2018 Highlight

Routine Vegetation Sampling
A total of 45 vegetation samples were collected on the Hanford Site in 2018. Generally, the concentrations of radionuclides in these samples were consistent with those seen in previous years.

Food and Farm Products
In calendar year 2018, analytical concentrations of potential Hanford-Site produced contaminants and natural occurring radioactive elements were similar to results seen in the previous 5 to 10 years.

Wildlife Surveillance
Mission Support Alliance collects and analyzes wildlife samples that sportsmen or the general public may collect as foodstuff. In 2018, smallmouth bass, common carp, upland game birds, mule deer, and elk were collected and submitted to laboratories for radiological and metals analyses. A total of 50 animals were collected in 2018.

10.0 Biota Monitoring

JR Draper

The U.S. Department of Energy's (DOE) subcontractor Mission Support Alliance (MSA) monitors the biota, including state and federally listed species, to assess the abundance, vigor or condition, and distribution on the Hanford Site. The associated data is used by DOE and Hanford Site contractors to support environmental cleanup and restoration activities, mitigation actions, land use planning, and to maintain compliance with ecological resource laws. MSA's Ecological Compliance staff conducts ecological compliance reviews for most projects on the Hanford Site to determine if the proposed scope of work will adversely impact biological resources and to provide recommendations to reduce environmental impacts.

10.1 Agricultural Monitoring

ME Hoefer

Food and farm products (i.e., corn, leafy vegetables, melons, milk, potatoes, tomatoes, and wine must) were collected in calendar year (CY) 2018 at locations near the Hanford Site (Figure 10-1; note not all agricultural monitoring locations shown are sampled each year due to program efficiencies, budgetary restrictions, and historical trending purposes). These products are used to determine pathway-specific exposure assumptions by way of annual dose calculations based on a 1 mrem/yr (10 microsievert [µSv]/yr) threshold and ingestion pathways for annual intake, assuming 100% of each food originated in the affected area.

Water removed from the river immediately downstream of the Hanford Site is used to irrigate a small portion of agricultural crops in Benton and Franklin counties. The majority of irrigation water utilized by Franklin County residents originates at Grand Coulee Dam and is provided through its extensive water

delivery systems (i.e., canals). Likewise, Benton County relies heavily on the Yakima River for irrigation purposes.

Samples analyzed to determine radiological contaminant concentrations were obtained from the following locations:

- Generally downwind (east and southeast) of the Hanford Site where airborne emissions or contaminated dust from the site potentially would be deposited
- Generally upwind of and distant from the Hanford Site to provide information about reference (background) contaminant levels
- From farms irrigated with water taken from the Columbia River downstream of the Hanford Site.

Sample analyses were used to assess the amounts of Hanford Site-origin contaminants in food and farm products by comparing the following:

- Analytical results obtained from similar samples collected from the same regions over long periods of time
- Samples collected at downwind locations to results from samples obtained from generally upwind or distant locations
- Samples collected in areas irrigated with water withdrawn from the Columbia River downstream of the Hanford Site to analytical results from samples obtained from locations irrigated with water from other regional sources.

Radionuclide concentrations in most food and farm product samples in CY 2018 were below the analytical laboratory detection levels; however, some potential Hanford Site-produced contaminants (e.g., carbon-14 and tritium) were found at low levels in some milk samples, leafy vegetable samples (strontium-90), and wine must (tritium). Data for potassium-40 and beryllium-7 were included to show the natural radioactive elements that exist in food products relative to concentrations of potential Hanford Site-produced contaminants. Radiological doses associated with potential Hanford Site-produced contaminants are discussed in Section 4.0. Where possible, the measured concentrations were compared to the applicable unusual concentration reporting levels. Unusual concentration reporting levels have been established based on environmental concentrations that would result in a dose of 1 mrem/yr (10 µSv/yr) (DOE/RL-91-50). Agricultural products sampled in CY 2018 are listed in Table 10-1 and are described in the following sections.

10.1.1 Milk

Milk samples were obtained quarterly in CY 2018 from several dairies in the East Wahluke and Sagemoor sampling areas. Milk was not obtained from a dairy in the Sunnyside area in 2018 due to closure of the dairy in late 2017. Surveillance personnel were attempting to locate a new Sunnyside-area dairy to sample at the time of this document.

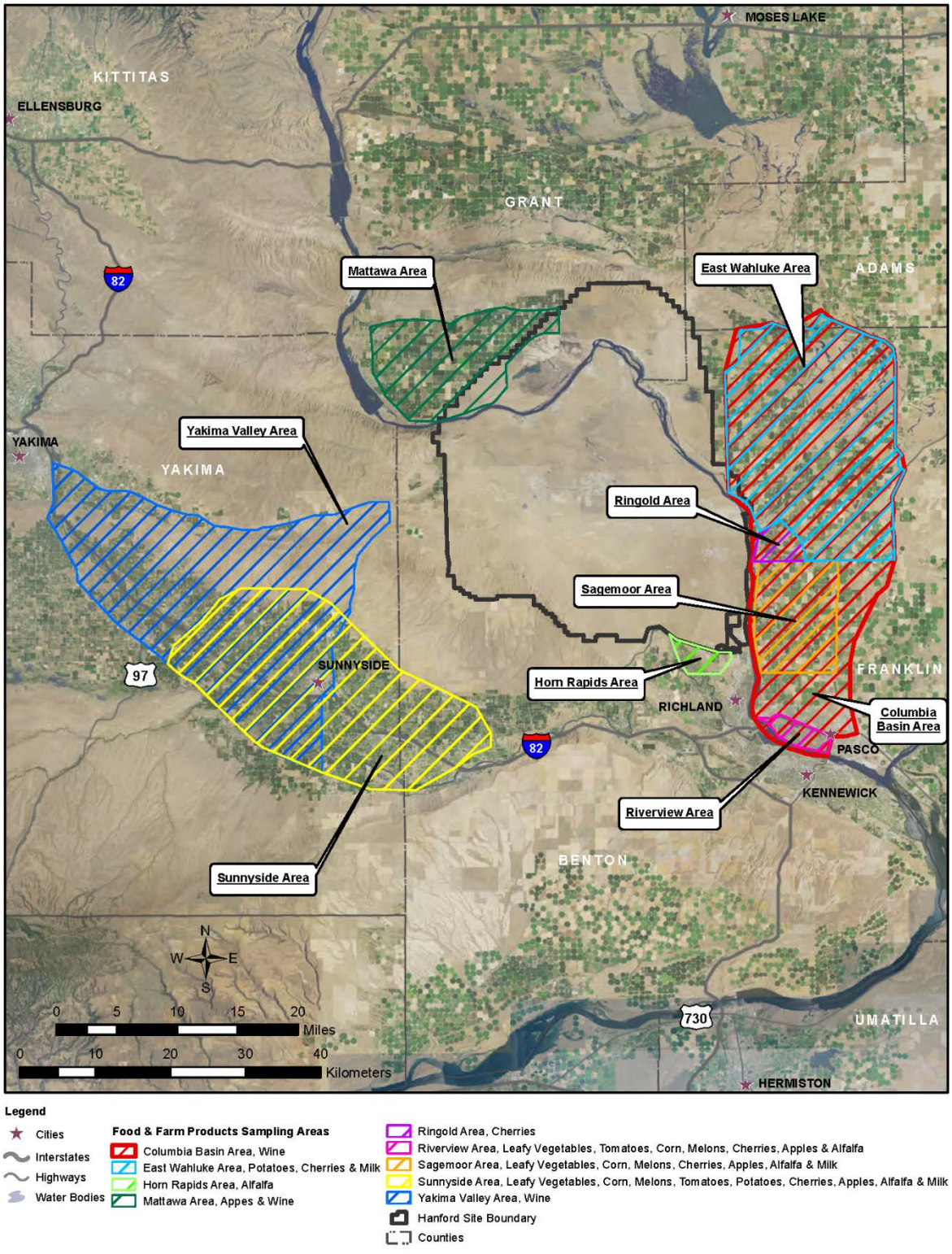


Figure 10-1. Agricultural Monitoring Locations.
NOTE: Duplicate information may or may not be included in this data.

