Rio Grande Trail

Rock Bottom Ranch to Catherine Store Road

2013 Wildlife Monitoring Update

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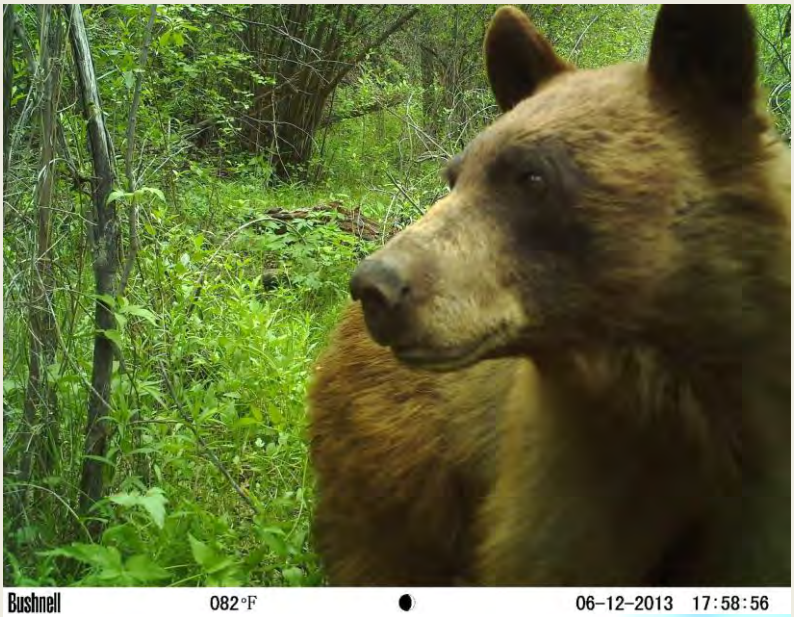

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EXECUTIVE SUMMARY

In 2006 the Roaring Fork Transportation Authority (RFTA) began construction of a paved multiple use trail (the "RGT") along the Rio Grande Railroad right-of-way that included a section that runs from the Aspen Center for Environmental Studies educational facility at Rock Bottom Ranch to the Catherine Store Road bridge (the "trail corridor"). In 2006, as construction progressed, it became apparent that the Rock Bottom Ranch segment of the trail would require a special wildlife management plan with rules and regulations to protect the area's natural ecological resources. The RFTA Board directed staff to create a plan, policies and a monitoring plan to protect the ecological resources in the area. To accomplish this, RFTA hired Colorado Wildlife Science, LLC (CWS) to produce a Wildlife & Ecological Resources Management Plan (WERMP). The WERMP in combination with annual and 5-year monitoring reports were the results of this direction. The WERMP and monitoring reports also help RFTA fulfill its obligations to protect the area's ecological resources as recommended by the Categorical Exclusion issued by the Federal Highways Administration (FHWA) for the construction of the Rio Grande Trail, and to Great Outdoors Colorado (GOCO) in connection with its participation in the corridor's purchase This report is an update to the 2011 monitoring report. Presented herein are the survey methods, results, and recommendations for additional mitigation measures.

Since 2007, 2,093 individuals of 81 species were detected. Species known to be sensitive to human activity (e.g., blue-gray gnatcatcher, plumbeous vireo) and species requiring riparian habitat (e.g., gray catbird, yellow warbler) are present within the trail corridor in substantial numbers. Redwing blackbirds, yellow warblers, and bank swallows continue to be the most abundant species within the corridor. The ratio of birds known to be sensitive to human activity and species dependent on specific habitat type to species known to benefit from human activity (synanthropes) such as American robins, American crows, and black-billed magpies, has not declined within the trail corridor and may be trending upward.

The great blue heron colony at Rock Bottom Ranch has persisted and successfully fledged a robust cohort of young in 2013. At this point it is safe to conclude that either the RGT does not negatively affect the herons or they have habituated to the activity associated with the trail.

Fifty-eight bald eagles and 14 golden eagles have been recorded within the trail corridor. Observed activity was dominated by flying and perched with 12 observed actively hunting and 7 observed soaring high above the trail. Observations trended slightly upward but this relationship is not significant.

Over the 7 years of monitoring, 3,933 individuals of 22 species of mammals were detected by the camera traps. Mule deer and Rocky Mountain elk continue to be abundant throughout the trail corridor. Deer use the corridor throughout the year and elk depend heavily on the habitat provided by the corridor from late fall through early spring. Deer, elk and other mammals are most active in the morning and evening hours. Black bears, coyotes and mountain lions were recorded using the trail throughout the day including mid-day. Mink and long-tailed weasels were recorded by the cameras for the first time in 2012 and more small and mid-sized mammals have been documented thanks to the increased quantity and quality of the cameras.

Results of the 7-year monitoring effort provide valuable information regarding the management of the trail corridor and status of wildlife within the corridor. In addition, the results suggest that current monitoring methods provide valuable insight into wildlife use of and responses to the trail. For the most part, it appears that current management strategies are exceeding expectations in minimizing the effects of recreation on the monitored wildlife community. Herons, songbirds, deer & elk, and other mammals all seem to have adapted to the increased recreational activity and are benefitting from the

winter closure. The species of waterbirds we expect to find within the corridor are indeed present and are benefitting from the winter closure as well. The eagle monitoring reveals that wintering bald eagles continue to use the corridor but not whether use has changed over time. There is some evidence that bald eagles are using the corridor more in summer but that is likely a product of the increased breeding production in the Roaring Fork Valley. The winter trail closure is the most significant management and effective measure in balancing the recreational and wildlife protection goals for the RGT. Closing the trail 2 weeks earlier, however, would likely benefit mule deer and migrating bald eagles.

1) Enforcement
    a. Investigate entry points for people with dogs during closure
    b. Add signs at entry points reinforcing importance of closure, dog prohibition and sensitive winter habitat
2) Mule Deer and Elk
    a. Maintain current opening date and closure
    b. Add fence openings at RGT intersections with game trails to facilitate movement and reduce the cost of repeated fence repair
3) Other mammals – No changes necessary
4) Great Blue Herons
    a. Continue to work with ACES/RBR to protect cottonwood suckers from elk herbivory in vicinity of heronry
    b. Limit activities that alter the landscape, especially landscaping activities involving noisy machinery such as skid steers, power mowers, chainsaws between April 1 and June 1
        i. Work with RBR to similarly limit work with tractors, mowers, chain saws, and other loud equipment within 250 m of the heronry during the nesting season
5) Bald Eagles
    a. Change the fall closure to November 15th to comply with the Categorical Exclusion and CPW 2007 recommendations
6) Other Birds – No changes necessary
7) Ecological Integrity – Intensify efforts to control non-native plants and noxious weeds within the trail corridor, particularly Russian olive, reed canarygrass and cheatgrass
8) Monitoring Recommendations
    a. The Rio Grande Trail Categorical Exclusion recommends monitoring of great blue herons (Categorical Exclusion, p. 22). Great blue heron monitoring should continue as per the Categorical Exclusion
        i. Osprey monitoring can continue in conjunction with the heron monitoring
    b. Bald eagle monitoring is recommended by the Categorical Exclusion to determine whether they continue to use roost sites within the corridor (Categorical Exclusion, p. 21)
    c. Continue monitoring with 5 cameras to sufficiently record use of the entire RBR-Catherine Store Road corridor by mammals year-round

d. Continue monitoring birds via point-transects but conduct 2 transects per year beginning in 2014 to increase the number of detections per species so that population trends can be determined for more species.

9) Additional Recommendations

a. The current closure gate configuration successfully excludes most trail users during the winter closure

i. The gate immediately west of the Crown access trail creates a significant barrier to wildlife movement

10) Once sufficient snow has accumulated to deter mountain bikers and most pedestrians (~8 inches), this gate should be left open allow both large and small animals to pass

Cover Photograph

The cover photos are a sample of the images of wildlife captured by the motion sensitive cameras place along the Rio Grande Trail Corridor in 2012 and 2013. Clockwise from top left are: black bear (*Ursus americanus*), wild turkey (*Meleagris gallopavo merriami*), mule deer (*Odocoileus hemionus*), and mountain lion (*Puma concolor*).

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I. BACKGROUND & INTRODUCTION

In 2006 the Roaring Fork Transportation Authority (RFTA) constructed a paved multiple use trail (the "trail") along the Rio Grande Railroad right-of-way that included a section that runs from the Aspen Center for Environmental Studies educational facility at Rock Bottom Ranch to the Catherine Store Road bridge at County Road 100 (the trail corridor). This trail was constructed under the authority of a Categorical Exclusion which recommends activity restrictions and monitoring of certain sensitive species. In addition, a portion of the funding to purchase the project railroad right-of-way for construction of the trail was acquired from the Legacy Project Grant Agreement, between the State Board of Great Outdoors Colorado Trust Fund (GOCO) and the Roaring Fork Railroad Holding Authority (RFRHA) which requires a commitment to design and maintain a wildlife compatible trail that protects the integrity of the natural systems while teaching users about wildlife and natural features.

In order to meet the recommendations of the Categorical Exclusion and the GOCO grant, RFTA hired Colorado Wildlife Science, LLC (CWS) to produce a Wildlife & Ecological Resources Management Plan (WERMP) for the trail corridor. This plan was submitted for public comment in August 2006. RFTA solicited and received comments on the WERMP from local governments, the Colorado Division of Wildlife (which is now known as Colorado Parks & Wildlife or CPW), user groups, local environmental and conservation organizations, and the general public. One of the primary goals of the WERMP was to ensure that the trail corridor is managed in an ecologically sensitive and sustainable manner. Accordingly, the WERMP was developed as an adaptive plan that establishes an iterative process that uses data gleaned from continuous ecological monitoring to constantly redirect management to achieve the objectives set forth in the WERMP.

RFTA contracted CWS in 2006 to implement the monitoring aspects of the WERMP as part of the adaptive management effort. The objective was for CWS to continue to monitor the trail corridor in order to assess wildlife responses to trail use and resource management. CWS also provides consultation and review of restoration, enhancement, and management projects. The monitoring and consultation is intended to help ensure the success of RFTA's goals to improve riparian and upland habitat within the trail corridor and minimize ecological effects of the trail. In late 2006, survey protocols were established to survey for 5 wildlife groups: breeding birds, great blue herons, bald eagles, waterfowl, and mammals.

In 2012, CWS presented the monitoring results from 2007 through 2011 to the RFTA Board. At that time, the Board determined that the ecological management of the trail corridor was successful in minimizing the effects of the trail on wildlife identified for monitoring by the Categorical Exclusion and by the Roaring Fork Valley community. As such, RFTA directed CWS to discontinue winter track and waterfowl surveys but continue bald eagle, breeding bird, great blue heron, and osprey surveys while monitoring mammals via the wildlife cameras. The number of cameras was increased to 5 to effectively monitor the entire length of the corridor.

This report briefly discusses the survey protocols, adds 2012-2013 monitoring results, evaluates the monitoring methods and makes recommendations for best management practices, and mitigation measures. Photographs are included in Appendix B. Common and scientific names of all species observed on site during the monitoring period are listed in Appendix C.

II. METHODS & PROTOCOLS

This section describes survey protocols. References to the literature upon which these protocols are based are included in Section VII. Any modification of survey protocols are described below in the appropriate section. Map 1 shows the locations of the bird monitoring points and Map 2 shows the winter and non-winter locations of the monitoring cameras.

A. AVIFAUNA

1. *Breeding Season Point-Transect*

Breeding birds were surveyed once per season beginning in Spring 2007 using a modified version of the Rocky Mountain Bird Observatory (RMBO) point-transect protocol (Leukering et al. 1998). One transect was established the length of the trail corridor, with interpoint intervals of 250 meters (m). Each point was monumented using sub-meter Global Positioning System (GPS). The point count duration was five minutes at each of 20 points. All birds seen and/or heard during the five minute period were recorded, the distance to each individual was estimated, and the sex of each bird was recorded for each point. Only individuals of low-density target bird species, as identified in (Leukering et al. 1998), were recorded along the transect.

2. *Great Blue Herons*

The major parameters of interest for long term monitoring of great blue herons are colony size (i.e., the number of active nests), nesting success (i.e., the proportion of nests successful in fledging young, or conversely the level of abandonment) and nesting productivity (i.e., the number of young fledged per successful and per active nests). Heron monitoring was conducted based on the protocol established by Vennesland and Norman (2006). Each segment of the heronry was visited by a CWS biologist at least every other week during the season beginning with arrival at the heronry in late March or April. We collected data using standardized methodologies as described Vennesland and Norman (2006). Data collected during nesting site surveys included location, total number of nests, number of active nests, activity at nest, failed nests, number of young, age of young, number of young fledged, number of successful nests, and evidence of predation.

3. *Bald Eagles*

The trail corridor was visited 8 times throughout each winter to collect data on bald eagle winter use of the trail corridor based on accepted wintering bald eagle monitoring protocols (Steenhof et al. 2002, Jackman and Jenkins 2004). All occurrences of bald eagles within the trail corridor were recorded on data forms. Data collected included age (i.e., adult or juvenile), activity (e.g., roosting, flying), and location description.

B. MAMMALS

1. *Motion Sensitive Cameras*

Year-round mammal use of the trail corridor was monitored via motion sensitive cameras. Cameras are effective at detecting a wide range of larger mammal species, including carnivores and herbivores, depending on the setup and whether bait is used. Motion-triggered cameras are being used more often to inventory and monitor ungulates and lagomorphs (Jacobson et al. 1997, Cutler and Swann 1999, Sweitzer et al. 2000, Jennelle et al. 2002). Cameras have increased in use, in part, because of the high probability of detecting a variety of species, including many species that are otherwise difficult to detect (Foresman and Pearson 1998). The reliability of the method is greatest when cameras are placed at sites where target species are likely to travel in order to obtain food or water (Jacobson et al. 1997, Cutler and Swann 1999, Koerth and Kroll 2000, Sweitzer et al. 2000).

The camera monitoring component varied in technology and effort during the monitoring period. The number of cameras increased over time from 2 in 2007 to 5 in 2012. The quality of cameras increased as well. In 2010, the cameras were replaced with Bushnell Trophy Cams. These cameras are among the most sensitive with a very short lag time between the triggering of the motion sensors and activation of the shutter. Consequently, the total number of captures and the number of species recorded increased substantially in 2010. As such, we must be careful when evaluating any trends in the camera detections prior to 2010.

Name	Trail Status	Longitude	Latitude	UTM_E	UTM_N
cam S1	Trail Open	-107.1160972	39.39306409	317773.4175	4362532.940
cam S2	Trail Open	-107.118494	39.39566116	317573.7668	4362826.042
cam S3	Trail Open	-107.1214967	39.39733037	317319.5328	4363017.389
cam S4	Trail Open	-107.1283258	39.39980474	316737.9132	4363305.878
cam S5	Trail Open	-107.1405886	39.40165786	315686.7931	4363536.544
cam W1	Trail Closed	-107.1153642	39.3927378	317835.6937	4362495.244

Name	Trail Status	Longitude	Latitude	UTM_E	UTM_N
cam W2	Trail Closed	-107.1188195	39.39611827	317546.9289	4362877.435
cam W3	Trail Closed	-107.1218763	39.39748923	317287.2580	4363035.790
cam W4	Trail Closed	-107.1253727	39.39903202	316990.1972	4363214.116
cam W5	Trail Closed	-107.1431837	39.40030739	315459.7633	4363391.955

Table 1. Locations of the monitoring cameras in Latitude-Longitude and UTM coordinates

Cameras (5 beginning in 2012) were placed along the trail during the winter closure in high traffic areas. When the trail was opened, the cameras were relocated at game trails just off the trail corridors to avoid capture of people and to prevent tampering. Cameras were secured to tree trunks or fence posts, typically at waist height. Since the purpose of the camera monitoring was to determine the variety of species using the trail corridor and document their interaction with the trail, no bait was used to avoid attracting animals to the trail that would not have visited of their own volition.

