EPA/600/R-04/080
August 2004

Analysis of Mercury in Vermont and New Hampshire Lakes: Evaluation of the Regional Mercury Cycling Model

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NOTICE

The U.S. Environmental Protection Agency (EPA), through its Office of Research and Development (ORD), partially funded and managed the research described herein under cooperative agreement CR 825495-01 with the Vermont Department of Environmental Conservation (VT DEC) under the Regional Environmental Monitoring and Assessment Program (REMAP). This work has been subjected to the Agency's peer and administrative review, and has been approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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ABSTRACT

An evaluation of the Regional Mercury Cycling Model (R-MCM, a steady-state fate and transport model used to simulate mercury concentrations in lakes) is presented based on its application to a series of 91 lakes in Vermont and New Hampshire. Visual and statistical analyses are presented in an effort to investigate both the behavior of the model as well as the model's ability to predict the observed mercury concentrations in the water column, sediments and fish tissue. The sensitivity of the model to certain parameters and processes was also evaluated. A comparison of model trends to the observed trends was made. These investigations provide further insight into the complications and challenges that surround modeling the fate and transport of mercury within a given water body, and understanding the exposure concentrations of mercury in the surrounding ecosystem via mercury bioaccumulation in the aquatic food web (e.g., fish) and its transfer to piscivorous wildlife and humans.

FOREWORD

The National Exposure Research Laboratory Ecosystems Research Division (ERD) in Athens, Georgia, conducts process, modeling, and field research to assess the exposure risks of humans and ecosystems to both chemical and non-chemical stressors. This research provides data, modeling, tools, and technical support to EPA Program and Regional Offices, state and local governments, and other customers, enabling achievement of Agency and ORD strategic goals for the protection of human health and the environment.

ERD research includes studies of the behavior of contaminants, nutrients, and biota in environmental systems, and the development of mathematical models to assess the response of aquatic systems, watersheds, and landscapes to stresses from natural and anthropogenic sources. ERD field and laboratory studies support process research, model development, testing and validation, and the characterization of variability and prediction uncertainty.

Leading-edge computational technologies are developed to integrate core science research results into multi-media (air, surface water, ground water, soil, sediment, biota), multi-stressor, and multi-scale (organism, population, community, ecosystem; field site, watershed, regional, national, global) modeling systems that provide predictive capabilities for complex environmental exposure scenarios face by the Agency.

Exposure models are distributed and supported via the EPA Center for Exposure Assessment Modeling (CEAM) (www.epa.gov/athens/ceampubl), the Watershed and Water Quality Model Technical Support Center (www.epa.gov/athens/wwqtsc), and through access to Internet tools (www.epa.gov/athens/onsite).

This research project is a component of the ERD mercury research program, which seeks to better understand the environmental cycling of the major speciated forms of mercury, especially the characteristics that induce mercury methylation in ecosystems and the pathways of exposure. In this project, the Regional Mercury Cycling Model was applied to a large set of lakes in Vermont and New Hampshire. The goals were to better understand mercury transformation and bioaccumulation processes and to evaluate our present ability to predict mercury fate. Knowledge and data gained in this evaluation will be used to develop or improve mercury analysis capabilities in existing models used by EPA in various regulatory programs.

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ACKNOWLEDGEMENT

This modeling study would not have been possible without the comprehensive regional mercury database created by the Vermont Agency of Natural Resources and documented in a companion report. Neil Kamman served as principal investigator for this project, and we gratefully acknowledge his advice and insight. Dr. Eric Miller provided insight on mercury deposition over the Vermont and New Hampshire region, along with personal communications, which we greatly appreciate. Dr. Reed Harris, a senior engineer at Tetra Tech, is the principal author of the Regional Mercury Cycling Model, which we applied in this study. Dr. Harris provided useful suggestions and comments throughout this study, which we appreciate. We also acknowledge the faithful modeling work performed by Adrienne Harris, a summer intern from Spelman College, now at Duke University. Her work is incorporated into Chapter 3 and Sections 6.3 and 6.4.

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EXECUTIVE SUMMARY

Mercury is recognized as an important environmental and ecological contaminant because of its neurotoxicity. Because of its inherent environmental risk, it is important to understand mercury fate and transport mechanisms, as well as to be able to predict its exposure concentrations within a given environment or ecosystem. This report is in partial fulfillment of Task # 15529, Mercury Fate and Transport in Watersheds, under Goal 8, GPRA Objective 8.3, and GPRA Sub-Objective 8.3.1. The goal of this research is to provide the scientific information and technical data needed to reduce uncertainties limiting the Agency's ability to assess and manage mercury and methylmercury risks. To that end, the details outlined in this report constitute the beginnings of an investigation of the impacts of mercury atmospheric deposition and subsequent lake and watershed fate and transport processes on the resulting mercury exposures of fish and piscivorous wildlife of New England lakes. A developmental model was used and evaluated for its ability to adequately capture and simulate the governing fate and transport processes of mercury in a watershed and associated water bodies. The ultimate goal in this project is to improve the assessment tools needed to successfully manage mercury exposure and risk. The starting point, however, was to evaluate currently available models and to understand their strengths and weaknesses. Based on this evaluation, ways to improve the model system can be investigated, and then, if necessary, used to develop a new and improved model.

In this effort, we first organized and synthesized for modeling purposes the observed mercury concentration data and lake characteristics collected and presented in the companion report, "Biogeochemistry of Mercury in Vermont and New Hampshire

Lakes: An Assessment of Mercury in Waters, Sediments and Biota of Vermont and New Hampshire Lakes," by the VT DEC, 2003. The model chosen for the study was the Regional Mercury Cycling Model (R-MCM). The R-MCM was run for a series of scenarios and parameter refinements. The predicted results were then compared with observed results.

From our evaluation, we have determined that the R-MCM is not currently at a level where it can be directly applied to a new region or series of lakes without some amount of calibration. The R-MCM was found to capture specific trends observed in the general mercury literature, for example, the trend of decreasing fish tissue mercury concentrations with increasing pH. Using various visual and statistical analyses, we found that R-MCM did not provide predictability that was better than simply using the mean of observed values. Through a rigorous separation technique of evaluating only specific lake characteristics, we concluded that there were no types of lake that the R-MCM simulated particularly well. The default level input parameterization was found to have the largest amount of random scatter for the data points. By specifying precise values for the default level characteristics, the scatter was greatly reduced. This suggests that the greatest improvement in the R-MCM's predictive capability might be gained by gathering precise data on more general lake characteristics such as: pH, size, trophic status, and stratification.

Further comparison of the R-MCM simulated versus observed mercury concentrations revealed these important results:

- Total mercury concentrations were generally under-predicted,
- Percent methylmercury in the epilimnion was generally under-predicted,

- Percent methylmercury in the sediment was generally over-predicted, and
- Increasing the outflow of methylmercury from the watershed improved the model's predictive ability.

These results taken in concert, suggest that the major problem with the R-MCM may lie more in the inaccuracies of modeling mercury loading to the water body and less in the modeling of the fate and transport of mercury within the water body. Clearly, if loading is not adequately modeled, then there is no hope for accurately predicting mercury concentrations within the watershed-lake system. Our results suggest that it is important to accurately model both the mercury cycle in watersheds and the loading from these watersheds into the water body of concern.

1 INTRODUCTION

Mercury has long been recognized as an important environmental pollutant by the USEPA because of its neurotoxicity (USEPA, 1997). The primary pathway of human exposure to mercury is via consumption of fish tissue contaminated with mercury (USEPA, 1997). Fish and piscivorous birds are also exposed to mercury contamination and are the primary ecosystem receptors of concern. Because of mercury's properties of appreciable bioaccumulation and biomagnification, the concentrations of mercury within wildlife are greater in the higher trophic levels (such as game fish and birds). High mercury concentrations in fish have been detected in remote lakes far from industrial sources, suggesting that atmospheric transport and deposition of mercury is a significant source of mercury to these ecosystems. Mercury enters the global pool of mercury in the atmosphere from both natural and anthropogenic sources. The mercury can then travel large distances until it transfers from the atmosphere to terrestrial and aquatic ecosystems via wet and dry deposition. Once mercury enters a watershed, it can undergo transformations and reactions controlled by both chemical and biological mechanisms to form methylmercury. The methylmercury then accumulates within the food web, increasing in concentration as it works its way up the trophic levels. Therefore, it is not only important to understand the general fate and transport of total mercury within the watershed and associated water bodies, but also to understand the transformations of mercury between oxidation states and molecular structures.

The Regional Mercury Cycling Model (R-MCM) was developed by Tetra Tech, Inc. in an effort to use process modeling and mass balances to predict mercury concentrations in the water column, the sediments and fish within a given lake under various loading scenarios. The R-MCM was originally developed with funding from the Electric Power Research Institute (EPRI) and the Wisconsin Department of Natural Resources for application to a set of seven, oligotrophic Wisconsin seepage lakes. The R-MCM (version 1.0b, Tetra Tech, 1996) used in the analyses presented in this report came out of that work with model enhancements that include: photochemical reduction of methylmercury and Hg(II) to elemental mercury; the use of runoff coefficients for Hg(II) and methylmercury to describe the fraction of mercury deposited on wetlands and uplands that results in loading to the water body; and an updated approach to mercury dynamics in the food web. Details on the R-MCM are described more fully in Section 2.2.

The R-MCM was originally developed for and calibrated to a set of seven, oligotrophic seepage lakes in Wisconsin (mid-west United States). The model was then applied to a dataset of 21 Wisconsin lakes that spanned a wider range of acidities (pH 5 – 8) and dissolved organic carbon concentrations (DOCs) ranging from 3 to 21 mg/L. The model was next applied to a clear, acidic lake in Florida and Lake 240, a small circumneutral pH Canadian Shield lake with a pH of 6.8 and DOC of 5 mg /L. The Wisconsin lakes did not have significant stream inflows, but it was believed that the elevated DOC levels may have reflected inputs from nearby wetland areas. Lake 240 was the first application of the R-MCM to a lake with significant surface stream inflows. Watershed export of Hg(II) was based on runoff coefficients derived from the work of St. Louis et al. (1994, 1996). Most recently, the model was applied to 24 lakes in Kejimkujik Park, Nova Scotia, with pHs of 4.3 – 5.9 and DOC of 2.3 – 15.3 mg /L. That application was the first test of the model calibration of watershed export coefficients.

The Kejimkujik model application was calibrated most effectively by assuming that there was no trapping of mercury in the upstream lakes, that is, by assuming that all mercury deposited on the upstream watersheds is subsequently transported downstream. Additionally, the R-MCM was found to predict a linear relationship of increasing concentration of methylmercury in surface waters with increasing DOC. For 21 out of 24 lakes, the predominant source of methylmercury was in-situ methylation.

The purpose of the current report is to present our recent work using and evaluating the R-MCM to model mercury concentrations in lakes in the Northeastern United States, specifically lakes in Vermont (VT) and New Hampshire (NH). This is the first time that the R-MCM has been used in the New England Region of the United States and will therefore evaluate how well the R-MCM can be transported to a different region of a country. The New England, Wisconsin, and Canadian lakes are on similar latitudes and in similarly temperate zones, but they are in different topographies and experience different climates. The New England application of the R-MCM was performed without recalibration to evaluate if the model can be directly applied to a new region, as well as to perform an evaluation of what level of parameter refinement (but not parameter calibration) would provide the best results. Additionally, this work will provide insight into the differences among the fate and transport processes governing mercury cycling in this new lake system, and it will allow for some level of mechanistic description of the governing mercury processes.

The data set used in this investigation is the largest available to our knowledge to which the R-MCM has been applied. The dataset covers a wide range of physical and chemical lake characteristics. The range of characteristics in these lakes include: small and medium sized lakes (mean 73 ha, range 8 – 669 ha); stratified and well-mixed lakes; acidic, circumneutral, and alkaline lakes (mean pH 6.65; range 4.60 – 7.97); trophic levels consisting of oligotrophic, mesotrophic, eutrophic and dystrophic; and a range of dissolved organic carbon (DOC) concentrations (mean 4.3 mg/L, range 0.35 – 10.9 mg/L). The experimental data set is described in Section 2.1.

The model was initially evaluated for the simplest, most general and qualitative approach using the default parameterization written in the R-MCM code. In the next evaluation, a more quantitative method was employed to refine the model parameterization by using measured values for parameters describing the actual lakes in our study. Our goal was to evaluate not only the success of the R-MCM, but to see which parameters are most important for model improvement. The parameter refinement levels we developed were designated as "Tiers;" five tiers were used. These tiers and the default level parameterization are described in Section 2.3.

The analyses developed in this project are presented in different chapters. First, the R-MCM was evaluated for patterns and trends, as described in Chapter 3. Next, the R-MCM was evaluated for its ability to predict the observed concentrations of the VT and NH data set as described in Chapter 4. Next, evaluation of the R-MCM was further broken down into groups of lakes, based on their lake characteristics, as described in Chapter 5. The model was then investigated for means on how best to improve model prediction. To this end, the sensitivity of the model to a few key processes and parameters was investigated in Chapter 6. Within Chapter 6, the large data set available was used in conjunction with the R-MCM evaluation to make mechanistic inferences on mercury processes and cycling. Conclusions from our study and evalustions are presented in Chapter 7.

2 METHODS

2.1 Experimental Dataset

The dataset used in this paper comes from a sampling program that occurred during 1998 through 2000, when individual Vermont and New Hampshire lakes were investigated through the Vermont and New Hampshire Environmental Monitoring and Assessment Program (EMAP). Lakes were selected using an algorithm to ensure random selection of sampling units, given specific constraints based on lake size and lake to watershed area ratio (Kamman et al., 2004). The number of lakes used in this study resulted in 91 lakes. These 91 lakes spanned a complete range of trophic states and acidities.

During this study, total mercury (HgT) and methylmercury (MeHg) concentrations were measured in the epilimnion, hypolimnion (if present), and sediment. Epilimnion samples were taken as subsurface (~0.2 m) grabs. Hypolimnion samples were collected at one-meter above the sediment-water interface. Sediment samples were taken from the deepest hole in the lake using a gravity corer.

Fish tissue concentrations were measured using yellow perch (*Perca flavescens*) as a standard. Yellow perch was chosen because of its use in previous studies of fish-Hg, its use in developing fish consumption advisories, its ubiquity and ease of capture, and because of its occupation of different trophic positions depending on size. Yellow perch were not present in all of our study lakes, however. A roster of all study lakes known to contain yellow perch was consulted, resulting in only 47 of our 91 study lakes having perch (and therefore could have fish tissue observations). Five perch were collected from each study lake with perch, and a two-inch section of fillet was taken for sampling. Length (in mm) and weight (in g) were measured for each fish, and scales and/or otolith[1] were retained for fish age determination. Because yellow perch tissue HgT is known to vary with fish size and age, an ANCOVA was used to assess the influence of length and age on tissue HgT concentrations, and to estimate length and age-corrected fillet HgT concentrations. Using the ANCOVA results, the five measured fish concentrations at each sampling were converted into concentrations normalized to an age of 4.6 yrs (mean age of perch in all lakes). This conversion allowed for lake cross-comparison and comparison to model-predicted fish concentrations.

In addition to the mercury concentrations from the sampling effort, the physical and chemical characteristics of the lakes were used to parameterize the model. More details on these parameters and the specific values used are presented in the following section. More details on the sampling techniques are provided elsewhere (Kamman and Estabrook, 1998a; Kamman and Estabrook, 1998b; Kamman et al., 2004).

2.2 Regional Mercury Cycling Model (R-MCM)

The R-MCM was developed with funding from the Electric Power Research Institute (EPRI) and the Wisconsin Department of Natural Resources (DNR). R-MCM is a steady-state, process-driven model that predicts the cycling and fate of total mercury, as well as MeHg, Hg(0), and Hg(II) for a given lake. The model was developed and calibrated for 7 oligotrophic seepage lakes in Wisconsin. Features have since been added

[1] An otolith is a structure within the inner ear of fishes formed from alternating layers of high and low-density calcium carbonate. Hard parts of the fish are frequently used as a method for aging fishes (assigning an appropriate age to a given fish). Fish scales have historically been used (and do not require sacrificing the fish), but otoliths are internal hard parts that continue to form annuli or increments despite times of stress or food deprivation (Murphy and Willis, 1996).

to the model to accommodate a larger range of lake conditions and to predict mercury export in a watershed. The R-MCM has been used for other regions, such as the lakes in the Kejimkujik Park of Nova Scotia (Tetra Tech, Inc., 2002).

The R-MCM models and couples the fate and transport of MeHg, Hg(0) and Hg(II) in the epilimnion, hypolimnion and sediments. Using a steady-state approximation, the concentrations of mercury species are calculated incorporating: atmospheric loadings of mercury through dry and wet deposition; loading from watershed sources; the specific hydrology characteristics of the lake; the chemical and physical parameters describing the lake; the biomass and particle characteristics of the lake; the predatory and prey fish species and their characteristics within the lake; and the equilibrium, partitioning, and thermodynamic constants for the various mercury species within the lake. Once the mercury concentrations have been calculated within the lake, a dynamic fish growth module is run to calculate the mercury concentrations in fish tissue for the fish species of interest.

The model has two levels with which the user can parameterize each lake. On the first level, a blank database is created for the given suite of lakes. Then, each lake is entered using its default parameterization. In this step, the type of lake is described in a qualitative sense. The lake characteristics and the options available are outlined in Table 2.1. In addition to these lake categories and characteristics, the R-MCM also has categories for fish populations. Specifically, the user can enter the fish to be modeled as predators and prey. Using the R-MCM Beta Version 1.0b, the available fish species are: lake trout, northern pike, muskellunge, finescale dace, largemouth bass, smallmouth bass, bluegill, walleye, and yellow perch. For the VT/NH study, perch were used as both predator and prey species. The model can then be run with the default parameterization as defined using the qualitative characteristics for the lakes and the input fish species selection.

As a second level of parameterization option, the user can go into the database using Microsoft Access 2.0 or use the "Edit" function in the R-MCM interface. To update the database using the Edit function, the user needs to open each lake individually, open the input edit form, and then edit each parameter value individually. Since the most user-friendly and efficient parameterization method is to use the simple, default user interface, clearly, it would be useful to understand how successful the R-MCM is by using only this level of input, as well as to know how much improvement is gained when specific parameters are updated/customized.

2.3 Application of the Model

As described previously, the model inputs were entered for the series of lakes initially using the default, qualitative inputs ("default scenario"). Then, the model parameterization was refined by using lake-specific and region-specific inputs. A total of six scenarios were created with different levels of parameter refinement (default scenario plus Tiers 1 through 5). Each Tier used an increased level of input parameter refinement. Tier numbers increased with increasing refinement. All refinements from one tier were carried into the next tier, resulting in an effective "building block" design. The initial level of user interface was the qualitative input of lake characteristics (see Table 2.1). The R-MCM program assigns default values to the model parameters depending on the user-selected lake characteristics in Table 2.1. R-MCM creates a Microsoft Access 2.0 database from the user input and model default parameters for each lake. The characteristics and the lake names used for the default scenario in this study are presented in Table 2.2.

Before any simulations were performed, a quality assurance and quality control program was created to make sure that all data were entered and read appropriately. This QA/QC was performed by creating a Microsoft Access 2.0 query, which extracted the assigned numeric codes for each category for each lake. This file was exported into a Microsoft Excel 2000 file. A Boolean comparison was made to check for errors. If any errors were found, the given lake was deleted and re-entered with the correct input data. The query was then re-run to verify that all parameters were input correctly. After all input data parameters were found to be correct, the default scenario was run and the output data for epilimnion MeHg and HgT, hypolimnion MeHg and HgT, fish tissue mercury concentration, and sediment mercury concentrations were exported into a Microsoft Excel 2000 file as well as into a Matlab data file.

After the default scenario was run, the default database was updated as described earlier to reflect the refined input parameters through a series of Tiers. The values of default parameters that were updated through the Tier refinements are listed in Table 2.3. The query capability of Microsoft Access 2.0 was used once again to ensure data quality. First, a database file consisting of the appropriate input parameters was created in the Project Database Access 2000 file. Because the R-MCM uses Access 2.0, the Access 2000 file could not be directly imported for use in the R-MCM. Therefore, an intermediate step was necessary. The data file was first imported into Microsoft Excel. The file was then saved as a Microsoft Excel 5.0 file, and imported into the Microsoft Access 2.0 R-MCM database. From there, an SQL update query was written and run to update the R-MCM project database. The query was designed to match the lake numbers of the database file with the lake numbers of the master file (R-MCM input parameter file), which correspond to each lake name. The master file was used as the link between the database, which uses lake numbers, and the REMAP project database, which uses lake names. Using SQL programs, the R-MCM project database was updated with the lake-specific or region-specific data. This method of updating was found to be efficient and successful. Manual checks were performed to verify that the updates were correct. The types of parameter updates are presented in the following sections as Tiers 1 through 5.

2.3.1 Tier 1

The first series of refinements focused on updating those parameters most associated with the characteristics of the default categories. Those parameters were:

- pH,
- Lake Surface Area,
- Hypolimnion Surface Area,
- Hydrologic Residence Time,
- Epilimnion DOC, and
- Hypolimnion DOC.

There were no data for hypolimnion surface area available, so this was modeled as a default value of one-third of the lake surface area. (Evaluation of the sensitivity of the model to hypolimnion surface area is detailed in Section 6.2.) Update values for these refinements are presented in Table 2.4.

2.3.2 Tier 2

The second series of refinements focused on updating the mercury loading according to regional specifications. These updates included the precipitation rate, the concentration of Hg(II) in precipitation, and the reactive gaseous mercury (RGM) deposition rate. The exact updates and values were:

- Hg(II) concentration in precipitation, default 10 ug/m^3 updated to regional estimate of 9 ug/m^3,
- Precipitation rate changed from default of 0.8 m/yr to regional estimate of 1.0 m/yr, and
- RGM updated to 4.5 ug/m^3 (estimated as half of Hg(II) wet deposition[2]).

2.3.3 Tier 3

The third series of refinements updated the mercury loading according to lake-specific estimates. These values came from research performed and modeling done by Dr. Eric Miller (Miller, 2002; Miller, personal communication, 2003). The inputs updated were:

- Hg(II) concentration in precipitation,
- Precipitation rate, and
- RGM (modeled as 1% of the total mercury vapor concentration).

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[2] The estimation of RGM deposition as half the Hg(II) wet deposition is a rough approximation used within R-MCM. The default parameterization within R-MCM was originally written assigning an RGM of 3.5 ug/m2/yr and wet Hg(II) deposition at 9 ug/m2/yr. The default RGM was, therefore, approximately 40% of wet deposition. This was rounded to 50%, as a rough estimator, because there is no general approximation for the VT/NH region without using site-specific data. Lake-specific RGM values, based on Eric Miller's work, were subsequently found to be nearer to 100% of the wet Hg(II) deposition. These latter values are incorporated into the Tier 3 refinement.

Values corresponding to the specific lakes of our study are presented in Table 2.5. Since there were some lakes that did not have update values; these lakes were left with their default parameter values.

2.3.4 Tier 4

The fourth series of refinements updated the watershed characteristics. These values came from lake-specific data collected during the VT/NH REMAP study. The updated inputs were:

- Total catchment ratio area to lake area,
- Fraction of total catchment covered by wetlands, and
- Fraction of total catchment covered by lakes.

Values corresponding to our specific study lakes are presented in Table 2.6. There were some lakes that did not have values for these parameters, so the parameters for those lakes were left as the default values.

2.3.5 Tier 5

The fifth series of refinements focused on updating specific lake characteristics:

- Mean thickness of the epilimnion, and
- Mean thickness of the hypolimnion (if present).

Values corresponding to our study lakes are presented in Table 2.7.

3 EVALUATION OF R-MCM: DEFAULT MODEL RESULTS AND TRENDS

R-MCM is a complex, process-based model that has almost 300 different parameters describing the mechanisms governing mercury fate, transport, and concentrations in a watershed. The default input allows for choosing different lake categories from those listed in Table 2.1 and described in Section 2.2. Before addressing the VT and NH data set, it was deemed useful to run the R-MCM on a default level and study/evaluate its predicted mercury concentrations. By investigating the predicted output of the default runs, some insight could be gained regarding the impacts of the various fate and transport mechanisms simulated in the model. Trends in the different predicted mercury species concentrations within the various media could also be examined.

3.1 Default Model Output

An R-MCM input parameter database was established for a series of 72 "default parameter" lakes. The lakes were chosen to represent an array of all combinations of the following characteristics: acidity, stratification, size and trophic state. All lakes in this evaluation were drainage lakes with no summer hypoxia, with perch modeled as both the predator and prey fish species. All lakes in the default model run were subjected to identical precipitation rates and atmospheric mercury loadings as defined in the default program (see Table 2.3 and discussion in Section 2.3, specifically Section 2.3.2). The default run combination of lakes is presented in Table 3.1. These lakes were simulated using R-MCM to predict Epilimnion MeHg and HgT, Hypolimnion MeHg and HgT, Sediment MeHg and HgT, and fish tissue mercury concentrations.

The predicted values for the range of default lakes (simply numbered from 1 to 72) are presented in Table 3.2. Summary information regarding these predictions is presented in Table 3.3. To put the predicted mercury concentrations into context relative to observed measurements of mercury concentration, Table 3.4 presents published values for observed mercury concentrations in different media, including ranges and means. The larger concentrations of the observed data were associated with water bodies impacted by direct mercury loading sources, which the default set-up runs were not parameterized to handle. The data presented in the first row of Table 3.4 (Driscoll et al., 1994) were for lakes in the Adirondack region of New York and, therefore, are believed to be more representative of lakes impacted predominately by atmospheric deposition. The observed results of Driscoll's work generally agree well with the range of predicted concentrations in the water and in fish tissue. This results suggest that the R-MCM is equipped to handle the general trends and ranges of mercury concentrations in the northeast region of the US.

3.2 Trends in the Default Run Data Output

After tabulating the default R-MCM run results, the predicted mercury concentrations were plotted against the lake characteristics specified in Table 2.1. These slots are presented in Figures 3.1 and 3.2. These figures provide insight into the range of values that a given mercury species concentration might have in a specific media depending on specific lake characteristics. These figures also reveal the output trends that the R-MCM produces given the inherent fate and transport processes and mechanisms incorporated in the model. Keeping in mind that these concentration output trends are not directly associated with observations or any specific water body but rather that they depict only possible behavior in the hypothetical default lakes. It is important to mentally separate these model predictions from actual observed results.

From these figures, it is very clear that for some lake characteristics and for mercury species in some media there is quite a wide range of possible predicted concentration values. The magnitude of the ranges of these predicted values point towards the most important parameters that affect the mercury prediction and the value of these predictions.

3.2.1 Lake Area (Lake Size)

The predictions of mercury species concentrations against lake area are consistent across the different media. An inverse correlation between mercury species concentration and lake size was exhibited. As the size of the lake increased, there was a corresponding decrease in mercury species concentration. Given a uniform mercury loading from both the atmosphere and the watershed across the different default set-up water bodies, there appears to be a consistent dilution effect as a lake increases in size. The scatter within any one given size lake (e.g., all small lakes) is large, however. This is important because it is not safe to assume that a small lake will have more mercury in its different media than a large lake. Indeed, these results suggest that the other characteristics describing the lake can so greatly affect the mercury concentration prediction that it is quite possible for a large lake to have a greater concentration than a small lake. However, if all other lake characteristics are similar, then it is likely that the larger lake will have lower mercury species concentrations than the small lake.

3.2.2 Epilimnion DOC (Trophic Status)

The trophic status of a lake is another characteristic that the user enters. The model uses trophic status to assign a default dissolved organic carbon (DOC) concentration. In Figures 3.1 and 3.2 in order of increasing DOC concentration (left to right), the trophic status for each lake mercury species concentrations range plot corresponds to oligotrophic, mesotrophic, eutrophic, and dystrophic, respectively. There was not a consistent pattern of predicted mercury species concentration versus trophic status. There was a positive correlation between epilimnion methylmercury and epilimnion DOC. For epilimnion total mercury, there was not much difference between the oligotrophic and mesotrophic lakes, but there wais an increase for the dystrophic lakes and a decrease for the eutrophic lakes. There were also apparent negative correlations between sediment mercury concentrations (both MeHg and HgT) and fish mercury (both prey and predator) and DOC. For fish and sediment, the predicted mercury species concentrations associated with eutrophic lakes spanned a tighter range (less scatter/smaller standard deviation) than the other trophic status lakes, and generally had lower concentrations. The dystrophic lakes had a larger predicted species concentration range than the eutrophic lakes, while the oligotrophic and mesotrophic lakes had similar predicted mercury concentration values and ranges. The hypolimnion mercury species concentration predictions were generally scattered and did not appear to demonstrate any appreciable correlation. As with the lake area (Section 3.2.1), interpretation of the correlation of mercury species concentrations with epilimnion DOC (trophic status) must be tempered because of the large amount of scatter in the predicted values. Even when a correlation was demonstrated, the amount of scatter tended to dominate over the subtleties across the other lake characteristics.

3.2.3 Epilimnion pH (Acidity)

For all of the default run mercury species concentration predictions, there was a general inverse correlation with increasing epilimnion pH. That is, as the pH increased (acidity decreased) there was a decrease in mercury species concentration. The correlation was most pronounced for the sediment and fish mercury concentrations, but was also clearly evident for the epilimnion mercury species concentrations. The correlation was much less noticeable for the hypolimnion mercury species concentrations. There was an appreciable scatter among the data points, which must be noted. The range of predictions for sediment and fish mercury species concentrations was quite small, however, for alkaline lakes. Having higher mercury concentrations in acidic lakes versus lower concentrations in alkaline lakes is a well-established phenomenon in natural systems. This is not a phenomenon imposed on the model system directly, but rather simply is a result of the chemistry and governing fate processes that affect mercury concentrations as a function of pH.

3.2.4 Lake Stratification

There was no appreciable correlation observed between simulated mercury species concentrations and lake stratification (i.e., well mixed versus stratified). There was a large amount of scatter across the range of default lakes, so it was difficult to make any conclusions on the impact of stratification.

4 EVALUATION OF R-MCM: ENTIRE LAKE DATA SET

4.1 General Visual Inspection

The modeling results for the default run plus the five Tiers are presented in Figures 4.1 through 4.6. In these figures, the results of predicted mercury species concentrations are plotted versus measured concentrations for: epilimnion MeHg, epilimnion HgT, hypolimnion MeHg, hypolimnion HgT, fish tissue HgT and sediment HgT. A scan of the figures reveals that some demonstrate a large amount of scatter as well as appreciable bias. In Figure 4.1, the initial run with default settings, there seems to be a general over-prediction (predicted values are greater than observed values) of epilimnion MeHg concentrations with some exceptions. There is a great amount of scatter in the epilimnion MeHg and HgT and fish HgT concentrations. The hypolimnion HgT concentrations were predicted to fall within a much narrower range than the measured values, indicating poor prediction ability for the observed ranges of hypolimnion concentrations. The default model runs generally predicted mercury species concentrations that were generally much less than the observed concentrations (under-prediction) for the hypolimnetic waters and sediments.

The first tier of refinement involved updating those parameters most directly associated with those defined by the default lake characteristics (as shown in Table 2.1). For example, if the lake is designated acidic, the default lake pH is assigned to be 5.3. Similarly, if the lake is designated circumneutral, the model assigns a default pH of 6.5, and likewise a pH of 8.0 for designated alkaline lakes. In Tier 1, the observed pHs, as measured in and reported from the VT/NH REMAP study, were input to replace the model default values. This was done for all the variables/parameters listed in Table 2.3 for Tier 1, producing the input data set shown in Table 2.4.

The results of the predicted versus observed mercury species concentrations for Tier 1 are presented in Figure 4.2. The most noticeable differences between the default run and the Tier 1 results are the decreased predicted concentrations for epilimnion MeHg and HgT and fish HgT. There was a large amount of scatter in the default run epilimnion concentrations that was not seen in the Tier 1 epilimnion concentrations. For some of the data, predominantly for lakes associated with lower observed concentrations, there appeared to be an improvement in the model. However, there remain large errors for the middle to high observed concentrations. Additionally, there were several data points predicted as zero or near-zero concentrations where non-zero concentrations were observed. In both the Tier 1 epilimnion MeHg and HgT, several of the higher observed concentrations were appreciably under-predicted. The predicted hypolimnion concentrations were not as dramatically different for the Tier 1 case compared to the default case. This suggests that the refinements of Tier 1 do not greatly affect the model's predictive capacity for hypolimnion concentrations. The fish concentrations were generally reduced in the Tier 1 compared to the default, except for a couple of predicted values that actually increased, and have larger residual errors than in the default case. The sediment concentrations also did not change appreciably from the default to the Tier 1 scenario.

The results for Tier 2 and Tier 3 are presented in Figures 4.3 and 4.4. These Tiers were parameter refinements associated with the atmospheric input of mercury to the system. Tier 3 was a region-specific adjustment and Tier 4 was a lake-specific adjustment. There were no appreciable differences between the model outputs of Tiers 2 and 3 and those of Tier 1. This suggests that these parameter refinements did not have a dramatic impact on the modeling results, although there does seem to be some minor adjustments in some predicted values. This is not to say that these results are not important, but rather that there are not dramatic differences between the model outputs for the refined atmospheric loads versus the default values. Therefore, minor adjustments did not cause noticeable shifts in the results. However, it is possible that if the model were to be applied to a region with dramatically different mercury depositions, then this refinement could be critical.

The Tier 4 scenario involved refining the watershed parameters for all the lakes. There was a wide range of parameter values and changes for the simulated lakes, so it was expected that the watershed input might have a dramatic impact on the model results. However, there were no major changes in the model results, but there were some subtle differences. Specifically, there was a general increase in the epilimnion predicted concentrations for both MeHg and HgT. In fact, in Mitchell Lake, the predicted epilimnion HgT jumped from 0.930 ng/L (Tier 3) to 5.93 ng/L (Tier 4) [predicted epilimnion MeHg was 0.080 ng/L (Tier 3) and 0.420 ng/L)]. The observed values for Mitchell Lake are 0.264 ng/L (MeHg) and 4.115 ng/L (HgT). This data point is now seen in Figure 4.5 above the y=x line, a big improvement from its previous Tier 3, Figure 4.4 under-prediction. This movement was caused by the fact that the total catchment are to lake area ratio for Mitchell Lake is 165.14, an order of magnitude larger than the default value of 10. This points to the importance of watershed property influences when modeling mercury in water bodies. Another general facet of the Tier 4 results was that some of the near-zero predictions were increased. These increases were not enough to bring the data points all the way up to the y = x line, but represented a significant improvement from the previous Tiers (i.e., residual errors were reduced). This result also shows that the model may be sensitive to the structure of the watershed, and that the watershed characteristics may have an important impact on accurately modeling mercury fate and characteristics in lakes.

The final Tier, Tier 5, involved refining the epilimnion and hypolimnion depths. The original R-MCM was designed for the mid-west lakes of Wisconsin. From the values used as defaults in the original model, it appears that those lakes were relatively shallow compared to the deeper lakes of the mountainous regions of Vermont and New Hampshire. It was therefore believed that these two depths could impact the model results. When our study lakes were updated with their estimated actual epilimnion and hypolimnion depths, model results did show an additional subtle increase in the epilimnion mercury species concentrations, but there was not as dramatic an impact on the other simulated mercury species concentrations as might have been expected.

A visual review of Figures 4.2 through 4.6 does not reveal many differences across the Tiers, but rather that the most dramatic difference was from the default run to Tier 1. This suggests that the changes in the parameter refinement from Tier 2 through Tier 5 generally produced subtle, but not dramatic, changes in predictive ability. Clearly, the most dramatic change in model output during the parameter refinement process occurred from the default run to the Tier 1 run. This suggests that user input update of the lake characteristics parameters is the place to start for R-MCM application. It also suggests that a higher level of accuracy in these lake characteristics parameters, and in understanding the mercury fate and transport processes that respond to these variables may result in a better predictive capability.

4.2 Error Sum of Squares Analysis

From an inspection of the predicted versus observed concentration plots for the default scenario, there is a wide range of scatter. This scatter seems to decrease (i.e., the data points are closer together) when the default run outputs are compared to the predicted versus observed concentration plots for the Tiered scenarios. However, this apparent decrease in scatter is also associated with a decrease in the value of the predicted concentrations themselves. That is, the range of prediction is both compressed and lowered. Specifically, some of the predicted species concentrations were even lowered below the y = x line. Therefore, it is unclear if the overall predictability of the model improved much, if at all during parameter refinement. A quantitative method for assessing improvement in model predictability can be performed by calculating the error sum of squares (also known as the residual sum of squares) for each species-media combination simulation. This is done by taking the sum of the squared differences between the predicted and measured species concentration values, as described in EQN 4-1 (see for example, Box et al., 1978; Neter and Wasserman, 1974),

$$S = \sum_{i=1}^{n} \left(O_i - P_i \right)^2 \qquad \text{(EQN 4-1)}$$

where S, is the error sum of squares, O_i is the observed species concentration in lake i and P_i is the predicted species concentration in lake i in the same medium.

The results of the error sum of squares for all runs and observations are presented in Figure 4.7 in graph form to more easily visualize the changes. The y-axis is plotted on a log-scale so that all variables can be plotted on the same figure. This figure shows that there were really only small changes in predictability in going from the default case through the five Tiers. There were some improvements for certain species, while for others the results actually got worse. For example, for epilimnion HgT, the default error sum of squares value was 291.3, which decreased to 228.4 by Tier 5 (22% decrease). The fish concentration error sum of squares had a similar 22% decrease. However, the epilimnion MeHg sum of squares increased 28%, the hypolimnion HgT and MeHg increased 24% and 21%, respectively, and the sediment concentration sum of squares increased 18%. From this analysis, it seems that the model, as a whole, did not improve significantly with the progression of parameter refinements. If the model user were solely interested in the fish tissue mercury concentration, then the user would probably have the best success with a Tier 5 setup. However, the likely decreased success for other species-media combinations should make one hesitant. If nothing else, this analysis gives one pause to wonder why the model would get better in some cases and worse in others. It seems that some fate and transport processes or sources may not be completely taken into account.

4.3 Summary

The analyses presented here show that the greatest changes in the behavior of the predicted versus observed mercury species concentration-media plots result from using the measured values of lake characteristics parameters in place of the default parameter assignment (i.e., the Tier 1 refinement). There were additionally only more subtle changes achieved in the results within the Tier refinements themselves (i.e., Tier 1 through Tier 5). In general, all the tiers produced an under-prediction of mercury species concentrations for most of the lakes. This suggested that the mercury loading needed to be investigated. But Tier 2 and 3 involved refinement of the atmospheric deposition of mercury, there were not many changes in the model results for Tier 2 and 3. This suggested that the default deposition values were on par with the region-specific and lake-specific values of our study area. Refinement in Tier 4 showed that the watershed structure can dramatically impact the R-MCM modeling capability. This was dramatically seen for Mitchell Lake, which had a significant improvement in modeling results from the default run through Tier 3 and Tier 4. Tier 5 did not produce any dramatic changes. An error sum of squares analysis of all the model run results showed that there was some improvement in the success of the model across all the tiers for some mercury species-media combinations but there was also a decline in performance for others. Overall, this analysis indicated that there was really not much difference, statistically, in the success of the model across the tiers.

Because there was not an appreciable difference in R-MCM performance across the Tiers, and it would take a significant amount of time and effort to evaluate each and every Tier, we decided that our time could be most effectively and efficiently spent by only investigating and comparing the results from the default run with those of Tier 5. The results of our investigation are provided in Section 5.0..

5 EVALUATION OF R-MCM: LAKE CHARACTERISTICS

5.1 Visual Analysis

After the visual inspection and the analysis of sum of squares error of our model outputs, we concluded that the model did not seem to be providing a good representation of mercury species concentrations in all the lakes of the study. Our next step then was to separate the lakes into groups and to see if there were any patterns between lake types and classifications. For Tier 5 and for the default run, modeled versus observed concentration data for the lakes were plotted using different symbols corresponding to each lake's characteristics (e.g., for acidities these are acidic, circumneutral, and alkaline). The results for the default run are presented in Figures 5.1 through 5.4 and for Tier 5 run are presented in Figures 5.5 through 5.8. The first thing that was noticed in this approach was that there was not a specific lake type that was clustered in any one region in any of the plots. This suggested that the errors are not simply related to a specific lake type, but rather there may be more general, confounding errors or process omissions that are not associated with one specific lake type or characteristic. There are some observed patterns, however, that are discussed in the following sections.

5.1.1 Acidity

Lake acidity was the first lake characteristic reviewed. For both the default (Figure 5.1) and Tier 5 (Figure 5.5) results, the alkaline lakes seemed to cluster more closely around the y=x line for epilimnion MeHg and HgT, hypolimnion MeHg and HgT and fish concentrations. For the alkaline lakes, the model grossly under-predicted sediment concentrations. For the acidic and circumneutral lakes, the model predicted a much greater scatter than for the alkaline lakes. In general, the scatter for the Tier 5 scenario was much less than the scatter for the default case and the predicted values were of smaller magnitude, resulting in a downward shift in the predicted results. From this simple visual analysis, it seemed that, generally speaking, the model did better predicting concentrations for the alkaline lakes than it did for the acidic or circumneutral lakes. This is an interesting result because the model was originally designed for acidic lakes, and not for alkaline lakes. There is a general belief that acidic lakes are more susceptible to increased mercury concentrations, so it is possible that other processes are confounding the modeling in these possibly more complicated lakes. Alkaline lakes may just be generally simpler to model, and therefore, there is a better predictive capability for them. This suggests that the model may be capturing the general processes occurring in the lakes, but the processes in lakes with lower pHs, and therefore more complicated mercury chemistry, cannot be as easily modeled successfully.

5.1.2 Stratification

Looking next at the stratification levels of the lakes, the picture wais less clear. For the default run (Figure 5.2), the well-mixed lakes appear to be generally over-estimated for the epilimnion MeHg and HgT, though there is an appreciable amount of scatter, with a few lakes even having appreciable under-predictions. For the epilimnion HgT, the well-mixed lakes had larger over-prediction residual errors than for the epilimnion MeHg, but the epilimnion HgT had more under-predicted lakes than the epilimnion MeHg. For the epilimnion HgT, there is a row of greatly over-predicted, well-mixed lakes around 5 ng/L, but below these the lakes are generally closer to the y=x line. For the epilimnion MeHg, the well-mixed lakes are clustered closer to the y=x line, with one lake far below the y=x line and far to the right of the major cluster.

The default, stratified lakes generally seemed to have less scatter for both the epilimnion MeHg and HgT concentrations. For example, the epilimnion MeHg default, stratified lake concentrations are predominately clustered tightly around the y=x line, suggesting a better predictability for the default model for stratified lakes compared to well-mixed lakes. However, there remained one far outlier to the right of the cluster and far below the y=x line. Indeed, this far-right outlier lake had the largest residual error and observed epilimnion MeHg concentration. The default, stratified lakes epilimnion HgT concentrations had a larger scatter than the default, stratified lakes epilimnion MeHg concentrations, but there is similarity between the epilimnion MeHg and HgT concentrations for these lakes because the HgT concentrations are also tightly clustered around the y=x line for many of the lakes. A few stratified lakes form a row of predictions at approximately 4 ng/L, and there is an outlier lake to the far right well, below the y=x line. No comparison information could be gleaned from the hypolimnion concentration predictions, because only stratified lakes have hypolimnion data.

For the default model fish concentration values, almost all of the well-mixed lakes were over-predicted, with some dramatically large residuals, while the stratified lakes were generally well-predicted, but with some scatter. For the sediment concentrations, there was not much of a visual distinction between the stratification types, and most results were under-predicted. Generally, for the default case, the visual analysis suggests that the model performed better for the stratified lakes than for the well-mixed lakes.

In the Tier 5 stratification runs for stratification (Figure 5.6), the stratified lakes were clumped together with appreciable under-prediction of epilimnion MeHg. In general, the model predicted values near zero, despite the range of measured concentrations. Even with the parameters refined to the Tier 5 level, it seems that the model could not adequately account for the total amount of MeHg in the epilimnion. This is readily seen in the extreme case of the lake where the largest measured concentration of epilimnion MeHg was predicted as having a near-zero value. The well-mixed lakes covered a wider predictive range, but possessed a large amount of scatter in both over-prediction and under-prediction, with a tendency toward in under-prediction. For the epilimnion HgT, the stratified lakes were found to generally be under-predicted. Again, the model could not capture the range of measured values with its predictions. This result was similar for the well-mixed lakes, except that at low measured concentrations the model did have some over-predictions, but as the measured concentrations increased the predicted values did not correspondingly increase. For fish concentrations, the Tier 5 results showed a smaller range of predictive results for the stratified lakes, which clustered well around the low measured concentrations, but did not increase with increased measured concentrations. This shows a lack in the necessary predictive range for these scenarios. For the well-mixed lakes, the fish concentrations have a wide range of scatter, with larger over-predictions than under-predictions, but both are present. There was not much of a distinction between the well-mixed and stratified predictions for the Tier 5 run sediment concentrations, and both had a strong tendency for under-prediction. The analysis of the Tier 5 results for lake stratification showed a different result from the default case. Here it seems that the well-mixed lakes have a better range of prediction and that the stratified lakes have a tendency for under-prediction. This is opposite to the default case.

5.1.3 Lake Size

The next series of model run separations was based on lake size. For the default run (Figure 5.3), the model had a narrow predictive range for medium lakes with respect to epilimnion MeHg and HgT, fish HgT, and sediment HgT concentrations, while the range for these variables for the small lakes was appreciably greater. There was not much difference for the small and medium lakes in the default and Tier 5 runs for the hypolimnion MeHg or HgT. For the default run results, the medium lakes were clustered relatively close to the y=x line for epilimnion MeHg and HgT and fish HgT concentrations except for a few outliers, while there was a larger pattern of scatter for these concentrations in the small lakes. The default sediment mercury concentrations were generally under-predicted in both the small and medium lakes, with a clustering of the results for the medium lakes, and a wider range of scatter for the small lakes.

For the Tier 5 case (Figure 5.7), the model did about the same for both small and medium lakes for epilimnion HgT, hypolimnion MeHg and HgT, fish HgT, and sediment HgT concentrations. The epilimnion MeHg was better predicted for small lakes, but there was still the strong tendency towards under-prediction for both lake sizes. The medium lakes had the greatest bias towards under-prediction. From this analysis, it seemed that for the default case, the model did better for small lakes, however, when all the data were incorporated, the model did about equally well for the small or medium lakes. That is, there was no specific bias towards success or failure with lake size.

5.1.4 Trophic Status

The final model runs separation was based on trophic status. For both the default (Figure 5.4) and Tier 5 cases (Figure 5.8), this separation did not lead to a clear pattern. For the default runs, the epilimnion MeHg in the oligotrophic lakes formed a tight cluster about the y = x line. This suggests that the epilimnion MeHg was modeled relatively well for the oligotrophic lakes. A similar pattern was seen in the default oligotrophic lakes for epilimnion HgT, but there was a bit more scatter with some lakes having large errors. Still there was a relatively good fit for these data. The default oligotrophic hypolimnion MeHg concentrations were generally over-predicted, however, while the default oligotrophic hypolimnion HgT concentrations were under-predicted. In fact, the most extreme outliers for the hypolimnion HgT were oligotrophic lakes. The default run oligotrophic fish concentrations spanned a wide range from under-prediction to over-prediction. Specifically, the range is nearly from the most under-predicted to the most over-predicted fish concentration, suggesting a weak predictive power for oligotrophic lakes. Default, oligotrophic lake sediment concentrations were scattered about the y = x line, and were the only type of lake to have over-predictions.

For default mesotrophic lakes, the epilimnion MeHg concentrations formed a tight cluster around the y = x line, but also had a string of over-predictions. The data were also scattered about the y = x line for the epilimnion HgT and hypolimnion MeHg. Hypolimnion HgT and sediment HgT concentrations were under-predicted within a narrow range of prediction values across the wider range of measured values. The fish mercury concentrations were mostly clustered about the y = x line but had a few dat points appreciably over-predicted, a pattern similar to the default epilimnion MeHg.

There are not that many eutrophic lakes in the study, and fewer eutrophic lakes with fish concentrations, so it was difficult to draw too many conclusions. For the data that were available, the default epilimnion MeHg predictions for eutrophic lakes were scattered about the y = x line. The results for the default epilimnion HgT and sediment mercury concentrations were predominately under-predicted.

For the default dystrophic lakes, there is a cluster about the y = x line for the epilimnion MeHg, but there are also two under-predicted outliers as well as a string of data points that are over-predictions. The default dystrophic epilimnion HgT data have results near the y = x line, with one data point appreciably under-predicted, but the results are predominately over-predicted. The data points predicted to have the highest epilimnion HgT, approximately 4 to 5 ng/L, were all dystrophic lakes. The default dystrophic lakes were scattered for the hypolimnion concentrations, as well as for the fish and sediment HgT concentrations.

For the Tier 5 scenario, the results were a little different. For the oligotrophic lakes, there is a downward shift in the predicted epilimnion MeHg concentrations yielding a preponderance of under-predicted results. For the epilimnion HgT, the oligotrophic lakes remained scattered about the y = x line, and the farthest outlier for the oligotrophic lakes was nearer the y = x line than for the default run. The oligotrophic hypolimnion MeHg concentrations were clustered tightly around the y = x line, while the hypolimnion HgT concentrations were still under-predicted with some severe results. The fish mercury concentrations for the oligotrophic lakes were better, with less scatter but a greater bias towards under-prediction. Oligotrophic sediment HgT concentrations were scattered with under-predictions similar to the default case.

For Tier 5 mesotrophic lakes, the epilimnion MeHg concentrations no longer had the string of over-predictions that the default case had. These concentrations decreased; some were nearer to the y = x line while others were closer to zero, effectively being farther from the y = x line. For the Tier 5 mesotrophic epilimnion HgT concentrations, the predicted values also decreased. The scatter remained similar to the default case, with an increased bias towards under-prediction. Hypolimnion MeHg concentrations were scattered closely about the y = x line, while the hypolimnion HgT concentrations were all under-predicted. The mesotrophic fish HgT concentrations covered a greater range of predicted values than those in the default case. The sediment HgT concentrations were all under-predicted.

Tier 5 eutrophic data were all under-predicted except for fish HgT concentrations where there were only three data points, all were over-predictions. The epilimnion and hypolimnion HgT all were under-predictions with little variability over the wide range of measured variables. Epilimnion and hypolimnion MeHg concentrations were also were under-predicted, but are scattered close to the y = x line with only a few outliers.

Tier 5 dystrophic lake data did not have the large, over-predicted values that the default dystrophic lake data exhibited. All the dystrophic lake epilimnion MeHg concentrations were predicted to be near zero, even though the measured values had a wide range. The epilimnion HgT concentrations were generally under-predicted, but the predicted values spanned a wide range and there was a cluster of data about the y = x line. Dystrophic lake hypolimnion MeHg and HgT concentrations both displayed a narrow predicted range with a wide measured range. This suggests little predictive capability for these lakes for these variables. For the dystrophic lakes, the fish HgT concentrations were generally under-predicted but with a good amount of scatter. The sediment HgT concentrations were all under-predicted.

5.1.5 Summary of Visual Analysis

Even after separating the predicted and measured data points by lake characteristic and visually analyzing the results, it was difficult to clearly discern general patterns. However, going through each lake variable by each lake characteristic, some general inferences could be made regarding the model capabilities.

- Relative to lake acidity, the model seemed to predict better for alkaline lakes than it did for acidic or circumneutral lakes. This may be due to the more complicated mercury chemistry and fate processes present in non-alkaline lakes.
- Relative to lake stratification, opposite results were found for the default runs versus the Tier 5 runs. For the default scenario, the model was found to be better at predicting concentrations in stratified lakes, while for the Tier 5 scenario, the model was found to be better at predicting concentrations in well mixed lakes. This result may point towards how pattern refinement can increase model prediction for different types of lakes, and that the governing fate processes and parameters must be well understood to adequately model these complex systems.
- Relative to lake size, there was more scatter in the predictions for the default scenario, medium lakes compared to the default scenario small lakes, whereas the Tier 5 results did not display any distinction in model predictive ability as a function of lake size.

- Relative to trophic status, there was a great deal of scatter in the predicted data, so that neither the default nor the Tier 5 scenarios showed a clear pattern. In some instances, such as in the epilimnion MeHg and HgT concentrations, the default runs for oligotrophic lakes indicated a relatively strong predictive capability, but this performance was not demonstrated for the hypolimnion, fish tissue, or sediment mercury concentration predictions. Therefore, the visual analysis did not provide much useful information on the model capability relative to the trophic status of lakes.

5.2 Statistical Evaluation of Model Successes and Inadequacies

Following the visual analysis, a statistical approach was used to further test the qualitative observations. A comprehensive residual sum of squares analysis suggested that there was not an appreciable improvement in the model performance due to the data input refinement when viewed as a whole. However, it may be important to sort through when the model does well and when it does not. During the visual analysis, the characteristics of the lakes were considered. Similarly, for the statistical approach, analyses based on the lake characteristics were also performed. A series of different statistical tests was used as described in standard textbooks and in the modeling literature. First, a Chi-Square goodness of fit analysis was performed (Tables 5.1 -5.6). Next, a t-test on the residuals was performed (Tables 5.7 – 5.12). Lastly, a set of model performance statistics, including maximum error, root mean square error, coefficient of determination, modeling efficiency and coefficient of residual mass were used (Tables

5.13 – 5.24). The equations used for these statistics are presented in the following sections and summarized in Table 5.25.

5.2.1 Chi-Square Goodness of Fit

A standard method of estimating how well a model fits observed data is the use a "Chi-Square Goodness of Fit" test. This test compares the measured values with the modeled values and estimates if there is an acceptable amount of error according to a certain preset level of confidence. Specifically, the chi-square statistic is given by

$$\chi^2 = \sum_{i=1}^{n} \frac{(P_i - O_i)^2}{O_i}, \qquad \text{(EQN 5-1)}$$

Where P_i and O_i are the predicted and observed values, respectively for each data point i and the statistic being tested is

$$P(\chi^2 \le \chi_0^2) = 1 - \alpha. \qquad \text{(EQN 5-2)}$$

This statistic is compared to a reference statistic given the degrees of freedom and the preset confidence value. A standard confidence value of 90% is commonly used. Using these conditions, the chi-square values were calculated for the epilimnion and hypolimnion methylmercury concentrations (EPI_Me and HYP_Me), the epilimnion and hypolimnion total mercury concentrations (EPI_T and HYP_T), the fish tissue mercury concentrations (Fish) and the sediment mercury concentrations (Sed) for all of the lake characteristics. To perform these calculations, a Matlab (version 6, The MathWorks, Inc.) program was written to sort the lakes into groups according to lake type. Then the chi-square statistic was determined and compared to the reference statistic given the number of samples and a confidence value of 90%. If the calculated chi-square statistic was less than the standard value, then the result was judged to be statistically significant at the 90% confidence level. These chi-square analyses were performed and tabulated for the six scenarios (default and Tiers 1 – 5) in Tables 5.1 – 5.6. All results are presented in the tables for completeness, but for brevity and clarity only the default and Tier 5 scenarios are specifically reviewed in the following text.

5.2.1.1 Default Scenario

For epilimnion methylmercury, the model seemed to fit the data quite well for all types of lakes (i.e., the model passed the chi-square goodness-of-fit test). Hypolimnion methylmercury was fit well for only alkaline and oligotrophic lakes. Epilimnion total mercury was modeled well only for alkaline and medium lakes, while hypolimnion total mercury never passed the chi-square test. The fish tissue mercury concentrations were modeled well for acidic, alkaline, medium, stratified, and dystrophic lakes. The model also seemed to fit all sediment data well.

The goodness-of-fit test suggests that the model could be used to model epilimnion methylmercury and sediment mercury concentrations for all types of lake with a reasonable error. However, because neither small nor medium lakes were modeled well for hypolimnion mercury concentrations, the model cannot be used to successfully simulate these species, regardless of acidity or trophic status. Similarly, the epilimnion total mercury concentration cannot be predicted because the model did not fit either well-for well mixed or stratified lakes. Fish concentrations could only be predicted well for acidic or alkaline, medium, stratified, dystrophic lakes. Based on general observation, it seems that the default case performed best across the various mercury species concentrations for alkaline, medium, stratified lakes.

5.2.1.2 Tier 5

The Tier 5 scenario had some similar successes and inadequacies as the default case. For example, the epilimnion methylmercury predictions again were fit well for all types of lakes. For epilimnion total mercury, the Tier 5 scenario fit the alkaline lakes well, similar to the default case, but did not fit medium lakes, unlike the default case. Additionally, the Tier 5 epilimnion total mercury concentration was simulated well for small, stratified, oligotrophic and mesotrophic lakes (unlike the default). Hypolimnion methylmercury was modeled well for alkaline lakes, similar to the default case, but also for oligotrophic lakes. Hypolimnion total mercury was never modeled well, just like the default case. For the fish tissue mercury concentrations, the Tier 5 case passed the chi-square test for all lakes except for the eutrophic and well-mixed lakes, unlike the default case, which failed for small, oligotrophic and mesotrophic lakes. The Tier 5 scenario passed the chi-square test for all sediment concentrations, similar to the default case.

In summary, as with the default case, the Tier 5 model was successful in modeling epilimnion methylmercury and sediment mercury concentrations for all types of lakes. Also like the default case, the model never passed the goodness-of-fit test for the hypolimnion total mercury concentrations. Because the Tier 5 model could not successfully simulate small or medium lakes for hypolimnion methylmercury, the model cannot be reliably used to predict this species behavior for any type of lake (regardless of acidity or trophic status). However, there was an improvement in predicting epilimnion total mercury concentration, with the model passing the chi-square test for alkaline, small, stratified, oligotrophic and mesotrophic lakes for this variable. From a general inspection of the model results across all the mercury species, the model did best for alkaline, small, stratified, oligotrophic lakes.

5.2.1.3 Chi-Square Test Summary

The Chi-Square Goodness of Fit test demonstrated the following:

- For the default case, the model showed good predictability for
    - Epilimnion MeHg (all lakes)
    - Epilimnion HgT (alkaline and medium lakes)
    - Hypolimnion MeHg (alkaline and oligotrophic lakes)
    - Hypolimnion HgT (no lakes – never predicted well)
    - Fish Tissue Hg (acidic and alkaline, medium, stratified, and dystrophic lakes)
    - Sediment HgT (all lakes).
- For the Tier 5 case, the model showed good predictability for
    - Epilimnion MeHg (all lakes)
    - Epilimnion HgT (alkaline, small, stratified, and oligotrophic and mesotrophic lakes)
    - Hypolimnion MeHg (alkaline and oligotrophic lakes)
    - Hypolimnion HgT (no lakes – never predicted well)
    - Fish Tissue Hg (all lakes except eutrophic and well-mixed)
    - Sediment HgT (all lakes).

The results of the chi-square test showed that Epilimnion MeHg and sediment HgT could be modeled for any type of lake in both scenarios, while Hypolimnion HgT could never be modeled. Excluding Hypolimnion HgT, alkaline lakes were the only type of lake for which each lake mercury species concentration predictions passed the chi-square test.

5.2.2 T-Test on the Mean of the Residuals

The paired t-test is a standard method for evaluating the deviation of predicted values from observed values. If the model fits the observed data perfectly, then the predicted value would exactly equal the observed value for all observations. Similarly, the model is acceptable if the deviation of the error residual (difference between the predicted and observed) is within an accepted region of confidence. A statistical method for evaluating this is by calculating the residual error and estimating if the mean error is not significantly different from zero. This is accomplished using the t-test, with the t-statistics as shown in EQN 5-3:

$$t = \frac{\bar{d}\sqrt{n}}{S_d}, \qquad \text{(EQN 5-3)}$$

where n is the total number of observations,

$$\bar{d} = \frac{\left|\sum_{i=1}^{n}(P_i - O_i)\right|}{n}, \qquad \text{(EQN 5-4)}$$

where P_i is the predicted value and O_i is the corresponding observed value,

$$S_d = \sqrt{\frac{\sum_{i=1}^{n} d_i^2}{n-1} - \frac{n}{n-1}\bar{d}^2}\ , \qquad \text{(EQN 5-5)}$$

where

$$d_i = P_i - O_i \qquad \text{(EQN 5-6)}$$

and the statistic being tested is

$$P(t \le t_0) = 1 - \alpha \qquad \text{(EQN 5-7)}$$

As with the chi-square test, the data were separated into their corresponding lake characteristics and the statistical calculations were performed by writing and using Matlab programming code. The t-statistic was calculated and compared to the reference statistic given the degrees of freedom and a confidence value of 90%. If the calculated statistic was less than the reference value, then the result was judged to be statistically significant at the 90% confidence level. Results are tabulated for the six scenarios (default and Tiers 1 – 5) in Tables 5.7 – 5.12. The mean residuals and standard deviations are also presented on these tables to provide information on the bias and the amount of error for the means. All results are presented in the tables, but for brevity and clarity only the default and Tier 5 scenarios are specifically discussed in the following text.

5.2.2.1 Default Scenario

5.2.2.1.1 Epilimnion Methylmercury

For the epilimnion methylmercury concentrations, the mean residual error was found to not be statistically different from zero for acidic, circumneutral, mesotrophic, eutrophic, and dystrophic lakes. The standard deviations for acidic and circumneutral lakes were larger than for the alkaline lakes. This suggests that there was a greater amount of scatter for the former lakes as compared to the alkaline lakes. The mean residuals indicated a slight bias towards over-prediction (positive mean residual) for acidic and circumneutral lakes, but a bias towards under-prediction for alkaline lakes (negative mean residual). The standard deviations (and the t-tests) for the acidic and circumneutral lakes suggested that the bias was not significant, while the bias for alkaline lakes was significant. There was also a positive bias for small and well mixed lakes (over-prediction) and a negative bias for medium, stratified and oligotrophic lakes (under-prediction).

5.2.2.1.2 Epilimnion Total Mercury

For the epilimnion total mercury concentrations, the mean residual error was found to pass the t-test with 90% confidence for alkaline, medium, stratified, and oligotrophic lakes. There was a positive bias for acidic and circumneutral lakes, with a stronger bias for acidic lakes than circumneutral. Small, well-mixed, mesotrophic lakes also exhibited a positive bias.

5.2.2.1.3 Hypolimnion Methylmercury

For hypolimnion methylmercury concentrations, the model passed the t-test at 90% confidence for all lakes except well-mixed and mesotrophic lakes. For these lakes, there was a positive prediction bias.

5.2.2.1.4 Hypolimnion Total Mercury

For hypolimnion total mercury concentrations, the t-test was passed only for eutrophic and dystrophic lakes. However, the standard deviations for these types of lakes were 10.38 and 24.50, respectively. Therefore, there was a high level of scatter, which resulted in the passing of the t-test (there was no statistical reason to believe that the mean was different from zero). All lakes had a negative mean residual, demonstrating a negative bias (under-prediction) for all hypolimnion total mercury concentration predictions. Additionally, the standard deviations and means were large. This test demonstrated the great difficulty of the model in predicting the hypolimnion total mercury concentrations, and especially demonstrated the negative bias of these predictions.

5.2.2.1.5 Fish Tissue Mercury Concentration

The t-test at 90% confidence for the fish tissue mercury concentrations revealed that acidic, alkaline, medium, stratified, eutrophic and dystrophic lakes all had mean error residuals that were not statistically different than zero. There was positive prediction bias for the circumneutral, small, well-mixed, oligotrophic and mesotrophic lakes. The oligotrophic and mesotrophic lakes generally had similar levels of positive bias. No lakes were found to have a significant negative bias.

5.2.2.1.6 Sediment Total Mercury Concentration

For the sediment mercury concentrations, only oligotrophic lakes had a mean error residual that was not statistically different from zero. All other lakes had a negative predictive bias (under-prediction).

5.2.2.2 Tier 5 Scenario

5.2.2.2.1 Epilimnion Methylmercury.

For the epilimnion methylmercury concentration predictions using the default scenario, the t-test at 90% confidence showed that only the dystrophic lakes had a mean error residual that was not significantly different than zero. However, the dystrophic lakes had a large standard deviation compared to the estimated mean. This suggests that there was a significant scatter for this lake type, but that the scatter was relatively equally distributed on either side of the mean (positive and negative). All other types of lakes had a negative prediction bias, suggesting that the Tier 5 scenario significantly under-predicted them..

5.2.2.2.2 Epilimnion Total Mercury

Only the oligotrophic lakes passed the t-test at 90% confidence. All other lake types had a negative bias. The model was found to under-predict all these other lake types.

5.2.2.2.3 Hypolimnion Methylmercury

For the hypolimnion methylmercury concentration predictions, the t-test revealed that the mean error residuals were not statistically different from zero for acidic, alkaline, mesotrophic, eutrophic, and dystrophic lakes. For the other types of lakes, the model had a negative bias resulting in under-prediction.

5.2.2.2.4 Hypolimnion Total Mercury

For hypolimnion total mercury concentration predictions, the mean residuals of the error were found to not be significantly different from zero for eutrophic and dystrophic lakes. However, for these two lake types, the standard deviations of the mean were quite large, suggesting that passing the *t*-test was due to the large amount of scatter, and not precision. The other lake types all had large negative means, demonstrating a significant negative bias and under-prediction for hypolimnion total mercury concentration.

5.2.2.2.5 Fish Tissue Mercury Concentration

For the fish tissue mercury concentrations, the mean residuals of the error for circumneutral, small, well-mixed, oligotrophic, mesotrophic, and eutrophic lakes were found to not be statistically significantly different from zero. The remaining lake characteristics produced significant, negative means suggesting the model's under-predictive bias for these conditions.

5.2.2.2.6 Sediment Total Mercury Concentration

For sediment mercury concentrations, the mean error residuals for oligotrophic lakes were found to not be statistically significantly different from zero. All other lake types had statistically significant negative means, suggesting the model's bias towards under-prediction for these lake types and characteristics.

5.2.2.3 t-test Summary

The t-test analyses combined with the mean residual errors produced the following general information:

- For the default case,
  - Epilimnion MeHg: Predictions for alkaline, medium, stratified and oligotrophic lakes had a significant negative prediction bias, while the small and well-mixed lakes had a significant positive bias.
  - Epilimnion HgT: Acidic and circumneutral, small, well-mixed and mesotrophic lakes had a positive prediction bias.
  - Hypolimnion MeHg: Well-mixed and mesotrophic lakes had a positive prediction bias.

  - Hypolimnion HgT: means and standard deviations were large and all means were negative, demonstrating the negative prediction bias for all predictions.
  - Fish Tissue Hg: Circumneutral, small, well-mixed, oligotrophic and mesotrophic lakes had positive prediction bias.
  - Sediment HgT: All lakes and conditions except the oligotrophic lakes had a negative prediction bias.
- For the Tier 5 scenario, the model showed good predictability for
  - Epilimnion MeHg: Even though all lake types had a negative prediction bias. Dystrophic lakes did not have a residual mean error statistically different from zero, but still exhibited negative prediction bias for this species.
  - Epilimnion HgT: All lake types exhibited a negative prediction bias. Oligotrophic lakes did not have a residual mean error statistically different from zero, but still showed a negative prediction bias.
  - Hypolimnion MeHg: Acidic and alkaline, mesotrophic, eutrophic, and dystrophic lakes all had mean residual errors that were not statistically different from zero. All other lake types and characteristics exhibited a negative prediction bias. Mesotrophic lakes displayed mean residual errors that were not statistically different from zero, and were the only lakes that had even a small positive mean residual error.

- Hypolimnion HgT: mean residual errors and standard deviations were large and all residual means were negative demonstrating the negative prediction bias for all prediction for this species.
- Fish Tissue Hg: Circumneutral, small, well-mixed, oligotrophic, mesotrophic, and eutrophic lakes had mean residual errors that were not statistically significantly different from zero. All other lake types and characteristics had negative prediction bias.
- Sediment HgT: All lake types and characteristics except oligotrophic had residual mean errors statistically significant from zero, and had negative predictive bias.

5.3 Model Performance Statistics

In addition to the standard t-test and chi-square goodness-of-fit test, there has been other research in the literature addressing the issue of model evaluation. In some of these works, additional metrics have been introduced. Specifically, a series of statistics have been suggested by Loague and Green (1991) that include maximum error (ME), root mean square error (RMSE), coefficient of determination (CD), modeling efficiency (EF), and coefficient of residual mass (CRM). As Loague and Green point out, ME, RMSE, and CD range from zero to infinity, EF is less than or equal to 1, and CRM can be any value. The optimal values for model fit are ME = 0.0, RMSE = 0.0, CD = 1.0, EF = 1.0, and CRM = 0.0.

5.3.1 Maximum Error

The maximum error (ME) statistic given by EQN 5-8

$$ME = Max\left|P_i - O_i\right|_{i=1}^{n} \qquad \text{(EQN 5-8)}$$

indicates the largest deviation from model fit for a series of data points. The ME is obviously correlated with the magnitude of the observed data, which must be taken into account. The ME for the hypolimnion total mercury concentration predictions is quite large, and was the largest ME from all the measurements. The epilimnion total mercury ME was next in magnitude, approximately an order of magnitude smaller than that for the hypolimnion total mercury concentration. The epilimnetic methylmercury, hypolimnetic methylmercury, fish tissue mercury and sediment mercury concentrations all had similar maximum errors, about an order of magnitude less than the epilimnetic total mercury concentration maximum error. The magnitude of these errors is more indicative of the magnitude of the concentrations; however it also indicates that the model has increasing error as the measurement value increases.

The maximum error can be used, however, across the same variable to compare errors. For example, for the epilimnion methylmercury concentrations, the circumneutral lakes had the largest error, followed by acidic lakes for both the default and Tier 5 scenarios. Circumneutral lakes had the largest maximum error for all variables in the default case and for all variables except hypolimnion concentrations for the Tier 5 runs. Alkaline lakes had the smallest maximum errors of all the lakes in the default and Tier 5 runs except for the default fish mercury concentrations.

The small lakes had greater maximum errors for all variables except for epilimnion methylmercury concentration, where the medium lakes had larger maximum errors. The maximum errors were similar for the different lake stratification types and neither medium nor stratified lakes for either the default or Tier 5 scenario came out as consistently having the larger maximum error. The largest maximum error was not consistent across lake trophic status and measured variable, either.

Lastly, the greatest maximum error was calculated for the hypolimnion total mercury concentration of a circumneutral, small, stratified, oligotrophic lake; the value was 28.31.

5.3.2 Root Mean Square Error

The root mean square error (RMSE) is the sum of the squares of the residuals normalized to the mean observed value and the number of observations expressed as a percent (it is multiplied by 100) as defined in EQN 5-9,

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}\left(P_i - O_i\right)^2}{n}} \bullet \frac{100}{\overline{O}} \qquad \text{(EQN 5-9)}$$

where P_i is the predicted value, O_i is the corresponding observed value, $\overline{O}$ is the mean of the observed values, and n is the number of observations. Large values for the RMSE are seen across all the default and Tier 5 model runs. The values are all around 100%, with the largest values for hypolimnion total mercury concentrations.

5.3.3 Coefficient of Determination

The coefficient of determination (CD) is a measure of how the variance of the observed data compares to the variance in the predicted data. CD is defined in EQN 5-10,

$$CD = \frac{\sum_{i=1}^{n}\left(O_i - \overline{O}\right)^2}{\sum_{i=1}^{n}\left(P_i - \overline{O}\right)^2} \qquad \text{(EQN 5-10)}$$

where P_i is the predicted value, O_i is the corresponding observed value, and $\overline{O}$ is the mean of the observed values. In effect, if the model is perfect, then CD = 1.0. However, the CD is based on the variances of the predicted and observed values about the mean observed value. So, if the predicted values have a similar variability about the observed mean as the observed values do, then the CD will be near unity even if the two variances are large. If both the predicted and observed values have small variability, but different means (regardless of whether the predictions are biased high or low), then the denominator will be large, and CD will approach zero. The closer to zero CD gets, the bigger the bias. If the observations have a larger variability than the corresponding predicted values, then the CD will increase, indicating that the predictive capability of the model is decreasing. In this latter case, the model essentially cannot capture the fluctuations in the observations.

The CDs for both the default and the Tier 5 scenarios generally had similar ranges. The larger values of CD were for the hypolimnion methylmercury concentrations, with values of 14.17 and 5.03 for the default acidic and small lakes, respectively, and 4.05 and 3.86 for the Tier 5 acidic and small lakes, respectively. The reduction in these generally large CDs suggests that the model improved from the default to the Tier 5 scenario for predicting hypolimnion methylmercury concentrations for small and acidic lakes. The CDs for both the default and Tier 5 hypolimnion methylmercury concentrations are still high, however, demonstrating that the model cannot adequately simulate the range of observed hypolimnion methylmercury concentrations.

Medium lakes also had relatively high CD values for epilimnion methylmercury and epilimnion total mercury concentrations (4.73 and 2.65, default; 2.09 and 1.38, Tier 5, respectively). For the Tier 5 runs, small lakes had a CD of 1.94 for epilimnion total mercury concentration. Stratified lakes had CDs of 2.50 and 1.31 for default and Tier 5 scenarios, respectively for epilimnion total mercury concentration. Tier 5 well-mixed and stratified lakes had CDs of 2.09 and 1.48, respectively, for epilimnion total mercury concentration. These CD values greater than unity also demonstrate how the model is unable to capture the range for these observed concentrations.

The CDs for fish mercury concentration were small (0.13) for the Tier 5 acidic lakes, suggesting a predictive bias. Similar low CD values were seen for circumneutral lakes for fish mercury concentration (0.12, default; 016, Tier 5), for alkaline lakes for sediment mercury concentration (0.14, default; 0.15, Tier 5), for small lakes for fish mercury concentration for the default scenario (0.10), for medium lakes for sediment mercury concentration for the Tier 5 scenario (0.13), and for well-mixed lakes for fish mercury concentration (0.06, default; 0.09, Tier 5).

For fish mercury concentrations as a function of trophic status characteristic, low CDs were also found. For the default scenario, the CD ranged from 0.00 to 0.36 and from 0.22 to 0.89 for the Tier 5 scenario. The fish mercury concentration CD for oligotrophic Tier 5 lakes had a value of 0.89, which is near unity. The lowest fish mercury concentration CDs were for mesotrophic and eutrophic lakes in each scenario (0.08 and 0.00, default; 0.09 and 0.03, Tier 5, respectively).

5.3.4 Modeling Efficiency

Modeling efficiency (EF) is another statistic to evaluate how well a model relates predictions to observed data as defined in EQN 5-11,

$$EF = \frac{\sum_{i=1}^{n}\left(O_i - \overline{O}\right)^2 - \sum_{i=1}^{n}\left(P_i - O_i\right)^2}{\sum_{i=1}^{n}\left(O_i - \overline{O}\right)^2} \qquad \text{(EQN 5-11)}$$

where P_i is the predicted value, O_i is the corresponding observed value, and $\overline{O}$ is the mean of the observed values. EF can be negative, but its maximum value is one. As Mayer and Butler discuss, EF is essentially an overall indicator for goodness of fit. If EF is negative, then the model cannot be recommended, with preferable values close to one indicating a "near-perfect" model (Mayer and Butler, 1993). If EF is negative, then the model predicted values are worse than using the observed mean as a predicted value.

Our use of modeling efficiency as a gauge of model success revealed an appreciable amount of negative numbers (indicating model inefficiency). Our most noticeable result was that for sediment mercury concentration, all the EFs were negative, for all Tiers and all lake characteristics. Not only were all these EFs negative, but many were large negative numbers. The EFs closest to one for sediment mercury concentrations were -1.79 for the Tier 5 small lakes and -1.12 for the default acidic lakes. The EFs farthest from unity for sediment mercury concentrations were -6.41 for Tier 5 medium lakes and -5.95 for default alkaline lakes.

The EFs for fish mercury concentration were also nearly all negative, except for the default medium lakes that were very near zero at 0.01 and for the Tier 5 stratified lakes at 0.08. The EFs for fish mercury concentration had some appreciable negative values. Specifically, for the default lakes, EFs were calculated to be -9.63, -12.07, -362.50, and -1.79 for oligotrophic, mesotrophic, eutrophic and dystrophic lakes, respectively. Similarly, the corresponding Tier 5 fish mercury concentration values were -0.12, -12.31, -30.21, and -3.45. The best EF results were for oligotrophic lakes in the Tier 5 scenario, and dystrophic lakes in the default scenario.

Hypolimnion methylmercury concentrations had better EF values. For acidic lakes, for example, EF was 0.93 for the default scenario and 0.75 for the Tier 5 scenario. However, the hypolimnion total mercury concentration EFs were all negative, except for one positive value of 0.32 for the default small lakes.

5.3.5 Coefficient of Residual Mass

The coefficient of residual mass (CRM) is defined by EQN 5-12,

$$CRM = \frac{\sum_{i=1}^{n} O_i - \sum_{i=1}^{n} P_i}{\sum_{i=1}^{n} O_i} \qquad \text{(EQN 5-12)}$$

where P_i is the predicted value and O_i is the corresponding observed value. Similar to the modeling efficiency, the CRM can take negative values. The maximum value of CRM is one. Ideally, CRM would be equal to zero. If the observed values are greater than the predicted values, then CRM will approach unity; if the predicted values are greater than the observed, then the CRM will become negative.

The instance where CRM was nearest to zero in this study was for the epilimnion total mercury concentration in the Tier 5 oligotrophic lakes, with a CRM equal to 0.18. For the default case, there were two CRMs near zero, -0.01 for the fish mercyrt concentration in stratified lakes, and 0.01 for the epilimnion methylmercury concentration in eutrophic lakes.

The default scenario produced an appreciable number of negative CRMs. This suggests that the model may be generally over-predicting, because the sum of the predicted concentrations is greater than the sum of the observed values. For the default scenario, eutrophic lake fish tissue mercury concentrations, there was a particularly large, negative CRM of -3.45. Conversely, for the Tier 5 scenario, there were only a few negative CRMs (fish tissue mercury concentrations in circumneutral lakes, CRM = -0.16; in small lakes, -0.38; in well-mixed lakes, -0.76; in mesotrophic lakes, -0.46; in eutrophic lakes, -0.95; and for the hypolimnion methylmercury concentration in mesotrophic lakes, -0.23). Generally speaking, the CRMs for the Tier 5 runs were closer to unity, suggesting that the model under-predicts for the Tier 5 scenario.

5.3.6 Model Performance Statistics Summary

The model performance statistics presented in the previous text sections provided a deeper insight into the model's predictive capabilities. A summary of key points derived from each of the statistics follows:

- Maximum Error
    - Circumneutral lakes had the largest maximum error of the lake acidity characteristics for epilimnion, fish and sediment total mercury concentrations.
    - Alkaline lakes had the smallest maximum errors for all lakes except for the default fish tissue mercury concentration, that had a CRM near the acidic lakes maximum error.

    - Small lakes had greater maximum errors for all concentrations except epilimnion MeHg concentrations.
    - All lake stratification and trophic status characteristics produces similar maximum errors for all lake mercury species concentrations.
    - The greatest maximum error was for Round Pond; a circumneutral, small, stratified, oligotrophic lake, with a maximum error value of 28.31.
- Root Mean Square Error normalized to mean observed value
    - All values were near 100%, suggesting that the predicted error is roughly the size of the predicted value.
- Coefficient of Determination
    - There was a wide range of coefficient of determinations: near zero, near unity, and greater than unity.
    - It was difficult to discern any clear pattern because for any given lake characteristic, the CDs were positive, negative, or near unity.
- Modeling Efficiency
    - Many negative modeling efficiency values calculated, suggesting that the model is inefficient, and that using the mean value of the observations would provide greater predictability than using the model.
    - Especially large negative model efficiency values were found for Tier 5 medium lake sediment HgT concentration and default alkaline lake sediment HgT concentrations.
    - Hypolimnion MeHg concentrations had some model efficiency values near unity, e.g., default and Tier 5 acidic lakes.

- Coefficient of Residual Mass
  - The closest CRMs to zero for the Tier 5 was for epilimnion HgT concentrations in oligotrophic lakes, CRM = 0.18.
  - The closest CRMs to zero for the default case were -0.01 for fish mercury concentrations in stratified lakes and 0.01 for epilimnion MeHg concentrations in eutrophic lakes.
  - Generally, a large number of negative coefficients of residual mass were observed.

5.4 Summary

Using the different statistical techniques presented in this section permitted a more thorough analysis of the behavior of the model and its predictive capabilities. Only alkaline lakes generally passed the chi-square goodness of fit test. This suggests that the complex behavior of mercury in acidic, and even circumneutral, lakes may be confounding predictive capacity. However, when the t-test was performed, it was found that alkaline lakes have a tendency to result in a negative bias. That is, the mean residual error was indeed statistically different from zero, and that there was a general tendency for the model to actually under-predict in alkaline lakes. There was a lack of any clear patterns within the various performance statistics. Therefore, it is difficult to make any strong conclusions regarding model performance for any particular type of lake.

