# 4.5 Fish and Wildlife Surveillance

*T. M. Poston*

Contaminants in fish and wildlife species 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 effluents might be harvested and may potentially contribute to the dose to the offsite public. 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, samples are collected at various locations annually, generally during the hunting or fishing seasons (Figure 4.5.1). More detailed rationale for the selection of specific species sampled in 1996 can be found in DOE (1994a).

Results from background samples are compared to results from Hanford samples to identify differences. Routine background sampling is conducted approximately every 5 years at locations believed to be unaffected by Hanford releases. Background data also may be collected during special studies or sampling efforts. In 1996, background contaminant concentrations were measured in bass and carp from the Priest Rapids reservoir near Mattawa, Washington. The Washington State Department of Health provided background deer samples collected near Vail, Washington (near Centralia approximately 240 km [150 mi] west of Hanford).

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-year period. Factors supporting these changes included the elimination of many radiological source terms onsite 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 Hanford, cesium-137 and strontium-90 historically have been the most frequently measured radionuclides in fish and wildlife.

Strontium-90 is chemically similar to calcium; consequently, it accumulates in hard tissues high in calcium such as bone, antlers, and eggshells. Strontium-90 has a long biological half-life in hard tissue. 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. Spring 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%) (Jaquish 1993).

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, 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 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.

