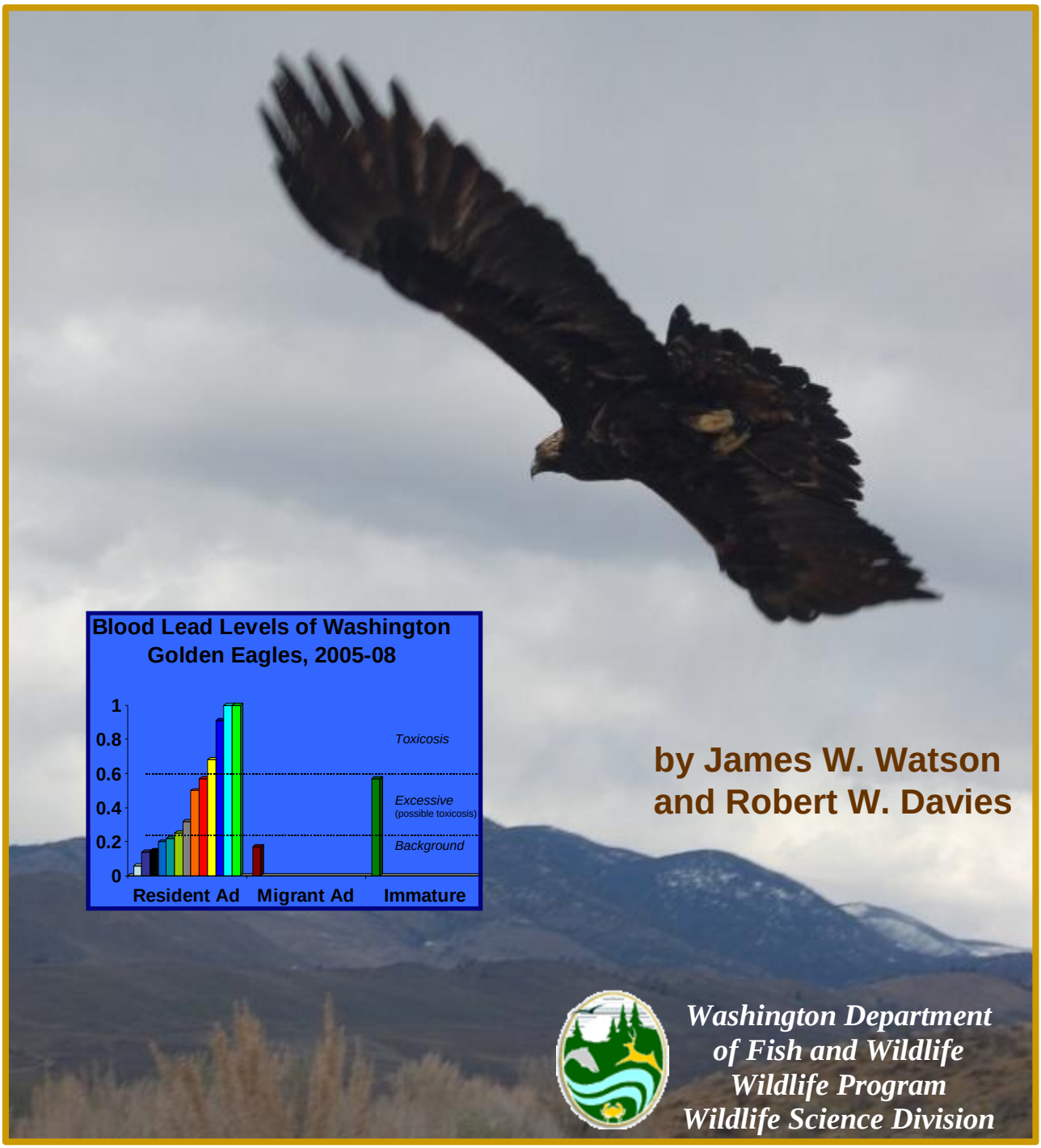
STATE OF WASHINGTON January 2009

RANGE USE AND CONTAMINANTS OF GOLDEN EAGLES IN WASHINGTON



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Progress Report

Abstract: In 2008 we conducted the fourth full year investigating the movements, range use, and contaminant loads of golden eagles (*Aquila chrysaetos*) in Washington. We captured and telemetered three adult eagles, sampled their blood for lead, and monitored their year-round movements with satellite telemetry. Prey were collected and identified from nine nests. To date, of 14 eagles tested for lead, six (43%) had background levels of lead, four (29%) had excessive levels of lead, and four (29%) had levels suggestive of toxicosis. There was no consistent geographic pattern associated with lead levels. Sampling has included birds on 20-30% of territories that are typically occupied in Washington, documenting lead contamination as a widespread and important concern for nesting golden eagles. Plans for 2009 include continued sampling of blood and prey collections at nests.

