SAFETY EVALUATION OF STATEWIDE OFF-HIGHWAY VEHICLE USE IN ALASKA

Crash Review, On- and Off-road System Use, and Conflict Evaluation

FINAL PROJECT REPORT

by

Nathan Belz | University of Alaska, Fairbanks

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University of Washington
More Hall 112, Box 352700
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16. Abstract

Standard measures of risk and conflict, design guidelines, and informed policies and regulations for off-highway vehicle users (e.g., all-terrain vehicles and snow machines) near and on the traveled way are not well established from a rural safety perspective. The State of Alaska currently has a Department policy to not prohibit their travel within the off-pavement area, but it does not currently design for or address crossings or other conflicts when these users approach roads and other publicly traveled ways. There is a need for statewide assessment of conflicts between these users and traditional roadway users. A recent all terrain vehicle (ATV)-related fatality in Akiachak, discussions on safety concerns surrounding ATV/off highway vehicle (OHV) use and policies in Wasilla, Bethel, and Kotzebue, and requests for AKDOT&PF to address conflicts in rural Native Alaska communities off the main road network make this very timely research. This research presents a statewide review of the data and types of conflicts occurring on highways, a compilation of borough and city/town OHV policies, and the results of a discourse analysis of nationwide news articles on OHV issues. Findings build on previous work related to mixed-use safety and provide greater insight on special user groups and modes to address safety concerns and the transportation needs of rural and small-urban areas of Alaska.

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List of Abbreviations

AK	Alaska
AKDOT&PF	Alaska Department of Transportation and Public Facilities
AKTR	Alaska Trauma Registry
ASGDC	Alaska State Geographic Data Center
ATV	All-terrain vehicle
AWTS	Alaska Winter Trails Safety
BAC	Blood alcohol content
CPSC	Consumer Product Safety Commission
DMV	Division of Motor Vehicles
DNR	Department of Natural Resources
DVR	Digital video recorder
ESRI	Environmental Systems Research Institute
GIS	Geographic information system
NMT	Non-motorized transportation
OHV	Off-highway vehicle
USDOT	United States Department of Transportation

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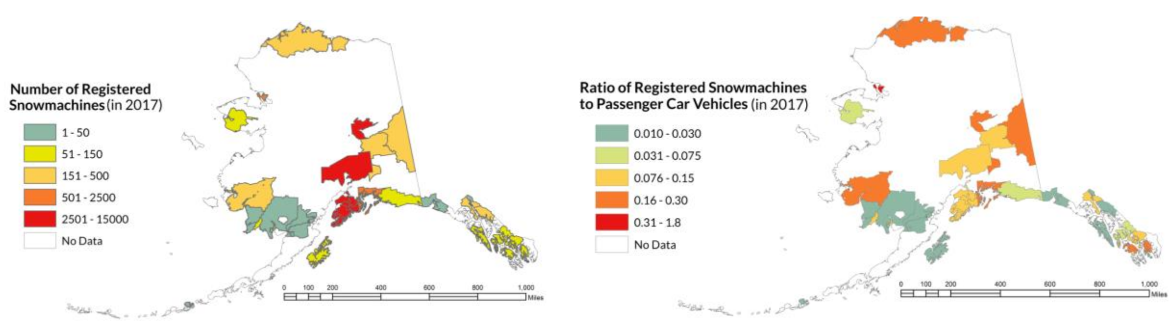
1. Introduction

Alaska ranks 44th in the nation with respect to the ratio of vehicles to households at 1,105 per 1,000 people, meaning it has the eighth highest vehicle ownership rate (USDOT, 2015; US Census Bureau, 2016). It is also estimated that about 10% percent of households where children are present and 10.3 percent of households in total do not have access to a vehicle (McDowell Group, 2017; FHWA 2017). Yet, many of these households maintain some level of mobility through the use of other and more "non-traditional" forms of transportation such as off-highway vehicles (OHVs) and all-terrain vehicles (ATVs). Though users are not required to register ATVs, the state Division of Motor Vehicles (DMV) does require that snowmachines (the colloquial term for snowmobiles in Alaska) be registered on an annual basis. ATVs with low pressure tires may be registered as "snow vehicles" but it is not required. In 2017, there were approximately 45,000 registered snowmachines and 473,000 registered passenger vehicles in the state (Alaska Division of Motor Vehicles, 2017). In looking specifically at rural communities, the ratio of snowmachines to passenger vehicles increases dramatically. For example, the village of Kotzebue, with a population 3,245 (US Census Bureau, 2016), had 604 registered snowmachines and only 372 passenger cars.



(a) (b)

Figure 1.1. Total number of (a) registered snowmachines and (b) ratio of registered snowmachines to passenger car vehicles in Alaska for 2017

The multi-purpose nature of these vehicles for activities such as hunting, recreation, and daily chores makes them even more appealing for rural residents. However, their use on roads and public facilities places different modes of travel that have disparate capabilities and performance in close proximity to each other. This jeopardizes the safety of users in these mixed-use environments. This has direct implications for safety. As an example, about a quarter of all traffic-related crashes in the village of Kotzebue with a population of only 4,000 involved either snowmachines or ATVs; 21 crashes in the last four years alone involved speeding ATVs on city streets (Native Village of Kotzebue, 2015). The problem remains that for Alaskan villages like Kotzebue, all-terrain vehicles and snow machines are often the only travel option and fulfill basic mobility needs for residents. Recent events—a pedestrian fatality caused by a drunk ATV operator in Akiachak (figure 1.2; Klint, 2016), ongoing discussion of road-related ATV policies in Bethel (figure 1.3; Demer, 2016), and the death of an ATV operator on the Denali Highway (figure 1.4; Boots, 2017—illustrate the need for further research and study into these modes and how they interact with existing transportation infrastructure and conventional modes of transportation, particularly in the State of Alaska.

Akiachak woman dies when struck by ATV

Author: Chris Klint   Updated: October 3, 2016   Published October 3, 2016

A 76-year-old pedestrian was killed in the Western Alaska village of Akiachak late Friday when she was struck by an all-terrain vehicle, Alaska State Troopers said.

Figure 1.2. Article of ATV-related death in Akiachak, Alaska.

Sudden crackdown on four-wheelers quiets Bethel streets and upsets residents

Author: Lisa Demer   Updated: October 10, 2016   Published October 10, 2016

BETHEL — In the space of just days, a crackdown targeting four-wheelers and snowmachines on the streets in the rural Southwest Alaska hub of Bethel changed life for many.

The Bethel City Council on Sept. 27 passed two enforcement measures. Streets grew quiet. In the first week, Bethel police wrote more than two dozen tickets carrying $50 fines for four-wheelers illegally on the streets.

Figure 1.3. News article of ATV-related policy disputes in Bethel, Alaska.

Anchorage man killed in ATV crash on Denali Highway

Author: Michelle Theriault Boots   Updated: August 27   Published August 27

An Anchorage man was killed in an ATV crash on the Denali Highway Saturday, the Alaska State Troopers said.

Song Her, 50, of Anchorage, was riding westbound on the highway at Mile 92 of the road when his ATV "left the roadway and rolled down an embankment," troopers wrote in an online dispatch.

Troopers were told the ATV driver appeared to be trying to avoid a vehicle, said troopers spokesperson Megan Peters.

Figure 1.4. News article of ATV operator death on the Denali Highway in Alaska.

Currently, we lack the proper knowledge to develop strategic and targeted engineering and policy decisions for non-conventional modes of travel (ATVs/snowmachine) or more traditional ways of travel (e.g., mushing/dogsledding). As we expand automobile-focused roadway infrastructure, we need to ensure that we aren’t hindering the mobility of those with limited travel options. The nature of OHV travel on mixed-use roads and facilities places different modes of travel that have disparate capabilities and performance in close proximity to each other. All-terrain vehicles alone account for approximately 100,000 injuries in the United

States, while snow machines contribute over 14,000 injuries and 200 deaths annually (Pierz, 2003).

On average, 144 children and 568 adults die each year as a result of ATV-related crashes (Topping and Garland, 2012). In 2012, it is estimated that there were more than 100,000 injuries nationwide, about 25 percent of which involved children under the age of 16. In a more localized context, Alaska was in the top ten highest ATV rider death rates on public roads, with 28.6 per 100 million people between the years 2007 and 2011 (Williamset al., 2014). Though more off-road in nature, travel by snowmachine (another form of OHV) is quite typical in winter months. In 2014, over 100,000 snowmachines were sold in the U.S. and Canada, with an average operator driving 1,620 miles per year (International Snowmobile Manufacturers Association, 2014). Nationwide, approximately 200 deaths and 14,000 injuries on snowmachines occur every year (Pierz, 2003). Historically, Alaska has seen years in which the injury and fatality rates for operators of snowmachines were higher than those for motor vehicles (Landen, et al., 1999).

1.1. Problem Statement

Existing guidance in the Pacific Northwest and other select states was examined and evaluated to determine what might be transferable across the region and most appropriate for the State of Alaska. The intent was to develop a holistic framework that considered what data currently exist, what data are needed, and the status of conflict and safety concerns for OHVs on and near state highways. This research addressed the need for both safety and travel demand data in rural areas, where the frequency of off-highway roadside users is generally considered to be negligible, un-reported, or non-existent.

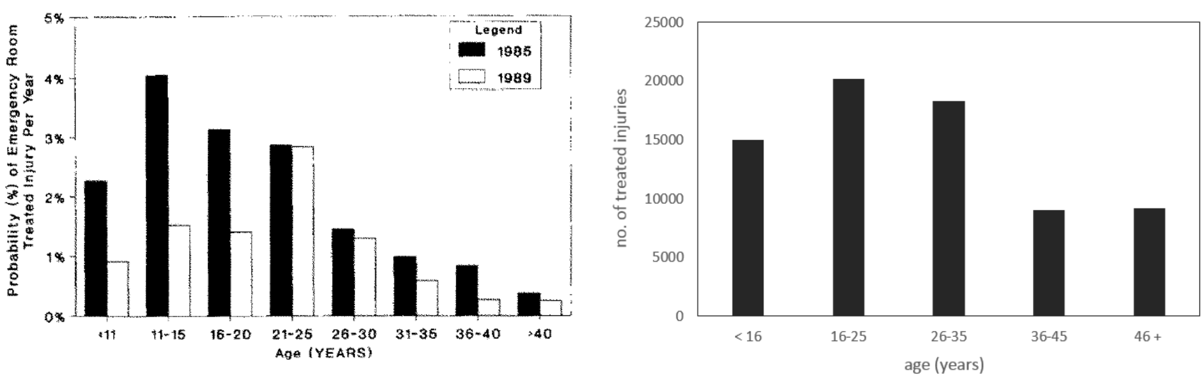
1.2. Background and Literature Review

1.2.1. General OHV/ATV Regulations

The U.S. Consumer Product Safety Commission (CPSC) began investigating the hazards associated with ATVs in 1984, after which a formal regulatory proceeding was initiated in 1985. The principal outcome of this proceeding was a legal settlement involving a series of consent decrees that stopped the sale of three-wheeled ATVs, called for the implementation of a nationwide rider training program, and required the development of a voluntary standard to make ATVs safer. This decree was formalized in 1988 between the U.S. Department of Justice, representing the Commission, and ATV distributors (Rodgers, 1993). The need for this decree stemmed directly from the following complaints made by the Department of Justice (U.S. District Court, 1987) stating that:

1. Although relatively safe to drive, ATVs were complex machines that required a high degree of skill for safe operation;
2. The industry failed to warn consumers about the potential risks and hazards associated with ATVs in an adequate manner; and
3. There was a relatively high risk of injury to ATV users, especially for those who were young and inexperienced.

After the CPSCs actions (warning labels discouraging young operators, free training programs, and ceasing three-wheeled ATV vehicles), the risk of injury did decrease, in general, except for the 21-25 and 26-30 age groups (figure 1/5). Why is this important? First, even after a federally initiated program to improve the safety of ATV use in the United States, the potential risk of injury for certain age groups was not decreased. Second, even though the initiative explicitly stated that consumers must be informed that ATVs are intended for adults and not recommended for children if the vehicle has an engine displacement size of 90cc or larger (the majority of all ATVs on the market currently are in this category), the potential risk for younger users (those under the age of 16) declined only by about 50 percent. Third, it is highly contingent upon “the market” to provide sufficient product risk information so as to not distort the consumer decision making process, e.g., consumers not using the ATV in a safe way if they are uninformed, purchasing an ATV if they would not have done so with complete information, or purchasing the wrong and possibly more risky type of ATV (Rodgers, 1993). Lastly, successful safety outcomes are highly contingent upon continued enforcement of the policies and regulations put in place. For example, Rodgers (1999) indicated that about only 4 percent of consumers opted to take the vehicle training course and a staggering 20 percent of ATV riders (an estimated 5.85 million in the United States) frequently operate their vehicles on paved roads.



(a) (b)

Figure 1.5. Nationwide ATV injuries shown by age group as (a) probability of injury in 1985 and 1989 (Rodgers, 1993); and (b) total number of emergency room treated injuries in 2010 (Garland, 2014).

1.2.2. Nationwide OHV/ATV Safety Trends

Over half of all ATV-related fatalities occur on roadways, and nonfatal roadway crashes result in more serious injuries than those off the road. A number of jurisdictions have passed or have considered legislation allowing ATVs on public roadways, sometimes limiting them to those unpaved, arguing that they are safe for ATVs. Garland (2014) illustrated, however, that both paved and unpaved road surfaces are the only two topography types for which the risk of fatality to an ATV operator is higher than that of injury (figure 1.6) and that more fatal ATV crashes occur on the roadway than off (Denning et al., 2016). This is consistent with other studies that also have shown that a lack of helmet use and the use of alcohol by ATV operators are more prevalent on roadways than off-roadway (Denning and Jennisen, 2016). Although there is a general downward trend in the overall number of ATV-related injuries in the United States, looking specifically at the under-16 age group, there has been little in the way of injury reduction since 2007 (figure 1.7).

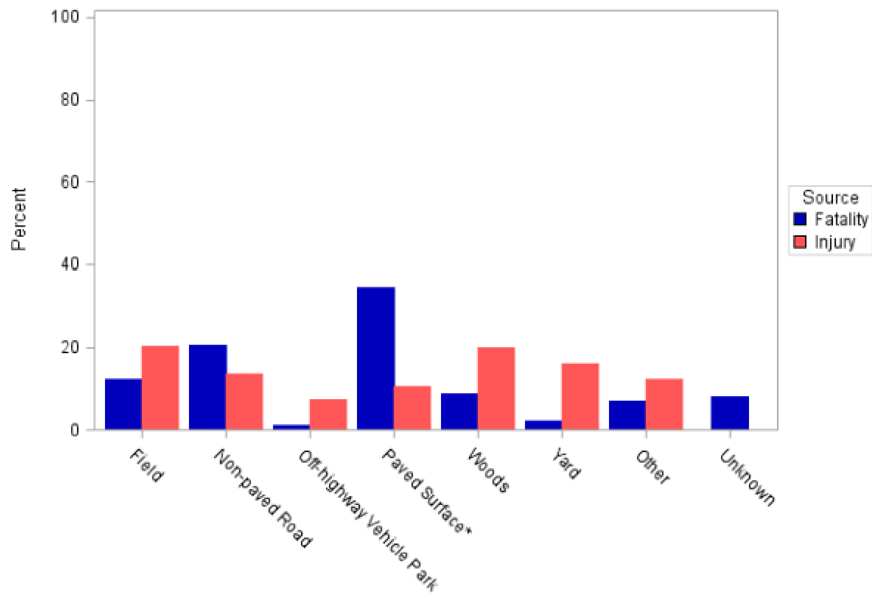


Figure 1.6. Percentage of ATV fatalities and injuries by location.

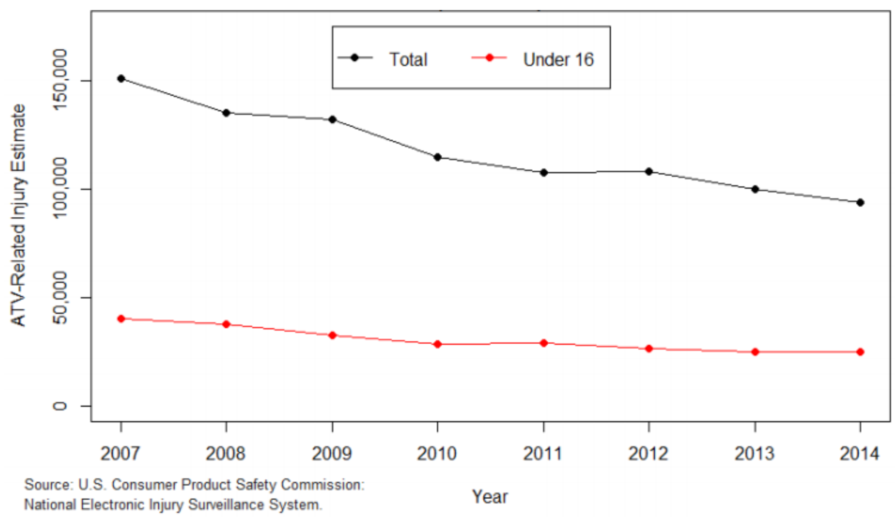


Figure 1.7. Yearly ATV-related injuries, 2007 – 2010 (Topping, 2015).

Furthermore, a number of recent studies have indicated that the injuries from ATVs are becoming both more serious and frequent (Phrampus et al., 2005), primarily because of an increase in engine power, more prevalent use by younger (under the age of 16) operators, inconsistent enforcement of helmet laws, and inconsistent enforcement of use, e.g., on public roadways (Axelband, et al., 2007; Rodgers, 1999; Bansal, et al., 2008; Su et al., 2006; Williams et al., 2014). Although some studies have indicated that certain states with laws regarding ATV use and safety have lower mortality and injury rates, and a stated preference survey indicated a support for stricter laws for young drivers, driver certifications, number of passengers, and helmet use (Stolz et al., 2009), the previously mentioned studies (e.g., Rodgers, 1999, and Bansal, et. al., 2008) have shown by way of hospital records and surveys that policies and (limited) enforcement have done little to actually improve ATV safety.

These trends are consistent with ATV injuries in Canada (Vanlaar, et al., 2014; Waight and Bath, 2014), Ireland (Moroney et al., 2003), and Sweden (Gustafsson and Eriksson, 2013), which have called for better planning and enforcement of these modal types as their use has become more utilitarian in nature. In general, studies have supported laws/ordinances greatly restricting ATV riding on all types of public roadways. It is clear that new research and new approaches are needed to address the issue of ATV/OHV use on public roadways. As previously mentioned, conversations about how to appropriately plan, design, and enforce laws related to ATV/OHV use are taking place in isolation. The work proposed in this research seeks to bring forward new data and perspectives on the issue of non-traditional vehicle use on Alaskan roads and highways to provide better planning, design, and enforcement guidance and to improve the safety of our traveling public.

