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DETRITUS CAST FROM HERON NESTS AS AN INDICATOR OF FOOD CHAIN CONTAMINATION

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DISCLAIMER

ABSTRACT

Approximately 40 pairs of great blue herons nest in a single colony on the Hanford Reservation in south-central Washington. Over a two-month period in the 1975 nesting season, 170 g/m^2 of detritus, dry weight, were collected on cheesecloth blankets placed on the ground beneath the nesting colony. Seven gamma-emitting radionuclides commonly associated with airborne debris (fallout) were measured in the heron detritus. Cesium-137 was the most abundant man-induced radionuclide measured in the detritus averaging 18 picocuries per gram dry weight.

Regular surveillance of heron detritus appears as a useful way to measure contaminants in heron foods gathered from the surrounding environment.

INTRODUCTION

The Hanford Reservation consists of 570 square miles of mostly undeveloped land that serves as a site of a major nuclear energy facility and also provides a refugium for wildlife. An important non-game bird species is the great blue heron, Ardea herodias, a year-round resident. A colony nests in a grove of deciduous trees on the west bank of the Columbia River in the northeast portion of the reservation (Figures 1 and 2). To survey environmental chemical contaminants without imposing mortality on the nesting colony, we investigated the detritus cast from heron nests.

METHODS

Detritus ejected from heron nests was collected on blankets spread on the ground beneath the nest trees. The dimensions of each blanket, made up of several layers of cheesecloth, was 3 × 12 ft (4.33 m^2). Eight blankets were staked out, collected, and replaced with new blankets at 21-day intervals between April 18 and June 20, 1975. In all, seven sites were staked out under the nest trees. Another blanket was located in the open to collect fallout radionuclides and to serve as a control since it was located at a sufficient distance so that it did not accumulate detritus cast from nesting herons.

FIGURE 1. Photograph of the heron colony on the Hanford Reservation.

