

Contaminant	Avian TEF		Canada Goose n=4		Glaucous-winged Gull n=4	
	Geo. Mean (Range) pg/g wet weight	TEQ Mean (Range) pg/g wet weight	Geo. Mean (Range) pg/g wet weight	TEQ Mean (Range) pg/g wet weight	Geo. Mean (Range) pg/g wet weight	TEQ Mean (Range) pg/g wet weight
<b>Dibenzodioxins</b>						
2,3,7,8-TCDD	1	0.29 (0.12 - 0.50) <sup>1</sup>	0.29 (0.12 - 0.50) <sup>1</sup>	0.29 (0.12 - 0.50) <sup>1</sup>	0.58 (0.18 - 1.40) <sup>1</sup>	0.58 (0.18 - 1.40) <sup>1</sup>
1,2,3,7,8-PeCDD	1	1.96 (1.40 - 3.10)	1.96 (1.40 - 3.10)	1.96 (1.40 - 3.10)	1.17 (0.53 - 2.30) <sup>3</sup>	1.17 (0.53 - 2.30) <sup>3</sup>
1,2,3,4,7,8-HxCDD	0.05	1.53 (0.90 - 2.20)	1.53 (0.90 - 2.20)	0.08 (0.05 - 0.11)	0.24 (0.20 - 0.32) <sup>1</sup>	0.01 (<0.01 - 0.01) <sup>1</sup>
1,2,3,6,7,8-HxCDD	0.01	5.33 (3.20 - 7.20)	5.33 (3.20 - 7.20)	0.05 (0.03 - 0.07)	5.52 (2.20 - 14.00)	0.06 (0.02 - 0.14)
1,2,3,7,8,9-HxCDD	0.1	1.42 (0.78 - 1.90)	1.42 (0.78 - 1.90)	0.14 (0.08 - 0.19)	0.45 (0.16 - 1.30) <sup>1,3</sup>	0.04 (0.01 - 0.13) <sup>1,3</sup>
1,2,3,4,6,7,8-HpCDD	<0.001	7.83 (5.20 - 14.00)	7.83 (5.20 - 14.00)	<0.01 (<0.01 - <0.01)	5.48 (2.30 - 22.00)	<0.01 (<0.01 - 0.02)
OCDD	N/A	9.43 (2.20 - 36.00) <sup>2</sup>	N/A	N/A	8.08 (2.25 - 78.00) <sup>2</sup>	N/A
<b>Dibenzofurans</b>						
2,3,7,8-TCDF	1	1.36 (0.90 - 2.80)	1.36 (0.90 - 2.80)	1.36 (0.90 - 2.80)	0.13 (0.10 - 0.26) <sup>1</sup>	0.13 (0.10 - 0.26) <sup>1</sup>
1,2,3,7,8-PeCDF	0.1	0.90 (0.52 - 1.50) <sup>3</sup>	0.90 (0.52 - 1.50) <sup>3</sup>	0.09 (0.05 - 0.15) <sup>3</sup>	0.12 (0.08 - 0.21) <sup>1</sup>	0.01 (<0.01 - 0.02) <sup>1</sup>
2,3,4,7,8-PeCDF	1	1.10 (0.58 - 2.60) <sup>3</sup>	1.10 (0.58 - 2.60) <sup>3</sup>	1.10 (0.58 - 2.60) <sup>3</sup>	0.59 (0.20 - 1.10) <sup>1,3</sup>	0.59 (0.20 - 1.10) <sup>1,3</sup>
1,2,3,4,7,8-HxCDF	0.1	1.03 (0.50 - 1.80) <sup>3</sup>	1.03 (0.50 - 1.80) <sup>3</sup>	0.10 (0.05 - 0.18) <sup>3</sup>	0.52 (0.27 - 1.30) <sup>1,3</sup>	0.05 (0.03 - 0.13) <sup>1,3</sup>
1,2,3,6,7,8-HxCDF	0.1	0.47 (0.22 - 0.76) <sup>3</sup>	0.47 (0.22 - 0.76) <sup>3</sup>	0.05 (0.02 - 0.08) <sup>3</sup>	1.12 (0.70 - 1.70) <sup>1,4</sup>	0.11 (0.07 - 0.17) <sup>1,4</sup>
