Investigating the Effect of Subsistence Opportunities on Motor Vehicle Crash Frequency in Alaska

FINAL PROJECT REPORT

by

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for

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16. Abstract

This study investigates the relationship between personal use subsistence activities (i.e., dipnetting) and motor vehicle crashes using the Chitina Subdistrict fishery as a case study. Using crash data from 2013 to 2021, salmon run counts, permit and harvest data, and traffic volume and speed records, the analysis reveals that crash rates, standard deviation in speeds, and percentage of vehicles traveling over the speed limit increase during peak subsistence periods, particularly on weekends and during late-night or early-morning hours. These trends suggest that the long travel distances and time constraints associated with reaching this subsistence activity may elicit from drivers risk-tolerant driving behaviors such as drowsy or high-speed driving. The findings underscore the need for targeted safety interventions during high-risk periods and recommend further research to more definitively link crash risk with subsistence-related travel.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: volumes greater than 1000 L shall be shown in m^3			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	$candela/m^2$	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

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EXECUTIVE SUMMARY

This report investigates the relationship between personal-use subsistence activities—specifically dipnetting in the Chitina Subdistrict—and motor vehicle crash frequency in Alaska. Subsistence activities, central to Alaskan culture and food security, often require long-distance travel along rural roadways with limited infrastructure. These trips are typically compressed into short windows of opportunity tied to fish runs and regulatory openings, resulting in significant pressures on the transportation network. The study hypothesizes that these conditions foster risk-tolerant driving behaviors, such as drowsy or late-night driving, contributing to increased crash frequency.

Utilizing crash data from the Alaska Department of Transportation and Public Facilities (DOT&PF), sonar-based salmon counts, permit and harvest data from the Alaska Department of Fish and Game (ADF&G), and traffic volume and speed data from continuous count stations, crash trends along the Glenn, Richardson, and Edgerton Highways from 2013 to 2021 are explored. Findings indicate that crash frequencies spike during subsistence months (June–August), particularly around weekends and late-night or early-morning hours—aligning with anecdotal patterns of travel for dipnetting.

Temporal alignment between salmon run data and crash occurrence reveals modest but consistent lagged correlations, typically offset by the 10–14 day period it takes salmon to reach Chitina from sonar detection points. Volume and speed analyses show elevated traffic activity and greater variability in speed during subsistence periods. These factors, known contributors to crash risk, underscore the role of subsistence-related travel in influencing safety outcomes.

In conclusion, while the study establishes strong correlational patterns between subsistence activity and motor vehicle crashes, it stops short of confirming causation due to confounding variables. Nonetheless, the findings support the need for targeted safety interventions—such as public education campaigns and enforcement efforts—during high-risk periods. Future research should incorporate intercept surveys or observational studies to better attribute travel purpose and strengthen causal inference.

CHAPTER 1. INTRODUCTION

In the state of Alaska, there are myriad opportunities for residents to participate in hunter-gatherer-type activities. These activities include fishing, hunting, and berry picking, to name a few. The "boom and bust" nature of most of these activities, coupled with the short seasons during which these resources are available, compresses the pressures on the physical infrastructure into short periods of time. In addition, the limited road network accessing the locations in which these activities are possible places significant traffic pressures on the transportation system.

Further still, the culture surrounding personal subsistence activities encourages travelers to engage in risky driving behaviors to access these resources, such as driving while drowsy either on their way to or returning from said activities, due to the rural nature of their locations and the long travel distances form population centers.

The goal of this research is to specifically address critical research identified under the Center for Safety Equity in Transportation (CSET) focus area Coordination and Context Sensitive Solutions and *use a data-driven approach to better understand characteristics of high-risk intersections and roadway features and propose solutions.*

Anecdotally, there are many occasions when people participating in "dipnetting," a colloquial term for the way in which salmon are caught in a river using large nets (Figure 1), either leave their lane or depart the roadway on their outbound or inbound trip from a "marathon run" at popular dipnetting spots like Chitina, AK. Lengthy travel distances are often necessary and personal use subsistence opportunities are often constrained to weekends, requiring driving late in the evening on a Friday and early in the morning on a Monday.

Figure 1. A local fisherman stands on a rock outcropping in Chitina, AK with a dipnet in the water.

Individuals will routinely monitor sonar-based fish counts provided by the Alaska Department of Fish and Game (ADF&G) such as those provided in Figure 2 and time their trip accordingly, sometimes with only a day or two worth of notice. A typical "marathon run" will consist of a six-hour drive (representative of a person living in Fairbanks driving to Chitina) on a Friday evening on a mix of highway and winding two-lane roads, dozens of hours standing over a net placed in the river, followed

immediately by a six-hour drive home in order to make it to work on Monday morning and typically involves minimal or no sleep for those involved. Access to these personal use subsistence areas typically require travel through and in Rural, Isolated, Tribal, and Indigenous (RITI) communities, inherently generating more traffic as well as imparting risky travel behavior in areas that would not have experienced these otherwise thus creating inequities in road safety.

