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## The Relationship of snowmobile year, track length, and riding terrain to the occurrence of musculoskeletal symptoms in recreational snowmobile drivers

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THE RELATIONSHIP OF SNOWMOBILE YEAR, TRACK LENGTH, AND  
RIDING TERRAIN TO THE OCCURRENCE OF MUSCULOSKELETAL  
SYMPTOMS IN RECREATIONAL SNOWMOBILE DRIVERS.

by

Erica Lynn Heisler

Bachelor of Science  
University of North Dakota  
2007

A thesis submitted in partial fulfillment  
of the requirements for the

**Masters of Science in Exercise Physiology  
Department of Kinesiology and Nutrition Sciences  
School of Allied Health Sciences  
Division of Health Sciences**

**Graduate College  
University of Nevada, Las Vegas  
December 2010**

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**THE GRADUATE COLLEGE**

We recommend the thesis prepared under our supervision by

**Erica Lynn Heisler**

entitled

**The Relationship of Snowmobile Year, Track Length, and Riding Terrain to the Occurrence of Musculoskeletal Symptoms in Recreational Snowmobile Drivers**

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## ABSTRACT

### **The Relationship of Snowmobile Year, Track Length, and Riding Terrain to the Occurrence of Musculoskeletal Symptoms in Recreational Snowmobile Drivers.**

By

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Dr. Jack Young, Examination Committee Chair  
Professor and Chair, Department of Kinesiology  
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The purpose of this retrospective study was to examine the occurrence of musculoskeletal symptoms in recreational snowmobile drivers and relate them to the manufacture year of the snowmobile, the length of the track, and/or the riding terrain. Participants included 186 males and 57 females (n=243), aged 18 years and older, and were all snowmobile drivers. Subjects were asked to complete either an online survey or a paper survey to gather information about the year of snowmobile they drove, the track length of that snowmobile, the typical riding terrain they drove on, and any musculoskeletal symptoms they developed from driving snowmobile. Each variable (snowmobile year, track length, and riding terrain) was compared to the musculoskeletal symptoms reported to find the percentage of each symptom (soreness in the neck and shoulders, arms, lower back, legs, and no soreness reported) reported in each category. In all three categories (snowmobile year, track length, and riding terrain) musculoskeletal symptoms in the neck and shoulder (45%) regions were most commonly reported followed

by, symptoms of the lower back (33%) and drivers reporting to have multiple symptoms (33%) (those who reported more than one symptom).

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## TABLE OF CONTENTS

|   |      |
|---|------|
| ABSTRACT .....  | iii  |
| ACKNOWLEDGEMENTS .....                                | v    |
| LIST OF TABLES .....                                  | viii |
| CHAPTER 1 INTRODUCTION .....                          | 1    |
| Purpose of the Study .....                            | 4    |
| Research Question .....                               | 4    |
| Significant of the Study .....                        | 4    |
| Definition of Terms .....                             | 5    |
| CHAPTER 2 REVIEW OF RELATED LITERATURE .....          | 6    |
| History of the Snowmobile .....                       | 6    |
| Whole Body Vibration .....                            | 10   |
| Hand-Arm Vibration .....                              | 14   |
| Ergonomics of the Snowmobile .....                    | 16   |
| Musculoskeletal Symptoms .....                        | 22   |
| Riding Terrain .....                                  | 24   |
| Injuries .....  | 25   |
| CHAPTER 3 METHODOLOGY .....                           | 30   |
| Subject Characteristics .....                         | 30   |
| Instrumentation .....                                 | 30   |
| Collection of the Data .....                          | 30   |
| Survey Questions .....                                | 31   |
| Data Analysis Methods .....                           | 33   |
| CHAPTER 4 RESULTS .....                               | 35   |
| Participant Demographics .....                        | 35   |
| Results .....   | 35   |
| Year of Manufacture .....                             | 36   |
| Track Length .....                                    | 38   |
| Riding Terrain .....                                  | 39   |
| Length of Symptoms .....                              | 40   |
| Type of Ongoing Physical Ailments .....               | 41   |
| CHAPTER 5 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS.. | 42   |
| Discussion of Results .....                           | 42   |
| Snowmobile Year .....                                 | 42   |



|  |     |
|--|-----|
| Track Length .....                         | 43  |
| Riding Terrain .....                       | 44  |
| Length of Symptoms .....                   | 46  |
| Types of Ongoing Physical Ailments .....   | 46  |
| Conclusions .....                          | 47  |
| Recommendations for Further Study .....    | 48  |
| REFERENCES .....                           | 49  |
| APPENDIX I INFORMED CONSENT .....          | 59  |
| APPENDIX II SURVEY .....                   | 61  |
| APPENDIX III PARTICIPANT SURVEY DATA ..... | 63  |
| VITA .....                                 | 114 |

## LIST OF TABLES

|  |    |
|--|----|
| Table 1 Demographics of the Participants .....   | 36 |
| Table 2 Comparison of Snowmobile Year to Reported Symptoms .....   | 37 |
| Table 3 Comparison of Track Length to Reported Symptoms .....  | 38 |
| Table 4 Comparison of Riding Terrain to Reported Symptoms .....  | 40 |
| Table 5 Comparison of Reported Symptoms to Number of Days<br>Symptoms Persist .....  | 40 |
| Table 6 Comparison of Reported Ongoing Physical Ailments Related<br>to Snowmobile Driving to Type of Ongoing Physical Ailments<br>Reported ..... | 41 |

## CHAPTER 1

### INTRODUCTION

“Snowmobiling, a popular winter activity for millions of people, originated when the Canadian J.A. Bombardier designed a four cylinder Ford model T engine on sleigh runners in 1923.” (James et al, 1991)

“Since their introduction in the early 1960’s, snowmobiles have had a profound effect on the economic and recreational life styles of many Canadians.” (Daniel and Midgley, 1972) Not only has the introduction of the snowmobile affected many Canadians, but it has also impacted areas of the United States and Europe. “Snowmobiles are defined as any motor vehicle designed for travel on snow or ice and steered and supported in whole or in part by skis, belts, cleats, runners or low-pressure tires.” (Skokian et al, 2001) “The snowmobile was developed to move people and supplies, and for emergencies in regions where heavy snow prohibited the use of conventional vehicles. Today, snowmobiling has become a popular winter sport enjoyed by more than 2 million people of all ages in North America.” (Pierz, 2003) “Most snowmobiles are used for recreation and a few for logging, reindeer breeding, police and customs duties.” (Bauer, 1979)

Snowmobiling has gained in popularity as both an individual and family sport. (Skokan et al, 2001) “Snowmobiling is the fastest growing winter sport in North America, increasing 35% yearly compared to 20% for the remainder of the recreational industries.” (Karleen, 1973) In

Sweden the number of snowmobiles being used doubled between 1976 and 1980, reaching 63,000 in use by January of 1980. (Bjornstig et al, 1984) In the winter season of 2003-2004, 1,774,232 snowmobiles were registered in the United States. (Sy and Corden, 2005) Many states have state wide trail systems that snowmobilers can enjoy during the winter season. The increase in available trail riding may influence the number of snowmobiles currently registered, and the increase in the use of snowmobiles as a recreational activity. For example, "Wisconsin residents can enjoy over 25,000 miles of marked snowmobile trails connecting all parts of the state." (Sy and Corden, 2005) In Alaska during the winter season of 1993-1994, an estimated 75 million miles were driven by snowmobiles. (Landen et al, 1999) The continual increase of recreational snowmobile driving is evident by the number of registered snowmobiles continues to climb. "Michigan is the leading snowmobiling state in the United States with over 350,000 registered snowmobiles in 2001." (DeCou et al, 2003)

As the use of the snowmobiles has increased more people use them as a recreational tool, and the reports of injuries and musculoskeletal symptoms have increased. "The machine itself appears to be an important contributor both to the initiation of the event and to the type and severity of injury." (Waller and Lamborn, 1975) With the modern day snowmobile weighing in at approximately 600 pounds and capable of reaching speeds of 110mph, there is no surprise at the increase in

reported musculoskeletal symptoms and injuries. As reported by Astrom et al (2006), "Driving terrain vehicles is also related to experiencing musculoskeletal symptoms in the neck, shoulders, and wrist."

Individuals report musculoskeletal symptoms of the arms, shoulders, legs, lower back, and neck regions. These symptoms seem to be caused by the ergonomics of the snowmobile, subjection to whole-body and hand-arm vibration, riding terrain, and riding posture. "Highly significant positive correlations were found between hours on snowmobile and exposure to cold, vibration, heavy lifts, static work, rotated head and bent back." (Daerga et al, 2003) The results of a study by Astrom et al (2006), "show increased odds for numbness, sensation of cold, white fingers and musculoskeletal symptoms in the neck, shoulders, and wrists, among professional drivers of various terrain vehicles." The study consisted of drivers of forest machines, snowmobiles, and snowgroomers. An ergonomic evaluation of the snowmobile done by Habes et al (2003) reported that "The National Park Service personnel, mainly rangers and maintenance workers, reported musculoskeletal disorders of the hands, arms, shoulders, and back from riding the snowmobiles for up to 10 hours per day during the winter months." As the advancement of the snowmobile has progressed, adjustments such as shock-absorbers, handlebar warmers, and adjustable seats and handlebars have made an appearance on newer

models. These advancements may provide the tools needed to decrease the effects of riding on the body.

### Purpose of the Study

The purpose of this retrospective study was to examine the occurrence of musculoskeletal symptoms in recreational snowmobile drivers and relate them to the manufacture year of the snowmobile, the length of the track, and/or the riding terrain.

### Research Question

Are the snowmobile year, track length, and riding terrain associated with musculoskeletal symptoms that occur in recreational snowmobile drivers?

### Significance of the Study

Most recreational snowmobile drivers sustain some sort of musculoskeletal symptom(s) while riding a snowmobile. As this type of recreational activity has grown the number of symptoms recorded has seen a dramatic increase.

Studies have shown an increase in injuries and the type of symptoms prevalent in snowmobile drivers; the vibration effects of driving a snowmobile; and the ergonomic evaluation and ergonomic recommendations for snowmobile drivers.

It is imperative that snowmobile riders be educated about the possible causes of the musculoskeletal symptoms they acquire while driving a snowmobile.

## Definition of Terms

The following definitions are given for the purpose of clarification:

Track Length: The length of the track measured from the front of the track located under the front of the snowmobile to the back of the track. A short track will measure 120"-128", a medium track will measure 130"-146", and a long track will measure 151" or more.

Riding Terrain: A groomed trail, which would be a smooth surface made by a grooming machine, or an ungroomed trail, which would include: deep snow with no previously cut trail, mountainous terrain with no previously cut trail, cross country riding with no previously cut trail, or a previously cut trail that is not groomed on a regular basis.

Musculoskeletal Symptoms: Any type of soreness related to snowmobile driving. Including, but is not limited to soreness in the following areas: arms, shoulders, hands, neck, lower back, legs, knees, and feet.

## CHAPTER 2

### REVIEW OF RELATED LITERATURE

#### History of the Snowmobile

The history of snowmobile can be traced back to the early 1900's. In 1908, the very first vehicle to travel on snow was built. It was built by Alvin Lombard in Waterville, Maine; weighing in at 20 tons this machine was only used in log hauling. In 1913 Virgil White, a Ford dealer from New Hampshire, invented a track and ski conversion system for the Model T Ford (Campbell, 2004).

The first snowmobile patent was issued in 1927, to Carl J. Eliason of Sayner, Wisconsin. It was a wooden toboggan fitted with two skis, which were steered with ropes, powered by a 2 ½ horsepower Johnson outboard motor. Over the next 15 years Eliason's snow vehicles went into production through Sayner. They were quickly refined and developed into larger models, only 40 were built and no three were identical. (Campbell, 2004) Between 1927 and 1962 thirteen patents were granted for snow vehicles. These thirteen patents lead to the modern snowmobile. "By 1955 Polaris Industries had made a commitment to the development, testing, and manufacturing of the definitive single track snowmobile, however, the company faced delays when they ran into design problems with in "Comet" model in 1963." (Allyson, 2010)



In 1958 the modern snowmobile was born. Joseph Armand Bombardier began manufacturing snow machines able to carry up to 12 passengers, by 1947. These machines were designed to be used by the military but were soon adopted by the Canadian police, mining and oil companies, and ski resorts. In the 1950's Bombardier had ambitions to build a lightweight, fast driving individual snow machine. By 1959, Bombardier's Ski-Doo has come into existence. The modern engines had become small enough and light enough to make this design possible. Bombardier's design revolutionized the snowmobile industry with its tunnel mounted engine, combined chassis/hood, and an endless rubber track affixed via sprung bogie wheels. (Ingram, 2000) By 1962 his endless track design had been patent in both Canada and the U.S. However, "it was not until 1964 that the machine became available in mass production." (Karleen, 1973)

By 1965 Ski-Doo's competitor, Arctic Cat, had revolutionized the suspension design. The company replaced the bogie wheels that were being used in Bombardier's design, to keep the machine on the track, with a pair of slide rails running on the cleats of the track. This design allowed for shock absorbers to be added, which would aid in smoothing the ride of the snowmobile. The very next year Arctic Cat redesigned yet another feature of their snowmobile. The new design moved the engine from on top of the drive unit, located behind the driver, and placed it in the front of the track tunnel, in the belly pan of the front of the machine.

By moving the engine they were able to lower the center of gravity of the snowmobile, which balanced it with the rider's body weight. This proved for substantially better handling and performance. (Ramstad, 1999) This design is still used by all four major snowmobile manufacturers today. Within just two years, Arctic Cat was able to launch the snowmobile design forward into the unexplored territory of sport riding and performance vehicles.

Yamaha manufactured its first snowmobile in 1968. There were only 350 snowmobiles manufactured by Yamaha that year; These snowmobiles were the forerunners of the most successful snowmobiles ever made. By the mid-1970s snowmobile racing had become of popularity. Yamaha went straight to the top of the racing scene in 1976 with their introduction of their SRX440 snowmobile. (Allyson, 2010) By this time there were more than 250 major races sanctioned by the U.S. Snowmobile Association.

The 1980s provided additional advancements in the technology of the snowmobile. Heated handlebar warmers were one of the leaps forward for snowmobile design. Gerard Karpik, a cross-country snowmobile racing legend from Minnesota, pioneered the M-10 suspension. This suspension system allowed the front and rear suspension to communicate so that when a bump was hit by the front of the machine it could be avoided by the rear of the machine. This advancement allowed for harder riding over rougher terrain. (Ingram, 2000)

Electronic fuel injection was the launch of the 90's. Polaris led this revolution based on the 1987 design by the Injection Research Specialist. They designed the Polar Indy 650 RXL with EFI in 1991. These machines boasted better fuel economy, a smoother ride, and improved performance. (Rodengen and Hubbard, 2003) Electronic fuel injection has become another snowmobile standard and is still used by all four major manufacturers today.

In 2001 Ski-Doo redesigned the engine-forward chassis originally introduced by Arctic Cat. This redesign placed the rider one foot forward of what use to be standard riding position. The mass of the machine was now centralized on the chassis and the suspension forces were spread about the engine, causing the rider's own weight to become the balancing element of the machine. (Ingram, 2000) A recent introduction by Arctic Cat called Infinite Rider Positioning has launched into the industry. This advancement in technology makes adjustment of the seat and handlebars as easy as the flip of a switch.

There have been many advancements in snowmobile technology and design over the last century, and there are many more to come. From the start of a large 20 ton machine designed for log hauling, so the design of Bombardier, which launched the snowmobile industry into a new dimension, to the introduction of electric start, heated handlebars, IRP technology, to heated seats. As technology and design advances the snowmobile will prove to become more comfortable and safer for the

rider. These advancements provide increased comfort and performance which will continue to lead these manufacturers to new and improved machines. As the popularity of riding snowmobile continues to grow the introduction of new technology will be welcomed. Today there are over 200,000 snowmobiles sold annually in the U.S., Canada, and Europe; Many being used for not only recreational purposes but also in some occupations. (Allyson, 2010)

### Whole Body Vibration

As seen in many studies, (Rehn et al, 2005; Rehn et al, 2004; Bovenzi and Hulshof, 1999; Kjellberg and Wikstrom, 1985; Rehn et al, 2002; National Institute for Occupational Safety and Health, 2001) whole-body vibration (WBV) exposure, awkward body positioning, as well as shock to the body caused by sudden jolts while riding a snowmobile potentially have a detrimental effect to the musculoskeletal system. “The magnitude of exposure to WBV is a result of several combined factors such as operating technique, vehicle type, terrain type, and seat suspension. WBV is transmitted from the seat, the backrest and the foot support in a vehicle and can have an adverse health effect on the musculoskeletal system.” (Rehn et al, 2002) It is also mentioned by Rehn et al (2002), that “the generation of WBV and shock is dependent on for example, vehicle type, speed and terrain conditions.” Furness and Maschette (2009) found that “During WBV, changes in gravitational conditions are produced by the vibrations of machinery (ie, vehicles and vibration

platforms). Gravity is a component of WBV because the product of amplitude and frequency is acceleration. Manipulations of amplitude or frequency can affect the rate of change of the WBV (ie acceleration) acting on an individual. Thus, the gravitational forces acting on the body are varied in most WBV environments (ie, recreational and occupational). Because the position of the whole body in space is changing, a role of the neuromuscular system during WBV must be to perceive and attenuate changes in body position for optimum performance and/or comfort.”

The development of musculoskeletal symptoms and disorders is a great concern for many snowmobile riders and has been addressed in many studies (Rehn et al, 2005; Rehn et al, 2004; Bovenzi and Hulshof, 1999; Kjellberg and Wikstrom, 1985; Rehn et al, 2002; National Institute for Occupational Safety and Health, 2001). Rehn et al (2002) suggests that “WBV and shock likely occurs in both the vertical and horizontal planes. This may be of particular importance for the development of musculoskeletal symptoms in the neck and shoulders since these muscles have to maintain balance and perform lever work simultaneously.” “Compared with studies on other vehicle types, the most distinct feature for WBV characteristics in ATVs is the strong influence of lateral vibration. This may account for the pattern of musculoskeletal symptoms observed for drivers of ATVs as reported by Rehn et al (2002) i.e. musculoskeletal symptoms primarily in the neck region.” (Rehn et al, 2005) “Exposure to shock and vibration that should

occur in both horizontal and vertical directions for all-terrain vehicles may be of particular importance, in developing symptoms of musculoskeletal disorders, as the worker has to have tensed muscles to maintain balance during exposure and to be able to handle the lever at the same time.” (Rehn et al, 2002).

“Awkward body postures and constrained positions due to mechanical workload are examples of potential confounding risk factors that are inherently associated with prolonged seated WBV exposure.” (Rehn et al, 2005). “Epidemiological investigations have led to suspicions that whole-body vibration above all constitutes a risk for the development of injuries and functional disorders of the skeleton and of joints.” (Kjellberg and Wikstrom, 1985). Low back pain has been an ongoing concern in association to whole-body vibration exposure. “Biodynamic experiments have shown that WBV exposure, combined with a constrained sitting posture, can put the lumbar intervertebral disc at risk of failure.” (Bovenzi and Hulshof, 1999). As found by Bovenzi and Hulshof (1999), “both cross-sectional and cohort epidemiologic studies indicate that there is an increased risk for lower back disorders among occupational groups exposed to WBV when compared to non-exposed control groups.” “The expected consequences result from the mechanical influences of the vibration which may induce tissue strain and compression.” (Kjellberg and Wikstrom, 1985) “An excess risk for lumbar disc disorders, including herniated disc, was also found in the WBV-exposed

occupational groups compared with the control groups. Biodynamic and physiological experiments have shown that seated WBV exposure can affect the spine by mechanical overloading and excessive muscular fatigue.” (Bovenzi and Hulshof, 1999).

Exposure to whole-body vibration has been linked to an increase in muscle activity. “Recording of electromyogram (EMG) have shown that muscles may be activated during exposure to vibration. It is suggested that muscle activity is a combination of control movements to stabilize the body, and so-called tonic reflexes generated by passive movements. Vigorous active muscle contractions seem to accompany shocks and very low-frequency vibrations which have high intensity later components. Under these circumstances symptoms of stress may occur, which in themselves may lead to a further increase in muscle activity.” (Kjellberg and Wikstrom, 1985) Similar findings were reported by Torvinen et al (2002), they reported that “vibration applied directly to the muscle belly or tendon or to whole body has been shown to elicit a response name ‘tonic vibration reflex.’ The vibration-induced TVR involves activation of muscle spindles, mediation of the neural signal by 1a afferents, and activation of the muscle fibers via large alpha-motor neurons. The TVR induced by the vibration is also capable of causing an increased recruitment or motor units via activation of muscle spindles and polysynaptic pathways which is seen as a temporary increase in muscle activity.” Snowmobile drivers are subjected to whole-body vibration

continuously during a riding session. This may be the cause of many of the reported musculoskeletal symptoms.

