
128	0.24	0.29	0.31	1.68	1.46	7.30	nd	2.66	3.25	1.17	1.35	1.30	2.03
185	0.08	0.28	0.28	0.85	1.19	nd	nd	0.28	0.39	0.45	0.13	0.12	0.64
174	0.23	1.34	1.43	0.44	0.27	nd	nd	0.73	0.95	2.26	0.35	0.47	2.49

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F28T20	F28T21	F28T22	F28T23	F28T24	F42T01	F42T02	F42T03	F42T04	F42T05	F42T06	F42T07	F42T08
Sample Extracted g	4.30	4.51	3.94	3.15	4.56	3.37	2.67	4.30	4.43	3.29	3.66	4.13	4.77
% Lipid	0.044	0.049	0.053	0.039	0.072	0.052	0.033	0.079	0.067	0.054	0.087	0.056	0.047
Day	28	28	28	28	28	42	42	42	42	42	42	42	42
Tank	20	21	22	23	24	1	2	3	4	5	6	7	8
MS222	2	1	2	1	1	2	4	3	1	1	4	2	3
PCB Treatment	0	1	1	1	0	0	0	0	0	1	0	0	1
PCBs Congeners													
177	0.32	0.92	1.02	1.49	1.09	nd	nd	1.07	1.09	1.49	0.51	0.64	1.75
202,171,156	0.38	0.79	0.92	0.91	0.82	nd	nd	1.30	1.56	1.31	0.66	0.85	1.56
157,200	nd	nd	nd	0.79	0.78	3.41	nd	1.13	0.48	1.91	0.61	0.67	1.64
172	0.02	0.03	0.10	10.75	5.99	nd	nd	0.14	0.21	0.18	0.08	0.09	0.58
197	0.03	0.01	0.07	0.03	0.26	nd	nd	0.11	nd	0.09	nd	nd	0.09
180	0.61	2.20	2.54	0.07	0.05	2.88	nd	1.81	3.25	5.21	1.28	1.73	5.46
193	0.14	0.27	0.25	2.54	2.43	1.11	nd	0.13	1.17	0.48	0.60	0.72	0.95
191	nd	0.06	0.05	0.28	0.32	nd	nd	nd	nd	nd	nd	nd	0.08
199	0.01	0.07	0.08	nd	nd	nd	nd	nd	nd	0.12	nd	nd	0.15
170,190	0.36	1.08	1.25	0.07	0.05	1.90	nd	1.72	2.13	2.88	0.86	1.22	3.33
198	nd	0.05	0.05	1.47	1.35	nd	nd	nd	nd	0.17	nd	nd	0.11
201	0.34	1.21	1.36	nd	nd	2.06	nd	1.81	2.23	3.56	0.91	1.29	3.96
203,196	0.29	1.19	1.33	1.72	1.52	1.89	nd	1.68	2.20	3.66	0.93	1.25	4.19
208,195	0.35	0.78	0.90	1.81	1.57	2.59	nd	2.34	2.76	2.70	1.22	1.67	3.15
207	0.03	0.08	0.08	1.25	1.37	0.32	nd	0.26	nd	0.35	0.13	0.19	0.33
194	0.05	0.27	0.27	nd	0.13	0.53	nd	0.55	0.56	1.34	0.21	0.37	1.43
205	nd	nd	nd	0.62	0.58	nd	nd	nd	nd	nd	nd	nd	nd
206	0.17	0.35	0.39	nd	nd	2.61	nd	2.21	2.73	1.72	1.23	1.59	1.97
Total PCBs	42.06	77.78	103.75	100.45	97.57	179.67	0.00	126.45	184.67	135.81	81.53	95.04	184.64
Surrogate Recoveries													
PCB 14	1.24	1.29	1.10	1.17	1.02	0.92	0.81	1.09	0.01	0.78	0.54	0.94	0.88
PCB 166	1.47	1.50	1.31	1.31	1.32	0.69	0.61	0.80	-	0.58	0.39	0.67	0.65

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F42T09	F42T10	F42T11	F42T12	F42T13	F42T14	F42T15	F42T16	F42T17	F42T18	F42T19	F42T20	F42T21
Sample Extracted g	4.56	4.79	3.38	3.34	2.89	3.74	2.98	2.25	3.52	3.40	4.55	4.07	3.45
% Lipid	0.032	0.022	0.026	0.065	0.040	0.042	0.050	0.024	0.039	0.039	0.051	0.066	0.065
Day	42	42	42	42	42	42	42	42	42	42	42	42	42
Tank	9	10	11	12	13	14	15	16	17	18	19	20	21
MS222	4	2	3	3	3	4	1	4	4	2	3	2	1
PCB Treatment	1	1	0	1	0	1	0	0	1	1	1	0	1
PCBs Congeners													
1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4,10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
7,9	0.74	0.19	0.12	nd	nd	nd	nd	nd	0.16	0.07	nd	nd	nd
6	0.61	0.11	0.18	nd	nd	nd	nd	nd	0.12	0.13	nd	nd	nd
8,5	7.28	2.87	0.18	nd	nd	nd	nd	nd	1.94	1.54	nd	nd	nd
19	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
12,13	nd	nd	0.02	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
18	1.84	0.05	0.35	nd	nd	nd	nd	nd	0.39	0.13	nd	nd	nd
17	1.02	0.10	0.21	nd	nd	nd	nd	nd	0.37	0.18	nd	nd	nd
24	0.05	nd	0.05	nd	nd	nd	nd	nd	0.01	0.01	nd	nd	nd
16,32	2.52	1.34	0.35	nd	nd	nd	nd	nd	0.84	0.45	nd	nd	nd
29	0.05	0.02	0.01	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
26	0.52	0.07	0.10	nd	nd	nd	nd	nd	0.21	0.15	nd	nd	nd
25	0.55	0.30	0.12	nd	nd	nd	nd	nd	0.21	0.14	nd	nd	nd
31, 28	13.37	10.24	1.16	nd	nd	nd	nd	nd	5.97	3.92	nd	nd	nd
33,21,53	1.78	0.38	0.08	nd	nd	nd	nd	nd	0.52	0.26	nd	nd	nd
51	0.20	0.14	0.08	nd	nd	nd	nd	nd	0.08	0.05	nd	nd	nd
22	3.17	2.22	0.48	nd	nd	nd	nd	nd	1.29	0.77	nd	nd	nd
45	0.60	0.17	0.06	nd	nd	nd	nd	nd	0.23	0.13	nd	nd	nd
46	0.11	0.02	0.02	nd	nd	nd	nd	nd	0.04	0.04	nd	nd	nd
52	3.44	0.48	0.29	nd	nd	nd	nd	nd	1.59	1.41	nd	nd	nd
49	3.36	1.30	0.26	nd	nd	nd	nd	nd	1.52	1.08	nd	nd	nd
47,48	2.75	1.67	0.26	nd	nd	nd	nd	nd	1.21	1.41	nd	nd	nd
44	3.91	1.30	0.22	nd	nd	nd	nd	nd	1.68	1.14	nd	nd	nd
37,42	1.94	0.91	0.07	nd	nd	nd	nd	nd	0.84	0.58	nd	nd	nd
41,64,71	5.04	3.53	0.29	nd	nd	nd	nd	nd	2.10	1.27	nd	nd	nd
40	0.66	0.31	0.05	nd	nd	nd	nd	nd	0.26	0.18	nd	nd	nd
100	0.24	0.14	0.05	nd	nd	nd	nd	nd	0.10	0.12	nd	nd	nd
63	0.39	0.15	0.12	nd	nd	nd	nd	nd	0.15	0.14	nd	nd	nd
74	3.04	1.98	0.19	nd	nd	nd	nd	nd	1.34	1.00	nd	nd	nd
70,76	6.82	4.01	0.50	nd	nd	nd	nd	nd	3.28	2.05	nd	nd	nd

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F42T09	F42T10	F42T11	F42T12	F42T13	F42T14	F42T15	F42T16	F42T17	F42T18	F42T19	F42T20	F42T21
Sample Extracted g	4.56	4.79	3.38	3.34	2.89	3.74	2.98	2.25	3.52	3.40	4.55	4.07	3.45
% Lipid	0.032	0.022	0.026	0.065	0.040	0.042	0.050	0.024	0.039	0.039	0.051	0.066	0.065
Day	42	42	42	42	42	42	42	42	42	42	42	42	42
Tank	9	10	11	12	13	14	15	16	17	18	19	20	21
MS222	4	2	3	3	3	4	1	4	4	2	3	2	1
PCB Treatment	1	1	0	1	0	1	0	0	1	1	1	0	1
PCBs Congeners													
66,95	10.96	5.86	1.17	nd	nd	nd	nd	nd	5.22	3.82	nd	nd	nd
91	1.02	0.52	0.07	nd	nd	nd	nd	nd	0.48	0.34	nd	nd	nd
56,60	5.54	3.06	0.40	nd	nd	nd	nd	nd	2.52	1.68	nd	nd	nd
92,84 (89)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
101	3.03	1.08	0.52	nd	nd	nd	nd	nd	1.48	1.13	nd	nd	nd
99	2.58	1.52	0.44	nd	nd	nd	nd	nd	1.24	0.92	nd	nd	nd
119	1.34	0.93	0.27	nd	nd	nd	nd	nd	0.68	0.49	nd	nd	nd
83	0.18	0.11	0.01	nd	nd	nd	nd	nd	0.11	0.09	nd	nd	nd
97	0.73	0.47	0.17	nd	nd	nd	nd	nd	0.36	0.20	nd	nd	nd
81, 87	0.96	0.61	0.17	nd	nd	nd	nd	nd	0.48	0.35	nd	nd	nd
136	0.50	0.24	0.03	nd	nd	nd	nd	nd	0.21	0.15	nd	nd	nd
77,110	4.02	2.92	0.65	nd	nd	nd	nd	nd	1.92	1.33	nd	nd	nd
82	0.26	0.23	0.02	nd	nd	nd	nd	nd	0.05	0.08	nd	nd	nd
151	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
135,144	0.91	0.68	0.07	nd	nd	nd	nd	nd	0.41	0.29	nd	nd	nd
107	0.73	0.61	0.27	nd	nd	nd	nd	nd	0.35	0.26	nd	nd	nd
149,123	1.66	1.26	0.24	nd	nd	nd	nd	nd	0.85	0.58	nd	nd	nd
118	2.94	2.64	0.69	nd	nd	nd	nd	nd	1.52	1.28	nd	nd	nd
134	0.50	0.41	0.10	nd	nd	nd	nd	nd	0.24	0.12	nd	nd	nd
114,131	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
146	2.69	2.03	0.79	nd	nd	nd	nd	nd	1.40	0.87	nd	nd	nd
132,153,105	20.12	15.16	4.81	nd	nd	nd	nd	nd	10.74	6.57	nd	nd	nd
141	1.71	1.25	0.10	nd	nd	nd	nd	nd	0.72	0.38	nd	nd	nd
137,130,176	0.95	0.76	0.18	nd	nd	nd	nd	nd	0.47	0.28	nd	nd	nd
138,163	9.34	7.48	2.22	nd	nd	nd	nd	nd	4.79	2.97	nd	nd	nd
158	0.93	0.84	0.08	nd	nd	nd	nd	nd	0.48	0.28	nd	nd	nd
129,178	1.80	1.52	0.23	nd	nd	nd	nd	nd	0.96	0.59	nd	nd	nd
187,182	7.57	6.18	1.26	nd	nd	nd	nd	nd	4.20	2.51	nd	nd	nd
183	3.86	3.28	0.53	nd	nd	nd	nd	nd	2.18	1.13	nd	nd	nd
128	2.00	1.71	0.69	nd	nd	nd	nd	nd	1.23	0.23	nd	nd	nd
185	0.76	0.71	0.06	nd	nd	nd	nd	nd	0.43	0.24	nd	nd	nd
174	4.04	3.57	0.21	nd	nd	nd	nd	nd	1.90	1.14	nd	nd	nd

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F42T09	F42T10	F42T11	F42T12	F42T13	F42T14	F42T15	F42T16	F42T17	F42T18	F42T19	F42T20	F42T21
Sample Extracted g	4.56	4.79	3.38	3.34	2.89	3.74	2.98	2.25	3.52	3.40	4.55	4.07	3.45
% Lipid	0.032	0.022	0.026	0.065	0.040	0.042	0.050	0.024	0.039	0.039	0.051	0.066	0.065
Day	42	42	42	42	42	42	42	42	42	42	42	42	42
Tank	9	10	11	12	13	14	15	16	17	18	19	20	21
MS222	4	2	3	3	3	4	1	4	4	2	3	2	1
PCB Treatment	1	1	0	1	0	1	0	0	1	1	1	0	1
PCBs Congeners													
177	2.84	2.46	0.32	nd	nd	nd	nd	nd	1.35	0.85	nd	nd	nd
202,171,156	2.54	2.19	0.41	nd	nd	nd	nd	nd	1.30	0.77	nd	nd	nd
157,200	nd	1.50	0.27	nd	nd	nd	nd	nd	1.08	0.42	nd	nd	nd
172	0.49	0.40	0.02	nd	nd	nd	nd	nd	0.16	0.13	nd	nd	nd
197	0.18	0.15	0.04	nd	nd	nd	nd	nd	0.09	0.06	nd	nd	nd
180	12.28	11.54	0.92	nd	nd	nd	nd	nd	5.23	3.94	nd	nd	nd
193	0.97	0.55	0.23	nd	nd	nd	nd	nd	0.45	nd	nd	nd	nd
191	0.19	0.18	nd	nd	nd	nd	nd	nd	0.05	0.06	nd	nd	nd
199	0.28	0.27	nd	nd	nd	nd	nd	nd	0.18	0.10	nd	nd	nd
170,190	7.39	6.41	0.72	nd	nd	nd	nd	nd	2.76	1.84	nd	nd	nd
198	0.30	0.28	nd	nd	nd	nd	nd	nd	0.12	0.07	nd	nd	nd
201	9.09	7.77	0.78	nd	nd	nd	nd	nd	3.43	2.21	nd	nd	nd
203,196	9.63	8.47	0.66	nd	nd	nd	nd	nd	3.65	2.25	nd	nd	nd
208,195	7.15	6.07	0.94	nd	nd	nd	nd	nd	2.88	1.59	nd	nd	nd
207	0.69	0.59	0.12	nd	nd	nd	nd	nd	0.22	0.14	nd	nd	nd
194	3.45	3.12	0.17	nd	nd	nd	nd	nd	1.36	0.74	nd	nd	nd
205	0.07	0.12	nd	nd	nd	nd	nd	nd	0.41	0.13	nd	nd	nd
206	4.05	3.77	0.59	nd	nd	nd	nd	nd	2.22	0.79	nd	nd	nd
Total PCBs	310.06	181.86	39.38	0.00	*	0.00	0.00	0.00	117.88	75.63	0.00	0.00	0.00
Surrogate Recoveries													
PCB 14	0.34	0.75	0.85	0.64	0.01	1.17	0.60	0.61	0.58	0.81	0.96	0.00	0.65
PCB 166	0.26	0.58	0.57	0.52	-	0.89	0.54	0.56	0.48	0.60	0.78	0.00	0.61

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F42T22	F42T23	F42T24	F56T01	F56T02	F56T03	F56T04	F56T05	F56T06	F56T07	F56T08	F56T09
Sample Extracted g	4.51	5.36	3.25	4.18	2.97	4.40	2.87	4.93	3.95	2.96	5.04	3.46
% Lipid	0.044	0.069	0.058	0.051	0.023	0.043	0.038	0.061	0.036	0.027	0.061	0.041
Day	42	42	42	56	56	56	56	56	56	56	56	56
Tank	22	23	24	1	2	3	4	5	6	7	8	9
MS222	2	1	1	2	4	3	1	1	4	2	3	4
PCB Treatment	1	1	0	0	0	0	0	1	0	0	1	1
PCBs Congeners												
1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4,10	nd	nd	nd	2.27	0.25	0.77	2.00	0.74	0.49	0.15	0.44	0.10
7,9	0.34	0.12	0.38	15.29	0.12	0.16	0.44	0.36	0.25	0.08	0.34	0.12
6	1.20	0.10	0.38	86.18	1.39	0.85	1.77	0.64	0.50	0.43	0.78	0.37
8,5	8.95	1.79	2.34	2.27	1.14	1.12	4.25	2.40	1.50	0.85	5.30	3.86
19	nd	nd	nd	1.84	nd	0.14	0.27	0.31	0.15	nd	0.20	0.19
12,13	0.08	nd	nd	27.26	nd	nd	0.16	nd	nd	nd	nd	nd
18	2.28	0.40	1.05	0.36	0.39	0.03	0.55	1.12	0.74	0.23	1.79	1.86
17	1.37	0.25	0.51	26.74	0.35	0.13	0.44	0.51	0.50	0.19	0.94	1.09
24	0.19	0.01	0.03	nd	0.01	0.01	0.09	0.03	0.04	nd	0.06	0.06
16,32	3.98	0.55	1.08	1.37	0.52	0.46	0.91	1.54	1.06	0.68	2.14	1.98
29	0.36	0.01	0.06	0.90	0.03	0.02	nd	nd	0.01	0.01	0.02	0.00
26	0.93	0.19	0.49	0.05	0.15	0.07	0.27	0.22	0.29	0.15	0.41	0.52
25	0.93	0.16	0.72	1.80	0.23	0.20	0.29	0.30	0.35	0.31	0.47	0.48
31, 28	17.63	3.30	3.90	0.05	2.51	3.43	2.89	7.60	4.50	5.17	10.54	10.20
33,21,53	3.10	0.36	0.99	0.55	0.38	0.20	0.29	0.96	0.73	0.24	1.87	1.94
51	0.25	0.04	0.09	0.86	0.02	0.02	0.07	0.11	0.03	0.04	0.12	0.12
22	5.03	0.71	1.30	8.41	0.36	0.61	1.33	1.58	1.22	1.18	2.35	2.22
45	1.63	0.18	0.47	1.87	0.12	0.06	0.41	0.28	0.12	0.10	0.39	0.36
46	0.77	0.06	0.27	0.16	0.02	0.04	0.32	0.07	0.03	0.01	0.08	0.09
52	3.82	1.18	1.77	2.18	0.73	0.31	1.20	1.87	1.32	0.89	2.37	3.04
49	4.31	0.93	1.59	0.32	0.71	0.54	1.03	1.80	1.02	1.01	2.09	2.32
47,48	6.69	1.39	2.69	0.11	1.30	1.07	1.99	3.10	1.60	1.69	3.52	3.59
44	4.99	1.11	1.38	2.29	0.58	0.44	1.06	2.15	0.98	1.02	2.56	2.79
37,42	2.44	0.55	0.67	4.05	0.30	0.22	0.56	1.33	0.55	0.65	1.30	1.47
41,64,71	7.30	1.27	1.90	5.30	0.71	0.84	1.63	3.16	1.11	1.55	3.30	3.19
40	1.15	0.21	0.57	2.08	0.11	0.13	0.57	0.39	0.18	0.35	0.38	0.40
100	0.67	0.08	0.42	1.30	0.09	0.07	0.46	0.24	0.10	0.39	0.13	0.14
63	0.81	0.10	0.48	2.84	0.05	0.14	0.48	0.34	0.10	0.23	0.22	0.21
74	4.28	0.76	1.26	0.63	0.43	0.38	1.10	2.02	0.61	0.94	1.83	1.82
70,76	8.99	1.55	2.20	0.39	1.02	1.14	1.59	4.25	1.53	1.68	4.16	4.60

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F42T22	F42T23	F42T24	F56T01	F56T02	F56T03	F56T04	F56T05	F56T06	F56T07	F56T08	F56T09
Sample Extracted g	4.51	5.36	3.25	4.18	2.97	4.40	2.87	4.93	3.95	2.96	5.04	3.46
% Lipid	0.044	0.069	0.058	0.051	0.023	0.043	0.038	0.061	0.036	0.027	0.061	0.041
Day	42	42	42	56	56	56	56	56	56	56	56	56
Tank	22	23	24	1	2	3	4	5	6	7	8	9
MS222	2	1	1	2	4	3	1	1	4	2	3	4
PCB Treatment	1	1	0	0	0	0	0	1	0	0	1	1
PCBs Congeners												
66,95	14.55	2.71	4.29	0.35	2.30	2.33	3.69	8.22	2.94	3.48	6.80	7.24
91	1.49	0.23	0.44	1.70	0.31	0.31	0.73	1.00	0.38	0.36	0.70	0.45
56,60	7.91	1.45	2.09	3.42	0.85	1.10	1.40	3.33	1.06	0.69	3.30	3.58
92,84 (89)	nd	nd	nd	8.13	nd	nd	nd	nd	nd	nd	nd	nd
101	3.98	0.93	2.23	1.96	1.12	0.94	1.67	1.81	1.30	1.06	1.72	2.08
99	4.28	0.78	1.64	nd	1.21	1.71	1.95	1.66	0.88	1.02	1.44	1.56
119	2.58	0.46	1.14	nd	0.78	0.92	1.40	0.99	0.86	0.87	0.85	0.95
83	0.76	0.11	0.16	3.28	0.06	0.17	0.44	0.10	0.06	0.07	0.10	0.11
97	1.24	0.22	0.52	2.80	0.21	0.27	0.36	0.43	0.21	0.20	0.42	0.48
81, 87	1.49	0.27	0.66	0.24	0.29	0.35	0.54	0.46	0.27	0.32	0.48	0.55
136	0.72	0.14	0.24	0.74	0.10	0.14	0.26	0.20	0.10	0.10	0.26	0.26
77,110	5.57	1.01	2.49	0.69	1.44	1.78	2.02	2.02	1.32	1.44	1.98	2.29
82	0.37	0.07	0.11	12.96	0.07	0.04	0.22	0.07	0.06	0.06	0.12	0.12
151	nd	nd	nd	0.35	nd	nd	nd	nd	nd	nd	nd	nd
135,144	1.25	0.24	0.42	4.29	0.20	0.32	0.40	0.43	0.20	0.19	0.40	0.44
107	1.09	0.18	0.57	0.07	0.37	0.46	0.49	0.25	0.28	0.30	0.31	0.35
149,123	2.28	0.42	0.84	nd	0.50	0.57	0.57	0.79	0.41	0.42	0.70	0.90
118	4.53	1.10	1.82	0.48	1.10	1.23	1.23	0.93	0.72	0.67	0.91	1.04
134	0.64	0.35	0.52	0.67	0.27	1.92	0.39	0.83	0.24	0.29	0.60	0.47
114,131	nd	nd	nd	0.92	nd	nd	nd	nd	nd	nd	nd	nd
146	3.34	1.66	3.34	1.96	2.02	2.35	2.29	3.39	1.77	1.80	2.79	2.30
132,153,105	25.07	12.25	20.07	0.48	12.71	13.76	14.10	24.46	10.49	10.31	19.20	17.07
141	1.95	1.20	0.54	nd	0.13	0.42	0.40	2.62	0.23	0.16	1.68	1.15
137,130,176	1.28	0.50	3.99	3.06	0.43	0.59	0.54	0.94	0.29	0.30	0.78	0.68
138,163	11.78	5.10	8.96	17.58	5.18	6.01	5.94	8.44	4.21	4.12	7.25	6.43
158	0.66	0.46	0.85	0.53	0.42	0.55	0.22	nd	0.39	0.38	0.76	0.64
129,178	2.00	0.94	0.95	0.60	0.60	0.67	0.62	1.30	0.46	0.43	1.16	1.08
187,182	8.56	3.58	4.09	0.69	2.67	2.51	2.85	5.42	2.00	1.89	4.55	4.45
183	3.84	1.47	1.43	0.96	0.95	0.88	1.06	2.18	0.64	0.64	1.76	1.82
128	0.80	0.27	0.63	13.41	0.41	0.43	0.48	0.32	0.27	0.31	0.36	0.39
185	0.86	0.32	0.20	3.76	0.12	0.13	0.14	0.37	0.07	0.10	0.39	0.37
174	4.53	1.61	0.72	1.38	0.39	0.46	0.46	2.10	0.32	0.28	1.96	1.78

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F42T22	F42T23	F42T24	F56T01	F56T02	F56T03	F56T04	F56T05	F56T06	F56T07	F56T08	F56T09
Sample Extracted g	4.51	5.36	3.25	4.18	2.97	4.40	2.87	4.93	3.95	2.96	5.04	3.46
% Lipid	0.044	0.069	0.058	0.051	0.023	0.043	0.038	0.061	0.036	0.027	0.061	0.041
Day	42	42	42	56	56	56	56	56	56	56	56	56
Tank	22	23	24	1	2	3	4	5	6	7	8	9
MS222	2	1	1	2	4	3	1	1	4	2	3	4
PCB Treatment	1	1	0	0	0	0	0	1	0	0	1	1
PCBs Congeners												
177	3.22	1.12	0.92	0.69	0.58	0.68	0.67	1.18	0.46	0.36	1.36	1.16
202,171,156	2.90	0.96	1.15	0.25	0.75	0.82	0.85	1.15	0.62	0.45	1.16	1.04
157,200	1.28	0.38	0.38	0.68	0.44	0.27	0.22	0.82	0.37	0.27	0.60	0.35
172	0.53	0.14	0.07	1.22	0.14	0.29	nd	nd	0.28	0.10	0.39	0.38
197	0.21	0.06	0.11	0.48	0.07	0.08	0.07	nd	0.07	nd	0.07	0.07
180	11.42	3.36	2.31	16.78	1.50	1.68	1.08	5.47	1.35	0.91	5.27	3.53
193	0.51	0.31	0.57	0.45	0.26	0.60	0.13	nd	0.73	0.55	nd	0.40
191	0.17	0.06	nd	0.12	nd	nd	nd	nd	nd	nd	0.02	0.07
199	0.39	0.13	0.18	2.49	nd	0.01	nd	nd	nd	nd	0.10	0.09
170,190	6.68	1.57	1.62	0.99	1.06	1.06	1.08	2.87	0.93	0.57	2.46	1.82
198	0.27	0.05	nd	nd	nd	nd	nd	nd	nd	nd	0.10	0.07
201	8.05	1.90	1.75	0.02	1.08	1.07	1.13	3.72	1.00	0.60	2.99	2.22
203,196	8.33	1.95	1.71	1.64	0.95	1.00	1.04	4.22	0.92	0.60	3.11	2.30
208,195	6.46	1.35	2.32	0.05	1.35	1.32	1.45	3.81	1.32	0.77	2.47	1.65
207	0.56	0.11	0.24	1.75	0.15	0.15	0.15	nd	0.16	0.09	0.29	0.16
194	3.23	0.70	1.03	1.61	0.38	0.38	0.38	1.85	0.29	0.24	1.31	0.88
205	0.43	0.16	0.65	2.19	0.24	0.15	0.22	nd	nd	nd	nd	nd
206	4.07	0.86	2.27	0.26	0.95	1.11	1.27	2.80	1.13	0.70	1.89	1.35
Total PCBs	336.35	90.07	179.05	232.68	61.14	67.59	85.04	142.38	63.68	58.65	137.40	127.71
Surrogate Recoveries												
PCB 14	0.60	1.51	0.37	0.92	0.81	1.09	0.01	0.78	0.54	0.94	0.88	0.34
PCB 166	0.49	1.23	0.28	0.69	0.61	0.80	-	0.58	0.39	0.67	0.65	0.26

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F56T10	F56T11	F56T12	F56T13	F56T14	F56T15	F56T16	F56T17	F56T18	F56T19	F56T20	F56T21	F56T22
Sample Extracted g	2.78	2.62	6.92	3.68	4.27	4.49	3.66	4.14	2.04	3.77	3.03	4.74	5.38
% Lipid	0.012	0.018	0.088	0.035	0.036	0.176	0.032	0.061	0.020	0.053	0.047	0.061	0.079
Day	56	56	56	56	56	56	56	56	56	56	56	56	56
Tank	10	11	12	13	14	15	16	17	18	19	20	21	22
MS222	2	3	3	3	4	1	4	4	2	3	2	1	2
PCB Treatment	1	0	1	0	1	0	0	1	1	1	0	1	1
PCBs Congeners													
1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4,10	0.67	0.33	8.67	0.87	0.18	1.15	nd	0.26	0.46	0.89	0.59	0.24	0.78
7,9	0.09	0.14	0.16	0.10	0.17	0.16	0.03	0.14	0.22	0.19	0.19	0.20	0.15
6	0.23	0.33	0.17	0.07	0.27	0.14	0.02	0.30	0.44	0.41	0.27	0.27	0.20
8,5	1.40	1.32	2.99	1.42	3.48	1.77	0.44	4.14	4.17	3.42	1.61	2.84	3.00
19	nd	nd	0.05	0.14	0.14	0.03	0.04	0.24	0.37	nd	0.15	0.11	0.10
12,13	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
18	0.16	0.39	0.29	0.74	0.78	0.03	0.35	1.77	2.32	0.07	0.29	0.82	0.17
17	0.30	0.22	0.32	0.49	0.47	0.09	0.23	0.82	1.18	0.25	0.16	0.40	0.14
24	0.01	0.01	0.01	0.03	0.02	nd	0.01	0.06	0.08	nd	0.01	0.02	0.00
16,32	0.87	0.42	1.24	1.02	1.05	0.55	0.39	1.61	2.00	1.40	0.62	1.02	1.08
29	nd	nd	nd	0.02	0.00	0.00	nd	nd	nd	nd	0.01	0.00	0.00
26	0.17	0.14	0.20	0.27	0.28	0.15	0.10	0.40	0.54	0.19	0.10	0.17	0.16
25	0.21	0.18	0.27	0.32	0.25	0.28	0.11	0.33	0.36	0.32	0.29	0.21	0.30
31, 28	6.50	2.35	7.69	4.90	6.70	3.76	1.83	7.68	10.02	11.35	3.56	5.76	7.66
33,21,53	0.62	0.37	0.97	0.51	0.85	0.38	0.23	1.78	1.62	0.92	0.37	0.85	0.86
51	0.08	0.02	0.12	0.04	0.09	0.05	0.02	0.10	0.12	0.20	0.08	0.08	0.11
22	1.49	0.49	1.75	1.09	1.38	0.86	0.38	1.73	1.95	2.69	0.93	1.18	1.67
45	0.17	0.07	0.26	0.12	0.19	0.07	0.04	0.30	0.46	0.27	0.10	0.19	0.22
46	0.03	nd	0.03	0.02	0.03	0.01	0.02	0.07	0.12	0.06	0.01	0.03	0.01
52	1.26	0.91	1.23	1.22	1.81	0.29	0.47	2.56	3.77	1.70	0.64	1.21	0.77
49	1.48	0.73	1.68	0.99	1.73	0.44	0.36	1.85	2.84	2.00	0.81	1.22	1.48
47,48	2.20	1.31	2.56	1.55	2.68	1.31	0.59	2.79	4.53	3.33	1.45	2.06	2.29
44	1.59	0.56	1.90	0.93	1.89	0.45	0.36	2.34	3.46	2.15	0.67	1.36	1.61
37,42	0.82	0.31	0.98	0.48	0.99	0.29	0.19	1.12	1.71	1.31	0.36	0.76	0.90
41,64,71	2.32	0.70	2.87	1.01	2.41	0.85	0.37	2.44	3.75	3.66	0.96	2.01	2.75
40	0.28	0.12	0.32	0.17	0.27	0.12	0.07	0.36	0.44	0.36	0.14	0.21	0.30
100	0.12	0.09	0.12	0.07	0.22	0.09	0.02	0.15	0.12	0.15	0.08	0.09	0.13
63	0.15	0.11	0.17	0.07	0.24	0.07	0.01	0.17	0.20	0.23	0.07	0.17	0.23
74	1.41	0.41	1.63	0.59	1.65	0.51	0.18	1.42	2.09	2.21	0.60	1.23	1.66
70,76	3.10	0.99	3.64	1.30	3.95	1.18	0.43	3.64	4.81	5.08	1.28	2.67	3.66

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F56T10	F56T11	F56T12	F56T13	F56T14	F56T15	F56T16	F56T17	F56T18	F56T19	F56T20	F56T21	F56T22
Sample Extracted g	2.78	2.62	6.92	3.68	4.27	4.49	3.66	4.14	2.04	3.77	3.03	4.74	5.38
% Lipid	0.012	0.018	0.088	0.035	0.036	0.176	0.032	0.061	0.020	0.053	0.047	0.061	0.079
Day	56	56	56	56	56	56	56	56	56	56	56	56	56
Tank	10	11	12	13	14	15	16	17	18	19	20	21	22
MS222	2	3	3	3	4	1	4	4	2	3	2	1	2
PCB Treatment	1	0	1	0	1	0	0	1	1	1	0	1	1
PCBs Congeners													
66,95	5.32	2.58	5.97	2.80	6.00	2.27	0.96	6.04	8.57	7.89	2.96	4.46	5.81
91	0.50	0.38	0.52	0.38	0.71	0.35	0.11	0.58	0.67	0.69	0.43	0.52	0.70
56,60	2.21	0.64	3.11	0.83	3.32	0.89	0.29	2.81	3.32	3.88	0.13	2.18	3.09
92,84 (89)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
101	1.24	1.24	1.38	1.26	1.71	1.10	0.43	1.57	2.32	1.63	1.09	1.03	1.24
99	1.18	1.15	1.43	1.16	1.38	1.13	0.36	1.13	1.58	1.63	1.30	0.95	1.25
119	0.57	0.73	0.77	0.75	0.73	0.85	0.25	0.61	0.79	0.99	0.88	0.52	0.73
83	0.07	0.07	0.09	0.06	0.09	0.07	0.02	0.08	0.12	0.08	0.07	0.07	0.08
97	0.30	0.18	0.41	0.19	0.39	0.25	0.07	0.32	0.50	0.49	0.19	0.24	0.34
81, 87	0.41	0.28	0.47	0.26	0.45	0.25	0.09	0.36	0.59	0.59	0.30	0.30	0.39
136	0.17	0.10	0.25	0.10	0.17	0.08	0.03	0.19	0.33	0.28	0.11	0.15	0.21
77,110	1.46	1.25	2.05	1.20	1.90	1.32	0.40	1.48	2.22	2.48	1.40	1.25	1.62
82	0.06	0.05	0.13	0.06	0.10	0.06	0.02	0.09	0.14	0.17	0.06	0.08	0.11
151	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
135,144	0.27	0.18	0.41	0.16	0.33	0.22	0.05	0.30	0.46	0.47	0.22	0.23	0.33
107	0.19	0.26	0.35	0.26	0.30	0.29	0.08	0.20	0.30	0.37	0.28	0.18	0.24
149,123	0.54	0.39	0.69	0.35	0.73	0.40	0.12	0.56	0.84	0.88	0.40	0.43	0.55
118	0.83	0.62	0.85	0.77	0.97	0.49	0.18	0.78	1.05	0.97	0.54	0.42	0.67
134	0.42	0.34	0.70	0.42	0.53	0.39	0.11	0.52	0.87	0.87	0.42	0.40	0.73
114,131	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
146	2.00	2.12	3.06	2.53	2.54	1.78	0.67	2.41	3.34	3.34	2.03	1.57	2.60
132,153,105	14.97	12.66	20.29	20.75	18.34	10.15	4.20	19.44	24.95	24.55	11.65	11.05	18.03
141	1.02	0.23	1.74	0.25	0.68	0.35	0.09	1.51	2.29	1.57	0.36	0.77	1.87
137,130,176	0.57	0.36	0.79	0.40	0.71	0.30	0.10	0.68	0.94	0.95	0.34	0.46	0.76
138,163	5.39	4.67	7.38	5.54	6.67	3.93	1.46	6.14	8.50	8.50	4.32	3.86	6.37
158	0.49	0.37	0.68	0.48	0.60	0.33	0.12	0.54	0.76	0.82	0.36	0.37	0.62
129,178	0.91	0.48	1.16	0.60	1.09	0.45	0.14	0.99	1.41	1.44	0.46	0.63	1.06
187,182	4.11	2.16	4.28	2.50	4.25	1.57	0.68	4.34	6.27	5.48	1.88	2.49	4.01
183	1.64	0.75	1.72	0.89	1.68	0.48	0.22	1.75	2.49	2.18	0.67	1.04	1.57
128	0.29	0.32	0.36	0.41	0.30	0.25	0.08	0.31	0.43	0.37	0.32	0.21	0.31
185	0.31	0.09	0.34	0.14	0.34	0.06	nd	0.34	0.46	0.46	0.11	0.22	0.36
174	1.54	0.31	1.79	0.33	1.75	0.28	0.09	1.77	2.25	2.38	0.29	1.04	1.77

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F56T10	F56T11	F56T12	F56T13	F56T14	F56T15	F56T16	F56T17	F56T18	F56T19	F56T20	F56T21	F56T22
Sample Extracted g	2.78	2.62	6.92	3.68	4.27	4.49	3.66	4.14	2.04	3.77	3.03	4.74	5.38
% Lipid	0.012	0.018	0.088	0.035	0.036	0.176	0.032	0.061	0.020	0.053	0.047	0.061	0.079
Day	56	56	56	56	56	56	56	56	56	56	56	56	56
Tank	10	11	12	13	14	15	16	17	18	19	20	21	22
MS222	2	3	3	3	4	1	4	4	2	3	2	1	2
PCB Treatment	1	0	1	0	1	0	0	1	1	1	0	1	1
PCBs Congeners													
177	1.00	0.40	1.27	0.46	1.14	0.38	0.11	1.09	1.47	1.50	0.36	0.65	1.15
202,171,156	0.87	0.53	1.08	0.63	1.01	0.47	0.15	0.97	1.31	1.29	0.46	0.55	0.98
157,200	0.44	0.15	0.42	0.13	0.32	0.13	0.05	0.28	0.44	0.35	0.14	0.16	0.33
172	nd	nd	0.16	nd	0.15	0.06	nd	0.16	0.16	0.17	0.03	0.09	0.16
197	nd	nd	0.06	nd	0.07	0.04	nd	nd	nd	0.09	nd	0.04	0.06
180	3.58	1.02	4.33	1.30	3.89	0.93	0.32	4.17	5.09	5.30	0.95	2.32	4.19
193	0.62	0.33	0.35	0.67	0.20	0.31	0.10	0.54	0.43	0.36	0.31	0.15	0.26
191	nd	nd	0.07	nd	nd	nd	nd	nd	nd	0.11	nd	0.04	0.06
199	0.10	nd	0.10	nd	0.11	nd	nd	0.11	0.16	0.15	nd	0.06	0.10
170,190	2.03	0.71	2.25	0.81	1.88	0.61	0.21	2.30	2.78	2.68	0.62	1.22	2.13
198	nd	nd	0.07	nd	0.06	nd	nd	nd	nd	0.11	nd	0.05	0.10
201	2.49	0.73	2.74	0.96	2.30	0.64	0.25	2.86	3.25	3.40	0.67	1.53	2.69
203,196	2.61	0.78	2.79	0.89	2.43	0.64	0.26	3.07	3.67	3.72	0.69	1.62	2.91
208,195	2.15	1.04	2.24	1.31	1.81	0.91	0.38	2.48	2.78	2.82	0.87	1.30	2.34
207	nd	nd	0.21	nd	0.20	0.12	nd	nd	nd	0.31	0.12	0.15	0.23
194	0.94	0.24	1.35	0.21	1.00	0.22	nd	1.41	1.56	1.82	0.24	0.72	1.36
205	nd	nd	0.14	nd	nd	nd	nd	nd	nd	0.14	nd	nd	nd
206	1.39	1.23	1.88	1.05	1.60	1.21	0.32	4.11	2.53	2.83	1.15	1.13	2.19
Total PCBs	94.92	55.16	126.94	74.77	111.07	52.11	20.83	121.94	158.55	148.43	56.63	76.28	111.08
Surrogate Recoveries													
PCB 14	0.75	0.85	0.64	0.01	1.17	0.60	0.61	0.58	0.81	0.96	0.00	0.65	0.60
PCB 166	0.58	0.57	0.52	-	0.89	0.54	0.56	0.48	0.60	0.78	0.00	0.61	0.49

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F56T23	F56T24	F80T01	F80T02	F80T03	F80T04	F80T05	F80T06	F80T07	F80T08	F80T09	F80T10	F80T11
Sample Extracted g	3.43	6.16	6.68	7.97	5.89	*	7.25	1.71	7.20	7.11	4.59	6.24	6.14
% Lipid	0.055	0.094	0.069	0.081	0.063	-	0.107	0.017	0.087	0.075	0.098	0.073	0.062
Day	56	56	80	80	80	80	80	80	80	80	80	80	80
Tank	23	24	1	2	3	4	5	6	7	8	9	10	11
MS222	1	1	2	4	3	1	1	4	2	3	4	2	3
PCB Treatment	1	0	0	0	0	0	1	0	0	1	1	1	0
PCBs Congeners													
1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4,10	0.10	0.88	0.02	0.14	0.46	-	0.17	0.37	0.27	0.11	0.18	0.50	0.16
7,9	0.21	0.05	0.08	0.05	0.32	-	0.23	0.26	0.22	0.12	1.06	0.36	0.06
6	0.29	0.09	0.04	0.20	0.24	-	0.58	0.38	0.18	0.34	1.19	0.35	0.10
8,5	4.65	1.00	0.33	1.67	1.51	-	5.40	4.04	1.97	5.26	13.81	5.20	1.04
19	0.21	0.09	0.03	0.09	0.07	-	0.27	0.35	0.25	0.14	0.33	0.13	0.13
12,13	nd	nd	nd	nd	nd	-	0.05	nd	nd	nd	nd	nd	nd
18	1.54	0.40	0.11	0.24	0.88	-	3.36	0.79	0.75	2.68	4.27	1.77	0.40
17	0.93	0.18	0.07	0.27	0.49	-	1.73	0.62	0.68	1.61	2.88	1.07	0.24
24	0.05	0.01	0.00	0.02	0.05	-	0.14	nd	0.05	0.11	0.20	0.07	0.04
16,32	1.91	0.46	0.16	0.85	0.93	-	3.41	1.75	1.46	3.14	5.56	2.51	0.50
29	0.01	0.03	nd	0.01	0.00	-	0.01	nd	nd	0.00	0.01	0.01	0.01
26	0.47	0.18	0.07	0.37	0.50	-	0.93	0.45	0.45	0.88	1.42	0.65	0.19
25	0.41	0.22	0.13	0.65	0.62	-	1.02	0.98	0.86	1.08	1.52	0.79	0.44
31, 28	9.57	1.87	0.42	2.75	2.41	-	8.83	5.35	3.88	9.55	13.47	7.71	1.71
33,21,53	1.44	0.38	0.11	1.09	1.33	-	3.77	1.87	0.88	2.84	7.03	2.63	0.64
51	0.15	0.04	0.03	0.09	0.09	-	0.26	0.12	0.08	0.22	0.30	0.21	0.06
22	2.06	0.49	0.21	1.27	1.00	-	3.77	2.76	1.99	3.80	5.92	3.07	0.72
45	0.37	0.08	0.03	0.13	0.17	-	0.69	0.32	0.17	0.59	1.00	0.56	0.10
46	0.09	0.02	0.01	0.04	0.10	-	0.23	0.04	0.05	0.15	0.33	0.10	0.02
52	3.13	0.59	0.26	1.11	1.59	-	4.99	2.17	2.26	5.10	7.71	3.44	0.94
49	2.35	0.59	0.22	1.20	1.21	-	3.84	2.16	1.75	3.94	5.82	3.27	0.86
47,48	3.33	1.14	0.24	1.09	1.13	-	3.56	1.87	1.33	3.37	5.32	2.97	1.02
44	2.83	0.48	0.18	0.95	1.03	-	5.17	2.02	1.75	4.76	7.81	4.03	0.64
37,42	1.44	0.28	0.11	0.54	0.61	-	2.99	1.11	0.96	2.63	4.37	2.24	0.42
41,64,71	3.15	0.70	0.27	1.28	1.20	-	6.24	2.61	1.79	5.62	9.10	5.29	1.08
40	0.39	0.12	0.04	0.20	0.23	-	1.16	0.47	0.35	0.68	1.51	0.66	0.16
100	0.11	0.08	0.04	0.14	0.15	-	0.36	0.20	0.14	0.18	0.44	0.24	0.16
63	0.17	0.09	0.06	0.13	0.15	-	nd	0.15	0.13	0.34	0.60	0.39	0.18
74	1.78	0.48	0.22	0.76	0.78	-	3.05	1.33	1.03	3.28	4.80	3.40	0.83
70,76	4.08	1.00	0.42	1.94	1.72	-	6.57	3.45	2.29	7.36	12.06	6.53	1.72

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F56T23	F56T24	F80T01	F80T02	F80T03	F80T04	F80T05	F80T06	F80T07	F80T08	F80T09	F80T10	F80T11
Sample Extracted g	3.43	6.16	6.68	7.97	5.89	*	7.25	1.71	7.20	7.11	4.59	6.24	6.14
% Lipid	0.055	0.094	0.069	0.081	0.063	-	0.107	0.017	0.087	0.075	0.098	0.073	0.062
Day	56	56	80	80	80	80	80	80	80	80	80	80	80
Tank	23	24	1	2	3	4	5	6	7	8	9	10	11
MS222	1	1	2	4	3	1	1	4	2	3	4	2	3
PCB Treatment	1	0	0	0	0	0	1	0	0	1	1	1	0
PCBs Congeners													
66,95	7.01	2.38	0.95	4.14	4.22	-	11.81	6.76	5.43	12.30	18.68	11.60	3.89
91	0.55	0.43	0.22	0.68	0.74	-	0.85	0.94	0.70	1.00	1.85	1.17	0.78
56,60	3.03	0.56	0.19	1.60	0.98	-	6.80	2.45	1.84	5.66	10.62	6.02	0.41
92,84 (89)	nd	nd	nd	nd	nd	-	nd	nd	nd	nd	nd	nd	nd
101	1.89	0.89	0.32	1.84	2.08	-	3.57	2.83	2.46	3.35	nd	3.18	1.54
99	1.36	0.97	0.33	1.91	1.84	-	2.96	2.81	2.08	2.48	5.13	3.86	1.77
119	0.78	0.67	0.31	1.41	1.31	-	1.81	2.13	1.75	1.44	3.77	2.50	1.41
83	0.09	0.07	0.02	0.12	0.13	-	0.24	0.16	0.13	0.18	2.30	0.22	0.09
97	0.42	0.19	0.07	0.42	0.42	-	0.98	0.62	0.40	0.83	0.29	0.90	0.33
81, 87	0.49	0.20	0.08	0.43	0.41	-	1.09	0.85	0.50	0.96	1.45	1.06	0.38
136	0.26	0.10	0.04	0.19	0.22	-	0.62	0.20	0.21	0.53	13.52	0.52	0.18
77,110	1.95	1.04	0.47	2.52	2.34	-	5.06	3.61	2.86	4.16	0.85	4.90	2.06
82	0.12	0.05	0.02	0.14	0.10	-	0.45	0.19	0.15	0.29	6.61	0.33	0.11
151	nd	nd	nd	nd	nd	-	nd	nd	nd	nd	0.59	nd	nd
135,144	0.37	0.18	0.07	0.41	0.48	-	1.28	0.64	0.52	0.93	nd	0.91	0.37
107	0.26	0.22	0.13	0.76	0.74	-	1.19	0.97	0.81	0.77	1.58	1.38	0.58
149,123	0.69	0.31	0.15	0.86	0.82	-	2.14	1.21	0.95	1.63	1.35	1.56	0.64
118	0.79	0.59	0.40	2.37	2.53	-	4.87	3.13	2.67	3.36	2.71	9.46	1.84
134	0.66	0.58	0.10	0.41	0.41	-	0.47	0.40	0.73	0.90	4.67	0.60	0.56
114,131	nd	nd	nd	nd	nd	-	nd	nd	nd	nd	0.84	nd	nd
146	2.82	2.57	0.64	3.06	2.62	-	2.24	2.98	4.20	4.19	nd	10.71	3.92
132,153,105	20.78	13.99	3.56	17.59	14.44	-	15.35	16.68	23.21	29.59	3.55	66.28	21.50
141	1.52	0.54	0.10	0.32	0.50	-	1.54	0.51	0.66	2.63	24.64	1.48	0.68
137,130,176	0.84	0.41	0.11	0.58	0.50	-	0.87	0.55	0.76	1.38	2.20	1.76	0.66
138,163	7.24	5.37	1.63	8.62	7.37	-	8.92	8.33	10.87	13.18	1.28	28.32	9.40
158	0.67	0.50	0.15	0.80	0.70	-	0.99	0.79	0.96	1.32	12.36	2.41	0.90
129,178	1.23	0.59	0.19	1.08	0.94	-	1.84	0.98	1.31	2.47	1.48	3.61	1.09
187,182	4.97	2.14	0.67	3.77	3.01	-	6.16	4.34	4.26	8.46	11.17	13.25	3.86
183	2.03	0.66	0.25	1.49	1.05	-	2.93	1.64	1.56	3.72	8.42	6.30	1.48
128	0.42	0.32	0.11	0.66	0.47	-	0.56	0.70	0.66	0.61	3.77	1.08	0.64
185	0.42	0.09	0.05	0.27	0.15	-	0.79	0.30	0.23	0.91	0.69	0.70	0.27
174	1.99	0.40	0.14	0.78	0.71	-	4.15	0.76	0.97	4.80	1.08	3.60	0.71

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F56T23	F56T24	F80T01	F80T02	F80T03	F80T04	F80T05	F80T06	F80T07	F80T08	F80T09	F80T10	F80T11
Sample Extracted g	3.43	6.16	6.68	7.97	5.89	*	7.25	1.71	7.20	7.11	4.59	6.24	6.14
% Lipid	0.055	0.094	0.069	0.081	0.063	-	0.107	0.017	0.087	0.075	0.098	0.073	0.062
Day	56	56	80	80	80	80	80	80	80	80	80	80	80
Tank	23	24	1	2	3	4	5	6	7	8	9	10	11
MS222	1	1	2	4	3	1	1	4	2	3	4	2	3
PCB Treatment	1	0	0	0	0	0	1	0	0	1	1	1	0
PCBs Congeners													
177	1.28	0.52	0.18	1.16	1.05	-	3.01	1.09	1.38	3.24	5.43	4.21	1.06
202,171,156	1.09	0.63	0.25	1.63	1.39	-	2.72	1.56	1.84	2.86	3.63	4.54	1.37
157,200	0.38	0.21	0.06	0.55	0.33	-	0.67	0.41	0.43	1.16	3.25	1.35	0.55
172	0.43	0.06	nd	0.44	0.40	-	0.51	0.27	0.52	0.81	18.54	0.83	0.39
197	0.08	0.02	nd	0.09	0.08	-	0.13	nd	0.10	0.14	1.05	0.19	0.10
180	4.34	1.28	0.48	2.05	2.96	-	10.91	3.02	3.54	11.08	0.17	20.95	2.68
193	0.45	0.35	0.08	0.49	0.76	-	1.73	1.50	1.25	0.92	13.02	1.39	1.31
191	nd	nd	0.03	nd	nd	-	0.16	nd	nd	0.22	1.19	0.28	nd
199	0.12	nd	0.02	nd	0.03	-	0.33	nd	0.05	0.32	0.22	0.25	nd
170,190	2.37	0.89	0.33	2.30	2.01	-	6.21	2.20	2.31	6.14	0.41	9.98	1.87
198	0.11	nd	0.09	nd	0.06	-	0.23	nd	nd	0.24	7.54	0.24	nd
201	3.08	1.00	0.33	2.38	2.07	-	7.37	2.19	2.43	7.42	0.36	8.77	1.98
203,196	3.30	0.96	0.33	2.15	1.93	-	7.63	2.12	2.32	7.63	8.96	8.97	1.81
208,195	2.49	1.38	0.46	2.96	2.52	-	5.56	2.71	3.11	5.41	9.56	6.17	2.65
207	0.23	0.17	nd	0.31	0.28	-	0.56	0.28	0.36	0.55	6.70	0.56	0.30
194	1.49	0.39	0.08	0.54	0.49	-	2.39	0.58	0.73	2.59	0.63	2.90	0.57
205	nd	nd	nd	nd	nd	-	0.19	nd	nd	nd	3.17	0.19	nd
206	2.17	1.62	0.35	2.17	1.86	-	10.05	2.07	2.61	2.95	0.27	2.93	2.12
Total PCBs	136.28	58.55	18.47	97.70	91.38	-	225.65	126.47	124.78	237.57	351.60	324.55	95.37
Surrogate Recoveries													
PCB 14	1.51	0.37	0.92	0.81	1.09	0.01	0.78	0.54	0.94	0.88	0.34	0.75	0.85
PCB 166	1.23	0.28	0.69	0.61	0.80	-	0.58	0.39	0.67	0.65	0.26	0.58	0.57

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F80T12	F80T13	F80T14	F80T15	F80T16	F80T17	F80T18	F80T19	F80T20	F80T21	F80T22	F80T23	F80T24
Sample Extracted g	7.04	6.79	6.53	3.55	5.20	7.43	5.09	6.21	5.39	2.83	6.31	*	6.32
% Lipid	0.092	0.073	0.054	0.047	0.055	0.106	0.064	0.058	0.080	0.038	0.085	-	0.078
Day	80	80	80	80	80	80	80	80	80	80	80	80	80
Tank	12	13	14	15	16	17	18	19	20	21	22	23	24
MS222	3	3	4	1	4	4	2	3	2	1	2	1	1
PCB Treatment	1	0	1	0	0	1	1	1	0	1	1	1	0
PCBs Congeners													
1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4,10	0.15	0.02	0.04	0.18	0.58	0.47	0.10	0.98	0.43	0.12	1.39	nd	0.79
7,9	0.07	0.06	0.07	0.08	0.39	0.18	0.13	0.21	0.31	0.16	0.14	nd	0.50
6	0.16	0.16	0.15	nd	0.30	0.36	0.30	0.18	0.24	0.14	0.14	nd	0.34
8,5	3.24	2.75	2.40	1.46	2.76	5.61	3.55	2.85	5.33	4.00	2.23	nd	1.88
19	0.11	0.20	0.11	0.16	0.20	0.13	0.26	0.20	0.27	nd	0.12	nd	0.15
12,13	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
18	0.97	0.92	0.82	0.11	1.45	1.88	2.40	1.06	0.50	0.22	0.24	nd	1.21
17	0.53	0.55	0.50	0.14	0.78	1.35	1.26	0.78	0.50	0.68	0.39	nd	0.65
24	0.04	0.04	0.03	nd	0.06	0.07	0.09	0.05	0.05	0.02	0.02	nd	0.06
16,32	1.81	1.56	1.02	0.95	1.33	2.76	2.17	1.80	2.31	1.68	1.74	nd	1.23
29	0.00	0.02	0.01	0.01	0.03	0.01	0.01	0.04	0.11	0.02	0.02	nd	0.06
26	0.36	0.36	0.27	0.20	0.48	0.73	0.75	0.55	0.57	0.66	0.28	nd	0.50
25	0.63	0.93	0.33	0.78	0.69	0.91	0.74	0.70	1.24	0.85	0.65	nd	0.81
31, 28	6.76	5.15	2.93	2.97	3.30	8.48	7.06	6.11	5.81	8.92	8.47	nd	2.47
33,21,53	1.08	1.39	1.41	0.96	1.26	2.79	2.08	1.24	2.24	1.05	0.62	nd	1.08
51	0.19	0.12	0.08	0.11	0.08	0.22	0.20	0.15	0.21	0.09	0.22	nd	0.11
22	2.53	2.15	1.19	1.37	1.55	3.52	2.29	2.70	3.27	3.25	3.04	nd	1.14
45	0.33	0.22	0.19	0.16	0.18	0.54	0.49	0.32	0.42	0.23	0.21	nd	0.19
46	0.04	0.04	0.05	0.02	0.04	0.12	0.12	0.08	0.07	0.06	0.04	nd	0.05
52	1.93	1.50	1.71	0.52	1.70	4.58	4.63	4.06	1.49	5.40	1.91	nd	2.16
49	2.39	1.63	1.51	1.04	1.33	3.78	3.57	3.34	2.15	3.98	2.19	nd	1.70
47,48	2.27	1.75	1.33	1.17	1.20	3.17	3.04	2.46	2.09	2.88	2.94	nd	1.54
44	2.62	1.38	1.65	0.86	1.19	4.55	4.03	3.55	2.07	4.41	2.25	nd	1.43
37,42	1.61	0.86	0.89	0.51	0.68	2.42	2.27	1.94	1.19	2.48	1.51	nd	0.86
41,64,71	4.59	2.27	2.15	1.58	1.42	5.49	4.89	4.18	3.14	4.80	5.82	nd	1.71
40	0.46	0.29	0.25	0.24	0.21	0.71	0.52	0.52	0.47	0.62	0.40	nd	0.33
100	0.16	0.21	0.09	0.14	0.11	0.20	0.21	0.16	0.25	0.29	0.18	nd	0.21
63	0.29	0.21	0.14	0.11	0.10	0.33	0.39	0.32	0.24	0.36	0.41	nd	0.22
74	2.70	1.34	1.33	0.86	0.76	3.27	3.06	3.01	1.80	3.31	3.96	nd	1.20
70,76	5.67	2.85	3.13	1.76	1.82	7.89	6.47	6.08	4.22	8.00	7.56	nd	2.35

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F80T12	F80T13	F80T14	F80T15	F80T16	F80T17	F80T18	F80T19	F80T20	F80T21	F80T22	F80T23	F80T24
Sample Extracted g	7.04	6.79	6.53	3.55	5.20	7.43	5.09	6.21	5.39	2.83	6.31	*	6.32
% Lipid	0.092	0.073	0.054	0.047	0.055	0.106	0.064	0.058	0.080	0.038	0.085	-	0.078
Day	80	80	80	80	80	80	80	80	80	80	80	80	80
Tank	12	13	14	15	16	17	18	19	20	21	22	23	24
MS222	3	3	4	1	4	4	2	3	2	1	2	1	1
PCB Treatment	1	0	1	0	0	1	1	1	0	1	1	1	0
PCBs Congeners													
66,95	9.50	5.94	4.92	4.37	3.73	12.47	11.72	11.01	8.15	12.86	12.97	nd	6.28
91	0.88	0.90	0.43	0.72	0.47	1.15	1.25	0.93	1.36	1.14	1.20	nd	1.11
56,60	4.67	2.10	2.46	1.06	1.34	6.49	5.04	4.59	3.51	5.77	6.44	nd	1.56
92,84 (89)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
101	2.10	2.38	1.39	1.66	1.74	3.62	3.56	3.33	2.94	3.99	2.26	nd	3.22
99	2.06	2.66	1.08	2.31	1.48	3.04	2.56	2.75	3.64	3.01	3.50	nd	2.98
119	1.28	2.06	0.63	1.71	1.09	1.80	1.41	1.61	2.63	1.83	2.23	nd	2.17
83	0.16	0.16	0.04	0.15	0.10	0.21	0.12	0.18	0.23	0.20	0.22	nd	0.20
97	0.74	0.60	0.38	0.53	0.33	0.99	0.91	0.65	0.91	0.92	1.01	nd	0.71
81, 87	0.79	0.63	0.41	0.55	0.40	1.10	0.99	1.03	0.92	1.20	1.39	nd	0.68
136	0.40	0.26	0.20	0.26	0.15	0.59	0.56	0.50	0.40	0.61	0.61	nd	0.33
77,110	3.39	3.27	1.69	2.93	1.99	5.25	4.56	4.74	5.04	5.26	6.51	nd	4.10
82	0.24	0.17	0.09	0.16	0.10	0.38	0.26	0.25	0.26	0.33	0.47	nd	0.25
151	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
135,144	0.72	0.51	0.35	0.53	0.32	1.31	1.08	1.08	0.90	1.32	1.50	nd	0.78
107	0.67	0.92	0.32	0.87	0.63	1.25	1.01	1.15	1.52	1.09	1.59	nd	1.42
149,123	1.25	1.02	0.68	1.05	0.68	2.40	2.06	2.05	1.90	2.51	2.76	nd	1.62
118	2.41	2.39	1.52	2.46	1.80	4.88	4.45	4.92	4.38	4.60	6.37	nd	4.11
134	0.83	0.60	0.35	0.32	0.17	0.33	0.39	0.38	0.38	0.29	0.37	nd	0.31
114,131	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
146	3.39	4.10	1.87	2.30	1.41	1.87	2.28	2.59	2.74	2.00	2.04	nd	2.24
132,153,105	23.17	22.44	13.47	13.39	8.16	13.57	16.52	18.64	16.22	15.24	14.52	nd	12.83
141	1.76	0.50	0.90	0.39	0.13	1.11	1.24	1.22	0.45	1.39	1.16	nd	0.31
137,130,176	1.10	0.70	0.60	0.50	0.28	0.72	0.83	0.90	0.62	0.74	0.80	nd	0.51
138,163	10.34	10.21	5.74	6.70	4.31	7.70	9.01	9.94	8.81	7.93	8.69	nd	7.53
158	1.03	0.92	0.59	0.59	0.38	0.82	0.89	0.97	0.89	0.81	0.89	nd	0.71
129,178	1.94	1.16	1.09	0.84	0.52	1.59	1.78	1.88	1.17	1.61	1.84	nd	0.99
187,182	6.46	3.94	3.92	3.26	1.93	5.63	6.48	6.78	4.15	6.21	6.35	nd	3.32
183	2.91	1.32	1.72	1.27	0.67	2.70	2.98	3.17	1.48	2.83	3.11	nd	1.30
128	0.46	0.59	0.24	0.55	0.29	0.46	0.50	0.54	0.60	0.43	0.54	nd	0.55
185	0.72	0.17	0.39	0.26	0.09	0.70	0.71	0.75	0.26	0.70	0.86	nd	0.21
174	3.64	0.77	2.05	0.68	0.42	3.82	4.25	3.78	1.21	3.79	4.33	nd	0.92

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F80T12	F80T13	F80T14	F80T15	F80T16	F80T17	F80T18	F80T19	F80T20	F80T21	F80T22	F80T23	F80T24
Sample Extracted g	7.04	6.79	6.53	3.55	5.20	7.43	5.09	6.21	5.39	2.83	6.31	*	6.32
% Lipid	0.092	0.073	0.054	0.047	0.055	0.106	0.064	0.058	0.080	0.038	0.085	-	0.078
Day	80	80	80	80	80	80	80	80	80	80	80	80	80
Tank	12	13	14	15	16	17	18	19	20	21	22	23	24
MS222	3	3	4	1	4	4	2	3	2	1	2	1	1
PCB Treatment	1	0	1	0	0	1	1	1	0	1	1	1	0
PCBs Congeners													
177	2.57	1.19	1.45	1.01	0.68	2.71	3.01	2.97	1.55	2.62	3.16	nd	1.32
202,171,156	2.23	1.55	1.29	1.36	0.93	2.44	2.71	2.64	1.86	2.38	2.80	nd	1.59
157,200	0.72	0.57	0.58	0.38	0.33	0.78	0.93	0.72	0.37	0.94	0.91	nd	0.62
172	0.62	0.43	0.47	0.48	0.37	0.69	0.58	0.54	0.62	0.90	0.82	nd	0.45
197	0.10	0.09	0.18	0.13	0.10	0.11	0.14	0.13	0.14	0.15	0.14	nd	0.12
180	7.87	2.90	5.62	2.96	2.16	10.92	10.67	9.85	4.12	9.35	13.01	nd	3.45
193	1.37	1.60	1.30	1.14	0.98	1.01	0.87	1.12	1.44	1.34	0.69	nd	1.14
191	0.15	nd	0.09	nd	0.10	0.15	0.17	0.17	nd	0.16	0.18	nd	0.11
199	0.25	nd	0.14	nd	0.04	0.30	0.34	0.27	0.07	0.28	0.36	nd	0.06
170,190	4.84	2.00	2.71	2.12	1.48	5.83	6.75	5.67	2.62	5.38	6.64	nd	2.17
198	0.19	nd	0.10	nd	0.03	0.24	0.19	0.22	0.09	0.22	0.29	nd	0.05
201	5.80	2.14	3.37	2.03	1.57	6.86	8.09	6.40	2.72	6.43	7.64	nd	2.16
203,196	6.10	2.04	3.51	1.89	1.40	7.12	8.15	6.45	2.56	6.70	7.99	nd	1.94
208,195	4.53	2.73	2.47	2.64	1.89	4.96	6.10	4.39	2.90	4.43	5.36	nd	2.42
207	0.45	0.33	0.25	0.25	0.22	0.51	0.64	0.40	0.30	0.40	0.49	nd	0.27
194	2.25	0.61	1.18	0.51	0.35	2.23	2.53	1.84	0.62	1.84	2.14	nd	0.45
205	0.11	nd	nd	nd	nd	0.16	0.19	0.13	nd	0.11	0.07	nd	nd
206	2.78	2.31	1.36	2.07	1.21	2.52	2.48	1.87	1.85	2.09	2.37	nd	1.40
Total PCBs	175.63	124.80	101.36	89.78	74.91	204.02	201.02	187.70	144.47	195.02	200.65	0.00	109.89
Surrogate Recoveries													
PCB 14	0.64	0.01	1.17	0.60	0.61	0.58	0.81	0.96	0.00	0.65	0.60	1.51	0.37
PCB 166	0.52	-	0.89	0.54	0.56	0.48	0.60	0.78	0.00	0.61	0.49	1.23	0.28

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F93T01	F93T02	F93T03	F93T04	F93T05	F93T06	F93T07	F93T08	F93T09	F93T10	F93T11	F93T12	F93T13
Sample Extracted g	4.83	3.14	3.41	1.80	6.75	4.59	5.50	4.67	5.20	1.66	3.54	5.38	3.22
% Lipid	0.075	0.034	0.041	0.009	0.081	0.055	0.065	0.081	0.032	0.015	0.039	0.042	0.023
Day	93	93	93	93	93	93	93	93	93	93	93	93	93
Tank	1	2	3	4	5	6	7	8	9	10	11	12	13
MS222	2	4	3	1	1	4	2	3	4	2	3	3	3
PCB Treatment	0	0	0	0	1	0	0	1	1	1	0	1	0
PCBs Congeners													
1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4,10	0.93	0.05	0.55	nd	0.44	0.52	0.49	0.16	0.73	0.14	1.69	0.30	0.84
7,9	0.14	0.10	0.13	nd	0.14	0.04	0.14	0.02	0.17	0.19	0.18	0.03	0.15
6	0.29	0.29	0.36	nd	0.45	0.14	0.41	0.17	0.45	0.25	0.55	0.24	0.44
8,5	1.42	2.45	2.55	nd	4.17	1.74	3.19	3.43	3.71	2.83	1.58	2.30	3.00
19	0.27	0.34	0.19	nd	0.18	0.06	0.12	0.02	0.27	nd	0.24	0.25	0.23
12,13	nd	nd	0.03	nd	0.01	nd	nd	nd	0.10	nd	nd	0.14	nd
18	0.69	0.53	0.13	nd	1.37	0.25	0.77	0.52	1.41	2.23	0.35	0.54	0.73
17	0.40	0.30	0.14	nd	0.97	0.37	0.50	0.97	0.86	1.01	0.25	0.39	0.43
24	0.03	0.03	0.03	nd	0.10	0.03	0.06	0.03	0.13	0.06	0.23	0.06	0.13
16,32	0.87	0.94	0.55	0.24	2.09	1.07	1.19	2.43	1.81	2.18	0.89	0.79	1.12
29	0.03	0.21	nd	nd	nd	0.00	0.01	0.03	0.08	0.07	0.08	nd	0.10
26	0.38	0.34	0.30	nd	0.73	0.35	0.36	0.89	0.66	0.69	0.29	0.31	0.52
25	0.48	0.40	0.45	0.10	0.51	0.46	0.41	0.80	0.45	0.55	0.40	0.30	0.55
31, 28	3.93	2.83	2.77	2.52	6.74	6.66	3.29	11.44	5.29	13.09	2.13	1.90	5.00
33,21,53	0.34	0.52	0.23	0.24	1.62	0.79	0.54	1.27	1.54	1.70	0.30	0.39	0.25
51	0.09	0.07	0.10	0.06	0.17	0.06	0.04	0.23	0.13	0.14	0.10	0.06	0.19
22	1.26	1.41	1.43	0.67	2.92	1.83	1.62	4.75	2.37	2.44	1.19	1.04	1.56
45	0.19	0.21	0.33	0.11	0.45	0.15	0.26	0.37	0.61	0.55	0.22	0.29	0.53
46	0.16	0.17	0.31	nd	0.20	0.03	0.20	0.12	0.22	0.12	0.20	0.17	0.38
52	1.48	1.32	0.61	0.09	3.99	1.49	1.19	5.81	3.34	5.83	0.64	0.64	1.32
49	1.27	1.29	1.12	0.11	3.42	1.47	1.34	4.83	2.93	4.75	1.01	0.52	1.32
47,48	1.22	1.30	1.29	0.54	2.97	1.30	1.21	3.75	2.89	3.94	1.24	0.24	1.05
44	1.10	1.08	1.05	0.16	3.89	1.37	1.16	5.30	2.81	4.72	1.14	0.56	1.19
37,42	0.59	0.59	0.58	0.10	2.14	0.74	0.62	2.96	1.57	2.70	0.46	0.36	0.65
41,64,71	1.45	1.82	1.93	0.74	4.77	1.64	1.76	6.01	3.98	5.73	1.86	1.08	1.65
40	0.37	0.46	0.63	0.11	0.68	0.29	0.35	0.82	0.45	0.53	0.59	0.31	0.56
100	0.27	0.40	0.81	0.40	0.28	0.14	0.27	0.20	0.25	0.16	0.42	0.39	0.67
63	0.28	0.46	0.63	0.26	0.46	0.14	0.30	0.44	0.39	0.37	0.50	0.36	0.49
74	0.89	1.19	1.41	0.99	2.98	0.92	1.03	4.08	2.60	3.55	1.05	0.72	1.01
70,76	1.64	2.17	2.29	1.43	6.05	2.33	1.79	8.82	5.11	7.05	1.97	1.19	1.57

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F93T01	F93T02	F93T03	F93T04	F93T05	F93T06	F93T07	F93T08	F93T09	F93T10	F93T11	F93T12	F93T13
Sample Extracted g	4.83	3.14	3.41	1.80	6.75	4.59	5.50	4.67	5.20	1.66	3.54	5.38	3.22
% Lipid	0.075	0.034	0.041	0.009	0.081	0.055	0.065	0.081	0.032	0.015	0.039	0.042	0.023
Day	93	93	93	93	93	93	93	93	93	93	93	93	93
Tank	1	2	3	4	5	6	7	8	9	10	11	12	13
MS222	2	4	3	1	1	4	2	3	4	2	3	3	3
PCB Treatment	0	0	0	0	1	0	0	1	1	1	0	1	0
PCBs Congeners													
66,95	4.11	4.47	4.79	3.26	10.56	4.53	4.01	14.82	8.66	14.35	4.22	2.45	3.68
91	0.56	0.67	0.85	0.82	0.87	0.64	0.51	1.28	0.67	1.08	0.90	0.51	0.75
56,60	1.31	1.57	1.82	2.64	4.56	1.70	1.47	6.48	3.62	4.33	1.44	0.88	1.20
92,84 (89)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
101	1.93	2.05	1.93	0.55	2.93	1.90	1.75	3.92	2.69	4.19	1.72	1.06	1.82
99	1.75	2.31	2.61	1.43	2.24	1.74	1.93	3.00	2.40	3.13	3.05	1.19	2.29
119	1.02	1.37	1.58	0.79	1.10	1.05	1.15	1.61	1.21	1.48	1.57	0.69	1.22
83	0.25	0.39	0.46	0.03	0.25	0.05	0.26	0.23	0.27	0.17	0.49	0.27	0.38
97	0.42	0.47	0.42	0.12	0.81	0.39	0.41	0.81	0.65	0.89	0.48	0.21	0.32
81, 87	0.48	0.59	0.62	0.43	0.95	0.45	0.48	1.22	0.85	1.22	0.58	0.34	0.52
136	0.22	0.19	0.22	0.08	0.53	0.18	0.20	0.67	0.37	0.60	0.23	0.16	0.25
77,110	2.32	2.49	2.69	1.58	4.01	2.48	2.15	5.51	3.26	5.07	2.49	1.35	2.11
82	0.13	0.13	0.14	0.08	0.30	0.13	0.11	0.39	0.16	0.25	0.11	0.20	0.23
151	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
135,144	0.46	0.35	0.43	0.15	0.93	0.43	0.37	1.27	0.66	1.03	0.39	0.35	0.36
107	0.69	0.70	0.79	0.46	0.83	0.70	0.60	1.05	0.65	0.89	0.67	0.56	0.58
149,123	0.79	0.85	0.91	0.48	1.61	0.84	0.71	2.18	1.30	2.16	0.78	0.39	0.59
118	1.89	2.07	2.23	1.45	2.88	1.97	1.72	3.82	2.40	3.80	1.78	1.30	1.44
134	0.31	0.20	0.26	0.14	0.65	0.30	0.24	0.81	0.49	0.42	1.40	0.52	0.43
114,131	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
146	2.09	2.10	2.07	1.51	2.91	1.87	1.86	3.54	2.07	3.00	2.55	1.76	1.49
132,153,105	11.75	12.66	12.51	9.49	20.06	10.41	10.62	24.40	15.31	22.92	15.19	7.26	9.26
141	0.34	0.17	0.20	0.24	1.64	0.22	0.27	2.07	0.87	1.29	0.28	0.21	0.15
137,130,176	0.42	0.42	0.44	0.34	1.01	0.36	0.39	0.81	0.71	1.01	0.57	0.28	0.32
138,163	5.85	6.20	6.12	4.31	9.67	5.27	5.27	12.77	7.15	10.69	6.98	3.21	4.40
158	0.45	0.43	0.48	0.46	0.91	0.49	0.33	1.70	0.55	1.07	0.35	0.19	0.21
129,178	0.74	0.71	0.75	0.52	1.93	0.67	0.62	2.41	1.36	1.95	0.76	0.34	0.50
187,182	2.57	2.87	2.75	2.68	6.48	2.33	2.13	8.12	5.28	8.51	2.83	1.39	2.16
183	1.01	1.13	0.98	1.01	3.08	0.81	0.81	3.71	2.54	3.89	0.95	0.45	0.86
128	0.48	0.47	0.45	0.30	0.54	0.39	0.37	0.67	0.48	0.64	0.45	0.19	0.35
185	0.17	0.15	0.13	nd	0.73	0.11	0.13	0.95	0.57	0.75	0.18	0.05	0.15
174	0.52	0.54	0.58	0.35	3.75	0.52	0.49	4.74	2.74	3.90	0.61	0.27	0.40

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F93T01	F93T02	F93T03	F93T04	F93T05	F93T06	F93T07	F93T08	F93T09	F93T10	F93T11	F93T12	F93T13
Sample Extracted g	4.83	3.14	3.41	1.80	6.75	4.59	5.50	4.67	5.20	1.66	3.54	5.38	3.22
% Lipid	0.075	0.034	0.041	0.009	0.081	0.055	0.065	0.081	0.032	0.015	0.039	0.042	0.023
Day	93	93	93	93	93	93	93	93	93	93	93	93	93
Tank	1	2	3	4	5	6	7	8	9	10	11	12	13
MS222	2	4	3	1	1	4	2	3	4	2	3	3	3
PCB Treatment	0	0	0	0	1	0	0	1	1	1	0	1	0
PCBs Congeners													
177	0.81	0.85	0.90	0.62	2.62	0.78	0.71	3.28	2.04	2.87	0.85	0.40	0.63
202,171,156	0.97	1.04	1.14	0.80	2.24	0.99	0.89	2.86	1.80	2.47	1.09	0.52	0.79
157,200	nd	nd	nd	nd	0.82	nd	nd	nd	nd	nd	nd	nd	nd
172	0.27	0.37	0.40	nd	0.64	0.39	0.31	0.88	0.64	1.23	nd	nd	nd
197	0.07	0.10	0.09	nd	0.13	0.09	0.08	0.17	0.12	0.24	0.06	nd	0.10
180	1.95	2.06	2.70	1.74	10.05	2.15	1.74	12.98	8.64	11.59	2.92	1.44	1.84
193	0.65	0.77	nd	0.67	nd	0.90	0.73	nd	nd	nd	nd	nd	0.79
191	nd	nd	nd	nd	0.17	nd	nd	0.07	0.20	nd	nd	nd	nd
199	0.02	nd	nd	nd	0.26	0.02	0.03	0.34	0.20	0.28	nd	nd	nd
170,190	1.20	1.22	1.74	1.07	4.50	1.41	1.10	5.81	3.98	5.02	1.33	0.64	1.28
198	nd	nd	nd	nd	0.20	nd	nd	0.27	0.14	nd	nd	nd	nd
201	1.18	1.20	1.81	1.15	5.20	1.47	1.10	6.81	4.87	5.83	1.40	0.64	1.30
203,196	1.08	1.04	1.68	1.08	5.44	1.36	0.98	7.21	4.93	5.94	1.35	0.55	1.18
208,195	1.41	1.40	2.28	1.18	3.64	1.78	1.35	4.83	3.41	4.17	1.76	0.80	1.63
207	0.16	0.18	0.30	nd	0.39	0.21	0.16	0.46	0.39	nd	nd	nd	0.20
194	0.25	0.24	0.42	nd	1.70	0.30	0.24	2.16	1.46	1.57	0.32	0.14	0.21
205	nd	nd	nd	nd	0.10	nd	nd	nd	nd	nd	nd	nd	nd
206	0.90	0.81	1.63	0.62	1.96	1.16	0.92	2.61	1.50	1.76	1.40	0.53	4.99
Total PCBs	78.41	83.29	88.26	53.47	183.67	82.30	76.33	236.37	151.60	215.18	88.20	49.55	80.98
Surrogate Recoveries													
PCB 14	0.56	1.03	1.09	2.51	0.49	1.01	0.54	0.97	0.93	2.98	1.13	0.65	1.03
PCB 166	0.51	0.91	0.82	2.25	0.37	0.84	0.40	0.82	0.72	2.59	1.00	0.53	0.80

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F93T14	F93T15	F93T16	F93T17	F93T18	F93T19	F93T20	F93T21	F93T22	F93T23	F93T24
Sample Extracted g	5.02	2.93	3.28	5.20	3.18	5.03	5.42	4.32	6.64	3.49	3.94
% Lipid	0.046	0.028	0.081	0.078	0.028	0.060	0.091	0.086	0.082	0.045	0.049
Day	93	93	93	93	93	93	93	93	93	93	93
Tank	14	15	16	17	18	19	20	21	22	23	24
MS222	4	1	4	4	2	3	2	1	2	1	1
PCB Treatment	1	0	0	1	1	1	0	1	1	1	0
PCBs Congeners											
1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4,10	0.97	0.58	0.22	1.02	1.43	1.34	0.94	1.84	0.38	0.00	3.08
7,9	0.12	0.21	0.19	0.26	0.38	0.24	0.25	0.21	nd	0.09	0.16
6	0.14	0.24	0.42	0.82	0.38	0.18	0.28	0.32	0.16	0.07	0.18
8,5	2.19	2.42	4.68	7.75	3.46	4.13	2.76	3.23	1.94	1.83	0.89
19	0.29	0.21	0.27	0.42	0.44	0.22	0.13	0.14	0.06	0.05	0.05
12,13	nd	nd	nd	0.06	nd	nd	0.02	nd	nd	nd	nd
18	0.82	1.10	2.38	2.42	1.40	1.16	0.90	0.92	0.72	0.01	0.32
17	0.52	0.58	1.13	1.51	0.74	1.00	0.48	0.72	0.39	0.08	0.22
24	0.03	0.04	0.07	0.16	0.05	0.06	0.05	0.06	0.04	nd	0.02
16,32	1.26	1.38	3.12	3.07	1.39	1.99	1.29	1.72	1.21	0.09	0.50
29	0.03	0.03	0.04	0.18	0.01	nd	0.00	0.01	nd	nd	0.01
26	0.29	0.41	0.68	0.87	0.49	0.64	0.42	0.48	0.26	0.02	0.20
25	0.28	0.48	0.69	0.71	0.38	0.55	0.54	0.47	0.32	0.00	0.29
31, 28	5.08	6.74	9.57	7.28	9.18	7.39	3.71	6.60	8.00	3.56	2.82
33,21,53	1.23	0.48	1.87	2.50	1.17	1.74	1.20	1.08	1.13	0.01	0.54
51	0.12	0.04	0.26	0.21	0.14	0.14	0.08	0.16	0.14	0.07	0.04
22	1.75	1.88	3.91	3.45	1.82	2.67	1.45	2.38	1.63	1.57	0.60
45	0.22	0.30	0.64	0.88	0.40	0.43	0.20	0.32	0.23	0.02	0.08
46	0.04	0.09	0.19	0.42	0.15	0.08	0.09	0.09	0.03	0.06	0.02
52	1.98	1.35	3.71	4.17	4.49	4.16	1.41	3.97	1.59	0.09	0.87
49	2.17	1.20	4.07	3.77	3.58	3.36	1.45	3.32	2.03	1.20	0.88
47,48	2.18	1.59	4.25	3.44	3.21	2.93	1.52	2.52	2.08	1.51	0.95
44	2.22	1.27	4.22	4.32	3.11	3.64	1.48	3.56	1.94	1.06	0.73
37,42	1.24	0.69	2.42	2.34	1.93	1.96	1.01	1.95	1.15	0.08	0.49
41,64,71	3.34	1.90	6.95	5.53	4.26	4.29	2.15	4.07	3.39	3.33	0.99
40	0.29	0.33	0.78	0.99	0.42	0.53	0.53	0.48	0.28	0.10	0.16
100	0.14	0.19	0.35	0.54	0.43	0.16	0.34	0.18	0.15	0.04	0.10
63	0.21	0.19	0.56	0.65	0.51	0.31	0.43	0.30	0.24	0.03	0.08
74	2.07	1.05	4.00	3.30	3.17	2.71	1.34	2.65	2.08	2.13	0.56
70,76	4.93	1.94	8.47	6.97	5.54	5.65	2.56	5.72	4.31	3.53	1.10

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F93T14	F93T15	F93T16	F93T17	F93T18	F93T19	F93T20	F93T21	F93T22	F93T23	F93T24
Sample Extracted g	5.02	2.93	3.28	5.20	3.18	5.03	5.42	4.32	6.64	3.49	3.94
% Lipid	0.046	0.028	0.081	0.078	0.028	0.060	0.091	0.086	0.082	0.045	0.049
Day	93	93	93	93	93	93	93	93	93	93	93
Tank	14	15	16	17	18	19	20	21	22	23	24
MS222	4	1	4	4	2	3	2	1	2	1	1
PCB Treatment	1	0	0	1	1	1	0	1	1	1	0
PCBs Congeners											
66,95	7.66	4.35	14.05	11.12	10.72	10.08	5.17	10.14	7.47	5.72	3.09
91	0.62	0.49	1.24	0.86	0.87	0.87	0.93	0.94	0.76	0.07	0.44
56,60	3.17	1.56	6.38	5.19	3.60	3.79	1.84	3.94	2.85	2.34	2.17
92,84 (89)	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
101	2.00	2.00	3.44	3.00	3.45	2.94	1.89	2.84	1.79	1.07	1.38
99	1.81	2.52	3.80	2.44	2.56	2.21	1.90	2.08	1.66	1.62	1.42
119	0.82	1.32	1.62	1.15	1.27	1.13	1.05	1.00	0.77	0.01	0.85
83	0.08	0.26	0.42	0.28	0.18	0.15	0.12	0.12	0.06	0.07	0.09
97	0.58	0.42	1.19	0.88	0.71	0.65	0.43	0.55	0.56	0.05	0.33
81, 87	0.67	0.60	1.30	1.00	1.01	0.82	0.43	0.78	0.61	0.01	0.33
136	0.37	0.17	0.66	0.58	0.46	0.44	0.23	0.49	0.31	0.05	0.16
77,110	3.03	2.80	5.71	4.33	4.18	3.76	2.42	3.55	2.79	1.96	1.85
82	0.15	0.11	0.39	0.31	0.13	0.23	0.12	0.24	0.17	0.02	0.10
151	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
135,144	0.71	0.35	1.22	1.08	0.89	0.82	0.46	0.86	0.56	0.01	0.31
107	0.61	0.80	1.18	0.98	0.88	0.74	0.66	0.65	0.50	0.00	0.49
149,123	1.32	0.89	2.29	1.87	1.85	1.59	0.86	1.51	1.16	0.09	0.64
118	2.32	2.19	5.90	3.68	3.55	2.85	1.84	2.40	1.95	1.40	1.39
134	0.29	1.48	1.64	0.26	0.26	0.35	0.34	0.51	0.35	0.08	0.29
114,131	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
146	1.76	2.31	3.48	1.40	2.12	2.01	2.17	2.44	1.92	1.57	1.92
132,153,105	13.06	13.80	25.67	10.62	16.37	14.69	12.38	17.68	14.30	11.54	11.23
141	1.09	0.16	1.77	0.88	0.86	1.00	0.47	1.69	0.80	0.06	0.25
137,130,176	0.58	0.46	1.33	0.56	0.66	0.67	0.42	0.82	0.61	0.06	0.34
138,163	6.15	6.76	13.51	5.94	7.91	7.12	6.09	7.94	6.36	4.95	5.23
158	0.62	0.57	1.28	0.50	0.77	0.72	0.58	0.85	0.66	0.00	0.48
129,178	1.22	0.77	2.66	1.22	1.58	1.42	0.81	1.64	1.25	0.03	0.65
187,182	4.56	2.89	9.70	4.57	6.34	5.31	2.81	5.96	4.58	3.60	2.51
183	2.03	1.06	4.66	2.26	2.76	2.44	1.01	2.62	2.08	1.61	0.97
128	0.33	0.47	0.82	0.39	0.35	0.40	0.39	0.41	0.32	nd	0.38
185	0.46	0.13	1.14	0.59	0.61	0.54	0.13	0.66	0.45	0.02	0.15
174	2.44	0.59	5.97	3.08	3.18	2.99	0.80	3.35	2.45	1.69	0.47

