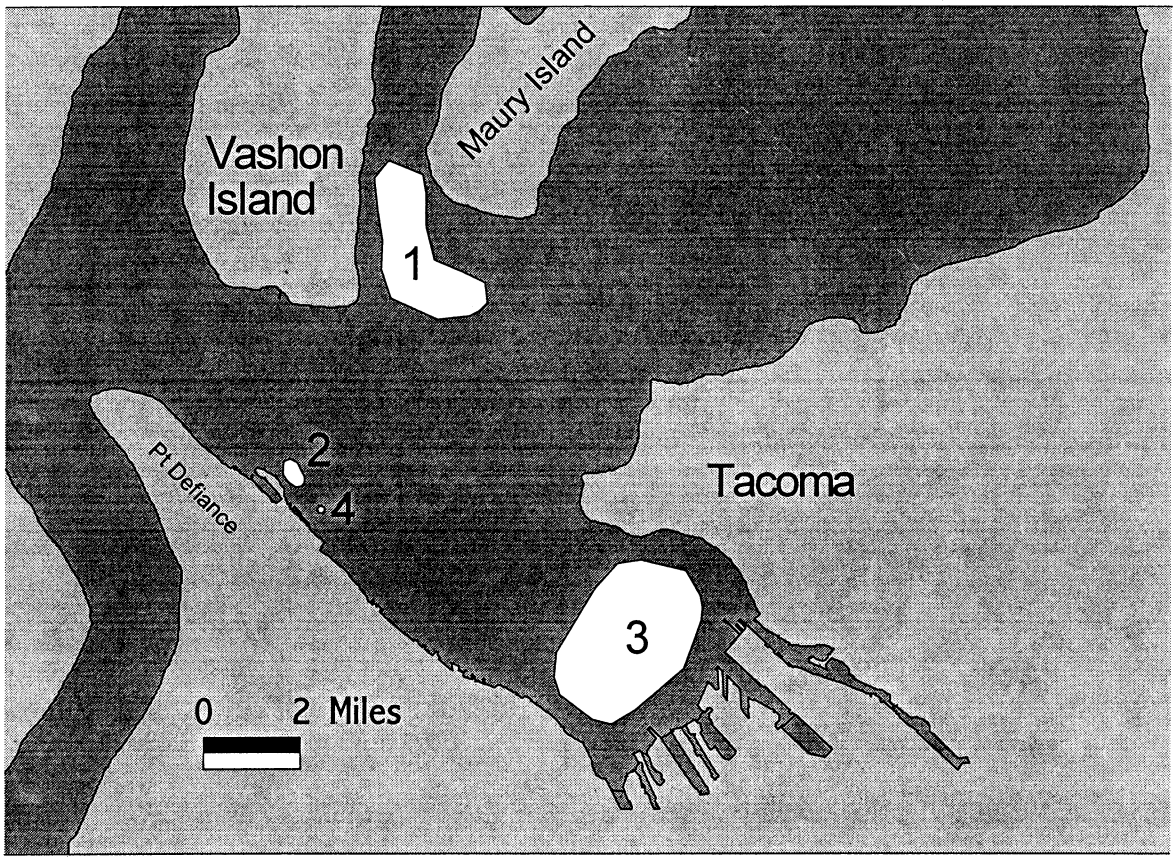

Figure 11. Surf scoter collection (1 and 2) and telemetry locations (4) in 1995/1996, and collection site (3) utilized in 1984-1985 by Henny et al. (1991) in Commencement Bay.

