SALMON ADVISORIES: PUGET SOUND & LOWER DUWAMISH RIVER

NOTE
Focus is on Salmon so not discussing resident fish

From: https://www.doh.wa.gov/Portals/1/Documents/Pubs/333-084.pdf

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SALMON ADVISORIES: PUGET SOUND & LOWER DUWAMISH RIVER

What is the Purpose of Fish Advisories?

To **Protect** Public Health

- Help people make healthy decisions about how much fish is *safe* to eat.
- This is important because some fish have pollutants at levels that can harm your health.

To **Promote** Public Health

- Help people make decisions about how much fish to eat to get health *benefits* of eating fish (healthy heart, early brain development).

From: https://www.doh.wa.gov/Portals/1/Documents/Pubs/333-084.pdf

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SALMON ADVISORIES: PUGET SOUND & LOWER DUWAMISH RIVER

Fish advisories are based on:

- How much of a contaminant is in the fish
- How much of a contaminant is "safe" for people to ingest

  [Acceptable Daily Intake (ADI) or Reference Dose (RfD)]

From: https://www.doh.wa.gov/Portals/1/Documents/Pubs/333-084.pdf

SALMON ADVISORIES: PUGET SOUND & LOWER DUWAMISH RIVER

For the Lower Duwamish River, fish advisories are based on levels of polychlorinated biphenyls (PCBs) in fish.

WHAT ARE PCBs?

From: https://www.doh.wa.gov/Portals/1/Documents/Pubs/333-084.pdf

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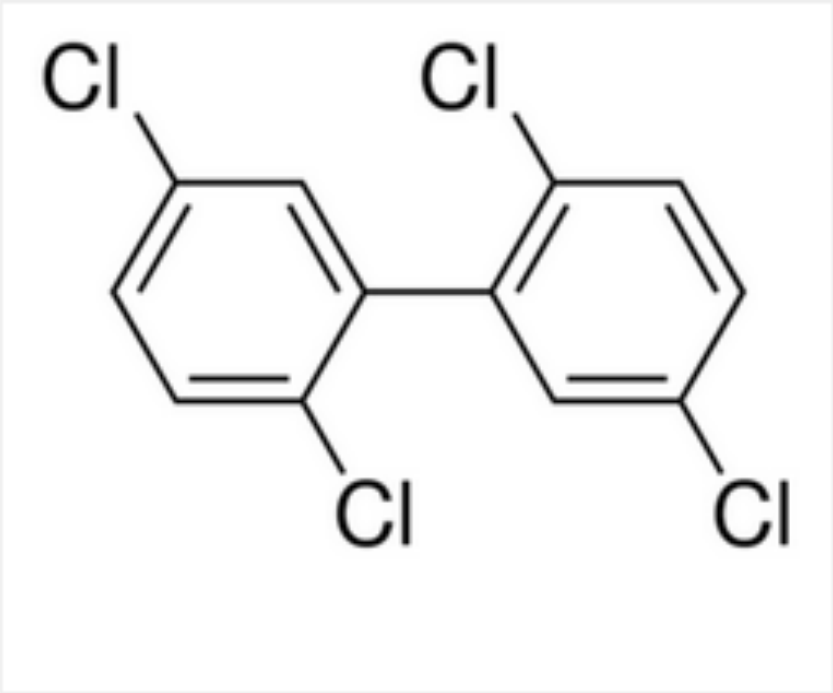
WHAT ARE PCBs?



From: https://www.sigmaaldrich.com/catalog/product/sial/35599?lang=en&region=US

PCBs are a group of chemicals formed by chlorine atoms attached to a pair of benzene rings.

There are over 200 PCBs (known as “congeners”).

There are no known natural sources of PCBs.

PCBs were used as coolants and lubricants.

They don’t burn easily and are good insulators.

They are found in transformers and other electrical equipment, and in products like caulk and paints.

From: https://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=140&tid=26

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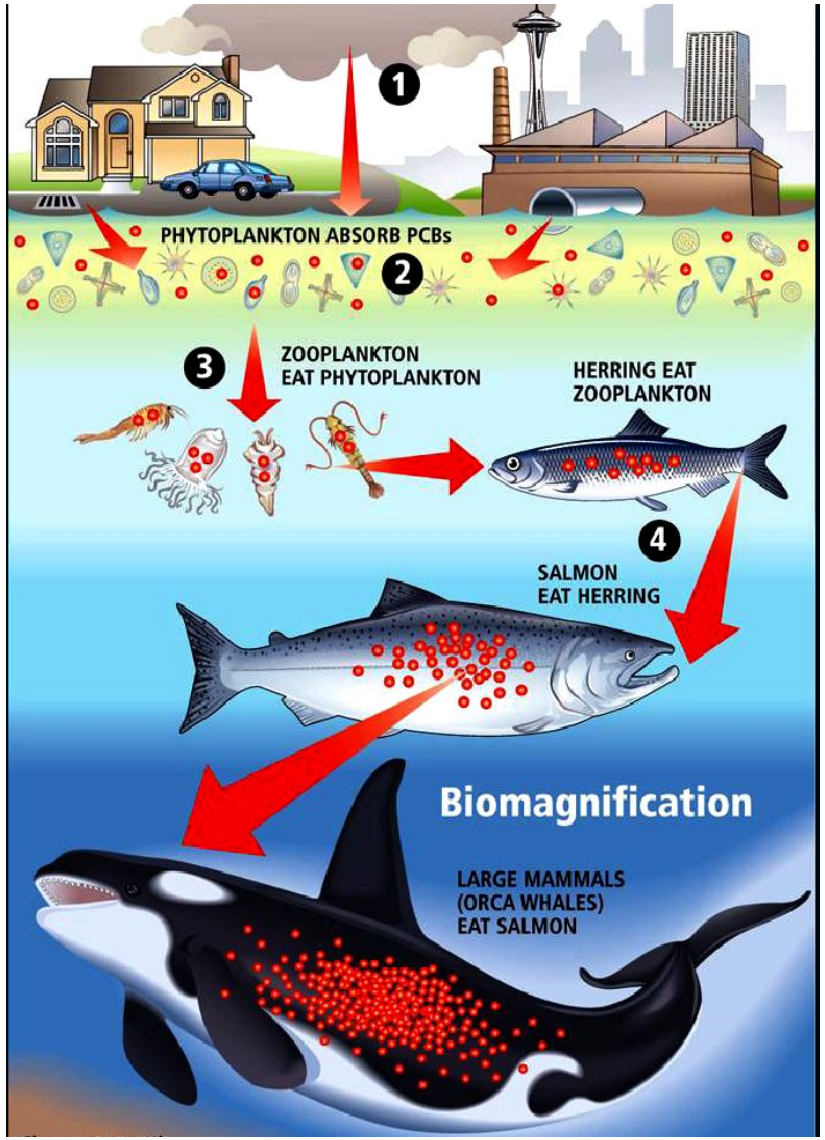