2,3,4,6,7,8-HxCDF	0.1	0.60 (0.38 - 0.72) <sup>3</sup>	0.60 (0.38 - 0.72) <sup>3</sup>	0.06 (0.04 - 0.07) <sup>3</sup>	0.38 (0.28 - 0.71) <sup>1,3</sup>	0.04 (0.02 - 0.07) <sup>1,3</sup>
1,2,3,7,8,9-HxCDF	0.1	0.05 (0.02 - 0.09) <sup>1</sup>	0.05 (0.02 - 0.09) <sup>1</sup>	<0.01 (<0.01 - <0.01) <sup>1</sup>	0.09 (0.04 - 0.30) <sup>1</sup>	<0.01 (<0.01 - 0.03) <sup>1</sup>
1,2,3,4,6,7,8-HpCDF	0.01	0.80 (0.34 - 1.10) <sup>3</sup>	0.80 (0.34 - 1.10) <sup>3</sup>	<0.01 (<0.01 - <0.01) <sup>3</sup>	0.43 (0.20 - 1.80) <sup>1</sup>	<0.01 (<0.01 - 0.01) <sup>1</sup>
1,2,3,4,7,8,9-HpCDF	0.01	0.07 (0.02 - 0.14) <sup>1,3,4</sup>	0.07 (0.02 - 0.14) <sup>1,3,4</sup>	<0.01 (<0.01 - <0.01) <sup>1,3,4</sup>	0.12 (0.07 - 0.26) <sup>1</sup>	<0.01 (<0.01 - <0.01) <sup>1</sup>
OCDF	0.0001	0.39 (0.32 - 0.49) <sup>1,2,3,4</sup>	0.39 (0.32 - 0.49) <sup>1,2,3,4</sup>	<0.01 (<0.01 - <0.01) <sup>1,2,3,4</sup>	0.42 (0.38 - 0.55) <sup>2</sup>	<0.01 (<0.01 - <0.01) <sup>2</sup>
<b>Non ortho-chlorinated Biphenyls</b>						
3,4,4',5'-TeCB (81)	0.1	2.66 (1.70 - 3.50) <sup>1</sup>	2.66 (1.70 - 3.50) <sup>1</sup>	<0.01 (<0.01 - <0.01) <sup>1</sup>	112.28 (58.00 - 210.00)	11.23 (5.80 - 21.00)
3,3',4,4'-TeCB (77)	0.05	52.71 (38.00 - 82.00)	52.71 (38.00 - 82.00)	2.64 (1.90 - 4.10)	32.09 (4.95 - 170.00) <sup>1</sup>	1.61 (0.25 - 8.50) <sup>1</sup>
3,3',4,4',5'-PeCB (126)	0.1	7.52 (3.00 - 33.00) <sup>1</sup>	7.52 (3.00 - 33.00) <sup>1</sup>	<0.01 (<0.01 - 3.30) <sup>1</sup>	88.32 (39.00 - 160.00)	8.83 (3.90 - 16.00)
3,3',4,4',5,5'-HxCB (169)	0.001	6.61 (5.00 - 8.50) <sup>1</sup>	6.61 (5.00 - 8.50) <sup>1</sup>	<0.01 (<0.01 - <0.01) <sup>1</sup>	12.60 (8.50 - 19.50) <sup>1</sup>	0.01 (0.01 - 0.02) <sup>1</sup>
<b>Mono ortho-chlorinated Biphenyls</b>						
2,3,3',4,4'-PeCB (105)	0.0001	N/A	N/A	N/A	N/A	N/A
2,3,4,4',5'-PeCB (114)	0.0001	N/A	N/A	N/A	N/A	N/A
2,3',4,4',5'-PeCB (118)	0.00001	1101.60 (120.00 - 5900.00)	1101.60 (120.00 - 5900.00)	0.01 (0.001 - 0.059)	21519.07 (11000.00 - 38000.00)	0.22 (0.11 - 0.38)
2',3,4,4',5'-PeCB (123)	0.00001	N/A	N/A	N/A	N/A	N/A
2,3,3',4,4',5-HxCB (156)	0.0001	N/A	N/A	N/A	N/A	N/A
2,3,3',4,4',5'-HxCB (157)	0.0001	N/A	N/A	N/A	N/A	N/A
2,3',4,4',5,5'-HxCB (167)	0.0001	N/A	N/A	N/A	N/A	N/A
2,3,3',4,4',5,5'-HpCB (189)	0.00001	N/A	N/A	N/A	N/A	N/A

