

Documenting Fire History in a British Columbia Ecological Reserve

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Abstract

Ponderosa pine (*Pinus ponderosa*) ecosystems in British Columbia have high concentrations of biodiversity and species at risk, and numerous studies suggest frequent, low-intensity fire was a historical disturbance pattern in this ecosystem type. Fire history was analyzed in the Trout Creek Ecological Reserve near Summerland, BC, a 75 ha parcel in the PPxh1 biogeoclimatic variant. The area's fire history spans from 1715 to 1952, with a mean area fire interval of 18 years. Fire management options are reviewed.

KEYWORDS: fire history; ponderosa pine; ecological reserve

Introduction

ranging from northern Mexico to southern British Columbia, ponderosa pine (*Pinus ponderosa* C. Lawson) is emblematic of the dry interior mountains and valleys of western North America. In British Columbia, the species typically grows in open stands and merges with Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) at higher elevations. Along its lower edge, the ponderosa pine zone forms a broad, dynamic ecotone ("parkland") with bunchgrass-dominated grasslands. British Columbia's ponderosa/bunchgrass parkland has both high values for biodiversity and concentrations of species at risk (Scudder & Warman 2003; Austin et al. 2008) and provides forage for livestock and wildlife.

The thick-barked ponderosa pine is fire tolerant (Weaver 1974) and historically has been associated with high frequency, low-severity fire regimes (Oliver & Ryker 1990; Agee 1993; Barrett et al. 1997) or mixed-severity regimes (Baker 2009). Recent decreases in fire frequency have been documented in many parts of its range (Barrett et al. 1997; Everett et al. 2000; Baker 2009), due to a combination of factors, including fire suppression, barriers to fire spread, and climate shifts. Other anthropogenic impacts, including urban encroachment, alien species introductions, overgrazing, and highgrade timber harvesting, have dramatically altered the condition of the ponderosa pine parkland (Covington & Moore 1994).

The suppression and exclusion of fire in ponderosa stands is typically followed by forest ingrowth (increased stem density in an existing forest stand) and encroachment (forest expansion into traditional grassland areas) (Taylor et al. 1998; Turner & Krannitz 2001; Gyug & Martens 2002; Bai 2005). Other factors, such as soil disturbance, overgrazing (Fuhlendorf et al. 2008), and pine beetle attack, can also contribute to the complex dynamic of tree-grass interactions. Forest ingrowth and encroachment are associated with



declines in forest health, biodiversity, grazing values for wild and domestic ungulates, and ecosystem resilience (Covington et al. 1993; Hessburg et al. 1994; Keane et al. 2002; Rocky Mountain Trench Ecosystem Restoration Steering Committee 2006).

The interval between fires over time (referred to as the historic natural fire regime, historical fire return interval, or historical range of variability—see discussion in Wong et al. 2004)—is one metric for judging the current condition of ponderosa pine stands. The historical range of variability provides background information for the development of management and ecological restoration strategies (Parsons et al. 1999). A number of detailed fire history studies have been performed in ponderosa pine forests in the United States (e.g., Barrett et al. 1997; Everett et al. 2000), but in the BC Interior such studies are scarce (Wong et al. 2004). Given the ecological and biodiversity importance of the ponderosa pine subzone in British Columbia, its limited extent, and its position at the northern edge of the species' continental range, a study was undertaken to document an area-based historical fire range of variability in a ponderosa site in the Okanagan–Similkameen region.

Study Area

The 75 ha Trout Creek Ecological Reserve (TCER) is located near Summerland in the Okanagan Valley, BC, at 49°33'N, 119°42'W. TCER was one of British Columbia's first ecological reserves, designated in 1971. Managed by BC Parks, TCER's purpose is "to conserve representative semi-arid vegetation dominated by ponderosa pine and Douglas-fir in the southern interior of BC" (BC Parks 2011a). Lying between 600 and 850 m a.s.l., TCER is largely south aspect and is within the PPxh1 biogeoclimatic variant. With the exception of a few level benches, most of the terrain is gently to steeply sloping. The deep, steep-sided Trout Creek Canyon forms the reserve's boundary to the south and west, and a south-facing ridge dominates the northern portion. The soils of the benchlands are Brunisolic sandy loams, grading into stonier loamy sands on the steeper slopes. The pH of the surface soil is 6.5, and organic matter levels range from 2.5 to 4.5 percent (Larmour 1975), (see Figure 1).



