Decadal Growth of Traffic Volume on US Highway 2 in Northwestern Montana

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Abstract

We measured vehicle traffic volume at two locations on US Highway 2 along the southern boundary of Glacier National Park during 2012 and 2013 and then compared results to those collected during 1999 through 2001. We show that traffic volumes have increased substantially in the 11 years between counts and that the increases are most dramatic during the hours in which grizzly bears (*Ursus arctos*) are most likely to cross the highway. Over the preceding decade, grizzly bears have lost two hours of suitable crossing opportunity and will, should observed growth rates and traffic continue, lose an additional three hours within five years.

Key words: connectivity, grizzly bear, habitat fragmentation, highways, Montana, roads, traffic volume, *Ursus arctos*

Introduction

The purpose of this study was to examine current traffic patterns on US Highway 2 (US2), compare them to patterns measured 10 years earlier in Waller and Servheen (2005) and then discuss our findings and their implications for grizzly bear (*Ursus arctos*) conservation.

Highway systems are key elements of human progress, development and economic growth (Bhatta and Drennan 2003), but can also be agents of environmental degradation (Hamilton and Harrison 1991). Highways can divert water-ways and create large areas of impermeable surfaces, interrupting and altering hydrologic systems (Wheeler et al. 2005). They can be sources of many forms of pollution, including noise, lighting and chemical runoff (Hamilton and Harrison 1991). They can become impassable barriers to movement for many forms of wildlife, thus fragmenting habitat and populations (Forman and Alexander 1998). Highways can also cause direct wildlife mortality through vehicle collisions and may further threaten endangered species (Lode 2000). Over the past 20 years, the conservation science community has been challenged to find ways to understand, eliminate, or mitigate the detrimental impacts of road systems (Van der Ree et al. 2011). Such efforts require detailed information on how road systems affect wildlife and ecological systems. It is also useful for planning mitigation efforts as road systems change through time with respect to the surrounding environment.

From 1998 through 2001, Waller and Servheen (2005) studied how traffic on US2, affected the local grizzly bear population. They systematically captured grizzly bears within the US2 corridor between East Glacier and West Glacier, Montana, USA and fitted them with GPS telemetry collars that recorded their position hourly. Beginning in 1999, they measured highway traffic volumes and related them to observed concurrent patterns of grizzly bear movement. They found that, while about half the sampled population of grizzly bears crossed US2 frequently and successfully, there were some effects on bear behavior. Grizzly bears avoided the highway corridor and also crossed the highway less than expected. Most crossings were by young males. Grizzly bears crossed US2 most often at night and when they crossed, they moved faster and farther than expected. Crossing frequency was strongly and negatively correlated with traffic volume, reaching zero when traffic volume exceeded 100 vehicles per hour (VPH). They concluded that the primary attribute allowing continued grizzly bear population connectivity across the highway was very low observed traffic volumes during evening and night hours. Based on the observed increase in traffic volume between 1984 and 2001, Waller and Servheen (2005) hypothesized that US2 would become a complete barrier to grizzly bear movement in about 30 years.

Study Area

The northern most highway in the contiguous United States, US2, is a two-lane highway separating Glacier National Park to the north from the Bob Marshall Wilderness complex to the south (Fig. 1). The western portion of the highway lies in the valley bottom of the Middle Fork of the Flathead River, from West Glacier (elevation 974 m) to its confluence with Bear Creek at the southern tip of Glacier National Park. Here the highway continues to follow the Bear Creek valley in a northeasterly direction until it crosses the Continental Divide at Marias Pass (elevation 1,610 m). East of Marias Pass, US2 parallels the Two Medicine River and crosses the western boundary of the Blackfeet Indian Reservation (elevation 1,462 m). A major railroad line parallels US2 for its entire length within the study area. This railroad line is a primary freight corridor between Chicago, Illinois and Seattle, Washington. Small concentrations of seasonal homes, businesses, ranches and small communities exist within the US2 corridor in the study area, but the majority of the area is undeveloped federal land. Topography associated with US2 varies from flat valley bottoms to steep mountainsides, up to 2,653 m elevation. Dominant vegetation is primarily spruce/fir forest (*Picea englemmanii/ Abies lasiocarpa*) in the western portions of the study area with open grass/forb/aspen (*Populus tremuloides*) communities in the eastern portions. Riparian areas associated with the Middle Fork Flathead River and Bear Creek parallel the highway for much of its length within the study area. Avalanche chutes, preferred grizzly bear foraging areas (Waller and Mace 1997, McLellan and Hovey 2001), occur in numerous locations, often close to the highway.

