Roadside Survey of Carcasses on US Highway-20 and State Highway-87 in Southeastern Idaho, 12/01/2017 to 12/01/2019

Prepared by,

Idaho Department of Fish and Game

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*This report satisfies the requirements of FS Agreement # 19-CS-11041552-057, as modified and agreed upon on September 5, 2019 by the Caribou-Targhee National Forest and the Idaho Department of Fish and Game.

Summary

The Greater Yellowstone Ecosystem (GYE) includes the Caribou-Targhee National Forest (CTNF) and Fremont County in eastern Idaho. The CTNF and Fremont County are bisected by US Highway-20 (US-20) and the town of Island Park. For big game such as deer, elk, and moose, Island Park is an ecologically important area. Mule deer and elk migrate between winter and summer range, crossing US-20 as part of their semiannual migrations (Anderson 2014, IDFG 2015). Mule deer and elk also summer on the CTNF in Fremont County. Moose migrate between Island Park and the Sand Creek Desert, and non-migratory moose live in Island Park year round, some crossing US-20 as a part of their daily movements (Andreasen et al. 2014).

Roads can have steep consequences for wildlife. In addition to direct mortality from wildlife-vehicle collisions (WVC), roads fragment habitat, sometimes acting as impediments or barriers to wildlife movement (Wilcove and Wikelski 2008). In order to understand the impacts of roads on wildlife in Idaho, the Idaho Department of Fish and Game (IDFG) collects and curates roadside carcass data in the Idaho Fish and Wildlife Information System (IFWIS) roadkill database. These data are available to the public and other agencies such as the Idaho Transportation Department (ITD) and the US Forest Service (USFS).

In 2017, IDFG developed a two-year carcass survey on US-20 and State Highway-87 (SH-87) to better understand the impacts of these roads on wildlife, as well as improve existing data collection efforts along these roads. Between December 1, 2017 and December 1, 2019, IDFG conducted roadside carcass surveys on US-20 and SH-87. We surveyed the 54-mile stretch of US-20 and 9-mile stretch of SH-87 by vehicle approximately every other day, resulting in 302 unique survey events. IDFG engaged a group of citizen scientist volunteers, mostly associated with the Idaho Master Naturalist (IMN) program, to assist with data collection. Also during the project, non-volunteer citizens salvaged animals and reported them to IDFG under the salvage rule. Additionally, other citizens reported carcasses without salvaging them. IDFG and ITD employees also reported carcasses.

In February 2019, in partnership with CTNF, IDFG applied for a $25,000 USFS Citizen Science grant to help finance the study through December 2019. The grant was awarded in May of 2019. As specified in the grant agreement, the project would provide road kill data to the CTNF to help identify key areas for big game movements on National Forest lands, aid in implementing the 1997 Targhee Revised Forest Plan, and facilitate compliance with the Grizzly Bear Conservation Strategy. The CTNF may also use these data to inform Forest Service land-use planning, travel planning, and project specific analyses on the Forest. The CTNF and IDFG also wanted to facilitate community engagement through citizen science and refine data collection protocols for future use in similar studies.

During the two-year study, we documented 246 big game carcasses on US-20 and SH-87. There were 126 mule deer, 52 elk, 24 moose, 19 white-tailed deer, and 6 pronghorn documented, as well as 10 deer of unknown species and 9 big game of unknown species. Additionally, we documented 1,167 other carcasses, representing 123 taxa in the project area. This included 602 birds, 522 non-big game mammals, and 43 reptiles and amphibians.

Citizen scientists were integral to the completion of the study. Volunteers began their commitments with project-specific training that emphasized safety and data accuracy. These well-trained volunteers were very capable of collecting quality data and contributed greatly to the success of this project.

This report satisfies the obligation of the Citizen Science award to provide a final report detailing the findings of the project. Accordingly, the report includes a summary of volunteer effort, a summary of data collected, lessons learned, recommended best practices and protocols, an evaluation of key accomplishments, including an assessment of volunteer perceptions, attitudes, and partnership outcomes, and a funding use summary. In addition, this report addresses knowledge gaps for the CTNF as outlined above and provides a general review of findings for use by IDFG, other agencies, and interested parties.

Introduction

Seventy-five percent of historical elk, bison, and pronghorn migration routes in the Greater Yellowstone Ecosystem (GYE) have been lost (Berger 2004). The CTNF is one of five National Forests in the GYE, and its Ashton/Island Park Ranger District in Fremont County, Idaho continues to support critical migration routes for elk, mule deer, pronghorn, and moose. US-20 and SH-87 bisect several big game migration routes in the Ashton/Island Park Ranger District (Andreasen et al. 2014, IDFG 2015).

Roads may have steep consequences for wildlife, including direct mortality. Obstacles and barriers to movement, such as roads, are also one of the major threats to long-distance migration (Wilcove and Wikelski 2008). Lost or altered big game migration routes are difficult and expensive to restore in part because information about migratory routes and wintering grounds is socially transmitted between animals (Jesmer et al. 2018). Additionally, lost big game migrations can result in substantially smaller populations and a loss of genetic diversity (Hanna 1982). Not only is long-distance migration an important natural heritage, but it also provides ecosystem services, such as nutrient cycling (Zabel et al. 2003).

Wildlife-vehicle collisions (WVCs) are increasing in frequency in the Unites States, even as vehicle collisions in general are decreasing (Huijser et al. 2008). Five-percent of all crashes are wildlife related and cost the nation over $8 billion each year (Clevenger and Huijser 2011). Annually, these collisions result in over 200 human deaths and 26,000 injuries (Huijser et al. 2008). The vast majority of these collisions involve deer. Collisions with animals larger than deer (moose, elk, or bison) typically cause more vehicular damage and human injury. Collisions with small animals are largely unreported, so calculating true wildlife losses is challenging (Teixeira et al. 2013).

The estimated national average WVC rate is 5% (Huijser et al. 2008), however, Idaho's state average is higher at 14% (Idaho Office of Highway Safety 2016). Some roads in Idaho have even higher rates, such as US-20 from Chester, ID to the Montana state line (ITD 2018). Reported WVCs on this stretch of road account for almost 20% of all collisions (Kittelson & Associates 2016). These estimates were derived from crashes that drivers reported to law enforcement. However, crash data do not represent the true impact roads can have on wildlife, because crashes with wild animals are often not reported to the police. Carcass data can provide better insight, but are not collected rigorously or according to a standardized protocol across Idaho, so they are not comparable statewide. Therefore, it is difficult to draw comparisons between locations or to understand the magnitude of the issue at many locations (Cramer et al. 2014). A past study documented moose and elk movements in Island Park in relation to US-20 and SH-87 using GPS radio collars, roadside track surveys, and IFWIS carcass data (Andreasen et

al. 2014). The study provided important information regarding where moose and elk cross the highways during migration, and how non-migratory moose cross the highways as part of their daily movements.

In order to serve its mission to preserve, protect, perpetuate and manage all wildlife in the state, IDFG collects wildlife data, which informs management. IDFG maintains and curates fish, wildlife, and plant data in the IFWIS comprehensive information system. These data are available to inform IDFG wildlife management decisions and improve IDFG technical assistance capabilities to entities such as the USFS. As a part of the IFWIS, IDFG collects and curates roadside carcass data. The IFWIS roadkill database contains more than 48,000 entries, from 1977 to present, including more than 11,000 salvage reports by citizens of Idaho since the salvage rule was enacted in 2012 (IFWIS 2019). ITD also collects roadkill data and enters it into their data system (Transportation Asset Management System; TAMS), which is integrated into the IFWIS roadkill database. By analyzing carcass data, management agencies can more accurately assess the distribution of WVCs, roadway mortality, and species vulnerability. The IFWIS roadkill database is available to agencies and the public (https://idfg.idaho.gov/species/roadkill/list).

In 2017, IDFG initiated a two-year roadside carcass survey on US-20 and SH-87 in Island Park to enhance understanding of wildlife movement and WVCs in this area. Prior to this study, rigorous collection of roadkill data had never taken place in the study area. Roadside carcass surveys began in December 2017. In May 2019, IDFG received a Citizen Science grant award from the USFS to continue the study through December. Citizen scientist volunteers from the IMN program assisted IDFG throughout the two-year survey effort. These volunteers were integral in the survey's completion. IDFG staff were responsible for project management, volunteer training, data management and quality assurance, in addition to data reporting.

Implementation of the Targhee Revised Forest Plan (1997) requires knowledge of both big game migration routes and threats to movement and migrations. The USFS is required by law to manage important habitat features—such as migration routes, winter range, food sources, and birthing areas—and to facilitate animal movement between summer and winter ranges. The Grizzly Bear Conservation Strategy requires the USFS to document grizzly bear sightings, big game mortality, and game trails (Interagency Grizzly Bear Committee 2016). The Grizzly Bear Conservation Strategy states that big game species such as deer, elk, and moose are one of the four seasonal food types of grizzly bears that should be monitored within the GYE to determine habitat quality. Because the CTNF is not currently collecting these types of data, the Forest relies on IDFG to supplement this information for management decisions. The CTNF and IDFG also wanted to facilitate community engagement in Island Park through citizen science and refine data collection protocols for future use in similar studies. The CTNF may use these data to inform Forest Service land-use planning, travel planning, and project specific analyses. In addition to addressing knowledge gaps for the CTNF, this project provided rigorously collected roadkill data for use by IDFG, other agencies, and interested parties.

Study Area

We surveyed approximately 63 miles of road on US-20 (54 miles) and SH-87 (9 miles) in Fremont County, Idaho (US-20/SH-87 Corridor) from Chester, ID to the Montana state border (Figure 1). The highway corridor bisects the Henry's Fork and Island Park volcanic calderas, where much of the land is managed by the CTNF on the 700,000-acre Ashton/Island Park Ranger District (USFS 2020; Figure 1). This district is

renowned for its recreational opportunities including fishing, hunting, camping, floating, sightseeing, hiking, cross-country skiing and snowmobiling. Approximately 28 miles of the US-20/SH-87 Corridor project area borders USFS lands. The project area averages over 6,000 feet in elevation and receives higher average annual precipitation (26 inches of rainfall and 219 inches of snow) than surrounding areas of the same elevation (US Climate Data 2018).

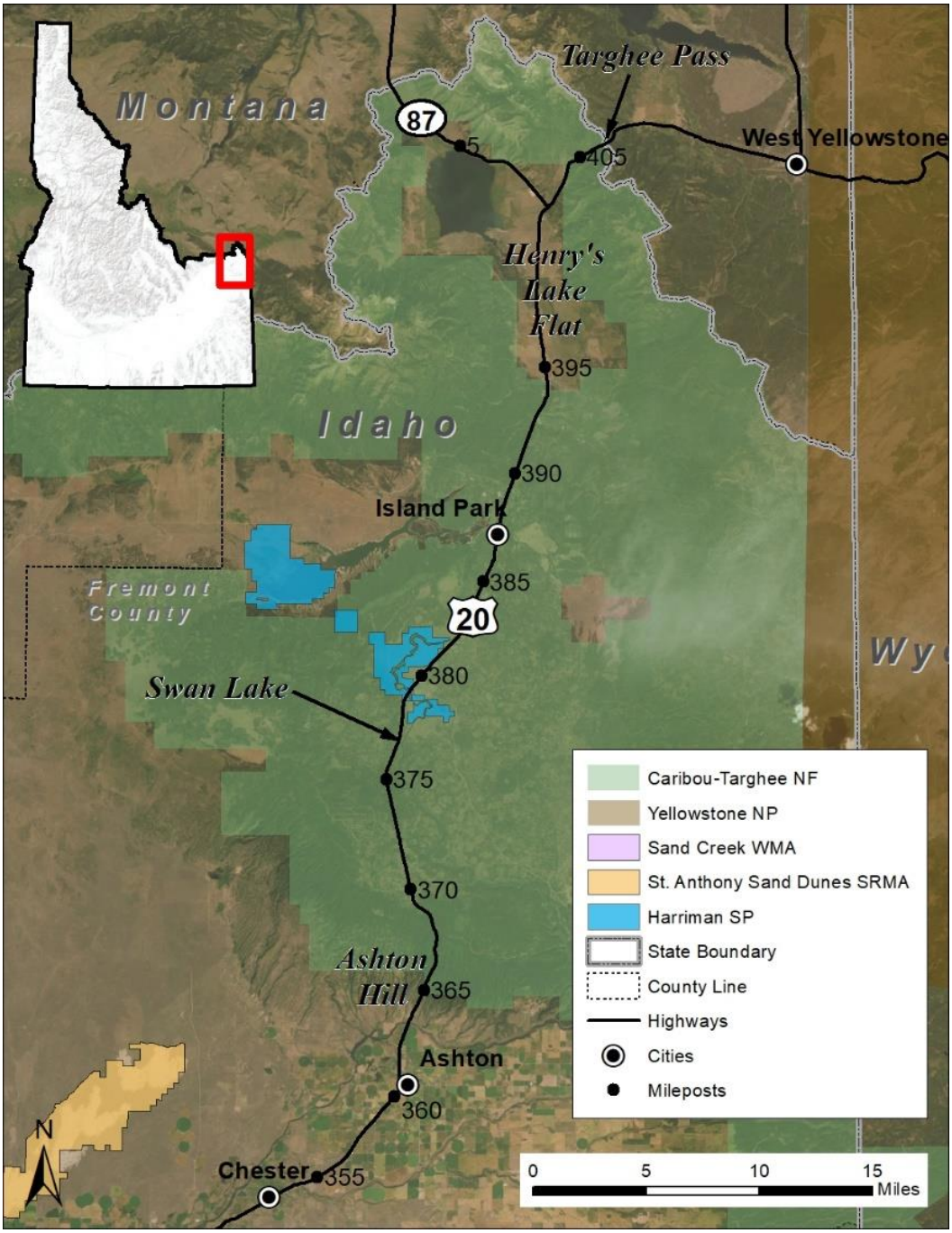

Figure 1. Map of project area highlighting public land ownership and geographic areas mentioned in the text.

The US-20/SH-87 Corridor leads to the busiest entrance of Yellowstone National Park (YNP; Figure 1). The West Entrance to YNP received 1.7 million visitors in 2018 (National Parks Service 2018). The junction of US-20 and SH-87 is at the base of Targhee Pass and SH-87 takes motorists toward Ennis, Montana and the Madison River valley (Figure 1). US-20 is a major freight truck route on the National Highway System (Federal Highway Administration 2017).

Much of the US-20/SH-87 Corridor bisects big game summer range and migration routes (IDFG 2015). Mule deer, elk, moose, and pronghorn summer and migrate between winter and summer ranges in and near the project area (Brown 1985, Andreasen et al. 2014, Anderson 2014, IDFG 2015). Mule deer traverse Ashton Hill during semiannual migrations between summer range in and near YNP and winter range in the Sand Creek Desert, which includes Sand Creek Wildlife Management Area (Figure 1; Anderson 2014). Moose cross US-20 and SH-87 during migration and winter in the largest known concentrations in North America (~400 individuals) on the Sand Creek Desert, approximately 20 miles west of US-20 (Figure 1; IDFG 2018). Elk and pronghorn migrate within the study area semi-annually, also crossing SH-87 and US-20 (IDFG 2015). Non-migratory moose are present in Island Park year-round and cross the highway as part of their daily movements (Figure 1; Andreasen et al. 2014). Additionally, the CTNF contains important grizzly bear habitat, a federally threatened species in the GYE. Grizzly bears may cross US-20 and SH-87 as part of their daily movements and may also be attracted to roads to scavenge roadkill (Grilo et al. 2015, IDFG 2015, Interagency Grizzly Bear Committee 2016).

Methods

Volunteers

We recruited and trained a team of volunteer IMNs to assist with data collection. Because the IMN program already had an eager pool of volunteers, we invested little time in recruitment. We informed volunteers what their positions would entail by holding formal trainings throughout the duration of the project. During trainings, we discussed the purpose, duties, responsibilities, qualifications, time commitment, working conditions (including emphasis on safety), protocol, animal identification and aging, and benefits of participating in the project (Tamez et al. 2018). We trained volunteers in the classroom and the field. During field trips, we stopped for each detected carcass and trained the volunteers on safety and data collection. Volunteers were required to participate in at least one ride-along with IDFG staff before heading into the field alone. After formal training, we provided a copy of the PowerPoint® training presentation, a project description and protocol to each volunteer for further reference. Volunteers signed the IDFG volunteer form (VF-A1; Appendix 1), which covered liability and media release.

We encouraged volunteers to work in teams to increase personal safety as well as having the opportunity to learn from one another on the job, though some volunteers preferred to work alone. We also required volunteers to take photos of carcasses they found for verification by IDFG staff and of themselves performing the survey tasks for use in presentations, articles, and reports. We checked in with volunteers after every carcass survey they performed.

Survey protocol

We surveyed the US-20/SH-87 Corridor approximately every two to three days between Dec 1, 2017 and Dec 1, 2019. We conducted vehicle surveys traveling between 45-65 mph. Generally, vehicles traveled the speed limit, which is 65 mph, except in the eight developments along the route, where the speed limit is 45 mph. Surveys were conducted by IDFG staff and volunteers. When IDFG personnel surveyed, typically one person drove while surveying. On 13 occasions, volunteers or others participated in ride-alongs with IDFG personnel.

Surveyors typically started the survey between 8am and 10am. We conducted all surveys during daylight hours to maximize the likelihood of detecting carcasses and for safety. Surveyors utilized DOT approved high visibility safety vests and flashing lights on their vehicles to increase safety, and prioritized safety at all times.

Surveyors relied on a variety of clues for carcass detection. These included the presence of an animal carcass, blood on the road, bone fragments, fecal matter, hair on the road and shoulders, vehicle debris on the road, disturbed dirt, mud, or snow on the road verge, corvids and other scavengers, and vehicles stopped on the road. Surveyors collected data on all detected carcasses. Once a surveyor detected a carcass, the surveyor safely pulled off the road, over the white line, and gathered information on species, age, sex, and location. Surveyors made notes about carcass decomposition; if the condition of the carcass precluded identification to species, we recorded a broader taxon (e.g., unknown mammal).

To assign a sex to a carcass, observers noted genitalia and antler presence or absence on big game animals. To assign an age class to a carcass (juvenile, yearling or adult), surveyors used the teeth and body size (Elbroch 2006). In some cases, observers were not able to assign an age or sex due to poor carcass condition.

During this project, IDFG tested a newly developed agency smartphone application (app) and also recorded data on a paper sheet. IMN volunteers did not have access to the agency app and therefore used a Garmin eTrex 10 GPS® unit to take location data and a paper data sheet to record information. Staff hand-entered and performed quality assurance/quality control (QA/QC) on all data from volunteer data sheets directly to the IFWIS database.

