PCBs in State Purchased Products: Fish Hatchery Products 2017 Results

By

Michael Zahn

For the

Environmental Assessment Program

Washington State Department of Ecology

Olympia, Washington

October 2025, Publication 25-03-017

Publication Information

This report is available on the Department of Ecology's website at:https://apps.ecology.wa.gov/publications/SummaryPages/2503017.html.

Data for this project are available in Ecology's Consumer Product Database.[1]

Search Study: PCBs in State Purchased Products – Fish Hatchery Products 2017

The Activity Tracker Code for this study is 25-001.

Suggested Citation
Zahn, M. 2025. PCBs in State Purchased Products: Fish Hatchery Products 2017 Results. Publication 25-03-017. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2503017.html.

Contact Information

Publications Coordinator
Environmental Assessment Program
Washington State Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600
Phone: 564-669-3028

Washington State Department of Ecology – https://ecology.wa.gov

• Headquarters, Olympia	360-407-6000
• Northwest Regional Office, Shoreline	206-594-0000
• Southwest Regional Office, Olympia	360-407-6300
• Central Regional Office, Union Gap	509-575-2490
• Eastern Regional Office, Spokane	509-329-3400

Cover Photo: Chinook salmon, primary food for Southern Resident orca. Photo: NOAA Fisheries

[1] https://apps.ecology.wa.gov/consumerproducts/

PCBs in State Purchased Products

Fish Hatchery Products
2017 Results

by

Michael Zahn

Environmental Assessment Program
Washington State Department of Ecology
Olympia, Washington

Table of Contents

Page

List of Figures **3**

List of Tables **4**

Acknowledgments **5**

Abstract **6**

Introduction **7**

Methods **9**

Sample collection and processing 9

Laboratory analysis and data quality 9

Results **11**

Results for PCB congeners 11

Results for tPCBs 11

Results by product type 11

Discussion **13**

Conclusions **18**

Recommendations **19**

References **20**

Glossary, Acronyms, and Abbreviations **22**

Acronyms and Abbreviations 22

Units of Measurement 23

Appendices **24**

Appendix A. Fish hatchery product component data 24

List of Figures

Page

Figure 1. The general chemical structure of chlorinated biphenyls. 7

Figure 2. Fish feed product component sample comparisons: estimated tPCB and tHexaCB vs total % protein and fat ingredients..... 16

List of Tables

Table 1. Fish hatchery feed product component sample tHexaCB results (ppb). 14

Table 2. Fish feed product component sample comparisons: tPCB and tHexaCB vs total % protein and fat ingredients..... 15

Table 3. Summary statistics: number of tPCB results by concentration range, ppb..... 18

Acknowledgments

The author of this report thanks the following for their contributions to this study:

- Ginna Grepo-Grove
- Dr. Kari Trumbull, PhD
- Chrissy Wiseman

Abstract

Washington State Department of Ecology (Ecology) conducted a study to assess levels of polychlorinated biphenyls (PCBs) in state contract products used at Washington State fish hatcheries in 2017. PCBs are a family of synthetic chemicals that are used in hundreds of industrial and commercial applications due to their non-flammability, chemical stability, high boiling point, and electrical insulating properties. PCBs are identified as persistent, bioaccumulative, and toxic chemicals.

Washington State law, Revised Code of Washington RCW 39.26, requires state agencies to limit the purchase of products and packaging containing PCBs. The Washington State Department of Enterprise Services (DES) implements the law. Fish hatchery products were identified as a subgroup of available Washington state contract products in 2017. Ecology tested 35 fish hatchery product component samples, and all contained detectable levels of PCBs. Among the product types evaluated, fish feed had more total PCBs than fish pharmaceuticals or salts.

Introduction

PCBs are a family of synthetic chemicals consisting of two benzene rings joined together (a biphenyl molecule) and one to 10 chlorine atoms attached to the benzene rings (ATSDR 2000; Figure 1). There are 209 possible configurations of chlorine positions around the biphenyl molecule. The configurations are known as congeners that are designated by numbers 1 through 209 (EPA 2022). The United States restricted the manufacturing of PCBs for intentional use in products more than 40 years ago. PCBs are persistent in the environment, build up in the food chain, and can cause adverse health effects in humans and wildlife, including cancer and harm to the immune, nervous, and reproductive systems (Ecology and Health, 2015).

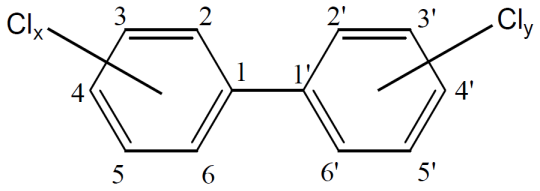

Figure 1. The general chemical structure of chlorinated biphenyls.

Products may still contain PCBs at an annual average concentration of less than 25 parts per million (ppm) with a 50 ppm maximum, according to the U.S. Toxic Substances Control Act (TSCA; EPA, 1979). Green purchasing, also called environmentally preferable purchasing (EPP), is the procurement of goods and services that cause less harm to humans and the environment than competing goods and services that serve the same purpose. Washington state has a broad mandate for EPP activities that includes laws and executive orders that direct state agencies to purchase environmentally preferred products.

Updated in 2014, RCW 39.26 (Procurement of goods and services)[2] directs state agencies to limit the purchase of products and packaging containing PCBs. The Washington State Department of Enterprise Services (DES) implements the law by outlining state purchasing policies and overseeing state master contracts.[3] There is no restriction level for PCB concentrations in products within the law; rather, it specifies that no agency may knowingly purchase products or products in packaging containing polychlorinated biphenyls above the practical quantification limit except when it is not cost-effective or technically feasible to do so (RCW 39.26.280). The DES purchasing preference policy[4] outlines this approach, along with

[2] https://app.leg.wa.gov/rcw/default.aspx?cite=39.26

[3] https://des.wa.gov/

[4] Purchasing Preference for Products and Product Packaging That Do Not Contain Polychlorinated Biphenyls (PCBs) DES-280-00 https://www.des.wa.gov/policies-legal/purchasing-preference-products-and-product-packaging-do-not-contain-polychlorinated-biphenyls-pcbs.

guidelines to incentivize suppliers to provide products and product packaging that do not contain PCBs.

