CAPTURE OF GOLDEN EAGLES TO DETERMINE SOURCES OF BLOOD LEAD (Pb) CONTAMINATION IN MONTANA, 2020, 2021

Report to Sacajawea Audubon Society, 1 May 2021

Abstract.-- Report covers work completed in 2020 and 2021 to obtain blood samples from Golden Eagles (*Aquila chrysaetos*) for analysis of isotopic ratios of $^{206}Pb/^{207}Pb$. The global pandemic and inclement weather curtailed capture operations in 2020. Traps were set on 5 days between 23 Jan and18 Feb with 8 eagles captured. Adults comprised most Golden Eagles captured. One adult male had 3 of 4 digits of the right foot absent from an encounter(s) with leg-hold traps. In 2021, Covid-19 pandemic inhibited capture operations but most severe problem was lack of road-kill ungulate bait carcasses. Traps were set on 12 days between 5 and 21 Mar with 7 eagles captured. A total of 36 Golden Eagles and one Bald Eagle (*Haliaeetus leucocephalus*) were captured and blood collected from 2018 to 2021. Capture of 2 Golden Eagles missing phalanges was due to encounters with illegal leg-hold traps. Studies of isotopic ratios of Pb in birds indicate a variety of sources in addition to Pb-based ammunition. Analysis of blood samples from Montana Golden Eagles may indicate other issues of contamination in need of attention. It is likely FERC will no longer support analysis of Golden Eagle blood samples from this effort and other funding options for analysis of existing 36 samples may need to be explored.

BACKGROUND

This report covers a continuation of work last reported in May 2019. Due to the global pandemic, work for 2020 was in doubt and support from Sacajawea Audubon Society (SAS) was not solicited nor received. However, a few days were spent in the field early anticipating the impact of the societal shut-down from Covid-19 in March 2020. In 2021, as the shut-down eased and SAS again provided support for the project. This report includes results of both 2020 and 2021 field seasons.

Collection of whole blood and feather samples from Golden Eagles (*Aquila chrysaetos*) for analysis of isotopic ratios of elemental lead (Pb)[1] began in southwestern Montana in 2018. The US Geological Survey (USGS), Forest & Rangeland Ecosystem Science Center (FRESC) in Boise, Idaho committed to analyze samples. However, FRESC had to archive samples prior to analysis because of labor management restrictions and a subsequent loss of funding due to the pandemic. Tissue samples from Montana Golden Eagles have continued to accumulate and other funding options for analysis of existing blood samples may need to be explored in 2022.

METHODS

Eagle capture, banding, and sampling were authorized by Federal Bird Banding Permit #20357 (exp. 4/30/23), Fish & Wildlife Permit (Federal) Eagle Scientific Collecting MB04651B-0 (exp. 3/31/2022), Montana Fish, Wildlife & Parks Institutional Animal Care and Use Committee protocol and Scientific Collector's Permit # 2021-006-W (exp. 12/31/2021). Capture operations occurred regionally near the communities of Dillon, Sheridan, Ringling, and Emigrant in southwestern Montana between 23 Jan and 31 March 2020, 2021. Eagles were captured with remote detonated Coda™ net launchers. Road-killed wild ungulate carcasses were used as bait; many supplied by City of Bozeman Street Dept. or recovered as road-kills in the study area. A captive adult female Golden Eagle was not used as a lure 2021 due to her impending late season (3/29, 4/2) egg laying. Capture sites were usually >500 m apart and monitored continuously via spotting scope.

[1] See 2018 & 2019 reports for descriptions of potential Pb sources, ratio analysis details, and appropriate citations.

Table 1. Golden Eagles captured, banded, tissue sampled, and released in 2020.

