5.5 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 contamination, and fish can be exposed to contamination in spring water 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 people receive. In addition, detection of radionuclides in fish and wildlife may indicate that wildlife are entering restricted contaminated areas (for example, burrowing in burial grounds) or that radioactive material is moving out of these restricted areas (for example, through blowing dust). Consequently, samples are collected at various locations annually, generally during the hunting or fishing season, for selected species (Figure 5.5.1).

Many of the operating facilities residing near nuclear facilities are buffered by natural areas, such as the ALE Reserve. These buffer zones isolate nonnomadic species on the Hanford Site (for example, rabbits) from contact with the public. Therefore, these species are not hunted. More detailed rationale for selection of specific species sampled in 1994 can be found in DOE (1991b).

When radionuclides are found in fish or wildlife, it is important to determine what fraction of those radionuclides originated at Hanford. Therefore, samples of fish and wildlife collected from distant locations unaffected by Hanford effluents (background locations) are analyzed, and results are compared to results from Hanford samples to identify any differences. Routine background sampling is conducted roughly every 5 years at locations believed to be unaffected by Hanford releases. Background data may also be collected during special studies or sampling efforts. In 1994, background concentrations were measured in carp from Vantage, pheasants from the Yakima Valley, and deer from offsite.

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 the potential to accumulate in fish or wildlife (Table 5.5.1). Cesium-137 and strontium-90 have been the most frequently measured radionuclides in fish and wildlife.

Strontium is chemically similar to calcium; consequently, it accumulates in hard tissues high in calcium such as bone, antlers, and egg shells. It has a long biological half-life in hard tissue and may profile the lifetime exposure of an organism to strontium-90. However, strontium-90 in wildlife samples 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 (Jaquish 1993).

Cesium is particularly important because it is chemically similar to potassium and accumulates in the muscle tissue of fish and wildlife. It is more likely, therefore, to contribute to the dose received by hunters and fishers from the consumption of game and fish. It has a relatively short biological half-life and 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 scan to detect a number of gamma emitters (see Appendix F). However, gamma scan results for most radionuclides are not discussed below because concentrations were too low to measure or because measured concentrations were considered artifacts of low background counts. Low background counts occur at random intervals during sample counting and can produce occasional spurious results.

Other specific radiochemical analyses were performed on fish and wildlife samples to measure plutonium-238, plutonium-239,240, technetium-99, uranium-234, uranium-235, and uranium-238. These radionuclides provide an indication of contaminant levels in edible portions of fish and wildlife and are useful when estimating doses to consumers. These radionuclides are important because:

