Fitzner

EXCREMENT FROM HERON COLONIES FOR ENVIRONMENTAL ASSESSMENT OF TOXIC ELEMENTS

R. E. FITZNER, W. H. RICKARD, and W. T. HINDS

Pacific Northwest Laboratory, Operated by the Battelle Memorial Institute, Richland, Washington 99352, U.S.A.

(Received 6 October, 1981)

Abstract. Excrement cast from Great Blue Heron nests was collected during the nesting period of 1978 from four colonies in Washington and Idaho. Cheesecloth strips placed on the ground beneath the nests served as excrement collecting devices. Chemical analysis for lead, mercury and cadmium were performed on dried samples. Lead was the most abundant trace metal found in heron debris. The Idaho colony at Lake Chatcolet had an average concentration of 46 ppm in the beneath-nest samples and 6 ppm in control samples. A heron colony near Tacoma, Washington had beneath-nest samples averaging 28 ppm and control samples averaging 20 ppm. Two colonies located in the interior region of Washington had substantially lower concentrations of lead. The difference observed between colonies was attributed to their associations with a polluted watershed (Chatcolet colony) an interstate highway (Tacoma colony) and an unpopulated largely agricultural area (inland Washington).

Great Blue Herons, *Ardea herodias* L., nest in colonies usually in tall trees located near rivers, lakes or estuaries. The colonies usually range in size from 2 to 200 pairs, sometimes more (Bent, 1926, Vermeer, 1973, Werschkul *et al.*, 1977, Custer and Osborn, 1977, English, 1978). During the nesting season, adults make daily foraging flights and return with food, mostly fish, to feed their young. Heron excrement (pellets and fecal matter) is cast from active nests, and accumulates on the ground (Wiese, 1978). Thus herons possess at least six ecological features that make them amenable to long-term studies of food chain contamination. (1) The parents have limited foraging ranges so that items delivered to the nests are of 'local' origin (Custer and Osborn, 1978, Palmer, 1962). (2) The amount of food brought to the colony by parent birds is large (Kushlan, 1978). (3) The amount of debris produced by individual colonies ranges from hundreds of kilograms at small colonies to thousands of kilograms per season at large colonies (Rickard *et al.*, 1978). (4) Passive collection of excrement would preclude direct research-induced mortality in the nesting heron population, because the collection could be done with minimal disturbance of the nesting birds. (5) Colonies of great blue herons are distributed throughout North America (American Ornithologists Union, 1957) and are generally reused so that the same colonies can be studied year after year. (6) Finally, it is likely that herons will continue to be a part of the fauna of the United States for many years, if suitable trees are available for nesting, if natural foods remain available, and if chemical contamination is kept below injurious levels.

Four colonies in Washington and Idaho were selected for study (Figure 1). Excrement cast from nests was collected during the nestling period (April–June) of the 1978 nesting season by placing multi-layered strips of cheesecloth beneath 6 different nest groups at each colony (Rickard *et al.*, 1978). Two cheesecloth strips were placed under nearby trees

Environmental Monitoring and Assessment 1 (1982) 383–386. 0167–6369/82/0014–0383$00.60.