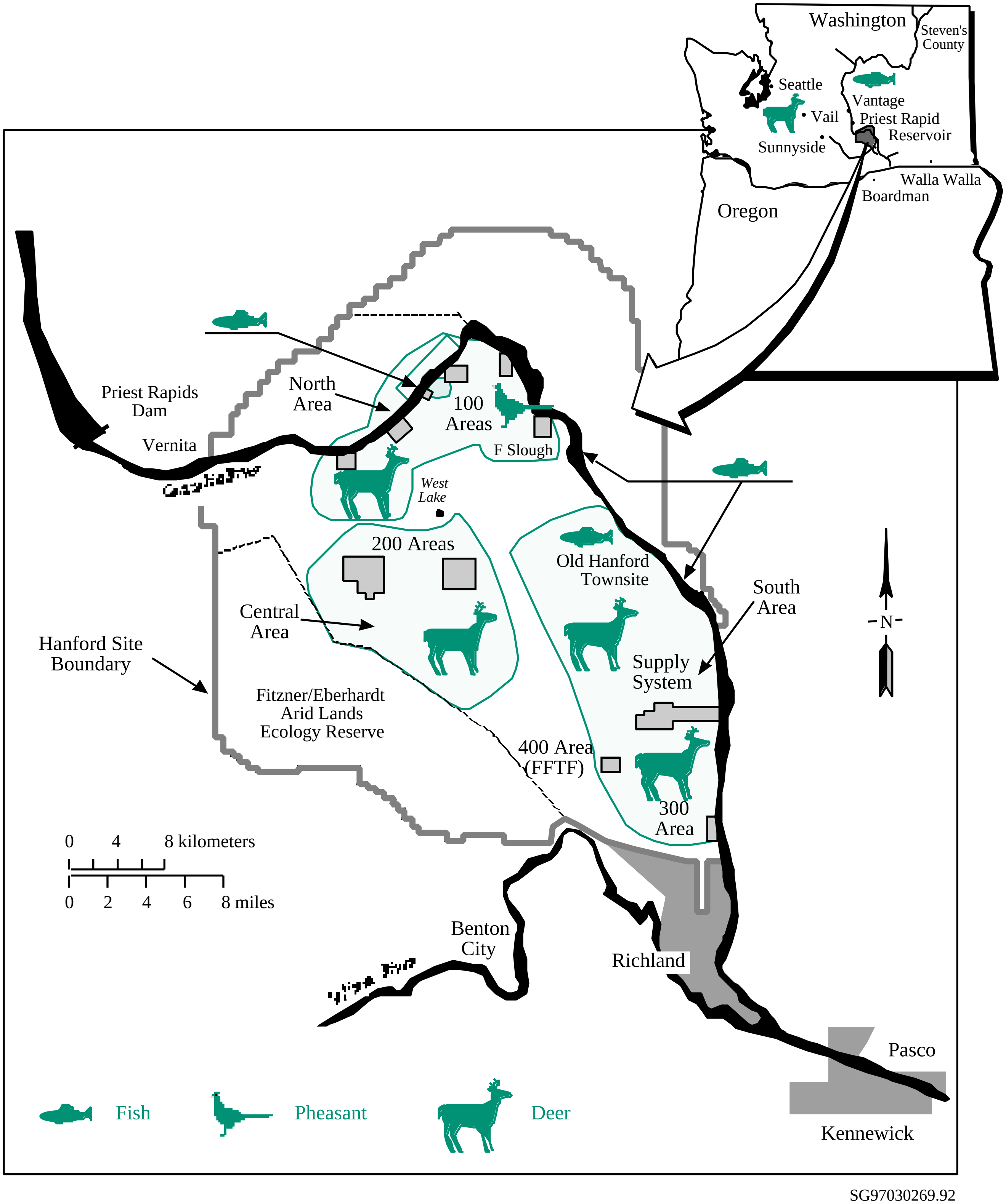


**Figure 4.5.1**. Fish and Wildlife Sampling Locations, 1996

**Table 4.5.1.** Locations, Species, and Contaminants Sampled for Fish and Wildlife, 1996

| Medium | Number of Species | Offsite Locations | Onsite Locations | Contaminants Sampled/Number of Locations | |
|---|---|---|---|---|---|
| | | | | Gamma | $^{90}Sr$ |
| Fish (Bass, Carp) | 2 | 1[(a)] | 2 | 3 | 3 |
| Pheasant | 1 | 0 | 1 | 1 | 1 |
| Mule deer | 1 | 1[(b)] | 3 | 4 | 4 |

(a) Background samples collected from Priest Rapids reservoir.
(b) Background sample (white-tailed deer) collected by Washington State Department of Health from Vail, Washington.

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 error is used as an estimate of the nominal detection level for that analyte and particular media. Propagated errors for all results may be found in Bisping (1997).

Great blue heron and deer were also sampled in support of graduate student studies in 1996. Liver samples were analyzed by inductively coupled plasma-mass spectrometry for several trace metals. Heron and deer sampled for metals analysis were collected from the riparian areas along the Columbia River on the site.

## Collection of Fish Samples and Analytes of Interest

In 1996, carp were collected from the 100-N to 100-D Areas of the Columbia River. Five bass were collected from the 100-F Slough and one bass was collected from the Hanford Slough. Attempts to electrofish for carp near the 300 Area were unsuccessful. Background samples of carp were collected in 1990 from the Columbia River at Vantage and again from Priest Rapids reservoir in 1996. Background bass were also collected from a pond near Sunnyside, Washington in 1991 and from Priest Rapids reservoir in 1996.

Fish are very mobile, and the length of time they reside at any given sampling location is unknown. This mobility may explain why analytical results in fish generally are variable. Fillets and the eviscerated remains (offal) were analyzed. Results for all 1996 samples are given by Bisping (1997).

## Radiological Results for Fish Samples

### Bass

**Muscle**. In 1996, muscle samples were analyzed with gamma spectrometry for cesium-137 and other gamma-emitting radionuclides (see Appendix E). Cesium-137 was found at the detection level of 0.02 pCi/g in the bass fillet collected from the Hanford Slough. Cesium-137 was not detected in the samples from 100-F Slough or Priest Rapids reservoir (Table 4.5.2).

**Offal**. Strontium-90 was found in all bass offal samples analyzed in 1996. There was no apparent difference between offal samples collected at the 100-F Slough and the Hanford Slough nor have concentrations changed much over the past 5 years (see Table 4.5.2). Concentrations of strontium-90 in offal were slightly elevated in the 100-F Slough and Hanford Slough samples compared to background samples collected at Sunnyside in 1991 and at Priest Rapids reservoir in 1996.

