

**U.S. FISH AND WILDLIFE SERVICE
MAINE FIELD OFFICE
SPECIAL PROJECT REPORT: FY97-MEFO-2-EC**



**ENVIRONMENTAL CONTAMINANTS
IN GOLDEN SHINERS FROM PICNIC POND**

**U.S. NAVAL AIR STATION
BRUNSWICK, MAINE**

January 1999

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**ENVIRONMENTAL CONTAMINANTS
IN GOLDEN SHINERS FROM PICNIC POND**

**U.S. Naval Air Station
Brunswick, Maine**

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EXECUTIVE SUMMARY

On July 25, 1995, the U.S. Fish and Wildlife Service conducted a contaminant survey of fish from Picnic Pond on the U.S. Naval Air Station in Brunswick, Maine (NASB). The 3.5-acre pond is located on the eastern portion of the installation where it receives flow from an unnamed stream. On several occasions in the past, spills from the NASB flight line introduced jet fuel into the unnamed stream. One of the installation's Superfund hazardous waste sites, Site 9 (Neptune Drive Disposal Site), is also located beside the unnamed stream. Consequently, it is possible that aviation fuel or hazardous waste residues in the unnamed stream could also have been deposited into Picnic Pond. The purposes of the Picnic Pond survey were:

- To qualitatively describe the fish resources in the pond, and
- To determine the concentrations of trace elements, organochlorine pesticides, and polychlorinated biphenyls (PCBs) in fish tissue.

Fish were collected from a boom-type electrofishing boat, identified to species, and the length and weight were measured. No common sportfish species such as trout or bass were observed during collections. Only two finfish species were found in the pond, the golden shiner (*Notemigonus crysoleucas*) and, in much lower numbers, the emerald shiner (*Notropis atherinoides*). American eel (*Anguilla rostrata*) were also observed in the pond.

Forty-seven whole-body golden shiners were kept for contaminant analysis and composited into eight samples. The composite samples were analyzed for trace elements at the Midwest Science Center of the National Biological Service¹ and for organochlorine pesticides and polychlorinated biphenyls at ABC Laboratories of Madera, California, a contract laboratory of the National Biological Service.

Contaminant results in Picnic Pond golden shiners were compared to national and regional data reported in the USFWS's National Contaminant Biomonitoring Program (NCBP) and EPA's Environmental Monitoring and Assessment Program (EMAP-Northeast). Most organochlorine and trace element levels in Picnic Pond golden shiners were similar or lower than the values reported in the NCBP and EMAP. Chromium, copper, and lead levels in whole-body golden shiner composite samples from Picnic Pond were slightly elevated compared to these two data sets. The mean zinc concentration was much higher than these national and regional databases, but zinc concentrations in fish tissue generally are not reliable indicators of exposure.

¹ The National Biological Service became the Biological Resources Division of the U.S. Geological Survey in October 1996

PREFACE

This report is the last in a series of three U.S. Fish and Wildlife Service (USFWS) environmental contaminant investigations conducted at the U.S. Naval Air Station in Brunswick (NASB), Maine, for the U.S. Environmental Protection Agency (EPA) and the U.S. Navy. The first two reports, *Toxicity Tests and Sediment Chemistry at Site 9* and *Environmental Contaminants in Fish from Mere Brook*, were submitted in January 1997 and February 1997, respectively. This final report describes the results of a study to measure trace element and organochlorine contaminants in golden shiners collected from Picnic Pond at NASB. Funding for this study was provided by Region 1 of the U.S. Environmental Protection Agency and the U.S. Navy. The analytical work for this study was performed under U.S. Navy Military Interdepartmental Purchase Request Number V0006095MIPR0013 and within an interagency agreement between the U.S. Fish and Wildlife Service (USFWS) and EPA for technical assistance in the Superfund Program (# DW-14934248-01-B).

Questions and comments to this report are encouraged. Written inquiries should be sent to:

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The USFWS requests that no part of this report be taken out of context, and if reproduced, the document should appear in its entirety.

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INTRODUCTION

Picnic Pond is a small pond located in the southeast quadrant of the U.S. Naval Air Station in Brunswick (NASB), Maine. Prior to this study, the Navy had no information on the fish species composition in Picnic Pond. There was also a concern that fish in the pond may have been exposed to contaminants. On several occasions in the past, spills from the NASB flight line introduced jet fuel into an unnamed stream that drains into the pond. One of the installation's Superfund hazardous waste sites, Site 9 (Neptune Drive Disposal Site), is also located beside the unnamed stream. Consequently, it is possible that aviation fuel or hazardous waste residues in the unnamed stream could also have been deposited into Picnic Pond. At the request of the U.S. Navy and with support from the Environmental Protection Agency, the U.S. Fish and Wildlife Service conducted a fishery stock assessment and contaminant survey of Picnic Pond.

