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 fish 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 in wildlife may indicate that wildlife are entering contaminated areas (e.g., burrowing in waste burial grounds) or that materials are moving out of 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 1998 can be found in DOE/RL-91-50, Rev. 2.

Routine background sampling is conducted approximately every 5 yr at locations believed to be unaffected by Hanford releases. Additional background data also may be collected during special studies.

As a result of changing site operations, 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-yr period. Factors supporting these changes included the elimination of many onsite radiological source terms 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 or they did not accumulate in fish or wildlife tissues of interest.

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 d. Hard-tissue concentrations may profile an organism's lifetime exposure to strontium-90. However, strontium-90 generally does not contribute much to human dose 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 d in muscle; <20 d in the gastrointestinal tract), cesium-137 is an indicator of more-recent exposure to radioactive materials and is also a major constituent of historical fallout.

Fish and wildlife samples were analyzed by gamma spectrometry to detect a number of gamma emitters (see Appendix E). However, gamma spectrometry

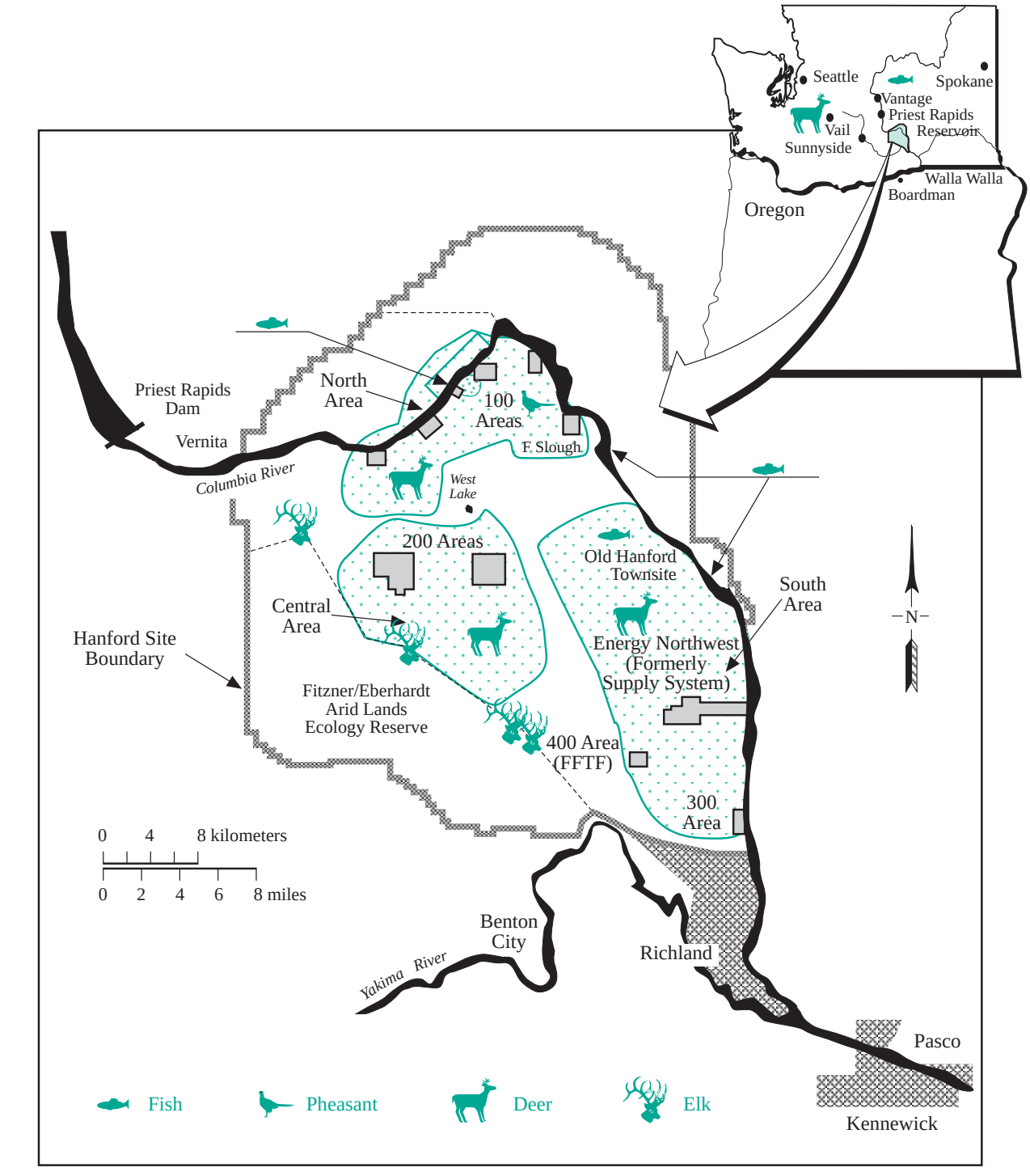

Figure 4.5.1. Fish and Wildlife Sampling Locations, 1998

Table 4.5.1. Locations, Species, and Contaminants Sampled for Fish and Wildlife, 1998

Medium	No. of Offsite Locations	No. of Onsite Locations	No. of Analyses Gamma	No. of Analyses Strontium-90
Fish (suckers, carp)	1[a]	2[b]	8	8
Pheasant	0	1[c]	1	1
Mule deer	0	3[d]	7	7
Elk	0	4[e]	4	4

(a) Background samples collected from the Columbia River near Vantage, Washington.
(b) Samples collected from 100-N to 100-D and 300 Areas.
(c) Samples collected from 100-D to 100-H Area.
(d) Samples collected from the north, south, and central area populations (see Figure 4.5.1).
(e) Samples collected along Highways 240 and 24.

results for most radionuclides are not discussed here because activities were too low to measure or measured activities 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, activities 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. Results and propagated uncertainties for all results may be found in PNNL-12088, APP. 1.