III. ANALYSIS

A. AVIFAUNA

1. *Breeding Birds*

a. DISTANCE Analysis – Density Estimation

DISTANCE analysis was used to estimate bird density (birds/ha) for the 2007 through 2011 datasets and will be calculated again for the next 5 year monitoring report (2017).

b. Species Richness

Sampling all of the species present is an impossible task, except in the most depauperate of ecosystems, and observed species richness is non-linearly related to sampling effort. We used Program SPADE (Chao and Shen 2010) to estimate total species richness using the ACE estimator (Chao and Lee 1992).

c. Species Diversity

Shannon's diversity index (Shannon and Weaver 1949) is used here to examine species diversity by year. This diversity index is a popular measure in ecology that is used to describe both the species richness and relative abundance of each species in a community. We used Program SPADE (Chao and Shen 2010) to calculate the non-parametric method to estimate Shannon's index of diversity when there are unseen species in a sample (Chao and Lee 1992, Chao 2005, Chao et al. 2005, Chao and Shen 2010). The Shannon Index gives a measure of both species numbers and the evenness of their abundance. Higher numbers indicate relatively high species richness (number of species) and a more even distribution of individuals among species.

d. Relative abundance

Relative abundance indices derived from point-count methods have been widely used to assess bird abundance. This wide acceptance is apparently based on the conviction that the assumption of constant proportionality is easier to meet and less stringent than the assumptions inherent in competing methods such as distance sampling. Here, relative abundance is used to describe the species composition of the avian community as well as the ratio of sensitive to human-adapted species and evaluate any changes over time.

2. *Bald Eagles & Great Blue Herons*

Simple linear regression was used to evaluate trends with year as the independent variable. A non-linear term was used for year if the linear fit was poor. For all tests significance was assumed at $\alpha = 0.05$ level. R 2.10.0 statistical software was used to conduct all statistical analyses (R Development Core Team 2009). Wate

B. MAMMALS

Data produced by the monitoring cameras were evaluated on simple presence-absence statistics to examine which mammal (and other) species were present within the trail, how they were interacting with the trail and patterns of use.

IV. RESULTS

A. AVIFAUNA

1. *Bird Monitoring*

a. Species Richness

Results for each year were pooled. Species abundance and species richness for each year was compiled by totaling the number of individuals and species detected. We calculated species richness (Chao 2) and species diversity (Shannon-Wiener Index or "Shannon Index") using Program SPADE (Chao and Shen 2010). The Chao 2 estimate of true species richness was chosen as the non-parametric estimator as it performs well on small samples (Colwell and Coddington 1994). Comparisons between years are shown in the tables and figures below.

Table 2. Detected and ACE estimates for true species richness for RGT surveys (2007-2013).

Year	Detected Species Richness	Estimated Species Richness	SE	Lower 95% CI	Upper 95% CI
2007	47	59.0	6.6	51.4	80.0
2008	41	67.5	13.8	51.1	110.3

Year	Detected Species Richness	Estimated Species Richness	SE	Lower 95% CI	Upper 95% CI
2009	44	48.9	3.5	45.4	61.2
2010	43	56.1	7.6	47.6	93.9
2011	51	71.9	10.1	59.5	102.2
2012	52	79.0	12.8	63.2	117.1
2013	59	72.3	6.6	64.2	92.5

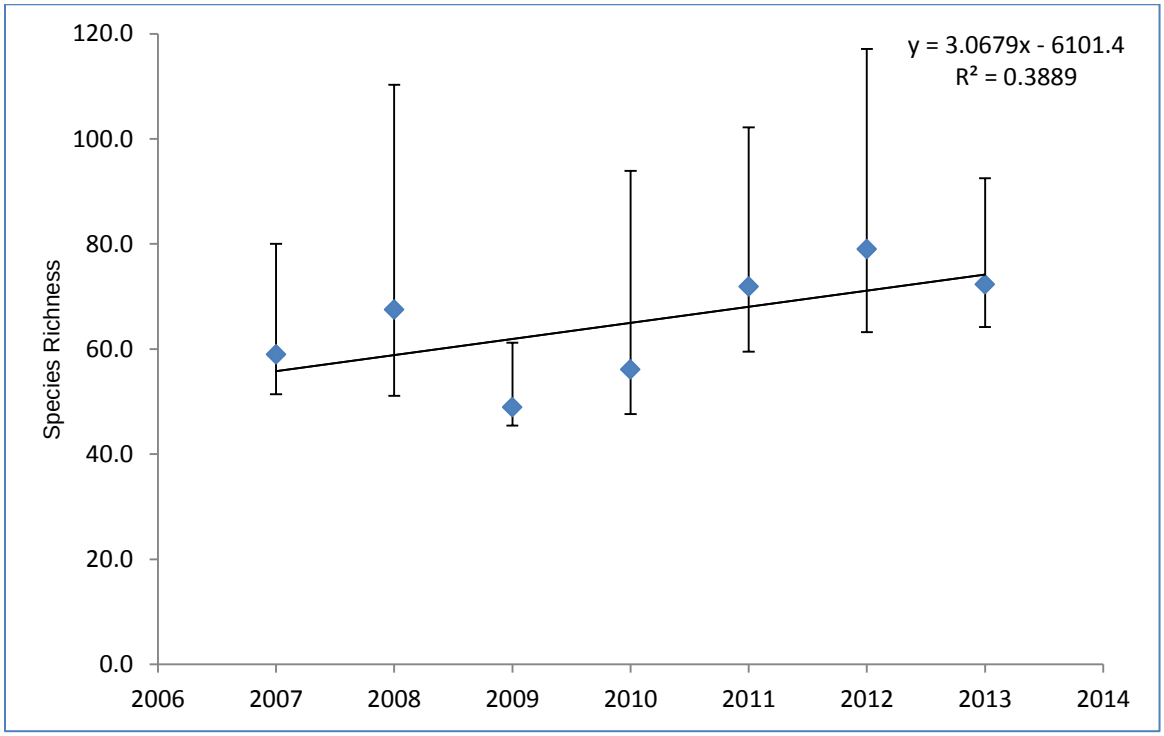

Figure 1. ACE species richness estimation of true species richness (with upper and lower 95% confidence intervals) within the RGT by year (species richness, lower and upper limits at the 95% confidence interval)

Table 2. RGT species diversity (with upper and lower 95% confidence intervals) as measured by the Shannon-Wiener index (Chao & Shen 2003).

Year	Shannon Index	SE	Lower 95% CI	Upper 95% CI
2007	3.301	6.800	3.167	3.435
2008	3.108	25.900	2.876	3.339
2009	3.278	2.600	3.138	3.418
2010	3.211	13.100	3.026	3.353
2011	3.170	12.100	2.989	3.352
2012	3.283	4.300	3.108	3.459
2013	3.493	2.500	3.343	3.643

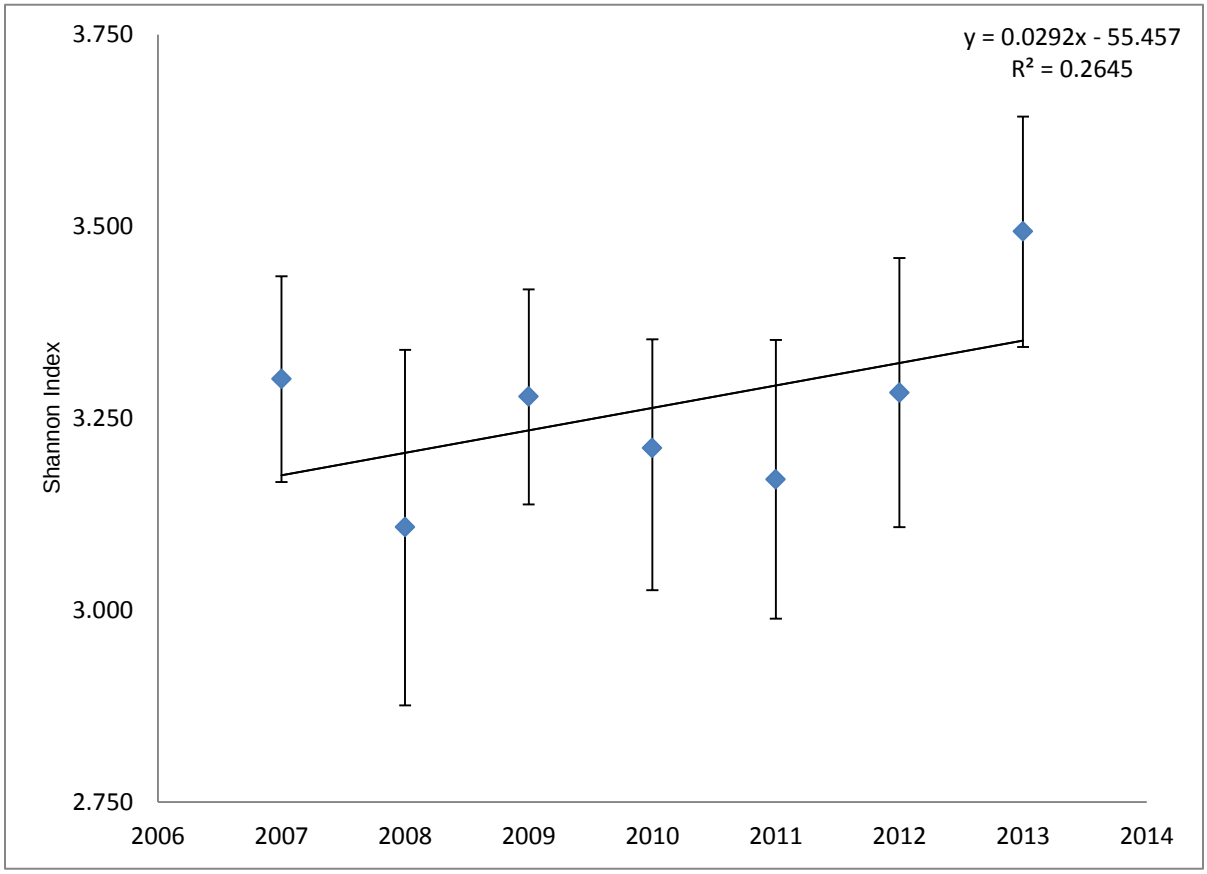

Figure 2. RGT species diversity (with upper and lower 95% confidence intervals) as measured by the Shannon-Wiener index

Over the 7 years of monitoring of the trail corridor, 2,093 individuals of 81 species were detected ($\overline{x}_{year}$ = 299 individuals). Estimated true species richness varied from a low of 48.9 in 2009 to a high of 79 in 2012 ($\overline{x}_{year}$ = 65). Although the linear trend indicates an upward trend, this trend is not significant and only 38% of the variation in species richness can be explained by the model; the remaining 62% results from unknown variables or inherent variability. Bird species diversity and evenness as measured by the Shannon Index likewise exhibited an upward trend but, again, the trend is not significant and only 26% of the variation in species richness can be explained by the model. The remaining 74% is explained by unknown variables or inherent variability. Typically, the higher the value of the Shannon index, the higher the species evenness and richness (Magurran 2004).

b. Relative Abundance

Mean relative abundance of just 3 species, red-winged blackbirds, yellow warblers, and bank swallows represented 20% of all avifauna detected during the monitoring period (Figure 3). In other words, although few individuals of most of the species at RGT were detected, most of the individuals detected were members of the most abundant species. Red-winged blackbirds and yellow warblers were among the 3 most abundant species in all years and bank swallows were within the 3 most abundant in all years except 2010 (Table 5).

c. Human-Sensitive vs. Human-Adapted Species

As bird habitat is fragmented and/or degraded the numbers and abundances of widespread species with low habitat specificity increase while the numbers and abundances of species with narrow habitat requirements or strong vegetation type affinities (habitat obligates) and/or sensitivity to human activity decline (van der Zande and Vos 1984, Gutzwiller 1995, Gutzwiller et al. 1998, Odell and Knight 2001, Rosenberg et al. 2004, Glennon and Kretser 2005, Glennon and Porter 2005, Lenth et al. 2006b). In other words, the relative abundance of human-intolerant and species habitat obligates species decreases in proportion to the relative abundance of human-tolerant and habitat generalist species.

The ratio of human-sensitive and habitat obligate species to generalist species may be increasing within the trail corridor over the 2007-2013 monitoring period (Figure 4). The ratio of human-adapted to human-sensitive species exhibited an upward trend but the trend is not significant and only 10% of the variation in species richness can be explained by the model. The remaining 90% is explained by unknown variables or inherent variability. From 2007 through 2013, this ratio varied from a low of 0.36 human-adapted for every one human-sensitive species to a high of 0.62:1 in 2011.

Table 3. Relative abundance of 10 most abundant species detected at RGT by year[1].

2007		2008		2009		2010		2011		2012		2013	
Species	Relative Abundance	Species	Relative Abundance	Species	Relative Abundance	Species	Relative Abundance	Species	Relative Abundance	Species	Relative Abundance	Species	Relative Abundance
RWBL	14.2%	RWBL	16.7%	BANS	14.9%	RWBL	16.3%	RWBL	22.5%	YWAR	16.6%	YWAR	15.3%
YWAR	12.0%	YWAR	14.5%	YWAR	12.8%	YWAR	14.7%	YWAR	10.7%	BANS	11.5%	BANS	12.9%
BANS	11.7%	BANS	11.8%	RWBL	11.8%	WAVI	7.5%	BANS	10.4%	RWBL	10.7%	RWBL	9.1%
TRES	6.8%	TRES	10.0%	WAVI	6.2%	BANS	7.1%	CEDW	5.1%	WAVI	6.8%	WAVI	5.9%
WAVI	4.3%	WAVI	5.4%	GRCA	5.5%	SOSP	5.6%	VGSW	3.7%	GRCA	6.2%	SOSP	5.0%
GRCA	3.7%	SOSP	5.0%	TRES	4.5%	BTLH	5.2%	WAVI	3.7%	CAGO	4.4%	VGSW	4.4%
SOSP	3.4%	GRCA	4.1%	SOSP	4.2%	GRCA	5.2%	GRCA	2.8%	SOSP	4.4%	CEDW	3.5%
CEDW	3.1%	BGGN	3.2%	BHCO	3.5%	BHGR	4.4%	AMRO	2.5%	BTLH	3.3%	GBHE	2.6%
SPTO	3.1%	BHGR	2.3%	BTLH	3.5%	COFL	3.2%	SOSP	2.5%	AMRO	2.4%	BTLH	2.4%
WEWP	3.1%	BTLH	2.3%	WEWP	2.4%	VGSW	2.4%	SPTO	2.3%	TRES	2.4%	BBMA	2.1%
TRA-10°	**65.4%**		**75.1%**		**69.2%**		**71.4%**		**66.2%**		**68.6**		**63.2%**

° TRA-10 = Combined relative abundance of 10 most abundant species for that year.

[1] Please see Appendix C for key to 4-letter species codes.