From: https://www.blue-growth.org/Plastics_Waste_Toxins_Pollution/PCBs_Poly_Chlorinated_Biphenyls.htm

WHAT ARE PCBs?

PCBs build up in the environment and can harm your health. They accumulate in fish and marine mammals, reaching levels that may be many thousands of times higher than in water.

The manufacture of PCBs was banned in the U.S. in 1977, but PCBs can still be released to the environment from:

- hazardous waste sites;
- improper disposal of wastes and consumer products;
- leaks from old electrical transformers containing PCBs;
- burning of some wastes in incinerators

The most important route of PCB exposure is through consuming fish contaminated with PCBs.

From: https://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=140&tid=26

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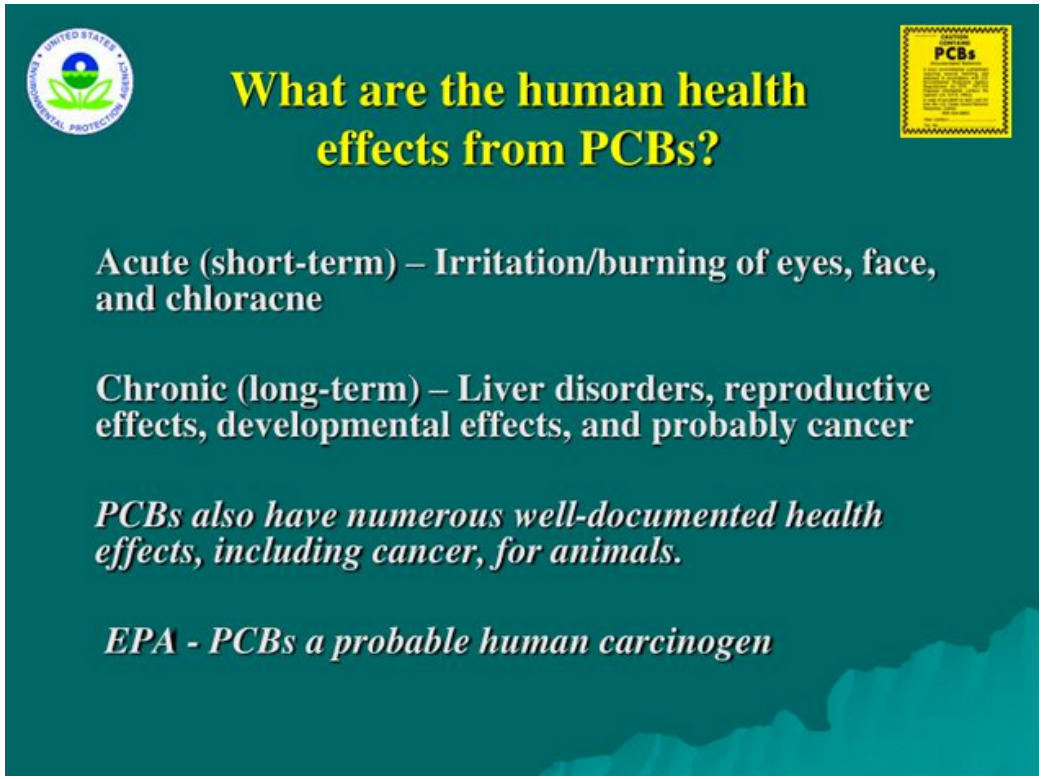
WHAT ARE PCBs?



High exposure to PCBs can cause skin conditions such as acne and rashes. High exposure is also associated with possible liver damage and cancer.

Babies of women who ate large amounts of PCB-contaminated fish showed problems with motor skills and a decrease in short-term memory for several years.

Other studies suggest that children born to and nursed by mothers exposed to high levels of PCBs have compromised or damaged immune systems.

From: https://www.slideserve.com/yachi/pcbs-in-building-materials

From: https://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=140&tid=26

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SALMON ADVISORIES: PUGET SOUND & LOWER DUWAMISH RIVER

EPA United States Environmental Protection Agency

Integrated Risk Information System

HOW DO WE KNOW THE AMOUNT OF PCBs THAT IS SAFE TO INGEST?