#### Hand-Arm Vibration

Hand-arm vibration associated with driving terrain vehicles has been known to cause vibration-induced white finger, frost-bite, temporary loss of grip strength, and other detrimental effects on the upper extremity.

“The hand-arm vibration is caused by the motor, the driving terrain or the resonance phenomena in the frame or steering yoke.” (Anttonen et al, 1995) “Steering devices in terrain vehicles have been reported to transmit hazardous levels of vibration-acceleration to the upper limbs.” (Astrom et al, 2006) According to the measurements and the results of the questionnaire by Anttonen and Virokannas (1994), the “vibration syndrome can be caused by hand-arm vibration associated with snowmobile driving.” As reported by Astrom et al (2006), “driving terrain vehicles are related to experiencing some symptoms related to hand-arm vibration syndrome (HAVS), such as numbness, sensation of cold and white fingers, suggesting that there is a possible association between exposure to HAV generated from steering devices in terrain vehicles and symptoms of HAVS.”

“Neurological, vascular, and musculoskeletal symptoms in the hands, such as numbness, white fingers and pain, are phenomena of HAVS.” (Astrom et al, 2006) “The exposure to hand-arm vibration can cause intimal lesions and hypertrophy in the wall of arteries. It can increase



blood viscosity, and cause functional changes in vessels.” (Virokannas and Anttonen, 1994) As reported by Virokannas and Anttonen (1994), “the exposure to hand-arm vibration and cold reduces circulation in the hand in a synergistic manner. The mechanism of the combined effect may be transferred via the sympathetic nervous system.” “Exposure to vibration can also lead to hyperreponsiveness to noradrenaline in the smooth muscle or arties, which results in a stronger vasoconstriction reaction to sympathetic stimuli such as cold.” (Virokannas and Anttonen, 1994) A reaction such as this can contribute to the occurrence of white-finger syndrome and frostbite due to the decrease in circulation to the extremity.

Frostbite is often a concern for individuals who enjoy recreational activities outdoors during the winter season. Studies have shown (Virokannas and Anttonen, 1993; Virokannas and Anttonen, 1994; Anttonen et al, 1995; Anttonen and Virokannas, 1994) that vibration-induced white finger syndrome (VWF) may increase the risk of frostbite, especially to the upper extremity. “The vibration syndrome in the hands occurs more often in cold than in warm conditions, which indicates that a cold climate may facilitate the generation of vibration-induced white finger.” (Virokannas and Anttonen, 1994) “As snowmobiles are used in winter the effect of cold and the static driving posture in the cold airstream can contribute to the prevalence of VWF.” (Anttonen and Virokannas, 1994) In a study by Virokannas and Anttonen (1994) it was

reported that “cold and hand-arm vibration both reduce blood flow in the fingers in a synergistic manner, and it was to be expected that the subjects with VWF rather frequently incurred frostbite on the fingers when driving snowmobiles.” Anttonen et al (1995) reported that “the dose-relationship for the snowmobile group showed a consistent increase in the prevalence of white finger with increasing exposure.” “The relationship between the total vibration exposure time and the prevalence of white finger indicated that white finger is mostly induced by vibration.” (Virokannas and Anttonen, 1993) “Hence, there is a need for health care, technical improvements, change of working habits and other protective means to reduce the symptoms of vibration in driving terrain vehicles.” (Anttonen and Virokannas, 1994)

#### Ergonomics of the Snowmobile

There are numerous studies (Nayha et al, 1994; Rehn et al, 2005; Rehn et al, 2004; Rehn et al, 2002; National Institute of Occupational Safety and Health, 2001; Tostrup, 1994; Habes et al, 2003) that have assessed ergonomic risk factors associated with snowmobiling, some of which include: pronated forearms, hand-arm vibration, extreme wrist posture, twisted trunk posture, non-neutral neck posture, elevated arms, prolonged seated posture, whole-body vibration, and shock. “The driving posture is mostly bent or twisted, due to the inappropriate height of the steering yoke and the seat, which may be highly stressful to the back.” (Nayha et al, 1994) The study conducted by the National Institute for

Occupational Safety and Health (2001) assessing Yellowstone National Park personnel confirmed that, “when rangers were asked to sit on their snowmobiles in their preferred position, the chosen seat back position often resulted in shoulder postures of about 90 degrees (recommended is 45 degrees) and elbow joints at about 180 degrees (recommended is 60-70 degrees) and the hand in non-neutral postures.” This occurred “because most of the rangers tend to sit far back on their seats to allow for clearance between the steering bar and the bulky equipment and heavy clothing they wear during their regular duties.” (NIOSH report, 2001) Recreational snowmobile drivers would have these same issues in accordance to seated posture due to the fact that they would be wearing similar heavy clothing due to the low temperatures of the winter season. “The posture typical of snowmobile driving is usually considered to cause stress upon the back and legs.” (Nayha et al, 1994) “By sitting down the back changes from lordotic to a kyphotic shape. Grandjean claimed that the backward position of the pelvis puts the spine into a state of kyphosis which, in turn, increases the pressure within the disk.” (Tostrup, 1994) This may explain the reason for low back pain and soreness in the back associated with snowmobile driving.

Many snowmobile drivers complain of soreness and fatigue in the arms and shoulders and studies (Rehn et al, 2005; Rehn et al, 2004; National Institute for Occupational Safety and Health, 2001; Tostrup, 1994; Habes et al, 2003) have shown that these symptoms are related to

the placement of the handlebar and the diameter of the handgrip.

“Drivers may also be required to sustain an elevated arm position which may further contribute to overload of the neck and shoulder muscles.” (Rehn et al, 2002) As found in a study by Rehn et al (2005), “the reach to the handlebar causes awkward postures of the shoulder and arm, and hand forces to grip and control the throttle control are high and increased by the small diameter of the steering control.” “Due to the sheering of the vehicle it is not possible to let the upper arm be parallel to the sideline of the body and the elbow at about 100°. That would give too little lever and therefore too little muscle power to steer, since power is the product of weight and lever.” (Tostrup, 1994) “Because snowmobile driving requires the arms to be outstretched to reach the handle bars, with considerable grip force required to control the snowmobile, a potential physical fatiguing condition exists for the driver.” (National Institute for Occupational Safety and Health, 2001) “When the elbow joint is kept in pronation by the biceps muscles, the insertion of the muscle may be pinched between the radius and ulna. With the hand in lateral deviation and dorsally flexed there is a possibility that the median nerve and veins might get stretched which could lead to carpal tunnel syndrome and be a contributing factor to the white-finger syndrome.” (Rehn et al, 2002) Rehn et al (2005) found that ‘the most important feature to adjust is the steering bar, which is moved closer to the body with grips oriented to provide for neutral wrist positions while

in typical use, would reduce grip forces and improve shoulder and arm positions.” “The diameter of the hand grip (just over one inch) is smaller than the generally recommended 1.5 inches, and the wearing of gloves when riding further increases the amount of grip force the operators must exert to stabilize themselves and maneuver the snowmobile.”

(Habes et al, 2003) Related to the diameter of the hand grip is a study by Fioranelli and Lee (2008) evaluating the diameter of the standard Olympic bar used in weight lifting. Fioranelli and Lee (2008) suggest that “the fat bar is the same length and has the same circular shape as a standard Olympic bar, but the gripping portion has a greater diameter. It measures 51mm (2 inches) in diameter as opposed to a standard Olympic bar diameter of 28 mm (1.1 inches). Proponents for the thicker bar claim that the oversized grip elicits greater muscle activation, especially within the forearm muscle group, therefore enhancing the strength of the muscles used for the exercise.” Their findings indicate “that bar diameter can influence neuromuscular activation during an isometric unilateral bench press exercise.” (Fioranelli and Lee, 2008)

They also state “with regards to neuromuscular activation of the forearm muscles, we report greater electromyographic activity with using the THIN bar.” (Fioranelli and Lee, 2008) These findings relate to the hand grip diameter as the reported diameters are similar. The recommendation for hand grip diameter, as suggest by Habes et al, 2003, is 1.5 inches. The Fioranelli and Lee (2008) study shows that the thin

bar, with a diameter of 1.1 inches shows greater muscle activation, which in the case of their study is beneficial. However, when concerned with the hand grip diameter of a snowmobile the increase in muscle activity may not be seen as beneficial, but may contribute to the musculoskeletal symptoms in the upper extremities reported by snowmobile drivers. Another concern reported is the use of the thumb operated throttle. Tostrup (1994) found that “the use of the thumb muscles for giving gas is tiring for the muscles. It may also result in arthrosis of the thumb joints.” “The force to depress the throttle control on the steering bar is appreciable, and not sustainable for continuous use.” (National Institute for Occupational Safety and Health, 2001) NIOSH (2001) suggests to “redesign of the throttle control mechanism so that the activation method does not require palmar pinch forces involving the thumb.” NIOSH reports (2001) “test results suggest that snowmobile use, particularly depressing the throttle control with the thumb, fatigues the muscle of the hands and arms.” Habes et al (2003) reported that “several NPS rangers indicated that it would be beneficial if the steering bar could be moved closer to the body and lowered, without having to move the seat back closer. This feature would allow the arms to be used more effectively in stabilizing the body position on the seat as the snowmobile is driven, particularly under bumpy road conditions.”

The seat and the position of the rider on the seat while driving has been known to cause back and neck problems. “The role of the seat is

not only related to vibration but also to the support function of the back during driving.” (Anttonen and Niskanen, 1994) Tostrup (1994) stated that “the hardness of the seat is also of importance in reducing vibrations and impact from the ground.” “The support for the back provided by the seat is rarely satisfactory, and the shock absorbers are often insufficient.” (Nayha et al, 1994) The seated position of the rider may cause the rider to hold the head in a non-neutral position causing musculoskeletal problems in the neck, shoulders, and upper back. “A correct spine posture in the snowmobile rider will decrease asymmetrical loading.” (Roberts et al (1971) A non-neutral neck position is common among riders due to the safety need of wearing a helmet. “Counteracting for the weight of the head when the cervical spine is flexed forward and excessive exposure times with the arms in flexed or abducted positions are associated with static muscle activity in the neck and shoulder area. A non-neutral neck position, occurring simultaneously with exposure to excessive shock would be undesirable.” (Rehn et al, 2005) Driving in a standing position, or on the knees, causes the driver to be bent forward shifting the body mass away from the supporting point increasing the physical force needed by the hands to hold the steering yoke. (Nayha et al, 1994) “Further achievements may be gained by instructions given to the drivers regarding the appropriate driving posture.” (Nayha et al, 1994) Although many advancement have been made in the design of the snowmobile there remains room for improvement. As stated by Waller et

al (1975), "There appears to have been an attempt by some manufacturers during the past year or two to upgrade the design and quality of the machines through options that the use may purchase if he wishes."

### Musculoskeletal Symptoms

Musculoskeletal Symptoms are a concern for many snowmobile drivers. These Musculoskeletal Symptoms may be influenced by many factors. Rehn et al (2002) reported that "musculoskeletal symptoms in the neck, shoulders and upper back are 2 to 3 times more prevalent among professional drivers of ATVs compared to a control group not using ATVs at work." "A cross-sectional study by Rehn, showed that occupational drivers of all-terrain vehicles, such as forest machines, snowmobiles, and snowgroomers, exhibited significantly increased risks for musculoskeletal symptoms primarily from the neck and shoulder region..." (Rehn et al, 2005) "The highly significant correlations between exposure to snowmobile riding and most of the other physical risk factors suggest that extensive usage of snowmobiles and motorcycles strongly increase the risk of acquiring musculoskeletal problems." (Daerga et al, 2003) "Four studies, Sara, Aira, Nayha, and Tostrup show a high prevalence of lumbar back pain, neck and shoulder pain, arm pain and knee pain. The same authors showed a correlation between driving time and musculoskeletal and joint symptoms." (Tostrup, 1994)



Nayha et al (1994) found that “38% of their subjects reported complaints in their upper limb or shoulder, which according to their own judgment was caused by riding snowmobile, 34% reported troubles with their knees and 42% reported symptoms in their back. Close to half (46%) of their subjects reported pain, aching or tenderness upon movement they had felt in at least one joint during the year, the most common location for symptoms being the back (30%), shoulder (22%), neck (21%), and knees (20%).” Astrom et al (2005) reported a “prevalence of musculoskeletal symptoms in the neck (43-61%), shoulder (26-43%), and wrist (15-30%) were high in the driver groups and reindeer herders compared to the referents (8-31%).” Astrom et al (2005) also reported “increased odds of musculoskeletal symptoms in the neck for all drivers groups and the reindeer herders.” Rehn et al (2002) also reported “the prevalence of symptoms was larger in the neck, shoulder and thoracic regions in drivers of all-terrain vehicles compared to the control group. Compared to controls, the driver group also showed an increased prevalence of severe symptoms in the neck, shoulder and lower back.” Rehn et al (2004) reported that “among drivers, complaints concerning the musculoskeletal system are most frequently reported from the neck, shoulders, and lower back.” “During a self-reported health survey of reindeer herders, Tostrup found that they had a high prevalence of musculoskeletal disorders of the lumbar back, neck, shoulder, arm, and knee.” (Habes et al, 2003).

## Riding Terrain

The riding terrain encountered by snowmobile drivers is another factor that may affect the musculoskeletal symptoms reported and may also be a contributing cause of snowmobile accidents. “The whole body vibration (WBV) in snowmobile riding is caused by the driving terrain resulting in different kinds of resonance phenomena in the structure of the snowmobile.” (Anttonen and Niskanen, 1994) “Two major environmental problems were involved in almost 40% of all injury events and almost 60% of events in which there was an environmental contribution. The most important of these was a bump or other rough terrain...” (Waller and Lamborn, 1975) In a study by James et al (1991) “Thirty-nine (46.2%) of the 84 patients were thrown from their snowmobile: 15 when the snowmobile encountered a bump, ditch, or snow ridge and 24 after hitting a tree stump, tree, embankment, or dirt wall.”

It is stated in the National Institute for Occupational Safety and Health report (2001) that “the jolts sustained by NPS personnel while riding snowmobiles for long hours under conditions of severely deteriorated roads are extremely higher, may be associated with the musculoskeletal symptoms reported by the workers, and amplify the effects of the design shortcomings of the snowmobiles used in the park.” As terrain conditions deteriorate it becomes more difficult for drivers to avoid terrain hazards. Deteriorating road conditions may affect

musculoskeletal symptoms as well as propose difficulty in handling the snowmobile, which may cause injury. According to Waller and Lamborn (1975) “younger persons and those of relatively light weight appeared to have difficulty in handling the machine more often than did individuals of greater weight.” The effects of riding terrain on musculoskeletal symptoms may be related to the suspension and available adjustments that are present on the snowmobile. In a study reviewing ergonomics of the snowmobiles used by the National Park Service personnel by Habes et al (2003) it was found that “the snowmobiles do not have the necessary features or adjustments in suspension components to significantly reduce the jolts the riders experience on the deteriorated trails.”

## Injuries

“Snowmobiling is a popular wintertime family activity and generates billions of dollars in revenue in the northern United States and Canada. However, snowmobiling has been associated with significant morbidity and mortality among adults and children.” (DeCou et al, 2003) “In 2005, the US Consumer Product Safety Commission reported 136,100 injuries and 767 estimated deaths associated with ATV use.” (Sanfilippo et al, 2008) Of those 767 estimated deaths associated with ATV use, “the consumer product safety commission estimates there are 100 deaths each year are related to snowmobile use.” (Sy and Corden, 2005) Decreasing risk of injury is imperative to the snowmobile driver’s

safety. “A study in Minnesota indicates that one out of every 25 snowmobilers can expect to be injured during his snowmobiling career.” (Karleen, 1973) According to Landen et al (1999), “for 1993-1994, injury death and hospitalization rates were greater for snowmobiles than for on-road motor vehicles. When rates by miles driven are calculated for injuries associated with each vehicle, the rate ratio becomes even greater and approaches a more accurate measure of the relative risk of injury associated with snowmobile use.” In the winter of 2000-2001, the Canadian institute for health reported there were 137 admissions to the hospital related to sever injuries from snowmobiling. (Hoey, 2003) “In the United States, more than 10,000 patients sought medical attention in an emergency room for snowmobile-related injuries during 1997 and 1998.” (Sy and Corden, 2005) As reported by Karleen (1973), “the accident rate is rising due to carelessness and negligence in snowmobile operations.”

There are many risk factors, and/or behaviors, that contribute to the both the frequency and severity of snowmobile incidents. (Nayci et al, 2006) “New high-powered machines, burgeoning numbers of riders, and a larger percentage of inexperienced riders are all possible factors” relating to the cause and increase of snowmobile incidents. (Beilman et al, 1999) “The most common accident mechanism was falling off the machine due to jumps and unexpected terrain irregularities.” (Sundstrom et al, 1994) In a study by Karlstad and Trousdale (2003),

“Collisions accounted for 24 (n=78) of the accidents. Thirty-seven lost control of their vehicle as a result of the terrain, whereas 5 others were injured by snowmobile machinery.” More than three-fourths of the 137 accidents reported by Bjornstig et al (1994) occurred during leisure activities and racing. DeCou et al (2003) reported that “the most common mechanism of injury was collision with a fixed object – this occurred in 13 cases (42%). The remaining mechanisms were rollover (3 cases), passenger falling off a moving snowmobile (2)...” Related to snowmobile injuries is the injuries sustained during motocross riding. “Motocross injuries usually result from falls after high jumps and direct impact against the ground at relatively lower speeds...” (Gorski et al, 2003) Waller and Lamborn (1975) found that “the injured population tended to have machines with higher horsepower engines than did the comparison group.” There are many contributing factors to injuries associated with snowmobile driving, however, most snowmobile related injuries could be prevented by increasing the drivers awareness of the risks involved.

The types of injuries reported from riding snowmobile are not concentrated on one area of the body; however, the lower extremity proves to be at the greatest risk for injury. A study conducted by the CDC assessing injuries and deaths in Maine from 1991-1996 reported that “of the 903 injuries, 282 (31%) involved a lower extremity, 165 (18%) an upper extremity, 151 (17%) the head or neck, 79 (9%) the chest or

trunk, and 63 (7%) the back. Specific types of injuries included fractures (32%); lacerations (10%); contusions (4%); abrasions (3%); dislocations (2%); burns (2%); exposure (1%); internal or puncture (<1%); drowning (<1%); and unspecified, other, or unknown (37%).” Waller and Lamborn (1975) reported that “overall 30% of events resulted in fractures, 38% in contusions or lacerations, 22% in sprains, 3% in concussions, and 6% in other injuries.” In a study by Beilman et al (1999) “types of injuries were classified as spine injuries, head injury, intraabdominal injury, thoracic injury, pelvic fracture, facial injury, and extremity fractures. Number of injuries reported in each category: extremity fractures (67%), head injury (34%), facial fractures or soft tissue injury (32%), thoracic injury (29%), spine injury (18%), intraabdominal injury (15%), and pelvic fracture (11%).” Injury to the extremities is the most common injury reported. Skokan et al (2001) reported that “more than 63% of the patients had serious isolated injuries involving the extremities, the internal organs, or the head.” In a study conducted by Sundstrom et al (1994) “The lower extremities were exposed to one third (32%) of the injuries, while the upper extremities and the head and neck region accounted for 21% and 19% of the injuries respectively.” An additional study by Soininen and Hantula (1992) stated that “half of all the injuries (50%) were in extremities. Sixty-six (18%) were head injuries, 41 (11%) thorax injuries, 8% back injuries, 3% abdominal, 3% on spine or neck and 6% in other parts of the body.” The injuries reported in this study were typically in

the extremities consisting of fractures in the legs and fractures and luxations in the upper extremities. (Soininen and Hantula, 1992) As these studies report the extremities are the most common location for injuries sustained while driving a snowmobile. Bauer and Hemborg (1979) reported that “it seems that the lower limbs are insufficiently protected in snowmobile accidents, as shown by the distribution of the injuries over the body.” Accidents and injuries are seen in all types of sport and recreational activity. Participants in these activities, including snowmobiling, need to take all necessary precaution while participating in their chosen recreation.

## CHAPTER 3

### METHODOLOGY

#### Subject Characteristics

Subjects were 18 year of age or older (Table 1) and drive a snowmobile recreationally during the winter season. Participants could either own a snowmobile or rent a snowmobile during the riding season. Subjects came from the northern regions of the United States including; North Dakota, South Dakota, Minnesota, Montana, Wisconsin, Michigan, and Maine.

