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RADIONUCLIDE CONCENTRATIONS IN NESTLING RAPTORS NEAR NUCLEAR FACILITIES

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The presence of some pollutants in raptors and the importance of raptors as indicators of environmental contaminants have been documented (Olendorff 1973). Literature on radionuclide concentrations in birds near nuclear facilities deals mainly with passerine species (Willard 1960) or waterfowl (Brisbin et al. 1974). The only available literature on raptors concerns radioiodine in thyroids (Hanson and Kornberg 1956). We conducted a study to determine the level of contamination by gamma-emitting radionuclides in nestling raptors near 2 nuclear facilities at the Idaho National Engineering Laboratory Site.

MATERIALS AND METHODS

The study was conducted from May through July 1976 on the Idaho National Engineering Laboratory (INEL) Site in southeastern Idaho. Big sagebrush (*Artemisia tridentata*) and grass (*Agropyron dasystachyum* and *Stipa comata*) are the predominant vegetation types on the study area.

Raptors were studied near 2 nuclear facilities, the Test Reactor Area (TRA) and the Idaho Chemical Processing Plant (ICPP). TRA is an advanced nuclear materials testing complex. Radioactive liquid waste from the TRA facilities is placed in two 1.5 ha leaching ponds. Approximately 46,400 curies (Ci) of beta-gamma activity were introduced into the ponds from 1952 to 1976. During the study period, 532 Ci of liquid beta-gamma radioactive waste were released from TRA facilities; 11% of this consisted of nuclides with half-lives greater than 1 year. In addition, a smaller sanitary waste disposal pond is located near TRA.

The ICPP recovers uranium from spent nuclear fuels and processes the resultant liquid waste into noncorrosive solid form. During operations, the ICPP releases radionuclides into the atmosphere, and in 1976, 0.04 Ci of particulate airborne waste containing 0.02 Ci of cesium-137 were released. During 1976, average atmospheric radioactivity at the INEL Site boundaries was not statistically different from concentrations in control or background areas (U.S. Energy Research and Development Administration 1977). However, the soil in the vicinity of the ICPP contains above background levels of radioactivity (Bowman et al. 1976).

The Big Lost River flows intermittently across the INEL Site for approximately 50 km; cottonwood trees (*Populus deltoides*) which grow on its banks provide nesting sites for American Kestrels (*Falco sparverius*) and Long-eared Owls (*Asio otus*), the most numerous nesting raptors along the river. We searched the area along the Big Lost River for nesting raptors and all American Kestrel and Long-eared Owl nests located within 1.5 km of ICPP or TRA were studied. Seven other nests downstream and 4 nests upstream of the facilities and a Marsh Hawk (*Circus cyaneus*) nest near the sanitary waste disposal pond near TRA were also studied. In addition to natural nest cavities, sampling locations were created by placing 5 American Kestrel nesting boxes (Hamer-

strom et al. 1973) near the facilities. Seventeen raptor nests were studied and 2 young from each nest were temporarily removed for analysis. The American Kestrels were analyzed when they were 20 days old and the Long-eared Owls when they were 15 days old. The Marsh Hawks were analyzed twice, at 11 and 21 days of age.

Each young was placed in a ventilated 1800 ml plastic container with absorbant material and analyzed for gamma-emitting radionuclides on a 65 cm^3 germanium-lithium crystal (within a shielded chamber) connected to a multichannel analyzer. Raptors were gamma counted for 30 min and then returned to their nests. Although they were away from the nest a total of 2 h, the process appeared to cause no harm to any of the young birds.

Food habits were determined by visiting each nest site every 3 days and identifying material in castings and prey remains found at the nest. Rodents were snap-trapped at the TRA ponds and were analyzed for radionuclide content by whole-body gamma scans.

Internal doses to raptors were calculated (Martin 1976) assuming the internal radionuclides were in equilibrium with the body and uniformly distributed throughout the body.