From: https://www.epa.gov/iris

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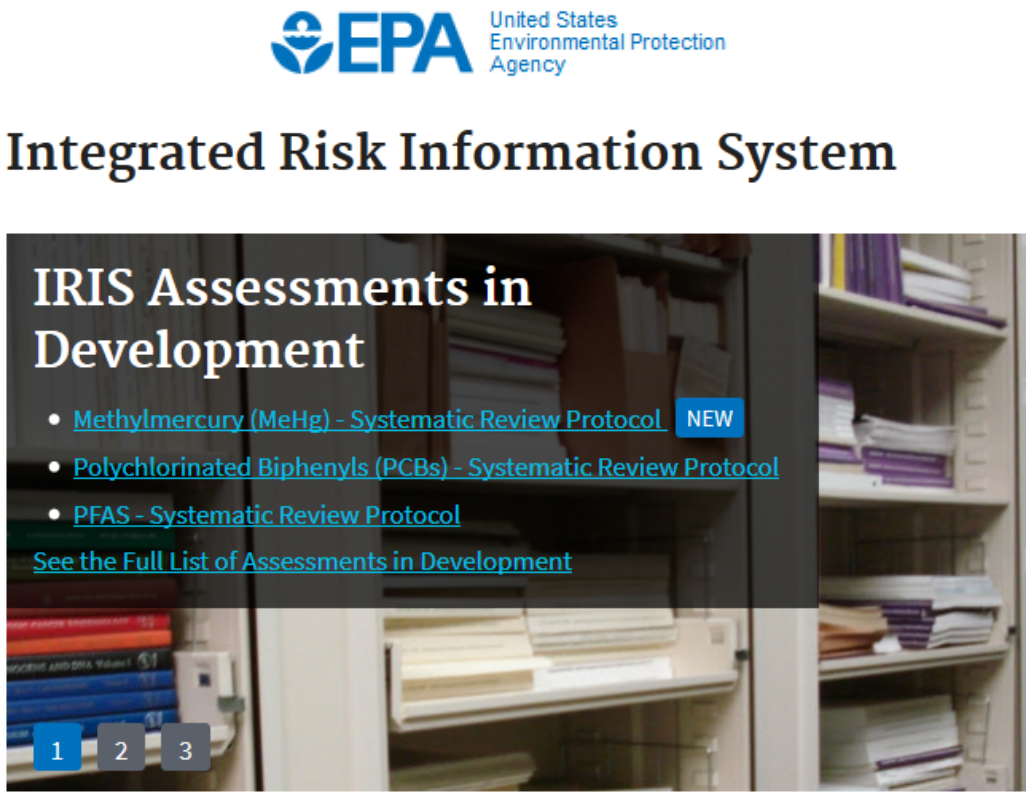
HOW MUCH PCB CONTAMINATED FISH IS SAFE TO EAT?



Different agencies use similar studies to determine the amount of PCBs that is safe to ingest, but they use different terms for this amount.

EPA's Integrated Risk Information System (IRIS) uses the term Reference Dose (RfD)

The Agency for Toxic Substances and Disease Registry (ATSDR) uses the term Minimal Risk Level (MRL)

Others use Acceptable Daily Intake (ADI)

From: https://www.epa.gov/iris

SALMON ADVISORIES: PUGET SOUND & LOWER DUWAMISH RIVER

United States Environmental Protection Agency

I.A.1. Oral RfD Summary

Critical Effect	Experimental Doses*	UF	MF	RfD
Ocular exudate, inflamed and prominent Meibomian glands, distorted growth of finger and toe nails; decreased antibody (IgG and IgM) response to sheep erythrocytes **Monkey Clinical and Immunologic Studies** **Arnold et al., 1994a,b; Tryphonas et al., 1989, 1991a,b**	NOAEL: None LOAEL: 0.005 mg/kg-day	300	1	2E-5 mg/kg-day

EPA and ATSDR indicate that the amount of PCBs that is safe to ingest every day for a ~155lb (70Kg) adult is: 0.02 ug/Kg/day

Note: EPA has determined that PCBs are “probable human carcinogens,” which means there is strong evidence that they cause cancer in animals, but not strong evidence in humans.

