Northwest Mountain Lion Ecoregion Population Estimate Report, 2019–2021

Photo courtesy of Cody and LeRee Hensen

MT Fish Wildlife and Parks

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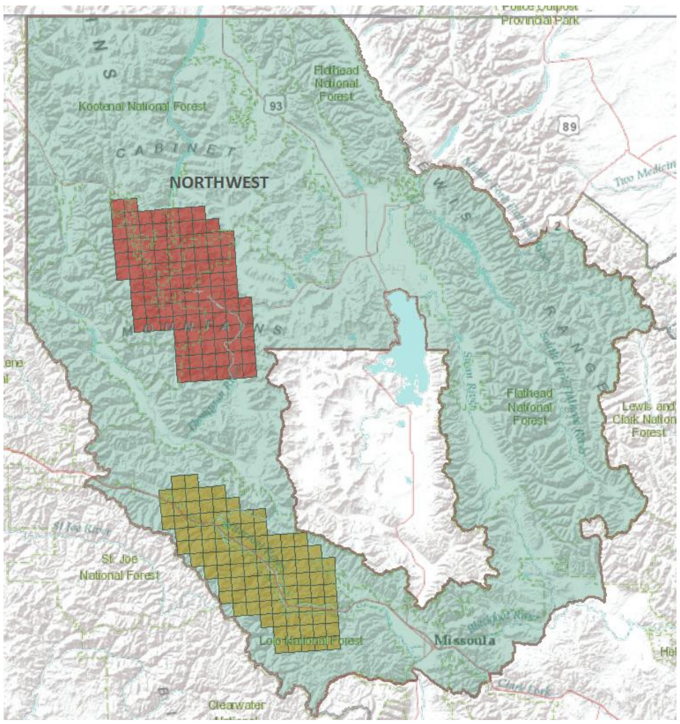
2021 Northwest Ecoregion Mountain Lion Population Estimate

SUMMARY: Based on spatial capture-recapture population estimates and lion density-habitat quality relationships estimated in the 2019-2020 trend monitoring area and the 2020-2021 supplemental monitoring area, the estimated population of the Northwest Ecoregion is 3.7 independent aged lions/100 km^2 (90% Credible interval: 3.3–7.9) or 1,376 individuals (90% Credible interval: 650-2547).

Introduction

The Montana Mountain Lion Monitoring and Management Strategy (MTFWP 2019) describes the monitoring program currently underway for the state's mountain lion populations. In brief, the state is divided into 4 ecoregions for which population objectives are set, and monitoring of population density will take place in the western 3 ecoregions. For each of the 3 western ecoregions, population estimates are produced every 6 years based on 2 winters of field data collection across 2 trend monitoring areas (TMAs; **Figure 1**). The field data allow for direct population size estimation in the TMAs via a spatial capture-recapture (SCR) methodology. The SCR method also estimates the relationship between habitat quality and lion density. This relationship is used to extrapolate lion density from the TMAs to the full ecoregion utilizing a model of habitat quality (known as a resource selection function [RSF]; Robinson et al. 2015 [revised in 2016]). The ecoregional population estimate is then used as an input to an integrated population model (IPM) which helps FWP estimate the impact of past and future harvest prescriptions. In addition to the periodic ecoregion population estimates, the IPM uses lion demographic rates obtained from past research in Montana (MTFWP 2019) and a population reconstruction method based on harvest data. Combining these 3 sources of information, the IPM estimates lion population size in years between ecoregional estimates. Critically, the IPM provides a tool for FWP staff to estimate harvest prescriptions necessary to achieve population objectives in each ecoregion, which are recommended by citizen working groups composed of diverse stakeholders and set by the Fish & Wildlife Commission.