Alkaline lakes were also found to have smaller maximum errors than the other lake acidity types, but as the chi-square test illustrated, alkaline lakes tended to be under-predicted. Modeling efficiency and the coefficient of residual mass analyses suggested that the variability in the model predictions is so great that the user would be more successful if the mean of the observed values were used for the specific lake in question. Therefore, for this set of northeast US lakes, the model did not have enough predictive power to add useful information to the modeler. Clearly, this is not a very satisfactory result. For the Tier 5 scenario, there was a pattern of negative residuals for the lake concentrations, again suggesting the tendency for model under-prediction.

Upon finding no clear pattern from this statistical parameter analysis based on a separation of lake characteristics, a different approach was taken to find ways of improving the model's predictive power. One result that was quite clear from the statistical analysis was the overwhelming amount of negative bias (under-predictability) demonstrated in the model. This implies that the total amount of mercury in the system is not being adequately taken into account, and this leads us to the topic of discussion in the next chapter.

6 MODEL SENSITIVITY AND SYSTEM EVALUATION

The next step in our evaluation delved deeper into the model itself and into an evaluation of the observed data once it became clear that the model had difficulty simulating this set of lakes as a whole. Particularly, it became clear that one overlying trend was the model's inability to predict the total mercury in the system. This was most evident in the hypolimnion, but also obvious in the epilimnion and sediment. The R-MCM had a strong tendency to under-predict these concentrations. Two different processes could produce this modeling result. First, the estimated loss rates could be dominating the system, resulting in lower concentrations. Second, the mercury input terms could be incomplete; there could even be a source not currently modeled. To better understand the reasons underlying the observed bias, we investigated the model sensitivity to certain key parameters, i.e., their impact on processes that affect the total mass of mercury in the system, and the relationship of certain parameters to the observed concentrations.

6.1 Evaluation of Loss Rates: Effect of Photoreduction and Particle Settling

In this section of the report, we investigate the possibility of bias in the simulated internal mercury loss rates. To this end, a quick and simple sensitivity study was performed to evaluate the impact of photoreduction and particle settling velocity on the predicted total mercury concentrations in the epilimnion, hypolimnion and sediment. Essentially, the rates governing these two mercury loss processes were decreased to see if there would be significant increases in the predicted total mercury concentrations.

6.1.1 Settling Velocity

The model uses a default particle settling velocity of 0.5 m/s. Two additional settling velocities, 1.0 and 10 m/s, were modeled to examine what changes would occur in the predicted mercury species concentrations. The effects of these settling velocities on epilimnion, hypolimnion and sediment total mercury concentrations are shown in Figure 6.1. These higher settling velocities had little impact on the epilimnion total mercury concentration. For the hypolimnion, there was a general increase in most of the mercury species concentrations, but not in a way that would produce any overall relevant improvement in the model performance. There was little change in the sediment mercury concentrations.

6.1.2 Photodegradation

For photodegradation, the model default photodegradation rate results were compared to those with no photodegradation at all. Photoreduction is a mechanism that can result in loss of mercury from the water column via dissolved species reduction to elemental mercury that can then enter the air via evasion. The effects of photodegradation rate on simulated epilimnion, hypolimnion and sediment total mercury concentrations are shown in Figure 6.2. Removing photodegradation completely did not result in any appreciable predicted concentration changes from the model default case values.

6.1.3 Settling Velocity and Photodegradation

For completeness, a further analysis was performed to evaluate if there is any difference in model output when both photodegradation and settling velocity are changed.

The combined effects of changing both settling velocity and photodegradation rate on epilimnion, hypolimnion and sediment total mercury concentrations are shown in Figure 6.3. Again, no appreciable difference in model performance was found through this analysis.

6.1.4 Summary of Evaluation of Loss Rates

From the results of our loss rate analysis, it was clear that these two factors are not those mostly causing under-prediction of the concentrations of mercury in the lakes. Therefore, additional investigation was necessary to elucidate those mechanisms that could alleviate these under-predictions.

6.2 Sensitivity Evaluation of Hypolimnion Surface Area

One of the Tier 1 parameter changes was the hypolimnion area, which is generally defined as a fraction of the lake surface (epilimnion) area (see Tier 1 parameters in Table 2.3). The model parameters of pH, lake size, residence time and water column DOC all came from lake-specific data, gathered in the VT/NH REMAP study (see Section 2.2). However, hypolimnion surface area was not immediately available for the lakes in this study. An assumption was therefore made to estimate it. For the default set-up, the R-MCM estimated the hypolimnion surface area as a given fraction of the epilimnion surface area. The epilimnion surface area (assumed identical to the parameter "lake size") was a measured parameter available in the VT/NH REMAP study data set. The hypolimnion surface area was estimated as one-third of the lake surface (epilimnion surface) area. The purpose here is to present a simple sensitivity analysis on how the model reacts to different approximations for the hypolimnion surface area in terms of the ratio between the hypolimnion surface area and the epilimnion surface area, *R*:

$$R = \frac{\text{Hypolimnion Surface Area}}{\text{Epilimnion Surface Area}} \qquad \text{(EQN 6-1)}$$

The sensitivity analysis was performed by repeatedly running the R-MCM using all the Tier 1 scenario parameter values except with different hypolimnion surface areas based on different choices of *R*. Because the hypolimnion surface area is only relevant for lakes with stratification, all well-mixed lakes were removed from the analysis. The ratios (R values) chosen were: 1/2, 1/3, 1/4, and 1/5, where 1/3 was the default base case. The R-MCM was used to predict seven mercury species concentrations: epilimnetic methylmercury (EPI_MeHg), epilimnetic total mercury (EPI_HgT), hypolimnion methylmercury (HYP_MeHg), hypolimnetic total mercury (HYP_HgT), sediment methylmercury (Sed_MeHg), sediment total mercury (Sed_HgT), and fish tissue mercury (Fish).

6.2.1 Visual Analysis and Maximum and Absolute Changes

The predicted concentrations were plotted versus the observed results for each of these sensitivity runs in Figures 6.4 and 6.5. The actual concentrations predicted are also presented in the appendix in Tables A-8 through A-14. From visual inspection of the figures, it is apparent that there can be quite a change in the predicted concentrations of mercury species in some lakes due to simply changing the hypolimnion surface area. There was a noted general tendency for the predicted mercury concentrations to increase as the hypolimnion surface area decreased (as *R* decreased). It also seemed that the methylmercury concentration had relatively larger changes than the associated changes in total mercury concentration. Finally, the sediment mercury concentrations did not seem to have a large change, whereas the associated fish tissue mercury concentrations seemed to be more affected by the changing hypolimnion surface area.

To gain a better understanding of the overall trends in the predicted concentrations, the average and maximum change for each concentration for each lake was calculated as a function of the area ratio from 1/5 to 1/2. Each was calculated both as a percent change and as an absolute change. The absolute change was simply the difference between the predicted mercury species concentrations at the extremes of the sensitivity analysis, i.e. for R = 1/2 and R = 1/5.

$$\text{Absolute Change} = C_{1/5} - C_{1/2} \qquad \text{(EQN 6-2)}$$

Similarly, the percent change is the absolute change divided by the predicted variable concentration for R = 1/2. This portion of the equation is an effective relative change. This term is then multiplied by 100 to create a percentage result.

$$\text{Percent Change} = 100 \bullet \frac{C_{1/5} - C_{1/2}}{C_{1/2}} \qquad \text{(EQN 6-3)}$$

The results from these calculations are presented in Table 6.1.

The data in Table 6.1 show that the hypolimnetic total mercury had the largest average and maximum absolute change. This is most likely a reflection of the higher predicted values for the hypolimnetic total mercury concentrations. This is confirmed by reviewing the percent changes for total mercury concentration. Specifically, the percent change for hypolimnetic total mercury concentration (58%) was not the greatest percent change of all the predicted concentrations. For the percent change, the largest value is seen for sediment methylmercury concentration, with a maximum percent change of

100%. The other predicted concentrations had maximum percent changes ranging from 32% to 67%, falling into a relatively narrow range including that for the hypolimnetic total mercury concentration.

The hypolimnetic methylmercury concentrations had a greater percent change than the hypolimnetic total mercury concentrations even though the hypolimnetic methylmercury concentration had the lesser absolute change. Therefore, the hypolimnetic methylmercury concentration is more sensitive to *R* than the total mercury concentration. There was a similar result with the epilimnetic methylmercury and total mercury concentrations.

Sediment methylmercury concentration had the smallest predicted values and absolute change (both average and maximum), followed closely by the sediment total mercury concentration. This is similar to the hypolimnion concentration analysis in that the magnitude of the absolute change was on par with the magnitude of the predicted concentration itself. However, unlike the sediment methylmercury concentration, the sediment total mercury concentration also had the smallest percent average change. For the maximum change, although the absolute change was smallest for sediment methylmercury concentration and followed closely by the total mercury concentration, but epilimnion total mercury concentration had the smallest maximum percent change. The sediment methylmercury concentration had the highest maximum percent change of all predicted concentrations. This may be due to the order of magnitude smaller values for the predicted sediment concentrations. Thus, an apparently slight absolute value change in sediment mercury concentration is in fact a large percent change. On average, the sediment mercury concentration was less sensitive to the hypolimnion surface area, although one must remember that small changes in absolute value result in large percentage increases.

The fish tissue mercury species concentrations were not as sensitive as the hypolimnion species concentrations, but were more sensitive than the sediment concentrations. Based on our statistical metrics, the fish concentrations were found to be sensitive to the changes in the hypolimnion surface area. The average percent change in fish mercury concentration of approximately 40% shows that changes in this one lake parameter can result in relatively important effects on the modeling results. In Figure 6.5, there are only a few lakes that span relatively wide ranges of sediment and fish mercury species concentrations. However, this figure does show how changes in hypolimnion surface area can change a lake's specific model prediction result from one of under-prediction to one of over-prediction for these two important modeling endpoints.

6.2.2 Non-dimensional Model Sensitivity Analysis

The visual analysis of the absolute and relative changes in Section 6.2.1 showed that the order of magnitude of a predicted mercury species concentration affected the calculated sensitivity of that prediction. Therefore, it is appropriate to use a non-dimensional metric to analyze model sensitivity. Such a parameter for model sensitivity is Δ, defined as the relative change in a predicted mercury species concentration divided by the relative change in the parameter undergoing sensitivity analysis, then multiplied by 100 to change this relative fractional change to a percentage relative change. This is identical to the sensitivity analysis approach used in the Mercury Report to Congress, Section 6.4 (EPA, 1997).

$$\Delta(C,R) = 100 \bullet \frac{\left(\dfrac{C_{\delta R} - C_{1/3}}{C_{1/3}}\right)}{\left(\dfrac{R_{\delta} - 1/3}{1/3}\right)} \qquad \text{(EQN 6-4)}$$

where:

$\Delta(C,R)$	=	the sensitivity of model output C to parameter R [percent]
C	=	model output [predicted mercury species concentration]
R	=	parameter being varied for sensitivity analysis (EQN 6-1)
$C_{1/3}$	=	model predicted output value for base case (i.e., R = 1/3)
$C_{\delta R}$	=	model predicted output value of changed parameter, R
1/3	=	sensitivity parameter value for base case (i.e., R = 1/3)
R_{δ}	=	current model parameter value in the sensitivity simulation

EQN 6-4 defines the percent change in modeled species concentration with respect to a fractional change from the hypolimnion surface area/epilimnion surface area ratio of one-third. The sensitivity simulations produced concentration predictions for R = 1/2, 1/4 and 1/5 relative to the base case R = 1/3. The extent of model output sensitivity is directly related to the value of Δ. A large Δ value equates to a greater sensitivity of the model to R. An arbitrary system of Δ value ranges was defined to classify this sensitivity. The sensitivity simulation results were then grouped into our four sensitivity level categories as follows:

SENSITIVITY	**Δ RANGE**
Extra Strong	>99%, <-99%
Strong	50% to 99%, -99% to -50%
Moderate	25% to 49%, -49% to -25%
Weak	-25% to 25%

The model sensitivity simulation results for this additional analysis are also presented in Table 6.1. The results show that there is a range of sensitivities to R for all of the predicted mercury species concentrations. On one extreme, it is clear that there are no predicted concentrations for which the model has an extra strong sensitivity to R. At the other end of the scale, the epilimnion and sediment total mercury concentrations have only a weak sensitivity to changes in R for this model. This analysis also shows that the methylmercury concentrations in the epilimnion, hypolimnion and sediment all have a moderate to strong sensitivity to R. The averages of all the Δs showed a strong sensitivity for the epilimnion, hypolimnion, and sediment methylmercury concentrations. The model also demonstrated that predictions for fish tissue mercury concentration had a strong sensitivity to R for all average Δs.

The results in Table 6.1 and the data presented in the appendix demonstrate that the extent of model sensitivity is dependent on what region of the parameter space is being evaluated. That is, the level of sensitivity was different for each value of R used to calculate Δ. To gain a better understanding of the sensitivity of the model predictions, the predictions were plotted against the different hypolimnion areas. These results are presented in Figure 6.6 using the epilimnetic total mercury predicted concentrations as an example. In this plot, there are a series of lines connecting four data points. Each line represents a specific lake in the modeling, each with its own, specified characteristics. Effectively, the characteristics represent an input vector that R-MCM uses to predict the output variables. For a given series of points plotted in Figure 6.6 (those connected by the line), the parameter vector is identical for all other parameters except for R. The data points represent the predicted concentration for each of the four R. Because of the large variability in the types of lakes, the lines connecting the points can cross each other. The data points and lines plotted in Figure 6.6 show that the predicted concentration generally decreases with increasing *R*. Upon visual inspection, it seems that there may be a correlation between the magnitude of the slope and the magnitude of the predicted concentration. Because the slope of the line corresponds to the amount of model sensitivity to the parameter *R*, it is difficult to make a clear-cut evaluation of the sensitivity over this wide range of lake characteristics. The slopes can be averaged (as done in Section 6.2.1) to get a general sense of the model sensitivity, but this will not capture the variability possible in parameter sensitivity.

To account for the variability of model sensitivity when predicting mercury species concentration, a response surface of two variables was generated using a second order polynomial and least squares regression. Specifically, the predicted mercury species concentrations were approximated using the following polynomial:

$$C(R, C_{1/3}) = \beta_0 + \beta_1 R + \beta_2 R^2 + \beta_3 C_{1/3} + \beta_4 C_{1/3}{}^2 + \beta_5 R C_{1/3} \qquad \text{(EQN 6-5)}$$

where $\beta_{0\text{-}5}$ are the fitted coefficients, *R* is the hypolimnion to epilimnion surface area ratio, and $C_{1/3}$ is the predicted concentration for *R* = 1/3 (i.e., the base case predicted concentration). The results of these linear regressions are plotted in Figures 6.7 – 6.13. These figures are three-dimensional plots of the predicted mercury species concentration for *R* = 1/3 versus *R* versus the predicted mercury species concentration at R. These plots show how well the response surface fits the data, as well as the shape of the response surface in general. The fitted coefficients, their standard errors, the adjusted R-square value, and the F significance of the regression for each mercury species concentration are presented in Table 6.2. Figures 6.7 – 6.13 and Table 6.2 together provide a clearer picture of the model sensitivity to *R*.

The change in sensitivity due to the predicted concentration value itself and the change due to the hypolimnion to epilimnion surface area ratio are effectively separated through this technique. The value and standard error for each coefficient (β) represent the significance of each estimated coefficient and the influence of each coefficient on the shape of the response surface. The adjusted R^2 is one measure of the goodness-of-fit of the model -- the higher the adjusted R^2, the better the model accuracy. The F value indicates the significance level of the model accuracy (i.e., an F value of 0.01 indicates a 99% confidence level in the fit). The adjusted R^2 and F significance values show that the polynomial fit is quite strong. The worst F significance and adjusted R^2 values were for the hypolimnion total mercury concentration prediction at 8.2E-58 and 0.82, respectively, demonstrating an excellent fit.

A reliable approximation of the parameter space by an analytical equation (such as EQN 6-5) permits various mathematical manipulations to yield better insights into the model sensitivity. For example, the instantaneous slope at any given point on the surface can be estimated by taking the first derivative of the response surface equation. This yields an exact and instantaneous sensitivity measure at each point within the parameter space. The derivative of EQN 6-5 is given in EQN 6-6.

$$\frac{\partial C}{\partial R} = \beta_1 + 2\beta_2 R + \beta_5 C_{1/3} \qquad \text{(EQN 6-6)}$$

This derivative relationship describes the instantaneous change in predicted mercury species concentration with respect to a change in *R* as a function of R, assuming that $C_{1/3}$ is held constant. Derivative values can be translated into a metric similar to Δ, so that a non-dimensional metric value can be calculated as a percentage similar to EQN 6-4. The sensitivity metric, DSM, is defined in EQN 6-7.

$$.DSM = \frac{\partial C}{\partial R} \bullet \frac{R}{C} \bullet 100\% \qquad \text{(EQN 6-7)}$$

The results of these calculations are plotted in Figures 6.14 – 6.20. These figures are plots of $C_{1/3}$ versus R with contours showing the regions of DSM. The lines plotted represent contour lines for constant values of constant DSM. A range of different colors are used between the contour lines to make it easier to see zones between the lines of constant values. The colors have no other significance other than to assist the reader in viewing the plots. The single color between contours does not mean that DSM is constant, but rather shows the region bounded by the constant value contours. Figures 6.14 – 6.20 present the regions of weak (-25% to 25%), moderate (25% to 49%, -49% to -25%), strong (50% to 99%, -99% to -50%), and extra strong (>99%, <-99%) sensitivity (The figures also reveal regions as R increases and decreases. There are added contour lines to provide insight into the shape of the response surface where DSM is near zero.) Additionally, the observed data points associated with each lake are plotted similar to Figure 6.6. The four data points associated with the four R values used in the sensitivity analysis are plotted and connected by a solid line to delineate points from the same lake. These points also show what the predicted concentration for a given lake becomes as R changes, and how the model output sensitivity changes across the R parameter space. The predicted concentration is plotted on the y-axis to show the predicted concentration for each lake, but the figure really is plotting the sensitivity regions of the response surface based on the base case, $C_{1/3}$, and EQN 6-7.

A specific feature of EQN 6-7 must be mentioned, specifically that it is a hyperbolic function multiplied by the derivative. As C approaches zero, the hyperbola approaches infinity, and the function is undefined at this point. Therefore, DSM will approach either positive or negative infinity near the x-axis. All the results in the figures from this method of sensitivity analysis agree with the results presented in Table 6.1.

Figure 6.14 presents the sensitivity of predicted epilimnetic methylmercury concentration. For the range of lakes and associated characteristics (parameter space) investigated, the model prediction sensitivity to R was moderate to strong. For lakes with predicted concentrations for $C_{1/3}$ greater than 0.05 ng/L, the model became more sensitive to R as R increased and less sensitive to R as R decreased. When $C_{1/3}$ decreases below approximately 0.05 ng/L, the impact of $C_{1/3}$ approaching zero becomes evident as the model sensitivity starts increasing rapidly. This figure verifies that the epilimnion methylmercury concentration has moderate to strong sensitivity to hypolimnion surface area.

Figure 6.15 presents the sensitivity of predicted epilimnetic total mercury concentration. Most of the parameter space shows that the model has a weak sensitivity to changes in R and $C_{1/3}$. The sensitivity changes to moderate in the upper right corner of the region, as the predicted concentration and the hypolimnion area increase. The same asymptotic approach towards infinity arises in the lower right corner. This figure verifies that the total epilimnetic mercury concentration is relatively insensitive to the hypolimnion surface area.

Figure 6.16 presents the sensitivity of predicted hypolimnetic methylmercury concentration. This figure is similar in shape to Figure 6.14. Most of the parameter space shows that the sensitivity is moderate. Sensitivity increases with increasing *R*. The band of moderate sensitivity spans a wider region of *R* than in Figure 6.14, crossing into an area of weak sensitivity to the left, and into a strong sensitivity on the right. The increasing hyperbolic shape as predicted concentration decreases toward zero once again exhibits the asymptotic nature of the function. This figure verifies that the model has predominately a moderate sensitivity to hypolimnion surface area.

Figure 6.17 presents the sensitivity of predicted hypolimnetic total mercury concentration. This figure shows a wide region of sensitivity near zero. Additional contours (-5 and -10) were added to specifically show the shape of the function across the upper half of the figure. As the predicted hypolimnetic total mercury concentration decreases and R increases, the model sensitivity increases. The contour where the sensitivity changes from weak to moderate is curved, but occurs between the predicted concentrations of 1 to 2 ng/L. Here the slope of the sensitivity is increasing with decreasing $C_{1/3}$. This figure shows the importance of an analysis of this type. The previously discussed average calculations showed a moderate to strong sensitivity for this prediction, but there is a strong correlation between sensitivity and predicted concentration value. For lakes where a high hypolimnetic total mercury concentration is predicted, the model is relatively insensitive to the hypolimnion surface area. However, as the predicted concentration decreases, the sensitivity changes from weak to moderate, even passing into a strong and extra strong region as $C_{1/3}$ approaches zero.

The first and most obvious observation from Figures 6.14 – 6.20 is that the methylmercury concentration is more sensitive to changes in *R* than total mercury concentration. Both the discrete and continuous analyses showed that the methylmercury concentrations in the epilimnion, hypolimnion, and sediment were all moderate to strongly sensitive to changes in *R*. Fish concentrations, which are modeled as methylmercury concentrations in fish tissue, were similarly sensitive. The total mercury concentrations in the epilimnion, hypolimnion and sediment were less sensitive, falling into the weak and moderately sensitive regions. There were regions within the parameter space where the total mercury concentrations became more sensitive, but predominately, the total mercury concentration remained relatively insensitive.

6.2.3 Re-evaluating Hypolimnion Area Sensitivity by Keeping Constant Volumetric Flow Rate (Adjusting θ with V)

Based upon the results of the previous section's sensitivity analysis, it was unclear as to why there was the evident inverse correlation between the hypolimnion area and the mercury concentrations in the different media. The processes and modeling structure of the R-MCM was explored in an attempt to understand this phenomenon. During this review, we realized that by changing *R* (and thus hypolimnion area) the volumetric flow rate through the lake was being inadvertently changed. The R-MCM calculates the volumetric flow rate, Q, through the lake as a function of the lake volume, V, and the hydraulic residence time, θ.

$$Q = \frac{V}{\theta} \qquad \text{(EQN 6-8)}$$

Certain parameters are defined during the initializing of the parameter set. Of particular importance to this section, the R-MCM has the following parameters defined as part of the input parameter vector: mean depth of each lake layer (i.e., the hypolimnion and epilimnion), the lake area (epilimnion surface area), the thermocline area (hypolimnion surface area), and the hydraulic residence time. When the R-MCM is run, the model calculates the other required parameters. Specifically, the R-MCM first calculates the volume of each layer in the lake as the product of the given layer's surface area and its mean depth.

$$V_E = A_E d_E \qquad \text{(EQN 6-9)}$$

$$V_H = A_H d_H = R A_E d_H \qquad \text{(EQN 6-10)}$$

Then, the total lake volume, V_T, is calculated as the sum of the volumes of the two layers.

$$V_T = A_E d_E + A_H d_H \qquad \text{(EQN 6-11)}$$

A_E and A_H are the areas of the epilimnion and hypolimnion, respectively, and d_E and d_H are the mean depths of the epilimnion and hypolimnion, respectively, with R defined in EQN 6-1. Thus,

$$V_T = A_E(d_E + R d_H). \qquad \text{(EQN 6-12)}$$

Then the volumetric flow rate, Q, is calculated via EQN 6-8. In the analyses of the previous sections (Sections 6.2.1 – 6.2.2), it was not realized that as the hypolimnion surface area was being updated that R-MCM was also recalculating Q. Therefore, Q was inadvertently being decreased as V decreased. Therefore, the calculations and analyses of Section 6.2.1 needed be to be performed again. To do this, the Q updating relationship needed to be formulated.

Keeping Q constant based on the initial volume, V_0, for the updated volume, V_1, with corresponding θ_0 and θ_1, gives

$$Q = \frac{V_0}{\theta_0} = \frac{V_1}{\theta_1} \qquad \text{(EQN 6-13)}$$

and through rearrangement

$$\theta_1 = \theta_0\left(\frac{V_1}{V_0}\right) = \theta_0\left(\frac{A_{E,1}\left(d_{E,1}+R_1 d_{H,1}\right)}{A_{E,0}\left(d_{E,0}+R_0 d_{H,0}\right)}\right) \qquad \text{(EQN 6-14)}$$

and because the area of the epilimnion is not changing, $A_{E,0} = A_{E,1}$, and because the depths of the epilimnion and hypolimnion are not changing, $d_{E,0} = d_{E,1}$ and $d_{H,0} = d_{H,1}$,

$$\theta_1 = \theta_0\left(\frac{V_1}{V_0}\right) = \theta_0\left(\frac{d_E+R_1 d_H}{d_E+R_0 d_H}\right) \qquad \text{(EQN 6-15)}$$

Using this formulation, a similar evaluation of the effect of changing R done in Section 6.2.1 and 6.2.2 was performed for the same series of R-MCM runs (R = 1/5, 1/4, 1/3, and 1/2) for the predicted mercury species concentrations in all media (MeHg and HgT in the epilimnion, hypolimnion, and sediments). Microsoft Access and SQL programming codes were used to calculate and update A_H and θ for each run of R value run. Particular care was taken to keep data files and data manipulations separate and distinct to assure a high level of data quality. Rerunning the model using the updated constant Q values resulted in similar results as when Q was not updated (as was done in Section 6.2.2). There were slight shifts in the predicted concentration values, and the extent of sensitivity to changes in R was slightly decreased. However, overall, there was no appreciable difference. It was still unclear what was impacting the predicted mercury species concentration due to changes in hypolimnion area.

6.2.4 Investigation of Mechanism Causing Increase in Mercury Concentration with Decreasing Hypolimnion Surface Area

Upon conclusion of the previous investigations (Sections 6.2.1 – 6.2.3), the sensitivity of predicted mercury species concentrations to hypolimnion surface area had materialized into a clearer phenomenon, however it was still unclear what the mechanism was. Therefore, additional modeling experiments were performed to ascertain if this phenomenon was indeed a modeling phenomenon, or if it were just an artifact of the modeling system. A hypothetical lake was created using the default set-up capability of the R-MCM to evaluate a simple lake system because we were interested in model behavior independent of the VT/NH data set. The lake used was an: acidic, stratified, medium-sized, drainage, oligotrophic lake. Using this hypothetical lake, the R-MCM was initially run for R = 1/10, 1/2, and 9/10, keeping Q constant. During this preliminary analysis, the same pattern of increasing predicted mercury species concentrations with decreasing hypolimnion area was demonstrated, even for the extreme values of R = 0.1 and 0.9. These modeling results are presented in Table 6.3, labeled as the base case, run 2, and run 3, and in Figure 6.21. These results show again the previously noted inverse correlation between predicted mercury species concentration and hypolimnion area and R.

An additional investigation was performed, keeping hypolimnion area constant but going to extremes with mean hypolimnion depth. In the base case, mean hypolimnion depth was set as 5 m. For this part of the investigation, the other mean hypolimnion depths were set at a minimal value of 0.1 m and an extreme value of 1000 m. These modeling results are also presented in Table 6.3 labeled as the base case and run 4 and run 5, and in Figure 6.22. These model results showed that increasing hypolimnion depth had little impact on the predicted mercury species concentrations in the epilimnion, but produced an increase in the HgT and a decrease in HgII concentration in the hypolimnion. These results merely underscore the probable importance of photolytic reactions and how the thickness of the hypolimnion layer impacts the distribution and concentrations of the various mercury species, but they did not help elucidate the processes governing the observed impact of hypolimnion surface area itself.

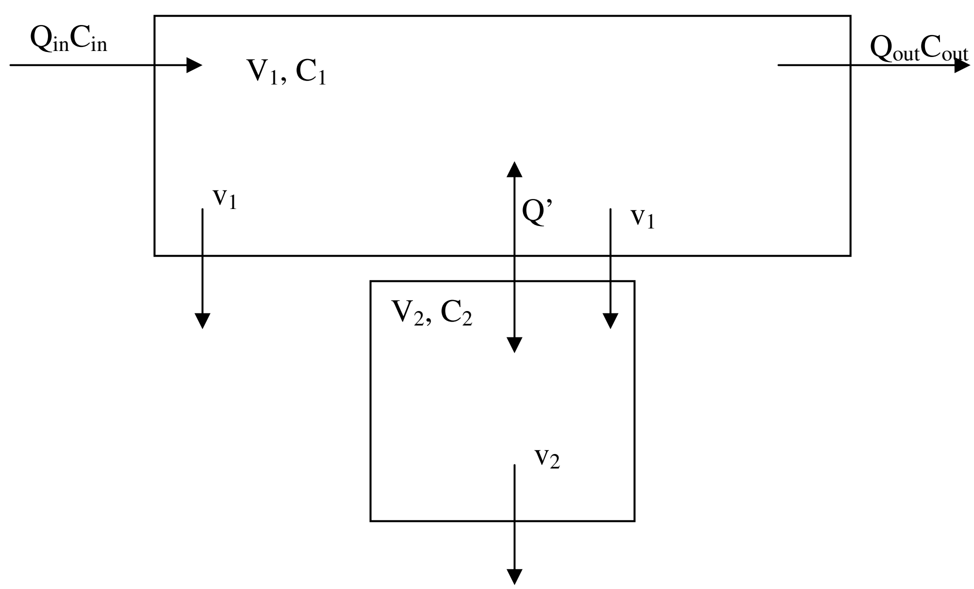
In reviewing Figure 6.21, it is difficult to make any general conclusions with only 3 points of data, so it was decided that additional *R* values would be modeled to see if there were a limiting values that the various mercury species concentrations would approach. Specifically, it was of interest to see how the shape of the curve reacted in the limit that $R \rightarrow 0$. The model lake was set up as before, except in this case, both the epilimnion and hypolimnion had mean depths of 5 m. A range of *R* values was used to give a better idea of the shape of the response function. The *R* values used were: 0.0001, 0.05, 0.1, 0.25, 0.5, and 0.95. Two different cases were run for the limiting result of R = 0. The first was as if the hypolimnion were completely removed. For this case, the model was run as a well-mixed lake with the total lake are equal to the exact dimensions of the epilimnion surface area used in the other modeling scenarios. A second case was run as if the total volume of the lake for the R = 0.95 case were actually a well-mixed lake, so that the lake had nearly twice the volume as the other well-mixed case. The modeling results for these two cases are presented in Table 6.4 (labeled as runs 1-1 and 1-2 along with the results at *R* values of 0.0001 to 0.5. The data are plotted in Figure 6.23 for the range of *R* values, as well as for the two limiting cases of *R*=0. The first case is plotted as distinct points at *R*= 0 as “Well-Mixed, Top Layer Only,” and the second case is plotted at *R*=1 as “Well-Mixed, Both Layers Modeled as One.” From these results, the same pattern was demonstrated as previously seen in Sections 6.2.1 – 6.2.3.

The inclusion of more data points (see Figure 6.23) gives a better idea of the shapes of the response curves and the extension of the results to the limits of $R = 0$ and $R = 1$. The results of the two well-mixed scenarios provide additional, interesting information. For one result, which is akin to an effective $R = 0$, where the hypolimnion layer goes to zero, the predicted mercury species concentrations in the epilimnion increased quite dramatically. As $R \rightarrow 0$, the predicted epilimnion mercury species concentrations approached values of 0.14 ng/L (MeHg), 1.5 ng/L (HgII), and 1.7 ng/L (HgT). However, for a lake of identical dimensions, but with an effective epilimnion only, that is, for a well-mixed lake of the same dimensions as the epilimnion in the other scenarios, the predicted mercury species concentrations were: 0.3 ng/L (MeHg), 3.0 ng/L (HgII), and 3.3 ng/L (HgT), respectively. The results of the well-mixed model runs were approximately twice the limiting value as $R \rightarrow 0$. It is unclear as to why this occurs, and it is also unclear which value is the more likely value to be measured in the field. Additionally, a simulation was made where the same dimensions as the R= 0.95 lake were run as a well-mixed lake. This would be the case of $R \rightarrow 1$, but running the model as a well-mixed lake instead of a stratified lake. These model runs produced a similar unexplainable gap as the $R \rightarrow 0$ results just discussed (see Figure 6.23).

6.2.5 Hypothetical Lake Evaluation of the Change in Simulated Mercury Species Concentrations as a Function of Hypolimnion Area: A Simple Mathematical Thought Experiment

Upon conclusion of the work in the previous section, we became more confident of the sensitivity of the model and the presence of the phenomenon of a decrease in mercury species concentrations as the size of the hypolimnion area increased. Therefore, in addition to the R-MCM modeling experiments, we believed it would be productive to investigate the phenomenon in a purely theoretical, mathematical analysis. In this section, we merely developed a very simple mathematical thought experiment that allowed us to investigate only a few, simple processes so that we might understand the physical nature of this system.

A simple construct of a stratified lake was modeled as shown here.



In this simplified two-layer lake system, there is

- Q_{in}: Volumetric Flow into the lake (into layer 1 only) [m^3/d]
- Q_{out}: Volumetric Flow out of the lake (from layer 1 only) [m^3/d]
- C_{in}: Concentration in Inflow [ng/L]
- C_{out}: Concentration in Outflow [ng/L]
- C_1: Concentration in Layer 1 [ng/L]
- C_2: Concentration in Layer 2 [ng/L]
- V_1: Volume of Layer 1 [m^3]
- V_2: Volume of Layer 2 [m^3]
- v_1: Effective Settling Velocity of particles from Layer 1 to Layer 2. Particles settle from Layer 1 to Layer 1 sediments and into Layer 2 as appropriate [m/d]
- v_2: Effective Settling Velocity of particles from Layer 2 to Layer 2

sediments [m/d]
Q': Exchange Flow between Layers 1 and 2. [m^3/d]

The two layers were modeled as Continuous-Flow Stirred Tank Reactors (CSTRs), so that $C_{out} = C_1$ and the total mass concentration of each mercury species is assumed constant throughout each layer. Mass Balance Equations for each layer are as follows:

Layer 1: $$\frac{d(V_1C_1)}{dt} = Q_{in}C_{in} - Q_{out}C_1 - v_1A_1C_1 - Q'(C_1 - C_2) \qquad \text{(EQN 6-16)}$$

Layer 2: $$\frac{d(V_2C_2)}{dt} = v_1A_2C_1 - v_2A_2C_2 - Q'(C_2 - C_1) \qquad \text{(EQN 6-17)}$$

In these equations, we define an "effective settling velocity." Generally, one does not incorporate a settling term in a CSTR, however with solid particulates in the system, settling can and will occur. To keep our model simple, we incorporate the fraction of total concentration that might settle (i.e., that fraction of the total concentration is sorbed to the settling matter) within the velocity term. We could have, in effect, incorporated a term defining this fraction, such as *f*, as a multiplier to the concentration. This would result in two parameters, *v* and *f*, and since we have no information on either of these, it is just as simple, and much cleaner mathematically, to incorporate them into one lump, "effective" parameter.

Assuming Steady State, then $\frac{d(V_iC_i)}{dt} = 0$ and EQN 6-16 and 6-17 become

Layer 1: $$Q_{in}C_{in} - Q_{out}C_1 - v_1A_1C_1 - Q'(C_1 - C_2) = 0 \qquad \text{(EQN 6-18)}$$

Layer 2: $$v_1A_2C_1 - v_2A_2C_2 - Q'(C_2 - C_1) = 0 \qquad \text{(EQN 6-19)}$$

After some rearrangement,

Layer 1: $$C_1 = \frac{Q'C_2 + Q_{in}C_{in}}{Q_{out} + v_1 A_1 + Q'}$$ (EQN 6-20)

Layer 2: $$C_2 = \frac{(v_1 A_2 + Q')C_1}{v_2 A_2 + Q'}$$ (EQN 6-21)

From these equations, we see that C_1 is a function of C_2, and vice-versa. This complicates our attempt to understand the influence of the hypolimnion area on the concentrations in each layer. Two approaches were taken to investigate the behavior of these coupled equations. First, a brute force method was used by assigning representative but arbitrary values to the various parameters. An MS Excel Spreadsheet was designed to iterate the solutions for C_2 and C_1 as a function of R, where $R = A_2/A_1$. Q' was calculated by

$$Q' = \frac{E_{12} A_2}{l},$$ (EQN 6-22)

where E_{12} is the exchange rate coefficient, as presented by Schnoor (1996) (from Mortimer, 1941), $E = 0.0142*(d_1 + d_1)^{1.49}$ and

$$l = \frac{1}{2}(d_1 + d_2),$$ (EQN 6-23)

where l is the distance between the midpoints of the lake layers [m].

Three different runs were performed with the results presented in Figure 6.24. Run (a) represents a scenario where the particle settling rate is greater in the hypolimnion than in the epilimnion, and Run (b) is the opposite. Run (c) uses settling velocities that were calculated from the default run modeled previously in Section 6.2.1.

Lastly, a purely mathematical evaluation was performed using Mathematica (Mathematica, v 5.0.1.0, Wolfram Research, Inc.) to calculate the derivatives of EQN 6-20 and 6-21. The results were:

$$\frac{dC_1}{dA_2} = \frac{C_{in}Q_{in}Q'^2\left(v_1 - v_2\right)}{\left(Q'\left(Q_{out} + \left(A_1 - A_2\right)v_1\right) + A_2\left(Q_{out} + Q' + A_1 v_1\right)v_2\right)^2} \qquad \text{(EQN 6-24)}$$

$$\frac{dC_2}{dA_2} = \frac{C_{in}Q_{in}Q'\left(Q_{out} + Q' + A_1 v_1\right)\left(v_1 - v_2\right)}{\left(Q'\left(Q_{out} + \left(A_1 - A_2\right)v_1\right) + A_2\left(Q_{out} + Q' + A_1 v_1\right)v_2\right)^2} \qquad \text{(EQN 6-25)}$$

From these equations, it was clear that the shape of these derivative curves can be quite complicated, depending on the input variables. However, one thing that can be simply derived from these equations is that

$$\frac{dC_i}{dA_2} \propto v_1 - v_2 \qquad \text{(EQN 6-26)}$$

Therefore, if the settling rate is greater in the hypolimnion than in the epilimnion, (i.e., $v_2 > v_1$), then *C* decreases as the hypolimnion area decreases. (This is true as long as $A_1 > A_2$, which is true in all real lake systems because the hypolimnion area is necessarily smaller than the epilimnion area.) An example of EQN 6-26 behavior is presented in Figure 6.24. In Figure 6.24 (a), $v_1 > v_2$ and C_T increased with *R*, while in (b) $v_1 < v_2$ and C_T decreased with *R*. Using actual settling velocities from the R-MCM, the curve becomes more gradual exhibiting the characteristic decrease in mercury concentration as *R* increases seen in the R-MCM runs (6.24(c)). From this simple mathematical analysis, it seems that the decreasing concentration is a function of the physical structure of the lake system. The difference in lake layer particle (with sorbed Hg) settling velocities in this simple system creates the phenomenon and sensitivity of the model output for total mercury concentration to hypolimnion area.

In this analysis, in contrast to the R-MCM outputs, the epilimnion concentration was found to be greater than the hypolimnion concentration; it is hypothesized that this results is due to the oversimplification of the model. Because this simplistic mathematical representation does not take into account the different mercury species, the true variation in mercury inputs, outputs and transformation processes are not adequately modeled. For example, the epilimnion will have a volatilization process governing additional loss of Hg0, while the hypolimnion does not have this process. Additionally, the depth governing the photoreduction process is not adequately captured. Incorporating processes associated with depth (as these are) would impact the ratio of epilimnion to hypolimnion mercury concentrations.

6.2.6 Summary

The hypolimnion surface area was originally defined as a default parameter in the R-MCM as a fraction of the epilimnion surface area, taken to be the lake surface area. The lake surface area is a relatively straight-forward measured parameter, while measuring the hypolimnion surface area provided a bit more of a challenge. The hypolimnion is a physically existing layer within a lake, but its thickness is a time-dependent variable. Specifying hypolimnion thickness is a challenge, but at any given point in time it can be measured. Since the R-MCM is a steady-state model, both the thickness and area of the hypolimnion must necessarily be assumed to be constant. Specification of hypolimnion surface area is complicated because the cross-sectional area of the hypolimnion is dependent on the hypolimnion thickness through the bathymetry of the lake. Depending on the specific shape of the lake floor, the hypolimnion area could vary widely for any given thickness or lake size. Given this complication, to decide upon a representative hypolimnion surface area would be a time-intensive effort, and the achievable accuracy of this effort is unclear. Additionally, the resulting amount of model improvement that could be achieved is not clear. The model and mathematical investigation presented in Section 6.2 have shown how the predicted mercury species concentrations are sensitive to the hypolimnion area. Further research should be conducted to investigate if significant improvements in mercury modeling can be made via a more rigorous physical representation of the lake system, especially in regard to modeling the size of the hypolimnion.

Based on our work, some conclusions regarding the sensitivity of modeled mercury species concentrations to hypolimnion surface area can be made:

- Methylmercury concentrations (epilimnion, hypolimnion, sediment, fish tissue) were all found to be more sensitive than the total mercury concentrations,
- Methylmercury concentrations were found to have sensitivities falling in the moderate and strong regions,
- Sensitivities were generally found to be negative, suggesting an inverse correlation between mercury species concentrations and hypolimnion surface area, and
- Generally, the predicted mercury species concentrations became more sensitive to changes in hypolimnion surface area (*R*) for the larger lakes.

6.3 Comparison of Model Behavior and Observed Data

In Chapter 3, the predicted results for a series of default-parameterized lakes were presented to illustrate the general trends and behavior that the default level model provides. In this section, the observed data was analyzed in an effort to understand if there are trends within the VT and NH data itself. Any observed trends can then be compared to the predicted results to see if similar trends are produced by the mechanistic model. This evaluation of observed data and comparison of trends provides insight into the mechanisms governing mercury cycling in lake ecosystems.

6.3.1 Trends in Observed Data

The observed data from the VT and NH data set were plotted as a function of the default-level lake characteristics, similar to the figures created by plotting the predicted concentrations from the hypothetical default lake. The observed results were plotted using the continuous data provided by lake-specific measurements, rather than the categorical/discrete data entered for the default level input. The measured values for epilimnion methylmercury and total mercury, hypolimnion methylmercury and total mercury, sediment methylmercury and total mercury, and fish tissue mercury concentrations are all plotted as a function of lake area, epilimnion DOC, epilimnion pH, and lake stratification. Because precise measurements of the first three characteristics were made for each lake, these are plotted as continuous variables, unlike lake stratification, which is not continuous, but rather is a binary function being stratified (1) or well-mixed (2). These data plots are presented in Figures 6.25 and 6.26. It is clear from these figures that there is a large amount of scatter in these data.

6.3.1.1 Lake Area

For epilimnion methylmercury, there may be an inverse correlation with lake area. There is appreciable scatter in the epilimnion methylmercury data versus lake area, but the average value appears to be decreasing with increasing lake size. The scatter amongst the data cannot be discounted, however. For the other observed mercury species concentrations, the scatter of the data dominated over any possibly visible trends.

6.3.1.2 Epilimnion DOC

In the plots of the different mercury species concentrations in the different media against epilimnion DOC, there did not seem to be any noticeable trend. The scatter amongst the data overwhelmed any possible trends.

6.3.1.3 Epilimnion pH

Similarly in the plots of the different mercury species concentrations in the different media against epilimnion pH, the scatter also tended to dominate the results. However, for the epilimnion methylmercury there was an apparent trend of decreasing concentration with increasing pH (i.e., decreasing acidity). This trend is similar to that seen in the R-MCM results presented in Section 3.2.3. There also was a noticeable trend in perch tissue mercury concentration versus the epilimnion pH. As with the other data, there was still scatter in the fish tissue data, but the inverse correlation is noticeable. This trend was also evident in the R-MCM output presented in Section 3.2.4. The inverse correlation of water and fish tissue mercury concentration with pH has also been documented in the field at other field sites. It is somewhat surprising that the epilimnion total mercury concentration, as well as the methylmercury and total mercury concentrations in the hypolimnion and sediment, did not demonstrate similar correlations with epilimnion pH.

6.3.1.4 Lake Stratification

There is a large amount of scatter in the data when lake types were separated into stratified and well-mixed lakes. This scatter generally dominated any trends, although there are some minor trends among the observed results. For the epilimnion methylmercury concentration, there is a slight increase in the average concentration in the well-mixed lakes as compared to the stratified lakes, but there is an outlier in the stratified lakes that is largest of any of the epilimnion methylmercury concentrations. Similarly, for the epilimnion total mercury concentration, the average value is larger in the well-mixed lakes. There are two stratified lakes that had appreciably higher total mercury concentrations than the other stratified lakes, and there were two well-mixed lakes with appreciably higher total mercury concentrations than the other well-mixed lakes. These outlying lakes also followed the trend of having the higher concentrations in the well-mixed lakes versus the stratified lakes.

For sediment methylmercury, there also appeared to be higher concentrations in the well-mixed lakes than in the stratified lakes, but the data scatter is appreciable enough to question if there really is any sort of trend. The scatter in the sediment total mercury concentrations dominated over any possible trend with lake stratification. That was also the situation with respect to the fish tissue mercury concentration. There is one outlying fish mercury concentration in a stratified lake, but exclusive of this one lake, there was little difference in the average and range of observed fish tissue mercury concentrations.

6.3.2 Percent Methylmercury for Observed and Predicted Data

An important facet of mercury modeling is the production, loading, and loss of methylmercury within a watershed and water body. There has been much debate, discussion and research on the relative importance of the methylmercury concentration in a water body versus the total mercury concentration in the same system. Therefore, the percent of total mercury concentration that is methylmercury as an additional model output was evaluated. Both the predicted model results and the observed results were compared solely on a percent methylmercury basis. The percent methylmercury (%MeHg) was calculated according to EQN 6-8.

$$\%MeHg = \frac{MeHg}{HgT} \times 100 \qquad \text{(EQN 6-8)}$$

6.3.2.1 Visual Analysis

The results of this comparative analysis are visually presented in Figure 6.27. In this figure, for both the first and second column the x-axis is arbitrary, since the lakes are plotted on the figure merely in order of lake number. Therefore, the order of the data is irrelevant. The scatter of the data for both the predicted and observed results gives a feeling for the range and mean of the data. The scale of the y-axis is different for each subfigure. The observed results for the epilimnion range up to almost 80% MeHg, while the predicted results range up to about 45% MeHg. For the percent methylmercury in the hypolimnion both the predicted and observed data fall within a similar range of up to about 35 – 40%. For the percent methylmercury in sediment, the predicted values have a wider spread by about a factor of 2 than the observed results.

In the third column of Figure 6.27, the observed data are plotted versus the predicted data. If the R-MCM were performing as a perfect model of the environment, then these latter results would fall along the y=x line. If the predicted and observed values displayed similar ranges, then these latter data would fall in a square splay centered about the y=x line. Our data do neither. Specifically, the epilimnion data are clustered along the x-axis, indicating that the predicted percent methylmercury was consistently smaller than the observed. The hypolimnion data have the opposite pattern, being clustered along the y-axis, showing how the predicted percent methylmercury was consistently greater than the observed. For the sediment, the data are predominately clustered near the origin, packed along the x-axis, showing how, similar to the epilimnion, the sediment percent methylmercury is consistently smaller than the observed by a factor of roughly 2. Also, for the sediment, however, there are two outliers, showing that this pattern is not entirely consistent. There is one outlier where the observed methylmercury concentration is quite high, while the corresponding predicted value is quite low; and conversely, there is another outlier where the predicted value is high and the observed value is quite small. The analysis of sediment percent methylmercury is confounded by the fact that one is dealing with relatively very small concentrations, and any errors in rounding or sampling have a dramatic impact on the calculated percent methylmercury.

6.3.2.2 Summary Statistics

In addition to the previously discussed graphical representation of the data, summary statistics for the predicted and observed percent methylmercury results in the three different media (i.e., epilimnion, hypolimnion, and sediment) were calculated and tabulated in Table 6.6. The minimum and maximum values for the three media elucidate how well the model does at predicting the extreme values of percent methylmercury. For both the epilimnion and sediment, the model predicted zero percent methylmercury as the minimum, when this was not the case. This could be just an issue of significant figures (i.e., the model rounds the numbers and they come out to be zero when they are just smaller than the rounding error), or that there are difficulties in predicting methylmercury concentrations in lakes with these more extreme characteristics. Similarly, on the other side of the scale, there were difficulties in predicting the extreme methylmercury percentages. For example, the percent methylmercury in the epilimnion, the R-MCM predicted a maximum of 43% when a value of 75% was observed. The model under-predicted this percent by almost half. For the hypolimnion, the maximum predicted percent methylmercury (35%) was just under the maximum observed percent methylmercury (39%). For the sediment, the R-MCM over-predicted the maximum percent methylmercury (40%) compared to the maximum observed methylmercury (29%) by roughly one-quarter. Therefore, relative to the maximum percent methylmercury, the model behaved differently in the three different media. In summary, for maximum percent methylmercury, R-MCM under-predicted for the epilimnion, overpredicted for sediment, and was on par for the hypolimnion.

The mean percent methylmercury comparison provides insight into how well the model is behaving overall. For the epilimnion, the model predicted a mean of 8.6% methylmercury while the observed data had a mean of 21%. A report by Krabbenhoft et al. (1999) suggested that the average observed percent methylmercury in water draining mixed agricultural and forested areas was approximately 8%. For many lakes in Vermont and New Hampshire, the land use type is mixed agricultural and forested, so the model-predicted value of 8% would seem to be appropriate. Our mean observed value of 21%, therefore, seems rather high for these lakes. In a report by Kelly et al. (1995), an average percent methylmercury was reported as 15.5% for a headwater wetland, suggesting that some wetlands might have percent methylmercury values on the order of 20%. The discrepancy between the average percent epilimnion methylmercury for the R-MCM predictions and our observations suggests that the R-MCM, as is, is unable to predict these relatively high methylmercury percentages. This suggests that processes affecting methylmercury concentration need to be adjusted, or additional processes and/or loadings need to be included. Also, it seems that our study lakes in VT and NH behaved differently than the collection of lakes studied earlier by others, where the average methylmercury percentage was typically nearer 10%.

Our mean methylmercury percentages for the hypolimnion and sediment were observed to be 9.2% and 2.4%, respectively, while the percentages predicted by R-MCM were 17% and 5.7%, respectively. Compared to the epilimnion, the hypolimnion and sediment had much lower observed mean methylmercury percentages. As mentioned earlier, it is of interest that the R-MCM is not consistent in its predictive capability for the percent methylmercury. Krabbenhoft et al. (1999) suggested that for a mixed agricultural and forested land use, the methylmercury percentage should be higher for sediments than for the water, the former with a value of approximately 10%, while a background reference or agriculturally dominant site should have a value of approximately 5%. The R-MCM is only predicting levels similar to the latter, and these are significantly over-predicted compared to the observed results. No typical or average methylmercury percentages were found reported for the hypolimnion.

6.3.3 Summary

Trends in the observed data were evaluated, and comparisons made between the observed and predicted model results. For the observations, it was clear that a large amount of scatter was present in the data that overwhelmed any trends. Most of the trends present in the original default model results (see Section 3.2) were not as clearly pronounced in the observed values. For example, there was a general, all media inverse correlation demonstrated for lake area in the R-MCM default set-up lakes modeling work. However, this trend was present in the observed data only for methylmercury concentration in the epilimnion.

No pattern of mercury species concentration as a function of trophic status was evident in the observed results. For epilimnion methylmercury concentration, there was a possibly inverse correlation with pH, and an even stronger inverse correlation for fish tissue mercury concentrations with pH for the observed data. The other observed mercury species concentrations did not demonstrate similar trends. The R-MCM predicted much stronger mercury species correlations with pH than the observed results demonstrated.

The percent of total mercury that is methylmercury was calculated for all three media (epilimnion water, hypolimnion water, and sediment). The observed results showed a much wider range of values in the epilimnion than did the R-MCM predictions, while the opposite was true in the sediment. The maximum methylmercury percentage decreased from the epilimnion down to the sediment. The model was unable to predict the high observed maximum methylmercury percentage in the epilimnion, while it over-predicted the maximum methylmercury percentage in the hypolimnion sediment by a factor of 2. For the mean sediment methylmercury percentage, the R-MCM predicted a value that was half the observed value.

The results of the analysis within this section lead us to a few conclusions:

- Plotting observed results versus lake characteristics produced a lot of scatter and only a few weak trends;
- The range and maximum values for the epilimnion percent methylmercury are greater for the observed than the predicted values, whereas the range and maximum values for the sediment percent methylmercury are greater for the predicted than for the observed values;
- The R-MCM predicts a smaller mean percent methylmercury for the epilimnion than the observed results, but predicts a larger mean percent methylmercury for the hypolimnion and sediment;
- The observed mean percent methylmercury decreases with depth (epilimnion is largest, hypolimnion is in the middle, and sediment is the smallest), while the modeled mean percent methylmercury is greatest in the hypolimnion, followed by the epilimnion, with the sediment having the smallest value;
- The R-MCM predicts a mean epilimnion percent methylmercury of 8.6%, which is very similar to a literature-reported observed average for lakes, while our observed result, 21%, is more than twice this predicted value and is greater than or on the order of values reported for wetlands; and
- The hypolimnion and sediment mean methylmercury percentages are half those of the predicted. However, the predicted sediment value falls within a range of literature values for agricultural, background, or mixed agricultural and forested watersheds.

The scatter present in our data and the lack of the more obvious trends present in the R-MCM outputs underscore the complications of modeling these systems, and that simple trends relative to a few specific characteristics are not enough to classify and predict the various mercury species concentrations. The differences in the ranges of percent methylmercury values point towards more specific problems. The inability to cover the ranges necessary for the epilimnion suggests the possibility of two things. First, there may be additional methylmercury production occurring within the water body, resulting in the higher observed methylmercury percentages that are not modeled. That is, if the in-situ methylation rates were higher, or demethylation rates were lower in the model, then the predicted methylmercury percentage would be increased. The R-MCM, as it stands, may not currently be parameterized to completely capture the methylmercury transformation processes. Secondly, it is possible the methylmercury loading rate into the water body may be higher than is currently modeled. It is unlikely that this unaccounted-for mercury loading is coming directly from the atmosphere, because it is relatively well understood that the primary atmospheric loading is in the divalent inorganic mercury form (HgII). Therefore, a different loading source may need to be investigated. One possibility is that other methylmercury loading sources may be incoming rivers and streams or direct watershed runoff. That is to say, processes upstream and within the watershed may be increasing the methylmercury loading to the lakes. This latter hypothesis may be particularly applicable since we observed that the methylmercury percent was greatest in the epilimnion, and it is well understood that methylation of mercury occurs primarily in the sediment; recall that in our study the model is over-predicting the mean methylmercury percentage in the sediment, but under-predicting it in the epilimnion.

6.4 Watershed Influences and Loading

The R-MCM focuses primarily on those processes governing mercury fate and transport within the receiving water body, but uses a relatively simplistic approach to model the watershed loading to the water body. This is understandable because much attention has been focused on the mechanisms and chemistry affecting mercury behavior within a water body, and the major source of mercury to any water body was assumed to be via atmospheric deposition. The simplistic perception of the overall mercury transport process can be envisioned as atmospheric transport of mercury emissions to the atmosphere as elemental mercury and divalent mercury (and the oxidation-reduction reactions between the two in the atmosphere), deposition as divalent mercury to the water, and then transformation to methylmercury in major water body sediments. The processes governing the transformation and transport of mercury once it enters a water body are rigorously modeled in the R-MCM. However, the mechanics of loading to the system (*i.e.*, how the mercury actually enters the system) focuses primarily on atmospheric inputs, with a relatively simple methodology for quantifying the watershed mercury inputs.

The R-MCM doe account for both dry and wet deposition of atmospheric mercury to the water body. Both depositions are modeled as fluxes to the system (mass/area/time, in R-MCM, this is in ug/m^2/yr). Both deposition fluxes consist primarily of HgII. The R-MCM calculates the wet deposition input by multiplying the annual precipitation rate by the annual average concentration of HgII in the precipitation. The mercury flux of each is multiplied by the lake area and then added together to produce the total annual atmospheric mercury loading to the water body (mass/time).

The mercury loadings to the watershed system are calculated by using the total annual atmospheric mercury flux calculated for the water body multiplied by the watershed (or sub-watershed) area. The subsequent mercury loading to the water body from the watershed system is modeled as the summation of loadings from the local upland, local wetland, and upstream sources. The local upland term accounts for water that runs off the land surface and enters the lake directly without passing through streams, rivers, lakes, or wetlands. The local wetland is that portion of the catchment deemed a wetland that is directly adjacent to the lake being modeled. The total annual atmospheric mercury deposition flux acts upon the local wetland area and then is assumed to immediately enter the lake. The upstream sources represent the rest of the catchment, where atmospheric mercury deposits directly into upstream lakes, onto uplands that run off into upstream lakes and streams, and upstream wetlands that flow into upstream lakes and streams; all of these then flow into the lake being modeled. The total mercury loading to the lake being modeled from all of these other sources is calculated essentially as the sum of the products of the modeled water body's total annual atmospheric mercury loading rate times the ratio of each sub-catchment area (upstream lake, upland, upstream wetland) to the modeled lake surface area, a fraction that accounts for the amount of mercury that passes through each sub-catchment unit (upstream lake, upland, upstream wetland). The R-MCM variables describing that fraction of atmospherically loaded mercury that passes through each sub-catchment area (*i.e.*, terrestrial classification) are designated by a prefix and a suffix, and are referred-to here as the "outflow parameters."

The prefixes, "R1" and "R2," correspond to whether the mercury species of interest is methylmercury (R1) or HgII (R2). The suffixes "Up" and "Wet" refer to whether the mercury is passing through an upland (Up) or a wetland (Wet), respectively. The uplands includes the area of the watershed that contributes directly through run-off to the lake, but does not include upstream lakes and streams that flow directly into the lake. The variable R1Up refers to the fraction of atmospheric methylmercury that passes through the upland. R-MCM assigns default values to these outflow parameters depending on the hydrology of the lake. The outflow parameter default values are assigned as follows.

	Drainage Lake	Ground Water Fed Seepage Lake	Mounded Seepage Lake
R1Up	0.1	0.05	0
R1Wet	3	0.3	0
R2Up	0.1	0.05	0
R2Wet	0.35	0.1	0

This table includes the three different types of lake hydrology that R-MCM incorporates. All lake types receive input from precipitation. A "Drainage Lake" receives water has surface water inflows and outflows. A "Ground Water Fed Seepage Lake" receives water from ground water sources only. A "Mounded Seepage Lake" has all ground water flowing out of the lake. In the VT/NH study, almost all lakes were drainage lakes.

An interesting facet of this approach is that the methylmercury and the divalent mercury are modeled separately. That is, transformation between the two in the watershed is not directly taken into account. Rather, the watershed methylation of HgII into MeHg is taken into account by modeling R1Wet as greater than unity. Specifically, for R1Wet, the value of "3" for drainage lakes is used to account for the methylation known to occur in wetlands (see, for example, Krabbenhoft et al. (1999) or Kelly et al.

(1995)). Because the methylmercury loading from the atmosphere is quite low, changes in all R1 outflow parameters may have to be dramatic to adequately capture real-world increases in methylmercury loading to a lake from its watershed. If the transformation of HgII into MeHg in the watershed is an important process for MeHg loading to the lake, then the current R-MCM configuration may not adequately capture this process. Although, the mercury chemistry and transformation processes that the R-MCM currently incorporates are rigorous, unless the methylmercury loading term is accurately captured, then the R-MCM will not be able to capture the trends in mercury species concentrations present in the receiving water system.

In this section (Section 6.4), we investigate the effect of adjusting the values for the various watershed element outflow parameters. Essentially, a sensitivity analysis was performed to investigate how increases in the outflows of mercury from the various watershed elements in the receiving lake would impact the R-MCM results. In a "real-world sense," this could be explained as more properly accounting for possibly greater methylation of HgII in the VT and NH watersheds and resulting in increased loading of MeHg and HgII into the lakes.

6.4.1 Investigation of the Watershed Element Mercury Outflow Parameters

The mercury species loadings from the various watershed elements to the receiving lakes are dependent on the area of the catchment or element, the atmospheric mercury deposition to the catchment, and the fraction of the mercury deposited that leaves the catchment or element and enters the receiving water body being modeled. Assuming the atmospheric mercury depositions and sizes of the catchments or elements are fixed parameters, then the only parameters that can be adjusted are the fractions of the deposited mercury that leaves each catchment or element. These parameters (fractions) are labeled as outflow parameters, as described and defined in Section 6.4. Because the wetland fractional areas of the of VT and NH catchments are relatively small, the analysis in this section focused on adjusting the upland parameters, R1Up and R2Up. The concentration of HgII in precipitation is approximately fifty times greater than the amount of MeHg in precipitation. Furthermore, the amount of MeHg in dry deposition is almost one hundred times less than the amount of HgII. Hypothetically, then, if all the HgII that deposited onto the catchment were transformed into MeHg, then the amount of MeHg loading to the lake could increase between fifty and one hundred times. Therefore, as discussed previously in Section 6.4, the fraction of R1Up could be greater than unity, indeed, as suggested here, it could be much greater than unity. Because HgII is the predominant deposition source, the fraction outflows of HgII would most likely always be less than unity. However, for sake of illustration, the test cases fractions herein were allowed to run in excess of unity for both R1Up and R2Up.

To perform the sensitivity analysis, ranges of R1Up and R2Up values were chosen. R-MCM currently assigns default values of 0.1 for both R1Up and R2Up. Because we were interested in how increases in loading from the watershed would impact the predicted lake mercury species concentration results, this value was chosen as the base case and the minimum value. The values chosen for the sensitivity runs were R1Up: 0.1, 1, 2, and 5 and R2Up: 0.1, 1, and 2. Using the R-MCM input variables for Tier 5, every combination of the R1Up and R2Up sensitivity run values was modeled to predict the epilimnion MeHg and HgT, hypolimnion MeHg and HgT, sediment HgT, and Fish

HgT lake concentrations. The predicted results for the VT and NH Lakes for these runs are presented in the appendix in Tables A-22 through A-27.

The predicted results for these runs are plotted against the observed values for all types of observations in Figures 6.28 through 6.33. The results are plotted in a grid fashion so that the R1Up values are constant on the vertical, and the R2Up values are constant along the horizontal. The y=x lines re plotted as dashed lines to graphically illustrate the model effectiveness for each combination of R1Up and R2Up values.

As would be expected, increasing R2Up had the greatest impact on increasing the mean predicted value of all mercury species concentrations. This is because the atmospheric deposition of HgII is much greater than MeHg and therefore a small increase in R2Up produces a large increase in total mercury load to the lake. For example, relative to the epilimnion methylmercury concentrations, holding R1Up = 0.1 constant, while increasing R2Up (the top row of Figure 6.28), there was a great increase in the scatter and range of the predicted values. (This scenario could account, crudely, for additional capture and storage of atmospheric mercury by the forest canopy and subsequent delivery to the forest floor and lake.) By holding R2Up=0.1 constant and increasing R1Up, the centroid of the data points moved upward and seemed to improve the modeling. An interesting aspect of this work was that all lakes did not increase equally. For some of the lakes, the data were seen to "jump up" quickly, while for other lakes the data remained in the cluster. For example, in the bottom left plot of Figure 6.28 (R1Up = 5, R2Up = 0.1), there is one lake in excess of 2.5 ng/L that was not so dramatically greater than the other lakes in the top left plot (R1Up = 0.1, R2Up = 0.1). A possible physical explanation of this phenomenon is that the size of the watershed is directly correlated to the amount of increase in loading as the RUp values are increased. Similarly, the size of the lake in relation to that of the watershed, as well as the flushing rate of the lake, will also have an impact on the amount of increase in predicted mercury species concentrations. This suggests that the physical, chemical, and biological aspects of the watershed and receiving water body all can impact the susceptibility of a lake to increases in mercury loading, while at the same time allowing others to be better buffered against increased loads. For the epilimnion total mercury concentrations, increases in R2Up at constant R1Up resulted in dramatic increases in the centroid of the data, but not an improvement in model performance.

Hypolimnion mercury species concentrations have a large bias in mercury concentrations, and that the R-MCM is having great difficulty predicting the large observed values (see Chapters 4 and 5). For the hypolimnion, increasing R2Up seemed to produce more improvement in model predictability for the total mercury than for the methylmercury concentrations.

Figure 6.32 presents the fish tissue concentrations. The fish tissue observations and predicted values have a large amount of scatter. From these runs, it was difficult to discern if there was any improvement by adjusting either of the watershed outflow parameters (*i.e.*, R1Up or R2Up). For the sediment concentrations, the large amount of under-prediction in the sediment total mercury concentrations was corrected by increasing R2Up at constant R1Up.

To get a better quantitative understanding of what possible improvements could be achieved by adjusting the R1Up and R2Up values, an interpolation of the data points was made. Using a cubic linear interpolation algorithm (Matlab v. 6, Mathworks, Inc.), the error sums of squares and associated standard deviation were plotted with a resolution of 100 points. From this interpolation, the minimum value for each was determined, and the R1Up and R2Up values associated with these minima were extracted. Figures 6.34 and 6.35 illustrate the shapes of these surfaces. From these surfaces, the sensitivity of the results to R2Up is obvious. Increasing R2Up for epilimnion MeHg and HgT, hypolimnion MeHg, fish tissue HgT, and sediment HgT concentrations all resulted in a general increase in the error sums of squares and associated standard deviations. There were some instances where the sum of squares first decreased, but in most instances there was a large increase as R2Up approached 2. The most noticeable difference was seen for the hypolimnion HgT concentration where there appeared to be more improvement with and sensitivity to R2Up rather than R1Up.

The surface minima values and associated R1Up and R2Up values are presented in Table 6.7. To improve the results, outlying lakes were removed from the epilimnion MeHg and HgT and the hypolimnion MeHg concentration data sets (see Table 6.7 for details on removed data). The refined surface minima and associated R1Up and R2Up values determined after these lakes were removed are also included in Table 6.7. A note on the removal of these outliers is necessary at this point. It is believed that the removed lakes may provide useful information on the reasons why the R-MCM is having difficulty and why these lakes may be greatly over- or under-predicted. However, their great distance from the y=x line resulted in too great an influence on the calculated standard deviations and error sums of squares. Therefore, they were removed to allow the investigation to be more evenly influenced by the other lakes in the study.

From the shape of the surfaces (Figures 6.34 and 6.35) and the estimated minima in Table 6.7, the results suggest that an increased mercury loading from the watershed may improve the overall modeling effort. The first thing that is seen is that for Epilimnion MeHg and HgT, hypolimnion MeHg, and fish tissue HgT concentrations, the R2Up value is best left at the default value of around 0.1. However, the R1Up value appears to be about a factor of 45 too low. This suggests the possibility that watershed loading is having an important influence on the overall R-MCM performance relative to predicting lake mercury species concentrations for our 91 lakes. Additionally, this may point towards the specific issue why methylmercury is not being adequately modeled by the R-MCM at all. Lastly, the removal of outliers from our observed data sets resulted in even larger values for the optimum R1Up for the epilimnion predicted mercury species concentrations, although there was a slightly smaller optimum value produced for the hypolimnion methylmercury concentration prediction. The removal of these outliers improved the modeling and decreased the estimated standard deviation of the results.

The results of this analysis were not intended to suggest what the best default values for R1Up and R2Up should be, but rather to investigate whether changes in mercury outflow parameters from the various watershed elements could improve R-MCM predictions in the receiving lake. Our results point towards the possibility that methylmercury production (via HgII transformation) within the watershed may be an important process that should be better modeled. We therefore believe that the modeling of watershed element mercury loadings to a water body (lake) needs to be improved before more accurate predictions via R-MCM can be made for the various mercury species concentrations in the water body.

7 CONCLUSIONS

In this report we used the R-MCM to predict mercury species concentrations in the epilimnion, hypolimnion, sediment, and fish tissue for a large array of lakes in the New England region of the United States. This is the first time that the R-MCM has been applied to such a large data set of lakes. This is also the first time that the R-MCM has been applied to lakes in New England. Therefore, this modeling effort, in effect, evaluated how robust the R-MCM is when applied to lakes in an environment and watershed ecosystems similar to those found in Vermont and New Hampshire. In particular, this extends the boundaries of mercury cycling modeling by evaluating how well the R-MCM is able to model mercury species concentrations for lakes in mountainous watersheds where the lakes range from acidic to alkaline and from oligotrophic to dystrophic. The R-MCM was originally developed for oligotrophic, acidic, seepage lakes in the mid-western state of Wisconsin. By taking the original R-MCM as is and applying it to a different region, our evaluation, therefore, probed into the processes governing mercury cycling in a different watershed system and allowed for mechanistic inference on the governing processes of mercury cycling science.

From our review of the visual inspections and statistical evaluations of all 91 modeled lakes as a whole and the lakes grouped via their characteristics, it is clear that the modeling of mercury in watersheds is a complicated problem. There were clear successes and failures that the R-MCM encountered while modeling these 91 lakes. One conclusion reached immediately was that the R-MCM has difficulty translating directly to a new environment. No calibration methods were undertaken in our evaluation because that was the not the specific goal of this study. The goal was to evaluate the level of success that could be gained by applying the original R-MCM directly to a new environment, specifically the New England region of the United States.

First, the R-MCM was applied using the simplest and front-most user interface. Next, the question was asked that if the model does not succeed using the simpler user interface, then what types of parameters are needed or need to be adjusted to improve model accuracy. Similarly, we asked how much accuracy is gained by providing certain additional information for each lake and watershed. Indeed, can the R-MCM reach a point with parameter refinement that would result in a strong model? Does the R-MCM require region-specific calibration or lake-specific calibration? These are the questions that our research set out to address. With this in mind, it is the ultimate goal to develop a process-based, watershed-lake model that will be robust enough to be applicable to different regions. Therefore, this study is viewed as the first step in a very challenging journey.

In this report, we have provided a rigorous analysis of the model using both visual inspection and a suite of statistical methods. With such a large number of lakes and such a large number of observed variables, it becomes challenging to sort through all the data and model results and retrieve a clear picture. We therefore have tried to separate the pieces so that they can be synthesized into the clearest results possible.

From the first general inspection, it became clear that using the default case resulted in a wide scatter of predicted concentrations. This scatter was reduced in the Tier case analysis. In fact, the amount of scatter was greatly reduced simply by overriding the default inputs and using the measured inputs as done in the Tier 1 case (*i.e.*, for pH, lake size, hypolimnion surface area, residence time and water column DOC). This seems to suggest that the model is sensitive to these input variables, and therefore it is worthwhile to invest time and effort in making these measurements. However, despite an apparent decrease in the predictive scatter, a closer inspection revealed that the predicted values were merely generally decreased across the board. Regardless of the observed value, most predicted concentrations decreased. This suggests a decrease in the range of R-MCM predictability when more refined values are used for the inputs.

Because of the decrease in scatter from the default case to the Tier 1 scenario, it was originally thought that it might be worthwhile to investigate if the shift were caused by one specific input parameter, by a combination of the input parameters, or only by all in consort. However, because there was still a significant amount of error and bias associated with the modeled results, these questions were not investigated. Obviously, investigating different combinations and individual parameters for the six measured mercury species concentrations predictions would be time intensive, and the value of that work is not completely clear. We therefore focused on the progression of model improvement achieved in the Tiers as outlined in Table 2.3 and described in the associated text.

Visual inspection of the Tier results was combined with the statistical evaluation using error sum of squares. The visual inspection indicated a decrease in prediction scatter in going from the default case to the Tier 1 scenario. However, calculating the error sum of squares revealed that this move did not provide much, if any, reduction in error. These general evaluation methods suggested that as a whole, the R-MCM performance did not improve across the Tiers. This caused us to not focus on individual improvements from Tier to Tier. It seemed evident that the R-MCM was having difficulties being applied to the VT and NH region, and, therefore, it became important to investigate where the strengths and weaknesses of the R-MCM lay so that each could be further investigated and understood. This led us to an evaluation of the R-MCM performance as a function of lake type and characteristics.

Evaluating the R-MCM by lake type helped to sort out some of the model successes and inadequacies. A visual analysis, combined with the t-test and chi-square test showed that the R-MCM did relatively well modeling alkaline lakes. This was a curious result because the model was designed with acidic lakes in mind. However, results have suggested that there may be a correlation between mercury species concentration and lake acidity. Therefore, the success of R-MCM in modeling alkaline lakes may correspond to simpler modeling processes, where the mass balance approach that R-MCM uses is successful. The greater difficulty in modeling acidic and circumneutral lakes points to processes that may not be adequately incorporated into the R-MCM.

The statistical analyses for lakes separated by characteristics provided further insight into the model's behavior. Alkaline lakes were the only type that passed the chi-square test, but the t-test showed that alkaline lakes had a bias towards under-prediction. Without the additional information of the t-test, this bias would not have been detected. Acidic and circumneutral lakes did not pass the chi-square test, but had mean error residuals of zero.

Alkaline lakes were also found to have the smallest maximum errors. The other statistical techniques pointed out the general tendency of the R-MCM to under-predict for these lakes. Unfortunately, the various statistical techniques did not separate out enough information to proclaim that the R-MCM could adequately model any specific type of lake. Going into the analysis, it was hoped that at least a certain type of lake or types of lakes could be certified as being adequately modeled by the R-MCM, but this was not found to be the case.

Due to the tendency of the R-MCM to under-predict the lake mercury species concentrations and the very large maximum errors noted (and the poor results of the model efficiency test, namely that the mean observed value was found to be a better predictor than the model for most lake variables), an investigation was made on the R-MCM sensitivity to the various lake mercury loss processes. Specific investigations of the photoreduction rate and particle settling velocity did not elucidate the under-prediction problems with the R-MCM. Specifically, R-MCM performance was not found to improve by reducing these loss rates (the predicted concentrations did not increase enough to effectively improve the model).

Lastly, the observed data were investigated for trends as a function of lake characteristics and compared to the trends that could be seen in the R-MCM predictions. The predicted data generally followed the attributes that would be expected for specific lake characteristics, while the observed data had too much scatter to discuss any possible trends. This was discouraging because it points to the fact that mercury modeling in these systems is even more complicated than expected. So many factors are at play in these systems that it appears more research and modeling are required to capture all the relevant fate processes. If this is not done, then large errors will need to be accepted with the R-MCM – or that require an appreciable amount of calibration for each system investigated will be required.

Percent total mercury as methylmercury was isolated as an indicator of the methylation rate of a given system. Because it is methylmercury that is being transferred through the food chain and accumulating in fish and wildlife, methylmercury concentrations in the various watershed and lake compartments are of particular interest. The extent of methylation can be investigated by looking at the percent total that is methylmercury. The present methylmercury was calculated for all observed and predicted data in the epilimnion, hypolimnion and sediment. From these calculations, it was found that the observed epilimnion percent methylmercury values spanned a much greater range than did the predicted values. The observed maximum percent methylmercury clearly decreased from epilimnion to hypolimnion to sediment, while the predicted maximums of percent methylmercury were not much different for these different media. The predicted mean percent methylmercury in the epilimnion was much smaller than the observed, while the observed was smaller than the predicted in the hypolimnion and in the sediments. It is generally believed that methylation of mercury occurs in the sediments, so it was strange to see a gradient in percent methylmercury in the water column that was in an opposite direction from the assumed source. This seems to imply that the source of methylmercury in these lake systems may be coming from more watershed related sources. This is not to discount the methylation processes occurring in the sediments. Clearly, the percent methylmercury in the sediments is important, but the dominant source may be watershed loading.

Further investigation into the impact of mercury watershed loading processes was performed by evaluating the various watershed loading outflow parameters. Through sensitivity analysis of these parameters it was found that the R-MCM error in the lake modeling could be improved by greatly increasing the amount of methylmercury loading from the watershed into the lake. Research results have suggested that litterfall and transformation of mercury in watersheds may be more important than previously thought, and our analysis lends support to this theory.

In conclusion, this report evaluates a currently accepted model (the R-MCM) for predicting various mercury species concentrations in a lake water column, sediments and fish populations within a regional set of lakes. Our analysis shows that the R-MCM model has difficulty in prediction without some level of calibration. Therefore, the R-MCM cannot be directly applied to a new region of lakes without calibration. An investigation of whether certain types of lakes would be able to be adequately modeled using the R-MCM as is was found to be fruitless. It seems for the VT and NH lakes that the watershed mercury loading and influence may be a critical factor. Because the R-MCM does not have a rigorous mercury watershed loading module, it is believed that this is an important area of research that needs to be developed. It is possible that improvements in watershed mercury modeling could interfaced with the water body (lake) modeling capability of R-MCM to create a more robust model for successfully modeling mercury in watersheds and water bodies without site-specific calibration.

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TABLES

Table 2.1. Lake Categories and Characteristics

<table>
<tr><th>Category</th><th colspan="7">Characteristic</th></tr>
<tr><td>Acidity</td><td colspan="2">Acidic</td><td colspan="3">Circumneutral</td><td colspan="2">Alkaline</td></tr>
<tr><td>Lake Stratification</td><td colspan="3">Stratified</td><td colspan="4">Well-Mixed</td></tr>
<tr><td>Lake Size (Area)</td><td colspan="2">Small (10 ha)</td><td colspan="3">Medium (1 km^2)</td><td colspan="2">Large (25 km^2)</td></tr>
<tr><td>Hydrology</td><td colspan="2">Drainage Lake</td><td colspan="3">Groundwater Fed Seepage Lake</td><td colspan="2">Mounded Seepage</td></tr>
<tr><td>Trophic State</td><td>Oligotrophic</td><td colspan="3">Mesotrophic</td><td colspan="2">Eutrophic</td><td>Dystrophic</td></tr>
</table>

Notes:
Italics: No VT NH lakes of this type in this study.
Summer anoxia: included as a category in the R-MCM default set up, but the rates and processes associated with summer anoxia are currently unavailable in R-MCM. The model therefore defaults to no anoxia.

Table 2.2. Lake Names and Input Characteristics for Default Set-Up.