Methods

Beginning in May 2012, we placed two Unicorn Limited pneumatic tube-type traffic counters (Diamond Traffic Products, Oakridge, OR) on US2 at the identical two locations used in 1999–2001; mile marker (MM) 184 near Java Creek and MM 202 near Coonsa Creek. We configured the counters to tally the number of vehicles passing over the counter sensors each hour of the day in each lane (east- and west-bound lanes). The counters used a rubber tube stretched across the road surface to detect the passage of each axle by registering the number of air bursts transmitted through the tube by tire compression. Having counters at each end of the study area provided system redundancy should one of the counters become inoperative and allowed calculation of local vs. through traffic by comparing same-lane counts within concurrent time intervals. Because the counters actually tallied axles, we developed a correction factor for multi-axle vehicles by having an observer count axles and classify vehicle types during nine 30–60 minute observation periods, conducted at or near peak traffic periods. We then compared these actual counts to those collected by the counters to derive a ratio estimate of the true number of vehicles. Vehicle types categorized were cars (includes motorcycles and light trucks), heavy trucks (straight and combination units of 3 to 10 axles), busses, recreational vehicles (motorhomes, pickup campers, house trailers) and cars pulling various types of trailers (boats, horse trailers and utility trailers). We monitored the counters biweekly and downloaded the stored data to a laptop computer. We removed the counters with the onset of snow in October, then redeployed them in May 2013, where again they remained in place until October. We