1.2.3. Motivations for OHV/ATV Use

It is clear that the use of OHVs and ATVs in Alaska is not negligible. Many indigenous people of Alaska (e.g., Alaska natives), in addition to others, still maintain a subsistence lifestyle in areas without roads or even access to roads or conventional towns (i.e., rural areas). These forms of transportation are critical lifelines for subsistence practices. In addition, gas and fuel prices can be quite cost-prohibitive and as expensive as $7/gallon in some locations of the state. For these areas, non-motorized and non-conventional modes of transportation can be more economical for daily travel (Demer, 2015). Recent estimates have indicated that the average ATV/OHV fleet fuel economy is roughly 40 miles per gallon, with a range of anything from 10 to 70 miles per gallon (Giacchino, 2012). Compare this with the mid-year 2015 estimate of adjusted fuel economy for personal vehicles at only 24.8 miles per gallon (US EPA, 2016).

The increasing numbers of facilities being created for vehicles, bicyclists, and pedestrians in rural areas on highways directly competes with space that would have otherwise been available for OHVs/ATVs. This has caused the following: 1) an increase in the number of OHVs/ATVs being operated on public roads; 2) an increase in the number of OHVs/ATVs being operated close to non-motorized users near or on public facilities; and 3) an increase in the unauthorized operation of OHVs on private property.

(a) (b)

Figure 1.8. Examples of unauthorized and unlawful use of ATVs on public facilities in (a) Wasilla, Alaska (Carpenter, 2014), and (b) Fairbanks, Alaska

1.3. <u>Research Need</u>

OHV modes of travel are not as regulated as conventional modes, and regulations are quite arguably difficult to enforce. There are no requirements for permits, operating licenses, or training of any kind. An estimated 77 percent of injuries suffered while operating an ATV are attributed to drivers under the age of 35, and 21 percent are attributed to drivers under the age of 16 (Garland, 2014). Even though ATVs are not permitted on most roadways, 62 percent of ATV-related deaths between 1985 and 2009 resulted from on-road crashes. The number of on-road deaths has increased to three times more likely than off-road deaths related to ATVs since 1998 (Denning et al., 2012). A large number of ATV users (94 percent) ride with more than one person (Jennissen, et al., 2012). From 1993 to 1994 the numbers of injuries, deaths, and hospitalizations related to snowmachine use was higher than those related to on-road vehicles (Landen et al., 1999). As of 2003 snowmachines were responsible for approximately 200 deaths per year and 14,000 injuries (Pierz, 2003). ATVs and OHVs are not currently being studied by the AKDOT&PF; however, ATVs and snowmachines were regarded as being a “significant safety issue” in 2003 (AKDOT&PF, 2013).

1.4. Objectives

This research addressed issues associated with the use of OHVs within public rights of way intended for what are otherwise considered "conventional" modes of travel (e.g., automobiles, pedestrians, and bicyclists). However, the issues were confounded by the fact that OHVs provide a certain level of mobility for some towns and villages, and in some cases, policies and laws state that their use is both appropriate and legal. That said, jurisdictions must ensure that facilities are provided in a way that ensures safe accommodation, limits the improper use of public rights-of-way, and maintains mobility. This study was intended to inform future guidelines for the design, education, and enforcement of OHV use in the State of Alaska. Four specific objectives were identified as integral pieces of this research effort.

First, this research sought to document the existing state of practice of OHV use and travel in the public right of way. This included a review of DOT design guidelines and practices and a review of national and international literature related to OHV/ATV safety and use. Understanding the motivations for the use of and accommodations for OHVs is central to understanding some of the key questions surrounding the safety of their use on corridors that accommodate other traffic types.

Second, the research sought to better understand the spatial distribution of OHV safety issues by reviewing and analyzing injury data available through the Alaska Vital Statistics Trauma Registry and crash data through the Alaska State Motor Vehicle Crash Database. Where available, events recorded in these data were mapped, characterized, and compared spatially. This comparison could help to identify deficiencies in injury/fatality reporting for crashes and injuries related to OHVs. Non-reports and reports with insufficient data were of most concern, particularly those occurring in public rights of way. Data completeness is a critical piece to understanding the safety problem associated with OHV modes of transportation. It is essential because the rates of OHV injuries and crashes have prompted AKDTO&PF to include OHVs in a special users group with targeted programs and objectives to reduce injuries and fatalities.

Third, this research sought to improve the extent of and vocabulary associated with OHV safety by conducting a media discourse analysis to identify trends and issues in the United States related to OHV/ATV use on public facilities. This will help to improve our ability to define the problem and gain a better understanding of the issues in a national context. Ultimately, the goal of this portion of the project was to develop the language to better frame the issue of OHV safety on and near public facilities.

Lastly, this research sought to identify the connectivity and extent of OHV user facilities and/or routes by using a GIS platform and to compare roadway system versus non-roadway system locations as well as formal and informal networks. The connectivity analysis was intended to directly inform the execution of seasonal mode counts using motion-activated day/night cameras at strategic locations. This preliminary counting effort was anticipated to 1) provide a better understanding of how many OHVs are being used in certain locations beyond the anecdotal evidence we have currently, and 2) inform and provide suggestions for where and how frequently future and broader OHV counts should be conducted.

2. OHV and ATV Policies

Current regulation of snowmachines and ATV/OHVs on highways and public rights of way in Alaska is conducted in accordance with Statute 13AAC 02.455, which strictly prohibits the following:

1. Use on multi-use trails, sidewalks or other areas located within a highway right of way that are intended for use by pedestrians;
2. Use in a controlled access highway right of way;
3. Use of roadways or shoulders within a highway right of way;
4. Use of the area dividing roadways of a divided highway;
5. Traveling at night in the opposite direction of traffic in the nearest lane of a roadway within a highway right of way.

Furthermore, Statute 13AAC 02.455 explicitly states the following:

A snowmobile or an off-highway vehicle may be driven on the roadway or shoulder of a highway only under the following circumstances:

1. When crossing a highway as provided in (f), or when traversing a bridge or culvert on a highway, but then only by driving at the extreme right-hand edge of the bridge or culvert and only when the traverse can be completed with safety and without interfering with other traffic on the highway;
2. When use of the highway by other motor vehicles is impossible because of snow or ice accumulation of other natural conditions or when the highway is posted or otherwise designated as being open to travel by off-highway vehicles;

3. When highway driving is authorized by an authority having jurisdiction over the highway, but only in accordance with restrictions that may be imposed by that authority with regard to highway use; or
4. When driving on the right-of-way of a highway that is not a controlled-access highway, outside the roadway or shoulder, and no closer than 3 feet from the nearest edge of the roadway; night driving may be only on the right-hand side of the highway and in the same direction of the highway motor vehicle traffic in the nearest lanes of the roadway; no person may drive an off-highway vehicle within the area dividing the roadways of a divided highway, except to cross the highway as provided in (f) of this section.

(f) A snowmobile or an off-highway vehicle may make a direct crossing of a highway if:

1. The crossing is made approximately at a right angle to the highway and at a location where visibility along the highway in both directions is clear for a sufficient distance to assure safety, and the crossing can be completed safely and without interfering with other traffic on the highway; and
2. The vehicle is brought to a complete stop before crossing the shoulder or roadway, and the driver yields the right-of-way to all traffic on the highway.

(g) No snowmobile or other off highway vehicle may cross or travel on a sidewalk, a location intended for pedestrian or other non-motorized traffic, an alley, or a vehicular way or area that is not open to snowmobile or off-highway vehicle operation, except as provided in (f) of this section. (Eff. 12/31/69, Reg. 31; am 7/23/70, Reg. 35; am 6/28/79, Reg. 70)

Of consideration is that state code applies to local roads and does not allow a particular city to pass ATV/OHV allowances that conflict with state code. However, the regulations and policies regarding the use of ATVs/OHVs and snowmachines vary widely across Alaska. Take for example Bethel, Alaska, which in 2006 passed an ordinance allowing the use of ATVs and snowmachines on city streets (deMarban, 2006). This followed a similar ordinance in Kotzebue, Alaska that limited use to only those older than the age of 14. In 2012, East Bethel modified the ordinance to require any born after July 1, 1987, to complete a safety training test and limited off-road vehicles to only Class I or Class II ATVs (Haggen, 2012). Then in 2013, the City Council decided to replace local traffic code with state laws, thereby making the use of ATVs and other off-highway vehicles on the city streets illegal. However, many stated that this 2013 change did little in the way of limiting on-road use of ATVs/OHVs (figure 1.3). Upon calling the City Council to take action, local police went from having issued seven citations related to ATVs and snowmachines on roadways over the course of nine months, to issuing 25 over the span of four days, with an additional two citations for driving an ATV without a license (Demer, 2016). The newly proposed ordinance would have allowed ATVs to operate on roads but restricted them from passing other cars and limited speeds to 15 mph.

This prompted the need to develop a comprehensive list of state, borough, and select town/village policies on OHV/ATV use. This list was compiled by searching public records and statutes or by contacting local municipalities directly by phone. These policies are summarized in table 2.1 through table 2.3. Records highlighted in yellow indicate municipalities that hadpolicies specific to their political region. For boroughs and towns without a policy, there was specific mention in their local code that they defaulted to state provisions.

Table 2.1. Summary of Alaska state regulations on OHV/ATV use

State	Policy	Allowed to cross state roads?	Allowed on state roads?	Allowed on city roads?	User Requirements	Vehicle Requirements	Speed Limit	Time Restrictions	Other Notes
Alaska	Yes	Yes	No*	No*	AS 28.39 and 13 AAC 02.430 through 13 AAC 02.455	13 AAC 04.400 through 13 AAC 04.420	N/A	N/A	All laws pertaining to snowmachines and ATVs at the state level are included in the Alaska State

Table 2.2. Summary of Alaskan borough policies on OHV/ATV use

Borough	Policy	Allowed to cross state roads?	Allowed on state roads?	Allowed on city roads?	User Requirements	Vehicle Requirements	Speed Limit	Time Restrictions	Other Notes
Aleutians East	No	Default to State Provisions							
Anchorage	Yes	Yes	No*	No*	Must wear helmet meeting Snell Foundation requirements with proof attached, must have license or licensed individual riding on same machine	Red light only 500'	N/A	Shall not operate from 10 PM to 7 AM	Operations on private property requires express consent of owner on paper. Can't operate within 500' of ice rink, skiing establishment, etc. Can't operate on lands not owned if destruction of soil or undergrowth is likely.
Bristol Bay	No	Default to State Provisions							
Denali Borough	No	Default to State Provisions							
Fairbanks North Star	No	Default to State Provisions							
Haines	Yes	Yes	No*	No*	16 years or older. Valid driver's license. Proof of insurance. Hand signals when turning.	Default to State Provisions	<25 mph on borough streets	Shall not operate from 9 PM to 9 AM at Tlingit Park or Seward parade grounds	
Juneau	Yes	No	No	No	N/A				
Kenai Peninsula	No	Default to State Provisions							
Ketchikan Gateway	No	Default to State Provisions							
Kodiak Island	No	Default to State Provisions							All road surfaces are gravel
Lake and Peninsula	No	Default to State Provisions							
Matanuska-Susitna	No	Default to State Provisions							
North Slope	No	Default to State Provisions							
Northwest Arctic	No	Default to State Provisions							
Petersburg	No	Default to State Provisions							Local provisions submitted for approval in October 2016
Sitka	No	Default to State Provisions							
Skagway	Yes	Yes	No*	Yes	**ATV:** if under 16 years old requires parent/guardin, if under 18 requires helmet, see city ordinances for designated and restricted steets of use. | **Snowmachines:** requires driver license, travel in single file on streets and alleys, may only tow passengers via a sled and skid, cannot operate on schoolgrounds or municipal streets designated by borough assembly	**ATV:** requires noise suppression muffler, liability insurance, trailers during daylight hours only	**ATV:** <15 mph, except on Yakutania Point and Pat Moore Bridges <5 mph **Snowmachine:** <20 mph in muncipality		Must travel single file along street or alley
Wrangell	Yes**	Yes	No*	Yes	Default to State Provisions	**Snowmobile:** Borough registration valid for 3 years. Forward light that reveals at least to 100'.	Default to State Provisions		ROW permitted for use changes based on decision of council, consult website and local authorities for currently approved areas
Yakutat	Yes	Yes	No*	Yes	Requires valid driver's license, approved safety helmets worn by operators and passengers, must be 16 or older, if under 16 valid license required.	Lights must be on at all times of operation,muffler s and tail pipes shall be sealed and operational	<15 mph	Unauthorized from 10 PM to 6 AM	

*** Special provision exists**

**** Policy on snowmachines only; ATVs categorized as snowmachines because of low-pressure tires**

Table 2.3. Summary of select Alaskan city and town policies on OHV/ATV use

City	Census Area	Policy	Allowed to cross state roads?	Allowed on state roads?	Allowed on city roads?	User Requirements	Vehicle Requirements	Speed Limit	Time Restrictions	Other Notes
Unalaska	Aleutians West	No	Default to State Provisions							
Bethel	Bethel	Yes	Yes	No*	Yes	**ALL:** If under 18 requires a driver's license or be within 100' of 21 year old who is supervising and has a valid driver's license, minors must wear helmets and travel shortest reasonable distance along city roads | **ATV**: liability insurance, proof of insurance, valid driver's license, may not pass other moving vehicles or weave in traffic | **Snowmachine**: proof of registration displayed, liability insurance, proof of insurance, may not pass other moving vehicles or weave	**ATV**: must be under 1500 pounds	**Low-speed vehicle**: <25 mph | **ATV**: <15 mph city road, <5 mph parking lot or congested with pedestrians | **Snowmachines**: <15 mph on city road, <5 mph parking lot or congested with pedestrians	N/A	Definitions: ATV = 3 ormore low-pressure tires, Low-speed vehicle = motor vehicle with 4 wheels that reaches minimum speed of 20 mph, Snow machine = motorized vehicle under 1300 lbs propelled by a track system over snow/ice
Dillingham	Dillingham	Yes	Yes	No*	Yes	**OHV/ATV**: 14 or older and possess a valid driver's license, 18 or younger requires helmet, cannot be operated within business district (see extra), allowed on ROW of all roads as long as 3' or more from edge of shoulder, operation after dark requires same direction of roadway motor traffic **Snowmachines:** Show proficiency of knowledge of rules of the road, under 18 must wear helmet, after dark operation remanded to right side of a designated snowmobile route and in same direction as roadway traffic, cannot be operated within business district (see extra) and Main Street from Denny Way to intersection of Second Avenue West	**OHV/ATV**: Cannot be modified to make more noise than when manufactured | **Snowmboile**: headlight illuminated at all times, visibly display valid state snowmobile registration	<20 mph	**OTV/ATV**: prohibited to operate between 12 AM and 5 AM from Serpt 1st until June 1st	
Haines	Haines	Yes	Yes	No*	Yes	16 years or older, valid driver's license, proof of insurance, must display hand signals while making turns if machine not equipped with turn signals	Equipment originally installed shall be in good working order, lighted headlight and tailight at all times	<25 mph	No snow machine or ATV use within confines of Tlingit Park or the Fort Seward parade grounds bewtween 9 PM to 9 AM	
Homer	Kenai Peninsula	Yes	Yes	No*	No*	Default to State Provisions				Beach is open for atv use and travel
Hoonah	Hoonah-Angoon	Yes	Yes	No*	Yes	Must have driver's licence, be 16 years or older, vehicle must obtain permit, must wear protective head gear	Protective shield over all moving parts, reflectors on sides of cowling	N/A	Operation allowed bewtween 6 AM and 9 PM except fridays and saturdays where they may be operated until midnight	
Hooper Bay	Kusilvak	Yes	Yes	No*	Yes	Default to State Provisions				
Nome	Nome	Yes	Yes	No*	Yes	If under 16 must be under direct supervision of adult, valid drivers license, must drive on far right of roadway and on shoulder if available, must wear helmet		<20 mph	N/A	If an alternative route is available that will not violate regulations it must be taken; Local police implied they do not enforce on local roads.
Craig	Prince of Wales-Hyder	No	Default to State Provisions							
Delta Junction	Southeast Fairbanks	No	Default to State Provisions							State troopers said ATV/snowmachine use is predominant; enforcement is lax unless user is blatantly speeding
Valdez	Valdez-Cordova	Yes**	Yes	No*	Yes	Motor vehicle operator's license, hard protective head gear	Default to State Provisions	N/A	Operation allowed between 6 AM and 11 PM, except Friday and Saturday allowed until midnight	No policy on ATV; In or within 100' of ski area or within 100' of ice rinks
Wasilla	Matanuska-Susitna	Yes	Yes	No*	No*	Valid driver's license, carry proof of registration, liability insurance, carry proof of insurance, wear DOT approved crash helmets, 16 or older unless supervised by adult	Red light mounted on rear visible at 500',	10 mph or less on right of way, 5 mph in congested areas or parking lots	Operation allowed 8 AM to 10 PM within city limits	Allowed on right of way of all roads, not allowed within 20' of railroad track unless crossing
Fort Yukon	Yukon-Koyukuk	Yes**	Yes	No*	Yes	City permit & 14 or older	Default to State Provisions	<15 mph	N/A	Local police indicated that snowmachine regulations apply to ATVs

*** Special provision exists**
**** Policy on snowmachines only; ATVs categorized as snowmachines because of low-pressure tires**

As can be seen in the preceding tables, the variations in policies across the state are tremendous. In some locations there are provisions that require the use of protective equipment, functional headlights and taillights, or restrictions on when and where OHVs can be used. In other locations, stipulations on OHV use are non-existent or not enforced (according to local public safety officers). However, it is important to note that the information provided in the tables was gathered in June of 2017. Because Alaska ordinances may change over time, it is recommended that one check with local authorities with any questions or concerns regarding OHV/ATV or snowmachine use and laws before operating in that area.

Although in some cases these policies were specific to a small geographic region and unique locale (e.g., no or limited operation in select parks or streets), there were several that might warrant modification to provide better consistency at the borough and city levels (e.g., speed limits, vehicle restrictions, and hours of operation). A more robust sampling and comprehensive documentation of city/town policies could be completed to identify other possible variations in policies at the local level.