LAKE NAME	Acidity	Stratification	Lake Size	Hydrology	Trophic Status
ADDER POND	Acidic	Stratified	Small	Eutrophic	Acidic
ARMINGTON LAKE	Circumneutral	Stratified	Medium	Oligotrophic	Circumneutral
BAKER (BARTON)	Alkaline	Stratified	Small	Eutrophic	Alkaline
BAKER POND- UPPER	Circumneutral	Well-Mixed	Medium	Mesotrophic	Circumneutral
BEARCAMP POND	Circumneutral	Stratified	Medium	Dystrophic	Circumneutral
BRANCH	Acidic	Stratified	Small	Dystrophic	Acidic
BRUCE	Circumneutral	Well-Mixed	Small	Dystrophic	Circumneutral
CAWLEY POND	Circumneutral	Well-Mixed	Small	Mesotrophic	Circumneutral
CHASE POND	Circumneutral	Well-Mixed	Small	Dystrophic	Circumneutral
CHILDS BOG	Circumneutral	Well-Mixed	Small	Mesotrophic	Circumneutral
CHITTENDEN	Circumneutral	Stratified	Medium	Mesotrophic	Circumneutral
CLUB POND	Acidic	Well-Mixed	Small	Dystrophic	Acidic
CRANBERRY MEADOW	Alkaline	Stratified	Small	Mesotrophic	Alkaline
CURTIS	Alkaline	Stratified	Small	Eutrophic	Alkaline
DENNIS	Circumneutral	Well-Mixed	Medium	Dystrophic	Circumneutral
DUNMORE	Circumneutral	Stratified	Medium	Oligotrophic	Circumneutral
DUTCHMAN POND	Acidic	Well-Mixed	Small	Oligotrophic	Acidic
EASTMAN POND	Circumneutral	Stratified	Medium	Eutrophic	Circumneutral
ECHO (CHARTN)	Alkaline	Stratified	Medium	Oligotrophic	Alkaline
ECHO (HUBDTN)	Alkaline	Stratified	Small	Mesotrophic	Alkaline
ELM BROOK POOL	Circumneutral	Well-Mixed	Medium	Mesotrophic	Circumneutral
FERN	Alkaline	Stratified	Small	Mesotrophic	Alkaline
FISH POND	Alkaline	Well-Mixed	Small	Dystrophic	Alkaline
FREESES POND- UPPER	Circumneutral	Well-Mixed	Small	Eutrophic	Circumneutral
GILES POND	Circumneutral	Well-Mixed	Small	Oligotrophic	Circumneutral
GREAT HOSMER	Alkaline	Stratified	Medium	Eutrophic	Alkaline
GREENWOOD POND	Alkaline	Well-Mixed	Small	Eutrophic	Alkaline
HALL POND- UPPER	Acidic	Stratified	Small	Dystrophic	Acidic
HARDWICK	Alkaline	Well-Mixed	Medium	Eutrophic	Alkaline
HARDWOOD	Circumneutral	Well-Mixed	Small	Dystrophic	Circumneutral
HIGH (SUDBRY)	Alkaline	Stratified	Small	Eutrophic	Alkaline
HILDRETH DAM POND	Circumneutral	Stratified	Small	Mesotrophic	Circumneutral
HORN POND	Circumneutral	Stratified	Medium	Oligotrophic	Circumneutral
HORTONIA	Alkaline	Stratified	Medium	Mesotrophic	Alkaline
HOWE RESERVOIR	Acidic	Well-Mixed	Medium	Dystrophic	Acidic
ISLAND POND	Acidic	Stratified	Medium	Dystrophic	Acidic
IVANHOE- LAKE	Circumneutral	Well-Mixed	Medium	Oligotrophic	Circumneutral
JACKSONVILLE	Circumneutral	Well-Mixed	Small	Dystrophic	Circumneutral
JENNESS POND	Circumneutral	Stratified	Medium	Oligotrophic	Circumneutral
KENT	Alkaline	Well-Mixed	Small	Mesotrophic	Alkaline
LARY POND	Circumneutral	Well-Mixed	Small	Eutrophic	Circumneutral
LEFFERTS	Circumneutral	Well-Mixed	Small	Mesotrophic	Circumneutral
LILY POND	Acidic	Well-Mixed	Small	Eutrophic	Acidic
LITTLE AVERILL	Alkaline	Stratified	Medium	Oligotrophic	Alkaline
LONG (WESTMR)	Alkaline	Stratified	Small	Oligotrophic	Alkaline

LAKE NAME	Acidity	Stratification	Lake Size	Hydrology	Trophic Status
LOON LAKE	Acidic	Stratified	Small	Oligotrophic	Acidic
LOVELL LAKE- STN 1	Circumneutral	Stratified	Medium	Mesotrophic	Circumneutral
LYFORD	Alkaline	Stratified	Small	Mesotrophic	Alkaline
MANSFIELD	Acidic	Stratified	Small	Dystrophic	Acidic
MCCONNELL	Circumneutral	Stratified	Small	Dystrophic	Circumneutral
MILLSFIELD POND	Circumneutral	Well-Mixed	Medium	Dystrophic	Circumneutral
MILTON	Circumneutral	Well-Mixed	Small	Mesotrophic	Circumneutral
MINARDS	Circumneutral	Stratified	Small	Mesotrophic	Circumneutral
MITCHELL	Alkaline	Well-Mixed	Small	Oligotrophic	Alkaline
MOOSE POND	Circumneutral	Well-Mixed	Small	Dystrophic	Circumneutral
MOUNTAIN LAKE- UPPER	Circumneutral	Well-Mixed	Small	Dystrophic	Circumneutral
NEWARK	Alkaline	Stratified	Medium	Oligotrophic	Alkaline
NORTH (BRKFLD)	Alkaline	Stratified	Small	Mesotrophic	Alkaline
NOTCH	Circumneutral	Stratified	Small	Dystrophic	Circumneutral
NOYES	Circumneutral	Well-Mixed	Small	Dystrophic	Circumneutral
PARAN	Alkaline	Well-Mixed	Small	Mesotrophic	Alkaline
PARKER	Alkaline	Stratified	Medium	Mesotrophic	Alkaline
PAUGUS BAY- STN 1	Circumneutral	Stratified	Medium	Mesotrophic	Circumneutral
PAWTUCKAWAY LAKE	Circumneutral	Stratified	Medium	Dystrophic	Circumneutral
PEMIGEWASSET LAKE	Circumneutral	Stratified	Medium	Dystrophic	Circumneutral
PERCH (BENSON)	Alkaline	Stratified	Small	Mesotrophic	Alkaline
PLEASANT VALLEY	Alkaline	Well-Mixed	Small	Mesotrophic	Alkaline
POUT POND	Circumneutral	Well-Mixed	Small	Eutrophic	Circumneutral
POWWOW POND	Circumneutral	Stratified	Medium	Dystrophic	Circumneutral
ROBB RESERVOIR	Acidic	Well-Mixed	Medium	Dystrophic	Acidic
ROUND POND	Circumneutral	Stratified	Small	Oligotrophic	Circumneutral
SABIN	Alkaline	Stratified	Medium	Mesotrophic	Alkaline
SHAWS POND	Alkaline	Well-Mixed	Small	Oligotrophic	Alkaline
SILVER LAKE	Acidic	Stratified	Medium	Oligotrophic	Acidic
SOMERSET	Acidic	Stratified	Medium	Mesotrophic	Acidic
SOUTH AMERICA	Circumneutral	Well-Mixed	Small	Dystrophic	Circumneutral
SPRUCE POND	Acidic	Stratified	Small	Eutrophic	Acidic
STRATTON	Circumneutral	Well-Mixed	Small	Mesotrophic	Circumneutral
SUNCOOK POND- UPPER	Circumneutral	Stratified	Medium	Dystrophic	Circumneutral
SUNRISE LAKE	Circumneutral	Well-Mixed	Medium	Mesotrophic	Circumneutral
SUNSET (BRKFLD)	Alkaline	Stratified	Small	Mesotrophic	Alkaline
TRIO PONDS- ONE AND TWO	Acidic	Stratified	Small	Dystrophic	Acidic
TUTTLE (HARDWK)	Alkaline	Well-Mixed	Small	Eutrophic	Alkaline
UNNAMED POND	Acidic	Well-Mixed	Small	Dystrophic	Acidic
WALKER POND	Circumneutral	Stratified	Medium	Dystrophic	Circumneutral
WILLEY POND- BIG	Acidic	Well-Mixed	Small	Oligotrophic	Acidic
WILLEY POND- LITTLE	Alkaline	Well-Mixed	Small	Oligotrophic	Alkaline
WILLOUGHBY	Alkaline	Stratified	Medium	Oligotrophic	Alkaline
WILSON POND	Circumneutral	Well-Mixed	Small	Mesotrophic	Circumneutral
WOLCOTT	Circumneutral	Stratified	Small	Dystrophic	Circumneutral
ZEPHYR LAKE	Circumneutral	Stratified	Small	Mesotrophic	Circumneutral

Table 2.3. Tiers 1 through 5 and their Associated Default Input Values and Lake Characteristics

Tier	Parameter	Lake Characteristic	Default Value
Tier 1	pH	Acidic	5.3
		Circumneutral	6.5
		Alkaline	8
	Lake Size (Surface Area)	Small	10 ha
		Medium	1 km^2
	Hypolimnion Surface Area	Small	25,000 m^2
		Medium	50,000 m^2
	Residence Time	Small	6 months
		Medium	2 years
	Water Column DOC	Oligotrophic	3 mg/L
		Mesotrophic	7 mg/L
		Eutrophic	15 mg/L
		Dystrophic	20 mg/L
Tier 2 and 3	HgII concentration in precipitation	n/a	10 ug/m^3
	Mean annual dry deposition rate of HgII	n/a	3.5 ug $HgII/m^2/yr$
	Precipitation Rate	n/a	0.8 m/yr
Tier 4	Total Catchment Ratio	n/a	10
	Wetland Fraction	n/a	0.15
	Lake Cover Fraction	n/a	0.05
Tier 5	Epilimnion Depth	Small lake	3 m
		Medium Lake	8 m
	Hypolimnion Depth	Small Lake	3 m
		Medium Lake	5 m

Table 2.4. Parameter Updates for Tier 1.

Lake Name	pH	Lake Surface Area [ha]	Hypolimnion Surface Area [ha]	Residence Time [yrs]	Epilimnion DOC [mg/L]	Hypolimnion DOC [mg/L]
ADDER POND	5.75	10.52	3.51	0.53	7.17	6.88
ARMINGTON LAKE	6.26	57.55	19.18	0.59	2.79	
BAKER (BARTON)	7.32	20.64	6.88	0.31	10.10	6.50
BAKER POND- UPPER	6.7	75.07	25.02	0.13	4.02	
BEARCAMP POND	6.61	67.58	22.53	0.15	4.45	4.38
BRANCH	4.6	13.76	4.59	0.50	4.63	6.07
BRUCE	7.05	10.93	3.64	0.14	5.40	
CAWLEY POND	6.53	10.00	3.33	0.01	3.53	
CHASE POND	6.17	15.78	5.26	0.01	4.75	
CHILDS BOG	6.09	42.65	14.22	0.71	2.56	
CHITTENDEN	6.98	284.10	94.70	0.72	3.05	3.66
CLUB POND	5.84	13.15	4.38	0.05	5.94	
CRANBERRY MEADOW	7.47	11.33	3.78	0.07	2.61	
CURTIS	7.42	29.14	9.71	0.47	3.02	2.63
DENNIS	6.82	74.87	24.96	0.04	5.24	
DUNMORE	7.17	398.63	132.88	1.15	2.55	
DUTCHMAN POND	5.86	11.29	3.76	0.71	3.40	
EASTMAN POND	6.93	135.57	45.19	0.30	3.52	4.30
ECHO (CHARTN)	7.44	222.59	74.20	1.05	2.70	2.10
ECHO (HUBDTN)	7.97	21.85	7.28	1.96	2.68	2.24
ELM BROOK POOL	6.37	86.52	28.84	0.00	5.30	
FERN	7.52	27.92	9.31	0.97	3.12	2.69
FISH POND	7.4	8.09	2.70	0.05	8.30	
FREESES POND- UPPER	5.9	11.09	3.70	0.01	5.40	
GILES POND	6.77	12.95	4.32	0.01	2.68	
GREAT HOSMER	7.52	56.66	18.89	1.79	6.45	2.74
GREENWOOD POND	7.62	20.03	6.68	0.71	3.02	
HALL POND- UPPER	5.8	9.19	3.06	0.67	4.20	3.80
HARDWICK	7.65	58.68	19.56	0.01	3.20	
HARDWOOD	6.13	17.81	5.94	0.45	4.72	
HIGH (SUDBRY)	7.46	8.09	2.70	2.00	2.77	2.74
HILDRETH DAM POND	6.61	15.18	5.06	0.06	4.30	3.80
HORN POND	6.33	80.13	26.71	0.12	3.58	2.52
HORTONIA	7.8	193.85	64.62	1.67	3.03	2.44
HOWE RESERVOIR	5.83	104.33	34.78	0.16	4.97	
ISLAND POND	5.6	63.94	21.31	0.00	5.45	5.94
IVANHOE- LAKE	6.04	50.18	16.73	2.00	2.80	
JACKSONVILLE	6.11	8.09	2.70	0.01	5.08	
JENNESS POND	6.11	94.09	31.36	0.63	2.81	
KENT	7.64	40.07	13.36	0.10	3.30	
LARY POND	6.4	12.54	4.18	0.04	6.30	
LEFFERTS	6.37	22.26	7.42	0.02	2.94	
LILY POND	5.87	33.79	11.26	0.77	6.25	
LITTLE AVERILL	7.32	188.99	63.00	3.70	9.00	2.59
LONG (WESTMR)	7.54	36.42	12.14	1.59	1.92	1.53
LOON LAKE	5.7	45.28	15.09	0.50	3.52	
LOVELL LAKE- STN 1	6.9	217.72	72.57	1.67	3.08	

Lake Name	pH	Lake Surface Area [ha]	Hypolimnion Surface Area [ha]	Residence Time [yrs]	Epilimnion DOC [mg/L]	Hypolimnion DOC [mg/L]
LYFORD	7.92	13.36	4.45	0.42	3.94	3.22
MANSFIELD	5.87	14.16	4.72	0.11	4.00	
MCCONNELL	6.3	35.21	11.74	0.06	8.66	
MILLSFIELD POND	6.53	65.07	21.69	0.11	5.17	
MILTON	7.23	9.71	3.24	0.42	3.52	
MINARDS	6.79	18.62	6.21	2.50	2.06	1.91
MITCHELL	7.91	11.33	3.78	0.50	3.60	
MOOSE POND	6.56	15.01	5.00	0.07	7.20	
MOUNTAIN LAKE- UPPER	6.72	12.14	4.05	0.06	4.46	
NEWARK	7.83	61.92	20.64	1.92	3.03	2.57
NORTH (BRKFLD)	7.81	9.71	3.24	0.08	3.10	
NOTCH	6.01	8.90	2.97	0.19	10.91	8.36
NOYES	6.96	15.78	5.26	0.03	6.00	
PARAN	7.92	16.19	5.40	0.03	3.07	
PARKER	7.9	101.18	33.73	0.58	3.26	2.61
PAUGUS BAY- STN 1	6.05	493.72	164.57	0.11	2.30	2.10
PAWTUCKAWAY LAKE	6.45	364.22	121.41	0.45	5.46	5.55
PEMIGEWASSET LAKE	6.18	97.61	32.54	0.36	4.32	4.82
PERCH (BENSON)	7.3	9.71	3.24	2.78	2.88	2.78
PLEASANT VALLEY	7.35	10.12	3.37	0.17	1.89	
POUT POND	6.06	11.49	3.83	0.43	3.60	
POWWOW POND	6.11	99.76	33.25	0.02	9.30	10.11
ROBB RESERVOIR	5.49	50.71	16.90	0.03	8.17	
ROUND POND	6.61	40.47	13.49	0.50	3.42	
SABIN	7.46	57.47	19.16	0.17	2.50	2.15
SHAWS POND	6.73	25.09	8.36	0.36	3.10	3.28
SILVER LAKE	7.38	134.64	44.88	5.00	1.86	1.55
SOMERSET	5.88	634.57	211.52	0.62	3.53	3.22
SOUTH AMERICA	5.17	11.74	3.91	0.09	7.80	
SPRUCE POND	5.15	9.39	3.13	1.43	8.33	
STRATTON	6.08	18.62	6.21	0.83	3.70	
SUNCOOK POND- UPPER	7.63	140.26	46.75	0.13	3.32	4.10
SUNRISE LAKE	5.91	103.96	34.65	0.50	4.09	
SUNSET (BRKFLD)	6.63	10.12	3.37	0.02	3.78	2.66
TRIO PONDS- ONE AND TWO	5.43	27.44	9.15	0.50	5.85	5.27
TUTTLE (HARDWK)	7.35	8.50	2.83	0.08	6.30	
UNNAMED POND	4.89	8.09	2.70	0.07	6.22	
WALKER POND	6.6	70.46	23.49	0.31	4.15	3.85
WILLEY POND- BIG	4.82	19.22	6.41	0.31	0.35	
WILLEY POND- LITTLE	4.7	13.15	4.38	0.34	0.72	
WILLOUGHBY	7.67	668.97	222.99	9.09	1.95	1.84
WILSON POND	6.5	32.54	10.85	0.29	3.55	
WOLCOTT	6.41	29.95	9.98	0.38	5.38	4.61
ZEPHYR LAKE	6.33	12.50	4.17	0.33	3.38	3.66

Table 2.5. Parameter Updates for Tier 3.

Lake Name	Mean HgII Conc [ug/m^3]	Mean Precipitation [cm/yr]	RGM1% [ug/m^2/yr]
ADDER POND	6.96	106.04	6.88
ARMINGTON LAKE	7.10	97.34	6.33
BEARCAMP POND	6.94	116.21	6.53
BRANCH	7.23	131.05	8.30
BRUCE	7.05	103.38	6.05
CAWLEY POND	6.96	103.25	6.49
CHASE POND	7.00	105.40	5.97
CHILDS BOG	7.20	110.63	7.82
CLUB POND	7.05	107.45	7.84
CRANBERRY MEADOW	6.97	99.01	6.76
CURTIS	6.97	98.79	6.25
DUNMORE	7.10	99.67	7.07
DUTCHMAN POND	7.03	108.83	5.54
EASTMAN POND	7.06	100.47	6.07
ELM BROOK POOL	6.98	106.64	3.43
FERN	7.11	100.17	6.77
FISH POND	7.13	104.66	6.40
FREESES POND- UPPER	7.24	106.62	6.49
GILES POND	6.94	102.58	5.92
GREAT HOSMER	7.00	103.39	5.41
HALL POND- UPPER	6.99	116.63	6.14
HARDWOOD	6.98	103.22	5.59
HILDRETH DAM POND	7.07	96.73	6.30
HORN POND	7.03	115.89	3.64
HORTONIA	7.18	96.84	6.54
HOWE RESERVOIR	7.20	113.05	7.58
IVANHOE- LAKE	7.02	116.02	5.83
JACKSONVILLE	7.21	127.86	7.53
JENNESS POND	7.16	105.44	6.36
KENT	7.14	108.91	8.00
LARY POND	7.04	99.52	6.99
LEFFERTS	7.15	108.43	8.64
LILY POND	7.16	112.98	3.77
LITTLE AVERILL	7.17	106.23	7.37
LONG (WESTMR)	7.11	107.77	7.34
LOON LAKE	6.98	105.08	6.07
LYFORD	7.02	103.88	5.15
MANSFIELD	6.98	103.74	8.74
MCCONNELL	7.15	103.06	7.70
MILLSFIELD POND	7.07	104.84	8.31
MILTON	7.01	94.82	7.49
MINARDS	7.16	101.95	5.68
MOOSE POND	7.06	105.71	8.20
MOUNTAIN LAKE- UPPER	7.13	92.38	6.49
NEWARK	7.12	107.33	5.95
NOTCH	7.16	103.10	7.76
NOYES	7.05	98.22	8.15

Lake Name	Mean HgII Conc [ug/m^3]	Mean Precipitation [cm/yr]	RGM1% [ug/m^2/yr]
PARAN	7.27	109.78	6.69
PAUGUS BAY- STN 1	6.96	100.79	4.31
PAWTUCKAWAY LAKE	7.22	108.25	4.81
PEMIGEWASSET LAKE	6.96	102.24	5.77
PERCH (BENSON)	7.18	96.82	6.86
PLEASANT VALLEY	7.20	116.97	7.43
POUT POND	7.07	97.09	5.66
POWWOW POND	7.14	113.93	4.28
ROBB RESERVOIR	7.16	109.82	8.19
ROUND POND	7.22	109.65	4.29
SABIN	6.97	97.48	6.81
SHAWS POND	7.01	111.18	6.52
SILVER LAKE	7.21	110.68	6.58
SOUTH AMERICA	7.17	102.58	8.43
SPRUCE POND	7.20	104.99	2.62
STRATTON	7.22	129.43	7.99
SUNRISE LAKE	7.09	110.35	7.12
TRIO PONDS- ONE AND TWO	7.11	110.24	8.72
TUTTLE (HARDWK)	7.00	101.76	4.17
UNNAMED POND	7.05	114.52	7.64
WALKER POND	6.95	106.73	5.73
WILLEY POND- BIG	7.17	109.47	6.76
WILLEY POND- LITTLE	7.17	109.47	7.34
WILSON POND	7.22	104.63	4.51
WOLCOTT	6.97	101.26	6.96
ZEPHYR LAKE	7.11	113.69	6.75

Table 2.6. Parameter Updates for Tier 4.

Lake Name	Total Catchment Ratio	Wetland Fraction	Lake Cover Fraction
ADDER POND	9.84	0.01	0.11
ARMINGTON LAKE	8.62	0.02	0.10
BAKER (BARTON)	27.22	0.02	0.06
BAKER POND- UPPER	32.12	0.02	0.03
BEARCAMP POND	45.17	0.03	0.02
BRANCH	8.71	0.09	0.20
BRUCE	12.67	0.05	0.14
CAWLEY POND	304.45	0.02	0.04
CHASE POND	229.87	0.03	0.08
CHILDS BOG	7.50	0.03	0.09
CHITTENDEN	13.50	0.02	0.12
CLUB POND	54.00	0.09	0.03
CRANBERRY MEADOW	67.04	0.05	0.10
CURTIS	11.74	0.02	0.14
DENNIS	27.85	0.11	0.02
DUNMORE	12.27	0.04	0.13
DUTCHMAN POND	3.10	0.04	0.24
EASTMAN POND	13.65	0.05	0.07
ECHO (HUBDTN)	9.07	0.02	0.13
ECHO (CHARTN)	26.61	0.01	0.27
ELM BROOK POOL	1,277.22	0.09	0.15
FERN	6.32	0.01	0.16
FISH POND	45.39	0.02	0.03
FREESES POND- UPPER	154.57	0.09	0.02
GILES POND	330.49	0.02	0.02
GREENWOOD POND	5.57	0.13	0.11
GREAT HOSMER	5.14	0.01	0.22
HALL POND- UPPER	8.02	0.02	0.08
HARDWICK	519.69	0.05	0.04
HARDWOOD	5.45	0.01	0.29
HIGH (SUDBRY)	7.65	0.00	0.14
HILDRETH DAM POND	102.17	0.02	0.01
HORN POND	57.11	0.02	0.15
HORTONIA	8.30	0.06	0.20
HOWE RESERVOIR	24.57	0.05	0.06
ISLAND POND	137.44	0.03	0.05
IVANHOE- LAKE	2.20	0.03	0.14
JACKSONVILLE	166.45	0.07	0.04
JENNESS POND	6.90	0.07	0.16
KENT	23.00	0.00	0.09
LARY POND	72.02	0.07	0.02
LITTLE AVERILL	5.11	0.04	0.18
LEFFERTS	68.35	0.04	0.06
LILY POND	2.61	0.09	0.16
LONG (WESTMR)	7.13	0.01	0.11
LOON LAKE	19.02	0.02	0.05
LOVELL LAKE- STN 1	4.60	0.02	0.17

Lake Name	Total Catchment Ratio	Wetland Fraction	Lake Cover Fraction
LYFORD	8.06	0.02	0.15
MANSFIELD	43.49	0.00	0.13
MCCONNELL	40.62	0.12	0.07
MILLSFIELD POND	39.60	0.01	0.03
MILTON	10.13	0.00	0.15
MINARDS	3.39	0.01	0.22
MITCHELL	165.14	0.01	0.05
MOOSE POND	19.71	0.00	0.04
MOUNTAIN LAKE- UPPER	70.83	0.02	0.01
NEWARK	2.62	0.00	0.31
NORTH (BRKFLD)	33.54	0.04	0.08
NOTCH	21.73	0.09	0.04
NOYES	60.72	0.05	0.17
PARAN	231.80	0.07	0.04
PARKER	20.67	0.01	0.08
PAUGUS BAY- STN 1	181.82	0.04	0.17
PAWTUCKAWAY LAKE	13.73	0.08	0.08
PEMIGEWASSET LAKE	12.80	0.03	0.08
PERCH (BENSON)	3.58	0.00	0.29
PLEASANT VALLEY	24.96	0.03	0.09
POUT POND	4.63	0.01	0.21
POWWOW POND	78.16	0.08	0.07
ROBB RESERVOIR	46.68	0.04	0.02
ROUND POND	3.35	0.08	0.20
SHAWS POND	16.55	0.06	0.08
SILVER LAKE	3.24	0.03	0.23
SOMERSET	11.24	0.04	0.14
SOUTH AMERICA	16.55	0.04	0.06
SPRUCE POND	2.83	0.29	0.26
STRATTON	4.78	0.19	0.02
SUNCOOK POND- UPPER	91.51	0.06	0.04
SUNRISE LAKE	7.22	0.07	0.09
SUNSET (BRKFLD)	105.56	0.04	0.04
TRIO PONDS- ONE AND TWO	11.33	0.00	0.06
TUTTLE (HARDWK)	15.29	0.08	0.00
UNNAMED POND	12.61	0.02	0.06
WALKER POND	32.82	0.04	0.04
WILLEY POND- BIG	19.21	0.10	0.07
WILLEY POND- LITTLE	8.65	0.05	0.05
WILLOUGHBY	6.41	0.00	0.19
WILSON POND	11.71	0.05	0.05
WOLCOTT	11.43	0.04	0.10
SABIN	62.48	0.04	0.13
ZEPHYR LAKE	13.90	0.05	0.06

Table 2.7. Parameter Updates for Tier 5.

Lake Name	Epilimnion Depth [m]	Hypolimnion Depth [m]
ADDER POND	6	3
ARMINGTON LAKE	9	4.4
BAKER (BARTON)	10	4.5
BAKER POND- UPPER	6	0
BEARCAMP POND	11	4.5
BRANCH	9	5
BRUCE	3	0
CAWLEY POND	4	0
CHASE POND	3.9	0
CHILDS BOG	4.5	0
CHITTENDEN	9	2.5
CLUB POND	3	0
CRANBERRY MEADOW	8	3.25
CURTIS	10	4
DENNIS	1	0
DUNMORE	25	17
DUTCHMAN POND	3	0
EASTMAN POND	11	4.5
ECHO (CHARTN)	32.79	23.79
ECHO (HUBDTN)	11	5
ELM BROOK POOL	6	0
FERN	13	4.5
FISH POND	3	0
FREESES POND- UPPER	3	0
GILES POND	6	0
GREAT HOSMER	14	6.5
GREENWOOD POND	4.5	0
HALL POND- UPPER	14	8.5
HARDWICK	3.7	0
HARDWOOD	4	0
HIGH (SUDBRY)	13.9	6.9
HILDRETH DAM POND	9	4
HORN POND	9.5	2.75
HORTONIA	18	10
HOWE RESERVOIR	5.5	0
ISLAND POND	5.375	1.875
IVANHOE- LAKE	7	0
JACKSONVILLE	2	0
JENNESS POND	8.83	3.33
KENT	5	0
LARY POND	3.5	0
LEFFERTS	2	0
LILY POND	2.5	0
LITTLE AVERILL	32	24
LONG (WESTMR)	21	15
LOON LAKE	9	3
LOVELL LAKE- STN 1	12	2.5

Lake Name	Epilimnion Depth [m]	Hypolimnion Depth [m]
LYFORD	5.8	1.55
MANSFIELD	6.5	4
MCCONNELL	6	2.5
MILLSFIELD POND	4.5	0
MILTON	4.32	0
MINARDS	14.04	6.74
MITCHELL	4	0
MOOSE POND	4.5	0
MOUNTAIN LAKE- UPPER	6	0
NEWARK	9	2.5
NORTH (BRKFLD)	5	1.5
NOTCH	8.6	4.6
NOYES	3.9	0
PARAN	5	0
PARKER	13	5.5
PAUGUS BAY- STN 1	23.5	13.5
PAWTUCKAWAY LAKE	14.75	9
PEMIGEWASSET LAKE	9.2	3.95
PERCH (BENSON)	11	3.5
PLEASANT VALLEY	8	0
POUT POND	2.5	0
POWWOW POND	3.25	0.75
ROBB RESERVOIR	2.4	0
ROUND POND	7	2.5
SABIN	17	10.5
SHAWS POND	5	0
SILVER LAKE	25	14.875
SOMERSET	25	15.25
SOUTH AMERICA	1.9	0
SPRUCE POND	5	1.5
STRATTON	4.9	0
SUNCOOK POND- UPPER	13.25	6.75
SUNRISE LAKE	4	0
SUNSET (BRKFLD)	9.5	4
TRIO PONDS- ONE AND TWO	9.75	4.75
TUTTLE (HARDWK)	2	0
UNNAMED POND	2	0
WALKER POND	13	6.5
WILLEY POND- BIG	7	0
WILLEY POND- LITTLE	4.5	0
WILLOUGHBY	80	66.75
WILSON POND	4.5	0
WOLCOTT	7	2
ZEPHYR LAKE	5.85	1.1

Table 3.1. Combinations of Characteristics for Default Runs of R-MCM.

	ACIDITY	STRATIFICATION	SIZE	TROPHIC STATE
1	ACIDIC	STRATIFIED	SMALL	OLIGOTROPHIC
2	CIRCUMNEUTRAL	STRATIFIED	SMALL	OLIGOTROPHIC
3	ALKALINE	STRATIFIED	SMALL	OLIGOTROPHIC
4	ACIDIC	WELL-MIXED	SMALL	OLIGOTROPHIC
5	CIRCUMNEUTRAL	WELL-MIXED	SMALL	OLIGOTROPHIC
6	ALKALINE	WELL-MIXED	SMALL	OLIGOTROPHIC
7	ACIDIC	STRATIFIED	MEDIUM	OLIGOTROPHIC
8	CIRCUMNEUTRAL	STRATIFIED	MEDIUM	OLIGOTROPHIC
9	ALKALINE	STRATIFIED	MEDIUM	OLIGOTROPHIC
10	ACIDIC	WELL-MIXED	MEDIUM	OLIGOTROPHIC
11	CIRCUMNEUTRAL	WELL-MIXED	MEDIUM	OLIGOTROPHIC
12	ALKALINE	WELL-MIXED	MEDUIM	OLIGOTROPHIC
13	ACIDIC	STRATIFIED	LARGE	OLIGOTROPHIC
14	CIRCUMNEUTRAL	STRATIFIED	LARGE	OLIGOTROPHIC
15	ALKALINE	STRATIFIED	LARGE	OLIGOTROPHIC
16	ACIDIC	WELL-MIXED	LARGE	OLIGOTROPHIC
17	CIRCUMNEUTRAL	WELL-MIXED	LARGE	OLIGOTROPHIC
18	ALKALINE	WELL-MIXED	LARGE	OLIGOTROPHIC
19	ACIDIC	STRATIFIED	SMALL	MESOTROPHIC
20	CIRCUMNEUTRAL	STRATIFIED	SMALL	MESOTROPHIC
21	ALKALINE	STRATIFIED	SMALL	MESOTROPHIC
22	ACIDIC	WELL-MIXED	SMALL	MESOTROPHIC
23	CIRCUMNEUTRAL	WELL-MIXED	SMALL	MESOTROPHIC
24	ALKALINE	WELL-MIXED	SMALL	MESOTROPHIC
25	ACIDIC	STRATIFIED	MEDIUM	MESOTROPHIC
26	CIRCUMNEUTRAL	STRATIFIED	MEDIUM	MESOTROPHIC
27	ALKALINE	STRATIFIED	MEDIUM	MESOTROPHIC
28	ACIDIC	WELL-MIXED	MEDIUM	MESOTROPHIC
29	CIRCUMNEUTRAL	WELL-MIXED	MEDIUM	MESOTROPHIC
30	ALKALINE	WELL-MIXED	MEDUIM	MESOTROPHIC
31	ACIDIC	STRATIFIED	LARGE	MESOTROPHIC
32	CIRCUMNEUTRAL	STRATIFIED	LARGE	MESOTROPHIC
33	ALKALINE	STRATIFIED	LARGE	MESOTROPHIC
34	ACIDIC	WELL-MIXED	LARGE	MESOTROPHIC
35	CIRCUMNEUTRAL	WELL-MIXED	LARGE	MESOTROPHIC
36	ALKALINE	WELL-MIXED	LARGE	MESOTROPHIC
37	ACIDIC	STRATIFIED	SMALL	EUTROPHIC
38	CIRCUMNEUTRAL	STRATIFIED	SMALL	EUTROPHIC
39	ALKALINE	STRATIFIED	SMALL	EUTROPHIC
40	ACIDIC	WELL-MIXED	SMALL	EUTROPHIC
41	CIRCUMNEUTRAL	WELL-MIXED	SMALL	EUTROPHIC
42	ALKALINE	WELL-MIXED	SMALL	EUTROPHIC
43	ACIDIC	STRATIFIED	MEDIUM	EUTROPHIC
44	CIRCUMNEUTRAL	STRATIFIED	MEDIUM	EUTROPHIC
45	ALKALINE	STRATIFIED	MEDIUM	EUTROPHIC

	ACIDITY	STRATIFICATION	SIZE	TROPHIC STATE
46	ACIDIC	WELL-MIXED	MEDIUM	EUTROPHIC
47	CIRCUMNEUTRAL	WELL-MIXED	MEDIUM	EUTROPHIC
48	ALKALINE	WELL-MIXED	MEDUIM	EUTROPHIC
49	ACIDIC	STRATIFIED	LARGE	EUTROPHIC
50	CIRCUMNEUTRAL	STRATIFIED	LARGE	EUTROPHIC
51	ALKALINE	STRATIFIED	LARGE	EUTROPHIC
52	ACIDIC	WELL-MIXED	LARGE	EUTROPHIC
53	CIRCUMNEUTRAL	WELL-MIXED	LARGE	EUTROPHIC
54	ALKALINE	WELL-MIXED	LARGE	EUTROPHIC
55	ACIDIC	STRATIFIED	SMALL	DYSTROPHIC
56	CIRCUMNEUTRAL	STRATIFIED	SMALL	DYSTROPHIC
57	ALKALINE	STRATIFIED	SMALL	DYSTROPHIC
58	ACIDIC	WELL-MIXED	SMALL	DYSTROPHIC
59	CIRCUMNEUTRAL	WELL-MIXED	SMALL	DYSTROPHIC
60	ALKALINE	WELL-MIXED	SMALL	DYSTROPHIC
61	ACIDIC	STRATIFIED	MEDIUM	DYSTROPHIC
62	CIRCUMNEUTRAL	STRATIFIED	MEDIUM	DYSTROPHIC
63	ALKALINE	STRATIFIED	MEDIUM	DYSTROPHIC
64	ACIDIC	WELL-MIXED	MEDIUM	DYSTROPHIC
65	CIRCUMNEUTRAL	WELL-MIXED	MEDIUM	DYSTROPHIC
66	ALKALINE	WELL-MIXED	MEDUIM	DYSTROPHIC
67	ACIDIC	STRATIFIED	LARGE	DYSTROPHIC
68	CIRCUMNEUTRAL	STRATIFIED	LARGE	DYSTROPHIC
69	ALKALINE	STRATIFIED	LARGE	DYSTROPHIC
70	ACIDIC	WELL-MIXED	LARGE	DYSTROPHIC
71	CIRCUMNEUTRAL	WELL-MIXED	LARGE	DYSTROPHIC
72	ALKALINE	WELL-MIXED	LARGE	DYSTROPHIC

Table 3.2. Predicted Results for Combination of Default Lake Characteristics.

	MeHg in Epilimnion (ng/L, unfiltered)	Total Hg in Epilimnion (ng/L, unfiltered)	MeHg in Hypolimnion (ng/L, unfiltered)	Total Hg in Hypolimnion (ng/L, unfiltered)	MeHg in Sediments (ug/g dry)	HgT in Sediments (ug/g dry)	MeHg in Prey Fish Muscle (ug/g)	MeHg in Pred Fish Muscle (ug/g)
1	0.14	1.91	0.905	3.723	0.016	0.222	0.43	0.81
2	0.14	1.77	0.8	3.912	0.007	0.166	0.3	0.58
3	0.05	0.92	0.272	2.239	0.002	0.012	0.1	0.2
4	0.38	2.91			0.01	0.301	1.19	2.25
5	0.3	2.52			0.005	0.237	0.67	1.29
6	0.09	1.02			0.001	0.039	0.18	0.35
7	0.08	1.32	0.691	2.292	0.011	0.154	0.24	0.43
8	0.07	1.11	0.572	2.46	0.004	0.098	0.15	0.27
9	0.03	0.46	0.197	1.122	0.001	0.004	0.05	0.09
10	0.15	1.79			0.005	0.197	0.51	0.9
11	0.11	1.39			0.002	0.136	0.26	0.46
12	0.04	0.48			0.001	0.016	0.07	0.13
13	0.06	1.14	0.537	1.95	0.008	0.133	0.17	0.28
14	0.05	0.94	0.439	2.303	0.003	0.077	0.1	0.18
15	0.03	0.39	0.17	0.99	0.001	0.003	0.04	0.07
16	0.11	1.56			0.004	0.176	0.35	0.6
17	0.08	1.19			0.002	0.118	0.18	0.31
18	0.03	0.41			0	0.013	0.05	0.1
19	0.29	2.03	2.041	5.121	0.015	0.103	0.36	0.65
20	0.29	1.98	1.946	5.112	0.006	0.085	0.26	0.49
21	0.13	1.13	0.772	3.324	0.002	0.014	0.11	0.2
22	0.68	3			0.008	0.118	0.9	1.65
23	0.57	2.78			0.004	0.104	0.54	1
24	0.21	1.3			0.001	0.029	0.18	0.34
25	0.15	1.39	1.083	3.04	0.008	0.071	0.19	0.34
26	0.14	1.28	0.963	3.007	0.003	0.054	0.13	0.23
27	0.06	0.56	0.318	1.636	0.001	0.005	0.04	0.08
28	0.29	1.86			0.004	0.082	0.41	0.72
29	0.24	1.64			0.002	0.067	0.23	0.41
30	0.08	0.6			0.001	0.013	0.07	0.17
31	0.11	1.2	0.809	2.487	0.006	0.061	0.13	0.22
32	0.1	1.09	0.71	2.598	0.002	0.045	0.09	0.15
33	0.04	0.47	0.242	1.422	0.001	0.003	0.03	0.05
34	0.21	1.62			0.003	0.075	0.28	0.48
35	0.17	1.41			0.002	0.061	0.16	0.27
36	0.06	0.51			0	0.011	0.05	0.08
37	0.24	1.19	0.1557	5.46	0.006	0.025	0.11	0.2
38	0.25	1.21	1.698	5.768	0.003	0.021	0.09	0.17
39	0.18	1.06	1.181	5.269	0.002	0.011	0.06	0.12
40	0.76	1.98			0.003	0.027	0.37	0.67
41	0.46	1.69			0.002	0.025	0.23	0.58
42	0.38	1.41			0.001	0.015	0.14	0.26

	MeHg in Epilimnion (ng/L, unfiltered)	Total Hg in Epilimnion (ng/L, unfiltered)	MeHg in Hypolimn ion (ng/L, unfiltered)	Total Hg in Hypolimnion (ng/L, unfiltered)	MeHg in Sediments (ug/g dry)	HgT in Sediments (ug/g dry)	MeHg in Prey Fish Muscle (ug/g)	MeHg in Pred Fish Muscle (ug/g)
43	0.15	0.94	0.994	3.869	0.004	0.02	0.08	0.13
44	0.15	0.94	1.044	3.807	0.002	0.017	0.06	0.11
45	0.09	0.64	0.558	3.08	0.001	0.006	0.03	0.06
46	0.4	1.4			0.002	0.023	0.21	0.37
47	0.32	1.31			0.001	0.021	0.13	0.23
48	0.16	0.77			0.001	0.009	0.06	0.11
49	0.12	0.85	0.782	3.071	0.003	0.018	0.05	0.09
50	0.11	0.85	0.82	3.215	0.001	0.015	0.04	0.07
51	0.06	0.55	0.413	2.79	0.001	0.004	0.02	0.04
52	0.31	1.25			0.002	0.022	0.15	0.26
53	0.25	1.18			0.001	0.02	0.09	0.16
54	0.11	0.65			0	0.008	0.04	0.07
55	0.5	4.17	1.853	5.711	0.009	0.086	0.38	0.83
56	0.49	3.98	1.591	5.315	0.004	0.073	0.26	0.59
57	0.24	1.86	0.715	2.901	0.002	0.014	0.12	0.28
58	0.86	5.41			0.006	0.118	0.72	1.55
59	0.79	5.08			0.003	0.106	0.44	0.97
60	0.35	2.14			0.001	0.035	0.18	0.41
61	0.19	2.1	0.727	2.714	0.004	0.043	0.15	0.27
62	0.19	1.97	0.609	2.538	0.001	0.035	0.1	0.18
63	0.1	0.83	0.257	1.328	0.001	0.004	0.05	0.08
64	0.28	2.52			0.002	0.059	0.24	0.43
65	0.26	2.33			0.001	0.052	0.14	0.26
66	0.1	0.88			0	0.015	0.06	0.12
67	0.13	1.69	0.532	2.157	0.003	0.035	0.1	0.17
68	0.13	1.58	0.301	1.879	0.001	0.027	0.07	0.25
69	0.07	0.68	0.188	1.125	0	0.003	0.03	0.05
70	0.19	2.08			0.001	0.05	0.16	0.27
71	0.18	1.91			0.001	0.044	0.1	0.33
72	0.09	0.74			0	0.012	0.04	0.07

Table 3.3. Summary of Results for the Combination of Default Lakes run by R-MCM. Includes minimum, maximum, mean, median, and the range of predicted values.

	Epilimnion		**Hypolimnion**		**Sediments**		**Fish Muscle**	
	MeHg	HgT	MeHg	HgT	MeHg	HgT	Prey	Predator
	ng/L, unfiltered	ng/L, unfiltered	ng/L, unfiltered	ng/L, unfiltered	ug/g dry	ug/g dry	ug/g	ug/g
Minimum	0.03	0.39	0.156	0.99	0	0.003	0.02	0.04
Maximum	0.86	5.41	2.04	5.77	0.016	0.301	1.19	2.25
Mean	0.21	1.54	0.77	3.08	0.00317	0.059	0.201	0.384
Median	0.15	1.31	0.713	2.86	0.002	0.035	0.135	0.26
Range	0.83	5.02	1.89	4.78	0.016	0.298	1.17	2.21

Table 3.4. Examples of Literature Published Ranges for Mercury Concentrations in Different Media in the Environment.

Water (ng/L)		Sediment (ug/g)		Fish (ug/g)	Reference
MeHg	HgT	MeHg	HgT		
0.068 – 0.61	1 - 5			0.05 – 1.2, mean 0.5	1
				0.018 – 5.84, mean .0478	2
0.01 – 1.481, mean 0.15	0.27 – 1106.7, mean 16.6	0.01 – 10.851, mean 1.87	1.85 – 451.7, mean 21.1		3

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2. Brumbaugh, W.G., D.P. Krabbenhoft, D.R. Helsel, J.G. Wiener, K.R. Echols. 2001. A National Pilot Study of Mercury Contamination of Aquatic Ecosystems Along Multiple Gradients: Bioaccumulation in Fish, USGS/BRD/BSR-2001-0009.

3. Krabbenhoft, J.G.Wiener, W.G. Brumbuahg, M.L. Olson, J.F. DeWild, T.J. Sabin. 1999. A National Pilot Study of Mercury Contamination of Aquatic Ecosystems Along Multiple Gradients. U.S. Geological Survey Toxic Substances Hydrology Program – Proceedings of the technical meeting, Charleston, S.C., March 8-12, 1999. USGS Water Resources Investigations Report 99-4018B, Vol 2.

Table 5.1. Model Performance Statistics for Default Scenario: χ^2, Reference χ^2 at 90% Confidence, and n, number of observations. Values that pass the χ^2 goodness of fit test (χ^2 Value<Reference χ^2) at 90% confidence, suggesting a good fit, are in bold italics.

	χ^2			Reference χ^2 (α=90%)			n		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_MeHg	***4.80***	***19.37***	***1.71***	9.31	32.49	18.94	17	45	29
EPI_HgT	70.01	140.82	***13.47***	9.31	32.49	18.94	17	45	29
HYP_MeHg	34.55	49.16	***4.70***	3.49	9.31	9.31	9	17	17
HYP_HgT	73.36	95.39	50.64	3.49	9.31	9.31	9	17	17
Fish_Hg	***1.59***	27.84	***4.21***	1.61	15.66	8.55	6	25	16
Sed_Hg	***2.86***	***4.84***	***4.49***	9.31	32.49	18.94	17	45	29

	χ^2		Reference χ^2 (α=90%)		n	
	Small	Medium	Small	Medium	Small	Medium
EPI_MeHg	***21.47***	***4.41***	42.94	23.11	57	34
EPI_HgT	204.05	***20.25***	42.94	23.11	57	34
HYP_MeHg	57.22	31.19	12.44	13.24	21	22
HYP_HgT	109.07	110.32	12.44	13.24	21	22
Fish_Hg	32.05	***1.58***	11.65	17.29	20	27
Sed_Hg	***8.03***	***4.17***	42.94	23.11	57	34

	χ^2		Reference χ^2 (α=90%)		n	
	Well-Mixed	Stratified	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_MeHg	***20.80***	***5.09***	29.05	37.69	41	50
EPI_HgT	175.51	48.78	29.05	37.69	41	50
Fish_Hg	29.41	***4.22***	6.30	23.95	13	34
Sed_Hg	***4.38***	***7.82***	29.05	37.69	41	50

	χ^2				Reference Chi-Square Value (α=90%)				n			
	Oligotrophic	Mesotrophic	Eutrophic	Dystrophic	Oligotrophic	Mesotrophic	Eutrophic	Dystrophic	Oligo	Meso	Eutro	Dystro
EPI_MeHg	***3.62***	***6.72***	***0.78***	***14.75***	10.87	18.94	7.04	18.94	19	29	14	29
EPI_HgT	22.48	33.57	13.62	154.62	10.87	18.94	7.04	18.94	19	29	14	29
HYP_MeHg	***3.17***	46.01	3.93	35.30	3.49	7.79	2.20	5.58	9	15	7	12
HYP_HgT	89.18	44.63	19.68	65.90	3.49	7.79	2.20	5.58	9	15	7	12
Fish_Hg	4.98	23.19	3.73	***1.74***	4.87	12.44	0.21	5.58	11	21	3	12
Sed_Hg	***1.91***	***3.84***	***2.38***	***4.07***	10.87	18.94	7.04	18.94	19	29	14	29

Table 5.2. Model Performance Statistics for Tier 1 Scenario: χ^2, Reference χ^2 at 90% Confidence, and n, number of observations. Values that pass the χ^2 goodness of fit test (χ^2 Value<Reference χ^2) at 90% confidence, suggesting a good fit, are in bold italics.

	χ^2			Reference χ^2 (α=90%)			n		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_MeHg	***3.52***	***14.17***	***3.25***	9.31	32.49	18.94	17	45	29
EPI_HgT	13.26	57.65	20.99	9.31	32.49	18.94	17	45	29
HYP_MeHg	23.54	21.28	***5.72***	3.49	9.31	9.31	9	17	17
HYP_HgT	194.92	131.42	51.20	3.49	9.31	9.31	9	17	17
Fish_Hg	***1.59***	***13.63***	***1.87***	1.61	15.66	8.55	6	25	16
Sed_Hg	***3.33***	***7.47***	***4.35***	9.31	32.49	18.94	17	45	29

	χ^2		Reference χ^2 (α=90%)		n	
	Small	Medium	Small	Medium	Small	Medium
EPI_MeHg	***13.85***	***7.09***	42.94	23.11	57	34
EPI_HgT	57.90	34.00	42.94	23.11	57	34
HYP_MeHg	36.93	13.62	12.44	13.24	21	22
HYP_HgT	141.86	235.68	12.44	13.24	21	22
Fish_Hg	12.95	***4.00***	11.65	17.29	20	27
Sed_Hg	***9.88***	***5.27***	42.94	23.11	57	34

	χ^2		Reference χ^2 (α=90%)		n	
	Well-Mixed	Stratified	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_MeHg	***13.23***	***7.72***	29.05	37.69	41	50
EPI_HgT	55.51	***36.39***	29.05	37.69	41	50
Fish_Hg	13.24	***3.71***	6.30	23.95	13	34
Sed_Hg	***6.30***	***8.85***	29.05	37.69	41	50

	χ^2				Reference Chi-Square Value (α=90%)				n			
	Oligotrophic	Mesotrophic	Eutrophic	Dystrophic	Oligotrophic	Mesotrophic	Eutrophic	Dystrophic	Oligo	Meso	Eutro	Dystro
EPI_MeHg	***2.13***	***7.37***	***2.02***	***9.42***	10.87	18.94	7.04	18.94	19	29	14	29
EPI_HgT	11.62	***18.48***	24.21	37.59	10.87	18.94	7.04	18.94	19	29	14	29
HYP_MeHg	***0.70***	17.00	3.80	29.05	3.49	7.79	2.20	5.58	9	15	7	12
HYP_HgT	93.51	59.76	24.92	199.36	3.49	7.79	2.20	5.58	9	15	7	12
Fish_Hg	***0.94***	***11.63***	0.88	***3.50***	4.87	12.44	0.21	5.58	11	21	3	12
Sed_Hg	***2.01***	***4.58***	***2.44***	***6.11***	10.87	18.94	7.04	18.94	19	29	14	29

Table 5.3. Model Performance Statistics for Tier 2 Scenario: χ^2, Reference χ^2 at 90% Confidence, and n, number of observations. Values that pass the χ^2 goodness of fit test (χ^2 Value<Reference χ^2) at 90% confidence, suggesting a good fit, are in bold italics.

	χ^2			Reference χ^2 (α=90%)			n		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_MeHg	***3.47***	***13.65***	***3.23***	9.31	32.49	18.94	17	45	29
EPI_HgT	13.56	57.40	20.61	9.31	32.49	18.94	17	45	29
HYP_MeHg	37.75	28.03	***8.03***	3.49	9.31	9.31	9	17	17
HYP_HgT	188.06	125.04	50.61	3.49	9.31	9.31	9	17	17
Fish_Hg	***1.59***	***12.21***	***1.73***	1.61	15.66	8.55	6	25	16
Sed_Hg	***3.37***	***7.62***	***4.45***	9.31	32.49	18.94	17	45	29

	χ^2		Reference χ^2 (α=90%)		n	
	Small	Medium	Small	Medium	Small	Medium
EPI_MeHg	***13.34***	***7.02***	42.94	23.11	57	34
EPI_HgT	57.22	34.35	42.94	23.11	57	34
HYP_MeHg	57.98	15.83	12.44	13.24	21	22
HYP_HgT	134.07	229.65	12.44	13.24	21	22
Fish_Hg	***11.44***	***3.93***	11.65	17.29	20	27
Sed_Hg	***10.04***	***5.40***	42.94	23.11	57	34

	χ^2		Reference χ^2 (α=90%)		n	
	Well-Mixed	Stratified	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_MeHg	***12.71***	***7.64***	29.05	37.69	41	50
EPI_HgT	54.85	***36.72***	29.05	37.69	41	50
Fish_Hg	11.73	***3.64***	6.30	23.95	13	34
Sed_Hg	***6.37***	***9.07***	29.05	37.69	41	50

	χ^2				Reference Chi-Square Value (α=90%)				n			
	Oligotrophic	Mesotrophic	Eutrophic	Dystrophic	Oligotrophic	Mesotrophic	Eutrophic	Dystrophic	Oligo	Meso	Eutro	Dystro
EPI_MeHg	***2.06***	***6.89***	***2.04***	***9.37***	10.87	18.94	7.04	18.94	19	29	14	29
EPI_HgT	***10.77***	***17.86***	24.71	38.23	10.87	18.94	7.04	18.94	19	29	14	29
HYP_MeHg	***1.16***	25.45	3.67	43.52	3.49	7.79	2.20	5.58	9	15	7	12
HYP_HgT	91.78	56.74	23.17	192.02	3.49	7.79	2.20	5.58	9	15	7	12
Fish_Hg	***0.95***	***10.30***	0.74	***3.37***	4.87	12.44	0.21	5.58	11	21	3	12
Sed_Hg	***2.11***	***4.67***	***2.48***	***6.18***	10.87	18.94	7.04	18.94	19	29	14	29

Table 5.4. Model Performance Statistics for Tier 3 Scenario: χ^2, Reference χ^2 at 90% Confidence, and n, number of observations. Values that pass the χ^2 goodness of fit test (χ^2 Value<Reference χ^2) at 90% confidence, suggesting a good fit, are in bold italics.

	χ^2			Reference χ^2 (α=90%)			n		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_MeHg	***3.61***	***19.73***	***2.99***	9.31	32.49	18.94	17	45	29
EPI_HgT	13.96	63.05	25.04	9.31	32.49	18.94	17	45	29
HYP_MeHg	37.75	27.50	***8.03***	3.49	9.31	9.31	9	17	17
HYP_HgT	188.06	125.90	50.87	3.49	9.31	9.31	9	17	17
Fish_Hg	***1.59***	21.28	***2.10***	1.61	15.66	8.55	6	25	16
Sed_Hg	***3.17***	***7.12***	***4.21***	9.31	32.49	18.94	17	45	29

	χ^2		Reference χ^2 (α=90%)		n	
	Small	Medium	Small	Medium	Small	Medium
EPI_MeHg	***19.50***	***6.83***	42.94	23.11	57	34
EPI_HgT	66.89	35.17	42.94	23.11	57	34
HYP_MeHg	57.98	15.30	12.44	13.24	21	22
HYP_HgT	134.52	230.31	12.44	13.24	21	22
Fish_Hg	20.35	***4.46***	11.65	17.29	20	27
Sed_Hg	***9.35***	***5.15***	42.94	23.11	57	34

	χ^2		Reference χ^2 (α=90%)		n	
	Well-Mixed	Stratified	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_MeHg	***19.25***	***7.08***	29.05	37.69	41	50
EPI_HgT	63.14	38.92	29.05	37.69	41	50
Fish_Hg	20.35	***4.46***	6.30	23.95	13	34
Sed_Hg	***6.16***	***8.34***	29.05	37.69	41	50

	χ^2				Reference Chi-Square Value (α=90%)				n			
	Oligotrophic	Mesotrophic	Eutrophic	Dystrophic	Oligotrophic	Mesotrophic	Eutrophic	Dystrophic	Oligo	Meso	Eutro	Dystro
EPI_MeHg	***2.34***	***12.99***	***1.90***	***9.10***	10.87	18.94	7.04	18.94	19	29	14	29
EPI_HgT	16.51	26.31	23.45	35.79	10.87	18.94	7.04	18.94	19	29	14	29
HYP_MeHg	***1.16***	24.92	3.67	43.52	3.49	7.79	2.20	5.58	9	15	7	12
HYP_HgT	91.78	57.66	23.17	192.21	3.49	7.79	2.20	5.58	9	15	7	12
Fish_Hg	***1.06***	19.25	0.79	***3.72***	4.87	12.44	0.21	5.58	11	21	3	12
Sed_Hg	***2.09***	***4.27***	***2.44***	***5.71***	10.87	18.94	7.04	18.94	19	29	14	29

Table 5.5. Model Performance Statistics for Tier 4 Scenario: χ^2, Reference χ^2 at 90% Confidence, and n, number of observations. Values that pass the χ^2 goodness of fit test (χ^2 Value<Reference χ^2) at 90% confidence, suggesting a good fit, are in bold italics.

	χ^2			Reference χ^2 (α=90%)			n		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_MeHg	***3.27***	***14.49***	***2.64***	9.31	32.49	18.94	17	45	29
EPI_HgT	16.60	43.17	24.91	9.31	32.49	18.94	17	45	29
HYP_MeHg	29.79	82.66	***6.95***	3.49	9.31	9.31	9	17	17
HYP_HgT	189.64	109.77	52.02	3.49	9.31	9.31	9	17	17
Fish_Hg	***1.59***	18.05	***1.62***	1.61	15.66	8.55	6	25	16
Sed_Hg	***2.85***	***5.72***	***3.58***	9.31	32.49	18.94	17	45	29

	χ^2		Reference χ^2 (α=90%)		n	
	Small	Medium	Small	Medium	Small	Medium
EPI_MeHg	***13.79***	***6.62***	42.94	23.11	57	34
EPI_HgT	57.02	27.65	42.94	23.11	57	34
HYP_MeHg	41.88	77.52	12.44	13.24	21	22
HYP_HgT	127.90	223.53	12.44	13.24	21	22
Fish_Hg	18.08	***3.17***	11.65	17.29	20	27
Sed_Hg	***7.82***	***4.33***	42.94	23.11	57	34

	χ^2		Reference χ^2 (α=90%)		n	
	Well-Mixed	Stratified	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_MeHg	***13.69***	***6.71***	29.05	37.69	41	50
EPI_HgT	51.09	***33.58***	29.05	37.69	41	50
Fish_Hg	17.27	***3.98***	6.30	23.95	13	34
Sed_Hg	***4.68***	***7.47***	29.05	37.69	41	50

	χ^2				Reference Chi-Square Value (α=90%)				n			
	Oligotrophic	Mesotrophic	Eutrophic	Dystrophic	Oligotrophic	Mesotrophic	Eutrophic	Dystrophic	Oligo	Meso	Eutro	Dystro
EPI_MeHg	***2.21***	***7.89***	***1.91***	***8.40***	10.87	18.94	7.04	18.94	19	29	14	29
EPI_HgT	17.89	***14.78***	22.13	29.87	10.87	18.94	7.04	18.94	19	29	14	29
HYP_MeHg	***2.28***	79.15	3.81	34.17	3.49	7.79	2.20	5.58	9	15	7	12
HYP_HgT	97.68	45.83	24.78	183.15	3.49	7.79	2.20	5.58	9	15	7	12
Fish_Hg	***0.77***	16.99	0.54	***2.96***	4.87	12.44	0.21	5.58	11	21	3	12
Sed_Hg	***1.53***	***3.40***	***2.39***	***4.83***	10.87	18.94	7.04	18.94	19	29	14	29

Table 5.6. Model Performance Statistics for Tier 5 Scenario: χ^2, Reference χ^2 at 90% Confidence, and n, number of observations. Values that pass the χ^2 goodness of fit test (χ^2 Value<Reference χ^2) at 90% confidence, suggesting a good fit, are in bold italics.

	χ^2			Reference χ^2 (α=90%)			n		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_MeHg	***3.67***	***12.02***	***3.52***	9.31	32.49	18.94	17	45	29
EPI_HgT	13.33	40.36	***13.17***	9.31	32.49	18.94	17	45	29
HYP_MeHg	7.45	20.00	***3.41***	3.49	9.31	9.31	9	17	17
HYP_HgT	132.38	122.25	56.31	3.49	9.31	9.31	9	17	17
Fish_Hg	***1.59***	***12.80***	***0.95***	1.61	15.66	8.55	6	25	16
Sed_Hg	***3.26***	***6.40***	***4.42***	9.31	32.49	18.94	17	45	29

	χ^2		Reference χ^2 (α=90%)		n	
	Small	Medium	Small	Medium	Small	Medium
EPI_MeHg	***12.30***	***6.91***	42.94	23.11	57	34
EPI_HgT	***42.65***	24.20	42.94	23.11	57	34
HYP_MeHg	16.75	14.10	12.44	13.24	21	22
HYP_HgT	154.12	156.82	12.44	13.24	21	22
Fish_Hg	***9.20***	***5.85***	11.65	17.29	20	27
Sed_Hg	***9.35***	***4.72***	42.94	23.11	57	34

	χ^2		Reference χ^2 (α=90%)		n	
	Well-Mixed	Stratified	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_MeHg	***10.08***	***9.13***	29.05	37.69	41	50
EPI_HgT	36.06	***30.79***	29.05	37.69	41	50
Fish_Hg	11.67	***3.38***	6.30	23.95	13	34
Sed_Hg	***4.83***	***9.25***	29.05	37.69	41	50

	χ^2				Reference Chi-Square Value (α=90%)				n			
	Oligotrophic	Mesotrophic	Eutrophic	Dystrophic	Oligotrophic	Mesotrophic	Eutrophic	Dystrophic	Oligo	Meso	Eutro	Dystro
EPI_MeHg	***2.18***	***6.01***	***1.98***	***9.03***	10.87	18.94	7.04	18.94	19	29	14	29
EPI_HgT	***7.14***	***12.55***	22.12	25.05	10.87	18.94	7.04	18.94	19	29	14	29
HYP_MeHg	***0.80***	11.65	5.11	13.31	3.49	7.79	2.20	5.58	9	15	7	12
HYP_HgT	101.57	54.58	28.72	126.07	3.49	7.79	2.20	5.58	9	15	7	12
Fish_Hg	***0.72***	***11.76***	0.26	***2.32***	4.87	12.44	0.21	5.58	11	21	3	12
Sed_Hg	***2.10***	***4.14***	***2.48***	***5.36***	10.87	18.94	7.04	18.94	19	29	14	29

Table 5.7. Model Performance Statistics for Default Scenario: T-test Value, Reference Value at 90% Confidence, number of observations, mean residual, and Standard Deviation. Values that pass the T-Test at 90% Confidence (T-Test Value< Reference T-Value) are in ***bold italics***.

	T-Test Value			T-Test Reference (a=90%)			d_bar: mean residual			Standard Deviation			n		
	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline
EPI_MeHg	***0.48***	***1.25***	-4.71	1.75	1.68	1.70	0.04	0.06	-0.08	0.35	0.35	0.09	17	45	29
EPI_HgT	1.92	2.43	***-1.53***	1.75	1.68	1.70	1.01	0.67	-0.28	2.18	1.84	0.98	17	45	29
HYP_MeHg	***0.06***	***0.39***	***1.00***	1.86	1.75	1.75	0.03	0.10	0.07	1.66	1.11	0.29	9	17	17
HYP_HgT	-2.82	-4.22	-4.27	1.86	1.75	1.75	-10.14	-7.29	-3.70	10.77	7.12	3.57	9	17	17
Fish_Hg	***0.31***	3.14	***0.55***	2.02	1.71	1.75	0.03	0.21	0.02	0.25	0.34	0.16	6	25	16
Sed_Hg	-4.05	-9.50	-13.93	1.75	1.68	1.70	-0.17	-0.15	-0.17	0.17	0.11	0.07	17	45	29

	T-Test Value		T-Test Reference (α=90%)		d_bar: mean residual		Standard Deviation		n	
	Small	Medium	Small	Medium	Small	Medium	Small	Medium	Small	Medium
EPI_MeHg	3.23	-2.36	1.67	1.69	0.10	-0.13	0.24	0.33	57	34
EPI_HgT	3.29	***-1.23***	1.67	1.69	0.83	-0.25	1.91	1.16	57	34
HYP_MeHg	***0.68***	***-0.20***	1.72	1.72	0.19	-0.03	1.26	0.72	21	22
HYP_HgT	-3.64	-4.77	1.72	1.72	-6.64	-6.30	8.36	6.20	21	22
Fish_Hg	4.14	***-0.84***	1.73	1.71	0.32	-0.02	0.34	0.11	20	27
Sed_Hg	-9.54	-13.22	1.67	1.69	-0.17	-0.15	0.13	0.07	57	34

	T-Test Value		T-Test Reference (α=90%)		d_bar: mean residual		Standard Deviation		n	
	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified
EPI_MeHg	2.49	-1.91	1.68	1.68	0.12	-0.07	0.30	0.26	41	51
EPI_HgT	2.25	***0.87***	1.68	1.68	0.77	0.15	2.19	1.22	41	51
Fish_Hg	4.91	***0.12***	1.78	1.69	0.44	0.00	0.33	0.15	13	35
Sed_Hg	-7.57	-12.09	1.68	1.68	-0.13	-0.19	0.11	0.11	41	51

	T-Test Value				T-Test Reference (α=90%)				d_bar: mean residual				Standard Deviation				n			
	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro
EPI_MeHg	-2.53	***0.76***	***-0.12***	***1.00***	1.73	1.70	1.77	1.70	-0.10	0.03	0.00	0.08	0.17	0.18	0.15	0.45	19	29	14	29
EPI_HgT	***0.13***	2.51	-2.74	4.34	1.73	1.70	1.77	1.70	0.04	0.43	-1.31	1.52	1.24	0.93	1.80	1.89	19	29	14	29
HYP_MeHg	1.15	3.97	***-1.00***	***-1.00***	1.86	1.76	1.94	1.80	0.12	0.57	-0.25	-0.38	0.30	0.55	0.65	1.31	9	15	7	12
HYP_HgT	-3.05	-4.02	***-1.00***	***-1.00***	1.86	1.76	1.94	1.80	-11.38	-4.23	-3.92	-7.07	11.19	4.07	10.38	24.50	9	15	7	12
Fish_Hg	1.75	2.63	***1.18***	***-0.29***	1.81	1.72	2.92	1.80	0.16	0.18	0.21	-0.02	0.30	0.31	0.30	0.22	11	21	3	12
Sed_Hg	***-3.68***	-11.21	-7.96	-7.52	1.73	1.70	1.77	1.70	-0.09	-0.17	-0.19	-0.19	0.11	0.08	0.09	0.13	19	29	14	29

Notes: "Neutral" --> Circumneutral "Mixed" --> Well-Mixed

Table 5.8. Model Performance Statistics for Tier 1 Scenario: T-test Value, Reference Value at 90% Confidence, number of observations, mean residual, and Standard Deviation. Values that pass the T-Test at 90% Confidence (T-Test Value< Reference T-Value) are in ***bold italics***.

	T-Test Value			T-Test Reference (α=90%)			d_bar: mean residual			Standard Deviation			n		
	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline
EPI_MeHg	***0.48***	***1.25***	-4.71	1.75	1.68	1.70	0.04	0.06	-0.08	0.35	0.35	0.09	17	45	29
EPI_HgT	1.92	2.43	***-1.53***	1.75	1.68	1.70	1.01	0.67	-0.28	2.18	1.84	0.98	17	45	29
HYP_MeHg	***0.06***	***0.39***	***1.00***	1.86	1.75	1.75	0.03	0.10	0.07	1.66	1.11	0.29	9	17	17
HYP_HgT	-2.82	-4.22	-4.27	1.86	1.75	1.75	-10.14	-7.29	-3.70	10.77	7.12	3.57	9	17	17
Fish_Hg	***0.31***	3.14	***0.55***	2.02	1.71	1.75	0.03	0.21	0.02	0.25	0.34	0.16	6	25	16
Sed_Hg	-4.05	-9.50	-13.93	1.75	1.68	1.70	-0.17	-0.15	-0.17	0.17	0.11	0.07	17	45	29

	T-Test Value		T-Test Reference (α=90%)		d_bar: mean residual		Standard Deviation		n	
	Small	Medium	Small	Medium	Small	Medium	Small	Medium	Small	Medium
EPI_MeHg	3.23	-2.36	1.67	1.69	0.10	-0.13	0.24	0.33	57	34
EPI_HgT	3.29	***-1.23***	1.67	1.69	0.83	-0.25	1.91	1.16	57	34
HYP_MeHg	***0.68***	***-0.20***	1.72	1.72	0.19	-0.03	1.26	0.72	21	22
HYP_HgT	-3.64	-4.77	1.72	1.72	-6.64	-6.30	8.36	6.20	21	22
Fish_Hg	4.14	***-0.84***	1.73	1.71	0.32	-0.02	0.34	0.11	20	27
Sed_Hg	-9.54	-13.22	1.67	1.69	-0.17	-0.15	0.13	0.07	57	34

	T-Test Value		T-Test Reference (α=90%)		d_bar: mean residual		Standard Deviation		n	
	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified
EPI_MeHg	2.49	-1.91	1.68	1.68	0.12	-0.07	0.30	0.26	41	51
EPI_HgT	2.25	***0.87***	1.68	1.68	0.77	0.15	2.19	1.22	41	51
Fish_Hg	4.91	***0.12***	1.78	1.69	0.44	0.00	0.33	0.15	13	35
Sed_Hg	-7.57	-12.09	1.68	1.68	-0.13	-0.19	0.11	0.11	41	51

	T-Test Value				T-Test Reference (α=90%)				d_bar: mean residual				Standard Deviation				n			
	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro
EPI_MeHg	-2.53	***0.76***	***-0.12***	***1.00***	1.73	1.70	1.77	1.70	-0.10	0.03	0.00	0.08	0.17	0.18	0.15	0.45	19	29	14	29
EPI_HgT	***0.13***	2.51	-2.74	4.34	1.73	1.70	1.77	1.70	0.04	0.43	-1.31	1.52	1.24	0.93	1.80	1.89	19	29	14	29
HYP_MeHg	1.15	3.97	***-1.00***	***-1.00***	1.86	1.76	1.94	1.80	0.12	0.57	-0.25	-0.38	0.30	0.55	0.65	1.31	9	15	7	12
HYP_HgT	-3.05	-4.02	***-1.00***	***-1.00***	1.86	1.76	1.94	1.80	-11.38	-4.23	-3.92	-7.07	11.19	4.07	10.38	24.50	9	15	7	12
Fish_Hg	1.75	2.63	***1.18***	***-0.29***	1.81	1.72	2.92	1.80	0.16	0.18	0.21	-0.02	0.30	0.31	0.30	0.22	11	21	3	12
Sed_Hg	***-3.68***	-11.21	-7.96	-7.52	1.73	1.70	1.77	1.70	-0.09	-0.17	-0.19	-0.19	0.11	0.08	0.09	0.13	19	29	14	29

Notes: "Neutral" --> Circumneutral "Mixed" --> Well-Mixed

Table 5.9. Model Performance Statistics for Tier 2 Scenario: T-test Value, Reference Value at 90% Confidence, number of observations, mean residual, and Standard Deviation. Values that pass the T-Test at 90% Confidence (T-Test Value< Reference T-Value) are in ***bold italics***.

	T-Test Value			T-Test Reference (α=90%)			d_bar: mean residual			Standard Deviation			n		
	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline
EPI_MeHg	-2.85	-4.65	-7.32	1.75	1.68	1.70	-0.22	-0.23	-0.14	0.31	0.33	0.10	17	45	29
EPI_HgT	-2.88	-5.02	-3.09	1.75	1.68	1.70	-0.96	-1.27	-0.65	1.37	1.70	1.13	17	45	29
HYP_MeHg	***-0.32***	***-1.17***	***1.00***	1.86	1.75	1.75	-0.19	-0.34	0.01	1.76	1.19	0.03	9	17	17
HYP_HgT	-1.96	-4.77	-3.55	1.86	1.75	1.75	-8.89	-8.44	-3.31	13.60	7.29	3.84	9	17	17
Fish_Hg	-3.02	***0.20***	***-0.11***	2.02	1.71	1.75	-0.25	0.01	0.00	0.20	0.34	0.12	6	25	16
Sed_Hg	-5.74	-12.18	-13.62	1.75	1.68	1.70	-0.21	-0.19	-0.17	0.15	0.11	0.07	17	45	29

	T-Test Value		T-Test Reference (α=90%)		d_bar: mean residual		Standard Deviation		n	
	Small	Medium	Small	Medium	Small	Medium	Small	Medium	Small	Medium
EPI_MeHg	-6.22	-3.80	1.67	1.69	-0.18	-0.23	0.22	0.35	57	34
EPI_HgT	-4.52	-4.95	1.67	1.69	-0.96	-1.11	1.59	1.31	57	34
HYP_MeHg	***-0.36***	***-1.41***	1.72	1.72	-0.11	-0.23	1.43	0.75	21	22
HYP_HgT	-3.81	-3.44	1.72	1.72	-7.31	-5.74	8.79	7.82	21	22
Fish_Hg	***1.41***	-3.85	1.73	1.71	0.11	-0.13	0.34	0.17	20	27
Sed_Hg	-12.37	-13.66	1.67	1.69	-0.20	-0.18	0.12	0.07	57	34

	T-Test Value		T-Test Reference (α=90%)		d_bar: mean residual		Standard Deviation		n	
	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified
EPI_MeHg	-4.59	-5.09	1.68	1.68	-0.22	-0.18	0.30	0.26	41	51
EPI_HgT	-4.55	-4.81	1.68	1.68	-1.26	-0.79	1.77	1.18	41	51
Fish_Hg	***0.86***	-2.85	1.78	1.69	0.11	-0.08	0.45	0.16	13	35
Sed_Hg	-10.34	-13.40	1.68	1.68	-0.17	-0.20	0.10	0.11	41	51

	T-Test Value				T-Test Reference (α=90%)				d_bar: mean residual				Standard Deviation				n			
	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro
EPI_MeHg	-3.49	-3.55	-3.30	***-1.00***	1.73	1.70	1.77	1.70	-0.12	-0.12	-0.19	-0.34	0.15	0.18	0.21	1.84	19	29	14	29
EPI_HgT	***-1.27***	-3.07	-3.59	-5.51	1.73	1.70	1.77	1.70	-0.31	-0.49	-2.04	-1.50	1.08	0.86	2.13	1.46	19	29	14	29
HYP_MeHg	***0.93***	2.20	***-1.00***	***-1.00***	1.86	1.76	1.94	1.80	0.06	0.37	-0.78	-0.66	0.18	0.66	2.07	2.30	9	15	7	12
HYP_HgT	-2.79	-3.61	***-1.00***	***-1.00***	1.86	1.76	1.94	1.80	-11.06	-4.39	-4.73	-6.78	11.90	4.72	12.50	23.47	9	15	7	12
Fish_Hg	***-1.15***	***1.03***	***1.38***	***-2.61***	1.81	1.72	2.92	1.80	-0.05	0.07	0.10	-0.21	0.14	0.31	0.13	0.27	11	21	3	12
Sed_Hg	***-5.16***	-13.39	-8.71	-10.26	1.73	1.70	1.77	1.70	-0.12	-0.19	-0.19	-0.24	0.10	0.08	0.08	0.12	19	29	14	29

Notes: "Neutral" --> Circumneutral "Mixed" --> Well-Mixed

Table 5.10. Model Performance Statistics for Tier 3 Scenario: T-test Value, Reference Value at 90% Confidence, number of observations, mean residual ,and Standard Deviation. Values that pass the T-Test at 90% Confidence (T-Test Value< Reference T-Value) are in ***bold italics***.

	T-Test Value			T-Test Reference (α=90%)			d_bar: mean residual			Standard Deviation			n		
	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline
EPI_MeHg	-2.85	-4.65	-7.32	1.75	1.68	1.70	-0.22	-0.23	-0.14	0.31	0.33	0.10	17	45	29
EPI_HgT	-2.88	-5.02	-3.09	1.75	1.68	1.70	-0.96	-1.27	-0.65	1.37	1.70	1.13	17	45	29
HYP_MeHg	***-0.32***	***-1.17***	***1.00***	1.86	1.75	1.75	-0.19	-0.34	0.01	1.76	1.19	0.03	9	17	17
HYP_HgT	-1.96	-4.77	-3.55	1.86	1.75	1.75	-8.89	-8.44	-3.31	13.60	7.29	3.84	9	17	17
Fish_Hg	-3.02	***0.20***	***-0.11***	2.02	1.71	1.75	-0.25	0.01	0.00	0.20	0.34	0.12	6	25	16
Sed_Hg	-5.74	-12.18	-13.62	1.75	1.68	1.70	-0.21	-0.19	-0.17	0.15	0.11	0.07	17	45	29

	T-Test Value		T-Test Reference (α=90%)		d_bar: mean residual		Standard Deviation		n	
	Small	Medium	Small	Medium	Small	Medium	Small	Medium	Small	Medium
EPI_MeHg	-6.22	-3.80	1.67	1.69	-0.18	-0.23	0.22	0.35	57	34
EPI_HgT	-4.52	-4.95	1.67	1.69	-0.96	-1.11	1.59	1.31	57	34
HYP_MeHg	***-0.36***	***-1.41***	1.72	1.72	-0.11	-0.23	1.43	0.75	21	22
HYP_HgT	-3.81	-3.44	1.72	1.72	-7.31	-5.74	8.79	7.82	21	22
Fish_Hg	***1.41***	-3.85	1.73	1.71	0.11	-0.13	0.34	0.17	20	27
Sed_Hg	-12.37	-13.66	1.67	1.69	-0.20	-0.18	0.12	0.07	57	34

	T-Test Value		T-Test Reference (α=90%)		d_bar: mean residual		Standard Deviation		n	
	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified
EPI_MeHg	-4.59	-5.09	1.68	1.68	-0.22	-0.18	0.30	0.26	41	51
EPI_HgT	-4.55	-4.81	1.68	1.68	-1.26	-0.79	1.77	1.18	41	51
Fish_Hg	***0.86***	-2.85	1.78	1.69	0.11	-0.08	0.45	0.16	13	35
Sed_Hg	-10.34	-13.40	1.68	1.68	-0.17	-0.20	0.10	0.11	41	51

	T-Test Value				T-Test Reference (α=90%)				d_bar: mean residual				Standard Deviation				n			
	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro
EPI_MeHg	-3.49	-3.55	-3.30	***-1.00***	1.73	1.70	1.77	1.70	-0.12	-0.12	-0.19	-0.34	0.15	0.18	0.21	1.84	19	29	14	29
EPI_HgT	***-1.27***	-3.07	-3.59	-5.51	1.73	1.70	1.77	1.70	-0.31	-0.49	-2.04	-1.50	1.08	0.86	2.13	1.46	19	29	14	29
HYP_MeHg	***0.93***	2.20	***-1.00***	***-1.00***	1.86	1.76	1.94	1.80	0.06	0.37	-0.78	-0.66	0.18	0.66	2.07	2.30	9	15	7	12
HYP_HgT	-2.79	-3.61	***-1.00***	***-1.00***	1.86	1.76	1.94	1.80	-11.06	-4.39	-4.73	-6.78	11.90	4.72	12.50	23.47	9	15	7	12
Fish_Hg	***-1.15***	***1.03***	***1.38***	***-2.61***	1.81	1.72	2.92	1.80	-0.05	0.07	0.10	-0.21	0.14	0.31	0.13	0.27	11	21	3	12
Sed_Hg	***-5.16***	-13.39	-8.71	-10.26	1.73	1.70	1.77	1.70	-0.12	-0.19	-0.19	-0.24	0.10	0.08	0.08	0.12	19	29	14	29

Notes: "Neutral" --> Circumneutral "Mixed" --> Well-Mixed

Table 5.11. Model Performance Statistics for Tier 4 Scenario: T-test Value, Reference Value at 90% Confidence, number of observations, mean residual, and Standard Deviation. Values that pass the T-Test at 90% Confidence (T-Test Value< Reference T-Value) are in ***bold italics***.

	T-Test Value			T-Test Reference (α=90%)			d_bar: mean residual			Standard Deviation			n		
	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline
EPI_MeHg	-2.73	-4.01	-4.89	1.75	1.68	1.70	-0.21	-0.21	-0.11	0.31	0.34	0.12	17	45	29
EPI_HgT	***-1.35***	-3.17	***-0.23***	1.75	1.68	1.70	-0.55	-0.78	-0.05	1.68	1.64	1.17	17	45	29
HYP_MeHg	***-0.46***	***-0.78***	***1.00***	1.86	1.75	1.75	-0.26	-0.22	0.02	1.71	1.18	0.07	9	17	17
HYP_HgT	-2.00	-4.22	-2.87	1.86	1.75	1.75	-9.03	-7.74	-2.87	13.51	7.57	4.12	9	17	17
Fish_Hg	-2.14	***1.16***	***1.34***	2.02	1.71	1.75	-0.22	0.09	0.03	0.25	0.40	0.10	6	25	16
Sed_Hg	-5.04	-10.03	-8.84	1.75	1.68	1.70	-0.19	-0.16	-0.14	0.15	0.11	0.09	17	45	29

	T-Test Value		T-Test Reference (α=90%)		d_bar: mean residual		Standard Deviation		n	
	Small	Medium	Small	Medium	Small	Medium	Small	Medium	Small	Medium
EPI_MeHg	-4.77	-3.61	1.67	1.69	-0.15	-0.22	0.23	0.36	57	34
EPI_HgT	***-1.64***	-3.30	1.67	1.69	-0.36	-0.75	1.64	1.32	57	34
HYP_MeHg	***-0.55***	***-0.66***	1.72	1.72	-0.16	-0.12	1.32	0.83	21	22
HYP_HgT	-3.86	-2.84	1.72	1.72	-7.28	-4.94	8.64	8.16	21	22
Fish_Hg	2.26	-2.79	1.73	1.71	0.20	-0.09	0.40	0.17	20	27
Sed_Hg	-9.98	-10.57	1.67	1.69	-0.17	-0.15	0.13	0.08	57	34

	T-Test Value		T-Test Reference (α=90%)		d_bar: mean residual		Standard Deviation		n	
	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified
EPI_MeHg	-3.64	-4.60	1.68	1.68	-0.18	-0.17	0.32	0.26	41	51
EPI_HgT	-2.31	-2.13	1.68	1.68	-0.67	-0.36	1.85	1.21	41	51
Fish_Hg	***1.49***	***-1.30***	1.78	1.69	0.21	-0.04	0.52	0.16	13	35
Sed_Hg	-8.35	-10.93	1.68	1.68	-0.14	-0.18	0.10	0.12	41	51

	T-Test Value				T-Test Reference (α=90%)				d_bar: mean residual				Standard Deviation				n			
	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro
EPI_MeHg	-2.50	-2.18	-3.49	***-1.00***	1.73	1.70	1.77	1.70	-0.10	-0.08	-0.19	-0.32	0.17	0.19	0.20	1.70	19	29	14	29
EPI_HgT	***0.94***	***0.59***	-3.43	-3.01	1.73	1.70	1.77	1.70	0.22	0.08	-1.91	-0.88	1.02	0.74	2.08	1.58	19	29	14	29
HYP_MeHg	***0.42***	3.16	***-1.00***	***-1.00***	1.86	1.76	1.94	1.80	0.03	0.45	-0.79	-0.62	0.24	0.56	2.08	2.16	9	15	7	12
HYP_HgT	-2.63	-2.97	***-1.00***	***-1.00***	1.86	1.76	1.94	1.80	-10.88	-3.67	-4.65	-6.35	12.43	4.78	12.30	21.99	9	15	7	12
Fish_Hg	***-0.35***	1.88	***1.64***	***-1.80***	1.81	1.72	2.92	1.80	-0.01	0.15	0.09	-0.15	0.14	0.38	0.09	0.29	11	21	3	12
Sed_Hg	***-3.33***	-9.05	-8.04	-9.41	1.73	1.70	1.77	1.70	-0.09	-0.15	-0.19	-0.21	0.11	0.09	0.09	0.12	19	29	14	29

Notes: "Neutral" --> Circumneutral "Mixed" --> Well-Mixed

Table 5.12. Model Performance Statistics for Tier 5 Scenario: T-test Value, Reference Value at 90% Confidence, number of observations, mean residual, and Standard Deviation. Values that pass the T-Test at 90% Confidence (T-Test Value< Reference T-Value) are are in ***bold italics***.

