4.5 Fish and Wildlife Surveillance

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Contaminants in fish and wildlife that inhabit the Columbia River and Hanford Site are monitored for several reasons. Wildlife have access to areas of the site containing radioactive or chemical contamination, and aquatic organisms can be exposed to contamination entering the river along the shoreline. Fish and some wildlife species exposed to Hanford contaminants might be harvested for food and may potentially contribute to offsite public exposure. In addition, detection of contaminants or changes in contaminant levels in wildlife over time may indicate that wildlife are entering contaminated areas (e.g., burrowing in waste burial grounds) or that materials are moving out of known contaminated areas (e.g., through blowing dust or food-chain transport). Consequently, fish and wildlife samples are collected at selected locations annually (Figure 4.5.1). More detailed rationale for the selection of specific species sampled in 2000 can be found in DOE/RL-91-50.

Routine background sampling is conducted approximately every 5 years at locations believed to be unaffected by Hanford Site releases. Additional background data also may be donated or collected during special studies or ecological impact monitoring efforts conducted under the Ecosystems Monitoring Project (see Section 8.2).

Fish and wildlife sampling frequencies were modified significantly in 1995. Species that had been collected annually were placed on a rotating schedule so that surveillance of all key species would be accomplished over a 3-year period. Factors supporting these changes included the elimination of many onsite radiological sources and a decrease in environmental concentrations of radionuclides of interest. Additionally, several radionuclides that were monitored in the past had not been detected in recent wildlife samples because they were no longer present in the environment in sufficient amounts to accumulate in wildlife.

For each species of fish or wildlife, radionuclides are selected for analysis based on the potential for the contaminant to be found at the sampling site and to accumulate in the organism (Table 4.5.1). At the Hanford Site, strontium-90 and cesium-137 have been historically the most frequently measured radionuclides in fish and wildlife.

Strontium-90 is chemically similar to calcium; consequently, it accumulates in hard tissues rich in calcium such as bone, antlers, and eggshells. Strontium-90 has a biological half-life in hard tissue of 14 to 600 days. Hard-tissue concentrations may profile an organism's lifetime exposure to strontium-90. However, strontium-90 generally does not contribute much to the dose humans receive from eating animals because it does not accumulate in edible portions of fish and wildlife. Springs water in the 100-N Area is the primary source of strontium-90 from Hanford to the Columbia River; however, the current contribution relative to historical fallout from atmospheric weapons testing is small (<2%) (PNL-8817).

Cesium-137 is particularly important because it is chemically similar to potassium and is found in the muscle tissue of fish and wildlife. Having a relatively short biological half-life (<200 days in muscle; <20 days in the gastrointestinal tract), cesium-137 is an indicator of more recent exposure to radioactive materials. Cesium-137 is also a major constituent of historical fallout.

Fish and wildlife samples were analyzed by gamma spectrometry to detect a number of gamma emitters