Table 10-1. Agricultural Monitoring Location.

Product	Sampling Locations	Analytes
Corn	East Wahluke, Riverview, Sagemoor, and Sunnyside	^{14}C, Gamma, Sr-90
Leafy vegetables	East Wahluke, Riverview, Sagemoor, and Sunnyside	^{14}C, Gamma, Sr-90
Melons	East Wahluke, Riverview, Sagemoor, and Sunnyside	^{14}C, Gamma, Sr-90
Milk	East Wahluke and Sagemoor	^{14}C, Gamma, ^{129}I, Sr-90, Tritium (Low level)
Potatoes	East Wahluke, Riverview, Sagemoor, and Sunnyside	^{14}C, Gamma, Sr-90
Tomatoes	Riverview and Sunnyside	^{14}C, Gamma, Sr-90, Tritium
Wine must	Columbia Basin, Mattawa, and Yakima Valley	^{14}C, Gamma, ^{129}I, Tritium (Low level)

The Sagemoor and East Wahluke sampling areas are located near the Hanford Site perimeter and could potentially be affected by airborne contaminants from the site. The Sunnyside area is a reference location generally upwind of the Hanford Site. If milk was obtained from more than one dairy within a sampling area, the milk samples were combined and the composite sample was analyzed. All samples were analyzed for carbon-14, gamma-emitting radionuclides, strontium-90, and tritium. Milk sampling was conducted because Hanford Site-produced radionuclides have the potential to move through the air-pasture-cow-milk or water-pasture-cow-milk food chains to humans. In recent years, levels of Hanford Site-produced radiological contaminants in milk samples have diminished in conjunction with facility shutdowns and remedial efforts. Concentrations in samples obtained from dairies downwind of the Hanford Site were similar to levels measured in samples obtained from the dairy generally upwind of the Hanford Site.

10.1.1.1 Tritium. Tritium was detected in all but one milk sample collected in CY 2018. Overall concentrations of the eight detections ranged from a maximum of 33 pCi/L (1.2 Bq/L) in a Sagemoor area sample to a minimum of 10 pCi/L (0.37 Bq/L) in an East Wahluke area sample. Annual average concentrations for the two sampling areas were 20 pCi/L (0.74 Bq/L). Specific location average was 24 pCi/L (0.89 Bq/L) for Sagemoor (n = 4) and 16 pCi/L (0.59 Bq/L) for East Wahluke (n = 4. Overall averages were similar to historical concentrations in all areas.

10.1.1.2 Strontium-90. No detectable concentrations were found in CY 2018 milk samples.

10.1.1.3 Cesium-137. No synthetic gamma emitters were detected in milk samples collected and analyzed in 2018.

10.1.1.4 Potassium-40. Naturally occurring potassium-40 was detected in all milk samples collected in CY 2018. Concentrations ranged from a maximum of 1,580 pCi/L (58 Bq/L) in a Sagemoor area sample to a minimum of 1,440 pCi/L (53 Bq/L) in an East Wahluke sample.

10.1.2 Fruit, Vegetables, and Farm Products.

Apples, corn, leafy vegetable (e.g., lettuce), melon, potato, tomato, and wine must samples were collected from upwind and downwind sampling areas during the CY 2018 growing season (Figure 10-1; Table 10-1). All fruit and vegetable samples were analyzed for gamma-emitting radionuclides and strontium-90. All products were analyzed for carbon-14 to support Waste Treatment Plant monitoring

baseline data. Wine must was analyzed for gamma-emitting radionuclides and low-level tritium. Tomato samples were also monitored for strontium-90 and tritium (Table 10-1) but showed no detectable concentrations during 2018.

Three individual leafy vegetable samples (East Wahluke, Sagemoor, and Sunnyside) had detectable concentrations of beryllium-7; however, these concentrations were within historical range and follow typical result patterns. Three additional samples of leafy vegetables (East Wahluke [2] and Sunnyside [1]) had detections of strontium-90, but values reported were well below DOE project dose-based reporting limits and were within historical limits measured at these locations. No leafy vegetable samples were available for collection in the Sagemoor area. All remaining fruit and vegetable contaminant concentrations were reported as non-detects and were well within historical range.

All wine must samples collected in CY 2018 had detectable concentrations of tritium, were slightly higher than concentrations seen in CY 2017, but were within the historical range. Mattawa area wine had an average of 29.8 pCi/L (1.1 Bq/L) while the Columbia River Priest Rapids Dam fixed-station water average was 14.5 pCi/L (0.54 Bq/L). The Columbia Basin area winery had an annual tritium average of 71.9 pCi/L (2.7 Bq/L) while the Columbia River Richland Pumphouse fixed-station water had an annual average of 24.4 pCi/L (0.90 Bq/L). Irrigation results in the Riverview (14.3 pCi/L; 0.53 Bq/L) and Horn Rapids (16.0 pCi/L; 0.59 Bq/L) areas were similar to the Sagemoor (15.3 pCi/L; 0.57 Bq/L) area. These results were less than concentrations reported in wine and the fixed-station location in Richland, Washington. All wine must values for 2018 were well below the Washington State drinking water standard of 20,000 pCi/L (740 Bq/L).

All apple, corn, leafy vegetable, melon, potato, tomato, and wine must samples (red and white) had detectable concentration levels of naturally occurring potassium-40.

10.2 Fish and Wildlife Monitoring

JW Wilde

The fish and wildlife species sampled and analyzed for Hanford Site operations-produced contaminants during CY 2018 included smallmouth bass (*Micropterus dolomieu*), common carp (*Cyprinus carpio*), mule deer (*Odocoileus hemionus*), RockyRocky Mountain elk (*Cervus elaphus*), and upland game birds including California Quail quail (*Callipepla californica*) and Ring-necked Pheasant (*Phasianus colchicus* Monitoring fish and wildlife for uptake and exposure to Hanford Site operations-produced contaminants ensures that consumption of fish and wildlife obtained from Hanford Site environs provides long tern contamination trends to identify any threats to human health. These species and the sample locations were selected and monitored because they provide a potential pathway for offsite human consumption. Figure 10-2 shows the locations on and around the Hanford Site where fish and wildlife were collected in 2018. Samples of fish and wildlife were analyzed for selected (suspected or known to be present at the Hanford Site) radionuclides and metals (Table 10-2). In addition, samples were collected from locations distant from the Hanford Site to obtain reference (background) contaminant measurements. All fish and wildlife samples were monitored for strontium-90 contamination and analyzed by gamma spectrometry to detect a number of gamma emitters, including cesium-137. Since the 1990s, strontium-90 and cesium-137 have been the most frequently measured radionuclides in fish and wildlife samples.

