AN ANALYSIS OF THE REDUCTION OF ANIMAL-VEHICLE COLLISIONS AS A RESULT OF WASHINGTON STATE COVID-19 “STAY AT HOME” ORDERS

by

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ABSTRACT

An Analysis of the Reduction of Animal-Vehicle Collisions as a Result of Washington State COVID-19 “Stay at Home” Orders

Raquel Sadé Sejour

Traffic volume saw an overall reduction of 20% across the entire state of Washington between April, the start of the COVID-19 “Stay at Home” order, and December 2020. The largest single reduction, of 38%, can be seen during from the start of the order during the week of April 26, 2020. Smaller reductions in traffic volume were seen during June, bottoming out at an 11% reduction in traffic volume. All counties saw reductions in traffic volume during the overall time period, with King County seeing the greatest reduction at 25%, and Spokane county seeing the smallest reduction at 6%.

Overall, Animal-Vehicle Collisions (AVCs) decreased 18% in total for all animals. This also held true for deer, which account for a majority of AVCs (59% from 2015 - 2019). However, there were too many confounding factors in both human and animal behavior to make it possible for us to infer direct causation. This was highlighted by the fact that the direction and magnitude of these changes were not consistent between different types of animals.

Work-from-home as the norm for certain professional fields would likely see a long-term reduction in AVCs, especially for deer. As many private and public offices grapple with the decision of whether or not to bring employees back to in-person work, AVCs and the loss of life and money associated with them should be considered. This potential long term reduction in AVCs for deer may also lead to a boom in deer population, which should continue to be monitored long term.

Regardless of how widespread work-from-home becomes, traffic volume inevitably increased as businesses and recreational activities resumed. For this reason, it may be a good time to build more wildlife crossing structures, wildlife fencing, and crossing signs to reduce the potential future increases in AVCs.

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Acknowledgements

Washington State Department of Transportation and the Incident Response Team

I would like to thank the Washington State Department of Transportation (WSDOT) for their commitment to employing student interns, *with pay*, and their willingness to share data for the sake of research. I also want to gratefully acknowledge the Incident Response Team at WSDOT, who work tirelessly across the state, 24 hours a day, 365 days a year, to keep the roadways of Washington safe, and provide help to Washingtonians during some of their most difficult moments. Without this team the carcass database that I utilized in this thesis would not exist.

Frasier Shilling

I would also like to thank Frasier Shilling, School of Road Ecology, University of California Davis, for giving me the opportunity to participate in his 2020 national study A Reprieve from US Wildlife Mortality on Roads during the COVID-19 Pandemic. This research provided inspiration and a jumping off point for this thesis paper.

Kelly McCallister

I am extremely grateful to Kelly McCallister, formerly WSDOT, for giving me the Habitat Connectivity Internship that lead me to this field of study. Kelly's way of constantly providing interns an opportunity to participate and advance has given me the confidence to take on this research.

Glen Kalisz

Finally, I am deeply indebted to Glen Kalisz. Glen provided me with the training and mentorship that I needed to make this thesis happen. Even after I left my position working with Glen, he continued to aid my research, from answering my questions at any hour of the day, to sending me valuable agency data. His advice, experience, and insight were crucial.

Introduction

Road Ecology & Animal Vehicle Collisions

Road ecology studies the ways in which roadways affect ecological attributes like habitat connectivity, genetic diversity, and migration. Animal vehicle collision (AVC) is a broad term used to describe any collision between an animal and a motor vehicle on a roadway. This includes scenarios during which there is no damage to the vehicle and the driver is unaware that the collisions even took place. Not all AVCs are reported, meaning that records underestimate the magnitude of these events. Nevertheless, AVCs nationally average over 400,000 auto insurance claims per year with around 4,800-5,300 in Washington state alone between 2014 and 2017 (Fennig). For both drivers and animals AVCs can lead to injury and death. Two groups handle reports in Washington state: state and local police, and WSDOT. While I will use the term animal vehicle collisions in this paper, I will reference other papers which use similar terms like wildlife vehicle collisions (WVCs), and deer vehicle collisions (DVCs). I have opted for the term AVCs over other, similar terms because it encompasses both wild and domestic animals which are hit on the road.

Habitat Connectivity

In the context of road ecology, habit connectivity studies the ways in which human roadways and associated roadway structures, like bridges and sound barriers, impede wildlife access to habitat. Habitat connectivity research seeks to improve wildlife access to habitat in order to reduce AVCs and promote breeding between individuals and herds that may not typically meet without crossing a roadway.

One common and effective method of improving access to habitats is the installation and maintenance of wildlife crossing structures. The term wildlife crossing structures usually conjures images of large, naturally landscaped land-bridges over major highways. One such structure was completed in the Snoqualmie Pass region of I-90, and it has been visited by a number of different species of animals seeking reprieve from the busy highway below, and access to the forest on the other side (Huijser and McGowen). This type of crossing structure is costly to build and maintain, and is not feasible in most AVC problem areas. More common wildlife crossing structures include things like culverts, jump outs, and strategically placed large road bridges with plenty of space for animals to pass underneath them.

Figure 1.

Large Wildlife Bench or Underpass

Note. This image depicts a large wildlife bench, a type of crossing structure that allows animals to pass underneath a roadway as if they are passing under a bridge. Source: WSDOT, https://wsdot.wa.gov/sites/default/files/2022-09/Wildlife-FishPassage-HabitatConnectivityReference.pdf

Figure 2.

Stream Simulation Structure

Note. This image depicts a type of medium wildlife bench known as a stream simulation structure, a type of crossing structure that allows both animals and a creek or river to pass underneath a roadway as if they are passing under a bridge. Source: WSDOT, https://wsdot.wa.gov/sites/default/files/2022-09/Wildlife-FishPassage-HabitatConnectivityReference.pdf

Non-linear Relationships Between Traffic and Animal-Vehicle Collisions

On first glance one might assume that more traffic will lead to more AVCs, and less traffic will lead to fewer. The truth is more nuanced than that. It is true that the largest, most heavily trafficked roadways in Washington see the highest number of AVCs when we look at a map with a snapshot of a year's worth of data. However, when comparing changes in traffic volume to changes in numbers of AVCs, the relationship is only very loosely linear. Unexpected variances may be explained by a number of variables difficult to pin down. These include mating seasons, diurnal behavioral patterns,

migrations, newly installed crossing structures, local faunal populations, and others. For this reason, localized traffic volume alone cannot be used to predict where AVCs may occur. As a result, AVC hotspots are frequently identified by WSDOT for further investigation.

Stay-at-Home Orders and Traffic Reductions

On February 19, 2020 the first positive COVID-19 test was reported in Washington state, although it is believed that cases in the US may have been present as far back as December 2019. On March 23, 2019 Governor Jay Inslee instituted Washington's first "Stay at Home" Order (Inslee), which was scheduled to last only two weeks. The order required every Washingtonian to stay at home except to pursue "essential activities," banned all social, religious, and recreational gatherings, and closed all but essential businesses. A marked drop in driving took place immediately, and traffic volume statistics and toll revenues fell as well(Steiner et al.). With some roadways showing as much as a 50% drop off in traffic volume, we would expect that AVCs would have fallen drastically as well—but this was not necessarily the case. As various phases of the Stay at Home Order and as public fatigue increased, traffic volumes and patterns became a little less predictable for WSDOT, and for Washington's wildlife. This paper will exam how the myriad of variables that affect AVCs in Washington interacted with COVID-19 related changes in traffic during 2020.

Positionality Statement

As a member of the Habitat Connectivity Team at WSDOT I was directly involved in the collection of camera trap data using wildlife cameras near various roadways in Washington. While I did not use any of this data for this thesis, it has greatly affected my personal outlook on the need to protect wildlife. Through these wildlife cameras I watched animals raise their young, put on weight for the winter, and grow old. I developed an emotional bond with the wildlife that I was monitoring. To my knowledge, I have never been involved in an animal vehicle collision myself either as a driver or as a passenger.

Literature Review

Introduction & Roadmap

Determining how a massive change in traffic volume, like the one seen as a result of the COVID-19 pandemic, does or does not lead to a change in animal vehicle collisions (AVCs) is a complicated process. Traffic volume alone may not provide a complete picture as to why a change in AVCs has, or has not, occurred. AVCs, and more specifically deer vehicle collisions, have been trending upwards nationally for around three decades, with diurnal and seasonal peaks that are well documented internationally (Steiner et al.). In order for researchers to model and predict AVCs and collisions hotspots as efficiently as they do, spatial and temporal information has to be considered when linking traffic volume and AVCs. Temporal trends are especially important for this thesis, which compares the unprecedented traffic volumes seen in 2020 to those seen in previous years.

Literature

Wildlife Vehicle Collision Reduction Study

This report was a broad, overarching introduction the problem of wildlife vehicle collisions (WVCs) in the United States, the costs associated with, prevention tactics, and their general trends over time (Huijser and McGowen). The rise in wildlife vehicle collisions (WVCs) seen in the US since the 1990s can be partially attributed to a few factors including a growing human population and a national decrease in carnivore species and populations, which has led to an increase in the populations of middle trophic level species like deer. This upward trend has negatively affected driver safety, increased

traffic times, and wasted millions of dollars. Those costs are incurred both as direct and indirect results of WVCs through things like insurance claims, insurance rates, auto repairs, medical bills, funeral costs, and lost time spent on the road. The time spent by first responders, DOT incident teams, and police dealing with these accidents could also be seen as a cost of WVCs. Mitigation tactics are also provided including things like wildlife fencing, crossing structures, and crossing signage.

The broad nature of the report allows for national, long term trends to be identified. It also makes it difficult to evaluate the effect that traffic volume and individual roadway scenarios may have on data trends. A more precise scope is needed to locate those kinds of trends and potential outliers. The report was sent to congress in 2007, and since then further research has indicated that crossing signs may not actually be an effective mitigation tool (Fennig). More current national statistics on accident frequency and the costs associated with WVCs are found in the insurance ForeCAST Report (Huijser and McGowen).

ForeCAST Report: 2014-2017 Insurance Claims & Wildlife Collisions

This report compiles and analyzes all auto insurance claims that classified a loss as animal-related (Fennig). The report covers claims in the US from 2014 to 2017. Pennsylvania saw the highest number of animal vehicle collision claims, with the remainder of the top ten states seeing 50% of the total claims made during this time period. Washington was not on the top ten list during this time period; in fact, no west coast states ranked amongst the states with the most yearly animal vehicle collision insurance claims. The report also breaks down losses to top ten cities with the most

claims, with Los Angeles coming in at number nine as the only west coast city on the list. While these charts are interesting, they aren't explanatory. The report makes no attempt to explain any patterns in the location-based trends it presents. I might assume that the west coast has fewer claims because it is less populated than the east coast, but I have no way of knowing that because the report doesn't try to explain itself.

Perhaps the most valuable chart in this report lays out national animal loss claims by month. This temporal information is the only section of the report that actually does try to explain its trends. November sees the most animal loss claims due to deer mating season, with the surrounding months also trending upwards. Deer behavior and movement changes so drastically during mating season that they tend to be on the road more often and cause more accidents. Temporal trends in animal vehicle collisions before COVID-19 are well understood, making it easy to compare them to the very strange changes in traffic that occurred during 2020 (Fennig).

The Wildlife Carcass Removal Database

The data that I am using reflects the nature of animal vehicle collision data across the country. This type of data is typically collected by transportation agencies in two or more forms: animal vehicle collision reports and animal carcass data. Neither sets of data are complete on their own for many reasons. AVC reports are typically filed by people who are unable or unwilling to deal with the deceased animal themselves. They don't always include species information because citizens are not always very good at identifying species. Animal carcass data is collected by DOT incident response workers, and only if the animal carcass is considered a distraction or obstructs the roadway.

Regulatory gaps and overlap between state, county, and local municipalities also complicate records. These types of datasets are incomplete on their own because they rely heavily on people self-reporting, which affects the quality of the data. Synthesizing these datasets is a refined practice in the field habitat connectivity, and it offers the best image of a region's connectivity strengths and weaknesses.

Given the weaknesses listed, current best practices could use a lot of improvement. While I have no way to improve the data collection now, after the fact, I can use this paper to try to address inherent weaknesses in my data and assumptions at the end of the thesis. I don't believe this paper does enough to address the culturally reasons for spatial trends in the data. I plan to address these trends with some assumptions of my own (Kalisz).

Utility of Expert-Based Knowledge for Predicting Wildlife-Vehicle Collisions

Contrary to the previous article, this comprehensive examination of predictive techniques used across Canada showed that experts are generally quite proficient at predicting moose vehicle collisions (MVCs), when using factors like traffic volume (Kalisz). Habitat factors were, however, shown to be better for predicting MVCs. In addition, habitat-based models were more proficient at predicting these MVCs than driver-based models, and local officials were more proficient than nonlocal officials, however nonlocals are nearly as good. This survey likely underestimated the accuracy of these predictions, according to the researchers. Having first-hand knowledge of a habitat does seem to offer some advantage with modeling and predicting MVCs in road ecology

research. The management implications of this indicate that locality only offers a minimal advantage for employers.