STUDY PURPOSES

- To qualitatively describe the fish resources in Picnic Pond and,
- To determine the concentrations of trace elements, organochlorine pesticides, and polychlorinated biphenyls in Picnic Pond fish.

STUDY AREA

The study was conducted at the U.S. Naval Air Station in Brunswick, Cumberland County, Maine (Figure 1). NASB is in the village of Brunswick approximately 3.2 kilometers (2 mi.) east of the Town of Brunswick. Brunswick is located in southern Maine, approximately 42 kilometers (26 mi.) northeast of Portland, Maine's largest city.

Picnic Pond is a shallow, 1.5 hectare (-3.7 ac.) pond with an average depth of about 1.5 meter (-5 ft.) and maximum depth of approximately 3.6 meters (-12 ft., Figure 2). The pond is located in the southeast section of NASB.

METHODS

Field - Fish were collected in Picnic Pond from a boom-type electrofishing boat on July 25, 1995. Four electrofishing runs, each approximately 10 minutes in duration, were performed. American eel (*Anguilla rostrata*), golden shiner (*Notemigonus crysoleucas*), emerald shiner (*Notropis atherinoides*), red-spotted newt (*Notophthalmus viridescens*), green frog (*Rana clamitans*), and eastern painted turtle (*Chrysemys picta*) were observed during electrofishing. Water quality parameters were also measured with a Hydrolab Datasonde (Table 1). Forty-seven golden shiners were collected and processed for contaminant analyses. Prior to processing, each fish was examined for external abnormalities. No abnormalities were observed. The maximum total length in centimeters

and total weight to the nearest gram were measured for each fish (Table 2). To meet the minimum weight for chemical analyses, whole-body golden shiners were composited into eight samples (Table 2). Each composite sample was wrapped in aluminum foil, labeled, and double-bagged in plastic freezer bags. The samples were immediately placed in coolers filled with dry ice and stored overnight at -20° C in a locked freezer until shipped the following day to the NBS Midwest Science Center.

Analytical - All samples were analyzed for twenty organochlorine pesticides, seven polychlorinated biphenyls (Aroclors) and thirteen trace elements. Moisture and lipid content were also measured. Trace element analyses were performed at the Midwest Science Center of the National Biological Service in Columbia, MO (Appendix A). Organochlorine pesticide and PCB analyses were conducted by ABC Laboratories of Madera, CA (Appendix B), a contract laboratory of the Midwest Science Center. Analytical methods of the Midwest Science Center and ABC Laboratories are included in the appendices. Quality assurance was accomplished through the use of spike recoveries, and the analysis of duplicate samples, reagent blanks, and reference materials.

Data Presentations - Concentrations reported in this report are in µg/g (ppm, parts-per-million), **wet weight**. Trace element analytical results were reported by the Midwest Science Center in µg/g (ppm), **dry weight**. To facilitate comparisons with other data sets, the trace element analytical results were converted from dry weight to wet weight using the following formula:

$$\text{Concentration}_{\text{wet weight}} = (\text{Concentration}_{\text{dry weight}}) * (1 - (\% \text{ moisture}/100))$$

The organochlorine analytical results from ABC Laboratories were reported in wet weight and no moisture conversions were necessary. The ABC Laboratories results, however, were reported in µk/kg (ppb, parts-per-billion) and we converted to µg/g (ppm) for consistency and to facilitate comparisons with other data sets.

RESULTS

Fish Assemblages - Only two finfish species were captured in Picnic Pond, the golden shiner and, in much fewer numbers, the emerald shiner. Although none were captured during collections, American eel were also observed in the pond. No predator species or bottom feeders were observed during electrofishing. Golden and emerald shiners are popular baitfish used by anglers. Emerald shiners are not indigenous to the area and were likely introduced illegally to Maine as baitfish in the 1970s (Kircheis 1994). One explanation for the low fish species diversity in Picnic Pond is the sporadic draining of the pond in the late 1980s and at least twice in the 1990s. According to NASB personnel (Jim Caruthers, US Navy. 1995. Personal communication; Kari Schenck, US Navy. 1999. Personal communication), Picnic Pond was nearly completely drained after the pond's water control structure failed following flooding events. New features were recently added to the water control design to maintain the structure's integrity during flooding.