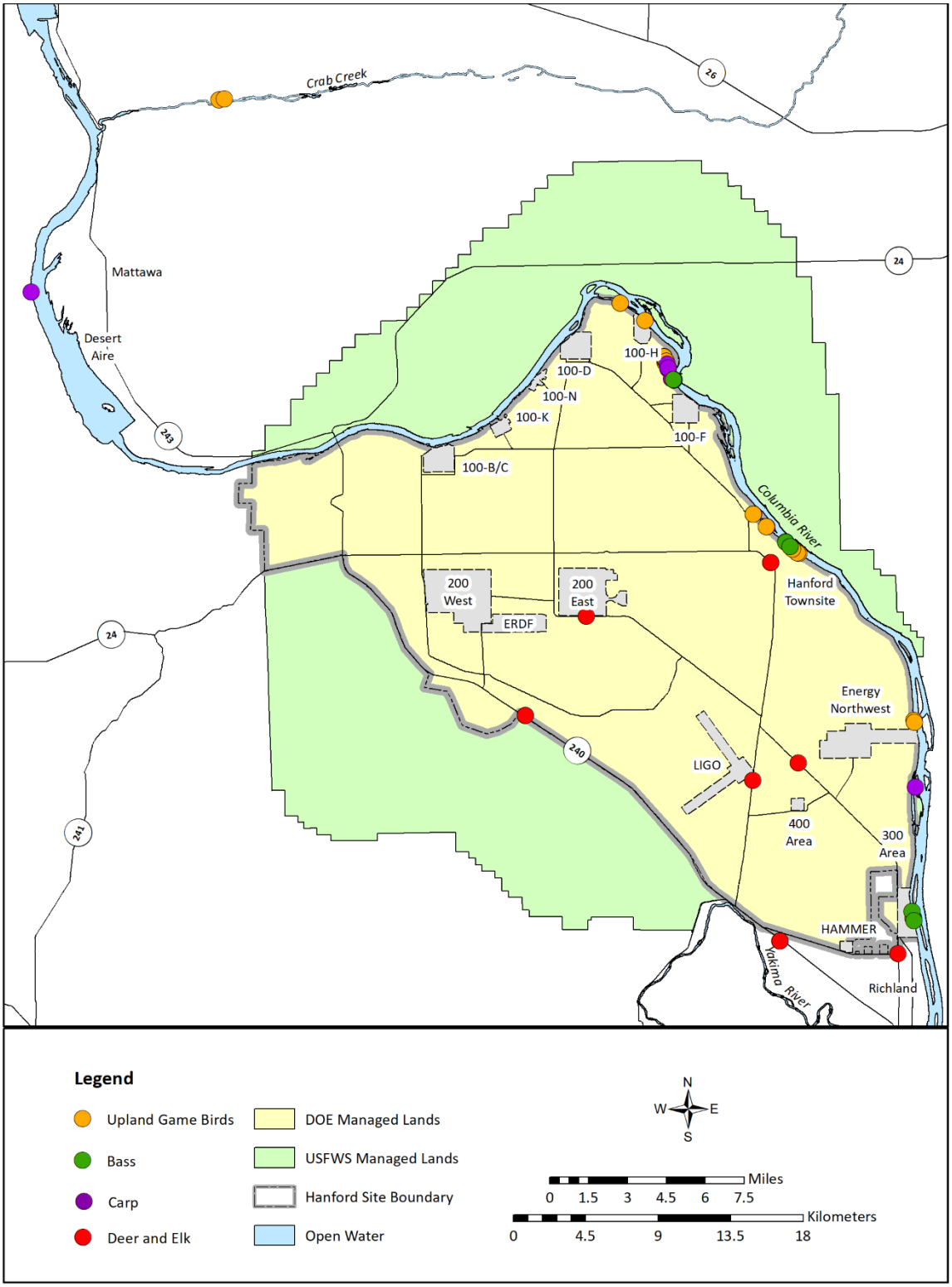


Figure 10-2. Locations of Wildlife Collections During Calendar Year 2018.

Table 10-2. Number of Wildlife Monitoring Samples Submitted for Analysis.

Biota	Offsite Sample Locations	Onsite Sample Locations	Gamma Samples	Strontium-90 Samples	Trace Metals Samples
Fish (smallmouth bass)	0	2	8	8	2
Fish (common carp)	1	2	9	12	9
Mammals (deer/elk)	0	9	16	12	7
Game birds (quail, pheasant)	1	2	8	8	0

Most fish and wildlife samples are collected on and around the Hanford Site and analyzed for human-pathway exposure every 2 to 3 years, with samples obtained at locations determined not to be affected by Hanford Site effluents and emissions at least every 3-5 years.

Strontium-90 is present in Hanford Site environments because of past Hanford Site operations, waste disposal practices and global nuclear fallout. Contaminated groundwater entering the Columbia River through shoreline springs in the 100-N and 100-H Areas is the primary source of measurable Hanford Site-produced strontium-90 in the Columbia River. Chemically similar to calcium, strontium-90 consequently accumulates in hard tissues rich in calcium such as bones, antlers, and eggshells. In addition, strontium-90 has a biological half-life in hard tissue from 14 to 600 days (PNL-9394).

Hard-tissue concentrations may profile an organism's lifetime exposure to strontium-90; however, because strontium-90 does not accumulate in edible portions of fish and wildlife, it generally does not contribute much to the human dose (NCRP 2009) from wildlife consumption.

Cesium-137 is present in Hanford Site environments because of past Hanford Site operations, waste disposal practices, and historical worldwide fallout resulting from nuclear weapons testing. Cesium-137 is particularly important to the human food chain because the isotope is chemically similar to potassium and is found in the muscle tissues of fish and wildlife. Cesium-137 is an indicator of recent exposure to radioactive materials because it has a relatively short biological half-life (less than 200 days in muscle and less than 20 days in the gastrointestinal tract [PNL-9394]).

Gamma spectrometry results for most radionuclides generally are too low to measure or the concentrations measured are 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 were below analytical laboratory detection levels.

A number of trace metals associated with Hanford Site operations have a potential to accumulate in certain fish and wildlife tissues. These metals are contaminants of potential concern (e.g., copper, lead, and mercury), particularly along the Hanford Site Columbia River shoreline where contaminated groundwater flows into the river. Hanford Site historical operations have resulted in the production of both radiological and non-radiological wastes, including trace-metal emissions in a variety of forms. Liquid and solid wastes that were placed in disposal sites (e.g., trenches, cribs, ditches, ponds, and underground storage tanks), and fly ash (produced from burning coal in coal-fired steam/power plants associated with some Hanford Site operations) were released to the atmosphere. The fly ash contains trace metals and natural radionuclides that may have deposited on soil surfaces around the 100 Area reactors.