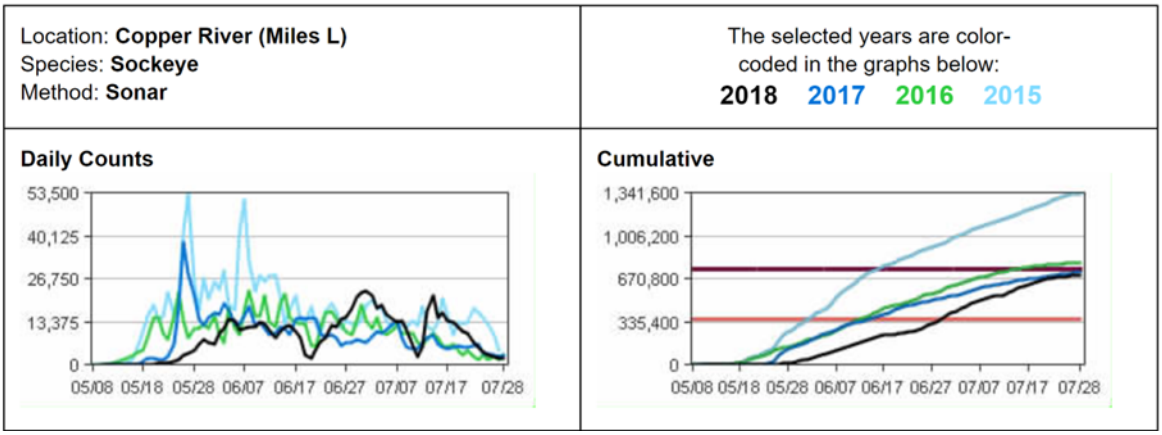


Figure 2. Copper River Sockeye Counts, 2015 - 2018

Comparing typical salmon run numbers from Figure 2 with road fatality rates from 2013-2021 as shown in Figure 3, one can see that crash rates tend to be higher in the same months that salmon run numbers are also at their highest. Now, it would be imprudent to assume that the statewide fatality rates are solely influenced by salmon runs, however, the propensity for risky driving behavior associated with these activity types and the higher fatality rates alone suggest that there may, in part, be some correlation and therefore is the primary focus of this study.

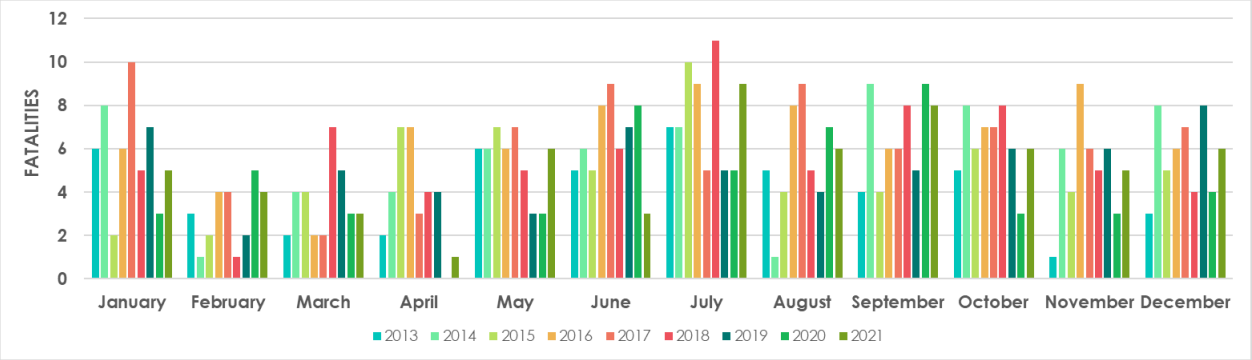


Figure 3. Fatalities by Month in Alaska, 2013 - 2021

Overall, the goal of this research was to better understand the impact of subsistence-type activities – more specifically the travel behaviors of motorists participating in those activities – on transportation safety and determine if there is correlation between periods with more subsistence pressure (i.e., more fishing permits recording harvests) and/or more potential for harvesting fish (i.e., higher salmon run numbers) and higher frequency of crashes or risky driving behaviors. Risk-tolerant driving behaviors for the purpose of this study are constrained to variations in speed and speeds in excess of the speed limit.

Additionally, but not considered in this study, are other risk-tolerant behaviors such as drivers who tend to operate a vehicle in a drowsy and sleep-deprived state before and after subsistence activities. To the extent possible, other variables to be controlled for include contributory factors such as rates of tourism, weather, speed, etc. The findings of this project may inform engineering, education, and enforcement activities with the intent of reducing roadway crashes in Alaska.

CHAPTER 2. DATA AND METHODOLOGY

2.1. Crash Data

UAF obtained access to the Department of Motor Vehicles Crash data through the Alaska Department of Transportation and Public Facilities (DOT&PF). The information in the DOT&PF crash database is compiled primarily 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.[1]

The crash database compilation is derived from crash reports completed by a responding law enforcement officer, or by a citizen, and maintained by the DMV. Crashes for which there is no motor vehicle crash report are not included. DOT&PF can make no representation about crash data accuracy.

The Model Minimum Uniform Crash Criteria (MMUCC), the model on which the crash report forms are based, was updated in 2013. For that reason, the period chosen for this study is from 2013 to 2021 and represents the most recent and complete crash dataset available at the time of the study. Roadway fatalities can also be extracted from this same dataset.

2.2. Sockeye Salmon Counts

The sonar used for counting fish passage on the Copper River is located at the outlet of Miles Lake, which is about 70 miles downstream from the Chitina dipnet fishery. It takes approximately 10 to 14 days for salmon to travel this distance, but this can be highly variable depending on the water level. While water levels listed on NOAA and ADF&G websites provide an indication of the general trends in the Copper River, they may not be indicative of what is occurring at the Chitina personal use subsistence fishery. More information about the sonar can be found on the ADF&G Copper River website.[2]

2.3. Chitina Subdistrict Permit and Harvest Numbers

Over the last 20 years the Alaska Department of Fish and Game (ADF&G) has issued anywhere from 5,000 to 13,000 permits annually for the Chitina Subdistrict personal use salmon fishery (Table 1). According to ADF&G, only about 65% of these permits are actually fished each year. ADF&G reports that more people fish in the beginning of the season when king salmon are present in the fishery (Figure 4a). The runs and harvest of king salmon is highest early in the season while the wild sockeye salmon run is typically highest in June and then trails off the remainder of the season. Although total harvest is typically highest in the month of June (Figure 4), which corresponds with the time of highest effort, the number of sockeye salmon caught per permit is highest in July and early August, which typically corresponds with the timing of later-run hatchery sockeye returning to the Gulkana River.