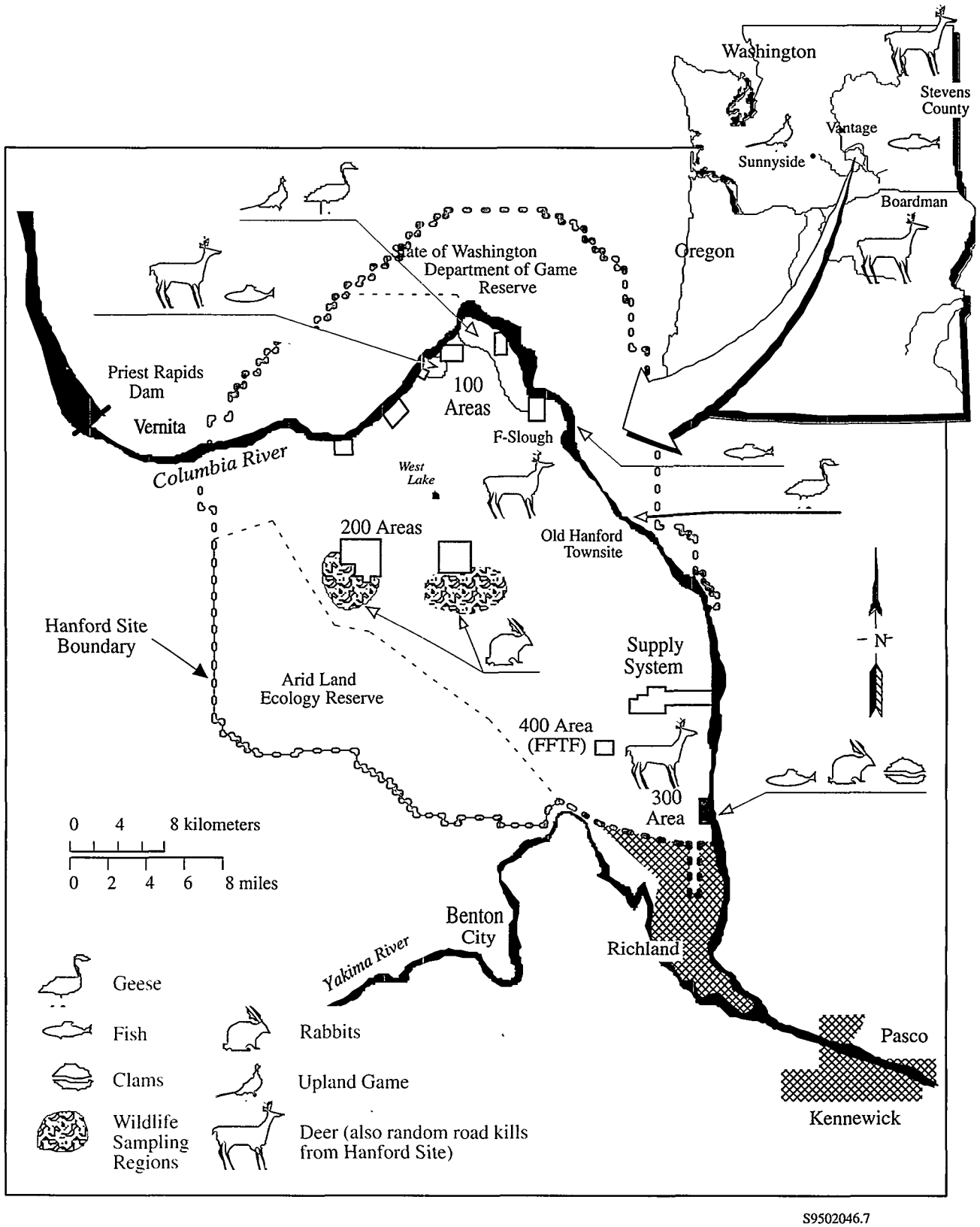

Figure 5.5.1 Fish and Wildlife Sampling Locations, 1994

Table 5.5.1 Locations, Species, and Radionuclides Sampled for Fish and Wildlife, 1994

Media	Number of Species	Onsite Locations	Radionuclides Sampled/Number of Locations				
			Gamma	^{90}Sr[a]	^{99}Tc	U	Pu[b]
Fish (Bass, Carp, Whitefish)	3	3	3	3	1	1	0
Geese	1	2	2	2	0	0	0
Upland gamebirds	2	3	3	3	0	0	0
Mule deer	1	5	5	2	0	0	3
Rabbits	2	3	3	3	0	0	3
Clams	1	1	1	1	0	1	0

(a) Analyzed in bone and some muscle samples.
(b) Analyzed in liver only.

- Technetium-99 is known to enter the Columbia River in shoreline seeps and springs and has a long half-life. In addition, its potential to accumulate in fish is not well-known.
- Isotopes of uranium enter the Columbia River in springs near the 300 Area and have been reported at slightly elevated concentrations in soil and vegetation near the 300 Area.
- Isotopes of plutonium accumulate in liver and may ultimately be deposited in bone. Liver tissue was analyzed in selected wildlife to monitor potential exposure to terrestrial contamination.

Fish Sampling

Bass, carp, and whitefish were collected from the Hanford Reach in the summer and winter of 1994. 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 are generally variable. A report on trends of radionuclide concentrations in fish was prepared in 1994 and provides detailed analysis of cesium-137 and strontium-90 in fish samples collected from 1982 through 1992 (Poston 1994). Results from all 1994 samples are listed by Bisping (1995).

Bass

Sample Collection and Analysis

Bass are sampled on alternating even years (Bisping 1994). Five bass were collected from the 100-F Slough in May 1994. The 100-F slough is located downstream of 100-N Springs and represents the largest backwater area suitable for the collection of adequate numbers of bass in the Hanford Reach. Bass were collected in May when they congregate in the sloughs to spawn, which is a behavioral characteristic that facilitates sample collection.

Muscle (fillet) samples and offal (referred to as carcass samples in past reports) samples were collected for analysis of gamma emitters and strontium-90.

