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Item 6 (a) of the provisional agenda*
Consideration of draft risk profiles: hexabromocyclododecane

Supporting document for the draft risk profile on hexabromocyclododecane

Note by the Secretariat

The annex to the present note contains a supporting document for the draft risk profile on hexabromocyclododecane prepared by the intersessional working group established at the fifth meeting of the Persistent Organic Pollutants Review Committee. The draft risk profile is set out in document UNEP/POPS/POPRC.6/10. The annex is presented as prepared by the working group and has not been formally edited by the Secretariat.

* UNEP/POPS/POPRC.6/1/Rev.1.

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Annex

Supporting document for the draft risk profile on hexabromocyclododecane

Four tables listed below as well as a list of references are given as supporting information to the draft risk profile on hexabromocyclododecane (UNEP/POPS/POPRC.6/10):

a) Table 1: Summary of acute and chronic ecotoxicity data, which have been considered reliable according to the European Commission (2007a) and as listed in NCM 2008

b) Table 2: Overview of HBCD levels detected in human breast milk

c) Table 3: HBCD concentrations measured in the ambient environment

d) Table 4: HBCD concentrations measured in biota

Table 1. Summary of acute and chronic ecotoxicity data, which have been considered reliable according to the European Commission (2007a) and as listed in NCM 2008

Compartment/Species	Method	Results	Remark and reference
Aquatic compartment			
Fish			
Onchorhyncus mykiss	OECD 203 and TSCA 40/797/1400, and ASTM Standard E729-88a	No mortalities or other effects around 2.5 µg/l.	Graves and Swigert (1997a)
Onchorhyncus mykiss	Flow-through OECD 210 and OPPTS 850.1400	NOEC: Hatching success ≥3.7 µg/l Swim-up ≥3.7 µg/l Larvae and fry survival ≥3.7 µg/l Growth ≥3.7 µg/l	Drottar et al. (2001)
Invertebrates			
Daphnia magna	OECD 202. Static immobilisation test, and TSCA 40/797/1300, and ASTM Standard E729-88a	48 h EC_{50} >3.2 µg/l	Graves and Swigert (1997b)
Daphnia magna	TSCA , OECD Flow through 21 day test.	NOEC 3.1 µg/l LOEC length 5.6 µg/l	Drottar and Krueger (1998)
Algae			
Selenastrum capricornutum	OECD 201 and TSCA40/797/1050	96 h EC_{50} >2.5 µg/l	Roberts and Swigert (1997)
Skeletonema costatum *Thallassiosira pseudonana* Chlorella sp.	Marine algal bioassay method, different marine growth media	72 h EC_{50} = 9 µg/l (lowest value) 72 h EC_{50} = 40 µg/l (lowest value) 96h EC_{50} >water solubility	Walsh et al. (1987) Not according to guidelines, results only used as supportive
Skeletonema costatum	OECD 201, ISO 10253:1995 and EU Directive 92/69/EEC – Method C.3. One test concentration at the limit of respective water solubilites of each diastereomer.	NOEC <40.6 µg/l EC_{50} >40.6	Desjardins et al. (2004)
Skeletonema costatum	OECD 201. EC50 obtained from a limit test with one test concentration (54.5 µg/l) at the limit of respective water solubilites of each diastereomer.	NOEC >10 µg/l EC_{50} = 52 µg/l	Desjardins et al. (2005)

Compartment/Species	Method	Results	Remark and reference
Aquatic compartment			
Sewage treatment plant, micro-organisms			
Acivated sludge	Respiration inhibition OECD 209	EC_{50} = 15 mg/l	Limit test with one test concentration, EC_{50} is an estimated value. Schaefer and Siddiqui (2003)
Sediment compartment			
Invertebrates			
Hyalella azteca (Amphipod)	Sediment toxicity test 28-day exposure period under flow-through conditions.	LOEC >1000 mg/kg dw of sediment NOEC 1000 mg/kg dw of sediment.	Thomas et al. (2003)
Lumbriculus variegatus (Worm)	28-day sediment bioassay	LOEC = 28.7 mg/kg dw NOEC = 3.1 mg/kg dw Normalized: NOEC = 8.61 mg/kg dw	Oetken et al. (2001)
Chironomus riparius (Mosquito)	28-day sediment bioassay Egg production of F generation	LOEC = 159 mg/kg dw NOEC = 13.6 mg/kg dw Normalized: NOEC = 37.8 mg/kg dw	Oetken et al. (2001)
Terrestrial compartment			
Plants			
Plants: corn (*Zea mays*), cucumber (*Cucumis sativa*), onion (*Allium cepa*), ryegrass, (*Lolium perenne*), soybean (*Glycine max*), and tomato (*Lycopersicon esculentum*)	Seedling emergence, suvival, height 21 days OECD 308 (proposal for revision), 850.4100 and 850.4225 (public drafts)	NOEC >5000 mg/kg dry soil	Porch et al. (2002)
Invertebrates			
Eisenia fetida (Earthworm)	Survival and reproduction, 56 days OECD prosal and 207 and OPPTS 850.6200	NOEC 128 mg/kg dry soil Normalized: NOEC 59 mg/kg dry soil (EC_{50} 771 mg/kg dry soil)	Aufderheide et al. (2003)

Table 2. Overview of HBCD levels detected in human breast milk

Region/ Country	Compound	Sample size (N)	Year	Detection frequency	Median	Mean	Range	Reference
Asia								
China	ΣHBCDs	1237	2007	n.s.	n.s.	n.s.	n.s.	Shi et al. 2009
	α-HBCD	-	-	n.s.	2.03	2.07	<0.05-4.32	
	β-HBCD	-	-	n.s.	n.d.	n.d.	n.d.	
	γ-HBCD	-	-	n.s.	n.s.	n.s.	<0.02.-0.46[a]	
Japan	ΣHBCDs	468 (18)[b]	1973-2006	83.3 %	1.47*	1.45*	<0.20-4.00*	Kakimoto et al. 2008
	α-HBCD	-	-	83.3 %	1.40*	1.30*	<0.10-1.90 *	
	β-HBCD	-	-	0 %	<0.10	<0.10	<0.10	
	γ-HBCD	-	-	50.0 %	0.37	0.73	<0.20-2.60*	
Philippines	ΣHBCDs	33	2004	n.s.	0.62	0.86	0.13-3.2	Malarvannan et al. 2009
	α-HBCD			n.s.	0.61	0.66	0.13-2.0	
	β-HBCD			n.s.	0.08	0.11	<0.01-0.46	
	γ-HBCD			n.s.	0.18	0.29	<0.01-1.9	
Vietnam	ΣHBCDs	33	2007	100 %	0.38*	0.70*	0.07-7.60	Tue et al. 2010
	α-HBCD	-	-	100 %	0.38*	0.68*	0.07-7.50	
	β-HBCD	-	-	n.s.	0.00*	0.00*	<0.01[c]-0.051	
	γ-HBCD	-	-	n.s.	0.00*	0.00*	<0.01[c]-0.27	
America								
Canada	α-HBCD	8	2002-2003	n.s.	1.60	3.80	0.40-19.00	Ryan et al. 2006
Mexico	ΣHBCDs	7	n.s.	n.s.	n.s.	1.20	0.80 – 5.40	Lopez et al. 2004
USA	α-HBCD	9	2002	n.s.	0.50	0.50	0.20-0.90	Ryan et al. 2006
	α-HBCD	40	2002, 2004	n.s.	0.40	0.48*	0.16-1.20	Schechter et al. 2008
Europe								
Belgium	ΣHBCDs	178 (1)[d]	2006	100 %.	1.50	n.s.	n.s.	Colles et al. 2008
France	α-HBCD	26	2005	26.9 %	n.s.	n.s.	2.5-5.0	Antignac et al. 2008
Norway	ΣHBCDs	310	2003-2005	56.8 %	0.86	1.70	<0.16-31.00[e]	Thomsen et al. 2010
	ΣHBCDs	10	2000-2002	10 %	0.13 [f]	0.13 [f]	<0.05 – 0.13[f]	Polder et al. 2008
	ΣHBCDs	85	1993-2001	57.6 %	0.60	n.s.	0.4-20.00	Thomsen et al. 2005
	ΣHBCDs	n.s.[g]	2001	100 %	n.s.	n.s.	0.25-2.00	Thomsen al. 2003
Russia		37	2000, 2002	29.7 %	n.a.	0.59*	0.2-1.67	Polder et al. 2008