Table C-1: Experiment 1Total PCB Tissue Concentrations and % Percent Lipid

Sample Name	F93T14	F93T15	F93T16	F93T17	F93T18	F93T19	F93T20	F93T21	F93T22	F93T23	F93T24
Sample Extracted g	5.02	2.93	3.28	5.20	3.18	5.03	5.42	4.32	6.64	3.49	3.94
% Lipid	0.046	0.028	0.081	0.078	0.028	0.060	0.091	0.086	0.082	0.045	0.049
Day	93	93	93	93	93	93	93	93	93	93	93
Tank	14	15	16	17	18	19	20	21	22	23	24
MS222	4	1	4	4	2	3	2	1	2	1	1
PCB Treatment	1	0	0	1	1	1	0	1	1	1	0
PCBs Congeners											
177	1.80	0.90	4.32	2.19	2.52	2.17	0.93	2.24	1.71	1.23	0.69
202,171,156	1.64	1.14	3.75	1.91	2.18	1.91	1.07	1.96	1.51	1.06	0.87
157,200	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
172	0.62	0.49	1.22	0.67	0.88	0.64	0.35	0.65	0.54	0.05	0.33
197	0.12	0.11	0.23	0.12	0.18	0.13	0.09	0.13	0.10	0.01	0.07
180	8.00	2.42	17.37	9.00	10.16	8.23	3.06	8.79	6.64	4.68	2.37
193	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
191	0.16	nd	0.29	0.16	0.19	0.14	nd	0.15	0.15	nd	nd
199	0.20	nd	0.46	0.25	0.23	0.21	0.04	0.24	0.18	0.02	0.03
170,190	3.90	1.52	8.09	3.99	4.31	3.59	1.36	3.85	2.90	2.08	1.10
198	0.15	nd	0.32	0.16	0.16	0.12	nd	0.19	0.12	nd	nd
201	4.66	1.57	9.28	4.57	4.98	4.14	1.46	4.69	3.43	2.46	1.17
203,196	4.86	1.43	9.39	4.67	4.83	4.16	1.44	4.92	3.54	2.46	1.10
208,195	3.41	1.80	6.26	3.05	3.00	2.66	1.57	3.20	2.21	1.67	1.37
207	0.34	0.20	0.67	0.28	0.36	0.26	0.18	0.41	0.21	0.08	0.18
194	1.39	0.32	2.48	1.14	1.09	1.00	0.34	1.46	0.98	0.09	0.28
205	nd	nd	0.14	0.07	nd	nd	nd	nd	nd	nd	nd
206	1.57	1.12	17.41	1.40	1.08	1.05	1.01	1.91	1.22	0.06	0.96
Total PCBs	129.47	94.20	276.22	174.68	170.29	156.80	90.62	162.91	121.41	76.24	67.35
Surrogate Recoveries											
PCB 14	0.77	1.24	1.09	0.79	1.62	0.79	0.73	0.67	0.47	0.69	0.76
PCB 166	0.57	1.10	1.08	0.46	1.23	0.60	0.65	0.57	0.41	0.49	0.70

Table D-1 : Experiment 1 - Total PCB Concentrations and % Lipid in Food Treatments

Sample Name		Control Food	PCB Spike Food
Sample Extracted g		6.35	5.38
% Lipid		0.11	0.14
Surrogate Recoveries			
PCB 14		0.96	1.01
PCB 166		0.74	0.47
Total PCBs		29.58	233.77
		nd = non-detect	
PCB Congeners	Log Kow		
1	4.46	nd	nd
3		nd	nd
4,10	4.69	nd	nd
7,9	4.65	nd	0.56
6	5.06	0.16	1.21
8,5	5.07	nd	10.68
19	5.02	0.01	nd
12,13	5.22	nd	nd
18	5.24	0.00	4.23
17	5.25	0.01	2.74
24	5.35	0.77	0.33
16,32	5.16	nd	4.24
29		nd	0.15
26	5.66	0.00	0.79
25	5.67	nd	0.42
31, 28	5.67	0.25	7.39
33,21,53	5.60	0.00	6.08
51	5.63	1.39	0.42
22	5.58	nd	3.99
45	5.53	nd	1.12
46	5.53	0.00	0.75
52	5.63	0.23	5.28
49	5.85	0.39	4.38
47,48	5.85	nd	4.15
44	5.75	0.43	5.82

Table D-1 : Experiment 1 - Total PCB Concentrations and % Lipid in Food Treatments

PCB Congeners	Log Kow		
37,42	5.83	0.27	3.95
41,64,71	5.69	nd	6.58
40	5.66	0.30	1.90
100	6.23	0.26	0.85
63	6.17	0.24	0.59
74	6.20	0.50	2.84
70,76	5.69	0.57	9.13
66,95	6.20	1.84	13.65
91	6.13	0.30	1.18
56,60	6.11	0.43	7.76
92,84 (89)	6.35	nd	nd
101	6.38	0.83	3.44
99	6.39	0.65	3.11
119	6.58	0.11	0.98
83	6.26	0.00	0.39
97	6.29	nd	1.06
81, 87	6.29	nd	0.97
136	6.22	0.01	0.72
77,110	6.48	1.20	5.06
82	6.20	0.43	0.58
151		nd	nd
135,144	6.64	0.31	1.32
107	6.55	nd	0.93
149,123	6.71	1.28	2.11
118	6.67	0.70	3.48
134	6.74	0.05	1.34
114,131	6.55	nd	nd
146		nd	1.37
132,153,105	6.89	3.30	10.54
141	6.82	0.38	1.55
137,130,176	6.76	0.16	0.95
138,163	6.99	2.39	5.83
158	7.02	nd	1.03
129,178	7.14	0.36	1.51

Table D-1 : Experiment 1 - Total PCB Concentrations and % Lipid in Food Treatments

PCB Congeners	Log Kow		
187,182	7.17	1.21	4.75
183	7.20	0.52	2.50
128	6.74	0.01	0.47
185	7.11	0.01	0.70
174	7.11	0.20	3.30
177	7.08	0.41	2.17
202,171,156	7.24	0.49	2.07
157,200	7.27	0.16	nd
172	7.33	0.16	0.76
197		0.01	0.13
180	7.36	1.24	11.14
193	7.52	0.47	0.63
191	7.55	0.01	0.16
199	7.20	nd	0.33
170,190	7.27	0.89	6.64
198	7.62	0.00	0.39
201	7.62	0.99	8.52
203,196	7.65	0.80	10.20
208,195	7.56	1.24	7.41
207	7.74	0.00	0.60
194	7.80	0.22	3.98
205	8.00	nd	nd
206	8.09	nd	5.47

Table E-1: Experiment 2 - Polycyclic aromatic hydrocarbon (PAH) Concentrations measured in food

Sample Name	AMFOOD-C	AMFOOD-D	AMFOOD-D2
g to extraction	4.23	4.77	4.60
% lipid	0.03	0.04	0.03
	Control	Contaminated	Contaminated
TOTAL PAHs	180	1570	1683
Napthalene	1.83	0.71	3.87
Azulene	nd	nd	nd
2MeNapthalene	5.59	5.34	21.67
1MeNapthalene	4.46	3.94	12.22
Acenapthylene	1.12	1.23	2.46
Biphenyl	2.09	1.01	3.05
Acenapthene	18.60	19.43	32.43
Fluorene	3.72	10.51	14.69
Phenanthrene	34.67	104.62	112.87
Anthracene	1.59	15.49	20.77
1Mefluorene	5.69	15.75	18.89
4,5-Methylenephenanthrene	2.35	27.35	28.11
2Methylphenanthrene	26.53	92.88	91.03
2Methylanthracene	6.91	19.61	19.12
1Methylanthracene	11.69	53.90	55.54
1Methylphenanthrene	7.05	30.62	30.92
9Methylanthracene	nd	2.69	nd
Fluoranthene	10.56	273.55	315.89
Pyrene	14.35	201.43	222.53
3,6Dimethylphenanthrene	nd	nd	nd
9,10,dimethylanthracene	7.33	24.06	28.07
Benzo[a]fluorene	1.69	99.81	111.86
Benzo[b]fluorene	0.78	56.85	63.51
Benz[a]anthracene	3.75	56.05	55.41
Chrysene + Triphenylene	7.89	96.29	101.54
Napthacene	nd	47.71	47.78
Benzo[b]fluoranthene	nd	52.48	59.65
Benzo[k]fluoranthene	nd	91.67	81.27
Benzo[e]pyrene	nd	64.32	55.50

Table E-1: Experiment 2 - Polycyclic aromatic hydrocarbon (PAH) Concentrations measured in food

Sample Name	AMFOOD-C	AMFOOD-D	AMFOOD-D2
g to extraction	4.23	4.77	4.60
% lipid	0.03	0.04	0.03
	Control	Contaminated	Contaminated
TOTAL PAHs	180	1570	1683
Benzo[a]pyrene	nd	75.11	65.25
Perylene	nd	17.03	7.33
Dimethylbenz[a]anthracene	nd	nd	nd
3Methylcholanthrene	nd	nd	nd
Indeno[1,2,3-c,d]pyrene	nd	nd	nd
Benzo[g,h,i]perylene	nd	8.84	nd
Anthanthrene	nd	nd	nd
Dibenz[a,h+ac]anthracene	nd	nd	nd
Coronene	nd	nd	nd
Surrogate Recoveries	% recoveries		
d8 Napthalene	9	6	19
d10 Fluorene	50	46	57
d10 Fluoranthene	79	75	71
d12 Perylene	96	149	120

"nd" = non-detect

Table E-2: Polychlorinated biphenyl (PCB) concentrations in food treatments

Sample Name	AMFOOD-C	AMFOOD-D	AMFOOD-D2
g to extraction	4.23	4.77	4.60
% lipid	0.029	0.036	0.033
	Control	Contaminated	Contaminated
Surrogate Recoveries			
PCB 14	1.34	1.23	1.34
PCB 166	0.89	0.92	0.89
PCBs (totals)	54.43	60.56	59.52
1	nd	nd	nd
3	nd	nd	nd
4,10	3.04	0.45	0.13
7,9	0.72	0.32	0.08
6	0.86	0.48	0.55
8,5	4.10	3.55	2.27
19	0.12	0.12	0.14
12,13	0.31	0.17	0.36
18	0.59	0.71	0.78
17	0.33	0.45	0.50
24	0.02	0.16	0.11
16,32	0.22	0.77	0.78
29	nd	0.06	0.13
26	0.12	0.36	0.55
25	0.06	0.17	0.19
31, 28	1.15	0.83	1.00
33,21,53	0.15	0.29	0.32
51	0.22	0.30	0.33
22	0.62	0.36	0.38
45	0.11	0.23	0.23
46	0.23	0.29	0.30
52	0.50	1.08	1.07
49	0.41	0.87	0.88
47,48	0.43	0.91	0.91
44	0.28	0.89	0.95
37,42	0.19	0.69	0.78

Table E-2: Polychlorinated biphenyl (PCB) concentrations in food treatments

Sample Name	AMFOOD-C	AMFOOD-D	AMFOOD-D2
g to extraction	4.23	4.77	4.60
% lipid	0.029	0.036	0.033
	Control	Contaminated	Contaminated
Surrogate Recoveries			
PCB 14	1.34	1.23	1.34
PCB 166	0.89	0.92	0.89
PCBs (totals)	54.43	60.56	59.52
41,64,71	0.77	1.16	1.23
40	0.75	0.55	0.64
100	1.20	0.36	0.72
63	0.88	0.55	0.68
74	0.93	0.45	0.46
70,76	2.66	1.76	1.91
66,95	4.68	2.92	3.79
91	0.71	0.42	0.45
56,60	nd	0.46	0.53
92,84, 89	nd	nd	nd
101	1.24	1.28	1.26
99	1.34	1.29	1.29
119	0.36	0.15	0.45
83	0.54	0.17	0.17
97	3.69	2.95	2.74
81, 87	0.57	0.39	0.35
85	2.61	2.70	2.52
136	0.03	0.02	0.01
77,110	1.63	1.67	1.52
82,151	0.71	0.22	0.15
135,144	0.41	0.33	0.29
107	0.46	0.34	0.28
149,123	1.10	1.71	1.60
118	0.85	0.92	0.83
134	0.41	0.19	0.19
114,131	nd	nd	nd

Table E-2: Polychlorinated biphenyl (PCB) concentrations in food treatments

Sample Name	AMFOOD-C	AMFOOD-D	AMFOOD-D2
g to extraction	4.23	4.77	4.60
% lipid	0.029	0.036	0.033
	Control	Contaminated	Contaminated
Surrogate Recoveries			
PCB 14	1.34	1.23	1.34
PCB 166	0.89	0.92	0.89
PCBs (totals)	54.43	60.56	59.52
146	0.66	0.98	0.88
132,153,105	3.38	6.45	6.03
168	nd	nd	nd
141	0.13	0.36	0.26
137,130,176	0.10	0.37	1.11
138,163	1.71	3.46	3.31
158	0.16	0.52	0.50
129,178	0.35	0.58	0.54
187,182	1.07	1.92	1.78
183	0.36	0.77	0.69
128	0.22	0.47	0.41
167	nd	nd	nd
185	0.06	0.29	0.24
174	0.22	0.48	0.43
177	0.27	0.55	0.50
202,171,156	0.28	0.63	0.58
157,200	0.07	0.07	0.10
172	nd	0.30	0.04
197	nd	0.09	0.02
180	0.65	1.44	1.28
193	0.06	0.21	0.28
191	nd	0.06	nd
199	nd	0.04	0.03
170,190	0.28	0.55	0.49
198	nd	0.04	0.03
201	0.27	0.62	0.55

Table E-2: Polychlorinated biphenyl (PCB) concentrations in food treatments

Sample Name		AMFOOD-C	AMFOOD-D	AMFOOD-D2
g to extraction		4.23	4.77	4.60
% lipid		0.029	0.036	0.033
		Control	Contaminated	Contaminated
Surrogate Recoveries				
PCB 14		1.34	1.23	1.34
PCB 166		0.89	0.92	0.89
PCBs (totals)		54.43	60.56	59.52
	203,196	0.42	0.92	0.82
	189	nd	nd	nd
	208,195	0.21	0.53	0.49
	207	0.05	0.13	0.11
	194	0.11	0.25	0.21
	205	nd	nd	nd
	206	nd	nd	nd
	209	nd	nd	nd

"nd" = non-detect

Table E-3: Experiment 2 - Polycyclic aromatic hydrocarbons (PAHs) Concentrations in Clams

Sample	CCLAM1.D	CCLAM2.D	DCLAM1.D	DCLAM2.D
Mass Extracted (g)	5.1	5.09	5.06	5.21
% lipid	-0.005	0.011	0.004	0.006
	Control 1	Control 2	Contaminated 1	Contaminated 2
Total PAH	10.7	11.0	3296.7	3980.4
Napthalene	0.19	0.23	0.36	0.35
Azulene	nd	nd	nd	nd
2MeNapthalene	0.30	0.29	0.20	0.24
1MeNapthalene	0.15	0.20	0.20	0.27
Acenapthylene	nd	nd	0.85	1.11
Biphenyl	0.59	0.69	0.46	0.48
Acenapthene	0.25	0.24	6.99	9.84
Fluorene	0.39	0.37	5.95	7.64
Phenanthrene	2.49	2.67	56.14	69.98
Anthracene	nd	nd	19.94	26.59
1Mefluorene	nd	0.25	1.60	2.77
4,5-Methylenephenanthrene	0.22	0.27	41.03	53.15
2Methylphenanthrene	0.72	0.79	18.12	22.08
2Methylanthracene	nd	nd	11.46	15.03
1Methylanthracene	0.55	0.45	24.59	30.13
1Methylphenanthrene	0.28	0.31	10.50	12.72
9Methylanthracene	nd	nd	nd	nd
Fluoranthene	1.98	1.82	470.03	530.86
Pyrene	1.09	1.10	383.97	437.28
3,6Dimethylphenanthrene	0.27	nd	1.67	1.01
9,10,dimethylanthracene	0.14	0.15	9.25	10.60
Benzo[a]fluorene	nd	0.15	122.58	140.52
Benzo[b]fluorene	0.12	0.12	126.78	148.76
Benz[a]anthracene	0.25	0.38	250.76	293.37
Chrysene + Triphenylene	0.44	0.35	209.20	248.18
Napthacene	nd	nd	70.87	85.71
Benzo[b]fluoranthene	nd	nd	374.22	478.93
Benzo[k]fluoranthene	nd	0.12	294.53	361.41
Benzo[e]pyrene	0.13	0.11	233.20	298.00
Benzo[a]pyrene	nd	nd	274.39	343.24
Perylene	nd	nd	52.69	69.57
Dimethylbenz[a]anthracene	nd	nd	1.86	2.21
3Methylcholanthrene	nd	nd	2.15	2.86
Indeno[1,2,3-c,d]pyrene	nd	nd	109.96	136.52
Benzo[g,h,i]perylene	0.12	nd	85.16	106.26
Anthanthrene	nd	nd	8.42	12.70
Dibenz[a,h+ac]anthracene	nd	nd	13.85	17.08
Coronene	nd	nd	2.74	2.95
Surrogates Recoveries (%)				
d8 Napthalene	63	65	54	49
d10 Fluorene	87	92	88	92
d10 Fluoranthene	84	82	83	85
d12 Perylene	85	86	79	82

Table E-4: Experiment 2 - Polychlorinated biphenyl (PCB) Concentrations in Clams

Sample	CCLAM1.D	CCLAM2.D	DCLAM1.D	DCLAM2.D
Mass Extracted (g)	5.1	5.09	5.06	5.21
% lipid	-0.005	0.011	0.004	0.006
	Control 1	Control 2	Contaminated 1	Contaminated 2
Total PCBs	9.4	9.5	26.8	31.6
1	0.40	0.38	1.13	1.13
3	nd	nd	1.85	1.94
4,10	0.10	0.11	0.13	0.13
7,9	0.02	0.03	0.04	0.04
6	0.01	nd	0.05	0.02
8,5	0.94	1.18	1.57	1.72
14	1.94	2.29	2.58	2.60
19	0.00	0.01	0.03	0.03
30	2.65	2.66	2.71	2.63
12,13	0.01	nd	0.03	nd
18	0.06	0.07	0.22	0.35
17	0.08	0.08	0.23	0.31
24	0.02	0.02	0.03	0.03
16,32	0.09	0.10	0.30	0.39
29	0.01	0.01	0.01	0.01
26	nd	nd	nd	nd
25	0.14	0.10	0.23	0.13
31, 28	0.19	nd	0.97	0.30
33,21,53	0.10	0.14	0.51	0.55
51	0.01	0.02	0.04	0.06
22	0.06	0.15	0.07	0.10
45	0.01	nd	0.07	0.11
46	0.03	0.03	0.05	0.07
52	0.05	0.06	0.45	0.57
49	0.38	0.24	0.51	0.59
47,48	0.07	0.10	0.49	0.69
65	1.69	1.80	1.74	1.81
44	0.03	0.06	0.27	0.38
37,42	0.03	0.03	0.06	0.14
41,64,71	0.12	0.14	0.44	0.61
40	nd	nd	0.05	0.07
100	nd	0.03	0.09	0.12
63	nd	0.05	nd	nd
74	nd	0.02	0.08	0.13
70,76	nd	nd	0.28	0.36
66,95	0.04	nd	1.10	1.53
91	0.01	nd	0.12	0.17
56,60 (92,84)	nd	nd	0.31	0.39
89	nd	0.03	0.24	0.33
101	0.01	0.08	0.46	0.63
99	nd	nd	0.24	0.40
119	0.01	0.04	0.05	0.07
83	nd	nd	0.03	nd

Table E-4: Experiment 2 - Polychlorinated biphenyl (PCB) Concentrations in Clams

97	nd	nd	0.51	0.79
81, 87	0.13	0.21	0.20	0.22
85	0.31	0.06	0.13	0.17
136	0.01	0.02	0.08	0.10
77,110	0.03	0.05	0.77	1.01
82, 151	0.00	0.01	0.04	0.06
135,144	0.02	0.03	0.16	0.18
107	0.01	0.03	0.08	0.08
123,149	0.07	0.09	0.72	0.92
118	0.04	0.04	0.39	0.53
134	0.00	0.01	0.02	0.02
146	0.06	0.12	0.24	0.32
132,153,105	0.29	0.25	1.12	2.01
141	0.02	0.03	0.21	0.31
137,130,176	0.02	0.03	0.06	0.09
163,138	0.10	0.10	0.97	1.21
158	0.12	0.14	0.13	0.14
129,178	0.02	nd	0.12	0.25
166	1.56	1.62	1.61	1.60
187,182	0.12	0.10	0.44	0.58
183	nd	nd	0.11	0.18
128	nd	nd	0.13	0.15
185	nd	nd	0.03	0.09
174	0.02	0.04	0.24	0.28
177	0.03	0.06	0.17	0.23
202,171,156	nd	nd	0.08	0.15
157,200	nd	nd	nd	0.06
204	2.65	2.66	2.71	2.63
172	nd	nd	nd	0.05
197	nd	nd	nd	0.02
180	0.03	0.05	0.61	0.70
193	0.02	0.05	0.11	0.10
191	0.01	nd	nd	0.04
199	0.23	0.13	0.42	0.30
170,190	0.02	nd	0.25	0.23
198	nd	nd	nd	nd
201	0.04	0.04	0.22	0.21
203,196	0.04	nd	0.31	0.29
189	nd	nd	nd	nd
208,195	0.01	nd	0.11	0.12
207	nd	nd	nd	nd
194	0.03	nd	0.13	0.12
205	0.08	nd	0.06	0.08
206	0.01	nd	0.09	0.13
209	0.01	nd	0.04	0.04

Table E-5: Experiment 2 - PCB Concentrations in Tissue and % Lipid

Sample Name	AMT4D30	AMT7D30	AMT11D30	AMT3D30	AMT6D30	AMT10D30	AMT5D30	AMT12D30	AMT14D30	AMT2D30	AMT8D30
g to extraction	4.51	6.8	5.6	5.37	4.64	6.52	5.39	6.17	5.98	4.84	5.25
% lipid	0.015	0.034	0.031	0.018	0.020	0.025	0.011	0.020	0.029	0.021	0.016
tank	4	7	11	3	6	10	5	12	14	2	8
MS222	0	0	0	1	1	1	2	2	2	3	3
PAH	0	0	0	0	0	0	0	0	0	0	0
Surrogate Recoveries											
PCB 14	0.83	1.05	0.54	0.67	0.73	1.06	0.53	0.92	1.02	0.91	0.98
PCB 166	0.91	1.05	0.85	0.78	0.99	0.94	-	0.92	0.90	1.02	1.01
	"nd" = non-detect										
PCBs (totals)	38.22	44.60	39.40	26.07	36.73	43.92	24.99	31.34	48.58	29.97	33.79
1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4,10	2.05	1.98	1.23	2.22	1.94	1.75	nd	3.18	2.26	1.42	2.19
7,9	0.32	0.20	0.07	0.04	0.09	0.16	0.05	0.29	0.33	0.06	0.34
6	nd	0.22	nd	nd	nd	0.09	0.26	0.07	0.14	nd	0.10
8,5	nd	0.80	0.21	0.21	0.79	1.11	1.50	0.52	1.40	0.31	0.46
19	nd	nd	nd	nd	nd	0.02	nd	nd	0.05	nd	nd
12,13	nd	nd	0.46	nd	nd	nd	nd	nd	nd	nd	nd
18	0.20	0.19	nd	0.07	0.12	0.44	nd	0.13	0.36	0.09	0.13
17	0.20	0.21	0.30	0.11	0.16	0.24	nd	0.08	0.22	0.16	0.25
24	0.09	0.07	nd	nd	0.07	0.01	nd	0.01	0.01	nd	nd
16,32	0.48	0.60	0.35	0.21	0.42	0.58	0.39	0.31	0.61	0.40	0.25
29	nd	nd	0.07	nd	nd	0.10	0.31	0.05	0.11	nd	nd
26	0.11	0.11	0.09	0.08	0.09	0.21	nd	0.03	0.21	0.13	0.12
25	0.13	0.15	0.10	0.10	0.08	0.19	0.55	0.07	0.18	0.12	0.08
31, 28	1.38	2.17	1.60	0.86	2.00	1.82	3.98	0.93	1.61	1.22	1.08
33,21,53	0.11	0.22	0.09	0.08	0.16	0.46	0.84	0.09	0.58	0.18	0.14
51	0.01	0.04	0.01	nd	0.02	0.06	0.56	0.01	0.05	0.01	0.03
22	0.12	0.49	0.29	0.12	0.51	0.54	4.36	0.14	0.47	0.24	0.18
45	nd	0.21	0.03	nd	0.30	0.26	1.18	nd	0.08	0.10	0.08
46	0.05	0.03	0.03	0.02	0.04	0.09	1.34	0.01	0.10	0.03	0.02
52	0.30	0.50	0.06	0.17	0.44	0.63	2.13	0.30	0.59	0.49	0.36
49	0.28	0.55	0.19	0.24	0.52	0.54	0.90	0.25	0.51	0.37	0.30
47,48	0.34	0.55	0.41	0.30	0.51	0.50	1.92	0.33	0.56	0.29	0.23
44	0.28	0.56	0.29	0.24	0.48	0.48	0.54	0.24	0.48	0.32	0.32
37,42	0.11	0.28	0.18	0.11	0.20	0.29	0.23	0.11	0.33	0.17	0.11
41,64,71	0.53	0.74	0.57	0.38	0.60	0.61	nd	0.36	0.59	0.39	0.41
40	0.06	0.09	0.07	0.05	0.07	0.09	0.13	0.05	0.11	0.07	0.06

Table E-5: Experiment 2 - PCB Concentrations in Tissue and % Lipid

Sample Name	AMT4D30	AMT7D30	AMT11D30	AMT3D30	AMT6D30	AMT10D30	AMT5D30	AMT12D30	AMT14D30	AMT2D30	AMT8D30
g to extraction	4.51	6.8	5.6	5.37	4.64	6.52	5.39	6.17	5.98	4.84	5.25
% lipid	0.015	0.034	0.031	0.018	0.020	0.025	0.011	0.020	0.029	0.021	0.016
tank	4	7	11	3	6	10	5	12	14	2	8
MS222	0	0	0	1	1	1	2	2	2	3	3
PAH	0	0	0	0	0	0	0	0	0	0	0
100	0.05	0.07	0.10	0.04	0.05	0.13	0.32	0.04	0.08	0.04	0.06
63	0.03	0.05	0.05	0.09	0.04	0.07	0.15	0.02	0.04	0.03	0.03
74	0.27	0.40	0.37	0.18	0.34	0.41	nd	0.21	0.31	0.23	0.25
70,76	0.36	0.68	0.68	0.40	0.71	0.79	nd	0.44	0.70	0.50	0.50
66,95	1.35	1.84	1.60	1.02	1.65	2.17	nd	1.17	1.85	1.31	1.29
91	0.17	0.26	0.27	0.13	0.18	0.35	0.64	0.12	0.23	0.16	0.17
56,60	nd	nd	0.26	nd	nd	nd	0.74	0.03	nd	nd	nd
92,84, 89	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
101	0.71	0.77	0.75	0.41	0.65	0.92	0.39	0.64	0.90	0.75	0.63
99	1.03	1.11	1.00	0.70	0.94	1.04	nd	0.76	1.20	0.79	0.78
119	0.31	0.33	0.36	0.05	0.07	0.34	0.45	0.24	0.41	0.06	0.23
83	0.05	0.06	0.05	0.04	0.04	0.05	0.12	0.04	0.08	0.04	0.03
97	0.73	1.33	0.98	0.66	0.72	0.78	nd	0.80	1.40	0.59	0.60
81, 87	0.27	0.31	0.30	0.20	0.30	0.27	0.15	0.22	0.31	0.25	0.24
85	3.18	3.42	3.10	2.10	2.96	2.96	nd	2.28	3.29	2.43	2.44
136	0.01	0.01	0.01	0.01	0.01	0.01	nd	0.01	0.01	0.01	0.00
77,110	1.21	1.49	1.41	0.86	1.20	1.20	nd	1.03	1.50	0.92	0.96
82,151	0.45	0.05	0.05	0.30	0.09	0.10	nd	0.03	0.05	0.09	0.32
135,144	0.15	0.19	0.17	0.12	0.13	0.15	nd	0.14	0.23	0.12	0.09
107	0.25	0.28	0.26	0.16	0.22	0.25	nd	0.19	0.29	0.19	0.20
149,123	1.30	1.58	1.54	0.89	1.14	1.29	nd	1.12	1.64	0.99	1.04
118	0.80	0.87	0.85	0.52	0.76	0.83	0.04	0.62	0.90	0.62	0.64
134	0.06	0.07	0.10	0.05	0.05	0.05	nd	0.05	0.11	0.06	0.05
114,131	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
146	0.83	0.83	0.78	0.53	0.68	0.78	0.11	0.60	0.90	0.61	0.71
132,153,105	6.36	6.04	5.65	3.70	4.85	5.79	0.54	4.24	6.39	4.25	5.38
168	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
141	0.09	0.10	0.08	0.08	0.17	0.06	nd	0.08	0.12	0.08	0.15
137,130,176	0.17	0.21	0.17	0.11	0.16	0.17	0.08	0.12	0.20	0.16	0.13
138,163	2.96	3.01	2.91	1.77	2.35	2.84	nd	2.10	3.21	2.05	2.51
158	0.27	0.24	0.26	0.18	0.22	0.24	nd	0.19	0.26	0.20	0.23
129,178	0.29	0.33	0.33	0.19	0.25	0.30	nd	0.24	0.38	0.22	0.25
187,182	1.59	1.54	1.49	0.97	1.25	1.52	nd	1.16	1.72	1.14	1.38
183	0.57	0.57	0.54	0.35	0.46	0.57	nd	0.41	0.66	0.40	0.46

Table E-5: Experiment 2 - PCB Concentrations in Tissue and % Lipid

Sample Name	AMT4D30	AMT7D30	AMT11D30	AMT3D30	AMT6D30	AMT10D30	AMT5D30	AMT12D30	AMT14D30	AMT2D30	AMT8D30
g to extraction	4.51	6.8	5.6	5.37	4.64	6.52	5.39	6.17	5.98	4.84	5.25
% lipid	0.015	0.034	0.031	0.018	0.020	0.025	0.011	0.020	0.029	0.021	0.016
tank	4	7	11	3	6	10	5	12	14	2	8
MS222	0	0	0	1	1	1	2	2	2	3	3
PAH	0	0	0	0	0	0	0	0	0	0	0
128	0.29	0.33	0.30	0.18	0.24	0.23	nd	0.22	0.34	0.21	0.21
167	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
185	0.05	0.08	0.07	0.04	0.04	nd	nd	0.04	0.08	0.04	0.04
174	0.28	0.36	0.38	0.19	0.24	0.30	nd	0.25	0.42	0.20	0.25
177	0.39	0.43	0.44	0.26	0.33	0.43	0.05	0.31	0.49	0.29	0.35
202,171,156	0.43	0.45	0.48	0.28	0.35	0.46	nd	0.35	0.55	0.33	0.36
157,200	0.15	0.18	0.20	0.12	0.09	0.12	0.04	0.13	0.17	0.09	0.20
172	0.09	0.06	0.06	0.06	0.16	0.22	nd	0.03	0.07	0.03	0.07
197	0.07	0.09	0.06	0.04	0.04	0.06	nd	0.05	0.06	0.04	0.05
180	1.10	1.23	1.38	0.86	1.07	1.43	nd	0.98	1.69	0.96	1.03
193	0.12	0.25	0.19	0.17	0.17	0.26	nd	0.10	0.15	0.20	0.16
191	nd	0.02	0.05	nd	nd	0.03	nd	nd	0.03	nd	nd
199	0.04	0.06	0.04	nd	0.02	0.04	nd	0.11	0.05	0.02	0.05
170,190	0.53	0.37	0.59	0.33	0.42	0.59	nd	0.40	0.69	0.38	0.58
198	nd	nd	0.02	nd	nd	0.02	nd	nd	0.03	nd	nd
201	0.51	0.45	0.57	0.34	0.42	0.60	nd	0.44	0.68	0.39	0.45
203,196	0.63	0.59	0.74	0.44	0.49	0.74	nd	0.52	0.90	0.48	0.53
189	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
208,195	0.30	0.35	0.38	0.23	0.25	0.36	nd	0.30	0.46	0.25	0.25
207	0.08	0.11	0.08	0.05	0.06	0.12	nd	0.08	0.12	0.06	0.07
194	0.14	0.17	0.19	0.12	0.11	0.19	nd	0.12	0.26	0.12	0.12
205	nd	nd	nd	nd	nd	nd	nd	nd	0.02	nd	nd
206	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
209	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Table E-5: Experiment 2 - PCB Concentrations in Tissue and % Lipid

Sample Name	AMT9D30	AMT9D30-2	AMT1D30	AMT13D30	AMT15D30
g to extraction	5.9	8.74	5.59	7.86	6.85
% lipid	0.027	0.018	0.016	0.025	0.027
tank	9	9	1	13	15
MS222	3	3	4	4	4
PAH	0	0	1	1	1
Surrogate Recoveries					
PCB 14	1.14	1.30	1.08	1.05	0.79
PCB 166	0.97	1.11	1.07	0.96	0.78
PCBs (totals)	53.13	30.32	51.37	50.51	51.64
1	nd	nd	nd	nd	nd
3	nd	nd	nd	nd	nd
4,10	3.84	0.56	1.01	4.33	1.84
7,9	0.33	0.11	0.17	0.40	0.73
6	0.36	0.14	0.17	0.01	nd
8,5	1.20	0.93	0.48	0.18	0.34
19	0.06	0.04	nd	0.06	0.11
12,13	nd	nd	nd	nd	nd
18	0.36	0.25	nd	0.33	0.86
17	0.21	0.13	0.19	nd	0.44
24	0.01	0.01	0.13	0.05	0.06
16,32	0.57	0.38	0.60	0.53	0.43
29	0.18	0.11	nd	0.11	0.09
26	0.29	0.17	0.14	0.13	0.16
25	0.24	0.14	0.17	0.17	0.13
31, 28	1.43	0.92	1.90	1.55	1.43
33,21,53	0.81	0.49	0.44	0.36	0.21
51	0.07	0.05	0.09	0.07	0.02
22	0.50	0.33	0.50	0.42	0.25
45	0.22	0.07	0.50	0.23	0.09
46	0.12	0.11	0.08	0.15	0.04
52	0.74	0.46	0.49	0.15	0.73
49	0.59	0.39	0.67	0.41	0.62
47,48	0.61	0.39	0.71	0.63	0.62
44	0.48	0.29	0.71	0.39	0.50
37,42	0.29	0.22	0.64	0.38	0.36
41,64,71	0.56	0.42	1.25	0.86	0.66
40	0.12	0.08	0.50	0.17	0.13

Table E-5: Experiment 2 - PCB Concentrations in Tissue and % Lipid

Sample Name	AMT9D30	AMT9D30-2	AMT1D30	AMT13D30	AMT15D30
g to extraction	5.9	8.74	5.59	7.86	6.85
% lipid	0.027	0.018	0.016	0.025	0.027
tank	9	9	1	13	15
MS222	3	3	4	4	4
PAH	0	0	1	1	1
100	0.14	0.07	0.57	0.24	0.10
63	0.05	0.02	0.26	0.11	0.04
74	0.34	0.21	0.81	0.52	0.39
70,76	0.66	0.43	1.18	0.67	0.45
66,95	1.87	1.24	3.08	2.18	2.13
91	0.20	0.15	0.58	0.35	0.25
56,60	nd	nd	nd	0.38	nd
92,84, 89	nd	nd	nd	nd	nd
101	1.07	0.66	1.08	0.53	1.26
99	1.24	0.74	1.49	1.22	1.26
119	0.40	0.23	0.49	0.38	0.42
83	0.08	0.04	0.18	0.05	0.04
97	1.29	0.82	1.89	1.26	1.22
81, 87	0.32	0.21	0.43	0.33	0.34
85	3.57	2.21	3.14	3.46	3.56
136	0.01	0.00	0.01	0.01	0.01
77,110	1.44	0.95	1.57	1.57	1.62
82,151	0.51	0.32	0.06	0.04	0.53
135,144	0.22	0.15	0.23	0.22	0.22
107	0.32	0.19	0.32	0.33	0.36
149,123	1.55	1.04	1.63	1.54	1.68
118	0.97	0.61	0.99	1.02	1.11
134	0.12	0.05	0.10	0.09	0.09
114,131	nd	nd	nd	nd	nd
146	0.97	0.56	0.88	0.97	1.05
132,153,105	7.29	4.07	6.17	7.02	7.72
168	nd	nd	nd	nd	nd
141	0.14	0.11	0.12	0.16	0.13
137,130,176	0.22	0.12	0.23	0.19	0.21
138,163	3.56	2.02	3.06	3.53	3.76
158	0.31	0.18	0.29	0.29	0.33
129,178	0.39	0.22	0.37	0.39	0.39
187,182	1.82	1.05	1.65	1.76	1.87
183	0.70	0.40	0.64	0.66	0.73

Table E-5: Experiment 2 - PCB Concentrations in Tissue and % Lipid

Sample Name	AMT9D30	AMT9D30-2	AMT1D30	AMT13D30	AMT15D30
g to extraction	5.9	8.74	5.59	7.86	6.85
% lipid	0.027	0.018	0.016	0.025	0.027
tank	9	9	1	13	15
MS222	3	3	4	4	4
PAH	0	0	1	1	1
128	0.35	0.20	0.32	0.35	0.39
167	nd	nd	nd	nd	nd
185	0.07	0.05	0.08	0.07	0.06
174	0.35	0.22	0.35	0.37	0.35
177	0.50	0.28	0.46	0.51	0.51
202,171,156	0.56	0.32	0.50	0.56	0.56
157,200	0.26	0.12	0.17	0.19	0.15
172	0.08	0.03	0.06	0.07	0.07
197	0.06	0.04	0.06	0.06	0.10
180	1.69	0.93	1.45	1.59	2.04
193	0.25	0.13	0.23	0.15	0.20
191	0.03	nd	0.01	0.01	0.05
199	0.04	0.03	0.04	0.03	0.06
170,190	0.67	0.37	0.56	0.65	0.74
198	0.02	0.02	0.03	0.02	0.02
201	0.67	0.38	0.61	0.68	0.66
203,196	0.82	0.49	0.75	0.85	0.83
189	nd	nd	nd	nd	nd
208,195	0.42	0.24	0.41	0.47	0.38
207	0.10	0.06	0.10	0.12	0.12
194	0.19	0.12	0.18	0.21	0.21
205	nd	nd	nd	nd	nd
206	nd	nd	nd	nd	nd
209	nd	nd	nd	nd	nd

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
0	F0-00	NA	Avg of Med	4.48	58.3	0	0	0	0	0	127.8	0.023	NA
0	F0-01	NA	1	9.07	75.0	M	Day 0 1	NA	NA	NA	NA	0.021	NA
0	F0-02	NA	2	5.60	64.0	F	Day 0 2	NA	NA	NA	NA	0.021	NA
0	F0-03	NA	3	5.28	63.0	F	Day 0 3	NA	NA	NA	NA	0.021	NA
0	F0-04	NA	4	7.70	68.0	M	Day 0 4	NA	NA	NA	NA	0.024	NA
0	F0-05	NA	5	8.18	71.0	M	Day 0 5	NA	NA	NA	NA	0.023	NA
0	F0-06	NA	6	6.08	65.0	M	Day 0 6	NA	NA	NA	NA	0.022	NA
120	F120-01A	1	A	4.26	61.1	M	1	2	0	0.1	NA	0.019	217
120	F120-01B	1	B	4.37	62.7	M	1	2	0	0.1	NA	0.018	218
120	F120-01C	1	C	5.37	64.9	F	1	2	0	0.1	NA	0.020	219
120	F120-01D	1	D	3.33	60.0	M	1	2	0	0.1	59.9	0.015	NA
120	F120-01E	1	E	3.01	59.7	M	1	2	0	0.1	99.8	0.014	NA
120	F120-01F	1	F	3.32	58.3	F	1	2	0	0.1	74.2	0.017	NA
120	F120-01G	1	G	4.55	62.4	M	1	2	0	0.1	84.0	0.019	NA
120	F120-01H	1	H	4.34	67.4	F	1	2	0	0.1	79.0	0.014	NA
120	F120-02A	2	A	*	*	*	2	4	0	1	*	*	220
120	F120-02B	2	B	*	*	*	2	4	0	1	*	*	221
120	F120-02C	2	C	*	*	*	2	4	0	1	*	*	222
120	F120-02D	2	D	*	*	*	2	4	0	1	*	*	NA
120	F120-02E	2	E	*	*	*	2	4	0	1	*	*	NA
120	F120-02F	2	F	*	*	*	2	4	0	1	*	*	NA
120	F120-03A	3	A	2.07	46.9	F	3	3	0	0.5	NA	0.020	223
120	F120-03B	3	B	3.87	61.4	M	3	3	0	0.5	NA	0.017	224
120	F120-03C	3	C	7.10	70.3	FG	3	3	0	0.5	NA	0.020	225
120	F120-03D	3	D	2.48	55.5	M	3	3	0	0.5	131.8	0.014	NA
120	F120-03E	3	E	3.79	57.1	*	3	3	0	0.5	65.8	0.020	NA
120	F120-03F	3	F	4.97	66.5	F	3	3	0	0.5	86.3	0.017	NA
120	f120-03G	3	G	2.91	60.0	F	3	3	0	0.5	90.7	0.013	NA
120	F120-03H	3	H	3.90	58.8	F	3	3	0	0.5	109.6	0.019	NA
120	F120-03I	3	I	3.92	58.9	M	3	3	0	0.5	101.5	0.019	NA
120	F120-04A	4	A	*	*	*	4	1	0	0	*	*	226
120	F120-04B	4	B	*	*	*	4	1	0	0	*	*	227
120	F120-04C	4	C	*	*	*	4	1	0	0	*	*	228
120	F120-04D	4	D	7.47	72.6	*	4	1	0	0	63.7	0.020	NA
120	F120-04E	4	E	3.14	57.2	F	4	1	0	0	104.9	0.017	NA

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
120	F120-04F	4	F	2.64	54.7	F	4	1	0	0	77.6	0.016	NA
120	F120-04G	4	G	2.87	57.5	F	4	1	0	0	86.9	0.015	NA
120	F120-05A	5	A	5.94	66.5	M	5	5	1	0	NA	0.020	229
120	F120-05B	5	B	8.64	72.6	M	5	5	1	0	NA	0.023	230
120	F120-05C	5	C	*	*	*	5	5	1	0	*	*	231
120	F120-05D	5	D	*	*	*	5	5	1	0	*	*	NA
120	F120-05E	5	E	5.62	66.0	F	5	5	1	0	81.7	0.020	NA
120	F120-05F	5	F	4.66	63.1	*	5	5	1	0	116.5	0.019	NA
120	F120-05G	5	G	5.45	65.6	F	5	5	1	0	83.8	0.019	NA
120	F120-06A	6	A	5.04	67.0	F	6	4	0	1	NA	0.017	232
120	F120-06B	6	B	*	*	*	6	4	0	1	*	*	233
120	F120-06C	6	C	*	*	*	6	4	0	1	*	*	234
120	F120-06D	6	D	3.37	57.6	F	6	4	0	1	85.5	0.018	NA
120	F120-06E	6	E	3.50	56.6	M	6	4	0	1	108.8	0.019	NA
120	F120-06F	6	F	3.55	59.0	F	6	4	0	1	134.3	0.017	NA
120	F120-07A	7	A	2.74	60.9	M	7	2	0	0.1	NA	0.012	235
120	F120-07B	7	B	*	*	*	7	2	0	0.1	*	*	236
120	F120-07C	7	C	*	*	*	7	2	0	0.1	*	*	237
120	F120-07D	7	D	*	*	*	7	2	0	0.1	*	*	NA
120	F120-07E	7	E	*	*	*	7	2	0	0.1	*	*	NA
120	F120-07F	7	F	*	*	*	7	2	0	0.1	*	*	NA
120	F120-08A	8	A	4.82	61.1	F	8	7	1	0.5	NA	0.021	238
120	F120-08B	8	B	*	*	*	8	7	1	0.5	*	*	239
120	F120-08C	8	C	*	*	*	8	7	1	0.5	*	*	240
120	F120-08D	8	D	5.45	66.5	M	8	7	1	0.5	73.9	0.019	NA
120	F120-08E	8	E	4.33	62.6	F	8	7	1	0.5	94.8	0.018	NA
120	F120-08F	8	F	6.16	70.1	M	8	7	1	0.5	76.2	0.018	NA
120	F120-08G	8	G	*	*	*	8	7	1	0.5	*	*	NA
120	F120-09A	9	A	3.94	62.1	M	9	8	1	1	NA	0.016	241
120	F120-09B	9	B	*	*	*	9	8	1	1	*	*	242
120	F120-09C	9	C	*	*	*	9	8	1	1	*	*	243
120	F120-09D	9	D	*	*	*	9	8	1	1	*	*	NA
120	F120-09E	9	E	4.57	61.6	M	9	8	1	1	107.9	0.020	NA
120	F120-09F	9	F	4.80	60.7	M	9	8	1	1	107.6	0.021	NA
120	F120-09G	9	G	5.83	66.0	M	9	8	1	1	82.3	0.020	NA

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
120	F120-10A	10	A	2.67	57.8	M	10	6	1	0.1	NA	0.014	244
120	F120-10B	10	B	4.43	60.6	M	10	6	1	0.1	NA	0.020	245
120	F120-10C	10	C	*	*	*	10	6	1	0.1	*	*	246
120	F120-10D	10	D	3.48	59.6	M	10	6	1	0.1	94.5	0.016	NA
120	F120-10E	10	E	3.38	63.0	M	10	6	1	0.1	96.5	0.014	NA
120	F120-10F	10	F	5.31	66.6	M	10	6	1	0.1	115.9	0.018	NA
120	F120-10G	10	G	4.17	60.4	M	10	6	1	0.1	89.0	0.019	NA
120	F120-11A	11	A	*	*	*	11	3	0	0.5	*	*	247
120	F120-11B	11	B	*	*	*	11	3	0	0.5	*	*	248
120	F120-11C	11	C	*	*	*	11	3	0	0.5	*	*	249
120	F120-11D	11	D	*	*	*	11	3	0	0.5	*	*	NA
120	F120-11E	11	E	*	*	*	11	3	0	0.5	*	*	NA
120	F120-11F	11	F	*	*	*	11	3	0	0.5	*	*	NA
120	F120-12A	12	A	4.53	60.1	M	12	7	1	0.5	NA	0.021	250
120	F120-12B	12	B	3.54	58.9	M	12	7	1	0.5	NA	0.017	251
120	F120-12C	12	C	*	*	*	12	7	1	0.5	*	*	252
120	F120-12D	12	D	4.52	65.8	F	12	7	1	0.5	88.5	0.016	NA
120	F120-12E	12	E	3.17	59.9	M	12	7	1	0.5	122.9	0.015	NA
120	F120-12F	12	F	2.55	52.7	M	12	7	1	0.5	95.9	0.017	NA
120	F120-12G	12	G	6.06	68.6	M	12	7	1	0.5	95.5	0.019	NA
120	F120-13A	13	A	3.19	53.1	M	13	3	0	0.5	NA	0.021	253
120	F120-13B	13	B	2.25	47.9	F	13	3	0	0.5	NA	0.020	254
120	F120-13C	13	C	*	*	*	13	3	0	0.5	*	*	255
120	F120-13D	13	D	2.63	52.5	M	13	3	0	0.5	71.4	0.018	NA
120	F120-13E	13	E	3.21	61.2	M	13	3	0	0.5	105.9	0.014	NA
120	F120-13F	13	F	2.33	46.5	M	13	3	0	0.5	101.8	0.023	NA
120	F120-13G	13	G	2.83	52.5	M	13	3	0	0.5	122.4	0.020	NA
120	F120-14A	14	A	4.29	59.4	M	14	8	1	1	NA	0.020	256
120	F120-14B	14	B	5.43	67.6	M	14	8	1	1	NA	0.018	257
120	F120-14C	14	C	*	*	*	14	8	1	1	*	*	258
120	F120-14D	14	D	2.22	51.0	F	14	8	1	1	133.0	0.017	NA
120	F120-14E	14	E	2.39	51.5	F	14	8	1	1	177.1	0.018	NA
120	F120-14F	14	F	2.82	56.0	F	14	8	1	1	155.6	0.016	NA
120	F120-14G	14	G	5.11	64.5	M	14	8	1	1	94.4	0.019	NA
120	F120-15A	15	A	*	*	*	15	1	0	0	*	*	259

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
120	F120-15B	15	B	*	*	*	15	1	0	0	*	*	260
120	F120-15C	15	C	*	*	*	15	1	0	0	*	*	261
120	F120-15D	15	D	*	*	*	15	1	0	0	*	*	NA
120	F120-15E	15	E	*	*	*	15	1	0	0	*	*	NA
120	F120-15F	15	F	*	*	*	15	1	0	0	*	*	NA
120	F120-16A	16	A	4.88	63.3	F	16	4	0	1	NA	0.019	262
120	F120-16B	16	B	2.89	55.6	M	16	4	0	1	NA	0.017	263
120	F120-16C	16	C	*	*	*	16	4	0	1	*	*	264
120	F120-16D	16	D	*	*	*	16	4	0	1	*	*	NA
120	F120-16E	16	E	2.23	54.4	M	16	4	0	1	118.3	0.014	NA
120	F120-16F	16	F	1.86	53.3	F	16	4	0	1	52.5	0.012	NA
120	F120-16G	16	G	5.02	65.9	M	16	4	0	1	95.8	0.018	NA
120	F120-17A	17	A	*	*	*	17	8	1	1	*	*	265
120	F120-17B	17	B	*	*	*	17	8	1	1	*	*	266
120	F120-17C	17	C	*	*	*	17	8	1	1	*	*	267
120	F120-17D	17	D	3.19	57.3	M	17	8	1	1	118.1	0.017	NA
120	F120-17E	17	E	4.67	65.1	F	17	8	1	1	106.8	0.017	NA
120	F120-17F	17	F	4.29	65.8	F	17	8	1	1	103.1	0.015	NA
120	F120-18A	18	A	*	*	*	18	6	1	0.1	*	*	268
120	F120-18B	18	B	*	*	*	18	6	1	0.1	*	*	269
120	F120-18C	18	C	*	*	*	18	6	1	0.1	*	*	270
120	F120-18D	18	D	*	*	*	18	6	1	0.1	*	*	NA
120	F120-18E	18	E	*	*	*	18	6	1	0.1	*	*	NA
120	F120-18F	18	F	*	*	*	18	6	1	0.1	*	*	NA
120	F120-19A	19	A	4.68	63.6	M	19	7	1	0.5	NA	0.018	271
120	F120-19B	19	B	*	*	*	19	7	1	0.5	*	*	272
120	F120-19C	19	C	*	*	*	19	7	1	0.5	*	*	273
120	F120-19D	19	D	4.66	62.4	M	19	7	1	0.5	98.3	0.019	NA
120	F120-19E	19	E	3.58	60.3	M	19	7	1	0.5	127.7	0.016	NA
120	F120-19F	19	F	2.68	54.4	F	19	7	1	0.5	110.5	0.017	NA
120	F120-20A	20	A	5.50	67.4	M	20	2	0	0.1	NA	0.018	274
120	F120-20B	20	B	*	*	*	20	2	0	0.1	*	*	275
120	F120-20C	20	C	*	*	*	20	2	0	0.1	*	*	276
120	F120-20D	20	D	3.86	61.1	F	20	2	0	0.1	67.5	0.017	NA
120	F120-20E	20	E	2.03	52.2	M	20	2	0	0.1	126.7	0.014	NA

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
120	F120-20F	20	F	6.42	70.9	M	20	2	0	0.1	89.6	0.018	NA
120	F120-20Fb	20	F	6.42	70.9	M	20	2	0	0.1	89.6	0.018	NA
120	F120-20G	20	G	2.68	55.8	M	20	2	0	0.1	124.5	0.015	NA
120	F120-20G	19	G	2.83	57.7	M	19	7	1	0.5	113.8	0.015	NA
120	F120-20H	20	H	3.58	56.5	M	20	2	0	0.1	85.0	0.020	NA
120	F120-21A	21	A	4.19	61.3	M	21	5	1	0	NA	0.018	277
120	F120-21B	21	B	*	*	*	21	5	1	0	*	*	278
120	F120-21C	21	C	*	*	*	21	5	1	0	*	*	279
120	F120-21D	21	D	2.74	56.7	M	21	5	1	0	82.2	0.015	NA
120	F120-21E	21	E	3.10	58.1	M	21	5	1	0	94.1	0.016	NA
120	F120-21F	21	F	3.64	59.4	M	21	5	1	0	99.3	0.017	NA
120	F120-22A	22	A	*	*	*	22	6	1	0.1	*	*	280
120	F120-22B	22	B	*	*	*	22	6	1	0.1	*	*	281
120	F120-22C	22	C	*	*	*	22	6	1	0.1	*	*	282
120	F120-22D	22	D	*		*	22	6	1	0.1	*	*	NA
120	F120-22E	22	E	3.99	61.1	M	22	6	1	0.1	117.8	0.018	NA
120	F120-22F	22	F	*		*	22	6	1	0.1	*	*	NA
120	F120-23A	23	A	3.95	63.0	M	23	5	1	0	NA	0.016	283
120	F120-23B	23	B	4.39	61.3		23	5	1	0	NA	0.019	284
120	F120-23C	23	C	*	*	*	23	5	1	0	*	*	285
120	F120-23D	23	D	2.92	58.4	F	23	5	1	0	80.1	0.015	NA
120	F120-23E	23	E	3.83	63.1	M	23	5	1	0	110.3	0.015	NA
120	F120-23F	23	F	4.38	65.0	*	23	5	1	0	122.5	0.016	NA
120	F120-23G	23	G	3.49	62.5	F	23	5	1	0	120.7	0.014	NA
120	F120-23H	23	H	3.79	63.1	M	23	5	1	0	103.8	0.015	NA
120	F120-24A	24	A	4.54	59.2	M	24	1	0	0	NA	0.022	286
120	F120-24B	24	B	*	*	*	24	1	0	0	*	*	287
120	F120-24C	24	C	*	*	*	24	1	0	0	*	*	288
120	F120-24D	24	D	2.91	56.2	M	24	1	0	0	82.9	0.016	NA
120	F120-24E	24	E	5.23	65.2	M	24	1	0	0	123.8	0.019	NA
120	F120-24F	24	F	*	*	*	24	1	0	0	*	*	NA
35	F35-01A	1	A	5.05	59.6	F	1	2	0	0.1	NA	0.024	1
35	F35-01B	1	B	4.17	58.4	F	1	2	0	0.1	NA	0.021	2
35	F35-01C	1	C	5.54	61.2	M	1	2	0	0.1	NA	0.024	3
35	F35-01D	1	D	4.10	60.9	F	1	2	0	0.1	117.2	0.018	NA

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
35	F35-01E	1	E	3.89	57.0	F	1	2	0	0.1	78.0	0.021	NA
35	F35-01F	1	F	5.22	56.7	M	1	2	0	0.1	68.3	0.029	NA
35	F35-02A	2	A	4.43	57.5	M	2	4	0	1	NA	0.023	4
35	F35-02B	2	B	6.02	65.4	M	2	4	0	1	NA	0.022	5
35	F35-02C	2	C	5.57	62.4	F	2	4	0	1	NA	0.023	6
35	F35-02D	2	D	3.54	57.2	M	2	4	0	1	174.4	0.019	NA
35	F35-02E	2	E	3.22	58.8	M	2	4	0	1	156.5	0.016	NA
35	F35-02F	2	F	6.72	68.6	F	2	4	0	1	80.8	0.021	NA
35	F35-03A	3	A	3.51	57.6	F	3	3	0	0.5	NA	0.018	7
35	F35-03B	3	B	5.38	63.2	F	3	3	0	0.5	NA	0.021	8
35	F35-03C	3	C	6.36	66.0	M	3	3	0	0.5	NA	0.022	9
35	F35-03D	3	D	5.48	63.7	F	3	3	0	0.5	124.8	0.021	NA
35	F35-03E	3	E	6.59	67.3	F	3	3	0	0.5	74.9	0.022	NA
35	F35-03F	3	F	3.23	52.8	F	3	3	0	0.5	87.9	0.022	NA
35	F35-04A	4	A	5.38	62.7	F	4	1	0	0	NA	0.022	10
35	F35-04B	4	B	3.72	54.2	M	4	1	0	0	NA	0.023	11
35	F35-04C	4	C	3.95	57.1	F	4	1	0	0	NA	0.021	12
35	F35-04D	4	D	5.64	65.6	F	4	1	0	0	113.1	0.020	NA
35	F35-04E	4	E	4.48	63.0	F	4	1	0	0	126.3	0.018	NA
35	F35-04F	4	F	6.26	63.0	F	4	1	0	0	80.5	0.025	NA
35	F35-05A	5	A	6.62	67.3	F	5	5	1	0	NA	0.022	13
35	F35-05B	5	B	4.62	62.8	M	5	5	1	0	NA	0.019	14
35	F35-05C	5	C	5.05	58.5	F	5	5	1	0	NA	0.025	15
35	F35-05D	5	D	6.08	68.0	M	5	5	1	0	96.6	0.019	NA
35	F35-05E	5	E	4.09	57.7	F	5	5	1	0	85.4	0.021	NA
35	F35-05F	5	F	2.23	46.7	M	5	5	1	0	116.0	0.022	NA
35	F35-06A	6	A	5.67	61.3	M	6	4	0	1	NA	0.025	16
35	F35-06B	6	B	5.45	60.1	M	6	4	0	1	NA	0.025	17
35	F35-06C	6	C	3.72	54.9	M	6	4	0	1	NA	0.022	18
35	F35-06D	6	D	5.49	63.2	M	6	4	0	1	78.1	0.022	NA
35	F35-06E	6	E	5.01	62.1	M	6	4	0	1	124.2	0.021	NA
35	F35-06F	6	F	3.03	52.8	M	6	4	0	1	155.1	0.021	NA
35	F35-07A	7	A	5.79	62.6	F	7	2	0	0.1	NA	0.024	19
35	F35-07B	7	B	4.45	56.2	M	7	2	0	0.1	NA	0.025	20
35	F35-07C	7	C	3.53	56.4	F	7	2	0	0.1	NA	0.020	21

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
35	F35-07D	7	D	6.51	66.8	M	7	2	0	0.1	92.1	0.022	NA
35	F35-07E	7	E	5.90	66.3	F	7	2	0	0.1	122.4	0.020	NA
35	F35-07F	7	F	7.16	65.0	F	7	2	0	0.1	75.7	0.026	NA
35	F35-08A	8	A	5.99	62.1	F	8	7	1	0.5	NA	0.025	22
35	F35-08B	8	B	5.03	59.9	F	8	7	1	0.5	NA	0.023	23
35	F35-08C	8	C	3.73	59.6	M	8	7	1	0.5	NA	0.018	24
35	F35-08D	8	D	7.21	72.2	F	8	7	1	0.5	86.3	0.019	NA
35	F35-08E	8	E	4.40	61.6	M	8	7	1	0.5	114.8	0.019	NA
35	F35-08F	8	F	6.40	68.8	F	8	7	1	0.5	82.8	0.020	NA
35	F35-09A	9	A	6.73	63.8	M	9	8	1	1	NA	0.026	25
35	F35-09B	9	B	6.32	67.5	F	9	8	1	1	NA	0.021	26
35	F35-09C	9	C	2.67	50.2	F	9	8	1	1	NA	0.021	27
35	F35-09D	9	D	2.10	51.3	M	9	8	1	1	99.5	0.016	NA
35	F35-09E	9	E	2.71	51.7	M	9	8	1	1	153.6	0.020	NA
35	F35-09F	9	F	4.31	58.4	F	9	8	1	1	113.4	0.022	NA
35	F35-10A	10	A	7.62	70.1	M	10	6	1	0.1	NA	0.022	28
35	F35-10B	10	B	5.15	64.0	M	10	6	1	0.1	NA	0.020	29
35	F35-10C	10	C	6.66	65.0	M	10	6	1	0.1	NA	0.024	30
35	F35-10D	10	D	6.50	67.2	F	10	6	1	0.1	97.2	0.021	NA
35	F35-10E	10	E	6.02	67.6	F	10	6	1	0.1	115.1	0.019	NA
35	F35-10F	10	F	7.32	66.1	F	10	6	1	0.1	73.6	0.025	NA
35	F35-11A	11	A	5.57	65.9	M	11	3	0	0.5	NA	0.019	31
35	F35-11B	11	B	5.40	62.1	M	11	3	0	0.5	NA	0.023	32
35	F35-11C	11	C	3.87	55.1	M	11	3	0	0.5	NA	0.023	33
35	F35-11D	11	D	4.48	58.6	M	11	3	0	0.5	116.5	0.022	NA
35	F35-11E	11	E	3.73	56.9	M	11	3	0	0.5	93.9	0.020	NA
35	F35-11F	11	F	6.41	62.6	M	11	3	0	0.5	68.4	0.026	NA
35	F35-12A	12	A	5.72	65.2	M	12	7	1	0.5	NA	0.021	34
35	F35-12B	12	B	5.66	63.5	M	12	7	1	0.5	NA	0.022	35
35	F35-12C	12	C	4.35	58.7	M	12	7	1	0.5	NA	0.021	36
35	F35-12D	12	D	7.19	69.2	M	12	7	1	0.5	90.3	0.022	NA
35	F35-12E	12	E	3.62	62.1	F	12	7	1	0.5	92.5	0.015	NA
35	F35-12F	12	F	4.01	58.1	M	12	7	1	0.5	64.0	0.020	NA
35	F35-13A	13	A	6.51	63.4	F	13	3	0	0.5	NA	0.026	37
35	F35-13B	13	B	2.55	50.3	F	13	3	0	0.5	NA	0.020	38

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
35	F35-13C	13	C	4.94	59.1	F	13	3	0	0.5	NA	0.024	39
35	F35-13D	13	D	4.47	61.0	M	13	3	0	0.5	95.2	0.020	NA
35	F35-13E	13	E	5.30	59.9	F	13	3	0	0.5	64.5	0.025	NA
35	F35-13F	13	F	5.14	59.5	F	13	3	0	0.5	94.5	0.024	NA
35	F35-14A	14	A	2.81	54.0	M	14	8	1	1	NA	0.018	40
35	F35-14B	14	B	5.78	64.5	F	14	8	1	1	NA	0.022	41
35	F35-14C	14	C	5.36	62.7	F	14	8	1	1	NA	0.022	42
35	F35-14D	14	D	5.14	61.0	F	14	8	1	1	91.1	0.023	NA
35	F35-14E	14	E	4.47	60.6	F	14	8	1	1	123.6	0.020	NA
35	F35-14F	14	F	4.92	61.2	F	14	8	1	1	71.8	0.022	NA
35	F35-15A	15	A	7.19	66.5	M	15	1	0	0	NA	0.024	43
35	F35-15B	15	B	3.66	54.7	M	15	1	0	0	NA	0.022	44
35	F35-15C	15	C	5.46	60.4	M	15	1	0	0	NA	0.025	45
35	F35-15D	15	D	3.15	54.3	M	15	1	0	0	193.4	0.020	NA
35	F35-15E	15	E	4.88	55.9	F	15	1	0	0	84.6	0.028	NA
35	F35-15F	15	F	4.31	61.6	F	15	1	0	0	94.0	0.018	NA
35	F35-16A	16	A	6.08	61.7	M	16	4	0	1	NA	0.026	46
35	F35-16B	16	B	2.47	52.1	M	16	4	0	1	NA	0.018	47
35	F35-16C	16	C	4.97	61.7	M	16	4	0	1	NA	0.021	48
35	F35-16D	16	D	5.42	66.0	M	16	4	0	1	145.6	0.019	NA
35	F35-16E	16	E	4.70	64.3	F	16	4	0	1	112.5	0.018	NA
35	F35-16F	16	F	5.04	58.6	M	16	4	0	1	86.8	0.025	NA
35	F35-17A	17	A	5.81	62.5	F	17	8	1	1	NA	0.024	49
35	F35-17B	17	B	4.79	61.2	F	17	8	1	1	NA	0.021	50
35	F35-17C	17	C	4.45	59.2	F	17	8	1	1	NA	0.021	51
35	F35-17D	17	D	2.31	52.5	M	17	8	1	1	193.3	0.016	NA
35	F35-17E	17	E	4.04	53.7	M	17	8	1	1	129.1	0.026	NA
35	F35-17F	17	F	4.87	51.8	M	17	8	1	1	116.6	0.035	NA
35	F35-18A	18	A	5.02	59.6	F	18	6	1	0.1	NA	0.024	52
35	F35-18B	18	B	6.22	67.8	M	18	6	1	0.1	NA	0.020	53
35	F35-18C	18	C	3.80	56.6	F	18	6	1	0.1	NA	0.021	54
35	F35-18D	18	D	5.68	64.7	F	18	6	1	0.1	96.1	0.021	NA
35	F35-18E	18	E	4.56	57.5	M	18	6	1	0.1	91.8	0.024	NA
35	F35-18F	18	F	3.55	54.8	F	18	6	1	0.1	107.9	0.022	NA
35	F35-19A	19	A	4.76	59.6	F	19	7	1	0.5	NA	0.022	55

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
35	F35-19B	19	B	2.22	45.7	M	19	7	1	0.5	NA	0.023	56
35	F35-19C	19	C	5.05	65.0	M	19	7	1	0.5	NA	0.018	57
35	F35-19D	19	D	4.00	58.6	F	19	7	1	0.5	106.9	0.020	NA
35	F35-19E	19	E	5.64	62.5	F	19	7	1	0.5	97.2	0.023	NA
35	F35-19F	19	F	5.35	64.2	M	19	7	1	0.5	87.7	0.020	NA
35	F35-20A	20	A	5.46	64.7	M	20	2	0	0.1	NA	0.020	58
35	F35-20B	20	B	5.98	65.2	M	20	2	0	0.1	NA	0.022	59
35	F35-20C	20	C	5.50	68.0	M	20	2	0	0.1	NA	0.017	60
35	F35-20D	20	D	5.46	61.6	M	20	2	0	0.1	68.3	0.023	NA
35	F35-20E	20	E	4.74	57.7	F	20	2	0	0.1	87.1	0.025	NA
35	F35-20F	20	F	2.45	48.3	M	20	2	0	0.1	101.9	0.022	NA
35	F35-21A	21	A	4.70	61.9	M	21	5	1	0	NA	0.020	61
35	F35-21B	21	B	4.58	60.9	F	21	5	1	0	NA	0.020	62
35	F35-21C	21	C	5.96	64.9	M	21	5	1	0	NA	0.022	63
35	F35-21D	21	D	6.71	65.4	M	21	5	1	0	94.7	0.024	NA
35	F35-21E	21	E	6.84	64.8	F	21	5	1	0	80.2	0.025	NA
35	F35-21F	21	F	6.69	65.0	M	21	5	1	0	71.0	0.024	NA
35	F35-22A	22	A	5.29	57.3	M	22	6	1	0.1	NA	0.028	64
35	F35-22B	22	B	5.02	60.8	M	22	6	1	0.1	NA	0.022	65
35	F35-22C	22	C	4.90	58.4	F	22	6	1	0.1	NA	0.025	66
35	F35-22D	22	D	3.89	60.5	M	22	6	1	0.1	99.4	0.018	NA
35	F35-22E	22	E	4.55	57.8	F	22	6	1	0.1	97.8	0.024	NA
35	F35-22F	22	F	3.31	52.2	M	22	6	1	0.1	147.0	0.023	NA
35	F35-23A	23	A	6.65	67.5	M	23	5	1	0	NA	0.022	67
35	F35-23B	23	B	4.22	60.5	M	23	5	1	0	NA	0.019	68
35	F35-23C	23	C	3.64	56.5	M	23	5	1	0	NA	0.020	69
35	F35-23D	23	D	5.42	69.1	F	23	5	1	0	147.6	0.016	NA
35	F35-23E	23	E	7.34	69.6	M	23	5	1	0	78.8	0.022	NA
35	F35-23F	23	F	5.37	56.9	F	23	5	1	0	70.1	0.029	NA
35	F35-24A	24	A	5.95	65.0	M	24	1	0	0	NA	0.022	70
35	F35-24B	24	B	2.87	52.0	M	24	1	0	0	NA	0.020	71
35	F35-24C	24	C	3.49	54.8	M	24	1	0	0	NA	0.021	72
35	F35-24D	24	D	3.13	56.6	F	24	1	0	0	88.1	0.017	NA
35	F35-24E	24	E	3.83	54.4	M	24	1	0	0	114.4	0.024	NA
35	F35-24F	24	F	5.11	56.7	F	24	1	0	0	116.1	0.028	NA

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
62	F62-01A	1	A	5.95	64.7	M	1	2	0	0.1	NA	0.022	73
62	F62-01B	1	B	4.89	60.9	M	1	2	0	0.1	NA	0.022	74
62	F62-01C	1	C	7.86	71.9	F	1	2	0	0.1	NA	0.021	75
62	F62-01D	1	D	8.02	65.9	M	1	2	0	0.1	68.3	0.028	NA
62	F62-01E	1	E	2.96	57.9	M	1	2	0	0.1	110.2	0.015	NA
62	F62-02A	2	A	7.06	64.7	F	2	4	0	1	NA	0.026	76
62	F62-02B	2	B	5.77	63.0	F	2	4	0	1	NA	0.023	77
62	F62-02C	2	C	4.47	57.5	F	2	4	0	1	NA	0.024	78
62	F62-02D	2	D	4.23	57.9	M	2	4	0	1	69.1	0.022	NA
62	F62-02E	2	E	5.21	63.0	M	2	4	0	1	118.3	0.021	NA
62	F62-03A	3	A	4.93	62.8	M	3	3	0	0.5	NA	0.020	79
62	F62-03B	3	B	3.18	53.4	F	3	3	0	0.5	NA	0.021	80
62	F62-03C	3	C	7.72	67.8	F	3	3	0	0.5	NA	0.025	81
62	F62-03D	3	D	7.17	68.6	M	3	3	0	0.5	76.0	0.022	NA
62	F62-03E	3	E	5.45	60.2	F	3	3	0	0.5	93.5	0.025	NA
62	F62-04A	4	A	8.05	70.5	M	4	1	0	0	NA	0.023	82
62	F62-04B	4	B	3.05	50.8	M	4	1	0	0	NA	0.023	83
62	F62-04C	4	C	4.68	63.2	M	4	1	0	0	NA	0.019	84
62	F62-04D	4	D	6.32	65.9	F	4	1	0	0	65.7	0.022	NA
62	F62-04E	4	E	5.72	65.6	F	4	1	0	0	80.5	0.020	NA
62	F62-05A	5	A	4.00	57.2	M	5	5	1	0	NA	0.021	85
62	F62-05B	5	B	3.90	67.2	F	5	5	1	0	NA	0.013	86
62	F62-05C	5	C	4.19	58.3	M	5	5	1	0	NA	0.021	87
62	F62-05D	5	D	7.45	77.3	F	5	5	1	0	69.3	0.016	NA
62	F62-05E	5	E	2.40	58.1	M	5	5	1	0	79.1	0.012	NA
62	F62-06A	6	A	4.41	59.6	F	6	4	0	1	NA	0.021	88
62	F62-06B	6	B	7.01	64.5	F	6	4	0	1	NA	0.026	89
62	F62-06C	6	C	4.33	58.8	M	6	4	0	1	NA	0.021	90
62	F62-06D	6	D	6.81	68.0	M	6	4	0	1	66.0	0.022	NA
62	F62-06E	6	E	3.79	56.5	F	6	4	0	1	100.5	0.021	NA
62	F62-07A	7	A	4.04	58.0	F	7	2	0	0.1	NA	0.021	91
62	F62-07B	7	B	3.36	51.3	M	7	2	0	0.1	NA	0.025	92
62	F62-07C	7	C	5.03	59.6	M	7	2	0	0.1	NA	0.024	93
62	F62-07D	7	D	4.14	59.9	F	7	2	0	0.1	86.9	0.019	NA
62	F62-07E	7	E	2.41	52.6	M	7	2	0	0.1	113.5	0.017	NA

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
62	F62-08A	8	A	2.79	49.2	M	8	7	1	0.5	NA	0.023	94
62	F62-08B	8	B	5.52	62.8	M	8	7	1	0.5	NA	0.022	95
62	F62-08C	8	C	4.90	57.4	F	8	7	1	0.5	NA	0.026	96
62	F62-08D	8	D	3.57	57.4	M	8	7	1	0.5	108.7	0.019	NA
62	F62-08E	8	E	6.20	72.8	F	8	7	1	0.5	96.8	0.016	NA
62	F62-09A	9	A	5.84	65.9	F	9	8	1	1	NA	0.020	97
62	F62-09B	9	B	5.59	65.9	M	9	8	1	1	NA	0.020	98
62	F62-09C	9	C	4.18	60.5	M	9	8	1	1	NA	0.019	99
62	F62-09D	9	D	3.42	56.0	M	9	8	1	1	106.4	0.019	NA
62	F62-09E	9	E	6.34	70.0	F	9	8	1	1	74.3	0.018	NA
62	F62-10A	10	A	2.99	52.0	F	10	6	1	0.1	NA	0.021	100
62	F62-10B	10	B	6.07	64.5	M	10	6	1	0.1	NA	0.023	101
62	F62-10C	10	C	6.84	66.0	F	10	6	1	0.1	NA	0.024	102
62	F62-10D	10	D	3.63	55.4	F	10	6	1	0.1	117.0	0.021	NA
62	F62-10E	10	E	6.42	66.7	F	10	6	1	0.1	77.0	0.022	NA
62	F62-11A	11	A	9.79	68.9	F	11	3	0	0.5	NA	0.030	103
62	F62-11B	11	B	7.30	70.2	M	11	3	0	0.5	NA	0.021	104
62	F62-11C	11	C	8.47	72.3	F	11	3	0	0.5	NA	0.022	105
62	F62-11D	11	D	7.48	68.5	M	11	3	0	0.5	62.7	0.023	NA
62	F62-11E	11	E	5.59	63.7	F	11	3	0	0.5	72.9	0.022	NA
62	F62-12A	12	A	7.11	73.1	F	12	7	1	0.5	NA	0.018	106
62	F62-12B	12	B	2.84	48.2	M	12	7	1	0.5	NA	0.025	107
62	F62-12C	12	C	6.46	67.1	M	12	7	1	0.5	NA	0.021	108
62	F62-12D	12	D	4.32	57.9	M	12	7	1	0.5	108.7	0.022	NA
62	F62-12E	12	E	6.22	70.8	M	12	7	1	0.5	81.7	0.018	NA
62	F62-13A	13	A	5.91	67.6	F	13	3	0	0.5	NA	0.019	109
62	F62-13B	13	B	4.94	57.9	M	13	3	0	0.5	NA	0.025	110
62	F62-13C	13	C	5.68	64.7	M	13	3	0	0.5	NA	0.021	111
62	F62-13D	13	D	3.68	54.2	M	13	3	0	0.5	103.6	0.023	NA
62	F62-13E	13	E	5.59	64.3	F	13	3	0	0.5	91.5	0.021	NA
62	F62-14A	14	A	3.62	54.3	M	14	8	1	1	NA	0.023	112
62	F62-14B	14	B	4.24	56.8	F	14	8	1	1	NA	0.023	113
62	F62-14C	14	C	3.76	59.2	M	14	8	1	1	NA	0.018	114
62	F62-14D	14	D	5.51	63.5	F	14	8	1	1	87.6	0.022	NA
62	F62-14E	14	E	6.31	62.7	F	14	8	1	1	76.9	0.026	NA

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
62	F62-15A	15	A	3.05	54.0	F	15	1	0	0	NA	0.019	115
62	F62-15B	15	B	6.54	66.2	M	15	1	0	0	NA	0.023	116
62	F62-15C	15	C	4.43	68.4	M	15	1	0	0	NA	0.014	117
62	F62-15D	15	D	3.03	55.6	F	15	1	0	0	101.5	0.018	NA
62	F62-15E	15	E	3.38	53.1	F	15	1	0	0	91.6	0.023	NA
62	F62-16A	16	A	3.85	55.1	F	16	4	0	1	NA	0.023	118
62	F62-16B	16	B	6.56	63.9	F	16	4	0	1	NA	0.025	119
62	F62-16C	16	C	4.45	59.3	F	16	4	0	1	NA	0.021	120
62	F62-16D	16	D	7.29	68.2	F	16	4	0	1	68.4	0.023	NA
62	F62-16E	16	E	5.57	64.6	F	16	4	0	1	92.0	0.021	NA
62	F62-17A	17	A	2.50	49.8	F	17	8	1	1	NA	0.020	121
62	F62-17B	17	B	5.22	61.4	M	17	8	1	1	NA	0.023	122
62	F62-17C	17	C	5.37	64.5	F	17	8	1	1	NA	0.020	123
62	F62-17D	17	D	6.22	65.7	F	17	8	1	1	117.6	0.022	NA
62	F62-17E	17	E	4.08	57.5	F	17	8	1	1	101.5	0.021	NA
62	F62-18A	18	A	6.27	69.5	F	18	6	1	0.1	NA	0.019	124
62	F62-18B	18	B	5.92	64.6	M	18	6	1	0.1	NA	0.022	125
62	F62-18C	18	C	5.50	64.2	F	18	6	1	0.1	NA	0.021	126
62	F62-18D	18	D	2.89	55.3	M	18	6	1	0.1	111.6	0.017	NA
62	F62-18E	18	E	5.21	59.9	F	18	6	1	0.1	96.0	0.024	NA
62	F62-19A	19	A	8.38	70.2	F	19	7	1	0.5	NA	0.024	127
62	F62-19B	19	B	4.80	57.3	M	19	7	1	0.5	NA	0.025	128
62	F62-19C	19	C	6.33	64.2	M	19	7	1	0.5	NA	0.024	129
62	F62-19D	19	D	2.96	51.5	F	19	7	1	0.5	109.4	0.022	NA
62	F62-19E	19	E	5.50	64.7	F	19	7	1	0.5	83.0	0.020	NA
62	F62-20A	20	A	5.65	62.2	M	20	2	0	0.1	NA	0.024	130
62	F62-20B	20	B	5.64	64.4	F	20	2	0	0.1	NA	0.021	131
62	F62-20C	20	C	7.40	67.9	M	20	2	0	0.1	NA	0.024	132
62	F62-20D	20	D	5.25	65.8	M	20	2	0	0.1	83.3	0.018	NA
62	F62-20E	20	E	5.04	59.2	M	20	2	0	0.1	97.7	0.024	NA
62	F62-21A	21	A	2.24	45.7	F	21	5	1	0	NA	0.024	133
62	F62-21B	21	B	4.74	58.6	F	21	5	1	0	NA	0.024	134
62	F62-21C	21	C	5.97	65.5	M	21	5	1	0	NA	0.021	135
62	F62-21D	21	D	3.72	57.8	F	21	5	1	0	86.0	0.019	NA
62	F62-21E	21	E	5.78	63.5	F	21	5	1	0	75.7	0.023	NA

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
62	F62-22A	22	A	5.10	59.5	F	22	6	1	0.1	NA	0.024	136
62	F62-22B	22	B	7.32	69.3	M	22	6	1	0.1	NA	0.022	137
62	F62-22C	22	C	5.40	64.5	M	22	6	1	0.1	NA	0.020	138
62	F62-22D	22	D	2.28	49.0	F	22	6	1	0.1	128.6	0.019	NA
62	F62-22E	22	E	5.13	57.9	F	22	6	1	0.1	85.5	0.026	NA
62	F62-23A	23	A	3.44	53.6	F	23	5	1	0	NA	0.022	139
62	F62-23B	23	B	5.91	64.7	F	23	5	1	0	NA	0.022	140
62	F62-23C	23	C	6.76	66.7	M	23	5	1	0	NA	0.023	141
62	F62-23D	23	D	4.15	55.8	F	23	5	1	0	65.4	0.024	NA
62	F62-23E	23	E	7.75	70.3	M	23	5	1	0	62.5	0.022	NA
62	F62-24A	24	A	2.72	50.4	F	24	1	0	0	NA	0.021	142
62	F62-24B	24	B	5.43	63.9	M	24	1	0	0	NA	0.021	143
62	F62-24C	24	C	5.26	59.3	F	24	1	0	0	NA	0.025	144
62	F62-24D	24	D	3.83	54.6	M	24	1	0	0	104.1	0.023	NA
62	F62-24E	24	E	6.12	66.7	F	24	1	0	0	76.6	0.021	NA
90	F90-01A	1	A	4.51	63.1	M	1	2	0	0.1	NA	0.018	145
90	F90-01B	1	A	6.01	57.0	FG	2	4	0	1	NA	0.032	148
90	F90-01C	1	A	7.11	67.4	M	3	3	0	0.5	NA	0.023	151
90	F90-01D	1	D	5.07	61.6	F	1	2	0	0.1	98.3	0.022	NA
90	F90-01E	1	E	4.06	61.3	F	1	2	0	0.1	89.3	0.018	NA
90	F90-01F	1	F	3.64	57.3	M	1	2	0	0.1	*	0.019	NA
90	F90-02A	2	A	4.94	66.1	F	4	1	0	0	NA	0.017	154
90	F90-02B	2	A	4.92	61.8	F	5	5	1	0	NA	0.021	157
90	F90-02C	2	A	2.91	50.7	M	6	4	0	1	NA	0.022	160
90	F90-02D	2	D	4.51	62.0	M	2	4	0	1	97.2	0.019	NA
90	F90-02E	2	E	5.37	67.0	F	2	4	0	1	73.8	0.018	NA
90	F90-02F	2	F	4.90	66.2	FG	2	4	0	1	85.2	0.017	NA
90	F90-03A	3	A	4.31	59.1	M	7	2	0	0.1	NA	0.021	163
90	F90-03B	3	A	4.65	61.3	M	8	7	1	0.5	NA	0.020	166
90	F90-03C	3	A	2.49	55.0	F	9	8	1	1	NA	0.015	169
90	F90-03D	3	D	*	*	M	3	3	0	0.5	*	*	NA
90	F90-03E	3	E	3.59	55.2	F	3	3	0	0.5	113.0	0.021	NA
90	F90-03F	3	F	2.49	55.7	M	3	3	0	0.5	66.1	0.014	NA
90	F90-04A	4	A	3.66	55.1	F	10	6	1	0.1	NA	0.022	172
90	F90-04B	4	A	4.93	61.5	M	11	3	0	0.5	NA	0.021	175

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
90	F90-04C	4	A	3.41	54.0	M	12	7	1	0.5	NA	0.022	178
90	F90-04D	4	D	6.38	65.5	M	4	1	0	0	78.8	0.023	NA
90	F90-04E	4	E	4.40	65.0	F	4	1	0	0	127.0	0.016	NA
90	F90-04F	4	F	5.15	62.6	F	4	1	0	0	114.2	0.021	NA
90	F90-05A	5	A	5.16	60.9	M	13	3	0	0.5	NA	0.023	181
90	F90-05B	5	A	6.75	67.0	FG	14	8	1	1	NA	0.022	184
90	F90-05C	5	A	*	*	*	15	1	0	0	*	*	187
90	F90-05D	5	D	*	*	M	5	5	1	0	*	*	NA
90	F90-05E	5	E	3.58	60.2	F	5	5	1	0	102.1	0.016	NA
90	F90-05F	5	F	5.65	70.4	M	5	5	1	0	100.3	0.016	NA
90	F90-06A	6	A	3.92	57.7	M	16	4	0	1	NA	0.020	190
90	F90-06B	6	A	2.94	52.2	M	17	8	1	1	NA	0.021	193
90	F90-06C	6	A	4.04	57.7	FG	18	6	1	0.1	NA	0.021	196
90	F90-06D	6	D	*	*	F	6	4	0	1	*	*	NA
90	F90-06E	6	E	4.16	59.2	M	6	4	0	1	112.3	0.020	NA
90	F90-06F	6	F	7.59	67.7	FG	6	4	0	1	89.9	0.024	NA
90	F90-07A	7	A	3.46	53.3	F	19	7	1	0.5	NA	0.023	199
90	F90-07B	7	A	5.88	66.5	M	20	2	0	0.1	NA	0.020	202
90	F90-07C	7	A	7.28	66.6	F	21	5	1	0	NA	0.025	205
90	F90-07D	7	D	*	*	*	7	2	0	0.1	*	*	NA
90	F90-07E	7	E	*	*	*	7	2	0	0.1	*	*	NA
90	F90-07F	7	F	*	*	*	7	2	0	0.1	*	*	NA
90	F90-08A	8	A	5.19	60.1	F	22	6	1	0.1	NA	0.024	208
90	F90-08B	8	A	6.29	65.1	M	23	5	1	0	NA	0.023	211
90	F90-08C	8	A	5.76	66.4	M	24	1	0	0	NA	0.020	214
90	F90-08D	8	D	3.99	55.8	F	8	7	1	0.5	95.0	0.023	NA
90	F90-08E	8	E	3.71	55.4	M	8	7	1	0.5	96.3	0.022	NA
90	F90-08F	8	F	4.89	63.8	M	8	7	1	0.5	127.9	0.019	NA
90	F90-09A	9	B	*	*	*	1	2	0	0.1	*	*	146
90	F90-09B	9	B	*	*	*	2	4	0	1	*	*	149
90	F90-09C	9	B	*	*	*	3	3	0	0.5	*	*	152
90	F90-09D	9	D	5.80	67.4	FG	9	8	1	1	85.3	0.019	NA
90	F90-09E	9	E	2.20	54.4	F	9	8	1	1	90.8	0.014	NA
90	F90-09F	9	F	5.85	65.6	M	9	8	1	1	94.3	0.021	NA
90	F90-10A	10	B	*	*	*	4	1	0	0	*	*	155