https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0389_summary.pdf

https://www.atsdr.cdc.gov/toxprofiles/tp17.pdf

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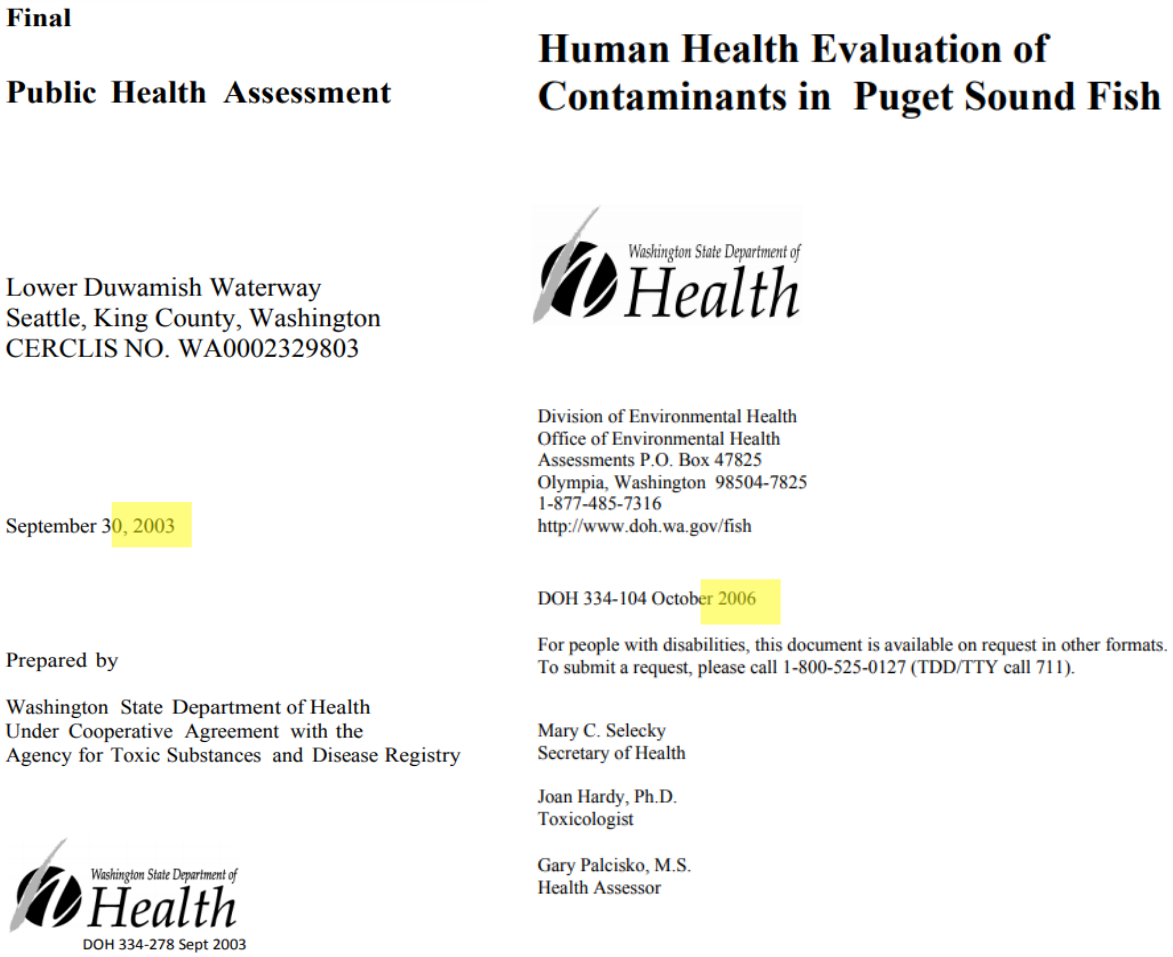
SALMON ADVISORIES: PUGET SOUND & LOWER DUWAMISH RIVER



Final

Public Health Assessment

Human Health Evaluation of Contaminants in Puget Sound Fish

Lower Duwamish Waterway
Seattle, King County, Washington
CERCLIS NO. WA0002329803

September 30, 2003

Prepared by

Washington State Department of Health
Under Cooperative Agreement with the
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Washington State Department of Health
DOH 334-278 Sept 2003

Washington State Department of Health

Division of Environmental Health
Office of Environmental Health
Assessments P.O. Box 47825
Olympia, Washington 98504-7825
1-877-485-7316
http://www.doh.wa.gov/fish

DOH 334-104 October 2006

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To submit a request, please call 1-800-525-0127 (TDD/TTY call 711).

Mary C. Selecky
Secretary of Health

Joan Hardy, Ph.D.
Toxicologist

Gary Palcisko, M.S.
Health Assessor

Remember: In the Duwamish, fish advisories are based on levels of polychlorinated biphenyls (PCBs).

https://www.doh.wa.gov/Portals/1/Documents/Pubs/334-278.pdf
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SUMMARY OF DATA FOR PCB LEVELS IN SALMON

Salmon Species	Location	Mean PCB Level (ng/g)	Range PCB Levels	Number Samples	Meal Limit Calculation *per month* (risk based)	Advisory Limits *per month* (adjusted for benefits)	Comments
Chinook							
2006 DOH Publication	**All Puget Sound**	**54***	**11--223**	**210**	**3.5**	**4 (1/wk)****	***Skinless fillets only / **assumes cooking per DOH recs**
2006 DOH Publication	**Duwamish River**	**57.2**		**65***	**3**	**"**	* 31 composite, 34 individual samples
2003 DOH Publication	**Duwamish River**	**55**	**64***	**45**	**3.7**		* 95% Upper Confidence Interval
2016 NOAA Publication	**Duwamish River**	**56**		**65**			
2016 NOAA Publication	**Puget Sound**	**76**		**28**			
2016 NOAA Publication	**Alaska**	**7.7**	**5--11**	**53**			
Coho							
2006 DOH Publication	**All Puget Sound**	**31.8***	**5--126**	**221**	**5.9**	**8-12 (2-3/wk)****	***Skinless fillets only / **assumes cooking per DOH recs**
2006 DOH Publication	**Duwamish River**	**39.6**		**45***	**4**	**"**	* 44 composite, 1 individual samples
2003 DOH Publication	**Duwamish River**	**39**	**45***	**45**	**5.2**		* 95% Upper Confidence Interval
2016 NOAA Publication	**Puget Sound**	**31**	**27--35**	**157**			
2016 NOAA Publication	**Alaska**	**2.9**	**1.6--4**	**22**			
Sockeye							
2016 NOAA Publication	**Alaska**	**14.4**	**3.6--130**	**142**			
2016 NOAA Publication	**British Columbia**	**5.2**	**1.5--13**	**52**			
Pink							
2016 NOAA Publication	**Alaska**	**2.2**	**1.3--3**	**25**			
Chum							
2016 NOAA Publication	**Alaska**	**2.7**	**2--3.2**	**24**			

