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RADIOTELEMETRY LOCATES WINTERING GROUNDS OF DDE-CONTAMINATED BLACK-CROWNED NIGHT-HERONS

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In a previous study (1978–1980) of black-crowned night-herons (*Nycticorax nycticorax*) nesting in the Pacific Northwest (Henny et al. 1984), some exceptionally high levels of DDE were found in eggs. Egg DDE levels >8 ppm (wet weight) were accompanied by low productivity and a high incidence of cracked eggs. A strong north-south clinal pattern of DDE residues in eggs was found, with the southern colonies most contaminated. Observed productivity was below population maintenance at Ruby Lake, Nevada. No breeding ground DDT–DDE contamination in prey species was found except along the Columbia River, where higher than expected (based on latitude relationship only) night-heron egg residues were documented. Fortunately, DDE residues in western night-heron eggs decreased in recent years (through 1983), which resulted in an improved outlook for western populations (Henny et al. In press).

The original study left 2 questions unanswered: (1) where did the night-herons obtain the DDE found in their eggs, and (2) what phenomenon explains the geographical cline in DDE residues? Disjunct wintering ranges with slight overlap could explain the observed residue cline if DDE presence was different among wintering localities. Some winter (Nov–Feb) band recoveries were available at the time of the original study, but the data were insufficient to draw firm conclusions. To answer the questions, we attached radio transmitters to 15 black-crowned night-herons at Ruby Lake and to 14 night-herons at Pocatello, Idaho, to determine wintering localities. In 1979, the Ruby Lake colony was heavily contaminated with DDE (geometric $\bar{x}$ in eggs = 8.2 ppm [Henny et al. 1984]), while colonies near Pocatello (about 400 km north-northeast of Ruby Lake) contained substantially less (Mud Lake—2.2 ppm, Blackfoot Reservoir—2.4 ppm, Minidoka—3.5 ppm [Findholt and Trost 1985]). Our study was designed to see if there were differences in wintering localities that could explain the 3-fold difference in DDE residues in eggs from the 2 colonies.

METHODS

Banding Analysis

Henny et al. (1984) and Findholt and Trost (1985) reported winter band recoveries from night-herons banded at nesting colonies in Oregon, Idaho, and Ruby Lake, but additional records are now available. We reevaluated all recoveries from night-herons banded in those locations that were on file at the Bird Banding Laboratory, Laurel, Maryland. The band recoveries of most interest were those during the wintering period (Nov–Feb). Unfortunately, many records from Mexico had inexact dates of recovery. If a night-heron was recovered south of the United States, it was included as a winter record in this study. Original letters to the Bird Banding Laboratory were examined to pinpoint where a night-heron was encountered (computer printout does not provide latitude and longitude for Mexico).

Radiotelemetry

Transmitters (MMK3MX in RB5 configuration with a 30-cm TA-5M antenna, manufactured by Telonics, Mesa, Ariz.)[1] were attached to 15 night-herons from

[1] Use of trade names does not constitute endorsement by the U.S. Government.