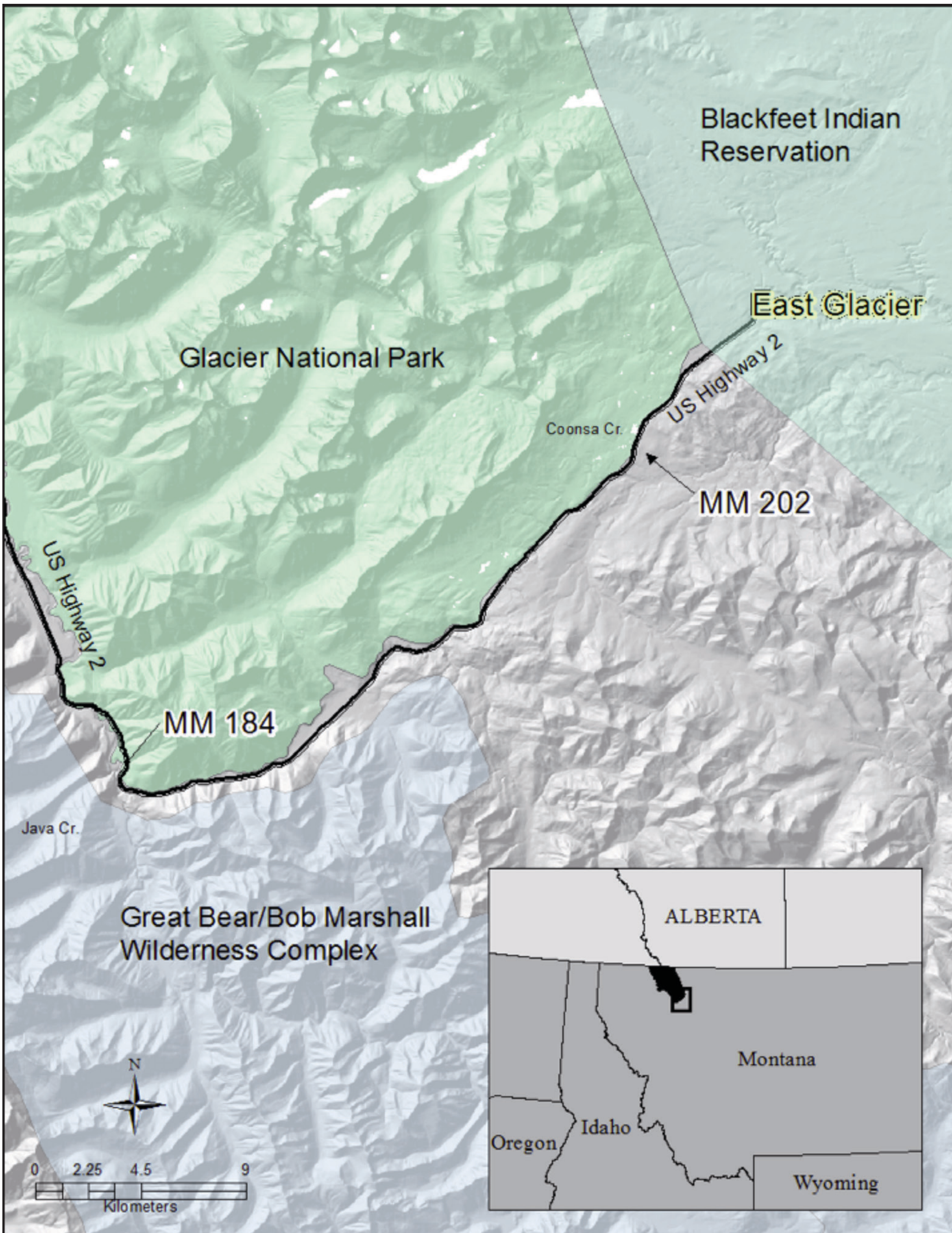

Figure 1. US Highway 2 study area and traffic counter locations in northwest Montana, USA. 1999–2001 and 2012–2013.

pooled the data collected during and within each time period, 1999 through 2001 and 2012 through 2013, to obtain mean values by hour, day and month. We performed all statistical analyses using the software Statistica (Statsoft Inc., Tulsa, OK 74104).

We estimated exponential growth rates using the formula $N_{(t)}=N_{(0)}e^{rt}$, where $N_{(t)}$ is the traffic volume at the end of the period of interest, $N_{(0)}$ is the traffic volume at the start of the period of interest, e is Euler's constant and r is the growth rate.

Results

The traffic counters recorded over 4,000 hours of highway traffic between May and October 2012 and 2013. Based on our correction factor, we estimated the actual number of vehicles to be 84 percent of the recorded number. Overall average hourly traffic volume was 112 (range 0–455) vehicles per hour (VPH)at MM 184 and 104 (range 0–390) VPH at MM 202. This was an increase from 77 (range 0–318) VPH at MM 184 and 87 (range 0–398) VPH at MM 202 from the 1999–2001 study (Waller and Servheen, 2005) (Fig. 2). Mean total vehicles per day (VPD) increased from 1806 to 2775 VPD at MM 184 and from 2066 to 2377 VPD at MM 202. Traffic volume continued to show strong daily and seasonal fluctuation (Fig. 3). As was the case in the 1999 through 2001 study period, traffic peaked at 1600 hours, but mean traffic volumes at that time of day increased in the 2012 through 2013 study period from 158 to 222 VPH at MM 184 (Fig. 4) and from 178 to 212 VPH at MM 202. Similarly, traffic volume continued to reach its minimum at 0400 hours, but mean traffic volumes at that time of day increased from 4-5 VPH to 8-9 VPH at both locations. Traffic also had a pronounced weekly pattern that did not vary between time periods, although its magnitude did; traffic volume was generally higher Friday through Sunday than Monday through Thursday (Fig. 5). The distribution of traffic types was unchanged; approximately 24 percent of traffic was local and 82 percent of the traffic consisted of cars, 4 percent was heavy trucks and 7 percent was recreational vehicles.

Overall traffic volume increased significantly between the two study periods; growth in mean hourly traffic volume was 45 percent at MM 184 and 19 percent at MM 202. Total daily traffic increased 54 percent and 15 percent at MM 184 and MM 202, respectively. However, the growth rate varied considerably by time of day. Peak hourly traffic volumes at 1600