ADF&G notes that harvest in the fishery is affected most by the number of fish running upriver, followed by the number of permits being fished, and finally by water level. Harvest is generally lowest during high water events due both to a lack of adequate site from which to dipnet as well as higher water flows

[1] 23 U.S.C. § 407; 23 U.S.C. § 148(h)(4); Walden v. DOT, 27 P.3d 297, 304-305 (Alaska 2001)

[2] ADF&G Fish Count Data Search| https://www.adfg.alaska.gov/index.cfm?adfg=sonar.site&site=10

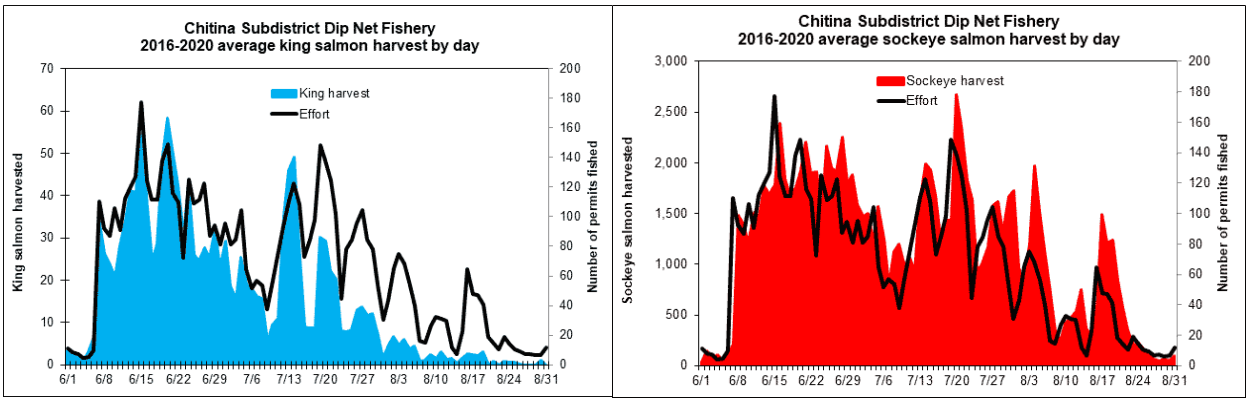
making it more difficult for fish to travel upstream. Additionally, harvest can also be low during very low water events, also contributing to a lack of adequate dipping sites.

Permit numbers and sockeye harvest numbers were obtained through ADF&G for the period of 2013-2021 for the purpose of this study.

Table 1. Annual Permits Issued and Salmon Harvests in Chitina Subdistrict, 1984 – 2020[3]

	Permits		Harvest					
Year	**Permits Issued**	**Permits Fished**	**King**	**Sockeye**	**Coho**	**Other**	**Total harvest**	**Harvest per permit fished**
1984-1988	4,419	4,419	3,113	41,200	509	34	44,026	10
1989-1993	6,158	6,158	3,053	75,999	1,731	48	80,852	13
1994-1998	8,022	7,649	4,841	110,785	2,507	31	118,194	15
1999-2003	8,159	6,374	3,234	109,936	2,608	260	116,039	18
2004-2008	8,260	5,186	2,404	112,854	2,415	504	118,177	23
2009-2013	8,497	5,833	671	134,537	1,535	411	137,156	24
2014-2018	8,377	6,074	1,278	149,889	1,783	665	152,923	25
2019	8,071	5,467	2,689	175,413	1,088	609	179,795	33
2020	6,810	4,466	847	81,428	838	230	83,343	17
Average 2015-2019	9,314	5,744	1,669	153,195	1,065	721	156,653	27
Average 2010-2019	9,808	6,017	1,221	150,663	1,248	572	153,706	25

[3] Alaska Department of Fish and Game (2005). *Chitina Personal Use Salmon Fishery: Harvest and Effort. https://www.adfg.alaska.gov/index.cfm?adfg=PersonalUsebyAreaInteriorChitina.harvest*



(a) (b)

Figure 4. Average king salmon harvest (a) and Average Sockeye salmon harvest (b) by day in the Chitina Personal Use Salmon Fishery[3]

2.4. Speed and Volume Counts

Alaska DOT&PF's Traffic Data Program (TDP) has approximately 130 continuous counting stations (CCS) across the state. These stations collect data 24 hours a day, 365 days a year, providing a spatio-temporal view of traffic volumes as well as vehicular speeds at select locations. TDP utilizes different combinations of in-road sensors such as piezoelectric strips and/or inductance counts and nonintrusive devices such radar detection for collection at the CCS sites. More information on the TDP on the CCS sites can be found on the DOT&PF Traffic Data website.[4]

There is one CCS location on the Edgerton Highway (Alaska Highway 10) leading into Chitina just east of the Richardson Highway (Station ID DOT13100000). According to Alaska DOT&PF, the Edgerton Highway is classified as a Major Rural Collector. The CCS is in close proximity to the intersection with the Richardson Highway. An additional portable continuous traffic counter (PCC) was placed approximately three miles to the east of the CCS location on a straight, flat section of roadway with no access points in either direction for a continuous 1500 ft. The purpose of the second PCC (Station ID UAF001) was to obtain an accurate representation of speeds at free-flow conditions in the absence of influence from an intersection (i.e., speeds during acceleration and deceleration).

