

Reducing the Risk of Injuries in Tree-Planters

Ariel-Ann Lyons
Human Kinetics Undergraduate Thesis
University of British Columbia

Note: The following text is not in its full version. The complete study is being submitted to the Journal of Occupational and Environmental Medicine.

Summary

The aim of this report was to investigate the rates of injuries and ways to reduce the risk of injuries in tree-planters. Seventy-two tree-planters responded to this survey. Greater than 76% of respondents reported an injury with more than 35% of these injuries occurring in the fingers and wrists. Working habits such as: shovel grip, shovel type, work-rest ratios and impact of the injuries were discussed. A strong, positive correlation was found between the incidence of injury and the increase in the number of consecutive work days. Eighty-eight percent of planters that reported injuries while tree-planting also reported re-injury when tree-planting was complete. Over 49% of persons injured stated that their injury still affects them in daily life and greater than 29% of participants reported a change in their physical activity habits as a result of the effects of treeplanting.

The first two weeks of the season had the highest rate of injury with over 46% of injuries occurring in this time period. This can be attributed to the high physical demands of the work and improper conditioning of the individuals. The last two weeks of the season claimed over 38% of the injuries. Muscle mass loss and a condition known as 'Burn Out' are potential reasons for a high rate of injury at the end of the season.

The findings discussed in this report provides strong evidence that tree-planting is an extremely physically demanding task that has a high incidence of injury. In order to reduce the risk of injury several recommendations have been made including: changes in tool design, equipment, proper conditioning and adequate work-rest ratios.

Introduction

On average, tree planters in B.C. report 120-200 work related injuries each season (WCB 1996); one in five tree-planters is injured every year. These injuries cost the Workers Compensation Board almost two million dollars last year (Roberts, CBC 2001). Repetitive motion injuries (RMI's) or cumulative trauma disorders (CTD's), accounted for 64 % of all lost-time claims, 54 % of all claims costs and 61 % of all days lost between 1994-1998 (WCB 1998).

The interaction of many factors plays an important role in understanding ways of reducing the risk of CTD's in tree-planters. Figure 1 outlines the social factors within the job that contribute to an injury.

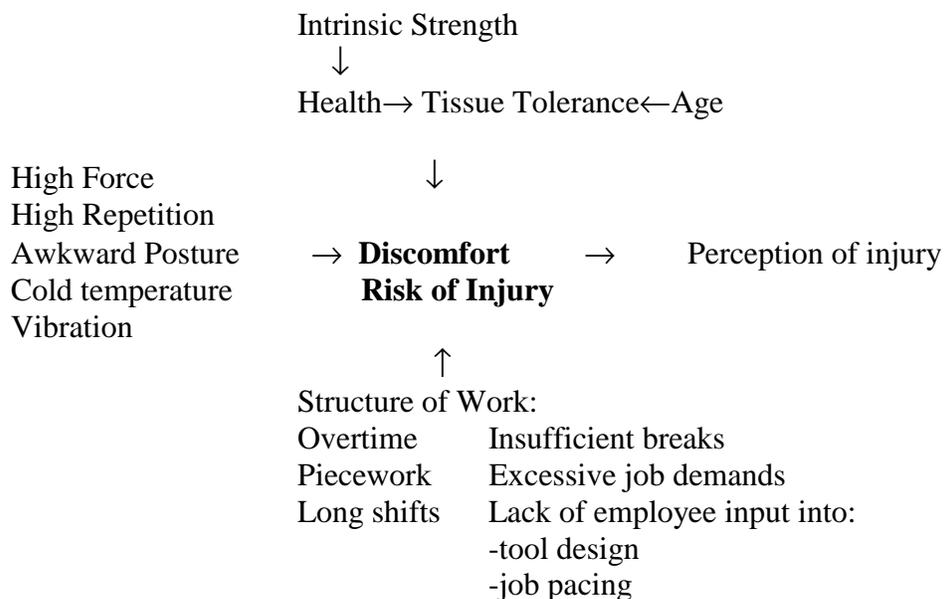


Figure1. Genesis of an injury (Ranney 1997).

Risk factors for CTD's directly related to tree-planting include: high force, high repetition, awkward posture and a dynamic environment. The structure of the work also increases the risk of injury because of insufficient breaks, long shifts and excessive job demands.

