Frontenac Provincial Park: Interior Camping Impact Study

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Abstract

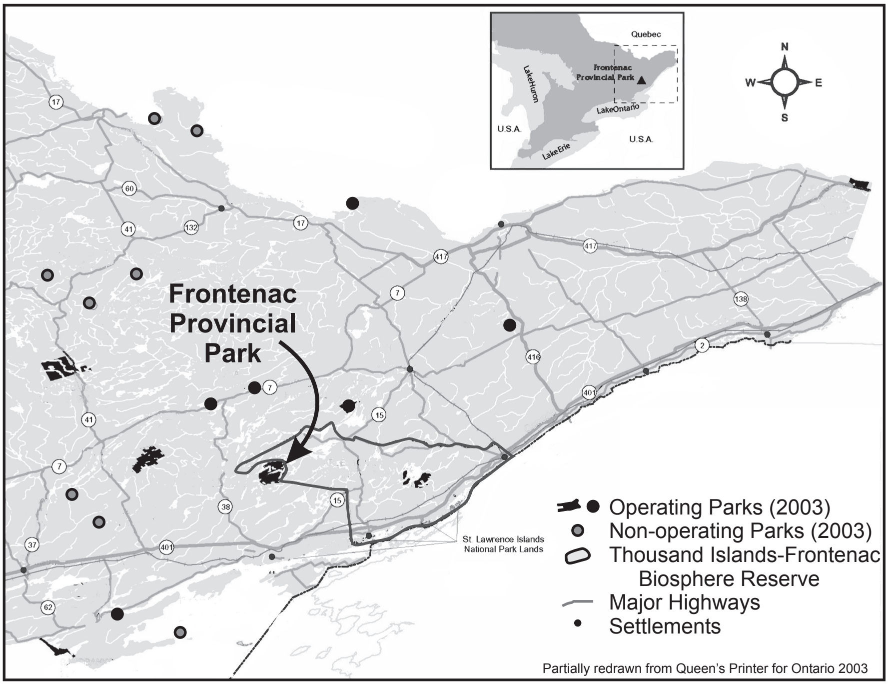
Frontenac Provincial Park is a semi-wilderness park located on the Frontenac Axis, a southerly extension of the Precambrian Shield. At Frontenac 'low-intensity' backcountry is a popular park use, with 11 267 camper nights in 2004. Previous researchers have found that camping has locally intensive impacts including the potential to decrease site productivity and cause greater occurrences of invasive non-native species. In 2004 Ontario Parks carried out an interior camping impact study to investigate if impacts are exceeding limits of acceptable change, assess if corrective measures are required, establish sampling protocol, and collect initial data for future comparison. Campsite clusters were found to be experiencing locally significant impacts including intentional human damage to vegetation, low densities of standing snags, and low volumes of downed woody debris. At this time it is recommended that the park continue to monitor and use the current cluster configurations because establishing new clusters would increase the size of the impacted area.

Keywords: *basal area, campsite cluster, decay class, downed woody debris, human damage, limits of acceptable change, nearest neighbour, stand and snag composition.*

Introduction

Frontenac Provincial Park is a semi-wilderness park located on the Frontenac Axis, a southerly extension of the Precambrian Shield. The park consists of a ridge and valley topography resulting from underlining bands of alternating erosion resistant igneous rock and softer marbles (Woerns, 1977). The soils consist of shallow tills with overlying mature maple-oak, young maple-ironwood and frequent rock barren landscapes. Many of the species found in the park are listed as provincially rare, attributed to the area's exceptional variety of habitats (Ecological Services, 2004) (Figure 1).

Figure 1. Location of Frontenac Provincial Park



Ontario Parks recognizes a growing popularity of wilderness areas for recreational activities in their parks and the importance of protecting the ecological integrity of these areas (OMNR, 1992). It also recognizes that a negative relationship can exist between recreational activities and ecological integrity, especially in areas where recreational activities are concentrated, such as provincial parks.

At Frontenac, 'low-intensity' backcountry camping is a popular park use, with 11,267 camper nights in 2004 (OMNR, 2004). Camping has locally intensive impacts (Cole, 1983; Cole, 1994; Cole and Landres, 1996; Cole, 1995; Hollenhorst *et al.*, 1992; Merigliano, 1998; and Marion and Snow, 1989) (Figure 2). The combination of vegetation and soil impacts can cause reductions in overall site productivity and lead to greater occurrences of invasive non-native species (Cole, 1988; Cole, 1989; James *et al.*, 1979). Impacts, including intentional damage to vegetation (Figure 3), compound site disturbance.