### Carp

**Muscle**. Cesium-137 was not detected in carp fillets collected in 1996 (Table 4.5.3). Moreover, cesium-137

**Table 4.5.2**. Concentrations of Select Radionuclides in Bass, 1996 Values Compared to Values from the Previous 5 Years

| | 1996 | | | 1991-1995 | | |
|---|---|---|---|---|---|---|
| Location | Maximum,[a] pCi/g wet wt. | Mean,[b] pCi/g wet wt. | No. Less Than Detection[c] | Maximum,[a] pCi/g wet wt. | Mean,[b] pCi/g wet wt. | No. Less Than Detection[c] |
| **Cesium-137 in Muscle** | | | | | | |
| 100-F Slough | 0.02 ± 0.01 | 0.01 ± 0.01 | 5 of 5 | 0.05 ± 0.03 | 0.03 ± 0.01 | 5 of 10 |
| Hanford Slough | 0.02 ± 0.01 | NA[d] | 0 of 1 | NS[e] | NS | |
| Sunnyside | NS | NS | | 0.09 ± 0.09 | 0.01 ± 0.01 | 20 of 20 |
| Priest Rapids Reservoir | 0.01 ± 0.04 | 0.00 ± 0.01 | 2 of 2 | NS | NS | |
| **Strontium-90 in Offal** | | | | | | |
| 100-F Slough | 0.027 ± 0.008 | 0.023 ± 0.003 | 0 of 5 | 0.03 ± 0.008 | 0.021 ± 0.005 | 0 of 10 |
| Hanford Slough | 0.023 ± 0.014 | NA | 0 of 1 | NS | NS | |
| Sunnyside | NS | NS | | 0.03 ± 0.009 | 0.007 ± 0.002 | 8 of 20 |
| Priest Rapids Reservoir | 0.018 ± 0.010 | 0.018 ± 0.000 | 0 of 2 | NS | NS | |

(a) Maximum is pCi/g ± total propagated analytical uncertainty (2-sigma).
(b) Result is pCi/g ±2 standard error of the mean.
(c) Number of samples with values less than the detection limit out of number of samples analyzed.
(d) NA = Not applicable, n = 1.
(e) NS = No sample.

---

**Table 4.5.3**. Concentrations of Select Radionuclides in Carp, 1996 Values Compared to Values from the Previous 5 Years

| | 1996 | | | 1991-1995 | | |
|---|---|---|---|---|---|---|
| Location | Maximum,[a] pCi/g wet wt. | Mean,[b] pCi/g wet wt. | No. Less Than Detection[c] | Maximum,[a] pCi/g wet wt. | Mean,[b] pCi/g wet wt. | No. Less Than Detection[c] |
| **Cesium-137 in Muscle** | | | | | | |
| 100-N to 100-D | 0.01 ± 0.01 | 0.01 ± 0.01 | 2 of 2 | 0.06 ± 0.02 | 0.01 ± 0.01 | 12 of 13 |
| 300 Area | NS[d] | NS | | 0.02 ± 0.02 | 0.01 ± 0.00 | 16 of 20 |
| Priest Rapids Reservoir | 0.01 ± 0.0[e] | 0.00 ± 0.01 | 2 of 2 | NS | NS | |
| Vantage | NS | NS | | 0.02 ± 0.01 | 0.01 ± 0.00 | 15 of 20 |
| **Strontium-90 in Offal** | | | | | | |
| 100-N to 100-D | 0.038 ± 0.009 | 0.027 ± 0.022 | 0 of 2 | 0.26 ± 0.051 | 0.055 ± 0.042 | 0 of 11 |
| 300 Area | NS | NS | | 0.15 ± 0.035 | 0.034 ± 0.014 | 1 of 20 |
| Priest Rapids Reservoir | 0.035 ± 0.008 | 0.033 ± 0.005 | 0 of 2 | NS | NS | |
| Vantage | NS | NS | | 0.11 ± 0.024 | 0.076 ± 0.012 | 0 of 20 |

(a) Maximum is pCi/g ± total propagated analytical uncertainty (2-sigma).
(b) Result is pCi/g ±2 standard error of the mean.
(c) Number of samples with values less than the detection limit out of number of samples analyzed.
(d) NS = No sample.
(e) This result is actually less than detection; uncertainty was rounded down to 0.0.

was not detected in approximately 85% of the carp fillet samples collected from the Hanford Reach from 1991 through 1995.

**Offal**. Strontium-90 was measured in all carp offal samples collected in 1996. Concentrations were low (<0.038 ± 0.009 pCi/g, wet wt.) and comparable to results obtained from 1991 through 1995 (see Table 4.5.3). There was no apparent difference between concentrations of strontium-90 in Hanford Reach carp and background carp collected in 1996.