[4] DOT&PF Traffic Data https://dot.alaska.gov/stwdplng/sis/traffic.shtml

CHAPTER 3. RESULTS AND DISCUSSION

The Chitina Subdistrict permit and harvest data for 2000 to 2023 is shown in Figure 5. Days with higher numbers of permits reporting fishing/harvest pressure are shown in red and orange. Days with lower pressure are shown in green. Days with no recorded data are shown in grey. Consistent with ADF&G findings, much of the pressure is confined to June, July, and August with the most activity occurring at the beginning of the subsistence season in early June. The diagonal patterns in the darker red and orange colors are a result of where weekends fall on the plot.

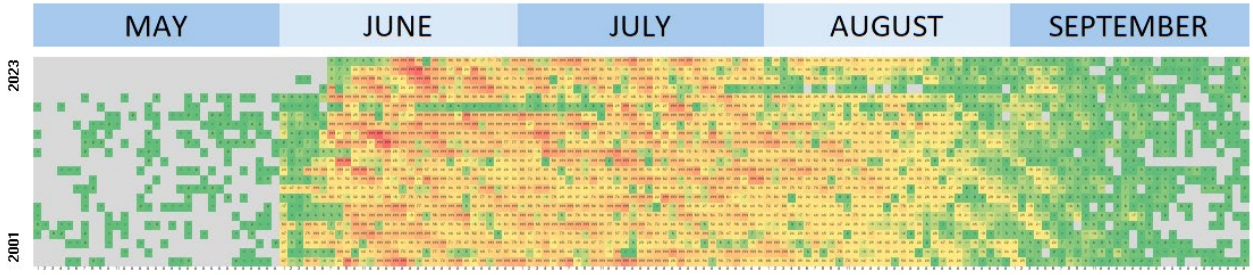


Figure 5. Combined permit and harvest data for Chitina Subdistrict, 2001-2023

Since most, if not all, of the activity falls within the June through September timeframe, crashes only during this period are explored. Figure 6 and Figure 7 present simultaneous plots of the cumulative number of crashes and cumulative number of counted sockeye from the Miles Lake sonar. In general, there is an increase in crash frequencies coinciding with general state and federal holidays as is typical of crash experiences in most states and locations. However, also observed are increases in crash frequencies (as observed by portions of the blue curve with a steeper slope), that coincide with the opening and reopening of the Chitina personal use subsistence fishery. In general, it is also observed that sections of steeper slope on the crash frequency curve also coincide with, and offset by approximately 10-14 days, sections of steeper slope on the cumulative sockeye curve.

Considering the tendency for subsistence activity to be more centralized on weekends (i.e., the period between Friday after business hours through Monday before the start of business hours), crash frequency by day is shown in Figure 8. Of note is that there is a higher percentage share of crashes on Sunday and Friday during the months of June, July, and August as compared to other non-winter months. January has a comparable percent share on Sundays while October has a comparable percent share on Saturdays.

Also, to explore the tendency for travel to and from the Chitina subdistrict to occur during distinct periods of the day, for example, early morning and late at night, Figure 9 shows the distribution of combined crash frequency for the Glenn, Richardson, and Edgerton Highways during subsistence (June through August) and non-subsistence (October-April) for the period of 2013 through 2021 in three-hour increments for both AM and PM. These distributions show a clear tendency for crash frequencies to be higher in both the 12am-3am and 3am-6am periods during June through August (subsistence period) as compared to the October through April (non-subsistence period) timeframe. Additionally, the distributions also show a clear tendency for crash frequencies to be higher in the 9pm-12pm period during the subsistence period as compared to the non-subsistence period.