#### Instrumentation

A survey was distributed to Snowmobile Clubs in both North and South Dakota, snowmobile rental facilities in West Yellowstone, Montana, and to the International Snowmobile Manufacturer's Association. The survey consisted of questions regarding the occurrence of musculoskeletal symptoms sustained while participating in snowmobile driving, snowmobile machine characteristics, and rider characteristics. (Appendix I and II)

#### Collection of the Data

Data were collected through an online survey and from participants returning a paper copy of the survey via of a self-addressed envelope that was included with the mailing of a paper copy of the survey.



## Survey Questions

The questions included on the survey were created to collect the data needed for this particular study.

The purpose of each question is as follows:

1. The year of the snowmobile will be used to compare to questions 4-7 to determine if snowmobile year is associated with the musculoskeletal symptoms that were reported.
2. The length of the track will be used to compare to questions 4-7 to determine if the track length is associated with the musculoskeletal symptoms that were reported.
3. The riding terrain will be used with to questions 4-7 to determine if riding terrain is associated with the musculoskeletal symptoms that were reported.
4. Used to assess which areas of soreness are reported most frequently.
5. Used to determine how long the soreness from questions 4 and 7 typically last.
6. Used to assess how many participants report ongoing physical ailments associated with driving a snowmobile.
7. Used to assess the type of ongoing physical ailment(s) and the areas of the body they are reported to assess if participants report ongoing symptoms in the same areas.

The available responses for each question were chosen by the researcher as being appropriate selections for the study. The reasons for each selection are as follows:

1. The 5 years increments were used due to the fact that most snowmobile manufacturers have made changes to their products within the 5-year increment.
2. The length of the snowmobile tracks were divided into short, medium, and long. Short being 120"-137", Medium 141"-146", and Long 151" or more. Track Length: the longer the track the less likely the driver will be to hit every bump on rough riding terrain. However, increasing the length of the snowmobile from the manufacture length may not be as structurally sound as a snowmobile of the same length from the manufacturer. This could potentially increase the risk of injury if the lengthening of the snowmobile is not completed correctly.
3. Groomed Trail: groomed trails are state sanctioned trails within each states trail system. These trails are groomed on a regular basis during the winter season.

Ungroomed Trail: ungroomed trails could be either a self cut trail or a trail that may be frequently used by other drivers but is not part of a state sanctioned trail system and is not groomed on a regular basis.

4. The shoulders, hands, arms, knees, hips, low back, feet, and neck were chosen as options due to the fact that these are the regions of the body that symptoms were reported in other studies.
5. Three day increments were given to determine how long soreness reported would last. The researcher chose to use 3 day increments to take into account the effects of delayed onset muscle soreness.
6. A yes or no answer is appropriate for this question.
7. Ongoing low back pain: low back pain has been associated with snowmobile driving.

Loss of Grip Strength: has been associated with driving a snowmobile due to the driving being subjected to hand-arm vibration.

Ongoing joint pain in the upper and/or lower body: These injuries are associated with any injury or overuse due to snowmobile driving.

#### Data Analysis Methods

Participants' data was summed across categories. This method was used in order to find the percentage and number of participants reporting specific symptoms for the three variables; snowmobile year, track length, and riding terrain.

Musculoskeletal pain in the neck/shoulders, arms, lower back, legs, and no soreness were reported for each snowmobile manufacture year category (1991-1995, 1996-2000, 2001-2005, 2006-2010). This was done in order to find how many snowmobile drivers within each manufacture year category (1991-1995, 1996-2000, 2001-2005, 2006-2010) reported specific pain symptoms.

Musculoskeletal pain symptoms in the neck/shoulders, arms, lower back, legs, and no soreness were reported for each snowmobile track length category (short – 120”-128”, medium – 130”-146”, long – 151”+). This was done in order to find how many snowmobile drivers within each category reported specific pain.

Musculoskeletal pain symptoms in the neck/shoulders, arms, lower back, legs, and no soreness were reported for each riding terrain category (groomed trail, ungroomed trail, equal riding on both, other). This was done in order to determine the number of snowmobile drivers within each category who reported specific pain symptoms.

## CHAPTER 4

### RESULTS

#### Participant Demographics

Participant demographics including; gender, age, snowmobile year, track length, riding terrain, the type of symptoms reported, how long the reported symptoms lasted, if drivers had any ongoing physical ailments, and the type of ongoing physical ailments reported are found in Table 1. The number of participants in each category and the percentage of participants reporting in each category are included in Table 1.

#### Results

The association among snowmobile year, track length and riding terrain and the presence of musculoskeletal symptoms in recreational snowmobile drivers was determined by comparing the snowmobile year, the track length of the snowmobile, and the riding terrain to the symptoms reported by the participants. A comparison was made between each variable separately (snowmobile year, track length, riding terrain) to the symptoms reported (soreness in the neck/shoulders, arms, lower back, legs, no soreness) to determine how the variables (snowmobile year, track length, and riding terrain) are associated with the musculoskeletal symptoms reported.

|                             |                              |                                 |                                    |                                    |                  |
|-----------------------------|------------------------------|---------------------------------|------------------------------------|------------------------------------|------------------|
| Total: n=243                |                              |                                 |                                    |                                    |                  |
| Number (%)                  |                              |                                 |                                    |                                    |                  |
| Gender                      | Male<br>186 (77)             | Female<br>57 (23)               |                                    |                                    |                  |
| Age                         | 18-25<br>21 (9)              | 26-35<br>38 (16)                | 36-45<br>69 (28)                   | 46-55<br>78 (32)                   | 56 +<br>36 (15)  |
| Snowmobile Year             | 1991-1995<br>9 (4)           | 1996-2000<br>33 (13)            | 2001-2005<br>67 (27)               | 2006-2010<br>133 (55)              |                  |
| Track Length                | Short (120"-128")<br>62 (26) | Medium (130"-146")<br>128 (52)  | Long (151" +)<br>53 (22)           |                                    |                  |
| Riding Terrain (Trail Type) | Groomed<br>73 (30)           | Ungroomed<br>57 (23)            | Both<br>94 (39)                    | Other<br>19 (8)                    |                  |
| Length of symptoms          | 1-3 days<br>193 (79)         | 3-5 days<br>7 (3)               | 5-7 days<br>3 (1)                  | 7-10 days<br>0 (0)                 | Other<br>40 (16) |
| Reported ongoing symptoms   | Yes<br>21 (9)                | No<br>222 (91)                  |                                    |                                    |                  |
| Type of ongoing symptoms    | Low back pain<br>31 (13)     | Loss of grip strength<br>12 (5) | Joint pain in lower body<br>21 (8) | Joint pain in upper body<br>11 (4) | Other<br>28 (11) |

## Year of Manufacture

Musculoskeletal symptoms were reported by the year the snowmobile was manufactured (Table 2). Drivers of snowmobiles manufactured between 1991 and 1995 reported symptoms in the neck and shoulders as the most prevalent symptom followed by, Legs, multiple symptoms, Arms/Lower Back, and no soreness, respectively. Drivers of snowmobiles manufactured between 1996 and 2000 reported symptoms

in the lower back as the most prevalent symptom followed by symptoms in the arms, neck and shoulders/multiple symptoms, legs, and no soreness, respectively. Drivers of snowmobiles manufactured between 2001 and 2005 reported symptoms in the neck and shoulders as the most prevalent symptom followed by multiple symptoms, symptoms in the lower back, legs, arms, and no soreness, respectively. Drivers of snowmobiles manufactured between 2006 and 2010 reported symptoms in the neck and shoulders as the most prevalent symptom followed by multiple symptoms, symptoms in the lower back, arms, legs/no soreness, respectively.

| Table 2 Comparison of Snowmobile Year to Reported Symptoms |                    |                     |                     |                      |
|--|--------------------|---------------------|---------------------|----------------------|
| Total: n=242   |                    |                     |                     |                      |
| Number (%)   | 1991-1995<br>(n=9) | 1996-2000<br>(n=33) | 2001-2005<br>(n=67) | 2006-2010<br>(n=133) |
| Neck/Shoulders   | 5 (55)             | 9 (27)              | 34 (51)             | 62 (47)              |
| Arms   | 2 (22)             | 10(30)              | 13 (19)             | 33 (25)              |
| Lower Back   | 2 (22)             | 15 (45)             | 26 (39)             | 37 (28)              |
| Legs   | 4 (44)             | 6 (18)              | 18 (27)             | 26 (19)              |
| No soreness  | 1 (1)              | 4 (12)              | 10 (15)             | 26 (19)              |
| Multiple Symptoms  | 3 (33)             | 9 (27)              | 28 (42)             | 41 (31)              |

## Track Length

Musculoskeletal symptoms were also recorded based on the track length of the snowmobile (Table 3). Drivers who drive snowmobiles with a short length track (120"-128") reported symptoms in the neck and shoulders as the most prevalent symptom followed by the lower back, arms/no soreness/multiple symptoms, and legs, respectively. Drivers who drive snowmobiles with a medium length track (130"-146") reported symptoms in the neck and shoulders as the most prevalent symptom followed by multiple symptoms, symptoms in the lower back, arms/legs, and no soreness, respectively. Drivers who drive snowmobiles with a long length track (151" or more) reported symptoms in the neck and shoulders as the most prevalent symptom followed by multiple symptoms, symptoms in the lower back, legs, arms, and no soreness, respectively.

| Total: n=243      | Short – 120"-128"<br>(n=62) | Medium – 130"-146"<br>(n=128) | Long – 151" +<br>(n=53) |
|-------------------|-----------------------------|-------------------------------|-------------------------|
| Neck/Shoulders    | 23 (37)                     | 62 (48)                       | 25 (47)                 |
| Arms              | 14 (22)                     | 30 (23)                       | 14 (26)                 |
| Lower Back        | 21 (34)                     | 40 (31)                       | 20 (38)                 |
| Legs              | 9 (14)                      | 30 (23)                       | 15 (28)                 |
| No Soreness       | 14 (22)                     | 22 (17)                       | 5 (9)                   |
| Multiple Symptoms | 14 (22)                     | 44 (34)                       | 23 (43)                 |



## Riding Terrain

Musculoskeletal symptoms were also reported based on the riding terrain (Table 4). Snowmobile drivers using groomed trails reported pain in the neck and shoulders as the most prevalent symptom followed by the lower back, multiple symptoms, no soreness, legs, and arms, respectively. Snowmobile drivers using ungroomed trails reported pain in the lower back as the most prevalent symptom followed by the neck and shoulders, multiple symptoms, arms, legs, and no soreness, respectively. Snowmobile drivers using both groomed and ungroomed trails reported pain in the neck and shoulder as the most prevalent symptom followed by pain in multiple locations, pain in the arms, lower back, legs, and no soreness, respectively. Snowmobile drivers driving on other types of terrain reported pain in the neck and shoulders as the most prevalent symptom followed by pain in multiple locations, lower back/legs, arms, and no soreness, respectively.

|                            | Groomed Trail<br>(n=73) | Ungroomed Trail<br>(n=57) | Both<br>(n=94) | Other<br>(n=19) |
|----------------------------|-------------------------|---------------------------|----------------|-----------------|
| Total: n=243<br>Number (%) |                         |                           |                |                 |
| Neck/Shoulders             | 31 (42)                 | 22 (38)                   | 45 (48)        | 12 (63)         |
| Arms                       | 12 (16)                 | 12 (21)                   | 31 (33)        | 3 (16)          |
| Lower Back                 | 22 (30)                 | 28 (49)                   | 23 (24)        | 8 (42)          |
| Legs                       | 13 (18)                 | 11 (19)                   | 22 (23)        | 8 (42)          |
| No Soreness                | 17 (23)                 | 8 (14)                    | 15 (16)        | 1 (5)           |
| Multiple Symptoms          | 19 (26)                 | 21 (37)                   | 32 (34)        | 9 (47)          |

#### Length of Symptoms

The symptoms reported were categorized by the reported length the symptoms persisted (Table 5).

|           | Neck/Shoulders<br>(n=110) | Arms<br>(n=58) | Lower Back<br>(n=81) | Legs<br>(n=54) | No Soreness<br>(n=41) |
|-----------|---------------------------|----------------|----------------------|----------------|-----------------------|
| 1-3 days  | 101 (92)                  | 53 (91)        | 77 (95)              | 47 (87)        | 8 (19)                |
| 3-5 days  | 6 (5)                     | 2 (3)          | 2 (2)                | 3 (5)          | 0 (0)                 |
| 5-7 days  | 1 (.9)                    | 1 (2)          | 0 (0)                | 2 (4)          | 0 (0)                 |
| 7-10 days | 0 (0)                     | 0 (0)          | 0 (0)                | 0 (0)          | 0 (0)                 |
| Other     | 2 (2)                     | 1 (2)          | 2 (2)                | 2 (4)          | 33 (80)               |

## Type of Ongoing Physical Ailments

Ongoing physical ailments were compared to reported types of ongoing physical ailments were also recorded (Table 6).

| Table 6 Comparison of Reported Ongoing Physical Ailments Related to Snowmobile Driving to |        |         |
|---|--------|---------|
| Type of Ongoing Physical Ailments Reported  | Yes    | No      |
| Total: n=243  |        |         |
| Number (%)  | (n=21) | (n=222) |
| Ongoing low back pain   | 7 (33) | 24 (11) |
| Loss of grip strength   | 2 (9)  | 10 (5)  |
| Ongoing joint pain in the lower body  | 5 (24) | 16 (7)  |
| Ongoing joint pain in the upper body  | 2 (9)  | 9 (4)   |
| Other   | 9 (43) | 19 (8)  |
| Multiple Symptoms   | 4 (19) | 7 (3)   |

CHAPTER 5  
SUMMARY, CONCLUSIONS,  
AND RECOMMENDATIONS

Discussion of Results

The occurrence of musculoskeletal pain symptoms has been shown to be related to snowmobile driving. This study looked at pain symptoms reported by snowmobile riders. The data was categorized by snowmobile manufacture year, track length, and riding terrain. Most participants reported pain in the neck and shoulders (110), followed by the low back (80 – snowmobile year, 81 – track length and riding terrain), multiple symptoms (81), the arms (58), the legs (54), and no reported soreness (41).

Snowmobile Year

Drivers of snowmobiles manufactured between the years of 1991-1995 and 2001-2010 reported pain in the neck and shoulders as the most prevalent symptom they experience after driving a snowmobile. The differences seen in the reported symptoms by each manufacture year may be due to the difference in design of the snowmobiles in each category. These design difference could affect the ergonomics of the riders, which would explain the difference in reported symptoms. The National Institute for Occupational Safety and Health (2001), Habes et al (2003), Rehn et al (2005a), Rehn et al (2005b), Tostrup (1994), all reported that the handle bars and the angle of the arms during

snowmobile driving influenced the occurrence of musculoskeletal pain in the neck and shoulders. Most participants experienced symptoms in the neck and shoulder despite the manufacture year of the snowmobile.

This shows that the changes to snowmobile design has not met the needs of the driver in order to see a decrease in the pain symptoms of the neck and shoulders. In the study evaluating the ergonomics of snowmobiles used by the National Park Service by Habes et al (2003) it was reported that “Several rangers indicated that it would be beneficial if the steering bar could be moved closer to the body and lowered, without having to move the seat back closer. This feature would allow the arms to be used more effectively in stabilizing the body position on the seat as the snowmobile is driven, particularly under bumpy road conditions.” The National Institute for Occupational Safety and Health (2001) reported that “the most important feature to adjust is the steering bar, which is moved closer to the body with grips oriented to provide for neutral wrist positions while in typical use, would reduce grip forces and improve shoulder and arm postures.” These studies reinforce the fact that there continues to be room for improvement in the ergonomics of the snowmobile.

### Track Length

Drivers of every track length reported pain in the neck and shoulders as the most prevalent followed by pain in the lower back. These findings show that track length may impact the occurrence of musculoskeletal

symptoms; however, as previously mentioned, the symptoms reported may be strongly related to ergonomics of the snowmobile, which is going to be related to the manufacturer's design. Pain in the neck and shoulders and lower back are the most commonly reported symptoms for snowmobile drivers according to the National Institute for Occupational Safety and Health (2001), Habes et al (2003), Nayha et al (1994), Rehn et al (2005a), Rehn et al (2005b), and Tostrup (1994), Astrom et al (2006), Daerga et al (2003), Rehn et al (2002), Rehn et al (2004). The reports of these two symptoms (neck and shoulders, and lower back) may account for the significant reports of multiple symptoms that occurred in the medium and long track length snowmobiles. Drivers of medium and long length track snowmobiles reported a greater occurrence of multiple symptoms while driving a snowmobile. This may be due to the track length, the driving behavior of participants on these snowmobiles, or various other reasons.

#### Riding Terrain

The most frequently reported pain locations reported by individuals who use an ungroomed trail compared to those who use a groomed trail are in the neck and shoulders and lower back, respectively. This difference in reported symptoms may be due to the deteriorated terrain of an ungroomed trail in which drivers would be subjected to significantly more jolts and bumps. Drivers who use both groomed and ungroomed trails reported pain in the neck and shoulders as being most prevalent.

As reported by the National Institute of Occupational Safety and Health (2001), “The jolts sustained by NPS personnel while riding snowmobiles for long hours under conditions of severely deteriorated roads are extremely higher, may be associated with the musculoskeletal symptoms reported by the works, and amplify the effects of the design shortcomings of the snowmobiles used in the park.” The National Park Service personnel in this study drove three models of snowmobiles manufactured by Polaris; the Trail 10, the Trail Touring, and the Widetrak LX. Driving on uneven terrain and deteriorated trails increase the risk of being subjected to jolts and bumps that the snowmobile may not be equipped to handle. As stated by Habes et al (2003), “The snowmobiles do not have the necessary features or adjustment in suspension components to significantly reduce the jolts and riders experience on the deteriorated trails.” As snowmobiling grows in popularity more groomed trails and trail systems are available however ungroomed trails continue to be used by snowmobile drivers. “Trail development and improvement should be evaluated as a snowmobile injury control strategy.” (Landen et al, 1999) By increasing the number of groomed trails available to snowmobile drivers, more drivers may use the provided trails instead of using ungroomed trails. This could potentially reduce some of the common musculoskeletal symptoms the occur during snowmobile driving.

## Length of Symptoms

Almost all drivers reporting pain in the neck and shoulders (92%), arms (91%), lower back (95%), and legs (87%) reported that their symptoms lasted between 1 and 3 days. Those reporting no soreness reported the length of their symptoms as other, meaning they did not get sore. The length of the reported symptoms lasting only 1-3 days could be related to the drivers' subjection to whole-body vibration. According to Rhea et al (2009), "Delayed-onset muscle soreness (DOMS) typically peaks within 24 to 48 hours after exercise and is resolved within 5-7 days. Enhanced local blood flow immediately after vibration training is one of the factors that would be expected to result in decreased DOMS." Snowmobile drivers are subjected to whole body vibration for the duration of the ride. Considering the majority of the snowmobile drivers reported symptoms only lasting 1-3 days, the subjection of vibration may be the reason for the soreness to diminish before the typical 5-7 days.

## Types of Ongoing Physical Ailments

Drivers who confirmed having ongoing physical ailments reported that other ailments were the most prevalent followed by ongoing low back pain, ongoing joint pain in the lower body, and loss of grip strength/ongoing joint pain in the upper body. Nayha et al (1994) reported that "close to half (46%) of the subjects reported pain, aching or tenderness upon movement they had felt in at least one joint during the



current year, the most common location for such symptoms being the back (30%), shoulder (22%), neck (21%), and knees (20%).”

## Conclusions

The results of the current study yield the following conclusions:

1. Ergonomics of the snowmobile, no matter what year the snowmobile was manufactured, seem to be associated with the occurrence of musculoskeletal pain symptoms. The potential to decrease the occurrence of musculoskeletal symptoms may be achieved by further developments in snowmobile design.
2. Drivers of snowmobiles with medium to long length track snowmobiles may have an increased risk of developing multiple musculoskeletal pain symptoms.
3. Riding terrain may be associated with the occurrence of musculoskeletal symptoms. Driving a snowmobile on an ungroomed surface may increase the risk of multiple musculoskeletal pain symptoms after driving.
4. Neck and Shoulder symptoms affect most snowmobile drivers. This may be due to the placement of the handle bars, and/or driving posture of the rider.
5. Musculoskeletal Symptoms that develop in snowmobile drivers last on average 1-3 days.

## Recommendations

Based on the finding of the current study, the following recommendations are offered:

1. Designing a similar study in which symptoms are reported immediately post snowmobile driving.
2. Construct groups to ride on each type of terrain only. (Groomed and Ungroomed) This would be beneficial in order to determine which of the two produced more symptoms, and having the opportunity to report exactly what conditions the subjects are driving on.
3. An interesting area would be to test each track length by directly measuring the jolts sustained while driving each length of snowmobile on the same terrain. This would help us to better understand if track length affects the number of jolts sustained by snowmobile drivers and how that affects the occurrence of musculoskeletal symptoms.

