

**Summary of Effects Thresholds to Fish, Birds and Wildlife Based on Concentrations of Toxic Compounds in Fish Tissue, NPS 2007**

<b>Fish Tissue Contaminant Thresholds for Fish and Wildlife Impacts</b>									
<b>Compound</b>	<b>Species</b>	<b>Prey (fish) Life Stage</b>	<b>Exposure</b>	<b>Detection Limits</b>	<b>Effects Threshold (whole body concentrations)</b>	<b>Effects Description-- laboratory toxicity tests and wildlife criteria</b>	<b>Research Study Results and effects on Fish</b>	<b>Source of Toxicity</b>	<b>Reference</b>
<b>Arsenic</b>		freshwater fish			<b>5.4-11.6 µg/g</b> -- reduces survival and growth (whole body concentrations).	Concentrations of As, Cd, Cu, and Pb in the Yukon River Basin (YRB) fish were universally low and did not exceed toxicity thresholds, according to the researchers. Arsenic concentrations were 0.03-0.95 µg/g which did not exceed effect thresholds. <b>Concentrations of 5.4-11.6 µg/g are known to reduce survival and growth in freshwater fish.</b>	The researchers collected and prepared samples of fish surveyed in the YRB (adult northern pike ( <i>Esox lucius</i> ), burbot ( <i>Lota lota</i> ), and longnose sucker ( <i>Catostomus, catostomus</i> ). The risk of contaminants were compared with toxicity thresholds from the scientific literature and risk analysis modeling.	Source of contaminant potentially comes from oil exploration and transportation.	Environmental Contaminants in Fish and their Associated Risk to Piscivorous Wildlife in the Yukon River Basin, Alaska, 2006, Hinck <i>et. al.</i> Arch. Environ. Contam. Toxicol. 51: 661-672.
<b>Cadmium</b>		freshwater fish			<b>&gt;5 µg/g</b> -- potentially lethal to fish. <b>2-8 µg/g</b> -- associated with decreased spawning and reproduction.	Concentrations of As, Cd, Cu, and Pb in YRB fish were overall low and did not exceed toxicity thresholds, according to the researchers. Cd concentrations were less than LOD in pike and burbot, but Cd was detected in all sucker samples at concentrations of 0.04-0.12 µg/g. All Cd concentrations were less than toxicity thresholds. <b>&gt;5 µg/g is potentially lethal to fish. 2-8 µg/g is associated with decreased spawning and reproduction in freshwater fish.</b>	The researchers collected and prepared samples of fish surveyed in the YRB (adult northern pike ( <i>Esox lucius</i> ), burbot ( <i>Lota lota</i> ), and longnose sucker ( <i>Catostomus, catostomus</i> ). The risk of contaminants were compared with toxicity thresholds from the scientific literature and risk analysis modeling.	Source of contaminant potentially comes from oil exploration and transportation.	Environmental Contaminants in Fish and their Associated Risk to Piscivorous Wildlife in the Yukon River Basin, Alaska, 2006, Hinck <i>et. al.</i> Arch. Environ. Contam. Toxicol. 51: 661-672.
<b>Cadmium</b>	Birds and Mammals and higher trophic levels.	freshwater fish			<b>&gt;100 µg/g</b> -- dietary toxicity thresholds where birds/mammals are resistant to Cd. <b>2 µg/g</b> -- evidence of contamination in fish. <b>5 µg/g</b> -- potentially life-threatening to fish. <b>13-15 µg/g</b> -- threat to higher trophic levels.	A review of Eisler (1990) stated the birds and mammals are resistant to Cd, dietary toxicity thresholds were >100 µg/g ww. <b>A Cd concentration of 2µg/g is evidence of contamination in fish. 5 µg/g is potentially life-threatening to fish. 13-15 µg/g is a threat to higher trophic levels.</b>	Concentrations of Cd in fish from the Columbia River Basin (CRB)*** were >LOD (Limits of Detection) (0.043-0.063 µg/g ww) in 27 samples (42%) from 12 stations. Carp and large-scale sucker had greater concentrations compared to other species that were collected.		

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Cadmium		freshwater fish			0.12 -15.6 µg/g ww -- reduced survival, growth or both. 2-8 µg/g ww -- decreased spawning and decreased number of embryos produced.	Whole body concentrations of Cd ranging from 0.12 to 15.6 µg/g ww resulted in reduced survival, growth or both. 2-8 µg/g ww caused decreased spawning and decreased # of embryos produced, review of Jarvinen and Ankley (1999).	The USEPA determined that whole body concentrations for Cd in smallmouth bass and large-scale sucker to range from 0.005-0.019 µg/g ww and 0.013-0.25 µg/g ww respectively in the CRB from 1996-1998, review of USEPA (2002). Concentrations were less than the benchmarks, some 1997 concentrations exceeded historical NCBP concentrations.	Cadmium, resulting from grazing, logging, mining, agriculture, irrigation, and industrial and urban land uses, has been associated with degraded water quality in the CRB, according to sources researched in the BEST report.	Biomonitoring of Environmental Status and Trends (BEST) * Program, Columbia River Basin, Hinck et al, 2004
Cadmium	Birds and Mammals and higher trophic levels.	freshwater fish, fish surveyed: carp, bass, and channel catfish			>100 µg/g -- dietary thresholds where birds and mammals are comparatively resistant to Cd. 2 µg/g -- evidence of contamination in fish. 5 µg/g -- potentially life-threatening to fish. 13-15 µg/g -- threat to higher trophic levels.	Birds and mammals are comparatively resistant to Cd, dietary toxicity thresholds studies (Eisler, 1990) showed levels of >100 µg/g ww. Cd concentration of 2µg/g is evidence of contamination in fish. 5 µg/g is potentially life-threatening to the fish, and 13-15 µg/g is a threat to higher trophic levels.	Historical NCBP concentrations of Cd were generally low in carp (≤0.18 µg/g), bass (≤0.05 µg/g), and channel catfish (≤0.12 µg/g) from 1971 to 1986, but relatively high concentrations were measured in carp in some stations.	The Colorado River Basin (CDRB) region is an area of concern for threatened and endangered species due to elevated Se concentrations in irrigation return flows, and decreasing water availability. Several federal programs are involved in the CDRB including the National Contaminant Biomonitoring Program (NCBP) and the National Water Quality Assessment (NAWQA) Program. NCBP seeks to document temporal and spatial trends of organochlorine and inorganic concentrations in fish.	
Cadmium		freshwater fish, fish surveyed: carp, bass, and channel catfish			0.12-15.6 µg/g ww -- reduced survival, growth or both in freshwater fish. 2-8 µg/g ww -- decreased spawning and embryo production in freshwater fish.	Whole body concentrations of Cd in freshwater fish of 0.12-15.6 µg/g ww resulted in reduced survival, growth or both. Concentrations of 2-8 µg/g ww decreased spawning and embryo production, review of Jarvinen and Ankley (1999).	Concentrations in the CDRB were well below the benchmarks, according to the researchers.	The highest mean concentrations of Se (>1.0 µg/g) were in fish from the CDRB; and, according to the researchers, these concentrations could be a threat to piscivorous wildlife.	Biomonitoring of Environmental Status and Trends (BEST) Program, Colorado River Basin, Hinck et al, 2006

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							Concentrations of Cd from Yukon River Basin (YRB)***** were compared to historical NCBP concentrations in northern pike, longnose sucker, burbot collected near Fairbanks (1971-1986); the researchers found the concentrations were higher in these fish in the 2002 YRB study.		
	Birds and Mammals	freshwater fish, smallmouth bass and large-scale sucker			>100 ug/g ww -- dietary thresholds, whereby birds and mammals are resistant to Cd.	According to the researchers, <b>birds and mammals are resistant to Cd, dietary thresholds were &gt;100 ug/g ww</b> in the studies in a review of Eisler (1990).			
<b>Cadmium</b>	higher trophic levels	freshwater fish			<b>2 µg/g ww and 5 µg/g ww</b> --potentially life threatening to fish. <b>13-15 µg/g ww</b> -- decreased spawning and number of embryos produced in freshwater fish.	Eisler (1990) suggests a Cd concentration of <b>2 µg/g ww and 5 µg/g ww is potentially life threatening to fish. 13-15 µg/g ww is a threat to higher trophic levels. Concentrations of 2-8 g/g ww caused decreased spawning and number of embryos produced in freshwater fish.</b>	Concentrations of Cd were <LOD in northern pike muscle samples from Koyukuk and Innoko NWRs from 1987 to 1988 in a review of Snyder-Conn and others (1992). Concentrations of Cd in fish of the YRB were less than the benchmarks, according to the researchers. Additional details are in the BEST report.		Biomonitoring of Environmental Status and Trends (BEST) Program, Yukon River Basin, Hinck et al, 2004
<b>Chlordane and heptachlor</b>							Wong and others (2000) reported concentrations of chlordane compounds, <i>Trans</i> -non-achlor (≤0.12 µg/g ww) detected in 34%, <i>cis</i> -chlordane (≤0.15 µg/g ww) in 24%, <i>cis</i> -non-achlor (≤0.05 µg/g ww) in 19%, <i>trans</i> -chlordane (≤0.06 µg/g ww) in 17%, oxychlordane (≤0.15 µg/g ww) in 12%, and heptachlor epoxide (≤0.02 µg/g ww) in 6% of the fish samples, according to a review by the researchers.		