10.2.1 Smallmouth Bass

In 2018, smallmouth bass were sampled and analyzed for radiological contaminants, since bass are sometimes harvested for food along the Hanford Reach of the Columbia River, which could potentially contribute to human exposure through digestion. Smallmouth and largemouth bass are one of the most popular sportfish in the area.

Fourteen smallmouth bass were collected from two locations along the Hanford Reach (seven along the 100 Areas shoreline and seven from the shoreline from the Hanford town site down through the 300 Area). A total of 14 samples were comprised of the 14 collected fish. The following are the radiological and trace-metal results for the 14 smallmouth bass samples analyzed. Naturally-based isotopes, such as potassium-40, are not discussed here.

Cesium-137. Manmade gamma-emitting radionuclides including cesium-137 were not detected above the reporting limit (0.03 pCi/g [0.001 Bq/g] wet weight) in any of the muscle samples analyzed. These results are consistent with those reported historically near the Hanford Site.

Strontium-90. Strontium-90 was not detected above the reporting limit (0.05 pCi/g [0.0019 Bq/g] wet weight) in any of the smallmouth bass samples analyzed. These results are consistent with those generally reported historically in the Columbia River near the Hanford Site.

Uranium. Uranium isotope uranium-235 was detected in two filet samples submitted. One sample was from near the 100 Areas and the other in the stretch of Columbia River between the Hanford Townsite and the 300 Area. Uranium-235 was reported at 9.9E-03 pCi/g in the 100 Area sample and 1.04E-02 pCi/g in the Townsite to 300 Area sample. Dose calculations for fish ingestion trigger reporting limits at 9.4E-02, a quantity 9 times greater than the maximum detected in any 2018 Hanford Site sample.

Trace Metals. Two smallmouth bass samples were analyzed for 18 different trace-metal concentrations. Only 6 of the 18 trace metals were detected in samples that were above the analytical detection limit at any location (Table 10-3). Surveillance data sets for trace-metal concentrations in fish both on and near the Hanford Site were relatively small with variable results. No established federal or state adverse-effects values (i.e., benchmark criteria) were available for trace-metal concentrations in fish tissue. Identifying Hanford Site contributions to trace-metal concentrations or drawing conclusions about contribution effects were limited by the factors above. Monitoring fish for uptake and exposure to radionuclides and metals at locations both near to and distant from the Hanford Site will continue to provide important information for tracking the extent and long-term trends of contamination in the Hanford Reach environment. The Washington State Department of Health (WDOH) provides lists of species retaining high concentrations of chemical contaminants and metals, and consumption guides for various water bodies throughout Washington State (https://www.doh.wa.gov/CommunityandEnvironment/Food/Fish/Advisories).

Table 10-3. Maximum Metal Concentrations (µg/kg) Detected in Wildlife Tissues Collected in 2018.

Species and Sample	Location	Metal	Maximum Concentration
Smallmouth Bass Filet	100 Areas	Ba	ND[a]
		Cu	299
		Mn	ND[a]
		Hg	125
		Se	1020
		Zn	6300
	Hanford Townsite to 300 Area	Ba	252
		Cu	763
		Mn	354
		Hg	155
		Se	1,160
		Zn	7,700
Common Carp Filet	100 Areas	Sb	ND[a]
		Cu	1,660
		Mn	488
		Hg	175
		Se	816
		U	3,650
		Zn	39,000
	Hanford Townsite to 300 Area	Sb	ND[a]
		Cu	ND[a]
		Mn	ND[a]
		Hg	86
		Se	ND
		U	2,470
		Zn	12,600
	Reference	Sb	471
		Cu	ND[a]
		Mn	ND[a]
		Hg	134
		Se	511
		U	4,630
		Zn	12,000
Deer/Elk Liver	Hanford and Adjacent Roadways	Al	11,300
		Sb	3,860
		Ba	325
		Cd	159
		Cr	678
		Cu	33,900
		Pb	668
		Mn	3,670
		Ni	516
		Se	1,260
		U	1,540
		Zn	42,900

10.2.2 Common Carp

In 2018, common carp were sampled and analyzed for radiological contaminants. The common carp are sometimes harvested for food and could potentially contribute to human exposure. Common carp are an omnivorous fish that feeds on a diet of plants, insects, crustaceans, crawfish, and benthic worms on the bottom of the Columbia River along the Hanford Reach and, therefore, may be exposed to trace metals and persistent radionuclides in the Columbia River environment through food sources. Carp is a common food in many cultures.

Seven carp were collected from three locations along the Hanford Reach, including a Reference Area (five from waters adjacent to the 100 Areas, one fish from waters adjacent to the Hanford Townsite through the 300 Area, and one fish from Priest Rapids Lake above Priest Rapids Dam). Twelve samples were sent for laboratory analysis including duplicates. The following are the radiological results for the 12 carp samples analyzed. Naturally-based isotopes, such as potassium-40, are not discussed here.

Cesium-137. Manmade gamma-emitting radionuclides including cesium-137 were not detected above the reporting limit (0.03 pCi/g [0.001 Bq/g] wet weight) in any of the muscle samples analyzed. These results are consistent with those reported historically near the Hanford Site.

Strontium-90. Strontium-90 was not detected above the reporting limit (0.05 pCi/g [0.0019 Bq/g] wet weight) in any of the carp smallmouth bass samples analyzed. These results are consistent with those generally reported historically in the Columbia River near the Hanford Site.

Uranium. Uranium isotopes (i.e., uranium-234, uranium-235, and uranium-238) were detected in four carp4 samples. All samples with uranium detections from the Hanford Reach were collected in waters adjacent to the 100 Areas. Uranium-234 maximum was reported at 2.28E-02 pCi/g (8.44E-04 Bq/g), uranium-235 maximum was reported at 1.93E-02 pCi/g (7.14E-04 Bq/g), and uranium-238 maximum was reported at 1.18E-02 pCi/g (4.37E-04 Bq/g). This is a higher number of detects and elevated results over recent carp collections. The values reported for uranium-234, uranium-235, and uranium-238 however, do not trip or even exceed 26% of the consumption-based dose limits provided in DOE/RL-91-50, Table 4-1.

Trace Metals. Six common carp samples were analyzed for 18 different trace-metal concentrations. Only seven trace metals were detected in samples that were above the analytical detection limit at any location. Table 10-3 provides a summary of the 2018 metal analyses for the carp samples. Uranium metal detections in these analyses were not radioactive isotopic analyses as described in the paragraph above. Surveillance data sets for trace-metal concentrations in fish both on and near the Hanford Site were relatively small with variable results. No established federal or state adverse-effects values (i.e., benchmark criteria) were available for trace-metal concentrations in fish tissue. Identifying Hanford Site contributions to trace-metal concentrations or drawing conclusions about contribution effects were limited by the factors above. Monitoring fish for uptake and exposure to radionuclides and metals at locations both near to and distant from the Hanford Site will continue to provide important information for tracking the extent and long-term trends of contamination in the Hanford Reach environment. The WDOH provides lists of species retaining high concentrations of chemical contaminants and metals, and consumption guides for various water bodies throughout Washington State. (https://www.doh.wa.gov/CommunityandEnvironment/Food/Fish/Advisories).