	T-Test Value			T-Test Reference (α=90%)			d_bar: mean residual			Standard Deviation			n		
	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline	Acidic	Neutral	Alkaline
EPI_MeHg	-3.78	-4.72	-8.58	1.75	1.68	1.70	-0.26	-0.23	-0.15	0.28	0.32	0.09	17	45	29
EPI_HgT	-2.60	-3.97	-3.03	1.75	1.68	1.70	-0.90	-0.95	-0.49	1.44	1.60	0.86	17	45	29
HYP_MeHg	***-1.49***	-1.88	***-1.00***	1.86	1.75	1.75	-0.80	-0.49	-0.24	1.61	1.07	0.99	9	17	17
HYP_HgT	-2.77	-4.81	-5.09	1.86	1.75	1.75	-11.27	-8.59	-4.27	12.23	7.36	3.45	9	17	17
Fish_Hg	-3.45	***0.57***	-2.30	2.02	1.71	1.75	-0.26	0.04	-0.05	0.18	0.34	0.09	6	25	16
Sed_Hg	-5.62	-10.55	-11.42	1.75	1.68	1.70	-0.21	-0.18	-0.17	0.16	0.11	0.08	17	45	29

	T-Test Value		T-Test Reference (α=90%)		d_bar: mean residual		Standard Deviation		n	
	Small	Medium	Small	Medium	Small	Medium	Small	Medium	Small	Medium
EPI_MeHg	-7.68	-3.72	1.67	1.69	-0.20	-0.22	0.20	0.35	57	34
EPI_HgT	-3.82	-4.19	1.67	1.69	-0.75	-0.86	1.48	1.20	57	34
HYP_MeHg	-2.16	-2.13	1.72	1.72	-0.60	-0.32	1.27	0.70	21	22
HYP_HgT	-4.79	-4.01	1.72	1.72	-8.80	-6.15	8.42	7.19	21	22
Fish_Hg	***1.06***	-2.70	1.73	1.71	0.08	-0.11	0.33	0.21	20	27
Sed_Hg	-11.30	-11.84	1.67	1.69	-0.19	-0.16	0.13	0.08	57	34

	T-Test Value		T-Test Reference (α=90%)		d_bar: mean residual		Standard Deviation		n	
	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified	Mixed	Stratified
EPI_MeHg	-4.63	-5.94	1.68	1.68	-0.20	-0.21	0.28	0.25	41	51
EPI_HgT	-2.86	-5.35	1.68	1.68	-0.75	-0.81	1.68	1.08	41	51
Fish_Hg	***1.65***	-4.32	1.78	1.69	0.19	-0.11	0.41	0.15	13	35
Sed_Hg	-8.98	-12.77	1.68	1.68	-0.14	-0.21	0.10	0.12	41	51

	T-Test Value				T-Test Reference (α=90%)				d_bar: mean residual				Standard Deviation				n			
	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro
EPI_MeHg	-4.29	-4.06	-4.00	***-1.00***	1.73	1.70	1.77	1.70	-0.14	-0.12	-0.20	-0.34	0.14	0.16	0.19	1.85	19	29	14	29
EPI_HgT	***-1.31***	-1.92	-3.71	-4.21	1.73	1.70	1.77	1.70	-0.23	-0.28	-1.97	-1.11	0.77	0.79	1.99	1.41	19	29	14	29
HYP_MeHg	-2.18	***0.84***	***-1.00***	***-1.00***	1.86	1.76	1.94	1.80	-0.12	0.08	-0.98	-1.08	0.16	0.39	2.59	3.75	9	15	7	12
HYP_HgT	-3.04	-4.46	***-1.00***	***-1.00***	1.86	1.76	1.94	1.80	-12.16	-4.90	-5.68	-8.10	12.00	4.26	15.04	28.05	9	15	7	12
Fish_Hg	***-2.55***	***1.14***	***1.27***	-2.98	1.81	1.72	2.92	1.80	-0.09	0.08	0.06	-0.19	0.12	0.33	0.08	0.22	11	21	3	12
Sed_Hg	***-4.94***	-10.86	-8.03	-8.75	1.73	1.70	1.77	1.70	-0.12	-0.18	-0.19	-0.22	0.11	0.09	0.09	0.13	19	29	14	29

Notes: "Neutral" --> Circumneutral "Mixed" --> Well-Mixed

Table 5.13. Model Performance Statistics for Default Scenario: Maximum Error and Root Mean Square Error.

	Maximum Error (ME)			Root Mean Square Error (RMSE)		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_Me	0.99	1.64	0.30	96.82	107.74	58.85
EPI_T	4.43	5.08	3.27	124.19	100.29	80.62
HYP_Me	2.90	2.30	0.56	120.89	116.42	61.45
HYP_T	26.08	25.70	12.22	98.64	93.22	79.84
Fish	0.53	0.86	0.56	59.13	163.01	115.63
Sed	0.52	0.53	0.31	85.87	77.96	94.47

	Maximum Error (ME)		Root Mean Square Error (RMSE)	
	Small	Medium	Small	Medium
EPI_Me	0.69	1.64	84.47	127.26
EPI_T	5.08	3.92	118.19	72.18
HYP_Me	2.90	2.30	117.39	116.71
HYP_T	26.08	24.84	94.60	102.04
Fish	0.86	0.23	227.13	47.12
Sed	0.53	0.31	86.03	81.10

	Maximum Error (ME)		Root Mean Square Error (RMSE)	
	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_Me	0.99	1.64	95.13	105.09
EPI_T	5.08	3.92	116.56	81.99
Fish	0.86	0.53	220.88	69.25
Sed	0.45	0.53	77.77	87.75

	Maximum Error (ME)				Root Mean Square Error (RMSE)			
	Oligotrophic	Mesotrophic	Eutrophic	Dystrophic	Oligotrophic	Mesotrophic	Eutrophic	Dystrophic
EPI_Me	0.41	0.50	0.30	1.64	88.70	78.62	45.20	111.85
EPI_T	3.10	2.08	5.08	4.67	94.92	88.80	83.95	113.42
HYP_Me	0.49	1.72	2.90	2.63	92.66	213.44	45.62	61.69
HYP_T	26.08	13.95	9.73	20.18	114.91	78.64	119.01	1,156.30
Fish	0.86	0.83	0.56	0.50	153.09	194.46	538.20	10.12
Sed	0.24	0.45	0.35	0.53	68.74	83.64	100.12	10.75

Table 5.14. Model Performance Statistics for Default Scenario:
Coefficient of Determination, Modeling Efficiency, and Coefficient of Residual Mass.

	Coefficient of Determination (CD)			Modeling Efficiency (EF)			Coefficient of Residual Mass (CRM)		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_Me	1.23	1.26	0.68	0.19	0.20	-0.47	-0.12	-0.20	0.39
EPI_T	0.54	0.91	4.51	-0.84	-0.10	0.78	-0.54	-0.35	0.22
HYP_Me	14.17	2.61	1.24	0.93	0.62	0.19	-0.03	-0.11	-0.15
HYP_T	0.94	0.87	0.72	-0.07	-0.15	-0.40	0.70	0.68	0.58
Fish	0.44	0.12	0.25	-1.27	-7.28	-3.01	-0.08	-0.88	-0.16
Sed	0.47	0.42	0.14	-1.12	-1.35	-5.95	0.61	0.64	0.88

	Coefficient of Determination (CD)		Modeling Efficiency (EF)		Coefficient of Residual Mass (CRM)	
	Small	Medium	Small	Medium	Small	Medium
EPI_Me	0.37	4.73	-1.68	0.79	-0.33	0.48
EPI_T	0.66	2.65	-0.52	0.62	-0.48	0.15
HYP_Me	5.03	4.87	0.80	0.79	-0.18	0.05
HYP_T	1.47	0.93	0.32	-0.08	0.60	0.74
Fish	0.10	1.01	-8.58	0.01	-1.56	0.08
Sed	0.44	0.15	-1.26	-5.65	0.68	0.74

	Coefficient of Determination (CD)		Modeling Efficiency (EF)		Coefficient of Residual Mass (CRM)	
	Well-Mixed	Stratified	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_Me	0.70	2.50	-0.42	0.60	-0.35	0.28
EPI_T	0.82	0.94	-0.23	-0.06	-0.39	-0.10
Fish	0.06	0.90	-14.55	-0.11	-1.80	-0.01
Sed	0.40	0.31	-1.50	-2.19	0.60	0.77

	Coefficient of Determination (CD)				Modeling Efficiency (EF)				Coefficient of Residual Mass (CRM)			
	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro
EPI_Me	0.84	0.29	0.96	1.83	-0.18	-2.50	-0.04	0.45	0.45	-0.11	0.01	-0.21
EPI_T	1.60	0.55	2.07	0.38	0.38	-0.83	0.52	-1.66	-0.03	-0.38	0.51	-0.72
HYP_Me	0.27	0.11	10.91	3.61	-2.75	-7.89	0.91	0.72	-0.35	-1.55	0.17	0.26
HYP_T	0.98	0.97	0.93	0.85	-0.02	-0.03	-0.08	-0.17	0.84	0.58	0.45	0.66
Fish	0.09	0.08	0.00	0.36	-9.63	-12.07	-362.50	-1.79	-0.74	-0.99	-3.45	0.05
Sed	0.33	0.24	0.21	0.47	-1.99	-3.13	-3.85	-1.14	0.45	0.76	0.91	0.70

Table 5.15. Model Performance Statistics for Tier 1 Scenario: Maximum Error and Root Mean Square Error.

	Maximum Error (ME)			Root Mean Square Error (RMSE)		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_Me	1.27	1.81	0.43	105.39	124.25	83.72
EPI_T	5.04	6.84	4.00	85.37	108.60	102.45
HYP_Me	3.24	2.87	1.10	128.86	128.03	55.24
HYP_T	27.52	27.03	11.95	111.00	104.37	81.25
Fish	0.46	1.17	0.27	80.49	146.86	90.81
Sed	0.53	0.59	0.30	91.46	93.10	92.49

	Maximum Error (ME)		Root Mean Square Error (RMSE)	
	Small	Medium	Small	Medium
EPI_Me	0.79	1.81	93.86	151.51
EPI_T	6.84	5.81	104.73	104.07
HYP_Me	3.24	2.52	129.18	128.09
HYP_T	27.52	24.85	104.85	113.88
Fish	1.17	0.46	184.64	86.85
Sed	0.59	0.36	94.04	90.40

	Maximum Error (ME)		Root Mean Square Error (RMSE)	
	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_Me	1.27	1.81	108.98	122.24
EPI_T	6.84	5.81	109.33	93.83
Fish	1.17	0.39	194.71	79.08
Sed	0.47	0.59	91.07	93.28

	Maximum Error (ME)				Root Mean Square Error (RMSE)			
	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro
EPI_Me	0.44	0.54	0.79	1.81	89.09	95.25	85.51	458.03
EPI_T	3.13	2.89	6.84	5.81	85.73	85.48	110.98	97.23
HYP_Me	0.35	1.25	3.24	3.19	47.74	169.36	155.04	138.50
HYP_T	27.52	16.06	11.56	22.13	118.48	90.02	156.07	1,198.50
Fish	0.26	1.17	0.27	0.63	67.60	184.57	259.68	15.99
Sed	0.25	0.47	0.35	0.59	73.00	89.42	100.46	12.49

Table 5.16. Model Performance Statistics for Tier 1 Scenario:
Coefficient of Determination, Modeling Efficiency, and Coefficient of Residual Mass.

	Coefficient of Determination (CD)			Modeling Efficiency (EF)			Coefficient of Residual Mass (CRM)		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_Me	1.01	1.13	0.38	0.01	0.11	-1.67	0.60	0.71	0.68
EPI_T	1.26	1.11	1.92	0.21	0.10	0.48	0.47	0.63	0.49
HYP_Me	6.43	1.93	1.65	0.84	0.48	0.39	0.31	0.47	0.13
HYP_T	0.85	0.60	0.74	-0.18	-0.65	-0.35	0.66	0.82	0.59
Fish	0.12	0.13	0.44	-7.10	-6.73	-1.29	0.64	-0.10	0.03
Sed	0.34	0.27	0.15	-1.94	-2.74	-5.72	0.74	0.81	0.86

	Coefficient of Determination (CD)		Modeling Efficiency (EF)		Coefficient of Residual Mass (CRM)	
	Small	Medium	Small	Medium	Small	Medium
EPI_Me	0.51	2.03	-0.97	0.51	0.59	0.84
EPI_T	1.67	0.94	0.40	-0.06	0.51	0.66
HYP_Me	4.83	2.78	0.79	0.64	0.27	0.46
HYP_T	1.04	0.76	0.04	-0.31	0.72	0.70
Fish	0.14	0.58	-6.25	-0.71	-0.60	0.52
Sed	0.34	0.12	-1.98	-7.27	0.80	0.83

	Coefficient of Determination (CD)		Modeling Efficiency (EF)		Coefficient of Residual Mass (CRM)	
	Well-Mixed	Stratified	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_Me	0.74	1.58	-0.35	0.37	0.62	0.73
EPI_T	1.17	1.48	0.15	0.32	0.61	0.51
Fish	0.07	1.17	-12.78	0.14	-0.52	0.35
Sed	0.26	0.27	-2.88	-2.64	0.77	0.84

	Coefficient of Determination (CD)				Modeling Efficiency (EF)				Coefficient of Residual Mass (CRM)			
	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro
EPI_Me	0.76	0.26	0.76	1.00	-0.32	-2.83	-0.32	0.00	0.56	0.51	0.57	0.85
EPI_T	2.14	0.82	0.95	0.62	0.53	-0.23	-0.06	-0.62	0.19	0.39	0.77	0.69
HYP_Me	1.78	0.22	2.20	1.65	0.44	-3.56	0.55	0.39	0.02	-0.72	0.59	0.59
HYP_T	0.97	0.76	0.55	0.59	-0.03	-0.32	-0.80	-0.70	0.85	0.65	0.59	0.68
Fish	1.06	0.07	0.01	0.14	0.06	-12.71	-90.27	-6.00	0.24	-0.44	-1.84	0.56
Sed	0.29	0.20	0.20	0.30	-2.47	-3.98	-4.00	-2.36	0.54	0.83	0.93	0.88

Table 5.17. Model Performance Statistics for Tier 2 Scenario: Maximum Error and Root Mean Square Error.

	Maximum Error (ME)			Root Mean Square Error (RMSE)		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_Me	1.27	1.81	0.43	105.27	123.79	83.58
EPI_T	5.13	6.84	4.00	86.64	109.04	103.10
HYP_Me	3.34	2.78	1.19	128.98	130.25	7.22
HYP_T	27.14	26.84	11.69	107.27	102.18	78.55
Fish	0.46	1.08	0.25	79.95	138.98	87.77
Sed	0.53	0.59	0.30	92.11	94.04	93.43

	Maximum Error (ME)		Root Mean Square Error (RMSE)	
	Small	Medium	Small	Medium
EPI_Me	0.79	1.81	93.42	151.28
EPI_T	6.84	5.81	105.37	104.70
HYP_Me	3.34	2.47	131.88	127.46
HYP_T	27.14	24.23	101.33	111.53
Fish	1.08	0.46	173.26	86.19
Sed	0.59	0.36	94.76	91.60

	Maximum Error (ME)		Root Mean Square Error (RMSE)	
	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_Me	1.27	1.81	108.50	122.09
EPI_T	6.84	5.81	109.74	94.83
Fish	1.08	0.40	183.09	78.68
Sed	0.48	0.59	91.77	94.23

	Maximum Error (ME)				Root Mean Square Error (RMSE)			
	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro
EPI_Me	0.44	0.54	0.79	1.81	88.14	93.57	85.89	458.03
EPI_T	3.19	2.90	6.84	5.81	85.56	85.53	111.80	97.97
HYP_Me	0.33	1.48	3.34	2.78	54.82	202.70	145.09	108.53
HYP_T	27.14	15.21	10.70	20.14	116.68	86.21	143.30	1,108.00
Fish	0.26	1.08	0.25	0.58	66.54	172.98	239.24	15.68
Sed	0.26	0.48	0.35	0.59	75.25	90.45	101.00	12.55

Table 5.18. Model Performance Statistics for Tier 2 Scenario:
Coefficient of Determination, Modeling Efficiency, and Coefficient of Residual Mass.

	Coefficient of Determination (CD)			Modeling Efficiency (EF)			Coefficient of Residual Mass (CRM)		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_Me	1.02	1.14	0.38	0.02	0.12	-1.65	0.61	0.71	0.68
EPI_T	1.20	1.07	1.80	0.17	0.06	0.44	0.51	0.66	0.52
HYP_Me	5.12	1.90	1.18	0.80	0.47	0.15	0.15	0.37	-0.02
HYP_T	0.96	0.65	0.85	-0.04	-0.54	-0.17	0.61	0.78	0.52
Fish	0.12	0.15	0.48	-7.06	-5.87	-1.10	0.64	-0.06	0.03
Sed	0.33	0.26	0.15	-1.99	-2.83	-5.88	0.76	0.83	0.87

	Coefficient of Determination (CD)		Modeling Efficiency (EF)		Coefficient of Residual Mass (CRM)	
	Small	Medium	Small	Medium	Small	Medium
EPI_Me	0.52	2.06	-0.93	0.51	0.60	0.83
EPI_T	1.60	0.91	0.37	-0.10	0.55	0.68
HYP_Me	3.76	2.87	0.73	0.65	0.10	0.38
HYP_T	1.20	0.81	0.17	-0.23	0.66	0.67
Fish	0.16	0.60	-5.39	-0.66	-0.53	0.52
Sed	0.33	0.12	-2.04	-7.51	0.81	0.84

	Coefficient of Determination (CD)		Modeling Efficiency (EF)		Coefficient of Residual Mass (CRM)	
	Well-Mixed	Stratified	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_Me	0.75	1.60	-0.33	0.37	0.64	0.73
EPI_T	1.14	1.39	0.12	0.28	0.64	0.54
Fish	0.08	1.20	-11.14	0.17	-0.44	0.36
Sed	0.25	0.27	-2.93	-2.74	0.78	0.85

	Coefficient of Determination (CD)				Modeling Efficiency (EF)				Coefficient of Residual Mass (CRM)			
	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro
EPI_Me	0.79	0.27	0.77	1.00	-0.26	-2.65	-0.29	0.00	0.56	0.52	0.58	0.85
EPI_T	2.21	0.80	0.92	0.60	0.55	-0.25	-0.09	-0.68	0.25	0.43	0.79	0.71
HYP_Me	1.04	0.14	2.52	1.62	0.04	-5.93	0.60	0.38	-0.17	-1.03	0.55	0.47
HYP_T	1.04	0.85	0.64	0.65	0.04	-0.17	-0.56	-0.53	0.82	0.60	0.54	0.63
Fish	1.15	0.08	0.01	0.15	0.13	-11.05	-77.72	-5.68	0.23	-0.39	-1.67	0.58
Sed	0.27	0.20	0.20	0.29	-2.69	-4.07	-4.08	-2.40	0.58	0.84	0.93	0.89

Table 5.19. Model Performance Statistics for Tier 3 Scenario: Maximum Error and Root Mean Square Error.

	Maximum Error (ME)			Root Mean Square Error (RMSE)		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_Me	1.27	1.81	0.43	104.68	127.56	80.94
EPI_T	4.99	6.82	4.00	85.66	108.22	104.10
HYP_Me	3.34	2.78	1.19	128.97	130.18	7.22
HYP_T	27.14	26.84	11.69	107.27	102.29	78.62
Fish	0.45	1.74	0.28	78.21	189.05	97.16
Sed	0.49	0.58	0.30	87.24	90.94	90.91

	Maximum Error (ME)		Root Mean Square Error (RMSE)	
	Small	Medium	Small	Medium
EPI_Me	0.82	1.81	97.54	150.70
EPI_T	6.82	5.81	105.16	103.46
HYP_Me	3.34	2.47	131.87	127.33
HYP_T	27.14	24.23	101.37	111.62
Fish	1.74	0.45	243.13	87.31
Sed	0.58	0.36	90.85	89.23

	Maximum Error (ME)		Root Mean Square Error (RMSE)	
	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_Me	1.27	1.81	113.65	120.01
EPI_T	6.82	5.81	110.33	92.39
Fish	1.74	0.38	253.28	80.07
Sed	0.47	0.58	89.40	90.16

	Maximum Error (ME)				Root Mean Square Error (RMSE)			
	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro
EPI_Me	0.43	0.82	0.79	1.81	90.32	110.72	84.01	436.75
EPI_T	3.19	2.89	6.82	5.81	91.57	93.89	109.94	94.71
HYP_Me	0.33	1.48	3.34	2.78	54.82	202.36	145.09	108.52
HYP_T	27.14	15.21	10.70	20.14	116.68	86.51	143.30	1,111.70
Fish	0.25	1.74	0.25	0.76	66.51	252.08	243.63	16.46
Sed	0.24	0.47	0.35	0.58	72.49	86.34	100.46	12.03

Table 5.20. Model Performance Statistics for Tier 3 Scenario: Coefficient of Determination, Modeling Efficiency, and Coefficient of Residual Mass.

	Coefficient of Determination (CD)			Modeling Efficiency (EF)			Coefficient of Residual Mass (CRM)		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_Me	1.09	1.05	0.42	0.08	0.05	-1.39	0.52	0.63	0.62
EPI_T	1.32	1.18	2.10	0.24	0.16	0.52	0.34	0.55	0.41
HYP_Me	5.12	1.86	1.18	0.80	0.46	0.15	0.14	0.37	-0.02
HYP_T	0.96	0.64	0.86	-0.04	-0.55	-0.17	0.61	0.79	0.52
Fish	0.14	0.08	0.34	-6.26	-12.12	-1.90	0.57	-0.35	-0.10
Sed	0.36	0.28	0.15	-1.76	-2.53	-5.49	0.67	0.77	0.84

	Coefficient of Determination (CD)		Modeling Efficiency (EF)		Coefficient of Residual Mass (CRM)	
	Small	Medium	Small	Medium	Small	Medium
EPI_Me	0.47	2.15	-1.12	0.53	0.49	0.81
EPI_T	1.75	1.02	0.43	0.01	0.41	0.60
HYP_Me	3.76	2.81	0.73	0.64	0.10	0.38
HYP_T	1.20	0.81	0.17	-0.24	0.66	0.67
Fish	0.08	0.60	-11.54	-0.68	-0.94	0.43
Sed	0.35	0.13	-1.83	-6.99	0.75	0.80

	Coefficient of Determination (CD)		Modeling Efficiency (EF)		Coefficient of Residual Mass (CRM)	
	Well-Mixed	Stratified	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_Me	0.68	1.74	-0.48	0.42	0.54	0.67
EPI_T	1.23	1.57	0.19	0.36	0.53	0.42
Fish	0.04	1.07	-22.86	0.07	-0.85	0.23
Sed	0.26	0.29	-2.82	-2.44	0.71	0.81

	Coefficient of Determination (CD)				Modeling Efficiency (EF)				Coefficient of Residual Mass (CRM)			
	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro
EPI_Me	0.73	0.18	0.78	1.05	-0.36	-4.49	-0.28	0.05	0.46	0.37	0.53	0.81
EPI_T	1.68	0.63	0.98	0.68	0.40	-0.59	-0.02	-0.47	0.05	0.25	0.76	0.60
HYP_Me	1.04	0.14	2.52	1.62	0.04	-5.96	0.60	0.38	-0.17	-1.01	0.55	0.47
HYP_T	1.04	0.84	0.64	0.65	0.04	-0.18	-0.56	-0.54	0.82	0.60	0.54	0.63
Fish	0.98	0.04	0.01	0.13	-0.02	-24.40	-79.33	-6.64	0.10	-0.78	-1.84	0.49
Sed	0.28	0.21	0.20	0.32	-2.61	-3.67	-4.00	-2.16	0.45	0.79	0.93	0.85

Table 5.21. Model Performance Statistics for Tier 4 Scenario: Maximum Error and Root Mean Square Error.

	Maximum Error (ME)			Root Mean Square Error (RMSE)		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_Me	1.26	1.81	0.43	102.80	122.59	76.65
EPI_T	5.44	6.48	3.68	91.15	93.35	92.62
HYP_Me	3.60	2.62	0.84	125.96	125.84	15.28
HYP_T	26.59	27.57	12.22	107.29	99.02	77.59
Fish	0.44	1.45	0.20	80.64	164.55	76.82
Sed	0.49	0.56	0.30	84.72	83.82	85.42

	Maximum Error (ME)		Root Mean Square Error (RMSE)	
	Small	Medium	Small	Medium
EPI_Me	0.76	1.81	90.24	150.20
EPI_T	6.48	5.68	95.02	92.68
HYP_Me	3.60	2.41	122.24	135.76
HYP_T	27.57	25.07	100.18	109.44
Fish	1.45	0.44	213.75	78.46
Sed	0.56	0.36	85.47	83.37

	Maximum Error (ME)		Root Mean Square Error (RMSE)	
	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_Me	1.26	1.81	106.97	119.16
EPI_T	6.48	5.68	99.16	83.67
Fish	1.45	0.38	220.79	74.85
Sed	0.47	0.56	80.44	86.68

	Maximum Error (ME)				Root Mean Square Error (RMSE)			
	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro
EPI_Me	0.43	0.60	0.76	1.81	89.47	92.38	84.03	423.34
EPI_T	2.09	1.56	6.48	5.68	79.71	64.22	107.08	84.13
HYP_Me	0.49	1.81	3.60	2.62	70.65	193.33	146.13	102.02
HYP_T	27.57	15.33	10.75	19.36	118.47	80.33	140.94	1,037.90
Fish	0.30	1.45	0.20	0.67	62.43	220.47	198.19	14.85
Sed	0.28	0.47	0.36	0.56	66.50	79.77	100.34	11.23

Table 5.22. Model Performance Statistics for Tier 4 Scenario:
Coefficient of Determination, Modeling Efficiency, and Coefficient of Residual Mass.

	Coefficient of Determination (CD)			Modeling Efficiency (EF)			Coefficient of Residual Mass (CRM)		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_Me	1.19	1.26	0.45	0.16	0.21	-1.22	0.58	0.63	0.52
EPI_T	1.57	2.23	0.86	0.36	0.55	-0.16	0.29	0.40	0.04
HYP_Me	5.35	2.82	2.00	0.81	0.65	0.50	0.20	0.24	-0.04
HYP_T	0.93	0.77	1.09	-0.07	-0.30	0.08	0.62	0.72	0.45
Fish	0.14	0.10	0.49	-6.28	-8.76	-1.04	0.56	-0.38	-0.25
Sed	0.39	0.35	0.18	-1.54	-1.84	-4.43	0.66	0.70	0.73

	Coefficient of Determination (CD)		Modeling Efficiency (EF)		Coefficient of Residual Mass (CRM)	
	Small	Medium	Small	Medium	Small	Medium
EPI_Me	0.62	2.24	-0.60	0.55	0.49	0.80
EPI_T	2.23	1.51	0.55	0.34	0.20	0.46
HYP_Me	5.43	2.45	0.82	0.59	0.15	0.19
HYP_T	1.24	0.99	0.19	-0.01	0.65	0.58
Fish	0.10	0.83	-8.56	-0.21	-0.98	0.38
Sed	0.43	0.15	-1.32	-5.82	0.68	0.73

	Coefficient of Determination (CD)		Modeling Efficiency (EF)		Coefficient of Residual Mass (CRM)	
	Well-Mixed	Stratified	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_Me	0.87	1.87	-0.14	0.46	0.53	0.66
EPI_T	1.65	2.19	0.39	0.54	0.34	0.25
Fish	0.06	1.49	-16.81	0.33	-0.87	0.17
Sed	0.34	0.33	-1.93	-2.01	0.64	0.74

	Coefficient of Determination (CD)				Modeling Efficiency (EF)				Coefficient of Residual Mass (CRM)			
	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro
EPI_Me	0.73	0.28	0.92	1.14	-0.36	-2.54	-0.08	0.12	0.45	0.35	0.58	0.79
EPI_T	0.62	1.07	1.06	1.17	-0.61	0.07	0.05	0.15	-0.17	-0.07	0.74	0.42
HYP_Me	0.95	0.17	2.58	1.94	-0.06	-4.80	0.61	0.49	-0.10	-1.25	0.55	0.44
HYP_T	1.07	1.19	0.66	0.73	0.06	0.16	-0.51	-0.37	0.81	0.50	0.53	0.59
Fish	1.13	0.05	0.02	0.17	0.11	-18.03	-53.59	-5.05	0.07	-0.85	-1.50	0.42
Sed	0.38	0.27	0.20	0.37	-1.60	-2.64	-3.88	-1.68	0.41	0.69	0.92	0.78

Table 5.23. Model Performance Statistics for Tier 5 Scenario: Maximum Error and Root Mean Square Error.

	Maximum Error (ME)			Root Mean Square Error (RMSE)		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_Me	1.24	1.80	0.39	106.30	120.44	84.84
EPI_T	5.40	6.48	3.30	87.95	95.83	78.39
HYP_Me	3.64	2.98	1.29	132.71	124.13	207.59
HYP_T	27.96	28.31	12.39	110.81	103.61	85.51
Fish	0.38	1.07	0.19	78.59	139.59	73.31
Sed	0.55	0.60	0.31	93.00	88.88	94.26

	Maximum Error (ME)		Root Mean Square Error (RMSE)	
	Small	Medium	Small	Medium
EPI_Me	0.76	1.80	91.42	149.74
EPI_T	6.48	5.38	94.25	90.21
HYP_Me	3.64	2.66	129.87	125.52
HYP_T	28.31	26.04	108.23	108.94
Fish	1.07	0.69	160.55	96.23
Sed	0.60	0.36	93.63	87.08

	Maximum Error (ME)		Root Mean Square Error (RMSE)	
	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_Me	1.24	1.80	101.51	126.58
EPI_T	6.48	5.38	92.75	90.23
Fish	1.07	0.51	175.80	83.94
Sed	0.49	0.60	82.76	95.99

	Maximum Error (ME)				Root Mean Square Error (RMSE)			
	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro
EPI_Me	0.47	0.52	0.76	1.80	90.96	90.69	83.40	461.27
EPI_T	2.11	2.06	6.48	5.38	61.52	71.91	106.13	83.82
HYP_Me	0.43	0.84	3.64	3.59	57.69	106.37	181.54	176.86
HYP_T	28.31	16.02	11.50	22.68	123.03	87.19	172.33	1,324.20
Fish	0.38	1.07	0.15	0.51	70.25	185.71	141.78	13.36
Sed	0.31	0.49	0.36	0.60	77.26	87.24	102.29	12.08

Table 5.24. Model Performance Statistics for Tier 5 Scenario:
Coefficient of Determination, Modeling Efficiency, and Coefficient of Residual Mass

	Coefficient of Determination (CD)			Modeling Efficiency (EF)			Coefficient of Residual Mass (CRM)		
	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline	Acidic	Circumneutral	Alkaline
EPI_Me	0.89	1.24	0.32	-0.13	0.19	-2.09	0.73	0.70	0.72
EPI_T	1.49	1.87	1.07	0.33	0.47	0.07	0.48	0.49	0.39
HYP_Me	4.05	2.41	2.20	0.75	0.59	0.55	0.62	0.53	0.50
HYP_T	0.72	0.64	0.59	-0.39	-0.56	-0.70	0.77	0.80	0.67
Fish	0.13	0.16	0.89	-6.89	-5.34	-0.12	0.66	-0.16	0.37
Sed	0.35	0.31	0.15	-1.90	-2.17	-5.80	0.76	0.75	0.86

	Coefficient of Determination (CD)		Modeling Efficiency (EF)		Coefficient of Residual Mass (CRM)	
	Small	Medium	Small	Medium	Small	Medium
EPI_Me	0.51	2.09	-0.97	0.52	0.65	0.81
EPI_T	1.94	1.38	0.48	0.28	0.43	0.53
HYP_Me	3.86	2.75	0.74	0.64	0.57	0.53
HYP_T	0.86	0.87	-0.16	-0.15	0.79	0.72
Fish	0.19	0.40	-4.23	-1.48	-0.38	0.45
Sed	0.36	0.13	-1.79	-6.41	0.78	0.78

	Coefficient of Determination (CD)		Modeling Efficiency (EF)		Coefficient of Residual Mass (CRM)	
	Well-Mixed	Stratified	Well-Mixed	Stratified	Well-Mixed	Stratified
EPI_Me	0.92	1.31	-0.08	0.24	0.60	0.83
EPI_T	2.09	1.48	0.52	0.33	0.38	0.56
Fish	0.09	1.08	-9.90	0.08	-0.76	0.51
Sed	0.34	0.26	-1.93	-2.79	0.68	0.86

	Coefficient of Determination (CD)				Modeling Efficiency (EF)				Coefficient of Residual Mass (CRM)			
	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro	Oligo	Meso	Eutro	Dystro
EPI_Me	0.66	0.28	0.80	1.03	-0.51	-2.58	-0.25	0.03	0.65	0.55	0.62	0.86
EPI_T	0.84	1.26	1.00	1.11	-0.18	0.21	0.00	0.10	0.18	0.25	0.76	0.52
HYP_Me	0.90	0.68	1.72	1.42	-0.11	-0.47	0.42	0.30	0.35	-0.23	0.69	0.76
HYP_T	0.86	0.75	0.46	0.61	-0.16	-0.34	-1.17	-0.64	0.90	0.67	0.65	0.75
Fish	0.89	0.08	0.03	0.22	-0.12	-12.31	-30.21	-3.45	0.44	-0.46	-0.95	0.53
Sed	0.28	0.22	0.20	0.34	-2.62	-3.46	-4.07	-1.91	0.59	0.78	0.93	0.82

Table 5.25. Formulas for Statistical Evaluation Parameters.

$$\chi^2 = \sum_{i=1}^{n} \frac{(P_i - O_i)^2}{O_i}$$

$$P(\chi^2 \le \chi_0^2) = 1 - \alpha$$

$$t = \frac{\bar{d}\sqrt{n}}{S_d}$$

$$\bar{d} = \frac{\left|\sum_{i=1}^{n} (P_i - O_i)\right|}{n}$$

$$S_d = \sqrt{\frac{\sum_{i=1}^{n} d_i^2}{n-1} - \frac{n}{n-1}\bar{d}^2}$$

$$P(t \le t_0) = 1 - \alpha$$

$$ME = Max\left|P_i - O_i\right|_{i=1}^{n}$$

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n} (P_i - O_i)^2}{n}} \bullet \frac{100}{\bar{O}}$$

$$CD = \frac{\sum_{i=1}^{n} (O_i - \bar{O})^2}{\sum_{i=1}^{n} (P_i - \bar{O})^2}$$

$$EF = \frac{\sum_{i=1}^{n} (O_i - \bar{O})^2 - \sum_{i=1}^{n} (P_i - O_i)^2}{\sum_{i=1}^{n} (O_i - \bar{O})^2}$$

$$CRM = \frac{\sum_{i=1}^{n} O_i - \sum_{i=1}^{n} P_i}{\sum_{i=1}^{n} O_i}$$

P_i = predicted value for observation i (modeled)
O_i = observed value for observation i (observed)

Table 6.1. Hypolimnion Surface Area Sensitivity Analysis Results.

	Average Change from 1/5 to 1/2[a]		Max Change from 1/5 to 1/2[a]		Average Δ(*C*,*R*)[b]			
	Percent	Absolute	Percent	Absolute	Δ (*C*,1/2)	Δ (*C*,1/4)	Δ (*C*,1/5)	Average
EPI_MeHg	35.83%	0.026	66.67%	0.120	-42.90%	-82.30%	-75.72%	-66.98%
EPI_HgT	13.25%	0.105	32.35%	0.330	-14.36%	-17.52%	-18.38%	-16.75%
HYP_MeHg	36.23%	0.209	65.51%	0.891	-42.99%	-59.71%	-63.43%	-55.38%
HYP_HgT	19.73%	0.581	58.28%	2.918	-22.88%	-27.62%	-30.26%	-26.92%
Sed_MeHg	25.55%	0.001	100.00%	0.011	-26.15%	-60.34%	-67.80%	-51.43%
Sed_HgT	5.12%	0.003	50.00%	0.020	-5.07%	-6.68%	-10.42%	-7.39%
Fish Tissue	39.09%	0.060	60.00%	0.190	-50.43%	-60.94%	-62.13%	-57.84%

Notes: [a] Change from 1/5 to 1/2 calculated as: Absolute Change $= C_{1/5} - C_{1/2}$, Percent Change $= 100 \bullet \dfrac{C_{1/5} - C_{1/2}}{C_{1/5}}$,

where: $C_{\#}$ is the predicted concentration for *R*, where *R* = 1/5 or 1/2.

[b]

$$\Delta(C,R) = 100 \bullet \frac{\left(\dfrac{C_{\delta R} - C_{1/3}}{C_{1/3}}\right)}{\left(\dfrac{R_{\delta} - 1/3}{1/3}\right)}$$

where:

Δ(*C*,*R*)	=	the sensitivity of model output *C* to parameter *R* [percent]
C	=	model output [mercury concentration]
R	=	parameter being varied [hypolimnion surface area/epilimnion surface area]
$C_{1/3}$	=	calculated model output value for base case (i.e., R = 1/3)
$C_{\delta R}$	=	calculated model output value for change in parameter, R
1/3	=	model parameter value for base case (i.e., R = 1/3)
R_{δ}	=	model parameter value in sensitivity simulation

Sensitivity:	Extra Strong (>100%)	Strong (50% - 99%)	Moderate (25%-49%)	Weak (<25%)

Table 6.2. Polynomial Linear Regression Results. Coefficients, Standard Errors, Adjusted R^2, and F Significance.

	β_0	Std Error	β_1	Std Error	β_2	Std Error	β_3	Std Error	β_4	Std Error	β_5	Std Error	Adj R^2	F Significance
EPI_MeHg	0.0030	0.0058	-0.043	0.034	0.11	0.046	1.9	0.072	1.2	0.50	-2.9	0.13	0.97	1.2E-144
EPI_HgT	-0.0061	0.018	-0.081	0.10	0.26	0.14	1.2	0.020	-0.0016	0.010	-0.68	0.037	0.997	1.3E-238
HYP_MeHg	0.042	0.039	-0.50	0.23	0.97	0.32	1.8	0.052	-0.0032	0.041	-2.36	0.098	0.98	2.1E-148
HYP_HgT	0.75	0.30	-3.3	1.8	2.2	2.4	1.1	0.050	-0.0055	0.0030	-0.051	0.11	0.97	1.1E-129
Sed_MeHg	0.0013	0.0013	-0.0043	0.0079	0.0071	0.011	1.1	0.14	25.0	6.0	-1.8	0.31	0.82	8.2E-58
Sed_HgT	0.0022	0.0027	-0.011	0.016	0.0098	0.023	1.06	0.018	-0.086	0.068	-0.13	0.041	0.996	1.6E-229
Fish Tissue	0.0015	0.0070	-0.056	0.040	0.15	0.055	1.76	0.037	0.21	0.11	-2.3	0.068	0.994	7.6E-143

$$C(R, C_{1/3}) = \beta_0 + \beta_1 R + \beta_2 R^2 + \beta_3 C_{1/3} + \beta_4 {C_{1/3}}^2 + \beta_5 R C_{1/3}$$

$$\frac{\partial C}{\partial R} = \beta_1 + 2\beta_2 R + \beta_5 C_{1/3}$$

Table 6.3. Hypolimnion Area Sensitivity Evaluation. Hypothetical Default Lake Conditions and Results: Changing R and D_H, Constant Q.

Hypolimnion Area Sensitivity		**Acidity**	**Stratification**	**Size**	**Hydrology**	**Trophic Status**
		Acidic	Stratified	Medium	Drainage	Oligotrophic
	Units	**Base Case**	**Run 2**	**Run 3**	**Run 4**	**Run 5**
Hydraulic Res Time	days	365	493	335	317	10181
pH_EPI/HYP		5.3	5.3	5.3	5.3	5.3
DOC_EPI/HYP	mg/L	3	3	3	3	3
Lake Area	m2	1000000	1000000	1000000	1000000	1000000
Hypo Area	m2	250000	900000	100000	250000	250000
EPI_Depth	m	8	8	8	8	8
HYP_Depth	m	5	5	5	0.1	1000
Lake Volume	m3	9250000	12500000	8500000	8025000	258000000
Vol Flow Rate	m3/day	25,342	25,342	25,342	25,342	25,342
Epilimnion		1	2	3	4	5
	MeHg	0.08	0.028	0.109	0.081	0.081
	HgII	1.217	0.834	1.362	1.218	1.184
	HgT	1.318	0.878	1.493	1.319	1.308
Hypolimnion						
	MeHg	0.69	0.207	0.949	0.709	0.777
	HgII	1.192	0.816	1.334	1.205	0.372
	HgT	2.291	1.215	2.801	2.229	6.049
Sediment						
(Hypolimnion)	MeHg	0.011	0.003	0.015	0.011	0.011
	HgII	0.144	0.098	0.161	0.145	0.045
	HgT	0.154	0.101	0.175	0.156	0.056

Table 6.4. Hypolimnion Area Sensitivity Evaluation. Hypothetical Default Lake Conditions and Results: Changing *R*, Constant *Q*.

Hypolimnion Area Sensitivity		**Acidity**	**Stratification**	**Size**	**Hydrology**	**Trophic Status**			
		Acidic	Stratified	Medium	Drainage	Oligotrophic			
	Units	**Run 1-1**	**Run 1-2**	**Run 1-3**	**Run 1-4**	**Run 1-5**	**Run 1-6**	**Run 1-7**	**Run 1-8**
Hydraulic Res Time	days	385	385	217	247	296	207	197	197
pH_EPI/HYP		5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
DOC_EPI/HYP	mg/L	3	3	3	3	3	3	3	3
Lake Area	m2	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Hypo Area	m2	950,000	0	100,000	250,000	500,000	50,000	0	100
EPI_Depth	m	5	9.75	5	5	5	5	5	5
HYP_Depth	m	5	0	5	5	5	5	0	5
Lake Volume	m3	9,750,000	9,750,000	5,500,000	6,250,000	7,500,000	5,250,000	5,000,000	5,000,500
Vol Flow Rate	m3/day	25,342	25,342	25,342	25,342	25,342	25,342	25,342	25,342
Raw Data		**1-1**	**1-2**	**1-3**	**1-4**	**1-5**	**1-6**	**1-7**	**1-8**
Epilimnion	**R**	**0.95**	**0**	**0.1**	**0.25**	**0.5**	**0.05**	**0**	**0.0001**
	MeHg	0.025	0.135	0.109	0.079	0.049	0.123	0.25	0.138
	HgII	0.818	1.471	1.375	1.228	1.042	1.432	2.989	1.494
	HgT	0.859	1.631	1.506	1.326	1.108	1.577	3.273	1.656
Hypolimnion									
	MeHg	0.16	N/A	0.849	0.608	0.368	0.955	N/A	1.079
	HgII	0.802	N/A	1.347	1.202	1.02	1.403	N/A	1.464
	HgT	1.17	N/A	2.862	2.321	1.739	3.093	N/A	3.357
Sediment (Hypolimnion)									
	MeHg	0.002	N/A	0.014	0.01	0.006	0.016	N/A	0.018
	HgII	0.097	N/A	0.162	0.145	0.123	0.169	N/A	0.176
	HgT	0.099	N/A	0.176	0.155	0.129	0.184	N/A	0.194

Table 6.5. Results for Mathematical Analysis of Simple, Stratified Lake System.

Run (a)	R	Hypolimnion Area [m^2]	Epilimnion C_T [ng/L]	Hypolimnion C_T [ng/L]
	1	1,000,000	0.167	0.330
	0.9	900,000	0.167	0.330
	0.8	800,000	0.167	0.330
	0.7	700,000	0.167	0.329
	0.6	600,000	0.167	0.328
	0.5	500,000	0.167	0.327
	0.4	400,000	0.167	0.325
	0.3	300,000	0.167	0.323
	0.2	200,000	0.167	0.317
	0.1	100,000	0.166	0.304
	0.05	50,000	0.166	0.283
	0.01	10,000	0.164	0.219
	0	0	0.163	0.167

Run (b)	R	Hypolimnion Area [m^2]	Epilimnion C_T [ng/L]	Hypolimnion C_T [ng/L]
	1	1,000,000	0.315	0.162
	0.9	900,000	0.315	0.162
	0.8	800,000	0.315	0.162
	0.7	700,000	0.315	0.162
	0.6	600,000	0.315	0.163
	0.5	500,000	0.315	0.163
	0.4	400,000	0.315	0.164
	0.3	300,000	0.315	0.166
	0.2	200,000	0.315	0.168
	0.1	100,000	0.315	0.176
	0.05	50,000	0.316	0.189
	0.01	10,000	0.318	0.244
	0	0	0.322	0.320

Run (c)	R	Hypolimnion Area [m^2]	Epilimnion C_T [ng/L]	Hypolimnion C_T [ng/L]
	1	1,000,000	4.131	2.412
	0.9	900,000	4.166	2.476
	0.8	800,000	4.207	2.554
	0.7	700,000	4.258	2.648
	0.6	600,000	4.321	2.767
	0.5	500,000	4.402	2.920
	0.4	400,000	4.511	3.125
	0.3	300,000	4.664	3.413
	0.2	200,000	4.895	3.846
	0.1	100,000	5.284	4.575
	0.05	50,000	5.597	5.163
	0.01	10,000	5.956	5.839
	0	0	6.069	6.051

Table 6.6. Comparison of Summary Statistics for Percent Methylmercury: Predicted and Observed Results.

	Percent MeHg in Epilimnion		Percent MeHg in Hypolimnion		Percent MeHg in Sediments	
	Predicted	Observed	Predicted	Observed	Predicted	Observed
Minimum	0	2.8	0.15	0.72	0	0.22
Maximum	43	75	35	39	40	29
Mean	8.6	21	17	9.2	5.7	2.4
Median	6.3	18	16	6.2	4	1.5
Std Dev.	7.5	14	8.8	8.0	5.8	3.6
Range	43	72	35	38	40	29

Table 6.7. Minima for Error Sum of Squares and Associated Standard Deviations and Their Associated R1Up and R2Up Values.

	R1Up	R2Up	Minimum Sum of Squares	Minimum Standard Deviation
EPI MeHg	1.7	0.1	9.03	0.315
EPI HgT	4.2	0.1	211	1.54
HYP MeHg	1.8	0.1	48.1	1.06
HYP HgT	1	1.19	3200	8.65
Fish Tissue	0.1	0.1	3.59	0.276
Sediment HgT	0.1	0.72	3.21	0.194

After Removal of Outliers for EPI MeHg, EPI HgT, and HYP MeHg:

	R1Up	R2Up	Minimum Sum of Squares	Minimum Standard Deviation
EPI MeHg	4.7	0.1	2.96	0.184
EPI HgT	4.6	0.1	206	1.52
HYP MeHg	1.4	0.1	9.67	0.499

Investigating EPI MeHg and HgT.

For MeHg, Removed 3 outlier lakes:

Lake No. 54, Mitchell Lake, was removed because the predicted values greatly exceeded the other lakes.

Lakes No. 69 and 70, Powwow and Robb Reservoir, were removed because they had observed values greatly exceeding the other lakes.

For HgT, Removed 1 outlier lake:

Lake No. 54, Mitchell Lake, was removed because the predicted values greatly exceeded the other lakes.

HYP_MeHg:

Removed 4 outlier lakes because all had observed values greatly exceeding the other lakes: Lakes No. 6 (Branch), 59 (Notch), 64 (Pawtuckaway Lake), and 77 (Spruce Pond).

APPENDIX

Table A-1. Observed Results from the VT/NH REMAP Study.

Lake Name	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	HgT	MeHg	HgT	HgT	HgT
	[ng/L]	[ng/L]	[ng/L]	[ng/L]	[ug/g]	[ug/g]
ADDER POND	0.289	2.143	1.004	15.191		0.166
ARMINGTON LAKE	0.218	0.908			0.231	0.296
BAKER (BARTON)	0.096	0.940	1.649	8.830		0.090
BAKER POND- UPPER	0.290	1.007			0.209	0.255
BEARCAMP POND	0.214	1.124	1.753	8.503	0.321	0.290
BRANCH	0.490	1.776	4.447	25.843		0.480
BRUCE	0.472	1.520				0.170
CAWLEY POND	0.541	0.717				0.210
CHASE POND	0.317	3.358				0.457
CHILDS BOG	0.390	0.692			0.389	0.263
CHITTENDEN	0.113	1.142	0.938	13.430	0.210	0.170
CLUB POND	0.184	0.957				0.180
CRANBERRY MEADOW	0.215	1.118			0.074	0.175
CURTIS	0.175	0.648	0.670	2.569	0.046	0.164
DENNIS	0.101	1.398				0.190
DUNMORE	0.098	0.507			0.111	0.270
DUTCHMAN POND	0.299	1.790				0.110
EASTMAN POND	0.194	1.639	0.388	4.685		0.230
ECHO (CHARTN)	0.072	0.594	0.142	2.094	0.276	0.174
ECHO (HUBDTN)	0.188	0.352	0.263	2.727	0.117	0.282
ELM BROOK POOL	0.100	0.587			0.261	0.110
FERN	0.231	1.035	0.374	5.625	0.163	0.283
FISH POND	0.363	2.680				0.210
FREESES POND- UPPER	0.787	6.910				0.090
GILES POND	0.038	0.511			0.267	0.160
GREAT HOSMER	0.123	0.679	0.394	9.763	0.049	0.200
GREENWOOD POND	0.243	0.600			0.085	0.278
HALL POND- UPPER	0.299	1.890	0.273	7.880		0.390
HARDWICK	0.113	4.040				0.072
HARDWOOD	0.249	1.435			0.417	0.200
HIGH (SUDBRY)	0.175	1.720	1.415	8.522		0.315
HILDRETH DAM POND	0.349	1.960	1.005	8.775		0.195
HORN POND	0.141	1.506	0.163	5.580	0.215	0.166
HORTONIA	0.166	0.656	0.127	1.266	0.132	0.268
HOWE RESERVOIR	0.241	1.168			0.386	0.220
ISLAND POND	0.295	1.578	0.379	2.421	0.382	0.363
IVANHOE- LAKE	0.209	1.790				0.140
JACKSONVILLE	0.588	2.410			0.255	0.187
JENNESS POND	0.475	3.101			0.215	0.195

	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	**HgT**	**MeHg**	**HgT**	**HgT**	**HgT**
KENT	0.177	1.370				0.180
LARY POND	0.298	4.010				0.220
LEFFERTS	0.260	1.868			0.115	0.220
LILY POND	0.510	6.380				0.280
LITTLE AVERILL	0.201	0.501	0.353	6.678		0.240
LONG (WESTMR)	0.067	0.817	0.288	2.015		0.140
LOON LAKE	0.520	0.861	0.552	29.786	0.189	0.140
LOVELL LAKE- STN 1	0.318	0.503	0.277	4.711	0.117	0.190
LYFORD	0.305	0.946	0.205	7.992	0.156	0.190
MANSFIELD	0.243	0.950				0.290
MCCONNELL	0.180	1.962				0.280
MILLSFIELD POND	0.336	2.152				0.170
MILTON	0.142	1.214			0.087	0.244
MINARDS	0.230	2.422	0.448	3.784		0.237
MITCHELL	0.264	4.115				0.185
MOOSE POND	0.665	3.840				0.190
MOUNTAIN LAKE-UPPER	0.095	0.396				0.170
NEWARK	0.165	1.066	0.584	13.346	0.076	0.256
NORTH (BRKFLD)	0.136	0.846			0.225	0.142
NOTCH	0.329	5.296	3.186	13.660		0.622
NOYES	0.269	2.581				0.270
PARAN	0.231	1.242				0.133
PARKER	0.217	1.741	0.156	4.911	0.233	0.110
PAUGUS BAY- STN 1	0.141	3.120	0.051	5.210		0.210
PAWTUCKAWAY LAKE	0.187	2.257	2.908	20.741	0.204	0.290
PEMIGEWASSET LAKE	0.456	2.057	1.213	8.703	0.331	0.163
PERCH (BENSON)	0.162	0.586	0.573	9.468	0.190	0.300
PLEASANT VALLEY	0.262	0.845				0.310
POUT POND	0.665	2.140				0.190
POWWOW POND	1.813	5.872	0.822	4.540	0.308	0.175
ROBB RESERVOIR	1.272	2.900			0.468	0.188
ROUND POND	0.287	0.690	0.433	29.604	0.233	0.370
SABIN	0.223	1.216	0.326	6.540	0.128	0.135
SHAWS POND	0.177	0.577				0.170
SILVER LAKE	0.077	2.224	0.195	27.134	0.462	0.237
SOMERSET	0.116	1.885	0.165	6.402	0.463	0.256
SOUTH AMERICA	0.695	3.140				0.125
SPRUCE POND	0.327	1.456	4.454	11.518		0.370
STRATTON	0.073	1.090				0.310

	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	**HgT**	**MeHg**	**HgT**	**HgT**	**HgT**
SUNCOOK POND-UPPER	0.107	1.380	0.733	12.303	0.331	0.257
SUNRISE LAKE	0.266	0.788			0.156	0.229
SUNSET (BRKFLD)	0.232	0.451	0.344	10.277	0.156	0.190
TRIO PONDS- ONE AND TWO	0.300	2.267	0.178	4.750		0.608
TUTTLE (HARDWK)	0.502	2.930				0.180
UNNAMED POND	0.408	1.027				0.128
WALKER POND	0.155	0.932	0.892	14.282	0.172	0.225
WILLEY POND- BIG	0.169	0.867				0.380
WILLEY POND- LITTLE	0.386	0.712				0.230
WILLOUGHBY	0.183	1.116	0.265	5.267	0.068	0.128
WILSON POND	0.218	0.835			0.100	0.550
WOLCOTT	0.322	1.132	0.303	5.659	0.696	0.215
ZEPHYR LAKE	0.213	0.899	0.221	19.048	0.112	0.140

Table A-2. Predicted Results for the Default Run

Lake Name	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	HgT	MeHg	HgT	HgT	HgT
	[ng/L]	[ng/L]	[ng/L]	[ng/L]	[ug/g]	[ug/g]
ADDER POND	0.240	1.190	1.556	5.458	0.190	0.020
ARMINGTON LAKE	0.070	1.110			0.260	0.110
BAKER (BARTON)	0.180	1.060	1.180	5.267	0.110	0.010
BAKER POND- UPPER	0.240	1.640			0.390	0.070
BEARCAMP POND	0.190	1.970	0.609	2.528	0.170	0.040
BRANCH	0.490	4.160	1.817	5.666	0.650	0.090
BRUCE	0.780	5.070			0.760	0.110
CAWLEY POND	0.570	2.770			0.920	0.100
CHASE POND	0.780	5.070			0.760	0.110
CHILDS BOG	0.570	2.770			0.920	0.100
CHITTENDEN	0.140	1.280	0.963	3.007	0.220	0.050
CLUB POND	0.840	5.390			1.200	0.120
CRANBERRY MEADOW	0.130	1.130			0.180	0.030
CURTIS	0.180	1.060	1.180	5.267	0.110	0.010
DENNIS	0.260	2.330			0.250	0.050
DUNMORE	0.070	1.110			0.260	0.110
DUTCHMAN POND	0.370	2.910			1.970	0.300
EASTMAN POND	0.150	0.940	1.044	3.807	0.100	0.020
ECHO (CHARTN)	0.030	0.460	0.197	1.122	0.090	0.020
ECHO (HUBDTN)	0.130	1.130	0.769	3.319	0.180	0.030
ELM BROOK POOL	0.240	1.640			0.390	0.070
FERN	0.060	0.670	0.152	1.201	0.140	0.020
FISH POND	0.350	2.130			0.320	0.040
FREESES POND- UPPER	0.600	1.830			0.400	0.030
GILES POND	0.290	2.510			1.130	0.240
GREAT HOSMER	0.090	0.640	0.558	3.080	0.050	0.010
GREENWOOD POND	0.230	1.240			0.640	0.010
HALL POND- UPPER	0.490	4.160	1.818	5.667	0.650	0.090
HARDWICK	0.160	0.770			0.100	0.010
HARDWOOD	0.780	5.070			0.760	0.110
HIGH (SUDBRY)	0.180	1.060	1.180	5.267	0.110	0.010
HILDRETH DAM POND	0.290	1.980	1.938	5.100	0.450	0.080
HORN POND	0.070	1.110	0.572	2.459	0.260	0.110
HORTONIA	0.060	0.560	0.318	1.636	0.080	0.010
HOWE RESERVOIR	0.280	2.520			0.410	0.060
ISLAND POND	0.190	2.100	0.727	2.714	0.260	0.050
IVANHOE- LAKE	0.110	1.390			0.440	0.140
JACKSONVILLE	0.780	5.070			0.760	0.110
JENNESS POND	0.070	1.110			0.260	0.110

	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	**HgT**	**MeHg**	**HgT**	**HgT**	**HgT**
KENT	0.210	1.300			0.310	0.030
LARY POND	0.600	1.830			0.400	0.030
LEFFERTS	0.570	2.770			0.920	0.100
LILY POND	0.760	1.980			0.630	0.030
LITTLE AVERILL	0.030	0.460	0.197	1.122	0.090	0.020
LONG (WESTMR)	0.050	0.920	0.270	2.235	0.180	0.040
LOON LAKE	0.140	1.910	0.897	3.706	0.720	0.210
LOVELL LAKE- STN 1	0.140	1.280	0.963	3.007	0.220	0.050
LYFORD	0.130	1.130	0.769	3.319	0.180	0.030
MANSFIELD	0.490	4.160			0.650	0.090
MCCONNELL	0.480	3.970			0.460	0.090
MILLSFIELD POND	0.260	2.330			0.250	0.050
MILTON	0.570	2.770			0.920	0.100
MINARDS	0.290	1.980	1.938	5.099	0.450	0.080
MITCHELL	0.090	1.020			0.300	0.040
MOOSE POND	0.780	5.070			0.760	0.110
MOUNTAIN LAKE-UPPER	0.780	5.070			0.760	0.110
NEWARK	0.030	0.460	0.197	1.122	0.090	0.020
NORTH (BRKFLD)	0.130	1.130			0.180	0.030
NOTCH	0.480	3.970	1.567	5.286	0.460	0.090
NOYES	0.780	5.070			0.760	0.110
PARAN	0.210	1.300			0.310	0.030
PARKER	0.060	0.560	0.318	1.636	0.080	0.010
PAUGUS BAY- STN 1	0.140	1.280	0.963	3.007	0.220	0.050
PAWTUCKAWAY LAKE	0.190	1.970	0.609	2.538	0.170	0.040
PEMIGEWASSET LAKE	0.190	1.970	0.609	2.538	0.170	0.040
PERCH (BENSON)	0.130	1.130	0.769	3.319	0.180	0.030
PLEASANT VALLEY	0.210	1.300			0.310	0.030
POUT POND	0.600	1.830			0.400	0.030
POWWOW POND	0.170	1.950	0.200	1.368	0.140	0.040
ROBB RESERVOIR	0.280	2.520			0.410	0.060
ROUND POND	0.130	1.770	0.794	3.900	0.510	0.170
SABIN	0.060	0.560	0.318	1.636	0.080	0.010
SHAWS POND	0.090	1.020			0.300	0.040
SILVER LAKE	0.080	1.320	0.690	2.291	0.410	0.150
SOMERSET	0.150	1.390	1.083	3.040	0.330	0.060
SOUTH AMERICA	0.780	5.070			0.760	0.110
SPRUCE POND	0.240	1.190	1.556	5.458	0.190	0.020
STRATTON	0.570	2.770			0.920	0.100

	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	**HgT**	**MeHg**	**HgT**	**HgT**	**HgT**
SUNCOOK POND- UPPER	0.190	1.970	0.609	2.538	0.170	0.040
SUNRISE LAKE	0.240	1.640			0.390	0.070
SUNSET (BRKFLD)	0.130	1.130	0.769	3.319	0.180	0.030
TRIO PONDS- ONE AND TWO	0.490	4.160	1.817	5.666	0.650	0.090
TUTTLE (HARDWK)	0.220	1.230			0.110	0.010
UNNAMED POND	0.840	5.390			1.200	0.120
WALKER POND	0.190	1.970	0.609	2.538	0.170	0.040
WILLEY POND- BIG	0.370	2.910			1.970	0.300
WILLEY POND- LITTLE	0.090	1.020			0.300	0.040
WILLOUGHBY	0.030	0.460	0.197	1.133	0.090	0.020
WILSON POND	0.570	2.770			0.920	0.100
WOLCOTT	0.480	3.970	1.567	5.385	0.460	0.090
ZEPHYR LAKE	0.290	1.980	1.938	5.099	0.450	0.080

Table A-3. Predicted Results for Tier 1.

Lake Name	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	HgT	MeHg	HgT	HgT	HgT
	[ng/L]	[ng/L]	[ng/L]	[ng/L]	[ug/g]	[ug/g]
ADDER POND	0.120	0.670	0.773	3.635	0.110	0.020
ARMINGTON LAKE	0.040	0.830			0.180	0.090
BAKER (BARTON)	0.090	0.660	0.554	3.115	0.070	0.010
BAKER POND- UPPER	0.020	0.340			0.070	0.020
BEARCAMP POND	0.010	0.330	0.126	1.035	0.040	0.020
BRANCH	0.160	1.710	1.254	3.717	0.700	0.090
BRUCE	0.080	0.910			0.190	0.040
CAWLEY POND	0.000	0.100			0.020	0.010
CHASE POND	0.000	0.120			0.020	0.010
CHILDS BOG	0.560	1.870			1.560	0.120
CHITTENDEN	0.070	0.680	0.669	2.687	0.170	0.040
CLUB POND	0.020	0.400			0.070	0.020
CRANBERRY MEADOW	0.020	0.330			0.060	0.020
CURTIS	0.080	0.530	0.425	3.819	0.090	0.020
DENNIS	0.000	0.130			0.010	0.010
DUNMORE	0.050	0.710			0.160	0.060
DUTCHMAN POND	0.280	2.580			1.200	0.240
EASTMAN POND	0.040	0.350	0.293	2.197	0.050	0.010
ECHO (CHARTN)	0.040	0.590	0.260	1.806	0.120	0.040
ECHO (HUBDTN)	0.100	0.920	0.739	3.631	0.210	0.020
ELM BROOK POOL	0.000	0.030			0.000	0.000
FERN	0.030	0.520	0.089	0.835	0.120	0.020
FISH POND	0.020	0.390			0.040	0.010
FREESES POND- UPPER	0.000	0.070			0.010	0.000
GILES POND	0.000	0.080			0.010	0.010
GREAT HOSMER	0.080	0.600	0.326	3.362	0.070	0.010
GREENWOOD POND	0.210	0.830			0.350	0.020
HALL POND- UPPER	0.260	1.920	1.870	4.391	0.680	0.100
HARDWICK	0.000	0.040			0.000	0.000
HARDWOOD	0.420	2.470			1.050	0.120
HIGH (SUDBRY)	0.100	0.600	0.541	4.595	0.110	0.020
HILDRETH DAM POND	0.020	0.290	0.179	1.076	0.050	0.020
HORN POND	0.010	0.270	0.080	0.861	0.040	0.020
HORTONIA	0.060	0.540	0.402	2.159	0.110	0.020
HOWE RESERVOIR	0.030	0.460			0.090	0.020
ISLAND POND	0.000	0.030	0.002	18.728	0.000	0.000
IVANHOE- LAKE	0.210	2.190			0.920	0.240
JACKSONVILLE	0.000	0.090			0.010	0.000
JENNESS POND	0.050	0.880			0.200	0.100

	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	HgT	MeHg	HgT	HgT	HgT
KENT	0.050	0.540			0.140	0.020
LARY POND	0.030	0.250			0.040	0.010
LEFFERTS	0.010	0.200			0.050	0.010
LILY POND	0.560	1.340			0.540	0.030
LITTLE AVERILL	0.070	1.350	0.270	2.326	0.120	0.060
LONG (WESTMR)	0.070	1.020	0.404	3.297	0.280	0.070
LOON LAKE	0.080	1.400	0.464	2.271	0.330	0.140
LOVELL LAKE- STN 1	0.130	0.920	1.259	3.958	0.280	0.060
LYFORD	0.070	0.790	0.514	2.770	0.140	0.020
MANSFIELD	0.030	0.570			0.120	0.030
MCCONNELL	0.010	0.330			0.030	0.010
MILLSFIELD POND	0.010	0.310			0.040	0.020
MILTON	0.270	1.320			0.600	0.060
MINARDS	0.190	1.090	1.697	5.182	0.500	0.080
MITCHELL	0.080	0.990			0.270	0.040
MOOSE POND	0.030	0.510			0.070	0.020
MOUNTAIN LAKE-UPPER	0.030	0.430			0.080	0.020
NEWARK	0.040	0.530	0.237	1.395	0.110	0.020
NORTH (BRKFLD)	0.020	0.350			0.050	0.010
NOTCH	0.060	0.960	0.316	1.350	0.100	0.030
NOYES	0.010	0.250			0.030	0.010
PARAN	0.010	0.210			0.030	0.010
PARKER	0.030	0.430	0.241	1.607	0.070	0.010
PAUGUS BAY- STN 1	0.010	0.230	0.164	1.098	0.050	0.020
PAWTUCKAWAY LAKE	0.060	0.830	0.386	1.710	0.120	0.040
PEMIGEWASSET LAKE	0.050	0.690	0.364	1.541	0.120	0.040
PERCH (BENSON)	0.180	1.180	1.478	5.209	0.390	0.060
PLEASANT VALLEY	0.120	0.730			0.370	0.040
POUT POND	0.410	1.000			0.430	0.030
POWWOW POND	0.000	0.060		0.024	0.000	0.000
ROBB RESERVOIR	0.000	0.110			0.010	0.000
ROUND POND	0.070	1.310	0.426	2.573	0.270	0.120
SABIN	0.020	0.280	0.145	1.457	0.040	0.010
SHAWS POND	0.140	1.530			0.570	0.140
SILVER LAKE	0.050	0.660	0.411	2.289	0.200	0.050
SOMERSET	0.080	0.790	0.725	2.193	0.210	0.060
SOUTH AMERICA	0.040	0.670			0.170	0.030
SPRUCE POND	0.160	0.830	1.217	4.326	0.160	0.020
STRATTON	0.590	2.200			1.410	0.120

	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	HgT	MeHg	HgT	HgT	HgT
SUNCOOK POND-UPPER	0.010	0.250	0.080	1.067	0.030	0.010
SUNRISE LAKE	0.150	1.040			0.410	0.060
SUNSET (BRKFLD)	0.000	0.120	0.058	1.375	0.020	0.010
TRIO PONDS- ONE AND TWO	0.190	1.830	1.289	3.443	0.510	0.080
TUTTLE (HARDWK)	0.070	0.430			0.050	0.010
UNNAMED POND	0.030	0.510			0.170	0.020
WALKER POND	0.040	0.590	0.284	1.458	0.090	0.030
WILLEY POND- BIG	0.370	1.190			3.990	0.320
WILLEY POND- LITTLE	0.100	0.880			0.580	0.040
WILLOUGHBY	0.050	0.570	0.355	1.805	0.170	0.030
WILSON POND	0.260	1.310			0.640	0.080
WOLCOTT	0.140	1.440	0.951	2.869	0.310	0.070
ZEPHYR LAKE	0.110	0.900	1.057	2.988	0.270	0.060

Table A-4. Predicted Results for Tier 2.

Lake Name	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	HgT	MeHg	HgT	HgT	HgT
	[ng/L]	[ng/L]	[ng/L]	[ng/L]	[ug/g]	[ug/g]
ADDER POND	0.120	0.630	0.959	4.495	0.110	0.020
ARMINGTON LAKE	0.050	0.780			0.180	0.080
BAKER (BARTON)	0.090	0.620	0.531	2.958	0.070	0.010
BAKER POND- UPPER	0.020	0.320			0.070	0.020
BEARCAMP POND	0.020	0.310	0.164	1.220	0.040	0.020
BRANCH	0.150	1.590	1.925	5.699	0.680	0.080
BRUCE	0.080	0.850			0.190	0.040
CAWLEY POND	0.000	0.090			0.020	0.010
CHASE POND	0.000	0.110			0.020	0.010
CHILDS BOG	0.530	1.740			1.470	0.120
CHITTENDEN	0.070	0.630	0.837	3.370	0.160	0.040
CLUB POND	0.020	0.380			0.070	0.020
CRANBERRY MEADOW	0.020	0.310			0.060	0.020
CURTIS	0.080	0.500	0.487	4.366	0.080	0.010
DENNIS	0.000	0.120			0.010	0.010
DUNMORE	0.050	0.670			0.170	0.050
DUTCHMAN POND	0.260	2.400			1.140	0.230
EASTMAN POND	0.040	0.330	0.338	2.497	0.050	0.010
ECHO (CHARTN)	0.040	0.560	0.301	2.044	0.130	0.030
ECHO (HUBDTN)	0.100	0.870	0.924	4.386	0.210	0.020
ELM BROOK POOL	0.000	0.020			0.000	0.000
FERN	0.030	0.480	0.106	1.003	0.110	0.020
FISH POND	0.020	0.370			0.040	0.010
FREESES POND- UPPER	0.000	0.070			0.010	0.000
GILES POND	0.000	0.080			0.010	0.010
GREAT HOSMER	0.080	0.560	0.365	3.729	0.070	0.010
GREENWOOD POND	0.200	0.770			0.330	0.020
HALL POND- UPPER	0.250	1.790	2.354	5.486	0.660	0.100
HARDWICK	0.000	0.040			0.000	0.000
HARDWOOD	0.410	2.300			1.000	0.110
HIGH (SUDBRY)	0.100	0.570	0.706	6.017	0.100	0.020
HILDRETH DAM POND	0.020	0.270	0.205	1.173	0.050	0.020
HORN POND	0.010	0.260	0.093	0.885	0.040	0.020
HORTONIA	0.060	0.510	0.469	2.521	0.120	0.010
HOWE RESERVOIR	0.030	0.430			0.090	0.020
ISLAND POND	0.000	0.030	0.002	18.727	0.000	0.000
IVANHOE- LAKE	0.200	2.040			0.880	0.220
JACKSONVILLE	0.000	0.080			0.010	0.000
JENNESS POND	0.050	0.820			0.190	0.090

	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	HgT	MeHg	HgT	HgT	HgT
KENT	0.050	0.510			0.140	0.020
LARY POND	0.030	0.230			0.040	0.010
LEFFERTS	0.010	0.180			0.050	0.010
LILY POND	0.530	1.250			0.510	0.030
LITTLE AVERILL	0.070	1.260	0.347	3.016	0.120	0.050
LONG (WESTMR)	0.070	0.950	0.522	4.282	0.280	0.060
LOON LAKE	0.080	1.310	0.547	2.651	0.320	0.130
LOVELL LAKE- STN 1	0.130	0.860	1.461	4.573	0.270	0.050
LYFORD	0.070	0.740	0.578	3.030	0.140	0.020
MANSFIELD	0.040	0.530			0.120	0.030
MCCONNELL	0.010	0.310			0.030	0.010
MILLSFIELD POND	0.020	0.290			0.040	0.010
MILTON	0.260	1.230			0.570	0.060
MINARDS	0.190	1.020	1.932	5.879	0.480	0.080
MITCHELL	0.080	0.930			0.270	0.030
MOOSE POND	0.030	0.480			0.070	0.020
MOUNTAIN LAKE- UPPER	0.030	0.400			0.080	0.020
NEWARK	0.040	0.500	0.292	1.658	0.120	0.020
NORTH (BRKFLD)	0.020	0.330			0.050	0.010
NOTCH	0.060	0.900	0.408	1.727	0.100	0.030
NOYES	0.010	0.230			0.030	0.010
PARAN	0.010	0.190			0.030	0.010
PARKER	0.040	0.400	0.254	1.550	0.070	0.010
PAUGUS BAY- STN 1	0.010	0.220	0.254	1.550	0.050	0.020
PAWTUCKAWAY LAKE	0.060	0.780	0.442	1.889	0.120	0.040
PEMIGEWASSET LAKE	0.050	0.650	0.417	1.719	0.120	0.040
PERCH (BENSON)	0.180	1.100	1.766	6.235	0.380	0.060
PLEASANT VALLEY	0.120	0.690			0.360	0.040
POUT POND	0.390	0.930			0.410	0.020
POWWOW POND	0.000	0.060	0.000	0.024	0.000	0.000
ROBB RESERVOIR	0.000	0.100			0.010	0.000
ROUND POND	0.080	1.220	0.472	2.768	0.260	0.110
SABIN	0.020	0.260	0.171	1.662	0.050	0.010
SHAWS POND	0.140	1.430			0.550	0.130
SILVER LAKE	0.060	0.620	0.526	2.901	0.210	0.040
SOMERSET	0.080	0.740	0.703	2.092	0.210	0.050
SOUTH AMERICA	0.040	0.620			0.170	0.020
SPRUCE POND	0.160	0.770	1.118	3.935	0.150	0.020
STRATTON	0.560	2.050			1.330	0.110

	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	HgT	MeHg	HgT	HgT	HgT
SUNCOOK POND-UPPER	0.010	0.230	0.095	1.191	0.030	0.010
SUNRISE LAKE	0.150	0.970			0.390	0.060
SUNSET (BRKFLD)	0.000	0.120	0.066	1.403	0.020	0.010
TRIO PONDS- ONE AND TWO	0.190	1.700	1.823	4.892	0.490	0.080
TUTTLE (HARDWK)	0.070	0.400			0.050	0.010
UNNAMED POND	0.030	0.480			0.170	0.020
WALKER POND	0.040	0.550	0.335	1.654	0.090	0.030
WILLEY POND- BIG	0.350	1.110			3.780	0.300
WILLEY POND- LITTLE	0.100	0.830			0.600	0.040
WILLOUGHBY	0.050	0.540	0.384	1.751	0.180	0.030
WILSON POND	0.250	1.220			0.610	0.070
WOLCOTT	0.140	1.350	1.156	3.748	0.300	0.060
ZEPHYR LAKE	0.110	0.840	1.368	3.839	0.260	0.050

Table A-5. Predicted Results for Tier 3.

Lake Name	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	HgT	MeHg	HgT	HgT	HgT
	[ng/L]	[ng/L]	[ng/L]	[ng/L]	[ug/g]	[ug/g]
ADDER POND	0.150	0.830	0.959	4.495	0.140	0.020
ARMINGTON LAKE	0.050	0.960			0.210	0.100
BAKER (BARTON)	0.090	0.620	0.531	2.958	0.070	0.010
BAKER POND- UPPER	0.030	0.350			0.080	0.020
BEARCAMP POND	0.020	0.420	0.164	1.220	0.050	0.020
BRANCH	0.240	2.630	1.926	5.699	1.080	0.140
BRUCE	0.100	1.060			0.220	0.040
CAWLEY POND	0.000	0.110			0.020	0.010
CHASE POND	0.000	0.140			0.020	0.010
CHILDS BOG	0.770	2.560			2.130	0.170
CHITTENDEN	0.090	0.850	0.837	3.370	0.210	0.050
CLUB POND	0.030	0.540			0.100	0.020
CRANBERRY MEADOW	0.020	0.390			0.070	0.020
CURTIS	0.100	0.600	0.487	4.366	0.100	0.020
DENNIS	0.000	0.120			0.010	0.010
DUNMORE	0.060	0.870			0.200	0.070
DUTCHMAN POND	0.320	2.960			1.390	0.280
EASTMAN POND	0.050	0.400	0.338	2.497	0.050	0.010
ECHO (CHARTN)	0.040	0.670	0.301	2.044	0.140	0.040
ECHO (HUBDTN)	0.120	1.170	0.924	4.586	0.270	0.030
ELM BROOK POOL	0.000	0.030			0.000	0.000
FERN	0.040	0.620	0.106	1.003	0.140	0.020
FISH POND	0.020	0.470			0.050	0.010
FREESES POND- UPPER	0.000	0.090			0.010	0.000
GILES POND	0.000	0.090			0.020	0.010
GREAT HOSMER	0.090	0.660	0.365	3.729	0.080	0.010
GREENWOOD POND	0.200	0.770			0.330	0.020
HALL POND- UPPER	0.320	2.390	2.354	5.486	0.860	0.130
HARDWICK	0.000	0.040			0.000	0.000
HARDWOOD	0.480	2.750			1.180	0.130
HIGH (SUDBRY)	0.140	0.790	0.706	6.017	0.140	0.020
HILDRETH DAM POND	0.020	0.330	0.205	1.173	0.050	0.020
HORN POND	0.010	0.280	0.093	0.885	0.040	0.030
HORTONIA	0.070	0.630	0.469	2.521	0.130	0.020
HOWE RESERVOIR	0.030	0.630			0.120	0.030
ISLAND POND	0.000	0.030	0.002	18.727	0.000	0.000
IVANHOE- LAKE	0.260	2.670			1.130	0.290
JACKSONVILLE	0.000	0.120			0.020	0.010
JENNESS POND	0.060	1.060			0.240	0.120

	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	HgT	MeHg	HgT	HgT	HgT
KENT	0.070	0.740			0.200	0.030
LARY POND	0.040	0.300			0.050	0.010
LEFFERTS	0.020	0.270			0.080	0.020
LILY POND	0.590	1.390			0.560	0.030
LITTLE AVERILL	0.090	1.750	0.347	3.016	0.160	0.080
LONG (WESTMR)	0.090	1.330	0.522	4.282	0.360	0.090
LOON LAKE	0.090	1.640	0.547	2.651	0.390	0.160
LOVELL LAKE- STN 1	0.150	1.060	1.461	4.573	0.320	0.060
LYFORD	0.080	0.850	0.578	3.030	0.160	0.020
MANSFIELD	0.050	0.780			0.160	0.050
MCCONNELL	0.020	0.430			0.040	0.020
MILLSFIELD POND	0.020	0.420			0.050	0.020
MILTON	0.330	1.620			0.730	0.080
MINARDS	0.220	1.240	1.932	5.879	0.570	0.090
MITCHELL	0.080	0.930			0.270	0.030
MOOSE POND	0.040	0.690			0.090	0.030
MOUNTAIN LAKE-UPPER	0.030	0.490			0.090	0.020
NEWARK	0.050	0.630	0.292	1.658	0.130	0.020
NORTH (BRKFLD)	0.020	0.410			0.060	0.010
NOTCH	0.070	1.260	0.408	1.727	0.130	0.040
NOYES	0.010	0.320			0.040	0.010
PARAN	0.010	0.260			0.040	0.010
PARKER	0.040	0.400	0.254	1.550	0.070	0.010
PAUGUS BAY- STN 1	0.010	0.230	0.169	1.104	0.060	0.020
PAWTUCKAWAY LAKE	0.070	0.920	0.442	1.889	0.140	0.040
PEMIGEWASSET LAKE	0.050	0.770	0.417	1.719	0.140	0.040
PERCH (BENSON)	0.210	1.410	1.766	6.235	0.470	0.070
PLEASANT VALLEY	0.170	1.010			0.510	0.060
POUT POND	0.450	1.090			0.480	0.030
POWWOW POND	0.000	0.060		0.024	0.000	0.000
ROBB RESERVOIR	0.000	0.150			0.020	0.010
ROUND POND	0.080	1.390	0.472	2.768	0.300	0.130
SABIN	0.020	0.330	0.171	1.662	0.050	0.020
SHAWS POND	0.180	1.910			0.710	0.170
SILVER LAKE	0.070	0.830	0.526	2.901	0.260	0.060
SOMERSET	0.080	0.740	0.703	2.092	0.210	0.050
SOUTH AMERICA	0.060	0.910			0.220	0.040
SPRUCE POND	0.150	0.740	1.118	3.935	0.150	0.020
STRATTON	0.890	3.310			2.130	0.180

	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	**HgT**	**MeHg**	**HgT**	**HgT**	**HgT**
SUNCOOK POND- UPPER	0.010	0.290	0.095	1.191	0.030	0.010
SUNRISE LAKE	0.200	1.350			0.530	0.080
SUNSET (BRKFLD)	0.010	0.130	0.066	1.403	0.020	0.010
TRIO PONDS- ONE AND TWO	0.270	2.620	1.823	4.892	0.720	0.120
TUTTLE (HARDWK)	0.070	0.420			0.050	0.010
UNNAMED POND	0.040	0.690			0.230	0.030
WALKER POND	0.040	0.670	0.335	1.654	0.110	0.040
WILLEY POND- BIG	0.480	1.570			5.260	0.430
WILLEY POND- LITTLE	0.110	0.880			0.630	0.040
WILLOUGHBY	0.050	0.540	0.384	1.751	0.180	0.030
WILSON POND	0.280	1.380			0.680	0.080
WOLCOTT	0.180	1.750	1.156	3.478	0.380	0.080
ZEPHYR LAKE	0.150	1.160	1.368	3.839	0.360	0.080

Table A-6. Predicted Results for Tier 4.

