

Study on Golden Eagle Activity, Skunk C
OSMP Studies 4258

Study



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**STUDY ON GOLDEN EAGLE ACTIVITY
SKUNK CANYON CLOSURE
BOULDER
Boulder County
Colorado**

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For Boulder Mountain Parks

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Abstract

We studied activity budgets and corridor usage during the incubation and fledgling cycles of a pair of nesting golden eagles (*Aquila chrysaetos*) in Boulder County, Colorado. During early March through July of 1997 we collected observational data in the Skunk Canyon closure located in Boulder Mountain Parks. The activity budget revealed that agnostic interactions were more frequent during flight activity than during perching activity. Furthermore, undulating flight occurred during the fledgling period, but was absent during the incubation period. Based on the activity budget and view shed analysis, the Skunk Canyon closure seems to provide adequate protection for the eagles. Corridor usage was found to vary greatly between the incubation and fledgling periods. However, both the incubation and fledgling periods showed that the eagles use the northeast corridor most frequently and the north corridor least frequently.

Introduction

The nesting behavior of golden eagles (*Aquila chrysaetos*) has been studied extensively, with studies focusing on food consumption (Collopy 1987), predation (Craig 1989), and territory (Collopy and Edwards 1989). Our study focused on off-nest behavioral aspects of nesting golden eagles. We accumulated data for the activity budget of the Skunk Canyon golden eagles to assess if current raptor closure sites are sufficient in buffering disturbances from the nesting site. By monitoring flight and perching behavior, we established the eagles' habits and defensive tactics. We also wanted to see if their behavior changes between the incubation and fledgling periods. Simultaneously, we provide insight into the usage of flight undulation in nesting golden eagles. Undulating flight has been observed as a mating display as well as a territorial display (Collopy 1989). By observing time, place, and situation of undulating flight we hoped to determine if undulating flight is exclusive to mating. Geometric calculation of the eagles' view shed provided clues for nesting site preference (Camp, Sinton, and Knight 1995). Since there are a total of three nest sites in the Skunk Canyon closure we established if the eagles chose their nest based on visual cues. Lastly, corridor usage was compared between incubation and fledgling periods to determine if flight patterns change with respect to nesting cycles.

Study Area and Method

Our study was conducted in Skunk Canyon (Figure 1) located in Boulder County, Colorado. This area is administered by the City of Boulder and is included in the Boulder Mountain Parks domain. The major vegetation types include ponderosa pine (*Pinus ponderosa*) douglas fir (*Pseudotsuga menziesii*) sagebrush (*Artemisia tridentata*) and scrub oak (*Quercus gambelii*). The nesting site for our study lies on Dinosaur Mountain, which serves as a defining boundary between wilderness and the City of Boulder. The surrounding area, is comprised of social trails and climbing routes, which are open to the public and are frequently used. The Skunk Canyon closure, however, is without trails and secluded from hiking activity. The nest, approximately 2.5x2x3m in size, served as the central reference point for all observational data.

Behavioral data on the adult eagles was collected during the incubation and fledgling periods for the spring and summer of 1997. Six to eight hours of observation were conducted on a weekly schedule and two sites were chosen to view the eagles' nest. The first site lies near the summit of Green Mountain, just south of Green Mountain West Ridge trail. This vantage point offers a 180 view of Skunk Canyon and its surroundings. The Green Mountain site lay approximately 900m from the nest and observations inside the nest were conducted with the aid of a 15x60 spotting scope. The second site lies at the summit of Dinosaur Mountain and is secluded from any trails. This site provided a 230

field of vision and offered close observations of all activity. The Dinosaur Mountain site lies approximately 300m from the nest. 10x35 Binoculars were sufficient in providing observational data from the Dinosaur site.

During our study period, the two sites were visited 18 times for a total of 50.33 hours of observation time. Twelve of the visits only a single observer was present and 6 times two observers were present. In an attempt to minimize our own impact on the eagles' behavior, we chose to divide the number of observation times at the respective sites. In all, Green Mountain comprised 10 days of observational material and Dinosaur Mountain the other 8 days.