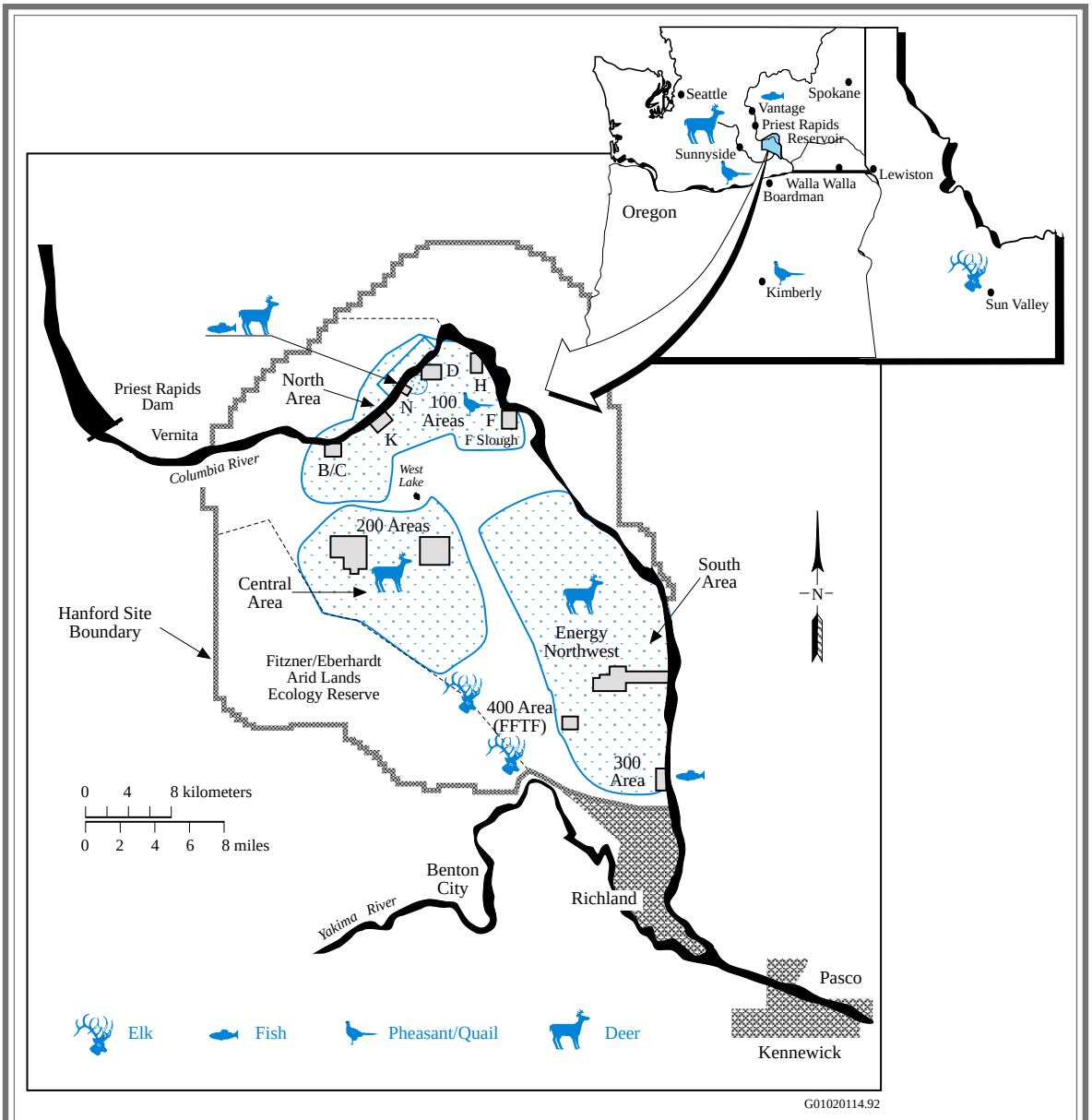

Figure 4.5.1. Sampling Locations for Fish and Wildlife, 2000

(see Appendix F). However, gamma spectrometry results for most radionuclides are not discussed here because concentrations were too low to measure or measured concentrations were considered artifacts of low background counts. Low background counts occur at random intervals during sample counting and can produce occasional spurious false-positive results.

For many radionuclides, concentrations are below levels that can be detected by the analytical laboratory. When this occurs for an entire group of samples, two times the total propagated analytical uncertainty is used as an estimate of the nominal detection level for that analyte and particular medium. The average nominal analytical detection limit for strontium-90 in the bone is 0.04 pCi/g wet

Table 4.5.1. Locations, Species, and Contaminants Sampled for Fish and Wildlife, 2000

Medium	No. of Offsite Locations	No. of Onsite Locations	No. of Analyses		
			Gamma	Strontium-90	Isotopic Plutonium
Fish (carp)	1[(a)]	2[(b)]	14	14	0
Upland game (pheasant, quail)	2	2[(c)]	14	14	0
Mule deer	1	3[(d)]	7	7	2
Elk	0	3[(e)]	3	3	0

(a) Background samples collected from the Columbia River near Vantage, Washington.
(b) Samples collected from 100-N to 100-D Areas and the 300 Area.
(c) Samples collected from 100-D to 100-H Areas and 100-H to 100-F Areas.
(d) Samples collected from the north, south, and central areas populations (see Figure 4.5.1).
(e) Samples collected along Highway 240 .

weight and is 0.04 pCi/g wet weight for cesium-137 in muscle. All analytical results and propagated uncertainties for calendar year 2000 fish and wildlife samples may be found in PNNL-13487, APP. 1.