Region/ Country	Compound	Sample size (N)	Year	Detection frequency	Median	Mean	Range	Reference
Spain	ΣHBCDs	33	n.s.	91 %	27.00	47.00	<0.20-188.00	Eljarrat et al. 2009
	α-HBCD	-	-	n.s.	4.00*	14.00*	<0.20-122.00*	
	β-HBCD	-	-	n.s.	n.d.	n.d.	n.d.	
	γ-HBCD	-	-	n.s.	23.00 *	41.00 *	<0.30-176.00*	
	ΣHBCDs	n.s.	2007	87 %	26.00*	52.00*	0.80-188.00	Guerra et al. 2008
	α-HBCD	-	-	-	4.00*	10.00 *	0.13-71.50*	
	β-HBCD	-	-	-	0.10*	0.10*	0.10*[h]	
	γ-HBCD	-	-	-	23.00*	49.00 *	7.80-176.00*	
Sweden	ΣHBCDs	177	1996-2006	44 %	0.25	0.39	<0.20-7.8	Lignell et al. 2008
	ΣHBCDs	273	1980-2004	100 %	0.35*	0.34*	0.09-0.64	Fängstrøm et al. 2008
	ΣHBCDs	178	2000-2004	n.s.	0.34*	0.34*	0.09-10.4	Lignell et al. 2005a
	ΣHBCDs	29	2004	100 %	0.33	9.58	0.14-4.36	Lignell et al. 2005b
	ΣHBCDs	5	n.s.	n.s.	n.s.	1.10	0.30-3.2 0	Lopez et al. 2004
	ΣHBCDs	29	2002-2003	20.7 %	0.35	0.42	0.16– 1.50	Lignell et al. 2003
	ΣHBCDs	33	2001	39,4 %	0.30	0.45	<0.15 – 2.37	Aune et al. 2002

Abbreviations: LOD, limit of detection; n.d., not detected; n.s., not specified.

*Value given is based on calculations made with information from the listed reference. Concentrations below limit of detection or limit of quantification were set to zero for calculations of mean and median.

[a]Only one rural sample from the Heibei province was found to contain γ-HBCD at a concentration of 0.46 ng/ g lw.

[b]Samples from 468 individuals collected during the period 19973-2006 were pooled by year and age (under or over 30 years) resulting in a total of 18 samples for analysis.

[c]The limit of detection is not specified separately for each stereoisiomer, the authors only state that the limit of detection for all stereoisiomers is in the 0.01-0.05 ng/ g lw range.

[d]This study was part of a WHO study on POPs in mother's milk. Milk samples from 178 mothers were pooled into one sample before analysis.

[e]Limit of detection given as 4.8 pg γ-HBCD/ g breast milk. The lipid content of the milk is not specified but according to the authors the limit of quantification of 0.6 pg/ g corresponded to approx. 0.2 ng/ g lw. Using these numbers for calculation the limit of quantification may be estimated to approx. 0.16 ng/ g lw.

[f]HBCD was only detected in one sample (0.13 ng/ g lw), all remaining samples were bellow the limit of detection at 0.05 ng/ g lw.

[g]Samples collected in 1993 and 2001 were pooled by region (Tromsø, Hamar, Skien) before analysis, in addition two individual samples the Tromsø area were analyzed separately.

[h]β-HBCD was detected in one sample only. Limit of detection was not specified.

Table 3. HBCD concentrations measured in the ambient environment

Unless otherwise stated air concentrations are in ng/m^3; water and leachate in ng/L; sediment, soil, sludge and compost in ng/g dw.

Sampling Location; Year	Medium	Concentration	Number of Samples	Detection Limit	Reference
AIR					
The Arctic					
Arctic; 1994 – 1995 Canadian (Alert, Tagish) Russian (Dunai)	air	nd[1]	12 8 4	0.0018	Alaee et al. 2003
Norwegian Arctic: 2006 Birkenes Zeppelin	air	mean (range) pg/m^3 α-HBCD 1.83 (0.49-4.25) β-HBCD 0.44 (0.26-0.64) γ-HBCD 5.88 (0.41-30.8) Σ HBCD 7.56 (1.03-34.0) α-HBCD 1.58 (0.1-4.72) β-HBCD 0.32 (0.04-0.57) γ-HBCD 5.54 (0.16-21.1) Σ HBCD 7.13 (0.26-26.39)	13 12		Klif 2010
Finland; 2000 – 2001 Pallas (Arctic)	air: gas phase rainwater deposition	 0.002, 0.003 5.1, 13 ng/m^2 day	 2 2	0.001	Remberger et al. 2004
North America					
United States; 2002 – 2003 Lake Michigan Chicago Indiana Arkansas Louisiana	air (particulate phase)	mean (range): 0.0012 (0.0002 – 0.0080) 0.0045 (0.0009 – 0.0096) 0.0010 (0.0002 – 0.0036) 0.0016 (0.0002 – 0.011) 0.0006 (0.00016 – 0.0062)	in: 29 of 35 28 of 28 33 of 37 20 of 30 10 of 26	0.00007 – 0.00013	Hoh and Hites 2005
Europe					
Sweden; 1990 – 1991 Hoburgen (south Sweden) Ammarnäs (the Swedish Arctic)	air	 0.0053 0.0061	2	ns[2]	Bergander et al. 1995