Lake Name	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	HgT	MeHg	HgT	HgT	HgT
	[ng/L]	[ng/L]	[ng/L]	[ng/L]	[ug/g]	[ug/g]
ADDER POND	0.140	0.840	0.937	4.439	0.140	0.020
ARMINGTON LAKE	0.040	0.890			0.170	0.100
BAKER (BARTON)	0.130	0.990	0.811	4.566	0.110	0.020
BAKER POND- UPPER	0.040	0.550			0.110	0.030
BEARCAMP POND	0.030	0.830	0.293	2.057	0.090	0.040
BRANCH	0.260	3.040	2.131	6.487	1.200	0.160
BRUCE	0.110	1.340			0.260	0.060
CAWLEY POND	0.040	1.100			0.220	0.080
CHASE POND	0.030	1.320			0.180	0.070
CHILDS BOG	0.660	2.250			1.840	0.150
CHITTENDEN	0.100	1.040	0.950	4.009	0.240	0.070
CLUB POND	0.070	1.370			0.250	0.060
CRANBERRY MEADOW	0.080	1.530			0.270	0.080
CURTIS	0.110	0.720	0.560	5.103	0.110	0.020
DENNIS	0.010	0.190			0.020	0.010
DUNMORE	0.060	1.040			0.200	0.080
DUTCHMAN POND	0.220	2.180			0.990	0.210
EASTMAN POND	0.050	0.450	0.368	2.750	0.060	0.020
ECHO (CHARTN)	0.090	1.840	0.628	5.361	0.300	0.120
ECHO (HUBDTN)	0.110	1.190	0.847	4.513	0.250	0.030
ELM BROOK POOL	0.010	0.480			0.060	0.030
FERN	0.050	0.800	0.145	1.689	0.180	0.030
FISH POND	0.040	0.950			0.090	0.030
FREESES POND- UPPER	0.030	0.430			0.070	0.010
GILES POND	0.020	0.810			0.150	0.090
GREAT HOSMER	0.070	0.570	0.298	3.154	0.060	0.010
GREENWOOD POND	0.170	0.650			0.280	0.020
HALL POND- UPPER	0.260	2.080	1.945	4.675	0.710	0.110
HARDWICK	0.010	0.360			0.040	0.010
HARDWOOD	0.440	2.650			1.090	0.130
HIGH (SUDBRY)	0.120	0.740	0.637	5.511	0.120	0.020
HILDRETH DAM POND	0.050	1.120	0.649	2.985	0.170	0.070
HORN POND	0.030	1.090	0.294	2.119	0.140	0.100
HORTONIA	0.060	0.690	0.447	2.672	0.130	0.020
HOWE RESERVOIR	0.050	0.980			0.170	0.050
ISLAND POND	0.000	0.060	0.011	18.776	0.000	0.000
IVANHOE- LAKE	0.160	1.690			0.690	0.180
JACKSONVILLE	0.020	0.750			0.100	0.040
JENNESS POND	0.050	1.010			0.210	0.110

	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	**HgT**	**MeHg**	**HgT**	**HgT**	**HgT**
KENT	0.100	1.150			0.280	0.050
LARY POND	0.110	0.880			0.160	0.030
LEFFERTS	0.050	0.910			0.250	0.070
LILY POND	0.390	0.940			0.380	0.020
LITTLE AVERILL	0.060	1.480	0.263	2.520	0.120	0.060
LONG (WESTMR)	0.070	1.170	0.403	3.674	0.280	0.080
LOON LAKE	0.100	2.030	0.630	3.195	0.450	0.200
LOVELL LAKE- STN 1	0.110	0.840	1.090	3.551	0.240	0.050
LYFORD	0.070	0.840	0.504	2.887	0.140	0.020
MANSFIELD	0.110	2.280			0.420	0.140
MCCONNELL	0.040	1.050			0.090	0.040
MILLSFIELD POND	0.020	0.740			0.080	0.040
MILTON	0.340	1.770			0.780	0.090
MINARDS	0.150	0.910	1.365	4.232	0.400	0.070
MITCHELL	0.420	5.930			1.440	0.210
MOOSE POND	0.040	0.840			0.100	0.030
MOUNTAIN LAKE-UPPER	0.060	1.270			0.210	0.070
NEWARK	0.020	0.440	0.157	1.125	0.070	0.020
NORTH (BRKFLD)	0.040	0.830			0.110	0.030
NOTCH	0.100	1.790	0.567	2.386	0.180	0.060
NOYES	0.040	1.400			0.150	0.060
PARAN	0.110	2.380			0.390	0.070
PARKER	0.040	0.560	0.281	2.038	0.080	0.010
PAUGUS BAY- STN 1	0.140	2.700	1.861	7.698	0.620	0.260
PAWTUCKAWAY LAKE	0.070	1.090	0.498	2.204	0.160	0.050
PEMIGEWASSET LAKE	0.050	0.840	0.411	1.817	0.140	0.050
PERCH (BENSON)	0.160	1.110	1.324	4.820	0.350	0.060
PLEASANT VALLEY	0.260	1.680			0.810	0.100
POUT POND	0.360	0.900			0.390	0.020
POWWOW POND	0.000	0.190	0.002	0.156	0.000	0.000
ROBB RESERVOIR	0.010	0.290			0.030	0.010
ROUND POND	0.060	1.030	0.328	2.030	0.210	0.090
SABIN	0.060	1.310	0.596	5.640	0.190	0.070
SHAWS POND	0.220	2.450			0.880	0.230
SILVER LAKE	0.040	0.610	0.321	2.063	0.160	0.040
SOMERSET	0.090	0.860	0.776	2.365	0.230	0.060
SOUTH AMERICA	0.060	1.110			0.260	0.040
SPRUCE POND	0.110	0.570	0.854	3.019	0.110	0.010
STRATTON	0.670	2.500			1.600	0.140

	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	**HgT**	**MeHg**	**HgT**	**HgT**	**HgT**
SUNCOOK POND- UPPER	0.040	1.110	0.335	3.452	0.120	0.040
SUNRISE LAKE	0.170	1.190			0.460	0.070
SUNSET (BRKFLD)	0.020	0.540	0.267	2.325	0.080	0.040
TRIO PONDS- ONE AND TWO	0.240	2.560	1.679	4.677	0.660	0.120
TUTTLE (HARDWK)	0.070	0.440			0.050	0.010
UNNAMED POND	0.040	0.710			0.210	0.030
WALKER POND	0.070	1.170	0.538	2.718	0.180	0.060
WILLEY POND- BIG	0.410	1.370			4.510	0.370
WILLEY POND- LITTLE	0.110	0.880			0.630	0.040
WILLOUGHBY	0.030	0.490	0.260	1.498	0.120	0.020
WILSON POND	0.270	1.370			0.660	0.080
WOLCOTT	0.180	1.910	1.189	3.715	0.390	0.090
ZEPHYR LAKE	0.160	1.280	1.189	3.715	0.380	0.090

Table A-7. Predicted Results for Tier 5.

Lake Name	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	HgT	MeHg	HgT	HgT	HgT
	[ng/L]	[ng/L]	[ng/L]	[ng/L]	[ug/g]	[ug/g]
ADDER POND	0.11	0.72	0.754	3.696	0.11	0.02
ARMINGTON LAKE	0.04	0.84			0.16	0.09
BAKER (BARTON)	0.05	0.56	0.363	2.566	0.05	0.01
BAKER POND- UPPER	0.06	0.72			0.16	0.04
BEARCAMP POND	0.02	0.66	0.22	1.759	0.07	0.04
BRANCH	0.09	1.55	0.861	3.161	0.48	0.08
BRUCE	0.11	1.34			0.26	0.06
CAWLEY POND	0.02	0.84			0.16	0.06
CHASE POND	0.02	1.02			0.13	0.06
CHILDS BOG	0.51	1.9			1.46	0.13
CHITTENDEN	0.1	1.01	0.931	3.364	0.23	0.06
CLUB POND	0.07	1.37			0.25	0.06
CRANBERRY MEADOW	0.03	0.75			0.11	0.04
CURTIS	0.06	0.48	0.31	3.284	0.07	0.01
DENNIS	0.1	1.28			0.24	0.06
DUNMORE	0.02	0.47			0.08	0.03
DUTCHMAN POND	0.22	2.18			0.99	0.21
EASTMAN POND	0.04	0.39	0.301	2.369	0.05	0.01
ECHO (CHARTN)	0.03	0.69	0.182	2.243	0.09	0.03
ECHO (HUBDTN)	0.04	0.51	0.333	1.872	0.1	0.01
ELM BROOK POOL	0.02	0.63			0.09	0.04
FERN	0.01	0.35	0.024	0.523	0.03	0.01
FISH POND	0.04	0.95			0.09	0.03
FREESES POND- UPPER	0.03	0.43			0.07	0.01
GILES POND	0.01	0.42			0.07	0.04
GREAT HOSMER	0.06	0.46	0.222	2.591	0.05	0.01
GREENWOOD POND	0.14	0.57			0.23	0.01
HALL POND- UPPER	0.05	0.79	0.484	1.719	0.17	0.04
HARDWICK	0.03	0.74			0.09	0.02
HARDWOOD	0.31	2.13			0.79	0.1
HIGH (SUDBRY)	0.07	0.51	0.368	3.896	0.07	0.01
HILDRETH DAM POND	0.01	0.48	0.232	2.095	0.06	0.03
HORN POND	0.03	1.02	0.28	1.866	0.13	0.1
HORTONIA	0.03	0.41	0.229	1.588	0.07	0.01
HOWE RESERVOIR	0.08	1.39			0.27	0.07
ISLAND POND	0	0.08	0.018	11.718	0.01	0
IVANHOE- LAKE	0.17	1.81			0.74	0.2
JACKSONVILLE	0.04	1.11			0.16	0.06
JENNESS POND	0.05	0.99			0.21	0.11

	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	HgT	MeHg	HgT	HgT	HgT
KENT	0.05	0.74			0.15	0.03
LARY POND	0.09	0.77			0.14	0.02
LEFFERTS	0.1	1.32			0.41	0.1
LILY POND	0.42	0.98			0.4	0.02
LITTLE AVERILL	0.03	0.54	0.114	1.193	0.05	0.02
LONG (WESTMR)	0.02	0.33	0.148	1.153	0.07	0.02
LOON LAKE	0.05	1.17	0.481	1.822	0.24	0.11
LOVELL LAKE- STN 1	0.09	0.69	0.87	2.639	0.19	0.04
LYFORD	0.04	0.55	0.319	1.655	0.08	0.01
MANSFIELD	0.04	1.24			0.18	0.08
MCCONNELL	0.02	0.63			0.05	0.02
MILLSFIELD POND	0.06	1.28			0.17	0.06
MILTON	0.23	1.37			0.55	0.07
MINARDS	0.08	0.55	0.716	2.719	0.21	0.04
MITCHELL	0.31	4.67			1.07	0.16
MOOSE POND	0.02	0.57			0.06	0.02
MOUNTAIN LAKE-UPPER	0.02	0.66			0.09	0.03
NEWARK	0.02	0.41	0.155	0.957	0.07	0.01
NORTH (BRKFLD)	0.03	0.62			0.08	0.02
NOTCH	0.03	0.77	0.205	1.248	0.07	0.02
NOYES	0.03	1.09			0.11	0.05
PARAN	0.06	1.47			0.22	0.05
PARKER	0.03	0.41	0.183	1.468	0.05	0.01
PAUGUS BAY- STN 1	0.03	1.06	0.586	4.463	0.2	0.1
PAWTUCKAWAY LAKE	0.03	0.65	0.25	1.533	0.08	0.03
PEMIGEWASSET LAKE	0.04	0.79	0.374	1.672	0.12	0.04
PERCH (BENSON)	0.08	0.6	0.647	2.484	0.17	0.03
PLEASANT VALLEY	0.07	0.75			0.25	0.04
POUT POND	0.39	0.94			0.41	0.02
POWWOW POND	0.01	0.49	0.007	0.396	0.01	0.01
ROBB RESERVOIR	0.03	0.93			0.12	0.04
ROUND POND	0.03	0.67	0.293	1.295	0.13	0.06
SABIN	0.02	0.71	0.239	3.901	0.08	0.03
SHAWS POND	0.12	1.67			0.53	0.15
SILVER LAKE	0.02	0.31	0.17	1.091	0.08	0.02
SOMERSET	0.03	0.41	0.275	1.314	0.08	0.03
SOUTH AMERICA	0.12	1.69			0.46	0.07
SPRUCE POND	0.11	0.55	0.812	2.893	0.11	0.01
STRATTON	0.49	2.03			1.21	0.12

	Epilimnion		Hypolimnion		Fish	Sediment
	MeHg	HgT	MeHg	HgT	HgT	HgT
SUNCOOK POND-UPPER	0.03	0.74	0.195	2.657	0.07	0.02
SUNRISE LAKE	0.35	1.86			0.85	0.11
SUNSET (BRKFLD)	0.01	0.22	0.094	3.492	0.03	0.01
TRIO PONDS- ONE AND TWO	0.07	1.19	0.582	2.085	0.23	0.06
TUTTLE (HARDWK)	0.11	0.57			0.08	0.01
UNNAMED POND	0.07	1.03			0.35	0.05
WALKER POND	0.04	0.79	0.319	2.041	0.11	0.04
WILLEY POND- BIG	0.17	0.85			2.12	0.26
WILLEY POND- LITTLE	0.08	0.65			0.46	0.03
WILLOUGHBY	0.01	0.16	0.105	0.459	0.05	0.003
WILSON POND	0.18	1.04			0.45	0.06
WOLCOTT	0.08	1.15	0.592	2.121	0.19	0.05
ZEPHYR LAKE	0.11	1.01	1.065	3.029	0.27	0.07

Table A-8. Predicted Epilimnetic Methylmercury Concentrations for the Hypolimnion Surface Area Sensitivity Analysis. Data are presented in columns of observed, and then for the fraction used to estimate the hypolimnion surface area (e.g., 1/2 data corresponds to a hypolimnion area = 1/2 lake surface area) in the model.

Lake Name	Observed	1/2	1/3	1/4	1/5
ADDER POND	0.289	0.06	0.11	0.15	0.18
ARMINGTON LAKE	0.218	0.03	0.04	0.04	0.05
BAKER (BARTON)	0.096	0.04	0.05	0.07	0.07
BEARCAMP POND	0.214	0.02	0.02	0.02	0.03
BRANCH	0.49	0.07	0.09	0.11	0.13
CHITTENDEN	0.113	0.07	0.1	0.12	0.13
CRANBERRY MEADOW	0.215	0.02	0.03	0.03	0.03
CURTIS	0.175	0.03	0.06	0.07	0.09
DUNMORE	0.098	0.02	0.02	0.02	0.02
EASTMAN POND	0.194	0.03	0.04	0.05	0.06
ECHO (CHARTN)	0.072	0.02	0.03	0.03	0.03
ECHO (HUBDTN)	0.188	0.03	0.04	0.05	0.06
FERN	0.231	0.01	0.01	0.02	0.02
GREAT HOSMER	0.123	0.03	0.06	0.07	0.08
HALL POND- UPPER	0.299	0.04	0.05	0.06	0.07
HIGH (SUDBRY)	0.175	0.04	0.07	0.09	0.11
HILDRETH DAM POND	0.349	0.01	0.01	0.02	0.02
HORN POND	0.141	0.02	0.03	0.03	0.03
HORTONIA	0.166	0.03	0.03	0.04	0.04
ISLAND POND	0.295	0	0	0	0
JENNESS POND	0.475	0.04	0.05	0.06	0.06
LITTLE AVERILL	0.201	0.03	0.03	0.03	0.03
LONG (WESTMR)	0.067	0.02	0.02	0.02	0.02
LOON LAKE	0.52	0.04	0.05	0.06	0.07
LOVELL LAKE- STN 1	0.318	0.06	0.09	0.1	0.11
LYFORD	0.305	0.03	0.04	0.05	0.05
MANSFIELD	0.243	0.03	0.04	0.05	0.05
MCCONNELL	0.18	0.02	0.02	0.02	0.02
MINARDS	0.23	0.05	0.08	0.1	0.11
NEWARK	0.165	0.02	0.02	0.03	0.03
NORTH (BRKFLD)	0.136	0.02	0.03	0.03	0.03
NOTCH	0.329	0.03	0.03	0.03	0.04
PARKER	0.217	0.02	0.03	0.03	0.03
PAUGUS BAY- STN 1	0.141	0.03	0.03	0.04	0.04
PAWTUCKAWAY LAKE	0.187	0.03	0.03	0.04	0.04
PEMIGEWASSET LAKE	0.456	0.03	0.04	0.05	0.05
PERCH (BENSON)	0.162	0.05	0.08	0.09	0.1
POWWOW POND	1.813	0.01	0.01	0.01	0.01

Lake Name	Observed	1/2	1/3	1/4	1/5
ROUND POND	0.287	0.03	0.03	0.04	0.04
SABIN	0.223	0.02	0.02	0.03	0.03
SILVER LAKE	0.077	0.02	0.02	0.02	0.03
SOMERSET	0.116	0.02	0.03	0.03	0.03
SPRUCE POND	0.327	0.06	0.11	0.15	0.18
SUNCOOK POND- UPPER	0.107	0.02	0.03	0.03	0.03
SUNSET (BRKFLD)	0.232	0	0.01	0.01	0.01
TRIO PONDS- ONE AND TWO	0.3	0.05	0.07	0.08	0.09
WALKER POND	0.155	0.03	0.04	0.04	0.04
WILLOUGHBY	0.183	0.01	0.01	0.02	0.02
WOLCOTT	0.322	0.06	0.08	0.09	0.1
ZEPHYR LAKE	0.213	0.07	0.11	0.13	0.14

Table A-9. Predicted Epilimnetic Total Mercury Concentrations for the Hypolimnion Surface Area Sensitivity Analysis. Data are presented in columns of observed, and then for the fraction used to estimate the hypolimnion surface area (e.g., 1/2 data corresponds to a hypolimnion area = 1/2 lake surface area) in the model.

Lake Name	Observed	1/2	1/3	1/4	1/5
ADDER POND	2.143	0.61	0.72	0.8	0.86
ARMINGTON LAKE	0.908	0.76	0.84	0.9	0.93
BAKER (BARTON)	0.94	0.5	0.56	0.59	0.62
BEARCAMP POND	1.124	0.62	0.66	0.68	0.7
BRANCH	1.776	1.38	1.55	1.64	1.71
CHITTENDEN	1.142	0.91	1.01	1.06	1.1
CRANBERRY MEADOW	1.118	0.71	0.75	0.77	0.79
CURTIS	0.648	0.43	0.48	0.52	0.54
DUNMORE	0.507	0.45	0.47	0.48	0.48
EASTMAN POND	1.639	0.35	0.39	0.42	0.44
ECHO (CHARTN)	0.594	0.67	0.69	0.7	0.71
ECHO (HUBDTN)	0.352	0.5	0.51	0.53	0.53
FERN	1.035	0.33	0.35	0.36	0.37
GREAT HOSMER	0.679	0.41	0.46	0.49	0.52
HALL POND- UPPER	1.89	0.71	0.79	0.84	0.87
HIGH (SUDBRY)	1.72	0.44	0.51	0.54	0.57
HILDRETH DAM POND	1.96	0.45	0.48	0.5	0.51
HORN POND	1.506	0.96	1.02	1.05	1.07
HORTONIA	0.656	0.4	0.41	0.42	0.42
ISLAND POND	1.578	0.08	0.08	0.08	0.08
JENNESS POND	3.101	0.89	0.99	1.05	1.09
LITTLE AVERILL	0.501	0.52	0.54	0.55	0.55
LONG (WESTMR)	0.817	0.32	0.33	0.34	0.34
LOON LAKE	0.861	1.06	1.17	1.24	1.28
LOVELL LAKE- STN 1	0.503	0.63	0.69	0.73	0.76
LYFORD	0.946	0.53	0.55	0.57	0.57
MANSFIELD	0.95	1.13	1.24	1.3	1.33
MCCONNELL	1.962	0.59	0.63	0.65	0.66
MINARDS	2.422	0.48	0.55	0.59	0.62
NEWARK	1.066	0.4	0.41	0.42	0.42
NORTH (BRKFLD)	0.846	0.59	0.62	0.63	0.64
NOTCH	5.296	0.71	0.77	0.8	0.82

Lake Name	Observed	1/2	1/3	1/4	1/5
PARKER	1.741	0.39	0.41	0.41	0.42
PAUGUS BAY- STN 1	3.12	0.97	1.06	1.11	1.14
PAWTUCKAWAY LAKE	2.257	0.6	0.65	0.69	0.71
PEMIGEWASSET LAKE	2.057	0.72	0.79	0.82	0.85
PERCH (BENSON)	0.586	0.55	0.6	0.63	0.65
POWWOW POND	5.872	0.5	0.49	0.49	0.49
ROUND POND	0.69	0.61	0.67	0.71	0.73
SABIN	1.216	0.67	0.71	0.74	0.75
SILVER LAKE	2.224	0.3	0.31	0.31	0.31
SOMERSET	1.885	0.37	0.41	0.43	0.45
SPRUCE POND	1.456	0.46	0.55	0.62	0.68
SUNCOOK POND- UPPER	1.38	0.7	0.74	0.76	0.77
SUNSET (BRKFLD)	0.451	0.21	0.22	0.23	0.23
TRIO PONDS- ONE AND TWO	2.267	1.08	1.19	1.26	1.3
WALKER POND	0.932	0.73	0.79	0.82	0.85
WILLOUGHBY	1.116	0.16	0.16	0.16	0.17
WOLCOTT	1.132	1.07	1.15	1.2	1.24
ZEPHYR LAKE	0.899	0.9	1.01	1.07	1.11

Table A-10. Predicted Hypolimnetic Methylmercury Concentrations for the Hypolimnion Surface Area Sensitivity Analysis. Data are presented in columns of observed, and then for the fraction used to estimate the hypolimnion surface area (e.g., 1/2 data corresponds to a hypolimnion area = 1/2 lake surface area) in the model.

Lake Name	Observed	1/2	1/3	1/4	1/5
ADDER POND	1.004	0.456	0.754	0.988	1.172
BAKER (BARTON)	1.649	0.271	0.363	0.436	0.487
BEARCAMP POND	1.753	0.189	0.22	0.237	0.248
BRANCH	4.447	0.6	0.861	1.045	1.18
CHITTENDEN	0.938	0.681	0.931	1.091	1.2
CURTIS	0.67	0.357	0.31	0.389	0.448
EASTMAN POND	0.388	0.206	0.301	0.366	0.414
ECHO (CHARTN)	0.142	0.149	0.182	0.201	0.213
ECHO (HUBDTN)	0.263	0.243	0.333	0.392	0.433
FERN	0.374	0.022	0.024	0.026	0.027
GREAT HOSMER	0.394	0.144	0.222	0.278	0.321
HALL POND- UPPER	0.273	0.367	0.484	0.559	0.61
HIGH (SUDBRY)	1.415	0.228	0.368	0.475	0.557
HILDRETH DAM POND	1.005	0.189	0.232	0.256	0.272
HORN POND	0.163	0.235	0.28	0.305	0.321
HORTONIA	0.127	0.177	0.229	0.262	0.284
ISLAND POND	0.379	0.016	0.018	0.019	0.02
LITTLE AVERILL	0.353	0.096	0.114	0.125	0.131
LONG (WESTMR)	0.288	0.117	0.148	0.167	0.179
LOON LAKE	0.552	0.354	0.481	0.561	0.617
LOVELL LAKE- STN 1	0.277	0.638	0.87	1.015	1.115
LYFORD	0.205	0.244	0.319	0.365	0.395
MINARDS	0.448	0.476	0.716	0.886	1.012
NEWARK	0.584	0.129	0.155	0.171	0.181
NOTCH	3.186	0.17	0.205	0.225	0.238
PARKER	0.156	0.145	0.183	0.205	0.219
PAUGUS BAY- STN 1	0.051	0.471	0.586	0.653	0.697
PAWTUCKAWAY LAKE	2.908	0.206	0.25	0.277	0.294
PEMIGEWASSET LAKE	1.213	0.303	0.374	0.417	0.444
PERCH (BENSON)	0.573	0.453	0.647	0.777	0.868
POWWOW POND	0.822	0.007	0.007	0.007	0.007
ROUND POND	0.433	0.224	0.293	0.336	0.365

Lake Name	Observed	1/2	1/3	1/4	1/5
SABIN	0.326	0.189	0.239	0.269	0.289
SILVER LAKE	0.195	0.137	0.17	0.19	0.203
SOMERSET	0.165	0.205	0.275	0.32	0.352
SPRUCE POND	4.454	0.469	0.094	1.108	1.36
SUNCOOK POND- UPPER	0.733	0.168	0.195	0.209	0.219
SUNSET (BRKFLD)	0.344	0.079	0.094	0.103	0.108
TRIO PONDS- ONE AND TWO	0.178	0.438	0.582	0.673	0.735
WALKER POND	0.892	0.265	0.319	0.35	0.37
WILLOUGHBY	0.265	0.09	0.105	0.114	0.119
WOLCOTT	0.303	0.476	0.592	0.66	0.704
ZEPHYR LAKE	0.221	0.768	1.065	1.257	1.39

Table A-11. Predicted Hypolimnetic Total Mercury Concentrations for the Hypolimnion Surface Area Sensitivity Analysis. Data are presented in columns of observed, and then for the fraction used to estimate the hypolimnion surface area (e.g., 1/2 data corresponds to a hypolimnion area = 1/2 lake surface area) in the model.

Lake Name	Observed	1/2	1/3	1/4	1/5
ADDER POND	15.191	2.467	3.696	4.644	5.385
BAKER (BARTON)	8.83	1.465	2.566	2.892	3.121
BEARCAMP POND	8.503	1.683	1.759	1.803	1.831
BRANCH	25.843	2.65	3.161	3.501	3.744
CHITTENDEN	13.43	2.81	3.364	3.707	3.94
CURTIS	2.569	3.292	3.284	3.836	4.242
EASTMAN POND	4.685	1.858	2.369	2.714	2.96
ECHO (CHARTN)	2.094	2.164	2.243	2.287	2.315
ECHO (HUBDTN)	2.727	1.678	1.872	1.995	2.08
FERN	5.625	0.493	0.523	0.539	0.55
GREAT HOSMER	9.763	2.029	2.591	2.984	3.274
HALL POND- UPPER	7.88	1.486	1.719	1.864	1.962
HIGH (SUDBRY)	8.522	2.915	3.896	4.614	5.159
HILDRETH DAM POND	8.775	2.038	2.095	2.131	2.155
HORN POND	5.58	1.77	1.866	1.921	1.955
HORTONIA	1.266	1.472	1.588	1.659	1.706
ISLAND POND	2.421	12.316	11.718	11.419	11.24
LITTLE AVERILL	6.678	1.143	1.193	1.22	1.237
LONG (WESTMR)	2.015	1.098	1.153	1.185	1.206
LOON LAKE	29.786	1.562	1.822	1.983	2.092
LOVELL LAKE- STN 1	4.711	2.193	2.639	2.914	3.1
LYFORD	7.992	1.493	1.655	1.752	1.816
MINARDS	3.784	2.135	2.719	3.121	3.411
NEWARK	13.346	0.908	0.957	0.984	1.001
NOTCH	13.66	1.175	1.248	1.291	1.319
PARKER	4.911	1.381	1.468	1.518	1.551
PAUGUS BAY- STN 1	5.21	4.184	4.463	4.633	4.748
PAWTUCKAWAY LAKE	20.741	1.412	1.533	1.604	1.651
PEMIGEWASSET LAKE	8.703	1.51	1.672	1.767	1.829
PERCH (BENSON)	9.468	2.065	2.484	2.755	2.944
POWWOW POND	4.54	0.385	0.396	0.403	0.406
ROUND POND	29.604	1.137	1.295	1.389	1.452

Lake Name	Observed	1/2	1/3	1/4	1/5
SABIN	6.54	3.688	3.901	4.024	4.104
SILVER LAKE	27.134	1.032	1.091	1.125	1.147
SOMERSET	6.402	1.157	1.314	1.415	1.485
SPRUCE POND	11.518	1.871	3.492	3.757	4.485
SUNCOOK POND- UPPER	12.303	2.58	2.657	2.702	2.73
SUNSET (BRKFLD)	10.277	3.63	3.492	3.426	3.387
TRIO PONDS- ONE AND TWO	4.75	1.804	2.085	2.257	2.374
WALKER POND	14.282	1.892	2.041	2.128	2.184
WILLOUGHBY	5.267	0.443	0.459	0.468	0.475
WOLCOTT	5.659	1.893	2.121	2.253	2.338
ZEPHYR LAKE	19.048	2.419	3.029	3.416	3.681

Table A-12. Predicted Sediment Methylmercury Concentrations for the Hypolimnion Surface Area Sensitivity Analysis. Data are presented in columns of observed, and then for the fraction used to estimate the hypolimnion surface area (e.g., 1/2 data corresponds to a hypolimnion area = 1/2 lake surface area) in the model.

Lake Name	Observed	1/2	1/3	1/4	1/5
ADDER POND	0.0032	0.002	0.003	0.004	0.005
ARMINGTON LAKE	0.0041	0.002	0.001	0.001	0.001
BEARCAMP POND	0.001	0.001	0.001	0.001	0.001
BRANCH	0.003	0.012	0.119	0.021	0.023
CHITTENDEN	0.0004	0.003	0.004	0.004	0.005
CRANBERRY MEADOW	0.002	0.001	0.001	0.002	0.002
CURTIS	0.01	0.001	0.002	0.002	0.002
DUNMORE	0.005	0.001	0.001	0.001	0.001
EASTMAN POND	0.003	0.001	0.001	0.001	0.001
ECHO (CHARTN)	0.0014	0.001	0.001	0.001	0.002
ECHO (HUBDTN)	0.008	0.001	0.002	0.002	0.002
FERN	0.012	0	0	0	0
GREAT HOSMER	0.007	0.001	0.009	0.001	0.001
HIGH (SUDBRY)	0.0018	0.001	0.002	0.002	0.003
HORN POND	0.0031	0.002	0.003	0.003	0.003
HORTONIA	0.021	0.001	0.001	0.001	0.001
ISLAND POND	0.00345	0	0	0	0
JENNESS POND	0.0023	0.003	0.004	0.005	0.005
LONG (WESTMR)	0.002	0.001	0.001	0.001	0.002
LOON LAKE	0.002	0.004	0.006	0.007	0.008
LOVELL LAKE- STN 1	0.001	0.002	0.003	0.003	0.003
LYFORD	0.001	0.001	0.001	0.002	0.002
MANSFIELD	0.002	0.002	0.002	0.002	0.003
MINARDS	0.0044	0.003	0.004	0.005	0.006
NEWARK	0.002	0.001	0.001	0.001	0.001
NORTH (BRKFLD)	0.004	0.001	0.001	0.001	0.001
NOTCH	0.0025	0.001	0.001	0.001	0.001
PARKER	0.001	0.001	0.001	0.001	0.001
PAUGUS BAY- STN 1	0.003	0.004	0.005	0.005	0.006
PEMIGEWASSET LAKE	0.007	0.001	0.001	0.002	0.001
PERCH (BENSON)	0.0031	0.002	0.003	0.003	0.002
ROUND POND	0.002	0.002	0.002	0.003	0.003

Lake Name	Observed	1/2	1/3	1/4	1/5
SABIN	0.001	0.001	0.001	0.001	0.002
SILVER LAKE	0.001	0.001	0.001	0.002	0.002
SOMERSET	0.001	0.001	0.002	0.002	0.002
SUNSET (BRKFLD)	0.008	0	0.001	0.001	0.001
TRIO PONDS- ONE AND TWO	0.002	0.003	0.004	0.005	0.006
WALKER POND	0.003	0.001	0.001	0.001	0.001
WILLOUGHBY	0.005	0.001	0.001	0.001	0.001
WOLCOTT	0.003	0.002	0.002	0.002	0.003
ZEPHYR LAKE	0.0055	0.004	0.005	0.006	0.007

Table A-13. Predicted Sediment Total Mercury Concentrations for the Hypolimnion Surface Area Sensitivity Analysis. Data are presented in columns of observed, and then for the fraction used to estimate the hypolimnion surface area (e.g., 1/2 data corresponds to a hypolimnion area = 1/2 lake surface area) in the model.

Lake Name	Observed	1/2	1/3	1/4	1/5
ADDER POND	0.166	0.02	0.02	0.02	0.02
ARMINGTON LAKE	0.296	0.08	0.09	0.1	0.1
BAKER (BARTON)	0.09	0.01	0.01	0.01	0.01
BEARCAMP POND	0.29	0.04	0.04	0.04	0.04
BRANCH	0.48	0.03	0.04	0.04	0.04
CHITTENDEN	0.17	0.08	0.08	0.09	0.09
CRANBERRY MEADOW	0.175	0.06	0.06	0.06	0.06
CURTIS	0.164	0.06	0.06	0.06	0.06
DUNMORE	0.27	0.06	0.06	0.06	0.06
EASTMAN POND	0.23	0.13	0.13	0.13	0.13
ECHO (CHARTN)	0.174	0.06	0.06	0.07	0.07
ECHO (HUBDTN)	0.282	0.06	0.06	0.06	0.06
FERN	0.283	0.04	0.04	0.04	0.04
GREAT HOSMER	0.2	0.01	0.01	0.01	0.01
HALL POND- UPPER	0.39	0.06	0.06	0.06	0.06
HIGH (SUDBRY)	0.315	0.03	0.03	0.03	0.03
HILDRETH DAM POND	0.195	0.21	0.21	0.21	0.21
HORN POND	0.166	0.01	0.01	0.01	0.02
HORTONIA	0.268	0.03	0.03	0.03	0.03
ISLAND POND	0.363	0.01	0.01	0.01	0.01
JENNESS POND	0.195	0.04	0.04	0.04	0.04
LITTLE AVERILL	0.24	0.01	0.01	0.01	0.01
LONG (WESTMR)	0.14	0.03	0.03	0.03	0.03
LOON LAKE	0.14	0.01	0.01	0.01	0.01
LOVELL LAKE- STN 1	0.19	0.04	0.04	0.04	0.04
LYFORD	0.19	0.01	0.01	0.01	0.01
MANSFIELD	0.29	0.01	0.01	0.01	0.01
MCCONNELL	0.28	0.04	0.04	0.05	0.05
MINARDS	0.237	0.02	0.02	0.02	0.02
NEWARK	0.256	0.1	0.1	0.1	0.1
NORTH (BRKFLD)	0.142	0.01	0.01	0.01	0.01
NOTCH	0.622	0.03	0.03	0.03	0.03

Lake Name	Observed	1/2	1/3	1/4	1/5
PARKER	0.11	0.09	0.1	0.1	0.1
PAUGUS BAY- STN 1	0.21	0.01	0.01	0.01	0.01
PAWTUCKAWAY LAKE	0.29	0.07	0.07	0.07	0.07
PEMIGEWASSET LAKE	0.163	0	0	0	0
PERCH (BENSON)	0.3	0.2	0.2	0.2	0.2
POWWOW POND	0.175	0.06	0.06	0.06	0.06
ROUND POND	0.37	0.1	0.11	0.12	0.12
SABIN	0.135	0.03	0.03	0.03	0.03
SILVER LAKE	0.237	0.02	0.02	0.02	0.02
SOMERSET	0.256	0.1	0.1	0.1	0.1
SPRUCE POND	0.37	0.02	0.02	0.02	0.02
SUNCOOK POND- UPPER	0.257	0.02	0.02	0.02	0.02
SUNSET (BRKFLD)	0.19	0.01	0.02	0.02	0.02
TRIO PONDS- ONE AND TWO	0.608	0.1	0.11	0.12	0.12
WALKER POND	0.225	0.04	0.04	0.04	0.05
WILLOUGHBY	0.128	0.01	0.01	0.01	0.01
WOLCOTT	0.215	0.07	0.08	0.08	0.08
ZEPHYR LAKE	0.14	0.02	0.02	0.02	0.02

Table A-14. Predicted Fish Mercury Concentrations for the Hypolimnion Surface Area Sensitivity Analysis. Data are presented in columns of observed, and then for the fraction used to estimate the hypolimnion surface area (e.g., 1/2 data corresponds to a hypolimnion area = 1/2 lake surface area) in the model.

Lake Name	Observed	1/2	1/3	1/4	1/5
CURTIS	0.046	0.04	0.07	0.08	0.1
GREAT HOSMER	0.049	0.03	0.05	0.06	0.07
WILLOUGHBY	0.068	0.04	0.05	0.05	0.06
CRANBERRY MEADOW	0.074	0.08	0.11	0.12	0.13
NEWARK	0.076	0.05	0.07	0.08	0.08
DUNMORE	0.111	0.06	0.08	0.09	0.09
ZEPHYR LAKE	0.112	0.18	0.27	0.33	0.37
ECHO (HUBDTN)	0.117	0.07	0.1	0.11	0.13
LOVELL LAKE- STN 1	0.117	0.13	0.19	0.23	0.25
SABIN	0.128	0.06	0.08	0.1	0.1
HORTONIA	0.132	0.05	0.07	0.08	0.08
LYFORD	0.156	0.06	0.08	0.1	0.11
SUNSET (BRKFLD)	0.156	0.02	0.03	0.03	0.03
FERN	0.163	0.03	0.03	0.04	0.04
WALKER POND	0.172	0.08	0.11	0.12	0.13
LOON LAKE	0.189	0.16	0.24	0.29	0.33
PERCH (BENSON)	0.19	0.11	0.17	0.21	0.24
PAWTUCKAWAY LAKE	0.204	0.06	0.08	0.09	0.1
CHITTENDEN	0.21	0.16	0.23	0.28	0.31
HORN POND	0.215	0.1	0.13	0.14	0.16
JENNESS POND	0.215	0.14	0.21	0.25	0.27
NORTH (BRKFLD)	0.225	0.06	0.08	0.09	0.09
ARMINGTON LAKE	0.231	0.11	0.16	0.2	0.22
PARKER	0.233	0.04	0.05	0.06	0.07
ROUND POND	0.233	0.09	0.13	0.15	0.17
ECHO (CHARTN)	0.276	0.07	0.09	0.1	0.11
POWWOW POND	0.308	0.01	0.01	0.01	0.01
BEARCAMP POND	0.321	0.06	0.07	0.08	0.08
PEMIGEWASSET LAKE	0.331	0.09	0.12	0.14	0.15
SUNCOOK POND- UPPER	0.331	0.06	0.07	0.08	0.08
ISLAND POND	0.382	0.01	0.01	0.01	0.01
SILVER LAKE	0.462	0.06	0.08	0.09	0.1

Lake Name	Observed	1/2	1/3	1/4	1/5
SOMERSET	0.463	0.06	0.08	0.1	0.11
WOLCOTT	0.696	0.14	0.19	0.22	0.23

Table A-15. Epilimnetic Methylmercury Concentration Sensitivity to Change in Hypolimnion Surface Area/Epilimnion Epilimnion Area. Percent change is calculated from the Tier 1 model results with the hypolimnion surface area to epilimnion surface area ratio, $R = 1/3$. The percent changes presented are for the other area ratios. The averages for all other ratios are presented in the fourth column (average percent change for that given lake). Also, the overall average for each ratio is presented at the bottom of each column, along with the median and largest absolute change.

Δ (*C*,1/2)	Δ (*C*,1/4)	Δ (*C*,1/5)	Average Δ
-90.91%	-145.45%	-159.09%	-131.82%
-50.00%	0.00%	-62.50%	-37.50%
-40.00%	-160.00%	-100.00%	-100.00%
0.00%	0.00%	-125.00%	-41.67%
-44.44%	-88.89%	-111.11%	-81.48%
-60.00%	-80.00%	-75.00%	-71.67%
-66.67%	0.00%	0.00%	-22.22%
-100.00%	-66.67%	-125.00%	-97.22%
0.00%	0.00%	0.00%	0.00%
-50.00%	-100.00%	-125.00%	-91.67%
-66.67%	0.00%	0.00%	-22.22%
-50.00%	-100.00%	-125.00%	-91.67%
0.00%	-400.00%	-250.00%	-216.67%
-100.00%	-66.67%	-83.33%	-83.33%
-40.00%	-80.00%	-100.00%	-73.33%
-85.71%	-114.29%	-142.86%	-114.29%
0.00%	-400.00%	-250.00%	-216.67%
-66.67%	0.00%	0.00%	-22.22%
0.00%	-133.33%	-83.33%	-72.22%
0.00%	0.00%	0.00%	0.00%
-40.00%	-80.00%	-50.00%	-56.67%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
-40.00%	-80.00%	-100.00%	-73.33%
-66.67%	-44.44%	-55.56%	-55.56%
-50.00%	-100.00%	-62.50%	-70.83%
-50.00%	-100.00%	-62.50%	-70.83%
0.00%	0.00%	0.00%	0.00%
-75.00%	-100.00%	-93.75%	-89.58%
0.00%	-200.00%	-125.00%	-108.33%
-66.67%	0.00%	0.00%	-22.22%

	0.00%	0.00%	-83.33%	-27.78%
	-66.67%	0.00%	0.00%	-22.22%
	0.00%	-133.33%	-83.33%	-72.22%
	0.00%	-133.33%	-83.33%	-72.22%
	-50.00%	-100.00%	-62.50%	-70.83%
	-75.00%	-50.00%	-62.50%	-62.50%
	0.00%	0.00%	0.00%	0.00%
	0.00%	-133.33%	-83.33%	-72.22%
	0.00%	-200.00%	-125.00%	-108.33%
	0.00%	0.00%	-125.00%	-41.67%
	-66.67%	0.00%	0.00%	-22.22%
	-90.91%	-145.45%	-159.09%	-131.82%
	-66.67%	0.00%	0.00%	-22.22%
	-200.00%	0.00%	0.00%	-66.67%
	-57.14%	-57.14%	-71.43%	-61.90%
	-50.00%	0.00%	0.00%	-16.67%
	0.00%	-400.00%	-250.00%	-216.67%
	-50.00%	-50.00%	-62.50%	-54.17%
	-72.73%	-72.73%	-68.18%	-71.21%
Mean	-42.90%	-82.30%	-75.72%	-66.98%
Abs. Max. Δ	-200.00%	-400.00%	-250.00%	-283.33%
Median	-50.00%	-69.70%	-73.21%	-70.83%

Table A-16. Epilimnetic Total Mercury Concentration Sensitivity to Change in Hypolimnion Surface Area/Epilimnion Epilimnion Area. Percent change is calculated from the Tier 1 model results with the hypolimnion surface area to epilimnion surface area ratio, $R = 1/3$. The percent changes presented are for the other area ratios. The averages for all other ratios are presented in the fourth column (average percent change for that given lake). Also, the overall average for each ratio is presented at the bottom of each column, along with the median and largest absolute change.

Δ (C,1/2)	Δ (C,1/4)	Δ (C,1/5)	Average Δ
-3.92%	-15.69%	-9.80%	-9.80%
-9.09%	-18.18%	-11.36%	-12.88%
-7.41%	-7.41%	-4.63%	-6.48%
-17.39%	-23.19%	-25.36%	-21.98%
-8.51%	-8.51%	-5.32%	-7.45%
-16.67%	-20.00%	-20.83%	-19.17%
-5.80%	-5.80%	-7.25%	-6.28%
-20.83%	-33.33%	-31.25%	-28.47%
-4.88%	-9.76%	-6.10%	-6.91%
-21.74%	-26.09%	-32.61%	-26.81%
-17.91%	-23.88%	-22.39%	-21.39%
-6.06%	-12.12%	-7.58%	-8.59%
-9.68%	-6.45%	-8.06%	-8.06%
-18.80%	-23.93%	-23.50%	-22.08%
-21.78%	-23.76%	-24.75%	-23.43%
-19.05%	-28.57%	-26.79%	-24.80%
-15.19%	-15.19%	-18.99%	-16.46%
-21.43%	-21.43%	-26.79%	-23.21%
-7.27%	-14.55%	-9.09%	-10.30%
-17.74%	-19.35%	-18.15%	-18.41%
-11.43%	-11.43%	-14.29%	-12.38%
-4.88%	-9.76%	-6.10%	-6.91%
0.00%	0.00%	-15.63%	-5.21%
-10.67%	-10.67%	-13.33%	-11.56%
-12.12%	-12.12%	-15.15%	-13.13%
-13.91%	-17.39%	-19.57%	-16.96%
-19.80%	-19.80%	-22.28%	-20.63%
-11.27%	-16.90%	-14.08%	-14.08%
-10.81%	-10.81%	-10.14%	-10.59%
-32.73%	-50.91%	-59.09%	-47.58%

	-11.76%	-11.76%	-12.25%	-11.93%
	0.00%	0.00%	0.00%	0.00%
	-20.51%	-30.77%	-32.05%	-27.78%
	-27.45%	-23.53%	-29.41%	-26.80%
	-9.76%	0.00%	-6.10%	-5.28%
	-21.94%	-23.23%	-25.81%	-23.66%
	-19.51%	-19.51%	-24.39%	-21.14%
	-20.25%	-25.32%	-25.32%	-23.63%
	-12.50%	-16.67%	-15.63%	-14.93%
	-12.70%	-12.70%	-11.90%	-12.43%
	-17.72%	-15.19%	-18.99%	-17.30%
	-30.56%	-44.44%	-48.61%	-41.20%
	-6.45%	0.00%	0.00%	-2.15%
	-15.38%	-24.62%	-23.08%	-21.03%
	-18.49%	-23.53%	-23.11%	-21.71%
	-25.45%	-29.09%	-31.82%	-28.79%
	-20.20%	-24.24%	-25.25%	-23.23%
	-16.98%	-18.87%	-18.87%	-18.24%
	-15.58%	-15.58%	-16.23%	-15.80%
	4.08%	0.00%	0.00%	1.36%
Mean	-14.36%	-17.52%	-18.38%	-16.75%
Abs. Max. Δ	-32.73%	-50.91%	-59.09%	-47.58%
Median	-15.29%	-17.15%	-18.51%	-16.71%

Table A-17. Hypolimnetic Methylmercury Concentration Sensitivity to Change in Hypolimnion Surface Area/Epilimnion Epilimnion Area. Percent change is calculated from the Tier 1 model results with the hypolimnion surface area to epilimnion surface area ratio, *R* = 1/3. The percent changes presented are for the other area ratios. The averages for all other ratios are presented in the fourth column (average percent change for that given lake). Also, the overall average for each ratio is presented at the bottom of each column, along with the median and largest absolute change.

Δ (*C*,1/2)	Δ (*C*,1/4)	Δ (*C*,1/5)	Average
-79.05%	-124.14%	-138.59%	-113.93%
-50.69%	-80.44%	-85.40%	-72.18%
-28.18%	-30.91%	-31.82%	-30.30%
-60.63%	-85.48%	-92.62%	-79.58%
-53.71%	-68.74%	-72.23%	-64.89%
30.32%	-101.94%	-111.29%	-60.97%
-63.12%	-86.38%	-93.85%	-81.12%
-36.26%	-41.76%	-42.58%	-40.20%
-54.05%	-70.87%	-75.08%	-66.67%
-16.67%	-33.33%	-31.25%	-27.08%
-70.27%	-100.90%	-111.49%	-94.22%
-48.35%	-61.98%	-65.08%	-58.47%
-76.09%	-116.30%	-128.40%	-106.93%
-37.07%	-41.38%	-43.10%	-40.52%
-32.14%	-35.71%	-36.61%	-34.82%
-45.41%	-57.64%	-60.04%	-54.37%
-22.22%	-22.22%	-27.78%	-24.07%
-31.58%	-38.60%	-37.28%	-35.82%
-41.89%	-51.35%	-52.36%	-48.54%
-52.81%	-66.53%	-70.69%	-63.34%
-53.33%	-66.67%	-70.40%	-63.47%
-47.02%	-57.68%	-59.56%	-54.75%
-67.04%	-94.97%	-103.35%	-88.45%
-33.55%	-41.29%	-41.94%	-38.92%
-34.15%	-39.02%	-40.24%	-37.80%
-41.53%	-48.09%	-49.18%	-46.27%
-39.25%	-45.73%	-47.35%	-44.11%
-35.20%	-43.20%	-44.00%	-40.80%
-37.97%	-45.99%	-46.79%	-43.58%
-59.97%	-80.37%	-85.39%	-75.24%

	Δ (C,1/2)	Δ (C,1/4)	Δ (C,1/5)	Average
	0.00%	0.00%	0.00%	0.00%
	-47.10%	-58.70%	-61.43%	-55.75%
	-41.84%	-50.21%	-52.30%	-48.12%
	-38.82%	-47.06%	-48.53%	-44.80%
	-50.91%	-65.45%	-70.00%	-62.12%
	-84.48%	-145.81%	-168.72%	-133.00%
	-27.69%	-28.72%	-30.77%	-29.06%
	-31.91%	-38.30%	-37.23%	-35.82%
	-49.48%	-62.54%	-65.72%	-59.25%
	-33.86%	-38.87%	-39.97%	-37.57%
	-28.57%	-34.29%	-33.33%	-32.06%
	-39.19%	-45.95%	-47.30%	-44.14%
	-55.77%	-72.11%	-76.29%	-68.06%
Mean	-42.99%	-59.71%	-63.43%	-55.38%
Abs. Max. Δ	-84.48%	-145.81%	-168.72%	-133.00%
Median	-41.84%	-51.35%	-52.36%	-48.54%

Table A-18. Hypolimnetic Total Mercury Concentration Sensitivity to Change in Hypolimnion Surface Area/Epilimnion Epilimnion Area. Percent change is calculated from the Tier 1 model results with the hypolimnion surface area to epilimnion surface area ratio, $R = 1/3$. The percent changes presented are for the other area ratios. The averages for all other ratios are presented in the fourth column (average percent change for that given lake). Also, the overall average for each ratio is presented at the bottom of each column, along with the median and largest absolute change.

Δ (C,1/2)	Δ (C,1/4)	Δ (C,1/5)	Average
-66.50%	-102.60%	-114.25%	-94.45%
-85.81%	-50.82%	-54.07%	-63.57%
-8.64%	-10.01%	-10.23%	-9.63%
-32.33%	-43.02%	-46.11%	-40.49%
-32.94%	-40.78%	-42.81%	-38.84%
0.49%	-67.24%	-72.93%	-46.56%
-43.14%	-58.25%	-62.37%	-54.59%
-7.04%	-7.85%	-8.02%	-7.64%
-20.73%	-26.28%	-27.78%	-24.93%
-11.47%	-12.24%	-12.91%	-12.21%
-43.38%	-60.67%	-65.90%	-56.65%
-27.11%	-33.74%	-35.34%	-32.06%
-50.36%	-73.72%	-81.04%	-68.37%
-5.44%	-6.87%	-7.16%	-6.49%
-10.29%	-11.79%	-11.92%	-11.33%
-14.61%	-17.88%	-18.58%	-17.02%
10.21%	10.21%	10.20%	10.20%
-8.38%	-9.05%	-9.22%	-8.89%
-9.54%	-11.10%	-11.49%	-10.71%
-28.54%	-35.35%	-37.05%	-33.64%
-33.80%	-41.68%	-43.67%	-39.72%
-19.58%	-23.44%	-24.32%	-22.45%
-42.96%	-59.14%	-63.63%	-55.24%
-10.24%	-11.29%	-11.49%	-11.01%
-11.70%	-13.78%	-14.22%	-13.23%
-11.85%	-13.62%	-14.13%	-13.20%
-12.50%	-15.24%	-15.96%	-14.57%
-15.79%	-18.53%	-19.24%	-17.85%
-19.38%	-22.73%	-23.47%	-21.86%
-33.74%	-43.64%	-46.30%	-41.22%

	Δ (C,1/2)	Δ (C,1/4)	Δ (C,1/5)	Average
	-5.56%	-7.07%	-6.31%	-6.31%
	-24.40%	-29.03%	-30.31%	-27.92%
	-10.92%	-12.61%	-13.01%	-12.18%
	-10.82%	-12.47%	-12.83%	-12.04%
	-23.90%	-30.75%	-32.53%	-29.06%
	-92.84%	-30.36%	-71.09%	-64.76%
	-5.80%	-6.77%	-6.87%	-6.48%
	7.90%	7.56%	7.52%	7.66%
	-26.95%	-33.00%	-34.65%	-31.53%
	-14.60%	-17.05%	-17.52%	-16.39%
	-6.97%	-7.84%	-8.71%	-7.84%
	-21.50%	-24.89%	-25.58%	-23.99%
	-40.28%	-51.11%	-53.81%	-48.40%
Mean	-22.88%	-27.62%	-30.26%	-26.92%
Abs. Max. Δ	-92.84%	-102.60%	-114.25%	-103.23%
Median	-15.79%	-22.73%	-23.47%	-21.86%

Table A-19. Sediment Methylmercury Concentration Sensitivity to Change in Hypolimnion Surface Area/Epilimnion Epilimnion Area. Percent change is calculated from the Tier 1 model results with the hypolimnion surface area to epilimnion surface area ratio, $R = 1/3$. The percent changes presented are for the other area ratios. The averages for all other ratios are presented in the fourth column (average percent change for that given lake). Also, the overall average for each ratio is presented at the bottom of each column, along with the median and largest absolute change.

	Δ (*C*,1/2)	Δ (*C*,1/4)	Δ (*C*,1/5)	Average
	-66.67%	-133.33%	-166.67%	-122.22%
	200.00%	0.00%	0.00%	66.67%
	0.00%	0.00%	0.00%	0.00%
	-58.82%	-94.12%	-88.24%	-80.39%
	-50.00%	0.00%	-62.50%	-37.50%
	0.00%	-400.00%	-250.00%	-216.67%
	-100.00%	0.00%	0.00%	-33.33%
	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	-250.00%	-83.33%
	-100.00%	0.00%	0.00%	-33.33%
	0.00%	0.00%	0.00%	0.00%
	-177.78%	355.56%	222.22%	133.33%
	-100.00%	0.00%	-125.00%	-75.00%
	-66.67%	0.00%	0.00%	-22.22%
	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%
	-50.00%	-100.00%	-62.50%	-70.83%
	0.00%	0.00%	-250.00%	-83.33%
	-66.67%	-66.67%	-83.33%	-72.22%
	-66.67%	0.00%	0.00%	-22.22%
	0.00%	-400.00%	-250.00%	-216.67%
	0.00%	0.00%	-125.00%	-41.67%
	-50.00%	-100.00%	-125.00%	-91.67%
	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%
	-40.00%	0.00%	-50.00%	-30.00%
	0.00%	-400.00%	0.00%	-133.33%
	-66.67%	0.00%	83.33%	5.56%
	0.00%	-200.00%	-125.00%	-108.33%
	0.00%	0.00%	-250.00%	-83.33%
	0.00%	-400.00%	-250.00%	-216.67%
	-100.00%	0.00%	0.00%	-33.33%
	-200.00%	0.00%	0.00%	-66.67%
	-50.00%	-100.00%	-125.00%	-91.67%
	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	-125.00%	-41.67%
	-40.00%	-80.00%	-100.00%	-73.33%
Mean	-30.49%	-51.67%	-62.38%	-48.18%
Abs. Max. Δ	-200.00%	-400.00%	-250.00%	-283.33%
Median	0.00%	0.00%	0.00%	-33.33%

Table A-20. Sediment Total Mercury Concentration Sensitivity to Change in Hypolimnion Surface Area/Epilimnion Epilimnion Area. Percent change is calculated from the Tier 1 model results with the hypolimnion surface area to epilimnion surface area ratio, R = 1/3. The percent changes presented are for the other area ratios. The averages for all other ratios are presented in the fourth column (average percent change for that given lake). Also, the overall average for each ratio is presented at the bottom of each column, along with the median and largest absolute change.

Δ (C,1/2)	Δ (C,1/4)	Δ (C,1/5)	Average
0.00%	0.00%	0.00%	0.00%
-22.22%	-44.44%	-27.78%	-31.48%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
-50.00%	0.00%	0.00%	-16.67%
0.00%	-50.00%	-31.25%	-27.08%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
0.00%	-66.67%	-41.67%	-36.11%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	-250.00%	-83.33%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%
0.00%	-100.00%	-62.50%	-54.17%
0.00%	0.00%	0.00%	0.00%
0.00%	0.00%	0.00%	0.00%

	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%
	-20.00%	0.00%	0.00%	-6.67%
	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%
	-18.18%	-36.36%	-22.73%	-25.76%
	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%
	-100.00%	0.00%	0.00%	-33.33%
	-18.18%	-36.36%	-22.73%	-25.76%
	0.00%	0.00%	-62.50%	-20.83%
	0.00%	0.00%	0.00%	0.00%
	-25.00%	0.00%	0.00%	-8.33%
	0.00%	0.00%	0.00%	0.00%
Mean	-5.07%	-6.68%	-10.42%	-7.39%
Abs. Max. Δ	-100.00%	-100.00%	-250.00%	-150.00%
Median	0.00%	0.00%	0.00%	0.00%

Table A-21. Fish Tissue Mercury Concentration Sensitivity to Change in Hypolimnion Surface Area/Epilimnion Epilimnion Area. Percent change is calculated from the Tier 1 model results with the hypolimnion surface area to epilimnion surface area ratio, $R = 1/3$. The percent changes presented are for the other area ratios. The averages for all other ratios are presented in the fourth column (average percent change for that given lake). Also, the overall average for each ratio is presented at the bottom of each column, along with the median and largest absolute change.

Δ (C,1/2)	Δ (C,1/4)	Δ (C,1/5)	Average
-85.71%	-57.14%	-107.14%	-83.33%
-80.00%	-80.00%	-100.00%	-86.67%
-40.00%	0.00%	-50.00%	-30.00%
-54.55%	-36.36%	-45.45%	-45.45%
-57.14%	-57.14%	-35.71%	-50.00%
-50.00%	-50.00%	-31.25%	-43.75%
-66.67%	-88.89%	-92.59%	-82.72%
-60.00%	-40.00%	-75.00%	-58.33%
-63.16%	-84.21%	-78.95%	-75.44%
-50.00%	-100.00%	-62.50%	-70.83%
-57.14%	-57.14%	-35.71%	-50.00%
-50.00%	-100.00%	-93.75%	-81.25%
-66.67%	0.00%	0.00%	-22.22%
0.00%	-133.33%	-83.33%	-72.22%
-54.55%	-36.36%	-45.45%	-45.45%
-66.67%	-83.33%	-93.75%	-81.25%
-70.59%	-94.12%	-102.94%	-89.22%
-50.00%	-50.00%	-62.50%	-54.17%
-60.87%	-86.96%	-86.96%	-78.26%
-46.15%	-30.77%	-57.69%	-44.87%
-66.67%	-76.19%	-71.43%	-71.43%
-50.00%	-50.00%	-31.25%	-43.75%
-62.50%	-100.00%	-93.75%	-85.42%
-40.00%	-80.00%	-100.00%	-73.33%
-61.54%	-61.54%	-76.92%	-66.67%
-44.44%	-44.44%	-55.56%	-48.15%
0.00%	0.00%	0.00%	0.00%
-28.57%	-57.14%	-35.71%	-40.48%
-50.00%	-66.67%	-62.50%	-59.72%
-28.57%	-57.14%	-35.71%	-40.48%

	0.00%	0.00%	0.00%	0.00%
	-50.00%	-50.00%	-62.50%	-54.17%
	-50.00%	-100.00%	-93.75%	-81.25%
	-52.63%	-63.16%	-52.63%	-56.14%
Mean	-50.43%	-60.94%	-62.13%	-57.84%
Abs. Max. Δ	-85.71%	-133.33%	-107.14%	-108.73%
Median	-51.32%	-57.14%	-62.50%	-57.24%

Table A-22. Epilimnion MeHg and HgT Concentrations for Range of R1Up and R2Up Values.

R1Up	0.1	0.1	0.1	0.1	0.1	0.1	1	1
R2Up	0.1	0.1	1	1	2	2	0.1	0.1
Lake Number	MeHg	HgT	MeHg	HgT	MeHg	HgT	MeHg	HgT
1	0.11	0.72	0.33	2.25	0.58	3.95	0.13	0.74
2	0.04	0.84	0.09	2.58	0.16	4.51	0.05	0.86
3	0.05	0.56	0.21	2.54	0.38	4.75	0.08	0.59
4	0.06	0.72	0.24	3.74	0.44	7.1	0.09	0.76
5	0.02	0.66	0.07	3.79	0.12	7.27	0.06	0.7
6	0.09	1.55	0.19	3.72	0.31	6.13	0.12	1.57
7	0.11	1.34	0.28	3.98	0.46	6.92	0.14	1.37
8	0.02	0.84	0.08	5.44	0.14	10.56	0.08	0.89
9	0.02	1.02	0.05	5.28	0.09	10.02	0.08	1.07
10	0.51	1.9	1.47	5.58	2.54	9.67	0.55	1.94
11	0.1	1.01	0.29	3.3	0.5	5.86	0.13	1.04
12	0.07	1.37	0.23	7.09	0.41	13.45	0.13	1.43
13	0.03	0.75	0.07	3.15	0.12	5.81	0.06	0.78
14	0.06	0.48	0.16	1.44	0.27	2.49	0.07	0.5
15	0.1	1.28	0.33	5.86	0.58	10.96	0.17	1.34
16	0.02	0.47	0.04	1.42	0.06	2.49	0.04	0.49
17	0.22	2.18	0.43	4.35	0.66	6.76	0.24	2.19
18	0.04	0.39	0.13	1.37	0.22	2.45	0.05	0.41
19	0.03	0.69	0.04	1.78	0.05	2.98	0.05	0.72
20	0.04	0.51	0.09	1.47	0.15	2.52	0.07	0.54
21	0.02	0.63	0.02	2.21	0.02	3.97	0.04	0.66
22	0.01	0.35	0.02	0.84	0.03	1.34	0.03	0.39
23	0.04	0.95	0.14	5.5	0.25	10.57	0.09	1.01
24	0.03	0.43	0.1	2.59	0.18	4.98	0.05	0.46
25	0.01	0.42	0.02	3.02	0.02	5.9	0.04	0.45
26	0.06	0.46	0.11	1.04	0.18	1.67	0.06	0.47
27	0.14	0.57	0.32	1.34	0.52	2.19	0.15	0.57
28	0.05	0.79	0.14	2.44	0.23	4.28	0.08	0.81
29	0.03	0.74	0.09	4.49	0.17	8.65	0.09	0.8
30	0.31	2.13	0.62	4.51	0.97	7.15	0.33	2.16
31	0.07	0.51	0.18	1.41	0.31	2.41	0.08	0.52
32	0.01	0.48	0.06	3.51	0.11	6.87	0.05	0.52
33	0.03	1.02	0.06	3.71	0.09	6.69	0.07	1.06
34	0.03	0.41	0.06	0.98	0.08	1.61	0.05	0.43
35	0.08	1.39	0.27	5.9	0.49	10.9	0.13	1.44
36	0	0.08	0	0.37	0	0.68	0.01	0.08
37	0.17	1.81	0.32	3.63	0.5	5.66	0.18	1.82
38	0.04	1.11	0.08	6.38	0.13	12.24	0.1	1.17
39	0.05	0.99	0.1	2.46	0.15	4.09	0.06	1.01
40	0.05	0.74	0.16	3	0.29	5.52	0.08	0.77
41	0.09	0.77	0.46	4.53	0.87	8.71	0.13	0.82
42	0.1	1.32	0.4	6.61	0.74	12.49	0.15	1.37
43	0.42	0.98	0.8	1.91	1.23	2.94	0.43	0.99
44	0.03	0.54	0.05	1.23	0.08	2	0.04	0.55
45	0.02	0.33	0.03	0.91	0.04	1.56	0.03	0.35
46	0.05	1.17	0.18	5.13	0.32	9.52	0.09	1.21

R1Up	0.1	0.1	0.1	0.1	0.1	0.1	1	1
R2Up	**0.1**	**0.1**	**1**	**1**	**2**	**2**	**0.1**	**0.1**
Lake Number	**MeHg**	**HgT**	**MeHg**	**HgT**	**MeHg**	**HgT**	**MeHg**	**HgT**
47	0.09	0.69	0.19	1.6	0.29	2.6	0.1	0.71
48	0.04	0.55	0.09	1.49	0.14	2.54	0.06	0.57
49	0.04	1.24	0.12	4.84	0.2	8.85	0.08	1.27
50	0.02	0.63	0.04	2.54	0.06	4.66	0.04	0.65
51	0.06	1.28	0.27	7.54	0.5	14.51	0.12	1.34
52	0.23	1.37	0.66	4.06	1.13	7.05	0.26	1.4
53	0.08	0.55	0.15	1.14	0.23	1.8	0.09	0.56
54	0.31	4.67	1.4	29.63	2.62	57.36	0.79	5.19
55	0.02	0.57	0.07	2.64	0.12	4.93	0.04	0.59
56	0.02	0.66	0.09	4.47	0.17	8.71	0.07	0.7
57	0.02	0.41	0.03	0.76	0.04	1.15	0.03	0.42
58	0.03	0.62	0.07	2.6	0.12	4.8	0.05	0.65
59	0.03	0.77	0.08	3.15	0.13	5.79	0.06	0.79
60	0.03	1.09	0.06	3.73	0.1	6.65	0.06	1.12
61	0.06	1.47	0.16	8.58	0.27	16.48	0.14	1.56
62	0.03	0.41	0.06	1.61	0.1	2.94	0.06	0.44
63	0.03	1.06	0.07	3.83	0.11	6.91	0.07	1.1
64	0.03	0.65	0.08	2.15	0.12	3.81	0.06	0.68
65	0.04	0.79	0.12	2.76	0.2	4.96	0.07	0.81
66	0.08	0.6	0.14	1.18	0.21	1.83	0.09	0.61
67	0.07	0.75	0.23	3.04	0.42	5.58	0.1	0.78
68	0.39	0.94	0.87	2.12	1.4	3.42	0.41	0.96
69	0.01	0.49	0.01	2.93	0.01	5.51	0.05	0.65
70	0.03	0.93	0.1	5.3	0.18	10.17	0.08	0.97
71	0.03	0.67	0.06	1.35	0.08	2.1	0.04	0.68
72	0.02	0.71	0.05	2.75	0.08	5.02	0.05	0.74
73	0.12	1.67	0.39	6.14	0.68	11.11	0.16	1.71
74	0.02	0.31	0.03	0.6	0.04	0.93	0.03	0.32
75	0.03	0.41	0.06	1.17	0.1	2.02	0.04	0.42
76	0.12	1.69	0.4	6.64	0.72	12.14	0.17	1.74
77	0.11	0.55	0.17	0.9	0.24	1.29	0.11	0.56
78	0.49	2.03	1.13	4.82	1.84	7.91	0.52	2.06
79	0.03	0.74	0.05	4.18	0.08	8	0.07	0.79
80	0.35	1.86	0.94	5.22	1.59	8.94	0.38	1.9
81	0.01	0.22	0.01	1.22	0.02	2.33	0.02	0.23
82	0.07	1.19	0.22	4.34	0.38	7.83	0.1	1.22
83	0.11	0.57	0.43	2.39	0.78	4.41	0.12	0.59
84	0.07	1.03	0.21	3.9	0.37	7.09	0.1	1.06
85	0.04	0.79	0.11	3.87	0.19	7.29	0.08	0.84
86	0.17	0.85	0.54	2.74	0.95	4.84	0.2	0.87
87	0.08	0.65	0.14	1.86	0.22	3.21	0.12	0.69
88	0.01	0.16	0.02	0.38	0.02	0.61	0.03	0.18
89	0.18	1.04	0.59	3.73	1.05	6.73	0.21	1.08
90	0.08	1.15	0.21	3.7	0.36	6.53	0.11	1.18
91	0.11	1.01	0.35	3.69	0.61	6.68	0.14	1.04

R1Up	1	1	1	1	2	2	2	2
R2Up	1	1	2	2	0.1	0.1	1	1
Lake Number	MeHg	HgT	MeHg	HgT	MeHg	HgT	MeHg	HgT
1	0.35	2.27	0.59	3.97	0.15	0.76	0.37	2.29
2	0.11	2.6	0.17	4.52	0.07	0.88	0.13	2.62
3	0.24	2.57	0.41	4.78	0.12	0.63	0.27	2.61
4	0.28	3.78	0.48	7.14	0.14	0.8	0.32	3.82
5	0.11	3.83	0.16	7.31	0.11	0.75	0.15	3.88
6	0.22	3.74	0.33	6.16	0.14	1.59	0.24	3.76
7	0.31	4.01	0.49	6.95	0.18	1.41	0.35	4.05
8	0.14	5.5	0.2	10.62	0.14	0.95	0.2	5.56
9	0.11	5.34	0.14	10.07	0.14	1.13	0.17	5.4
10	1.51	5.62	2.58	9.71	0.59	1.98	1.55	5.66
11	0.32	3.34	0.53	5.89	0.16	1.07	0.35	3.37
12	0.29	7.15	0.47	13.51	0.2	1.5	0.36	7.22
13	0.1	3.18	0.15	5.85	0.09	0.81	0.13	3.21
14	0.17	1.45	0.28	2.51	0.08	0.51	0.18	1.46
15	0.4	5.93	0.65	11.03	0.24	1.42	0.47	6
16	0.06	1.44	0.08	2.5	0.06	0.51	0.08	1.46
17	0.44	4.36	0.67	6.78	0.25	2.21	0.46	4.38
18	0.14	1.38	0.24	2.46	0.07	0.42	0.15	1.4
19	0.06	1.8	0.08	3.01	0.08	0.75	0.09	1.83
20	0.12	1.49	0.17	2.55	0.1	0.57	0.15	1.52
21	0.04	2.24	0.05	4	0.07	0.69	0.07	2.27
22	0.03	0.85	0.04	1.36	0.04	0.4	0.04	0.86
23	0.19	5.56	0.3	10.62	0.15	1.07	0.25	5.62
24	0.12	2.61	0.2	5	0.08	0.49	0.15	2.64
25	0.05	3.05	0.06	5.93	0.08	0.49	0.08	3.08
26	0.12	1.05	0.19	1.68	0.07	0.48	0.13	1.06
27	0.33	1.34	0.53	2.2	0.16	0.58	0.34	1.35
28	0.16	2.46	0.25	4.3	0.1	0.84	0.18	2.49
29	0.15	4.54	0.22	8.71	0.15	0.86	0.21	4.61
30	0.65	4.54	1	7.18	0.36	2.19	0.68	4.57
31	0.2	1.42	0.32	2.42	0.09	0.53	0.21	1.44
32	0.09	3.54	0.14	6.9	0.09	0.56	0.13	3.58
33	0.09	3.75	0.12	6.73	0.11	1.1	0.14	3.79
34	0.07	1	0.1	1.63	0.07	0.45	0.09	1.02
35	0.32	5.95	0.54	10.95	0.19	1.5	0.38	6
36	0.01	0.37	0.01	0.69	0.01	0.09	0.01	0.37
37	0.34	3.64	0.51	5.67	0.19	1.83	0.35	3.66
38	0.14	6.44	0.2	12.3	0.17	1.24	0.21	6.51
39	0.11	2.48	0.17	4.11	0.08	1.02	0.13	2.49
40	0.19	3.03	0.32	5.55	0.11	0.8	0.22	3.06
41	0.5	4.58	0.91	8.75	0.18	0.87	0.55	4.62
42	0.45	6.67	0.79	12.55	0.21	1.44	0.51	6.73
43	0.82	1.92	1.25	2.95	0.44	1.01	0.83	1.94
44	0.07	1.25	0.09	2.02	0.06	0.57	0.08	1.26
45	0.05	0.93	0.06	1.57	0.05	0.37	0.06	0.95
46	0.21	5.17	0.35	9.56	0.13	1.25	0.25	5.21
47	0.2	1.61	0.31	2.62	0.12	0.73	0.22	1.63
48	0.11	1.51	0.16	2.56	0.08	0.59	0.13	1.53

R1Up	1	1	1	1	2	2	2	2
R2Up	1	1	2	2	0.1	0.1	1	1
Lake Number	MeHg	HgT	MeHg	HgT	MeHg	HgT	MeHg	HgT
49	0.15	4.88	0.24	8.88	0.12	1.32	0.2	4.92
50	0.06	2.56	0.08	4.68	0.06	0.68	0.08	2.59
51	0.33	7.61	0.57	14.57	0.2	1.42	0.41	7.68
52	0.69	4.09	1.16	7.08	0.3	1.44	0.72	4.13
53	0.16	1.15	0.24	1.81	0.1	0.57	0.17	1.17
54	1.88	30.15	3.1	57.88	1.32	5.76	2.42	30.72
55	0.09	2.66	0.14	4.95	0.07	0.62	0.11	2.68
56	0.14	4.52	0.21	8.75	0.11	0.75	0.18	4.56
57	0.04	0.77	0.05	1.16	0.04	0.43	0.05	0.78
58	0.1	2.63	0.15	4.83	0.08	0.68	0.12	2.66
59	0.1	3.17	0.16	5.81	0.08	0.82	0.13	3.2
60	0.09	3.75	0.13	6.68	0.09	1.15	0.12	3.78
61	0.25	8.67	0.36	16.57	0.24	1.66	0.34	8.77
62	0.09	1.64	0.13	2.98	0.1	0.48	0.13	1.68
63	0.11	3.87	0.15	6.95	0.12	1.15	0.15	3.91
64	0.1	2.17	0.14	3.83	0.08	0.7	0.12	2.19
65	0.14	2.79	0.23	4.98	0.1	0.84	0.17	2.82
66	0.15	1.19	0.22	1.85	0.1	0.62	0.16	1.21
67	0.26	3.07	0.45	5.62	0.14	0.82	0.3	3.11
68	0.89	2.13	1.42	3.44	0.42	0.98	0.9	2.15
69	0.05	2.97	0.05	5.54	0.08	0.69	0.09	3.01
70	0.15	5.35	0.23	10.21	0.13	1.02	0.2	5.4
71	0.07	1.36	0.09	2.11	0.05	0.69	0.07	1.37
72	0.08	2.78	0.11	5.05	0.08	0.77	0.11	2.81
73	0.43	6.19	0.72	11.15	0.21	1.76	0.47	6.23
74	0.04	0.61	0.05	0.94	0.04	0.33	0.05	0.63
75	0.07	1.18	0.11	2.04	0.05	0.43	0.08	1.2
76	0.45	6.69	0.77	12.19	0.22	1.79	0.5	6.74
77	0.17	0.91	0.24	1.29	0.12	0.56	0.18	0.91
78	1.16	4.84	1.86	7.94	0.55	2.09	1.18	4.87
79	0.1	4.23	0.13	8.05	0.13	0.84	0.15	4.28
80	0.97	5.25	1.62	8.97	0.41	1.93	1	5.28
81	0.02	1.23	0.03	2.34	0.03	0.25	0.04	1.25
82	0.25	4.37	0.41	7.86	0.14	1.26	0.28	4.4
83	0.44	2.41	0.8	4.43	0.14	0.61	0.46	2.43
84	0.24	3.93	0.4	7.12	0.13	1.1	0.27	3.97
85	0.15	3.92	0.24	7.34	0.13	0.88	0.2	3.96
86	0.56	2.76	0.97	4.87	0.22	0.9	0.59	2.79
87	0.18	1.9	0.26	3.25	0.16	0.74	0.23	1.95
88	0.03	0.39	0.03	0.63	0.05	0.2	0.05	0.41
89	0.62	3.77	1.08	6.76	0.24	1.12	0.66	3.81
90	0.24	3.73	0.39	6.56	0.14	1.22	0.27	3.76
91	0.38	3.73	0.64	6.72	0.17	1.08	0.41	3.76

R1Up	2	2	5	5	5	5	5	5
R2Up	2	2	0.1	0.1	1	1	2	2
Lake Number	MeHg	HgT	MeHg	HgT	MeHg	HgT	MeHg	HgT
1	0.61	3.99	0.2	0.82	0.42	2.35	0.67	4.05
2	0.19	4.54	0.13	0.94	0.18	2.67	0.24	4.6
3	0.44	4.81	0.21	0.73	0.37	2.72	0.54	4.92
4	0.52	7.18	0.27	0.94	0.45	3.96	0.65	7.32
5	0.21	7.36	0.25	0.89	0.29	4.02	0.34	7.5
6	0.35	6.18	0.21	1.66	0.31	3.84	0.42	6.25
7	0.53	6.99	0.29	1.52	0.46	4.16	0.64	7.1
8	0.26	10.68	0.32	1.14	0.38	5.75	0.44	10.87
9	0.2	10.13	0.31	1.31	0.34	5.57	0.38	10.31
10	2.62	9.75	0.7	2.1	1.66	5.78	2.73	9.87
11	0.56	5.93	0.27	1.18	0.45	3.48	0.67	6.04
12	0.54	13.58	0.4	1.7	0.57	7.43	0.74	13.79
13	0.18	5.88	0.19	0.92	0.23	3.32	0.28	5.98
14	0.29	2.52	0.12	0.56	0.22	1.51	0.33	2.57
15	0.72	11.1	0.45	1.63	0.68	6.22	0.93	11.32
16	0.1	2.53	0.12	0.57	0.14	1.53	0.16	2.59
17	0.69	6.8	0.3	2.26	0.51	4.43	0.74	6.84
18	0.25	2.48	0.11	0.47	0.19	1.44	0.29	2.52
19	0.1	3.04	0.16	0.84	0.17	1.92	0.19	3.13
20	0.2	2.58	0.18	0.66	0.23	1.61	0.29	2.67
21	0.07	4.02	0.15	0.77	0.15	2.35	0.16	4.11
22	0.05	1.37	0.07	0.44	0.08	0.89	0.08	1.4
23	0.36	10.69	0.34	1.26	0.44	5.81	0.55	10.88
24	0.23	5.03	0.17	0.58	0.24	2.73	0.32	5.12
25	0.09	5.97	0.18	0.6	0.19	3.19	0.2	6.08
26	0.2	1.7	0.1	0.52	0.16	1.09	0.23	1.73
27	0.54	2.21	0.18	0.61	0.36	1.38	0.57	2.24
28	0.28	4.32	0.17	0.91	0.26	2.56	0.35	4.4
29	0.28	8.77	0.33	1.05	0.4	4.8	0.47	8.96
30	1.03	7.21	0.45	2.28	0.77	4.66	1.12	7.3
31	0.34	2.44	0.13	0.58	0.25	1.48	0.37	2.48
32	0.18	6.94	0.21	0.68	0.25	3.7	0.3	7.07
33	0.17	6.78	0.23	1.24	0.26	3.93	0.29	6.91
34	0.12	1.65	0.13	0.51	0.15	1.08	0.17	1.71
35	0.59	11.01	0.35	1.66	0.54	6.17	0.75	11.17
36	0.01	0.69	0.02	0.1	0.02	0.39	0.03	0.71
37	0.52	5.69	0.24	1.88	0.39	3.7	0.56	5.73
38	0.27	12.37	0.38	1.45	0.42	6.73	0.48	12.59
39	0.18	4.13	0.12	1.07	0.17	2.54	0.23	4.18
40	0.35	5.58	0.2	0.9	0.31	3.16	0.44	5.68
41	0.96	8.8	0.32	1.01	0.69	4.77	1.1	8.95
42	0.85	12.61	0.38	1.62	0.69	6.91	1.03	12.79
43	1.26	2.97	0.49	1.06	0.87	1.98	1.3	3.01
44	0.11	2.03	0.1	0.61	0.12	1.31	0.15	2.08
45	0.08	1.59	0.1	0.42	0.11	1	0.13	1.65
46	0.39	9.6	0.24	1.38	0.37	5.33	0.51	9.73
47	0.33	2.63	0.17	0.78	0.27	1.68	0.38	2.69
48	0.18	2.58	0.14	0.66	0.19	1.6	0.24	2.64

R1Up	2	2	5	5	5	5	5	5
R2Up	**2**	**2**	**0.1**	**0.1**	**1**	**1**	**2**	**2**
Lake Number	**MeHg**	**HgT**	**MeHg**	**HgT**	**MeHg**	**HgT**	**MeHg**	**HgT**
49	0.28	8.93	0.24	1.44	0.32	5.05	0.4	9.05
50	0.1	4.71	0.13	0.74	0.15	2.66	0.17	4.78
51	0.64	14.65	0.41	1.64	0.62	7.9	0.86	14.87
52	1.2	7.12	0.4	1.55	0.83	4.24	1.3	7.22
53	0.26	1.82	0.13	0.61	0.21	1.2	0.29	1.86
54	3.64	58.46	2.92	7.49	4.02	32.45	5.24	60.19
55	0.16	4.98	0.14	0.69	0.18	2.76	0.23	5.05
56	0.26	8.8	0.26	0.9	0.33	4.71	0.41	8.95
57	0.06	1.17	0.07	0.46	0.08	0.81	0.09	1.2
58	0.17	4.86	0.17	0.77	0.21	2.75	0.26	4.95
59	0.18	5.84	0.17	0.91	0.22	3.28	0.27	5.93
60	0.16	6.71	0.18	1.24	0.21	3.88	0.25	6.81
61	0.46	16.67	0.53	1.96	0.63	9.07	0.75	16.97
62	0.17	3.02	0.21	0.6	0.24	1.8	0.28	3.14
63	0.2	6.99	0.25	1.28	0.28	4.05	0.33	7.13
64	0.17	3.86	0.15	0.77	0.19	2.27	0.24	3.93
65	0.25	5.01	0.18	0.93	0.26	2.9	0.34	5.1
66	0.23	1.86	0.14	0.66	0.2	1.25	0.27	1.9
67	0.48	5.65	0.24	0.94	0.41	3.22	0.59	5.77
68	1.43	3.45	0.47	1.03	0.95	2.2	1.48	3.5
69	0.09	5.58	0.2	0.81	0.2	3.12	0.2	5.7
70	0.28	10.26	0.28	1.18	0.35	5.56	0.43	10.42
71	0.1	2.12	0.08	0.72	0.1	1.39	0.12	2.15
72	0.14	5.08	0.17	0.87	0.2	2.91	0.23	5.17
73	0.77	11.2	0.35	1.91	0.61	6.38	0.9	11.35
74	0.06	0.95	0.08	0.37	0.09	0.66	0.1	0.99
75	0.12	2.05	0.09	0.47	0.12	1.24	0.16	2.09
76	0.82	12.24	0.37	1.95	0.66	6.9	0.97	12.39
77	0.25	1.3	0.14	0.58	0.2	0.93	0.26	1.32
78	1.89	7.97	0.63	2.18	1.27	4.96	1.98	8.06
79	0.18	8.11	0.29	1.01	0.32	4.45	0.35	8.28
80	1.65	9.01	0.51	2.04	1.1	5.39	1.75	9.11
81	0.04	2.36	0.07	0.29	0.08	1.29	0.09	2.4
82	0.45	7.9	0.24	1.36	0.39	4.51	0.55	8
83	0.82	4.45	0.2	0.67	0.52	2.49	0.88	4.51
84	0.43	7.15	0.23	1.2	0.38	4.07	0.54	7.25
85	0.29	7.39	0.27	1.03	0.35	4.11	0.43	7.54
86	0.99	4.89	0.3	0.98	0.66	2.87	1.07	4.97
87	0.3	3.3	0.3	0.88	0.37	2.1	0.44	3.44
88	0.05	0.64	0.09	0.25	0.1	0.46	0.1	0.7
89	1.12	6.8	0.35	1.23	0.77	3.92	1.23	6.91
90	0.42	6.59	0.24	1.32	0.37	3.87	0.52	6.7
91	0.68	6.75	0.27	1.18	0.51	3.87	0.78	6.86

Table A-23. Hypolimnion MeHg and HgT Concentrations for Range of R1Up and R2Up Values.