Figure 1: Typical terrain of the Trout Creek Ecological Reserve, looking southwest. Trout Creek Canyon is in the upper part of the photo. The trees are generally in younger age classes.

The overstorey vegetation of TCER is dominated by ponderosa pine, with occasional Douglas-fir in mesic microsites. The area has a forest site index of 8.5–15, tree basal area (stems >12.5 cm dbh) of 5–15 m²/ha, and 100–250 live stems/ha (BC Ministry of Forests 2007). Larmour (1975) reported 195 stems/ha plus a seedling (height not defined) count of 300 stems/ha.

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The understorey vegetation is dominated by bluebunch wheatgrass (*Pseudoroegneria spicata* (Pursh) A. Love) (Larmour 1975) with recent accumulations of Idaho and rough fescue (*Festuca idahoensis* Elmer and *F. campestris* Rydb.) (D. Gayton, unpublished data). Larmour's original 1975 floristic list has recently been expanded to include 113 vascular species (L. Rockwell, pers. comm.). Three plant species of provincial concern have been found on TCER: Dalles milk-vetch (*Astragalus sclerocarpus* A. Gray) on the Red list; narrow-leaved brickellia (*Brickellia oblongifolia* Nutt.) on the Blue list; and Columbian gold-



enweed (*Pyrrocoma carthamoides* Hook.) on the Yellow list. The dominant invasive plant is Dalmatian toadflax (*Linaria genistifolia* L.), with trace amounts of cheatgrass (*Bromus tectorum* L.), sulfur cinquefoil (*Potentilla recta* L.), and diffuse knapweed (*Centaurea diffusa* Lam.) (Alcock 2006).

White-tailed deer (*Odocoileus virginianus* Zimmerman), black bears (*Ursus americanus* Pallas), and coyotes (*Canis latrans* Say) are occasionally seen on TCER, but large mammals are not common, likely because the only available water is in Trout Creek itself, which has very difficult access. Both the BC Blue-listed Northern Pacific rattlesnake (*Crotalus oreganus oreganus*) and Great Basin Gopher Snake (*Pituophis catenifer deserticola* Stejneger) have been observed on TCER. Volunteer warden Laurie Rockwell has recorded 70 species of birds onsite and has nest records for 11 species, including the Blue-listed Gray Flycatcher (*Empidonax wrightii* Baird) (L. Rockwell, pers. comm.).

TCER was selectively horse-logged, likely around 1910 based on stump ages, but no timber harvest data could be found. The harvest may have been for apple box wood, since small as well as large diameter trees were taken. Live-stock grazing historically occurred on site, but it was likely limited and sporadic due to the absence of water. In the 1960s and 1970s, dirt-biking created trails and soil disturbance throughout the area. A woven wire fence completed in 1977 eliminated further disturbances (Sirk & Bayliss 1977).

Methods

In fall 2010 the author reconnoitred the entire TCER, identifying and georeferencing 85 candidate trees, snags, and stumps containing fire scars. From this initial inventory, 18 live trees and 10 stumps were selected based on criteria that included geographical distribution, soundness of wood, and condition of fire scars (see Figure 2). Of the 28 trees sampled, 11 were ponderosa pine and 11 were Douglas-fir; six stumps had deteriorated to the point that they could not be identified to species. Five of the 28 trees were located just outside the TCER boundary, less than 30 m from the fence. The cross-sectional “cookies” cut from these were dried, mounted, and then sanded using progressively finer grits, starting with 40 grit and finishing with 600, as per Arno and Sneek (1977). Cookies were dated and fire scars noted. Fire scars were separated from pine beetle attack by the shape and bilateral symmetry of the scar and the absence of bluestain. Stump cross-dating was conducted using two verified ponderosa pine chronologies (CANA015 from Naramata, BC, and CANA018 from Tranquille, BC) selected from the International Tree-Ring Data Bank (ITDRB 2011). Several of the stumps were cross-dated by Dr. Emily Heyerdahl of the USDA’s Fire Sciences Laboratory in Missoula, MT. Resulting data were analyzed using the Fire History Analysis and Exploration System (FHAES 2011).

