Species	Status	Food Habits	Observations (mean counts)
Western Grebe	Winter Resident	piscivore	6(235)
Mew Gull	Winter Resident	omnivore	6(207)
Northern Pintail	Winter Resident, Migrant	herbivore, benthivore	6(121)
> ***Glaucous-winged Gull***	***Resident, Breeding***	***piscivore, omnivore***	***5(83)***
Green-winged Teal	Winter Resident, Migrant	herbivore, benthivore	6(74)
Dunlin	Winter Resident, Migrant	insectivore, benthivore	4(69)
> ***Great Blue Heron***	***Resident, Breeding***	***piscivore, omnivore***	***6(64)***
American Coot	Resident	herbivore, omnivore	6(46)
> ***Mallard***	***Resident, Breeding***	***herbivore, benthivore***	***6(46)***
Barrows Goldeneye	Resident, Migrant	benthivore	6(29)
American Wigeon	Winter Resident, Migrant	herbivore, benthivore	6(27)
Greater Scaup	Winter Resident, Migrant	benthivore	5(26)
Western Sandpiper	Migrant	insectivore, benthivore	2(21)
Black Turnstone	Migrant	benthivore	5(11)
Red-breasted Merganser	Winter Resident, Migrant	piscivore, benthivore	6(9)
Double-crested Cormorant	Winter Resident	piscivore	4(9)
Northern Shoveler	Winter Resident	herbivore, benthivore	6(8)
> ***Canada Goose***	***Resident, Breeding***	***herbivore, benthivore***	***4(8)***
Killdeer	Resident, Breeding	insectivore, benthivore	2(6)
Least Sandpiper	Migrant	benthivore, insectivore	3(5)
Surf Scoter	Winter Resident, Migrant	benthivore	6(5)
Horned Grebe	Winter Resident	piscivore, benthivore	6(5)
Common Goldeneye	Winter Resident, Migrant	benthivore	6(5)

Table 1. Compiled bird list and selected species (>) for 1995 and 1996 egg collection in Commencement Bay using Hylebos Waterway Christmas Bird Count Data, 1977-1982.

