FINAL REPORT ON

INVESTIGATIONS OF POTENTIAL CONCENTRATIONS AND SOURCES OF CONTAMINANTS IN NEW JERSEY HATCHERY TROUT

Submitted to:

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EXECUTIVE SUMMARY

Elevated concentrations of PCBs have been reported in farmed and hatchery fish from areas outside New Jersey. In response to these reports, the New Jersey Division of Fish and Wildlife and the Division of Science, Research and Technology of the New Jersey Department of Environmental Protection initiated this study of contaminants in New Jersey hatchery trout, including fish from both state-operated and private facilities. The study included brook, brown and rainbow trout from the Pequest Hatchery. For comparison, wild brook trout (from Schooley's Mountain Brook River and Bear Brook), wild brown trout (from Saddle River and Old York River), brook, brown and rainbow trout from commercial fish hatcheries, and rainbow trout from retail markets were also analyzed. Analytes included total mercury, PCBs, DDX, and selected organic pesticides. Data from this study were compared with data from a variety of species analyzed in the New Jersey routine monitoring program and with published data on hatchery and wild salmonids. Concentrations of all analytes were much lower than applicable FDA consumption limits. Concentrations of PCBs, DDX, dieldrin, chlordanes, nonachlors, heptachlor, heptachlor epoxide, endosulfans and BHCs were lower than those seen in most wild fish analyzed as part of the New Jersey routine monitoring program. Concentrations of mercury, aldrin and lindane were similar to or less than those found in the routine monitoring program. Endrin was the only analyte found in higher concentrations in this study than in most wild fish from the routine monitoring program. Concentrations of PCBs, DDX, chlordanes, dieldrin and mercury in salmonids from other hatcheries and from farms were generally similar to or somewhat lower than concentrations found in this study. Among samples in this study, concentrations of PCBs were generally similar among samples, with a few higher values found in some wild trout and a few Pequest Hatchery trout samples, and lower values found in some wild trout, a few Pequest Hatchery trout samples, and market rainbow trout. The highest and lowest concentrations of DDX were seen in some of the wild trout, with intermediate concentrations in Pequest hatchery trout. The highest concentrations of chlordanes, heptachlor epoxide, nonachlors, dieldrin and mercury were in wild trout, with lower values in Pequest Hatchery fish. Concentrations of aldrin and BHCs were somewhat higher in Pequest Hatchery fish than in the other fish analyzed. There was no clear pattern in concentrations of endrin, aldrin, lindane, heptachlor and endosulfans. The highest concentrations of some of these were in Pequest Hatchery fish, but this may only reflect the greater number of Pequest Hatchery fish analyzed and analytical variability at very low concentrations.

INTRODUCTION

In June, 2004, the United States Fish and Wildlife Service issued a press release concerning elevated PCB concentrations in Atlantic salmon, lake trout and rainbow trout cultured through their Region 5 hatchery system (see also Millard, et al 2004). The USFWS findings add to growing documentation of elevated concentrations of PCBs in trout culture facilities (Hites, et al. 2004, Carline et al. 2004). The source of the contaminants is believed to be from bioaccumulation of PCBs from feed used at the culture facility, although other sources may be present at some facilities. Feed is comprised mainly of fish meal and oils from coastal menhaden

stocks. In response to problems documented at other fish culture facilities and implementation of more stringent consumption advisories, the Division of Fish and Wildlife (DFW) and the Division of Science, Research and Technology (DSRT) of the New Jersey Department of Environmental Protection initiated this study of contaminants in trout cultured at the DFW Pequest facility in comparison to wild fish, fish from other hatcheries and fish available in retail food markets. The objectives of the study are:

1) Determine concentrations, if any, of PCBs, selected OCPs and mercury in species of hatchery trout (brown, brook and rainbow trout) produced by DFW;

2) Compare concentrations in DFW hatchery trout, private sources of hatchery trout, commercially available trout and wild trout, by analyses of contaminants in limited numbers of commercial hatchery trout, commercially available market trout, and wild trout.

The outlined program represents a preliminary sampling program intended to determine the magnitude, if any, of contaminant issues for hatchery trout. More intensive sampling would be required to provide more information on variability in contaminant concentrations, to allow more powerful statistical comparisons of concentrations, and to assess sources.

STUDY DESIGN

A total of 39 samples consisting of 140 fish were analyzed. The study (Table 1) included analysis of 26 samples of hatchery trout from the DFW Pequest Hatchery, 3 samples of commercially-produced hatchery trout, 2 samples of market trout and 8 samples of wild trout for PCBs, selected OCPs and mercury. Commercially-produced hatchery trout were obtained from 2 different hatcheries. Market trout were obtained from 4 retail sources in New Jersey. Each sample contained specimens from 2 of the markets. Wild trout were obtained by DFW from New Jersey streams with reproducing trout. Wild brook trout were taken from the Schooley's Mountain Brook and Bear Brook. Wild brown trout were taken from Old York Brook and Saddle River.

Table 1. Study design for NJ study of contaminants in hatchery trout. Each composite sample consisted of 6 fish. All samples consisted of fillets. Trimmed means that the skin was removed and fat trimmed from the surface of the fillet.

	Total Length	Sample Type	Brown Trout	Brook Trout	Rainbow Trout	TOTAL Samples	TOTAL Fish
Primary spring stocking	9-12"	Composite Trimmed	2	2	2	6	36
Primary spring stocking	9-12"	Individual Trimmed	3	2	3	8	8
		Individual Skin on	2	2	2	6	6
Secondary, fall stocking	6-8"	Composite Trimmed	2			2	12
		Composite Skin on	2			2	12
Secondary, fall stocking	9-11"	Composite trimmed			2	2	12
Market fish		Composite trimmed			2	2	12
Commercial hatchery		Composite trimmed	1	1	1	3	18
Wild trout		Composite trimmed	2	2		4	12
		Composite skin on	2	2		4	12
TOTAL			16	11	12	39	140

LABORATORY METHODS

Sample preparation

Samples were analyzed in two ways: 1) as fillets with the skin and surface fat removed, matching recommended procedures for anglers; 2) as fillets with the skin and surface fat included, allowing comparison with contaminant data from other programs which use untrimmed fillets.

Fish were analyzed as fillets. Some samples (“trimmed” in Table 1) were prepared with the skin removed and fat trimmed from the surface of the fillet. The skin and fat trimmed from these samples was retained, in case separate analyses of this tissue were to be subsequently requested. For the other samples (“skin on” in Table 1), fish were scaled, but the skin were left on and fat was not trimmed from specimens. Composites were formed by combining entire fillets of 6 fish.

All samples were stored frozen (0°C) until processing in the ANSP laboratory. All transfers of samples were properly documented throughout transport and analysis (internal lab chain-of-custody). All laboratory equipment was properly calibrated as per

each method completed. Careful cleaning of all laboratory equipment and instruments using the appropriate soaps, solvents, acids, and double deionized water (DDW) was done throughout the program.

Tissue preparation of fish followed common preparation methods for consumption. The selected fish specimens were filleted using clean methods for both trace metals and organic contaminants as outlined in EPA (1995; ANSP SOP-14-12r4). The archived sample material (including the extra sample homogenate not analyzed) will be retained by ANSP for a period of one year following project final report submission.

All glassware and materials coming into contact with the fish specimens were pre-cleaned with the appropriate cleaning agent (e.g., micro soap, acids, deionized water, solvents, etc) pertaining to the specific parameter or group of parameters.

Each tissue sample was minced and tissuemized and placed into separate pre-cleaned jars (e.g., ICHEM) for trace metals and organic analysis. Chemical analysis were performed by ANSP using modified U.S. EPA and NOAA Status and Trends approved methods (ANSP SOPs P-16-84r4, P-16-111, P-16-109r1, and P-16-108). Chemical contaminants and ancillary parameters are listed in Table 2.

As part of quality assurance and quality control (QA/QC), Standard Reference Material (SRM) were analyzed as part of the QA/QC procedure. The SRM was obtained from the National Institute of Standards and Technology (NIST) or equivalent agency (see MacLeod, 1993) and consisted of DORM-1, EPA SRS903, SRM 1974 (or equivalent as available). Also, additional duplicate fish tissue samples were analyzed to help assess laboratory variations and provide critical information for the assessment of both geographical and temporal trends.

Mercury: **Extractions and Analyses**

Strong acid digestions were performed using 10 ml nitric acid on approximately 1g homogenized wet fish material in a CEM MDS 2100 microwave digestion system. Mercury quantitation was subsequently accomplished using a Perkin Elmer Fimms 400 Cold Vapor AA. Calibration blanks, intercalibration verification samples, and instrument duplicates were analyzed to insure instrument performance and accuracy.

Polychlorinated Biphenyls, and Organochlorine Pesticides: Extractions and Analyses

All methods employed were similar to those used in previous monitoring studies for the State of New Jersey and the Delaware River Basin Commission. Homogenized fish samples were stored frozen until extraction. For extraction, samples were thawed and 2 g of the homogenate were sub-sampled using a stainless steel spatula. An additional 2-5 g sub-sample was taken for moisture analysis. Approximately 30 g of Na2SO4 (previously

extracted with hexane using a Soxhlet extractor and dried) was added to the sub-sample to eliminate water. The dried sample was then placed in a glass thimble and extracted using a Soxhlet extractor with ca. 200 ml dichloromethane (DCM) for a minimum of 18 h. The extracts were then sub-sampled for gravimetric lipid determination. For this, a known volume of extract was transferred to a pre-weighed aluminum pan. The solvent was evaporated at 110C for at least 24 h. The residue remaining (lipid) was weighed and percent lipid calculated. Lipids were removed from sample extracts by gel permeation chromatography (GPC) using DCM as the mobile phase. The collected fraction containing analytes was concentrated by roto-evaporation and a N2 stream. Solid-liquid chromatography using florisil was performed as an additional clean-up step. Using this technique, PCBs (as well as heptachlor, nonachlors, and DDEs) were eluted from the chromatographic column containing florosil using petroleum ether (F1 fraction). The remaining organochlorine pesticides were eluted using 50:50 petroleum ether and dichloromethane (F2 fraction).

Congener-specific PCBs and organochlorine pesticides were analyzed using a Hewlett Packard 5890 gas chromatograph equipped with a 63Ni electron capture detector and a 5% phenylmethyl silicon capillary column. The identification and quantification of PCB congeners follows the '610 Method' (Swackhamer and Trowbridge, 1996; Mullin, 1985) in which the identities and concentrations of each congener in a mixed Aroclor standard (25:18:18 mixture of Aroclors 1232, 1248 and 1262) were determined by calibration with individual PCB congener standards. Congener identities in the sample extracts were based on their chromatographic retention times relative to the internal standards added. In cases where two or more congeners could not be chromatographically resolved, the combined concentrations were reported. Organochlorine pesticides (OCPs) were identified and quantified based on comparisons (retention times and peak areas) with a known calibration standard prepared from individual compounds. Quality assurance and control measures were included at a frequency of 10% of the total number of samples. These measures included: evaluation of surrogate recoveries, calculation of blank-based detection limits, use of NIST standard reference materials and involvement in NIST's annual inter-laboratory comparison to assess ANSP's accuracy and precision in quantifying PCBs and OCPs, duplicate analysis, and spike recoveries.

In this study, chromatographic peaks associated with retention times at or near those for congeners 1 and 3 were observed. However, observation of congeners 1 and 3 within fish tissue matrices does not seem reasonable. Past studies from this lab and others show that these very lightly chlorinated congeners are often not associated with biological matrices. It is likely that there were chromatographic and/or matrix interferences that rendered the quantification of congeners 1 and 3 inaccurate. Therefore, concentrations assigned to these two congeners were not included in the summarized concentrations for total PCBs.

Table 2. Analyte list						
Organochlorinated Pesticides	**Polychlorinated biphenyls[1]**					
BHC (alpha, beta, delta)	1	31,28	74	134,144	185	208,195
Heptachlor	3	33,21,53	70,76	107	174	205
Heptachlor epoxide	4,10	22	66,95	149	177	206
Chlordanes (gamma and alpha)	6	45	91	118	201,171	207
Nonachlors (cis and trans)	7	46	56,60	131	172,197	209
Dieldrin	85	52	101	146	180	16,32
DDDs (o,p and p,p)	11	49	99	132,153,105	193	26
DDEs (o,p and p,p)	19	48,47	83	141	191	64
DDTs (o,p and p,p)	12,13	44	97	137,176	199	151
Aldrin	18	37,42	81,87	163,138	170,190	128
Endosulfan I and II	17	41,71	85	158	201	198
Endrin	24,27	40	136	129,178	189	
Oxychlordane	29	100	77,110	187,182	203,196	
Lindane	25	63	82	183	194	
Total Mercury (T Hg)						
Total lipid (proportion)						

[1] PCB congeners appearing as pairs or triplets will coelute and were reported as sum.

RESULTS

Concentrations of compounds (heptachlor, heptachlor epoxide, endrin, aldrin, and lindane) and groups of compounds (PCBs, DDXs, chordanes, nonachlors, BHCs and total mercury) varied among groups of samples or showed a few single relatively high values (Tables 3-6 and Figures 1-12). Relationships between contaminant concentrations and fish length or %lipid were not evident, probably because of the small range of these variables among samples. Patterns of concentrations differed among contaminants. Notable patterns for each contaminant are presented in the following section. In the following sections, references to “high” or “low” concentrations are made solely with respect to this data set; i.e., they are not statements about contamination of these samples relative to other species or sources of fish or relative to potential health risks. For several of the contaminants, concentrations were at low levels where relatively large analytical variance may be expected. In these cases, a few higher values may be seen, which would often occur in Pequest Hatchery fish, since these comprised most of the samples.

In addition to comparisons among groups within this study, concentrations of Pequest hatchery fish were compared with results for freshwater and estuarine fish analyzed as

part of the 1998 and 2004 portions of the NJ Routine Monitoring Program for Contaminants in Fish, conducted by ANS for DEP. For comparison, average, minimum and maximum concentration of each contaminant group was calculated for each station-year group for each species. The average, minimum and maximum of these was calculated for each species and contaminant (Tables 7-9). These data provide a basis for comparison of concentrations in hatchery trout relative to other wild fish in New Jersey.