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<b>Chlordane (cis-chlordane, trans-chlordane cis-nonachlor, trans-nonachlor, ocychlordane, and heptachlor epoxide (table in report).</b>	Predatory fish and fish-eating birds	freshwater fish			<b>&gt;0.1 µg/g ww</b> -- Cd residues are a concern for the health of predatory fish and fish eating birds	Concentrations of total chlordanes (sum of 6 compounds) in 1997 ranged from 0.03-0.13 µg/g ww, with the maximum concentration measured in male carp from station 42. All geometric station means for total chlordane were ≤0.06 µg/g ww similar for large-scale sucker and carp from the mid-CRB from reports by mid-CRB. <b>Chlordane residues of &gt;0.1 µg/g ww are of concern for the health of predatory fish and fish-eating birds</b> , review of Eisler (1990).	Concentrations of <i>trans</i> -chlordane, <i>cis</i> -non-achlor, <i>trans</i> -nonachlor were <LOD (0.01 µg/g ww) in all samples except for large-scale sucker from Station 506. NCBP concentration from all these compounds except <i>trans</i> -nonachlor were either not detected or detected at trace concentrations (0.005 or 0.01 µg/g ww). Additional details in the BEST report.	Chlordane is a mixture of cyclopentadiene-derived compounds widely used as an insecticide. Concentrations of chlordane are greatest in fish in corn-growing regions, urban areas, and the southeast U.S., and also near production and formulation facilities, review of Schmitt and others (2002). Heptachlor epoxide is a metabolite of heptachlor, minor constituent of chlordane, also used as an insecticide. Oxychlordane is a metabolite of cis-chlordane.	Biomonitoring of Environmental Status and Trends (BEST) Program, Columbia River Basin, Hinck et al, 2004
<b>Chlordane</b>	Predatory fish and fish-eating birds	freshwater fish			<b>&gt;0.03µg/g ww</b> -- total cd concentrations are concern for the health of predatory fish and fish eating birds	<b>Total chlordane concentrations of &gt;0.03 µg/g are of concern for the health of predatory fish and fish eating birds</b> , review of Eisler (1990).	Concentrations of <i>cis</i> chlordane, were >LOD in 52 of 54 (96%) samples representing all stations, and concentrations were >0.01 µg/g ww in carp from stations 315, 324, and 325 and channel catfish from station 324. Historical NCBP concentrations of total chlordane were <0.1 µg/g in fish from 1976 to 1986. Most concentrations from individual metabolites were <LOD. Additional details in the BEST report.	Chlordane is a mixture of cyclopentadiene-derived compounds that was widely used as a soil insecticide.	Biomonitoring of Environmental Status and Trends (BEST) Program, Colorado River Basin, Hinck et al, 2006
<b>Chlordane (cis-chlordane, trans-chlordane cis-nonachlor, trans-nonachlor, ocychlordane, heptachlor, and heptachlor epoxide.</b>	piscivorous wildlife	freshwater fish			<b>100 ng/g</b> -- fish effects threshold for fish and piscivorous birds.	Total Chlordane (sum of the seven compounds) were 0.67-10.3 ng/g in the YRB, which is less than the <b>fish effects thresholds of 100 ng/g for fish and piscivorous birds</b> , review of Eisler (1990).	The researchers collected and prepared samples of fish surveyed in the YRB (adult northern pike ( <i>Esox lucius</i> ), burbot ( <i>Lota lota</i> ), and longnose sucker ( <i>Catostomus, catostomus</i> ). The risk of contaminants were compared with toxicity thresholds from the scientific literature and risk analysis modeling.	Sources of contaminant potentially come from oil exploration and transportation. Organochlorine contaminant concentrations have been low historically and associated with military facilities near Fairbanks, Alaska.	Environmental Contaminants in Fish and their Associated Risk to Piscivorous Wildlife in the Yukon River Basin, Alaska, 2006, Hinck et. al. Arch. Environ. Contam. Toxicol. 51: 661-672.

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<b>Chlordane and heptachlor</b>	Predatory fish and fish-eating birds	freshwater fish			<b>&lt;0.1 µg/g ww</b> -- level of concern for the health of predatory fish and fish eating birds.	All fish samples from the YRB had concentrations less than <b>&lt;0.1 µg/g ww, the level of concern for the health of predatory fish and fish eating birds</b> , review of Eisler (1990).	Concentrations of all six compounds were low (<0.003 µg/g ww) in all composite samples. Concentrations of total chlordanes in 2002 ranged from <0.001 to 0.007 µg/g ww, with the maximum concentration measured in female northern pike from Station 306.	Chlordane and heptachlor are mixtures of cyclopentadiene-derived compounds that were widely used as a soil insecticide; typically, greatest in fish from corn-growing regions, urban areas in the "termite belt" and near production and formulation facilities, review of Schmitt (2002).	Biomonitoring of Environmental Status and Trends (BEST) Program, Yukon River Basin, Hinck et al, 2004**
<b>Chlordane</b>	Mink ( <i>Mustela vison</i> )	Consume both aquatic and terrestrial prey, each varying with habitat. The aquatic portion is non-piscivorous wetland animals (muskrats, amphibians, water fowl); the non-fish species are at same or lower trophic level as the fish consumed.		0.002 mg/kg fish	<b>0.83 mg/kg fish</b> -- Wildlife value (WV) * for Mink	Wildlife Values (tissue based) are derived from the U.S. EPA Great Lakes Water Quality Initiative (GLWQI) and the U.S. EPA report and assess chemical contaminant data, (EPAs values are water based). Exposure parameter (EPAs) values are used to calculate WVs for the piscivorous species. All species are assumed to have a dietary consumption of 100% fish.*	Chlordane concentration is below WV throughout the MAR (Mid-Atlantic Region).	Mercury, chlordane, dieldrin, PCBs and DDT and its metabolites are broadly distributed across the MAR, as a result of atmospheric sources, according to the researchers.	Contamination of fish in streams of the Mid-Atlantic Region (MAR) *: an approach to regional indicator selection and wildlife assessment, Lazorchak J.M., McCormick, F.H, Henry, T.R., and A.T. Herlihy. Environmental Toxicology, 22:3, pp 545-553.*
	River Otter ( <i>Lutra canadensis</i> )	Feed primarily on fish, usually small fish, and large fish--northern pike, walley and trout.		0.002 mg/kg fish	<b>1.14 mg/kg fish</b> -- Wildlife value (WV) for Otter		Chlordane concentration is below WV throughout the MAR (Mid-Atlantic Region).		
	Belted Kingfisher ( <i>Ceryle alcyon</i> )	Feed exclusively on aquatic prey--predominately fish (<10 cm in length) from shallow water.		0.002 mg/kg fish	<b>0.0045 mg/kg fish</b> -- Wildlife value (WV) for Belted Kingfisher		Chlordane concentration exceeded the kingfisher WV for 43.9% (small), 46.5% (large) of the stream length.		
<b>Dacthal</b>						The technical product of dacthal can contain 2,3,7,8-TCDD and HCB as impurities. Dacthal was detected in 24 of 52 samples (46%). Dacthal concentrations were ≤0.01-0.06 µg/g in NCBP samples from the CDRB in a review of Schmitt and others, 1999. The risk of dacthal to fish and wildlife in the CDRB is unknown.	Dacthal is a broad-spectrum herbicide used on ornamental plants, turf, and vegetable and field crops, heavily used in the CDRB.	Biomonitoring of Environmental Status and Trends (BEST) Program, Colorado River Basin, Hinck et al, 2006	

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Dieldrin	piscivorous wildlife	freshwater fish			120-2130 ng/g -- toxicity threshold for freshwater fish and piscivorous birds.	Dieldrin concentrations were 0.17-0.58 ng/g, below <b>toxicity thresholds of 120-2130 ng/g for freshwater fish and piscivorous birds</b> , review of Jarvinen and Ankley (1999).	The researchers collected and prepared samples of fish surveyed in the YRB (adult northern pike (Esox lucius), burbot (Lota lota), and longnose sucker (Catostomus, catostomus). The risk of contaminants were compared with toxicity thresholds from the scientific literature and risk analysis modeling.	Sources of dieldrin potentially come from oil exploration and transportation. Organochlorine contaminant concentrations have been low historically and associated with military facilities near Fairbanks, Alaska.	Environmental Contaminants in Fish and their Associated Risk to Piscivorous Wildlife in the Yukon River Basin, Alaska, 2006, Hinck et. al. Arch. Environ. Contam. Toxicol. 51: 661-672.
Dieldrin		rainbow trout			5.65 µg/g ww -- reduced survival for rainbow trout.	Whole body concentrations of 0.36-2.13 µg/g ww were determined to have no effect on the survival or growth of rainbow trout, review of Macek and others (1970), Shubat and Curtis (1986), and as cited in Jarvinen and Ankley (1999). <b>Rainbow trout experienced reduced survival at concentrations of 5.65 µg/g ww</b> , review of Shubat and Curtis (1986).	Concentrations of dieldrin were ≤LOD (0.0002 µg/g ww) and found in 35% of the samples from 7 sites. Historical NCBP concentrations were ≤LOD (0.01 µg/g ww) in northern pike, longnose sucker, and burbot from station 305. The YRB concentrations of dieldrin are less than benchmarks set to protect fish and piscivorous, according to the researchers.	Most environmental dieldrin is present due to the breakdown of aldrin and has not used in the U.S. since 1974.	Biomonitoring of Environmental Status and Trends (BEST) Program, Yukon River Basin, Hinck et al, 2004
Dieldrin	piscivorous wildlife	rainbow trout			5.65 µg/g ww -- reduced survival in rainbow trout	Whole body concentrations of 0.36-2.13 µg/g ww in juvenile rainbow trout did not effect survival or growth. <b>Concentrations of 5.65 µg/g ww reduced survival in rainbow trout</b> , review of Shubat and Curtis (1986), Macek and others (1970). Dieldrin concentrations of CDRB fish samples are unlikely to represent a significant threat to either fish or piscivorous wildlife, review of Jarvinen and Ankley (1999) and Peakall (1996).	Concentrations of Dieldrin were ≤LOD (0.01 µg/g ww) in carp, bass, and channel catfish from NCBP stations in the CDRB from 1976-1986 (Schmitt and others, 1999) and dieldrin concentrations were ≤0.03 µg/g ww in fish from the Yuma Valley, review of Baker and others (1992).	Most environmental dieldrin is present due to the breakdown of aldrin and was not detected in the CRB samples.	Biomonitoring of Environmental Status and Trends (BEST) Program, Columbia River Basin, Hinck et al, 2004

