United States Department of the Interior
FISH AND WILDLIFE SERVICE
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VERO BEACH, FLORIDA 32961-2676

September 1, 1994

MEMORANDUM

TO: Refuge Manger, Florida Panther NWR

FROM: EC Biologist, Vero Beach Field Office Douglas Mansar

SUBJECT: Report on mercury in fishes on refuge.

Enclosed is a copy of the final report for an EC Study (VB-93-4N29) on mercury levels in fishes in Bullet and Pistol Ponds. All fish (n=39), but one, had mercury levels above the 0.5 ppm limited-consumption level. All largemouth bass collected had mercury levels >1.5 ppm, the no consumption health advisory level. Mean mercury concentrations for Florida gar and bluegill were significantly greater than the 0.5 ppm limited-consumption health advisory. We recommend that these ponds not be open to public fishing; or at least have Florida HRS issue health advisories, and catch-and-release fishing only.

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MERCURY CONCENTRATIONS IN FISHES

IN FLORIDA PANTHER NATIONAL WILDLIFE REFUGE

PUBLICATION NO. VBFO-EC 94-01

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1994

U.S FISH AND WILDLIFE SERVICE / SOUTHEAST REGION / ATLANTA, GEORGIA

TITLE: Mercury concentrations in fishes in Florida Panther National Wildlife Refuge

ABSTRACT: Mercury contamination in Florida aquatic and terrestrial environments is a growing public health concern. HRS issues a health advisory for fish when mercury (Hg) levels are between 0.5 and 1.5 parts per million (ppm). This project investigates mercury levels in game fish in Florida Panther National Wildlife Refuge (NWR) to determine if freshwater game fishes are safe for human consumption. Largemouth bass, bluegill and Florida gar were collected from locations within the Florida Panther NWR, Collier County, Florida. Fish lengths and weights were obtained and muscle tissue samples (fillets) were analyzed for concentration of mercury. Lengths ranged from 276 to 368 mm in largemouth bass, 296 to 596 mm in Florida gar, 128 to 200 mm in Pistol Pond bluegill and 168 to 198 mm in Bullet Pond bluegill. Weights varied from 208 to 682 g/wet weight in largemouth bass, 88 to 994 g/wet weight in Florida gar, 34 to 126 g/wet weight in Pistol Pond bluegill and 84 to 114 g/wet weight in Bullet Pond bluegill. There was no significant correlation between mercury concentration and length or mercury concentration and weight. Mercury concentrations from all fish species were analyzed to see if they were significantly greater than the 0.5 ppm limited consumption health advisory or the 1.5 ppm no-consumption health advisory. Mercury concentrations ranged from 1.60 to 4.68 mg/kg wet weight (ppm) in largemouth bass, 0.97 to 1.74 ppm in Florida gar, 0.43 to 2.19 ppm in Pistol Pond bluegill and 0.53 to 1.39 ppm in Bullet Pond bluegill. All fish (n=39), but one, had mercury levels above the 0.5 ppm limited-consumption level. Mean mercury concentrations for Florida gar and bluegill were significantly greater than the 0.5 ppm limited-consumption health advisory. Largemouth bass mercury concentration was significantly greater than the 1.5 ppm no-consumption health advisory. Due to the high levels of mercury, aquatic areas of Florida Panther NWR should either have HRS health advisories placed on areas of concern or be closed to public fishing.

KEY WORDS: Mercury, Florida Panther NWR, largemouth bass, Florida gar, bluegill

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INTRODUCTION

There is increasing evidence of extensive mercury contamination, and its effects on fish and wildlife resources, in Florida freshwater and terrestrial ecosystems (Lambou et al., 1991; Zillioux et al., 1993). Freshwater sport fish and alligators in numerous watersheds have high mercury levels (Lambou et al., 1991; Lange et al., 1993). High mercury concentrations in fish are of concern because of the toxicological threat to the fish themselves, and birds, mammals, and humans that consume contaminated fish. Mercury toxicosis may have been responsible for at least one endangered Florida panther death, and is strongly implicated in two others since 1989 (Roelke et al., 1991). Mercury contamination has been detected in the endangered wood stork and other birds (Lambou et al., 1991; Facemire and Chlebowski, 1991).