4.5.1 Fish Samples and Analytes of Interest

In 1998, carp and large-scale suckers were collected from the Columbia River. Carp were electrofished from the 100-N to 100-D sampling area by the U.S. Geological Service, Biological Resource Division, and donated to the Pacific Northwest National Laboratory. Carp samples were collected from the 300 Area and suckers were collected from the background sampling area near Vantage, Washington by Pacific Northwest National Laboratory staff using beach seines. Results for carp collected in 1998 are compared to background fishes collected from the Columbia River approximately 80 km (50 mi) upstream of the Hanford Site (Vantage). Fillets and the eviscerated remains (carcass) of fish were analyzed for radiological contaminants. All analytical data for 1998 samples are given in PNNL-12088, APP. 1.

In 1998, fillet (muscle) samples were analyzed with gamma spectrometry for cesium-137 and other gamma-emitting radionuclides (PNNL-12088, APP. 1). Cesium-137 was not detected in any of the five carp fillet samples collected in 1998. The number of cesium-137 analyses that were reported below the analytical detection limits was greater in 1998 (5 of 5) compared to the number reported (26 of 41)

over the preceding 8 yr (Table 4.5.2). An increase in the number of results below the detection limit was also apparent in samples collected from the background location in 1998 (3 of 3) when these samples were compared to background samples collected in 1992 (14 of 25).

Strontium-90 was found in three of five carp carcass samples collected and analyzed in 1998. The number of detectable strontium-90 levels were lower in 1998 (3 of 5), compared to the preceding 8 yr (28 of 28). Mean levels of strontium-90 in carcass tissues collected from the Hanford Reach in 1998 were not significantly different from those observed in Hanford Reach samples collected over the preceding 8 yr, as well as levels observed in background suckers collected from the Columbia River near Vantage in 1998. Average strontium-90 activities in background suckers collected in 1998 (0.02 ± 0.01 pCi/g) were lower than average levels found in carp collected from the same background location in 1992 (0.07 ± 0.01 pCi/g).

Overall, radionuclide activities in Hanford Reach carp were similar to the levels observed in background carp and suckers. The associated dose from the hypothetical consumption of fish is found in Section 5.0, "Potential Radiological Doses from 1998 Hanford Operations."