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<b>Dieldrin</b>		rainbow trout--juvenile			<b>5.65 µg/g ww</b> -- reduced survival in rainbow trout	Whole body concentrations of 0.36-2.13 µg/g ww in juvenile rainbow trout had <b>no effect</b> on survival or growth. <b>Concentrations of 5.65 µg/g ww reduced survival in rainbow trout</b> , review of Macek and others (1970) and Shubat and Curtis (1986).	Concentrations of dieldrin were detected in 47 of 52 (90%) of the samples representing all stations. Most concentrations were ≤LOD (0.1 µg/g) in carp, bass, and channel catfish from the NCBP stations in the CDRB from 1976 to 1986. Dieldrin concentrations in CDRB fish samples are unlikely to represent a significant threat to either fish or wildlife. Additional details are in the BEST report.	Most environmental dieldrin is present due to the breakdown of aldrin, which has not been used in the U.S. since 1974. Dieldrin was not detected in CDRB samples.	Biomonitoring of Environmental Status and Trends (BEST) Program, Colorado River Basin, Hinck et al, 2006
<b>Dieldrin</b>	Mink ( <i>Mustela vison</i> )	Consume both aquatic and terrestrial prey, each varying with habitat. The aquatic portion is non-piscivorous wetland animals (muskrats, amphibians, water fowl); the non-fish species are at same or lower trophic level as fish consumed.		0.002 mg/kg fish	<b>0.02 mg/kg fish</b> -- Wildlife value (WV) for Mink	Wildlife Values (tissue based) are derived from the U.S. EPA Great Lakes Water Quality Initiative (GLWQI) and the U.S. EPA report and assess chemical contaminant data, (EPAs values are water based). Exposure parameter (EPAs) values are used to calculate WVs for the piscivorous species. All species are assumed to have a dietary consumption of 100% fish.	Dieldrin concentration exceeded the mink WV for 1.8% (small), 1.4% (large) fish of the stream length.	Mercury, chlordane, dieldrin, PCBs and DDT and its metabolites are broadly distributed across the MAR, and according to the researchers, are a result of atmospheric deposition.	Contamination of fish in streams of the Mid-Atlantic Region: an approach to regional indicator selection and wildlife assessment, Lazorchak J.M., McCormick, F.H., Henry, T.R., and A.T. Herlihy. Environmental Toxicology, 22:3, pp 545-553.
	River Otter ( <i>Lutra canadensis</i> )	feed primarily on fish, usually small fish, and large fish--northern pike, walley and trout.		0.002 mg/kg fish	<b>0.03 mg/kg fish</b> -- Wildlife value (WV) for Otter		Dieldrin concentration exceeded the mink WV for 0.8% (small), 1.4% (large) of the stream length		
	Belted Kingfisher ( <i>Ceryle alcyon</i> )	feed exclusively on aquatic prey--predominately fish (<10 cm in length) from shallow water		0.002 mg/kg fish	<b>0.36 mg/kg fish</b> -- Wildlife value (WV) for Belted Kingfisher		Dieldrin concentration is below WV throughout the MAR (Mid-Atlantic Region)		
	Brown Pelican ( <i>Pelicanus occidentalis</i> )	freshwater fish			<b>&gt;0.15 µg/g ww</b> --total DDT in fish is potentially harmful to brown pelican, a sensitive avian species.	<b>Concentrations of total DDT in fish &gt;0.15 µg/g ww are potentially harmful to brown pelican, a sensitive avian species</b> , review of Anderson et al (1975) and as low as 0.20 µg/g ww to freshwater fish, review of Newell and others (1987).	The CRB study found that the parent compound, <i>p,p'</i> -DDT exceeded LOD (>0.01 µg/g ww) in 13 of 64 samples (20%) from 6 stations and accounted for 3.1% of total detected DDT ( <i>p,p'</i> -homologs in fish sampled in 1997.		

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DDT	Piscivorous Birds	freshwater fish			1-3 µg/g ww -- harmful to most piscivorous birds 0.5 µg/g ww -- associated toxic effects to freshwater fish.	Concentrations of 1-3 µg/g ww are harmful to most piscivorous birds, review of Blus (1996). Concentrations as low as 0.5 µg/g ww have associated toxic effects to freshwater fish, review of Jarvinen and Ankley (1999).	The major metabolite of <i>p,p'</i> -DDT, <i>p,p'</i> -DDE was detected in 60 of 64 fish composites and accounted for 87% of the total detected DDT. Additional details are in the BEST report.		
		freshwater fish			0.5 µg/g ww -- associated toxic effects to fish.	Concentrations ranged from 0.97-1.7 µg/g ww for <i>p,p'</i> -DDE and 0.004-0.08 µg/g ww for <i>p,p'</i> -DDT. Concentrations in large-scale sucker ranged from 0.028-1.30 µg/g ww for <i>p,p'</i> -DDE and <0.001-.18 µg/g ww for <i>p,p'</i> -DDT. There are associated toxic effects to fish with concentrations as low as 0.5 µg/g ww.	USEPA determined whole body concentrations for <i>p,p'</i> -DDT and <i>p,p'</i> -DDE for a variety of fish species including smallmouth bass and large-scale sucker from the CRB from 1996-1998, review of USEPA (2002).	Organochlorine insecticide and its metabolites are persistent in the environment historically, and as a result of atmospheric transport. DDT, both <i>p,p'</i> and <i>p,o'</i> congeners, were measured in the CRB. Elevated concentrations of DDT residues are most common in cotton-growing areas of the U.S.	Biomonitoring of Environmental Status and Trends (BEST) Program, Columbia River Basin, Hinck et al, 2004
DDT	fish eaten by Brown Pelican ( <i>Pelicanus occidentalis</i> )	freshwater fish			>0.15 µg/g ww -- potentially harmful to brown pelican, a sensitive avian species. 0.20 µg/g ww -- protective wildlife criteria for freshwater fish.	Concentrations of total DDT in fish >0.15 µg/g ww are potentially harmful to brown pelican, a sensitive avian species, review of Anderson et al (1975). Protective wildlife criteria as low as concentrations of 0.20 µg/g ww have been suggested for freshwater fish, review of Newell and others (1987).	The CDRB study found that the parent compound, <i>p,p'</i> -DDT exceeded LOD (>0.0014 µg/g ww) in 40% of the samples, but all concentrations of <i>p,p'</i> -DDT were low. There were relatively high historical concentrations of total DDT, primarily <i>p,p'</i> - DDE in fish from the intensively farmed valleys of the lower Colorado and Gila Rivers. Conversely, Stephens and others (1988) reported concentrations were <LOD in fish in the upper CDRB.		
	Piscivorous Birds	freshwater fish			1-3 µg/g ww -- potentially hazardous to most piscivorous birds. 0.5 µg/g ww -- toxic effects to fish.	Concentrations of 1-3 µg/g ww are potentially hazardous to most piscivorous birds, review of Blus (1996). Whole body concentrations as low as 0.5 µg/g ww have been associated with toxic effects to fish, review of Jarvinen and Ankley (1999).	The major metabolite of <i>p,p'</i> -DDT, <i>p,p'</i> -DDE was detected in all samples. Additional details in the BEST report.	The U.S. banned the use of DDT in 1972. Concentrations of this persistent organochlorine insecticide and its metabolites remain present in the environment from historical use and a result of atmospheric transport. Elevated concentrations of DDT residues are most common in cotton-growing areas of the U.S.	Biomonitoring of Environmental Status and Trends (BEST) Program, Colorado River Basin, Hinck et al, 2006



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DDT	Brown Pelican ( <i>Pelicanus occidentalis</i> ), avian species	freshwater fish			>0.15 µg/g ww -- potentially harmful to brown pelican. 0.20 µg/g ww -- protective wildlife criteria.	Concentrations of total DDT in fish >0.15 µg/g ww are potentially harmful to brown pelican, a sensitive avian species, review of Anderson and others (1975). <b>Protective wildlife criteria as low as 0.20 µg/g ww have been suggested</b> , Newell and others (1987)	The YRB study found that the parent compound, <i>p,p'</i> -DDT at concentrations > LOD (>0.0007-0.0008 µg/g ww) in 2 of 31 samples (6%) .		
	Piscivorous Birds	freshwater fish			1-3 µg/g ww -- harmful to most piscivorous birds.	Concentrations of 1-3 µg/g ww DDT are harmful to most piscivorous birds, review by Blus (1996).	The major metabolite of <i>p,p'</i> -DDT, <i>p,p'</i> -DDE was detected in 25 of 31 composites and accounted for 44% of the total detected DDT.		
		freshwater fish, fish surveyed: northern pike, longnose sucker				0.5 µg/g ww -- associated toxic effects to fish	Associated toxic effects of total DDT to fish have been found with whole body concentrations as low as 0.5 µg/g ww, review of Jarvinen and Ankley (1999).	Yukon River Basin: greatest concentrations of DDT in sampled female northern Pike 0.0091 µg/g ww and male longnose sucker 0.0047 µg/g ww from Station 305, Fairbanks, AK	DDT is common in cotton growing areas of US, and DDT still remains present as a consequence of atmospheric transport and historical use
DDT		cutthroat trout ( <i>O. Clarki</i> )--fry or fingerlings							
		rainbow trout--fry or fingerlings							
		brook trout--fry or fingerlings							
		lake trout ( <i>S. namaycush</i> )--fry or fingerlings							
					0.57 µg/g ww -- reduced survival to cutthroat trout.	Reduced survival to cutthroat trout, review by Cuerrier et al (1967).	Concentrations of total DDT in 2002 were less than these benchmarks, and were not identified as hazardous to fish or wildlife in the YRB	According to the researchers, technical DDT contains <i>o,p</i> -DDT as an impurity--residues and its metabolites remain widespread, review of Schmitt and others, 2002.	
					1.14-1.42 µg/g ww -- reduced survival to rainbow trout.	Reduced survival to rainbow trout, review by Burdock et al (1964).	Additional details in the BEST report.		
					0.46-5.03 µg/g ww -- reduced survival to brook trout.	Reduced survival to brook trout, review by Cuerrier et al (1967), Hopkins et al (1969).			
					2.93 µg/g ww -- reduced survival to lake trout.	Reduced survival to lake trout, review by Cuerrier et al (1967), Hopkins et al (1969).			Biomonitoring of Environmental Status and Trends (BEST) Program, Columbia River Basin, Hinck et al, 2004