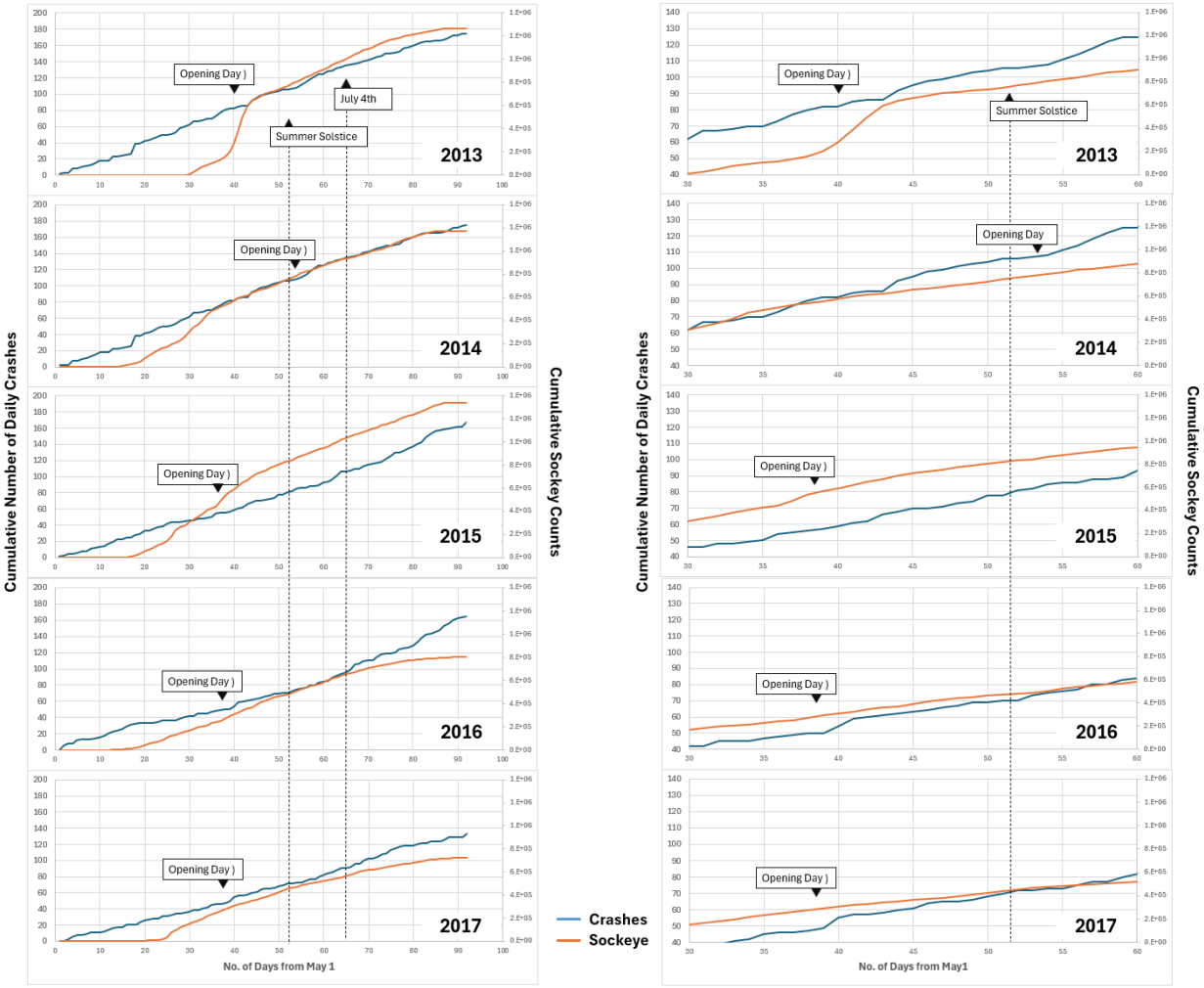


Figure 6. (a) Cumulative number of motor vehicle crashes on the Glenn, Richardson, and Edgerton Highways; and (b) cumulative number of sockeye from the Miles Lake sonar (2013-2017).

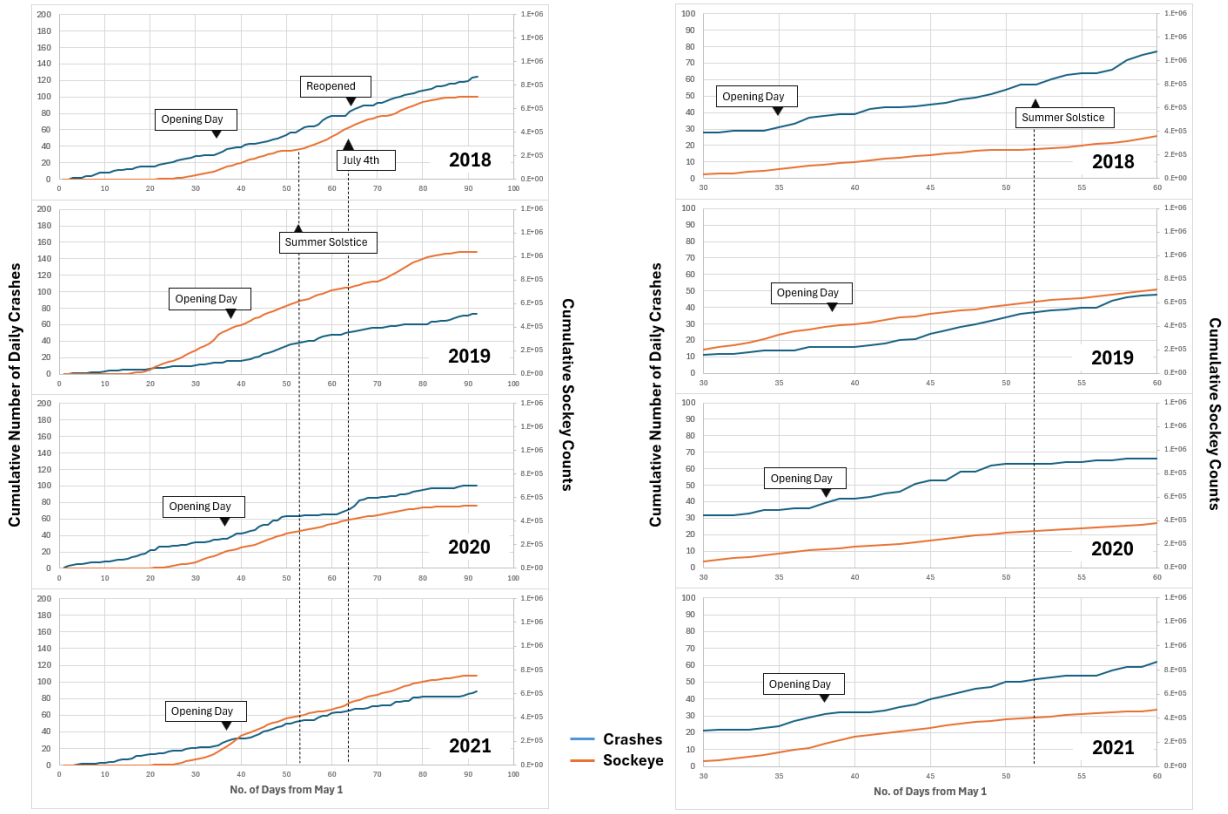


Figure 7. (a) Cumulative number of motor vehicle crashes on the Glenn, Richardson, and Edgerton Highways; and (b) cumulative number of sockeye from the Miles Lake sonar (2018-2021).