We defined corridor usage as flight to and from the nest using the natural contours and geological formations of Skunk Canyon and the surrounding area. We defined five corridors (Figure 3), they are:

- northeast corridor**- which is comprised of the northern edge of the Achean Pronouncement and the lower sections of the Ridges [1-4]
- southeast corridor**-located just south of the Skunk Canyon closure in Bear Canyon. It opens eastward towards the plains, and is defined by Dinosaur Mountain to the north, and Overhang Rock to the south.
- southwest corridor**- located just south of the Skunk Canyon closure in Bear Canyon. It opens westward, and is defined by the Southern end of the Sacred Cliffs to the north, and the Bear Peak West Ridge to the south.
- western corridor**-found on the saddle between the Sacred Cliffs and Green Mountain. It opens westward towards the Green Bear trail.
- northern corridor**-lies between the Green Mountain summit and Hippo's Head. It opens northward toward the Royal Arch trail.

Corridor observations for both the incubation and fledgling periods were categorized into frequency of corridor usage and percent of daily budget.

Flight and perching activities for the activity budget were compared between the incubation and fledgling periods. Flight activities were characterized into four categories:

- 1) soaring flight-consisting of non-powered flight in which the eagle is gliding
- 2) directional flight- characterized by powered flight in a specific direction
- 3) undulating flight- initiated by a steep dive with wings folded, followed by an upward swoop with wings flapping at the apex of the climb (Collopy, and Edwards, 1989)
- 4) agnostic interaction- any form of behavior associated with another animal ending in aggression, including, threat, attack, appeasement, or flight. (A Dictionary of Biology, Oxford 3rd). All perching activities represented off of the nest perching. Perching activity consisted of preening, perched agnostic interactions, and perching with no observable action. Flight and perching activity were recorded in seconds and all categories of observation were divided into percentage of total activity, average time, number in sample, and number of observations. The Chi-square test was used to compare the likelihood of an agnostic interaction occurring during flight or perching activity.

Calculations of the view shed were done on a 7 1/2 minute USGS topographic map. By contour analysis we assimilated what obstructions lay in the eagle's field of view. Once this was completed we used the UTM (Universal Transverse Mercator) system on a topographic map to estimate where those obstructions occurred (Figure 2). This allowed for a straight line diagram of the eagle's view shed. We used this same technique to calculate the other unoccupied nests' view sheds.

RESULTS

Flight and Perching Activity

A total of 70 flight observations were made comprising 4,059 seconds of total flight time: 2,012 seconds during the incubation period, and 2,047 seconds during the fledgling period. 50% of the total time of flight activity (Data set 1) for the incubation period was soaring. The remaining 50% consisted of 21.3% agnostic interactions and 28.7%

directional flight. Directional flight was observed most frequently with 17 observations, followed by 11 agnostic interactions, and 9 soaring observations. No undulating flight was observed during the incubation period. The fledgling period (Data set 2) had fewer observations with only 33 sightings, but saw an increase in total activity. As with the incubation period, soaring comprised a majority of the time occupying 67.3% of the eagle's activity. Directional flight made up 26.8% of the activity followed by agnostic interactions with 4.4% and undulating flight consisting of 1.5%. Soaring flight was observed most frequently with 12 sightings.

Forty-one perching observations were made, with a total of 17,220 seconds of activity being recorded: 9,844 seconds during the incubation period, and 7,576 seconds during the fledgling period. During the incubation cycle (Data set 3), 31 observations were made with 90% of the perching activity having no interactions and the remaining 10% comprising agnostic interactions. The fledgling cycle (Data set 4) saw similar results, with 99% of the perching activity having no interactions and 1% being agnostic interactions. A Chi-square test between flight and perching activities was performed to find if agnostic interactions were more likely to occur while in flight or while perched. Both the incubation and fledgling periods revealed no significant Chi-square values, .0701 and .3286 respectively (Data sets 5 & 6).

Corridor Usage

Corridor usage varied greatly between the incubation and fledgling periods (Data sets 7 & 8). 24 observations were made during the incubation period and 10 observations during the fledgling period. During both the incubation and fledgling cycles the eagles frequented the northeast corridor most often, 14 and 4 times respectively. The west corridor also saw drastic changes in selection, with a greater degree of usage during incubation, 8 times, compared to the fledgling period, 2 times. A comparison between the southeast corridor selection showed a 26% increase in activity during the fledgling period. The north corridor had no observable usage.

