IDAHO TRANSPORTATION DEPARTMENT SUPPLEMENTAL INFORMATION SOURCE DOCUMENT IDENTIFICATION OF WILDLIFE-VEHICLE CONFLICT MITIGATION OPPORTUNITY LOCATIONS IN IDAHO

By

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Table of Contents

List of Tables

List of Figures

List of Abbreviations and Acronyms

AADT	average annual daily traffic
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
CAADT	commercial average annual daily traffic
GIS	geographic information systems
I	Interstate
IDFG	Idaho Department of Fish and Game
IDTM	Idaho Transverse Mercator
IPaC	Information for Planning and Consultation
ITD	Idaho Transportation Department
ITIP	Idaho Transportation Investment Program
LRS	linear referencing system
NHDPlus	National Hydrography Dataset Plus
OHSA	Optimized Hot Spot Analysis
QC	quality control
SH	State highway
SHS	State Highway System
SQL	Standard Query Language
TAC	Technical Advisory Committee
US	United States highway
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WVC	wildlife-vehicle collision

Introduction

This is a technical document that details the methodology used to identify Idaho's top Wildlife-Vehicle Conflict Mitigation Opportunity Locations as of 2025. The methods used were largely through mapping and models in geographic information systems (GIS). The study was conducted in two phases. Phase one used ArcGIS' Optimized Hot Spot Analysis (OHSA) to identify top hot spots based on reported crashes with wildlife, ranked based on crashes per mile per year. The wildlife carcass hot spots were also modeled and mapped with this method. In Phase Two, the objective was to map and identify top hot spots for wildlife-vehicle conflict which was based on transportation data such as the reported crashes, and traffic volume, and ecological data such as protected species' habitat and water bodies. This second OHSA was based on intersecting the road shape file with these multiple layers and scoring each half mile road segment of Idaho Transportation Department-administered roads for their intersection with those shape files. The final hot spots, or Wildlife-Vehicle Conflict Areas were then ranked based on their final scores. In the last step of mapping and modeling, the Wildlife-Vehicle Conflict Areas were evaluated with respect to three feasibility factors related to the protection of land on both sides and the upcoming Idaho Transportation Investment Program (ITIP). Those top scoring Areas were then named the Wildlife-Vehicle Conflict Mitigation Opportunity Locations. This was done at the state level which allows for an broad view of the state, and each District's data were separately analyzed to identify opportunity locations at the District level.

The Methodology Used for Phase One - The Optimized Hot Spot Analysis of the Crash and Carcass Data

This section details the steps taken to analyze crash and carcass data across Idaho to create the two products of Phase One; Wildlife-Vehicle Crash Hot Spots and Carcass Hot Spots.

Projections

Data used were projection **NAD83 IDTM** which refers to the **Idaho Transverse Mercator (IDTM)** coordinate system based on the North American Datum of 1983.

Data Preparation Overview

The process of preparing the road dataset and crash point data to be used in the OHSA is summarized here, and presented in greater detail below.

The ITD Roads Dataset – The most recent ITD roads data should be pulled from the Linear Referencing System, and the data should be queried to contain only ITD-administered roads.

Simplify Roads to Single Line Features – The many highways that are represented by two line features for opposing lanes of traffic, such as we see on interstates, have to be represented by a single line in the process of creating polygons segments representing a highway. In this step, all roads were represented by single lines.

Scale and Defining Unit of Measure for Road Segments – The units of measure for segmenting ITD-administered roads through both Phases of the study were buffered segments created from a simplified version of the State Highway System (SHS) or ITD-administered roads, including Interstates (I), State highways (SH), and US highways (US). This allowed the study to focus on the immediate area surrounding highways and serve as a planning tool for future transportation projects. We created two versions of the road shape file; a one mile road segment version, and a half mile road segment version. Each shape file had the road segments buffered by 200 meters (656 feet) on either side, to create one quarter mile wide road segments. These road segments were cleaned to ensure lack of overlaps or orphaned road segments created around intersections. Each road shape file (half mile and one mile versions) was the precursor to the shape file to be used in the OHSA. There were several important "clean up" steps to make sure these road segments were straight forward enough to accurately model with.

Filter Reported Crashes to Obtain Wildlife Crash Data Points – This begins with the leveraging of ITD's WebCars crash database and spatial datasets created through dynamic segmentation (placing points on a map via route and measure). Crash data points were filtered for containing the event "Wild Animal" in the Events field indicating that a crash with a wild animal occurred during the incident. These crashes were filtered to include those only on the SHS and those that occurred between 2013 to 2022.

Tabulating Crashes – Crash data points were joined to each of the two shape files with road segments, and assigned to the segment the data point occurred within to establish collision counts for each road segment. Crashes were also counted for each crash severity type. Three different spans of crash data were used: crashes between 2013 and 2017; crashes between 2018 and 2022; and total count of all wildlife-vehicle crashes between 2013 to 2022. This then created three shape files for the half mile road segments, and three shape files for the one mile road segments, each with a specific range of crash data. These paired shape files with road segments and the crashes within them were then the shape files input into the OHSA, with the crash points the unit of measure. Each shape file of paired road segments and crash points was individually placed into OHSA for a specific model run, so this resulted in six OHSA maps of hot spots, each slightly different than the other. The process requires multiple model runs with parameter changed to help select the best representation of Idaho's crash hot spots from the different OHSA maps.

Additional Data to Help Interpret the Findings

The Technical Advisory Committee (TAC) was interested in learning several factors across Districts that were then brought into the maps to help better interpret the results. These parameters were included in an ArcGIS Online Operations Dashboard table for when users clicked on a certain hot spot. The city boundaries were placed on the map used in this study and included in the hot spot attribute tables so users could evaluate the options available in more urban versus wild areas. Federal lands, Tribal lands, and state lands were also incorporated into the maps, attribute tables, and popup menu to show where there were areas protected from development. The number of collisions of the three injury types and fatal collisions were also calculated for each hot spot and included in the attribute table and popup table. These complementary data were provided to assist ITD personnel and other partnering agencies in evaluating how future transportation plans may affect wildlife and for the potential of wildlife mitigation measures inclusion in those plans.

Data Preparation Steps

Roads Data Preparation

The ITD-administered roads shapefile, SHS Merged Linework was used for the OHSA. The roads were queried and cleaned up for the shapefile, then input into the analysis. The following processes were applied to the roads shape file (Figure 1). Each of the numbered processes is explained with more detail in sections below.

1. Obtain most recent ITD-administered roads linear referencing system (LRS) dataset
2. Query the roads datasets to contain only ITD-administered roads
3. Remove interchanges and spurs
4. Simplify road geometry by merging roads into single line features
5. Generate segments and buffers
6. Clean up resulting road buffers, and segments

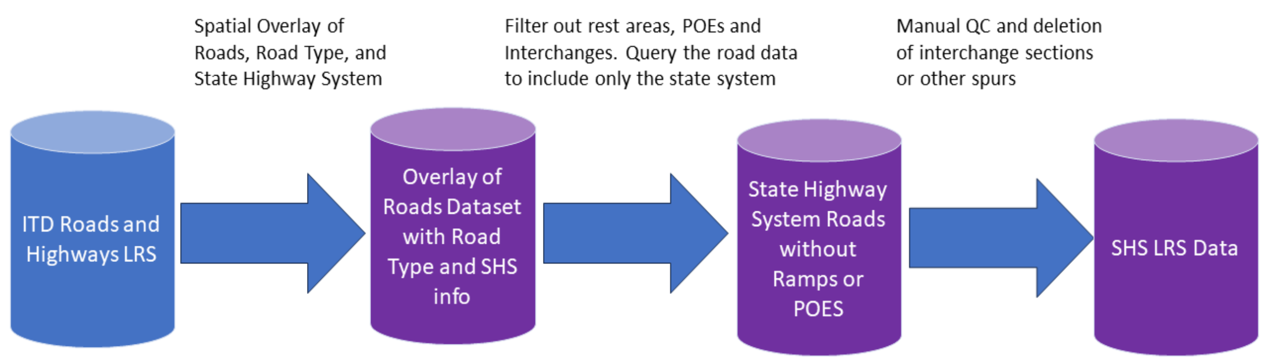


Figure 1. Process to extract and prep linework from ITD's Linear Referencing System.

1. Obtain the Most Recent ITD-Administered Roads Dataset

The ITD-administered roads data was pulled from ITD's LRS.

2. Query the Roads Datasets to Contain Only ITD-Administered Roads

Using the RouteID attribute in ITD's LRS layers the GIS analyst was able to query only ITD-administered roads (RouteIDs containing SH, US, and I) or SHS and exclude the off-highway system roads or federal roads, including US Forest Service (USFS) and Bureau of Land Management (BLM). This Standard Query Language query was applied to both the ITD-administered roads network and other road datasets including Road Type and SHS which contained ramp and interchange information.

3. Remove Interchanges and Spurs

Road linework was manually cleaned by removing interchange segments and spurs. Ramps, points of entry, and rest areas from the highway system were also removed using the Road Type Dataset overlaid with the Road Network Data. The new road layer, the SHS, and LRS road layer can were used to change the road lines into road segments resulting in a polygon shape file (Figure 2).

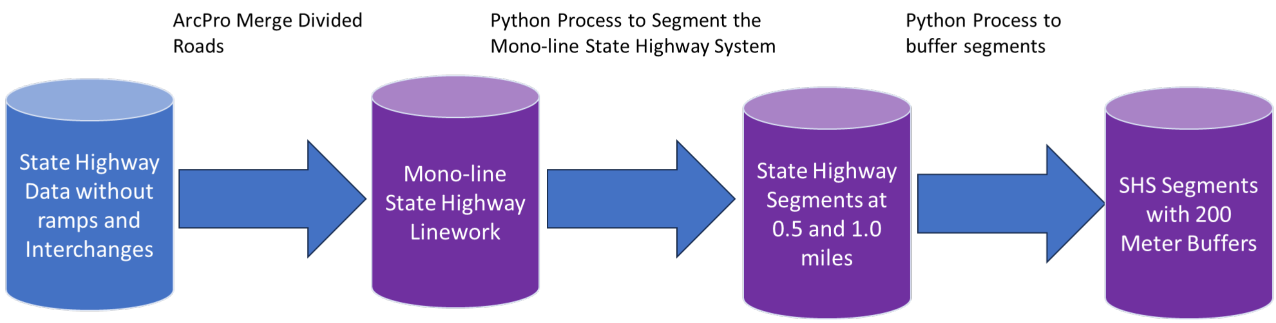


Figure 2. Flow diagram of converting the roads shape file into buffered segments file. This figure will be replaced with a higher resolution flow diagram.

4. Simplify Road Geometry by Merging Roads into Single Line Features

There are three steps in this merging function, see below.

1. Run the tool *"Merge Divided Roads."* This is done to combine dual carriageway roads (a road that has a median that cannot be driven over) into a single line.
2. "*Dissolve*" down to the minimum number of routes by combining on route names. This is important for the hot spot analyses.
3. Conduct quality control (QC) to simplify route geometry and remove spurs and segments of road that would fall fully within the buffer of another centerline. See below for other clean up steps.

5. Generate Segments and Buffers

This step buffers and segments the road shapefile from lines into polygons. The buffer is calculated for a series of distances on either side of the road creating the width of the polygons. The road segments are categorized into several different classes of lengths. The GIS Analyst ran the Python script (Figure 3) to generate half mile and one mile road segments with 200 meter (656 feet) buffer on either side of the road outward from the road edge (based on prior studies). This resulted in a 400 meter (1,312 feet) wide segment (approximately a quarter mile).

The Python code (Figure 3) was developed by Chris Gerard at Utah State University, for the Nevada state wildlife and animal hot spot analyses (Cramer and McGinty 2018), and was adjusted for multiple other states (Utah, Cramer et al. 2019, Arizona 2021, Williams et al. 2021, and New Mexico, Cramer et al. 2022) before its adjustment for Idaho's hot spot analysis. The code had to be adjusted in a series of runs to calibrate the model to best suit ITD-administered roads. The code was adapted for use in this study. Several file inputs and outputs will need to be changed for running the code from other computers.

```
########################################################################################################################
#Original script by Christine Gerrard
#Adapted by Emanuel Vasquez - Wild Utah Project
#Last updated on April 2019
#Description:   The script below generates 0.10, 0.25, and 0.5 mile buffers from road segments (lines)that then are used
#               in a Optimized Hot Spot Analysis to determine areas of high frequency wildlife-vehicle collisions.
#               In the script, the process begings by creating road segments based on a set of distances (e.g. 0.1, 0.25, 0.5 miles)
#               provided by the user.  Second, the process continues with the creation of squared buffers around each of the
#               generated roads segmentes in the previous step. As final result, the script returns a set of polygon feature classes that
#               represent buffered roads segments at specified distances. These results can then be used in a subsequent Optimized Hot Spot
#               Analysis (Getis-Ord Gi* Statistic).

#Note:          Questions concerning this code may be directed to Dr. Patrcia Cramer (cramerwildlife@gmail.com).

########################################################################################################################

import os, arcpy
#Definition of the main function
def make_buffer(road_fn, segment_fn, buffer_fn, segment_length, buffer_distance):
    arcpy.CreateFeatureclass_management(out_path=arcpy.env.workspace, out_name=segment_fn,geometry_type="POLYLINE",spatial_reference=road_fn)
    sr = arcpy.Describe(road_fn).spatialReference
    with arcpy.da.SearchCursor(road_fn, 'SHAPE@') as road_cursor,\
        arcpy.da.InsertCursor(segment_fn, ['SHAPE@', 'Id']) as segment_cursor:
        for road_row in road_cursor:
            #error handling if there is a null record
            if road_row[0] is not None:
                roads = road_row[0]
            else:
                pass
            for road_array in roads:
                road = arcpy.Polyline(road_array, sr)
                location = 0
                i = 0
                while location < road.length:
                    segment_cursor.insertRow([road.segmentAlongLine(location, location + segment_length), i])
                    location += segment_length
                    i += 1
    #deletes the cursors after completion of the run
    del segment_cursor
    del road_cursor
    arcpy.Buffer_analysis(in_features=segment_fn, out_feature_class=buffer_fn,buffer_distance_or_field=buffer_distance,line_end_type='FLAT')

#Project dependent variables

folder = r"C:\Users\wthoman\Desktop\WVC\WVC_2_21" # make sure you map this variable to the folder in your computer

road_fn = r"C:\Users\wthoman\Desktop\WVC\WVC_2_7\SHS_merged_combined_2_13.shp" # make sure you enter a shapefile here

segment_lengths_mile = [0.5,1] #don't change this

buffer_distance_meters = 200 #don't change this

#Environment variables
arcpy.env.workspace = folder
arcpy.env.overwriteOutput = True

#Local variable in FOR LOOP "for distance in segment_lengths_mile"

meters_per_mile = 1609.34 #the number of meters per mile #don't change this

# Create names for output shapefiles and runs the make_buffer function with the specified distance values
# in the segment_lengths_mile variable
for distance in segment_lengths_mile:
    segment_length = distance * meters_per_mile
    segment_fn = 'segments_{}.shp'.format(str(distance).replace('0.', ''))
    buffer_fn = 'buffers_{}.shp'.format(str(distance).replace('0.', ''))
    print(distance)
    make_buffer(road_fn, segment_fn, buffer_fn, segment_length, buffer_distance_meters)
```

Figure 3. The Python code script used in the roads layer preparation process.