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Compound	Species	Prey (fish) Life Stage	Exposure	Detection Limits	Effects Threshold (whole body concentrations)	Effects Description-- laboratory toxicity tests and wildlife criteria	Research Study Results and effects on Fish	Source of Toxicity	Reference
DDT		cutthroat trout ( <i>O. Clarki</i> )--fry or fingerlings			.57 µg/g ww -- reduced survival to cutthroat trout.	<b>Reduced survival to cutthroat trout</b> , review of Cuerrier and others (1967).	Concentrations of total DDT in 2002 were less than these benchmarks and not hazardous to fish or wildlife in the CRB, stated by the researchers.	According to the researchers, technical DDT contains o,p-DDT as an impurity. Residues and its metabolites remain widespread, review of Schmitt and others (2002).	Biomonitoring of Environmental Status and Trends (BEST) Program, Yukon River Basin, Hinck et al, 2003
		rainbow trout			1.14-1.42 µg/g ww -- reduced survival to rainbow trout.	<b>Reduced survival to rainbow trout</b> , review of Currier and others (1967), Hopkins and others (1969).		Technical DDT contains o,p'-DDT--residues of the compound and its metabolites remain widespread, review of Schmitt and others (1985, 1999, 2002).	
		brook trout			0.46-5.03 µg/g ww -- reduced survival to brook trout.	<b>Reduced survival to brook trout</b> , review of Cuerrier and others (1967), Maeke, (1968).			
		lake trout ( <i>S. namaycush</i> )			2.93 µg/g ww -- reduced survival to lake trout.	<b>Reduced survival to lake trout</b> , review of Burdick and others, (1964).			
		coho salmon ( <i>O. kisutch</i> )			1.09-2.76 µg/g ww -- reduced survival to coho salmon.	<b>Reduced survival to coho salmon</b> , review of Johnson and Pecor (1969).			
		Chinook salmon ( <i>O. tshawytscha</i> )			11.6-21.7 µg/g ww -- reduced survival to chinook salmon.	<b>Reduced survival to chinook salmon</b> , review by Buhler and others (1969).			
		Green sunfish ( <i>Lepomis, cyanellus</i> ) and pumpkinseed ( <i>L. gibbosus</i> )--juvenile and adult			24 µg/g ww -- reduced survival to green sunfish and pumpkinseed.	<b>Reduced survival to green sunfish and pumpkinseed</b> , review by Hamelink and others (1971).			
		fathead minnows ( <i>Pimephales promelas</i> )			57-209 µg/g ww -- reduced survival to fathead minnows.	<b>Reduced survival to fathead minnows</b> , review by Jarvinen and others (1977).			
		goldfish ( <i>Carassius auratus</i> )			200-400 µg/g ww -- reduced survival to goldfish.	<b>Reduced survival to goldfish</b> , review by Rhead and Perkins (1984).			

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DDE		Carp and bass, fish nationwide				Carp and bass from the lower Snake River and Middle Columbia River consistently exceeded the 95th percentile (0.33 µg/g ww) for p,p'-DDE concentrations for a nationwide survey 1992-1995 in a review of Wong and others (2000). Also, detected p,p'-DDE (≤1.2 µg/g ww) in 42% of the fish collected in the U.S. fish survey.	The major metabolite of p,p'-DDT, p,p'-DDE was detected in 60 of 64 fish composites and accounted for 87% of total detected DDT. o,p'-DDE is relatively estrogenic, Ackerman and others (2002), Guillette and others (1996), Toppari and others (1996).	Concentrations of p,p'-DDE are due to p,p'-DDT breakdown and use as an insecticide. The compound accounted for 10.2% of the total detected DDT (≥0.01 µg/g ww) and detected in 43 of 64 composite samples. Wong and others, (2000) reported concentrations of o,p'-DDT ≤0.14 µg/g ww.	Biomonitoring of Environmental Status and Trends (BEST) Program, Columbia River Basin, Hinck et al, 2004
		rainbow trout				<b>Dietary exposure to estrogenic chemicals including o,p'-DDT and o,p'-DDE produced hepatotoxicity in rainbow trout potentially cause decreased HIS values, plasma vtg concentrations, and lipid levels. Low concentrations may interfere with the binding of natural ligands to steroid binding receptors and proteins resulting in endocrine disrupting effects such as decreased GSI values.</b>	The o,p' homologs were historically considered relatively benign, multiple studies have found these homologs estrogenic.	Massive amounts of DDT (>25kg/ha) have been applied to cotton growing regions of the lower Gila River from the 1950s-1970's, resulting in some of the highest reported concentrations in the U.S.	

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<b>o,p'-DDT and o,p' DDE</b>		Atlantic croaker				Increases in o,p'-DDT concentrations are associated with increased GSI values in female, but not male Atlantic croaker. O,p'-DDT binds to the different lipoproteins in the plasma of female fish and compartmentalizes in the oocyte, review of Ungerer and Thomas (1996). Continuous exposure to estrogenic compounds such as o,p'-DDT must begin in ovo and continue throughout early development to affect reproductive endpoints in fish, review of Metcalfe and others (2000).	The total risk to fish and wildlife represented by concentrations of o,p'-DDT and its homologs is unknown, according to the researchers.	The U.S. banned the use of DDT in 1972. Concentrations of this persistent organochlorine insecticide and its metabolites remain present in the environment from historical use and a result of atmospheric transport.	Biomonitoring of Environmental Status and Trends (BEST) Program, Colorado River Basin, Hinck et al, 2006
<b>DDT and its metabolites</b>	Mink ( <i>Mustela vison</i> )	Consume both aquatic and terrestrial prey, each varying with habitat. The aquatic portion is non-piscivorous wetland animals (muskrats, amphibians, water fowl); the non-fish species are at same or lower trophic level as the fish consumed.		0.002 mg/kg fish	<b>0.36 mg/kg fish --</b> Wildlife value (WV) for Mink	Wildlife Values (tissue based) are derived from the U.S. EPA Great Lakes Water Quality Initiative (GLWQI) and the U.S. EPA report and assess chemical contaminant data, (EPAs values are water based). Exposure parameter (EPAs) values are used to calculate WVs for the piscivorous species. All species are assumed to have a dietary consumption of 100% fish.	DDT concentration exceeded the mink WV for 1.4% (large) fish of the stream length.	Mercury, chlordane, dieldrin, PCBs and DDT and its metabolites are broadly distributed across the MAR, and according to the researchers, are a result of atmospheric deposition.	Contamination of fish in streams of the Mid-Atlantic Region (MAR) *: an approach to regional indicator selection and wildlife assessment, Lazorchak J.M., McCormick, F.H, Henry, T.R., and A.T. Herlihy. Environmental Toxicology, 22:3, pp 545-553.
	River Otter ( <i>Lutra canadensis</i> )	Feed primarily on fish, usually small fish, and large fish--northern pike, walley and trout.		0.002 mg/kg fish	<b>0.49 mg/kg fish --</b> Wildlife value (WV) for Otter		DDT concentration exceeded the mink WV for 1.4% (large) of the stream length		
	Belted Kingfisher ( <i>Ceryle alcyon</i> )	Feed exclusively on aquatic prey--predominately fish (<10 cm in length) from shallow water.		0.002 mg/kg fish	<b>0.02 mg/kg fish --</b> Wildlife value (WV) for Belted Kingfisher		DDT concentration exceeded the kingfisher WV for 21.2% (small), 26.0% (large) of the stream length		

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DDTr	Pelican		5 years		LOAEL 0.027 (mg/kg-day) --Toxic effect observed: Reproductive effects****	Toxic effect observed: Reproductive effects****			U.S. EPA, Great Lakes Quality Initiative Criteria Documents for the Protection of Wildlife; DDT, Mercury, 2378-TCDD, PCBs, March 1995. Review of Anderson et al., 1975
p,p'-DDT and metabolites	Mammals Avian Wildlife				280 (pg/l) --Wildlife value for mammals. 11 (pg/l) -- Wildlife value for avian wildlife.	Avian wildlife value is one order of magnitude lower than the mammalian value.	Great Lake Wildlife Criteria for total DDT plus its metabolites are assessed for the Great Lakes, other water-bodies may require different bioaccumulation factors.		Great Lakes Quality Initiative Criteria Documents for the Protection of Wildlife; DDT, Mercury, 2378-TCDD, PCBs, March 1995, U.S. EPA, Office of Water, EPA-820-B-95-008, p.86.
DDT	piscivorous aquatic birds	freshwater fish			>1000 ng/g --effects threshold for aquatic birds.	Total DDT (p,p' homologs) concentrations (1.10-13.6 ng/g) were less than the effects thresholds for aquatic birds >1000 ng/g, review of IJC, 1987).	All concentrations of o,p' homologs were ≤1.33 ng/g and not considered a hazard to YRB fish and wildlife.		Environmental Contaminants in Fish and their Associated Risk to Piscivorous Wildlife in the Yukon River Basin, Alaska, 2006, Hinck et al. Arch. Environ. Contam. Toxicol. 51: 661-672.
	piscivorous wildlife	freshwater fish			>150 ng/g --effects thresholds for piscivorous wildlife.	Total DDT (p,p' homologs) concentrations (1.10-13.6 ng/g) were less than the effects threshold for piscivorous wildlife of >150 ng/g, review of Anderson et al. (1975), Blus (1996) and Newell et al. (1987).	The YRB ecosystem might be susceptible to a variety of organochlorine contaminants including p,p'-DDT. The objectives of the study were to document organochlorine and elemental contaminant concentrations in YRB fish, and additionally, to evaluate the risk of these contaminant concentrations to fish and piscivorous wildlife.	Yukon River and its tributaries and habitats have been affected by mining for gold, other precious metals and coal, resulting in trace metal contamination and habitat degradation for andromous fish in the YRB.	
		freshwater fish				>500 ng/g -- effects threshold for fish	Total DDT (p,p' homologs) concentrations (1.10-13.6 ng/g) were less than the effects thresholds for fish >500 ng/g, review of Jarvinen and Ankley, 1999).	The researchers collected and prepared samples of fish surveyed in the YRB (adult northern pike (Esox lucius), burbot (Lota lota), and longnose sucker (Catostomus, catostomus). The risk of contaminants were compared with toxicity thresholds from the scientific literature and risk analysis modeling.	