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APPENDIX I  
INFORMED CONSENT

## **Informed Consent**

Please Read and Sign the following before completing the Survey

You are invited to participate in a research study by completing a survey. The purpose of this study is to understand which factors are related to injuries during snowmobiling.

If you want to participate in the study, please provide answers to the questions in the survey.

In this survey, you will be asked about things like injuries you may have, how long you have been riding snowmobiles, and what type of snowmobile you use, for example.

If you have questions about the research, please contact the student investigator, Erica Heisler ([heislere@unlv.nevada.edu](mailto:heislere@unlv.nevada.edu)) or the principal investigator, Dr. John Young ([john.young@unlv.edu](mailto:john.young@unlv.edu)).

If you have questions about the rights of subjects, any complaints/concerns regarding the study, you may contact the UNLV Research Integrity – Human Subjects Division at (702)895-2794, toll free at (877)895-2794, or via email at [IRB@unlv.edu](mailto:IRB@unlv.edu).

If you mail the survey back, we will use your answers as part of the research.

Thank you for your consideration and time in completing the survey if you decide to.

Participant Signature \_\_\_\_\_

Date \_\_\_\_\_

APPENDIX II  
SURVEY

|      |        |                   |             |             |
|------|--------|-------------------|-------------|-------------|
| Male | Female | <u>Age Group:</u> | 18-25 _____ | 36-45 _____ |
|      |        |                   | 26-35 _____ | 46-55 _____ |
|      |        |                   | 56+ _____   |             |

1. What year is the snowmobile you typically ride?
  - a. Older than 1980
  - b. 1980-1985
  - c. 1985-1990
  - d. 1991-1995
  - e. 1996-2000
  - f. 2001-2005
  - g. 2006-2010
  
2. How long is the track length on the snowmobile you most often ride?
  - a. Short (120"-128")
  - b. Medium (130"-146")
  - c. Long (151" +)
  
3. What type of trail do you typically ride snowmobile on?
  - a. A groomed trail
  - b. An un-groomed trail
  - c. Equal riding on both
  - d. Other \_\_\_\_\_
  
4. While riding a snowmobile do you have any soreness or fatigue in the following areas? (check all that apply)
  - a. Shoulders
  - b. Hands
  - c. Arms
  - d. Knees
  - e. Hips
  - f. Low back
  - g. Feet
  - h. Neck
  - i. Other \_\_\_\_\_
  
5. How long does the soreness last?
  - a. 1-3 days
  - b. 3-5 days
  - c. 5-7 days
  - d. 7-10 days
  - e. Other \_\_\_\_\_
  
6. Do you have any ongoing physical ailments originating from snowmobile riding or a snowmobile injury accident last longer than 6 months?
  - a. Yes
  - b. No
  
7. What type of ongoing physical ailments do you have? (check all that apply)
  - a. Ongoing low back pain
  - b. Loss of grip strength \_
  - c. Ongoing joint pain in the lower body
  - d. Ongoing joint pain in the upper body
  - e. Other \_\_\_\_\_



APPENDIX III  
PARTICIPANT SURVEY DATA

| Participant | Please specify your gender |      | Select your appropriate age range. |       |       |       |            |
|-------------|----------------------------|------|------------------------------------|-------|-------|-------|------------|
|             | Female                     | Male | 18-25                              | 26-35 | 36-45 | 46-55 | 56 & older |
| 1           |                            | Male |                                    |       |       | 46-55 |            |
| 2           |                            | Male |                                    |       |       | 46-55 |            |
| 3           | Female                     |      |                                    |       |       | 46-55 |            |
| 4           | Female                     |      |                                    |       | 36-45 |       |            |
| 5           |                            | Male |                                    |       |       | 46-55 |            |
| 6           |                            | Male |                                    |       |       |       | 56 & older |
| 7           |                            | Male |                                    |       | 36-45 |       |            |
| 8           |                            | Male |                                    |       |       | 46-55 |            |
| 9           |                            | Male |                                    |       |       | 46-55 |            |
| 10          |                            | Male |                                    |       |       |       | 56 & older |
| 11          |                            | Male |                                    |       | 36-45 |       |            |
| 12          | Female                     |      |                                    |       |       | 46-55 |            |
| 13          |                            | Male |                                    |       |       | 46-55 |            |
| 14          |                            | Male |                                    |       | 36-45 |       |            |
| 15          |                            | Male |                                    |       | 36-45 |       |            |
| 16          |                            | Male |                                    |       |       | 46-55 |            |
| 17          | Female                     |      |                                    |       |       | 46-55 |            |
| 18          |                            | Male | 18-25                              |       |       |       |            |
| 19          |                            | Male |                                    |       | 36-45 |       |            |
| 20          |                            | Male |                                    | 26-35 |       |       |            |
| 21          |                            | Male |                                    |       |       | 46-55 |            |
| 22          |                            | Male | 18-25                              |       |       |       |            |
| 23          |                            | Male | 18-25                              |       |       |       |            |
| 24          |                            | Male |                                    |       |       | 46-55 |            |
| 25          |                            | Male |                                    |       |       | 46-55 |            |
| 26          | Female                     |      |                                    |       |       | 46-55 |            |
| 27          |                            | Male |                                    |       |       | 46-55 |            |
| 28          |                            | Male | 18-25                              |       |       |       |            |
| 29          |                            | Male |                                    |       |       | 46-55 |            |
| 30          |                            | Male |                                    |       | 36-45 |       |            |
| 31          |                            | Male |                                    |       | 36-45 |       |            |
| 32          |                            | Male |                                    |       | 36-45 |       |            |
| 33          |                            | Male |                                    |       |       |       | 56 & older |
| 34          | Female                     |      |                                    |       |       |       | 56 & older |
| 35          |                            | Male |                                    |       | 36-45 |       |            |
| 36          |                            | Male |                                    |       | 36-45 |       |            |
| 37          | Female                     |      |                                    |       |       | 46-55 |            |
| 38          | Female                     |      |                                    |       |       |       | 56 & older |
| 39          |                            | Male |                                    |       |       |       | 56 & older |

|    |        |      |  |       |       |       |            |
|----|--------|------|--|-------|-------|-------|------------|
| 40 |        | Male |  |       | 36-45 |       |            |
| 41 |        | Male |  |       | 26-35 |       |            |
| 42 |        | Male |  |       | 26-35 |       |            |
| 43 |        | Male |  |       | 26-35 |       |            |
| 44 |        | Male |  |       |       | 36-45 |            |
| 45 |        | Male |  |       |       |       | 46-55      |
| 46 |        | Male |  |       |       | 36-45 |            |
| 47 |        | Male |  | 18-25 |       |       |            |
| 48 | Female |      |  |       |       |       | 46-55      |
| 49 |        | Male |  |       |       |       | 46-55      |
| 50 |        | Male |  |       |       |       | 46-55      |
| 51 |        | Male |  |       | 26-35 |       |            |
| 52 |        | Male |  | 18-25 |       |       |            |
| 53 |        | Male |  |       |       | 36-45 |            |
| 54 | Female |      |  | 18-25 |       |       |            |
| 55 |        | Male |  |       |       |       | 46-55      |
| 56 |        | Male |  |       |       |       | 46-55      |
| 57 |        | Male |  |       |       |       | 46-55      |
| 58 |        | Male |  | 18-25 |       |       |            |
| 59 |        | Male |  |       |       |       | 56 & older |
| 60 |        | Male |  |       |       | 36-45 |            |
| 61 |        | Male |  |       |       | 36-45 |            |
| 62 |        | Male |  |       |       |       | 46-55      |
| 63 | Female |      |  |       | 26-35 |       |            |
| 64 |        | Male |  |       |       |       | 46-55      |
| 65 |        | Male |  |       |       | 36-45 |            |
| 66 |        | Male |  |       | 26-35 |       |            |
| 67 |        | Male |  |       | 26-35 |       |            |
| 68 |        | Male |  |       |       |       | 46-55      |
| 69 | Female |      |  |       |       | 36-45 |            |
| 70 |        | Male |  | 18-25 |       |       |            |
| 71 |        | Male |  |       |       | 36-45 |            |
| 72 |        | Male |  | 18-25 |       |       |            |
| 73 |        | Male |  |       |       | 36-45 |            |
| 74 |        | Male |  |       |       |       | 46-55      |
| 75 |        | Male |  |       |       | 36-45 |            |
| 76 |        | Male |  |       |       |       | 56 & older |
| 77 |        | Male |  |       |       |       | 56 & older |
| 78 |        | Male |  |       |       |       | 56 & older |
| 79 |        | Male |  | 18-25 |       |       |            |
| 80 |        | Male |  | 18-25 |       |       |            |
| 81 |        | Male |  |       |       | 36-45 |            |
| 82 |        | Male |  |       |       | 36-45 |            |

|     |        |      |       |       |       |       |            |
|-----|--------|------|-------|-------|-------|-------|------------|
| 83  |        | Male |       |       |       | 46-55 |            |
| 84  |        | Male |       | 26-35 |       |       |            |
| 85  |        | Male |       |       | 36-45 |       |            |
| 86  |        | Male |       |       |       | 46-55 |            |
| 87  |        | Male |       |       |       | 46-55 |            |
| 88  |        | Male |       |       | 36-45 |       |            |
| 89  |        | Male |       |       |       | 46-55 |            |
| 90  |        | Male |       |       | 36-45 |       |            |
| 91  |        | Male |       |       | 36-45 |       |            |
| 92  |        | Male |       |       |       |       | 56 & older |
| 93  |        | Male | 18-25 |       |       |       |            |
| 94  |        | Male |       | 26-35 |       |       |            |
| 95  |        | Male |       |       | 36-45 |       |            |
| 96  |        | Male |       |       |       | 46-55 |            |
| 97  |        | Male |       |       |       | 46-55 |            |
| 98  |        | Male |       |       |       |       | 56 & older |
| 99  | Female |      |       |       | 36-45 |       |            |
| 100 |        | Male |       |       | 36-45 |       |            |
| 101 | Female |      | 18-25 |       |       |       |            |
| 102 |        | Male |       |       | 36-45 |       |            |
| 103 | Female |      |       |       |       |       | 56 & older |
| 104 |        | Male |       |       |       | 46-55 |            |
| 105 |        | Male |       | 26-35 |       |       |            |
| 106 |        | Male |       |       |       | 46-55 |            |
| 107 |        | Male |       | 26-35 |       |       |            |
| 108 |        | Male |       | 26-35 |       |       |            |
| 109 |        | Male |       |       | 36-45 |       |            |
| 110 |        | Male |       |       | 36-45 |       |            |
| 111 | Female |      |       | 26-35 |       |       |            |
| 112 |        | Male | 18-25 |       |       |       |            |
| 113 |        | Male |       |       | 36-45 |       |            |
| 114 |        | Male |       | 26-35 |       |       |            |
| 115 |        | Male |       |       |       | 46-55 |            |
| 116 |        | Male |       |       | 36-45 |       |            |
| 117 |        | Male |       |       |       |       | 56 & older |
| 118 | Female |      | 18-25 |       |       |       |            |
| 119 |        | Male |       |       |       | 46-55 |            |
| 120 | Female |      |       |       |       | 46-55 |            |
| 121 | Female |      |       |       |       | 46-55 |            |
| 122 | Female |      |       |       |       |       | 56 & older |
| 123 | Female |      |       |       |       | 46-55 |            |

|     |        |      |       |       |  |       |            |
|-----|--------|------|-------|-------|--|-------|------------|
| 124 | Female |      |       |       |  | 46-55 |            |
| 125 | Female |      |       |       |  | 46-55 |            |
| 126 |        | Male |       |       |  | 46-55 |            |
| 127 |        | Male |       |       |  | 46-55 |            |
| 128 |        | Male |       |       |  | 36-45 |            |
| 129 | Female |      |       |       |  | 46-55 |            |
| 130 |        | Male |       |       |  | 36-45 |            |
| 131 |        | Male |       |       |  | 36-45 |            |
| 132 |        | Male |       |       |  | 36-45 |            |
| 133 |        | Male |       | 26-35 |  |       |            |
| 134 |        | Male |       |       |  | 46-55 |            |
| 135 |        | Male |       |       |  |       | 56 & older |
| 136 | Female |      |       |       |  |       | 56 & older |
| 137 |        | Male |       |       |  | 46-55 |            |
| 138 |        | Male |       |       |  | 46-55 |            |
| 139 | Female |      |       |       |  |       | 56 & older |
| 140 |        | Male |       |       |  |       | 56 & older |
| 141 |        | Male |       |       |  |       | 56 & older |
| 142 |        | Male |       |       |  |       | 56 & older |
| 143 | Female |      |       |       |  | 46-55 |            |
| 144 | Female |      |       |       |  | 46-55 |            |
| 145 |        | Male |       |       |  | 36-45 |            |
| 146 |        | Male | 18-25 |       |  |       |            |
| 147 |        | Male |       |       |  | 36-45 |            |
| 148 | Female |      |       | 26-35 |  |       |            |
| 149 |        | Male |       |       |  | 46-55 |            |
| 150 | Female |      |       | 26-35 |  |       |            |
| 151 |        | Male |       |       |  | 36-45 |            |
| 152 |        | Male |       | 26-35 |  |       |            |
| 153 | Female |      |       | 26-35 |  |       |            |
| 154 |        | Male |       | 26-35 |  |       |            |
| 155 | Female |      |       |       |  | 36-45 |            |
| 156 |        | Male |       |       |  |       | 56 & older |
| 157 |        | Male |       |       |  | 36-45 |            |
| 158 |        | Male |       |       |  |       | 56 & older |
| 159 |        | Male |       | 26-35 |  |       |            |
| 160 |        | Male |       |       |  | 46-55 |            |
| 161 |        | Male |       |       |  | 46-55 |            |
| 162 |        | Male |       | 26-35 |  |       |            |
| 163 | Female |      | 18-25 |       |  |       |            |

|     |        |      |       |       |       |       |            |
|-----|--------|------|-------|-------|-------|-------|------------|
| 164 | Female |      |       |       | 36-45 |       |            |
| 165 | Female |      |       |       | 36-45 |       |            |
| 166 |        | Male | 18-25 |       |       |       |            |
| 167 | Female |      |       | 26-35 |       |       |            |
| 168 |        | Male |       |       |       |       | 56 & older |
| 169 | Female |      |       |       |       | 46-55 |            |
| 170 | Female |      |       |       |       |       | 56 & older |
| 171 |        | Male |       |       |       |       | 56 & older |
| 172 |        | Male |       |       | 36-45 |       |            |
| 173 | Female |      |       |       |       |       | 56 & older |
| 174 |        | Male |       |       |       |       | 56 & older |
| 175 |        | Male |       |       |       | 46-55 |            |
| 176 |        | Male |       |       |       | 46-55 |            |
| 177 |        | Male |       |       | 36-45 |       |            |
| 178 |        | Male |       |       |       |       | 56 & older |
| 179 | Female |      |       | 26-35 |       |       |            |
| 180 |        | Male |       |       |       | 46-55 |            |
| 181 |        | Male |       |       | 36-45 |       |            |
| 182 |        | Male |       |       | 36-45 |       |            |
| 183 | Female |      |       |       | 36-45 |       |            |
| 184 |        | Male |       |       |       |       | 56 & older |
| 185 | Female |      |       | 26-35 |       |       |            |
| 186 |        | Male |       |       |       | 46-55 |            |
| 187 |        | Male |       | 26-35 |       |       |            |
| 188 | Female |      |       |       | 36-45 |       |            |
| 189 | Female |      |       |       | 36-45 |       |            |
| 190 |        | Male |       | 26-35 |       |       |            |
| 191 |        | Male |       |       | 36-45 |       |            |
| 192 | Female |      |       |       | 36-45 |       |            |
| 193 | Female |      |       |       | 36-45 |       |            |
| 194 |        | Male |       |       |       |       | 56 & older |
| 195 | Female |      |       | 26-35 |       |       |            |
| 196 |        | Male |       |       |       | 46-55 |            |
| 197 |        | Male |       |       |       | 46-55 |            |
| 198 |        | Male |       | 26-35 |       |       |            |
| 199 |        | Male |       |       |       | 46-55 |            |
| 200 |        | Male |       | 26-35 |       |       |            |
| 201 |        | Male |       |       |       |       | 56 & older |
| 202 | Female |      |       |       | 36-45 |       |            |
| 203 |        | Male |       |       |       |       | 56 & older |

|     |        |      |       |       |       |       |            |
|-----|--------|------|-------|-------|-------|-------|------------|
| 204 | Female |      |       |       | 36-45 |       |            |
| 205 |        | Male |       |       | 36-45 |       |            |
| 206 |        | Male |       |       |       | 46-55 |            |
| 207 |        | Male |       |       | 36-45 |       |            |
| 208 | Female |      |       |       |       | 46-55 |            |
| 209 |        | Male |       | 26-35 |       |       |            |
| 210 |        | Male |       | 26-35 |       |       |            |
| 211 |        | Male |       |       |       |       | 56 & older |
| 212 |        | Male |       | 26-35 |       |       |            |
| 213 |        | Male |       |       |       | 46-55 |            |
| 214 |        | Male |       |       |       |       | 56 & older |
| 215 |        | Male |       |       |       | 46-55 |            |
| 216 |        | Male |       |       | 36-45 |       |            |
| 217 |        | Male |       | 26-35 |       |       |            |
| 218 |        | Male |       |       | 36-45 |       |            |
| 219 |        | Male |       | 26-35 |       |       |            |
| 220 |        | Male |       |       |       |       | 56 & older |
| 221 |        | Male |       |       |       | 46-55 |            |
| 222 | Female |      |       |       | 36-45 |       |            |
| 223 | Female |      |       | 26-35 |       |       |            |
| 224 |        | Male |       |       |       | 46-55 |            |
| 225 |        | Male | 18-25 |       |       |       |            |
| 226 |        | Male |       |       |       | 46-55 |            |
| 227 |        | Male |       |       | 36-45 |       |            |
| 228 |        | Male |       |       |       | 46-55 |            |
| 229 |        | Male |       |       |       | 46-55 |            |
| 230 |        | Male |       |       |       | 46-55 |            |
| 231 |        | Male |       |       | 36-45 |       |            |
| 232 | Female |      |       |       |       | 46-55 |            |
| 233 | Female |      |       |       | 36-45 |       |            |
| 234 | Female |      |       |       |       | 46-55 |            |
| 235 | Female |      |       |       |       | 46-55 |            |
| 236 |        | Male |       |       |       | 46-55 |            |
| 237 |        | Male |       |       |       | 46-55 |            |
| 238 |        | Male |       |       | 36-45 |       |            |
| 239 |        | Male |       |       |       | 46-55 |            |
| 240 |        | Male |       |       | 36-45 |       |            |
| 241 |        | Male | 18-25 |       |       |       |            |
| 242 | Female |      |       |       | 36-45 |       |            |
| 243 |        | Male |       | 26-35 |       |       |            |

|                    | <b>Question #1</b>                                     |                  |                  |                  |
|--------------------|--|------------------|------------------|------------------|
|                    | <b>What year is the snowmobile you typically ride?</b> |                  |                  |                  |
| <b>Participant</b> | <b>1991-1995</b>                                       | <b>1996-2000</b> | <b>2001-2005</b> | <b>2006-2010</b> |
| 1                  | 1991-1995  |                  |                  |                  |
| 2                  |  |                  |                  | 2006-2010        |
| 3                  |  |                  | 2001-2005        |                  |
| 4                  |  | 1996-2000        |                  |                  |
| 5                  |  | 1996-2000        |                  |                  |
| 6                  |  | 1996-2000        |                  |                  |
| 7                  |  |                  | 2001-2005        |                  |
| 8                  |  |                  |                  | 2006-2010        |
| 9                  |  |                  |                  | 2006-2010        |
| 10                 |  |                  |                  | 2006-2010        |
| 11                 |  |                  |                  | 2006-2010        |
| 12                 |  |                  | 2001-2005        |                  |
| 13                 |  |                  |                  | 2006-2010        |
| 14                 |  | 1996-2000        |                  |                  |
| 15                 |  |                  |                  | 2006-2010        |
| 16                 |  |                  | 2001-2005        |                  |
| 17                 |  |                  |                  | 2006-2010        |
| 18                 |  |                  |                  | 2006-2010        |
| 19                 |  | 1996-2000        |                  |                  |
| 20                 |  |                  |                  | 2006-2010        |
| 21                 |  |                  |                  | 2006-2010        |
| 22                 |  |                  |                  | 2006-2010        |
| 23                 |  |                  | 2001-2005        |                  |
| 24                 |  |                  |                  | 2006-2010        |
| 25                 |  |                  |                  | 2006-2010        |
| 26                 |  |                  | 2001-2005        |                  |
| 27                 |  |                  | 2001-2005        |                  |
| 28                 |  |                  | 2001-2005        |                  |
| 29                 |  |                  |                  | 2006-2010        |
| 30                 |  |                  |                  | 2006-2010        |
| 31                 |  |                  | 2001-2005        |                  |
| 32                 |  |                  |                  | 2006-2010        |
| 33                 |  |                  |                  | 2006-2010        |
| 34                 |  | 1996-2000        |                  |                  |
| 35                 |  |                  | 2001-2005        |                  |
| 36                 |  |                  |                  | 2006-2010        |
| 37                 |  |                  | 2001-2005        |                  |



|    |           |           |           |           |
|----|-----------|-----------|-----------|-----------|
| 38 |           |           |           | 2006-2010 |
| 39 |           |           |           | 2006-2010 |
| 40 |           | 1996-2000 |           |           |
| 41 |           |           |           | 2006-2010 |
| 42 |           |           |           | 2006-2010 |
| 43 |           |           | 2001-2005 |           |
| 44 |           | 1996-2000 |           |           |
| 45 |           | 1996-2000 |           |           |
| 46 |           |           |           | 2006-2010 |
| 47 |           | 1996-2000 |           |           |
| 48 |           |           | 2001-2005 |           |
| 49 |           | 1996-2000 |           |           |
| 50 |           | 1996-2000 |           |           |
| 51 |           | 1996-2000 |           |           |
| 52 |           |           |           | 2006-2010 |
| 53 |           |           |           | 2006-2010 |
| 54 |           | 1996-2000 |           |           |
| 55 |           |           | 2001-2005 |           |
| 56 |           |           |           | 2006-2010 |
| 57 |           |           |           | 2006-2010 |
| 58 |           |           | 2001-2005 |           |
| 59 |           |           | 2001-2005 |           |
| 60 |           |           | 2001-2005 |           |
| 61 |           |           | 2001-2005 |           |
| 62 |           | 1996-2000 |           |           |
| 63 |           |           |           | 2006-2010 |
| 64 |           | 1996-2000 |           |           |
| 65 |           |           | 2001-2005 |           |
| 66 |           |           |           | 2006-2010 |
| 67 |           |           |           | 2006-2010 |
| 68 |           |           |           | 2006-2010 |
| 69 |           |           |           | 2006-2010 |
| 70 |           |           |           | 2006-2010 |
| 71 |           |           | 2001-2005 |           |
| 72 |           |           |           | 2006-2010 |
| 73 |           |           |           | 2006-2010 |
| 74 |           |           | 2001-2005 |           |
| 75 | 1991-1995 |           |           |           |
| 76 |           |           | 2001-2005 |           |
| 77 |           |           |           | 2006-2010 |
| 78 |           |           |           | 2006-2010 |
| 79 |           | 1996-2000 |           |           |
| 80 |           |           |           | 2006-2010 |