Trace Elements - Fish samples were analyzed for arsenic, beryllium, cadmium, chromium, copper, mercury, nickel, lead, antimony, selenium, strontium, vanadium, and zinc. The results of arsenic, cadmium, chromium, copper, mercury, nickel, lead, selenium, and zinc are listed and summarized in [Figures 3 and 4, and Table 3](#). In New England, fish tissue concentrations of beryllium, antimony, strontium, and vanadium are generally not evaluated as ecological contaminants of concern. The reason, in part, is because relatively little information exists to evaluate the potential toxic effects of these contaminants in fish tissue. Consequently, it is not known if the concentrations of these trace elements detected in Picnic Pond fish are low or high, or if these contaminants are likely to cause toxic effects in fish or pose a risk to piscivorous wildlife. These elements are not discussed in this report, although the analytical results are included in [Appendix A](#).

Among the eight composite samples of whole-body golden shiners from Picnic Pond, there is relatively little variation in concentrations of arsenic (geometric mean (GM) 0.04 µg/g, range: 0.03 to 0.06 µg/g), cadmium (GM 0.04 µg/g, range: 0.03 - 0.05 µg/g), mercury (GM 0.06 µg/g, range: 0.05 - 0.09 µg/g), and selenium (GM 0.37 µg/g, range: 0.33 - 0.43 µg/g). Nickel concentrations are highly variable. Nickel was not detected three samples. In the remaining five samples, detectable concentrations of nickel range from 0.06 µg/g to 0.18 µg/g. Similarly, there is considerable variation among golden shiner composite samples for chromium (GM 0.40 µg/g, range: 0.23 - 1.03 µg/g), copper (GM 1.02 µg/g, range: 0.62 - 3.00 µg/g), lead (GM 0.19 µg/g, range: 0.13 - 0.42 µg/g), and zinc (GM 49.2 µg/g, range: 35.5 - 55.9 µg/g).

Organochlorines - Fish samples were analyzed for *alpha*-BHC (hexachlorocyclohexane), *beta*-BHC, *gamma*-BHC (lindane), *delta*-BHC, heptachlor, heptachlor epoxide, *alpha*-chlordane, *gamma* chlordane, chlordane, toxaphene, endosulfan I, endosulfan II, endosulfan sulfate, aldrin, dieldrin, endrin, endrin aldehyde, endrin ketone, methoxychlor, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, and Aroclor 1260.

The only organochlorines detected in Picnic Pond fish samples were 4,4'-DDD and 4,4'-DDE. The DDT metabolite results are depicted in [Figure 5](#) and summarized in [Table 5](#). 4,4'-DDD ranged from 0.022 µg/g to 0.040 µg/g (GM 0.030 µg/g), while the geometric mean 4,4'-DDE concentration is 0.020 µg/g (range: 0.014 - 0.027 µg/g).

DISCUSSION

In [Table 3](#), contaminant concentrations in whole-body golden shiner composite samples are compared to national levels reported in the U.S. Fish and Wildlife Service's National Contaminant Biomonitoring Program (NCBP; Schmitt and Brumbaugh 1990, Schmitt *et al.* 1990) and regional levels reported in the Environmental Monitoring and Assessment Program (EMAP; Yearley *et al.* 1998).

The NCBP tracks temporal and geographic trends in trace element and organochlorine concentrations in composite samples of whole fish collected from 112 riverine stations throughout the United States.

The most recent results of the NCBP included fish collected in 1984. We used these results for comparative purposes and recognize the limitations of the NCBP data set. The geometric mean and 85th percentile concentrations reported in the NCBP have no regulatory significance or meaning with respect to potential hazards to fishery resources (May and McKinney 1981), but serve as reference points to distinguish elevated contaminant concentrations in fish.

Trace element results are also compared in [Table 3](#) against results reported in EPA's Environmental Monitoring and Assessment Program (EMAP). The EMAP whole fish results for 167 lakes in the northeastern portion of the United States (New England states, New York, New Jersey) were recently reported by Yeardeley *et al.* (1998). In the northeastern EMAP, between 1992 and 1994, six species of warm-water fish (e.g., largemouth bass, yellow perch) and five species of cold-water fish (e.g., brook trout, brown trout) were collected throughout the region and analyzed for 11 trace elements.