Mercury contamination in freshwater sport fish is a public health concern. By 1992, the Florida Department of Health and Rehabilitative Services (HRS) had issued mercury health advisories for 68 Florida waterways. Approximately one million acres of the Everglades are under health advisories that recommend complete avoidance of consumption of certain fish species and an additional one million acres of water in the remainder of Florida that are under HRS health advisories restricting fish consumption (Lambou et al., 1991). HRS issues a health advisory for fish when mercury (Hg) levels are between 0.5 and 1.5 parts per million (ppm) (HRS, 1989). The HRS advisory recommends adults should limit their consumption to no more than one meal (=4 oz. or 133.5 gm) of fish per week. Nursing mothers, pregnant women or women who intend to have children, and children under 15 years of age are advised not to eat these fish more than once a month. Fish containing 1.5 ppm of mercury should not be eaten by anyone.

Many mercury species have low toxicity, but can be transformed to methylmercury, the most hazardous mercury form. Methylmercury is introduced to aquatic systems through bacteria synthesis. Methylmercury can be bioaccumulated in organisms and biomagnified through the food chain. Mercury is known to be a mutagen, carcinogen and teratogen, and may cause embryocidal, cytochemical, and histopathological effects (Eisler, 1987).

Nearly 95-99% of mercury in fish is in the form of methylmercury, although little of the total mercury in the waters and sediments of freshwater ecosystems exists as methylmercury (Wiener and Spry, in press). Fish acquire the majority of methylmercury from their diet. Once in the body, methylmercury is rapidly distributed throughout the body, with most of it concentrating in muscle tissue.

Florida Panther National Wildlife Refuge (NWR) is considering opening some waterbodies on the refuge to public fishing. As of 1992, HRS considered fish from Florida Panther NWR safe for human

consumption (HRS, 1992). However, recent sampling of largemouth bass on the refuge found mean mercury concentration was 0.57 ppm, but sample sizes were small (Brim et al., 1994). The primary purpose of the present study is to collect additional mercury contamination data on freshwater game fishes to determine if these fishes are safe for human consumption. This study also provides further information on the extent of mercury contamination in living resources on Florida Panther NWR.

MATERIALS AND METHODS

Two stations were sampled on Florida Panther NWR, Pistol Pond and Bullet Pond (Figure 1). These stations were selected due to their accessibility for public fishing and proximity on refuge property. Fish species were collected by electro-shocker or hook and line techniques. Wet weights and lengths were obtained for each species. Muscle samples (fillets) were analyzed for mercury concentration by Research Triangle Institute. Tissue samples were prehomoginized using a food processor. A portion of the tissue sample was freeze-dried for determination of moisture content and ground to 100 mesh with a mill. Samples were prepared for digestion for Graphite Furnace and Cold Vapor Atomic Absorption (GFAA) measurements. Using a CEM microwave oven, 0.25 to 0.5 g of freeze dried sample was heated in a capped 120 ml Teflon vessel in the presence of 5 ml of Baker Intra-Analyzed nitric acid for three minutes at 120 watts, three minutes at 300 watts, and fifteen minutes at 450 watts. The residue was then diluted to 50 ml with laboratory pure water. Mercury measurements by Cold Vapor Atomic Absorption (CVAA) were conducted using SnC14 as the reducing agent. A Leeman PS200 Hg Analyzer was used.

Log transformed mercury data for gar and bluegill were statistically analyzed with one-tailed t-tests to determine if mean mercury concentrations were significantly ($p<0.05$) greater than the 0.5 ppm mercury lower limit advisory issued by HRS (Zar, 1984). Largemouth bass log transformed mercury data were analyzed to determine if mean mercury concentration was significantly ($p<0.05$) greater than the upper 1.5 ppm mercury HRS advisory. Mercury concentrations from largemouth bass in Pistol Pond were compared to Pistol Pond bass collected by Brim et al. (1994c) using Mann-Whitney U-test (variances not homogeneous; $p<0.01$, F-test; Zar 1984). Significance tests for correlations between fish weight and mercury concentration and fish length and mercury concentration were analyzed using t-test (Sokal and Rohlf, 1981).