In 2005 we initiated an investigation of golden eagle range use and lead contaminants in eastern Washington (Watson and Davies 2005, 2006). Concerns regarding the species status and pending state status review prompted the investigation. In 2008, we completed the fourth year of the investigation and continued the field effort focused on the capture, monitoring, and testing of lead levels in the blood of adult golden eagles.

We also initiated a study of golden eagle diet from prey collected from nests to better understand potential relationships to contaminants and whether nesting diets have changed as a result of habitat and prey changes in the past 30 years. In the 1970s food habitats of golden eagles in eastern Washington included <1% of jackrabbits and ground squirrels in prey, with yellow-bellied marmots (*Marmota flaviventris*) comprising 42% of prey consumed (Knight and Erickson 1978, Marr and Knight 1983). The number of prey species and prey items were not related to the number of habitats <2 km from nests, suggesting eagles may have been foraging well beyond nests for prey. Because of the loss of shrub-steppe habitats in the past 30 years, and the fact that cyclic fluctuations in jackrabbit and squirrel populations will affect raptor feeding habits (Smith and Murphy 1978, Steenhof et al. 1997), it is unknown if these food habitats are representative of current prey use by Washington golden eagles.

Study Area and Methods

In 2008 we focused the capture effort in north-central and southeast Washington to sample areas where we had previously not captured eagles (Fig. 1). We used a bow-net and deer carcasses for capture as previously described with the same methodologies for processing captured eagles, and collecting satellite data (Watson and Davies 2005, 2006). Home range data were summarized and analyzed in ArcMap using Hawth's Tools for measuring all aspects of home range including kernel size, minimum convex polygon size, and location of polygon centroids (Appendix A). We used a single parameter smoothing factor (h) setting of 2500 for all ranges which was a compromise between least-squares cross validation (undersmoothed) and biased cross validation

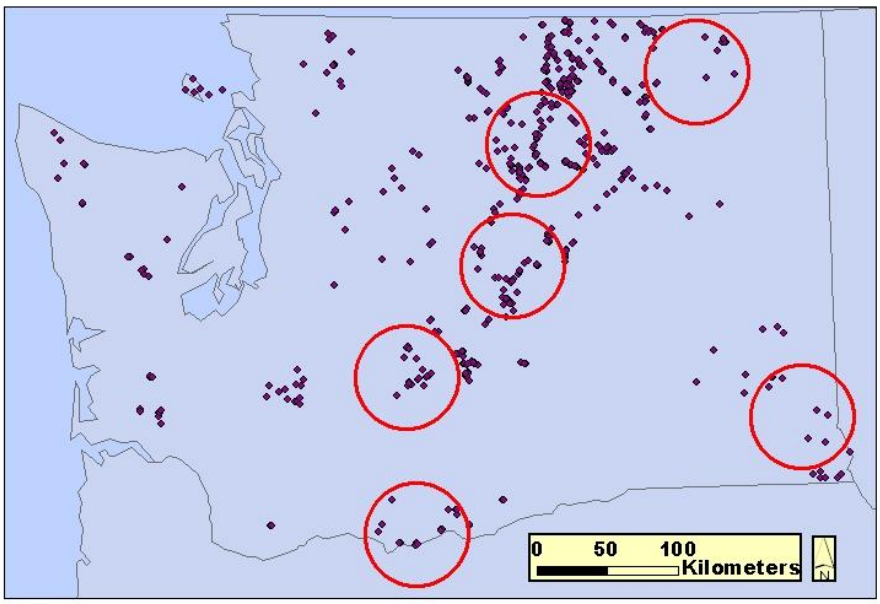

Fig. 1. Distribution of historic golden eagle nests in Washington and target capture areas of breeding golden eagles in eastern Washington, 2005-08.