No spatial or temporal variables were used in this research, making these models rather incomplete. Despite that, the survey participants were around 80% accurate at predicting MVCs in the models they were presented with, suggesting that the conclusions of the previous paper may not be accurate; accurate predictive models can be made using no spatial or temporal data. However, the inclusion of this data can only improve a model's ability to predict. These variables can only serve to offer a more complete picture of a region's situation (Hurley et al.).

A Review on the Temporal Pattern of Deer–Vehicle Accidents: Impact of Seasonal, Diurnal and Lunar Effects in Cervids

Temporal and diurnal patterns in deer vehicle accidents (DVAs) can be clearly linked to certain deer behaviors and patterns in human commutes (Steiner et al.). Diurnal increases in DVAs can be seen at dusk and dawn, time periods when deer are most active and when humans are more likely to be commuting. While many believe that daylight savings time causes an uptick in accidents, there is no definitive research regarding daylight savings and its impact on DVAs. Seasonal increases in DVAs can be linked to mating season, which in this Austrian study is in the Spring. For Washington deer that peak can be seen in November, during their own mating season. Mating deer cover more ground than deer who are not interested in finding a partner, increasing the likelihood that they may end up on roadways. These differences in species are common across different regions. Hunting seasons and outdoor tourism seasons also increase diurnal peaks in

DVAs, and these vary by region. In Washington, hunting season takes place in late October through November.

It is possible to broadly look for these patterns when assessing other animals and their road behavior, especially other ungulates and large game animals that experience a hunting season or a mating season. While these patterns have not been studied or observed in non-ungulates amongst road ecologists, they may be helpful in explaining fluctuations during a large drop in traffic volume (Steiner et al.).

Deer-Vehicle Collisions and Deer Value: an Analysis of Competing Literatures

Deer are widely considered to be a pest across the US, partially because of all of the vehicle collisions they are responsible for (Schwabe and Schuhmann). They eat our gardens, they poop on our lawns. However, they also provide meat to and sport in the form of hunting. The value of a deer can be listed in real dollars using methods that determine how much a person is willing to pay for a commodity. Any actual purchasing does not need to take place as these are valuation models that do not need to be mirrored in real world scenarios. These valuation models use hunting expenditures, household production functions, contingencies, and random utilities. Each method also tries to place a value on a different deer species, probably due to the regional differences in species across research paper. The results are varied, with valuations for an individual deer ranging from $35 to $965 in 1996. Adjusted for inflation circa 2020 (?????) that's $58 to roughly $1,600 per deer.

Assigning a dollar amount to a life is an act that should not be performed in a vacuum; the intrinsic value of deer is not something that can be quantified. Our

enjoyment of the outdoors depends, at least partially, on the existence of wildlife. Furthermore, while deer are not salmon, they do hold some cultural significance to certain indigenous tribes across Washington, and the country (Schwabe and Schuhmann).

Locations of Deer-Vehicle Collisions are Unrelated to Traffic Volume or Posted Speed Limit

Researchers used multiple regression tests to show no significant correlation existed between deer vehicle collisions (DVCs) and posted speed limits (PSLs) or annual average daily traffic flow (AADT) (Bissonette and Kassar). As a result, they claim that these two variables cannot be used to explain or predict DVCs. AADT, and similar measures of traffic flow or volume offer an incomplete image of the reality of a roadway. Construction, landslides, and changes in signage may all drastically change AADT in a stretch of roadway from one year to another. One way to account for this that should be explicitly mentioned is that these volumes are measured at many hundreds of locations across a region to give as many data points as possible and paint a more complete image of changes in traffic. I can't say if that is true of the Utah data used in this study, but it is true of the data coming out of WSDOT. PSLs may change DVCs in specific, small stretches of roads, or hotspots, but they do not tend to change DVCs in the stretches of roads where they are most common. These are roads that are in mountainous habitat, roads that curve, with low visibility, etc.

The claims made about proper modeling using spatial and temporal data, but not traffic volume data, does not necessarily match with the rest of the generally accepted literature, nor does it match with the assumptions put forth in the Shilling paper that is the

foundation of the project. However, I do intend to include spatial data, carcass data, and potentially more if possible, to create a more complete image and lend more weight to any assumptions I draw from my results (Bissonette and Kassar).

A Reprieve from US Wildlife Mortality on Roads during the COVID-19 Pandemic

This article analyzed the changes in traffic volume and change in the rate of animal vehicle collisions across four different states, as a result of stay-at-home orders put in place across these states during the COVID-19 pandemic (Shilling et al.). It is a short, quick analysis of available data from California, Idaho, Maine, and Washington. Requests were made to various agencies across all fifty states, however the short time frame necessitated by the nature of this quickly changing pandemic meant that only the state that responded in time, and with comparable datasets, could be included. As a co-author on this paper I cleaned and analyzed the changes in traffic volume in Washington state and changes in the rate of wildlife vehicle collisions in Washington state, before submitting them to Shilling so that cross-state comparisons could be made. While statistically significant changes in traffic and wildlife vehicle collisions were not present in every state, they were present in Washington. The paper finds, generally, that an approximate 50% reduction in traffic across the US may save the lives of as many as 500 million vertebrate animals in 2020.

Any attempt to compare data across state agencies is going to run into roadblocks and inconsistencies. Some important, potentially confounding factors to consider here: all four states that responded are border states, three with Canadian borders and one with a Mexican border. Three of the four states are coastal, with the fourth being very near to the coast. The fact that these states were prepared to share data of this nature on short

notice indicates that they may have a reason to regularly and properly maintain this data; it is possible that the four states that responded did so because they face an abnormally large number of wildlife vehicle collisions in comparison to other states, although the earlier insurance report leads me to believe that this is not true. It is also possible that these states responded because they have exceptionally robust or well-funded habitat connectivity programs, an implication with its own potential issues.

While the ability to extrapolate results and conclusions out so that they apply to the entire country creates a project that has wide implications, narrowing in on a specific region allows for a more in -depth exploration of specific animals, roadways, and scenarios. Vertebrates are the focus of this study, however vertebrates in North America can range in size from very small, like a squirrel, to very large, like a moose. Some of them are endangered, and some are invasive pests. For this reason, the author states that further research can and should be done with a focus on specific animal species, and that rates at which they were affected by these drops in traffic volume (Shilling et al.).

Conclusion

A large-scale reduction in traffic volume like the one seen as a result of the COVID-19 pandemic was an unprecedented opportunity to see the world as it could be if fewer people drove personal vehicles. This kind of massive reduction was not a trend that has been widely studied in road ecology, which made its effects on AVCs difficult to predict. According to the literature, lower traffic volumes alone cannot explain lower AVCS, however this may have been a special exception. By comparing volume and temporal data across multiple years this project aims to determine just how much of an

exception 2020 was in lowering AVCs. The inclusion of temporal data also seeks to place this project within a similar framework as existing, current research.

Methods

Introduction & Roadmap

This chapter begins by laying out the origins and circumstances under which traffic volume data and AVC carcass data is collected and cleaned. This will be followed by an explanation of the statistical analyses used in this paper.

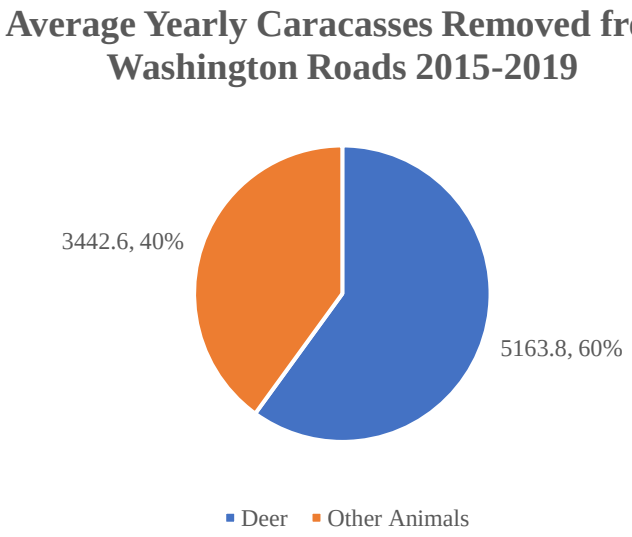
Data

Traffic Volume Data

WSDOT maintains and updates a COVID-19 Transportation System Report where changes in transportation infrastructure are monitored including changes in volume of cars on the road, as well as changes in toll collections, transit ridership, etc. For the purposes of this paper I will focus on changes in the volume of cars on the road. These changes in traffic volume are measured as a percent change in volume of cars on the road on corresponding weeks in 2020 and 2019, which is referred to as the "base" year. The volume of cars is measured using traffic cameras at 36 different highway intersections across Benton, Clark, Franklin, King, Lewis, Pierce, Snohomish, Spokane, and Thurston counties, for a total of nine of Washington's 39 counties. Of these nine counties, three are located in eastern Washington, four are located directly adjacent to the Puget Sound, and two are located in western Washington but are not directly adjacent to the sound. Most of these counties contain large, urban population centers, and all of them are in the top 16 most populous counties in the state, with Lewis county at number 16.

Carcass Data

The Carcass Removal Database (CRD) is an internal database maintained by WSDOT and populated by its Incident Response Team (IRT). When animal carcasses are removed from the roadway they must be logged in the CRD. Carcasses are removed from the roadway under a handful of specific scenarios, the most common being directly after an AVC during which emergency services are called. In these scenarios, state or local police call on WSDOT to remove the carcass from the roadway. Another common scenario occurs when an individual is involved in an AVC and simply continues driving, either because they do not wish to remove the carcass themselves or because they may not be aware that they have even collided with an animal. When a carcass is physically blocking the roadway, police or citizens contact an IRT, which will be dispatched to remove it. The least common scenario occurs when a carcass is not physically in the roadway but adjacent to it. Under these circumstances if a carcass is found to be a visual distraction, because motorists are disturbed or distracted by its visibility from the roadway, then it may be removed by an IRT.



Removing a carcass from the roadway may mean different things depending on the location, appearance, and size of the carcass. Small carcasses or those deemed unlikely to be a visual distraction, or unlikely to attract scavengers to the roadway, may be placed or pulled into right of ways so that they are out of sight from the roadway. Larger carcasses, especially those which may be disturbing to look at, are often transported to pit sites across the state. These sites are under various state agency jurisdictions and are typically kept behind locked fences. Here the carcasses can decompose and be consumed by scavengers without causing a distraction or attracting those scavengers to the roadway. Whether a carcass is transported to a pit sight or not, if it is moved by an IRT then it is logged in the CRD (Kalisz).

Other Data Under Consideration

Monetary Data

The estimated average costs of AVCs are taken from a National Insurance Crime Bureau Forecast Report which analyzes and documents cost trends in automobile insurance claims with the loss type "animal" submitted in the US from January 2014 to December 2017.

Statistical Analysis

Percent Change in Traffic Volume From 2019 to 2020

WSDOT has calculated the percent change in traffic volume between corresponding weeks in 2019 and 2020 in their COVID-19 Transportation System Report. As previously stated, this data is also separated by intersection. Individual

intersections were removed to better visualize state-wide trends temporally. Weekly timeframes were maintained, and a monthly average percent change was added.

Percent Change in AVCs from 2015-2019 to 2020

The percent change in AVCs from 2015-2019 as compared to the corresponding week in 2020 was calculated by me using carcass data from the CRD, and is broken down by species, game size, and deer vs non-deer AVCs. Weekly time frames were based on WSDOT data timeframes, and a monthly and yearly sum and average was added.

Results

Introduction

This chapter lays out the results of the data collection and processing methods used in this paper and discusses what went wrong as well as what went right with that process. Next, a summary of the result of the statistical analysis performed with this data is provided.

Data and Sample Collection Details

What Went Right

Traffic Volume Data

Daily traffic volume data on state owned roadways has been reliably collected and processed consistently by WSDOT for decades prior to 2020, offering a consistent view of traffic data trends across the state. Spatial and temporal breakdowns provide greater detail and make trends easier to track.

Carcass Removal Data

The WSDOT Habitat Connectivity Team works to follow up on potentially inaccurate species identification, allowing some of that error to be corrected by wildlife biologists who have a better understanding of local wildlife and their home ranges.

What Went Wrong

Traffic Volume Data

There were a few errors in the traffic volume data collection. Camera sites 19, 22, 26, 28, and 36 were missing one or days of traffic data due to short-term malfunctions in

the traffic volume cameras. In addition, all of the volume cameras were missing data from March 12, 2020 due to Daylight Savings time.

When analyzing traffic volume data, a lack of coverage is also a source of error. WSDOT traffic volume cameras cover state highways, not local or county roads. Changes in traffic volume are likely much more variable when considering localized traffic, however the data provided does not measure those changes. Finally, specific measurement locations appear to be skewing both county and regional averages. For example: a new Amazon warehouse opened in Spokane within 17 miles of traffic volume monitoring site 25. Traffic volume in this area showed a marked increase over nearly the entirety of 2020, a unique occurrence when compared to most other locations. In a sense, increased demand for online shopping, and the shipping in requires, could be described as an effect of COVID-19 "Stay-at-Home" orders in Washington state, however this localized increase in traffic volume was an unexpected effect.

