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Cesium-137 Levels Detected in Georgia Otters

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Beginning in the 1940's and continuing through the 50's and early 60's, nuclear devices were tested by aerial detonation in the United States and other countries around the world. The discovery of radionuclide by-products in various foods and in humans during the mid- and late 1950's led to the curtailment of atmospheric testing in the U.S., although some foreign countries continued to periodically have aerial detonations. Cesium-137 (^{137}Cs) is one of the most important radionuclide by-products due to its abundance and slow decay (30-year half-life) (Shannon et al. 1965). The uptake of ^{137}Cs in animal tissue is the result of its similarity to potassium (Davis 1963; NAS 1963). Cesium-137 is rapidly absorbed in the gastrointestinal tract and the greatest concentrations eventually accumulate in voluntary muscles (Davis 1963; Comar 1965; Ekman 1966). The somatic and genetic effects of ^{137}Cs, along with its effect on reproductive cells, can pose great hazards to wildlife species (Langham and Anderson 1959; French 1965; Shannon et al. 1965).

Jenkins (1977) reported that the buildup of ^{137}Cs in white-tailed deer (*Odocoileus virginianus*) in the lower coastal plain of Georgia during the 1960's was followed by a gradual decline during the 1970's. Similar studies by Monroe (1966) and Stockbridge (1973) have shown accumulations in other terrestrial species such as bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), and raccoon (*Procyon lotor*). Although numerous studies have involved terrestrial mammals of Georgia, few have involved aquatic mammals such as the river otter. The route of Cesium-137 transfer through different aquatic trophic levels involves the adsorption and absorption by aquatic plants, ingestion by fish, and subsequent accumulation in piscivorous birds or mammals at the top of the food chain (Davis and Foster 1958; Shure and Gottschalk 1976; Smedile and Queirazza 1976). Shure and Gottschalk (1976) have reported mean concentration factors of 1334 - 2595 in largemouth bass (*Micropterous salmoides*), the top carnivore from a reactor effluent stream in South Carolina. This accumulation factor would have been even larger had piscivorous mammals been associated with the food web. With continued atmospheric testing by some foreign countries and the increased use of nuclear power as an energy source, there is a need for continued monitoring of radionuclides in wildlife to ascertain the quality of the environment. This study was initiated as part of an overall study of environmental pollutants in the river otter of Georgia and deals with analysis of the ^{137}Cs accumulations in this species.

MATERIALS AND METHODS

Otter carcasses were collected from trappers and fur dealers during the 1976-1977 trapping season from two areas in the Georgia coastal plain (Ware and Echols counties) and from several counties located in the Georgia piedmont (Wilkes, Green, Taliaferro, and Columbia counties). One hundred twenty-eight carcasses were

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collected: 58 from the Ware Co. area, 36 from the Echols Co. area, and 34 from the piedmont. Muscle tissue was collected from each otter and frozen in plastic containers until cesium analysis could be performed. Representative samples of fish including bowfin (*Amia calva*), shortnose gar (*Lepisosteus platostomus*), largemouth bass (*Micropterus salmoides*), channel catfish (*Ictalurus punctatus*), bream (*Lepomis* sp.), and spotted sucker (*Minytrema melanops*) were collected from the Satilla River in Ware Co., GA, and analyzed for ^{137}Cs by whole body counting.

Muscle tissue and fish (whole body) were analyzed for Cesium-137 by gamma spectroscopy using equipment and methods described by Monroe (1966), Jenkins and Fendley (1968), Fendley (1968), Bara (1970), and Stockbridge (1973). Samples were placed in lead protected counting chambers directly on or below a 3 x 3 inch sodium iodide crystal and scintillations were recorded for 40 min. on 100 channels of a 400 channel pulse height analyzer. The analyzer was equipped with an oscilloscope and automatic printout.

The ratio between standards containing known amounts of cesium chloride and otter muscle tissues was used to determine the ^{137}Cs levels present in picocuries per kilogram (pCi/Kg). Mean cesium levels found in the Ware County, Echols County, and piedmont samples were compared using Duncan's New Multiple Range Test.

RESULTS AND DISCUSSION

There was a significant difference among mean ^{137}Cs concentrations detected in the otters from all three study areas (Table 1). Samples from the lower coastal plain had 6-9 times higher concentrations than those from the piedmont ($p = .05$). No significant differences were found among sexes.