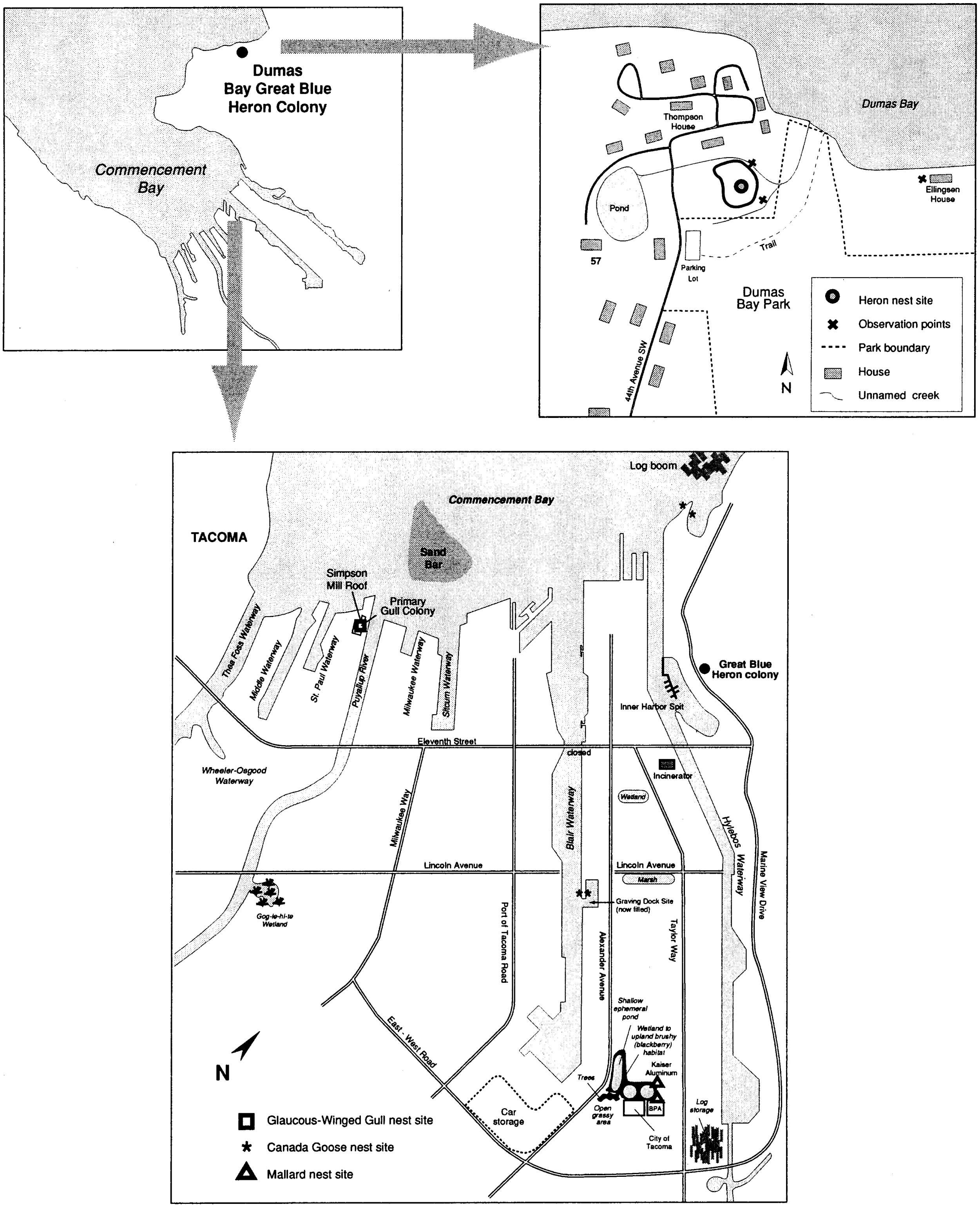

Figure 2. Map of egg collection locations in Commencement Bay in 1995 and 1996.

Sample ID	# in Nest	Species	Date Collected	Location	Method
HBS-1	1 of 7	Canada Goose	07apr95	Inner Hylebos Spit	Blown
HBS-2	1 of 5	Canada Goose	07apr95	Inner Hylebos Spit	Blown
BGD-1	1 of 6	Canada Goose	07apr95	Blair Graving Dock	Blown
BGD-2	1 of 5	Canada Goose	07apr95	Blair Graving Dock	Blown
SIM-1	1 of 3	Glaucous-winged Gull	05may95	Simpson Mill Roof	Blown
SIM-2	1 of 2	Glaucous-winged Gull	05may95	Simpson Mill Roof	Blown
SIM-3	1 of 1	Glaucous-winged Gull	05may95	Simpson Mill Roof	Blown
SIM-4	1 of 1	Glaucous-winged Gull	05may95	Simpson Mill Roof	Blown
GBH96-1	1of 2	Great Blue Heron	08apr96	Dumas Bay	USFWS SOP
GBH96-2	1 of 5	Great Blue Heron	08apr96	Dumas Bay	USFWS SOP
GBH96-3	1 of 1	Great Blue Heron	08apr96	Dumas Bay	USFWS SOP
GBH96-4	1 of 3	Great Blue Heron	08apr96	Dumas Bay	USFWS SOP
GBH96-5	1 of 5	Great Blue Heron	08apr96	Dumas Bay	USFWS SOP
MAL96-1	1 of 8	Mallard	01may96	Kaiser/BPA	USFWS SOP
MAL96-2	1 of 9	Mallard	06may96	Kaiser/BPA	USFWS SOP

Table 2. Summary information on eggs collected in 1995 and 1996 in Commencement Bay.

weight (**Appendix A**). Egg contents were then placed in chemically clean I-CHEM® jars and frozen prior to shipment for analysis. All standard chain-of-custody procedures were followed for both sets of samples.

A2.3 Lab Methodology and Analysis

Analysis of egg residues was conducted by Alta Analytical Laboratory Inc. of El Dorado Hills, California. Samples were analyzed using EPA Method 8290 for tetra- to octa-chlorinated dioxins/dibenzofurans and modified EPA Method 680 for polychlorinated biphenyls (PCBs). Additional analysis for organics and inorganics was carried out by ToxScan, Inc. of Watsonville, California. **Table 3** lists the compounds or elements analyzed and the analytical methodology followed for each.