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Endosulfan		Amphibians, fish, birds and mammals. Adult blue gill.				Amphibians, fish, birds and mammals treated with endosulfan exhibit developmental and reproductive effects, typically associated with endocrine disrupting chemicals, review of Dutta and others (2006) and USEPA (2002). Dutta and others (2006) also reported that significant damage to testicular tissue occurs after exposure to endosulfan and may have deleterious effects on spermatogenesis and male fertility.	Endosulfan II was detected in 24 of the 52 samples (46%) and concentrations were <.01 in all samples except those from station 325. Endosulfan sulfate was detected in most samples. Endosulfan concentrations were ≤0.17 µg/g in whole fish from monitoring studies across the U.S.		
Endosulfan		birds and mammals			30-120 µg/g --exposure impaired genital tract development in birds. 15-75 µg/g --reduced hormone and sperm production in mammals.	<b>Endosulfan exposure of concentrations of 30-120 µg/g impaired genital tract development in birds.</b> <b>Concentrations of 15-75 µg/g reduced hormone and sperm production in mammals,</b> review of USEPA (2002). Effects in fish were observed at much lower concentrations, growth and survival were the most sensitive endpoints, review of USEPA (2002).	Endosulfan II was detected in 24 of the 52 samples (46%) and concentrations were <0.01 in all samples, except those from station 325. Endosulfan sulfate was detected in most samples. Endosulfan concentrations were ≤0.17 µg/g in whole fish from monitoring studies across the U.S.		
Endosulfan		tilapia ( <i>Sarotherodon mossambicus</i> )			0.001 µg/g -- Reproductive effects including decreased GSI, reduced oocyte size, and increased oocyte atresia	<b>Reproductive effects including decreased GSI, reduced oocyte size, and increased oocyte atresia were documented in tilapia after exposure to endosulfan concentrations of 0.001 µg/g,</b> review of Shukla and Pandey (1986).		Endosulfan is a broad spectrum insecticide used on a wide variety of vegetables, fruits, cereal grains, cotton, and ornamental plants. The compound is heavily used in the Lower CDRB. Technical grade endosulfan contains two pure isomers, endosulfan I and II. Endosulfan sulfate is a reaction product of technical endosulfan and can be found in organisms as a result of oxidation of endosulfan I and II.	Biomonitoring of Environmental Status and Trends (BEST) Program, Colorado River Basin, Hinck et al, 2006

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<b>Endrin</b>		Freshwater fish				According to the researchers, toxicity studies documenting whole-body concentrations of fish were not found, and the total risk to fish and wildlife by endrin is unknown in the CDRB.	Endrin was detected in 51 of 52 (98%) samples. Only trace levels of endrin $\geq 0.01 \mu\text{g/g}$ ww have been found at the NCBP sites since 1980, review of Schmitt and others (1999).	Endrin is one of the most toxic organochlorine pesticides to fish, review of Johnson and Finley (1980).	Biomonitoring of Environmental Status and Trends (BEST) Program, Columbia River Basin, Hinck et al, 2004
<b>Endrin</b>	Mink ( <i>Mustela vison</i> )	Consume both aquatic and terrestrial prey, each varying with habitat. The aquatic portion is non-piscivorous wetland animals (muskrats, amphibians, water fowl); the non-fish species are at same or lower trophic level as the fish consumed.		0.002 mg/kg fish	<b>0.04 mg/kg fish --</b> Wildlife value (WV) for Mink	Wildlife Values (tissue based) are derived from the U.S. EPA Great Lakes Water Quality Initiative (GLWQI) and the U.S. EPA report and assess chemical contaminant data, (EPAs values are water based). Exposure parameter (EPAs) values are used to calculate WVs for the piscivorous species. All species are assumed to have a dietary consumption of 100% fish.	Endrin concentration is below the WV throughout the MAR (Mid-Atlantic Region)	Mercury, chlordane, dieldrin, PCBs and DDT (and its metabolites) are broadly distributed across the MAR, and, according to the researchers, a result of atmospheric deposition.	Contamination of fish in streams of the Mid-Atlantic Region (MAR) *: an approach to regional indicator selection and wildlife assessment, Lazorchak J.M., McCormick, F.H. Henry, T.R., and A.T. Herlihy. Environmental Toxicology, 22:3, pp 545-553.
	River Otter ( <i>Lutra canadensis</i> )	Feed primarily on fish, usually small fish, and large fish--northern pike, walley and trout.		0.002 mg/kg fish	<b>0.05 mg/kg fish --</b> Wildlife value (WV) for Otter		Endrin concentration is below the WV throughout the MAR (Mid-Atlantic Region)		
	Belted Kingfisher ( <i>Ceryle alcyon</i> )	Feed exclusively on aquatic prey--predominately fish (<10 cm in length) from shallow water.		0.002 mg/kg fish	<b>0.22 mg/kg fish --</b> Wildlife value (WV) for Belted Kingfisher		Endrin concentration below the WV throughout the MAR (Mid-Atlantic Region)		
<b>HCH</b>	piscivorous wildlife	freshwater fish			<b>&lt;0.10 <math>\mu\text{g/g}</math> --</b> concentrations of lindane $\gamma$ -HCH in whole fish to protect piscivorous wildlife.	Histopathological alterations in the gill, liver, and kidney of freshwater fish have been associated with $\gamma$ -HCH contamination, review of Ortiz and others (2003). <b>Concentrations of <math>\gamma</math>-HCH &lt;0.10 <math>\mu\text{g/g}</math> in whole fish have been suggested to protect piscivorous wildlife,</b> review of Newell and others (1987).	HCH isomers (relatively short-lived) were detected at trace concentrations in most samples. $\alpha$ and $\gamma$ -HCH concentrations were <LOD (0.01 $\mu\text{g/g}$ ) in most samples collected by the NCBP. $\gamma$ -HCH concentrations were $\leq 0.12 \mu\text{g/g}$ in whole fish from monitoring studies across U.S. Concentrations in CDRB fish were well below this benchmark.	A mixture of HCH isomers was historically used on cotton and other crops. Lindane is not heavily used in the CDRB.	Biomonitoring of Environmental Status and Trends (BEST) Program, Colorado River Basin, Hinck et al, 2006

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HCH		fish surveyed in Yukon River Basin region					Four short-lived isomers HCH isomers were measured in the YRB samples. All fish samples had concentrations of <0.01 µg/g ww for these isomers.	A mixture of HCH isomers was historically used on cotton and other crops, only lindane is still used in North America. These compounds stem from agricultural and domestic sources.	Biomonitoring of Environmental Status and Trends (BEST) Program, Yukon River Basin, Hinck et al, 2004
HCB		fish surveyed in Columbia River Basin region				HCB detected at concentrations of ≤0.03 µg/g ww in 7% of fish sampled in a U.S. Survey, review of Wong and others (2000).	In the CRB, all fish samples were ≤LOD (0.01 µg/g ww) in all samples except Station 96, with concentrations of male and female carp 0.01-0.02 µg/g ww, respectively. Historically, the same concentrations ≤LOD (0.01 µg/g ww) were found.	HCB produced for use as a fungicide, a by-product of the production of other chlorinated HCH. HCB is less toxic to fish than many other persistent organochlorines, but contains toxic impurities, review of Schmitt and others, (1999).	Biomonitoring of Environmental Status and Trends (BEST) Program, Columbia River Basin, Hinck et al, 2004
HCB		fish surveyed					In the YRB, all fish samples were <LOD (0.003 µg/g ww) in 2002 and in historical NCBP concentrations	HCB is produced for use as a fungicide and is a bi-product of the production of other chlorinated hydrocarbons. According to the BEST report, the compound is less toxic to fish than many other persistent organochlorines, but contains toxic impurities.	Biomonitoring of Environmental Status and Trends (BEST) Program, Yukon River Basin, Hinck et al, 2003
HCB	piscivorous wildlife	freshwater fish			0.33 µg/g -- toxic thresholds suggested to protect piscivorous wildlife.	Protective criteria for HCB are limited, as stated by the researchers. <b>Concentrations as low as 0.33 µg/g in whole fish have been suggested to protect piscivorous wildlife.</b>	HCB was detected at trace concentrations in 94% of the samples. Historical NCBP concentrations of HCB were <0.01 µg/g, review of Schmitt and others (1999). Concentrations of HCB were ≤27 µg/g in whole fish from monitoring studies across the U.S. HCB concentrations in the CDRB fish are well below the suggested benchmark.	HCB is used as a fungicide, a by-product of the production of other chlorinated HCH, and has been considered less toxic to fish than many other persistent organochlorines that may contain toxic impurities, review of Schmitt and others (1999).	Biomonitoring of Environmental Status and Trends (BEST) Program, Colorado River Basin, Hinck et al, 2006



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Lead		brook trout -- various life stages			<p>≥0.4 µg/g --effects threshold for fish</p> <p>0.4 µg/g ww -- reduced hatch ability in brook trout.</p> <p>4.0-8.8 µg/g ww -- reduced growth in 3rd generation brook trout.</p>	<p>Effects threshold of Pb in fish is ≥0.4 µg/g ww, based on whole body concentrations. Reduced hatch ability (0.4 µg/g ww) and reduced growth (4.0-8.8 µg/g ww) concentrations are suggested for third generation brook trout at various life stages, review of Halcombe and others (1976).</p>	<p>In the CRB concentrations of Pb in fish were &gt;LOD (0.09-0.14 µg/g ww) in 15 of 64 samples (23%) from 8 stations. concentrations ranged from 0.10-9.3 µg/g ww. USEPA determined whole body concentrations for smallmouth bass and large-scale sucker to range from 0.01-0.14 µg/g ww and 0.01-0.49 µg/g ww respectively in CRB from 1996-1998.</p>		
		freshwater fish, large-scale sucker--various life stages			<p>&gt;1.0 µg/g ww -- effects on heme synthesis on carcass concentrations, varying indirectly with Zn burden</p>	<p><b>Effects on heme synthesis have been associated with carcass concentrations of Pb &gt; 1.0 µg/g ww, varying indirectly with Zink burden,</b> review of Schmitt and others (1993). Concentrations in largescale sucker exceeded this value and the lowest thresholds, but all concentrations of largescale sucker from the CRB were &lt;0.34 µg/g ww in 1997.</p>	<p>In the Interior CRB, pollutants of concern were Sox, Nox, ozone, small airborne particles, radionuclides, Hg, PCBs, and dioxins. West of Yellowstone had the greatest concentrations of airborne pollutants, mostly sulfate and nitrates in the CRB. Pb concentrations were greater at high elevation snowpack sites. Agriculture, mining and industry accounted for the other sources.</p>	<p>Biomonitoring of Environmental Status and Trends (BEST) Program, Columbia River Basin, Hinck et al, 2004</p>	
Lead		brook trout--various life stages			<p>≥0.4 µg/g -- effects threshold for fish</p> <p>0.4 µg/g ww -- reduced hatchability in fish</p> <p>4.0-8.8 µg/g ww -- reduced growth in brook trout</p>	<p><b>Effects threshold of Pb in fish is ≥0.4 µg/g ww based on whole body concentrations. Whole body concentrations of 0.4 µg/g ww resulted in reduced hatchability and 4.0-8.8 µg/g ww in reduced growth in third generation brook trout at various life stages,</b> review of Halcombe and others, 1976.</p>	<p>Colorado River Basin (CDRB): Concentrations of Pb in fish were &lt;LOD in all samples except male carp (0.29 µg/g from Station 316. These low concentrations of Pb are similar to previous CDRB studies. The researchers found that CDRB wildlife are not at risk from Pb.</p>		<p>Biomonitoring of Environmental Status and Trends (BEST) Program, Colorado River Basin, Hinck et al, 2006</p>