(oversmoothed). Flight and perch fixes were combined for sampling because assessment of flight space is relevant to potential wind turbine conflicts.

Prey remains were collected prey remains from and below nine active nests in July and August at the end of the nesting period. We selected eight nests in central Washington, and one nest in southeast Washington based on activity, logistics, and access. Thus, we were able to collect prey at only some of the nests where adults were telemetered. About 25 golden eagle territories are typically active in eastern Washington in a given year (WDFW unpubl. data). A climbing team of 3 members accessed both cliff and tree nests, and bagged and labeled remains for later identification. Skeletal remains were identified using Elbroch (2006), and guard hair keyed with Moore et al. (1974), supplemented by field guides to birds and mammals (Burt and Grossenheider 1976, Sibley 2000).

Results

Contaminants

We captured and telemetered three golden eagles in 2008 resulting in 15 captured during the entire study (Appendix B). Blood lead levels were highly varied, but most levels of mercury, selenium, and DDE were background (Table 1). West Nile Virus was not detected in three birds that were tested. Based on thresholds used to define lead toxicosis in large raptors[a], six of 14 resident adult eagles for which we tested lead (43%) had

[a] The accepted blood-lead thresholds for large raptors (Analytical Sciences Lab, Univ. of Idaho) background: <0.20 mg/l, lead exposure: 0.20-0.59 mg/l, and possible toxicosis: >0.60 mg/l. Recent work in the Greater Yellowstone Ecosystem suggests background levels are lower than 0.20 mg/l (Bedrosian and Craighead 2008).

Table 1. Heavy metal, selenium, pesticide (ppm) residues and West Nile Virus occurrence in golden eagles captured in Washington state, 2005-08. ND = not detected, NT = not tested.

Territory (OccNo)	PTT ID	Lead (mg/l)	Mercury (mg/kg)	Selenium (µg/g)	DDE (µg/g)	WestNile
Swakane Canyon[a]	33238	0.17	.022	0.390	[c]	NT
Douglas Creek (386)	33240	0.25	<0.015	0.390	0.042	NT
Robinson Canyon 123)	22169	0.50	0.047	0.260	<0.03	NT
Naches-Tieton (117)	28018	0.15	0.021	0.290	0.11	NT
Garrett Canyon (456)	22171	0.14	0.160	0.340	[c]	NT
Colockum WA HQ (499)	28012	1.00	0.018	0.390	[c]	NT
Colfax[b]	N/A	0.57	0.094	0.260	ND	NT
Rocky Reach Dam (306)	28018b	0.15	0.150	NT	ND	ND
Flat Creek (407)	33241	0.22	<0.06	NT	ND	ND
Alta Coulee (157)	28017	1.00	0.062	NT	ND	ND
John Day Male (413)	62818	0.06	0.140	NT	0.03	NT
Rock Creek (100)	62819	0.91	0.110	NT	0.03	NT
John Day Female (413)	33238	0.20	0.055	NT	0.03	NT
Asotin Creek (xxx)	22171b	0.32	0.046	NT	0.03	NT
Finley Canyon (151)	72463	0.68	0.028	NT	0.03	NT

[a]Capture location, nest site in southwest Yukon.
[b]Gunshot, moribund juvenile collected at T16N R42E S10 on 5 April, 2005.
[c]Too little blood taken for analysis.

background levels, four (29%) had excessive levels of lead, and four (29%) had levels suggestive of toxicosis (Fig. 2). There was no consistent geographic pattern associated with lead levels (Fig. 3).

As of January 2009, four eagles continued to provide telemetry information (Table 2). Four eagles, two with high lead levels (22169, 62819), died during the study but causes were undetermined. The remaining eagles either removed PTTs or their PTTs expired.

Movements and Ranges

Except for the migrant adult captured in 2005 (33238), all telemetered eagles were resident adults occupying ranges within several kilometers of their nests for most of the year with occasional forays in the fall away from the territory. About 3000 locations were collected from six eagles with standard PTTs from 2004-07 prior to deployment of GPS PTTs. We estimated home range characteristics for eight eagles with GPS PTTs (Table 3). Mean 95% kernel ranges were 50.6 km^2 and an average of 53% of the 95% kernel was contained within a 3.2-km (2-mile) radius from the nest. Core areas (50% kernels) averaged 5.5 km^2.