PCBs

PCBs were generally similar among samples, with relatively high values for the single brook trout composite sample from the Schooley's Mountain Brook, one Pequest brown trout composite sample, and two individual Pequest hatchery spring samples (Figure 1, Tables 3-4). One of the Bear Brook samples was also relatively high on a lipid-normalized basis. Concentrations were lowest in some of the wild samples (brook trout from Bear Brook and brown trout from Old York Brook), one of the Pequest hatchery brown trout composites and one of the market rainbow trout samples. In general, there wasn't much difference between the skin-on and trimmed samples, except that the skin-on samples had higher concentrations for fall brown trout Pequest samples. One of the trimmed samples of spring brook trout from Bear Brook had a similar concentration as the skin-on sample, while the other trimmed sample had a higher concentration.

Compared to other species of wild fish from New Jersey (Table 7-9), PCBs concentrations in Pequest Hatchery fish were low, with average and maximum values for the hatchery fish among the lowest seen in wild fish. In 1988, ANS analyzed 15 samples of brown trout from five Connecticut streams; total PCB concentrations in all samples were below the detection limit of 30 ng/g at that time. Studies of trout from the Great Lakes and sites with known point sources (e.g., in the Housatonic River) have found much higher values of PCBs. These data are not summarized here.

Concentrations in farm-raised Atlantic salmon (Hites, et al. 2004) had geometric mean concentrations of 39 ng/g (Eastern Canada) and 26 ng/g (Maine), similar to those of the hatchery trout in this study. In a study of rainbow trout from 11 hatcheries in Washington State, four had PCB concentrations below the detection limit (2.4 ng/g), 6 had concentrations between 4.8 and 18.5 ng/g, and one had an average concentration of 67 ng/g, with a median of 11.7 for all 11 hatcheries (Serdar, et al. 2006). The same study analyzed planted rainbow trout from 10 lakes. Total PCB concentrations were below the detection limit in 6 lakes and ranged from 5.0-11.8 ng/g in the remaining 4 hatcheries. Except for the single hatchery, these concentrations are lower than those found in hatchery fish in this study. New York State conducted a study of PCBs in hatchery trout, but minimal data results were presented in the summary cited (NYSDEC 2007): "usually less than the detection limit at our laboratory of 20 parts per billion" for stocking sized brook, brown and rainbow trout. Broodstock Atlantic salmon (51-56 cm in length) had concentrations ranging from non-detect to 120 ppb (presumably equivalent to ng/g). Rawn et al. (2006) studied PCBs in seafood from Canadian retail markets. They found

ranges of 4.1-29 ng/g total PCBs in farmed trout, 3.5-14 ng/g in farmed char, 3.1-9.7 ng/g in wild char, 4.4-45 in farmed salmon, and 2.8-14 in wild salmon.

The FDA action level for total PCBs is 2,000 ng/g, which is much greater than the concentration of any specimen analyzed in this study. The NJDEP has developed a group of risk-based action limits for total PCBs. Based on these criteria, all specimens would warrant some advisory on frequency of consumption, especially for high risk groups.

DDX

DDX concentrations were generally similar among samples (Figure 2, Tables 3-4), except for high values for the two brown trout samples from the Saddle River. Concentrations were lowest in the other wild fish samples. There was little difference between DDX concentrations in skin on and trimmed fish.

Compared to other species of wild fish from New Jersey (Table 7-9), DDX concentrations in Pequest Hatchery fish were very low, with average and maximum values for the hatchery fish lower than any of the wild fish species analyzed. Fish from Washington State hatcheries (Serdar, et al. 2006) had total DDX concentrations (reported as total DDT, but including DDE and DDD as in this study) of 2.4-6.5 ng/g, with a median of 4 ng/g. These concentrations are similar to those seen in the Pequest Hatchery fish in this study (Table 7). Concentrations of total DDX in planted rainbow trout (Serdar, et al., 2006) were 1.9-5.8 ng/g in 9 lakes and 57 ng/g in one lake, with an overall median of 3.4 ng/g.

Chlordanes, heptachlor epoxide and nonachlors

The highest values of all three of these contaminants were seen in the two brown trout samples from the Saddle River, which also had the highest DDX concentrations, and in the brook trout sample from the Schooley's Mountain Brook, which also had the highest PCB concentration (Figures 3-5, Tables 3-4). Two of the rainbow trout samples from the Pequest hatchery also had relatively high concentrations. There were no clear differences in chlordane concentrations between skin on and trimmed samples.

Compared to other species of wild fish from New Jersey (Table 7-9), chlordane concentrations in Pequest Hatchery fish were very low, with average values for the hatchery fish lower than any of the wild fish species analyzed. Nonachlor concentrations were very low, with average values for the hatchery fish similar or lower than those in the wild species analyzed. Hepatchlor epoxide concentrations in the hatchery fish were low compared to wild fish.

Table 3. Concentrations of pesticides and other organic compounds in ANSP hatchery trout study. Total PCBs excludes congeners 1 and 3, which could not be accurately quantitated.

Station	Season	Total Length	Sample prep.	Sample Type	Sample	Lipid	Total PCBs	Total DDX	Chlordanes	heptachlor epoxide	Nonachlors	Dieldrin
Species	Unit:	cm				%	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
Brook trout												
Pequest Hatchery	Spring	23.5	Skin On	Ind	5484	3.47	24.4	3.27	1.51	0.18	0.34	0.39
Pequest Hatchery	Spring	26.1	Skin On	Ind	5483	4.58	33.7	4.70	1.37	0.34	0.56	0.70
Pequest Hatchery	Spring	25.5	Trimmed	Comp	5469	4.19	27.7	4.88	2.10	0.30	0.48	0.51
Pequest Hatchery	Spring	26.5	Trimmed	Comp	5468	4.10	29.6	4.48	1.54	0.21	0.45	0.51
Pequest Hatchery	Spring	27.3	Trimmed	Ind	5470	3.66	26.1	4.63	1.94	0.21	0.42	0.40
Pequest Hatchery	Spring	31.1	Trimmed	Ind	5471	5.05	26.3	3.66	1.43	0.23	0.40	0.48
Comm. Hatchery	Spring	22.7	Trimmed	Comp	5867	4.37	22.1	2.81	1.72	0.34	0.33	0.43
Schooley's Mt Brook	Spring	19.7	Skin On	Comp	5862	3.91	87.9	5.05	7.02	1.46	2.82	4.48
Bear Brook	Spring	21.5	Skin On	Comp	5861	3.24	13.0	2.48	0.85	0.12	0.28	0.13
Bear Brook	Spring	20.5	Trimmed	Comp	5863	2.65	12.6	2.03	0.58	0.11	0.27	0.11
Bear Brook	Spring	22.1	Trimmed	Comp	5866	2.84	35.6	2.93	2.87	0.64	1.21	2.17
Brown trout												
Pequest Hatchery	Fall	18.4	Skin On	Comp	5477	5.77	77.2	6.82	2.45	0.56	0.66	0.81
Pequest Hatchery	Fall	18.9	Skin On	Comp	5476	5.37	38.6	5.05	1.94	0.48	0.61	0.95
Pequest Hatchery	Spring	26.3	Skin On	Ind	5478	7.41	53.1	6.80	2.48	0.65	0.90	1.33
Pequest Hatchery	Spring	27.0	Skin On	Ind	5479	5.68	59.6	6.78	2.68	0.38	1.17	0.91
Pequest Hatchery	Fall	18.6	Trimmed	Comp	5472	6.00	35.5	4.84	1.54	0.49	0.57	0.99
Pequest Hatchery	Fall	17.8	Trimmed	Comp	5473	5.00	16.4	4.58	1.35	0.44	0.32	0.88
Pequest Hatchery	Spring	25.0	Trimmed	Comp	5465	6.00	37.2	6.69	2.18	0.42	0.57	0.92
Pequest Hatchery	Spring	25.8	Trimmed	Comp	5464	5.29	35.9	6.87	1.91	0.31	0.56	0.83
Pequest Hatchery	Spring	24.9	Trimmed	Ind	5482	5.19	37.1	4.95	1.69	0.41	0.60	0.89
Pequest Hatchery	Spring	26.5	Trimmed	Ind	5481	6.27	38.4	5.33	1.76	0.43	0.67	1.02
Pequest Hatchery	Spring	27.3	Trimmed	Ind	5480	3.58	42.6	5.00	1.25	0.42	0.63	0.97
Comm. Hatchery	Spring	20.0	Trimmed	Comp	5892	7.07	31.9	3.33	0.93	0.21	0.48	0.42
Old York Brook	Spring	21.2	Skin On	Comp	5851	4.41	24.0	2.67	2.21	0.61	0.89	0.18
Old York Brook	Spring	20.3	Trimmed	Comp	5864	3.32	19.8	1.40	1.14	0.24	0.42	0.11
Saddle River	Spring	21.1	Skin On	Comp	5852	4.13	37.3	20.67	17.18	6.98	4.10	4.71
Saddle River	Spring	22.8	Trimmed	Comp	5865	3.08	41.4	18.09	12.98	4.88	2.98	3.35
Rainbow trout												
Pequest Hatchery	Spring	24.6	Skin On	Ind	5486	6.58	41.7	4.91	2.47	0.52	0.74	1.25
Pequest Hatchery	Spring	25.7	Skin On	Ind	5485	4.73	45.4	7.57	2.51	0.49	0.88	1.10
Pequest Hatchery	Fall	20.5	Trimmed	Comp	5475	3.68	31.3	5.57	1.22	0.23	0.50	0.12
Pequest Hatchery	Fall	21.4	Trimmed	Comp	5474	4.35	33.3	4.98	1.29	0.24	0.57	0.45
Pequest Hatchery	Spring	26.7	Trimmed	Comp	5466	5.38	37.1	7.03	5.04	0.42	2.87	0.89
Pequest Hatchery	Spring	27.7	Trimmed	Comp	5467	5.15	31.1	4.14	4.12	0.39	2.38	0.77
Pequest Hatchery	Spring	26.0	Trimmed	Ind	5487	5.24	40.0	4.67	2.18	0.37	0.67	0.79
Pequest Hatchery	Spring	26.1	Trimmed	Ind	5489	3.70	32.2	6.19	1.89	0.38	0.52	0.82
Pequest Hatchery	Spring	28.9	Trimmed	Ind	5488	6.34	49.1	7.63	2.20	0.41	0.78	1.12
Comm. Hatchery	Spring	19.7	Trimmed	Comp	5893	4.95	26.4	3.58	1.40	0.32	0.46	0.62
Market	Fall	20.2	Trimmed	Comp	5895	7.41	32.5	5.62	2.18	0.37	0.53	0.91
Market	Fall	34.4	Trimmed	Comp	5894	7.47	19.1	5.11	1.14	0.26	0.35	0.54

Table 4. Lipid-normalized concentrations (ng/g lipid) of PCBs and selected pesticides in the ANSP hatchery trout study.

Station	Season	Ave. TL	Sample prep.	Sample Type	Lipid	lipPCBs	LipDDX	lipChlor-dane	lipHept-Epox	lipTotnonachlor
	unit:	cm			%	ng/g lip	ng/g lip	ng/g lip	ng/g lip	ng/g lip
Brook Trout										
Comm. Hatch.	Spring	22.7	Trimmed	Comp	4.4	505	64	39	7.8	7.6
Pequest Hatchery	Spring	26.5	Trimmed	Comp	4.1	723	109	38	5.1	11.1
Pequest Hatchery	Spring	25.5	Trimmed	Comp	4.2	661	117	50	7.2	11.4
Pequest Hatchery	Spring	27.3	Trimmed	Ind	3.7	713	127	53	5.7	11.4
Pequest Hatchery	Spring	31.1	Trimmed	Ind	5.1	520	72	28	4.5	7.9
Pequest Hatchery	Spring	26.1	Skin On	Ind	4.6	736	103	30	7.5	12.3
Pequest Hatchery	Spring	23.5	Skin On	Ind	3.5	703	94	43	5.3	9.9
Bear Brook	Spring	21.5	Skin On	Comp	3.2	403	77	26	3.7	8.5
Schooley's Mt Brook	Spring	19.7	Skin On	Comp	3.9	2246	129	180	37.3	72.1
Bear Brook	Spring	20.5	Trimmed	Comp	2.7	476	77	22	4.0	10.1
Bear Brook	Spring	22.1	Trimmed	Comp	2.8	1254	103	101	22.7	42.6
Brown Trout										
Comm. Hatch.	Spring	20.0	Trimmed	Comp	7.1	450	47	13	3.0	6.8
Pequest Hatchery	Spring	25.8	Trimmed	Comp	5.3	678	130	36	5.8	10.6
Pequest Hatchery	Spring	25.0	Trimmed	Comp	6.0	620	111	36	6.9	9.5
Pequest Hatchery	Fall	18.6	Trimmed	Comp	6.0	593	81	26	8.2	9.6
Pequest Hatchery	Fall	17.8	Trimmed	Comp	5.0	328	92	27	8.9	6.4
Pequest Hatchery	Fall	18.9	Skin On	Comp	5.4	719	94	36	8.8	11.4
Pequest Hatchery	Fall	18.4	Skin On	Comp	5.8	1338	118	42	9.7	11.5
Pequest Hatchery	Spring	26.3	Skin On	Ind	7.4	716	92	33	8.8	12.1
Pequest Hatchery	Spring	27.0	Skin On	Ind	5.7	1049	119	47	6.7	20.5
Pequest Hatchery	Spring	27.3	Trimmed	Ind	3.6	1190	140	35	11.7	17.5
Pequest Hatchery	Spring	26.5	Trimmed	Ind	6.3	612	85	28	6.9	10.7
Pequest Hatchery	Spring	24.9	Trimmed	Ind	5.2	715	95	33	7.9	11.5
Old York Brook	Spring	21.2	Skin On	Comp	4.4	544	61	50	13.9	20.2
Saddle River	Spring	21.1	Skin On	Comp	4.1	903	501	416	169.2	99.3
Old York Brook	Spring	20.3	Trimmed	Comp	3.3	596	42	34	7.4	12.7
Saddle River	Spring	22.8	Trimmed	Comp	3.1	1346	588	422	158.5	96.7
Rainbow trout										
Comm. Hatch.	Spring	19.7	Trimmed	Comp	5.0	532	72	28	6.4	9.4
Market	Fall	34.4	Trimmed	Comp	7.5	256	68	15	3.4	4.6
Market	Fall	20.2	Trimmed	Comp	7.4	439	76	29	5.0	7.2
Pequest Hatchery	Spring	26.7	Trimmed	Comp	5.4	690	131	94	7.8	53.4
Pequest Hatchery	Spring	27.7	Trimmed	Comp	5.1	604	80	80	7.6	46.2
Pequest Hatchery	Fall	21.4	Trimmed	Comp	4.3	765	114	30	5.6	13.1
Pequest Hatchery	Fall	20.5	Trimmed	Comp	3.7	850	151	33	6.3	13.7
Pequest Hatchery	Spring	25.7	Skin On	Ind	4.7	960	160	53	10.3	18.6
Pequest Hatchery	Spring	24.6	Skin On	Ind	6.6	634	75	38	8.0	11.2
Pequest Hatchery	Spring	26.0	Trimmed	Ind	5.2	764	89	42	7.1	12.9
Pequest Hatchery	Spring	28.9	Trimmed	Ind	6.3	775	120	35	6.5	12.3
Pequest Hatchery	Spring	26.1	Trimmed	Ind	3.7	870	168	51	10.2	14.1

Table 5. Concentrations of total mercury (Hg) and selected organic compounds in trout in the ANSP hatchery trout study.