**Table 6. Congener specific mean and range values in pg/g (ppt) wet weight and corresponding TEF/TEQ values for Canada goose and glaucous-winged gull eggs collected in Commencement Bay in 1995.**

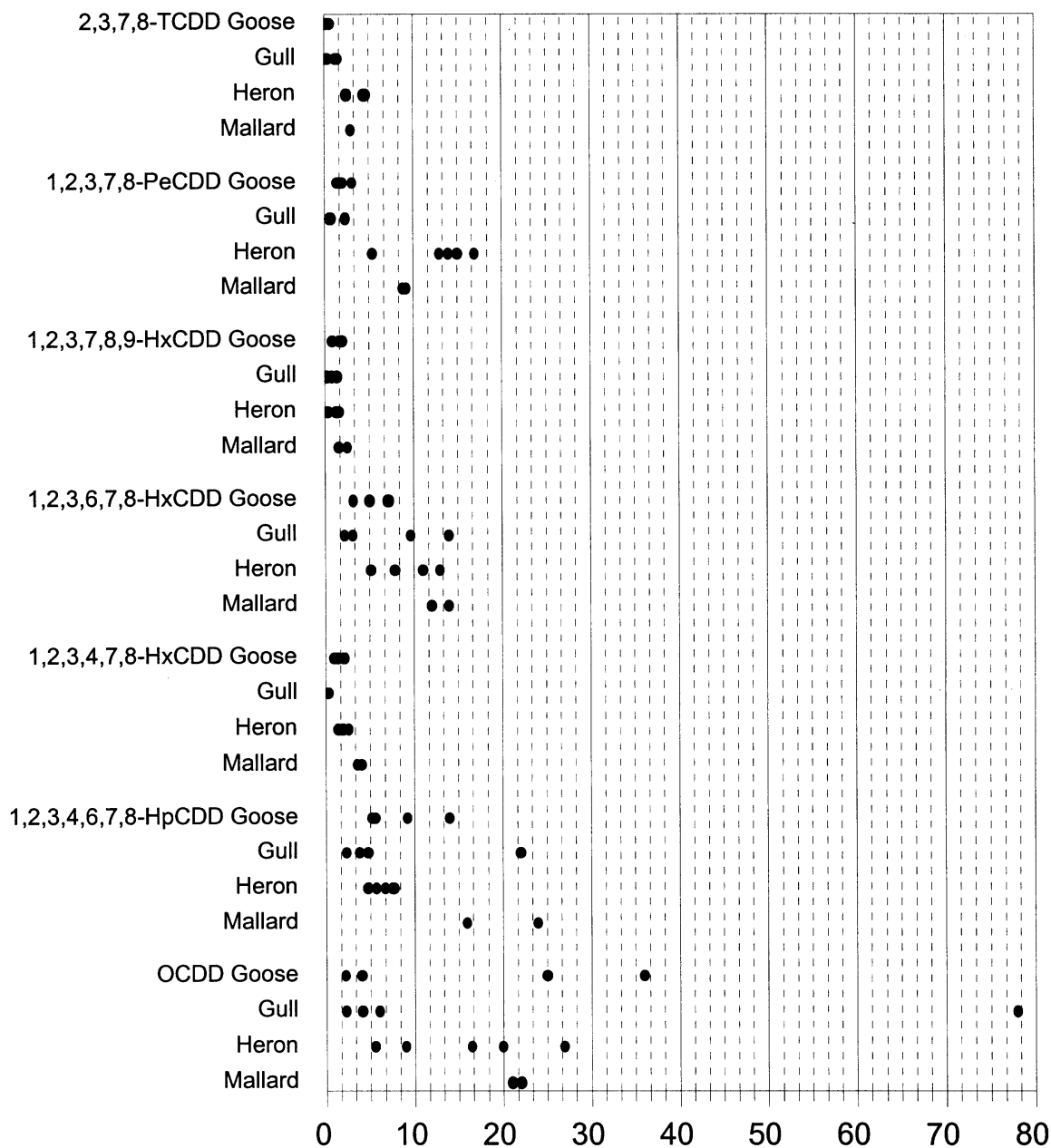
<sup>1</sup>Detection Limit for some or all of the values. Value reported as ½ detection limit.  
<sup>2</sup>Compound detected in the blank for some or all of the values. Value reported as ½ detection limit  
<sup>3</sup>The amount detected is below the method calibration limit for some or all of the values.  
<sup>4</sup>The amount reported is the maximum possible concentration for some or all of the values.  
N/A = not available