In 2017, the Washington State Department of Ecology (Ecology) and DES identified the need to assess levels of PCBs in products available from state contracts. A previous Ecology study reported the presence of PCBs in fish hatchery feed in the State of Washington (Serdar et.al., 2006). That study investigated the potential for PCBs to be present within fish hatchery products in use at the time that could be introduced directly into fish hatchery water and hatchery fish, identifying a source of environmental release of PCBs.

A new study would assist state agencies in identifying where PCBs may be present, including fish hatchery products available through state contracts in support of EPP. In this study, 35 fish hatchery products (categorized as fish feed, fish pharmaceuticals, and hatchery salts) were studied by Ecology for possible PCBs. The study was performed according to the published Quality Assurance Project Plan (QAPP) and addendum (Sekerak 2016, Trumbull 2017a, 2017b, 2021).

Methods

Sample collection and processing

Ecology evaluated 35 fish hatchery product component samples that were either purchased from an internet supplier or collected from selected Washington state fish hatchery locations from April 19, 2017, to May 9, 2017. Three products were collected from the Cowlitz salmon hatchery (Salkum), and two products were collected from the Cowlitz Trout Hatchery (Toledo) on April 27, 2017. One product was purchased from Forestry Supplier (electronic website purchase) on April 24, 2017. Eight products were collected from the Lakewood Fish Hatchery (Tacoma) on April 20, 2017. Ten products were collected from Minter Creek hatchery (Gig Harbor) on April 19, 2017. Six products were collected from Puyallup fish hatchery (Puyallup) on April 21, 2017, and five products were collected on May 9, 2017, from Spokane hatchery (Spokane).

Fish hatchery samples were labeled with a unique Ecology identification and component number. For example, the pellet fish feed sample MCH-1-1-1 corresponds to: MCH for Minter Creek hatchery, the first number, "1" indicates the first time Ecology collected samples from MCH, the second number, "1" refers to a unique fish hatchery product at the location, and the third number, "1" indicates the first sample from the product. Samples were processed to an appropriate lab analysis size and logged into the database per Ecology Standard Operating Procedures (SOPs) PTP001 and PTP002, respectively (both SOPs were per version 1.0 at the time).

Samples were submitted to the contract lab at ambient temperature instead of at reduced temperature as specified by the QAPP. This deviation is not considered to have adversely impacted the study data quality since fish hatchery products are regularly stored at ambient temperature.

Laboratory analysis and data quality

Analysis for PCBs was performed by ALS Life Sciences – Environmental Division (ALS) in Burlington, Ontario, Canada. Samples were sent to ALS via Manchester Environmental Laboratory (MEL) and followed the quality assurance (QA) system in place at that time. All samples were received in good condition. ALS extracted component samples using EPA Method 1668C. The sample extracts were analyzed for all 209 PCB congeners by high-resolution gas chromatography mass spectrometry in accordance with EPA Method 1668C (EPA 2010).

Ecology's QA Coordinator at MEL performed a stage 4 validation in accordance with the QAPP, EPA Method 1668C, and applicable criteria from the National functional Guidelines for Organic Superfund Methods Data Review (EPA 2009, 2017, 2020). The data were verified to have been generated following the analytical method with no omissions or errors. The project manager also reviewed all the data points. The data, as qualified at the time, were found acceptable for all purposes.

PCB congener concentrations below the limit of quantitation (LOQ) and above the estimated detection limit (EDL) were qualified "J". A "J" qualifier indicates that the analyte was positively identified, and the associated value is an estimate. PCB congener concentrations at levels less than five times the concentrations found in the associated lab method blank were qualified as non-detects: either "UJ" when concentrations were reported below the LOQ or "U" when concentrations were reported above the LOQ. PCB congeners that were tentatively identified ("NJ") by the lab and were also detected in the blank at concentrations less than 5 times the blank value were qualified "NUJ" as non-detects at the EDL.

Measurement quality objectives (MQO) for laboratory control standards, laboratory duplicates, and internal recovery standards were found acceptable as validated at the time. MQO were met with the following exceptions:

- Some data were qualified as "estimated" (J) due to detections that were less than the LOQ, chromatographic interferences, mass resolution, and/or continuing calibration verification limitations.
- Some data were qualified as "tentatively identified" at estimated concentrations due to out-of-control mass-ion abundance ratios
- Some data were qualified as "non-detects" due to contamination in the associated blank(s).
- Some results were qualified "estimated" (J) since the associated lab duplicate did not meet the MQO for the relative percent difference (RPD).
- Some of the data points were qualified using the reviewer's professional judgment.

Total PCB (tPCB) concentrations, calculated by the project manager as the sum of PCB congeners in the sample, include only detected congener results that were either unqualified or were qualified "J," as estimates. Total PCB calculations were qualified "J" when 10% or more of the detected congener concentration results were qualified "J," as estimates. All non-detect PCB congener results (those qualified as NJ, U, UJ, or NUJ) were not included in tPCB and homolog calculations. Homologs are subcategories of PCB congeners that have equal numbers of chlorine substituents. For example, hexachlorobiphenyls (HexaCBs) are all PCB congeners with exactly 6 chlorine substituents that can be in any arrangement (EPA 2022).

All PCB concentrations were reported on an as-received wet weight based on material type. The data results from ALS were reported in parts per trillion, as picogram per gram (pg/g) or nanogram per liter (ng/L). Most data in this report have been converted to nanogram per gram (ng/g), or parts per billion (ppb), for reporting purposes.