6. Clean Up Resulting Road Buffers and Segments

Since roads are not of even lengths, the research team removed any "orphan" segments less than half mile in length or occurring at intersections. For example, when a highway concludes or intersects with another highway, one highway often had a segment that overlapped with the intersected highway. This overlapping segment can interfere with the hot spots modeling process by breaking up continuous road segments on the highway. These steps in Figure 4 below are necessary to "clean up" the partial road segments that were overlapping other highways as well as the ends of roads that had partial segments.

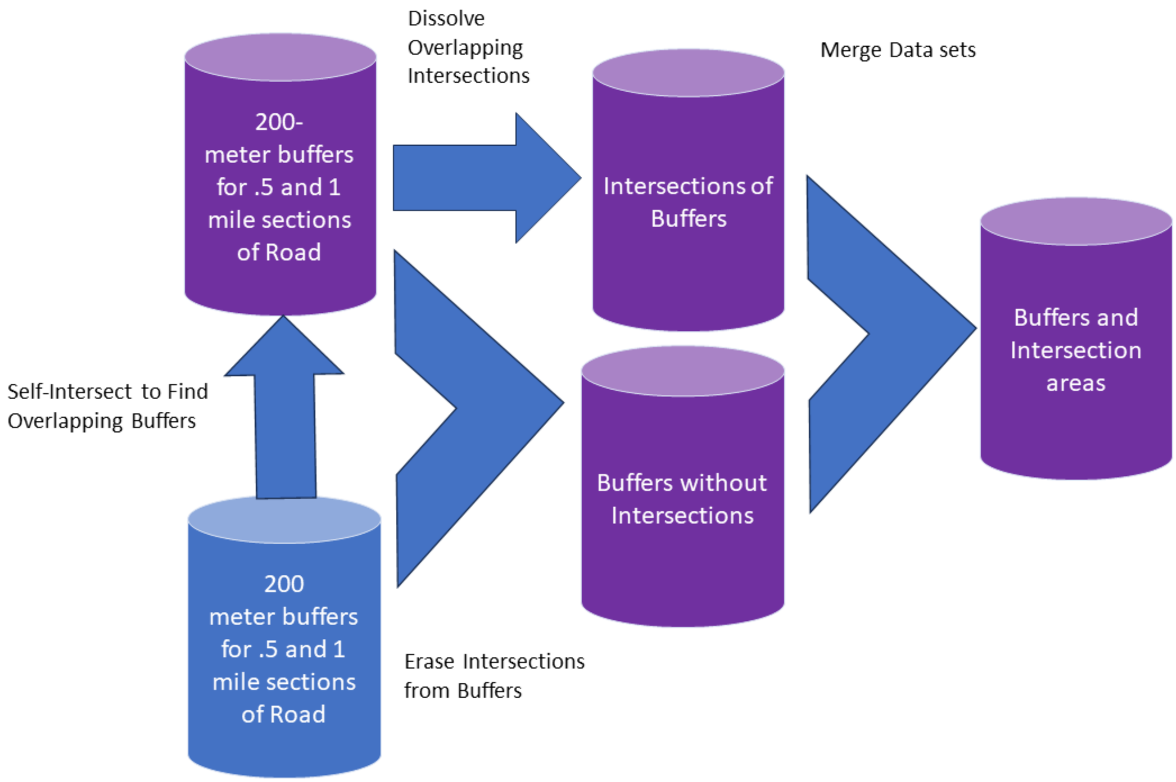


Figure 4. Process to "clean up" road segment and buffers. This is done for both half mile and one mile road segments.

Run "*Intersect"* on a resulting buffer from the Python code (Figure 3). This generates areas of self-intersection or overlaps.

1. Run "*Erase*" to erase the intersections from the initial buffer feature.
2. Run "*Merge*" on the result of the "Intersect" intersections with the original buffer. This creates a feature with the intersections with just one record per overlap rather than multiple records. This creates two layers: The buffers without intersections/overlaps in 6.2 and a layer that is exclusively overlaps/intersections that was created in 6.1. These two layers were merged.
3. Merged layers were then further reviewed for overlapping areas and manually assigned to larger roads prioritizing interstates, US highways, state highways, and finally county and local roads
4. This hand-selected "Merge" tool merged these two (or in some cases several) records. The records were reviewed starting with the largest overlap areas first, continuing until the overlapped areas became too small to meaningfully affect the analysis.

The resulting shape file is a cleaned "Buffers File," Figure 5 and Figure 6 below.

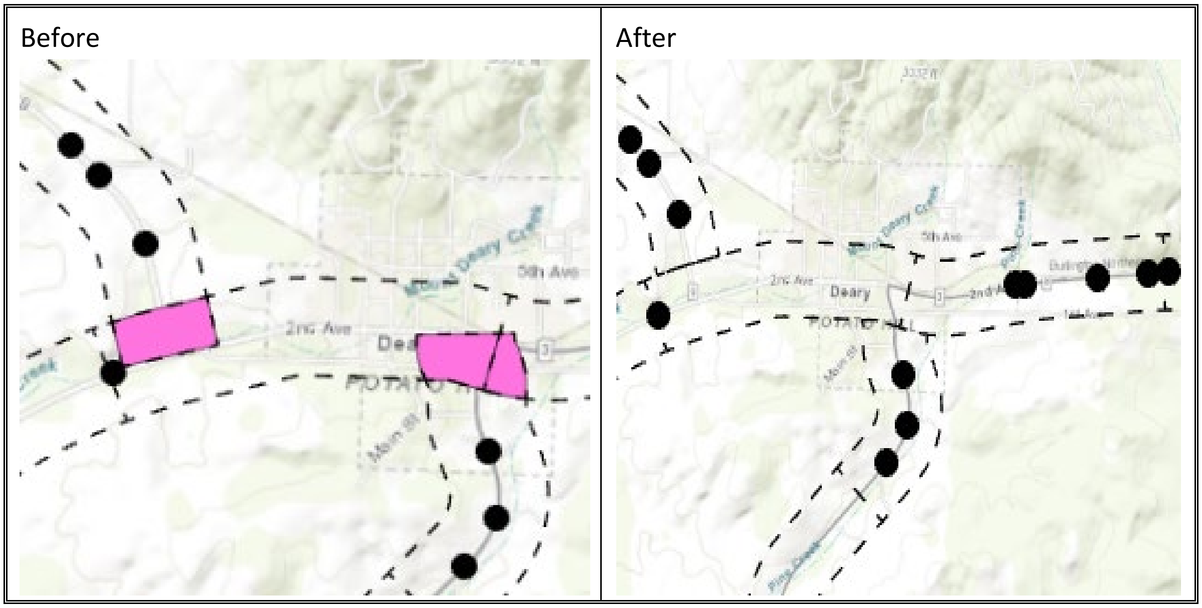


Figure 5. The process of removing smaller "orphan" road segments at intersections begins with a situation in the figure to the left, and ends with the figure to the right.

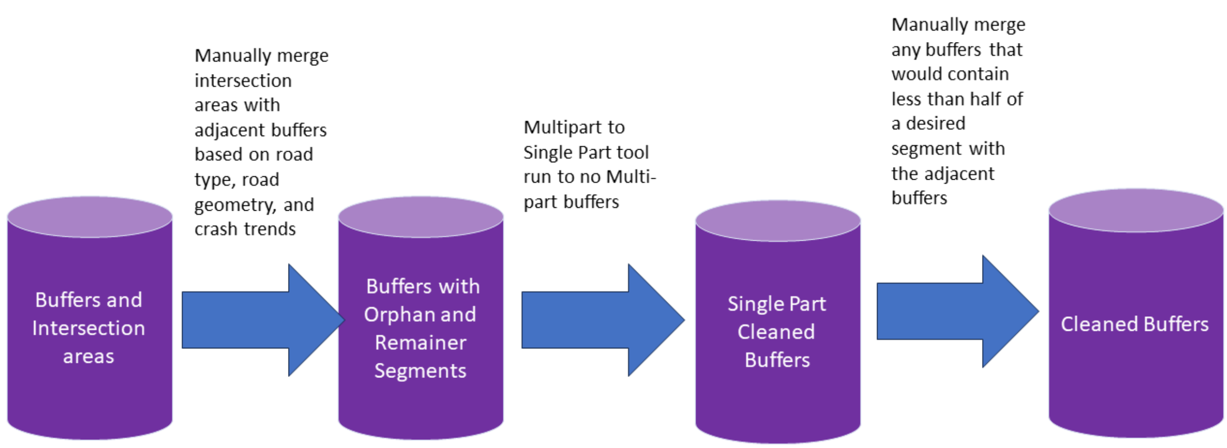


Figure 6. Cleaning the buffers and their intersections to create a buffer layer with no intersections.

Steps 5 to 6 below include when a road is "truncated" at an intersection, meaning the other road received the road segment at the intersection and the remaining road segment of that smaller road that was cut at the intersection will then be less than one mile or half mile, depending on the roads layer (see Figure 7, left side). The next steps take that smaller remaining road segment and merge it with its nearest neighbor (Figure 7, right side).

5. Run "*Single Part to Multipart*" tool to ensure no buffer polygons that are spatially adjacent. When the parts were Intersected certain buffer polygons were cut in half by intersecting buffer polygons running a different direction. We can have a single polygon in two parts on either side of the road. This tool ensures that each of these divided multipart features are split up.

6. Manually combine any buffer areas that would contain less than a half section for mile long section buffers and less than a quarter mile section for half mile section buffers with the nearest adjacent longer buffer section. For example, in Figure 7, below, after the vertical road "lost" its segment in the intersection with the horizontal road, the resulting remaining road segment below the horizonal road was a shorter segment than the rest in that roads layer. Therefore, this step adds that partial segment to its neighboring segment.

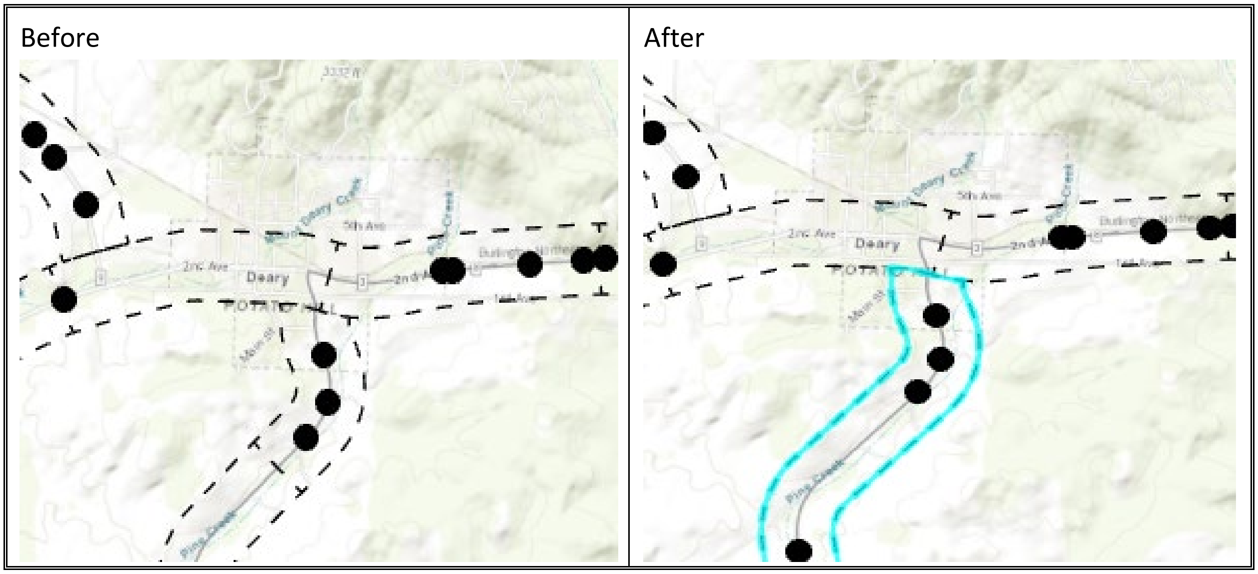


Figure 7. The shortened road segment lying just beneath the horizontal road (left) is merged with its nearest neighbor (right).

Once the road segments are cleaned up, the road data layer can be ready for input in the OHSA. This roads layer can also be used in other GIS modeling, such as the OHSA of other kinds of crash data.

Crash Data Preparation

Ten years of ITD crash data from 2013 to 2022 were obtained for this study. ITD performs QC on the crash data and it is very accurate, but all use of crash data should involve a review of accuracy of the data because any data points off of roads could affect the results of the OHSA. The overall process of crash data preparation is demonstrated in Figure 8 below. Table 1 below illustrates several columns of the ITD WebCars crash database that can possibly contain information on the involvement of an animal and specifically a wild animal in the collision.