10.2.3 Deer and Elk

Deer and elk can be exposed to metals and persistent radionuclides when they forage on plants whose roots have access to contaminated groundwater or soil, drink contaminated water, or incidentally ingest contaminated soil. Deer and elk hunting is not allowed above the high-water mark on the Benton County side of the Columbia River (at the Hanford Site); however, the river is not a barrier to large mammal movements. In 2018, the Hanford Site Environmental Surveillance Program collected deer and elk killed due to road strikes rather than hunting animals onsite. Deer and elk are analyzed for public consumption as past animals that were captured and tagged at the Hanford Site have been legally killed by hunters on the Hanford Reach shoreline below the highwater mark and across the Columbia River in Franklin County. Harvesting deer and elk for food could potentially contribute to human exposure to contaminants. A total of five deer and three elk were collected from vehicle collisions with animals and a total of 25 samples, including duplicates, were submitted for analyses. All samples were collected when the location led investigators to believe the herd could contact Hanford environs. The following are the radiological results for the deer and elk samples analyzed. Naturally-based isotopes, such as potassium-40, are not discussed here.

Cesium-137. Cesium-137 was not detected in any of the nine muscle tissue samples collected as a Hanford sample or a reference sample. Cesium-137 was not detected in any of the seven liver samples collected as a Hanford Site sample or a reference sample. These results are consistent with a decline in cesium-137 levels in wildlife examined from the preceding 10 years.

Strontium-90. Strontium-90 was detected in four of the nine bone samples analyzed during 2018. Strontium-90 was not detected in three liver samples analyzed for strontium. Concentrations of strontium-90 detected in bone samples collected ranged from 8.53E-02 pCi/g (3.16E-03 Bq/g) to 1.82E-01 pCi/g (6.73E-03 Bq/g). Bone is not usually considered an edible product. Historical strontium-90 values in deer and elk bone is displayed in Figure 10-3.

Trace Metals. Trace metals were analyzed in mule deer and elk liver samples collected from Hanford Site samples. Twelve of the 18 metals analyzed were found above analytical detection limits in 2018. The metals and the maximum detected concentration is found in Table 10-3.

10.2.4 Upland Game Birds

California quail and ring necked pheasants are some of the most prevalent upland game birds found at the Hanford Site. Most quail that reside onsite are found along the Columbia River where trees and shrubs provide shelter, and pheasants inhabit similar areas as well as the open steppe areas. Quail and pheasants forage for seeds, other plant parts, and grit in grassy and weedy places not far from cover. Ordinarily, upland game birds do not travel far from where they hatch; as such, individual birds on the Hanford Site may spend their entire lives in the area they are collected. Upland game birds can be exposed to persistent radionuclides when they forage on materials from plants that have roots in contact with contaminated groundwater or soil, drink contaminated water, or ingest contaminated grit. In 2018, 21 upland game birds were collected on the Hanford Site (8 quail and 1 pheasant from the 100 Area, 10 quail in the Hanford Townsite to 300 Area region, and 2 quail from a reference area near Crab Creek Wildlife Area). These birds were processed into 16 samples, including duplicates. All quail game birds were monitored for gamma emitting isotopes, such as cesium-137, in muscle and strontium-90 in bone. The following are the radiological results for the quail and pheasant samples analyzed. Naturally-based isotopes, such as potassium-40, are not discussed here and no metals analyses is performed on upland game birds.

Cesium-137. Manmade gamma-emitting radionuclides including cesium-137 were not detected above the reporting limit (0.03 pCi/g [0.001 Bq/g] wet weight) in any of the upland game bird muscle samples analyzed. These results are consistent with those reported historically near the Hanford Site.

Strontium-90. Strontium-90 was not detected above the reporting limit (0.05 pCi/g [0.0019 Bq/g] wet weight) in any of the upland game bird bone samples analyzed.

10.3 Vegetation Monitoring

JE Cranna

Radiological monitoring of native vegetation is conducted from locations on or adjacent to waste disposal sites, as well as from locations downwind, near, or within the boundaries of operating facilities and remedial action sites. Vegetation sampling is also performed offsite at perimeter and distant locations, and in nearby communities. Contaminant data collected were used to:

- Determine the effectiveness of effluent monitoring and controls within facilities
- Assess the adequacy of contaminant containment at waste disposal sites, waste site remediation, and contamination areas
- Detect and monitor unusual conditions associated with a potential release or spread of radioactive material
- Provide long-term radionuclide contamination trends
- Provide complimentary monitoring to airborne sampling methods for atmospheric releases.

Vegetation is an integrating sample medium that accounts for contaminants released to the atmosphere either directly (gaseous effluent), indirectly (re-suspension/deposition), or through liquid effluent waste streams that are subsequently used for irrigation or from uptake of contaminants via their root system. Deep-rooted vegetation (e.g., tumbleweeds, sagebrush) growing over underground sources of radionuclides may selectively uptake contaminants (e.g., cesium, strontium) into their tissues. When radionuclides are transported from roots to above surface portions of the plant, surface contamination may result, which poses a potential risk of environmental/biological transport or human contact.

Vegetation samples have been collected on and around the Hanford Site for more than 50 years, and a significant data set exists that documents onsite and offsite levels of manmade radionuclides in and around the Hanford Site. These data provide a baseline to which unplanned releases are compared.

Vegetation samples from offsite locations are collected every 3 to 5 years and were last collected in 2015; sampling is currently on the schedule for summer 2019. Offsite vegetation sampling is used for long-term trend analysis and is not used in dose model calculations. The sampling frequency of every 3 to 5 years is consistent with the guidance provided in DOE-HDBK-1216-2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance*.

10.3.1 Hanford Site Vegetation Monitoring

Contamination in vegetation can occur as the result of surface deposition of radioactive materials from other radiologically contaminated sources or by absorption of radionuclides through the roots of vegetation growing on or near former waste disposal sites. The location and analyses of vegetation samples collected in CY 2018 are depicted in Table 10-4. The number of vegetation samples per operational area are summarized in Table 10-5.

Table 10-4. Hanford Site Vegetation Monitoring Locations and Sample Analyses.

Location	EDP Codes[a]	Collection Period	Analyses
100-N Area	Y719, Y724	September	^{90}Sr, Pu-Iso, U-Iso, GEA
200-East Area	V054, V058[b], V060, V062, V064, V066, V076, V078	May-July	^{90}Sr, Pu-Iso, U-Iso, GEA
200-West Area	V004, V016, V020, V022, V024, V026, V046, V048[b], V050, V052	May-July	^{90}Sr, Pu-Iso, U-Iso, GEA
Plutonium Finishing Plant (200-West Area)	V006, V010, V012, V032[c], V034, V044[b], V112[c]	May-July	^{90}Sr, Pu-iso, U-iso, GEA, ^{241}Am
300 Area[(e)]	V123[b, c], V132[c]	May-July	^{90}Sr, Pu-Iso, U-Iso, GEA
400 Area	V130	May-July	^{90}Sr, Pu-Iso, U-Iso, GEA
600 Area	V080, V082, V086, V088[b], V090, V092, V094, V096[c], V098, V100, V102, V104, V106, V108, V114[c]	May-July	^{90}Sr, Pu-Iso, U-Iso, GEA

[a] EDP Code=environmental data point code = sample location code
[b] Collocated sampling location with WDOH
[c] Quality assurance duplicate sample
GEA = Gamma Energy Analysis
^{90}Sr = Strontium-90
^{241}Am = Americium-241
Pu-iso = isotopic plutonium (^{238}Pu, $^{239/240}$Pu)
U-iso = isotopic uranium (^{234}U, ^{235}U, ^{238}U)
WDOH == Washington State Department of Health

Table 10-5. Number of Vegetation Samples per Operational Area.