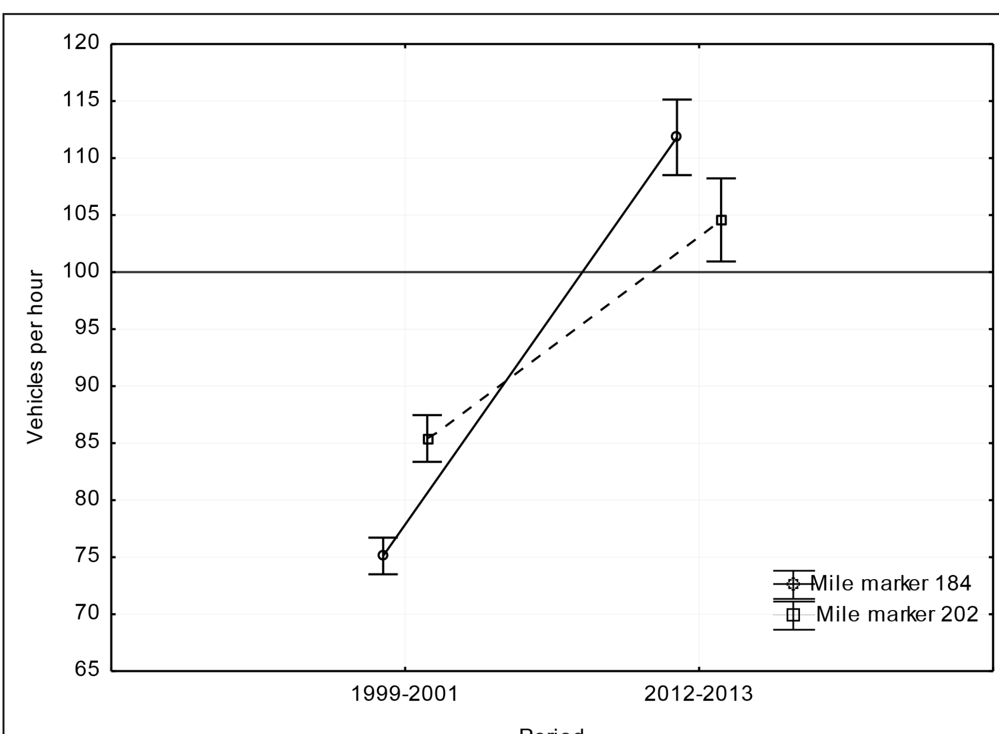

Figure 2. Change in mean bidirectional hourly traffic volume at two traffic counters on US Highway 2 in Western Montana during 1999–2001 and 2012–2013.

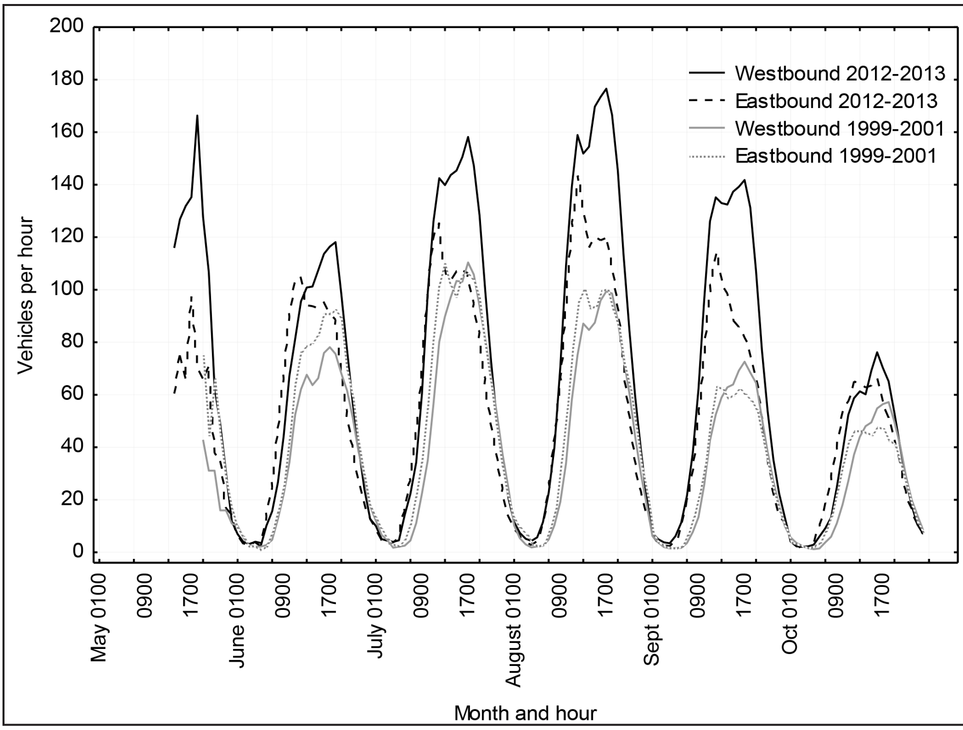

Figure 3. Mean hourly unidirectional traffic volume by month at US Highway 2 in Western Montana, mile marker 184, during; 1999–2001 and 2012–2013.

