COLORADO PARKS & WILDLIFE

Wildlife Research Reports

MAMMALS – JANUARY 2023

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WILDLIFE RESEARCH REPORTS

JULY 2021–DECEMBER 2022

MAMMALS RESEARCH PROGRAM

COLORADO PARKS AND WILDLIFE
Research Center, 317 W. Prospect, Fort Collins, CO 80526

EXECUTIVE SUMMARY

This Wildlife Research Report represents summaries (≤5 pages each with tables and figures) of wildlife research projects conducted by the Mammals Research Section of Colorado Parks and Wildlife (CPW) during 2021 and 2022. These research efforts represent long-term projects (4–11 years) in various stages of completion addressing applied questions to benefit the management and conservation of various mammal species in Colorado. In addition to the research summaries presented in this document, more technical and detailed versions of most projects (Annual Federal Aid Reports) and related scientific publications that have thus far been completed can be accessed on the CPW website at http://cpw.state.co.us/learn/Pages/ResearchMammalsPubs.aspx or from the project principal investigators listed at the beginning of each summary.

Current research projects address various aspects of wildlife management and ecology to enhance understanding and management of wildlife responses to habitat alterations, human-wildlife interactions, and investigating improved approaches for wildlife population monitoring and management. The Nongame Mammal Conservation Section addresses ongoing monitoring of lynx in the San Juan mountain range and preliminary results addressing influence of forest management practices on snowshoe hare density in Colorado. The Ungulate Management and Conservation Section includes a project addressing mule deer/energy development interactions to inform future development planning, a pilot evaluation of moose behavioral response to recent wolf-pack establishment in North Park, Colorado, an evaluation of factors influencing elk calf recruitment, and two studies addressing elk response to human recreation. The Predatory Mammals Management and Conservation Section describes a pilot research project developing longer-term research to address bobcat population demographics and improved monitoring approaches.

In addition to the ongoing project summaries described above, Appendix A includes final results presented to U.S. Bureau of Land Management addressing development of a spatial energy development planning tool to guide mule deer management on winter range. Appendix B includes publication abstracts (<1 page summaries) completed by CPW research staff since July 2021. These scientific publications provide results from recently completed CPW research projects and other collaborations with universities and wildlife management agencies. Topics addressed include nongame species ecology and conservation (application of joint species distribution models and a comparison of Canada lynx distribution pre and post spruce beetle outbreak), carnivore ecology and management (literature review related to common management questions associated with human-cougar interactions, an evaluation of human impact on movement and habitat use by male brown bears, and 3 publications addressing wolf-disease/parasite relationships), ungulate ecology and management (applying memory covariates to enhance assessment of mule deer habitat use patterns, addressing the influence of willow nutrition on moose calving rates, 2 publications addressing CWD status and data standardization for white-tailed deer management, factors influencing elk productivity and recruitment, and plant and mule deer responses to 3 mechanical treatment methods), university collaborations addressing wildlife genetics and disease research (characteristics of anelloviruses in domestic and wild cat species, and reconstructing viral phylogenies from commonly collected mountain lion tooth samples), and a *Journal of Wildlife Management* editorial evaluating the journal from established career scientists to provide suggestions for future improvement.

We have benefitted from numerous collaborations that support these projects and the opportunity to work with and train wildlife technicians and graduate students that will likely continue their careers in wildlife management and ecology in the future. Research collaborators include the CPW Wildlife Commission, statewide CPW personnel, Federal Aid in Wildlife Restoration, Colorado State University, Montana State University, University of Wyoming, Southern Illinois University, U.S. Bureau of Land Management, U.S. Forest Service, CPW big game auction-raffle grants, Species Conservation Trust Fund, Great Outdoors Colorado, CPW Habitat Partnership Program, Rocky Mountain Elk Foundation, Colorado Mule Deer Association, The Mule Deer Foundation, Muley Fanatic Foundation, EnCana Corp., ExxonMobil/XTO Energy, Marathon Oil, Shell Exploration and Production, WPX Energy, and numerous private land owners providing access to support field research projects.

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Colorado Parks and Wildlife

WILDLIFE RESEARCH PROJECT SUMMARY

Canada lynx monitoring in Colorado 2020 – 2021

Period Covered: July 1, 2020 – June 30, 2021

Principal Investigators: Eric Odell, Eric.Odell@state.co.us; Morgan Hertel, Morgan.Hertel@state.co.us; Jake Ivan, Jake.Ivan@state.co.us

In an effort to restore a viable population of Canada lynx (*Lynx canadensis*) to the southern portion of their former range, 218 individuals were reintroduced into Colorado from 1999–2006. In 2010, the Colorado Division of Wildlife (now Colorado Parks and Wildlife [CPW]) determined that the reintroduction effort met all benchmarks of success and that the population of Canada lynx in the state was apparently viable and self-sustaining. In order to track the persistence of this new population and thus determine the long-term success of the reintroduction, a minimally-invasive, statewide monitoring program is required. From 2014−2021 CPW initiated a portion of the statewide monitoring scheme described in Ivan (2013) by completing surveys in a random sample of monitoring units (n = 50) from the San Juan Mountains in southwest Colorado (n = 179 total units; Figure 1).