Sampling Location; Year	Medium	Concentration	Number of Samples	Detection Limit	Reference
Sweden; 2000 – 2001 XPS production facility landfill (construction, demolition waste) textile plant Stockholm Aspvreten Rörvik Stockholm Rörvik	air (combined gas and particulates) rainwater deposition	 1070 0.013, 0.18 0.019, 0.74 0.076, 0.61 0.025, 0.28 nd, 0.005 5.5, 366 ng/m^2 day 0.02, 1.6 ng/m^2 day	11 4	0.001	Remberger et al. 2004
The Netherlands; 1999 Broomchemie B.V. production plant	air	280	ns	ns	Waindzioch 2000
Asia					
Guangzhou, China; 2006	air (combined gas and particulates)	mean (range): 0.0014 (0.0012 – 0.0018)	4	0.0003 – 0.0005	Yu et al. 2008
WET DEPOSITION					
North America					
Great Lakes; no year	wet-only precipitation	nd – 35 ng/L	ns	ns	Backus et al. 2005
Europe					
The Netherlands; 2003 Terneuzen	rainwater deposition	1835 ng/L	in 1 of 50	15	Peters 2003
WATER					
North America					
Lake Winnipeg; 2004	surface water: dissolved phase	mean (range): α-HBCD 0.011 (0.006 – 0.013) β-HBCD nd γ-HBCD 0.003 (nd – 0.005)	3	0.003 – 0.006	Law et al. 2006a
Europe					
United Kingdom; no year upstream of Aycliffe STP 1 km downstream of STP remote sites	surface water: water particulates water particulates water particulates	filtered water samples: 57, 80, 1520 87, nd, 1310 nd 215 210, nd nd	 3 1 2	50	Deuchar 2002
United Kingdom; 1999 manufacturing plant using HBCD, Aycliffe	surface water	mean (range):	ns	ns	Dames and Moore 2000b

Sampling Location; Year	Medium	Concentration	Number of Samples	Detection Limit	Reference
process water supply domestic water supply		11400 (4810 – 15800) 7260 (4970 – 10200)			
The Netherlands; no year	surface water: particulates	73.6 – 472 ng/g dw	ns	ns	Bouma et al. 2000
The Netherlands; 2000 process water from local supply	surface water	same sample: nd (GC/MS) 160 (LC/MS)	ns	500 (GC/MS) ns (LC/MS)	Institut Fresenius 2000b
Asia					
Japan; 1987	surface water	nd	75	200	Watanabe and Tatsukawa 1990
SEDIMENT					
The Arctic					
Norwegian Arctic; 2001	sediment	α-HBCD 0.43 β-HBCD nd γ-HBCD 3.88	4	0.06	Evenset et al. 2007
North America					
Detroit River; 2001 upstream stations upper reaches near Belle Isle near mouth of Rouge River near head of Trenton Channel in Trenton Channel eastern side near Fighting Island western side near outflow to Lake Erie same latitude as above station but on Canadian side of river	suspended sediments	annual mean: 0.106, 0.019 0.910 ~ 0.810[3] ~ 0.675[3] 0.393 0.012 1.14 0.066 monthly range: α-HBCD nd – 1.85 β-HBCD nd – 0.246 γ-HBCD nd – 2.27 Σ HBCD nd – 3.65	63	0.025	Marvin et al. 2004, 2006
Lake Winnipeg; 2003	sediment	mean (range): α-HBCD nd β-HBCD nd γ-HBCD 0.05 (nd – 0.10)	4	0.04 – 0.08	Law et al. 2006a
Europe					
United Kingdom; no year upstream of Aycliffe STW	river sediments	1131	1	50	Deuchar 2002
England; 2000 – 2002	estuarine and river sediments	mean (range): 199 (nd – 1680)	22	2.4	Morris et al. 2004
Ireland; 2000 – 2002	estuarine sediments	mean (range): 3.3 (nd – 12)	8	1.7	Morris et al. 2004
Belgium; 2001	estuarine sediments	mean (range): 60 (nd – 950)	20	0.2	Morris et al. 2004
The Netherlands; no year	sediments (< 63 µm)	25.4 - 151	ns	ns	Bouma et al. 2000

Sampling Location; Year	Medium	Concentration	Number of Samples	Detection Limit	Reference
The Netherlands; 2000 Western Scheldt rivers	estuarine sediments river sediments	mean (range): 10 (nd – 99) 3.2 (nd – 9.9)	19 9	0.6 0.8	Morris et al. 2004
The Netherlands; 2001	estuarine sediments	14 – 71	ns	ns	Verslycke et al. 2005
The Dutch North Sea; 2000	surface sediments (< 63 µm)	0.76 – 6.9	in 9 of 10	0.20	Klamer et al. 2005
Switzerland; no year	lake sediment	< 0.1 – 0.7[3]	1	ns	Kohler et al. 2007
Switzerland; 2003 1974 1982 1989 1995 2001	lake sediment	 0.51 0.40 1.3 1.8 2.5	1	ns	Kohler et al. 2008
Sweden; 1995	river sediments	nd – 7600 ng/g ignition loss (nd – 1600 ng/g dw)	18	ns	Sellström et al. 1999 (de Wit 1999)
Sweden; textile plant; 2000 Stockholm; 1996 – 1997 1999	river sediments: upstream downstream sediments sediment traps	 nd, 0.2 1, 4.6, 7.8, 25 0.2 – 1.5 nd – 2.1	 2 4 6 3	 0.1 ns ns 1	Remberger et al. 2004
S.E. Norway; no year 2003	lake and river sediments river and estuarine sediments	α-HBCD β-HBCD γ-HBCD nd – 0.1 nd – 7.91 nd – 0.05 nd –10.15 nd – 0.65 nd – 3.34	 15 11	 0.2 – 0.4 0.08 – 0.4	Schlabach et al. 2004a,b
Spain; 2002 industrialized urban area with chemical industry	river sediments: 20 km upstream 12 km upstream just downstream 30 km downstream	 nd nd 513.6 89.7	4	0.006 – 0.050	Eljarrat et al 2004
Spain; no year Sampling sites in vicinity of those used in Eljarrat et al. 2004	river sediments: 20 km upstream at urban site 27 km downstream 67 km downstream	 nd 2658 76.8 48.4	4	0.0003 – 0.0015	Guerra et al. 2008

Asia					
Japan; 1987	marine and river sediments	20 – 90	in 3 of 69	ns	Watanabe and Tatsukawa 1990
Japan; 2002	estuarine sediments	0.056 – 2.3	in 9 of 9	0.01	Minh et al. 2007
SOIL					
Europe					
United Kingdom; 1999 formulator/compounder plant	soil	mean (range): 62,800 (18,700 – 89,600)	4	ns	Dames and Moore 2000a
Sweden; 2000 XPS production facility	soil	140, 1000, 1300	3	ns	Remberger et al. 2004
Asia					
Guangzhou, China; 2006	soil	1.7 – 5.6	3	0.0003 – 0.0005	Yu et al. 2008
LANDFILLS					
Europe					
United Kingdom; no year	landfill leachate: dissolved phase particulate phase	 nd nd	ns	 15 3.9	RIVM 2002
S.E. England; 2002	landfill leachate: dissolved phase particulate phase	 nd nd	3	ns	Morris et al. 2004
Ireland; no year	landfill leachate: dissolved phase particulate phase	 nd nd	ns	 15 3.9	RIVM 2002
Ireland; 2002	landfill leachate: dissolved phase particulate phase	 nd nd	3	ns	Morris et al. 2004
The Netherlands; no year	landfill leachate	α 48 – 7000 ng/g dw β < 0.8 – 13 ng/g dw γ 2.5 – 36,000 ng/g dw	ns	ns 0.8 ns	RIVM 2002
The Netherlands; 2002	landfill leachate: particulates	mean (range): 5906 (2.5 – 36,000) ng/g dw	11	ns	Morris et al. 2004
Sweden; 2000 landfill (construction, demolition waste)	landfill leachate sedimentation basin for leachate	3, 9 nd	2 2	ns 0.1	Remberger et al. 2004
Norway; no year	sedimentation basin for leachate water from landfill	α nd – 0.0091 ng/g ww β nd – 0.0038 ng/g ww γ nd – 0.079 ng/g ww	ns	ns	Schlabach et al. 2002