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
90	F90-10B	10	B	*	*	*	5	5	1	0	*	*	158
90	F90-10C	10	B	*	*	*	6	4	0	1	*	*	161
90	F90-10D	10	D	3.01	55.3	M	10	6	1	0.1	127.7	0.018	NA
90	F90-10E	10	E	6.84	64.9	F	10	6	1	0.1	76.2	0.025	NA
90	F90-10F	10	F	4.67	62.3	F	10	6	1	0.1	77.2	0.019	NA
90	F90-11A	11	B	*	*	*	7	2	0	0.1	*	*	164
90	F90-11B	11	B	*	*	*	8	7	1	0.5	*	*	167
90	F90-11C	11	B	*	*	*	9	8	1	1	*	*	170
90	F90-11D	11	D	3.27	55.2	F	11	3	0	0.5	84.5	0.019	NA
90	F90-11E	11	E	3.16	56.3	M	11	3	0	0.5	114.0	0.018	NA
90	F90-11F	11	F	3.77	57.3	M	11	3	0	0.5	107.4	0.020	NA
90	F90-12A	12	B	*	*	*	10	6	1	0.1	*	*	173
90	F90-12B	12	B	*	*	*	11	3	0	0.5	*	*	176
90	F90-12C	12	B	*	*	*	12	7	1	0.5	*	*	179
90	F90-12D	12	D	5.10	66.6	F	12	7	1	0.5	99.2	0.017	NA
90	F90-12E	12	E	*	*	*	12	7	1	0.5	*	*	NA
90	F90-12F	12	F	5.20	67.6	F	12	7	1	0.5	110.5	0.017	NA
90	F90-13A	13	B	*	*	*	13	3	0	0.5	*	*	182
90	F90-13B	13	B	*	*	*	14	8	1	1	*	*	185
90	F90-13C	13	B	*	*	*	15	1	0	0	*	*	188
90	F90-13D	13	D	3.70	54.2	M	13	3	0	0.5	88.1	0.023	NA
90	F90-13E	13	E	5.08	65.4	M	13	3	0	0.5	103.6	0.018	NA
90	F90-13F	13	F	5.16	66.4	F	13	3	0	0.5	101.8	0.018	NA
90	F90-14A	14	B	*	*	*	16	4	0	1	*	*	191
90	F90-14B	14	B	*	*	*	17	8	1	1	*	*	194
90	F90-14C	14	B	*	*	*	18	6	1	0.1	*	*	197
90	F90-14D	14	D	4.70	63.7	F	14	8	1	1	92.5	0.018	NA
90	F90-14E	14	E	4.84	62.7	FG	14	8	1	1	95.6	0.020	NA
90	F90-14F	14	F	4.84	62.7	F	14	8	1	1	*	0.020	NA
90	F90-15A	15	B	*	*	*	19	7	1	0.5	*	*	200
90	F90-15B	15	B	*	*	*	20	2	0	0.1	*	*	203
90	F90-15C	15	B	*	*	*	21	5	1	0	*	*	206
90	F90-15D	15	D	*	*	*	15	1	0	0	*	*	NA
90	F90-15E	15	E	*	*	*	15	1	0	0	*	*	NA
90	F90-15F	15	F	*	*	*	15	1	0	0	*	*	NA

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
90	F90-16A	16	B	*	*	*	22	6	1	0.1	*	*	209
90	F90-16B	16	B	*	*	*	23	5	1	0	*	*	212
90	F90-16C	16	B	*	*	*	24	1	0	0	*	*	215
90	F90-16D	16	D	3.13	56.3	M	16	4	0	1	134.7	0.018	NA
90	F90-16E	16	E	*	*	*	16	4	0	1	*	*	NA
90	F90-16F	16	F	4.51	65.0	M	16	4	0	1	116.9	0.016	NA
90	F90-17A	17	C	*	*	*	1	2	0	0.1	*	*	147
90	F90-17B	17	C	*	*	*	2	4	0	1	*	*	150
90	F90-17C	17	C	*	*	*	3	3	0	0.5	*	*	153
90	F90-17D	17	D	5.41	65.6	M	17	8	1	1	84.4	0.019	NA
90	F90-17E	17	E	2.74	52.8	M	17	8	1	1	140.4	0.019	NA
90	F90-17F	17	F	5.90	66.9	M	17	8	1	1	110.6	0.020	NA
90	F90-18A	18	C	*	*	*	4	1	0	0	*	*	156
90	F90-18B	18	C	*	*	*	5	5	1	0	*	*	159
90	F90-18C	18	C	*	*	*	6	4	0	1	*	*	162
90	F90-18D	18	D	*	*	*	18	6	1	0.1	*	#VALUE!	NA
90	F90-18E	18	E	*	*	*	18	6	1	0.1	*	#VALUE!	NA
90	F90-18F	18	F	3.35	60.1	F	18	6	1	0.1	135.6	0.015	NA
90	F90-19A	19	C	*	*	*	7	2	0	0.1	*	*	165
90	F90-19B	19	C	*	*	*	8	7	1	0.5	*	*	168
90	F90-19C	19	C	*	*	*	9	8	1	1	*	*	171
90	F90-19D	19	D	3.76	63.2	F	19	7	1	0.5	107.8	0.015	NA
90	F90-19E	19	E	4.64	64.6	F	19	7	1	0.5	105.9	0.017	NA
90	F90-19F	19	F	3.63	55.1	M	19	7	1	0.5	122.8	0.022	NA
90	F90-20A	20	C	*	*	*	10	6	1	0.1	*	*	174
90	F90-20B	20	C	*	*	*	11	3	0	0.5	*	*	177
90	F90-20C	20	C	*	*	*	12	7	1	0.5	*	*	180
90	F90-20D	20	D	4.50	62.3	M	20	2	0	0.1	102.2	0.019	NA
90	F90-20E	20	E	2.56	53.5	M	20	2	0	0.1	124.0	0.017	NA
90	F90-20F	20	F	7.83	73.5	M	20	2	0	0.1	94.4	0.020	NA
90	F90-21A	21	C	*	*	*	13	3	0	0.5	*	*	183
90	F90-21B	21	C	*	*	*	14	8	1	1	*	*	186
90	F90-21C	21	C	*	*	*	15	1	0	0	*	*	189
90	F90-21D	21	D	*	*	*	21	5	1	0	*	#VALUE!	NA
90	F90-21E	21	E	6.26	70.9	F	21	5	1	0	74.9	0.018	NA

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
90	F90-21F	21	F	5.55	66.0	M	21	5	1	0	95.5	0.019	NA
90	F90-22A	22	C	*	*	*	16	4	0	1	*	*	192
90	F90-22B	22	C	*	*	*	17	8	1	1	*	*	195
90	F90-22C	22	C	*	*	*	18	6	1	0.1	*	*	198
90	F90-22D	22	D	1.96	49.8	M	22	6	1	0.1	130.3	0.016	NA
90	F90-22E	22	E	4.98	65.1	M	22	6	1	0.1	108.2	0.018	NA
90	F90-22F	22	F	6.08	67.9	F	22	6	1	0.1	77.2	0.019	NA
90	F90-23A	23	C	*	*	*	19	7	1	0.5	*	*	201
90	F90-23B	23	C	*	*	*	20	2	0	0.1	*	*	204
90	F90-23C	23	C	*	*	*	21	5	1	0	*	*	207
90	F90-23D	23	D	4.31	63.9	M	23	5	1	0	95.8	0.017	NA
90	F90-23E	23	E	5.11	66.2	M	23	5	1	0	102.1	0.018	NA
90	F90-23F	23	F	5.04	62.1	FG	23	5	1	0	85.9	0.021	NA
90	F90-24A	24	C	*	*	*	22	6	1	0.1	*	*	210
90	F90-24B	24	C	*	*	*	23	5	1	0	*	*	213
90	F90-24C	24	C	*	*	*	24	1	0	0	*	*	216
90	F90-24D	24	D	2.86	54.0	M	24	1	0	0	105.6	0.018	NA
90	F90-24E	24	E	4.67	65.8	F	24	1	0	0	89.8	0.016	NA
90	F90-24F	24	F	5.89	65.5	M	24	1	0	0	110.7	0.021	NA
120	F120-01A	1	A	4.26	61.1	M	1	2	0	0.1	NA	0.019	217
120	F120-01B	1	B	4.37	62.7	M	1	2	0	0.1	NA	0.018	218
120	F120-01C	1	C	5.37	64.9	F	1	2	0	0.1	NA	0.020	219
120	F120-01D	1	D	3.33	60.0	M	1	2	0	0.1	59.9	0.015	NA
120	F120-01E	1	E	3.01	59.7	M	1	2	0	0.1	99.8	0.014	NA
120	F120-01F	1	F	3.32	58.3	F	1	2	0	0.1	74.2	0.017	NA
120	F120-01G	1	G	4.55	62.4	M	1	2	0	0.1	84.0	0.019	NA
120	F120-01H	1	H	4.34	67.4	F	1	2	0	0.1	79.0	0.014	NA
120	F120-02A	2	A	*	*	*	2	4	0	1	*	*	220
120	F120-02B	2	B	*	*	*	2	4	0	1	*	*	221
120	F120-02C	2	C	*	*	*	2	4	0	1	*	*	222
120	F120-02D	2	D	*	*	*	2	4	0	1	*	*	NA
120	F120-02E	2	E	*	*	*	2	4	0	1	*	*	NA
120	F120-02F	2	F	*	*	*	2	4	0	1	*	*	NA
120	F120-03A	3	A	2.07	46.9	F	3	3	0	0.5	NA	0.020	223
120	F120-03B	3	B	3.87	61.4	M	3	3	0	0.5	NA	0.017	224

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
120	F120-03C	3	C	7.10	70.3	FG	3	3	0	0.5	NA	0.020	225
120	F120-03D	3	D	2.48	55.5	M	3	3	0	0.5	131.8	0.014	NA
120	F120-03E	3	E	3.79	57.1	*	3	3	0	0.5	65.8	0.020	NA
120	F120-03F	3	F	4.97	66.5	F	3	3	0	0.5	86.3	0.017	NA
120	f120-03G	3	G	2.91	60.0	F	3	3	0	0.5	90.7	0.013	NA
120	F120-03H	3	H	3.90	58.8	F	3	3	0	0.5	109.6	0.019	NA
120	F120-03I	3	I	3.92	58.9	M	3	3	0	0.5	101.5	0.019	NA
120	F120-04A	4	A	*	*	*	4	1	0	0	*	*	226
120	F120-04B	4	B	*	*	*	4	1	0	0	*	*	227
120	F120-04C	4	C	*	*	*	4	1	0	0	*	*	228
120	F120-04D	4	D	7.47	72.6	*	4	1	0	0	63.7	0.020	NA
120	F120-04E	4	E	3.14	57.2	F	4	1	0	0	104.9	0.017	NA
120	F120-04F	4	F	2.64	54.7	F	4	1	0	0	77.6	0.016	NA
120	F120-04G	4	G	2.87	57.5	F	4	1	0	0	86.9	0.015	NA
120	F120-05A	5	A	5.94	66.5	M	5	5	1	0	NA	0.020	229
120	F120-05B	5	B	8.64	72.6	M	5	5	1	0	NA	0.023	230
120	F120-05C	5	C	*	*	*	5	5	1	0	*	*	231
120	F120-05D	5	D	*	*	*	5	5	1	0	*	*	NA
120	F120-05E	5	E	5.62	66.0	F	5	5	1	0	81.7	0.020	NA
120	F120-05F	5	F	4.66	63.1	*	5	5	1	0	116.5	0.019	NA
120	F120-05G	5	G	5.45	65.6	F	5	5	1	0	83.8	0.019	NA
120	F120-06A	6	A	5.04	67.0	F	6	4	0	1	NA	0.017	232
120	F120-06B	6	B	*	*	*	6	4	0	1	*	*	233
120	F120-06C	6	C	*	*	*	6	4	0	1	*	*	234
120	F120-06D	6	D	3.37	57.6	F	6	4	0	1	85.5	0.018	NA
120	F120-06E	6	E	3.50	56.6	M	6	4	0	1	108.8	0.019	NA
120	F120-06F	6	F	3.55	59.0	F	6	4	0	1	134.3	0.017	NA
120	F120-07A	7	A	2.74	60.9	M	7	2	0	0.1	NA	0.012	235
120	F120-07B	7	B	*	*	*	7	2	0	0.1	*	*	236
120	F120-07C	7	C	*	*	*	7	2	0	0.1	*	*	237
120	F120-07D	7	D	*	*	*	7	2	0	0.1	*	*	NA
120	F120-07E	7	E	*	*	*	7	2	0	0.1	*	*	NA
120	F120-07F	7	F	*	*	*	7	2	0	0.1	*	*	NA
120	F120-08A	8	A	4.82	61.1	F	8	7	1	0.5	NA	0.021	238
120	F120-08B	8	B	*	*	*	8	7	1	0.5	*	*	239

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
120	F120-08C	8	C	*	*	*	8	7	1	0.5	*	*	240
120	F120-08D	8	D	5.45	66.5	M	8	7	1	0.5	73.9	0.019	NA
120	F120-08E	8	E	4.33	62.6	F	8	7	1	0.5	94.8	0.018	NA
120	F120-08F	8	F	6.16	70.1	M	8	7	1	0.5	76.2	0.018	NA
120	F120-08G	8	G	*	*	*	8	7	1	0.5	*	*	NA
120	F120-09A	9	A	3.94	62.1	M	9	8	1	1	NA	0.016	241
120	F120-09B	9	B	*	*	*	9	8	1	1	*	*	242
120	F120-09C	9	C	*	*	*	9	8	1	1	*	*	243
120	F120-09D	9	D	*	*	*	9	8	1	1	*	*	NA
120	F120-09E	9	E	4.57	61.6	M	9	8	1	1	107.9	0.020	NA
120	F120-09F	9	F	4.80	60.7	M	9	8	1	1	107.6	0.021	NA
120	F120-09G	9	G	5.83	66.0	M	9	8	1	1	82.3	0.020	NA
120	F120-10A	10	A	2.67	57.8	M	10	6	1	0.1	NA	0.014	244
120	F120-10B	10	B	4.43	60.6	M	10	6	1	0.1	NA	0.020	245
120	F120-10C	10	C	*	*	*	10	6	1	0.1	*	*	246
120	F120-10D	10	D	3.48	59.6	M	10	6	1	0.1	94.5	0.016	NA
120	F120-10E	10	E	3.38	63.0	M	10	6	1	0.1	96.5	0.014	NA
120	F120-10F	10	F	5.31	66.6	M	10	6	1	0.1	115.9	0.018	NA
120	F120-10G	10	G	4.17	60.4	M	10	6	1	0.1	89.0	0.019	NA
120	F120-11A	11	A	*	*	*	11	3	0	0.5	*	*	247
120	F120-11B	11	B	*	*	*	11	3	0	0.5	*	*	248
120	F120-11C	11	C	*	*	*	11	3	0	0.5	*	*	249
120	F120-11D	11	D	*	*	*	11	3	0	0.5	*	*	NA
120	F120-11E	11	E	*	*	*	11	3	0	0.5	*	*	NA
120	F120-11F	11	F	*	*	*	11	3	0	0.5	*	*	NA
120	F120-12A	12	A	4.53	60.1	M	12	7	1	0.5	NA	0.021	250
120	F120-12B	12	B	3.54	58.9	M	12	7	1	0.5	NA	0.017	251
120	F120-12C	12	C	*	*	*	12	7	1	0.5	*	*	252
120	F120-12D	12	D	4.52	65.8	F	12	7	1	0.5	88.5	0.016	NA
120	F120-12E	12	E	3.17	59.9	M	12	7	1	0.5	122.9	0.015	NA
120	F120-12F	12	F	2.55	52.7	M	12	7	1	0.5	95.9	0.017	NA
120	F120-12G	12	G	6.06	68.6	M	12	7	1	0.5	95.5	0.019	NA
120	F120-13A	13	A	3.19	53.1	M	13	3	0	0.5	NA	0.021	253
120	F120-13B	13	B	2.25	47.9	F	13	3	0	0.5	NA	0.020	254
120	F120-13C	13	C	*	*	*	13	3	0	0.5	*	*	255

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
120	F120-13D	13	D	2.63	52.5	M	13	3	0	0.5	71.4	0.018	NA
120	F120-13E	13	E	3.21	61.2	M	13	3	0	0.5	105.9	0.014	NA
120	F120-13F	13	F	2.33	46.5	M	13	3	0	0.5	101.8	0.023	NA
120	F120-13G	13	G	2.83	52.5	M	13	3	0	0.5	122.4	0.020	NA
120	F120-14A	14	A	4.29	59.4	M	14	8	1	1	NA	0.020	256
120	F120-14B	14	B	5.43	67.6	M	14	8	1	1	NA	0.018	257
120	F120-14C	14	C	*	*	*	14	8	1	1	*	*	258
120	F120-14D	14	D	2.22	51.0	F	14	8	1	1	133.0	0.017	NA
120	F120-14E	14	E	2.39	51.5	F	14	8	1	1	177.1	0.018	NA
120	F120-14F	14	F	2.82	56.0	F	14	8	1	1	155.6	0.016	NA
120	F120-14G	14	G	5.11	64.5	M	14	8	1	1	94.4	0.019	NA
120	F120-15A	15	A	*	*	*	15	1	0	0	*	*	259
120	F120-15B	15	B	*	*	*	15	1	0	0	*	*	260
120	F120-15C	15	C	*	*	*	15	1	0	0	*	*	261
120	F120-15D	15	D	*	*	*	15	1	0	0	*	*	NA
120	F120-15E	15	E	*	*	*	15	1	0	0	*	*	NA
120	F120-15F	15	F	*	*	*	15	1	0	0	*	*	NA
120	F120-16A	16	A	4.88	63.3	F	16	4	0	1	NA	0.019	262
120	F120-16B	16	B	2.89	55.6	M	16	4	0	1	NA	0.017	263
120	F120-16C	16	C	*	*	*	16	4	0	1	*	*	264
120	F120-16D	16	D	*	*	*	16	4	0	1	*	*	NA
120	F120-16E	16	E	2.23	54.4	M	16	4	0	1	118.3	0.014	NA
120	F120-16F	16	F	1.86	53.3	F	16	4	0	1	52.5	0.012	NA
120	F120-16G	16	G	5.02	65.9	M	16	4	0	1	95.8	0.018	NA
120	F120-17A	17	A	*	*	*	17	8	1	1	*	*	265
120	F120-17B	17	B	*	*	*	17	8	1	1	*	*	266
120	F120-17C	17	C	*	*	*	17	8	1	1	*	*	267
120	F120-17D	17	D	3.19	57.3	M	17	8	1	1	118.1	0.017	NA
120	F120-17E	17	E	4.67	65.1	F	17	8	1	1	106.8	0.017	NA
120	F120-17F	17	F	4.29	65.8	F	17	8	1	1	103.1	0.015	NA
120	F120-18A	18	A	*	*	*	18	6	1	0.1	*	*	268
120	F120-18B	18	B	*	*	*	18	6	1	0.1	*	*	269
120	F120-18C	18	C	*	*	*	18	6	1	0.1	*	*	270
120	F120-18D	18	D	*	*	*	18	6	1	0.1	*	*	NA
120	F120-18E	18	E	*	*	*	18	6	1	0.1	*	*	NA

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
120	F120-18F	18	F	*	*	*	18	6	1	0.1	*	*	NA
120	F120-19A	19	A	4.68	63.6	M	19	7	1	0.5	NA	0.018	271
120	F120-19B	19	B	*	*	*	19	7	1	0.5	*	*	272
120	F120-19C	19	C	*	*	*	19	7	1	0.5	*	*	273
120	F120-19D	19	D	4.66	62.4	M	19	7	1	0.5	98.3	0.019	NA
120	F120-19E	19	E	3.58	60.3	M	19	7	1	0.5	127.7	0.016	NA
120	F120-19F	19	F	2.68	54.4	F	19	7	1	0.5	110.5	0.017	NA
120	F120-20A	20	A	5.50	67.4	M	20	2	0	0.1	NA	0.018	274
120	F120-20B	20	B	*	*	*	20	2	0	0.1	*	*	275
120	F120-20C	20	C	*	*	*	20	2	0	0.1	*	*	276
120	F120-20D	20	D	3.86	61.1	F	20	2	0	0.1	67.5	0.017	NA
120	F120-20E	20	E	2.03	52.2	M	20	2	0	0.1	126.7	0.014	NA
120	F120-20F	20	F	6.42	70.9	M	20	2	0	0.1	89.6	0.018	NA
120	F120-20Fb	20	F	6.42	70.9	M	20	2	0	0.1	89.6	0.018	NA
120	F120-20G	20	G	2.68	55.8	M	20	2	0	0.1	124.5	0.015	NA
120	F120-20G	19	G	2.83	57.7	M	19	7	1	0.5	113.8	0.015	NA
120	F120-20H	20	H	3.58	56.5	M	20	2	0	0.1	85.0	0.020	NA
120	F120-21A	21	A	4.19	61.3	M	21	5	1	0	NA	0.018	277
120	F120-21B	21	B	*	*	*	21	5	1	0	*	*	278
120	F120-21C	21	C	*	*	*	21	5	1	0	*	*	279
120	F120-21D	21	D	2.74	56.7	M	21	5	1	0	82.2	0.015	NA
120	F120-21E	21	E	3.10	58.1	M	21	5	1	0	94.1	0.016	NA
120	F120-21F	21	F	3.64	59.4	M	21	5	1	0	99.3	0.017	NA
120	F120-22A	22	A	*	*	*	22	6	1	0.1	*	*	280
120	F120-22B	22	B	*	*	*	22	6	1	0.1	*	*	281
120	F120-22C	22	C	*	*	*	22	6	1	0.1	*	*	282
120	F120-22D	22	D	*	*	*	22	6	1	0.1	*	*	NA
120	F120-22E	22	E	3.99	61.1	M	22	6	1	0.1	117.8	0.018	NA
120	F120-22F	22	F	*	*	*	22	6	1	0.1	*	*	NA
120	F120-23A	23	A	3.95	63.0	M	23	5	1	0	NA	0.016	283
120	F120-23B	23	B	4.39	61.3		23	5	1	0	NA	0.019	284
120	F120-23C	23	C	*	*	*	23	5	1	0	*	*	285
120	F120-23D	23	D	2.92	58.4	F	23	5	1	0	80.1	0.015	NA
120	F120-23E	23	E	3.83	63.1	M	23	5	1	0	110.3	0.015	NA
120	F120-23F	23	F	4.38	65.0	*	23	5	1	0	122.5	0.016	NA

* Fish Died

Table F-1: Experiment 3 - Fish Growth Parameters and Standard Metabolic Rates

Day	Sample Name	Tank	Replicate	Weight (g)	Length (mm)	Sex	Tank	TRT	MS222	Food	SMR (J/g-d)	CF ((g/cm^3)	P450
120	F120-23G	23	G	3.49	62.5	F	23	5	1	0	120.7	0.014	NA
120	F120-23H	23	H	3.79	63.1	M	23	5	1	0	103.8	0.015	NA
120	F120-24A	24	A	4.54	59.2	M	24	1	0	0	NA	0.022	286
120	F120-24B	24	B	*	*	*	24	1	0	0	*	*	287
120	F120-24C	24	C	*	*	*	24	1	0	0	*	*	288
120	F120-24D	24	D	2.91	56.2	M	24	1	0	0	82.9	0.016	NA
120	F120-24E	24	E	5.23	65.2	M	24	1	0	0	123.8	0.019	NA
120	F120-24F	24	F	*	*	*	24	1	0	0	*	*	NA

* Fish Died

Table G-1: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 35

Sample Name			F35004D	F35004E	F35004F	F35-T15D	F35-T15E	F35-T15F	F35-T24D	F35-T24E	F35-T24F	F35001D	F35001E
g to Extraction			5.60	4.43	6.21	3.11	4.85	4.19	3.07	3.76	5.09	4.09	3.85
% Lipid			0.020	0.025	0.031	0.015	0.045	0.011	0.015	0.010	0.028	0.019	0.028
Tank			4	4	4	15	15	15	24	24	24	1	1
Treatment			1	1	1	1	1	1	1	1	1	2	2
MS222			0	0	0	0	0	0	0	0	0	0	0
PAH Food			0	0	0	0	0	0	0	0	0	0.1	0.1
PCB Congeners	Log Kow	Homologue #	"nd" = non-detect										
4,10	4.65	2	0.49	0.51	0.09	0.27	0.15	1.83	1.44	0.02	0.40	2.66	1.93
18	5.24	2	0.04	0.09	nd	0.23	0.43	nd	0.10	nd	nd	0.04	nd
17	5.25	2	0.13	0.14	nd	0.31	0.23	nd	0.21	nd	nd	0.08	nd
16,32	5.16	3	0.29	0.35	0.65	0.68	0.51	1.01	0.46	0.37	0.22	0.28	0.46
31, 28	5.67	3	1.39	2.01	1.13	3.67	1.86	5.46	2.60	1.68	0.90	1.99	2.16
33,21,53	5.60	3	0.24	0.33	0.22	0.66	0.48	0.67	0.53	0.25	0.12	0.28	0.17
52	5.84	4	0.81	1.14	0.02	1.88	1.00	0.17	1.63	0.05	0.03	1.09	0.09
49	5.85	4	0.71	0.93	0.10	1.73	0.93	0.77	1.41	0.34	0.13	0.99	0.46
47,48	5.85	4	0.58	0.65	0.47	1.59	0.87	1.64	1.17	0.75	0.32	0.87	0.80
44	5.75	4	0.47	0.67	0.06	0.97	0.61	0.65	1.06	0.21	0.09	0.64	0.34
41,64,71	5.69	4	0.57	0.84	0.50	1.51	0.88	2.31	1.29	1.02	0.40	0.70	0.90
74	6.20	4	0.39	0.54	0.39	1.04	0.49	1.25	1.08	0.57	0.27	0.51	0.57
70,76	6.20	4	0.58	1.00	0.56	1.23	0.77	2.17	1.97	0.80	0.38	0.70	0.97
66,95	6.20	4	2.27	3.29	1.63	5.87	2.94	5.56	5.49	2.68	1.24	3.12	2.89
92,84, 89	6.35	4	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
110,77	6.48	4	1.69	2.37	1.56	4.33	2.23	4.47	3.55	2.55	1.13	2.22	2.23
101	6.39	5	1.36	1.82	0.25	3.11	1.59	1.27	2.69	0.67	0.26	1.67	0.76
99	6.39	5	1.35	1.89	1.16	3.32	1.57	3.45	2.84	1.85	0.83	1.70	1.80
119	6.58	5	0.61	0.88	0.53	1.30	0.37	0.99	0.91	0.55	0.26	0.77	0.81
97	6.29	5	1.51	2.01	0.80	3.20	2.37	3.99	2.88	2.03	1.01	2.40	1.85
81, 87	6.29	5	0.37	0.47	0.30	0.86	0.45	0.92	0.71	0.52	0.23	0.45	0.46
85	6.30	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
82,151	6.20	5	0.06	0.06	0.04	0.09	0.06	0.16	0.12	0.87	0.40	0.15	0.07
149,123	6.67	5	1.85	2.55	1.46	4.50	2.49	4.14	3.82	2.70	1.20	2.52	2.24
107	6.71	6	0.32	0.45	0.30	0.95	0.46	0.91	0.69	0.51	0.24	0.40	0.38
118	6.74	6	0.81	1.29	1.08	2.14	1.00	1.83	2.28	1.07	0.85	1.38	1.43
146	6.89	6	1.19	1.71	1.42	2.21	1.11	1.82	2.29	1.27	1.09	1.59	1.83
132,153,105	6.92	6	7.83	11.43	9.73	14.71	7.38	12.28	15.72	8.38	7.31	10.39	12.03
141	6.82	6	0.10	0.33	0.11	0.36	0.08	0.22	0.16	0.25	0.19	0.16	0.37
137,130,176	6.76	6	0.23	0.32	0.25	0.53	0.25	0.41	0.51	0.25	0.25	0.36	0.37
163,138	6.99	6	3.64	5.52	4.67	7.43	3.66	6.40	7.72	3.94	3.45	5.00	5.85

Table G-1: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 35

Sample Name			F35004D	F35004E	F35004F	F35-T15D	F35-T15E	F35-T15F	F35-T24D	F35-T24E	F35-T24F	F35001D	F35001E
g to Extraction			5.60	4.43	6.21	3.11	4.85	4.19	3.07	3.76	5.09	4.09	3.85
% Lipid			0.020	0.025	0.031	0.015	0.045	0.011	0.015	0.010	0.028	0.019	0.028
Tank			4	4	4	15	15	15	24	24	24	1	1
Treatment			1	1	1	1	1	1	1	1	1	2	2
MS222			0	0	0	0	0	0	0	0	0	0	0
PAH Food			0	0	0	0	0	0	0	0	0	0.1	0.1
PCB Congeners	Log Kow	Homologue #	"nd" = non-detect										
158	7.02	6	0.29	0.44	0.38	0.61	0.31	0.50	0.60	0.36	0.31	0.41	0.49
128	6.74	6	0.40	0.44	0.58	2.05	1.30	2.07	2.43	1.35	1.06	0.64	0.65
129,178	7.14	7	0.43	0.61	0.51	0.81	0.43	0.70	0.89	0.45	0.40	0.58	0.65
187,182	7.17	7	2.03	2.95	2.56	4.20	2.07	3.28	4.24	2.47	2.00	2.83	3.05
183	7.20	7	0.66	1.05	0.91	1.49	0.77	1.18	1.42	0.82	0.67	1.02	1.02
174	7.11	7	0.37	0.89	0.49	0.91	0.47	0.68	0.92	0.49	0.41	0.64	0.67
177	7.08	7	0.55	0.91	0.68	1.18	0.59	0.96	1.15	0.61	0.56	0.78	0.87
157,200	7.27	7	0.31	0.37	0.45	0.65	0.34	nd	0.28	0.31	0.26	nd	0.53
172	7.33	7	0.36	0.19	0.15	0.55	0.23	0.35	0.44	0.37	0.26	0.58	0.68
180	7.36	7	1.44	2.49	2.12	4.21	1.70	2.71	3.38	2.03	1.86	2.21	2.24
193	7.52	7	0.30	0.39	0.38	0.31	0.26	0.69	0.48	0.26	0.22	0.51	0.57
170,190	7.27	7	0.60	0.98	0.77	1.59	0.74	1.22	1.47	0.76	0.67	0.92	0.93
202,171,156	7.24	8	0.56	0.88	0.70	1.15	0.60	1.03	1.25	0.59	0.54	0.78	0.90
201	7.62	8	0.61	0.92	0.73	1.26	0.66	1.08	1.34	0.65	0.63	0.82	0.88
203,196	7.65	8	0.71	1.14	0.85	1.55	0.77	1.37	1.59	0.76	0.71	1.03	1.11
208,195	7.56	8	0.36	0.57	0.44	0.74	0.42	0.74	0.88	0.38	0.37	0.52	0.53
194	7.80	8	0.16	0.34	0.19	0.45	0.20	0.38	0.39	0.19	0.18	0.27	0.26
206	8.09	9	0.25	0.32	0.80	nd	nd	nd	nd	nd	nd	0.37	0.37
Total PCBs			42.25	61.49	43.19	94.38	49.09	85.67	90.49	49.00	34.28	60.02	60.64
Surrogate Recovery													
PCB 14			0.87	0.77	1.08	0.84	0.89	0.66	1.07	0.87	1.27	1.14	1.15
PCB 166			1.06	0.87	0.94	0.99	1.12	0.96	1.03	1.18	0.99	1.02	1.00

Table G-1: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 35

Sample Name			F35001F	F35-T7D	F35-T7E	F36-T7F	F35-T20D	F35-T20E	F35-T20F	F35003D	F35003E	F35003F	F35-T11D
g to Extraction			5.15	6.46	5.79	7.05	5.24	4.67	2.40	5.45	6.54	3.19	4.43
% Lipid			0.028	0.046	0.030	0.021	0.012	0.024	0.017	0.040	0.041	0.015	0.009
Tank			1	7	7	7	20	20	20	3	3	3	11
Treatment			2	2	2	2	2	2	2	3	3	3	3
MS222			0	0	0	0	0	0	0	0	0	0	0
PAH Food			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5
PCB Congeners	Log Kow	Homologue #											
4,10	4.65	2	0.35	0.75	0.32	0.08	1.02	0.77	0.49	1.39	0.63	0.20	2.90
18	5.24	2	0.34	0.05	0.03	nd	0.63	nd	0.17	0.28	0.03	nd	0.14
17	5.25	2	0.20	0.08	0.03	nd	0.29	nd	nd	0.24	0.11	nd	0.11
16,32	5.16	3	0.46	0.65	0.20	0.19	0.63	0.10	0.63	0.66	0.32	0.91	0.16
31, 28	5.67	3	1.65	3.16	1.19	1.37	2.52	1.03	3.87	3.04	2.17	2.03	0.84
33,21,53	5.60	3	0.33	0.20	0.13	0.22	0.43	0.22	0.30	0.39	0.24	0.74	0.36
52	5.84	4	0.93	0.30	0.06	0.05	1.33	0.04	0.08	1.54	1.04	0.09	0.43
49	5.85	4	0.83	0.96	0.23	0.20	1.16	0.19	0.44	1.41	0.94	0.35	0.38
47,48	5.85	4	0.72	1.42	0.62	0.85	1.02	0.50	1.60	1.16	0.77	0.91	0.37
44	5.75	4	0.60	0.65	0.19	0.09	0.85	0.13	0.31	0.99	0.71	0.22	0.23
41,64,71	5.69	4	0.80	1.60	0.65	0.71	1.15	0.49	1.83	1.29	0.83	0.94	0.39
74	6.20	4	0.44	0.72	0.44	0.53	0.68	0.43	1.36	0.76	0.53	0.64	0.26
70,76	6.20	4	0.65	1.06	0.67	0.73	1.10	0.28	2.02	1.15	0.95	0.76	0.14
66,95	6.20	4	2.66	3.56	1.95	2.20	3.84	1.74	5.93	4.48	2.97	2.79	1.34
92,84, 89	6.35	4	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
110,77	6.48	4	1.87	3.66	1.73	2.25	2.57	1.56	4.97	2.95	1.94	2.62	1.50
101	6.39	5	1.40	1.58	0.44	0.40	1.93	0.36	1.17	2.12	1.45	0.54	1.22
99	6.39	5	1.44	2.73	1.22	1.67	2.07	1.31	3.96	2.29	1.59	2.13	1.20
119	6.58	5	0.70	0.82	0.41	0.61	0.66	0.38	1.31	1.11	0.79	1.02	0.38
97	6.29	5	1.94	4.13	1.28	1.19	2.06	0.76	3.70	2.66	1.96	1.59	1.18
81, 87	6.29	5	0.36	0.69	0.34	0.41	0.54	0.35	1.17	0.56	0.38	0.49	0.31
85	6.30	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
82,151	6.20	5	0.06	0.13	0.05	0.05	0.89	0.62	0.12	0.09	0.07	0.15	0.48
149,123	6.67	5	2.12	3.70	1.71	2.14	2.52	1.37	4.56	3.17	2.10	2.69	1.76
107	6.71	6	0.35	0.71	0.36	0.46	0.55	0.41	1.00	0.55	0.35	0.48	0.33
118	6.74	6	1.32	1.61	1.12	1.38	1.31	0.98	2.72	0.75	1.25	1.63	0.97
146	6.89	6	1.71	1.28	0.88	1.20	1.34	1.30	2.92	0.92	1.55	2.22	1.10
132,153,105	6.92	6	10.99	8.64	6.07	8.13	9.42	8.76	19.78	6.06	9.96	14.75	7.78
141	6.82	6	0.14	0.10	0.18	0.23	0.24	0.13	0.21	0.20	0.30	0.29	0.23
137,130,176	6.76	6	0.42	0.31	0.21	0.27	0.32	0.23	0.63	2.98	0.35	0.37	0.21
163,138	6.99	6	5.42	4.56	3.12	4.11	4.75	4.05	9.88	0.24	4.89	7.08	3.82

Table G-1: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 35

Sample Name			F35001F	F35-T7D	F35-T7E	F36-T7F	F35-T20D	F35-T20E	F35-T20F	F35003D	F35003E	F35003F	F35-T11D
g to Extraction			5.15	6.46	5.79	7.05	5.24	4.67	2.40	5.45	6.54	3.19	4.43
% Lipid			0.028	0.046	0.030	0.021	0.012	0.024	0.017	0.040	0.041	0.015	0.009
Tank			1	7	7	7	20	20	20	3	3	3	11
Treatment			2	2	2	2	2	2	2	3	3	3	3
MS222			0	0	0	0	0	0	0	0	0	0	0
PAH Food			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5
PCB Congeners	Log Kow	Homologue #											
158	7.02	6	0.43	0.39	0.25	0.35	0.38	0.35	0.74	0.33	0.40	0.61	0.33
128	6.74	6	0.54	0.51	0.32	0.56	1.24	0.95	3.39	nd	0.56	0.69	1.00
129,178	7.14	7	0.64	0.54	0.35	0.48	0.52	0.42	1.05	0.78	0.57	0.73	0.41
187,182	7.17	7	3.06	2.37	1.69	2.34	2.49	2.41	5.21	0.58	2.60	4.05	2.15
183	7.20	7	1.11	0.89	0.61	0.82	0.90	0.81	1.91	0.38	0.88	1.23	0.77
174	7.11	7	0.71	0.64	0.41	0.54	0.49	0.29	1.07	0.45	0.63	0.79	0.43
177	7.08	7	0.86	0.91	0.54	0.70	0.77	0.64	1.48	0.45	0.76	1.06	0.61
157,200	7.27	7	0.42	0.21	0.24	0.29	0.49	0.32	0.64	3.80	0.47	0.53	0.26
172	7.33	7	0.49	0.21	0.20	0.21	0.29	0.28	0.62	0.04	0.19	0.10	0.18
180	7.36	7	2.20	2.71	2.03	2.52	2.36	2.29	4.40	0.27	2.11	2.86	1.90
193	7.52	7	0.46	0.25	0.14	0.23	0.30	0.28	0.65	0.02	0.39	0.46	0.23
170,190	7.27	7	0.99	1.06	0.81	1.00	0.99	0.86	1.94	0.01	0.83	1.24	0.86
202,171,156	7.24	8	0.86	0.92	0.54	0.70	0.78	0.62	1.50	0.32	0.78	0.98	0.58
201	7.62	8	0.89	0.99	0.66	0.85	0.92	0.82	1.64	0.52	0.73	1.06	0.73
203,196	7.65	8	1.04	1.19	0.85	1.03	1.12	0.91	2.14	nd	0.89	1.26	0.79
208,195	7.56	8	0.56	0.67	0.44	0.54	0.59	0.49	1.08	0.05	0.43	0.59	0.45
194	7.80	8	0.25	0.35	0.28	0.31	0.33	0.21	0.61	nd	0.22	0.30	0.23
206	8.09	9	0.29	nd	nd	nd	nd	nd	nd	nd	0.26	0.26	nd
Total PCBs			57.00	64.64	36.21	45.21	62.74	41.44	107.21	53.42	54.86	67.44	42.39
Surrogate Recovery													
PCB 14			1.58	0.72	1.83	1.09	0.91	0.90	0.90	0.89	1.18	0.62	0.57
PCB 166			1.22	1.00	1.84	1.08	1.13	1.05	0.96	1.90	0.98	0.57	0.57

Table G-1: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 35

Sample Name			F35-T11E	F35-T11F	F35-T13D	F35-T13E	F35-T13F	F35002D	F35002E	F35002F	F35-T6D	F35-T6E	F35-T6F
g to Extraction			3.69	6.34	4.41	5.25	4.94	3.54	3.15	6.64	5.44	4.94	2.92
% Lipid			0.011	0.029	0.013	0.038	0.013	0.012	0.007	0.027	0.013	0.028	0.015
Tank			11	11	13	13	13	2	2	2	6	6	6
Treatment			3	3	3	3	3	4	4	4	4	4	4
MS222			0	0	0	0	0	0	0	0	0	0	0
PAH Food			0.5	0.5	0.5	0.5	0.5	1	1	1	1	1	1
PCB Congeners	Log Kow	Homologue #											
4,10	4.65	2	4.04	1.23	0.10	0.20	0.37	1.33	1.27	0.45	0.07	0.22	0.04
18	5.24	2	0.22	0.09	0.06	0.10	0.13	0.23	0.20	0.10	0.03	0.06	0.00
17	5.25	2	0.19	nd	nd	0.21	0.18	0.20	0.11	0.13	0.02	0.07	nd
16,32	5.16	3	0.29	0.32	0.32	0.53	0.56	0.53	0.26	0.32	0.21	0.47	0.05
31, 28	5.67	3	2.05	1.40	1.25	2.04	3.43	0.73	1.82	1.57	0.92	1.61	2.41
33,21,53	5.60	3	0.52	0.11	0.24	0.51	0.24	0.34	0.29	0.34	0.07	0.33	0.07
52	5.84	4	0.87	0.11	0.09	1.34	1.69	1.37	0.55	1.05	0.02	0.14	0.05
49	5.85	4	0.78	0.38	0.28	1.19	1.46	1.22	0.46	0.93	0.17	0.43	0.08
47,48	5.85	4	0.81	0.65	0.42	1.08	1.33	1.11	0.36	0.75	0.75	0.79	1.09
44	5.75	4	0.55	0.26	0.22	0.81	0.95	0.77	0.36	0.65	0.09	0.32	0.00
41,64,71	5.69	4	0.85	0.75	0.53	1.08	1.23	1.05	0.51	0.81	0.74	0.89	1.06
74	6.20	4	0.45	0.49	0.27	0.66	0.71	0.65	0.31	0.52	0.57	0.46	0.08
70,76	6.20	4	0.65	0.46	0.21	0.90	1.27	0.79	0.23	0.69	0.27	0.83	0.89
66,95	6.20	4	2.95	2.39	1.28	3.90	4.67	3.67	1.96	3.12	2.08	2.34	3.03
92,84, 89	6.35	4	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
110,77	6.48	4	2.37	2.22	1.54	2.88	3.61	2.80	1.65	2.26	2.52	1.98	2.62
101	6.39	5	1.76	0.67	0.52	2.02	2.52	2.21	1.25	1.64	0.46	0.67	0.06
99	6.39	5	1.74	1.42	1.00	1.97	2.70	2.16	1.17	1.68	1.52	1.38	1.96
119	6.58	5	0.14	0.38	0.25	0.53	0.93	1.00	0.39	0.76	0.03	0.38	0.03
97	6.29	5	2.67	1.96	1.63	2.57	2.68	2.41	1.38	1.94	1.77	1.91	1.98
81, 87	6.29	5	0.49	0.43	0.40	0.58	0.71	0.60	0.36	0.42	0.48	0.41	0.08
85	6.30	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
82,151	6.20	5	0.84	0.05	0.05	0.11	0.12	0.08	0.11	0.06	0.05	0.07	0.87
149,123	6.67	5	2.73	2.27	1.55	2.97	3.85	3.13	2.08	2.50	2.51	1.90	2.61
107	6.71	6	0.46	0.51	0.34	0.60	0.68	0.54	0.29	0.43	0.52	0.36	0.07
118	6.74	6	1.31	1.36	0.86	1.55	1.47	1.64	0.75	1.18	1.37	1.45	1.19
146	6.89	6	1.68	1.49	1.08	1.60	1.64	2.04	1.24	1.51	1.38	1.29	1.06
132,153,105	6.92	6	11.31	9.75	7.48	10.65	10.96	13.82	8.36	9.97	9.35	8.63	7.31
141	6.82	6	0.33	0.25	0.04	0.13	0.11	0.45	0.28	0.14	0.03	0.17	0.01
137,130,176	6.76	6	0.35	0.34	0.20	0.37	0.37	0.39	0.23	0.31	0.29	0.29	0.05
163,138	6.99	6	5.36	4.96	3.45	5.50	5.52	6.72	3.80	5.09	4.60	4.45	3.69

Table G-1: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 35

Sample Name			F35-T11E	F35-T11F	F35-T13D	F35-T13E	F35-T13F	F35002D	F35002E	F35002F	F35-T6D	F35-T6E	F35-T6F
g to Extraction			3.69	6.34	4.41	5.25	4.94	3.54	3.15	6.64	5.44	4.94	2.92
% Lipid			0.011	0.029	0.013	0.038	0.013	0.012	0.007	0.027	0.013	0.028	0.015
Tank			11	11	13	13	13	2	2	2	6	6	6
Treatment			3	3	3	3	3	4	4	4	4	4	4
MS222			0	0	0	0	0	0	0	0	0	0	0
PAH Food			0.5	0.5	0.5	0.5	0.5	1	1	1	1	1	1
PCB Congeners	Log Kow	Homologue #											
158	7.02	6	0.56	0.40	0.34	0.44	0.53	0.59	0.32	0.42	0.42	0.40	0.06
128	6.74	6	1.61	1.33	1.16	1.43	1.94	0.86	0.42	0.68	0.47	0.52	0.06
129,178	7.14	7	0.62	0.59	0.44	0.65	0.63	0.74	0.43	0.59	0.53	0.53	0.01
187,182	7.17	7	3.02	2.75	2.08	2.88	2.96	3.58	2.33	2.69	2.67	2.45	2.01
183	7.20	7	1.05	1.04	0.78	1.05	1.04	1.33	0.77	1.00	0.95	0.92	0.68
174	7.11	7	0.68	0.62	0.34	0.68	0.73	0.74	0.49	0.68	0.59	0.57	0.02
177	7.08	7	0.83	0.84	0.53	0.86	0.89	1.03	0.56	0.81	0.78	0.74	0.03
157,200	7.27	7	0.39	0.33	0.51	0.39	0.25	0.36	0.34	0.27	0.51	0.37	0.02
172	7.33	7	0.12	0.22	0.20	0.31	0.36	0.75	nd	0.48	0.28	0.28	0.04
180	7.36	7	2.56	2.70	1.95	2.61	2.64	2.88	1.49	2.35	2.64	2.39	2.07
193	7.52	7	0.28	0.24	0.24	0.46	0.37	0.54	0.32	0.38	0.28	0.30	0.03
170,190	7.27	7	1.10	1.14	0.68	1.13	1.17	1.19	0.62	0.92	1.04	0.95	0.88
202,171,156	7.24	8	0.83	0.83	0.57	0.91	0.89	0.98	0.51	0.76	0.71	0.74	0.01
201	7.62	8	1.00	0.99	0.70	0.97	1.01	1.06	0.57	0.81	0.85	0.86	0.66
203,196	7.65	8	1.15	1.25	0.74	1.29	1.31	1.19	0.68	0.93	0.97	1.11	0.93
208,195	7.56	8	0.67	0.63	0.44	0.66	0.67	0.61	0.32	0.46	0.48	0.59	0.03
194	7.80	8	0.33	0.36	0.15	0.38	0.39	0.29	0.15	0.22	0.25	0.31	0.00
206	8.09	9	nd	nd	nd	nd	nd	0.23	0.29	0.19	nd	nd	nd
Total PCBs			65.54	52.95	37.51	65.64	73.91	72.94	42.63	55.96	47.32	48.32	39.96
Surrogate Recovery													
PCB 14			0.44	1.04	0.87	0.94	0.48	0.83	0.87	0.96	0.83	1.32	1.57
PCB 166			0.45	1.01	1.02	0.99	0.66	0.87	1.06	1.01	0.89	1.03	2.03

Table G-1: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 35

Sample Name			F35-T16D	F35-T16E	F35-T16F	F35005D	F35005E	F35005F	F35-T21D	F35-T21E	F35-T21F	F35-T23D
g to Extraction			5.35	4.59	4.93	6.04	4.04	2.19	6.60	6.71	6.57	5.35
% Lipid			0.023	0.020	0.019	0.045	0.020	0.014	0.022	0.000	0.024	0.008
Tank			16	16	16	5	5	5	21	21	21	23
Treatment			4	4	4	5	5	5	5	5	5	5
MS222			0	0	0	1	1	1	1	1	1	1
PAH Food			1	1	1	0	0	0	0	0	0	0
PCB Congeners	Log Kow	Homologue #										
4,10	4.65	2	0.30	0.35	0.19	5.55	2.19	0.49	0.17	nd	3.66	0.25
18	5.24	2	0.14	0.06	0.06	0.42	0.07	0.41	0.08	nd	0.35	0.34
17	5.25	2	nd	0.07	0.07	0.24	0.13	0.24	nd	nd	nd	0.18
16,32	5.16	3	0.31	0.33	0.19	0.46	0.34	0.50	0.18	nd	1.10	0.39
31, 28	5.67	3	0.76	1.36	0.84	1.60	1.80	1.58	0.51	nd	2.82	1.73
33,21,53	5.60	3	0.12	0.25	0.15	0.47	0.24	0.41	0.08	nd	0.55	0.39
52	5.84	4	nd	0.34	0.63	0.99	0.93	0.89	0.03	nd	0.34	0.84
49	5.85	4	0.06	0.64	0.54	0.86	0.83	0.79	0.13	nd	0.86	0.72
47,48	5.85	4	0.33	0.68	0.48	0.77	0.68	0.66	0.22	nd	0.97	0.65
44	5.75	4	0.04	0.43	0.34	0.60	0.61	0.57	0.09	nd	0.52	0.45
41,64,71	5.69	4	0.34	0.72	0.52	0.82	0.69	0.72	0.27	nd	1.16	0.67
74	6.20	4	0.28	0.48	0.30	0.48	0.43	0.39	0.16	nd	0.83	0.36
70,76	6.20	4	0.26	0.39	0.29	0.89	0.81	0.74	0.23	nd	1.56	0.71
66,95	6.20	4	1.13	2.30	1.83	2.84	2.50	2.48	0.74	nd	4.48	2.38
92,84, 89	6.35	4	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
110,77	6.48	4	1.19	1.80	1.47	1.89	1.79	1.86	0.69	nd	3.06	1.77
101	6.39	5	0.19	1.05	1.05	1.45	1.56	1.45	0.23	nd	1.37	1.35
99	6.39	5	0.88	1.35	1.02	1.50	1.59	1.38	0.50	nd	2.38	1.30
119	6.58	5	0.28	0.36	0.28	0.66	0.67	0.48	0.14	nd	0.74	0.38
97	6.29	5	0.44	1.70	0.79	1.92	1.57	1.74	0.65	nd	3.34	1.71
81, 87	6.29	5	0.24	0.39	0.32	0.37	0.41	0.41	0.15	nd	0.72	0.37
85	6.30	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
82,151	6.20	5	0.38	0.06	0.04	0.15	0.56	0.60	0.23	nd	1.05	0.61
149,123	6.67	5	1.15	1.82	1.53	2.06	1.91	2.11	0.68	nd	2.99	1.96
107	6.71	6	0.26	0.39	0.30	0.37	0.35	0.33	0.13	nd	0.57	0.35
118	6.74	6	0.84	1.53	1.04	1.46	1.04	1.42	0.71	nd	1.20	0.85
146	6.89	6	0.86	1.58	1.13	1.97	1.38	2.07	0.68	nd	1.47	1.04
132,153,105	6.92	6	5.86	10.85	7.78	12.82	9.55	13.67	4.63	nd	9.40	7.02
141	6.82	6	0.13	0.11	0.07	0.35	0.25	0.14	0.04	nd	0.26	0.16
137,130,176	6.76	6	0.18	0.36	0.25	0.45	0.26	0.37	0.14	nd	0.29	0.22
163,138	6.99	6	2.91	5.52	3.87	6.18	4.52	6.30	2.28	nd	4.41	3.33

Table G-1: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 35

Sample Name			F35-T16D	F35-T16E	F35-T16F	F35005D	F35005E	F35005F	F35-T21D	F35-T21E	F35-T21F	F35-T23D
g to Extraction			5.35	4.59	4.93	6.04	4.04	2.19	6.60	6.71	6.57	5.35
% Lipid			0.023	0.020	0.019	0.045	0.020	0.014	0.022	0.000	0.024	0.008
Tank			16	16	16	5	5	5	21	21	21	23
Treatment			4	4	4	5	5	5	5	5	5	5
MS222			0	0	0	1	1	1	1	1	1	1
PAH Food			1	1	1	0	0	0	0	0	0	0
PCB Congeners	Log Kow	Homologue #										
158	7.02	6	0.25	0.48	0.35	0.48	0.37	0.51	0.20	nd	0.41	0.28
128	6.74	6	0.79	2.03	1.23	0.75	0.55	0.72	0.71	nd	1.43	0.99
129,178	7.14	7	0.31	0.67	0.44	0.72	0.48	0.66	0.24	nd	0.50	0.35
187,182	7.17	7	1.64	2.88	2.11	3.34	2.54	3.69	1.20	nd	2.48	1.85
183	7.20	7	0.58	1.12	0.77	1.16	0.94	1.25	0.42	nd	0.81	0.62
174	7.11	7	0.34	0.62	0.47	0.70	0.39	0.65	0.23	nd	0.47	0.37
177	7.08	7	0.45	0.95	0.65	0.96	0.63	0.88	0.33	nd	0.69	0.50
157,200	7.27	7	0.21	0.46	0.30	0.60	0.19	0.42	0.16	nd	0.27	0.22
172	7.33	7	0.18	0.36	0.26	0.21	0.29	0.11	0.23	nd	0.35	0.24
180	7.36	7	1.27	2.89	1.89	2.75	1.76	2.40	0.93	nd	1.83	1.42
193	7.52	7	0.26	0.38	0.30	0.53	0.22	0.50	0.14	nd	0.29	0.18
170,190	7.27	7	0.58	1.16	0.83	1.09	0.71	0.99	0.48	nd	0.82	0.64
202,171,156	7.24	8	0.43	0.94	0.62	0.99	0.66	0.92	0.36	nd	0.74	0.52
201	7.62	8	0.51	1.07	0.75	1.01	0.71	0.93	0.42	nd	0.84	0.59
203,196	7.65	8	0.57	1.34	0.94	1.26	0.80	1.07	0.55	nd	0.95	0.73
208,195	7.56	8	0.31	0.66	0.48	0.62	0.44	0.58	0.28	nd	0.58	0.38
194	7.80	8	0.16	0.36	0.24	0.36	0.16	0.25	0.16	nd	0.24	0.19
206	8.09	9	nd	nd	nd	0.31	0.15	0.28	nd	nd	nd	nd
Total PCBs			28.71	55.60	40.01	68.43	51.67	62.03	21.84	0.00	66.13	42.51
Surrogate Recovery												
PCB 14			1.11	1.51	1.11	1.28	0.70	1.30	1.47	-	0.22	0.81
PCB 166			0.98	1.10	0.94	0.97	0.78	1.00	0.99	-	0.33	0.99

Table G-1: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 35

Sample Name			F35-T23E	F35-T23F	F35010D	F35010E	F35010F	F35-T18D	F35-T18E	F35-T18F	F35-T22D	F35-T22E	F35-T22F
g to Extraction			7.25	5.26	6.44	5.98	7.25	5.63	4.50	3.44	3.83	4.50	3.22
% Lipid			0.039	0.024	0.035	0.024	0.035	0.034	0.025	0.015	0.019	0.022	0.010
Tank			23	23	10	10	10	18	18	18	22	22	22
Treatment			5	5	6	6	6	6	6	6	6	6	6
MS222			1	1	1	1	1	1	1	1	1	1	1
PAH Food			0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
PCB Congeners	Log Kow	Homologue #											
4,10	4.65	2	0.18	1.82	0.51	0.75	0.48	3.18	1.96	7.21	4.43	1.49	1.53
18	5.24	2	0.04	0.20	0.06	0.04	0.02	0.16	0.42	0.79	0.50	0.13	0.06
17	5.25	2	0.04	0.19	0.10	0.03	0.04	0.17	0.43	0.46	0.35	0.16	0.08
16,32	5.16	3	0.19	0.50	0.25	0.24	0.60	0.55	1.01	0.93	0.86	0.46	0.63
31, 28	5.67	3	0.38	3.04	1.56	0.92	1.40	2.55	3.92	3.76	2.78	2.46	3.89
33,21,53	5.60	3	0.14	0.53	0.22	0.10	0.28	0.38	0.91	0.82	0.64	0.47	0.37
52	5.84	4	0.08	0.74	0.84	0.19	0.27	0.81	1.97	1.83	1.61	0.66	0.40
49	5.85	4	0.14	1.17	0.73	0.41	0.61	1.09	1.86	1.58	1.39	0.99	1.08
47,48	5.85	4	0.20	1.21	0.60	0.48	0.66	1.08	1.77	1.45	1.27	0.99	1.27
44	5.75	4	0.12	0.88	0.55	0.28	0.36	0.84	1.42	1.24	0.96	0.73	0.71
41,64,71	5.69	4	0.34	1.50	0.61	0.66	0.75	1.37	1.89	1.60	1.29	1.17	1.40
74	6.20	4	0.36	1.06	0.38	0.48	0.57	0.73	1.13	0.94	0.85	0.62	0.99
70,76	6.20	4	0.48	1.86	0.72	0.68	0.96	1.10	2.23	1.78	1.49	1.16	1.76
66,95	6.20	4	1.44	4.77	2.30	2.06	2.57	4.11	5.92	5.38	4.74	3.56	4.55
92,84, 89	6.35	4	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
110,77	6.48	4	1.11	3.45	1.57	1.55	1.91	3.30	4.50	3.92	3.47	2.78	3.39
101	6.39	5	0.43	1.77	1.22	0.73	1.03	1.87	3.16	2.86	2.85	1.63	1.72
99	6.39	5	0.91	2.63	1.31	1.26	1.61	2.38	3.67	3.02	2.80	2.14	2.92
119	6.58	5	0.31	0.84	0.65	0.62	0.85	0.81	1.12	0.88	0.84	0.64	1.01
97	6.29	5	1.05	3.04	1.57	1.26	1.89	3.52	4.14	4.10	2.67	2.82	2.73
81, 87	6.29	5	0.24	0.70	0.32	0.31	0.38	0.64	0.85	0.77	0.73	0.56	0.73
85	6.30	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
82,151	6.20	5	0.36	0.08	0.05	0.44	0.05	0.10	0.14	0.15	1.28	0.08	0.08
149,123	6.67	5	1.27	3.44	1.67	1.65	2.00	3.56	4.59	4.23	3.58	2.93	3.32
107	6.71	6	0.25	0.79	0.29	0.31	0.36	0.66	0.92	0.81	0.78	0.56	0.41
118	6.74	6	0.56	1.71	1.23	1.15	1.38	1.34	1.82	2.03	1.89	1.28	1.75
146	6.89	6	0.73	1.84	1.47	1.48	1.79	1.31	1.84	2.14	2.22	1.44	1.80
132,153,105	6.92	6	4.87	12.39	9.89	9.82	11.45	8.82	12.74	14.47	14.91	9.78	12.48
141	6.82	6	0.12	0.16	0.13	0.31	0.18	0.17	0.20	0.36	0.22	0.27	0.10
137,130,176	6.76	6	0.16	0.41	0.35	0.29	0.35	0.33	0.47	0.49	0.48	0.32	0.40
163,138	6.99	6	2.25	6.25	4.83	4.78	5.56	4.60	6.50	7.30	7.25	4.73	6.21

Table G-1: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 35

Sample Name			F35-T23E	F35-T23F	F35010D	F35010E	F35010F	F35-T18D	F35-T18E	F35-T18F	F35-T22D	F35-T22E	F35-T22F
g to Extraction			7.25	5.26	6.44	5.98	7.25	5.63	4.50	3.44	3.83	4.50	3.22
% Lipid			0.039	0.024	0.035	0.024	0.035	0.034	0.025	0.015	0.019	0.022	0.010
Tank			23	23	10	10	10	18	18	18	22	22	22
Treatment			5	5	6	6	6	6	6	6	6	6	6
MS222			1	1	1	1	1	1	1	1	1	1	1
PAH Food			0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
PCB Congeners	Log Kow	Homologue #											
158	7.02	6	0.20	0.48	0.41	0.38	0.48	0.37	0.53	0.57	0.57	0.39	0.52
128	6.74	6	0.57	2.15	0.58	0.40	0.68	1.17	2.47	1.92	2.34	1.55	2.19
129,178	7.14	7	0.26	0.70	0.55	0.53	0.61	0.52	0.74	0.86	0.83	0.55	0.68
187,182	7.17	7	1.42	3.37	2.50	2.77	2.99	2.44	3.57	3.91	4.00	2.57	3.24
183	7.20	7	0.48	1.21	0.89	0.94	0.99	0.87	1.39	1.43	1.42	0.89	1.15
174	7.11	7	0.27	0.67	0.57	0.71	0.65	0.63	0.76	0.87	0.70	0.53	0.67
177	7.08	7	0.36	1.06	0.80	0.79	0.90	0.75	1.03	1.16	1.16	0.78	1.12
157,200	7.27	7	0.14	0.43	0.49	0.33	0.44	0.29	0.58	0.34	0.54	0.31	0.40
172	7.33	7	0.14	0.36	0.20	0.19	0.54	0.29	0.39	0.46	0.43	0.33	0.41
180	7.36	7	1.05	3.49	2.10	2.31	2.30	2.40	3.32	3.57	3.64	2.39	3.02
193	7.52	7	0.16	0.24	0.37	0.25	0.46	0.21	0.32	0.45	0.44	0.20	0.36
170,190	7.27	7	0.48	1.35	0.85	0.87	1.09	1.02	1.36	1.50	1.51	0.96	1.28
202,171,156	7.24	8	0.34	1.08	0.83	0.74	0.88	0.75	1.10	1.27	1.21	0.78	1.10
201	7.62	8	0.42	1.19	0.85	0.80	0.79	0.85	1.23	1.43	1.43	0.88	1.15
203,196	7.65	8	0.42	1.47	1.06	0.92	0.97	1.11	1.57	1.82	1.68	1.11	1.44
208,195	7.56	8	0.23	0.74	0.53	0.45	0.42	0.55	0.82	0.99	0.92	0.55	0.71
194	7.80	8	0.10	0.42	0.24	0.22	0.32	0.33	0.43	0.52	0.42	0.31	0.43
206	8.09	9	nd	nd	0.34	0.21	0.19	nd	nd	nd	nd	nd	nd
Total PCBs			25.75	79.40	50.14	47.11	56.07	66.10	95.14	100.34	92.35	62.08	77.64
Surrogate Recovery													
PCB 14			0.72	1.06	1.21	1.09	1.13	0.80	0.61	0.82	0.76	0.75	1.01
PCB 166			0.88	1.32	0.92	0.88	0.87	1.11	0.89	0.94	0.91	0.97	1.22

Table G-1: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 35

Sample Name			F35008D	F35008E	F35008F	F35-T12D	F35-T12E	F35-T12F	F35-T19D	F35-T19E	F35-T19F	F35009D	F35009E
g to Extraction			7.15	4.34	6.36	7.12	3.58	3.89	3.95	5.53	5.25	2.07	2.67
% Lipid			0.033	0.009	0.020	0.051	0.011	0.012	0.026	0.027	0.029	0.002	0.010
Tank			8	8	8	12	12	12	19	19	19	9	9
Treatment			7	7	7	7	7	7	7	7	7	8	8
MS222			1	1	1	1	1	1	1	1	1	1	1
PAH Food			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1
PCB Congeners	Log Kow	Homologue #											
4,10	4.65	2	0.29	0.92	0.35	0.22	0.46	0.34	6.70	0.49	0.54	0.75	1.80
18	5.24	2	0.12	0.08	0.04	0.69	0.10	0.43	0.09	0.09	0.34	0.24	0.13
17	5.25	2	0.14	0.06	0.05	0.40	0.10	0.25	0.12	nd	0.29	nd	0.14
16,32	5.16	3	0.49	0.11	0.24	1.02	0.19	0.50	0.72	0.50	0.55	0.21	0.38
31, 28	5.67	3	1.89	1.07	1.70	2.98	2.06	2.50	3.20	2.85	2.82	1.70	1.27
33,21,53	5.60	3	0.35	0.13	0.31	0.65	0.09	0.28	0.40	0.32	0.49	0.34	0.57
52	5.84	4	0.33	0.34	0.23	1.56	0.24	1.21	0.34	0.12	1.42	0.19	0.45
49	5.85	4	0.52	0.28	0.62	1.41	0.66	1.09	0.91	0.62	1.27	0.18	0.56
47,48	5.85	4	0.57	0.23	0.74	1.37	0.95	1.08	1.06	1.04	1.14	0.21	0.56
44	5.75	4	0.40	0.13	0.34	1.09	0.49	0.66	0.65	0.58	1.01	0.16	0.42
41,64,71	5.69	4	0.61	0.32	0.76	1.49	1.02	1.06	1.25	1.36	1.19	0.56	0.65
74	6.20	4	0.41	0.24	0.56	0.63	0.72	0.63	0.69	0.77	0.71	0.15	0.37
70,76	6.20	4	0.72	0.16	0.86	1.22	0.73	0.92	1.31	1.51	1.26	0.17	0.59
66,95	6.20	4	2.15	1.12	2.51	4.84	3.08	3.33	3.70	3.54	4.21	0.98	2.32
92,84, 89	6.35	4	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
110,77	6.48	4	1.46	1.31	2.01	3.61	3.24	2.54	3.12	3.09	3.05	1.16	1.86
101	6.39	5	0.75	1.05	1.01	2.30	1.12	1.95	1.49	1.08	2.34	0.52	1.04
99	6.39	5	1.23	1.03	1.79	2.37	2.19	2.09	2.25	2.39	2.60	0.86	1.32
119	6.58	5	0.65	0.37	0.94	0.65	0.80	0.71	0.73	0.68	0.78	0.25	0.59
97	6.29	5	1.18	0.74	1.63	3.45	2.65	2.43	2.31	2.61	2.68	0.49	1.87
81, 87	6.29	5	0.29	0.24	0.38	0.58	0.73	0.56	0.63	0.63	0.63	0.31	0.39
85	6.30	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
82,151	6.20	5	0.05	0.05	0.05	0.15	0.35	0.87	0.09	0.10	0.10	0.47	0.04
149,123	6.67	5	1.52	1.70	2.18	3.80	2.94	2.70	3.28	3.06	3.21	1.32	2.16
107	6.71	6	0.27	0.29	0.43	0.77	0.72	0.57	0.59	0.61	0.63	0.28	0.32
118	6.74	6	0.97	0.76	1.32	1.48	1.72	1.40	1.31	1.31	1.39	0.75	1.33
146	6.89	6	1.28	1.24	1.76	1.59	1.66	1.53	1.40	1.42	1.54	1.59	1.72
132,153,105	6.92	6	8.70	8.64	11.86	10.52	11.24	10.44	9.65	9.49	10.68	10.75	12.00
141	6.82	6	0.10	0.19	0.33	0.27	0.25	0.31	0.22	0.11	0.25	0.28	0.31
137,130,176	6.76	6	0.28	0.21	0.36	0.46	0.31	0.32	0.31	0.32	0.33	0.21	0.32
163,138	6.99	6	4.35	3.75	5.64	5.39	5.95	5.11	4.76	4.81	5.16	4.34	5.77

Table G-1: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 35

Sample Name			F35008D	F35008E	F35008F	F35-T12D	F35-T12E	F35-T12F	F35-T19D	F35-T19E	F35-T19F	F35009D	F35009E
g to Extraction			7.15	4.34	6.36	7.12	3.58	3.89	3.95	5.53	5.25	2.07	2.67
% Lipid			0.033	0.009	0.020	0.051	0.011	0.012	0.026	0.027	0.029	0.002	0.010
Tank			8	8	8	12	12	12	19	19	19	9	9
Treatment			7	7	7	7	7	7	7	7	7	8	8
MS222			1	1	1	1	1	1	1	1	1	1	1
PAH Food			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1
PCB Congeners	Log Kow	Homologue #											
158	7.02	6	0.47	0.29	0.46	0.43	0.60	0.46	0.39	0.38	0.43	0.41	0.50
128	6.74	6	0.71	0.31	0.75	1.56	2.19	1.84	1.65	1.26	1.79	0.34	0.67
129,178	7.14	7	0.58	0.39	0.63	0.69	0.72	0.57	0.53	0.54	0.59	0.46	0.60
187,182	7.17	7	2.39	2.40	3.30	2.93	3.20	2.85	2.65	2.52	2.71	3.13	3.24
183	7.20	7	1.09	0.85	1.18	1.18	1.11	1.08	0.95	0.90	1.02	0.91	1.15
174	7.11	7	0.62	0.45	0.59	0.72	0.69	0.53	0.59	0.57	0.63	0.38	0.76
177	7.08	7	0.89	0.66	0.93	0.91	1.00	0.85	0.73	0.75	0.85	0.74	0.89
157,200	7.27	7	0.23	0.15	0.25	0.25	0.37	0.45	nd	0.33	0.42	0.07	0.42
172	7.33	7	0.17	0.06	0.17	0.23	0.36	0.26	0.30	0.30	0.31	0.07	0.25
180	7.36	7	1.90	1.89	2.94	2.98	3.34	2.64	1.99	nd	2.75	2.01	2.30
193	7.52	7	0.33	0.16	0.20	0.31	0.25	0.28	0.35	0.30	0.37	0.25	0.44
170,190	7.27	7	0.73	0.71	1.05	1.16	1.24	1.15	0.93	0.96	1.04	0.85	1.02
202,171,156	7.24	8	0.67	0.53	0.89	0.95	0.97	0.82	0.76	0.80	0.88	0.63	0.80
201	7.62	8	0.71	0.66	0.93	1.05	1.06	0.93	0.85	0.85	0.92	0.75	0.89
203,196	7.65	8	0.84	0.63	1.09	1.36	1.31	1.13	1.07	1.09	1.16	0.81	1.00
208,195	7.56	8	0.40	0.33	0.50	0.70	0.64	0.56	0.56	0.58	0.57	0.37	0.47
194	7.80	8	0.19	0.11	0.27	0.39	0.36	0.35	0.27	0.30	0.32	0.16	0.23
206	8.09	9	0.24	0.07	0.18	nd	nd	nd	nd	nd	nd	nd	0.23
Total PCBs			45.24	37.41	57.30	74.76	66.13	64.57	67.87	57.93	69.36	41.76	57.12
Surrogate Recovery													
PCB 14			1.23	0.93	1.03	0.79	0.92	0.77	0.71	0.78	0.73	0.93	1.21
PCB 166			1.04	1.02	0.93	1.10	0.96	0.89	1.00	1.04	0.97	0.96	0.98

Table G-1: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 35

Sample Name			F35009F	F35-T14D	F35-T14E	F35-T14F	F35-T17D	F35-T17E	F35-T17F
g to Extraction			4.22	5.08	4.42	4.68	2.29	4.01	4.79
% Lipid			0.016	0.018	0.031	0.018	0.009	0.024	0.024
Tank			9	14	14	14	17	17	17
Treatment			8	8	8	8	8	8	8
MS222			1	1	1	1	1	1	1
PAH Food			1	1	1	1	1	1	1
PCB Congeners	Log Kow	Homologue #							
4,10	4.65	2	0.20	0.15	0.43	0.35	0.97	0.26	1.74
18	5.24	2	0.16	0.09	0.06	0.10	0.07	0.32	0.28
17	5.25	2	0.19	0.16	0.10	0.10	0.08	0.20	0.15
16,32	5.16	3	0.50	0.39	0.49	0.42	0.64	0.44	0.35
31, 28	5.67	3	1.83	1.82	1.48	1.36	3.96	1.62	1.45
33,21,53	5.60	3	0.41	0.39	0.31	0.29	0.45	0.50	0.31
52	5.84	4	1.18	1.14	0.23	0.22	0.38	0.92	0.83
49	5.85	4	0.98	1.07	0.50	0.49	1.12	0.80	0.71
47,48	5.85	4	0.82	0.97	0.63	0.62	1.33	0.74	0.67
44	5.75	4	0.63	0.63	0.33	0.34	0.75	0.56	0.50
41,64,71	5.69	4	0.83	0.97	0.64	0.65	1.60	0.74	0.67
74	6.20	4	0.50	0.64	0.48	0.45	1.13	0.38	0.38
70,76	6.20	4	0.82	0.89	0.77	0.72	1.02	0.57	0.66
66,95	6.20	4	3.02	3.47	2.34	2.23	5.87	2.36	2.25
92,84, 89	6.35	4	nd	nd	nd	nd	nd	nd	nd
110,77	6.48	4	2.02	2.70	1.76	1.64	4.50	1.82	1.67
101	6.39	5	1.60	1.81	0.88	0.83	2.21	1.37	1.24
99	6.39	5	1.57	1.85	1.34	1.27	3.40	1.39	1.25
119	6.58	5	0.68	0.56	0.41	0.39	1.09	0.38	0.41
97	6.29	5	1.58	2.07	1.55	1.44	4.15	1.62	1.64
81, 87	6.29	5	0.43	0.53	0.39	0.37	0.84	0.41	0.35
85	6.30	5	nd	nd	nd	nd	nd	nd	nd
82,151	6.20	5	0.65	0.09	0.05	0.05	0.14	0.64	0.05
149,123	6.67	5	2.13	2.83	1.73	1.63	4.82	1.95	1.72
107	6.71	6	0.36	0.58	0.37	0.34	0.92	0.37	0.33
118	6.74	6	1.49	1.33	1.35	1.20	4.15	0.87	1.38
146	6.89	6	1.85	1.33	1.29	1.23	4.12	0.98	1.45
132,153,105	6.92	6	12.58	8.88	8.96	8.56	28.12	6.77	9.86
141	6.82	6	0.26	0.07	0.30	0.29	0.29	0.07	0.14
137,130,176	6.76	6	0.36	0.31	0.28	0.26	1.01	0.24	0.33
163,138	6.99	6	6.08	4.50	4.56	4.33	14.54	3.31	5.06

Table G-1: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 35

Sample Name			F35009F	F35-T14D	F35-T14E	F35-T14F	F35-T17D	F35-T17E	F35-T17F
g to Extraction			4.22	5.08	4.42	4.68	2.29	4.01	4.79
% Lipid			0.016	0.018	0.031	0.018	0.009	0.024	0.024
Tank			9	14	14	14	17	17	17
Treatment			8	8	8	8	8	8	8
MS222			1	1	1	1	1	1	1
PAH Food			1	1	1	1	1	1	1
PCB Congeners	Log Kow	Homologue #							
158	7.02	6	0.53	0.38	0.39	0.37	1.18	0.30	0.42
128	6.74	6	0.67	1.50	1.64	1.37	4.30	1.11	1.39
129,178	7.14	7	0.63	0.53	0.53	0.48	1.67	0.36	0.56
187,182	7.17	7	3.28	2.56	2.47	2.28	8.01	1.86	2.71
183	7.20	7	1.10	0.88	0.97	0.84	3.00	0.67	1.04
174	7.11	7	0.67	0.58	0.51	0.48	2.03	0.38	0.61
177	7.08	7	0.91	0.75	0.70	0.65	2.46	0.51	0.80
157,200	7.27	7	0.42	0.36	0.33	0.21	nd	0.17	0.30
172	7.33	7	0.19	0.27	0.25	0.16	0.71	0.23	0.31
180	7.36	7	2.58	2.26	2.21	2.05	8.98	1.71	2.38
193	7.52	7	0.45	0.21	0.29	0.22	nd	0.14	0.31
170,190	7.27	7	1.03	1.00	0.91	0.85	5.98	0.89	1.10
202,171,156	7.24	8	0.89	0.74	0.74	0.69	2.21	0.50	0.80
201	7.62	8	0.92	0.82	0.84	0.78	2.47	0.64	0.87
203,196	7.65	8	1.13	1.00	1.01	0.94	3.08	0.70	1.15
208,195	7.56	8	0.53	0.48	0.56	0.52	1.55	0.35	0.58
194	7.80	8	0.27	0.27	0.24	0.23	1.02	0.19	0.37
206	8.09	9	0.24	nd	nd	nd	nd	nd	nd
Total PCBs			62.12	56.79	48.59	45.31	142.30	43.28	53.54
Surrogate Recovery									
PCB 14			0.75	0.92	1.35	1.41	1.48	0.85	1.50
PCB 166			0.60	1.06	1.14	1.23	0.89	1.05	1.07

Table G-2: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 62

Sample Name			F62-T04D	F62-T04E	F62-T04F	F62-T15D	F62-T15E	F62-T15F	F62-T24D	F62-T24E	F62-T24F	F62-T01D	F62-T01E
g to Extraction			6.21	5.61	3.53	2.97	3.30	3.23	3.71	6.05	5.76	7.82	2.91
% Lipid			0.024	0.031	0.006	0.014	0.017	0.004	0.026	0.032	0.021	0.050	0.017
Tank			4	4	4	15	15	15	24	24	24	1	1
Treatment			1	1	1	1	1	1	1	1	1	2	2
MS222			0	0	0	0	0	0	0	0	0	0	0
PAH Food			0	0	0	0	0	0	0	0	0	0.1	0.1
PCB Congeners	log Kow	Homologue #	"nd" = non-detect										
4,10	4.65	2	0.20	0.29	0.61	2.50	0.19	0.12	2.23	1.57	0.25	0.75	4.11
18	5.24	2	0.03	0.05	nd	nd	0.12	0.03	0.32	0.04	0.45	0.04	0.41
17	5.25	2	0.10	0.14	nd	0.05	nd	nd	0.50	0.09	0.27	0.08	0.29
16,32	5.16	3	0.28	0.44	0.09	0.35	0.77	0.05	0.97	0.64	0.55	0.64	0.82
31, 28	5.67	3	1.54	2.66	0.59	2.60	2.22	0.55	3.91	2.88	2.35	4.16	3.06
33,21,53	5.60	3	0.23	0.23	0.06	0.25	0.20	nd	0.73	0.28	0.39	0.43	0.50
52	5.84	4	1.06	1.52	nd	0.75	0.05	nd	2.51	0.49	1.37	0.60	1.70
49	5.85	4	0.94	1.44	0.06	1.13	0.09	nd	2.22	1.14	1.20	1.72	1.52
47,48	5.85	4	0.84	2.52	0.37	1.12	0.91	0.60	3.84	1.22	1.15	3.92	1.49
44	5.75	4	0.55	0.88	0.03	0.72	0.14	nd	1.70	0.75	0.80	1.25	1.07
41,64,71	5.69	4	0.81	1.30	0.38	1.05	0.78	0.44	2.12	1.38	1.17	2.29	1.51
74	6.20	4	0.55	0.92	0.44	0.69	0.67	0.32	1.06	0.71	0.72	1.56	0.83
70,76	6.20	4	0.91	1.34	0.43	1.11	1.01	0.33	2.16	1.16	0.96	2.31	1.25
66,95	6.20	4	3.09	4.61	1.73	3.94	2.41	1.35	6.90	4.27	3.98	8.17	5.11
92,84, 89	6.35	4	2.02	nd	1.23	2.70	2.56	0.82	3.55	3.26	2.94	4.86	3.45
110,77	6.48	4	2.52	3.60	1.49	3.33	2.85	1.38	4.84	3.84	3.10	6.54	3.93
101	6.39	5	1.68	2.36	0.31	2.07	1.64	0.19	3.57	1.98	2.37	2.91	2.84
99	6.39	5	1.80	2.92	1.23	2.54	2.27	1.03	3.63	2.80	2.52	4.56	2.94
119	6.58	5	0.85	1.06	0.42	0.95	0.92	0.32	1.21	1.18	0.94	1.54	1.24
97	6.29	5	2.07	2.96	0.59	2.51	2.43	0.44	5.95	3.45	3.01	7.41	4.61
81, 87	6.29	5	0.48	0.71	0.36	0.69	0.56	0.29	0.94	0.76	0.64	1.25	0.79
85	6.30	5	5.47	6.89	3.42	7.35	6.20	2.75	9.56	9.60	7.57	12.62	7.81
82,151	6.20	5	0.07	0.10	0.60	0.10	1.00	0.06	0.17	0.11	0.07	0.21	0.13
149,123	6.67	5	2.70	3.68	1.23	3.44	2.99	1.37	5.22	3.83	3.04	6.66	4.22
107	6.71	6	0.53	0.70	0.37	0.71	0.64	0.28	0.87	0.96	0.75	1.30	0.77
118	6.74	6	1.51	2.03	1.06	2.20	2.01	0.77	1.84	2.24	1.67	1.60	2.55
146	6.89	6	1.77	2.33	1.28	2.25	1.94	0.94	2.24	2.16	2.00	1.83	2.72
132,153,105	6.92	6	10.84	14.83	7.69	13.63	11.80	6.15	14.28	12.74	11.99	11.26	17.13
141	6.82	6	0.17	0.16	0.06	0.48	0.35	0.13	0.48	0.18	0.16	0.36	0.34
137,130,176	6.76	6	0.40	0.51	0.24	0.45	0.42	0.18	0.47	0.55	0.41	0.44	0.54
163,138	6.99	6	5.40	7.55	3.76	7.03	6.16	2.98	7.01	6.97	6.18	5.86	8.68

Table G-2: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 62

Sample Name			F62-T04D	F62-T04E	F62-T04F	F62-T15D	F62-T15E	F62-T15F	F62-T24D	F62-T24E	F62-T24F	F62-T01D	F62-T01E
g to Extraction			6.21	5.61	3.53	2.97	3.30	3.23	3.71	6.05	5.76	7.82	2.91
% Lipid			0.024	0.031	0.006	0.014	0.017	0.004	0.026	0.032	0.021	0.050	0.017
Tank			4	4	4	15	15	15	24	24	24	1	1
Treatment			1	1	1	1	1	1	1	1	1	2	2
MS222			0	0	0	0	0	0	0	0	0	0	0
PAH Food			0	0	0	0	0	0	0	0	0	0.1	0.1
PCB Congeners	log Kow	Homologue #	"nd" = non-detect										
158	7.02	6	0.43	0.62	0.33	0.59	0.52	0.27	0.57	0.57	0.52	0.45	0.72
128	6.74	6	0.71	0.73	0.56	1.43	1.08	0.24	0.61	1.30	1.10	0.51	1.08
129,178	7.14	7	0.63	0.82	0.40	0.79	0.67	0.30	0.80	0.78	0.69	0.70	0.94
187,182	7.17	7	2.88	3.75	2.03	3.76	2.94	1.81	3.59	3.35	2.97	3.01	4.24
183	7.20	7	1.00	1.31	0.69	1.46	1.09	0.54	1.18	1.28	1.13	1.12	1.50
174	7.11	7	0.69	0.93	0.32	0.76	0.68	0.26	0.85	0.78	0.55	0.73	0.96
177	7.08	7	0.87	1.14	0.55	1.01	0.93	0.46	1.03	1.12	0.94	0.90	1.23
157,200	7.27	7	0.31	0.54	0.32	0.32	0.41	0.09	0.35	0.38	0.28	0.35	0.64
172	7.33	7	0.29	0.37	0.37	0.51	0.37	0.21	0.36	0.28	0.34	0.27	0.47
180	7.36	7	2.67	3.33	1.59	3.04	2.13	1.27	2.77	3.03	2.58	2.65	3.89
193	7.52	7	0.41	0.86	0.21	0.57	0.69	0.21	0.65	0.79	0.45	0.65	0.70
170,190	7.27	7	1.07	1.45	0.67	1.38	1.22	0.59	1.21	1.49	1.15	1.14	1.50
202,171,156	7.24	8	0.91	1.20	0.57	1.16	0.98	0.47	1.14	1.21	1.01	0.99	1.34
201	7.62	8	1.00	1.26	0.69	1.29	1.06	0.66	1.16	1.35	1.11	1.08	1.46
203,196	7.65	8	1.29	1.60	0.75	1.75	1.32	0.71	1.44	1.70	1.36	1.30	1.79
208,195	7.56	8	0.67	0.83	0.47	1.00	0.73	0.43	0.82	0.99	0.80	0.75	0.97
194	7.80	8	0.36	0.42	0.16	0.49	0.35	0.15	0.35	0.43	0.44	0.34	0.43
206	8.09	9	nd	nd	nd	nd	nd	nd	nd	nd	0.66	nd	nd
Total PCBs			67.59	91.86	40.81	89.99	73.48	32.58	115.89	94.09	83.06	116.07	112.21
Surrogate Recoveries													
PCB 14			0.86	1.05	0.84	1.02	1.03	0.77	0.60	0.84	0.73	0.43	1.07
PCB 166			0.81	1.08	0.80	0.92	0.96	0.94	0.88	0.91	0.85	1.02	0.97