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|-----|-----------|-----------|-----------|-----------|
| 81  |           |           | 2001-2005 |           |
| 82  |           |           |           | 2006-2010 |
| 83  |           |           |           | 2006-2010 |
| 84  |           |           |           | 2006-2010 |
| 85  |           |           |           | 2006-2010 |
| 86  |           |           |           | 2006-2010 |
| 87  |           |           |           | 2006-2010 |
| 88  |           |           | 2001-2005 |           |
| 89  |           |           |           | 2006-2010 |
| 90  |           |           |           | 2006-2010 |
| 91  |           |           | 2001-2005 |           |
| 92  |           |           | 2001-2005 |           |
| 93  |           |           | 2001-2005 |           |
| 94  |           |           |           | 2006-2010 |
| 95  |           |           |           | 2006-2010 |
| 96  |           | 1996-2000 |           |           |
| 97  |           |           |           | 2006-2010 |
| 98  |           |           |           | 2006-2010 |
| 99  |           | 1996-2000 |           |           |
| 100 |           |           |           | 2006-2010 |
| 101 |           |           |           | 2006-2010 |
| 102 |           |           |           | 2006-2010 |
| 103 |           |           |           | 2006-2010 |
| 104 |           |           |           | 2006-2010 |
| 105 |           |           |           | 2006-2010 |
| 106 | 1991-1995 |           |           |           |
| 107 |           | 1996-2000 |           |           |
| 108 |           |           |           | 2006-2010 |
| 109 |           | 1996-2000 |           |           |
| 110 |           |           |           | 2006-2010 |
| 111 |           |           |           | 2006-2010 |
| 112 |           |           |           | 2006-2010 |
| 113 |           |           | 2001-2005 |           |
| 114 |           |           |           | 2006-2010 |
| 115 |           |           |           | 2006-2010 |
| 116 |           |           |           | 2006-2010 |
| 117 |           |           |           | 2006-2010 |
| 118 |           |           |           | 2006-2010 |
| 119 |           |           | 2001-2005 |           |
| 120 |           |           | 2001-2005 |           |

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|-----|-----------|-----------|-----------|-----------|
| 121 |           |           | 2001-2005 |           |
| 122 | 1991-1995 |           |           |           |
| 123 |           |           | 2001-2005 |           |
| 124 |           |           |           | 2006-2010 |
| 125 |           |           |           | 2006-2010 |
| 126 |           |           |           | 2006-2010 |
| 127 |           |           |           | 2006-2010 |
| 128 |           |           | 2001-2005 |           |
| 129 |           |           |           | 2006-2010 |
| 130 |           |           |           | 2006-2010 |
| 131 |           |           |           | 2006-2010 |
| 132 |           |           | 2001-2005 |           |
| 133 |           |           |           | 2006-2010 |
| 134 |           |           |           | 2006-2010 |
| 135 |           | 1996-2000 |           |           |
| 136 |           |           | 2001-2005 |           |
| 137 |           |           |           | 2006-2010 |
| 138 |           |           | 2001-2005 |           |
| 139 | 1991-1995 |           |           |           |
| 140 |           |           |           | 2006-2010 |
| 141 |           |           |           | 2006-2010 |
| 142 |           |           |           | 2006-2010 |
| 143 |           |           |           | 2006-2010 |
| 144 |           |           |           | 2006-2010 |
| 145 |           | 1996-2000 |           |           |
| 146 |           |           |           | 2006-2010 |
| 147 |           |           |           | 2006-2010 |
| 148 |           |           |           | 2006-2010 |
| 149 |           |           |           | 2006-2010 |
| 150 |           |           |           | 2006-2010 |
| 151 |           |           |           | 2006-2010 |
| 152 |           |           |           | 2006-2010 |
| 153 |           |           |           | 2006-2010 |
| 154 |           |           | 2001-2005 |           |
| 155 |           |           | 2001-2005 |           |
| 156 |           |           |           | 2006-2010 |
| 157 |           |           |           | 2006-2010 |
| 158 |           |           |           | 2006-2010 |
| 159 |           |           | 2001-2005 |           |
| 160 |           |           |           | 2006-2010 |

|     |           |           |           |           |
|-----|-----------|-----------|-----------|-----------|
| 161 |           |           |           | 2006-2010 |
| 162 |           |           |           | 2006-2010 |
| 163 |           |           |           | 2006-2010 |
| 164 |           |           | 2001-2005 |           |
| 165 |           |           |           | 2006-2010 |
| 166 |           |           | 2001-2005 |           |
| 167 |           |           |           | 2006-2010 |
| 168 |           |           | 2001-2005 |           |
| 169 |           |           |           | 2006-2010 |
| 170 |           |           | 2001-2005 |           |
| 171 |           |           |           | 2006-2010 |
| 172 |           |           | 2001-2005 |           |
| 173 |           |           | 2001-2005 |           |
| 174 |           | 1996-2000 |           |           |
| 175 |           |           |           | 2006-2010 |
| 176 |           |           | 2001-2005 |           |
| 177 | 1991-1995 |           |           |           |
| 178 |           |           |           | 2006-2010 |
| 179 |           | 1996-2000 |           |           |
| 180 |           |           |           | 2006-2010 |
| 181 |           |           | 2001-2005 |           |
| 182 |           |           |           | 2006-2010 |
| 183 |           |           |           | 2006-2010 |
| 184 |           | 1996-2000 |           |           |
| 185 |           |           |           | 2006-2010 |
| 186 |           |           | 2001-2005 |           |
| 187 |           | 1996-2000 |           |           |
| 188 |           |           | 2001-2005 |           |
| 189 |           | 1996-2000 |           |           |
| 190 |           |           |           | 2006-2010 |
| 191 |           |           | 2001-2005 |           |
| 192 |           |           | 2001-2005 |           |
| 193 |           |           |           | 2006-2010 |
| 194 |           |           | 2001-2005 |           |
| 195 |           |           |           | 2006-2010 |
| 196 |           |           |           | 2006-2010 |
| 197 |           |           | 2001-2005 |           |
| 198 |           |           |           | 2006-2010 |
| 199 |           |           |           | 2006-2010 |
| 200 |           |           |           | 2006-2010 |

|     |           |           |           |           |
|-----|-----------|-----------|-----------|-----------|
| 201 |           | 1996-2000 |           |           |
| 202 |           |           |           | 2006-2010 |
| 203 | 1991-1995 |           |           |           |
| 204 |           |           |           | 2006-2010 |
| 205 |           |           |           | 2006-2010 |
| 206 |           |           |           | 2006-2010 |
| 207 |           |           |           | 2006-2010 |
| 208 | 1991-1995 |           |           |           |
| 209 | 1991-1995 |           |           |           |
| 210 |           |           | 2001-2005 |           |
| 211 |           |           | 2001-2005 |           |
| 212 |           |           | 2001-2005 |           |
| 213 |           |           |           | 2006-2010 |
| 214 |           |           |           | 2006-2010 |
| 215 |           |           | 2001-2005 |           |
| 216 |           |           |           | 2006-2010 |
| 217 |           |           |           | 2006-2010 |
| 218 |           |           |           | 2006-2010 |
| 219 |           |           |           | 2006-2010 |
| 220 |           | 1996-2000 |           |           |
| 221 |           |           |           | 2006-2010 |
| 222 |           |           |           | 2006-2010 |
| 223 |           |           |           | 2006-2010 |
| 224 |           |           |           | 2006-2010 |
| 225 |           |           | 2001-2005 |           |
| 226 |           |           | 2001-2005 |           |
| 227 |           |           | 2001-2005 |           |
| 228 |           |           | 2001-2005 |           |
| 229 |           |           |           | 2006-2010 |
| 230 |           | 1996-2000 |           |           |
| 231 |           |           |           | 2006-2010 |
| 232 |           |           | 2001-2005 |           |
| 233 |           |           | 2001-2005 |           |
| 234 |           |           | 2001-2005 |           |
| 235 |           | 1996-2000 |           |           |
| 236 |           |           | 2001-2005 |           |
| 237 |           | 1996-2000 |           |           |
| 238 |           |           | 2001-2005 |           |
| 239 |           |           | 2001-2005 |           |
| 240 |           |           |           | 2006-2010 |

|     |  |           |  |           |
|-----|--|-----------|--|-----------|
| 241 |  |           |  | 2006-2010 |
| 242 |  | 1996-2000 |  |           |
| 243 |  |           |  | 2006-2010 |

|                    | <b>Question #2</b>   |               |             |
|--------------------|--|---------------|-------------|
|                    | <b>How long is the track length on the snowmobile you most often ride?</b> |               |             |
| <b>Participant</b> | <b>short</b>   | <b>medium</b> | <b>long</b> |
| 1                  | short  |               |             |
| 2                  |  |               | long        |
| 3                  |  | medium        |             |
| 4                  |  | medium        |             |
| 5                  |  | medium        |             |
| 6                  | short  |               |             |
| 7                  | short  |               |             |
| 8                  | short  |               |             |
| 9                  | short  |               |             |
| 10                 |  |               | long        |
| 11                 | short  |               |             |
| 12                 | short  |               |             |
| 13                 |  | medium        |             |
| 14                 | short  |               |             |
| 15                 |  | medium        |             |
| 16                 |  | medium        |             |
| 17                 |  | medium        |             |
| 18                 |  | medium        |             |
| 19                 | short  |               |             |
| 20                 |  |               | long        |
| 21                 |  |               | long        |
| 22                 |  |               | long        |
| 23                 |  |               | long        |
| 24                 |  |               | long        |
| 25                 |  |               | long        |
| 26                 | short  |               |             |
| 27                 | short  |               |             |
| 28                 | short  |               |             |
| 29                 |  |               | long        |
| 30                 |  |               | long        |
| 31                 | short  |               |             |
| 32                 | short  |               |             |

|    |       |        |      |
|----|-------|--------|------|
| 33 | short |        |      |
| 34 | short |        |      |
| 35 |       | medium |      |
| 36 |       |        | long |
| 37 | short |        |      |
| 38 | short |        |      |
| 39 | short |        |      |
| 40 | short |        |      |
| 41 |       | medium |      |
| 42 | short |        |      |
| 43 | short |        |      |
| 44 |       | medium |      |
| 45 | short |        |      |
| 46 | short |        |      |
| 47 | short |        |      |
| 48 | short |        |      |
| 49 | short |        |      |
| 50 | short |        |      |
| 51 | short |        |      |
| 52 |       |        | long |
| 53 |       |        | long |
| 54 |       | medium |      |
| 55 | short |        |      |
| 56 |       | medium |      |
| 57 |       | medium |      |
| 58 | short |        |      |
| 59 |       |        | long |
| 60 | short |        |      |
| 61 | short |        |      |
| 62 | short |        |      |
| 63 |       | medium |      |
| 64 | short |        |      |
| 65 |       |        | long |
| 66 |       |        | long |
| 67 |       | medium |      |
| 68 |       | medium |      |
| 69 | short |        |      |
| 70 | short |        |      |
| 71 |       | medium |      |
| 72 |       |        | long |

|     |       |        |      |
|-----|-------|--------|------|
| 73  |       |        | long |
| 74  | short |        |      |
| 75  | short |        |      |
| 76  | short |        |      |
| 77  |       |        | long |
| 78  |       | medium |      |
| 79  | short |        |      |
| 80  | short |        |      |
| 81  | short |        |      |
| 82  |       | medium |      |
| 83  |       | medium |      |
| 84  |       |        | long |
| 85  |       | medium |      |
| 86  | short |        |      |
| 87  |       |        | long |
| 88  |       | medium |      |
| 89  |       |        | long |
| 90  |       | medium |      |
| 91  | short |        |      |
| 92  |       |        | long |
| 93  |       |        | long |
| 94  |       |        | long |
| 95  | short |        |      |
| 96  | short |        |      |
| 97  |       | medium |      |
| 98  | short |        |      |
| 99  | short |        |      |
| 100 |       |        | long |
| 101 | short |        |      |
| 102 |       |        | long |
| 103 |       | medium |      |
| 104 | short |        |      |
| 105 | short |        |      |
| 106 | short |        |      |
| 107 | short |        |      |
| 108 |       |        | long |
| 109 | short |        |      |
| 110 | short |        |      |
| 111 | short |        |      |
| 112 | short |        |      |



|     |       |        |      |
|-----|-------|--------|------|
| 113 |       | medium |      |
| 114 |       | medium |      |
| 115 | short |        |      |
| 116 | short |        |      |
| 117 |       |        | long |
| 118 | short |        |      |
| 119 |       | medium |      |
| 120 | short |        |      |
| 121 |       |        | long |
| 122 |       | medium |      |
| 123 | short |        |      |
| 124 |       | medium |      |
| 125 | short |        |      |
| 126 |       |        | long |
| 127 |       | medium |      |
| 128 |       | medium |      |
| 129 | short |        |      |
| 130 |       |        | long |
| 131 |       |        | long |
| 132 |       | medium |      |
| 133 |       |        | long |
| 134 |       |        | long |
| 135 | short |        |      |
| 136 |       | medium |      |
| 137 | short |        |      |
| 138 |       |        | long |
| 139 | short |        |      |
| 140 | short |        |      |
| 141 |       |        | long |
| 142 |       | medium |      |
| 143 |       | medium |      |
| 144 |       | medium |      |
| 145 | short |        |      |
| 146 |       | medium |      |
| 147 |       | medium |      |
| 148 |       | medium |      |
| 149 |       |        | long |
| 150 | short |        |      |
| 151 |       |        | long |
| 152 | short |        |      |

|     |       |        |      |
|-----|-------|--------|------|
| 153 | short |        |      |
| 154 | short |        |      |
| 155 |       | medium |      |
| 156 | short |        |      |
| 157 | short |        |      |
| 158 |       | medium |      |
| 159 | short |        |      |
| 160 |       | medium |      |
| 161 | short |        |      |
| 162 |       | medium |      |
| 163 | short |        |      |
| 164 | short |        |      |
| 165 | short |        |      |
| 166 |       | medium |      |
| 167 |       | medium |      |
| 168 | short |        |      |
| 169 |       | medium |      |
| 170 |       | medium |      |
| 171 | short |        |      |
| 172 |       | medium |      |
| 173 | short |        |      |
| 174 | short |        |      |
| 175 |       |        | long |
| 176 | short |        |      |
| 177 | short |        |      |
| 178 |       | medium |      |
| 179 |       | medium |      |
| 180 | short |        |      |
| 181 |       | medium |      |
| 182 |       |        | long |
| 183 | short |        |      |
| 184 |       | medium |      |
| 185 |       |        | long |
| 186 | short |        |      |
| 187 | short |        |      |
| 188 | short |        |      |
| 189 | short |        |      |
| 190 |       | medium |      |
| 191 |       | medium |      |
| 192 | short |        |      |

|     |       |        |      |
|-----|-------|--------|------|
| 193 | short |        |      |
| 194 | short |        |      |
| 195 | short |        |      |
| 196 | short |        |      |
| 197 | short |        |      |
| 198 | short |        |      |
| 199 | short |        |      |
| 200 |       |        | long |
| 201 |       | medium |      |
| 202 |       | medium |      |
| 203 |       | medium |      |
| 204 |       | medium |      |
| 205 |       | medium |      |
| 206 | short |        |      |
| 207 |       |        | long |
| 208 | short |        |      |
| 209 |       | medium |      |
| 210 |       | medium |      |
| 211 | short |        |      |
| 212 |       | medium |      |
| 213 | short |        |      |
| 214 |       | medium |      |
| 215 | short |        |      |
| 216 | short |        |      |
| 217 |       |        | long |
| 218 | short |        |      |
| 219 |       |        | long |
| 220 | short |        |      |
| 221 |       |        | long |
| 222 |       | medium |      |
| 223 |       | medium |      |
| 224 |       |        | long |
| 225 | short |        |      |
| 226 |       |        | long |
| 227 | short |        |      |
| 228 |       | medium |      |
| 229 |       | medium |      |
| 230 | short |        |      |
| 231 | short |        |      |
| 232 | short |        |      |

|     |       |        |      |
|-----|-------|--------|------|
| 233 | short |        |      |
| 234 | short |        |      |
| 235 | short |        |      |
| 236 |       | medium |      |
| 237 | short |        |      |
| 238 |       |        | long |
| 239 | short |        |      |
| 240 | short |        |      |
| 241 |       |        | long |
| 242 |       | medium |      |
| 243 |       |        | long |

| <b>Question #3</b>   |                        |                            |                             |              |
|--|------------------------|----------------------------|-----------------------------|--------------|
| <b>What type of trail do you typically ride snowmobile on?</b> |                        |                            |                             |              |
| <b>Participant</b>   | <b>A groomed trail</b> | <b>An un-groomed trail</b> | <b>Equal riding on both</b> | <b>Other</b> |
| 1  |                        | An un-groomed trail        |                             |              |
| 2  |                        |                            | Equal riding on both        |              |
| 3  | A groomed trail        |                            |                             |              |
| 4  |                        |                            | Equal riding on both        |              |
| 5  | A groomed trail        |                            |                             |              |
| 6  |                        |                            | Equal riding on both        |              |
| 7  | A groomed trail        |                            |                             |              |
| 8  | A groomed trail        |                            |                             |              |
| 9  | A groomed trail        |                            |                             |              |
| 10   | A groomed trail        |                            |                             |              |
| 11   | A groomed trail        |                            |                             |              |
| 12   | A groomed trail        |                            |                             |              |
| 13   |                        |                            | Equal riding on both        |              |
| 14   |                        |                            | Equal riding on both        |              |
| 15   |                        |                            | Equal riding on both        |              |
| 16   |                        |                            | Equal riding on both        |              |
| 17   | A groomed trail        |                            |                             |              |
| 18   |                        | An un-groomed trail        |                             |              |
| 19   |                        |                            | Equal riding on both        |              |
| 20   |                        |                            | Equal riding on both        |              |
| 21   |                        |                            | Equal riding on both        |              |
| 22   |                        | An un-groomed trail        |                             |              |