Analyte	Methodology	Lab
Dioxins/Furans	EPA Method 8290	Alta Analytical
PCBs	EPA modified Method 680	Alta Analytical
Antimony	EPA Method 7041	ToxScan
Arsenic	EPA Method 7060	ToxScan
Cadmium	EPA Method 7131	ToxScan
Chromium	EPA Method 7191	ToxScan
Copper	EPA Method 7211	ToxScan
Lead	EPA Method 7421	ToxScan
Mercury	EPA Method 7470	ToxScan
Nickel	EPA Method 7521	ToxScan
Selenium	EPA Method 7741	ToxScan
Silver	EPA Method 7761	ToxScan
Chlorinated pesticides	EPA Method 8080	ToxScan
Chlorinated herbicides	EPA Method 8150	ToxScan
Semivolatile organic compounds	EPA Method 8270	ToxScan
Butyltins	Gas Chromatograph with Flame Photometric Detector	ToxScan

Table 3. Methodologies used by contracted labs for analyzing constituents in avian eggs collected in Commencement Bay in 1995 and 1996.

To determine the overall dioxin-like potency of planar chlorinated compounds in the egg tissue, congener-specific analysis was requested for dibenzodioxins, dibenzofurans and biphenyl compounds (McFarland *et al.* 1989). Dioxin toxic equivalents (TEQs) in each of the samples were calculated by normalizing concentrations of individual dioxin-like compounds relative to the potency of TCDD using toxic equivalency factors (TEFs) as proposed by Safe (1990) and Ahlborg *et al.* (1992, 1994) with modifications by Van den Berg *et al.* (1998). Specifically, the Van den Berg derivation of TEFs specific to avian species follows a tiered approach that gives higher weight to overt toxicity *in vivo* studies than to biochemical effects such as enzyme induction *in vitro* (Van Leeuwen 1997). These TEF values were recently applied by the FWS in evaluating productivity and contaminant levels in bald eagles of the lower Columbia River (Buck 1998). Comparisons were made between I-TEF values (based on mammalian endpoints), H4IIE - TEF values (bioassay endpoints) and TEF values proposed for birds (aka. C-TEFs or WHO avian TEFs). For the purposes of this assessment, all TEQ calculations were derived from using these avian specific TEFs (**Table 4**).

Dibenzodioxin	TEF	Dibenzofuran	TEF	Biphenyl (IUPAC #)	TEF
2,3,7,8-TCDD	1	2,3,7,8-TCDF	1	3,3',4,4'-TeCB (77)	0.05
1,2,3,7,8-PeCDD	1	1,2,3,7,8-PeCDF	0.1	3,4,4',5-TeCB (81)	0.1
1,2,3,4,7,8-HxCDD	0.05	2,3,4,7,8-PeCDF	1	2,3,3',4,4'-PeCB (105)	0.0001
1,2,3,6,7,8-HxCDD	0.01	1,2,3,4,7,8-HxCDF	0.1	2,3,4,4',5-PeCB (114)	0.0001
1,2,3,7,8,9-HxCDD	0.1	1,2,3,6,7,8-HxCDF	0.1	2,3',4,4',5-PeCB (118)	0.00001
1,2,3,4,6,7,8-HpCDD	0.001	2,3,4,6,7,8-HxCDF	0.1	2',3,4,4',5-PeCB (123)	0.00001
		1,2,3,7,8,9-HxCDF	0.1	3,3',4,4',5-PeCB (126)	0.1
		1,2,3,4,6,7,8-HpCDF	0.01	2,3,3',4,4',5-HxCB (156)	0.0001
		1,2,3,4,7,8,9-HpCDF	0.01	2,3,3',4,4',5'-HxCB (157)	0.0001
		OCDF	0.0001	2,3',4,4',5,5'-HxCB (167)	0.0001
				3,3',4,4',5,5'-HxCB (169)	0.001
				2,3,3',4,4',5,5'-HpCB (189)	0.00001

Table 4. Avian toxic equivalency factors (TEFs) used to calculate TCDD-equivalents in avian egg tissues collected in Commencement Bay in 1995 and 1996.