Table G-2: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 62

Sample Name			F62-T01F	F62-T07D	F62-T07E	F62-T07F	F62-T20D	F62-T20E	F62-T20F	F62-T03D	F62-T03E	F62-T03F	F62-T11D
g to Extraction			7.28	4.07	2.36	4.56	5.18	4.94	4.97	6.99	5.36	4.35	7.26
% Lipid			0.049	0.026	0.017	0.020	0.022	0.044	0.036	0.038	0.033	0.016	0.056
Tank			1	7	7	7	20	20	20	3	3	3	11
Treatment			2	2	2	2	2	2	2	3	3	3	3
MS222			0	0	0	0	0	0	0	0	0	0	0
PAH Food			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5
PCB Congeners	log Kow	Homologue #											
4,10	4.65	2	0.70	0.70	1.59	1.40	0.99	2.66	0.97	1.60	1.20	0.05	0.45
18	5.24	2	0.40	0.07	nd	0.21	nd	0.05	0.00	0.47	0.10	nd	0.02
17	5.25	2	0.28	0.12	nd	nd	0.12	0.09	0.01	0.37	0.22	nd	0.03
16,32	5.16	3	0.66	0.34	0.48	0.71	0.69	0.85	0.05	0.92	0.70	0.18	0.35
31, 28	5.67	3	2.31	2.59	2.86	2.09	2.69	4.46	1.75	2.84	2.41	1.27	1.87
33,21,53	5.60	3	0.43	0.16	0.34	0.39	0.33	0.33	0.05	0.79	0.42	0.09	0.15
52	5.84	4	1.46	1.53	0.14	0.31	0.14	0.53	0.03	2.52	1.66	0.05	0.23
49	5.85	4	1.40	1.37	0.66	0.89	0.53	1.53	0.77	2.20	1.42	0.21	0.71
47,48	5.85	4	1.41	1.26	2.64	1.11	1.25	3.63	0.84	2.12	1.26	1.34	1.80
44	5.75	4	0.98	0.83	0.41	0.60	0.28	1.04	0.02	1.60	0.91	0.14	0.45
41,64,71	5.69	4	1.43	1.16	1.50	1.24	1.45	2.15	0.97	1.92	1.23	0.86	1.04
74	6.20	4	0.88	0.78	0.99	0.77	0.99	1.18	0.05	1.03	0.75	0.55	0.65
70,76	6.20	4	1.06	1.21	1.25	1.15	1.26	1.96	0.76	1.02	1.07	0.44	0.76
66,95	6.20	4	4.95	4.36	4.58	3.88	4.09	6.19	3.01	7.06	4.25	2.57	3.22
92,84, 89	6.35	4	2.84	2.95	3.42	2.54	3.61	4.45	2.14	4.74	2.83	2.05	2.32
110,77	6.48	4	3.66	3.61	4.16	3.47	4.26	4.95	2.60	5.29	3.42	2.44	2.76
101	6.39	5	2.37	2.56	1.25	1.57	0.96	2.43	1.40	4.19	2.39	0.56	1.16
99	6.39	5	2.63	2.80	3.29	2.44	3.16	4.21	1.92	3.94	2.52	1.82	2.01
119	6.58	5	1.12	1.22	1.17	0.94	1.27	1.48	0.74	1.40	1.11	0.74	0.69
97	6.29	5	4.24	2.65	3.64	3.64	4.01	4.59	2.88	5.19	2.81	1.62	2.72
81, 87	6.29	5	0.69	0.68	0.83	0.68	0.81	0.99	0.05	1.00	0.67	0.48	0.55
85	6.30	5	8.18	7.49	7.93	7.60	10.04	10.65	6.07	10.35	6.97	4.55	5.95
82,151	6.20	5	0.13	1.19	1.30	0.09	1.49	1.71	0.02	1.89	0.09	0.81	0.06
149,123	6.67	5	3.76	3.73	4.08	3.67	4.13	4.85	2.64	5.75	3.43	2.40	2.69
107	6.71	6	0.80	0.70	0.80	0.72	1.06	0.99	0.62	1.00	0.67	0.48	0.56
118	6.74	6	1.62	2.28	2.45	1.78	2.15	2.08	2.28	1.87	2.20	1.43	1.71
146	6.89	6	1.76	2.48	2.66	1.77	2.29	2.35	2.48	2.22	2.15	1.62	1.80
132,153,105	6.92	6	10.54	15.85	17.38	11.14	13.71	15.13	14.52	14.16	13.52	10.40	11.33
141	6.82	6	0.29	0.37	0.21	0.14	0.43	0.45	0.08	0.38	0.12	0.08	0.18
137,130,176	6.76	6	0.40	0.48	0.55	0.36	0.49	0.50	0.03	0.40	0.49	0.33	0.41
163,138	6.99	6	5.65	7.93	8.61	5.65	7.15	7.50	7.65	6.82	7.11	5.14	6.02

Table G-2: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 62

Sample Name			F62-T01F	F62-T07D	F62-T07E	F62-T07F	F62-T20D	F62-T20E	F62-T20F	F62-T03D	F62-T03E	F62-T03F	F62-T11D
g to Extraction			7.28	4.07	2.36	4.56	5.18	4.94	4.97	6.99	5.36	4.35	7.26
% Lipid			0.049	0.026	0.017	0.020	0.022	0.044	0.036	0.038	0.033	0.016	0.056
Tank			1	7	7	7	20	20	20	3	3	3	11
Treatment			2	2	2	2	2	2	2	3	3	3	3
MS222			0	0	0	0	0	0	0	0	0	0	0
PAH Food			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5
PCB Congeners	log Kow	Homologue #											
158	7.02	6	0.43	0.65	0.71	0.45	0.57	0.61	0.05	0.59	0.57	0.43	0.50
128	6.74	6	0.65	0.99	0.89	0.76	1.25	0.72	1.32	0.90	0.95	0.54	0.50
129,178	7.14	7	0.66	0.82	0.89	0.63	0.77	0.81	0.84	0.72	0.76	0.57	0.65
187,182	7.17	7	2.75	3.81	4.45	2.82	3.72	3.87	3.73	3.50	3.39	2.86	2.98
183	7.20	7	1.01	1.32	1.62	0.99	1.32	1.29	1.40	1.23	1.20	0.99	1.06
174	7.11	7	0.70	0.82	0.97	0.64	0.80	0.75	0.82	0.71	0.82	0.63	0.69
177	7.08	7	0.91	1.14	1.24	0.84	1.13	1.15	1.19	0.96	1.06	0.85	0.95
157,200	7.27	7	0.35	0.69	0.47	0.56	0.41	0.41	0.05	0.36	0.69	0.37	0.35
172	7.33	7	0.16	0.44	0.45	0.31	0.43	0.39	0.00	0.43	0.50	0.28	0.29
180	7.36	7	2.83	3.07	3.62	2.66	3.13	3.54	3.21	2.59	3.05	2.64	2.96
193	7.52	7	0.42	0.64	0.91	0.49	0.75	0.62	0.05	0.40	0.64	0.38	0.55
170,190	7.27	7	1.09	1.42	1.58	1.09	1.56	1.40	1.66	1.14	1.34	1.03	1.19
202,171,156	7.24	8	0.93	1.19	1.29	0.92	1.15	1.21	1.27	0.95	1.10	0.81	0.99
201	7.62	8	1.02	1.30	1.40	1.07	1.27	1.32	1.43	1.07	1.19	0.95	1.15
203,196	7.65	8	1.22	1.60	1.65	1.34	1.52	1.70	1.75	1.25	1.55	1.09	1.40
208,195	7.56	8	0.68	0.86	0.91	0.74	0.85	0.88	1.07	0.69	0.78	0.61	0.77
194	7.80	8	0.33	0.42	0.39	0.29	0.44	0.47	0.07	0.31	0.43	0.25	0.31
206	8.09	9	nd	nd	nd	nd	nd	0.58	0.01	nd	nd	nd	nd
Total PCBs			85.16	96.62	104.60	79.61	96.91	117.66	77.32	114.86	90.12	59.98	71.94
Surrogate Recoveries													
PCB 14			0.96	1.02	0.98	0.81	1.12	0.65	1.25	0.48	0.84	1.02	0.78
PCB 166			1.25	0.96	1.01	0.97	1.31	0.96	0.87	0.78	0.74	1.06	0.77

Table G-2: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 62

Sample Name			F62-T11E	F62-T11F	F62-T13D	F62-T13E	F62-T13F	F62-T02D	F62-T02E	F62-T02F	F62-T06D	F62-T06E	F62-T06F
g to Extraction			5.53	4.51	3.61	5.48	6.01	4.06	5.14	5.97	6.70	3.70	6.44
% Lipid			0.024	0.024	0.018	0.037	0.028	0.022	0.048	0.012	0.039	0.011	0.047
Tank			11	11	13	13	13	2	2	2	6	6	6
Treatment			3	3	3	3	3	4	4	4	4	4	4
MS222			0	0	0	0	0	0	0	0	0	0	0
PAH Food			0.5	0.5	0.5	0.5	0.5	1	1	1	1	1	1
PCB Congeners	log Kow	Homologue #											
4,10	4.65	2	0.77	4.15	0.65	1.11	1.83	0.43	2.00	0.07	2.10	0.51	0.67
18	5.24	2	0.05	nd	nd	0.11	0.06	0.13	0.05	0.05	0.41	0.09	0.35
17	5.25	2	0.07	nd	nd	0.13	0.12	0.20	0.10	0.04	0.46	0.13	0.23
16,32	5.16	3	0.30	0.23	0.25	0.51	0.20	0.36	0.67	0.08	1.43	0.30	0.56
31, 28	5.67	3	1.43	1.55	1.28	1.86	1.31	2.01	3.53	0.43	3.59	1.40	2.47
33,21,53	5.60	3	0.26	0.19	0.15	0.25	0.32	0.26	0.42	0.12	0.94	0.24	0.35
52	5.84	4	1.05	0.13	0.07	1.30	0.89	1.65	0.66	0.59	2.52	1.22	1.55
49	5.85	4	0.89	0.54	0.40	1.21	0.72	1.45	1.27	0.52	2.19	0.93	1.35
47,48	5.85	4	0.83	0.96	1.65	1.07	0.68	1.40	1.53	1.12	2.06	0.73	2.20
44	5.75	4	0.56	0.35	0.26	0.77	0.46	0.93	0.89	0.26	1.51	0.69	0.96
41,64,71	5.69	4	0.73	1.05	0.90	1.07	0.63	1.36	1.85	0.54	2.06	0.84	1.20
74	6.20	4	0.45	0.66	0.53	0.70	0.37	0.92	1.05	0.32	1.17	0.50	0.67
70,76	6.20	4	0.81	0.70	0.64	0.95	0.50	0.70	1.52	0.32	1.37	0.53	0.67
66,95	6.20	4	2.96	3.38	2.69	4.12	2.47	5.11	5.83	2.06	7.45	3.47	4.35
92,84, 89	6.35	4	1.94	2.97	2.30	2.96	1.94	3.18	3.79	1.29	4.74	nd	2.63
110,77	6.48	4	2.43	3.32	2.77	3.32	1.97	4.04	4.79	1.88	5.48	2.65	3.14
101	6.39	5	1.78	1.02	0.77	2.12	1.54	2.85	2.06	1.45	3.92	2.17	2.21
99	6.39	5	1.71	2.31	2.08	2.40	1.50	3.27	3.32	1.39	3.93	1.91	2.31
119	6.58	5	0.73	0.97	0.71	0.93	0.57	1.55	1.42	0.55	1.48	0.62	0.84
97	6.29	5	2.12	3.13	2.66	2.33	1.73	3.71	4.91	1.64	5.92	1.82	3.03
81, 87	6.29	5	0.47	0.65	0.57	0.63	0.41	0.81	0.94	0.38	1.07	0.58	0.62
85	6.30	5	4.97	6.84	5.36	7.46	4.32	17.45	9.45	3.40	11.79	4.99	5.67
82,151	6.20	5	0.84	0.09	0.95	0.10	0.80	0.08	0.18	0.07	0.16	0.96	0.11
149,123	6.67	5	2.56	3.39	2.78	3.31	1.99	4.04	4.74	2.28	5.58	2.84	3.25
107	6.71	6	0.46	0.66	0.54	0.76	0.44	0.89	0.93	0.42	1.08	0.46	0.56
118	6.74	6	1.51	1.68	1.67	2.47	1.37	2.50	2.32	1.49	1.97	1.25	1.63
146	6.89	6	1.54	1.74	1.82	2.31	1.42	2.52	2.28	1.25	2.30	1.53	1.55
132,153,105	6.92	6	10.05	11.30	12.02	13.79	8.55	16.93	14.12	7.76	14.50	9.88	9.99
141	6.82	6	0.18	0.11	0.16	0.35	0.24	0.17	0.61	0.28	0.45	0.15	0.20
137,130,176	6.76	6	0.33	0.37	0.40	0.54	0.31	0.57	0.64	0.25	0.49	0.28	0.36
163,138	6.99	6	5.01	5.67	5.94	7.61	4.46	8.66	7.65	3.85	7.41	4.69	5.27

Table G-2: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 62

Sample Name			F62-T11E	F62-T11F	F62-T13D	F62-T13E	F62-T13F	F62-T02D	F62-T02E	F62-T02F	F62-T06D	F62-T06E	F62-T06F
g to Extraction			5.53	4.51	3.61	5.48	6.01	4.06	5.14	5.97	6.70	3.70	6.44
% Lipid			0.024	0.024	0.018	0.037	0.028	0.022	0.048	0.012	0.039	0.011	0.047
Tank			11	11	13	13	13	2	2	2	6	6	6
Treatment			3	3	3	3	3	4	4	4	4	4	4
MS222			0	0	0	0	0	0	0	0	0	0	0
PAH Food			0.5	0.5	0.5	0.5	0.5	1	1	1	1	1	1
PCB Congeners	log Kow	Homologue #											
158	7.02	6	0.41	0.47	0.49	0.63	0.37	0.73	0.82	0.32	0.60	0.42	0.44
128	6.74	6	0.62	0.75	0.61	1.41	0.81	0.87	1.07	0.41	1.01	0.50	0.55
129,178	7.14	7	0.55	0.62	0.65	0.85	0.50	0.86	0.96	0.46	0.81	0.52	0.59
187,182	7.17	7	2.53	2.90	3.25	3.65	2.22	4.06	3.56	2.24	3.57	2.55	2.52
183	7.20	7	0.87	0.99	1.19	1.38	0.83	1.50	1.30	0.82	1.30	0.83	0.93
174	7.11	7	0.57	0.66	0.68	0.97	0.46	0.81	1.01	0.53	0.86	0.52	0.72
177	7.08	7	0.76	0.84	0.97	1.21	0.68	1.19	1.14	0.67	1.13	0.71	0.80
157,200	7.27	7	0.40	0.36	0.42	0.49	0.37	0.34	0.60	0.30	0.60	0.31	0.37
172	7.33	7	0.30	0.35	0.35	0.38	0.24	0.24	0.40	0.24	0.36	0.33	0.27
180	7.36	7	2.29	2.87	2.76	3.23	1.94	4.14	3.58	2.10	3.05	2.12	2.62
193	7.52	7	0.42	0.43	0.64	0.86	0.46	0.49	0.64	0.32	0.66	0.31	0.45
170,190	7.27	7	0.98	1.12	1.23	1.68	0.93	1.62	1.45	0.87	1.32	0.84	1.06
202,171,156	7.24	8	0.82	0.88	0.97	1.26	0.75	1.21	1.17	0.66	1.16	0.73	0.84
201	7.62	8	0.94	0.98	1.18	1.36	0.87	1.29	1.23	0.87	1.25	0.87	0.93
203,196	7.65	8	1.19	1.26	1.44	1.75	1.10	1.59	1.65	1.03	1.55	1.08	1.23
208,195	7.56	8	0.66	0.67	0.79	0.96	0.67	0.73	0.80	0.56	0.85	0.57	0.65
194	7.80	8	0.34	0.36	0.41	0.52	0.32	0.41	0.46	0.28	0.38	0.26	0.36
206	8.09	9	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Total PCBs			64.45	76.61	71.01	91.17	57.63	112.18	107.38	48.84	122.01	61.85	76.30
Surrogate Recoveries													
PCB 14			0.84	0.99	0.86	1.21	0.99	0.88	0.85	0.97	0.69	0.76	0.96
PCB 166			0.80	1.14	0.90	0.95	0.90	1.02	0.97	1.03	1.10	0.92	1.05

Table G-2: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 62

Sample Name			F62-T16D	F62-T16E	F62-T16F	F62-T05D	F62-T05E	F62-T05F	F62-T21D	F62-T21E	F62-T21F	F62-T23D	F62-T23E
g to Extraction			7.09	5.44	6.12	7.25	2.36	4.52	3.64	5.69	5.25	4.10	7.68
% Lipid			0.017	0.027	0.022	0.028	0.004	0.006	0.013	0.022	0.006	0.027	0.057
Tank			16	16	16	5	5	5	21	21	21	23	23
Treatment			4	4	4	5	5	5	5	5	5	5	5
MS222			0	0	0	1	1	1	1	1	1	1	1
PAH Food			1	1	1	0	0	0	0	0	0	0	0
PCB Congeners	log Kow	Homologue #											
4,10	4.65	2	0.17	1.75	0.12	0.13	nd	0.06	2.74	0.34	0.17	1.58	3.06
18	5.24	2	0.01	0.06	0.03	0.03	1.14	nd	0.03	nd	0.12	0.60	0.92
17	5.25	2	0.02	nd	0.06	0.04	nd	nd	0.05	nd	0.20	0.35	0.57
16,32	5.16	3	0.09	0.47	0.45	0.32	1.08	0.03	0.20	0.28	0.15	0.62	1.05
31, 28	5.67	3	0.38	1.83	1.55	1.26	0.58	0.24	1.40	2.17	1.60	3.56	4.27
33,21,53	5.60	3	0.09	0.11	0.30	0.08	0.78	nd	0.18	0.19	0.32	0.62	0.77
52	5.84	4	0.17	0.08	0.21	0.21	0.04	0.10	0.34	0.15	1.02	1.58	2.13
49	5.85	4	0.29	0.14	0.53	0.49	0.19	0.15	0.72	0.62	0.89	1.42	2.06
47,48	5.85	4	0.57	1.06	0.87	0.63	0.35	0.32	0.75	1.58	0.80	1.22	3.72
44	5.75	4	0.20	0.21	0.27	0.35	0.31	0.09	0.49	0.42	0.50	1.03	1.46
41,64,71	5.69	4	0.29	0.92	0.92	0.70	0.38	0.19	0.77	0.93	0.75	1.38	2.16
74	6.20	4	0.15	0.79	0.58	0.34	0.32	0.16	0.47	0.52	0.47	0.87	1.21
70,76	6.20	4	0.20	0.80	0.58	0.73	0.45	0.20	0.93	1.00	0.93	1.75	2.42
66,95	6.20	4	1.13	2.93	2.98	1.93	1.41	0.71	2.70	2.77	2.90	4.40	6.39
92,84, 89	6.35	4	0.85	2.96	2.59	1.63	1.13	0.75	2.28	2.13	nd	2.87	3.86
110,77	6.48	4	0.91	3.60	3.00	2.03	2.02	0.87	2.29	2.62	2.35	3.45	4.58
101	6.39	5	0.58	1.82	1.03	1.05	0.66	0.49	1.44	1.09	1.78	2.44	3.12
99	6.39	5	0.67	2.52	2.32	1.65	1.49	0.78	1.81	1.94	1.91	2.68	3.56
119	6.58	5	0.21	1.04	0.78	0.81	0.60	0.21	0.77	0.76	0.84	1.11	1.29
97	6.29	5	0.66	2.20	2.51	2.11	1.38	0.26	2.11	1.91	1.85	3.67	5.20
81, 87	6.29	5	0.19	0.70	0.61	0.43	0.36	0.19	0.48	0.50	0.48	0.70	0.87
85	6.30	5	1.62	7.50	6.96	4.17	4.13	2.14	5.22	5.22	5.50	8.02	10.44
82,151	6.20	5	0.33	1.44	0.07	0.70	0.58	0.34	0.86	0.88	0.88	0.11	0.13
149,123	6.67	5	1.00	3.49	2.82	2.15	2.40	0.81	2.46	2.90	2.44	3.57	4.73
107	6.71	6	0.15	0.84	0.72	0.39	0.45	0.23	0.29	0.25	0.55	0.80	0.93
118	6.74	6	0.53	2.20	1.75	1.33	1.26	0.66	1.81	1.53	1.48	2.75	1.90
146	6.89	6	0.65	2.20	2.02	1.55	1.77	0.95	1.81	1.69	1.54	2.66	2.18
132,153,105	6.92	6	4.17	13.45	12.38	9.78	12.89	6.79	11.16	11.84	9.26	16.04	13.84
141	6.82	6	0.15	0.17	0.19	0.14	0.25	0.14	0.12	0.41	0.09	0.13	0.19
137,130,176	6.76	6	0.14	0.46	0.40	0.34	0.38	0.15	0.41	0.37	0.33	0.51	0.50
163,138	6.99	6	2.04	7.14	6.37	4.81	5.58	2.92	5.68	5.93	4.74	8.61	7.19

Table G-2: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 62

Sample Name			F62-T16D	F62-T16E	F62-T16F	F62-T05D	F62-T05E	F62-T05F	F62-T21D	F62-T21E	F62-T21F	F62-T23D	F62-T23E
g to Extraction			7.09	5.44	6.12	7.25	2.36	4.52	3.64	5.69	5.25	4.10	7.68
% Lipid			0.017	0.027	0.022	0.028	0.004	0.006	0.013	0.022	0.006	0.027	0.057
Tank			16	16	16	5	5	5	21	21	21	23	23
Treatment			4	4	4	5	5	5	5	5	5	5	5
MS222			0	0	0	1	1	1	1	1	1	1	1
PAH Food			1	1	1	0	0	0	0	0	0	0	0
PCB Congeners	log Kow	Homologue #											
158	7.02	6	0.18	0.61	0.55	0.41	0.51	0.23	0.47	0.54	0.38	0.72	0.57
128	6.74	6	0.21	1.25	1.16	0.66	0.69	0.29	0.95	0.56	0.98	1.50	0.80
129,178	7.14	7	0.25	0.82	0.68	0.58	0.54	0.30	0.63	0.66	0.55	0.91	0.79
187,182	7.17	7	1.19	3.62	3.19	2.69	3.30	1.82	2.93	3.27	2.54	3.91	3.71
183	7.20	7	0.42	1.38	1.22	0.91	1.05	0.63	1.06	1.16	1.03	1.52	1.39
174	7.11	7	0.26	0.88	0.65	0.62	0.55	0.16	0.62	0.92	0.51	0.92	0.86
177	7.08	7	0.32	1.17	0.98	0.76	0.81	0.43	0.87	0.98	0.73	1.18	1.16
157,200	7.27	7	0.15	0.53	0.28	0.46	0.32	nd	0.33	0.23	0.35	0.50	0.33
172	7.33	7	0.13	0.44	0.28	0.29	0.27	0.19	0.41	0.33	0.29	0.50	0.33
180	7.36	7	0.98	3.65	2.84	2.63	2.27	1.35	2.39	3.31	1.82	3.56	3.33
193	7.52	7	0.18	0.59	0.49	0.31	0.27	0.24	0.49	0.48	0.50	0.79	0.75
170,190	7.27	7	0.39	1.66	1.33	0.92	0.95	0.58	1.17	1.31	0.97	1.65	1.36
202,171,156	7.24	8	0.35	1.19	1.00	0.83	0.72	0.46	1.00	0.97	0.84	1.39	1.19
201	7.62	8	0.44	1.41	1.17	0.98	0.83	0.58	1.12	1.16	0.95	1.41	1.24
203,196	7.65	8	0.55	1.84	1.47	1.15	0.81	0.67	1.42	1.41	1.14	1.85	1.51
208,195	7.56	8	0.32	0.99	0.78	0.64	0.43	0.37	0.87	0.67	0.72	1.01	0.79
194	7.80	8	0.14	0.61	0.40	0.28	0.15	0.14	0.40	0.37	0.28	0.53	0.36
206	8.09	9	nd	nd	nd	nd	nd	nd	nd	0.29	nd	nd	nd
Total PCBs			25.06	87.51	74.43	57.39	58.80	29.41	69.88	71.55	61.40	104.96	117.14
Surrogate Recoveries													
PCB 14			1.05	0.80	0.72	0.87	0.87	0.81	1.09	0.92	2.45	1.02	0.72
PCB 166			1.05	0.82	0.78	0.76	0.82	0.88	0.88	0.97	2.43	0.80	1.02

Table G-2: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 62

Sample Name			F62-T23F	F62-T10D	F62-T10E	F62-T10F	F62-T18D	F62-T18E	F62-T18F	F62-T22D	F62-T22E	F62-T22F	F62-T08D
g to Extraction			3.82	3.56	6.31	4.12	2.80	5.09	7.24	2.21	5.04	5.43	3.52
% Lipid			0.013	0.013	0.025	0.007	0.004	0.029	0.054	0.002	0.015	0.046	0.006
Tank			23	10	10	10	18	18	18	22	22	22	8
Treatment			5	6	6	6	6	6	6	6	6	6	7
MS222			1	1	1	1	1	1	1	1	1	1	1
PAH Food			0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5
PCB Congeners	log Kow	Homologue #											
4,10	4.65	2	0.56	0.82	0.20	0.71	nd	0.76	0.67	0.49	0.14	1.16	0.97
18	5.24	2	0.15	nd	0.06	0.03	0.12	0.08	0.05	0.29	0.06	0.46	0.12
17	5.25	2	0.17	0.18	0.10	0.03	nd	0.12	0.06	0.40	0.08	0.37	0.12
16,32	5.16	3	0.31	1.10	0.16	0.22	0.81	0.78	0.30	0.58	0.14	0.73	0.34
31, 28	5.67	3	1.96	1.76	0.88	0.41	0.18	1.65	1.11	0.92	1.23	4.22	0.62
33,21,53	5.60	3	0.47	0.35	0.09	0.11	nd	0.52	0.12	0.96	0.38	0.54	0.17
52	5.84	4	1.19	0.28	0.77	0.33	0.32	0.36	0.46	0.75	0.94	2.07	0.63
49	5.85	4	0.99	0.69	0.70	0.26	0.32	0.69	0.66	0.57	0.81	1.95	0.58
47,48	5.85	4	0.96	0.92	1.20	0.23	0.34	0.87	1.32	0.51	0.75	3.18	0.55
44	5.75	4	0.67	0.42	0.40	0.17	0.17	0.44	0.46	0.43	0.38	1.36	0.29
41,64,71	5.69	4	0.98	1.03	0.52	0.25	0.41	0.91	0.57	0.69	0.69	1.82	0.55
74	6.20	4	0.59	0.55	0.36	0.36	0.32	0.64	0.41	0.45	0.43	1.09	0.47
70,76	6.20	4	1.20	1.12	0.68	0.53	0.39	1.35	0.81	0.60	0.67	2.06	0.54
66,95	6.20	4	3.27	3.04	2.12	0.98	1.35	3.25	2.44	2.22	2.44	6.16	2.20
92,84, 89	6.35	4	2.47	2.31	1.45	0.92	1.38	2.36	1.81	1.81	1.77	3.18	1.62
110,77	6.48	4	2.64	2.81	1.89	0.92	1.53	2.45	2.09	2.13	2.10	4.21	2.01
101	6.39	5	2.04	1.25	1.41	0.96	1.32	1.24	1.17	1.73	1.54	2.99	1.72
99	6.39	5	2.06	2.19	1.43	0.91	1.43	1.95	1.52	1.70	1.58	3.22	1.83
119	6.58	5	0.76	0.99	0.52	0.45	0.41	0.78	0.52	0.64	0.70	1.11	0.86
97	6.29	5	2.73	2.05	1.82	0.78	0.41	2.52	2.10	1.14	1.36	3.74	0.77
81, 87	6.29	5	0.56	0.54	0.36	0.28	0.37	0.50	0.41	0.44	0.41	0.83	0.41
85	6.30	5	5.96	5.90	3.63	2.15	4.19	5.53	4.15	4.97	4.77	9.91	5.08
82,151	6.20	5	0.98	0.95	0.58	0.34	0.58	0.92	0.06	0.77	0.79	0.12	0.68
149,123	6.67	5	2.76	2.96	2.15	0.92	1.46	2.44	2.20	2.18	2.23	4.15	2.03
107	6.71	6	0.62	0.55	0.37	0.21	0.46	0.56	0.39	0.53	0.51	0.84	0.50
118	6.74	6	1.93	1.72	1.10	0.82	1.22	1.85	1.43	1.49	1.32	2.04	1.59
146	6.89	6	2.02	1.78	1.20	0.86	1.57	1.68	1.55	1.78	1.42	2.24	1.68
132,153,105	6.92	6	12.18	11.59	7.79	5.64	9.74	9.98	9.99	10.97	8.61	14.06	11.58
141	6.82	6	0.40	0.21	0.24	0.06	0.22	0.14	0.27	0.27	0.10	0.38	0.28
137,130,176	6.76	6	0.45	0.39	0.30	0.17	0.24	0.35	0.35	0.35	0.31	0.50	0.33
163,138	6.99	6	6.26	5.67	3.91	2.67	4.93	5.32	5.18	5.42	4.37	7.35	5.47

Table G-2: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 62

Sample Name			F62-T23F	F62-T10D	F62-T10E	F62-T10F	F62-T18D	F62-T18E	F62-T18F	F62-T22D	F62-T22E	F62-T22F	F62-T08D
g to Extraction			3.82	3.56	6.31	4.12	2.80	5.09	7.24	2.21	5.04	5.43	3.52
% Lipid			0.013	0.013	0.025	0.007	0.004	0.029	0.054	0.002	0.015	0.046	0.006
Tank			23	10	10	10	18	18	18	22	22	22	8
Treatment			5	6	6	6	6	6	6	6	6	6	7
MS222			1	1	1	1	1	1	1	1	1	1	1
PAH Food			0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.5
PCB Congeners	log Kow	Homologue #											
158	7.02	6	0.51	0.47	0.32	0.23	0.46	0.42	0.43	0.47	0.36	0.59	0.47
128	6.74	6	1.04	0.85	0.37	0.39	0.62	1.03	0.52	1.03	0.73	0.59	0.67
129,178	7.14	7	0.70	0.62	0.45	0.28	0.45	0.59	0.60	0.56	0.46	0.79	0.57
187,182	7.17	7	3.14	3.12	2.13	1.52	2.68	2.52	2.59	3.14	2.36	3.54	2.85
183	7.20	7	1.14	1.18	0.70	0.56	0.89	1.01	0.90	1.18	0.81	1.27	1.00
174	7.11	7	0.61	0.64	0.47	0.20	0.23	0.58	0.67	0.42	0.49	0.81	0.42
177	7.08	7	0.93	0.85	0.65	0.38	0.68	0.79	0.82	0.82	0.70	1.15	0.82
157,200	7.27	7	0.31	0.66	0.26	0.19	0.20	0.39	0.29	0.27	0.24	0.43	0.45
172	7.33	7	0.40	0.49	0.22	0.16	0.32	0.29	0.27	0.65	0.32	0.37	0.35
180	7.36	7	2.77	3.35	2.00	1.04	2.10	1.71	2.52	2.35	2.06	3.42	2.53
193	7.52	7	0.46	nd	0.33	0.26	0.33	0.73	0.53	0.35	0.35	0.57	0.51
170,190	7.27	7	1.22	1.11	0.83	0.47	0.88	1.02	1.03	1.09	0.97	1.39	1.09
202,171,156	7.24	8	1.06	0.95	0.68	0.42	0.67	0.92	0.89	0.80	0.71	1.22	0.85
201	7.62	8	1.19	1.05	0.82	0.49	0.82	1.00	1.00	0.96	0.86	1.29	1.06
203,196	7.65	8	1.47	1.45	1.00	0.55	0.90	1.28	1.30	1.09	1.05	1.65	1.26
208,195	7.56	8	0.90	0.75	0.56	0.32	0.48	0.81	0.70	0.64	0.59	0.88	0.62
194	7.80	8	0.38	0.41	0.29	0.10	0.18	0.35	0.36	0.27	0.28	0.39	0.31
206	8.09	9	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Total PCBs			78.56	74.07	50.49	31.21	49.08	68.43	60.02	64.31	56.37	108.42	62.40
Surrogate Recoveries													
PCB 14			0.88	0.83	0.99	1.23	0.83	1.02	1.12	0.81	0.74	0.69	0.88
PCB 166			0.79	0.82	1.04	1.05	0.84	0.90	0.99	0.76	0.72	0.87	0.86

Table G-2: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 62

Sample Name			F62-T08E	F62-T08F	F62-T12D	F62-T12E	F62-T12F	F62-T19D	F62-T19E	F62-T19F	F62-T09D	F62-T09E	F62-T09F
g to Extraction			6.04	6.15	4.25	6.06	2.46	2.90	5.40	5.52	3.33	6.15	3.95
% Lipid			0.016	0.035	0.022	0.019	0.004	0.015	0.039	0.055	0.008	0.025	0.012
Tank			8	8	12	12	12	19	19	19	9	9	9
Treatment			7	7	7	7	7	7	7	7	8	8	8
MS222			1	1	1	1	1	1	1	1	1	1	1
PAH Food			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1
PCB Congeners	log Kow	Homologue #											
4,10	4.65	2	0.34	0.41	4.75	1.71	1.64	2.38	1.12	0.98	0.41	0.51	0.12
18	5.24	2	0.07	0.04	0.31	0.06	0.18	0.07	0.06	0.04	nd	nd	0.05
17	5.25	2	0.07	0.09	0.19	0.06	nd	0.08	0.07	0.09	nd	0.02	0.07
16,32	5.16	3	0.14	0.54	0.50	0.13	0.39	1.55	0.35	0.67	0.17	0.18	0.16
31, 28	5.67	3	0.82	1.76	1.53	0.53	0.64	2.03	2.03	2.69	1.08	1.07	0.64
33,21,53	5.60	3	0.16	0.31	0.52	0.11	0.15	0.32	0.25	0.10	0.21	0.08	0.17
52	5.84	4	0.77	0.40	1.24	0.34	0.41	0.32	0.60	0.22	0.35	0.29	0.31
49	5.85	4	0.70	0.83	1.09	0.55	0.38	0.75	1.06	0.42	0.66	0.54	0.52
47,48	5.85	4	1.25	0.97	1.03	1.22	0.36	0.99	2.15	1.14	0.66	1.21	0.59
44	5.75	4	0.33	0.59	0.69	0.37	0.18	0.49	0.74	0.53	0.37	0.34	0.37
41,64,71	5.69	4	0.58	1.01	1.00	0.59	0.33	0.62	1.13	1.33	0.95	0.61	0.57
74	6.20	4	0.37	0.60	0.58	0.45	0.31	0.67	0.64	0.87	0.47	0.35	0.38
70,76	6.20	4	nd	1.08	1.00	0.60	0.36	1.03	1.26	1.58	0.51	0.76	0.52
66,95	6.20	4	1.99	3.29	3.67	2.26	1.60	3.49	3.96	3.62	2.82	1.99	2.10
92,84, 89	6.35	4	1.61	2.16	2.27	1.66	1.27	2.87	2.75	3.46	2.49	1.54	1.82
110,77	6.48	4	1.86	2.89	2.84	2.15	1.54	3.18	3.10	3.88	2.75	1.75	2.11
101	6.39	5	nd	1.39	1.98	1.14	1.29	1.48	1.78	1.75	1.62	0.91	1.13
99	6.39	5	1.49	2.07	1.98	1.69	1.17	2.48	2.31	2.82	2.01	1.33	1.47
119	6.58	5	0.53	0.89	0.84	0.57	0.44	0.97	0.78	1.04	0.79	0.45	0.47
97	6.29	5	1.39	2.54	3.20	1.71	0.70	2.50	2.96	3.47	2.19	1.88	1.84
81, 87	6.29	5	0.44	0.52	0.54	0.42	0.36	0.69	0.63	0.77	0.58	0.37	0.43
85	6.30	5	3.87	5.98	5.77	4.71	3.47	7.06	6.27	9.21	5.72	3.27	4.32
82,151	6.20	5	0.67	0.08	0.07	0.73	0.56	1.21	0.08	0.11	0.97	0.59	0.72
149,123	6.67	5	1.86	3.04	3.05	2.28	1.79	3.07	3.14	3.67	3.01	1.81	2.31
107	6.71	6	0.41	0.57	0.55	0.49	0.35	0.73	0.56	0.91	0.53	0.31	0.44
118	6.74	6	1.23	1.88	1.92	1.43	1.26	2.30	1.38	2.87	1.63	0.97	1.54
146	6.89	6	1.21	1.96	1.90	1.68	1.40	2.25	1.45	2.57	1.99	1.09	1.70
132,153,105	6.92	6	8.05	12.32	12.13	10.99	9.33	13.92	9.40	15.45	13.28	7.09	11.38
141	6.82	6	0.11	0.39	0.30	0.07	0.06	0.31	0.23	0.37	0.42	0.13	0.35
137,130,176	6.76	6	0.29	0.43	0.44	0.10	0.23	0.46	0.31	0.57	0.34	0.23	0.31
163,138	6.99	6	4.34	6.39	6.17	5.81	4.37	7.35	4.74	8.69	6.26	3.52	5.45

Table G-2: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 62

Sample Name			F62-T08E	F62-T08F	F62-T12D	F62-T12E	F62-T12F	F62-T19D	F62-T19E	F62-T19F	F62-T09D	F62-T09E	F62-T09F
g to Extraction			6.04	6.15	4.25	6.06	2.46	2.90	5.40	5.52	3.33	6.15	3.95
% Lipid			0.016	0.035	0.022	0.019	0.004	0.015	0.039	0.055	0.008	0.025	0.012
Tank			8	8	12	12	12	19	19	19	9	9	9
Treatment			7	7	7	7	7	7	7	7	8	8	8
MS222			1	1	1	1	1	1	1	1	1	1	1
PAH Food			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1
PCB Congeners	log Kow	Homologue #											
158	7.02	6	0.38	0.51	0.47	0.65	0.38	0.62	0.39	0.69	0.56	0.29	0.47
128	6.74	6	0.45	0.83	0.76	0.53	0.47	1.31	0.47	1.58	0.81	0.34	0.60
129,178	7.14	7	0.44	0.71	0.65	0.61	0.44	0.77	0.53	0.92	0.61	0.38	0.58
187,182	7.17	7	2.25	3.25	3.07	2.84	2.45	3.45	2.38	3.92	3.48	1.80	2.90
183	7.20	7	0.77	1.10	1.04	0.97	0.78	1.30	0.84	1.54	1.23	0.64	0.98
174	7.11	7	0.44	0.83	0.77	0.54	0.40	0.77	0.55	0.99	0.66	0.41	0.58
177	7.08	7	0.72	1.00	0.95	0.84	0.64	1.13	0.72	1.30	0.94	0.52	0.82
157,200	7.27	7	0.29	0.45	0.49	0.34	0.33	0.39	0.30	0.50	0.35	0.24	0.37
172	7.33	7	0.22	0.37	0.37	0.25	0.34	0.51	0.25	0.44	0.42	0.20	0.31
180	7.36	7	2.24	3.10	2.78	2.57	1.99	3.12	2.36	4.08	2.69	1.54	2.34
193	7.52	7	0.40	0.61	0.48	0.46	0.33	0.64	0.47	0.69	0.42	0.33	0.44
170,190	7.27	7	0.92	1.33	1.20	1.09	0.83	1.46	0.88	1.77	1.19	0.67	1.03
202,171,156	7.24	8	0.69	1.05	0.98	0.85	0.67	1.21	0.81	1.45	0.91	0.59	0.82
201	7.62	8	0.87	1.14	1.10	1.01	0.82	1.34	0.91	1.51	1.10	0.67	0.99
203,196	7.65	8	0.98	1.55	1.34	1.14	0.96	1.73	1.19	2.01	1.35	0.86	1.15
208,195	7.56	8	0.54	0.77	0.74	0.61	0.51	0.98	0.67	1.13	0.70	0.47	0.61
194	7.80	8	0.25	0.48	0.34	0.27	0.23	0.50	0.32	0.58	0.33	0.23	0.26
206	8.09	9	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Total PCBs			49.80	76.50	81.59	62.17	49.07	88.84	71.36	100.99	72.99	45.36	59.63
Surrogate Recoveries													
PCB 14			1.01	1.12	1.11	0.95	1.01	0.84	0.80	0.89	0.87	0.89	1.03
PCB 166			1.06	0.97	0.93	0.98	0.91	0.74	1.11	0.75	0.90	0.96	0.91

Table G-2: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 62

Sample Name			F62-T14D	F62-T14E	F62-T14F	F62-T17D	F62-T17E	F62-T17F
g to Extraction			5.38	6.18	4.03	6.12	4.01	6.09
% Lipid			0.019	0.024	0.029	0.028	0.019	0.049
Tank			14	14	14	17	17	17
Treatment			8	8	8	8	8	8
MS222			1	1	1	1	1	1
PAH Food			1	1	1	1	1	1
PCB Congeners	log Kow	Homologue #						
4,10	4.65	2	0.65	1.05	1.03	0.37	0.79	1.15
18	5.24	2	0.08	0.11	0.08	0.03	0.17	0.05
17	5.25	2	0.18	nd	0.11	0.09	0.27	0.08
16,32	5.16	3	0.20	0.42	0.44	0.33	0.92	0.39
31, 28	5.67	3	1.71	1.10	2.72	1.85	2.51	2.03
33,21,53	5.60	3	0.17	0.22	0.19	0.13	0.49	0.16
52	5.84	4	1.18	0.20	0.82	1.09	0.41	0.54
49	5.85	4	1.03	0.47	1.35	0.97	0.99	0.94
47,48	5.85	4	0.94	0.67	2.66	0.89	1.26	1.91
44	5.75	4	0.64	0.33	0.91	0.58	0.62	0.68
41,64,71	5.69	4	1.03	0.69	1.44	0.84	1.28	1.14
74	6.20	4	0.57	0.43	0.82	0.61	0.79	0.69
70,76	6.20	4	0.93	0.64	1.45	0.80	1.26	1.32
66,95	6.20	4	3.37	2.18	4.61	3.31	4.30	3.69
92,84, 89	6.35	4	2.63	2.14	3.47	2.60	3.58	2.53
110,77	6.48	4	3.01	2.21	4.07	2.66	3.99	2.95
101	6.39	5	2.21	0.95	2.28	1.84	1.89	1.49
99	6.39	5	2.27	1.61	3.05	1.94	3.07	2.12
119	6.58	5	0.93	0.64	1.03	0.75	1.37	0.70
97	6.29	5	2.59	1.97	3.86	2.33	3.15	3.12
81, 87	6.29	5	0.61	0.44	0.77	0.55	0.78	0.56
85	6.30	5	6.34	4.59	7.30	6.45	8.88	6.24
82,151	6.20	5	1.17	0.87	0.11	0.06	1.56	0.97
149,123	6.67	5	3.18	2.31	4.29	2.60	4.07	3.00
107	6.71	6	0.68	0.48	0.74	0.64	0.90	0.59
118	6.74	6	1.93	1.56	2.32	2.30	2.39	2.04
146	6.89	6	1.85	1.47	2.56	2.26	2.49	2.21
132,153,105	6.92	6	11.48	9.04	16.66	13.65	15.13	13.85
141	6.82	6	0.21	0.19	0.18	0.22	0.40	0.37
137,130,176	6.76	6	0.42	0.33	0.58	0.51	0.54	0.49
163,138	6.99	6	6.06	4.85	8.57	7.49	7.86	7.15

Table G-2: Experiment 3 - Total PCB Tissue Concentrations and % Lipid Day 62

Sample Name			F62-T14D	F62-T14E	F62-T14F	F62-T17D	F62-T17E	F62-T17F
g to Extraction			5.38	6.18	4.03	6.12	4.01	6.09
% Lipid			0.019	0.024	0.029	0.028	0.019	0.049
Tank			14	14	14	17	17	17
Treatment			8	8	8	8	8	8
MS222			1	1	1	1	1	1
PAH Food			1	1	1	1	1	1
PCB Congeners	log Kow	Homologue #						
158	7.02	6	0.52	0.41	0.71	0.64	0.68	0.56
128	6.74	6	1.09	0.84	0.91	1.43	1.35	0.57
129,178	7.14	7	0.68	0.53	0.94	0.82	0.85	0.79
187,182	7.17	7	3.07	2.40	4.51	3.54	4.00	3.61
183	7.20	7	1.15	0.90	1.58	1.36	1.43	1.29
174	7.11	7	0.76	0.63	1.17	0.82	0.94	0.86
177	7.08	7	0.97	0.76	1.38	1.20	1.24	1.14
157,200	7.27	7	0.37	0.16	0.50	0.49	0.56	0.48
172	7.33	7	0.39	0.30	0.51	0.44	0.64	0.33
180	7.36	7	3.04	2.17	4.06	3.50	3.53	3.72
193	7.52	7	0.44	0.49	0.72	0.65	0.65	0.66
170,190	7.27	7	1.40	1.06	1.74	1.59	1.69	1.43
202,171,156	7.24	8	1.03	0.81	1.39	1.25	1.26	1.23
201	7.62	8	1.19	0.97	1.43	1.40	1.40	1.35
203,196	7.65	8	1.55	1.28	1.98	1.83	1.84	1.64
208,195	7.56	8	0.82	0.74	0.94	0.97	0.95	0.96
194	7.80	8	0.47	0.38	0.62	0.54	0.56	0.42
206	8.09	9	nd	nd	nd	nd	nd	nd
Total PCBs			79.18	58.97	105.56	83.23	101.67	86.20
Surrogate Recoveries								
PCB 14			0.69	1.34	1.05	1.23	0.84	1.09
PCB 166			0.65	1.18	1.01	0.89	0.82	0.94

Table G-3: Experiment 3 - Total PCB Tissue Concentrations and Lipid % Day 90

Sample Name				F90-T04D	F90-T04E	F90-T04F	F90-24D	F90-24E	F90-24F	F90-T01D
g to extraction				6.28	4.11	4.97	2.78	4.35	5.74	4.95
% Lipid				0.018	0.017	0.030	0.010	0.011	0.028	0.030
Tank				4	4	4	24	24	24	1
Treatment				1	1	1	1	1	1	2
MS222				0	0	0	0	0	0	0
PAH Food				0	0	0	0	0	0	0.1
PCB Congeners	Log Kow	Homologue	Homologue #	"nd" = non-detect						
4,10	4.65	di	2	0.23	0.56	1.00	2.35	1.02	3.60	0.93
18	5.24	di	2	nd	nd	nd	0.48	0.11	0.03	0.08
17	5.25	di	2	nd	nd	nd	0.37	nd	0.04	0.15
16,32	5.16	tri	3	0.35	0.36	0.73	0.93	0.39	0.50	0.48
31,28	5.67	tri	3	0.24	0.47	2.14	2.73	0.84	2.46	2.92
33,21,53	5.6	tri	3	0.07	0.12	nd	0.59	0.06	0.08	0.27
52	5.84	tetra	4	0.04	0.02	0.03	1.99	0.03	0.12	1.66
49	5.85	tetra	4	0.13	0.07	0.30	1.88	0.18	0.61	1.69
47,48	5.85	tetra	4	0.76	0.79	1.50	1.95	0.65	1.18	1.97
44	5.75	tetra	4	0.07	0.06	0.31	0.91	0.09	0.29	0.98
41,64,71	5.69	tetra	4	0.54	0.57	1.26	1.46	0.47	1.17	1.37
74	6.2	tetra	4	0.41	0.51	0.88	0.84	0.41	0.71	0.93
70,76	6.2	tetra	4	0.27	0.57	1.38	1.09	0.30	0.89	1.31
66,95	6.2	tetra	4	1.74	2.12	3.86	5.33	1.55	3.36	5.55
92,84,89	6.35	penta	4	1.79	1.83	2.82	nd	1.41	3.26	3.22
110,77	6.48	tetra	4	2.10	2.42	3.70	4.23	1.79	3.09	4.51
101	6.39	penta	5	0.33	0.32	0.67	3.39	0.32	1.00	2.91
99	6.39	penta	5	1.44	1.69	2.64	3.59	1.50	2.45	3.13
119	6.58	penta	5	0.44	0.60	0.94	1.47	0.68	1.03	1.05
97	6.29	penta	5	1.59	1.52	2.95	4.14	0.71	3.43	3.17
81,87	6.29	tetra/penta	5	0.40	0.45	0.69	0.94	0.35	0.63	0.85
85	6.3	penta	5	5.12	5.33	8.54	10.42	4.44	7.76	10.33
82, 151	6.2	penta	5	0.77	0.87	1.29	1.62	0.62	1.14	1.62
149, 123	6.67	penta	5	2.12	2.29	3.46	4.19	1.46	3.03	4.55
107	6.71	hexa	6	0.56	0.56	0.90	0.53	0.47	0.73	1.08
118	6.74	hexa/penta	6	1.45	1.57	2.44	2.55	1.16	1.81	2.76
146	6.89	hexa	6	1.37	1.46	1.96	3.85	1.66	2.63	2.46
132,153,105	6.92	hexa	6	8.53	9.19	12.54	22.74	9.87	15.13	15.03
141	6.82	hexa	6	0.05	0.29	0.09	0.31	0.21	0.30	0.30
137,130,176	6.76	hexa	6	0.26	0.29	0.44	0.74	0.28	0.55	0.51
163,138	6.99	hexa	6	4.36	4.62	6.47	11.19	4.85	7.72	7.99

Table G-3: Experiment 3 - Total PCB Tissue Concentrations and Lipid % Day 90

Sample Name				F90-T04D	F90-T04E	F90-T04F	F90-24D	F90-24E	F90-24F	F90-T01D
g to extraction				6.28	4.11	4.97	2.78	4.35	5.74	4.95
% Lipid				0.018	0.017	0.030	0.010	0.011	0.028	0.030
Tank				4	4	4	24	24	24	1
Treatment				1	1	1	1	1	1	2
MS222				0	0	0	0	0	0	0
PAH Food				0	0	0	0	0	0	0.1
PCB Congeners	Log Kow	Homologue	Homologue #	"nd" = non-detect						
158	7.02	hexa	6	0.32	0.35	0.50	0.96	0.44	0.65	0.62
128	6.74	hexa	6	0.43	0.44	0.66	0.78	0.36	0.59	0.83
129,178	7.14	hepta	7	0.48	0.51	0.69	1.23	0.53	0.90	0.86
187,182	7.17	hepta	7	2.16	2.28	3.02	5.34	2.44	3.63	3.71
183	7.2	hepta	7	0.78	0.76	1.10	1.98	0.88	1.38	1.32
174	7.11	hepta	7	0.45	0.55	0.70	0.97	0.37	0.82	0.89
177	7.08	hepta	7	0.69	0.72	0.97	1.52	0.73	1.11	1.21
157,200	7.27	hepta/octa	7	0.25	0.29	0.36	0.43	0.22	0.36	0.49
172	7.33	hepta	7	0.20	0.29	0.39	0.58	0.25	0.37	0.41
180	7.36	hepta	7	2.07	2.23	3.26	3.61	1.79	2.88	3.62
193	7.52	hepta	7	0.36	0.57	0.91	0.93	0.45	0.76	0.87
170,190	7.27	hepta	7	0.89	1.03	1.39	1.75	0.83	1.30	1.67
202,171,156	7.24	octa	8	0.75	0.80	1.12	1.71	0.76	1.23	1.33
201	7.62	octa	8	0.98	0.95	1.35	1.78	0.91	1.24	1.54
203,196	7.65	octa	8	1.09	1.29	1.76	2.00	0.93	1.54	2.00
208,195	7.56	nona/octa	8	0.74	0.70	1.04	1.23	0.60	0.90	1.15
194	7.8	octa	8	0.25	0.41	0.59	0.43	0.17	0.39	0.60
206	8.09	nona	9	0.38	0.57	0.88	nd	0.12	0.53	0.91
Surrogate Recoveries										
PCB 14				1.19	1.18	1.69	0.81	1.10	1.12	0.98
PCB 166				0.87	0.82	1.30	0.83	0.94	0.95	0.82
Total PCBs				50.79	56.27	86.64	126.00	50.67	91.32	109.76

Table G-3: Experiment 3 - Total PCB Tissue Concentrations and Lipid % Day 90

Sample Name			F90-T01E	F90-T20D	F90-T20E	F90-T20F	F90-T03E	F90-TO3F	F90-T11D	F90-T11F	F90-T13D
g to extraction			3.89	4.49	2.43	7.63	3.37	2.34	3.23	3.59	3.65
% Lipid			0.014	0.029	0.010	0.071	0.011	0.002	0.019	0.006	0.024
Tank			1	20	20	20	3	3	11	11	13
Treatment			2	2	2	2	3	3	3	3	3
MS222			0	0	0	0	0	0	0	0	0
PAH Food			0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5	0.5
PCB Congeners	Log Kow	Homologue									
4,10	4.65	di	1.02	4.00	1.80	15.80	3.07	1.54	nd	nd	0.93
18	5.24	di	nd	0.40	0.09	0.40	0.07	nd	nd	0.24	0.36
17	5.25	di	nd	0.29	0.07	0.50	nd	nd	nd	nd	0.27
16,32	5.16	tri	0.47	0.66	0.80	1.12	0.84	nd	1.89	0.31	0.51
31,28	5.67	tri	1.94	2.81	3.04	4.18	1.45	0.22	2.45	0.46	2.13
33,21,53	5.6	tri	nd	0.55	0.30	0.74	0.06	nd	0.53	0.22	0.44
52	5.84	tetra	0.06	1.78	0.76	2.67	0.02	nd	0.09	nd	1.81
49	5.85	tetra	0.16	1.69	1.74	2.52	0.12	0.11	0.25	0.10	1.71
47,48	5.85	tetra	0.81	1.73	1.97	2.58	1.56	0.28	1.86	0.78	1.70
44	5.75	tetra	0.15	0.94	0.80	1.63	0.09	0.06	0.15	0.09	0.91
41,64,71	5.69	tetra	0.76	1.43	1.74	2.22	0.98	0.15	1.98	0.78	1.48
74	6.2	tetra	0.49	0.84	0.95	1.38	0.86	0.12	1.47	0.56	0.84
70,76	6.2	tetra	0.73	1.07	1.12	1.98	0.45	0.10	1.83	0.36	0.69
66,95	6.2	tetra	2.21	4.99	5.66	7.59	3.51	0.64	6.33	2.51	5.31
92,84,89	6.35	penta	1.32	3.38	4.87	4.74	2.65	0.53	5.00	2.94	3.55
110,77	6.48	tetra	2.36	3.80	4.49	5.75	4.09	0.91	6.55	3.49	4.48
101	6.39	penta	0.43	2.96	2.95	4.07	0.53	0.18	1.11	0.43	3.24
99	6.39	penta	1.62	3.24	3.94	4.66	2.86	0.63	5.11	2.54	3.36
119	6.58	penta	0.52	1.41	1.56	1.92	1.10	0.15	2.05	0.93	1.23
97	6.29	penta	1.93	3.91	3.76	6.36	2.22	0.44	4.77	2.82	5.26
81,87	6.29	tetra/penta	0.48	0.78	1.01	1.17	0.80	0.19	1.32	0.70	0.89
85	6.3	penta	5.02	9.45	11.48	15.77	8.70	1.87	14.27	8.11	9.97
82, 151	6.2	penta	0.90	1.42	1.83	2.08	1.48	0.29	2.37	1.28	1.62
149, 123	6.67	penta	2.25	3.86	4.36	5.52	3.86	1.00	6.38	3.65	4.82
107	6.71	hexa	0.53	0.91	0.60	1.42	0.50	0.25	1.47	0.84	1.05
118	6.74	hexa/penta	1.50	2.23	2.84	3.43	2.57	0.72	3.73	2.06	2.53
146	6.89	hexa	1.37	2.80	4.28	3.87	2.32	0.82	4.80	2.95	2.91
132,153,105	6.92	hexa	8.66	16.38	25.14	22.59	14.62	5.67	28.92	18.02	17.41
141	6.82	hexa	0.14	0.18	0.62	0.25	0.31	0.12	0.36	0.52	0.19
137,130,176	6.76	hexa	0.26	0.59	0.83	0.86	0.47	0.12	1.07	0.59	0.64
163,138	6.99	hexa	4.27	8.37	12.58	12.20	7.46	2.63	14.82	8.86	9.17

Table G-3: Experiment 3 - Total PCB Tissue Concentrations and Lipid % Day 90

Sample Name			F90-T01E	F90-T20D	F90-T20E	F90-T20F	F90-T03E	F90-TO3F	F90-T11D	F90-T11F	F90-T13D
g to extraction			3.89	4.49	2.43	7.63	3.37	2.34	3.23	3.59	3.65
% Lipid			0.014	0.029	0.010	0.071	0.011	0.002	0.019	0.006	0.024
Tank			1	20	20	20	3	3	11	11	13
Treatment			2	2	2	2	3	3	3	3	3
MS222			0	0	0	0	0	0	0	0	0
PAH Food			0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5	0.5
PCB Congeners	Log Kow	Homologue									
158	7.02	hexa	0.32	0.76	1.18	1.04	0.57	nd	1.35	0.78	0.81
128	6.74	hexa	0.37	0.70	0.99	0.84	0.69	0.21	1.13	0.60	0.75
129,178	7.14	hepta	0.49	0.90	1.36	1.37	0.79	0.28	1.61	0.95	1.01
187,182	7.17	hepta	2.25	4.01	5.91	5.34	3.67	1.67	6.83	4.37	4.25
183	7.2	hepta	0.74	1.53	2.18	2.18	1.24	0.53	2.61	1.63	1.64
174	7.11	hepta	0.48	0.82	1.00	1.22	0.94	0.25	1.74	0.94	1.09
177	7.08	hepta	0.67	1.22	1.76	1.71	1.17	0.40	2.16	1.29	1.35
157,200	7.27	hepta/octa	0.32	0.49	nd	0.75	0.48	0.26	0.90	0.66	0.60
172	7.33	hepta	0.29	0.50	0.69	0.65	0.41	0.27	0.91	0.46	0.56
180	7.36	hepta	2.09	3.25	4.03	4.62	3.77	1.36	5.81	3.24	3.48
193	7.52	hepta	0.54	0.88	1.12	1.20	0.73	0.21	1.42	0.79	0.86
170,190	7.27	hepta	0.93	1.51	2.02	2.06	1.67	0.59	2.67	1.67	1.69
202,171,156	7.24	octa	0.79	1.31	1.93	1.97	1.19	0.39	2.26	1.30	1.42
201	7.62	octa	1.01	1.27	1.89	1.85	1.55	0.63	2.34	1.42	1.46
203,196	7.65	octa	1.33	1.57	2.33	2.36	2.02	0.71	3.00	1.70	1.83
208,195	7.56	nona/octa	0.79	0.86	1.36	1.36	1.13	0.39	1.68	0.94	1.05
194	7.8	octa	0.36	0.36	0.55	0.53	0.57	0.13	0.89	0.47	0.44
206	8.09	nona	0.64	0.45	0.80	0.74	0.69	0.14	1.03	0.48	0.56
Surrogate Recoveries											
PCB 14			0.89	0.96	0.82	0.66	0.87	1.07	1.23	0.86	0.88
PCB 166			0.81	0.79	0.82	0.76	0.81	0.79	1.47	0.81	0.77
Total PCBs			56.77	111.26	139.05	173.76	92.89	28.15	163.26	90.83	116.25

Table G-3: Experiment 3 - Total PCB Tissue Concentrations and Lipid % Day 90

Sample Name			F90-T13E	F90-T13F	F90-T02D	F90-T02E	F90-T02F	F90-T06D	F90-T06E	F90-T06F	F90-16D
g to extraction			4.93	5.01	4.39	4.99	4.76	5.63	3.9	7.38	3.07
% Lipid			0.033	0.040	0.010	0.014	0.019	0.026	0.014	0.039	0.018
Tank			13	13	2	2	2	6	6	6	16
Treatment			3	3	4	4	4	4	4	4	4
MS222			0	0	0	0	0	0	0	0	0
PAH Food			0.5	0.5	1	1	1	1	1	1	1
PCB Congeners	Log Kow	Homologue									
4,10	4.65	di	0.39	2.39	3.90	3.44	4.59	1.04	5.30	6.99	0.89
18	5.24	di	0.05	0.51	0.30	0.26	nd	0.07	nd	0.08	nd
17	5.25	di	0.08	0.39	0.19	0.17	nd	0.21	nd	0.11	nd
16,32	5.16	tri	1.16	0.86	0.80	0.70	0.31	0.99	0.43	0.34	1.35
31,28	5.67	tri	3.31	3.29	0.96	0.84	1.60	2.33	0.61	1.28	4.30
33,21,53	5.6	tri	0.69	0.69	0.49	0.43	0.08	0.58	0.30	0.28	0.48
52	5.84	tetra	0.33	2.57	1.26	1.11	0.05	1.81	0.06	1.03	0.23
49	5.85	tetra	1.45	2.25	1.23	1.08	0.15	1.67	0.54	0.97	1.14
47,48	5.85	tetra	2.23	2.19	1.51	1.33	1.58	1.99	1.66	1.12	2.60
44	5.75	tetra	0.93	1.38	0.78	0.69	0.14	0.98	0.28	0.57	0.66
41,64,71	5.69	tetra	2.32	1.90	1.12	0.99	1.18	1.23	1.21	0.77	2.35
74	6.2	tetra	1.35	1.03	0.74	0.65	0.68	0.80	0.78	0.43	1.48
70,76	6.2	tetra	1.81	1.36	0.46	0.40	0.62	1.06	0.55	0.59	1.43
66,95	6.2	tetra	7.11	6.80	4.28	3.77	3.40	5.26	4.09	2.96	7.39
92,84,89	6.35	penta	nd	4.88	2.88	2.53	2.92	3.74	3.11	2.00	6.32
110,77	6.48	tetra	6.57	5.24	3.87	3.41	4.12	4.45	4.53	2.73	7.11
101	6.39	penta	2.63	3.86	2.94	2.59	0.47	3.18	1.14	1.99	2.19
99	6.39	penta	4.75	3.96	2.77	2.44	2.58	2.81	2.93	2.02	5.68
119	6.58	penta	1.72	1.41	0.93	0.82	0.87	0.98	1.20	0.72	2.43
97	6.29	penta	8.17	6.10	3.77	3.31	3.03	4.58	3.82	2.23	6.93
81,87	6.29	tetra/penta	1.36	1.05	0.73	0.64	0.78	0.87	0.94	0.57	1.43
85	6.3	penta	15.29	11.67	8.09	7.12	8.22	8.60	9.80	6.13	22.64
82, 151	6.2	penta	0.22	1.94	1.41	1.24	1.56	0.15	1.71	1.03	2.70
149, 123	6.67	penta	6.59	5.28	4.38	3.85	3.58	4.81	4.35	2.72	7.21
107	6.71	hexa	1.48	1.16	0.94	0.82	0.90	0.95	0.58	0.64	1.57
118	6.74	hexa/penta	3.77	2.94	2.54	2.24	2.44	2.78	2.95	1.80	4.27
146	6.89	hexa	4.67	3.60	2.13	1.88	2.25	2.22	2.49	1.28	5.20
132,153,105	6.92	hexa	27.58	20.83	13.90	12.23	14.38	13.93	16.24	8.12	32.14
141	6.82	hexa	0.81	0.54	0.25	0.22	0.42	0.51	0.28	0.17	0.49
137,130,176	6.76	hexa	1.11	0.79	0.40	0.35	0.45	0.48	0.48	0.29	1.12
163,138	6.99	hexa	14.58	10.98	7.38	6.50	7.47	7.44	8.37	4.44	16.71

Table G-3: Experiment 3 - Total PCB Tissue Concentrations and Lipid % Day 90

Sample Name			F90-T13E	F90-T13F	F90-T02D	F90-T02E	F90-T02F	F90-T06D	F90-T06E	F90-T06F	F90-16D
g to extraction			4.93	5.01	4.39	4.99	4.76	5.63	3.9	7.38	3.07
% Lipid			0.033	0.040	0.010	0.014	0.019	0.026	0.014	0.039	0.018
Tank			13	13	2	2	2	6	6	6	16
Treatment			3	3	4	4	4	4	4	4	4
MS222			0	0	0	0	0	0	0	0	0
PAH Food			0.5	0.5	1	1	1	1	1	1	1
PCB Congeners	Log Kow	Homologue									
158	7.02	hexa	1.28	1.05	0.55	0.48	0.59	0.58	0.65	0.37	1.60
128	6.74	hexa	1.15	0.94	0.54	0.47	0.75	0.71	0.76	0.33	1.41
129,178	7.14	hepta	1.74	1.28	0.75	0.66	0.83	0.84	0.86	0.49	1.81
187,182	7.17	hepta	6.57	4.93	3.41	3.00	3.63	3.53	3.96	2.08	7.54
183	7.2	hepta	2.56	2.03	1.21	1.06	1.30	1.23	1.37	0.75	3.07
174	7.11	hepta	1.66	1.26	0.92	0.81	1.05	1.04	0.90	0.55	1.92
177	7.08	hepta	2.06	1.60	1.12	0.99	1.23	1.18	1.28	0.68	2.39
157,200	7.27	hepta/octa	0.88	0.77	0.31	0.27	0.59	0.34	0.39	0.28	0.87
172	7.33	hepta	0.70	0.58	0.43	0.38	0.42	0.45	0.48	0.23	0.90
180	7.36	hepta	5.68	4.26	3.74	3.29	3.62	3.86	4.00	2.41	6.20
193	7.52	hepta	1.14	1.11	0.71	0.63	0.79	0.82	0.91	0.39	1.53
170,190	7.27	hepta	2.49	1.95	1.61	1.41	1.64	1.76	1.47	1.00	3.15
202,171,156	7.24	octa	2.34	1.80	1.17	1.03	1.31	1.28	1.33	0.75	2.51
201	7.62	octa	2.33	1.82	1.46	1.29	1.58	1.61	1.65	0.93	2.58
203,196	7.65	octa	3.01	2.39	2.01	1.77	2.08	2.18	2.13	1.24	3.36
208,195	7.56	nona/octa	1.75	1.39	1.10	0.97	1.19	1.31	1.23	0.73	1.76
194	7.8	octa	0.65	0.71	0.56	0.49	0.62	0.75	0.93	0.40	0.76
206	8.09	nona	1.12	0.83	0.91	0.80	1.04	1.10	0.86	0.61	1.19
Surrogate Recoveries											
PCB 14			0.57	0.74	0.84	0.77	0.90	0.60	0.96	1.17	0.85
PCB 166			0.77	0.82	0.78	0.72	0.86	0.77	0.72	0.84	0.93
Total PCBs			163.63	144.52	99.83	87.83	95.10	107.09	105.86	70.61	195.00

Table G-3: Experiment 3 - Total PCB Tissue Concentrations and Lipid % Day 90

Sample Name			F90-T16F	F90-T05E	F90-T05F	F90-21F	F90-T21E	F90-23D	F90-23E	F90-23F	F90-T10D
g to extraction			4.32	3.33	5.45	5.43	6.06	4.25	4.91	4.9	2.97
% Lipid			0.025	0.021	0.011	0.017	0.035	0.008	0.015	0.025	0.025
Tank			16	5	5	21	21	23	23	23	10
Treatment			4	5	5	5	5	5	5	5	6
MS222			0	1	1	1	1	1	1	1	1
PAH Food			1	0	0	0	0	0	0	0	0.1
PCB Congeners	Log Kow	Homologue									
4,10	4.65	di	3.63	0.39	0.33	4.29	3.04	2.20	3.08	2.82	2.81
18	5.24	di	0.03	0.05	0.10	0.17	0.46	nd	0.09	0.16	0.23
17	5.25	di	0.04	0.24	0.10	0.19	0.30	nd	0.16	0.24	0.32
16,32	5.16	tri	0.23	0.90	0.40	0.30	0.72	0.36	0.58	0.60	1.06
31,28	5.67	tri	1.66	3.99	0.75	2.09	2.58	0.92	2.56	2.78	4.02
33,21,53	5.6	tri	0.12	0.33	0.15	0.29	0.28	nd	0.18	0.26	0.77
52	5.84	tetra	0.06	2.14	0.69	1.65	1.48	0.02	0.48	1.45	1.57
49	5.85	tetra	0.52	2.13	0.64	1.59	1.41	0.15	0.69	1.37	2.11
47,48	5.85	tetra	1.40	2.48	0.77	1.51	1.36	0.27	1.44	1.34	2.63
44	5.75	tetra	0.35	1.23	0.27	0.74	0.84	0.05	0.48	0.87	1.18
41,64,71	5.69	tetra	1.31	1.75	0.53	1.22	1.14	0.27	1.14	1.15	1.96
74	6.2	tetra	0.74	1.28	0.45	0.78	0.68	0.28	0.88	0.71	1.11
70,76	6.2	tetra	0.60	2.28	0.59	1.23	1.21	0.22	1.34	1.17	2.26
66,95	6.2	tetra	3.82	6.78	2.28	4.50	4.01	0.88	3.15	3.91	6.76
92,84,89	6.35	penta	2.98	3.60	1.54	3.27	2.87	1.01	3.21	nd	4.37
110,77	6.48	tetra	3.86	5.21	2.15	3.51	2.95	1.09	3.01	2.91	5.53
101	6.39	penta	1.00	3.50	1.69	2.65	2.30	0.27	2.36	2.21	3.63
99	6.39	penta	2.73	3.77	1.58	2.82	2.51	1.01	2.66	2.46	3.92
119	6.58	penta	1.05	1.41	0.54	1.29	1.17	0.34	1.20	1.18	1.31
97	6.29	penta	4.31	4.49	1.85	3.01	2.74	0.23	2.25	2.80	6.21
81,87	6.29	tetra/penta	0.80	0.97	0.41	0.72	0.60	0.25	0.65	0.61	1.09
85	6.3	penta	8.91	11.86	5.08	9.44	7.42	3.27	8.97	7.20	11.92
82, 151	6.2	penta	1.45	1.78	0.76	1.29	1.11	0.46	1.19	1.07	1.98
149, 123	6.67	penta	3.86	5.25	2.48	3.48	2.92	0.83	2.86	2.88	5.75
107	6.71	hexa	0.88	1.23	0.54	0.90	0.71	0.37	0.83	0.70	1.24
118	6.74	hexa/penta	2.20	3.40	1.50	2.14	1.76	0.93	1.99	1.68	3.60
146	6.89	hexa	2.98	2.58	1.30	2.88	2.30	1.47	2.94	2.44	3.25
132,153,105	6.92	hexa	17.79	16.29	8.29	16.94	13.57	9.24	17.07	14.15	20.27
141	6.82	hexa	0.24	0.34	0.20	0.18	0.11	0.19	0.28	0.33	0.30
137,130,176	6.76	hexa	0.64	0.51	0.25	0.58	0.47	0.22	0.67	0.57	0.61
163,138	6.99	hexa	9.20	8.34	4.15	8.70	6.87	4.21	8.61	7.29	10.23

Table G-3: Experiment 3 - Total PCB Tissue Concentrations and Lipid % Day 90

Sample Name			F90-T16F	F90-T05E	F90-T05F	F90-21F	F90-T21E	F90-23D	F90-23E	F90-23F	F90-T10D
g to extraction			4.32	3.33	5.45	5.43	6.06	4.25	4.91	4.9	2.97
% Lipid			0.025	0.021	0.011	0.017	0.035	0.008	0.015	0.025	0.025
Tank			16	5	5	21	21	23	23	23	10
Treatment			4	5	5	5	5	5	5	5	6
MS222			0	1	1	1	1	1	1	1	1
PAH Food			1	0	0	0	0	0	0	0	0.1
PCB Congeners	Log Kow	Homologue									
158	7.02	hexa	0.83	0.59	0.31	0.76	0.61	0.38	0.74	0.63	0.79
128	6.74	hexa	0.83	0.85	0.37	0.75	0.58	0.29	0.71	0.60	0.96
129,178	7.14	hepta	1.05	0.85	0.43	0.92	0.77	0.43	0.88	0.79	1.08
187,182	7.17	hepta	4.39	3.95	2.19	4.13	3.31	2.35	4.07	3.43	4.81
183	7.2	hepta	1.85	1.35	0.70	1.64	1.28	0.83	1.61	1.31	1.71
174	7.11	hepta	1.06	0.91	0.42	0.81	0.64	0.17	0.68	0.75	1.04
177	7.08	hepta	1.36	1.32	0.62	1.30	1.01	0.62	1.18	1.04	1.47
157,200	7.27	hepta/octa	0.60	0.59	0.23	0.38	0.26	0.27	0.43	0.58	0.62
172	7.33	hepta	0.48	0.49	0.22	0.37	0.36	0.26	0.40	0.31	0.59
180	7.36	hepta	3.65	3.87	1.97	3.18	2.40	1.64	3.06	3.05	4.36
193	7.52	hepta	0.87	0.78	0.38	0.75	0.76	0.41	0.87	0.55	1.19
170,190	7.27	hepta	1.64	1.76	0.91	1.49	1.23	0.75	1.46	1.25	2.13
202,171,156	7.24	octa	1.42	1.49	0.69	1.42	1.14	0.64	1.35	1.17	1.72
201	7.62	octa	1.47	1.61	0.95	1.45	1.08	0.73	1.29	1.06	1.93
203,196	7.65	octa	1.87	1.98	1.02	1.63	1.32	0.79	1.46	1.36	2.57
208,195	7.56	nona/octa	1.02	1.21	0.66	0.98	0.75	0.37	0.87	0.73	1.53
194	7.8	octa	0.53	0.61	0.26	0.37	0.34	0.16	0.37	0.37	0.88
206	8.09	nona	0.55	0.53	0.21	0.36	0.35	nd	0.26	0.37	1.41
Surrogate Recoveries											
PCB 14			0.92	1.00	1.13	1.07	1.05	0.87	0.87	1.05	0.78
PCB 166			0.80	0.85	0.89	0.87	0.84	0.79	0.86	0.89	0.92
Total PCBs			104.84	125.28	54.92	107.01	90.03	42.11	98.72	88.65	144.78

Table G-3: Experiment 3 - Total PCB Tissue Concentrations and Lipid % Day 90

Sample Name			F90-T10F	F90-T18F	F90-22D	F90-22E	F90-22F	F90-T08D	F90-T08E	F90-T08F	F90-T12D
g to extraction			4.45	3.2	1.92	4.75	5.94	3.89	3.55	4.75	5.01
% Lipid			0.032	0.011	0.006	0.021	0.039	0.026	0.021	0.024	0.028
Tank			10	18	22	22	22	8	8	8	12
Treatment			6	6	6	6	6	7	7	7	7
MS222			1	1	1	1	1	1	1	1	1
PAH Food			0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5
PCB Congeners	Log Kow	Homologue									
4,10	4.65	di	7.98	1.40	nd	1.54	1.55	0.35	-	1.81	4.84
18	5.24	di	0.70	0.15	0.22	0.19	0.33	0.10	-	0.07	0.21
17	5.25	di	1.12	0.19	0.24	0.17	0.24	nd	-	0.08	0.17
16,32	5.16	tri	0.29	1.42	0.85	0.25	0.72	0.40	-	0.40	0.45
31,28	5.67	tri	3.75	2.40	2.48	1.57	3.23	2.54	-	2.43	1.63
33,21,53	5.6	tri	0.89	0.30	0.31	0.26	0.31	0.14	-	0.30	0.34
52	5.84	tetra	2.37	1.67	2.03	1.43	2.06	0.23	-	0.64	1.36
49	5.85	tetra	2.22	1.52	2.01	1.36	2.13	0.88	-	1.46	1.17
47,48	5.85	tetra	2.55	1.51	2.20	1.41	2.03	1.83	-	2.09	1.10
44	5.75	tetra	1.60	0.70	0.70	0.65	1.16	0.66	-	0.81	0.65
41,64,71	5.69	tetra	1.85	1.11	1.56	1.04	1.67	1.36	-	1.56	0.89
74	6.2	tetra	1.08	0.77	1.05	0.68	1.09	0.80	-	0.85	0.56
70,76	6.2	tetra	2.29	1.33	1.58	1.30	1.97	1.43	-	1.42	0.93
66,95	6.2	tetra	6.71	4.30	5.49	4.13	6.29	4.31	-	5.32	3.51
92,84,89	6.35	penta	5.32	3.07	4.48	3.17	4.34	3.47	-	4.21	2.66
110,77	6.48	tetra	5.10	3.45	5.12	3.48	5.27	4.21	-	4.74	2.69
101	6.39	penta	3.71	2.68	4.03	2.67	3.66	1.46	-	2.62	2.15
99	6.39	penta	4.00	2.83	3.88	2.79	4.04	2.95	-	3.32	2.18
119	6.58	penta	1.29	1.23	1.61	1.25	1.85	1.04	-	1.03	0.78
97	6.29	penta	5.64	2.61	4.06	3.95	4.70	3.61	-	4.81	2.32
81,87	6.29	tetra/penta	0.94	0.71	1.24	0.70	1.04	0.81	-	0.93	0.62
85	6.3	penta	11.48	7.91	12.43	8.93	13.16	8.76	-	10.89	6.73
82, 151	6.2	penta	0.17	1.17	1.73	1.29	1.91	1.48	-	1.78	1.06
149, 123	6.67	penta	5.39	3.62	5.05	3.79	5.38	4.37	-	4.84	2.66
107	6.71	hexa	1.16	0.43	1.25	0.87	1.27	0.93	-	1.13	0.66
118	6.74	hexa/penta	3.23	2.12	3.31	2.09	3.10	2.49	-	2.99	1.72
146	6.89	hexa	2.84	2.54	4.50	2.97	3.44	2.26	-	2.77	2.08
132,153,105	6.92	hexa	17.93	15.48	26.63	17.27	20.28	14.20	-	17.53	12.57
141	6.82	hexa	0.23	0.46	0.88	0.22	0.14	0.26	-	0.21	0.09
137,130,176	6.76	hexa	0.63	0.50	0.60	0.62	0.77	0.47	-	0.57	0.43
163,138	6.99	hexa	9.30	7.80	14.06	8.82	10.64	7.35	-	9.09	6.40

Table G-3: Experiment 3 - Total PCB Tissue Concentrations and Lipid % Day 90

Sample Name			F90-T10F	F90-T18F	F90-22D	F90-22E	F90-22F	F90-T08D	F90-T08E	F90-T08F	F90-T12D
g to extraction			4.45	3.2	1.92	4.75	5.94	3.89	3.55	4.75	5.01
% Lipid			0.032	0.011	0.006	0.021	0.039	0.026	0.021	0.024	0.028
Tank			10	18	22	22	22	8	8	8	12
Treatment			6	6	6	6	6	7	7	7	7
MS222			1	1	1	1	1	1	1	1	1
PAH Food			0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5
PCB Congeners	Log Kow	Homologue									
158	7.02	hexa	0.74	0.70	1.36	0.76	0.93	0.58	-	0.73	0.55
128	6.74	hexa	0.97	0.59	1.10	0.73	0.92	0.73	-	0.87	0.54
129,178	7.14	hepta	1.02	0.86	1.28	0.97	1.22	0.79	-	0.93	0.71
187,182	7.17	hepta	4.33	3.71	6.20	4.16	4.97	3.52	-	4.29	2.99
183	7.2	hepta	1.56	1.39	2.42	1.67	1.99	1.24	-	1.52	1.16
174	7.11	hepta	1.08	0.80	1.14	0.92	1.18	0.91	-	1.00	0.61
177	7.08	hepta	1.46	1.15	1.87	1.30	1.58	1.13	-	1.35	0.95
157,200	7.27	hepta/octa	0.76	0.39	0.82	nd	1.03	0.43	-	0.71	0.39
172	7.33	hepta	0.70	0.50	0.72	0.49	0.64	0.37	-	0.59	0.33
180	7.36	hepta	4.43	4.23	4.77	nd	4.44	3.37	-	4.53	2.36
193	7.52	hepta	0.91	nd	1.22	0.69	1.11	0.62	-	0.89	0.61
170,190	7.27	hepta	1.88	1.45	2.21	1.64	1.91	1.52	-	1.88	1.16
202,171,156	7.24	octa	1.73	1.28	2.03	1.45	1.82	1.22	-	1.52	1.10
201	7.62	octa	1.81	1.33	1.96	1.42	1.79	1.41	-	1.75	1.16
203,196	7.65	octa	2.50	1.72	2.30	1.89	2.27	1.75	-	2.45	1.46
208,195	7.56	nona/octa	1.48	0.95	1.37	0.98	1.32	1.01	-	1.39	0.85
194	7.8	octa	0.85	0.48	0.57	0.58	0.63	0.49	-	0.75	0.38
206	8.09	nona	1.36	0.52	0.54	0.81	1.02	0.57	-	1.35	0.44
Surrogate Recoveries											
PCB 14			0.64	0.91	0.81	1.15	0.79	0.97	-	0.80	0.98
PCB 166			0.76	0.73	0.82	0.94	0.78	0.94	-	0.86	0.82
Total PCBs			143.31	99.41	149.47	101.35	140.55	96.77	-	121.18	83.35

Table G-3: Experiment 3 - Total PCB Tissue Concentrations and Lipid % Day 90

Sample Name			F90-T12F	F90-T19D	F90-T19E	F90-T19F	F90-T09D	F90-T09E	F90-T09F	F90-14E	F90-T14D
g to extraction			5.07	3.69	4.45	3.51	5.7	2.01	5.51	4.60 F G	4.56
% Lipid			0.017	0.014	0.030	0.029	0.022	0.003	0.022	0.011	0.019
Tank			12	19	19	19	9	9	9	14	14
Treatment			7	7	7	7	8	8	8	8	8
MS222			1	1	1	1	1	1	1	1	1
PAH Food			0.5	0.5	0.5	0.5	1	1	1	1	1
PCB Congeners	Log Kow	Homologue									
4,10	4.65	di	4.92	0.30	2.36	3.74	0.50	4.13	4.81	-	5.68
18	5.24	di	nd	0.07	0.23	0.53	nd	1.01	0.18	-	nd
17	5.25	di	0.06	0.19	0.25	0.38	0.02	nd	0.09	-	nd
16,32	5.16	tri	0.38	0.59	0.64	1.01	0.31	nd	0.45	-	0.34
31,28	5.67	tri	1.16	2.13	2.93	2.63	1.63	nd	0.93	-	0.47
33,21,53	5.6	tri	0.06	0.26	0.46	0.83	0.04	nd	0.34	-	nd
52	5.84	tetra	0.29	1.62	1.91	1.79	0.18	0.77	0.90	-	0.21
49	5.85	tetra	0.69	1.48	1.72	1.59	0.71	0.79	0.85	-	0.84
47,48	5.85	tetra	0.70	1.47	1.65	1.55	1.31	0.84	1.03	-	1.03
44	5.75	tetra	0.34	0.72	1.02	0.98	0.41	0.30	0.44	-	0.46
41,64,71	5.69	tetra	0.80	1.16	1.60	1.26	0.88	0.66	0.72	-	0.83
74	6.2	tetra	0.52	0.71	0.81	0.73	0.58	0.64	0.41	-	0.55
70,76	6.2	tetra	0.68	1.30	1.33	1.35	0.78	0.36	0.56	-	0.80
66,95	6.2	tetra	2.58	4.10	4.68	4.81	3.00	3.13	2.67	-	3.13
92,84,89	6.35	penta	2.42	2.81	3.43	3.22	2.59	2.62	2.06	-	2.96
110,77	6.48	tetra	2.69	3.56	3.61	3.47	3.18	3.74	2.40	-	2.96
101	6.39	penta	1.47	2.77	2.86	2.74	1.24	2.79	1.78	-	1.70
99	6.39	penta	1.92	2.81	3.08	2.99	2.05	2.79	1.71	-	2.38
119	6.58	penta	0.76	1.28	1.34	1.20	0.71	0.91	0.52	-	0.88
97	6.29	penta	2.35	3.34	3.20	3.84	2.53	1.32	2.27	-	2.02
81,87	6.29	tetra/penta	0.56	0.74	0.75	0.74	0.63	0.70	0.46	-	0.70
85	6.3	penta	6.27	8.56	9.19	8.15	6.74	8.32	5.37	-	6.99
82, 151	6.2	penta	1.00	1.37	1.33	1.36	1.19	1.39	0.87	-	1.27
149, 123	6.67	penta	2.83	3.73	3.53	3.47	3.31	3.70	2.65	-	3.16
107	6.71	hexa	0.64	0.86	0.87	0.80	0.70	0.98	0.59	-	0.68
118	6.74	hexa/penta	1.61	2.16	2.14	2.04	1.94	2.70	1.60	-	2.16
146	6.89	hexa	2.10	2.87	2.69	2.84	1.68	2.29	1.54	-	2.49
132,153,105	6.92	hexa	12.64	16.84	15.89	16.76	10.60	17.05	10.14	-	14.95
141	6.82	hexa	0.45	0.36	0.56	0.49	0.33	0.41	0.10	-	0.55
137,130,176	6.76	hexa	0.45	0.60	0.57	0.64	0.36	0.40	0.30	-	0.45
163,138	6.99	hexa	6.32	8.60	8.32	8.65	5.53	8.09	5.10	-	6.06