The most common shovel used while tree-planting is the D-handle with a minimum blade length of 24 cm. The smaller the blade length, the lesser the weight and therefore, less risk of injury. Another common shovel used by tree-planters is the staff handle. The staff shovel is a straight pole handle. This design is beneficial to the planter because the wrist is maintained in a neutral position and receives less force upon impact. The minimum blade length for staff shovels is 21 cm. (Bell 1993). The average weight of a shovel used in planting is 1.8 kg (WSCA 1989).

The other tool common to all tree-planters are planting bags that are used to transporting the seedlings. The planting bags rest at hip level and are supported with a waist belt and two shoulder straps. Three large pouches are standard; two at each hip and one located at the lower back. The recommended weight for carrying seedlings is 10-15 kg. (Bell 1993), but most commonly tree-planters carry bags weighing over 23 kg. The average tree-planter carries a cumulative weight of over 1,000 kg per day. In addition, a tree-planter carries this heavy load approximately 16 km and bends more than 200 times per hour (WCB 1996).

The most common area of the body for tree-planters to be injured is the wrist and fingers with 26 % of injuries occurring here (WCB1996). Tendinitis is a common condition seen among tree-planters. Tendinitis is the inflammation of the tendon and the muscle-tendon junction. It can also be defined as the “symptomatic degeneration of the tendon with vascular disruption and inflammatory response” (Zernicke and Whiting 1998). The risk of tendonitis is 26 % more likely in persons who perform forceful and repetitive motion jobs such as tree-planting. Tendon units are unlike bone and muscle units that easily adapt to stress. When the stress becomes too great for the tendon, damage occurs (Cassvan 1997).

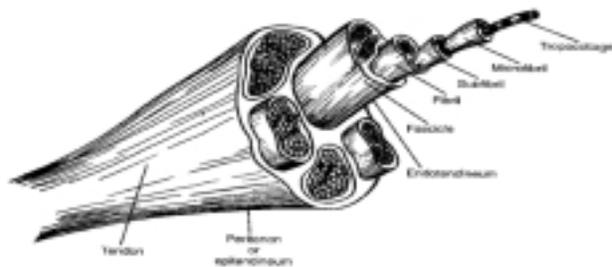


Figure 2. Hierarchy of a tendon (Whiting, 31, 1998).

Changes in tool design can greatly decrease the incidence of tendonitis and other injuries to the wrist and forearm. Padding is necessary when hand-gripping a tool to protect the median nerve which is superficial in the palm and also at the base of the thumb. Refer to Figure 3. When grasping is combined with wrist deviation, as in holding the D-handle shovel, a greater stress is put on the muscles of the forearm as well as the median nerve (Sanders 1997).

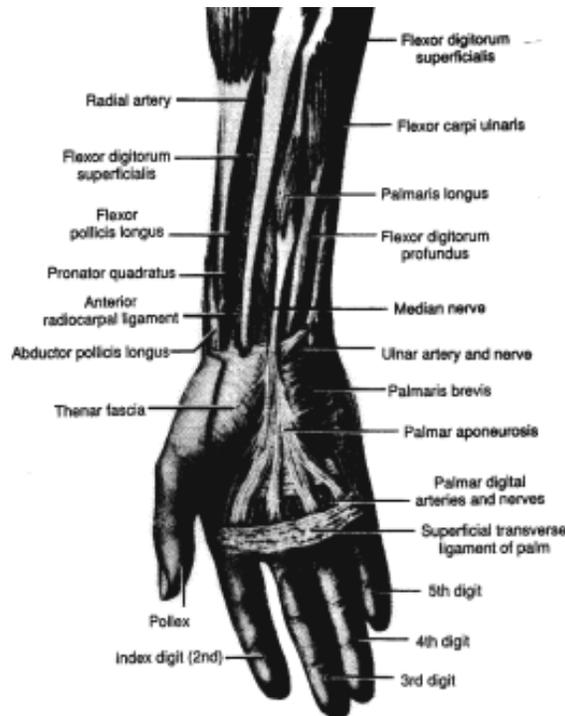


Figure 3. Anatomy of the wrist (Ranney, 1997) Several questions were asked in order to determine the habits of the planters. The two most common types of shovels used by tree-planters are the D-handle and the staff. Such habits as whether or not the planter uses both hands throughout the day are important in determining methods to reduce the risk of injury. Figure 4. is a summary of the daily working habits of the planters.