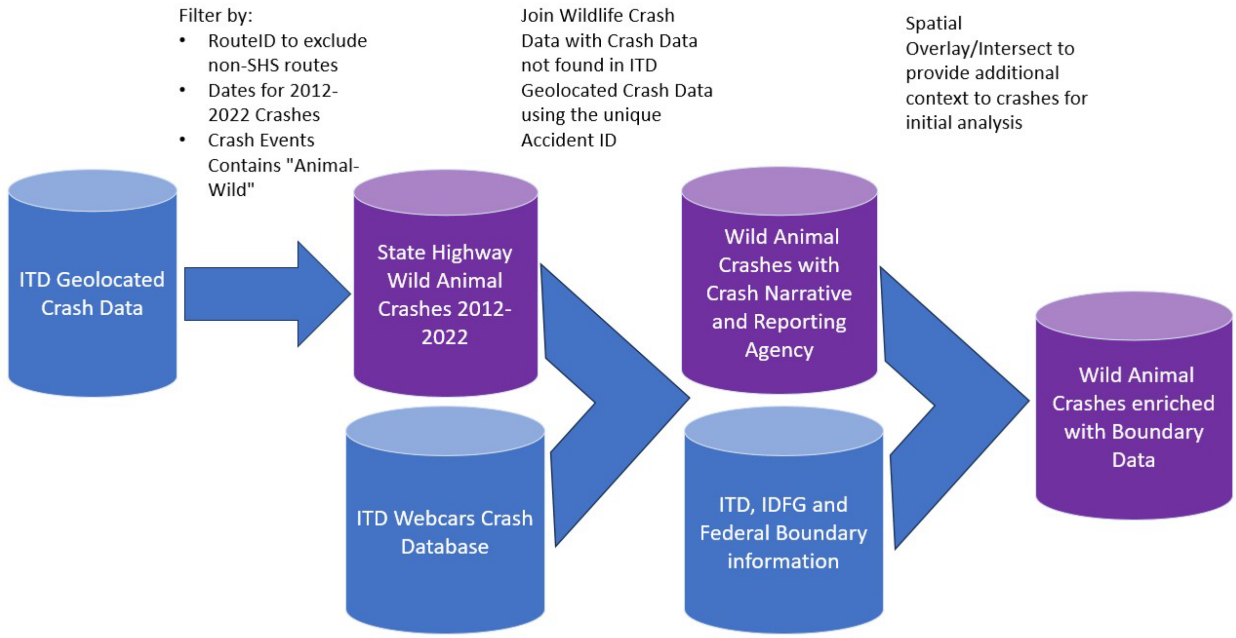


Figure 8. Process for filtering and enriching ITD Crash Data to extract wildlife-vehicle collisions.

The wildlife divisions of all federally recognized Idaho Tribes were contacted, however no additional crash data was provided in time to be included in these analyses. No other crash data was included in the OHSA for this study.

Table 1. A Sample collision entry where animals were involved in the incident, and it was indicated it was wild animals that were involved, see grey colored columns. This was extracted from a larger table and contains fields only relevant to filtering by Events.

Severity	Accident_Year	Contrib_Circ_1	Contrib_Circ_2	Most_Harmful_Event	Events	RouteID
Property Dmg Report	2017	Animal(s) in Roadway	None	Ran Off Road	Animal – Wild, Ran Off Road	02350AUS091

The wildlife collisions are NOT a subset of animal collisions but of total collisions.

The five steps for crash data preparation are listed below. Each instructional step is explained in more detail below.

1. Filter roads and collision years
2. Select for wild animal collisions
3. Join collisions with narratives
4. Query narratives of collisions
5. Add additional features of land ownership/management and region to each crash data point

1. Filter Roads And Collision Years

The ITD Crash Unit Dataset contains over 30 fields of information including Events. The overview Crash Unit Dataset lacks this field and only includes Most Harmful Event, as it is a summary of the collision whereas Crash Unit Data has more detail about each vehicle in a collision. Crash Unit Data was filtered by excluding non ITD-administered roads and included collisions that occurred between 2013 and 2022 using RouteID fields and Accident Year fields respectively.

2. Select for Wild Animal Collisions

The Events attribute contains all events that occurred during a collision. All Crash Unit Data that included "Animal-Wild" in the Events Field were included. Then Crash Unit Data by Accident ID were dissolved from each unit or vehicle into a collision in order to display individual accident records.

3. Join Collisions with Narratives

The Accidents were combined with the full record of collisions in the ITD WebCars crash database. Some of this information is not included in the public facing data because of confidentiality purposes. Collision narrative and reporting agency was added to collision records for further analysis. Feature Manipulation Engine was leveraged for this process, but Standard Query Language and other tools could have been used directly.

4. Query Narratives of Collisions

The accident narrative field was queried for any mention of the wildlife words (Table 2). While some species and wildlife information were found, due to the nature of the data, the narratives had more focus on the impact of vehicles and human injury as opposed to information on species or genus of animal collided with.

Table 2. Identification words used in a query of narratives of crashes to find those that pertained to wildlife.

Species	
Antelope	Coyote
Bear	Deer
Bighorn sheep	Elk
Sheep	Mule (for mule deer)
Cougar	Moose

5. Add Additional Features of Land Ownership/Management and Region To Each Crash Data Point

Following creation of this crash dataset overlayed the crash data points with boundary layers from Idaho Department of Fish and Game (IDFG), ITD, Bureau of Indian Affairs (BIA), and BLM to see collision counts of wildlife by state or federal land ownership/management, ITD District, IDFG Region, and Indian Reservation. Buffers were added to each jurisdiction type to see if collisions were within a half mile or one mile buffer of these different boundary type. The collision severity code for every collision entry was preserved for additional analyses.

After these steps, there were 12,000+ collisions with wildlife, including 1,300 injury collisions and nine human fatality collisions from 2013 to 2022.

The overall process is displayed in Figure 9, below. Once these actions were performed, the crash data from the ITD Highway Safety Corridor Application, were ready to be input into the OHSA.

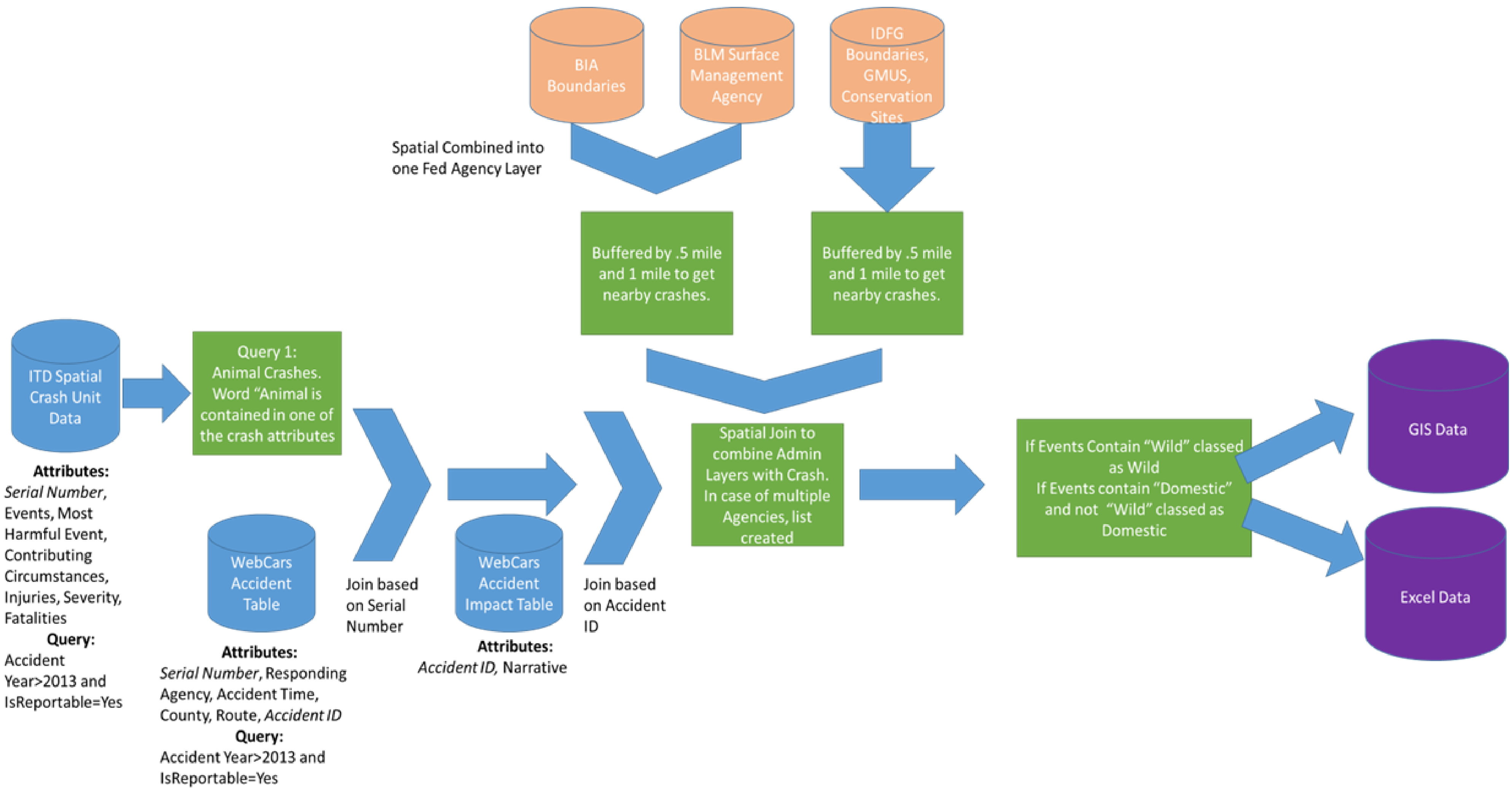


Figure 9. The processes of preparing the crash data for the Optimized Hot Spot Analysis.

Carcass Data Preparation

Carcass data were obtained from the IDFG Roadkill & Salvage Database (IDFG n.d.). Data were limited to the study years 2013 to 2022 to parallel the rest of the study and only included data within the ITD-administered roads polygon (see "Roads Data Preparation"). Each ungulate species record was run through a similar OHSA as was done with the crash data. Records of meso and small carnivores, large carnivores, and birds of prey were run as well but hot spot results were more limited due to fewer reports distributed over the state. While provided to the TAC for context, these were not viewed to be as statistically significant at a statewide level when compared with thousands of ungulate records.

The wildlife divisions of all federally recognized Idaho Tribes were contacted, however no additional carcass was provided in time to be included in these analyses. No other carcass data was included in the OHSA for this study.

Optimized Hot Spot Analysis

*Introduction to the Optimized Hot Spot Analysis Tool with the Getis-Ord Gi**

The OHSA for the wildlife-collision dataset were completed using the Esri® ArcGIS 10.5.1 statistical tool, OHSA. This tool is ultimately running a Getis-Ord Gi* analysis even though the modeling name does not include Getis-Ord Gi*. The tool extracts insights from the dataset to obtain the settings that yield the optimal hot spot results and produces automatic settings, much like a digital camera on automatic settings. However, the tool allows the user to have full control and has a manual mode to override those settings.

The OHSA spatial statistic was used because it employs a polygon aggregation as a critical part of the analysis method. Past studies have used the OHSA spatial statistic to create hot spot maps of wildlife-vehicle collision (WVC) and carcass data (Cramer and McGinty 2018, Cramer et al. 2019, Williams et al. 2021, Cramer et al. 2022, Garrah et al. 2015, Kociolek et al. 2016, Shilling and Waetjen 2015). The aggregation polygons allow the user to assess a total number of incidents (collisions) within a given area when each incident, or spatial location, is an independent record, such as crash data. Hot spots are attributed using statistically significant groups binned into 90%, 95%, and 99% Confidence Intervals. The hot spots in the map are color coded according to the Confidence Intervals, with the 99% Confidence Interval typically represented by the reddest color used.

Optimized Hot Spot Analysis Directions

The overall steps in this OHSA can be summarized in the following four points, described in more detail below:

1. Test for Spatial Autocorrelation in the data and determine distance band values
2. Preparation and slicing of the data
3. Apply the Optimized Hot Spots Analysis tool with Getis-Ord Gi*
4. Group together hot spots and get collision counts and mileage

1. Test for Spatial Autocorrelation in the Data and Determine Distance Band Values

Selection of an adequate distance band value is a critical step before running the OHSA tool in ArcGIS. It was assumed that WVCs are clustered together by their nature or positively autocorrelated. A distance band is the distance cutoff for how far out to look from one road segment to all others surrounding it for assessment. The selected distance band should reflect the level of scale of the problem that is being analyzed and a z-score value that supports the rejection of the null hypothesis for [Spatial Autocorrelation] that states that features are randomly distributed across the study area. To select an appropriate distance value, the data was assessed using the Spatial Autocorrelation tool in ArcGIS. Point data of all wildlife-vehicle collisions was compared to all collisions.

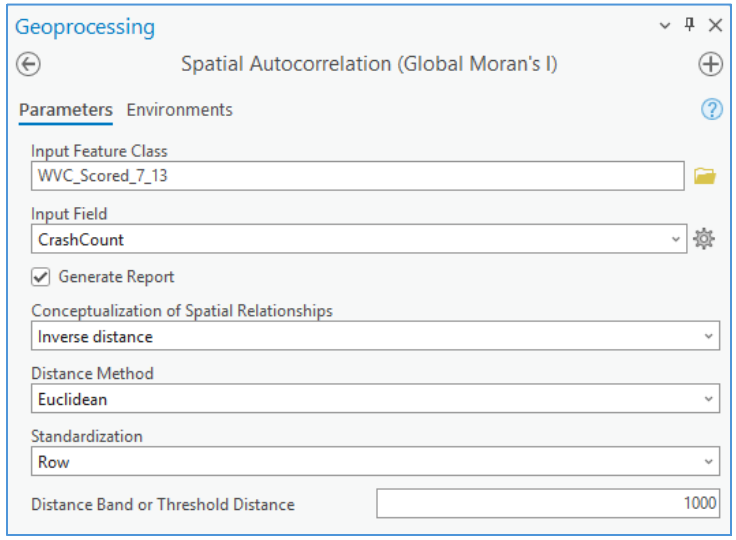


Figure 10. Spatial Autocorrelation Tool and inputs example.

To conduct the assessment of distance band, the Spatial Autocorrelation tool was manually set to run at various distance bands with a start distance of 1,000 meters (3,280 feet) and increments of 1,000 meters (3,280 feet), and up to 15,000 meters (9.32 miles). Figure 10 to the right shows the configuration of the Spatial Autocorrelation tool in ArcGIS.