Results

Results for PCB congeners

For the assessment of data results in this study, PCB congener, tPCB, and homolog results shown are selected for discussion purposes and do not represent any regulatory levels. Non-regulatory threshold concentrations of 0.5 and 1.0 ppb were used to evaluate study results.

The number of PCB congener results detected at or above 0.5 ppb in each fish hatchery product sample is listed in Table A-3. All but one fish hatchery feed sample (PFH-1-2-1) had at least one PCB congener detected at or above 0.5 ppb. None of the pharmaceutical or salt product component samples resulted in detections at or above this threshold concentration. Sixteen fish hatchery feed product component samples had at least one or more PCB congeners detected at or above 1.0 ppb, with all other fish hatchery product component sample results below this threshold concentration.

Results for tPCBs

All fish hatchery product component samples had detectable tPCBs, with results ranging from 0.107 J parts per trillion (ppt) to 29.9 J ppb (Table A-3)**.** Pharmaceutical sample product component MCH 1-2-1 and feed sample product component MCH-1-5-1 represented the lowest and highest results, respectively. Average tPCB results for all fish feed, pharmaceutical, and salt product component samples were approximately 15.5 J ppb, 163.4 J ppt, and 0.92 ppt J, respectively. Seven feed product component samples (MCH-1-3-1, LFH-1-4-1, LFH-1-5-1, PFH-1-3-1, PFH-1-6-1, PFH-1-7-1, and SPH-1-2-1) were not qualified J for tPCBs. These seven samples represented approximately 21% of the overall product component samples evaluated and approximately 30% of the feed product component samples.

Results by product type

The product type for each sample component was either described on the product label (if available), product safety data sheet (SDS), product data sheet, and/or product website. Data are available in the Ecology database, and select results are shown in the report tables for discussion purposes. Some results are listed in ppt vs ppb due to the approximately 100 times difference in concentration results.

Most fish hatchery product component samples evaluated were fish hatchery feed, consisting of 24 of the 35 tested samples (approximately 68.6%). Feed sample PCB congener results on average were approximately 100 times higher than the pharmaceutical and salts samples. Feed sample MCH-1-5-1 had the highest detected tPCB result at 29.9 J ppb. For all the pharmaceutical and salt samples, PCB congener detections were below the threshold concentrations of 0.5 ppb and 1.0 ppb. All the tPCB results for the pharmaceutical and salt samples were below the threshold of 1.0 ppb.

For pharmaceutical sample tPCB detections, CTH-1-6-1 was the highest (680 J ppt) while MCH-1-9-1 was the lowest (2.15 J ppt). LFH-1-1-1 and MCH-1-2-1 were the highest and lowest tPCB detections of the hatchery salt samples (1.72 J ppt and 0.107 J ppt, respectively).

Discussion

Per the QAPP, the estimated laboratory reporting limit and range of PCB congener results expected were approximately < 1.0 ppb to 2.3 ppm. Results reported in this study are within the expected range, including < 1.0 ppb. Table A-2 displays the distribution of PCB congener results by concentration range (detections greater than 0.5 ppb) in the fish hatchery feed samples.

- All feed product component samples had at least one PCB congener detected at or above 0.5 ppb.
- All feed product component samples (n=24) except eight had at least one PCB congener detection at or above 1.0 ppb.
- None of the pharmaceutical or salt product component samples had PCB congener detection results at or above 0.5 ppb.
- Product component sample CTH-1-6-1 (Aquashade Aquatic Plant Growth Control) had a tPCB result of 680 J ppt (or approximately 0.680 J ppb) and was the highest of the pharmaceutical and salt product categories.
- Co-eluted PCB congeners number 168/153 and 138/163/129 had the highest average result for all samples at approximately 2.8 J ppb.

PCB 153 and 168 are both HexaCB homologs. PCB153 can be used as a marker for PCB exposure in humans, as it is primarily stored in the adipose tissue and skin. People are usually exposed to PCB153 through diet (Ecology and Health 2015). Consumption of hatchery fish containing PCBs is a possible pathway of human exposure.

Of the 209 PCB congeners, there are 12 that have a spatial and electronic structure similar to polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). These 12 PCB congeners (numbers 77, 81, 126, 169, 105, 114, 118, 123, 156, 157, 167, 189) are known as dioxin-like PCBs and considered highly toxic (EPA 2025). Within the study samples, only PCB118 was detected at or above 0.5 ppb at approximately 0.8 J ppb (feed sample components MCH-1-5-1 and LFH-1-7-1, Table A-2).

A previous Ecology study (Serdar et al. 2006) reported the presence of PCBs in fish hatchery feed in the State of Washington using different analytical methodology. Compared with this previous study and a more recent study (Wong 2018), HexaCB again represented the largest homolog group concentration in fish feed product component samples tested. The highest result of tHexaCB in fish feed component samples was found in MCH-1-5-1 at approximately 10.7 J ppb (Table 1).

Table 1. Fish hatchery feed product component sample tHexaCB results (ppb).

Component ID	Total HexaCB
MCH-1-1-1	2.4 J
MCH-1-3-1	6.3 J
MCH-1-4-1	5.2 J
MCH-1-5-1	10.7 J
MCH-1-6-1	8.8 J
LFH-1-3-1	8.5 J
LFH-1-4-1	9.8 J
LFH-1-5-1	8.2 J
LFH-1-6-1	8.1 J
LFH-1-7-1	8.0 J
LFH-1-8-1	2.9 J
PFH-1-1-1	2.3 J
PFH-1-2-1	0.9 J
PFH-1-3-1	5.5 J
PFH-1-5-1	2.5 J
PFH-1-6-1	5.6 J
PFH-1-7-1	2.1 J
CSH-1-2-1	1.8 J
SPH-1-1-1	5.7 J
SPH-1-2-1	6.5 J
SPH-1-3-1	6.8 J
SPH-1-4-1	3.9 J
SPH-1-5-1	6.8 J
CTH-1-2-1	1.8 J

In the current study, fish feed was the largest subset of fish product component samples. Fish feed ingredients can include protein, fats, fiber, oils, etc., as indicated on the product label ingredient information. Samples from this study showed that all fish feed product component samples contained formulations of at least 50-73% protein and fat combined. A correlation of these ingredients to tPCB and tHexaCB results is shown in Table 2 and Figure 2.

