CAUSES AND CONSEQUENCES OF INGESTED LEAD PELLETS IN CHUKARS

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EXTENDED ABSTRACT.—Lead-pellet ingestion and the resulting toxicosis are well-documented in waterfowl, raptors, and Mourning Doves (*Zenaida macroura*) (Kendall et al. 1996). Ingestion of lead shot by other avian taxa is less well-understood, but a growing body of literature suggests it does occur and can be a significant source of mortality (Keymer and Stebbings 1987, Lewis and Schweitzer 2000, Vyas et al. 2000, Walter and Reese 2003, Butler 2005). We are currently investigating the ingestion of lead pellets by Chukars (*Alectoris chukar)* in Utah.

We have carefully processed hunter-harvested Chukars by removing the gizzards, inspecting them, and excluding any gizzards with penetration wounds. We have documented ingestion of lead pellets by Chukars throughout four counties in western Utah. We have found ingested lead-pellets in 8.74% of gizzards from our sample (n = 286). We used Inductively-Coupled Plasma/Mass Spectroscopy (ICP/MS) to analyze Chukar livers for lead residues. Toxicology results show elevated concentrations of lead (>0.5 ppm) in 14% (n = 50) of livers from our sample. Elevated concentrations of lead ranged from 0.7 to 42.6 ppm (wet weight). We consider lead concentrations from our sample that are greater than 0.5 ppm (ww) to be elevated because: 1) 43/50 (86%) of analyzed livers from our sample population contained less than 0.5 ppm lead and 2) the frequency of individuals in our sample between the categories of >0.1<0.5 ppm (n = 10) and >0.5<1.0 ppm (n = 1) decreased by an order of magnitude. Table 1 shows the categories for all our sample of analyzed livers. Regarding liver tissue, lead concentrations greater than 2 ppm (ww) are considered indicative of chronic exposure, whereas values greater than 6 ppm (ww) denote acute exposure (Pain et al. 1993). The discovery that multiple Chukars from independent populations have ingested lead pellets warrants additional investigation into the causes and consequences of lead-pellet ingestion by Chukars.

Ingestion of lead pellets by Chukars is likely related to 1) the arid, rocky, and alkaline nature of Chukar habitat, which reduces pellet settlement and dissolution (Shranck and Dollahon 1975, Walter and Reese 2003), 2) similarities in appearance between lead pellets and grit and food sources used by Chukars, and 3) use of natural and man-made water sources (Best et al. 1992). The inert nature of lead allows it to persist in acidic soils for up to 300 years (Jorgensen and Willems 1987) and presumably longer in basic soils such as those characteristic of Chukar habitat. We found that nearly a third of examined grit from our sample of Chukars, and all lead shot sizes that are generally used for upland game (#'s 4–8) are intercepted by a soil sieve with mesh having 2 mm diameter openings. Chukars from our sample commonly contained Indian Ricegrass (*Stipa hymenoides*) seeds in their crops and gizzards. These seeds have a strong resemblance in size, shape, and color to lead pellets.

Table 1. Lead concentrations and their corresponding frequencies and percents for 50 Chukar livers analyzed using ICP/MS.

Category	Frequency	Percent of Sample
<0.05[a]	20	40
>0.05 <0.1	13	26
>0.1 <0.5	10	20
>0.5 <1	1	2
>1 <2	4	8
>2 <6[b]	1	2
>6[c]	1	2

[a] All values are reported in ppm (ww).
[b] Values >2 ppm (ww) are consistent with chronic exposure to lead (Pain et al. 1993).
[c] Values >6 ppm (ww) are consistent with acute exposure to lead (Pain et al. 1993).