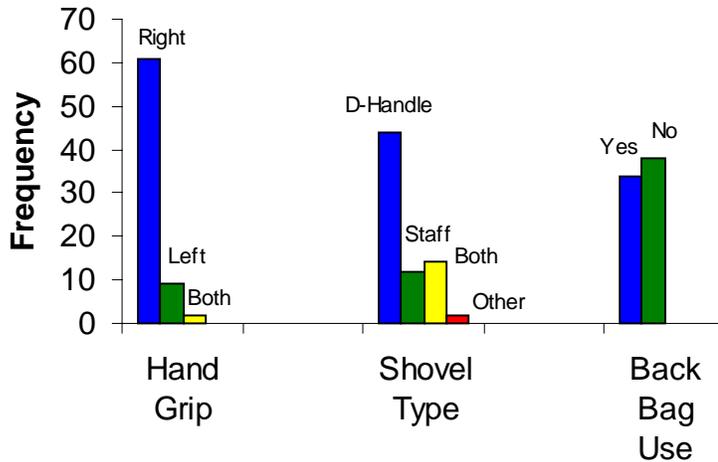


Figure 4. Working Habits of the Tree-Planter.

The D-handle proved to be most popular with 61.1% of planters preferring to use this type. The use of the back bag was almost equal with not using the back-bag, 47.2% of planters use their back bag on a regular basis.

Seventy-six percent of the subjects reported an injury during their time working. The most common areas of injury are shown in Figure 5.

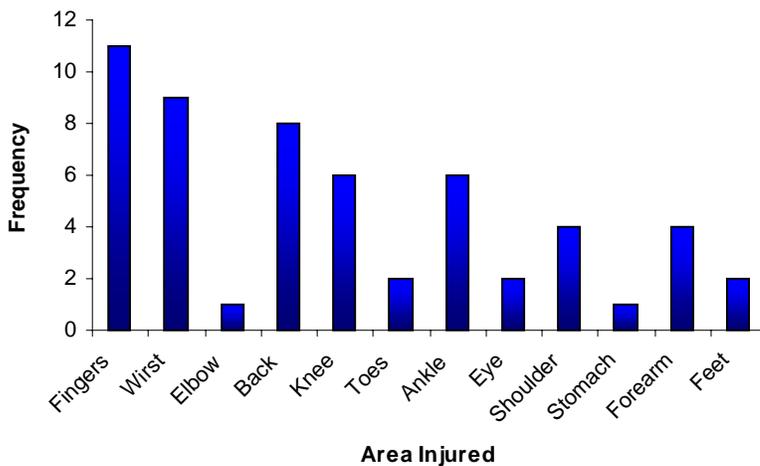


Figure 5. Areas of the body that suffered injury.

The most common area of injury was fingers with 19.60% of the reported injuries occurring here. The second most common area was the wrist, 16.07% followed by the back with 14.29% of the injuries.

The time of the season when the injury occurred is shown in Figure 6. The beginning of the season was the time period when most injuries happened, 46.77%. The end of the season, weeks 4-6 had the second most injuries at 38.71%. Finally, the fewest injuries occurred mid-season, at 14.52%. Chronic injuries were more common than acute injuries. Over eighty-three percent of injuries reported were chronic.

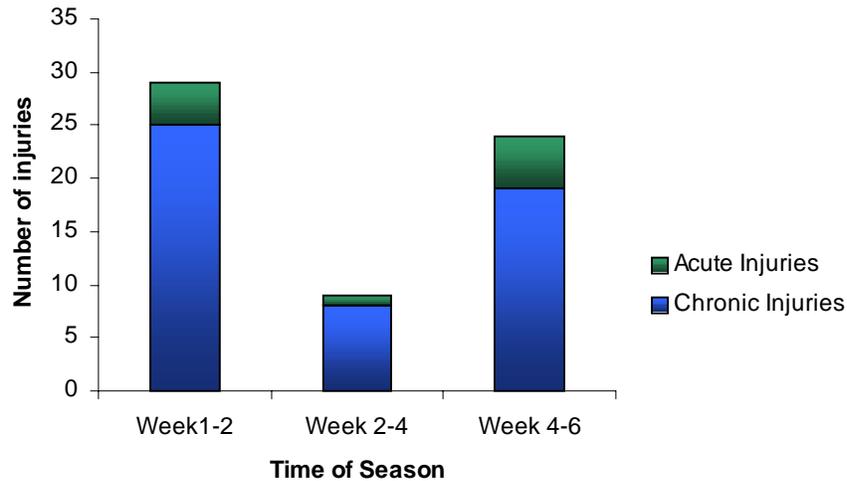


Figure 6. Time in season when injury occurred and whether the injury was classified as acute or chronic.