Results

Cesium-137 was detected in all five fillet samples collected in 1994. The mean concentration was 0.04 ± 0.01 pCi/g (see Appendix A, Table A.11). When last sampled in 1992, the mean concentration was 0.02 ± 0.01 pCi/g. The 1994 concentrations of cesium-137 represent normal fluctuations close to the MDC of 0.02 pCi/g. Strontium-90 was not detected in any of the five fillet samples analyzed (MDC = 0.005 pCi/g).

The mean concentration of strontium-90 in bass offal was 0.019 ± 0.006 pCi/g (see Appendix A, Table A.11). These results were lower than the mean

concentration observed in bass offal samples collected from 1989-1993 (0.031 ± 0.007 pCi/g). There has been a general reduction in strontium-90 concentrations measured in bass offal since 1986 (Poston 1994); however, the changes in the last 5 years have been small because concentrations are very close to background levels (Figure 5.5.2).

Carp

Sample Collection and Analysis

Five carp were collected from the Columbia River between the 100-N and 100-D Areas because of the proximity of the N Springs and its release of strontium-90 to the river. Five carp were also collected near the 300 Area because of the potential releases of gamma emitting radionuclides, strontium-90, and uranium from ground-water springs along the river shoreline at the 300 Area and upstream. Additionally, carp were collected at Vantage in July 1994 to evaluate background concentrations. Muscle tissues and offal samples were analyzed.

Results

The only manmade radionuclides found in Columbia River carp were strontium-90 in offal and cesium-137 in muscle samples.

Muscle. Strontium-90 was not detected in carp muscle samples from Vantage, the 100 Areas, or the 300 Area (MDC = 0.005 pCi/g). Cesium-137 also was not routinely detected in muscle samples (see Appendix A, Table A.11); however, there were several instances of cesium-137 detected at the MDC of 0.02 pCi/g (Bisping 1995). Concentrations of both radionuclides in carp muscle are hovering at the MDC, and there is no indication of accumulation of cesium-137 above background levels in carp muscle.

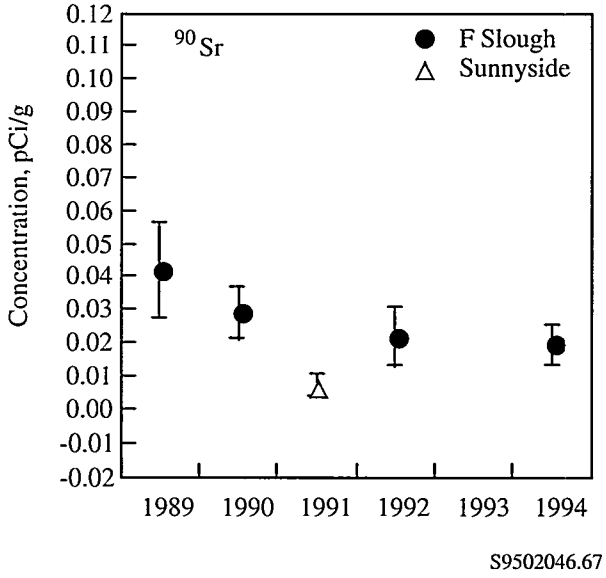

Figure 5.5.2 Strontium-90 (±2 standard error of the mean) in Bass Offal, 1989 Through 1994

Offal. Concentrations of strontium-90 in carp offal were higher in samples collected at Vantage than in samples collected at either the 100-N to 100-D Areas or the 300 Area (see Appendix A, Table A.11). The maximum observed concentration of strontium-90, 0.150 ± 0.035 pCi/g, was found in an offal sample collected from the 300 Area. Concentrations of strontium-90 in offal samples from Vantage generally exceeded concentrations reported in Hanford Reach carp offal samples collected in 1994; however, the range in concentrations at each sampling area is similar.

Whitefish

Sample Collection and Analysis

Whitefish were collected because historically they have been the Columbia River sport fish that accumulated the highest radionuclide concentrations. Whitefish are currently collected from the Columbia River along the 100-N to 100-D Area shoreline and along the 300 Area shoreline. Background samples were collected in 1991 from the Kettle River, which enters the Columbia River upstream from Grande Coulee Dam. Ten whitefish samples were collected between the 100-N and 100-D Areas in August 1994, and seven whitefish samples were collected from the 300 Area in September and December 1994.