3. OHV Facilities and Network Connectivity

There are 355 incorporated places in Alaska (figure 3.1) according to the US Census Bureau (2016). Not all of these incorporated places are located on the contiguous road system. Anecdotally, studies have typically used the statistic that *"70 percent of Alaskans don't live on the connected road system."* However, it is not clear whether that statistic refers to the populations (i.e., number of residents) or the places themselves. Furthermore, this statistic neglects to account for other types of networks that may connect these places (e.g., trails, rivers, and other frozen waterways in the winter). Data available through the Alaska State Geographic Data Center (ASGDC) indicated that there are 31,692 miles of streets/roads and 23,191 miles of trails, with an additional 20,428 miles of RS2477[1] trails (figure 3.2 and figure 3.3a). Many of these trails reach places in the state that roads simply do not go. It is in these locations where one may expect to find higher rates of OHV use as a primary form of transportation. Figure 3.3b shows the ratio of trails to roads for each town/place in Alaska and indicates that there are large geographic regions that have more trail mileage than road mileage. Further still, there are a handful of locations where there are only trails, no roads. To be conservative, it is worth noting that although these data sets are the most current, they may not reflect *all* of the trails (or roads for that matter) that exist in the state. They are, however, our best estimate and are the most comprehensive, given the tools and data that we have. However, there are some places that are identified as having no trails and no roads but are known to have "boardwalks" as the primary transportation network within the village because they are situated on permafrost.

[1] RS2477 trails are rights-of-way designated for the construction of roads/trails over public lands but (officially) not reserved for public uses, though across much of the state these trails are substantiated and used frequently by OHV users.

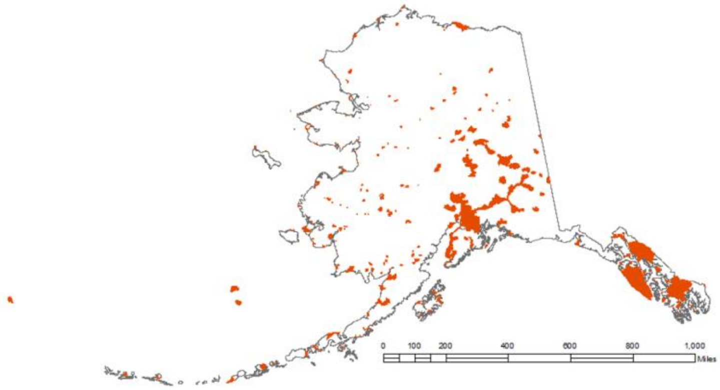


Figure 3.1. U.S. Census Bureau defined incorporated places in Alaska

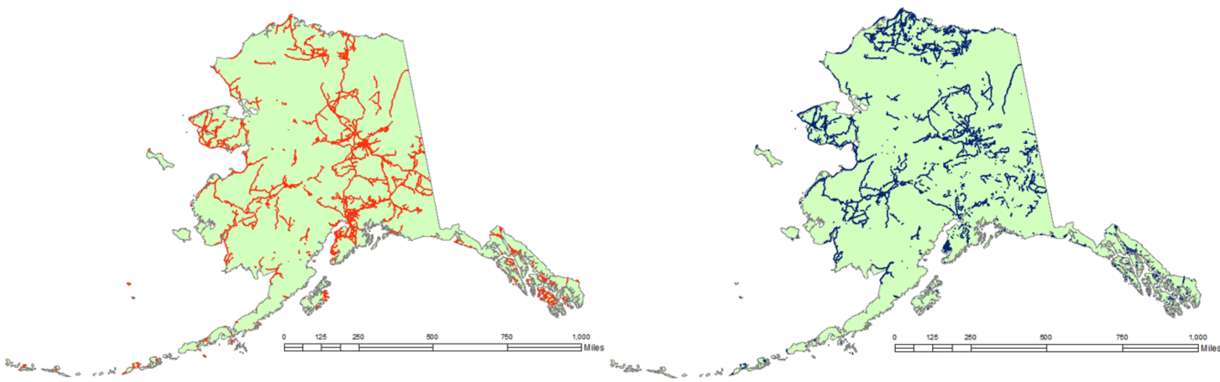


Figure 3.2. Statewide (a) street and (b) trails networks in Alaska

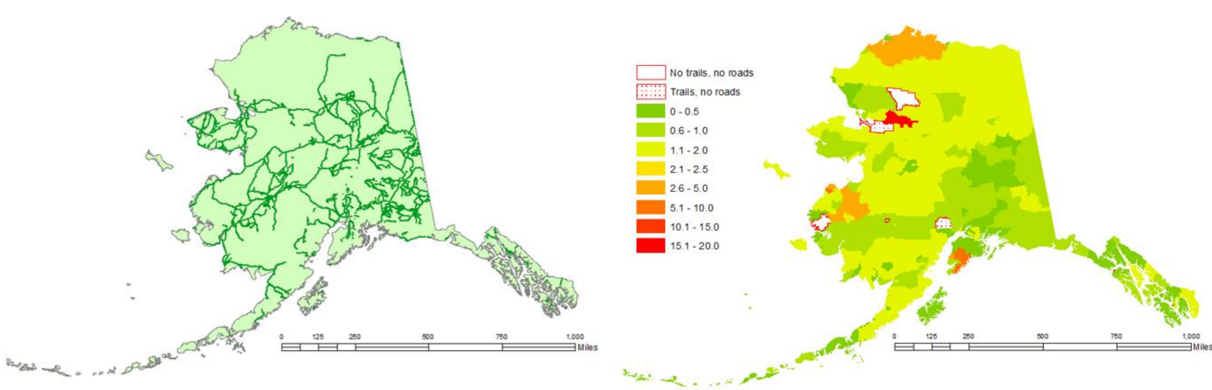


Figure 3.3. Statewide (a) RS2477 trails and (b) ratio of miles of trails to roads by zip code in Alaska.

Figure 3.4 shows examples of proximal (e.g., in the ditch or on the slope of the roadway), adjacent (e.g., on the dirt shoulder), and coincident (e.g., fully or partially on the road or non-motorized) shared-use facilities. Not only do these have inherent safety issues (e.g., mixed-use) but also can cause physical damage to the transportation infrastructure. Beyond that, informal crossings are often established at locations with poor sight distance (e.g., on horizontal curves or in ditches that intersect and come to meet the grate of a side street) or at critical points of conflict at or near the head of an intersection. The former two are of particular concern with respect to safety, as they increase exposure rates for the more vulnerable party (see figure 3.5).

(a) (b) (c)

Figure 3.4. Examples of (a) proximal, (b) adjacent, and (c) coincident informal ATV/OHV trail systems.

Figure 3.5. Examples of (a) ATV use on a highway in Copper Center, Alaska, and (b) NTV use adjacent to the highway and through an intersection in Fairbanks, Alaska.

Figure 3.6. Examples of ATV use on roads in (a) McCarthy, Alaska, and (b) Nome, Alaska.

Of the 355 populated places (according to the US Census Bureau) in Alaska, 227 places are connected to other places by various means (figure 3.7). Only five places are connected by highways alone. The majority of places are connected via roads and trails. Places connected by highways have a lower average percentage of native Alaskans (8 percent) than those connected by roads (34 percent).

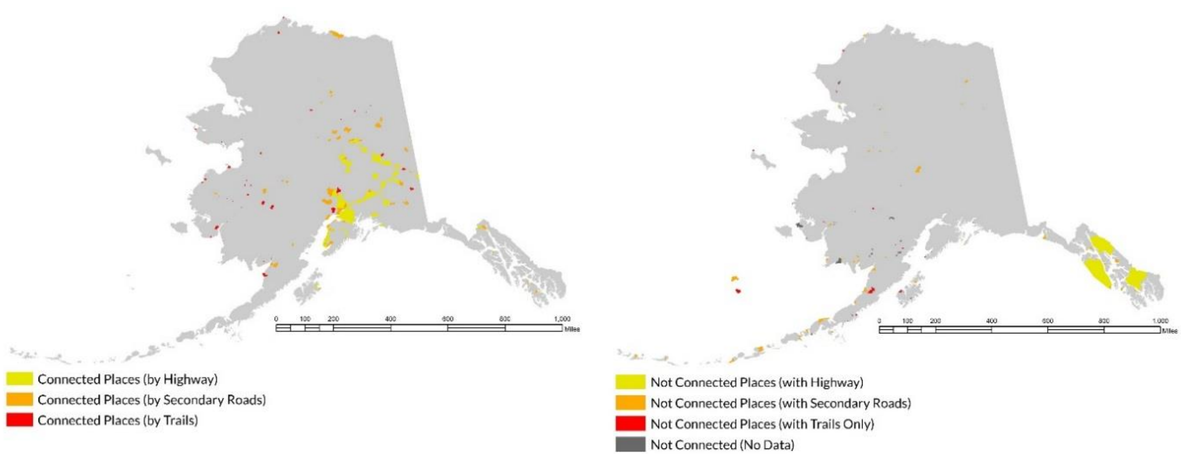


Figure 3.7. Incorporated places in Alaska that are (a) connected by formal facilities (n = 227) and (b) not-connected on the contiguous road system (n = 128).

The total distance of recorded trails in Alaska is 23,205 miles. Of those, 22,350 miles of trails are one-half mile or more from roads and highways. Here, we consider this trail mileage to supplement the road and highway networks and to provide access for those using OHVs to a more varied set of points of interest. Only 855 miles of trails are within one-half mile of roads and highways and are therefore considered redundant and not serving any other access function than to provide a presumably “legal” place for OHVs to operate. Figure 3.8 and figure 3.9 show the spatial distribution of supplementary and redundant trail lengths over the state of Alaska. The interior and North Slope regions of the state have the most supplementary mileage, while the interior also has the most redundant mileage.

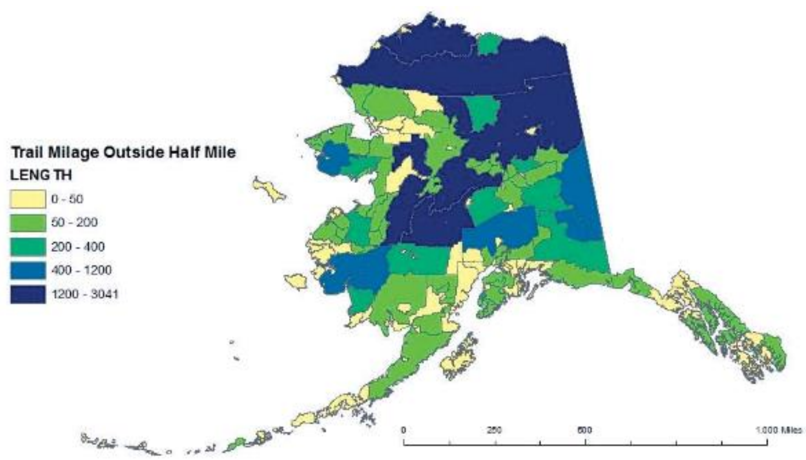


Figure 3.8. Trail mileage supplementary to road and highway networks in Alaska.

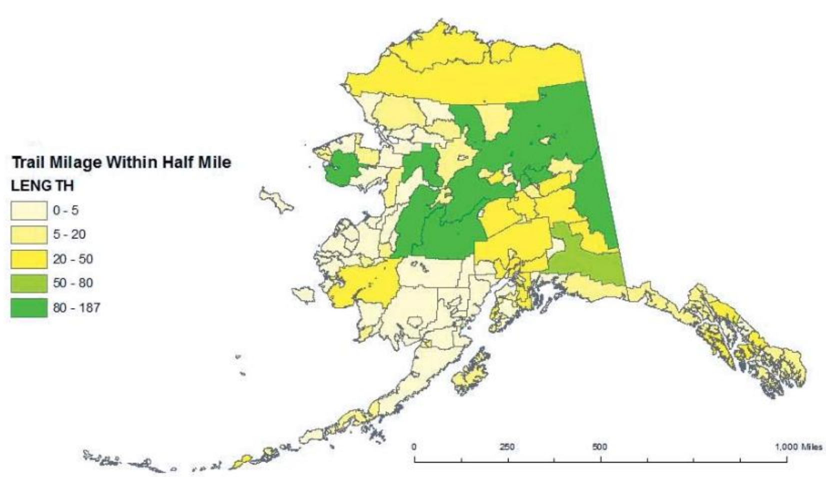


Figure 3.9. Trail mileage redundant with road and highway networks in Alaska.

4. OHV Injury and Fatality Data

Traditionally, limited data about OHV incidents have been available through departments of public safety. Some OHV crashes do end up in the DMV crash records, provided that the event was deemed to have occurred on a road or within the public right-of-way. Here, we present a summary of Trauma Registry from the State of Alaska with the hopes of providing more insight into these injury-related events.

The Alaska Trauma Registry (AKTR) is a system used to track the most seriously injured persons in Alaska along with the treatment (if appropriate) received at an acute care facility. These data have been tracked for all 24 of Alaska's acute care hospitals since 1991. The primary purpose of the registry is to evaluate quality of care and to develop, execute, and evaluate injury prevention programs. In order to be included in the trauma registry, patients must be

1. admitted to an Alaska hospital;
2. held for observation;
3. transferred to another hospital or declared dead in the emergency department; and
4. someone for whom contact occurred within 30 days of the injury.

Typical injuries may include trauma, poisoning, suffocation, and the effects of reduced temperature that may have occurred as the result of myriad events/causes. Trauma Registry data are confidential and protected under Alaska Statute 18.23.010-070. All trauma registry personnel and those requesting trauma registry data are required to sign a confidentiality statement. The trauma registry data are completely anonymous and do not include patient, physician, hospital, clinic, or ambulance service identifiers.

4.1 Obtaining and Organizing Trauma Registry Data

The AKTR data were obtained by filing a request form via e-mail with the Department of Health and Social Services (see Belz and Chang, 2018 for more information). Here, we analyzed only the five most recent and available years for the AKTR at the time of acquisition which covered the period of 2009 through 2014. The AKTR is used as a supplement to DMV records because of the ability to compare on-road and off-road events and because of the prevalence of injuries in incorporated places without state roads or facilities. The data were first sorted by injury cause to eliminate non-transportation mode causes. The remaining records were then consolidated into trauma events that occurred on/near roads, on paths/trails, and off-road.

4.2 Trauma Registry Results by Category

Motor vehicles had the most traumas, with about 2.5 times more traumas than ATVs. ATVs had a total of 1,352 traumas 347 (25.6 percent) of which occurred on or near roads (based on previously defined categories). There were 983 snowmachines traumas, with 172 (17.4 percent) of those happening in on-road categories. On-road injury and trauma counts and percentages are shown in figure 4.1, and off-road counts and percentages are shown in figure 4.2 In comparison with bike and pedestrian injuries, the total numbers for non-motorized and OHV injuries and traumas were similar.

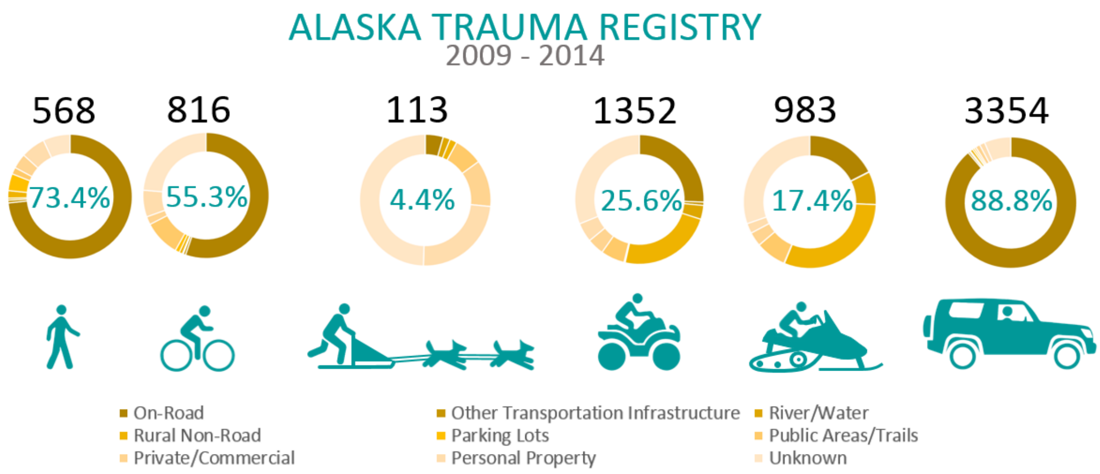


Figure 4.1. Numbers and percentages of modal traumas with percentage of on-road incidents

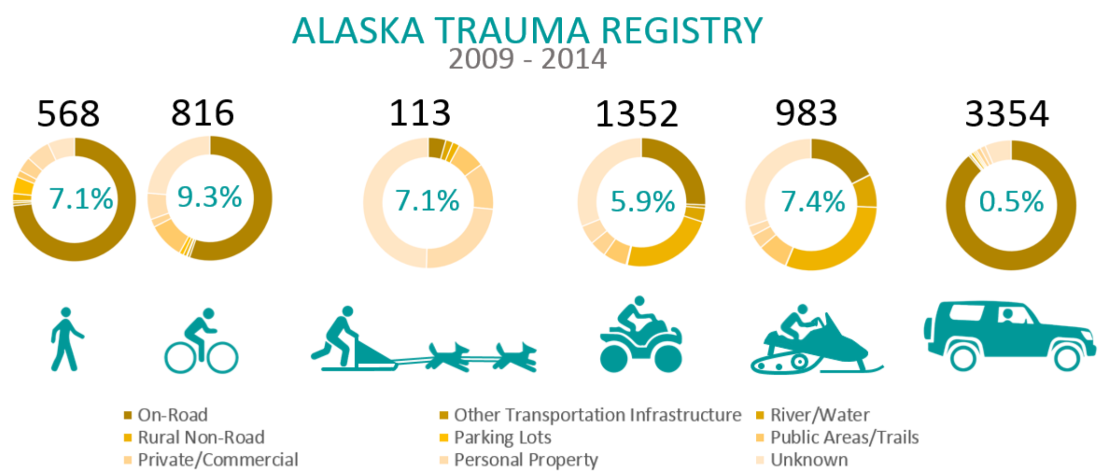
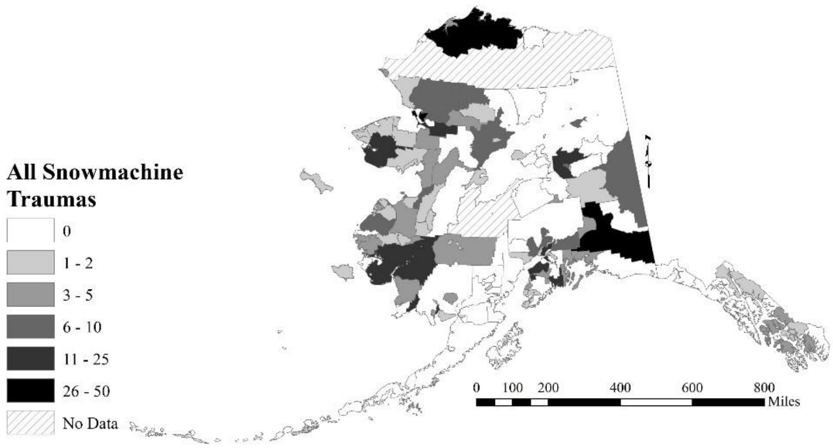
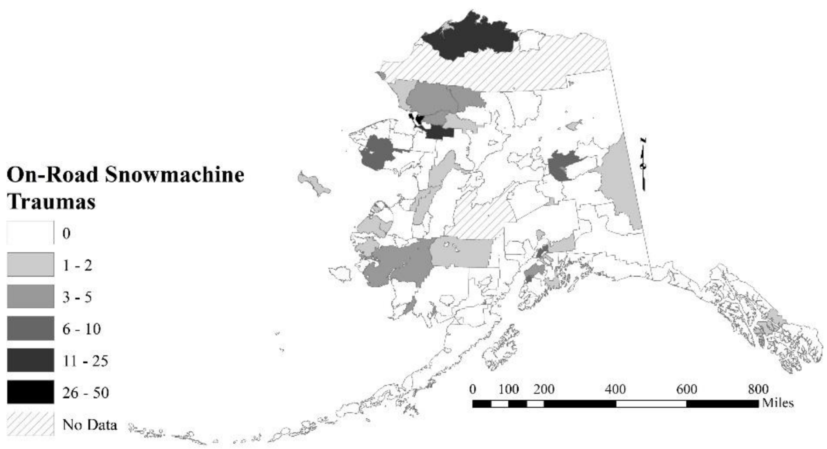