After the tool was executed, a report with z-scores, p-values, and a chart of the data distribution was provided. Figure 11 shows an example of the report produced after each iteration of the Spatial Autocorrelation tool.

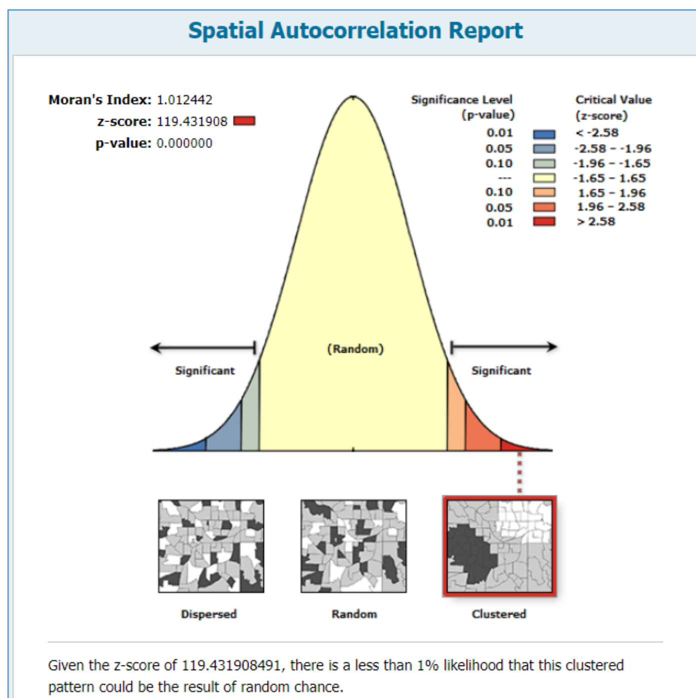


Figure 11. Spatial Autocorrelation Report produced by the Spatial Autocorrelation Tool.

Information provided by the reports was used to plot z-score and distance values in a line chart in Excel (Figure 12). Each chart was then used to further evaluate the relationship between the distance and z-score values. The trend where the z-score has an inflection point, as the one shown inside the red circle in Figure 12, was observed for each of the subsets that were subject to the spatial autocorrelation analysis. This inflection point means that there are diminishing marginal returns for expanding the distance threshold in terms of statistically significant autocorrelation. During this process it was discovered that the Incremental Spatial Autocorrelation tool in ArcGIS Pro could be used instead of running the Spatial Autocorrelation tool above multiple times.

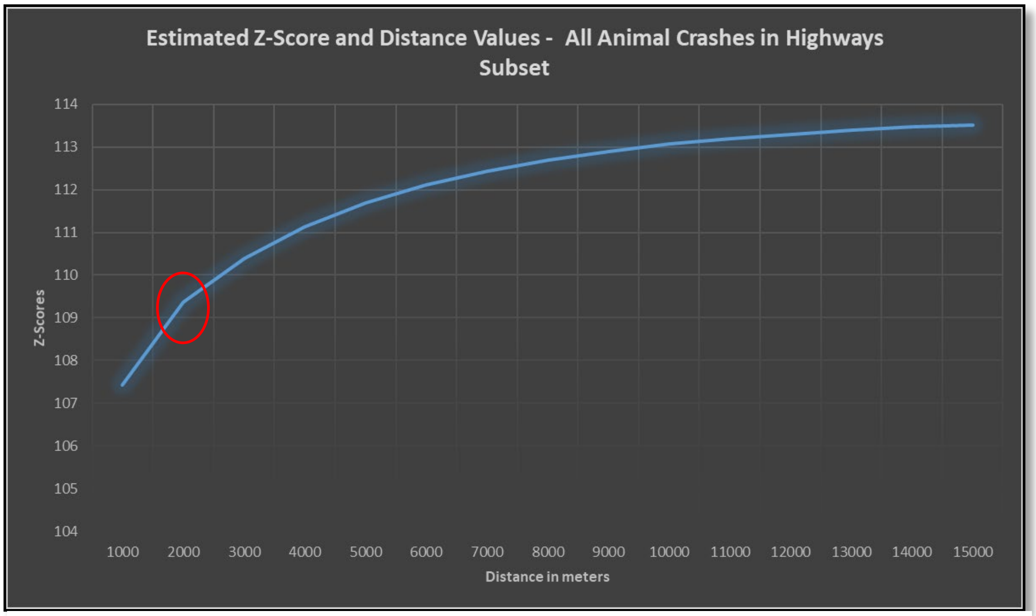


Figure 12. Line chart of the relationship of distance values derived from z-score values. The red circle indicates the inflection point of the z-score.

Based on the visualization of the inflection point of the z-score and distance values, it was concluded that 2,000 meters (1.24 miles) was an adequate distance value for the distance band since it closely matched the scale of analysis of one mile (1,609.34 meters) for this study. In addition, the estimated z-score value of 109.3 at 2,000 meters (1.24 miles) support the rejection of null hypothesis of spatial randomness and confirms that clustering exists in the crash and carcass datasets.

2. Preparation of Data

The parameters the authors wanted to vary were year ranges and District vs Statewide analysis to examine differences in time and space for the crash data and resulting OHSA maps. Instead of querying the data and running manually multiple times, the decision was made to use model-builder. To iterate through the data with the iterator tool in model-builder, a parameter was created that would replicate the desired query logic for both the collision and segment layers. This attribute would thus read "Statewide_2017-2022" for the data needed for Statewide analysis for 2017 to 2022 collision records. A master dataset was created with all different combinations needed to run through the process. There may be a way to leverage a list of different queries instead.

The resulting datasets were "Wildlife Collisions with Run Info" a point dataset with copies of collisions and "Buffers with Run Info" which was a copy of the buffers with region or year information.

To allow for 21 runs of OHSA for the many parameter values, especially the various distance bands and road segment length, a model was created with the following inputs (Figure 13). This required additional data preparation allowed us to be able to run the processes overnight and will allow for easy returns in the future. Mileage and Confidence Interval parameters are used to select the Confidence Interval threshold and mileage for the resulting grouped hot spots as we decided to filter to select above 95% Confidence Interval and at least two segments within a hot spot. (Figure 14).

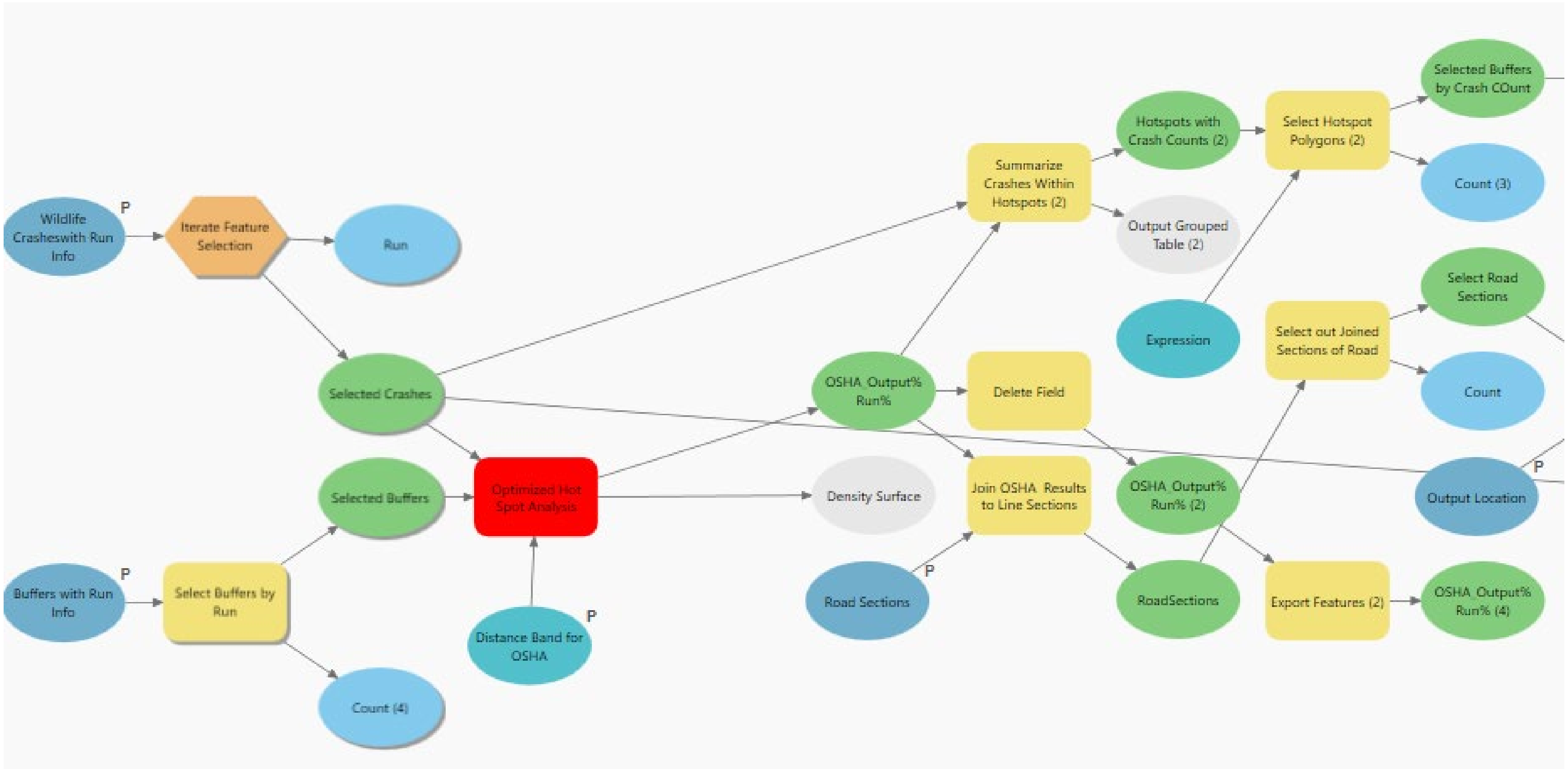


Figure 13. Integrated OHSA Workflow in Model-builder. Process continued in Figure X below.

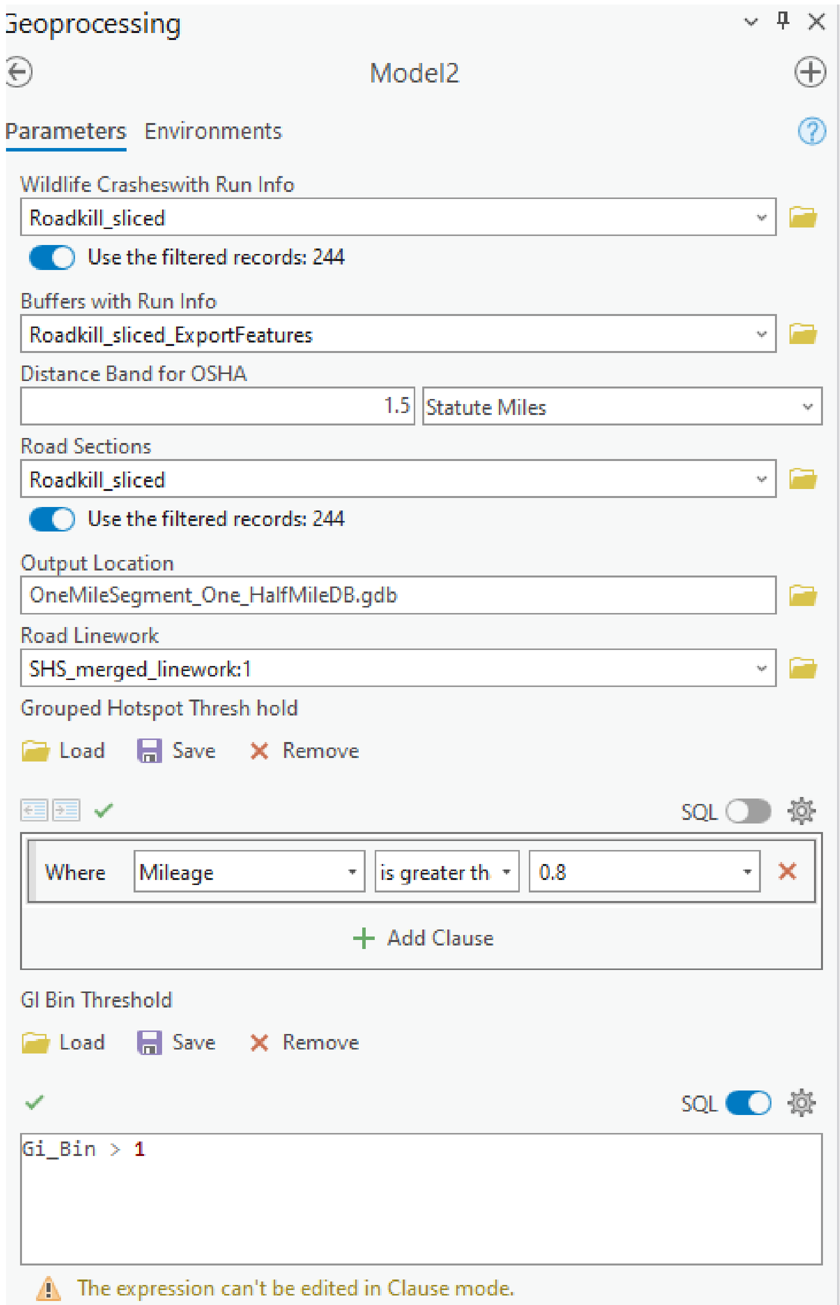


Figure 14. Parameters used in the model.

3. Apply the OHSA to Crash Data

The "Optimized Hot Spot Tool is available in ArcGIS Pro: Toolboxes\ Spatial Statistic Tools \ Mapping Clusters \ Optimized Hot spot Analysis.

The interactive model menu used on carcass data is presented in Figure 15, below.

4. Grouping Together Hot Spots and Getting Collision Counts and Mileage

After OHSA is run the hot spots are grouped and statistics are calculated

1. OHSA output is *joined* to the road segments in order to calculate mileage using their ID fields. These linear road segments are output and used later in the model, Figure 16.

2. Next collisions are calculated for each hot spots. Hot spots with no collisions were excluded from future analysis.

3. Following this a threshold for Confidence Interval was applied in this case using the GI_BIN attribute. We wanted to only include 95% Confidence Interval and above in the analyses.