Table 1. Cesium-137 concentrations (pCi/kg) found in otter samples from three study areas in Georgia.

Geographical Province	N	Mean[1]	Range
Coastal plain (Ware Cty.)	57	4,578	182-17,314
Coastal plain (Echols Cty.)	35	6,819	435-21,219
Piedmont (Wilkes, Talieferro, Green, Columbia Ctys.)	34	752	54-4,628

[1]Means were significantly different ($p = .05$) according to Duncan's New Multiple Range Test.

Cesium concentrations in carnivorous fish ranged from 1-5 times higher than concentrations detected in omnivorous and insectivorous fish from Ware Co. (Table 2). The mean ^{137}Cs concentration in the omnivorous and insectivorous fish was 401.0 pCi/kg compared to 775.3 pCi/kg in carnivorous fish.

Wildlife species in the Southeast have been extensively analyzed for ^{137}Cs accumulations. The results of studies by Monroe (1966), Jenkins and Fendley (1968), Stockbridge (1973), and Jenkins (1977) indicate that the physical and chemical properties of the soil in the lower coastal plain of Georgia resulted in greater availability of ^{137}Cs to plant and animal species, which is reflected in larger accumulation concentrations in the biotic communities. The ^{137}Cs accumulations that have occurred in the lower coastal plain of Georgia are believed to be the result of fallout from atmospheric nuclear testing during the 1940's, 50's, and early 60's.

Table 3. Comparison of Cesium-137 levels found in bobcats, gray fox, raccoons and otters from the lower coastal plain of Georgia.

Species	1965[1]		1970-71[2]		1976-77	
	Mean	Range	Mean	Range	Mean	Range
Bobcat (*Lynx rufus*)	16,755	3,495-36,377	45,194	33,320-60,234		
Gray fox (*Urocyon cinereoargenteus*)	1,695	430-8,996	33,369	9,044-74,831		
Raccoon (*Procyon lotor*)	2,070	806-5,600	10,449	1,710-21,790		
Otter (*Lutra canadensis*)					5,698	182-21,219

[1]Monroe (1966)
[2]Stockbridge (1973)

By comparing the ^{137}Cs concentrations in bobcats, gray fox, and raccoons collected in 1965 from the lower coastal plain of Georgia with those collected in 1970-71, it is apparent that ^{137}Cs concentrations continued to increase until the early 1970's (Table 3). The ^{137}Cs concentrations detected in otters from the lower coastal plain of Georgia were higher than those observed in gray fox and raccoons in 1965, but lower than the concentrations detected in these species in 1970-71. Since ^{137}Cs concentrations in otters have not been studied previously, it is not known whether concentrations have also increased in this species. Similarly, ^{137}Cs concentrations detected in otters from the piedmont were lower than mean concentrations detected in bobcats (3,018 pCi/kg) and raccoons (1,337 pCi/kg) from the piedmont in 1970-71, while being comparable to concentrations detected in gray fox (897 pCi/kg) from that region.

Table 2. Cesium-137 levels (pCi/kg) found in various fish species from the Satilla River in Ware Co. Georgia.

Species	N	Mean	Range
Gar[1] (*Lepisosteus platostomus*)	1	1391.4	-----
Channel catfish[2] (*Ictalurus punctatus*)	1	727.4	-----
Bowfin[1] (*Amia calva*)	1	675.1	-----
Largemouth bass[1] (*Micropterus salmoides*)	2	517.3	396.7-637.8
Bream[3] (*Lepomis* sp.)	8	434.8	183.7-748.7
Spotted sucker[2] (*Minytrema melanops*)	4	260.2	42.6-619.2

[1]Carnivorous, [2]Omnivorous, [3]Insectivorous

The results of research by Monroe (1966) and Jenkins (1977) indicate that the accumulation of ^{137}Cs in terrestrial mammals is 3-4 times the concentrations detected in deer rumen samples or in prey species of the raccoon and grey fox. The ^{137}Cs concentrations detected in fish from the current study averaged 494.9 pCi/kg, which would indicate an accumulation factor of 9 times for Ware Co. otters.

The results of this study have shown that high cesium concentrations do occur in otters in the lower coastal plain of Georgia. The effects of continued low level contamination on this species, as well as other wildlife, is speculative. With the anticipated increase in nuclear energy sources, continued monitoring of fish and aquatic mammals is necessary in order to keep abreast of environmental pollution by radionuclides.

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