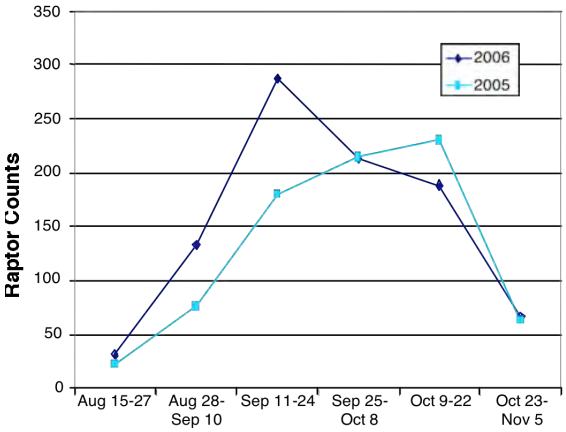

Figure 1. Raptor counts conducted by Hawkwatch International during the fall migrations of 2005 and 2006 in the Goshute Mountains of Eastern Nevada directly west of our Utah study area.

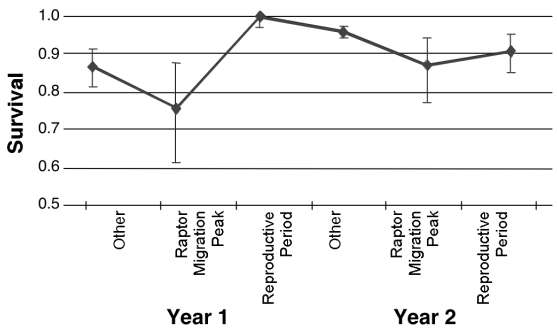

Figure 2. Two-week survival for radio-marked Chukars in our study area during 2005 and 2006. Survival estimates were less during peak raptor migration in both years (P = 0.06 in 2005) and (P <0.05 in 2006).

To monitor and assess the survival and probable causes of mortality of Chukars, we trapped Chukars on water sources using funnel traps and subsequently fitted these Chukars with nine and 14 g backpack-style radios from Advanced Telemetry Systems. We employed known fate models in Program MARK 4.1 (White and Burnham 1999) to estimate seasonal rates of survival and used model selection (Burnham and Anderson 2002) to evaluate hypotheses concerning seasonal differences in survival. Results from our radio-telemetry research showed that Chukar mortalities in our study area were due primarily to raptors and shooting. We obtained estimates of raptor migration for 2005 and 2006 using counts from the nearby Goshute Mountains of Eastern Nevada conducted by Hawkwatch International (Smith and Neal 2005, 2006). Figure 1 portrays the complete data from the 2005 and 2006 counts. During 2005 and 2006, nearly three-fourths (74%) of identified fatalities (n = 42) were attributed to raptors. Additionally, Chukars showed markedly-decreased survival rates during the fall raptor migrations of 2005 (P = 0.06) and 2006 (P <0.05). During the peak of raptor migration for 2005 and 2006, two-week rates of survival for radio-marked Chukars were lower than during any other two-week interval of the year, including the vulnerable period concomitant with reproductive behavior (see Figure 2).

Nearly half of Chukar mortalities that were attributed to raptors occurred during the fall migration of raptors through our study area. Also, fall migration of raptors coincides with the hunting season for all species of upland game in Utah including Chukars. Research concerning the relation between the hunting season for waterfowl and concentrations of blood lead in Marsh Harriers (*Circus aeruginosus*) has shown that amounts of blood lead rise significantly during the hunting season (Pain et al. 1997). Similar risks may be apparent to both migrating and resident raptors when feeding on upland game, particularly Chukars, in Utah.

Consuming Chukars may expose humans and wildlife to unhealthy concentrations of lead (Scheuhammer et al. 1998). Additional research is needed to clarify this risk. We are currently conducting further work to understand and assess the magnitude of this challenge. However, our research is largely

incomplete at this time. We are addressing such questions as: 1) why do Chukars eat lead pellets, 2) what are the toxicological consequences that accompany such ingestion, 3) do natural and man-made water sources contribute to elevated concentrations of lead pellets in soil, and 4) is Chukar breast unhealthy for consumption if it has been harvested with lead pellets? *Received 9 June 2008, accepted 4 September 2008.*

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