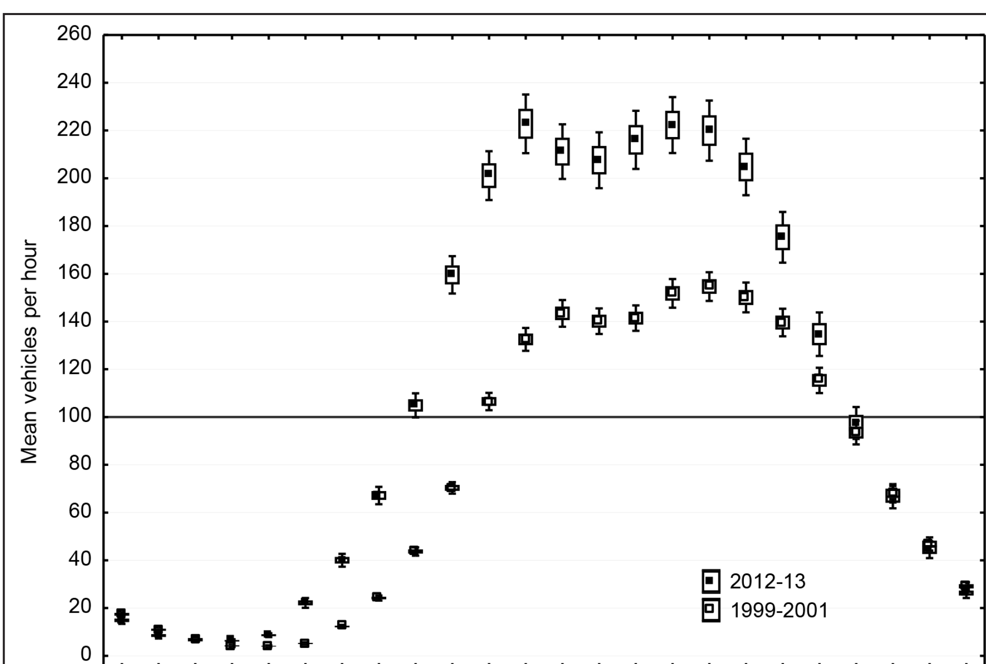

Figure 4. Mean traffic volume by hour at US Highway 2 mile marker 184 in western Montana during; 1999–2001 and 2012–2013.