Figure 1. *The northwest ecoregion boundary (green polygon) and Northwest (red polygon) and Middle Clark Fork (yellow polygon) trend monitoring areas sampled during the winters of 2019-2020 and 2020-2021, respectively.*



Method for ecoregion density extrapolation

The SCR method used for estimating lion abundance in each TMA during the winters of 2019-2020 and 2020-2021 are described in the section below and in the Mountain Lion Monitoring and Management Strategy (MTFWP 2019). The relationship between lion density and the RSF within the Northwest TMAs were virtually identical and were therefore combined (i.e., averaged between the TMAs; **Figure 2**) and this relationship was extrapolated across the larger ecoregion not directly covered by the TMA statespaces. A statespace in the SCR methodology refers to the sampled grid cells of the TMA and a surrounding 10 km buffer area which crews do not search, but from which lions may occasionally enter the searched area. The SCR model estimates density not only in the grid cells of the trend area, but also in the surrounding buffer area.

Results

The combined TMA statespaces encompassed 31% of the total Northwest ecoregion area. Habitat quality was slightly lower on average in the ecoregion (mean RSF value = 0.82), compared to the TMA statespaces (mean RSF value = 0.87). The ecoregion population estimate was 1376 (90% CI: 650-2547) or 3.73 per 100 km^2 (90% CI 1.76-6.90). This estimated density was lower than the NW TMA (4.9 lions/100 km^2; 90% Credible interval: 3.5–7.3), and slightly above the Middle Clark Fork supplemental TMA (3.6 lions/100 km^2; 90% Credible interval: 2.3–7.7) – both TMA estimates are described in detail in sections below. **Figure 3** shows each of these estimates in context of others created using similar methodologies in Montana. Credible intervals for the ecoregion density estimate were wider than those for TMAs, reflecting the additional uncertainty induced by extrapolating TMA density estimates to the entire ecoregion based on the density-RSF relationship.

Figure 2. *The SCR-estimated relationship between lion density and habitat quality (indexed via resource selection function [RSF]) for both winters of monitoring in the Northwest ecoregion.*

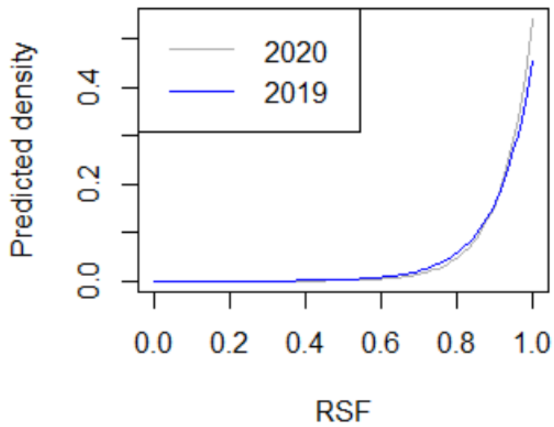
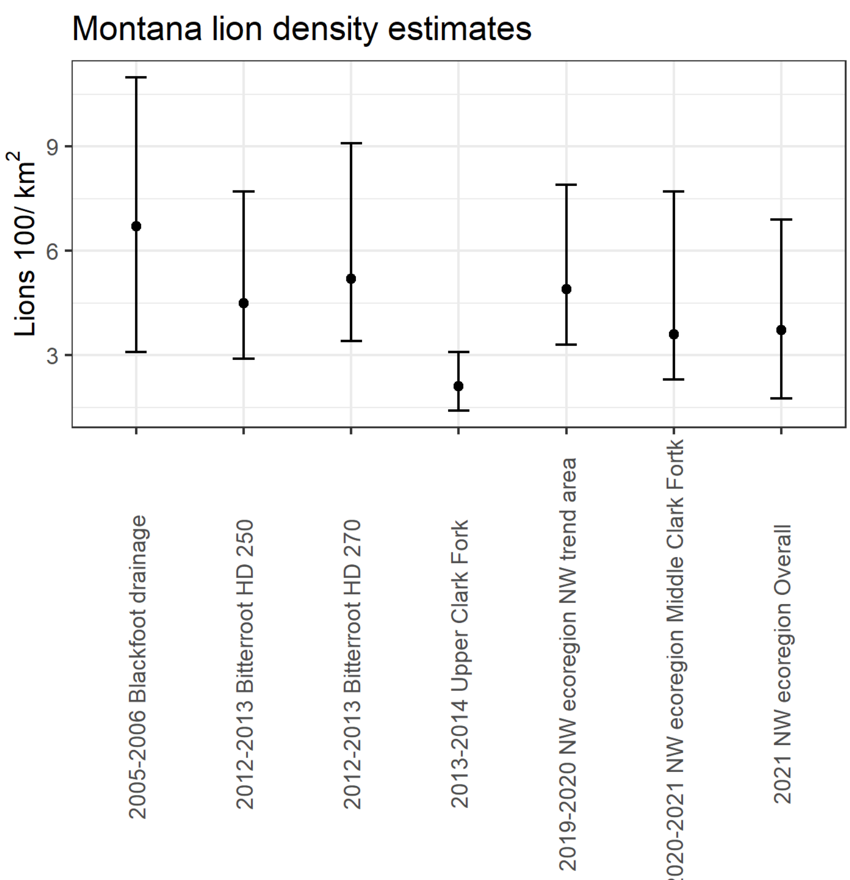