Surveyors moved all carcasses away from the road to eliminate roadside hazards, reduce scavenger mortality, and diminish the potential for report duplication (Figure 2). Sometimes, we took carcasses to a landfill; other times, we dragged carcasses at least 30 meters from the side of the road because it was impractical to remove them completely. Surveyors recorded whether they removed the carcass or moved it away from the road.

Figure 2. An IDFG employee removes a white-tailed deer carcass from the right-of-way on US-20.

Other Carcass Reports

ITD and IDFG staff both regularly report roadkill around the state. This also occurred in our study area, and we included those data in this report. IDFG employees not involved with the study entered data directly to IFWIS, either via the smartphone app or the IDFG website. ITD employees entered data into the TAMS database, which was then transferred into the IFWIS database. Citizens who salvaged animals entered data directly into IFWIS and were provided a CE-51 salvage permit for their records.

Quality Assurance/Quality Control (QA/QC)

The IFWIS roadkill database contains data from a variety of sources including ITD TAMS carcass data, citizen salvage reports, IDFG reports, and other citizen reports that are not associated with a salvage. Because these sources are integrated, the potential exists for duplicate reports.

IDFG staff performed QA/QC, screening daily carcass reports for egregious errors and possible duplication. If we found duplicate reports or errors, we contacted the reporting party to assess whether the report was actually a duplicate or error. We corrected duplicates and erroneous reports when the reporting party responded to the IDFG query.

We used report details such as species, sex, life stage, disposition, decomposition, location, and date/time to detect and eliminate duplicates from the full dataset later in the QA/QC process. Details such as observer confidence, additional comments, and observer contact information allowed IDFG staff to assess data reliability and contact the observer with any questions. Photos were helpful in both detecting duplicates and ascertaining reporting accuracy.

Finally, we used Program R (v3.5.0) to flag duplicate reports that we may have missed during daily screenings. We wrote code to identify potential duplicates when carcasses of the same species and sex were reported within seven days and one mile of each other. We then used the output from Program R to guide duplicate removal by hand in ArcMap 10.6™. When comments and notes revealed that potential duplicates were actually unique carcasses, we maintained those records in the dataset. We removed erroneous reports when they contained obviously incorrect information.

Analysis

We used ArcMap 10.6™ to process and display spatial data. After we created roadkill shapefiles by species and taxa, we used the Integrate tool in ArcMap to bin points into quarter or one-mile neighborhoods. We used quarter-mile increments for species with larger sample sizes ($n \geq 24$; mule deer, moose, elk, combined big game,) and one-mile and half-mile increments for species which had smaller sample sizes ($n < 24$; white-tailed deer and pronghorn respectively).

We created histograms to show the number of roadkill reports per mile of US-20 and SH-87. In order to do this, we used the Locate Features Along Routes tool in ArcMap using a search radius of 10 m. We then plotted the linked roadkill reports and mile markers using the Frequency Function in Microsoft Excel 2016® to bin the data by mile. We also used Microsoft Excel to display the numbers of species and taxa reported and to display temporal relationships among the data (species per month of the project for its duration).

Roadkill data collection effort increased substantially in the project area during the two-year study. We compared data collected during our study to data collected before our study. We also compared numbers of roadkill reports before and after implementation of the salvage rule in 2012, because we wanted to know if roadkill data reporting increased after implementation of the rule.

Results

Effort

We completed 302 surveys during Dec 1, 2017 – Dec 1, 2019, including six partial surveys that we suspended due to hazardous driving conditions. We detected zero carcasses on 56 of the surveys. We also included data from ITD and citizens who salvaged and reported roadkill during the survey period. IDFG staff completed 203 surveys (67%) and 16 volunteers completed 99 surveys (33%). Some volunteers worked in pairs and others were alone during surveys. Volunteers accompanied IDFG staff during 13 of the surveys.

IDFG reported the majority of the 246 big game carcasses during the study (61.4%, n = 151) and project volunteers reported 17.5% (n = 43) of the carcasses. Citizen scientists spent 578 volunteer hours on the project and drove 15,762 miles to collect data. Citizens and salvagers reported 15.4% (n = 38) of carcasses, and agency personnel who were not directly involved with the study reported 5.7% (n = 14) of the carcasses (Figure 3). For clarification, we advised agency staff that the study was occurring, so their efforts to collect roadkill data were reduced in the area for the duration of the project. For a breakdown of the budget during the USFS Citizen Science grant period (May 2019 – March 2020), see Appendix 2.

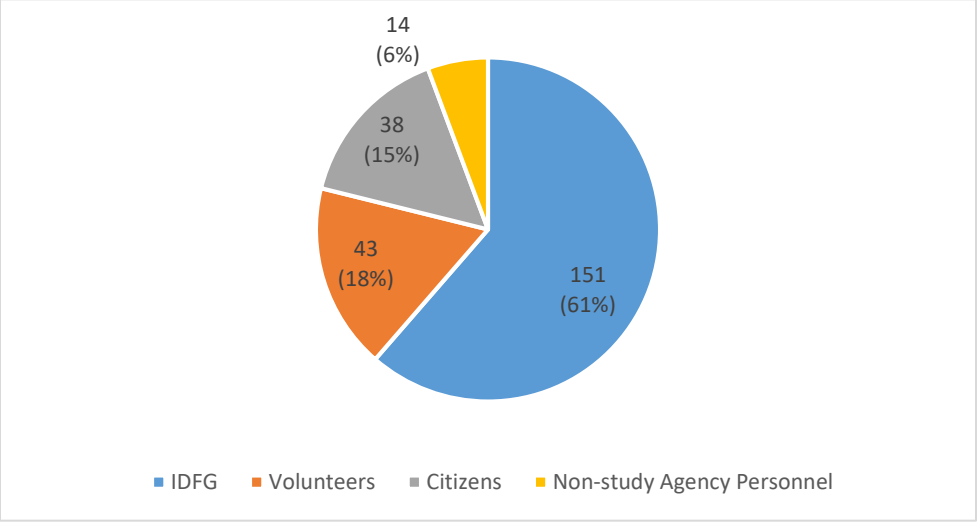

Figure 3. Percent of big game carcass data collected by reporting party in the US-20/SH-87 Corridor project during Dec 1, 2017-Dec 1, 2019.

Big Game Road Mortality

For the purposes of this report, we refer to deer, elk, moose, and pronghorn as big game. The QA/QC process flagged 40 reports as potential duplicates; we confirmed 25 as duplicates and removed them (Table 1). After duplicate removal, 246 big game carcasses were reported including 126 mule deer, 52 elk, 24 moose, 19 white-tailed deer, and 6 pronghorn (Figure 4). Additionally, we were unable to identify 10 deer carcasses and 9 ungulate carcasses to species due to the condition of the carcass. We also recorded 1,167 other animal carcasses recorded during the study (Appendix 3).

Table 1. These 25 duplicate records of reported carcasses were removed from the data used in this report. Sources of data include the Idaho Transportation Department (ITD) and the Idaho Fish and Wildlife Information System (IFWIS).

Observed	Source	Species	Sex	Count	Latitude	Longitude
12/5/2017	IFWIS	[1]Mule deer	Female	1	44.1347604	-111.424799
5/4/2018	ITD	Mule deer	Female	1	44.18441919	-111.4378299
5/11/2018	IFWIS	Mule deer	Female	1	44.17314405	-111.4269692
5/29/2018	ITD	[2]Elk	Female	2	44.23891784	-111.4606218
5/29/2018	ITD	Elk	Female	2	44.23891784	-111.4606218
7/10/2018	ITD	Elk	Female	1	44.25584362	-111.4660456
7/10/2018	ITD	Elk	Female	1	44.21069846	-111.4516179
8/21/2018	IDFG	Mule deer	Unknown	1	44.20085066	-111.4485624
8/21/2018	IDFG	Mule deer	Unknown	1	44.20078285	-111.4485254
8/21/2018	IDFG	Mule deer	Unknown	1	44.20086692	-111.4485595
8/21/2018	IDFG	Mule deer	Unknown	1	44.19249135	-111.4458649
8/21/2018	IDFG	Mule deer	Unknown	1	44.19249135	-111.4458649
8/21/2018	IDFG	Mule deer	Female	1	44.02857963	-111.4995897
8/21/2018	IDFG	Mule deer	Female	1	44.13322932	-111.4346263
9/28/2018	IFWIS	[3]Moose	Male	1	44.14077054	-111.4297243
10/14/2018	IFWIS	Elk	Female	1	44.3935594	-111.3838694
10/15/2018	IFWIS	Mule deer	Female	1	44.2947459	-111.4577025
11/29/2018	IFWIS	Elk	Male	1	44.642512	-111.3186296
12/22/2018	IFWIS	Elk	Female	1	44.62529214	-111.3365277
1/3/2019	ITD	Elk	Female	1	44.12593507	-111.4392668
2/24/2019	IFWIS	Moose	Female	1	44.4976441	-111.3362116
5/21/2019	IDFG	Mule deer	Female	1	44.20113334	-111.4486331
6/20/2019	IDFG	Elk	Female	1	44.21190295	-111.4519837
10/16/2019	IDFG	Elk	Female	1	44.21387119	-111.4522072
10/27/2019	IFWIS	Moose	Male	1	44.42802556	-111.3703524

[1]Odocoileus hemionus

[2]Cervus canadensis

[3]Alces americanus

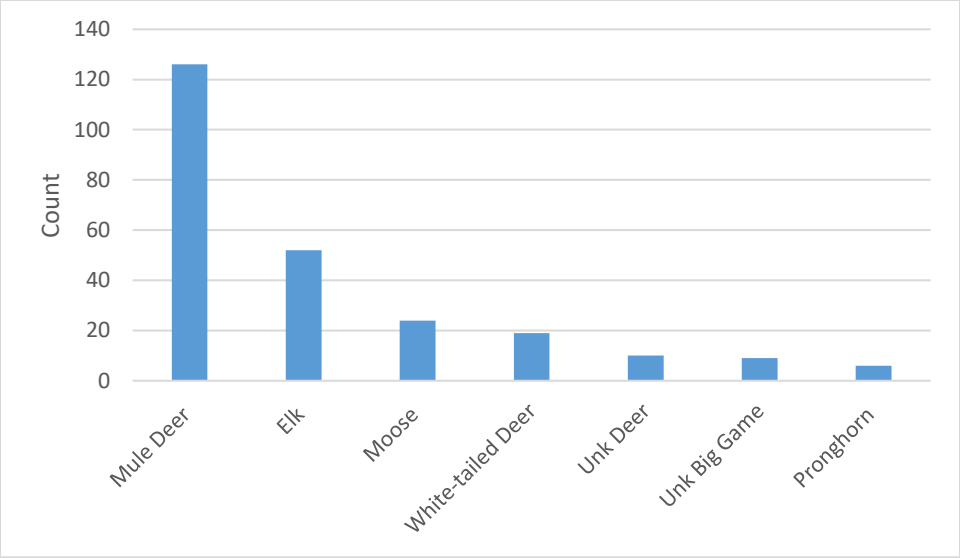

Figure 4. Number of reported big game carcasses (n = 246) plotted by species in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019. Carcasses in poor condition, precluding a species-level identification, were categorized as unknown deer or unknown big game.

Big game carcass reports peaked in May and October (Figure 5), and carcasses were most prevalent from mile marker 363-375 on US-20 (from the bottom of Ashton Hill to Swan Lake; Figures 6 and 7). More than half of big game carcasses reported on US-20 during this project were in this area (n = 129 out of 219). On SH-87, more than 75% of big game carcasses were found in the first five miles of the nine-mile stretch of road (n = 21; Figures 6 and 8).

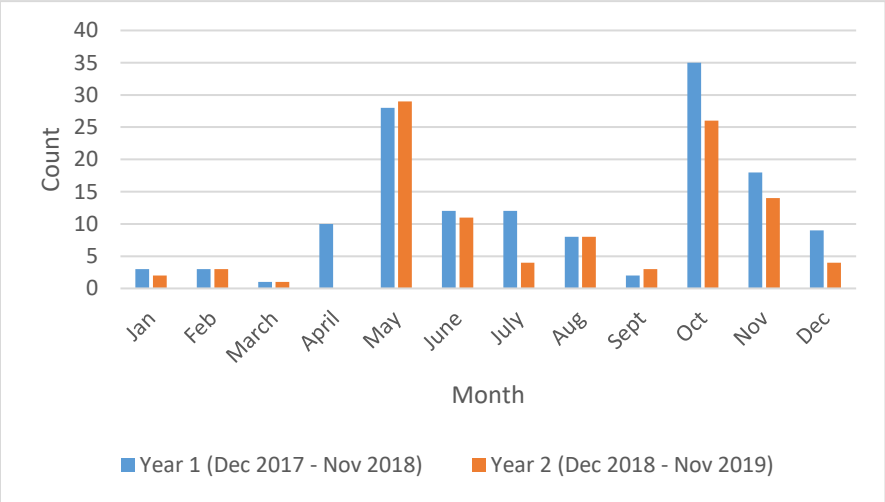

Figure 5. Monthly distribution of reported big game carcasses (deer, elk, moose, pronghorn; n = 246) in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019.

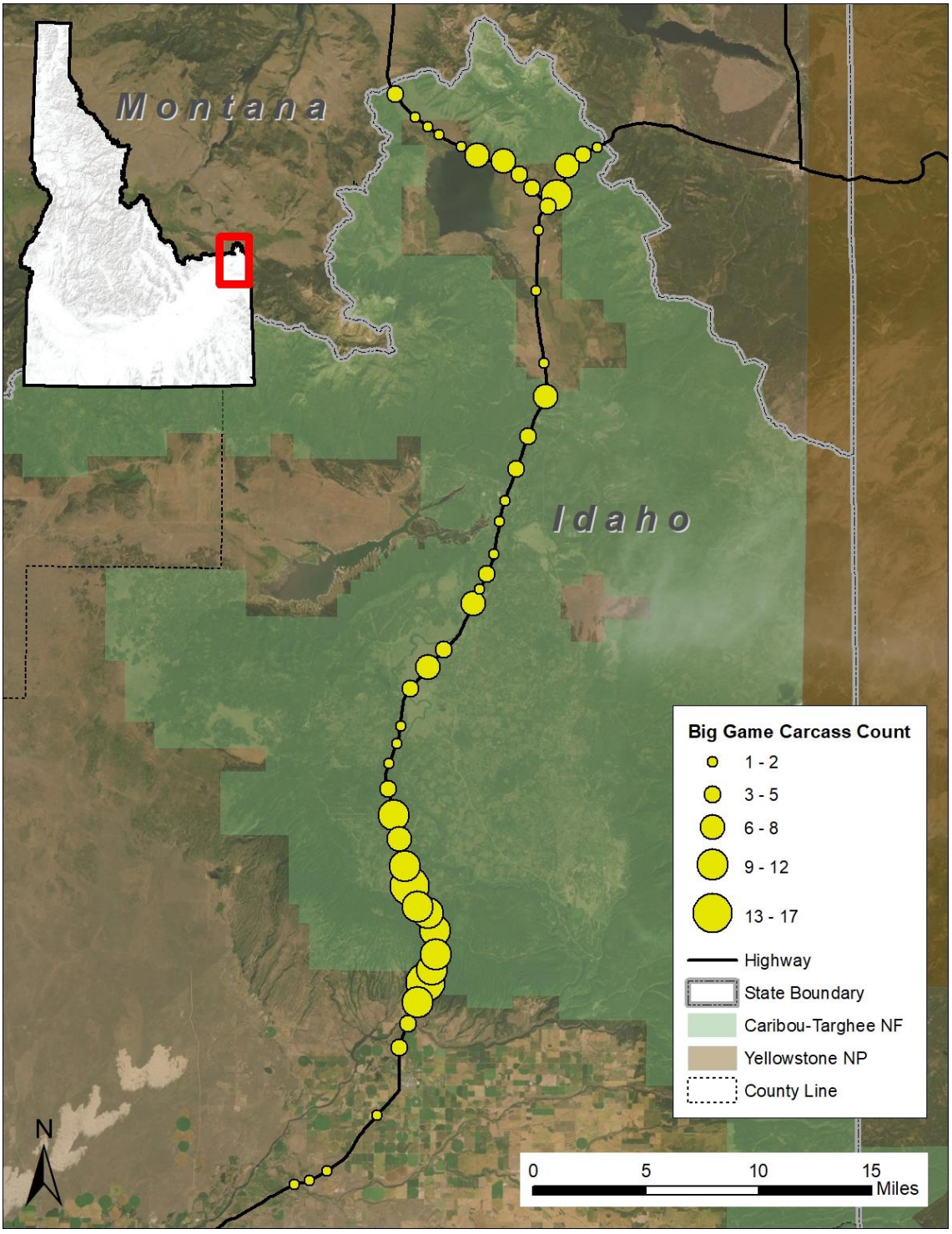

Figure 6. Reported big game road carcasses (deer, elk, moose, and pronghorn; n = 246) in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019.

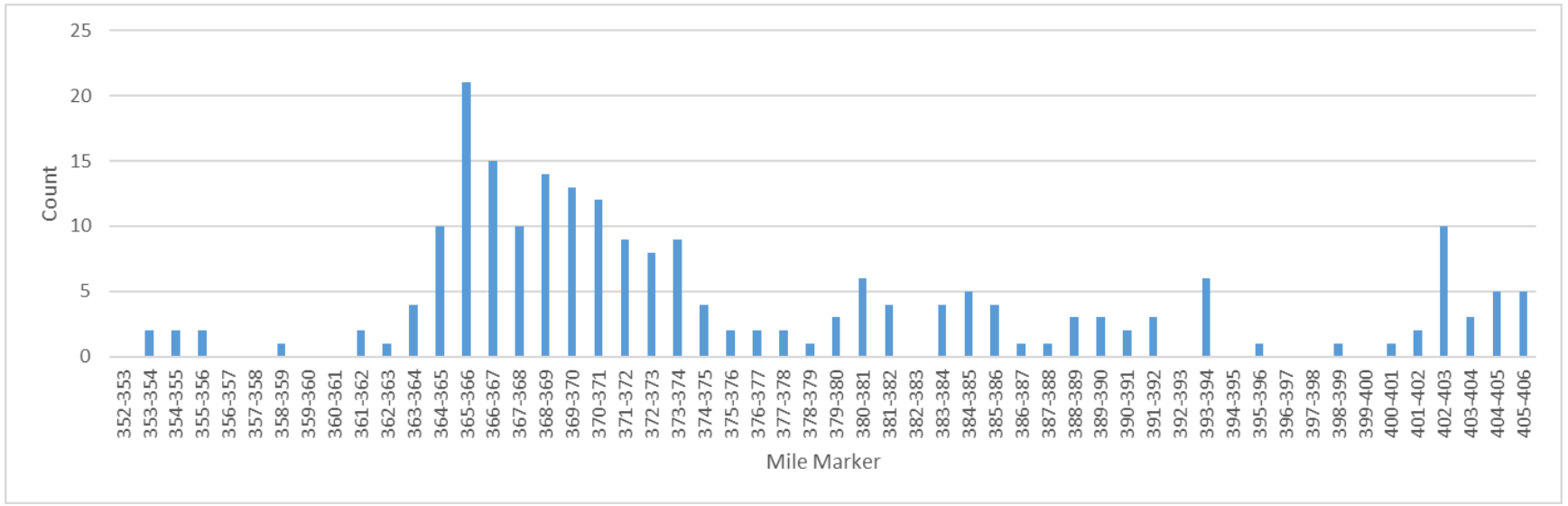

Figure 7. Distribution of reported big game carcasses (deer, elk, moose, and pronghorn; n = 219) displayed by mile marker on US-20 during Dec 1, 2017-Dec 1, 2019.. Big game carcass reports on US-20 were concentrated between mile markers 363-375. Over half of the total big game carcasses on US-20 were reported in this area (n = 129).