Table 4.5.2. Cesium-137 and Strontium-90 Activities (pCi/g) in Columbia River Carp and Suckers, 1998 Compared to Previous 8 Years

	1998			1990-1997		
Location	Maximum[a]	Mean[b]	No. Less Than Detection[c]	Maximum[a]	Mean[b]	No. Less Than Detection[c]
Cesium-137 in Muscle						
100-N to 100-D Areas	0.01 ± 0.02	-0.001 ± 0.01	4 of 4	0.06 ± 0.03	0.01 ± 0.008	13 of 21
300 Area	0.04 ± 0.02[d]	NA[e]	1 of 1	0.02 ± 0.01	0.001 ± 0.003	13 of 20
Background[f]	-0.003 ± 0.03	-0.01 ± 0.01	3 of 3	0.02 ± 0.01[g]	0.007 ± 0.002[g]	14 of 25
Strontium-90 in Carcass						
100-N to 100-D Areas	0.07 ± 0.02	0.03 ± 0.03	2 of 4	0.06 ± 0.02	0.04 ± 0.009	0 of 8
300 Area	0.03 ± 0.02	NA	0 of 1	0.2 ± 0.04	0.03 ± 0.01	0 of 20
Background[f]	0.03 ± 0.02	0.02 ± 0.01	2 of 3	0.1 ± 0.02[g]	0.07 ± 0.01[g]	0 of 25

(a) Maximum is ± total propagated uncertainty (2 sigma).
(b) Result is ±2 standard error of the mean.
(c) Number of samples with values less than the detection limit out of number of samples analyzed.
(d) Not detected; best estimated activity.
(e) NA = Not applicable; only one sample.
(f) 1998 background samples were suckers collected from the Columbia River near Vantage, Washington.
(g) Background samples were carp collected from the Columbia River near Vantage, Washington in 1992.

4.5.2 Wildlife Sampling

Wildlife sampled and analyzed in 1998 for radioactive constituents included elk, deer, and pheasants. Radiological constituents analyzed for in 1998 wildlife samples included gamma emitters and strontium-90.

4.5.2.1 Deer and Elk Samples and Analytes of Interest

Studies of mule deer populations residing on the Hanford Site indicate their division into three distinct groups (PNL-10711): 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, deer collected around the 200 Areas, away from the river is designated the central area population (see Figure 4.5.1).

Radionuclide levels in deer collected onsite in 1998 were compared to levels in deer collected distant from the site from 1991 through 1995 near Boardman, Oregon and in Stevens County, Washington. Additionally, onsite levels were compared to levels in a white-tailed deer that was cosampled with the Washington State Department of Health in 1996 at Vail, Washington. These comparisons with samples from distant locations are useful in evaluating Hanford's impact to deer. The deer collected in Stevens County and Vail inhabited mountain regions that received more rainfall than Hanford; therefore, background levels of radionuclides are usually higher there (PNL-10174). The climate and precipitation surrounding the Boardman region is similar to Hanford.

Until recently, elk have not inhabited areas on the Hanford Site where the potential for uptake of radionuclide contaminants exists (see Section 7.2, "Ecosystem Monitoring [Plants and Wildlife]"). There are very little data available about contaminant concentrations in elk residing on or near the Hanford Site.

Radiological Results for Deer Samples. Cesium-137 was not detected in the seven deer muscle samples collected from the Hanford Site and analyzed in 1998 (Table 4.5.3). These results are consistent with those obtained over the preceding 8 yr and with the trends observed in a Hanford wildlife summary report (PNL-10174). As shown in Table 4.5.3, the number of results reported at or below the analytical detection limit is higher (7 of 7) in 1998 when compared to the previous 8 yr (35 of 55). PNL-10174 summarized wildlife radionuclide data collected from 1983 through 1992 and also indicated a decline in cesium-137 levels in all wildlife examined. In addition, the levels of cesium-137 in >60 Hanford 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 and, in 1996, from Vail.