View Shed Analysis

The nest site is located at 150°17'30" longitude, 39°58'30" latitude. At this point total obstruction eastward occurs due to Dreadnaught ridge. View shed analysis (Figure 2) revealed the eagle's field of view is obstructed at Green Mountain 105°17'50" long., 39°58'45" lat. to the north, Dinosaur Ridge 105°17'40" long., 39°58'20" lat. to the south, and the Sacred Cliffs 105°18' long., 39°58'30" to the west. The protruding ridge which lies just west of Dreadnaught (Figure 1) obstructs the nest from viewing part of the valley floor. There are two other nesting sites located within the Skunk Canyon closure. Both are located on Ridge Two directly adjacent to the current nesting site (see fig. 1).

Discussion

Interactive activities always involved neighboring ravens (*Corvus corax*) which have a communal nesting site in the area. Interactions included repeated diving, high-pitched "kraak" calls, and relentless pursuit of the eagles. Duration and length of the interactions varied, as did the number of ravens involved in the interactions. An observable difference in interaction activity occurred between the incubation and fledgling periods. Agnostic interactions occurred more frequently during the incubation cycle. It is plausible that the decrease in interactions during the fledgling period arises from increased parental care and increased food consumption. We believe fewer agnostic interactions occurred during the fledgling period because the eagles needed to spend less time defending their territory and more time insuring the survival of their offspring. This means that greater time was spent engaging in other activities (i.e. hunting) away from the nest rather than in

interactions with the ravens. Undulating flight was another interaction that differed between the two cycles, appearing only during the fledgling cycle. We suggest that this change in behavior (as mentioned above) reflects a change in the eagles' instinctual priorities. The usage of undulating flight ensures a quick means (avg. time an agnostic activity lasts, 28.65 sec, vs. 6.2 sec for the avg. undulating flight) to avert conflict and allows the eagles to pursue other fitness related activities rather than engaging in time and energy consuming conflict.

The corridor data showed high use for the northeast corridor. The northeast corridor seemed to serve as the primary entrance and exit from the nesting site. This may seem surprising to some as this corridor leads to the City of Boulder in less than a mile. However, the corridor provides the most geographically accessible route to the nest from the plains. The north corridor, on the other hand, saw no activity during our study. This inactivity may be explained by the fact that golden eagles are primarily plains hunters and the north corridor leads to forested habitat. Also, the north corridor comprises the highest relief feature, Green Mountain at 8,144 ft, which makes it the most geographically inaccessible corridor. The southeast corridor became a more important route for the eagles during the fledgling period than during the incubation period. This corridor has the least amount of human settlement and leads to prime hunting grounds. This shift may have been due to the increased caloric demand of their new born eaglet.

Even though both the west and southwest corridors remain virtually void of human activity, their use was rarely observed. This may best be explained by feeding strategy. The east facing corridors are optimal for plains hunting, while the west facing corridors access forest and were employed more for defense. The west corridor was most often used during agnostic interactions and territorial disputes with the neighboring ravens. Similarly, the southwest corridor saw very little activity, except for during agnostic interactions.

Our view shed analysis showed that the eagles did choose their nesting site based on visual cues. The current nesting site is facing a trailless area which creates a viewing area that is largely undisturbed. Green Mountain and Dinosaur Ridge serve as large visual barriers protecting the canyon from possible disturbance. Another advantage to their current nest site is that it is easily viewed outside the nest (i.e. snags, cliffs, etc.) from almost anywhere around the rim of the canyon. This gives the eagle's a distinct defensive advantage, as it allows them to keep a close eye on the nest regardless of their position in the canyon. The other nesting sites on Ridge Two are more exposed and cannot be as easily viewed from elsewhere in the canyon. The reasons given above coupled with highly reduced view shed area makes the nesting sites on Ridge Two less desirable for the eagles. We must also note that the current nesting site is very well protected from natural disturbance such as snow, rain, and wind due to an overhang that forms the top section of the Dreadnaught slab.

Conclusion

Our findings help to confirm the adequacy of the Skunk Canyon raptor closing site established by Boulder Mountain Parks for the nesting golden eagles. Our assessment of view sheds, corridor usage, and eagle activity suggests that the eagles base their nest site on visual and defensive advantages which provide optimal isolation from human activity. The success of the present nesting site (over 10 years of successful return) helps to back our conclusion that the area is and will continue to be a safe haven for nesting golden eagles even as the City of Boulder continues to grow and absorb our natural areas. View shed findings indicate that the nest is well protected from both visual observation and physical attack, offering a safe and secure nesting locale. Also, the Skunk Canyon closure effectively reduces human activity near the nesting site, restricting social trail use, climbing access, and offering little to no human presence in the main corridors of flight.

