

# Total mercury levels in Alaskan Pacific Halibut

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## Abstract

Since 2002, the International Pacific Halibut Commission (IPHC or Commission) has collected halibut muscle tissue samples during our setline surveys from locations within Alaska for the Alaska Department of Environmental Conservation, as part of a larger study on environmental contaminants in fish. Summaries of the total mercury levels in samples collected from the first six years of this study show an average total mercury content of 0.340 ppm, with a trend of higher mercury levels in the western Aleutian Islands.

## Introduction

In recent years, reports from health officials and the media have raised the profile of mercury contamination in fish. In 2002, the Alaska Department of Environmental Conservation (ADEC), in conjunction with the U.S. Environmental Protection Agency (EPA), launched an environmental contamination study looking into levels of organochlorine pesticides, dioxins, furans, polybrominated diphenyl ethers, PCB congeners, methyl mercury (meHg), and heavy metals (arsenic, selenium, lead, cadmium, nickel, chromium) within 13 Alaskan fish species, including Pacific halibut. The Commission has collected halibut muscle tissue samples from various locations within Alaska for ADEC every year since the inception of the study (Table 1). Samples collected in 2002 and 2003 were analyzed for both total mercury (THg) and meHg (the bioactive (toxic) component of THg). Due to the cost of analysis, all samples from 2004 forward have only been analyzed for THg. Heavy metal results from the first year of samples can be found in Dykstra (2004).

## Methods

Halibut samples were collected during standard IPHC grid survey vessel operations. Stations corresponding with commercial fishing grounds were targeted for sample collection. In the first year, only eight samples were targeted from each of eight general areas (within seven different Commission charter regions) to get a general indication of levels throughout Alaska. From 2003 to 2006, generally three to four charter regions were sampled, with 30 animals in the 20 lb to 40 lb (round weight) range and 30 animals in the 40 to 100 lb (round weight) range being targeted. Round weights were used because the results of these tests are used for interpretation purposes with regard to fisheries consumption advisories (and most personal and subsistence eaters determine the size of their catch in the round). Beginning in 2007, an additional size range category of less than 20 pounds (round weight) was introduced so as to better characterize the mercury content in the commercial catch size ranges. All samples came from fish targeted for an age sample (otolith) and were free from any gross abnormalities or disease. After processing the fish in the usual manner and collecting an otolith from it, samplers wearing nitrile gloves collected a three to five pound fillet from behind the head, and stored the sample in a food grade plastic bag. Care was taken in all cases to avoid any gross contamination of the fish with bilge, wastewater, fuel, or exhaust

emissions. Upon landing, all samples were shipped frozen to ADEC's Seafood and Food Safety Lab in Anchorage, AK.

ADEC prepared the samples for analysis using a standard protocol outlined in the Quality Assurance Project Plan established for the study (Gerlach et al. 2002). Total mercury was determined by EPA Method 7473 using a DMA-80 Mercury Analyzer. All samples were prepared from skinless fillets, and fatty tissue located between the skin and muscle was removed.

## Results

Between 2002 and 2007, a total of 981 samples were tested for THg (Table 1). Mean THg levels by region are listed in Tables 2 and 3. Mean THg by sex showed a range of 0.090 ppm to 0.581 for males and 0.103 ppm to 0.523 ppm for females (Table 2). Mean THg by charter region ranged from a low of 0.104 ppm in St. Paul to a high of 0.501 ppm in Attu (Table 3). The overall mean THg level found in all samples was 0.340 ppm. In the first two years of the study, samples were also tested for meHg. Of the 215 samples where both meHg and THg readings were taken, meHg represented 85.5% of the THg value. This is consistent with similar studies on marine species (Baeyens et al. 2003). Using this percentage, the overall average of 0.340 ppm THg converts to a mean meHg concentration of 0.291 ppm.