During the 2020−2021 winter, personnel from CPW and USFS completed the seventh year of monitoring work on this same sample. Fourteen units were sampled via snow-tracking surveys conducted between December 1 and March 31. On each of 1–3 independent occasions, survey crews searched roadways (snow-covered paved roads and logging roads) and trails for lynx tracks. Crews searched the maximum linear distance of roads possible within each survey unit given safety and logistical constraints. Each survey covered a minimum of 10 linear kilometers (6.2 miles) distributed across at least 2 quadrants of the unit. The remaining 36 units could not be surveyed via snow tracking. Instead, survey crews deployed 4 passive infrared motion cameras in each of these units during fall 2020. Cameras were lured with visual attractants and scent lure to enhance detection of lynx in the area. Cameras were retrieved during summer or fall 2021 and all photos were archived and viewed by at least 2 observers to determine species present in each. Camera data were then binned such that each of 10 15-day periods from December 1 through April 30 was considered an 'occasion,' and any photo of a lynx obtained during a 15-day period was considered a 'detection' during that occasion.

Surveyors covered 744 km during snow tracking surveys and detected lynx at 7 units (Table 1). In 2020-21 surveyors collected more DNA samples than in previous years, likely because new environmental DNA (eDNA) sampling is more efficient to collect than the previous scat or hare sampling. As in 2019-20, significantly more photos were collected in 2020-21 than in the first 5 seasons of sampling. This can be mostly attributed to the use of new, more sensitive cameras along with new, high-capacity memory cards. However, for the fourth year in a row, we collected <50% of the number of lynx photos taken during the initial years of the monitoring effort (Table 2). In fact, the 36 lynx photos collected during the 2019-20 and 2020-21 seasons are the fewest recorded since the inception of the project. We initially considered at least 3 possible explanations for the lack of photos collected in recent years. First, we hypothesized that abnormal snow patterns (lack of snow in 2017–18, record snow in 2018–19) could have impacted detection probability. Second, lack of detections could have been due to the new lure (Caven's Violator 7; Minnesota Trapline Products, https://www.minntrapprod.com/Bobcat-and-Lynx/products/829/) we used in 2017–18, 2018–19, 2019-20, and 2020-21 after the lure we used previously (Pikauba; Luerres Forget's Lures, http://www.leurresforget.com/product.php?id_product=15) became unavailable. Finally, it could be that lynx have disappeared from a number of camera units. Unfortunately, the changes in snow and lure were confounded for a few years, thus making it difficult to determine which factor resulted in fewer detections. However, 2019-20 and 2020-21 were normal snow years, yet the number of lynx photos was still low. This suggests that abnormal snow was not the cause of the pattern we observed. Also, the number of snow tracking units with lynx has remained fairly steady throughout the project; we can think of no reason why snow track units would remain occupied while lynx blinked out of camera units, unless just by chance. Thus, we suggest that the new lure is less effective than the original. Fortunately the original formulation, Pikauba, is again available and will be deployed for the 2021-22 survey. We plan to utilize this lure for the remainder of the survey efforts, provided it remains available.

We obtained lynx detections for the first time in a unit near Mesa Mountain in the La Garitas. This detection represents the northernmost detection of lynx since surveys began. We also detected lynx for the first time in the unit that encompasses Fern Creek and lower Trout Creek west of Creede. This unit, however, is surrounded by other units where lynx have been detected several times previously. After a 1-year absence, lynx were again detected in the Barlow Creek Unit near Rico and the Pass Creek Unit near Wolf Creek Pass; lynx were not detected at the two units adjacent to Pass Creek, or at the southern Conejos Peak Unit after having been detected in all 3 last year (Figure 1).

We used the R (R Development Core Team 2018) package 'RMark' (Laake 2018) to fit multiple-season (i.e., "dynamic") occupancy models (MacKenzie et al. 2006) to our survey data using program MARK (White and Burnham 1999). Thus, we estimated the derived probability of a unit being occupied (i.e., used) by lynx over the course of the winter (ψ), along with the probability of detecting a lynx (p) given that the unit was occupied, the probability a unit that was unused in one year was used the next (i.e., "local colonization," γ), and the probability a used unit became unused from one year to the next (i.e., "local extinction," ε). For each model we fit for the analysis, we specified that the initial ψ in the time series should be a function of the proportion of the unit that is covered by spruce/fir forest – the single most important and consistent predictor of ψ in past analyses. For sake of comparison we fit a base model in which p was specified to be constant for the duration of the survey. Based on previous work, however, we considered several other structures for p we anticipated would fit better. We fit models that specified 1) p could vary by survey method (i.e., detection could be different for cameras compared to snowtracking), 2) p could be higher during breeding season when lynx tend to move more and are therefore more likely to be detected by track or at a camera, and 3) p for cameras deployed from 2017–21 could be different than p for other years due to the lure substitution. Additionally we fit a model in which the effect of breeding season was only allowed to act on cameras, not snowtracking. We allowed annual estimates of ε and γ to be different each year (i.e., assuming occupancy dynamics were not random but instead dependent on the year previous and the population is not at equilibrium), which allowed derived ψ to vary as freely as possible given the data. We used Akaike's Information Criterion (AIC), adjusted for small sample size (Burnham and Anderson 2002) to identify the best-fitting model from this small set. Ultimately, we fit a linear model through the time series of ψ estimates to estimate the slope of the trend in occupancy through time. Ideally we would test other predictions of lynx occupancy to see, for instance, if colonization or extinction were influenced by bark beetles, fire, or the presence of competitors or prey species. However, we do not currently have enough data to test these predictions in addition to assessing trend, which is the highest priority.