TREATMENT PLANTS					
Europe					
United Kingdom; 1999 HBCD manufacturing plant, Aycliffe	on-site treatment plant: influent effluent off-site treatment plant: effluent receiving water	mean (range): 8.28×10^7 (7.91×10^7 – 8.61×10^7) 3.58×10^7 (5.10×10^6 – 8.17×10^7) 25,100 (8850 – 84,400) 606 (528 – 744)	3 3 6 3	ns	Dames and Moore 2000b
United Kingdom; no year Aycliffe STP	treatment plant: influent: water particulates effluent: water particulates sludge	934 216,000 nd 1260 9547	ns	ns ns 50 ns ns	Deuchar 2002
United Kingdom; 1999 formulator/backcoater plant	site treatment plant: influent effluent	mean (range): 7.46×10^5 (1.72×10^5– 1.89×10^6) 21,500 (3030 – 46,400)	3 3	ns	Dames and Moore 2000a
United Kingdom; no year	STP sludge	530 – 2680	5	ns	RIVM 2002
S.E. England; 2002	STP: influent particulates influent dissolved effluent sewage sludge	mean (range): 6.3 (nd – 29.4) ng/g dw up to 24 ng/L nd 1401 (531 – 2683)	5 5 5 5	0.4 ns 3.9 ns	Morris et al. 2004
Ireland; 2002	sewage sludge	mean (range): 3322 (153 – 9120)	6	ns	Morris et al. 2004
The Netherlands; 1999 – 2000 Broomchemie B.V.	treatment plant: effluent same sample activated sludge	11,800 – 26,000 (GC/MS) 10,800 – 24,300 (LC/MS) 728,000 – 942,000 (LC/MS)	ns 3	ns	Institut Fresenius 2000a,b
The Netherlands; no year	sewage sludge	nd – 93	10	0.4	RIVM 2002
The Netherlands; 2002	STP: influent particulates effluent particulates sewage sludge	mean (range): 954 (nd – 3800) ng/g dw 4.9 (nd – 18) ng/g dw 175 (nd – 1300)	5 5 8	330 1 0.6	Morris et al. 2004
Sweden; 1997 – 1998 three Stockholm STPs	sewage sludge	11 – 120 mean at each plant: 19, 21, 54	4	ns	Sellström 1999; Sellström et al. 1999

Sweden; 2000 public laundry STP treating public laundry wastewater	outgoing sewage water sewage sludge	31 30, 33	1 2	ns	Remberger et al. 2004
Sweden; 2000 three Stockholm STPs	primary sludge digested sludge	6.9 nd	1 3	1	Remberger et al. 2004
Sweden; 2000	sewage sludge	mean (range): 45 (3.8 – 650)	ns	ns	Law et al. 2006c
Switzerland; 2003 and 2005	sewage sludge	mean (range): 149 (39 – 597)_	19	6.4	Kupper et al. 2008
COMPOST					
Europe					
Switzerland; no year	compost	mean (range): 85 (19 – 170)	ns	ns	Zennegg et al. 2005

Notes:

[1] not detected

[2] not specified

[3] values estimated from graphical representation of data

Table 4. HBCD concentrations measured in biota

Concentrations are in ng/g lw, unless otherwise stated.

Sampling Location; Year	Organism	Concentration (ng/g lw)	Number of Samples	Detection Limit (ng/g lw)	Reference
The Arctic					
BIRDS					
Norwegian Arctic; ***2002*** ***2004***	***blood plasma: female polar bear*** ***glaucous gull female male***	***ng/g ww: nd – 0.85*** ***mean (range): 0.32 (0.12 – 0.73) 0.34 (0.07 – 1.24)***	***in 2 of 15*** ***in 15 of 15 in 12 of 12***	***ng/g ww: 0.03*** ***ns ns***	***Verreault et al. 2005***
Norwegian Arctic; 2002	glaucous gull blood plasma liver whole body: with feathers without feathers	ng/g ww; mean (range): 3.29 (0.51 – 11.2) 75.6 (5.88 – 292) 117 (52.6 – 270) 91.0 (38.4 – 194)	 19 19 9 10	ns	Verreault et al. 2007b
Norwegian Arctic; 2006	glaucous gull blood plasma: female male egg yolk	ng/g ww: mean (range): 2.07 (nd – 6.12) 1.73 (nd – 5.37) 19.8 (7.23 – 63.9)	 30 19 31	ng/g ww: 0.59 0.59 0.65	Verreault et al. 2007a
Svalbard, Norwegian Arctic; 2002	kittiwake (yolk sac)	118	18	ns	Murvoll et al. 2006b
Bear Island, Norwegian Arctic; no year	northern fulmar (liver)	mean (range): 14.8 (3.8 – 61.6)	14	ns	Knudsen et al. 2007a
Bear Island, Norwegian Arctic; 2003-2005	glaucous gulls brain liver great black-backed gulls brain liver	α-HBCD mean ±SD (min – max) 98.9 ± 136 (5.1- 475) 3,026 ± 4,322 (195-15,027) β-HBCD and γ-HBCD nd α-HBCD measured value 44.7 and 44.8 1881 and 3699 β-HBCD and γ-HBCD nd	in 21 of 21 in 21 of 21 in 2 of 2 in 2 of 2	 0.25 1.5	Klif 2007
Arctic; Norwegian (Svalbard); 2007 Russian (Franz Josef land and Severnaya Zemlya); 2006	ivory gull (egg)	median (range): 81,5 (42.8-124) 136 (70.6-272) 124 (48.4-157) 38.1 (14.0-115)	10 6 7 12	ns	Miljeteig et al. 2009
Canadian Arctic; 1976 1987 2004	ivory gull (egg)	mean: 3.8 3.0 2.1	9 9 6	ng/g ww: 0.01	Braune et al. 2007
SEA MAMMALS					
Barrow Strait, Nunavut; 2007	ringed seal (blubber)	0.38	10	ns	Morris et al. 2007
MAMMALS					
Svalbard, Norwegian Arctic; 2002	polar bear (fat) female	mean (range): 44.4 (18.2 – 109)	in 15 of 15	0.01	Muir et al. 2006
Alaska; 1994-2002	polar bear (fat) female male	mean (range): 0.40 (nd[1] – 35.1) nd	in 2 of 8 7	0.01	Muir et al. 2006
East Greenland; 1999-2001	polar bear (fat)	mean (range): 44.5 (32.4 – 58.6)	in 11 of 11	0.01	Muir et al. 2006
East Greenland; 1999-2001	polar bear adipose blood brain	ng/g ww, mean; 41 nd nd	20 in 13 - -	ns	Gebbink et al. 2008