Results

Muscle. Strontium-90 was measured in one of the ten muscle samples collected between the 100-N and 100-D Areas in 1994 [0.012 ± 0.005 pCi/g (Bisping 1995)], but was not measured in the nine muscle samples collected and analyzed from the 300 Area (MDC is 0.005 pCi/g).

Cesium-137 was measured in half of the muscle samples collected between the 100-N and 100-D Areas and in none of the samples from the 300 Area (see Appendix A, Table A.11). Concentrations over

the past 6 years have remained near the minimum detectable concentration (0.02 pCi/g).

No other manmade radionuclides were detected in 1994 whitefish muscle samples (Bisping 1995).

Offal. Mean and maximum concentrations of strontium-90 in whitefish offal were higher in 1994 than for the previous 5 years. Strontium-90 was found in all offal samples analyzed (see Appendix A, Table A.11). Mean concentrations of strontium-90 in whitefish offal sampled from the Kettle River in 1991 were approximately three times those reported in 300 Area whitefish offal samples and equivalent to those found in 100 Areas whitefish offal samples in 1994. The higher background concentrations may indicate exposure to elevated levels of fallout radioactivity in that area. The Kettle River drainage generally receives more precipitation, hence potentially more fallout, than does the Hanford Site.

Clam Sampling

Asiatic clams were collected along the Columbia River shoreline downstream of the 300 Area in the summer of 1994. The soft tissues were analyzed for gamma emitters, strontium-90, uranium-234,-235, and -238. The shells were analyzed for strontium-90 only.

Results

Concentrations of radionuclides in Asiatic clams were similar to results reported in the past (Table 5.5.2 and Woodruff et al. 1992). Concentrations of cesium-137 and strontium-90 in soft tissues collect in 1990 from the 300 Area were also very close to the limits of detection (0.005 and 0.02 pCi/g, respectively). The concentration of strontium-90 in clam shell is consistent with levels reported in other hard tissues from Site wildlife (fish offal, wildlife bone, and antler samples).

Wildlife Sampling

Wildlife sampled in 1994 for radioactive constituents included deer, jackrabbits, geese, pheasants, and pigeons. A report on radioactivity in wildlife was prepared in 1994 (Poston and Cooper 1994) and provides additional details on recent concentration trends in wildlife from 1983 through 1992. Results from all 1994 samples are listed by Bisping (1995).

Deer

Sample Collection and Analysis

Samples were taken from Hanford Site mule deer that were selectively hunted (three deer near the 100-N Area) or killed in road accidents. Samples included muscle, bone, antler, and liver, which were analyzed for radionuclides. While deer hunting is not allowed onsite, deer can leave the Site, and a small number of deer potentially from Hanford are harvested annually from Columbia River islands and across the river in Grant and Franklin counties. Road kill sampling was employed to minimize impacts to the Hanford deer population. Radionuclide concentrations in animals collected on the Site were compared to concentrations in deer collected distant from the Site from 1992 through 1994 at Boardman, Oregon and in Stevens County, Washington. The Stevens County deer

Table 5.5.2 Radionuclide Concentrations in Asiatic Clams Collected from the Columbia River Downstream of the 300 Area

Radionuclide	Tissue	Concentration[(a)] 1994	Concentration[(a)] 1991
^{90}Sr	Shell	0.28 ± 0.056	
^{90}Sr	Soft Tissues	0.003 ± 0.004	0.003 ± 0.002
^{137}Cs	Soft Tissues	-0.02 ± 0.03	-0.003 ± 0.008
^{234}U	Soft Tissues	0.052 ± 0.011	0.050 ± 0.006
^{235}U	Soft Tissues	0.002 ± 0.002	0.001 ± 0.001
^{238}U	Soft Tissues	0.042 ± 0.010	0.045 ± 0.006

(a) pCi/g ± 2 total propagated analytical uncertainty.

samples were donated to the program. These comparisons are useful in evaluating Hanford's impact to deer; however, because the distant sampling area at Stevens County gets more rainfall than Hanford, background concentrations of cesium-137 and strontium-90 are usually higher in those deer than in onsite deer (Poston and Cooper 1994). This relationship was not noted in deer at the background location in Boardman, Oregon because the climate is similar to Hanford.

