Radiocesium in White-tailed Deer on the Savannah River Site

Consumption of wildlife species can result in the transfer of contaminants to humans. One of these contaminants, radiocesium (cesium-137 or ^{137}Cs), is widespread across the Department of Energy's Savannah River Site (SRS) as a result of the production of nuclear materials and atmospheric fallout from nuclear weapons testing. Radiocesium naturally changes into other atomic forms and in the process releases radiation that can cause biological effects. Cesium-137 deposited in soils or sediments is taken up by plants, which may be eaten by deer.

The first studies of radioactivity in SRS deer were conducted during the early 1960s by The University of Georgia and E. I. DuPont de Nemours and Company. Their work documented the levels of radioactivity in deer on the SRS and in surrounding areas. Global fallout distributed radioactivity evenly across the SRS, whereas releases from operations were more concentrated around facilities and their waste streams. There is no consistent pattern for deer with high average levels of ^{137}Cs to occur together or around Site nuclear facilities or waste streams. The spatial pattern of ^{137}Cs levels in SRS deer was more consistent with the contamination resulting from global fallout rather than Site releases. Researchers did find that ^{137}Cs levels were elevated in deer from upland habitats in the northeastern part of the SRS (map, page 2). This region of the Site has well-drained sandy soils with low potassium levels. Because cesium behaves chemically like potassium, plants and animals living in environments with low potassium levels may accumulate more ^{137}Cs in their tissues than they otherwise would. Consequently, elevated ^{137}Cs levels in deer from the northeastern portion of the SRS probably can be attributed to the type of soils found in this region rather than to SRS operations.

Because of global fallout from nuclear weapons testing, all deer have some radiocesium in their bodies.

In 1965, public hunting of SRS white-tailed deer was initiated to reduce the number of deer-vehicle accidents. However, initiation of public hunting increased the probability that ^{137}Cs in deer from SRS activities might be consumed by humans. The primary concern for people eating deer meat contaminated with ^{137}Cs is an increased probability of contracting cancer. Radioactivity has been monitored in more than 30,000 deer by Westinghouse Savannah River Company (WSRC) and its predecessor since 1965 and only one deer has ever exceeded standards set for consumption of SRS deer and been confiscated.

We expect that industrial releases should increase the average levels of ^{137}Cs in deer as well as the variation in ^{137}Cs levels among individual deer. Levels of ^{137}Cs were not higher in SRS deer compared to those from Fort Jackson in South Carolina or Fort Stewart in Georgia, which, like the SRS, are located in areas having well-drained sandy soils with low potassium levels. Deer from these Department of Defense (DOD) facilities have relatively high ^{137}Cs levels but are located a long distance from facilities generating radioactivity. These findings, coupled with the relatively low variation in ^{137}Cs levels among SRS deer, are the most compelling reasons

Radioactivity is the release of energy from a substance as it goes from a higher energy less stable state to a lower energy more stable state. The release of this energy can be detected with various instruments. Measurement of radioactivity is based on the number of such state changes in a given unit of time. The international unit of radioactivity is the ***becquerel*** *(Bq), which is defined as one radioactive disintegration per second.*

to conclude that most of the ^{137}Cs in SRS white-tailed deer is the result of global fallout rather than operation of SRS facilities.

High levels of ^{137}Cs in some deer are a result of increased sampling from a large distribution of deer in which a few have high levels of ^{137}Cs. If more than 30,000 deer had been harvested from places like Fort Stewart or Fort Jackson, there probably would have been an equivalent number of deer with the higher levels of ^{137}Cs. Consuming deer harvested from the SRS should result in no more exposure to ^{137}Cs than eating deer harvested from some other coastal areas of the Southeastern United States.

Levels of cesium-137 found in white-tailed deer from the Department of Energy's (DOE) Savannah River Site and four other coastal plain locations, including two Department of Defense (DOD) sites.