Figure 3. Mean relative abundance (2007-2013) of bird species at RGT. For each species, mean relative abundance was derived by summing the maximum abundance in each year and averaging over the 5 survey years. Note: "9 spp" represents 9 species with only 1 detection each over the course of the monitoring period.

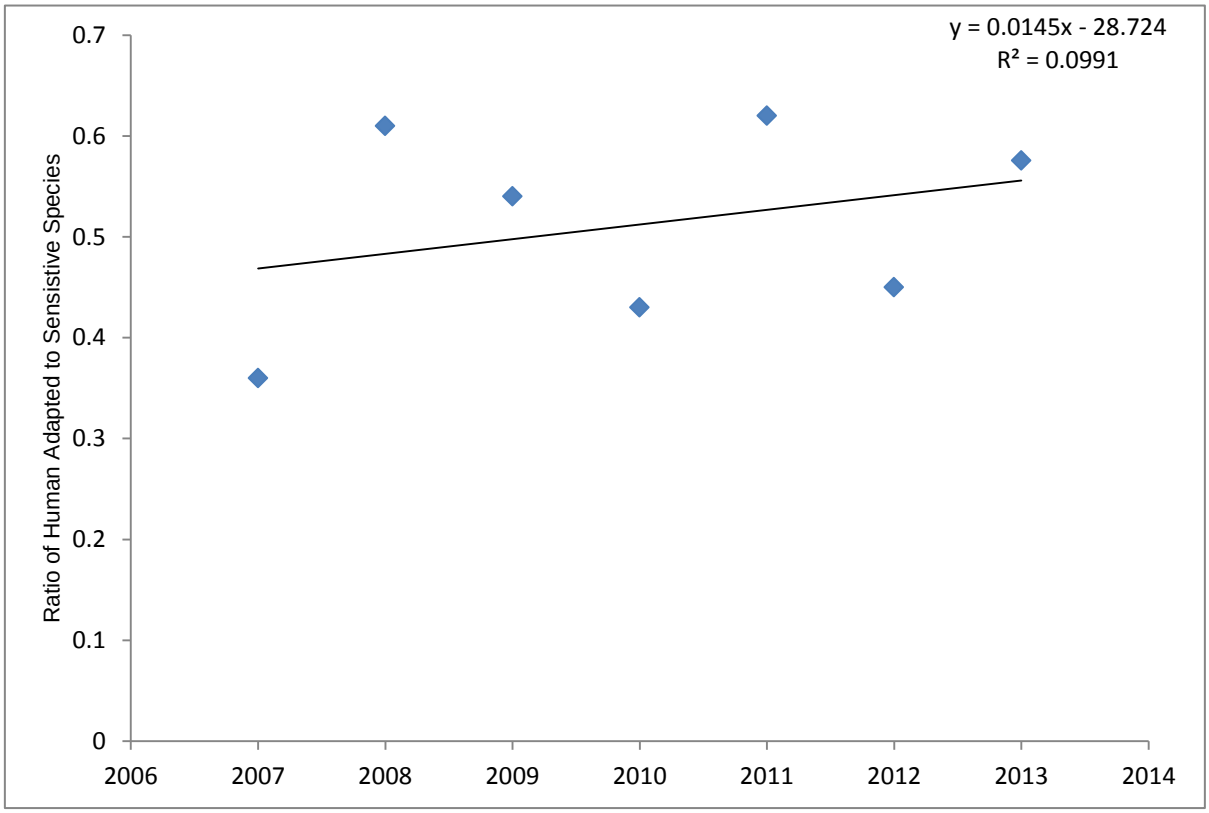

Figure 4. Ratio of human-adapted to human-sensitive species within the RGT by year

2. *Great Blue Herons*

At the start of the monitoring period the great blue heron colony (or heronry) at Rock Bottom Ranch (RBR) was divided into 2 segments. The eastern segment (RBR-East or RBR-E; Photo 1) was situated approximately 201 m northeast of the pole barn at RBR and approximately 281 m from the RGT. The western segment (RBR-West or RBR-W; Photo 2) approximately 545 m northwest of the hay barn, approximately 248 m south-southwest of the nearest private residence, and approximately 199 m from the RGT. This heronry has a history of abandonment. The first abandonment we are aware of occurred in the late 1990's when the heronry was located roughly ¼-mile downstream. That nesting area was abandoned when a pair of red-tailed hawks occupied one of the heron nests. The herons relocated to the RBR-E location the following season. In 2001, RBR-E was abandoned on June 1st. In 2002, they re-some of the herons re-occupied RBR-E while others established the RBR-W location. Prior to initiation of RGT monitoring, RBR staff documented nest occupancy of RBR-E from 2002-2006:

Table 4. Historical occupancy of RBR-E.

Year	Occupied Nests
2002	9
2003	7

Year	Occupied Nests
2004	5
2005	9
2006	13

a. 2007-2013 Nest Occupancy & Success

Nesting success of the great blue herons at Rock Bottom Ranch varied tremendously and a number of significant events transpired during the monitoring period. A total of 50 young successfully fledged over the 7 years of monitoring. Complete abandonment of the heronry occurred in 2008 and 2009. Partial abandonments occurred in 2007, 2010, and 2012. Success of most occupied nests occurred in 2011 (16 young fledged) and 2013 (24 young fledged). The cause of the abandonments in 2006, 2007, and 2008 are unknown. Golden eagle predation caused the complete abandonment in 2009 as well as the partial abandonment in 2010. The eagle returned to prey on some of the nestlings in 2011 but did not cause abandonment. Following the 2008 abandonment, a pair of red-tailed hawks occupied one of the heron nests at RBR-E and continued to nest through 2011. In 2011, 2 pairs of herons built nests at a new site a short distance to the west of RBR-W. One of those nests was successful.

Table 5. Heron nest occupancy and success 2007-2011. * denotes known golden eagle predation.

Year	RBR-E				RBR-W			
	Observed Arrival	Active Nests	Fledged	Abandon	Observed Arrival	Active Nests	Fledged	Abandon
2007	3/8	9	6	–	3/10	10	0	6/12
2008	3/17	5	0	5/14	3/17	10	0	5/14
2009	–	–	–	–	4/8	7	0	5/21*
2010	–	–	–	–	4/4	8	2	6/6*
2011	–	–	–	–	3/5	15	16	–*
2012	–	–	–	–	4/4	8	2	6/6*
2013	–	–	–	–	3/19	9	24	–*

3. *Bald Eagles*

The trail corridor was visited 6 times throughout each winter from 2007-2008 through 2013-2014 (December-March) to collect data on bald eagle winter behavior. All occurrences of bald eagles within the trail corridor were recorded on data forms. In addition to CWS efforts, data collected by Rock Bottom Ranch staff through 2011 is included.

Table 6. Winter eagle observations 2007-2014

Table 6. Winter Bald (and Golden) Eagle Detections − 2007-2014

Date	Species	Age	*n*	Activity	Observer	Comments
12/6/2007	Bald eagle	Adult	1	Perched	CWS	Perched in cottonwood over river
12/6/2007	Bald eagle	Imm	1	Flying	CWS	Flying east low over river
12/6/2007	Golden eagle	Adult	1	Hunting	CWS	Circling high over RBR
1/3/2008	Bald eagle	Adult	1	Flying	CWS	Flying east over river
1/3/2008	Bald eagle	Adult	1	Perched	RBR Staff	Perched at RBR
1/11/2008	Bald eagle	Adult	1	Flying	RBR Staff	Flying east over cottonwoods
1/15/2008	Bald eagle	Adult	1	Perched	RBR Staff	Perched/Flushed at RBR
1/15/2008	Bald eagle	Adult	2	Flying	RBR Staff	From Salty's north then 1 west over river, 2 cont. north
1/21/2008	Bald eagle	Imm	1	Perched	RBR Staff	Perched at RBR over marsh
1/22/2008	Bald eagle	Adult	1	Perched	RBR Staff	Perched above winter-killed elk at RBR
2/8/2008	Bald eagle	Adult	1	Perched	RBR Staff	Perched in cottonwood at RBR
2/9/2008	Bald eagle	Adult	1	Flying	CWS	Perched near confluence with unidentified prey in talons
1/2/2009	Golden eagle	Adult	1	Flying	CWS	Flying south over trail at Flying Fish Road
1/7/2009	Bald eagle	Adult	1	Flying	RBR Staff	Flying east over RBR
1/17/2009	Bald eagle	Adult	1	Perched	RBR Staff	Perched in RBR-W nest, flushed when disturbed
1/28/2009	Bald eagle	Adult	1	Hunting	RBR Staff	Hunting over west RBR pasture
1/29/2009	Bald eagle	Adult	1	Perched	CWS	Perched over river at Blue Creek Ranch
1/29/2009	Golden eagle	Adult	1	Hunting	CWS	Hunting at Waldorf
2/2/2009	Bald eagle	Imm	1	Flying	RBR Staff	Flying west at RBR
2/2/2009	Bald eagle	Adult	1	Hunting	RBR Staff	Hunting over RBR pastures
2/19/2009	Bald eagle	Adult	1	Perched	CWS	Perched over river at confluence
2/19/2009	Golden eagle	Adult	1	Soaring	CWS	Soaring high above trail at west of Waldorf School
2/21/2009	Bald eagle	Adult	1	Flying	RBR Staff	Hunting over RBR island
2/27/2009	Bald eagle	Adult	1	Flying	RBR Staff	Hunting over RBR island
12/31/2009	Bald eagle	Adult	1	Perched	CWS	Perched over river at Blue Creek Ranch
1/8/2010	Bald eagle	Adult	1	Perched	CWS	Perched over river at Flying Fish Rd
1/12/2010	Bald eagle	Adult	1	Flying	CWS	Flying west over river
1/12/2010	Bald eagle	Adult	1	Perched	CWS	Perched at Flying Fish Rd
1/26/2010	Bald eagle	Adult	1	Hunting	CWS	Hunting near confluence with unidentified prey in talons
2/16/2010	Bald eagle	Adult	1	Perched	CWS	Perched in cottonwood at RBR
2/16/2010	Bald eagle	Adult	1	Flying	CWS	Flying west at confluence
2/21/2010	Bald eagle	Imm	1	Perched	CWS	Perched at Blue Creek Ranch
2/27/2010	Bald eagle	Adult	1	Flying	CWS	Flying east at Catherine Store bridge
3/4/2010	Golden eagle	Adult	1	Hunting	CWS	Hunting at RBR-W
3/9/2010	Golden eagle	Adult	1	Hunting	CWS	Hunting over pasture near RBR-W
3/9/2010	Bald eagle	Adult	1	Flying	CWS	Flying south over trail at Waldorf
12/20/2010	Bald eagle	Adult	1	Flying	CWS	Flying low over RBR
12/20/2010	Bald eagle	Imm	1	Soaring	CWS	Soaring high above trail at Waldorf School
1/9/2011	Bald eagle	Adult	1	Perched	CWS	Perched at RBR-W
1/12/2011	Golden eagle	Adult	1	Hunting	CWS	Hunting at Waldorf
1/12/2011	Bald eagle	Imm	1	Flying	CWS	Flying west at RBR
1/26/2011	Bald eagle	Adult	1	Soaring	CWS	Soaring between Flying Fish Rd and Waldorf
2/1/2011	Bald eagle	Imm	1	Hunting	CWS	Hunting over RBR west pasture
2/8/2011	Bald eagle	Adult	1	Hunting	CWS	Hunting near RBR-W
2/20/2011	Bald eagle	Adult	1	Perched	CWS	Perched over river at confluence
2/20/2011	Golden eagle	Adult	1	Perched	CWS	Perched near Waldorf School
2/21/2011	Bald eagle	Adult	1	Flying	RBR Staff	Flying east at Flying Fish Road
3/9/2011	Bald eagle	Adult	1	Flying	CWS	Hunting over RBR island
3/15/2011	Golden eagle	Adult	1	Soaring	CWS	Soaring between Waldorf and Blue Creek Ranch
12/2/2011	Bald eagle	Adult	1	Flying	CWS	Flying east at RBR gate

Table 6. Winter Bald (and Golden) Eagle Detections – 2007-2014

Date	Species	Age	*n*	Activity	Observer	Comments
12/20/2011	Bald eagle	Adult	1	Hunting	CWS	Hunting over river east of Blue Creek Ranch
1/13/2012	Golden eagle	Adult	1	Flying	CWS	Flying up river across from Flying Fish Rd
1/17/2012	Bald eagle	Imm	1	Perched	CWS	200 m downstream of osprey nest
2/20/2012	Bald eagle	Adult	1	Soaring	CWS	Soaring over pasture near RBR-W
2/20/2012	Bald eagle	Adult	1	Flying	CWS	Flying northeast over trail at RBR
11/28/2012	Bald eagle	Adult	1	Perched	CWS	In large spruce east of Blue Creek Ranch
11/28/2012	Golden eagle	Adult	1	Flying	CWS	Flying over Waldorf school toward the Crown
12/28/2012	Bald eagle	Adult	1	Perched	CWS	Perched in cottonwood over river west of Flying Fish Road
1/8/2013	Bald eagle	Adult	1	Soaring	CWS	Soaring high over Catherine Store Birdge
1/8/2013	Bald eagle	Imm	1	Flying	CWS	Flying east over river near picnic area
2/5/2013	Bald eagle	Adult	1	Perched	CWS	Perched over river east of Blue Creek Ranch
3/19/2013	Golden eagle	Imm	1	Flying	CWS	Flying west over river
11/5/2013	Bald eagle	Adult	1	Hunting	CWS	Hunting over RBR west pasture
11/20/2013	Bald eagle	Adult	1	Flying	CWS	Flying southwest near confluence
12/8/2013	Bald eagle	Adult	1	Flying	CWS	Flying from Saltonstall toward river
1/10/2014	Bald eagle	Adult	1	Flying	CWS	Flying south near confluence
1/23/2014	Golden eagle	Adult	1	Flying	CWS	Flying from Crown north across trail
2/26/2014	Bald eagle	Adult	2	Flying	CWS	Two eagles flying east 300 m west of RBR gate
2/26/2014	Bald eagle	Adult	1	Flying	CWS	Perched in cottonwood on RBR island
3/21/2014	Golden eagle	Adult	1	Soaring	CWS	Soaring high over the Crown near Waldorf

Seventy-two eagles – 58 bald eagles and 14 golden eagles – were recorded by CWS and RBR staff during the monitoring period. Of the bald eagles observed, 49 were adults and 9 were immature. Observed activity was dominated by flying (*n* = 32) followed by perched (*n* = 21) with 12 observed actively hunting and 7 observed soaring above the trail

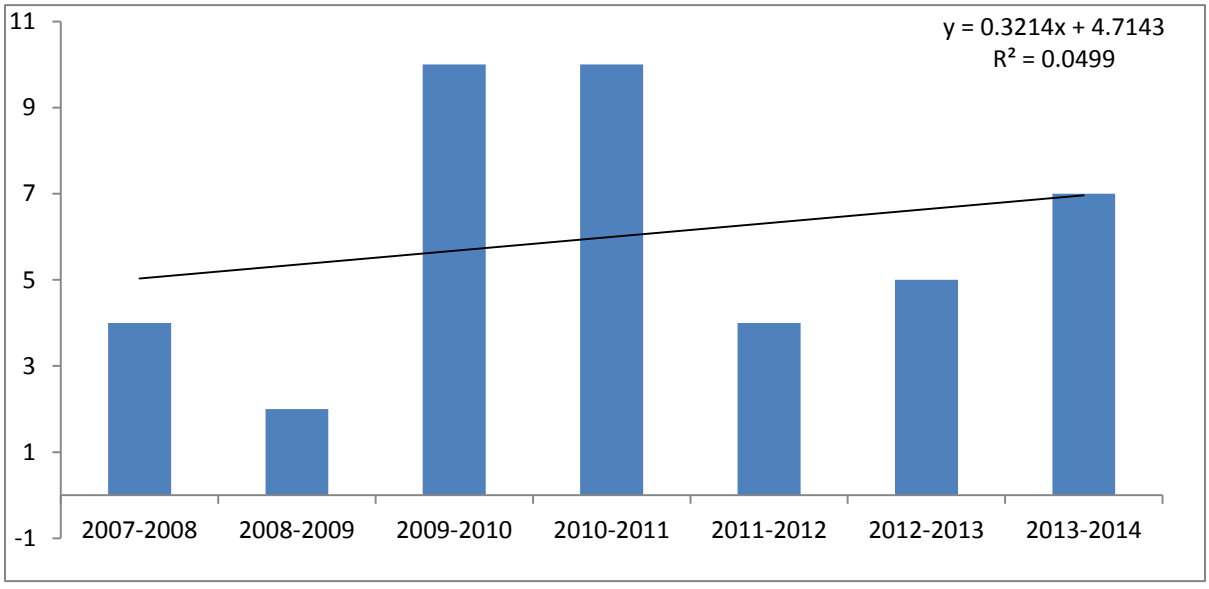

Figure 5. Winter observations of bald eagles at RGT from 2007-2008 through 2013-2014

corridor. Observations of eagles by CWS biologists trended slightly upward but this relationship is not significant. This data is informal observation data and is not suitable for statistical analysis.