Our comparison of composite whole-body golden shiner samples with NCBP and EMAP data has considerable limitations. Ideally, contaminant levels in fish from similar trophic levels and size ranges are compared. Larger, older fish species from the highest trophic levels have the greatest concentrations of contaminants that bioaccumulate or biomagnify. Picnic Pond did not contain predator fish. We had no alternative than to compare contaminant concentrations in a forage fish species (i.e., golden shiner) with the predator and bottom-feeding fish species data collected in the NCBP or EMAP.

Trace elements - In general, whole-body golden shiner composite samples from Picnic Pond do not have elevated concentrations of trace elements. Compared to the NCBP or EMAP, fish tissue samples from Picnic Pond have slightly higher levels of cadmium, chromium, copper, and lead. The mean nickel level in whole-body golden shiners is higher than the EMAP concentration, but the nickel results are inconclusive, with detections ranging from non-detect to 0.18 µg/g.

The mean zinc level in Picnic Pond golden shiner composite samples (49.2 µg/g) is more than twice as high as the NCBP geometric mean (21.7 µg/g) and the EMAP mean (21.1 µg/g). The zinc level in Picnic Pond fish, however, is not alarmingly high. Zinc is an essential element for vertebrates. Generally, zinc is efficiently regulated by wildlife and tissue concentrations are not reliable indicators of exposure (Beyer and Storm 1995). Spry *et al.* (1988) found no toxic effects in rainbow trout from exposure to high dietary and waterborne concentrations of zinc based on growth, mortality, major plasma ions, hematocrit, or plasma protein. However, Eisler (1993) reported that elevated concentrations of waterborne zinc have adverse effects on growth, survival, behavior, and reproduction of sensitive fish, with early life stages being the most sensitive.

Although the Picnic Pond mean zinc level in tissue is higher than the NCBP and EMAP means, the mean level is not highly unusual. Citing several sources, Murphy *et al.* (1978) reported average zinc whole fish concentrations from uncontaminated areas ranging from 12 µg/g to 43 µg/g. The range of zinc concentrations in Picnic Pond whole-body golden shiner composite samples is 35.5 µg/g to 55.9 µg/g.

Organochlorine pesticides and PCBs - Of the twenty organochlorines included in the analytical scan, only two DDT metabolites were detected in whole-body golden shiner samples from Picnic Pond, 4,4'-DDD and 4,4'-DDE. No other organochlorine pesticides or polychlorinated biphenyl Aroclors were detected in composite samples.

Although banned in the United States since 1972 (EPA 1990), DDT metabolites continue to be detected in biological tissue. DDD, DDE and Σ DDT levels detected in Picnic Pond composite samples are well below the mean concentrations reported in the NCBP (Table 3). New York State has proposed a fish flesh Σ DDT concentration of 0.2 $\mu\text{g/g}$ to protect piscivorous birds (Newell *et al.* 1987). We do not consider the DDT metabolites a potential risk to ecological receptors. The mean Σ DDT level in whole-body golden shiners from Picnic Pond are lower than the NCBP geometric mean or the NYS piscivorous bird protection criterion.

SUMMARY

- Picnic Pond does not contain a diverse assemblage of finfish species. Only golden shiner and, to a lesser extent, emerald shiner were observed in the pond. American eel were also observed in the pond.
- Most mean trace element concentrations in Picnic Pond whole-body golden shiner composite samples were not highly elevated compared to the USFWS's National Contaminant Monitoring Program or EPA's Environmental Monitoring and Assessment Program. Zinc concentrations in Picnic Pond golden shiner were elevated compared to the NCBP and EMAP, but tissue levels are not reliable indicators of zinc exposure.
- Organochlorine pesticide contaminant concentrations in Picnic Pond whole-body golden shiner composite samples were lower than levels reported in the NCBP.
- PCBs were not detected in Picnic Pond golden shiners.