Diet

We identified 15 prey species among prey 49 items at nine nests (Table 4). Yellowbellied marmots were the most abundant prey. One fish was identified at the Horseshoe Bend territory, where the nest is situated across from a stocked lake.

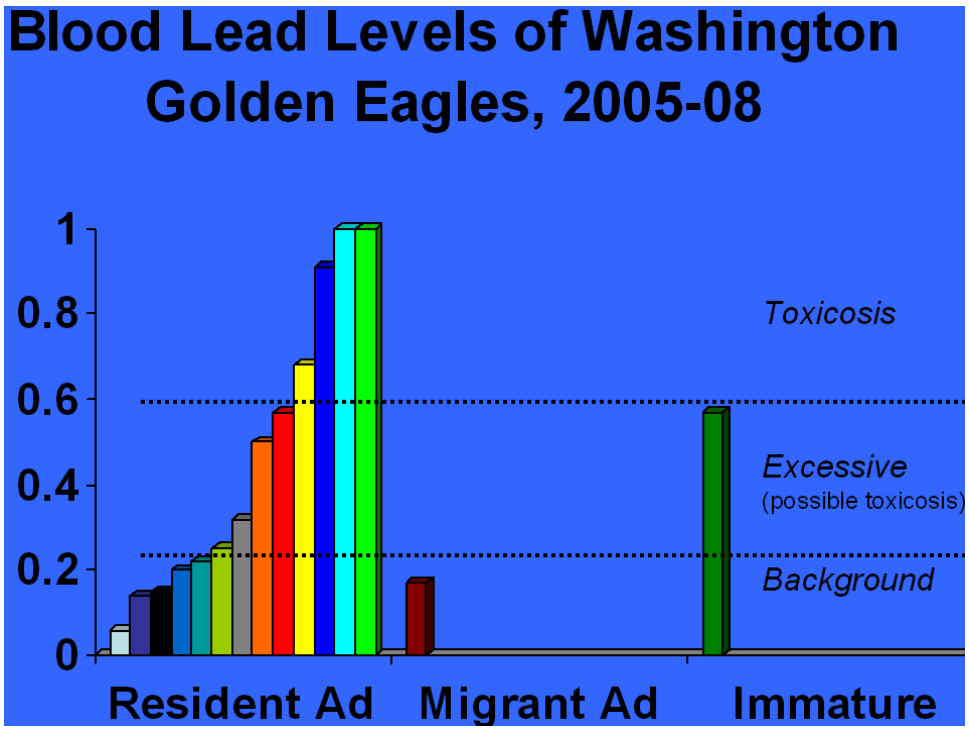

Fig. 2. Levels of lead contamination in golden eagles (*n* = 15) captured in Washington, 2005-08.