Changes in traffic volume are bound to be more pronounced in an area that normally has more cars on the road. Given the focus of these measuring devices in counties that normally have a high volume it is possible that these changes represent the higher end of the spectrum compared to counties with smaller populations. These volumes are also measured at highway intersections, some interstate highways and some state highways. It is possible that traffic on county, forest, residential, and private roads did not dip as drastically for various reasons, such as the lack of work commutes on these types of roads.

Carcass Removal Data

The carcass removal data (CRD) has some caveats and shortcomings. Widespread use of iPads by IRTs did not begin until 2015. The CRD shows a sharp increase in data points during this year. For this reason, I have opted to only use data from 2015 onward. The CRD is populated by various WSDOT employees across the state, most of whom are not employed as wildlife biologists, meaning that accurate species identification is not always consistent.

Another potential error in CRD reports comes from the cultural differences in citizen reporting of carcasses in the western half of the state versus the eastern half of the state. Eastern Washington residents appear to be less likely to report carcasses as physically obstructive or visually distracting. In part, this may be because they are removing the carcasses and/or salvaging the animals themselves. The salvaging of deer carcasses from AVCs was legalized in 2016 in Washington state. Citizens need only report their salvage to the Washington State Department of Wildlife (WDFW) to obtain a free salvage tag. A higher percentage of salvage tags come from eastern Washington than western, as do more hunting licenses. It is also important to consider that Western Washington has more urban centers and a denser population, and it is possible that the citizens of this region are more likely to report a carcass for removal because a higher number of people are encountering any given carcass on the roadway.

Summary of all Data Produced

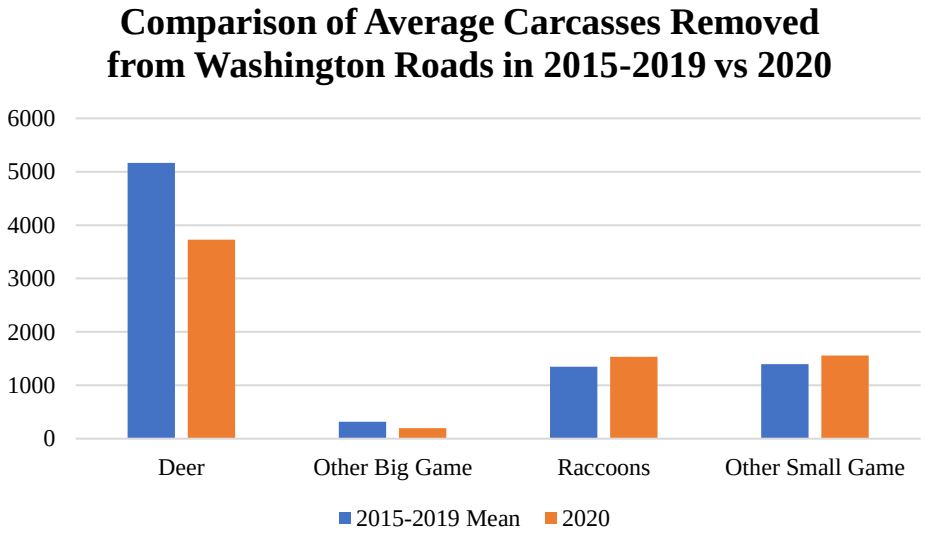
Changes in Traffic Volume

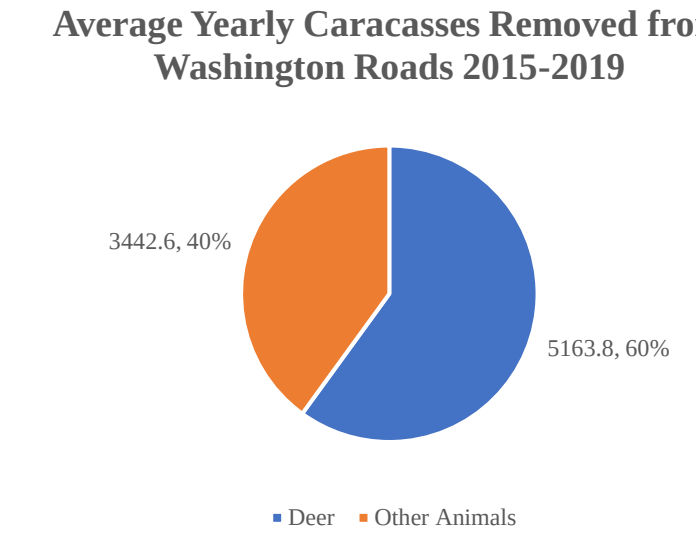
Traffic volume saw a reduction of 20% across the entire state of Washington from March to December 2020. A greater reduction, of 38%, can be seen during from the start of the "Stay at Home" order to April 26, 2020, while smaller reductions in traffic volume were seen during June, bottoming out at an 11% reduction in traffic volume. On a more granular level, all regions saw overall reductions in traffic volumes, with the northwest region experiencing the largest average drop in traffic volume at 25%, and the eastern region experiencing the smallest average drop in traffic volume at 7%. Within these regions, all counties saw reductions in traffic volume during the allotted time period, with King County seeing the greatest reduction at 25%, and Spokane county seeing the smallest reduction at 6%. However, on a site-to-site basis some anomalies stood out, primarily the marked increase of small game AVCs that occurred during this time.

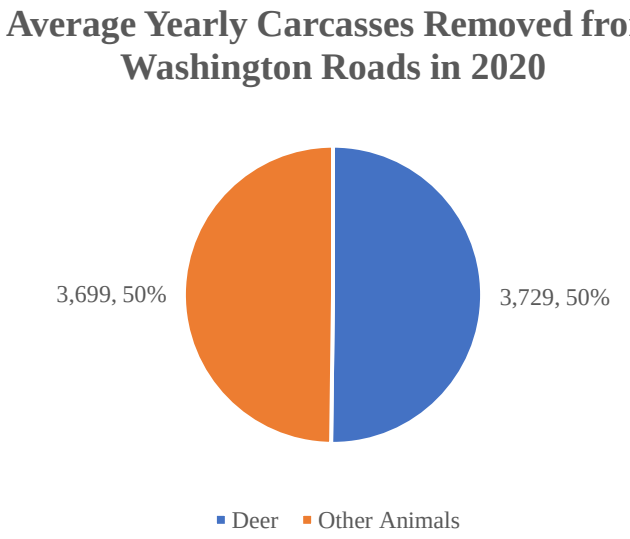
Changes in Carcass Removal Data

Changes in carcass removal data from the CRD describes changes from the number of carcasses removed from state roadways in 2020 versus the number of carcasses removed from roadways on average from 2015-2019. Carcass data is not presented by county or region in this study. When looking at all carcass data, there was an 18% reduction in carcass removals across the state of Washington. When considering deer, the largest subgroup represented in the CRD and a significant contributor to AVCs, the overall trend was downward, with 21% fewer deer carcasses removed from state roadways. Small game, a subgroup which represents 21 different animals, saw an overall trend upwards, with 9.8% more small game carcasses being removed from state roadways. One species, raccoons, had a particularly tough year. Compared to their 2015-

2019 average, 185 more raccoon carcasses were reported as removed during 2020. That's an increase of 5%. Big game, the smallest subgroup including only six animals and two non-ungulates, saw an overall trend downward, with 10.8% fewer carcasses removed. In addition, a few species with small populations saw small improvements in the number of carcasses removed in 2020. These changes may not be significant due to small numbers, but they may be significant for a small population of animals. Black bears, for example, went from an average of 20 carcasses removed yearly to 14 in 2020, a 30% decrease.




Average Yearly Caracasses Removed from Washington Roads 2015-2019
3442.6, 40%
5163.8, 60%
Deer
Other Animals


Average Yearly Carcasses Removed from Washington Roads in 2020
3,699, 50%
3,729, 50%
Deer
Other Animals

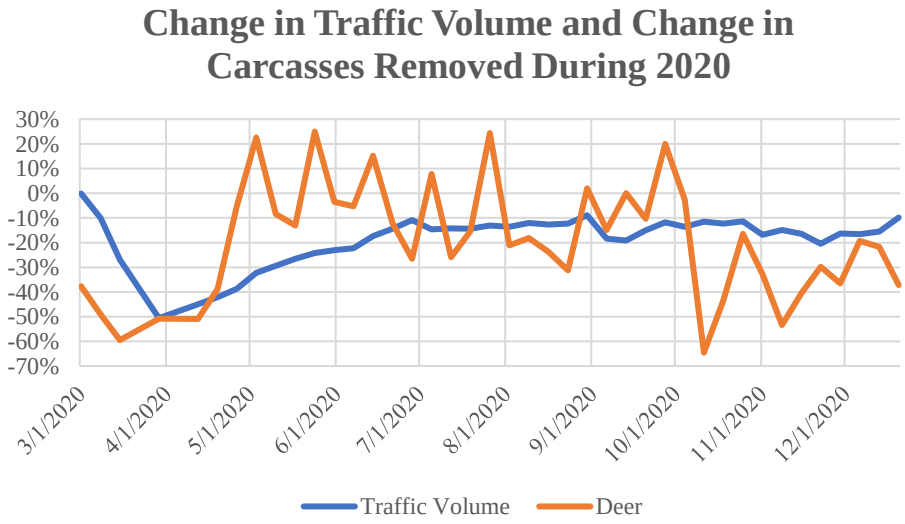

Change in Traffic Volume and Change in Carcasses Removed During 2020
30%
20%
10%
0%
-10%
-20%
-30%
-40%
-50%
-60%
-70%
3/1/2020
4/1/2020
5/1/2020
6/1/2020
7/1/2020
8/1/2020
9/1/2020
10/1/2020
11/1/2020
12/1/2020
Traffic Volume
Deer