Contaminant	Avian TEF		Great Blue Heron n=5		Mallard Duck n=2	
	Geo. Mean (Range) pg/g wet weight	TEQ Mean (Range) pg/g wet weight	Geo. Mean (Range) pg/g wet weight	TEQ Mean (Range) pg/g wet weight	Geo. Mean (Range) pg/g wet weight	TEQ Mean (Range) pg/g wet weight
<b>Dibenzodioxins</b>						
2,3,7,8-TCDD	1	3.54 (2.40 - 4.60)	3.54 (2.40 - 4.60)	3.54 (2.40 - 4.60)	3.00 (3.00 - 3.00)	3.00 (3.00 - 3.00)
1,2,3,7,8-PeCDD	1	12.02 (5.40 - 17.00)	12.02 (5.40 - 17.00)	12.02 (5.40 - 17.00)	9.00 (8.80 - 9.20)	9.00 (8.80 - 9.20)
1,2,3,4,7,8-HxCDD	0.05	1.79 (1.40 - 2.60)	1.79 (1.40 - 2.60)	0.09 (0.07 - 0.13)	3.79 (3.60 - 4.00)	0.19 (0.18 - 0.20)
1,2,3,6,7,8-HxCDD	0.01	9.41 (5.10 - 13.00)	9.41 (5.10 - 13.00)	0.09 (0.05 - 0.13)	12.96 (12.00 - 14.00)	0.13 (0.12 - 0.14)
1,2,3,7,8,9-HxCDD	0.1	0.77 (0.28 - 1.50) <sup>1</sup>	0.77 (0.28 - 1.50) <sup>1</sup>	0.08 (0.02 - 0.15) <sup>1</sup>	1.94 (1.50 - 2.50)	0.19 (0.15 - 0.25)
1,2,3,4,6,7,8-HpCDD	<0.001	6.34 (4.70 - 7.60)	6.34 (4.70 - 7.60)	<0.01 (<0.01 - <0.01)	19.60 (16.00 - 24.00)	0.02 (0.02 - 0.02)
OCDD	N/A	13.46 (5.50 - 27.00) <sup>2</sup>	13.46 (5.50 - 27.00) <sup>2</sup>	N/A	21.49 (21.00 - 22.00) <sup>2</sup>	N/A
<b>Dibenzofurans</b>						
2,3,7,8-TCDF	1	0.70 (0.33 - 1.30)	0.70 (0.33 - 1.30)	0.70 (0.33 - 1.30)	82.58 (62.00 - 110.00)	82.58 (62.00 - 110.00)
1,2,3,7,8-PeCDF	0.1	1.20 (0.48 - 1.80) <sup>3</sup>	1.20 (0.48 - 1.80) <sup>3</sup>	0.12 (0.04 - 0.18) <sup>3</sup>	31.08 (23.00 - 42.00)	3.11 (2.30 - 4.20)
2,3,4,7,8-PeCDF	1	17.59 (4.20 - 80.00)	17.59 (4.20 - 80.00)	17.59 (4.20 - 80.00)	36.52 (29.00 - 46.00)	36.52 (29.00 - 46.00)
1,2,3,4,7,8-HxCDF	0.1	2.79 (0.72 - 12.00) <sup>3</sup>	2.79 (0.72 - 12.00) <sup>3</sup>	0.28 (0.07 - 1.20) <sup>3</sup>	12.30 (8.90 - 17.00)	1.23 (0.89 - 1.70)
1,2,3,6,7,8-HxCDF	0.1	4.74 (2.60 - 12.00) <sup>4</sup>	4.74 (2.60 - 12.00) <sup>4</sup>	0.47 (0.26 - 1.20) <sup>4</sup>	4.41 (3.60 - 5.40)	0.44 (0.36 - 0.54)
2,3,4,6,7,8-HxCDF	0.1	0.83 (0.71 - 0.98) <sup>3</sup>	0.83 (0.71 - 0.98) <sup>3</sup>	0.08 (0.07 - 0.09) <sup>3</sup>	2.25 (2.20 - 2.30)	0.22 (0.22 - 0.23)
1,2,3,7,8,9-HxCDF	0.1	0.13 (0.11 - 0.18) <sup>1</sup>	0.13 (0.11 - 0.18) <sup>1</sup>	0.01 (0.01 - 0.02) <sup>1</sup>	0.53 (0.29 - 1.00) <sup>1,3</sup>	0.05 (0.02 - 0.10) <sup>1,3</sup>
1,2,3,4,6,7,8-HpCDF	0.01	1.65 (1.00 - 3.00) <sup>3,4</sup>	1.65 (1.00 - 3.00) <sup>3,4</sup>	0.02 (0.01 - 0.03) <sup>3,4</sup>	3.33 (3.00 - 3.70)	0.03 (0.03 - 0.04)