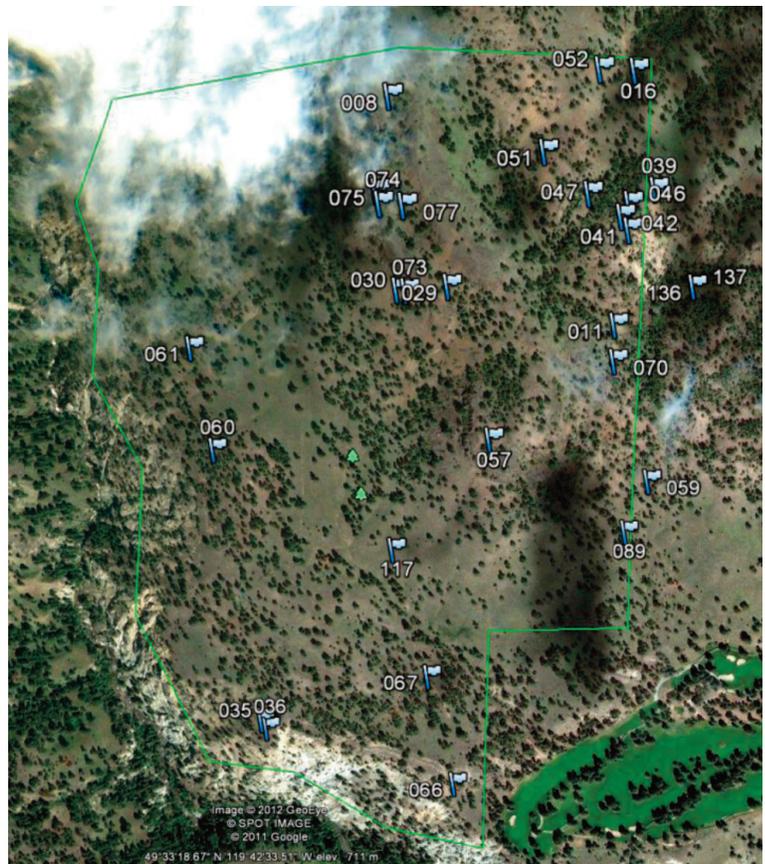


Figure 2: Locations of sampled trees. Faint green line is the TCER boundary; Summerland Golf Course is in the bottom right. Trout Creek Canyon is visible along the lower left-hand side of the aerial photo.