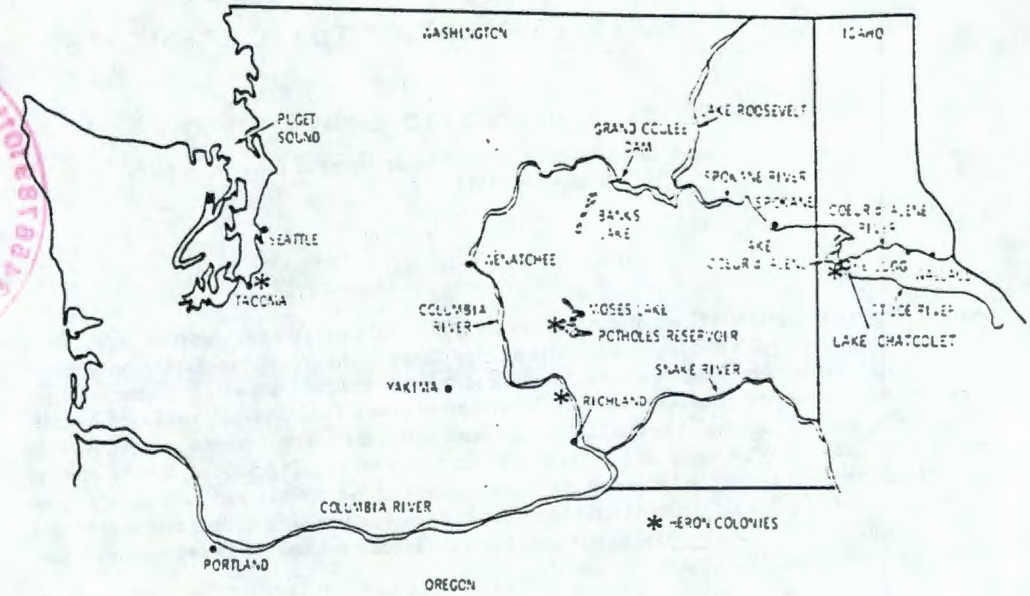

Fig. 1. Map of Washington and northern Idaho showing the location of the heron colonies studied in 1978.

without nests. These served as negative controls to quantify contamination contributed directly to cheesecloth strips via precipitation and airborne deposition and by foliage drip. Chemical analyses for lead, mercury and cadmium were performed on dried samples by Raltech Scientific Services, Madison, Wisconsin.

Lead was the most abundant trace metal in heron debris. It was most abundant at the Lake Chatcolet, Idaho colony, and moderately abundant at Tacoma, Washington. The difference between the means of the lead content for these two areas is significant at $p < 0.05$ (paired-t test). Small amounts of lead were found at Richland and the Potholes Reservoir, Washington (Table I).

The average concentration of lead in the beneath-nest strips at Chatcolet was 46 ppm while the negative control strips had only about 6 ppm dry weight. This suggested that less than 15% of the lead found in excrement was being contributed by airborne deposition. The colony near Tacoma produced beneath-nest cheesecloth strips averaging 28 ppm dry weight but the negative control strips averaged 20 ppm. This suggested that the lead measured at the Tacoma colony was derived mostly from airborne deposition and foliage drip. Cadmium followed the same distributional pattern as lead. Mercury was found only in small amounts (Table I).

Northern Idaho is one of the largest producers of metal ore in the United States and a smelter has been in operation at Kellogg for decades. Nevertheless, the high concentrations of lead in Lake Chatcolet heron debris were not expected, because of the distance of the Kellogg-Wallace mining district (50 km) from Lake Chatcolet. Furthermore, Lake Chatcolet and its watershed are detached from the polluted Couer d'Alene river system (Rabe and Bauer, 1977). The Couer d'Alene River, however, empties into Lake Couer

TABLE I

Average lead, cadmium and mercury content (ppm) ± standard error in debris cast from heron nests at colonies in Washington and Idaho. Treatment = cheesecloth strips receiving heron debris; control = cheesecloth strips with no heron debris

Location	Lead	Cadmium	Mercury
Lake Chatcolet, Idaho			
Excrement (n = 6)	46 ± 7.4	1.8 ± 0.08	0.28 ± 0.011
Neg. control (n = 2)	5.7 ± 1.3	0.22 ± 0.030	0.085 ± 0.016
Debris (treatment – control)	40[a] ± 7.4	1.6[a] ± 0.08	0.20[b] ± 0.016
Tacoma, Washington			
Treatment (n = 6)	29 ± 5.3	0.19 ± 0.020	0.17 ± 0.019
Control (n = 2)	20 ± 1.8	0.24 ± 0	0.14 ± 0.061
Debris (treatment – control)	8 ± 5.6		
Richland, Washington			
Treatment (n = 6)	3.3 ± 0.35	0.45 ± 0.040	0.10 ± 0.007
Control (n = 2)	1.4 ± 0.42	0.11 ± 0.08	< 0.05
Debris (treatment – control)	1.9 ± 0.42	0.34 ± 0.09	> 0.05
Potholes Reservoir, Washington			
Treatment (n = 6)	0.79 ± 0.06	0.092 ± 0.013	0.059 ± 0.004
Control (n = 2)	1.0 ± 0.38	0.14 ± 0.045	0.420 ± 0.330
Debris (treatment – control)	Nil	Nil	Nil

[a] Control is significantly ($P < 0.05$) different from treatment.
[b] Control is significantly ($P < 0.10$) different from treatment.

d'Alene less than 5 km from the Chatcolet colony. Herons feeding in or near other small lakes associated with the Couer d'Alene river system could also be feeding in polluted waters (Rabe and Bauer, 1977).