Table 2. Fish feed product component sample comparisons: tPCB and tHexaCB vs total % protein and fat ingredients.

Component ID	tPCB, ppb	tHexaCB, ppb	%Total Protein + Fat	% Protein	% Fat
PFH-1-2-1	3.03 J	0.9 J	57	43	14
CSH-1-2-1	4.57 J	1.8 J	65	47	18
CTH-1-2-1	5.19 J	1.8 J	72	52	20
PFH-1-7-1	6.68	2.1 J	68	50	18
PFH-1-1-1	6.65 J	2.3 J	57	43	14
MCH-1-1-1	7.80 J	2.4 J	70	52	18
PFH-1-5-1	5.90 J	2.5 J	72	52	20
LFH-1-8-1	8.61 J	2.9 J	65	47	18
SPH-1-4-1	11.6 J	3.9 J	63	45	18
MCH-1-4-1	14.3 J	5.2 J	72	52	20
PFH-1-3-1	15.4	5.5 J	61	43	18
PFH-1-6-1	16.0	5.6 J	72	50	22
SPH-1-1-1	16.9 J	5.7 J	65	47	18
MCH-1-3-1	18.6	6.3 J	65	47	18
SPH-1-2-1	17.0	6.5 J	70	52	18
SPH-1-3-1	20.0 J	6.8 J	66	50	16
SPH-1-5-1	20.5 J	6.8 J	66	50	16
LFH-1-7-1	20.7 J	8.0 J	70	54	16
LFH-1-6-1	21.4 J	8.1 J	70	54	16
LFH-1-5-1	24.7	8.2 J	57	43	14
LFH-1-3-1	25.1 J	8.5 J	73	53	20
MCH-1-6-1	23.4 J	8.8 J	71	53	18
LFH-1-4-1	27.0	9.8 J	70	50	20
MCH-1-5-1	29.9 J	10.7 J	72	52	20

J = tPCB calculations were qualified “J” when 10% or more of the detected congener concentration results were qualified “J” as estimates.
ppb = parts per billion.
tPCB = total polychlorinated biphenyls.
tHexaCB = total hexachlorobiphenys.

Previous studies have determined that fish feed containing high concentrations of oils, fats, and lipids was found to be the primary source of PCBs in unstocked hatchery-raised fish. Additionally, these studies determined a relationship between PCBs in fish feed and hatchery fish that consume the feed (Carline et al. 2004: Serdar et al. 2006). Results from Table 2 and Figure 2 show that two samples (PFH-1-2-1 and CSH-1-2-1) with lower total concentrations of protein and fat had the lowest tPCB and tHexaCB results from the fish feed samples. Four feed samples with higher total concentrations of protein and fat had higher tPCB and tHexaCB results (LFH-1-3-1, MCH-1-6-1, LFH-1-4-1, and MCH-1-5-1). Sample CTH-1-2-1 had one of the highest total concentrations of protein and fat (minimum 72%) with lower results for tPCB and tHexaCB (5.19 J ppb and 1.8 J ppb, respectively). Overall, there seems to be no significant relationship between concentration (either tPCBs or tHexCBs) and other variables. This could be due to variability in the actual amounts of fat in each sample as compared to the ingredient label.