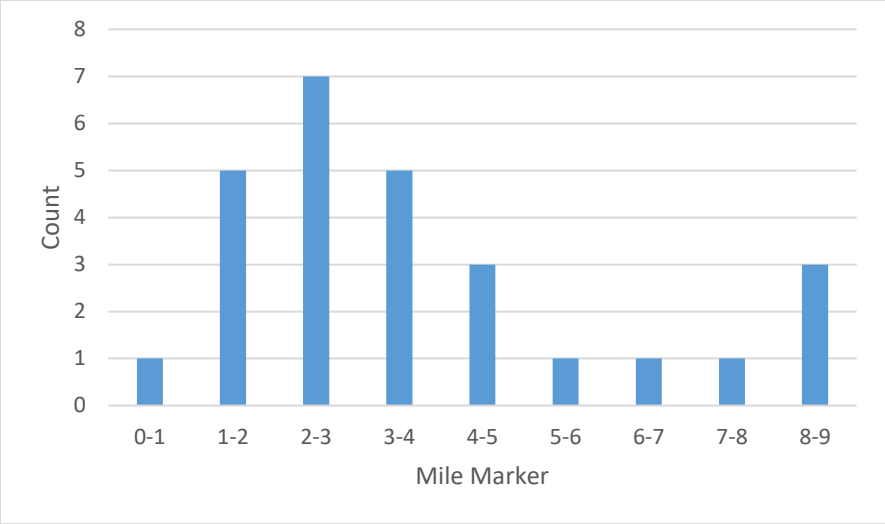

Figure 8. Distribution of reported big game carcasses (deer, elk, moose, and pronghorn; n = 27) displayed by mile marker on SH-87 during Dec 1, 2017-Dec 1, 2019.

Mule Deer

Mule deer carcass reports were strongly seasonal on US-20, with 58% of the total reports occurring during May and October (Figure 9). Mule deer carcasses were reported throughout the project area but carcass reports on US-20 were concentrated between mile markers 363-375 from the bottom of Ashton Hill to Swan Lake (Figures 10 and 11). Almost three-quarters of the total mule deer carcasses on US-20 were reported in this area (n = 89). Another 10% of mule deer carcasses on US-20 were reported on Targhee Pass between mile markers 402-406 (n = 12; Figure 10). Mule deer carcass reports on SH-87 were concentrated between mile markers 3-5 (Figure 12).

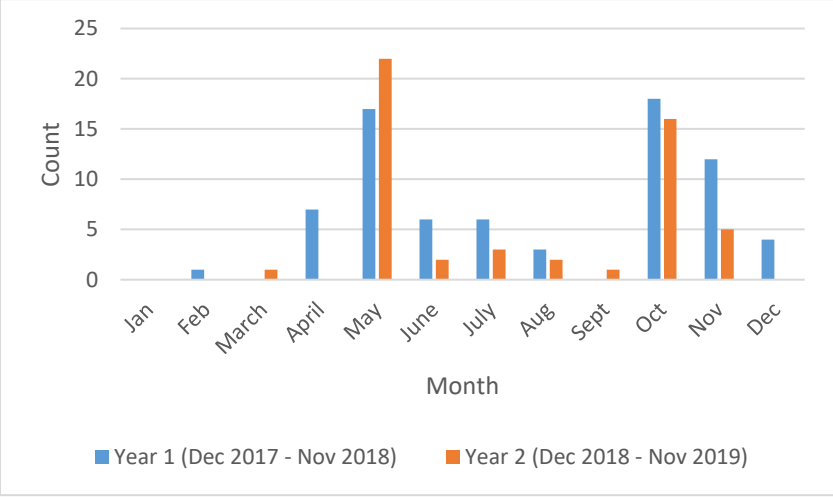

Figure 9. Monthly distribution of reported mule deer carcasses (n = 126) in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019.

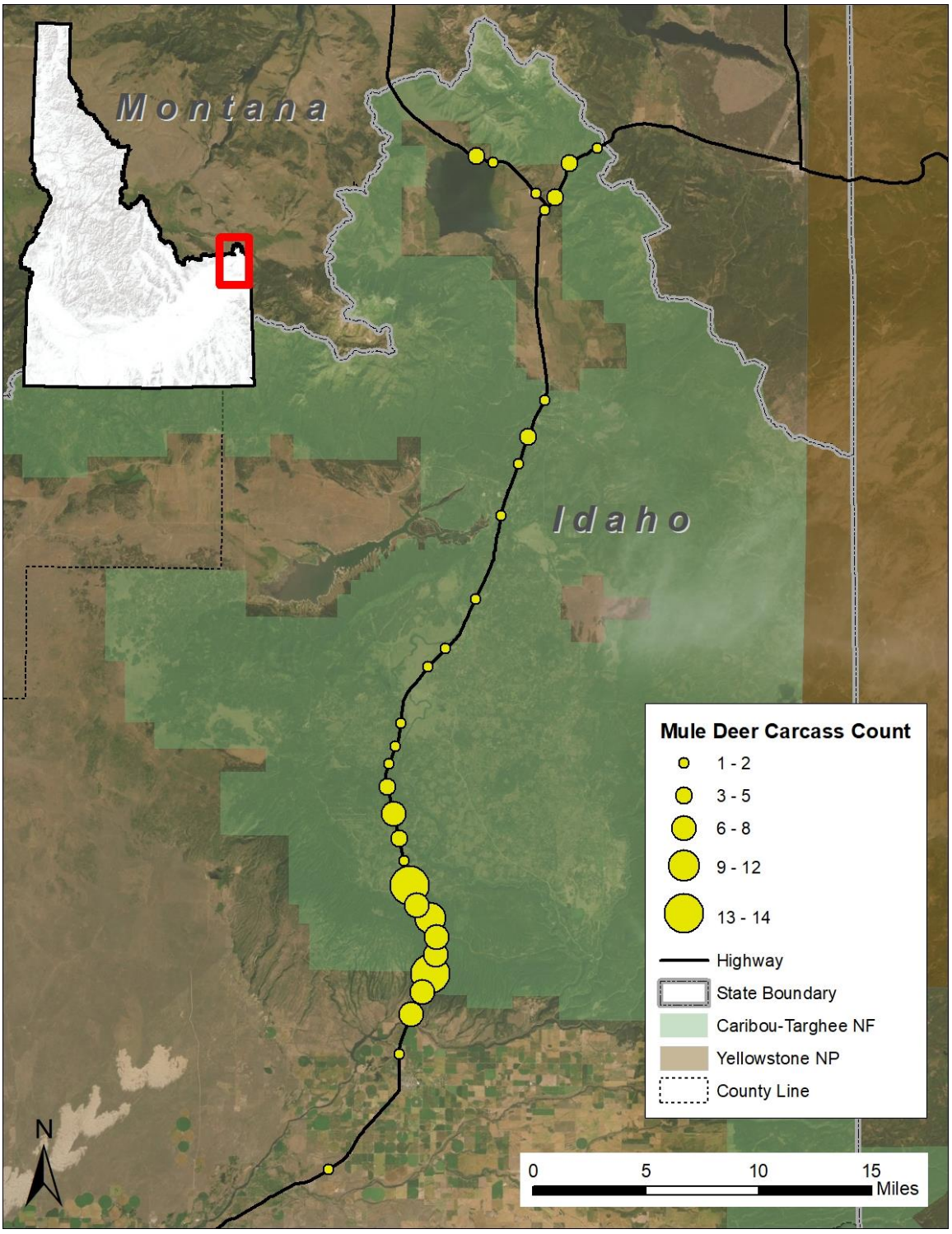

Figure 10. Reported mule deer road carcasses during Dec 1, 2017-Dec 1, 2019 (n = 126) in the US-20/SH-87 Corridor project area.

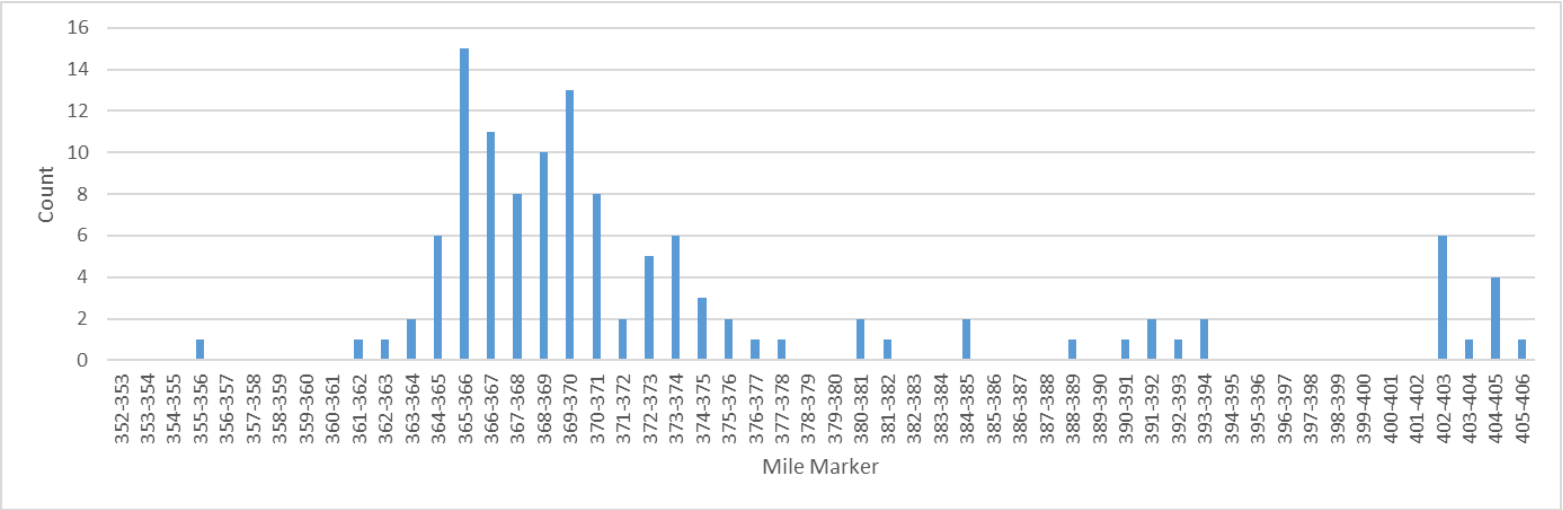

Figure 11. Distribution of reported mule deer carcasses (n = 121) displayed by mile marker in the US-20 project area during Dec 1, 2017-Dec 1, 2019.

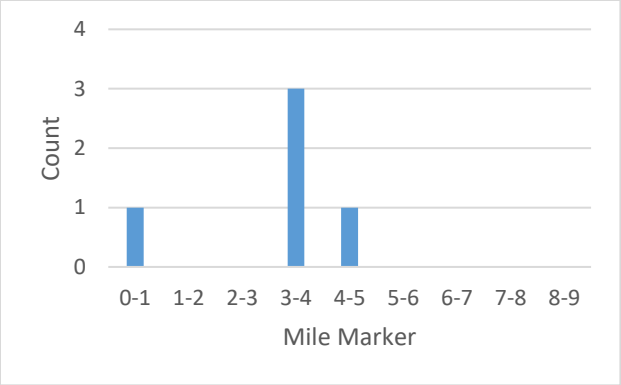

Figure 12. Distribution of reported mule deer carcasses (n = 5) displayed by mile marker in the SH-87 project area during Dec 1, 2017-Dec 1, 2019.

Elk

Elk carcasses were reported during spring, summer, and fall (Figure 13), and were encountered throughout the project area (Figure 14). On US-20, elk carcasses were frequently reported between mile markers 369-375 (Ashton Hill to Swan Lake) where 28% of elk carcasses were documented (n = 15) and between mile markers 379-391 where 38% of the carcasses were reported (Harriman State Park and the central part of the US-20 corridor; n = 19). Eleven percent of elk carcasses on US-20 were reported on Targhee Pass between mile markers 402-406 (n = 12; Figures 14 and 15). On SH-87, elk carcasses were reported between mile markers 1-3 and 6-9 (Figure 16).

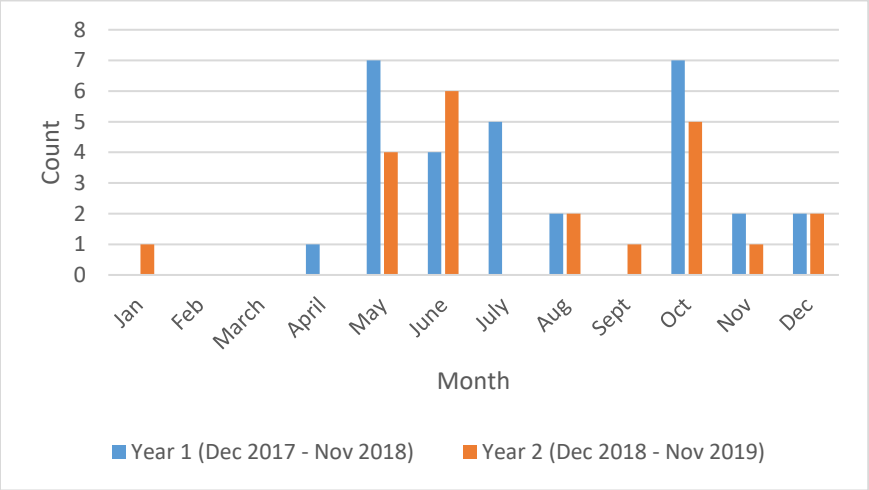

Figure 13. Monthly distribution of reported elk carcasses (n = 52) in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019.

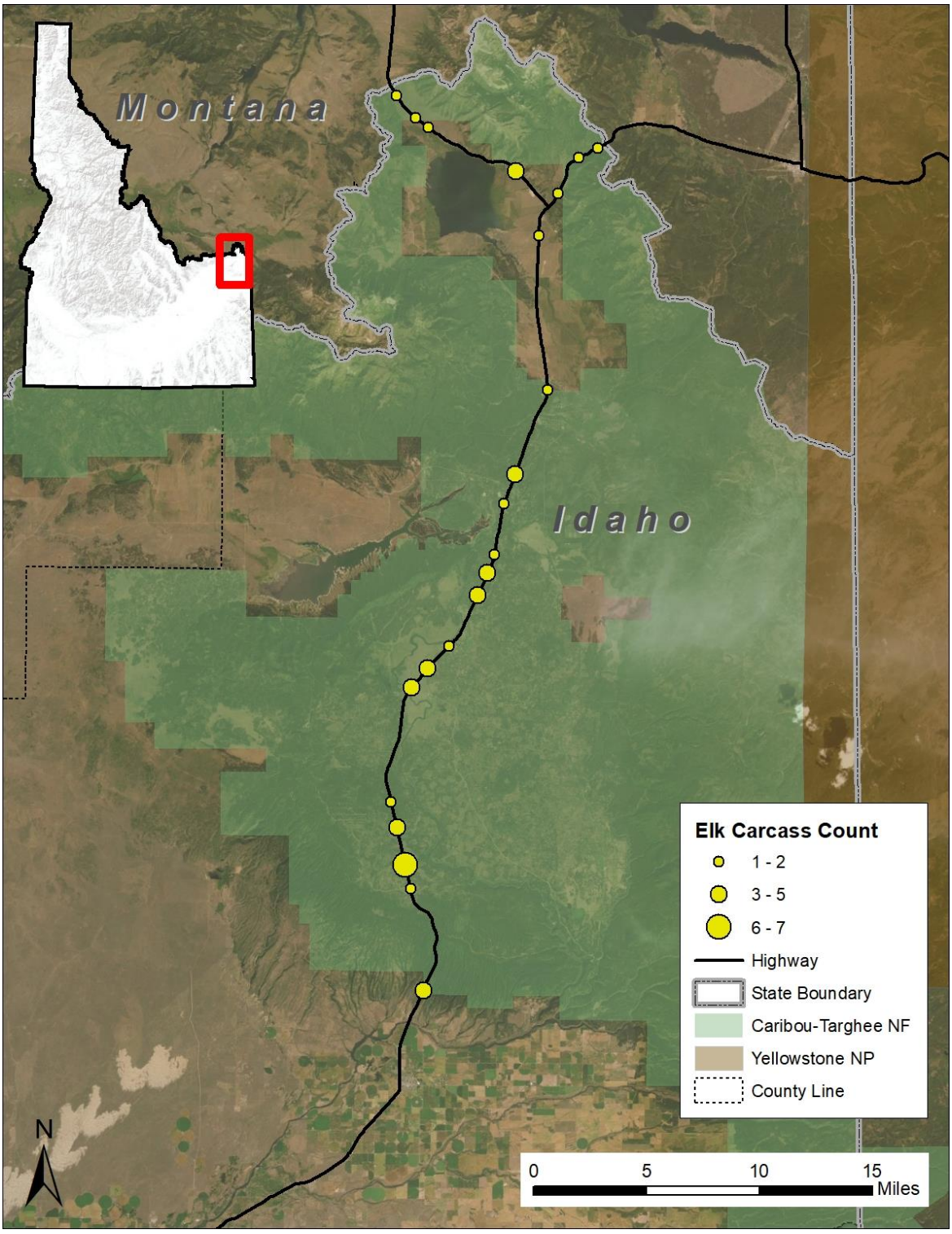

Figure 14. Reported elk carcasses (n = 52) in the US-20/SH-87 Corridor project area during Dec 1, 2017 - Dec 1, 2019.