Each sample concentration for planar chlorinated compounds was multiplied by its corresponding TEF value and then summed. The resulting TEQ value represents a single value for determining dioxin-like potency. Percent contribution from dibenzodioxin, dibenzofuran, and biphenyl compounds were then determined for each sample.

Residue values for each egg were not adjusted for moisture loss and lipid content and therefore all values are reported as wet weight. All trace metal and butyltin values are reported in dry weight. Heron and mallard egg samples collected in 1996 were measured for volume by means of whole egg displacement with egg content calculated from length and width measurements (Stickel *et al.* 1973). Field measurements were unavailable for goose or gull egg samples collected in 1995. Lab generated percent moisture values were unavailable for heron and mallard samples. Correction factors for conversion to fresh weight are presented in **Table 11**. Since these values were not all available for each species, no attempt was made to adjust analytical results accordingly. This was decided due to the screening nature of the analysis and to maintain a species-to-species comparability for all analytes tested.

EcoChem, Inc. of Seattle, Washington reviewed the data packages provided by the analytical laboratories and provided a validation report to the FWS (**Appendix B**). Upon their recommendations, unqualified data was treated as not detected and reported as half the detection value for computational purposes. Non-detect values are calculated as half the detection limit for TEQ computational purposes only. This approach was applied to all dibenzodioxin, dibenzofuran, and biphenyl data. For the remaining contaminants, not-detected values are reported as the detection limit for that constituent. In addition, limited sample volumes in the egg samples collected in 1996 (heron and mallard) resulted in the contract lab setting higher detection limits for trace metals, butyltins, and pesticides.

A3.0 Results

A3.1 Dibenzodioxin, Dibenzofuran, and Biphenyls

Total PCB data is summarized per species in **Table 5**. Congener-specific values and their corresponding TEF value for dibenzodioxin, dibenzofuran, and non ortho- and mono ortho-chlorinated biphenyls (PCBs) are reported in **Table 6** and **Table 7**. With the exception of PCB 118[2], no mono ortho-chlorinated biphenyl data were reported for eggs collected in 1995 (goose and gull). Since total TEQs were determined by summing the individual TEQs from all three groups of planar chlorinated compounds, including the non ortho- and mono ortho-chlorinated biphenyls, reported total TEQ values for goose and gull may be underestimated.

Avian Species (n)	*Geometric Mean (Range) ng/g wet weight*
Canada Goose (4)	32.80 (21.63 - 80.10)
Glaucous-winged Gull (4)	760.45 (452.65 - 1575.38)
Great Blue Heron (5)	1971.65 (509.74 - 6462.65)
Mallard Duck (2)	399.10 (397.82 - 400.39)

Table 5. Total PCBs in ng/g (ppb) wet weight in avian egg tissues collected in Commencement Bay in 1995 and 1996.

Tables 6 and **7** present congener specific values in pg/g (ppt) wet weight and their corresponding TCDD-Eq. value for each species. Because of the small sample sizes, means were calculated geometrically with the range of values. In an attempt to tease out forage preference and/or congener assimilation differences between species, values were plotted graphically for each congener for dibenzodioxins, dibenzofurans, and biphenyls. Congeners with corresponding tissue levels and TEF/TEQ values are illustrated in **Figures 3 - 6**. Other congener data (congeners not currently assigned a TEF) are available but not included for the purposes of this report.

Looking solely at dibenzodioxin congener concentrations most species compared relatively equal (**Figure 3**). One exception appeared to be with OCDD and gulls. However, because of blank contamination problems with OCDD in the lab analysis and a lack of data on avian toxicity related to this congener, no further investigation was pursued. Comparing dibenzofuran congener concentrations between species appears to show mallard eggs containing the higher levels of most of the dibenzofuran congeners (**Figure 4**). One exception may be with 2,3,4,7,8 -PeCDF in heron, where at least one heron egg scored

[2]Union of Pure and Applied Chemists congener number (Ballschmiter and Zell 1980).