RESULTS

Whole-body gamma scans of young raptors (Table 1) indicated that birds from nests near TRA and ICPP had higher concentrations and a larger variety of gamma-emitting radionuclides than those from other locations. Cesium-137 occurred in all birds in which radionuclides were detected and had the highest concentration of any radionuclides. It was the only radionuclide detected in birds near ICPP. Birds analyzed from nests near TRA contained up to 9 radionuclides (selenium-75, cesium-137 and -134, niobium-95, iodine-131, cobalt-60, zinc-65, barium-140 and lanthanum-140). The highest total activities were found in the Marsh Hawk and American Kestrel nestlings at TRA; 87 and 44 picocuries (pCi) per gram, respectively (pCi = 3.7×10^{-2} disintegrations/sec). Only young from nests near facilities had detectable amounts of radionuclides. The young Marsh Hawks were analyzed twice over a 10-day period, during which both radionuclide concentration and the number of nuclides in the nestlings increased.

Prey remains and feces from 2 American Kestrel nests were gamma scanned after the young had fledged. Seventeen radionuclides were detected. The radionuclides common to both the young from these nests and in the fecal and prey remains were of the same order of magnitude. Most of the radionuclides detected in the prey remains and feces as well as in the young raptors from the TRA area were also present in rodents (deer mouse [*Peromyscus maniculatus*]; least chipmunk [*Eutamias minimus*]; Ord's kangaroo rat [*Dipodomys ordii*]) captured near the TRA radioactive leaching ponds. These animals were all represented in the prey remains and castings of the American Kestrel: 2.7% were deer mice, 17.8% were chipmunks, and 1.4% were kangaroo rats. The mean concentration of radionuclides in

TABLE 1

RADIONUCLIDE CONCENTRATIONS IN AMERICAN KESTRELS, LONG-EARED OWLS, AND MARSH HAWKS IN RELATION TO DISTANCES FROM NUCLEAR FACILITIES ON THE INEL SITE*

Species	Distance km	(Facility)	Number of radionuclides detected	Activity (pCi/g) Bird 1	Bird 2
Marsh Hawk (1st count)	0.1	(TRA)	9	1.3	1.5
Marsh Hawk (2nd count)	0.1	(TRA)	9	35.0	87.0
American Kestrel	0.1	(TRA)	8	44.0	11.0
American Kestrel	0.2	(TRA)	3	1.3	3.3
American Kestrel	1.0	(ICPP)	1[a]	0.8	0.3
American Kestrel	1.0	(ICPP)	1	0.4	0.6
Long-eared Owl	1.4	(ICPP)	1	0.0[b]	0.0
Long-eared Owl	1.6	(ICPP)	1	ND[c]	0.4
Long-eared Owl	2.0	(ICPP)	0	ND	ND
Long-eared Owl	2.6	(ICPP)	1	0.3	0.2
Long-eared Owl	3.5	(ICPP)	1	ND	0.3

* No nuclides were detected in 2 young from each of 5 Long-eared Owl nests located from 4.2 to 12.5 km from ICPP or in 2 young from each of 2 American Kestrel nests located 6.6 and 11.2 km, respectively, from ICPP.
[a] Those with 1 detected radionuclide contained only Cs-137.
[b] Nuclide detected, but value not determined.
[c] ND = No nuclides detected.

rodents was approximately 4 to 290 times greater than in the raptors at TRA (deer mice, 381 pCi/g; least chipmunks, 68 pCi/g; Ord's kangaroo rats, 4 pCi/g).

Based on the radionuclide concentrations at the time of analyses, doses to raptors from internal gamma-emitting radionuclides ranged from 0 to 0.1 mrem/day (mrem is a unit of absorbed dose equivalent).

DISCUSSION

Young birds from 1 Marsh Hawk and 2 American Kestrel nests nearest TRA contained the highest radionuclide concentrations (Table 1). However, the concentrations encountered in the raptors were lower than those found in potential prey items collected near the TRA ponds. Since the contamination at the TRA ponds is primarily contained within a 2.6 ha area of the pond complex, other prey within the home range of the raptors in the TRA vicinity contained only cesium-137 at background concentrations of 0.3 pCi/g. Therefore the raptors likely fed on prey both from the TRA pond area and from noncontaminated areas.