2020 Capture Date/#	0799 Band	Age[1]	Sex	Mass	Ulna (mm)	Capture/Release Time/Location Cap	Rel	Latitude (N)	Longitude (W)
1/23-1	01757	AD	M	3375		1000	1038	45°27'20"	112°17'37"
1/23-2	01760	SY	M	3658		1555	1635	45°28'11.7"	112°17'31.17"
1/25-3	01759	AD[2]	M	4567		1251	1328	45°14'19"	112°55'59"
1/30-4	01872	AD	M	4217	209.6	1484	1512	45°35'2.24"	111°47'11.04"
2/13-5	01868	SY	M	3033	198	1121	1152	45°27'20"	112°17'37"
2/13-6	01869	SY	M	3375	198	1425	1457	45°26'49.7"	112°16'07.7"
2/17-7	01870	AD	M	3333	191	1110	1147	45°00'12"	112°53'58"
2/18-8	01871	NAD[3]	F	4833	207	1522	1557	45°00'12"	112°53'58"

[1]AD = Adult, SY = Second Year (Juvenile), NAD = Near Adult.
[2]Three toes absent, R foot.
[3]White R #5 rectrice.

Age classes assigned to captured eagles were based on plumage: juvenile = Second Year (SY), immature = Third Year (TY) subadult = After Third Year (ATY), and adult (AD). Various morphometrics[2] of captured golden eagles assisted in assigning sex and assessing general condition and a USGS rivet band was applied to one leg. One cc of whole blood was collected from each eagle captured and deposited in vacutainers. A small sample of feathers was collected from some eagles from the lower breast or abdomen. Eagles without full crops were force fed to satiation prior to release on site. Processing eagles on site spanned between 28 and 75 min depending on cooperation of the eagle. Blood samples were frozen and archived. Capture results of 2020 and 2021 are presented separately.

RESULTS

2020--. Capture operations began in late Jan. Initially, snow drifts blocked access to the historically most productive capture site near Ringling. Later, effects of the Covid-19 pandemic inhibited further field work for the remainder of the season.

Traps were set on 5 days between 23 Jan and 18 Feb with 8 eagles captured (Table 1). Most traps were set in the vicinity of Sheridan and Dillon, Montana. Two eagles were caught on 2 days and 1 on 4 days. Mean trap success was 1.6 eagles/day.

Adults (or Near Adult) comprised 63% of eagles captured. No adults were females. Most (60%) adults were captured early in the season. Three juveniles (SY, 38%) also were all males and 1 subadult was the only female captured in 2020. One adult male Golden Eagle (01759, Table 1) had 3 of 4 toes of the right foot absent (Fig.1) but was in remarkably good condition despite this relatively severe handicap. An NAD (near adult) male had a single completely white # 5 tail feather (01871 Table 1, Capture 7, APPENDIX: 2020 GOLDEN EAGLE CAPTURES). Mean processing time was 36 min/eagle (range 31 – 40 min, n = 8) in 2021. See APPENDIX for photos of captured eagles in sequence of capture.

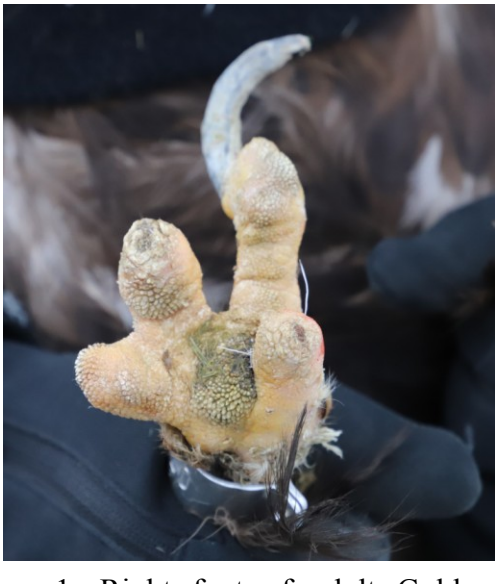

Figure 1. Right foot of adult Golden Eagle male with 3 toes amputated likely by an encounter with leg-hold trap(s) set for fur-bearers.

[2] See 2018 & 2019 reports for processing details.

EXPENDITURES

Table 2. Expenditures for Golden Eagle capture operations in southwestern Montana, Jan - Feb 2020. All expenditures donated by crew.

CATEGORY	COST
Mileage: 485@ MSU rates = 57.5¢/mi	279
Per diem ($23/d x 5 techs x 7 days)	805
Syringes: 80 @ 0.25	20
Vacutainers: 10 @	6
Grass Hay (cert. weed free)	30
9V Batteries	13
Total	1153

PERSONNEL

All personnel involved in the project were MSU graduates. Success would have not been possible without participation of Volunteer Eagle Capture Specialists (VECS). Participants were:
Eric Johnston, Field Team Leader
Kimberly Johnston, VECS
Colton Langell, VECS
Trenton Heisel, VECS
Al Harmata, VECS, PI

Table 3. Golden Eagles captured, banded, tissue sampled & released in 2021.