Table G-3: Experiment 3 - Total PCB Tissue Concentrations and Lipid % Day 90

Sample Name			F90-T12F	F90-T19D	F90-T19E	F90-T19F	F90-T09D	F90-T09E	F90-T09F	F90-14E	F90-T14D
g to extraction			5.07	3.69	4.45	3.51	5.7	2.01	5.51	4.60 F G	4.56
% Lipid			0.017	0.014	0.030	0.029	0.022	0.003	0.022	0.011	0.019
Tank			12	19	19	19	9	9	9	14	14
Treatment			7	7	7	7	8	8	8	8	8
MS222			1	1	1	1	1	1	1	1	1
PAH Food			0.5	0.5	0.5	0.5	1	1	1	1	1
PCB Congeners	Log Kow	Homologue									
158	7.02	hexa	0.55	0.78	0.76	0.82	0.44	0.72	0.38	-	0.89
128	6.74	hexa	0.48	0.73	0.70	0.73	0.55	0.67	0.48	-	0.67
129,178	7.14	hepta	0.69	0.98	0.90	0.94	0.62	0.78	0.54	-	0.76
187,182	7.17	hepta	3.13	4.26	3.99	3.95	2.66	4.28	2.49	-	3.72
183	7.2	hepta	1.18	1.66	1.53	1.55	0.94	1.33	0.91	-	1.58
174	7.11	hepta	0.66	0.93	0.82	0.88	0.73	0.68	0.56	-	0.69
177	7.08	hepta	0.96	1.35	1.19	1.23	0.88	1.29	0.77	-	1.08
157,200	7.27	hepta/octa	0.31	0.51	0.45	0.59	0.40	0.55	0.31	-	0.59
172	7.33	hepta	0.37	0.51	0.43	0.47	0.35	0.53	0.25	-	0.99
180	7.36	hepta	2.58	3.62	3.07	3.43	2.78	3.62	2.55	-	3.15
193	7.52	hepta	0.50	0.82	0.84	0.86	0.61	1.17	0.56	-	0.69
170,190	7.27	hepta	1.15	1.65	1.47	1.50	1.19	1.70	1.14	-	1.30
202,171,156	7.24	octa	1.05	1.49	1.35	1.41	0.96	1.29	0.86	-	1.13
201	7.62	octa	1.15	1.51	1.30	1.32	1.19	1.62	1.05	-	1.24
203,196	7.65	octa	1.39	1.89	1.72	1.77	1.59	1.71	1.30	-	1.59
208,195	7.56	nona/octa	0.83	1.04	0.94	0.94	0.96	1.15	0.81	-	0.90
194	7.8	octa	0.35	0.52	0.48	0.51	0.48	0.41	0.40	-	0.42
206	8.09	nona	0.55	0.69	0.64	0.66	0.72	0.32	0.54	-	1.04
Surrogate Recoveries											
PCB 14			0.98	0.90	1.06	1.18	1.01	0.76	1.20	0.98	0.45
PCB 166			0.87	0.78	0.82	0.83	0.82	0.76	0.86	0.87	0.42
Total PCBs			77.56	104.30	107.55	110.15	73.71	96.66	69.75	-	89.12

Table G-3: Experiment 3 - Total PCB Tissue Concentrations and Lipid % Day 90

Sample Name			F90-T17D	F90-T17E	F90-T17F
g to extraction			5.29	2.6	5.72
% Lipid			0.017	0.041	0.039
Tank			17	17	17
Treatment			8	8	8
MS222			1	1	1
PAH Food			1	1	1
PCB Congeners	Log Kow	Homologue			
4,10	4.65	di	1.24	5.00	6.04
18	5.24	di	0.22	0.28	0.23
17	5.25	di	0.10	0.23	0.25
16,32	5.16	tri	0.17	1.19	0.66
31,28	5.67	tri	0.93	2.02	1.83
33,21,53	5.6	tri	0.19	0.42	0.51
52	5.84	tetra	1.05	1.44	1.43
49	5.85	tetra	0.84	1.37	1.23
47,48	5.85	tetra	0.73	1.92	1.20
44	5.75	tetra	0.35	1.12	0.76
41,64,71	5.69	tetra	0.75	1.87	1.02
74	6.2	tetra	0.37	1.13	0.53
70,76	6.2	tetra	0.63	1.84	0.95
66,95	6.2	tetra	2.67	6.04	3.78
92,84,89	6.35	penta	1.97	nd	2.89
110,77	6.48	tetra	2.18	5.63	2.95
101	6.39	penta	1.95	4.29	2.26
99	6.39	penta	1.76	4.08	2.11
119	6.58	penta	0.62	1.53	0.63
97	6.29	penta	1.91	6.38	3.44
81,87	6.29	tetra/penta	0.50	1.20	0.61
85	6.3	penta	5.03	11.47	6.35
82, 151	6.2	penta	0.87	2.18	1.13
149, 123	6.67	penta	2.19	4.17	3.08
107	6.71	hexa	0.50	8.46	0.62
118	6.74	hexa/penta	1.39	nd	1.67
146	6.89	hexa	2.02	91.49	2.11
132,153,105	6.92	hexa	12.23	124.94	12.64
141	6.82	hexa	0.47	16.98	0.26
137,130,176	6.76	hexa	0.37	20.03	0.46
163,138	6.99	hexa	5.99	25.54	6.63

Table G-3: Experiment 3 - Total PCB Tissue Concentrations and Lipid % Day 90

Sample Name			F90-T17D	F90-T17E	F90-T17F
g to extraction			5.29	2.6	5.72
% Lipid			0.017	0.041	0.039
Tank			17	17	17
Treatment			8	8	8
MS222			1	1	1
PAH Food			1	1	1
PCB Congeners	Log Kow	Homologue			
158	7.02	hexa	0.55	nd	0.61
128	6.74	hexa	0.42	33.10	0.51
129,178	7.14	hepta	0.60	28.69	0.72
187,182	7.17	hepta	2.84	127.22	2.97
183	7.2	hepta	1.09	52.35	1.16
174	7.11	hepta	0.54	32.31	0.76
177	7.08	hepta	0.87	37.17	0.95
157,200	7.27	hepta/octa	0.40	18.41	0.53
172	7.33	hepta	0.36	nd	0.35
180	7.36	hepta	2.22	31.38	2.36
193	7.52	hepta	0.48	nd	0.80
170,190	7.27	hepta	1.06	82.98	1.14
202,171,156	7.24	octa	0.93	37.25	1.04
201	7.62	octa	1.01	nd	1.05
203,196	7.65	octa	1.22	70.79	1.32
208,195	7.56	nona/octa	0.68	nd	0.75
194	7.8	octa	0.30	13.55	0.34
206	8.09	nona	0.45	21.57	0.54
Surrogate Recoveries					
PCB 14			1.58	0.75	0.72
PCB 166			1.32	13.83	0.48
Total PCBs			68.22 *		88.18

Table G-4: Experiment 3 – Total PCB Tissue Concentrations and % Lipid (Day 120)

Sample Name			F120-T04E	F120-T04F	F120-T04G	F120-T24D	F120-T24E	F120-T01D	F120-T01E	F120-T20D
g to extraction			3.02	2.52	2.77	2.87	5.1	3.25	3.16	3.73
% lipid			0.009	0.003	0.005	0.009	0.013	0.038	0.005	0.022
Tank			4	4	4	24	24	1	1	20
Treatment			1	1	1	1	1	2	2	2
MS222			0	0	0	0	0	0	0	0
PAH Food			0	0	0	0	0	0.1	0.1	0.1
PCB Congeners	log Kow	Homologue #	"nd" = non-detect							
4,10	4.65	2	0.35	nd	0.22	0.85	0.49	0.23	0.24	0.65
18	5.24	2	0.34	0.32	0.18	0.45	0.37	0.21	0.16	0.72
17	5.25	2	0.31	0.25	0.19	0.41	0.32	nd	0.31	0.58
16,32	5.16	3	0.59	0.47	0.31	0.71	0.64	0.25	0.30	0.89
31, 28	5.67	3	1.39	2.09	0.93	2.75	1.72	0.32	0.71	2.92
33,21,53	5.6	3	0.43	0.59	0.59	0.72	0.48	0.32	0.38	0.80
52	5.84	4	1.10	0.88	0.65	0.13	1.28	nd	0.38	2.32
49	5.85	4	1.11	0.83	0.66	0.70	1.14	0.05	0.37	2.17
47,48	5.85	4	0.76	1.00	0.88	2.15	0.66	0.42	0.21	2.43
44	5.75	4	0.55	0.26	0.18	0.51	0.63	nd	0.16	1.16
41,64,71	5.69	4	1.17	0.88	0.83	2.18	1.23	0.57	0.27	2.14
74	6.2	4	0.60	0.54	0.42	1.10	0.66	0.37	0.20	1.09
70,76	6.2	4	0.55	0.34	0.22	0.98	0.73	0.13	0.61	1.00
66,95	6.2	4	3.39	2.55	2.18	4.79	4.18	0.68	1.00	6.44
92,84, 89	6.35	4	3.15	2.78	2.68	nd	nd	1.29	1.58	3.94
110,77	6.48	4	3.11	2.10	1.92	4.57	2.63	1.29	0.93	5.17
101	6.39	5	2.01	1.60	1.52	1.31	2.07	0.22	1.15	3.76
99	6.39	5	2.23	1.66	1.64	3.70	1.99	1.09	1.10	3.62
119	6.58	5	0.68	0.49	0.46	1.47	0.62	0.07	0.10	1.41
97	6.29	5	2.22	0.99	0.72	3.98	2.26	0.56	0.53	4.53
81, 87	6.29	5	0.61	0.44	0.45	1.00	0.53	0.31	0.30	1.01
85	6.3	5	7.02	4.72	4.96	11.58	6.92	3.02	2.74	11.82
82,151	6.2	5	0.10	0.60	0.67	1.59	0.90	0.54	0.38	0.19
149,123	6.67	5	3.76	2.22	2.01	4.47	2.55	1.01	1.21	5.53
107	6.71	6	0.57	0.34	0.37	0.93	0.55	0.28	0.21	0.98
118	6.74	6	2.36	2.11	1.92	2.57	2.16	1.10	1.10	2.66
146	6.89	6	3.26	2.58	2.28	3.02	2.40	1.54	1.31	3.01
132,153,105	6.92	6	19.58	17.46	15.10	18.49	14.60	9.51	8.78	18.57
141	6.82	6	0.45	0.62	0.21	0.31	0.15	0.10	0.30	0.15
137,130,176	6.76	6	0.60	0.49	0.43	0.73	0.50	0.25	0.24	0.67
163,138	6.99	6	8.81	7.91	6.81	9.23	7.46	4.46	3.93	9.48

Table G-4: Experiment 3 – Total PCB Tissue Concentrations and % Lipid (Day 120)

Sample Name			F120-T04E	F120-T04F	F120-T04G	F120-T24D	F120-T24E	F120-T01D	F120-T01E	F120-T20D
g to extraction			3.02	2.52	2.77	2.87	5.1	3.25	3.16	3.73
% lipid			0.009	0.003	0.005	0.009	0.013	0.038	0.005	0.022
Tank			4	4	4	24	24	1	1	20
Treatment			1	1	1	1	1	2	2	2
MS222			0	0	0	0	0	0	0	0
PAH Food			0	0	0	0	0	0.1	0.1	0.1
158	7.02	6	0.74	1.27	0.78	0.93	0.59	0.53	0.51	0.81
128	6.74	6	0.69	0.76	0.64	1.14	0.73	0.43	0.39	1.19
129,178	7.14	7	1.01	0.74	0.68	0.98	0.84	0.50	0.42	1.11
187,182	7.17	7	5.36	4.26	3.84	4.55	3.57	2.98	2.42	4.74
183	7.2	7	2.15	1.39	1.26	1.66	1.34	0.88	0.82	1.73
174	7.11	7	1.25	0.79	0.57	0.89	0.69	0.37	0.35	1.16
177	7.08	7	1.49	1.13	1.05	1.43	1.10	0.77	0.63	1.49
157,200	7.27	7	0.64	0.65	0.38	0.52	0.45	0.26	0.26	0.54
172	7.33	7	0.53	0.72	0.39	0.49	0.35	0.23	0.23	0.56
180	7.36	7	5.94	3.34	2.99	3.64	2.82	1.78	1.73	4.32
193	7.52	7	1.08	0.95	0.86	1.06	1.07	0.33	0.52	1.11
170,190	7.27	7	2.26	1.36	1.32	1.80	1.36	0.87	0.81	1.94
202,171,156	7.24	8	1.71	1.14	1.08	1.55	1.31	0.77	0.68	1.67
201	7.62	8	2.57	1.34	1.43	1.76	1.48	1.10	0.92	1.85
203,196	7.65	8	3.14	1.34	1.46	2.00	1.70	0.88	0.92	2.46
208,195	7.56	8	1.72	0.87	0.94	1.28	1.11	0.65	0.63	1.37
194	7.8	8	0.80	0.30	0.33	0.48	0.43	0.13	0.34	0.73
206	8.09	9	0.88	0.21	0.25	0.71	0.45	0.24	0.14	0.91
Total PCBs			107.14	82.67	72.88	114.25	84.21	43.91	43.89	131.49
Surrogate Recoveries										
PCB 14			1.22	1.20	1.21	0.79	1.17	1.21	1.40	0.83
PCB 166			1.10	0.76	0.90	0.93	0.95	1.10	1.09	0.94

Table G-4: Experiment 3 – Total PCB Tissue Concentrations and % Lipid (Day 120)

Sample Name			F120-T20E	F120-T20FA	F120-T20FB	F120-T20G	F120-T03D	F120-T03F	F120-T03G	F120-T03H
g to extraction			1.96	6.32	6.32	2.62	2.44	4.8	2.84	3.54
% lipid			0.003	0.009	0.009	0.011	0.007	0.014	0.004	0.009
Tank			20	20	20	20	3	3	3	3
Treatment			2	2	2	2	3	3	3	3
MS222			0	0	0	0	0	0	0	0
PAH Food			0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5
PCB Congeners	log Kow	Homologue #								
4,10	4.65	2	0.46	0.42	0.39	4.29	1.29	0.44	0.29	0.26
18	5.24	2	nd	0.33	0.35	1.18	0.22	1.01	0.25	0.20
17	5.25	2	0.83	0.30	0.28	0.91	0.16	nd	0.18	0.15
16,32	5.16	3	0.70	0.48	0.51	1.30	0.62	0.62	0.47	0.34
31, 28	5.67	3	0.92	1.26	0.90	4.15	0.81	1.50	0.30	0.74
33,21,53	5.6	3	0.41	0.73	0.42	1.13	0.36	0.44	0.25	0.25
52	5.84	4	0.89	0.92	0.86	3.13	0.03	0.96	0.70	0.77
49	5.85	4	0.80	0.88	0.81	2.78	0.15	1.02	0.62	0.64
47,48	5.85	4	0.91	1.13	1.10	2.74	0.79	1.13	0.40	0.66
44	5.75	4	0.34	0.52	0.39	1.41	0.13	0.52	0.24	0.26
41,64,71	5.69	4	0.97	0.83	1.06	2.49	0.98	1.11	0.72	0.64
74	6.2	4	0.66	0.44	0.40	1.22	0.57	1.01	0.42	0.36
70,76	6.2	4	0.32	0.40	0.24	1.38	0.30	0.71	0.18	0.25
66,95	6.2	4	1.98	2.46	2.19	6.14	1.97	3.00	1.70	2.07
92,84, 89	6.35	4	1.88	1.99	1.91	4.58	3.12	3.57	2.04	2.28
110,77	6.48	4	2.42	2.50	2.44	6.82	2.50	3.05	1.82	1.78
101	6.39	5	2.14	2.21	1.97	4.73	0.44	2.11	1.48	1.46
99	6.39	5	2.20	2.05	1.70	4.34	1.88	2.08	1.37	1.37
119	6.58	5	0.84	0.82	0.75	2.34	0.51	0.57	0.39	0.35
97	6.29	5	2.29	2.22	2.02	5.87	1.56	2.74	1.13	0.92
81, 87	6.29	5	0.64	0.54	0.50	1.12	0.56	0.63	0.44	0.41
85	6.3	5	6.25	6.84	6.84	14.62	5.64	6.22	4.04	3.95
82,151	6.2	5	0.09	0.08	0.07	0.24	0.07	0.10	0.05	0.55
149,123	6.67	5	2.48	2.79	2.56	7.39	2.25	3.43	2.05	1.82
107	6.71	6	0.57	0.60	0.56	1.33	0.43	0.48	0.31	0.29
118	6.74	6	1.98	1.90	1.74	4.57	2.21	1.21	1.52	1.18
146	6.89	6	2.32	2.13	2.14	4.90	2.58	1.53	1.86	1.38
132,153,105	6.92	6	14.76	13.44	13.08	30.75	17.42	10.10	11.97	9.21
141	6.82	6	0.43	0.42	0.43	0.53	0.16	0.12	0.43	0.07
137,130,176	6.76	6	0.41	0.36	0.41	1.07	0.51	0.30	0.36	0.28
163,138	6.99	6	7.19	6.80	6.54	15.47	8.20	5.00	5.58	4.35

Table G-4: Experiment 3 – Total PCB Tissue Concentrations and % Lipid (Day 120)

Sample Name			F120-T20E	F120-T20FA	F120-T20FB	F120-T20G	F120-T03D	F120-T03F	F120-T03G	F120-T03H
g to extraction			1.96	6.32	6.32	2.62	2.44	4.8	2.84	3.54
% lipid			0.003	0.009	0.009	0.011	0.007	0.014	0.004	0.009
Tank			20	20	20	20	3	3	3	3
Treatment			2	2	2	2	3	3	3	3
MS222			0	0	0	0	0	0	0	0
PAH Food			0.1	0.1	0.1	0.1	0.5	0.5	0.5	0.5
158	7.02	6	0.85	0.69	0.51	1.37	0.80	0.46	0.70	0.44
128	6.74	6	0.55	0.81	0.60	1.54	0.91	0.58	0.63	0.47
129,178	7.14	7	0.71	0.75	0.73	1.77	0.81	0.57	0.58	0.45
187,182	7.17	7	3.90	3.40	3.28	7.77	4.44	2.71	3.13	2.44
183	7.2	7	1.39	1.26	1.25	3.08	1.62	0.99	1.10	0.88
174	7.11	7	0.73	0.61	0.64	1.79	0.83	1.17	0.62	0.44
177	7.08	7	1.12	1.07	1.03	2.72	1.28	0.83	0.85	0.66
157,200	7.27	7	0.61	0.38	0.40	0.91	0.73	0.25	0.38	0.25
172	7.33	7	0.45	0.40	0.30	0.83	0.51	0.22	0.43	0.26
180	7.36	7	2.88	3.03	2.75	6.32	4.27	2.16	2.83	2.19
193	7.52	7	0.88	0.76	0.74	1.68	1.01	0.50	0.74	0.61
170,190	7.27	7	1.44	1.38	1.30	2.65	1.57	1.00	1.11	0.80
202,171,156	7.24	8	1.10	1.16	1.10	2.60	1.28	0.86	0.92	0.72
201	7.62	8	1.42	1.38	1.28	2.93	1.63	1.05	1.18	0.89
203,196	7.65	8	1.33	1.54	1.42	3.49	1.90	1.33	1.50	1.04
208,195	7.56	8	1.00	0.94	0.89	2.13	1.04	0.76	0.74	0.66
194	7.8	8	0.28	0.39	0.34	1.71	0.45	0.30	0.39	0.26
206	8.09	9	0.17	0.30	0.29	1.08	0.41	0.33	0.51	0.49
Total PCBs			79.91	79.01	74.40	191.29	83.93	72.81	61.88	53.20
Surrogate Recoveries										
PCB 14			1.34	0.51	0.94	0.72	1.30	0.73	1.30	1.30
PCB 166			1.22	0.50	0.92	0.70	0.98	1.11	1.06	1.28

Table G-4: Experiment 3 – Total PCB Tissue Concentrations and % Lipid (Day 120)

Sample Name			F120-T03I	F120-T13D	F120-T13E	F120-T13G	F120-T06D	F120-T06E	F120-T06F	F120-T16E
g to extraction			3.85	2.56	3.11	2.71	3.31	3.42	3.5	2.16
% lipid			0.017	0.007	0.005	0.017	0.004	0.016	0.009	0.004
Tank			3	13	13	13	6	6	6	16
Treatment			3	3	3	3	4	4	4	4
MS222			0	0	0	0	0	0	0	0
PAH Food			0.5	0.5	0.5	0.5	1	1	1	1
PCB Congeners	log Kow	Homologue #								
4,10	4.65	2	0.65	0.22	0.18	0.34	0.27	0.45	0.29	0.58
18	5.24	2	0.42	0.17	0.11	0.33	0.20	0.55	0.26	0.31
17	5.25	2	0.34	0.16	0.08	0.30	0.18	0.41	0.26	0.36
16,32	5.16	3	0.87	0.43	0.38	0.64	0.37	0.77	0.59	0.98
31, 28	5.67	3	2.87	0.51	0.23	2.37	1.27	1.89	1.17	2.82
33,21,53	5.6	3	0.64	0.35	0.31	0.55	0.38	0.55	0.38	0.66
52	5.84	4	0.30	0.03	0.02	0.05	0.03	1.64	1.05	nd
49	5.85	4	1.23	0.27	0.07	0.30	0.08	1.51	0.90	0.24
47,48	5.85	4	1.97	0.29	0.31	1.35	0.54	1.87	1.07	2.01
44	5.75	4	0.63	0.12	0.02	0.15	0.09	0.94	0.39	0.45
41,64,71	5.69	4	1.98	0.81	0.46	1.73	1.04	1.54	0.98	3.79
74	6.2	4	1.03	0.47	0.33	0.92	0.54	0.89	0.54	1.45
70,76	6.2	4	0.96	0.18	0.06	0.93	0.29	0.76	0.30	1.09
66,95	6.2	4	4.89	1.93	0.64	4.55	2.35	4.20	2.80	5.81
92,84, 89	6.35	4	5.38	2.01	0.86	3.38	2.80	2.58	2.57	4.93
110,77	6.48	4	4.53	2.25	1.20	4.08	2.85	3.33	2.61	5.25
101	6.39	5	2.15	0.61	0.24	0.76	0.41	2.49	1.95	0.89
99	6.39	5	3.45	1.59	1.12	2.95	1.84	2.34	1.76	3.93
119	6.58	5	0.71	0.45	0.27	0.88	0.45	0.72	0.52	1.22
97	6.29	5	3.86	1.75	0.61	3.68	1.38	3.12	1.85	5.10
81, 87	6.29	5	0.83	0.60	0.37	0.87	0.57	0.70	0.58	1.16
85	6.3	5	9.52	5.11	3.41	8.74	5.53	6.50	5.19	10.69
82,151	6.2	5	0.13	0.78	0.04	0.14	0.09	0.10	0.08	1.82
149,123	6.67	5	4.79	2.37	0.94	3.71	2.72	3.41	2.75	5.52
107	6.71	6	0.75	0.42	0.31	0.70	0.44	0.56	0.42	0.89
118	6.74	6	3.08	1.48	1.06	2.58	1.75	2.41	1.64	3.33
146	6.89	6	3.57	2.09	1.53	3.15	2.09	2.63	2.15	3.83
132,153,105	6.92	6	23.01	13.24	10.11	20.09	14.25	16.42	13.31	25.94
141	6.82	6	0.34	0.14	0.23	0.34	0.51	0.53	0.23	0.61
137,130,176	6.76	6	0.80	0.40	0.28	0.64	0.44	0.55	0.46	0.90
163,138	6.99	6	11.38	6.17	4.57	9.87	6.77	8.41	6.46	12.49

Table G-4: Experiment 3 – Total PCB Tissue Concentrations and % Lipid (Day 120)

Sample Name			F120-T03I	F120-T13D	F120-T13E	F120-T13G	F120-T06D	F120-T06E	F120-T06F	F120-T16E
g to extraction			3.85	2.56	3.11	2.71	3.31	3.42	3.5	2.16
% lipid			0.017	0.007	0.005	0.017	0.004	0.016	0.009	0.004
Tank			3	13	13	13	6	6	6	16
Treatment			3	3	3	3	4	4	4	4
MS222			0	0	0	0	0	0	0	0
PAH Food			0.5	0.5	0.5	0.5	1	1	1	1
158	7.02	6	0.89	0.69	0.53	0.91	0.75	0.72	0.61	1.19
128	6.74	6	1.21	0.60	0.43	1.06	0.68	0.58	0.72	1.26
129,178	7.14	7	1.19	0.65	0.48	1.06	0.73	0.93	0.69	1.29
187,182	7.17	7	5.57	3.36	2.67	5.01	3.64	4.17	3.29	6.48
183	7.2	7	2.02	1.15	0.88	1.79	1.29	1.59	1.16	2.27
174	7.11	7	1.40	0.60	0.29	1.15	0.92	1.37	0.78	1.69
177	7.08	7	1.70	0.91	0.70	1.50	1.06	1.32	0.97	1.92
157,200	7.27	7	0.67	0.32	0.25	0.54	0.34	0.51	0.37	0.78
172	7.33	7	0.51	0.33	0.22	0.56	0.39	0.37	0.33	0.77
180	7.36	7	4.63	2.72	0.74	4.25	3.16	3.76	2.85	6.26
193	7.52	7	1.25	0.73	nd	1.04	0.82	0.84	0.64	1.39
170,190	7.27	7	2.02	1.07	0.80	1.77	1.30	1.58	1.11	2.31
202,171,156	7.24	8	1.76	0.99	0.69	1.61	1.07	1.31	1.03	1.87
201	7.62	8	1.97	1.13	0.83	1.74	1.30	1.50	1.14	2.21
203,196	7.65	8	2.30	1.21	0.75	2.14	1.50	1.82	1.37	2.61
208,195	7.56	8	1.35	0.71	0.45	1.21	0.84	1.05	0.75	1.30
194	7.8	8	0.57	0.24	0.11	0.58	0.37	0.44	0.32	0.67
206	8.09	9	0.64	0.20	0.06	0.64	0.57	0.41	0.33	0.81
Total PCBs			128.68	65.02	41.22	109.62	73.25	99.02	73.96	146.10
Surrogate Recoveries										
PCB 14			1.15	1.32	1.53	0.99	1.07	1.40	1.39	1.06
PCB 166			1.01	1.34	1.52	0.96	1.03	1.16	1.30	1.06

Table G-4: Experiment 3 – Total PCB Tissue Concentrations and % Lipid (Day 120)

Sample Name			F120-T16G	F120-T21D	F120-T21E	F120-T21F	F120-T23D	F120-T23E	F120-T23H	F120-TO5E
g to extraction			4.89	2.68	3.03	3.58	2.88	3.75	3.69	5.39
% lipid			0.026	0.005	0.006	0.015	0.007	0.007	0.013	0.013
Tank			16	21	21	21	23	23	23	5
Treatment			4	5	5	5	5	5	5	5
MS222			0	1	1	1	1	1	1	1
PAH Food			1	0	0	0	0	0	0	0
PCB Congeners	log Kow	Homologue #								
4,10	4.65	2	0.29	0.63	0.56	0.83	0.58	0.60	1.08	0.92
18	5.24	2	1.03	0.87	nd	0.34	nd	0.16	0.95	0.19
17	5.25	2	0.76	nd	0.93	0.33	0.93	0.20	0.85	0.12
16,32	5.16	3	1.47	0.80	0.92	0.96	0.81	0.82	1.18	0.23
31, 28	5.67	3	3.26	1.12	1.18	1.88	1.12	1.11	3.71	0.52
33,21,53	5.6	3	0.79	0.49	0.75	0.49	0.54	0.34	1.12	0.22
52	5.84	4	2.64	0.27	0.12	0.26	0.99	0.05	2.14	0.55
49	5.85	4	2.43	0.82	0.54	0.64	0.89	0.38	1.88	0.47
47,48	5.85	4	2.73	1.22	0.65	0.69	1.25	0.51	0.99	0.60
44	5.75	4	1.36	0.13	0.22	0.49	0.33	0.15	1.14	0.21
41,64,71	5.69	4	2.54	1.34	1.43	1.36	1.02	1.32	2.46	0.57
74	6.2	4	1.28	0.77	0.99	0.72	0.34	0.54	1.12	0.27
70,76	6.2	4	1.45	0.94	0.62	0.84	0.37	0.66	1.24	0.28
66,95	6.2	4	8.24	2.63	2.80	3.13	1.95	1.62	6.40	1.48
92,84, 89	6.35	4	5.57	nd	2.45	nd	1.80	nd	3.96	1.47
110,77	6.48	4	6.17	2.89	3.68	2.82	2.51	2.70	4.65	1.15
101	6.39	5	4.49	1.69	1.28	1.71	2.09	0.86	3.78	1.02
99	6.39	5	4.20	2.55	2.86	2.32	2.03	1.72	3.91	0.93
119	6.58	5	1.31	0.21	1.05	0.82	0.78	0.66	1.43	0.25
97	6.29	5	6.18	2.36	2.91	2.24	1.49	2.70	3.98	0.84
81, 87	6.29	5	1.13	0.80	0.79	0.60	0.61	0.72	0.93	0.25
85	6.3	5	12.86	7.53	9.13	7.56	6.21	6.37	10.68	2.78
82,151	6.2	5	0.22	1.00	0.07	1.06	0.77	0.08	0.12	0.37
149,123	6.67	5	6.65	3.04	3.81	2.86	2.73	2.82	5.09	1.26
107	6.71	6	1.04	0.34	0.81	0.60	0.52	0.54	0.90	0.21
118	6.74	6	3.05	1.83	2.15	2.39	1.58	1.55	2.32	1.27
146	6.89	6	3.06	2.57	2.59	3.14	2.07	1.88	3.06	1.53
132,153,105	6.92	6	19.70	14.45	16.20	19.95	12.65	11.86	18.73	10.12
141	6.82	6	0.22	0.39	0.14	0.42	0.33	0.27	0.57	0.14
137,130,176	6.76	6	0.76	0.41	0.49	0.62	0.38	0.37	0.69	0.30
163,138	6.99	6	9.96	6.77	8.00	9.37	5.96	5.78	9.12	4.69

Table G-4: Experiment 3 – Total PCB Tissue Concentrations and % Lipid (Day 120)

Sample Name			F120-T16G	F120-T21D	F120-T21E	F120-T21F	F120-T23D	F120-T23E	F120-T23H	F120-TO5E
g to extraction			4.89	2.68	3.03	3.58	2.88	3.75	3.69	5.39
% lipid			0.026	0.005	0.006	0.015	0.007	0.007	0.013	0.013
Tank			16	21	21	21	23	23	23	5
Treatment			4	5	5	5	5	5	5	5
MS222			0	1	1	1	1	1	1	1
PAH Food			1	0	0	0	0	0	0	0
158	7.02	6	0.69	1.03	0.74	0.87	0.74	0.64	0.93	0.42
128	6.74	6	0.88	0.57	0.68	1.08	0.77	0.71	0.82	0.48
129,178	7.14	7	1.07	0.71	0.80	1.00	0.65	0.65	1.04	0.48
187,182	7.17	7	4.82	3.55	4.10	4.80	3.25	2.93	4.74	2.55
183	7.2	7	1.73	1.21	1.46	1.77	1.10	1.07	1.64	0.91
174	7.11	7	1.31	0.64	0.85	0.82	0.56	0.58	1.01	0.44
177	7.08	7	1.53	1.07	1.22	1.48	0.97	0.87	1.40	0.74
157,200	7.27	7	0.64	0.50	0.38	0.64	0.47	0.40	0.64	0.38
172	7.33	7	0.52	0.45	0.39	0.50	0.52	0.24	0.43	0.23
180	7.36	7	4.22	2.63	3.54	4.22	3.50	2.03	3.80	2.29
193	7.52	7	1.22	0.96	0.89	0.90	nd	0.79	1.02	0.59
170,190	7.27	7	1.83	1.28	1.67	1.89	1.17	0.99	2.63	0.87
202,171,156	7.24	8	1.56	1.13	1.22	1.54	0.97	0.99	1.49	0.80
201	7.62	8	1.73	1.31	1.43	1.72	1.23	1.25	1.85	1.08
203,196	7.65	8	1.93	1.43	1.54	1.92	1.16	1.06	2.05	1.17
208,195	7.56	8	1.11	0.90	0.91	1.09	0.79	0.83	1.14	0.77
194	7.8	8	0.38	0.36	0.37	0.47	0.23	0.12	0.52	0.27
206	8.09	9	0.41	0.32	0.35	0.46	0.26	0.23	0.64	0.26
Total PCBs			144.41	80.90	92.65	98.59	73.99	65.72	127.99	49.94
Surrogate Recoveries										
PCB 14			0.84	0.70	0.80	0.89	0.77	1.01	0.77	1.26
PCB 166			0.98	0.78	0.91	0.74	0.88	1.15	0.93	0.82

Table G-4: Experiment 3 – Total PCB Tissue Concentrations and % Lipid (Day 120)

Sample Name			F120-T10D	F120-T10E	F120-T10F	F120-T10G	F120-T22E	F120-T08D	F120-T08E	F120-T12D
g to extraction			3.42	3.26	5.23	4.05	3.92	5.34	4.13	4.43
% lipid			0.006	0.002	0.012	0.006	0.028	0.030	0.018	0.015
Tank			10	10	10	10	22	8	8	12
Treatment			6	6	6	6	6	7	7	7
MS222			1	1	1	1	1	1	1	1
PAH Food			0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.5
PCB Congeners	log Kow	Homologue #								
4,10	4.65	2	0.20	0.27	0.36	0.38	-	0.33	0.34	0.16
18	5.24	2	0.16	0.14	0.38	0.26	-	0.28	0.33	0.14
17	5.25	2	0.15	0.14	0.34	0.12	-	0.25	0.29	0.13
16,32	5.16	3	0.30	0.35	0.71	0.99	-	0.59	0.67	0.36
31, 28	5.67	3	0.19	0.85	1.24	0.32	-	1.69	1.17	0.85
33,21,53	5.6	3	0.30	0.32	0.38	0.43	-	0.47	0.45	0.29
52	5.84	4	0.34	0.05	0.96	0.50	-	0.29	1.40	0.06
49	5.85	4	0.34	0.28	0.92	0.41	-	1.03	1.39	0.26
47,48	5.85	4	0.54	0.37	0.64	0.60	-	1.80	1.69	1.01
44	5.75	4	0.05	0.14	0.37	0.19	-	0.53	0.99	0.19
41,64,71	5.69	4	0.47	0.85	1.04	0.75	-	1.49	1.59	0.88
74	6.2	4	0.29	0.48	0.53	0.29	-	0.76	0.57	0.39
70,76	6.2	4	0.13	0.39	0.45	0.16	-	0.98	0.92	0.58
66,95	6.2	4	1.07	1.96	3.11	1.50	-	4.31	3.45	1.90
92,84, 89	6.35	4	1.26	1.84	2.80	1.59	-	3.39	2.63	1.62
110,77	6.48	4	1.38	1.95	2.45	1.49	-	3.38	2.74	1.82
101	6.39	5	1.16	0.84	2.22	1.44	-	1.70	2.12	0.45
99	6.39	5	1.01	1.68	2.05	1.36	-	2.36	2.04	1.32
119	6.58	5	0.08	0.53	0.13	0.11	-	0.61	0.66	0.44
97	6.29	5	0.96	1.14	1.72	0.99	-	3.48	2.76	1.44
81, 87	6.29	5	0.34	0.43	0.53	0.39	-	0.64	0.57	0.42
85	6.3	5	2.94	4.83	6.28	5.03	-	7.26	5.70	3.97
82,151	6.2	5	0.41	0.61	0.91	0.07	-	0.11	0.10	0.59
149,123	6.67	5	1.57	1.99	2.48	1.74	-	3.50	3.05	1.78
107	6.71	6	0.26	0.41	0.49	0.32	-	0.58	0.46	0.31
118	6.74	6	1.00	1.58	1.86	0.99	-	2.12	1.01	1.03
146	6.89	6	1.46	2.20	2.53	1.83	-	2.65	1.30	1.38
132,153,105	6.92	6	9.43	14.46	16.05	11.01	-	16.41	8.31	8.74
141	6.82	6	0.22	0.38	0.32	0.21	-	0.19	0.09	0.07
137,130,176	6.76	6	0.26	0.41	0.49	0.22	-	0.59	0.33	0.32
163,138	6.99	6	4.25	6.52	7.49	5.18	-	8.16	4.04	4.15

Table G-4: Experiment 3 – Total PCB Tissue Concentrations and % Lipid (Day 120)

Sample Name			F120-T10D	F120-T10E	F120-T10F	F120-T10G	F120-T22E	F120-T08D	F120-T08E	F120-T12D
g to extraction			3.42	3.26	5.23	4.05	3.92	5.34	4.13	4.43
% lipid			0.006	0.002	0.012	0.006	0.028	0.030	0.018	0.015
Tank			10	10	10	10	22	8	8	12
Treatment			6	6	6	6	6	7	7	7
MS222			1	1	1	1	1	1	1	1
PAH Food			0.1	0.1	0.1	0.1	0.1	0.5	0.5	0.5
158	7.02	6	0.53	0.73	0.74	0.85	-	0.61	0.34	0.37
128	6.74	6	0.39	0.73	0.78	0.48	-	0.71	0.45	0.44
129,178	7.14	7	0.42	0.65	0.76	0.59	-	0.91	0.46	0.43
187,182	7.17	7	2.42	3.68	3.75	3.09	-	4.03	2.13	2.24
183	7.2	7	0.78	1.28	1.34	1.02	-	1.50	0.76	0.79
174	7.11	7	0.41	0.53	0.58	0.43	-	1.00	0.53	0.47
177	7.08	7	0.64	0.98	1.04	0.81	-	1.21	0.64	0.63
157,200	7.27	7	0.19	0.22	0.38	0.34	-	0.44	0.17	0.26
172	7.33	7	0.17	0.34	0.38	0.45	-	0.41	0.18	0.23
180	7.36	7	1.52	2.50	2.75	1.71	-	3.98	1.79	1.95
193	7.52	7	0.35	0.62	0.80	0.57	-	0.80	0.42	0.49
170,190	7.27	7	0.67	1.13	1.26	0.80	-	1.50	0.76	0.76
202,171,156	7.24	8	0.64	0.98	1.18	0.85	-	1.35	0.71	0.71
201	7.62	8	0.80	1.09	1.26	1.02	-	1.41	0.77	0.75
203,196	7.65	8	0.68	1.10	1.45	0.95	-	1.82	0.97	0.97
208,195	7.56	8	0.49	0.66	0.87	0.62	-	0.95	0.54	0.51
194	7.8	8	0.08	0.24	0.38	0.14	-	0.54	0.27	0.27
206	8.09	9	0.07	0.21	0.32	0.09	-	0.65	0.28	0.40
Total PCBs			43.75	66.06	82.23	55.69	-	95.77	65.34	49.75
Surrogate Recoveries										
PCB 14			1.33	1.25	0.89	0.67	-	1.11	1.30	1.90
PCB 166			1.17	1.09	0.84	0.68	-	1.01	2.07	2.00

Table G-4: Experiment 3 – Total PCB Tissue Concentrations and % Lipid (Day 120)

Sample Name			F120-T12E	F120-T12F	F120-T12G	F120-T19D	F120-T19E	F120-T19F	F120-T19G	F120-09E
g to extraction			3.09	2.48	5.91	4.58	3.47	2.63	2.78	4.48
% lipid			0.005	0.018	0.036	0.012	0.019	0.006	#VALUE!	0.036
Tank			12	12	12	19	19	19	19	9
Treatment			7	7	7	7	7	7	7	8
MS222			1	1	1	1	1	1	1	1
PAH Food			0.5	0.5	0.5	0.5	0.5	0.5	0.5	1
PCB Congeners	log Kow	Homologue #								
4,10	4.65	2	0.33	0.41	0.50	0.46	1.30	0.48	0.74	0.40
18	5.24	2	0.50	0.36	0.53	0.54	nd	0.22	1.23	0.30
17	5.25	2	0.37	0.33	0.33	0.49	3.38	0.46	0.92	0.32
16,32	5.16	3	0.65	1.08	0.71	0.79	1.87	0.79	2.73	1.00
31, 28	5.67	3	1.52	2.20	1.63	1.32	4.04	1.53	3.85	1.97
33,21,53	5.6	3	0.43	0.82	0.59	0.61	1.08	0.32	0.99	0.71
52	5.84	4	1.23	0.38	1.29	1.34	1.07	1.18	3.66	0.34
49	5.85	4	1.16	1.29	1.21	1.18	2.60	1.09	2.48	1.11
47,48	5.85	4	1.55	2.09	1.42	0.85	3.22	0.98	1.82	1.69
44	5.75	4	0.49	0.73	0.89	0.46	2.12	0.41	1.57	0.66
41,64,71	5.69	4	1.41	1.74	1.30	1.44	3.42	0.97	2.48	1.47
74	6.2	4	0.70	0.81	0.54	0.91	5.18	0.54	1.41	0.69
70,76	6.2	4	0.51	1.06	0.88	0.91	2.86	0.61	2.27	0.85
66,95	6.2	4	4.00	4.36	3.42	3.80	8.84	2.31	8.81	3.84
92,84, 89	6.35	4	2.87	nd	2.24	2.32	5.05	nd	5.32	3.01
110,77	6.48	4	2.99	3.67	2.55	3.38	7.77	1.12	6.38	3.32
101	6.39	5	2.46	2.16	1.91	2.81	4.26	2.34	5.27	1.78
99	6.39	5	2.36	2.86	1.85	2.70	5.65	1.96	5.31	2.41
119	6.58	5	0.73	0.81	0.57	0.91	2.04	0.83	1.82	0.71
97	6.29	5	2.28	3.24	2.91	2.82	7.31	1.97	6.05	3.10
81, 87	6.29	5	0.66	0.80	0.49	0.76	1.54	0.58	1.37	0.64
85	6.3	5	7.22	7.90	5.47	8.74	16.79	6.84	14.54	6.64
82,151	6.2	5	0.93	0.09	0.11	0.10	0.27	0.10	0.21	0.12
149,123	6.67	5	3.01	3.70	2.70	3.45	7.91	3.13	6.68	3.39
107	6.71	6	0.57	0.61	0.43	0.74	1.49	0.90	1.26	0.55
118	6.74	6	2.01	2.34	1.70	2.12	2.72	2.10	3.18	2.31
146	6.89	6	2.92	3.21	2.30	2.31	2.96	2.29	3.29	2.76
132,153,105	6.92	6	18.91	20.89	13.39	14.46	18.04	16.44	20.78	17.53
141	6.82	6	0.64	0.25	0.24	0.49	0.48	0.53	0.64	0.32
137,130,176	6.76	6	0.57	0.71	0.48	0.45	0.59	0.53	0.81	0.68
163,138	6.99	6	8.89	9.93	6.71	7.22	9.89	7.63	10.55	8.74

Table G-4: Experiment 3 – Total PCB Tissue Concentrations and % Lipid (Day 120)

Sample Name			F120-T12E	F120-T12F	F120-T12G	F120-T19D	F120-T19E	F120-T19F	F120-T19G	F120-09E
g to extraction			3.09	2.48	5.91	4.58	3.47	2.63	2.78	4.48
% lipid			0.005	0.018	0.036	0.012	0.019	0.006	#VALUE!	0.036
Tank			12	12	12	19	19	19	19	9
Treatment			7	7	7	7	7	7	7	8
MS222			1	1	1	1	1	1	1	1
PAH Food			0.5	0.5	0.5	0.5	0.5	0.5	0.5	1
158	7.02	6	0.90	0.96	0.53	0.64	0.73	0.81	1.10	0.67
128	6.74	6	0.95	1.03	0.58	0.66	26.25	1.12	1.32	0.77
129,178	7.14	7	0.87	0.99	0.76	0.75	1.16	0.72	1.12	0.97
187,182	7.17	7	4.55	4.93	3.30	3.62	4.35	4.04	5.12	4.27
183	7.2	7	1.60	1.70	1.21	1.36	1.78	1.58	1.87	1.62
174	7.11	7	0.80	1.00	0.87	0.69	2.48	1.09	1.14	1.13
177	7.08	7	1.32	1.44	1.00	1.15	1.42	1.30	1.65	1.34
157,200	7.27	7	0.43	0.70	0.33	0.50	0.62	0.84	0.66	0.33
172	7.33	7	0.56	0.49	0.30	0.34	0.46	0.60	0.63	0.41
180	7.36	7	3.77	3.58	2.86	3.47	3.81	4.00	4.45	4.08
193	7.52	7	0.88	1.07	0.69	0.64	0.94	1.00	1.59	1.08
170,190	7.27	7	1.57	1.69	1.19	1.43	1.89	1.72	2.12	1.68
202,171,156	7.24	8	1.33	1.55	1.13	1.24	1.62	1.30	1.84	1.43
201	7.62	8	1.49	1.65	1.14	1.50	1.78	1.70	1.98	1.53
203,196	7.65	8	1.68	1.93	1.41	1.66	2.53	2.13	2.47	1.94
208,195	7.56	8	0.91	1.11	0.81	1.01	1.38	1.17	1.45	1.06
194	7.8	8	0.39	0.66	0.29	0.36	0.74	0.63	0.71	0.54
206	8.09	9	0.35	0.51	0.47	0.29	0.90	0.78	0.82	0.53
Total PCBs			99.22	107.84	80.15	92.17	190.56	87.72	160.48	98.74
Surrogate Recoveries										
PCB 14			1.17	1.04	1.66	0.80	0.68	0.90	-2.28	1.29
PCB 166			1.13	1.00	1.41	0.89	1.17	0.77	-3.01	1.10

Table G-4: Experiment 3 – Total PCB Tissue Concentrations and % Lipid (Day 120)

Sample Name			F120-T09G	F120-T14D	F120-T14E	F120-T14F	F120-T14G	F120-T17D	F120-T17E	F120-T17F
g to extraction			5.63	2.18	2.3	2.72	5.03	3.12	4.58	4.22
% lipid			0.026	0.006	0.005	0.006	0.013	0.024	0.022	0.025
Tank			9	14	14	14	14	17	17	17
Treatment			8	8	8	8	8	8	8	8
MS222			1	1	1	1	1	1	1	1
PAH Food			1	1	1	1	1	1	1	1
PCB Congeners	log Kow	Homologue #								
4,10	4.65	2	0.35	0.47	0.42	0.38	0.34	0.50	0.26	0.44
18	5.24	2	0.21	0.41	0.60	0.54	0.48	1.00	0.51	0.39
17	5.25	2	0.17	0.41	0.48	0.49	0.39	0.83	0.43	0.37
16,32	5.16	3	0.49	0.93	0.99	1.32	0.66	1.54	0.83	0.74
31, 28	5.67	3	1.47	1.46	2.12	1.87	1.53	4.12	2.18	2.34
33,21,53	5.6	3	0.47	0.62	0.76	1.21	0.52	1.17	0.48	1.01
52	5.84	4	0.12	1.51	1.98	1.38	1.41	3.71	1.77	2.12
49	5.85	4	0.70	1.28	1.97	1.23	1.33	3.26	1.56	1.83
47,48	5.85	4	1.40	0.60	2.67	0.72	0.77	3.90	0.84	1.89
44	5.75	4	0.44	0.77	0.90	0.42	0.40	2.25	0.98	1.18
41,64,71	5.69	4	1.22	1.92	1.90	1.57	1.40	3.35	1.68	1.86
74	6.2	4	0.61	0.68	1.01	0.74	0.81	1.49	0.76	0.91
70,76	6.2	4	0.77	1.00	1.25	0.60	0.73	2.00	1.05	1.41
66,95	6.2	4	2.92	3.54	5.26	4.42	4.47	9.96	4.33	5.96
92,84, 89	6.35	4	2.46	2.84	nd	3.67	nd	6.69	2.74	3.21
110,77	6.48	4	2.44	3.15	4.80	3.57	3.98	7.10	3.40	4.46
101	6.39	5	1.16	2.68	3.54	3.15	2.96	5.70	2.75	3.30
99	6.39	5	1.82	2.34	3.37	2.74	2.71	5.34	2.57	3.18
119	6.58	5	0.54	0.74	1.15	0.83	0.90	1.54	0.88	1.15
97	6.29	5	2.43	2.79	3.77	2.43	3.30	6.38	2.99	3.81
81, 87	6.29	5	0.50	0.80	0.95	0.87	0.71	1.43	0.73	0.86
85	6.3	5	5.56	6.90	9.99	8.30	8.88	15.21	8.03	9.13
82,151	6.2	5	0.08	0.12	0.13	1.34	0.07	0.19	0.11	0.16
149,123	6.67	5	2.40	3.59	5.21	3.74	4.26	7.30	3.36	4.66
107	6.71	6	0.44	0.54	0.80	0.65	0.72	1.22	0.68	0.79
118	6.74	6	1.98	1.88	3.11	1.92	2.59	3.33	2.06	2.36
146	6.89	6	2.69	2.47	3.96	2.68	2.85	3.53	2.14	2.42
132,153,105	6.92	6	16.59	16.06	25.66	17.60	18.38	22.85	13.54	14.91
141	6.82	6	0.46	0.62	0.95	0.41	0.61	0.26	0.14	0.52
137,130,176	6.76	6	0.57	0.53	0.84	0.55	0.62	0.80	0.50	0.60
163,138	6.99	6	8.11	7.49	12.46	8.08	9.23	11.36	7.04	7.79

Table G-4: Experiment 3 – Total PCB Tissue Concentrations and % Lipid (Day 120)

Sample Name			F120-T09G	F120-T14D	F120-T14E	F120-T14F	F120-T14G	F120-T17D	F120-T17E	F120-T17F
g to extraction			5.63	2.18	2.3	2.72	5.03	3.12	4.58	4.22
% lipid			0.026	0.006	0.005	0.006	0.013	0.024	0.022	0.025
Tank			9	14	14	14	14	17	17	17
Treatment			8	8	8	8	8	8	8	8
MS222			1	1	1	1	1	1	1	1
PAH Food			1	1	1	1	1	1	1	1
158	7.02	6	0.61	0.97	1.05	0.86	0.61	0.82	0.62	0.63
128	6.74	6	0.98	0.77	1.44	0.88	0.76	1.25	0.88	0.76
129,178	7.14	7	0.91	0.80	1.27	0.85	0.86	1.17	0.73	0.87
187,182	7.17	7	4.06	3.98	6.47	4.47	4.61	5.64	3.36	3.74
183	7.2	7	1.59	1.38	2.36	1.61	1.61	2.08	1.28	1.44
174	7.11	7	0.90	0.91	1.53	0.78	1.07	1.28	0.70	1.04
177	7.08	7	1.24	1.15	1.90	1.23	1.45	1.74	1.11	1.24
157,200	7.27	7	0.51	0.46	0.65	0.41	0.39	0.70	0.40	0.52
172	7.33	7	0.37	0.52	0.65	0.50	0.36	0.58	0.36	0.46
180	7.36	7	3.32	3.42	5.15	4.91	3.28	5.39	3.05	3.68
193	7.52	7	0.90	0.85	1.39	nd	1.38	0.89	0.60	0.82
170,190	7.27	7	1.41	1.37	2.22	1.48	1.71	2.13	1.39	1.59
202,171,156	7.24	8	1.34	1.23	1.88	1.28	1.42	1.84	1.18	1.39
201	7.62	8	1.40	1.32	2.01	1.40	1.61	2.00	1.35	1.55
203,196	7.65	8	1.70	1.68	2.37	1.76	1.64	2.51	1.63	2.06
208,195	7.56	8	0.94	0.86	1.25	0.86	0.96	1.39	0.95	1.20
194	7.8	8	0.42	0.47	0.61	0.45	0.37	0.68	0.44	0.62
206	8.09	9	0.52	0.44	0.71	0.34	0.26	0.81	0.42	0.90
Total PCBs			84.66	93.73	137.87	103.49	102.37	172.22	91.75	110.25
Surrogate Recoveries										
PCB 14			1.52	0.95	1.19	0.80	1.02	0.78	1.04	1.04
PCB 166			1.15	1.02	1.08	1.01	0.95	1.02	1.10	1.15

Table H-1 Experiment 3 - PAH Concentrations in Food Treatments

Sample Name	Control 1	Control 2	90:10 1	90:10 2	50:50 1	50:50 2	Contaminated 1	Contaminated 2	Contaminated 3	Contaminated 4
Mass extracted	5.05	4.88	4.73	4.9	5.29	5.06	5.04	2.62	5.04	5.05
% lipid	0.033	0.035	0.035	0.036	0.036	0.039	0.040	0.021	0.041	0.033
	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1
PAH totals (ng/g)	620.8	590.4	1183.0	831.7	3698.7	2391.8	5363.5	5646.2	3090.1	3518.0
Napthalene	8.9	6.1	5.8	7.0	11.0	7.6	6.8	2.5	2.9	5.2
Azulene	0.0	0.1	nd	nd	nd	nd	nd	nd	nd	0.2
2MeNapthalene	42.3	34.0	35.4	32.3	48.3	40.4	29.2	16.7	20.3	29.9
1MeNapthalene	22.7	16.7	19.6	17.6	26.6	18.5	14.4	11.2	11.2	14.8
Acenapthylene	2.2	2.0	2.2	1.9	3.7	2.8	3.9	3.7	2.7	3.0
Biphenyl	3.4	2.7	3.1	3.3	5.0	4.1	4.0	3.0	2.7	3.1
Acenapthene	30.4	24.9	33.6	27.0	48.3	35.2	44.5	41.0	31.9	35.0
Fluorene	13.6	12.6	15.5	13.4	29.7	21.3	33.3	35.6	22.9	23.5
Phenanthrene	99.9	99.3	125.2	97.7	228.1	166.0	284.2	296.5	183.2	184.3
Anthracene	9.5	11.0	12.5	11.1	30.4	22.7	41.6	47.3	25.2	25.3
1Mefluorene	19.3	19.5	21.6	17.5	25.2	21.7	21.1	23.8	19.2	17.3
4,5-Methylenephenantl	5.9	6.4	14.7	10.7	64.6	35.0	99.8	106.1	49.8	52.7
2Methylphenanthrene	97.1	93.0	104.6	86.9	120.7	102.7	120.3	124.1	98.5	90.6
2Methylanthracene	17.5	16.9	20.3	15.8	26.5	21.5	29.9	32.2	22.3	21.2
1Methylanthracene	50.5	50.0	58.8	46.0	77.3	61.3	82.9	82.6	61.4	57.4
1Methylphenanthrene	32.0	32.4	35.2	30.8	43.9	37.1	43.1	47.7	36.5	34.2
9Methylanthracene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Fluoranthene	8.7	10.1	101.4	59.7	545.6	325.8	776.1	855.8	432.3	539.7
Pyrene	32.6	35.1	98.6	65.3	380.6	246.9	488.7	584.4	306.0	374.0
3,6Dimethylphenanthre	3.5	nd	nd	nd	nd	nd	nd	nd	nd	nd
9,10,dimethylanthracer	21.3	22.9	27.2	19.7	28.5	33.8	26.4	27.5	22.6	24.7
Benzo[a]fluorene	13.6	13.8	47.2	29.8	207.9	126.3	304.0	327.0	165.9	196.8
Benzo[b]fluorene	4.5	5.3	24.8	16.1	141.1	84.6	221.2	230.6	114.8	133.7
Benz[a]anthracene	15.0	13.3	32.6	23.6	141.0	87.2	244.3	231.8	122.4	132.0
Chrysene + Triphenyle	25.4	22.6	56.6	42.2	188.9	119.1	271.3	293.6	160.2	180.9
Napthacene	4.2	3.3	34.5	23.5	171.3	102.0	270.4	269.8	132.5	159.4
Benzo[b]fluoranthene	3.6	4.6	67.6	27.0	281.6	152.4	573.6	430.6	318.4	252.9
Benzo[k]fluoranthene	4.0	3.9	59.9	34.4	281.7	225.1	406.5	477.4	252.3	346.2
Benzo[e]pyrene	9.0	9.4	44.2	26.5	182.0	125.3	285.4	311.8	150.1	179.8

Table H-1 Experiment 3 - PAH Concentrations in Food Treatments

Sample Name	Control 1	Control 2	90:10 1	90:10 2	50:50 1	50:50 2	Contaminated 1	Contaminated 2	Contaminated 3	Contaminated 4
Mass extracted	5.05	4.88	4.73	4.9	5.29	5.06	5.04	2.62	5.04	5.05
% lipid	0.033	0.035	0.035	0.036	0.036	0.039	0.040	0.021	0.041	0.033
	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1
Benzo[a]pyrene	13.4	13.6	58.3	34.7	175.5	141.9	304.5	300.5	160.6	171.4
Perylene	3.0	4.9	12.5	8.0	40.2	23.7	54.2	61.5	29.8	41.2
Dimethylbenz[a]anthra	1.6	nd	nd	nd	nd	nd	5.7	nd	nd	nd
3Methylcholanthrene	nd	nd	nd	nd	nd	nd	4.0	2.9	nd	nd
Indeno[1,2,3-c,d]pyren	nd	nd	nd	nd	90.1	nd	176.1	137.9	88.5	121.8
Benzo[g,h,i]perylene	1.9	nd	9.3	2.2	49.2	nd	73.8	77.9	36.7	59.8
Anthanthrene	nd	nd	nd	nd	nd	nd	5.4	144.5	nd	nd
Dibenz[a,h+ac]anthrac	nd	nd	nd	nd	4.1	nd	12.9	6.7	6.2	6.1
Coronene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

d8 Napthalene
d10 Fluorene
d10 Fluoranthene
d12 Perylene

Table H-1 Experiment 3 - PAH Concentrations in Food Treatments

Sample Name	Control 1	Control 2	90:10 1	50:50 1	Contaminated 1	Contaminated 2	Contaminated 3	Contaminated 4
Mass extracted	3.76	4.59	4.04	4.32	4.64	4.84	4.71	4.99
% lipid	0.020	0.026	0.028	0.030	0.029	0.033	0.025	0.024
	BATCH 2	BATCH 2	BATCH 2	BATCH 2	BATCH 2	BATCH 2	BATCH 2	BATCH 2
PAH totals (ng/g)	580.7	587.1	661.8	1034.6	1320.5	1328.8	1056.2	1205.7
Napthalene	6.3	5.2	6.5	8.3	9.5	9.3	6.6	8.5
Azulene	nd	nd	nd	nd	nd	nd	nd	nd
2MeNapthalene	29.3	27.5	24.2	33.0	35.0	38.8	20.8	26.2
1MeNapthalene	16.2	16.0	13.7	18.0	19.5	20.7	11.5	14.4
Acenapthylene	2.0	2.1	1.8	2.7	2.9	2.8	1.9	2.3
Biphenyl	3.1	2.8	2.8	2.9	4.0	3.2	2.5	3.2
Acenapthene	25.5	25.0	21.0	30.6	33.5	34.4	19.6	23.7
Fluorene	10.5	10.4	9.1	13.0	15.3	14.3	9.5	11.6
Phenanthrene	72.2	70.6	67.0	86.4	95.4	91.7	65.4	77.1
Anthracene	7.0	6.8	7.1	9.9	12.3	12.1	8.3	9.9
1Mefluorene	13.3	13.3	13.1	16.4	16.5	16.4	11.6	13.8
4,5-Methylenephenantl	5.5	5.7	7.1	12.8	21.1	21.0	15.8	18.5
2Methylphenanthrene	68.7	66.6	64.4	77.8	80.8	79.1	56.5	65.2
2Methylanthracene	10.3	10.5	10.7	13.7	15.4	15.3	10.1	12.3
1Methylanthracene	34.3	35.2	32.2	43.2	45.9	42.0	31.6	35.5
1Methylphenanthrene	26.3	25.7	25.1	30.4	31.6	32.4	22.8	27.0
9Methylanthracene	123.5	138.5	98.4	159.3	nd	nd	nd	nd
Fluoranthene	7.8	7.3	34.7	79.5	167.2	177.4	148.1	167.3
Pyrene	25.2	23.9	43.9	74.9	132.6	138.8	111.1	131.4
3,6Dimethylphenanthre	nd	nd	nd	nd	nd	nd	nd	nd
9,10,dimethylanthracer	16.0	16.8	16.3	19.2	20.7	18.2	16.3	17.7
Benzo[a]fluorene	7.5	8.0	15.2	28.0	54.3	54.6	45.5	52.1
Benzo[b]fluorene	4.8	5.1	11.7	25.4	48.0	50.9	41.6	47.6
Benz[a]anthracene	12.6	12.2	20.1	35.2	61.7	60.1	48.9	55.6
Chrysene + Triphenyle	21.3	21.1	34.1	52.7	84.5	84.5	69.0	80.9
Napthacene	1.5	1.8	8.4	18.3	38.0	38.9	31.9	36.1
Benzo[b]fluoranthene	5.3	4.8	18.1	36.1	72.3	72.1	65.4	72.0
Benzo[k]fluoranthene	2.4	2.1	11.9	29.3	63.6	62.2	56.5	60.6
Benzo[e]pyrene	7.8	7.2	16.2	29.7	52.2	52.4	46.6	51.8

Table H-1 Experiment 3 - PAH Concentrations in Food Treatments

Sample Name	Control 1	Control 2	90:10 1	50:50 1	Contaminated 1	Contaminated 2	Contaminated 3	Contaminated 4
Mass extracted	3.76	4.59	4.04	4.32	4.64	4.84	4.71	4.99
% lipid	0.020	0.026	0.028	0.030	0.029	0.033	0.025	0.024
	BATCH 2	BATCH 2	BATCH 2	BATCH 2	BATCH 2	BATCH 2	BATCH 2	BATCH 2
Benzo[a]pyrene	8.0	7.8	16.1	31.0	55.6	55.5	46.1	54.1
Perylene	1.1	1.3	2.2	4.4	8.0	8.7	6.3	8.5
Dimethylbenz[a]anthra	1.5	1.0	1.3	1.9	4.0	1.3	3.3	1.1
3Methylcholanthrene	1.2	1.2	1.5	1.4	1.8	1.4	1.1	1.8
Indeno[1,2,3-c,d]pyren	0.7	0.8	2.1	3.8	8.1	8.6	6.5	8.6
Benzo[g,h,i]perylene	1.4	1.8	2.6	4.2	7.5	8.0	6.9	7.9
Anthanthrene	0.1	0.3	0.3	0.5	0.6	0.6	9.7	0.6
Dibenz[a,h+ac]anthrac	0.4	0.5	0.7	0.7	0.9	1.1	0.9	1.0
Coronene	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1
d8 Napthalene	84%	72%	60%	59%	71%	88%	60%	80%
d10 Fluorene	114%	119%	87%	86%	102%	117%	85%	105%
d10 Fluoranthene	118%	118%	104%	89%	100%	119%	96%	110%
d12 Perylene	119%	133%	109%	95%	114%	112%	104%	104%

Table H-2: Experiment 3 - PCB Concentrations in Food Treatments

Sample Name	Control 1	Control 2	90:10 1	90:10 2	50:50 1	50:50 2	Contaminated 1	Contaminated 2	Contaminated 3	Contaminated 4
g to extraction	5.05	4.88	4.73	4.9	5.29	5.06	5.04	2.62	5.04	5.05
% lipid	0.0328	0.0346	0.0349	0.0355	0.0359	0.0394	0.0398	0.0206	0.0408	0.0331
	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1	BATCH 1
Surrogate Recoveries										
PCB 14	84%	78%	75%	80%	89%	115%	73%	82%	72%	60%
PCB 166	80%	86%	73%	81%	92%	100%	76%	73%	75%	73%
PCBs	47.90	50.92	48.01	42.14	50.49	42.91	53.81	90.03	28.62	59.32
4,10	0.22	0.13	0.04	0.04	0.22	0.15	0.08	0.19	0.10	0.09
18	0.19	0.08	0.06	0.10	0.10	0.15	0.14	0.26	0.10	0.11
17	0.10	0.08	0.02	0.04	0.13	0.12	0.03	nd	nd	0.03
16,32	0.16	0.30	0.17	0.14	0.18	0.30	0.27	0.43	0.04	0.10
31, 28	1.12	1.10	0.81	0.72	0.92	1.49	0.96	2.11	0.32	0.92
33,21,53	0.32	0.35	0.11	0.09	0.48	0.39	0.10	0.18	0.04	0.08
52	0.82	0.89	0.94	0.80	1.02	0.81	1.08	1.81	0.59	1.21
49	0.72	0.78	0.77	0.68	0.94	0.65	0.82	1.47	0.40	0.84
47,48	0.70	0.75	0.61	0.67	0.80	0.67	0.90	1.46	0.37	0.89
44	0.56	0.67	0.69	0.53	0.71	0.51	0.67	1.11	0.30	0.74
41,64,71	0.49	0.44	0.63	0.52	0.97	0.59	0.69	1.21	0.36	0.79
74	0.61	0.17	0.15	0.13	0.62	0.13	0.15	0.22	0.03	0.13
70,76	0.81	0.73	1.07	0.95	0.74	0.69	1.17	2.01	0.58	1.36
66,95	1.92	1.53	2.29	2.27	1.90	1.60	2.93	4.74	1.55	2.98
92,84, 89	1.06	1.14	nd	nd	nd	nd	nd	nd	nd	nd
77,110	2.12	2.42	2.23	1.80	2.66	2.02	2.62	3.99	1.35	2.76
101	1.27	1.36	1.43	1.28	1.91	1.27	1.66	2.89	0.91	1.91
99	1.23	1.39	1.25	1.13	1.39	1.52	1.38	2.44	0.72	1.63
119	0.29	0.36	0.25	0.23	0.08	0.59	0.46	0.70	0.14	0.32
97	1.92	1.84	2.43	2.45	1.87	1.77	2.89	5.06	1.58	3.62
81, 87	0.57	0.27	0.24	0.21	0.64	0.44	0.41	0.59	0.13	0.37
85	3.66	4.20	4.12	3.52	3.04	2.52	4.27	7.13	2.27	4.97
82,151	0.14	0.16	0.06	0.06	0.18	0.15	0.05	0.08	0.06	0.24
149,123	2.00	2.26	2.38	1.98	2.58	2.06	2.47	4.35	1.45	2.97
107	0.48	0.51	0.44	0.48	0.60	0.51	0.58	0.90	0.31	0.48
118	1.27	1.41	1.39	1.26	1.58	1.29	1.43	2.20	0.66	1.55
146	1.03	1.10	1.05	0.92	1.07	0.90	1.09	1.56	0.55	1.20
132,153,105	5.61	6.23	6.52	5.88	5.62	4.67	6.70	12.77	4.17	8.03
141	0.32	0.32	0.16	0.15	0.35	0.28	0.29	0.33	0.11	0.29
137,130,176	0.37	0.30	0.14	0.14	0.31	0.34	0.21	0.38	0.10	0.24
138,163	3.24	3.62	3.52	3.00	3.08	2.49	4.16	6.44	2.23	4.46
158	0.49	0.54	0.23	0.08	0.54	0.44	0.20	0.14	0.11	0.22
128	0.49	0.55	0.20	0.18	0.54	0.46	0.36	0.59	0.16	0.27
129,178	0.55	0.59	0.30	0.31	0.60	0.51	0.30	0.60	0.27	0.36
187,182	1.63	1.80	1.48	1.31	1.78	1.51	1.67	2.78	0.92	1.90
183	0.70	0.76	0.60	0.51	0.75	0.64	0.70	0.97	0.34	0.59
174	0.42	0.48	0.39	0.33	0.53	0.43	0.55	0.84	0.30	0.59
177	0.54	0.59	0.64	0.44	0.60	0.50	0.58	1.01	0.31	0.64
157,200	0.26	0.19	0.16	0.13	0.28	nd	0.21	0.39	0.08	0.16
172	0.25	0.31	0.16	0.09	0.34	0.22	0.19	0.15	0.10	0.17
180	1.29	1.66	1.61	1.55	1.71	1.51	2.11	3.26	1.19	2.36
193	0.42	0.54	0.52	0.42	0.35	0.35	0.41	0.84	0.21	0.43
170,190	0.77	0.82	0.69	0.58	0.74	0.74	0.97	1.32	0.46	0.89
202,171,156	0.68	0.78	0.82	0.59	0.75	0.64	0.77	1.47	0.38	0.89
201	0.77	0.84	0.76	0.62	0.79	0.73	0.78	1.19	0.42	0.87
203,196	1.33	1.41	1.06	0.90	1.38	1.25	1.16	1.88	0.64	1.26
208,195	0.68	0.76	0.81	0.63	0.70	0.63	0.74	1.25	0.39	0.83
194	0.35	0.39	0.43	0.28	0.38	0.34	0.39	0.55	0.20	0.39
206	0.97	1.02	1.16	1.01	1.01	0.94	1.06	1.79	0.61	1.19

Table H-2: Experiment 3 - PCB Concentrations in Food Treatments

Sample Name	Control 1	Control 2	90:10 1	50:50 1	Contaminated 1	Contaminated 2	Contaminated 3	Contaminated 4
g to extraction	3.76	4.59	4.04	4.32	4.64	4.84	4.71	4.99
% lipid	0.0204	0.0259	0.0284	0.0299	0.0294	0.0329	0.0254	0.0241
	BATCH 2	BATCH 2	BATCH 2	BATCH 2	BATCH 2	BATCH 2	BATCH 2	BATCH 2
Surrogate Recoveries								
PCB 14	65%	71%	64%	72%	99%	77%	78%	87%
PCB 166	70%	80%	78%	88%	90%	81%	79%	83%
PCBs	33.28	30.12	35.81	35.02	30.90	29.86	24.40	30.64
4,10	0.20	0.03	0.15	0.18	0.22	0.19	0.01	0.02
18	0.15	0.11	0.16	0.15	0.10	0.07	0.08	0.07
17	nd	nd	nd	nd	nd	nd	nd	nd
16,32	nd	0.05	0.38	0.74	nd	0.01	0.03	0.02
31, 28	0.22	0.45	0.33	0.92	0.18	0.16	0.18	0.17
33,21,53	nd	nd	2.21	0.05	2.30	0.94	nd	1.04
52	0.54	0.55	0.14	0.56	0.72	0.47	0.42	0.64
49	0.49	0.48	0.49	0.57	0.58	0.54	0.46	0.44
47,48	0.60	0.56	0.53	0.66	0.51	0.59	0.46	0.50
44	0.06	0.09	0.13	0.04	0.01	0.04	0.03	0.07
41,64,71	0.13	0.14	nd	0.02	nd	nd	0.01	0.09
74	1.65	1.18	1.30	1.65	0.23	0.47	0.15	0.94
70,76	0.93	1.00	0.65	1.16	0.20	0.32	0.29	0.63
66,95	0.79	0.75	0.64	0.84	0.94	0.82	0.81	0.62
92,84, 89	nd	nd	nd	nd	nd	nd	nd	nd
77,110	0.66	0.55	0.65	0.64	0.63	0.59	0.42	0.55
101	0.74	0.79	1.37	0.76	0.62	0.84	0.66	0.63
99	0.80	0.79	1.30	0.92	0.97	0.94	0.75	0.75
119	0.32	0.29	0.54	0.45	0.17	0.18	0.16	0.23
97	2.59	1.93	2.64	2.21	1.38	1.58	1.31	2.05
81, 87	0.51	0.41	0.47	0.44	0.21	0.24	0.20	0.35
85	nd	nd	nd	nd	nd	nd	nd	nd
82,151	0.13	0.11	0.13	0.15	0.05	0.14	0.05	0.13
149,123	nd	nd	nd	nd	nd	nd	nd	nd
107	0.23	0.21	0.23	0.26	0.28	0.27	0.24	0.20
118	0.43	0.37	0.40	0.42	0.45	0.46	0.27	0.37
146	0.95	0.85	0.90	0.91	0.85	0.86	0.73	0.85
132,153,105	4.64	4.32	4.96	5.05	5.99	6.19	5.26	5.29
141	0.36	0.33	0.35	0.35	0.17	0.33	0.25	0.36
137,130,176	0.23	0.23	0.22	0.24	0.07	0.17	0.14	0.22
138,163	3.14	2.77	2.97	3.13	3.03	3.01	2.74	2.85
158	0.66	0.55	0.63	0.61	0.43	0.31	0.32	0.54
128	0.69	0.65	0.75	0.58	0.32	0.30	0.29	0.66
129,178	0.49	0.47	0.50	0.51	0.23	0.41	0.34	0.47
187,182	1.66	1.52	1.63	1.68	1.47	1.50	1.33	1.52
183	0.69	0.65	0.70	0.71	0.50	0.46	0.38	0.64
174	0.40	0.37	0.40	0.43	0.38	0.37	0.29	0.40
177	0.52	0.46	0.50	0.54	0.46	0.42	0.37	0.47
157,200	0.19	0.33	0.26	0.17	0.16	0.12	0.15	0.26
172	0.30	0.24	0.24	0.29	0.17	0.10	0.15	0.22
180	1.31	1.16	1.28	1.33	1.45	1.41	1.05	1.21
193	0.54	0.43	0.48	0.48	0.39	0.38	0.40	0.44
170,190	0.58	0.49	0.57	0.58	0.57	0.50	0.41	0.52
202,171,156	0.66	0.61	0.64	0.65	0.62	0.59	0.51	0.59
201	0.61	0.55	0.59	0.59	0.63	0.55	0.46	0.53
203,196	0.92	0.84	0.90	0.90	0.83	0.68	0.65	0.84
208,195	0.57	0.52	0.56	0.56	0.48	0.52	0.43	0.47
194	0.27	0.25	0.26	0.26	0.22	0.18	0.18	0.24
206	0.73	0.70	0.68	0.70	0.74	0.62	0.57	0.54

Table I-1: Main Model Parameters

					Growth					
Growth	1				Valiela and CERP F2 pop. param					
	Age	age (d)	Age Class	Start size (cm)	End size cm	W (g) = a L^(b)		W start (g)	W end (g)
	0 - 1 yr	182.5	1	1	3.5	a	0.011732755	0.01	0.952969137
	1 - 2 yr	547.5	2	3.5	5	b	3.51	0.952969137	3.332611704
	2 - 3 yr	912.5	3	5	6.2			3.332611704	7.090793373
	3 - 4 yr	1277.5	4	6.2	7.2			7.090793373	11.98497307
			Age classes from Munns et al. 1997						

Table I-1: Main Model Parameters

		Reproduction (Biomass lost per g female)			Mortality			
1								
Age	Growth (g/g-d)	# spawns/year	T W(g) of Repro/d	Tot Repr (g/g-d)	Mortality	Mort (g/g-day)	(x) = days	(y) = mort rate (1/d)
0 - 1 yr	0.012484924	0	0	0	0.995	0.014515938	28	0.02
1 - 2 yr	0.003429943	4	0.00230137	0.000199913	0.54	0.002127476	182.5	0.014515938
2 - 3 yr	0.002068605	3	0.003645205	0.000156559	0.54	0.002127476	547.5	0.002127476
3 - 4 yr	0.001437963	2	0.003408219	8.14388E-05	0.99999	0.031542262	912.5	0.002127476
				from Munns et al., and Abraham 1985			1277.5	0.000522842

Table I-2: Model Parameters and Consumption Calculations

						Adult Fh	Juv	Larvae	
Cmax					f(T)	0.8388183	0.838818	0.825544675	
Weight (g)	W				V	1.5555556	1.555556	1.555555556	
Proportion of Cmax		0.2			CTM	34	34	34	
F(t)					T	20	20	20	
C					CTO	25	25	25	
					X	1.5455231	1.545523	1.685782385	
					Z	7.1775648	7.177565	7.496182106	
					Y	8.7725792	8.772579	9.162000352	
					CQ	2.22	2.22	2.3	
					CA	0.2	0.2	0.51	
					CB	-0.25	-0.25	-0.42	
					p	0.2	0.2	0.1	
			1		C1	0.0335527			
			2		C2	0.0671055			
			3		C3	0.1006582			
			5		C5	0.1677637			
			10		C10	0.3355273			
		ACT		SDA1	RA (gO2/g-d)	0.008	0.008	0.008	
			1	0.2	RB	-0.1414	-0.1414	-0.1414	
					RQ	2	2	2.1	
			1	0.1	R1	0.1067105			
					SDA	0.2	0.2	0.2	
					ACT	1	1	4.4	
								1	multiplier to adjust Respiration

		Inputs into BioData File										Assim effic	0.8	
									Respiration = R = SMR+ACT +SDA + FandE					S = AE*SDA1
	Age	**Weight**	**G g/g-d**	**Mortality (1/(**	**Repro (g/g-d)**	**Cmax**	**C (g/g-d)**	**C (g/d)**	**R**	**SMR**	**ACT**	**SDA**	**Act Mult**	**S (prop of R lost by S**
Larvae to 1 year Old	1	0.01	0.02	0.0208645	0	3.528337952	0.291280061	0.002912801	0.057756	0.012666	0.043064	0.002027	4.4	0.16
	2	0.010202	0.02	0.02082901	0	3.498824045	0.288843556	0.002946786	0.057593	0.01263	0.042942	0.002021	4.4	0.16
	3	0.010408	0.02	0.02079351	0	3.469557016	0.286427432	0.002981168	0.05743	0.012594	0.042821	0.002015	4.4	0.16
	4	0.010618	0.02	0.02075802	0	3.440534801	0.284031518	0.00301595	0.057268	0.012559	0.0427	0.002009	4.4	0.16
	5	0.010833	0.02	0.02072252	0	3.411755352	0.281655646	0.003051139	0.057106	0.012523	0.042579	0.002004	4.4	0.16
	6	0.011052	0.02	0.02068703	0	3.383216638	0.279299648	0.003086738	0.056945	0.012488	0.042459	0.001998	4.4	0.16
	7	0.011275	0.02	0.02065153	0	3.354916644	0.276963357	0.003122753	0.056784	0.012453	0.042339	0.001992	4.4	0.16
	8	0.011503	0.02	0.02061604	0	3.326853375	0.274646609	0.003159188	0.056624	0.012417	0.042219	0.001987	4.4	0.16
	9	0.011735	0.02	0.02058054	0	3.29902485	0.27234924	0.003196048	0.056464	0.012382	0.0421	0.001981	4.4	0.16
	10	0.011972	0.02	0.02054504	0	3.271429106	0.270071088	0.003233338	0.056304	0.012347	0.041981	0.001976	4.4	0.16
	11	0.012214	0.02	0.02050955	0	3.244064195	0.267811992	0.003271063	0.056145	0.012313	0.041863	0.00197	4.4	0.16
	12	0.012461	0.02	0.02047405	0	3.216928186	0.265571793	0.003309228	0.055987	0.012278	0.041745	0.001964	4.4	0.16
	13	0.012712	0.02	0.02043856	0	3.190019166	0.263350333	0.003347839	0.055829	0.012243	0.041627	0.001959	4.4	0.16
	14	0.012969	0.02	0.02040306	0	3.163335234	0.261147456	0.0033869	0.055671	0.012209	0.041509	0.001953	4.4	0.16
	15	0.013231	0.02	0.02036757	0	3.136874509	0.258963005	0.003426417	0.055514	0.012174	0.041392	0.001948	4.4	0.16
	16	0.013499	0.02	0.02033207	0	3.110635123	0.256796826	0.003466395	0.055357	0.01214	0.041275	0.001942	4.4	0.16
	17	0.013771	0.02	0.02029658	0	3.084615224	0.254648767	0.003506839	0.055201	0.012105	0.041158	0.001937	4.4	0.16
	18	0.014049	0.02	0.02026108	0	3.058812977	0.252518676	0.003547755	0.055045	0.012071	0.041042	0.001931	4.4	0.16
	19	0.014333	0.02	0.02022558	0	3.033226562	0.250406404	0.003589149	0.054889	0.012037	0.040926	0.001926	4.4	0.16
	20	0.014623	0.02	0.02019009	0	3.007854172	0.248311799	0.003631025	0.054734	0.012003	0.040811	0.001921	4.4	0.16
	21	0.014918	0.02	0.02015459	0	2.982694018	0.246234716	0.00367339	0.05458	0.011969	0.040695	0.001915	4.4	0.16
	22	0.01522	0.02	0.0201191	0	2.957744323	0.244175008	0.00371625	0.054426	0.011935	0.040581	0.00191	4.4	0.16
	23	0.015527	0.02	0.0200836	0	2.933003329	0.242132528	0.003759609	0.054272	0.011902	0.040466	0.001904	4.4	0.16
	24	0.015841	0.02	0.02004811	0	2.908469288	0.240107133	0.003803475	0.054119	0.011868	0.040352	0.001899	4.4	0.16

Table I-2: Model Parameters and Consumption Calculations

	25	0.016161	0.02	0.02001261	0	2.88414047	0.238098681	0.003847852	0.053966	0.011835	0.040238	0.001894	4.4	0.16
	26	0.016487	0.02	0.01997712	0	2.860015158	0.236107028	0.003892747	0.053813	0.011801	0.040124	0.001888	4.4	0.16
	27	0.01682	0.02	0.01994162	0	2.83609165	0.234132036	0.003938166	0.053661	0.011768	0.040011	0.001883	4.4	0.16
	28	0.01716	0.02	0.01990612	0	2.812368258	0.232173564	0.003984114	0.05351	0.011735	0.039898	0.001878	4.4	0.16
	29	0.017507	0.02	0.01987063	0	2.788843308	0.230231474	0.004030599	0.053359	0.011701	0.039785	0.001872	4.4	0.16
Juvenile	30	0.01786	0.02	0.01983513	0	0.547088135	0.091781503	0.001639253	0.025609	0.011856	0.011856	0.001897	2	0.16
	31	0.018221	0.02	0.01979964	0	0.544359521	0.091323741	0.001664027	0.025537	0.011823	0.011823	0.001892	2	0.16
	32	0.018589	0.02	0.01976414	0	0.541644517	0.090868262	0.001689176	0.025465	0.011789	0.011789	0.001886	2	0.16
	33	0.018965	0.02	0.01972865	0	0.538943053	0.090415054	0.001714704	0.025393	0.011756	0.011756	0.001881	2	0.16
	34	0.019348	0.02	0.01969315	0	0.536255064	0.089964107	0.001740619	0.025321	0.011723	0.011723	0.001876	2	0.16
	35	0.019739	0.02	0.01965766	0	0.53358048	0.08951541	0.001766925	0.02525	0.01169	0.01169	0.00187	2	0.16
	36	0.020138	0.02	0.01962216	0	0.530919237	0.08906895	0.001793628	0.025178	0.011657	0.011657	0.001865	2	0.16
	37	0.020544	0.02	0.01958666	0	0.528271266	0.088624716	0.001820736	0.025107	0.011624	0.011624	0.00186	2	0.16
	38	0.020959	0.02	0.01955117	0	0.525636502	0.088182699	0.001848252	0.025036	0.011591	0.011591	0.001855	2	0.16
	39	0.021383	0.02	0.01951567	0	0.523014879	0.087742886	0.001876185	0.024966	0.011558	0.011558	0.001849	2	0.16
	40	0.021815	0.02	0.01948018	0	0.520406331	0.087305266	0.00190454	0.024895	0.011525	0.011525	0.001844	2	0.16
	41	0.022255	0.02	0.01944468	0	0.517810794	0.086869829	0.001933324	0.024825	0.011493	0.011493	0.001839	2	0.16
	42	0.022705	0.02	0.01940919	0	0.515228202	0.086436564	0.001962542	0.024755	0.01146	0.01146	0.001834	2	0.16
	43	0.023164	0.02	0.01937369	0	0.512658491	0.08600546	0.001992202	0.024685	0.011428	0.011428	0.001828	2	0.16
	44	0.023632	0.02	0.0193382	0	0.510101596	0.085576506	0.00202231	0.024615	0.011396	0.011396	0.001823	2	0.16
	45	0.024109	0.02	0.0193027	0	0.507557453	0.085149691	0.002052874	0.024545	0.011364	0.011364	0.001818	2	0.16
	46	0.024596	0.02	0.0192672	0	0.505026	0.084725006	0.002083899	0.024476	0.011332	0.011332	0.001813	2	0.16
	47	0.025093	0.02	0.01923171	0	0.502507172	0.084302438	0.002115393	0.024407	0.0113	0.0113	0.001808	2	0.16
	48	0.0256	0.02	0.01919621	0	0.500000907	0.083881978	0.002147363	0.024338	0.011268	0.011268	0.001803	2	0.16
	49	0.026117	0.02	0.01916072	0	0.497507142	0.083463615	0.002179816	0.024269	0.011236	0.011236	0.001798	2	0.16
	50	0.026645	0.02	0.01912522	0	0.495025815	0.083047338	0.00221276	0.024201	0.011204	0.011204	0.001793	2	0.16
	51	0.027183	0.02	0.01908973	0	0.492556864	0.082633138	0.002246202	0.024133	0.011172	0.011172	0.001788	2	0.16
	52	0.027732	0.02	0.01905423	0	0.490100226	0.082221003	0.002280149	0.024064	0.011141	0.011141	0.001783	2	0.16
	53	0.028292	0.02	0.01901874	0	0.487655841	0.081810924	0.002314609	0.023996	0.011109	0.011109	0.001778	2	0.16
	54	0.028864	0.02	0.01898324	0	0.485223647	0.081402891	0.002349589	0.023929	0.011078	0.011078	0.001772	2	0.16
	55	0.029447	0.02	0.01894774	0	0.482803584	0.080996892	0.002385099	0.023861	0.011047	0.011047	0.001767	2	0.16
	56	0.030042	0.02	0.01891225	0	0.480395591	0.080592918	0.002421145	0.023794	0.011016	0.011016	0.001762	2	0.16
	57	0.030649	0.02	0.01887675	0	0.477999608	0.080190959	0.002457736	0.023726	0.010984	0.010984	0.001758	2	0.16
	58	0.031268	0.02	0.01884126	0	0.475615575	0.079791005	0.00249488	0.023659	0.010953	0.010953	0.001753	2	0.16
	59	0.031899	0.02	0.01880576	0	0.473243433	0.079393046	0.002532585	0.023593	0.010923	0.010923	0.001748	2	0.16
	60	0.032544	0.02	0.01877027	0	0.470883121	0.078997072	0.00257086	0.023526	0.010892	0.010892	0.001743	2	0.16
	61	0.033201	0.02	0.01873477	0	0.468534582	0.078603072	0.002609714	0.02346	0.010861	0.010861	0.001738	2	0.16
	62	0.033872	0.02	0.01869928	0	0.466197756	0.078211038	0.002649155	0.023393	0.01083	0.01083	0.001733	2	0.16
	63	0.034556	0.02	0.01866378	0	0.463872585	0.077820958	0.002689192	0.023327	0.0108	0.0108	0.001728	2	0.16
	64	0.035254	0.02	0.01862828	0	0.461559011	0.077432825	0.002729833	0.023261	0.010769	0.010769	0.001723	2	0.16
	65	0.035966	0.02	0.01859279	0	0.459256976	0.077046627	0.00277109	0.023196	0.010739	0.010739	0.001718	2	0.16
	66	0.036693	0.02	0.01855729	0	0.456966422	0.076662355	0.002812969	0.02313	0.010708	0.010708	0.001713	2	0.16
	67	0.037434	0.02	0.0185218	0	0.454687292	0.07628	0.002855482	0.023065	0.010678	0.010678	0.001709	2	0.16
	68	0.03819	0.02	0.0184863	0	0.45241953	0.075899552	0.002898637	0.023	0.010648	0.010648	0.001704	2	0.16
	69	0.038962	0.02	0.01845081	0	0.450163078	0.075521002	0.002942444	0.022935	0.010618	0.010618	0.001699	2	0.16
	70	0.039749	0.02	0.01841531	0	0.44791788	0.075144339	0.002986914	0.02287	0.010588	0.010588	0.001694	2	0.16
	71	0.040552	0.02	0.01837982	0	0.445683881	0.074769555	0.003032055	0.022805	0.010558	0.010558	0.001689	2	0.16
	72	0.041371	0.02	0.01834432	0	0.443461023	0.07439664	0.003077879	0.022741	0.010528	0.010528	0.001685	2	0.16
	73	0.042207	0.02	0.01830883	0	0.441249252	0.074025586	0.003124395	0.022677	0.010499	0.010499	0.00168	2	0.16
	74	0.04306	0.02	0.01827333	0	0.439048512	0.073656381	0.003171614	0.022613	0.010469	0.010469	0.001675	2	0.16
	75	0.043929	0.02	0.01823783	0	0.436858749	0.073289019	0.003219547	0.022549	0.010439	0.010439	0.00167	2	0.16
	76	0.044817	0.02	0.01820234	0	0.434679906	0.072923488	0.003268204	0.022485	0.01041	0.01041	0.001666	2	0.16
	77	0.045722	0.02	0.01816684	0	0.432511931	0.072559781	0.003317597	0.022422	0.01038	0.01038	0.001661	2	0.16