B. MAMMALS

1. *All Mammals*

a. Relative Abundance

Over the 7 years of monitoring, 23 species of interest (mammals plus wild turkeys) were detected by the camera traps, 3,933 ($\overline{x}_{year}$ = 561.9) (Figure 6). Mule deer (*n* = 1,791;

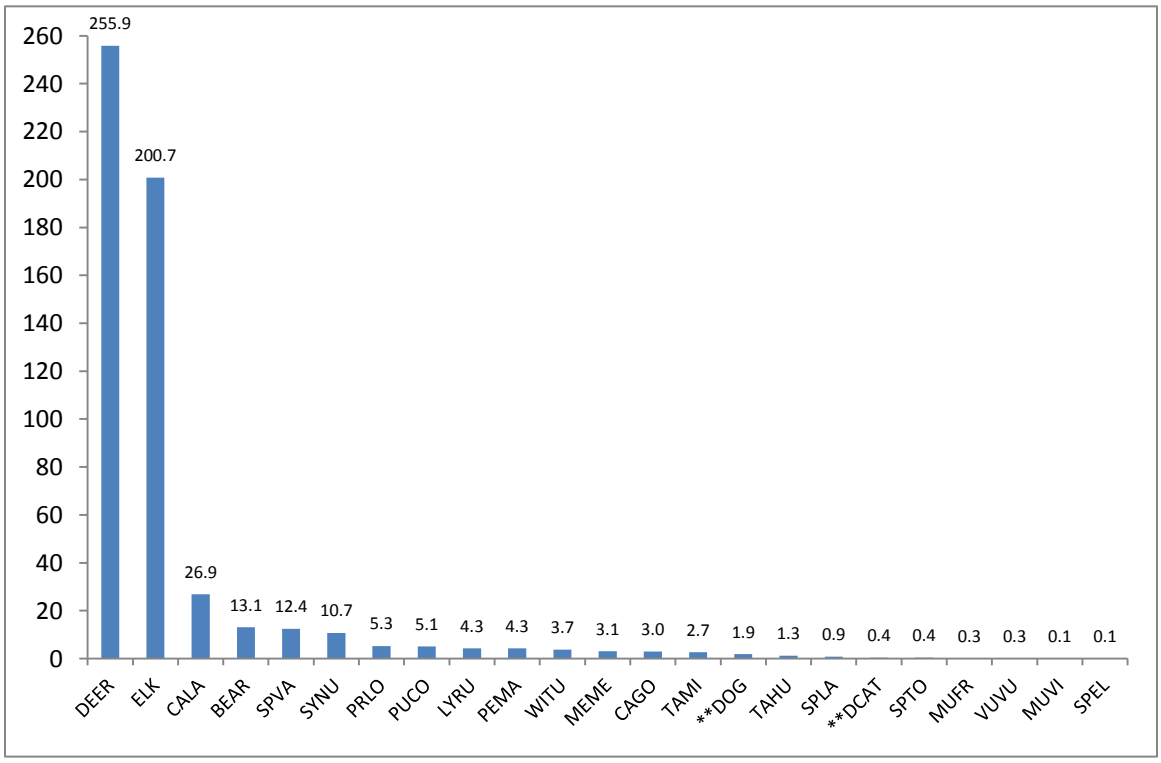

Figure 6. Total species and number of individuals detected by cameras 2007-2013

$\overline{x}_{year}$ = 255.9) and Rocky Mountain elk (*n*=1,405; $\overline{x}_{year}$ = 200.7) are abundant throughout the trail corridor and detections of these species were correspondingly greater by year and total abundance than any other species. Other than deer and elk, coyotes, American black bears, rock squirrels, mountain cottontails, raccoons, and mountain lions were (in order) the next 5 most abundant mammals detected by the cameras (Table 11). Mule deer (45.5%) and elk (35.7%) represented a combined 81.3% of all individuals detected during the monitoring period. The next 5 most detected species combine for only 12.2% of total annual abundance. In other words, although few individuals of most of the species at RGT were detected, most of the individuals detected were members of the most abundant species. Domestic dogs and domestic cats were detected during the monitoring period as well. A total of 13 dogs ($\overline{x}_{year}$ = 1.9) and 3 cats ($\overline{x}_{year}$ = 0.4) were captured by the monitoring cameras.

Table 7. Relative abundance of 10 most abundant species detected at RGT by year[2]. Only years with new cameras (i.e., more complete sampling effort) are shown.

2010		2011		2012		2013		Mean Annual	
Species	Relative Abundance	Species	Relative Abundance	Species	Relative Abundance	Species	Relative Abundance	Species	Relative Abundance
ELK	39.00%	DEER	46.12%	DEER	33.43%	DEER	55.60%	DEER	33.61%
DEER	36.87%	ELK	41.55%	ELK	31.59%	ELK	22.48%	ELK	23.85%
CALA	12.55%	CALA	3.04%	CALA	5.92%	CALA	4.61%	CALA	4.47%
BEAR	5.98%	SPVA	2.28%	SYNU	5.08%	BEAR	3.95%	BEAR	2.31%
LYRU	2.12%	BEAR	1.83%	SPVA	4.37%	SYNU	3.67%	SPVA	2.16%
PRLO	0.97%	PRLO	1.52%	PEMA	4.23%	SPVA	3.39%	SYNU	1.91%
PUCO	0.58%	WITU	1.07%	PUCO	2.40%	MEME	1.32%	PUCO	0.84%
SPVA	0.58%	TAHU	0.76%	BBMA	1.55%	PUCO	0.85%	PEMA	0.76%
TAHU	0.58%	PUCO	0.61%	PRLO	1.55%	TAMI	0.75%	PRLO	0.74%
CAGO	0.19%	SPLA	0.46%	TAMI	1.55%	LYRU	0.66%	LYRU	0.69%

b. Species Richness & Diversity

Mammalian species diversity and evenness (2010-2013) as measured by the Shannon index exhibited an upward trend but the trend is not significant and only 7% of the

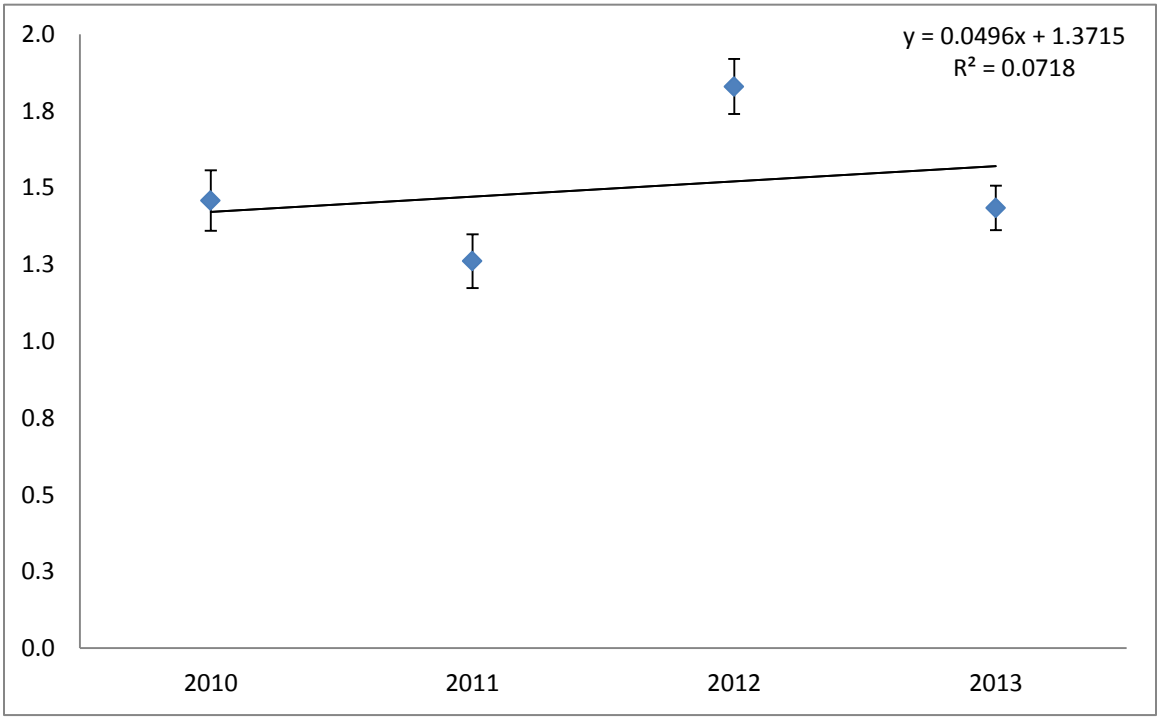

Figure 7. RGT mammalian species diversity (with upper and lower 95% confidence intervals) as measured by the Shannon-Wiener index

[2] Please see Appendix C for key to 4-letter species codes.

variation in species richness can be explained by the model. The remaining 93% is explained by unknown variables or inherent variability. Typically, the higher the value of the Shannon index, the higher the species evenness and richness (Magurran 2004).

Table 8. RGT species diversity (with upper and lower 95% confidence intervals) as measured by the Shannon-Wiener index (Chao & Shen 2003).

Year	Shannon Index	SE	Lower 95% CI	Upper 95% CI
2010	1.458	0.050	1.360	1.557
2011	1.261	0.045	1.173	1.348
2012	1.829	0.046	1.740	1.919
2013	1.434	0.037	1.362	1.506
2011	3.170	12.100	2.989	3.352
2012	3.283	4.300	3.108	3.459

Species richness was estimated[3] for 2011-2013 and varied from a low of 15.5 in 2011 to a high of 17.5 in 2012 ($\overline{x}_{year}$ = 22.7). Although the linear trend indicates a slightly positive trend, only 11% of the variation in species richness can be explained by the model. The remaining 89% can be explained by unknown

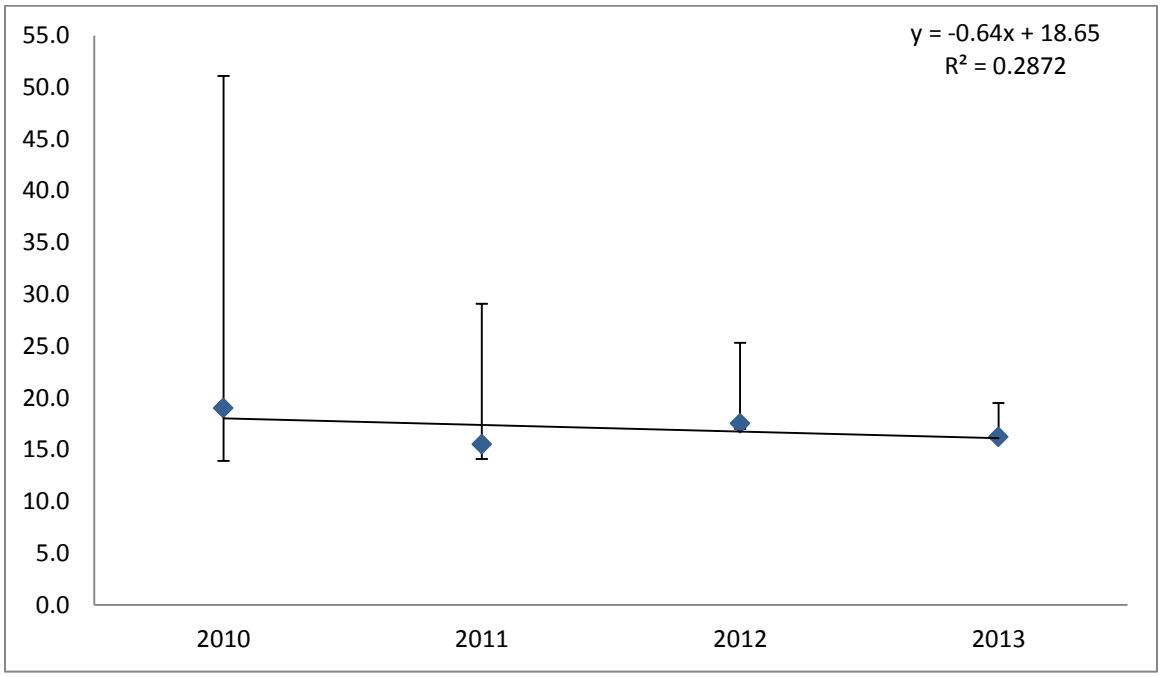

Figure 8. RGT mammalian species richness estimation of true species richness (with upper and lower 95% confidence intervals) within the RGT by year (2010-2013).

[3] Due to incomplete data, the estimated standard error was too great for 2007-2009 to provide a reasonable estimate.

variables or inherent variability.

Table 9. Estimates for true mammal species richness for RGT camera monitoring (2010-2013).