Station	Season	Total Length	Sample prep.	Sample Type	Sample Number	Endrin	Total Hg	Endosulfans	BHCs	Heptachlor	Aldrin	Lindane
Species	Unit:	cm				ng/g	ug/g	ng/g	ng/g	ng/g	ng/g	ng/g
Brook trout												
Pequest Hatchery	Spring	23.5	Skin On	Ind	5484	0.17	0.02	0.09	0.85	0.05	0.23	0.26
Pequest Hatchery	Spring	26.1	Skin On	Ind	5483	0.39	0.02	0.29	3.75	0.07	0.35	0.32
Pequest Hatchery	Spring	25.5	Trimmed	Comp	5469	0.38	0.02	1.82	1.67	0.17	0.29	0.29
Pequest Hatchery	Spring	26.5	Trimmed	Comp	5468	0.22	0.01	0.28	3.45	0.15	0.19	0.00
Pequest Hatchery	Spring	27.3	Trimmed	Ind	5470	0.39	0.01	2.32	2.59	0.16	0.28	0.35
Pequest Hatchery	Spring	31.1	Trimmed	Ind	5471	0.23	0.01	0.33	1.25	0.06	0.44	0.30
Comm. Hatchery	Spring	22.7	Trimmed	Comp	5867	0.21	0.02	0.17	0.24	0.10	0.03	0.07
Schooley's Mt Brook	Spring	19.7	Skin On	Comp	5862	0.11	0.02	0.83	0.23	0.06	0.27	0.06
Bear Brook	Spring	21.5	Skin On	Comp	5861	0.12	0.07	0.54	0.35	0.11	0.02	0.09
Bear Brook	Spring	20.5	Trimmed	Comp	5863	0.09	0.07	0.34	0.17	0.06	0.01	0.05
Bear Brook	Spring	22.1	Trimmed	Comp	5866	0.08	0.06	0.34	0.30	0.08	0.17	0.04
Brown trout												
Pequest Hatchery	Fall	18.4	Skin On	Comp	5477	0.76	0.01	1.26	2.50	0.21	0.05	0.46
Pequest Hatchery	Fall	18.9	Skin On	Comp	5476	0.39	0.01	0.48	2.49	0.09	0.26	0.34
Pequest Hatchery	Spring	26.3	Skin On	Ind	5478	0.44	0.02	0.89	4.27	0.16	0.19	0.41
Pequest Hatchery	Spring	27.0	Skin On	Ind	5479	0.36	0.02	0.17	1.66	0.08	0.18	0.32
Pequest Hatchery	Fall	18.6	Trimmed	Comp	5472	0.36	0.01	0.17	0.36	0.10	0.06	0.04
Pequest Hatchery	Fall	17.8	Trimmed	Comp	5473	0.35	0.02	0.21	1.44	0.13	0.11	0.41
Pequest Hatchery	Spring	25.0	Trimmed	Comp	5465	0.38	0.01	1.09	2.88	0.10	0.19	0.42
Pequest Hatchery	Spring	25.8	Trimmed	Comp	5464	0.32	0.01	0.13	2.50	0.09	0.37	0.33
Pequest Hatchery	Spring	24.9	Trimmed	Ind	5482	0.32	0.01	0.08	1.54	0.07	0.24	0.31
Pequest Hatchery	Spring	26.5	Trimmed	Ind	5481	0.37	0.01	0.13	1.89	0.13	0.19	0.36
Pequest Hatchery	Spring	27.3	Trimmed	Ind	5480	0.34	0.01	0.07	2.49	0.06	0.22	0.25
Comm. Hatchery	Spring	20.0	Trimmed	Comp	5892	0.14	0.02	0.02	0.08	0.06	0.01	0.05
Old York Brook	Spring	21.2	Skin On	Comp	5851	0.05	0.04	0.07	0.28	0.04	0.04	0.06
Old York Brook	Spring	20.3	Trimmed	Comp	5864	0.06	0.03	0.21	0.37	0.15	0.02	0.18
Saddle River	Spring	21.1	Skin On	Comp	5852	0.69	0.05	0.79	0.53	0.10	0.19	0.24
Saddle River	Spring	22.8	Trimmed	Comp	5865	0.39	0.04	0.67	0.35	0.05	0.18	0.06
Rainbow trout												
Pequest Hatchery	Spring	24.6	Skin On	Ind	5486	0.59	0.01	0.03	0.23	0.00	0.02	0.07
Pequest Hatchery	Spring	25.7	Skin On	Ind	5485	0.58	0.02	0.84	0.12	0.10	0.02	0.03
Pequest Hatchery	Fall	20.5	Trimmed	Comp	5475	0.45	0.02	1.19	2.72	0.04	0.24	0.51
Pequest Hatchery	Fall	21.4	Trimmed	Comp	5474	0.24	0.02	1.20	2.16	0.07	0.23	0.30
Pequest Hatchery	Spring	26.7	Trimmed	Comp	5466	0.63	0.03	3.47	2.39	0.00	0.28	0.32
Pequest Hatchery	Spring	27.7	Trimmed	Comp	5467	0.41	0.01	0.30	3.03	0.10	0.19	0.45
Pequest Hatchery	Spring	26.0	Trimmed	Ind	5487	0.39	0.01	0.10	0.14	0.09	0.06	0.07
Pequest Hatchery	Spring	26.1	Trimmed	Ind	5489	0.54	0.02	0.16	0.76	0.05	0.09	0.10
Pequest Hatchery	Spring	28.9	Trimmed	Ind	5488	0.62	0.01	0.06	0.24	0.06	0.02	0.09
Comm. Hatchery	Spring	19.7	Trimmed	Comp	5893	0.21	0.01	0.33	0.16	0.05	0.05	0.03
Market	Fall	20.2	Trimmed	Comp	5895	0.44	0.02	0.16	0.46	0.09	0.08	0.03
Market	Fall	34.4	Trimmed	Comp	5894	0.27	0.03	0.10	0.18	0.14	0.04	0.07

Table 6. Lipid-normalized concentrations (ng/g lipid) of PCBs and selected pesticides in the ANSP hatchery trout study.

Station	Season	Ave TL	Sample prep.	Sample Type	Lipid	lip-PCB	lip-endrin	lip-TEndosulf	lip-TBHC	lip-heptachlor	lip-Aldrin	lip-Lindane
Species	Unit:	cm			%	ng/g lip	ng/g lip	ng/g lip	ng/g lip	ng/g lip	ng/g lip	ng/g lip
Brook Trout												
Comm. Hatch.	Spring	22.7	Trimmed	Comp	4.4	505	4.8	3.8	0.06	2.3	0.7	0.02
Pequest Hatchery	Spring	26.5	Trimmed	Comp	4.1	723	5.4	6.9	0.84	3.6	4.7	0.00
Pequest Hatchery	Spring	25.5	Trimmed	Comp	4.2	661	9.1	43.4	0.40	4.0	6.9	0.07
Pequest Hatchery	Spring	27.3	Trimmed	Ind	3.7	713	10.6	63.3	0.71	4.3	7.5	0.09
Pequest Hatchery	Spring	31.1	Trimmed	Ind	5.1	520	4.5	6.5	0.25	1.2	8.7	0.06
Pequest Hatchery	Spring	26.1	Skin On	Ind	4.6	736	8.6	6.3	0.82	1.4	7.7	0.07
Pequest Hatchery	Spring	23.5	Skin On	Ind	3.5	703	4.8	2.7	0.25	1.3	6.7	0.07
Bear Brook	Spring	21.5	Skin On	Comp	3.2	403	3.8	16.7	0.11	3.3	0.5	0.03
Schooley's Mt Brk	Spring	19.7	Skin On	Comp	3.9	2246	2.9	21.3	0.06	1.6	6.8	0.01
Bear Brook	Spring	20.5	Trimmed	Comp	2.7	476	3.3	12.7	0.06	2.3	0.4	0.02
Bear Brook	Spring	22.1	Trimmed	Comp	2.8	1254	2.8	12.1	0.11	3.0	5.9	0.01
Brown Trout												
Comm. Hatch.	Spring	20.0	Trimmed	Comp	7.1	450	1.9	0.3	0.01	0.8	0.2	0.01
Pequest Hatchery	Spring	25.8	Trimmed	Comp	5.3	678	6.0	2.4	0.47	1.7	7.0	0.06
Pequest Hatchery	Spring	25.0	Trimmed	Comp	6.0	620	6.3	18.2	0.48	1.7	3.1	0.07
Pequest Hatchery	Fall	18.6	Trimmed	Comp	6.0	593	6.0	2.8	0.06	1.7	0.9	0.01
Pequest Hatchery	Fall	17.8	Trimmed	Comp	5.0	328	7.0	4.1	0.29	2.7	2.3	0.08
Pequest Hatchery	Fall	18.9	Skin On	Comp	5.4	719	7.2	9.0	0.46	1.7	4.8	0.06
Pequest Hatchery	Fall	18.4	Skin On	Comp	5.8	1338	13.1	21.8	0.43	3.7	0.9	0.08
Pequest Hatchery	Spring	26.3	Skin On	Ind	7.4	716	5.9	12.1	0.58	2.2	2.6	0.05
Pequest Hatchery	Spring	27.0	Skin On	Ind	5.7	1049	6.4	3.0	0.29	1.4	3.2	0.06
Pequest Hatchery	Spring	27.3	Trimmed	Ind	3.6	1190	9.4	2.0	0.70	1.7	6.2	0.07
Pequest Hatchery	Spring	26.5	Trimmed	Ind	6.3	613	6.0	2.1	0.30	2.1	3.1	0.06
Pequest Hatchery	Spring	24.9	Trimmed	Ind	5.2	715	6.2	1.6	0.30	1.3	4.7	0.06
Old York Brook	Spring	21.2	Skin On	Comp	4.4	544	1.2	1.6	0.06	0.9	0.9	0.01
Saddle River	Spring	21.1	Skin On	Comp	4.1	903	16.7	19.2	0.13	2.5	4.7	0.06
Old York Brook	Spring	20.3	Trimmed	Comp	3.3	596	1.7	6.3	0.11	4.5	0.5	0.05
Saddle River	Spring	22.8	Trimmed	Comp	3.1	1346	12.8	21.8	0.11	1.7	5.8	0.02
Rainbow trout												
Comm. Hatch.	Spring	19.7	Trimmed	Comp	5.0	532	4.2	6.7	0.03	0.9	1.1	0.01
Market	Fall	34.4	Trimmed	Comp	7.5	256	3.6	1.3	0.02	1.9	0.5	0.01
Market	Fall	20.2	Trimmed	Comp	7.4	439	5.9	2.1	0.06	1.3	1.1	0.00
Pequest Hatchery	Spring	26.7	Trimmed	Comp	5.4	690	11.7	64.4	0.45	0.0	5.2	0.06
Pequest Hatchery	Spring	27.7	Trimmed	Comp	5.1	604	7.9	5.8	0.59	1.9	3.6	0.09
Pequest Hatchery	Fall	21.4	Trimmed	Comp	4.3	765	5.6	27.5	0.50	1.6	5.3	0.07
Pequest Hatchery	Fall	20.5	Trimmed	Comp	3.7	850	12.2	32.3	0.74	1.2	6.6	0.14
Pequest Hatchery	Spring	25.7	Skin On	Ind	4.7	960	12.4	17.8	0.03	2.1	0.3	0.01
Pequest Hatchery	Spring	24.6	Skin On	Ind	6.6	634	9.0	0.4	0.03	0.0	0.3	0.01
Pequest Hatchery	Spring	26.0	Trimmed	Ind	5.2	764	7.4	1.9	0.03	1.8	1.2	0.01
Pequest Hatchery	Spring	28.9	Trimmed	Ind	6.3	775	9.8	1.0	0.04	1.0	0.4	0.01
Pequest Hatchery	Spring	26.1	Trimmed	Ind	3.7	870	14.6	4.3	0.21	1.4	2.4	0.03

Chlordanes (as cis-chlordane) were detected in 50% of hatchery rainbow trout from Washington hatcheries (Serdar, et al. 2006), with a range of 0.17-0.31 ng/g in samples above the detection limit. These values are lower than those seen in most Pequest Hatchery fish. Trans-nonachlor was detected in 80% of hatchery rainbow trout in that study, with a range of 0.094-0.45 ng/g among samples with values above the detection limit. The maximum value is similar to or less than many of the Pequest Hatchery fish.

The US FDA has set an action limit of 300 ng/g wet weight for total chlordanes **(**cis and trans forms). This limit is much higher than the concentration in any sample from this study. The FDA action limit for heptachlor and heptachlor epoxide (i.e., the sum of the two chemicals) is 300 ng/g wet weight. The sum of heptachlor and heptachlor epoxide was much lower than this action limit for all samples analyzed in this study.

Dieldrin

Concentrations of dieldrin in some of the wild trout (brown trout from Saddle River and brook trout from Schooley's Mountain Brook and one brook trout sample from Bear Brook) were much higher than those in other samples (Figure 6, Tables 3-4). The lowest concentrations were in some of the Pequest hatchery fish and the other Bear Brook samples. Moderately high concentrations were seen in some of the Pequest hatchery samples.

Dieldrin concentrations were low compared to those in wild fish species analyzed. Broodstock Atlantic salmon and lake trout from Northeast Federal hatcheries had maximum values of 1.1 and 1.3 ng/g, respectively (Millard et al. 2004), which are similar to maximal values seen in this study (Table 3).

The US FDA action limit for dieldrin in fish is 300 ng/g wet weight, which is much greater than the concentration of any sample in this study.

Endrin

Concentrations of endrin were generally similar among hatchery fish, except for higher concentrations in some of the Pequest rainbow trout (Figure 7, Tables 5-6). Other than these, the highest concentrations were seen in wild brown trout from Saddle River and the lowest in the wild trout from the other 3 streams.

Average concentrations of endrin in hatchery fish in this study were greater than those of many of the wild fish species analyzed (Table 7). However, wild fish showed higher maximum concentrations than the hatchery fish.