In 2007, the average commercially landed halibut in Alaska was 34 lbs round weight. Table 3 shows the mean weight for halibut sampled in three different round weight size classes: less than 20 lbs, between 20 and 40 lbs, and greater than 40 lbs. The average THg for halibut in the 20 to 40 lb size class (most similar to the average size in Alaskan commercial landings) is 0.263 ppm (or 0.224 meHg).

Results from the heavy metal testing and the persistent organic pollutant testing can be found at: <http://www.dec.state.ak.us/eh/vet/fish.htm>

## Discussion

As seen in previous studies (Hall et al. 1976), THg levels in Pacific halibut tend to increase with size and age (Tables 2 and 3). Additionally, the data show that for similar sized fish, males tend to have higher THg levels than females, which would be expected as males are slower growing than females.

The data also show higher levels of THg in fish collected in the Aleutian Islands chain (Attu and Adak charter regions), with mean levels in Attu of 0.501 ppm and in Adak of 0.476 ppm (Table 3). The initial results from fish collected in Attu in 2005 were high enough to prompt us to collect more samples in 2007. Rather than showing a 'hot spot' of activity, this region seems to be generally high compared to other regions tested. The findings by Hall et al. (1976) demonstrated that THg concentration increased in fish of the same size from the northern to the southern part of the species range. Their study did not test fish from the Aleutian Islands (Attu and Adak charter regions), but did have samples from the Bering Sea, Gulf of Alaska, southeast Alaska, BC, and Washington and Oregon. There appears to be a similar trend in this study when the Aleutian Island areas are excluded (Figure 1), although we have not tested for significance on that trend. One item of interest is the rather low THg levels from the area around St. Paul Island. As the data are further analyzed, it will be interesting to see if these differences are significant or not.

The Food and Drug Administration (FDA) and EPA both have issued limits (levels of concern) for meHg in tissue (1.00 ppm and 0.50 ppm respectively) above which they recommend limits

on consumption. The discrepancy in the levels arises from different methods of calculating and interpreting risk assessments. This joint study with ADEC shows that mean levels of THg and meHg in Alaskan Pacific halibut are below levels of concern of both the FDA and EPA. While the mean value for both THg and meHg is below these reference levels, there remain concerns for consumers (particularly recreational and subsistence users) who consume many meals from one large animal. In October 2007, the Alaska Division of Public Health released new fish consumption guidelines (using a reference level of 0.4 ppm.) for women who can become pregnant, nursing mothers, and children under the age of 12. The advisory has a graduated number of meals (one meal is considered a 6 oz piece of flesh, roughly equivalent to the size of a deck of cards) based on the size of the animal being consumed. For full details of their specific advice and the full risk management strategy, please see Verbrugge (2007). The Alaska Division of Public Health continues to encourage everyone else, including adult men, adult women who cannot become pregnant, and teenage boys to eat as much fish (including Pacific halibut) from Alaskan waters as they would like.

Continued collaboration with ADEC is expected on this project over the next several years. We are still awaiting results from Fairweather samples collected in 2007, and from the Sitka, Prince William Sound, and Upper Shelikof (Cook Inlet) samples collected in 2008. We also hope to test the various factors (length, weight, age, region) for significance over the next year or two.

## Acknowledgements

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## References

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[http://www.epi.hss.state.ak.us/bulletins/docs/rr2007\\_04.pdf](http://www.epi.hss.state.ak.us/bulletins/docs/rr2007_04.pdf)