1,2,3,4,7,8,9-HpCDF	0.01	0.29 (0.22 - 0.35) <sup>1</sup>	0.29 (0.22 - 0.35) <sup>1</sup>	<0.01 (<0.01 - <0.01) <sup>1</sup>	0.30 (0.24 - 0.37) <sup>1</sup>	<0.01 (<0.01 - <0.01) <sup>1</sup>
OCDF	0.0001	0.62 (0.32 - 4.30) <sup>1</sup>	0.62 (0.32 - 4.30) <sup>1</sup>	<0.01 (<0.01 - <0.01) <sup>1</sup>	7.25 (2.50 - 21.00)	<0.01 (<0.01 - <0.01)
<b>Non ortho-chlorinated Biphenyls</b>						
3,4,4',5'-TeCB (81)	0.1	125.85 (31.00 - 970.00) <sup>1</sup>	125.85 (31.00 - 970.00) <sup>1</sup>	12.59 (3.10 - 97.00) <sup>1</sup>	285.66 (240.00 - 340.00)	28.57 (24.00 - 34.00)
3,3',4,4'-TeCB (77)	0.05	174.82 (60.00 - 310.00)	174.82 (60.00 - 310.00)	8.74 (3.00 - 15.50)	5509.99 (4600.00 - 6600.00)	275.50 (230.00 - 330.00)
3,3',4,4',5'-PeCB (126)	0.1	540.61 (220.00 - 1700.00)	540.61 (220.00 - 1700.00)	54.06 (22.00 - 170.00)	418.21 (330.00 - 530.00)	41.82 (33.00 - 53.00)
3,3',4,4',5,5'-HxCB (169)	0.001	<1.25 (<1.25 - <1.25) <sup>1</sup>	<1.25 (<1.25 - <1.25) <sup>1</sup>	<0.01 (<0.01 - <0.01) <sup>1</sup>	<1.25 (<1.25 - <1.25) <sup>1</sup>	<0.01 (<0.01 - <0.01) <sup>1</sup>
<b>Mono ortho-chlorinated Biphenyls</b>						
2,3,3',4,4'-PeCB (105)	0.0001	75,750.67 (17,000.00 - 390,000.00)	75,750.67 (17,000.00 - 390,000.00)	7.58 (1.70 - 39.00)	23,366.64 (21,000.00 - 26,000.00)	2.34 (2.10 - 2.60)
2,3,4,4',5'-PeCB (114)	0.0001	8294.76 (1200.00 - 83,000.00)	8294.76 (1200.00 - 83,000.00)	0.83 (0.12 - 8.30)	1349.07 (1300.00 - 1400.00)	0.13 (0.13 - 0.14)
2,3',4,4',5'-PeCB (118)	0.00001	364,083.71 (75,000.00 - 1,700,000.00)	364,083.71 (75,000.00 - 1,700,000.00)	3.64 (0.75 - 17.00)	78,364.53 (69,000.00 - 89,000.00)	0.78 (0.69 - 0.89)
2',3,4,4',5'-PeCB (123)	0.00001	6967.64 (1200.00 - 65,000.00)	6967.64 (1200.00 - 65,000.00)	0.07 (0.01 - 0.65)	1691.15 (1300.00 - 2200.00)	0.02 (0.01 - 0.02)
2,3,3',4,4',5'-HxCB (156)	0.0001	35,597.51 (9500.00 - 130,000.00)	35,597.51 (9500.00 - 130,000.00)	3.56 (0.95 - 13.00)	7097.18 (6900.00 - 7300.00)	0.71 (0.69 - 0.73)
2,3,3',4,4',5'-HxCB (157)	0.0001	7822.65 (1500.00 - 38,000.00)	7822.65 (1500.00 - 38,000.00)	0.78 (0.15 - 3.80)	1843.91 (1700.00 - 2000.00)	0.18 (0.17 - 0.20)
2,3',4,4',5,5'-HxCB (167)	0.0001	54,112.78 (16,000.00 - 250,000.00)	54,112.78 (16,000.00 - 250,000.00)	5.41 (1.60 - 25.00)	12,000.00 (12,000.00 - 12,000.00)	1.20 (1.20 - 1.20)
2,3,3',4,4',5,5'-HpCB (189)	0.00001	2481.62 (860.00 - 6000.00)	2481.62 (860.00 - 6000.00)	0.02 (0.01 - 0.06)	449.00 (320.00 - 630.00)	<0.01 (<0.01 - <0.01)