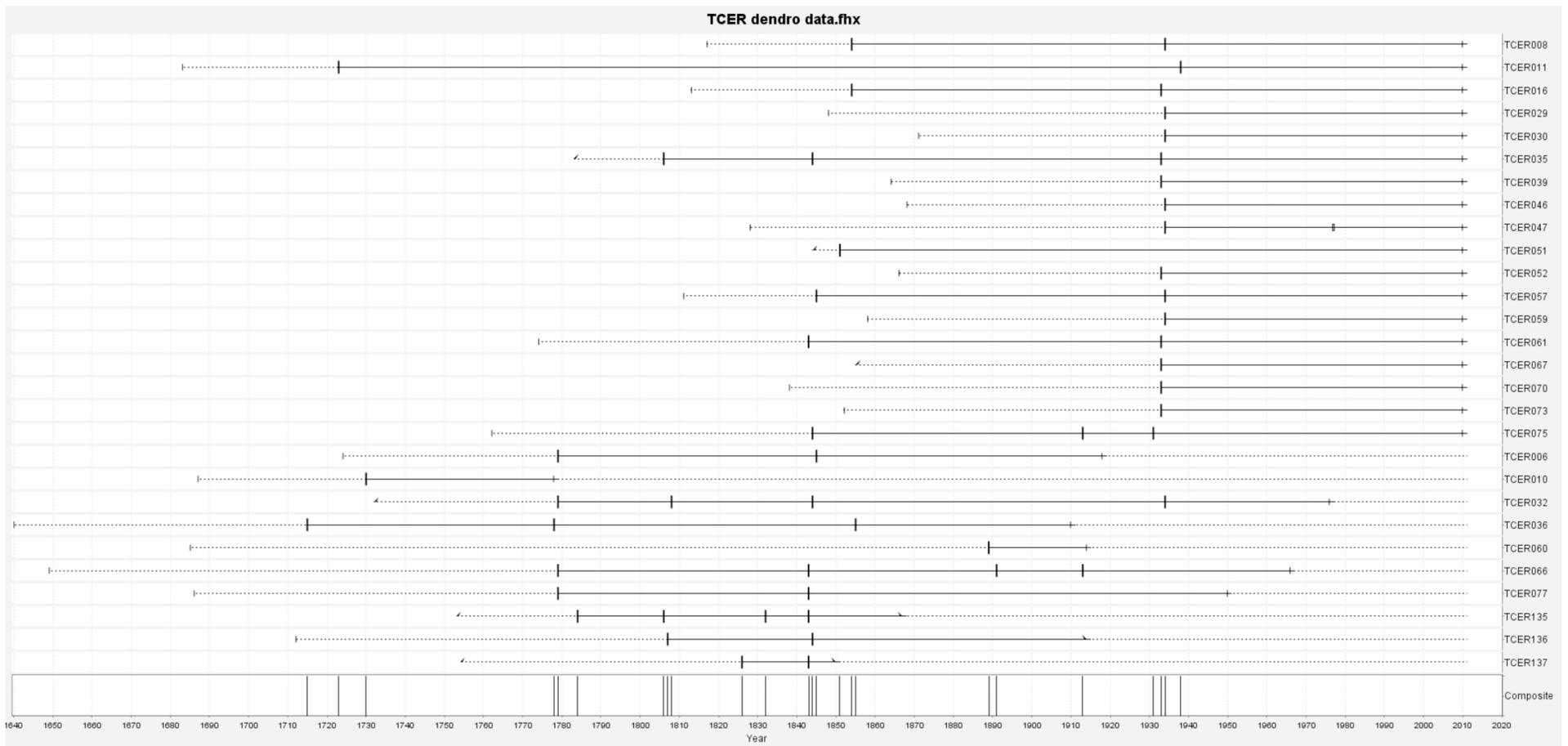


Figure 3: History of fire scarring in TCER. Upper 18 trees were live; lower 10 trees were stumps. Live trees were sampled in fall 2010. Numbers along right-hand axis are tree/stump sample numbers that correspond to numbers in Figure 2. Legend: Faint vertical tick mark: pith date/death date; Slanted tick mark: end of datable wood; Bold vertical tick marks: fire scars; Dotted horizontal line: tree growth prior to first scarring; Solid horizontal line: recording period (after first scar)

Results

The cookies provided a 370-year chronology, with the oldest pith dating to 1640. A total of 51 fire scars were identified and dated. Most fire scars had been damaged to some degree by wood-boring insects, so the season of fire was difficult to determine. In a few cases insect damage restricted dating accuracy to within 1 to 3 years of the actual fire event. Data are presented graphically in Figure 3.

The earliest recorded fire occurred in 1715 and the last in 1952, providing a 237-year fire record. To derive an area-based fire return interval (the time between any fire occurring anywhere on the site) all intervals of 2 years or less were discarded, to eliminate possible dating inaccuracies; the resulting interval was 16 years. Thus on TCER between 1730 and 1952, there was a fire of sufficient intensity to scar a tree on average every 16 years. Intervals ranged from 3 to 49 years (see Figure 4).

Scar data were insufficient to make any estimate of fire sizes; however, the 1933 fire was assumed to be large since it scarred multiple trees across TCER. The author verified a July 1933 fire (and suppression efforts) at Trout Creek in the local newspaper archives (Penticton Herald 1933). The fire was also identified in the BC Wildfire spatial database, covering roughly one third of TCER (ILMB 2012; see Figure 5). The cluster of 1934 scars could represent dating inaccuracies or a re-burn of the previous year's fire. No reference to a 1934 fire was found in either the database or the newspaper.