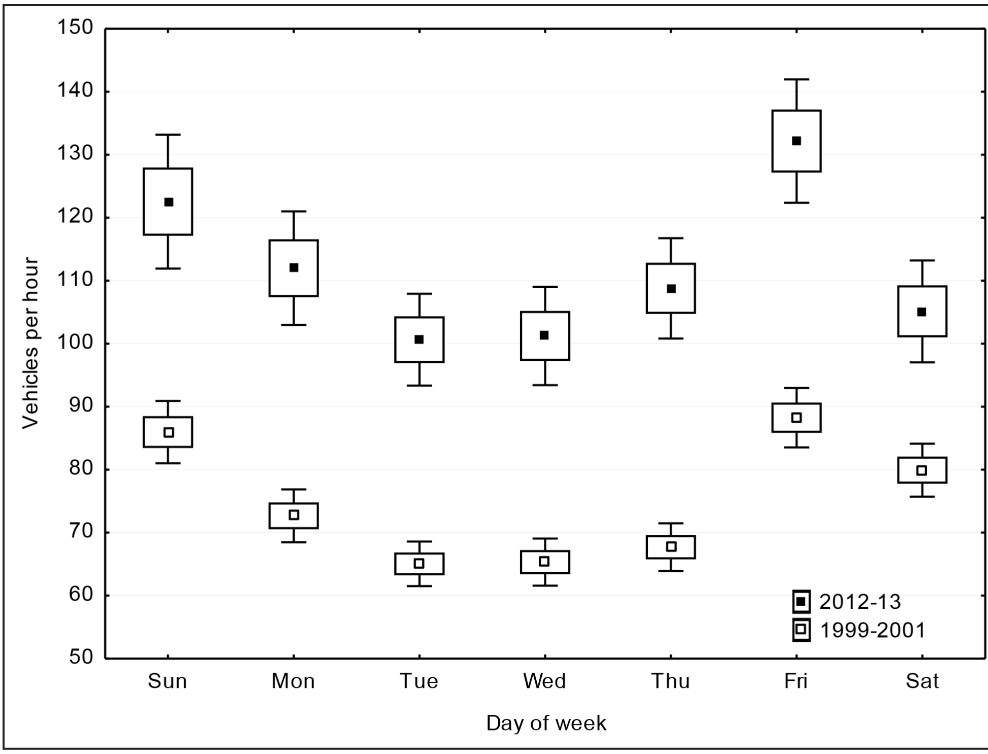

Figure 5. Mean hourly traffic by day of the week, US Highway 2, mile marker 184, in western Montana.

hours increased 40 percent and 21 percent respectively and minimum traffic volumes at 0400 hours increased 100 percent and 80 percent, respectively. Mean VPH at MM 184 and MM 202 declined between 2200 and 0300, then increased from 0400 to 2100 (Fig. 6).

Discussion

In the wildlife literature, traffic volumes are often expressed as average daily traffic (ADT; expressed here as VPD), or annual average daily traffic (AADT). These are the measurements commonly collected at automated vehicle counters and reported by state departments of transportation. While sufficient for transportation planners, they lack the resolution necessary to understand the true environmental impact of traffic (Bissonette and Kassar 2008). Important daily, weekly and seasonal patterns of traffic flow are masked through averaging. For example, strong daily fluctuations in traffic volume can have vastly different effects on species if they are diurnal or nocturnal. Reporting ADT for our study area would suggest lower traffic volumes than what is observed during the day and higher traffic than what we observed at night. Further, US2 is the primary western access for Glacier National Park, a major summer tourist destination. Visitors to the park create high traffic volumes during the summer months, followed by relatively low counts during the winter. These low winter counts offset high summer counts in AADT calculations, thus masking important traffic impacts during the seasons when grizzly bears are not in winter dens.

In 2005, Waller and Servheen (2005) estimated that US2 would become a complete barrier to grizzly bears in 30 years, when minimum traffic levels exceeded 100 VPH. This estimate was based on an observed 35 percent exponential growth rate in mean VPH between 1984 and 2001. Although mean VPH again increased exponentially between 1999 through 2001