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		general fish in Yukon region					Yukon River Basin: Concentrations of Pb in fish were <LOD (0.21-0.27 ug/g ww) in all composite samples. Historical concentrations of Pb were also very low, for example <0.2 µg/g ww in northern pike, longnose sucker, and burbot.		
		freshwater fish			≥0.4 µg/g ww -- threshold effects for fish	<b>The threshold for effects of Pb in fish is ≥0.4 µg/g ww based on whole body concentrations</b> , review of Holcombe and others (1999) and Jarvinen and Ankley (1999). The researchers say that Pb is not a contaminant of concern in the YRB.	In the YRB in recent years, whole body concentrations of Pb were <LOD (0.025 µg/g ww) in northern pike samples from the Innoko and Koyukuk NWRs, review of Mueller and Matz (2002) and Snyder-Conn and others (1992). According to the BEST report, Pb is not a contaminant of concern in the Yukon River Basin.		
<b>Lead</b>									
<b>Mercury</b>	Mink ( <i>Mustela vison</i> )	Consume both aquatic and terrestrial prey, each varying with habitat. The aquatic portion is non-piscivorous wetland animals (muskrats, amphibians, water fowl); the non-fish species are at same or lower trophic level as the fish consumed.		0.0025 mg/kg fish	<b>0.07 mg/kg fish --</b> Wildlife value (WV) for Mink	Wildlife Values (tissue based) are derived from the U.S. EPA Great Lakes Water Quality Initiative (GLWQI) and the U.S. EPA report and assess chemical contaminant data, (EPAs values are water based). Exposure parameter (EPAs) values are used to calculate WVs for the piscivorous species. All species are assumed to have a dietary consumption of 100% fish.	Small short-lived fishes represented 83.6% of all individuals collected in the Mid-Atlantic Region, while larger, longer-lived species comprised 16.4%. Hg concentration exceeded the mink Wildlife Value (WV) for 22.7% (small fish), 26.6% (large fish) of stream length.	Mercury, chlordane, dieldrin, PCBs and DDT and its metabolites are broadly distributed across the MAR, and according to the researchers, a result of atmospheric deposition.	Contamination of fish in streams of the Mid-Atlantic Region (MAR) *: an approach to regional indicator selection and wildlife assessment, Lazorchak J.M., McCormick, F.H, Henry, T.R., and A.T. Herlihy. Environmental Toxicology, 22:3, pp 545-553.
	River Otter ( <i>Lutra canadensis</i> )	Feed primarily on fish, usually small fish, and large fish--northern pike, walley and trout.		0.0025 mg/kg fish	<b>0.10 mg/kg fish --</b> Wildlife value (WV) for Otter		Hg concentration exceeded the river otter WV for 9.4% (small), 13.0% (large) of the stream length		
	Belted Kingfisher ( <i>Ceryle alcyon</i> )	Feed exclusively on aquatic prey--predominately fish (<10 cm in length) from shallow water.		0.0025 mg/kg fish	<b>0.03 mg/kg fish --</b> Wildlife value (WV) for Belted Kingfisher		Hg concentration exceeded the kingfisher WV for 72% (small), 71.2% (large) of the stream length		

**Summary of Effects Thresholds to Fish, Birds and Wildlife Based on Concentrations of Toxic Compounds in Fish Tissue, NPS 2007**

Compound	Species	Prey (fish) Life Stage	Exposure	Detection Limits	Effects Threshold (whole body concentrations)	Effects Description-- laboratory toxicity tests and wildlife criteria	Research Study Results and effects on Fish	Source of Toxicity	Reference
Mercury	Mink	in fish	145 days		NOAEL 0.057 (mg/kg-day) --Toxic effect observed: Reproduction/ Development. *****	Toxic effect observed: Reproduction/Development			U.S. EPA, Great Lakes Quality Initiative Criteria Documents for the Protection of Wildlife; DDT, Mercury, 2378-TCDD, PCBs, March 1995. Review of Woberser et al., 1976b
Mercury	Mammals Avian Wildlife				2,400 (pg/l) -- mammalian wildlife value. 1,300 (pg/l) -- avian wildlife value.	Avian wildlife value is one order of magnitude lower than the mammalian value.	According to the Great Lake Wildlife Criteria for Mercury, WV values are thresholds based on available exposure, toxicity, and the variability inherent in the mercury risk assessment. Bioaccumulation factors are based on an analysis for the Great Lakes, other water-bodies may require different bioaccumulation factors.		Great Lakes Quality Initiative Criteria Documents for the Protection of Wildlife; DDT, Mercury, 2378-TCDD, PCBs, March 1995, U.S. EPA, Office of Water, EPA-820-B-95-008, p.86.
Mercury	Mink				NEHCs (0.21µg/g) -- concentrations compared to toxicity thresholds. *****				Environmental Contaminants in Fish and their Associated Risk to Piscivorous Wildlife in the Yukon River Basin, Alaska, 2006, Hinck <i>et al.</i> Arch. Environ. Contam. Toxicol. 51: 661-672.
	bald eagle				NEHCs (0.27 µg/g) -- concentrations compared to toxicity thresholds.				
	Osprey				NEHCs (0.05 µg/g) -- concentrations compared to toxicity thresholds.				
	Belted Kingfisher (Ceryle alcyon)				NEHCs (0.002 µg/g) -- concentrations compared to toxicity thresholds.	All Hg samples exceeded the NEHCs for belted kingfisher, osprey and from certain stations for bald eagle and mink. Hg concentrations in all samples represented a risk to belted kingfisher (0.02 µg/g).	The researchers collected and prepared samples of fish surveyed in the YRB (adult northern pike ( <i>Esox lucius</i> ), burbot ( <i>Lota lota</i> ), and longnose sucker ( <i>Catostomus, catostomus</i> ). The risk of contaminants were compared with toxicity thresholds from the scientific literature and risk analysis modeling.	Sources of mercury potentially come from oil exploration and transportation.	
Mirex		Fish surveyed				Mirex was not detected in a U.S. fish survey from 1992-1995 in a review of Wong and others, 2000.	Concentrations of Mirex were ≤LOD (0.01 µg/g ww) in the 1997 CRB samples.	Mirex was used as an insecticide against red imported fire ants in the southern U.S., and as a flame retardant and polymerizing agent.	Biomonitoring of Environmental Status and Trends (BEST) Program, Columbia River Basin, Hinck et al, 2004

**Summary of Effects Thresholds to Fish, Birds and Wildlife Based on Concentrations of Toxic Compounds in Fish Tissue, NPS 2007**

Compound	Species	Prey (fish) Life Stage	Exposure	Detection Limits	Effects Threshold (whole body concentrations)	Effects Description-- laboratory toxicity tests and wildlife criteria	Research Study Results and effects on Fish	Source of Toxicity	Reference
Mirex		Fish surveyed				According to the researchers, toxicity studies reporting whole-body concentrations were not found; the total risk to fish and wildlife from mirex is unknown.	Mirex was detected in 48 of the 52 (92%) of the samples. All concentrations were $\leq 0.001 \mu\text{g}$ .	Mirex was used as an insecticide to combat red imported fire ants in the southern U.S., and as a flame retardant and polymerizing agent.	Biomonitoring of Environmental Status and Trends (BEST) Program, Colorado River Basin, Hinck et al, 2006
Mirex		Fish surveyed					Results were consistent with NCBP data from 1981 to 1986; researchers reported that concentrations of mirex were low ( $< 0.0003 \mu\text{g/g ww}$ ) in the 2002 YRB samples, similar to findings found in a review of Synder-Conn (1992).		Biomonitoring of Environmental Status and Trends (BEST) Program, Yukon River Basin, Hinck et al, 2004
Organochlorines							Concentrations of most organochlorine chemical residues were relatively low ( $< 10 \mu\text{g/g}$ ) in YRB's whole fish samples, consistent with other YRB studies. Concentrations of aldrin, pentachlorobenzene, HCH, endosulfan were also low $< 4 \text{ ng/g}$ in YRB fish.	Sources of contaminant potentially come from oil exploration and transportation. Organochlorine contaminant concentrations have been low historically and associated with military facilities near Fairbanks, Alaska.	Environmental Contaminants in Fish and their Associated Risk to Piscivorous Wildlife in the Yukon River Basin, Alaska, 2006, Hinck et al. Arch. Environ. Contam. Toxicol. 51: 661-672.
		freshwater fish			$< 0.11 \mu\text{g/g ww}$ -- New York Dept. of Environmental Conservation wildlife guideline for total PCBs.	The New York Dept. of Environmental Conservation (NYSDEC) wildlife guideline for total PCBs in fish is $0.11 \mu\text{g/g ww}$ , review of Newell and others (1987). Concentrations of PCBs in 2002 CRB fish samples were below these thresholds.	In the CRB, total PCBs were $> \text{LOD}$ ( $0.03 \mu\text{g/g ww}$ ) in 67% of the samples. Concentrations ranged from $0.03$ to $1.13 \mu\text{g/g ww}$ , maximum concentrations were found in female northern pike minnow Station 503. More details are given in the BEST report.		