# Wildlife Sampling

Wildlife sampled in 1996 for radioactive constituents included deer and pheasants. Results from all 1996 samples are summarized in Bisping (1997).

## Collection of Deer Samples and Analytes of Interest

Ongoing studies of site mule deer indicate that populations residing along the river can be divided into two distinct categories (Tiller et al. 1995): 1) the population that inhabits land around the retired reactors in the 100 Areas is designated the north population and 2) the population that resides from the Old Hanford Townsite south to the 300 Area is designated the south population. By default, deer collected around the 200 Areas, away from the river, constitute a third grouping named the central population (see Figure 4.5.1).

Radionuclide concentrations in animals collected onsite in 1996 were compared to concentrations in deer collected distant from the site from 1991 through 1995 near Boardman, Oregon and in Stevens County, Washington. Additionally, a white-tailed deer was cosampled for background concentrations with the Washington State Department of Health in 1996 at Vail, Washington. The Stevens County deer samples were donated to the program. These comparisons are useful in evaluating Hanford's impact to deer because the distant sampling areas in Stevens County and Vail get more rainfall containing atmospheric fallout than Hanford; therefore, background concentrations of cesium-137 and strontium-90 are usually higher (Poston and Cooper 1994). This difference was not noted in deer collected from Boardman because the climate and precipitation there are similar to Hanford.

## Radiological Results for Deer Samples

**Muscle**. Cesium-137 was not detected in the 13 deer muscle samples collected and analyzed in 1996 (Table 4.5.4). These results are consistent with trends observed in Hanford deer muscle samples analyzed in recent years (Poston and Cooper 1994). The cesium-137 concentration in Hanford deer muscle was less than background concentrations measured in the deer samples collected from 1991 through 1995 from Stevens County and, in 1996, from Vail.

**Bone**. Strontium-90 was detected in all deer bone samples analyzed in 1996. The maximum concentration was 1.6 ± 0.30 pCi/g in a deer sampled from the North Area. Generally, strontium-90 concentrations were higher in deer collected from the North Area when compared to the South or Central Areas. These 1996 results are consistent with prior observations (Poston and Cooper 1994). Boardman deer bone samples had a maximum strontium-90 concentration of 0.13 ± 0.04 pCi/g, which was lower than the concentrations 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 4.5.4). The apparently higher concentrations of strontium-90 in onsite deer bone from the North Area may indicate some prior exposure to localized low-level contamination onsite.

## Collection of Pheasant Samples and Analytes of Interest

Two pheasants where collected from the 100-D to 100-F Areas in the fall of 1996. Radionuclide concentrations in these samples were compared to background concentrations in pheasants collected in the lower Yakima Valley near Sunnyside, Washington in 1994.

**Muscle**. Cesium-137 was not detected in pheasant muscle samples collected in 1996, but was detected in approximately 75% of the pheasants collected onsite since 1991 (Table 4.5.5).

**Bone**. Strontium-90 was measured in pheasant bones in both samples collected onsite in 1996. The mean concentration (0.07 ± 0.005 pCi/g, wet wt.) was similar to strontium-90 levels observed in site pheasants over the preceding 5 years and exceeded concentrations observed in background samples collected from 1991 through 1995 by a factor of two.

**Table 4.5.4**. Concentrations of Select Radionuclides in Deer, 1996 Values Compared to Values from the Previous 5 Years