Results

Muscle. Two of seven deer sampled at Hanford had positive measurements of cesium-137 in muscle (see Appendix A, Table A.12). Both were collected near the 100-N Area. The maximum concentration of cesium-137 was 0.007 ± 0.003 pCi/g. This maximum concentration was less than background concentrations of cesium-137 measured in donated deer samples collected in 1992 and 1994 from Stevens County and in 1994 deer samples from Boardman, Oregon.

Bone. Strontium-90 was detected in all deer bone samples analyzed in 1994, and the maximum concentration on the site was 0.93 ± 0.24 pCi/g (see Appendix A, Table A.12). Boardman deer bone samples had a mean concentration of 0.11 ± 0.015 pCi/g strontium-90 which was lower than the Stevens County results. These higher levels in onsite deer bone may indicate some route of low-level exposure onsite (Table A.12). During the last 5 years, concentrations of strontium-90 have been elevated in deer bone collected near the 100-N Area relative to the rest of the Site. The likely source of these elevated concentrations is the 100-N Area where strontium-90 is known to enter the river.

Antler. Strontium-90 concentrations in mule deer antlers collected from the Hanford Site from 1991 through 1994 were compared to strontium-90 concentrations in antlers collected at Silver Lake, Oregon. The Silver Lake area was selected because it is semiarid and has been used in prior studies on background levels of radionuclides in deer. Initial results for antlers collected at Hanford indicated that deer inhabiting the 100 Areas had a higher range of strontium-90 in antlers (0.31 to 0.68 pCi/g) than deer near the Old Hanford townsite and south to the 300 Area (0.10 to 0.26 pCi/g). In comparison, concentrations of strontium-90 in Silver Lake deer antlers were a factor of 10 higher than Hanford Site deer (1.2 ± 0.24 to 4.5 ± 0.83 pCi/g). The reason for the elevated concentrations is that the Silver Lake deer spend the summer months in the surrounding mountains when their antlers are growing. These mountains have historically received more fallout strontium-90 than the semiarid Silver Lake area and the Hanford Site. Soil measurements of strontium-90 from the Silver Lake area ranged from 0.14 ± 0.030 to 0.23 ± 0.045 pCi/g in the valley and 0.54 ± 0.10 to 0.69 ± 0.13 pCi/g in the mountains. The mean (± 2 standard error of the mean) strontium-90 concentration in soils collected from the Hanford Site deer sampling areas was 0.31 ± 0.11 pCi/g for the period 1983 through 1993. Collectively, these results suggest that concentrations of strontium-90 in antler reflect general environmental exposure as indicated by soil concentrations.

Liver. Isotopes of plutonium were not detected in any deer liver samples collected in 1994. Liver data for 1994 are summarized by Bisping (1995).

Rabbits

Sample Collection and Analysis

Rabbits have small home ranges. They cannot be hunted for human consumption on the Hanford Site, and they cannot cross the Columbia River to areas where they could be hunted. However, rabbits are good indicators of potential exposure to contamination because they occupy burrows and can enter fenced restricted areas. Rabbit populations are cyclic and attempts to collect rabbits onsite in 1994 were only marginally successful (16 planned, 6 collected). Muscle, bone, and liver samples were taken from four jackrabbits collected from the 200-E Area, a jackrabbit collected from the 200-West area, and a cottontail collected at the 300 Area. Background samples of jackrabbits and cottontails were last collected at Boardman, Oregon in 1990.

Results

Muscle. Muscle concentrations of cesium-137 were similar to the range measured in the past 5 years (Table 5.5.3). Most values were less than detection limits or measured right at the limit of detection. The maximum observed concentrations of cesium-137 in muscle indicate that some animals may be entering low-level radiation control areas onsite.

Table 5.5.3 Summary of Cesium-137 in Rabbit Muscle (pCi/g wet weight), 1994 Compared to Values from the Previous 5 Years

Location/ Species	1994			1989-1993		
	Maximum[a]	Mean[b]	No. Less Than Detection[c]	Maximum[a]	Mean[b]	No. Less Than Detection[c]
200-East Area jackrabbit	0.04 ± 0.03	0.01 ± 0.04	3 of 4	0.25 ± 0.05	0.03 ± 0.03	11 of 15
200-West Area jackrabbit	-0.02 ± 0.03	---	1 of 1	0.15 ± 0.03	0.02 ± 0.03	7 of 12
300 Area cottontail	0.00 ± 0.04	---	1 of 1	---	---	---
Boardman[d]	---	---	---	0.03 ± 0.027	0.005 ± 0.005	19 of 20

(a) Maximum is the concentration in pCi/g ±2 total propagated analytical uncertainty.
(b) Mean 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) Collected in 1990, combined jackrabbit and cottontail data (no difference).