Year	Shannon Index	SE	Lower 95% CI	Upper 95% CI
2010	19.000	7.2	13.900	51.100
2011	15.500	2.6	14.100	29.100
2012	17.500	1.3	17.000	25.300
2013	16.200	0.5	16.000	19.500

Wildlife was observed at every hour of the day (Figure 9), but peak observations was clearly bimodal. Peak use occurred in 2 4-hour periods: 7AM – 10AM (22.3%) and 4PM – 7PM (22.6%). The peak morning hour was 7-8AM (8.5%) and the peak evening hour was 5-6PM (8.1%).

c. Diel Activity Patterns

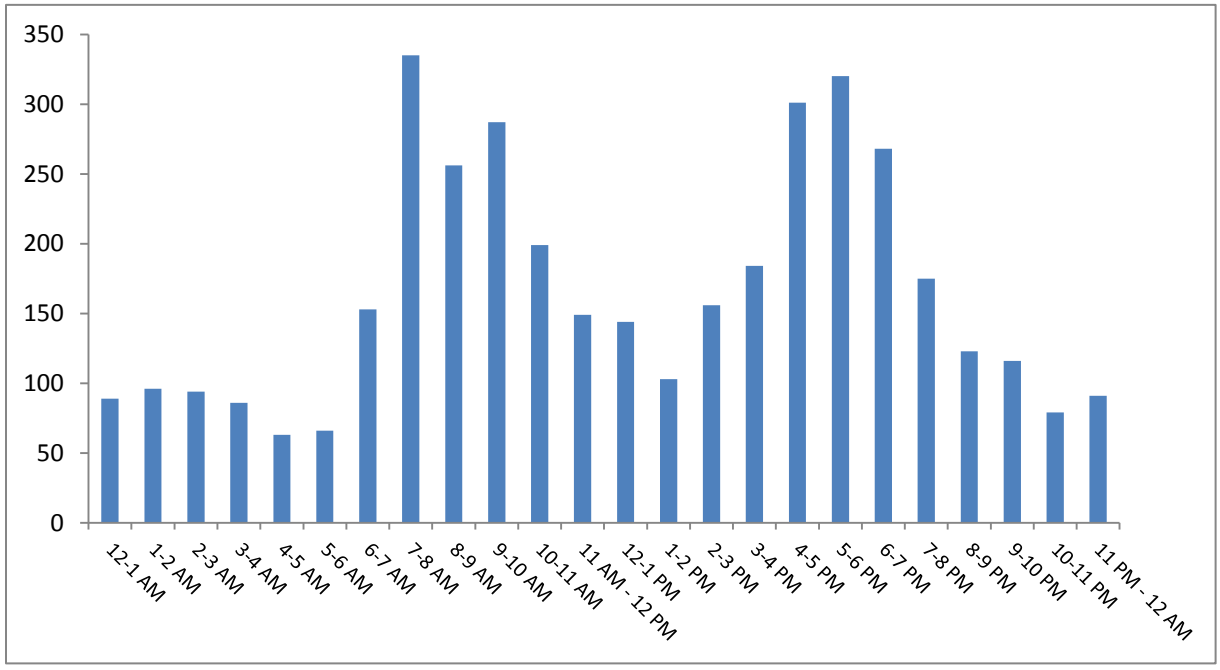

Figure 9. Diel activity pattern of all detected species 2007-2013.

Diel patterns were similar when the trail was open (7 months) and closed (5 months) but when adjusted for the length of time for each period, wildlife activity during the closed period was substantially greater (Figure 16). Although much of this difference was due to increased mule deer and elk activity within the trail corridor during the winter months non-ungulate activity in the trail corridor during the 5 month closed period was greater as well (Figure 17). Diel activity for non-ungulates was somewhat less bimodal with substantially more activity (22.3%) in the morning (6-10AM) as compared with the most active 4 hour period (17.9%) in the evening (5-9PM). Activity for non-ungulates was more consistent throughout the day with no single hour representing more than 6.5% of total activity in a 24 hour period (Figure 18). Mountain lions were most active from 5-

6AM (22.2%) and 8-9PM (13.9%). Black bear activity was more evenly distributed but were most active from 6-7AM (8.7%), 5-6PM (10.9%), and 8-9PM (8.7%).

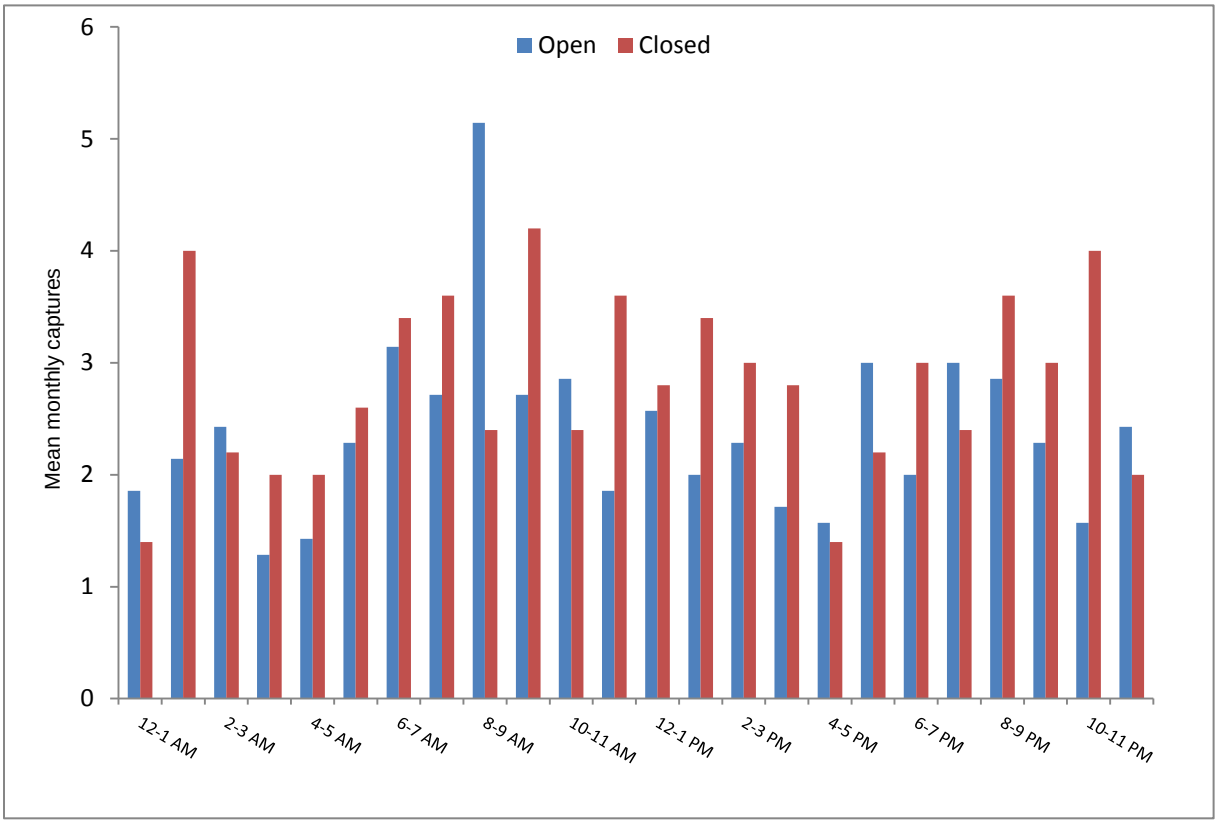

Figure 10. Diel activity of non-ungulate mammals during the period when the trail is open (May 1-November 30) and closed (December 1-April 30).

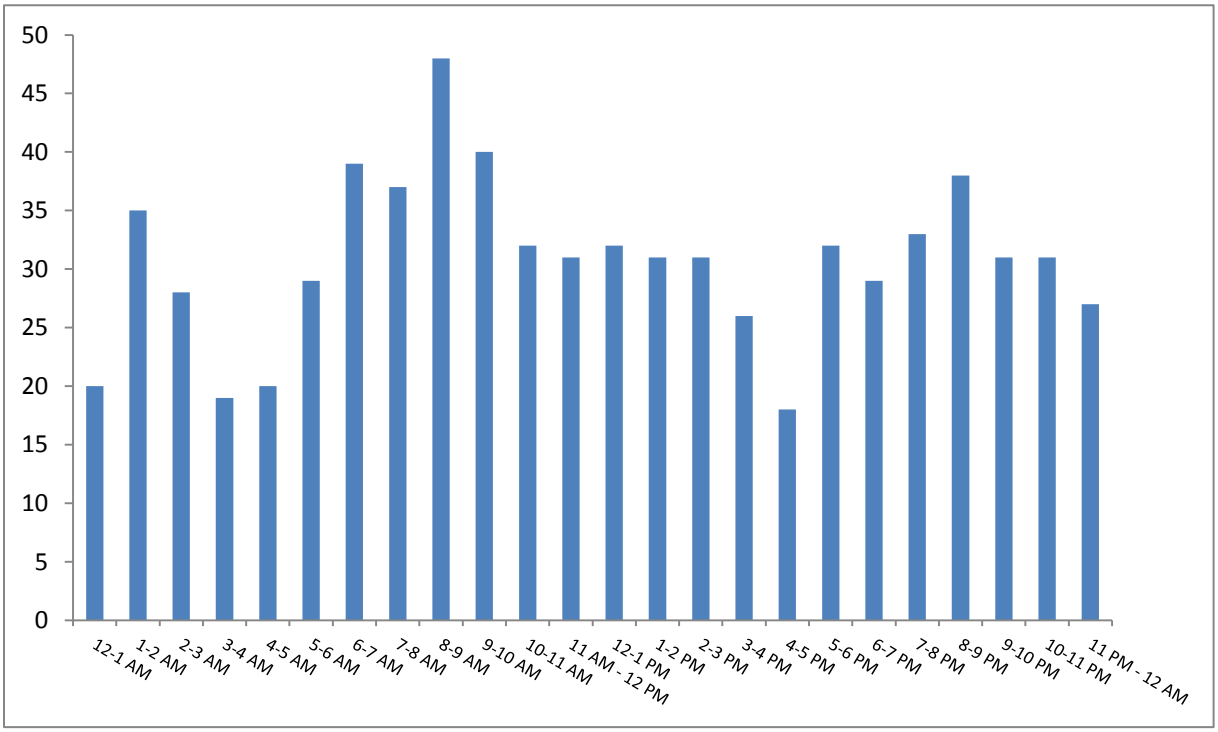

Figure 11. Total diel activity of non-ungulate mammals irrespecitve of trail status.

d. Seasonal Activity Patterns

Mean monthly activity of all mammals within the trail corridor is somewhat bimodal with peaks in the late winter (March) and late fall (November) with substantially less activity during the summer (Figure 18). This pattern, however, is heavily influenced by the large numbers of deer and elk recorded. Non-ungulate mammalian activity (Figures 18, 19)

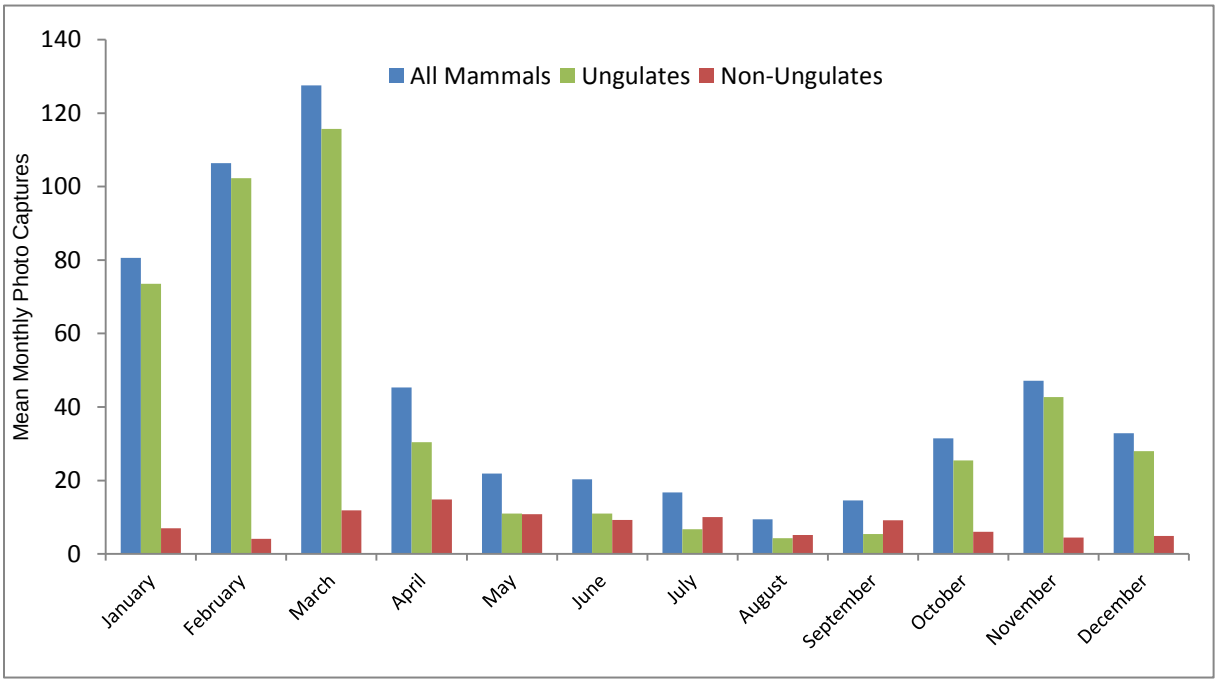

Figure 12. Mean monthly photo captures of individual mammals 2007-2013.

peaks in April (15.2%) and, to a lesser extent, in September (9.4%). While ungulate use of the trail corridor is substantially greater in the winter when the trail is closed, the most

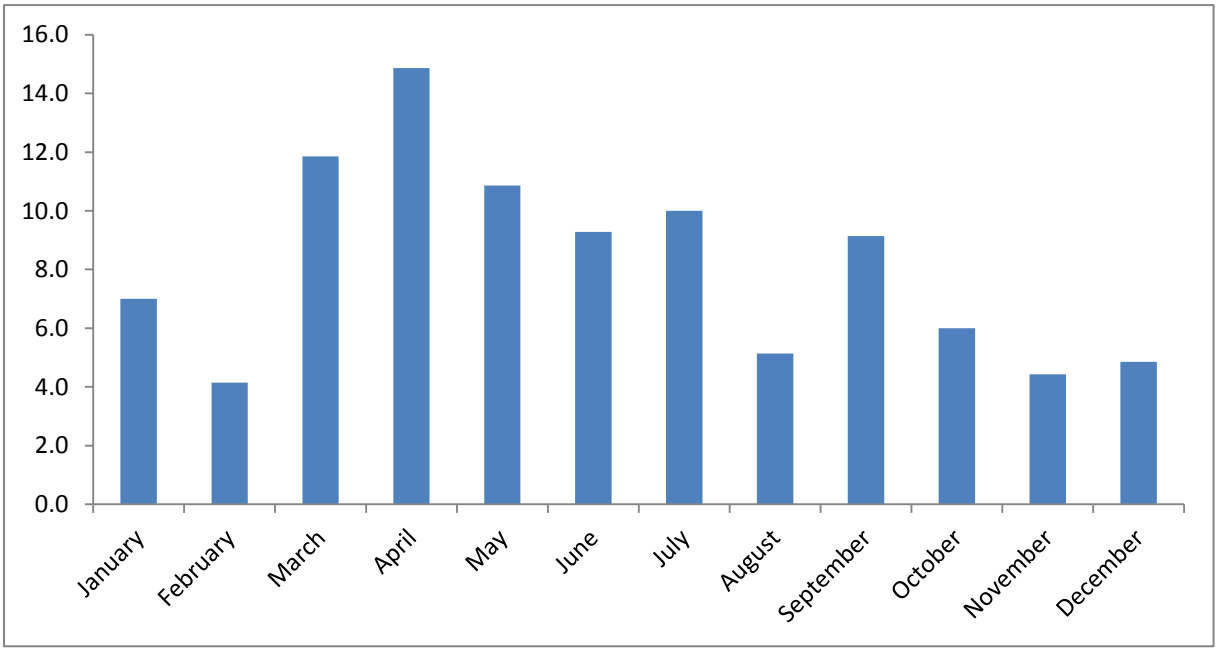

Figure 13. Mean monthly photo captures of individual non-ungulate mammals 2007-2013.

photo-captures of non-ungulates was in the spring (March-May) for a combined 38.5% of the total mean annual photo-captures.