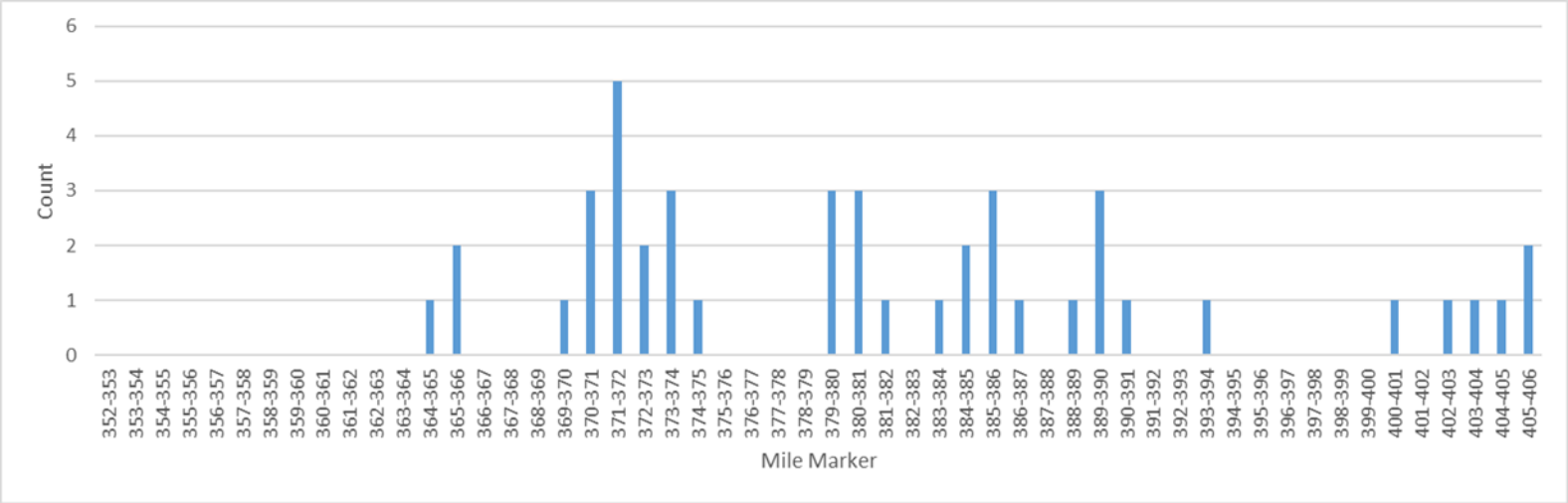

Figure 15. Distribution of reported elk carcasses (n = 44) displayed by mile marker in the US-20 project area during Dec 1, 2017-Dec 1, 2019.

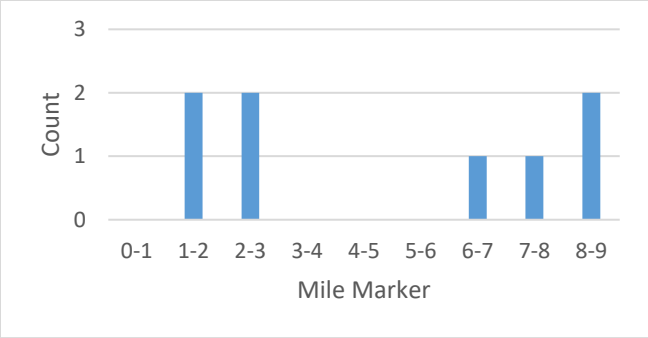

Figure 16. Distribution of reported elk carcasses (n = 8) displayed by mile marker in the SH-87 project area during Dec 1, 2017-Dec 1, 2019.

Moose

Twenty-four moose carcasses were reported on the US-20/SH-87 Corridor. Moose carcass reports were fairly uniform throughout the year, except for a peak during the second fall and zero carcasses during March, April, and May in both years (Figure 17). More than half of moose carcasses on US-20 were found between mile markers 363-372 on Ashton Hill (n = 11; Figures 18 and 19). Moose carcasses were most frequently reported between mile markers 3-6 on SH-87 (Figures 18 and 20).

One ear-tagged moose was reported during the study. This cow was at least 10 years old, as she was marked by IDFG and partners as an adult in 2010. She was a non-migratory moose that was tagged at Pond's Lodge in Island Park, which is where we found her in November 2019 (Andreasen et al. 2014).

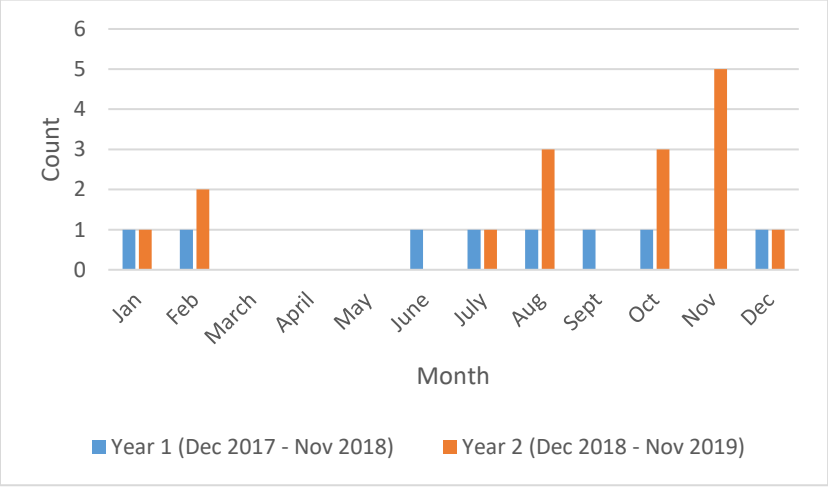

Figure 17. Monthly distribution of reported moose carcasses (n = 24) in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019.

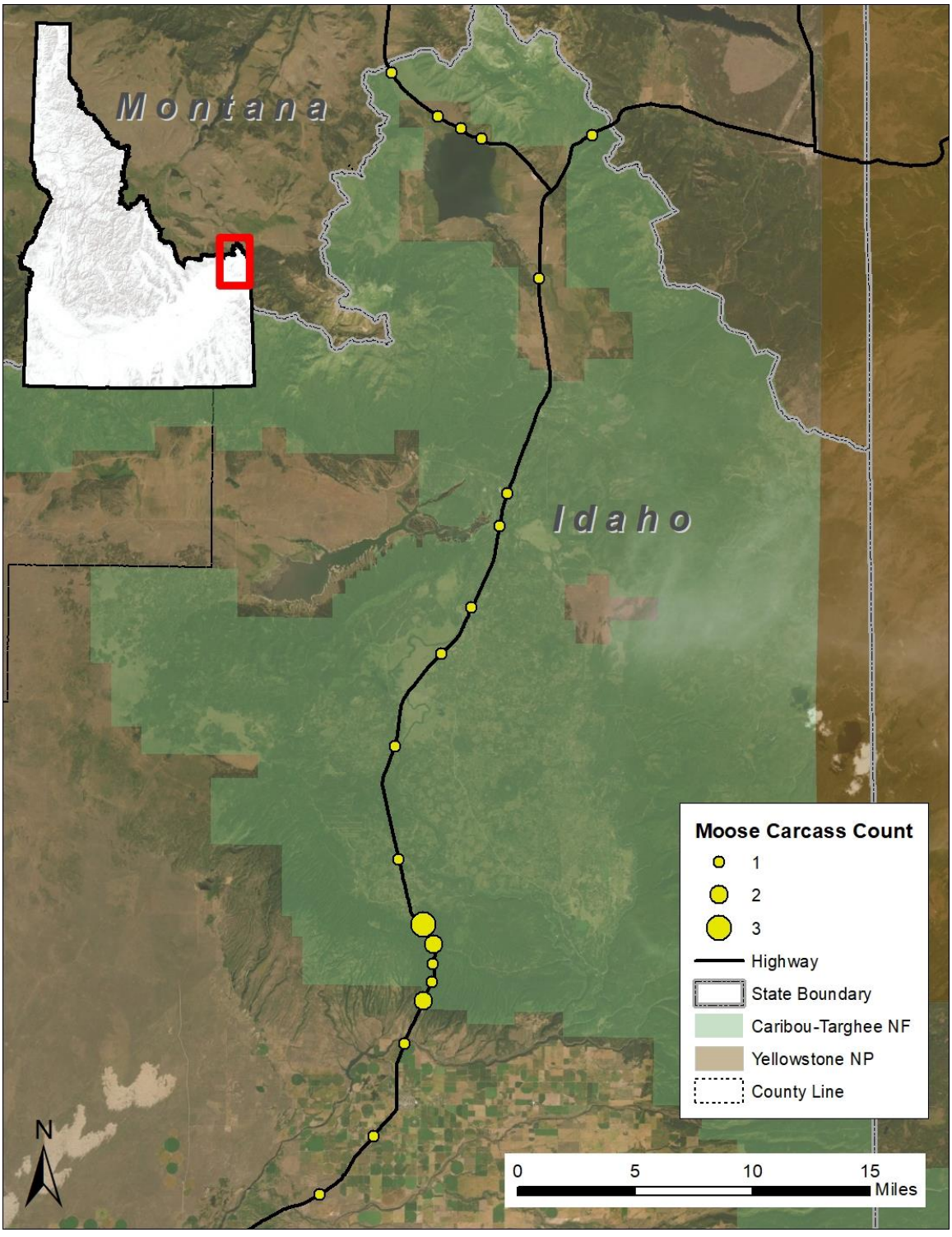

Figure 18. Reported moose carcasses (n = 24) displayed in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019.

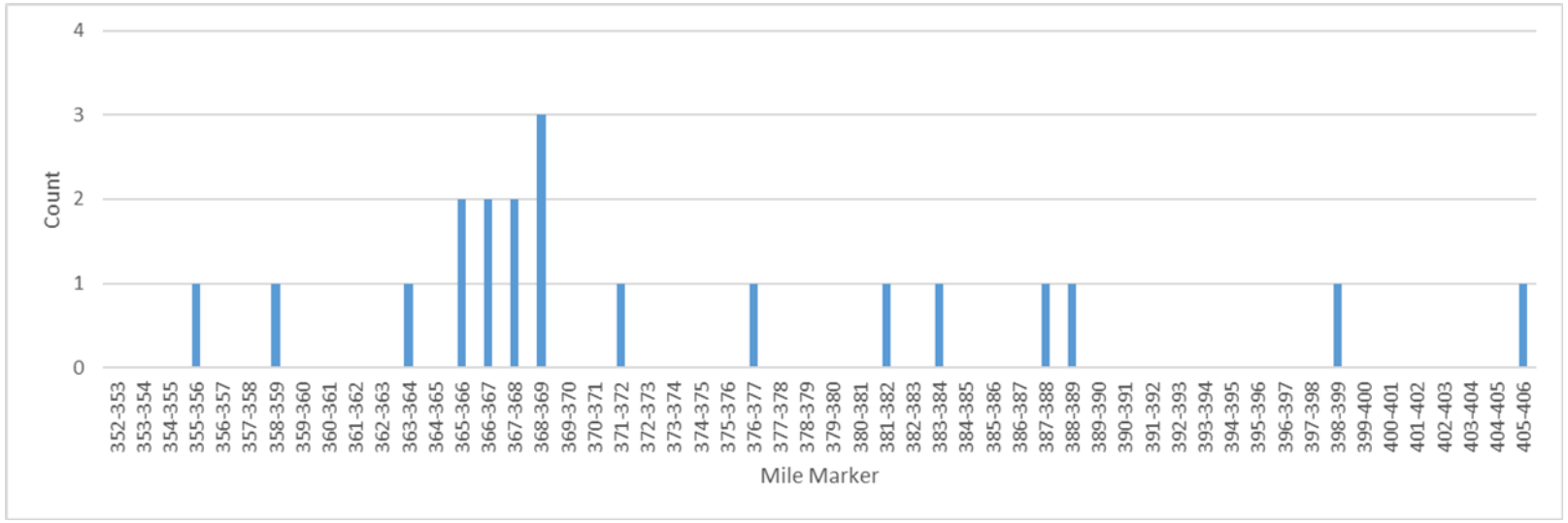

Figure 19. Distribution of reported moose carcasses (n = 20) displayed by mile marker in the US-20 project area during Dec 1, 2017 and Dec 1, 2019.

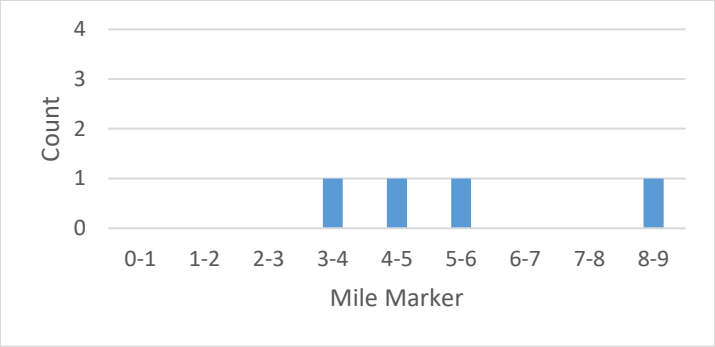

Figure 20. Distribution of reported moose carcasses (n = 4) displayed by mile marker in the SH-87 project area during Dec 1, 2017-Dec 1, 2019.

White-tailed Deer

Nineteen white-tailed deer carcasses were reported in the project area. White-tailed deer carcasses were most common during the fall (Figure 21). The greatest numbers of white-tailed deer carcasses on US-20 were reported at mile marker 353-355 (Chester area; n = 3) and between mile markers 1-5 on SH-87 (n = 7; Figure 22).

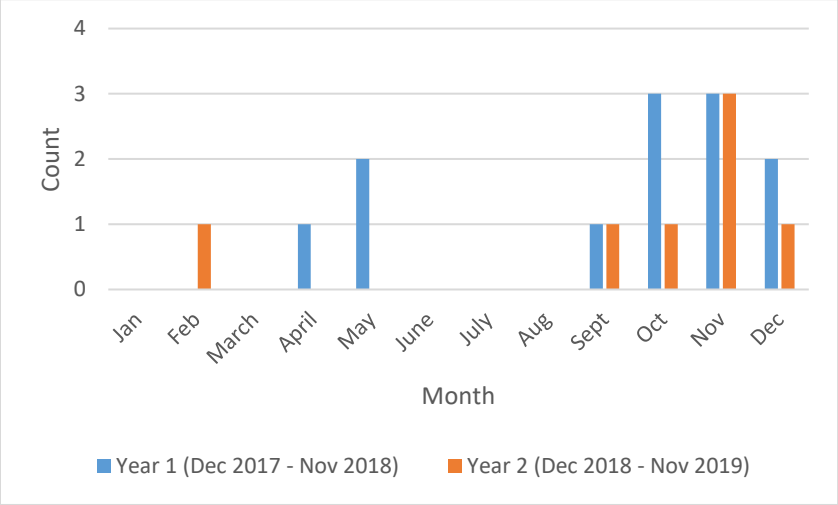

Figure 21. Monthly distribution of reported white-tailed deer carcasses (n = 19) in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019.

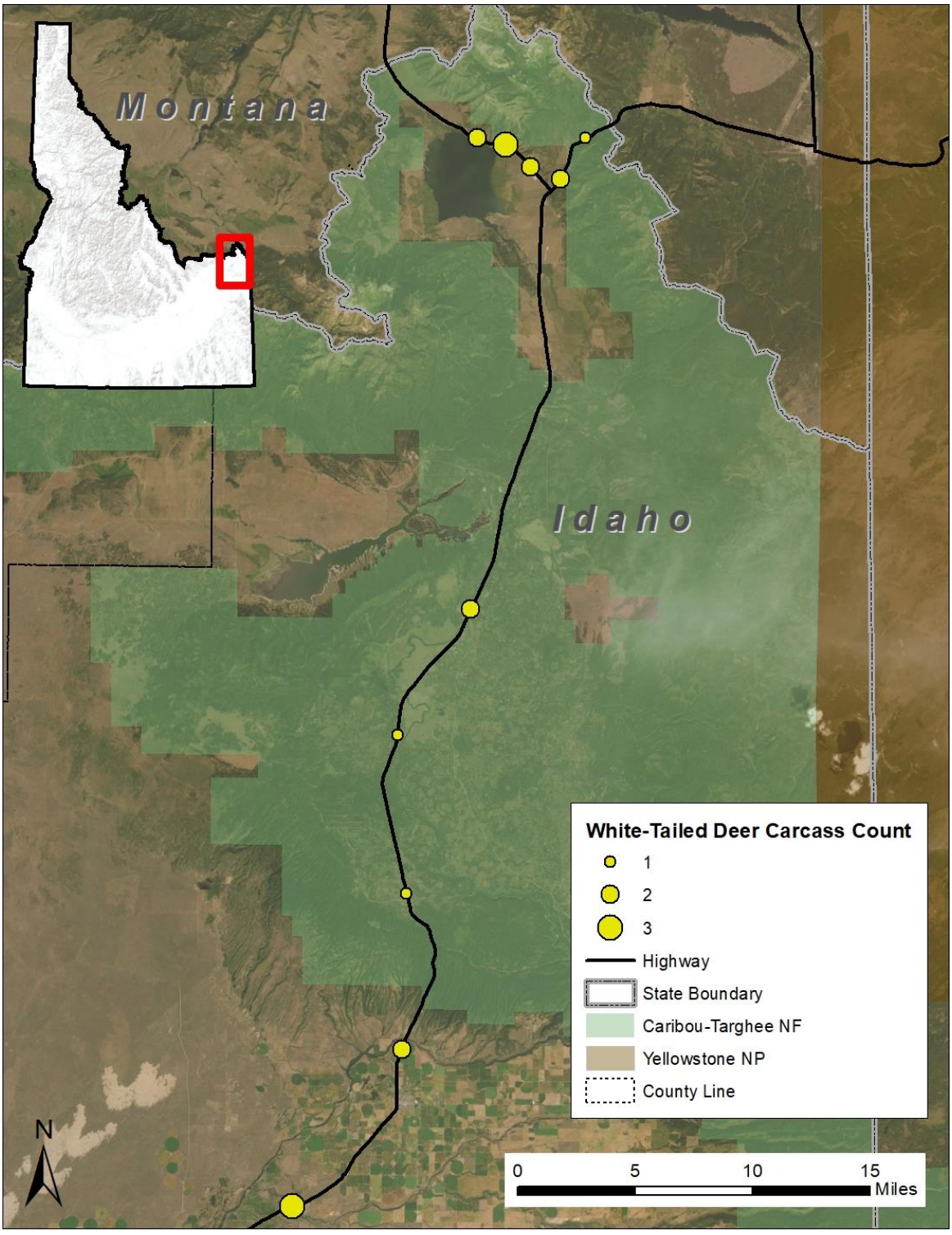

Figure 22. Reported white-tailed deer carcasses (n = 19) in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1 2019.

Pronghorn

Six pronghorn carcasses were reported during the first year of the study. Zero pronghorn carcasses were reported during the second year of the study. Pronghorn carcasses were most frequently reported in October, with three of the six killed in that month (Figure 23). The pronghorn carcasses reported on US-20 during this project were near Harriman State Park at mile marker 380-382 and on the Henrys Lake Flats between mile markers 395-402 (Figure 24). The three pronghorn carcasses reported in Oct 2018 included a doe/fawn pair that were killed and salvaged together between mile markers 2-3 on SH-87.