R1Up	0.1	0.1	0.1	0.1	0.1	0.1	1	1
R2Up	0.1	0.1	1	1	2	2	0.1	0.1
Lake Number	MeHg	HgT	MeHg	HgT	MeHg	HgT	MeHg	HgT
1	0.754	3.696	2.284	11.168	3.984	19.47	0.836	3.983
3	0.363	2.566	1.516	10.582	2.797	19.488	0.492	3.034
5	0.22	1.759	0.983	7.766	1.831	14.44	0.427	2.02
6	0.861	3.161	1.888	7.257	3.03	11.809	0.991	3.325
11	0.931	3.364	2.829	10.601	4.938	18.642	1.139	3.709
14	0.31	3.284	0.883	9.369	1.52	16.13	0.357	3.554
18	0.301	2.369	0.992	7.538	1.76	13.281	0.36	2.624
19	0.182	2.243	0.305	5.337	0.441	8.776	0.332	2.445
20	0.333	1.872	0.743	5	1.199	8.476	0.502	2.189
22	0.024	0.523	0.038	2.224	0.053	4.014	0.058	0.646
26	0.222	2.591	0.472	5.675	0.75	9.101	0.249	2.746
28	0.484	1.719	1.355	4.885	2.322	8.402	0.607	1.876
31	0.368	3.896	0.992	10.696	1.685	18.251	0.414	4.154
32	0.232	2.095	1.458	8.67	2.821	15.975	0.444	2.448
33	0.28	1.866	0.792	5.311	1.361	9.137	0.479	2.131
34	0.229	1.588	0.406	3.532	0.602	5.691	0.333	1.777
36	0.018	11.718	0.071	12.127	0.13	12.581	0.039	11.744
44	0.114	1.193	0.21	2.639	0.361	4.247	0.153	1.244
45	0.148	1.153	0.268	2.909	0.401	4.86	0.258	1.306
46	0.481	1.822	1.855	7.323	3.382	13.434	0.682	2.089
47	0.87	2.639	1.874	5.882	2.99	9.486	0.984	2.811
48	0.319	1.655	0.727	4.168	1.179	6.96	0.432	1.849
53	0.716	2.719	1.416	5.525	2.194	8.643	0.787	2.859
57	0.155	0.957	0.222	1.69	0.296	2.504	0.206	1.025
59	0.205	1.248	0.678	4.054	1.205	7.172	0.291	1.354
62	0.183	1.468	0.48	5.136	0.811	9.211	0.386	1.831
63	0.586	4.463	1.828	12.112	3.209	20.611	0.843	4.95
64	0.25	1.533	0.661	4.43	1.118	7.649	0.35	1.657
65	0.374	1.672	1.143	5.319	1.996	9.37	0.51	1.842
66	0.647	2.484	1.2	4.803	1.814	7.379	0.725	2.622
69	0.007	0.396	0.007	2.904	0.008	5.543	0.046	0.567
71	0.293	1.295	0.527	2.45	0.788	3.734	0.336	1.353
72	0.239	3.901	0.704	13.068	1.221	23.254	0.414	4.227
74	0.17	1.091	0.24	2.044	0.318	3.103	0.242	1.191
75	0.275	1.314	0.714	3.18	1.201	5.254	0.344	1.431
77	0.812	2.893	1.286	4.628	1.812	6.555	0.842	2.969
79	0.195	2.657	0.574	11.775	0.996	21.907	0.485	3.024
81	0.094	3.492	0.447	5.653	0.839	8.054	0.168	3.625
82	0.582	2.085	1.942	7.083	3.452	12.637	0.74	2.285
85	0.319	2.041	1.219	8.693	2.218	16.083	0.545	2.329
88	0.105	0.459	0.125	0.859	0.147	1.304	0.206	0.596
90	0.592	2.121	1.701	6.365	2.933	11.08	0.739	2.307
91	1.065	3.029	3.655	10.483	6.532	18.766	1.275	3.382

R1Up	1	1	1	1	2	2	2	2
R2Up	**1**	**1**	**2**	**2**	**0.1**	**0.1**	**1**	**1**
Lake Number	**MeHg**	**HgT**	**MeHg**	**HgT**	**MeHg**	**HgT**	**MeHg**	**HgT**
1	2.366	11.455	4.065	19.757	0.926	4.301	2.456	11.773
3	1.645	11.049	2.927	19.955	0.636	3.553	1.789	11.569
5	1.19	8.026	2.038	14.7	0.657	2.309	1.42	8.316
6	2.018	7.422	3.16	11.974	1.136	3.508	2.163	7.605
11	3.037	10.946	5.146	18.987	1.37	4.093	3.268	11.33
14	0.93	9.639	1.567	16.401	0.409	3.855	0.982	9.94
18	1.051	7.793	1.819	13.536	0.426	2.907	1.117	8.076
19	0.455	5.539	0.592	8.978	0.5	2.669	0.622	5.764
20	0.912	5.317	1.368	8.793	0.69	2.542	1.1	5.67
22	0.071	2.257	0.086	4.047	0.092	0.681	0.106	2.292
26	0.499	5.83	0.777	9.256	0.28	2.918	0.53	6.002
28	1.477	5.042	2.445	8.559	0.742	2.051	1.613	5.217
31	1.037	10.954	1.73	18.509	0.464	4.441	1.088	11.241
32	1.67	9.023	3.033	16.329	0.68	2.841	1.906	9.416
33	0.991	5.576	1.56	9.403	0.7	2.426	1.212	5.87
34	0.51	3.72	0.706	5.879	0.448	1.986	0.625	3.929
36	0.092	12.153	0.151	12.607	0.062	11.773	0.115	12.182
44	0.248	2.691	0.354	4.298	0.196	1.301	0.291	2.748
45	0.378	3.062	0.511	5.014	0.381	1.477	0.5	3.233
46	2.056	7.59	3.583	13.702	0.905	2.387	2.279	7.887
47	1.988	6.054	3.104	9.658	1.11	3.001	2.115	6.245
48	0.839	4.362	1.292	7.154	0.556	2.065	0.964	4.578
53	1.487	5.665	2.265	8.782	0.866	3.013	1.566	5.819
57	0.273	1.758	0.347	2.572	0.263	1.101	0.33	1.834
59	0.764	4.16	1.291	7.278	0.386	1.471	0.86	4.277
62	0.683	5.499	1.014	9.574	0.612	2.235	0.909	5.903
63	2.086	12.599	3.467	21.098	1.13	5.492	2.372	13.141
64	0.76	4.554	1.217	7.772	0.46	1.794	0.871	4.691
65	1.278	5.488	2.131	9.54	0.66	2.031	1.428	5.677
66	1.278	4.941	1.892	7.517	0.811	2.776	1.364	5.095
69	0.046	2.943	0.047	5.582	0.087	0.608	0.087	2.984
71	0.57	2.509	0.83	3.793	0.383	1.419	0.618	2.574
72	0.879	13.394	1.395	23.579	0.608	4.589	1.073	13.756
74	0.313	2.144	0.391	3.203	0.323	1.303	0.393	2.256
75	0.782	3.297	1.269	5.371	0.419	1.562	0.858	3.428
77	1.315	4.705	1.842	6.631	0.875	3.052	1.348	4.787
79	0.864	12.142	1.286	22.273	0.807	3.432	1.187	12.55
81	0.521	5.786	0.912	8.187	0.25	3.772	0.603	5.933
82	2.099	7.283	3.609	12.837	0.915	2.506	2.275	7.505
85	1.445	8.98	2.444	16.37	0.796	2.648	1.695	9.299
88	0.226	0.997	0.248	1.441	0.318	0.749	0.338	1.15
90	1.847	6.55	3.079	11.265	0.901	2.513	2.01	6.756
91	3.864	10.837	6.741	19.119	1.508	3.775	4.098	11.229

R1Up	2	2	5	5	5	5	5	5
R2Up	2	2	0.1	0.1	1	1	2	2
Lake Number	MeHg	HgT	MeHg	HgT	MeHg	HgT	MeHg	HgT
1	4.156	20.075	1.197	5.257	2.727	12.728	4.427	21.03
3	3.07	20.474	1.067	5.111	2.22	13.127	3.501	22.033
5	2.267	14.99	1.346	3.178	2.108	9.184	2.956	15.858
6	3.304	12.156	1.569	4.056	2.596	8.153	3.737	12.705
11	5.377	19.371	2.062	5.244	3.96	12.481	6.069	20.522
14	1.618	16.701	0.564	4.757	1.137	10.842	1.773	17.603
18	1.885	13.819	0.623	3.756	1.314	8.925	2.082	14.668
19	0.759	9.202	1.001	3.342	1.124	6.436	1.26	9.875
20	1.556	9.146	1.254	3.599	1.664	6.727	2.12	10.203
22	0.12	4.082	0.196	0.785	0.209	2.397	0.223	4.187
26	0.808	9.428	0.371	3.435	0.622	6.519	0.899	9.945
28	2.58	8.734	1.15	2.575	2.02	5.741	2.988	9.258
31	1.781	18.796	0.616	5.301	1.239	12.101	1.932	19.656
32	3.269	16.721	1.387	4.02	2.613	10.595	3.976	17.9
33	1.781	9.697	1.362	3.31	1.874	6.754	2.443	10.581
34	0.821	6.088	0.793	2.613	0.97	4.556	1.166	6.716
36	0.175	12.636	0.132	11.86	0.185	12.269	0.245	12.723
44	0.397	4.355	0.325	1.473	0.42	2.919	0.526	4.526
45	0.633	5.185	0.747	1.99	0.867	3.747	1	5.698
46	3.806	13.999	1.574	3.278	2.949	8.779	4.475	14.891
47	3.23	9.849	1.49	3.574	2.495	6.818	3.61	10.422
48	1.416	7.369	0.931	2.712	1.338	5.224	1.791	8.016
53	2.344	8.937	1.104	3.478	1.804	6.284	2.582	9.401
57	0.404	2.648	0.433	1.328	0.5	2.061	0.574	2.876
59	1.386	7.395	0.672	1.823	1.146	4.629	1.672	7.747
62	1.24	9.978	1.29	3.447	1.587	7.115	1.918	11.19
63	3.753	21.64	1.989	7.117	3.232	14.766	4.612	23.265
64	1.327	7.91	0.791	2.206	1.202	5.103	1.658	8.322
65	2.281	9.729	1.11	2.597	1.878	6.243	2.732	10.295
66	1.978	7.671	1.07	3.236	1.623	5.555	2.237	8.132
69	0.088	5.623	0.21	0.732	0.211	3.107	0.211	5.746
71	0.878	3.858	0.526	1.614	0.76	2.77	1.02	4.054
72	1.589	23.942	1.189	5.675	1.654	14.842	2.171	25.028
74	0.471	3.315	0.564	1.637	0.634	2.59	0.712	3.649
75	1.345	5.501	0.647	1.952	1.085	3.819	0.007	5.892
77	1.875	6.714	0.974	3.303	1.447	5.038	1.973	6.965
79	1.608	22.681	1.774	4.655	2.154	13.773	2.575	23.904
81	0.995	8.334	0.497	4.213	0.849	6.374	1.241	8.775
82	3.785	13.058	1.441	3.171	2.8	8.169	4.311	13.723
85	2.695	16.689	1.549	3.605	2.448	10.256	3.488	17.646
88	0.361	1.594	0.656	1.208	0.675	1.608	0.698	2.053
90	3.242	11.471	1.39	3.13	2.499	7.374	3.73	12.089
91	6.974	19.512	2.207	4.952	4.797	0.442	7.673	20.689

Table A-24. Sediment HgT Concentrations for Range of R1Up and R2Up Values.

R1Up	0.1	0.1	0.1	1	1	1	2	2	2	5	5	5
R2Up	**0.1**	**1**	**2**	**0.1**	**1**	**2**	**0.1**	**1**	**2**	**0.1**	**1**	**2**
1	0.02	0.06	0.11	0.02	0.06	0.11	0.02	0.06	0.11	0.02	0.06	0.11
2	0.09	0.29	0.51	0.09	0.29	0.51	0.09	0.29	0.51	0.09	0.29	0.51
3	0.01	0.05	0.1	0.01	0.05	0.1	0.01	0.05	0.1	0.01	0.05	0.1
4	0.04	0.24	0.45	0.04	0.24	0.45	0.04	0.24	0.45	0.05	0.24	0.45
5	0.04	0.21	0.4	0.04	0.21	0.4	0.04	0.21	0.4	0.04	0.21	0.4
6	0.08	0.21	0.34	0.08	0.21	0.34	0.08	0.21	0.34	0.09	0.21	0.34
7	0.06	0.17	0.3	0.06	0.17	0.3	0.06	0.17	0.3	0.06	0.17	0.3
8	0.06	0.39	0.77	0.06	0.39	0.77	0.06	0.39	0.77	0.06	0.4	0.77
9	0.06	0.29	0.56	0.06	0.29	0.56	0.06	0.29	0.56	0.06	0.3	0.56
10	0.13	0.39	0.68	0.13	0.39	0.68	0.13	0.39	0.68	0.13	0.39	0.68
11	0.06	0.21	0.38	0.06	0.21	0.38	0.06	0.21	0.38	0.06	0.21	0.38
12	0.06	0.34	0.65	0.06	0.34	0.65	0.06	0.34	0.65	0.07	0.34	0.65
13	0.04	0.16	0.31	0.04	0.16	0.31	0.04	0.17	0.31	0.04	0.17	0.31
14	0.01	0.04	0.07	0.01	0.04	0.07	0.01	0.04	0.07	0.01	0.04	0.07
15	0.06	0.28	0.53	0.06	0.28	0.53	0.06	0.28	0.53	0.06	0.28	0.53
16	0.03	0.1	0.18	0.03	0.1	0.18	0.03	0.1	0.18	0.03	0.1	0.18
17	0.21	0.42	0.65	0.21	0.42	0.65	0.21	0.42	0.65	0.21	0.42	0.65
18	0.01	0.05	0.09	0.01	0.05	0.09	0.01	0.05	0.09	0.01	0.05	0.09
19	0.03	0.08	0.14	0.03	0.08	0.14	0.03	0.08	0.14	0.03	0.09	0.14
20	0.01	0.03	0.06	0.01	0.03	0.06	0.01	0.03	0.06	0.01	0.03	0.06
21	0.04	0.13	0.23	0.04	0.13	0.23	0.04	0.13	0.23	0.04	0.13	0.24
22	0.01	0.02	0.03	0.01	0.02	0.03	0.01	0.02	0.03	0.01	0.02	0.03
23	0.03	0.18	0.34	0.03	0.18	0.34	0.03	0.18	0.34	0.03	0.18	0.34
24	0.01	0.09	0.18	0.01	0.09	0.18	0.02	0.09	0.18	0.02	0.09	0.18
25	0.04	0.33	0.64	0.04	0.33	0.64	0.04	0.33	0.64	0.05	0.33	0.64
26	0.01	0.02	0.04	0.01	0.02	0.04	0.01	0.02	0.04	0.01	0.02	0.04
27	0.01	0.03	0.05	0.01	0.03	0.05	0.01	0.03	0.05	0.01	0.03	0.05
28	0.04	0.14	0.25	0.05	0.14	0.25	0.05	0.14	0.25	0.05	0.14	0.25
29	0.02	0.15	0.29	0.02	0.15	0.29	0.02	0.15	0.29	0.02	0.15	0.29
30	0.1	0.22	0.35	0.1	0.22	0.35	0.1	0.22	0.35	0.11	0.22	0.35
31	0.01	0.04	0.06	0.01	0.04	0.06	0.01	0.04	0.06	0.01	0.04	0.06
32	0.03	0.22	0.43	0.03	0.22	0.43	0.03	0.22	0.43	0.03	0.22	0.43
33	0.1	0.36	0.66	0.1	0.36	0.66	0.1	0.36	0.66	0.1	0.36	0.66
34	0.01	0.02	0.04	0.01	0.03	0.04	0.01	0.03	0.04	0.01	0.03	0.04
35	0.07	0.32	0.59	0.07	0.32	0.6	0.08	0.32	0.6	0.08	0.32	0.6
36	0	0.02	0.04	0	0.02	0.04	0	0.02	0.04	0	0.02	0.04
37	0.2	0.4	0.62	0.2	0.4	0.62	0.2	0.4	0.62	0.2	0.4	0.62
38	0.06	0.34	0.65	0.06	0.34	0.66	0.06	0.34	0.66	0.06	0.34	0.66
39	0.11	0.28	0.47	0.11	0.28	0.47	0.11	0.28	0.47	0.11	0.28	0.47
40	0.03	0.12	0.23	0.03	0.12	0.23	0.03	0.12	0.23	0.03	0.12	0.23
41	0.02	0.14	0.27	0.02	0.14	0.27	0.02	0.14	0.27	0.02	0.14	0.27
42	0.1	0.52	0.99	0.1	0.52	0.99	0.1	0.52	0.99	0.1	0.52	0.99
43	0.02	0.04	0.06	0.02	0.04	0.06	0.02	0.04	0.06	0.02	0.04	0.06
44	0.02	0.05	0.07	0.02	0.05	0.07	0.02	0.05	0.07	0.02	0.05	0.07
45	0.02	0.04	0.07	0.02	0.04	0.07	0.02	0.04	0.07	0.02	0.04	0.08
46	0.11	0.51	0.95	0.11	0.51	0.95	0.12	0.51	0.95	0.12	0.51	0.95
47	0.04	0.1	0.16	0.04	0.1	0.16	0.04	0.1	0.16	0.04	0.1	0.16
48	0.01	0.04	0.07	0.01	0.04	0.07	0.01	0.04	0.07	0.01	0.04	0.07
49	0.08	0.3	0.55	0.08	0.3	0.55	0.08	0.3	0.55	0.08	0.3	0.55

R1Up	**0.1**	**0.1**	**0.1**	**1**	**1**	**1**	**2**	**2**	**2**	**5**	**5**	**5**
R2Up	**0.1**	**1**	**2**	**0.1**	**1**	**2**	**0.1**	**1**	**2**	**0.1**	**1**	**2**
50	0.02	0.1	0.18	0.02	0.1	0.18	0.02	0.1	0.18	0.02	0.1	0.18
51	0.06	0.39	0.74	0.06	0.39	0.74	0.06	0.39	0.74	0.07	0.39	0.74
52	0.07	0.2	0.35	0.07	0.2	0.35	0.07	0.2	0.35	0.07	0.2	0.35
53	0.04	0.08	0.13	0.04	0.08	0.13	0.04	0.08	0.13	0.04	0.08	0.13
54	0.16	1.06	2.06	0.17	1.07	2.07	0.18	1.08	2.08	0.19	1.09	2.09
55	0.02	0.11	0.2	0.02	0.11	0.2	0.02	0.11	0.2	0.02	0.11	0.2
56	0.03	0.24	0.47	0.03	0.24	0.47	0.03	0.24	0.47	0.04	0.24	0.47
57	0.01	0.03	0.04	0.01	0.03	0.04	0.01	0.03	0.04	0.01	0.03	0.04
58	0.02	0.09	0.17	0.02	0.09	0.17	0.02	0.09	0.17	0.02	0.09	0.17
59	0.02	0.1	0.19	0.02	0.1	0.19	0.02	0.1	0.19	0.02	0.1	0.19
60	0.05	0.16	0.29	0.05	0.16	0.29	0.05	0.16	0.29	0.05	0.16	0.29
61	0.05	0.27	0.52	0.05	0.27	0.52	0.05	0.27	0.52	0.05	0.27	0.52
62	0.01	0.04	0.07	0.01	0.04	0.07	0.01	0.04	0.07	0.01	0.04	0.07
63	0.1	0.38	0.69	0.1	0.38	0.69	0.1	0.38	0.69	0.11	0.38	0.7
64	0.03	0.1	0.19	0.03	0.1	0.19	0.03	0.1	0.19	0.03	0.1	0.19
65	0.04	0.16	0.29	0.04	0.16	0.29	0.04	0.16	0.29	0.05	0.16	0.29
66	0.03	0.06	0.09	0.03	0.06	0.09	0.03	0.06	0.09	0.03	0.06	0.09
67	0.04	0.19	0.34	0.04	0.19	0.34	0.05	0.19	0.34	0.05	0.19	0.34
68	0.02	0.06	0.09	0.02	0.06	0.09	0.02	0.06	0.09	0.02	0.06	0.09
69	0.01	0.07	0.14	0.01	0.07	0.14	0.01	0.07	0.14	0.02	0.07	0.14
70	0.04	0.22	0.42	0.04	0.22	0.42	0.04	0.22	0.42	0.04	0.22	0.42
71	0.06	0.12	0.19	0.06	0.12	0.19	0.06	0.12	0.19	0.06	0.12	0.19
72	0.03	0.14	0.25	0.03	0.14	0.25	0.03	0.14	0.25	0.04	0.14	0.25
73	0.15	0.57	1.04	0.15	0.57	1.04	0.15	0.58	1.04	0.16	0.58	1.04
74	0.02	0.03	0.05	0.02	0.03	0.05	0.02	0.03	0.05	0.02	0.03	0.05
75	0.03	0.09	0.15	0.03	0.09	0.15	0.03	0.09	0.15	0.03	0.09	0.15
76	0.07	0.27	0.49	0.07	0.27	0.49	0.07	0.27	0.49	0.07	0.27	0.49
77	0.01	0.02	0.03	0.01	0.02	0.03	0.01	0.02	0.03	0.01	0.02	0.03
78	0.12	0.28	0.46	0.12	0.28	0.46	0.12	0.28	0.46	0.12	0.28	0.46
79	0.02	0.15	0.28	0.03	0.15	0.28	0.03	0.15	0.28	0.03	0.15	0.28
80	0.11	0.31	0.54	0.11	0.32	0.54	0.11	0.32	0.54	0.11	0.32	0.54
81	0.01	0.08	0.16	0.01	0.08	0.16	0.01	0.08	0.16	0.01	0.08	0.16
82	0.06	0.21	0.37	0.06	0.21	0.37	0.06	0.21	0.38	0.06	0.21	0.38
83	0.01	0.06	0.11	0.01	0.06	0.11	0.01	0.06	0.11	0.01	0.06	0.11
84	0.05	0.18	0.33	0.05	0.18	0.33	0.05	0.18	0.33	0.05	0.18	0.33
85	0.04	0.22	0.41	0.04	0.22	0.41	0.04	0.22	0.41	0.04	0.22	0.42
86	0.26	0.85	1.51	0.26	0.85	1.51	0.26	0.85	1.51	0.26	0.86	1.51
87	0.03	0.08	0.14	0.03	0.08	0.14	0.03	0.08	0.14	0.03	0.08	0.14
88	0.003	0.01	0.01	0	0.01	0.01	0	0.01	0.01	0	0.01	0.01
89	0.06	0.23	0.42	0.06	0.23	0.42	0.06	0.23	0.42	0.06	0.23	0.42

Table A-25. Fish Hg Concentrations for range of R1Up and R2Up values.

R1Up	0.1	0.1	0.1	1	1	1	2	2	2	5	5	5
R2Up	**0.1**	**1**	**2**	**0.1**	**1**	**2**	**0.1**	**1**	**2**	**0.1**	**1**	**2**
1	0.11	0.34	0.6	0.12	0.35	0.61	0.13	0.36	0.62	0.17	0.4	0.65
2	0.16	0.44	0.76	0.21	0.49	0.8	0.25	0.54	0.85	0.4	0.68	0.99
3	0.05	0.21	0.39	0.06	0.23	0.4	0.08	0.24	0.42	0.13	0.29	0.47
4	0.16	0.77	1.44	0.22	0.83	1.5	0.29	0.9	1.57	0.5	1.11	1.78
5	0.07	0.31	0.57	0.14	0.38	0.64	0.22	0.45	0.72	0.45	0.69	0.95
6	0.48	1.07	1.72	0.56	1.14	1.79	0.64	1.22	1.87	0.87	1.45	2.1
7	0.26	0.7	1.19	0.32	0.76	1.25	0.38	0.82	1.31	0.57	1.01	1.5
8	0.16	0.95	1.82	0.26	1.05	1.92	0.38	1.16	2.03	0.71	1.5	2.37
9	0.13	0.56	1.03	0.24	0.66	1.13	0.36	0.78	1.25	0.72	1.14	1.61
10	1.46	4.22	7.29	1.54	4.3	7.37	1.63	4.39	7.46	1.89	4.65	7.72
11	0.23	0.71	1.24	0.28	0.76	1.29	0.33	0.81	1.34	0.5	0.97	1.51
12	0.25	1.04	1.93	0.37	1.16	2.05	0.5	1.3	2.18	0.89	1.69	2.57
13	0.11	0.38	0.68	0.16	0.43	0.73	0.22	0.49	0.79	0.39	0.66	0.97
14	0.07	0.19	0.33	0.07	0.2	0.34	0.08	0.21	0.35	0.11	0.23	0.37
15	0.24	0.85	1.54	0.34	0.96	1.64	0.46	1.08	1.76	0.81	1.43	2.11
16	0.08	0.17	0.28	0.12	0.22	0.32	0.18	0.27	0.38	0.33	0.43	0.53
17	0.99	1.92	2.96	1.03	1.97	3	1.08	2.02	3.05	1.23	2.16	3.2
18	0.05	0.17	0.3	0.06	0.18	0.31	0.07	0.18	0.32	0.09	0.21	0.34
19	0.09	0.16	0.24	0.15	0.22	0.3	0.22	0.29	0.37	0.44	0.51	0.59
20	0.1	0.22	0.36	0.14	0.26	0.4	0.19	0.31	0.45	0.34	0.46	0.6
21	0.09	0.25	0.43	0.12	0.28	0.47	0.16	0.32	0.51	0.28	0.44	0.62
22	0.03	0.06	0.09	0.05	0.08	0.1	0.07	0.1	0.12	0.13	0.15	0.18
23	0.09	0.42	0.79	0.16	0.5	0.87	0.24	0.58	0.95	0.49	0.82	1.19
24	0.07	0.41	0.78	0.09	0.43	0.8	0.12	0.45	0.83	0.19	0.52	0.9
25	0.07	0.4	0.77	0.17	0.51	0.88	0.29	0.62	0.99	0.63	0.96	1.33
26	0.05	0.1	0.16	0.05	0.11	0.17	0.06	0.11	0.17	0.07	0.13	0.19
27	0.23	0.53	0.87	0.24	0.55	0.88	0.26	0.56	0.9	0.3	0.6	0.94
28	0.17	0.48	0.83	0.22	0.53	0.87	0.27	0.58	0.93	0.42	0.73	1.08
29	0.09	0.46	0.88	0.13	0.5	0.92	0.18	0.55	0.97	0.32	0.7	1.11
30	0.79	1.61	2.53	0.85	1.67	2.59	0.91	1.73	2.65	1.09	1.91	2.83
31	0.07	0.2	0.34	0.08	0.21	0.35	0.09	0.22	0.36	0.11	0.24	0.38
32	0.06	0.4	0.77	0.11	0.45	0.82	0.17	0.5	0.88	0.33	0.67	1.04
33	0.13	0.37	0.63	0.21	0.45	0.72	0.31	0.55	0.82	0.6	0.84	1.11
34	0.07	0.12	0.18	0.09	0.15	0.21	0.12	0.18	0.24	0.21	0.27	0.33
35	0.27	1.01	1.84	0.37	1.11	1.94	0.48	1.22	2.05	0.81	1.55	2.38
36	0.01	0.03	0.05	0.01	0.03	0.05	0.02	0.04	0.06	0.05	0.07	0.09
37	0.74	1.45	2.23	0.78	1.49	2.27	0.83	1.53	2.31	0.96	1.66	2.44
38	0.16	0.69	1.28	0.28	0.81	1.4	0.42	0.95	1.54	0.83	1.36	1.95
39	0.21	0.46	0.74	0.24	0.49	0.77	0.28	0.53	0.81	0.41	0.66	0.94
40	0.15	0.56	1.02	0.2	0.61	1.07	0.26	0.67	1.13	0.43	0.84	1.3
41	0.14	0.76	1.46	0.17	0.79	1.49	0.2	0.83	1.52	0.3	0.93	1.62
42	0.41	1.9	3.56	0.51	2.01	3.67	0.64	2.13	3.79	1	2.49	4.15
43	0.4	0.77	1.18	0.41	0.78	1.19	0.42	0.79	1.2	0.45	0.82	1.24
44	0.05	0.1	0.15	0.07	0.11	0.17	0.08	0.13	0.18	0.14	0.18	0.23
45	0.07	0.14	0.21	0.12	0.19	0.26	0.18	0.24	0.31	0.34	0.4	0.47
46	0.24	0.93	1.71	0.34	1.03	1.8	0.44	1.14	1.91	0.76	1.45	2.22
47	0.19	0.41	0.66	0.21	0.44	0.68	0.24	0.46	0.71	0.32	0.54	0.79
48	0.08	0.19	0.32	0.11	0.22	0.34	0.14	0.25	0.37	0.23	0.34	0.46
49	0.18	0.64	1.15	0.26	0.72	1.23	0.35	0.81	1.32	0.62	1.08	1.59

R1Up	**0.1**	**0.1**	**0.1**	**1**	**1**	**1**	**2**	**2**	**2**	**5**	**5**	**5**
R2Up	**0.1**	**1**	**2**	**0.1**	**1**	**2**	**0.1**	**1**	**2**	**0.1**	**1**	**2**
50	0.05	0.16	0.27	0.08	0.18	0.3	0.11	0.21	0.33	0.19	0.29	0.41
51	0.17	0.89	1.68	0.28	1	1.79	0.41	1.12	1.92	0.77	1.49	2.29
52	0.55	1.57	2.71	0.6	1.62	2.76	0.66	1.68	2.82	0.85	1.87	3
53	0.21	0.42	0.65	0.23	0.44	0.67	0.25	0.46	0.69	0.32	0.53	0.76
54	1.07	5.4	10.21	2.34	6.67	11.48	3.76	8.09	12.9	8.01	12.34	17.15
55	0.06	0.25	0.45	0.09	0.28	0.49	0.13	0.31	0.52	0.23	0.42	0.63
56	0.09	0.51	0.98	0.18	0.6	1.06	0.27	0.69	1.16	0.55	0.97	1.44
57	0.07	0.1	0.14	0.09	0.12	0.16	0.11	0.15	0.18	0.19	0.22	0.25
58	0.08	0.27	0.48	0.12	0.31	0.52	0.17	0.36	0.57	0.31	0.5	0.71
59	0.07	0.21	0.38	0.09	0.24	0.41	0.12	0.27	0.44	0.22	0.37	0.53
60	0.11	0.32	0.56	0.16	0.37	0.6	0.2	0.41	0.65	0.35	0.56	0.8
61	0.22	0.96	1.78	0.38	1.12	1.95	0.57	1.31	2.13	1.12	1.86	2.68
62	0.05	0.15	0.26	0.1	0.2	0.31	0.16	0.26	0.36	0.33	0.43	0.54
63	0.2	0.65	1.14	0.28	0.72	1.22	0.36	0.81	1.3	0.62	1.06	1.56
64	0.08	0.21	0.36	0.11	0.24	0.39	0.15	0.28	0.43	0.26	0.39	0.54
65	0.12	0.37	0.64	0.17	0.42	0.69	0.22	0.47	0.74	0.38	0.63	0.9
66	0.17	0.32	0.48	0.19	0.34	0.5	0.21	0.36	0.52	0.27	0.42	0.59
67	0.25	0.92	1.66	0.32	0.99	1.74	0.41	1.08	1.83	0.66	1.33	2.08
68	0.41	0.93	1.5	0.43	0.94	1.51	0.44	0.95	1.52	0.48	0.99	1.56
69	0.01	0.01	0.02	0.04	0.05	0.05	0.08	0.08	0.09	0.18	0.19	0.19
70	0.12	0.56	1.05	0.2	0.64	1.13	0.29	0.73	1.22	0.56	1	1.49
71	0.13	0.23	0.35	0.15	0.25	0.37	0.17	0.27	0.39	0.23	0.33	0.45
72	0.08	0.27	0.47	0.13	0.31	0.51	0.18	0.36	0.57	0.34	0.52	0.72
73	0.53	1.76	3.13	0.65	1.88	3.25	0.78	2.01	3.38	1.18	2.42	3.78
74	0.08	0.12	0.16	0.11	0.15	0.19	0.15	0.19	0.23	0.26	0.3	0.34
75	0.08	0.22	0.37	0.1	0.24	0.39	0.12	0.26	0.41	0.18	0.32	0.47
76	0.46	1.64	2.95	0.56	1.75	3.06	0.69	1.87	3.18	1.05	2.23	3.55
77	0.11	0.17	0.24	0.11	0.17	0.24	0.11	0.18	0.25	0.12	0.19	0.26
78	1.21	2.79	4.55	1.26	2.84	4.6	1.31	2.9	4.66	1.48	3.06	4.82
79	0.07	0.24	0.43	0.17	0.34	0.53	0.28	0.45	0.63	0.61	0.78	0.96
80	0.85	2.32	3.95	0.91	2.38	4.01	0.97	2.44	4.07	1.16	2.63	4.26
81	0.03	0.14	0.25	0.05	0.15	0.27	0.07	0.18	0.29	0.13	0.24	0.36
82	0.23	0.76	1.35	0.29	0.82	1.41	0.36	0.89	1.48	0.57	1.1	1.69
83	0.08	0.31	0.56	0.09	0.32	0.57	0.1	0.33	0.59	0.14	0.37	0.62
84	0.35	1.21	2.17	0.45	1.31	2.27	0.56	1.42	2.38	0.89	1.75	2.71
85	0.11	0.4	0.72	0.18	0.47	0.8	0.27	0.56	0.88	0.53	0.82	1.14
86	2.12	6.64	11.67	2.33	6.85	11.88	2.56	7.08	12.11	3.26	7.78	12.81
87	0.46	0.88	1.35	0.69	1.1	1.57	0.93	1.35	1.82	1.68	2.1	2.56
88	0.05	0.06	0.07	0.09	0.1	0.11	0.14	0.15	0.16	0.29	0.3	0.31
89	0.45	1.55	2.77	0.51	1.61	2.83	0.58	1.68	2.89	0.78	1.88	3.1

FIGURES

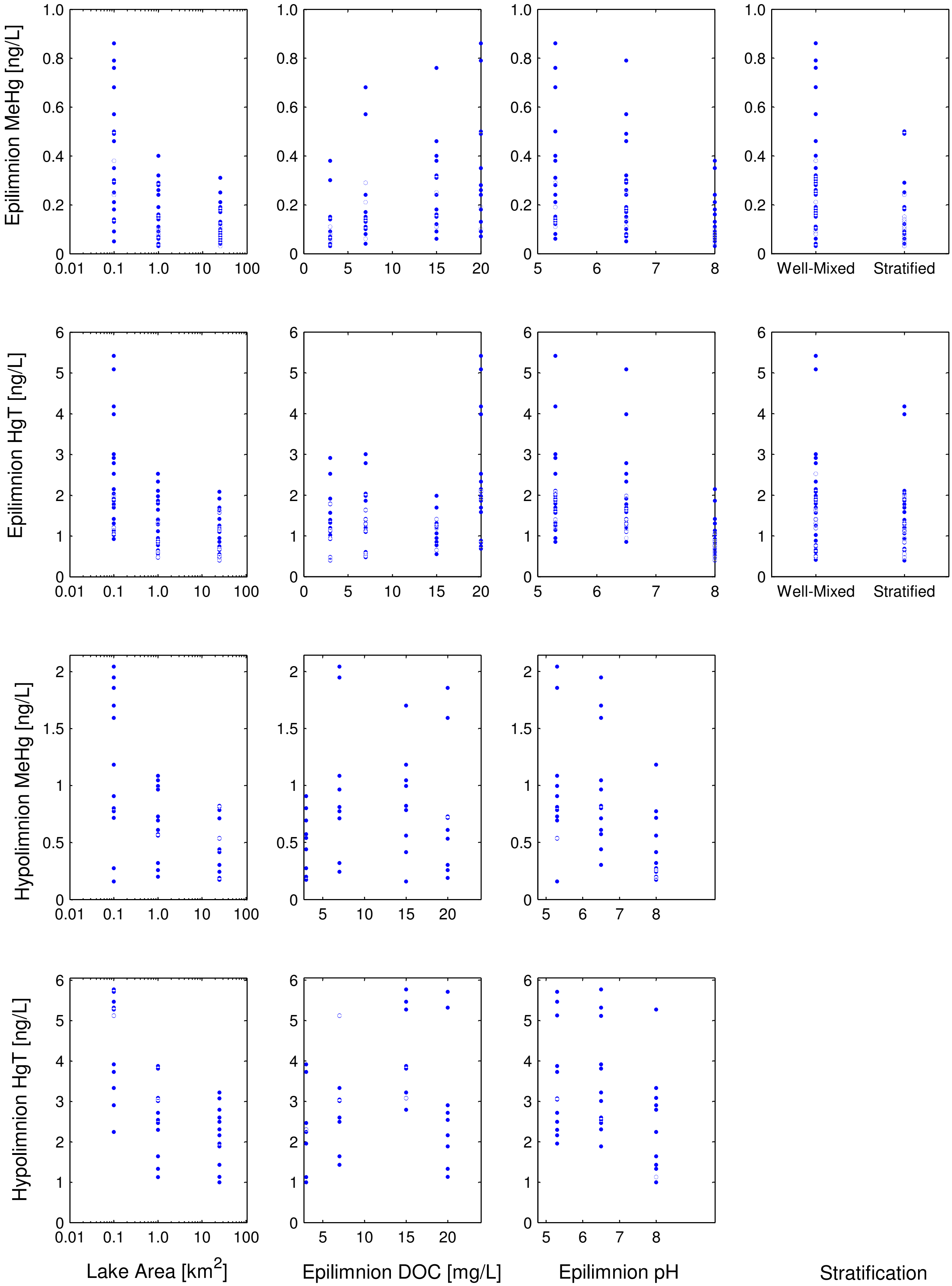


Figure 3.1. Default Modeling Outputs for All Combinations of Drainage Lakes. Epilimnion and Hypolimnion Mercury Concentrations.

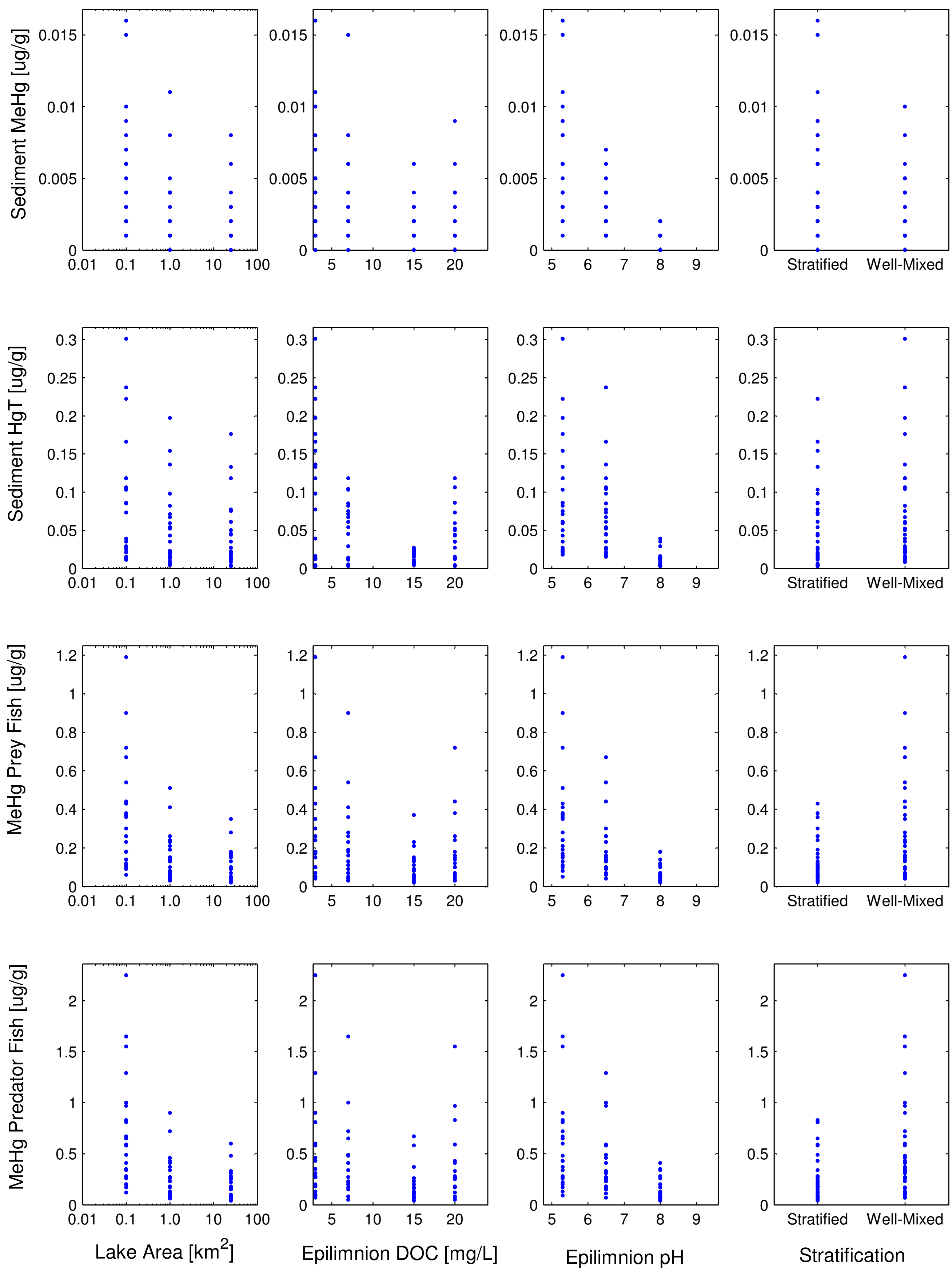


Figure 3.2. Default Modeling Outputs for All Combinations of Drainage Lakes.
Sediment and Fish Mercury Concentrations.

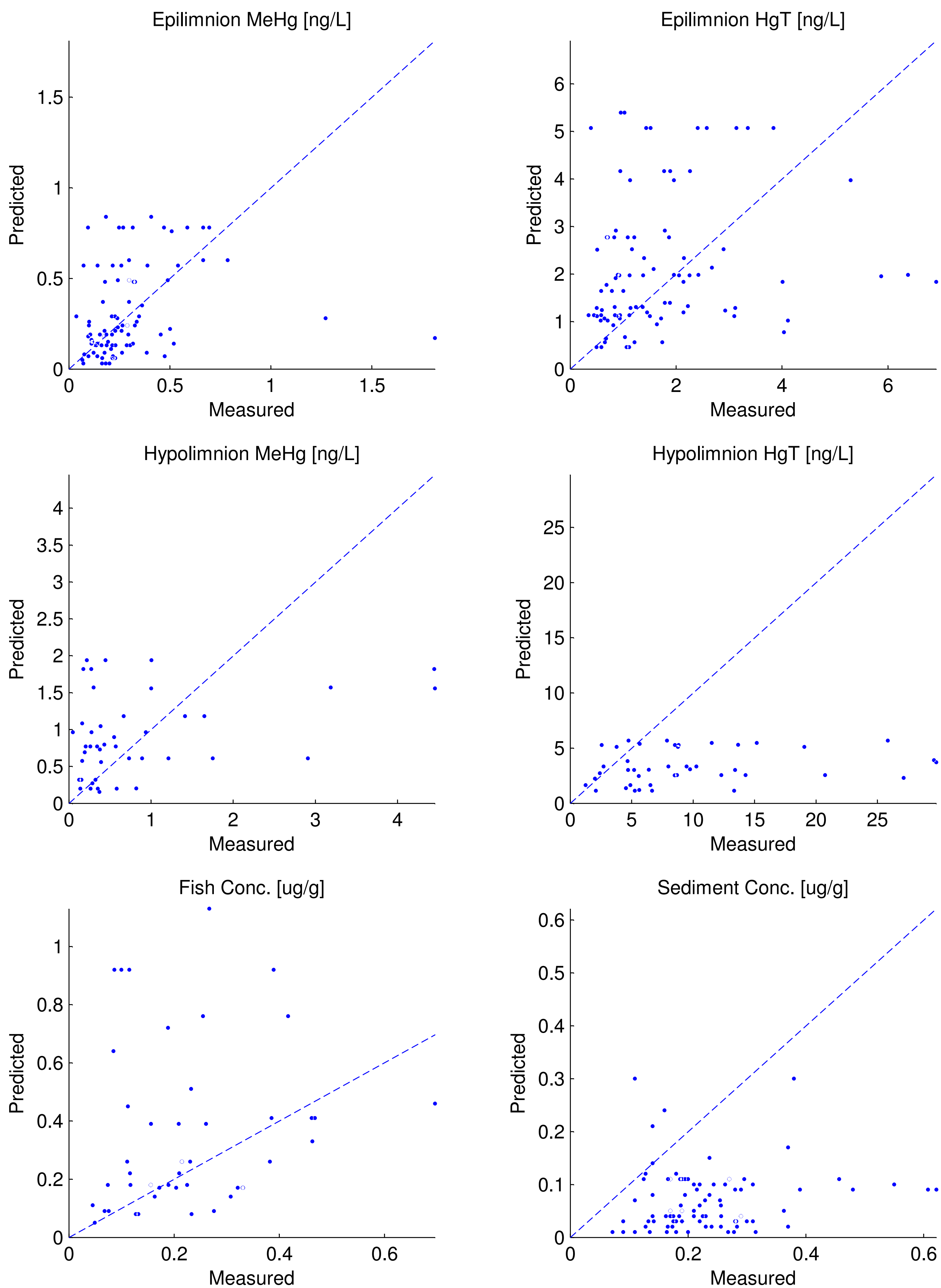


Figure 4.1. Predicted Conc. vs Measured Conc. with Lake Variables for Default Run. Dashed Line is y=x.

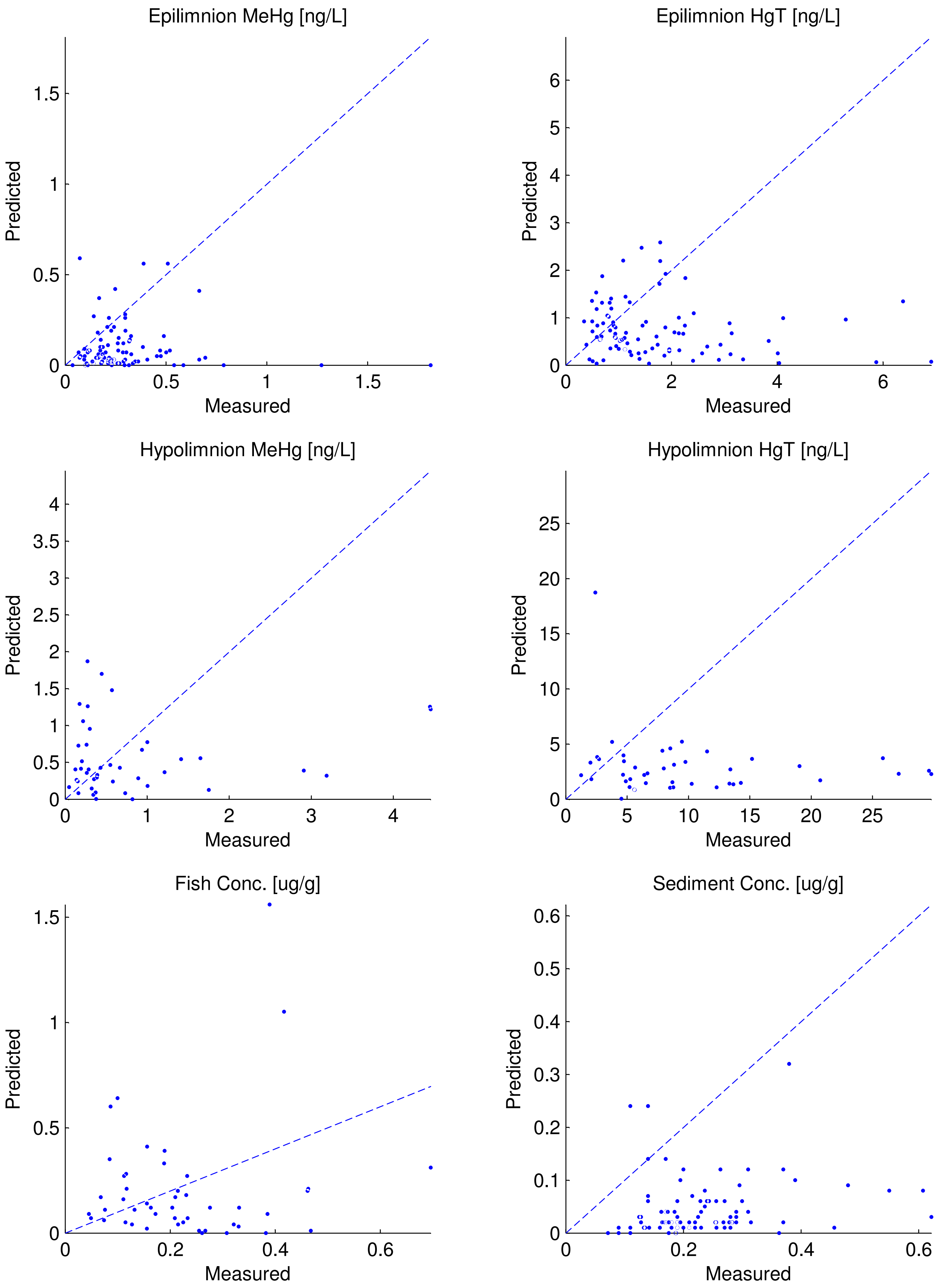


Figure 4.2. Predicted Conc. vs Measured Conc. of Lake Variables for Tier 1 Run. Dashed line is y = x.

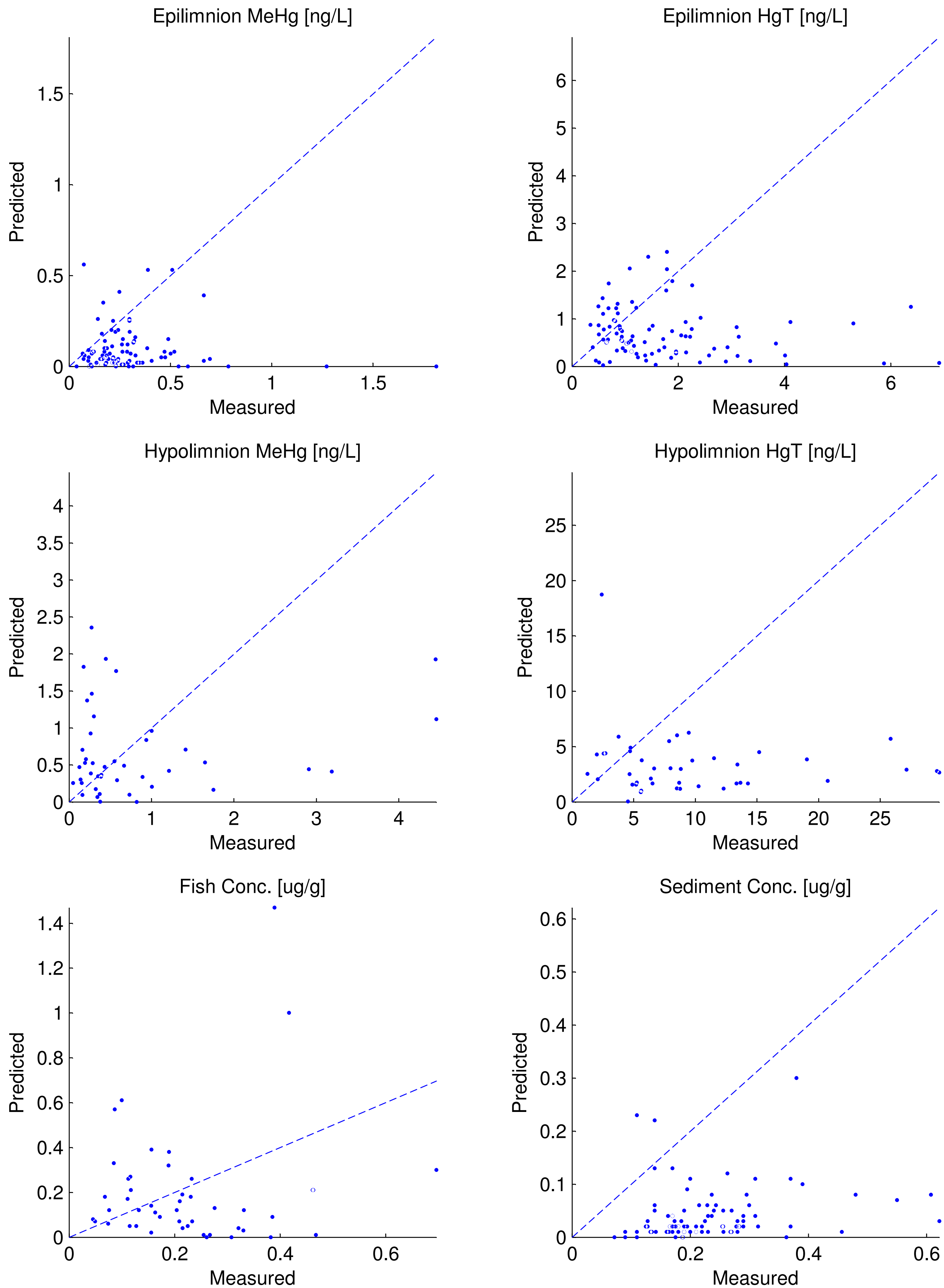


Figure 4.3. Predicted Conc. vs Measured Conc. with Lake Variables for Tier 2 Run. Dashed Line is y = x.

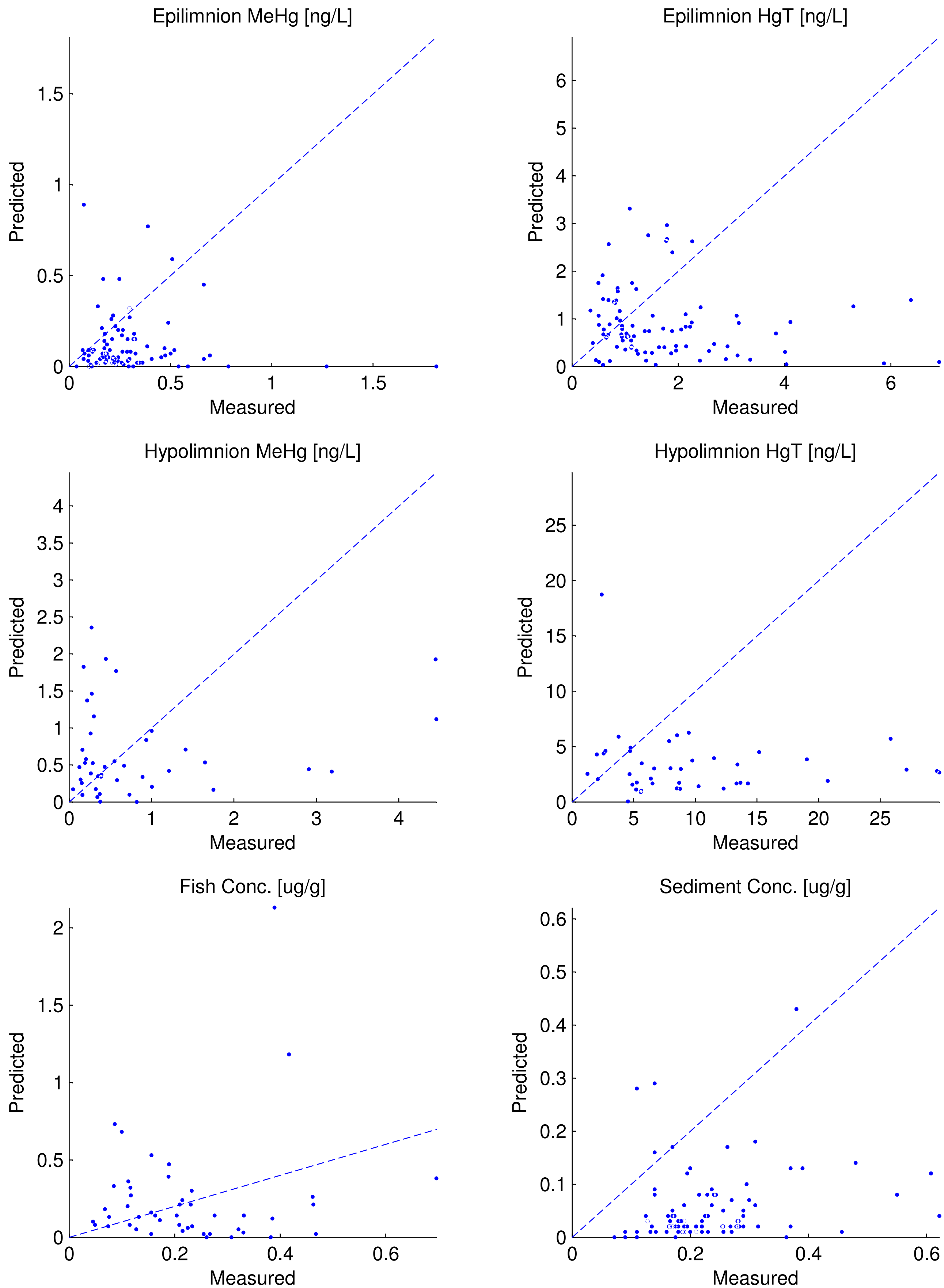


Figure 4.4. Predicted Conc. vs Measured Conc. with Lake Variables for Tier 3 Run. Dashed Line is y = x.

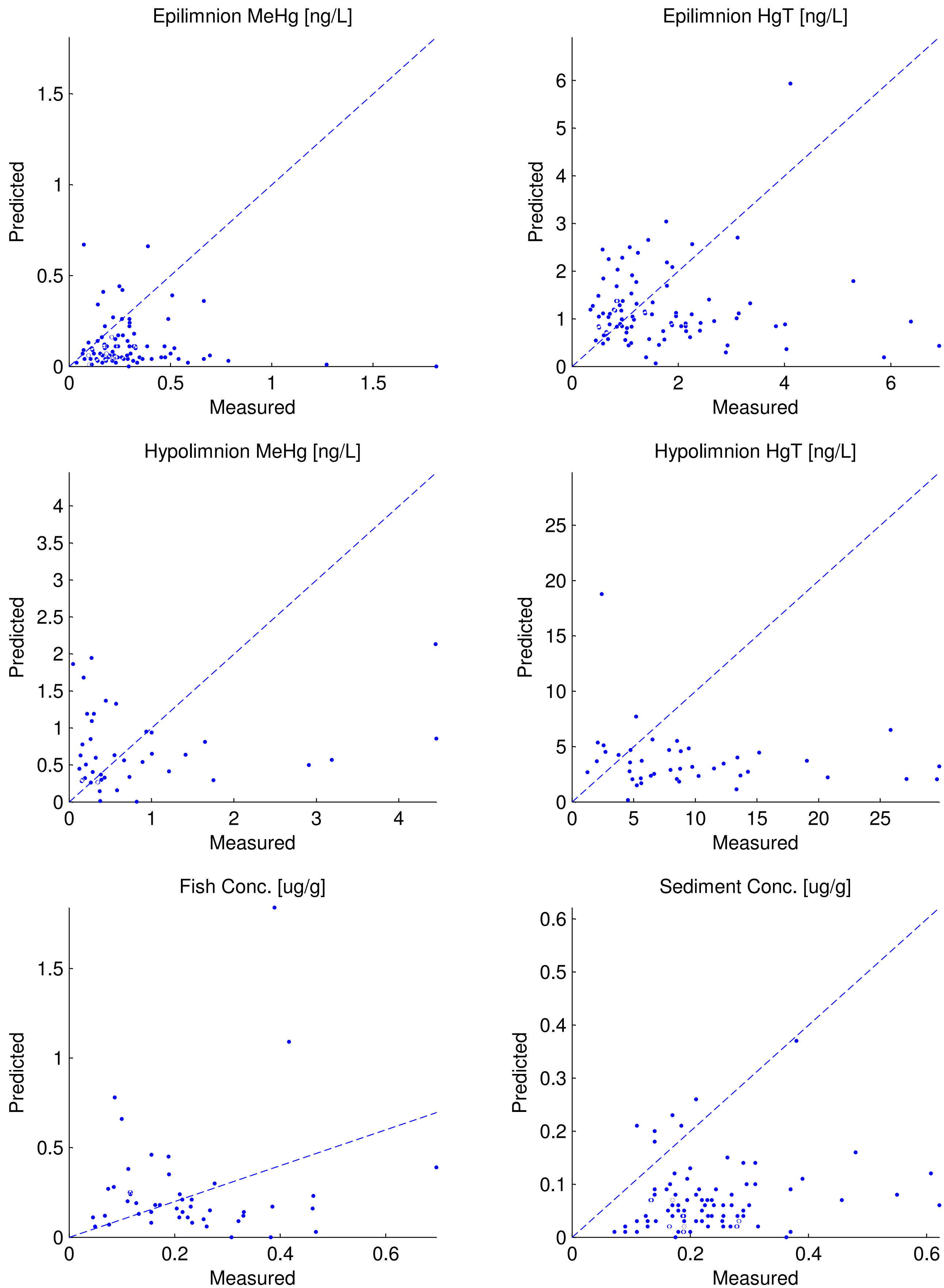


Figure 4.5. Predicted Conc. vs Measured Conc. with Lake Variables for Tier 4 Run. Dashed Line is y = x.

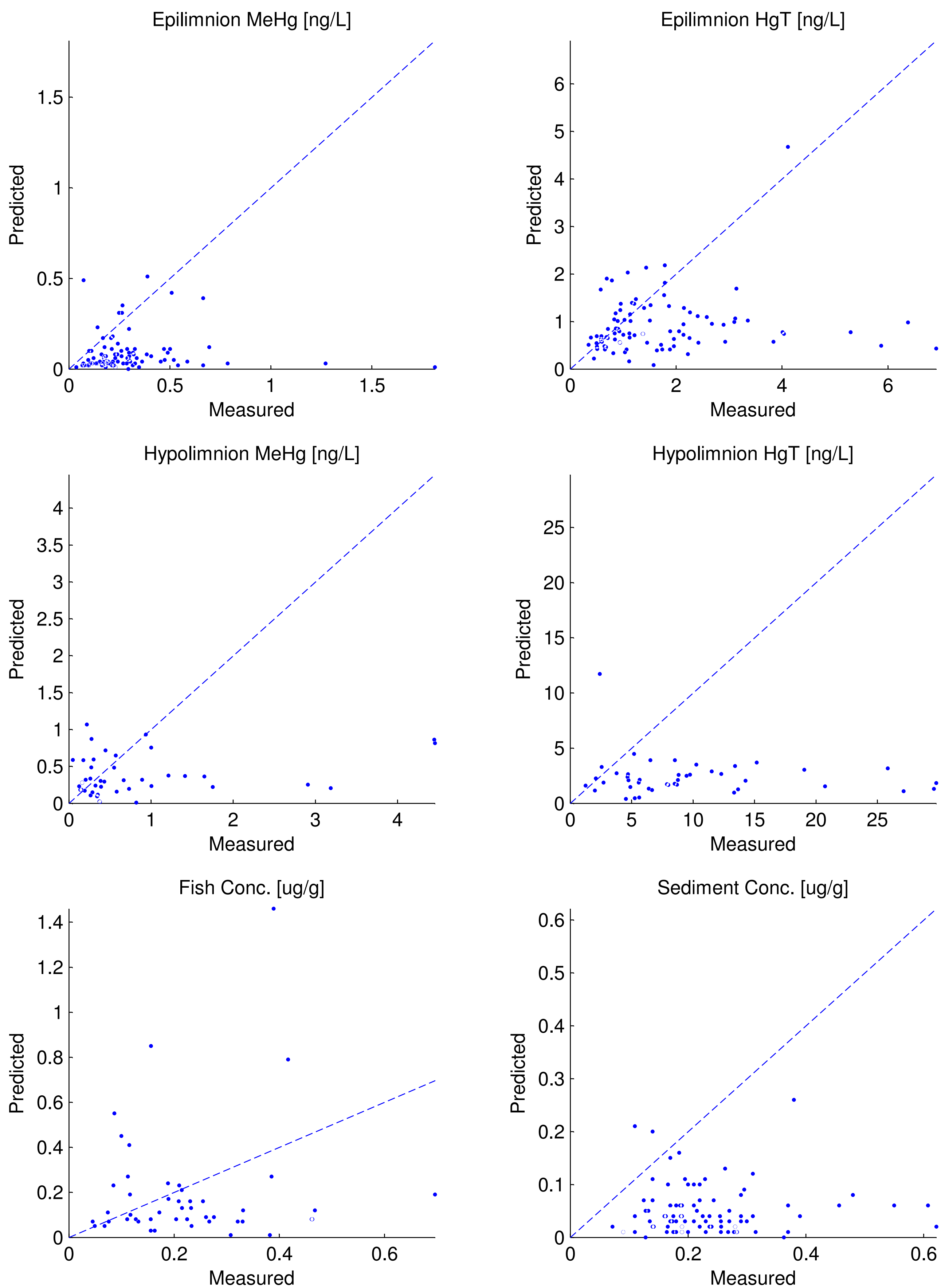


Figure 4.6. Predicted Conc. vs Measured Conc. of Lake Variables for Tier 5 Run. Dashed Line is y = x.

Error Sum of Squares for Default and Different Tiers

	EPI MeHg	EPI HgT	HYP MeHg	HYP HgT	Fish	Sediment
Default	7.9	291.3	43.4	4005.5	4.6	3.5
Tier 1	10.6	289.0	52.5	4949.6	4.0	4.2
Tier 2	10.5	292.5	54.0	4675.7	3.7	4.3
Tier 3	10.9	289.4	54.0	4680.9	6.1	4.0
Tier 4	10.1	234.9	50.0	4540.3	4.8	3.5
Tier 5	10.2	228.4	52.4	4958.9	3.6	4.1
Percent Change	28.4%	-21.6%	20.7%	23.8%	-22.3%	17.6%

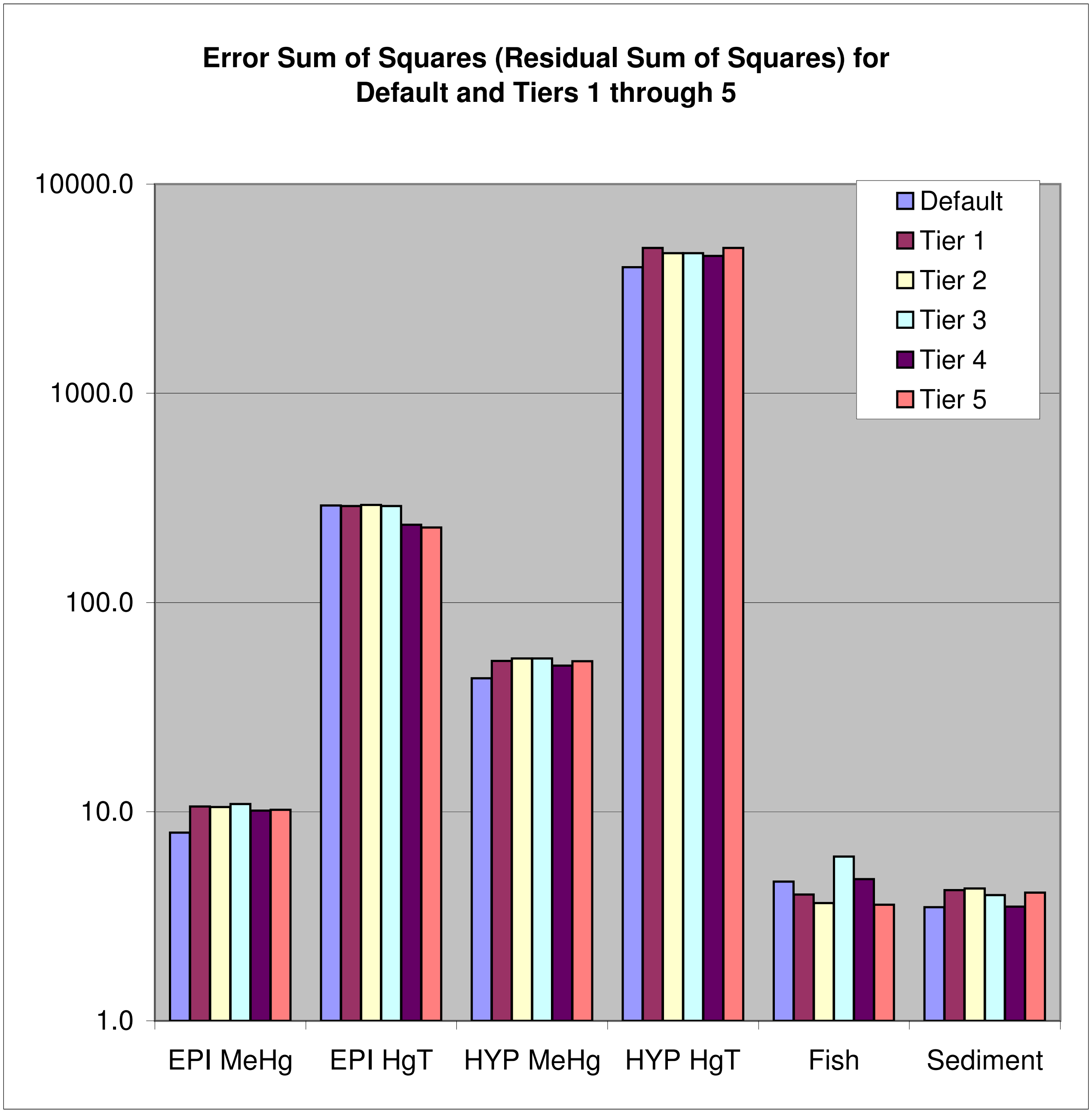


Figure 4.7. Error Sum of Squares for runs and variables.

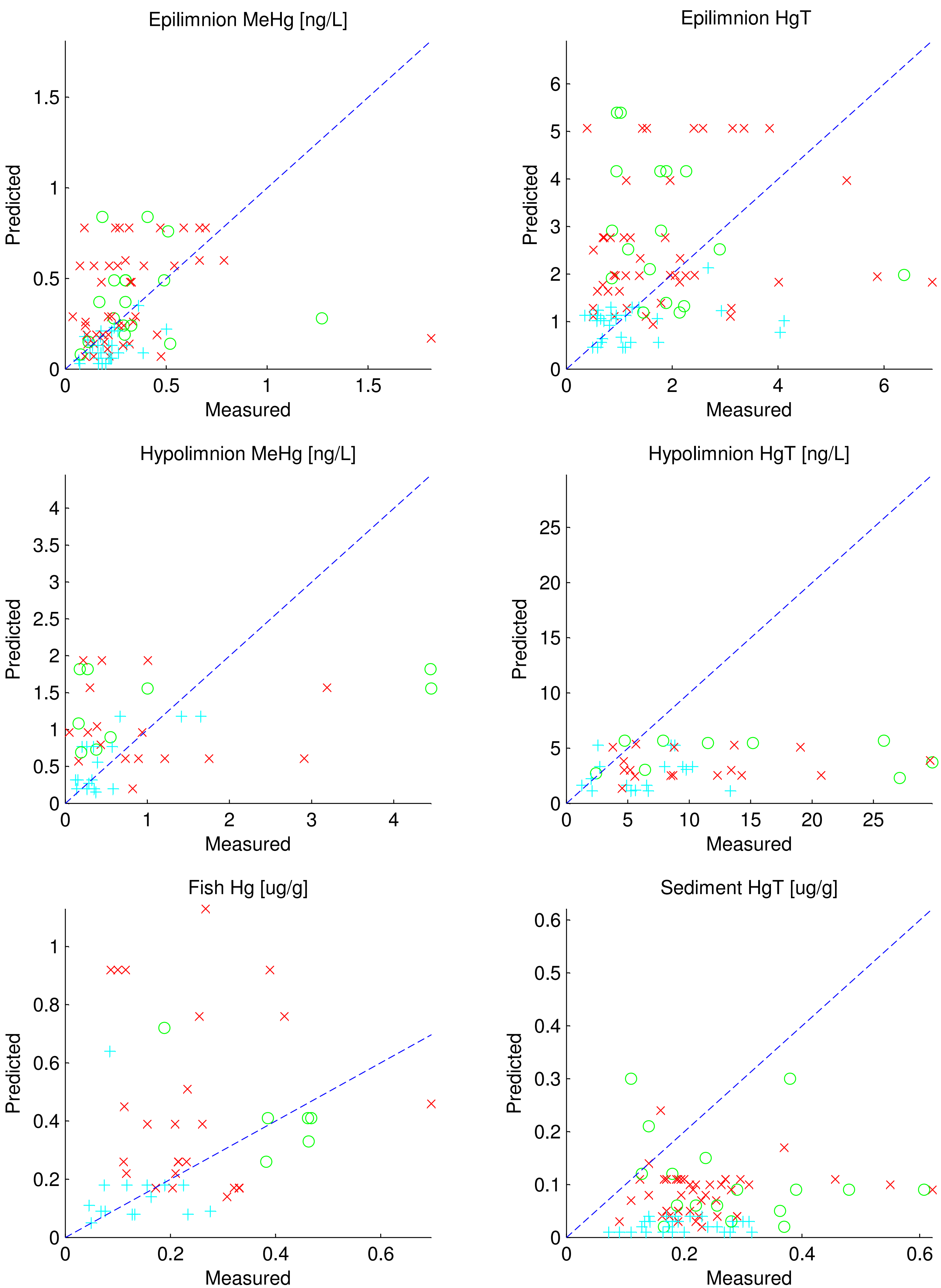


Figure 5.1. Default Results. Lakes Separated by Acidity: o: Acidic, x: Circumneutral, +: Alkaline.

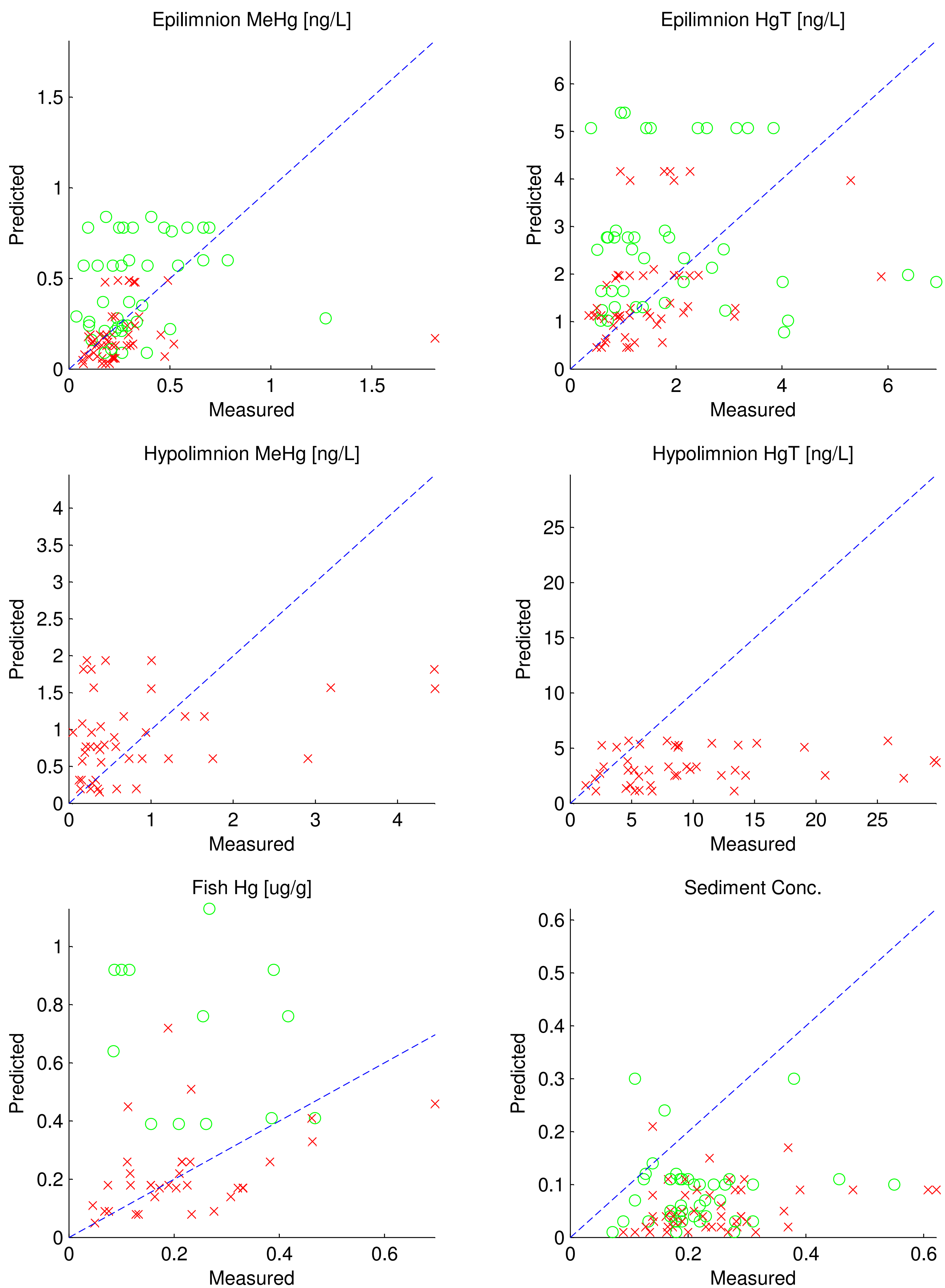


Figure 5.2. Default Results. Lakes Separated by Stratification: o: Well Mixed, x: Stratification.