2021 Capture Date/#	Band Number	Age[3]	Sex	Mass	Ulna (mm)	Capture/Release Time/Location Cap	Rel	Latitude (N)	Longitude (W)
3/9-1	01881[1]	ATY	F	4925		1119	1157	45°25'57.61"	112°09'25.79"
3/13-2	01606[2]	SY	F	4783	241.3	1230	1305	46°14'31.86"	110°46'26.1"
3/13-3	01607[2]	TY	F	4925	247.7	1450	1520	46°14'31.86"	110°46'26.1"
3/14-4	01608[2]	AD	M	3600	219.0	1230	1345	46°14'31.86"	110°46'26.1"
3/14-5	01609[2]	ATY	F	4550	241.3	1615	1652	46°14'31.86"	110°46'26.1"
3/16-6	01882[1]	TY	F	4418		1323	1351	45°56'56.7"	111°51'29.11"
3/18-7	01883[1]	TY	M	3475	219.1	1235	1322	46°14'31.86"	110°46'26.1"

[1]Prefix 0799.
[2]Prefix 0829.
[3]AD = Adult, SY = Second Year (Juvenile), ATY = After Third Year (subadult).

2021--. The Covid-19 pandemic moderately inhibited capture operations but most severe problem was lack of road-kill ungulate carcasses. Bozeman Road Dept. delivered only 2 white-tailed deer (*Odocoileus virginianus*) all season and only 1 was usable as bait. Mileage was excessive searching for bait (225 mi) and only 3 deer carcasses were recovered.

Traps were set on 12 days between 5 and 21 Mar with 7 eagles captured (Table 3). At least 1 eagle was caught on 5 trap days; 2 were caught on 2 days and 1 on 3 days. Mean trap success was 0.58 eagles/day. Only 1 adult and 1 juvenile Golden Eagle were captured. The remainder was immature (TY) or subadult (ATY) eagles. Overall sex ratio was 3:2. Mean processing time was 41.4 min/eagle (range 28 – 75 min, n = 7), virtually no different from 2020 processing time (Z = -0.06, P = 0.95).

EXPENDITURES

Table 4. Expenditures for Golden Eagle capture operations in southwestern Montana, Mar 2021.

CATEGORY	COST
Mileage: 1470@ MSU rates = 56¢/mi	823
Per diem ($23/d x 4 techs x 10 days)	920
Grass Hay (cert. weed free)	35
9V Batteries	15
Camo netting	10
Compensation, Field Tech (KA)	200
Total	2003

PERSONNEL

Principals and Volunteer Eagle Capture Specialists (VECS) in 2021 field season were:
Eric Johnston, Field Team Leader
Kimberly Johnston, VECS
Logan Miller, VECS
Kelly Atkins
Marco Restani, VECS
Al Harmata, PI, VECS

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DISCUSSION

Capture--. A total of 36 Golden Eagles (APPENDIX Table 1) and one Bald Eagle (*Haliaeetus leucocephalus*) were captured and blood sampled from 2018 to 2021. Age class composition of Golden Eagles captured was not different from expected (χ^2 = -1.93, P = 0.59, APPENDIX Fig 1). Sex assignment in the field was 97.2% consistent with published models (APPENDIX Fig. 2). Over 4 years of effort, capture numbers were modest compared to the late 1980's when up to 36 eagles were caught in just one season. Low numbers stemmed from a variety of reasons; pandemic shut-down in 2020, a paucity of migrant Golden Eagles during capture, and lack of ungulate carcass baits in 2021. Possibly, success may have been greater in 2021 had the Golden Eagle lure been used. Passive observations suggested the actual peak of northward movement may have been later in Mar or early Apr 2021. By then, operations had ceased due to lack of appropriate bait. More eagles may have been caught had more days been expended in the field but ultimately, bad weather and availability of ungulate carcasses were the primary culprits.