Figure 3. *Mountain lion density estimates and 95% credible intervals from all spatial capture-recapture studies in Montana, which used similar methodologies and detection models, 2005–2021. Blackfoot drainage (Russell et al. 2012), Bitterroot and Upper Clark Fork (Proffitt et al. 2015, Proffitt et al. 2020), and NW ecoregion (this report).*



Winter 2019-2020 Northwest Trend Monitoring Area

Photo courtesy of Cody and LeRee Hensen

SUMMARY: Based on 93 DNA samples from 68 individual lions, we estimated a density of 4.9 lions/100km^2 (95% Credible interval: 3.3–7.9) in the Northwest permanent trend area during the winter of 2019-2020.

Field season summary

The first lion monitoring field season began in the permanent Trend Monitoring Area (TMA) between Libby and Thompson Falls (**Figure 4a**) and ran from Dec 1, 2019 – Apr 15, 2020. The lion crew consisted of 6 contracted hound handlers that worked on a rotating schedule throughout the season. Overall, it was a mild winter. December had minimal snow cover, and we therefore only utilized one houndsman early in the month and delayed starting the remainder of the crew until December 16th. Through December and early January, crews had poor searching and tracking conditions caused by warm temperatures, rain, and poor snow cover. More favorable conditions began in late January and into February. Early March started with good conditions, but warming temperatures melted much of the snow before the end of the month, curtailing tracking and trailing efforts. The crew collected a total of 88 samples, 73 of which were high quality muscle samples and an additional 15 hair/scat samples. Fifteen samples were collected in December (8 muscle samples from treed lions, 2 hair, and 5 scat), 27 samples in January (24 muscle, 2 hair, 1 scat), 15 samples in February (14 muscle, 1 hair), 26 in March (22 muscle, 3 hair, 1 scat), and 5 samples in April (all muscle samples).

Overall, lion presence was detected frequently throughout the entire study area. There appeared to be a robust lion population with a significant number of family groups detected. The crew also encountered consistent wolf activity throughout the study area. In several cases, the crew found fresh lion tracks but were unable to turn dogs loose due to potential conflicts between hounds and wolves. These efforts to minimize wolf-hound conflicts proved successful, and no hounds were lost to wolves during the field season. The extensive road network in the TMA also played a positive role in minimizing wolf-hound conflicts. Aside from enabling crew members to conduct a thorough search of their assigned cells each day, the road system allowed houndsmen to get to a treed lion quickly and retrieve dogs efficiently, thereby reducing the time hounds spent unsupervised in the field. Despite its challenges, the first field season was highly productive and a positive start to the new Montana lion monitoring program.