4.5.1 Fish Samples and Analytes of Interest

Although the amounts of radiological contamination measured in fish samples are well below levels that cause adverse health effects, monitoring fish for uptake and exposure to radionuclides at both nearby and distant locations continues to be important to track the long-term trends of contamination in the Columbia River environment. In 2000, carp were collected from two regions near the Hanford Site as well as from a background sampling area ~80 kilometers (50 miles) upstream of the Hanford Site near Vantage, Washington (see Figure 4.5.1). Fillets and the eviscerated remains (carcass) of fish were analyzed for a variety radiological contaminants and results from the nearby and distant locations were compared and are discussed below. All analytical data for 2000 samples are given in PNNL-13487, APP. 1.

In 2000, fillet (muscle) samples were analyzed with gamma spectrometry for cesium-137 and other gamma-emitting radionuclides (PNNL-13487, APP. 1). Cesium-137 results were below the analytical detection limit (0.04 pCi/g wet weight) in all 14 carp fillet samples collected in 2000. These results are consistent with results from eight carp fillet samples analyzed and reported in 1998 (PNNL-12088) and support results reported throughout the 1990s that indicate a gradual decline in cesium-137 levels in carp. All five samples collected from the upriver control area in 2000 also fell below the analytical detection limit as compared to 14 of 25 (56%) control area results below the analytical detection limit in 1996 and 1992.

Strontium-90 was found in 9 of 14 carp carcass samples collected and analyzed in 2000. Median levels of strontium-90 in carcass tissues collected from the Hanford Reach in 2000 were consistent with those observed in Hanford Reach samples collected over the preceding 8 years, as well as levels observed in five carp from the background area in 2000 (Figure 4.5.2). However, the strontium-90 concentration in one of the five carp samples

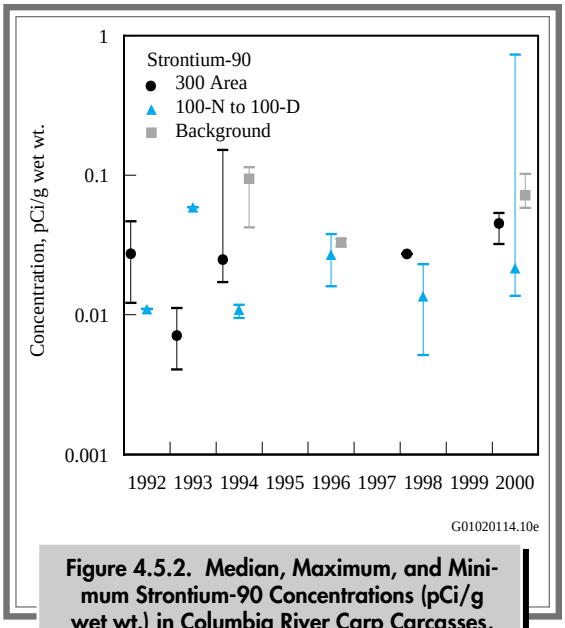

Figure 4.5.2. Median, Maximum, and Minimum Strontium-90 Concentrations (pCi/g wet wt.) in Columbia River Carp Carcasses, 2000 Compared to Previous 8 Years

collected between 100-N and 100-D Areas was over ten times greater than the median concentrations from all three sampling regions, and seven times greater than the highest value reported from the background area. Although this result (0.73 ± 0.17 pCi/g) is the highest reported over the preceding 8-year period, elevated amounts have been measured in carp and other bottom-feeding fishes (suckers and whitefish) collected near the 100-N Area in the past. This maximum-result pattern near the 100-N Area indicates some of the fish have consumed items containing elevated amounts of strontium-90 and have incorporated some strontium into their tissues. However, strontium-90 concentrations in carcass tissue would have to be around 600 pCi/g wet weight to be near the no-effect dose limit of 1.0 rad/day for aquatic organisms (see Section 6.6). The hypothetical dose associated with the consumption of Hanford Reach fish is found in Section 6.0.