|    |                 |                     |                      |       |
|----|-----------------|---------------------|----------------------|-------|
| 23 |                 | An un-groomed trail |                      |       |
| 24 |                 | An un-groomed trail |                      |       |
| 25 |                 |                     | Equal riding on both |       |
| 26 |                 | An un-groomed trail |                      |       |
| 27 |                 |                     | Equal riding on both |       |
| 28 |                 |                     | Equal riding on both |       |
| 29 |                 |                     | Equal riding on both |       |
| 30 |                 |                     | Equal riding on both |       |
| 31 | A groomed trail |                     |                      |       |
| 32 | A groomed trail |                     |                      |       |
| 33 | A groomed trail |                     |                      |       |
| 34 | A groomed trail |                     |                      |       |
| 35 | A groomed trail |                     |                      |       |
| 36 |                 | An un-groomed trail |                      |       |
| 37 | A groomed trail |                     |                      |       |
| 38 | A groomed trail |                     |                      |       |
| 39 | A groomed trail |                     |                      |       |
| 40 |                 |                     | Equal riding on both |       |
| 41 |                 |                     | Equal riding on both |       |
| 42 |                 |                     | Equal riding on both |       |
| 43 |                 |                     | Equal riding on both |       |
| 44 |                 |                     | Equal riding on both |       |
| 45 |                 |                     | Equal riding on both |       |
| 46 |                 |                     | Equal riding on both |       |
| 47 |                 |                     | Equal riding on both |       |
| 48 |                 |                     | Equal riding on both |       |
| 49 | A groomed trail |                     |                      |       |
| 50 |                 |                     | Equal riding on both |       |
| 51 |                 |                     | Equal riding on both |       |
| 52 |                 | An un-groomed trail |                      |       |
| 53 |                 | An un-groomed trail |                      |       |
| 54 |                 | An un-groomed trail |                      |       |
| 55 | A groomed trail |                     |                      |       |
| 56 |                 | An un-groomed trail |                      |       |
| 57 |                 |                     | Equal riding on both |       |
| 58 |                 |                     | Equal riding on both |       |
| 59 |                 | An un-groomed trail |                      |       |
| 60 |                 |                     | Equal riding on both |       |
| 61 | A groomed trail |                     |                      |       |
| 62 |                 |                     | Equal riding on both |       |
| 63 |                 |                     |                      | Other |

|     |                 |                     |                      |       |
|-----|-----------------|---------------------|----------------------|-------|
| 64  |                 |                     | Equal riding on both |       |
| 65  |                 | An un-groomed trail |                      |       |
| 66  |                 |                     |                      | Other |
| 67  |                 | An un-groomed trail |                      |       |
| 68  |                 | An un-groomed trail |                      |       |
| 69  |                 |                     | Equal riding on both |       |
| 70  |                 |                     | Equal riding on both |       |
| 71  |                 |                     |                      | Other |
| 72  |                 | An un-groomed trail |                      |       |
| 73  |                 | An un-groomed trail |                      |       |
| 74  | A groomed trail |                     |                      |       |
| 75  |                 | An un-groomed trail |                      |       |
| 76  |                 | An un-groomed trail |                      |       |
| 77  |                 |                     | Equal riding on both |       |
| 78  | A groomed trail |                     |                      |       |
| 79  |                 | An un-groomed trail |                      |       |
| 80  |                 | An un-groomed trail |                      |       |
| 81  | A groomed trail |                     |                      |       |
| 82  |                 |                     | Equal riding on both |       |
| 83  |                 |                     | Equal riding on both |       |
| 84  |                 |                     |                      | Other |
| 85  | A groomed trail |                     |                      |       |
| 86  | A groomed trail |                     |                      |       |
| 87  |                 |                     | Equal riding on both |       |
| 88  |                 | An un-groomed trail |                      |       |
| 89  |                 | An un-groomed trail |                      |       |
| 90  |                 |                     |                      | Other |
| 91  | A groomed trail |                     |                      |       |
| 92  |                 |                     |                      | Other |
| 93  |                 |                     | Equal riding on both |       |
| 94  | A groomed trail |                     |                      |       |
| 95  |                 |                     |                      | Other |
| 96  | A groomed trail |                     |                      |       |
| 97  |                 |                     | Equal riding on both |       |
| 98  |                 |                     | Equal riding on both |       |
| 99  | A groomed trail |                     |                      |       |
| 100 |                 | An un-groomed trail |                      |       |
| 101 |                 | An un-groomed trail |                      |       |
| 102 |                 | An un-groomed trail |                      |       |
| 103 |                 |                     | Equal riding on both |       |

|     |                 |                     |                      |       |
|-----|-----------------|---------------------|----------------------|-------|
| 104 |                 | An un-groomed trail |                      |       |
| 105 |                 | An un-groomed trail |                      |       |
| 106 |                 |                     | Equal riding on both |       |
| 107 |                 |                     | Equal riding on both |       |
| 108 | A groomed trail |                     |                      |       |
| 109 |                 | An un-groomed trail |                      |       |
| 110 |                 | An un-groomed trail |                      |       |
| 111 |                 |                     | Equal riding on both |       |
| 112 |                 |                     | Equal riding on both |       |
| 113 | A groomed trail |                     |                      |       |
| 114 |                 | An un-groomed trail |                      |       |
| 115 |                 |                     | Equal riding on both |       |
| 116 |                 |                     | Equal riding on both |       |
| 117 |                 |                     | Equal riding on both |       |
| 118 |                 | An un-groomed trail |                      |       |
| 119 |                 | An un-groomed trail |                      |       |
| 120 | A groomed trail |                     |                      |       |
| 121 |                 |                     | Equal riding on both |       |
| 122 | A groomed trail |                     |                      |       |
| 123 |                 |                     | Equal riding on both |       |
| 124 | A groomed trail |                     |                      |       |
| 125 | A groomed trail |                     |                      |       |
| 126 |                 |                     |                      | Other |
| 127 |                 |                     | Equal riding on both |       |
| 128 | A groomed trail |                     |                      |       |
| 129 | A groomed trail |                     |                      |       |
| 130 |                 |                     | Equal riding on both |       |
| 131 |                 | An un-groomed trail |                      |       |
| 132 |                 |                     |                      | Other |
| 133 |                 | An un-groomed trail |                      |       |
| 134 |                 | An un-groomed trail |                      |       |
| 135 |                 |                     | Equal riding on both |       |
| 136 | A groomed trail |                     |                      |       |
| 137 |                 |                     | Equal riding on both |       |
| 138 |                 |                     |                      | Other |
| 139 |                 |                     | Equal riding on both |       |
| 140 |                 |                     | Equal riding on both |       |
| 141 |                 | An un-groomed trail |                      |       |
| 142 |                 |                     | Equal riding on both |       |
| 143 |                 | An un-groomed trail |                      |       |

|     |                 |                     |                      |       |
|-----|-----------------|---------------------|----------------------|-------|
| 144 |                 |                     |                      | Other |
| 145 | A groomed trail |                     |                      |       |
| 146 | A groomed trail |                     |                      |       |
| 147 |                 | An un-groomed trail |                      |       |
| 148 |                 | An un-groomed trail |                      |       |
| 149 | A groomed trail |                     |                      |       |
| 150 | A groomed trail |                     |                      |       |
| 151 |                 | An un-groomed trail |                      |       |
| 152 |                 |                     |                      | Other |
| 153 | A groomed trail |                     |                      |       |
| 154 |                 |                     |                      | Other |
| 155 |                 | An un-groomed trail |                      |       |
| 156 | A groomed trail |                     |                      |       |
| 157 |                 |                     | Equal riding on both |       |
| 158 | A groomed trail |                     |                      |       |
| 159 |                 |                     | Equal riding on both |       |
| 160 |                 |                     | Equal riding on both |       |
| 161 | A groomed trail |                     |                      |       |
| 162 | A groomed trail |                     |                      |       |
| 163 | A groomed trail |                     |                      |       |
| 164 | A groomed trail |                     |                      |       |
| 165 |                 |                     | Equal riding on both |       |
| 166 |                 |                     |                      | Other |
| 167 |                 |                     | Equal riding on both |       |
| 168 | A groomed trail |                     |                      |       |
| 169 | A groomed trail |                     |                      |       |
| 170 |                 |                     | Equal riding on both |       |
| 171 |                 |                     | Equal riding on both |       |
| 172 |                 |                     | Equal riding on both |       |
| 173 | A groomed trail |                     |                      |       |
| 174 |                 |                     | Equal riding on both |       |
| 175 |                 | An un-groomed trail |                      |       |
| 176 | A groomed trail |                     |                      |       |
| 177 |                 |                     | Equal riding on both |       |
| 178 |                 |                     | Equal riding on both |       |
| 179 | A groomed trail |                     |                      |       |
| 180 |                 |                     | Equal riding on both |       |
| 181 |                 | An un-groomed trail |                      |       |
| 182 |                 | An un-groomed trail |                      |       |
| 183 |                 |                     | Equal riding on both |       |



|     |                 |                     |                      |       |
|-----|-----------------|---------------------|----------------------|-------|
| 184 |                 | An un-groomed trail |                      |       |
| 185 |                 |                     | Equal riding on both |       |
| 186 | A groomed trail |                     |                      |       |
| 187 |                 |                     | Equal riding on both |       |
| 188 |                 |                     | Equal riding on both |       |
| 189 | A groomed trail |                     |                      |       |
| 190 |                 | An un-groomed trail |                      |       |
| 191 |                 |                     | Equal riding on both |       |
| 192 | A groomed trail |                     |                      |       |
| 193 | A groomed trail |                     |                      |       |
| 194 | A groomed trail |                     |                      |       |
| 195 | A groomed trail |                     |                      |       |
| 196 |                 |                     | Equal riding on both |       |
| 197 | A groomed trail |                     |                      |       |
| 198 |                 |                     | Equal riding on both |       |
| 199 | A groomed trail |                     |                      |       |
| 200 |                 |                     | Equal riding on both |       |
| 201 | A groomed trail |                     |                      |       |
| 202 |                 |                     | Equal riding on both |       |
| 203 |                 |                     | Equal riding on both |       |
| 204 |                 |                     | Equal riding on both |       |
| 205 |                 |                     | Equal riding on both |       |
| 206 | A groomed trail |                     |                      |       |
| 207 | A groomed trail |                     |                      |       |
| 208 |                 |                     | Equal riding on both |       |
| 209 |                 | An un-groomed trail |                      |       |
| 210 |                 |                     | Equal riding on both |       |
| 211 | A groomed trail |                     |                      |       |
| 212 |                 |                     | Equal riding on both |       |
| 213 | A groomed trail |                     |                      |       |
| 214 | A groomed trail |                     |                      |       |
| 215 | A groomed trail |                     |                      |       |
| 216 |                 |                     | Equal riding on both |       |
| 217 |                 |                     |                      | Other |
| 218 | A groomed trail |                     |                      |       |
| 219 |                 |                     |                      | Other |
| 220 |                 |                     | Equal riding on both |       |
| 221 |                 | An un-groomed trail |                      |       |
| 222 | A groomed trail |                     |                      |       |
| 223 |                 |                     | Equal riding on both |       |

|     |                 |                     |                      |       |
|-----|-----------------|---------------------|----------------------|-------|
| 224 |                 |                     |                      | Other |
| 225 |                 | An un-groomed trail |                      |       |
| 226 |                 |                     |                      | Other |
| 227 | A groomed trail |                     |                      |       |
| 228 |                 | An un-groomed trail |                      |       |
| 229 |                 |                     | Equal riding on both |       |
| 230 |                 | An un-groomed trail |                      |       |
| 231 |                 |                     | Equal riding on both |       |
| 232 |                 |                     | Equal riding on both |       |
| 233 |                 | An un-groomed trail |                      |       |
| 234 |                 |                     | Equal riding on both |       |
| 235 | A groomed trail |                     |                      |       |
| 236 |                 |                     | Equal riding on both |       |
| 237 |                 |                     | Equal riding on both |       |
| 238 |                 |                     |                      | Other |
| 239 |                 | An un-groomed trail |                      |       |
| 240 |                 |                     | Equal riding on both |       |
| 241 |                 | An un-groomed trail |                      |       |
| 242 |                 | An un-groomed trail |                      |       |
| 243 |                 | An un-groomed trail |                      |       |

| Question #4  |                |      |            |      |                   |
|--|----------------|------|------------|------|-------------------|
| If you get sore from riding, where do you usually get sore? (check all that apply) |                |      |            |      |                   |
| Participant  | Neck/shoulders | Arms | Lower back | Legs | I do not get sore |
| 1  |                |      |            | Legs |                   |
| 2  |                | Arms |            | Legs |                   |
| 3  | Neck/shoulders | Arms |            |      |                   |
| 4  |                | Arms | Lower back |      |                   |
| 5  |                |      | Lower back |      |                   |
| 6  |                |      |            |      | I do not get sore |
| 7  |                |      |            |      | I do not get sore |
| 8  |                |      | Lower back |      |                   |
| 9  |                |      | Lower back |      |                   |
| 10   | Neck/shoulders |      | Lower back |      |                   |
| 11   | Neck/shoulders |      |            |      |                   |
| 12   | Neck/shoulders |      | Lower back |      |                   |
| 13   | Neck/shoulders |      | Lower back |      |                   |
| 14   | Neck/shoulders |      |            |      |                   |
| 15   | Neck/shoulders |      |            |      |                   |

|    |                |      |            |      |                   |
|----|----------------|------|------------|------|-------------------|
| 16 |                | Arms |            |      |                   |
| 17 | Neck/shoulders | Arms |            |      |                   |
| 18 |                |      | Lower back |      |                   |
| 19 |                |      |            | Legs |                   |
| 20 |                |      | Lower back |      |                   |
| 21 | Neck/shoulders | Arms |            |      |                   |
| 22 |                |      | Lower back |      |                   |
| 23 |                | Arms | Lower back |      |                   |
| 24 | Neck/shoulders |      |            |      |                   |
| 25 | Neck/shoulders |      | Lower back |      |                   |
| 26 |                |      |            |      | I do not get sore |
| 27 | Neck/shoulders |      | Lower back | Legs |                   |
| 28 |                |      |            |      | I do not get sore |
| 29 | Neck/shoulders | Arms |            |      |                   |
| 30 |                | Arms |            |      |                   |
| 31 |                |      |            | Legs |                   |
| 32 |                | Arms |            |      |                   |
| 33 |                |      |            |      | I do not get sore |
| 34 |                |      | Lower back |      |                   |
| 35 |                |      | Lower back |      |                   |
| 36 |                | Arms |            | Legs |                   |
| 37 | Neck/shoulders |      |            |      |                   |
| 38 |                |      |            |      | I do not get sore |
| 39 | Neck/shoulders |      |            |      |                   |
| 40 |                | Arms |            |      |                   |
| 41 | Neck/shoulders |      |            |      |                   |
| 42 |                |      |            |      | I do not get sore |
| 43 | Neck/shoulders |      |            |      |                   |
| 44 |                |      |            | Legs |                   |
| 45 | Neck/shoulders |      | Lower back |      |                   |
| 46 | Neck/shoulders |      |            |      |                   |
| 47 |                |      |            |      | I do not get sore |
| 48 | Neck/shoulders |      |            |      |                   |
| 49 |                |      | Lower back |      |                   |
| 50 | Neck/shoulders |      | Lower back |      |                   |
| 51 |                |      | Lower back |      |                   |
| 52 | Neck/shoulders |      | Lower back |      |                   |
| 53 | Neck/shoulders |      | Lower back |      |                   |
| 54 |                |      |            | Legs |                   |
| 55 | Neck/shoulders |      |            | Legs |                   |

|    |                |      |            |      |                   |
|----|----------------|------|------------|------|-------------------|
| 56 | Neck/shoulders |      |            |      |                   |
| 57 |                | Arms |            | Legs |                   |
| 58 | Neck/shoulders |      | Lower back |      |                   |
| 59 |                | Arms |            | Legs |                   |
| 60 |                |      | Lower back |      |                   |
| 61 |                |      |            | Legs |                   |
| 62 | Neck/shoulders | Arms | Lower back |      |                   |
| 63 |                | Arms | Lower back |      |                   |
| 64 |                | Arms |            |      |                   |
| 65 |                |      | Lower back |      |                   |
| 66 | Neck/shoulders |      |            | Legs |                   |
| 67 | Neck/shoulders |      | Lower back |      |                   |
| 68 | Neck/shoulders |      | Lower back |      |                   |
| 69 | Neck/shoulders |      |            |      |                   |
| 70 | Neck/shoulders |      | Lower back |      |                   |
| 71 | Neck/shoulders |      |            |      |                   |
| 72 | Neck/shoulders |      |            |      |                   |
| 73 | Neck/shoulders |      |            |      |                   |
| 74 |                |      | Lower back |      |                   |
| 75 |                | Arms | Lower back | Legs |                   |
| 76 |                |      | Lower back |      |                   |
| 77 |                |      |            |      | I do not get sore |
| 78 |                | Arms |            |      |                   |
| 79 |                |      | Lower back |      |                   |
| 80 |                |      | Lower back |      |                   |
| 81 | Neck/shoulders |      |            |      |                   |
| 82 | Neck/shoulders |      |            |      |                   |
| 83 |                | Arms |            | Legs |                   |
| 84 | Neck/shoulders | Arms | Lower back | Legs |                   |
| 85 |                |      | Lower back |      |                   |
| 86 |                |      | Lower back |      |                   |
| 87 | Neck/shoulders |      |            | Legs |                   |
| 88 | Neck/shoulders | Arms | Lower back | Legs |                   |
| 89 |                | Arms |            |      |                   |
| 90 |                |      |            | Legs |                   |
| 91 |                |      | Lower back |      |                   |
| 92 | Neck/shoulders |      |            | Legs |                   |
| 93 |                |      | Lower back |      |                   |
| 94 | Neck/shoulders |      | Lower back |      |                   |
| 95 | Neck/shoulders |      |            |      |                   |

|     |                |      |            |      |                   |
|-----|----------------|------|------------|------|-------------------|
| 96  |                |      | Lower back |      |                   |
| 97  | Neck/shoulders |      |            |      |                   |
| 98  |                |      |            |      | I do not get sore |
| 99  |                |      |            |      | I do not get sore |
| 100 |                |      |            |      | I do not get sore |
| 101 | Neck/shoulders |      | Lower back |      |                   |
| 102 |                | Arms |            |      |                   |
| 103 | Neck/shoulders | Arms |            |      |                   |
| 104 |                |      |            |      | I do not get sore |
| 105 | Neck/shoulders |      |            |      |                   |
| 106 | Neck/shoulders | Arms |            | Legs |                   |
| 107 |                | Arms |            |      |                   |
| 108 |                |      |            | Legs |                   |
| 109 |                | Arms | Lower back |      |                   |
| 110 | Neck/shoulders |      | Lower back |      |                   |
| 111 |                | Arms |            |      |                   |
| 112 | Neck/shoulders | Arms | Lower back | Legs |                   |
| 113 |                |      |            |      | I do not get sore |
| 114 | Neck/shoulders | Arms |            |      |                   |
| 115 | Neck/shoulders |      |            |      |                   |
| 116 |                | Arms |            |      |                   |
| 117 |                |      |            | Legs |                   |
| 118 | Neck/shoulders |      | Lower back |      |                   |
| 119 | Neck/shoulders |      |            | Legs |                   |
| 120 | Neck/shoulders |      |            |      |                   |
| 121 | Neck/shoulders |      |            |      |                   |
| 122 |                |      |            | Legs |                   |
| 123 |                | Arms |            | Legs |                   |
| 124 | Neck/shoulders | Arms | Lower back | Legs |                   |
| 125 |                |      |            |      | I do not get sore |
| 126 |                |      | Lower back | Legs |                   |
| 127 |                |      |            | Legs |                   |
| 128 | Neck/shoulders |      | Lower back |      |                   |
| 129 | Neck/shoulders |      |            |      |                   |
| 130 | Neck/shoulders |      |            |      |                   |
| 131 |                |      |            | Legs |                   |
| 132 | Neck/shoulders |      |            |      |                   |
| 133 |                |      |            |      | I do not get sore |
| 134 | Neck/shoulders |      |            |      |                   |
| 135 |                |      |            |      | I do not get sore |