Table 1. *Traffic Volume & Carcass Data, Condensed*

Traffic Volume & Carcass Data, Condensed

Traffic Volume & Carcass Data, Condensed													
		Traffic Volume Percent Change										Carcasses Removed	
2019 Date	2020 Date	State Avg.	Benton	Clark	Franklin	King	Lewis	Pierce	Snohomish	Spokane	Thurston	Total	Deer
3/3/2019	3/1/2020	-0.10%	8.43%	0.39%	12.14%	-4.63%	-0.71%	-5.50%	-4.64%	16.89%	-2.29%	-21.82%	-37.74%
3/10/2019	3/8/2020	-10.05%	0.50%	-9.71%	4.50%	-16.44%	-10.17%	-13.83%	-14.17%	6.87%	-12.42%	-43.01%	-49.07%
3/17/2019	3/15/2020	-26.91%	-27.43%	-26.68%	-21.29%	-31.68%	-26.71%	-28.36%	-29.21%	-13.77%	-29.79%	-46.82%	-59.46%
3/24/2019	3/22/2020	-45.27%	-47.29%	-46.14%	-41.43%	-50.41%	-47.43%	-45.50%	-50.21%	-29.57%	-47.50%	-49.01%	-44.44%
3/31/2019	3/29/2020	-50.58%	-49.71%	-48.71%	-44.43%	-56.18%	-49.43%	-50.14%	-56.43%	-38.66%	-51.71%	-27.52%	-50.82%
4/7/2019	4/5/2020	-47.72%	-49.57%	-45.89%	-44.14%	-52.62%	-46.00%	-46.57%	-52.50%	-36.43%	-50.71%	-17.12%	-8.00%
4/14/2019	4/12/2020	-44.92%	-45.86%	-44.04%	-41.29%	-50.84%	-43.14%	-43.86%	-50.43%	-30.66%	-47.50%	-20.00%	-50.85%
4/21/2019	4/19/2020	-42.12%	-35.43%	-42.36%	-31.43%	-48.88%	-41.71%	-42.69%	-47.64%	-27.43%	-43.86%	-25.97%	-38.89%
4/28/2019	4/26/2020	-38.79%	-40.43%	-38.50%	-34.29%	-45.16%	-37.57%	-37.90%	-42.93%	-23.40%	-40.00%	-7.14%	-5.45%
5/5/2019	5/3/2020	-32.27%	-36.57%	-33.68%	-29.86%	-38.21%	-32.14%	-29.88%	-35.43%	-17.63%	-33.50%	8.20%	22.64%
5/12/2019	5/10/2020	-29.44%	-33.86%	-31.25%	-27.00%	-35.68%	-30.43%	-27.43%	-31.86%	-12.11%	-32.36%	17.81%	-8.45%
5/19/2019	5/17/2020	-26.49%	-14.57%	-29.46%	-25.00%	-33.26%	-27.43%	-24.05%	-29.29%	-7.86%	-31.79%	-2.54%	-13.11%
5/26/2019	5/24/2020	-24.20%	-21.71%	-25.79%	-22.29%	-32.63%	-24.14%	-23.69%	-29.50%	-0.11%	-25.93%	26.92%	25.00%
6/2/2019	5/31/2020	-23.02%	-28.86%	-23.32%	-23.00%	-31.35%	-22.57%	-21.84%	-24.64%	-1.11%	-23.57%	1.34%	-3.45%
6/9/2019	6/7/2020	-22.24%	-30.00%	-23.43%	-22.71%	-29.42%	-24.71%	-20.50%	-24.50%	-2.77%	-21.00%	4.83%	-5.26%
6/16/2019	6/14/2020	-17.31%	-27.29%	-20.04%	-19.29%	-24.03%	-17.57%	-14.95%	-19.79%	2.51%	-17.00%	-1.95%	15.19%
6/23/2019	6/21/2020	-14.38%	-25.71%	-15.68%	-19.29%	-20.79%	-13.29%	-11.62%	-15.29%	4.17%	-14.43%	9.03%	-12.15%
6/30/2019	6/28/2020	-10.91%	-13.86%	-11.54%	-8.29%	-18.39%	-7.14%	-8.43%	-12.50%	7.80%	-11.50%	-28.32%	-26.60%
7/7/2019	7/5/2020	-14.66%	-21.86%	-15.25%	-17.71%	-20.79%	-11.43%	-12.17%	-15.14%	1.91%	-16.36%	-7.22%	7.84%
7/14/2019	7/12/2020	-14.25%	-16.14%	-14.50%	-13.29%	-20.99%	-14.00%	-12.21%	-15.43%	2.14%	-16.57%	-16.58%	-25.89%
7/21/2019	7/19/2020	-14.31%	-19.43%	-15.36%	-15.29%	-20.66%	-13.14%	-12.62%	-15.00%	2.40%	-15.36%	0.63%	-15.38%
7/28/2019	7/26/2020	-13.10%	-17.29%	-13.54%	-14.86%	-18.69%	-11.14%	-11.43%	-14.93%	2.11%	-15.14%	17.86%	24.39%
8/4/2019	8/2/2020	-13.56%	-16.00%	-13.96%	-13.14%	-20.03%	-13.14%	-11.88%	-15.36%	3.17%	-16.21%	-24.75%	-21.15%
8/11/2019	8/9/2020	-12.00%	-17.57%	-12.68%	-15.00%	-17.45%	-10.71%	-10.21%	-13.64%	3.89%	-14.43%	-20.81%	-18.18%
8/18/2019	8/16/2020	-12.72%	-20.00%	-13.93%	-14.29%	-18.49%	-11.14%	-11.10%	-13.14%	3.71%	-14.21%	-19.69%	-23.71%
8/25/2019	8/23/2020	-12.23%	-19.71%	-11.29%	-14.29%	-16.96%	-10.29%	-10.00%	-11.93%	-1.46%	-13.36%	-23.29%	-31.18%
9/1/2019	8/30/2020	-8.96%	-19.14%	-6.79%	-14.57%	-13.62%	-4.71%	-7.38%	-8.93%	1.97%	-8.07%	6.22%	1.98%
9/8/2019	9/6/2020	-18.35%	-22.86%	-17.21%	-20.57%	-21.75%	-9.00%	-22.71%	-14.43%	-8.43%	-15.79%	-22.89%	-14.94%
9/15/2019	9/13/2020	-19.19%	-24.00%	-20.41%	-22.14%	-21.66%	-15.43%	-20.31%	-16.64%	-11.49%	-18.00%	12.87%	0.00%
9/22/2019	9/20/2020	-15.01%	-16.57%	-18.14%	-13.71%	-17.76%	-10.71%	-15.17%	-12.71%	-4.69%	-12.86%	-7.07%	-10.38%
9/29/2019	9/27/2020	-11.82%	-16.86%	-9.96%	-11.71%	-14.44%	-6.00%	-10.19%	-10.00%	-2.29%	-10.86%	17.76%	20.00%
10/6/2019	10/4/2020	-13.56%	-16.00%	-12.00%	-11.86%	-16.32%	-8.43%	-13.38%	-13.29%	-2.20%	-12.86%	-20.87%	-2.59%
10/13/2019	10/11/2020	-11.57%	-17.43%	-11.04%	-11.43%	-16.09%	-7.86%	-8.86%	-13.07%	-2.83%	-10.79%	-56.04%	-64.53%
10/20/2019	10/18/2020	-12.35%	-18.00%	-10.54%	-11.29%	-16.41%	-7.00%	-10.17%	-12.57%	-7.06%	-9.57%	-35.38%	-43.26%
10/27/2019	10/25/2020	-11.34%	-15.71%	-9.68%	-9.14%	-15.51%	-6.43%	-11.05%	-11.71%	-4.00%	-8.79%	-12.55%	-16.45%
11/3/2019	11/1/2020	-16.81%	-17.86%	-12.79%	-13.00%	-25.08%	-11.14%	-15.38%	-21.57%	-3.57%	-10.43%	-25.00%	-32.70%
11/10/2019	11/8/2020	-14.92%	-16.71%	-13.54%	-11.29%	-20.54%	-10.14%	-11.81%	-18.57%	-7.09%	-12.07%	-52.67%	-53.33%
11/17/2019	11/15/2020	-16.46%	-18.14%	-16.11%	-13.14%	-21.49%	-12.71%	-14.07%	-17.36%	-9.17%	-13.64%	-42.61%	-40.46%
11/24/2019	11/22/2020	-20.40%	-20.14%	-20.39%	-14.00%	-24.65%	-22.14%	-18.48%	-22.86%	-12.51%	-21.14%	-29.63%	-29.76%
12/1/2019	11/29/2020	-16.29%	-19.14%	-15.00%	-11.29%	-20.57%	-13.71%	-13.71%	-15.86%	-10.71%	-17.57%	-25.89%	-36.51%
12/8/2019	12/6/2020	-16.52%	-19.00%	-16.21%	-12.29%	-20.54%	-13.86%	-14.26%	-16.36%	-10.89%	-16.86%	-16.88%	-19.23%
12/15/2019	12/13/2020	-15.49%	-19.00%	-15.14%	-12.29%	-19.63%	-12.14%	-13.45%	-16.07%	-8.74%	-14.57%	-13.57%	-21.69%
12/22/2019	12/20/2020	-9.80%	-1.14%	-10.14%	-1.29%	-14.80%	-12.57%	-11.12%	-14.36%	3.89%	-12.79%	-40.12%	-37.14%
Yearly Average		-20.06%	-22.44%	-20.03%	-17.94%	-25.48%	-18.17%	-19.07%	-21.90%	-6.63%	-20.58%	-18.28%	-23.18%

Note. This table includes changes in traffic volume statewide for each week of the study period. Results are broken down by region, and for select representative counties. All changes in traffic volume are versus pre-pandemic baseline, represented as a percentage OR in decimal format. The table also includes changes in all carcasses removed as well as deer carcasses removed for each week of the study period. A more expansive presentation of this data can be found in appendix A.

Discussion and Conclusions

Introduction

This chapter covers reasons for the strong correlation between drops in traffic volume and AVCs, as well as the confounding factors that prevent me from claiming a statistical causation for said correlation. This chapter also summarizes the larger implications of this project and lays out potential avenues for future research.

Correlation Between Traffic Changes and Animal-Vehicle Collisions

From March to December 2020 traffic volume decreased by 20%. The most notable drop compared to volumes in March was 38%, occurring the week of April 26 during the early "Stay at Home" order. Smaller overall reductions, rebounding to an 11% decrease, were seen the week of June 28, 2020. The northwest region experienced the average largest traffic reduction at 25%, while the eastern region had the smallest at 7% on average over the entire 9 month period. The largest weekly decrease in traffic volume was 39% and occurred the week of April 26, 2020. The smallest weekly decrease occurred the week of December 20, 2020, which saw only a 10% decrease. Carcass removal data showed an 18% reduction statewide in 2020 compared to the 2015-2019 yearly average. Annual small game removals increased by 9.8% versus average, while raccoons specifically saw a 5% increase. Big game carcass removals declined by 10.8%. Most significantly, deer carcasses decreased by 21% versus the five year average, an almost exact correlation to the 20% overall yearly decrease in traffic volume.

A direct linear relationship between these two averages should not be assumed, as

confounding factors like seasonality and regionality can not be controlled for. This is especially true as traffic volume reductions were not constant, but oscillated throughout the year. It may be that decreases in traffic volumes during the year didn't correspond to times when animals are more (or less) likely to be on the roadway. For example, deer were much more likely to be on the roadway in the fall during mating season than they are during the rest of the year. For traffic volume decreases that occurred outside of the fall we may not expect to have seen as big of a reduction in deer AVCs. In addition, deer mating season varies by species, with different species occupying different regions of the state, and some overlapping. This was regardless of human seasonal schedule changes such as those with schools, colleges, vacations, and Daylight Savings.

Lack of Causation

Some changes were observed year over year in AVCs, but the direction and magnitude of these changes were not consistent between different types of animals. Overall, AVCs did decrease 18% in total for all animals, a strong correlation to the 20% traffic volume decrease. However, there were too many confounding factors in both human and animal behavior to make it possible for us to infer causation.

It is difficult to infer causation for other reasons. Unusual and irregular driving schedules for humans plays a role in the strength of the correlation between traffic volume and AVCs, combined with changes in "Stay at Home" phases and surges in COVID-19 cases. While wildlife, and deer especially, may be able to adapt to large-scale changes in human driving behavior, that ability may be weakened by inconsistency. That inconsistency can be seen in the traffic volume data. However, describing the changes in

the traffic volume data is much easier to do than pinpointing the reasons for spikes and drops in the data. Predicting those traffic inconsistencies was most likely impossible for wildlife.

Confounding factors: deer

When looking at deer behavior specifically, the significant drop in carcasses seen may be directly attributed to work-from-home practices that became widely implemented in 2020. This was especially true for those that worked during standard business hours. Deer AVCs are useful to break out from total AVCs as they compose the single largest AVC group and the single largest drop in carcasses. Deer are crepuscular animals, meaning they are most active at two points of the day: dusk and dawn. These periods of high activity often line up with the average 9-5 worker's driving commute. As these workers began to stay home, either to work or because of lack of employment, deer and human rush hours coincided less often. Because of this crepuscular behavior on the part of deer, it is expected that it isn't just the overall miles driven that would correlate to AVCs but more specifically commuting miles. On the other hand, increases or decreases in daytime miles would be expected to have less influence on deer related AVCs. For these reasons we cannot assume direct causation between vehicle miles and AVCs, even if there is a correlation.

Confounding factors: small game

The apparent 9.8% increase in the number of small game carcasses was an unexpected finding. Typical driving behaviors likely underwent a number of changes

during 2020; people driving shorter distances, and using highways less often. Small game AVCs are much more common on residential and smaller roads, and less frequently reported for major highways (Rico et al.). Therefore, a greater proportion of miles driven on narrow roadways might be expected to result in more small animal AVCs. This is what was apparent in this study's data. It may be that reduced traffic resulted in quieter roadways, which encouraged increased animal crossings. It is also possible that speeding on these more narrow roadways makes AVCs a more likely possibility. However, this study does not have the necessary information to distinguish between these possibilities. Many of the small game animals studied, such as racoons and coyotes are also crepuscular, but did not see a decrease in AVCs in the same way that deer did. Any, all, or a combination of these changes may have contributed to the increase in small game carcasses on roadways. Another possibility is that small game animal carcasses were simply reported more often as people who sat at home and walked their pets were more likely to see these caracasses and call them in.

Final Conclusions

Big picture meaning and implications

Work-from-home as the norm for a majority of non-service jobs would likely see a long-term reduction in AVCs, especially those involving deer. As many private and public offices grappled with the decision of whether or not to bring employees back to in-person work, AVCs and the loss of life and money associated with them are legitimate considerations. This potential long term reduction in AVCs for deer may also lead to a boom in deer population, which should continue to be monitored long term.

Regardless of how permanent work-from-home jobs become, traffic volume will inevitably increase in tandem with business and recreational activities. In more recent history and looking forward, one may expect increases in AVCs to be correlated with driving activity, though not as has been noted here in a direct fashion. For this reason, wildlife crossing structures, wildlife fencing, and crossing signs should be considered to reduce potential spikes in AVCs as human driving behavior continues to vary.

Directions for future research

The continued monitoring of traffic volumes compared to carcass removals is a necessary place for research to continue, given the uncertainty of the results of this thesis, and the many confounding factors listed above. It may be some time before human driving behaviors reach a new equilibrium, and while we can expect the wildlife to continue to benefit from overall reduced traffic volumes, we can also expect the wildlife to continue to face our changing behaviors with a certain level of confusion. Only continued monitoring will reveal whether or not "Stay-at-Home" orders were an overall net-benefit for the wildlife of Washington state. Towards the end of the study period, traffic volumes were at a 9% reduction, which is still a sizable decrease that is worth striving for.