Aldrin

Concentrations of aldrin were somewhat higher in Pequest hatchery fish and in Saddle River wild brown trout than in most wild fish or commercial hatchery fish (Figure 8, Tables 5-6). Aldrin was not detected in many of the wild fish species analyzed (Tables 7-9). Concentrations in the Pequest hatchery fish were similar to those of wild species in which aldrin was quantifiable.

The US FDA action limit for aldrin in fish is 300 ng/g wet weight, which is much greater than the concentration of any sample in this study.

Total endosulfans

Concentrations of endosulfans were variable within and among different groups of fish, with no clear patterns (Figure 9, Tables 5-6). Concentrations of endosulfans were low relative to most species of wild fish analyzed (Tables 7-9)

Total BHCs

Concentrations of BHCs were variable within the Pequest Hatchery fish, but were generally higher than in wild fish, fish from other commercial hatcheries, or market fish (Figure 10, Tables 5-6). Exceptions were low concentrations of total BHCs in some of the Pequest Hatchery individual rainbow trout samples. However, total BHC concentrations in Pequest Hatchery were still lower than the average and median concentrations in wild species analyzed (Tables 7-9)

Lindane

Concentrations of lindane were variable, but were highest in some of the Pequest Hatchery fish (Figure 11, Tables 5-6). However, concentrations were typical of most of the wild fish species analyzed (Tables 7-9).

Heptachlor

Concentrations of heptachlor were variable within and among groups (Figure 12, Tables 5-6). The highest concentrations were seen in some of the Pequest Hatchery brown and brook trout (Tables 7-9). However, heptachlor concentrations were very low in all the fish in this study compared to the species analyzed in the routine monitoring program (Tables 7-9), with only a few estuarine species showing lower concentrations than the Pequest Hatchery fish. As noted above, the concentrations of heptachlor and heptachlor epoxide found in this study are much lower than the US FDA action limit of 300 ng/g.

Table 7. Comparison of average concentrations of Pequest hatchery trout in this study with species averages (averages over species-year combinations) from 1998 and 2004 NJDEP Routine Monitoring program.

	Total PCBs	Lindane	Total BHC	Aldrin	Dieldrin	Chlor-danes	Endo-sulfans	Total DDX	Endrin	Hepta-chlor	Heptachlor epoxide	Nona-chlors
Species	ave	ave	ave	ave	ave	ave	ave	ave	ave	ave	ave	ave
Unit:	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
This Study (Pequest Hatchery):												
Salvelinus fontinalis	28	0.3	2.3	0.3	0.5	1.6	0.9	4.3	0.30	0.1	0.2	0.4
Salmo trutta	43	0.3	2.2	0.2	1.0	1.9	0.4	5.8	0.40	0.1	0.5	0.7
Oncorhynchus mykiss	38	0.2	1.3	0.1	0.8	2.5	0.8	5.9	0.49	0.1	0.4	1.1
NJ monitoring (1998, 2004):												
Ameiurus catus	228	0.5	4.7	0.1	4.2	18.6	3.3	97.7	0.08	0.8	1.2	9.5
Ameiurus natalis	354	0.2	4.9	0.0	6.8	52.9	2.2	72.1	0.00	1.7	0.9	5.5
Ameiurus nebulosus	49	0.1	4.4	0.1	6.1	28.1	1.8	42.9	0.23	1.3	0.3	9.8
Anguilla rostrata	506	0.7	8.1	0.4	18.7	41.9	5.6	304.9	0.43	3.8	2.1	38.6
Cynoscion regalis	125	0.1	0.1	0.0	0.0	4.6	0.1	18.7	0.20	0.1	0.7	2.5
Cyprinus carpio	746	1.0	31.4	0.3	49.3	194.1	10.1	654.5	0.96	6.9	2.5	108.1
Ictalurus punctatus	301	0.4	5.6	0.0	14.3	53.2	2.0	344.1	0.00	2.9	1.4	43.8
Lepomis auritus	57	0.2	2.1	0.0	1.7	5.2	3.1	17.5	0.15	0.8	0.1	9.0
Lepomis gibbosus	142	0.5	6.1	0.0	7.4	10.5	4.3	83.6	0.54	1.0	0.2	12.3
Lepomis macrochirus	62	0.3	3.0	0.0	5.2	4.6	1.9	88.4	0.21	0.7	0.1	19.0
Micropogonias undulatus	41	0.1	0.1	0.1	0.0	1.9	0.0	8.0	0.08	0.0	0.6	1.1
Micropterus salmoides	291	0.3	8.4	0.1	15.5	31.1	3.8	148.6	0.35	1.7	0.6	27.0
Morone americana	692	0.4	25.8	1.2	10.2	64.4	4.7	311.9	0.66	2.5	3.6	27.3
Morone saxatilis	431	0.2	3.8	0.1	9.1	18.8	2.3	160.4	0.25	1.4	1.0	20.7
Pomatomus saltatrix	470	0.3	1.9	0.4	4.2	18.0	0.9	88.4	0.50	0.8	1.6	18.9
Pomoxis nigromaculatus	33	0.0	0.0	0.0	2.5	3.8	0.6	20.5	0.00	0.4	0.2	4.9
Stenotomus chrysops	171	0.2	0.3	0.0	0.1	6.1	0.2	19.6	0.18	0.2	0.8	3.4
Summary statistics for NJ Routine Monitoring Program for Toxics in Fish data												
Minima	33	0.0	0.0	0.0	0.0	1.9	0.0	8.0	0.00	0.0	0.1	1.1
Maxima	746	1.0	31.4	1.2	49.3	194.1	10.1	654.5	0.96	6.9	3.6	108.1
Averages	277	0.3	6.5	0.2	9.1	32.8	2.8	146.0	0.28	1.6	1.1	21.3
Medians	228	0.3	4.4	0.1	6.1	18.6	2.2	88.4	0.21	1.0	0.8	12.3

Table 8. Comparison of minimal concentrations of Pequest hatchery trout in this study with species averages (averages over species-year combinations) from 1998 and 2004 NJDEP Routine Monitoring program.

	Total PCBs	Lindane	BHC	Aldrin	Dieldrin	Chlor-danes	Endo-sulfans	Total DDX	Endrin	Hepta-chlor	Heptachlor epoxide	Nona-chlors
	min	min	min	min	min	min	min	min	min	min	min	min
	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
This Study (Pequest Hatchery):												
Salvelinus fontinalis	24	0.0	0.9	0.2	0.4	1.4	0.1	3.3	0.17	0.0	0.2	0.3
Salmo trutta	16	0.0	0.4	0.1	0.8	1.2	0.1	4.6	0.32	0.1	0.3	0.3
Oncorhynchus mykiss	31	0.0	0.1	0.0	0.1	1.2	0.0	4.1	0.24	0.0	0.2	0.5
NJ monitoring (1998, 2004):												
Ameiurus catus	50	0.1	0.0	0.0	0.0	4.1	0.0	17.6	0.00	0.1	0.0	1.7
Ameiurus natalis	354	0.2	4.9	0.0	6.8	52.9	2.2	72.1	0.00	1.7	0.9	5.5
Ameiurus nebulosus	12	0.0	0.0	0.0	0.8	1.1	0.0	5.4	0.00	0.1	0.0	0.6
Anguilla rostrata	0	0.0	0.0	0.0	0.0	0.0	0.0	12.5	0.00	0.0	0.0	0.0
Cynoscion regalis	7	0.0	0.0	0.0	0.0	0.4	0.0	5.4	0.00	0.0	0.1	0.2
Cyprinus carpio	40	0.0	2.7	0.0	0.6	2.6	0.6	21.9	0.00	0.2	0.1	5.7
Ictalurus punctatus	301	0.4	5.6	0.0	14.3	53.2	2.0	344.1	0.00	2.9	1.4	43.8
Lepomis auritus	46	0.0	0.0	0.0	0.8	3.4	1.2	11.9	0.00	0.3	0.0	2.8
Lepomis gibbosus	81	0.4	3.7	0.0	2.2	2.9	1.3	13.0	0.39	0.4	0.1	5.0
Lepomis macrochirus	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	1.3
Micropogonias undulatus	14	0.0	0.1	0.0	0.0	0.5	0.0	2.6	0.00	0.0	0.1	1.0
Micropterus salmoides	49	0.0	0.0	0.0	1.2	4.7	0.4	15.1	0.00	0.3	0.0	3.0
Morone americana	91	0.0	0.0	0.0	0.0	9.4	0.0	29.5	0.00	0.4	1.7	3.9
Morone saxatilis	85	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.00	0.0	0.0	0.0
Pomatomus saltatrix	69	0.0	0.0	0.0	0.0	2.6	0.0	11.1	0.00	0.0	0.0	1.4
Pomoxis nigromaculatus	15	0.0	0.0	0.0	1.3	3.5	0.5	9.3	0.00	0.2	0.0	1.0
Stenotomus chrysops	64	0.1	0.2	0.0	0.0	2.2	0.0	5.0	0.10	0.1	0.3	1.4

Table 9. Comparison of maximal concentrations of Pequest hatchery trout in this study with species averages (averages over species-year combinations) from 1998 and 2004 NJDEP Routine Monitoring program.

	Total PCBs	Lindane	BHCs	Aldrin	Dieldrin	Chlor-danes	Endo-sulfans	Total DDX	Endrin	Hepta-chlor	Heptachlor epoxide	Nona-chlors
	max	max	max	max	max	max	max	max	max	max	max	max
	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g	ng/g
This Study (Pequest Hatchery):												
Salvelinus fontinalis	34	0.3	3.7	0.4	0.7	2.1	2.3	4.9	0.39	0.2	0.3	0.6
Salmo trutta	77	0.5	4.3	0.4	1.3	2.7	1.3	6.9	0.76	0.2	0.7	1.2
Oncorhynchus mykiss	49	0.5	3.0	0.3	0.1	5.0	3.5	7.6	0.63	0.1	0.5	2.9
NJ monitoring (1998, 2004):												
Ameiurus catus	581	0.9	15.2	0.4	17.1	35.3	15.4	191.6	0.30	2.8	4.3	19.1
Ameiurus natalis	354	0.2	4.9	0.0	6.8	52.9	2.2	72.1	0.00	1.7	0.9	5.5
Ameiurus nebulosus	260	0.6	16.5	1.8	17.7	84.0	8.8	150.5	1.78	3.9	1.1	42.9
Anguilla rostrata	3448	7.8	83.3	5.9	180.1	264.9	58.5	2572.4	3.30	34.6	51.4	293.3
Cynoscion regalis	717	0.3	0.6	0.1	0.1	21.2	0.4	81.3	0.50	1.0	2.5	13.1
Cyprinus carpio	2775	3.2	119.1	5.5	199.9	622.4	48.3	3813.7	23.06	19.9	9.4	367.8
Ictalurus punctatus	301	0.4	5.6	0.0	14.3	53.2	2.0	344.1	0.00	2.9	1.4	43.8
Lepomis auritus	66	0.4	6.6	0.0	2.8	11.8	8.9	25.2	0.61	1.8	0.1	18.3
Lepomis gibbosus	202	0.7	8.5	0.0	12.5	18.2	7.3	154.1	0.69	1.7	0.4	19.6
Lepomis macrochirus	297	1.2	8.7	0.0	12.0	8.2	5.2	548.9	0.59	1.3	0.6	135.4
Micropogonias undulatus	52	0.1	0.2	0.1	0.0	2.7	0.1	9.8	0.20	0.1	1.0	1.3
Micropterus salmoides	2678	0.7	34.7	3.0	76.0	176.5	18.3	622.3	2.72	6.5	3.3	110.9
Morone americana	2009	1.5	144.5	5.5	22.7	137.3	15.3	900.6	2.19	5.2	9.5	97.0
Morone saxatilis	1631	1.1	27.8	4.1	142.8	126.6	17.0	1114.0	3.03	17.4	4.6	176.2
Pomatomus saltatrix	1820	1.2	19.8	4.2	62.6	67.1	4.6	338.3	5.15	9.5	8.7	98.6
Pomoxis nigromaculatus	51	0.0	0.0	0.0	3.8	4.0	0.8	31.7	0.00	0.6	0.5	8.8
Stenotomus chrysops	323	0.3	0.5	0.1	0.3	12.8	0.5	44.6	0.20	0.4	1.5	6.8

Mercury

Concentrations of total mercury (Figure 13, Table 5) were low in all fish from Pequest Hatchery and commercial hatcheries; all but one sample (0.03 mg/kg in a rainbow trout sample from Pequest Hatchery) were less than or equal to 0.02 mg/kg. Concentrations were higher in wild fish: 0.06-0.07 in Bear Brook brook trout, 0.04-0.05 in Saddle River brown trout, and 0.03-0.04 in Old York River brown trout. Market rainbow trout were 0.02-0.03 mg/kg.

Concentrations in this study are similar or lower than concentrations of trout analyzed in the New Jersey monitoring programs. In the 1992 study (ANSP 1994), 2 rainbow trout from Merrill Creek had mercury concentrations of 0.04 and 0.08 mg/kg, and one specimen from the Rockaway River had a concentration of 0.04. Concentrations of three larger rainbow trout from Merrill Creek Reservoir had concentrations ranging from 0.14-0.24 mg/kg. Four specimens of rainbow trout purchased in markets were analyzed (as trip blanks) in that study, with concentrations of 0.03-0.07 mg/kg. Concentrations of most other specimens of most other species in the 1992 study and subsequent ANSP monitoring studies in New Jersey were higher than the concentrations of the trout analyzed in the present study. USGS (Brightbill, et al. 2004) analyzed mercury in fillets of fish from 35 sites (one fish species per site) in the Delaware River drainage in New York, Pennsylvania and New Jersey. Concentrations in three brown trout samples were 0.03, 0.03 and 0.12 mg/kg. Concentrations in other fish (mostly smallmouth bass, but some largemouth bass, rock bass and chain pickerel) ranged from 0.09-0.35 mg/kg.

Concentrations were lower or similar to those found in other studies of hatchery fish. Broodstock of Atlantic salmon, lake trout and rainbow trout from Federal hatcheries had geometric mean concentrations less than or equal to 0.03 mg/kg., with maxima of 0.07 in Atlantic salmon, 0.04 in lake trout, and less than 0.03 in rainbow trout (Millard, et al. 2004).