The heron colony near Tacoma was close to an interstate highway, an operational copper smelter and a large industrial metropolitan complex. The control cheesecloth strips indicated significant airborne accumulations of lead. In contrast, the trace metal content of heron debris in the sparsely populated, largely agricultural interior region of Washington was substantially lower than either the Tacoma or Idaho sites.

The approach described here is appropriate for long-term environmental monitoring using herons as indicator species. The data appear to reflect the relative levels of contaminants in the environment, without requiring knowledge of the conditions of the herons, or details of their food supply network. Nevertheless, prey and heron tissue contaminant measurements coupled with these excrement measurements are planned for the future to provide us with a quantitative understanding of the implications of the simple excrement monitoring technique. With this understanding, our data suggest that simple field procedures, plus appropriate analyses, allow the great blue heron to serve as environmental filters. They will provide inexpensive comparisons of pollution trends in widely distributed areas.

Acknowledgement

This research was performed under contract DE-AC06-76 RLO-1830 for the U.S. Department of Energy.

References

American Ornithologists' Union: 1957, *Check-list of North American Birds.* 5th ed. Amer. Ornithol. Union, Baltimore.

Bent, A. C.: 1926, *Life Histories of North American Marsh Birds.* U.S. Natl. Mus. Bull. 135.

Custer, T. W. and Osborn, R. G.: 1977, *Wading Birds as Biological Indicators: 1975 Colony Survey,* U.S. Dept. of Interior. Fish and Wild. Serv. Special Scientific Report No. 206, 28 pp.

Custer, T. W. and Osborn, R. G.: 1978, 'Feeding Habitat Use by Colonially – Breeding Herons, Egrets, and Ibises in North Carolina', *The Auk* 95, 733–743.

English, S. M.: 1978, 'Distribution and Ecology of Great Blue Heron Colonies on the Willamette River, Oregon', in A. Sprunt, IV, J. C. Ogden, and S. Winckler (eds.), *Wading Birds.* National Aubudon Society, New York, New York, pp. 235–255.

Kushlan, J. A.: 1978, 'Feeding Ecology of Wading Birds', in A. Sprunt IV, J. C. Ogden, and S. Winckler (eds.), *Wading Birds.* National Audubon Society, New York, New York, pp. 249–297.

Palmer, R. S. (ed.): 1962, *Handbook of North American Birds.* Vol. I, Yale University Press, New Haven, Connecticut.

Rabe, F. W. and Bauer, S. B.: 1977, 'Heavy Metals on Lakes of the Couer d'Alene River Valley, Idaho', *Northwest Sci.* 51, 183–197.

Rickard, W. H., Hedlund, J. D., and Schreckhise, R. G.: 1978, 'Rejecta Cast from Heron Nests as an Indicator of Food Chain Contamination', *The Auk* 95, 425–427.

Vermeer, K.: 1973, 'Great Blue Heron and Double-crested Cormorant Colonies in the Prairie Provinces', *The Canadian Field Naturalist* 87, 427–432.

Werschkul, D., McMahon, E., Leitzchuk, M., English, M., Skibinski, C., and Williamson, G.: 1977, 'Observations on the Reproductive Ecology of the Great Blue Heron (Ardea herodias) in Western Oregon', *The Murrelet* 58, 7–12.

Wiese, J. H.: 1978, 'Heron Nest-site Selection and Its Ecological Effects', in A. Sprunt IV, J. C. Ogden, and S. Winckler (eds.), *Wading Birds,* National Audubon Society, New York, New York, pp. 27–34.