**Table 1. Yearly number of halibut sampled by charter region and size category.**

Year	IPHC Charter Region	Size Class (round weight)			Total Samples
		< 20 lbs	20 - 40 lbs	> 40lbs	
2002	4A Edge		4	4	8
2002	Ketchikan		4	4	8
2002	Portlock		4	4	8
2002	Prince William Sound		8	4	12
2002	Sitka		4	4	8
2002	Shelikof		4	4	8
2002	Unalaska		4	4	8
2003	4D Edge		30	30	60
2003	Gore Point		30	10	40
2003	Ommaney		26	29	55
2004	Adak	3	25	32	60
2004	Ketchikan	1	24	19	44
2004	Shumagin		31	30	61
2005	Attu		30	30	60
2005	Seward		30	30	60
2005	Unalaska		32	28	60
2006	4A Edge		30	30	60
2006	Prince William Sound		30	20	50
2006	Sitka		31	29	60
2007	St. Paul		20	24	44
2007	Attu	39	67	42	148
2007	Trinity	20	20	19	59
Totals		63	488	430	981

**Table 2. Mean THg (ppm) by sex, round weight, age, and charter region.**

IPHC Charter Region	Sex	N	Mean round weight (lbs)	Mean age (years)	Mean THg (ppm)
4A Edge	Male	26	27.8	24	0.282
	Female	42	46.2	21	0.363
4D Edge	Male	14	32.6	22	0.290
	Female	46	42.5	17	0.248
Adak	Male	28	36.7	20	0.581
	Female	32	45.0	14	0.384
Attu	Male	112	27.8	17	0.488
	Female	94	41.3	15	0.523
	Unknown	2	33.6	11	0.250
Gore Pt.	Male	5	27.8	20	0.245
	Female	35	32.3	15	0.189
Ketchikan	Male	4	22.7	13	0.387
	Female	48	41.3	13	0.343
Ommaney	Male	7	36.7	17	0.328
	Female	48	45.0	15	0.365
Portlock	Male	1	23.5	18	0.127
	Female	7	40.1	15	0.175
Prince William Sound	Male	9	26.0	17	0.278
	Female	53	41.3	14	0.297
Seward	Male	12	28.7	21	0.262
	Female	48	42.5	17	0.365
Shelikof	Male	1	22.0	15	0.090
	Female	7	40.1	12	0.185
Shumagin	Male	23	29.6	21	0.349
	Female	37	45.0	16	0.318
	Unknown	1	45.0	16	0.183
Sitka	Male	6	26.0	17	0.330
	Female	62	43.7	13	0.216
St. Paul	Male	1	42.5	22	0.159
	Female	43	42.5	13	0.103
Trinity	Male	25	19.1	19	0.208
	Female	34	37.9	15	0.309
Unalaska	Male	17	27.8	20	0.323
	Female	48	41.3	15	0.271
	Unknown	3	37.9	16	0.390
Totals	Male	291	27.8	19	0.392
	Female	684	41.3	15	0.318
	Unknown	6	37.9	14	0.309

**Table 3. Mean THg (ppm) for different size classes (round weight) by charter region.**

IPHC Charter Region	Size Class (round weight)											
	< 20 lbs			20 - 40 lbs			> 40lbs			All weights		
	N	Mean THg (ppm)	SD	N	Mean THg (ppm)	SD	N	Mean THg (ppm)	SD	N	Mean THg (ppm)	SD
4A Edge				34	0.227	0.170	34	0.437	0.233	68	0.332	0.228
4D Edge				30	0.210	0.124	30	0.306	0.181	60	0.258	0.162
Adak	3	0.240	0.251	25	0.339	0.151	32	0.605	0.266	60	0.476	0.262
Attu	39	0.280	0.273	97	0.410	0.307	72	0.744	0.436	208	0.501	0.395
Gore Pt.				30	0.155	0.059	10	0.317	0.114	40	0.196	0.103
Ketchikan	1	0.177	0.000	28	0.237	0.199	23	0.486	0.332	52	0.346	0.290
Ommaney				26	0.292	0.319	29	0.421	0.299	55	0.360	0.313
Portlock				4	0.134	0.053	4	0.204	0.092	8	0.169	0.079
PWS				38	0.222	0.109	24	0.408	0.384	62	0.294	0.267
Seward				30	0.218	0.107	30	0.474	0.227	60	0.344	0.218
Shelikof				4	0.103	0.034	4	0.244	0.124	8	0.173	0.113
Shumagin				31	0.361	0.306	30	0.292	0.186	61	0.327	0.254
Sitka				33	0.188	0.119	35	0.261	0.228	68	0.226	0.185
St. Paul				20	0.077	0.022	24	0.126	0.062	44	0.104	0.054
Trinity	20	0.188	0.100	20	0.201	0.108	19	0.417	0.212	59	0.266	0.179
Unalaska				36	0.221	0.105	32	0.367	0.266	68	0.289	0.209
Totals	63	0.248	0.230	486	0.263	0.221	432	0.440	0.332	981	0.340	0.289