Number of Samples	Operational Area (discrete samples analyzed)					
	100-N	200-East	200-West [a]	300 Area[a]	400 Area	600 Area[a]
45	2	8	17	2	1	15

[a] Includes one or more duplicate samples.

10.3.1.1 Sampling and Analysis. Samples were collected and analyzed according to DOE/RL-2013-53, *Hanford Site Environmental Surveillance Master Sampling Schedule for Calendar Year 2018*. Onsite vegetation samples are collected annually. Collections in the 200 and 600 Areas are alternated between even and odd numbered years, aligning with even and odd numbered sample locations. Individual vegetation samples (approximately 17.6 oz [500 g]) consist of new-growth leaf cuttings taken from the available brushy, deep-rooted species (e.g., sagebrush and/or rabbitbrush). To avoid decimation of any individual plant through overharvesting, samples may consist of mixed biota representing several like members of the sampling site plant community. Vegetation samples are dried prior to analyses and analytical results are reported on a dry weight basis.

Vegetation samples were analyzed for strontium-90, uranium-234, uranium-235, uranium-238, plutonium-238, plutonium-239/240, and gamma-emitting radionuclides. In support of the current deactivation and decommissioning project at the Plutonium Finishing Plant (PFP) located in the 200-West Area, and especially for monitoring during the demolition of the Americium Recovery Facility, an americium-241 alpha energy analysis was added to the analyte list at six vegetation monitoring locations (V006, V010, V012, V032, V034, and V044) near the PFP complex.

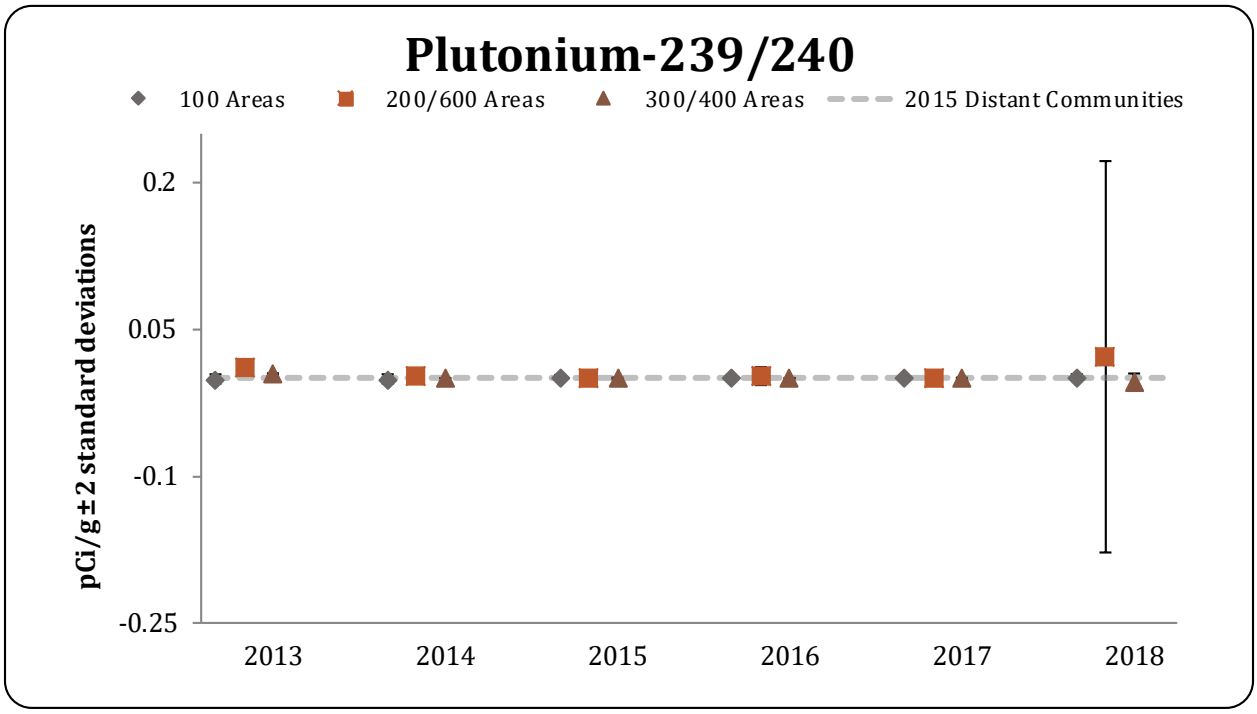
10.3.1.2 Vegetation Monitoring Results. The analytical results from Hanford Site vegetation samples collected in CY 2018 were compared with concentrations of radionuclides measured in samples collected offsite at various locations in Grant, Yakima, Walla Walla, Adams, Benton, and Franklin Counties in 2015. These comparisons are used to differentiate concentrations of Hanford Site-produced contaminants from levels resulting from natural sources and worldwide fallout.