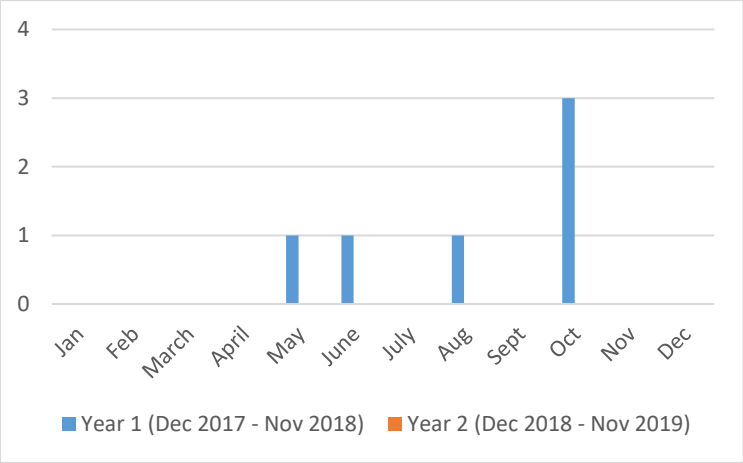

Figure 23. Monthly distribution of reported pronghorn carcasses (n = 6) in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019. No Pronghorn carcasses were reported during the second year of the study.

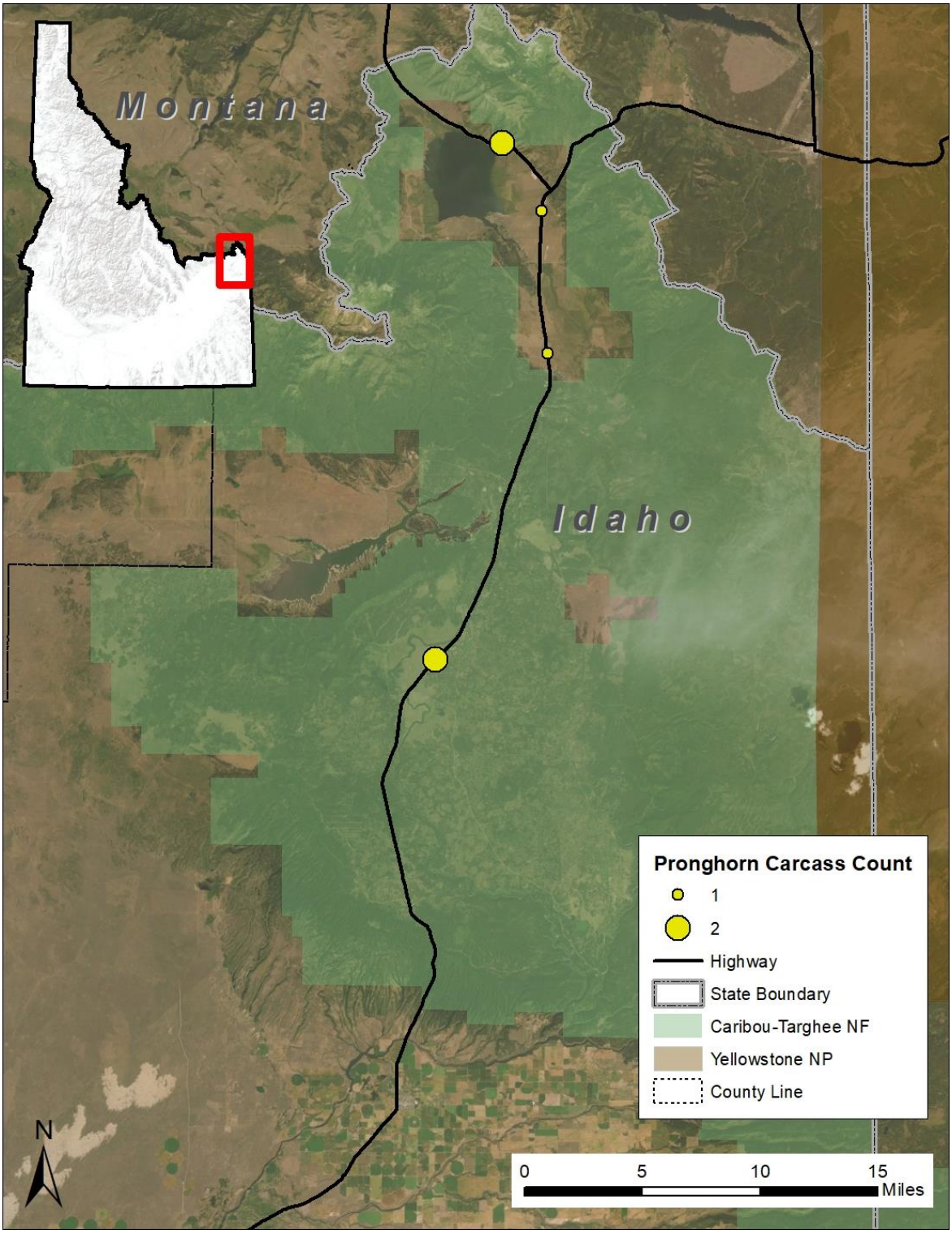

Figure 24. Reported pronghorn carcasses (n = 6) in the US-20/SH-87 Corridor project area during Dec 1, 2017 - Dec 1 2019.

Prior Data

During January 1, 2006 – December 31, 2011, 95 big game carcasses were reported to IFWIS on US-20/SH-87. Most roadkill during this time period was reported by IDFG staff, with 15 citizen reports (16% of total). The Idaho roadkill salvage rule was implemented in 2012. There were nine carcasses reported to the IFWIS roadkill database in 2011 and 34 carcasses reported in 2012. From January 1, 2012 to December 1, 2017, 239 big game carcasses were reported on US-20/SH-87 by citizens, ITD and IDFG. Of the reports during this time period, 55 were submitted by citizens who salvaged roadkill (23% of total). ITD began reporting carcasses in 2012 and reported 48 carcasses between January 1 2012 and December 31 2016.

Annual numbers of big game roadkill reported on US-20/SH-87 between January 1, 2006 and December 1, 2017 range from a low of zero in 2008 to a high of 55 in 2016. In the first year of this study (Dec 1 2017 – Dec 1 2018), 138 unique big game carcasses were reported, and in the second year (Dec 1 2018 – Dec 1 2019), 108 big game carcasses were reported (Figure 25).

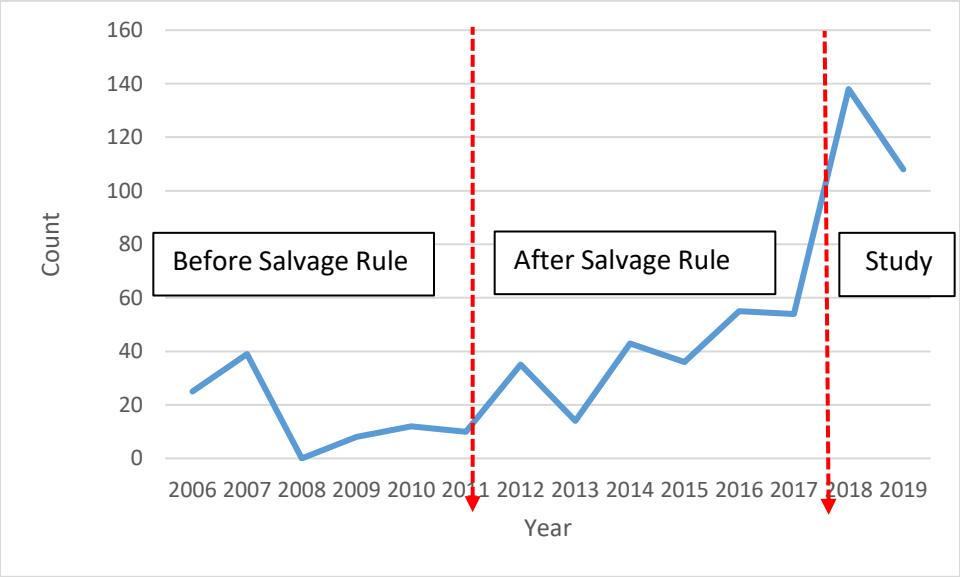

Figure 25. Number of big game carcasses reported per year in the US-20/SH-87 Corridor project area during 2006-2019.The red arrows indicate the passing of the Salvage Rule (2012) and the initiation of this study (2017).

Discussion

Project Purpose

We initiated this project to address knowledge gaps and to provide rigorously collected roadkill data for use by CTNF, IDFG, other agencies, and interested parties for identifying key areas for big game movements across National Forest lands. These data will also help the CTNF implement its 1997 Targhee Revised Forest Plan, which requires knowledge of big game migration routes as well as potential threats to those migrations. The USFS manages important seasonal and migratory big game habitats. Migratory big game species must interface with roads as they migrate between summer and winter ranges, and

non-migratory big game encounter roads during daily movements. Rigorous road kill data can help identify key animal movement areas and elucidate where movement may be impacted by roads and traffic, as well as where animals and drivers are at risk for WVCs.

This project also aimed to help the Forest comply with the Grizzly Bear Conservation Strategy, which requires the Forest to document big game mortality. Wildlife killed by vehicles persist near roads, attracting scavengers like grizzly bears, which may become vulnerable to collisions with vehicles themselves.

The CTNF and IDFG also wanted to facilitate community engagement and refine data collection protocols for use in future studies. We met these goals by engaging 16 citizen science volunteers during the project.

Additionally, the CTNF may also use the data to inform Forest Service land-use planning, travel planning, and project specific analyses. Traffic on US-20/SH-87 may affect wildlife movements, migration, and population health. The CTNF is not currently collecting these types of data due to a lack of capacity and other more pressing priorities. Subsequently, the CTNF relied on IDFG to collect these data using the latest scientific methods. These types of partnerships provide information beneficial to the Forest in making management decisions.

Roadkill Trends

Big game migrations in our study area have been documented with radio-collar, track, and carcass data (Andreasen et al. 2014). During our study, deer, elk, moose, and pronghorn were more vulnerable to WVC as they departed Island Park to reach winter range and again when returning in the spring, which is consistent with previous research. Some moose are present in the project area year-round, and patterns in moose carcass reports were consistent with the expectation of year-round detections. Although spring and fall are when big game carcass counts were the greatest, we also detected carcasses of most species during summer as well. Some big game spend summers on the caldera, which coincides with peak tourist travel in the project area. There is more traffic on the road at this time of year with drivers who are unfamiliar with the area, which may lead to higher WVC.

Underreporting

Roadkill is vastly underreported, even when rigorous survey efforts are undertaken (Slater 2002, Guinard et al. 2012, Teixeira et al. 2013). Roadside carcasses are underreported for a variety of reasons. Public enthusiasm for carcass reporting is low, but can increase with outreach campaigns and public data entry portals (Waetjen and Shilling 2017). Even agency personnel do not have the time or resources to stop for all carcasses they see while driving. Additionally, many animals are injured but are able to move off the road, only to die later, far from the road, undetected. There was a substantial increase in the number of reported carcasses during our study, suggesting that big game carcass are underreported in the study area, even when citizens salvage roadkill and professionals are encouraged to report roadkill.

It is important to understand that our estimates for big game road mortality are minimum estimates. We did not assess searcher efficiency or conduct scavenger carcass removal trials during our study. Therefore, we could not estimate detection probabilities for carcasses on US-20/SH-87, and we only report minimum estimates.

Citizen Science

Citizen scientist engagement in the US-20/SH-87 roadkill data collection project was very successful and was essential to the project's success. We worked with 16 volunteers who participated directly in surveys with IDFG during ride-alongs or as independent volunteers. Many other local citizens also reported roadkill via the IFWIS system or through contact with IDFG staff. Additionally, IDFG staff facilitated community engagement through training and informational presentations, which were attended by citizens of Island Park.

Volunteer enthusiasm for the project was high. Volunteers reported that even though the work they performed was sometimes saddening, the educational and experiential benefit of performing the work outweighed the negative aspects. Volunteers collected accurate scientific data, verified through photographs by IDFG staff, demonstrating that well-trained volunteers are capable of collecting quality data.

Volunteers indicated that their favorite aspect of participating in surveys was direct interaction with agency biologists and the education they received as a part of those interactions. They said they were aware of roadkill before the survey, (as members of the public they had seen dead animals on the side of the road), but they were able to truly understand the breadth of the issue when participating in formal surveys. They also mentioned the value of educational opportunities presented by experiencing wildlife up close, even post-mortem.

When asked about any negative aspects of participation in the project, volunteers specified safety concerns. They indicated it was sometimes difficult to stop because of dense traffic, the lack of road shoulder, or a guardrail in the way. They said it was unnerving to hear the whooshing of freight trucks passing them while stopped on the side of the road. However, they also indicated that IDFG always emphasized "safety first," advising them to stop only when they judged the situation to be safe, and outfitted them with safety gear and training. This increased their security, even when performing work that included stopping to collect roadkill data. They also indicated that the work could be devastating at times, such as when a volunteer encountered a severely injured cow elk on the side of US-20 during a survey. However, volunteers reported that IDFG staff were amazingly supportive during difficult times, responding to phone calls and texts right away for emotional support, and sending an officer to euthanize the suffering animal.

Ecologists face two major challenges when engaging with citizens who perform roadkill data collection – people management and data quality. It is quite difficult to inspire excitement about roadkill data collection, especially in the recruitment and maintenance of volunteers. Ensuring location accuracy and species identification is critical in roadkill data collection and duplication of reports must be avoided (Vercayie and Herremans 2015). We recruited volunteers from an established pool of eager IMNs, easing the challenge of recruitment. We worked closely with volunteers and responded quickly and enthusiastically to emails, texts, and phone calls. We also shared information about species that volunteers encountered, which aided in the maintenance of our volunteer base once it was established.

To ensure data accuracy, we trained all volunteers on GPS use and animal identification in the classroom and again in the field. We instructed volunteers to photograph carcasses so that biologists could verify species identification and control the quality of data. In many instances, volunteers photographed unknown species, and IDFG staff were able to identify the carcass from the photos. However, in some

cases, we used a broader taxon because identification to species was not possible. To reduce the potential for duplicate reports, all carcasses were moved to a location not visible from the roadway when possible. Even when carcasses were particularly large, volunteers dragged the carcass out of sight. When carcass removal was not possible by the volunteer (i.e. a moose or elk carcass), GPS coordinates of the carcass were given to the next surveyor so they would know where carcasses were reported but not removed. In these cases, the next time IDFG staff surveyed, they removed the large carcasses using a truck and winch. IDFG staff reviewed volunteers' data and found data collected by well-trained volunteers were just as reliable as data collected by IDFG staff. Other studies have also found that volunteers are capable of collecting accurate data, reporting on species identification with up to 97% accuracy (Waetjen and Shilling 2017).

Volunteer retention was solid during the project until the last four months when personal circumstances meant that some volunteers had to step away from the project. Volunteers were rewarded through the IMN program, and those who contributed heavily to our project received a gift and a plaque at the end, which gave them a sense of ownership of the project and allowed us to thank them for their service. One of our volunteers received a 100-hour volunteer award during both years of the project; many of those hours were spent on US-20 doing weekend carcass surveys.

Other Observations

We observed live mule deer grazing the roadside during the spring, summer, and fall. Surveyors also saw mule deer cross and attempt to cross the road. Several times, surveyors witnessed near deer-vehicle collisions, when deer attempted to cross the road and were almost struck by motorists. We observed groups of elk and pronghorn during spring and fall, walking in single file, parallel to SH-87.

Harriman State Park and other parts of the Henry's Fork Caldera host summering herds of elk, which may cross US-20 as a part of their daily movements (Andreasen et al. 2014). This situation presents a safety hazard to motorists during the highest traffic season of the year in Island Park (ITD 2018). In fact, during the study, on the evening of June 15, 2018, five motorists were hospitalized following a WVC in Island Park on US-20. Traffic was stopped in the north- and south-bound lanes for a herd of elk, which was crossing the road. A motorist attempted to navigate around the traffic when he struck an elk, crossed into the oncoming lane, and struck another motorist head-on. Three of the injured motorists were air lifted to Eastern Idaho Regional Medical Center in Idaho Falls and two were taken in an ambulance to Madison Memorial Hospital in Rexburg (Figure 26; Local News 8 2018).

Figure 26. Wreckage from an elk WVC on US-20 in Island Park, ID, June 15, 2018

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Appendix 1

IDFG Volunteer Form (VF-A1

revised rcb 7/2012

Volunteer Application & Service Agreement

Name (Last, First, Middle)_____

Mailing Address: Street/P.O. Box _____

City _____State _____ Zip _____

Are you over the age of 18? _____If not, your parent or guardian must sign below*

Telephone: (Home) _____ (Work) _____(Cell) _____

Email _____

Please specify any physical conditions or limitations that may influence your volunteer work:_____

_____

Agreement by Volunteer

I offer and agree to volunteer my services without compensation in wages to assist the Idaho Department of Fish and Game (IDFG) in accordance with the following understandings:

- Although this volunteer service will not confer on me the status of a State employee while acting within the scope of this Agreement, I will be deemed to be as if I were a State employee for the purposes of the following:
  - __ State Tort Claims Act, which protects a State employee from liability for injury or damage to others while the employee is acting within the scope of his or her duties, and:
  - __ State Workers' Compensation Act, which authorizes compensation for work-related injury.
- I am at least 18 years old (or if I am less than 18, my parent or guardian consents to this Agreement by signature below).
- I understand that volunteer projects will frequently be out-of-doors and that I will need to be in a physical condition adequate for normal outdoor physical activities. I will notify the Volunteer Coordinator of any significant change in my ability to do outdoor work. If special skills are required for a project, I will be trained therein before being assigned to that project.
- If I or my minor daughter/son drives my personal vehicle to and from a volunteer project, I certify that the vehicle is properly insured as required by Idaho state law.

Signature of Volunteer_____ Date _____

Person to Notify in an Emergency_____ Relationship to Volunteer _____

Address_____City _____State _____Zip _____

Telephone: (Home) _____ (Work)_____

Special Skills: _____

_____

Comments: _____

If volunteer is under 18:

*Signature of Parent or Guardian _____ Date _____

Name (print)_____Relationship to Volunteer _____

Parent or Guardian phone number: _____

Media Release

The Idaho Department of Fish and Game periodically uses photographs or video and audio footage of volunteers involved in activities or projects for local, regional or state publicity or for educational purposes. By my signature/ agreement, I acknowledge my understanding of the use of such publicity or educational material and give permission to the Idaho Department of Fish and Game to use such reproductions for educational and publicity purposes. Refusal to provide permission will not impact your participation in the Idaho Department of Fish and Game Volunteer Program.