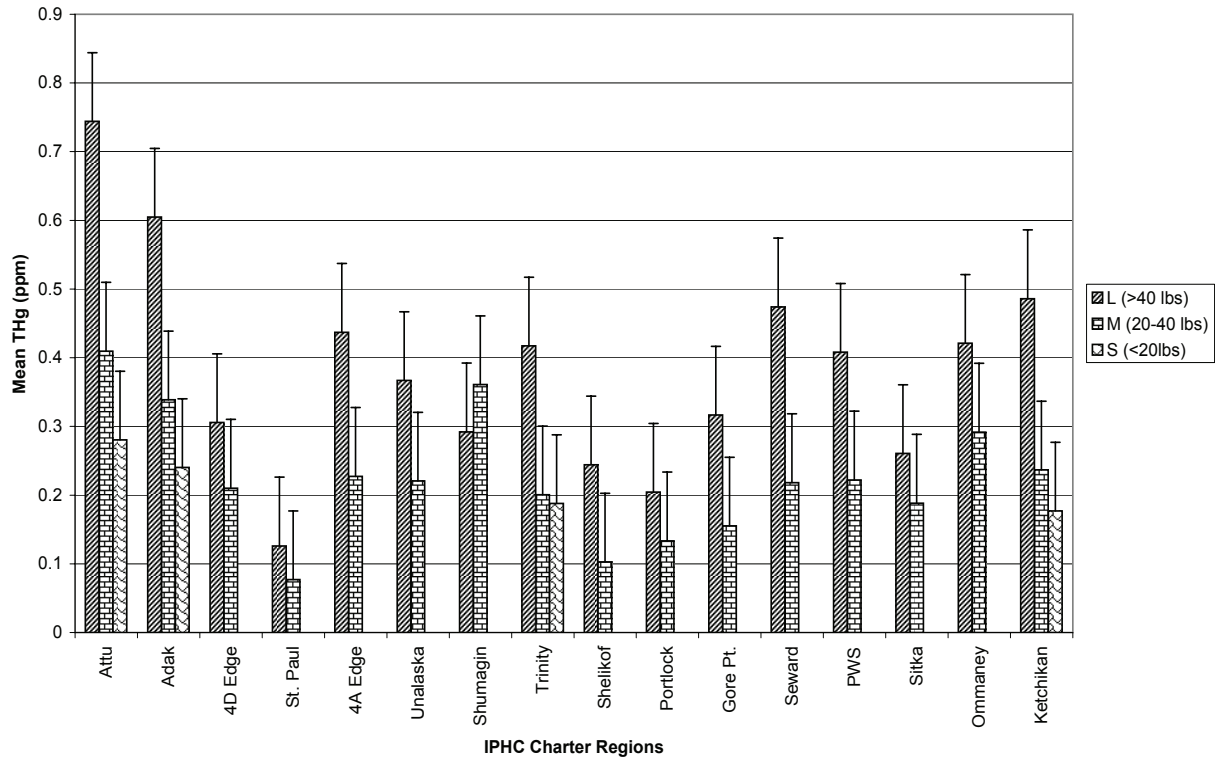


Figure 1. Mean total mercury (ppm) by size grouping and IPHC charter region.