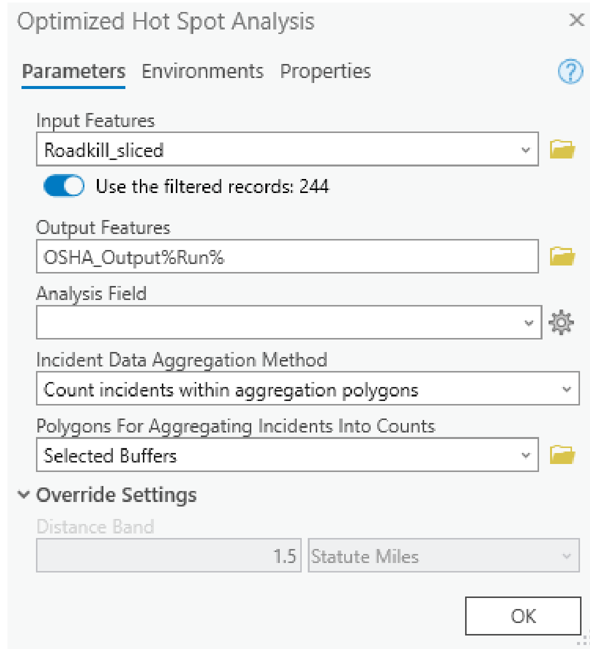


Figure 15. Optimized Hot Spot Analysis Parameters Interactive Menu (Override Settings is pulled from the Model Parameters to use a user-defined distance band instead of an automatically generated one).

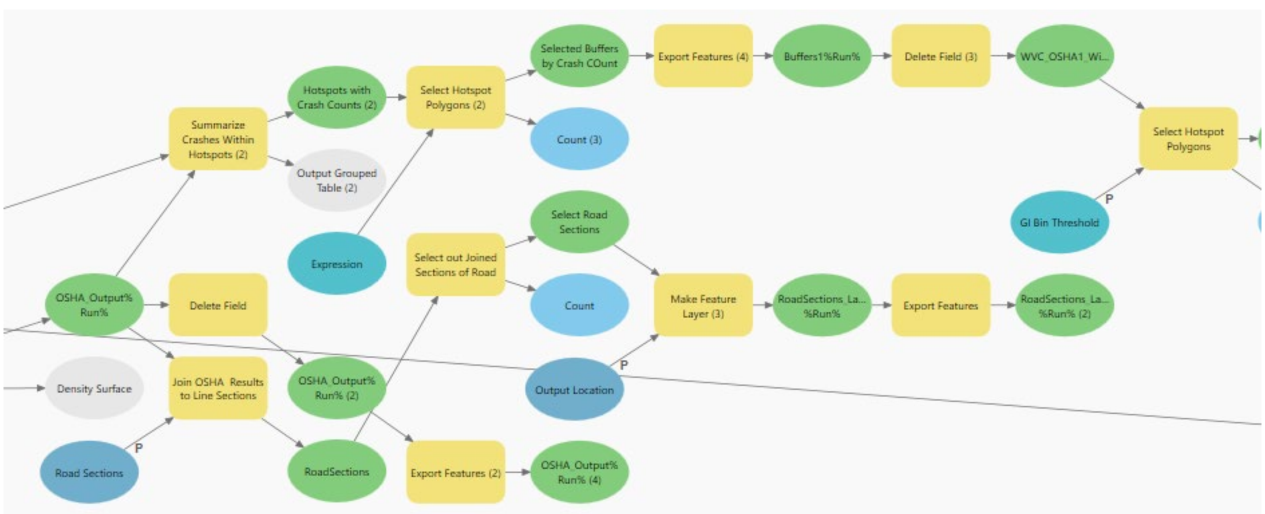


Figure 16. Flow diagram of how OHSA output is classified into hot spots.

4. Following this we *dissolved* small buffer segments identified as hot spots that had at least one collision and fell within the 95% or 99% Confidence Intervals. Each of our segments was buffered by five meters (16 feet) due to the potential for gaps, then dissolved and then buffer by five meters (16 feet) to remove excess buffer.

5. Next, road linework was *clipped* and *joined* to the resulting dissolved hot spots to allow for us to obtain the mileage of road in each.

6. Hot spots had to be minimum of 0.8 miles for half mile road segments and 1.8 miles for one mile road segments to be included.

7. Finally, collisions per mile per year was calculated for each grouped hot spot. Grouped hot spots, road segments, and OHSA results were output for each different year grouping and spatial grouping.

These last steps within the model are summarized in Figure 17.

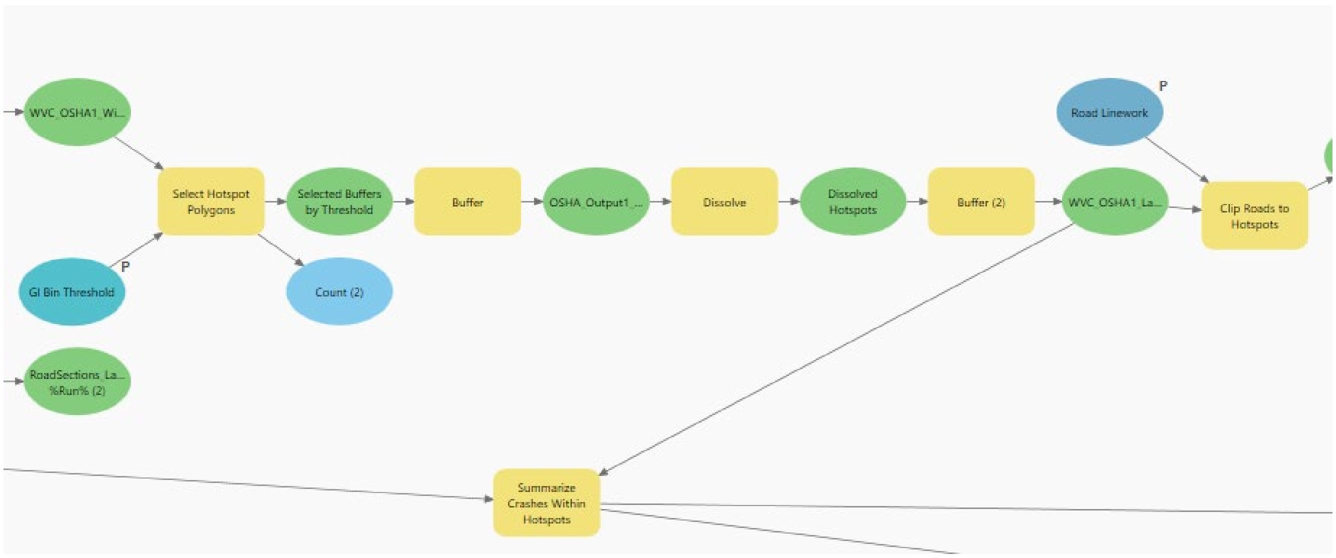


Figure 17. Flow diagram of final steps in creating grouped hot spots.

The Five Parameters of Importance in the Optimized Hot Spot Analysis of Crash Data

The actual run time for the OHSA can be a matter of minutes. However, the preparation of the data and the selection of the best values of five important parameters is the process a team of people must take to make sure the parameters selected best represent the state's roads, crash data, and ecological setting.

There are five parameters to assess the changes in their values and the contribution they make to the most accurate hot spot prioritization:

1. Road segment length
2. Buffer distance = road segment width
3. Distance band = search distance, how far out to look at other crash data point neighbors
4. Years of crash data
5. Confidence Interval selection.

Table 3 below provides a summary of the final values selected for the five parameters.

Table 3. Parameters that were adjusted to conduct the most accurate OHSA of Idaho wildlife-vehicle collisions.

Parameter	Set Value	Justification
Road Segment Length	Half mile road segment	Half mile road segments were able to absorb smaller fragments of segments near intersections and boundaries and remain "intact" rather than become fragmented. One mile road segments resulted in fragmented hot spots when there was a road intersection or the road came to a state boundary.
Buffer distance	200 meters (656 feet, 0.12 of a mile) segment width	This is the distance the model reaches out from the center line created earlier, to represent the road outward in both directions. This results in road segments with the width of quarter mile.
Distance Band	One mile	This is the distance the model looks out from the half mile road segments to adjacent road segments. This results in more accurate model results. Half mile distance bands made the hot spots too small; with a half mile distance band the longer hot spots were broken up into multiple hot spots, and they competed overall and with each other for priority. One point five mile distance band resulted in many of the same hot spots and lengths as one mile distance bands.
Years of Crash Data	2013 to 2022 and 2018 through 2022	There was modeling of 10 years of data (2013 to 2022) to allow comparisons with the prior ITD 2014 Study which used 10 years of data. However, to best represent more recent collisions after several wildlife mitigation projects, Covid 19 pandemic changes, landscape and wildlife populations changes, and to be in line with how traffic safety engineers examine crash data, modeling also examined the years of data from 2013 to 2018 and 2018 to 2022. The final maps were created with the five years of data from 2018-2022.
Confidence Intervals	95% and 99% Confidence Intervals	Confidence Intervals represents a level of certainty of the modeling results. The model also output 90% Confidence Intervals, while we kept this as part of OHSA, but wanted to only include above a 5% Confidence Interval. Thus only 95% and 99% Confidence Intervals were included in the hot spots.

Below we review the parameters and what the OHSA model results displayed for Idaho wildlife-crash hot spots.

1. Road Segment Length

In preparation for the OHSA, the roads data layer was prepared by first making all roads a single line. Then roads were segmented into polygons for the OHSA. There were two decisions that had to be made for those segments: their length, and their width. It is standard in these modeling exercises to first choose half mile or one mile road segments, and sometimes up to five miles segments, keep all three data layers, and run them in the model to see how length affects results. In previous experience in other states, it is only the half mile or one mile road segments that provide reasonable results that can help identify areas of wildlife-vehicle collisions.

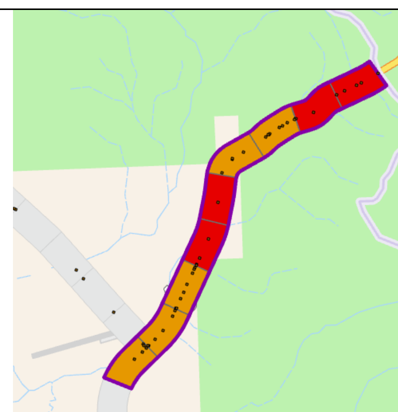
The principal investigator worked through the model runs to try and decide if half mile or one mile road segments work better in giving us a clear indication where collisions were concentrated.

Initially one mile road segments were chosen. This was important to help create accurate road intersections where there were residual pieces of road segments when two roads intersect. However, after examining several of the hot spot areas in Coeur d'Alene, Pocatello, Lava Hot Springs, and Henry's Lake/Island Park, it was decided that the half mile road segments, with a one mile search distance (distance band) did the best job of representing crash data hot spots when there were road intersections. See the case study below for how one mile road segment model failed to include a collision dense area in 95% and 99% Confidence Intervals, but the half mile road segment included it. The final road segment length used in the ITD's ArcGIS IPLAN web-based portal map was half mile.

Case Study on Hot Spot Differences with Half Mile and One Mile Road Segments – Henry's Lake US-20/SR-87

US-20 runs just west of the ID-WY border in Island Park. The road segmentation of half mile and one mile road segments created different results where US-20 intersected with SR-87, and when it ended at the Montana border. With one mile road segments, the last mile of US-20 was truncated at the Montana border and the piece of road remaining was incorporated with the one mile segment south of it, see map on the left, below. The one mile road segment map also had the intersection of SR-87 incorporated into the nearby US-20 road segments. These adaptations to ends of roads and intersections made the one mile road map OHSA unable to accurately identify this area as a hot spot, as the half mile road segments did, see right side map. The half mile road segments seemed to be able to break up the road into half mile road segments without that problem of the intersections and road ends, and identify a hot spot more accurately.

One mile road segment, one mile distance band



Half mile road segment, one mile distance band

2. Buffer Distance – Road Segment Width

Preparation of the roads data layer included decisions on the road segment width. This is the buffer distance in ArcGIS. The Python code script above helped with the determination of the optimum buffer. The script was adapted by the ITD GIS Analyst to produce more accurate results when it came to road segments that were less than the standard half mile or one mile. The code that was used in Nevada, Utah, New Mexico, and Arizona has a standard 200 meters (656 feet, 0.12 of a mile) for the buffer width on each side of the road. This is the distance the model reaches out from that center line first created earlier, to represent the road outward in both directions. This results in road segments with the width of quarter mile. This helps to ensure that all collisions recorded on divided roads are brought into the road segment. It also can bring in collisions on interstate frontage roads and roads near a highway of interest. These are tradeoffs. It is of value to ask the question: "Is it more important to bring in collisions within 0.12 of a mile outside of the center line of a road that may bring in nearby collisions, or is it more important to restrict collisions to those more closely aligned with the center line of a road to minimize including collisions on nearby roads?" Since this study analyzes an ecological phenomenon of wildlife trying to get across roads, it is of importance to identify critical areas of wildlife collisions, not just a specific road segment. For instance, there may be areas where deer are getting killed on nearby roads as they approach a highway. We are looking for that area, not just the reported collisions. This can also help elucidate problem highway areas where collisions on the main highway are not being reported but may be on the local/frontage road. Again, we are looking for problem areas and are not conducting a fine scale identification of the number of collisions in a very specific spot on a highway.

The road segment width, which was defined by the buffer distance, was 200 meters (656 feet) for the ITD's ArcGIS IPLAN web-based portal map.

3. Distance Band = Search Distance

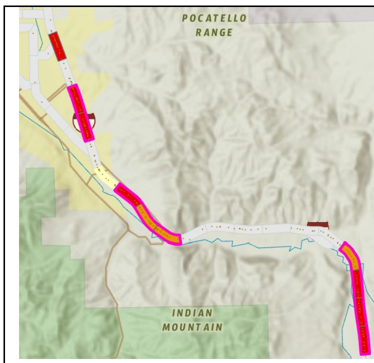
This is a critical factor in evaluating which search distance provides the most accurate results. This is the distance the OHSA goes out from every crash data point and looks at neighboring crash data points. Those neighboring crash data points can be on the same road in nearby road segments, but it also means looking at neighboring crash data points on other roads outside of its road's segments. Distance bands selected to evaluate for the OHSA were half mile, one mile, and one and a half miles. The research team found that half mile distance bands make the hot spots too small; the longer hot spots get broken up into multiple hot spots, and they compete overall and with each other for priority. The longer the distance band, meaning the farther out the model searches from a crash data point, the more the resulting hot spots are not centered on the crash data points and the farther out the hot spot segment extends. See the case study below and how it helped make the distance band length decision.