As has been the case since the inception of our monitoring program, the proportion of the sample unit covered by spruce-fir forest was significantly and positively associated with the initial occupancy estimate in the time series. Even though local colonization and extinction were allowed to vary freely from year to year, annual estimates were near zero and varied little (ε = 0.00–0.08; γ = 0.00–0.10). Accordingly, derived occupancy was relatively stable across years (ψ = 0.26–0.38). The slope of the trend in occupancy through time was slightly positive but not significantly different from zero (β = 0.017, SE = 0.01; Figure 2). These results suggests that future analyses may benefit from fitting models that hypothesize occupancy is at or near equilibrium and extinction/colonization are either Markovian (as modeled here) or possibly zero. Similar to previous years, detection probability was relatively high for snow tracking surveys ($p = 0.69$, SE = 0.06), lower for camera surveys ($p = 0.23$, SE = 0.03) using Pikauba, and lowest for camera surveys utilizing Violator 7 ($p = 0.06$, SE = 0.02). We estimated that 38% of the sample units in the San Juan's were occupied by lynx (95% confidence interval: 20–55%) during 2020–21 (Figure 2). The spatial distribution of lynx in the San Juan mountains remained largely unchanged (Figure 1).

Table 1. Summary statistics from snow tracking effort.

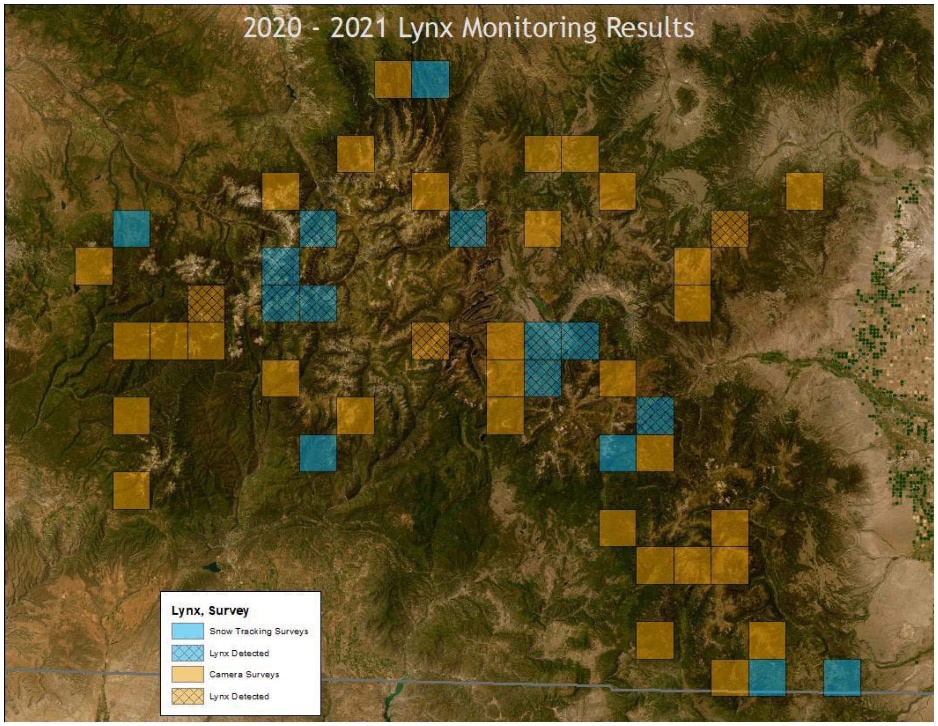
Season	#Units Surveyed	#Units with Lynx	#Lynx Tracks	#Genetic Samples[a]	Lynx DNA[b]	Km Surveyed (Total)	Mean Km Surveyed per Visit	#CPW Personnel[c]	#USFS Personnel[c]
2014–2015	18	7	12	8	8	884	20.1	30	13
2015–2016	17	7	14	9	6	987	21.9	23	6
2016–2017	16	8	13	7	5	703	18.0	20	8
2017–2018	14	7	9	3	1	578	19.3	14	5
2018–2019	14	6	8	2	1	510	19.6	16	5
2019–2020	14	7	11	3	2	640	19.4	15	3
2020–2021	15	9	14	12	7	790	18.8	17	3

[a] Number of genetic samples (scat, hair, or eDNA) collected via backtracking putative lynx tracks
[b] Number of genetic samples that came back positive for Lynx
[c]Number of staff that participate in the annual sampling effort

Table 2. Summary statistics from camera effort.