The risk associated with radionuclide contamination found in deer muscle during the 1990s can be quantified by the expected dose resulting from consumption of deer meat. A 50-yr effective dose equivalent resulting from the consumption of 41 kg (90 lb) of meat/year collected from a Hanford Site deer in 1992, containing the highest cesium-137 activity, was determined to be 0.041 mrem. An individual would need to ingest approximately 100,000 kg (220,000 lb) of deer meat to approach the 100-mrem maximum annual dose allowed by DOE Order 5400.5 and the National Council on Radiation Protection and Measurements (1993). To put this dose estimate in perspective, natural background doses in the United States average approximately 300 mrem.

Strontium-90 was detected in six of seven deer bone samples analyzed in 1998 (see Table 4.5.3).

Table 4.5.3. Activities of Selected Radionuclides (pCi/g) in Deer and Elk, 1998 Compared to Previous 8 Years

Location	1998 Maximum[a]	1998 Mean[b]	1998 No. Less Than Detection[c]	1990-1997 Maximum[a]	1990-1997 Mean[b]	1990-1997 No. Less Than Detection[c]
Cesium-137 in Muscle						
Deer						
Central	0.003 ± 0.007	0.003 ± 0.003	2 of 2	0.37 ± 0.05	0.05 ± 0.08	5 of 9
North	0.005 ± 0.005	0.004 ± 0.004	2 of 2	0.03 ± 0.01	0.006 ± 0.003	18 of 24
South	0.0004 ± 0.004	0.0004 ± 0.004	3 of 3	0.01 ± 0.007	0.002 ± 0.002	12 of 22
Stevens Co., WA[d]	NS[e]	NS		0.5 ± 0.06	0.31 ± 0.26	0 of 3
Boardman, OR[d]	NS	NS		0.03 ± 0.03	0.01 ± 0.01	3 of 4
Vail, WA[f]	NS	NS		0.12 ± 0.03	NA[g]	0 of 1
Elk						
ALE[h]	0.003 ± 0.005	0.0006 ± 0.002	4 of 4	NS	NS	
Strontium-90 in Bone						
Deer						
Central	0.19 ± 0.05	0.19 ± 0.008	0 of 2	3.3 ± 0.6	0.74 ± 1.0	1 of 6
North	0.39 ± 0.08	0.37 ± 0.12	0 of 2	58.3 ± 11.3	5.4 ± 6.2	0 of 20
South	0.19 ± 0.05	0.12 ± 0.13	1 of 3	0.42 ± 0.1	4.0 ± 4.6	1 of 7
Stevens Co., WA	NS	NS		2.1 ± 0.41	1.1 ± 1.0	0 of 3
Boardman, OR	NS	NS		0.13 ± 0.041	0.11 ± 0.015	0 of 4
Vail, WA	NS	NS		0.94 ± 0.20	NA	0 of 1
Elk						
ALE	1.41 ± 0.03	0.44 ± 0.52	1 of 4	NS	NS	

(a) Maximum is ± total propagated uncertainty (2 sigma).
(b) Result is ±2 standard error of the mean.
(c) Number of samples with values less than the detection limit out of number of samples analyzed.
(d) Background samples collected between 1991 and 1995.
(e) NS = No sample.
(f) Background samples collected in 1996.
(g) NA = Not applicable; only one sample.
(h) ALE = Fitzner-Eberhardt Arid Lands Ecology Reserve; samples refer to elk samples collected along Highways 24, 240, and 241.

Two of the seven animals sampled came from the north (retired reactor) population and contained 0.39 ± 0.08 and 0.27 ± 0.06 pCi/g strontium-90, respectively. Three of the seven animals sampled were from the south area population, and results ranged from below detection to 0.19 ± 0.05 pCi/g. Two deer samples were collected from the central area population (near the 200 Areas), and the results were 0.19 ± 0.05 and 0.18 ± 0.06 pCi/g, respectively. The lower values found in deer bone from the south area and central area populations are consistent with strontium-90 levels found in deer antlers summarized in PNL-10711. Strontium-90 levels found in deer bone in 1998 were similar to the levels found in the previous 7 yr, and no unusually high values were found in samples collected during 1998. Deer bone samples from Boardman had a maximum strontium-90 activity of 0.13 ± 0.04 pCi/g, which was lower than the maximum values in the deer bone samples from Vail and Stevens County but comparable to results

from Hanford deer samples analyzed over the past several years (see Table 4.5.3). The apparently higher strontium-90 activities in onsite deer bone from the north area may indicate some prior exposure to localized, low-level contamination on the site.