Figure 4.2. Numbers and percentages of modal traumas with percentage of public area and trail incidents

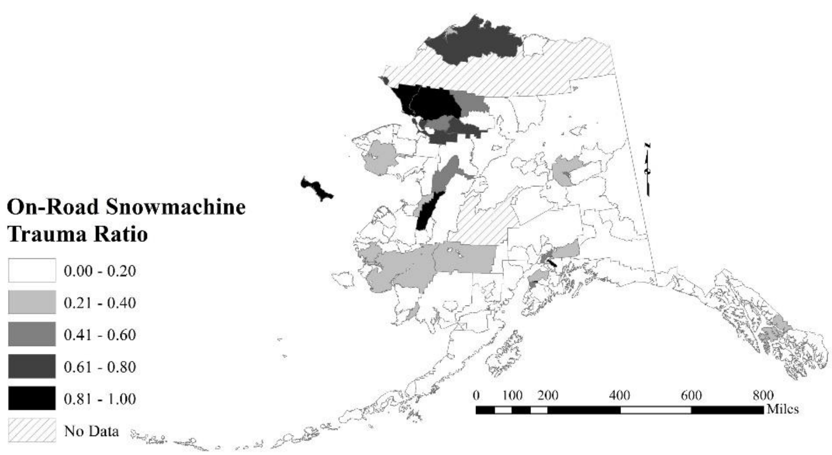
Figure 4.3 and figure 4.4 show the spatial distribution of events in the Alaska Trauma Registry for the period of 2009 through 2014, which are broken out for snowmachines and OHVs. Figure 4.5 shows the automobile-related trauma events for reference. A higher proportion of on-road snowmachine traumas occurred in the northwest and south central regions of the state, while the proportion of OHV traumas was fairly well distributed across the entire state.



(a)

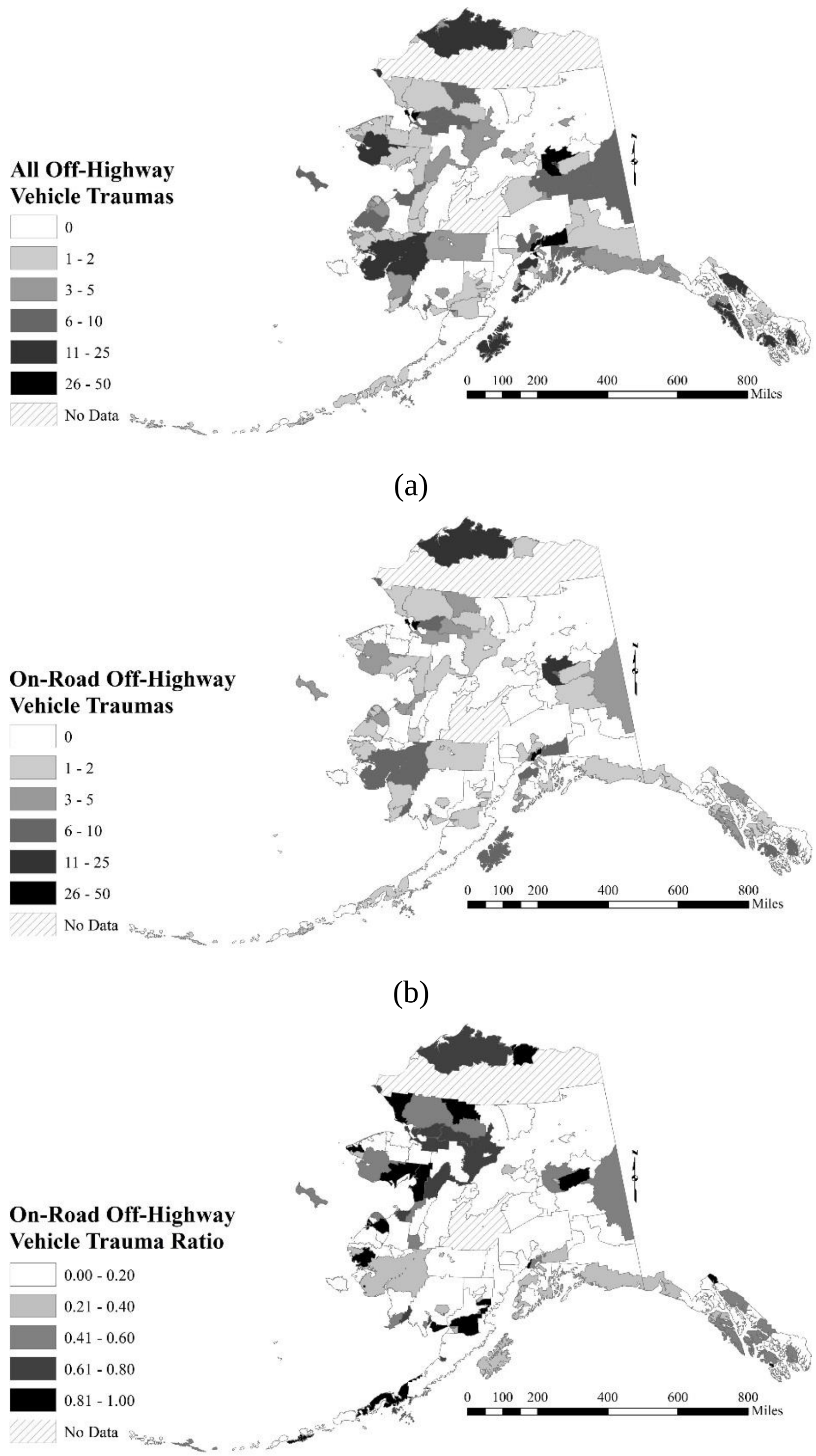


(b)



(c)

Figure 4.3. Snowmachine-related records in the Alaska Trauma Registry showing (a) all traumas, (b) on-road traumas only, and (c) ratio of on-road snowmachine traumas.

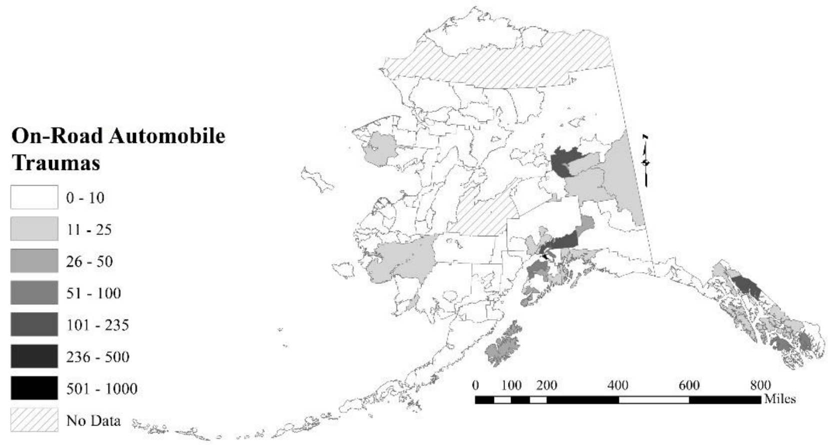


(a)

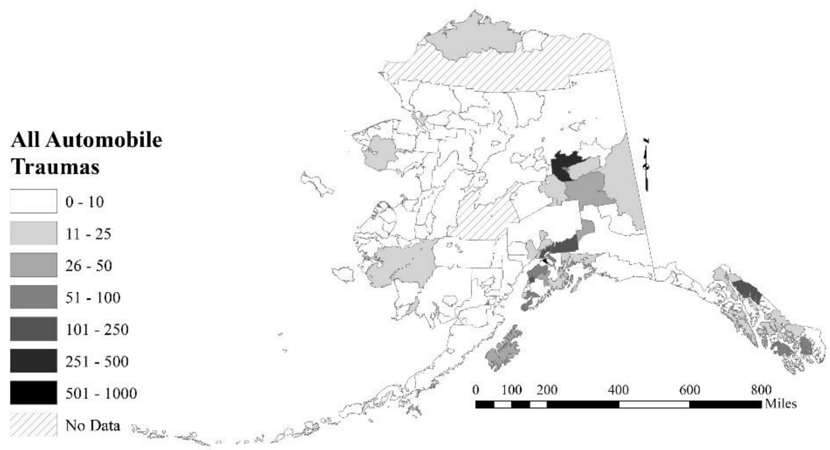
(b)

(c)

Figure 4.4. OHV-related records in the Alaska Trauma Registry showing (a) all traumas, (b) on-road traumas only, and (c) ratio of on-road OHV traumas.



(a)



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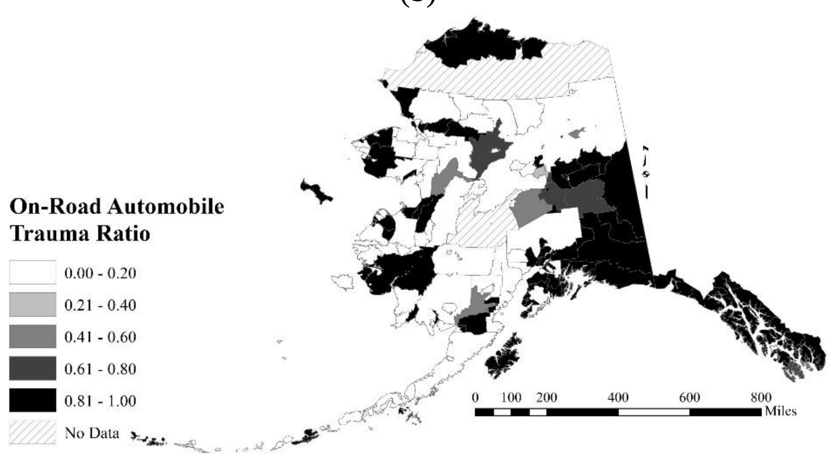


(c)

Figure 4.5. Automobile-related records in the Alaska Trauma Registry showing (a) all traumas, (b) on-road traumas only, and (c) ratio of on-road automobile traumas.

4.3 Trauma Registry Results by Location

There was a significant difference (p = 0.012) in all ATV traumas between connected and not- connected locations (table 4.1). There were more than twice as many ATV traumas on average in connected places than in not-connected places. Bicycle and pedestrian traumas are also shown for reference. There was a significant difference between the categories of connected areas for all ATV traumas. Highway connected places had about three times as many ATV traumas as secondary road connected places (table 4.2). There was also a significant difference (p = 0.017) in the number of snowmachine traumas between highway and secondary road connected places. There were roughly 4.5 times as many snowmachine-related traumas in highway connected places. For not-connected places, the most traumas occurred on highways as well, then secondary roads, then trails, then not on roads at all (table 4.3). For on-road traumas, significant differences were not observed for varying levels of connectivity or lack of connectedness (table 4.4 through table 4.6 However, for on-road ATV traumas, there was a marginally significant difference (p = 0.070) between places connected by highways and places connected by roads (table 4.5).

Table 4.1. Comparative statistics for traumas by mode and by connectedness

Transportation Mode & Trauma Location	Connected		Not-Connected		STAT	
	Mean	Std. Error	Mean	Std. Error	t-test	p-value
All ATV Traumas	7.23	1.492	3.12	0.568	2.576	0.012**
All Snowmachine Traumas	4.18	0.881	2.710	0.689	1.314	0.191
All Bicycle Traumas	8.47	5.060	1.140	0.395	1.445	0.154
All Pedestrian Traumas	6.54	4.560	1.290	0.395	1.147	0.256

** Indicates $p \leq 0.05$

Table 4.2. Comparative statistics for traumas by mode and level of connectivity

Transportation Mode & Trauma Location	Connected						STAT	
	Highway		Secondary Roads		Trails			
	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error	t-test	p-value
All ATV Traumas	10.56	2.468	2.96	0.654	No Data		2.978	0.005**
All Snowmachine Traumas	5.91	1.355	1.96	0.855			2.463	0.017**
All Bicycle Traumas	14.44	8.926	0.84	0.423			1.522	0.138
All Pedestrian Traumas	10.59	8.088	1.36	0.712			1.137	0.264

** Indicates p ≤ 0.05

Table 4.3. Comparative statistics for traumas by mode and level of non-connectivity

Transportation Mode & Trauma Location	Not-Connected								STAT	
	Highway		Secondary Roads		Trails		None			
	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error	F-test	p-value
All ATV Traumas	5.00	2.864	3.55	0.982	2.88	0.766	1.69	0.463	2.227	0.070*
All Snowmachine Traumas	0.80	0.374	3.48	1.260	2.47	0.986	1.63	0.446	0.818	0.516
All Bicycle Traumas	9.00	4.764	0.73	0.280	0.53	0.298	0.38	0.155	0.830	0.509
All Pedestrian Traumas	7.60	4.411	1.20	0.442	0.65	0.209	0.25	0.194	0.548	0.701

* Indicates 0.05 < p ≤ 0.1

Table 4.4. Comparative statistics for on-road traumas by mode and by connectedness

Transportation Mode & Trauma Location	Connected		Not-Connected		STAT	
	Mean	Std. Error	Mean	Std. Error	t-test	p-value
On-Road ATV Traumas	2.28	0.580	1.67	0.394	0.875	0.383
On-Road Snowmachine Traumas	0.81	0.267	1.03	0.388	-0.464	0.643
On-Road Bicycle Traumas	5.81	3.794	0.83	0.322	1.306	0.197
On-Road Pedestrian Traumas	5.16	3.805	0.87	0.297	1.123	0.266

Table 4.5. Comparative statistics for on-road traumas by mode and level of connectivity

Transportation Mode & Trauma Location	Connected						STAT	
	Highway		Secondary Roads		Trails		t-test	p-value
	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error		
On-Road ATV Traumas	3.19	0.983	1.12	0.307	No Data		2.007	0.052*
On-Road Snowmachine Traumas	1.16	0.414	0.36	0.282			1.589	0.118
On-Road Bicycle Traumas	9.81	6.713	0.68	0.34			1.359	0.184
On-Road Pedestrian Traumas	8.41	6.756	1.00	0.523			1.093	0.283

* Indicates $0.05 < p \leq 0.1$

Table 4.6. Comparative statistics for on-road traumas by mode and level of non-connectivity

Transportation Mode & Trauma Location	Not-Connected								STAT	
	Highway		Secondary Roads		Trails		None		F-test	p-value
	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error		
On-Road ATV Traumas	2.20	1.158	1.98	0.710	1.59	0.522	0.81	0.332	0.481	0.750
On-Road Snowmachine Traumas	0.00	0.000	1.28	0.692	1.14	0.697	0.31	0.176	0.584	0.675
On-Road Bicycle Traumas	7.20	4.055	0.50	0.203	0.35	0.191	0.19	0.101	0.724	0.577
On-Road Pedestrian Traumas	5.60	3.415	0.78	0.319	0.35	0.170	0.19	0.136	0.508	0.730

4.4 DMV Crash Records for Off-Highway Vehicles

The DMV crash records for the period for 2009 through 2013 (the most current and complete five-year set of data available at the time of acquisition) were acquired through AKDOT&PF (see Appendix B for signed user agreements). Events involving OHVs were identified by using the “vehicle configuration” and “vehicle type” categories, as this data category changed between the 2012 and the 2013 data sets. If either the primary or secondary vehicles listed in the event record included OHV in the 2009 through 2012 data or “open body” in the 2013 data, these were reserved for further analysis. Figure 4.6 shows the total number of records present in the DMV data for 2009 through 2013. For reference, the figure also shows the total number of on-road-specific injury events cataloged in the AKTR from 2009 through 2014. In general, it is clear that the two sets of data track each other. However, there are consistently more than twice the number of records in the AKTR than in the DMV data. Figure 4.7 shows the spatial distribution of those events. To prepare this information, latitudes and longitudes associated with the records were used to match the event to a GIS shapefile representing zip codes. This allowed a more direct comparison to the AKTR, in which only town name and zip code of the event were provided. Figure 4.8 shows the AKTR records again for reference.