The final distance band length selected for the ITD's ArcGIS IPLAN web-based portal map was one mile.

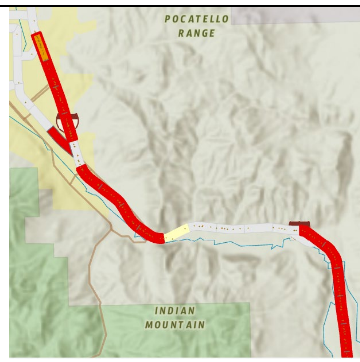
Case Study on Distance Band Differences – I-15 Pocatello

The OHSA identified a top 10 hot spot on I-15 south of Pocatello with every run of the model with various parameter values. The hot spot was broken up into multiple hot spots with a half mile distance band. With one mile and one and a half mile distance bands, the hot spots coalesced into three longer hot spots. This helps keep the three hot spots from becoming many. One mile distance bands connected various hot spots that were close by rather than having them broken up; it provides a more continuous hot spot. This helps keep the hot spots from competing against many more for prioritization. Having continuous hot spots rather than many nearby helps in identifying the areas as a problem for wildlife-collisions and gives planning personnel options for additional areas for mitigation.

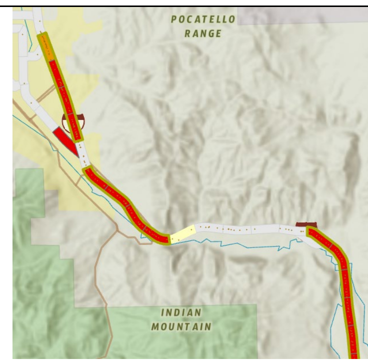
See the three maps below with half mile, one mile, and one and a half mile distance bands.



One mile road segment, half mile distance band



One mile road segment, one mile distance band



One mile road segment, one and a half mile distance band

4. Years of Crash Data

OHSA work included modeling ten years of wildlife-vehicle crash data from 2013 to 2022. Ten years of data allow for a robust analysis, but a five-year span of crash data is more traditional in transportation collision analyses. It is also more reflective of changes in recent years as ITD personnel install wildlife crossings, wildlife exclusion fence, and other mitigation to reduce wildlife-vehicle collisions. Five years of data are also a better reflection than ten years of data of what is happening in the landscape near the road. It can account for changes in systems from fire, changes in agricultural crops, human development near the highway, and changes in large ungulate populations over time. This modeling effort created hot spot analyses with both ten years and five years of crash data. These data layers will allow ITD Environmental Planners, other ITD personnel, and partnering agencies to evaluate changes over time. The "official" hot spot map represents the most recent five years of crash data, to best reflect the more immediate history of these collisions.

The ITD's ArcGIS IPLAN web-based portal map identifies years of crash data including the five years of data from 2018 through 2022.

5. Confidence Interval Selection

The Getis-Ord OHSA modeling is a statistically sound method to determine aggregation of crash data points at 90%, 95%, and the 99% Confidence Intervals. The higher the Confidence Interval value, the more certain the results are to be considered priority hot spots. Typically modeling results are presented for at minimum, the 99% Confidence Intervals, with 95% Confidence Intervals added to provide a richer result presentation to show how the hot spot continues beyond the most intense areas of 99% Confidence Intervals. The model runs of half mile road segments and one mile distance bands selected as the most appropriate road segment size included most 90% Confidence Interval areas without having to instruct the model to include these. Thus only 95% and 99% Confidence Intervals were included in the hot spots. The final Confidence Intervals selected were 95% and 99%.

These different values of the road segment length, distance band, years of data and Confidence Intervals were run through the OHSA. The 200 meter (656 feet) buffer for the road segment width was kept the same, as it was shown to encompass the opposing lanes of the highways. Collisions that were not on ITD-administered roads were excluded, thus the concerns of the OHSA pulling in crash data points from nearby roads was largely alleviated and the 200 meter (656 feet) buffer remained the standard.

District Level Wildlife-Vehicle Crash Hot Spots

When the hot spot analysis is run for the state, it identifies the worst wildlife-vehicle reported collisions in the state overall. It is important for transportation planning on a more focused level to evaluate the worst collision areas for a District. Thus, various OHSAs were run for each District to identify hot spots on a District level. Those results are available in the final report for this study, “Identification of Wildlife-Vehicle Conflict Mitigation Opportunity Locations,” Chapter 3, Phase One – Optimized Hot Spot Modeling of Reported Collision with Wildlife and Wildlife Carcasses.

Context of How We Interpret the Findings

The crash data driven hot spot mapping takes into account only crash data points and road segments. The carcass data driven hot spots also only takes into account where carcasses have been recorded on ITD-administered roads. The Phase One results still needed to be interpreted within a context related to: traffic volume, number of lanes, the percentage of tractor trailer truck traffic on a road which decreases reporting of wildlife collisions, the landscape, land ownership/management and land use, and canals and other water bodies, and the human use of the land and its ability to foster wildlife movement. Phase Two of this study brought in georeferenced data related to these factors. Prior to the Phase Two mapping, the TAC members asked for several considerations for the hot spot mapping. These included:

1. Include factors of urban areas, frontage roads, rail lines that will limit the opportunities to install wildlife crossing structures on the roads with the hot spots.
2. Private lands may be adjacent to a hot spot, and landowner management decisions and commitment to wildlife conservation or the lack of it can greatly influence ITD’s ability to install

wildlife crossing structures, to the point that in many places, private lands adjacent to the road preclude wildlife crossing structure considerations. Map private lands, public lands, and Tribal lands.

3. Urbanized areas may have hot spots of wildlife collisions, but their highly developed lands, predominance of private property adjacent to the roads, and the difficulty of placing crossing structures with wildlife exclusion fences make these places less than optimal for priority wildlife crossing structures. Consider how to identify areas of high human densities.
4. Local support or opposition to wildlife crossing structures and concurrent fence may make prioritizing an area for wildlife mitigation a difficult challenge for agencies. However, public opinion can be one factor, but the safety and ecological reasons for crossing structures and fences should be held as priority over local opposition. See if these feasibility factors can be included.

Some of these factors were better addressed in Phase Two below, however not all data were available at the time of this study.

The Methodology Used for Phase Two - Modeling Wildlife Vehicle Conflict Mitigation Opportunity Areas and Locations

Projections

Data used in Phase Two were from the same projection coordinate system **NAD83 IDTM** as Phase One.

Scale and Defining Unit of Measure

Phase Two used the same sections and buffers created from Phase One.

Scoring Road Segments

These datasets were spatially joined with additional georeferenced data sources by using various intersections. Additional grouping and scoring then occurred which will be covered for each layer below. Ultimately transportation and ecology factor scores were assigned to each road segment along with a total score combining the two categories.

Parameters Used in the Hot Spot Modeling

With the conclusion of Phase One and with consultation of the TAC, half mile road segments and a one mile distance band were selected for use in the OHSA.

Wildlife Vehicle Conflict Areas and Wildlife Vehicle Conflict Mitigation Opportunity Locations

Similar to Phase One, road segments which had an equivalent or higher than 95% Confidence Interval for total scores of factors were combined into larger areas of wildlife-vehicle conflict. Feasibility factor scores were then assigned to these areas to create a final product of areas with high conflict but also considered if it is feasible to construct mitigation effort within these areas of high conflict. Each one half mile road segment was evaluated for each of the below factors.

Data Preparation

The details of exactly how data were prepared, scored, and used were detailed in the final report for this study, in Chapter 4, Phase Two – Identification of Wildlife-Vehicle Conflict Mitigation Opportunity Locations.

Transportation Factors

Wildlife-Vehicle Collision Hot Spots

Wildlife-Vehicle Collision Hot Spots from Phase One were evaluated at one mile distance bands and half mile road segments; the amount of points a half mile road segment received for being in one of these hot spots was based on the Confidence Interval of that hot spot. The half mile segment could receive a maximum of 20 points if within a 99% Confidence Interval hot spot, or 15 points if it was within a 95%, Confidence Interval hot spot, or 10 points if it was within a segment that was in the 90% Confidence Interval. The way the evaluation was carried out for each one half mile road segment using a simple join, as sections were the same between phases.

Commercial Traffic Volume (CAADT)

Commercial Traffic Volume data also known as the CAADT was extracted from the 2024 ITD AADT Dataset for a maximum of 10 points for this shape file values; if a road segment had a specific CAADT and its value was compared with similar rural or urban maps it received a certain amount of points. The Urban Area Boundary Data was extracted from ITD's Finalized Urban Boundaries Dataset. To prepare the CAADT data the AADT data was intersected with road segments and length-weighted averages were calculated for AADT and CAADT. If a segment contained two AADT records they would be multiplied by the length of each AADT segment and divided by the total length of road in the segment. Following this, Urban Areas were intersected with segment, and if it fell more than 50% inside an urban area it would be classified as Urban, otherwise it would be classified as rural.

Wildlife Collisions Per Mile Per Year

Data for Wildlife Collisions Per Mile Per Year was extracted from the 2013 to 2022 wildlife collision data from Phase One with a maximum of 10 points. Each segment was spatially joined with wildlife collisions. This total was divided by the half mile road segment and then divided by ten for the number of years of data.

Percentage of Collisions That Were Wildlife-Related

These data for percentage of collisions that were wildlife-related were also extracted from the 2013 to 2022 wildlife collision data from Phase One as well as an ITD crash dataset. Percentage of collisions that were wildlife-related could also receive a maximum of 10 points. Each segment was spatially joined with wildlife collisions and total collisions. Data were queried to exclude sections with under three wildlife collisions. Wildlife collisions were then divided by the total number of collisions to calculate the percentage.

Ecological Factors

Average Annual Daily Traffic (AADT)

Similar to CAADT, the AADT data were extracted from the 2024 ITD AADT Dataset for a maximum of 10 points. The AADT data were then intersected with segments and length-weighted averages were calculated for AADT per segment.

US Fish and Wildlife Service Information for Planning and Consultation

The USFWS IPaC potential habitat and range maps were extracted for the protected species that could cause the most harm if struck: Canada lynx (*Lynx canadensis*), grizzly bear (*Ursus arctos*), and North American wolverine (*Gulo gulo*) with a maximum of 10 points. Segments were intersected with the three species ranges. A Boolean presence-absence value was assigned per species per each segment. If at least one species' range intersected a segment then it received the maximum of 10 points.

Carcass Data Hot Spot Analysis

Data of ungulate and large carnivore carcasses from the IDFG Roadkill & Salvage Database from 2013 to 2022 were tabulated in each of the segments. An OHSA was run for carcasses using the same parameters as the OHSA for WVC earlier in this Phase. If the segment was at or above a 95% Confidence Interval then it received the maximum of 10 points.

Idaho Department of Fish and Game Ungulates Migration Routes and Stopovers

The IDFG ungulates migration routes and stopovers data were merged into a single layer which was intersected with the segments. Those segments that intersected with a migration route or stopover were given the maximum of 10 points.

US Geological Survey National Hydrography Dataset Plus

Smaller line features such as pipelines were queried out of the USGS National Hydrography Dataset Plus**.** As rivers, streams, and creeks often run parallel to roads, the research team decided to intersect the mono-line road network data with the NHDPlus data to minimize false positives. The points from the intersection were then joined with the segments to identify areas where these bodies of water crossed ITD-administered roads. Segments that contained an intersection of road and NHDPlus layer were given the maximum of 10 points.

The Top Wildlife-Vehicle Conflict Areas

The scores from each of the factors above were added together for every half mile road segment to create scores for transportation factors and ecological factors with a total out of 100 points. An OHSA was run on all road segments using total score as the analysis field. Again 95% and 99% Confidence Intervals were queried out and dissolved together to generate Wildlife-Vehicle Conflict Areas.

The final OHSA on the statewide transportation and ecological factor scores for road segments, and the OHSA for each District produced the top Wildlife-Vehicle Conflict Areas. Below, these areas are presented for both the state and the individual Districts.

The 108 Statewide Wildlife-Vehicle Conflict Areas

The Wildlife-Vehicle Conflict Areas were identified by the OHSA process, using the total transportation and ecological factor points out of 100 that each half mile road segment was assigned (Table 4). Since this was an intermediary step in the identification of the final Wildlife-Vehicle Conflict Mitigation Opportunity Locations, it is presented in this Supplemental Information Source Document rather than in the body of the *Identification of Wildlife-Vehicle Conflict Mitigation Opportunity Locations in Idaho* report. See Figure 18 for the map of these top Areas.