2. *Elk & Mule Deer Seasonal and Diel Activity Patterns*

As stated above, 1,791 total individual mule deer ($\overline{x}_{year}$ = 255.9) and 1,405 Rocky Mountain elk ($\overline{x}_{year}$ = 200.7) were recorded by the monitoring cameras between 2007 and

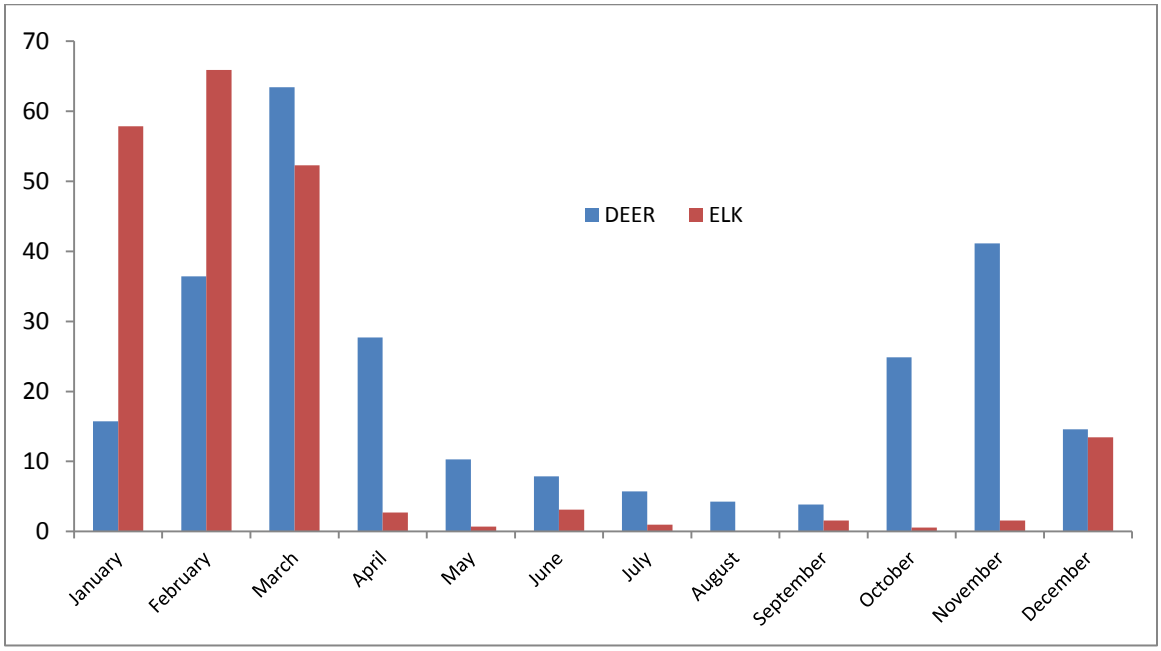

Figure 14. Mean monthly photo captures of individual mule deer and elk 2007-2013.

2013. Trends in both elk and mule deer photo captures (i.e., use of the trail corridor) increased over the monitoring period. Elk and mule deer seasonal use of the trail corridor appears to diverge to some extent (Figure 14). Elk use peaks in February with 88% of all elk photo-captures occurring in January-March. Elk activity within the trail corridor is minimal from April through November with only 5.6% of all elk photo-captures occurring in those 8 months. Mule deer activity peaks in March with almost half (49.9%) of deer photo-captures occurring in February through April. Unlike elk, however, mule deer are also quite active within the trail corridor in the fall with 16.1% of deer photo-captures occurring in November and a combined 31.5% from October through December. Similar to elk, summer deer activity is greatly reduced as many wintering animals migrate to summer range leaving resident animals behind. Only 12.5% of the deer photo-captures occurred in the 5 months from May through September.

As discussed earlier, daily elk and mule deer activity within the trail corridor is clearly bimodal (Figure 21). Daily mule deer activity peaks between 4-5PM with 10.4% of the mean daily photo-captures and 8-9AM with 8.7% of mean daily photo-captures. Mule deer are most active in the 3 hour period of 3-6PM (25.7%) and 7-10AM (22.4%). In comparison, elk are most active from 6-7PM (10.2%) and 7-8AM (11.6%) with the most active 3 hour periods of 5-8PM (26.9%) and 7-10AM (25.0%) (Figure 15). Figure 16 reinforces the peak ungulate activity periods and bimodal distribution of that activity. The

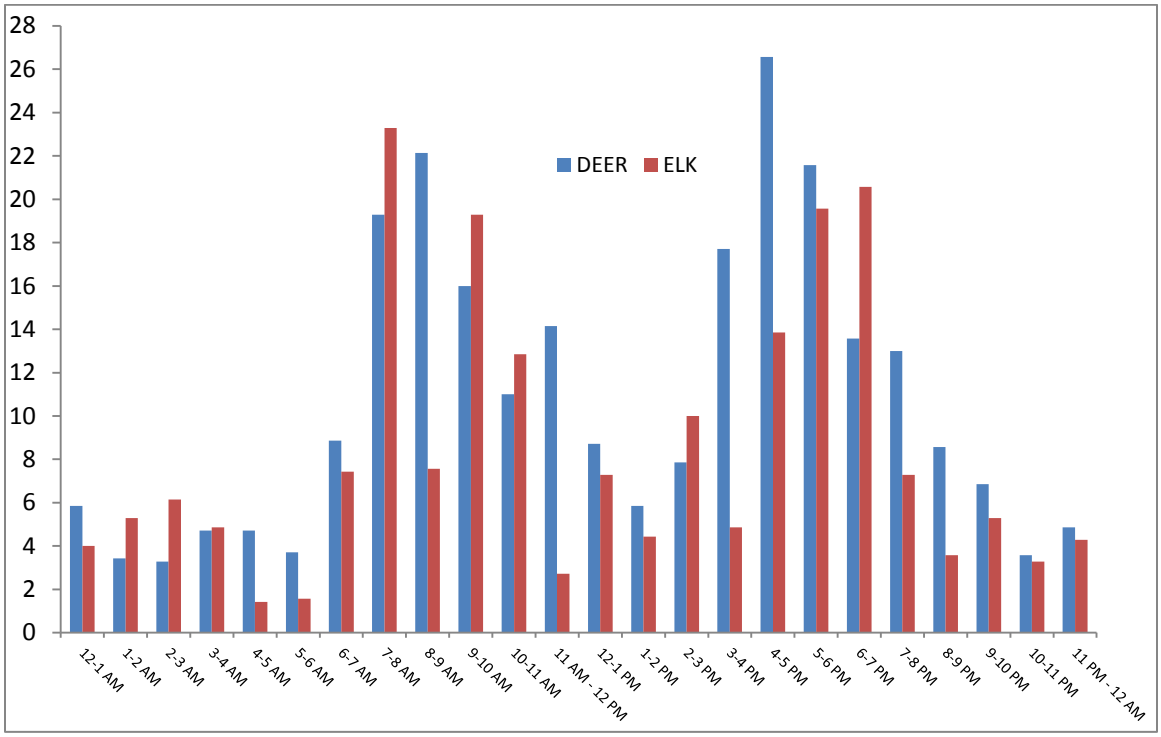

Figure 15. Mean monthly photo captures of individual mule deer and elk by hour 2007-2013.

most active periods for all ungulates is 7-8AM and 5-6PM. The morning period from 7-10AM and the evening period from 4-7PM are the most active 3 hour periods for both species combined.

V. DISCUSSION

Current methods used to monitor the ecological condition of the trail corridor are

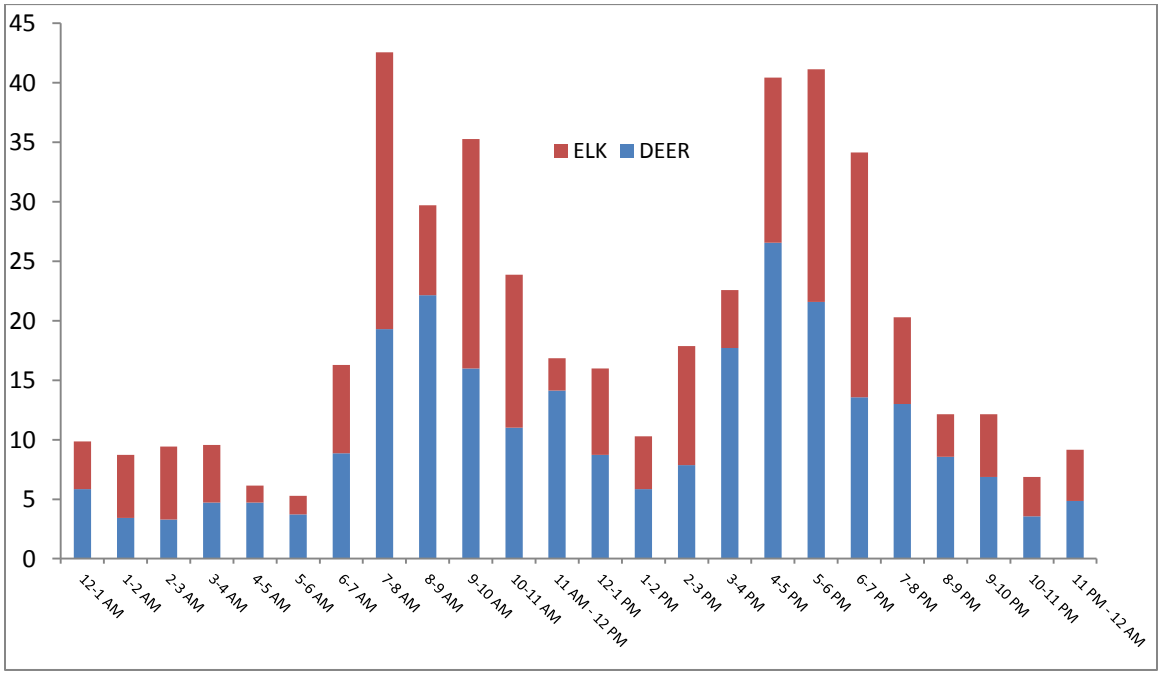

Figure 16. Combined mean monthly photo captures of individual mule deer and elk by hour 2007-2013.

providing valuable information for managers. The adaptive management plan for the RGT from RBR to Catherine Store Road requires the modification of management actions or implementation of additional strategies to remediate gaps or flaws revealed by monitoring. As stated in the 2011 Monitoring Report, it is difficult to detect trends in population density, species richness, or species composition over 7 years in a limited study area such as the RGT. The problem is in obtaining sample sizes that are large enough to provide robust statistical analysis. Only the bird point-transect effort was conducted in a manner that provides statistically defensible results. (Density estimates will be reported in the next 5-year monitoring report in 2017.) That being said, if that effort is to continue, steps can and should be taken to increase sample size. Results of the observational data obtained during 2007-2013 monitoring effort, however, provide us with valuable information regarding the ecological condition of the trail corridor. Although findings from observational studies are prone to bias, monitoring can reduce the chance of reaching erroneous conclusions by formulating *a priori* hypotheses that can be pursued multiple ways and by evaluating the sensitivity of study conclusions to biases of various magnitudes. In the end, however, professional judgment that considers all available evidence is necessary to render a decision regarding causality based on observational studies.

As described above, bird species known to be sensitive to human activity continue to be present within the trail corridor during the breeding season and at the height of the breeding season. Densities of these species did not appear to be decreasing over the initial 5 year monitoring period and the ratio of these species and species known to be adapted to the presence of humans is not decreasing and may be increasing. This suggests that these species are tolerating the presence of the trail and the current level and timing of use. But again, these results do not provide information regarding nesting success or recruitment nor can they be interpreted regarding population trends and should be considered descriptive information only. In addition, both bird species richness and species diversity increased from 2007-2013. These measures can be misleading, particularly when one is evaluating the effects of a disturbance factor such as a trail. This is because as synanthropes are attracted by human activity and waste, species richness and diversity could initially increase – that is, until the sensitive species decline. This is not the case within the trail corridor, however. As discussed above, densities of the synanthropes are not increasing and the human-sensitive species analyzed may be increasing, or at least not decreasing. As data is collected and analyzed in the future it may be possible to determine whether there are statistically significant trends in density, richness, or species composition.

The great blue herons at Rock Bottom Ranch appear to have finally found an equilibrium with the golden eagle nest predation. Although the eastern segment of the heronry (RBR-E) has been permanently abandoned, the western segment (RBR-W) continues to successfully fledge young and 2013 was a banner year with approximately 24 young fledged. At this point we can probably conclude that the RGT is not having a substantial effect on occupancy and success at the heronry. The increased activity at the Rock Bottom Ranch educational facility in combination with the declining cottonwoods and red-tailed hawk nesting activity likely combined to diminish the suitability of the RBR-E.

Wintering bald eagles continue to use the trail corridor. It remains difficult to say whether use has changed since establishment of the trail. Given that the trail is closed from

December 1 through April 30, it is unlikely that there are any negative effects on bald eagles during that period. Residential development and habitat alteration on the north side of the river poses a far greater threat to bald eagles along the reach of the Roaring Fork River paralleling the trail corridor. In 2011, John Groves, CPW, suggested that there is anecdotal evidence that the trail may result in some disruption of migrating eagles and early winter arrivals in November (J. Groves, personal communication). The Categorical Exclusion recommends a November 15 closure date to accommodate the protection of migrating eagles and in 2007, CPW requested an extension of the closure to that date for the same reason. Our monitoring data, however, indicate that, as with other monitored species, use of the trail corridor by bald eagles over the monitoring period has not decreased and may be trending upward.

Currently, there are no bald eagle nests within or adjacent to the trail corridor. Adult and immature bald eagles have been observed by CWS within the trail corridor during and immediately following the breeding season. These were likely eagles from the Aspen Glen nest and a possible new nest near Ranch at Roaring Fork but young adults are now frequently observed in the mid-valley during the breeding season. As the population of bald eagles in western Colorado continues to grow, it is not unlikely that a pair of eagle could nest within or adjacent to the RGT.

The ospreys have continued nesting on a power pole near the RGT at Rock Bottom Ranch. They have produced young every year since 2008. The only problem associated with the osprey nest has been the repeated use of the nest at the beginning of the breeding season by Canada geese. These geese are quite aggressive and keep the ospreys from nesting for a few weeks each year. In 2012, the ospreys built an alternate nest on a high-tension power pole on BLM land on the south side of the trail but abandoned it for the original nest once the geese left.

It appears that the trail is having no negative effect on wintering mule deer and elk and, both species may actually benefit from current management of the trail corridor. Throughout the winter both species were very active in the trail corridor. Major game trails were very active throughout the winter. Since the camera monitoring effort has changed over time, we cannot yet determine whether there are any long-term trends in use of the corridor. It is, however, clear that large numbers of mule deer and elk using the corridor throughout the winter, particularly in February and March. Mule deer are active throughout the year with heaviest use in late spring and late fall. Again, we cannot determine whether there is any change in use between now and before the trail was built. We can, however, say that the trail corridor is being used heavily by both species and that the winter closure has created a safe extension of valuable winter range on the Crown.