Radiological Results for Elk Samples. Radionuclide levels were monitored in tissue collected from four road-killed elk along Highways 240 and 24 in 1998 (see Table 4.5.3). With the exception of strontium-90, all other radionuclides were reported as below analytical detection limits. Strontium-90 was detected in bone tissue from three of the four animals; 0.32 ± 0.07, 0.46 ± 0.13, and 1.41 ± 0.3 pCi/g, respectively. These levels are similar to north area deer levels; however, elk inhabit the higher elevations on the Hanford Site and reflect levels of strontium-90 that are expected from atmospheric fallout from worldwide weapons testing in the 1950s and 1960s. Strontium-90 is sequestered in the calcium-rich tissues like bone. As such, strontium-90 is unlikely to be transferred to humans because bone is not the edible portion of the animal.

4.5.2.2 Pheasant Samples and Analytes of Interest

Six pheasants were collected from the 100-D to 100-F Areas in the fall of 1998 (see Figure 4.5.1). Attempts were made to collect upland game from near the 100-N Area but upland game habitat there was limited. Radionuclide levels found in the 100-D to 100-F samples were compared to levels in samples collected onsite during the previous 7 yr and were also compared to levels found in samples collected from a background location in the lower Yakima Valley near Sunnyside in 1994.

Cesium-137 was not detected in the six pheasant muscle samples collected in 1998 (Table 4.5.4). The number of results reported at or below the analytical detection limit was higher in 1998 (6 of 6),

Table 4.5.4. Activities of Selected Radionuclides (pCi/g) in Upland Game, 1998 Compared to Previous 8 Years

	1998			1990-1997		
Location	Maximum[a]	Mean[b]	No. Less Than Detection[c]	Maximum[a]	Mean[b]	No. Less Than Detection[c]
Cesium-137 in Muscle						
100-N Area	NS[d]	NS		-0.014 ± 0.02	-0.018 ± 0.008	2 of 2
100-D to 100-F Area	0.018 ± 0.019	0.005 ± 0.008	6 of 6	0.17 ± 0.03	0.017 ± 0.012	15 of 28
Background[e]	NS	NS		0.16 ± 0.14	0.011 ± 0.017	19 of 20
Strontium-90 in Bone						
100-N Area	NS	NS		0.08 ± 0.05	0.07 ± 0.02	0 of 2
100-D to 100-F Area	0.07 ± 0.09	0.04 ± 0.006	6 of 6	0.2 ± 0.1	0.07 ± 0.02	4 of 28
Background[e]	NS	NS		0.1 ± 0.06	0.04 ± 0.01	8 of 20

(a) Maximum is ± total propagated analytical uncertainty (2 sigma).
(b) Result is ±2 standard error of the mean.
(c) Number of samples with values at or less than the detection limit out of number of samples analyzed.
(d) NS = No sample.
(e) Background samples collected from Yakima Valley near Sunnyside, Washington.

compared to the previous 8 yr (17 of 30). The 1998 levels were consistent with those reported in PNL-10174. The levels found in upland game collected on the Hanford Site during the 1990s were not elevated, compared to levels found in upland game from the Yakima Valley in 1994. Of the samples from the Yakima Valley, 95% (19 of 20) were found to be at or below the analytical detection limit.

Strontium-90 levels were not found above the analytical detection limit in any of the six bone samples collected during 1998. Only 14% (4 of 28) of the upland game samples collected from the 100-D to 100-F Areas during the past 8 yr were found to be at or below analytical detection limits.

Levels of strontium-90 found in upland game bone samples during the 1990s were consistently lower ($P \leq 0.005$) than levels found in deer bone collected from the same vicinity (see Tables 4.5.3 and 4.5.4). 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.