Capture of 2 Golden Eagles missing toes during the tenure of this project is likely indicative of the all too pervasive danger of leg-hold traps to raptors and other nontarget species. Too often leg-hold trap sets for furbearers are placed with illegally exposed baits which attract nontarget species. Sets go unchecked for much greater periods than regulations allow. The number of Golden Eagle band recoveries (dead eagles) produced over the tenure of Banding Permit #20357 as a result of leg-hold traps is >20.

Isotopic Analysis--.The science of isotopic analysis of Pb is well established (Sangster et al. 2000) and has been shown to be useful as a tool for distinguishing between ammunition of various manufacturing origins (Buttigieg et al. 2003). Previous work has identified isotopic ratios from other origins, e.g. aerosols (Bollhöfer and Rosman 2001), gasoline (Flegal et al. 2010), and dust (Del Rio-Salas et al. 2012).

We (see PERSONNEL) are aware of five studies involving Pb isotopic ratios in birds. One involved the North Island Kaka Parrot (*Nestor septentrionalis*) and found rainwater as the primary source of Pb contamination (Sriram et al. 2018). Four studies involved eagles. Three involved dead eagles; one looked at tissues other than blood in both Bald and Golden Eagles (Scheuhammer and Templeton 1998), one used liver tissue of eagles found dead in Japan (Ishii et al. 2017), and one analyzed crop and gut contents of a juvenile Bald Eagle (Franzen-Klein et al. 2018). All found Pb contamination consistent with Pb-based ammunition. Only one study used blood of live, normal, wild Golden Eagle nestlings (Herring et al. 2020). Herring et al (*op cit*.) found the $^{206}Pb/^{207}Pb$ stable isotope ratios spanned a range of sources but only 45% of blood Pb ratios fell within the range associated with Pb-based ammunition. Over 55% were indicative of other sources.

We are sampling free ranging eagles at least 1 yr old and older eagles may provide different results which may warn of other Pb contamination sources in need of attention. FERC likely may no longer support analysis of 36 blood samples blood samples already collected and other mechanisms for analysis may need to be explored. Analysis estimates are ≥$150/sample or ≥$5250 for 36, minimum.

Although expenditures (Tables 2 & 4, previous years) exceeded grant funds from SAS, grant funds served as impetus and motivation to conduct the project. Perhaps modest results may serve as justification for similar or greater levels of funding from SAS for increased effort next year. The Board of SAS and/or individual members might consider funding the 2022 field season and/or

laboratory $^{206}Pb/^{207}Pb$ stable isotope ratio analysis of Montana Golden Eagle blood samples.

LITERATURE CITED

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APPENDIX

2020 GOLDEN EAGLE CAPTURES
(See Table 1 for associated data)

Capture 1 Adult Male

Capture 4 Adult Male

Capture 2 SY Male

Capture 5 SY Male

Capture 3 Adult Male

Capture 6 SY Male

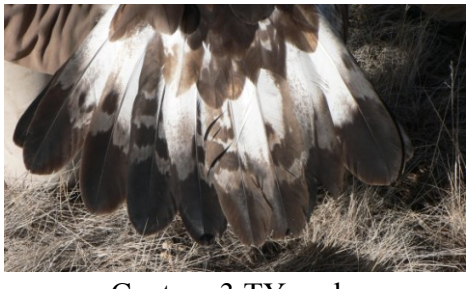
Capture 7 Adult Male.