Season	#Units Surveyed	#Units With Lynx	#Photos (Total)	#Photos (Lynx)	#Cameras With Lynx	#CPW Personnel	#USFS Personnel
2014–2015	31	7	133,483	184	11	46	12
2015–2016	31	7	101,534	455	10	33	9
2016–2017	33	6	168,705	251	10	29	9
2017–2018	35	5	173,279	90	8	35	8
2018–2019	35	6	201,782	59	9	31	7
2019–2020	36	4	706,074	36	4	29	6
2020–2021	35	3	347,868	36	3	23	5

a)



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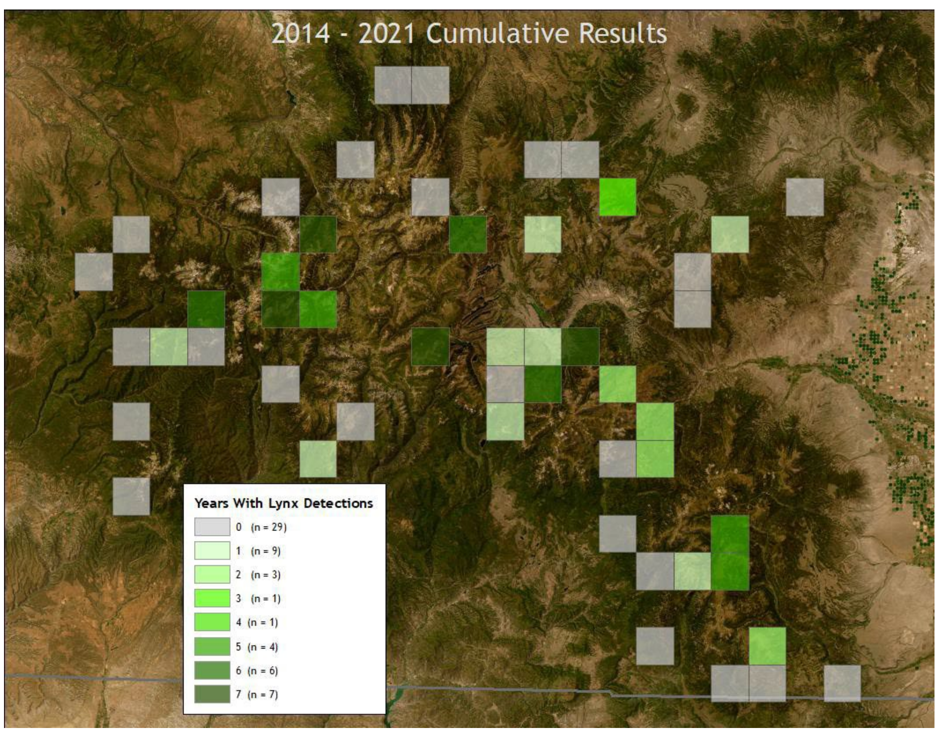

Figure 1. Lynx monitoring results for a) the current sampling season (2020–2021) and b) the cumulative monitoring effort (2014–2021), San Juan Mountains, southwest Colorado. Colored units (n = 50) depicted here are those selected at random from the population of units (n = 179) encompassing lynx habitat in the San Juan Mountains. Lynx were detected in 12 units in 2020−2021 and 24 units cumulatively since monitoring began in 2014−2015.

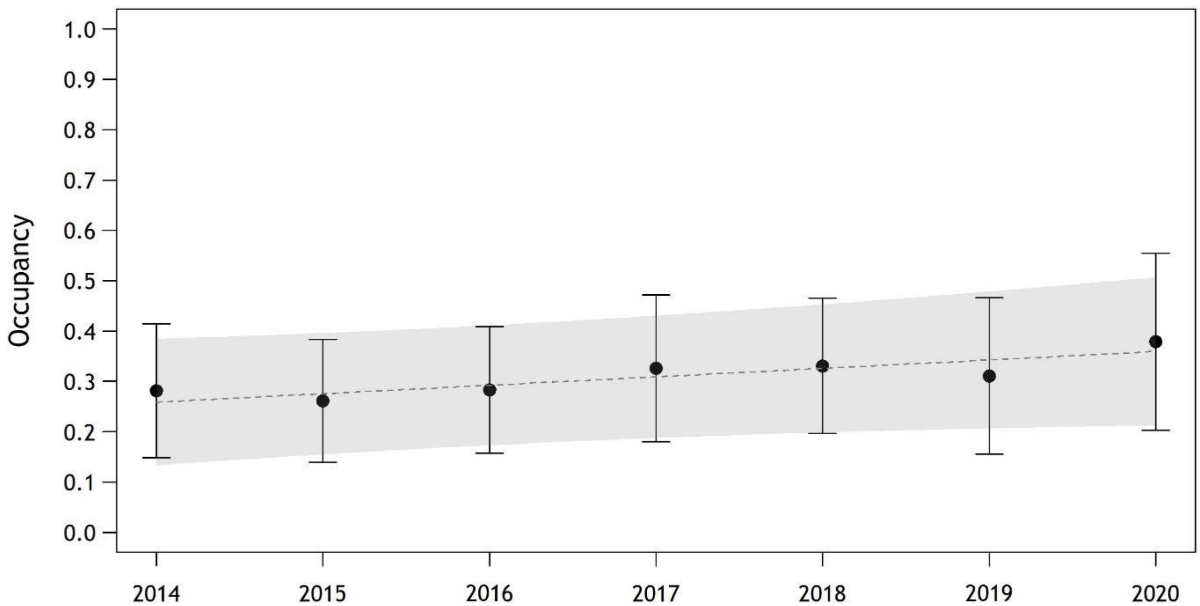

Figure 2. Occupancy estimates (Ψ) and trend (including 95%CI) for Canada lynx in the San Juan Mountains, southwest Colorado.