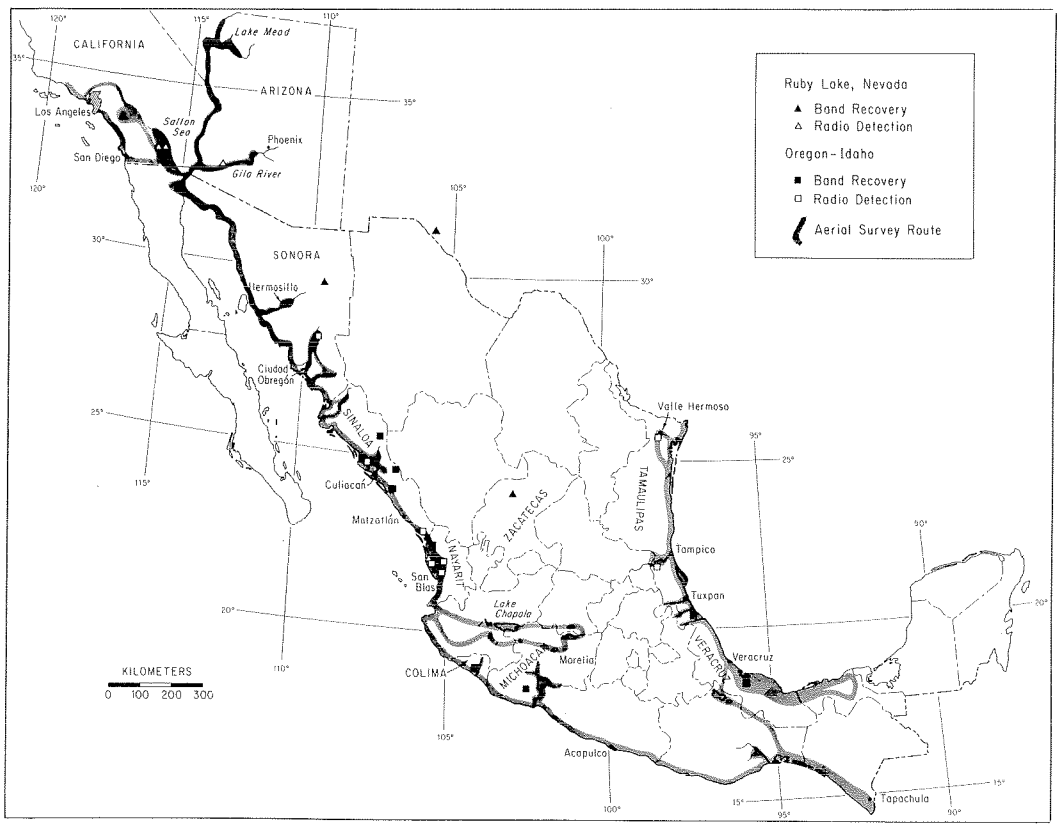

Fig. 1. Aerial survey route to locate wintering black-crowned night-herons.

Ruby Lake (frequency 164.5375 MHz) and to 14 night-herons from Pocatello (frequency 164.5875 MHz). Transmitters were attached as described by Brander (1968) and modified by Castillo et al. (1984). Birds were recognized only by their breeding colony of origin, rather than individually. The hermetically sealed transmitter and harness weighed about 30 g with a pulse rate of 40–44/min and a pulse width of 13–17 milliseconds. This arrangement allowed 9 months of battery life. Seven adult (after second year, ASY) and 8 second year (SY) night-herons were trapped at night at the Gallager Fish Hatchery, adjacent to Ruby Lake between 16 and 22 June 1982; 13 ASY and 1 SY night-herons were trapped at Batise Spring Fish Hatchery near Pocatello on 14 July 1982. They were released immediately after the transmitter was attached. Hatch-year birds were not selected because of anticipated higher mortality during the first year, i.e., lower probability of reaching the wintering grounds.

Two 3-element yagi antennas (side-looking antennas, set at 20° angles) were attached to wings of a Cessna 185 aircraft for relocating the night-herons in January. A left-right switch box (Gilmer et al. 1981) was used to locate each bird. We used 2 model LA12 receivers (AVM Instruments, Champaign, Ill.) simultaneously that continually monitored the 2 frequencies. Ear phones were modified to simultaneously receive each frequency in a different ear. Field tests of the equipment showed that signals could usually be detected at distances of 15–20 km and sometimes up to 40 km in flat terrain when flying at 1,000 m. We are confident that no double-counting of radio-equipped night-herons occurred because of the speed at which we were moving from area to area. Radio interference was minimal when flying in Mexico, but was a serious problem around cities and some military installations in southern California.

The area surveyed by aircraft was delineated based on patterns of band recoveries from Pacific Northwest colonies. Only a few night-herons were banded at Ruby Lake over the years, while relatively large numbers were banded at locations in Oregon and Idaho. The survey started in southern Nevada at Lake Mead and followed the Colorado River south with searches of

Table 1. Wintering localities of black-crowned night-herons that nested at Ruby Lake, Nevada, and at several colonies in Oregon and Idaho.