Sampling Location; Year	Organism	Concentration (ng/g lw)	Number of Samples	Detection Limit (ng/g lw)	Reference
	liver	nd	-		
FOOD WEBS					
Svalbard, Norwegian Arctic; 2002 - 2003	amphipod (whole) polar cod (whole) ringed seal (blubber) polar bear (adipose)	mean (range): nd 1.89 (1.38 – 2.87) 19.56 (14.6 – 34.5) 11.53 (5.31 – 16.51)	5 7 6 4	0.012 – 1.299 0.030 – 0.30 0.014 – 0.75 0.014 – 0.75	Sørmo et al. 2006
eastern Canadian Arctic; 1996 1998 2000 2000-2001 2000-2001 2000-2001 2002 2002	beluga (blubber) walrus (blubber) narwhal (blubber) arctic cod (whole) redfish (whole) shrimp (whole) clam (whole) zooplankton (whole)	mean (range): α-HBCD γ-HBCD 1.2 (<0.63-2.08) 0.2 (<0.07-0.46) 0.2 (nd-0.86) 0.4 (<0.12-1.86) 2.9 (2.05-6.10) 0.5 (<0.11-1.27) 0.4 (nd-1.38) 0.02 (nd-0.07) 1.4 (<0.74-3.37) 0.6 (<0.28-1.03) 1.4 (0.91-2.60) 0.5 (0.23-1.24) 0.2 (nd-1.03) 1.2 (<0.46-5.66) 0.16 (nd-9.16) 0.5 (0.13-2.66)	5 5 5 8 5 5 5 5	0.0004 – 0.0115	Tomy et al. 2008
North America					
BIRDS					
British Columbia, southern California; 2001-2003	bald eagle (blood)	nd	29	0.01 ng/g ww	McKinney et al. 2006
Great Lakes; 2004 Eastern Lake Superior Northern Lake Michigan North channel, Lake Huron Detroit River Niagara River Toronto Harbour	herring gull (egg)	ng/g ww: α-HBCD γ-HBCD[3] 12 0.22 20 0.67 nd nd 2.1 nd 4.7 nq[4] 4.6 nq	pooled samples (n=10-13) 2 4 5 6 11 13	0.01	Gauthier et al. 2006, 2007
FISH					
Lake Ontario; no year	whitefish walleye (whole body)	92 40	ns	ns	Tomy et al. 2004b
Lake Ontario 1979 1983 1988 1993 1998	lake trout (whole body)	α-HBCD: 25 ± 2.1 β-HBCD: 0.94 ± 0.27 γ-HBCD: 6.5 ± 1.9 Σ HBCD: 33 ± 3.0 α-HBCD: 25 ± 1.7 β-HBCD: 0.40 ± 0.08 γ-HBCD: 2.9 ± 0.2 Σ HBCD: 28 ± 1.8 α-HBCD: 15 ± 1.4 β-HBCD: 0.26 ± 0.05 γ-HBCD: 2.5 ± 0.3 Σ HBCD: 18 ± 1.7 α-HBCD: 27 ± 8.7 β-HBCD: 0.38 ± 0.09 γ-HBCD: 4.6 ± 0.9 Σ HBCD: 32 ± 9.7 α-HBCD: 22 ± 1.3 β-HBCD: 0.28 ± 0.04 γ-HBCD: 2.3 ± 0.6	29	0.001 – 0.01	Ismail et al. 2008

Sampling Location; Year	Organism	Concentration (ng/g lw)	Number of Samples	Detection Limit (ng/g lw)	Reference
2004		Σ HBCD: 25 ± 1.6 α-HBCD: 15 ± 3.2 β-HBCD: 0.16 ± 0.03 γ-HBCD: 1.4 ± 0.3 Σ HBCD: 16 ± 3.5			
SEA MAMMALS					
Florida, United States; 1991 to 1996 2000 to 2001 2001 to 2004 1993 to 1994 2002 to 2004 2004	bottlenose dolphin (blubber) bull shark (muscle) Atlantic sharpnose shark (muscle)	mean (range): α-HBCD: 1.29 (0.330 – 3.690) β-HBCD: 0.337 (0.121 – 0.799) γ-HBCD: 0.582 (0.086 – 1.7) Σ HBCD: 2.21 (0.537 – 6.19) α-HBCD: 7.87 (0.122 – 35.4) β-HBCD: 2.49 (0.023 – 11.8) γ-HBCD: 5.18 (0.0036 – 25.3) Σ HBCD: 15.5 (0.460 – 72.6) α-HBCD: 1.37 (0.200 – 3.86) β-HBCD: 0.524 (0.083 – 1.8) γ-HBCD: 2.13 (0.104 – 4.43) Σ HBCD: 4.02 (0.720 – 9.11) α-HBCD: 8.01 (1.52 – 23.5) β-HBCD: 5.57 (0.849 – 20.9) γ-HBCD: 71.3 (5.08 – 368) Σ HBCD: 84.9 (9.15 – 413) α-HBCD: 14.5 (4.88 – 33.1) β-HBCD: 4.83 (1.75 – 9.74) γ-HBCD: 52.3 (0.0036 – 267) Σ HBCD: 71.6 (16.6 – 310) α-HBCD: 11 (0.805 – 31.3) β-HBCD: 3.78 (0.587 – 8.33) γ-HBCD: 39.7 (0.439 – 116) Σ HBCD: 54.5 (1.83 – 156)	4 5 6 6 7 3	α-HBCD: 0.0013 β-HBCD: 0.0028 γ-HBCD: 0.0036	Johnson-Restrepo et al. 2008
California, USA; 1993 1996 1997 1998 1999 2000 2002 2003 2000	male sea lion (blubber) sea lion (blubber)	ng/g ww: 0.71 0.31 – 1.51 1.26 – 6.56 0.63 2.15, 3.18 2.31 – 5.91 5.60, 8.63 11.85 6.95	1 in 4 of 7 in 6 of 8 1 2 in 3 of 3 2 1 2 samples pooled	ng/g ww 0.3	Stapleton et al. 2006
eastern U.S. coast; 1993 – 2004	white-sided dolphin blubber liver	median (range): 100 (19 – 380) (14 – 280 ng/g ww) 24 (2.9 – 140) (0.051 – 3.6 ng/g ww)	57 16	α-HBCD: ns β- and γ-HBCD: 0.4 ng/g ww	Peck et al. 2008
FOOD WEBS					
Lake Winnipeg, MB; 2000-2002	whitefish (muscle) walleye	mean (range): α-HBCD β-HBCD γ-HBCD 1.22 0.53 1.03 (0.56-1.86) (0.10-1.25)	5 5	0.04 – 0.08	Law et al. 2006a