ERRATA: We note here that some data in Tables 1 and 2, and Figure 1 are incongruent with reports issued for the previous two seasons. This was due to inadvertent removal of filters in our database that were originally set to exclude pilot data from report tables, figures, and input files. These filters have been restored. The cumulative tables and figures presented here are accurate and supersede discrepancies with previous reports.

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Appendix 1. Model selection results for lynx monitoring data collected in the San Juan Mountains, Colorado, 2014–2021. Rankings are based on Akaike's Information Criterion adjusted for small sample size (AIC_c). We mostly sought to tease out best fitting models for detection, allowing constant detection (.), along with effects for survey type (ST), breeding season (B), substituting Violator 7 lure for Pikauba (V), and interactions to allow lure and breeding to act only on cameras. For these models we fixed the initial ψ to be a function of spruce-fir forest while local extinction (ε) and colonization (γ) were estimated annually to allow for non-equilibrium estimates in ψ that depended on previous year's occupancy state. Post-hoc, we added tested for equilibrium conditions (ε (.) γ (.)) or that occupancy from year to year was random ({ε = 1- γ}).

Model	AIC_c	ΔAIC_c	AIC_c Wts	No. Par.
ψ (Prop Spruce/Fir) ε (t) γ (t) *p* (ST+V+ST*V)	674.04	0.00	0.61	17
ψ (Prop Spruce/Fir) ε (t) γ (t) *p* (ST+B+V+ST*V)	675.88	1.85	0.24	18
ψ (Prop Spruce/Fir) ε (t) γ (t) *p* (ST+B+V+ST*B+ST*V)	676.77	2.74	0.15	19
ψ (Prop Spruce/Fir) ε (t) γ (t) *p* (ST)	697.55	23.52	0.00	15
ψ (Prop Spruce/Fir) ε (t) γ (t) *p* (ST+B)	699.41	25.38	0.00	16
ψ (Prop Spruce/Fir) ε (.) γ (.) *p* (.)	749.98	75.95	0.00	4
ψ (Prop Spruce/Fir) ε (t) γ (t) *p* (.)	768.42	94.38	0.00	14
ψ (Prop Spruce/Fir) {ε = 1- γ}*p* (1)	914.99	240.95	0.00	8

Colorado Parks and Wildlife

WILDLIFE RESEARCH PROJECT SUMMARY

Canada lynx monitoring in Colorado 2021 – 2022

Period Covered: July 1, 2021 – June 30, 2022

Principal Investigators: Eric Odell, Eric.Odell@state.co.us; Morgan Hertel, Morgan.Hertel@state.co.us; Jake Ivan, Jake.Ivan@state.co.us

In an effort to restore a viable population of Canada lynx (*Lynx canadensis*) to the southern portion of their former range, 218 individuals were reintroduced into Colorado from 1999–2006. In 2010, the Colorado Division of Wildlife (now Colorado Parks and Wildlife [CPW]) determined that the reintroduction effort met all benchmarks of success and that the population of Canada lynx in the state was apparently viable and self-sustaining. In order to track the persistence of this new population and thus determine the long-term success of the reintroduction, a minimally-invasive, statewide monitoring program is required. From 2014−2022 CPW initiated a portion of the statewide monitoring scheme described in Ivan (2013) by completing surveys in a random sample of monitoring units (n = 50) from the San Juan Mountains in southwest Colorado (n = 179 total units; Figure 1).

During the 2021−2022 winter, personnel from CPW and USFS completed the eighth year of monitoring work on this same sample. Fourteen units were sampled via snow-tracking surveys conducted between December 1 and March 31. On each of 1–3 independent occasions, survey crews searched roadways (snow-covered paved roads and logging roads) and trails for lynx tracks. Crews searched the maximum linear distance of roads possible within each survey unit given safety and logistical constraints. Each survey covered a minimum of 10 linear kilometers (6.2 miles) distributed across at least 2 quadrants of the unit. The remaining 36 units could not be surveyed via snow tracking. Instead, survey crews deployed 4 passive infrared motion cameras in each of these units during fall 2021. Cameras were lured with visual attractants and scent lure to enhance detection of lynx in the area. Cameras were retrieved during summer or fall 2022 and all photos were archived and viewed by at least 2 observers to determine species present in each. Camera data were then binned such that each of 10 15-day periods from December 1 through April 30 was considered an 'occasion,' and any photo of a lynx obtained during a 15-day period was considered a 'detection' during that occasion.