An important concern to many employers are the implications of the injury and the time until the employee is able to return to work. Figure 7. shows the amount of time off due to injury.

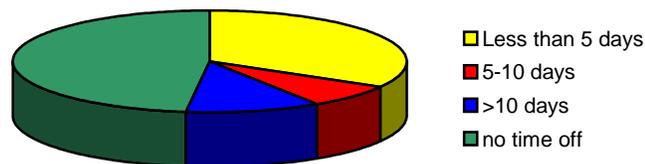


Figure 7. Amount of time off work due to injury.

Forty-eight percent of the injured subjects took no time off work due to their injury. Almost 35% of injured subjects took less than five days, or one shift off work and nearly 12% took greater than 10 days off work. Only 41.80% of the subjects injured consulted doctors.

It is most common for tree-planters to work five days followed by one day of rest as shown by Figure 8. Thirty-eight percent of the participants worked in a five and one cycle. Other cycles are shown: 4 days on and 1 day off, 6 days on and 1 day off and 7 days on with 1 day off.

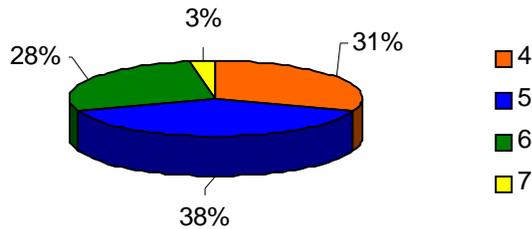


Figure 8. Work-rest ratios for the participants in the study. The numbers shown represent the number of consecutive work days. In each case, one day of rest is given before work begins again.

A strong correlation was found between the occurrence of injury and the work-rest ratios. As the number of consecutive work days increased, the rate of injury also increased. The correlation value is 0.96. Figure 9. represents these findings.

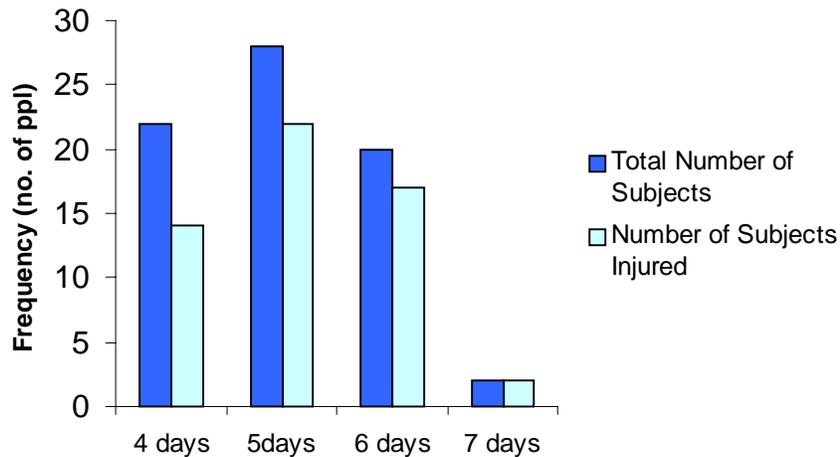


Figure 9. Total number of participants working 4, 5, 6 and 7 consecutive days. Also, the number of participants injured working 4,5,6 and 7 consecutive days.

Conclusion

The results from the survey agree with the previous literature that wrists and fingers are the most common area of injury among tree-planters. Improper tool design, high physical demands and lack of an adequate amount of rest time increase the susceptibility of injury. Implementation of the recommendations outlined in this report could significantly reduce the risk of injury among tree-planters.

Recommendations

The following recommendations encompass the ideas and findings discussed in this paper.

- D-handle shovel:
 - Re-orientate the handle in such a way that the wrist is maintained in a neutral position.
 - Provide different grip sizes that are appropriate for different sized hands.
 - Different shovel lengths for different heights of people.
 - Changes in the actual handle such as: highly absorptive material, grooves in the handle to increase the coefficient of friction to reduce the amount of force needed to grip the tool.
 - Investigation into light-weight materials that are efficient shock absorbers or potentially the addition of a spring to absorb the shock.
- Planting Bags:
 - There is a significant need for different sized bags for different sized tree-planters.
- Work-Rest Ratios:
 - Further research is necessary to assess an appropriate amount of time for the body to recuperate. Findings from this study have shown that working seven-day work-weeks greatly increases the risk of injuries for tree-planters.
- Conditioning:
 - Improvements in aerobic capacity prior to the tree-planting season is important in improving production and preventing injuries early in the season.
 - Perhaps, the first shift should include a two-half days followed by a three-quarter day to allow the body to adjust. Or, strong encouragement/incentive by employers for tree-planters to arrive with a certain level of aerobic capacity.
 - Mandatory stretching programs in the morning and throughout the day.