4.5.2 Wildlife Sampling

The amount of radiological contamination measured in fish and wildlife samples is well below levels that cause adverse health effects. Monitoring various biota for uptake and exposure to radionuclides both near and distant from Hanford Site operations continues so that long-term trends of contamination in the ecosystem can be tracked. Wildlife sampled and analyzed in 2000 for radioactive constituents included elk, deer, and upland game (pheasants and quail). Wildlife samples were analyzed for gamma emitters, strontium-90, and isotopic plutonium. Three American avocets also were collected in response to a biological dose assessment screening process (see Section 6.6) and samples of bone tissues were analyzed for isotopic uranium.

4.5.2.1 Upland Game Samples and Analytes of Interest

Ten pheasants and four California quail were collected from three selected sampling areas in the fall of 2000 (see Figure 4.5.1). Radionuclide levels found in samples collected onsite in 2000 were compared to levels in samples collected onsite during the previous 8-year period and were also compared to levels found in samples collected from two background locations near Sunnyside, Washington, and Kimberly, Oregon.

Analyses for cesium-137 in muscle tissue require more mass than what is available on a single quail. For this reason, quail collected between the 100-D and 100-H Areas were composited into two samples for the gamma-scan analysis, for a total of two results from that particular area. Cesium-137 was not detected (at or below 0.03 pCi/g wet weight) in any of the five pheasant muscle samples collected between the 100-H and 100-F Areas nor in any of the five samples collected in the background areas (see Figure 4.5.3). These results were consistent with those reported in 1998 (6 of 6 below the analytical detection limit). The number of samples reported at or below the analytical detection limit in both 1998

and 2000 (18 of 18 collectively), reflects the continued downward trend in worldwide levels of cesium-137 fallout. Cesium-137 concentrations in 56% (17 of 30) of upland game muscle samples collected between 1990 and 1997 were reported as at or below the analytical detection limit.

Only 14% (2 of 14) of the upland game bone samples collected and analyzed for strontium-90 in 2000 had concentrations above the analytical detection limit (0.04 pCi/g wet weight). Although both positive results were collected between the 100-H and 100-F Areas along the river shoreline, they are not atypically high compared to results obtained from the background areas and do not indicate elevated levels of strontium-90 in upland game there (see Figure 4.5.3).

4.5.2.2 Deer and Elk Samples and Analytes of Interest

Studies of mule deer populations residing on the central portions of the Hanford Site indicate their division into three distinct groups (Tiller and Poston 2000): 1) the population that inhabits land around the retired reactors in the 100 Areas is designated the north area population; 2) the population that resides from the Old Hanford Townsite south to the 300 Area is designated the south area population; and 3) by default, the deer living around the 200 Areas, away from the river are designated the central area population (see Figure 4.5.1).

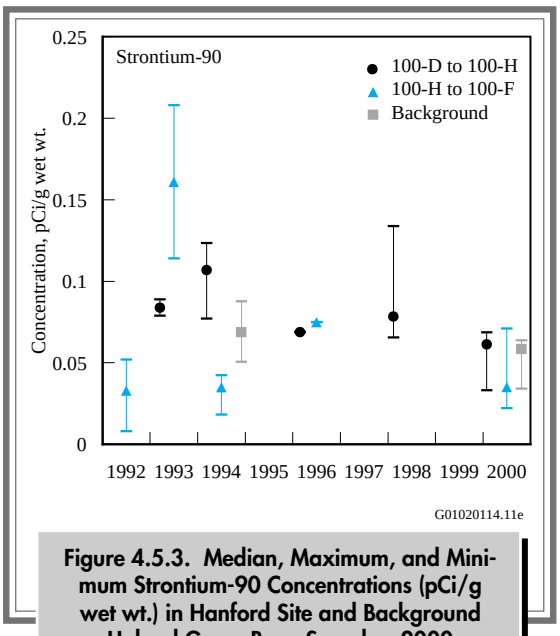

Figure 4.5.3. Median, Maximum, and Minimum Strontium-90 Concentrations (pCi/g wet wt.) in Hanford Site and Background Upland Game Bone Samples, 2000 Compared to Previous 8 Years