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ENVIRONMENTAL & OCCUPATIONAL HEALTH SCIENCES

PCB LEVELS IN SALMON USED FOR DOH ADVISORY*

Human Health Evaluation of Contaminants in Puget Sound Fish

Washington State Department of Health

Division of Environmental Health
Office of Environmental Health
Assessments P.O. Box 47825
Olympia, Washington 98504-7825
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Toxicologist

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Health Assessor

https://www.doh.wa.gov/Portals/1/Documents/Pubs/334-104.pdf

Table 3. (cont.) Summary of mercury (ppm, wet weight) and PCBs (ppb, wet weight) measured in four species of rockfish, English sole, Chinook salmon and coho salmon from Puget Sound.

	Mercury			Total PCBs (Aroclors)[a]			Total PCBs (Aroclor Equivalent)[b]		
	n	Range (ppm)	Mean (ppm)	n	Range (ppb)	Mean (ppb)	n	Range (ppb)	Mean (ppb)
ENGLISH SOLE	577	0.017-0.14	0.060	434	2-462	38.6	169	4-214	46.6
Urban	256	0.023-0.140	0.072	191	6-462	73.6	82	12-214	74.1
Near-urban	81	0.020-0.118	0.053	57	3-76	17.2	27	13-96	36.2
Non-urban	240	0.017-0.130	0.051	186	2-52	9.3	60	4-39	13.7
SALMON									
Chinook									
All of Puget Sound	106	0.051-0.160	0.093	210	11-223	54.0	NA	NA	NA
In-river[c]	78	0.058-0.160	0.096	176	11-223	50.2	NA	NA	NA
Marine[d]	28	0.051-0.130	0.082	34	21-212	73.2	NA	NA	NA
Central Sound	22	0.051-0.120	0.074	18	21-170	75.6	NA	NA	NA
South Sound	6	0.092-0.130	0.113	16	24-212	70.6	NA	NA	NA
Coho									
All of Puget Sound	225	0.008-0.110	0.039	221	5-126	31.8	224	16-106	35.5
In-river[c]	183	0.008-0.110	0.038	175	5-98	31.1	139	17-82	34.6
Marine[d]	32	0.028-0.071	0.051	46	8-126	34.4	42	21-106	42.1
Minter Creek and Wallace River Hatchery	10	0.020-0.043	0.029	NA	NA	NA	43	16-106	32.1
Central Sound	26	0.028-0.069	0.049	20	8-61	18.3	10	30-59	46.8
South Sound	6	0.045-0.071	0.057	26	18-126	46.8	32	21-106	40.6

Note: Means reflect equal weighting of individual and composite samples.
[a] Sum of Aroclors 1248, 1254, and 1260.
[b] Approximation of equivalent Aroclor concentration from HPLC data.
[c] "In-river" refers to nearshore areas near rivers and river mouths from which salmon most likely originated.
[d] "Marine" refers to offshore areas where the origins of salmon are unknown.

* Based on discussions with Dave McBride from WA State Department of Health

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ADDITIONAL DATA ON PCB LEVELS IN SALMON

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Table D3. Estimated meals per month for Chinook salmon from Puget Sound, based on contaminant concentrations for each station and chemical.

Location	Mercury				Total PCBs (Aroclors)		
	Type	N	Mean (ppm)	Meals/ month	N	Mean (ppb)	Meals/month
In-river Fisheries							
Nooksak River	C	18	0.087	9	28	37.9	4
Skagit River	C and I	18 C	0.100	8	3 I 26 C	40.6	4
Duwamish River	C and I	18 C	0.102	8	34 I 31 C	57.2	3

C = Composite sample
I = Individual sample

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ADDITIONAL DATA ON PCB LEVELS IN SALMON

Human Health Evaluation of Contaminants in Puget Sound Fish

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Table D4. Estimated meals per month for coho salmon from Puget Sound based on contaminant concentrations for each station and chemical.

Location	Mercury				Total PCBs (Aroclors)			Total PCBs (Sum of 15 congeners Aroclor equivalent)		
	Type	N	Mean (ppm)	Meals/ month	N	Mean (ppb)	Meals/ month	N	Mean (ppb)	Meals/ month
In-river Fisheries										
Nooksak River	C	18	0.041	20	38	24.7	7	20	26.6	6
Skagit River	C and I	56C	0.039	21	2 I 26 C	24.0	7	38 C	36.4	4
Duwamish River	C and I	58 C	0.030	27	1 I 44 C	39.6	4	53 C	33.6	5

ADDITIONAL DATA ON PCB LEVELS IN SALMON

Final

Public Health Assessment

Lower Duwamish Waterway
Seattle, King County, Washington
CERCLIS NO. WA0002329803

September 30, 2003

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Washington State Department of Health
DOH 334-278 Sept 2003

Contaminant concentrations used to estimate exposure to contaminants in Duwamish River fish are given below in Table C2.