Capture 8 Near Adult

2021 GOLDEN EAGLE CAPTURES
(See Table 3 for associated data)

Capture 1 ATY Female

Capture 2 SY Male



Capture 3 TY male

Capture 4 Adult Male

Capture 5 ATY Female

Capture 6 TY Female

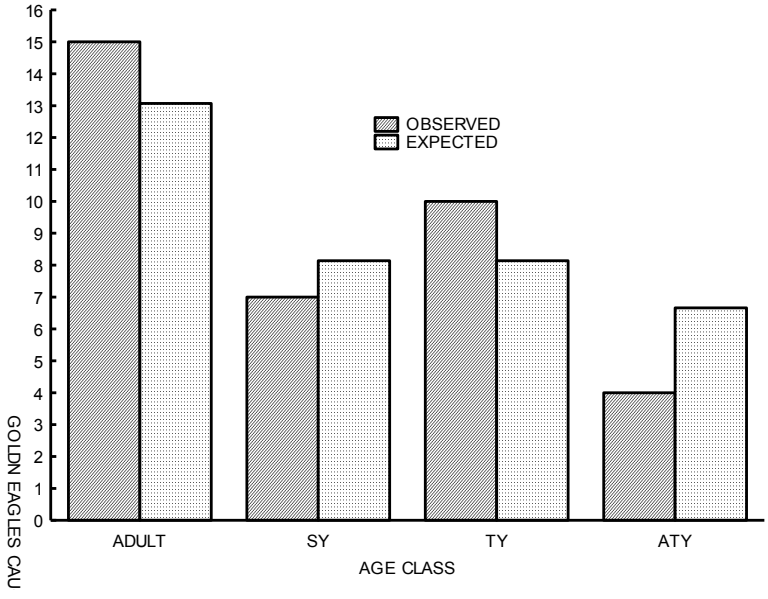
Capture 7 TY Male

Photos by Eric Johnston, Al Harmata, Kim Johnston, Trent Heisel, Colt Langell

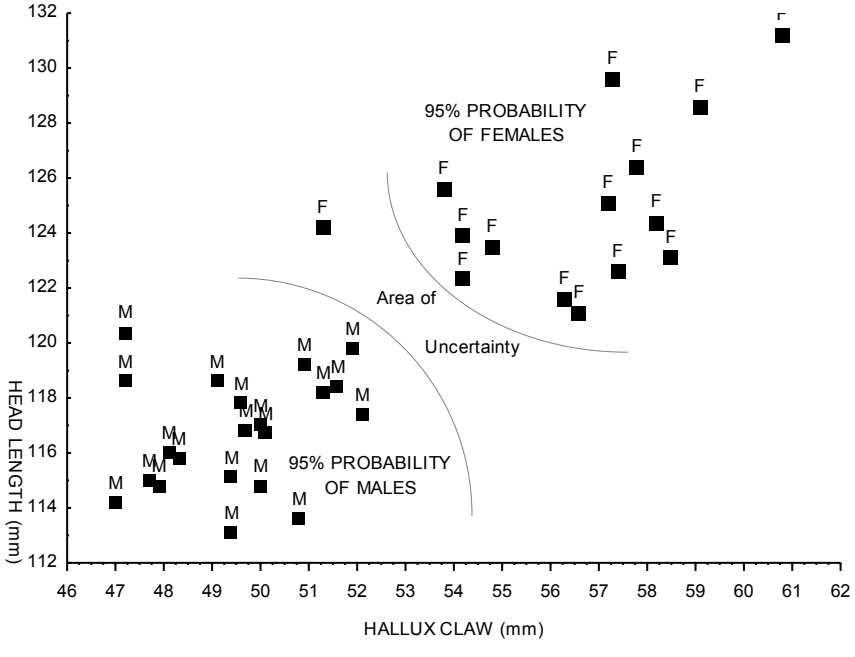
Appendix Table 1. Golden Eagles captured and sampled for $^{206}Pb/^{207}Pb$ stable isotope ratios in blood between March 2018 and March 2021.

