Arborists as Athletes: Energy Expenditures

by John Ball

Physical effort is required for almost every tree care operation. Whether cabling, pruning, removing a tree, or other arboricultural tasks, everyone on a tree crew is involved in activities that require aerobic fitness and muscular strength.

Aerobic fitness and muscular strength are requirements most often associated with athletes. But tree workers really can be viewed as athletes, and this designation is not limited to just the climbers who compete in chapter or international competitions. One tree care company has T-shirts that say, “Industrial Athletes: We Train for Your Trees.” It’s a true statement; tree workers are athletes, but with some differences between those engaged in professional sports. Unlike the typical athletes seen during sporting events, tree workers generally are not training every day—they are working every day. The average professional athlete *trains* about 20 hours a week; tree workers have to *work* 40 or more hours a week. Professional athletes also tend to have relatively short careers. The average age of a National Football League player in the United States is 27 years and his career spans a little more than 3 years. Tree workers often start in their 20s, but they may continue to perform production work into their 40s, or even longer. Continuing to work in trees for decades requires a focus on efficiency.

Efficiency is economy of motion. More efficiency means the worker is expending less energy to accomplish a task, whether that task is climbing a tree, felling, or even dragging brush. Efficiency also means that a worker is not operating at his maximum capacity so that his performance can be prolonged—an important consideration for tree workers who are not called upon to work for minutes during the day, in the case of many athletes, but continue working for much of the day.

If a worker can perform an activity without labored breathing and muscular pain, they are not operating at maximum limits and can continue the activity longer. A study of loggers concluded that the optimum work capacity—one that can be sustained during the day—is about 40% of maximal oxygen consumption (Martinia et al 2006).

VO_2 is a measure of the individual’s capacity to transport and utilize oxygen during exercise. It is an excellent measure of aerobic fitness for high-intensity activities, such as entering a tree, an activity that can be accomplished in a relatively short time period of 5 to 15 minutes. The VO_2 for measuring aerobic power is ml of oxygen consumed per kg of body weight of the worker per minute (ml//kg/min). Oxygen consumption is measured with a portable metabolimeter, carried on the back of the worker, connected to a mask that covers the nose and mouth. Wearing a mask does not affect performance. Tree workers can become comfortable wearing the device in a short time period and are able to work without giving it much thought or attention. In addition to VO_2, the worker's heart rate (HR) is also an important measure, and this can be easily monitored in the field.

There are six methods of entering a tree; 1) ladders, 2) alternate lanyard technique, 3) body thrust, 4) secured footlock, 5) single rope technique, and 6) climbing spurs (Jepson 2000). Three of these methods, body thrust, secured footlock, and the single rope technique involve the use of a climbing line. The body thrust method also has a variation, the modified body thrust, where the climber footlocks on the climbing line rather than placing the feet on the trunk. These four methods depend on different muscle groups, some requiring more arm strength than others, have differing sources of friction and are either a dynamic or static climbing line system.

Four climbers, two men and two women, had their oxygen consumption and heart rate monitored as they climbed 10.3 m (34 ft) using the four climbing methods. At rest, the VO_2 averaged about 4 ml/kg/min with a heart rate of 57 beats/minute. Climbing increased oxygen consumption by six times or more and more than doubled the heart rate. The results also showed a different in oxygen consumption and heart rate among the four methods (table 1). Climbing using the body thrust method where the arm muscle are used for pulling down on the line as the hips and legs are thrust up resulted in the highest oxygen consumption and heart rate. Performing a modified body thrust, where the climber is footlocking on the climbing line, lowered the climber's oxygen consumption and heart rate; and the two static climbing line systems, the secured footlock and single rope technique, lowered oxygen consumption and heart rate even further.

Utilizing the leg muscles more than arm muscles is the most efficient means of entering a tree. The body thrust method makes the most use of arm muscles among the four methods, since the arms are pulling when the legs are holding. The other three methods make more use of the leg muscles, but to varying degrees. When using the modified body thrust method, the climber leans back when taking a wrap of the line on their feet, meaning the arm muscles are used to pull the climber in a vertical position on the line. When using the secured footlock and the single rope technique, a climber can maintain a more vertical position and the arms used more to hold than lift, with the legs used for lifting. This is more efficient and is similar to what has been observed in rock climbing (Booth, et al 1999). Any time the hands are held above the head, this will disproportionally increase HR to VO_2 (Sheel 2004).

This was more a demonstration of methods than a study, and further work is ongoing, but static climbing systems appear to be the most efficient means of entering a tree. While there are a number of factors that play a role in this efficiency, using the leg muscles more than arms will result in the least amount of climbing effort.

Table 1. Oxygen consumption and heart rate of climbers using four different methods of entering a tree.

Method	Sample size	Mean VO_2 (ml/kg/min)	Heart rate (beat/min)
Body thrust	4	29	183
Modified body thrust	4	25	168
Secured footlock	4	23	165
Single rope technique	4	22	160

Literature Cited

Booth J., F. Marino, C. Hill. 1999. Energy cost of sport rock climbing in elite performers. *British Journal of Sports Medicine* 33: 14-18

Jepson, J. 2000. *The Tree Climber's Companion*, 2nd Edition. Beaver Tree Publishing, Longvill, Minnesota, USA.

Martinic, I, K. Segotic, S. Risovic and V. Goglia. 2006. The effect of body mass on physiological indicators in the performance of forestry workers. *Coll. Anthropology*. 30:305-311.

Sheel A.W. 2004. Physiology of sport rock climbing. *British Journal of Sports Medicine* 38: 355-359.

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