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 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).

Fish and wildlife species are collected on a 2- to 3-year rotation. Routine background sampling is conducted approximately every 5 years at locations believed to be unaffected by Hanford releases. Additional background data also may be collected during special studies.

Wildlife species were selected for sampling based on recommendations provided by a review committee during the early 1980s. Primary consideration for species selection included their likelihood to accumulate contaminants in their tissue, their likelihood of being consumed by people, and their likelihood of being found at the monitoring sites identified in Figure 4.5.1. For each species of fish or wildlife, radionuclides are selected for analysis based on their potential 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 (PNL-9394). 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. Contaminated groundwater that enters the Columbia River via shoreline springs in the 100-N and 100-H Areas is the primary source of strontium-90 from Hanford to the river; however, current contaminant 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 tissues of fish and wildlife. Having a relatively short biological half-life (<200 days in muscle; <20 days in the gastrointestinal tract [PNL-9394]), cesium-137 is an indicator of more recent exposure to radioactive materials and is also a major constituent of historical worldwide fallout.

Heavy metals have the potential to accumulate in certain fish and wildlife tissue and have been identified in the Hanford Site environment as contaminants of concern (e.g., chromium, copper, lead, and mercury), particularly in areas where groundwater enters the Columbia River.

Fish and wildlife samples were analyzed by gamma spectrometry to detect a number of gamma emitters (Appendix F). However, gamma spectrometry results for most radionuclides are not discussed here because levels 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. Results and propagated uncertainties for all results may be found in PNNL-14295, APP. 1.