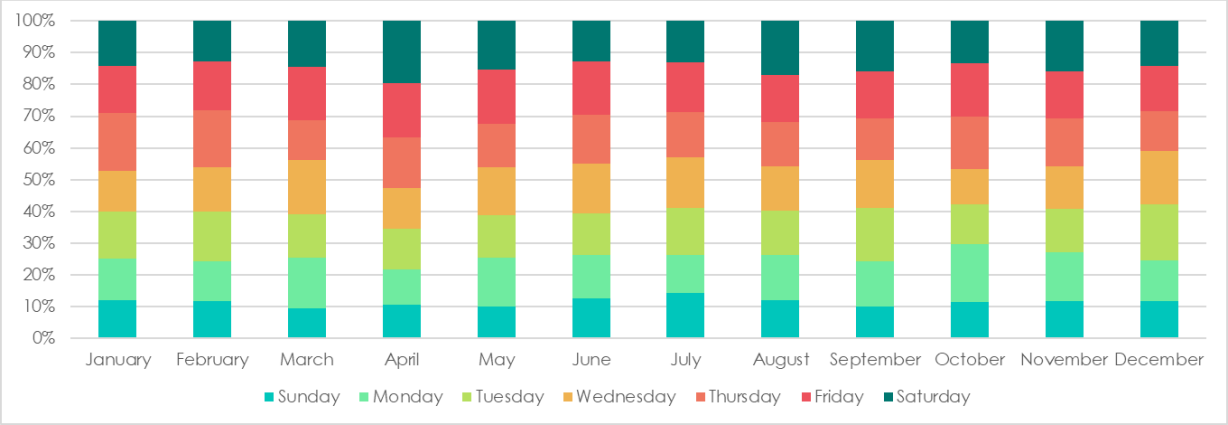


Figure 8. Percent share of crashes by day within each month for Glenn, Richardson, and Edgerton Highways (2013-2021)

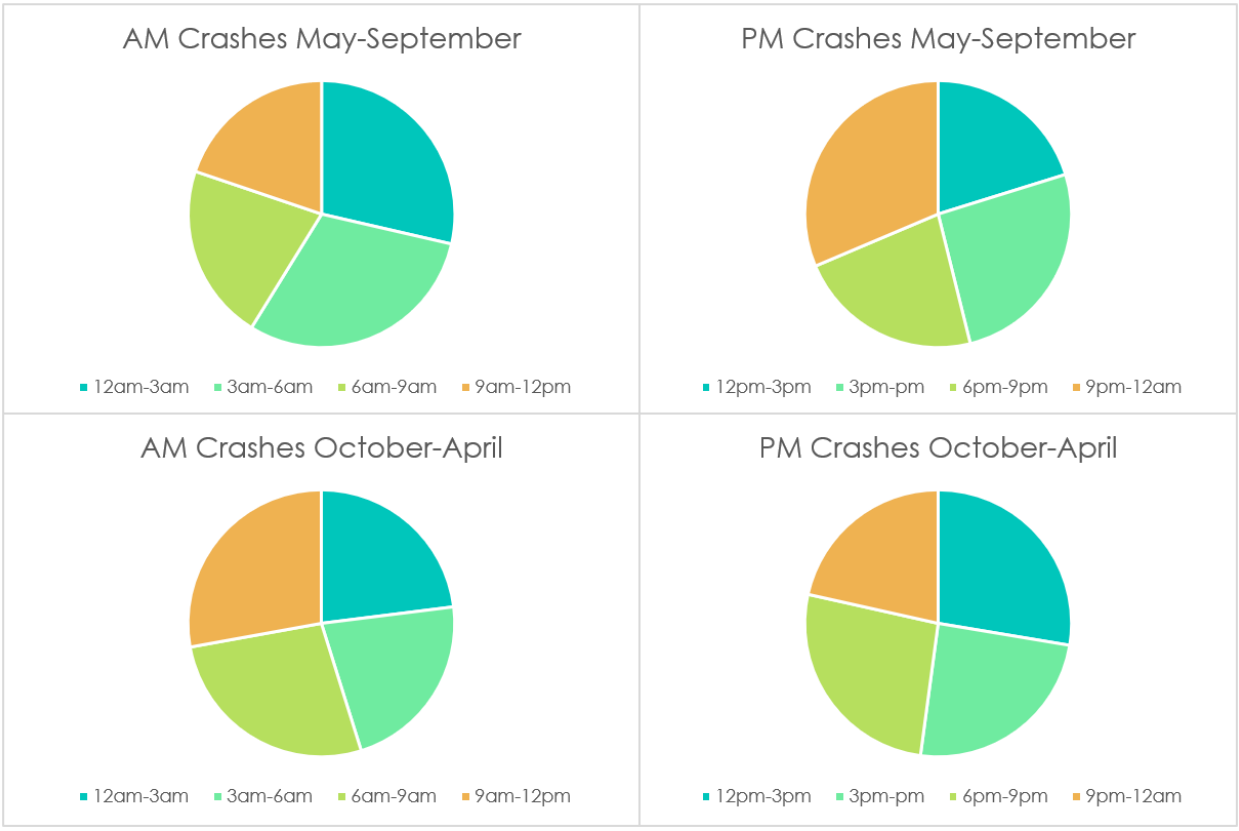


Figure 9. Hourly distribution of combined crash frequency for the Glenn, Richardson, and Edgerton Highways during subsistence (June through August) and non-subsistence (October-April), 2013-2021.

To normalize the crash data based on traffic volumes, the Edgerton Highway CCS is used and average hourly volumes for subsistence periods and non-subsistence periods are shown in Figure 10 and Figure 11, respectively. Comparing these two figures clearly shows a tendency for higher vehicular volumes late at night through early morning (i.e., 10:00PM through 5:00AM) to occur in subsistence periods than non-subsistence periods.