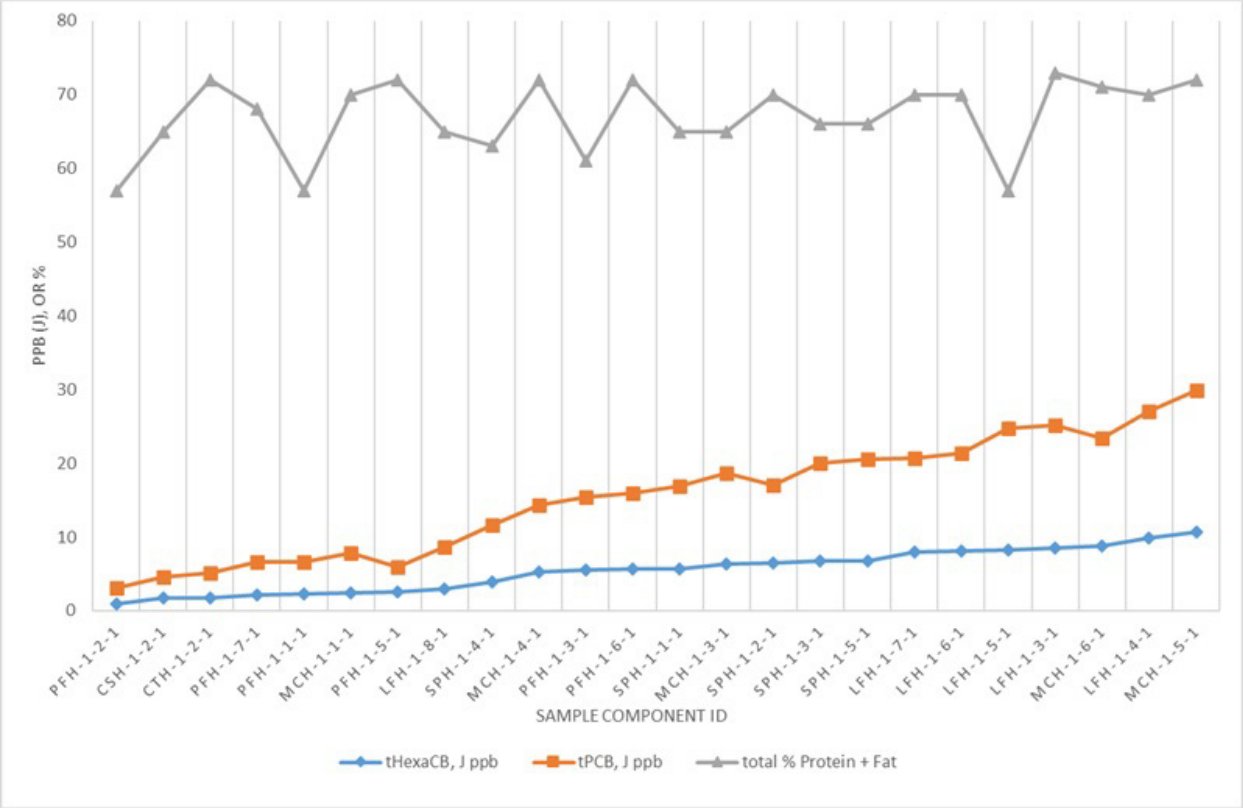

Figure 2. Fish feed product component sample comparisons: estimated tPCB and tHexaCB vs total % protein and fat ingredients.

Colorants (pigments, dyes, etc.) may also have been added to some of the products to give the product a specific color, such as blue, red, green, yellow, etc. It is known that certain colorants may contain PCBs, inadvertent or otherwise (Trumbull 2022). Inadvertent PCBs can be formed

during processes that involve carbon, chlorine, and high temperatures during the production of pigments, dyes, and chlorinated chemicals. Inadvertent PCBs may be released from products during their use and eventual disposal.

Product component samples from this study that had a visual color added (e.g., dye, pigment, colorant, etc.) included fish pharmaceutical samples CTH-1-6-1, FS-1-1-1, and MCH-1-9-1. These three samples accounted for approximately 8.6% of the 35 fish hatchery samples tested in the study. The tPCB and tHexaCB results from these samples were found to be higher than the salt samples and lower than the fish feed samples. Sample CTH-1-6-1 had the highest concentration of these three samples with tPCB at approximately 680 ppt (or 0.680 J ppb). This sample's ingredient label included 23.63% Acid Blue 9 and 2.39% Acid Yellow 23.

Conclusions

Results of this 2017 study support the following conclusions:

- All 35 fish hatchery product component samples tested from a variety of category types had detectable levels of tPCBs.
- The tPCB concentrations ranged from 0.107 J ppt to 29.9 J ppb in the samples. The results were all below the 25 ppm annual average and 50 ppm maximum TSCA limits (Table 3).

Table 3. Summary statistics: number of tPCB results by concentration range, ppb.

Number of Fish Hatchery Product Component Samples	<0.5	0.5 to <1.0	1.0 to <10	10 to <100	≥100
35	10	1	8	16	0

- The exact source of PCBs in the fish hatchery product samples is unknown. tPCBs detected in these fish hatchery product component samples may be due to several sources:
    - Product ingredients used and/or manufacturing of the product, including:
        - Environmental contamination, colorants (pigments, dyes, etc.), and/or additional chemicals throughout the manufacturing process.
        - Packaging, handling, and/or storage of fish hatchery raw material and/or intermediate ingredients prior to final product manufacturing.
    - No conclusions can be drawn from one sample of one product because of the variability of results in the same product with different manufacture dates/lots.

Recommendations

Results of this 2017 study support the following recommendations:

- Purchasing preference for state contracts can be applied to the products or product packaging items if the test results for the specified products or packaging confirm they do not contain PCBs within the limits of the analytical test EPA method 1668C (DES-280-00). Since there are no established standardized practical quantitation limits (PQL) for PCBs in fish hatchery products, further work could include PQL method development.
- Previous studies have determined a loading relationship between PCB concentrations in fish feed and hatchery fish that consume the feed (Carline et al. 2004; Serdar et al. 2006). However, additional research by the Washington Department of Fish and Wildlife indicated that hatchery feed was not a significant source of PCB contamination in adult Chinook salmon that originated from state hatcheries (DFW 2018). Additional studies could be performed, such as the evaluation of new and existing potential sources of PCBs within fish hatchery products. For example, PCB-containing paints that are used to coat the surfaces of the fish tanks (Wong 2018). Additionally, the ranges and variability among different types and batches of products available by state contracts and those in use by hatcheries could be further assessed. A mass balance study approach accounting for all inputs and outputs could be performed (Wong 2018).

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological profile for Polychlorinated Biphenyls (PCBs). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. https://www.atsdr.cdc.gov/ToxProfiles/tp17.pdf

Carline, R.F., P.M. Barry, and H.G. Ketola, 2004. Dietary Uptake of Polychlorinated Biphenyls (PCBs) by Rainbow Trout. North American Journal of Aquaculture 66:91-99.

DES-280-00. 2019. Purchasing Preference for Products and Product Packaging That Do Not Contain Polychlorinated Biphenyls (PCBs). Washington State Department of Enterprise Services. Effective date: January 1, 2019. https://des.wa.gov/sites/default/files/public/documents/About/Procurement_reform/Policies/DES-280-000PCB.pdf.

DFW. 2018. Southern Resident Killer Whale Executive Order Immediate Action Report. Washington State Department of Fish and Wildlife.

Ecology and Health. 2015. PCB Chemical Action Plan. Publication 15-07-002, 223 pages. Washington State Department of Ecology (Ecology) and Washington State Department of Health (Health), Olympia. February 2015. https://apps.ecology.wa.gov/publications/SummaryPages/1507002.html

EPA. 1979. EPA Bans PCB Manufacture; Phases out Uses. U.S. Environmental Protection Agency (EPA) press release on April 19, 1979. Retrieved from https://archive.epa.gov/epa/aboutepa/epa-bans-pcb-manufacture-phases-out-uses.html

EPA. 2009. Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use. EPA 540-R-08-005. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency. January 2009.