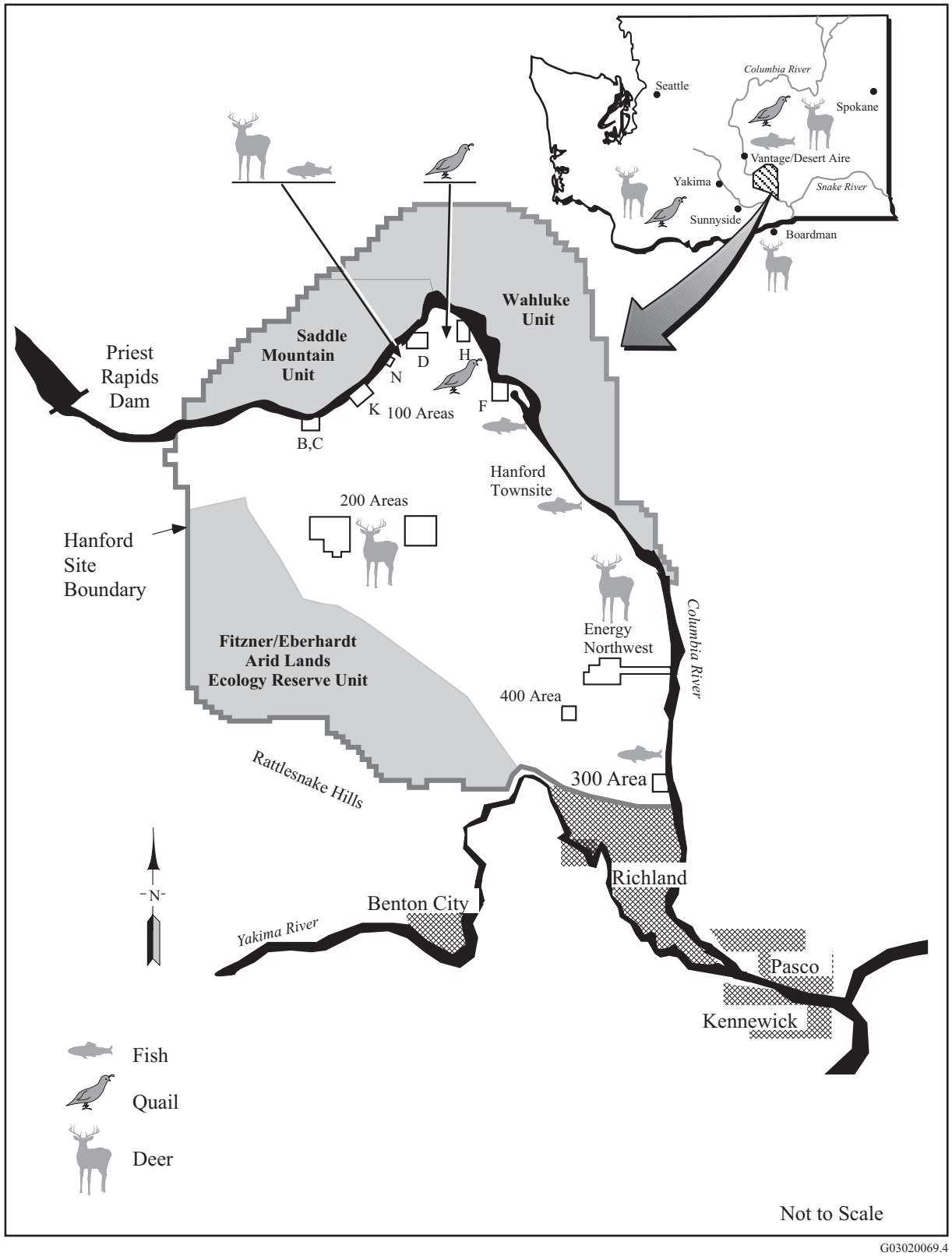

Figure 4.5.1. Fish and Wildlife Sampling Locations On and Around the Hanford Site, 2002

Table 4.5.1. Hanford Site Fish and Wildlife Sampling Locations and Analyses, 2002

Biota	No. of Reference Locations	No. of Onsite Locations	No. of Analyses		
			Gamma	Strontium-90	Isotopic Plutonium
Fish (carp)	1	2	15	15	0
(bass)	1	3	13	13	0
Upland game (California quail)	0	2	10	10	0
Big game (mule deer)	1	3	9	9	1

4.5.1 Fish Samples and Analytes of Interest

The amount of radiological contamination measured in fish samples has consistently been well below levels that are thought to cause adverse biological effects and contributes only a small proportion of the radiation dose to the maximally exposed individual (Chapter 5). However, monitoring fish and other organisms for uptake and exposure to radionuclides at both nearby and distant locations continues to be important to track the extent and long-term trends of contamination in the Columbia River environment. During 2002, 15 carp (*Eyprinus cyprinus*) were collected from three locations on the Columbia River: near the 100-N Area, near the 300 Area, and from an upstream reference site near Vantage, Washington (Figure 4.5.1). Thirteen smallmouth bass (*Micropterus dolomieui*) were also collected in 2002 from two major backwater areas along the Hanford Reach, near the 300 Area, and from an upstream reference area near Vantage, Washington (Figure 4.5.1). Fillets and the eviscerated remains (carcass) of fish were analyzed for a variety of radiological contaminants and results from the nearby and distant locations were compared and are discussed in the following paragraphs. During 2002, fillet (muscle) samples were analyzed with gamma spectrometry for cesium-137 and other gamma-emitting radionuclides (PNNL-14295, APP. 1).

Cesium-137 results were below the analytical detection limit (0.04 pCi/g [0.0015 Bq/g] wet weight) in 10 carp fillet samples collected near the 100-N and 300 Areas during 2002. All five samples collected from the upriver reference area (Vantage, Washington) during 2002 also fell below the analytical detection limit as compared to 19 of 30 (53%) reference area fish tissue levels reported below the analytical detection limit in 2000, 1996, and 1992 (PNNL-11472; PNNL-12088). Cesium-137 was also not detected in any of the 13 bass fillets analyzed during 2002. These results are consistent with results reported throughout the 1990s that indicated a gradual decline in cesium-137 levels in fish found both near to and distant from the Hanford Site.

Strontium-90 was found in 13 of 15 carp carcass samples collected and analyzed during 2002. The median level of strontium-90 in carcass tissues collected from the 100-N to 100-D region during 2002 was slightly higher than levels observed in fish from the 300 Area and in fish from the upstream reference site (Figure 4.5.2). However, results