Surveyors covered 692 km during snow tracking surveys and detected only 6 lynx tracks at 4 units, both all-time low for the program (Table 1). Significantly, more photos were collected in the past three seasons than in the first 5 seasons of sampling. This can be mostly attributed to the use of new, more sensitive cameras along with new, high-capacity memory cards. After four seasons (2017-2020) in which we collected the fewest lynx photos of any set of years on the project (<50% of the number of lynx photos taken during the initial years of the monitoring effort), the number of lynx photos collected this year rebounded substantially (Table 2). This substantiates our previous conclusions that the Violator7 lure (in use during those 4 season) was less effective than the Pikauba lure used this year and during the first 3 years of sampling. Pikauba will be utilized for the remainder of the survey efforts, provided it remains available.

We obtained lynx detections in the La Garita Mountains north of Creede for first time in 5 years. Lynx were detected in the two units near Conejos Peak after having not been detected last year. Snowtracking surveys did not provide lynx detections in either the Mineral Creek or Molas Pass units near Silverton, nor at the Lime Creek unit south of Creede. This lack of detections is notable because these 3 units are among the most reliable for detecting lynx in the entire study area; each has provided lynx detections for 6–7 of the 8 years these areas have been surveyed (Figure 1).

We used the R package (R Development Core Team 2018) 'RMark' (Laake 2018) to fit multiple-season (i.e., "dynamic") occupancy models (MacKenzie et al. 2006) to our survey data using program MARK (White and Burnham 1999). Thus, we estimated the derived probability of a unit being occupied (i.e., used) by lynx over the course of the winter (ψ), along with the probability of detecting a lynx (p) given that the unit was occupied, the probability a unit that was unused in one year was used the next (i.e., "local colonization," γ), and the probability a used unit became unused from one year to the next (i.e., "local extinction," ε). For each model we fit for the analysis, we specified that the initial ψ in the time series should be a function of the proportion of the unit that is covered by spruce/fir forest – the single most important and consistent predictor of ψ in past analyses. For sake of comparison we fit a base model in which p was specified to be constant for the duration of the survey. However, based on previous work, we considered several other structures for p we anticipated would fit better. We fit models that specified 1) p could vary by survey method (i.e., detection could be different for cameras compared to snowtracking), 2) p could be higher during breeding season when lynx tend to move more and are therefore more likely to be detected by track or at a camera, and 3) p for cameras deployed from 2017–21 could be different than p for other years due to the lure substitution. Additionally we fit a model in which the effect of breeding season was only allowed to act on cameras, not snowtracking. We allowed annual estimates of ε and γ to be different each year (i.e., assuming occupancy dynamics were not random but instead dependent on the year previous and the population is not at equilibrium), which allowed derived ψ to vary as freely as possible given the data. We used Akaike's Information Criterion (AIC), adjusted for small sample size (Burnham and Anderson 2002) to identify the best-fitting model from this small set. Ultimately, we fit a linear model through the time series of ψ estimates to estimate the slope of the trend in occupancy through time. Ideally we would test other predictions of lynx occupancy to see, for instance, if colonization or extinction were influenced by bark beetles, fire, or the presence of competitors or prey species. However, we do not currently have enough data to test these predictions in addition to assessing trend, which is the highest priority.

As has been the case since the inception of our monitoring program, the proportion of the sample unit covered by spruce-fir forest was significantly and positively associated with the initial occupancy estimate in the time series. Even though local colonization and extinction were allowed to vary freely from year to year, annual estimates were near zero and varied little (ε = 0.00–0.08; γ = 0.00–0.10) up until the most recent season when extinction probability was high (ε = 0.40, SE = 0.15). Accordingly, derived occupancy was relatively stable across years (ψ = 0.26–0.35), but dropped to the lowest level observed to date this past season (ψ = 0.23, SE = 0.07). The slope of the trend in occupancy through time was zero (β = 0.001, SE = 0.01; Figure 2), indicating stability. Similar to previous years, detection probability was relatively high for snow tracking surveys (p = 0.65, SE = 0.06), lower for camera surveys (p = 0.22, SE = 0.03) using Pikauba, and lowest for camera surveys utilizing Violator 7 (p = 0.06, SE = 0.02). We estimated that 24% of the sample units in the San Juan's were occupied by lynx (95% confidence interval: 11–37%) during 2021–22 (Figure 2). The broad spatial distribution of lynx in the San Juan's remained largely unchanged with the exception of no detection in 3 core snow tracking units where lynx are usually detected (Figure 1).

Table 1. Summary statistics from snow tracking effort.