Acknowledgements

I would like to thank the following people for their support and feedback throughout this study: Dr. Jack Taunton, the seventy-seven tree-planters that participated in the survey, Delia Roberts and Scott Chisholm.

Appendix A. Preconditioning Program for Tree-Planters

Workers who are fit are able to plant more trees with less effort, reducing the risk of injury. Three areas of fitness must be considered for general conditioning: aerobic, strength and stretching.

In order to maintain and develop aerobic fitness the FITT principle should be followed; that is: Frequency, Intensity, Timing and Type. Training should be 3-4 days per week at an intensity of 50-85% heart rate (HR). See Appendix C to calculate HR. Each training session should be between 20-60 minutes of continuous aerobic activity. There are many types of activities that can achieve this criteria. It is important to choose activities that use large muscle groups and is rhythmic and aerobic in nature. For example: running, hiking and biking.

Low back pain is an injury which can't be ignored. It affects 60-80% of all adults at some point in their lives and is the primary workers compensation claim with more than 20%. Certain exercises can increase the endurance and strength capacity of the back muscles (Avila 1999).

Back Strengthening Exercises: (McMurry, 1999)

Knee-to-Chest Raise: To help limber up a stiff back.

- Start by lying on your back or standing.
- Raise knee to chest without the aid of arms or hands.
- Hold for five seconds and repeat with each leg five times.

Hip Stretch: To stretch back muscles and hamstrings.

- Place foot on a chair with leg extended and hands on that knee.
- Lean forward from the hip, keeping the back straight.
- Feel the stretch in the weight bearing leg and hold for 10 seconds. Switch legs.
- Alternate arm and leg lift: To strengthen lower back and hamstring muscles.
- Lie face down with arms and legs extended.
- Raise the right arm and left leg at the same time and keep them extended a few seconds.
- Return to starting position and raise the left arm and the right leg, again simultaneously. Repeat 5-10 times on each side.

Other body parts that require special consideration in preparation for the planting season include: wrist, forearm, knees and elbows. The following exercises are examples of type specific strength training that can help to improve these areas: (Bell 1996)

- Barbell wrist curls to strengthen the wrist and forearm
- Using a handle of a broom, alternate wrists, and roll the bar up to strengthen the wrist and the forearm.
- Tricep push-downs will strengthen the elbow and triceps.
- Leg extensions to strengthen the knees.

Stretching is an important part of the preconditioning program but should also be continued daily in the tree-planters schedule; both before and after the work day. Warming-up and stretching before exercise is important as it prepares the body for physical activity by increasing the range of motion. Stretching has also been proven to enhance physical performance and decrease the risk of injury, especially during repetitive motion activity (McMurray, 77). While stretching, it is crucial to pay attention to the location of the alignment of the trunk and pelvic area. Noting these positions will prevent injury due to hyperextension of the lumbar vertebrae. The following stretches are specific to the task of tree-planting:

Area

Stretch

Arms, shoulders and upper back

Hold arms straight out in front of the body, lace fingers together with palms facing outward, bring hands over head keeping arms straight, push hands and shoulders slightly upward and back.

Upper and lower back

Bring arms in front of the body, lace your fingers together, and push your arms and shoulders outward rounding the upper back. At the same time, contract the abdominal muscles and tuck the buttocks under, rounding the lower back, hold, and release.

Lower back and hamstrings

Lie supine on the floor, bring both knees to the chest and hold, release (make sure to hold knees inside the bend of the knee to protect against over flexing the knee).

Calves and Ankles

Lean against a wall with both legs straight behind the body and heels pressed into the ground or floor until a slight stretch is felt in the gastrocnemius.

Wrist and Fingers

Manipulate the wrist and rotate in such a way that you are spelling the alphabet in the air. The same can be done with each individual finger. It is especially important to stretch the wrist and fingers as this will ease the effect of the 'claw'.

With the above guidelines, a planter is capable of beginning the season in good condition; reducing the risk of injury and increasing productivity (McMurray 1980).

Appendix B. Copy of the survey used for this research study.

Personal Information

Age: _____ Height: _____

Weight: _____ Sex: _____

Off-season occupation: _____

Planting History

What company did you plant for and where?