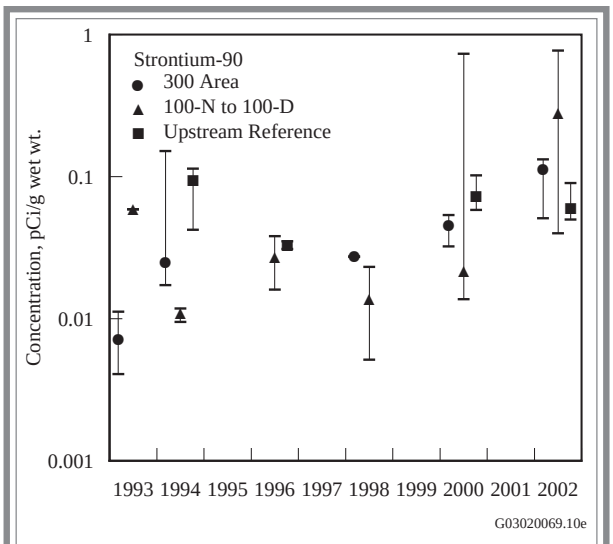

Figure 4.5.2. Median, Maximum, and Minimum Strontium-90 Concentrations (pCi/g wet wt.) in Columbia River Carp Carcasses at the Hanford Site, 2002 Compared to Previous Years

reported during 2002 are consistent with samples collected over the preceding 8 years. The strontium-90 concentration in one of the five carp samples collected between 100-N and 100-D Areas was over six times greater than the median concentrations from all three sampling regions, and eight times greater than the highest value reported from the reference areas. This result (0.77 ± 0.22 pCi/g [0.03 ± 0.008 Bq/g]) was the highest reported over the preceding 8-year period. Elevated amounts have been consistently measured in carp and other bottom-feeding fishes (suckers and whitefish) collected near the 100-N Area in the past. The five results reported during 2002 are all greater than 17 of 18 results reported for carp carcass tissues throughout the 1990s. The median and maximum-result pattern near the 100-N Area may indicate some of the fish have consumed items containing elevated amounts of strontium-90 from Hanford sources and have incorporated some strontium into their tissues. Strontium-90 concentrations in carcass tissue would have to be around 600 pCi/g (22.2 Bq/g) wet weight (in the absence of other radionuclides and external exposure) to be near the DOE dose limit of 1.0 rad (10 mGy) per day established for aquatic organisms (Section 5.6). The hypothetical dose associated with the consumption of Hanford Reach fish is found in Chapter 5.

Liver tissue samples from all bass and carp collected in 2002 were analyzed for a number of heavy metals using inductively-coupled plasma gas chromatography analytical techniques (EPA 1994, 1998). Concentrations of most metals (antimony, beryllium, lead, nickel, silver, thallium, thorium, and uranium [PNNL-14295, APP. 1]) were found to be near or below their analytical detection limits. The highest chromium concentrations (PNNL-14295, APP. 1) were reported from bass samples collected at the upstream reference locations (Figure 4.5.1). Tissue residue levels of metals did not appear to differ between each sampling location; however, copper and zinc concentrations in carp samples were generally 10 times higher than concentrations in bass samples.

4.5.2 Wildlife Sampling

The amount of radiological contamination measured in wildlife samples under this project has been well below levels that are estimated to cause adverse health effects (Section 5.6). Monitoring various biota for uptake and exposure to radionuclides both near and distant from Hanford Site operations continues to assure that consumption of wildlife does not pose a threat to humans. This work is also intended to provide long-term trends of contamination in the selected components of the ecosystem. Wildlife sampled and analyzed during 2002 for radioactive constituents included mule deer (*Odocoileus hemionus*) and upland game (California quail [*Callipepla californica*]). Wildlife samples were analyzed for gamma emitters, strontium-90, and isotopic plutonium.

4.5.2.1 Upland Game Samples and Analytes of Interest

Fifteen California quail were collected from two selected sampling areas on Hanford in the fall of 2002 (Figure 4.5.1). Radionuclide levels found in ten samples analyzed during 2002 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. Quail samples were provided to the Washington State Department of Health for comparative purposes.