SCR Methods

We followed the spatial capture recapture (SCR) data collection and analysis methods described by Proffitt et al. (2015) and the MTFWP Mountain Lion Monitoring and Management Strategy (2018). These methods estimate the density of independent-aged (i.e., legally harvestable) mountain lions in the study area (including transient lions). The detection model included covariates for search effort and sex and it allowed expected home range size to differ by sex. The model for the density of activity centers included a covariate for habitat quality, indexed by the resource selection function developed with radio-collar data (MTFWP Mountain Lion Monitoring and Management Strategy [2018]). We fit the model using the R package ‘SCRbayes’ (Royle et al. 2013). We ran 1 Markov-chain Monte Carlo chain run for 240,000 iterations with the first 60,000 iterations discarded as burn-in.

Spatial capture-recapture model results

Winter habitat suitability in NW permanent trend area was generally very high with 75% of grid cells having mean RSF > 0.88 (range = 0.62–0.95; **Figure 4b**). We searched a total of 42,876 km in the 102 grid cells from Dec–Apr (**Figure 4c**). Of the 88 successfully amplified DNA samples collected by crews, 81 were usable in analysis, because they represented unique encounters of individuals for a given grid cell during each monthly sampling occasion (**Table 1, Figure 4d, Figure 5**). An additional 86 samples were obtained from harvested individuals with 12 of these occurring inside the study area. Of the 74 samples from harvested individuals outside the study area, none were previously encountered inside the study area and were therefore not used in analysis. Of the 93 total usable samples, 68 were from unique individuals (38 males, 30 females) and the remaining 25 were recaptures of those individuals in other grid cells or sampling occasions (**Table 2**). Based on these samples, we estimated a median density of 4.9 lions/100km^2 (95% CrI: 3.3–7.9) with 55% male (90% CrI 40%-68%) in the Northwest permanent trend area during the winter of 2019-2020 (**Table 3**), which equates to 326 (90% CrI: 232–482) in the state space and 123 activity centers in the grid cells. Therefore, the overall detection rate for lions with any portion of their activity center in the statespace was 21% (90% CrI: 14–29%). Of the 68 unique lions detected, 16 were first detected in December, 22 in January, 10 in February, and 20 in March–April.

Figure 4. *a) location of study area (blue fill) and statespace (grey fill around study area) with Northwest ecoregion lion hunting districts, b) average resource selection function (RSF) values for each study area grid cell – scaled 0 to 1 with 1 being highest suitability, c) total kilometers of search effort by houndsmen, d) total captures in each grid cell.*