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FIGURES

Figure 1. USGS Quadrangle, Brunswick, Maine 1:24,000



Picnic Pond

Figure 2. Depth map of Picnic Pond (soundings in feet)

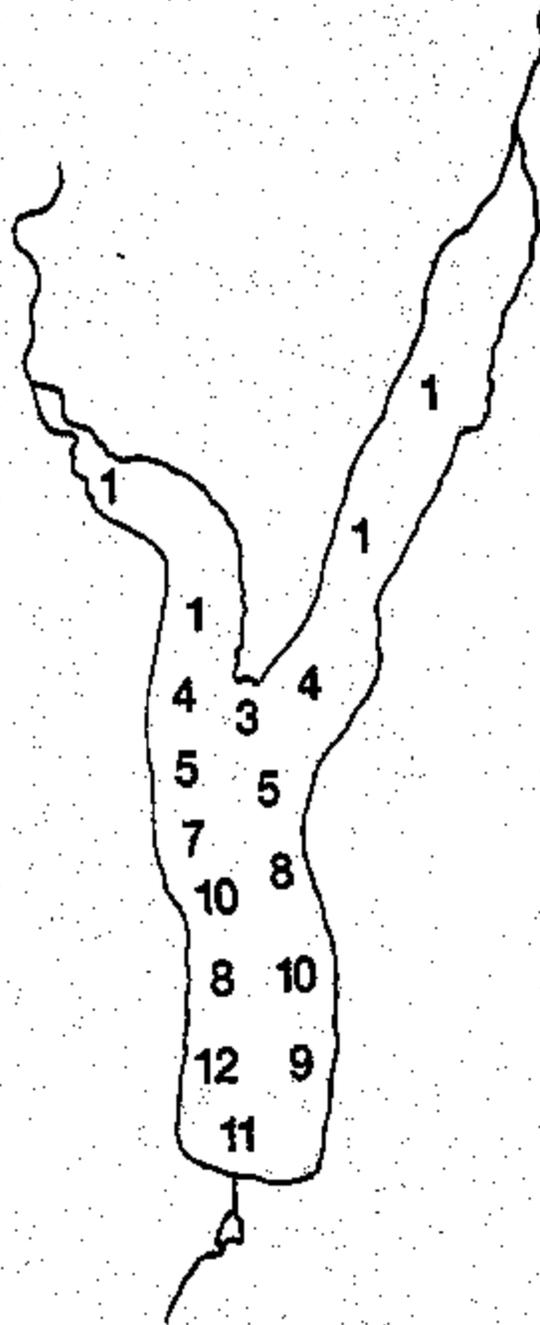


Figure 3. Trace elements in wholebody golden shiners from Picnic Pond compared EMAP and NCBP