While traffic volumes alone may provide some rationale for the increase in crashes during these periods by providing a measure of exposure, the traffic volumes during these periods are not significantly or abnormally higher than volumes in other periods. To further explore correlated variables, vehicular speed data were also extracted from the Edgerton Highway CCS and the UAF PCC. Figure 12 and Figure 13 show the standard deviation of speeds and the percentage of vehicles exceeding the speed limit by hour for subsistence and non-subsistence periods. For the purpose of this analysis, non-subsistence periods are constrained to September, October, and May as to avoid bias from snowy and icy road conditions present during winter months and the different driving behaviors that are elicited during those months.

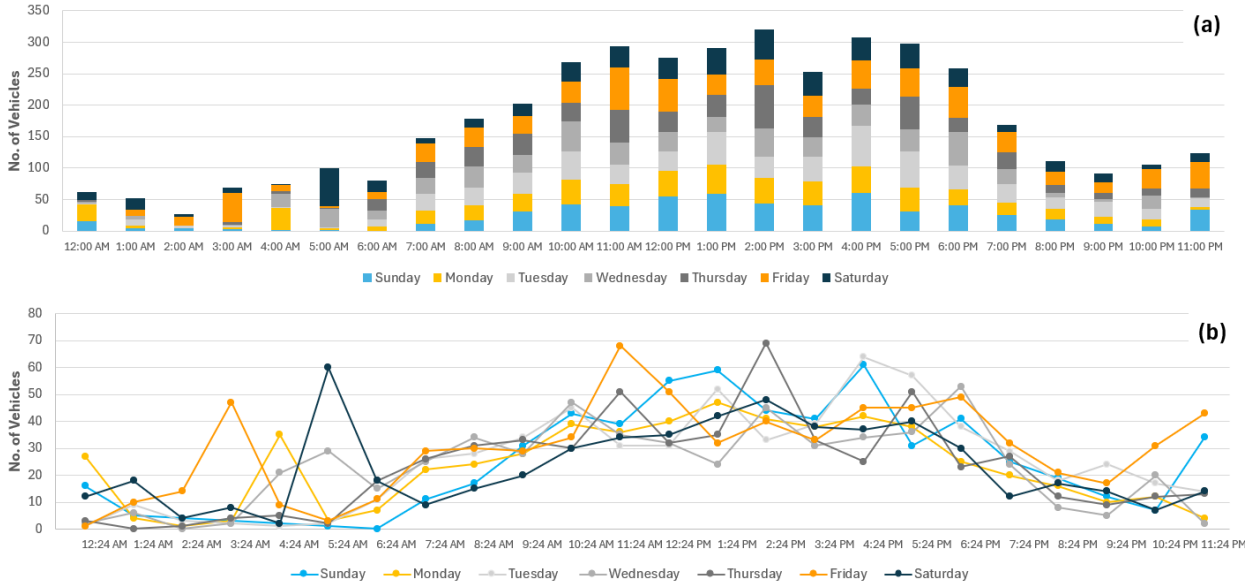


Figure 10. Average hourly volumes for June-August from Edgerton Highway CCS based on available data for 2013-2021.

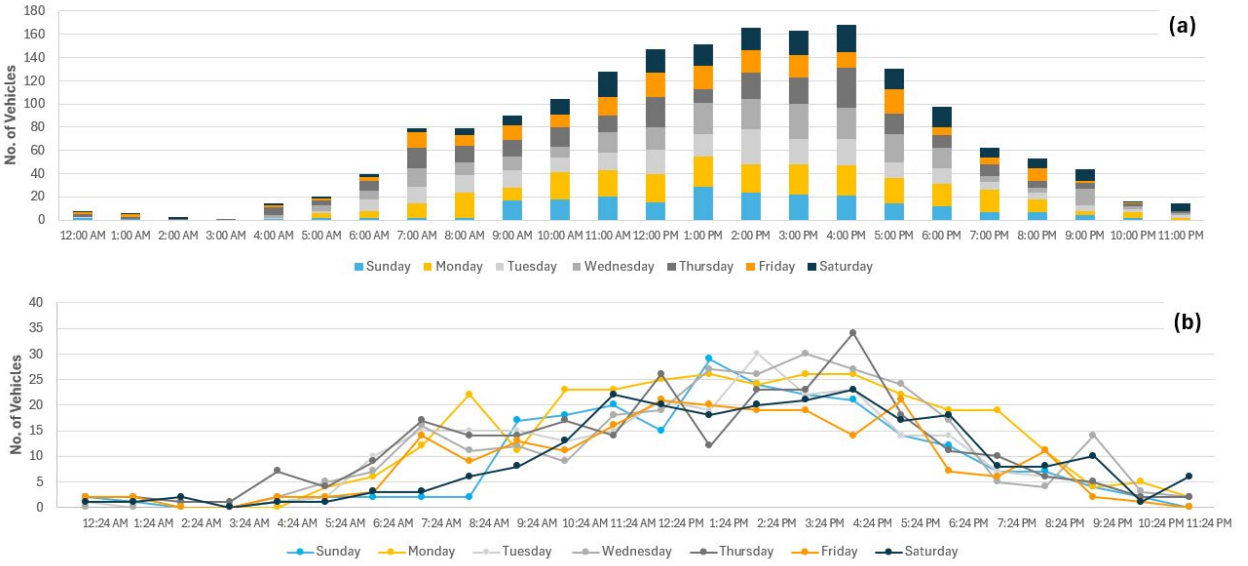
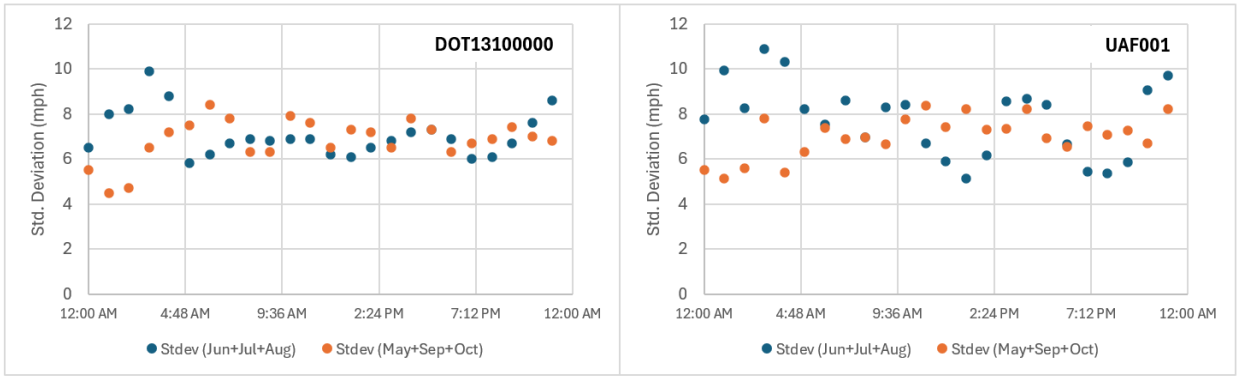