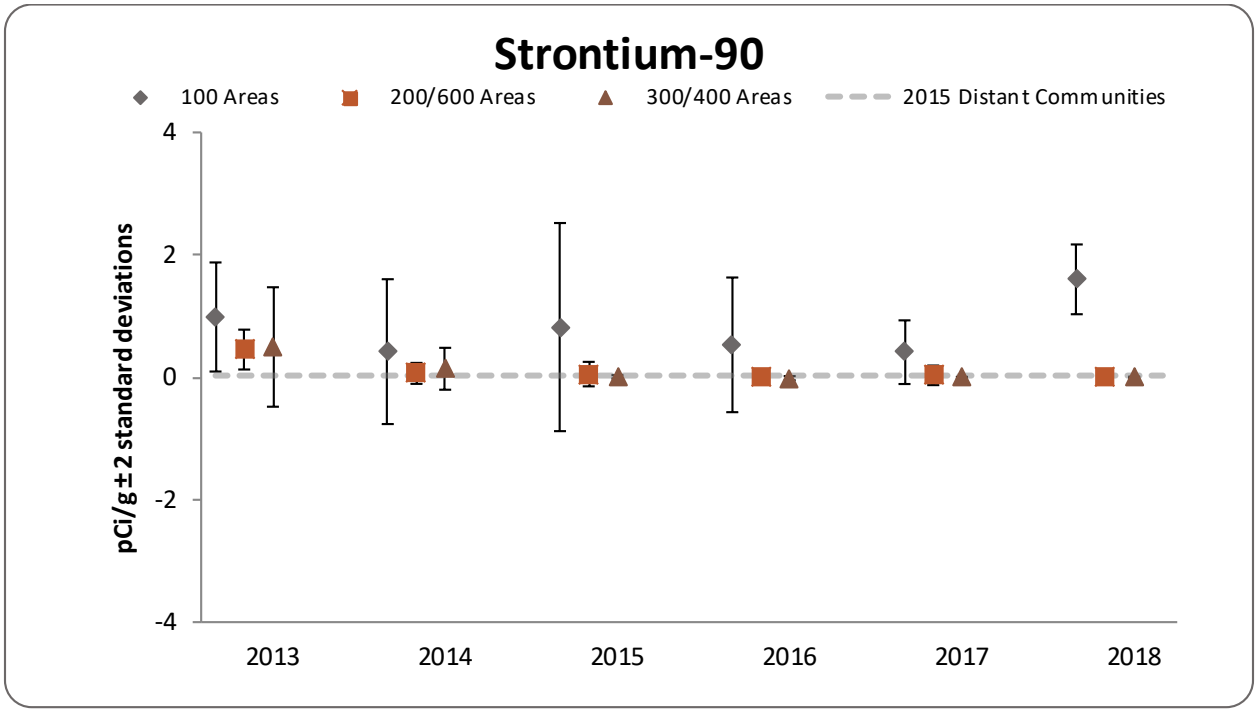
In general, radionuclide concentrations in vegetation samples collected from or adjacent to waste disposal facilities in 2018 were similar to or slightly higher than concentrations in samples collected further away, including concentrations measured offsite in 2015. Cesium-137, strontium-90, plutonium-239/240, uranium-234, and uranium-238 were detected in the 2018 vegetation samples at locations and concentrations consistent with previous years. Figure 10-3 shows the annual average vegetation concentrations of selected radionuclides in the 100, 200, 300, 400, and 600 Areas. Appendix C, Table C-18 shows the annual average and maximum concentrations of radionuclides in vegetation samples by area during 2018 and for the preceding 5 years.

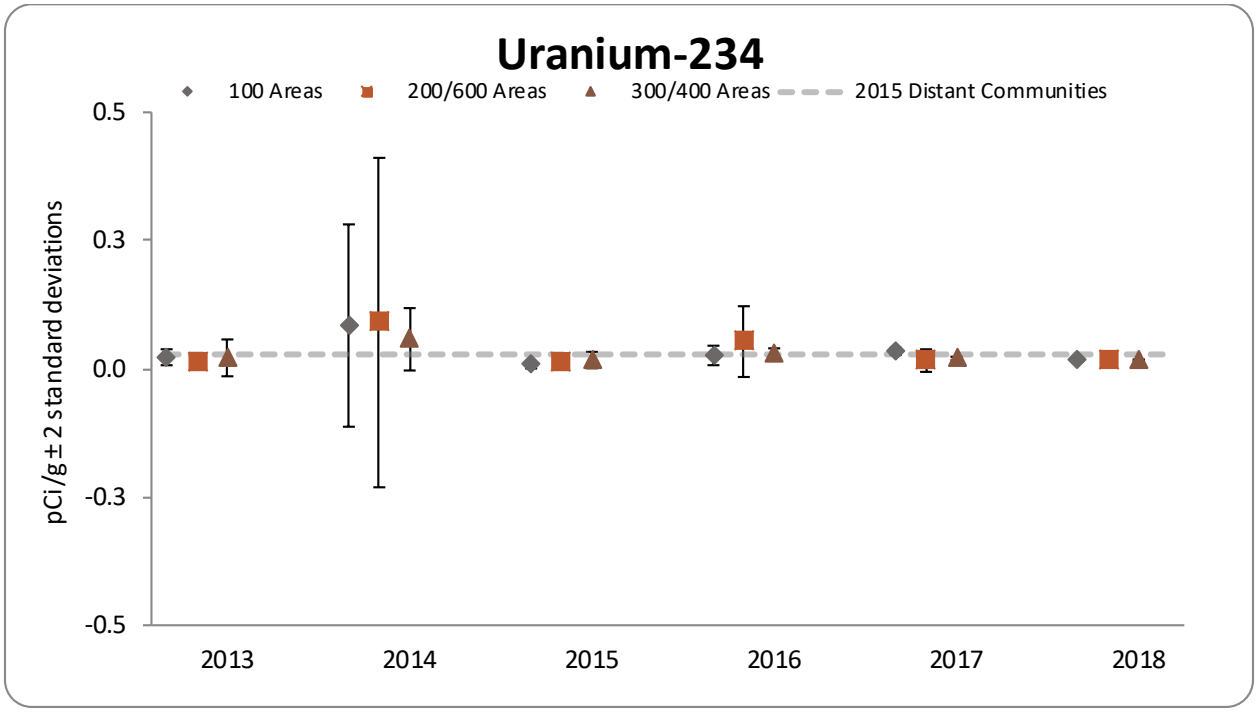
Uranium. Uranium-234, uranium-235, and uranium-238 were detected in approximately 60% of the vegetation samples at concentrations that were consistent with historical concentrations. The uranium levels are a result of uranium releases to the environment during past fuel-fabrication operations in that area.

Plutonium. Plutonium-239/240 was detected in 35% of the vegetation samples collected in the 200 and 600 Areas, with the majority of these detections coming from the 200-West Area. Generally, the concentrations measured were within historical ranges, however, there was a slightly elevated plutonium-239/240 concentration measured at location V034 in the 200-West Area. This elevated result is higher than the 5-year maximum concentration for the 200-West Area, and may be attributed to PFP demolition activities that occurred in 2017.

Strontium-90. Strontium-90 was detected in both samples collected at 100-N and in approximately 18% of the samples in the 200 and 600 Areas. Concentrations of strontium-90 were within historical ranges.


Plutonium-239/240
100 Areas
200/600 Areas
300/400 Areas
2015 Distant Communities
pCi/g ± 2 standard deviations
0.2
0.05
-0.1
-0.25
2013
2014
2015
2016
2017
2018


Strontium-90
100 Areas
200/600 Areas
300/400 Areas
2015 Distant Communities
pCi/g ± 2 standard deviations
4
2
0
-2
-4
2013
2014
2015
2016
2017
2018