Signature, Volunteer _____ Date _____

Signature, Parent or Guardian of Minor Volunteer*_____ Date _____

*By signing/agreeing parents and/or guardians give permission for the Idaho Department of Fish and Game to use photographs and/or video and audio recording of their minor child (ren) participating in volunteer activities or projects for publicity or educational purposes. Refusal to provide permission will not impact your child's participation in the Idaho Department of Fish and Game Volunteer Program.

VF A-1

Appendix 2

Citizen Science Budget Completion Report

In May 2019, IDFG was granted a $25,000 matching award from the USFS Citizen Science program to complete this project. This table shows how these funds were spent along with IDFG contributions and volunteer in-kind contributions.

Category	Expenses	Citizen Science Grant	IDFG	Volunteers	Note
Salary/labor	$44,976	$19,395	$25,581	161 Hours	IDFG project coordination, data collection, entry and analysis, report completion; volunteer hours are from 5/1/2019 - 11/10/2019
Travel	$5,561	$2,605	$2,956	4,502 Miles	IDFG mileage and reimbursed volunteer mileage combined; volunteer in-kind mileage is listed as miles (5/1/2019 - 11/10/2019)
Equipment	$400	$400	$0		ESRI license
Supplies/materials	$971	$600	$371		Computer
Project outreach	$4,985	$2,000	$2,985		[1]ICOET
Total	$56,893	$25,000	$31,893		

[1]International Conference on Ecology and Transportation

Appendix 3

Roadside Survey of Non-Big Game Carcasses on US Highway-20 and State Highway-87 in Southeastern Idaho

Introduction

Roadkill surveyors encountered many non-big game species during the project. Wildlife-vehicle collisions (WVC) are the number one threat to 21 federally listed species (Huijser et al. 2008) and in 2014, Loss et al. reported that between 80 and 340 million birds die annually on roads in the US, making roads and their associated traffic the third largest cause of anthropogenic bird mortality in the US and Canada.

Methods

Data were collected, entered, and cleaned according to the same protocols as big game big game carcass data and in the same study area along the US-20/SH-87 Corridor during the same time period (Figure A1). For the purposes of this report we refer to deer, elk, moose, and pronghorn as big game. All other mammal species (including bear, wolf and mountain lion) are referred to as non-big game.

Non-big game carcasses documented were aged and sexed as accurately as possible by surveyors. We used teeth, body size, and genitalia to age and sex mammals. We used plumage characteristics, including color, wear, and molt to age and sex birds. In some cases, we reached out to experts who aided us in correct identification, aging and sexing of carcasses. We used body size to determine the age of some reptiles.

When salvageable bird specimens were preserved and transferred to the Intermountain Bird Observatory for addition to their scientific museum skin collection. We transferred eagle carcasses to the National Eagle Repository. The Eagle Repository is operated under the US Fish and Wildlife Service (USFWS) and provides “a central location for the receipt, storage and distribution of bald and golden eagles found dead and their parts throughout the United States” (USFWS 2019). Volunteers on this project were covered under state and federal permits to possess bird carcasses found on US-20 for less than six months before they transferred the specimen to IDFG staff.

Results

During the study, 1,167 carcasses not classified as big game species were documented, which represented 82.6% of the total data collected during the study (Figure A2). Carcasses of 123 species were reported on US-20 and SH-87 (86 bird species [Table A1]; 31 mammal species [Table A2]; four reptile and amphibian species [Table A3]). These numbers included 45 domestic cats and three domestic dogs, which we make no further mention of in this report. Sixteen of these species are designated as special status species (Species of Greatest Conservation Need by IDFG or Sensitive Species by the USFS and/or BLM; Tables A1, A2, and A3; BLM 2014, IDFG 2015, USFS 2017). Because species identification was not always possible, we used 15 broader taxa in 133 instances (Table A4). We documented 602 birds, 474 non-big game mammals, and 43 reptiles and amphibians (Figure A3).

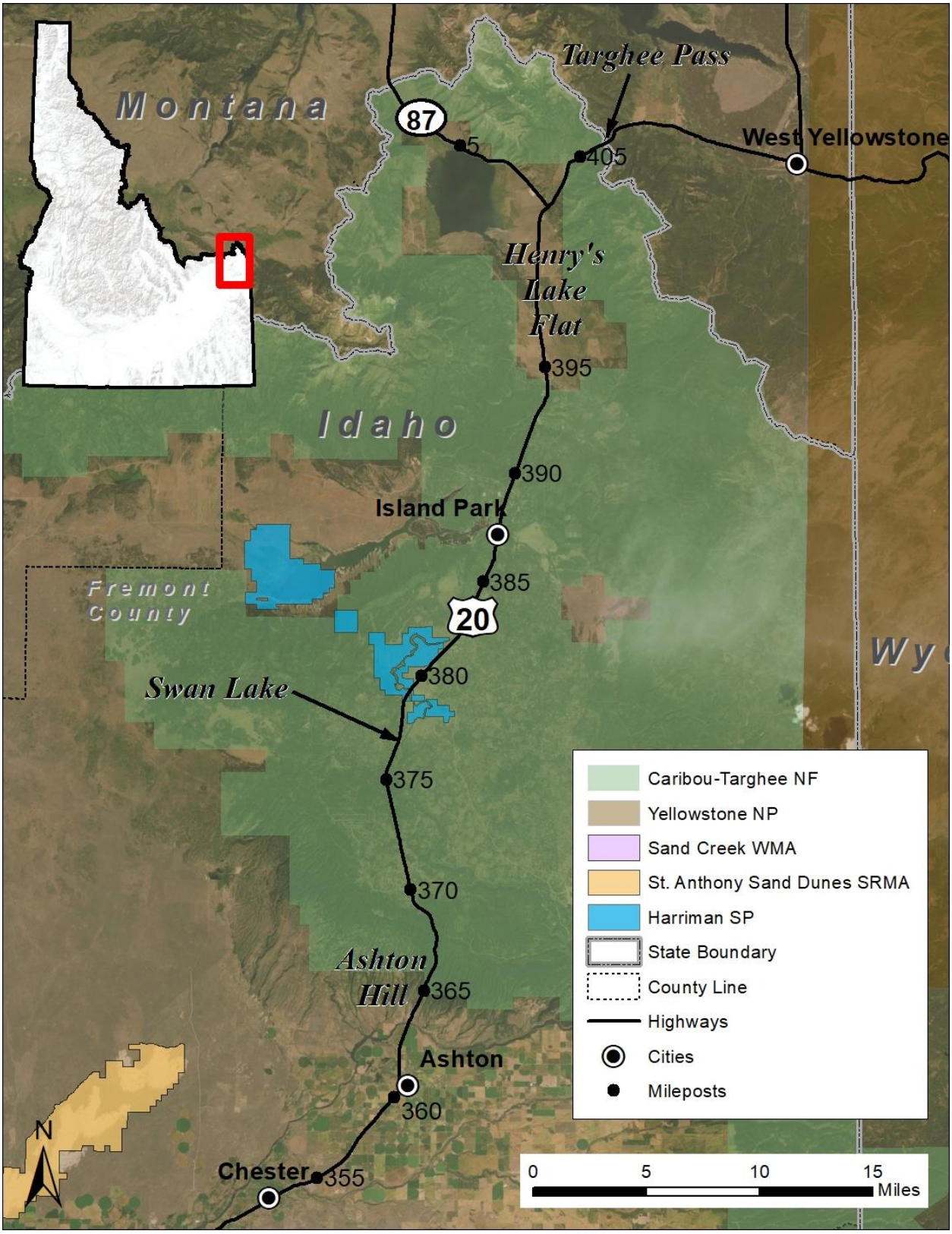

Figure A1. Map of project area highlighting public land ownership and geographic areas mentioned in the text.

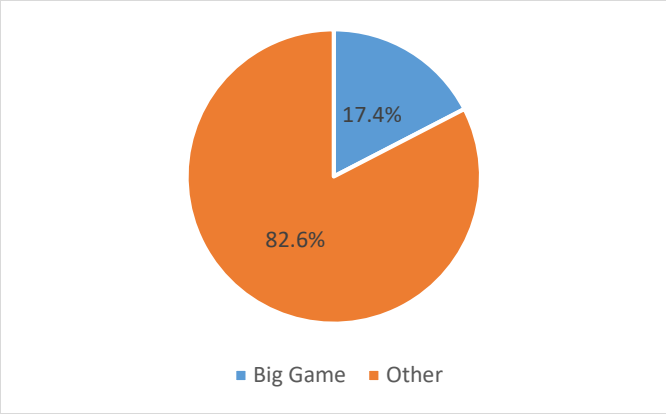

Figure A2. Percent of big game (n = 246) and other species (n = 1,167) found as roadkill in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019.

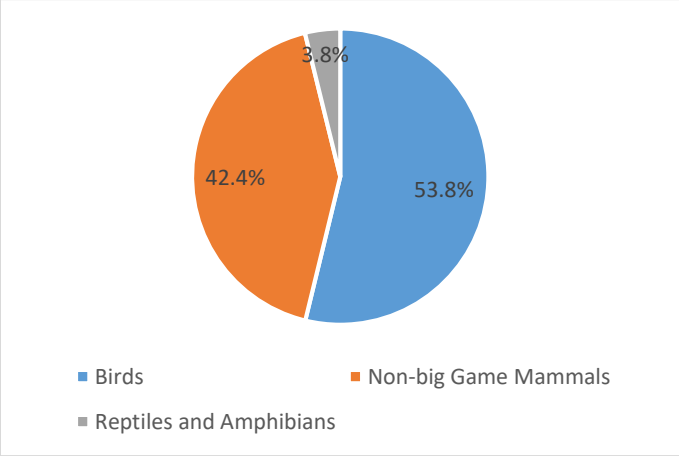

Figure A3. Percent of bird (n = 602), non-big game mammal (n = 474), and reptile and amphibian (n = 43) carcasses reported in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019.

Table A1. Bird species reported in the project area as roadkill and the total number of reports per species in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019. Species of Greatest Conservation Need (SGCN) are designated in the 2015 SWAP (IDFG) and Sensitive Species are designated by the USFS Region 2 Forest Manager and the Idaho State Director for the BLM (IDFG 2015, USFS 2017, BLM 2019).

Common Name	Scientific Name	Count	Designation
Great Horned Owl	*Bubo virginianus*	44	N/A
American Robin	*Turdus migratorius*	43	N/A
Brewer's Blackbird	*Euphagus cyanocephalus*	41	N/A
European Starling	*Sturnus vulgaris*	36	N/A
White-crowned Sparrow	*Zonotrichia leucophrys*	24	N/A
Chipping Sparrow	*Spizella passerina*	16	N/A
Western Meadowlark	*Sturnella neglecta*	16	N/A
Ring-necked Pheasant	*Phasianus colchicus*	14	N/A
Ruffed Grouse	*Bonasa umbellus*	14	N/A
Mallard	*Anas platyrhynchos*	12	N/A
Yellow Warbler	*Setophaga petechia*	12	N/A
Great Gray Owl	*Strix nebulosa*	11	SGCN Tier 3
House Wren	*Troglodytes aedon*	11	N/A
Northern Flicker	*Colaptes auratus*	11	N/A
Vesper Sparrow	*Pooecetes gramineus*	11	N/A
American Crow	*Corvus brachyrhynchos*	10	N/A
Brewer's Sparrow	*Spizella breweri*	10	USFS/BLM SS
Brown-headed Cowbird	*Molothrus ater*	9	N/A
Cliff Swallow	*Petrochelidon pyrrhonota*	9	N/A
Gray Partridge	*Perdix perdix*	9	N/A
Mourning Dove	*Zenaida macroura*	8	N/A
Song Sparrow	*Melospiza melodia*	8	N/A
Cedar Waxwing	*Bombycilla cedrorum*	7	N/A
Dusky Grouse	*Dendragapus obscurus*	7	N/A
Dark-eyed Junco	*Junco hyemalis*	6	N/A
Red-tailed Hawk	*Buteo jamaicensis*	6	N/A
Red-winged Blackbird	*Agelaius phoeniceus*	6	N/A
Savannah Sparrow	*Passerculus sandwichensis*	6	N/A
Tree Swallow	*Tachycineta bicolor*	6	N/A
Western Tanager	*Piranga ludoviciana*	6	N/A
American Wigeon	*Anas americana*	5	N/A
Cassin's Finch	*Haemorhous cassinil*	5	BLM SS
Rock Dove	*Columba livia*	5	N/A
Barn Swallow	*Hirundo rustica*	4	N/A
Belted Kingfisher	*Megaceryle alcyon*	4	N/A
Bullock's Oriole	*Icterus bullockii*	4	N/A
Chukar	*Alectoris chukar*	4	N/A
Common Nighthawk	*Chordeiles minor*	4	SGCN Tier 3

House Sparrow	*Passer domesticus*	4	N/A
Killdeer	*Charadrius vociferus*	4	N/A
Mountain Bluebird	*Sialia currucoides*	4	N/A
Pine Siskin	*Spinus pinus*	4	N/A
Red Crossbill	*Loxia curvirostra*	4	N/A
Sora	*Porzana carolina*	4	N/A
Yellow-rumped Warbler	*Setophaga coronata*	4	N/A
Canada Goose	*Branta canadensis*	3	N/A
Common Raven	*Corvus corax*	3	N/A
Green-tailed Towhee	*Pipilo chlorurus*	3	BLM SS
Lincoln's Sparrow	*Melospiza lincolnii*	3	N/A
Swainson's Hawk	*Buteo swainsoni*	3	N/A
Wild Turkey	*Meleagris gallopavo*	3	N/A
Barn Owl	*Tyto alba*	2	N/A
Black-billed Magpie	*Pica hudsonia*	2	N/A
Gray Catbird	*Dumetella carolinensis*	2	N/A
Long-eared Owl	*Asio otus*	2	N/A
Sage Thrasher	*Oreoscoptes montanus*	2	SGCN Tier 2/BLM SS
Sharp-shinned Hawk	*Accipiter striatus*	2	N/A
American Goldfinch	*Spinus tristis*	1	N/A
American Kestrel	*Falco sparverius*	1	N/A
American Pipit	*Anthus rubescens*	1	N/A
Black-headed Grosbeak	*Pheucticus melanocephalus*	1	N/A
Burrowing Owl	*Athene cunicularia*	1	SGCN Tier 2/USFS/BLM SS
Cinnamon Teal	*Anas cyanoptera*	1	N/A
Common Goldeneye	*Bucephala clangula*	1	N/A
Eastern Kingbird	*Tyrannus tyrannus*	1	N/A
Eurasian Collared-Dove	*Streptopelia decaocto*	1	N/A
Evening Grosbeak	*Coccothraustes vespertinus*	1	N/A
Golden Eagle	*Aquila chrysaetos*	1	SGCN Tier 2/BLM SS
Great Blue Heron	*Ardea herodias*	1	N/A
Hairy Woodpecker	*Picoides villosus*	1	N/A
Horned Lark	*Eremophila alpestris*	1	N/A
Lazuli Bunting	*Passerina amoena*	1	N/A
Lesser Scaup	*Aythya affinis*	1	N/A
Mountain Chickadee	*Poecile gambeli*	1	N/A
Northern Saw-whet Owl	*Aegolius acadicus*	1	N/A
Red-naped Sapsucker	*Sphyrapicus nuchalis*	1	N/A
Ring-billed Gull	*Larus delawarensis*	1	SGCN Tier 3
Rufous Hummingbird	*Selasphorus rufus*	1	N/A
Sharp-tailed Grouse	*Tympanuchus phasianellus*	1	SGCN Tier 2/USFS/BLM SS
Short-eared Owl	*Asio flammeus*	1	SGCN Tier 3/USFS/BLM SS
Turkey Vulture	*Cathartes aura*	1	N/A

Warbling Vireo	*Vireo gilvus*	1	N/A
Western Kingbird	*Tyrannus verticalis*	1	N/A
Western Wood-Pewee	*Contopus sordidulus*	1	N/A
Wilson's Snipe	*Gallinago delicata*	1	N/A
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	1	N/A

Table A2. Non-big game mammal species reported in the project area as roadkill and the total number of reports per species in the US-20/SH-87 Corridor project area during Dec 1 2017-Dec 1 2019. Species of Greatest Conservation Need (SGCN) are designated in the 2015 SWAP (IDFG) and Sensitive Species (SS) are designated by the USFS Region 2 Forest Manager and the Idaho State Director for the BLM (IDFG 2015, USFS 2017, BLM 2019).

Common Name	Scientific Name	Number	Designation
Striped Skunk	*Mephitis mephitis*	126	N/A
Uinta Ground Squirrel	*Urocitellus armatus*	45	N/A
Red Squirrel	*Tamiasciurus hudsonicus*	30	N/A
Common Raccoon	*Procyon lotor*	29	N/A
North American Porcupine	*Erethizon dorsatum*	28	N/A
Red Fox	*Vulpes vulpes*	21	N/A
Muskrat	*Ondatra zibethicus*	16	N/A
Long-tailed Weasel	*Mustela frenata*	12	N/A
American Marten	*Martes americana*	10	USFS SS
Yellow-bellied Marmot	*Marmota flaviventris*	10	N/A
Deer Mouse	*Peromyscus maniculatus*	9	N/A
Mountain Cottontail	*Sylvilagus nuttallii*	9	N/A
Coyote	*Canis latrans*	8	N/A
American Badger	*Taxidea taxus*	6	N/A
Yellow-pine Chipmunk	*Tamias amoenus*	6	N/A
American Mink	*Vison vison*	5	N/A
Snowshoe Hare	*Lepus americanus*	3	N/A
Water Vole	*Microtus richardsoni*	3	N/A
Western Jumping Mouse	*Zapus princeps*	3	N/A
Little Brown Myotis	*Myotis lucifugus*	2	SGCN Tier 3/BLM SS
Mountain Lion	*Puma concolor*	2	N/A
Northern River Otter	*Lontra canadensis*	2	USFS SS
American Beaver	*Castor canadensis*	1	N/A
American Black Bear	*Ursus americanus*	1	N/A
Eastern Fox Squirrel	*Sciurus niger*	1	N/A
Ermine	*Mustela erminea*	1	N/A
Gray Wolf	*Canis lupus*	1	BLM SS
Hoary Bat	*Lasiurus cinereus*	1	SGCN Tier 2/USFS/BLM SS

Meadow Vole	*Microtus pennsylvanicus*	1	N/A
Northern Pocket Gopher	*Thomomys talpoides*	1	N/A
White-tailed Jack Rabbit	*Lepus townsendii*	1	N/A

Table A3. Reptile and amphibian species reported in the project area as roadkill and the total number of reports per species in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019.