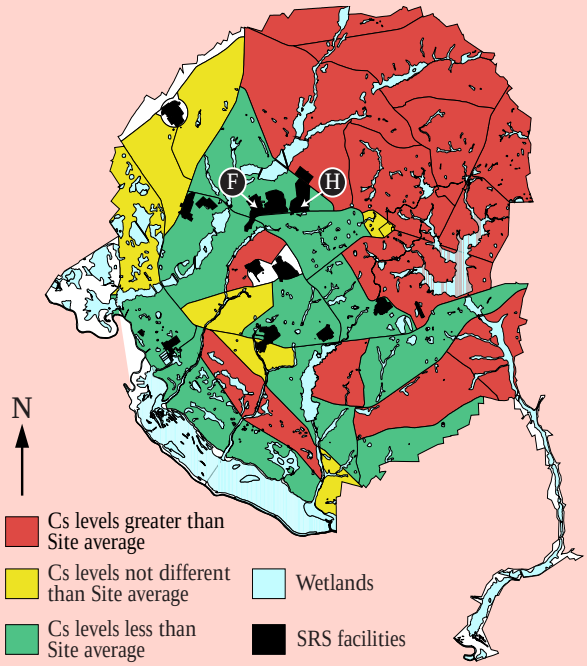
			^{137}Cesium Concentration (Bq/kg, Wet Weight)	
Location	**Distance from SRS (miles)**	**Number of Samples**	**Average**	**Range**
Webb Wildlife Center, SC **	40	10	44	1-56
Cedar Knoll Plantation, SC **	18	16	67	17-118
Savannah River Site (DOE), SC	0	44	281	112-851
Fort Jackson (DOD), SC	55	26	363	39-666
Fort Stewart (DOD), GA	65	20	330	63-740

** *Fertilizers with potassium are used which probably reduce ^{137}Cs levels in deer.*

The time for half of a contaminant to disappear from a wildlife population is its "ecological half life," which is about 47 years for ^{137}Cs in SRS deer. This represents a decline in ^{137}Cs of about 1.5% per year. This ecological half-life is much longer than values for other animals. The ecological half-life for ^{137}Cs is two years for Wood Ducks in the Savannah River swamp, five years for American Coots in the Par Pond reservoir, three years for reindeer from Northern Europe, and 13 years for bass in the Pond B reservoir on the SRS. Radioactive ^{137}Cs naturally decays at a rate of 2.3% per year, resulting in a physical half-life of 30 years, which is considerably less than 47 years.

The slower rate of decline of radiocesium in SRS deer results from the continuing deposition of ^{137}Cs by global fallout. Although ^{137}Cs deposited on the SRS in the early 1960s during the height of atmospheric weapons testing has naturally decayed away at 2.3% per year, some of the lost

Deer harvested in public hunts on the SRS are monitored for radiocesium levels by WSRC before being released to hunters.



Levels of cesium-137 found in white-tailed deer on the SRS. Site facilities, including the F and H reprocessing plants, are shown.

isotope has been replaced by the continuing deposition of ^{137}Cs by fallout. Because of this deposition, the "^{137}Cs inventory" from global fallout on the SRS has declined at only 1.7% per year since the mid 1960s. Both the estimated rates of decline of 1.5% per year for deer radiocesium concentrations and the 1.7% per year for global fallout ^{137}Cs inventories have uncertainties due to sampling and measurement errors and are not significantly different. Because the two rates are similar, we know that there has not been significant export of fallout radiocesium from SRS terrestrial ecosystems or increasing immobility of ^{137}Cs because of its attachment to soil clays.

Despite concern about radiocesium on the SRS, the risk of a person contracting a fatal cancer from eating an SRS deer with an average ^{137}Cs level is no greater than that associated with other routine human activities, such as drinking milk as a child or breathing air with typical radon levels. Only 84 of over 30,000 deer taken from the entire SRS contained sufficient ^{137}Cs that they would, if eaten, result in a dose equivalent to that of the naturally occurring radioactivity already in the human body from other sources. These risks are probably no greater than those associated with eating deer harvested from other areas like Fort Jackson or Fort Stewart, which have soils and vegetation similar to those on the SRS. There also are risks associated with an unlimited expansion of the SRS deer herd. For every 1,000 deer added to the herd, the chance of dying in a deer-vehicle collision increases by 0.5% per year and the chance of being injured increases by 67%. Most hunters would not help harvest the SRS deer herd if they were not allowed to take their deer home. There is much more risk associated with car accidents than from eating SRS deer, so the SRS deer herd needs to be kept down to reasonable numbers.