Season	#Units Surveyed	#Units with Lynx	#Lynx Tracks	#Genetic Samples[a]	Lynx DNA[b]	Km Surveyed (Total)	Mean Km Surveyed per Visit	#CPW Personnel[c]	#USFS Personnel[c]
2014-2015	18	7	12	8	8	884	20.1	30	13
2015-2016	17	7	14	9	6	987	21.9	23	6
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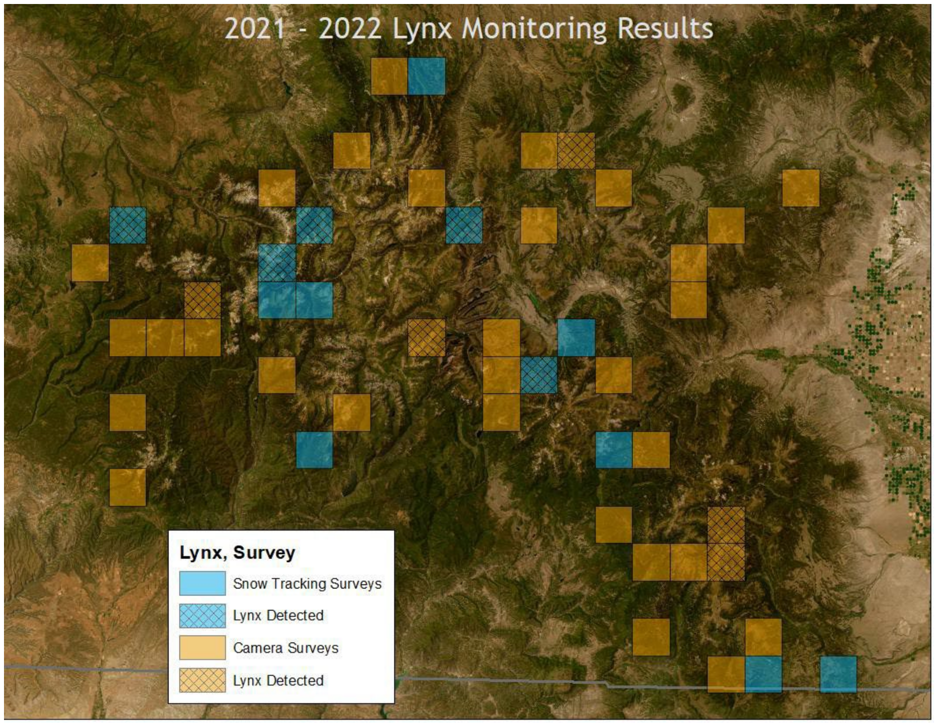
2017-2018	14	7	9	3	1	578	19.3	14	5
2018-2019	14	6	8	2	1	510	19.6	16	5
2019-2020	14	7	11	3	2	640	19.4	15	3
2020-2021	15	9	14	12	7	790	18.8	17	3
2021-2022	13	4	6	5	4	692	18.7	11	3

[a] Number of genetic samples (scat, hair, or eDNA) collected via backtracking putative lynx tracks
[b] Number of genetic samples that came back positive for Lynx
[c] Number of staff that participate in the annual effort

Table 2. Summary statistics from camera effort.

Season	#Units Surveyed	#Units With Lynx	#Photos (Total)	#Photos (Lynx)	#Cameras With Lynx	#CPW Personnel	#USFS Personnel
2014-2015	31	7	133,483	184	11	46	12
2015-2016	31	7	101,534	455	10	33	9
2016-2017	33	6	168,705	251	10	29	9
2017-2018	35	5	173,279	90	8	35	8
2018-2019	35	6	201,782	59	9	31	7
2019-2020	36	4	706,074	36	4	29	6
2020-2021	35	3	347,868	36	3	23	5
2021-2022	35	5	576,288	116	7	23	4

a)



b)

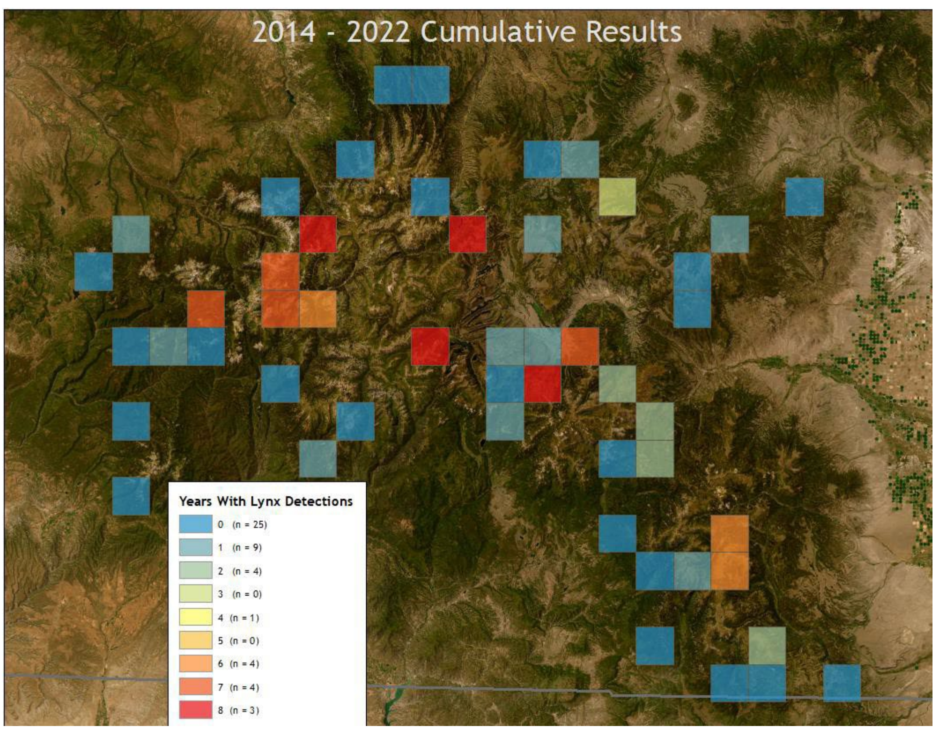


Figure 1. Lynx monitoring results for a) the current sampling season (2021–2022) and b) the cumulative monitoring effort (2014–2022), San Juan Mountains, southwest Colorado. Colored units (n = 50) depicted here are those selected at random from the population of units (n = 179) encompassing lynx habitat in the San Juan Mountains. Lynx were detected in 9 units in 2021−2022 and 25 units cumulatively since monitoring began in 2014−2015.