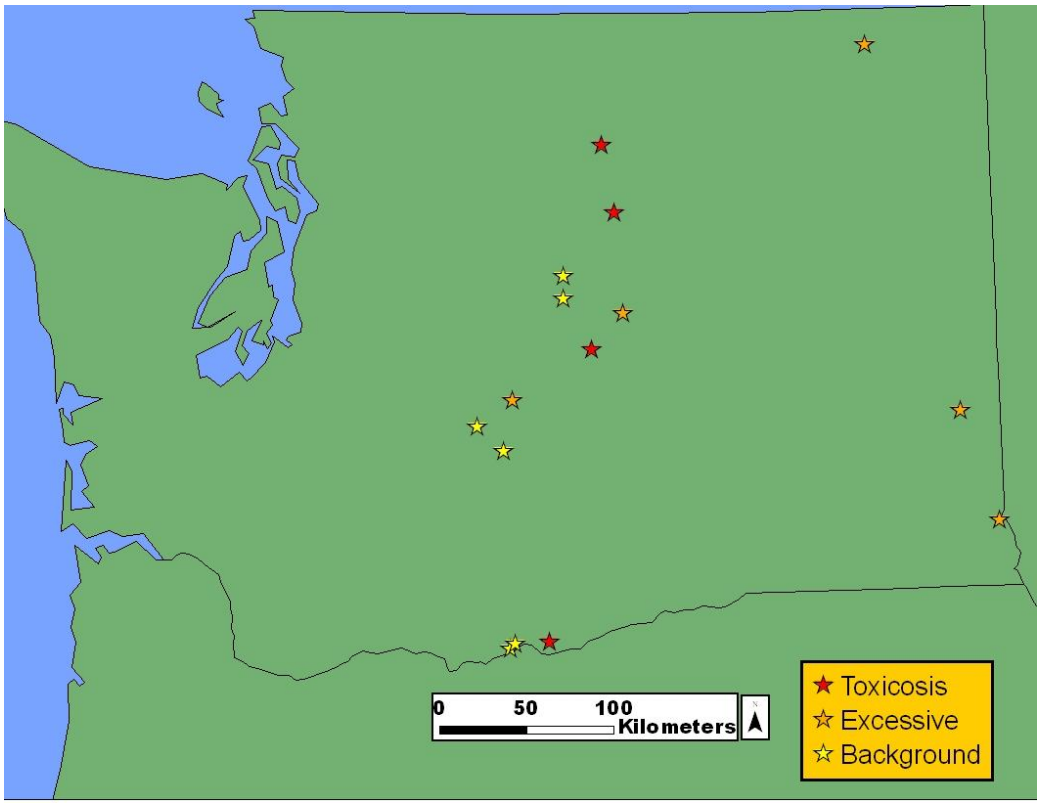

Fig. 3. Distribution of golden eagles captured in Washington from 2005-08 and associated blood lead levels. One subadult eagle with excessive levels is included (middle point in far east-central area).

Table 2. Status of golden eagles telemetered in eastern Washington as of January 2009.

Eagle (PTT ID)	Months Monitored	Status
28011	12	Eagle removed PTT
33238	3	Eagle probably removed PTT
33240	47	Active
22169	17	Mortality, unknown cause
22171	27	PTT expired
28018	1	Broken wing from territorial encounter, euthanized
28012	9	Unknown; probably removed PTT
28018b	11	Mortality, unknown cause
33241	34	Active
28017	15	Eagle removed PTT
62818	8	Mortality, unknown cause
62819	13	Mortality, unknown cause
22171b	10	Active
33238b	3	Eagle probably removed PTT
72463	10	Active

Table 3. Home range characteristics of 8 golden eagles monitored with GPS satellite telemetry in Washington, 2005-08. All range areas are in km^2.

ID	Date	No. Days	No. Loc.	95% kernel	% of 95% kernel <6.4 km (4 mi) from nest	50% kernel	100% MCP[a]
62819	3/9/07-3/23/08	379	2191	33.9	98	6.0	75.4
62818	3/9/07-10/8/08	213	1742	35.2	89	4.9	343.2
33238b	3/12/08-5/17/08[b]	66	649	27.5	100	2.8	598.2
28017	3/30/06-6/11/07[b]	457	5251	54.2	80	7.3	9294.8
33240	2/23/05-2/27/07[c]	734	3972	48.6	95	5.9	1188.5
33241	3/15/06-10/28/08	957	9695	109.0	71	8.0	975.3
72463	3/27/08-10/28/08	215	2132	25.3	95	2.8	53.5
22171b	3/19/08-10/28/08	223	2580	71.5	71	6.0	1273.5
Mean		406	3527	50.6	88	5.5	1725.3
SD		302	2861	28.2	11	1.9	3094.9

[a]Minimum convex polygon.
[b]Range estimates exclude extensive off-range movements in the fall.
[c]GPS transmissions stopped in 2007 but PTT continued to transmit ARGOS signals as of January 2009.

Table 4. Golden eagle prey collected at nine nests in Washington (one nest in 2007, eight nests in 2008).

Species	No.
Yellowbellied marmot (*Marmota flaviventris*)	12
CA ground squirrel (*Citellus beecheyi*)	4
Coyote pup (*Canis latrans*)	5
Deer fawn (Odocoileus sp.)	5
Striped skunk (*Mephitis mephitis*)	2
Mountain cottontail (*Sylvilagus nuttalli*)	1
Black-tailed jackrabbit (*Lepus californicus*)	1
Deer (Odocoileus sp.)	1
Un. Large mammal	2
Wild turkey (*Meleagris gallopavo*)	2
Great horned owl (*Bubo virginianus*)	2
Steller's jay (*Cyanocitta stelleri*)	2
Chukar (*Alectoris chukar*)	2
American magpie (*Pica hudsonia*)	1
White-headed woodpecker (*Picoides albolarvatus*)	1
Hairy woodpecker (*Picoides villosus*)	1
Unid. Passeriformes	4
Largescale sucker (*Catostomus macrocheilus*)	1
Total	**49**