Habitat fragmentation may have been less impactful during 2020 due to the lack of traffic volume. The noise and movement of a roadway is a barrier that fragments habitats, and this barrier would have been considerably more permeable with 20% lower traffic volume. If fewer animals were being hit by cars on roadways then we should expect that many animals were able to actually cross roads safely, reaching habitat and

potential mates on the other side. For species like deer, already considered a pest by many due to their out of control populations, this may actually have a negative impact on future population numbers, sending them even higher. For protected and endangered species, especially big game, the unexpected increase in connectivity seen during 2020 may have provided immensely valuable opportunities for mating and reproduction. Continued monitoring of wildlife populations over the oming two years will provide further insight.

Temporal changes in traffic volume may be explained by a few variables for the purposes of this study, mainly COVID-19 cases and AQI. Air quality data shows a peak in hazardous air quality conditions in Washington state at the end of September 2020, likely due to wildfires. While AQI was likely improved overall by the decrease in traffic volume that occurred during 2020, the future of hazardous air quality conditions is projected to worsen due to climate change. It is unclear how that may affect animal and human behavior, and conversely, AVCs.

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Appendices

Region		Olympic										Olympic Avg
	County	Pierce						Pierce Avg	Thurston		Thurson Avg	
	Site Number	12	13	16	28	31	32		14	21		
Day of Past Date	Day of Date											
Sun, 03/03/19	Sun, 03/01/20	-0.04	-0.15	-0.04	-0.08	-0.01	-0.02	-0.06	-0.04	0.00	-0.02	-0.04
Sun, 03/10/19	Sun, 03/08/20	-0.13	-0.23	-0.15	-0.16	-0.08	-0.09	-0.14	-0.14	-0.11	-0.12	-0.13
Sun, 03/17/19	Sun, 03/15/20	-0.29	-0.35	-0.29	-0.31	-0.22	-0.24	-0.28	-0.30	-0.29	-0.30	-0.29
Sun, 03/24/19	Sun, 03/22/20	-0.47	-0.52	-0.47	-0.49	-0.38	-0.40	-0.46	-0.48	-0.47	-0.48	-0.47
Sun, 03/31/19	Sun, 03/29/20	-0.51	-0.57	-0.53	-0.53	-0.42	-0.45	-0.50	-0.53	-0.50	-0.52	-0.51
Sun, 04/07/19	Sun, 04/05/20	-0.48	-0.54	-0.49	-0.50	-0.36	-0.42	-0.47	-0.50	-0.52	-0.51	-0.49
Sun, 04/14/19	Sun, 04/12/20	-0.46	-0.52	-0.46	-0.47	-0.34	-0.38	-0.44	-0.47	-0.48	-0.48	-0.46
Sun, 04/21/19	Sun, 04/19/20	-0.44	-0.50	-0.45	-0.47	-0.32	-0.37	-0.43	-0.45	-0.42	-0.44	-0.43
Sun, 04/28/19	Sun, 04/26/20	-0.40	-0.44	-0.41	-0.40	-0.28	-0.34	-0.38	-0.41	-0.39	-0.40	-0.39
Sun, 05/05/19	Sun, 05/03/20	-0.32	-0.35	-0.34	-0.29	-0.21	-0.28	-0.30	-0.34	-0.33	-0.34	-0.32
Sun, 05/12/19	Sun, 05/10/20	-0.30	-0.32	-0.32	-0.27	-0.17	-0.26	-0.27	-0.33	-0.31	-0.32	-0.30
Sun, 05/19/19	Sun, 05/17/20	-0.27	-0.29	-0.27	-0.22	-0.16	-0.22	-0.24	-0.33	-0.31	-0.32	-0.28
Sun, 05/26/19	Sun, 05/24/20	-0.26	-0.29	-0.27	-0.22	-0.17	-0.21	-0.24	-0.26	-0.26	-0.26	-0.25
Sun, 06/02/19	Sun, 05/31/20	-0.23	-0.27	-0.25	-0.25	-0.12	-0.19	-0.22	-0.23	-0.24	-0.24	-0.23
Sun, 06/09/19	Sun, 06/07/20	-0.22	-0.26	-0.23	-0.24	-0.10	-0.18	-0.21	-0.21	-0.21	-0.21	-0.21
Sun, 06/16/19	Sun, 06/14/20	-0.17	-0.21	-0.19	-0.18	0.00	-0.14	-0.15	-0.16	-0.18	-0.17	-0.16
Sun, 06/23/19	Sun, 06/21/20	-0.13	-0.19	-0.15	-0.11	0.01	-0.11	-0.12	-0.13	-0.16	-0.14	-0.13
Sun, 06/30/19	Sun, 06/28/20	-0.10	-0.16	-0.09	-0.10	0.02	-0.09	-0.08	-0.11	-0.12	-0.12	-0.10
Sun, 07/07/19	Sun, 07/05/20	-0.14	-0.17	-0.13	-0.12	-0.04	-0.12	-0.12	-0.15	-0.18	-0.16	-0.14
Sun, 07/14/19	Sun, 07/12/20	-0.14	-0.17	-0.13	-0.12	-0.07	-0.10	-0.12	-0.15	-0.18	-0.17	-0.14
Sun, 07/21/19	Sun, 07/19/20	-0.12	-0.17	-0.14	-0.11	-0.11	-0.11	-0.13	-0.14	-0.16	-0.15	-0.14
Sun, 07/28/19	Sun, 07/26/20	-0.12	-0.17	-0.12	-0.07	-0.11	-0.11	-0.11	-0.15	-0.16	-0.15	-0.13
Sun, 08/04/19	Sun, 08/02/20	-0.12	-0.17	-0.12	-0.07	-0.13	-0.10	-0.12	-0.16	-0.16	-0.16	-0.14
Sun, 08/11/19	Sun, 08/09/20	-0.10	-0.15	-0.11	-0.06	-0.11	-0.08	-0.10	-0.14	-0.15	-0.14	-0.12
Sun, 08/18/19	Sun, 08/16/20	-0.09	-0.15	-0.09	-0.06	-0.16	-0.11	-0.11	-0.13	-0.15	-0.14	-0.13
Sun, 08/25/19	Sun, 08/23/20	-0.10	-0.14	-0.11	-0.01	-0.15	-0.09	-0.10	-0.12	-0.14	-0.13	-0.12
Sun, 09/01/19	Sun, 08/30/20	-0.06	-0.10	-0.07	-0.04	-0.12	-0.06	-0.07	-0.09	-0.07	-0.08	-0.08
Sun, 09/08/19	Sun, 09/06/20	-0.11	-0.16	-0.12	-0.14	-0.65	-0.19	-0.23	-0.15	-0.17	-0.16	-0.19
Sun, 09/15/19	Sun, 09/13/20	-0.14	-0.17	-0.14	-0.14	-0.47	-0.16	-0.20	-0.17	-0.19	-0.18	-0.19
Sun, 09/22/19	Sun, 09/20/20	-0.11	-0.14	-0.10	-0.10	-0.32	-0.13	-0.15	-0.14	-0.12	-0.13	-0.14
Sun, 09/29/19	Sun, 09/27/20	-0.08	-0.10	-0.07	-0.07	-0.20	-0.09	-0.10	-0.11	-0.11	-0.11	-0.11
Sun, 10/06/19	Sun, 10/04/20	-0.10	-0.14	-0.11	-0.11	-0.23	-0.11	-0.13	-0.14	-0.12	-0.13	-0.13
Sun, 10/13/19	Sun, 10/11/20	-0.10	-0.14	-0.09	-0.09	-0.04	-0.09	-0.09	-0.10	-0.11	-0.11	-0.10
Sun, 10/20/19	Sun, 10/18/20	-0.08	-0.14	-0.08	-0.09	-0.13	-0.09	-0.10	-0.10	-0.09	-0.10	-0.10
Sun, 10/27/19	Sun, 10/25/20	-0.09	-0.13	-0.09	-0.10	-0.16	-0.09	-0.11	-0.09	-0.08	-0.09	-0.10
Sun, 11/03/19	Sun, 11/01/20	-0.12	-0.23	-0.12	-0.22	-0.13	-0.10	-0.15	-0.13	-0.08	-0.10	-0.13
Sun, 11/10/19	Sun, 11/08/20	-0.12	-0.17	-0.12	-0.14	-0.06	-0.10	-0.12	-0.14	-0.10	-0.12	-0.12
Sun, 11/17/19	Sun, 11/15/20	-0.16	-0.18	-0.14	-0.16	-0.08	-0.13	-0.14	-0.17	-0.10	-0.14	-0.14
Sun, 11/24/19	Sun, 11/22/20	-0.20	-0.24	-0.20	-0.20	-0.11	-0.16	-0.18	-0.22	-0.20	-0.21	-0.20
Sun, 12/01/19	Sun, 11/29/20	-0.16	-0.18	-0.15	-0.14	-0.06	-0.13	-0.14	-0.17	-0.18	-0.18	-0.16
Sun, 12/08/19	Sun, 12/06/20	-0.16	-0.18	-0.16	-0.16	-0.08	-0.12	-0.14	-0.16	-0.18	-0.17	-0.16
Sun, 12/15/19	Sun, 12/13/20	-0.14	-0.17	-0.14	-0.16	-0.09	-0.11	-0.13	-0.16	-0.13	-0.15	-0.14
Sun, 12/22/19	Sun, 12/20/20	-0.14	-0.16	-0.13	-0.12	-0.05	-0.07	-0.11	-0.13	-0.12	-0.13	-0.12
Yearly Average		-0.19	-0.24	-0.19	-0.19	-0.17	-0.17	-0.19	-0.21	-0.20	-0.21	-0.20

Region		Southwest						Southwest Avg
	County	Clark				Clark Avg	Lewis	
	Site Number	2	19	20	27		8	
Day of Past Date	Day of Date							
Sun, 03/03/19	Sun, 03/01/20	0.01	0.00	0.01	0.00	0.00	-0.01	0.00
Sun, 03/10/19	Sun, 03/08/20	-0.08	-0.10	-0.09	-0.11	-0.10	-0.10	-0.10
Sun, 03/17/19	Sun, 03/15/20	-0.26	-0.24	-0.28	-0.29	-0.27	-0.27	-0.27
Sun, 03/24/19	Sun, 03/22/20	-0.45	-0.43	-0.49	-0.47	-0.46	-0.47	-0.47
Sun, 03/31/19	Sun, 03/29/20	-0.49	-0.45	-0.52	-0.49	-0.49	-0.49	-0.49
Sun, 04/07/19	Sun, 04/05/20	-0.46	-0.40	-0.49	-0.49	-0.46	-0.46	-0.46
Sun, 04/14/19	Sun, 04/12/20	-0.43	-0.39	-0.47	-0.47	-0.44	-0.43	-0.44
Sun, 04/21/19	Sun, 04/19/20	-0.42	-0.37	-0.45	-0.45	-0.42	-0.42	-0.42
Sun, 04/28/19	Sun, 04/26/20	-0.38	-0.33	-0.41	-0.42	-0.39	-0.38	-0.38
Sun, 05/05/19	Sun, 05/03/20	-0.34	-0.30	-0.35	-0.36	-0.34	-0.32	-0.33
Sun, 05/12/19	Sun, 05/10/20	-0.31	-0.28	-0.33	-0.32	-0.31	-0.30	-0.31
Sun, 05/19/19	Sun, 05/17/20	-0.29	-0.27	-0.31	-0.31	-0.29	-0.27	-0.28
Sun, 05/26/19	Sun, 05/24/20	-0.26	-0.24	-0.25	-0.27	-0.26	-0.24	-0.25
Sun, 06/02/19	Sun, 05/31/20	-0.23	-0.23	-0.20	-0.27	-0.23	-0.23	-0.23
Sun, 06/09/19	Sun, 06/07/20	-0.23	-0.22	-0.22	-0.26	-0.23	-0.25	-0.24
Sun, 06/16/19	Sun, 06/14/20	-0.20	-0.21	-0.18	-0.21	-0.20	-0.18	-0.19
Sun, 06/23/19	Sun, 06/21/20	-0.16	-0.16	-0.13	-0.18	-0.16	-0.13	-0.14
Sun, 06/30/19	Sun, 06/28/20	-0.11	-0.10	-0.13	-0.12	-0.12	-0.07	-0.09
Sun, 07/07/19	Sun, 07/05/20	-0.16	-0.15	-0.13	-0.17	-0.15	-0.11	-0.13
Sun, 07/14/19	Sun, 07/12/20	-0.16	-0.14	-0.13	-0.15	-0.15	-0.14	-0.14
Sun, 07/21/19	Sun, 07/19/20	-0.16	-0.16	-0.14	-0.16	-0.15	-0.13	-0.14
Sun, 07/28/19	Sun, 07/26/20	-0.14	-0.15	-0.12	-0.14	-0.14	-0.11	-0.12
Sun, 08/04/19	Sun, 08/02/20	-0.12	-0.16	-0.13	-0.15	-0.14	-0.13	-0.14
Sun, 08/11/19	Sun, 08/09/20	-0.12	-0.14	-0.11	-0.14	-0.13	-0.11	-0.12
Sun, 08/18/19	Sun, 08/16/20	-0.13	-0.18	-0.10	-0.15	-0.14	-0.11	-0.13
Sun, 08/25/19	Sun, 08/23/20	-0.10	-0.14	-0.09	-0.12	-0.11	-0.10	-0.11
Sun, 09/01/19	Sun, 08/30/20	-0.06	-0.10	-0.04	-0.07	-0.07	-0.05	-0.06
Sun, 09/08/19	Sun, 09/06/20	-0.16	-0.21	-0.09	-0.23	-0.17	-0.09	-0.13
Sun, 09/15/19	Sun, 09/13/20	-0.15	-0.26	-0.15	-0.26	-0.20	-0.15	-0.18
Sun, 09/22/19	Sun, 09/20/20	0.06	-0.49	-0.11	-0.19	-0.18	-0.11	-0.14
Sun, 09/29/19	Sun, 09/27/20	-0.03	-0.20	-0.05	-0.13	-0.10	-0.06	-0.08
Sun, 10/06/19	Sun, 10/04/20	-0.09	-0.16	-0.08	-0.15	-0.12	-0.08	-0.10
Sun, 10/13/19	Sun, 10/11/20	-0.09	-0.14	-0.07	-0.14	-0.11	-0.08	-0.09
Sun, 10/20/19	Sun, 10/18/20	-0.08	-0.14	-0.06	-0.14	-0.11	-0.07	-0.09
Sun, 10/27/19	Sun, 10/25/20	-0.09	-0.12	-0.05	-0.14	-0.10	-0.06	-0.08
Sun, 11/03/19	Sun, 11/01/20	-0.11	-0.16	-0.09	-0.15	-0.13	-0.11	-0.12
Sun, 11/10/19	Sun, 11/08/20	-0.12	-0.16	-0.10	-0.16	-0.14	-0.10	-0.12
Sun, 11/17/19	Sun, 11/15/20	-0.16	-0.19	-0.10	-0.19	-0.16	-0.13	-0.14
Sun, 11/24/19	Sun, 11/22/20	-0.19	-0.24	-0.19	-0.19	-0.20	-0.22	-0.21
Sun, 12/01/19	Sun, 11/29/20	-0.14	-0.18	-0.12	-0.17	-0.15	-0.14	-0.14
Sun, 12/08/19	Sun, 12/06/20	-0.15	-0.19	-0.11	-0.20	-0.16	-0.14	-0.15
Sun, 12/15/19	Sun, 12/13/20	-0.14	-0.18	-0.11	-0.19	-0.15	-0.12	-0.14
Sun, 12/22/19	Sun, 12/20/20	-0.10	-0.14	-0.09	-0.09	-0.10	-0.13	-0.11
Yearly Average		-0.19	-0.21	-0.18	-0.22	-0.20	-0.18	-0.19