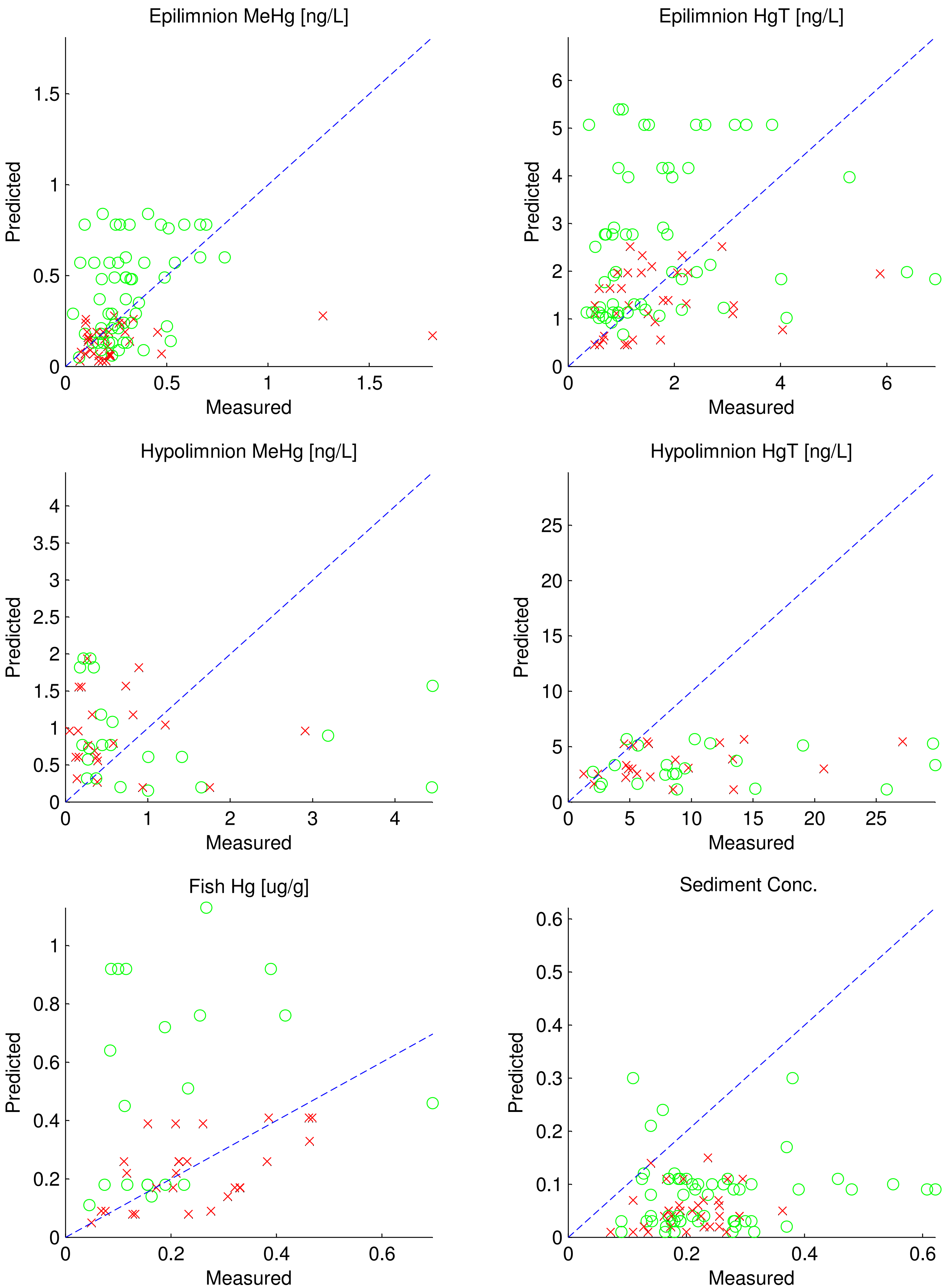


Figure 5.3. Default Results. Lakes Separated by Lake Size: o: Small, x: Medium.

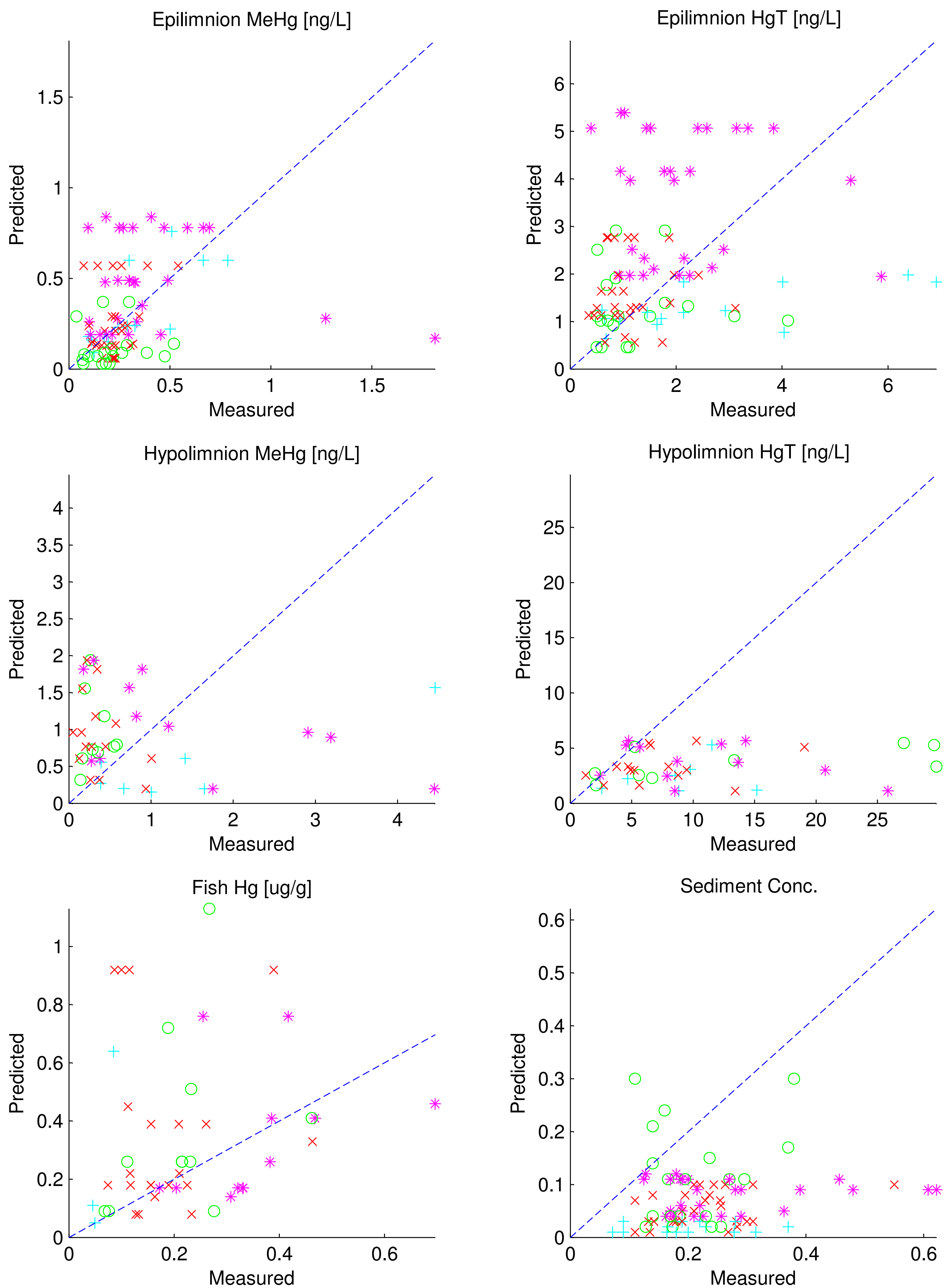


Figure 5.4. Default Results. Lakes Separated by Trophic Status:
o: Oligotrophic, x: Mesotrophic, +: Eutrophic, *: Dystrophic.

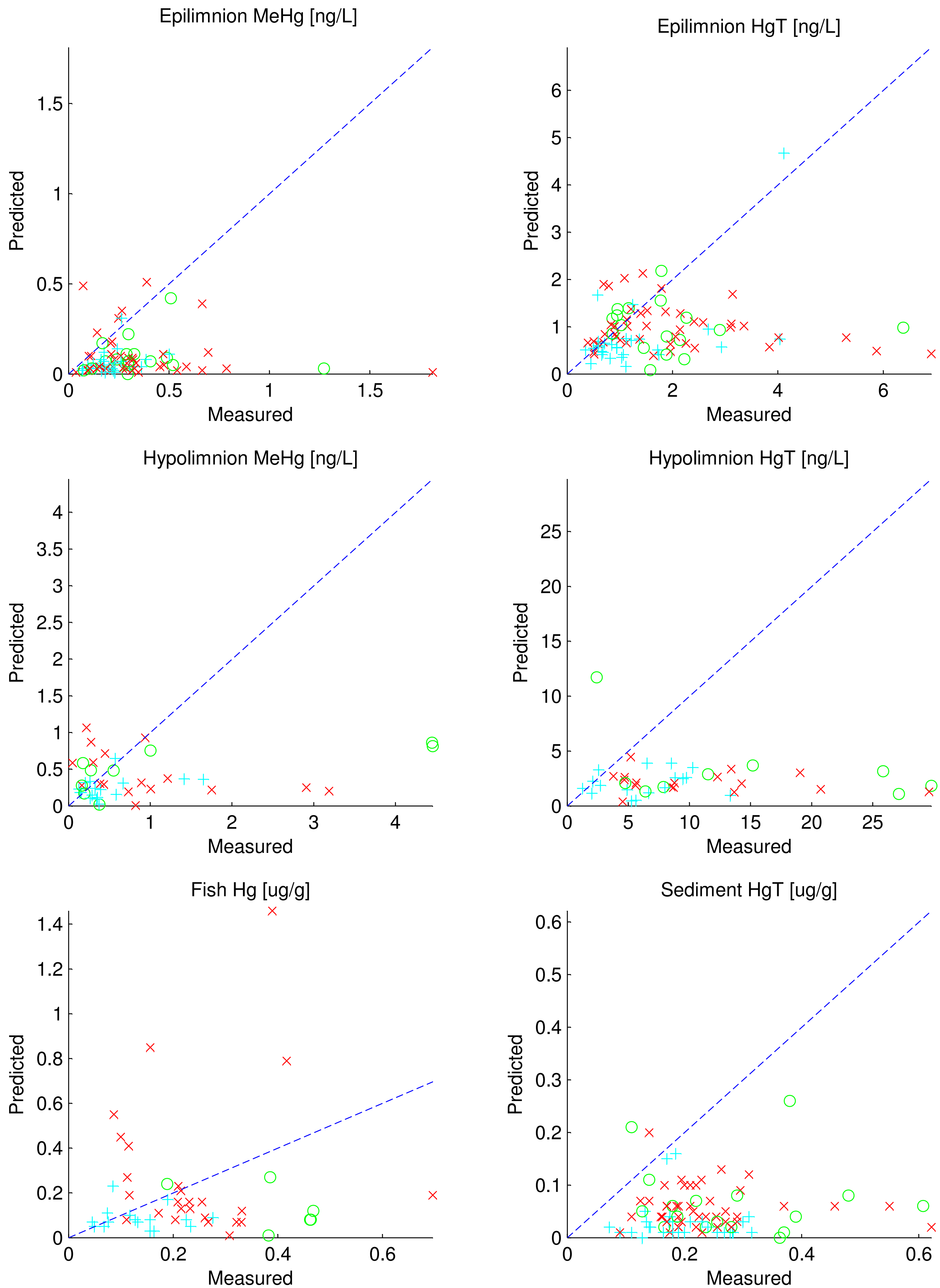


Figure 5.5. Tier 5 Results. Lakes Separated by Acidity: o: Acidic, x: Circumneutral, +: Alkaline.

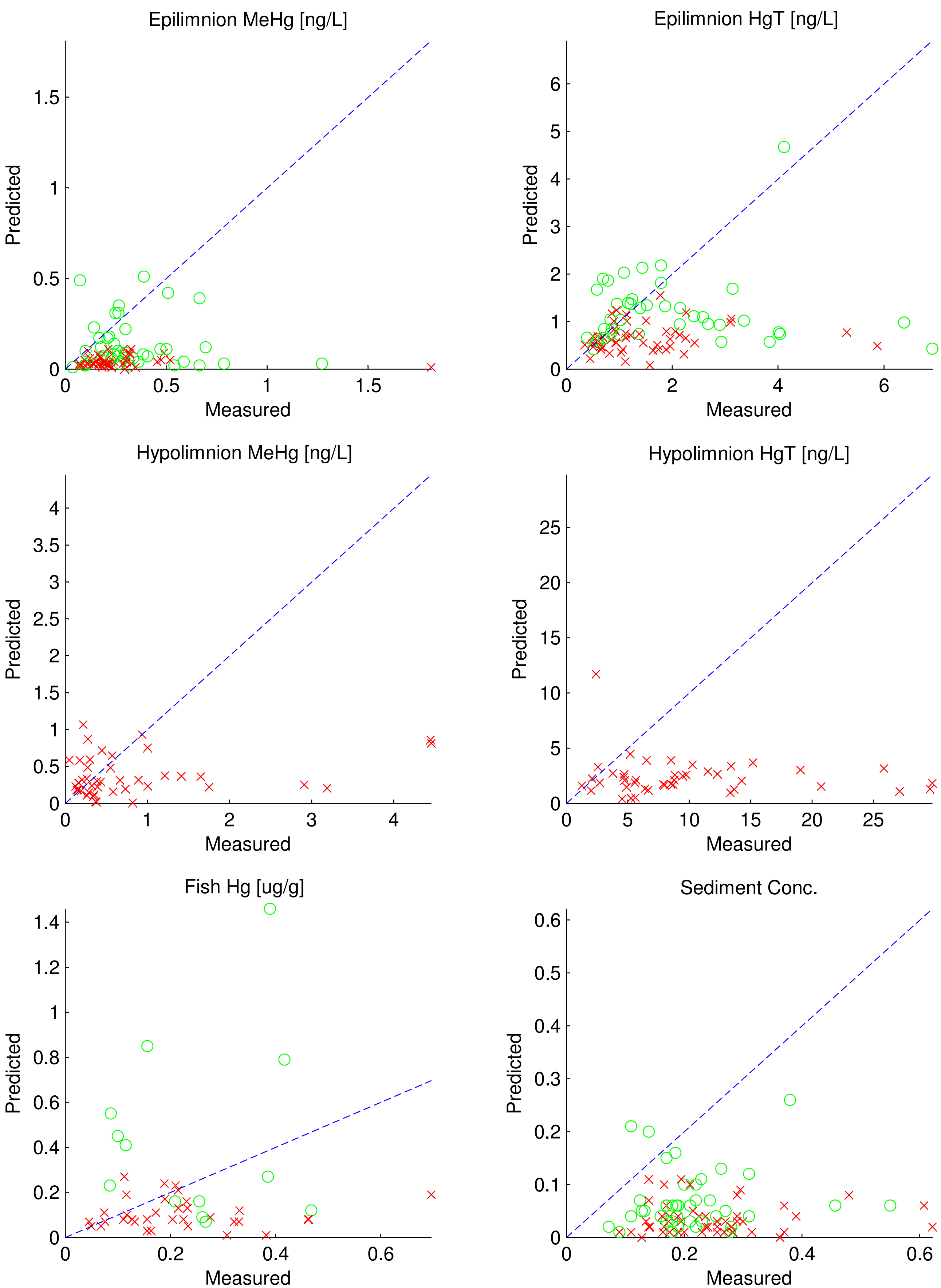


Figure 5.6. Tier 5 Results. Lakes Separated by Stratification: o: Well Mixed, x: Stratification.

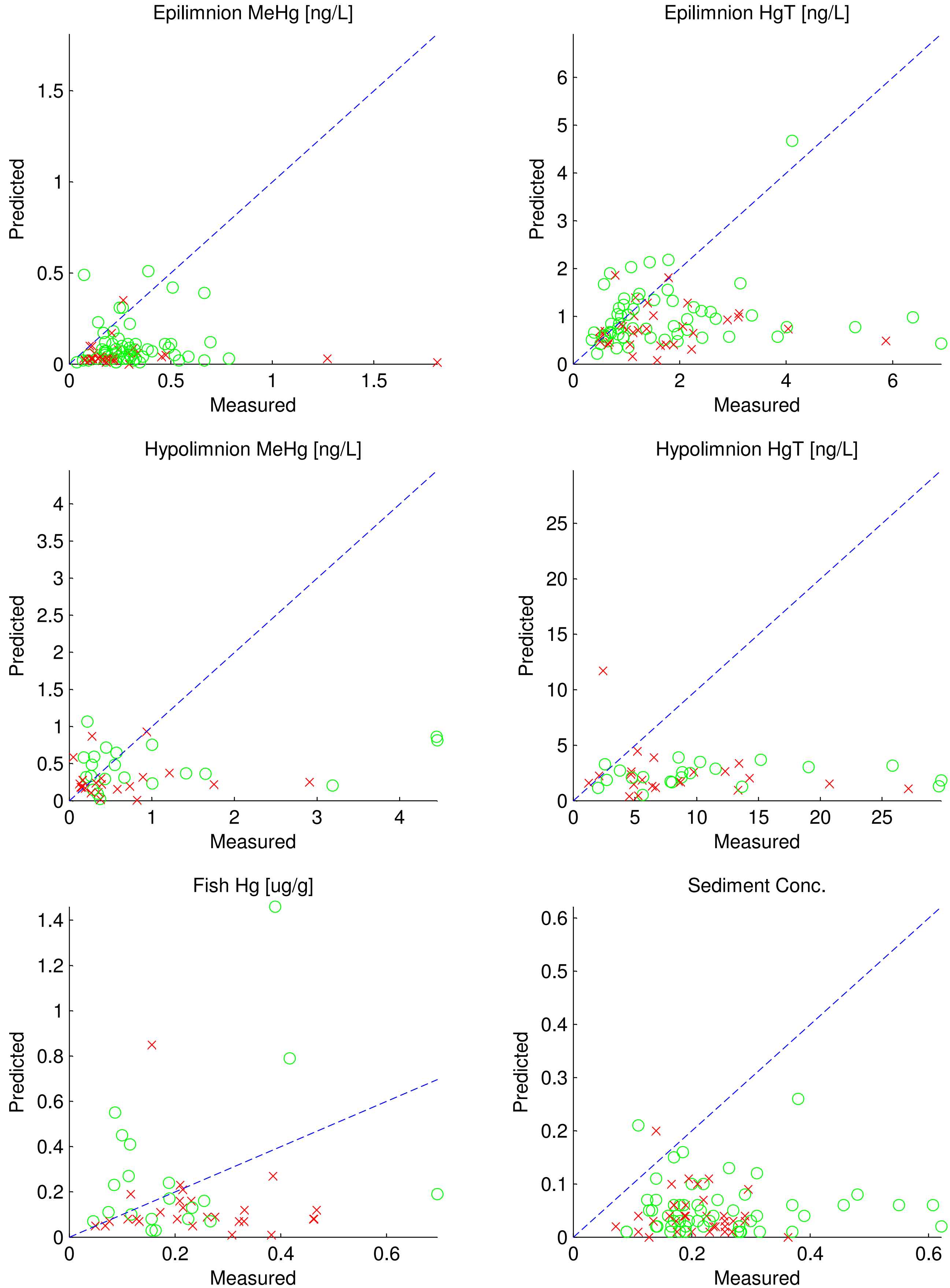


Figure 5.7. Tier 5 Results. Lakes Separated by Lake Size: o: Small, x: Medium.

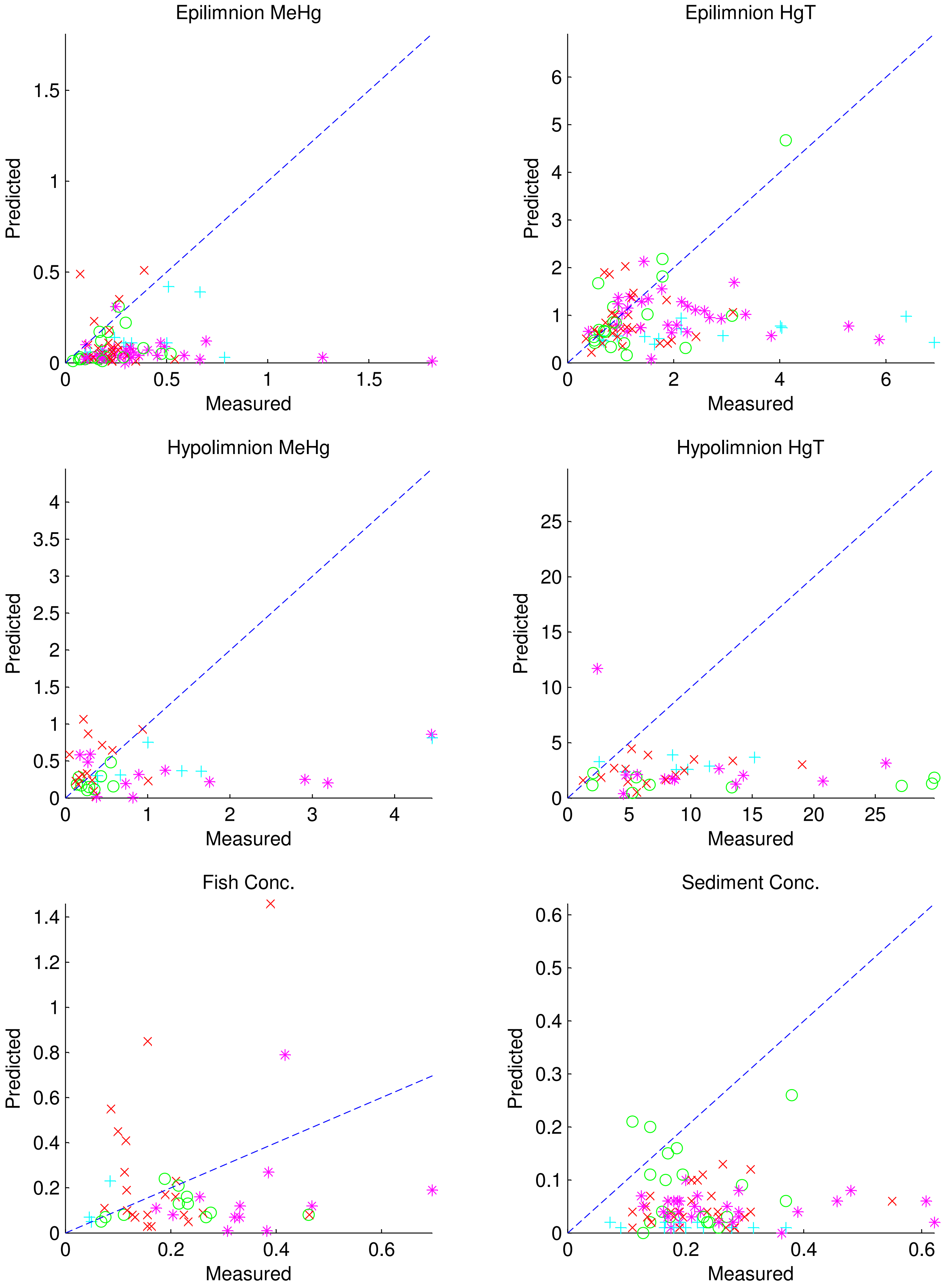


Figure 5.8. Tier 5 Results. Lakes Separated by Trophic Status:
o: Oligotrophic, x: Mesotrophic, +: Eutrophic, *: Dystrophic.

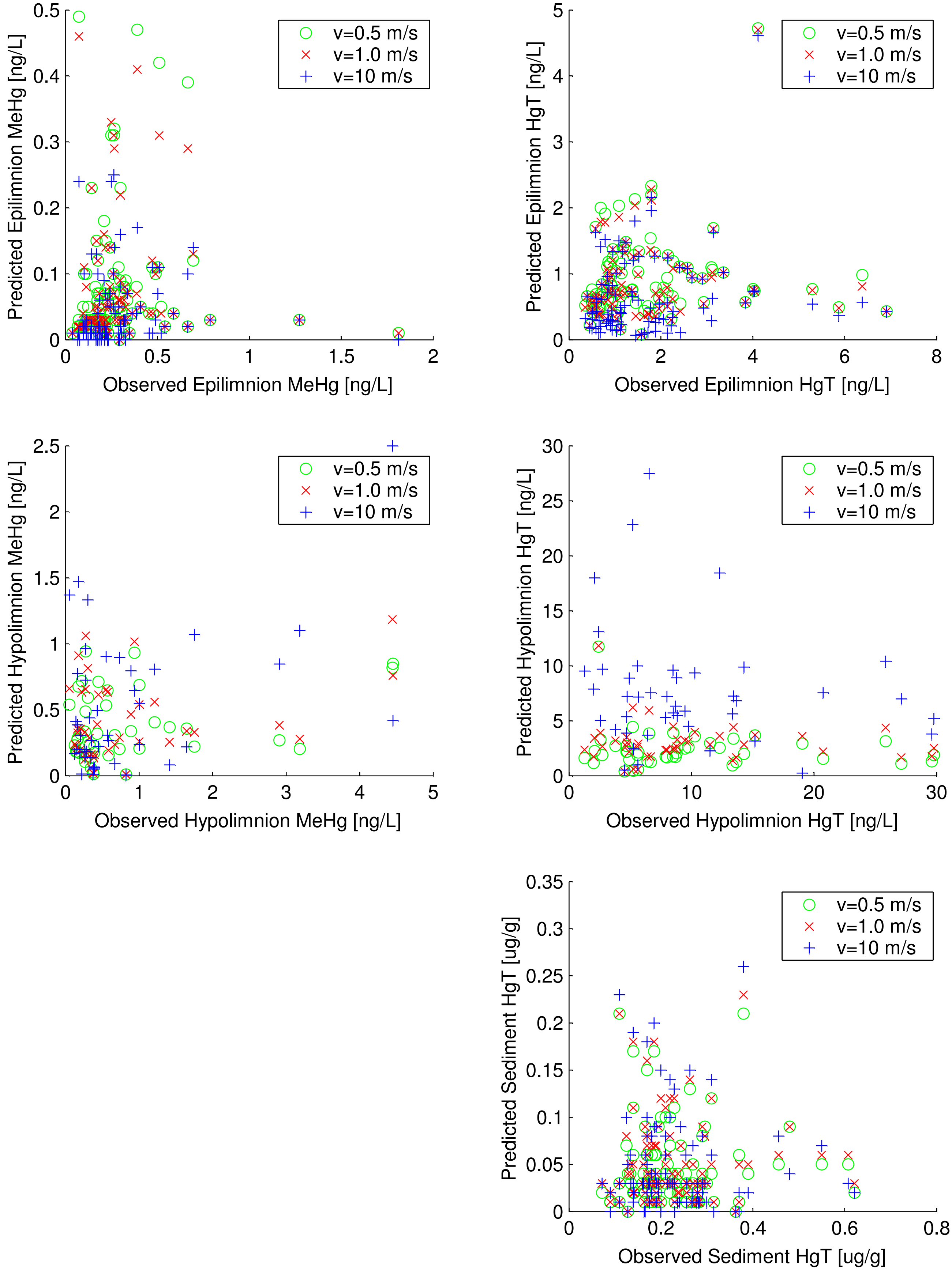


Figure 6.1. Effects of Settling Velocity on Predicted Mercury Concentrations.

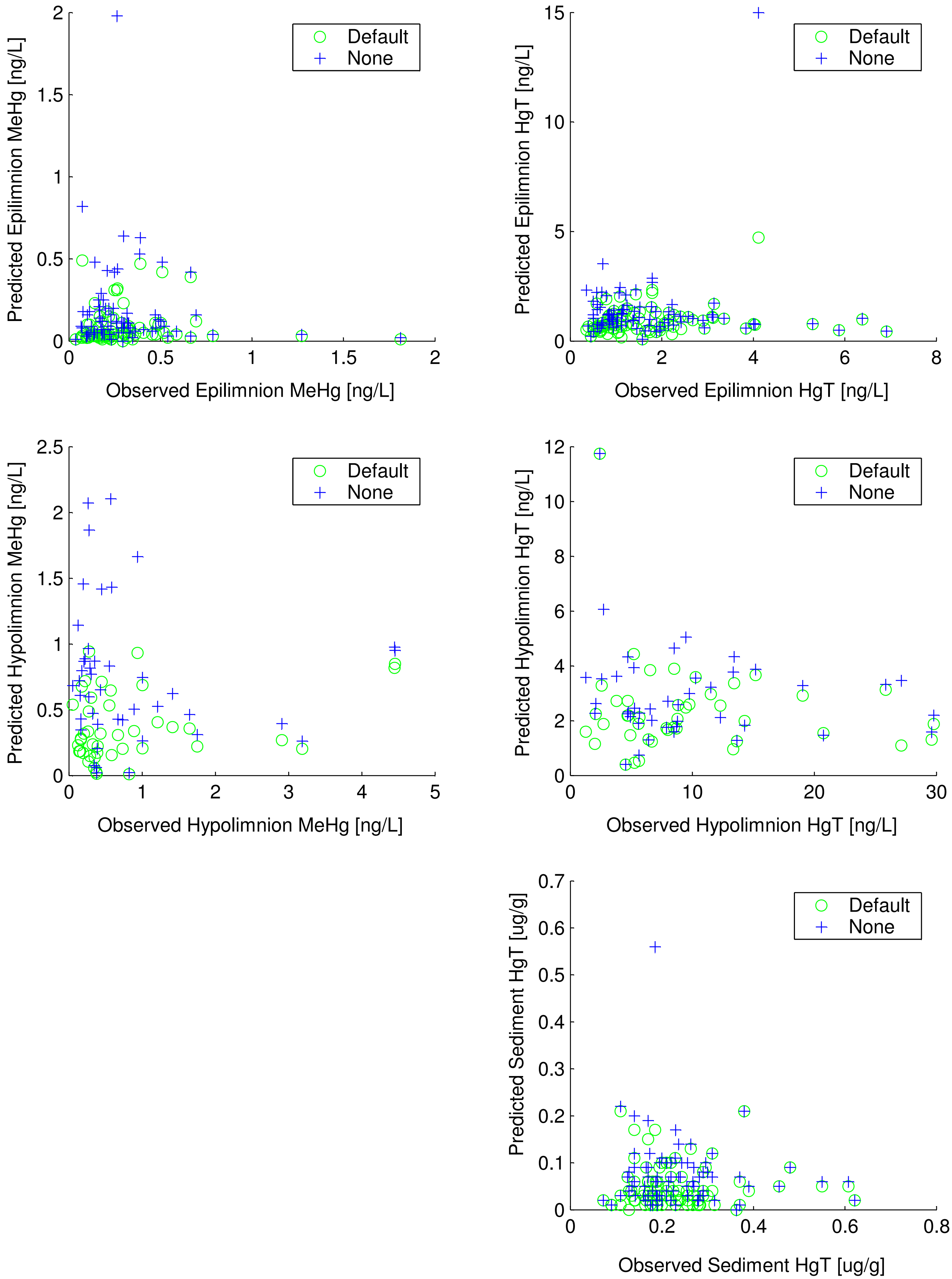


Figure 6.2. Effects of Photoreduction (default rate and none) on Predicted Mercury Concentrations.

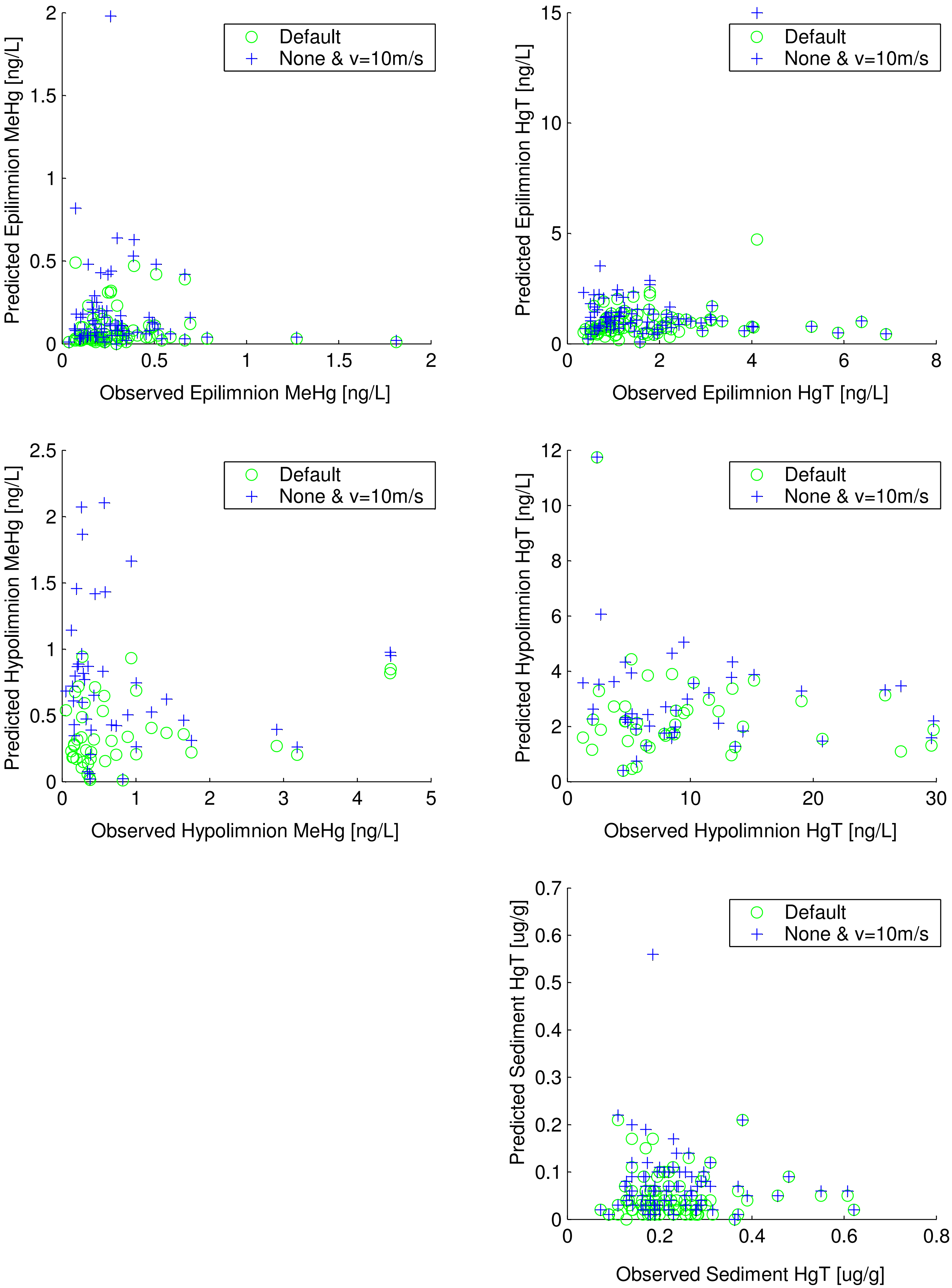


Figure 6.3. Combined Effects of Photoreduction and Settling Velocity on Predicted Mercury Concentrations.

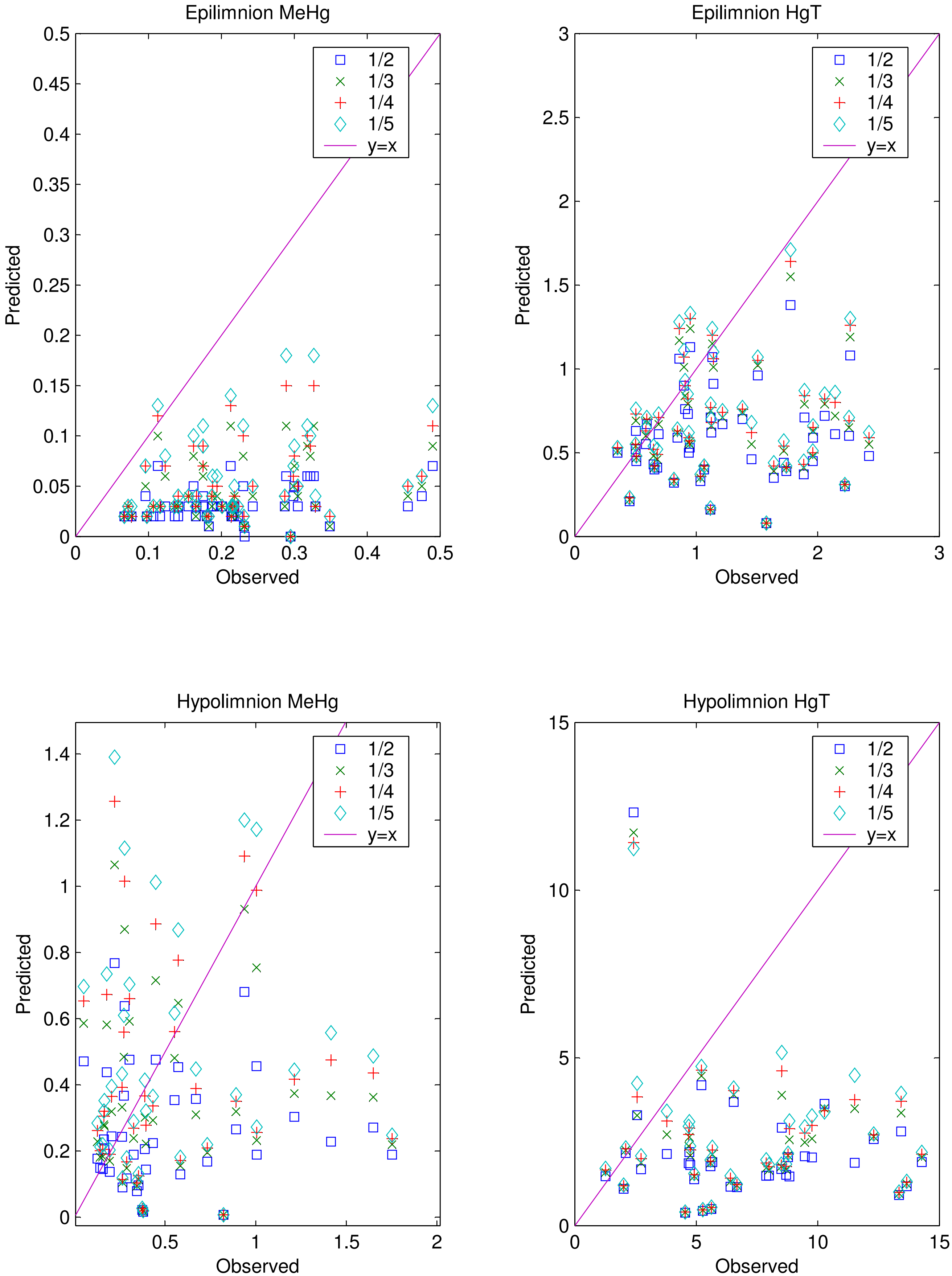


Figure 6.4. Predicted vs. Observed Epilimnion and Hypolimnion Mercury Concentrations for the Hypolimnion Area Sensitivity Runs.

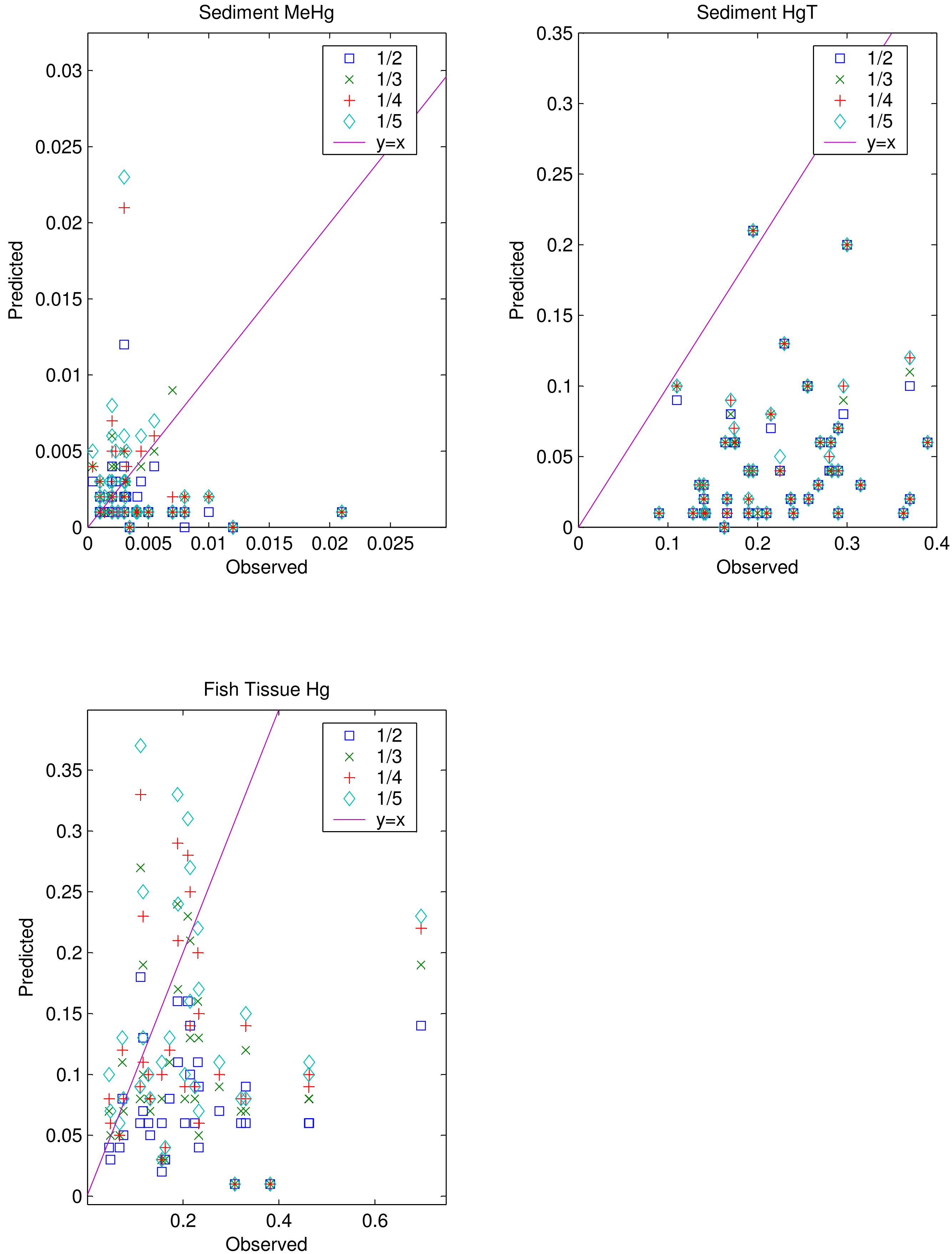


Figure 6.5. Predicted vs. Observed Sediment and Fish Tissue Mercury Concentrations for the Hypolimnion Area Sensitivity Runs.

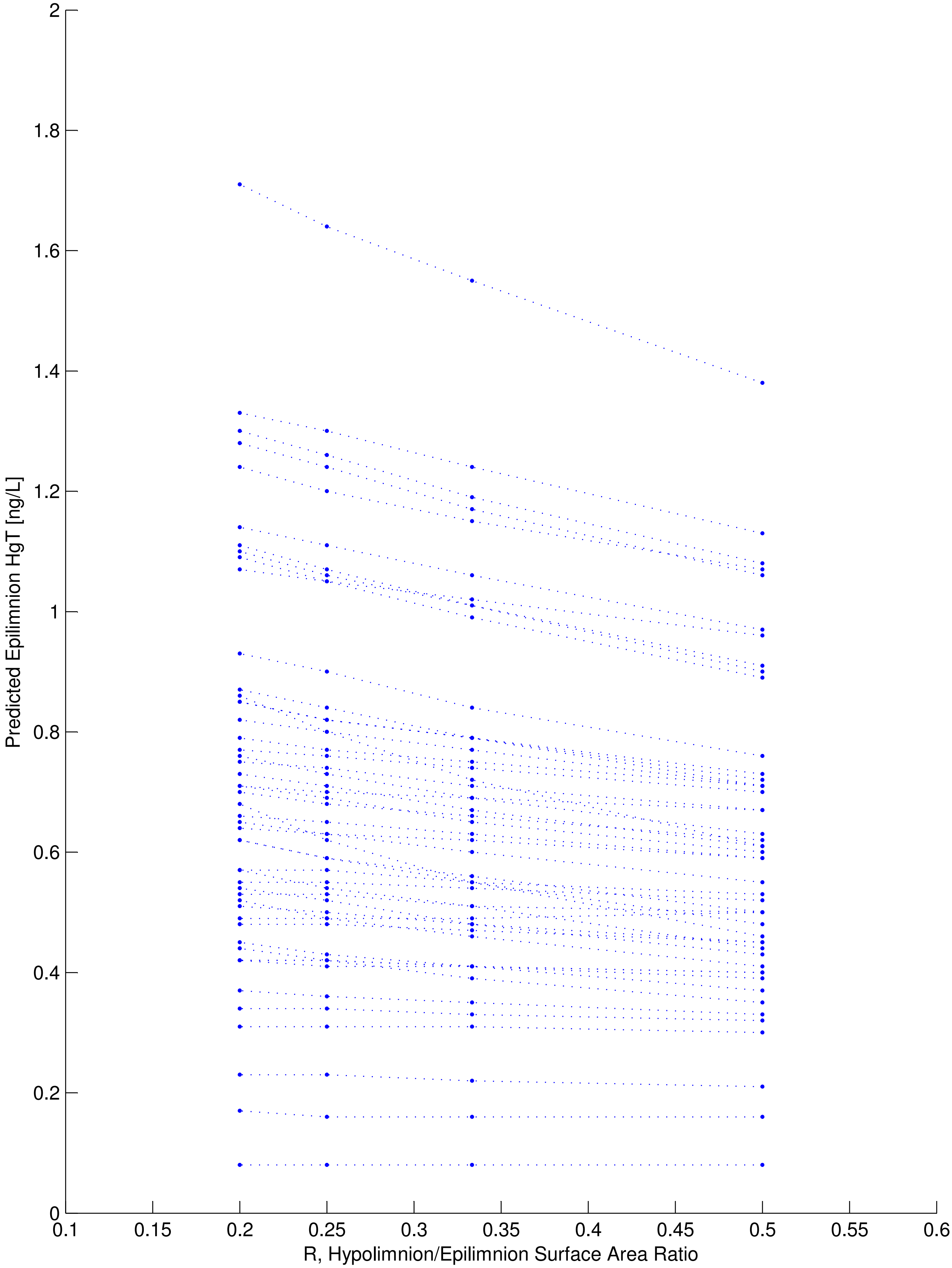


Figure 6.6. Hypolimnion Area Sensitivity Analysis. Predicted Concentration vs. R, Hypolimnion/Epilimnion Surface Area Ratio. Each lake is connected by a line.

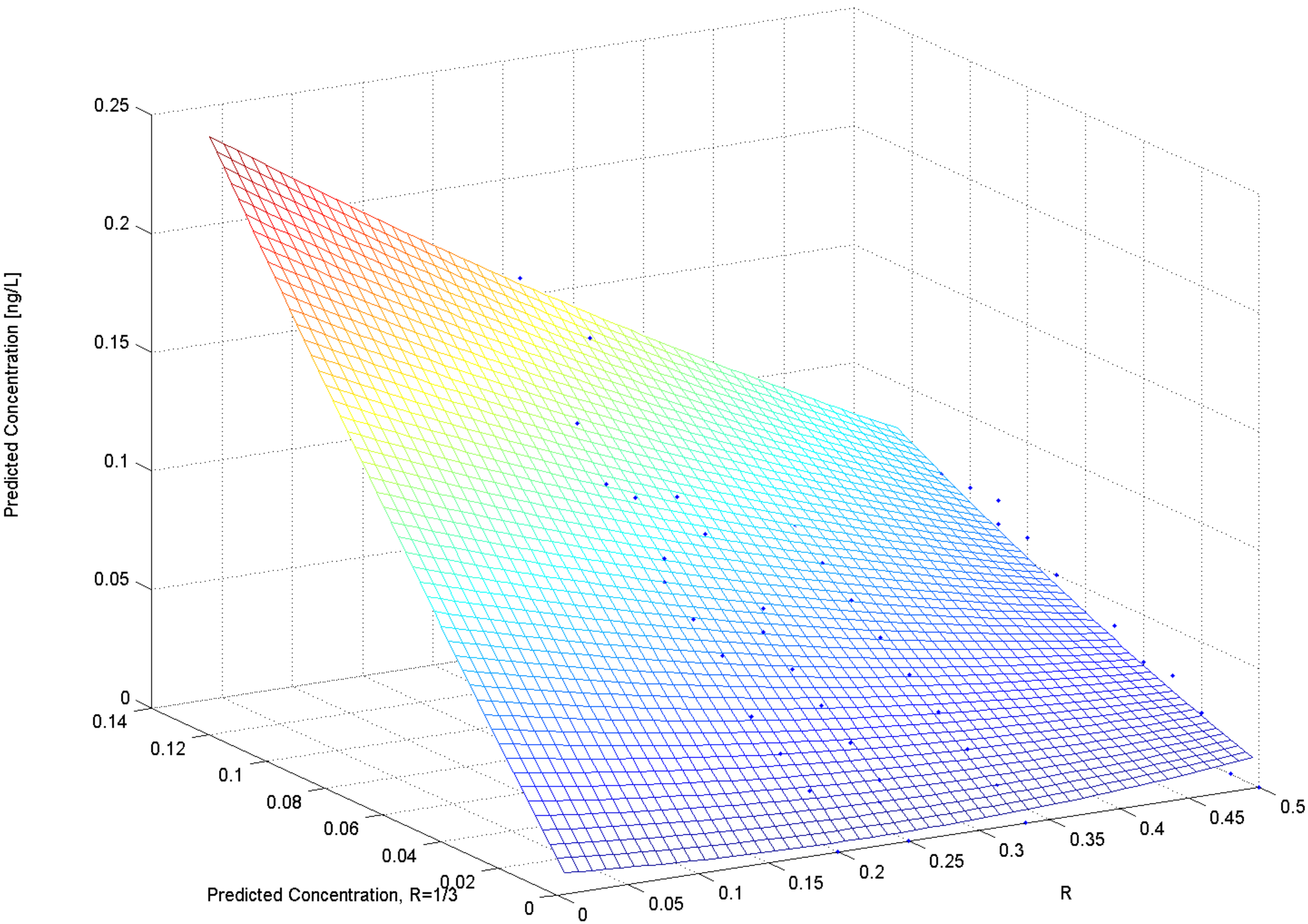


Figure 6.7. Hypolimnion Area Sensitivity Analysis. Response Surface and Predicted Concentrations for Epilimnetic Methylmercury Concentrations.

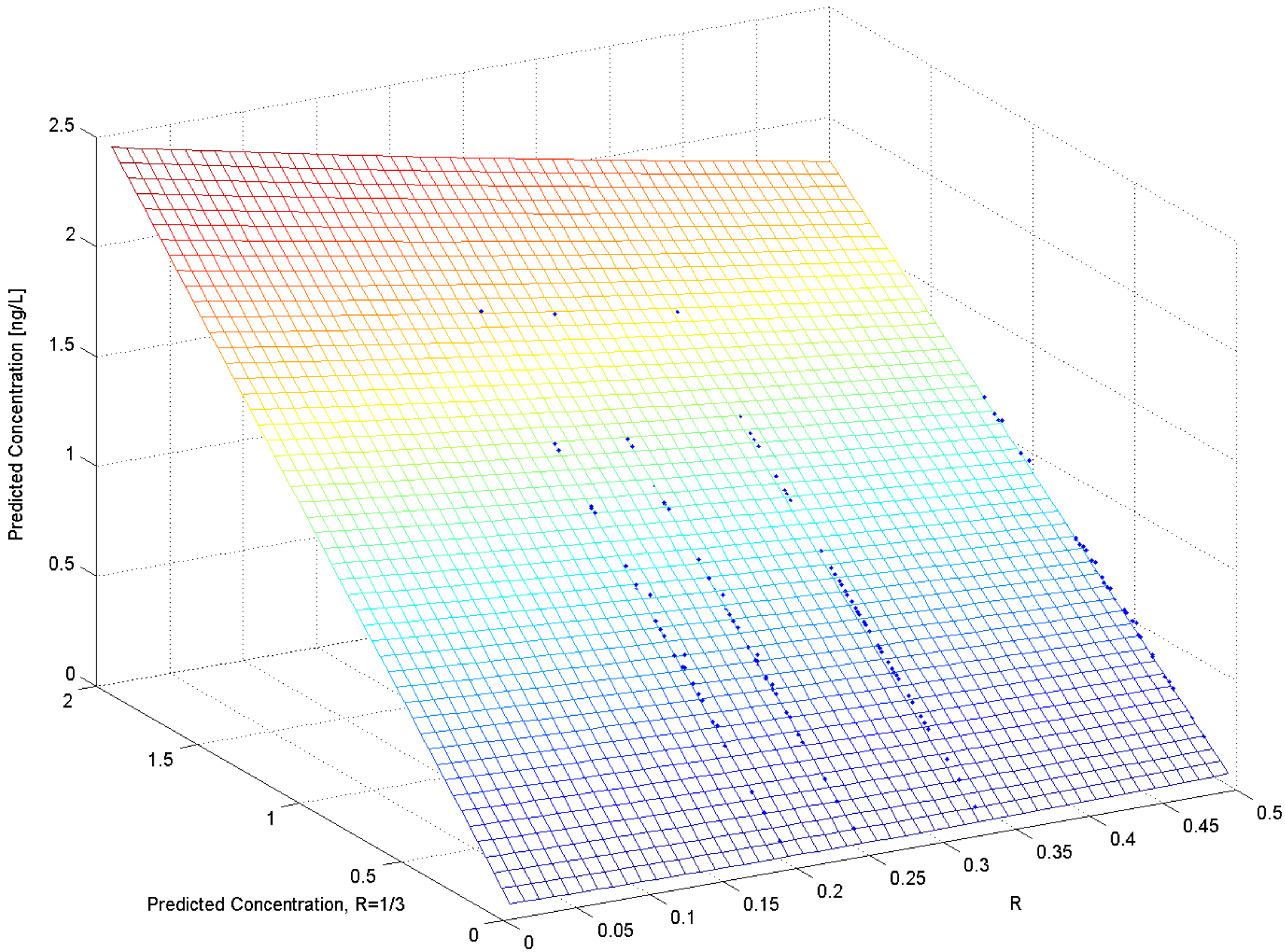


Figure 6.8. Hypolimnion Area Sensitivity Analysis. Response Surface and Predicted Concentrations for Epilimnetic Total Mercury Concentrations.

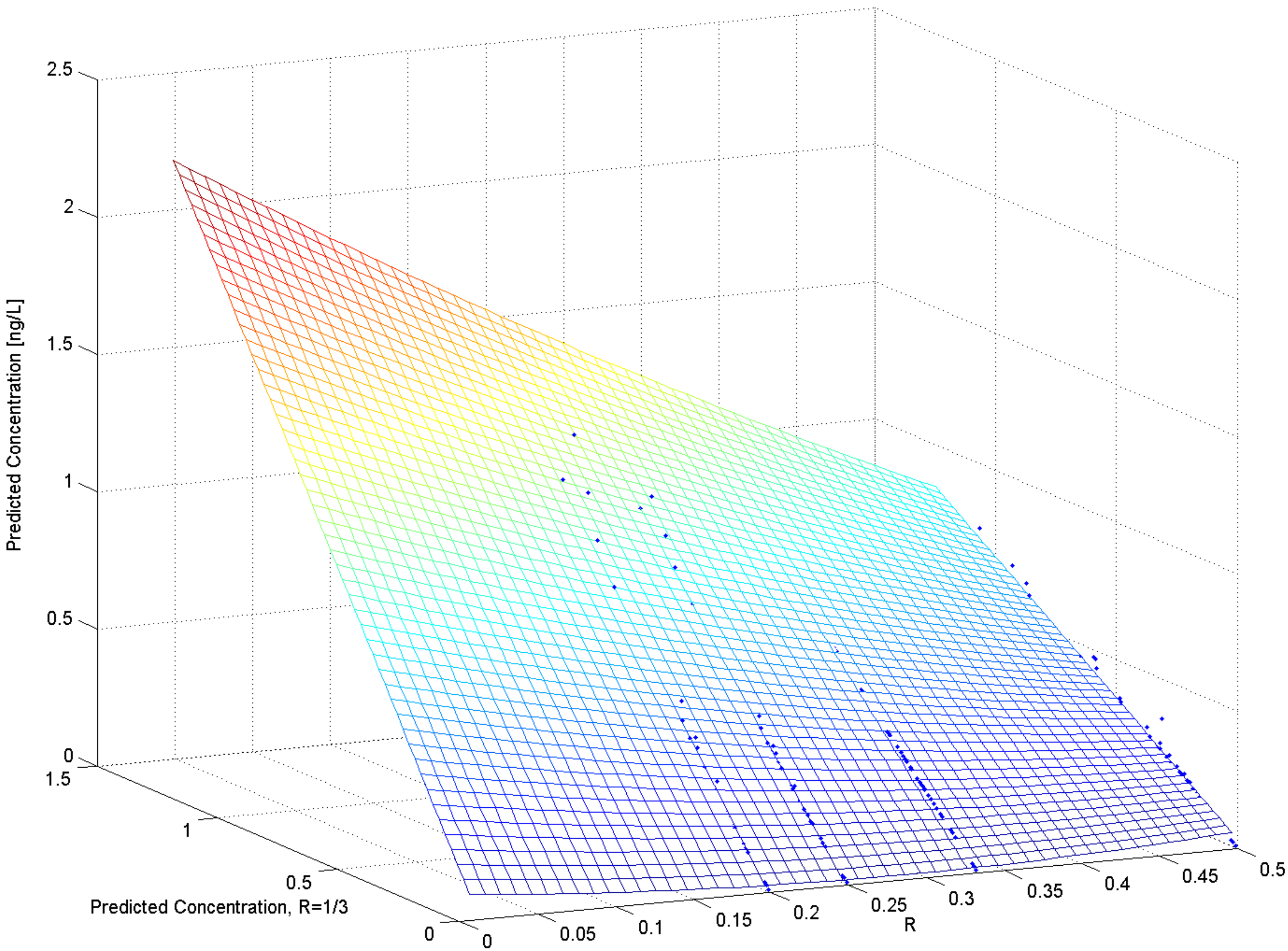


Figure 6.9. Hypolimnion Area Sensitivity Analysis. Response Surface and Predicted Concentrations for Hypolimnetic Methylmercury Concentrations.

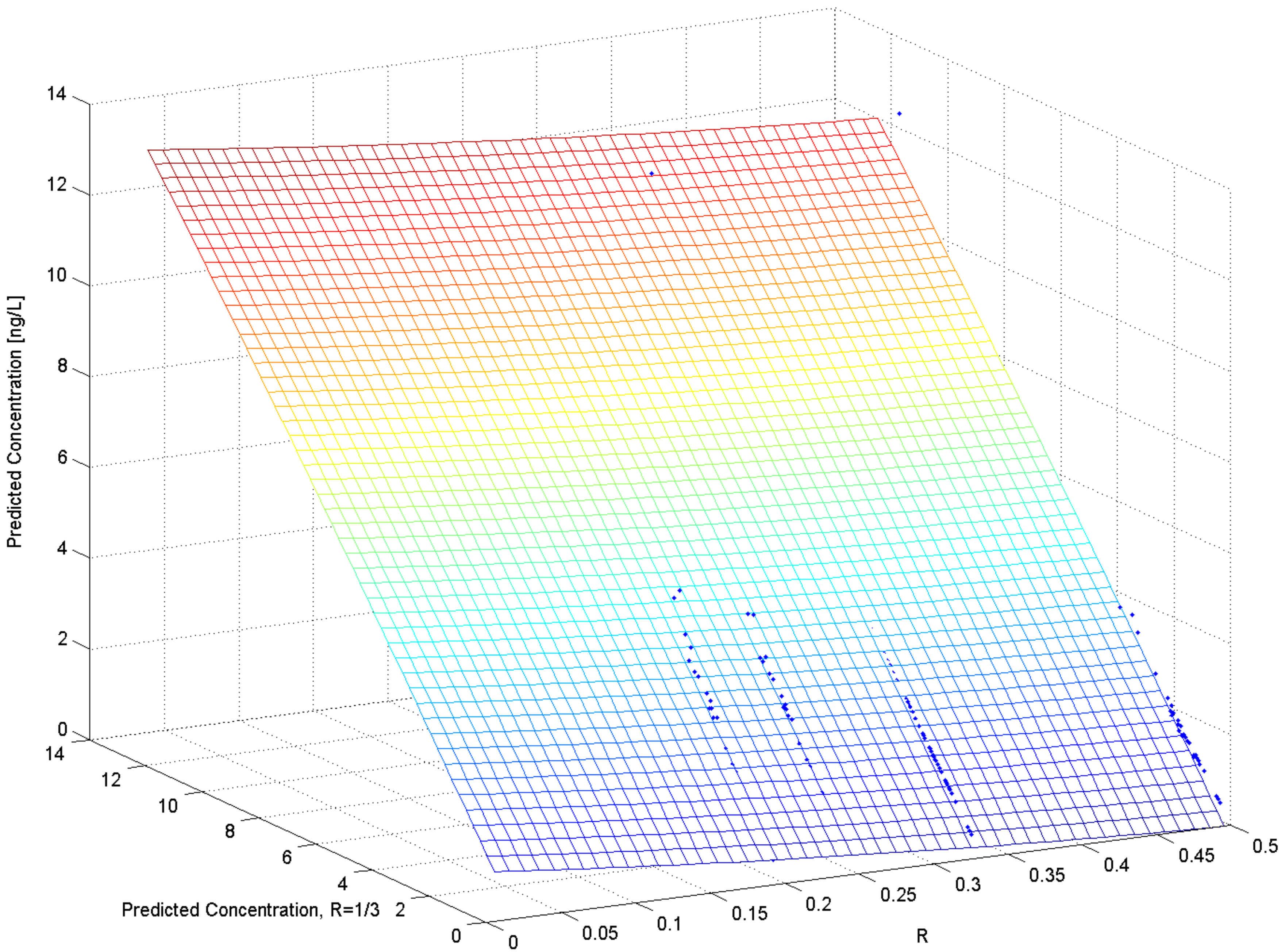


Figure 6.10. Hypolimnion Area Sensitivity Analysis. Response Surface and Predicted Concentrations for Hypolimnetic Total Mercury Concentrations.

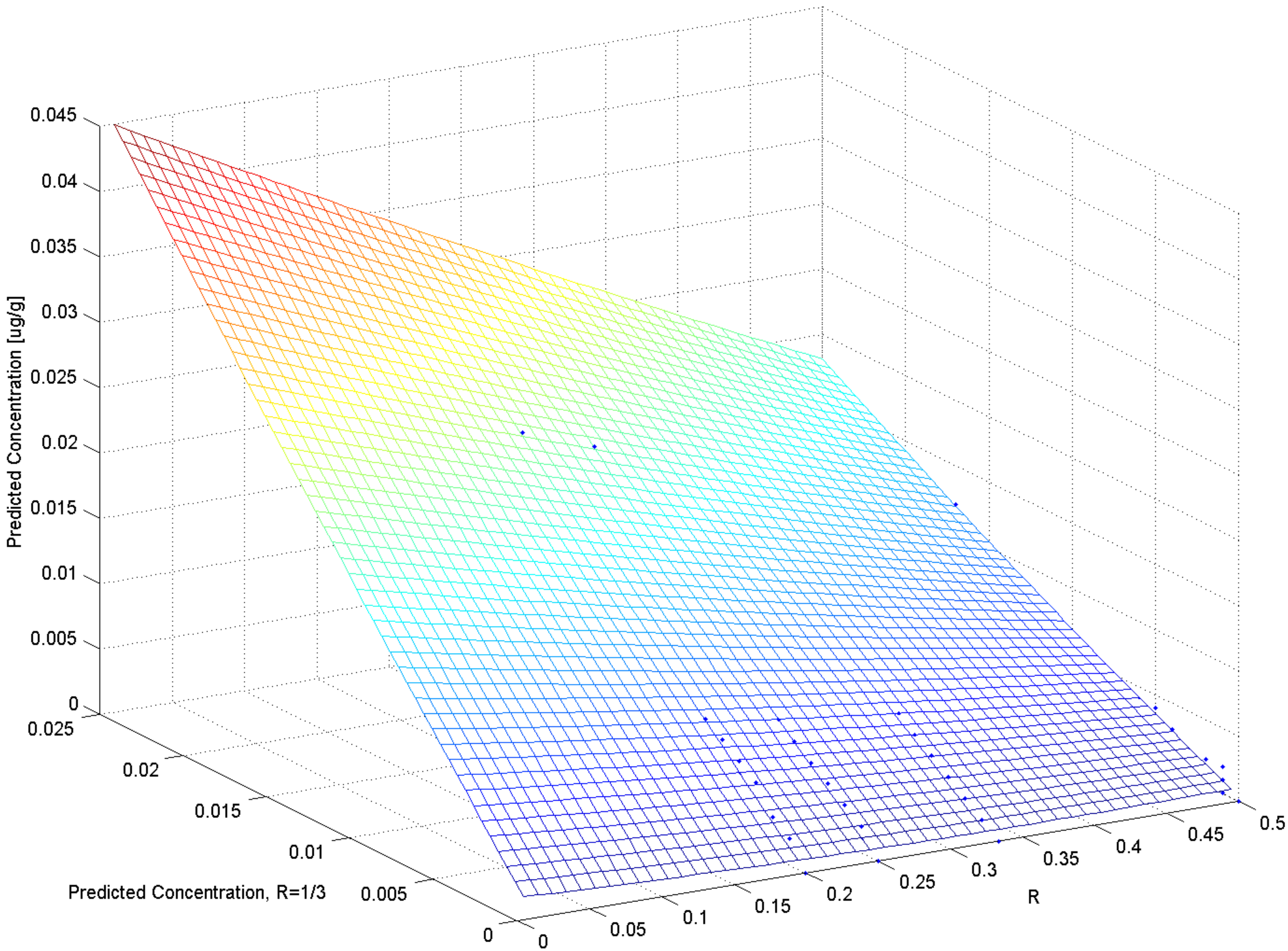


Figure 6.11. Hypolimnion Area Sensitivity Analysis. Response Surface and Predicted Concentrations for Sediment Methylmercury Concentrations.

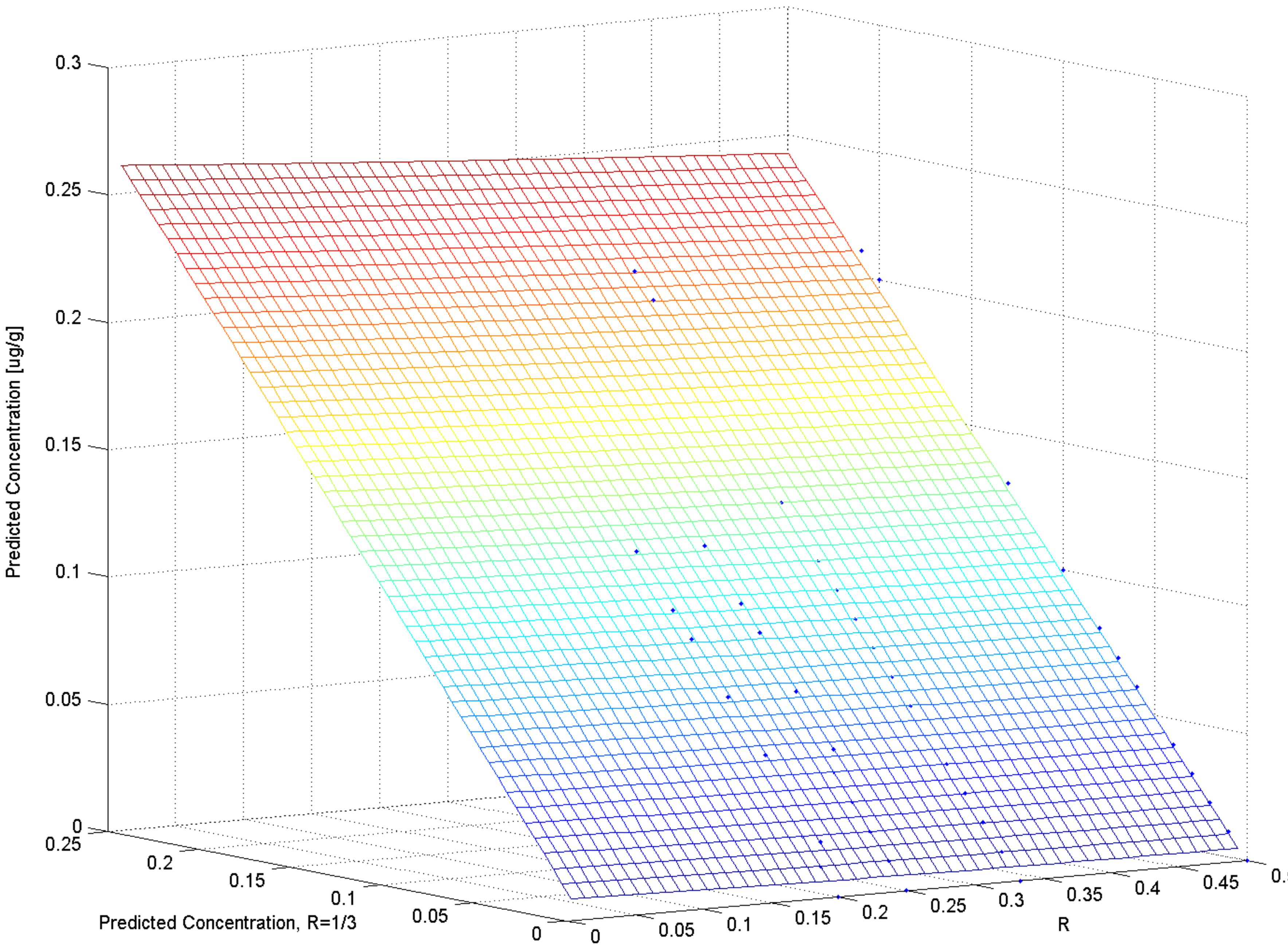


Figure 6.12. Hypolimnion Area Sensitivity Analysis. Response Surface and Predicted Concentrations for Sediment Total Mercury Concentrations.

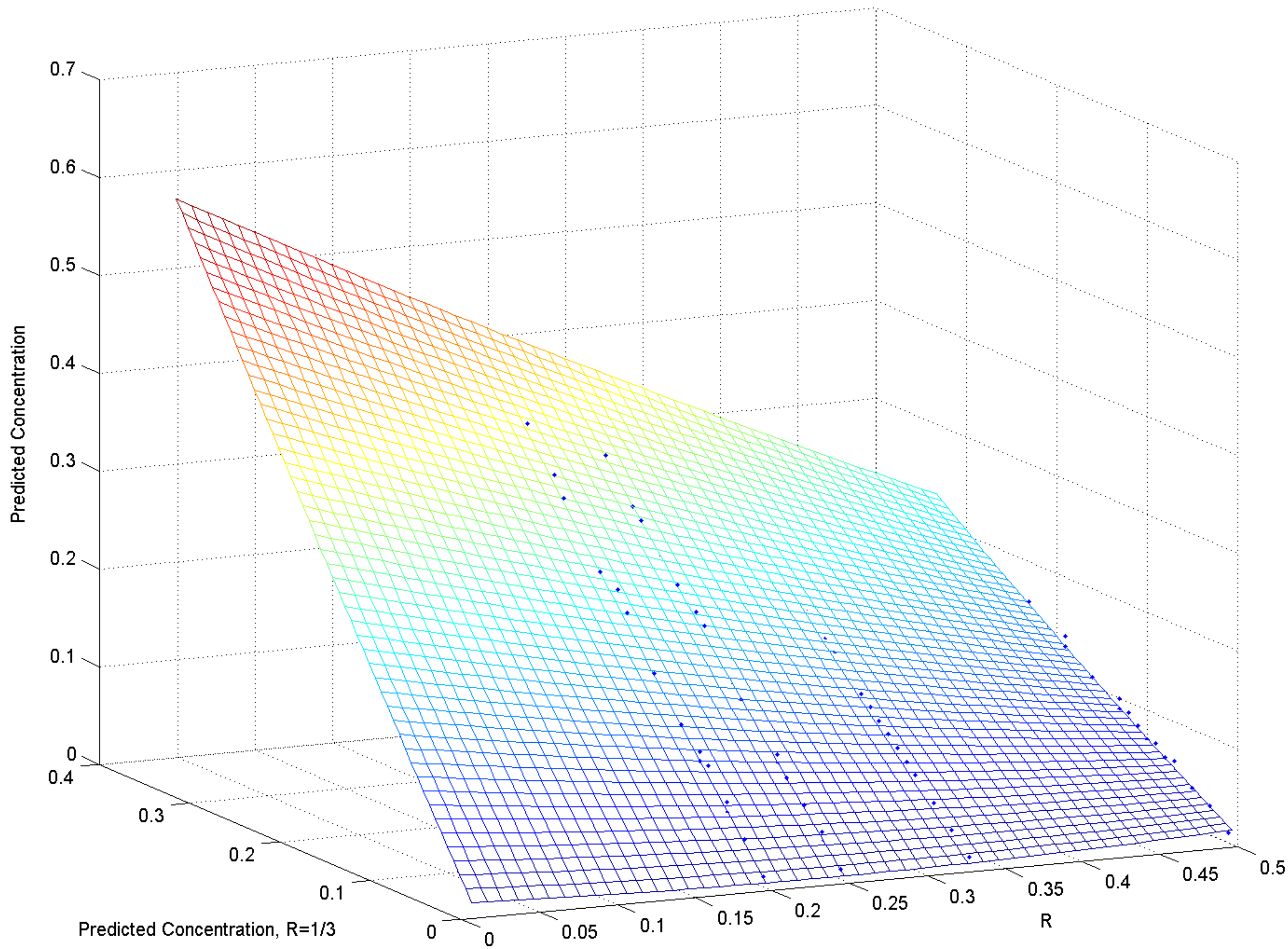


Figure 6.13. Hypolimnion Area Sensitivity Analysis. Response Surface and Predicted Concentrations for Fish Tissue Mercury Concentrations.

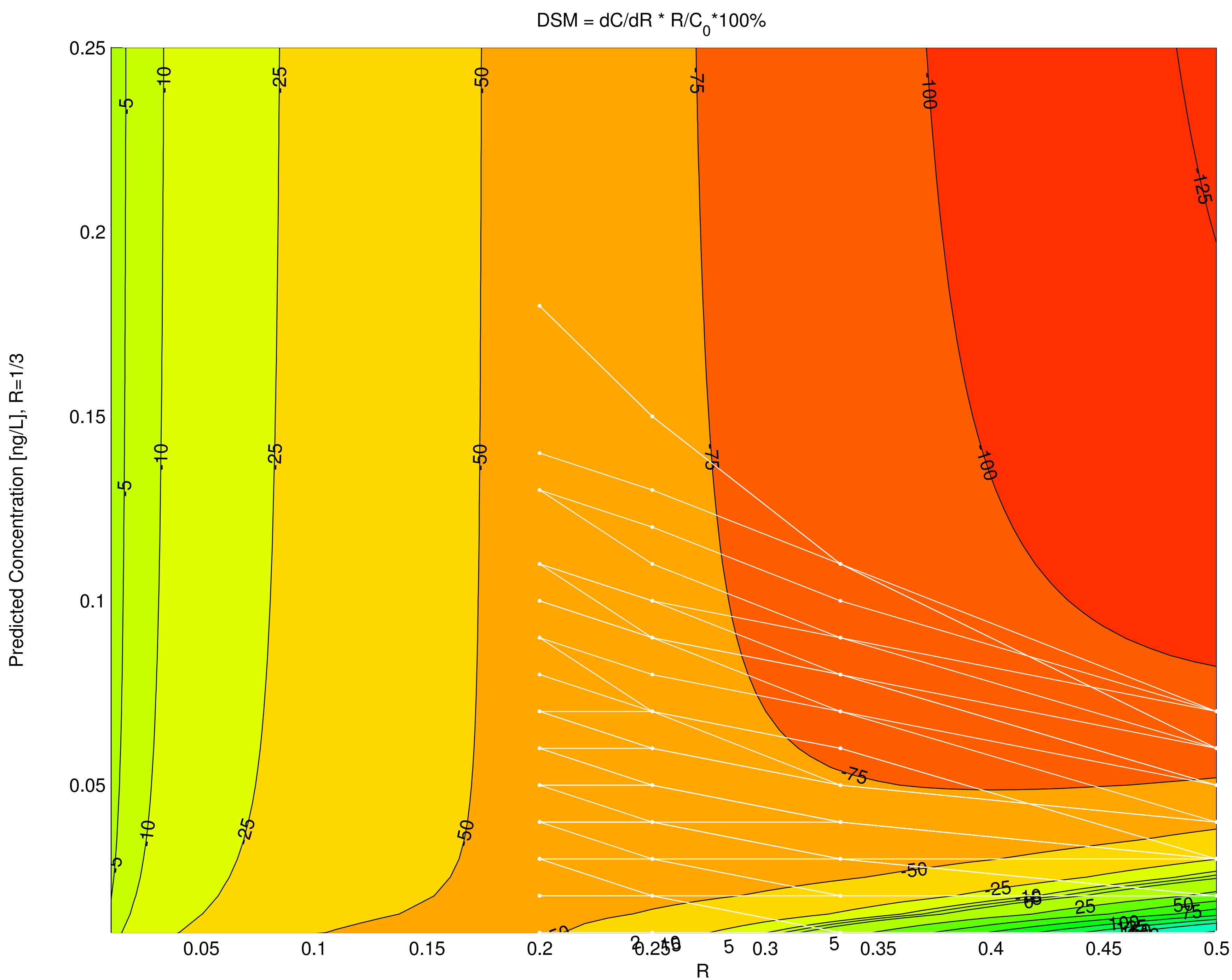


Figure 6.14. Hypolimnion Area Sensitivity Analysis. Delineation of Regions of Specific Percent of Model Sensitivity. Epilimnetic Methylmercury.