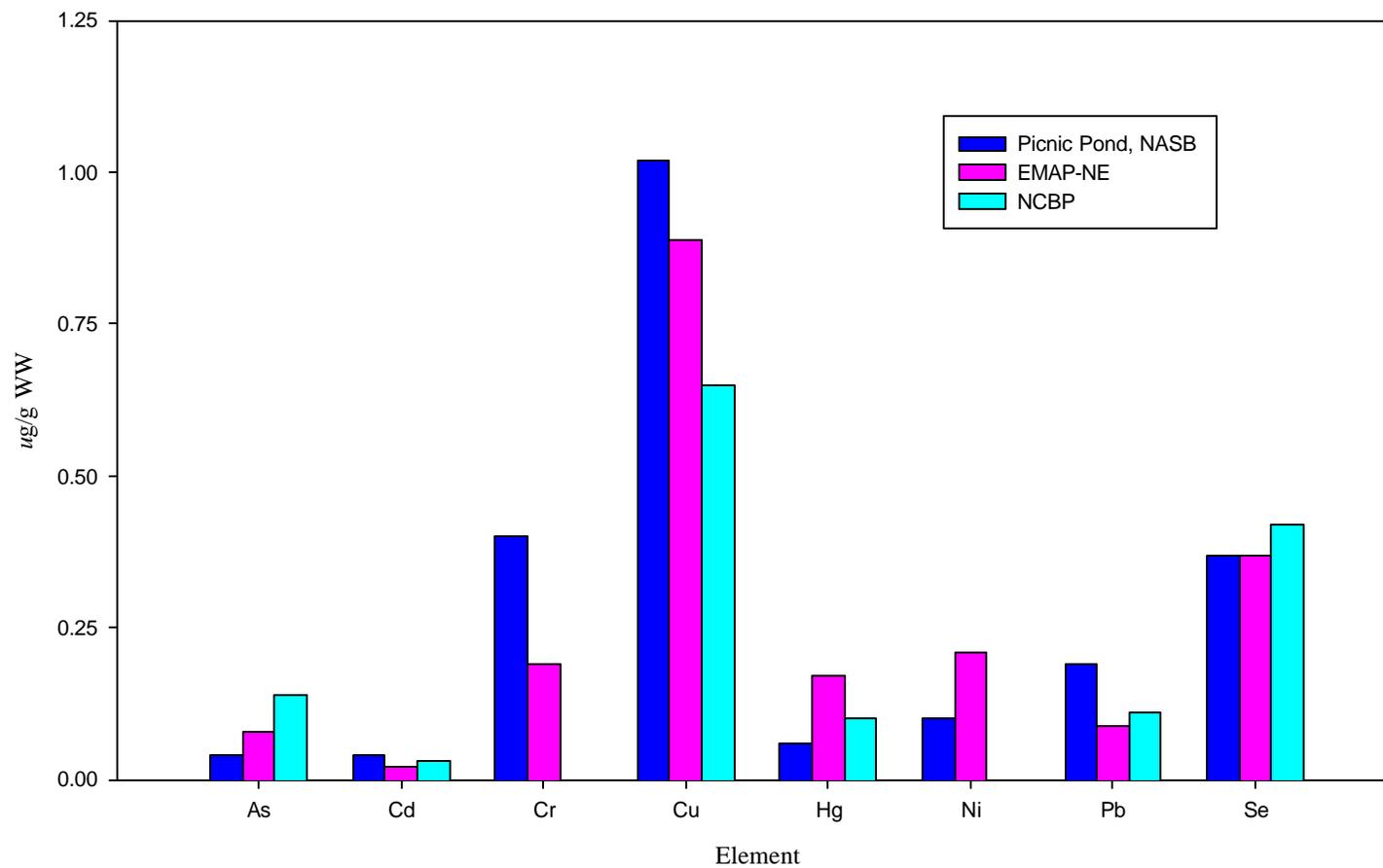


Figure 4. Zinc in wholebody golden shiners from Picnic Pond compared to EMAP and NCBP