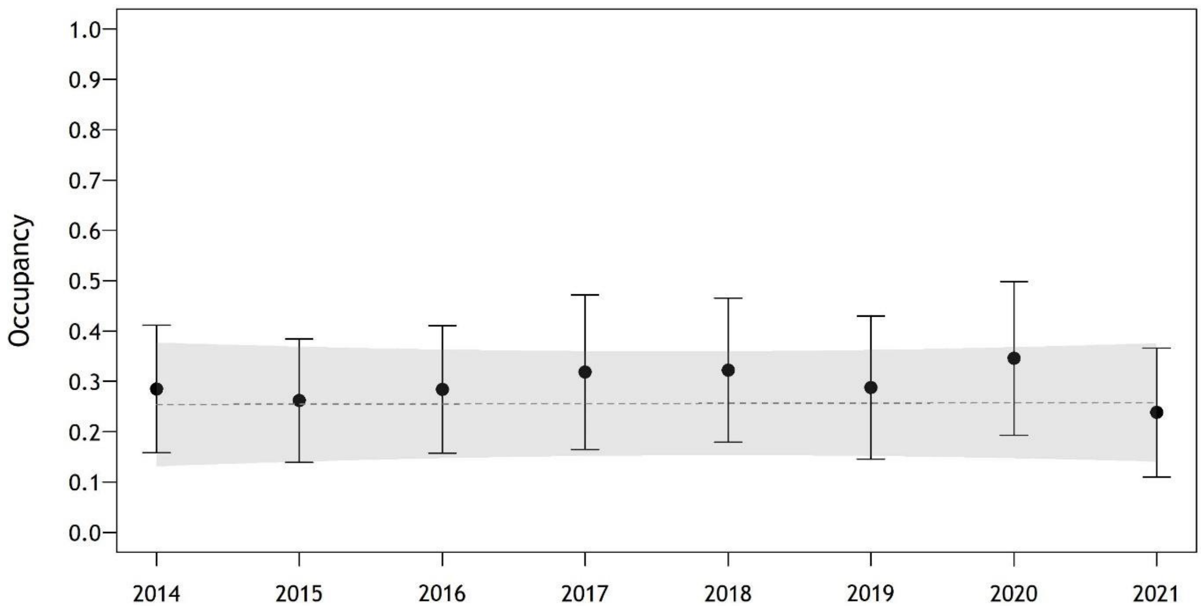


Figure 2. Occupancy estimates (Ψ) and trend (including 95%CI) for Canada lynx in the San Juan Mountains, southwest Colorado.

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Appendix 1. Model selection results for lynx monitoring data collected in the San Juan Mountains, Colorado, 2014–2022. Rankings are based on Akaike's Information Criterion adjusted for small sample size (AIC_c). We mostly sought to tease out best fitting models for detection, allowing constant detection (.), along with effects for survey type (ST), breeding season (B), substituting Violator 7 lure for Pikauba (V), and interactions to allow lure and breeding to act only on cameras. For these models we fixed the initial ψ to be a function of spruce-fir forest while local extinction (ε) and colonization (γ) were estimated annually to allow for non-equilibrium estimates in ψ that depended on previous year's occupancy state. Post-hoc, we added tested for equilibrium conditions (ε (.) γ (.)) or that occupancy from year to year was random ({ε = 1- γ}).

Model	AIC_c	ΔAIC_c	AIC_c Wts	No. Par.
ψ (Prop Spruce/Fir) ε (t) γ (t) *p* (ST+V+ST*V)	784.65	0.00	0.58	19
ψ (Prop Spruce/Fir) ε (t) γ (t) *p* (ST+B+V+ST*B+ST*V)	786.47	1.81	0.23	21
ψ (Prop Spruce/Fir) ε (t) γ (t) *p* (ST+B+V+ ST*V)	786.86	2.21	0.19	20
ψ (Prop Spruce/Fir) ε (t) γ (t) *p* (ST)	804.81	20.16	0.00	17
ψ (Prop Spruce/Fir) ε (t) γ (t) *p* (ST+B)	807.00	22.34	0.00	18
ψ (Prop Spruce/Fir) ε (.) γ (.) *p* (.)	859.30	74.64	0.00	4
ψ (Prop Spruce/Fir) ε (t) γ (t) *p* (.)	880.01	95.36	0.00	16
ψ (Prop Spruce/Fir) {ε = 1- γ}*p* (.)	1038.81	254.16	0.00	9