| Location | 1996 Maximum,[a] pCi/g wet wt. | 1996 Mean,[b] pCi/g wet wt. | 1996 No. Less Than Detection[c] | 1991-1995 Maximum,[a] pCi/g wet wt. | 1991-1995 Mean,[b] pCi/g wet wt. | 1991-1995 No. Less Than Detection[c] |
|---|---|---|---|---|---|---|
| **Cesium-137 in Muscle** | | | | | | |
| North Area | 0.02 ± 0.02 | 0.01 ± 0.01 | 7 of 7 | 0.02 ± 0.01 | 0.00 ± 0.00 | 13 of 14 |
| South Area | 0.49 ± 0.11 | 0.42 ± 0.051 | 5 of 5 | 0.01 ± 0.005 | 0.00 ± 0.00 | 16 of 16 |
| Central Area | -0.003 ± 0.01 | NA[d] | 1 of 1 | 0.4 ± 0.05 | 0.07 ± 0.12 | 3 of 6 |
| Stevens Co., WA | NS[e] | NS | | 0.5 ± 0.06 | 0.31 ± 0.26 | 0 of 3 |
| Boardman, OR | NS | NS | | 0.03 ± 0.03 | 0.01 ± 0.01 | 3 of 4 |
| Vail, WA | 0.12 ± 0.03 | NA | 0 of 1 | NS | NS | |
| **Strontium-90 in Bone** | | | | | | |
| North Area | 1.6 ± 0.30 | 0.63 ± 0.41 | 0 of 6 | 21 ± 10 | 3.6 ± 3.6 | 0 of 11 |
| South Area | 0.49 ± 0.11 | 0.42 ± 0.051 | 0 of 4 | 0.22 ± 0.11 | 0.11 ± 0.11 | 2 of 4 |
| Central Area | 0.14 ± 0.054 | NA | 0 of 1 | 3.3 ± 0.64 | 1.1 ± 1.5 | 1 of 4 |
| 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 | 0.94 ± 0.20 | NA | 0 of 1 | NS | NS | |

(a) Maximum is pCi/g ± total propagated analytical uncertainty (2-sigma).
(b) Result is pCi/g ±2 standard error of the mean.
(c) Number of samples with values less than the detection limit out of number of samples analyzed.
(d) NA = Not applicable, n = 1.
(e) NS = No sample.

**Table 4.5.5**. Concentrations of Select Radionuclides in Pheasant, 1996 Values Compared to Values from the Previous 5 Years

| Location | 1996 Maximum,[a] pCi/g wet wt. | 1996 Mean,[b] pCi/g wet wt. | 1996 No. Less Than Detection[c] | 1991-1995 Maximum,[a] pCi/g wet wt. | 1991-1995 Mean,[b] pCi/g wet wt. | 1991-1995 No. Less Than Detection[c] |
|---|---|---|---|---|---|---|
| **Cesium-137 in Muscle** | | | | | | |
| 100-D to 100-F | 0.00 ± 0.01 | 0.00 ± 0.00 | 2 of 2 | 0.17 ± 0.03 | 0.02 ± 0.01 | 19 of 26 |
| 100-N Area | NS[d] | NS | | -0.01 ± 0.01 | -0.02 ± 0.00 | 2 of 2 |
| Yakima Valley | NS | NS | | 0.16 ± 0.14 | 0.02 ± 0.03 | 10 of 10 |
| **Strontium-90 in Bone** | | | | | | |
| 100-D to 100-F | 0.08 ± 0.06 | 0.07 ± 0.005 | 0 of 2 | 0.21 ± 0.11 | 0.077 ± 0.023 | 7 of 19 |
| 100-N Area | NS | NS | | 0.080 ± 0.048 | 0.072 ± 0.014 | 0 of 2 |
| Yakima Valley | NS | NS | | 0.055 ± 0.037 | 0.032 ± 0.010 | 6 of 10 |

(a) Maximum is pCi/g ± total propagated analytical uncertainty (2-sigma).
(b) Result is pCi/g ±2 standard error of the mean.
(c) Number of samples with values less than the detection limit out of number of samples analyzed.
(d) NS = No sample.

## Nonradiological Results for Deer and Great Blue Heron Samples

Deer and great blue heron samples were also collected in 1996 for trace metal analyses. These analyses were conducted in support of efforts to evaluate metals concentrations in the Hanford environs and the potential risk these metals pose to site biota. Generally, analyses focused on liver tissue because this organ provides a better indicator of metals exposure than muscle or other tissues. Data on metal concentrations in site biota will assist in efforts to evaluate the relative risk from metal contaminants in the environment.

## Metals Analysis in Hanford Site Wildlife

Liver samples were collected from 12 nonfledged juvenile herons residing in the Hanford Reach as part of a graduate student study. Chromium, copper, mercury, selenium, and zinc were consistently measured in heron liver samples collected in 1996. Nickel was detected in two-thirds of the heron samples collected. These concentrations can be compared to concentrations in pigeon samples analyzed in 1995 (Table 4.5.6). Most concentrations were similar, except for cadmium and lead that were not detected in heron liver samples but were found in pigeon liver samples. These differences may be indicative of the different behavior, dietary sources, and physiology of the two birds. Herons are predatory birds feeding on aquatic life and pigeons feed on grain.