Radionuclide levels in deer collected onsite in 2000 were compared to levels in deer collected distant from the site and to results reported for the preceding 8-year period. Background samples were collected between 1992 and 1995 near Boardman, Oregon and in Stevens County, Washington (see PNNL-11472, Section 4.5). In 2000, one background deer sample was obtained from the lower Yakima Valley, near Sunnyside, Washington (see Figure 4.5.1). Additionally, levels in onsite mule deer were compared to levels in a white-tailed deer that was cosampled with the Washington State Department of Health in 1996 from Vail, Washington (see PNNL-12088, Section 4.5). These comparisons with samples from distant locations are useful in evaluating Hanford's impact to deer. The deer collected in Stevens County and Vail, Washington, inhabited mountain regions that received more rainfall (and more atmospheric fallout) than Hanford, increasing background levels of fallout radionuclides there (Tiller and Poston 2000). The climate and precipitation of the Boardman, Oregon, and the Sunnyside, Washington, regions are similar to Hanford.

Until recently, elk have not inhabited areas on the Hanford Site where the potential for uptake of radionuclide contaminants exists (PNNL-13331) and very little data were available about contaminant concentrations in elk residing near or distant from the Hanford Site. In 1999, a baseline assessment of radionuclide levels in elk near and distant from the Hanford Site was conducted (PNNL-13230).

In 2000, elk continued to move across State Highway 240 from the Fitzner/Eberhardt Arid Lands Ecology Reserve Unit to the central portions of the Hanford Site and resulted in three vehicle collisions during the year. Further discussion of elk movements, and the impact to animals from a large wildfire in late June 2000, are discussed in Section 8.2.

Radiological Results for Deer Samples. Cesium-137 was not detected (at or less than 0.02 pCi/g wet weight) in the seven deer muscle samples analyzed in 2000. These results are consistent with a decline in cesium-137 levels in all wildlife examined from 1983 through 1992 (PNNL-10174) and with data obtained over the preceding 8 years. In addition, the levels of cesium-137 in more than 60 Hanford Site deer muscle samples collected during the 1990s were less than the background levels measured in deer samples collected from 1991 through 1995 from Stevens County, Washington, and, in 1996, from Vail, Washington.

Strontium-90 was detected in all seven deer bone samples collected and analyzed in 2000. The lower results found in deer bone from the south and central areas populations are consistent with strontium-90 levels found in deer antlers (Tiller and Poston 2000). Median levels of strontium-90 found in deer bone in 2000 were similar between the three sampling areas onsite and the one background sample (Figure 4.5.4). One sample from the north area contained approximately ten times the amount of strontium-90 (3.54 ± 0.9 pCi/g wet weight) as other samples obtained onsite and was collected near the 100-N Area. Elevated levels of strontium-90 in samples from the north area occurred in about 1 of 3 deer samples collected there throughout the preceding 8-year period, with the highest concentration (20.8 ± 5.2 pCi/g wet weight) reported in 1992 (see Figure 4.5.4). Background samples of deer bone indicate strontium-90 concentrations can be as high as 2.06 pCi/g ± 0.4 pCi/g wet weight. The apparently higher concentrations in deer bone from the north area may indicate some exposure to

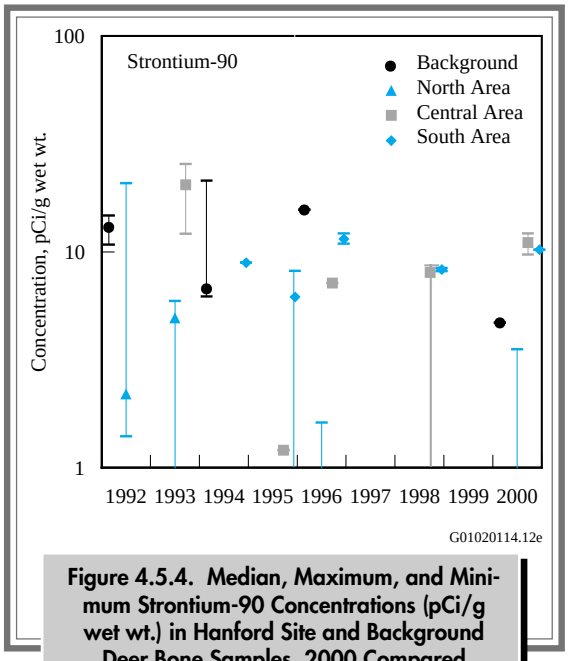

Figure 4.5.4. Median, Maximum, and Minimum Strontium-90 Concentrations (pCi/g wet wt.) in Hanford Site and Background Deer Bone Samples, 2000 Compared to Previous 8 Years

localized, low-level contamination near the N Reactor (Tiller and Poston 2000).