78	0.046646	0.02	0.01813135	0	0.430354769	0.072197887	0.003367736	0.022358	0.010351	0.010351	0.001656	2	0.16
79	0.047588	0.02	0.01809585	0	0.428208366	0.071837799	0.003418632	0.022295	0.010322	0.010322	0.001652	2	0.16
80	0.04855	0.02	0.01806036	0	0.426072668	0.071479506	0.003470298	0.022232	0.010293	0.010293	0.001647	2	0.16
81	0.04953	0.02	0.01802486	0	0.423947621	0.071123001	0.003522745	0.02217	0.010264	0.010264	0.001642	2	0.16
82	0.050531	0.02	0.01798937	0	0.421833174	0.070768273	0.003575985	0.022107	0.010235	0.010235	0.001638	2	0.16
83	0.051552	0.02	0.01795387	0	0.419729272	0.070415315	0.003630029	0.022045	0.010206	0.010206	0.001633	2	0.16
84	0.052593	0.02	0.01791837	0	0.417635864	0.070064117	0.00368489	0.021982	0.010177	0.010177	0.001628	2	0.16
85	0.053656	0.02	0.01788288	0	0.415552896	0.069714671	0.00374058	0.02192	0.010148	0.010148	0.001624	2	0.16
86	0.054739	0.02	0.01784738	0	0.413480317	0.069366968	0.003797111	0.021858	0.01012	0.01012	0.001619	2	0.16
87	0.055845	0.02	0.01781189	0	0.411418076	0.069020998	0.003854497	0.021797	0.010091	0.010091	0.001615	2	0.16
88	0.056973	0.02	0.01777639	0	0.409366119	0.068676755	0.003912751	0.021735	0.010062	0.010062	0.00161	2	0.16
89	0.058124	0.02	0.0177409	0	0.407324397	0.068334228	0.003971884	0.021674	0.010034	0.010034	0.001605	2	0.16
90	0.059299	0.02	0.0177054	0	0.405292858	0.06799341	0.004031912	0.021612	0.010006	0.010006	0.001601	2	0.16
91	0.060496	0.02	0.01766991	0	0.403271452	0.067654291	0.004092846	0.021551	0.009977	0.009977	0.001596	2	0.16
92	0.061719	0.02	0.01763441	0	0.401260127	0.067316864	0.004154702	0.021491	0.009949	0.009949	0.001592	2	0.16
93	0.062965	0.02	0.01759891	0	0.399258834	0.06698112	0.004217492	0.02143	0.009921	0.009921	0.001587	2	0.16
94	0.064237	0.02	0.01756342	0	0.397267522	0.06664705	0.004281231	0.021369	0.009893	0.009893	0.001583	2	0.16
95	0.065535	0.02	0.01752792	0	0.395286142	0.066314646	0.004345934	0.021309	0.009865	0.009865	0.001578	2	0.16
96	0.066859	0.02	0.01749243	0	0.393314644	0.065983901	0.004411614	0.021249	0.009837	0.009837	0.001574	2	0.16
97	0.06821	0.02	0.01745693	0	0.391352979	0.065654805	0.004478287	0.021189	0.00981	0.00981	0.00157	2	0.16
98	0.069588	0.02	0.01742144	0	0.389401098	0.06532735	0.004545968	0.021129	0.009782	0.009782	0.001565	2	0.16
99	0.070993	0.02	0.01738594	0	0.387458952	0.065001528	0.004614671	0.021069	0.009754	0.009754	0.001561	2	0.16
100	0.072427	0.02	0.01735045	0	0.385526492	0.064677332	0.004684413	0.02101	0.009727	0.009727	0.001556	2	0.16
101	0.073891	0.02	0.01731495	0	0.383603671	0.064354752	0.004755209	0.02095	0.009699	0.009699	0.001552	2	0.16
102	0.075383	0.02	0.01727945	0	0.38169044	0.064033782	0.004827075	0.020891	0.009672	0.009672	0.001548	2	0.16
103	0.076906	0.02	0.01724396	0	0.379786751	0.063714412	0.004900026	0.020832	0.009645	0.009645	0.001543	2	0.16
104	0.07846	0.02	0.01720846	0	0.377892556	0.063396635	0.004974081	0.020773	0.009617	0.009617	0.001539	2	0.16
105	0.080045	0.02	0.01717297	0	0.376007809	0.063080443	0.005049254	0.020715	0.00959	0.00959	0.001534	2	0.16
106	0.081662	0.02	0.01713747	0	0.374132463	0.062765828	0.005125564	0.020656	0.009563	0.009563	0.00153	2	0.16
107	0.083311	0.02	0.01710198	0	0.372266469	0.062452782	0.005203027	0.020598	0.009536	0.009536	0.001526	2	0.16
108	0.084994	0.02	0.01706648	0	0.370409782	0.062141297	0.005281661	0.02054	0.009509	0.009509	0.001521	2	0.16
109	0.086711	0.02	0.01703099	0	0.368562356	0.061831366	0.005361483	0.020482	0.009482	0.009482	0.001517	2	0.16
110	0.088463	0.02	0.01699549	0	0.366724144	0.061522981	0.005442511	0.020424	0.009456	0.009456	0.001513	2	0.16
111	0.09025	0.02	0.01695999	0	0.364895099	0.061216134	0.005524764	0.020366	0.009429	0.009429	0.001509	2	0.16
112	0.092073	0.02	0.0169245	0	0.363075177	0.060910817	0.00560826	0.020309	0.009402	0.009402	0.001504	2	0.16
113	0.093933	0.02	0.016889	0	0.361264332	0.060607023	0.005693018	0.020251	0.009376	0.009376	0.0015	2	0.16
114	0.095831	0.02	0.01685351	0	0.359462519	0.060304745	0.005779057	0.020194	0.009349	0.009349	0.001496	2	0.16
115	0.097767	0.02	0.01681801	0	0.357669692	0.060003973	0.005866397	0.020137	0.009323	0.009323	0.001492	2	0.16
116	0.099742	0.02	0.01678252	0	0.355885807	0.059704702	0.005955056	0.02008	0.009296	0.009296	0.001487	2	0.16
117	0.101757	0.02	0.01674702	0	0.354110819	0.059406924	0.006045055	0.020024	0.00927	0.00927	0.001483	2	0.16
118	0.103812	0.0198524	0.01671153	0	0.352344684	0.059110631	0.006136414	0.019967	0.009244	0.009244	0.001479	2	0.16
119	0.105894	0.01966721	0.01667603	0	0.350600295	0.058817985	0.006228465	0.019911	0.009218	0.009218	0.001475	2	0.16
120	0.107997	0.01948527	0.01664053	0	0.348880693	0.058529499	0.006321018	0.019856	0.009192	0.009192	0.001471	2	0.16
121	0.110122	0.01930651	0.01660504	0	0.347185317	0.058245076	0.006414072	0.019801	0.009167	0.009167	0.001467	2	0.16
122	0.112269	0.01913084	0.01656954	0	0.34551362	0.057964626	0.006507622	0.019747	0.009142	0.009142	0.001463	2	0.16
123	0.114437	0.01895818	0.01653405	0	0.343865075	0.05768806	0.006601668	0.019694	0.009118	0.009118	0.001459	2	0.16
124	0.116628	0.01878846	0.01649855	0	0.342239167	0.057415292	0.006696205	0.019641	0.009093	0.009093	0.001455	2	0.16
125	0.11884	0.0186216	0.01646306	0	0.3406354	0.057146238	0.006791231	0.019589	0.009069	0.009069	0.001451	2	0.16
126	0.121073	0.01845753	0.01642756	0	0.339053292	0.056880818	0.006886744	0.019537	0.009045	0.009045	0.001447	2	0.16
127	0.123329	0.0182962	0.01639207	0	0.337492374	0.056618953	0.006982741	0.019487	0.009022	0.009022	0.001443	2	0.16
128	0.125606	0.01813752	0.01635657	0	0.335952192	0.056360566	0.00707922	0.019436	0.008998	0.008998	0.00144	2	0.16
129	0.127905	0.01798143	0.01632107	0	0.334432306	0.056105585	0.007176178	0.019386	0.008975	0.008975	0.001436	2	0.16
130	0.130226	0.01782788	0.01628558	0	0.332932287	0.055853936	0.007273612	0.019337	0.008952	0.008952	0.001432	2	0.16

Table I-2: Model Parameters and Consumption Calculations

131	0.132568	0.0176768	0.01625008	0	0.33145172	0.055605551	0.00737152	0.019289	0.00893	0.00893	0.001429	2	0.16
132	0.134932	0.01752814	0.01621459	0	0.3299902	0.055360361	0.007469899	0.01924	0.008908	0.008908	0.001425	2	0.16
133	0.137318	0.01738183	0.01617909	0	0.328547335	0.055118301	0.007568747	0.019193	0.008886	0.008886	0.001422	2	0.16
134	0.139726	0.01723783	0.0161436	0	0.327122744	0.054879306	0.007668062	0.019146	0.008864	0.008864	0.001418	2	0.16
135	0.142155	0.01709608	0.0161081	0	0.325716056	0.054643315	0.007767841	0.019099	0.008842	0.008842	0.001415	2	0.16
136	0.144607	0.01695653	0.01607261	0	0.32432691	0.054410266	0.007868082	0.019053	0.008821	0.008821	0.001411	2	0.16
137	0.14708	0.01681912	0.01603711	0	0.322954955	0.054180102	0.007968783	0.019007	0.0088	0.0088	0.001408	2	0.16
138	0.149574	0.01668382	0.01600161	0	0.321599851	0.053952765	0.008069941	0.018962	0.008779	0.008779	0.001405	2	0.16
139	0.152091	0.01655057	0.01596612	0	0.320261266	0.053728199	0.008171553	0.018917	0.008758	0.008758	0.001401	2	0.16
140	0.154629	0.01641933	0.01593062	0	0.318938877	0.053506351	0.008273618	0.018873	0.008738	0.008738	0.001398	2	0.16
141	0.157189	0.01629005	0.01589513	0	0.31763237	0.053287166	0.008376133	0.018829	0.008717	0.008717	0.001395	2	0.16
142	0.15977	0.01616269	0.01585963	0	0.316341439	0.053070595	0.008479097	0.018786	0.008697	0.008697	0.001392	2	0.16
143	0.162373	0.01603722	0.01582414	0	0.315065785	0.052856586	0.008582506	0.018743	0.008677	0.008677	0.001388	2	0.16
144	0.164998	0.01591358	0.01578864	0	0.31380512	0.052645093	0.008686359	0.018701	0.008658	0.008658	0.001385	2	0.16
145	0.167645	0.01579174	0.01575315	0	0.312559159	0.052436066	0.008790654	0.018659	0.008638	0.008638	0.001382	2	0.16
146	0.170314	0.01567166	0.01571765	0	0.311327629	0.05222946	0.008895387	0.018617	0.008619	0.008619	0.001379	2	0.16
147	0.173004	0.0155533	0.01568215	0	0.31011026	0.052025229	0.009000558	0.018576	0.0086	0.0086	0.001376	2	0.16
148	0.175716	0.01543663	0.01564666	0	0.308906792	0.051823331	0.009106164	0.018535	0.008581	0.008581	0.001373	2	0.16
149	0.178449	0.01532161	0.01561116	0	0.307716969	0.051623722	0.009212203	0.018495	0.008562	0.008562	0.00137	2	0.16
150	0.181204	0.01520822	0.01557567	0	0.306540543	0.051426361	0.009318673	0.018455	0.008544	0.008544	0.001367	2	0.16
151	0.183981	0.0150964	0.01554017	0	0.305377273	0.051231206	0.009425572	0.018415	0.008525	0.008525	0.001364	2	0.16
152	0.18678	0.01498614	0.01550468	0	0.30422692	0.051038219	0.009532898	0.018376	0.008507	0.008507	0.001361	2	0.16
153	0.1896	0.0148774	0.01546918	0	0.303089256	0.05084736	0.009640648	0.018337	0.008489	0.008489	0.001358	2	0.16
154	0.192442	0.01477014	0.01543369	0	0.301964055	0.050658592	0.009748821	0.018298	0.008471	0.008471	0.001355	2	0.16
155	0.195305	0.01466435	0.01539819	0	0.300851098	0.050471879	0.009857415	0.01826	0.008454	0.008454	0.001353	2	0.16
156	0.19819	0.01455999	0.01536269	0	0.299750171	0.050287183	0.009966428	0.018222	0.008436	0.008436	0.00135	2	0.16
157	0.201097	0.01445703	0.0153272	0	0.298661065	0.050104471	0.010075858	0.018185	0.008419	0.008419	0.001347	2	0.16
158	0.204025	0.01435544	0.0152917	0	0.297583575	0.049923707	0.010185702	0.018148	0.008402	0.008402	0.001344	2	0.16
159	0.206975	0.01425521	0.01525621	0	0.296517503	0.049744859	0.01029596	0.018111	0.008385	0.008385	0.001342	2	0.16
160	0.209947	0.01415629	0.01522071	0	0.295462654	0.049567894	0.010406629	0.018074	0.008368	0.008368	0.001339	2	0.16
161	0.21294	0.01405867	0.01518522	0	0.294418839	0.049392779	0.010517707	0.018038	0.008351	0.008351	0.001336	2	0.16
162	0.215955	0.01396233	0.01514972	0	0.29338587	0.049219485	0.010629192	0.018002	0.008334	0.008334	0.001334	2	0.16
163	0.218991	0.01386723	0.01511423	0	0.292363568	0.04904798	0.010741083	0.017967	0.008318	0.008318	0.001331	2	0.16
164	0.222049	0.01377335	0.01507873	0	0.291351755	0.048878234	0.010853378	0.017932	0.008302	0.008302	0.001328	2	0.16
165	0.225129	0.01368068	0.01504323	0	0.290350258	0.048710219	0.010966075	0.017897	0.008286	0.008286	0.001326	2	0.16
166	0.22823	0.01358918	0.01500774	0	0.289358907	0.048543907	0.011079172	0.017862	0.00827	0.00827	0.001323	2	0.16
167	0.231353	0.01349883	0.01497224	0	0.288377538	0.048379269	0.011192667	0.017828	0.008254	0.008254	0.001321	2	0.16
168	0.234497	0.01340963	0.01493675	0	0.287405988	0.048216278	0.011306558	0.017794	0.008238	0.008238	0.001318	2	0.16
169	0.237662	0.01332153	0.01490125	0	0.286444099	0.048054908	0.011420844	0.01776	0.008222	0.008222	0.001316	2	0.16
170	0.24085	0.01323453	0.01486576	0	0.285491717	0.047895133	0.011535524	0.017727	0.008207	0.008207	0.001313	2	0.16
171	0.244058	0.01314861	0.01483026	0	0.284548691	0.047736927	0.011650594	0.017694	0.008192	0.008192	0.001311	2	0.16
172	0.247289	0.01306373	0.01479477	0	0.283614872	0.047580266	0.011766054	0.017661	0.008176	0.008176	0.001308	2	0.16
173	0.25054	0.0129799	0.01475927	0	0.282690115	0.047425126	0.011881902	0.017628	0.008161	0.008161	0.001306	2	0.16
174	0.253813	0.01289707	0.01472377	0	0.28177428	0.047271482	0.011998137	0.017596	0.008146	0.008146	0.001303	2	0.16
175	0.257108	0.01281525	0.01468828	0	0.280867227	0.047119311	0.012114755	0.017564	0.008131	0.008131	0.001301	2	0.16
176	0.260424	0.01273441	0.01465278	0	0.279968821	0.046968592	0.012231757	0.017532	0.008117	0.008117	0.001299	2	0.16
177	0.263762	0.01265453	0.01461729	0	0.279078929	0.0468193	0.01234914	0.017501	0.008102	0.008102	0.001296	2	0.16
178	0.267121	0.0125756	0.01458179	0	0.278197421	0.046671415	0.012466902	0.017469	0.008088	0.008088	0.001294	2	0.16
179	0.270501	0.0124976	0.0145463	0	0.277324169	0.046524915	0.012585043	0.017438	0.008073	0.008073	0.001292	2	0.16
180	0.273903	0.01242051	0.0145108	0	0.27645905	0.04637978	0.012703559	0.017407	0.008059	0.008059	0.001289	2	0.16
181	0.277326	0.01234433	0.01447531	0	0.27560194	0.046235988	0.012822451	0.017377	0.008045	0.008045	0.001287	2	0.16
182	0.280771	0.01226902	0.01443981	0	0.274752721	0.04609352	0.012941715	0.017347	0.008031	0.008031	0.001285	2	0.16
183	0.284237	0.01219458	0.01440431	0	0.273911276	0.045952356	0.013061352	0.017317	0.008017	0.008017	0.001283	2	0.16

184	0.287724	0.012121	0.01436882	0	0.273077489	0.045812477	0.013181358	0.017287	0.008003	0.008003	0.00128	2	0.16
185	0.291233	0.01204826	0.01433332	0	0.272251248	0.045673863	0.013301733	0.017257	0.007989	0.007989	0.001278	2	0.16
186	0.294763	0.01197634	0.01429783	0	0.271432443	0.045536498	0.013422474	0.017228	0.007976	0.007976	0.001276	2	0.16
187	0.298314	0.01190523	0.01426233	0	0.270620967	0.045400361	0.013543582	0.017199	0.007962	0.007962	0.001274	2	0.16
188	0.301887	0.01183492	0.01422684	0	0.269816713	0.045265437	0.013665053	0.01717	0.007949	0.007949	0.001272	2	0.16
189	0.305481	0.0117654	0.01419134	0	0.269019578	0.045131707	0.013786886	0.017141	0.007936	0.007936	0.00127	2	0.16
190	0.309096	0.01169665	0.01415585	0	0.26822946	0.044999153	0.013909081	0.017112	0.007922	0.007922	0.001268	2	0.16
191	0.312733	0.01162866	0.01412035	0	0.267446259	0.044867761	0.014031635	0.017084	0.007909	0.007909	0.001265	2	0.16
192	0.316391	0.01156141	0.01408485	0	0.266669878	0.044737512	0.014154547	0.017056	0.007896	0.007896	0.001263	2	0.16
193	0.32007	0.0114949	0.01404936	0	0.265900221	0.044608392	0.014277815	0.017028	0.007883	0.007883	0.001261	2	0.16
194	0.323771	0.01142911	0.01401386	0	0.265137193	0.044480384	0.014401439	0.017001	0.007871	0.007871	0.001259	2	0.16
195	0.327492	0.01136404	0.01397837	0	0.264380704	0.044353472	0.014525416	0.016973	0.007858	0.007858	0.001257	2	0.16
196	0.331235	0.01129967	0.01394287	0	0.263630661	0.044227642	0.014649746	0.016946	0.007845	0.007845	0.001255	2	0.16
197	0.334999	0.01123598	0.01390738	0	0.262886978	0.044102879	0.014774426	0.016919	0.007833	0.007833	0.001253	2	0.16
198	0.338784	0.01117298	0.01387188	0	0.262149565	0.043979168	0.014899456	0.016892	0.00782	0.00782	0.001251	2	0.16
199	0.342591	0.01111064	0.01383639	0	0.26141834	0.043856495	0.015024834	0.016865	0.007808	0.007808	0.001249	2	0.16
200	0.346418	0.01104896	0.01380089	0	0.260693216	0.043734846	0.015150559	0.016839	0.007796	0.007796	0.001247	2	0.16
201	0.350267	0.01098792	0.0137654	0	0.259974113	0.043614206	0.015276629	0.016813	0.007784	0.007784	0.001245	2	0.16
202	0.354137	0.01092753	0.0137299	0	0.259260949	0.043494563	0.015403043	0.016786	0.007772	0.007772	0.001243	2	0.16
203	0.358028	0.01086776	0.0136944	0	0.258553645	0.043375903	0.0155298	0.016761	0.00776	0.00776	0.001242	2	0.16
204	0.36194	0.01080861	0.01365891	0	0.257852123	0.043258214	0.015656898	0.016735	0.007748	0.007748	0.00124	2	0.16
205	0.365874	0.01075007	0.01362341	0	0.257156308	0.043141481	0.015784336	0.016709	0.007736	0.007736	0.001238	2	0.16
206	0.369828	0.01069213	0.01358792	0	0.256466124	0.043025693	0.015912112	0.016684	0.007724	0.007724	0.001236	2	0.16
207	0.373804	0.01063478	0.01355242	0	0.255781497	0.042910838	0.016040226	0.016659	0.007712	0.007712	0.001234	2	0.16
208	0.3778	0.01057801	0.01351693	0	0.255102355	0.042796902	0.016168676	0.016634	0.007701	0.007701	0.001232	2	0.16
209	0.381818	0.01052182	0.01348143	0	0.254428627	0.042683875	0.01629746	0.016609	0.007689	0.007689	0.00123	2	0.16
210	0.385856	0.01046619	0.01344594	0	0.253760244	0.042571745	0.016426578	0.016584	0.007678	0.007678	0.001228	2	0.16
211	0.389916	0.01041111	0.01341044	0	0.253097136	0.0424605	0.016556028	0.01656	0.007666	0.007666	0.001227	2	0.16
212	0.393997	0.01035659	0.01337494	0	0.252439237	0.042350128	0.016685809	0.016535	0.007655	0.007655	0.001225	2	0.16
213	0.398098	0.0103026	0.01333945	0	0.25178648	0.042240619	0.01681592	0.016511	0.007644	0.007644	0.001223	2	0.16
214	0.402221	0.01024915	0.01330395	0	0.251138801	0.042131962	0.016946359	0.016487	0.007633	0.007633	0.001221	2	0.16
215	0.406365	0.01019622	0.01326846	0	0.250496135	0.042024146	0.017077125	0.016463	0.007622	0.007622	0.001219	2	0.16
216	0.410529	0.0101438	0.01323296	0	0.24985842	0.041917161	0.017208217	0.016439	0.007611	0.007611	0.001218	2	0.16
217	0.414715	0.0100919	0.01319747	0	0.249225594	0.041810996	0.017339634	0.016416	0.0076	0.0076	0.001216	2	0.16
218	0.418921	0.0100405	0.01316197	0	0.248597597	0.04170564	0.017471375	0.016392	0.007589	0.007589	0.001214	2	0.16
219	0.423149	0.0099896	0.01312648	0	0.247974368	0.041601085	0.017603437	0.016369	0.007578	0.007578	0.001213	2	0.16
220	0.427397	0.00993918	0.01309098	0	0.24735585	0.04149732	0.017735821	0.016346	0.007568	0.007568	0.001211	2	0.16
221	0.431666	0.00988925	0.01305548	0	0.246741984	0.041394336	0.017868525	0.016323	0.007557	0.007557	0.001209	2	0.16
222	0.435956	0.00983978	0.01301999	0	0.246132715	0.041292123	0.018001547	0.0163	0.007546	0.007546	0.001207	2	0.16
223	0.440267	0.00979079	0.01298449	0	0.245527985	0.041190671	0.018134887	0.016278	0.007536	0.007536	0.001206	2	0.16
224	0.444599	0.00974226	0.012949	0	0.244927742	0.041089972	0.018268543	0.016255	0.007525	0.007525	0.001204	2	0.16
225	0.448951	0.00969418	0.0129135	0	0.24433193	0.040990017	0.018402515	0.016233	0.007515	0.007515	0.001202	2	0.16
226	0.453325	0.00964656	0.01287801	0	0.243740498	0.040890796	0.0185368	0.01621	0.007505	0.007505	0.001201	2	0.16
227	0.457719	0.00959937	0.01284251	0	0.243153392	0.040792301	0.018671399	0.016188	0.007495	0.007495	0.001199	2	0.16
228	0.462134	0.00955263	0.01280702	0	0.242570561	0.040694523	0.018806309	0.016166	0.007484	0.007484	0.001198	2	0.16
229	0.466569	0.00950631	0.01277152	0	0.241991956	0.040597454	0.01894153	0.016145	0.007474	0.007474	0.001196	2	0.16
230	0.471026	0.00946042	0.01273602	0	0.241417526	0.040501086	0.019077061	0.016123	0.007464	0.007464	0.001194	2	0.16
231	0.475503	0.00941494	0.01270053	0	0.240847223	0.04040541	0.0192129	0.016101	0.007454	0.007454	0.001193	2	0.16
232	0.480001	0.00936988	0.01266503	0	0.240280999	0.040310418	0.019349046	0.01608	0.007444	0.007444	0.001191	2	0.16
233	0.48452	0.00932523	0.01262954	0	0.239718807	0.040216102	0.019485499	0.016059	0.007435	0.007435	0.00119	2	0.16
234	0.489059	0.00928098	0.01259404	0	0.239160599	0.040122455	0.019622257	0.016037	0.007425	0.007425	0.001188	2	0.16
235	0.493619	0.00923713	0.01255855	0	0.238606331	0.040029469	0.019759319	0.016016	0.007415	0.007415	0.001186	2	0.16
236	0.4982	0.00919367	0.01252305	0	0.238055957	0.039937136	0.019896683	0.015996	0.007405	0.007405	0.001185	2	0.16

237	0.502801	0.0091506	0.01248756	0	0.237509433	0.03984545	0.02003435	0.015975	0.007396	0.007396	0.001183	2	0.16
238	0.507424	0.00910791	0.01245206	0	0.236966715	0.039754401	0.020172318	0.015954	0.007386	0.007386	0.001182	2	0.16
239	0.512066	0.0090656	0.01241656	0	0.236427761	0.039663984	0.020310585	0.015934	0.007377	0.007377	0.00118	2	0.16
240	0.516729	0.00902366	0.01238107	0	0.235892528	0.039574192	0.020449152	0.015913	0.007367	0.007367	0.001179	2	0.16
241	0.521413	0.00898208	0.01234557	0	0.235360975	0.039485016	0.020588016	0.015893	0.007358	0.007358	0.001177	2	0.16
242	0.526118	0.00894087	0.01231008	0	0.23483306	0.039396451	0.020727176	0.015873	0.007348	0.007348	0.001176	2	0.16
243	0.530843	0.00890002	0.01227458	0	0.234308743	0.03930849	0.020866633	0.015853	0.007339	0.007339	0.001174	2	0.16
244	0.535588	0.00885952	0.01223909	0	0.233787984	0.039221126	0.021006384	0.015833	0.00733	0.00733	0.001173	2	0.16
245	0.540355	0.00881937	0.01220359	0	0.233270745	0.039134352	0.021146428	0.015813	0.007321	0.007321	0.001171	2	0.16
246	0.545141	0.00877956	0.0121681	0	0.232756987	0.039048162	0.021286765	0.015793	0.007312	0.007312	0.00117	2	0.16
247	0.549948	0.00874009	0.0121326	0	0.232246671	0.038962549	0.021427394	0.015774	0.007303	0.007303	0.001168	2	0.16
248	0.554776	0.00870096	0.0120971	0	0.231739761	0.038877508	0.021568314	0.015754	0.007294	0.007294	0.001167	2	0.16
249	0.559624	0.00866216	0.01206161	0	0.231236219	0.038793032	0.021709523	0.015735	0.007285	0.007285	0.001166	2	0.16
250	0.564493	0.00862369	0.01202611	0	0.23073601	0.038709115	0.02185102	0.015715	0.007276	0.007276	0.001164	2	0.16
251	0.569382	0.00858554	0.01199062	0	0.230239097	0.038625751	0.021992806	0.015696	0.007267	0.007267	0.001163	2	0.16
252	0.574291	0.00854771	0.01195512	0	0.229745445	0.038542935	0.022134877	0.015677	0.007258	0.007258	0.001161	2	0.16
253	0.579221	0.0085102	0.01191963	0	0.22925502	0.038460659	0.022277235	0.015658	0.007249	0.007249	0.00116	2	0.16
254	0.584172	0.00847299	0.01188413	0	0.228767787	0.038378919	0.022419878	0.015639	0.007241	0.007241	0.001158	2	0.16
255	0.589142	0.0084361	0.01184864	0	0.228283713	0.038297709	0.022562804	0.015621	0.007232	0.007232	0.001157	2	0.16
256	0.594133	0.00839951	0.01181314	0	0.227802764	0.038217023	0.022706013	0.015602	0.007223	0.007223	0.001156	2	0.16
257	0.599145	0.00836322	0.01177764	0	0.227324908	0.038136857	0.022849504	0.015584	0.007215	0.007215	0.001154	2	0.16
258	0.604177	0.00832723	0.01174215	0	0.226850113	0.038057203	0.022993276	0.015565	0.007206	0.007206	0.001153	2	0.16
259	0.609229	0.00829153	0.01170665	0	0.226378346	0.037978058	0.023137328	0.015547	0.007198	0.007198	0.001152	2	0.16
260	0.614301	0.00825612	0.01167116	0	0.225909577	0.037899415	0.023281659	0.015529	0.007189	0.007189	0.00115	2	0.16
261	0.619394	0.00822099	0.01163566	0	0.225443773	0.037821271	0.023426268	0.015511	0.007181	0.007181	0.001149	2	0.16
262	0.624507	0.00818615	0.01160017	0	0.224980906	0.037743618	0.023571155	0.015493	0.007172	0.007172	0.001148	2	0.16
263	0.62964	0.00815159	0.01156467	0	0.224520945	0.037666454	0.023716318	0.015475	0.007164	0.007164	0.001146	2	0.16
264	0.634794	0.00811731	0.01152918	0	0.224063861	0.037589771	0.023861756	0.015457	0.007156	0.007156	0.001145	2	0.16
265	0.639968	0.00808329	0.01149368	0	0.223609623	0.037513567	0.024007469	0.015439	0.007148	0.007148	0.001144	2	0.16
266	0.645162	0.00804955	0.01145818	0	0.223158204	0.037437835	0.024153456	0.015421	0.00714	0.00714	0.001142	2	0.16
267	0.650376	0.00801608	0.01142269	0	0.222709574	0.037362571	0.024299715	0.015404	0.007131	0.007131	0.001141	2	0.16
268	0.65561	0.00798286	0.01138719	0	0.222263707	0.037287771	0.024446247	0.015386	0.007123	0.007123	0.00114	2	0.16
269	0.660865	0.00794991	0.0113517	0	0.221820574	0.037213429	0.024593049	0.015369	0.007115	0.007115	0.001138	2	0.16
270	0.66614	0.00791722	0.0113162	0	0.221380148	0.037139542	0.024740122	0.015352	0.007107	0.007107	0.001137	2	0.16
271	0.671435	0.00788478	0.01128071	0	0.220942403	0.037066104	0.024887463	0.015335	0.007099	0.007099	0.001136	2	0.16
272	0.67675	0.00785259	0.01124521	0	0.220507312	0.036993112	0.025035073	0.015318	0.007091	0.007091	0.001135	2	0.16
273	0.682085	0.00782065	0.01120972	0	0.220074848	0.03692056	0.025182951	0.015301	0.007084	0.007084	0.001133	2	0.16
274	0.68744	0.00778896	0.01117422	0	0.219644986	0.036848445	0.025331095	0.015284	0.007076	0.007076	0.001132	2	0.16
275	0.692815	0.00775751	0.01113872	0	0.219217701	0.036776762	0.025479506	0.015267	0.007068	0.007068	0.001131	2	0.16
276	0.698211	0.0077263	0.01110323	0	0.218792967	0.036705507	0.025628181	0.01525	0.00706	0.00706	0.00113	2	0.16
277	0.703626	0.00769533	0.01106773	0	0.21837076	0.036634676	0.02577712	0.015233	0.007053	0.007053	0.001128	2	0.16
278	0.709062	0.00766459	0.01103224	0	0.217951055	0.036564265	0.025926323	0.015217	0.007045	0.007045	0.001127	2	0.16
279	0.714517	0.00763409	0.01099674	0	0.217533828	0.036494269	0.026075788	0.0152	0.007037	0.007037	0.001126	2	0.16
280	0.719993	0.00760381	0.01096125	0	0.217119056	0.036424686	0.026225515	0.015184	0.00703	0.00703	0.001125	2	0.16
281	0.725488	0.00757377	0.01092575	0	0.216706715	0.03635551	0.026375503	0.015168	0.007022	0.007022	0.001124	2	0.16
282	0.731004	0.00754395	0.01089026	0	0.216296781	0.036286738	0.02652575	0.015151	0.007015	0.007015	0.001122	2	0.16
283	0.73654	0.00751435	0.01085476	0	0.215889233	0.036218366	0.026676257	0.015135	0.007007	0.007007	0.001121	2	0.16
284	0.742095	0.00748497	0.01081926	0	0.215484047	0.036150391	0.026827023	0.015119	0.007	0.007	0.00112	2	0.16
285	0.74767	0.0074558	0.01078377	0	0.215081202	0.036082808	0.026978046	0.015103	0.006992	0.006992	0.001119	2	0.16
286	0.753266	0.00742686	0.01074827	0	0.214680674	0.036015614	0.027129326	0.015087	0.006985	0.006985	0.001118	2	0.16
287	0.758881	0.00739812	0.01071278	0	0.214282443	0.035948805	0.027280862	0.015071	0.006978	0.006978	0.001116	2	0.16
288	0.764516	0.0073696	0.01067728	0	0.213886488	0.035882378	0.027432653	0.015056	0.00697	0.00697	0.001115	2	0.16
289	0.770171	0.00734128	0.01064179	0	0.213492786	0.035816329	0.027584698	0.01504	0.006963	0.006963	0.001114	2	0.16

Table I-2: Model Parameters and Consumption Calculations

290	0.775846	0.00731318	0.01060629	0	0.213101317	0.035750655	0.027736998	0.015024	0.006956	0.006956	0.001113	2	0.16
291	0.781541	0.00728527	0.0105708	0	0.212712062	0.035685352	0.02788955	0.015009	0.006949	0.006949	0.001112	2	0.16
292	0.787255	0.00725757	0.0105353	0	0.212324998	0.035620417	0.028042354	0.014993	0.006941	0.006941	0.001111	2	0.16
293	0.792989	0.00723006	0.0104998	0	0.211940107	0.035555846	0.02819541	0.014978	0.006934	0.006934	0.001109	2	0.16
294	0.798744	0.00720276	0.01046431	0	0.211557368	0.035491636	0.028348716	0.014963	0.006927	0.006927	0.001108	2	0.16
295	0.804517	0.00717564	0.01042881	0	0.211176761	0.035427784	0.028502272	0.014948	0.00692	0.00692	0.001107	2	0.16
296	0.810311	0.00714873	0.01039332	0	0.210798269	0.035364287	0.028656077	0.014932	0.006913	0.006913	0.001106	2	0.16
297	0.816125	0.007122	0.01035782	0	0.21042187	0.035301141	0.02881013	0.014917	0.006906	0.006906	0.001105	2	0.16
298	0.821958	0.00709546	0.01032233	0	0.210047548	0.035238343	0.028964431	0.014902	0.006899	0.006899	0.001104	2	0.16
299	0.827811	0.00706911	0.01028683	0	0.209675282	0.035175891	0.029118979	0.014887	0.006892	0.006892	0.001103	2	0.16
300	0.833683	0.00704295	0.01025134	0	0.209305055	0.03511378	0.029273773	0.014872	0.006885	0.006885	0.001102	2	0.16
301	0.839576	0.00701696	0.01021584	0	0.208936848	0.035052008	0.029428812	0.014858	0.006879	0.006879	0.001101	2	0.16
302	0.845488	0.00699116	0.01018034	0	0.208570644	0.034990573	0.029584096	0.014843	0.006872	0.006872	0.001099	2	0.16
303	0.851419	0.00696554	0.01014485	0	0.208206424	0.03492947	0.029739624	0.014828	0.006865	0.006865	0.001098	2	0.16
304	0.857371	0.0069401	0.01010935	0	0.207844172	0.034868697	0.029895395	0.014814	0.006858	0.006858	0.001097	2	0.16
305	0.863342	0.00691483	0.01007386	0	0.20748387	0.034808251	0.030051409	0.014799	0.006851	0.006851	0.001096	2	0.16
306	0.869332	0.00688974	0.01003836	0	0.2071255	0.03474813	0.030207664	0.014785	0.006845	0.006845	0.001095	2	0.16
307	0.875342	0.00686482	0.01000287	0	0.206769047	0.03468833	0.03036416	0.01477	0.006838	0.006838	0.001094	2	0.16
308	0.881372	0.00684007	0.00996737	0	0.206414493	0.034628849	0.030520897	0.014756	0.006831	0.006831	0.001093	2	0.16
309	0.887421	0.00681549	0.00993188	0	0.206061822	0.034569684	0.030677873	0.014742	0.006825	0.006825	0.001092	2	0.16
310	0.89349	0.00679108	0.00989638	0	0.205711018	0.034510831	0.030835088	0.014727	0.006818	0.006818	0.001091	2	0.16
311	0.899579	0.00676683	0.00986088	0	0.205362064	0.03445229	0.030992541	0.014713	0.006812	0.006812	0.00109	2	0.16
312	0.905687	0.00674275	0.00982539	0	0.205014945	0.034394056	0.031150232	0.014699	0.006805	0.006805	0.001089	2	0.16
313	0.911814	0.00671883	0.00978989	0	0.204669645	0.034336127	0.03130816	0.014685	0.006799	0.006799	0.001088	2	0.16
314	0.917961	0.00669507	0.0097544	0	0.204326148	0.034278501	0.031466324	0.014671	0.006792	0.006792	0.001087	2	0.16
315	0.924127	0.00667147	0.0097189	0	0.20398444	0.034221174	0.031624723	0.014657	0.006786	0.006786	0.001086	2	0.16
316	0.930313	0.00664803	0.00968341	0	0.203644505	0.034164146	0.031783357	0.014644	0.006779	0.006779	0.001085	2	0.16
317	0.936519	0.00662474	0.00964791	0	0.203306327	0.034107412	0.031942225	0.01463	0.006773	0.006773	0.001084	2	0.16
318	0.942743	0.00660161	0.00961242	0	0.202969893	0.03405097	0.032101327	0.014616	0.006767	0.006767	0.001083	2	0.16
319	0.948988	0.00657863	0.00957692	0	0.202635187	0.033994819	0.032260661	0.014602	0.00676	0.00676	0.001082	2	0.16
320	0.955251	0.0065558	0.00954142	0	0.202302196	0.033938955	0.032420228	0.014589	0.006754	0.006754	0.001081	2	0.16
321	0.961534	0.00653312	0.00950593	0	0.201970904	0.033883376	0.032580026	0.014575	0.006748	0.006748	0.00108	2	0.16
322	0.967837	0.00651059	0.00947043	0	0.201641299	0.03382808	0.032740054	0.014562	0.006742	0.006742	0.001079	2	0.16
323	0.974158	0.00648821	0.00943494	0	0.201313364	0.033773065	0.032900313	0.014549	0.006735	0.006735	0.001078	2	0.16
324	0.980499	0.00646597	0.00939944	0	0.200987088	0.033718328	0.033060801	0.014535	0.006729	0.006729	0.001077	2	0.16
325	0.98686	0.00644388	0.00936395	0	0.200662457	0.033663866	0.033221518	0.014522	0.006723	0.006723	0.001076	2	0.16
326	0.99324	0.00642193	0.00932845	0	0.200339455	0.033609678	0.033382464	0.014509	0.006717	0.006717	0.001075	2	0.16
327	0.999639	0.00640013	0.00929296	0	0.200018072	0.033555762	0.033543636	0.014496	0.006711	0.006711	0.001074	2	0.16
328	1.006057	0.00637846	0.00925746	0	0.199698293	0.033502115	0.033705036	0.014482	0.006705	0.006705	0.001073	2	0.16
329	1.012495	0.00635693	0.00922197	0	0.199380105	0.033448734	0.033866662	0.014469	0.006699	0.006699	0.001072	2	0.16
330	1.018951	0.00633554	0.00918647	0	0.199063495	0.033395619	0.034028514	0.014456	0.006693	0.006693	0.001071	2	0.16
331	1.025428	0.00631429	0.00915097	0	0.198748451	0.033342766	0.03419059	0.014443	0.006687	0.006687	0.00107	2	0.16
332	1.031923	0.00629317	0.00911548	0	0.19843496	0.033290173	0.034352891	0.014431	0.006681	0.006681	0.001069	2	0.16
333	1.038437	0.00627218	0.00907998	0	0.198123009	0.033237839	0.034515415	0.014418	0.006675	0.006675	0.001068	2	0.16
334	1.044971	0.00625133	0.00904449	0	0.197812587	0.033185762	0.034678163	0.014405	0.006669	0.006669	0.001067	2	0.16
335	1.051524	0.00623061	0.00900899	0	0.19750368	0.033133938	0.034841133	0.014392	0.006663	0.006663	0.001066	2	0.16
336	1.058096	0.00621002	0.0089735	0	0.197196278	0.033082367	0.035004325	0.014379	0.006657	0.006657	0.001065	2	0.16
337	1.064687	0.00618956	0.008938	0	0.196890367	0.033031047	0.035167739	0.014367	0.006651	0.006651	0.001064	2	0.16
338	1.071298	0.00616922	0.00890251	0	0.196585937	0.032979974	0.035331373	0.014354	0.006646	0.006646	0.001063	2	0.16
339	1.077927	0.00614901	0.00886701	0	0.196282975	0.032929149	0.035495227	0.014342	0.00664	0.00664	0.001062	2	0.16
340	1.084576	0.00612893	0.00883151	0	0.19598147	0.032878567	0.0356593	0.014329	0.006634	0.006634	0.001061	2	0.16
341	1.091244	0.00610897	0.00879602	0	0.195681411	0.032828228	0.035823593	0.014317	0.006628	0.006628	0.001061	2	0.16
342	1.09793	0.00608914	0.00876052	0	0.195382786	0.032778129	0.035988103	0.014305	0.006622	0.006622	0.00106	2	0.16

Table I-2: Model Parameters and Consumption Calculations

	343	1.104636	0.00606943	0.00872503	0	0.195085584	0.03272827	0.036152832	0.014292	0.006617	0.006617	0.001059	2	0.16
	344	1.111361	0.00604983	0.00868953	0	0.194789794	0.032678647	0.036317777	0.01428	0.006611	0.006611	0.001058	2	0.16
	345	1.118105	0.00603036	0.00865404	0	0.194495405	0.032629259	0.036482939	0.014268	0.006605	0.006605	0.001057	2	0.16
	346	1.124868	0.00601101	0.00861854	0	0.194202407	0.032580105	0.036648316	0.014256	0.0066	0.0066	0.001056	2	0.16
	347	1.13165	0.00599177	0.00858305	0	0.193910788	0.032531182	0.036813909	0.014244	0.006594	0.006594	0.001055	2	0.16
	348	1.138451	0.00597265	0.00854755	0	0.193620538	0.032482488	0.036979717	0.014231	0.006589	0.006589	0.001054	2	0.16
	349	1.145271	0.00595365	0.00851205	0	0.193331647	0.032434023	0.037145739	0.014219	0.006583	0.006583	0.001053	2	0.16
	350	1.15211	0.00593476	0.00847656	0	0.193044104	0.032385784	0.037311974	0.014207	0.006578	0.006578	0.001052	2	0.16
	351	1.158967	0.00591599	0.00844106	0	0.192757898	0.032337769	0.037478423	0.014196	0.006572	0.006572	0.001052	2	0.16
	352	1.165844	0.00589732	0.00840557	0	0.192473021	0.032289977	0.037645083	0.014184	0.006567	0.006567	0.001051	2	0.16
	353	1.17274	0.00587877	0.00837007	0	0.192189461	0.032242406	0.037811956	0.014172	0.006561	0.006561	0.00105	2	0.16
	354	1.179654	0.00586033	0.00833458	0	0.191907209	0.032195054	0.03797904	0.01416	0.006556	0.006556	0.001049	2	0.16
	355	1.186588	0.005842	0.00829908	0	0.191626255	0.03214792	0.038146335	0.014148	0.00655	0.00655	0.001048	2	0.16
	356	1.19354	0.00582378	0.00826359	0	0.191346589	0.032101002	0.03831384	0.014137	0.006545	0.006545	0.001047	2	0.16
	357	1.200511	0.00580566	0.00822809	0	0.191068202	0.032054299	0.038481554	0.014125	0.006539	0.006539	0.001046	2	0.16
	358	1.207502	0.00578766	0.00819259	0	0.190791083	0.032007809	0.038649478	0.014113	0.006534	0.006534	0.001045	2	0.16
	359	1.21451	0.00576975	0.0081571	0	0.190515225	0.03196153	0.03881761	0.014102	0.006529	0.006529	0.001045	2	0.16
	360	1.221538	0.00575196	0.0081216	0	0.190240616	0.03191546	0.03898595	0.01409	0.006523	0.006523	0.001044	2	0.16
	361	1.228585	0.00573426	0.00808611	0	0.189967249	0.031869599	0.039154497	0.014079	0.006518	0.006518	0.001043	2	0.16
	362	1.23565	0.00571667	0.00805061	0	0.189695113	0.031823945	0.039323252	0.014068	0.006513	0.006513	0.001042	2	0.16
	363	1.242734	0.00569919	0.00801512	0	0.189424201	0.031778495	0.039492212	0.014056	0.006507	0.006507	0.001041	2	0.16
	364	1.249837	0.0056818	0.00797962	0	0.189154502	0.03173325	0.039661379	0.014045	0.006502	0.006502	0.00104	2	0.16
	365	1.256958	0.00566452	0.00794413	0	0.188886008	0.031688206	0.03983075	0.014034	0.006497	0.006497	0.00104	2	0.16
1 year old	366	1.264098	0.00564733	0.00790863	0.0001999	0.18861871	0.031643364	0.040000327	0.014022	0.006492	0.006492	0.001039	2	0.16
	367	1.271257	0.00563024	0.00787313	0.0001999	0.1883526	0.03159872	0.040170107	0.014011	0.006487	0.006487	0.001038	2	0.16
	368	1.278435	0.00561325	0.00783764	0.0001999	0.188087669	0.031554274	0.040340091	0.014	0.006481	0.006481	0.001037	2	0.16
	369	1.285631	0.00559636	0.00780214	0.0001999	0.187823908	0.031510025	0.040510279	0.013989	0.006476	0.006476	0.001036	2	0.16
	370	1.292846	0.00557957	0.00776665	0.0001999	0.18756131	0.03146597	0.040680669	0.013978	0.006471	0.006471	0.001035	2	0.16
	371	1.30008	0.00556287	0.00773115	0.0001999	0.187299864	0.031422109	0.040851261	0.013967	0.006466	0.006466	0.001035	2	0.16
	372	1.307332	0.00554626	0.00769566	0.0001999	0.187039564	0.03137844	0.041022054	0.013956	0.006461	0.006461	0.001034	2	0.16
	373	1.314603	0.00552975	0.00766016	0.0001999	0.186780402	0.031334962	0.041193049	0.013945	0.006456	0.006456	0.001033	2	0.16
	374	1.321893	0.00551333	0.00762467	0.0001999	0.186522368	0.031291673	0.041364244	0.013934	0.006451	0.006451	0.001032	2	0.16
	375	1.329201	0.005497	0.00758917	0.0001999	0.186265455	0.031248573	0.041535639	0.013923	0.006446	0.006446	0.001031	2	0.16
	376	1.336528	0.00548077	0.00755367	0.0001999	0.186009655	0.031205659	0.041707234	0.013912	0.006441	0.006441	0.001031	2	0.16
	377	1.343873	0.00546463	0.00751818	0.0001999	0.185754961	0.03116293	0.041879028	0.013902	0.006436	0.006436	0.00103	2	0.16
	378	1.351237	0.00544857	0.00748268	0.0001999	0.185501364	0.031120386	0.04205102	0.013891	0.006431	0.006431	0.001029	2	0.16
	379	1.358619	0.00543261	0.00744719	0.0001999	0.185248856	0.031078024	0.04222321	0.01388	0.006426	0.006426	0.001028	2	0.16
	380	1.36602	0.00541673	0.00741169	0.0001999	0.184997431	0.031035844	0.042395597	0.013869	0.006421	0.006421	0.001027	2	0.16
	381	1.37344	0.00540095	0.0073762	0.0001999	0.18474708	0.030993845	0.042568182	0.013859	0.006416	0.006416	0.001027	2	0.16
	382	1.380878	0.00538525	0.0073407	0.0001999	0.184497796	0.030952024	0.042740963	0.013848	0.006411	0.006411	0.001026	2	0.16
	383	1.388334	0.00536963	0.00730521	0.0001999	0.184249572	0.030910381	0.04291394	0.013838	0.006406	0.006406	0.001025	2	0.16
	384	1.395809	0.00535411	0.00726971	0.0001999	0.184002399	0.030868914	0.043087113	0.013827	0.006401	0.006401	0.001024	2	0.16
	385	1.403302	0.00533866	0.00723421	0.0001999	0.183756272	0.030827623	0.04326048	0.013817	0.006397	0.006397	0.001023	2	0.16
	386	1.410814	0.0053233	0.00719872	0.0001999	0.183511182	0.030786506	0.043434042	0.013806	0.006392	0.006392	0.001023	2	0.16
	387	1.418345	0.00530803	0.00716322	0.0001999	0.183267123	0.030745562	0.043607799	0.013796	0.006387	0.006387	0.001022	2	0.16
	388	1.425893	0.00529284	0.00712773	0.0001999	0.183024088	0.030704789	0.043781748	0.013786	0.006382	0.006382	0.001021	2	0.16
	389	1.43346	0.00527773	0.00709223	0.0001999	0.182782069	0.030664187	0.043955891	0.013775	0.006377	0.006377	0.00102	2	0.16
	390	1.441046	0.0052627	0.00705674	0.0001999	0.182541059	0.030623755	0.044130226	0.013765	0.006373	0.006373	0.00102	2	0.16
	391	1.448649	0.00524776	0.00702124	0.0001999	0.182301052	0.03058349	0.044304754	0.013755	0.006368	0.006368	0.001019	2	0.16
	392	1.456272	0.00523289	0.00698575	0.0001999	0.182062041	0.030543393	0.044479473	0.013745	0.006363	0.006363	0.001018	2	0.16
	393	1.463912	0.00521811	0.00695025	0.0001999	0.181824019	0.030503461	0.044654383	0.013734	0.006358	0.006358	0.001017	2	0.16
	394	1.471571	0.0052034	0.00691475	0.0001999	0.18158698	0.030463695	0.044829484	0.013724	0.006354	0.006354	0.001017	2	0.16
	395	1.479248	0.00518877	0.00687926	0.0001999	0.181350916	0.030424092	0.045004775	0.013714	0.006349	0.006349	0.001016	2	0.16

Table I-2: Model Parameters and Consumption Calculations

396	1.486943	0.00517422	0.00684376	0.0001999	0.181115821	0.030384651	0.045180256	0.013704	0.006344	0.006344	0.001015	2	0.16
397	1.494657	0.00515975	0.00680827	0.0001999	0.180881689	0.030345373	0.045355926	0.013694	0.00634	0.00634	0.001014	2	0.16
398	1.502389	0.00514535	0.00677277	0.0001999	0.180648514	0.030306254	0.045531785	0.013684	0.006335	0.006335	0.001014	2	0.16
399	1.510139	0.00513103	0.00673728	0.0001999	0.180416288	0.030267295	0.045707832	0.013674	0.006331	0.006331	0.001013	2	0.16
400	1.517908	0.00511679	0.00670178	0.0001999	0.180185006	0.030228494	0.045884067	0.013664	0.006326	0.006326	0.001012	2	0.16
401	1.525694	0.00510262	0.00666629	0.0001999	0.179954661	0.030189851	0.04606049	0.013654	0.006321	0.006321	0.001011	2	0.16
402	1.533499	0.00508852	0.00663079	0.0001999	0.179725248	0.030151364	0.046237099	0.013644	0.006317	0.006317	0.001011	2	0.16
403	1.541323	0.0050745	0.00659529	0.0001999	0.179496759	0.030113032	0.046413895	0.013635	0.006312	0.006312	0.00101	2	0.16
404	1.549164	0.00506055	0.0065598	0.0001999	0.179269189	0.030074854	0.046590877	0.013625	0.006308	0.006308	0.001009	2	0.16
405	1.557023	0.00504668	0.0065243	0.0001999	0.179042532	0.030036829	0.046768045	0.013615	0.006303	0.006303	0.001009	2	0.16
406	1.564901	0.00503288	0.00648881	0.0001999	0.178816782	0.029998956	0.046945398	0.013605	0.006299	0.006299	0.001008	2	0.16
407	1.572797	0.00501914	0.00645331	0.0001999	0.178591933	0.029961235	0.047122935	0.013596	0.006294	0.006294	0.001007	2	0.16
408	1.580711	0.00500548	0.00641782	0.0001999	0.178367979	0.029923663	0.047300657	0.013586	0.00629	0.00629	0.001006	2	0.16
409	1.588643	0.00499189	0.00638232	0.0001999	0.178144914	0.029886241	0.047478563	0.013576	0.006285	0.006285	0.001006	2	0.16
410	1.596593	0.00497837	0.00634683	0.0001999	0.177922733	0.029848967	0.047656652	0.013567	0.006281	0.006281	0.001005	2	0.16
411	1.604561	0.00496492	0.00631133	0.0001999	0.177701429	0.029811841	0.047834924	0.013557	0.006277	0.006277	0.001004	2	0.16
412	1.612548	0.00495154	0.00627583	0.0001999	0.177480997	0.02977486	0.048013379	0.013548	0.006272	0.006272	0.001004	2	0.16
413	1.620552	0.00493823	0.00624034	0.0001999	0.177261432	0.029738025	0.048192015	0.013538	0.006268	0.006268	0.001003	2	0.16
414	1.628574	0.00492498	0.00620484	0.0001999	0.177042728	0.029701334	0.048370834	0.013529	0.006263	0.006263	0.001002	2	0.16
415	1.636615	0.0049118	0.00616935	0.0001999	0.176824879	0.029664787	0.048549833	0.013519	0.006259	0.006259	0.001001	2	0.16
416	1.644673	0.00489869	0.00613385	0.0001999	0.17660788	0.029628383	0.048729014	0.01351	0.006255	0.006255	0.001001	2	0.16
417	1.65275	0.00488565	0.00609836	0.0001999	0.176391726	0.02959212	0.048908374	0.013501	0.00625	0.00625	0.001	2	0.16
418	1.660844	0.00487267	0.00606286	0.0001999	0.17617641	0.029555998	0.049087915	0.013491	0.006246	0.006246	0.000999	2	0.16
419	1.668957	0.00485975	0.00602737	0.0001999	0.175961928	0.029520016	0.049267635	0.013482	0.006242	0.006242	0.000999	2	0.16
420	1.677087	0.00484691	0.00599187	0.0001999	0.175748275	0.029484172	0.049447534	0.013473	0.006237	0.006237	0.000998	2	0.16
421	1.685236	0.00483412	0.00595637	0.0001999	0.175535446	0.029448467	0.049627612	0.013464	0.006233	0.006233	0.000997	2	0.16
422	1.693402	0.0048214	0.00592088	0.0001999	0.175323434	0.029412899	0.049807868	0.013454	0.006229	0.006229	0.000997	2	0.16
423	1.701586	0.00480874	0.00588538	0.0001999	0.175112235	0.029377468	0.049988301	0.013445	0.006225	0.006225	0.000996	2	0.16
424	1.709789	0.00479615	0.00584989	0.0001999	0.174901844	0.029342172	0.050168912	0.013436	0.00622	0.00622	0.000995	2	0.16
425	1.718009	0.00478362	0.00581439	0.0001999	0.174692256	0.029307011	0.050349701	0.013427	0.006216	0.006216	0.000995	2	0.16
426	1.726247	0.00477115	0.0057789	0.0001999	0.174483465	0.029271983	0.050530665	0.013418	0.006212	0.006212	0.000994	2	0.16
427	1.734503	0.00475874	0.0057434	0.0001999	0.174275468	0.029237089	0.050711806	0.013409	0.006208	0.006208	0.000993	2	0.16
428	1.742776	0.00474639	0.00570791	0.0001999	0.174068258	0.029202327	0.050893123	0.0134	0.006204	0.006204	0.000993	2	0.16
429	1.751068	0.00473411	0.00567241	0.0001999	0.173861832	0.029167696	0.051074615	0.013391	0.006199	0.006199	0.000992	2	0.16
430	1.759377	0.00472188	0.00563691	0.0001999	0.173656183	0.029133195	0.051256282	0.013382	0.006195	0.006195	0.000991	2	0.16
431	1.767704	0.00470972	0.00560142	0.0001999	0.173451308	0.029098825	0.051438123	0.013373	0.006191	0.006191	0.000991	2	0.16
432	1.77605	0.00469761	0.00556592	0.0001999	0.173247202	0.029064583	0.051620138	0.013364	0.006187	0.006187	0.00099	2	0.16
433	1.784412	0.00468556	0.00553043	0.0001999	0.173043859	0.02903047	0.051802328	0.013355	0.006183	0.006183	0.000989	2	0.16
434	1.792793	0.00467357	0.00549493	0.0001999	0.172841276	0.028996483	0.05198469	0.013346	0.006179	0.006179	0.000989	2	0.16
435	1.801191	0.00466164	0.00545944	0.0001999	0.172639447	0.028962624	0.052167226	0.013338	0.006175	0.006175	0.000988	2	0.16
436	1.809607	0.00464977	0.00542394	0.0001999	0.172438369	0.02892889	0.052349934	0.013329	0.006171	0.006171	0.000987	2	0.16
437	1.818041	0.00463795	0.00538845	0.0001999	0.172238035	0.028895282	0.052532814	0.01332	0.006167	0.006167	0.000987	2	0.16
438	1.826493	0.0046262	0.00535295	0.0001999	0.172038443	0.028861797	0.052715865	0.013311	0.006163	0.006163	0.000986	2	0.16
439	1.834962	0.00461449	0.00531745	0.0001999	0.171839587	0.028828437	0.052899089	0.013303	0.006159	0.006159	0.000985	2	0.16
440	1.843449	0.00460285	0.00528196	0.0001999	0.171641463	0.028795199	0.053082483	0.013294	0.006155	0.006155	0.000985	2	0.16
441	1.851954	0.00459126	0.00524646	0.0001999	0.171444067	0.028762083	0.053266047	0.013285	0.006151	0.006151	0.000984	2	0.16
442	1.860476	0.00457972	0.00521097	0.0001999	0.171247394	0.028729088	0.053449782	0.013277	0.006147	0.006147	0.000983	2	0.16
443	1.869016	0.00456824	0.00517547	0.0001999	0.17105144	0.028696214	0.053633687	0.013268	0.006143	0.006143	0.000983	2	0.16
444	1.877574	0.00455682	0.00513998	0.0001999	0.1708562	0.02866346	0.053817761	0.013259	0.006139	0.006139	0.000982	2	0.16
445	1.886149	0.00454545	0.00510448	0.0001999	0.170661671	0.028630825	0.054002004	0.013251	0.006135	0.006135	0.000982	2	0.16
446	1.894742	0.00453413	0.00506899	0.0001999	0.170467847	0.028598308	0.054186415	0.013242	0.006131	0.006131	0.000981	2	0.16
447	1.903352	0.00452287	0.00503349	0.0001999	0.170274726	0.02856591	0.054370995	0.013234	0.006127	0.006127	0.00098	2	0.16
448	1.911981	0.00451165	0.00499799	0.0001999	0.170082302	0.028533628	0.054555743	0.013225	0.006123	0.006123	0.00098	2	0.16

Table I-2: Model Parameters and Consumption Calculations

449	1.920626	0.0045005	0.0049625	0.0001999	0.169890572	0.028501463	0.054740658	0.013217	0.006119	0.006119	0.000979	2	0.16
450	1.92929	0.00448939	0.004927	0.0001999	0.169699532	0.028469413	0.05492574	0.013209	0.006115	0.006115	0.000978	2	0.16
451	1.93797	0.00447834	0.00489151	0.0001999	0.169509177	0.028437478	0.055110989	0.0132	0.006111	0.006111	0.000978	2	0.16
452	1.946669	0.00446733	0.00485601	0.0001999	0.169319503	0.028405658	0.055296405	0.013192	0.006107	0.006107	0.000977	2	0.16
453	1.955385	0.00445638	0.00482052	0.0001999	0.169130507	0.028373951	0.055481986	0.013184	0.006103	0.006103	0.000977	2	0.16
454	1.964118	0.00444548	0.00478502	0.0001999	0.168942185	0.028342358	0.055667733	0.013175	0.0061	0.0061	0.000976	2	0.16
455	1.972869	0.00443463	0.00474953	0.0001999	0.168754531	0.028310876	0.055853645	0.013167	0.006096	0.006096	0.000975	2	0.16
456	1.981637	0.00442383	0.00471403	0.0001999	0.168567544	0.028279507	0.056039722	0.013159	0.006092	0.006092	0.000975	2	0.16
457	1.990423	0.00441308	0.00467854	0.0001999	0.168381218	0.028248248	0.056225964	0.01315	0.006088	0.006088	0.000974	2	0.16
458	1.999226	0.00440238	0.00464304	0.0001999	0.168195551	0.0282171	0.05641237	0.013142	0.006084	0.006084	0.000974	2	0.16
459	2.008047	0.00439173	0.00460754	0.0001999	0.168010537	0.028186061	0.056598939	0.013134	0.006081	0.006081	0.000973	2	0.16
460	2.016885	0.00438113	0.00457205	0.0001999	0.167826174	0.028155132	0.056785672	0.013126	0.006077	0.006077	0.000972	2	0.16
461	2.025741	0.00437058	0.00453655	0.0001999	0.167642457	0.028124311	0.056972568	0.013118	0.006073	0.006073	0.000972	2	0.16
462	2.034614	0.00436007	0.00450106	0.0001999	0.167459384	0.028093598	0.057159627	0.01311	0.006069	0.006069	0.000971	2	0.16
463	2.043504	0.00434962	0.00446556	0.0001999	0.167276949	0.028062992	0.057346848	0.013102	0.006066	0.006066	0.00097	2	0.16
464	2.052412	0.00433921	0.00443007	0.0001999	0.167095151	0.028032493	0.057534231	0.013094	0.006062	0.006062	0.00097	2	0.16
465	2.061337	0.00432884	0.00439457	0.0001999	0.166913984	0.028002099	0.057721776	0.013086	0.006058	0.006058	0.000969	2	0.16
466	2.07028	0.00431853	0.00435908	0.0001999	0.166733445	0.027971812	0.057909482	0.013078	0.006054	0.006054	0.000969	2	0.16
467	2.07924	0.00430826	0.00432358	0.0001999	0.166553532	0.027941629	0.058097349	0.01307	0.006051	0.006051	0.000968	2	0.16
468	2.088217	0.00429804	0.00428808	0.0001999	0.166374239	0.02791155	0.058285376	0.013062	0.006047	0.006047	0.000968	2	0.16
469	2.097212	0.00428786	0.00425259	0.0001999	0.166195565	0.027881575	0.058473564	0.013054	0.006043	0.006043	0.000967	2	0.16
470	2.106224	0.00427773	0.00421709	0.0001999	0.166017504	0.027851703	0.058661911	0.013046	0.00604	0.00604	0.000966	2	0.16
471	2.115253	0.00426764	0.0041816	0.0001999	0.165840055	0.027821933	0.058850418	0.013038	0.006036	0.006036	0.000966	2	0.16
472	2.124299	0.0042576	0.0041461	0.0001999	0.165663212	0.027792265	0.059039085	0.01303	0.006032	0.006032	0.000965	2	0.16
473	2.133363	0.00424761	0.00411061	0.0001999	0.165486974	0.027762699	0.05922791	0.013022	0.006029	0.006029	0.000965	2	0.16
474	2.142444	0.00423766	0.00407511	0.0001999	0.165311337	0.027733233	0.059416893	0.013014	0.006025	0.006025	0.000964	2	0.16
475	2.151542	0.00422775	0.00403962	0.0001999	0.165136296	0.027703868	0.059606035	0.013007	0.006022	0.006022	0.000963	2	0.16
476	2.160657	0.00421789	0.00400412	0.0001999	0.16496185	0.027674602	0.059795335	0.012999	0.006018	0.006018	0.000963	2	0.16
477	2.16979	0.00420807	0.00396862	0.0001999	0.164787994	0.027645435	0.059984791	0.012991	0.006014	0.006014	0.000962	2	0.16
478	2.17894	0.00419829	0.00393313	0.0001999	0.164614725	0.027616367	0.060174406	0.012983	0.006011	0.006011	0.000962	2	0.16
479	2.188107	0.00418856	0.00389763	0.0001999	0.164442041	0.027587397	0.060364176	0.012976	0.006007	0.006007	0.000961	2	0.16
480	2.197291	0.00417887	0.00386214	0.0001999	0.164269937	0.027558524	0.060554104	0.012968	0.006004	0.006004	0.000961	2	0.16
481	2.206493	0.00416922	0.00382664	0.0001999	0.164098411	0.027529749	0.060744187	0.01296	0.006	0.006	0.00096	2	0.16
482	2.215711	0.00415962	0.00379115	0.0001999	0.163927459	0.027501069	0.060934426	0.012953	0.005997	0.005997	0.000959	2	0.16
483	2.224947	0.00415005	0.00375565	0.0001999	0.163757079	0.027472485	0.061124821	0.012945	0.005993	0.005993	0.000959	2	0.16
484	2.2342	0.00414053	0.00372016	0.0001999	0.163587267	0.027443997	0.061315371	0.012937	0.00599	0.00599	0.000958	2	0.16
485	2.24347	0.00413105	0.00368466	0.0001999	0.16341802	0.027415604	0.061506075	0.01293	0.005986	0.005986	0.000958	2	0.16
486	2.252757	0.00412161	0.00364916	0.0001999	0.163249335	0.027387305	0.061696934	0.012922	0.005983	0.005983	0.000957	2	0.16
487	2.262061	0.00411221	0.00361367	0.0001999	0.16308121	0.027359099	0.061887948	0.012915	0.005979	0.005979	0.000957	2	0.16
488	2.271382	0.00410285	0.00357817	0.0001999	0.16291364	0.027330987	0.062079114	0.012907	0.005976	0.005976	0.000956	2	0.16
489	2.28072	0.00409354	0.00354268	0.0001999	0.162746622	0.027302968	0.062270435	0.0129	0.005972	0.005972	0.000956	2	0.16
490	2.290076	0.00408426	0.00350718	0.0001999	0.162580155	0.02727504	0.062461908	0.012892	0.005969	0.005969	0.000955	2	0.16
491	2.299448	0.00407502	0.00347169	0.0001999	0.162414235	0.027247205	0.062653535	0.012885	0.005965	0.005965	0.000954	2	0.16
492	2.308838	0.00406583	0.00343619	0.0001999	0.162248859	0.027219461	0.062845314	0.012877	0.005962	0.005962	0.000954	2	0.16
493	2.318244	0.00405667	0.0034007	0.0001999	0.162084024	0.027191808	0.063037245	0.01287	0.005958	0.005958	0.000953	2	0.16
494	2.327667	0.00404755	0.0033652	0.0001999	0.161919727	0.027164245	0.063229328	0.012863	0.005955	0.005955	0.000953	2	0.16
495	2.337108	0.00403847	0.0033297	0.0001999	0.161755965	0.027136771	0.063421562	0.012855	0.005952	0.005952	0.000952	2	0.16
496	2.346565	0.00402943	0.00329421	0.0001999	0.161592736	0.027109387	0.063613948	0.012848	0.005948	0.005948	0.000952	2	0.16
497	2.35604	0.00402042	0.00325871	0.0001999	0.161430037	0.027082092	0.063806484	0.012841	0.005945	0.005945	0.000951	2	0.16
498	2.365531	0.00401146	0.00322322	0.0001999	0.161267864	0.027054886	0.063999172	0.012833	0.005941	0.005941	0.000951	2	0.16
499	2.375039	0.00400253	0.00318772	0.0001999	0.161106215	0.027027767	0.064192009	0.012826	0.005938	0.005938	0.00095	2	0.16
500	2.384565	0.00399364	0.00315223	0.0001999	0.160945087	0.027000735	0.064384996	0.012819	0.005935	0.005935	0.00095	2	0.16
501	2.394107	0.00398479	0.00311673	0.0001999	0.160784478	0.026973791	0.064578133	0.012812	0.005931	0.005931	0.000949	2	0.16

Table I-2: Model Parameters and Consumption Calculations

502	2.403666	0.00397598	0.00308124	0.0001999	0.160624385	0.026946933	0.06477142	0.012804	0.005928	0.005928	0.000948	2	0.16
503	2.413242	0.0039672	0.00304574	0.0001999	0.160464805	0.026920162	0.064964855	0.012797	0.005925	0.005925	0.000948	2	0.16
504	2.422834	0.00395846	0.00301024	0.0001999	0.160305735	0.026893475	0.065158439	0.01279	0.005921	0.005921	0.000947	2	0.16
505	2.432444	0.00394975	0.00297475	0.0001999	0.160147172	0.026866874	0.065352172	0.012783	0.005918	0.005918	0.000947	2	0.16
506	2.442071	0.00394108	0.00293925	0.0001999	0.159989115	0.026840358	0.065546053	0.012776	0.005915	0.005915	0.000946	2	0.16
507	2.451714	0.00393245	0.00290376	0.0001999	0.15983156	0.026813926	0.065740081	0.012769	0.005911	0.005911	0.000946	2	0.16
508	2.461374	0.00392386	0.00286826	0.0001999	0.159674505	0.026787578	0.065934257	0.012761	0.005908	0.005908	0.000945	2	0.16
509	2.471051	0.00391529	0.00283277	0.0001999	0.159517947	0.026761313	0.06612858	0.012754	0.005905	0.005905	0.000945	2	0.16
510	2.480745	0.00390677	0.00279727	0.0001999	0.159361883	0.026735131	0.06632305	0.012747	0.005902	0.005902	0.000944	2	0.16
511	2.490456	0.00389828	0.00276178	0.0001999	0.159206312	0.026709032	0.066517667	0.01274	0.005898	0.005898	0.000944	2	0.16
512	2.500183	0.00388982	0.00272628	0.0001999	0.15905123	0.026683015	0.06671243	0.012733	0.005895	0.005895	0.000943	2	0.16
513	2.509928	0.0038814	0.00269078	0.0001999	0.158896634	0.02665708	0.066907339	0.012726	0.005892	0.005892	0.000943	2	0.16
514	2.519689	0.00387302	0.00265529	0.0001999	0.158742524	0.026631225	0.067102393	0.012719	0.005889	0.005889	0.000942	2	0.16
515	2.529466	0.00386467	0.00261979	0.0001999	0.158588895	0.026605452	0.067297593	0.012712	0.005885	0.005885	0.000942	2	0.16
516	2.539261	0.00385635	0.0025843	0.0001999	0.158435746	0.026579759	0.067492938	0.012705	0.005882	0.005882	0.000941	2	0.16
517	2.549072	0.00384807	0.0025488	0.0001999	0.158283073	0.026554146	0.067688428	0.012698	0.005879	0.005879	0.000941	2	0.16
518	2.5589	0.00383982	0.00251331	0.0001999	0.158130876	0.026528613	0.067884063	0.012691	0.005876	0.005876	0.00094	2	0.16
519	2.568744	0.0038316	0.00247781	0.0001999	0.15797915	0.026503159	0.068079841	0.012685	0.005873	0.005873	0.00094	2	0.16
520	2.578606	0.00382342	0.00244232	0.0001999	0.157827894	0.026477784	0.068275764	0.012678	0.005869	0.005869	0.000939	2	0.16
521	2.588484	0.00381527	0.00240682	0.0001999	0.157677106	0.026452487	0.06847183	0.012671	0.005866	0.005866	0.000939	2	0.16
522	2.598378	0.00380715	0.00237132	0.0001999	0.157526782	0.026427268	0.068668039	0.012664	0.005863	0.005863	0.000938	2	0.16
523	2.60829	0.00379907	0.00233583	0.0001999	0.157376921	0.026402127	0.068864392	0.012657	0.00586	0.00586	0.000938	2	0.16
524	2.618217	0.00379102	0.00230033	0.0001999	0.157227521	0.026377063	0.069060887	0.01265	0.005857	0.005857	0.000937	2	0.16
525	2.628162	0.003783	0.00226484	0.0001999	0.157078578	0.026352076	0.069257525	0.012644	0.005854	0.005854	0.000937	2	0.16
526	2.638123	0.00377501	0.00222934	0.0001999	0.156930092	0.026327165	0.069454305	0.012637	0.00585	0.00585	0.000936	2	0.16
527	2.648101	0.00376706	0.00219385	0.0001999	0.156782058	0.02630233	0.069651226	0.01263	0.005847	0.005847	0.000936	2	0.16
528	2.658095	0.00375914	0.00215835	0.0001999	0.156634476	0.026277572	0.06984829	0.012623	0.005844	0.005844	0.000935	2	0.16
529	2.668106	0.00375124	0.00212286	0.0001999	0.156487342	0.026252888	0.070045495	0.012617	0.005841	0.005841	0.000935	2	0.16
530	2.678134	0.00374338	0.00208736	0.0001999	0.156340656	0.026228279	0.07024284	0.01261	0.005838	0.005838	0.000934	2	0.16
531	2.688178	0.00373556	0.00205186	0.0001999	0.156194413	0.026203745	0.070440327	0.012603	0.005835	0.005835	0.000934	2	0.16
532	2.698238	0.00372776	0.00201637	0.0001999	0.156048613	0.026179285	0.070637954	0.012597	0.005832	0.005832	0.000933	2	0.16
533	2.708316	0.00371999	0.00198087	0.0001999	0.155903253	0.026154899	0.070835721	0.01259	0.005829	0.005829	0.000933	2	0.16
534	2.718409	0.00371226	0.00194538	0.0001999	0.155758331	0.026130586	0.071033628	0.012583	0.005826	0.005826	0.000932	2	0.16
535	2.728519	0.00370455	0.00190988	0.0001999	0.155613844	0.026106347	0.071231675	0.012577	0.005823	0.005823	0.000932	2	0.16
536	2.738646	0.00369688	0.00187439	0.0001999	0.155469791	0.02608218	0.071429861	0.01257	0.00582	0.00582	0.000931	2	0.16
537	2.748789	0.00368923	0.00183889	0.0001999	0.155326169	0.026058085	0.071628187	0.012564	0.005817	0.005817	0.000931	2	0.16
538	2.758949	0.00368162	0.0018034	0.0001999	0.155182977	0.026034063	0.071826651	0.012557	0.005813	0.005813	0.00093	2	0.16
539	2.769125	0.00367403	0.0017679	0.0001999	0.155040212	0.026010112	0.072025253	0.012551	0.00581	0.00581	0.00093	2	0.16
540	2.779318	0.00366647	0.0017324	0.0001999	0.154897871	0.025986232	0.072223994	0.012544	0.005807	0.005807	0.000929	2	0.16
541	2.789527	0.00365895	0.00169691	0.0001999	0.154755954	0.025962424	0.072422873	0.012538	0.005804	0.005804	0.000929	2	0.16
542	2.799752	0.00365145	0.00166141	0.0001999	0.154614458	0.025938686	0.07262189	0.012531	0.005801	0.005801	0.000928	2	0.16
543	2.809994	0.00364398	0.00162592	0.0001999	0.15447338	0.025915018	0.072821044	0.012525	0.005798	0.005798	0.000928	2	0.16
544	2.820252	0.00363655	0.00159042	0.0001999	0.15433272	0.025891421	0.073020335	0.012518	0.005795	0.005795	0.000927	2	0.16
545	2.830527	0.00362914	0.00155493	0.0001999	0.154192474	0.025867892	0.073219763	0.012512	0.005792	0.005792	0.000927	2	0.16
546	2.840818	0.00362175	0.00151943	0.0001999	0.154052641	0.025844434	0.073419328	0.012505	0.005789	0.005789	0.000926	2	0.16
547	2.851125	0.0036144	0.00148394	0.0001999	0.153913219	0.025821044	0.073619029	0.012499	0.005787	0.005787	0.000926	2	0.16
548	2.861449	0.00360708	0.00144844	0.0001999	0.153774206	0.025797722	0.073818867	0.012493	0.005784	0.005784	0.000925	2	0.16
549	2.871789	0.00359978	0.00141294	0.0001999	0.153635599	0.025774469	0.07401884	0.012486	0.005781	0.005781	0.000925	2	0.16
550	2.882146	0.00359251	0.00137745	0.0001999	0.153497398	0.025751284	0.074218949	0.01248	0.005778	0.005778	0.000924	2	0.16
551	2.892518	0.00358527	0.00238883	0.0001999	0.1533596	0.025728166	0.074419193	0.012473	0.005775	0.005775	0.000924	2	0.16
552	2.902907	0.00357806	0.00238663	0.0001999	0.153222202	0.025705116	0.074619572	0.012467	0.005772	0.005772	0.000923	2	0.16
553	2.913313	0.00357088	0.00238443	0.0001999	0.153085204	0.025682133	0.074820086	0.012461	0.005769	0.005769	0.000923	2	0.16
554	2.923734	0.00356372	0.00238224	0.0001999	0.152948603	0.025659216	0.075020734	0.012455	0.005766	0.005766	0.000923	2	0.16

Table I-2: Model Parameters and Consumption Calculations

555	2.934172	0.00355659	0.00238004	0.0001999	0.152812397	0.025636366	0.075221517	0.012448	0.005763	0.005763	0.000922	2	0.16
556	2.944627	0.00354948	0.00237784	0.0001999	0.152676585	0.025613581	0.075422434	0.012442	0.00576	0.00576	0.000922	2	0.16
557	2.955097	0.00354241	0.00237564	0.0001999	0.152541164	0.025590863	0.075623484	0.012436	0.005757	0.005757	0.000921	2	0.16
558	2.965584	0.00353536	0.00237344	0.0001999	0.152406133	0.025568209	0.075824668	0.01243	0.005754	0.005754	0.000921	2	0.16
559	2.976087	0.00352833	0.00237125	0.0001999	0.15227149	0.025545621	0.076025985	0.012423	0.005752	0.005752	0.00092	2	0.16
560	2.986606	0.00352134	0.00236905	0.0001999	0.152137233	0.025523098	0.076227436	0.012417	0.005749	0.005749	0.00092	2	0.16
561	2.997141	0.00351437	0.00236685	0.0001999	0.152003361	0.025500639	0.076429019	0.012411	0.005746	0.005746	0.000919	2	0.16
562	3.007693	0.00350742	0.00236465	0.0001999	0.15186987	0.025478244	0.076630734	0.012405	0.005743	0.005743	0.000919	2	0.16
563	3.018261	0.0035005	0.00236245	0.0001999	0.151736761	0.025455913	0.076832582	0.012399	0.00574	0.00574	0.000918	2	0.16
564	3.028845	0.00349361	0.00236026	0.0001999	0.15160403	0.025433646	0.077034561	0.012393	0.005737	0.005737	0.000918	2	0.16
565	3.039445	0.00348675	0.00235806	0.0001999	0.151471677	0.025411441	0.077236672	0.012386	0.005734	0.005734	0.000918	2	0.16
566	3.050061	0.0034799	0.00235586	0.0001999	0.151339698	0.0253893	0.077438915	0.01238	0.005732	0.005732	0.000917	2	0.16
567	3.060693	0.00347309	0.00235366	0.0001999	0.151208094	0.025367222	0.077641289	0.012374	0.005729	0.005729	0.000917	2	0.16
568	3.071342	0.0034663	0.00235146	0.0001999	0.151076861	0.025345206	0.077843794	0.012368	0.005726	0.005726	0.000916	2	0.16
569	3.082007	0.00345953	0.00234926	0.0001999	0.150945998	0.025323252	0.07804643	0.012362	0.005723	0.005723	0.000916	2	0.16
570	3.092687	0.00345279	0.00234707	0.0001999	0.150815504	0.02530136	0.078249196	0.012356	0.00572	0.00572	0.000915	2	0.16
571	3.103384	0.00344608	0.00234487	0.0001999	0.150685376	0.025279529	0.078452092	0.01235	0.005718	0.005718	0.000915	2	0.16
572	3.114097	0.00343939	0.00234267	0.0001999	0.150555614	0.025257759	0.078655118	0.012344	0.005715	0.005715	0.000914	2	0.16
573	3.124826	0.00343272	0.00234047	0.0001999	0.150426215	0.025236051	0.078858274	0.012338	0.005712	0.005712	0.000914	2	0.16
574	3.135571	0.00342608	0.00233827	0.0001999	0.150297177	0.025214403	0.07906156	0.012332	0.005709	0.005709	0.000913	2	0.16
575	3.146332	0.00341946	0.00233608	0.0001999	0.1501685	0.025192816	0.079264975	0.012326	0.005706	0.005706	0.000913	2	0.16
576	3.15711	0.00341287	0.00233388	0.0001999	0.150040181	0.025171289	0.079468518	0.01232	0.005704	0.005704	0.000913	2	0.16
577	3.167903	0.0034063	0.00233168	0.0001999	0.149912218	0.025149821	0.079672191	0.012314	0.005701	0.005701	0.000912	2	0.16
578	3.178712	0.00339976	0.00232948	0.0001999	0.149784611	0.025128413	0.079875992	0.012308	0.005698	0.005698	0.000912	2	0.16
579	3.189537	0.00339324	0.00232728	0.0001999	0.149657357	0.025107065	0.080079921	0.012302	0.005695	0.005695	0.000911	2	0.16
580	3.200379	0.00338674	0.00232508	0.0001999	0.149530455	0.025085775	0.080283978	0.012296	0.005693	0.005693	0.000911	2	0.16
581	3.211236	0.00338027	0.00232289	0.0001999	0.149403904	0.025064544	0.080488163	0.01229	0.00569	0.00569	0.00091	2	0.16
582	3.222109	0.00337382	0.00232069	0.0001999	0.149277701	0.025043372	0.080692476	0.012285	0.005687	0.005687	0.00091	2	0.16
583	3.232998	0.00336739	0.00231849	0.0001999	0.149151845	0.025022258	0.080896916	0.012279	0.005685	0.005685	0.00091	2	0.16
584	3.243903	0.00336099	0.00231629	0.0001999	0.149026334	0.025001202	0.081101483	0.012273	0.005682	0.005682	0.000909	2	0.16
585	3.254824	0.00335461	0.00231409	0.0001999	0.148901168	0.024980204	0.081306177	0.012267	0.005679	0.005679	0.000909	2	0.16
586	3.265761	0.00334825	0.0023119	0.0001999	0.148776344	0.024959263	0.081510997	0.012261	0.005676	0.005676	0.000908	2	0.16
587	3.276714	0.00334192	0.0023097	0.0001999	0.148651861	0.024938379	0.081715944	0.012255	0.005674	0.005674	0.000908	2	0.16
588	3.287683	0.00333561	0.0023075	0.0001999	0.148527717	0.024917552	0.081921016	0.01225	0.005671	0.005671	0.000907	2	0.16
589	3.298668	0.00332932	0.0023053	0.0001999	0.148403911	0.024896782	0.082126215	0.012244	0.005668	0.005668	0.000907	2	0.16
590	3.309668	0.00332305	0.0023031	0.0001999	0.148280442	0.024876068	0.08233154	0.012238	0.005666	0.005666	0.000907	2	0.16
591	3.320685	0.00331681	0.00230091	0.0001999	0.148157307	0.024855411	0.082536989	0.012232	0.005663	0.005663	0.000906	2	0.16
592	3.331717	0.00331058	0.00229871	0.0001999	0.148034506	0.024834809	0.082742564	0.012227	0.00566	0.00566	0.000906	2	0.16
593	3.342766	0.00330439	0.00229651	0.0001999	0.147912036	0.024814263	0.082948264	0.012221	0.005658	0.005658	0.000905	2	0.16
594	3.35383	0.00329821	0.00229431	0.0001999	0.147789897	0.024793773	0.083154089	0.012215	0.005655	0.005655	0.000905	2	0.16
595	3.364909	0.00329205	0.00229211	0.0001999	0.147668087	0.024773337	0.083360038	0.012209	0.005653	0.005653	0.000904	2	0.16
596	3.376005	0.00328592	0.00228991	0.0001999	0.147546604	0.024752957	0.083566112	0.012204	0.00565	0.00565	0.000904	2	0.16
597	3.387117	0.00327981	0.00228772	0.0001999	0.147425448	0.024732631	0.083772309	0.012198	0.005647	0.005647	0.000904	2	0.16
598	3.398244	0.00327371	0.00228552	0.0001999	0.147304615	0.02471236	0.083978631	0.012192	0.005645	0.005645	0.000903	2	0.16
599	3.409387	0.00326765	0.00228332	0.0001999	0.147184106	0.024692143	0.084185076	0.012187	0.005642	0.005642	0.000903	2	0.16
600	3.420546	0.0032616	0.00228112	0.0001999	0.147063919	0.02467198	0.084391644	0.012181	0.005639	0.005639	0.000902	2	0.16
601	3.431721	0.00325557	0.00227892	0.0001999	0.146944052	0.024651871	0.084598335	0.012176	0.005637	0.005637	0.000902	2	0.16
602	3.442911	0.00324957	0.00227673	0.0001999	0.146824504	0.024631815	0.08480515	0.01217	0.005634	0.005634	0.000901	2	0.16
603	3.454117	0.00324358	0.00227453	0.0001999	0.146705274	0.024611812	0.085012087	0.012164	0.005632	0.005632	0.000901	2	0.16
604	3.465339	0.00323762	0.00227233	0.0001999	0.146586359	0.024591863	0.085219146	0.012159	0.005629	0.005629	0.000901	2	0.16
605	3.476577	0.00323168	0.00227013	0.0001999	0.146467759	0.024571966	0.085426328	0.012153	0.005627	0.005627	0.0009	2	0.16
606	3.48783	0.00322575	0.00226793	0.0001999	0.146349473	0.024552122	0.085633631	0.012148	0.005624	0.005624	0.0009	2	0.16
607	3.499099	0.00321985	0.00226574	0.0001999	0.146231499	0.02453233	0.085841057	0.012142	0.005621	0.005621	0.000899	2	0.16