Table C2. Contaminant concentrations used to estimate exposure from consumption of fish from the Lower Duwamish Waterway, Seattle, Washington

Fish Species	Arsenic [a] (mg/kg)			Cadmium (mg/kg)			Chlordane (ug/kg)			cPAHs (ug/kg)			DDE (ug/kg)			Mercury [c] (ug/kg)			Total PCBs [b] (ug/kg)		
	Mean	95 UCL	n	Mean	95 UCL	n	Mean	95 UCL	n	Mean	95 UCL	n	Mean	95 UCL	n	Mean	95 UCL	n	Mean	95 UCL	n
English sole	10	12	9	0.02	0.05	3	1.1	1.3	9	26	41	6	2.7	5.9	9	54	61	24	267	312	21
Coho	0.8	0.9	18	NA	NA	NA	0.9	1.1	57	42	45	16	8.3	9	57	32	37	16	39	45	45
Chinook	1	1.2	18	NA	NA	NA	1.2	1.3	83	41	44	19	19	22	83	102	124	18	55	64	65
Quillback rockfish	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.04	0.04	1	408	438	8	292	336	5
Red Rock Crab	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	63	88	9	110	152	9
Dungeness Crab [f]	9.9	12.5 [f]	2	0.02	0.02	2	NA	NA	NA	40	40	2	NA	NA	NA	90	110	3	130	177	3
Mussels	0.8	0.9	63	0.43	0.47	63	3.4		27	42	43	62	0.7	0.7	27	11	15	62	29	34	60
Perch [g]	1.3	1.4 [f]	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	15	20	9	111	140	9

a = Arsenic concentrations are given as total arsenic. Ten percent of this value was used in dose calculations to represent the amount of inorganic arsenic, to be consistent with EPA's RfD and cancer slope factor, both of which are based on exposure to inorganic arsenic.
b = Sum of Aroclors. The predominant Aroclors detected in Puget Sound fish are Aroclor 1254 and Arolcor-1260
c = Mercury concentrations are given as total mercury. All measured mercury is assumed to be in the methylmercury form for comparison with EPA's RfD for methylmercury. f = Represents maximum value detected.
g = striped perch

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ADDITIONAL DATA ON PCB LEVELS IN SALMON

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DOH 334-278 Sept 2003

Table 10. Meal limits based on PCB, mercury, and DDE contamination in Lower Duwamish Waterway fish, Seattle, Washington.

Fish Species	Recommended 8 ounce meals per month	
	Developmental [b]	Immune [c]
English Sole	0.9	0.7
Perch	2.1	1.7
Chinook	3.0	3.7
Coho	5.0	5.2
Red Rock Crab	1.9	1.7
Rockfish [a]	0.6	0.6

a = Rockfish were sampled from Elliot Bay near Harbor Island
b = Based on developmental endpoint of PCBs, mercury, and DDE, assuming a female body weight of 60 kg
c = Based on the Immune endpoint of PCBs, assuming an adult body weight of 70 kg

https://www.doh.wa.gov/Portals/1/Documents/Pubs/334-278.pdf

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ADDITIONAL STUDIES OF PCB LEVELS IN SALMON

NOAA Technical Memorandum NMFS-NWFSC-135

Exposure to a Mixture of Toxic Chemicals:
Implications for the Health of Endangered Southern Resident Killer Whales

doi:10.7289/V5/TM-NWFSC-135

Teresa M. Mongillo, Gina M. Ylitalo,[1] Linda D. Rhodes,[1]
Sandie M. O'Neill,[1,2] Dawn P. Noren,[3] and M. Bradley Hanson[3]

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November 2016

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northwest Fisheries Science Center
https://www.nwfsc.noaa.gov/index.cfm

Table 2. Percent lipid and POP concentrations (ng/g wet weight) of adult and subadult Pacific salmon sampled in terminal areas. Terminal areas include coastal marine waters and river mouths through which fish migrate en route to their natal streams. NR = not reported.

Species	Region	Subregion	Population	*n*	Tissue Analyzed	Lipids (%)	PCBs	PBDEs	DDTs	Reference(s)
Chinook salmon	Alaska	unknown	unknown	2	muscle, no skin	NR	5.6	0.95	NR	4
	Alaska	Aleutian Islands	unknown	3	muscle, skin	7.6	5.0	0.71	22	14, 15[a]
	Alaska	SE Alaska/Gulf of Alaska/Bering Sea	unknown	35	muscle, no skin	9.7	11	0.53	7.1	21
	Alaska	SE Alaska	unknown	3	muscle, skin	NR	8.0	0.50	NR	5[a], 6[a]
	Alaska	South Central	River	10	muscle, no skin	NR	9.1	NR	9.8	13
		Alaskan Chinook salmon average				**8.7**	**7.7**	**0.67**	**13.0**	
	British Columbia	BC North Coast	Skeena	30	whole body	NR	7.3	0.08	7.3	11
	British Columbia	Fraser River	Thompson	6	muscle, no skin	10	9.1	NR	1.5	1
	British Columbia	Fraser River		13	whole body	NR	9.4	0.80	6.6	11
	British Columbia	Fraser River	Thompson	7	muscle, no skin	12	8.6	1.54	7.7	17[b]
	British Columbia	Fraser River	Shuswap	2	muscle, no skin	3.0	9.8	NR	5.5	17[b]
	British Columbia	Fraser River	Harrison	6	muscle, no skin	5.4	47	17.7	4.3	1
		Fraser River Chinook salmon average (excluding Harrison)				**8.3**	**10**	**1.67**	**5.7**	
		British Columbia Chinook salmon average				**7.6**	**15**	**4.87**	**5.5**	
	Washington	Puget Sound	Nooksack River	28	muscle, no skin	3.5	37	NR	NR	12
	Washington	Puget Sound	Skagit River	29	muscle, no skin	4.8	40	NR	NR	12
	Washington	Puget Sound	Duwamish River	65	muscle, no skin	7.3	56	NR	NR	12
	Washington	Puget Sound	Nisqually River	20	muscle, no skin	3.8	41	NR	NR	12
	Washington	Puget Sound	Deschutes River	34	muscle, no skin	1.7	59	NR	NR	12
	Washington	Puget Sound	Puget Sound mixed	28	muscle, no skin	4.8	76	NR	NR	12
	Washington	Puget Sound	Duwamish River	3	whole body	6.4	35	6.43	18.3	1
	Washington	Puget Sound	Deschutes River	4	whole body	4.3	56	NR	NR	1
	Washington	Puget Sound	Deschutes River	10	muscle, no skin	1.0	49	NR	NR	8
	Washington	Puget Sound	Issaquah Creek	10	muscle, no skin	0.6	49	NR	NR	8
	Washington	Puget Sound	Puget Sound mixed	36	whole body	NR	43	18.9	29.1	11