	CAPTURE				BAND				HALLUX		BILL	HEAD
#	DATE	SITE	PROCESS TIME		SUFFIX	AGE[1]	SEX	MASS	CLAW	CULMEN	DEPTH	LENGTH
1	3/9/18	Big Creek	1255	1335	08806	AD	M	3700	50	47	29	117.0
2	3/14/18	Big Creek	1535	1559	00276	AD	M	2933	49.4	42.6	26.6	115.1
3	3/18/18	Big Creek	1320	1432	08811	AD	F	4133	57.2	49.1	30.7	125.1
4	3/18/18	Bowler Flats	1020	1045	08807	AD	M	3275	47.9	39.3	28.2	114.8
5	3/19/18	Bowler Flats	1400	1425	08808	AD	M	3768	47	40.3	27.5	114.2
6	3/19/18	Big Creek	1245	1340	00848	SY	F	4533	53.8	47.6	31.4	125.6
7	3/19/18	Big Creek	1410	1448	00277	AD	M	3758	47.2	43	27.7	118.6
8	3/19/18	Big Creek	1710	1752	00849	TY	F	4058	58.5	49.2	31.3	123.1
9	3/21/18	Morse Land Co	931	1005	08813	TY	F	4033	54.8	47.4	29.5	123.5
10	3/21/18	Morse Land Co	1517	1555	00278	TY	M	3124	49.6	43.3	28.7	117.8
11	3/29/18	Higgins Snodgr	1637	1735	06425	TY	M	3316	47.2	45.8	30.1	120.4
12	3/30/18	Bowler Flats	1135	1235	08809	TY	F	4600	54.2	45.9	30.7	122.3
13	4/1/18	Big Creek	1050	1133	00850	TY	F	4633	56.3	49.3	30.8	121.6
14	4/1/18	Big Creek	1222	1318	01756	ATY	F	4558	59.1	48.2	30.1	128.6
15	2/23/19	Morse Land Co	1220	1255	00281	TY	M	3259	50.1	44.7	28.1	116.7
16	2/24/19	Morse Land Co	1403	1440	01758	SY	F	4135	57.8	48.6	30.3	126.4
17	2/23/19	Morse Land Co	1500	1538	08818	AD	M	3476	49.7	44	27.8	116.8
18	3/14/19	Morse Land Co	1303	1340	08819	SY	M	3135	47.7	41	27.4	115
19	3/15/19	Morse Land Co	1133	1212	08820	AD	F	4135	52.1	45.7	29.8	117.4
20	3/20/19	Argenta BLM	857	952	08821	AD	M	3617	49.1	43.7	27.6	118.6
21	3/20/19	Argenta BLM	1517	1605	08822	AD	F	4400	57.4	46.5	28.8	122.6
22	1/23/20	Morse Land Co	1000	1038	01757	AD	M	3375	51.9	42.4	27.9	119.8
23	1/23/20	Morse Land Co	1555	1635	01760	SY	M	3658	49.4	40.4	26.4	113.1
24	1/25/20	Badger Pass	1251	1328	01759	AD	M	4567	51.6	44.7	29.6	118.4
25	1/30/20	Sitz Feedlot	1484	1512	01872	AD	M	4216	50.9	44.8	30.1	119.2
26	2/13/20	Morse Land Co	1121	1152	01868	SY	M	3033	48.3	42.3	27.3	115.8
27	2/13/20	Morse Land Co	1425	1457	01869	SY	M	3375	50	44.2	27.3	114.8
28	2/17/20	Argenta BLM	1110	1147	01870	AD	M	3333	50.8	47.2	28	113.6
29	2/18/20	Argenta BLM	1522	1557	01871	ATY	F	4833	60.8	52.8	33.4	131.2
30	3/9/21	C bar (Sans)	1119	1157	01881	ATY	F	4925	57.3	48.1	31.1	129.6
31	3/13/21	Ringling	1230	1305	01606[3]	SY	F	4783	51.3	48.9	29.6	124.2
32	3/13/21	Ringling	1450	1520	01607	TY	F	4925	54.2	45.1	29.4	123.9
33	3/14/21	Ringling	1230	1345	01608	AD	M	3600	51.3	42.9	28.7	118.2
34	3/14/21	Ringling	1615	1652	01609	ATY	F	4550	56.6	47.3	29.9	121.1
35	3/16/21	Boulder River	1323	1351	01882	TY	F	4416	58.2	48.9	32.5	124.4
36	3/18/21	Ringling	1235	1322	01883	TY	M	3475	48.1	44.1	28.8	116

[1]AD = Adult, SY = Second Year (juvenile), TY = Third Year (immature), ATY = After Third Year (subadult).



APPENDIX Figure 1. Observed vs expected age classes of Golden Eagles captured for tissue sampling to determine sources of lead (Pb) contamination, 2018 – 2021. Expected age class was calculated from frequencies of camera trapped Golden Eagles recorded in the eastern US (*Kenney, M.L. et al. 2020. Spatial and temporal patterns in age structure of Golden Eagles wintering in eastern North America. J. Field Ornithol. 91(1):92–101*). SY = Second Year (juvenile), TY = Third Year (immature), ATY = After Third Year (subadult).



APPENDIX Figure 2. *Apriori* field classification of sex (M/F) of 36 captured Golden eagles by morphometric values relative to predictive model of *Harmata, A. and G. Montopoli. 2013. Morphometric Sex Determination of North American Golden Eagles. Journal of Raptor Research 47(2):108-116.*