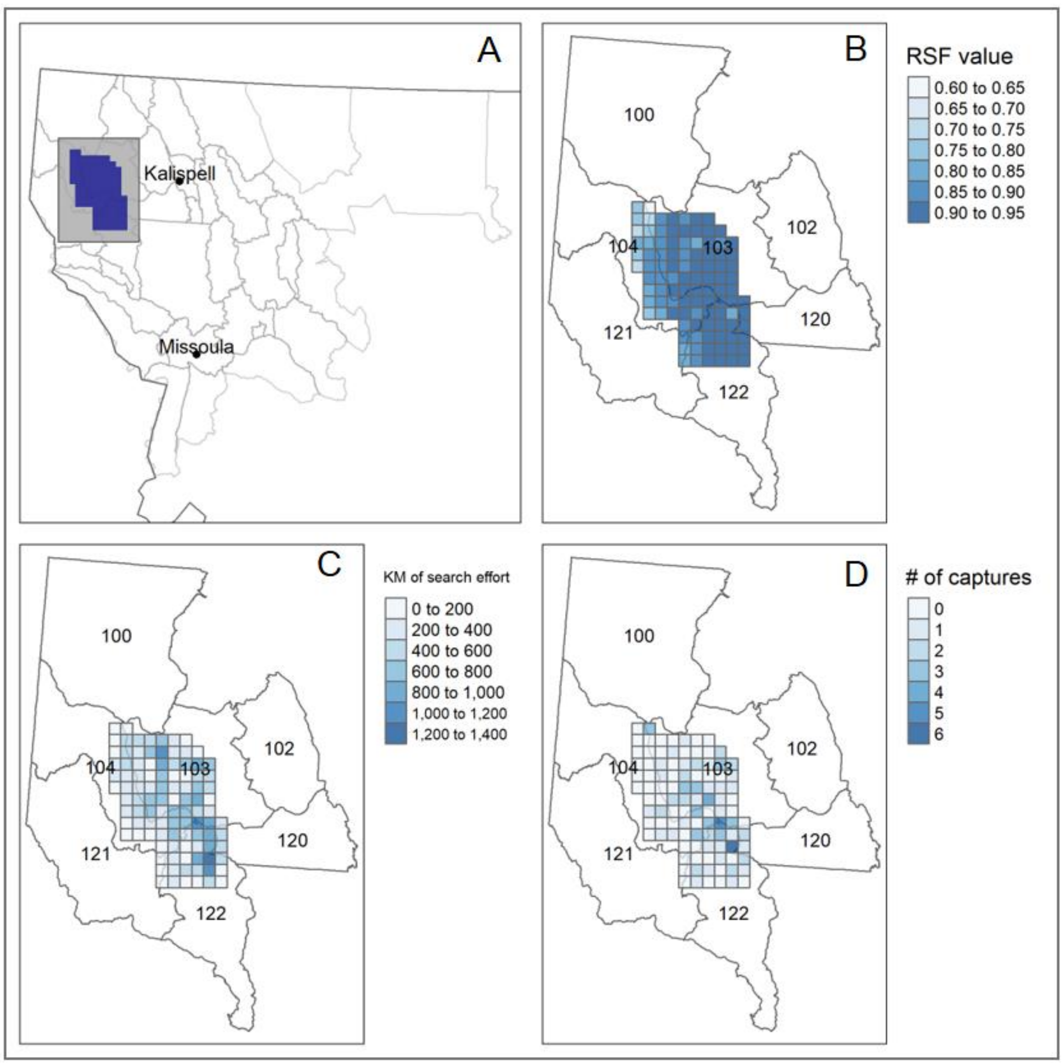


Figure 5. *Locations of captures in permanent NW trend area, 2019-2020. Trapping grid cells (5 x 5 km) are exposed in light purple. Yellow dots are successfully amplified DNA from live captured lions or samples of their hair or scat. Purple dots are samples from harvested animals.*

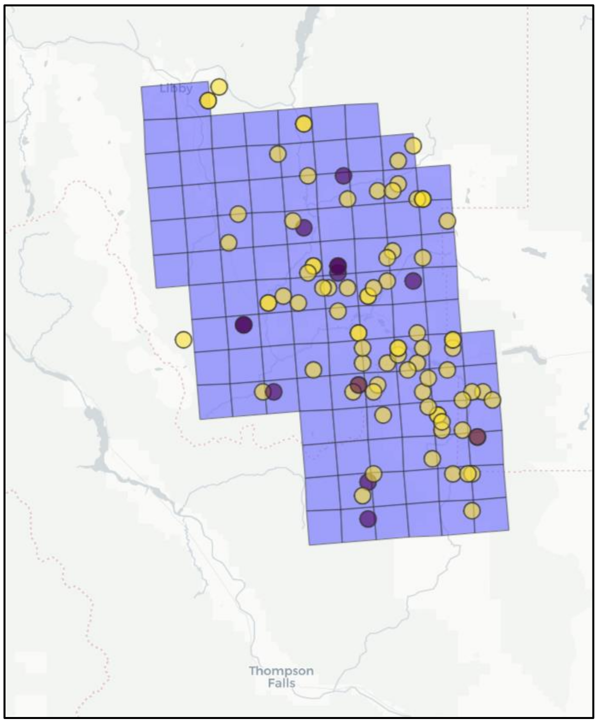


Table 1. *Summary of DNA sample types used in density estimation for winter 2019-2020 in the permanent Northwest trend area.*

Type	***n***
Muscle	72
Hair	4
Scat	5
Tissue (from dead lion)	12

Table 2. *Frequency of capture for 68 individuals identified during winter 2019-2020, in permanent NW trend area.*