[a] Value estimated from figure.
[b] Value estimated from reported lipid weight.

https://www.nwfsc.noaa.gov/assets/25/8314_11302016_111957_TechMemo135.pdf

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Table 2 continued. Percent lipid and POP concentrations (ng/g wet weight) of adult and subadult Pacific salmon sampled in terminal areas. Terminal areas include coastal marine waters and river mouths through which fish migrate en route to their natal streams. NR = not reported.

Species	Region	Subregion	Population	*n*	Tissue Analyzed	Lipids (%)	PCBs	PBDEs	DDTs	Reference(s)
Coho salmon	Alaska	unknown	unknown	2	muscle, no skin	NR	1.6	0.32	NR	4
	Alaska	Kodiak	unknown	3	muscle, skin	NR	4.0	0.10	NR	5[a], 6[a]
	Alaska	SE Alaska/ Gulf of Alaska	unknown	14	muscle, no skin	2.9	2.0	0.19	1.5	21
	Alaska	SE Alaska	unknown	3	muscle, skin	NR	4.0	0.10	NR	5a, 6a
	Alaskan coho salmon average					**2.9**	**2.9**	**0.18**	**1.5**	
Coho salmon	British Columbia	unknown	unknown	3	muscle, skin	NR	6.0	0.30	NR	5[a], 6[a]
	Washington	Puget Sound	unknown	32	muscle, no skin	3.1	35	NR	NR	10
	Washington	Puget Sound	Puget Sound mixed	125	muscle, no skin	3.1	27	NR	NR	10
	Washington	Puget Sound	Puget Sound mixed	266	muscle, no skin	3.3	NR	NR	11.7	20
	Washington coho salmon average					**3.2**	**31**	**NR**	**11.7**	
	Oregon	Columbia River	Umatilla River	3	muscle, skin	2.5	35	NR	41.0	18
	Coho salmon average					**3.0**	**14**	**0.20**	**18.1**	

https://www.nwfsc.noaa.gov/assets/25/8314_11302016_111957_TechMemo135.pdf

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NOAA Technical Memorandum NMFS-NWFSC-135

Exposure to a Mixture of Toxic Chemicals:
Implications for the Health of Endangered Southern Resident Killer Whales

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Species	Region	Subregion	Population	*n*	Tissue Analyzed	Lipids (%)	PCBs	PBDEs	DDTs	Reference(s)
Sockeye salmon	Alaska	unknown	Alaska	2	muscle, no skin	NR	3.6	0.21	NR	4
	Alaska	Aleutian Islands	unknown	13	muscle, no skin	5.8	130	NR	6.9	3
	Alaska	Kodiak	unknown	3	muscle, skin	NR	5.0	0.10	NR	5[a], 6[a]
	Alaska	Gulf of Alaska/ Bering Sea	unknown	24	muscle, no skin	8.2	13	0.22	12.0	21
Sockeye salmon	Alaska	Gulf of Alaska/ Bering Sea	Copper River	97	muscle, no skin	5.5	37	NR	12.2	19[b]
	Alaska	SE Alaska	unknown	3	muscle, skin	NR	13.3	0.10	NR	5[a], 6[a]
		Alaskan sockeye salmon average				**6.5**	**14.4[c]**	**0.16**	**10.4**	
	British Columbia	unknown	unknown	3	muscle, skin	NR	8.0	0.10	NR	5[a], 6[a]
	British Columbia	Fraser River	Early Stuart	3	soma[d]	16	13	NR	NR	7[b]
	British Columbia	Fraser River	Early Stuart	5	muscle, no skin	4.0	3.9	NR	NR	7[b]
	British Columbia	Fraser River	Early Stuart	6	muscle, no skin	5.0	6.9	NR	NR	7[b]
	British Columbia	Fraser River	Adams	5	muscle, no skin	8.8	7.7	NR	6.6	17[b]
	British Columbia	Fraser River	Weaver Creek	3	muscle, no skin	1.4	6.8	NR	NR	7[b]
	British Columbia	Fraser River	Weaver Creek	2	muscle, no skin	1.1	3.6	NR	NR	7[b]
	British Columbia	Fraser River	Weaver Creek	2	muscle, no skin	1.5	5.3	NR	NR	7[b]
	British Columbia	Fraser River	Weaver Creek	1	muscle, no skin	1.1	4.0	NR	NR	7[b]
	British Columbia	Fraser River	Weaver	8	muscle, no skin	3.9	6.8	NR	5.4	17[b]
	British Columbia	West Coast VI	Great Central Lake	6	muscle	6.1	1.7	NR	NR	7[b]
	British Columbia	West Coast VI	Great Central Lake	3	muscle	6.6	1.6	NR	NR	2[b]
	British Columbia	West Coast VI	Great Central Lake	2	muscle	1.0	1.5	NR	NR	2[b]
	British Columbia	West Coast VI	Great Central Lake	3	muscle	1.0	2.4	NR	NR	2[b]
	British Columbia sockeye salmon average					**4.4**	**5.2**	**0.10**	**6.00**	
	Sockeye salmon average					**4.8**	**7.6[c]**	**0.15**	**8.6**	