Variation in ungulate species composition and activity in the corridor seems to vary seasonally and with snow depth. Both species are present in greatest numbers during the winter which is probably historically consistent. In most years, elk head to higher elevations in spring and return again in late fall. CPW believes that trail use in November may be affecting mule deer activity within the corridor (J. Groves, CPW, personal communication). Our results do not, however, indicate any negative trends in mule deer use of the corridor in late fall or winter. Rather, use may be increasing. Given, the preference of mule deer to avoid recreationists (Loveless 1967, Aune 1981, Freddy 1986, Freddy et al. 1986, Bauer and Bauer 1995, Cole and Landres 1995, Knight and Cole 1995, Canfield 1999, DeVos et al. 2003), it is indeed possible deer may be avoiding the

trail corridor when the trail is open in the spring and summer yet using the corridor in the late fall despite the presence of human disturbance, then staying for the winter in what has become a de facto protected area from December through April 30.

The difference between the winters within the monitoring period is a reminder of why short-term data is often misleading and cannot be used to discern changes in ecological communities or to influence major management actions (Likens 1999). Stochastic variation is simply too great in the short-term. Long-term data smooths out the peaks and troughs of variation resulting from weather, drought, population irruptions, etc. and allows us to more accurately detect real shifts in a given ecological community.

Other mammal species are also using the trail corridor as part of their home range. Twenty-three species of mammal (plus wild turkeys) have been documented by the monitoring cameras. Since the number and quality of monitoring cameras has increased over time smaller and more cryptic species have been photo-captured. The captures of mountain cottontails, raccoons, chipmunks, and striped skunks have increased substantially over time. In addition, although the track surveys indicated the presence of long-tailed weasels and mink, no images had been captured of those species until the higher quality cameras were installed in 2011. Other than deer and elk, other charismatic species such as coyotes, bears, mountain lions, and bobcats continue to be recorded with relatively high frequency.

Daily and seasonal use of the trail corridor by non-ungulate mammals is somewhat similar to that of deer and elk with slight peaks in the morning and evening (as expected) and in the spring and fall but seasonal use by non-ungulate species is more consistent. It is important to note that use of the corridor by all photo-captured species, but particularly with the non-ungulates appears to be independent of trail status (Figure 16). In other words, bobcats, coyotes, mountain lions, and rock squirrels are active within the trail corridor at all hours of the day when the trail is open and when it is closed.

Over the course of the monitoring period, the number of dogs and people recorded by the monitoring cameras during the winter closure has increased. Some of the pedestrian violators were likely Rock Bottom Ranch staff. The total annual number of violations remains relatively low (e.g., 6 dogs in 2012 and 5 in 2013). Harassment by dogs, however, is the greatest threat to the continued use of the trail corridor by wintering wildlife. Some dog owners delight in seeing their dogs roam free off the leash, since the dogs get even more fun from that. Unfortunately, dogs significantly exacerbate the effects of recreation related impacts on wildlife (MacArthur 1979, MacArthur 1982, Yalden and Yalden 1990, Mainini et al. 1993, Kay 1998, Abraham 2001, Miller et al. 2001). Banks and Bryant (2007) found in field studies that dog-walking in otherwise undisturbed habitat causes a 35% reduction in bird diversity − the number of species − and a 41% reduction in abundance − the number of individual birds in an area. Lenth et al. (2006a) documented that trails in areas that allow dogs have a wider area of influence on mule deer and small mammals, including prairie dogs, rabbits, squirrels and mice. This area of influence surrounding trails is potentially unsuitable habitat for these species.

Dogs are capable of catching and killing prey species, such as white-tailed deer (Lowry and McArthur 1978), small mammals (Scott and Causey 1973), herpetofauna such as the endangered gopher tortoise (Causey and Cude 1978), and ground-nesting birds such as wild turkeys (Miller and Leopold 1992). Numerous breeds of dogs have been specifically

bred for hunting, with specialized traits for finding and catching prey, while others are bred for racing or fighting, making them potentially dangerous to wildlife (Serpell 1995). Even without being chased, animals that are prey of wild canids such as coyotes may perceive dogs as predators and may be subject to non-lethal, fear-based alterations in physiology, activity, and habitat use (MacArthur 1982, Lima 1998, Miller et al. 2001), with potentially complex effects (Ripple and Beschta 2004).

VI. MANAGEMENT RECOMMENDATIONS

As stated above, our results indicate that most of the species of interest are present and active within the trail corridor. In fact, it could be argued that wintering animals are presented with improved conditions with diminished human disturbance due to the trail closure. On the other hand, some management actions are recommended to reduce effects of non-winter recreation and to provide the great blue herons the continued opportunity to inhabit and expand the heronry near the RGT at Rock Bottom Ranch.

Recommended RFTA Management Actions

1. Enforcement
    a. Investigate entry points for people with dogs during closure.
    b. Add signs at entry points reinforcing importance of closure, dog prohibition and sensitive winter habitat.
2. Mule Deer and Elk
    a. Maintain current opening date and closure.
    b. Add fence openings at RGT intersections with game trails to facilitate movement and reduce the cost of repeated fence repair.
3. Other mammals – No changes necessary.
4. Great Blue Herons
    a. Continue to work with ACES/RBR to protect cottonwood suckers from elk herbivory in vicinity of heronry.
    b. Limit activities that alter the landscape, especially landscaping activities involving noisy machinery such as skid steers, power mowers, chainsaws between April 1 and June 1.
        i. Work with RBR to similarly limit work with tractors, mowers, chain saws, and other loud equipment within 250 m of the heronry during the nesting season.
5. Bald Eagles
    a. Change the fall closure to November 15th to comply with the Categorical Exclusion and CPW 2007 recommendation.
6. Other Birds – No changes necessary.

7. Ecological Integrity – Intensify efforts to control non-native plants and noxious weeds within the trail corridor, particularly Russian olive, reed canarygrass and cheatgrass.
8. Monitoring Recommendations
    a. The Rio Grande Trail Categorical Exclusion recommends monitoring of great blue herons (Categorical Exclusion, p. 22). Great blue heron monitoring should continue as recommended by the Categorical Exclusion.
        i. Osprey monitoring can continue in conjunction with the heron monitoring.
    b. Bald eagle monitoring is recommended by the Categorical Exclusion to determine whether they continue to use roost sites within the corridor (Categorical Exclusion, p. 21).
    c. Continue monitoring with 5 cameras to sufficiently record use of the entire RBR-Catherine Store Road corridor by mammals year-round.
    d. Continue monitoring birds via point-transects but conduct 2 transects per year beginning in 2014 to increase the number of detections per species so that population trends can be determined for more species.
9. Additional Recommendations
    a. The current closure gate configuration successfully excludes most trail users during the winter closure.
        i. The gate immediately west of the Crown access trail creates a significant barrier to wildlife movement.
        ii. Once sufficient snow has accumulated to deter mountain bikers and most pedestrians (~8 inches), this gate should be left open allow both large and small animals to pass.

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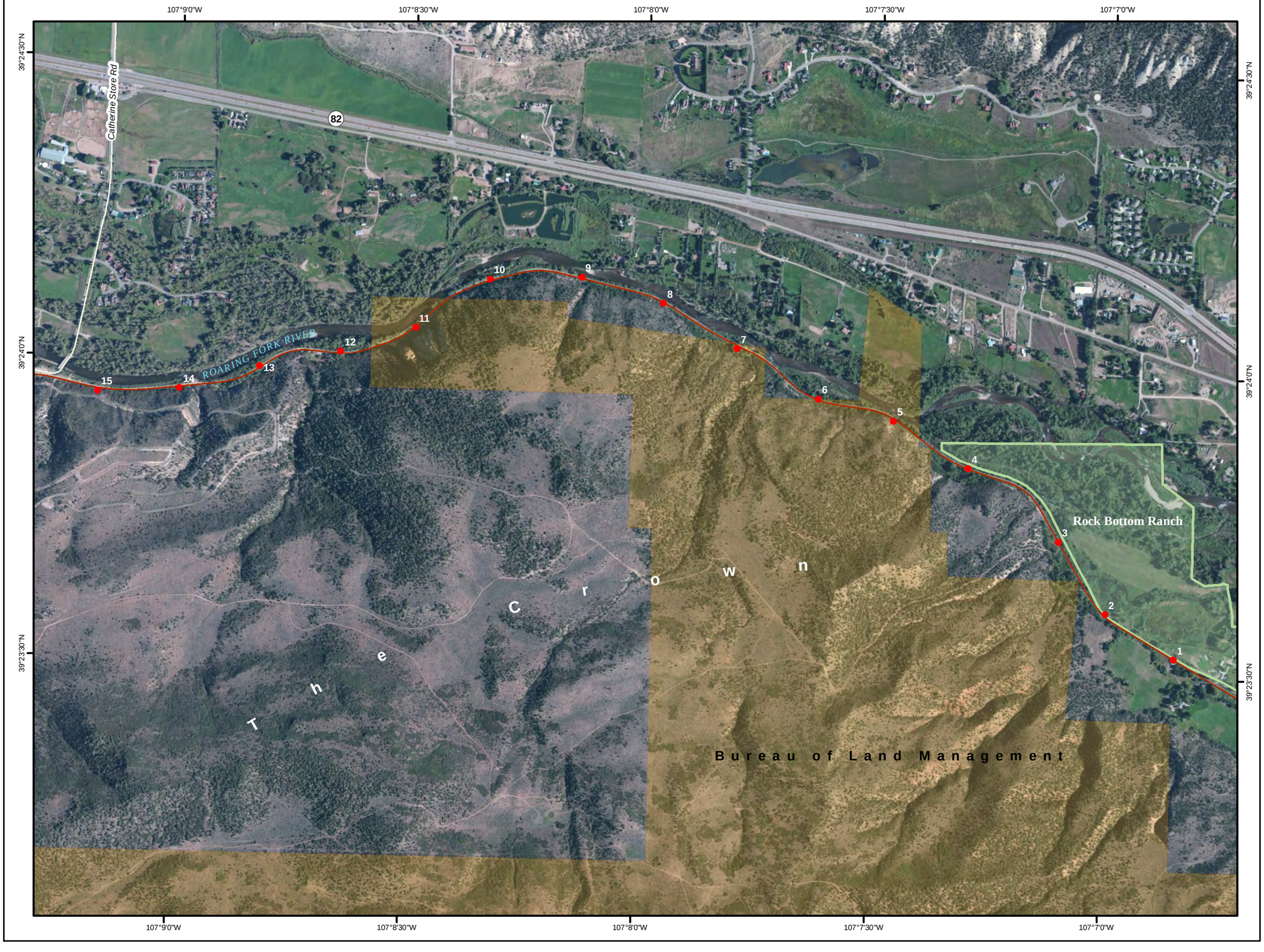
Appendix A – Maps



Rio Grande Trail

Rock Bottom Ranch to Catherine Store Road

Roaring Fork Transportation Authority

WILDLIFE MONITORING REPORT 2007-2013

Map 1.
Bird Monitoring Point Transect

Legend:

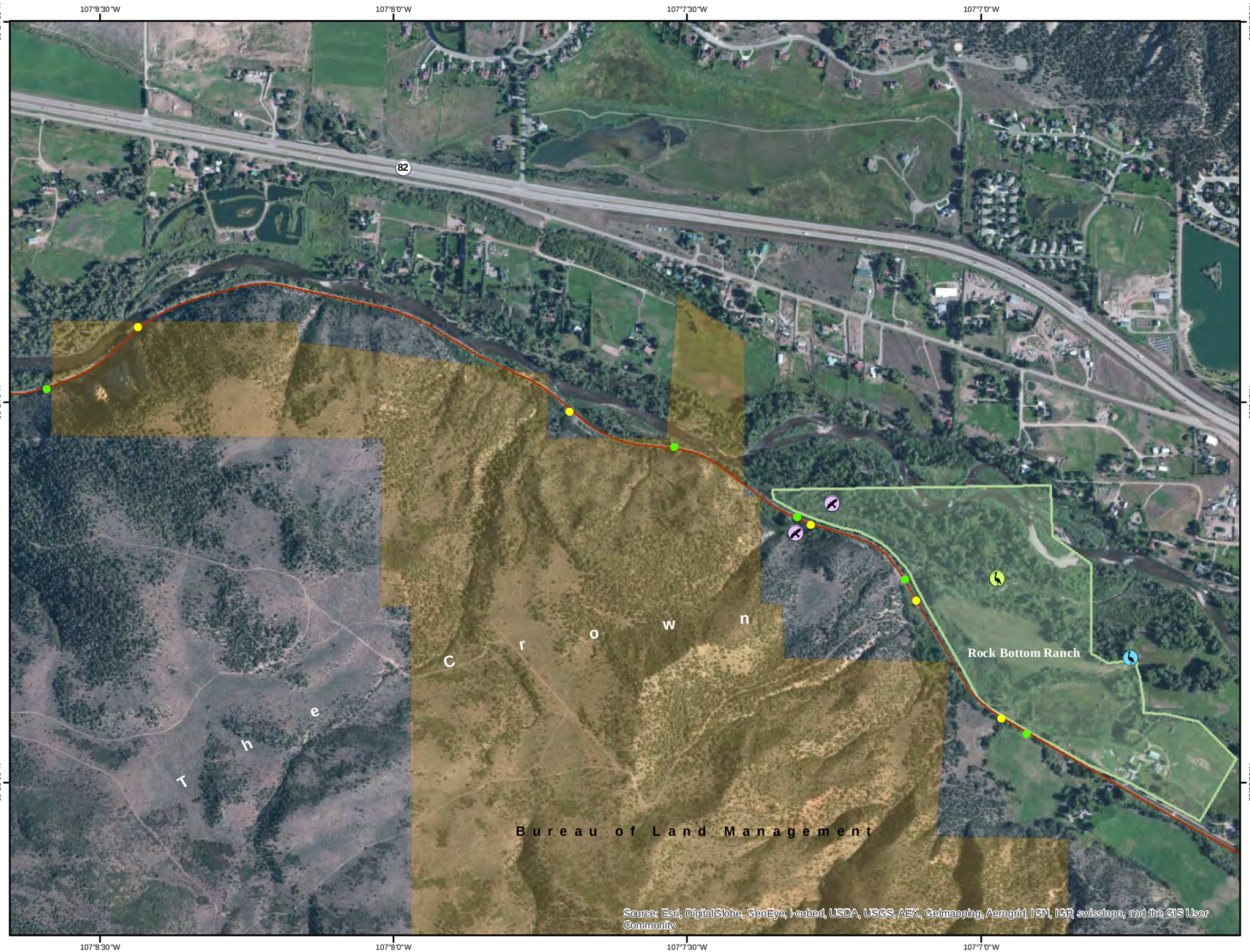
8 Monitoring Point

0 50 100 200 300 Meters

1:11,000

Basemap Source:
USDA-FSA--APFO NAIP
2011 Mosaicked County Image
Garfield County, CO

COLORADO WILDLIFE SCIENCE LLC
0100 Elk Run Dr, Ste 128, Basalt, CO 81621
970.927.4549
Email: info@coloradowildlifescience.com
Web: http://coloradowildlifescience.com



Roaring Fork Transportation Authority

Rio Grande Trail

Rock Bottom Ranch to Catherine Store Road

WILDLIFE MONITORING REPORT
2007-2013

Map 2.
Camera Locations, Heronries & Osprey Nest

Legend:

- Open Trail Camera Location
- Closed Trail Camera Location
- RBR-W Heronry
- RBR-E Heronry
- Osprey Nest