The FDA action limit for total mercury is 1 mg/kg, which is much greater than the concentration of any fish in this sample. Other states and agencies, including New Jersey, have developed risk-based action limits, which result in lower limits. These concentrations vary with risk group and define different advised frequencies of consumption. No restrictions are advised for fish with concentrations less than or equal to 0.07 mg/kg. The highest concentration of mercury in this study was 0.07 mg/kg (in two samples of wild brook trout from Bear Creek), so all fish fell below the threshold for consumption advisories.

SUMMARY AND CONCLUSIONS

1) Concentrations of all analytes were lower than applicable FDA consumption limits for all fish.

2) Although low, concentrations of PCBs in all samples were greater than the minimum threshold for consumption advisories under the NJ risk-based action limits.

3) All fish had mercury concentrations less than the threshold for consumption advisories.

4) Relative concentrations of contaminants in Pequest hatchery fish, wild fish, commercial hatchery and market fish varied between contaminants. Concentrations of PCBs were generally similar among samples, with a few higher values found in some wild trout and a few Pequest Hatchery trout samples, and lower values found in some wild trout, a few Pequest Hatchery trout samples, and market rainbow trout. The highest and lowest concentrations of DDX were seen in some of the wild trout, with intermediate concentrations in Pequest hatchery trout. The highest concentrations of chlordanes, heptachlor epoxide, nonachlors, dieldrin and mercury were in wild trout, with lower values in Pequest Hatchery fish. Concentrations of aldrin and BHCs were somewhat higher in Pequest Hatchery fish than in the other fish analyzed. There was no clear pattern in concentrations of endrin, aldrin, lindane, heptachlor and endosulfans. The highest concentrations of some of these were in Pequest Hatchery fish, but this may only reflect the greater number of Pequest Hatchery fish analyzed and analytical variability at very low concentrations.

5) Concentrations of PCBs, DDX, dieldrin, chlordanes, nonachlors, heptachlor, heptachlor epoxide, endosulfans and BHCs were lower than those seen in most wild fish analyzed as part of the New Jersey routine monitoring program. Concentrations of mercury, aldrin and lindane were similar to or less than those found in the routine monitoring program. Endrin was the only analyte found in higher concentrations in this study than in most wild fish from the routine monitoring program.

6) Concentrations of PCBs, DDX, chlordanes, dieldrin and mercury in salmonids from other hatcheries and from farms were generally similar to or somewhat lower than concentrations found in this study.

FIGURES

Figures 1-13. Each figure shows the average and 1 standard error (s.e.) of concentrations of each contaminant or group of contaminants for groups of samples. Names of sample group include the species (rainb= rainbow trout; brown = brown trout; brook= brook trout), source (H = Pequest Hatchery; Comm= Commercial Hatchery; W1 = wild trout from first stream; W2 = wild trout from second stream), season of collection (S= spring; F= fall), and sample preparation type (S = skin on; N = no skin, i.e., trimmed). For rainbow trout, commercial hatchery and market trout are included in the same bar).

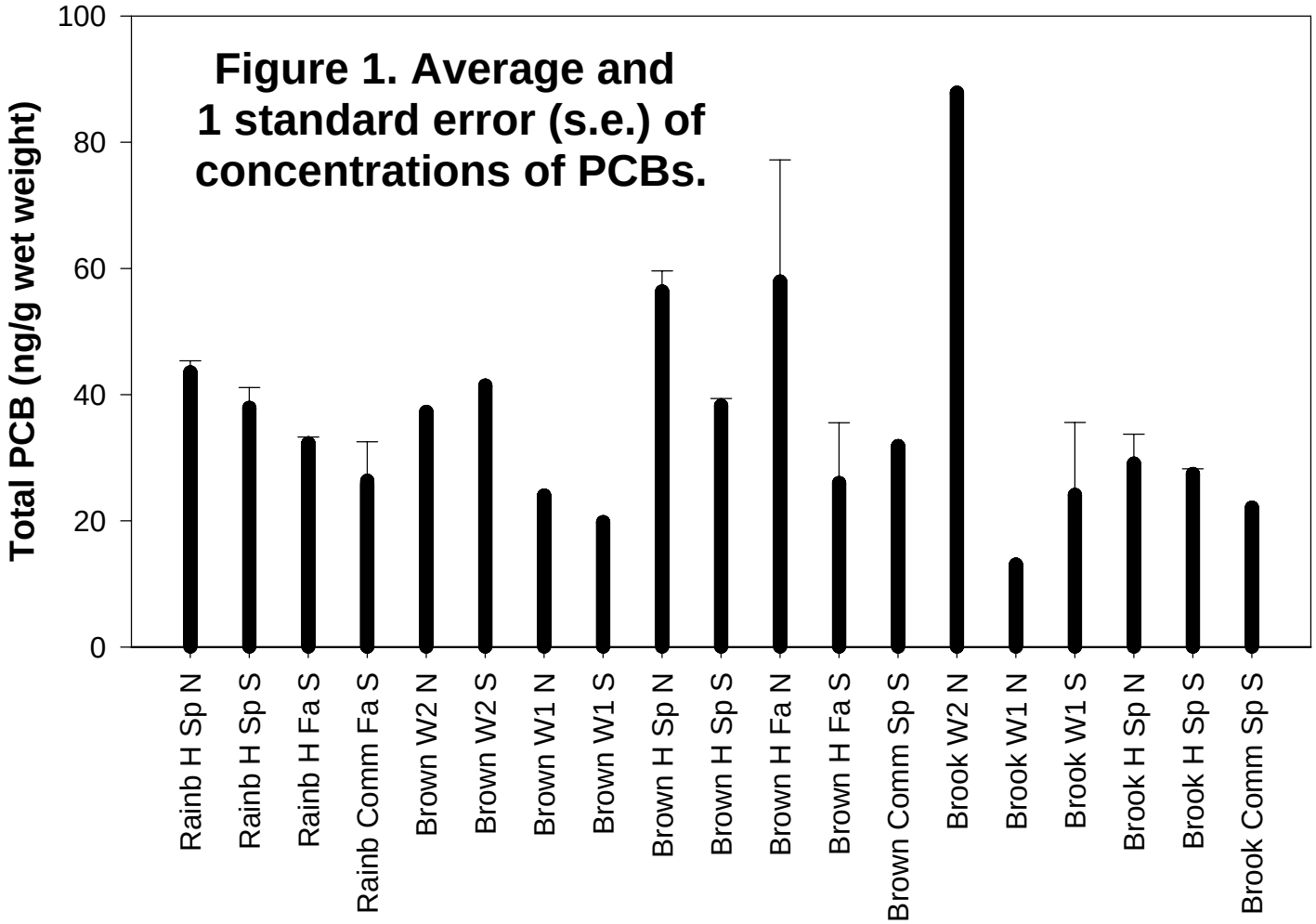


Figure 1. Average and 1 standard error (s.e.) of concentrations of PCBs.
Total PCB (ng/g wet weight)
100
80
60
40
20
0
Rainb H Sp N
Rainb H Sp S
Rainb H Fa S
Rainb Comm Fa S
Brown W2 N
Brown W2 S
Brown W1 N
Brown W1 S
Brown H Sp N
Brown H Sp S
Brown H Fa N
Brown H Fa S
Brown Comm Sp S
Brook W2 N
Brook W1 N
Brook W1 S
Brook H Sp N
Brook H Sp S
Brook Comm Sp S

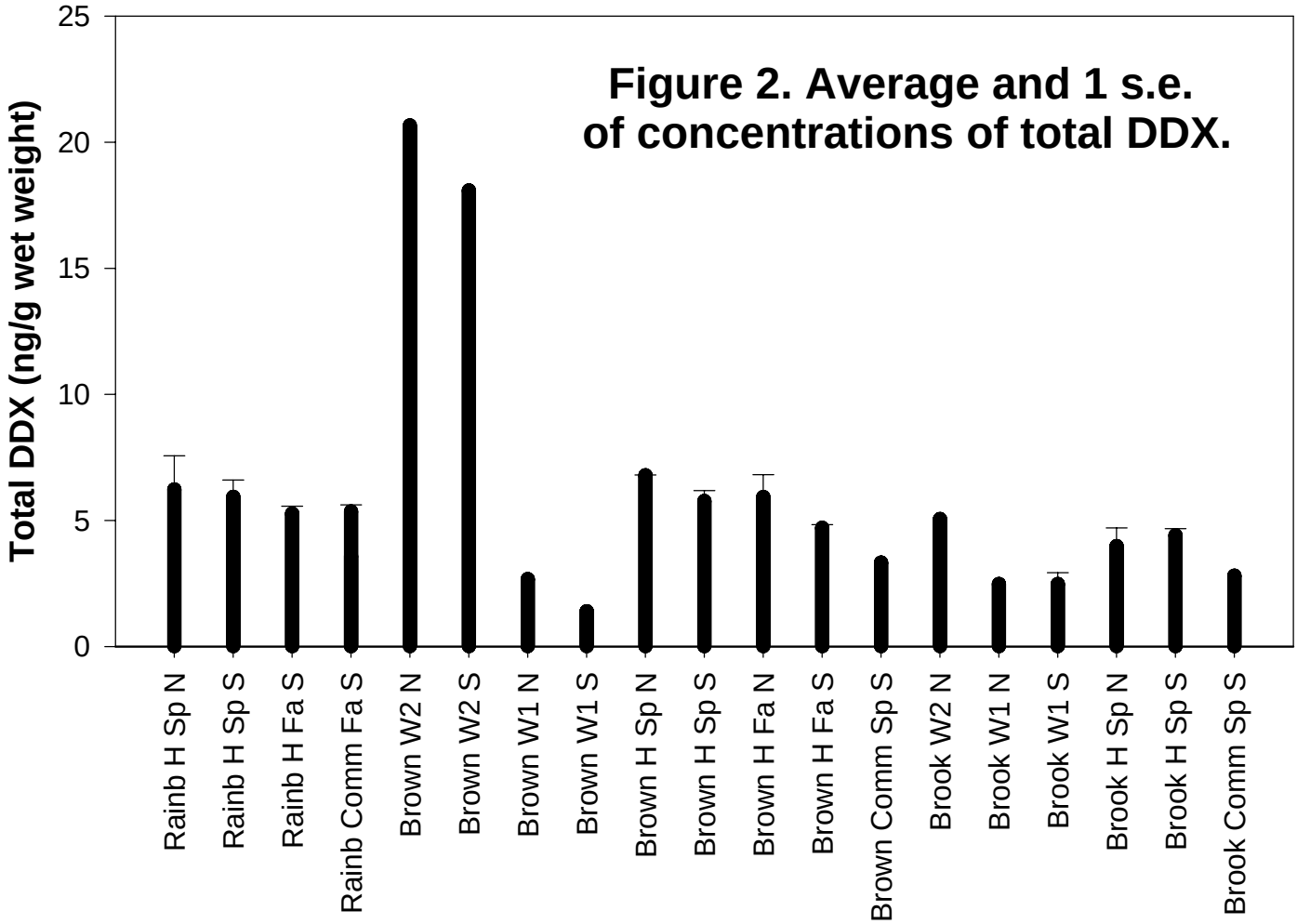


Figure 2. Average and 1 s.e.
of concentrations of total DDX.
Total DDX (ng/g wet weight)
25
20
15
10
5
0
Rainb H Sp N
Rainb H Sp S
Rainb H Fa S
Rainb Comm Fa S
Brown W2 N
Brown W2 S
Brown W1 N
Brown W1 S
Brown H Sp N
Brown H Sp S
Brown H Fa N
Brown H Fa S
Brown Comm Sp S
Brook W2 N
Brook W1 N
Brook W1 S
Brook H Sp N
Brook H Sp S
Brook Comm Sp S

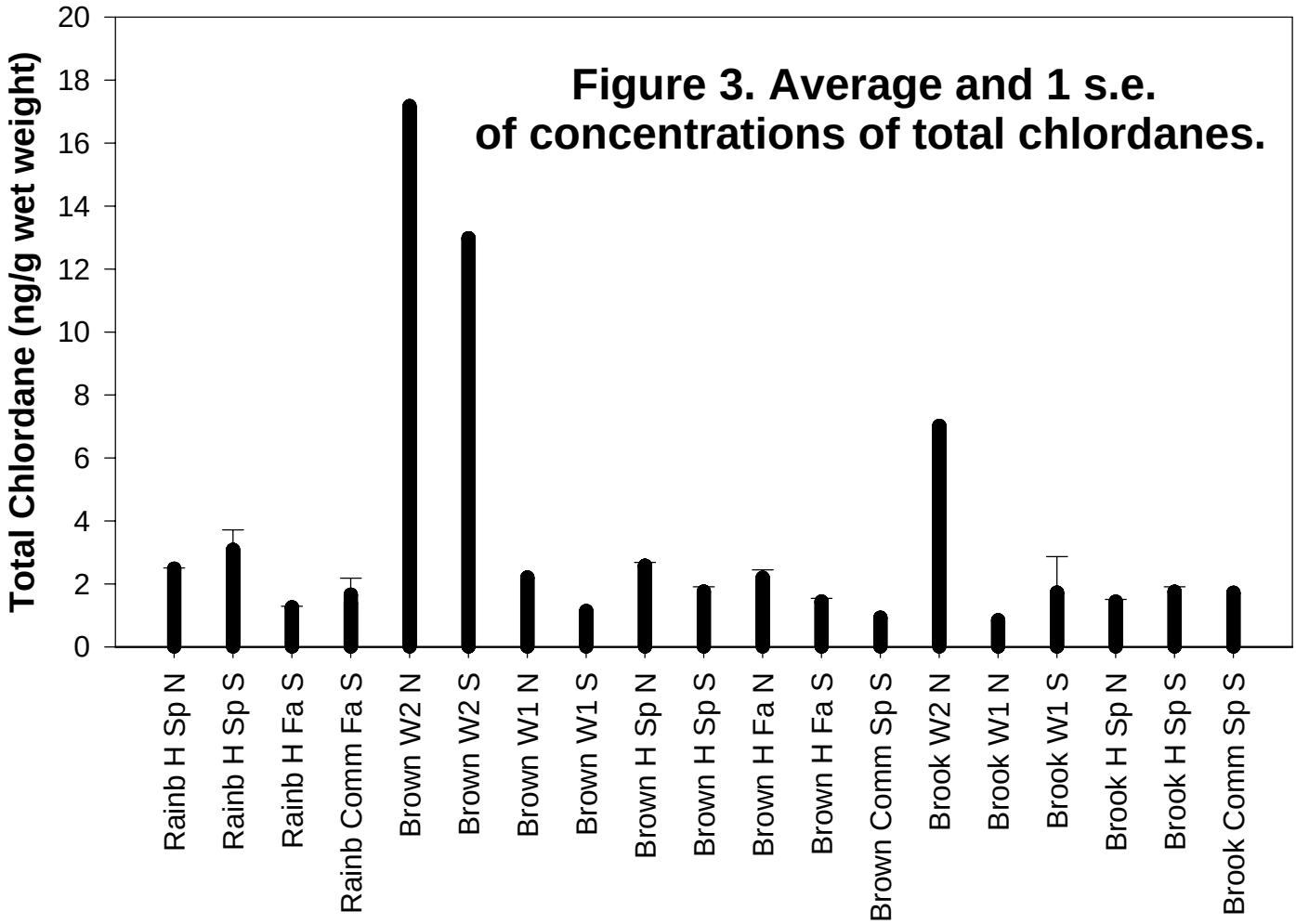


Figure 3. Average and 1 s.e.
of concentrations of total chlordanes.
Total Chlordane (ng/g wet weight)
0
2
4
6
8
10
12
14
16
18
20
Rainb H Sp N
Rainb H Sp S
Rainb H Fa S
Rainb Comm Fa S
Brown W2 N
Brown W2 S
Brown W1 N
Brown W1 S
Brown H Sp N
Brown H Sp S
Brown H Fa N
Brown H Fa S
Brown Comm Sp S
Brook W2 N
Brook W1 N
Brook W1 S
Brook H Sp N
Brook H Sp S
Brook Comm Sp S