Region		Northwest								
	County	King								
	Site Number	3	5	6	7	10	11	15	17	18
Day of Past Date	Day of Date									
Sun, 03/03/19	Sun, 03/01/20	-0.07	-0.09	-0.05	-0.04	-0.04	-0.07	-0.05	-0.01	-0.04
Sun, 03/10/19	Sun, 03/08/20	-0.21	-0.22	-0.16	-0.15	-0.15	-0.17	-0.17	-0.11	-0.14
Sun, 03/17/19	Sun, 03/15/20	-0.35	-0.36	-0.32	-0.30	-0.30	-0.31	-0.31	-0.27	-0.29
Sun, 03/24/19	Sun, 03/22/20	-0.53	-0.54	-0.50	-0.48	-0.49	-0.50	-0.51	-0.46	-0.47
Sun, 03/31/19	Sun, 03/29/20	-0.61	-0.61	-0.57	-0.54	-0.55	-0.54	-0.55	-0.51	-0.51
Sun, 04/07/19	Sun, 04/05/20	-0.57	-0.57	-0.55	-0.51	-0.51	-0.51	-0.52	-0.49	-0.49
Sun, 04/14/19	Sun, 04/12/20	-0.55	-0.56	-0.52	-0.49	-0.49	-0.49	-0.50	-0.47	-0.46
Sun, 04/21/19	Sun, 04/19/20	-0.53	-0.53	-0.50	-0.46	-0.48	-0.47	-0.48	-0.44	-0.44
Sun, 04/28/19	Sun, 04/26/20	-0.48	-0.49	-0.45	-0.43	-0.43	-0.43	-0.44	-0.41	-0.40
Sun, 05/05/19	Sun, 05/03/20	-0.41	-0.42	-0.39	-0.38	-0.36	-0.37	-0.37	-0.33	-0.35
Sun, 05/12/19	Sun, 05/10/20	-0.37	-0.39	-0.34	-0.35	-0.35	-0.34	-0.35	-0.31	-0.30
Sun, 05/19/19	Sun, 05/17/20	-0.35	-0.36	-0.34	-0.34	-0.31	-0.31	-0.32	-0.32	-0.30
Sun, 05/26/19	Sun, 05/24/20	-0.34	-0.35	-0.33	-0.34	-0.30	-0.31	-0.33	-0.31	-0.32
Sun, 06/02/19	Sun, 05/31/20	-0.29	-0.32	-0.27	-0.30	-0.28	-0.31	-0.34	-0.28	-0.36
Sun, 06/09/19	Sun, 06/07/20	-0.30	-0.32	-0.28	-0.29	-0.25	-0.27	-0.29	-0.22	-0.27
Sun, 06/16/19	Sun, 06/14/20	-0.25	-0.27	-0.23	-0.24	-0.22	-0.22	-0.24	-0.18	-0.23
Sun, 06/23/19	Sun, 06/21/20	-0.19	-0.22	-0.19	-0.21	-0.18	-0.20	-0.23	-0.17	-0.23
Sun, 06/30/19	Sun, 06/28/20	-0.16	-0.18	-0.22	-0.18	-0.13	-0.18	-0.21	-0.14	-0.20
Sun, 07/07/19	Sun, 07/05/20	-0.20	-0.22	-0.19	-0.20	-0.15	-0.20	-0.23	-0.16	-0.20
Sun, 07/14/19	Sun, 07/12/20	-0.20	-0.23	-0.19	-0.20	-0.17	-0.18	-0.23	-0.15	-0.20
Sun, 07/21/19	Sun, 07/19/20	-0.19	-0.22	-0.20	-0.20	-0.17	-0.18	-0.22	-0.13	-0.20
Sun, 07/28/19	Sun, 07/26/20	-0.17	-0.20	-0.15	-0.17	-0.15	-0.18	-0.22	-0.11	-0.17
Sun, 08/04/19	Sun, 08/02/20	-0.18	-0.21	-0.17	-0.19	-0.15	-0.18	-0.23	-0.15	-0.18
Sun, 08/11/19	Sun, 08/09/20	-0.14	-0.18	-0.14	-0.17	-0.14	-0.16	-0.21	-0.12	-0.17
Sun, 08/18/19	Sun, 08/16/20	-0.15	-0.18	-0.15	-0.17	-0.12	-0.17	-0.20	-0.14	-0.16
Sun, 08/25/19	Sun, 08/23/20	-0.13	-0.16	-0.14	-0.16	-0.13	-0.17	-0.19	-0.11	-0.14
Sun, 09/01/19	Sun, 08/30/20	-0.10	-0.12	-0.12	-0.14	-0.09	-0.13	-0.15	-0.10	-0.13
Sun, 09/08/19	Sun, 09/06/20	-0.19	-0.23	-0.18	-0.20	-0.16	-0.20	-0.23	-0.15	-0.19
Sun, 09/15/19	Sun, 09/13/20	-0.20	-0.22	-0.18	-0.18	-0.17	-0.20	-0.22	-0.16	-0.18
Sun, 09/22/19	Sun, 09/20/20	-0.17	-0.19	-0.15	-0.16	-0.13	-0.17	-0.19	-0.13	-0.15
Sun, 09/29/19	Sun, 09/27/20	-0.15	-0.17	-0.12	-0.15	-0.10	-0.14	-0.16	-0.11	-0.13
Sun, 10/06/19	Sun, 10/04/20	-0.18	-0.19	-0.13	-0.15	-0.13	-0.18	-0.20	-0.14	-0.15
Sun, 10/13/19	Sun, 10/11/20	-0.17	-0.19	-0.14	-0.16	-0.12	-0.17	-0.19	-0.12	-0.15
Sun, 10/20/19	Sun, 10/18/20	-0.16	-0.18	-0.13	-0.15	-0.12	-0.17	-0.19	-0.13	-0.15
Sun, 10/27/19	Sun, 10/25/20	-0.15	-0.17	-0.12	-0.15	-0.12	-0.15	-0.17	-0.11	-0.14
Sun, 11/03/19	Sun, 11/01/20	-0.28	-0.37	-0.34	-0.26	-0.15	-0.28	-0.26	-0.14	-0.18
Sun, 11/10/19	Sun, 11/08/20	-0.21	-0.24	-0.20	-0.20	-0.15	-0.20	-0.19	-0.15	-0.18
Sun, 11/17/19	Sun, 11/15/20	-0.21	-0.24	-0.18	-0.20	-0.17	-0.22	-0.21	-0.17	-0.19
Sun, 11/24/19	Sun, 11/22/20	-0.25	-0.27	-0.23	-0.24	-0.23	-0.26	-0.25	-0.21	-0.23
Sun, 12/01/19	Sun, 11/29/20	-0.22	-0.24	-0.20	-0.21	-0.18	-0.20	-0.22	-0.19	-0.20
Sun, 12/08/19	Sun, 12/06/20	-0.21	-0.24	-0.20	-0.21	-0.19	-0.19	-0.21	-0.18	-0.21
Sun, 12/15/19	Sun, 12/13/20	-0.19	-0.22	-0.19	-0.20	-0.17	-0.18	-0.20	-0.16	-0.18
Sun, 12/22/19	Sun, 12/20/20	-0.17	-0.14	-0.17	-0.18	-0.16	-0.16	-0.20	-0.19	-0.19
Yearly Average		-0.26	-0.28	-0.24	-0.25	-0.22	-0.25	-0.26	-0.21	-0.24