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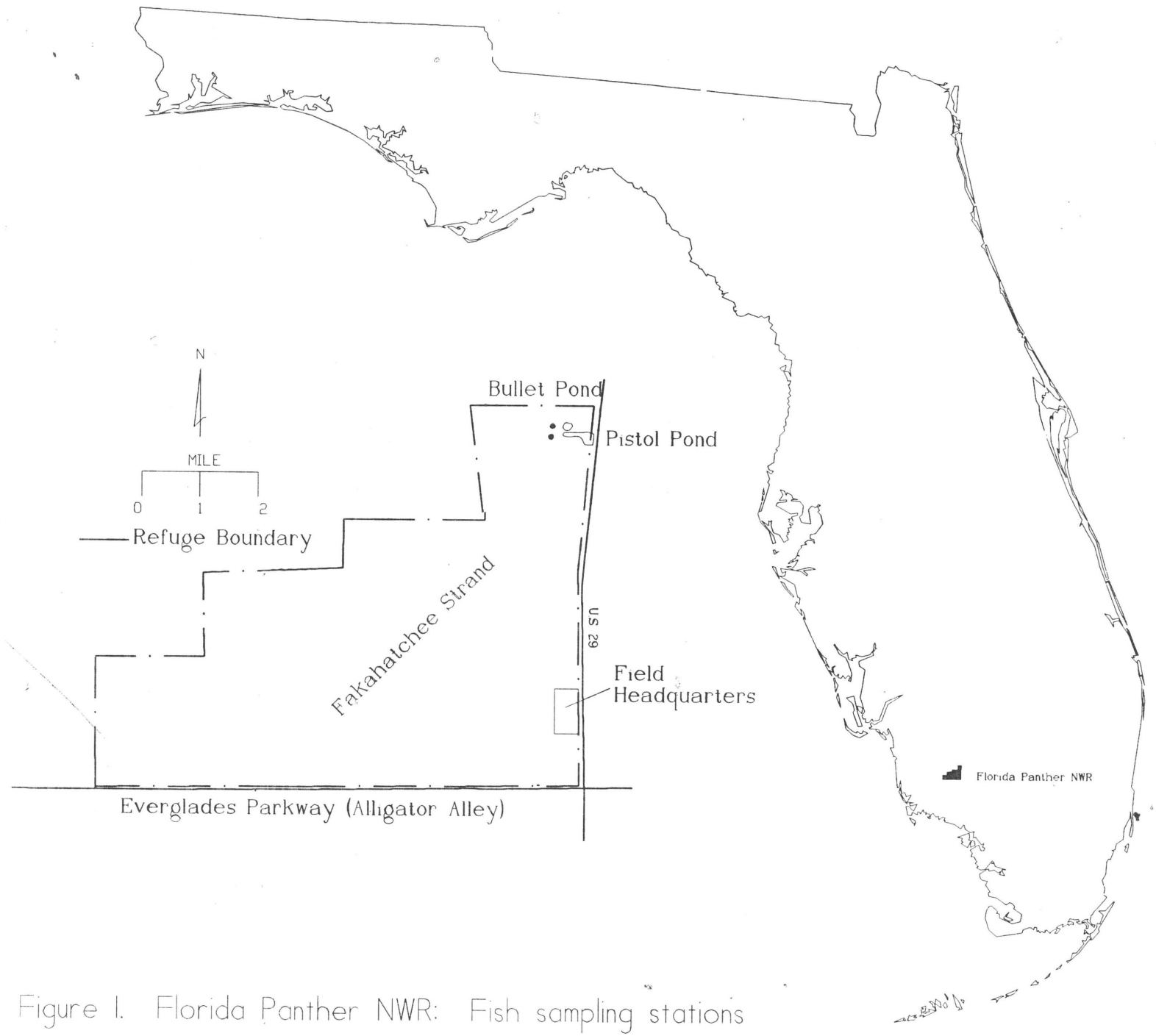

Figure 1. Florida Panther NWR: Fish sampling stations

RESULTS AND DISCUSSIONS

Mercury Concentrations

Mean mercury concentration (2.61 ppm) for largemouth bass was significantly ($p<0.05$) greater than the 1.5 ppm no-consumption limit (Table 1). All largemouth bass mercury concentrations exceeded 1.5 ppm (Table 2). Recent data from Florida Panther NWR had dissimilar findings with none of the largemouth bass exceeding 1.5 ppm and only 43% exceeding 0.5 ppm (Brim et al., 1994c). Mercury levels (mean = 0.37 ppm) for largemouth bass collected from Pistol pond by Brim et al. were significantly different than those collected in our study ($p<0.05$, Mann-Whitney U-test). There is no significant difference ($p>0.05$, t-test) in length and weight of the bass collected in both studies. Small sample sizes (N= 7 and 9) may at least partially explain the different findings.