Sampling Location; Year	Organism	Concentration (ng/g lw)	Number of Samples	Detection Limit (ng/g lw)	Reference
	(muscle) mussel (muscle) zooplankton (whole body) emerald shiner (muscle) goldeye (muscle) white sucker (muscle) burbot (muscle)	(0.90-1.19) 6.53 1.26 4.20 (2.02-13.07)(0.66-2.36) (1.65-6.59) 8.25 1.11 15.32 (6.15-10.09) (nd-2.37) (6.69-23.04) 8.64 0.85 1.39 (1.40-17.54) (nd-1.80) (0.22-1.82) 8.70 1.65 6.95 (4.51-6.53) (nd-5.70) (3.66-12.09) 8.58 1.09 4.96 (7.39-10.06) (nd-2.08) (3.23-6.95) 3.66 0.56 3.94 (2.30-5.98) (0.27-0.90)(1.53-10.34) 15.71 5.58 44.13 (10.6-25.5)(2.29-10.3)(24.4-47.9)	5 5 5 3 5 5		
Lake Ontario; 2002	(whole body) lake trout rainbow smelt slimy sculpin alewife mysid amphipod plankton	ng/g ww: α-HBCD γ-HBCD[3] 0.37 – 3.78 0.07 – 0.73 0.19 – 0.26 0.03 – 0.04 0.15 – 0.46 0.02 – 0.17 0.08 – 0.15 0.01 – 0.02 0.04, 0.07 0.01, 0.02 0.05, 0.06 0.02, 0.03 0.02, 0.04 nd, 0.03	5 3 3 3 2 2 2	ng/g ww: α-HBCD: 0.017 β-HBCD: 0.030 γ-HBCD: 0.0067	Tomy et al. 2004a
Chesapeake Bay, USA; 2003	(composite fillets) American eel bluegill brown bullhead brown trout channel catfish largemouth bass pumpkinseed sunfish redbreast sunfish rock bass smallmouth bass striped bass white perch white sucker yellow bullhead	 2.2, 5.9 4.8 25.4 7.5 2.2 – 73.9 8.7 5.3 4.5 – 9.1 1.7 – 6.0 7.1, 15.9 nd – 59.1 1.0 – 21.0 3.9 – 19.1 6.9, 18.9	50	ns	Larsen et al. 2005
South America					
FISH					
Asia-Pacific; 1997 – 2001 off Brazil	skipjack tuna (muscle)	α-HBCD: 0.28 β-HBCD: nd γ-HBCD: nd Σ HBCD: 0.28	4 fish	α-HBCD: 0.1 β-HBCD: 0.1 γ-HBCD: 0.4	Ueno et al. 2006

Europe					
BIRDS					
	egg	Median mean±SD(min – max)			
Northern Norway: Hornøya			5 in 5		
1983	herring gull	ww: 2.0 1.8±0.4 (0.4-3.1) lw: 15.5 ns (4.7-28.1)	5 in 5		
1993		ww: 1.9 1.9±0.4 (1.6-2.2) lw: 18.0 ns (16.1 – 18.2)	5 in 5		
2003		ww: 6.7 9.3±1.9(5.7-17.8) lw: 67.2 ns (25.5-62.0)			
			5 in 5		
1983	black-legged kittiwake	ww: 1.5 1.7±0.3 (1.2-2.4) lw: 15.9 ns (12.3-54.9)	5 in 5		
1993		ww: 2.7 3.0±0.7 (2.4-3.7) lw: 27.0 ns (25.2-39.5)	5 in 5		
2003		ww: 11.5 10.8±2.2 (7.9-12.7) lw: 114.3 ns (91.6-110)	5 in 5		
1983	atlantic puffin	ww: 2.0 1.9±0.4 (1.2-2.3) lw: 14.4 ns (11.1-203)	4 in 4		
1993		ww: 5.2 4.9±1.0 (4.0-5.6) lw: 41.7 ns (31.8-85.3)	5 in 5		
2003		ww: 10.5 10.1±2.0 (6.3-13.1) lw: 72.3 ns (57.5-124)	5 in 5	ns	Klif 2005
Røst					
1983	herring gull	ww: 0.8 1.4±0.3 (0.6-2.7) lw:7.9 ns (6.3 – 20.4)	5 in 5		
1993		ww: 3.1 3.7±0.7 (2.4-5.3) lw: 37.6 ns (34.7-52.0)	5 in 5		
2003		ww: 11.3 11.6±2.3 (6.5-16.5) lw: 110 ns (71.3-136)	5 in 5		
			5 in 5		
1983	black-legged kittiwake	ww: 2.0 2.9±0.6 (0.7-7.9) lw: 32.8 ns (10.0-168)	5 in 5		
1993		ww: 5.7 7.1±(4.6-10.5) lw: 65.0 ns (26.4-55.4)	5 in 5		
2003		ww: 17.0 17.3±3.5 (11.7-26.5) lw: 161.3 ns (106-362)	5 in 5		
1983	atlantic puffin		4 in 4		
1993		ww: 1.0 1.1±0.2 (0.8-1.7) lw: 8.4 ns (7.8-28.5)	5 in 5		
2003		ww: 2.1 2.2±0.5 (1.6-2.9) lw: 16.3 ns (12.7-13.7)			
		ww: 5.0 6.1±1.2 (3.5-11.2) lw: 44.2 ns (21.6-65.1)			
Norwegian Arctic:					

Bjørnøya (Svalbard) 1997 2002	Glaucous gull	 ww: 2.3 2.3±0.2 (1.7-2.9) lw: 25.3 ns (19.1-32.2) ww: 7.5 12.0±3.3 (5.2-23.4) lw: 81.4 ns (62.8-292)	3 in 3 4 in 4		
Northern Norway; 1983 1993 2003 1983 1993 2003 1983 1993 2003	egg herring gull black-legged kittiwake atlantic puffin	α-HBCD mean ±SD 16±9 31±15 108±48 30±34 57±26 142±91 12±4 32±15 58±20 β-HBCD and γ-HBCD nd	 10 10 10 10 10 10 10 9 10 10	0.01 to 0.17	Helgason et al. 2009
central Norway; 2002	kittiwake (yolk sac) European shag (yolk sac)	260 417 (28.5 ng/g ww)	19 30	ns	Murvoll et al. 2006a,b
Sweden; northern population; 1991 – 1999 southern population; 1992 – 1999 captive population; 1987 – 1999	peregrine falcon (egg)	mean (range): 210 (nd – 1100) 270 (nd – 1900) nd	17 19 8	8.9 11 1.3	Johansson et al. 2009
central Norway; 1986 – 2004	tawny owl	mean (range): 2.21 (0.04 – 36.5)	in 34 of 139	ng/g ww: 0.03	Bustnes et al. 2007
United Kingdom; no year	peregrine falcon (egg) sparrow hawk (muscle)	71 – 1200 84 – 19000	in 12 of 51 in 9 of 65	ns	de Boer et al. 2004
FISH					
Norway; Arctic; 2003 Norwegian Sea; 2003 southern industrial region; 1998 2003	(liver): polar cod Atlantic cod Atlantic cod	mean (range): ng/g ww ng/g lw 2.39 (0.53–5.66) 14.7 (7.67–23.4) nd (nd–13.3) nd (nd–51.2) nd (nd–2.70) nd (nd–22.67) nd (nd–16.9) nd (nd–56.9)	 6 14 11 16	ns	Bytingsvik et al. 2004
S.E. Norway; no year 2003	perch (whole body) pike (whole body) smelt (whole body) vendace (whole body) trout (muscle) perch (muscle) orfe (muscle) flounder (liver) cod (liver) trout (muscle) eel (muscle)	α-HBCD β-HBCD γ-HBCD ng/g ww: 3.14 – 8.12 nd nd – 0.37 1.02 – 9.25 nd 0.03 – 0.92 2.1 0.03 0.25 3.15 0.4 0.62 2.28 – 13.3 0.06 – 1.12 0.24 – 3.73 ng/g lw: 22.3 nd nd 14.8 nd nd	pool of 7 – 20 individuals pool of 5 – 20 individuals	ng/g ww: 0.02 – 0.1 ng/g lw: 0.2 – 4.5	Schlabach et al. 2004b Schlabach et al. 2004a