**Table 7. Congener specific mean and range values in pg/g (ppt) wet weight and corresponding TEF/TEQ values for great blue heron and mallard duck eggs collected in Commencement Bay in 1996.**

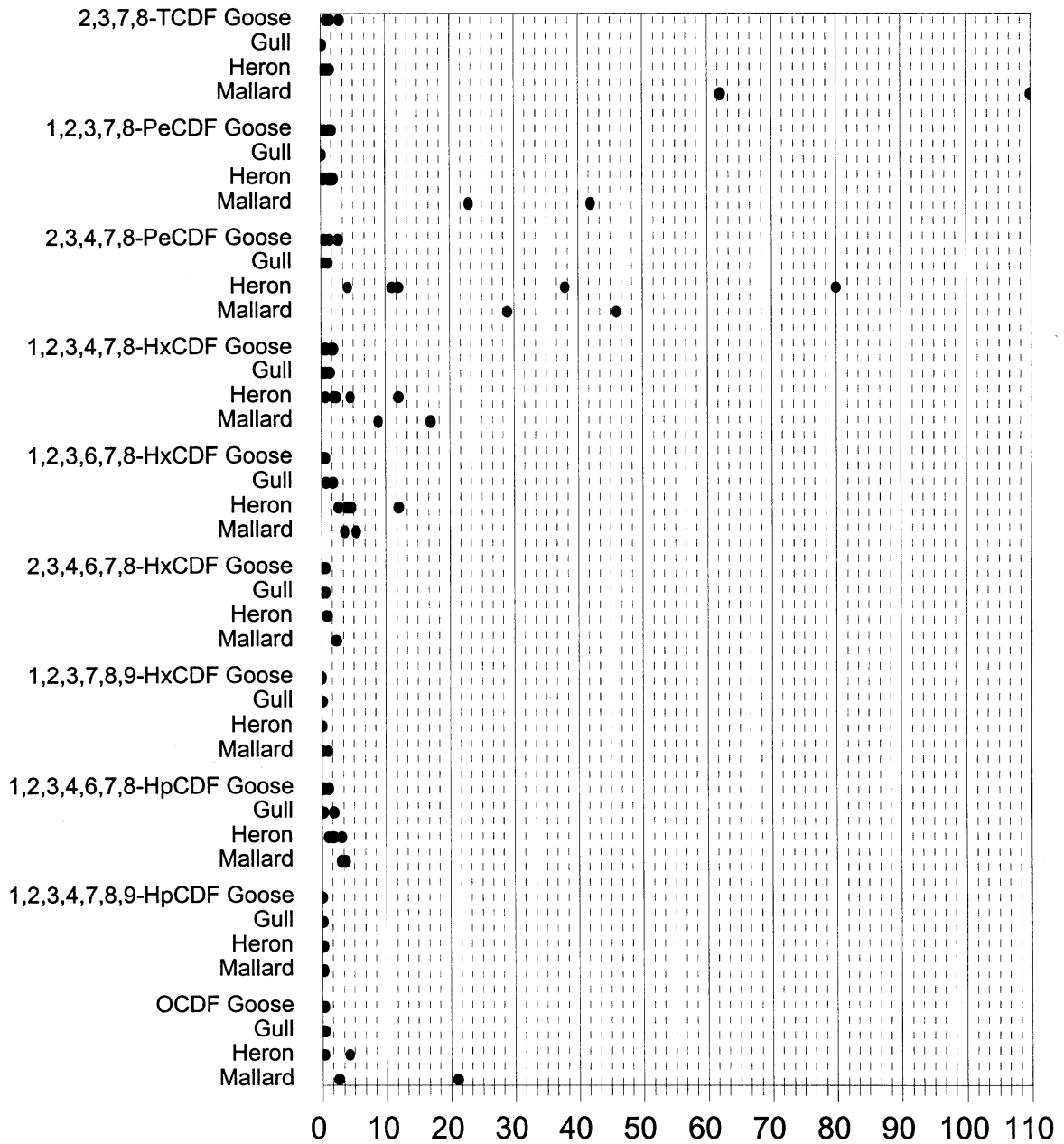
<sup>1</sup>Detection Limit for some or all of the values. Value reported as ½ detection limit.  
<sup>2</sup>Compound detected in the blank for some or all of the values. Value reported as ½ detection limit.  
<sup>3</sup>The amount detected is below the method calibration limit for some or all of the values.  
<sup>4</sup>The amount reported is the maximum possible concentration for some or all of the values.  
N/A = not available