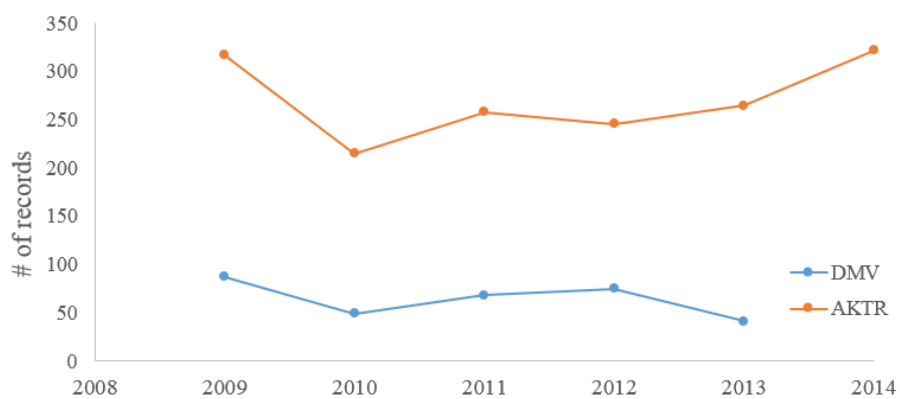


Figure 4.6. Total number of OHV-related crash and injury records in the DMV and AKTR databases for 2009 through 2014

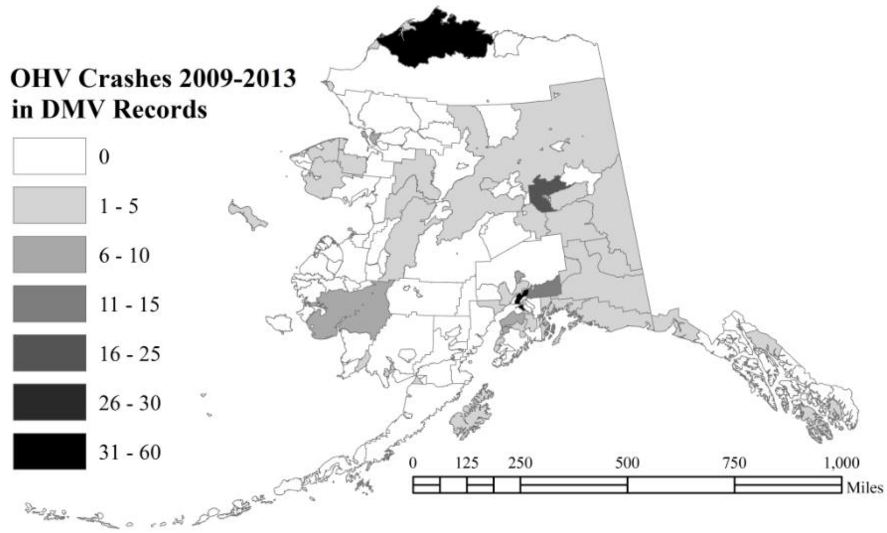


Figure 4.7. Spatial distribution of statewide OHV crashs in the DMV records, 2009 through 2013

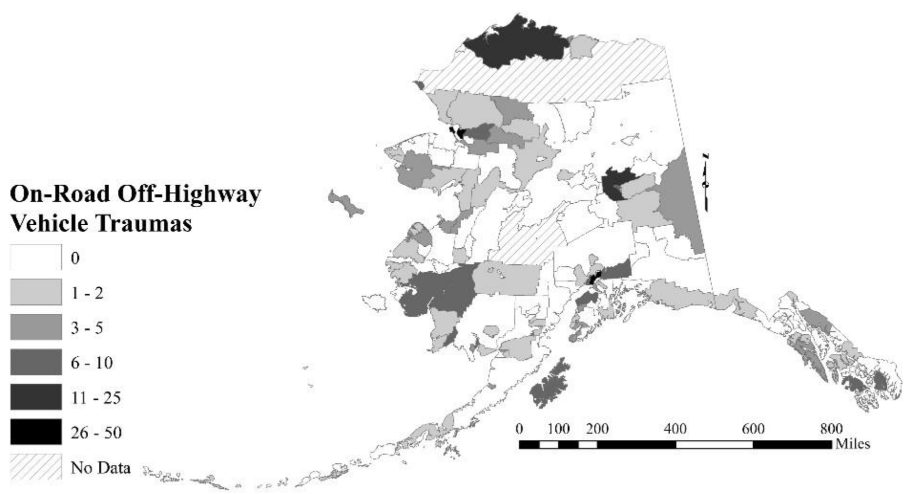


Figure 4.8. Spatial distribution of statewide on-road-related OHV injuries/traumas in the AKTR records, 2009 through 2014

Figure 4.9 shows the ratio of DMV to AKTR events by zip codes, collapsed to place name. Events occurring in 2014 for the AKTR were ignored so the data sets would be comparable. There were only 12 cases (i.e., towns) for which there were non-zero values in the DMV records and zero values in the AKTR so the ratio could not be computed. These only totaled 25 out of the 272 events in the DMV records. Areas in blueish-green, green, and yellow indicate places where more events were observed in the AKTR. Areas in orange and red are places where more events were observed in the DMV. Areas in blue-ish green and red are highly problematic, as they indicate severe and significant discrepancies between the two data sets.

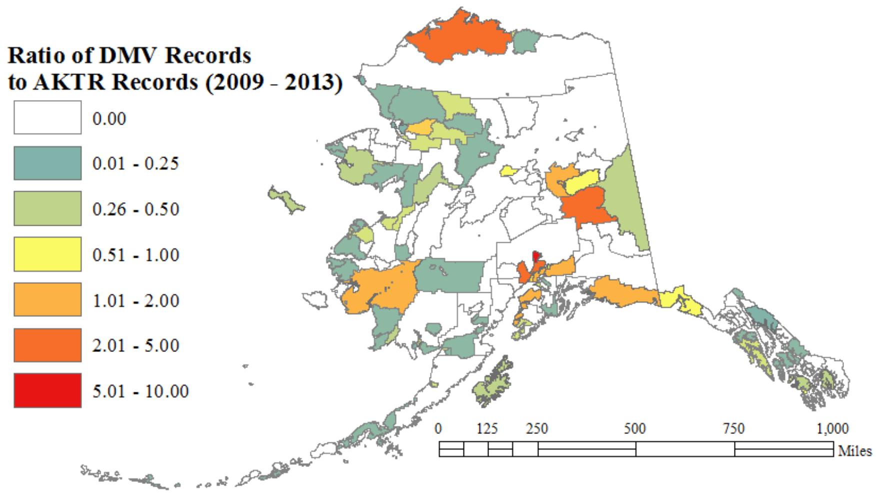


Figure 4.9. Ratio of on-road-related OHV events in the DMV and AKTR records for 2009 through 2013

5. Media Discourse Analysis

In order to gain a better understanding of the types of concerns, safety trends, and conversations surrounding OHV use, national online media coverage was tracked and compiled for a period of one year beginning July 1, 2017, through June 30, 2018, using Google Alerts. Tracking was accomplished by identifying any article or online post that met the inclusion criteria of [ATV *OR* OHV *OR* Snowmobile *AND* road *OR* roadway *OR* "off-road vehicle" *OR* "all-terrain vehicle"], and then results were analyzed and filtered to separate articles that referenced cases or incidences that were on-road from those that were off-road. This period of analysis yielded 1,327 articles in total, 812 of which dealt with on-road OHV use. Table 5.1 summarizes the specific numbers of each article theme.

A common method for quantitatively analyzing media content is word counting (Riffe et al., 2005), which can be used to identify and extract themes from text. Crawley (2007) and Murphy (2001) analyzed keyword frequencies and applied factor analysis to the co-occurrence of words in articles on particular topics. From this factor analysis, themes (or frames) can be conceptualized as words that factor together. Keywords are words that are used unambiguously yet occur frequently in the set of text and substantively represent the issue of interest. Word analyses can also be achieved by developing content analysis dictionaries (Riffe et al., 2005) in which words that are related or share a common theme are grouped together, also referred to as "semantic fields" (Sonnet et al., 2006).

Extracting keywords from the one-year set of media (July 1, 2017, through June 30, 2018) yielded seven distinct topic areas within each of the themes: location and spatial relation, policies and laws, user characteristics, temporal relation, vehicle types, protective equipment (or lack thereof), and crash/accident descriptors. These categories reinforce the idea that policies, laws, and the characteristics of the vehicle operator are at the forefront of OHV safety issues. Table 5.1 presents a summary of the number of articles by theme, the percentage that involved an on-road incident or issue, and the number of articles from Alaska, specifically.

Table 5.1. OHV media discourse summary

Theme	**Total**	**On-Road (N, %)**	**Alaska**
Injuries	409	232, 56.7	1
Fatalities	467	250, 53.5	10
Policy	360	297, 82.5	7
Education	91	33, 36.3	0
Total	1327	812, 61.2	18

One interesting finding that is clearly shown in table 5.1 is the predomincance of on-road issues (reflected in percentages) for injuries, fatalities, and policies. However, most articles dealing with education focused primarily on trails. Policy-related articles almost exlusively (roughly 83 percent of the articles) dealt with on-road issues. No articles dealt with education for Alaska specifically. To provide a further breakdown, figure 5.1 and figure 5.2 show the most frequently occurring words in each of the identified thematic categories for injury- and fatality-related articles. Words indicating the event happened on the weekend and nighttime occurred more frequently than other times of the day and week. Snowmobile-related incidents were more prevalent in off-road-related events, while ATV/OHVs were more prevalent in on-road-related events. Words indicating that the operator was male (e.g., his, him, he, etc.) were in total more prevalent for off-road events.

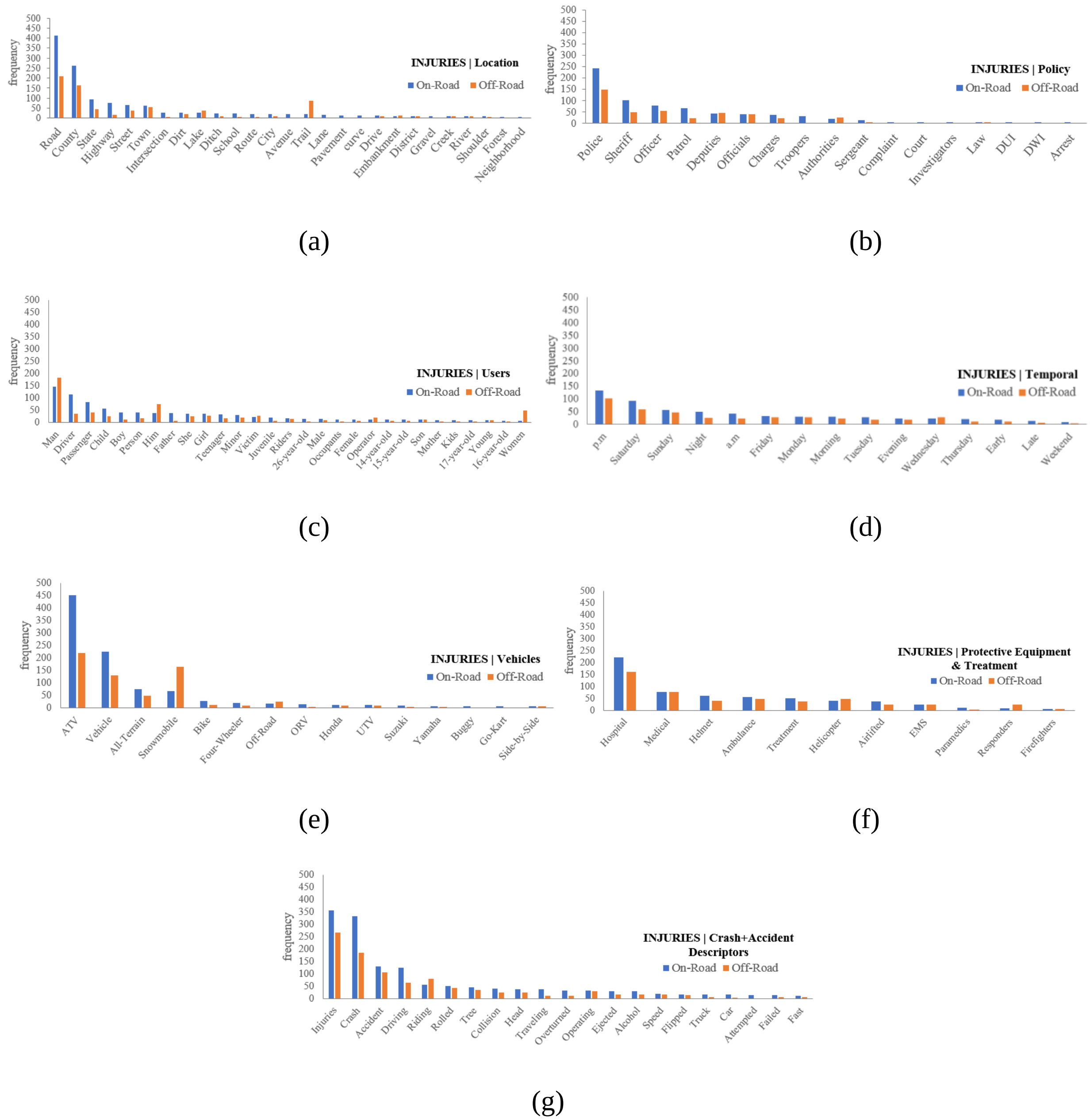
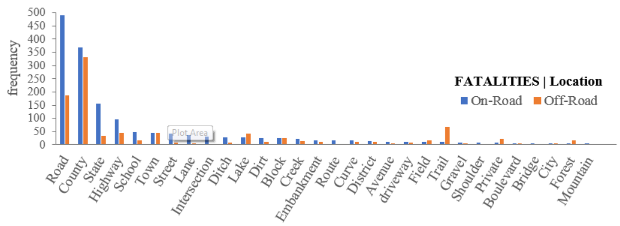
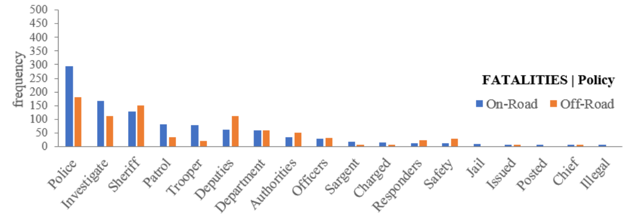


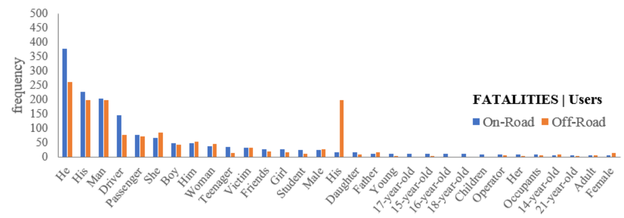
Figure 5.1. Word frequencies from OHV-injury-related media content showing counts for (a) location, (b) policy, (c) users, (d), temporal, (e) vehicles, (f) protective equipment and treatment and (g) crash/accident descriptor thematic categories.



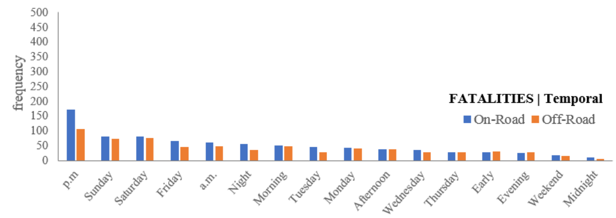
(a)



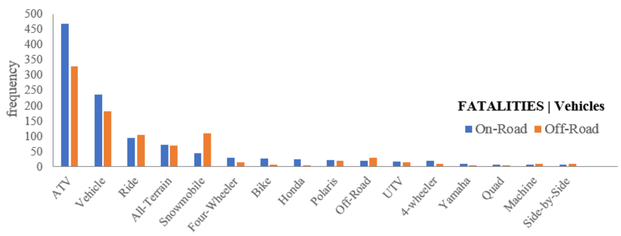
(b)



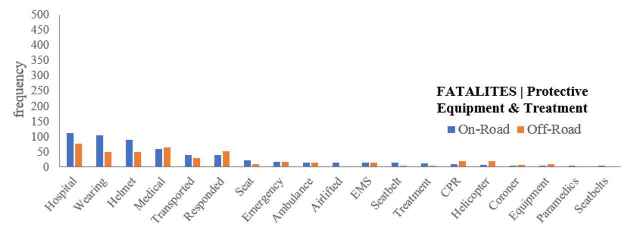
(a)



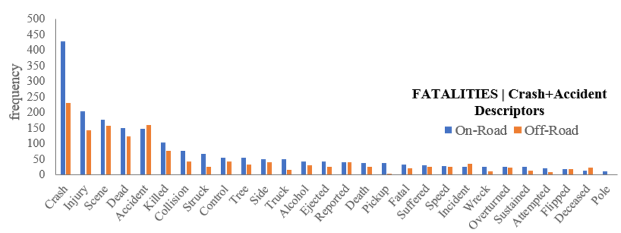
(b)



(a)



(b)



(g)

Figure 5.2. Word frequencies from OHV-fatality-related media content showing counts for (a) location, (b) policy, (c) users, (d), temporal, (e) vehicles, (f) protective equipment and treatment and (g) crash/accident descriptor thematic categories.

6. OHV Counts

6.1 Site Selection

Multiple sources of mapping data were used to generate the network analysis and trails maps. Several types of data were assembled from a variety of sources, including federal and local data (e.g., Department of Natural Resources (DNR) trails and Department of Transportation road centerlines). These data were used to identify key locations where 1) trails and roads intersected; 2) a trail followed the road in an adjacent and proximal manner; or 3) a trail terminated and the road was the only likely corridor to be used by OHVs. Some of these data were discussed in Chapter 3 and are highlighted again here for reference.

The primary sources of data used to identify locations of interest were 1) DNR polylines that represented RS2477 trails (right-of-way for the construction of highways over public lands, not reserved for public uses); 2) DNR polylines that represented other general trail networks but presumably were open for public use; 3) AKDOT&PF road centerlines; and 4) ESRI GIS street centerlines. The AKDOT&PF and ESRI data sets were used in conjunction to ensure that complete road networks were represented. Figure 6.1 and figure 6.2 show how the data overlaid each other for a select location in Petersville, Alaska. Here, one can see several key locations where the road network provided shorter connectivity between trail ends and a location where OHV use could be observed.

(a) (b)

Figure 6.1. DNR (a) RS2477 trails (purple) and easement (grey) data and (b) general trails data (red) in Petersville, Alaska.

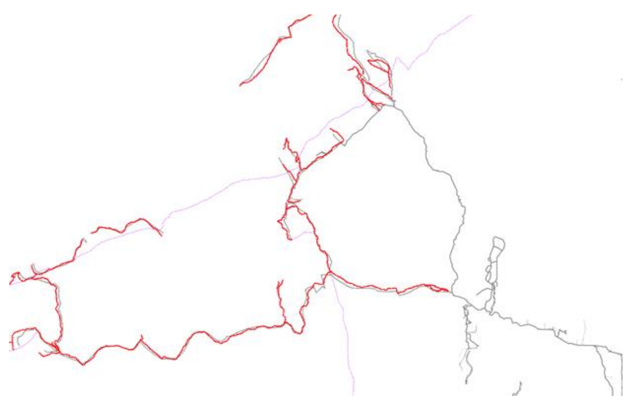


Figure 6.2. DNR RS2477 trails (purple) and easement data (grey), trails data (red), and AKDOT&PF and ESRI road centerline data (dark grey) in Petersville, Alaska.

Figure 6.3 shows the statewide network of roads and trails. One must consider that although this information was the most robust, complete, and up-to-date information available at this time, it may not represent all available road and trail networks in the state. However, considered holistically, the data in their current form were sufficient for purposes of this research project and provided a good indication of current points of conflict for OHVs, automobiles, and non-motorized forms of transportation.