0 250 500 1,000 Feet
1:11,539

Basemap Source:
ESRI-USDA-USGS etc.
2011 Mosaicked County Image
Garfield County, CO

COLORADO WILDLIFE SCIENCE LLC
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970.927.4549
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Appendix B – Photos

Photo 1. Gray catbirds are common riparian birds in the trail corridor

Photo 2. Warbling vireo in the corridor

Photo 3. Yellow warblers were the second most abundant bird detected in the corridor

Photo 4. Bank swallows are common thanks to the abundant nesting habitat in the corridor

Photo 5. Black-headed grosbeak in pinyon pine next to RGT

Photo 6. Cordilleran flycatcher in cottonwood along the trail

Photo 7. Active coyote den adjacent to the RGT

Photo 8. Tree swallows like this one are common within the trail corridor

Photo 9. This violet-green swallow was photographed along the trail in 2013

Photo 10. Wild turkeys seem to be increasing within the trail corridor

Photo 11. Black-billed magpies, a synanthrope, were often captured by the monitoring cameras

Photo 12. Canada geese were often photo-captured walking down the trail

Photo 13. Goose strolls were sometimes in pairs

Photo 14. Mallards also would walk along the trail…

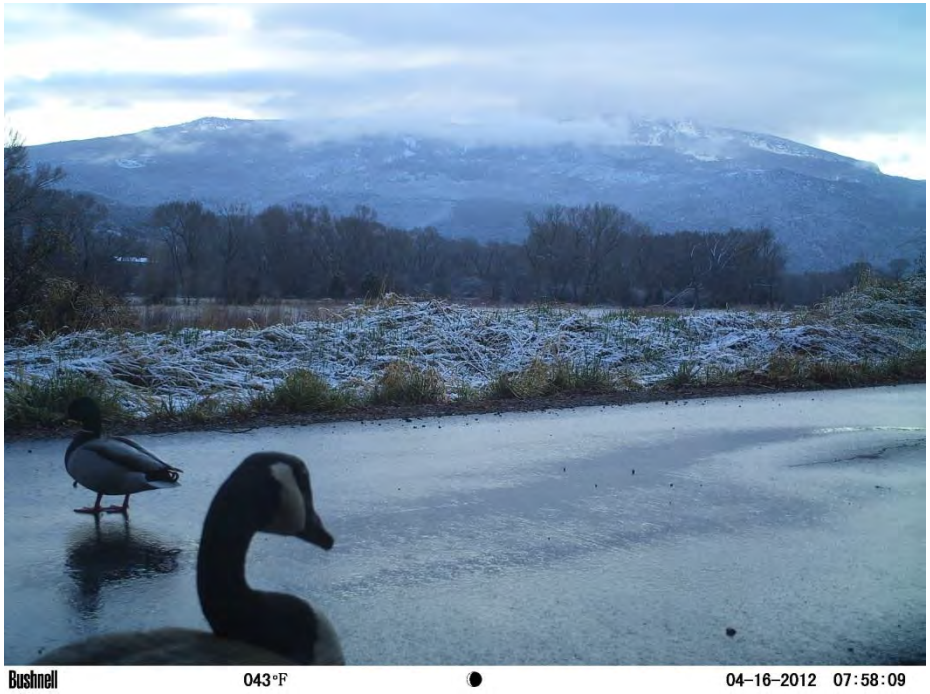

Photo 15. …sometimes with a goose!

Photo 16. Wild turkeys were often captured using game trails

Photo 17. Turkeys use the trail throughout the year

Photo 18. Wild turkey hens

Photo 19. Two-tone black bear sow with 2 ciubs

Photo 20. Large black bear using the trail

Photo 21. Black bear cub approaching the trail from the south

Photo 22. Black bear in profile

Photo 23. Black bear early in the spring – soon after emerging from winter hibernation

Photo 24. Coyote using the trail in January

Photo 25. Coyote following tracks at Camera 5 (west end)

Photo 26. Coyotes hunting on the trail

Photo 27. Coyote in summer coat on game trail approaching RGT

Photo 28. Bobcat heading toward The Crown

Photo 29. Bobcat heading toward the trail during daylight (5:12 PM)

Photo 30. Large bobcat at night

Photo 31. Striped skunk using the trail

Photo 32. Increased quantity & quality of cameras has increased captures of smaller animals such as skunks

Photo 33. This is the first photo-capture of an American mink since monitoring began

Photo 34. 2012 also was the first time a long-tailed weasel was photo-captured by the monitoring cameras

Photo 35. Long-tailed weasel in pursuit of a chipmunk or ground squirrel often captured at this location

Photo 36. The higher quality cameras were able to capture deer mice such as this one

Photo 37. As with skunks, more raccoons have been captured by the better cameras

Photo 38. Mall captures of raccoons were at night

Photo 39. The first photo-capture of a red fox was in 2012

Photo 40. Rock squirrels are very common within the trail corridor throughout the year

Photo 41. Rock squirrels, golden-mantled ground squirrels and least chipmunks are common in the corridor

Photo 42. Mountain cottontails use the many game trails intersecting the RGT

Photo 43. Mountain cottontails and other prey species support a robust predator population along the trail

Photo 44. Mountain lions photo-captures has substantially increased since the better cameras were installed

Photo 45. Lions use the trail throughout the year and all times of day

Photo 46. Mountain lion in winter at 10:21 AM

Photo 47. A lion heading from the trail toward the river

Photo 48. Two lions (perhaps a female and yearling) using the trail

Photo 49. Lion using the trail at night near at RBR

Photo 50. Lion heading across “the slough” toward RBR west meadow

Photo 51. Lion using the trail at Camera 4 in March

Photo 52. Sequence of mountain lion photo-captures on March 20, 2013 from 11:22- 11:25 AM

Photo 53. Large groups of does and yearlings are commonly captured from late fall through early spring

Photo 54. Mule deer doe entering RGT from game trail

Photo 55. When the trail is clear of snow, deer often choose the soft surface shoulder over the asphalt

Photo 56. Young buck about to drop an antler

Photo 57. Group of does and yearlings using the trail in late winter

Photo 58. Group of 11 does & yearlings

Photo 59. Does crossing "the slough" from RBR west meadow toward RGT

Photo 60. Buck crossing "the slough" from RGT toward RBR west meadow

Photo 61. Large mule deer buck heading toward the trail

Photo 62. Buck on game trail heading toward the RGT

Photo 63. Another buck heading toward the trail in November

Photo 64. Doe on game trail at Camera 4 heading toward the Crown

Photo 65. Bull elk were often photo-captured in groups of 2 and 3

Photo 66. Bull using untracked powder on the RGT

Photo 67. Bull following another's trail through shallow snow

Photo 68. The trail corridor provides valuable winter habitat to some large bulls

Photo 69. Another bull using the trail in winter

Photo 70. Since the cameras were often positioned to capture smaller animals, many elk photos look like this…

Photo 71. …and this

Photo 72. Large groups of cow, yearlings, and spike bulls (often >50), use the trail corridor in winter

Photo 73. Another group of cows – elk find usable winter forage growing along the edge of the trail

Photo 74. Sometimes counting individuals in a photo-capture can be a challenge

Photo 75. Violations of the dog prohibition seem to be increasing

Photo 76. Unsupervised dogs pose a substantial disturbance to the trail corridor's wildlife

Photo 77. Dog accompanying trail user but off leash poses greater threat than leashed dog

Photo 78. Leashed dogs leaving trail – all dogs are prohibited to protect wildlife

Photo 79. If the dogs are going to be leashed at least the person should hold the leash!

Photo 80. Two dogs on the trail during the closure at the western segment of the corridor

Photo 81. At least the person has one dog leashed

Photo 82. A pair of domestic cats were photo-captured a few times in this location

Photo 83. The second cat of the pair often recorded together

Photo 84. Both cats prowling together

Photo 85. Violations of the closure have been trending upward

Photo 86. A pair of closure violators

Photo 87. Two more people using the trail during the closure

Photo 88. Jogger using the trail when it is closed

Photo 89. Recent photo-capture of man teaching his kid that it is ok to break the rules

Photo 90. Same child as previous photo

Photo 91. Trail closure violations increase when the trail is clear of snow

Photo 92. On the trail when it is closed near midnight

Photo 93. Another person that likely entered the trail at the Carbondale end during the closure

Photo 94. Another violator at the Rock Bottom side

Appendix C – Species Detected

TABLE A1. MAMMALS

	COMMON NAME	LATIN NAME	CODE
1	American mink	*Mustela vison*	MUVI
2	Black bear	*Ursus americanus*	URAM
3	Bobcat	*Lynx rufus*	LYRU
4	Coyote	*Canis latrans*	CALA
5	Deer mouse	*Peromyscus maniculatus*	PEMA
6	Golden-mantled ground squirrel	*Spermophilus lateralis*	SPLA
7	Long-tailed vole	*Microtus longicaudus*	VOLE
8	Least chipmunk	*Tamias minimus*	TAMI
9	Long-tailed weasel	*Mustela frenata*	MUFR
10	Montane vole	*Microtus montanus*	VOLE
11	Mountain cottontail	*Sylvilagus nuttallii*	SYNU
12	Mountain lion	*Puma concolor*	PUCO
13	Mule deer	*Odocoileus hemionus hemionus*	DEER
14	North American red squirrel	*Tamiasciurus hudsonicus*	TAHU
15	Raccoon	*Procyon lotor*	PRLO
16	Red fox	*Vulpes vulpes*	VUVU
17	Rock squirrel	*Spermophilus variegatus*	SPVA
18	Rocky Mountain elk	*Cervus elaphus nelsoni*	ELK
19	Striped skunk	*Mephitis mephitis*	MEME
20	Wyoming ground squirrel	*Spermophilus elegans*	SPEL

TABLE A2. BIRDS

	COMMON NAME	LATIN NAME	CODE
1	American crow	*Corvus brachyrynchos*	AMCR
2	American dipper	*Cinclus mexicanus*	AMDI
3	American goldfinch	*Carduelis tristis*	AMGO
4	American kestrel	*Falco sparverius*	AMKE
5	American redstart	*Setophaga ruticilla*	AMRE
6	American robin	*Turdus migratorius*	AMRO
7	Bald eagle	*Haliaeetus leucocephalus*	BAEA
8	Band-tailed pigeon	*Patagioenas fasciata*	BTPI
9	Bank swallow	*Riparia riparia*	BANS
10	Barn swallow	*Hirundo rustica*	BARS
11	Belted kingfisher	*Ceryle alcyon*	BEKI
12	Black-billed magpie	*Pica hudsonia*	BBMA
13	Black-capped chickadee	*Poecile atricapillus*	BCCH
14	Black-headed grosbeak	*Pheucticus melanocephalus*	BHGR
15	Black-throated gray warbler	*Setophaga nigrescens*	BTYW
16	Blue-gray gnatcatcher	*Polioptila caerulea*	BGGN
17	Blue-winged teal	*Anas discors*	BWTE
18	Brewer's blackbird	*Euphagus cyanocephalus*	BRBL
19	Broad-tailed hummingbird	*Selasphorus Platycercus*	BTLH
20	Brown-headed cowbird	*Molothrus ater*	BHCO
21	Bullock's oriole	*Icterus bullockii*	BUOR
22	Canada goose	*Branta canadensis*	CAGO
23	Cedar waxwing	*Bombycilla cedrorum*	CEDW
24	Chipping sparrow	*Spizella passerina*	CHSP
25	Cinnamon teal	*Anas cyanoptera*	CITE
26	Common merganser	*Mergus merganser*	COME
27	Common raven	*Corvus corax*	CORA
28	Cooper's hawk	*Accipiter cooperii*	COHA
29	Cordilleran flycatcher	*Empidonax occidentalis*	COFL
30	Downy woodpecker	*Picoides pubescens*	DOWO
31	Dusky flycatcher	*Empidonax oberholseri*	DUFL
32	Eurasian collared-dove	*Streptopelia decaocto*	ECDO
33	European starling	*Sturnus vulgaris*	EUST
34	Fox sparrow	*Passerella iliaca*	FOSP
35	Gadwall	*Anas strepera*	GADW

TABLE A2. BIRDS

	COMMON NAME	LATIN NAME	CODE
36	Golden eagle	*Aquila chrysaetos*	GOEA
37	Gray catbird	*Dumetella carolinensis*	GRCA
38	Great blue heron	*Ardea herodias*	GBHE
39	Great-horned owl	*Bubo virginianus*	GHOW
40	Green-tailed towhee	*Pipilo chlorurus*	GTTO
41	Green-winged teal	*Anas crecca*	AGWT
42	Hairy woodpecker	*Picoides villosus*	HAWO
43	House finch	*Carpodacus mexicanus*	HOFI
44	House wren	*Troglodytes aedon*	HOWR
45	Lazuli bunting	*Passerina amoena*	LAZB
46	Lesser goldfinch	*Carduelis psaltria*	LEGO
47	Lewis's woodpecker	*Melanerpes lewis*	LEWO
48	Lincoln's sparrow	*Melospiza lincolnii*	LISP
49	MacGillivray's warbler	*Oporornis tolmiei*	MACW
50	Mallard	*Anas Platyrynchus*	MALL
51	Mountain bluebird	*Sialia currucoides*	MOBL
52	Mountain chickadee	*Poecile gambeli*	MOCH
53	Mourning dove	*Zenaida macroura*	MODO
54	Northern flicker	*Colaptes auratus*	RSFL
55	Olive-sided flycatcher	*Contopus cooperi*	OSFL
56	Orange-crowned warbler	*Vermivora celata*	OCWA
57	Osprey	*Pandion haliaetus*	OSPR
58	Pine siskin	*Carduelis pinus*	PISI
59	Plumbeous vireo	*Vireo plumbeus*	PLVI
60	Red-tailed hawk	*Buteo jamaicensis*	RTHA
61	Red-winged blackbird	*Agelaius phoeniceus*	RWBL
62	Sharp-shinned hawk	*Accipiter striatus*	SSHA
63	Song sparrow	*Melospiza melodia*	SOSP
64	Sora	*Porzana carolina*	SORA
65	Spotted sandpiper	*Actitis macularia*	SPSA
66	Spotted towhee	*Pipilo maculatus*	SPTO
67	Steller's jay	*Cyanocitta stelleri*	STJA
68	Swainson's thrush	*Catharus ustulatus*	SWTH
69	Tree swallow	*Tachycineta bicolor*	TRES
70	Turkey vulture	*Cathartes aura*	TUVU
71	Violet-green swallow	*Tachycineta thalassina*	VGSW
72	Virginia rail	*Rallus limicola*	VIRA
73	Virginia's warbler	*Vermivora virginiae*	VIWA
74	Warbling vireo	*Vireo gilvus*	WAVI
75	Western kingbird	*Tyrannus verticalis*	WEKI
76	Western scrub-jay	*Aphelocoma californica*	WESJ
77	Western tanager	*Piranga ludoviciana*	WETA
78	Western wood-pewee	*Contopus sordidulus*	WEWP
79	White-crowned sparrow	*Zonotrichia leucophrys*	WCSP
80	Wild turkey	*Meleagris gallopavo merriami*	WITU
81	Wilson's snipe	*Gallinago delicata*	WISN
82	Wilson's snipe	*Gallinago delicata*	WISN
83	Yellow warbler	*Dendroica petechia*	YWAR
84	Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	YHBL
85	Yellow-rumped warbler	*Dendroica coronata*	AUWA