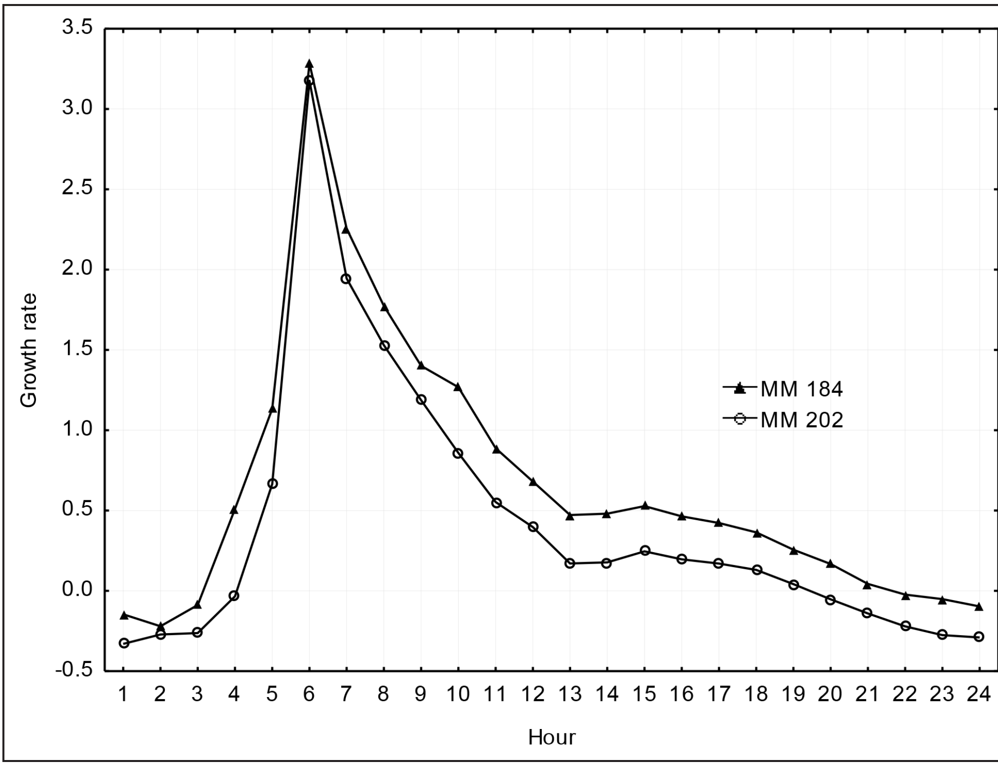

Figure 6. Growth rate in mean vehicles per hour between 1999–2001 and 2012–2013 at two locations on US Highway 2, in western Montana.

and 2012 through 2013, given the observed variation in growth rates during the day, we wondered if this estimate would hold true for those hours when grizzly bears were most likely to cross the highway (2300–0700). Applying a 35 percent growth rate to the low traffic volumes observed during these hours suggests that traffic might not reach 100 VPH for 80 years or more. Unfortunately, the mean observed exponential growth rates for these hours was much higher; 73 percent at MM 184 and 48 percent at MM 202. These averages were driven primarily by large increases in traffic between 0500 and 0700 hours. At these rates, the 100 VPH point during those hours will be reached in 22 years and 35 years at MM 184 and 202, while some crossing opportunity may remain 2300 through 0300 hours.

Since we last monitored traffic in 2001, mean VPH has surpassed 100 in the 0900 and 1000 hours. Mean VPH remained over 100 from 1100–2000. In other words, out of a 24-hour day, 12 hours now have traffic volumes above that threshold where grizzly bears were observed to stop crossing the highway. Based on the traffic growth rates observed here, bears will lose an additional three hours over the next five years. The hours 2200 to 0300 will likely remain below 100 VPH for much longer. Unfortunately, Waller and Servheen (2005) showed that rail traffic was significantly higher during these hours. If that remains the case, then grizzly bears will continue to have to choose between high risk of vehicle strike or high risk of train strike.

It is important to recognize that grizzly bear behavior is affected at traffic volumes well below 100 VPH. Northrup et al. (2012) documented strong avoidance of roads by grizzly bears where traffic volume exceeded 20 VPD, (as did Waller and Servheen (2005)), and showed that traffic volume is a strong behavioral determinant independent of any habitat covariates. Proctor et al. (2012) documented continental scale fragmentation of grizzly bear populations in the USA and Canada and related it to increasing human development and highway traffic. Within our study area, Kendall et al. (2009) discovered incipient genetic population fragmentation along the western portions of US2 south of Glacier National Park.

The intervening decade between these two traffic samples encompassed broad societal upheavals at the national and local levels, including the 11 September 2001 terrorist bombing of the World Trade Center in New York City, US military actions in Afghanistan and Iraq, the boom in the national housing market followed by economic recession in 2008 and development of large oil fields in Alberta and North Dakota. These events are reflected to some extent in the observed changes in traffic volumes on US2 by changing the distribution of economic activity centers and the movement of people to and from those centers. Interest in widening US2 by local chambers of commerce was a hot topic in the early 2000's (Missoulian 2001), but died down during the economic recession and development of eastern oilfields. We do not know if an improving economy will renew calls for widening the highway, but interest in the transportation corridor from business groups is increasing (Great Falls Tribune 2014). Regardless, it seems likely that traffic will continue to increase, with commensurate impacts to grizzly bears and other species.

Habitat connectivity is a national issue. In 2007, the Western Governors Association launched an ambitious plan to support wildlife corridor protection efforts (Western Governors Association 2008). This initiative fostered a diversity of GIS mapping and corridor modeling efforts, many of which identify locations within our study area as important locations for regional wildlife connectivity (Cushman et al. 2013, Ament et al. 2014, McClure and Ament 2014, Weaver 2014). Given the growth in traffic volume observed here, we recommend that efforts to identify locations for crossing structures transition from landscape modeling to field validation. Empirical documentation of wildlife movement patterns is essential to inform placement of highway crossing structures. Highway planners should recognize that mitigation should be in place within 20 years to minimize detrimental impacts to grizzly bears.

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