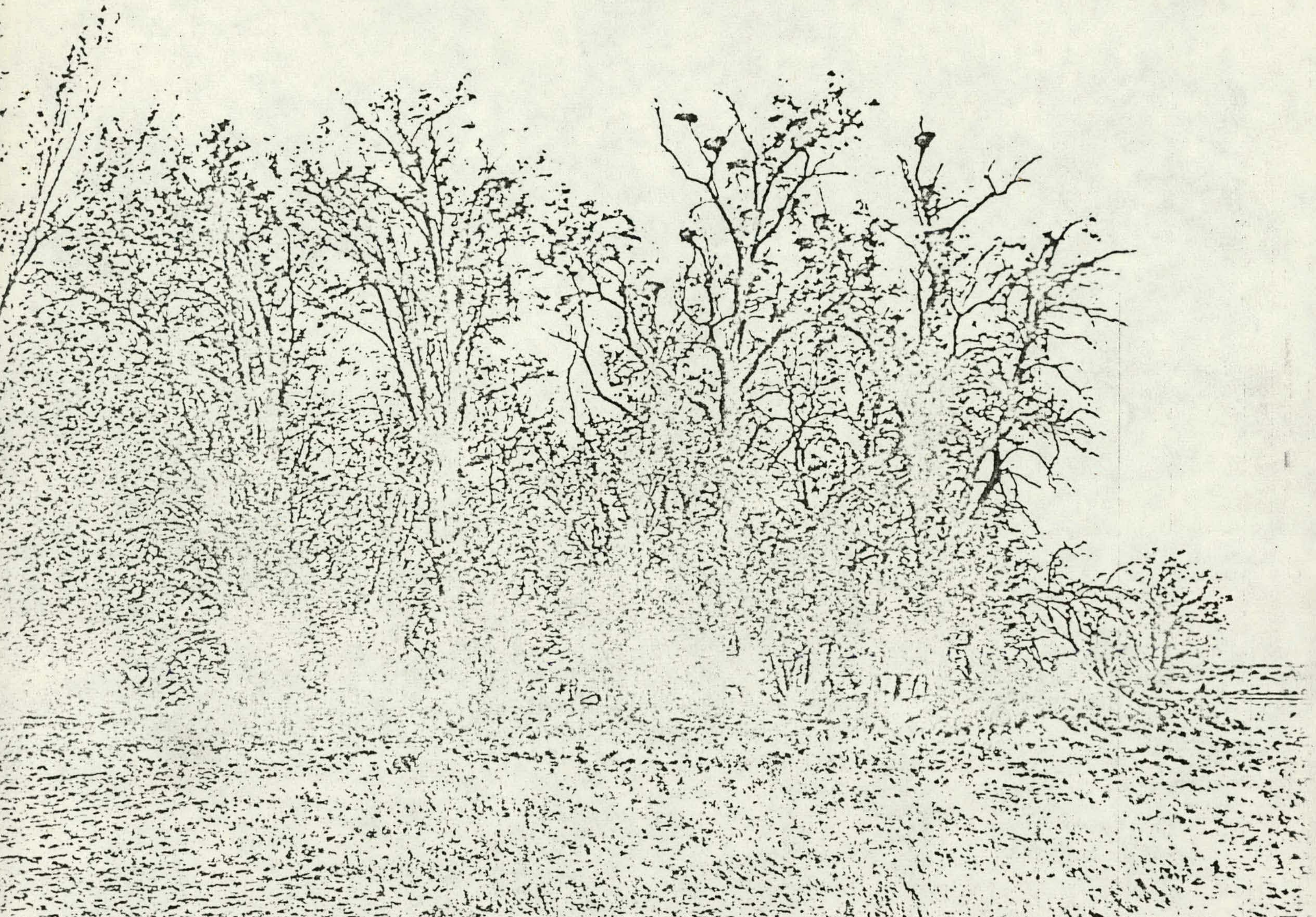
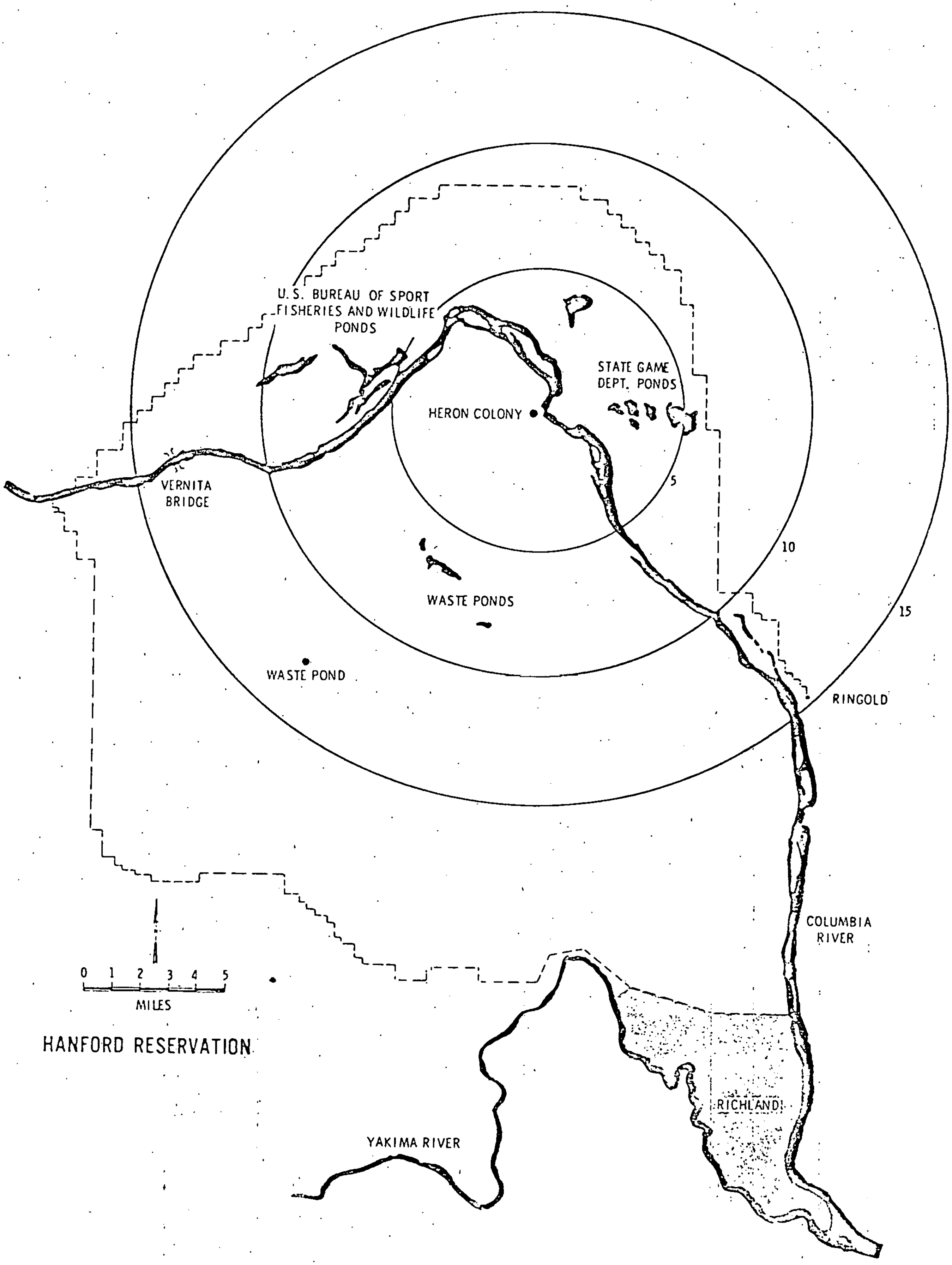


FIGURE 2. Map showing the location of the heron colony on the ERDA Hanford Reservation, south-central Washington.