|     |                |      |            |      |                   |
|-----|----------------|------|------------|------|-------------------|
| 136 | Neck/shoulders |      | Lower back |      |                   |
| 137 | Neck/shoulders |      |            |      |                   |
| 138 | Neck/shoulders |      | Lower back |      |                   |
| 139 | Neck/shoulders |      |            |      |                   |
| 140 | Neck/shoulders |      |            |      |                   |
| 141 |                | Arms |            |      |                   |
| 142 |                |      |            |      | I do not get sore |
| 143 |                | Arms |            |      |                   |
| 144 | Neck/shoulders |      |            |      |                   |
| 145 |                |      | Lower back |      |                   |
| 146 | Neck/shoulders |      |            |      |                   |
| 147 |                |      |            |      | I do not get sore |
| 148 |                |      | Lower back |      |                   |
| 149 |                | Arms |            | Legs |                   |
| 150 | Neck/shoulders | Arms |            |      |                   |
| 151 | Neck/shoulders |      |            |      |                   |
| 152 |                |      |            |      | I do not get sore |
| 153 | Neck/shoulders | Arms | Lower back |      |                   |
| 154 | Neck/shoulders |      | Lower back |      |                   |
| 155 |                |      | Lower back |      |                   |
| 156 | Neck/shoulders |      |            | Legs |                   |
| 157 |                | Arms |            |      |                   |
| 158 |                |      |            |      | I do not get sore |
| 159 | Neck/shoulders |      | Lower back |      |                   |
| 160 |                |      |            |      | I do not get sore |
| 161 |                |      |            |      | I do not get sore |
| 162 |                |      |            |      | I do not get sore |
| 163 | Neck/shoulders |      |            |      |                   |
| 164 |                | Arms |            |      |                   |
| 165 |                |      |            |      | I do not get sore |
| 166 | Neck/shoulders |      | Lower back | Legs |                   |
| 167 | Neck/shoulders | Arms | Lower back | Legs |                   |
| 168 |                |      |            |      | I do not get sore |
| 169 | Neck/shoulders |      |            |      |                   |
| 170 |                |      |            | Legs |                   |
| 171 |                |      | Lower back |      |                   |
| 172 | Neck/shoulders | Arms |            | Legs |                   |
| 173 | Neck/shoulders |      | Lower back |      |                   |
| 174 |                | Arms |            |      |                   |
| 175 |                |      |            |      | I do not get sore |

|     |                |      |            |      |                   |
|-----|----------------|------|------------|------|-------------------|
| 176 | Neck/shoulders |      |            |      |                   |
| 177 | Neck/shoulders |      |            |      |                   |
| 178 |                | Arms |            |      |                   |
| 179 | Neck/shoulders |      |            |      |                   |
| 180 |                |      |            |      | I do not get sore |
| 181 | Neck/shoulders |      |            | Legs |                   |
| 182 | Neck/shoulders |      | Lower back |      |                   |
| 183 |                | Arms |            |      |                   |
| 184 |                |      | Lower back |      |                   |
| 185 |                |      |            |      | I do not get sore |
| 186 |                |      | Lower back |      |                   |
| 187 |                | Arms | Lower back | Legs |                   |
| 188 |                |      |            | Legs |                   |
| 189 |                | Arms |            |      |                   |
| 190 |                | Arms |            | Legs |                   |
| 191 | Neck/shoulders | Arms |            |      |                   |
| 192 |                |      |            |      | I do not get sore |
| 193 |                |      |            |      | I do not get sore |
| 194 |                |      |            |      | I do not get sore |
| 195 | Neck/shoulders |      |            |      |                   |
| 196 |                |      |            |      | I do not get sore |
| 197 |                |      |            | Legs |                   |
| 198 |                |      | Lower back |      | I do not get sore |
| 199 |                |      |            |      | I do not get sore |
| 200 | Neck/shoulders |      | Lower back |      |                   |
| 201 | Neck/shoulders |      |            | Legs |                   |
| 202 | Neck/shoulders | Arms |            |      |                   |
| 203 | Neck/shoulders |      | Lower back |      |                   |
| 204 | Neck/shoulders |      |            |      |                   |
| 205 |                |      |            | Legs |                   |
| 206 |                |      |            |      | I do not get sore |
| 207 | Neck/shoulders | Arms |            |      |                   |
| 208 | Neck/shoulders |      |            |      |                   |
| 209 |                |      |            |      | I do not get sore |
| 210 |                | Arms | Lower back |      |                   |
| 211 |                |      |            |      | I do not get sore |
| 212 | Neck/shoulders |      |            |      |                   |
| 213 |                |      |            | Legs |                   |
| 214 | Neck/shoulders |      | Lower back |      |                   |
| 215 |                |      |            |      | I do not get sore |

|     |                |      |            |      |                   |
|-----|----------------|------|------------|------|-------------------|
| 216 |                |      |            | Legs |                   |
| 217 |                |      |            | Legs |                   |
| 218 | Neck/shoulders |      |            |      |                   |
| 219 |                |      | Lower back |      |                   |
| 220 | Neck/shoulders |      |            |      |                   |
| 221 |                |      |            | Legs |                   |
| 222 |                |      |            | Legs |                   |
| 223 | Neck/shoulders |      |            |      |                   |
| 224 | Neck/shoulders |      |            |      |                   |
| 225 |                |      | Lower back |      |                   |
| 226 | Neck/shoulders |      |            |      |                   |
| 227 | Neck/shoulders |      |            | Legs |                   |
| 228 | Neck/shoulders |      | Lower back |      |                   |
| 229 |                |      |            |      | I do not get sore |
| 230 |                |      | Lower back |      |                   |
| 231 |                |      | Lower back | Legs |                   |
| 232 |                | Arms |            | Legs |                   |
| 233 |                |      |            |      | I do not get sore |
| 234 | Neck/shoulders | Arms |            |      |                   |
| 235 | Neck/shoulders | Arms |            |      |                   |
| 236 | Neck/shoulders |      |            |      |                   |
| 237 | Neck/shoulders |      |            | Legs |                   |
| 238 |                | Arms | Lower back | Legs |                   |
| 239 | Neck/shoulders |      | Lower back |      |                   |
| 240 |                | Arms |            |      |                   |
| 241 | Neck/shoulders |      | Lower back |      |                   |
| 242 |                |      | Lower back |      |                   |
| 243 |                |      | Lower back |      |                   |

| Question #5                      |          |          |          |           |       |
|----------------------------------|----------|----------|----------|-----------|-------|
| How long does the soreness last? |          |          |          |           |       |
|                                  | 1-3 days | 3-5 days | 5-7 days | 7-10 days | Other |
| 1                                | 1-3 days |          |          |           |       |
| 2                                | 1-3 days |          |          |           |       |
| 3                                | 1-3 days |          |          |           |       |
| 4                                | 1-3 days |          |          |           |       |
| 5                                | 1-3 days |          |          |           |       |
| 6                                |          |          |          |           | Other |
| 7                                | 1-3 days |          |          |           |       |
| 8                                | 1-3 days |          |          |           |       |
| 9                                | 1-3 days |          |          |           |       |
| 10                               | 1-3 days |          |          |           |       |



|    |          |          |          |  |       |
|----|----------|----------|----------|--|-------|
| 11 | 1-3 days |          |          |  |       |
| 12 | 1-3 days |          |          |  |       |
| 13 | 1-3 days |          |          |  |       |
| 14 |          |          | 5-7 days |  |       |
| 15 | 1-3 days |          |          |  |       |
| 16 | 1-3 days |          |          |  |       |
| 17 | 1-3 days |          |          |  |       |
| 18 | 1-3 days |          |          |  |       |
| 19 |          | 3-5 days |          |  |       |
| 20 | 1-3 days |          |          |  |       |
| 21 |          | 3-5 days |          |  |       |
| 22 | 1-3 days |          |          |  |       |
| 23 | 1-3 days |          |          |  |       |
| 24 | 1-3 days |          |          |  |       |
| 25 | 1-3 days |          |          |  |       |
| 26 |          |          |          |  | Other |
| 27 | 1-3 days |          |          |  |       |
| 28 |          |          |          |  | Other |
| 29 | 1-3 days |          |          |  |       |
| 30 | 1-3 days |          |          |  |       |
| 31 | 1-3 days |          |          |  |       |
| 32 | 1-3 days |          |          |  |       |
| 33 |          |          |          |  | Other |
| 34 | 1-3 days |          |          |  |       |
| 35 | 1-3 days |          |          |  |       |
| 36 |          |          | 5-7 days |  |       |
| 37 | 1-3 days |          |          |  |       |
| 38 |          |          |          |  | Other |
| 39 | 1-3 days |          |          |  |       |
| 40 | 1-3 days |          |          |  |       |
| 41 | 1-3 days |          |          |  |       |
| 42 |          |          |          |  | Other |
| 43 | 1-3 days |          |          |  |       |
| 44 | 1-3 days |          |          |  |       |
| 45 | 1-3 days |          |          |  |       |
| 46 | 1-3 days |          |          |  |       |
| 47 |          |          |          |  | Other |
| 48 | 1-3 days |          |          |  |       |
| 49 | 1-3 days |          |          |  |       |
| 50 | 1-3 days |          |          |  |       |

|    |          |          |  |  |       |
|----|----------|----------|--|--|-------|
| 51 | 1-3 days |          |  |  |       |
| 52 | 1-3 days |          |  |  |       |
| 53 | 1-3 days |          |  |  |       |
| 54 | 1-3 days |          |  |  |       |
| 55 | 1-3 days |          |  |  |       |
| 56 | 1-3 days |          |  |  |       |
| 57 | 1-3 days |          |  |  |       |
| 58 | 1-3 days |          |  |  |       |
| 59 | 1-3 days |          |  |  |       |
| 60 | 1-3 days |          |  |  |       |
| 61 | 1-3 days |          |  |  |       |
| 62 | 1-3 days |          |  |  |       |
| 63 | 1-3 days |          |  |  |       |
| 64 | 1-3 days |          |  |  |       |
| 65 | 1-3 days |          |  |  |       |
| 66 | 1-3 days |          |  |  |       |
| 67 |          | 3-5 days |  |  |       |
| 68 | 1-3 days |          |  |  |       |
| 69 | 1-3 days |          |  |  |       |
| 70 | 1-3 days |          |  |  |       |
| 71 | 1-3 days |          |  |  |       |
| 72 | 1-3 days |          |  |  |       |
| 73 | 1-3 days |          |  |  |       |
| 74 |          |          |  |  | Other |
| 75 | 1-3 days |          |  |  |       |
| 76 | 1-3 days |          |  |  |       |
| 77 | 1-3 days |          |  |  |       |
| 78 | 1-3 days |          |  |  |       |
| 79 | 1-3 days |          |  |  |       |
| 80 | 1-3 days |          |  |  |       |
| 81 | 1-3 days |          |  |  |       |
| 82 | 1-3 days |          |  |  |       |
| 83 | 1-3 days |          |  |  |       |
| 84 | 1-3 days |          |  |  |       |
| 85 | 1-3 days |          |  |  |       |
| 86 | 1-3 days |          |  |  |       |
| 87 | 1-3 days |          |  |  |       |
| 88 | 1-3 days |          |  |  |       |
| 89 | 1-3 days |          |  |  |       |
| 90 | 1-3 days |          |  |  |       |

|     |          |          |  |  |       |
|-----|----------|----------|--|--|-------|
| 91  |          |          |  |  | Other |
| 92  | 1-3 days |          |  |  |       |
| 93  | 1-3 days |          |  |  |       |
| 94  | 1-3 days |          |  |  |       |
| 95  | 1-3 days |          |  |  |       |
| 96  | 1-3 days |          |  |  |       |
| 97  | 1-3 days |          |  |  |       |
| 98  |          |          |  |  | Other |
| 99  |          |          |  |  | Other |
| 100 |          |          |  |  | Other |
| 101 | 1-3 days |          |  |  |       |
| 102 | 1-3 days |          |  |  |       |
| 103 | 1-3 days |          |  |  |       |
| 104 |          |          |  |  | Other |
| 105 | 1-3 days |          |  |  |       |
| 106 | 1-3 days |          |  |  |       |
| 107 | 1-3 days |          |  |  |       |
| 108 |          |          |  |  | Other |
| 109 | 1-3 days |          |  |  |       |
| 110 | 1-3 days |          |  |  |       |
| 111 | 1-3 days |          |  |  |       |
| 112 | 1-3 days |          |  |  |       |
| 113 |          |          |  |  | Other |
| 114 | 1-3 days |          |  |  |       |
| 115 | 1-3 days |          |  |  |       |
| 116 | 1-3 days |          |  |  |       |
| 117 |          |          |  |  | Other |
| 118 | 1-3 days |          |  |  |       |
| 119 |          | 3-5 days |  |  |       |
| 120 | 1-3 days |          |  |  |       |
| 121 |          |          |  |  | Other |
| 122 | 1-3 days |          |  |  |       |
| 123 | 1-3 days |          |  |  |       |
| 124 |          | 3-5 days |  |  |       |
| 125 |          |          |  |  | Other |
| 126 | 1-3 days |          |  |  |       |
| 127 | 1-3 days |          |  |  |       |
| 128 | 1-3 days |          |  |  |       |
| 129 | 1-3 days |          |  |  |       |
| 130 | 1-3 days |          |  |  |       |

|     |          |  |          |  |       |
|-----|----------|--|----------|--|-------|
| 131 | 1-3 days |  |          |  |       |
| 132 | 1-3 days |  |          |  |       |
| 133 |          |  |          |  | Other |
| 134 | 1-3 days |  |          |  |       |
| 135 |          |  |          |  | Other |
| 136 | 1-3 days |  |          |  |       |
| 137 | 1-3 days |  |          |  |       |
| 138 | 1-3 days |  |          |  |       |
| 139 | 1-3 days |  |          |  |       |
| 140 | 1-3 days |  |          |  |       |
| 141 | 1-3 days |  |          |  |       |
| 142 |          |  |          |  | Other |
| 143 | 1-3 days |  |          |  |       |
| 144 | 1-3 days |  |          |  |       |
| 145 | 1-3 days |  |          |  |       |
| 146 | 1-3 days |  |          |  |       |
| 147 |          |  |          |  | Other |
| 148 | 1-3 days |  |          |  |       |
| 149 | 1-3 days |  |          |  |       |
| 150 | 1-3 days |  |          |  |       |
| 151 | 1-3 days |  |          |  |       |
| 152 | 1-3 days |  |          |  |       |
| 153 | 1-3 days |  |          |  |       |
| 154 | 1-3 days |  |          |  |       |
| 155 | 1-3 days |  |          |  |       |
| 156 | 1-3 days |  |          |  |       |
| 157 | 1-3 days |  |          |  |       |
| 158 |          |  |          |  | Other |
| 159 | 1-3 days |  |          |  |       |
| 160 |          |  |          |  | Other |
| 161 |          |  |          |  | Other |
| 162 |          |  |          |  | Other |
| 163 | 1-3 days |  |          |  |       |
| 164 | 1-3 days |  |          |  |       |
| 165 |          |  |          |  | Other |
| 166 | 1-3 days |  |          |  |       |
| 167 | 1-3 days |  |          |  |       |
| 168 | 1-3 days |  |          |  |       |
| 169 | 1-3 days |  |          |  |       |
| 170 |          |  | 5-7 days |  |       |

|     |          |          |  |  |       |
|-----|----------|----------|--|--|-------|
| 171 | 1-3 days |          |  |  |       |
| 172 | 1-3 days |          |  |  |       |
| 173 | 1-3 days |          |  |  |       |
| 174 | 1-3 days |          |  |  |       |
| 175 |          |          |  |  | Other |
| 176 | 1-3 days |          |  |  |       |
| 177 |          | 3-5 days |  |  |       |
| 178 | 1-3 days |          |  |  |       |
| 179 | 1-3 days |          |  |  |       |
| 180 |          |          |  |  | Other |
| 181 | 1-3 days |          |  |  |       |
| 182 | 1-3 days |          |  |  |       |
| 183 | 1-3 days |          |  |  |       |
| 184 | 1-3 days |          |  |  |       |
| 185 |          |          |  |  | Other |
| 186 | 1-3 days |          |  |  |       |
| 187 | 1-3 days |          |  |  |       |
| 188 | 1-3 days |          |  |  |       |
| 189 | 1-3 days |          |  |  |       |
| 190 | 1-3 days |          |  |  |       |
| 191 | 1-3 days |          |  |  |       |
| 192 |          |          |  |  | Other |
| 193 |          |          |  |  | Other |
| 194 | 1-3 days |          |  |  |       |
| 195 | 1-3 days |          |  |  |       |
| 196 | 1-3 days |          |  |  |       |
| 197 | 1-3 days |          |  |  |       |
| 198 | 1-3 days |          |  |  |       |
| 199 | 1-3 days |          |  |  |       |
| 200 | 1-3 days |          |  |  |       |
| 201 | 1-3 days |          |  |  |       |
| 202 | 1-3 days |          |  |  |       |
| 203 | 1-3 days |          |  |  |       |
| 204 | 1-3 days |          |  |  |       |
| 205 | 1-3 days |          |  |  |       |
| 206 |          |          |  |  | Other |
| 207 | 1-3 days |          |  |  |       |
| 208 | 1-3 days |          |  |  |       |
| 209 |          |          |  |  | Other |
| 210 | 1-3 days |          |  |  |       |

|     |          |          |  |  |       |
|-----|----------|----------|--|--|-------|
| 211 |          |          |  |  | Other |
| 212 | 1-3 days |          |  |  |       |
| 213 | 1-3 days |          |  |  |       |
| 214 | 1-3 days |          |  |  |       |
| 215 |          |          |  |  | Other |
| 216 | 1-3 days |          |  |  |       |
| 217 | 1-3 days |          |  |  |       |
| 218 | 1-3 days |          |  |  |       |
| 219 | 1-3 days |          |  |  |       |
| 220 | 1-3 days |          |  |  |       |
| 221 | 1-3 days |          |  |  |       |
| 222 | 1-3 days |          |  |  |       |
| 223 | 1-3 days |          |  |  |       |
| 224 |          |          |  |  | Other |
| 225 | 1-3 days |          |  |  |       |
| 226 | 1-3 days |          |  |  |       |
| 227 | 1-3 days |          |  |  |       |
| 228 | 1-3 days |          |  |  |       |
| 229 |          |          |  |  | Other |
| 230 | 1-3 days |          |  |  |       |
| 231 | 1-3 days |          |  |  |       |
| 232 | 1-3 days |          |  |  |       |
| 233 |          |          |  |  | Other |
| 234 |          | 3-5 days |  |  |       |
| 235 | 1-3 days |          |  |  |       |
| 236 | 1-3 days |          |  |  |       |
| 237 | 1-3 days |          |  |  |       |
| 238 | 1-3 days |          |  |  |       |
| 239 | 1-3 days |          |  |  |       |
| 240 |          |          |  |  | Other |
| 241 | 1-3 days |          |  |  |       |
| 242 | 1-3 days |          |  |  |       |
| 243 | 1-3 days |          |  |  |       |

|    |  | <b>Question #6</b>   |           |
|----|--|--|-----------|
|    |  | <b>Do you have any ongoing physical ailments originating from snowmobile riding or a snowmobile injury accident last longer than 6 months?</b> |           |
|    |  | <b>Yes</b>   | <b>No</b> |
| 1  |  |  | No        |
| 2  |  |  | No        |
| 3  |  |  | No        |
| 4  |  |  | No        |
| 5  |  |  | No        |
| 6  |  |  | No        |
| 7  |  |  | No        |
| 8  |  |  | No        |
| 9  |  | Yes  |           |
| 10 |  |  | No        |
| 11 |  |  | No        |
| 12 |  | Yes  |           |
| 13 |  |  | No        |
| 14 |  |  | No        |
| 15 |  |  | No        |
| 16 |  |  | No        |
| 17 |  |  | No        |
| 18 |  |  | No        |
| 19 |  |  | No        |
| 20 |  |  | No        |
| 21 |  |  | No        |
| 22 |  |  | No        |
| 23 |  |  | No        |
| 24 |  |  | No        |
| 25 |  |  | No        |
| 26 |  |  | No        |
| 27 |  |  | No        |
| 28 |  |  | No        |
| 29 |  |  | No        |
| 30 |  |  | No        |
| 31 |  | Yes  |           |
| 32 |  |  | No        |
| 33 |  |  | No        |
| 34 |  |  | No        |
| 35 |  |  | No        |
| 36 |  |  | No        |

|    |     |    |
|----|-----|----|
| 37 |     | No |
| 38 |     | No |
| 39 |     | No |
| 40 | Yes |    |
| 41 |     | No |
| 42 |     | No |
| 43 |     | No |
| 44 |     | No |
| 45 |     | No |
| 46 |     | No |
| 47 |     | No |
| 48 |     | No |
| 49 | Yes |    |
| 50 |     | No |
| 51 |     | No |
| 52 |     | No |
| 53 |     | No |
| 54 |     | No |
| 55 |     | No |
| 56 |     | No |
| 57 |     | No |
| 58 |     | No |
| 59 |     | No |
| 60 |     | No |
| 61 |     | No |
| 62 |     | No |
| 63 |     | No |
| 64 |     | No |
| 65 |     | No |
| 66 |     | No |
| 67 |     | No |
| 68 |     | No |
| 69 |     | No |
| 70 |     | No |
| 71 | Yes |    |
| 72 |     | No |
| 73 |     | No |
| 74 |     | No |
| 75 | Yes |    |
| 76 |     | No |