		7.2 nd nd 9.3 nd nd nd nd nd 4.7 nd nd			
Sweden; 2002	herring	1.5 – 31	ns	ns	Asplund et al. 2004
United Kingdom; no year	(muscle) eel brown trout	ng/g ww: 39.9 – 10275 nd – 6758	ns	ns 1.2	Allchin and Morris 2003
Sweden; 1995	pike (muscle)	nd – 8000	15	50 – 100	Sellström et al. 1998
The Netherlands; 2003	freshwater eel	ng/g ww: α-HBCD β-HBCD γ-HBCD median 12 0.9 3 max. 41 1.6 8.4	10	ns	van Leeuwen et al. 2004
Belgium; 2000	eel	mean (range): 43 (nd – 266)	19	1	Morris et al. 2004
Spain; 2002 industrialized urban area with chemical industry	barbel: 20 km upstream 12 km upstream just downstream 30 km downstream bleak (whole body): 12 km upstream just downstream 30 km downstream	µg/kg ww: mean (range): muscle liver nd nd nd nd 529.7(215–1127) 554.4 (161–1172) 89.5 (42 – 135) 432.3 (49 – 180)[7] mean (range): adult young nd nd 1501(1274 – 1643) 381 (247 – 510) 760 (460 – 1103) 172 (72.8 – 268)	23 22	ns	Eljarrat et al. 2004, 2005
INVERTEBRATES					
The Netherlands; 2001	mysid shrimp (whole body)	562 – 727	ns	ns	Verslycke et al. 2005
SEA MAMMALS					
Baltic Sea; 1980 – 1985 1993 – 2000 1993 – 2000	grey seal (blubber) healthy no or slight gut ulcers moderate, severe or fatal gut ulcers	estimated mean[6]: 30 60 90	20	ns	Roos et al. 2001
United Kingdom; 1994 – 2003	harbour porpoise (blubber)	ng/g ww: α-HBCD β-HBCD γ-HBCD 10 – 19200 nd – 54 nd – 21	85	ng/g ww: 3 – 4	Law et al. 2006d
United Kingdom; 2003 2004 2005 2006	harbour porpoise (blubber)	ng/g ww; mean (range): 2245 (72 – 11 500) 1184 (34 – 4150) 1079 (nd – 8470) 698 (64 – 6358)	in 16 of 16 in 31 of 31 in 61 of 62 in 29 of 29	3 – 11	Law et al. 2008
western Europe; no year North Sea Scotland, northwest coast Irish Sea Ireland, south and west coasts Spain, northwest coast Galacia France, western English Channel	(blubber) harbour porpoise harbour porpoise harbour porpoise harbour porpoise	 393 – 2593 1009 – 9590 466 – 8786 710 – 2269 193 – 3416 79 – 142 51 – 454 97 – 898	 24 5 8 3 6 3 24 31	ns	Zegers et al. 2005

	common dolphin harbour porpoise common dolphin common dolphin				
FOOD WEBS					
United Kingdom; 1998 1999 – 2000 2001 no year	porpoise (blubber) cormorant (liver) sea star hake (liver)	mean (range): 312 (nd – 1019) 796 (138 – 1320) 769 nd	5 5 1 1	5 ns ns 0.6	Morris et al. 2004
North Sea; 1999	whelk (whole) sea star (pyloric caeca) hermit crab (abdomen) whiting (muscle) cod (liver) harbour seal (blubber) porpoise (blubber)	mean (range): 35 (29 – 47) 44 (nd – 84) nd nd nd – 50 63 – 2055 2945 (440 – 6800)	3 3 9 3 2 2 4	ns 30 30 73 0.7 ns ns	Morris et al. 2004
The Netherlands; no year	mussel sprat (muscle?) bass (muscle?) tern (egg)	ng/g dw: 125 – 177 65.5 124 533 – 844	ns	ns	Bouma et al. 2000
The Netherlands; 1999 – 2001	eel tern (egg)	mean (range): 184 (6 – 690) 1501 (330 – 7100)	11 10	ns ns	Morris et al. 2004
The Netherlands; 2001	shrimp (whole) eel (muscle)[5] sole (muscle) sole (liver) plaice (muscle) plaice (liver) bib (muscle) bib (liver)[5] whiting (muscle) whiting (liver)	α-HBCD / γ-HBCD 28 – 38 / nd – 18 7 – 27 / 2 – 3 110 – 1100 / 6 – 17 100 – 680 / nd – 8 38 / nd 21 – 26 / 4 – 8 53 – 97 / nd – 43 73 – 150 / 5 – 10 45 – 75 / nd – 51 16 – 240 / nd – 38	28	α-HBCD: ns β-HBCD: ns γ-HBCD:1 – 3	Janák et al. 2005
Norwegian North East Atlantic: Sothern Norway (Oslofjord) Northern Norway (Froan) Norwegian Arctic Bjørnøya Spitsbergen	*Calanus* sp. atlantic cod harbour seal common tern *Calanus finmarchius* atlantic cod harbour seal arctic tern polar cod *Calanus glacialis* polar cod harbour seal ringed seal arctic tern	Mean±SD 4.01±2.82 25.6±13.4 50.5±23.8 36.4±9.3 nd 18.7±10.5 22.3±11.9 17.0±8.8 11.7±7.2 nd 1.80±0.58 3.66±1.54 19.6±7.6 4.62±1.44	3 21 5 10 18 9 10 6 7 5 6 10		Jenssen et al. 2007
northern Norway; no year	blue mussel Atlantic cod (liver)	3.6 – 11 6.6, 7.7	ns	ns	Fjeld et al. 2004