HANFORD RESERVATION

The blankets were oven-dried, ashed at 400°C to reduce the volume of material, and counted for gamma-emitting radionuclides in a well-type NaI (Tl) crystal using gamma-ray spectroscopic techniques.

RESULTS

Heron Detritus

Approximately 40 pairs of great blue herons nested in the colony in the spring of 1975. The accumulated dry weight of detritus, mostly parts of fish and fecal material, ejected from heron nests averaged 170 g/m^2 (Table 1). Locations 1 and 6 accumulated the greatest amounts of detritus, while locations 3 and 4 accumulated less. The amount of detritus increased as the nestling birds grew and their food demands increased. Only 30 g/m^2 of detritus were accumulated during the first 21-day period. This increased to 80 g/m^2 during the final 21-day period. Approximately 290 kg dry weight of detritus was estimated to have been deposited over the 1700 m^2 area under the nest trees. This would probably represent about one metric ton of heron foods.

Radionuclides in Heron Detritus

Six gamma-emitting radionuclides accumulated on the control blanket as airborne detritus (Table 2). These are man-made radionuclides except for the naturally-occurring ^{40}K.

TABLE 1. Dry weight (g/m^2) of detritus ejected from heron nests during the spring of 1975.

Location	April 18-May 9	May 10-May 30	May 31-June 20	Accumulated Total
1	7	110	101	268
2	38	60	79	117
3	24	43	36	103
4	26	34	46	106
5	22	47	69	138
6	24	88	142	254
7	25	54	93	172
Average (±SE)	31 (±5)	62 (±10)	81 (±14)	174 (±25)
Control	1.0	0.9	2.3	4.2

TABLE 2. Radionuclide content of cheesecloth blankets exposed from 18 April to 20 June 1975 to detritus ejected from heron nests as compared to controls.

Radio-nuclides	pCi/g Dry Weight: Blanket Locations 1	2	3	4	5	6	7	Avg.	Control	pCi/m^2 Detritus	Control
^{144}Ce	3.3	4.2	5.0	4.9	4.6	2.9	3.8	4.1	131	606	408
^{106}Ru	*	1.3	3.4	1.1	*	*	1.1	0.99	143	109	489
^{137}Cs	36	6.4	3.2	13	39	16	10	18	10.2	3300	34
^{95}Zr	0.74	1.0	1.3	1.4	1.4	0.90	1.2	1.1	43	167	133
^{54}Mn	0.31	1.0	0.23	0.39	0.55	0.38	0.13	0.43	2.1	98	6.0
^{65}Zn	0.35	0.42	0.17	0.73	0.60	0.28	0.21	0.39	*	66	*
^{40}K	14	14	10	13	14	13	16	13	3.2	2410	22
^{60}Co	0.34	0.87	0.43	0.49	0.54	0.51	0.23	0.48	*	93	*

*Below detection limits

Eight radionuclides were measured on the blankets containing heron detritus (Table 2). When expressed in terms of picocuries per gram dry weight (pCi/g), the control blankets had higher concentrations of ^{144}Ce, ^{106}Ru, ^{95}Zr, and ^{54}Mn than did blankets exposed to heron detritus. When expressed as pCi per square meter of blanket area, the blankets with accumulated detritus had more biologically active radionuclides—^{137}Cs, ^{40}K, ^{65}Zn, and ^{60}Co—indicating that these radionuclides were associated with the materials which herons have transported to the nest as food for young birds. The concentration of ^{40}K was more or less uniform in the detritus, regardless of blanket locations (Table 2), but ^{137}Cs was not. This suggests that the man-induced radionuclide ^{137}Cs is not as uniformly distributed in heron foods as ^{40}K. Blanket locations 1 and 5 had higher ^{137}Cs levels, while locations 2 and 3 had lower levels (Table 2). This suggests that herons are foraging in areas with different levels of radiocesium available to them in their foods.

Radionuclides in Heron Tissues

Herons are distributed throughout the United States, but they are not abundant enough to warrant killing of birds for tissue analyses. Two adult great blue herons were found dead on the Hanford Reservation, both apparently killed by colliding with aerial-strung wires. Samples of breast muscle and liver were removed from the birds and radiochemically analyzed for gamma-emitting radionuclides (Table 3). One bird had higher concentrations of ^{137}Cs in the muscle tissue in comparison to the other. The liver of one bird also contained detectable amounts of ^{95}Zr and ^{54}Mn, while the other bird's liver did not contain measurable quantities of these radionuclides. Although limited in scope, these tissue data suggest that these two herons had accumulated different amounts of radionuclides by foraging on foods of variable radionuclide content.