Region										Northwest Avg
	County					King Avg	Snohomish		Snohomish Avg	
	Site Number	22	26	29	33		4	9		
Day of Past Date	Day of Date									
Sun, 03/03/19	Sun, 03/01/20	-0.08	0.04	0.10	-0.20	-0.05	-0.06	-0.03	-0.05	-0.05
Sun, 03/10/19	Sun, 03/08/20	-0.25	-0.04	0.02	-0.41	-0.16	-0.16	-0.12	-0.14	-0.15
Sun, 03/17/19	Sun, 03/15/20	-0.41	-0.18	-0.12	-0.59	-0.32	-0.31	-0.28	-0.29	-0.30
Sun, 03/24/19	Sun, 03/22/20	-0.60	-0.42	-0.33	-0.72	-0.50	-0.50	-0.51	-0.50	-0.50
Sun, 03/31/19	Sun, 03/29/20	-0.64	-0.52	-0.39	-0.77	-0.56	-0.56	-0.57	-0.56	-0.56
Sun, 04/07/19	Sun, 04/05/20	-0.60	-0.43	-0.36	-0.72	-0.53	-0.52	-0.53	-0.53	-0.53
Sun, 04/14/19	Sun, 04/12/20	-0.61	-0.43	-0.32	-0.73	-0.51	-0.51	-0.50	-0.50	-0.51
Sun, 04/21/19	Sun, 04/19/20	-0.59	-0.41	-0.29	-0.73	-0.49	-0.48	-0.47	-0.48	-0.48
Sun, 04/28/19	Sun, 04/26/20	-0.57	-0.37	-0.25	-0.71	-0.45	-0.44	-0.42	-0.43	-0.44
Sun, 05/05/19	Sun, 05/03/20	-0.50	-0.24	-0.18	-0.67	-0.38	-0.37	-0.34	-0.35	-0.37
Sun, 05/12/19	Sun, 05/10/20	-0.49	-0.22	-0.18	-0.65	-0.36	-0.34	-0.30	-0.32	-0.34
Sun, 05/19/19	Sun, 05/17/20	-0.45	-0.19	-0.12	-0.61	-0.33	-0.31	-0.28	-0.29	-0.31
Sun, 05/26/19	Sun, 05/24/20	-0.44	-0.14	-0.15	-0.59	-0.33	-0.31	-0.28	-0.30	-0.31
Sun, 06/02/19	Sun, 05/31/20	-0.47	-0.17	-0.10	-0.59	-0.31	-0.26	-0.23	-0.25	-0.28
Sun, 06/09/19	Sun, 06/07/20	-0.44	-0.19	-0.10	-0.58	-0.29	-0.26	-0.23	-0.25	-0.27
Sun, 06/16/19	Sun, 06/14/20	-0.39	-0.09	-0.04	-0.52	-0.24	-0.21	-0.19	-0.20	-0.22
Sun, 06/23/19	Sun, 06/21/20	-0.34	-0.07	-0.01	-0.48	-0.21	-0.16	-0.14	-0.15	-0.18
Sun, 06/30/19	Sun, 06/28/20	-0.27	-0.07	-0.08	-0.38	-0.18	-0.11	-0.14	-0.13	-0.15
Sun, 07/07/19	Sun, 07/05/20	-0.34	-0.01	-0.11	-0.49	-0.21	-0.17	-0.14	-0.15	-0.18
Sun, 07/14/19	Sun, 07/12/20	-0.34	-0.02	-0.12	-0.50	-0.21	-0.17	-0.14	-0.15	-0.18
Sun, 07/21/19	Sun, 07/19/20	-0.33	-0.05	-0.12	-0.47	-0.21	-0.16	-0.14	-0.15	-0.18
Sun, 07/28/19	Sun, 07/26/20	-0.30	-0.05	-0.10	-0.46	-0.19	-0.16	-0.14	-0.15	-0.17
Sun, 08/04/19	Sun, 08/02/20	-0.31	-0.06	-0.11	-0.48	-0.20	-0.17	-0.14	-0.15	-0.18
Sun, 08/11/19	Sun, 08/09/20	-0.28	0.00	-0.08	-0.46	-0.17	-0.14	-0.13	-0.14	-0.16
Sun, 08/18/19	Sun, 08/16/20	-0.26	-0.04	-0.10	-0.54	-0.18	-0.14	-0.12	-0.13	-0.16
Sun, 08/25/19	Sun, 08/23/20	-0.24	-0.03	-0.09	-0.51	-0.17	-0.12	-0.12	-0.12	-0.14
Sun, 09/01/19	Sun, 08/30/20	-0.22	-0.05	-0.05	-0.37	-0.14	-0.09	-0.09	-0.09	-0.11
Sun, 09/08/19	Sun, 09/06/20	-0.31	-0.05	-0.16	-0.57	-0.22	-0.16	-0.12	-0.14	-0.18
Sun, 09/15/19	Sun, 09/13/20	-0.32	-0.10	-0.12	-0.57	-0.22	-0.16	-0.17	-0.17	-0.19
Sun, 09/22/19	Sun, 09/20/20	-0.30	0.00	-0.10	-0.46	-0.18	-0.13	-0.12	-0.13	-0.15
Sun, 09/29/19	Sun, 09/27/20	-0.26	0.10	-0.07	-0.43	-0.14	-0.11	-0.09	-0.10	-0.12
Sun, 10/06/19	Sun, 10/04/20	-0.30	0.03	-0.07	-0.33	-0.16	-0.14	-0.12	-0.13	-0.15
Sun, 10/13/19	Sun, 10/11/20	-0.31	0.00	-0.06	-0.32	-0.16	-0.14	-0.12	-0.13	-0.15
Sun, 10/20/19	Sun, 10/18/20	-0.31	0.07	-0.06	-0.45	-0.16	-0.13	-0.12	-0.13	-0.14
Sun, 10/27/19	Sun, 10/25/20	-0.28	0.06	-0.07	-0.43	-0.16	-0.13	-0.11	-0.12	-0.14
Sun, 11/03/19	Sun, 11/01/20	-0.39	0.00	-0.27	-0.35	-0.25	-0.27	-0.16	-0.22	-0.23
Sun, 11/10/19	Sun, 11/08/20	-0.34	-0.13	-0.14	-0.34	-0.21	-0.22	-0.15	-0.19	-0.20
Sun, 11/17/19	Sun, 11/15/20	-0.34	-0.08	-0.12	-0.48	-0.21	-0.19	-0.16	-0.17	-0.19
Sun, 11/24/19	Sun, 11/22/20	-0.32	-0.10	-0.17	-0.44	-0.25	-0.24	-0.22	-0.23	-0.24
Sun, 12/01/19	Sun, 11/29/20	-0.33	0.11	-0.12	-0.48	-0.21	-0.18	-0.14	-0.16	-0.18
Sun, 12/08/19	Sun, 12/06/20	-0.33	0.10	-0.13	-0.49	-0.21	-0.18	-0.15	-0.16	-0.18
Sun, 12/15/19	Sun, 12/13/20	-0.32	0.04	-0.12	-0.45	-0.20	-0.17	-0.15	-0.16	-0.18
Sun, 12/22/19	Sun, 12/20/20	-0.10	0.02	-0.10	-0.19	-0.15	-0.12	-0.16	-0.14	-0.15
Yearly Average		-0.36	-0.10	-0.13	-0.50	-0.25	-0.23	-0.21	-0.22	-0.24

Region		South Central				South Central Avg	Eastern					Eastern Avg
	County	Benton		Benton Avg	Franklin		Spokane					Spokane Avg
	Site Number	30	36		1		23	24	25	34	35	
Day of Past Date	Day of Date											
Sun, 03/03/19	Sun, 03/01/20	0.08	-0.03	0.03	0.12	0.08	0.07	0.02	0.61	0.01	0.12	0.17
Sun, 03/10/19	Sun, 03/08/20	0.00	-0.02	-0.01	0.05	0.02	-0.03	-0.07	0.44	-0.07	0.07	0.07
Sun, 03/17/19	Sun, 03/15/20	-0.27	-0.18	-0.23	-0.21	-0.22	-0.23	-0.26	0.17	-0.29	-0.08	-0.14
Sun, 03/24/19	Sun, 03/22/20	-0.47	-0.38	-0.42	-0.41	-0.42	-0.40	-0.42	-0.03	-0.43	-0.20	-0.30
Sun, 03/31/19	Sun, 03/29/20	-0.50	-0.42	-0.46	-0.44	-0.45	-0.47	-0.48	-0.20	-0.51	-0.27	-0.39
Sun, 04/07/19	Sun, 04/05/20	-0.50	-0.43	-0.46	-0.44	-0.45	-0.45	-0.47	-0.15	-0.48	-0.27	-0.36
Sun, 04/14/19	Sun, 04/12/20	-0.46	-0.37	-0.42	-0.41	-0.41	-0.41	-0.25	-0.11	-0.45	-0.31	-0.31
Sun, 04/21/19	Sun, 04/19/20	-0.35	-0.26	-0.31	-0.31	-0.31	-0.36	-0.10	-0.08	-0.43	-0.39	-0.27
Sun, 04/28/19	Sun, 04/26/20	-0.40	-0.33	-0.37	-0.34	-0.35	-0.33	-0.06	-0.03	-0.41	-0.34	-0.23
Sun, 05/05/19	Sun, 05/03/20	-0.37	-0.27	-0.32	-0.30	-0.31	-0.28	0.01	0.03	-0.34	-0.30	-0.18
Sun, 05/12/19	Sun, 05/10/20	-0.34	-0.26	-0.30	-0.27	-0.29	-0.24	0.07	0.10	-0.28	-0.26	-0.12
Sun, 05/19/19	Sun, 05/17/20	-0.15	-0.31	-0.23	-0.25	-0.24	-0.21	0.12	0.19	-0.29	-0.21	-0.08
Sun, 05/26/19	Sun, 05/24/20	-0.22	-0.22	-0.22	-0.22	-0.22	-0.14	0.20	0.31	-0.21	-0.16	0.00
Sun, 06/02/19	Sun, 05/31/20	-0.29	-0.20	-0.25	-0.23	-0.24	-0.14	0.21	0.32	-0.22	-0.23	-0.01
Sun, 06/09/19	Sun, 06/07/20	-0.30	-0.19	-0.25	-0.23	-0.24	-0.11	0.22	0.35	-0.24	-0.37	-0.03
Sun, 06/16/19	Sun, 06/14/20	-0.27	-0.16	-0.21	-0.19	-0.20	-0.07	0.27	0.46	-0.20	-0.34	0.03
Sun, 06/23/19	Sun, 06/21/20	-0.26	-0.18	-0.22	-0.19	-0.21	-0.04	0.28	0.41	-0.15	-0.29	0.04
Sun, 06/30/19	Sun, 06/28/20	-0.14	-0.19	-0.16	-0.08	-0.12	-0.01	0.37	0.42	-0.10	-0.30	0.08
Sun, 07/07/19	Sun, 07/05/20	-0.22	-0.19	-0.20	-0.18	-0.19	-0.08	0.27	0.37	-0.17	-0.29	0.02
Sun, 07/14/19	Sun, 07/12/20	-0.16	-0.12	-0.14	-0.13	-0.14	-0.08	0.27	0.38	-0.16	-0.30	0.02
Sun, 07/21/19	Sun, 07/19/20	-0.19	-0.13	-0.16	-0.15	-0.16	-0.06	0.28	0.35	-0.16	-0.30	0.02
Sun, 07/28/19	Sun, 07/26/20	-0.17	-0.13	-0.15	-0.15	-0.15	-0.07	0.29	0.33	-0.15	-0.30	0.02
Sun, 08/04/19	Sun, 08/02/20	-0.16	-0.11	-0.14	-0.13	-0.13	-0.06	0.29	0.35	-0.14	-0.29	0.03
Sun, 08/11/19	Sun, 08/09/20	-0.18	-0.13	-0.15	-0.15	-0.15	-0.06	0.29	0.39	-0.14	-0.29	0.04
Sun, 08/18/19	Sun, 08/16/20	-0.20	-0.14	-0.17	-0.14	-0.16	-0.05	0.26	0.40	-0.14	-0.28	0.04
Sun, 08/25/19	Sun, 08/23/20	-0.20	-0.13	-0.16	-0.14	-0.15	-0.05	0.33	0.06	-0.14	-0.28	-0.01
Sun, 09/01/19	Sun, 08/30/20	-0.19	-0.12	-0.15	-0.15	-0.15	0.01	0.44	0.02	-0.10	-0.28	0.02
Sun, 09/08/19	Sun, 09/06/20	-0.23	-0.18	-0.20	-0.21	-0.20	-0.09	0.26	-0.05	-0.18	-0.36	-0.08
Sun, 09/15/19	Sun, 09/13/20	-0.24	-0.18	-0.21	-0.22	-0.21	-0.10	0.24	-0.13	-0.22	-0.37	-0.11
Sun, 09/22/19	Sun, 09/20/20	-0.17	-0.31	-0.24	-0.14	-0.19	-0.05	0.33	-0.07	-0.13	-0.32	-0.05
Sun, 09/29/19	Sun, 09/27/20	-0.17	-0.49	-0.33	-0.12	-0.22	-0.04	0.37	-0.03	-0.11	-0.31	-0.02
Sun, 10/06/19	Sun, 10/04/20	-0.16	-0.48	-0.32	-0.12	-0.22	-0.05	0.34	0.07	-0.13	-0.34	-0.02
Sun, 10/13/19	Sun, 10/11/20	-0.17	N/A	-0.17	-0.11	-0.14	-0.07	0.33	0.06	-0.15	-0.32	-0.03
Sun, 10/20/19	Sun, 10/18/20	-0.18	N/A	-0.18	-0.11	-0.15	-0.13	0.26	0.04	-0.18	-0.34	-0.07
Sun, 10/27/19	Sun, 10/25/20	-0.16	-0.09	-0.13	-0.09	-0.11	-0.11	0.25	0.18	-0.16	-0.35	-0.04
Sun, 11/03/19	Sun, 11/01/20	-0.18	-0.12	-0.15	-0.13	-0.14	-0.13	0.31	0.13	-0.13	-0.35	-0.04
Sun, 11/10/19	Sun, 11/08/20	-0.17	-0.10	-0.14	-0.11	-0.12	-0.14	0.28	0.11	-0.20	-0.40	-0.07
Sun, 11/17/19	Sun, 11/15/20	-0.18	-0.13	-0.15	-0.13	-0.14	-0.15	0.24	0.03	-0.21	-0.37	-0.09
Sun, 11/24/19	Sun, 11/22/20	-0.20	-0.15	-0.17	-0.14	-0.16	-0.16	0.23	-0.07	-0.23	-0.40	-0.13
Sun, 12/01/19	Sun, 11/29/20	-0.19	-0.12	-0.16	-0.11	-0.14	-0.15	0.26	-0.09	-0.20	-0.36	-0.11
Sun, 12/08/19	Sun, 12/06/20	-0.19	-0.11	-0.15	-0.12	-0.14	-0.15	0.26	-0.08	-0.20	-0.37	-0.11
Sun, 12/15/19	Sun, 12/13/20	-0.19	-0.13	-0.16	-0.12	-0.14	-0.13	0.28	-0.04	-0.18	-0.36	-0.09
Sun, 12/22/19	Sun, 12/20/20	-0.01	-0.03	-0.02	-0.01	-0.02	0.04	0.51	0.10	-0.10	-0.36	0.04
Yearly Average		-0.22		-0.20	-0.21	-0.18	-0.20	-0.14	0.17	0.14	-0.21	-0.29	-0.07