Wintering locality	Ruby Lake		Oregon–Idaho	
	Radios	Bands	Radios	Bands
Calif.	2	1	0	0
Ariz.	1	0	0	0
Tex.	0	1	0	0
Subtotal (U.S.)	3	2	0	0
Sonora	0	1	1	0
Sinaloa	0	0	2	5
Tamaulipas	0	0	1	0
Zacatecas	0	1	0	0
Nayarit	1	0	3	3
Colema	0	0	0	1
Michoacan	0	0	0	1
Vera Cruz	0	0	1	2
Subtotal (Mex.)	1	2	8	12
Total	4	4	8	12
Latitude (mean) encountered	30°15′N	29°30′N	23°30′N	22°15′N

adjacent wetlands in Arizona and southern California; the survey route then followed the coastal zones of Mexico with a few incursions inland to wetland habitats. One pass was made along the coast unless the expanse of the wetlands was too large, then transects were made at about 10- to 15-km intervals. The survey was conducted between 12 and 23 January 1983 and represented nearly 80 hours of total flying time.

RESULTS

Oregon–Idaho Colonies

All band recoveries (12) of wintering birds from the Oregon–Idaho populations were from Mexico (Fig. 1), mainly along the west coast (Sinaloa, Nayarit, Colema, and Michoacan) (Table 1). Two night-herons were reported during the migration period (12 Oct and 5 Mar) in southern California (33°20′N 116°50′W, 33°10′N 116°40′W).

Eight of the 14 Pocatello night-herons with transmitters were relocated during the January flight; all were located in Mexico and their distribution paralleled the band recoveries. A concentration was found at the Marismas Nacionales (Nayarit) between Mazatlan and San Blas. Other night-herons were found at a reservoir north of Cuidad Obregon, a marsh (Presa Palito Blanco) near Valle Hermoso, small rivers near the coastal zone, and in the coastal zone. A search of inland wetlands in Jalisco and Michoacan yielded no detections.

Ruby Lake Colony

Except for an occasional winter record at the Ruby Lake Fish Hatchery, the population at Ruby Lake was migratory. Our limited banding resulted in only 1 winter recovery (Calif.) before the telemetry flight and 3 afterward. One night-heron was recovered east of Los Angeles (in Jan near Perris, Calif.), 1 in southwest Texas (in Dec near Tornillo, Hudspeth County), and 2 from the interior of Mexico (Moctezuma, Sonora; Nieves, Zacatecas).

Only 4 of 15 night-herons from Ruby Lake were relocated during the telemetry flight. Three were located in the southwestern United States: 2 in the Imperial Valley of southern California near the Salton Sea, and 1 along the Gila River about 35 km east of Yuma, Arizona. The other bird was in the Marismas Nacionales of coastal Mexico, the same general location as 4 night-herons from the Pocatello

colony. Results from both the banded and radio-equipped birds from Ruby Lake suggest that most of them do not winter in the coastal regions of Mexico used by the Pocatello night-herons.

DISCUSSION AND CONCLUSIONS

Twelve of 29 night-herons with radios were relocated on their wintering grounds. Based on average mortality rates for adult black-crowned night-herons (Henny 1972), we estimate that 13 of 15 night-herons from Ruby Lake and 12 of 14 from Pocatello were alive at the time of the January survey. Only 4 night-herons (31%) from Ruby Lake in contrast to 8 (67%) from Pocatello were relocated. Although differences in the percent relocated appeared large between the 2 colonies, no statistical difference was found ($\chi^2 = 1.68$, $P = 0.20$). It was obvious from the outset that not all wetland areas in the southwestern United States and Mexico could be surveyed; therefore, it was anticipated that only a fraction of the birds would be relocated. The lower percentage of Ruby Lake night-herons relocated is probably related to several factors including (1) radio interference around certain regions, e.g., southern California; (2) the lack of survey effort in some areas of use; or (3) lower bird survival (more SY birds were marked at Ruby Lake). The survey plane was no closer than 150 and 300 km to the 2 locations of postsurvey band recoveries in Mexico, and no survey was made in Texas, where another was located.