Deer liver samples collected at Hanford were compared with liver samples collected from near Boardman, Oregon. Boardman has a similar climate compared to Hanford, but it is also the site of a coal-fired power plant that could raise the levels of metals in the environment. With the exception of copper, metals that were detected in deer livers from animals collected onsite were generally higher than concentrations observed in Boardman deer in 1994 (Table 4.5.7).

**Table 4.5.6**. Comparison of Metal Concentrations in Liver Samples of Pigeons and Herons

| Tissue/Sampling Location | No. of Samples | Mean,[a] µg/g, dry weight | | | |
|---|---|---|---|---|---|
| | | Cadmium | Chromium | Copper | Lead |
| **Pigeon (1995 data)** | | | | | |
| 300 Area (January) | 5 | 0.68 ± 0.22 | 0.49 ± 0.07 | 8.45 ± 1.03 | 0.11 ± 0.02 |
| 300 Area (August) | 5 | 0.59 ± 0.74 | 0.81 ± 0.12 | 17 ± 4.62 | 0.69 ± 0.53 |
| Seattle | 8 | 4.3 ± 2.4 | 0.81 ± 0.22 | 17.6 ± 4.95 | 1.75 ± 1.19 |
| Walla Walla | 7 | 1.4 ± 0.38 | 0.72 ± 0.11 | 10.8 ± 1.33 | 0.17 ± 0.12 |
| **Heron (1996 data)** | 12 | ND[b] | 0.49 ± 0.044 | 59.2 ± 28.6 | ND |
| | | Zinc | Selenium | Nickel | Mercury |
| **Pigeon (1995 data)** | | | | | |
| 300 Area (January) | 5 | 59.5 ± 10.8 | NR[c] | ND | NR |
| 300 Area (August) | 5 | 175 ± 94.9 | NR | ND | NR |
| Seattle | 8 | 123 ± 60 | NR | ND | NR |
| Walla Walla | 7 | 78.1 ± 19.4 | NR | ND | NR |
| **Heron (1996 data)** | 12 | 236 ± 63.4 | 5.76 ± 0.698 | 0.49 ± 0.28 | 2.2 ± 0.7 |

(a) Result is ±2 standard error of the mean.
(b) Not detected.
(c) Not reported.

**Table 4.5.7**. Comparison of Metal Concentrations in Deer Liver Samples Collected from the Hanford Site in 1996 and Boardman, Oregon in 1994

| | Hanford Site, 1996 | | | Boardman, Oregon, 1994 | | |
|---|---|---|---|---|---|---|
| Metal | Maximum, µg/g | Mean,[a] µg/g | No. Less Than Detection | Maximum, µg/g | Mean,[a] µg/g | No. Less Than Detection |
| Cadmium | 1.75 | 0.787 ± 0.51 | 0 of 5 | 0.39 | 0.34 ± 0.087 | 0 of 4 |
| Chromium | 0.445 | 0.386 ± 0.049 | 0 of 5 | 0.11 | 0.08 ± 0.021 | 3 of 4 |
| Copper | 125 | 56.0 ± 36.4 | 0 of 5 | 161 | 144 ± 17.8 | 0 of 4 |
| Iron | 698 | 498 ± 171 | 0 of 5 | | | NA[b] |
| Mercury | 0.045 | 0.0103 ± 0.017 | 3 of 5 | 0.016 | 0.014 ± 0.0024 | 0 of 4 |
| Nickel | 0.99 | 0.44 ± 0.33 | 1 of 5 | <0.056[c] | | 4 of 4 |
| Zinc | 183 | 148 ± 20.5 | 0 of 5 | 155 | 133 ± 20.7 | 0 of 4 |
| Silver | <0.20[c] | | 5 of 5 | 0.182 | 0.143 ± 0.029 | 0 of 4 |

(a) Mean result is ±2 standard error of the mean.
(b) Not available.
(c) Detection limit.