Analyses for gamma-emitting radionuclides (cesium-137) in muscle tissue typically require more mass than what is available on a single quail. For this reason, quail collected on the Hanford Site were often composited into a single sample for the gamma-scan analysis. Samples of bone analyzed for strontium-90 were also composited in a similar fashion as muscle tissue samples. Cesium-137 was not detected (at or below ~0.04 pCi/g [~0.001 Bq/g] wet weight) in any of the six quail muscle samples collected between the 100-H and 100-F Areas nor in any of the four samples collected between the 100-D and 100-H Areas. These results were consistent with those reported in 1998 and 2000 as 18 of 18 samples were reported below the analytical detection limit (PNNL-13487). The number of samples reported at or below the analytical detection limit during 1998, 2000, and 2002 (24 of 24 collectively) reflects the continued downward trend in worldwide levels of cesium-137 fallout due to atmospheric dispersion of radionuclides during the weapons testing era (1950s through the 1970s).

None (0 of 10) of the quail bone samples collected and analyzed for strontium-90 during 2002 had concentrations above the analytical detection limit (0.04 pCi/g [0.001 Bq/g] wet weight). Although upland game samples were not obtained from a reference area during 2002, the onsite results are consistent with results obtained from the background areas in past years and do not indicate elevated levels of strontium-90 in upland game (Figure 4.5.3).

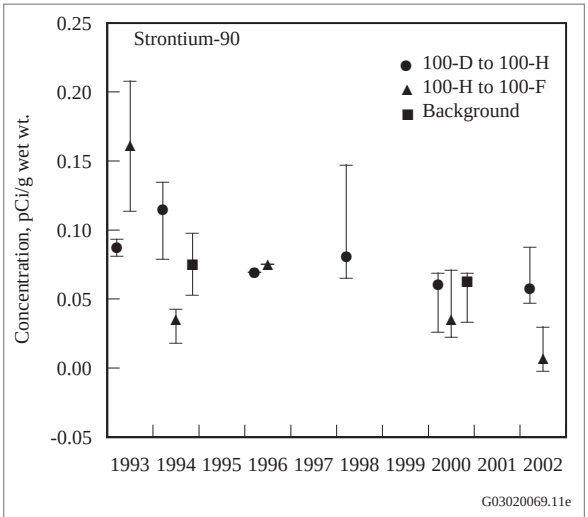

Figure 4.5.3. Median, Maximum, and Minimum Strontium-90 Concentrations (pCi/g wet wt.) in Hanford Site and Background Upland Game Bone Samples, 2002 Compared to Previous Years

4.5.2.2 Deer Samples and Analytes of Interest

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

Radionuclide levels in nine deer collected onsite in 2002 were compared to levels in deer collected distant from the site and to results reported for the preceding 8-year period. One deer was from the central population (200 Areas), four were from the north population (100 Areas), and four were from the south population (300 Area). Background samples were collected between 1992 and 1995 near Boardman, Oregon and in Stevens County, Washington (see PNNL-11472, Section 4.5). During 2000, one background deer sample was obtained from the lower Yakima Valley, near Sunnyside, Washington (see PNNL-13487, Section 4.5). Additionally, levels in onsite mule deer were compared to levels in a white-tailed deer that was co-sampled with the Washington State Department of Health during 1996 from Vail, Washington (see PNNL-12088, Section 4.5). These comparisons with samples from distant locations are useful in evaluating Hanford's relative contribution of radionuclides in 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.

Radiological Results for Deer Samples. Cesium-137 was not detected (at or <0.02 pCi/g [0.007 Bq/g] wet weight) in all nine deer muscle samples analyzed during 2002. These results are consistent with a decline in cesium-137 levels in all wildlife examined from 1983 through 1992 (PNL-10174) and with data obtained over the preceding 8 years. In this time period, the levels of cesium-137 in more than 60 Hanford Site deer muscle samples were less than the background levels measured in deer samples collected from 1991 through 1995 from Stevens County, Washington, and, during 1996, from Vail, Washington.

Strontium-90 was detected in all nine deer bone samples collected and analyzed in 2002 and continues to demonstrate the utility of this organism to accumulate and depict trends of strontium-90 contamination in the environment. 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 2002 were similar between the three sampling areas onsite (Figure 4.5.4). The highest concentration of strontium-90 (1.51 ± 0.5 pCi/g [0.05 ± 0.02 Bq/g] wet weight) obtained onsite during 2002 was obtained from the south area.