At Frontenac Provincial Park, sites typically have shallow soils, low soil

Figure 2. Typical lack of ground vegetation at a campsite

Figure 3. Birch Bark Stripping

moisture levels and low organic content. These site attributes increase the vulnerability of sites to these disturbances (Cole, 1992 and 1993). A park policy allowing interior campers to collect downed woody debris for use in campfires may also increase the likelihood that impacts are exceeding conservation goals.

In 2004, Ontario Parks carried out an interior camping impact study within Frontenac Provincial Park. The aim of this study was to determine if impacts associated with interior camping are exceeding the parks' limits of acceptable change, assess if corrective measures were required, and establish protocol and collect initial data for future monitoring work. Indicators utilized included volume of downed woody debris (m^3/ha), density of human damage on vegetation (stems/ha), and an evaluation of basal area (m^2) and standing snags (m^2).

Methods

Campsites at the park are organized into thirteen clusters (numbered one through thirteen), six of which were visited during the course of the 2004 field study. At each cluster a random campsite signpost was chosen to represent the center of the impacted area. Measurements were taken along predefined azimuths and positioned to lead directly away from the cluster and perpendicular to the lake, since a lake was present at each of the clusters.

Downed Woody Debris

Downed woody debris volumes were measured every 25 meters (m) from the campsite signpost to a 200 m distance. Each transect was positioned 90^{o} to the predetermined azimuth. The line intercept method with transects of 25 m lengths was used (Taylor, 1997). Two volumes, 174.8 m3/ha and 163.4 m3/ha at clusters eight and nine, were omitted from further analysis. These volumes were a result of human woodpiles and not representative for these distances.

The diameter for each piece of downed woody debris encountered was taken at the midpoint of intercept with the transect tape. In addition to diameter, distances along the 25 m transect and decay class codes (Table 1) were recorded.

Table 1. Decay class codes.

Class	Description
1	Fine branches and bark still present on trunk and trunk not incorporated into soil matrix.
2	Fine branches no longer present on trunk, some courser branches and bark still present on trunk with trunk not incorporated into soil matrix.
3	No bark on trunk, branches no longer present and trunk not incorporated into soil matrix.
4	No branches or bark. Trunk is being incorporated into soil matrix with some woody material still visible above ground.
5	No branches or bark. Trunk is being incorporated into soil matrix with little to no above ground woody detritus visible.

The equation for determining the volume of downed woody debris is below (Van Wagner, 1968 in Lutes, 2002):

$$\text{Volume (m3/ha)} = V = (\pi^2 \sum di^2/8L)\ \pi$$

$$di = \text{diameter of log at point of intercept}$$

$$L = \text{length of transect}$$

A polynomial trendline was used to graph downed woody debris volumes as they fluctuated between the clusters.

Vegetation Damage Density

Determining the density of human damage on surrounding vegetation was accomplished using a "nearest neighbour" method:

$$\text{Stem density per hectare} = \frac{10000 \times 1.67}{D^2}$$

D = average distance to nearest damaged tree

Using the campsite signpost as the center of these plots, twenty nearest neighbour measurements were recorded for each campsite (Figure 4). Stems were restricted to those damaged by human activities and restricted to tree species. Distances between damaged trees was performed for trees ≥10 cm in diameter at breast height (dbh) and <10 cm dbh, bringing the total to twenty distances per plot. The four damage classes used are shown in Table 2.

Figure 4. Station set-up for evaluating tree damage.

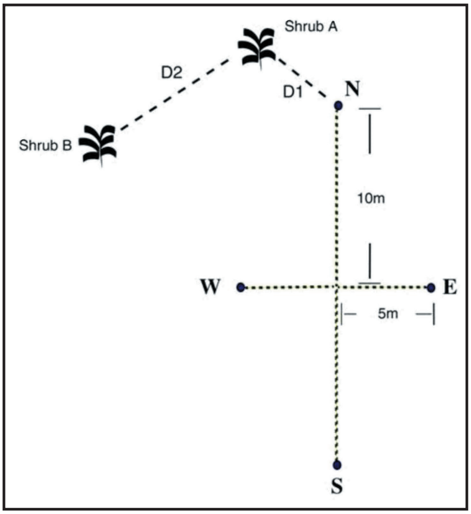


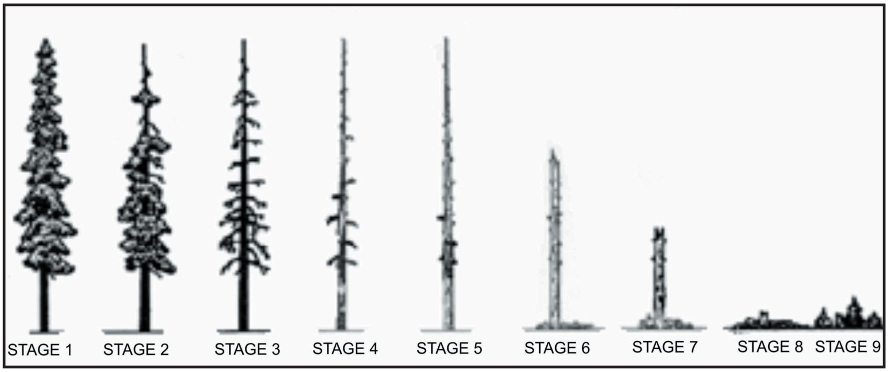
Table 2. Tree damage codes.