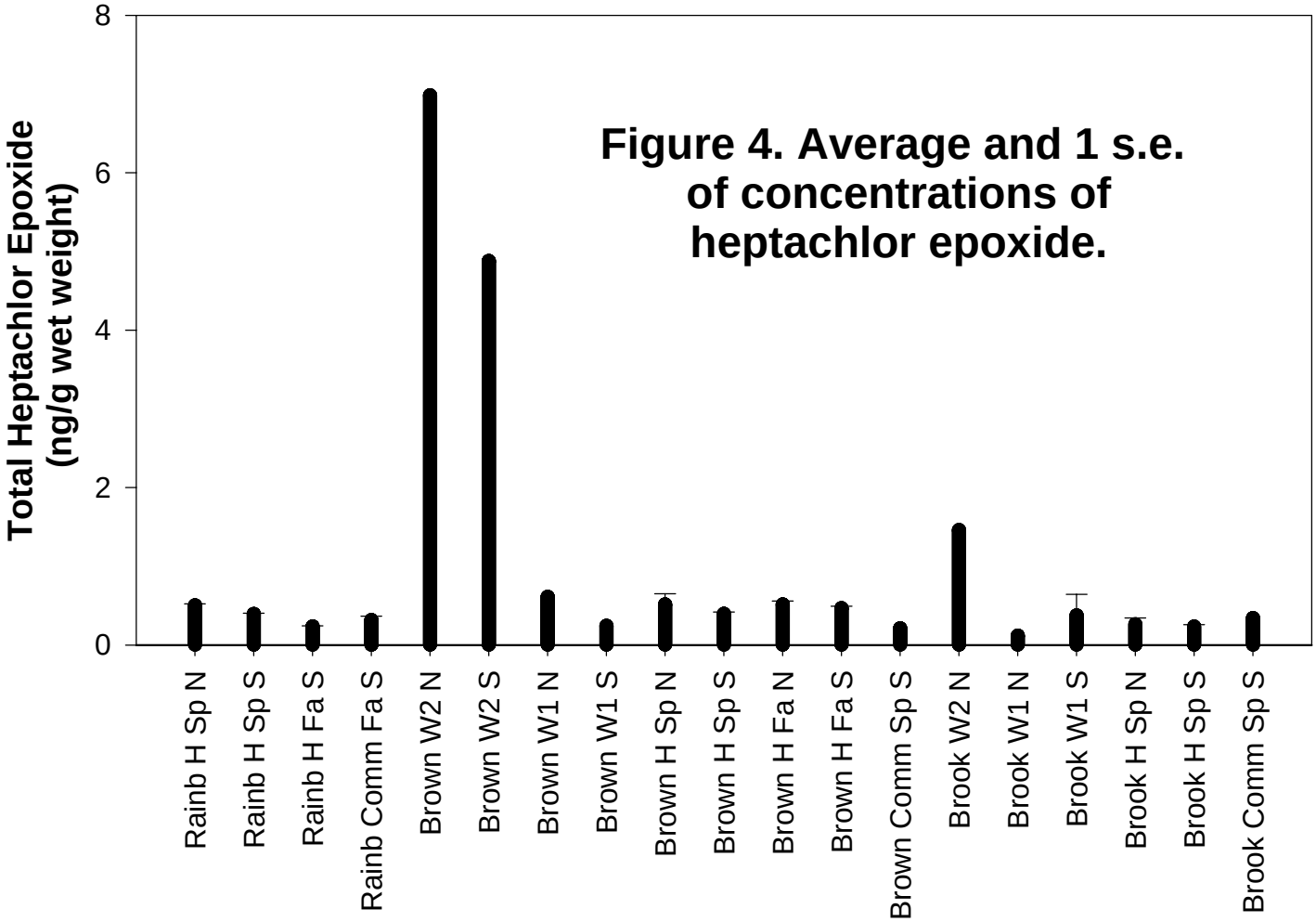


Figure 4. Average and 1 s.e. of concentrations of heptachlor epoxide.

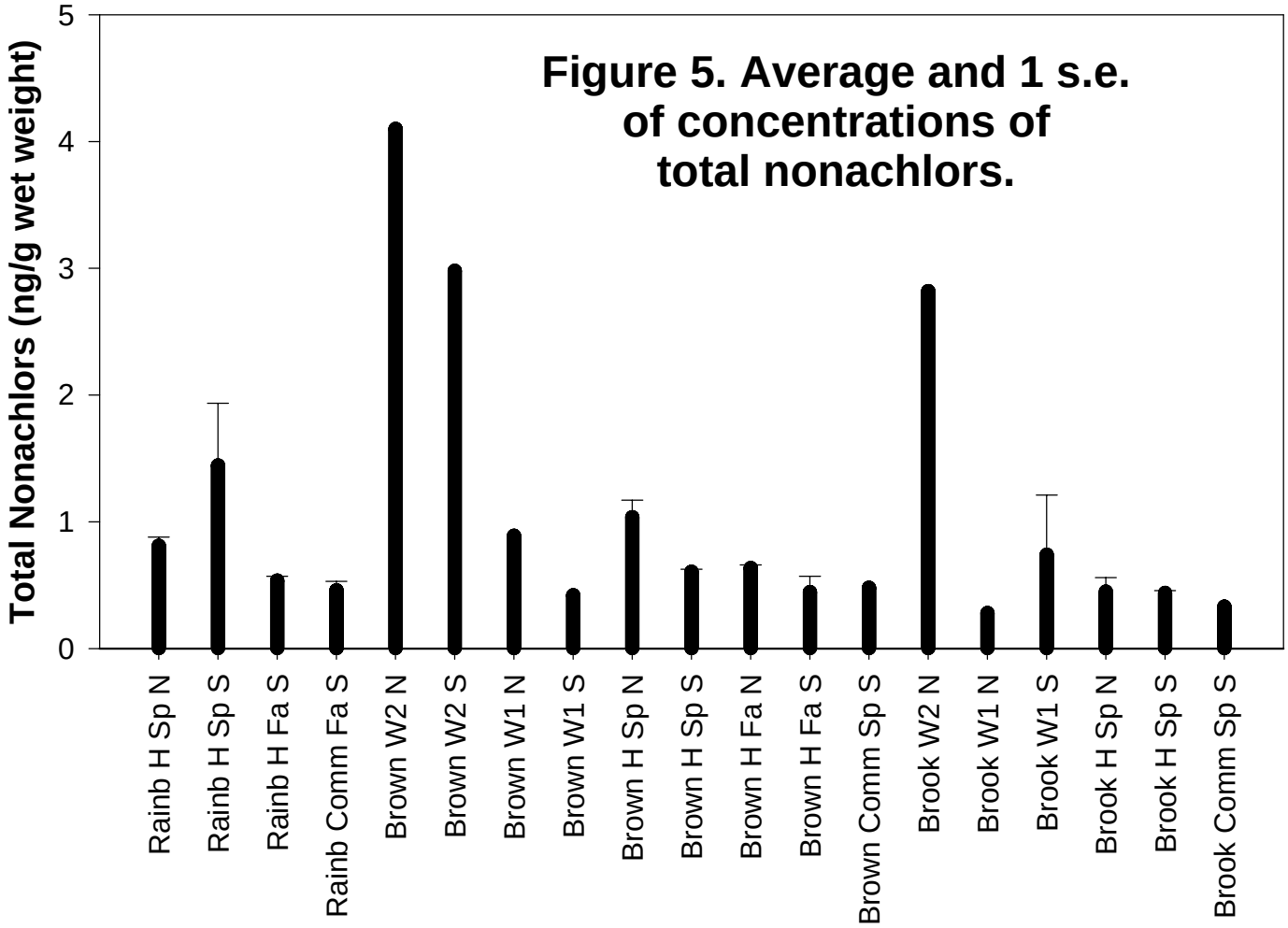


Figure 5. Average and 1 s.e. of concentrations of total nonachlors.
Total Nonachlors (ng/g wet weight)
0
1
2
3
4
5
Rainb H Sp N
Rainb H Sp S
Rainb H Fa S
Rainb Comm Fa S
Brown W2 N
Brown W2 S
Brown W1 N
Brown W1 S
Brown H Sp N
Brown H Sp S
Brown H Fa N
Brown H Fa S
Brown Comm Sp S
Brook W2 N
Brook W1 N
Brook W1 S
Brook H Sp N
Brook H Sp S
Brook Comm Sp S

Figure 6. Average and 1 s.e. of concentrations of dieldrin.

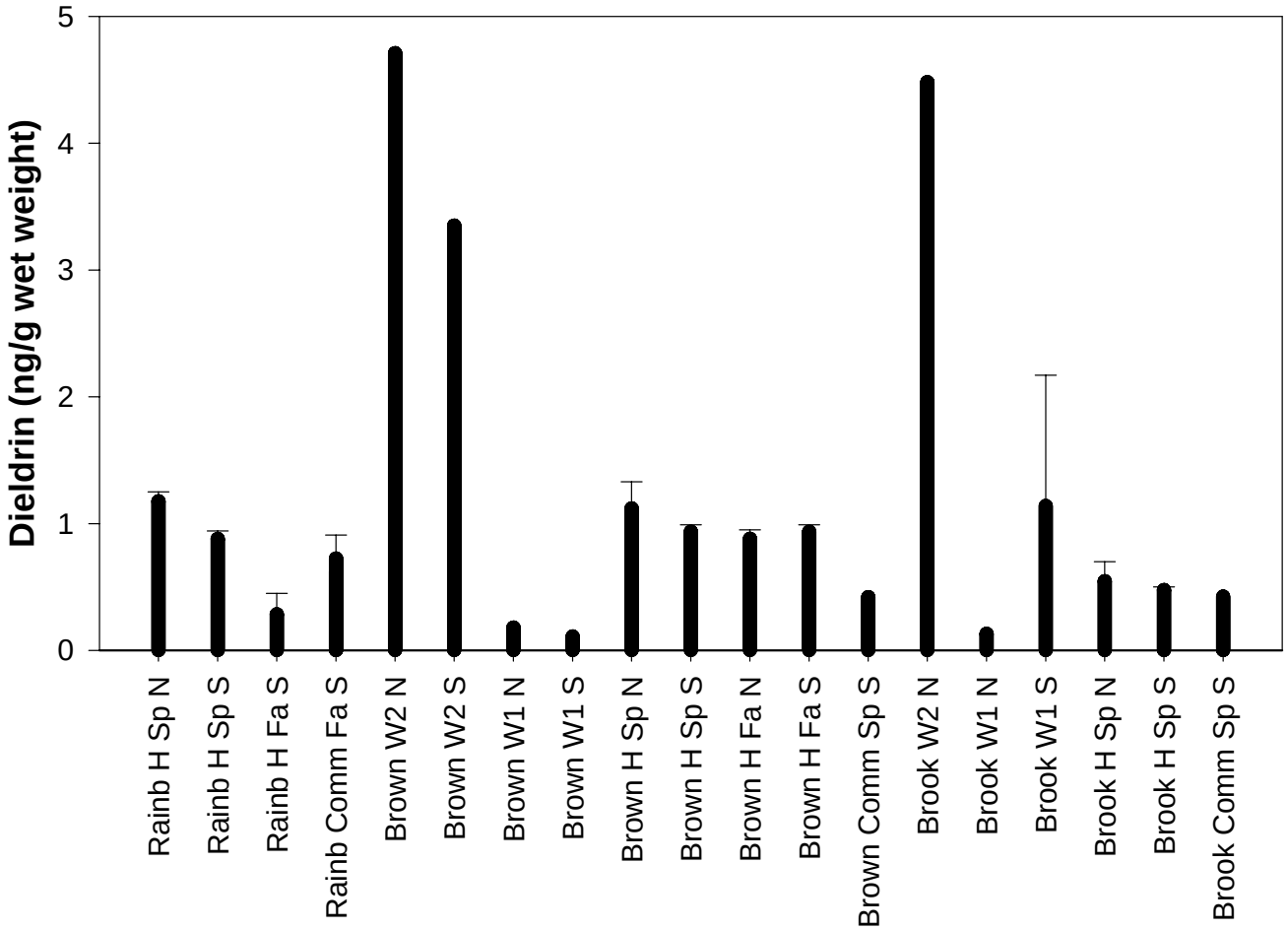
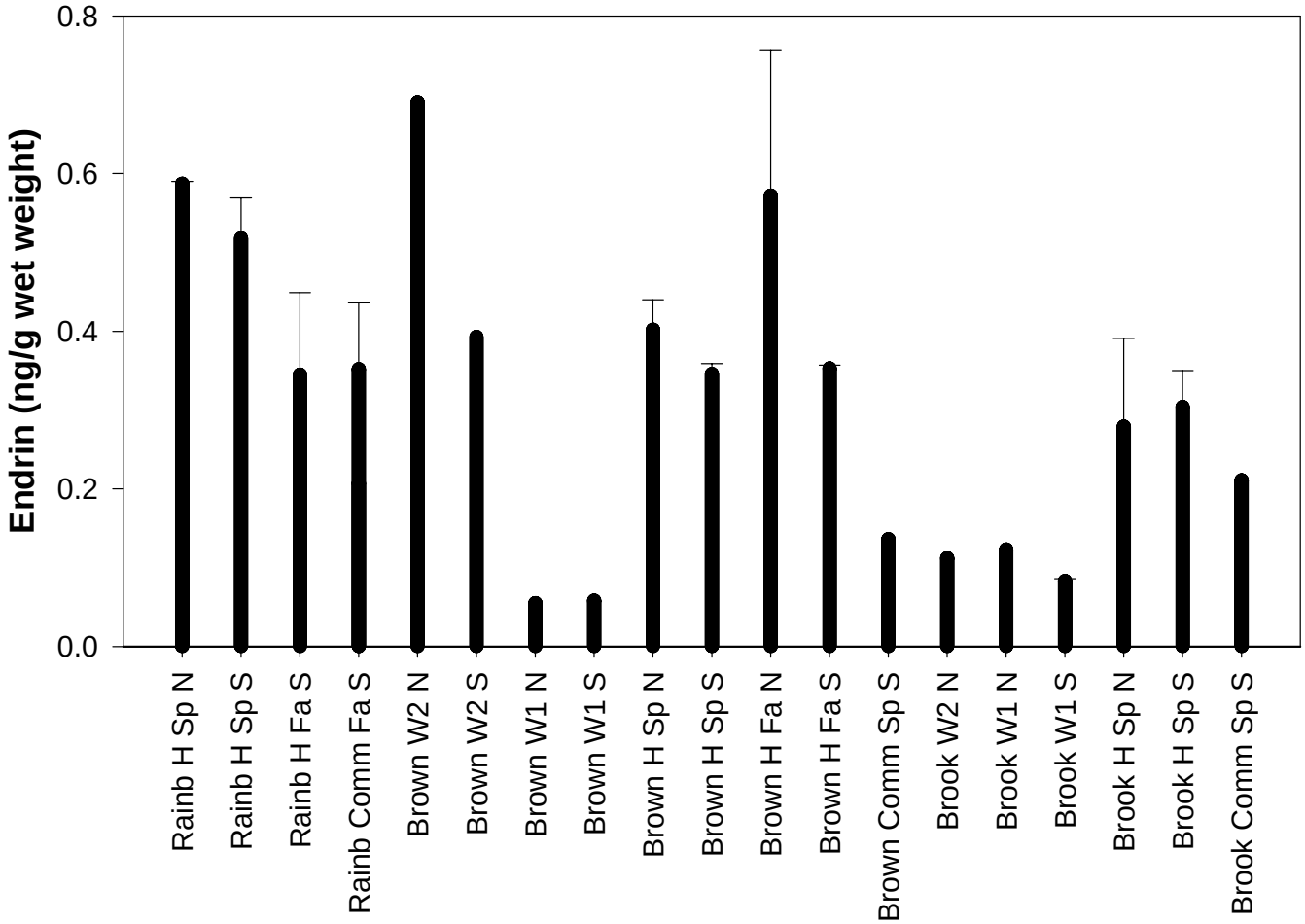