|     |     |    |
|-----|-----|----|
| 77  |     | No |
| 78  |     | No |
| 79  |     | No |
| 80  |     | No |
| 81  | Yes |    |
| 82  |     | No |
| 83  |     | No |
| 84  |     | No |
| 85  |     | No |
| 86  |     | No |
| 87  |     | No |
| 88  |     | No |
| 89  |     | No |
| 90  |     | No |
| 91  |     | No |
| 92  |     | No |
| 93  |     | No |
| 94  | Yes |    |
| 95  | Yes |    |
| 96  |     | No |
| 97  |     | No |
| 98  |     | No |
| 99  |     | No |
| 100 |     | No |
| 101 | Yes |    |
| 102 |     | No |
| 103 |     | No |
| 104 |     | No |
| 105 |     | No |
| 106 |     | No |
| 107 |     | No |
| 108 | Yes |    |
| 109 |     | No |
| 110 |     | No |
| 111 |     | No |
| 112 |     | No |
| 113 | Yes |    |
| 114 |     | No |
| 115 |     | No |
| 116 |     | No |

|     |     |    |
|-----|-----|----|
| 117 |     | No |
| 118 |     | No |
| 119 |     | No |
| 120 |     | No |
| 121 |     | No |
| 122 |     | No |
| 123 |     | No |
| 124 |     | No |
| 125 |     | No |
| 126 |     | No |
| 127 |     | No |
| 128 |     | No |
| 129 |     | No |
| 130 |     | No |
| 131 |     | No |
| 132 |     | No |
| 133 |     | No |
| 134 |     | No |
| 135 |     | No |
| 136 |     | No |
| 137 |     | No |
| 138 |     | No |
| 139 |     | No |
| 140 |     | No |
| 141 |     | No |
| 142 |     | No |
| 143 |     | No |
| 144 |     | No |
| 145 |     | No |
| 146 |     | No |
| 147 |     | No |
| 148 |     | No |
| 149 |     | No |
| 150 |     | No |
| 151 |     | No |
| 152 |     | No |
| 153 |     | No |
| 154 | Yes |    |
| 155 |     | No |
| 156 |     | No |

|     |     |    |
|-----|-----|----|
| 157 |     | No |
| 158 |     | No |
| 159 |     | No |
| 160 |     | No |
| 161 |     | No |
| 162 |     | No |
| 163 |     | No |
| 164 |     | No |
| 165 |     | No |
| 166 |     | No |
| 167 |     | No |
| 168 |     | No |
| 169 |     | No |
| 170 |     | No |
| 171 |     | No |
| 172 |     | No |
| 173 |     | No |
| 174 |     | No |
| 175 |     | No |
| 176 |     | No |
| 177 | Yes |    |
| 178 |     | No |
| 179 |     | No |
| 180 |     | No |
| 181 |     | No |
| 182 |     | No |
| 183 |     | No |
| 184 |     | No |
| 185 |     | No |
| 186 |     | No |
| 187 |     | No |
| 188 |     | No |
| 189 |     | No |
| 190 |     | No |
| 191 |     | No |
| 192 |     | No |
| 193 |     | No |
| 194 |     | No |
| 195 |     | No |
| 196 |     | No |

|     |     |    |
|-----|-----|----|
| 197 |     | No |
| 198 |     | No |
| 199 |     | No |
| 200 |     | No |
| 201 |     | No |
| 202 |     | No |
| 203 | Yes |    |
| 204 |     | No |
| 205 |     | No |
| 206 |     | No |
| 207 |     | No |
| 208 |     | No |
| 209 |     | No |
| 210 |     | No |
| 211 |     | No |
| 212 |     | No |
| 213 |     | No |
| 214 |     | No |
| 215 |     | No |
| 216 |     | No |
| 217 |     | No |
| 218 |     | No |
| 219 |     | No |
| 220 |     | No |
| 221 |     | No |
| 222 |     | No |
| 223 |     | No |
| 224 | Yes |    |
| 225 | Yes |    |
| 226 |     | No |
| 227 | Yes |    |
| 228 |     | No |
| 229 |     | No |
| 230 |     | No |
| 231 |     | No |
| 232 |     | No |
| 233 |     | No |
| 234 |     | No |
| 235 | Yes |    |
| 236 |     | No |

|     |     |    |
|-----|-----|----|
| 237 |     | No |
| 238 |     | No |
| 239 | Yes |    |
| 240 |     | No |
| 241 |     | No |
| 242 |     | No |
| 243 |     | No |

| <b>Question #7</b>  |                              |                              |   |   |              |
|---|------------------------------|------------------------------|---|---|--------------|
| <b>What type of ongoing physical ailments do you have? (check all that apply)</b> |                              |                              |   |   |              |
|   | <b>Ongoing low back pain</b> | <b>Loss of grip strength</b> | <b>Ongoing joint pain in the lower body</b> | <b>Ongoing joint pain in the upper body</b> | <b>Other</b> |
| 1   |                              |                              |   |   | Other        |
| 2   |                              |                              |   |   |              |
| 3   |                              |                              |   |   |              |
| 4   |                              |                              |   |   |              |
| 5   | Ongoing low back pain        |                              | Ongoing joint pain in the lower body        | Ongoing joint pain in the upper body        |              |
| 6   |                              |                              |   |   |              |
| 7   |                              |                              |   |   | Other        |
| 8   |                              |                              |   |   |              |
| 9   | Ongoing low back pain        |                              |   |   |              |
| 10  | Ongoing low back pain        | Loss of grip strength        | Ongoing joint pain in the lower body        | Ongoing joint pain in the upper body        |              |
| 11  | Ongoing low back pain        |                              |   |   |              |
| 12  |                              | Loss of grip strength        |   | Ongoing joint pain in the upper body        |              |
| 13  | Ongoing low back pain        |                              |   |   |              |
| 14  |                              | Loss of grip strength        |   |   |              |
| 15  |                              |                              |   |   |              |
| 16  |                              |                              |   |   |              |
| 17  |                              |                              |   |   |              |
| 18  |                              |                              |   |   |              |
| 19  |                              |                              |   |   |              |
| 20  |                              |                              |   |   |              |
| 21  |                              |                              |   |   |              |
| 22  |                              |                              | Ongoing joint pain in the lower body        |   |              |

|    |                       |                       |                                      |                                      |       |
|----|-----------------------|-----------------------|--------------------------------------|--------------------------------------|-------|
| 23 |                       |                       |                                      |                                      |       |
| 24 |                       |                       |                                      |                                      |       |
| 25 |                       |                       |                                      |                                      |       |
| 26 |                       |                       |                                      |                                      |       |
| 27 |                       |                       | Ongoing joint pain in the lower body |                                      |       |
| 28 |                       |                       |                                      |                                      |       |
| 29 |                       |                       |                                      |                                      |       |
| 30 |                       |                       |                                      |                                      | Other |
| 31 |                       |                       |                                      |                                      | Other |
| 32 |                       |                       |                                      |                                      |       |
| 33 |                       |                       |                                      |                                      |       |
| 34 |                       |                       |                                      |                                      |       |
| 35 | Ongoing low back pain |                       |                                      |                                      |       |
| 36 |                       |                       |                                      | Ongoing joint pain in the upper body |       |
| 37 |                       |                       |                                      |                                      |       |
| 38 |                       | Loss of grip strength |                                      |                                      |       |
| 39 |                       |                       |                                      |                                      |       |
| 40 |                       | Loss of grip strength |                                      |                                      |       |
| 41 |                       |                       |                                      |                                      |       |
| 42 |                       |                       |                                      |                                      |       |
| 43 |                       |                       |                                      |                                      |       |
| 44 |                       |                       |                                      |                                      |       |
| 45 | Ongoing low back pain |                       |                                      |                                      |       |
| 46 |                       |                       |                                      |                                      |       |
| 47 |                       |                       |                                      |                                      |       |
| 48 |                       |                       |                                      |                                      |       |
| 49 |                       |                       | Ongoing joint pain in the lower body |                                      |       |
| 50 |                       |                       |                                      |                                      |       |
| 51 |                       |                       |                                      |                                      |       |
| 52 |                       |                       |                                      |                                      |       |
| 53 |                       |                       |                                      |                                      |       |
| 54 |                       |                       |                                      |                                      |       |
| 55 |                       |                       |                                      |                                      |       |
| 56 |                       |                       |                                      |                                      |       |
| 57 |                       |                       | Ongoing joint pain in the lower body |                                      |       |
| 58 |                       |                       |                                      |                                      | Other |
| 59 | Ongoing low back pain |                       | Ongoing joint pain in the lower body |                                      |       |
| 60 |                       |                       |                                      |                                      | Other |

|    |                       |                       |                                      |  |       |
|----|-----------------------|-----------------------|--------------------------------------|--|-------|
| 61 |                       |                       |                                      |  |       |
| 62 | Ongoing low back pain | Loss of grip strength | Ongoing joint pain in the lower body |  |       |
| 63 |                       |                       |                                      |  |       |
| 64 |                       |                       |                                      |  |       |
| 65 | Ongoing low back pain |                       |                                      |  |       |
| 66 |                       |                       |                                      |  |       |
| 67 |                       |                       |                                      |  | Other |
| 68 |                       |                       |                                      |  |       |
| 69 | Ongoing low back pain |                       |                                      |  |       |
| 70 |                       |                       |                                      |  |       |
| 71 |                       |                       |                                      |  | Other |
| 72 |                       |                       |                                      |  |       |
| 73 |                       |                       |                                      |  |       |
| 74 |                       |                       |                                      |  |       |
| 75 |                       |                       |                                      |  | Other |
| 76 |                       |                       |                                      |  |       |
| 77 | Ongoing low back pain |                       |                                      |  |       |
| 78 |                       |                       |                                      |  |       |
| 79 | Ongoing low back pain |                       |                                      |  |       |
| 80 |                       |                       |                                      |  |       |
| 81 | Ongoing low back pain |                       |                                      |  |       |
| 82 |                       |                       |                                      |  |       |
| 83 |                       |                       |                                      |  |       |
| 84 |                       |                       |                                      |  |       |
| 85 |                       |                       |                                      |  |       |
| 86 | Ongoing low back pain |                       |                                      |  |       |
| 87 |                       |                       |                                      |  |       |
| 88 |                       |                       | Ongoing joint pain in the lower body |  |       |
| 89 |                       |                       |                                      |  |       |
| 90 |                       |                       |                                      |  |       |
| 91 |                       |                       |                                      |  |       |
| 92 |                       |                       |                                      |  |       |
| 93 |                       |                       |                                      |  |       |
| 94 | Ongoing low back pain |                       | Ongoing joint pain in the lower body |  |       |
| 95 | Ongoing low back pain |                       |                                      |  |       |

|     |                       |                       |                                      |                                      |       |
|-----|-----------------------|-----------------------|--------------------------------------|--------------------------------------|-------|
| 96  |                       |                       |                                      |                                      | Other |
| 97  |                       |                       |                                      | Ongoing joint pain in the upper body |       |
| 98  |                       |                       |                                      |                                      |       |
| 99  |                       |                       |                                      |                                      |       |
| 100 |                       |                       |                                      |                                      |       |
| 101 | Ongoing low back pain |                       |                                      |                                      |       |
| 102 |                       |                       |                                      |                                      |       |
| 103 |                       | Loss of grip strength |                                      |                                      |       |
| 104 |                       |                       |                                      |                                      |       |
| 105 |                       |                       |                                      |                                      |       |
| 106 |                       |                       |                                      |                                      | Other |
| 107 |                       |                       |                                      |                                      | Other |
| 108 |                       |                       |                                      |                                      | Other |
| 109 |                       |                       |                                      |                                      | Other |
| 110 |                       |                       |                                      |                                      |       |
| 111 |                       |                       |                                      |                                      |       |
| 112 |                       |                       |                                      |                                      |       |
| 113 | Ongoing low back pain |                       |                                      |                                      |       |
| 114 | Ongoing low back pain |                       |                                      |                                      |       |
| 115 |                       |                       |                                      |                                      |       |
| 116 |                       |                       |                                      |                                      |       |
| 117 |                       |                       |                                      |                                      |       |
| 118 |                       |                       |                                      |                                      |       |
| 119 |                       |                       |                                      |                                      |       |
| 120 |                       |                       |                                      |                                      |       |
| 121 | Ongoing low back pain |                       |                                      |                                      |       |
| 122 |                       | Loss of grip strength |                                      |                                      |       |
| 123 |                       |                       |                                      |                                      |       |
| 124 | Ongoing low back pain | Loss of grip strength | Ongoing joint pain in the lower body | Ongoing joint pain in the upper body |       |
| 125 |                       |                       |                                      |                                      |       |
| 126 |                       |                       |                                      |                                      |       |
| 127 |                       |                       |                                      |                                      |       |
| 128 | Ongoing low back pain |                       |                                      |                                      |       |
| 129 |                       |                       |                                      |                                      |       |
| 130 |                       |                       |                                      |                                      |       |
| 131 |                       |                       |                                      |                                      |       |
| 132 |                       |                       |                                      |                                      |       |
| 133 |                       |                       |                                      |                                      |       |



|     |                       |  |                                      |                                      |       |
|-----|-----------------------|--|--------------------------------------|--------------------------------------|-------|
| 134 |                       |  |                                      |                                      | Other |
| 135 |                       |  |                                      |                                      | Other |
| 136 |                       |  |                                      |                                      |       |
| 137 |                       |  |                                      |                                      |       |
| 138 |                       |  |                                      |                                      |       |
| 139 |                       |  |                                      |                                      | Other |
| 140 |                       |  | Ongoing joint pain in the lower body | Ongoing joint pain in the upper body |       |
| 141 |                       |  |                                      |                                      |       |
| 142 |                       |  |                                      |                                      |       |
| 143 |                       |  |                                      |                                      |       |
| 144 |                       |  |                                      |                                      |       |
| 145 |                       |  |                                      |                                      |       |
| 146 | Ongoing low back pain |  |                                      |                                      |       |
| 147 |                       |  |                                      |                                      |       |
| 148 | Ongoing low back pain |  |                                      |                                      |       |
| 149 |                       |  |                                      |                                      |       |
| 150 |                       |  |                                      |                                      |       |
| 151 |                       |  |                                      |                                      | Other |
| 152 |                       |  |                                      |                                      |       |
| 153 |                       |  |                                      |                                      |       |
| 154 | Ongoing low back pain |  |                                      |                                      |       |
| 155 |                       |  | Ongoing joint pain in the lower body |                                      |       |
| 156 |                       |  |                                      |                                      |       |
| 157 |                       |  |                                      |                                      |       |
| 158 |                       |  |                                      |                                      |       |
| 159 | Ongoing low back pain |  |                                      |                                      |       |
| 160 |                       |  |                                      |                                      |       |
| 161 | Ongoing low back pain |  |                                      |                                      |       |
| 162 |                       |  |                                      |                                      |       |
| 163 |                       |  |                                      |                                      |       |
| 164 |                       |  |                                      |                                      |       |
| 165 |                       |  |                                      |                                      |       |
| 166 |                       |  |                                      |                                      |       |
| 167 |                       |  |                                      |                                      |       |
| 168 |                       |  |                                      |                                      |       |
| 169 |                       |  |                                      |                                      |       |
| 170 |                       |  |                                      |                                      | Other |
| 171 |                       |  |                                      |                                      |       |

|     |                       |                       |                                      |                                      |       |
|-----|-----------------------|-----------------------|--------------------------------------|--------------------------------------|-------|
| 172 | Ongoing low back pain |                       | Ongoing joint pain in the lower body |                                      |       |
| 173 |                       | Loss of grip strength |                                      |                                      |       |
| 174 |                       |                       |                                      |                                      |       |
| 175 |                       |                       |                                      |                                      |       |
| 176 |                       |                       |                                      |                                      |       |
| 177 |                       |                       |                                      |                                      | Other |
| 178 |                       |                       |                                      |                                      |       |
| 179 |                       |                       |                                      |                                      |       |
| 180 |                       |                       |                                      |                                      | Other |
| 181 |                       |                       |                                      |                                      |       |
| 182 |                       |                       |                                      |                                      |       |
| 183 |                       |                       |                                      |                                      |       |
| 184 |                       |                       |                                      |                                      |       |
| 185 |                       |                       |                                      |                                      |       |
| 186 |                       |                       |                                      |                                      |       |
| 187 |                       |                       |                                      |                                      |       |
| 188 |                       |                       |                                      |                                      |       |
| 189 |                       |                       |                                      |                                      |       |
| 190 |                       |                       |                                      |                                      |       |
| 191 |                       |                       |                                      |                                      |       |
| 192 |                       |                       |                                      |                                      | Other |
| 193 |                       |                       |                                      |                                      |       |
| 194 |                       |                       | Ongoing joint pain in the lower body |                                      |       |
| 195 |                       |                       |                                      |                                      |       |
| 196 |                       |                       |                                      |                                      | Other |
| 197 |                       |                       |                                      |                                      |       |
| 198 |                       |                       |                                      |                                      |       |
| 199 |                       |                       |                                      |                                      |       |
| 200 |                       |                       |                                      |                                      |       |
| 201 |                       |                       |                                      |                                      |       |
| 202 |                       |                       |                                      |                                      |       |
| 203 |                       |                       | Ongoing joint pain in the lower body |                                      | Other |
| 204 |                       |                       |                                      |                                      |       |
| 205 |                       |                       | Ongoing joint pain in the lower body |                                      |       |
| 206 |                       |                       |                                      |                                      |       |
| 207 |                       |                       |                                      |                                      |       |
| 208 |                       |                       |                                      |                                      |       |
| 209 |                       |                       |                                      |                                      |       |
| 210 |                       |                       |                                      | Ongoing joint pain in the upper body |       |

|     |                       |                       |                                      |                                      |       |
|-----|-----------------------|-----------------------|--------------------------------------|--------------------------------------|-------|
| 211 |                       |                       |                                      |                                      |       |
| 212 |                       |                       |                                      |                                      |       |
| 213 |                       |                       |                                      |                                      |       |
| 214 |                       |                       | Ongoing joint pain in the lower body |                                      |       |
| 215 |                       | Loss of grip strength |                                      |                                      |       |
| 216 |                       |                       |                                      |                                      |       |
| 217 |                       |                       |                                      |                                      |       |
| 218 |                       |                       |                                      |                                      |       |
| 219 |                       |                       |                                      |                                      |       |
| 220 |                       | Loss of grip strength |                                      |                                      |       |
| 221 | Ongoing low back pain |                       |                                      |                                      |       |
| 222 |                       |                       |                                      |                                      |       |
| 223 |                       |                       |                                      |                                      |       |
| 224 |                       |                       |                                      |                                      | Other |
| 225 |                       |                       |                                      | Ongoing joint pain in the upper body | Other |
| 226 |                       |                       |                                      |                                      |       |
| 227 |                       |                       | Ongoing joint pain in the lower body |                                      |       |
| 228 |                       |                       |                                      |                                      |       |
| 229 |                       |                       |                                      |                                      |       |
| 230 | Ongoing low back pain |                       |                                      |                                      |       |
| 231 |                       |                       |                                      |                                      |       |
| 232 |                       |                       |                                      |                                      |       |
| 233 |                       |                       |                                      |                                      |       |
| 234 |                       |                       |                                      | Ongoing joint pain in the upper body |       |
| 235 |                       |                       | Ongoing joint pain in the lower body |                                      |       |
| 236 |                       |                       |                                      | Ongoing joint pain in the upper body |       |
| 237 |                       |                       | Ongoing joint pain in the lower body |                                      |       |
| 238 |                       |                       |                                      |                                      |       |
| 239 |                       |                       |                                      |                                      | Other |
| 240 |                       |                       |                                      |                                      |       |
| 241 |                       |                       |                                      |                                      |       |
| 242 |                       |                       |                                      |                                      |       |
| 243 |                       |                       |                                      |                                      | Other |

VITA

Graduate College  
University of Nevada, Las Vegas

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Degrees:

Bachelor of Science, Exercise Science, 2007  
Cum Laude  
University of North Dakota, Grand Forks

Thesis Title: The Relationship of Snowmobile Year, Track Length,  
and Riding Terrain to the Occurrence of Musculoskeletal Symptoms in  
Recreational Snowmobile Drivers.

Thesis Examination Committee:

Chairperson, Dr. Jack Young, Ph.D.  
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Committee Member, Dr. Lawrence Golding, Ph.D.  
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