EPA. 2010. Method 1668C: Chlorinated Biphenyl Congeners in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS. EPA-820-R-10-005. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Engineering and Analysis Division. April 2010.

EPA. 2017. National Functional Guidelines for Organic Superfund Methods Data Review, EPA-540-R-2017-002. https://www.epa.gov/sites/production/files/2017-01/documents/national_functional_guidelines_for_organic_superfund_methods_data_review_013072017.pdf

EPA. 2020. National Functional Guidelines for High Resolution Superfund Methods Data Review. EPA 542-R-20-007. Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency. November 2020.

EPA. 2022. Learn about Polychlorinated Biphenyls (PCBs). Retrieved from https://www.epa.gov/pcbs/learn-about-polychlorinated-biphenyls-pcbs

EPA. 2025. Learn about Dioxin. Retrieved from https://www.epa.gov/dioxin/learn-about-dioxin

Sekerak, S. 2016. Quality Assurance Project Plan: Product Testing Program Version 1.0. Publication 16-03-113. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/1603113.html

Serdar, D., K. Kinney, M. Mandjikov, and D. Montgomery. 2006. Persistent Organic Pollutants in Feed and Rainbow Trout from Selected Trout Hatcheries. Publication 06-03-017. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/0603017

Trumbull, K. 2017a. PCBs in State Purchased Products – 2017: Addendum to Quality Assurance Project Plan: Product Testing Program, Version 1.0. Publication 17-04-004. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/1704004.html

Trumbull, K. 2017b. Addendum 1 to PCBs in State Purchased Products – 2017: Addendum to Quality Assurance Project Plan: Product Testing Program, Version 1.0. Publication 17-04-045. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/1704045.html

Trumbull, K. 2021. Quality Assurance Project Plan: PCBs in Washington State Products. Publication 21-03-121. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2103121.html

Trumbull, K. 2022. PCBs in Washington State Products: Printing Inks, 2021. Publication 22-03-001. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2203001.html

Wong, S. 2018. Evaluation of Fish Hatcheries as Sources of PCBs to the Spokane River. Publication 18-03-014. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/1803014

Glossary, Acronyms, and Abbreviations

Acronyms and Abbreviations

ALS	ALS Life Sciences – Environmental Division
ATDSR	Agency for Toxic Substances and Disease Registry
DQO	Data quality objectives
DES	Washington State Department of Enterprise Services
DFW	Washington State Department of Fish and Wildlife
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
EPP	Environmentally preferable purchasing
EDL	Estimated detection limit
HexaCB	Hexachlorobiphenyls
J	Individual congener qualified concentration below the LOQ and above the EDL. tPCB calculations were qualified "J" when 10% or more of the detected congener concentration results were qualified "J" as estimates.
LOQ	Limit of quantitation
MQO	Measurement quality objective
MEL	Manchester Environmental Laboratory
NJ	Qualified concentration tentatively identified
NUJ	Qualified non-detect tentatively identified and also detected in the blank at a concentration less than 5 times the blank value
PCB	Polychlorinated biphenyl
ppb	Parts per billion
ppm	Parts per million
ppt	Parts per trillion
PCDD	Polychlorinated dibenzodioxins
PCDF	Polychlorinated dibenzofurans
PQL	Practical quantitation limit
QA	Quality Assurance
QAPP	Quality Assurance Project Plan

RCW	Revised Code of Washington
RPD	Relative percent difference
SDS	Safety data sheet
tHexaCB	Total Hexachlorobiphenyls
tPCB	Total polychlorinated biphenyls
TSCA	Toxic Substances Control Act
U	Qualified non-detect, concentration reported above the LOQ
UJ	Qualified non-detect, concentration reported below the LOQ

Units of Measurement

g	gram, a unit of mass
kg	kilograms, a unit of mass equal to 1,000 grams
kg/d	kilograms per day
m	meter
mg	milligram
mg/kg	milligrams per kilogram (parts per million)
mg/L	milligrams per liter (parts per million)
mL	milliliters
ng/g	nanograms per gram (parts per billion)
ng/kg	nanograms per kilogram (parts per trillion)
ng/L	nanograms per liter (parts per trillion)
pg/g	picograms per gram (parts per trillion)
pg/L	picograms per liter (parts per quadrillion)
µg/g	micrograms per gram (parts per million)
µg/kg	micrograms per kilogram (parts per billion)
µg/L	micrograms per liter (parts per billion)
ww	wet weight

Appendices

Appendix A. Fish hatchery product component data

Table A-1. Fish hatchery product component samples.