Table I-2: Model Parameters and Consumption Calculations

608	3.510384	0.00321397	0.00226354	0.0001999	0.146113835	0.02451259	0.086048604	0.012137	0.005619	0.005619	0.000899	2	0.16
609	3.521684	0.00320811	0.00226134	0.0001999	0.145996481	0.024492903	0.086256272	0.012131	0.005616	0.005616	0.000899	2	0.16
610	3.533	0.00320227	0.00225914	0.0001999	0.145879435	0.024473267	0.086464062	0.012126	0.005614	0.005614	0.000898	2	0.16
611	3.544332	0.00319645	0.00225694	0.0001999	0.145762695	0.024453682	0.086671973	0.01212	0.005611	0.005611	0.000898	2	0.16
612	3.55568	0.00319065	0.00225474	0.0001999	0.145646261	0.024434149	0.086880004	0.012115	0.005609	0.005609	0.000897	2	0.16
613	3.567043	0.00318487	0.00225255	0.0001999	0.145530131	0.024414666	0.087088155	0.012109	0.005606	0.005606	0.000897	2	0.16
614	3.578421	0.00317911	0.00225035	0.0001999	0.145414303	0.024395234	0.087296427	0.012104	0.005604	0.005604	0.000897	2	0.16
615	3.589816	0.00317337	0.00224815	0.0001999	0.145298777	0.024375853	0.087504819	0.012098	0.005601	0.005601	0.000896	2	0.16
616	3.601226	0.00316765	0.00224595	0.0001999	0.145183551	0.024356523	0.087713331	0.012093	0.005599	0.005599	0.000896	2	0.16
617	3.612651	0.00316195	0.00224375	0.0001999	0.145068624	0.024337242	0.087921963	0.012087	0.005596	0.005596	0.000895	2	0.16
618	3.624092	0.00315626	0.00224156	0.0001999	0.144953995	0.024318011	0.088130713	0.012082	0.005594	0.005594	0.000895	2	0.16
619	3.635549	0.0031506	0.00223936	0.0001999	0.144839662	0.02429883	0.088339583	0.012077	0.005591	0.005591	0.000895	2	0.16
620	3.647021	0.00314496	0.00223716	0.0001999	0.144725624	0.024279699	0.088548572	0.012071	0.005589	0.005589	0.000894	2	0.16
621	3.658509	0.00313934	0.00223496	0.0001999	0.144611879	0.024260617	0.08875768	0.012066	0.005586	0.005586	0.000894	2	0.16
622	3.670012	0.00313373	0.00223276	0.0001999	0.144498427	0.024241584	0.088966906	0.012061	0.005584	0.005584	0.000893	2	0.16
623	3.681531	0.00312814	0.00223057	0.0001999	0.144385267	0.0242226	0.089176251	0.012055	0.005581	0.005581	0.000893	2	0.16
624	3.693065	0.00312258	0.00222837	0.0001999	0.144272397	0.024203664	0.089385714	0.01205	0.005579	0.005579	0.000893	2	0.16
625	3.704615	0.00311703	0.00222617	0.0001999	0.144159815	0.024184777	0.089595294	0.012045	0.005576	0.005576	0.000892	2	0.16
626	3.716181	0.0031115	0.00222397	0.0001999	0.144047521	0.024165938	0.089804993	0.012039	0.005574	0.005574	0.000892	2	0.16
627	3.727762	0.00310599	0.00222177	0.0001999	0.143935514	0.024147147	0.090014809	0.012034	0.005571	0.005571	0.000891	2	0.16
628	3.739358	0.0031005	0.00221957	0.0001999	0.143823792	0.024128404	0.090224742	0.012029	0.005569	0.005569	0.000891	2	0.16
629	3.75097	0.00309502	0.00221738	0.0001999	0.143712354	0.024109709	0.090434792	0.012023	0.005566	0.005566	0.000891	2	0.16
630	3.762597	0.00308957	0.00221518	0.0001999	0.143601199	0.024091061	0.090644959	0.012018	0.005564	0.005564	0.00089	2	0.16
631	3.77424	0.00308413	0.00221298	0.0001999	0.143490325	0.024072461	0.090855243	0.012013	0.005562	0.005562	0.00089	2	0.16
632	3.785898	0.00307871	0.00221078	0.0001999	0.143379732	0.024053907	0.091065643	0.012008	0.005559	0.005559	0.000889	2	0.16
633	3.797572	0.00307331	0.00220858	0.0001999	0.143269418	0.024035401	0.09127616	0.012002	0.005557	0.005557	0.000889	2	0.16
634	3.809261	0.00306793	0.00220639	0.0001999	0.143159383	0.024016941	0.091486792	0.011997	0.005554	0.005554	0.000889	2	0.16
635	3.820965	0.00306256	0.00220419	0.0001999	0.143049624	0.023998527	0.091697541	0.011992	0.005552	0.005552	0.000888	2	0.16
636	3.832685	0.00305721	0.00220199	0.0001999	0.142940142	0.02398016	0.091908405	0.011987	0.005549	0.005549	0.000888	2	0.16
637	3.84442	0.00305188	0.00219979	0.0001999	0.142830934	0.023961839	0.092119384	0.011982	0.005547	0.005547	0.000888	2	0.16
638	3.856171	0.00304657	0.00219759	0.0001999	0.142721999	0.023943564	0.092330479	0.011976	0.005545	0.005545	0.000887	2	0.16
639	3.867937	0.00304128	0.0021954	0.0001999	0.142613338	0.023925334	0.092541689	0.011971	0.005542	0.005542	0.000887	2	0.16
640	3.879719	0.003036	0.0021932	0.0001999	0.142504947	0.02390715	0.092753013	0.011966	0.00554	0.00554	0.000886	2	0.16
641	3.891515	0.00303074	0.002191	0.0001999	0.142396827	0.023889012	0.092964452	0.011961	0.005538	0.005538	0.000886	2	0.16
642	3.903327	0.0030255	0.0021888	0.0001999	0.142288976	0.023870918	0.093176006	0.011956	0.005535	0.005535	0.000886	2	0.16
643	3.915155	0.00302027	0.0021866	0.0001999	0.142181393	0.02385287	0.093387674	0.011951	0.005533	0.005533	0.000885	2	0.16
644	3.926997	0.00301506	0.0021844	0.0001999	0.142074077	0.023834866	0.093599456	0.011946	0.00553	0.00553	0.000885	2	0.16
645	3.938855	0.00300987	0.00218221	0.0001999	0.141967026	0.023816907	0.093811352	0.011941	0.005528	0.005528	0.000884	2	0.16
646	3.950729	0.0030047	0.00218001	0.0001999	0.141860241	0.023798992	0.094023361	0.011936	0.005526	0.005526	0.000884	2	0.16
647	3.962617	0.00299954	0.00217781	0.0001999	0.141753719	0.023781121	0.094235484	0.01193	0.005523	0.005523	0.000884	2	0.16
648	3.974521	0.0029944	0.00217561	0.0001999	0.14164746	0.023763295	0.09444772	0.011925	0.005521	0.005521	0.000883	2	0.16
649	3.98644	0.00298928	0.00217341	0.0001999	0.141541462	0.023745512	0.094660069	0.01192	0.005519	0.005519	0.000883	2	0.16
650	3.998375	0.00298417	0.00217122	0.0001999	0.141435725	0.023727774	0.094872531	0.011915	0.005516	0.005516	0.000883	2	0.16
651	4.010324	0.00297908	0.00216902	0.0001999	0.141330247	0.023710078	0.095085106	0.01191	0.005514	0.005514	0.000882	2	0.16
652	4.022289	0.00297401	0.00216682	0.0001999	0.141225028	0.023692426	0.095297793	0.011905	0.005512	0.005512	0.000882	2	0.16
653	4.034269	0.00296895	0.00216462	0.0001999	0.141120066	0.023674818	0.095510592	0.0119	0.005509	0.005509	0.000882	2	0.16
654	4.046265	0.00296391	0.00216242	0.0001999	0.14101536	0.023657252	0.095723504	0.011895	0.005507	0.005507	0.000881	2	0.16
655	4.058275	0.00295888	0.00216023	0.0001999	0.14091091	0.023639729	0.095936527	0.01189	0.005505	0.005505	0.000881	2	0.16
656	4.070301	0.00295387	0.00215803	0.0001999	0.140806714	0.023622248	0.096149662	0.011885	0.005502	0.005502	0.00088	2	0.16
657	4.082342	0.00294888	0.00215583	0.0001999	0.140702771	0.023604811	0.096362909	0.01188	0.0055	0.0055	0.00088	2	0.16
658	4.094398	0.0029439	0.00215363	0.0001999	0.14059908	0.023587415	0.096576266	0.011875	0.005498	0.005498	0.00088	2	0.16
659	4.106469	0.00293894	0.00215143	0.0001999	0.140495641	0.023570062	0.096789735	0.01187	0.005496	0.005496	0.000879	2	0.16
660	4.118556	0.002934	0.00214923	0.0001999	0.140392452	0.02355275	0.097003315	0.011866	0.005493	0.005493	0.000879	2	0.16

661	4.130657	0.00292907	0.00214704	0.0001999	0.140289512	0.023535481	0.097217006	0.011861	0.005491	0.005491	0.000879	2	0.16
662	4.142774	0.00292415	0.00214484	0.0001999	0.14018682	0.023518253	0.097430807	0.011856	0.005489	0.005489	0.000878	2	0.16
663	4.154906	0.00291926	0.00214264	0.0001999	0.140084375	0.023501066	0.097644719	0.011851	0.005486	0.005486	0.000878	2	0.16
664	4.167053	0.00291437	0.00214044	0.0001999	0.139982177	0.023483921	0.09785874	0.011846	0.005484	0.005484	0.000877	2	0.16
665	4.179215	0.00290951	0.00213824	0.0001999	0.139880224	0.023466817	0.098072872	0.011841	0.005482	0.005482	0.000877	2	0.16
666	4.191392	0.00290466	0.00213605	0.0001999	0.139778515	0.023449754	0.098287113	0.011836	0.00548	0.00548	0.000877	2	0.16
667	4.203584	0.00289982	0.00213385	0.0001999	0.13967705	0.023432732	0.098501465	0.011831	0.005477	0.005477	0.000876	2	0.16
668	4.215792	0.002895	0.00213165	0.0001999	0.139575827	0.02341575	0.098715925	0.011826	0.005475	0.005475	0.000876	2	0.16
669	4.228014	0.00289019	0.00212945	0.0001999	0.139474846	0.023398809	0.098930495	0.011822	0.005473	0.005473	0.000876	2	0.16
670	4.240252	0.0028854	0.00212725	0.0001999	0.139374105	0.023381909	0.099145174	0.011817	0.005471	0.005471	0.000875	2	0.16
671	4.252504	0.00288063	0.00212506	0.0001999	0.139273604	0.023365048	0.099359961	0.011812	0.005468	0.005468	0.000875	2	0.16
672	4.264772	0.00287587	0.00212286	0.0001999	0.139173341	0.023348228	0.099574858	0.011807	0.005466	0.005466	0.000875	2	0.16
673	4.277054	0.00287112	0.00212066	0.0001999	0.139073316	0.023331447	0.099789863	0.011802	0.005464	0.005464	0.000874	2	0.16
674	4.289352	0.00286639	0.00211846	0.0001999	0.138973527	0.023314706	0.100004976	0.011798	0.005462	0.005462	0.000874	2	0.16
675	4.301664	0.00286168	0.00211626	0.0001999	0.138873975	0.023298005	0.100220197	0.011793	0.00546	0.00546	0.000874	2	0.16
676	4.313992	0.00285697	0.00211406	0.0001999	0.138774657	0.023281343	0.100435526	0.011788	0.005457	0.005457	0.000873	2	0.16
677	4.326335	0.00285229	0.00211187	0.0001999	0.138675574	0.023264721	0.100650963	0.011783	0.005455	0.005455	0.000873	2	0.16
678	4.338692	0.00284762	0.00210967	0.0001999	0.138576723	0.023248137	0.100866508	0.011778	0.005453	0.005453	0.000872	2	0.16
679	4.351065	0.00284296	0.00210747	0.0001999	0.138478105	0.023231593	0.10108216	0.011774	0.005451	0.005451	0.000872	2	0.16
680	4.363452	0.00283832	0.00210527	0.0001999	0.138379718	0.023215087	0.101297919	0.011769	0.005449	0.005449	0.000872	2	0.16
681	4.375855	0.00283369	0.00210307	0.0001999	0.138281562	0.02319862	0.101513786	0.011764	0.005446	0.005446	0.000871	2	0.16
682	4.388272	0.00282907	0.00210088	0.0001999	0.138183635	0.023182191	0.101729759	0.01176	0.005444	0.005444	0.000871	2	0.16
683	4.400704	0.00282447	0.00209868	0.0001999	0.138085936	0.023165801	0.101945839	0.011755	0.005442	0.005442	0.000871	2	0.16
684	4.413152	0.00281989	0.00209648	0.0001999	0.137988466	0.023149449	0.102162025	0.01175	0.00544	0.00544	0.00087	2	0.16
685	4.425614	0.00281532	0.00209428	0.0001999	0.137891222	0.023133135	0.102378318	0.011745	0.005438	0.005438	0.00087	2	0.16
686	4.438091	0.00281076	0.00209208	0.0001999	0.137794204	0.023116859	0.102594717	0.011741	0.005436	0.005436	0.00087	2	0.16
687	4.450583	0.00280622	0.00208989	0.0001999	0.137697412	0.023100621	0.102811222	0.011736	0.005433	0.005433	0.000869	2	0.16
688	4.46309	0.00280169	0.00208769	0.0001999	0.137600843	0.02308442	0.103027833	0.011731	0.005431	0.005431	0.000869	2	0.16
689	4.475611	0.00279717	0.00208549	0.0001999	0.137504499	0.023068257	0.103244549	0.011727	0.005429	0.005429	0.000869	2	0.16
690	4.488148	0.00279267	0.00208329	0.0001999	0.137408376	0.023052131	0.103461371	0.011722	0.005427	0.005427	0.000868	2	0.16
691	4.500699	0.00278818	0.00208109	0.0001999	0.137312476	0.023036042	0.103678298	0.011718	0.005425	0.005425	0.000868	2	0.16
692	4.513266	0.00278371	0.00207889	0.0001999	0.137216796	0.023019991	0.10389533	0.011713	0.005423	0.005423	0.000868	2	0.16
693	4.525847	0.00277925	0.0020767	0.0001999	0.137121337	0.023003976	0.104112467	0.011708	0.005421	0.005421	0.000867	2	0.16
694	4.538443	0.0027748	0.0020745	0.0001999	0.137026096	0.022987998	0.104329709	0.011704	0.005418	0.005418	0.000867	2	0.16
695	4.551053	0.00277036	0.0020723	0.0001999	0.136931074	0.022972057	0.104547056	0.011699	0.005416	0.005416	0.000867	2	0.16
696	4.563679	0.00276594	0.0020701	0.0001999	0.13683627	0.022956152	0.104764506	0.011695	0.005414	0.005414	0.000866	2	0.16
697	4.576319	0.00276154	0.0020679	0.0001999	0.136741682	0.022940284	0.104982062	0.01169	0.005412	0.005412	0.000866	2	0.16
698	4.588974	0.00275714	0.00206571	0.0001999	0.13664731	0.022924452	0.105199721	0.011685	0.00541	0.00541	0.000866	2	0.16
699	4.601644	0.00275276	0.00206351	0.0001999	0.136553154	0.022908656	0.105417484	0.011681	0.005408	0.005408	0.000865	2	0.16
700	4.614329	0.0027484	0.00206131	0.0001999	0.136459212	0.022892896	0.105635351	0.011676	0.005406	0.005406	0.000865	2	0.16
701	4.627028	0.00274404	0.00205911	0.0001999	0.136365483	0.022877171	0.105853321	0.011672	0.005404	0.005404	0.000865	2	0.16
702	4.639743	0.0027397	0.00205691	0.0001999	0.136271967	0.022861483	0.106071395	0.011667	0.005402	0.005402	0.000864	2	0.16
703	4.652472	0.00273537	0.00205472	0.0001999	0.136178663	0.02284583	0.106289572	0.011663	0.005399	0.005399	0.000864	2	0.16
704	4.665215	0.00273106	0.00205252	0.0001999	0.136085569	0.022830212	0.106507852	0.011658	0.005397	0.005397	0.000864	2	0.16
705	4.677974	0.00272676	0.00205032	0.0001999	0.135992687	0.02281463	0.106726235	0.011654	0.005395	0.005395	0.000863	2	0.16
706	4.690747	0.00272247	0.00204812	0.0001999	0.135900014	0.022799082	0.106944721	0.011649	0.005393	0.005393	0.000863	2	0.16
707	4.703534	0.00271819	0.00204592	0.0001999	0.135807549	0.02278357	0.107163309	0.011645	0.005391	0.005391	0.000863	2	0.16
708	4.716337	0.00271393	0.00204372	0.0001999	0.135715293	0.022768093	0.107382	0.01164	0.005389	0.005389	0.000862	2	0.16
709	4.729154	0.00270968	0.00204153	0.0001999	0.135623244	0.022752651	0.107600792	0.011636	0.005387	0.005387	0.000862	2	0.16
710	4.741986	0.00270544	0.00203933	0.0001999	0.135531401	0.022737243	0.107819687	0.011631	0.005385	0.005385	0.000862	2	0.16
711	4.754833	0.00270121	0.00203713	0.0001999	0.135439764	0.022721869	0.108038684	0.011627	0.005383	0.005383	0.000861	2	0.16
712	4.767694	0.002697	0.00203493	0.0001999	0.135348332	0.02270653	0.108257782	0.011622	0.005381	0.005381	0.000861	2	0.16
713	4.78057	0.0026928	0.00203273	0.0001999	0.135257104	0.022691226	0.108476983	0.011618	0.005379	0.005379	0.000861	2	0.16

Table I-2: Model Parameters and Consumption Calculations

	714	4.79346	0.00268861	0.00203054	0.0001999	0.13516608	0.022675955	0.108696284	0.011614	0.005377	0.005377	0.00086	2	0.16
	715	4.806365	0.00268444	0.00202834	0.0001999	0.135075258	0.022660718	0.108915687	0.011609	0.005375	0.005375	0.00086	2	0.16
	716	4.819285	0.00268027	0.00202614	0.0001999	0.134984638	0.022645516	0.10913519	0.011605	0.005373	0.005373	0.00086	2	0.16
	717	4.832219	0.00267612	0.00202394	0.0001999	0.13489422	0.022630347	0.109354795	0.0116	0.005371	0.005371	0.000859	2	0.16
	718	4.845168	0.00267198	0.00202174	0.0001999	0.134804002	0.022615211	0.1095745	0.011596	0.005369	0.005369	0.000859	2	0.16
	719	4.858132	0.00266785	0.00201955	0.0001999	0.134713983	0.02260011	0.109794306	0.011592	0.005366	0.005366	0.000859	2	0.16
	720	4.87111	0.00266374	0.00201735	0.0001999	0.134624164	0.022585041	0.110014213	0.011587	0.005364	0.005364	0.000858	2	0.16
	721	4.884102	0.00265964	0.00201515	0.0001999	0.134534543	0.022570006	0.110234219	0.011583	0.005362	0.005362	0.000858	2	0.16
	722	4.89711	0.00265555	0.00201295	0.0001999	0.134445119	0.022555004	0.110454326	0.011579	0.00536	0.00536	0.000858	2	0.16
	723	4.910131	0.00265147	0.00201075	0.0001999	0.134355893	0.022540035	0.110674532	0.011574	0.005358	0.005358	0.000857	2	0.16
	724	4.923168	0.0026474	0.00200855	0.0001999	0.134266862	0.022525099	0.110894839	0.01157	0.005356	0.005356	0.000857	2	0.16
	725	4.936219	0.00264334	0.00200636	0.0001999	0.134178027	0.022510196	0.111115245	0.011566	0.005354	0.005354	0.000857	2	0.16
	726	4.949284	0.0026393	0.00200416	0.0001999	0.134089387	0.022495325	0.11133575	0.011561	0.005352	0.005352	0.000856	2	0.16
	727	4.962364	0.00263527	0.00200196	0.0001999	0.13400094	0.022480487	0.111556355	0.011557	0.00535	0.00535	0.000856	2	0.16
	728	4.975458	0.00263125	0.00199976	0.0001999	0.133912687	0.022465681	0.111777059	0.011553	0.005348	0.005348	0.000856	2	0.16
	729	4.988567	0.00262724	0.00199756	0.0001999	0.133824627	0.022450908	0.111997862	0.011548	0.005346	0.005346	0.000855	2	0.16
	730	5.001691	0.00262324	0.00199537	0.0001999	0.133736758	0.022436167	0.112218763	0.011544	0.005344	0.005344	0.000855	2	0.16
2 year old	731	5.014828	0.00261926	0.00199317	0.0001566	0.133649081	0.022421458	0.112439764	0.01154	0.005342	0.005342	0.000855	2	0.16
	732	5.027981	0.00261529	0.00199097	0.0001566	0.133561594	0.022406781	0.112660862	0.011535	0.00534	0.00534	0.000854	2	0.16
	733	5.041148	0.00261132	0.00198877	0.0001566	0.133474297	0.022392135	0.112882059	0.011531	0.005339	0.005339	0.000854	2	0.16
	734	5.054329	0.00260737	0.00198657	0.0001566	0.133387189	0.022377522	0.113103355	0.011527	0.005337	0.005337	0.000854	2	0.16
	735	5.067525	0.00260343	0.00198437	0.0001566	0.13330027	0.02236294	0.113324748	0.011523	0.005335	0.005335	0.000854	2	0.16
	736	5.080735	0.00259951	0.00198218	0.0001566	0.133213539	0.02234839	0.113546239	0.011518	0.005333	0.005333	0.000853	2	0.16
	737	5.093959	0.00259559	0.00197998	0.0001566	0.133126995	0.022333871	0.113767828	0.011514	0.005331	0.005331	0.000853	2	0.16
	738	5.107198	0.00259168	0.00197778	0.0001566	0.133040637	0.022319383	0.113989515	0.01151	0.005329	0.005329	0.000853	2	0.16
	739	5.120452	0.00258779	0.00197558	0.0001566	0.132954465	0.022304926	0.114211299	0.011506	0.005327	0.005327	0.000852	2	0.16
	740	5.13372	0.0025839	0.00197338	0.0001566	0.132868478	0.022290501	0.11443318	0.011502	0.005325	0.005325	0.000852	2	0.16
	741	5.147002	0.00258003	0.00197119	0.0001566	0.132782676	0.022276107	0.114655158	0.011497	0.005323	0.005323	0.000852	2	0.16
	742	5.160298	0.00257617	0.00196899	0.0001566	0.132697058	0.022261743	0.114877234	0.011493	0.005321	0.005321	0.000851	2	0.16
	743	5.173609	0.00257232	0.00196679	0.0001566	0.132611623	0.02224741	0.115099406	0.011489	0.005319	0.005319	0.000851	2	0.16
	744	5.186935	0.00256848	0.00196459	0.0001566	0.13252637	0.022233108	0.115321675	0.011485	0.005317	0.005317	0.000851	2	0.16
	745	5.200274	0.00256465	0.00196239	0.0001566	0.1324413	0.022218836	0.11554404	0.011481	0.005315	0.005315	0.00085	2	0.16
	746	5.213628	0.00256083	0.0019602	0.0001566	0.132356411	0.022204595	0.115766501	0.011476	0.005313	0.005313	0.00085	2	0.16
	747	5.226997	0.00255703	0.001958	0.0001566	0.132271702	0.022190384	0.115989059	0.011472	0.005311	0.005311	0.00085	2	0.16
	748	5.240379	0.00255323	0.0019558	0.0001566	0.132187174	0.022176203	0.116211713	0.011468	0.005309	0.005309	0.000849	2	0.16
	749	5.253776	0.00254945	0.0019536	0.0001566	0.132102824	0.022162052	0.116434463	0.011464	0.005307	0.005307	0.000849	2	0.16
	750	5.267188	0.00254567	0.0019514	0.0001566	0.132018654	0.022147931	0.116657308	0.01146	0.005306	0.005306	0.000849	2	0.16
	751	5.280613	0.00254191	0.0019492	0.0001566	0.131934662	0.022133841	0.116880249	0.011456	0.005304	0.005304	0.000849	2	0.16
	752	5.294053	0.00253815	0.00194701	0.0001566	0.131850847	0.022119779	0.117103286	0.011452	0.005302	0.005302	0.000848	2	0.16
	753	5.307507	0.00253441	0.00194481	0.0001566	0.131767209	0.022105748	0.117326417	0.011448	0.0053	0.0053	0.000848	2	0.16
	754	5.320976	0.00253068	0.00194261	0.0001566	0.131683748	0.022091746	0.117549644	0.011443	0.005298	0.005298	0.000848	2	0.16
	755	5.334458	0.00252695	0.00194041	0.0001566	0.131600462	0.022077774	0.117772966	0.011439	0.005296	0.005296	0.000847	2	0.16
	756	5.347955	0.00252324	0.00193821	0.0001566	0.131517351	0.022063831	0.117996383	0.011435	0.005294	0.005294	0.000847	2	0.16
	757	5.361467	0.00251954	0.00193602	0.0001566	0.131434414	0.022049917	0.118219895	0.011431	0.005292	0.005292	0.000847	2	0.16
	758	5.374992	0.00251585	0.00193382	0.0001566	0.131351652	0.022036033	0.118443501	0.011427	0.00529	0.00529	0.000846	2	0.16
	759	5.388532	0.00251217	0.00193162	0.0001566	0.131269063	0.022022177	0.118667201	0.011423	0.005288	0.005288	0.000846	2	0.16
	760	5.402086	0.0025085	0.00192942	0.0001566	0.131186646	0.022008351	0.118890996	0.011419	0.005287	0.005287	0.000846	2	0.16
	761	5.415654	0.00250484	0.00192722	0.0001566	0.131104402	0.021994553	0.119114885	0.011415	0.005285	0.005285	0.000846	2	0.16
	762	5.429236	0.00250119	0.00192503	0.0001566	0.131022328	0.021980784	0.119338867	0.011411	0.005283	0.005283	0.000845	2	0.16
	763	5.442833	0.00249755	0.00192283	0.0001566	0.130940426	0.021967044	0.119562944	0.011407	0.005281	0.005281	0.000845	2	0.16
	764	5.456443	0.00249392	0.00192063	0.0001566	0.130858694	0.021953332	0.119787114	0.011403	0.005279	0.005279	0.000845	2	0.16
	765	5.470068	0.0024903	0.00191843	0.0001566	0.130777132	0.021939649	0.120011378	0.011399	0.005277	0.005277	0.000844	2	0.16
	766	5.483707	0.00248668	0.00191623	0.0001566	0.130695739	0.021925994	0.120235735	0.011395	0.005275	0.005275	0.000844	2	0.16

Table I-2: Model Parameters and Consumption Calculations

767	5.497361	0.00248308	0.00191403	0.0001566	0.130614515	0.021912368	0.120460186	0.011391	0.005274	0.005274	0.000844	2	0.16
768	5.511028	0.00247949	0.00191184	0.0001566	0.130533458	0.021898769	0.12068473	0.011387	0.005272	0.005272	0.000843	2	0.16
769	5.524709	0.00247591	0.00190964	0.0001566	0.130452569	0.021885199	0.120909366	0.011383	0.00527	0.00527	0.000843	2	0.16
770	5.538405	0.00247234	0.00190744	0.0001566	0.130371847	0.021871657	0.121134096	0.011379	0.005268	0.005268	0.000843	2	0.16
771	5.552115	0.00246878	0.00190524	0.0001566	0.13029129	0.021858143	0.121358918	0.011375	0.005266	0.005266	0.000843	2	0.16
772	5.565839	0.00246523	0.00190304	0.0001566	0.1302109	0.021844656	0.121583832	0.011371	0.005264	0.005264	0.000842	2	0.16
773	5.579577	0.00246169	0.00190085	0.0001566	0.130130675	0.021831197	0.121808839	0.011367	0.005262	0.005262	0.000842	2	0.16
774	5.593329	0.00245816	0.00189865	0.0001566	0.130050614	0.021817766	0.122033939	0.011363	0.005261	0.005261	0.000842	2	0.16
775	5.607095	0.00245463	0.00189645	0.0001566	0.129970718	0.021804362	0.12225913	0.011359	0.005259	0.005259	0.000841	2	0.16
776	5.620875	0.00245112	0.00189425	0.0001566	0.129890984	0.021790986	0.122484413	0.011355	0.005257	0.005257	0.000841	2	0.16
777	5.63467	0.00244762	0.00189205	0.0001566	0.129811414	0.021777637	0.122709789	0.011351	0.005255	0.005255	0.000841	2	0.16
778	5.648478	0.00244412	0.00188986	0.0001566	0.129732006	0.021764315	0.122935255	0.011347	0.005253	0.005253	0.000841	2	0.16
779	5.662301	0.00244064	0.00188766	0.0001566	0.12965276	0.02175102	0.123160814	0.011343	0.005252	0.005252	0.00084	2	0.16
780	5.676137	0.00243717	0.00188546	0.0001566	0.129573675	0.021737753	0.123386464	0.011339	0.00525	0.00525	0.00084	2	0.16
781	5.689988	0.0024337	0.00188326	0.0001566	0.129494751	0.021724512	0.123612205	0.011335	0.005248	0.005248	0.00084	2	0.16
782	5.703852	0.00243024	0.00188106	0.0001566	0.129415988	0.021711299	0.123838037	0.011332	0.005246	0.005246	0.000839	2	0.16
783	5.717731	0.0024268	0.00187886	0.0001566	0.129337383	0.021698112	0.12406396	0.011328	0.005244	0.005244	0.000839	2	0.16
784	5.731623	0.00242336	0.00187667	0.0001566	0.129258938	0.021684951	0.124289975	0.011324	0.005242	0.005242	0.000839	2	0.16
785	5.74553	0.00241993	0.00187447	0.0001566	0.129180652	0.021671818	0.124516079	0.01132	0.005241	0.005241	0.000839	2	0.16
786	5.759451	0.00241651	0.00187227	0.0001566	0.129102523	0.021658711	0.124742275	0.011316	0.005239	0.005239	0.000838	2	0.16
787	5.773385	0.0024131	0.00187007	0.0001566	0.129024552	0.02164563	0.124968561	0.011312	0.005237	0.005237	0.000838	2	0.16
788	5.787334	0.0024097	0.00186787	0.0001566	0.128946739	0.021632576	0.125194937	0.011308	0.005235	0.005235	0.000838	2	0.16
789	5.801296	0.00240631	0.00186568	0.0001566	0.128869081	0.021619548	0.125421403	0.011304	0.005234	0.005234	0.000837	2	0.16
790	5.815273	0.00240293	0.00186348	0.0001566	0.12879158	0.021606546	0.12564796	0.011301	0.005232	0.005232	0.000837	2	0.16
791	5.829263	0.00239955	0.00186128	0.0001566	0.128714234	0.02159357	0.125874606	0.011297	0.00523	0.00523	0.000837	2	0.16
792	5.843268	0.00239619	0.00185908	0.0001566	0.128637043	0.02158062	0.126101342	0.011293	0.005228	0.005228	0.000837	2	0.16
793	5.857286	0.00239283	0.00185688	0.0001566	0.128560006	0.021567696	0.126328168	0.011289	0.005226	0.005226	0.000836	2	0.16
794	5.871318	0.00238949	0.00185469	0.0001566	0.128483124	0.021554798	0.126555083	0.011285	0.005225	0.005225	0.000836	2	0.16
795	5.885365	0.00238615	0.00185249	0.0001566	0.128406394	0.021541926	0.126782088	0.011281	0.005223	0.005223	0.000836	2	0.16
796	5.899425	0.00238282	0.00185029	0.0001566	0.128329818	0.021529079	0.127009181	0.011278	0.005221	0.005221	0.000835	2	0.16
797	5.913499	0.0023795	0.00184809	0.0001566	0.128253394	0.021516258	0.127236364	0.011274	0.005219	0.005219	0.000835	2	0.16
798	5.927587	0.00237619	0.00184589	0.0001566	0.128177122	0.021503462	0.127463636	0.01127	0.005218	0.005218	0.000835	2	0.16
799	5.941689	0.00237289	0.00184369	0.0001566	0.128101001	0.021490692	0.127690997	0.011266	0.005216	0.005216	0.000835	2	0.16
800	5.955804	0.00236959	0.0018415	0.0001566	0.128025032	0.021477947	0.127918446	0.011263	0.005214	0.005214	0.000834	2	0.16
801	5.969934	0.00236631	0.0018393	0.0001566	0.127949212	0.021465227	0.128145984	0.011259	0.005212	0.005212	0.000834	2	0.16
802	5.984077	0.00236303	0.0018371	0.0001566	0.127873543	0.021452532	0.128373611	0.011255	0.005211	0.005211	0.000834	2	0.16
803	5.998234	0.00235976	0.0018349	0.0001566	0.127798023	0.021439863	0.128601325	0.011251	0.005209	0.005209	0.000833	2	0.16
804	6.012406	0.0023565	0.0018327	0.0001566	0.127722652	0.021427218	0.128829128	0.011247	0.005207	0.005207	0.000833	2	0.16
805	6.026591	0.00235325	0.00183051	0.0001566	0.12764743	0.021414599	0.129057019	0.011244	0.005205	0.005205	0.000833	2	0.16
806	6.040789	0.00235001	0.00182831	0.0001566	0.127572355	0.021402004	0.129284998	0.01124	0.005204	0.005204	0.000833	2	0.16
807	6.055002	0.00234677	0.00182611	0.0001566	0.127497428	0.021389434	0.129513065	0.011236	0.005202	0.005202	0.000832	2	0.16
808	6.069228	0.00234355	0.00182391	0.0001566	0.127422648	0.021376889	0.129741219	0.011233	0.0052	0.0052	0.000832	2	0.16
809	6.083469	0.00234033	0.00182171	0.0001566	0.127348015	0.021364368	0.129969461	0.011229	0.005199	0.005199	0.000832	2	0.16
810	6.097723	0.00233712	0.00181952	0.0001566	0.127273527	0.021351872	0.13019779	0.011225	0.005197	0.005197	0.000831	2	0.16
811	6.11199	0.00233392	0.00181732	0.0001566	0.127199185	0.0213394	0.130426206	0.011221	0.005195	0.005195	0.000831	2	0.16
812	6.126272	0.00233073	0.00181512	0.0001566	0.127124989	0.021326952	0.13065471	0.011218	0.005193	0.005193	0.000831	2	0.16
813	6.140567	0.00232755	0.00181292	0.0001566	0.127050937	0.021314529	0.1308833	0.011214	0.005192	0.005192	0.000831	2	0.16
814	6.154876	0.00232437	0.00181072	0.0001566	0.126977029	0.02130213	0.131111978	0.01121	0.00519	0.00519	0.00083	2	0.16
815	6.169199	0.00232121	0.00180852	0.0001566	0.126903265	0.021289755	0.131340742	0.011207	0.005188	0.005188	0.00083	2	0.16
816	6.183536	0.00231805	0.00180633	0.0001566	0.126829644	0.021277404	0.131569592	0.011203	0.005187	0.005187	0.00083	2	0.16
817	6.197886	0.0023149	0.00180413	0.0001566	0.126756166	0.021265077	0.13179853	0.011199	0.005185	0.005185	0.00083	2	0.16
818	6.21225	0.00231175	0.00180193	0.0001566	0.126682831	0.021252774	0.132027553	0.011196	0.005183	0.005183	0.000829	2	0.16
819	6.226628	0.00230862	0.00179973	0.0001566	0.126609637	0.021240495	0.132256663	0.011192	0.005181	0.005181	0.000829	2	0.16

820	6.24102	0.00230549	0.00179753	0.0001566	0.126536585	0.021228239	0.132485859	0.011188	0.00518	0.00518	0.000829	2	0.16
821	6.255425	0.00230237	0.00179534	0.0001566	0.126463673	0.021216008	0.132715141	0.011185	0.005178	0.005178	0.000828	2	0.16
822	6.269844	0.00229926	0.00179314	0.0001566	0.126390903	0.021203799	0.132944509	0.011181	0.005176	0.005176	0.000828	2	0.16
823	6.284276	0.00229616	0.00179094	0.0001566	0.126318272	0.021191615	0.133173962	0.011177	0.005175	0.005175	0.000828	2	0.16
824	6.298723	0.00229307	0.00178874	0.0001566	0.126245781	0.021179453	0.133403502	0.011174	0.005173	0.005173	0.000828	2	0.16
825	6.313183	0.00228998	0.00178654	0.0001566	0.12617343	0.021167315	0.133633126	0.01117	0.005171	0.005171	0.000827	2	0.16
826	6.327656	0.0022869	0.00178435	0.0001566	0.126101217	0.0211552	0.133862836	0.011166	0.00517	0.00517	0.000827	2	0.16
827	6.342144	0.00228383	0.00178215	0.0001566	0.126029142	0.021143109	0.134092631	0.011163	0.005168	0.005168	0.000827	2	0.16
828	6.356644	0.00228077	0.00177995	0.0001566	0.125957205	0.021131041	0.134322512	0.011159	0.005166	0.005166	0.000827	2	0.16
829	6.371159	0.00227771	0.00177775	0.0001566	0.125885406	0.021118995	0.134552477	0.011156	0.005165	0.005165	0.000826	2	0.16
830	6.385687	0.00227466	0.00177555	0.0001566	0.125813744	0.021106973	0.134782527	0.011152	0.005163	0.005163	0.000826	2	0.16
831	6.400229	0.00227162	0.00177335	0.0001566	0.125742218	0.021094974	0.135012662	0.011148	0.005161	0.005161	0.000826	2	0.16
832	6.414784	0.00226859	0.00177116	0.0001566	0.125670829	0.021082997	0.135242881	0.011145	0.00516	0.00516	0.000826	2	0.16
833	6.429353	0.00226557	0.00176896	0.0001566	0.125599575	0.021071043	0.135473185	0.011141	0.005158	0.005158	0.000825	2	0.16
834	6.443936	0.00226255	0.00176676	0.0001566	0.125528457	0.021059112	0.135703574	0.011138	0.005156	0.005156	0.000825	2	0.16
835	6.458532	0.00225954	0.00176456	0.0001566	0.125457473	0.021047204	0.135934046	0.011134	0.005155	0.005155	0.000825	2	0.16
836	6.473142	0.00225654	0.00176236	0.0001566	0.125386624	0.021035318	0.136164603	0.011131	0.005153	0.005153	0.000824	2	0.16
837	6.487766	0.00225355	0.00176017	0.0001566	0.125315909	0.021023454	0.136395244	0.011127	0.005151	0.005151	0.000824	2	0.16
838	6.502403	0.00225056	0.00175797	0.0001566	0.125245328	0.021011613	0.136625968	0.011124	0.00515	0.00515	0.000824	2	0.16
839	6.517053	0.00224758	0.00175577	0.0001566	0.125174879	0.020999795	0.136856777	0.01112	0.005148	0.005148	0.000824	2	0.16
840	6.531717	0.00224461	0.00175357	0.0001566	0.125104564	0.020987998	0.137087669	0.011116	0.005147	0.005147	0.000823	2	0.16
841	6.546395	0.00224164	0.00175137	0.0001566	0.125034381	0.020976224	0.137318644	0.011113	0.005145	0.005145	0.000823	2	0.16
842	6.561086	0.00223869	0.00174918	0.0001566	0.12496433	0.020964472	0.137549703	0.011109	0.005143	0.005143	0.000823	2	0.16
843	6.575791	0.00223574	0.00174698	0.0001566	0.12489441	0.020952742	0.137780845	0.011106	0.005142	0.005142	0.000823	2	0.16
844	6.590509	0.0022328	0.00174478	0.0001566	0.124824622	0.020941034	0.13801207	0.011102	0.00514	0.00514	0.000822	2	0.16
845	6.60524	0.00222986	0.00174258	0.0001566	0.124754965	0.020929348	0.138243379	0.011099	0.005138	0.005138	0.000822	2	0.16
846	6.619986	0.00222694	0.00174038	0.0001566	0.124685437	0.020917684	0.13847477	0.011095	0.005137	0.005137	0.000822	2	0.16
847	6.634744	0.00222402	0.00173818	0.0001566	0.12461604	0.020906042	0.138706244	0.011092	0.005135	0.005135	0.000822	2	0.16
848	6.649517	0.0022211	0.00173599	0.0001566	0.124546772	0.020894421	0.138937801	0.011088	0.005134	0.005134	0.000821	2	0.16
849	6.664302	0.0022182	0.00173379	0.0001566	0.124477634	0.020882822	0.13916944	0.011085	0.005132	0.005132	0.000821	2	0.16
850	6.679101	0.0022153	0.00173159	0.0001566	0.124408624	0.020871245	0.139401162	0.011081	0.00513	0.00513	0.000821	2	0.16
851	6.693914	0.00221241	0.00172939	0.0001566	0.124339742	0.020859689	0.139632966	0.011078	0.005129	0.005129	0.000821	2	0.16
852	6.70874	0.00220953	0.00172719	0.0001566	0.124270989	0.020848155	0.139864852	0.011075	0.005127	0.005127	0.00082	2	0.16
853	6.72358	0.00220665	0.001725	0.0001566	0.124202363	0.020836642	0.140096821	0.011071	0.005125	0.005125	0.00082	2	0.16
854	6.738433	0.00220378	0.0017228	0.0001566	0.124133864	0.02082515	0.140328871	0.011068	0.005124	0.005124	0.00082	2	0.16
855	6.753299	0.00220092	0.0017206	0.0001566	0.124065492	0.02081368	0.140561003	0.011064	0.005122	0.005122	0.00082	2	0.16
856	6.768179	0.00219806	0.0017184	0.0001566	0.123997246	0.020802231	0.140793217	0.011061	0.005121	0.005121	0.000819	2	0.16
857	6.783072	0.00219521	0.0017162	0.0001566	0.123929126	0.020790803	0.141025512	0.011057	0.005119	0.005119	0.000819	2	0.16
858	6.797979	0.00219237	0.00171401	0.0001566	0.123861132	0.020779396	0.141257889	0.011054	0.005118	0.005118	0.000819	2	0.16
859	6.812899	0.00218954	0.00171181	0.0001566	0.123793264	0.02076801	0.141490348	0.01105	0.005116	0.005116	0.000819	2	0.16
860	6.827832	0.00218671	0.00170961	0.0001566	0.12372552	0.020756645	0.141722888	0.011047	0.005114	0.005114	0.000818	2	0.16
861	6.842779	0.00218389	0.00170741	0.0001566	0.1236579	0.020745301	0.141955508	0.011044	0.005113	0.005113	0.000818	2	0.16
862	6.857739	0.00218108	0.00170521	0.0001566	0.123590405	0.020733978	0.14218821	0.01104	0.005111	0.005111	0.000818	2	0.16
863	6.872713	0.00217827	0.00170301	0.0001566	0.123523033	0.020722675	0.142420993	0.011037	0.00511	0.00511	0.000818	2	0.16
864	6.8877	0.00217547	0.00170082	0.0001566	0.123455785	0.020711393	0.142653857	0.011033	0.005108	0.005108	0.000817	2	0.16
865	6.9027	0.00217268	0.00169862	0.0001566	0.123388659	0.020700132	0.142886801	0.01103	0.005106	0.005106	0.000817	2	0.16
866	6.917714	0.00216989	0.00169642	0.0001566	0.123321657	0.020688891	0.143119826	0.011027	0.005105	0.005105	0.000817	2	0.16
867	6.932741	0.00216711	0.00169422	0.0001566	0.123254776	0.020677671	0.143352932	0.011023	0.005103	0.005103	0.000817	2	0.16
868	6.947781	0.00216434	0.00169202	0.0001566	0.123188018	0.020666472	0.143586117	0.01102	0.005102	0.005102	0.000816	2	0.16
869	6.962835	0.00216157	0.00168983	0.0001566	0.123121381	0.020655292	0.143819383	0.011016	0.0051	0.0051	0.000816	2	0.16
870	6.977902	0.00215881	0.00168763	0.0001566	0.123054865	0.020644133	0.144052729	0.011013	0.005099	0.005099	0.000816	2	0.16
871	6.992982	0.00215606	0.00168543	0.0001566	0.122988469	0.020632995	0.144286156	0.01101	0.005097	0.005097	0.000816	2	0.16
872	7.008075	0.00215332	0.00168323	0.0001566	0.122922195	0.020621876	0.144519662	0.011006	0.005096	0.005096	0.000815	2	0.16

Table I-2: Model Parameters and Consumption Calculations

873	7.023182	0.00215058	0.00168103	0.0001566	0.12285604	0.020610778	0.144753247	0.011003	0.005094	0.005094	0.000815	2	0.16
874	7.038302	0.00214784	0.00167883	0.0001566	0.122790005	0.0205997	0.144986913	0.011	0.005092	0.005092	0.000815	2	0.16
875	7.053436	0.00214512	0.00167664	0.0001566	0.122724089	0.020588641	0.145220658	0.010996	0.005091	0.005091	0.000815	2	0.16
876	7.068582	0.0021424	0.00167444	0.0001566	0.122658292	0.020577603	0.145454483	0.010993	0.005089	0.005089	0.000814	2	0.16
877	7.083742	0.00213969	0.00167224	0.0001566	0.122592614	0.020566585	0.145688387	0.01099	0.005088	0.005088	0.000814	2	0.16
878	7.098916	0.00213698	0.00167004	0.0001566	0.122527054	0.020555586	0.14592237	0.010986	0.005086	0.005086	0.000814	2	0.16
879	7.114102	0.00213428	0.00166784	0.0001566	0.122461612	0.020544607	0.146156432	0.010983	0.005085	0.005085	0.000814	2	0.16
880	7.129302	0.00213159	0.00166565	0.0001566	0.122396288	0.020533648	0.146390573	0.01098	0.005083	0.005083	0.000813	2	0.16
881	7.144515	0.0021289	0.00166345	0.0001566	0.122331081	0.020522709	0.146624793	0.010976	0.005082	0.005082	0.000813	2	0.16
882	7.159741	0.00212622	0.00166125	0.0001566	0.122265991	0.020511789	0.146859092	0.010973	0.00508	0.00508	0.000813	2	0.16
883	7.17498	0.00212354	0.00165905	0.0001566	0.122201017	0.020500889	0.14709347	0.01097	0.005079	0.005079	0.000813	2	0.16
884	7.190233	0.00212088	0.00165685	0.0001566	0.122136159	0.020490008	0.147327926	0.010967	0.005077	0.005077	0.000812	2	0.16
885	7.205499	0.00211821	0.00165466	0.0001566	0.122071417	0.020479147	0.147562461	0.010963	0.005076	0.005076	0.000812	2	0.16
886	7.220777	0.00211556	0.00165246	0.0001566	0.122006791	0.020468305	0.147797074	0.01096	0.005074	0.005074	0.000812	2	0.16
887	7.23607	0.00211291	0.00165026	0.0001566	0.12194228	0.020457482	0.148031765	0.010957	0.005073	0.005073	0.000812	2	0.16
888	7.251375	0.00211027	0.00164806	0.0001566	0.121877884	0.020446679	0.148266535	0.010953	0.005071	0.005071	0.000811	2	0.16
889	7.266693	0.00210763	0.00164586	0.0001566	0.121813602	0.020435895	0.148501382	0.01095	0.005069	0.005069	0.000811	2	0.16
890	7.282025	0.002105	0.00164366	0.0001566	0.121749434	0.02042513	0.148736308	0.010947	0.005068	0.005068	0.000811	2	0.16
891	7.29737	0.00210238	0.00164147	0.0001566	0.12168538	0.020414384	0.148971311	0.010944	0.005066	0.005066	0.000811	2	0.16
892	7.312728	0.00209976	0.00163927	0.0001566	0.12162144	0.020403657	0.149206392	0.01094	0.005065	0.005065	0.00081	2	0.16
893	7.328099	0.00209715	0.00163707	0.0001566	0.121557613	0.020392949	0.14944155	0.010937	0.005063	0.005063	0.00081	2	0.16
894	7.343483	0.00209455	0.00163487	0.0001566	0.121493898	0.02038226	0.149676786	0.010934	0.005062	0.005062	0.00081	2	0.16
895	7.358881	0.00209195	0.00163267	0.0001566	0.121430296	0.02037159	0.1499121	0.010931	0.00506	0.00506	0.00081	2	0.16
896	7.374291	0.00208935	0.00163048	0.0001566	0.121366807	0.020360939	0.15014749	0.010927	0.005059	0.005059	0.000809	2	0.16
897	7.389715	0.00208677	0.00162828	0.0001566	0.121303429	0.020350306	0.150382958	0.010924	0.005057	0.005057	0.000809	2	0.16
898	7.405152	0.00208419	0.00162608	0.0001566	0.121240162	0.020339692	0.150618503	0.010921	0.005056	0.005056	0.000809	2	0.16
899	7.420601	0.00208161	0.00162388	0.0001566	0.121177007	0.020329097	0.150854125	0.010918	0.005054	0.005054	0.000809	2	0.16
900	7.436064	0.00207904	0.00162168	0.0001566	0.121113962	0.020318521	0.151089824	0.010914	0.005053	0.005053	0.000808	2	0.16
901	7.45154	0.00207648	0.00161949	0.0001566	0.121051028	0.020307962	0.151325599	0.010911	0.005052	0.005052	0.000808	2	0.16
902	7.467029	0.00207392	0.00161729	0.0001566	0.120988205	0.020297423	0.151561451	0.010908	0.00505	0.00505	0.000808	2	0.16
903	7.482531	0.00207137	0.00161509	0.0001566	0.120925491	0.020286902	0.15179738	0.010905	0.005049	0.005049	0.000808	2	0.16
904	7.498047	0.00206883	0.00161289	0.0001566	0.120862887	0.020276399	0.152033385	0.010902	0.005047	0.005047	0.000808	2	0.16
905	7.513575	0.00206629	0.00161069	0.0001566	0.120800392	0.020265915	0.152269466	0.010899	0.005046	0.005046	0.000807	2	0.16
906	7.529116	0.00206376	0.00160849	0.0001566	0.120738006	0.020255449	0.152505624	0.010895	0.005044	0.005044	0.000807	2	0.16
907	7.54467	0.00206123	0.0016063	0.0001566	0.120675728	0.020245001	0.152741858	0.010892	0.005043	0.005043	0.000807	2	0.16
908	7.560238	0.00205871	0.0016041	0.0001566	0.120613559	0.020234571	0.152978167	0.010889	0.005041	0.005041	0.000807	2	0.16
909	7.575818	0.00205619	0.0016019	0.0001566	0.120551498	0.020224159	0.153214553	0.010886	0.00504	0.00504	0.000806	2	0.16
910	7.591411	0.00205368	0.0015997	0.0001566	0.120489545	0.020213766	0.153451014	0.010883	0.005038	0.005038	0.000806	2	0.16
911	7.607018	0.00205118	0.0015975	0.0001566	0.120427699	0.02020339	0.153687552	0.010879	0.005037	0.005037	0.000806	2	0.16
912	7.622637	0.00204868	0.00159531	0.0001566	0.12036596	0.020193033	0.153924164	0.010876	0.005035	0.005035	0.000806	2	0.16
913	7.63827	0.00204619	0.00159311	0.0001566	0.120304327	0.020182693	0.154160853	0.010873	0.005034	0.005034	0.000805	2	0.16
914	7.653915	0.00204371	0.00159091	0.0001566	0.120242802	0.020172371	0.154397616	0.01087	0.005032	0.005032	0.000805	2	0.16
915	7.669573	0.00204123	0.00158871	0.0001566	0.120181382	0.020162067	0.154634455	0.010867	0.005031	0.005031	0.000805	2	0.16
916	7.685245	0.00203875	0.00158651	0.0001566	0.120120069	0.020151781	0.154871369	0.010864	0.00503	0.00503	0.000805	2	0.16
917	7.700929	0.00203628	0.00158432	0.0001566	0.12005886	0.020141513	0.155108358	0.010861	0.005028	0.005028	0.000804	2	0.16
918	7.716626	0.00203382	0.00158212	0.0001566	0.119997758	0.020131262	0.155345423	0.010857	0.005027	0.005027	0.000804	2	0.16
919	7.732336	0.00203136	0.00157992	0.0001566	0.11993676	0.020121029	0.155582562	0.010854	0.005025	0.005025	0.000804	2	0.16
920	7.748059	0.00202891	0.00157772	0.0001566	0.119875866	0.020110813	0.155819776	0.010851	0.005024	0.005024	0.000804	2	0.16
921	7.763796	0.00202646	0.00157552	0.0001566	0.119815078	0.020100615	0.156057064	0.010848	0.005022	0.005022	0.000804	2	0.16
922	7.779545	0.00202402	0.00157332	0.0001566	0.119754393	0.020090434	0.156294427	0.010845	0.005021	0.005021	0.000803	2	0.16
923	7.795306	0.00202159	0.00157113	0.0001566	0.119693812	0.020080271	0.156531865	0.010842	0.005019	0.005019	0.000803	2	0.16
924	7.811081	0.00201916	0.00156893	0.0001566	0.119633334	0.020070125	0.156769377	0.010839	0.005018	0.005018	0.000803	2	0.16
925	7.826869	0.00201673	0.00156673	0.0001566	0.11957296	0.020059996	0.157006963	0.010836	0.005017	0.005017	0.000803	2	0.16

Table I-2: Model Parameters and Consumption Calculations

926	7.84267	0.00201431	0.00156453	0.0001566	0.119512688	0.020049885	0.157244623	0.010833	0.005015	0.005015	0.000802	2	0.16
927	7.858483	0.0020119	0.00156233	0.0001566	0.11945252	0.020039791	0.157482358	0.01083	0.005014	0.005014	0.000802	2	0.16
928	7.87431	0.00200949	0.00156014	0.0001566	0.119392453	0.020029714	0.157720166	0.010826	0.005012	0.005012	0.000802	2	0.16
929	7.890149	0.00200709	0.00155794	0.0001566	0.119332488	0.020019654	0.157958049	0.010823	0.005011	0.005011	0.000802	2	0.16
930	7.906001	0.00200469	0.00155574	0.0001566	0.119272626	0.020009611	0.158196005	0.01082	0.005009	0.005009	0.000802	2	0.16
931	7.921866	0.0020023	0.00155354	0.0001566	0.119212864	0.019999585	0.158434035	0.010817	0.005008	0.005008	0.000801	2	0.16
932	7.937744	0.00199992	0.00155134	0.0001566	0.119153204	0.019989577	0.158672138	0.010814	0.005007	0.005007	0.000801	2	0.16
933	7.953635	0.00199754	0.00154915	0.0001566	0.119093645	0.019979585	0.158910315	0.010811	0.005005	0.005005	0.000801	2	0.16
934	7.969538	0.00199516	0.00154695	0.0001566	0.119034186	0.01996961	0.159148565	0.010808	0.005004	0.005004	0.000801	2	0.16
935	7.985454	0.00199279	0.00154475	0.0001566	0.118974828	0.019959652	0.159386889	0.010805	0.005002	0.005002	0.0008	2	0.16
936	8.001384	0.00199043	0.00154255	0.0001566	0.11891557	0.01994971	0.159625285	0.010802	0.005001	0.005001	0.0008	2	0.16
937	8.017326	0.00198807	0.00154035	0.0001566	0.118856411	0.019939786	0.159863755	0.010799	0.005	0.005	0.0008	2	0.16
938	8.033281	0.00198571	0.00153815	0.0001566	0.118797352	0.019929878	0.160102298	0.010796	0.004998	0.004998	0.0008	2	0.16
939	8.049248	0.00198337	0.00153596	0.0001566	0.118738393	0.019919986	0.160340914	0.010793	0.004997	0.004997	0.000799	2	0.16
940	8.065229	0.00198102	0.00153376	0.0001566	0.118679532	0.019910112	0.160579602	0.01079	0.004995	0.004995	0.000799	2	0.16
941	8.081222	0.00197868	0.00153156	0.0001566	0.11862077	0.019900253	0.160818363	0.010787	0.004994	0.004994	0.000799	2	0.16
942	8.097228	0.00197635	0.00152936	0.0001566	0.118562106	0.019890412	0.161057197	0.010784	0.004993	0.004993	0.000799	2	0.16
943	8.113247	0.00197402	0.00152716	0.0001566	0.11850354	0.019880587	0.161296103	0.010781	0.004991	0.004991	0.000799	2	0.16
944	8.129278	0.0019717	0.00152497	0.0001566	0.118445073	0.019870778	0.161535082	0.010778	0.00499	0.00499	0.000798	2	0.16
945	8.145323	0.00196939	0.00152277	0.0001566	0.118386702	0.019860985	0.161774133	0.010775	0.004988	0.004988	0.000798	2	0.16
946	8.16138	0.00196707	0.00152057	0.0001566	0.118328429	0.019851209	0.162013256	0.010772	0.004987	0.004987	0.000798	2	0.16
947	8.177449	0.00196477	0.00151837	0.0001566	0.118270254	0.01984145	0.162252452	0.010769	0.004986	0.004986	0.000798	2	0.16
948	8.193532	0.00196246	0.00151617	0.0001566	0.118212174	0.019831706	0.162491719	0.010766	0.004984	0.004984	0.000797	2	0.16
949	8.209627	0.00196017	0.00151398	0.0001566	0.118154192	0.019821979	0.162731058	0.010763	0.004983	0.004983	0.000797	2	0.16
950	8.225735	0.00195788	0.00151178	0.0001566	0.118096306	0.019812267	0.162970469	0.01076	0.004981	0.004981	0.000797	2	0.16
951	8.241856	0.00195559	0.00150958	0.0001566	0.118038515	0.019802572	0.163209952	0.010757	0.00498	0.00498	0.000797	2	0.16
952	8.25799	0.00195331	0.00150738	0.0001566	0.117980821	0.019792893	0.163449507	0.010754	0.004979	0.004979	0.000797	2	0.16
953	8.274136	0.00195103	0.00150518	0.0001566	0.117923221	0.01978323	0.163689133	0.010751	0.004977	0.004977	0.000796	2	0.16
954	8.290295	0.00194876	0.00150298	0.0001566	0.117865717	0.019773583	0.16392883	0.010748	0.004976	0.004976	0.000796	2	0.16
955	8.306466	0.0019465	0.00150079	0.0001566	0.117808308	0.019763952	0.164168599	0.010745	0.004975	0.004975	0.000796	2	0.16
956	8.32265	0.00194423	0.00149859	0.0001566	0.117750994	0.019754337	0.164408439	0.010742	0.004973	0.004973	0.000796	2	0.16
957	8.338847	0.00194198	0.00149639	0.0001566	0.117693774	0.019744737	0.164648351	0.010739	0.004972	0.004972	0.000795	2	0.16
958	8.355057	0.00193973	0.00149419	0.0001566	0.117636648	0.019735154	0.164888333	0.010736	0.00497	0.00497	0.000795	2	0.16
959	8.371279	0.00193748	0.00149199	0.0001566	0.117579616	0.019725586	0.165128386	0.010733	0.004969	0.004969	0.000795	2	0.16
960	8.387514	0.00193524	0.0014898	0.0001566	0.117522678	0.019716034	0.165368511	0.01073	0.004968	0.004968	0.000795	2	0.16
961	8.403762	0.001933	0.0014876	0.0001566	0.117465833	0.019706497	0.165608706	0.010727	0.004966	0.004966	0.000795	2	0.16
962	8.420022	0.00193077	0.0014854	0.0001566	0.117409081	0.019696976	0.165848971	0.010724	0.004965	0.004965	0.000794	2	0.16
963	8.436295	0.00192855	0.0014832	0.0001566	0.117352422	0.019687471	0.166089308	0.010721	0.004964	0.004964	0.000794	2	0.16
964	8.45258	0.00192632	0.001481	0.0001566	0.117295856	0.019677981	0.166329715	0.010719	0.004962	0.004962	0.000794	2	0.16
965	8.468878	0.00192411	0.00147881	0.0001566	0.117239382	0.019668507	0.166570192	0.010716	0.004961	0.004961	0.000794	2	0.16
966	8.485189	0.00192189	0.00147661	0.0001566	0.117183001	0.019659048	0.16681074	0.010713	0.00496	0.00496	0.000794	2	0.16
967	8.501512	0.00191969	0.00147441	0.0001566	0.117126711	0.019649605	0.167051358	0.01071	0.004958	0.004958	0.000793	2	0.16
968	8.517848	0.00191749	0.00147221	0.0001566	0.117070513	0.019640177	0.167292046	0.010707	0.004957	0.004957	0.000793	2	0.16
969	8.534197	0.00191529	0.00147001	0.0001566	0.117014406	0.019630764	0.167532804	0.010704	0.004956	0.004956	0.000793	2	0.16
970	8.550558	0.00191309	0.00146781	0.0001566	0.11695839	0.019621367	0.167773632	0.010701	0.004954	0.004954	0.000793	2	0.16
971	8.566932	0.00191091	0.00146562	0.0001566	0.116902465	0.019611984	0.16801453	0.010698	0.004953	0.004953	0.000792	2	0.16
972	8.583318	0.00190872	0.00146342	0.0001566	0.116846631	0.019602617	0.168255497	0.010695	0.004952	0.004952	0.000792	2	0.16
973	8.599717	0.00190655	0.00146122	0.0001566	0.116790888	0.019593266	0.168496535	0.010692	0.00495	0.00495	0.000792	2	0.16
974	8.616128	0.00190437	0.00145902	0.0001566	0.116735234	0.019583929	0.168737642	0.01069	0.004949	0.004949	0.000792	2	0.16
975	8.632552	0.0019022	0.00145682	0.0001566	0.116679671	0.019574608	0.168978818	0.010687	0.004948	0.004948	0.000792	2	0.16
976	8.648989	0.00190004	0.00145463	0.0001566	0.116624197	0.019565301	0.169220064	0.010684	0.004946	0.004946	0.000791	2	0.16
977	8.665438	0.00189788	0.00145243	0.0001566	0.116568812	0.01955601	0.16946138	0.010681	0.004945	0.004945	0.000791	2	0.16
978	8.681899	0.00189572	0.00145023	0.0001566	0.116513517	0.019546733	0.169702764	0.010678	0.004944	0.004944	0.000791	2	0.16

979	8.698373	0.00189357	0.00144803	0.0001566	0.116458311	0.019537471	0.169944218	0.010675	0.004942	0.004942	0.000791	2	0.16
980	8.71486	0.00189143	0.00144583	0.0001566	0.116403193	0.019528225	0.170185741	0.010672	0.004941	0.004941	0.000791	2	0.16
981	8.731359	0.00188929	0.00144364	0.0001566	0.116348164	0.019518993	0.170427332	0.010669	0.00494	0.00494	0.00079	2	0.16
982	8.747871	0.00188715	0.00144144	0.0001566	0.116293223	0.019509776	0.170668993	0.010667	0.004938	0.004938	0.00079	2	0.16
983	8.764395	0.00188502	0.00143924	0.0001566	0.116238371	0.019500573	0.170910722	0.010664	0.004937	0.004937	0.00079	2	0.16
984	8.780931	0.00188289	0.00143704	0.0001566	0.116183606	0.019491386	0.17115252	0.010661	0.004936	0.004936	0.00079	2	0.16
985	8.79748	0.00188077	0.00143484	0.0001566	0.116128928	0.019482213	0.171394387	0.010658	0.004934	0.004934	0.000789	2	0.16
986	8.814042	0.00187865	0.00143264	0.0001566	0.116074338	0.019473055	0.171636322	0.010655	0.004933	0.004933	0.000789	2	0.16
987	8.830616	0.00187653	0.00143045	0.0001566	0.116019836	0.019463911	0.171878326	0.010652	0.004932	0.004932	0.000789	2	0.16
988	8.847203	0.00187443	0.00142825	0.0001566	0.115965419	0.019454782	0.172120398	0.01065	0.00493	0.00493	0.000789	2	0.16
989	8.863802	0.00187232	0.00142605	0.0001566	0.11591109	0.019445668	0.172362538	0.010647	0.004929	0.004929	0.000789	2	0.16
990	8.880413	0.00187022	0.00142385	0.0001566	0.115856847	0.019436568	0.172604747	0.010644	0.004928	0.004928	0.000788	2	0.16
991	8.897037	0.00186812	0.00142165	0.0001566	0.11580269	0.019427482	0.172847023	0.010641	0.004926	0.004926	0.000788	2	0.16
992	8.913673	0.00186603	0.00141946	0.0001566	0.115748619	0.019418411	0.173089368	0.010638	0.004925	0.004925	0.000788	2	0.16
993	8.930322	0.00186395	0.00141726	0.0001566	0.115694634	0.019409354	0.17333178	0.010636	0.004924	0.004924	0.000788	2	0.16
994	8.946983	0.00186186	0.00141506	0.0001566	0.115640735	0.019400312	0.173574261	0.010633	0.004923	0.004923	0.000788	2	0.16
995	8.963657	0.00185979	0.00141286	0.0001566	0.115586921	0.019391284	0.173816809	0.01063	0.004921	0.004921	0.000787	2	0.16
996	8.980343	0.00185771	0.00141066	0.0001566	0.115533191	0.01938227	0.174059424	0.010627	0.00492	0.00492	0.000787	2	0.16
997	8.997041	0.00185564	0.00140847	0.0001566	0.115479547	0.01937327	0.174302108	0.010624	0.004919	0.004919	0.000787	2	0.16
998	9.013752	0.00185358	0.00140627	0.0001566	0.115425987	0.019364285	0.174544858	0.010622	0.004917	0.004917	0.000787	2	0.16
999	9.030475	0.00185152	0.00140407	0.0001566	0.115372512	0.019355314	0.174787676	0.010619	0.004916	0.004916	0.000787	2	0.16
1000	9.047211	0.00184946	0.00140187	0.0001566	0.115319121	0.019346357	0.175030562	0.010616	0.004915	0.004915	0.000786	2	0.16
1001	9.063958	0.00184741	0.00139967	0.0001566	0.115265813	0.019337414	0.175273514	0.010613	0.004914	0.004914	0.000786	2	0.16
1002	9.080719	0.00184536	0.00139747	0.0001566	0.11521259	0.019328485	0.175516534	0.01061	0.004912	0.004912	0.000786	2	0.16
1003	9.097491	0.00184332	0.00139528	0.0001566	0.11515945	0.01931957	0.175759621	0.010608	0.004911	0.004911	0.000786	2	0.16
1004	9.114277	0.00184128	0.00139308	0.0001566	0.115106393	0.019310669	0.176002775	0.010605	0.00491	0.00491	0.000786	2	0.16
1005	9.131074	0.00183924	0.00139088	0.0001566	0.11505342	0.019301782	0.176245995	0.010602	0.004908	0.004908	0.000785	2	0.16
1006	9.147884	0.00183721	0.00138868	0.0001566	0.115000529	0.019292909	0.176489283	0.010599	0.004907	0.004907	0.000785	2	0.16
1007	9.164706	0.00183519	0.00138648	0.0001566	0.114947721	0.019284049	0.176732637	0.010597	0.004906	0.004906	0.000785	2	0.16
1008	9.18154	0.00183317	0.00138429	0.0001566	0.114894995	0.019275204	0.176976058	0.010594	0.004905	0.004905	0.000785	2	0.16
1009	9.198387	0.00183115	0.00138209	0.0001566	0.114842352	0.019266372	0.177219545	0.010591	0.004903	0.004903	0.000785	2	0.16
1010	9.215246	0.00182914	0.00137989	0.0001566	0.114789791	0.019257554	0.177463099	0.010588	0.004902	0.004902	0.000784	2	0.16
1011	9.232117	0.00182713	0.00137769	0.0001566	0.114737311	0.01924875	0.177706719	0.010586	0.004901	0.004901	0.000784	2	0.16
1012	9.249001	0.00182512	0.00137549	0.0001566	0.114684913	0.01923996	0.177950405	0.010583	0.0049	0.0049	0.000784	2	0.16
1013	9.265897	0.00182312	0.00137329	0.0001566	0.114632597	0.019231183	0.178194158	0.01058	0.004898	0.004898	0.000784	2	0.16
1014	9.282805	0.00182112	0.0013711	0.0001566	0.114580361	0.01922242	0.178437976	0.010577	0.004897	0.004897	0.000784	2	0.16
1015	9.299726	0.00181913	0.0013689	0.0001566	0.114528207	0.01921367	0.178681861	0.010575	0.004896	0.004896	0.000783	2	0.16
1016	9.316658	0.00181714	0.0013667	0.0001566	0.114476133	0.019204934	0.178925812	0.010572	0.004894	0.004894	0.000783	2	0.16
1017	9.333604	0.00181516	0.0013645	0.0001566	0.11442414	0.019196212	0.179169828	0.010569	0.004893	0.004893	0.000783	2	0.16
1018	9.350561	0.00181318	0.0013623	0.0001566	0.114372228	0.019187502	0.179413911	0.010567	0.004892	0.004892	0.000783	2	0.16
1019	9.367531	0.0018112	0.00136011	0.0001566	0.114320395	0.019178807	0.179658059	0.010564	0.004891	0.004891	0.000783	2	0.16
1020	9.384512	0.00180923	0.00135791	0.0001566	0.114268642	0.019170125	0.179902272	0.010561	0.004889	0.004889	0.000782	2	0.16
1021	9.401507	0.00180726	0.00135571	0.0001566	0.114216969	0.019161456	0.180146552	0.010558	0.004888	0.004888	0.000782	2	0.16
1022	9.418513	0.0018053	0.00135351	0.0001566	0.114165376	0.0191528	0.180390896	0.010556	0.004887	0.004887	0.000782	2	0.16
1023	9.435531	0.00180334	0.00135131	0.0001566	0.114113862	0.019144158	0.180635306	0.010553	0.004886	0.004886	0.000782	2	0.16
1024	9.452562	0.00180138	0.00134912	0.0001566	0.114062427	0.019135529	0.180879781	0.01055	0.004884	0.004884	0.000782	2	0.16
1025	9.469605	0.00179943	0.00134692	0.0001566	0.114011071	0.019126914	0.181124322	0.010548	0.004883	0.004883	0.000781	2	0.16
1026	9.486661	0.00179748	0.00134472	0.0001566	0.113959794	0.019118311	0.181368928	0.010545	0.004882	0.004882	0.000781	2	0.16
1027	9.503728	0.00179554	0.00134252	0.0001566	0.113908595	0.019109722	0.181613598	0.010542	0.004881	0.004881	0.000781	2	0.16
1028	9.520808	0.0017936	0.00134032	0.0001566	0.113857475	0.019101146	0.181858334	0.01054	0.004879	0.004879	0.000781	2	0.16
1029	9.537899	0.00179166	0.00133812	0.0001566	0.113806433	0.019092583	0.182103134	0.010537	0.004878	0.004878	0.000781	2	0.16
1030	9.555004	0.00178973	0.00133593	0.0001566	0.113755468	0.019084033	0.182348	0.010534	0.004877	0.004877	0.00078	2	0.16
1031	9.57212	0.0017878	0.00133373	0.0001566	0.113704582	0.019075496	0.18259293	0.010532	0.004876	0.004876	0.00078	2	0.16

Table I-2: Model Parameters and Consumption Calculations

1032	9.589248	0.00178588	0.00133153	0.0001566	0.113653773	0.019066972	0.182837924	0.010529	0.004875	0.004875	0.00078	2	0.16
1033	9.606389	0.00178396	0.00132933	0.0001566	0.113603041	0.019058461	0.183082983	0.010526	0.004873	0.004873	0.00078	2	0.16
1034	9.623541	0.00178205	0.00132713	0.0001566	0.113552386	0.019049963	0.183328107	0.010524	0.004872	0.004872	0.00078	2	0.16
1035	9.640706	0.00178013	0.00132494	0.0001566	0.113501809	0.019041478	0.183573295	0.010521	0.004871	0.004871	0.000779	2	0.16
1036	9.657883	0.00177822	0.00132274	0.0001566	0.113451308	0.019033006	0.183818547	0.010518	0.00487	0.00487	0.000779	2	0.16
1037	9.675072	0.00177632	0.00132054	0.0001566	0.113400884	0.019024546	0.184063864	0.010516	0.004868	0.004868	0.000779	2	0.16
1038	9.692274	0.00177442	0.00131834	0.0001566	0.113350536	0.0190161	0.184309245	0.010513	0.004867	0.004867	0.000779	2	0.16
1039	9.709487	0.00177252	0.00131614	0.0001566	0.113300264	0.019007666	0.184554689	0.01051	0.004866	0.004866	0.000779	2	0.16
1040	9.726713	0.00177063	0.00131395	0.0001566	0.113250068	0.018999245	0.184800198	0.010508	0.004865	0.004865	0.000778	2	0.16
1041	9.74395	0.00176874	0.00131175	0.0001566	0.113199948	0.018990837	0.185045771	0.010505	0.004864	0.004864	0.000778	2	0.16
1042	9.7612	0.00176686	0.00130955	0.0001566	0.113149904	0.018982441	0.185291407	0.010503	0.004862	0.004862	0.000778	2	0.16
1043	9.778462	0.00176498	0.00130735	0.0001566	0.113099935	0.018974058	0.185537108	0.0105	0.004861	0.004861	0.000778	2	0.16
1044	9.795736	0.0017631	0.00130515	0.0001566	0.113050042	0.018965688	0.185782872	0.010497	0.00486	0.00486	0.000778	2	0.16
1045	9.813022	0.00176122	0.00130295	0.0001566	0.113000223	0.01895733	0.186028699	0.010495	0.004859	0.004859	0.000777	2	0.16
1046	9.83032	0.00175935	0.00130076	0.0001566	0.112950479	0.018948985	0.18627459	0.010492	0.004857	0.004857	0.000777	2	0.16
1047	9.847631	0.00175749	0.00129856	0.0001566	0.11290081	0.018940652	0.186520545	0.010489	0.004856	0.004856	0.000777	2	0.16
1048	9.864953	0.00175563	0.00129636	0.0001566	0.112851216	0.018932332	0.186766563	0.010487	0.004855	0.004855	0.000777	2	0.16
1049	9.882287	0.00175377	0.00129416	0.0001566	0.112801695	0.018924024	0.187012644	0.010484	0.004854	0.004854	0.000777	2	0.16
1050	9.899634	0.00175191	0.00129196	0.0001566	0.112752249	0.018915729	0.187258788	0.010482	0.004853	0.004853	0.000776	2	0.16
1051	9.916992	0.00175006	0.00128977	0.0001566	0.112702877	0.018907446	0.187504995	0.010479	0.004851	0.004851	0.000776	2	0.16
1052	9.934363	0.00174821	0.00128757	0.0001566	0.112653579	0.018899176	0.187751266	0.010476	0.00485	0.00485	0.000776	2	0.16
1053	9.951745	0.00174637	0.00128537	0.0001566	0.112604354	0.018890918	0.187997599	0.010474	0.004849	0.004849	0.000776	2	0.16
1054	9.96914	0.00174453	0.00128317	0.0001566	0.112555202	0.018882672	0.188243996	0.010471	0.004848	0.004848	0.000776	2	0.16
1055	9.986547	0.00174269	0.00128097	0.0001566	0.112506124	0.018874438	0.188490455	0.010469	0.004847	0.004847	0.000775	2	0.16
1056	10.00397	0.00174086	0.00127878	0.0001566	0.112457119	0.018866217	0.188736977	0.010466	0.004845	0.004845	0.000775	2	0.16
1057	10.0214	0.00173903	0.00127658	0.0001566	0.112408186	0.018858008	0.188983561	0.010464	0.004844	0.004844	0.000775	2	0.16
1058	10.03884	0.00173721	0.00127438	0.0001566	0.112359327	0.018849811	0.189230208	0.010461	0.004843	0.004843	0.000775	2	0.16
1059	10.05629	0.00173538	0.00127218	0.0001566	0.112310539	0.018841626	0.189476918	0.010458	0.004842	0.004842	0.000775	2	0.16
1060	10.07376	0.00173357	0.00126998	0.0001566	0.112261824	0.018833454	0.18972369	0.010456	0.004841	0.004841	0.000775	2	0.16
1061	10.09124	0.00173175	0.00126778	0.0001566	0.112213182	0.018825293	0.189970525	0.010453	0.004839	0.004839	0.000774	2	0.16
1062	10.10873	0.00172994	0.00126559	0.0001566	0.112164611	0.018817145	0.190217421	0.010451	0.004838	0.004838	0.000774	2	0.16
1063	10.12623	0.00172813	0.00126339	0.0001566	0.112116112	0.018809008	0.19046438	0.010448	0.004837	0.004837	0.000774	2	0.16
1064	10.14375	0.00172633	0.00126119	0.0001566	0.112067684	0.018800884	0.190711401	0.010446	0.004836	0.004836	0.000774	2	0.16
1065	10.16127	0.00172453	0.00125899	0.0001566	0.112019328	0.018792772	0.190958484	0.010443	0.004835	0.004835	0.000774	2	0.16
1066	10.17881	0.00172273	0.00125679	0.0001566	0.111971044	0.018784671	0.191205629	0.010441	0.004834	0.004834	0.000773	2	0.16
1067	10.19636	0.00172094	0.0012546	0.0001566	0.11192283	0.018776583	0.191452836	0.010438	0.004832	0.004832	0.000773	2	0.16
1068	10.21392	0.00171915	0.0012524	0.0001566	0.111874687	0.018768506	0.191700105	0.010435	0.004831	0.004831	0.000773	2	0.16
1069	10.2315	0.00171736	0.0012502	0.0001566	0.111826615	0.018760441	0.191947435	0.010433	0.00483	0.00483	0.000773	2	0.16
1070	10.24909	0.00171558	0.001248	0.0001566	0.111778614	0.018752388	0.192194827	0.01043	0.004829	0.004829	0.000773	2	0.16
1071	10.26668	0.0017138	0.0012458	0.0001566	0.111730683	0.018744347	0.192442281	0.010428	0.004828	0.004828	0.000772	2	0.16
1072	10.28429	0.00171203	0.00124361	0.0001566	0.111682822	0.018736318	0.192689796	0.010425	0.004827	0.004827	0.000772	2	0.16
1073	10.30192	0.00171026	0.00124141	0.0001566	0.111635031	0.0187283	0.192937373	0.010423	0.004825	0.004825	0.000772	2	0.16
1074	10.31955	0.00170849	0.00123921	0.0001566	0.11158731	0.018720295	0.193185011	0.01042	0.004824	0.004824	0.000772	2	0.16
1075	10.3372	0.00170672	0.00123701	0.0001566	0.111539659	0.0187123	0.19343271	0.010418	0.004823	0.004823	0.000772	2	0.16
1076	10.35485	0.00170496	0.00123481	0.0001566	0.111492077	0.018704318	0.193680471	0.010415	0.004822	0.004822	0.000772	2	0.16
1077	10.37252	0.0017032	0.00123261	0.0001566	0.111444565	0.018696347	0.193928292	0.010413	0.004821	0.004821	0.000771	2	0.16
1078	10.3902	0.00170145	0.00123042	0.0001566	0.111397122	0.018688388	0.194176175	0.01041	0.00482	0.00482	0.000771	2	0.16
1079	10.4079	0.0016997	0.00122822	0.0001566	0.111349748	0.01868044	0.194424119	0.010408	0.004818	0.004818	0.000771	2	0.16
1080	10.4256	0.00169795	0.00122602	0.0001566	0.111302443	0.018672504	0.194672124	0.010405	0.004817	0.004817	0.000771	2	0.16
1081	10.44332	0.00169621	0.00122382	0.0001566	0.111255206	0.01866458	0.194920189	0.010403	0.004816	0.004816	0.000771	2	0.16
1082	10.46105	0.00169446	0.00122162	0.0001566	0.111208038	0.018656667	0.195168315	0.0104	0.004815	0.004815	0.00077	2	0.16
1083	10.47879	0.00169273	0.00121943	0.0001566	0.111160939	0.018648765	0.195416502	0.010398	0.004814	0.004814	0.00077	2	0.16
1084	10.49654	0.00169099	0.00121723	0.0001566	0.111113907	0.018640875	0.19566475	0.010395	0.004813	0.004813	0.00077	2	0.16