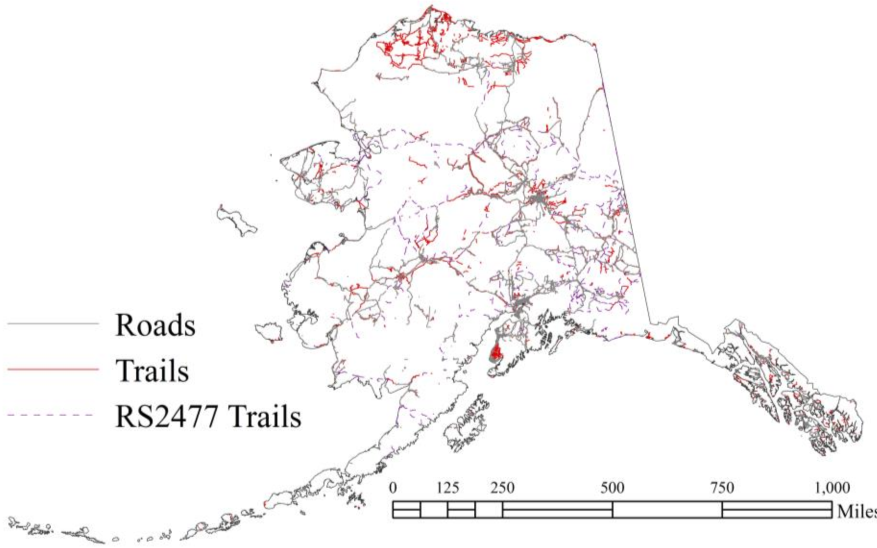
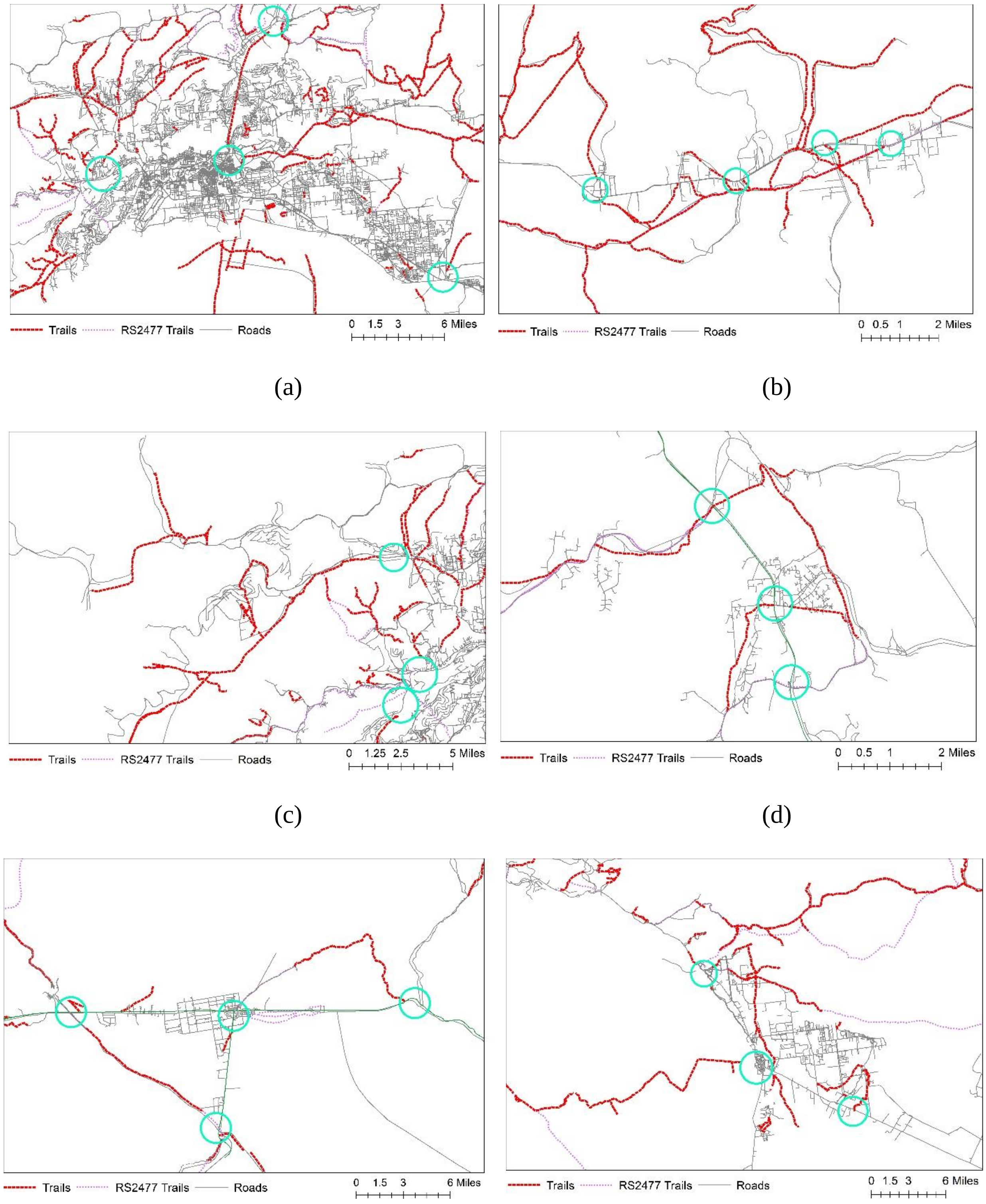


Figure 6.3. Statewide road, trail, and RS2477 trail networks.

On the basis of a visual inspection of road and trail networks in towns with areas of concern (for example, in Delta Junction), six locations were chosen for the primary phase of data collection. Figure 6.4 shows the trail and road network, with the final set of general locations with potential areas for count locations identified with cyan-colored circles. Figure 6.5 shows an example Google Street View of Nistler Road in Delta Junction, which was used to corroborate site identifications in figure 6.4. From these, a final set of locations was selected on the basis of timeline and budget, and they included six count locations in each of the towns of Fairbanks, Two Rivers, Ester, Healy, Tok, and Delta Junction.



(e) (f)

Figure 6.4. Identified possible count locations in (a) Fairbanks, (b) Two Rivers, (c) Ester, (d) Healy, (e) Tok, and (f) Delta Junction.

Figure 6.5. Google Street View of an intersection showing worn areas from OHV use at Nistler Road and North Clearwater Avenue in Delta Junction, Alaska

6.2 Data Collection

Data collection for OHV use was executed over the period of May 15, 2018, through July 30, 2018. The period of May 23, 2018, through May 30, 2018, was used to refine the data collection method and camera set-up process. These data were also used to provide information for the Fairbanks Metropolitan Area Transportation System annual bicycle and pedestrian count. During this period, 10 OHVs were observed using the bike path along the Parks Highway near Sheep Creek Extension (see figure 6.6). Th data were also used to refine the MatLab coding used to extract still images of movement that were captured in the video frame. The final code used for video processing can be found in Appendix C.

(a) (b) (c)

Figure 6.6. Preliminary video-based OHV counting along Parks Highway near Sheep Creek Extension in Fairbanks, Alaska.

A motion-activated day-night camera was used, powered by two 12V batteries stored in a waterproof housing. A digital video recorder (DVR) that stored the video files was also placed in the waterproof housing. Existing infrastructure (e.g., light poles and power poles) or trees with unobstructed views to the point of interest were used to mount the cameras. Each camera was affixed to a metal bar, and pipe strapping was used to affix the camera to the mounting device. Two example mounting set-ups are shown in figure 6.7 and figure 6.8 for the Healy and Fairbanks locations, respectively. The DVR allowed areas within the video frame to be masked out that were not of interest. This significantly reduced the number of non-OHV-related events and consequently the amount of video that had to be processed. A total of 624 hours were observed at all the locations.

(a) (b) (c)

Figure 6.7. Camera mounting in Healy, Alaska, showing (a) location near Hilltop Road, (b) waterproof box locked to a power pole, and (c) video camera mounted to a pole with pipe straps.

(a) (b) (c)

Figure 6.8. Camera mounting example in Fairbanks, Alaska showing (a) location along Farmers Loop Road looking west, (b) location along Farmers Loop Road looking east, and (c) location proximal to a “No Motor Vehicles” sign.

After the video collection for a particular location had been completed, the video files were fed into the MatLab processing code to extract still images or motion events. These images were processed manually to produce counts and characterizations of each event (e.g., bicycle, pedestrian, automobile, OHV, etc.). For OHV events, the number of occupants on the vehicle and the presence (or non-presence) of a helmet were also recorded. Figure 6.9 through figure 6.14 show example images from select count locations. It is important to note, particularly for figure 6.10, that even though the images show use in a "gore-like" area, the trail network connects and continues onto the road way beyond the frame of the video. Locating the camera in some locations was problematic because there were no fixed objects to accommodate the camera set-up. In these cases, a proximal location was chosen.

(a) (b) (c)

Figure 6.9. Farmers Loop Road location in Fairbanks, Alaska, showing (a) an ATV, (b) a side-by-side, and (c) three ATVs using the space between a bike path and roadway.

(a) (b) (c)

Figure 6.10. Parks Highway location in Ester, Alaska, showing (a) an ATV using the shoulder, (b) an ATV and a dirt bike in the gore area, and (c) an ATV operator with no helmet.

(a) (b) (c)

Figure 6.11. Hilltop Road location in Healy, Alaska, showing (a) an ATV using the shoulder, (b) two side-by-sides using the shoulder, and (c) an ATV using the roadway.

(a) (b) (c)

Figure 6.12. Nistler Road location in Delta Junction, Alaska, showing (a) several ATVs and side-by-sides on the side and in the roadway, (b) a side-by-side using the shoulder, and (c) multiple ATVs using the informal side path.

(a) (b) (c)

Figure 6.13. Alaska Highway location in Tok, Alaska, showing (a) a side-by-side in the buffer between the bike path and the roadway, (b) an ATV partially on the bike path, and (c) an ATV in the buffer between the bike path and the roadway.

(a) (b)

Figure 6.14. Chena Hot Springs Road location in Two Rivers, Alaska, showing (a) a dirtbike using the gravel shoulder and (b) a side-by-side using the gravel shoulder in the wrong direction of travel.

6.3 Results

In total, 263 OHVs were captured on video. Of those, 85 (32 percent) were observed using either the road or a facility meant (and signed) specifically for non-motorized use. The highest rate of use was observed at the Healy, Alaska, location. The lowest rate of use was observed at the Two Rivers, Alaska, location. Only one day was counted at the Tok, Alaska, location because of a battery malfunction that melted the wire providing power to the camera and DVR. Figure 6.15 shows a summary of each count location, with the icons depicting (from left to right) total number of OHVs observed, total number of occurrences with one or more passengers, percentage of riders wearing helmets, and percentage of occurrences in which the OHV was riding either directly on the road or on a non-motorized facility. The dates over which data were collected are listed under the location in italic font.

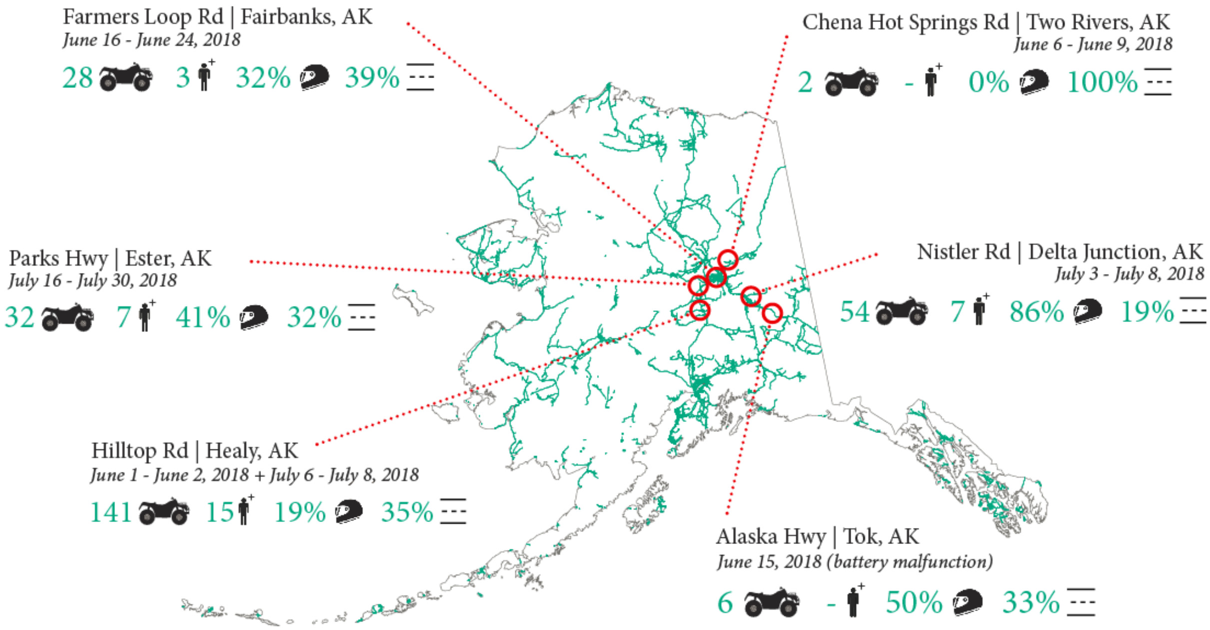


Figure 6.15. OHV count summaries by location

This data collection effort showed that OHV use near roads is not negligible. This corroborated the rates of injuries and crashes observed in the DMV and AKTR records. Furthermore, the use of OHV modes on roads and non-motorized facilities was as high was 100 percent (in the cases where the “informal” OHV facility coincided with the gravel shoulder of the road). However, that was only two total cases at the Two Rivers location. That said, there were several instances at the other observed locations where the OHV percentage was also very high. On average, OHV on-road and public facility use for the six observed locations was roughly 32 percent of all users.

7. Discussion and Conclusions

The research presented here had four primary objectives. First, to document the existing state of practice and policies in the State of Alaska regarding OHV use on roads and in public rights of way. Second, to characterize and identify the spatial distribution of OHV crashes and injuries by using DMV crash records and AKTR data. Third, to conduct a media discourse analysis using online media with OHV content to construct themes related to OHV issues. Lastly, to develop a GIS framework for identifying locations of possible conflict where OHV use is likely and to conduct in-field counts of frequency and use.

On the basis of the analysis of state-, borough- and town-based policies on OHV use on roads, it is clear that there are significant variations in policies across the state. In some locations provisions require the use of protective equipment, require functional headlights and taillights, or restrict when and where OHVs can be used. In other locations, stipulations on OHV use are non-existent or not enforced (according to local public safety officers). Although in some cases these policies are specific to a small geographic region and unique locale (e.g., no or limited operation in select parks or streets), there are several that may warrant modification to provide better consistency at the borough and city levels (e.g., speed limits, vehicle restrictions, and hours of operation). It is highly recommended that, where possible, these policies are aligned to achieve consistency. Though this is not expected to be the sole solution to the problem, it will certainly help rectify problems that arise when residents relocate to new towns or when those enforcing the regulations move to new jurisdictions. There are two limitations worth noting. First, that the information provided in the tables was gathered in June of 2017. Because Alaska ordinances may change over time, it is recommended that one checks with the local authorities with any questions or concerns regarding OHV/ATV or snowmachine use and laws before operating in that area. Second, only a select set of town-level policies were gathered and reviewed. Therefore, the town-level summaries does not provide a complete picture of variations that may exist across the state. A more robust sampling and comprehensive documentation of city/town policies could be completed to identify other possible variations in policies at the local level.

The results of the spatial analysis of crash and injury data indicated that, in general, the trauma registry is a more reliable and comprehensive source of OHV “conflicts.” However, this applies primarily to locations that are located off primary highway corridors. There were 12 cases (i.e., towns) for which there were non-zero values in the DMV records and zero values in the AKTR, but those accounted for only 25 of the 272 events in the DMV records. While the AKTR provides better spatial coverage, the DMV records do provide more robust data for the larger population centers while also having more comprehensive information and more variables within the data sets from which to parse out other relevant issues. If possible, agencies that manage data sets like the AKTR should consider formats that make cross-source comparisons easier.

For the media discourse analysis, over 1,300 articles were retrieved during the period of July 1, 2017, through June 30, 2018. From those articles, the four most prevalent content themes included injuries, fatalities, policy, and education. Of the 1,300 articles, only 18 were from Alaska. Of those, 55 percent were on the subject of fatalities and 39 percent were on policies. None of the articles discussed education. Nationwide, the article content indicated that events on the weekend and at night occurred more frequently than other times of the day and week. Snowmobile-related incidents were more prevalent in off-road related events, while ATV/OHVs were more prevalent in on-road-related events. Words indicating that the operator was male (e.g., his, him, he, etc.) were in total more prevalent for off-road events. Several articles also indicated issues related to helmet use and injury of passengers, likely on vehicles not intended for more than one or two persons at a time.

The GIS framework for selecting count locations proved to be incredibly useful. Data were collected and analyzed regarding OHV transportation modes in Alaska to gain a better understanding of usage rates. This was a first step in providing a set of data that can be used to normalize other safety-related information specific to OHV use, i.e., DMV crash records and the AKTR. However, a few limitations of the network analysis and site selection methodology must be considered. First, the use of several sources of data has the potential to impart error, as there are likely mismatches between layers because of the varying scales of the source documents, the intended use of the mapping layers (i.e., easements may have been platted but never developed as actual trails), and cartographic generalization that results when road/trail features are generalized and complex detail is removed. Second, many of these features have not been validated directly in the field, ideally using GPS equipment. For example, what may appear in an old air photograph used to develop a map layer of trails may not, in reality, be traversable, such as powerline rights-of way. Lastly, the analysis presented here was subjective even though the spatial data were entirely objective. That said, locations were chosen on the basis of both the spatial data, anecdotal evidence and *a priori* knowledge of the research team, and Google Street View imagery. This limitation was considered to have little to no adverse effects on the outcomes and needs of this project. However, future work should seek to either 1) develop methods to avoid the use of subjective selection of locations; or preferably 2) develop a robust and static set of sites of interest at which counts can be conducted on a routine basis.

Secondary to the GIS-based location selection, this analysis determined (on the basis of available spatial data at the time of analysis) that highways and primary roads connect 184 of the census-defined populated places in Alaska and represent 52 percent of all populated places. Trails alone connect 72 places (21 percent of all populated places) and 97 places (27 percent of all populated places) are not connected by any formal network. On average 67 percent of the population in isolated places are Native Alaskan. This percentage increases to roughly 88 percent when road and highway networks are not present.

Highway connected places have a significantly higher risk of having ATV and snowmachine traumas than road connected places (considering both on-road and off-road trauma events). This indicates that parts of the issue may be the amount of traffic in connected areas; the frequency of use of ATVs rather than automobiles in non-connected areas, which may lead to fewer mixed-use scenarios; or simply the presence of highways being inherent to more highly populated areas and thus higher exposure rates overall. The data indicated that connected and urban locations have significantly more safety issues related to ATVs and OHVs, suggesting that they should be accommodated by alternative networks or the implementation of different policies (e.g., enforcement and regulations) or design practices.

The results presented here further illustrate the unique transportation environment present in Alaska. It is important that we holistically consider the transportation needs of residents and how they may vary between those living in villages and towns and those in larger cities. By integrating data in a GIS framework, some spatial trends became apparent, but future work should seek to integrate the data sets presented here. Future research should also attempt to define the network structure of trail-connected and trail-only places, as well as the extent to which rivers and frozen tundra, particularly during winter months, contribute to these informal networks. Additionally, projects geared toward obtaining more robust counts of ATV and snowmachine use will help to normalize the trauma and DMV crash inventories.