Component ID	Component Description	Hatchery Location	Category
CSH-1-1-1	Champion's Choice White Salt Block - Salt	Cowlitz Salmon	Hatchery Salts
CSH-1-2-1	BioClark's Fry 2.0 mm Fish Feed - Pellets	Cowlitz Salmon	Fish Feed
CSH-1-3-1	Solar Naturals Water Softener Solar Salt - Salt	Cowlitz Salmon	Hatchery Salts
CTH-1-2-1	Bio Oregon MedicatedBio #1 Crum Fish Feed - Crumble	Cowlitz Trout	Fish Feed
CTH-1-6-1	Aquashade Aquatic Plant Growth Control - Liquid	Cowlitz Trout	Fish Pharmaceuticals
FS-1-1-1	Hi-Light Blue Dye - Dye	Forestry Supplier	Fish Pharmaceuticals
LFH-1-1-1	American Stockman White Salt Block - Salt Block Chunk	Lakewood	Hatchery Salts
LFH-1-2-1	American Stockman Fine Stock Salt - Salt	Lakewood	Hatchery Salts
LFH-1-3-1	EWOS Micro Crumble 2CR Fish Feed - Crumble	Lakewood	Fish Feed
LFH-1-4-1	EWOS Transfer 1.5 mm Pellet Fish Feed - Pellets	Lakewood	Fish Feed
LFH-1-5-1	EWOS Vita 5 mm Pellet Fish Feed - Pellets	Lakewood	Fish Feed
LFH-1-6-1	EWOS Micro Crumble 1CR Fish Feed - Crumble	Lakewood	Fish Feed
LFH-1-7-1	EWOS Micro Crumble 0CR Fish Feed - Crumble	Lakewood	Fish Feed
LFH-1-8-1	EWOS Pacific 2 mm Pellet Fish Feed- Pellets	Lakewood	Fish Feed
MCH-1-1-1	EWOS Pacific 1.2 mm PelleT Fish Feed - Pellets	Minter Creek	Fish Feed
MCH-1-2-1	Sure Soft Salt Pellets - Salt	Minter Creek	Hatchery Salts
MCH-1-3-1	EWOS Pacific 3.0 mm Pellet Fish Feed - Pellets	Minter Creek	Fish Feed
MCH-1-4-1	Bio-Oregon BioVita Starter #2 Crumble Fish Feed - Crumble	Minter Creek	Fish Feed
MCH-1-5-1	Bio-Oregon BioVita Starter #1 Crumble Fish Feed - Crumble	Minter Creek	Fish Feed
MCH-1-6-1	Bio-Oregon BioClark's Starter #0 Crumble Fish Feed - Crumble	Minter Creek	Fish Feed
MCH-1-7-1	Ovadine Fish Egg Disinfectant - Disinfectant	Minter Creek	Fish Pharmaceuticals
MCH-1-8-1	Virkon Aquatic Disinfectant - Disinfectant	Minter Creek	Fish Pharmaceuticals

Component ID	Component Description	Hatchery Location	Category
MCH-1-9-1	Parasite-s with Highlight - Parasite-s Liquid	Minter Creek	Fish Pharmaceuticals
MCH-1-10-1	Virkon Aquatic Disinfectant Packet - Disinfectant	Minter Creek	Fish Pharmaceuticals
PFH-1-1-1	EWOS Vita 1.5 mm Pellet Fish Feed - Pellets	Puyallup	Fish Feed
PFH-1-2-1	EWOS Vita 4 mm Pellet Fish Feed - Pellets	Puyallup	Fish Feed
PFH-1-3-1	EWOS Calform Floating 9 mm Pellet Fish Feed - Pellets	Puyallup	Fish Feed
PFH-1-5-1	Bio-Oregon BioVita Starter #2 Crumble Fish Feed - Crumble	Puyallup	Fish Feed
PFH-1-6-1	EWOS Transfer 2.0 mm Pellet Fish Feed - Pellets	Puyallup	Fish Feed
PFH-1-7-1	EWOS Pacific 1.5 mm Pellet Fish Feed - Pellets	Puyallup	Fish Feed
SPH-1-1-1	EWOS Pacific 3 mm Fish Feed - Pellets	Spokane	Fish Feed
SPH-1-2-1	EWOS Pacific 1.2 mm Fish Feed - Crumble	Spokane	Fish Feed
SPH-1-3-1	EWOS Brood 5 mm Fish Feed - Pellets	Spokane	Fish Feed
SPH-1-4-1	EWOS Pacific 4 mm Fish Feed - Pellets	Spokane	Fish Feed
SPH-1-5-1	EWOS Brood 7 mm Fish Feed - Pellets	Spokane	Fish Feed

Table A-2. Fish hatchery feed component sample detection results at or above 0.5 ppb (ng/g, wet weight).

Component ID	PCB 44/47/65	PCB 52	PCB 61/70/74/	PCB 49/46	PCB 83/99	PCB 95	PCB 86/87/97/	PCB 90/ 101/	PCB 85/110/11 5/116/	PCB 118	PCB 129/ 138/ 163	PCB 146	PCB 147/ 149	PCB 135/ 151	PCB 153/ 168	PCB 180/ 193	PCB 187
MCH-1-1-1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	0.7	<0.5	<0.5
MCH-1-3-1	<0.5	0.6	0.5	<0.5	0.8	0.7	0.5	0.9	1.0	0.5	1.5	<0.5	1.1	<0.5	1.6	0.6	0.6
MCH-1-4-1	<0.5	0.5	<0.5	<0.5	0.6	0.5	<0.5	0.7	0.7	<0.5	1.2	<0.5	0.9	<0.5	1.4	0.5	0.5
MCH-1-5-1	0.7	1.2	0.7	0.6	1.1	1.1	0.6	1.3	1.4	0.8	2.4	0.6	1.9	0.8	2.8	1.0	1.1
MCH-1-6-1	0.5	0.9	0.6	<0.5	0.9	0.7	0.5	1.1	1.0	0.7	2.0	0.5	1.5	0.7	2.4	0.8	0.8
LFH-1-3-1	0.6	1.0	0.6	0.5	1.0	0.9	0.6	1.2	1.3	0.7	2.0	0.5	1.4	0.7	2.1	0.9	0.9
LFH-1-4-1	0.5	0.7	0.6	<0.5	1.3	0.9	0.6	1.3	1.3	0.7	2.3	0.7	1.6	0.6	2.7	0.9	1.1
LFH-1-5-1	0.6	0.8	0.6	0.5	1.1	1.0	0.6	1.2	1.4	0.6	1.9	0.5	1.5	0.6	2.1	0.8	0.8
LFH-1-6-1	<0.5	0.7	0.6	<0.5	0.9	0.6	0.5	1.0	1.0	0.7	2.0	0.5	1.2	0.6	2.3	0.7	0.7
LFH-1-7-1	<0.5	0.7	0.5	<0.5	0.8	0.7	<0.5	1.1	1.0	0.8	1.9	<0.5	1.3	0.6	2.2	0.7	0.7
LFH-1-8-1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	0.5	<0.5	0.7	<0.5	<0.5	<0.5	0.9	<0.5	<0.5
PFH-1-1-1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	0.7	<0.5	<0.5
PFH-1-2-1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
PFH-1-3-1	<0.5	<0.5	<0.5	<0.5	0.7	0.6	<0.5	0.8	0.8	0.5	1.2	<0.5	0.9	<0.5	1.5	0.6	0.6
PFH-1-5-1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	0.4	<0.5	0.7	<0.5	<0.5
PFH-1-6-1	<0.5	0.5	0.5	<0.5	0.8	0.5	<0.5	0.8	0.7	0.5	1.3	<0.5	0.9	<0.5	1.7	<0.5	0.6
PFH-1-7-1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	0.7	<0.5	<0.5
CSH-1-2-1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5
SPH-1-1-1	<0.5	0.6	0.5	<0.5	0.7	0.6	<0.5	0.8	0.8	0.5	1.4	<0.5	1.0	<0.5	1.5	0.5	0.5
SPH-1-2-1	<0.5	0.6	0.6	<0.5	0.6	0.5	<0.5	0.9	0.7	0.7	1.8	<0.5	0.9	<0.5	1.8	0.5	0.5