Common Name	Scientific Name	Count	Designation
Tiger Salamander	*Ambystoma mavortium*	32	N/A
Terrestrial Garter Snake	*Thamnophis elegans*	6	N/A
Painted Turtle	*Chrysemys picta*	2	N/A
Racer	*Coluber constrictor*	1	N/A

Table A4. Broader taxa that were used when an unidentifiable organism was reported in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019.

Common Name	Scientific Name	Count
Mammal	*Mammalia*	35
Bird	*Aves*	27
Rodents	*Rodentia*	15
Sparrow	*Emberizidae*	12
Lagomorph	*Lagomorpha*	9
Bat	*Chirpotera*	8
Duck	*Anatidae*	7
Weasel	*Mustela*	5
Vole	*Myodes*	4
Squirrel	*Sciuridae*	3
Gull	*Laridae*	2
Owl	*Strigiformes*	2
Snake	*Serpentes*	2
Flycatcher	*Empidonax*	1
Mustelid	*Mustelidae*	1

Birds

During the study, 602 birds of 86 species were reported as roadkill on the US-20/SH-87 Corridor (Table A1); 371 were passerine songbirds, 92 were game birds, and 77 were raptors. There were also woodpeckers, kingfishers, rails, shorebirds, and nightjars reported on US-20/SH-87. We recorded 367 migratory species and the rest were residents. We were unable to identify species for 21 birds due to carcass condition.

There were 11 special status bird species reported during surveys, including great gray owl, Brewer's sparrow, and Cassin's finch (Table A1).

Bird carcass numbers varied seasonally and by taxon but generally had one peak in the summer (Figure A4). The most frequently reported bird carcass on the US-20/SH-87 Corridor was great horned owl, followed by American robin, and Brewer's blackbird (Figure A5). Bird carcasses were most common from Chester to the base of Ashton Hill and on SH-87 near Henry's Lake (Figure A6). Almost half of reported bird carcasses on US-20 occurred between mile markers 353-364 (n = 249 out of 521; Figures A6 and A7) and half of the bird carcasses reported on SH-87 occurred between mile markers three and five (n = 42 out of 81; Figures A6 and A8).

Surveyors reported seven owl species during US-20 carcass surveys and five other raptor species. A single great blue heron carcass was found on a bridge. Passerines included many yellow warblers, white-crowned sparrows, house wrens, a black-headed grosbeak, an evening grosbeak, and mountain chickadee. A single roadkill rufous hummingbird was found (Figure A9).

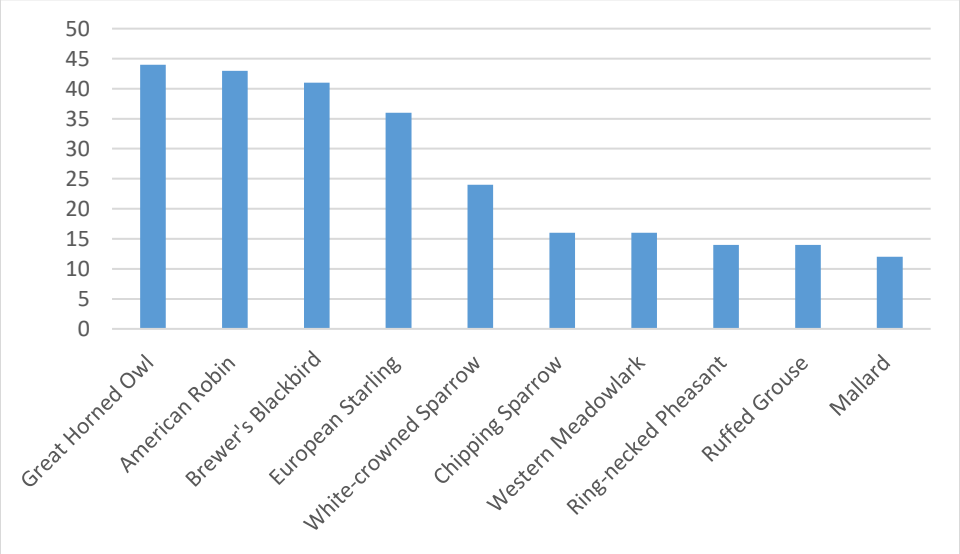

Figure A5. Ten most frequently reported bird species carcasses in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019.

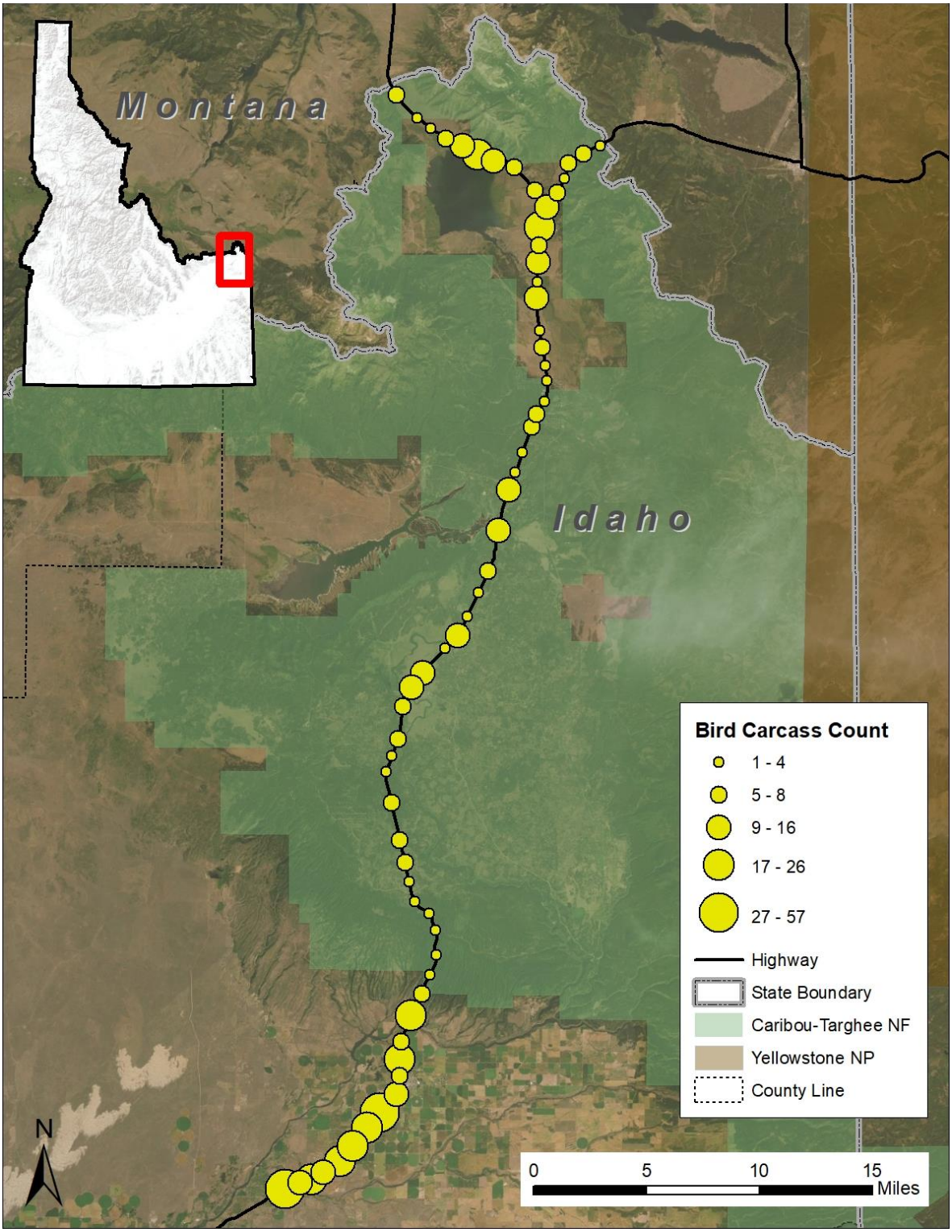

Figure A6. Reported bird carcasses (n = 602) on US-20/SH-87 project area during Dec 1, 2017 to Dec 1, 2019.

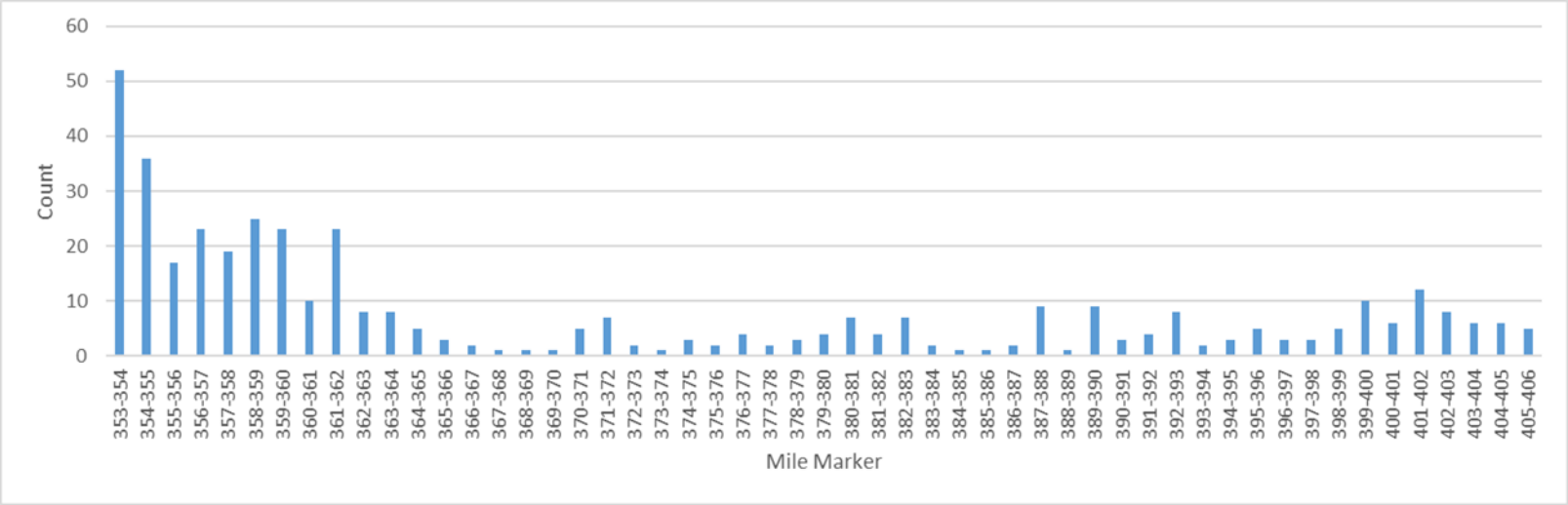

Figure A7. Distribution of reported bird carcasses (n = 521) displayed by mile marker in the US-20 project area during Dec 1, 2017-Dec 1, 2019.

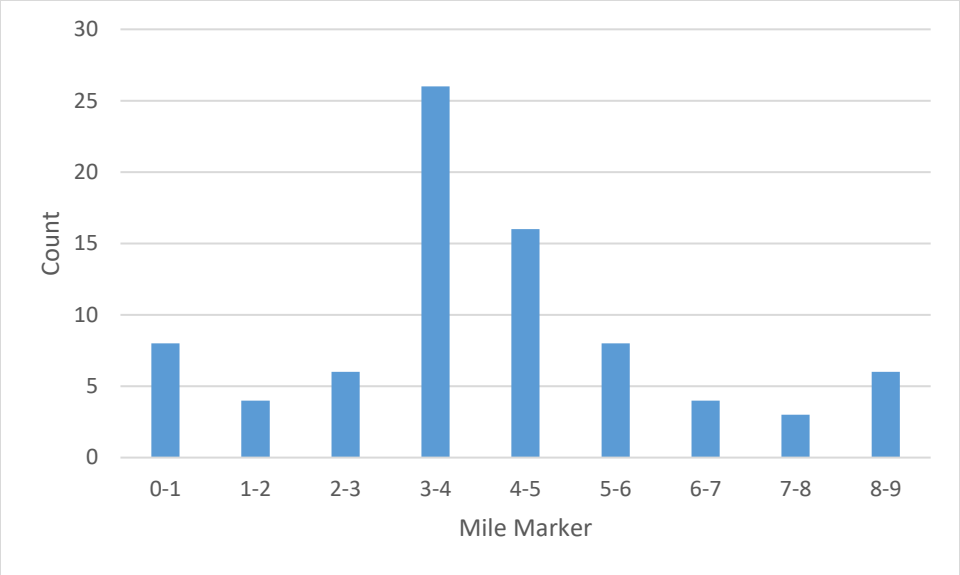

Figure A8. Distribution of reported bird carcasses (n = 81) displayed by mile marker in the SH-87 project area during Dec 1, 2017-Dec 1, 2019.

Figure A9. Rufous hummingbird that was detected as roadkill on US-20 in 2019.

Mammals

There were 474 mammals of 31 species reported during the survey period, excluding domestic and big game species (Table A2). This number included 176 rodents, 42 mustelids, and 22 lagomorphs. There were also foxes, coyotes, large carnivores, and bats reported. Non-big game mammal carcass reports varied seasonally and by taxon but generally had one peak in the summer (Figure A10). The most common non-big game mammal reported on the route was striped skunk (n = 126; Figure A11).

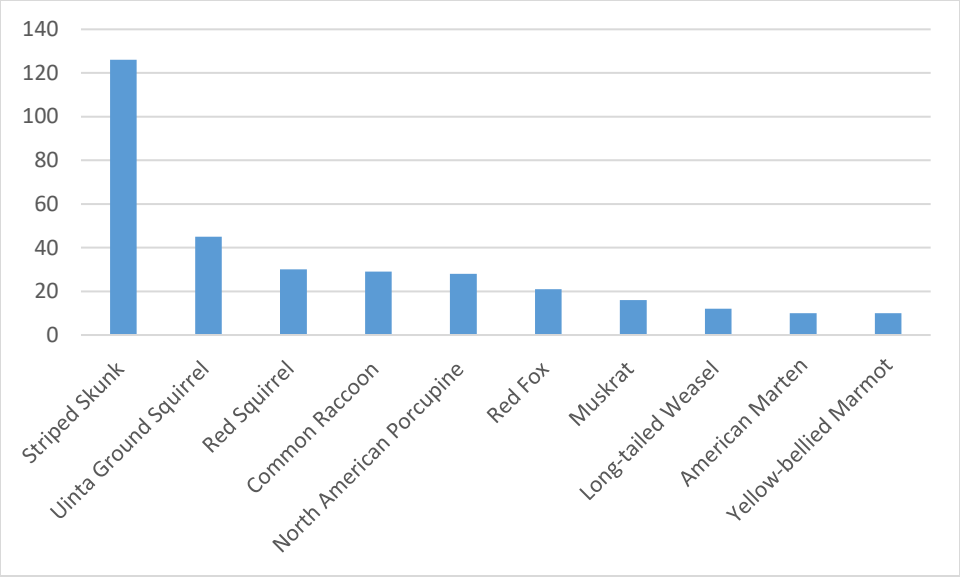

Figure A11. Ten most frequently reported non-big game mammal carcasses (n = 474) in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019.

There were five special status non-big game mammal species encountered during surveys. They were American marten, little brown myotis, North American river otter, hoary bat, and gray wolf (Table A2).

Surveyors encountered road killed mustelids including badger, mink, and weasel. Carnivore carcasses such as mountain lion and American black bear were reported in the project area as well as many rodents including muskrat, water vole, northern pocket gopher, western jumping mouse, red squirrel, and Uinta ground squirrel.

Non-big game mammals were most frequently reported on the Chester to base of Ashton Hill stretch of US-20 and on SH-87 (Figure A12). About a quarter of non-big game mammal carcasses on US-20 were reported between mile markers 353-360 (n = 86 out of 389). Non-big game mammal carcass reports were fairly consistent throughout the rest of the US-20 Corridor, occurring at higher frequencies where human development and water approach the road (Figures A12 and A13). Over half of the reported non-big game mammal carcasses reported on SH-87 occurred between mile markers 2-5 (n = 49 out of 85; Figures A12 and A14).

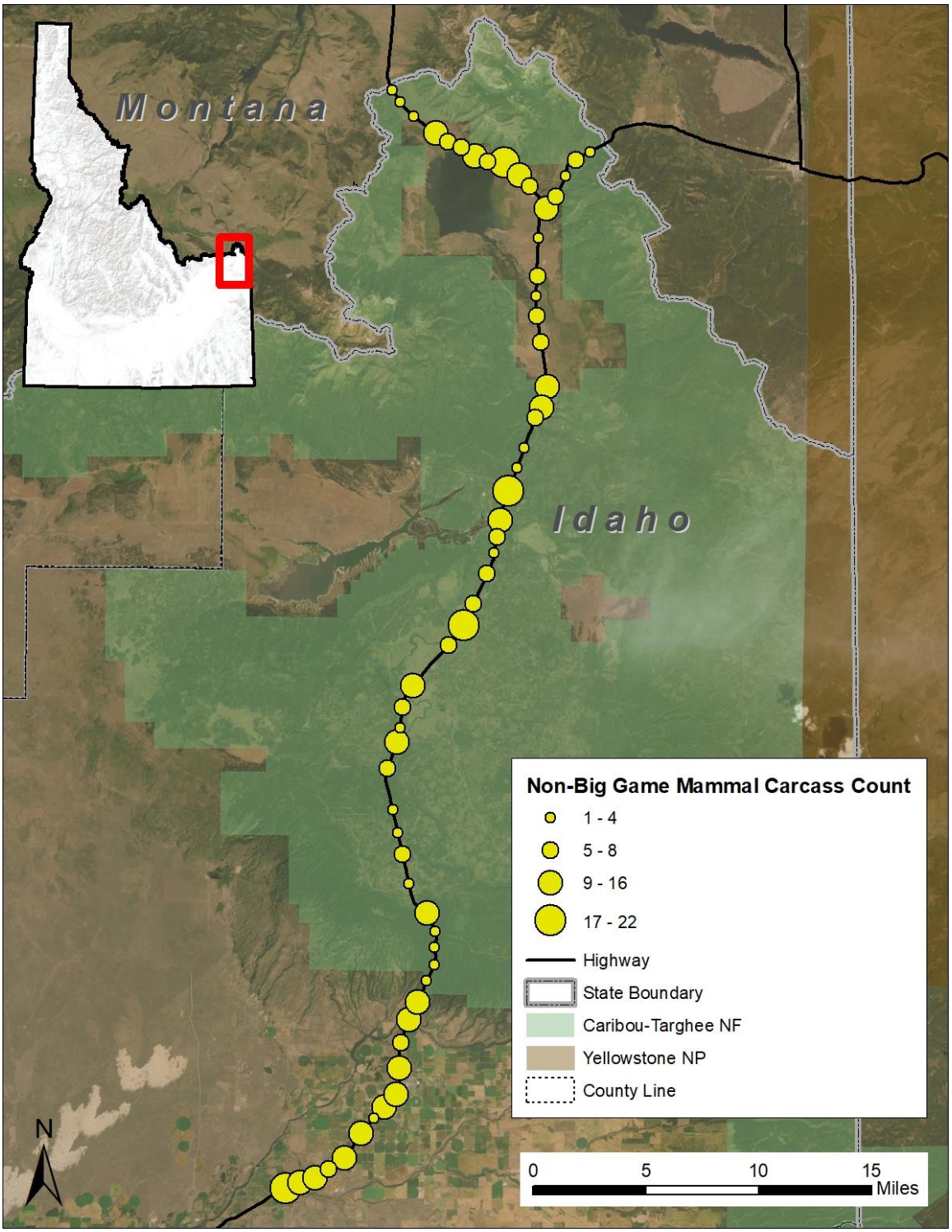

Figure A12. Reported non-big game mammal carcasses (n = 474) in the US-20/SH-87 Corridor project area during Dec 1, 2017 - Dec 1, 2019.