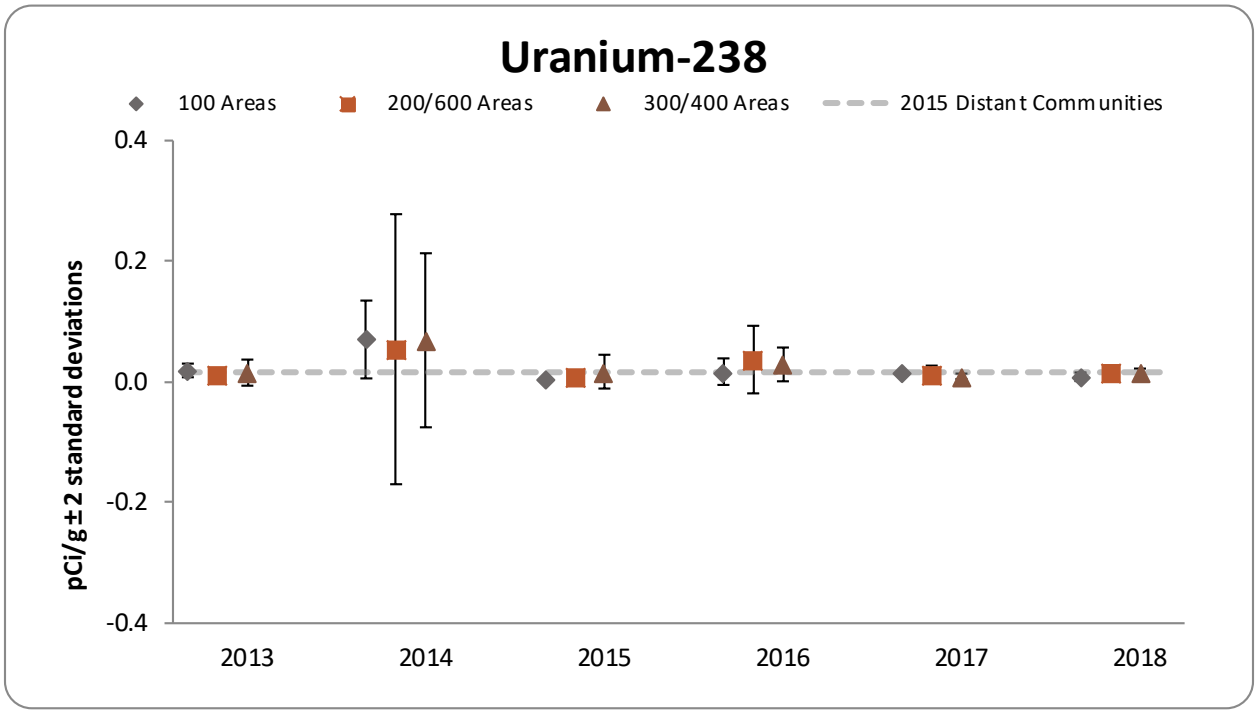


Figure 10-3. Hanford Site Vegetation Average Concentrations of Selected Radionuclides.

Cesium-137. Cesium-137 was detected in two samples in the 200 Areas. One of the samples had a slightly elevated cesium-137 concentration compared to historical data.

Americium-241. In support of the current deactivation and decommissioning project at the PFP, and especially for monitoring during the demolition of the Americium Recovery Facility, an americium-241 alpha energy analysis was added to the analyte list at six vegetation monitoring locations (V006, V010, V012, V032, V034, and V044) near the PFP complex. Americium-241 was detected in two of the seven samples analyzed for americium-241. The americium-241 concentration at location V034 in the 200-West Area was slightly elevated compared to what has been seen in the previous 2 years of analyzing for americium-241.

10.3.2 Radiological Contamination Surveys

Radiological surveys were performed in and near Hanford operational areas to monitor the presence or movement of radioactive materials or to verify radiological conditions at specific project sites.

Radiological surveys performed in CY 2018 identified 38 instances of radiological contamination in vegetation; 37 were Russian thistle (*Salsola tragus*) plants or fragments and 1 was gray rabbitbrush (*Ericameria nauseosa*). Of the 38 instances, 6 locations were posted as a contamination area and 32 were cleaned up and disposed of at a licensed facility.

Section 10.3.3 provides a discussion of the vegetation control on the Hanford Site. Table 10-6 summarizes the general locations of vegetation contamination incidents discovered in CY 2018. Table 10-7 provides the number of contamination incidents from 2000 to 2018.

Table 10-6. Hanford Site Vegetation Contamination Incidents Discovered in CY 2018. (2 Pages)

Location	2018 Incidents
100 Area	0
200-East Area	
Tank farms	8
Burial grounds	2
Cribs, ponds, and ditches	4
Fence lines	0
Roads and railroads	0
Unplanned release sites	0
Underground pipelines	1
Liquid Effluent Treatment Facility/Effluent Treatment Facility	7
Miscellaneous	0
200-West Area	
Tank farms	7
Burial grounds	3
Cribs, ponds, and ditches	5
Fence lines	0
Roads and railroads	0
Unplanned release sites	1
Underground pipelines	0
Miscellaneous	0

Table 10-6. Hanford Site Vegetation Contamination Incidents Discovered in CY 2018. (2 Pages)

Location	2018 Incidents
Cross-site transfer line	0
200-North Area	0
300 Area	0
400 Area	0
600 Area	0
Total	**38**

Table 10-7. Hanford Site Vegetation Contamination Incidents from 2000 through 2018.

Year	Incidents
2000	66
2001	20
2002	16
2003	32
2004	60
2005	66
2006	75
2007	62
2008	127
2009	109
2010	36
2011	10
2012	18
2013	35
2014	50
2015	48
2016	45
2017	23
2018	38

10.3.3 Vegetation Control

JM Rodriguez, RC Roos

The purpose of vegetation control at the Hanford Site is effective control and minimization of noxious weeds, industrial weeds, and other vegetation to ensure protection of Hanford Site workers, the public, facilities, property, and the Hanford Site's cultural and environmental (including biological) resources. Risks that are mitigated through effective vegetation control are the spread of contamination, wildfire fuel loading, harborage of vermin and insect pests around facilities, damage and destruction of native plant communities, damage to facilities, and interference with work and transportation.

Approximately 5,170 ac (2,092 ha) were treated with herbicides in 2018 on radiological waste sites, around operations areas, and along roadways to keep areas free of deep-rooted vegetation (e.g., Russian thistle, also known as tumbleweed). Follow-up treatments were included in the total treated acres; several areas received more than one herbicide application.

Noxious Weeds. Noxious weeds were controlled at the Hanford Site to prevent their spread and eliminate populations. A noxious weed is a legal and administrative category designated by federal or state regulatory agencies (e.g., the U.S. Department of Agriculture, Washington State Department of Agriculture). Noxious weeds are non-native, aggressively invasive, and hard to control. Noxious weed plant communities degrade ecosystems unless control measures are taken. Control measures can be mechanical, chemical, cultural, or biological. Approximately 39 ac (15.8 ha) of noxious weeds on the Hanford Site were treated with herbicides in 2018. These control measures were focused on revegetation and restoration sites including cleaned-up waste sites and revegetated mitigation sites. Noxious weed species that were controlled in 2018 included: diffuse knapweed (*Centaurea diffusa*), rush skeletonweed (*Chondrilla juncea*), Saltcedar (*Tamarix spp.*), Tackweed (*Tribulus terrestris*), and phragmites (P*hragmites spp.*).

10.4 Waste Site Remediation and Revegetation

RC Roos, JM Rodriguez

In 2018, 171 ac (69 ha) across the Hanford Site (100K – 100-K-95, 100-K-CTA, 128-K-2, 600-370, 600-301, 600-120, 600-100; 100 B/C – 116-C-5, 116-B/C-MISC, 100-B-14, 100-C-6; 100D – 128-D-2 East, 128-D-2 West, 118-D-2, 628-3 Inner, 628-3 Outer; 600A – 600-358, 600-566, 600-30) was planted with grass seed in an effort to restore native plant communities on revegetation and restoration sites including cleaned up waste sites and revegetated mitigation sites. In addition to planting grass seed, native shrub and forb seed was planted and nearly 2,000 shrub and forb seedlings were planted (DOE/RL-96-32).

10.5 References

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