Component ID	PCB 44/47/65	PCB 52	PCB 61/70/74/	PCB 49/46	PCB 83/99	PCB 95	PCB 86/87/97/	PCB 90/ 101/	PCB 85/110/11 5/116/	PCB 118	PCB 129/ 138/ 163	PCB 146	PCB 147/ 149	PCB 135/ 151	PCB 153/ 168	PCB 180/ 193	PCB 187
SPH-1-3-1	0.5	0.9	0.6	<0.5	0.8	0.7	0.5	1.0	1.0	0.6	1.6	<0.5	1.1	0.5	1.8	0.6	0.5
SPH-1-4-1	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	0.6	0.6	<0.5	0.9	<0.5	0.6	<0.5	1.0	<0.5	<0.5
SPH-1-5-1	0.6	0.9	0.7	<0.5	0.9	0.8	0.5	1.2	1.2	0.7	1.6	<0.5	1.1	0.5	1.8	0.6	0.6
CTH-1-2-1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

ppb = parts per billion

Table A-3. Sample analysis results by category: tPCB results and congener detection frequencies.

Component ID	Category	tPCB Analysis Result	tPCB Analysis Units	tPCB Analysis Qualifier	Number of PCB Congeners Detected at or Above 0.5 ppb	Number of PCB Congeners Detected at or Above 1.0 ppb
MCH-1-1-1	Fish Feed	7.80	ppb	J	3	0
MCH-1-3-1	Fish Feed	18.6	ppb		13	4
MCH-1-4-1	Fish Feed	14.3	ppb	J	10	2
MCH-1-5-1	Fish Feed	29.9	ppb	J	17	10
MCH-1-6-1	Fish Feed	23.4	ppb	J	16	5
LFH-1-3-1	Fish Feed	25.1	ppb	J	17	7
LFH-1-4-1	Fish Feed	27.0	ppb		16	7
LFH-1-5-1	Fish Feed	24.7	ppb		17	7
LFH-1-6-1	Fish Feed	21.4	ppb	J	15	5
LFH-1-7-1	Fish Feed	20.7	ppb	J	13	5
LFH-1-8-1	Fish Feed	8.61	ppb	J	4	0
PFH-1-1-1	Fish Feed	6.65	ppb	J	3	0
PFH-1-2-1	Fish Feed	3.03	ppb	J	0	0
PFH-1-3-1	Fish Feed	15.4	ppb		10	2
PFH-1-5-1	Fish Feed	5.90	ppb	J	2	0
PFH-1-6-1	Fish Feed	16.0	ppb		12	2
PFH-1-7-1	Fish Feed	6.68	ppb		3	0
CSH-1-2-1	Fish Feed	4.57	ppb	J	1	0
SPH-1-1-1	Fish Feed	16.9	ppb	J	12	3
SPH-1-2-1	Fish Feed	17.0	ppb		12	2
SPH-1-3-1	Fish Feed	20.0	ppb	J	15	5
SPH-1-4-1	Fish Feed	11.6	ppb	J	6	1
SPH-1-5-1	Fish Feed	20.5	ppb	J	15	3
CTH-1-2-1	Fish Feed	5.19	ppb	J	1	0
MCH-1-8-1	Fish Pharmaceuticals	85.2	ppt	J	0	0

Component ID	Category	tPCB Analysis Result	tPCB Analysis Units	tPCB Analysis Qualifier	Number of PCB Congeners Detected at or Above 0.5 ppb	Number of PCB Congeners Detected at or Above 1.0 ppb
MCH-1-10-1	Fish Pharmaceuticals	115	ppt	J	0	0
MCH-1-7-1	Fish Pharmaceuticals	89.2	ppt	J	0	0
FS-1-1-1	Fish Pharmaceuticals	8.91	ppt	J	0	0
CTH-1-6-1	Fish Pharmaceuticals	680	ppt	J	0	0
MCH-1-9-1	Fish Pharmaceuticals	2.15	ppt	J	0	0
MCH-1-2-1	Hatchery Salts	0.107	ppt	J	0	0
LFH-1-1-1	Hatchery Salts	1.72	ppt		0	0
LFH-1-2-1	Hatchery Salts	0.249	ppt	J	0	0
CSH-1-3-1	Hatchery Salts	1.46	ppt	J	0	0
CSH-1-1-1	Hatchery Salts	1.06	ppt	J	0	0

J = tPCB calculations were qualified "J" when 10% or more of the detected congener concentration results were qualified "J" as estimates.
ppb = part per billion, ng/g wet weight.
ppt = part per trillion, pg/g wet weight or ng/L.
tPCB = total polychlorinated biphenyls.