**Summary of Effects Thresholds to Fish, Birds and Wildlife Based on Concentrations of Toxic Compounds in Fish Tissue, NPS 2007**

Compound	Species	Prey (fish) Life Stage	Exposure	Detection Limits	Effects Threshold (whole body concentrations)	Effects Description-- laboratory toxicity tests and wildlife criteria	Research Study Results and effects on Fish	Source of Toxicity	Reference
Total PCBs		freshwater fish--fry, female fish, offspring			5 µg/g ww of Arocolor - decreased survival of fry. 100 µg/g ww affect fish reproduction in females or be lethal. 50 µg/g ww -- reduce growth and survival.	Decreased survival of fry at approximately 5 µg/g ww of Aroclor 1254 in lab studies, review of Hansen (1973), Schimmel and others (1974), and Beyer and others (1996). Fish concentration of 100 µg/g ww can affect fish reproduction in females or be lethal. Concentration of 50 µg/g ww can reduce growth and survival in offspring, review of Nimmi (1996). These concentrations may be lower in more sensitive fish species.	The toxicity of individual PCB congeners ranges over several orders of magnitude and varies with the endpoint being considered, review of Ahlborg and others (1994), van de Berg and others (1998), and Hansen and others (1998).		
	Mink and offspring	Great Lake fish			0.48 µg/g ww of fish -- Mink had inferior reproductive performance	Mink fed Great Lake fish with concentrations of PCBs of 0.48 µg/g ww had inferior reproductive performance and offspring survival, review of Hornshaw and others (1983).	Total PCB detected in 80% of the fish sampled in a U.S. survey with concentrations ranging from <0.05-72 µg/g ww, review of Wong and others (2000).		Biomonitoring of Environmental Status and Trends (BEST) Program, Columbia River Basin, Hinck et al, 2004
		freshwater fish			<0.11µg/g ww -- New York Dept. of Environmental Conservation wildlife guideline for total PCBs.	The New York Dept. of Environmental Conservation (NYSDEC) wildlife guideline for total PCBs in fish is 0.11 µg/g ww, review of Newell and others (1987). This concentration was exceeded by all samples at Stations 320, 324, and 325.	In the CDRB, total PCB concentrations were >LOD (0.48 µg/g ww) in 22 of the 52 samples (42%) from 9 stations. Previous studies reported low concentrations of PCB in the CDRB. Concentrations at NCBP sites were historically <LOD (0.1 µg/g) in the CDRB.		

**Summary of Effects Thresholds to Fish, Birds and Wildlife Based on Concentrations of Toxic Compounds in Fish Tissue, NPS 2007**

Compound	Species	Prey (fish) Life Stage	Exposure	Detection Limits	Effects Threshold (whole body concentrations)	Effects Description-- laboratory toxicity tests and wildlife criteria	Research Study Results and effects on Fish	Source of Toxicity	Reference
		freshwater fish--fry, female fish, offspring			<p><b>5 µg/g ww</b> -- survival of fry decreased at this concentration.</p> <p><b>100 µg/g ww</b> -- affect on reproduction in females or be lethal.</p> <p><b>50 µg/g ww</b> -- reduces growth and survival in offspring.</p>	<p><b>Survival of fry decreased at approximately 5 µg/g ww of Aroclor 1254 in several laboratory studies</b>, review of Hansen (1973), Schimmel and others (1974), Beyer and others (1996). <b>Concentrations of PCBs exceeding 100 µg/g ww in fish tissues can affect reproduction in females or be lethal. Concentrations of 50 µg/g ww can reduce growth and survival in offspring</b>, review of Nimmi (1996). These concentrations may be lower in more sensitive fish species.</p>	<p>The toxicity of individual PCB congeners ranges over several orders of magnitude and varies with the endpoint being considered, review of Ahlborg and others (1994), van de Berg and others (1998), Hansen and others (1998).</p>		
<b>Total PCBs</b>	Mink and offspring	Great Lake fish			<p><b>0.48 µg/g ww</b> -- mink fed Great Lakes fish had inferior reproductive performance at these levels.</p>	<p>Mink fed Great Lakes fish with concentrations of PCBs of 0.48 µg/g ww had inferior reproductive performance and offspring survival, review of Hornshaw and others (1983).</p>	<p>Concentrations of PCBs in CDRB fish were generally low, but concentrations in fish from some stations were elevated and could be a risk to piscivorous wildlife.</p>	<p>PCBs were used as coolants and lubricants in electrical capacitors and transformers, for pressure treating lumber, and paper manufacturers--banned in the U.S. in 1977.</p>	<p>Biomonitoring of Environmental Status and Trends (BEST) Program, Colorado River Basin, Hinck et al, 2006</p>
		freshwater fish--offspring			<p><b>0.11 µg/g ww</b> -- New York Dept. of Environmental Conservation wildlife guideline for total PCBs.</p> <p><b>100 µg/g ww</b> --affects reproduction in females or be lethal.</p> <p><b>50 µg/g ww</b> --reduce growth and survival in offspring.</p>	<p><b>Concentrations of PCBs in YRB samples did not exceed the NY State Dept. of Env. Conservation (NYSDEC) wildlife guideline for fish is 0.11 µg/g ww</b>, review of Newell and others (1987). <b>Fish tissue concentrations of 100 µg/g ww can affect reproduction in females or be lethal, and concentrations of 50 µg/g ww can reduce growth and survival in offspring</b>, review of Niimi (1996).</p>	<p>In the YRB, total PCBs exceeded the LOD (0.02 µg/g ww) in 28 of 31 fish samples. Concentrations ranged from 0.02 to 0.09 µg/g ww. YRB data in 2002 was lower compared to NCBP concentrations (1969-1986) that measure Aroclor mixtures. Whole body concentrations of PCBs were 0.09 µg/g ww in lakes in the upper YRB, review of Braun and others (1999).</p>		

**Summary of Effects Thresholds to Fish, Birds and Wildlife Based on Concentrations of Toxic Compounds in Fish Tissue, NPS 2007**

Compound	Species	Prey (fish) Life Stage	Exposure	Detection Limits	Effects Threshold (whole body concentrations)	Effects Description-- laboratory toxicity tests and wildlife criteria	Research Study Results and effects on Fish	Source of Toxicity	Reference
<b>Total PCBs</b>	Mink	Great Lakes fish or fish products			<b>0.48 µg/g ww fish</b> -- minks have inferior reproductive performance when fed Great Lakes fish or fish products with this concentration.	<b>Mink had inferior reproductive performance &amp; offspring survival when fed Great Lakes fish or fish products with concentrations of PCBs of 0.48 µg/g ww</b> , review of Hornshaw and others, (1983).	Concentrations of PCBs in 2002 YRB fish samples were below the thresholds for fish, according to the researchers.		Biomonitoring of Environmental Status and Trends (BEST) Program, Yukon River Basin, Hinck et al, 2004
<b>Total PCBs</b>	piscivorous wildlife	freshwater fish			<b>100-110 ng/g</b> -- conservative wildlife guidelines for fish	Total PCB and TCDD-EQ were low in all samples. <b>All PCB concentrations were less than conservative wildlife guidelines (100-110 ng/g) available for fish</b> , review of IJC (1987) and Newell and others (1987).	The researchers collected and prepared samples of fish surveyed in the YRB (adult northern pike ( <i>Esox lucius</i> ), burbot ( <i>Lota lota</i> ), and longnose sucker ( <i>Catostomus, catostomus</i> ). The risk of contaminants were compared with toxicity thresholds from the scientific literature and risk analysis modeling.	Sources of contaminant potentially came from oil exploration and transportation. Organochlorine contaminant concentrations have been low historically and associated with military facilities near Fairbanks, Alaska.	Environmental Contaminants in Fish and their Associated Risk to Piscivorous Wildlife in the Yukon River Basin, Alaska, 2006, Hinck et. al. Arch. Environ. Contam. Toxicol. 51: 661-672.
<b>Total PCBs</b>	Mink	Metabolized total PCBs (fish taken from PCB-contaminated waters were fed to mink)	290 days		<b>LOAEL 0.072 (mg/kg-day)</b> <b>NOAEL 0.032 (mg/kg-day)</b> --Toxic effect observed: Reproductive/Kit Survival*	<b>Toxic effect observed: Reproductive/Kit Survival</b>			U.S. EPA, Great Lakes Quality Initiative Criteria Documents for the Protection of Wildlife; DDT, Mercury, 2378-TCDD, PCBs, March 1995. Review of Hornshaw et al., 1983
	Mink ( <i>Mustela vison</i> )	Consume both aquatic and terrestrial prey, each varying with habitat. The aquatic portion is non-piscivorous wetland animals (muskrats, amphibians, water fowl); the non-fish species are at same or lower trophic level as the fish consumed.		0.002 mg/kg fish	<b>0.13 mg/kg fish</b> -- Wildlife value (WV) for Mink	Wildlife Value (tissue based)	PCB concentration exceeded the mink WV for 13.0% (small), 20.4% (large) fish of stream length.		

**Summary of Effects Thresholds to Fish, Birds and Wildlife Based on Concentrations of Toxic Compounds in Fish Tissue, NPS 2007**

Compound	Species	Prey (fish) Life Stage	Exposure	Detection Limits	Effects Threshold (whole body concentrations)	Effects Description-- laboratory toxicity tests and wildlife criteria	Research Study Results and effects on Fish	Source of Toxicity	Reference
PCBs-- polychlorinated biphenyls	River Otter ( <i>Lutra canadensis</i> )	Feed primarily on fish, usually small fish, and large fish--northern pike, walley and trout.		0.002 mg/kg fish	0.18 mg/kg fish -- Wildlife value (WV) for Otter	Wildlife values (tissue based) were derived from the U.S. EPA Great Lakes Water Quality Initiative (GLWQI) and the U.S. EPA report on assessing chemical contaminant data, (EPAs values are water based).	PCB concentration exceeded the mink WV for 5.7% (small), 15.7% (large) of stream length		Contamination of fish in streams of the Mid-Atlantic Region: an approach to regional indicator selection and wildlife assessment, Lazorchak J.M., McCormick, F.H., Henry, T.R., and A.T. Herlihy. Environmental Toxicology, 22:3, pp 545-553.
	Belted Kingfisher ( <i>Ceryle alcyon</i> )	Feed exclusively on aquatic prey--predominately fish (<10 cm in length) from shallow water.		0.002 mg/kg fish	0.44 mg/kg fish -- Wildlife value (WV) for Otter	Exposure parameter (EPAs) values were used to calculate WVs for the piscivorous species. All species were assumed to have a dietary consumption of 100% fish.	PCB concentration exceeded the kingfisher WV for 1.4% (small), 2.2% (large) of stream length	Mercury, chlordane, dieldrin, PCBs and DDT and its metabolites are broadly distributed across the MAR, and according to the researchers, are a result of atmospheric deposition.	
Selenium	Piscivorous wildlife	freshwater fish--larval fish			4 µg/g dw (1.0 µg/g ww assuming 75% moisture) -- threshold to avoid contamination to larval fish 3 µg/g dw (0.75 µg/g ww assuming 75% moisture) -- threshold for piscivorous wildlife	Selenium was detected in all samples at concentrations of 0.23-0.85 µg/g. Toxicity thresholds associated with Se tissue concentrations are relatively low because of this element's high toxicity and potential to bioaccumulate, according to the researchers. Whole body concentrations should not exceed 4 µg/g dw (1.0 µg/g ww assuming 75% moisture) to avoid contamination to larval fish, and 3 µg/g dw (0.75 µg/g ww assuming 75% moisture) to piscivorous wildlife.	The researchers collected and prepared samples of fish surveyed in the YRB (adult northern pike ( <i>Esox lucius</i> ), burbot ( <i>Lota lota</i> ), and longnose sucker ( <i>Catostomus, catostomus</i> ). The risk of contaminants were compared with toxicity thresholds from the scientific literature and risk analysis modeling.	Oil exploration and transportation are potential contaminant sources.	
	Belted Kingfisher ( <i>Ceryle alcyon</i> )	freshwater fish			NEHC 0.12 µg/g LEHC 0.24 µg/g -- thresholds for belted kingfisher	All Selenium concentrations were less than the NEHCs and LEHCs for all species except for belted kingfisher. Selenium did not represent a risk to larger birds or mammals in the YRB model. All Se concentrations were greater than the NEHC (0.12 µg/g and LEHC (0.24 µg/g) for belted kingfisher.	The researchers collected and prepared samples of fish surveyed in the YRB (adult northern pike ( <i>Esox lucius</i> ), burbot ( <i>Lota lota</i> ), and longnose sucker ( <i>Catostomus, catostomus</i> ). The risk of contaminants were compared with toxicity thresholds from the scientific literature and risk analysis modeling.	Sources of contaminant potentially came from oil exploration and transportation.	Environmental Contaminants in Fish and their Associated Risk to Piscivorous Wildlife in the Yukon River Basin, Alaska, 2006, Hinck <i>et. al.</i> Arch. Environ. Contam. Toxicol. 51: 661-672.