Figure 7. Average and 1 s.e. of concentrations of endrin.



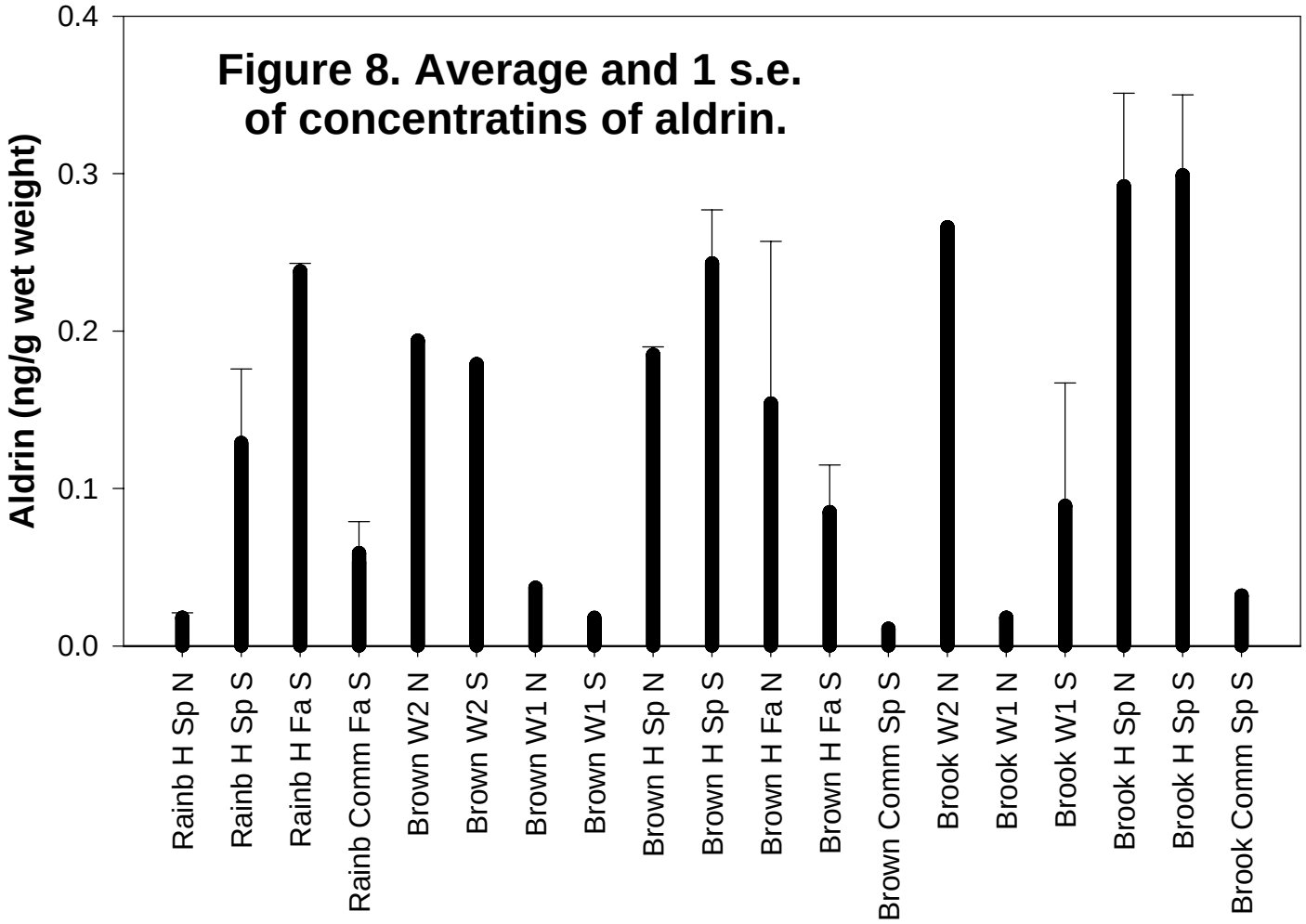


Figure 8. Average and 1 s.e. of concentratins of aldrin.
Aldrin (ng/g wet weight)
0.4
0.3
0.2
0.1
0.0
Rainb H Sp N
Rainb H Sp S
Rainb H Fa S
Rainb Comm Fa S
Brown W2 N
Brown W2 S
Brown W1 N
Brown W1 S
Brown H Sp N
Brown H Sp S
Brown H Fa N
Brown H Fa S
Brown Comm Sp S
Brook W2 N
Brook W1 N
Brook W1 S
Brook H Sp N
Brook H Sp S
Brook Comm Sp S

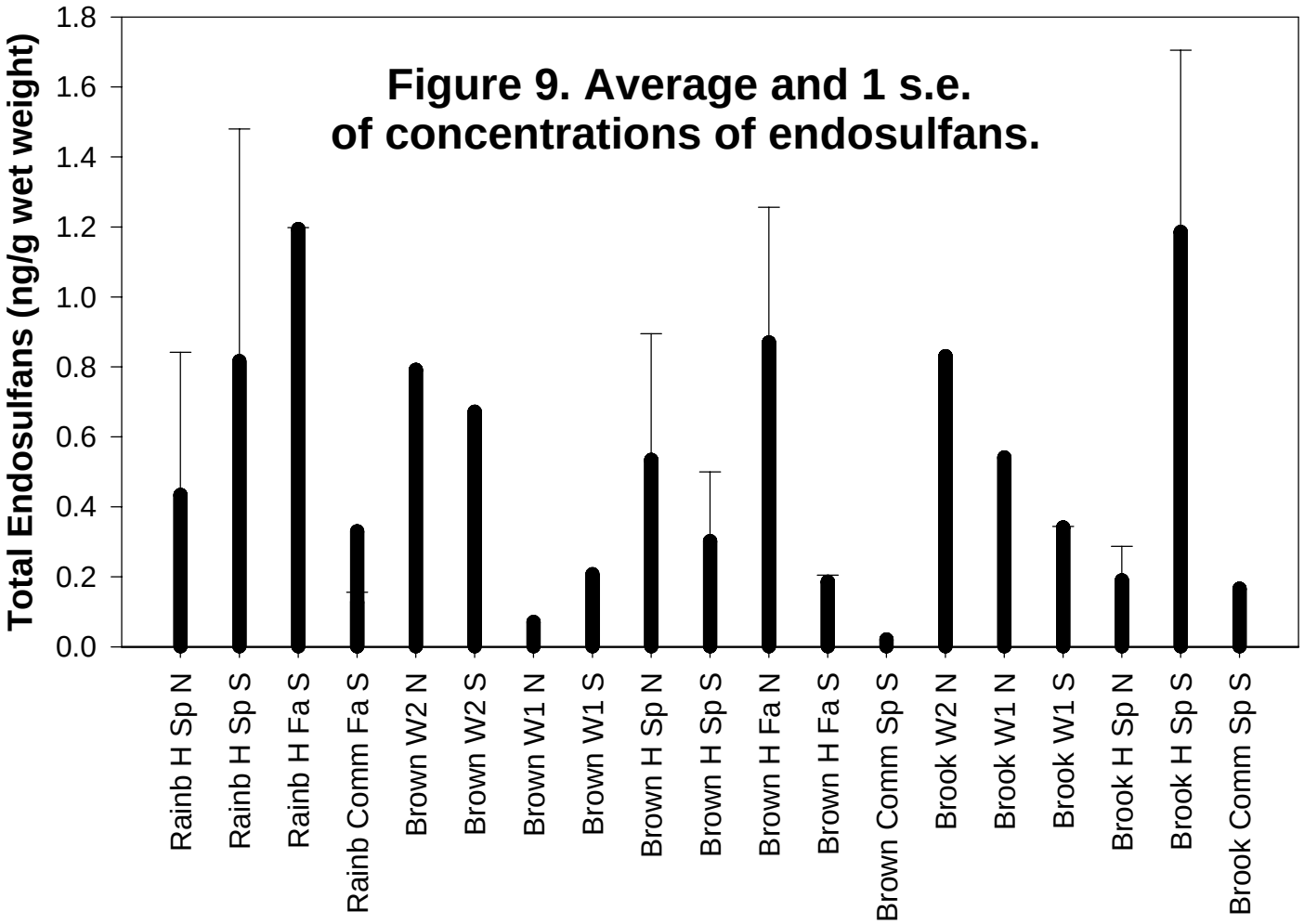


Figure 9. Average and 1 s.e.
of concentrations of endosulfans.
Total Endosulfans (ng/g wet weight)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Rainb H Sp N
Rainb H Sp S
Rainb H Fa S
Rainb Comm Fa S
Brown W2 N
Brown W2 S
Brown W1 N
Brown W1 S
Brown H Sp N
Brown H Sp S
Brown H Fa N
Brown H Fa S
Brown Comm Sp S
Brook W2 N
Brook W1 N
Brook W1 S
Brook H Sp N
Brook H Sp S
Brook Comm Sp S

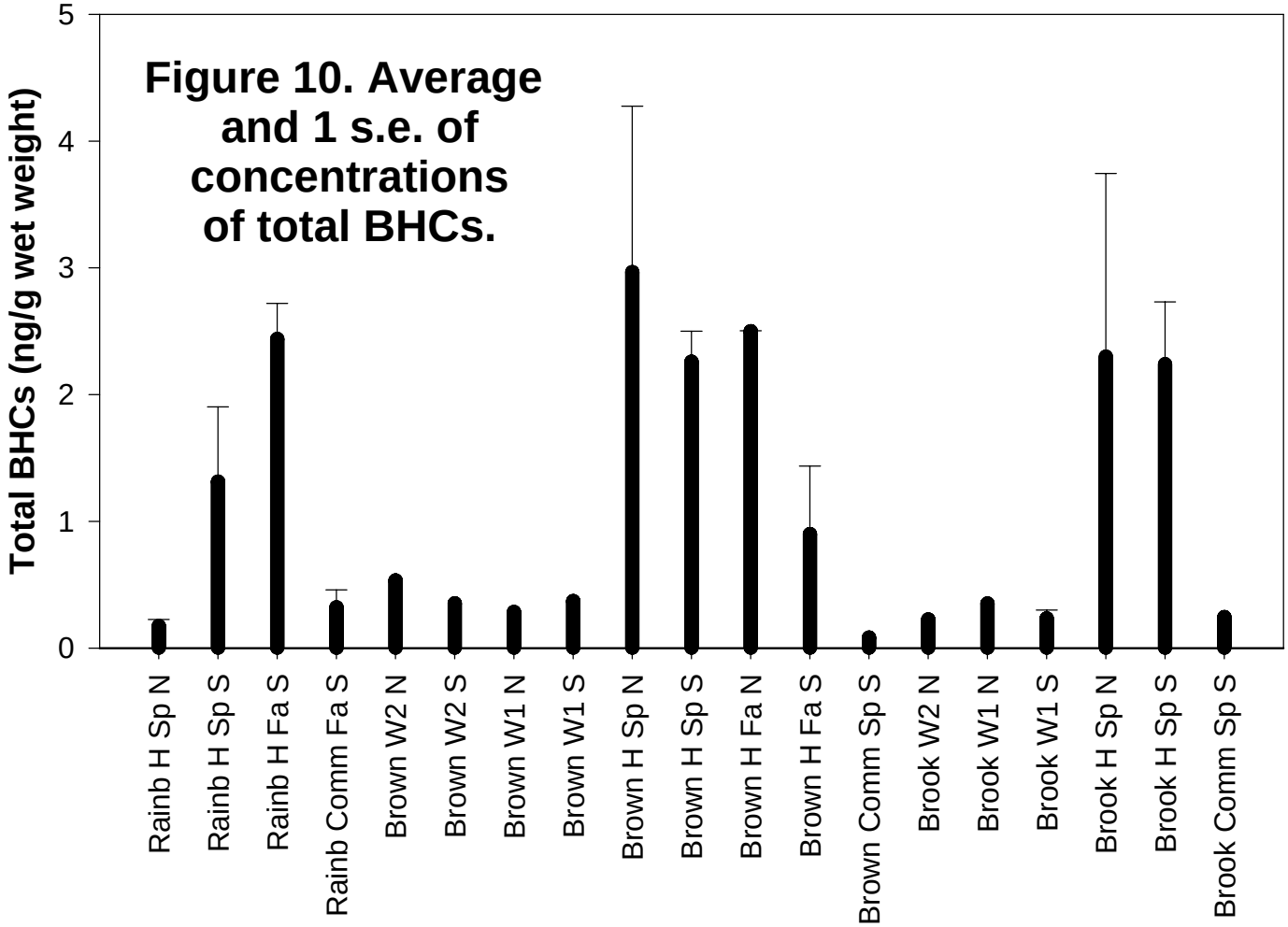


Figure 10. Average and 1 s.e. of concentrations of total BHCs.
Total BHCs (ng/g wet weight)
0
1
2
3
4
5
Rainb H Sp N
Rainb H Sp S
Rainb H Fa S
Rainb Comm Fa S
Brown W2 N
Brown W2 S
Brown W1 N
Brown W1 S
Brown H Sp N
Brown H Sp S
Brown H Fa N
Brown H Fa S
Brown Comm Sp S
Brook W2 N
Brook W1 N
Brook W1 S
Brook H Sp N
Brook H Sp S
Brook Comm Sp S