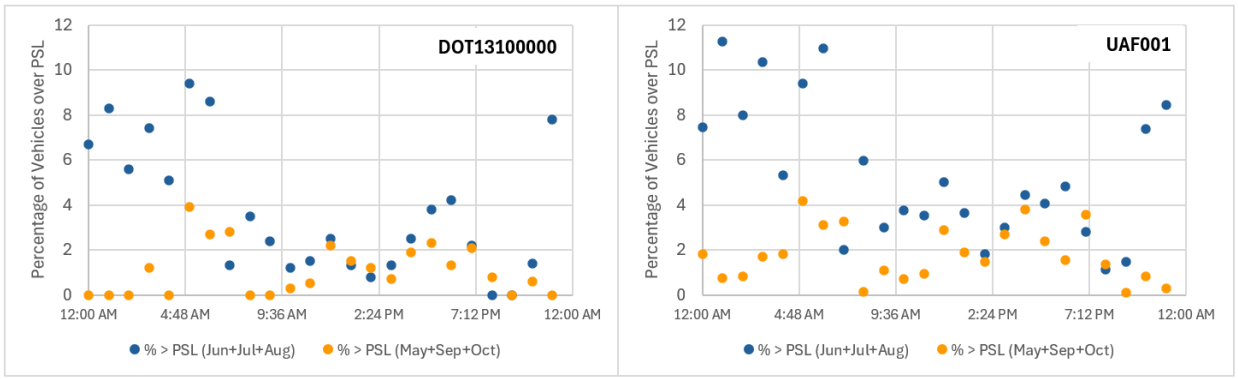
Figure 11. Average hourly volumes for October-April from Edgerton Highway CCS based on available data for 2013-2021

Similar to the volumetric trends presented in Figure 10 and Figure 11, both standard deviations of speed and percentage of vehicles over the speed limit are higher during late-night and early-morning periods for subsistence periods as compared to non-subsistence periods. Even through the Edgerton Highway CCS is proximally located to an intersection, the results are similar to and trend with those of the UAF PCC which validates these results.



(a) (b)

Figure 12. Standard deviation of vehicular speeds by hour for subsistence periods (June, July, and August) and non-subsistence periods (May, September, and October) based on (a) Edgerton Highway CCS (DOT13100000) and (b) UAF portable continuous counter (UAF001).



(a) (b)

Figure 13. Percentage of vehicles measured over the speed limit by hour for subsistence periods (June, July, and August) and non-subsistence periods (May, September, and October) based on (a) Edgerton Highway CCS (DOT13100000) and (b) UAF portable continuous counter (UAF001).

CHAPTER 4. CONCLUSIONS

Food systems in Alaska are incredibly fragile and often unreliable. As much as 95% of food is imported into the state and accounts for nearly $2 billion in expenditure annually. As a result, personal-use subsistence activities are incredibly popular and provide critical opportunities for families to harvest and store food, primarily protein in the form of salmon, for winter months more affordably than would be possible otherwise. However, these opportunities tend not to be collocated with population centers and require long travel distances during constrained periods of time, forcing many to engage in risk-tolerant driving behaviors such as "drowsy driving." The goal of the research presented here was to examine the extent to which the temporal variations in subsistence activity trend with motor vehicle crashes and, if so, can other traffic data lend more insight to risk and exposure to account for those differences in crash frequency.

The results of the analysis show that outside of winter months when crash frequency tends to be highest, crashes on the Glenn Highway, Richardson Highway, and Edgerton Highway (the three corridors that provide access to the Chitina Subdistrict) tend to be more centralized in the same period, a the personal-use subsistence period, June through August. These crashes tend to be more prevalent on Friday, Saturday, and Sunday and tend to occur late at night (between 10:00PM and 12:00PM) or early in the morning (between 12:00AM and 6:00AM). This is consistent with traffic volume data and confirms anecdotal evidence that travel behaviors require getting to and from the fishery location after work on Friday and before work on Monday.

Additionally, speed data from an Alaska DOT&PF continuous count station (CCS) and a portable continuous counter (PCC) indicate that these time periods also have significantly higher standard deviations in speeds as well as a higher percentage of vehicles traveling at speeds greater than the speed limit, both of which are variables correlated with higher crash risk.

While this study highlights correlation between available traffic data (i.e., crash data, volume data, and speed data), it cannot be said definitively that the higher speeds and higher volumes are directly attributed to travelers going to and from subsistence activities in Chitina since the Edgerton Highway services other recreation destinations. Future work should aim to conduct intercept studies or surveys to complement to results of this study and provide more comprehensive links between those traveling to Chitina specifically for subsistence purposes.