Table I-2: Model Parameters and Consumption Calculations

	1085	10.51431	0.00168926	0.00121503	0.0001566	0.111066944	0.018632996	0.195913058	0.010393	0.004811	0.004811	0.00077	2	0.16
	1086	10.53208	0.00168753	0.00121283	0.0001566	0.111020049	0.018625129	0.196161427	0.01039	0.00481	0.00481	0.00077	2	0.16
	1087	10.54987	0.00168581	0.00121063	0.0001566	0.110973221	0.018617273	0.196409856	0.010388	0.004809	0.004809	0.000769	2	0.16
	1088	10.56767	0.00168409	0.00120844	0.0001566	0.110926461	0.018609428	0.196658345	0.010385	0.004808	0.004808	0.000769	2	0.16
	1089	10.58548	0.00168237	0.00120624	0.0001566	0.110879768	0.018601595	0.196906895	0.010383	0.004807	0.004807	0.000769	2	0.16
	1090	10.60331	0.00168066	0.00120404	0.0001566	0.110833143	0.018593773	0.197155504	0.01038	0.004806	0.004806	0.000769	2	0.16
	1091	10.62114	0.00167895	0.00120184	0.0001566	0.110786584	0.018585962	0.197404174	0.010378	0.004805	0.004805	0.000769	2	0.16
	1092	10.63899	0.00167724	0.00119964	0.0001566	0.110740093	0.018578162	0.197652904	0.010375	0.004803	0.004803	0.000769	2	0.16
	1093	10.65685	0.00167554	0.00119744	0.0001566	0.110693668	0.018570374	0.197901694	0.010373	0.004802	0.004802	0.000768	2	0.16
	1094	10.67472	0.00167383	0.00119525	0.0001566	0.11064731	0.018562597	0.198150544	0.010371	0.004801	0.004801	0.000768	2	0.16
	1095	10.6926	0.00167214	0.00119305	0.0001566	0.110601019	0.018554831	0.198399454	0.010368	0.0048	0.0048	0.000768	2	0.16
3 year old	1096	10.7105	0.00167044	0.00119085	8.144E-05	0.110554793	0.018547076	0.198648423	0.010366	0.004799	0.004799	0.000768	2	0.16
	1097	10.7284	0.00166875	0.00118865	8.144E-05	0.110508634	0.018539332	0.198897452	0.010363	0.004798	0.004798	0.000768	2	0.16
	1098	10.74632	0.00166706	0.00118645	8.144E-05	0.110462541	0.018531599	0.199146541	0.010361	0.004797	0.004797	0.000767	2	0.16
	1099	10.76425	0.00166538	0.00118426	8.144E-05	0.110416513	0.018523877	0.199395689	0.010358	0.004796	0.004796	0.000767	2	0.16
	1100	10.78219	0.0016637	0.00118206	8.144E-05	0.110370552	0.018516167	0.199644897	0.010356	0.004794	0.004794	0.000767	2	0.16
	1101	10.80015	0.00166202	0.00117986	8.144E-05	0.110324655	0.018508467	0.199894164	0.010353	0.004793	0.004793	0.000767	2	0.16
	1102	10.81811	0.00166034	0.00117766	8.144E-05	0.110278824	0.018500778	0.20014349	0.010351	0.004792	0.004792	0.000767	2	0.16
	1103	10.83609	0.00165867	0.00117546	8.144E-05	0.110233059	0.0184931	0.200392876	0.010349	0.004791	0.004791	0.000767	2	0.16
	1104	10.85408	0.001657	0.00117327	8.144E-05	0.110187358	0.018485433	0.200642321	0.010346	0.00479	0.00479	0.000766	2	0.16
	1105	10.87208	0.00165534	0.00117107	8.144E-05	0.110141722	0.018477777	0.200891825	0.010344	0.004789	0.004789	0.000766	2	0.16
	1106	10.89009	0.00165368	0.00116887	8.144E-05	0.110096151	0.018470132	0.201141388	0.010341	0.004788	0.004788	0.000766	2	0.16
	1107	10.90811	0.00165202	0.00116667	8.144E-05	0.110050645	0.018462498	0.20139101	0.010339	0.004787	0.004787	0.000766	2	0.16
	1108	10.92615	0.00165036	0.00116447	8.144E-05	0.110005203	0.018454874	0.201640691	0.010336	0.004785	0.004785	0.000766	2	0.16
	1109	10.9442	0.00164871	0.00116227	8.144E-05	0.109959825	0.018447262	0.20189043	0.010334	0.004784	0.004784	0.000765	2	0.16
	1110	10.96225	0.00164706	0.00116008	8.144E-05	0.109914511	0.01843966	0.202140229	0.010332	0.004783	0.004783	0.000765	2	0.16
	1111	10.98032	0.00164541	0.00115788	8.144E-05	0.109869262	0.018432068	0.202390086	0.010329	0.004782	0.004782	0.000765	2	0.16
	1112	10.99841	0.00164377	0.00115568	8.144E-05	0.109824076	0.018424488	0.202640002	0.010327	0.004781	0.004781	0.000765	2	0.16
	1113	11.0165	0.00164213	0.00115348	8.144E-05	0.109778954	0.018416918	0.202889976	0.010324	0.00478	0.00478	0.000765	2	0.16
	1114	11.03461	0.00164049	0.00115128	8.144E-05	0.109733895	0.018409359	0.203140009	0.010322	0.004779	0.004779	0.000765	2	0.16
	1115	11.05272	0.00163886	0.00114909	8.144E-05	0.1096889	0.01840181	0.2033901	0.01032	0.004778	0.004778	0.000764	2	0.16
	1116	11.07085	0.00163723	0.00114689	8.144E-05	0.109643968	0.018394272	0.20364025	0.010317	0.004777	0.004777	0.000764	2	0.16
	1117	11.08899	0.0016356	0.00114469	8.144E-05	0.109599099	0.018386745	0.203890457	0.010315	0.004775	0.004775	0.000764	2	0.16
	1118	11.10714	0.00163398	0.00114249	8.144E-05	0.109554293	0.018379228	0.204140723	0.010312	0.004774	0.004774	0.000764	2	0.16
	1119	11.12531	0.00163235	0.00114029	8.144E-05	0.10950955	0.018371722	0.204391048	0.01031	0.004773	0.004773	0.000764	2	0.16
	1120	11.14348	0.00163074	0.0011381	8.144E-05	0.109464869	0.018364226	0.20464143	0.010308	0.004772	0.004772	0.000764	2	0.16
	1121	11.16167	0.00162912	0.0011359	8.144E-05	0.109420251	0.018356741	0.20489187	0.010305	0.004771	0.004771	0.000763	2	0.16
	1122	11.17987	0.00162751	0.0011337	8.144E-05	0.109375696	0.018349266	0.205142368	0.010303	0.00477	0.00477	0.000763	2	0.16
	1123	11.19808	0.0016259	0.0011315	8.144E-05	0.109331202	0.018341802	0.205392924	0.010301	0.004769	0.004769	0.000763	2	0.16
	1124	11.2163	0.00162429	0.0011293	8.144E-05	0.109286771	0.018334348	0.205643538	0.010298	0.004768	0.004768	0.000763	2	0.16
	1125	11.23453	0.00162269	0.0011271	8.144E-05	0.109242402	0.018326904	0.20589421	0.010296	0.004767	0.004767	0.000763	2	0.16
	1126	11.25278	0.00162109	0.00112491	8.144E-05	0.109198094	0.018319471	0.206144939	0.010294	0.004766	0.004766	0.000762	2	0.16
	1127	11.27103	0.00161949	0.00112271	8.144E-05	0.109153848	0.018312048	0.206395726	0.010291	0.004764	0.004764	0.000762	2	0.16
	1128	11.2893	0.0016179	0.00112051	8.144E-05	0.109109664	0.018304636	0.20664657	0.010289	0.004763	0.004763	0.000762	2	0.16
	1129	11.30758	0.0016163	0.00111831	8.144E-05	0.109065541	0.018297233	0.206897472	0.010286	0.004762	0.004762	0.000762	2	0.16
	1130	11.32587	0.00161472	0.00111611	8.144E-05	0.109021479	0.018289841	0.207148431	0.010284	0.004761	0.004761	0.000762	2	0.16
	1131	11.34418	0.00161313	0.00111392	8.144E-05	0.108977478	0.01828246	0.207399447	0.010282	0.00476	0.00476	0.000762	2	0.16
	1132	11.36249	0.00161155	0.00111172	8.144E-05	0.108933538	0.018275088	0.207650521	0.010279	0.004759	0.004759	0.000761	2	0.16
	1133	11.38082	0.00160997	0.00110952	8.144E-05	0.108889659	0.018267727	0.207901652	0.010277	0.004758	0.004758	0.000761	2	0.16
	1134	11.39915	0.00160839	0.00110732	8.144E-05	0.10884584	0.018260376	0.20815284	0.010275	0.004757	0.004757	0.000761	2	0.16
	1135	11.4175	0.00160682	0.00110512	8.144E-05	0.108802083	0.018253035	0.208404085	0.010272	0.004756	0.004756	0.000761	2	0.16
	1136	11.43586	0.00160525	0.00110293	8.144E-05	0.108758385	0.018245704	0.208655387	0.01027	0.004755	0.004755	0.000761	2	0.16
	1137	11.45424	0.00160368	0.00110073	8.144E-05	0.108714748	0.018238383	0.208906746	0.010268	0.004754	0.004754	0.000761	2	0.16

Table I-2: Model Parameters and Consumption Calculations

1138	11.47262	0.00160211	0.00109853	8.144E-05	0.108671171	0.018231072	0.209158162	0.010265	0.004752	0.004752	0.00076	2	0.16
1139	11.49101	0.00160055	0.00109633	8.144E-05	0.108627653	0.018223772	0.209409634	0.010263	0.004751	0.004751	0.00076	2	0.16
1140	11.50942	0.00159899	0.00109413	8.144E-05	0.108584196	0.018216481	0.209661164	0.010261	0.00475	0.00475	0.00076	2	0.16
1141	11.52784	0.00159744	0.00109193	8.144E-05	0.108540798	0.018209201	0.20991275	0.010258	0.004749	0.004749	0.00076	2	0.16
1142	11.54627	0.00159588	0.00108974	8.144E-05	0.10849746	0.01820193	0.210164392	0.010256	0.004748	0.004748	0.00076	2	0.16
1143	11.56471	0.00159433	0.00108754	8.144E-05	0.108454182	0.018194669	0.210416091	0.010254	0.004747	0.004747	0.00076	2	0.16
1144	11.58316	0.00159279	0.00108534	8.144E-05	0.108410962	0.018187419	0.210667847	0.010251	0.004746	0.004746	0.000759	2	0.16
1145	11.60163	0.00159124	0.00108314	8.144E-05	0.108367802	0.018180178	0.210919658	0.010249	0.004745	0.004745	0.000759	2	0.16
1146	11.6201	0.0015897	0.00108094	8.144E-05	0.108324701	0.018172947	0.211171527	0.010247	0.004744	0.004744	0.000759	2	0.16
1147	11.63859	0.00158816	0.00107875	8.144E-05	0.108281658	0.018165726	0.211423451	0.010245	0.004743	0.004743	0.000759	2	0.16
1148	11.65709	0.00158662	0.00107655	8.144E-05	0.108238675	0.018158515	0.211675432	0.010242	0.004742	0.004742	0.000759	2	0.16
1149	11.6756	0.00158509	0.00107435	8.144E-05	0.10819575	0.018151314	0.211927468	0.01024	0.004741	0.004741	0.000759	2	0.16
1150	11.69412	0.00158356	0.00107215	8.144E-05	0.108152883	0.018144123	0.212179561	0.010238	0.00474	0.00474	0.000758	2	0.16
1151	11.71265	0.00158203	0.00106995	8.144E-05	0.108110075	0.018136941	0.21243171	0.010235	0.004739	0.004739	0.000758	2	0.16
1152	11.7312	0.00158051	0.00106776	8.144E-05	0.108067325	0.018129769	0.212683915	0.010233	0.004738	0.004738	0.000758	2	0.16
1153	11.74975	0.00157898	0.00106556	8.144E-05	0.108024633	0.018122607	0.212936175	0.010231	0.004736	0.004736	0.000758	2	0.16
1154	11.76832	0.00157746	0.00106336	8.144E-05	0.107981999	0.018115454	0.213188492	0.010229	0.004735	0.004735	0.000758	2	0.16
1155	11.7869	0.00157595	0.00106116	8.144E-05	0.107939423	0.018108312	0.213440864	0.010226	0.004734	0.004734	0.000757	2	0.16
1156	11.80549	0.00157443	0.00105896	8.144E-05	0.107896905	0.018101179	0.213693292	0.010224	0.004733	0.004733	0.000757	2	0.16
1157	11.82409	0.00157292	0.00105676	8.144E-05	0.107854444	0.018094055	0.213945775	0.010222	0.004732	0.004732	0.000757	2	0.16
1158	11.84271	0.00157141	0.00105457	8.144E-05	0.107812041	0.018086942	0.214198314	0.010219	0.004731	0.004731	0.000757	2	0.16
1159	11.86133	0.00156991	0.00105237	8.144E-05	0.107769695	0.018079838	0.214450908	0.010217	0.00473	0.00473	0.000757	2	0.16
1160	11.87997	0.0015684	0.00105017	8.144E-05	0.107727406	0.018072743	0.214703558	0.010215	0.004729	0.004729	0.000757	2	0.16
1161	11.89861	0.0015669	0.00104797	8.144E-05	0.107685174	0.018065658	0.214956263	0.010213	0.004728	0.004728	0.000756	2	0.16
1162	11.91727	0.00156541	0.00104577	8.144E-05	0.107643	0.018058583	0.215209024	0.01021	0.004727	0.004727	0.000756	2	0.16
1163	11.93594	0.00156391	0.00104358	8.144E-05	0.107600882	0.018051517	0.21546184	0.010208	0.004726	0.004726	0.000756	2	0.16
1164	11.95462	0.00156242	0.00104138	8.144E-05	0.10755882	0.01804446	0.21571471	0.010206	0.004725	0.004725	0.000756	2	0.16
1165	11.97332	0.00156093	0.00103918	8.144E-05	0.107516815	0.018037413	0.215967636	0.010204	0.004724	0.004724	0.000756	2	0.16
1166	11.99202	0.00155944	0.00103698	8.144E-05	0.107474867	0.018030376	0.216220617	0.010201	0.004723	0.004723	0.000756	2	0.16
1167	12.01073	0.00155796	0.00103478	8.144E-05	0.107432975	0.018023348	0.216473653	0.010199	0.004722	0.004722	0.000755	2	0.16
1168	12.02946	0.00155648	0.00103258	8.144E-05	0.107391139	0.01801633	0.216726744	0.010197	0.004721	0.004721	0.000755	2	0.16
1169	12.0482	0.001555	0.00103039	8.144E-05	0.107349359	0.01800932	0.21697989	0.010195	0.00472	0.00472	0.000755	2	0.16
1170	12.06695	0.00155352	0.00102819	8.144E-05	0.107307635	0.018002321	0.21723309	0.010192	0.004719	0.004719	0.000755	2	0.16
1171	12.08571	0.00155205	0.00102599	8.144E-05	0.107265967	0.01799533	0.217486345	0.01019	0.004718	0.004718	0.000755	2	0.16
1172	12.10448	0.00155058	0.00102379	8.144E-05	0.107224355	0.017988349	0.217739655	0.010188	0.004717	0.004717	0.000755	2	0.16
1173	12.12327	0.00154911	0.00102159	8.144E-05	0.107182798	0.017981377	0.217993019	0.010186	0.004716	0.004716	0.000754	2	0.16
1174	12.14206	0.00154765	0.0010194	8.144E-05	0.107141296	0.017974415	0.218246438	0.010183	0.004715	0.004715	0.000754	2	0.16
1175	12.16087	0.00154618	0.0010172	8.144E-05	0.10709985	0.017967462	0.218499912	0.010181	0.004714	0.004714	0.000754	2	0.16
1176	12.17968	0.00154472	0.001015	8.144E-05	0.107058459	0.017960518	0.218753439	0.010179	0.004712	0.004712	0.000754	2	0.16
1177	12.19851	0.00154327	0.0010128	8.144E-05	0.107017123	0.017953583	0.219007021	0.010177	0.004711	0.004711	0.000754	2	0.16
1178	12.21735	0.00154181	0.0010106	8.144E-05	0.106975842	0.017946658	0.219260658	0.010174	0.00471	0.00471	0.000754	2	0.16
1179	12.2362	0.00154036	0.00100841	8.144E-05	0.106934616	0.017939742	0.219514348	0.010172	0.004709	0.004709	0.000754	2	0.16
1180	12.25507	0.00153891	0.00100621	8.144E-05	0.106893444	0.017932834	0.219768093	0.01017	0.004708	0.004708	0.000753	2	0.16
1181	12.27394	0.00153746	0.00100401	8.144E-05	0.106852327	0.017925937	0.220021892	0.010168	0.004707	0.004707	0.000753	2	0.16
1182	12.29283	0.00153602	0.00100181	8.144E-05	0.106811265	0.017919048	0.220275745	0.010166	0.004706	0.004706	0.000753	2	0.16
1183	12.31172	0.00153458	0.00099961	8.144E-05	0.106770257	0.017912168	0.220529652	0.010163	0.004705	0.004705	0.000753	2	0.16
1184	12.33063	0.00153314	0.00099741	8.144E-05	0.106729303	0.017905298	0.220783612	0.010161	0.004704	0.004704	0.000753	2	0.16
1185	12.34955	0.0015317	0.00099522	8.144E-05	0.106688403	0.017898436	0.221037627	0.010159	0.004703	0.004703	0.000753	2	0.16
1186	12.36848	0.00153027	0.00099302	8.144E-05	0.106647557	0.017891584	0.221291695	0.010157	0.004702	0.004702	0.000752	2	0.16
1187	12.38742	0.00152883	0.00099082	8.144E-05	0.106606765	0.01788474	0.221545817	0.010155	0.004701	0.004701	0.000752	2	0.16
1188	12.40637	0.0015274	0.00098862	8.144E-05	0.106566027	0.017877906	0.221799993	0.010152	0.0047	0.0047	0.000752	2	0.16
1189	12.42534	0.00152598	0.00098642	8.144E-05	0.106525342	0.01787108	0.222054222	0.01015	0.004699	0.004699	0.000752	2	0.16
1190	12.44431	0.00152455	0.00098423	8.144E-05	0.106484711	0.017864264	0.222308505	0.010148	0.004698	0.004698	0.000752	2	0.16

Table I-2: Model Parameters and Consumption Calculations

1191	12.4633	0.00152313	0.00098203	8.144E-05	0.106444134	0.017857456	0.222562841	0.010146	0.004697	0.004697	0.000752	2	0.16
1192	12.4823	0.00152171	0.00097983	8.144E-05	0.106403609	0.017850658	0.222817231	0.010144	0.004696	0.004696	0.000751	2	0.16
1193	12.50131	0.0015203	0.00097763	8.144E-05	0.106363138	0.017843868	0.223071674	0.010141	0.004695	0.004695	0.000751	2	0.16
1194	12.52033	0.00151888	0.00097543	8.144E-05	0.10632272	0.017837088	0.223326171	0.010139	0.004694	0.004694	0.000751	2	0.16
1195	12.53936	0.00151747	0.00097324	8.144E-05	0.106282355	0.017830316	0.22358072	0.010137	0.004693	0.004693	0.000751	2	0.16
1196	12.5584	0.00151606	0.00097104	8.144E-05	0.106242042	0.017823553	0.223835323	0.010135	0.004692	0.004692	0.000751	2	0.16
1197	12.57745	0.00151466	0.00096884	8.144E-05	0.106201782	0.017816799	0.224089979	0.010133	0.004691	0.004691	0.000751	2	0.16
1198	12.59652	0.00151325	0.00096664	8.144E-05	0.106161575	0.017810053	0.224344688	0.010131	0.00469	0.00469	0.00075	2	0.16
1199	12.6156	0.00151185	0.00096444	8.144E-05	0.10612142	0.017803317	0.22459945	0.010128	0.004689	0.004689	0.00075	2	0.16
1200	12.63468	0.00151045	0.00096224	8.144E-05	0.106081318	0.017796589	0.224854265	0.010126	0.004688	0.004688	0.00075	2	0.16
1201	12.65378	0.00150905	0.00096005	8.144E-05	0.106041268	0.01778987	0.225109133	0.010124	0.004687	0.004687	0.00075	2	0.16
1202	12.67289	0.00150766	0.00095785	8.144E-05	0.10600127	0.01778316	0.225364053	0.010122	0.004686	0.004686	0.00075	2	0.16
1203	12.69201	0.00150627	0.00095565	8.144E-05	0.105961324	0.017776459	0.225619027	0.01012	0.004685	0.004685	0.00075	2	0.16
1204	12.71114	0.00150488	0.00095345	8.144E-05	0.10592143	0.017769766	0.225874053	0.010118	0.004684	0.004684	0.000749	2	0.16
1205	12.73029	0.00150349	0.00095125	8.144E-05	0.105881588	0.017763082	0.226129131	0.010116	0.004683	0.004683	0.000749	2	0.16
1206	12.74944	0.00150211	0.00094906	8.144E-05	0.105841797	0.017756406	0.226384262	0.010113	0.004682	0.004682	0.000749	2	0.16
1207	12.76861	0.00150072	0.00094686	8.144E-05	0.105802058	0.01774974	0.226639446	0.010111	0.004681	0.004681	0.000749	2	0.16
1208	12.78778	0.00149935	0.00094466	8.144E-05	0.105762371	0.017743081	0.226894682	0.010109	0.00468	0.00468	0.000749	2	0.16
1209	12.80697	0.00149797	0.00094246	8.144E-05	0.105722735	0.017736432	0.227149971	0.010107	0.004679	0.004679	0.000749	2	0.16
1210	12.82617	0.00149659	0.00094026	8.144E-05	0.10568315	0.017729791	0.227405312	0.010105	0.004678	0.004678	0.000749	2	0.16
1211	12.84538	0.00149522	0.00093807	8.144E-05	0.105643616	0.017723159	0.227660705	0.010103	0.004677	0.004677	0.000748	2	0.16
1212	12.8646	0.00149385	0.00093587	8.144E-05	0.105604133	0.017716535	0.227916151	0.010101	0.004676	0.004676	0.000748	2	0.16
1213	12.88383	0.00149248	0.00093367	8.144E-05	0.105564701	0.01770992	0.228171648	0.010098	0.004675	0.004675	0.000748	2	0.16
1214	12.90308	0.00149112	0.00093147	8.144E-05	0.10552532	0.017703313	0.228427198	0.010096	0.004674	0.004674	0.000748	2	0.16
1215	12.92233	0.00148975	0.00092927	8.144E-05	0.10548599	0.017696715	0.2286828	0.010094	0.004673	0.004673	0.000748	2	0.16
1216	12.9416	0.00148839	0.00092707	8.144E-05	0.10544671	0.017690125	0.228938454	0.010092	0.004672	0.004672	0.000748	2	0.16
1217	12.96087	0.00148704	0.00092488	8.144E-05	0.105407481	0.017683544	0.229194159	0.01009	0.004671	0.004671	0.000747	2	0.16
1218	12.98016	0.00148568	0.00092268	8.144E-05	0.105368302	0.017676971	0.229449917	0.010088	0.00467	0.00467	0.000747	2	0.16
1219	12.99946	0.00148433	0.00092048	8.144E-05	0.105329174	0.017670407	0.229705726	0.010086	0.004669	0.004669	0.000747	2	0.16
1220	13.01877	0.00148298	0.00091828	8.144E-05	0.105290095	0.017663851	0.229961587	0.010084	0.004668	0.004668	0.000747	2	0.16
1221	13.03809	0.00148163	0.00091608	8.144E-05	0.105251067	0.017657303	0.2302175	0.010081	0.004667	0.004667	0.000747	2	0.16
1222	13.05742	0.00148028	0.00091389	8.144E-05	0.105212088	0.017650764	0.230473465	0.010079	0.004666	0.004666	0.000747	2	0.16
1223	13.07676	0.00147894	0.00091169	8.144E-05	0.10517316	0.017644233	0.230729481	0.010077	0.004665	0.004665	0.000746	2	0.16
1224	13.09612	0.00147759	0.00090949	8.144E-05	0.105134281	0.017637711	0.230985548	0.010075	0.004664	0.004664	0.000746	2	0.16
1225	13.11548	0.00147625	0.00090729	8.144E-05	0.105095451	0.017631197	0.231241667	0.010073	0.004663	0.004663	0.000746	2	0.16
1226	13.13486	0.00147492	0.00090509	8.144E-05	0.105056672	0.017624691	0.231497838	0.010071	0.004662	0.004662	0.000746	2	0.16
1227	13.15425	0.00147358	0.0009029	8.144E-05	0.105017941	0.017618193	0.23175406	0.010069	0.004661	0.004661	0.000746	2	0.16
1228	13.17364	0.00147225	0.0009007	8.144E-05	0.10497926	0.017611704	0.232010333	0.010067	0.00466	0.00466	0.000746	2	0.16
1229	13.19305	0.00147092	0.0008985	8.144E-05	0.104940628	0.017605223	0.232266657	0.010065	0.00466	0.00466	0.000746	2	0.16
1230	13.21247	0.00146959	0.0008963	8.144E-05	0.104902046	0.01759875	0.232523033	0.010062	0.004659	0.004659	0.000745	2	0.16
1231	13.23191	0.00146827	0.0008941	8.144E-05	0.104863512	0.017592286	0.232779459	0.01006	0.004658	0.004658	0.000745	2	0.16
1232	13.25135	0.00146694	0.0008919	8.144E-05	0.104825027	0.017585829	0.233035937	0.010058	0.004657	0.004657	0.000745	2	0.16
1233	13.2708	0.00146562	0.00088971	8.144E-05	0.104786591	0.017579381	0.233292466	0.010056	0.004656	0.004656	0.000745	2	0.16
1234	13.29027	0.0014643	0.00088751	8.144E-05	0.104748204	0.017572941	0.233549046	0.010054	0.004655	0.004655	0.000745	2	0.16
1235	13.30974	0.00146299	0.00088531	8.144E-05	0.104709865	0.017566509	0.233805676	0.010052	0.004654	0.004654	0.000745	2	0.16
1236	13.32923	0.00146167	0.00088311	8.144E-05	0.104671575	0.017560086	0.234062358	0.01005	0.004653	0.004653	0.000744	2	0.16
1237	13.34872	0.00146036	0.00088091	8.144E-05	0.104633333	0.01755367	0.23431909	0.010048	0.004652	0.004652	0.000744	2	0.16
1238	13.36823	0.00145905	0.00087872	8.144E-05	0.10459514	0.017547262	0.234575873	0.010046	0.004651	0.004651	0.000744	2	0.16
1239	13.38775	0.00145774	0.00087652	8.144E-05	0.104556994	0.017540863	0.234832706	0.010044	0.00465	0.00465	0.000744	2	0.16
1240	13.40728	0.00145643	0.00087432	8.144E-05	0.104518897	0.017534472	0.235089591	0.010042	0.004649	0.004649	0.000744	2	0.16
1241	13.42682	0.00145513	0.00087212	8.144E-05	0.104480848	0.017528088	0.235346526	0.01004	0.004648	0.004648	0.000744	2	0.16
1242	13.44637	0.00145383	0.00086992	8.144E-05	0.104442846	0.017521713	0.235603511	0.010038	0.004647	0.004647	0.000744	2	0.16
1243	13.46594	0.00145253	0.00086773	8.144E-05	0.104404892	0.017515346	0.235860547	0.010035	0.004646	0.004646	0.000743	2	0.16

Table I-2: Model Parameters and Consumption Calculations

1244	13.48551	0.00145123	0.00086553	8.144E-05	0.104366986	0.017508987	0.236117633	0.010033	0.004645	0.004645	0.000743	2	0.16
1245	13.5051	0.00144994	0.00086333	8.144E-05	0.104329128	0.017502635	0.236374769	0.010031	0.004644	0.004644	0.000743	2	0.16
1246	13.52469	0.00144865	0.00086113	8.144E-05	0.104291317	0.017496292	0.236631956	0.010029	0.004643	0.004643	0.000743	2	0.16
1247	13.5443	0.00144736	0.00085893	8.144E-05	0.104253554	0.017489957	0.236889193	0.010027	0.004642	0.004642	0.000743	2	0.16
1248	13.56392	0.00144607	0.00085673	8.144E-05	0.104215837	0.017483629	0.23714648	0.010025	0.004641	0.004641	0.000743	2	0.16
1249	13.58354	0.00144478	0.00085454	8.144E-05	0.104178168	0.01747731	0.237403818	0.010023	0.00464	0.00464	0.000742	2	0.16
1250	13.60318	0.0014435	0.00085234	8.144E-05	0.104140546	0.017470998	0.237661205	0.010021	0.004639	0.004639	0.000742	2	0.16
1251	13.62283	0.00144222	0.00085014	8.144E-05	0.104102972	0.017464695	0.237918642	0.010019	0.004638	0.004638	0.000742	2	0.16
1252	13.6425	0.00144094	0.00084794	8.144E-05	0.104065443	0.017458399	0.23817613	0.010017	0.004637	0.004637	0.000742	2	0.16
1253	13.66217	0.00143966	0.00084574	8.144E-05	0.104027962	0.017452111	0.238433667	0.010015	0.004637	0.004637	0.000742	2	0.16
1254	13.68185	0.00143839	0.00084355	8.144E-05	0.103990528	0.017445831	0.238691254	0.010013	0.004636	0.004636	0.000742	2	0.16
1255	13.70154	0.00143711	0.00084135	8.144E-05	0.10395314	0.017439558	0.238948891	0.010011	0.004635	0.004635	0.000742	2	0.16
1256	13.72125	0.00143584	0.00083915	8.144E-05	0.103915798	0.017433294	0.239206577	0.010009	0.004634	0.004634	0.000741	2	0.16
1257	13.74097	0.00143458	0.00083695	8.144E-05	0.103878503	0.017427037	0.239464314	0.010007	0.004633	0.004633	0.000741	2	0.16
1258	13.76069	0.00143331	0.00083475	8.144E-05	0.103841255	0.017420788	0.2397221	0.010005	0.004632	0.004632	0.000741	2	0.16
1259	13.78043	0.00143204	0.00083256	8.144E-05	0.103804052	0.017414547	0.239979935	0.010003	0.004631	0.004631	0.000741	2	0.16
1260	13.80018	0.00143078	0.00083036	8.144E-05	0.103766896	0.017408313	0.24023782	0.010001	0.00463	0.00463	0.000741	2	0.16
1261	13.81994	0.00142952	0.00082816	8.144E-05	0.103729785	0.017402088	0.240495755	0.009999	0.004629	0.004629	0.000741	2	0.16
1262	13.83971	0.00142826	0.00082596	8.144E-05	0.103692721	0.017395869	0.240753738	0.009997	0.004628	0.004628	0.00074	2	0.16
1263	13.85949	0.00142701	0.00082376	8.144E-05	0.103655702	0.017389659	0.241011772	0.009995	0.004627	0.004627	0.00074	2	0.16
1264	13.87928	0.00142575	0.00082156	8.144E-05	0.10361873	0.017383456	0.241269854	0.009993	0.004626	0.004626	0.00074	2	0.16
1265	13.89908	0.0014245	0.00081937	8.144E-05	0.103581802	0.017377261	0.241527986	0.009991	0.004625	0.004625	0.00074	2	0.16
1266	13.9189	0.00142325	0.00081717	8.144E-05	0.103544921	0.017371074	0.241786167	0.009989	0.004624	0.004624	0.00074	2	0.16
1267	13.93872	0.00142201	0.00081497	8.144E-05	0.103508085	0.017364894	0.242044397	0.009987	0.004623	0.004623	0.00074	2	0.16
1268	13.95855	0.00142076	0.00081277	8.144E-05	0.103471294	0.017358722	0.242302676	0.009985	0.004623	0.004623	0.00074	2	0.16
1269	13.9784	0.00141952	0.00081057	8.144E-05	0.103434549	0.017352557	0.242561004	0.009983	0.004622	0.004622	0.000739	2	0.16
1270	13.99826	0.00141828	0.00080838	8.144E-05	0.103397848	0.017346401	0.242819382	0.009981	0.004621	0.004621	0.000739	2	0.16
1271	14.01812	0.00141704	0.00080618	8.144E-05	0.103361193	0.017340251	0.243077808	0.009979	0.00462	0.00462	0.000739	2	0.16
1272	14.038	0.0014158	0.00080398	8.144E-05	0.103324583	0.017334109	0.243336283	0.009977	0.004619	0.004619	0.000739	2	0.16
1273	14.05789	0.00141456	0.00080178	8.144E-05	0.103288018	0.017327975	0.243594806	0.009975	0.004618	0.004618	0.000739	2	0.16
1274	14.07779	0.00141333	0.00079958	8.144E-05	0.103251497	0.017321848	0.243853379	0.009973	0.004617	0.004617	0.000739	2	0.16
1275	14.0977	0.0014121	0.00079739	8.144E-05	0.103215022	0.017315729	0.244112	0.009971	0.004616	0.004616	0.000739	2	0.16
1276	14.11762	0.00141087	0.00079519	8.144E-05	0.10317859	0.017309617	0.24437067	0.009969	0.004615	0.004615	0.000738	2	0.16
1277	14.13756	0.00140964	0.00079299	8.144E-05	0.103142204	0.017303513	0.244629389	0.009967	0.004614	0.004614	0.000738	2	0.16
1278	14.1575	0.00140842	0.00079079	8.144E-05	0.103105862	0.017297416	0.244888156	0.009965	0.004613	0.004613	0.000738	2	0.16
1279	14.17745	0.0014072	0.00078859	8.144E-05	0.103069564	0.017291326	0.245146972	0.009963	0.004612	0.004612	0.000738	2	0.16
1280	14.19742	0.00140598	0.00078639	8.144E-05	0.103033311	0.017285244	0.245405836	0.009961	0.004611	0.004611	0.000738	2	0.16
1281	14.21739	0.00140476	0.0007842	8.144E-05	0.102997102	0.01727917	0.245664748	0.009959	0.004611	0.004611	0.000738	2	0.16
1282	14.23738	0.00140354	0.000782	8.144E-05	0.102960936	0.017273103	0.245923709	0.009957	0.00461	0.00461	0.000738	2	0.16
1283	14.25738	0.00140232	0.0007798	8.144E-05	0.102924815	0.017267043	0.246182718	0.009955	0.004609	0.004609	0.000737	2	0.16
1284	14.27738	0.00140111	0.0007776	8.144E-05	0.102888738	0.01726099	0.246441775	0.009953	0.004608	0.004608	0.000737	2	0.16
1285	14.2974	0.0013999	0.0007754	8.144E-05	0.102852705	0.017254945	0.246700881	0.009951	0.004607	0.004607	0.000737	2	0.16
1286	14.31743	0.00139869	0.00077321	8.144E-05	0.102816715	0.017248908	0.246960035	0.009949	0.004606	0.004606	0.000737	2	0.16
1287	14.33747	0.00139749	0.00077101	8.144E-05	0.102780769	0.017242877	0.247219236	0.009947	0.004605	0.004605	0.000737	2	0.16
1288	14.35752	0.00139628	0.00076881	8.144E-05	0.102744867	0.017236854	0.247478486	0.009945	0.004604	0.004604	0.000737	2	0.16
1289	14.37758	0.00139508	0.00076661	8.144E-05	0.102709008	0.017230838	0.247737784	0.009943	0.004603	0.004603	0.000737	2	0.16
1290	14.39765	0.00139388	0.00076441	8.144E-05	0.102673192	0.01722483	0.24799713	0.009941	0.004602	0.004602	0.000736	2	0.16
1291	14.41774	0.00139268	0.00076222	8.144E-05	0.10263742	0.017218828	0.248256523	0.009939	0.004601	0.004601	0.000736	2	0.16
1292	14.43783	0.00139148	0.00076002	8.144E-05	0.102601691	0.017212834	0.248515965	0.009937	0.0046	0.0046	0.000736	2	0.16
1293	14.45793	0.00139029	0.00075782	8.144E-05	0.102566005	0.017206848	0.248775454	0.009935	0.0046	0.0046	0.000736	2	0.16
1294	14.47805	0.00138909	0.00075562	8.144E-05	0.102530363	0.017200868	0.249034991	0.009933	0.004599	0.004599	0.000736	2	0.16
1295	14.49817	0.0013879	0.00075342	8.144E-05	0.102494763	0.017194896	0.249294575	0.009931	0.004598	0.004598	0.000736	2	0.16
1296	14.51831	0.00138671	0.00075122	8.144E-05	0.102459206	0.01718893	0.249554207	0.009929	0.004597	0.004597	0.000736	2	0.16

Table I-2: Model Parameters and Consumption Calculations

1297	14.53846	0.00138552	0.00074903	8.144E-05	0.102423692	0.017182972	0.249813887	0.009927	0.004596	0.004596	0.000735	2	0.16
1298	14.55861	0.00138434	0.00074683	8.144E-05	0.10238822	0.017177022	0.250073614	0.009925	0.004595	0.004595	0.000735	2	0.16
1299	14.57878	0.00138316	0.00074463	8.144E-05	0.102352791	0.017171078	0.250333389	0.009923	0.004594	0.004594	0.000735	2	0.16
1300	14.59896	0.00138197	0.00074243	8.144E-05	0.102317405	0.017165141	0.250593211	0.009921	0.004593	0.004593	0.000735	2	0.16
1301	14.61915	0.00138079	0.00074023	8.144E-05	0.102282061	0.017159212	0.250853081	0.00992	0.004592	0.004592	0.000735	2	0.16
1302	14.63935	0.00137962	0.00073804	8.144E-05	0.10224676	0.01715329	0.251112998	0.009918	0.004591	0.004591	0.000735	2	0.16
1303	14.65956	0.00137844	0.00073584	8.144E-05	0.1022115	0.017147374	0.251372962	0.009916	0.004591	0.004591	0.000734	2	0.16
1304	14.67978	0.00137727	0.00073364	8.144E-05	0.102176283	0.017141466	0.251632973	0.009914	0.00459	0.00459	0.000734	2	0.16
1305	14.70001	0.00137609	0.00073144	8.144E-05	0.102141108	0.017135565	0.251893032	0.009912	0.004589	0.004589	0.000734	2	0.16
1306	14.72026	0.00137492	0.00072924	8.144E-05	0.102105975	0.017129671	0.252153137	0.00991	0.004588	0.004588	0.000734	2	0.16
1307	14.74051	0.00137376	0.00072704	8.144E-05	0.102070884	0.017123784	0.25241329	0.009908	0.004587	0.004587	0.000734	2	0.16
1308	14.76077	0.00137259	0.00072485	8.144E-05	0.102035835	0.017117904	0.25267349	0.009906	0.004586	0.004586	0.000734	2	0.16
1309	14.78105	0.00137142	0.00072265	8.144E-05	0.102000828	0.017112031	0.252933736	0.009904	0.004585	0.004585	0.000734	2	0.16
1310	14.80133	0.00137026	0.00072045	8.144E-05	0.101965862	0.017106165	0.25319403	0.009902	0.004584	0.004584	0.000733	2	0.16
1311	14.82163	0.0013691	0.00071825	8.144E-05	0.101930938	0.017100306	0.25345437	0.0099	0.004583	0.004583	0.000733	2	0.16
1312	14.84193	0.00136794	0.00071605	8.144E-05	0.101896056	0.017094454	0.253714757	0.009898	0.004583	0.004583	0.000733	2	0.16
1313	14.86225	0.00136679	0.00071386	8.144E-05	0.101861215	0.017088609	0.253975191	0.009896	0.004582	0.004582	0.000733	2	0.16
1314	14.88258	0.00136563	0.00071166	8.144E-05	0.101826415	0.017082771	0.254235672	0.009895	0.004581	0.004581	0.000733	2	0.16
1315	14.90292	0.00136448	0.00070946	8.144E-05	0.101791657	0.01707694	0.2544962	0.009893	0.00458	0.00458	0.000733	2	0.16
1316	14.92326	0.00136333	0.00070726	8.144E-05	0.10175694	0.017071116	0.254756774	0.009891	0.004579	0.004579	0.000733	2	0.16
1317	14.94362	0.00136218	0.00070506	8.144E-05	0.101722264	0.017065298	0.255017394	0.009889	0.004578	0.004578	0.000733	2	0.16
1318	14.96399	0.00136103	0.00070287	8.144E-05	0.101687629	0.017059488	0.255278061	0.009887	0.004577	0.004577	0.000732	2	0.16
1319	14.98437	0.00135988	0.00070067	8.144E-05	0.101653035	0.017053684	0.255538775	0.009885	0.004576	0.004576	0.000732	2	0.16
1320	15.00476	0.00135874	0.00069847	8.144E-05	0.101618481	0.017047887	0.255799535	0.009883	0.004576	0.004576	0.000732	2	0.16
1321	15.02517	0.0013576	0.00069627	8.144E-05	0.101583969	0.017042098	0.256060341	0.009881	0.004575	0.004575	0.000732	2	0.16
1322	15.04558	0.00135646	0.00069407	8.144E-05	0.101549497	0.017036314	0.256321194	0.009879	0.004574	0.004574	0.000732	2	0.16
1323	15.066	0.00135532	0.00069187	8.144E-05	0.101515066	0.017030538	0.256582093	0.009877	0.004573	0.004573	0.000732	2	0.16
1324	15.08643	0.00135418	0.00068968	8.144E-05	0.101480676	0.017024769	0.256843038	0.009876	0.004572	0.004572	0.000732	2	0.16
1325	15.10688	0.00135305	0.00068748	8.144E-05	0.101446326	0.017019006	0.257104029	0.009874	0.004571	0.004571	0.000731	2	0.16
1326	15.12733	0.00135191	0.00068528	8.144E-05	0.101412016	0.01701325	0.257365066	0.009872	0.00457	0.00457	0.000731	2	0.16
1327	15.1478	0.00135078	0.00068308	8.144E-05	0.101377747	0.017007501	0.25762615	0.00987	0.004569	0.004569	0.000731	2	0.16
1328	15.16827	0.00134965	0.00068088	8.144E-05	0.101343518	0.017001759	0.257887279	0.009868	0.004568	0.004568	0.000731	2	0.16
1329	15.18876	0.00134852	0.00067869	8.144E-05	0.101309329	0.016996023	0.258148455	0.009866	0.004568	0.004568	0.000731	2	0.16
1330	15.20925	0.0013474	0.00067649	8.144E-05	0.101275181	0.016990294	0.258409676	0.009864	0.004567	0.004567	0.000731	2	0.16
1331	15.22976	0.00134627	0.00067429	8.144E-05	0.101241072	0.016984572	0.258670944	0.009862	0.004566	0.004566	0.000731	2	0.16
1332	15.25028	0.00134515	0.00067209	8.144E-05	0.101207003	0.016978856	0.258932257	0.00986	0.004565	0.004565	0.00073	2	0.16
1333	15.2708	0.00134403	0.00066989	8.144E-05	0.101172974	0.016973148	0.259193616	0.009859	0.004564	0.004564	0.00073	2	0.16
1334	15.29134	0.00134291	0.0006677	8.144E-05	0.101138985	0.016967445	0.25945502	0.009857	0.004563	0.004563	0.00073	2	0.16
1335	15.31189	0.00134179	0.0006655	8.144E-05	0.101105036	0.01696175	0.259716471	0.009855	0.004562	0.004562	0.00073	2	0.16
1336	15.33245	0.00134068	0.0006633	8.144E-05	0.101071126	0.016956061	0.259977967	0.009853	0.004562	0.004562	0.00073	2	0.16
1337	15.35302	0.00133956	0.0006611	8.144E-05	0.101037255	0.016950379	0.260239508	0.009851	0.004561	0.004561	0.00073	2	0.16
1338	15.3736	0.00133845	0.0006589	8.144E-05	0.101003425	0.016944703	0.260501095	0.009849	0.00456	0.00456	0.00073	2	0.16
1339	15.39419	0.00133734	0.0006567	8.144E-05	0.100969633	0.016939034	0.260762728	0.009847	0.004559	0.004559	0.000729	2	0.16
1340	15.41479	0.00133623	0.00065451	8.144E-05	0.100935881	0.016933372	0.261024406	0.009845	0.004558	0.004558	0.000729	2	0.16
1341	15.4354	0.00133513	0.00065231	8.144E-05	0.100902168	0.016927716	0.261286129	0.009844	0.004557	0.004557	0.000729	2	0.16
1342	15.45603	0.00133402	0.00065011	8.144E-05	0.100868495	0.016922067	0.261547898	0.009842	0.004556	0.004556	0.000729	2	0.16
1343	15.47666	0.00133292	0.00064791	8.144E-05	0.10083486	0.016916424	0.261809712	0.00984	0.004556	0.004556	0.000729	2	0.16
1344	15.4973	0.00133182	0.00064571	8.144E-05	0.100801264	0.016910788	0.262071572	0.009838	0.004555	0.004555	0.000729	2	0.16
1345	15.51795	0.00133072	0.00064352	8.144E-05	0.100767708	0.016905159	0.262333476	0.009836	0.004554	0.004554	0.000729	2	0.16
1346	15.53862	0.00132962	0.00064132	8.144E-05	0.10073419	0.016899535	0.262595426	0.009834	0.004553	0.004553	0.000728	2	0.16
1347	15.55929	0.00132852	0.00063912	8.144E-05	0.100700711	0.016893919	0.262857421	0.009833	0.004552	0.004552	0.000728	2	0.16
1348	15.57998	0.00132743	0.00063692	8.144E-05	0.100667271	0.016888309	0.263119461	0.009831	0.004551	0.004551	0.000728	2	0.16
1349	15.60067	0.00132634	0.00063472	8.144E-05	0.100633869	0.016882705	0.263381546	0.009829	0.00455	0.00455	0.000728	2	0.16

Table I-2: Model Parameters and Consumption Calculations

1350	15.62138	0.00132525	0.00063253	8.144E-05	0.100600506	0.016877108	0.263643675	0.009827	0.00455	0.00455	0.000728	2	0.16
1351	15.64209	0.00132416	0.00063033	8.144E-05	0.100567181	0.016871518	0.26390585	0.009825	0.004549	0.004549	0.000728	2	0.16
1352	15.66282	0.00132307	0.00062813	8.144E-05	0.100533895	0.016865933	0.26416807	0.009823	0.004548	0.004548	0.000728	2	0.16
1353	15.68356	0.00132198	0.00062593	8.144E-05	0.100500647	0.016860356	0.264430335	0.009821	0.004547	0.004547	0.000728	2	0.16
1354	15.7043	0.0013209	0.00062373	8.144E-05	0.100467438	0.016854784	0.264692644	0.00982	0.004546	0.004546	0.000727	2	0.16
1355	15.72506	0.00131982	0.00062153	8.144E-05	0.100434266	0.016849219	0.264954998	0.009818	0.004545	0.004545	0.000727	2	0.16
1356	15.74583	0.00131874	0.00061934	8.144E-05	0.100401133	0.016843661	0.265217397	0.009816	0.004544	0.004544	0.000727	2	0.16
1357	15.76661	0.00131766	0.00061714	8.144E-05	0.100368038	0.016838109	0.26547984	0.009814	0.004544	0.004544	0.000727	2	0.16
1358	15.7874	0.00131658	0.00061494	8.144E-05	0.100334981	0.016832563	0.265742328	0.009812	0.004543	0.004543	0.000727	2	0.16
1359	15.80819	0.0013155	0.00061274	8.144E-05	0.100301962	0.016827023	0.266004861	0.00981	0.004542	0.004542	0.000727	2	0.16
1360	15.829	0.00131443	0.00061054	8.144E-05	0.10026898	0.01682149	0.266267438	0.009809	0.004541	0.004541	0.000727	2	0.16
1361	15.84982	0.00131336	0.00060835	8.144E-05	0.100236036	0.016815963	0.266530059	0.009807	0.00454	0.00454	0.000726	2	0.16
1362	15.87065	0.00131228	0.00060615	8.144E-05	0.10020313	0.016810443	0.266792725	0.009805	0.004539	0.004539	0.000726	2	0.16
1363	15.89149	0.00131122	0.00060395	8.144E-05	0.100170262	0.016804929	0.267055435	0.009803	0.004539	0.004539	0.000726	2	0.16
1364	15.91235	0.00131015	0.00060175	8.144E-05	0.100137431	0.016799421	0.26731819	0.009801	0.004538	0.004538	0.000726	2	0.16
1365	15.93321	0.00130908	0.00059955	8.144E-05	0.100104638	0.01679392	0.267580989	0.0098	0.004537	0.004537	0.000726	2	0.16
1366	15.95408	0.00130802	0.00059736	8.144E-05	0.100071882	0.016788424	0.267843832	0.009798	0.004536	0.004536	0.000726	2	0.16
1367	15.97496	0.00130696	0.00059516	8.144E-05	0.100039163	0.016782935	0.268106719	0.009796	0.004535	0.004535	0.000726	2	0.16
1368	15.99585	0.00130589	0.00059296	8.144E-05	0.100006482	0.016777453	0.268369651	0.009794	0.004534	0.004534	0.000725	2	0.16
1369	16.01675	0.00130483	0.00059076	8.144E-05	0.099973838	0.016771976	0.268632626	0.009792	0.004533	0.004533	0.000725	2	0.16
1370	16.03767	0.00130378	0.00058856	8.144E-05	0.099941231	0.016766506	0.268895646	0.00979	0.004533	0.004533	0.000725	2	0.16
1371	16.05859	0.00130272	0.00058636	8.144E-05	0.099908661	0.016761042	0.269158709	0.009789	0.004532	0.004532	0.000725	2	0.16
1372	16.07952	0.00130167	0.00058417	8.144E-05	0.099876128	0.016755584	0.269421817	0.009787	0.004531	0.004531	0.000725	2	0.16
1373	16.10047	0.00130061	0.00058197	8.144E-05	0.099843632	0.016750132	0.269684968	0.009785	0.00453	0.00453	0.000725	2	0.16
1374	16.12142	0.00129956	0.00057977	8.144E-05	0.099811173	0.016744687	0.269948164	0.009783	0.004529	0.004529	0.000725	2	0.16
1375	16.14239	0.00129851	0.00057757	8.144E-05	0.09977875	0.016739247	0.270211403	0.009781	0.004528	0.004528	0.000725	2	0.16
1376	16.16336	0.00129746	0.00057537	8.144E-05	0.099746364	0.016733814	0.270474686	0.00978	0.004528	0.004528	0.000724	2	0.16
1377	16.18435	0.00129642	0.00057318	8.144E-05	0.099714015	0.016728387	0.270738012	0.009778	0.004527	0.004527	0.000724	2	0.16
1378	16.20534	0.00129537	0.00057098	8.144E-05	0.099681703	0.016722966	0.271001383	0.009776	0.004526	0.004526	0.000724	2	0.16
1379	16.22635	0.00129433	0.00056878	8.144E-05	0.099649427	0.016717552	0.271264797	0.009774	0.004525	0.004525	0.000724	2	0.16
1380	16.24736	0.00129329	0.00056658	8.144E-05	0.099617187	0.016712143	0.271528254	0.009773	0.004524	0.004524	0.000724	2	0.16
1381	16.26839	0.00129225	0.00056438	8.144E-05	0.099584984	0.01670674	0.271791755	0.009771	0.004523	0.004523	0.000724	2	0.16
1382	16.28943	0.00129121	0.00056219	8.144E-05	0.099552817	0.016701344	0.2720553	0.009769	0.004523	0.004523	0.000724	2	0.16
1383	16.31047	0.00129017	0.00055999	8.144E-05	0.099520686	0.016695954	0.272318888	0.009767	0.004522	0.004522	0.000723	2	0.16
1384	16.33153	0.00128914	0.00055779	8.144E-05	0.099488592	0.016690569	0.272582519	0.009765	0.004521	0.004521	0.000723	2	0.16
1385	16.3526	0.0012881	0.00055559	8.144E-05	0.099456533	0.016685191	0.272846194	0.009764	0.00452	0.00452	0.000723	2	0.16
1386	16.37367	0.00128707	0.00055339	8.144E-05	0.099424511	0.016679819	0.273109912	0.009762	0.004519	0.004519	0.000723	2	0.16
1387	16.39476	0.00128604	0.00055119	8.144E-05	0.099392524	0.016674453	0.273373674	0.00976	0.004519	0.004519	0.000723	2	0.16
1388	16.41586	0.00128501	0.000549	8.144E-05	0.099360574	0.016669093	0.273637478	0.009758	0.004518	0.004518	0.000723	2	0.16
1389	16.43697	0.00128399	0.0005468	8.144E-05	0.099328659	0.016663738	0.273901326	0.009757	0.004517	0.004517	0.000723	2	0.16
1390	16.45809	0.00128296	0.0005446	8.144E-05	0.09929678	0.01665839	0.274165217	0.009755	0.004516	0.004516	0.000723	2	0.16
1391	16.47921	0.00128194	0.0005424	8.144E-05	0.099264937	0.016653048	0.274429152	0.009753	0.004515	0.004515	0.000722	2	0.16
1392	16.50035	0.00128091	0.0005402	8.144E-05	0.099233129	0.016647712	0.274693129	0.009751	0.004514	0.004514	0.000722	2	0.16
1393	16.5215	0.00127989	0.00053801	8.144E-05	0.099201357	0.016642382	0.274957149	0.009749	0.004514	0.004514	0.000722	2	0.16
1394	16.54266	0.00127887	0.00053581	8.144E-05	0.09916962	0.016637058	0.275221212	0.009748	0.004513	0.004513	0.000722	2	0.16
1395	16.56383	0.00127785	0.00053361	8.144E-05	0.099137919	0.016631739	0.275485318	0.009746	0.004512	0.004512	0.000722	2	0.16
1396	16.58501	0.00127684	0.00053141	8.144E-05	0.099106253	0.016626427	0.275749467	0.009744	0.004511	0.004511	0.000722	2	0.16
1397	16.6062	0.00127582	0.00052921	8.144E-05	0.099074622	0.01662112	0.276013659	0.009742	0.00451	0.00451	0.000722	2	0.16
1398	16.6274	0.00127481	0.00052702	8.144E-05	0.099043027	0.01661582	0.276277894	0.009741	0.00451	0.00451	0.000722	2	0.16
1399	16.64861	0.0012738	0.00052482	8.144E-05	0.099011467	0.016610525	0.276542171	0.009739	0.004509	0.004509	0.000721	2	0.16
1400	16.66983	0.00127279	0.00052262	8.144E-05	0.098979942	0.016605236	0.276806491	0.009737	0.004508	0.004508	0.000721	2	0.16
1401	16.69106	0.00127178	0.00052042	8.144E-05	0.098948452	0.016599954	0.277070854	0.009735	0.004507	0.004507	0.000721	2	0.16
1402	16.7123	0.00127077	0.00051822	8.144E-05	0.098916997	0.016594676	0.277335259	0.009734	0.004506	0.004506	0.000721	2	0.16

Table I-2: Model Parameters and Consumption Calculations

1403	16.73355	0.00126976	0.00051602	8.144E-05	0.098885576	0.016589405	0.277599707	0.009732	0.004505	0.004505	0.000721	2	0.16
1404	16.75481	0.00126876	0.00051383	8.144E-05	0.098854191	0.01658414	0.277864198	0.00973	0.004505	0.004505	0.000721	2	0.16
1405	16.77609	0.00126776	0.00051163	8.144E-05	0.09882284	0.016578881	0.27812873	0.009728	0.004504	0.004504	0.000721	2	0.16
1406	16.79737	0.00126676	0.00050943	8.144E-05	0.098791525	0.016573627	0.278393306	0.009727	0.004503	0.004503	0.00072	2	0.16
1407	16.81866	0.00126576	0.00050723	8.144E-05	0.098760243	0.016568379	0.278657924	0.009725	0.004502	0.004502	0.00072	2	0.16
1408	16.83996	0.00126476	0.00050503	8.144E-05	0.098728997	0.016563137	0.278922584	0.009723	0.004501	0.004501	0.00072	2	0.16
1409	16.86127	0.00126376	0.00050284	8.144E-05	0.098697785	0.016557901	0.279187286	0.009721	0.004501	0.004501	0.00072	2	0.16
1410	16.8826	0.00126276	0.00050064	8.144E-05	0.098666607	0.01655267	0.279452031	0.00972	0.0045	0.0045	0.00072	2	0.16
1411	16.90393	0.00126177	0.00049844	8.144E-05	0.098635464	0.016547446	0.279716818	0.009718	0.004499	0.004499	0.00072	2	0.16
1412	16.92527	0.00126078	0.00049624	8.144E-05	0.098604355	0.016542227	0.279981647	0.009716	0.004498	0.004498	0.00072	2	0.16
1413	16.94662	0.00125979	0.00049404	8.144E-05	0.09857328	0.016537013	0.280246519	0.009714	0.004497	0.004497	0.00072	2	0.16
1414	16.96798	0.0012588	0.00049185	8.144E-05	0.09854224	0.016531806	0.280511432	0.009713	0.004497	0.004497	0.000719	2	0.16
1415	16.98936	0.00125781	0.00048965	8.144E-05	0.098511233	0.016526604	0.280776388	0.009711	0.004496	0.004496	0.000719	2	0.16
1416	17.01074	0.00125682	0.00048745	8.144E-05	0.098480261	0.016521408	0.281041385	0.009709	0.004495	0.004495	0.000719	2	0.16
1417	17.03213	0.00125584	0.00048525	8.144E-05	0.098449323	0.016516218	0.281306425	0.009708	0.004494	0.004494	0.000719	2	0.16
1418	17.05354	0.00125486	0.00048305	8.144E-05	0.098418419	0.016511033	0.281571506	0.009706	0.004493	0.004493	0.000719	2	0.16
1419	17.07495	0.00125387	0.00048085	8.144E-05	0.098387548	0.016505854	0.281836629	0.009704	0.004493	0.004493	0.000719	2	0.16
1420	17.09637	0.00125289	0.00047866	8.144E-05	0.098356712	0.016500681	0.282101795	0.009702	0.004492	0.004492	0.000719	2	0.16
1421	17.11781	0.00125191	0.00047646	8.144E-05	0.098325909	0.016495513	0.282367001	0.009701	0.004491	0.004491	0.000719	2	0.16
1422	17.13925	0.00125094	0.00047426	8.144E-05	0.09829514	0.016490352	0.28263225	0.009699	0.00449	0.00449	0.000718	2	0.16
1423	17.1607	0.00124996	0.00047206	8.144E-05	0.098264404	0.016485195	0.282897541	0.009697	0.004489	0.004489	0.000718	2	0.16
1424	17.18217	0.00124898	0.00046986	8.144E-05	0.098233703	0.016480045	0.283162873	0.009696	0.004489	0.004489	0.000718	2	0.16
1425	17.20364	0.00124801	0.00046767	8.144E-05	0.098203034	0.0164749	0.283428247	0.009694	0.004488	0.004488	0.000718	2	0.16
1426	17.22512	0.00124704	0.00046547	8.144E-05	0.0981724	0.01646976	0.283693662	0.009692	0.004487	0.004487	0.000718	2	0.16
1427	17.24662	0.00124607	0.00046327	8.144E-05	0.098141798	0.016464626	0.283959119	0.00969	0.004486	0.004486	0.000718	2	0.16
1428	17.26812	0.0012451	0.00046107	8.144E-05	0.09811123	0.016459498	0.284224617	0.009689	0.004486	0.004486	0.000718	2	0.16
1429	17.28964	0.00124413	0.00045887	8.144E-05	0.098080695	0.016454376	0.284490157	0.009687	0.004485	0.004485	0.000718	2	0.16
1430	17.31116	0.00124317	0.00045668	8.144E-05	0.098050194	0.016449258	0.284755739	0.009685	0.004484	0.004484	0.000717	2	0.16
1431	17.33269	0.0012422	0.00045448	8.144E-05	0.098019725	0.016444147	0.285021361	0.009684	0.004483	0.004483	0.000717	2	0.16
1432	17.35424	0.00124124	0.00045228	8.144E-05	0.09798929	0.016439041	0.285287025	0.009682	0.004482	0.004482	0.000717	2	0.16
1433	17.37579	0.00124028	0.00045008	8.144E-05	0.097958888	0.016433941	0.285552731	0.00968	0.004482	0.004482	0.000717	2	0.16
1434	17.39736	0.00123932	0.00044788	8.144E-05	0.097928518	0.016428846	0.285818477	0.009678	0.004481	0.004481	0.000717	2	0.16
1435	17.41893	0.00123836	0.00044568	8.144E-05	0.097898182	0.016423756	0.286084265	0.009677	0.00448	0.00448	0.000717	2	0.16
1436	17.44051	0.0012374	0.00044349	8.144E-05	0.097867878	0.016418673	0.286350094	0.009675	0.004479	0.004479	0.000717	2	0.16
1437	17.46211	0.00123644	0.00044129	8.144E-05	0.097837608	0.016413594	0.286615964	0.009673	0.004478	0.004478	0.000717	2	0.16
1438	17.48371	0.00123549	0.00043909	8.144E-05	0.09780737	0.016408521	0.286881876	0.009672	0.004478	0.004478	0.000716	2	0.16
1439	17.50533	0.00123453	0.00043689	8.144E-05	0.097777164	0.016403454	0.287147828	0.00967	0.004477	0.004477	0.000716	2	0.16
1440	17.52695	0.00123358	0.00043469	8.144E-05	0.097746992	0.016398392	0.287413821	0.009668	0.004476	0.004476	0.000716	2	0.16
1441	17.54859	0.00123263	0.0004325	8.144E-05	0.097716852	0.016393336	0.287679856	0.009667	0.004475	0.004475	0.000716	2	0.16
1442	17.57023	0.00123168	0.0004303	8.144E-05	0.097686744	0.016388285	0.287945931	0.009665	0.004475	0.004475	0.000716	2	0.16
1443	17.59188	0.00123073	0.0004281	8.144E-05	0.097656669	0.016383239	0.288212047	0.009663	0.004474	0.004474	0.000716	2	0.16
1444	17.61355	0.00122979	0.0004259	8.144E-05	0.097626626	0.016378199	0.288478204	0.009662	0.004473	0.004473	0.000716	2	0.16
1445	17.63522	0.00122884	0.0004237	8.144E-05	0.097596616	0.016373165	0.288744402	0.00966	0.004472	0.004472	0.000716	2	0.16
1446	17.65691	0.0012279	0.00042151	8.144E-05	0.097566638	0.016368135	0.28901064	0.009658	0.004471	0.004471	0.000715	2	0.16
1447	17.6786	0.00122696	0.00041931	8.144E-05	0.097536692	0.016363112	0.28927692	0.009657	0.004471	0.004471	0.000715	2	0.16
1448	17.70031	0.00122601	0.00041711	8.144E-05	0.097506778	0.016358093	0.28954324	0.009655	0.00447	0.00447	0.000715	2	0.16
1449	17.72202	0.00122507	0.00041491	8.144E-05	0.097476897	0.01635308	0.2898096	0.009653	0.004469	0.004469	0.000715	2	0.16
1450	17.74374	0.00122414	0.00041271	8.144E-05	0.097447047	0.016348072	0.290076001	0.009652	0.004468	0.004468	0.000715	2	0.16
1451	17.76548	0.0012232	0.00041051	8.144E-05	0.09741723	0.01634307	0.290342443	0.00965	0.004468	0.004468	0.000715	2	0.16
1452	17.78722	0.00122226	0.00040832	8.144E-05	0.097387444	0.016338073	0.290608926	0.009648	0.004467	0.004467	0.000715	2	0.16
1453	17.80898	0.00122133	0.00040612	8.144E-05	0.09735769	0.016333082	0.290875448	0.009647	0.004466	0.004466	0.000715	2	0.16
1454	17.83074	0.0012204	0.00040392	8.144E-05	0.097327968	0.016328095	0.291142012	0.009645	0.004465	0.004465	0.000714	2	0.16
1455	17.85251	0.00121947	0.00040172	8.144E-05	0.097298278	0.016323114	0.291408615	0.009643	0.004464	0.004464	0.000714	2	0.16

Table I-2: Model Parameters and Consumption Calculations

1456	17.8743	0.00121854	0.00039952	8.144E-05	0.09726862	0.016318139	0.291675259	0.009642	0.004464	0.004464	0.000714	2	0.16
1457	17.89609	0.00121761	0.00039733	8.144E-05	0.097238993	0.016313168	0.291941944	0.00964	0.004463	0.004463	0.000714	2	0.16
1458	17.91789	0.00121668	0.00039513	8.144E-05	0.097209398	0.016308203	0.292208668	0.009638	0.004462	0.004462	0.000714	2	0.16
1459	17.93971	0.00121575	0.00039293	8.144E-05	0.097179834	0.016303244	0.292475433	0.009637	0.004461	0.004461	0.000714	2	0.16
1460	17.96153	0.00121483	0.00039073	8.144E-05	0.097150302	0.016298289	0.292742238	0.009635	0.004461	0.004461	0.000714	2	0.16

Bibliography

Abernathy, S.G., D. Mackay, and L.S. McCarty. 1988. "Volume fraction" correlation for narcosis in aquatic organisms: the key role of partitioning. Env. Tox. and Chem. 7, 469.

Abraham, B.J. 1985. Species Profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic). 1985. US Fish and Wildlife Service Biological Report 82(11.40) TR EL-82-4.

Adams, S.M., W.D. Crumby, M.S. Greely, Jr., M.G. Ryon, and E.M. Schilling. 1992. Relationships between physiological and fish population responses in a contaminated stream. Env. Tox. and Chem. 11. 1549-1557.

Alpharma, Animal Health Ltd., 2001. MS222 (Tricaine methane sulphonate). Technical Bulletin 5/2001.

Arditsoglou, A., C. Petaloti, E. Terzi, M. Sofoniou, and C. Samara. 2004. Size distribution of trace elements and polycyclic aromatic hydrocarbons in fly ashes generated in Greek lignite-fired power plants. Science of the Total Environment. 323: 153-167.

Ashley, J.T.F. and J.E. Baker. 1999. Hydrophobic organic contaminants in surficial sediments of Baltimore harbor: inventories and sources. Environ. Toxicol. Chem. 18(5) 839-849.

Baker J.E., R.P. Mason, J Cornwell, J.T.F Ashley, J. Halka, and J. Hill. 1997. Spatial Mapping of Sedimentary Contaminants in the Baltimore Harbor/Patapsco River/Back River System. Maryland Department of the Environment, Baltimore, MD, USA.

Baird, W. M., and Ralston, S. L. 1997. Carcinogenic Polycyclic Aromatic Hydrocarbons. In *Comprehensive Toxicology, Carcinogens and Anticarcinogens*. (G. T. Bowden and S. M. Fischer, Eds.), Vol. 12, pp. 171–200. Elsevier-North Holland, Amsterdam.

Barron, M.G., J.A. Hansen, and J. Lipton. 2002. Association between contaminant tissue residues and effects in aquatic organisms. Rev. Environ. Contam. Toxicol. 173:1-37.

Barron, M.G., M.G. Carls, R. Heintz, and S.D. Rice. 2004a. Evaluation of fish early life-stage toxicity models of chronic embryonic exposures to complex polycyclic aromatic hydrocarbon mixtures. Toxicological Sciences. 78: 60-67.

Barron, M.G., R. Heintz, and S.D. Rice. 2004b. Relative potency of PAHs and heterocycles as aryl hydrocarbon receptor agonists in fish. Mar. Env. Research. 58: 95-100.

Bello, S.M., D.G. Franks, J.J. Stegeman, and M.E. Hahn. 2001. Acquired resistance to Ah Receptor agonists in a population of Atlantic Killifish (*Fundulus heteroclitus*) inhabiting a marine superfund site: *in vivo* and *in vitro* studies on the inducibility of xenobiotic metabolizing enzymes. Toxicological Sciences. 60:77-91.

Beyers, D.W, J.A. Rice, W.H. Clements, and C.J. Henry. 1999. Estimating physiological cost of chemical exposure: integrating energetics and stress to quantify toxic effects in fish. Can. J. Fish. Aquat. Sci. 56:814-822.

Beyers, D.W., J.A. Rice, and W. H. Clements. 1999. Evaluating biological significance of chemical exposure to fish using a bioenergetics-based stressor-response model. Can. J. Fish. Aquat. Sci. 56: 823 – 829.

Black, D.E., R. Gutjahr-Gobell, R.J. Pruell, B. Bergen, and A.E. McElroy. 1998. Effects of a mixture of non-ortho- and mono-ortho-polychlorinated biphenysl on reproduction in *Fundulus heteroclitus* (Linnaeus). Env. Tox. and Chem. 17 (7) 1396-1404.

Bowser, P.R. 2001. Anesthetic Options for Fish. In: Recent Advances in Veterinary Anesthesia and Analgesia: Companion Animals. R.D. Gleed and J.W. Ludders (Eds.). International Veterinary Information Services. Ithaca, NY. USA.

Brinkworth, L.C., P.V. Hodson, and S. Tabash., 2003. CYP1A induction and blue sac disease in early developmental stages of rainbow trout (*Oncorhynchus mykiss*) exposed to retene. J. Tox. Environ. Health, Part A. 66:627-646.

Call, D.J., L.T. Brooke, M.L. Knuth, S.H. Poirier, and M.D. Hoglund. 1983. Fish subchronic toxicity prediction model for industrial organic chemicals. Presented at Fourth Annual Meeting of the Society of Environmental Toxicology and Chemistry, Arlington, VA. In McCarty et al., 1985.

Calow, P. 1991. Physiological costs of combating chemical toxicants: ecological implications: mini-review. Comp. Biochem. Physiol. 100C, No. 1/2:3-6.

Calow, P., and R.M. Sibly, 1990. Essay Review. A physiological basis of population processes: ecotoxicological implications. Functional Ecology. 4:283-288.

Carls, M.G., S.D. Rice, and J.E. Hose. 1999. Sensitivity of fish embryos to weathered crude oil: part I. Low-level exposure during incubation causes malformations, genetic damage, and mortality in larval pacific herring (*Clupea pallasi*). Env. Tox. and Chem. 18 (3) 481-493.

Caswell, H. 1989. Matrix population models: construction, analysis and interpretation. Sinauer Associates, Inc. Sunderland, MA. 328 p.

Congdon, J.D., A.E. Dunham, W.A. Hopkins, C.L. Rowe, and T.G. Hinton. 2001. Resource allocation-based life histories: a conceptual basis for studies of ecological toxicology. *Environmental Toxicology and Chemistry.* 20(8): 1698-1703.

Di Giulio, R.T., W.H. Benson, BM Sanders, PA Van Veld. 1995. Biochemical mechanisms: metabolism, adaptation, and toxicity. In Rand, G.M. (Ed.) Fundamentals of Aquatic Toxicology: Effects, Environmental Fate, and Risk Assessment, Second Edition. Taylor and Francis, Washington, DC. pp. 1125.

Di Toro, D.M., J.A. McGrath, and D.J. Hansen. 2000. Technical basis for narcotic chemicals and polycyclic aromatic hydrocarbon criteria. I. Water and Tissue. Env. Toxicol. Chem. 19 (8) 1951-1970.

Di Toro, D.M., and J.A. McGrath. 2000. Technical basis for narcotic chemicals and polycyclic aromatic hydrocarbon criteria. II. Mixtures and Sediments. Env. Toxicol. Chem. 19 (8) 1971-1982.

Escher, B., M. Snozzi, K. Haberli, R.P. Schwarzenbach. 1997. A new method for simultaneous uncoupling and inhibitory activity of organic pollutants in energy-transducing membranes. Env. Tox. Chem. 16(3):405-414.

Escher, B. and J.L.M. Hermens. 2002. Modes of action in ecotoxicology: their role in body burdens, species sensitivity, QSARs, and mixture effects. Critical Review in Environmental Science &Technology. 36 (20) 4201-4217.

Escher, B.I., R.I.L. Eggen, U. Schreiber, Z. Schreiber, E. Vye, B. Wisner, and R.P. Schwarzenbach. 2002. Baseline toxicity (narcosis) of organic chemicals determined by *in vitro* membrane potential measurements in energy-transducing membranes. Env. Sci. Tech. 36(9):1971-1979.

Escher, B.I. and R.P. Schwarzenbach. 2002. Mechanistic studies on baseline toxicity and uncoupling of organic compounds as a basis for modeling effective membrane concentrations in aquatic organisms. Aquatic Sciences. 64:20-35.

Essington, T.E. and J.N Houser. 2003. The effect of whole-lake-nutrient enrichment on mercury concentration in Age-1 yellow perch. Trans. Amer. Fish. Soc. 132: 57-68.

Fairey, R., E.R. Long, C.A. Roberts, B.S. Anderson, B.M. Phillips, J.W. Hunt, H.R. Puckett, and C.J. Wilson. An evaluation of methods for calculating mean sediment quality guideline quotients as indicators of contamination and acute toxicity to amphipods by chemical mixtures. 2001. Environmental Toxicology and Chemistry. 20 (10) 2276-2286.

Forbes, V.E., P. Calow, and R.M. Sibly. 2001. Are current species extrapolation models a good basis for ecological risk assessment? Env. Tox. and Chem. 20 (2) 442-447.

Forbes, V.E., R.M. Sibly, and P. Calow. 2001. Toxicant impacts on density-limited populations: a critical review of theory, practice, and results. Ecol. Applications. 11 (4) 1249-1257.

Fritz, E.S. and E.T. Garside. 1975. Comparison of age composition, growth, and fecundity between two populations each of *Fundulus heteroclitus* and *Fundulus diaphanus* (Pisces: Cyprinodontidae). Can. J. Zool. 53 (4) 361-369.

Gotelli, N.J. 2001. A primer of ecology. Sinauer Associates, Inc. Sunderlund, MA.

Gutjahr-Gobell, R.E., D.E. Black, L.J.Mills, R.J. Pruell, B.K. Taplin, and S. Jayaraman. 1999. Feeding the mummichog (Fundulus heteroclitus) a diet spiked with Non-ortho- and mono-ortho-substituted polychlorinated bi phenyls: accumulation and effects. Env. Tox. Chem. 18 (4) 699-707.

Hallam, T.G., G.A. Canziani, and R.R. Lassiter. 1993. Sublethal narcosis and population persistence: a modeling study on growth effects. Env. Toxicol. and Chem. 12: 947-954.

Hanson, P.C., T.B. Johnson, D.E. Schindler, and J.R. Kitchell. 1997. Fish Bioenergetics 3.0. University of Wisconsin-Madison Center for Limnology and University of Wisconsin Sea Grant Institute.

Heintz, R.A., J.W. Short, and S.D. Rice. 1999. Sensitivity of fish embryos to weathered crude oil: part II. Increased mortality of pink salmon (*Onchorhynchus gorbuscha*) embryos incubating downstream from weathered *Exxon Valdez* crude oil. Env. Tox. and Chem. 18 (3) 494-503.

Hopkins, W.A., J.W. Snodgrass, J.H. Roe, B.P. Jackson, J.C. Cariboldi, and J.D. Congdon. 2000. Detrimental effects associated with trace metal uptake in Lake Chubsuckers (*Erimyzon sucetta*) exposed to polluted sediments. Archives of Environmental Contamination and Toxicology. 39: 193-199.

Hopkins, W.A., C.P. Tatara, H.A. Brant, and C.H. Jagoe. 2003. Relationships between mercury body concentrations, standard metabolic rate, and body mass in Eastern Mosquitofish (*Gambusia holbrooki*) from three experimental populations. Env. Toxicol. Chem. 22(3): 586-590.

Houde, E.D. 1997. Patterns and trends in larval-stage growth and mortality of teleost Fish. Journal of Fish Biology 51: 52-83 Suppl. A.

Incardona, J.P., T.K. Collier, and N.L. Scholz. 2004. Defects in cardiac function precede morphological abnormalities in fish embryos exposed to polycyclic aromatic hydrocarbons. Toxicology and Applied Pharmacology. 196:191-205.

Jaworska, J. S., T.B. Hallam, and T.W. Schultz. 1996. Chronic effects of nonpolar narcotics on a model microbial community. Env. Tox. and Chem. 15 (7) 1049-1056.

Jaworska, J.S., Rose, K.A., Brenkert, A.L. 1997. Individual based modeling of PCB effects on young of the year largemouth bass in southeastern USA reservoirs. Ecol. Model. 99:113-135.

Johnson, L.L., T.K. Collier, and J.E. Stein. 2002. An analysis in support of sediment quality thresholds for polycyclic aromatic hydrocarbons (PAHs) to protect estuarine fish. Aquatic Conservation: Marine and Freshwater Ecosystems. 12:517-538.

Kitchell, J.F., D.J. Stewart, and D. Weininger. 1977. Applications of a bioenergetics model to yellow perch (*Perca flavescens*) and walleye (*Stizostedion vitreum vitreum*). Journal of the Fisheries Research Board of Canada. 34: 1922-1935.

Kneib, R.T., A.E. Stiven, and E.B. Haines. 1980. Stable carbon isotope ratios in *Fundulus heteroclitus* (L.) muscle tissue and gut contents from a North Carolina *Spartina* Marsh. J. Exp. Mar. Biol. Ecol. 46: 89-98.

Kneib, R.T. and J.H. Parker. 1991. Gross conversion efficiencies of mummichog and spotfin larvae from a Georgia salt marsh. Transactions of the American Fisheries Society. 120: 803-809.

Kolanczyk, R.C., P.N. Fitzsimmons, J.M. McKim, R.J. Erickson, P.K. Schmieder. Aquatic Toxicology. 64: 177-184.

Landrum, P.F., G.R. Lotufo, D.C. Gossiaux, M. L. Gedeon, J-H Lee. 2003. Bioaccumulation and critical body residue of PAHs in the amphipod, *Diporeia* spp.: additional evidence to support toxicity additivity for PAH mixtures. Chemosphere. 51:481-489.

Lee, J-H., Landrum, P.F., Field, L.J., Koh, C.-H., 2001. Application of a (-polycyclic aromatic hydrocarbon model to sediment toxicity data based on a species-specific, wwater-only LC50 toxic unit for Hyalella azteca. Env. Tox. and Chem. 20:2102-2113.

Mackay, D. 1982. Correlation of bioconcentration factors. Env. Sci. and Technol. 16:274-278.

Madon, S.P., G.D. Williams, J.M. West, and J.B. Zedler. 2001. The importance of marsh access to growth of the California killifish, Fundulus parvipinnis, evaluated through bioenergetics modeling. Ecol. Modeling. 135:149-165.

Matta, M.B., J. Linse, C. Cairncross, L. Francendese, and RM. Kocan. 2001. Reproductive and transgenerational effects of methylmercury or Aroclor 1268 on Fundulus heteroclitus. Env. Tox. Chem. 20 (2) 327-335.

McCarty, L.S., P.V. Hodson, G.R. Craig, and K.L.E. Kaiser. 1985. Review. The use of quantitative structure-activity relationships to predict the acute and chronic toxicities of organic chemicals to fish. Env. Tox. and Chem. 4: 595-606.

McCarty, L.S., 1986. The relationship between aquatic toxicity QSARs and bioconcentration for some organic chemicals. Env. Tox. and Chem. 5: 1071-1080.

McCarty, L.S., D. Mackay, A.D. Smith, G.W. Ozburn, and D.G. Dixon. 1991. Interpreting aquatic toxicity QSARs: the significance of toxicant body residues at the pharmacologic endpoint. The Science of the Total Environment. 109/110:515-525.

McCarty L.S., D. Mackay, A.D. Smith, G.W. Ozburn, and D.G. Dixon. 1992. Residue-based interpretation of toxicity and bioconcentration QSARs from aquatic bioassays: neutral narcotic organics. Env. Tox. Chem. Vol 11, pp: 917-930.

McCarty, L.S. and D. Mackay. 1993. Enhancing ecotoxicological modeling and assessment. Body residues and modes of toxic action. 27 (9) 1719-1727.

McGroddy S.E, J.W. Farrington, and P.M. Gschwend. 1996. Comparison of the in situ and desorption sediment-water partitioning of polycyclic aromatic hydrocarbons and polychlorinated biphenyls. Environmental Science and Technology. 30:172-177.

McKim, J.M., P.K. Schmieder, R.W. Carlson, E.P. Hunt, and G.J. Niemi. 1987. Use of respiratory-cardiovascular response of rainbow trout (Salmo gairdneri) in identifying acute toxicity syndromes in fish. I. Pentachlorophenol, 2,4-dinitrophenol, tricaine methanesulfonate and 1-octanol. Environmental Toxicology and Chemistry. 6:313.

McKim, J.M., and P.K. Schmieder. 1991. Cited in Rand, G.M. 1995. (Ed.) Fundamentals of Aquatic Toxicology: Effects, Environmental Fate, and Risk Assessment, Second Edition. Taylor and Francis, Washington, DC. pp. 1125.

Meador, J.P., J.E. Stein, W.L. Reichert, and U.Varanasi. 1995. Bioaccumulation of polycyclic aromatic hydrocarbons by marine organisms. Reviews of Environmental Contamination and Toxicology. 143: 79-165.

Meyer, J.N., D.E. Nacci, R.T. Di Giulio. 2002. Cytochrome P4501A (CYP1A) in Killifish (Fundulus heterclitus): heritability of altered expression and relationship to survival in contaminated sediments. Toxicological Sciences. 68: 69-81.

Moore, M.N., D.R. Livingstone, J. Widdows, D.M. Lowe, and R.K. Pipe. 1987. Molecular, cellularr and physiological effects of oil-derived hydrocarbons on molluscs and their use in impact assessment Phil. Trans. R. Soc. Lond. 316: 603-623.

Mullins, M.D., C.M. Pochini, S. McCrindle, M. Romkes, S.H. Safe, L.M. Safe. 1984. High-resolution PCB analysis: synthesis and chromatographic properties of all 209 PCB congeners. Environmental Science and Technology. 18:468-476.

Munns, Jr., W.R., D.E. Black, T.R. Gleason, K. Salomon, D. Bengtson, and R. Gutjar-Gobell. 1997. Evaluation of the effects of dioxin and PCBs on Fundulus heteroclitus populations using a modeling approach. Env. Tox. Chem. 16(5):1074-1081.

Myers, M.S., L.L. Johnson, T.K. Collier. 2003. Establishing the causal relationship between polycyclic aromatic hydrocarbon (PAH) exposure and hepatic neoplasms and neoplasia-related liver lesions in English Sole (Pleuronectes vetulus). Human and Ecological Risk Assessment. 9(1):67-94.

Nacci, D.E., Coiro, L., Champlin, D., Jayaraman, S., McKinney, R., Gleason, T.R., Munns, W.R., Jr., Specker, J.L., and Cooper, K.R.1999. Adaptations of wild populations of the estuarine fish *Fundulus heteroclitus* to persistent environmental contaminants. Marine Biology. 134:9-17.

National Academy of Sciences. 2003. Oil in the Sea III: inputs, fates, and effects. Washington, DC. 265 pp.

National Academy of Sciences. 2005. Understanding Oil Spill Dispersants: Efficacy and Effects. Washington, DC 235 pp.

Penttinen, O-P. and J. Kukkonen. 1998. Chemical stress and metabolic rate in aquatic invertebrates: threshold, dose-response relationships, and mode of toxic action. Env. Tox. Chem. Vol 17, No. 5, pp:883-890.

Rand, G.M. 1995. (ed.) Fundamentals of Aquatic Toxicology: Effects, Environmental Fate, and Risk Assessment, Second Edition. Taylor and Francis, Washington, DC. pp. 1125.

Rowe, C.L, O.M. Kinney, R.D. Nagle, and J.D. Congdon. 1998. Elevated maintenance costs in an Anuran (*Rana catesbeiana*) exposed to a mixture of trace elements during the embryonic and early larval periods. Physiol. Zool. 71(1):27-35.

Rowe, C.L. 1998. Elevated standard metabolic rate in a freshwater shrimp (*Palaemonetes palusosus*) exposed to trace element-rich coal combustion waste. *Comparative biochemistry and physiology Part A.* 121:299-304.

Rowe, C.L. 2003. Growth responses of estuarine fish exposed to mixed trace elements in sediments over a full life cycle. Ecotox. Environ. Safety. 54:229-239.

Russom, C.L., S.P. Bradbury, and S.J. Broderius, 1997. Predicting modes of toxic action from chemical structure: acute toxicity in Fathead Minnows (*Pimephales* promelas). Env. Tox. Chem. 16(5):948-967.

Sherwood, G.D., J.B. Rasmussen, D.J. Rowan, J. Brodeur, and A. Hontela. 2000. Bioenergetic costs of heavy metal exposure in yellow perch (*Perca flavenscens*): in situ estimates with a radiotracer (^{137}Cs) technique. Can. J. Fish. Aquat. Sci. 57:441-450.

Sijm, D.T.H.M, W. Seinen, and A. Opperhuizen. 1992. Life-cycle biomagnification study in fish. Env. Sci. Tech. 26:2162-2174.

Sijm, D.T.H.M., M. Schipper, and A. Opperhuizen. 1993. Toxicokinetics of chlorobenzenes in fish. Lethal body burdens as a toxicological endpoint. Env. Tox. and Chem. 12:1117-1127.

Sikkema, J, J.A.M. de Bont, and B. Poolman. 1994. Interactions of cyclic hydrocarbons with biological membranes. Journal of Biological Chemistry. 269 (11):8022-8028.

Smith, E.P., T. Robinson, LJ Field, and S.B. Norton. 2003. Predicting sediment toxicity using logistic regression: a concentration-addition approach. Environmental Toxicology and Chemistry. 22 (3): 565-575.

Spromberg, J.A. and J.P. Meador 2005. Relating results of chronic toxicity responses to population-level effects: modeling effects on wild Chinook salmon populations. Integrated Environmental Assessment and Management. 1 (1) 9-21.

Swartz, R.C., D.W. Schults, R.J. Ozretich, J.O. Lamberson, F.A. Cole, T.H. DeWitt, M.S. Redmond, and S.P. Ferraro. 1995. Sigma-PAH – A model to predict the toxicity of polynuclear aromatic hydrocarbon mixtures in field-collected sediments. Env. Tox. Chem. 14:11: 1977-1987.

Thomann, R.V. and J.P. Connolly. 1984. Model of PCB in the Lake Michigan lake trout food chain. Environmental Science and Technology. 18 (2):65-71.

U.S. EPA. 2003. Procedures for the derivation of equilibrium partitioning sediment benchmarks (ESBs) for the protection of benthic organisms: PAH mixtures. EPA-600-R-02-013. Office of Research and Development. Washington, DC 20460.

Valiela, I., J.E. Wright, J.M. Teal, and S.B. Volkmann. 1977. Growth, production and energy transformations in the salt-marsh killifish *Fundulus heteroclitus.* Marine Biology. 40:135-144.

Van der Oost, R., J. Beyer, and N.P.E. Vermeulen. Fish bioaccumulation and biomarkers in environmental risk assessment: a review. Env. Toxicol. and Pharm. 13:57-149.

Van Veld, P.A, W. Vogelbein, R. Smolowitz, B.R. Woodin, and J.J. Stegeman. 1992. Cytochrome P450 A in hepatic lesions of a teleost fish (*Fundulus heteroclitus),* collected from a polycyclic aromatic hydrocarbon-contaminated site. Carcinogenesis. 13:505-507.

Van Veld, P.A. and D.J. Westbrook. 1995. Evidence of depression of cytochrome P4501A in a population of chemically resistant mummichog (*Fundulus heteroclitus)*. Environ. Sci. 3, 221-234.

Van Wezel, A.P., and A. Opperhuizen. 1995. Narcosis due to environmental pollutants in aquatic organisms: residue-based toxicity, mechanisms, and membrane burdens. Critical Reviews in Toxicology. 25(3):255-279.

Van Wezel, A.P., D.A.M. de Vries, S. Kostense, D.T.H.M. Sijm, and A. Opperhuizen. 1995. Intraspecies variation in lethal body burdens of narcotic compounds. Aquatic Toxicology. 33:325-342.

Van Wezel, A.P., G. Cornelissen, J.K. Van Miltenburg, A. Opperhuizen. 1996. Membrane burdens of chlorinated benzenes lower the main phase transistion temperature in dipalmitoyl-phosphatidylcholine vesicles: implications of toxicity by narcotic chemicals. Env. Tox. Chem. 15:203-212.

Varanasi, U., Stein, J.E., and Nishimoto, M. 1989. Biotransformation and disposition of polycyclic aromatic hydrocarbons (PAHs) in fish. In: Varanasi, U. (ed). Metabolism of polycyclic aromatic hydrocarbons in the Aquatic Environment. Boca Raton, FL: CRC Press. Pp. 94-149.

Veith, G.D., D. Call, and L.T. Brooke. 1983. Structure-toxicity relationships for the fathead minnow, *Pimephales promelas*: narcotic industrial chemicals. Can. J. Fish. Aquat. Sci. 743-748.

Weis, J.S. 2002. Tolerance to environmental contaminants in the Mummichog, *Fundulus heteroclitus.* Human and Ecological Risk Assessment. 8 (5): 933-953.

Weisberg, S.B. and V.A. Lotrich. 1982. Ingestion, egestion, excretion, growth, and conversion efficiency for the mummichog, *Fundulus heteroclitus (L.).* J. Exp. Mar. Biol. Ecol. 62: 237-249.