**Summary of Effects Thresholds to Fish, Birds and Wildlife Based on Concentrations of Toxic Compounds in Fish Tissue, NPS 2007**

Compound	Species	Prey (fish) Life Stage	Exposure	Detection Limits	Effects Threshold (whole body concentrations)	Effects Description-- laboratory toxicity tests and wildlife criteria	Research Study Results and effects on Fish	Source of Toxicity	Reference
<b>TCDD-EQ (2,3,7,8-tetrachlorobenzo-p-dioxin)</b>	mammals, birds				<b>4.4 pg/g</b> -- dietary toxicity threshold for mammals <b>5.0 pg/g</b> --dietary toxicity threshold for birds	TCDD-EQ were also less than or equal to LOD (1.7 pg/g) in all samples (i.e., dioxin-like activity was not detected in any sample) and all <b>TCDD-EQs were less than the dietary toxicity thresholds for mammals of 4.4 pg/g</b> , review of Heaton <i>et al.</i> (1995), Tillitte <i>et al.</i> (1996), and <b>birds (5.0 pg/g)</b> , review of Nosek <i>et al.</i> (1992).	The researchers collected and prepared samples of fish surveyed in the YRB (adult northern pike ( <i>Esox lucius</i> ), burbot ( <i>Lota lota</i> ), and longnose sucker ( <i>Catostomus</i> , <i>catostomus</i> ). The risk of contaminants were compared with toxicity thresholds from the scientific literature and risk analysis modeling.	Oil exploration and transportation are potential contaminant sources. Organochlorine contaminant concentrations have been low historically and primarily associated with military facilities near Fairbanks, Alaska.	Environmental Contaminants in Fish and their Associated Risk to Piscivorous Wildlife in the Yukon River Basin, Alaska, 2006, Hinck <i>et al.</i> Arch. Environ. Contam. Toxicol. 51: 661-672.
<b>Zinc</b>		Cyprinids--larval and adult			<b>&gt;40 µg/g</b> -- associated with reduced growth and survival in larval and adult cyprinids	Zinc is highly regulated in fish, review of Bury <i>et al.</i> , 2003. <b>Zinc concentrations in most pike were &gt;40 µg/g, a concentration that has been associated with reduced growth and survival in larval and adult cyprinids.</b>	Zinc was detected in all samples. Zinc greater in pike (36-56 µg/g) than burbot (<16 µg/g) or sucker (15-31 µg/g). Zinc concentrations differed significantly among stations in sucker but not in pike or burbot.	Oil exploration and transportation are potential contaminant sources.	Environmental Contaminants in Fish and their Associated Risk to Piscivorous Wildlife in the Yukon River Basin, Alaska, 2006, Hinck <i>et al.</i> Arch. Environ. Contam. Toxicology. 51: 661-672.
	Belted Kingfisher (Ceryle alcyon)	pike samples			<b>NEHC 4 µg/g LEHC 39 µg/g</b> -- thresholds for pike samples and belted kingfisher	All Zinc concentrations were less than the NEHCs and LEHCs for all species except for belted kingfisher. Zinc did not represent a risk to larger birds or mammals in the YRB model. <b>All Zn concentrations exceeded the NEHC (4 µg/g and LEHC (39 µg/g) in all pike samples for belted kingfisher.</b>	The researchers collected and prepared samples of fish surveyed in the YRB (adult northern pike ( <i>Esox lucius</i> ), burbot ( <i>Lota lota</i> ), and longnose sucker ( <i>Catostomus</i> , <i>catostomus</i> ). The risk of contaminants were compared with toxicity thresholds from the scientific literature and risk analysis modeling.	Sources of contaminant potentially came from oil exploration and transportation.	

## Summary of Effects Thresholds to Fish, Birds and Wildlife Based on Concentrations of Toxic Compounds in Fish Tissue, NPS 2007

Compound	Species	Prey (fish) Life Stage	Exposure	Detection Limits	Effects Threshold (whole body concentrations)	Effects Description-- laboratory toxicity tests and wildlife criteria	Research Study Results and effects on Fish	Source of Toxicity	Reference
<b>Notes:</b>									
<p>*The researchers developed Wildlife Values (WVs) for the contamination of fish in the Mid-Atlantic Region based on the U.S. Environmental Protection Agency's Monitoring and Assessment Program's regional assessment from 1993-1994. The study examined the spatial extent of potential risk to piscivorous wildlife for the contaminants DDT, dieldrin, chlordane and mercury. The study derived tissue-based wildlife values for piscivorous birds and mammals that are likely to experience the highest exposures to bioaccumulative contaminants through the aquatic food web. WVs represent toxicant concentrations in whole fish. Exposure parameter values for mink, otter and belted kingfisher were derived from USEPA, (100% fish consumption based on EPA GLWQI (see reference) where water ingestion contributed less than 1/10000 of the total intake of bioaccumulative compounds. <b>WVs are designed to be protective, according to the researchers; as long as exposure remains below the value, it is unlikely that adverse effects will occur. However, exceeding the value does not necessarily indicate that the wildlife population will suffer adverse effects.</b></p>									
<p>* (continued) All species were assumed to have a dietary consumption of 100% fish (according to the researchers, not unreasonable based on the species selected). Test Doses (TDs) for DDT, mercury and PCBs were derived from USEPA GLWQI criteria and used to calculate species-specific WVs, as well as, "best professional judgement", according to the researchers. For Chlordane, dieldrin and endrin, the selection criteria for measurement endpoint were applied for selected studies where TDs could be derived, but also based on USEPA GLWQI. TDs were converted to milligrams ingested per kilogram body weight per day according to the USEPA procedure. The TD calculated is presented in Appendix 2, uncertainty factors were applied to the TDs to adjust for interspecies differences in toxicological sensitivity and extrapolations. The equation used to calculate WVs is essentially identical to the USEPA equation, except that it is tissue-based and eliminates the need for bio-accumulation factors, and is expressed in milligrams of chemical per kilogram of fish.</p>									
<p>**The Best Program started in the 1990s and is founded on information from previous Federal Monitoring Programs including the National Pesticide Monitoring Program (NPMP) that was established in the 1960s, renamed the National Contaminant Biomonitoring Program (NCBP) in the 1970s and maintained by the U.S. Fish and Wildlife Service (USFWS). The BEST program's goal is to provide more biologically relevant information regarding potential contaminant effects on lands and species. <b>LOD - Limits of Detection.</b></p>									
<p>***CRB - The project examined 560 fish representing 8 fish species collected from 16 stations in the Columbia River Basin from September 1997 to April 1998. 10 of the 16 sampling locations are historical National Contaminant Biomonitoring Sites. Common carp (<i>Cyprinus carpio</i>), black bass (<i>Micropoterus</i> sp.) and largescale sucker (<i>Castomus macrocheilus</i>) accounted for 80% of the fish sampling during the study. Fish were weighed, measured, and field-examined for external and internal lesions, liver, spleen, and gonads to compute somatic indices. Several contaminants were measured at concentrations that exceeded wildlife guidelines or thresholds and have been previously identified as chemicals of concern in the CRB. Concentrations of lead (&gt;0.4 µg/g ww) in upper Columbia River, selenium (&gt;0.6 µg/g ww) in the lower Salmon and middle Columbia Rivers, and mercury (&gt;0.1 µg/g ww) throughout the basins exceeded one or more wildlife criteria in composite fish samples. According to the researchers, trend analysis reflected decreasing or stable concentrations of total PCBs, p,p'-DDE, mercury, selenium, and lead in fish samples at stations where historical data were available. Results of the study indicate that some organochlorines and biomarker responses are consistent with contaminant exposure in fish at specific sites within the CRB.</p>									
<p>****YRB - Project examined 217 fish representing 3 fish species (northern pike, longnose sucker, and burbot in the U.S. portion of the YRB. Fish were examined for external and internal lesions, liver, spleen, and gonads to compute somatic indices. Fish health and reproductive biomarkers did not indicate widespread responses to contaminants, but individual fish from sites throughout the basin expressed isolated responses.</p>									
<p>*****Great Lake Wildlife Criteria for total DDT plus its metabolites. The WV values are water-concentration thresholds based on bioaccumulation factors based on an analysis for the Great Lakes, other water-bodies may require different bioaccumulation factors. <b>LOAEL--lowest observed adverse effect level, NOAEL--no observed adverse effect level, TRVs (Toxicity Reference Values). NEHC -- No Effect Hazard Concentrations, LEHC -- Low Effect Hazard concentrations.</b></p>									
<b>References:</b>									
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