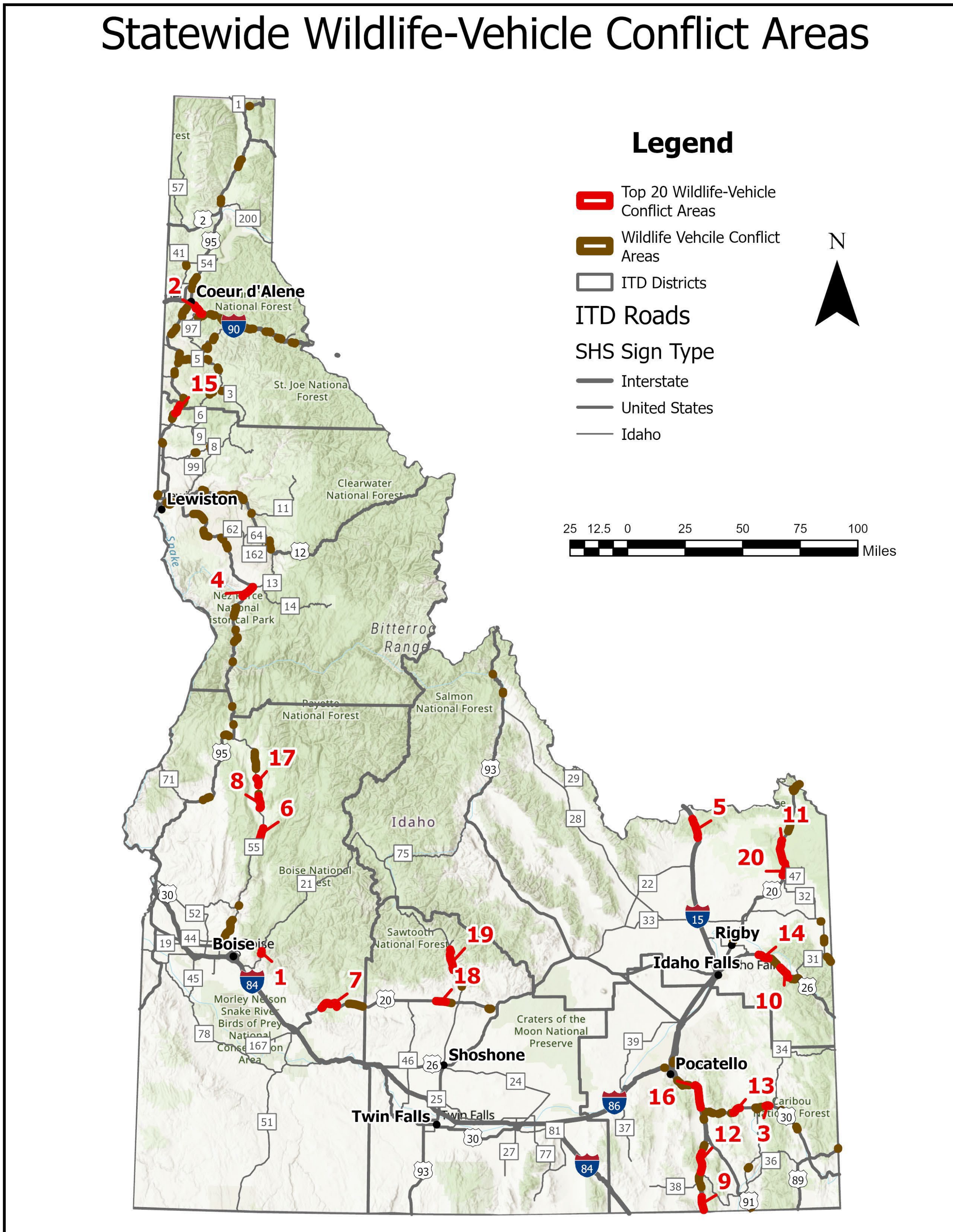


Figure 18. All 108 Statewide Wildlife-Vehicle Conflict Areas with the Top 20 Statewide Areas based on Transportation and Ecological Scores Identified in Red.

Table 4. The Top Wildlife-Vehicle Conflict Areas in Idaho Including Transportation and Ecological Factors out of 100 points.

Rank	Official Name of Wildlife-Vehicle Conflict Areas	District	Points
1	Ashton – Harriman State Park US-20 MP 363 – 380	6	72.21
2	Hailey to Ketchum SH-75 MP 117 – 127	4	71.68
3	Alpha SH-55 MP 102 – 108	3	68.73
4	Spencer – Humphrey I-15 MP 179 – 188	6	68.17
5	Wild Horse Creek US-20 MP 128 – 135	3	67.93
6	Alexander Junction of US-30 MP 386 – 387; MP 399 – 401; & SH-34 MP 47 – 50	5	65.77
7	Soda Springs – Alexander Reservoir US-30 MP 401 – 404	5	65.60
8	South Donnelly SH-55 MP 127 – 130	3	65.50
9	Southeast Coeur d'Alene I-90 MP 14 – 19	1	64.58
10	North of Timmerman Junction SH-75 MP 103 – 104	4	64.00
11	Middle Sulphur Canyon – Diamond Gulch US-30 MP 409 – 413	5	64.00
12	Malad Summit I-15 MP 22 – 26	5	63.78
13	Bennett Creek – Dixie – Centennial Trail – Cat Creek US-20 MP 113 – 124	3	62.73
14	Crimson Ridge – South Grangeville US-95 MP 234 – 238	2	62.67
15	McCammon – Inkom I-15 MP 48 – 57	5	62.53
16	Camas National Wildlife Refuge – Camas I-15 MP 153 – 155	6	62.50
17	Coeur d'Alene Reservation – Deep Creek US-95 MP 364 – 373	2	61.18
18	Wood River Valley – Bellevue SH-75 MP 108 – 111	4	60.83
19	Rigby – Thorton US-20 MP 323 – 328	6	60.27
20	Cascade Reservoir – Grandmas Creek SH-55 MP 118 – 123	3	59.60
21	Portneuf-Pocatello I-15 MP 62 – 70	5	59.47
22	Island Park-Buffalo River US-20 MP 384 – 389	6	59.36
23	Fish Creek – Lund US-30 MP 375 – 379	5	59.00
24	Conant Valley – Snake River US-26 MP 667 – 371	6	59.00
25	Northeast Twin Falls I-84 MP 177 – 179	4	58.20
26	Coeur d'Alene Reservation – St. Joe River SH-3 MP 88 – 89	1	58.00
27	Poplar – Antelope Flat US-26 MP 354 – 358	6	58.00
28	Driggs to Chapin SH-33 MP 142 – 145	6	58.00
29	Blackfoot I-15 MP 93 – 94	5	58.00
30	Weiser US-95 MP 84 – 86	3	57.75
31	Henrys Lake to Montana State Boundary US-20 MP 402 – 406; SH-87 MP 0 – 1	6	57.64
32	Nez Perce East Kamiah US-12 MP 67 – 71	2	57.44
33	Victor to Wyoming State Boundary SH-33 MP 151 -154	6	57.43
34	Lake Fork SH-55 MP 135 – 136	3	57.33
35	Dry Creek Vally to McLeod Way SH-55 MP 48 – 53	3	57.27
36	Utah State Line I-15 MP 0 – 7	5	57.23
37	Southwest Coeur d'Alene US-95 MP 422 – 429	1	57.21

Rank	Official Name of Wildlife-Vehicle Conflict Areas	District	Points
38	Snake River – Swan Valley US-26 MP 374 – 377	6	57.14
39	Market Lake Wildlife Management Area – Sage Junction I-15 MP 141 – 142	6	57.00
40	North of Hayden US-95 MP 435 – 442	1	56.73
41	Canyon to Kingston I-90 MP 35 – 43	1	56.67
42	Tetonia – Clawson SH 33 MP 133 – 135	6	56.50
43	North Franklin – Cub River US-91 MP 1 – 3	5	56.50
44	Hauser SH-53 MP 1 – 3	1	56.00
45	South Potlatch Junction US-95 MP 361	2	56.00
46	Portneuf Marsh – Lava Hot Springs US-30 MP 367 – 370	5	55.83
47	North of Magic Reservoir US-20 MP 168 – 176	4	55.81
48	Orofino North Fork Clearwater River US-12 MP 38 – 40	2	55.75
49	Lucky Creek – Mores Creek SH-20 MP 19 – 22	3	55.22
50	Harpers Bend – Big Canyon Creek US-12 MP 32 – 36	2	55.14
51	Beaver Dick Park – Henrys Fork SH-33 MP 72 – 74	6	55.00
52	Nez Perce – Valley View Heights-Clearwater River US-95 MP 306 – 311	2	54.82
53	St. Maries SH-3 MP 82 – 84	1	54.80
54	Rocky Point US-30 MP 442 – 447	5	54.70
55	Salmon River – Tower Creek US-93 MP 312 – 316	6	54.63
56	North of Malad City I-15 MP 15 – 16	5	54.33
57	Smiths Ferry SH-55 MP 95 – 98	3	54.33
58	Westmond US-95 MP 464	1	54.00
59	Palouse Range US-95 MP 349 – 352	2	54.00
60	Coeur d'Alene Reservation Belgrove US-95 MP 412 – 417	1	53.90
61	North Sandpoint US-95 MP 478 – 482	1	53.56
62	Thorn Creek US-95 MP 334 – 338	2	53.50
63	Georgetown Summit US-30 MP 419 – 421	5	53.17
64	Crystal US-95 MP 74 – 75	3	53.00
65	South Belvidere – Big Creek SH-55 MP 110	3	52.50
66	Three-Mile Corner to Moyie Springs US-2 MP 65 – 69	1	52.29
67	Round Prairie Creek US-95 MP 526 – 529	1	52.00
68	Lewiston Hill – Hatwai Creek US-95 MP 318 – 324	2	52.00
69	Deadman Flat US-20 MP 258 – 259	6	52.00
70	Nez Perce – Big George Clearwater River US-12 MP 29 – 31	2	51.67
71	Soda Springs – Conda SH-34 MP 59 – 61	5	51.33
72	South Devil Creek Reservoir I-15 MP 18 – 20	5	51.20
73	Picabo to Carey US-20 MP 191 – 194	4	51.17
74	Salmon River – North Fork Salmon River US-93 MP 325 – 328	6	50.67
75	East of Glenns Ferry & Snake River I-84 MP 122 – 123	3	50.50
76	Spirit Lake SH-41 MP 16 – 17	1	50.50
77	McCall – Lake Fork SH-55 MP 138 – 142	3	50.44

Rank	Official Name of Wildlife-Vehicle Conflict Areas	District	Points
78	Algoma – South Sandpoint Lake Pend Oreille US-95 MP 469 – 471	1	50.40
79	Blaine US-20 MP 161	4	50.00
80	Nez Perce – Winchester US-95 MP 277 – 280	2	50.00
81	McArthur – Naples US-95 MP 492 – 502	1	50.00
82	North of Ketchum – Dip Creek SH-75 MP 132 – 133	4	49.67
83	Nora SH-8 MP 17 – 19	2	49.33
84	Harriman State Park US-20 MP 380 – 382	6	48.50
85	Coeur d'Alene Reservation – East of Plummer – Little Plummer Creek SH-5 MP 2 – 5	1	48.40
86	Three-Mile Corner to North Bench US-95 MP 510 – 517	1	48.25
87	Lucky Peak SH-21 MP 13 – 17	3	48.11
88	Geneva – Wyoming State Boundary US-89 MP 42 – 43	5	48.00
89	Black Canyon SH-52 MP 37 – 39	3	48.00
90	Nez Perce – Agatha Clearwater River US-12 MP 24 – 28	2	48.00
91	Dufort US-95 MP 465	1	48.00
92	Coeur d'Alene Reservation – North of Plummer – North Fork Rock Creek US-95 MP 398 – 400	1	47.33
93	Nez Perce – Joseph – Clearwater River US-12 MP 11-13 & US-95 MP 303	2	47.00
94	Kennedy Ford US-95 MP 360	2	46.67
95	Horse Shoe Bend Road SH-55 MP 55 – 56	3	46.50
96	Elmira US-95 MP 99	1	45.50
97	Banks – North Fork Payette River SH-55 MP 82	3	45.00
98	Pollock US-95 MP 185 – 186	2	45.00
99	Palisades Reservoir US-26 MP 398 – 399	6	45.00
100	Blackfoot River SH-34 MP 67 – 70	5	44.50
101	Antelope Flat US-26 MP 362 – 363	6	44.00
102	Cornwall to Troy SH-8 MP 12 – 13	2	42.50
103	Cow Creek Road – Bennett Creek US-20 MP 110	3	41.00
104	Centennial Trail – Old Highway 68 US-20 MP 126	3	41.00
105	East Lenore – Clearwater River US-12 MP 28 – 29	2	35.00
106	Land of the Yankee Fork State Park US-93 MP 244 – 245	6	35.00
107	Lemhi Valley SH-28 MP 101	6	31.00
108	Orofino US-12 MP 40 – 41	2	26.00

District Level Wildlife-Vehicle Conflict Areas

Each of the District's top Wildlife-Vehicle Conflict Areas are presented in Table 5 through Table 10, below. Each OHSA for each District produced different numbers of hot spot areas, based on the 95% to 99% Confidence Interval cut offs. Thus, some Districts have more hot spots than others.

Table 5. District 1 Coeur d'Alene Top Transportation and Ecological Factor Hot Spots based on Maximum Score out of 100 points.

Rank	Name of Hot Spot	Points
1	Southeast Coeur d'Alene I-90 MP 13.5 – 16.5	59.58
2	Canyon to Kingston I-90 MP 35.3 – 444	56.67
3	South Sandpoint US-95 MP 469.5 – 471	56.00
4	Southwest Coeur d'Alene US-95 MP 422 – 428.3	54.85
5	North of Hayden US-95 MP 440 – 442.5	54.17
6	Coeur d'Alene Reservation – Belgrove US-95 MP 413 – 417.4	53.00
7	Moyie Springs – Fly Creek US-2 MP 65.9 – 68.8	52.67
8	North of Hayden US-95 MP 436 – 437.9	52.50
9	McArthur Lake – Paradise Valley US-95 MP 494.6 – 501.5	51.79
10	Coeur d'Alene Reservation East of Plummer SH-5 MP 2 – 3.5	49.00
11	Three-Mile Corner – Fleming Creek US-95 MP 510 – 515.5: US-2 MP 64 – 65	48.77
12	St. Maries SH-3 MP 82 – 83.6	47.67
13	Hauser SH-53 MP 1 – 3	46.00
14	Kootenai Indian Reservation US-95 MP 516.1 – 517	42.50

Table 6. District 2 Lewiston Top Transportation and Ecological Factors Hot Spots based on Maximum Score out of 100 points.