Class	Type of Damage
1	Damage to trunk including bark stripping
2	Damage to limbs directly connected to trunk
3	Damage to limbs not connected to trunk
4	Other, record damage type

Stand and Snag Composition

A linear trendline was used to graph basal areas due to basal areas being similar among clusters. Stand and snag compositions were determined using a factor two prism at three separate distances from the clusters: one at the campsite signpost, one 100 m from the cluster, and one 200 m from the cluster. Information recorded included species type, dbh, and stage (Figure 5). Snags were defined as trees at stage 3 or greater.

Figure 5. Standing tree stages.



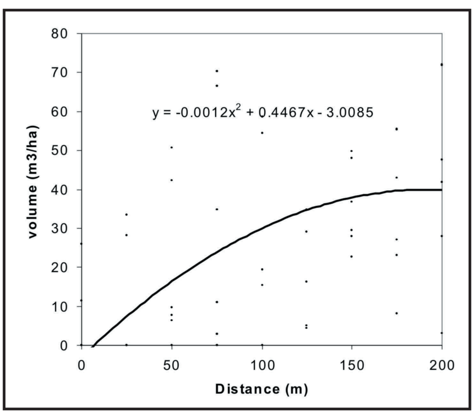
Results and Discussion

Downed Woody Debris

Using the polynomial trendline, there is a positive relationship between downed woody debris volume and distance from cluster (Figure 6). At 175 m, a plateau is reached (40 m^3/ha), beyond which no noticeable change in volume occurred. Volumes between clusters had a high sample standard deviation, s = 55.03, in part due to the absence of the trend at all of the clusters, such as cluster 3 where the largest downed woody debris volume appeared at 75 m from the cluster. For all clusters, the downed woody debris volumes beyond 175 m continued to be lower than expected.

The sample covariance coefficient for distance from cluster and downed woody debris volume indicated a positive 0.9288 linear association. With 7 degrees of freedom and α=0.05, the t distribution table value is 1.895. The test of statistical significance was found to be +0.9726, which does not ex-

Figure 6. Volume of downed woody debris versus distance from campsite cluster.

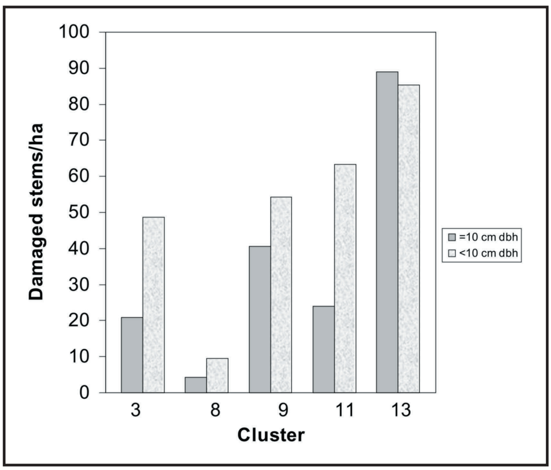


ceed the t distribution value; thus there is no significant correlation between distance from cluster and volume of downed woody debris.

Vegetation Damage Density

Vegetation damage resulting from human impacts was noticeable at most sites, except cluster 12 where heavy beaver damage concealed the presence of human damage. At the other clusters, damage to trees ≥10 cm dbh averaged 35.7 stems/ha and vegetation <10 cm dbh averaged 52.2 stems/ha. These values only represent the immediate area around clusters. This illustrates that human activities such as birch bark stripping are causing locally severe impacts. Cluster 13 had the greatest density of human damage, with trees ≥10 cm dbh being 88.92 stems/ha and trees <10 cm dbh being 85.33 stems/ha. Cluster 8 had the least damage, with trees ≥10cm dbh being 4.18 stems/ha and trees <10cm dbh being 9.46 stems/ha (Figure 7).

Figure 7. Damaged trees/ha at five of the campsite clusters.



The type of human damage varied little between the four clusters, 81% of damage fell into class 1 (the highest damage ranking) and the other 19% fell into class 2. This is cause for concern as these two types of damage have the greatest potential to negatively affect a tree's health including increasing the risk of forest pathogens.