Levels of strontium-90 found in deer bone samples collected between 1992 and 2000 were consistently higher ($p < 0.005$) than levels found in upland game bone or carp collected from the same vicinity (Figure 4.5.5). The diet of upland game primarily includes insects and dry-land grass seeds, whereas deer generally consume riparian and woody plants. Deep-rooted riparian plants can contain higher contaminant levels if their roots are deep enough to reach contaminated groundwater. Strontium-90 concentrations measured in carp and other bottom-feeding fishes (i.e., suckers and whitefish) near the 100-N Area indicates some of the aquatic organisms also have consumed items containing elevated amounts of strontium-90 and have incorporated a portion of the contamination into their tissues.

Plutonium-238 and -239/240 were not found above detection (0.00004 pCi/g wet weight) in two liver samples collected in 2000 from deer that

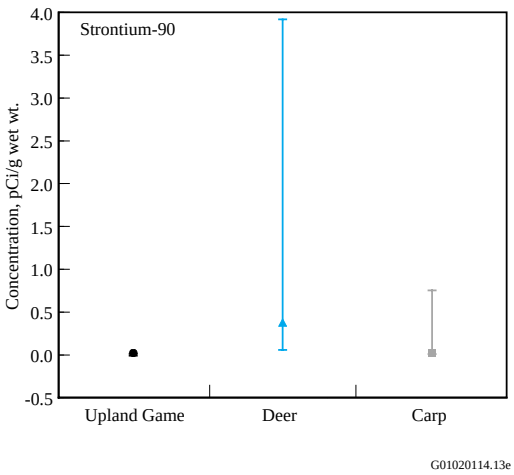

Figure 4.5.5. Comparison of Median, Maximum, and Minimum Strontium-90 Concentrations (pCi/g wet wt.) in the Bones of Deer, Upland Game, and Fish Collected near the 100-N Area, 2000

resided near the 200 Areas. These results are consistent with results reported through the 1990s. Since 1992, only 6% (2 of 34) samples of deer liver were reported above analytical detection for isotopic plutonium.

Radiological Results for Elk Samples. Radionuclide levels were monitored in tissue collected from three road-killed elk along State Highway 240 in 2000 (see Figure 4.5.1). With the exception of strontium-90, concentrations of all manmade radionuclides were reported at or below analytical detection limits. Strontium-90 was detected in bone tissue from all three of the animals (0.32 ± 0.09, 0.33 ± 0.09, and 0.28 ± 0.07 pCi/g wet weight). Figure 4.5.6 depicts strontium-90 concentrations in bone from elk collected between 1998 and 2000 on or near the Hanford Site, and from elk collected in central Idaho in 1999. Median and maximum results illustrate background elk samples contained over twice the amount of strontium-90 as compared to all elk samples that have been collected on or near the Hanford Site. Elk in central Idaho live at higher elevations where higher levels of strontium-90 reflect exposure to fallout contaminants in the atmosphere produced by worldwide weapons testing in the 1950s and 1960s (Tiller and Poston 2000). The median result reported in Hanford Site elk in 2000 (0.32 ± 0.09 pCi/g wet weight) was similar to levels reported in Hanford Site deer inhabiting the south and central areas (see Figure 4.5.4).