Discussion

Our growing sample of blood analyzed from golden eagles increasingly indicates that there is a high degree of lead contamination among nesting adults in Washington with >50% of birds showing excess levels, and over half of those birds with levels expected to impair behavior and survival. The last statewide surveys documented occupancy at 48 of 104 historic golden eagle territories in eastern Washington, so by sampling adults on 12 different territories we have assessed lead associated with about 25% of the territories that are typically occupied. Mortality was confirmed for two of four birds with excessive levels, but cause of death undetermined. Because blood lead in large raptors is reflective of lead consumed within 3 to 4 weeks previously, with a blood depuration rate (half-life) of 2-3 weeks (Bedrosian and Craighead 2008, Fry et al. 2008), our results provide a "snap-shot" of lead exposure just prior to and during the early nesting period (late February through early April). The level of lead recorded from analysis (Table 1) therefore represents a value at an unknown point during depuration and could be representative of continual exposure levels, seasonal exposures, or one-time exposures at

the beginning or end of an individual exposure episode (e.g., one meal). Mortality several months or years after blood sampling may therefore not be correlated if exposure was seasonal rather than consistent throughout the year. Lead content of bones may provide the best long-term picture of lead exposure but evidence in adult California Condors (*Gymnogyps californianus*) suggests the short half-life of blood lead results in most deposition in soft tissues rather than bone (Parmentier et al. 2008). Feather-lead provides a longer-term picture of exposure than blood but requires documentation of the period in which the feather was grown.

Our data documents that exposure for an individual is confined to a well-defined range and that most birds occupy consistently throughout the entire year. Prey data were too sparse after 1 year of collection to assess potential changes in prey from the 1970s although marmots appeared to be important both periods. Whether prey collected late in the nest season are representative of prey taken early in the nest season when blood was sampled is unknown.

In 2009 we plan to continue to sample blood from adult eagles as well as nest prey collections. We are examining the possibility of using trail cameras at nests to remotely gather prey data during the nesting season.

Acknowledgements

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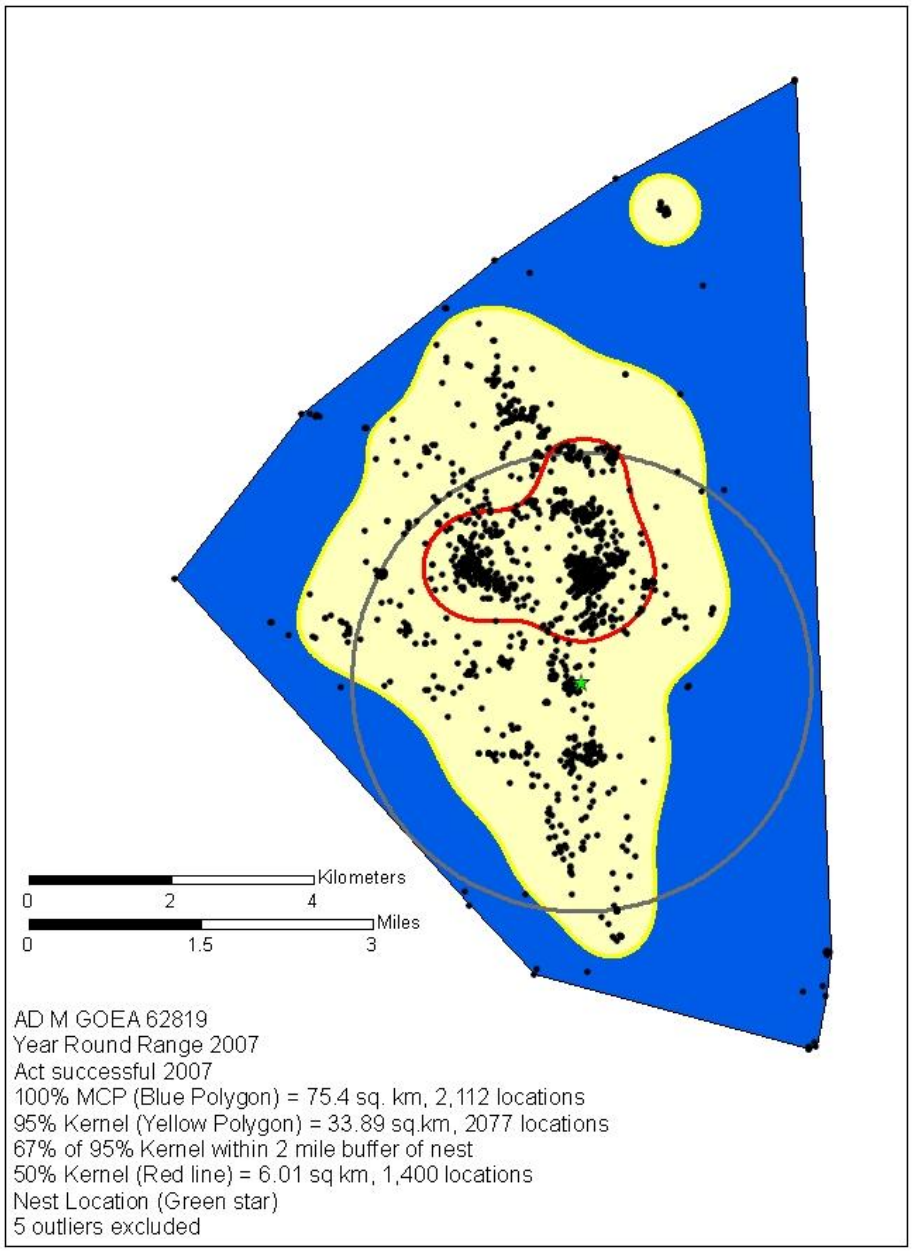
Appendix A. Example of home range characteristics analyzed from GPS telemetry data.