Largemouth bass in many waterbodies in south Florida have high (>0.5 ppm) mercury levels (Lambou et al. 1991). All bass collected in Loxahatchee NWR exceeded the 0.5 ppm limited-consumption level (Brim et al, 1993).

Table 1. Mean (Standard Error) mercury (Hg) concentrations (ppm), lengths (mm) and weights (g) in fish species collected from Florida Panther NWR.

Species n=sample	Hg ppm	Length mm	Weight g	Length r value[d]	Weight r value[d]
bass (n=9)	2.61[b] (0.30)	306.2 (10.2)	342.2 (49.9)	0.46	0.57
gar (n=10)	1.32[c] (0.08)	448.4 (32.3)	466.0 (100.6)	0.12	0.13
bluegill (n=10)	0.96[c] (0.15)	167.4 (7.2)	76.7 (10.5)	0.49	0.55
bluegill[a] (n=10)	0.80[c] (0.09)	186.8 (3.1)	96.0 (3.4)	0.35	0.34

[a] collected from Bullet Pond
[b] significantly greater than 1.5 ppm, $p<0.05$
[c] significantly greater than 0.5 ppm, $p<0.05$
[d] not significantly different from zero, $p>0.05$

Mean mercury concentration (1.32 ppm) for Florida gar was significantly ($p<0.05$) greater than the 0.5 ppm limited-consumption health advisory (Table 1). All mercury levels in Florida gar were above 0.5 ppm, with 30% greater than 1.5 ppm (Table 3). Similar findings were seen in mercury concentrations in spotted gar from Florida Panther NWR which ranged from 0.72 to 1.45 ppm (Brim et al., 1994c). Thirty-three percent of the Florida gar from Loxahatchee NWR exceeded the 0.5 ppm mercury advisory level (Brim et al., 1993). In contrast, gar collected from coastal refuges had mercury concentrations well below the 0.5 ppm advisory level. Spotted gar collected from Ding Darling NWR ranged from 0.05 to 0.26 ppm and Florida gar from St. Marks NWR ranged from 0.05 to 0.14 ppm (Brim et al., 1994b,e).

Mean mercury concentrations (0.96 ppm) for Pistol Pond bluegill and Bullet Pond bluegill (0.80 ppm) were significantly ($p<0.05$) greater than the 0.5 ppm limited-consumption health advisory (Table 1). Ninety percent of bluegill collected from Pistol Pond had concentrations greater than 0.5 ppm, and 100% of bluegill from Bullet Pond had mercury levels greater than 0.5 ppm (Table 4, 5). Results from other refuges were not available for comparison.

Relationship of mercury concentrations to length and weight

Product-moment correlation coefficients are shown for mercury-length and mercury-weight for each species in Table 1. There was no significant ($p>0.05$) correlation between mercury concentration and length for any of the fish species sampled. Lengths ranged from 276 to 368 mm for largemouth bass (Table 2), 296 to 596 mm for Florida gar (Table 3), 128 to 200 mm for Pistol Pond bluegill (Table 4) and 168 to 198 mm for Bullet Pond bluegill (Table 5).

Largemouth bass in Loxahatchee NWR showed no correlation between mercury concentration and length (Brim et al., 1993). Other studies have provided statistical evidence of positive correlations between mercury concentration and length. A strong correlation ($r=0.91$) exists between total fish length and mercury concentration in muscle tissue of largemouth bass from Crystal River NWR (Brim et al., 1994a). A positive trend of increasing mercury concentration with increasing length was also evident for largemouth bass collected from St. Vincent NWR (Brim et al., 1994f).

There was no significant ($p>0.05$) correlation between mercury concentration and weight for any of the fish species sampled. Weights varied from 208 to 682 g/wet weight for largemouth bass (Table 2), 88 to 994 g/wet weight for Florida gar (Table 3), 34 to 126 g/wet weight for Pistol Pond bluegill (Table 4) and 84 to 114 g/wet weight for Bullet Pond bluegill (Table 5).

Largemouth bass from Loxahatchee NWR showed no significant mercury concentration and weight correlation (Brim et al., 1993). Yet results from Crystal River NWR exhibited a strong correlation

(r=0.90) between total weight and mercury concentration in largemouth bass (Brim et al., 1994a).