Bone. Strontium-90 was found in all four 200-E rabbit bone samples at levels about a factor of ten higher than the 200-W Area sample (Table 5.5.4). The maximum concentration of 14.2 ± 3.2 pCi/g indicates onsite exposure to low levels of strontium-90 around or in the 200-E Area.

Liver. No isotopes of plutonium were found above detection limits in liver samples from any rabbits collected in 1994 (<0.0004 pCi/g plutonium-238 or plutonium-239,240 (Bisping 1995).

Waterfowl

Sample Collection and Analysis

Resident duck sampling was terminated in 1994 because the draining and decommissioning of B-Pond and low water levels in West Lake eliminated

Table 5.5.4 Summary of Strontium-90 in Rabbit Bone (pCi/g wet weight), 1994 Compared to Values from the Previous 5 Years

Location/ Species	1994			1989-1993		
	Maximum[a]	Mean[b]	No. Less Than Detection[c]	Maximum[a]	Mean[b]	No. Less Than Detection[c]
200-East Area jackrabbit	14.2 ± 3.2	7.4 ± 5.4	0 of 4	49 ± 8.9	9.5 ± 7.0	0 of 15
200-West Area jackrabbit	0.43 ± 0.10	---	0 of 1	140 ± 4	14 ± 24	0 of 12
300 Area cottontail	0.12 ± 0.05	---	0 of 1	---	---	---
Boardman[d]						
jackrabbit	---	---	---	0.91 ± 0.09	0.47 ± 0.09	0 of 10
cottontail	---	---	---	0.36 ± 0.08	0.27 ± 0.03	0 of 10

(a) Maximum is the concentration in pCi/g ±2 total propagated analytical uncertainty.
(b) Mean 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) Collected in 1990.

most viable duck habitat on the Site. Duck sampling was replaced with Canada goose sampling, and two geese were collected along the Columbia River in 1994: a western Canada goose from the Old Hanford townsite, and a lesser Canada goose from the area between the 100-N and 100-D Areas. The lessor Canada goose was a migrating bird; the western Canada goose may have been either a resident or a migrant. Muscle tissue was analyzed for gamma emitters and strontium-90, and bone was analyzed for strontium-90. Goose eggshell collections were scheduled in 1994; however, coyotes have gained access to Hanford Reach islands, and there was no successful nesting on the islands in 1994.

Results

The concentration of cesium-137 in the Hanford Townsite goose muscle was 0.03 ± 0.02 pCi/g (Table 5.5.5). Strontium-90 was not detected in muscle from either fowl; however, the concentration in bone from the Old Hanford townsite goose was lower than that found in the migrating goose collected from the area between the 100-N and 100-D Areas.

Pheasants

Sample Collection and Analysis

During the fall of 1994, 12 Chinese ringneck pheasants were collected on the Hanford Site. Additionally, ten pheasants were collected in Yakima County, which is located generally upwind of the Hanford Site. This game bird has the potential to migrate across the Columbia River or move onto river islands where it may be hunted. Conversely, hunting pressure in Franklin County may force pheasants onto the Hanford Site. Samples of muscle were analyzed for gamma emitters, and bone samples were analyzed for strontium-90.

Results

Muscle. Cesium-137 was not measured in Yakima Valley pheasant muscle collected in 1994 (Bisping 1995). The maximum value of 0.16 ± 0.14 pCi/g in the Yakima County sample is believed to be an anomalous result. Two of the 12 birds collected from the 100 Areas had detectable concentrations of cesium-137 greater than the MDC of 0.02 pCi/g (Table 5.5.6).