## Dibenzodioxins



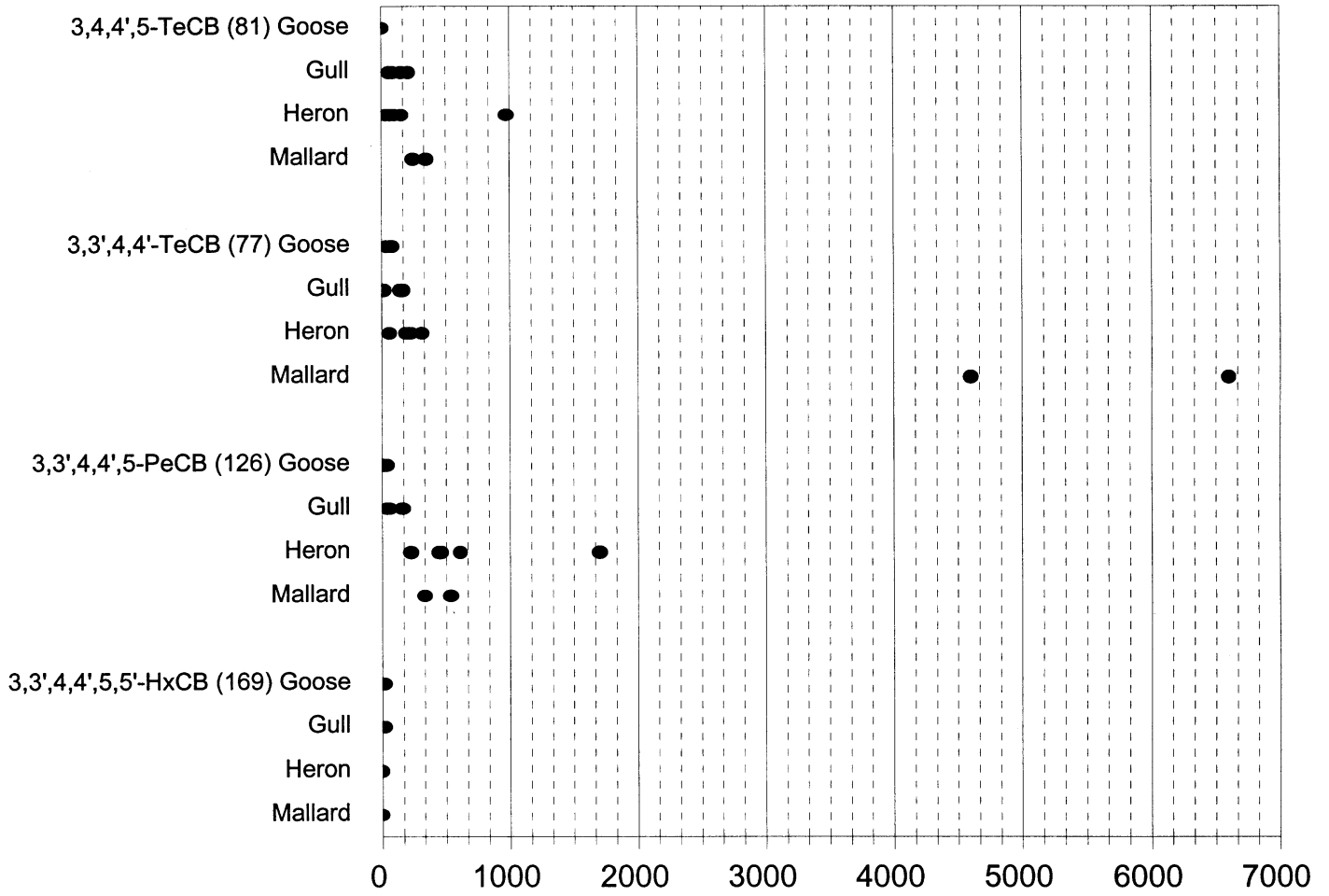
**Figure 3. Congener-specific comparison between avian species for dibenzodioxins in pg/g (ppt) wet weight in egg tissues collected in Commencement Bay in 1995 and 1996.**

## Dibenzofurans



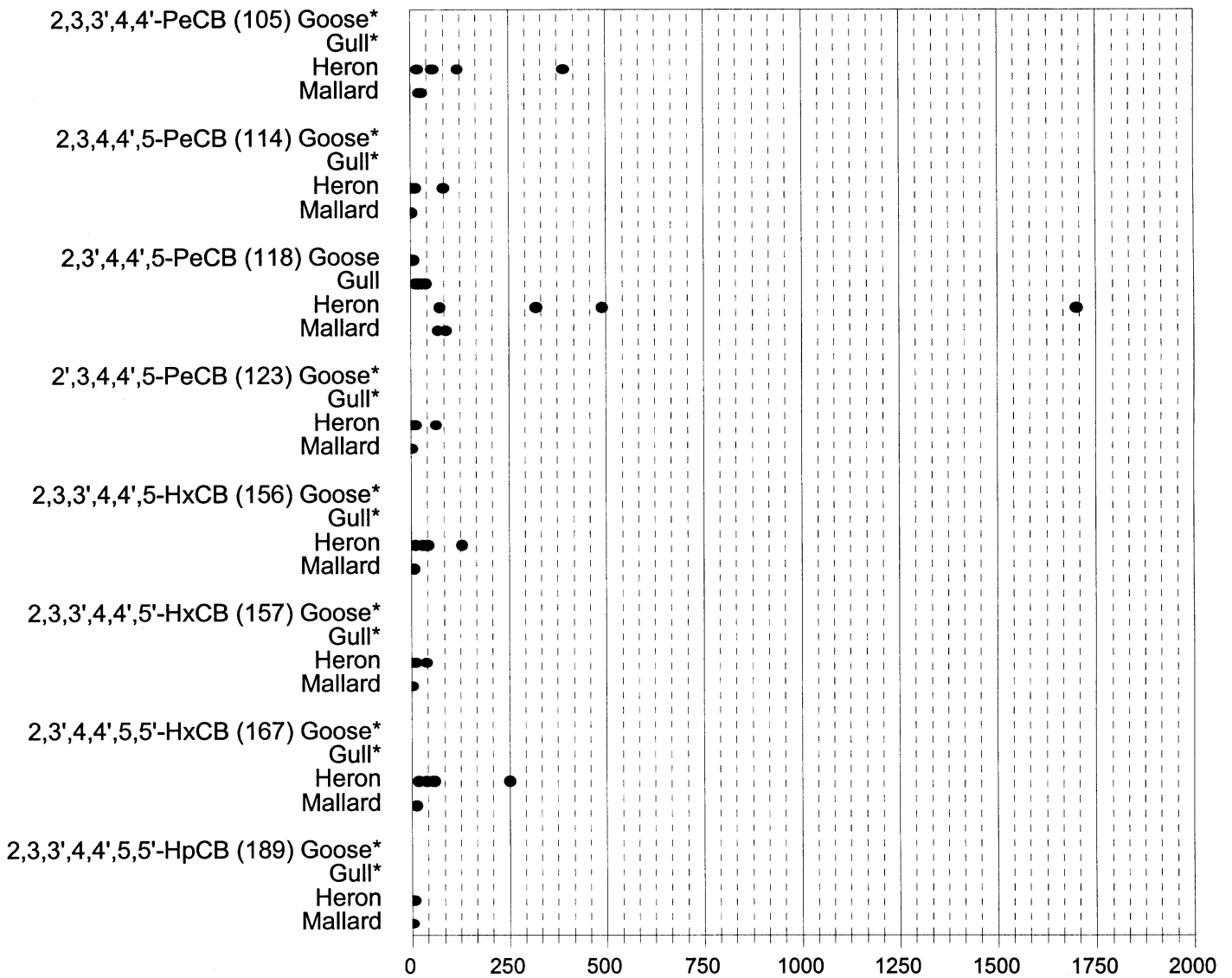
**Figure 4. Congener-specific comparison between avian species for dibenzofurans in pg/g (ppt) wet weight in egg tissues collected in Commencement Bay in 1995 and 1996.**