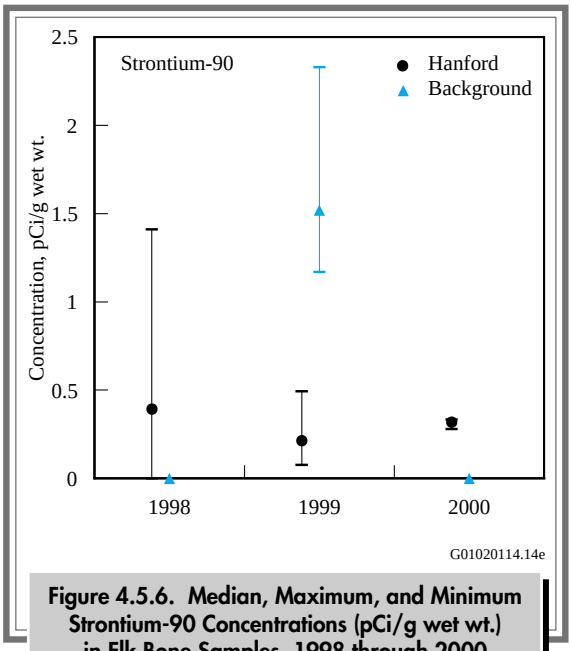

Figure 4.5.6. Median, Maximum, and Minimum Strontium-90 Concentrations (pCi/g wet wt.) in Elk Bone Samples, 1998 through 2000

4.5.3 West Lake Study

In 2000, a special study was initiated to measure uranium concentrations in biota, water and sediment in West Lake. West Lake is located north of the 200-East Area at the base of Gable Mountain. Originally, the site consisted of a small spring but in the 1950s became a small lake (about 7.8 hectares [19.2 acres] in 1979) after discharges of process water in the 200 Areas raised the local water table (PNL-7662). The resulting lake is highly saline and in recent years, has diminished in size (<1 hectare [0.4 acre]) due to reductions in wastewater discharges to the ground in the 200 Areas.

West Lake historically has had elevated uranium concentrations in sediment and most unfiltered water samples (see Section 4.2 and PNL-7662). Water soluble uranium can be distinguished from particulate uranium by filtering the samples. Soluble uranium has the potential to move through the aquatic food pathway to resident, salt-tolerant organisms.

Because of the ponds high salinity, mammals and many birds will not drink West Lake water. However, swallows, bats, and several species of shorebirds forage along the water's edge for saline tolerant black fly larvae (*Ephidridae*) and adults. Biological surveys in 2000 found that small sandpipers, killdeer, and several pairs of American avocet were the most common resident shorebirds at West Lake. Avocets, because of their size, feeding behavior, and relative abundance, were chosen as the best resident bird species to monitor for radiological contaminants and food-chain transfer of contaminants from West Lake water. The foraging patterns of avocets on black fly larvae maximized the potential for uptake of uranium through the water-food pathways. Avocet bone tissue was monitored for the accumulation of uranium-238 because bone tissue is known to absorb heavy metals including uranium (PNL-5484; Hammond and Beliles 1980).

Three adult American avocets were collected for analysis in July 2000. In addition, black fly larvae, black fly adults, pond water (filtered and unfiltered), seep water, and pond sediment were collected and analyzed for uranium-234, uranium-235, and uranium-238. This discussion focuses on uranium-238 (Table 4.5.2). Additional analytical data may be found in PNNL-13487, APP. 1. Uranium-238 concentrations in filtered seep water collected along the West Lake shoreline were above analytical detection limits but well below concentrations in pond water samples. Both filtered and unfiltered pond water samples contained comparable concentrations of uranium-238, indicating the uranium was present in a soluble form and that a food-chain pathway from black flies to shorebirds was likely. Black fly larvae, which are consumed by avocets, contained about twice as much uranium-238 as adult flies. However, uranium-238 concentrations in avocet bone samples (see Table 4.5.2) were one to two orders of magnitude lower than concentrations in blackflies. This indicates that there was no "magnification" of uranium through the food chain. Uranium data collected for this study were also used to evaluate the radiological dose to avocets (see Section 6.0).

Table 4.5.2. Uranium-238 Concentrations in the West Lake Environment

Sample	Concentration[a]
Avocet 1	0.024 ± 0.011 pCi/g wet wt.
Avocet 2	0.007 ± 0.007 pCi/g wet wt.
Avocet 3	0.007 ± 0.006 pCi/g wet wt.
Black fly - larvae	0.55 ± 0.01 pCi/g dry wt.[b]
Black fly - adult	0.25 ± 0.06 pCi/g dry wt.[b]
Filtered seep water	27.7 ± 5.2 pCi/L
Filtered pond water	1,280 ± 220 pCi/L
Unfiltered pond water	1,120 ± 200 pCi/L
Sediment	1.2 ± 0.25 pCi/g dry wt.

(a) ±2 sigma total analytical error.
(b) Wet weight concentrations are 0.16 and 0.073 pCi/g for larvae and adults, respectively.