Appendix B.

Table 1. Golden eagle capture and mensural data, 2004-08.

Territory (OccNo)	Capture Date	PTT ID	USGS Band	Sex	Hallux Length (mm)	Culmen (mm)	Tail (mm)	Wing Chord (mm)	Weight (g)	Eye Color	Keel Shape	Crop	Wingpit Fat	Parasite
Oak Creek HMA HQ (205)[a]	04/22/04	28011	629-09119	F	59.14	47.27	280	670	4470	Br	sharp	1/4	-	n/a
Swakane Canyon	02/23/05	33238	629-09122	F	57.08	46.52	310	675	5014	Br	round	0	strip	n/a
Douglas Creek (386)	02/24/05	33240	629-09123	M	46.29	41.78	284	610	3560	Y/Br	round	0	strip	lice
Robinson Canyon (123)	03/02/05	22169	629-09124	F	49.06	43.05	325	641	4114	Br	round	0	strip	n/a
Garrett Canyon (456)	03/09/05	22171	629-09125	M	48.39	48.55	299	644	3820	Y/Br	sharp	1/2	n/a	n/a
Naches-Tieton (117)	03/22/05	28018	629-09126	M	49.77	39.75	270	575	3475	Br	sharp	1/2	strip	n/a
Colockum WA HQ (499)	04/12/05	28012	629-09127	M	50.16	38.35	287	587	3570	Br	round	1/4	full	n/a
Rocky Reach Dam (306)	02/23/06	28018b	629-08801	F	56.67	47.51	312	610	4814	Br	round	0	strip	n/a
Flat Creek (407)	03/15/06	33241	629-08802	M	53.48	42.77	288	610	4064	Br	round	0	strip	n/a
Alta Coulee (157)	03/30/06	28017	629-08803	M	52.20	44.38	286	610	3770	Y	sharp	0	strip	n/a
John Day Dam ( )	02/22/07	62818	629-08804	M	50.54	42.68	295	580	4000	Y/Br	sharp	1/4	strip	n/a
Rock Creek ()	03/08/07	62819	629-08805	M	50.96	44.16	330	640	3900	Br	sharp	0	strip	n/a
John Day Dam ()	03/11/08	33238	629-08806	F	53.21	46.31	305	610	5000	Br	round	1/4	strip	n/a
Asotin Creek ()	03/18/08	22171b	629-08807	M	49.43	43.02	280	585	4250	Y	sharp	1/2	strip	n/a
Finley Canyon ()	03/27/08	72463	629-08808	F	58.58	53.36	310	630	5000	Y	sharp	0	strip	n/a

[a]no blood taken.