Norway; 2004	blue mussel (whole body) herring (fillet with skin) mackerel (fillet, no skin)	ng/g ww, mean (range): 0.43 (< 0.17 – 0.87) 1.34 (< 0.63 – 2.75) < 0.89 – 1.19	33 23 24	0.17 0.63 0.89	Bethune et al. 2005
Africa					
BIRDS					
South Africa; 2004 – 2005	(egg) African darter reed cormorant cattle egret sacred ibis crowned plover little grebe white-fronted plover kelp gull	mean (range): 3.0 (< 0.2 – 11) < 0.2 < 0.2 4.8, 71 1.6 < 0.2 < 0.2 < 0.2	14 3 20 2 1 1 1 1	µg/kg ww: 0.2	Polder et al. 2008
Asia					
FISH					
Yangtze River, China; 2006	silver carp, muscle	α-HBCD: 15 – 29 β-HBCD: nd – 1.2 γ-HBCD: 5.5 – 8.9 Σ HBCD: 23 – 38	3	ng/g ww: α-HBCD: 0.005 β-HBCD: 0.005 γ-HBCD: 0.005	Xian et al. 2008
	bighead carp, muscle	α-HBCD: 11 – 17 β-HBCD: nd – 0.63 γ-HBCD: 1.7 – 2.7 Σ HBCD: 13 – 20	3		
	bighead carp, liver	α-HBCD: 20 β-HBCD: 0.69 γ-HBCD: 2.8 Σ HBCD: 24	1		
	grass carp, muscle	α-HBCD: 7.2 – 54 β-HBCD: nd – 2.2 γ-HBCD: 4.3 – 13 Σ HBCD: 12 – 68	2		
	grass carp, liver	α-HBCD: 75 β-HBCD: 2.8 γ-HBCD: 12 Σ HBCD: 91	1		
	common carp, muscle	α-HBCD: 28 β-HBCD: 0.76 γ-HBCD: 5.7 Σ HBCD: 34	1		
	common carp, liver	α-HBCD: 27 β-HBCD: 0.51 γ-HBCD: 2.9 Σ HBCD: 30	1		
	common carp, egg	α-HBCD: 14 β-HBCD: 0.50 γ-HBCD: 3.9 Σ HBCD: 18	1		
	crucian carp, whole	α-HBCD: 130 β-HBCD: 2.2 γ-HBCD: 26 Σ HBCD: 160	1		
		α-HBCD: 12 β-HBCD: 0.37 γ-HBCD: 2.9 Σ HBCD: 16	1		
		α-HBCD: 12 β-HBCD: 1.8	1		

	crucian carp, muscle	γ-HBCD: 10 Σ HBCD: 24			
	crucian carp, egg	α-HBCD: 20 – 57 β-HBCD: nd – 1.7 γ-HBCD: 5.2 – 5.6 Σ HBCD: 25 – 64	2		
		α-HBCD: 10 – 74 β-HBCD: 0.46 – 6.7 γ-HBCD: 2.7 – 51 Σ HBCD: 14 – 130	2		
	brass gudgeon, muscle	α-HBCD: 8.1 – 29 β-HBCD: 0.32 – 3.1 γ-HBCD: 2.0 – 20 Σ HBCD: 11 – 52	2		
	white amur bream, muscle	α-HBCD: 120 β-HBCD: 3.6 γ-HBCD: 200 Σ HBCD: 330	1		
	white amur bream, egg	α-HBCD: 80 β-HBCD: 2.8 γ-HBCD: 150 Σ HBCD: 240	1		
	mandarin fish, muscle	α-HBCD: 37 β-HBCD: nd γ-HBCD: 0.26 Σ HBCD: 37	1		
	mandarin fish, egg				
	snakehead, muscle				
Asia-Pacific; 1997 – 2001	skipjack tuna (muscle)		pooled:	α-HBCD: 0.1	Ueno et al. 2006
North Pacific		α-HBCD: 0.86 – 24 β-HBCD: 0.22 – 0.63 γ-HBCD: nd – 4.2 Σ HBCD: 1.1 – 29	15 fish	β-HBCD: 0.1 γ-HBCD: 0.4	
off Japan		α-HBCD: 30 – 45 β-HBCD: 0.27 – 0.30 γ-HBCD: 1.9 – 4.2 Σ HBCD: 32 – 45	10 fish		
Japan Sea		α-HBCD: 5.0 β-HBCD: 0.66 γ-HBCD: 1.4 Σ HBCD: 6.5	5 fish		
East China Sea		α-HBCD: 21 – 29 β-HBCD: 0.41 – 0.75 γ-HBCD: 6.5 – 14 Σ HBCD: 28 – 44	10 fish		
off Taiwan		α-HBCD: 24 β-HBCD: 0.38 γ-HBCD: 2.3 Σ HBCD: 27	5 fish		

South China Sea		α-HBCD: 2.5 β-HBCD: 0.10 γ-HBCD: 0.65 Σ HBCD: 3.2	1 fish		
off Philippines		α-HBCD: 0.86 β-HBCD: nd γ-HBCD: nd Σ HBCD: 0.86	5 fish		
Bay of Bengal		α-HBCD: 0.27 β-HBCD: nd γ-HBCD: nd Σ HBCD: 0.27	5 fish		
off Indonesia		α-HBCD: 0.41 β-HBCD: nd γ-HBCD: nd Σ HBCD: 0.41	2 fish		
off Seychelles		α-HBCD: nd β-HBCD: nd γ-HBCD: nd Σ HBCD: nd	3 fish		
Japan; 1987	fish	10 – 23 ng/g ww	in 4 of 66	ns	Watanabe and Tatsukawa 1990
INVERTEBRATES					
Korea; 2005	blue mussel (whole body)	6.0 – 500	17	0.005	Ramu et al. 2007
SEA MAMMALS					
South China Sea; Hong Kong; 1997 – 2001	(blubber): finless porpoise	α-HBCD: 21 – 55 β-HBCD: nd γ-HBCD: nd – 0.21 Σ HBCD: 21 – 55	5	0.006	Isobe et al. 2008
	humpback dolphin	α-HBCD: 31 – 370 β-HBCD: nd – 0.59 γ-HBCD: nd – 4.6 Σ HBCD: 31 – 380	7		
Dongshan; 1990	finless porpoise	α-HBCD: 4.4 – 15 β-HBCD: nd – 4.0 γ-HBCD: nd – 21 Σ HBCD: 4.7 – 37	7		
Japan; 1999	blubber: striped dolphin Minke whale	 90 57	 1 1	ns	Marsh et al. 2004
MAMMALS					
Japan;	raccoon dog liver	α-HBCD: nd - 10 β-HBCD: nd γ-HBCD: nd – 0.044 Σ HBCD: nd – 10	10	α-HBCD: 0.005 β-HBCD: 0.005 γ-HBCD: 0.005	Kunisue et al. 2008
Kanagawa (Eastern metropolis); 2001 – 2003	liver	α-HBCD: nd – 7.6 β-HBCD: nd – 3.7 γ-HBCD: nd – 20 Σ HBCD: nd – 29	21		
Ehime (Western local prefecture); 2001 – 2003	liver	α-HBCD: 0.51 – 1.2 β-HBCD: nd – 0.71 γ-HBCD: 0.029 – 1.0 Σ HBCD: 0.73 – 2.9	8		
Osaka (Western metropolis); 2004 – 2006	adipose tissue	α-HBCD: 0.20 – 4.1 β-HBCD: nd – 0.14 γ-HBCD: nd – 0.17 Σ HBCD: 0.21 – 4.3	8		

Notes:

[1] not detected

[2] not specified

[3] concentrations of β-isomer were below detection limits

[4] not quantifiable

[5] the β isomer was detected in one eel sample (3.4 ng/g lipid weight) and two bib liver samples (1.6 and 2.2 ng/g lipid weight)

[6] values estimated from graphical representation of data

[7] mean value provided in the reference article exceeds the upper limit of the indicated range

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