Times captured	***n* individuals**
1	52
2	10
3	5
4	0
5	0
6	1

Table 3. *Density estimate from analysis of spatially explicit capture-recapture data for the 2019-2020 permanent Northwest trend area. The model incorporated search effort and sex as covariates for detection probability and allowed home range size to vary by sex. The model for density of lion activity centers used resource selection function (RSF) values as a covariate.*

Model	**Median density (per 100km^2)**	**95% CI**
$\boldsymbol{Effort + RSF + Sex + \sigma_{sex}}$	4.9	3.3 – 7.9

Winter 2020-2021 Northwest Supplemental Monitoring Area

Photo courtesy of Molly Parks

SUMMARY: Based on 77 DNA samples from 60 individual lions, we estimated a density of 3.6 lions/100km^2 (90% Credible interval: 2.3–7.7) in the Northwest Supplemental Monitoring Area during the winter of 2020-2021.

Field season summary

Our second season of lion monitoring was conducted in the Supplemental Monitoring Area (SMA) between Haugan and Alberton (**Figure 6a**). We faced housing limitations due to the Covid-19 pandemic. Our crew was housed in 2 Forest Service bunkhouses, but we could only allow one houndsmen (or husband-wife team) per bunkhouse at a time. Thus, we crafted a schedule to rotate through the crew and deep clean the bunkhouses each time we exchanged crew members. The crew experienced an even milder winter than 2019-2020 with minimal snow cover for most of the study period. Through December and early January, we struggled with warm temperatures, minimal snow cover, and rain. The weather shifted in February, producing our best snow and tracking/trailing conditions. Early March started with good conditions, but unseasonably warm temperatures melted much of the snow in our study area by the end of March.

Crews also encountered extensive wolf activity throughout the season, and in several cases, detected fresh lion tracks but didn't turn dogs loose to prevent potential conflicts between hounds and wolves. We also experienced an unusual number of lions that would run all day without treeing. This led to numerous races that ran from first light until dark, without treeing the lion. We also noticed a pattern of lions jumping out of trees upon seeing the houndsmen approach. Further, the lack of snow cover led to races where houndsmen turned dogs loose but were unsuccessful in treeing and sampling the lion due to losing the trail on extensive bare ground. Several sample opportunities were also lost due to losing a trail in the rain.

Crews collected 10 samples in December (8 muscle samples from treed lions, 1 hair, and 1 scat), 13 samples in January (all muscle), 17 samples in February (all muscle), 7 in March (all muscle), and 0 samples in April. Overall, lion presence was detected sporadically throughout the study area. The study area had several "holes" where lion sign was never detected, despite high RSF values. The crew also noted the lions and game in the study area were widely dispersed until the late part of the season, where snow finally accumulated significantly in the higher elevations. At that point, the majority of sign was detected in lower elevations close to the I-90 corridor, where snow also melted the quickest when daily temperatures warmed. The crew did not detect as many family groups as were found the year prior in the trend monitoring area between Libby and Thompson Falls. When groups were found, the poor field conditions limited efforts to sample the entire group. If mild winters continue to be the trend for Montana, we may benefit from incorporating passive detection sites to the monitoring design to collect samples from areas with extensive bare ground.