Analysis of the extensive (N>400) Florida Game and Fresh Water Fish Commission largemouth bass mercury data for Florida lakes revealed significant, but weak, correlations for length and weight (Lange et al. 1993). Length and weight explained only 11.6% and 9.6%, respectively, of the variation in mercury concentrations; whereas, age accounted for 28% of the variance. Correlation coefficients for specific lakes varied greatly.

Table 2. Mercury concentrations, lengths, and weights of largemouth bass collected from Pistol Pond, Florida Panther NWR.

Sample ID	Hg (ppm)	Length (mm)	Weight (g)
PPLB1 0.715	1.76	330	426
PPLB2 0.555	1.75	286	264
PPLB3 1,360	3.22	278	208
PPLB4 0.995	2.88	294	282
PPLB5 0.647	1.60	314	326
PPLB6 1,800	2.71	324	420
PPLB7 1,290	2.12	276	232
PPLB8 1,204	2.82	286	240
PPLB9 2,110	4.68	368	682

Table 3. Mercury concentrations, lengths, and weights of Florida gar collected from Pistol Pond, Florida Panther NWR.

Sample ID	Hg (ppm)	Length (mm)	Weight (g)
PPFG1	1.74	330	118
PPFG2	1.31	382	232
PPFG3	1.33	566	838
PPFG4	1.19	476	424
PPFG5	1.03	508	634
PPFG6	1.02	296	88
PPFG7	1.68	500	618
PPFG8	0.97	476	580
PPFG9	1.33	354	134
PPFG10	1.62	596	994

Table 4. Mercury concentrations, lengths, and weights of bluegill collected from Pistol Pond, Florida Panther NWR.

Sample ID	Hg (ppm)	Length (mm)	Weight (g)
PPBG1	1.06	180	85
PPBG2	0.58	174	76
PPBG3	2.19	180	98
PPBG4	1.11	200	126
PPBG5	1.27	186	118
PPBG6	0.76	182	96
PPBG7	0.43	146	50
PPBG8	0.74	128	34
PPBG9	0.77	146	43
PPBG10	0.68	152	41

Table 5. Mercury concentrations, lengths, and weights of bluegill collected from Bullet Pond, Florida Panther NWR.

Sample ID	Hg (ppm)	Length (mm)	Weight (g)
BPBG1	0.53	180	92
PPBG2	0.73	188	114
BPBG3	0.62	196	92
BPBG4	1.39	196	92
BPBG5	0.58	168	92
BPBG6	0.82	198	110
BPBG7	0.69	84	90
BPBG8	1.32	195	110
BPBG9	0.68	178	84
BPBG10	0.67	185	86

CONCLUSIONS AND RECOMMENDATIONS

Mean mercury concentration in largemouth bass exceeds the 1.5 ppm no-consumption health advisory. Mean mercury concentrations in Florida gar and bluegill exceed the 0.5 ppm limited-consumption health advisory. In addition to mercury being a hazard to human health, fish and wildlife species on the refuge may be accumulating mercury at concentrations that may affect organism fitness. The extent of these effects need to be investigated further.

Recommendations:

1. Do not open Pistol and Bullet Ponds to public fishing; or at least have HRS issue health advisories, and catch-and-release fishing only.

2. Due to the high mercury concentrations found in fish in Florida Panther NWR, a long term mercury monitoring program should be implemented. In addition to analyzing mercury levels in pertinent fish species, water quality and sediments should also be examined.

3. Investigate how mercury contamination affects Service trust species, including fishes, endangered species and migratory birds. Organisms lower on the food chain, such as crayfish and forage fish, should be examined to help explain pathways and processes of how mercury cycles through the food chain to endangered species.

4. Coordinate any mercury studies initiated in Florida Panther NWR with other ongoing studies in south Florida.

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Addendum

Geometric mean mercury concentrations found in largemouth bass collected from Pistol Pond, Florida Panther National Wildlife Refuge, Florida.

Location and Date Collected	Geometric Mean Concentration (mg/kg, wet weight)	Reference
Pistol Pond, 1990	0.32	Brim et al., 1994
Pistol Pond, 1993	1.08	Richards and Morrison, 1994

Note: Arithmetic mean values are necessary for comparison with HRS consumption advisory values. Arithmetic mean concentration in largemouth bass collected from Pistol Pond in 1993 is 1.19 mg/kg, wet weight. This value is above the Florida lower-level consumption advisory of 0.5 mg/kg, wet weight yet below the Florida upper-level consumption advisory of 1.5 mg/kg, wet weight.