When we compared the activity budget of the incubation cycle to the fledgling cycle we found some interesting characteristics in their activities. Flight undulation was observed during the fledgling period, indicating that it is not exclusive to mating and that it

serves a dual function as a defensive tactic. The activity budget also provided insight into the amount of time spent in the nesting area. The vast majority of the eagle's time was spent outside the nesting site. Further data collection on where and how this time is spent would provide a more concise activity budget for the eagles, including hunting locations and possible territory size. We also believe that through strong initiatives such as the Raptor Monitoring Program (Boulder Mountain Parks) continuous reevaluation of the area can be made in order to insure adequate protection of our native eagle population.

Acknowledgments

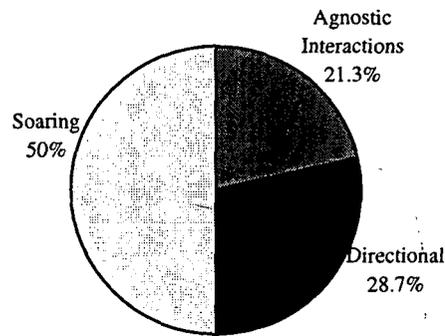
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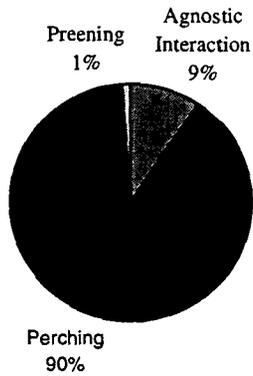
DATA SET 1		FLIGHT ACTIVITY FOR INCUBATION PERIOD		
Flight		Agnostic Interaction	Directional	Soaring
(# of observations)		Time (sec)	Time (sec)	Time (sec)
1		90	10	40
2		60	15	191
3		49	40	120
4		90	40	90
5		25	60	10
6		10	30	136
7		15	120	185
8		21	6	28
9		24	18	68
10		32	120	
11		12	60	
12			10	
13			5	
14			10	
15			15	
16			10	
17			9	
	Sum of Activity	428	578	1006
	Total Time	2012		
	% of Activity	21.27236581	28.72763419	50
	Average Time	38.90909091	34	96.44444444
	# in Sample	11	17	9
	#Flight Obs.	37		

Percentage of Flight Activity



DATA SET 3		PERCHING ACTIVITY FOR INCUBATION		
Perching		Agnostic Interaction	Off Nest	Preening
# of observations)		Time (sec)	Time (sec)	Time (sec)
1		520	360	10
2		20	600	14
3		22	601	7
4		32	544	37
5		64	195	29
6		51	252	26
7		17	3015	12
8		30	1098	
9		131	314	
10		37	1462	
11		57	87	
	Sum of Activity	981	8528	135
	Total Time	9644		
	% of Activity	10.17212775	88.42803816	1.399834094
	Average time	89.18181818	775.2727273	19.28571429
	# Sample Size	11	11	9
	# Perched Obs.	31		

Percentage of Perching Activity



DATA SET 6		CHI-SQUARE VALUE FOR FLEDGLING PERIOD				
			Flight	Perched	Total	
		Non-interactions	23	6	29	
		Interactions	10	4	14	
		Total	33	10	43	
		Expected Values	Flight	Perched		
		Non-interactions	22.255814	6.744186		
		Interactions	10.744186	3.255814		
	Chi-Square	(Observed-Expected) ² /Expected				
			Flight	Perched		
	Non-interaction	0.024883964	0.0821171			
	Interaction	0.051545354	0.1700997			
			Chi-Square	0.328646		

CORRIDOR OBSERVATIONS FOR FLEDGLING PERIOD						DATA SET 7
Corridor Usage	North	Northeast	Southeast	Southwest	West	
# of times	0	4	3	1	2	
total usage observed	10					
Frequency of corridor	0	40	30	10	20	
	Number of Times Used					
Day/Site	North	Northeast	Southeast	Southwest	West	
1	0	1			1	
2	0				1	
3	0		1	1		
4	0		1			
5	0	3	1			
6	N/A	N/A	N/A	N/A	N/A	
7	N/A	N/A	N/A	N/A	N/A	
# of Days	0	2	3	1	2	
Total # of Days	7	7	7	7	7	
AVERAGE USE	N/A	2	1	1	0.5	
% of Daily Budget	0	28.57143	42.85714	14.28571	28.57143	

Figure 1

SKUNK CANYON/SACRED CLIFFS CLOSURE