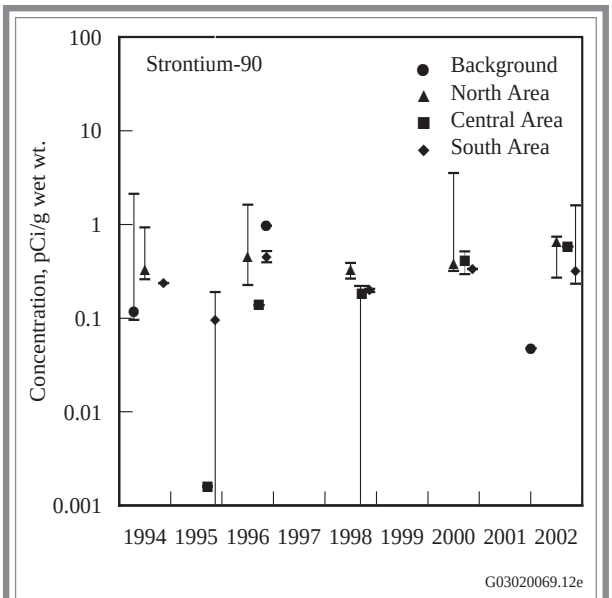

Figure 4.5.4. Median, Maximum, and Minimum Strontium-90 Concentrations (pCi/g wet wt.) in Hanford Site and Background Deer Bone Samples, 2002 Compared to Previous Years

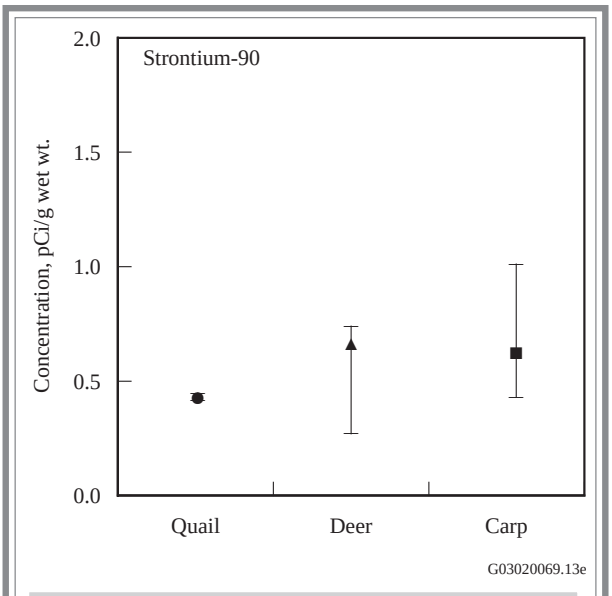

Figure 4.5.5. Comparison of Median, Maximum, and Minimum Strontium-90 Concentrations (pCi/g wet wt.) in the Bones of Deer, Quail, and Fish Collected on the Hanford Site Near the 100-N Area, 2002

However, these results do not indicate excessive exposure of strontium-90 to mule deer. Elevated levels of strontium-90 in samples from the north area typically occurred in about one of three deer samples collected there throughout the preceding 8-year period, with the highest concentration (20.8 ± 5.2 pCi/g [0.77 ± 0.19 Bq/g] wet weight) reported during 1992 (see PNNL-13487, Section 4.5). Background samples of deer bone indicate strontium-90 concentrations can be as high as 2.06 ± 0.4 pCi/g (0.08 ± 0.01 Bq/g) wet weight. The apparently higher concentrations reported in deer bone from the north area may indicate some exposure to localized, low-level contamination near the N Reactor.

Levels of strontium-90 found in deer bone samples collected between 1992 and 2000 have been consistently higher than levels found in quail bone collected from the same general vicinity (Figure 4.5.5). The diet of quail primarily includes insects and dry-land grass seeds, whereas deer generally consume riparian and woody plants. Deep-rooted riparian plants can contain higher levels of Hanford-produced contaminants 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 in previous years also indicate some of the aquatic organisms have consumed items containing elevated amounts of strontium-90 from Hanford sources and have incorporated a portion of the contamination into their tissues.

Plutonium-238 and plutonium-239/240 were not found above the analytical detection limit (0.00004 pCi/g [0.0000015 Bq/g] wet weight) in the one deer liver sample obtained during 2002 near the 200 Areas. The result is consistent with results reported through the 1990s. Less than 6% (2 of 35) of the deer livers analyzed since 1992 have contained plutonium at concentrations above the analytical detection limit.