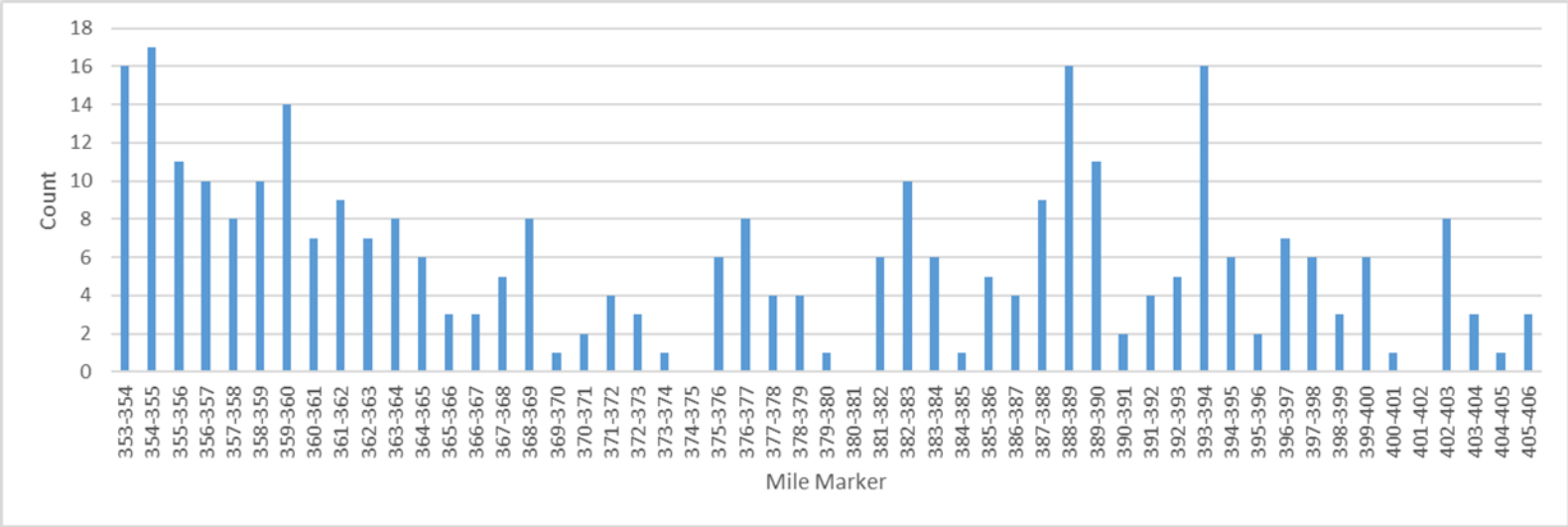

Figure A13. Reported non-big game mammal carcasses (n = 389) displayed by mile marker in the US-20 project area during Dec 1, 2017-Dec 1, 2019.

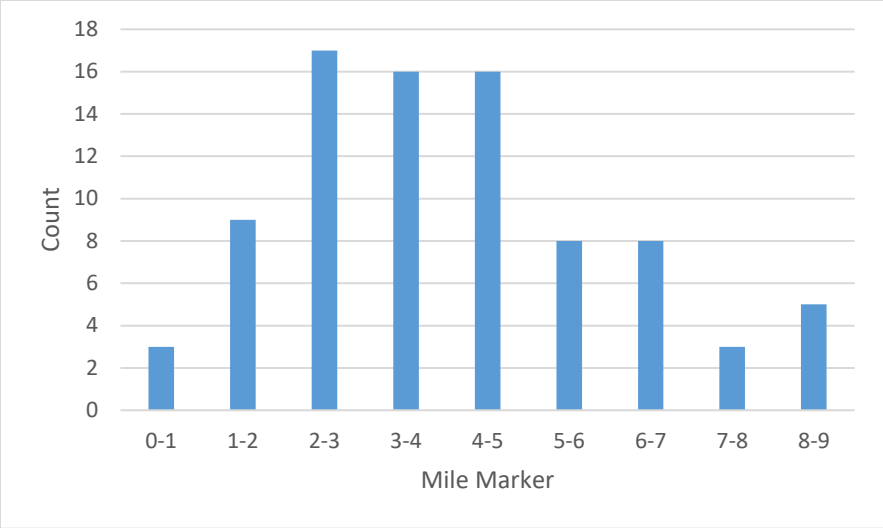

Figure A14. Distribution of reported non-big game mammal carcasses (n = 85) displayed by mile marker in the SH-87 project area during Dec 1, 2017-Dec 1, 2019.

Reptiles and Amphibians

A variety of reptiles and amphibians are present in Island Park and 43 carcasses of four species were reported in the US-20/SH-87 Corridor project area during the project (Table A3).

Reptiles and amphibians were only reported in the warm months, with a peak occurring in August of 2018, when high western tiger salamander mortality was documented after a late summer thunderstorm (Figure A15). Of the total reptiles and amphibians reported, 32 carcasses were western tiger salamanders. Also reported in the project area were painted turtles, western terrestrial garter snakes, and a racer (Figure A16).

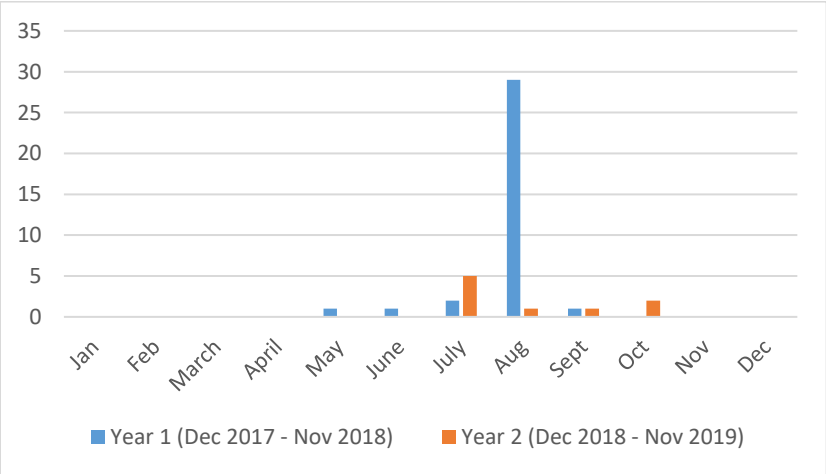

Figure A15. Annual cycle for reptile and amphibian roadkill (n = 43) in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019.

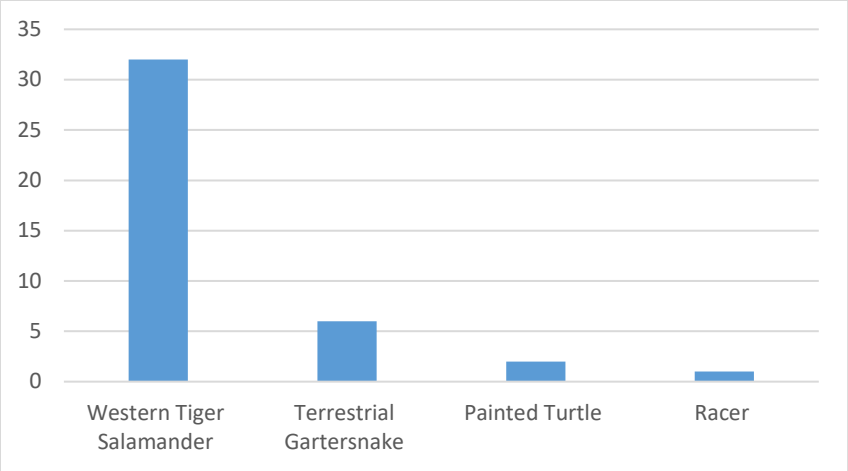

Figure A16. Reptile and amphibian carcasses (n = 43) reported in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019.

Reptile and amphibian carcasses were found throughout the project area, mainly near water sources (Figure A17). However, over three-quarters of reported reptile and amphibian carcasses on US-20 were reported between mile markers 376 and 377 (n = 28 out of 39, Figure A17). Juvenile western terrestrial garter snake carcasses were reported between mile markers 2-4, 5-6, and 7-8 on SH-87 in the fall of 2019 (Figure A17).

Citizen Science

IDFG reported 80.1%, (n = 935) of non-big game carcasses and volunteers reported 19.1% (n = 222). Other citizens and local salvagers reported 0.8% (n = 9) of the non-big game carcasses and agency personnel who were not involved with the survey reported one mountain lion (Figure 18). Volunteers collected data on non-big game carcasses as small as wrens and bats and as large as great gray owls and red foxes.

Discussion

Trends

The monthly trend for birds, non-big game mammals, reptiles, and amphibians all reflect the same pattern. They have one peak in the summer. This makes sense for a variety of reasons. Tourist traffic increases in the summer, meaning that more drivers were on the road and many of these drivers are unfamiliar with the area and unfamiliar with the amount of wildlife present on and near the road during the summer. The summer peak and winter low for non-big game WVC reports are also partly attributed to the harsh nature of the climate in Island Park in the winter. Many small- and medium-sized mammals hibernate or follow migrating game out of the area, so they are simply not present in Island Park during the winter. Sixty-one percent of the total reported bird carcasses were of migratory birds. Migratory birds arrive in Island Park in April-May, breed during the summer, and migrate south in the fall to avoid the harsh winter. June, July, and August were the peak months for bird carcass reports. Most birds breed during summer months, so road-naïve young may be at increased risk for WVC. Salamander

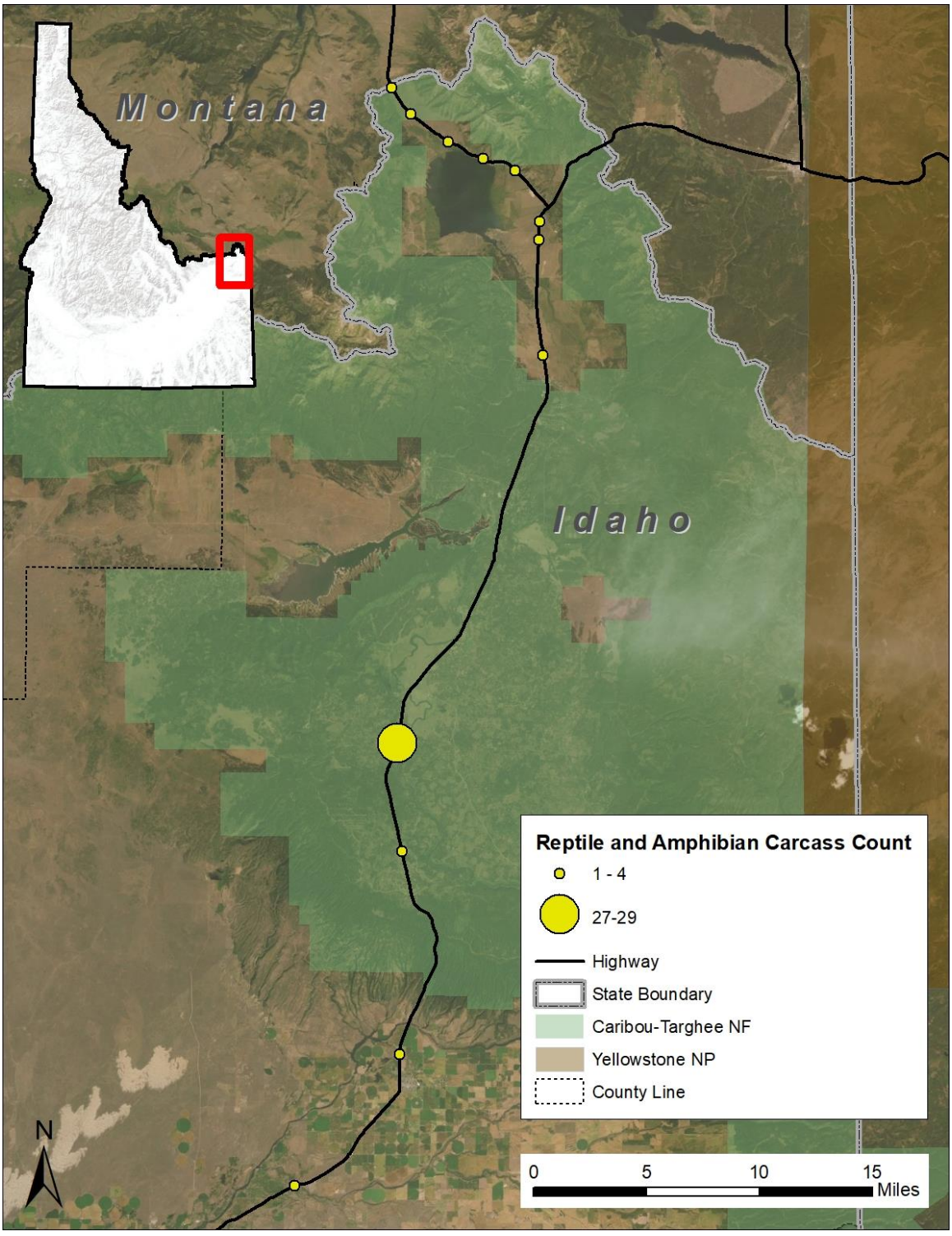

Figure A17. Reported reptile and amphibian carcasses (n = 43) in the US-20/SH-87 Corridor project area during Dec 1, 2017 - Dec 1, 2019.

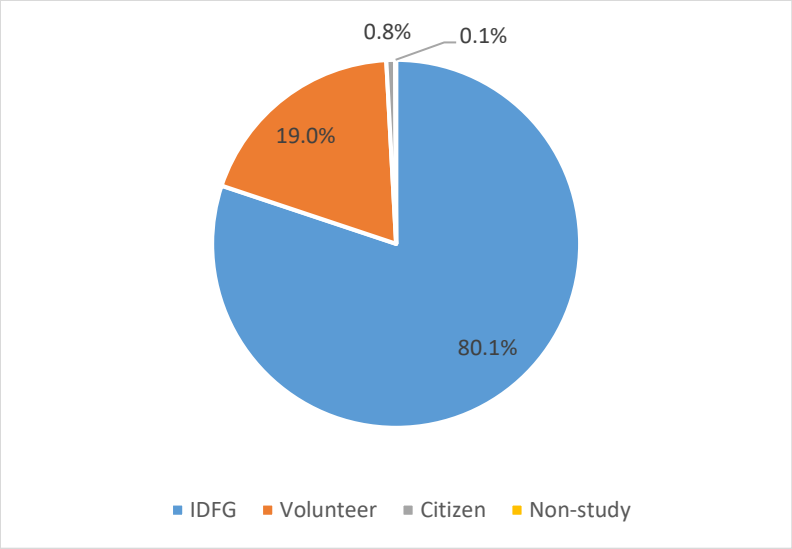

Figure A18. Proportion of all non-big game carcasses (n = 1,167) reported by each group of reporters in the US-20/SH-87 Corridor project area during Dec 1, 2017-Dec 1, 2019.

movements are expected during late summer rainstorms and mass mortality events can occur when roads are between salamanders and their breeding ponds (Russell et al. 2005). Although tiger salamanders are not listed as a sensitive status species by any of the management agencies, declines have been documented in YNP (Spear et al. 2006).

Underreporting

Carcasses from small animals such as birds and rodents underreported more than the carcasses of big game species such as deer, elk, and moose (Teixeira et al. 2013). We see that pattern reflected in our data (15% of big game carcass reports came from salvagers and concerned citizens during our study, compared to 0.7% reports of other species). There are two primary reasons for this. Big game carcasses are large and therefore easier to see from a moving vehicle and salvagers are interested in salvaging meat and antlers from big game species.

Although the numbers of non-big game carcasses reported here may seem impressive, these data underrepresent the true numbers lost to vehicle collisions. Driving surveys are time and money efficient, but they are fairly ineffective for detecting small-bodied species such as songbirds, amphibians, reptiles, and rodents. A study in Brazil conducted carcass surveys along a 66 km stretch of road from a moving vehicle (40-50 kph) and by foot. When monitoring on foot, 205 total roadkill were detected (190 of which were small-size animals and 15 of which were large-sized animals) and from the moving vehicle only 12 of those roadkill were detected (of these, one was a small-size animal and 11 were large sized animals). The authors concluded that there were significant differences in the detectability of roadkill between driving and walking surveys across all groups (Teixeira et al. 2013). In 2002, Slater conducted roadside carcass removal trials in Wales and found that carcass counts of small-sized animals from moving vehicles can be 12-16 times lower than the actual mortality rate.

Additionally, small carcasses do not persist long on roadways. In southwestern France, mark-recapture studies were used to assess the natural persistence of bird carcasses (Guinard et al. 2012). Similar to our study, the authors found the most frequently encountered bird carcasses were owls and songbirds. Between walking and driving surveys, there was no statistically significant difference in the number of carcasses found on the pavement, but walking surveys alone detected many more carcasses on road verges. They also found that persistence probability for owls was much higher than for songbirds, suggesting that large carcasses persist longer than small carcasses. Antworth et al. found that 60-97% of all bird and snake carcasses placed on a Florida road disappeared within 36 hours. Snakes disappeared faster and at a higher rate than birds (2005).

Citizen Science

Non-big game species were important to our study because they provided an opportunity for education and community engagement as well as a metric to understanding the extent and location of WVCs. We were able to engage very positively with our volunteers when they came to us with questions about birds and other small animals. Some species, such as American Marten, volunteers had only encountered while hiking in remote wilderness areas and they did not realize these species lived "right in their own backyards!" Other species, such as sora, volunteers had "never even heard of" before finding them as roadkill on the project. Volunteers indicated these learning experiences increased the value of the project for them.

Citizen scientists became very keen at finding small animals on the project, and at times reported species such as bats, house wrens, and sparrows, which are very small and difficult to detect from a moving vehicle.

At the end of the project, citizen science volunteers emphasized that their lives had been enriched by gaining knowledge about non-game species from IDFG staff.

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