This research contributes to the larger effort of promoting safe use and travel on roads in the Pacific Northwest. The project efforts presented here were based on and developed in accordance with the Alaska Strategic Highway Safety Plan in efforts Toward Zero Deaths for special users, specifically operators of ATVs and snow machines. Further, the Federal Highway Administration, through the Office of Federal Lands Highway and the Tribal Transportation Program, has expressed interest and provided formal support in matters related to this project as it aligns with its efforts to conduct research on Alaska Winter Trails Safety (AWTS). This study sought to develop and document opportunities to reduce serious and fatal incidents involving snow machines that occur on winter trails in Alaska. The scope of the AWTS work may serve as follow-on research and supplement the work being proposed in this study as it contributes to the spatial extent of safety issues related to non-traditional vehicles by considering formal and informal trail systems that are connected to public facilities

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8. References

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9. Appendix A: Trauma Registry Data Request

THE STATE of ALASKA

GOVERNOR BILL WALKER

Department of Health and Social Services

DIVISION OF PUBLIC HEALTH
Emergency Programs

3601 C Street, Suite 424
Anchorage, Alaska 99503-5924
Main: [illegible]
Fax: [illegible]

ALASKA TRAUMA REGISTRY
RELEASE OF INFORMATION POLICY

INTRODUCTION

The purpose of the Release of Information Policy is to establish guidelines for the release of data from the Alaska Trauma Registry to individuals or organizations requesting information pursuant to the provisions of 7 AAC 26.745 TRAUMA REGISTRY which provides in part: (b) The Trauma System Review Committee shall keep Trauma Registry Data confidential in accordance with AS 18.23.030 except that (3) reports on trauma registry data, not including patient identifiers, physician identifiers, or hospital identifiers, may be provided to epidemiologists, health planners, medical researchers, or other interested persons to study causes, severity, demographics and outcomes of injuries, or for other purposes of studying the epidemiology of injuries or emergency medical services and trauma system issues.

In sharing trauma registry information it is the intent of the Trauma System Review Committee that

1. patient, facility, health care provider, and service confidentiality be protected

2. legitimate and responsible use of trauma registry data for the purposes of promoting public health research, public health education, injury prevention, and peer review be insured, and

3. trauma registry data is represented accurately and without prejudice to an individual or institution.

PROCEDURE

Information requests will be put into one of two categories and considered as outlined below.

1. As established by the Trauma System Review Committee, participating trauma registry hospitals and ambulance services may request reports or information under 7 AAC 26.745. Customized reports or information will be provided to individuals or institutions requesting information pertaining to themselves to include privileged and nonprivileged data and information; privileged data or information is defined as any data or information identifying an individual patient, physician, hospital, or prehospital care provider, and acquired in the performance of activities of the Alaska Trauma Registry program.

2. A recognized and known legitimate individual or organization requesting nonprivileged data or information from the trauma registry for the purpose of promoting public health research or public health education will be provided the requested information by the Trauma Registry Database Manager. The Trauma Registry Database Manager may require that the requestor submit his/her request in writing and provide proof of requester legitimacy. Nonprivileged data or information is defined as any data or information that does not identify an individual patient, physician, hospital, or prehospital care provider, and data or information that constitutes a limited data set under 45 C.F.R. 164.514(e).

Release of information may be contingent upon signature of the following agreement:

ALASKA TRAUMA REGISTRY DATA UTILIZATION AGREEMENT

The Trauma Program of the Alaska Department of Health and Social Services, Division of Public Health, places the following conditions on the acceptance and utilization of data from the Alaska Trauma Registry:

1. Ownership of the data will remain with the Alaska Department of Health and Social Services, Division of Public Health, Section of Emergency Programs/Trauma Program (ADHSS/DPH/EP/TP).

2. Applicant will have access to the "raw" data that has been sent for research and analysis. No other person will have access to the data unless for technical support and with ADHSS/DPH/EP/TP approval. Upon completion of the proposed research project in the application, the "raw" data will be deleted, and transmittal copies destroyed.

3. Access to the data file will be protected by a security system that requires the user to provide at least one password.

4. Release of nonaggregate data to any other individual or agency without the express permission of the ADHSS/DPH/EP/TP is prohibited. If given permission, recipient will ensure that the individual or agency agrees to the same restrictions and conditions that apply to the recipient with respect to the data.

5. The recipient will commit to protecting the identity of trauma registry patients, ambulance services, and hospitals. (Although we do not give names, in some communities, the dates, age, sex, race and place of injury occurrence are sufficient to identify an individual or service.) No use will be made of the identity of a person, service or hospital discovered inadvertently.

6. The recipient will comply with all statutes and regulations related to the protection of patient-identifiable information, including HIPAA privacy and security regulations. An agency using the data will ensure minimum use and provide for personal sanctions against an individual who violates the regulations regarding disclosure.

7. The recipient shall immediately report to ADHSS/DPH/EP/TP any use or disclosure of the data not provided for by its data utilization agreement of which it becomes aware.

8. Data will not be linked to any data set with individually identifiable records.

9. The recipient will submit to the ADHSS/DPH/EP/TP a signed Alaska Trauma Registry confidentiality statement.

10. The data may only be used for studies of a public health nature.

11. The recipient will allow the ADHSS/DPH/EP/TP and the Trauma System Review Committee prepublication review of conclusions based upon data from the trauma registry. (This is to insure correct interpretation of the contents of the database.) If disagreement exists, the recipient will allow the Trauma System Review Committee the opportunity to include their comment within the published document. Acknowledgement is to be given to the ADHSS/DPH/EP/TP as the source of data in any publications, articles or studies that are prepared or published.

12. The recipient will not identify the data or contact the individuals represented in the data.

STUDY PROPOSAL

The study proposal will include objectives, methods, study population of interest, and specific elements needed from the trauma registry. The requestor must inform the Trauma Registry Database Manager of any changes to the study design or changes in the estimation of time for project completion.

DUTIES OF THE TRAUMA SYSTEM REVIEW COMMITTEE

The Trauma System Review Committee will be available to make final determinations on requests for information from the trauma registry. An information request review by the Trauma Registry Database Manager may be accomplished by circulation of the proposal to committee members.

DUTIES OF THE TRAUMA REGISTY DATABASE MANAGER

The Trauma Registry Database Manger will:

1. Prepare requested reports to participating hospitals or ambulance service
2. Answer legitimate requests for non-privileged data by recognized individuals
3. Reject inappropriate requests
4. Work with requestors and Trauma System Review Committee members on requests
5. Report all information requests, as requested by the Trauma System Review Committee, during regularly scheduled meetings by presenting short summaries of information provided.

CONFIDENTIALITY

Any and all release of information pursuant to this policy shall be expressly subject to the provisions of AS 18.23.030 (a), which provides that such information shall be held in confidence and is not subject to subpoena or discovery. Such released information shall be used solely for research/investigation purposes, and shall have any patient, provider and facility identifying information redacted. Those persons or institutions who receive any information pursuant to this policy shall be required to sign and return a confidentiality agreement that forbids re-disclosure of released information, except for the described purposes of study or research pursuant to the provisions of 7 AAC 26.745.

RESEARCH APPLICATION
(To be filled out by applicant)

Upon approval by the Trauma Registry Database Manager, and/or the Trauma Program Manager, and/or Trauma System Review Committee; the Trauma Registry has up to 30 business-days (excluding weekends and holidays), to complete a data request. Depending upon the complexity of the data request, more complex requests could lengthen this time period. This time period has the potential to be expedited for less complex data requests.

Please complete the following for data release.

Name NATHAN BELZ, Ph.D.

Agency UNIVERSITY OF ALASKA FAIRBANKS

Address 245 DUCKERING, 306 TANANA DRIVE
FAIRBANKS, AK 99775-5900

City FAIRBANKS State AK ZIP 99775-5900

Phone Number 907-474-5765

Fax Number 907-474-7067

Email npbelz@alaska.edu

Project Title: MIXED USE SAFETY ON RURAL FACILITIES IN THE PACIFIC NORTHWEST

Expected time of completion 12/31/2016

Person receiving data transfer NATHAN BELZ

I have read and agree to the above conditions for the use of data from the Alaska Trauma Registry of the ADHSS/DPH/EP/TP.

Signature [signature] Date 07.26.2016

(Print Name) NATHAN BELZ

PLEASE ATTACH A COPY OF THE STUDY PROPOSAL

1. Objective
2. Methods
3. Population of interest
4. Years of interest
5. Data elements of interest

(1) **OBJECTIVE**: This research will address the issues associated with providing safe accommodation, limiting the improper use of public rights-of-way, and maintaining mobility, and provide future guidelines for design, education, and enforcement for mixed-use rural facilities. Four specific objectives have been identified as integral pieces of this research effort. First, this research seeks to determine the characteristics of NTV and NMT crashes in five rural area types: edge, traditional/main street, gateway, resource dependent (agriculture and mining), and tribal/village/isolated. Second, this research will document the state-of-practice related to the motivation for use, extent and magnitude of safety-related issues, and deficiencies in fatality/injury reporting methods for NTVs and NMT on mixed-use facilities. Third, and directly tied to the first objective, this research will critique and identify deficiencies in injury/fatality reporting for crashes involving NTVs and NMT on rural mixed-use facilities. Lastly, and more generally, this research will improve the definition of "mixed-use facility" in a rural context by more robustly identifying the types of non-traditional and non-motorized forms of travel and considering the spaces and areas where specific conflicts occur both between and within these forms of travel.

(2) **METHODS:** Use SPSS software to determine frequencies of specific injuries or vulnerable populations. Calculate injury rates and trends using population data from the Alaska Department of Labor and Workforce Development. Serious and fatal crash data analysis to be accompanied by a comprehensive literature review and a regional travel survey.

(3) **POPULATION OF INTEREST:** Injuries due to crashes (motor vehicle, snow machine, ATV, boating, airplane). No single population of particular interest, though rural areas are most concern. All areas in the state needed for comparison.

(4) **YEARS OF INTEREST:** requesting data from the new ATR data system to include 2005 through the most recent available

(5) **Data ELEMENTS OF INTEREST:** All demography, injury event, emergency/admission, and injury data elements. Discharge information not needed.

THE STATE
of ALASKA
GOVERNOR BILL WALKER

Department of
Health and Social Services

DIVISION OF PUBLIC HEALTH
Emergency Programs

3601 C Street, Suite 424
Anchorage, Alaska 99503-5924
Main: 907.334-2002
Fax: 907.269-0056

ALASKA TRAUMA REGISTRY CONFIDENTIALITY STATEMENT

I understand and agree that in the performance of my role on a steering or review committee or board or group; or as an employee of Southern Region Emergency Medical Services Council, Inc.; or as an employee of ADHSS/DPH/EP/TP; or as an employee of a participating hospital or prehospital service; or as a trauma registry manager, trauma registrar, or data entry clerk; or as a professional services contractor for the Department of Health and Social Services; or as a recipient of trauma registry data, I must maintain and safeguard the confidentiality of privileged Alaska Trauma Registry data and information. I understand that privileged data and information is defined as:

> "Data and information generated and/or acquired by the Alaska Trauma Registry Program which identifies an individual patient, practitioner, or facility; written or recorded records of any trauma registry steering or review committee sessions, data collection staff meeting, or any regularly constituted committee of the Alaska Trauma Registry Program; data and information generated and/or acquired in the administration of the Alaska Trauma Registry Program; any personal knowledge of any representative or employee of the Alaska Trauma Registry Program who can identify an individual patient, practitioner, or facility."

Further, I understand that violation of the Alaska Trauma System Confidentiality Policy may result in legal action.

In order that we may exchange data from time to time which otherwise may be considered of a confidential nature, the undersigned agrees to abide by the following statement:

> "Any data or information identifying an individual patient, physician, hospital, or prehospital care provider, and acquired by either party in the performance of activities of the Alaska Trauma Registry project shall be held in strict confidence and shall not be disclosed to any person or legal entity without the prior written consent of the other party."

(SIGNATURE)

07.26.2016
(DATE)

NATHAN BELZ
(PRINT NAME)

ASST. PROFESSOR
(TITLE)

ALASKA TRAUMA REGISTRY: INJURY SURVEILLANCE DATA ELEMENTS 1991 – 2012 (UPDATED 12/15/2010)			
DEMOGRAPHY	**VARIABLE LABE**	**DECSRIPTION**	ELEMENTS OF INTEREST PLEASE MARK WITH AN X
AGE	AGE		X
SEX	SEX	MALE OR FEMALE	X
RACE	ETHNICITY	WHITE,BLACK,HISPANIC,AMERICAN INDIAN,ASIAN,PACIFIC ISLAND, ALASKA NATIVE, UNK	X
CITY OF RESIDENCE	HOMECITY		X
REGION OF RESIDENCE	RESREGION		X
INJURY EVENT	**VARIABLE LABE**	**DECSRIPTION**	
MONTH OF INJURY	INJMO		X
YEAR OF INJURY	YEAR		X
PLEACE OF INJURY OCCURRENCE	PLACESPEC	ECODE CATEGORY	X
PLACE OF INJURY OCCURRENCE	INJPLACE	FREE TEXT	X
CITY OF INJURY OCCURRENCE	SCENECITY		X
REGION OF INJURY OCCURRENCE	INJREGION		X
ETIOLOGY CODE	ECODE	ICD9 ECODE	X
CAUSE OF INJURY	INJCAUSE		X
INJURY DESCRIPTION	INJDESC		X
INJURY DESCRIPTION CONTINUED	INJDESC2		X
WORK-RELATEDNESS OF INJURY	WORKRELATE		X
INDUSTRY	INDNARR		X
OCCUPATION	OCCNARR		X
SAFETY EQUIPMENT USE (1ST)	PROTECTION		X
SUSPECTED ALCOHOL USE	ALCOHOLDOC	TESTED POSITIVE OR NOTED IN MEDICAL RECORDS	X
SUSPECTED DRUG USE	DRUGDOC	TESTED POSITIVE OR NOTED IN MEDICAL RECORDS	X
EMERGENCY/ADMISSION	**VARIABLE LABE**	**DECSRIPTION**	
BLOOD ALCOHOL CONCENTRATION	EDALCOHOL	TEST RESULT IF PERFORMED	X
DRUG SCREEN	EDDRUGS	TEST RESULT IF PERFORMED	X
TOTAL NUMBER OF INTENSTIVE CARE D	ICUDAYS		
INJURIES	**VARIABLE LABE**	**DECSRIPTION**	
PRIMARY DIAGNOSIS	DIAGNOSIS		
DIAGNOSIS CODE 1-10	NCODE1 - NCODE1	ICD9 NCODE	
TRAUMATIC BRAIN INJURY	TBI	TBI = B	
SPINAL CORD INJURY	SPINE	SPNIE = S	
ABBREVIATED INJURY SCORE	AIS_MAX	AIS OF THE MOST SERIOUSLY INJURED BODY REGION SCORES = 1-6, NA, INSUFFICENT DATA	X
ABBREVIATED INJURY SCORE	AIS_TEXT	AIS DESCRIPTION	X
INJURY SEVERITY SCORE	ISS	SCORES = 1-75, NA, INSUFFICENT DATA	X
DISCHARGE	**VARIABLE LABE**	**DECSRIPTION**	
HOSPITAL DISCHARGE DISPOSITION	FINALDISCH		
GENERAL CONDITION ON DISCHARGE	GENCONDDC		
DISABILITY	DISABILITY	THE JUDGEMENT MADE UPON DISCHARGE	
FATALITY	FATAL		
NUMBER OF HOSPITAL DAYS	HOSPDAYS		
NUMBER OF HOSPITAL DAYS	HOSPDAYS2	2ND FACILITY IF TRANSFERRED	
NUMBER OF HOSPITAL DAYS	HOSPDAYS3	3RD FACILITY IF TRANSFERRED	
HOSPITAL CHARGES	HOSPCHARGE	ZERO OR BLANK = NOT COLLECTED AT THE PARTICULAR FACILITY	
HOSPITAL CHARGES	HOSPCHARG2	2ND FACILITY IF TRANSFERRED	
HOSPITAL CHARGES	HOSPCHARG3	3RD FACILITY IF TRANSFERRED	
HOSPITAL PAYMENT SOURCE 1- 4	PAYER1 - PAYER4	ALL AT THE FIRST FACILITY	
HOSPITAL PAYMENT SOURCE	PAYER2ADM	2ND FACILITY IF TRANSFERRED	

10. Appendix B: AKDOT&PF Crash Database User Agreements

Alaska Department of Transportation and Public Facilities
Highway Safety Improvement Program (HSIP)
UAF Crash Database User Agreement

Notice

The **UAF Crash Database** **(2000_2012_Crash_Data_UAF.accdb)** and Alaska Motor Vehicle Collision Report Instruction Manual is shared with the **University of Alaska Fairbanks (UAF) College of Engineering** and their staff by the Alaska Department of Transportation and Public Facilities (DOT&PF). DOT&PF assumes no liability for the use of information contained in the UAF Crash Database.

Data Usage

Highway agencies are required to collect crash data for a variety of uses. Objective, timely, and forthright data analysis is an essential part of systematically improving highway safety at the local, State, and Federal levels. To maintain HSIP objectives, the highway safety planning and analysis process involving the UAF Crash Database is protected under federal law.

By accepting the Crash Database, **UAF College of Engineering** agrees to use the data for engineering classwork. The crash data shall not be used outside of this purpose. Extracts, interpretations, and conclusions drawn from analyzing data in the UAF Crash Database may be included in reports, assignments, and presentations. These documents should not imply or label DOT&PF as the source of data interpretation within charts, tables, graphs, etc. without DOT&PF concurrence.

Reporting Disclaimer

The below disclaimer is to be included in all UAF reports and documents compiled through the use of the Crash Data before submission, sharing, printing, distribution, or dissemination.

The information in this document is compiled for highway safety planning purposes. Federal law prohibits its discovery or admissibility in litigation against state, tribal or local government that involves a location or locations mentioned in the crash data. 23 U.S.C. § 409; 23 U.S.C. § 148(h)(4); *Walden v. DOT*, 27 P.3d 297, 304-305 (Alaska 2001).

I hereby agree to the above terms of the UAF Crash Database User Agreement:

Signature	Name and Title	Date
	NATHAN BELZ, ASST. PROF. UAF	07-06-2016

Alaska Department of Transportation and Public Facilities
Highway Safety Improvement Program
Statewide Crash Spreadsheets User Agreement

Notice

This **Statewide Spreadsheets for 2013 and 2014 Crash Data** are shared with other public safety agencies and their staff and agents under the sponsorship of the Alaska Department of Transportation and Public Facilities (Alaska DOT&PF) in the interest of information exchange and furthering the goals of Alaska DOT&PF. Alaska DOT&PF assumes no liability for the use of information contained in the Statewide Spreadsheets for 2013 and 2014 Crash Data (Spreadsheets).