**Non ortho-chlorinated Biphenyls**



**Figure 5. Congener-specific comparison between avian species for non ortho-chlorinated biphenyls in pg/g (ppt) wet weight in egg tissues collected in Commencement Bay in 1995 and 1996.**

## Mono ortho-chlorinated Biphenyls



**Figure 6. Congener-specific comparison between avian species for mono ortho-chlorinated biphenyls in ng/g (ppb) wet weight in egg tissues collected in Commencement Bay in 1995 and 1996.**

\*Not analyzed in Canada goose and glaucous-winged gull.

higher than all the other species including mallard.

Hérons appeared to assimilate higher amounts of the non ortho-chlorinated biphenyl congeners (**Figure 5**). The one notable exception was with PCB 77 in mallards where concentration levels in both samples were clearly more elevated than the other species. Herons also appeared to have higher concentration levels of the mono ortho-chlorinated biphenyl congeners than the mallard (**Figure 6**). This comparison was limited to PCB 118 for all species, and between mallard and heron for the remaining mono ortho-chlorinated congeners that have assigned TEF values. **Table 8** describes lowest observable adverse effect levels (LOAELs) associated with total PCBs in bird eggs from the Great Lakes region.

<b>Species</b>	<b>Adverse Effect</b>	<b>PCBs-LOAEL</b>	<b>Reference</b>
<b>Bald Eagle</b>	egg lethality	<b>4.0 mg/kg</b>	Weimeyer <i>et al.</i> 1984
<b>Herring Gull</b>	embryonic deformities egg lethality	<b>5.0 mg/kg</b>	Weseloh <i>et al.</i> 1991
<b>Caspian Tern</b>	21% embryonic deformities egg lethality	<b>4.2 mg/kg</b>	Yamashita <i>et al.</i> 1993
<b>Double-crested Cormorant</b>	egg lethality (twice as great as control)	<b>3.5 mg/kg</b>	Yamashita <i>et al.</i> 1993 Tillitt <i>et al.</i> 1992

**Table 8. Lowest observable adverse effect levels in mg/kg or  $\mu\text{g/g}$  (ppm) wet weight of total polychlorinated biphenyls (PCBs) in bird eggs from the Great Lakes region (modified and adapted from FWS December 2, 1996 letter to EPA).**

### A3.2 TCDD Equivalentents (or TEQs)

To more accurately assess the true toxicity and potential for avian injury from the dioxin-like compounds, TEQs were calculated for each sample. This approach assumes an additive model for toxicity and that the chemistry-derived TCDD equivalentents are a function of the specific toxic equivalency factors used (**Table 4**). Total TEQ values derived from eggs collected in Commencement Bay ranged from approximately 6.6 pg/g (Canada goose) to 598 pg/g (mallard duck)(**Table 9**).

For each species, all dioxin-like compounds were evaluated for percent contribution to a total TEQ value calculated from TEFs and tissue values. Although a complete picture of toxic contributors for goose and gull is limited due to the lack of data for most of the mono ortho-chlorinated biphenyls, some general comparisons can be made among the more toxic