DISCUSSION

Suitable nesting sites for great blue herons are scarce in south-central Washington, and the only known colony in Benton County and Franklin County is the one on the Hanford Reservation. Because the Hanford Reservation is not accessible to the public, the colony has not been subjected to harrassment sometimes imposed on unprotected colonies. Over the years the heron colony has benefitted greatly from this protective land management.

Within the next few years, dying nest trees are expected to topple and be unusable, at which time the herons will seek nest sites elsewhere along the Columbia River and perhaps beyond the Hanford Reservation boundaries.

TABLE 3. Radionuclide content pCi/g dry weight of muscle and liver tissues obtained from two great blue herons accidentally killed on the Hanford Reservation.

Radionuclide	15 October 1974		21 July 1975	
	Muscle	Liver	Muscle	Liver
^{144}Ce	–	–	–	–
^{106}Ru	–	–	–	–
^{137}Cs	50	–	0.3	1.3
^{95}Zr	9	610	–	–
^{54}Mn	–	89	–	–
^{65}Zn	–	–	–	–
^{40}K	9	–	10	–
^{60}Co	0.4	–	–	–

The distance that parent herons normally travel in search of food is not known, but nesting colonies do serve as focal points of food gathering activity.

As nestlings, young birds are sedentary and for several weeks during each year food scraps and fecal droppings accumulate on the ground beneath the nest trees. By collecting this material and analyzing it, a determination of the kinds and quantities of gamma-emitting radionuclides in heron foods was made. These data are especially useful if future comparisons with other heron colonies living in environments without a history of nuclear materials processing are made. Because the method does not impose mortality, it can be employed year after year and could provide a means of detecting changing levels of trace metals as well as radionuclides within the foraging territories of herons.

Most of the information concerning radionuclide accumulation by wild birds has been obtained at nuclear energy facilities located at Oak Ridge, Tennessee; Savannah River, South Carolina; and Hanford, Washington (Mellinger and Schultz, 1975). All birds utilizing a waste pond habitat at Oak Ridge accumulated radionuclides (Krumholz, 1954); however, fish-eating birds, such as herons and kingfishers, had lower levels than ducks. Silker (1958) measured ^{90}Sr in bird bones at Hanford and found that fish-eating mergansers had less ^{90}Sr than did mallards. Brisbin _et al._ (1974) measured ^{137}Cs in American coots utilizing a waste pond associated with a nuclear facility in South Carolina had found that cesium levels increased according to the length of time birds stayed on the ponds. Because herons are fish-eating birds, some idea of the amounts of radioactivity associated with fish tissues are shown in Table 4. Cesium-137 is widely distributed in freshwater fishes as a result of nuclear weapons testing. One of the highest ^{137}Cs levels measured is for brook trout from high altitude lakes in Colorado. Goldfish collected from a pond that receives process water from a nuclear chemical facility on the Hanford Reservation had about 15 times greater amounts of ^{137}Cs than brook trout exposed only to fallout ^{137}Cs sources. The Columbia River probably provides the bulk of heron colony foods. Data are not available for all species of Columbia River fish, but whitefish had very low ^{137}Cs levels.

Great blue herons often forage around the Hanford waste ponds that contain goldfish (Fitzner and Rickard, 1974), although the ponds are located 12 miles from the nesting colony. Goldfish could have contributed to the levels of ^{137}Cs measured in heron detritus.

The total amount of ^{137}Cs dropped to the ground beneath nest trees can be calculated at about 5 microcuries per year. If the heron colony remains about the same size and the ^{137}Cs in heron foods remains constant, about 50 μCi can be expected to accumulate in a 10-year period.

A systematic collection of heron detritus for radioactivity, trace metals, and other kinds of potentially biologically transportable industrial pollutants appears to be

TABLE 4. Cesium-137 levels in freshwater fish from various locations throughout the United States.

Fish Species	Picocuries Per Gram Wet Weight	Source
White crappie (Tennessee)	0.63	Nelson (1969)
Northern pike (Minnesota)	1.1	Gustafson (1969)
Walleye and Perch (Minnesota)	0.6	Gustafson (1969)
Brook trout (Colorado)	5.8	Nelson and Whicker (1969)
Cutthroat trout (Washington)	1.2*	Rickard and Eberhardt (1971)
Large mouth bass (Michigan)	0.55	Kevern and Spigarelli (1971)
Mummichog (New York)	0.054	Wrenn *et al.* (1974)
Whitefish (Washington)	0.43	Blumer *et al.* (1976)
†Goldfish (Washington)	84.0*	Cushing and Watson (1974)

*Converted to a wet weight basis, assuming wet weight to dry weight ratio equals 4.0

†Waste pond habitat

a useful way of detecting trends in local environmental contamination of food chains without imposing mortality upon a relatively small heron population.

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