Spatial capture-recapture model results

Winter habitat suitability in NW supplemental trend area was generally high with 75% of grid cells having mean RSF > 0.92 (range = 0.76–0.95; **Figure 6b**). We searched a total of 51,917 km in the 100 grid cells from Dec–Apr (**Figure 6c**). Of the 48 successfully amplified DNA samples collected by crews, 43 were usable in analysis, because they represented unique encounters of individuals for a given grid cell during each monthly sampling occasion (**Table 4, Figure 6d, Figure 7**). An additional 87 samples were obtained from harvested individuals with 32 of these occurring inside the study area. Of the 56 samples from harvested individuals outside the study area, only 1 was previously encountered inside the study area and used in the analysis. Of the 77 total usable samples, 60 were from unique individuals (30 males and 30 females) and the remaining 17 were recaptures or dead recoveries of those individuals in other grid cells or sampling occasions (**Table 5**). Based on these samples, we estimated a median density of 3.6 lions/100km^2 (90% CrI: 2.3–7.7) with 43% males (90% CrI: 8–62%) in the Northwest supplemental area during the winter of 2020-2021 (**Table 6**) – this equates to 194 (90% CrI 159–203) total lions with activity centers in the state space and 90 with activity centers falling within the 100 study area grid cells. Therefore, the overall detection rate for lions with any activity center in the statespace was 31% (90% CrI: 30–38%). Of the 60 unique lions detected, 9 were first detected in December, 16 in January, 29 in February, and 5 in March–April.

Figure 6) *a) location of study area (blue fill) and statespace (grey fill around study area) with Northwest ecoregion lion hunting districts, b) average resource selection function (RSF) values for each study area grid cell – scaled 0 to 1 with 1 being highest suitability, c) total kilometers of search effort by houndsmen, d) total captures in each grid cell.*