Blood samples were taken immediately after collection, chilled, and submitted to Consolidated Veterinary Diagnostics, Inc./ITEH Wildlife Health Center at the University of California -Davis for hematology. Information such as body weight and length, stomach contents, subcutaneous fat indexing and other field data on the carcasses was recorded for each bird collected. Livers and kidneys were removed, frozen, and submitted to Hazleton Laboratories America, Inc. in Madison, Wisconsin for trace metal and/or organochlorine analysis. Bile was collected from the gall bladder, frozen, and sent to the Northwest Fisheries Science Center of the National Marine Fisheries Service in Seattle, Washington for fluorescent aromatic compound (FACs) analysis. Liver samples were also analyzed for cytochrome P450-associated monooxygenase activities at the Patuxent Environmental Science Center in Laurel, Maryland. Histology on the carcasses was performed by Wildlife Pathology International of Fort Collins, Colorado.

B2.3 Statistical Analysis

Inorganic and organic analytical results were evaluated using the non-parametric Wilcoxon' Rank-Sum Test (Mann-Whitney Two-Sample method) due to numerous outliers and high standard deviations. Unless stated otherwise, the probability level used to determine statistical significance was $P<0.05$.

B3.0 Results

B3.1 Tissue and Bile Chemistry

Mean concentrations of mercury in the livers and kidneys were significantly higher ($P<0.001$) in the late winter birds collected than in the fall set (**Table 13**). Chromium in liver tissue was also significantly higher ($P<0.001$) in the late winter bird set. Mean concentrations of cadmium, copper, iron, molybdenum, and zinc were significantly lower in the livers of the late winter birds when compared to the fall set[3]. A significant decrease in cadmium was also recorded in the kidneys between the two sampling periods.

The only organic compounds detected were p,p'-DDE and total PCBs. DDE was detected in a greater number of the late winter birds than from the fall set. Similarly, PCBs were measured in a greater number of birds in the late winter than in the fall (**Table 13**). However, the differences between the fall and late winter mean concentrations of total PCBs was not significant.

Analyte	*Fall Sample (n=20)*	*Late Winter Sample (n=20)*
p,p'-DDE	Detected in 55% of birds	Detected in 95% of birds
PCBs	Detected in 65% of birds	Detected in 85% of birds
Mercury	Kidney = 1.11 mg/kg Liver = 2.10 mg/kg	Kidney = 1.84 mg/kg Liver = 2.59 mg/kg
Chromium	Liver = 0.55 mg/kg	Liver = 0.58 mg/kg

Table 13. Comparisons between selected analytes and surf scoter sampling sets collected from Commencement Bay in 1995 and 1996 (Mercury and Chromium values are mean concentrations in ppm).

Bile samples analyzed for biliary FACs (mean concentrations) measured at the phenanthrene, benzo(a)pyrene, and naphthalene wavelengths were not significantly different between the fall and in the late winter samples suggesting no appreciable uptake of PAHs by surf scoters had occurred during their residency in Commencement Bay.

[3]Text in the final report (Mahaffy *et al.* 1997) incorrectly includes chromium in this statement on page 11.

B3.2 Cytochrome P450, Blood and Histology

Both Ethoxyresorufin-0-dealkylase (EROD) and methoxyresorufin-0-dealkylase (MROD) activity were measured and normalized for the fall and late winter liver samples. No clearcut difference could be detected between the two sets of samples. However, within each set of samples, there were a great range of values suggesting that there were both relatively uninduced and induced birds in both the fall and late winter birds.

The mean white blood cell (mononuclear WBC/lymphocytes) count estimates were not significantly different between the fall and late winter samples. However, there was a significant decrease in heterophils (polymorphonuclear WBCs) in the late winter samples. The occurrence of blood parasites appeared to be limited to only one bird out of each of the sampling sets.

Histological examination of the carcasses from both sampling periods revealed the presence of lesions similar in both sets. Overall, the lesions found were extremely minimal and fairly common to sea birds. The most common lesion identified was a mild inflammation of the collecting ducts of the kidneys. This type of lesion was determined to be most likely caused by a trematode parasite.