There were sufficient differences in the geographical distribution of the night-herons on their wintering grounds that differences in DDE residues in eggs could be explained based on wintering ground contamination. Night-herons from Oregon and Idaho colonies "leap-frogged" and migrated beyond the Ruby Lake birds and wintered primarily in the coastal zones of central Mexico (mean latitude 22°15′N or 23°30′N, respectively) (Table 1). Night-herons from Ruby Lake wintered in southern California, southern Arizona, and southern Texas with some continuing into Mexico—primarily the interior (mean latitude 30°15′N, or 29°30′N). The slight overlap in wintering distribution could explain the existing DDE cline in residue burdens on the breeding range in the Pacific Northwest (Henny et al. 1984).

Coupled with the different wintering areas for the populations were the distinct residue profiles in their eggs (Henny et al. 1984, Findholt and Trost 1985). Ruby Lake night-herons in 1979 had the highest mean residues of DDE, the highest incidence ($\geq$0.10 ppm detection limit) of DDT (52%), and the highest incidence ($\geq$0.50 ppm detection limit) of PCBs (70%). In contrast, colonies in southeastern Idaho showed low residues of DDE and a comparatively low incidence of PCBs (18%). PCBs are industrial pollutants (Zinkl 1982) and, with respect to the Ruby Lake colony, are most likely associated with the industrialized southwestern United States rather than agricultural lands in the interior of Mexico. Thus, before evaluating residues from the wintering grounds, the localities of marked birds and egg residue profiles from Ruby Lake intimated that the southwestern United States was an important source of the pollutants.

Other studies also have suggested that wildlife may be exposed to contaminants, particularly DDE, in the southwestern United States. Northern pintails (*Anas acuta*) accumulated DDE and PCBs during fall and winter in the Imperial Valley of southern California but lower residues were accumulated in 3 regions of southwestern Mexico (Mora 1984, Ohlendorf and Miller 1984). Channel catfish (*Ictalurus punctatus*) and carp (*Cyprinus carpio*) from the Alamo River (which flows into the Salton Sea) in the Imperial Valley contained the highest total DDT levels in fish recorded in a California monitoring program in 1981 (La Caro et al. 1982). Furthermore, European starlings (*Sturnus vulgaris*) from the Imperial Valley and Maricopa County, Arizona (loca-

tion of Gila River), contained elevated concentrations of DDE in 1979 (Fleming et al. 1983). In the same review paper, high DDE levels were noted in fish collected from Painted Rock Reservoir and the Gila River. Another area with elevated DDE residues in fish and birds was the lower Rio Grande Valley in Texas (White et al. 1983). Thus, all known Ruby Lake night-heron wintering localities in the United States contained elevated pollutant burdens. We have no contaminant data from the interior of northern Mexico, but fish collected in coastal Mexico in 1983 and 1984 (Henny et al. In press), near locations where night-herons from Oregon and Idaho wintered, contained lower DDT–DDE residues. Rosales and Escalona (1983) also reported low DDT–DDE residues in the muscle of fish, crustaceans, decapods, and mollusks collected at 2 lagoons in northwestern Mexico (Yavaros, Sonora, and Huizache-Caimanera, Sinaloa).

SUMMARY

This study was designed to determine if night-herons nesting at Ruby Lake, Nevada, shared a common wintering area with lesser contaminated night-herons nesting farther north in Oregon and Idaho. Radiotelemetry (29 transmitters) and banding studies indicated that the lesser-contaminated Oregon–Idaho night-herons wintered primarily in coastal Mexico (mean 22–23°N latitude), while the Ruby Lake night-herons wintered in the southwestern United States with some in the interior of northern Mexico (mean 29–30°N latitude). We believe the nearly disjunct wintering areas for the populations, and the apparent differing pollutant loads on the wintering areas accounted for the 3-fold higher DDE egg residues at Ruby Lake. Findings from this study emphasize the influence migration patterns can have on pollutants accumulated by populations of migratory birds nesting in relatively unpolluted areas and at relatively short distances apart (400 km).

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