The increase in body burdens of young Marsh Hawks over a 10-day period suggests that they fed on radioactively contaminated prey or consumed a more contaminated prey item prior to the later gamma counting. Since the nuclides that were detected in these nestlings were found in the TRA pond prey species and the young birds were confined to the nest, we presumed the raptors were being contaminated through their food. However, we could not conclude that the nestlings were fed prey items exclusively from the contaminated area.

All remaining young which had detectable radionuclides contained only Cs-137 with a minimum detection limit of 0.02 pCi/g ($P = 0.05$). The average Cs-137 concentrations in nestling raptors was 1.8 pCi/g. Average Cs-137 concentrations in passerine birds from the Oak Ridge National Laboratory White Oak Lake Bed in Tennessee were 12 to 1550 times higher than in the birds in this study (Willard 1960). Coots (*Fulica americana*) from a cooling reservoir at the Savannah River Plant in South Carolina had Cs-137 concentrations 2 to 4 times higher than nestling raptors studied at the INEL (Brisbin et al. 1974).

Some Cs-137 may be expected in all nestlings since it is an ubiquitous component of world-wide fallout. Young raptors containing detectable amounts of Cs-137 were from nests located adjacent to or within 3.5 km northeast of ICPP. Birds from the nests farther northeast or southwest of ICPP did not contain detectable concentrations of radionuclides (Table 1). The predominant winds on the INEL Site are from the southwest. Since ICPP releases Cs-137 into the atmosphere, and the soils near ICPP have detectable concentrations of Cs-137, we concluded that the Cs-137 body burdens in nestling raptors northeast of the facility have resulted from effluents at ICPP. Previous studies on pronghorns (*Antilocapra americana*) (Markham et al. 1976) and Mourning Doves (*Zenaida macroura*) (Markham 1976) have shown that elevated Cs-137 muscle concentrations in these species near ICPP were due to ICPP atmospheric releases.

The maximum dose received by raptors from internal radionuclides was 0.10 mrem/day which is less than ¼ of the natural background radiation for this area (0.45 mrem/day, U.S. ERDA 1977). Due to the small dose from internal radionuclides and the short time young raptors are exposed to them, no injurious radiation effects would be expected.

A high uncertainty (± 25%) was associated with our gamma counting method. This uncertainty resulted because our instruments were not calibrated for such irregularly shaped specimens and because the distribution of the radionuclides in the bodies of the raptors was unknown. However, the data are available for indicating which radionuclides are present and the relative magnitude of the concentrations.

SUMMARY

Young raptors from nests near a nuclear reactor facility and a nuclear fuel reprocessing plant in Idaho were studied to determine the concentrations of gamma-emitting radionuclides in them. Young from nests close to the Test Reactor Area (TRA) showed the highest concentrations and largest variety of radionuclides of any birds studied. Since the same radionuclides were present in potential prey items collected near the radioactive leaching ponds and in samples of fecal material and prey remains from the nests, we concluded that the radionuclides originated at the radioactive leaching pond near TRA and were passed to the raptors through their prey. However, the concentration of radionuclides in raptors was much lower than in prey items from the TRA pond. Our data indicated that although radionuclides were transferred to higher trophic levels, the concentrations were diluted considerably by consumption of uncontaminated rodents. Raptors which nested immediately downwind of or near the Idaho Chemical Processing Plant (ICPP) showed detectable concentrations of Cs-137. Since the soils around ICPP were contaminated with low levels of Cs-137 and ICPP released Cs-137 to the atmosphere, the concentrations in these nestlings probably was due to atmospheric release of radioactivity from this facility. We concluded from our data that the influences of ICPP and TRA on radionuclide concentrations in nestling raptors were limited to an area within 3.5 km of the facilities.

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