C2.0 Methods

In Section A of this report, contaminant data was presented from five great blue heron eggs collected in 1996 from the Dumas Bay heron colony located near Commencement Bay **(Figure 2).** Chemical analysis revealed that some of these eggs contained elevated levels of organochlorine contaminants similar to those levels found during the 1984 and 1988 sampling events. This information and the reports of low productivity of the colony when compared to other nearby heron colonies (EVS 1995) prompted the next approach in the reconnaissance effort to assess the potential for avian injury in the Commencement Bay area. In this section, an overview of the great blue heron field studies is provided.

C2.1 Objectives

The primary objective of the great blue heron field studies conducted in 1997 was to determine if a link could be established and quantified between low productivity in a heron colony (Dumas Bay) located near Commencement Bay and forage site selection. In an attempt to determine this linkage, three primary tasks were pursued: (1) Establish where herons nesting in the colony were feeding; (2) determine how much time the Dumas Bay birds were spending in potentially contaminated feeding areas; and (3) link individual heron productivity outcomes with actual feeding site preferences.

C2.2 Tasks

Monitoring studies of the Dumas Bay colony conducted in 1996 suggested that the bimodal distribution of chick production and wide ranges of contaminant values in heron eggs were correlated. This suggested that herons were using both contaminated and uncontaminated foraging areas. In order to establish a link between lowered productivity and feeding site preferences, a study was designed to determine nesting success per nest and compare the amount of time individual birds spent feeding in areas of Commencement Bay known to be contaminated. Observation data would be collected and linked to specific foraging locations inside Commencement Bay and then regressed against productivity data for individual nests in the colony.

To establish where the Dumas Bay herons were feeding and for how long, observers were placed in strategic vantage points and records of flight direction (arrivals and departures), numbers of birds, and time of day data was collected. These time intensive observations were designed to delineate the major roosting and foraging territories used by the colony. For comparison purposes, numbers of active nests, failed nests, and all colony disturbances were recorded from the Dumas Bay colony as well as from two other nearby heron colonies: the Peasley Canyon heronry in Auburn, and the Nisqually National Wildlife Refuge heronry near Olympia **(Figure 12).**

An attempt was made to divide arrival and departure observation data into three nesting phase time periods: (1) a "pre-clutch completion" period when the egg is being formed; (2) a "small chick present" period (incubation and one adult foraging away from nest); and (3) a "large chick present" period (both adults foraging away from nest). The transition from pre-clutch completion phase to beginning incubation and small chick present phase was determined by adding 7 days to the first confirmed incubation since herons typically lay one egg every other day and begin incubation after the first egg is laid. This division of observation data was designed to allow for a greater level of discernment as to when the greatest potential for contaminant exposure, uptake, and injury may exist for the colony.

Along with temporal considerations, all arrival and departure data was qualified and assigned a code as to the "quality" of the observation. Birds observed with a clearly known origin or destination into or out of a foraging site location were given a "high confidence" data qualifier. If the arrival or departure was clearly seen along with flight direction, but no determination could be made whether the bird came directly from or landed in a specific foraging site location, the observation was given a separate qualifier. A third designation or qualifier was assigned if the bird observation was not recorded or observed by one of the two observers and flight direction could not be established.

Seasonal changes in foraging locations in female herons was also recognized as a concern when determining potential contaminant sources by measuring chemical burdens in egg tissue. Therefore, attempts were made to sex the birds during the observational periods. All SOPs used and developed for this study are from Norman (1998).

C3.0 Results

Several unanticipated events during the 1997 field season significantly altered the original study design and time line, as well as the anticipated results. In early March, a new heron colony began to establish itself on the hillside above the Chinook Marina in the Hylebos Waterway. This colony (referenced as "the Hylebos colony") was subsequently added to the list of colonies to be observed and monitored. In mid-May, the focus colony in Dumas Bay failed and was abandoned. As a result, the ability to catagorize observation data by nesting phase was limited. Similarly, one of the control colonies (Peasley Canyon in Auburn) failed and was abandoned at the end of May.