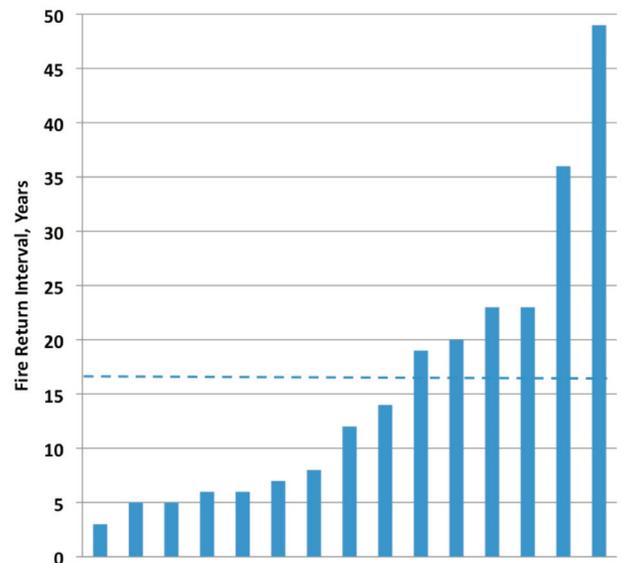


Figure 4: Graph of fire return intervals, TCER, 1715–1952. Dotted line is average interval (16 years).

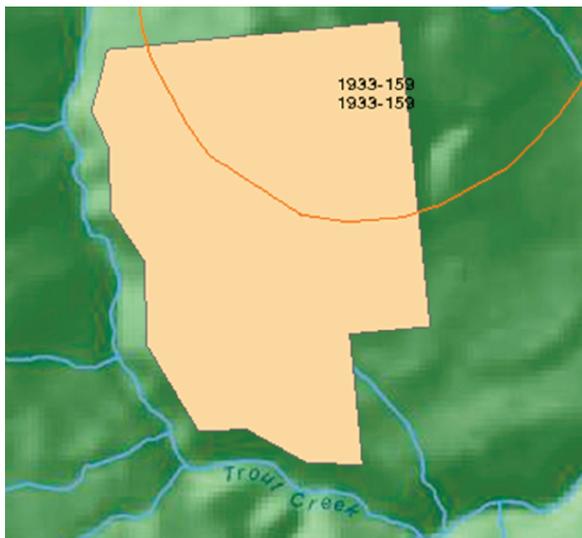


Figure 5: Map of 1933 wildfire (Trout Creek Ecological Reserve is solid yellow; red line is the fire perimeter).

Discussion

Few relevant fire histories are available for comparison, but they provide a fire narrative similar to the TCER results. Schellhaas et al. (2003), working in a mixed Py/Fd area in the Washington Okanogan (roughly 160 km south of TCER), reported area fire return intervals of 12 to 23 years between 1660 and 1889. Heyerdahl et al. (2007), working in PPxh2/IDFxh2 in BC's Stein Valley, found an area mean fire interval of 16 years between 1750 and 1950, with minimum and maximum intervals of 2 and 83 years, respectively. Schuurmans and Hughes (unpublished data) calculated an interval of 8 years between

1769 and 1969 at a PPxh1 site near Oliver, BC, 60 km south of TCER. Riccius (1998) reported point mean fire intervals of 9 to 28 years at a PPxh/IDFxh site near Lytton, BC. Gray et al. (2002) found point mean intervals of 7 years in PPxh near Spences Bridge, BC. Gray and Riccius (1999), working in a 5 ha research IDFdk1 site east of Merritt, BC, determined a fire



interval of 13 years between 1693 and 1967. All studies show a contemporary (post-1900) decline in fire frequency, similar to TCER.

Fire histories typically cover more than 75 ha, but given the distinct tenures and uses of lands surrounding TCER, it made sense to confine the current study. At approximately 1 tree sampled per 2 ha, sample density is higher than representative larger studies (e.g., Kernan & Hessl 2010). A full characterization of the historical fire regime at TCER would require an analysis of tree age class distribution, but that was beyond the scope of this project.

A frequent, low-intensity fire regime does not preclude occasional high-intensity fires (Klenner et al. 2008); these fires are often driven by severe droughts and/or climate oscillations. The 1933 fire recorded over much of TCER could be an example of this, although it may have been exacerbated by the presence of recent logging slash.

The current emphasis on managing for ecological integrity and resilience in North America suggests that emulating traditional disturbance patterns is one of the most effective ways of restoring those attributes (Holling 1973; Landres et al. 1999; Drever et al. 2006). The degree of departure from traditional fire return interval is one measure of landscape-scale ecological and fuel loading conditions (Blackwell et al. 2003). If one assumes a conservative 20-year historical fire return interval for TCER, and 60 years have elapsed since the last fire (1952), the ecological reserve is three times departed from its historical mean and has exceeded its longest previous fire-free interval of 49 years.