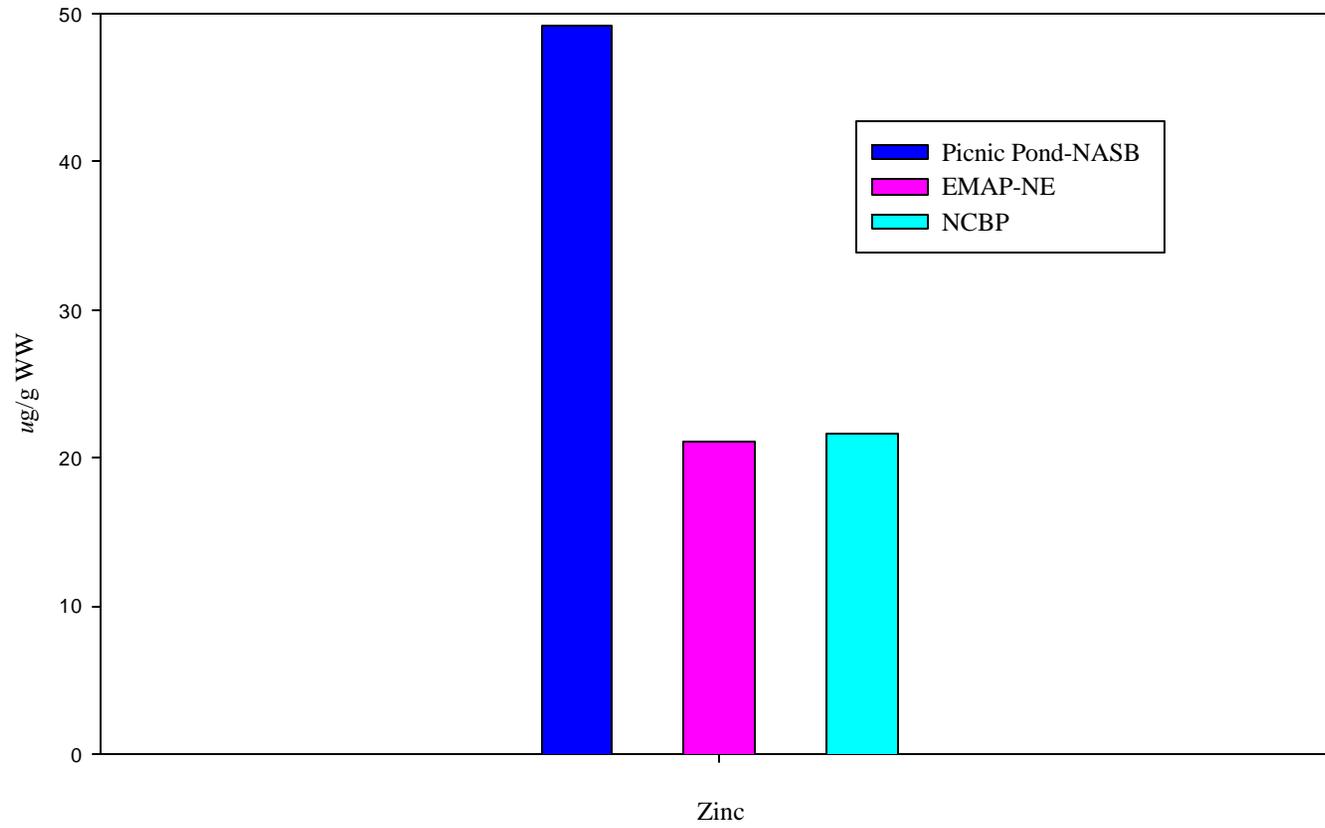
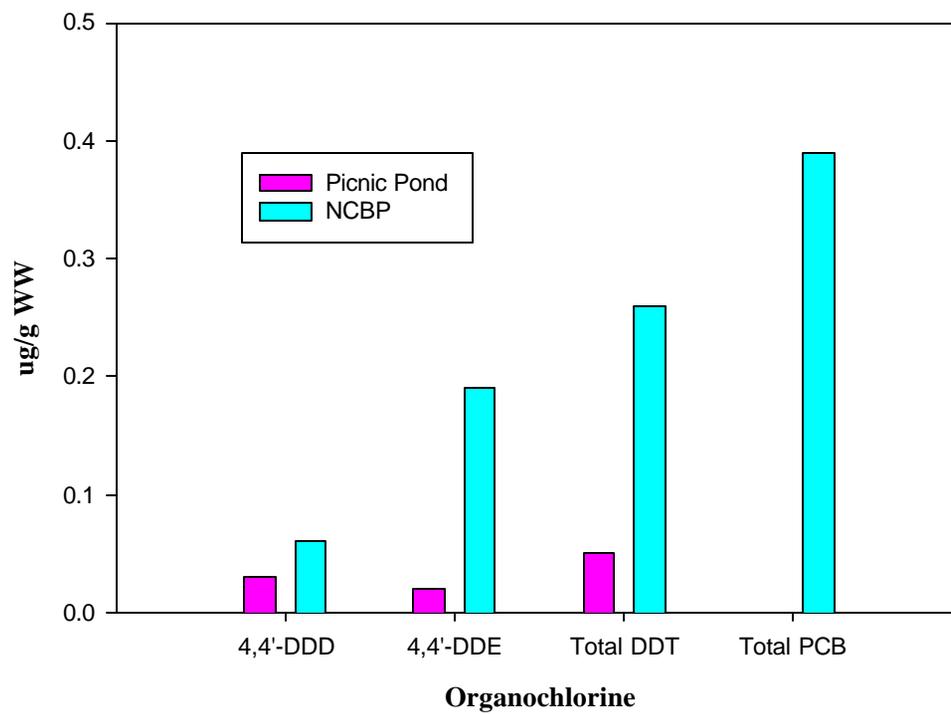


Figure 5. Organochlorines in wholebody golden shiner from Picnic Pond compared to NCBP



Missing bars indicate a non-detect

TABLES

Table 1. Water Quality Measurements - Picnic Pond, NASB

Depth (m)	Temp (°C)	DO (mg/l)	Conductivity (µS/cm)	pH	Redox (mV)
1.0	23.5	8.29	91.3	6.78	231
2.0	20.56	4.67	125.7	6.45	234
2.8	16.98	3.40	103.3	6.33	206
3.6	14.35	0.10	134.4	6.33	203

Water quality parameters were measured with a Datasonde® Hydrolab on July 25, 1995, 0930 hrs.