Data Usage

Highway agencies are required to collect crash data for a variety of uses. Objective and forthright data analysis is an essential part of systematically improving highway safety at State and Federal levels. To maintain this objectivity, the highway safety planning and analysis process involving the Statewide Crash Spreadsheets is protected under federal law.

Agencies and their staff and agents, as signed below, agree to keep the Spreadsheets and its source data secured and confidential. Interpretations and conclusions drawn from data generated from the Spreadsheets and its source data shall not be shared, distributed or disseminated in any fashion without first having requested and received express written consent from Alaska DOT&PF for sharing, distribution or dissemination. Reports, summaries or results of analysis using data generated from the Spreadsheets and its source data shall not be shared, distributed or disseminated in any fashion without first having requested and received express written consent from Alaska DOT&PF for sharing, distribution or dissemination. Raw data obtained through querying the Spreadsheets shall not be shared, distributed or disseminated in any way without first having requested and received express written consent from Alaska DOT&PF for sharing, distribution or dissemination.

Reporting Disclaimer

The below disclaimer is to be included in all reports and documents compiled through the use of the Spreadsheets or its source data before submission, sharing, printing, distribution or dissemination:

The information in this document is compiled for highway safety planning purposes. Federal law prohibits its discovery or admissibility in litigation against state, tribal or local government that involves a location or locations mentioned in the crash data. 23 U.S.C. § 409; 23 U.S.C. § 148(h)(4); *Walden v. DOT*, 27 P.3d 297, 304-305 (Alaska 2001).

I hereby agree to the above terms and requirements of the Statewide Crash Spreadsheets User's Agreement:

Signature	Name and Title	Date
[signature]	NATHAN BELZ, UAF	12.13.2017

11. Appendix C: Motion Based Multi Object Tracking (MatLab)

```
%% Motion-Based Multiple Object Tracking
%%
% Detection of moving objects and motion-based tracking are important
% components of many computer vision applications, including activity
% recognition, traffic monitoring, and automotive safety.  The problem of
% motion-based object tracking can be divided into two parts:
%
% # Detecting moving objects in each frame
% # Associating the detections corresponding to the same object over time
%
% The detection of moving objects uses a background subtraction algorithm
% based on Gaussian mixture models. Morphological operations are applied to
% the resulting foreground mask to eliminate noise. Finally, blob analysis
% detects groups of connected pixels, which are likely to correspond to
% moving objects.
%
% The association of detections to the same object is based solely on
% motion. The motion of each track is estimated by a Kalman filter. The
% filter is used to predict the track's location in each frame, and
% determine the likelihood of each detection being assigned to each
% track.
%
% Track maintenance becomes an important aspect of this example. In any
% given frame, some detections may be assigned to tracks, while other
% detections and tracks may remain unassigned. The assigned tracks are
% updated using the corresponding detections. The unassigned tracks are
% marked invisible. An unassigned detection begins a new track.
%
% Each track keeps count of the number of consecutive frames, where it
% remained unassigned. If the count exceeds a specified threshold, the
% example assumes that the object left the field of view and it deletes the
% track.
%
% For more information please see
%
<matlab:helpview(fullfile(docroot,'toolbox','vision','vision.map'),'multipleO
bjectTracking') Multiple Object Tracking>.
%
% This example is a function with the main body at the top and helper
% routines in the form of
%
<matlab:helpview(fullfile(docroot,'toolbox','matlab','matlab_prog','matlab_pr
og.map'),'nested_functions') nested functions>
% below.

function MotionBasedMultiObjectTracking()

% Create System objects used for reading video, detecting moving objects,
% and displaying the results.
```

```
% ************************************************************************
% User Input:
% Must add input folder to Matlab folder manually
% Assign desired folder name in MATLAB document folder to folderInputName
% variable
% Assign desired file name prefix to location variable, followed by a
% period
% ************************************************************************

folderInputName = 'Videos2';
location = 'Ester.';
addpath(folderInputName);
videos = dir(folderInputName);
count = 0;
n=2199;
oldFrame = [];
[minX, minY, maxX, maxY] = maskingArea();


for k = 3:length(videos)    %loops through (number of videos in folder) times
    vidName = videos(k).name
    obj = setupSystemObjects();

    tracks = initializeTracks(); % Create an empty array of tracks.

    nextId = 1; % ID of the next track

    % Detect moving objects, and track them across video frames.
    while ~isDone(obj.reader)
        frame = readFrame();
        [centroids, bboxes, mask] = detectObjects(frame);
        c=centroids;
        predictNewLocationsOfTracks();
        [assignments, unassignedTracks, unassignedDetections] = ...
        detectionToTrackAssignment();
        updateAssignedTracks();
        updateUnassignedTracks();
        deleteLostTracks();
        createNewTracks();
        displayTrackingResults();
    end
end
%% Create Masking Area
% Creates a limit to what parts of the frame will be used to be
% recorded for motion
    function [minX, minY, maxX, maxY] = maskingArea()

        % ****************************************************************
        % If desired masking area is in upper half of frame, assign new
        % value to minY:
        minY = 0;

        % If desired masking area is in lower half of frame, assign new
        % value to maxY:
        maxY = 480;
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        % If desired masking area is in right half of frame, assign new
        % value to minX:
        minX = 0;

        % If desired masking area is in left half of frame, assign new
        % value to maxX:
        maxX = 710;

    end
%% Create System Objects
% Create System objects used for reading the video frames, detecting
% foreground objects, and displaying results.

    function obj = setupSystemObjects()
        % Initialize Video I/O
        % Create objects for reading a video from a file, drawing the tracked
        % objects in each frame, and playing the video.

        % Create a video file reader.
        obj.reader = vision.VideoFileReader(vidName);
        %obj.videoPlayer=vision.VideoPlayer;

        % creates videoplayer so video can be watched live with object
        % detection
        % obj.videoPlayer = vision.VideoPlayer('Position', [200, 400, 700,
400]);

        % Create System objects for foreground detection and blob analysis

        % The foreground detector is used to segment moving objects from
        % the background. It outputs a binary mask, where the pixel value
        % of 1 corresponds to the foreground and the value of 0 corresponds
        % to the background.

        obj.detector = vision.ForegroundDetector('NumGaussians', 5, ...
            'NumTrainingFrames', 30, 'MinimumBackgroundRatio', 0.7);

        % Connected groups of foreground pixels are likely to correspond to
moving
        % objects.  The blob analysis System object is used to find such
groups
        % (called 'blobs' or 'connected components'), and compute their
        % characteristics, such as area, centroid, and the bounding box.


        % ****************************************************************
        % Adjust MinimumBlobArea for program to recognize different sized
        % objects
        % ****************************************************************'

        obj.blobAnalyser = vision.BlobAnalysis('BoundingBoxOutputPort', true,
...
            'AreaOutputPort', true, 'CentroidOutputPort', true, ...
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            'MinimumBlobArea', 1800);
    end

%% Initialize Tracks
% The |initializeTracks| function creates an array of tracks, where each
% track is a structure representing a moving object in the video. The
% purpose of the structure is to maintain the state of a tracked object.
% The state consists of information used for detection to track assignment,
% track termination, and display.
%
% The structure contains the following fields:
%
% * |id| :                  the integer ID of the track
% * |bbox| :                the current bounding box of the object; used
%                           for display
% * |kalmanFilter| :        a Kalman filter object used for motion-based
%                           tracking
% * |age| :                 the number of frames since the track was first
%                           detected
% * |totalVisibleCount| :   the total number of frames in which the track
%                           was detected (visible)
% * |consecutiveInvisibleCount| : the number of consecutive frames for
%                                  which the track was not detected
(invisible).
%
% Noisy detections tend to result in short-lived tracks. For this reason,
% the example only displays an object after it was tracked for some number
% of frames. This happens when |totalVisibleCount| exceeds a specified
% threshold.
%
% When no detections are associated with a track for several consecutive
% frames, the example assumes that the object has left the field of view
% and deletes the track. This happens when |consecutiveInvisibleCount|
% exceeds a specified threshold. A track may also get deleted as noise if
% it was tracked for a short time, and marked invisible for most of the
% frames.

    function tracks = initializeTracks()
        % create an empty array of tracks
        tracks = struct(...
            'id', {}, ...
            'bbox', {}, ...
            'kalmanFilter', {}, ...
            'age', {}, ...
            'totalVisibleCount', {}, ...
            'consecutiveInvisibleCount', {});
    end

%% Read a Video Frame
% Read the next video frame from the video file.
    function frame = readFrame()
        frame = obj.reader.step();
    end
%% Detect Objects
% The |detectObjects| function returns the centroids and the bounding boxes
% of the detected objects. It also returns the binary mask, which has the
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% same size as the input frame. Pixels with a value of 1 correspond to the
% foreground, and pixels with a value of 0 correspond to the background.
%
% The function performs motion segmentation using the foreground detector.
% It then performs morphological operations on the resulting binary mask to
% remove noisy pixels and to fill the holes in the remaining blobs.

    function [centroids, bboxes, mask] = detectObjects(frame)
        % Detect foreground.
        mask = obj.detector.step(frame);

        % Apply morphological operations to remove noise and fill in holes.
        mask = imopen(mask, strel('rectangle', [3,3]));
        mask = imclose(mask, strel('rectangle', [15, 15]));
        mask = imfill(mask, 'holes');
        % Perform blob analysis to find connected components.
        [~, centroids, bboxes] = obj.blobAnalyser.step(mask);
    end

%% Predict New Locations of Existing Tracks
% Use the Kalman filter to predict the centroid of each track in the
% current frame, and update its bounding box accordingly.
    function predictNewLocationsOfTracks()
        for i = 1:length(tracks)
            bbox = tracks(i).bbox;

            % Predict the current location of the track.
            predictedCentroid = predict(tracks(i).kalmanFilter);

            % Shift the bounding box so that its center is at
            % the predicted location.
            predictedCentroid = int32(predictedCentroid) - bbox(3:4) / 2;
            tracks(i).bbox = [predictedCentroid, bbox(3:4)];
        end
    end

%% Assign Detections to Tracks
% Assigning object detections in the current frame to existing tracks is
% done by minimizing cost. The cost is defined as the negative
% log-likelihood of a detection corresponding to a track.
%
% The algorithm involves two steps:
%
% Step 1: Compute the cost of assigning every detection to each track using
% the |distance| method of the |vision.KalmanFilter| System object(TM). The
% cost takes into account the Euclidean distance between the predicted
% centroid of the track and the centroid of the detection. It also includes
% the confidence of the prediction, which is maintained by the Kalman
% filter. The results are stored in an MxN matrix, where M is the number of
% tracks, and N is the number of detections.
%
% Step 2: Solve the assignment problem represented by the cost matrix using
% the |assignDetectionsToTracks| function. The function takes the cost
% matrix and the cost of not assigning any detections to a track.
%
% The value for the cost of not assigning a detection to a track depends on
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% the range of values returned by the |distance| method of the
% |vision.KalmanFilter|. This value must be tuned experimentally. Setting
% it too low increases the likelihood of creating a new track, and may
% result in track fragmentation. Setting it too high may result in a single
% track corresponding to a series of separate moving objects.
%
% The |assignDetectionsToTracks| function uses the Munkres' version of the
% Hungarian algorithm to compute an assignment which minimizes the total
% cost. It returns an M x 2 matrix containing the corresponding indices of
% assigned tracks and detections in its two columns. It also returns the
% indices of tracks and detections that remained unassigned.

    function [assignments, unassignedTracks, unassignedDetections] = ...
            detectionToTrackAssignment()

        nTracks = length(tracks);
        nDetections = size(centroids, 1);

        % Compute the cost of assigning each detection to each track.
        cost = zeros(nTracks, nDetections);
        for i = 1:nTracks
            cost(i, :) = distance(tracks(i).kalmanFilter, centroids);
        end

        % Solve the assignment problem.
        % *****************************************************************
        % costOfNonAssignment must be manually tuned
        % *****************************************************************
        costOfNonAssignment = 100;
        [assignments, unassignedTracks, unassignedDetections] = ...
            assignDetectionsToTracks(cost, costOfNonAssignment);
    end

%% Update Assigned Tracks
% The |updateAssignedTracks| function updates each assigned track with the
% corresponding detection. It calls the |correct| method of
% |vision.KalmanFilter| to correct the location estimate. Next, it stores
% the new bounding box, and increases the age of the track and the total
% visible count by 1. Finally, the function sets the invisible count to 0.

    function updateAssignedTracks()
        numAssignedTracks = size(assignments, 1);
        for i = 1:numAssignedTracks
            trackIdx = assignments(i, 1);
            detectionIdx = assignments(i, 2);
            centroid = centroids(detectionIdx, :);
            bbox = bboxes(detectionIdx, :);

            % Correct the estimate of the object's location
            % using the new detection.
            correct(tracks(trackIdx).kalmanFilter, centroid);

            % Replace predicted bounding box with detected
            % bounding box.
            tracks(trackIdx).bbox = bbox;
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            % Update track's age.
            tracks(trackIdx).age = tracks(trackIdx).age + 1;

            % Update visibility.
            tracks(trackIdx).totalVisibleCount = ...
                tracks(trackIdx).totalVisibleCount + 1;
            tracks(trackIdx).consecutiveInvisibleCount = 0;
        end
    end

%% Update Unassigned Tracks
% Mark each unassigned track as invisible, and increase its age by 1.

    function updateUnassignedTracks()
        for i = 1:length(unassignedTracks)
            ind = unassignedTracks(i);
            tracks(ind).age = tracks(ind).age + 1;
            tracks(ind).consecutiveInvisibleCount = ...
                tracks(ind).consecutiveInvisibleCount + 1;
        end
    end

%% Delete Lost Tracks
% The |deleteLostTracks| function deletes tracks that have been invisible
% for too many consecutive frames. It also deletes recently created tracks
% that have been invisible for too many frames overall.

    function deleteLostTracks()
        if isempty(tracks)
            return;
        end

        invisibleForTooLong = 20;
        ageThreshold = 8;

        % Compute the fraction of the track's age for which it was visible.
        ages = [tracks(:).age];
        totalVisibleCounts = [tracks(:).totalVisibleCount];
        visibility = totalVisibleCounts ./ ages;

        % Find the indices of 'lost' tracks.
        lostInds = (ages < ageThreshold & visibility < 0.6) | ...
            [tracks(:).consecutiveInvisibleCount] >= invisibleForTooLong;

        % Delete lost tracks.
        tracks = tracks(~lostInds);
    end

%% Create New Tracks
% Create new tracks from unassigned detections. Assume that any unassigned
% detection is a start of a new track. In practice, you can use other cues
% to eliminate noisy detections, such as size, location, or appearance.
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    function createNewTracks()
        centroids = centroids(unassignedDetections, :);
        bboxes = bboxes(unassignedDetections, :);

        for i = 1:size(centroids, 1)

            centroid = centroids(i,:);
            bbox = bboxes(i, :);

            % Create a Kalman filter object.
            kalmanFilter = configureKalmanFilter('ConstantVelocity', ...
                centroid, [200, 50], [100, 25], 100);

            % Create a new track.
            newTrack = struct(...
                'id', nextId, ...
                'bbox', bbox, ...
                'kalmanFilter', kalmanFilter, ...
                'age', 1, ...
                'totalVisibleCount', 1, ...
                'consecutiveInvisibleCount', 0);

            % Add it to the array of tracks.
            tracks(end + 1) = newTrack;

            % Increment the next id.
            nextId = nextId + 1;
        end
    end

%% Display Tracking Results
% The |displayTrackingResults| function draws a bounding box and label ID
% for each track on the video frame and the foreground mask. It then
% displays the frame and the mask in their respective video players.

    function displayTrackingResults()
        % Convert the frame and the mask to uint8 RGB.
        frame = im2uint8(frame);
        mask = uint8(repmat(mask, [1, 1, 3])) .* 255;

        % Enter desired output image filetype
        % ****************************************************************
        b = '.png';

        % Adjusts number of frames that must be changed for image to be
        % displayed
        % ****************************************************************
        minVisibleCount = 10;

        if ~isempty(tracks)
            % Noisy detections tend to result in short-lived tracks.
            % Only display tracks that have been visible for more than
            % a minimum number of frames.
            reliableTrackInds = ...
                [tracks(:).totalVisibleCount] > minVisibleCount;
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    reliableTracks = tracks(reliableTrackInds);

    % Display the objects. If an object has not been detected
    % in this frame, display its predicted bounding box.
    if ~isempty(reliableTracks)
        % Get bounding boxes.
        bboxes = cat(1, reliableTracks.bbox);
        % Get ids.
        ids = int32([reliableTracks(:).id]);

        % Create labels for objects indicating the ones for
        % which we display the predicted rather than the actual
        % location.
        labels = cellstr(int2str(ids'));

        predictedTrackInds = ...
            [reliableTracks(:).consecutiveInvisibleCount] > 0;
        isPredicted = cell(size(labels));
        isPredicted(predictedTrackInds) = {' predicted'};
        labels = strcat(labels, isPredicted);

        % Draw the objects on the frame.
        % Uncomment this for yellow rectangle to appear around
        % object
        % ********************************************************
        % frame = insertObjectAnnotation(frame, 'rectangle', ...
        %   bboxes, labels);
    end
end

nDetections = size(c, 1);

if nDetections >= 1
    oldFrame = frame;
    if (count >= minVisibleCount)
        for i = 1:length(reliableTracks)
            % bbox parameters: [x y width height] where x,y is the
            % upper  left corner
            maskingBox = reliableTracks(i).bbox;
            whos
            xMinBox = double(maskingBox(1));
            yMinBox = double(maskingBox(2));
            boxWidth = double(maskingBox(3));
            boxHeight = double(maskingBox(4));

            %=====================================================
            % comment if statement if masking is not desired
            %if (xMinBox < maxX && (xMinBox + boxWidth) > minX &&...
              %     yMinBox < maxY && (yMinBox + boxHeight) > minY)

               for z = 1:length(reliableTracks)
               reliableTracks(z)
               end

               a = num2str(n);
```

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                        name = strcat(location,a,b);
                        imwrite(frame,name);
                        n = n+1;
                        count=0;
                        break;
                     %end
                end
            else
                % counts the number of frames containing motion before a
                % frame is saved to file
                count = count+1;
            end

    % If motion is detected but does not reach minVisibleCount, the last
    % frame containing the motion is saved
    %{
        elseif count >= 1 && maskingBox(1)<maxX && maskingBox(2)>minX &&
maskingBox(3)<maxY && maskingBox(4)>minY
            a = num2str(n);
            name = strcat(location,a,b);
            imwrite(oldFrame,name);
            n = n+1;
            count = 0;
    %}
        else
            count = 0;
        end

        %obj.videoPlayer.step(frame);
    end
%% Summary
% The tracking in this example was solely based on motion with the
% assumption that all objects move in a straight line with constant speed.
End
```