A priority for park, ecoreserve, and protected area managers is the impact of fire, and fire suppression, on species and ecosystems of concern and on invasive plants (Stevens et al. 2004). No data are available for the fire response of TCER's three listed plant species or the two listed snakes, but all prefer dry, open habitats where fire is unlikely to carry. The Western rattlesnake specifically favours dry, rocky habitats with sparse tree cover (Blood 1983). Gopher Snakes also favour open areas (BCReptiles 2012). The Gray Flycatcher, on the other hand, requires open stands of small to medium (up to 15 m) ponderosa pines; these stands usually have a scattered shrub or young pine understorey (Cannings 1992).

Invasive species have waxed and waned on TCER. Cheatgrass was the only invasive reported in 1977; subsequently there were visual reports of both diffuse knapweed and Dalmatian toadflax. Alcock (2006) reported six sites (a total of 2.4 ha) containing diffuse knapweed; at three of these, the plant had reached high densities. Although diffuse knapweed can occasionally be found on TCER, dense patches no longer exist (L. Rockwell, pers. comm.), and the plant now appears to be under successful biological control. Dalmatian toadflax is still extremely common, but casual observation suggests the majority of toadflax plants on TCER are currently being attacked by the toadflax biological control agent *Mecinus janthinus* Germar.

The primary objective of the BC Protected Areas program is preservation (BC Parks 2011b). Indeed, TCER has not experienced significant human intervention since it was fenced in 1977, other than occasional weed control. But the ponderosa pine ecosystem presents a conservation conundrum, since its "preservation"—particularly in terms of stem density, old growth values, and biodiversity—depends on occasional human intervention. Studies have documented that the short fire return intervals historically experienced in dry forests cannot be generated by lightning starts alone and that long-term First Nation use of fire was a substantial component (Williams 2002; Wierzchowski et al. 2002; Kay 2007). Summerland and environs have long been traditional use areas for the Syil'x First Nation (R. Armstrong, pers. comm.)



Many land managers (and large segments of the public) do not perceive fire suppression as a perturbation (a human-caused disruption of a natural disturbance, *sensu* White & Jentsch 2001). They are largely unaware of suppression's negative ecological consequences—to forest health, biodiversity, grazing values, and ecosystem resilience—in British Columbia's ponderosa pine communities. This presents a conceptual stumbling block. Once the concept of historical range of variability is understood and documented, then ponderosa pine stand management and restoration prescriptions can be further adjusted to reflect other imperatives such as commercial harvesting, urban interface wildfire risk reduction, grazing, climate change, and species at risk (Allen et al. 2002).

The recent large, intense fires in dry forest types (e.g., Penticton 1994; Kelowna and Barriere 2003; Lillooet 2007/2010) are likely to generate greater negative ecological consequences than a return to a frequent, low-intensity fire regime. Fire suppression, forest ingrowth/encroachment, and subsequent large, intense wildfires increase stand- and landscape-level homogeneity in ponderosa pine. A return to a more frequent fire (and/or fire analogue) interval would be consistent with the recent call for the maintenance of ecological integrity in BC's parks and protected areas (British Columbia Auditor General 2010). But "cookie cutter" prescriptions should be avoided. Patches, edges, corridors, and a diverse range of fire intensities and effects should be the hallmark of dry forest restoration treatments. The high biodiversity and aesthetic qualities of BC's ponderosa pine parklands provide a rationale for this enhanced level of management.

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Article Received: September 26, 2011 • Article Accepted: July 24, 2012

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Test Your Knowledge

How well can you recall the main messages in the preceding article?
Test your knowledge by answering the following questions.

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- 1) The Trout Creek Ecological Reserve is in which biogeoclimatic zone?
 - a. Interior Douglas-fir
 - b. Bunchgrass
 - c. Ponderosa pine

- 2) The last recorded fire on the Trout Creek Ecological Reserve was:
 - a. 20 years ago
 - b. 60 years ago
 - c. 90 years ago

- 3) The dominant invasive plant on the Trout Creek Ecological Reserve is:
 - a. Diffuse knapweed
 - b. Cheatgrass
 - c. Dalmatian toadflax