Table 2. Mean lengths and weights of golden shiners in composite samples

Sample Number	Number of Fish in Composite	Mean Length ± SD	Mean Weight ± SD
NASB 14	5	10.0 ± 1.03	11.0 ± 3.08
NASB 15	10	9.5 ± 0.62	9.0 ± 2.15
NASB 16	2	15.3 ± 0.00	44.4 ± 0.71
NASB 17	5	11.8 ± 0.87	18.0 ± 4.25
NASB 18	5	10.6 ± 1.00	13.7 ± 3.75
NASB 19	12	9.4 ± 0.60	9.6 ± 2.50
NASB 20	5	9.8 ± 0.68	10.6 ± 2.67
NASB 21	5	9.8 ± 0.64	10.1 ± 1.74
All Fish	Σ49	10.1 ± 1.46	12.4 ± 7.63

Table 3. Mean contaminant concentrations in whole-body golden shiner from Picnic Pond compared to NCBP and EMAP results, $\mu\text{g/g}$ WW.

Compound/ Element	Picnic Pond - NASB	NCBP ^{1,2}	EMAP-NE ³
4,4'-DDD	0.03	0.06	not available
4,4'-DDE	0.02	0.19	not available
Total DDT	0.05	0.26	not available
Total PCBs	non-detect	0.39	not available
As	0.04	0.14	0.08
Cd	0.04	0.03	0.02
Cr	0.40	not available	0.19
Cu	1.02	0.65	0.89
Hg	0.06	0.10	0.17
Ni	0.10	not available	0.21
Pb	0.19	0.11	0.09
Se	0.37	0.42	0.37
Zn	49.2	21.7	21.1

¹ Schmitt *et al.* 1990 (organochlorines)

² Schmitt and Brumbaugh 1990 (trace elements)

³ Yeardeley *et al.* 1998 (trace elements)

Table 4. Trace elements in wholebody golden shiner composite samples from Picnic Pond, μ g/g, WW.

FWS#	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Zn
NASB14	0.04	0.04	0.32	0.62	0.05	0.115	0.13	0.35	53.82
NASB15	0.06	0.05	0.57	0.73	0.05	0.13	0.42	0.35	55.66
NASB16	0.04	0.05	1.03	3.00	0.09	0.18	0.17	0.43	35.50
NASB17	0.03	0.04	0.25	1.05	0.05	0.115	0.14	0.38	48.25
NASB18	0.05	0.04	0.44	1.74	0.05	0.07	0.18	0.37	44.66
NASB19	0.06	0.05	0.23	0.97	0.05	0.08	0.30	0.35	55.89
NASB20	0.03	0.03	0.44	0.66	0.07	0.115	0.13	0.33	49.94
NASB21	0.04	0.05	0.32	0.76	0.05	0.06	0.16	0.39	54.05
GeoMean	0.04	0.04	0.40	1.02	0.06	0.10	0.19	0.37	49.24
SE	0.004	0.003	0.092	0.288	0.005	nc	0.036	0.011	2.460

*Shaded cells were non-detects. The shaded cell value is one-half the method detection limit.

nc = not calculated

Table 5. Organochlorines in wholebody golden shiner composite samples from Picnic Pond, *u g/g, WW.*

FWS#	% Lipid	4,4'-DDE	4,4'-DDD	4,4'-DDT	Total DDT	Total PCBs
NASB14	2.09	0.016	0.026	nd	0.042	nd
NASB15	1.86	0.017	0.026	nd	0.043	nd
NASB16	2.38	0.023	0.039	nd	0.062	nd
NASB17	2.51	0.022	0.035	nd	0.057	nd
NASB18	1.74	0.018	0.025	nd	0.043	nd
NASB19	1.55	0.026	0.035	nd	0.061	nd
NASB20	2.45	0.027	0.040	nd	0.067	nd
NASB21	1.89	0.014	0.022	nd	0.036	nd
GeoMean		0.020	0.030	nd	0.050	nd
SE		0.0017	0.0025		0.0041	

nd = non-detect

Total DDT = 4,4'-DDE+4,4'-DDD+4,4'-DDT

Total PCBs = Sum of Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260.

APPENDIX A

TRACE ELEMENTS LABORATORY REPORT - FR32102

US DEPARTMENT OF THE INTERIOR
NATIONAL BIOLOGICAL SERVICE
MIDWEST SCIENCE CENTER
COLUMBIA, MO

AVAILABLE BY REQUEST FROM:

USFWS
Maine Field Office
1033 South Main Street
Old Town, ME 04468

APPENDIX B

ORGANOCHLORINES LABORATORY REPORT - 001250

ABC LABORATORIES - CALIFORNIA
32380 AVENUE 10
MADERA, CALIFORNIA 93638

AVAILABLE BY REQUEST FROM:

USFWS
Maine Field Office
1033 South Main Street
Old Town, ME 04468