Category	Sub-Category	2015		2016		2017		2018		2,019		2015-2019 Sum		2015-2019 Mean		2020	
		Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Mean	Mean %	Total	%
Deer*		5,490	0.757868581	5,443	0.61301948	4,786	0.570033349	5,392	0.55132924	4,708	0.53928981	25,819	0.599995352	5163.8	0.60002324	3,729	0.50222222
Non-Deer		1,754	0.242131419	3,436	0.38698052	3,610	0.429966651	4,388	0.44867076	4,025	0.46105384	17,213	0.400004648	3442.6	0.40002324	3,699	0.49818182
		7,244	1	8,879	1	8,396	1.000000000	9,780	1	8,733	1	43,032	1	8,606	1	7,428	1
Ungulates		5,767	0.796107123	5,734	0.64579345	5,069	0.603739876	5,708	0.58364008	5,010	0.57388316	27,288	0.634132738	5457.6	0.63416221	3,909	0.52646465
	Deer	5,490	0.757868581	5,443	0.61301948	4,786	0.570033349	5,392	0.55132924	4,708	0.53928981	25,819	0.599995352	5163.8	0.60002324	3,729	0.50222222
	Elk	248	0.034235229	265	0.0298457	259	0.030848023	294	0.03006135	283	0.03241695	1,349	0.031348764	269.8	0.03135022	164	0.02208754
	Moose	23	0.003175041	21	0.00236513	16	0.001905669	17	0.00173824	14	0.00160367	91	0.002114705	18.2	0.0021148	14	0.00188552
	Big Horn Sheep	6	0.000828272	5	0.00056313	8	0.000952835	5	0.00051125	5	0.00057274	29	0.000673917	5.8	0.00067395	5	0.0006734
Non-Ungulates		1,477	0.203892877	3,145	0.35420655	3,327	0.396260124	4,072	0.41635992	3,723	0.42646048	15,744	0.365867262	3148.8	0.36588427	3,516	0.47353535
		7,244	1	8,879	1	8,396	1.000000000	9,780	1	8,733	1.00034364	43,032	1	8,606	1.00004648	7428	1.00040404
Big Game		5,806	0.801490889	5,757	0.64838383	5,084	0.605526441	5,727	58.56	5,034	0.5766323	27,409	0.636944599	5481.8	0.6369742	3,927	0.52888889
	Ungulates	5,767	0.796107123	5,734	0.64579345	5,069	0.603739876	5,708	58.37	5,010	0.57388316	27,288	0.634132738	5457.6	0.63416221	3,909	0.52646465
	Cougars	3	0.000414136	4	0.0004505	3	0.000357313	3	0.03	5	0.00057274	19	0.000441532	3.8	0.00044155	4	0.00053872
	Bears	36	0.00496963	19	0.00213988	12	0.001429252	16	0.16	19	0.0021764	102	0.002370329	20.4	0.00237044	14	0.00188552
Non-Big Game		1,438	0.198509111	3,122	0.35161617	3,312	0.394473559	4,053	41.44	3,699	0.42371134	15,623	0.363055401	3124.6	0.36307228	3,501	0.47151515
		7,244	1	8,879	1	8,396	1.000000000	9,780	100	8,733	1.00034364	43032	1	8606.4	1.00004648	7428	1.00040404
Small Game		1,223	0.168829376	2,788	0.31399932	2,898	0.345164364	3,568	36.49	3,232	0.37021764	13,712	0.318646589	2742.4	0.3186614	3,092	0.41643098
	Badger	34	0.004693539	51	0.00574389	56	0.006669843	78	0.8	45	0.00515464	264	0.006134969	52.8	0.00613525	37	0.00498316
	Beaver	38	0.005245721	155	0.01745692	148	0.017627442	132	1.35	137	0.01569301	610	0.014175497	122	0.01417616	157	0.02114478
	Bobcat	8	0.001104362	12	0.0013515	7	0.000833730	12	0.12	19	0.0021764	58	0.001347834	11.6	0.0013479	13	0.00175084
	Coyote	242	0.033406957	509	0.05732628	615	0.073249166	714	7.3	603	0.06907216	2,683	0.06234895	536.6	0.06235185	569	0.076633
	Fox	6	0.000828272	16	0.001802	7	0.000833730	10	0.1	12	0.00137457	51	0.001185165	10.2	0.00118522	6	0.00080808
	Jackrabbit	3	0.000414136	3	0.00033788	0	0.000000000	0	0	0	0	6	0.000139431	1.2	0.00013944	3	0.00040404
	Marmot	3	0.000414136	17	0.00191463	12	0.001429252	8	0.08	7	0.00080183	47	0.00109221	9.4	0.00109226	8	0.00107744
	Mink	5	0.000690226	11	0.00123888	9	0.001071939	12	0.12	10	0.00114548	47	0.00109221	9.4	0.00109226	10	0.0013468
	Mountain Beaver	5	0.000690226	0	0	0	0.000000000	0	0	3	0.00034364	8	0.000185908	1.6	0.00018592	1	0.00013468
	Muskrat	5	0.000690226	4	0.0004505	14	0.001667461	8	0.08	9	0.00103093	40	0.000929541	8	0.00092958	4	0.00053872
	Nutria	1	0.000138045	5	0.00056313	4	0.000476417	2	0.02	5	0.00057274	17	0.000395055	3.4	0.00039507	7	0.00094276
	Otter	11	0.001518498	21	0.00236513	24	0.002858504	34	0.35	11	0.00126002	101	0.002347091	20.2	0.0023472	24	0.00323232
	Porcupine	119	0.016427388	291	0.03277396	275	0.032753692	253	2.59	238	0.02726231	1,176	0.0273285	235.2	0.02732977	234	0.03151515
	Rabbit	42	0.005797902	127	0.01430341	138	0.016436398	188	1.92	188	0.02153494	683	0.015871909	136.6	0.01587265	187	0.02518519
	Raccoon	647	0.089315295	1,342	0.15114315	1,319	0.157098618	1,767	18.07	1,667	0.19095074	6,742	0.156674103	1348.4	0.15668139	1,533	0.20646465
	Skunk	45	0.006212038	201	0.02263768	242	0.028823249	313	3.2	244	0.0279496	1,045	0.024284254	209	0.02428538	257	0.03461279
	Squirrel	5	0.000690226	21	0.00236513	21	0.002501191	30	0.31	29	0.00332188	106	0.002463283	21.2	0.0024634	33	0.00444444
	Weasel	1	0.000138045	2	0.00022525	6	0.000714626	5	0.05	8	0.00091638	22	0.000511247	4.4	0.00051127	7	0.00094276
	Wolf	1	0.000138045	0	0	1	0.000119104	0	0	0	0	2	4.6477E-05	0.4	4.6479E-05	1	0.00013468
	Wolverine	0	0	0	0	0	0.000000000	1	0.01	0	0	1	2.32385E-05	0.2	2.324E-05	0	0
	Woodrat	2	0.000276091	0	0	0	0.000000000	1	0.01	0	0	3	6.97156E-05	0.6	6.9719E-05	1	0.00013468
Non-Small Game		6,021	0.831170624	6,091	0.68600068	5,471	0.651619819	6,212	63.51	5,498	0.62978236	29,320	0.681353411	5864	0.68138508	4,336	0.58397306
		7,244	1	8,879	1	8,369	0.996784183	9,780	99.99	8,733	1.00034364	43032	1	8606.4	1.00004648	7428	1.00040404
Ungulates		5,767	0.796107123	5,734	0.64579345	5,069	0.603739876	5,708	58.37	5,010	0.57388316	27,288	0.634132738	5457.6	0.63416221	3,909	0.52646465
Big-Game (excluding Ung)		39	0.005383766	23	0.00259038	15	0.001786565	19	0.19	24	0.00274914	121	0.002811861	24.2	0.00281199	18	0.00242424
Small-Game		1,223	0.168829376	2,788	0.31399932	2,898	0.345164364	3,568	36.49	3,232	0.37021764	13,712	0.318646589	2742.4	0.3186614	3,092	0.41643098
Herps***		5	0.000690226	3	0.00033788	5	0.000595522	7	0.07	5	0.00057274	25	0.000580963	5	0.00058099	2	0.00026936
Avian****		153	0.021120928	324	0.0364906	406	0.048356360	471	4.82	449	0.05143184	1,802	0.041875813	360.4	0.04187776	369	0.04969697
Other*****		57	0.007868581	7	0.00078838	3	0.000357313	7	0.07	10	0.00114548	84	0.001952036	16.8	0.00195213	35	0.0047138
Total carcass removal reports:		7,244	1	8,879	1	8,396	1.000000000	9,780	100	8,730	1	43,032	1	8,606	1	7,425	1

Recovered Carcasses by Week							
		All Carcasses			Deer		
Day of Past Date	Day of Date	2019	2020	Percent Change	2019	2020	Percent Change
Sun, 03/03/19	Sun, 03/01/20	165	129	-0.218181818	106	66	-0.377358491
Sun, 03/10/19	Sun, 03/08/20	186	106	-0.430107527	108	55	-0.490740741
Sun, 03/17/19	Sun, 03/15/20	173	92	-0.468208092	111	45	-0.594594595
Sun, 03/24/19	Sun, 03/22/20	151	77	-0.490066225	72	40	-0.444444444
Sun, 03/31/19	Sun, 03/29/20	109	79	-0.275229358	61	30	-0.508196721
Sun, 04/07/19	Sun, 04/05/20	111	92	-0.171171171	50	46	-0.080000000
Sun, 04/14/19	Sun, 04/12/20	105	84	-0.2	59	29	-0.508474576
Sun, 04/21/19	Sun, 04/19/20	154	114	-0.25974026	72	44	-0.388888889
Sun, 04/28/19	Sun, 04/26/20	112	104	-0.071428571	55	52	-0.054545455
Sun, 05/05/19	Sun, 05/03/20	122	132	0.081967213	53	65	0.226415094
Sun, 05/12/19	Sun, 05/10/20	146	172	0.178082192	71	65	-0.084507042
Sun, 05/19/19	Sun, 05/17/20	118	115	-0.025423729	61	53	-0.131147541
Sun, 05/26/19	Sun, 05/24/20	104	132	0.269230769	48	60	0.250000000
Sun, 06/02/19	Sun, 05/31/20	149	151	0.013422819	87	84	-0.034482759
Sun, 06/09/19	Sun, 06/07/20	145	152	0.048275862	95	90	-0.052631579
Sun, 06/16/19	Sun, 06/14/20	154	151	-0.019480519	79	91	0.151898734
Sun, 06/23/19	Sun, 06/21/20	155	169	0.090322581	107	94	-0.121495327
Sun, 06/30/19	Sun, 06/28/20	173	124	-0.283236994	94	69	-0.265957447
Sun, 07/07/19	Sun, 07/05/20	180	167	-0.072222222	102	110	0.078431373
Sun, 07/14/19	Sun, 07/12/20	199	166	-0.165829146	112	83	-0.258928571
Sun, 07/21/19	Sun, 07/19/20	159	160	0.006289308	91	77	-0.153846154
Sun, 07/28/19	Sun, 07/26/20	168	198	0.178571429	82	102	0.243902439
Sun, 08/04/19	Sun, 08/02/20	198	149	-0.247474747	104	82	-0.211538462
Sun, 08/11/19	Sun, 08/09/20	149	118	-0.208053691	77	63	-0.181818182
Sun, 08/18/19	Sun, 08/16/20	193	155	-0.196891192	97	74	-0.237113402
Sun, 08/25/19	Sun, 08/23/20	219	168	-0.232876712	93	64	-0.311827957
Sun, 09/01/19	Sun, 08/30/20	193	205	0.062176166	101	103	0.019801980
Sun, 09/08/19	Sun, 09/06/20	201	155	-0.228855721	87	74	-0.149425287
Sun, 09/15/19	Sun, 09/13/20	171	193	0.128654971	83	83	0.000000000
Sun, 09/22/19	Sun, 09/20/20	198	184	-0.070707071	106	95	-0.103773585
Sun, 09/29/19	Sun, 09/27/20	214	252	0.177570093	85	102	0.200000000
Sun, 10/06/19	Sun, 10/04/20	254	201	-0.208661417	116	113	-0.025862069
Sun, 10/13/19	Sun, 10/11/20	323	142	-0.560371517	172	61	-0.645348837
Sun, 10/20/19	Sun, 10/18/20	277	179	-0.353790614	141	80	-0.432624113
Sun, 10/27/19	Sun, 10/25/20	247	216	-0.125506073	152	127	-0.164473684
Sun, 11/03/19	Sun, 11/01/20	296	222	-0.25	211	142	-0.327014218
Sun, 11/10/19	Sun, 11/08/20	243	115	-0.526748971	165	77	-0.533333333
Sun, 11/17/19	Sun, 11/15/20	230	132	-0.426086957	131	78	-0.404580153
Sun, 11/24/19	Sun, 11/22/20	135	95	-0.296296296	84	59	-0.297619048
Sun, 12/01/19	Sun, 11/29/20	224	166	-0.258928571	126	80	-0.365079365
Sun, 12/08/19	Sun, 12/06/20	154	128	-0.168831169	78	63	-0.192307692
Sun, 12/15/19	Sun, 12/13/20	140	121	-0.135714286	83	65	-0.216867470
Sun, 12/22/19	Sun, 12/20/20	162	97	-0.401234568	70	44	-0.371428571
Totals		7659	6259	-0.182791487	4138	3179	-0.231754471