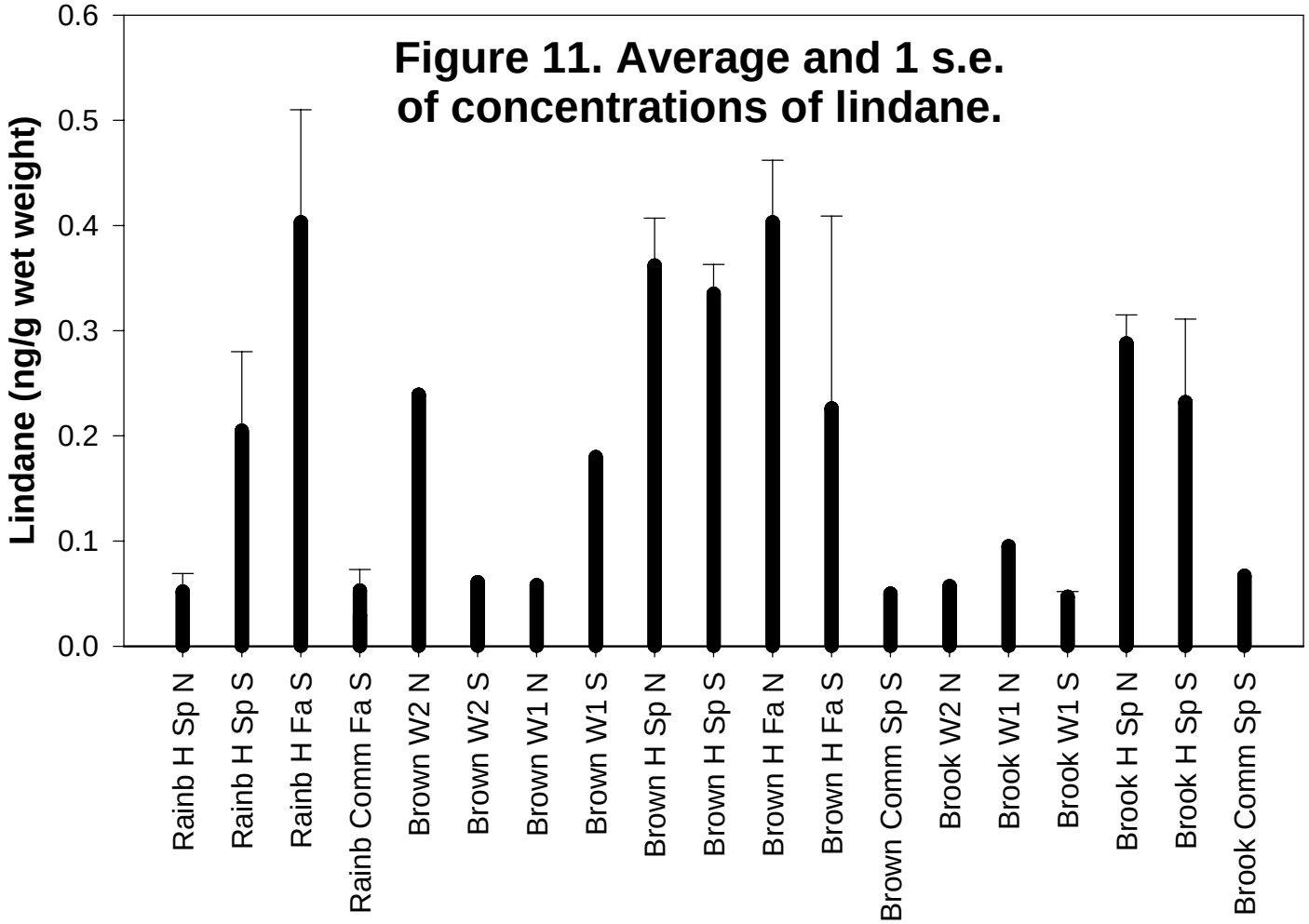


Figure 11. Average and 1 s.e. of concentrations of lindane.
Lindane (ng/g wet weight)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Rainb H Sp N
Rainb H Sp S
Rainb H Fa S
Rainb Comm Fa S
Brown W2 N
Brown W2 S
Brown W1 N
Brown W1 S
Brown H Sp N
Brown H Sp S
Brown H Fa N
Brown H Fa S
Brown Comm Sp S
Brook W2 N
Brook W1 N
Brook W1 S
Brook H Sp N
Brook H Sp S
Brook Comm Sp S

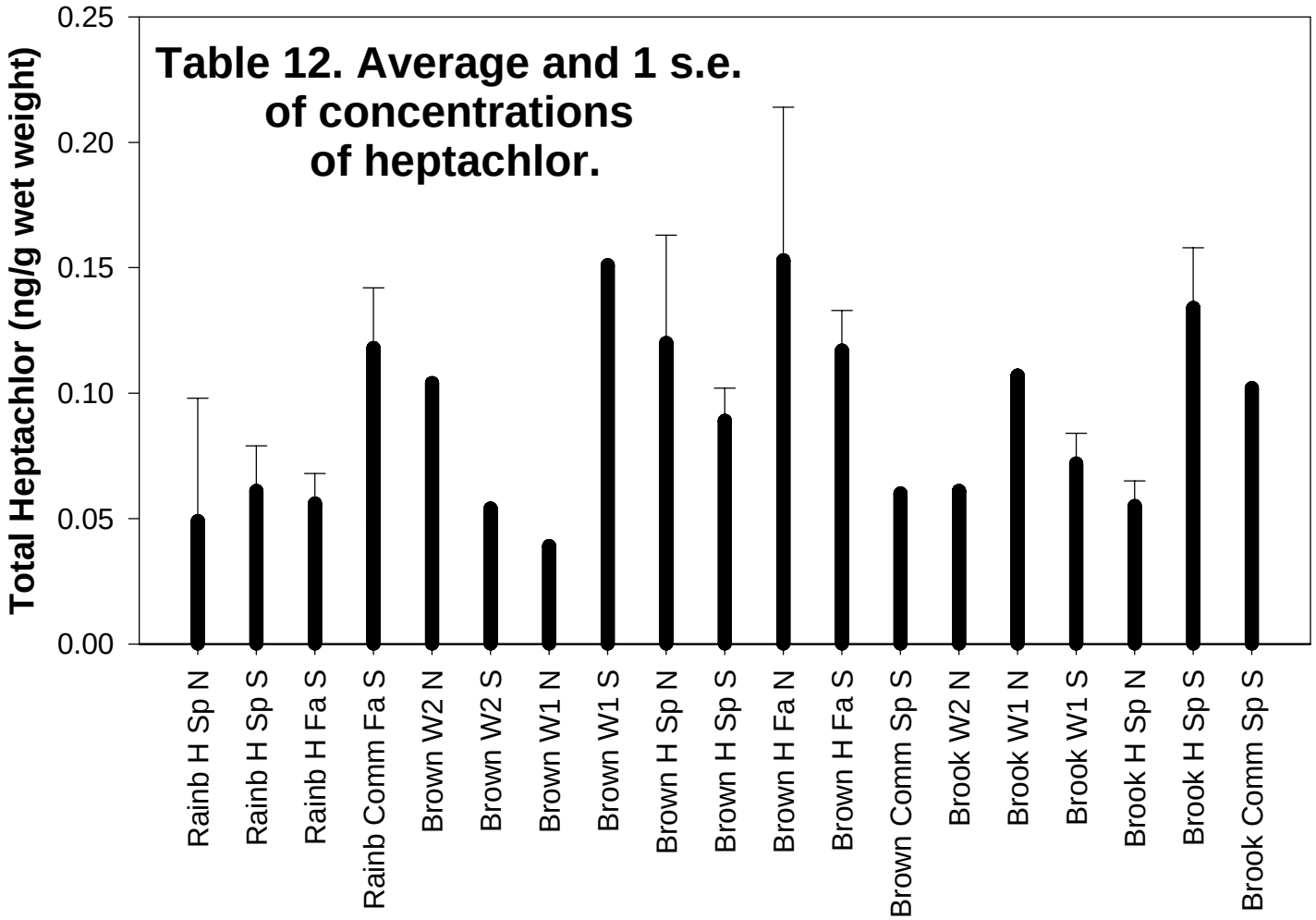


Table 12. Average and 1 s.e. of concentrations of heptachlor.
Total Heptachlor (ng/g wet weight)
0.25
0.20
0.15
0.10
0.05
0.00
Rainb H Sp N
Rainb H Sp S
Rainb H Fa S
Rainb Comm Fa S
Brown W2 N
Brown W2 S
Brown W1 N
Brown W1 S
Brown H Sp N
Brown H Sp S
Brown H Fa N
Brown H Fa S
Brown Comm Sp S
Brook W2 N
Brook W1 N
Brook W1 S
Brook H Sp N
Brook H Sp S
Brook Comm Sp S

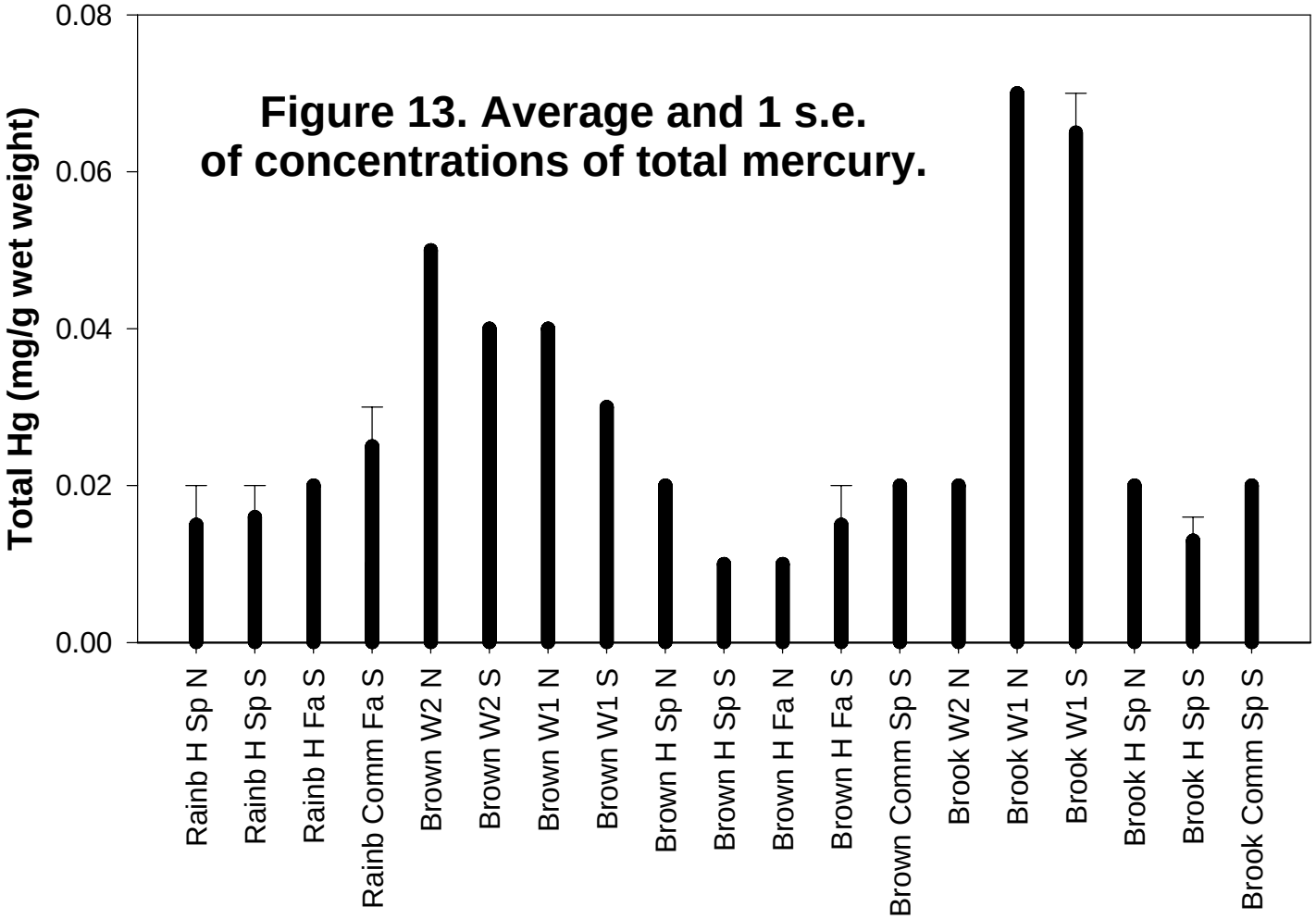


Figure 13. Average and 1 s.e.
of concentrations of total mercury.
Total Hg (mg/g wet weight)
0.08
0.06
0.04
0.02
0.00
Rainb H Sp N
Rainb H Sp S
Rainb H Fa S
Rainb Comm Fa S
Brown W2 N
Brown W2 S
Brown W1 N
Brown W1 S
Brown H Sp N
Brown H Sp S
Brown H Fa N
Brown H Fa S
Brown Comm Sp S
Brook W2 N
Brook W1 N
Brook W1 S
Brook H Sp N
Brook H Sp S
Brook Comm Sp S

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