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Species	Region	Subregion	Population	*n*	Tissue Analyzed	Lipids (%)	PCBs	PBDEs	DDTs	Reference(s)
Pink salmon	Alaska	Kodiak	unknown	3	muscle, skin	NR	3.0	0.10	NR	5[a], 6[a]
	Alaska	northern Alaska	unknown	7	canned	6.3	2.6	NR	1.8	22
	Alaska	SE Alaska/GOA	unknown	12	muscle, no skin	3.5	1.3	0.22	0.6	21
	Alaska	SE Alaska	unknown	3	muscle, skin	NR	2.0	0.10	NR	5[a], 6[a]
	Alaskan pink salmon average					**4.9**	**2.2**	**0.14**	**1.2**	
	British Columbia	unknown	unknown	3	muscle, skin	NR	3.0	0.30	NR	5[a], 6[a]
	Pink salmon average					**4.9**	**2.4**	**0.18**	**1.2**	
Chum salmon	Alaska	Kodiak	unknown	3	muscle, skin	NR	2.0	0.10	NR	5[a], 6[a]
	Alaska	SE Alaska	unknown	3	muscle, skin	NR	3.0	0.10	NR	5[a], 6[a]
	Alaska	Bering Sea	unknown	18	muscle, no skin	4.8	3.2	0.16	1.9	21
	Alaskan chum salmon average					**4.8**	**2.7**	**0.12**	**1.9**	
	British Columbia	unknown	unknown	3	muscle, skin	NR	2.0	0.20	NR	5[a], 6[a]
	Chum salmon average					**4.8**	**2.6**	**0.14**	**1.9**	

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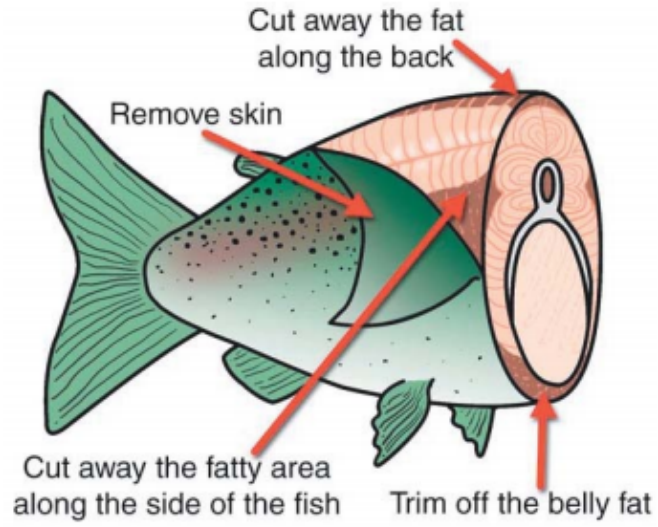
Calculating how much fish is “safe” to eat: Other considerations

DOH Fish Preparation Recommendations

The following recommendations can reduce, by up to 50 percent, PCBs and other contaminants that collect in the fat of fish. Mercury is stored in the muscle (fillet) and cannot be reduced by preparing this way.

- When cleaning salmon remove the skin, fat, and internal organs before cooking.
- Grill, bake, or broil fish so that fat drips off while cooking.
- Do not use the fat drippings for sauces or gravies.



How fish is prepared and cooked can affect how much of the PCBs are still in the fish when you eat it.

The fish consumption calculations account for removing the fatty parts of the fish (skin, belly, head, and organs), but do not account for how the fish is cooked.

PCBs can be further reduced by grilling, baking or broiling in a way that lets the fat drip off while cooking, vs boiling, frying, or cooking the fish whole.

https://www.doh.wa.gov/Portals/1/Documents/Pubs/334-139.pdf

Calculating how much fish is “safe” to eat: Other considerations

The American Heart Association recommends eating fish (particularly fatty fish) at least two times (two servings) a week. Each serving is 3.5 ounce cooked, or about ¾ cup of flaked fish. Fatty fish like **salmon, mackerel, herring, lake trout, sardines and albacore tuna** are high in omega-3 fatty acids.

SALMON ADVISORIES: PUGET SOUND & LOWER DUWAMISH RIVER

Recommended consumption levels are adjusted to reflect the lower levels of PCBs that are expected to be in salmon prepared according to the "Healthy Tips" provided in the advisory.

Thus, the advisory for the number of meals per week is higher than what would be calculated based solely on PCB concentrations in skinless raw fish tissue to promote the consumption of fish.

NOTE: 8 meals/month is considered "Unrestricted (healthy choice)" on DOH website

https://www.doh.wa.gov/DataandStatisticalReports/HealthDataVisualization/fishadvisory

From: https://www.doh.wa.gov/Portals/1/Documents/Pubs/333-084.pdf

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Lon Kissinger	Region 10 Environmental Protection Agency
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