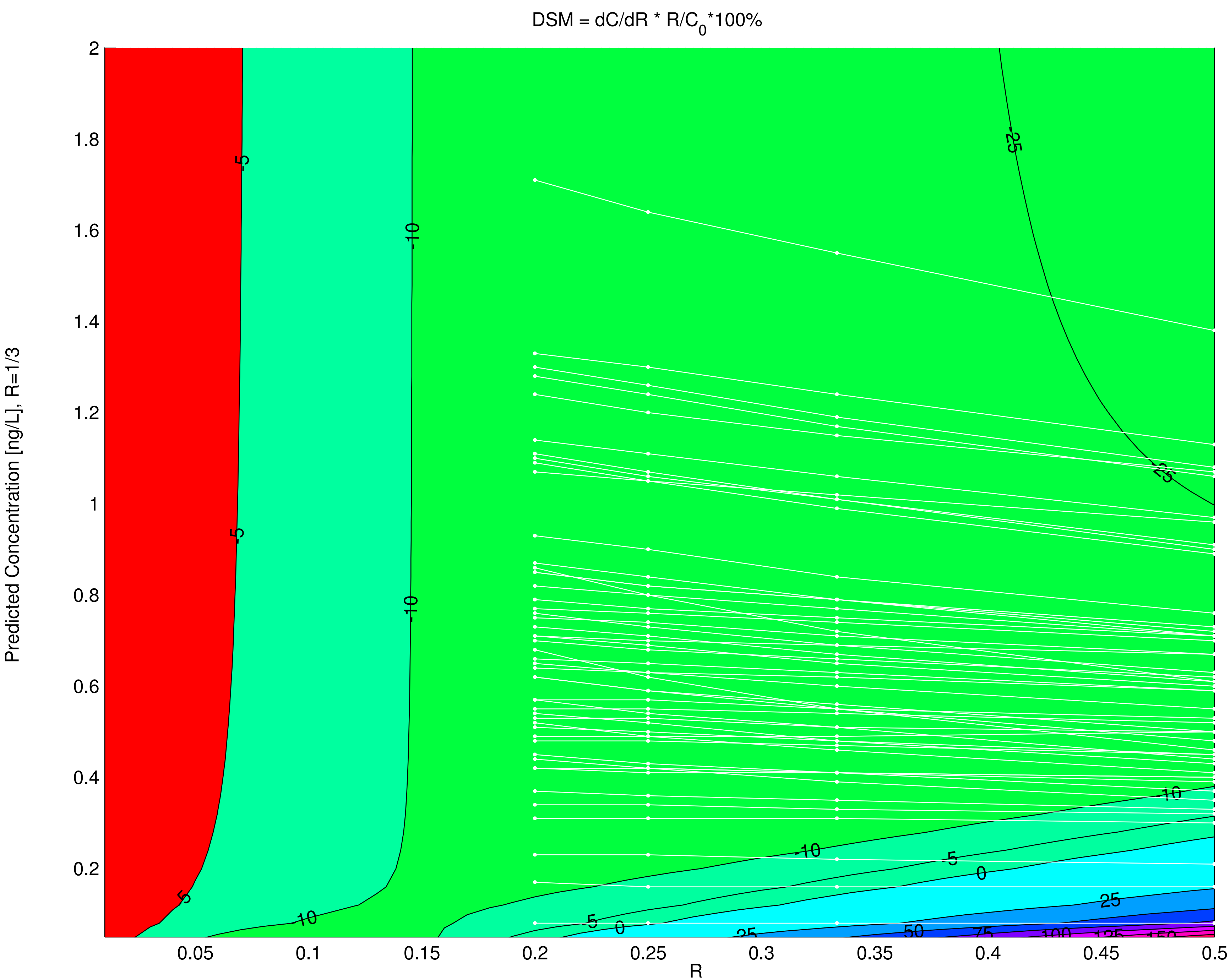


Figure 6.15.Hypolimnion Area Sensitivity Analysis. Deliniation of Regions of Specific Percent of Model Sensitivity. Epilimnetic Total Mercury

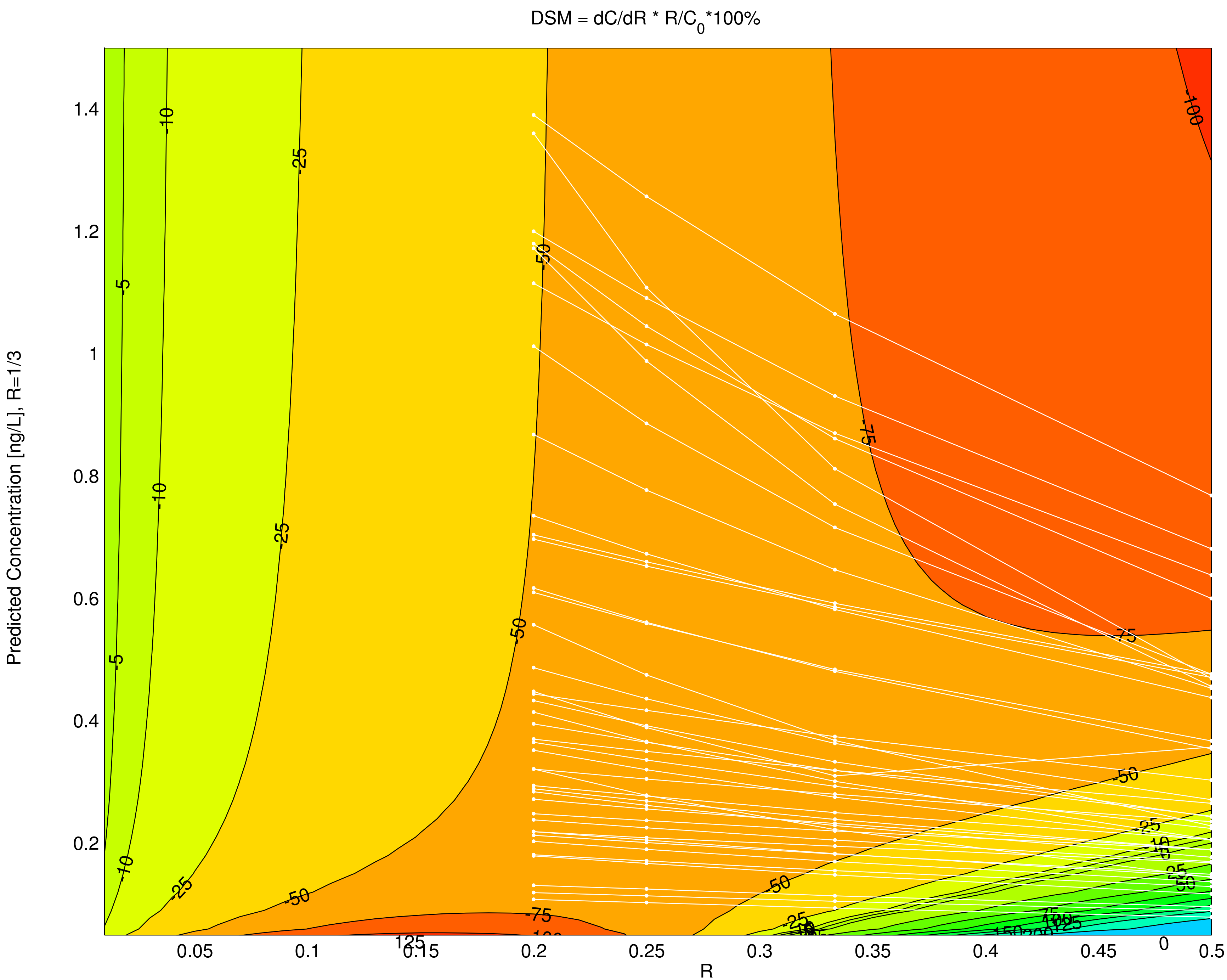


Figure 6.16. Hypolimnion Area Sensitivity Analysis. Delineation of Regions of Specific Percent of Model Sensitivity. Hypolimnetic Methylmercury.

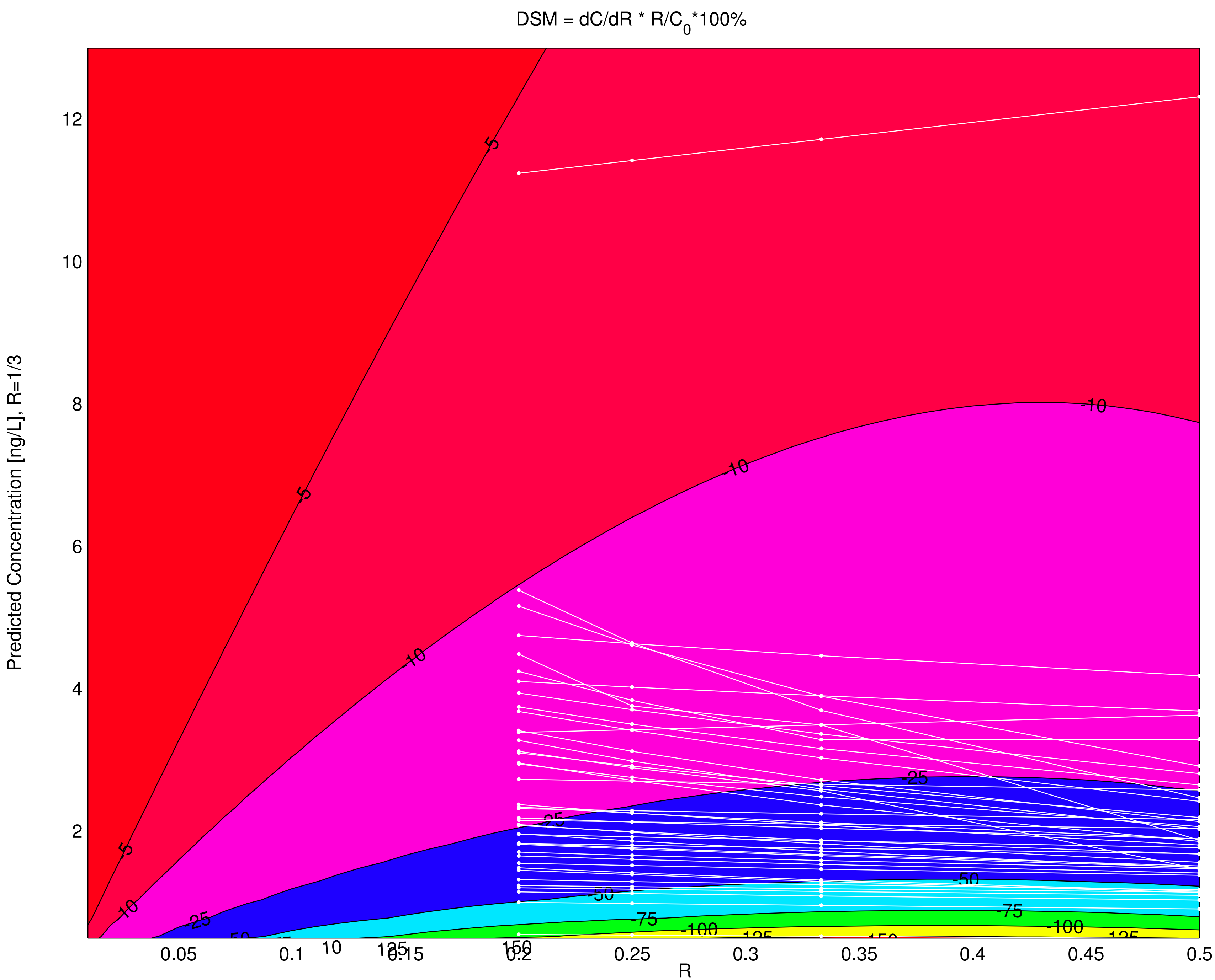


Figure 6.17. Hypolimnion Area Sensitivity Analysis. Delineation of Regions of Specific Percent of Model Sensitivity. Hypolimnetic Total Mercury.

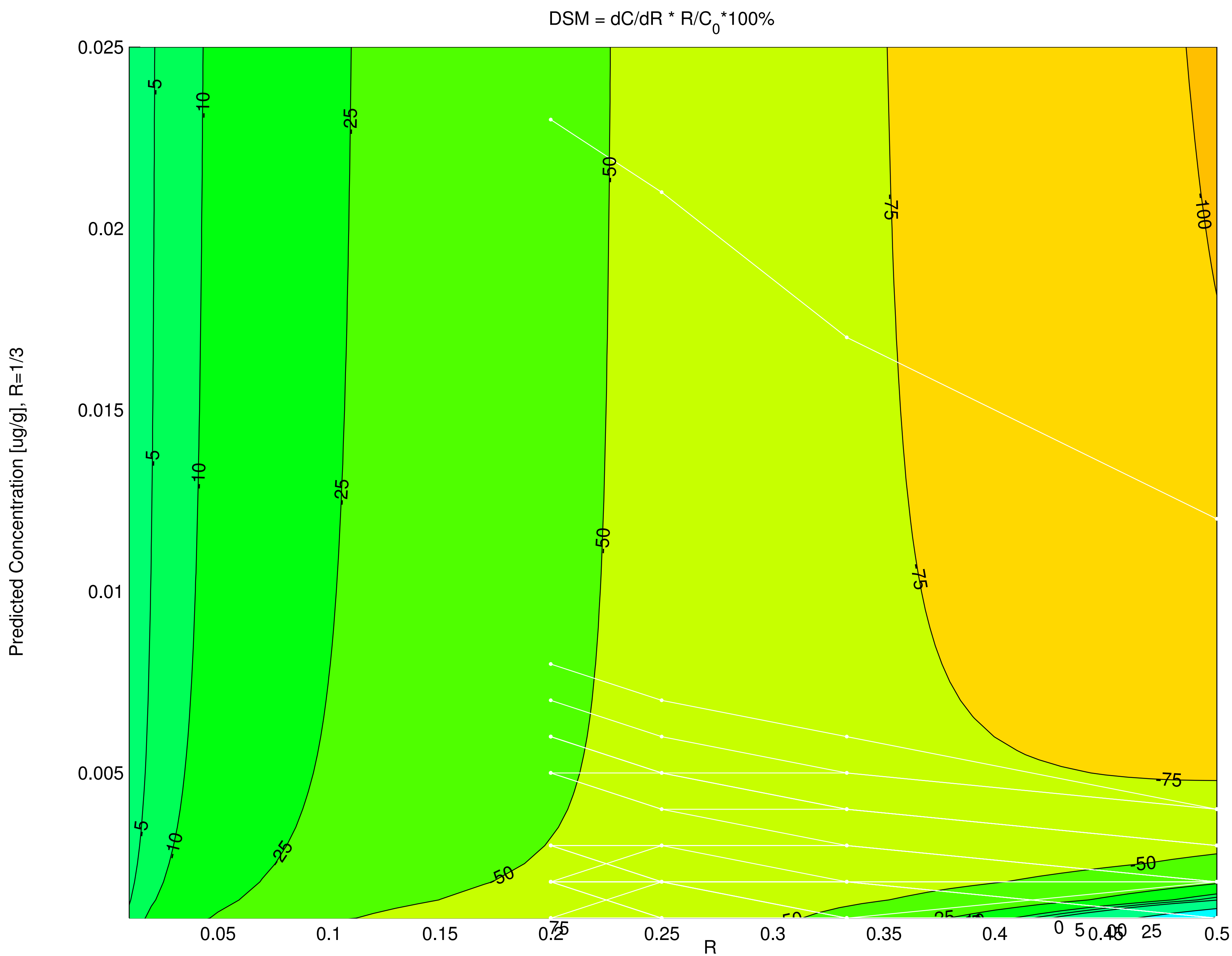


Figure 6.18. Hypolimnion Area Sensitivity Analysis. Delineation of Regions of Specific Percent of Model Sensitivitiy. Sediment Methylmercury.

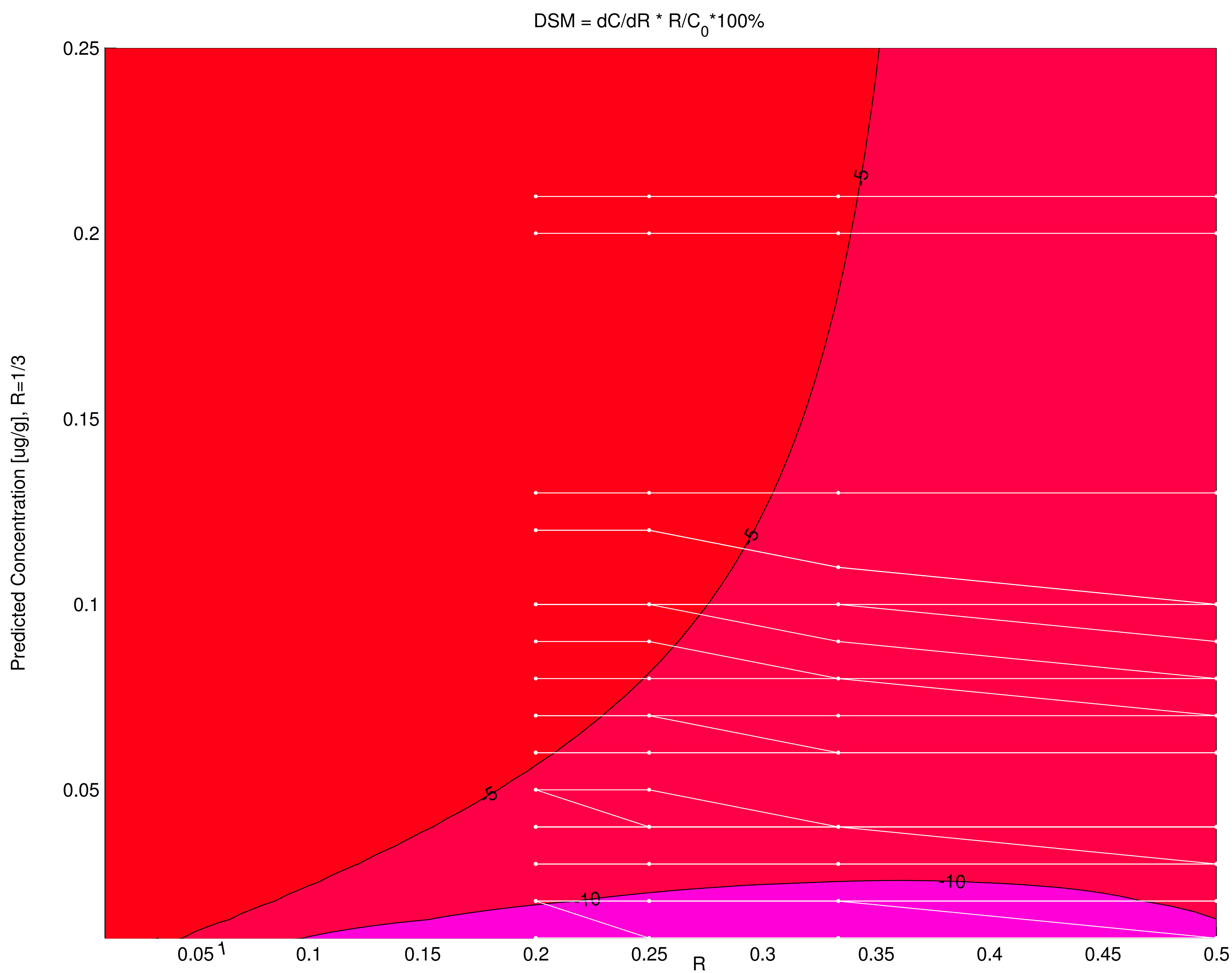


Figure 6.19. Hypolimnion Area Sensitivity Analysis. Delineation of Regions of Specific Percent of Model Sensitivity. Sediment Total Mercury

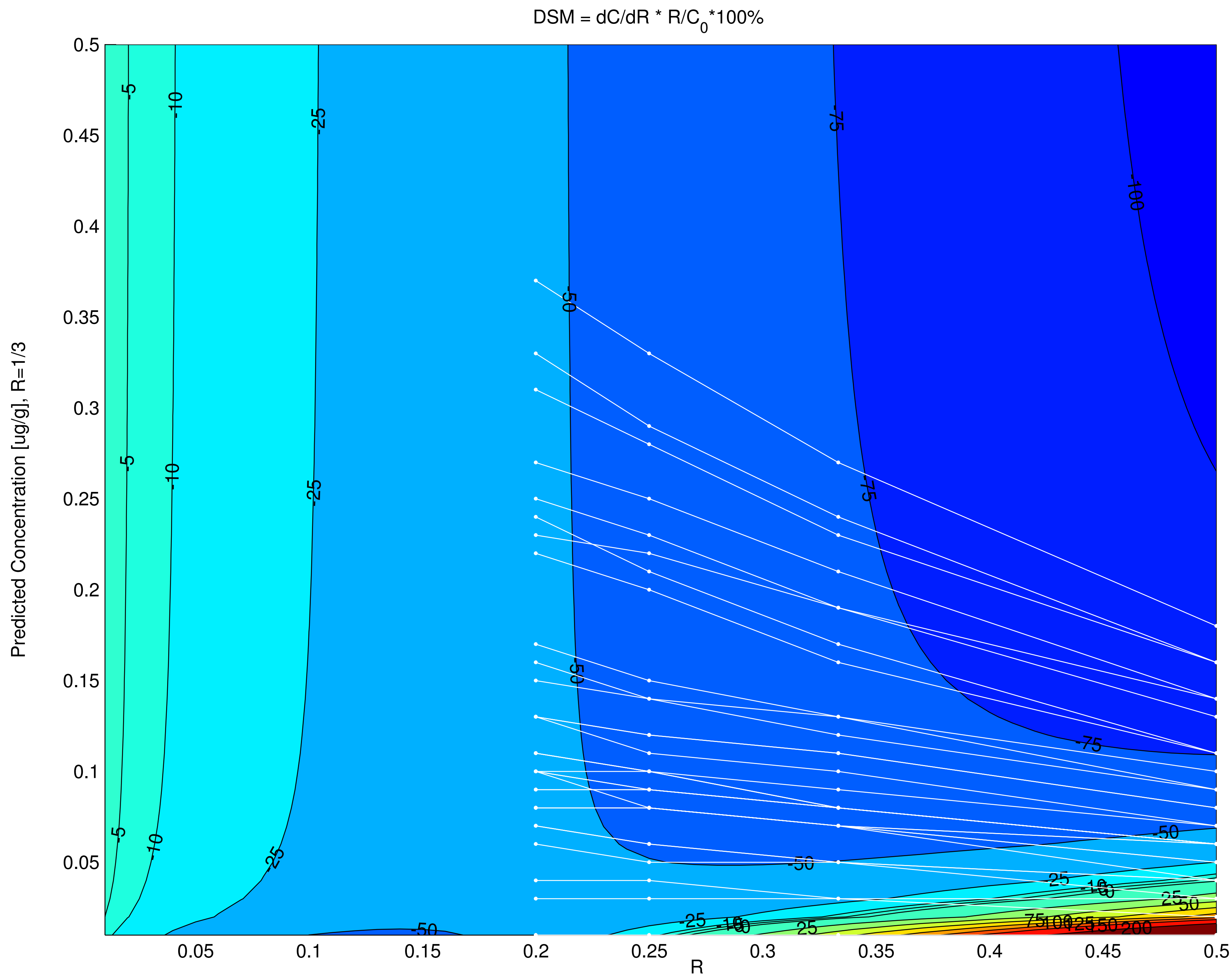


Figure 6.20. Hypolimnion Area Sensitivity Analysis. Delineation of Regions of Specific Percent of Model Sensitivity.
Fish Tissue Mercury

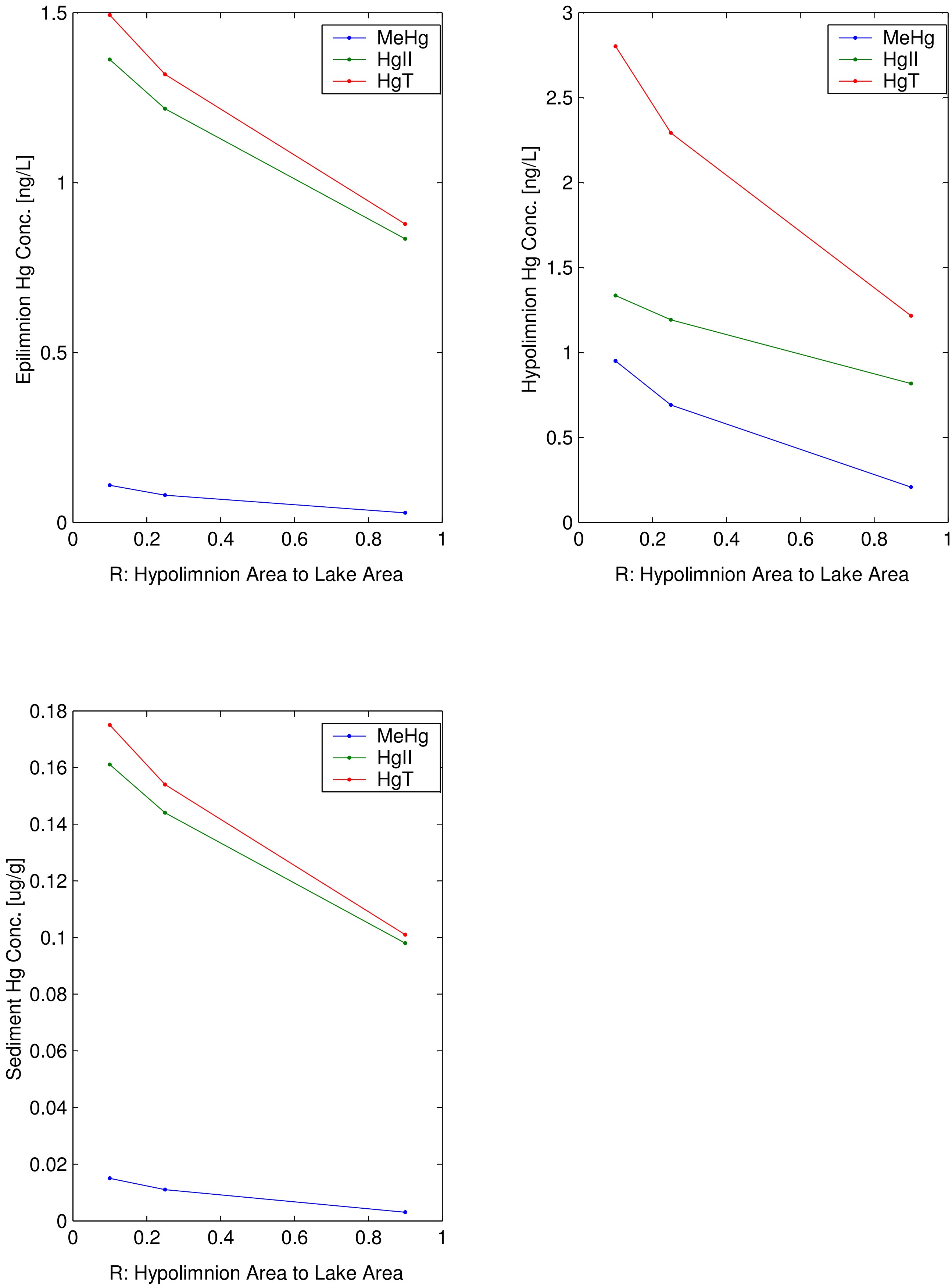


Figure 6.21. Hypolimnion Area Sensitivity Evaluation. Hypothetical Default Model Runs with Changes in R.

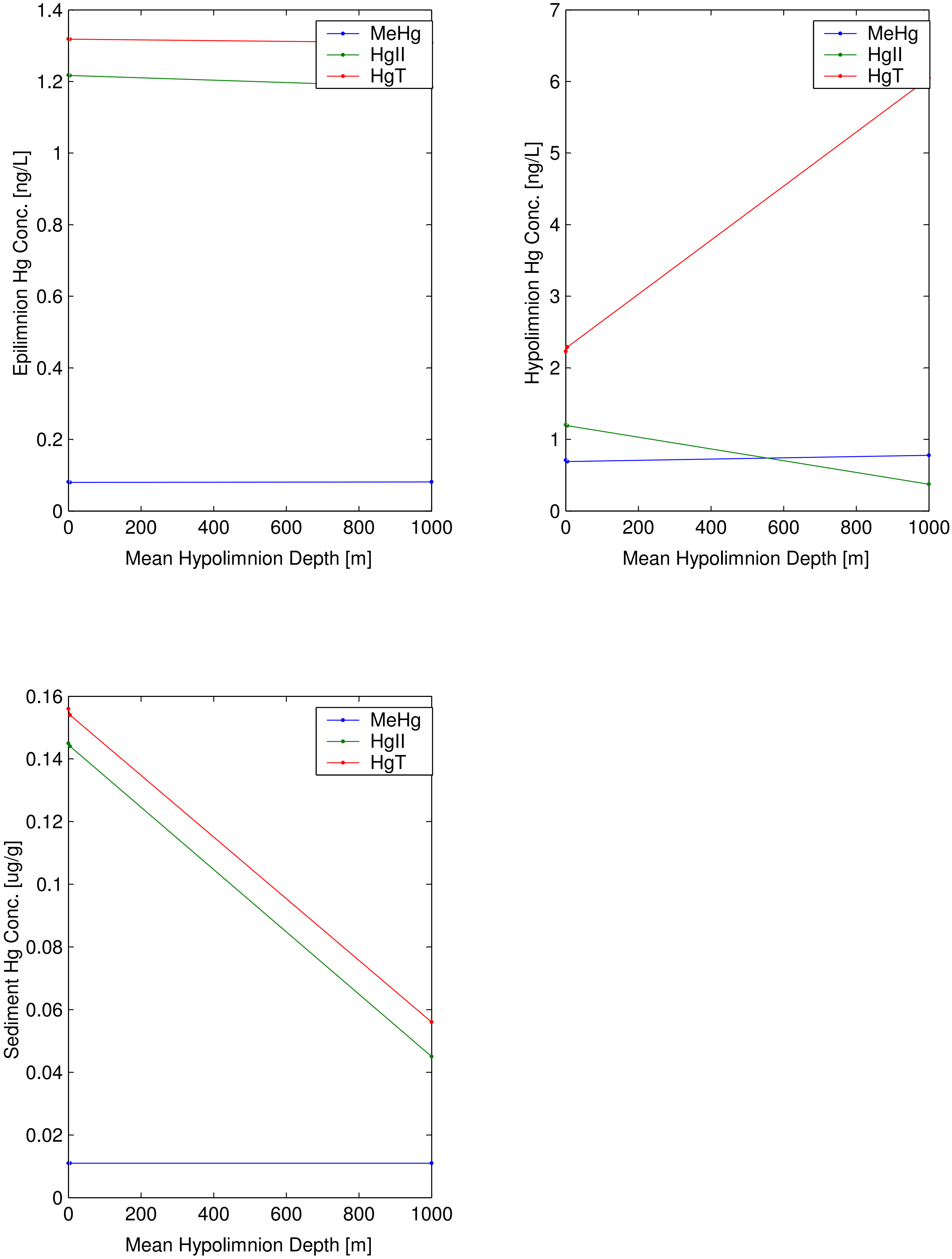


Figure 6.22. Hypolimnion Area Sensitivity Evaluation. Default Model Runs with Changes in Mean Hypolimnion Depth.

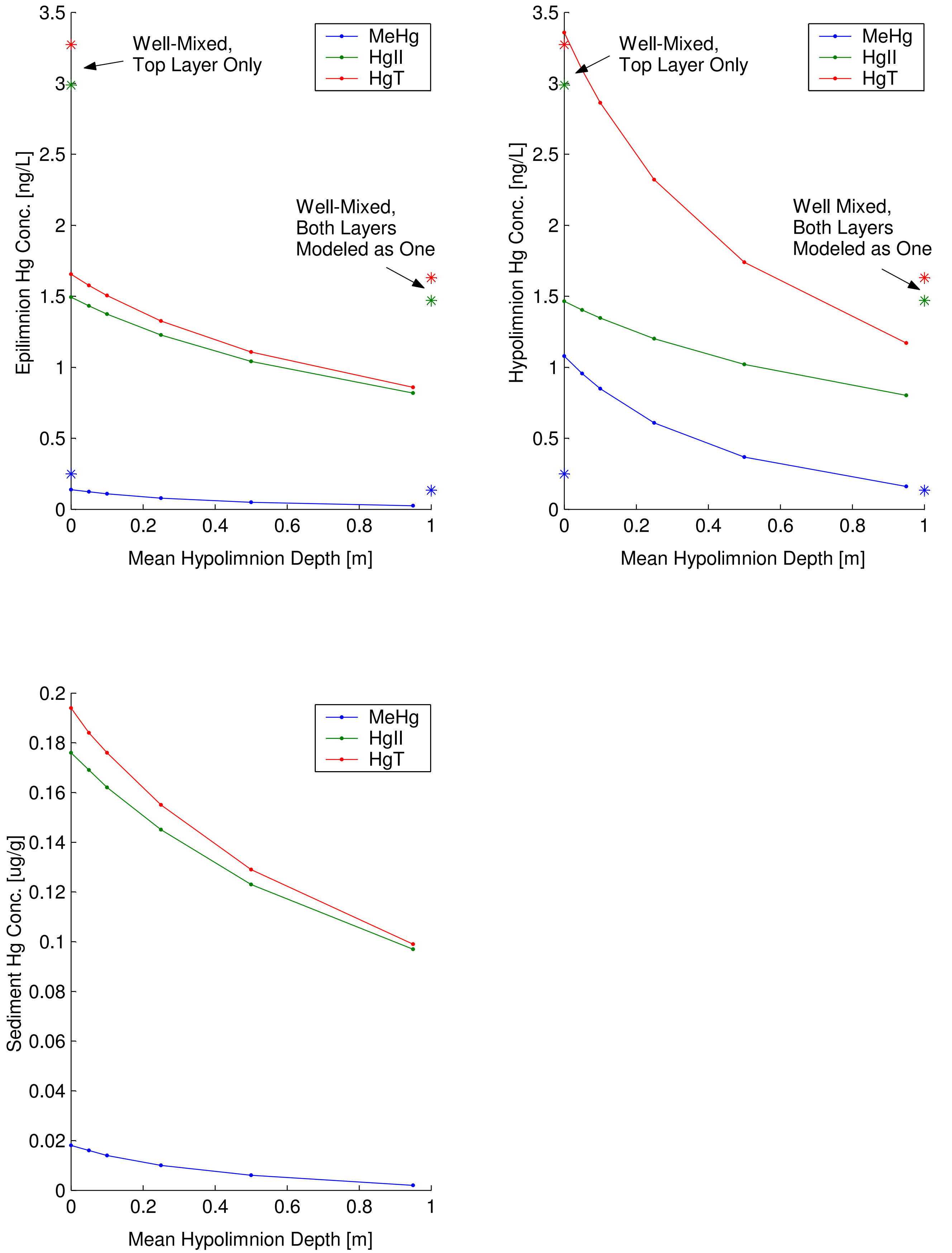
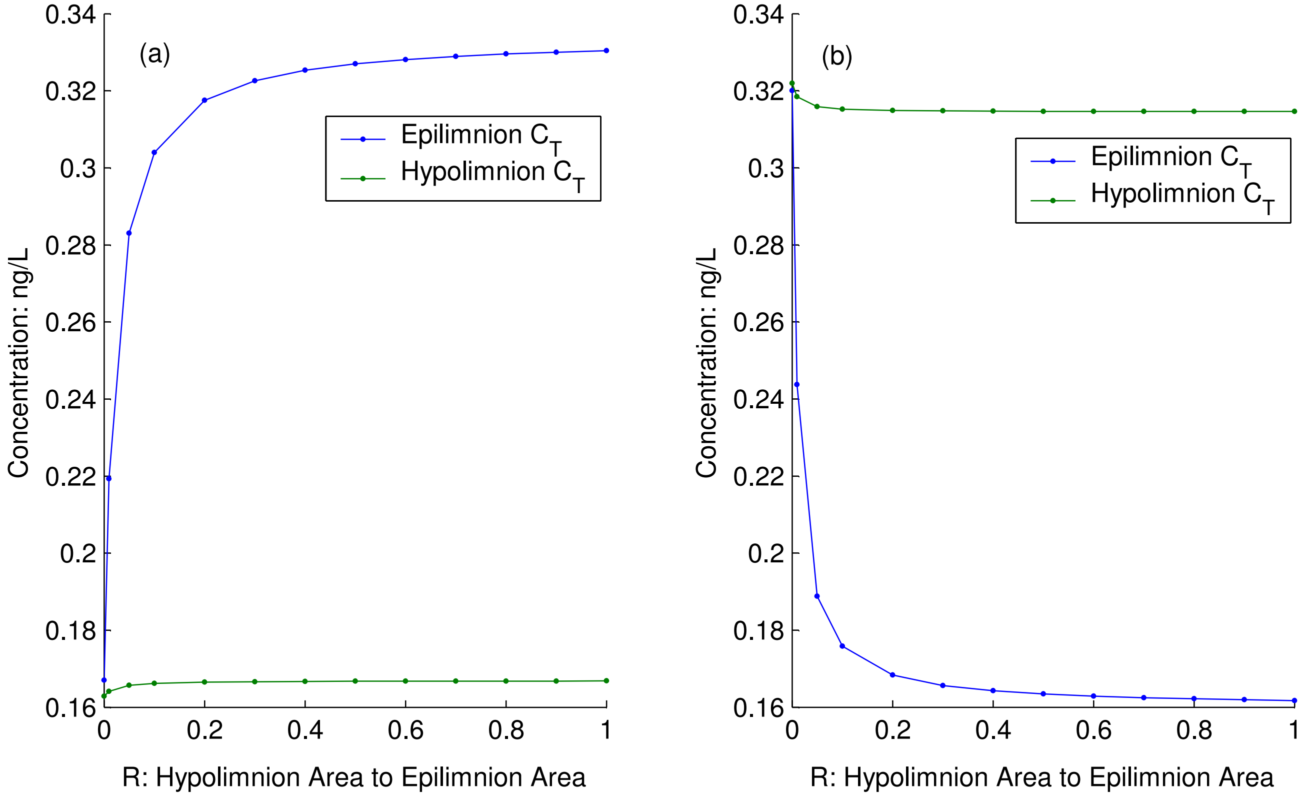
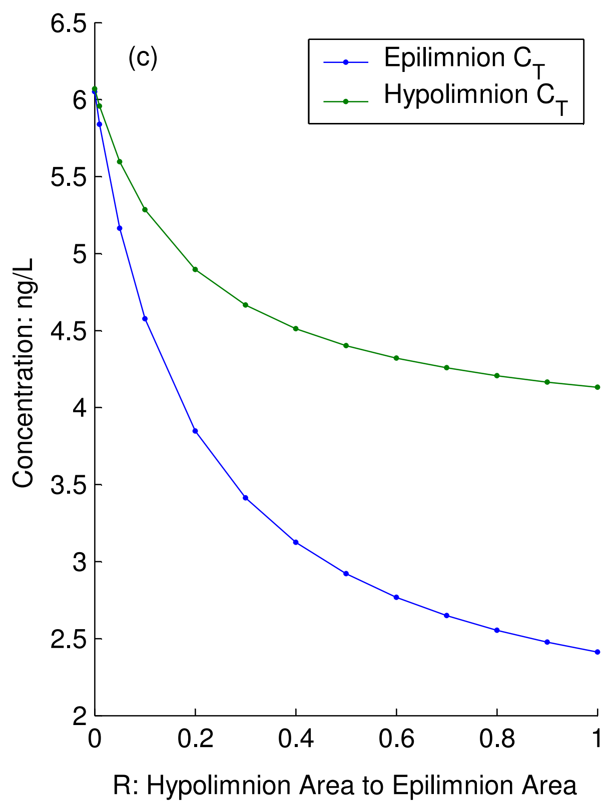


Figure 6.23. Hypolimnion Area Sensitivity Evaluation. Default Model Runs with Wider Range Variation in R, and Well Mixed Models with Dimensions Similar to R = 0.95 and R = 0.





Input Parameters:
C_{in} = 15 ng/L
Epi Area = 1,000,000 m^2

(a) and (b)
Q_{in} = 25,000 m^3/d
Q_{out} = 25,000 m^3/d
$Depth_{Epi}$ = 5 m
$Depth_{Hyp}$ = 5 m

(a) v_1 = 1.0 m/d
v_2 = 0.5 m/d

(b) v_1 = 0.5 m/d
v_2 = 1.0 m/d

(c) Q_{in} = 35,000 m^3/d
Q_{out} = 35,000 m^3/d
$Depth_{Epi}$ = 8 m
$Depth_{Hyp}$ = 8 m
v_1 = 0.018 m/d
v_2 = 0.040 m/d

Figure 6.24. Hypolimnion Area Sensitivity Evaluation. Output from Simple Mathematical Formulation of Arbitrary Lake System with structure of Default Model.

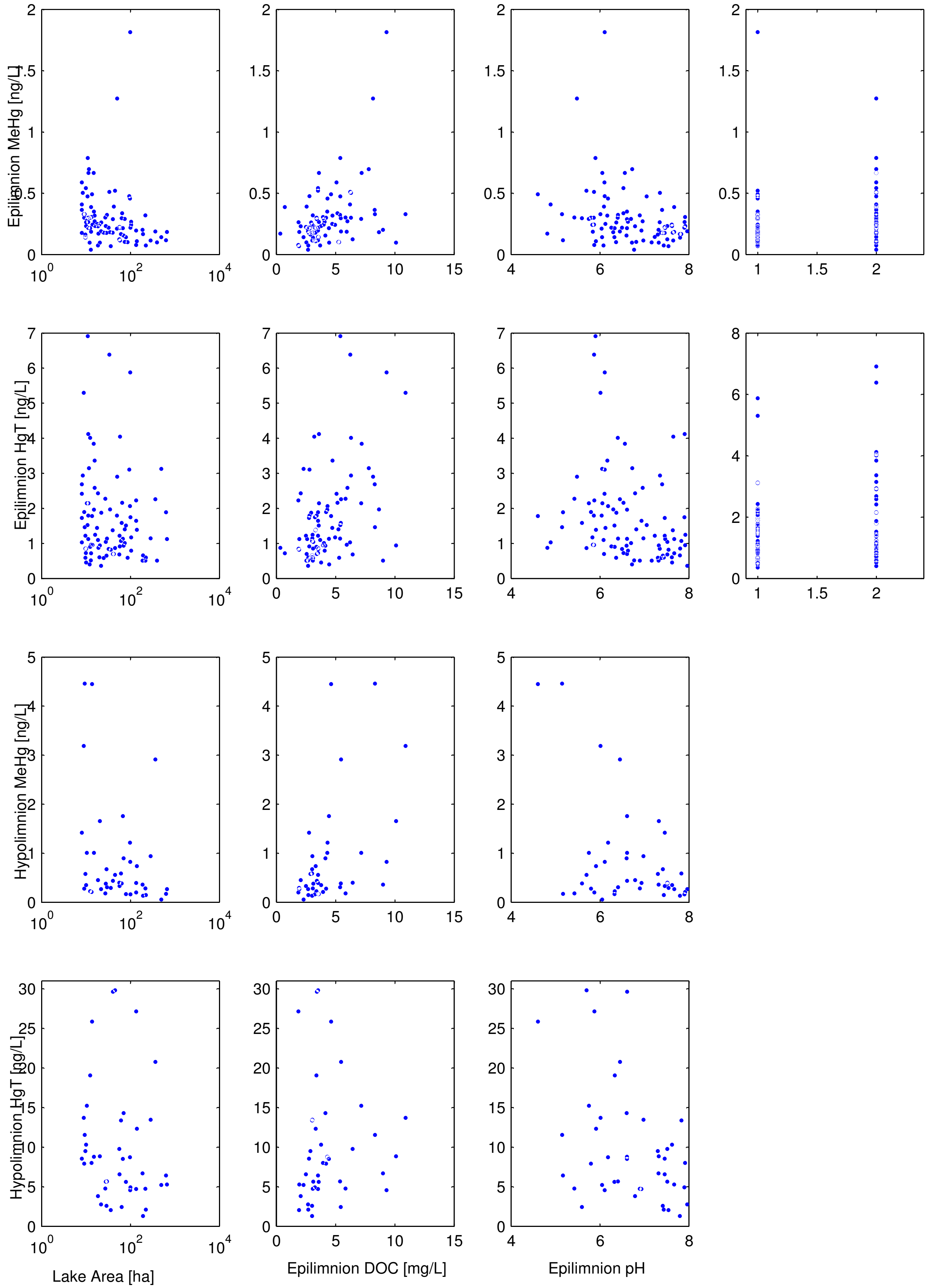


Figure 6.25. Observed Mercury Concentrations versus the Default Level Classifications/Characteristics for the VT and NH Lakes Dataset.

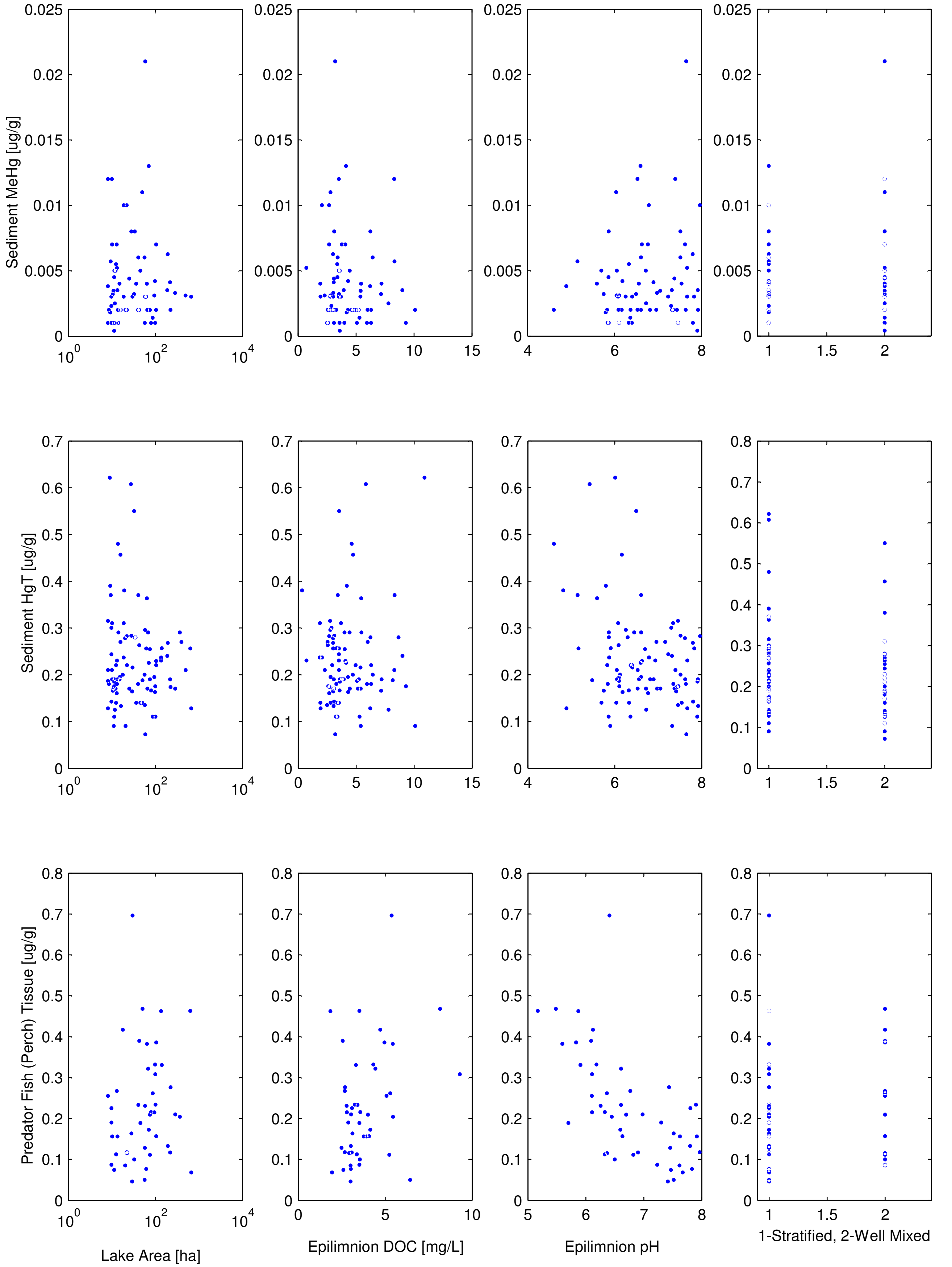


Figure 6.26. Observed Mercury Concentrations versus the Default Level Classifications/Characteristics for the VT and NH Lakes Dataset.

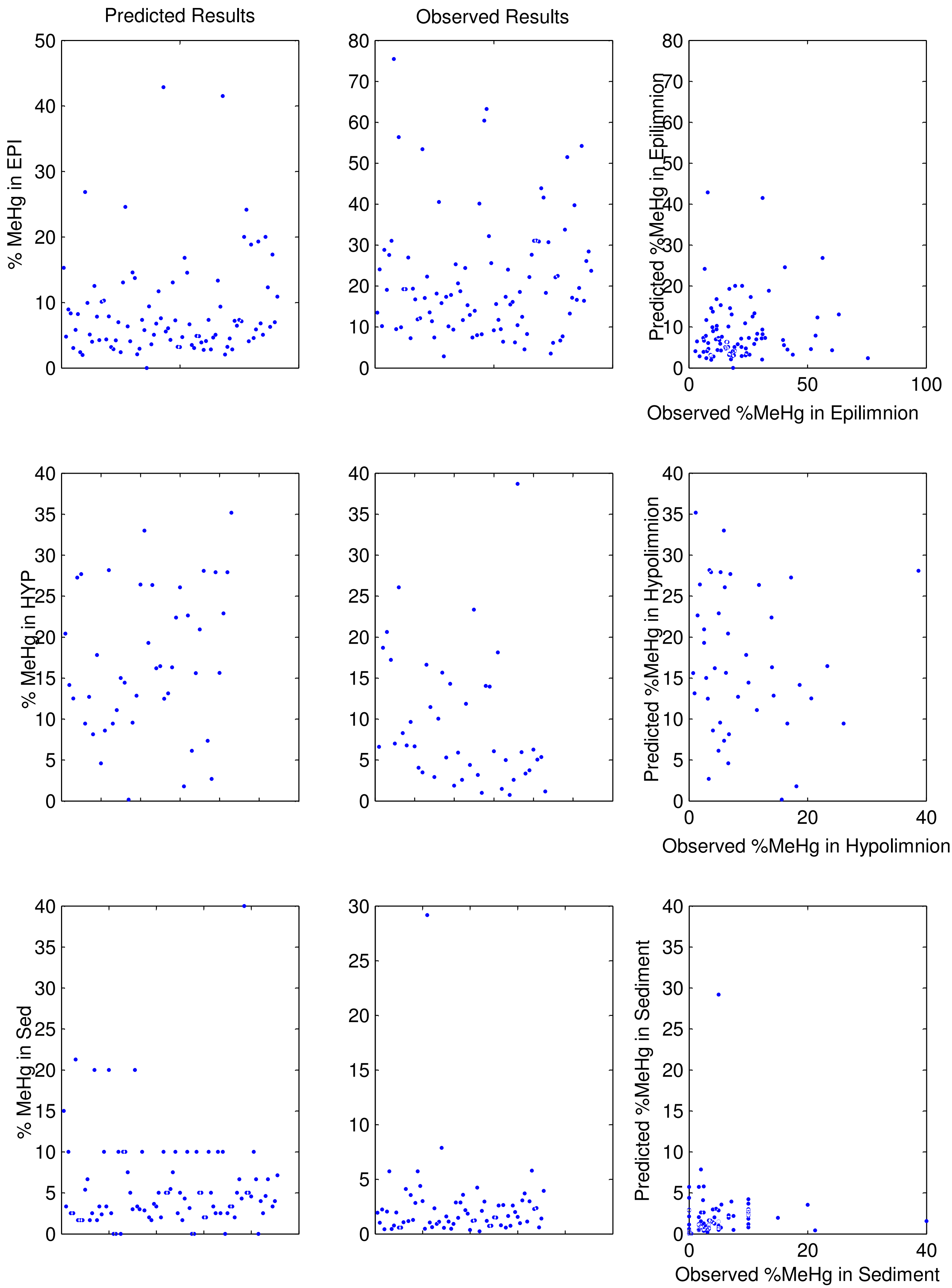


Figure 6.27. Percent Methylmercury in total mercury in the hypolimnion, epilimion and sediments. For the first two columns of plots, the data are plotted in order of lakes in database (x-axis is arbitrary). The third column is the percent methylmercury of the predicted Tier 5 data versus the observed percent methylmercury.

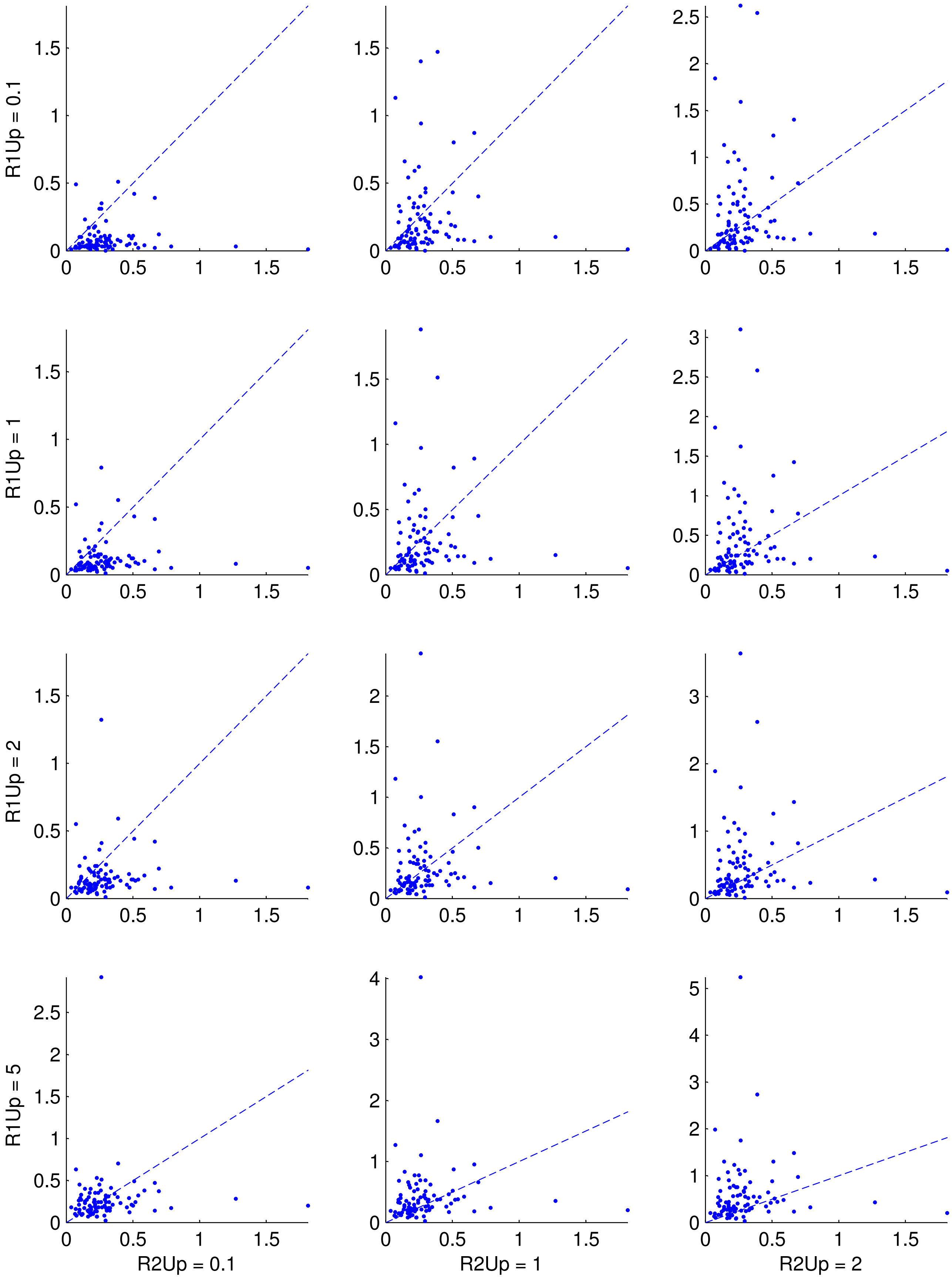


Figure 6.28. Predicted (y-axis) versus Observed (x-axis) Epilimnion Methylmercury Concentrations for different combinations of R1Up and R2Up. Default/Baseline case is R1Up = 0.1, R2Up = 0.1.

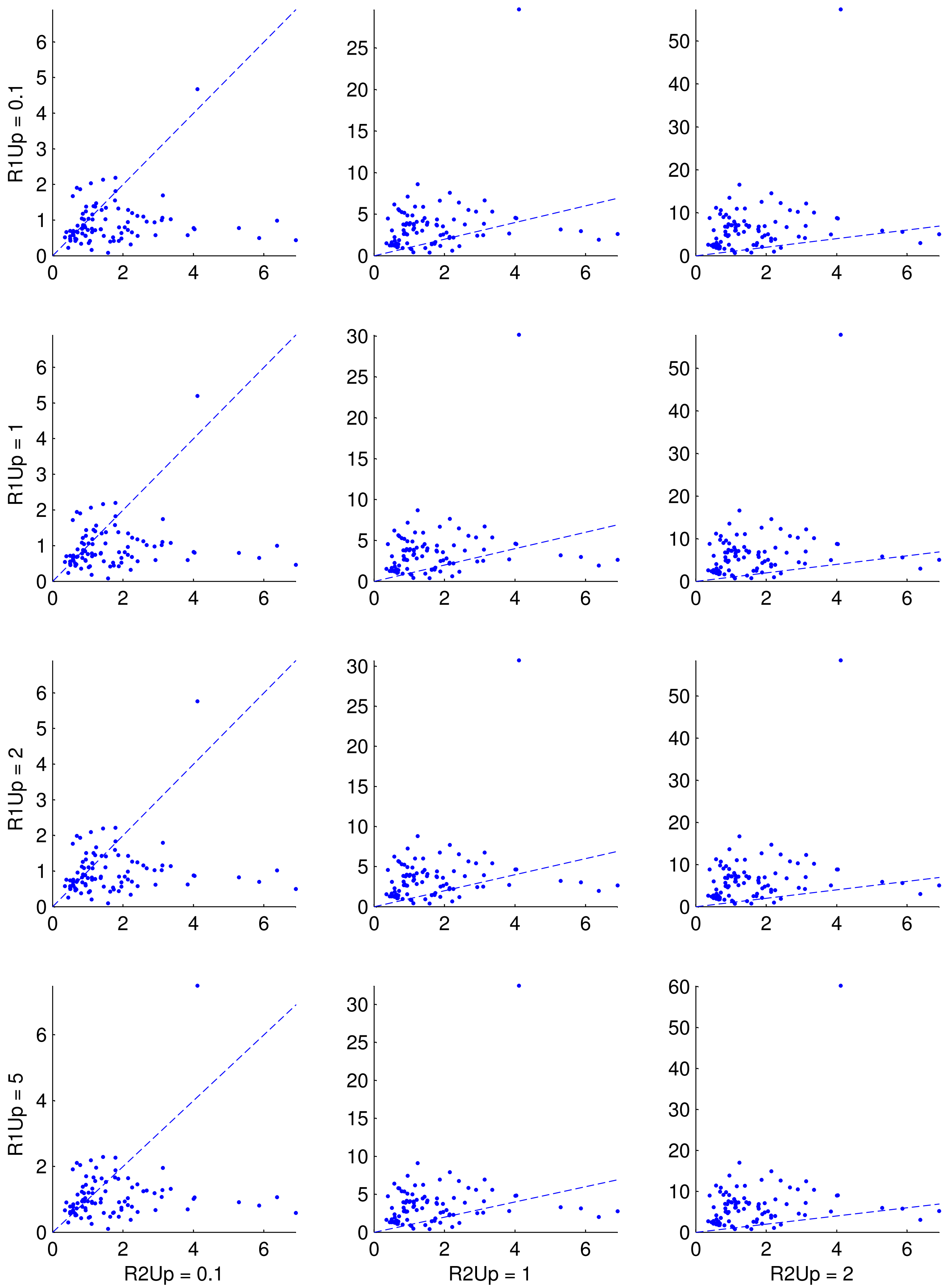


Figure 6.29. Predicted (y-axis) versus Observed (x-axis) Epilimnion Total Mercury Concentrations for different combinations of R1Up and R2Up. Default/Baseline case is R1Up = 0.1, R2Up = 0.1.

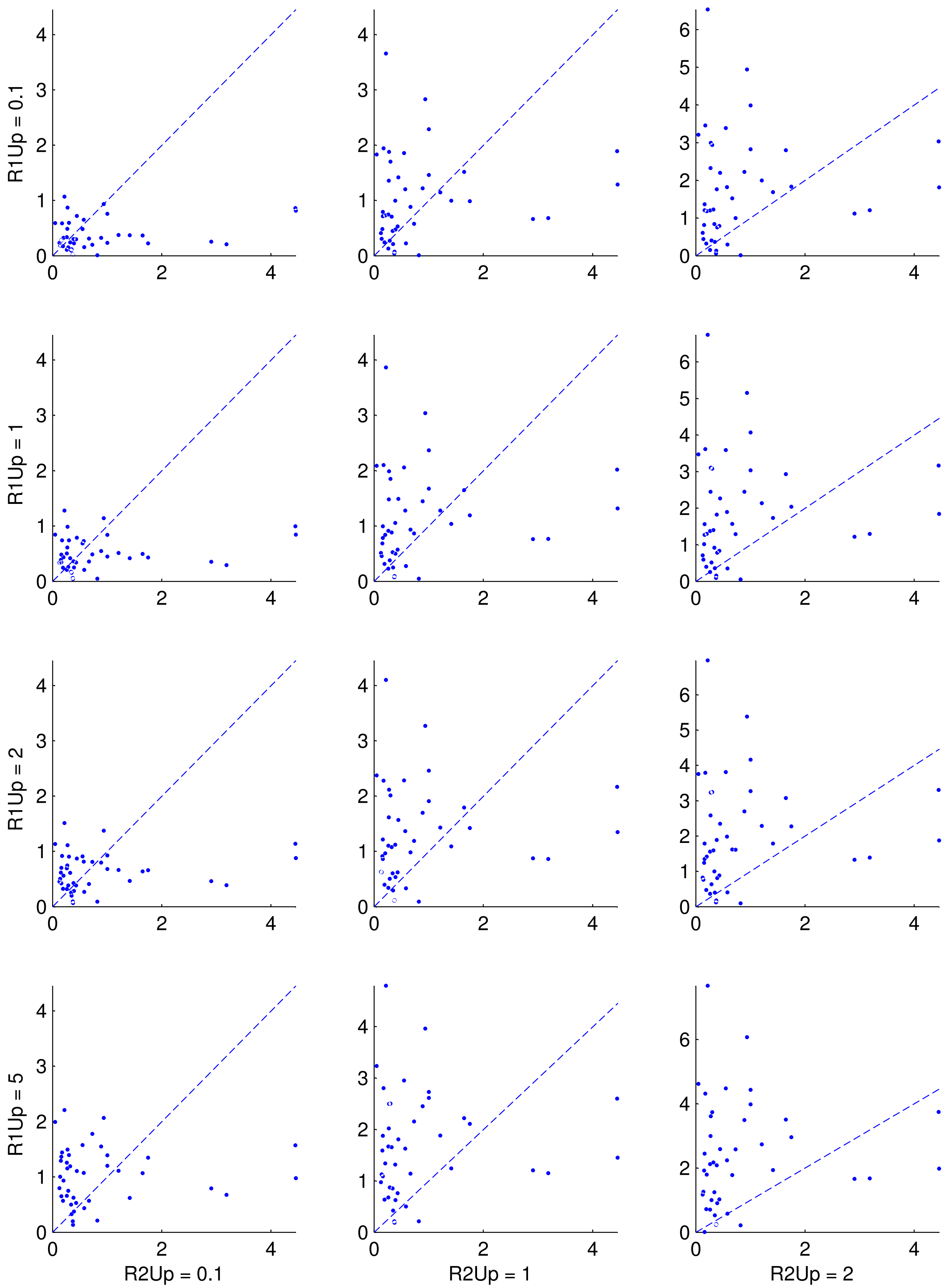


Figure 6.30. Predicted (y-axis) versus Observed (x-axis) Hypolimnion Methylmercury Concentrations for different combinations of R1Up and R2Up. Default/Baseline case is R1Up = 0.1, R2Up = 0.1.

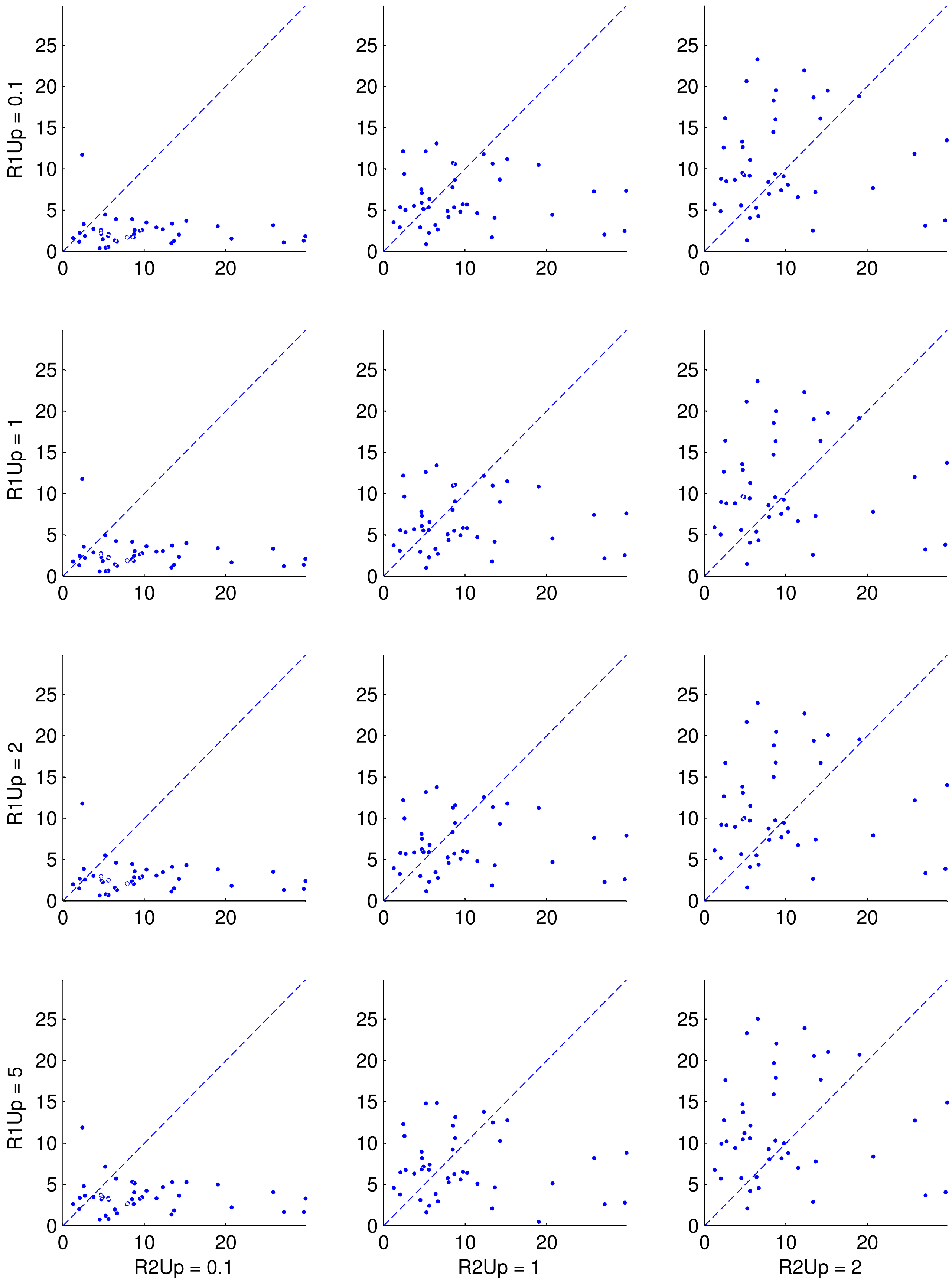


Figure 6.31. Predicted (y-axis) versus Observed (x-axis) Hypolimnion Total Mercury Concentrations for different combinations of R1Up and R2Up. Default/Baseline case is R1Up = 0.1, R2Up = 0.1.

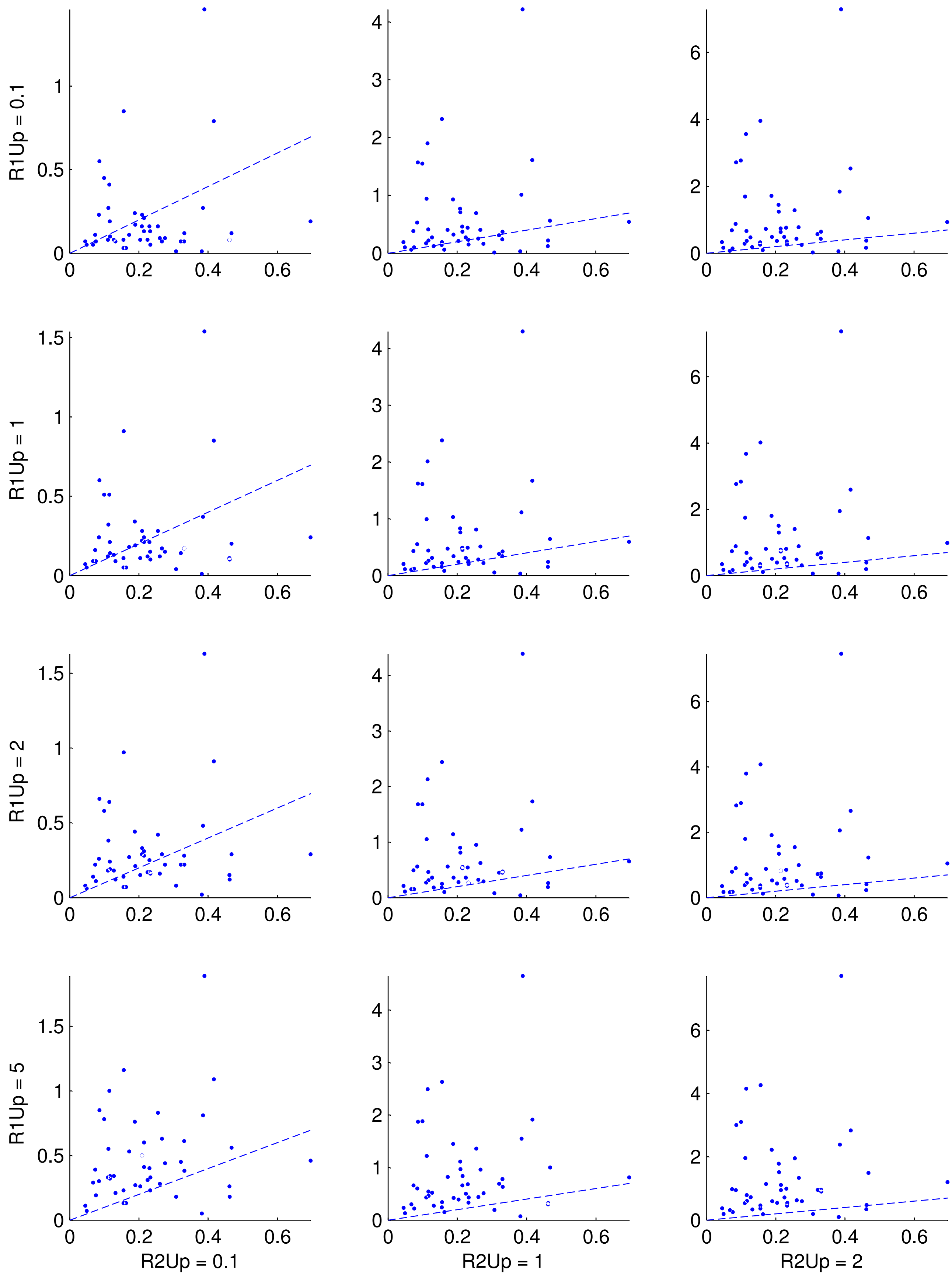


Figure 6.32. Predicted (y-axis) versus Observed (x-axis) Fish Tissue Mercury Concentrations for different combinations of R1Up and R2Up. Default/Baseline case is R1Up = 0.1, R2Up = 0.1.

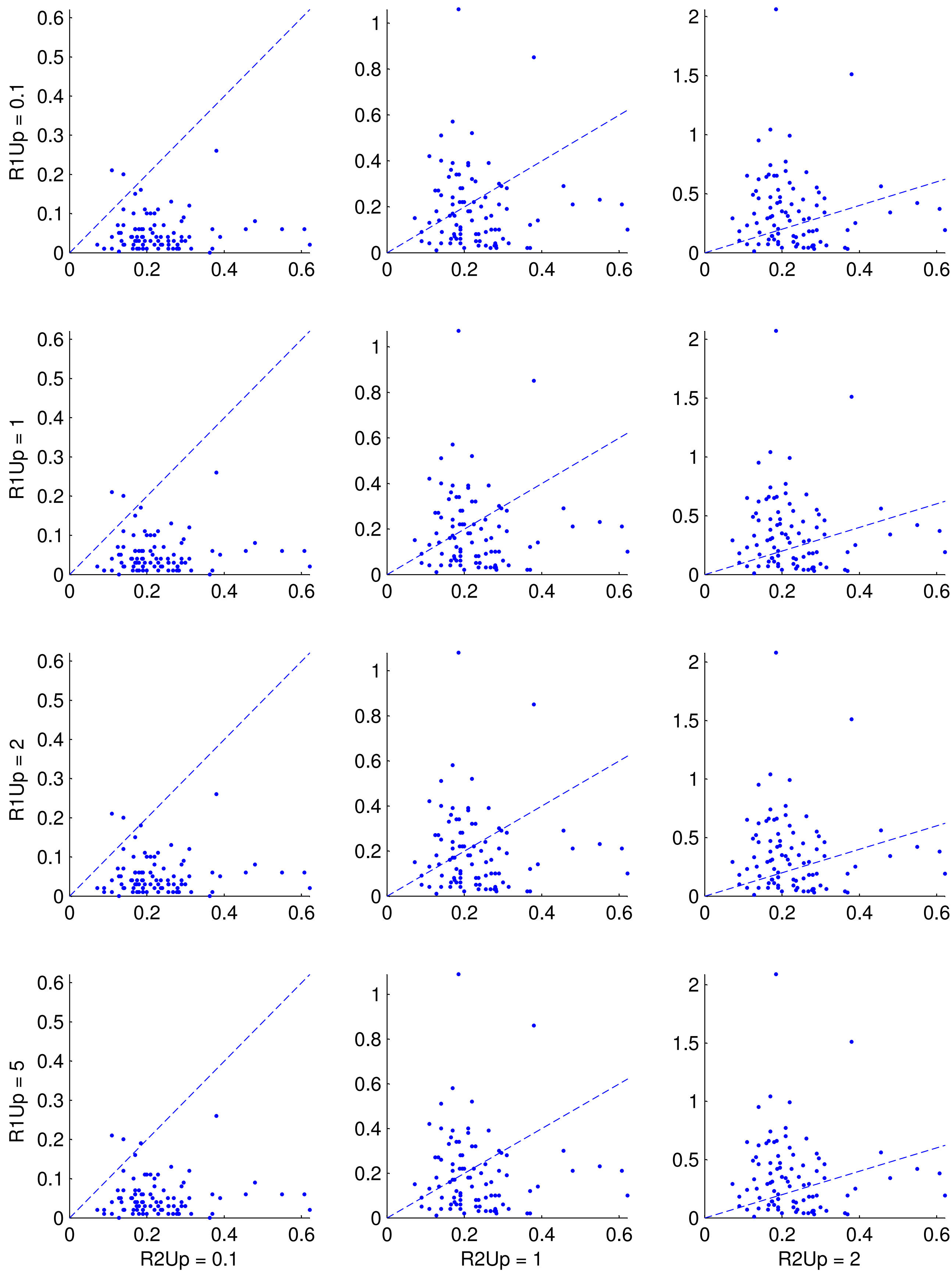


Figure 6.33. Predicted (y-axis) versus Observed (x-axis) Sediment Total Mercury Concentrations for different combinations of R1Up and R2Up. Default/Baseline case is R1Up = 0.1, R2Up = 0.1.

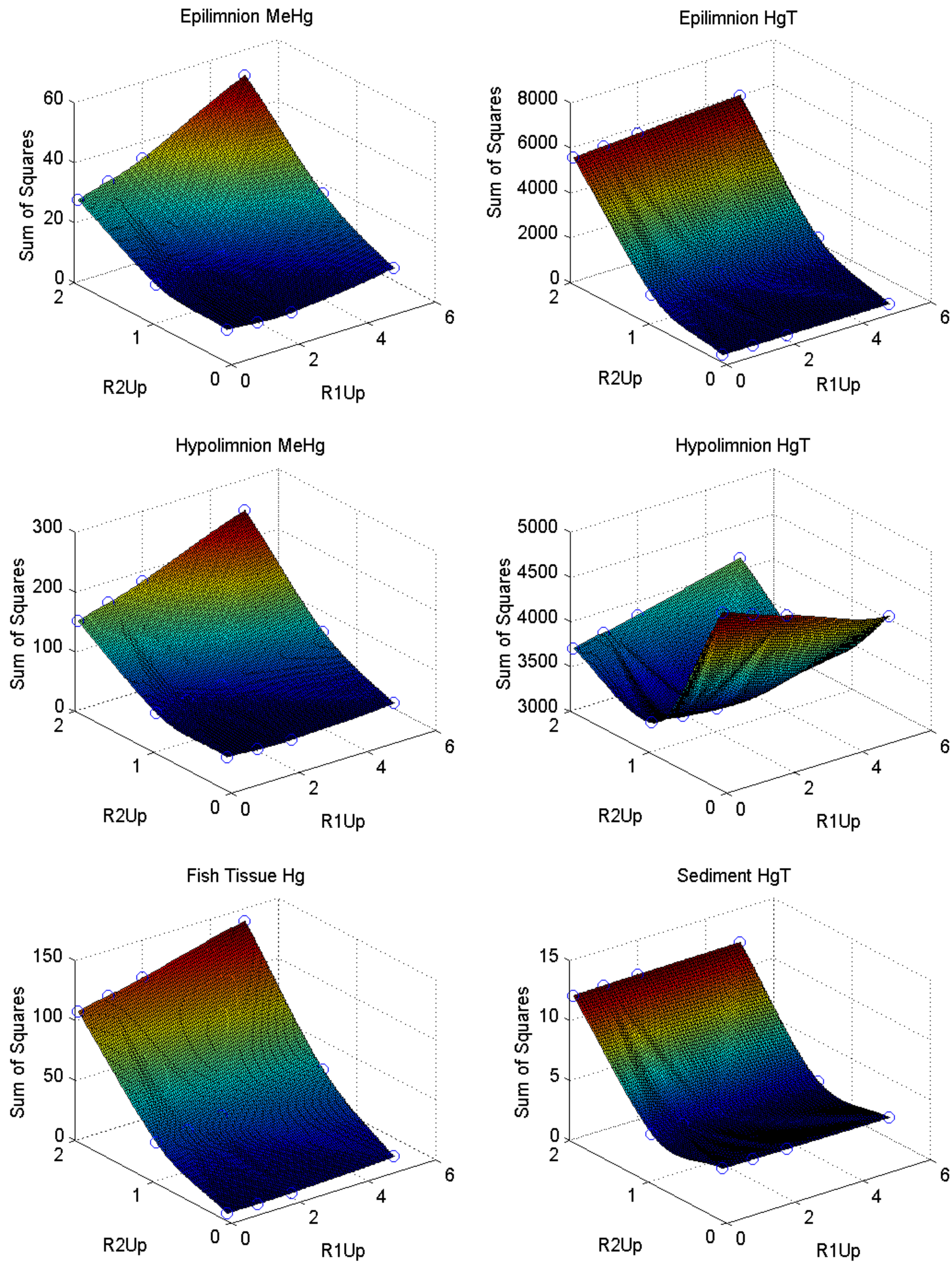


Figure 6.34. Surface interpolation plots of the sum of squares values for all combinations of the R1Up and R2Up values explored in Figures 6.24 to 6.29.

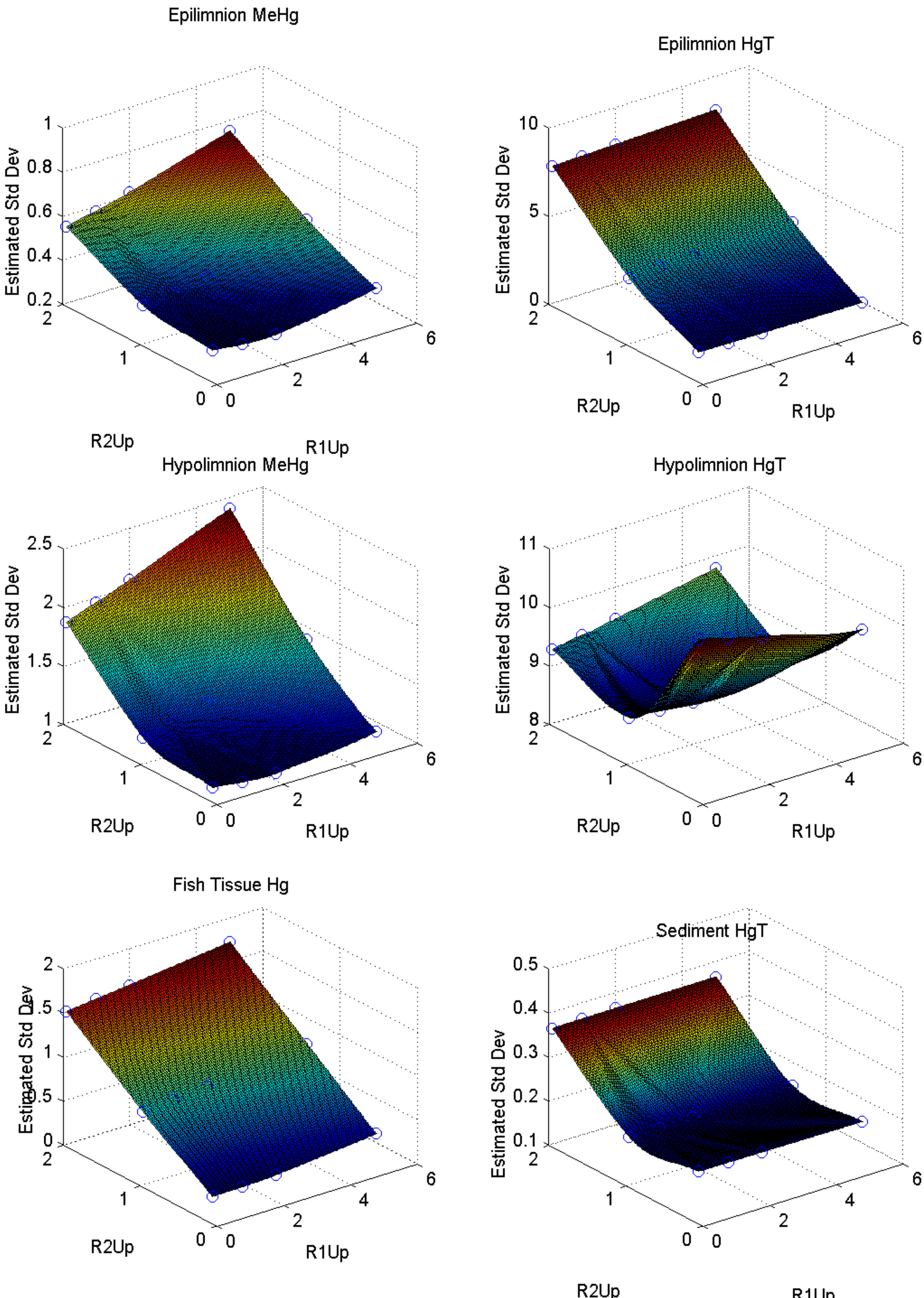


Figure 6.35. Surface interpolation plots of the estimated standad deviations for all combinations of the R1Up and R2Up values explored in Figures 6.24 to 6.29.