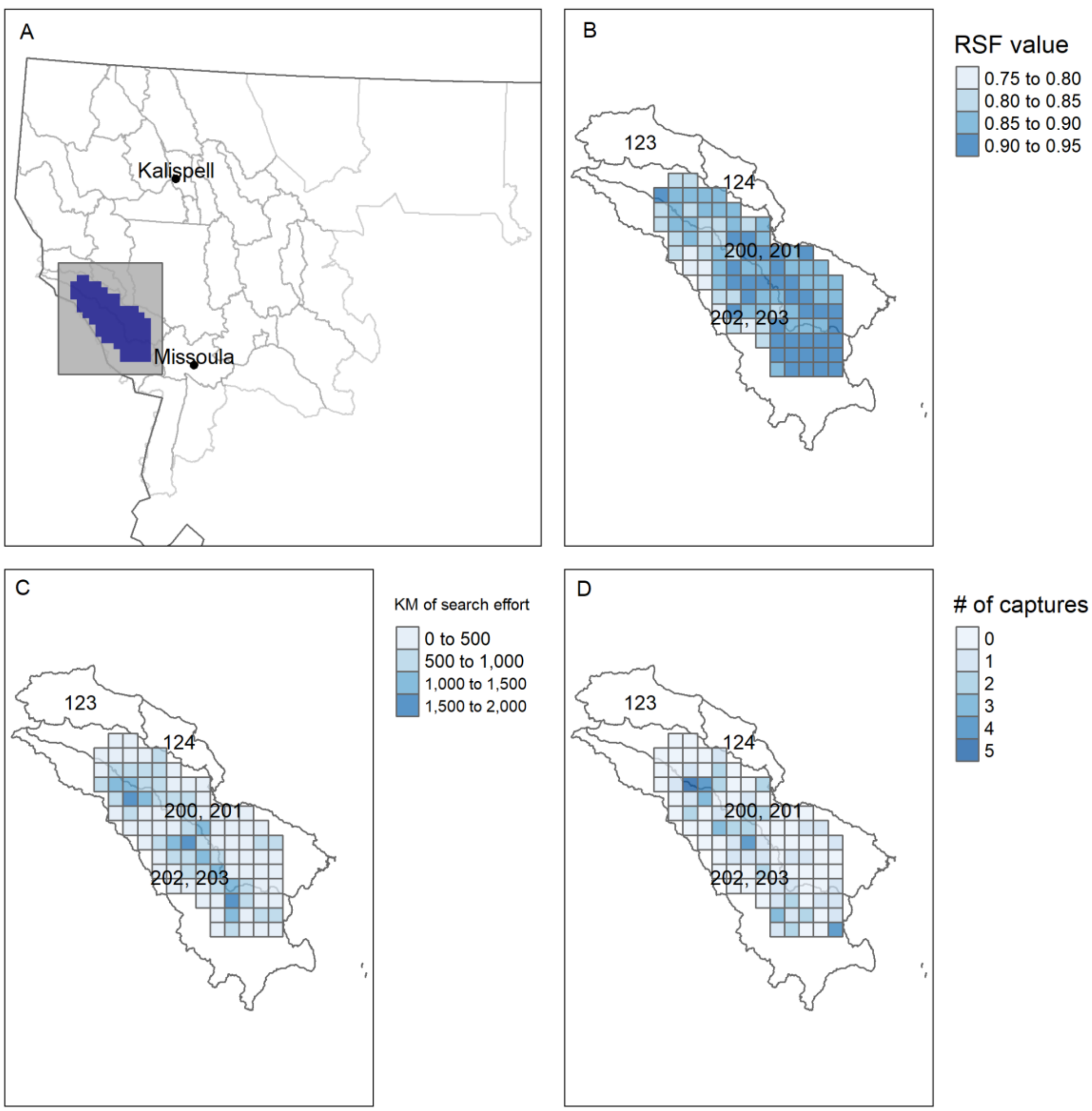


Figure 7. *Locations of captures in supplemental northwest area winter 2020-2021. Trapping grid cells (5 x 5 km, n = 100) are shown in light purple. Yellow dots are successfully amplified DNA from live captured lions or samples of their hair or scat. Purple dots are samples from harvested animals.*

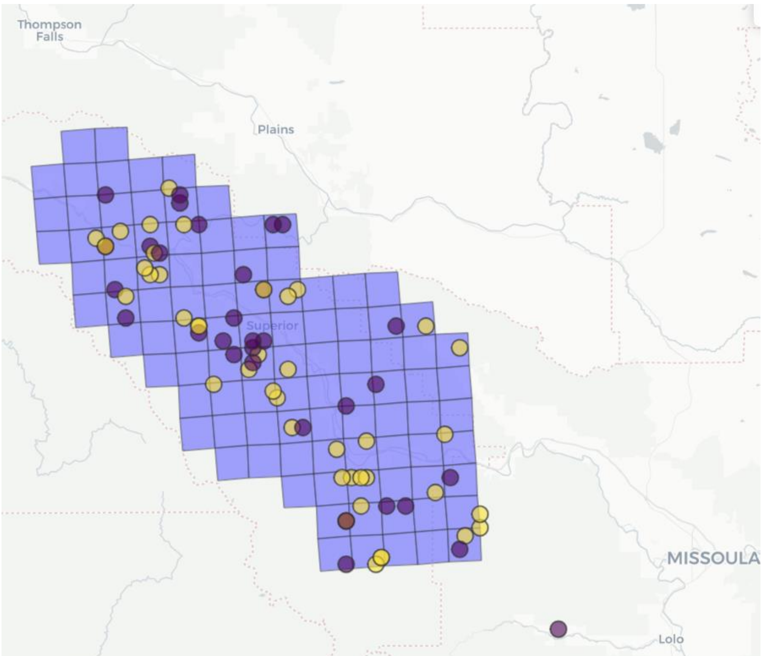


Table 4. *Summary of DNA sample types used in density estimation for winter 2020-2021 in the supplemental Northwest area.*

Type	*n*
Muscle	42
Hair	0
Scat	1
Tissue (from dead lion)	33

Table 5. *Frequency of capture for 60 individuals detected during winter 2020-2021 in the supplemental Northwest area.*

Times captured	***n* individuals**
1	48
2	8
3	4

Table 6. *Density estimate from analysis of spatially explicit capture-recapture data for the winter 2020-2021 in the supplemental Northwest area. The model was the same as used in 2019-2020 trend monitoring area and incorporated search effort and sex as covariates for the detection probability model and allowed home range size to vary by sex. The model for density of lion activity centers used resource selection function (RSF) values as a covariate.*

Model	**Median density (per 100km^2)**	**95% CI**
$\boldsymbol{Effort + RSF + Sex + \sigma_{sex}}$	3.6	2.3–7.7

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