How many seasons have you planted (ie. 1 season = approx. six continuous weeks)?

What was your work/rest cycle (i.e. 4 days on, 1 day off)?

Which hand did you grip the shovel with? Did you alternate hands?

Do you plant with a staff or a D-handle?

Have you ever used any orthotics, braces or splints. Did you use these as a result of injury?

Did you consistently put trees in your back bag?

Describe your daily eating habits?
(Did you eat breakfast? Did you eat at every bag-up?)

Physical Activity History

Did you consider yourself in good physical condition prior to the planting season?

Which physical activities did you participate in previous to planting?

Which physical activities do you currently participate in?

Are there any activities you had to discontinue as a result of planting?

Medical History

Please list all injuries:

- a) Two Years Prior to Planting: b) As a Result of Planting: c) After planting:

_____	_____	_____
_____	_____	_____

If you have no answer for b, then please continue to the last question.

Injury as A Result of Planting

Please describe the injury in depth, and the circumstances under which it happened. Was a physician consulted? Be sure to include where i.e. left index finger, the injury occurred and be specific.

If a doctor was consulted, what was your diagnosis?

At what point in the season did this injury occur (i.e. the second day of the fourth shift)? Also, what was the actual date of the injury?

What time of day did the injury occur?

How does this injury affect you daily life now?

How long has it been since your injury?

What treatment and drugs were recommended/prescribed?

How long were you unable to work? Did you require a change in equipment?

Final Thoughts

Please include and other information you feel may be relevant about your injury or suggestions and ideas that would help to reduce the risk of injuries in tree planters. Thanks for your thoughts.

Appendix C. Protocol for calculating target heart rate.

1. $220 - \text{age (in years)} = \text{Maximal heart rate}$
2. $\text{Maximal Heart Rate} - \text{Resting Heart rate} = \text{Working Heart Rate}$
3. $\text{Threshold of Training Heart Rate: Working Heart Rate} \times 50\% + \text{Resting Heart Rate} = \text{Threshold of Training Heart Rate.}$
4. $\text{Upper Limit of Target Heart Rate Zone: Working Heart Rate} \times 85\% + \text{Resting Heart Rate} = \text{Upper Limit for Target Heart Rate Zone}$

References

1996. *Preventing Tree Planting Injuries*. Worker's Compensation Board, Vancouver, B.C. 1-16 pp.
1998. *Preventing Musculoskeletal Injuries in Tree Planters*. Worksafe, Worker's Compensation Board, B.C. 1-15 pp.
- Avila, P., 1999. *Fitness for Health and Sports*. Penmarin Books, Granite Bay, California.
- Banister, E., Robinson and Trites, D. 1990. *FRDA Report 127: Ergonomics of Tree Planting*. Government of Canada, Province of British Columbia, Victoria, B.C. 1-18 pp.
- Bell, G., 1993. *Minimum Safety Guidelines for Tree Planters*. Province of British Columbia, Ministry of Forests, Victoria, B.C. 1-42 pp.
- Cassvan, A, et al. 1997. *Cumulative Trauma Disorders*. Butterworth-Heinemann, Newton, MA.
- Corbin, L and R. Lindsey 1997. *Concepts of Fitness and Wellness*. McGraw-Hill, Boston, MA.
- Crumback, D. CBC FM Radio, Daybreak Kelowna. March 6, 2001.
- Jones, R., and Lousier, D. 1989. *A WSCA Report: Silviculture Employment Issues*. Forests Canada Production, Vancouver, B.C. 1-94 pp.
- Knapik J, Ang P et al. 1993. *Physical fitness, age and injury incidence in infantry soldiers*. Journal of occupational Medicine 35:598-603.
- McMurry, G., Robert 1999. *Concepts in fitness Programming*. CRC Press, Washington, D.C.
- Ranney, D., et al. 1997. *Chronic Musculoskeletal Injuries in the Workplace*. W.B. Saunders Company, Philadelphia, Pennsylvania.
- Roberts, D. 2000. *Physiological Programs for the Reduction of Occupational Injury and Illness, and Productivity Enhancement in Tree-Planters*. Department of Biology, Selkirk College, B.C. 1-20 pp.
- Roberts, D. CBC-FM 'Daybreak', March 6, 2001.
- Sanders, M. 1997. *Management of Cumulative Trauma Disorders*. Butterworth-Heinemann, Newton, MA.
- Zernicke, F. and William Whiting. 1998. *Biomechanics of Musculoskeletal Injury*. Human Kinetics, Champaign, IL.