Stand and Snag Composition

The stand compositions (Table 3) are based on three prism surveys.

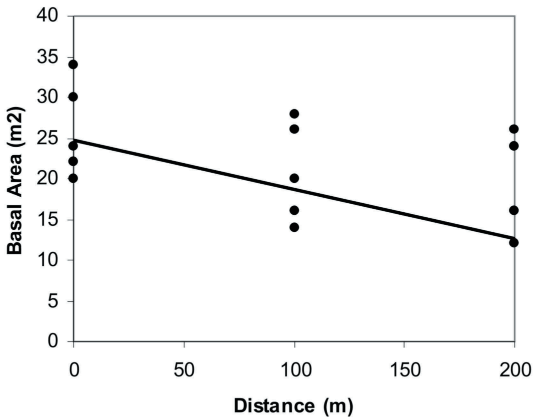
Table 3. Stand composition from selected campsite clusters.

Cluster	Stand Composition
3	Mh_{64}, Or_{14}, Ew_{11}, Iw_{11}
8	Mh_{28}, Or_{20}, Aw_{16}, By_{12}, He_{8}, Iw_{8} , Pw_{4}, Bn_{4}
9	Mh_{62}, Or_{24}, Iw_{6}, Bw_{5}, Ew_{3}
11	Mh_{48}, Aw_{15}, Or_{13}, Bw_{8}, Ow_{5}, Pw_{5}, Iw_{3}, Ms_{3}, Bn_{3}
12	Mh_{53}, Or_{33}, Aw_{6}, Iw_{6}, Unk_{3}
13	Pw_{54}, Ms_{23}, Bw_{9}, Aw_{9}, Or_{6}

Mh = *Acer saccharum*; Ms = *Acer rubrum*; Bw = *Betula papyrifera*; Be = *Fagus grandifolia*; Aw = *Fraxinus americana*; Bn = *Juglans cinerea*; Iw = *Ostrya virginiana*; Pw = *Pinus strobus*; Ow = *Quercus alba*; Or = *Quercus rubra*; Bs = *Tilia americana*; Ew = *Ulmus americana*; Unk = unknown; He = *Tsuga canadensi*s. Numbers in subscript represent percentage of total stand composition.

Using a linear trendline, basal area declined with distance from cluster (Figure 8). Using the sample covariance coefficient method, a negative linear association of 0.9858 was found. This unexpected result may be attributed to increased light levels near forest edges (lake) and historic logging practices near water bodies. With 1 degree of freedom and $\alpha = 0.05$ the t distribution table value is 6.314. The statistical significance value of 0.9398 does not exceed the t distribution table value thus no significant correlation exists between basal area and distance from cluster.

Figure 8. Basal area versus distance from campsite cluster.



Snags were erratically scattered throughout the clusters. Due to too few snags being encountered (none at the cluster, four at 100 m and five at 200 m) trends can only be treated as anecdotal. The lack of snags at the clusters suggests that campsites are void of snags, which was expected due to management of sites for visitor safety and firewood collection activities. The extremely low number of snags encountered at the 100 m and 200 m distances is probably a result of the stands young age combined with park visitor activities.

Conclusion and Management Options

Historic land-uses continue to strongly influence Frontenac Provincial Park, with second growth forests and old abandoned fields, mines, and buildings being witnessed throughout the park. Current land-uses are also influencing the park, with interior camping causing increased rates of damage to vegetation surrounding clusters and low densities of standing snags. The high incidence of class 1 and 2 damage increases the risk of forest pathogens and increases stress on vegetation. These findings support other research findings in that the effects of camping are locally significant (Cole 1985 and 1992).

Forests throughout the park are young in age making it difficult to assess the effects of allowing downed woody debris collection within the park. The stands' ages also complicated interpretation of how firewood collection limits the more advanced stages of decaying downed woody debris.

Impacts associated with camping persist for a long time on the landscape (Cole and Monz, 2003). Closure of clusters for rehabilitation and the opening of new clusters is not advisable. If new clusters are opened to continue to meet demands, closures would result in an increase in the impacted area. The best management option is to continue monitoring efforts. Incorporation of photographic monitoring, assessments of clusters not visited during the 2004 survey, determination of annual inputs of woody biomass including fine woody debris, developing control plots, and expanding the monitoring to include aquatic communities would enhance future monitoring efforts.

In addition to monitoring, educating park visitors concerning the sensitivity of vegetation and ecosystems to recreational activities should continue. This could help to reduce the intentional damage seen at the clusters. Visitor education could also help to reduce the quantity of woody biomass being consumed in campfires. This can be achieved by reducing the number of nights campers have campfires and by reducing the size of campfires.

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