Bone. Strontium-90 was found in Hanford Site pheasant bones at roughly twice the level in background pheasants collected in Yakima County in 1994; however, the 1994 results are within the concentration range seen in background pheasant collected in 1990 (Figure 5.5.3)

Pigeons

Sample Collection and Analysis

Whole body pigeon samples were collected and scanned with a portable gamma spectrometer. This was a qualitative screening analysis to evaluate the possible concentrations of gamma emitters in pigeons. Pigeons collected at the Old Hanford townsite, 100-K Area, and 300 Area were screened. Accumulations of cesium-137 in birds would be expected in stomach contents, grit in the crop, and muscle. If unexpectedly high concentrations had been obtained, the birds would have been submitted for more precise radiochemical analysis.

Table 5.5.5 Concentrations of Radionuclides (±2 total propagated analytical uncertainty) in Canada Geese Sampled in 1994

Radionuclide	Concentration (pCi/g wet weight)	Variety	Tissue	Site Collected
^{137}Cs	0.003 ± 0.020	Lesser	Muscle	100-N to 100-D
^{137}Cs	0.031 ± 0.020	Western	Muscle	old Hanford Townsite
^{90}Sr	0.192 ± 0.059	Lesser	Bones	100-N to 100-D
^{90}Sr	0.049 ± 0.031	Western	Bones	old Hanford Townsite
^{90}Sr	-0.001 ± 0.002	Lesser	Muscle	100-N to 100-D
^{90}Sr	0.000 ± 0.003	Western	Muscle	old Hanford Townsite

Table 5.5.6 Summary of Cesium-137 in Upland Gamebird Muscle (pCi/g wet weight), 1994 Compared to Values from the Previous 5 Years

	1994			1989-1993		
Location	Maximum[a]	Mean[b]	No. Less Than Detection [c]	Maximum[a]	Mean[b]	No. Less Than Detection[c]
Pheasants						
100-D to 100-H Areas	0.17 ± 0.03	0.05 ± 0.08	3 of 4	0.04 ± 0.02 [d]	0.01 ± 0.01[d]	21 of 25[d]
100-H to 100-F Areas	0.02 ± 0.01	0.01 ± 0.01	5 of 6			
100-N	-0.01 ± 0.01	-0.02 ± 0.01	2 of 2	2.00 ± 0.20	---	1 of 1
Yakima County	0.16 ± 0.14	0.02 ± 0.03	10 of 10	0.007 ± 0.013	0.001 ± 0.007	10 of 10[e]

(a) Maximum is the concentration in pCi/g ±2 total propagated analytical uncertainty.
(b) Mean is pCi/g ±2 standard error of the mean of all samples analyzed including less-than-detection values.
(c) Number of samples with values less than the detection limit out of number of samples analyzed.
(d) 100-D to 100-F Areas combined.
(e) Collected in 1990.

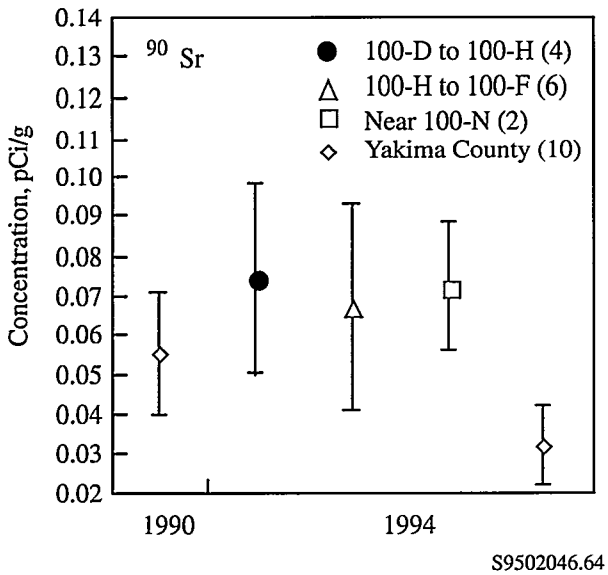

Figure 5.5.3 Strontium-90 (±2 standard error of the mean) in Pheasant Bone Sampled in 1994. The number of samples analyzed is in parentheses.

Results

Screening results are reported as pCi/bird and bird weights are generally about 150 g. The screening analysis found only a slight indication of activity in two of nine birds screened, one from the 100 Areas (5.9 pCi/bird) and one from the old Hanford townsite (2.5 pCi/bird). These concentrations indicate background concentrations and no additional analyses were conducted. Pigeon screening data for 1994 are summarized by Bisping (1995).