Rank	Official Name of Hot Spot	Points
1	Coeur d'Alene Reservation – Deep Creek US-95 MP 364 – 372	63.53
2	North of Hayden US-95 MP 233.6 – 238	62.67
3	Nez Perce East Kamiah US-12 MP 67 – 71	57.44
4	South Potlatch Junction US-95 MP 361	56.00
5	Orofino North Fork Clearwater River US-12 MP 38 – 40	55.75
6	Harpers Bend – Big Canyon Creek US-12 MP 32 – 36	55.14
7	Nez Perce – Valley View Heights – Clearwater River US-95 MP 306 – 311	54.82
8	Hauser SH-53 MP 1 – 3 & US-95 MP 349.1 – 352	54.00
9	Thorn Creek US 95 MP 334 – 338.7	53.50
10	Lewiston Hill – Hatwai Creek US-95 MP 318 – 324	52.00
11	Nez Perce – Winchester US-95 MP 277 – 280	50.00
12	Nez Perce Lapwai Creek US-95 MP 288 – 289	50.00
13	Nora SH-8 MP 17 – 19	49.33
14	Nez Perce – Agatha Clearwater River US-12 MP 24 – 28	48.00
15	Nez Perce – Joseph-Clearwater River US-12 MP 11.7 – 13	46.75
16	Kennedy Ford US-95 MP 360 & SH-6 MP 104	46.67
17	Pollock US-95 MP 185 – 186	45.00
18	Nez Perce – Big George Clearwater River US-12 MP 28 – 31	45.00
19	Cornwall to Troy SH-8 MP 11 – 13	43.67
20	North of Pollock – Grouse Creek US-95 MP 187 – 188	40.00
21	Nez Perce Jaques – Culdesac US-95 MP 292	36.00

Table 7. District 3 Boise Top Transportation and Ecological Factors Hot Spots based on Maximum Score out of 100 points.

Rank	Official Name of Hot Spot	Points
1	Wild Horse Creek US-20 MP 128.6 – 135.5	70.79
2	Alpha SH-55 MP 102 – 108	68.73
3	Bennett Creek – Dixie-Centennial Trail – Cat Creek US-20 MP 114 – 124.5	62.73
4	South Donnelly SH-55 MP 127 – 131	59.71
5	Dry Creek Valley SH-55 MP 47.6 – 50.6	59.09
6	Cascade Reservoir – Grandmas Creek SH-55 MP 117 – 122.3	58.18
7	Weiser US-95 MP 83 to 86	57.75
8	Lucky Creek – Mores Creek SH-21 MP 18.7 – 22.1	56.33
9	Mount Maria – Payette River SH-55 MP 68 – 68.6	56.00
10	Crystal US-95 MP 74 – 75.4	55.00
11	Smiths Ferry SH-55 MP 94.8 – 98	54.33
12	North Horse Shoe Bend SH-55 MP 64.7 – 65.6	53.50
13	Notus US-20 MP 14	53.00
14	East of Glenns Ferry & Snake River I-84 MP 122 – 123	50.50
15	McCall-Lake Fork SH-55 MP 138 – 142	50.44
16	Black Canyon SH-52 MP 36.6 – 39	50.17
17	South Belvidere – Big Creek SH-55 MP 109 – 111	49.00
18	West of New Meadows US-95 MP 158	48.00
19	Eagle SH-44 MP 14.5 – 18 & SH-44 MP 42	48.00
20	Lake Fork SH-55 MP 135 – 137	47.40
21	Lucky Peak SH-21 MP 10.7 – 16.6	45.92
22	Banks – North Fork Payette River SH-55 MP 82	45.00
23	Bennett Mountains US-20 MP 112.6 – 113	44.00
24	Horse Shoe Bend Road SH-55 MP 54 – 56	43.60
25	Malad River US-20 MP 126.1 – 126.5	41.00
26	Cow Creek Road – Bennett Creek US-20 MP 110.5 – 111.4	36.00
27	Cascade Reservoir SH-55 MP 123	25.00

Table 8. District 4 Shoshone Top Transportation and Ecological Factors Hot Spots based on Maximum Score out of 100 points.

Rank	Official Name of Hot Spot	Points
1	Hailey to Ketchum SH-75 MP 116.8 – 127.2	70.33
2	Wood River Valley – Bellevue SH-75 MP 108.3 – 111.2	59.86
3	Northeast Twin Falls I-84 MP 176.6 – 180	55.86
4	North of Magic Reservoir US-20 MP 167 – 176	53.89
5	North of Timmerman Junction SH-75 MP 102.8 – 104.7	53.00
6	South of Timmerman Junction SH-75 MP 99.3 – 100.7	50.33
7	Picabo to Carey US-20 MP 191 – 195	50.00

Rank	Official Name of Hot Spot	Points
8	Meadow Creek I-84 MP 255.7 – 257	50.00
9	North of Ketchum – Eagle Creek SH-75 MP 129.8 – 135.7	49.00
10	North of Buhl Clear Lakes Road SH-46 MP 88.7 – 90.1	47.67
11	Blaine US-20 MP 159.6 – 162.5	43.83
12	Hill City West US-20 MP 136.6 – 138.5	43.25
13	North of Shoshone – Milner Goodling Canal SH-75 MP 75.7 – 76.1	43.00
14	Corral Creek US-20 MP 144 – 146.5	42.40
15	Hill City – Corral US-20 MP 140 – 143.5	39.57

Table 9. District 5 Pocatello Top Transportation and Ecological Factors Hot Spots based on Maximum Score out of 100 points.

Rank	Official Name of Hot Spot	Points
1	West of Soda Springs US-30 MP 385 – 401 & SH 34 MP 47 – 50.5	65.77
2	Soda Springs – Alexander Reservoir US-30 MP 401.6 – 404	65.60
3	Middle Sulphur Canyon – Diamond Gulch US 30 MP 409 – 413	64.00
4	Malad Summit I-15 MP 22 – 26.3	63.78
5	McCammon to Inkom I-15 MP 48 – 57	62.53
6	Fish Creek – Lund US-30 MP 375.6 – 379	62.43
7	Pocatello I-15 MP 62 – 70 & BUS Loop I-15 MP 0 – 1.5	59.47
8	North of Malad City I-15 MP 15 – 15.8	59.00
9	Fort Hall Tribal Land I-15 MP 93.4 to 93.8	58.00
10	North Franklin – Cub River US-91 MP 1.6 – 3	57.00
11	Utah State Line I-15 MP 0.9 – 6.8	56.75
12	Portneuf Marsh – Lava Hot Springs US-30 MP 367.6 – 370.5	55.83
13	Rocky Point US-30 MP 441.6 – 446.5	54.70
14	Georgetown Summit US-30 MP 418.6 – 421	53.17
15	South Devil Creek Reservoir I-15 MP 18 – 20.3	51.20
16	Blackfoot River SH-34 MP 69.8 – 70.2	48.00
17	Soda Springs – Conda SH 34 MP 60.3 – 61.2	45.50

Table 10. District 6 Rigby Top Transportation and Ecological Factors Hot Spots based on Maximum Score out of 100 points.

Rank	Official Name of Hot Spot	Points
1	Ashton – Harriman State Park US-20 MP 363 – 380	73.38
2	Swan Valley US-26 MP 374 – 376.5	68.20
3	Spencer-Humphrey I-15 MP 179 – 188	68.17
4	Market Lake Wildlife Refuge I-15 MP 140 – 143	63.67
5	Henrys Lake to Montana State Boundary US-20 MP 402 – 406 & SH-87 MP 0 – 1	63.09
6	Camas National Wildlife Refuge I-15 MP 153.5 – 155.4	62.50
7	Driggs to Chapin SH-33 MP 142 – 145	62.20
8	Rigby – Thorton US-20 MP 323 – 328	61.18

Rank	Official Name of Hot Spot	Points
9	Conant Valley-Snake River US-26 MP 667 – 371	60.57
10	Island Park-Buffalo River US-20 MP 384 – 389	59.36
11	Poplar US-26 MP 354 – 358	58.63
12	Lemhi Valley SH-28 MP 91.8 – 92.2	58.00
13	Victor to Wyoming State Boundary SH-33 MP 151 – 154	57.67
14	Salmon River-Tower Creek US-93 MP 311 – 316	56.11
15	Harriman State Park US-20 MP 380 – 382	56.00
16	Tetonia – Clawson SH-33 MP 133 – 135	55.33
17	Beaver Dick Park-Henrys Fork SH-33 MP 72 – 74	55.00
18	Salmon River – North Fork Salmon River US-93 MP 325 – 328	52.00
19	Palisades Reservoir US-26 MP 399	45.00

Feasibility Factors

Each of the top 108 statewide Wildlife-Vehicle Conflict Areas was then evaluated with respect to feasibility factors that represent the land cover, land protection status, and upcoming ITIP projects. Each of the 108 Areas was scored based on 10 points for each of these three factors, for a total of 30 extra points. This led to the ranking of the Areas for the final Wildlife-Vehicle Conflict Mitigation Opportunity Locations based on the final scores after this feasibility ranking.

US Geological Survey Land Cover

The USGS Multi-Resolution Land Characteristics Consortium land cover data classifications were simplified on what may be permeable to wildlife or impermeable to wildlife. Developed or urbanized land (not including agricultural) was deemed impermeable to wildlife. The raster Land Cover layer was clipped to the areas and then vectorized. An intersect was conducted between the Areas and the developed land area. Developed areas were then divided by the total area of each Area to yield percent development per area. Segments that had less than 40% development were given the maximum of 10 points.

State and Federally Protect Lands

To model for the ITD right-of-way, left and right buffers were generated on the initial monoline linework from Phase One, which were 0.12 of a mile on each side of the road. The linework was clipped to Wildlife-Vehicle Conflict Areas and then buffers were generated and tied to areas based on a specific ID field. For interstates, 150 foot (45 meters) buffers were added on both sides of the road and 50 foot (15 meters) buffers were added to both state and US highways. These buffers were then intersected with the Bureau of Land Management Idaho Surface Management Agency Data, which included both state and federal agency lands. Data were divided into Federal and State agencies. Points were totaled depending on if an Area had a State and Federal agency on one or both sides of the Area. If federal lands were on both sides of the Area then it would receive a maximum of 10 points.

Idaho Transportation Investment Program (ITIP) Projects

A subset of proposed ITD projects was selected from the Idaho Transportation Investment Program (ITIP) projects by Wildlife Biologist and Project Manager of the study, Julie Hausknecht using specific keywords or were large enough in scale that could potentially incorporate wildlife mitigation efforts. These project line and point data were intersected with the Areas and would receive the maximum of 10 points.

Identifying Wildlife-Vehicle Conflict Mitigation Opportunity Locations

Each of the Wildlife-Vehicle Conflict Areas were then evaluated with feasibility factors and scores were calculated for each Wildlife-Vehicle Conflict Area producing a ranked organization. Transportation and ecological factor scores were averaged for each Area and added to the feasibility factor score to calculate a total score out of 130 points. Feasibility factor score ranking then produced the Wildlife-Vehicle Conflict Mitigation Opportunity Locations. Those top locations at the state and District level are presented in the final report. The final map is presented below, Figure 19.

All data layers presented were uploaded to ITD's ArcGIS IPLAN web-based portal map for use.

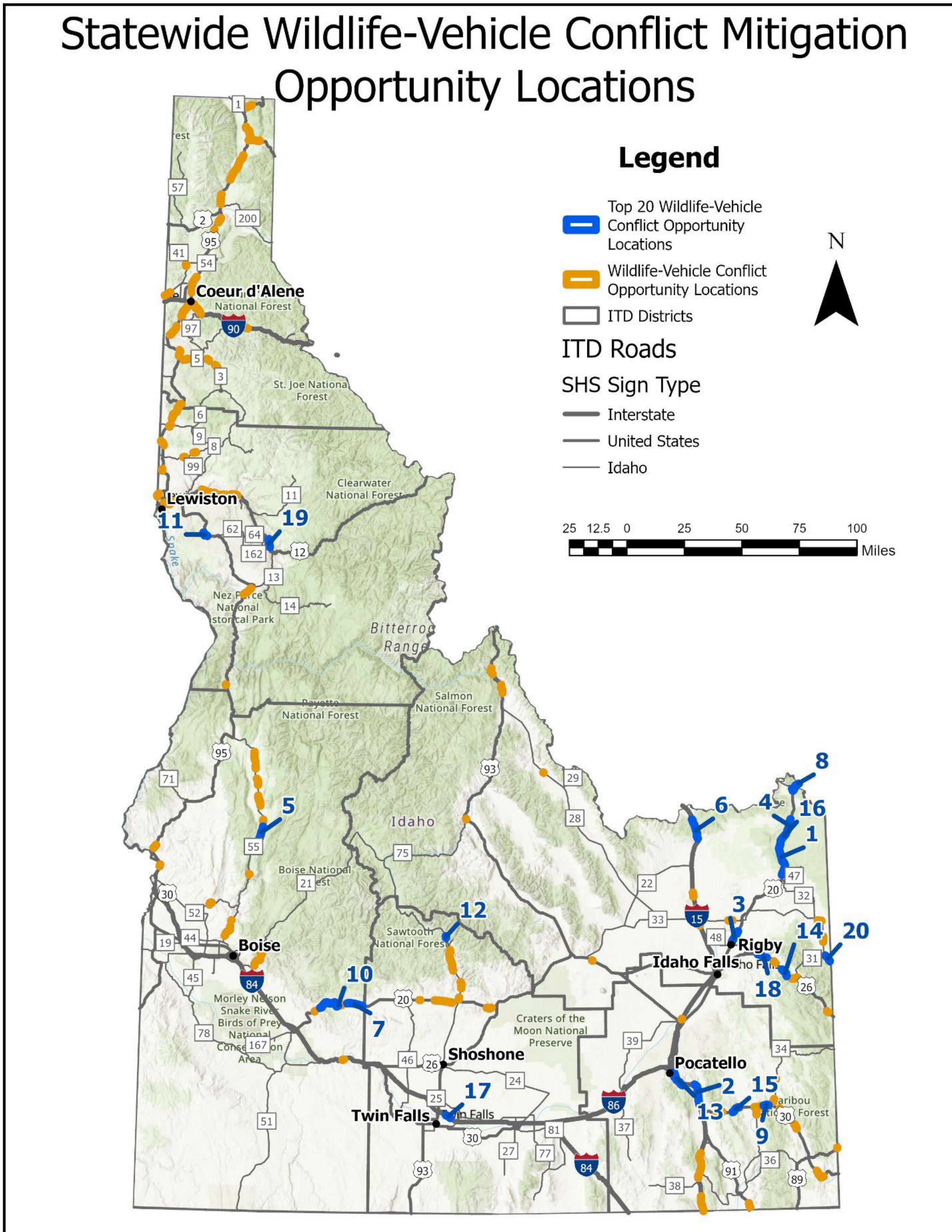


Figure 19. All 108 statewide Wildlife-Vehicle Conflict Mitigation Opportunity Locations with the top 20 statewide Locations after factoring in feasibility scores identified in blue.

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