

# YELLOWSTONE PATCHES METADATA

## CLASS I. DATA SET DESCRIPTORS

**A. Data set identity:** Effects of fire size and pattern on early succession in Yellowstone National Park.

**B. Data set identification code:** YNPpatches.txt

### C. Data set description

**Principal Investigators:** Monica G. Turner, William H. Romme and Robert H. Gardner

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#### Additional citations:

Turner, M. G., W. H. Romme and D. B. Tinker. 2003. Surprises and lessons from the 1988 Yellowstone fires. *Frontiers in Ecology and the Environment* 1:351-358.

Romme W. H., and M. G. Turner. 2004. Ten years after the 1988 Yellowstone fires: is restoration needed? Pages 318-361 In: L. L. Wallace, editor. *After the fires: the ecology of change in Yellowstone National Park*. Yale University Press, New Haven, Connecticut.

**Abstract:** The Yellowstone fires of 1988 affected >250,000 ha, creating a mosaic of burn severities across the landscape and providing an ideal opportunity to study effects of fire size and pattern on postfire succession. We asked whether vegetation responses differed between small and large burned patches within the fire-created mosaic in Yellowstone National Park (YNP) and evaluated the influence of spatial patterning on the postfire vegetation. Vegetation in a small (1 ha), moderate (70-200 ha) and large (500-3600 ha) burned patch at each of three geographic locations was sampled annually from 1990 to 1993 and again in 1996.

**D. Key words:** Yellowstone National Park; secondary succession; spatial pattern; landscape ecology; *Pinus contorta*; patch size; disturbance; fire ecology; spatial heterogeneity.

## CLASS II. RESEARCH ORIGIN DESCRIPTORS

### A. Overall project description

**Identity:** Effects of fire size and pattern on early succession in Yellowstone National Park.

**Originator:** Monica G. Turner (contact information above), William H. Romme and Robert H. Gardner.

**Period of Study:** 1990-1993, 1996

**Objectives:** We asked whether vegetation responses differ between small and large burned patches within the fire-created mosaic in YNP and evaluated the importance of spatial patterning and fire severity on the postfire vegetation.

**Abstract:** Same as above.

**Sources of funding:** National Geographic Society (Grant No. 4284-90), National Science Foundation (BSR - 9016281 and BSR-90118381), and Ecological Research Division, Office of Health and Environmental Research, U.S. Department of Energy, under contract no. DE-AC05-84OR21400 with Martin Marietta Energy Systems, Inc.

**Site description/selection criteria:** In order to establish three replicates of three patch sizes that differed in size by an order of magnitude, we selected a small (1 ha), moderate (70-200 ha) and large (500-3600 ha) patch of crown fire at three geographic locations (Table 2) across the subalpine plateau. Regions of lesser burn severity were contained within and around each patch. Selection was based on patch size and accessibility based on digital satellite imagery. Availability of accessible large crown-fire patches was limited, and the large patch at Yellowstone Lake was substantially larger than at the other two locations.

**Site type:** Subalpine forested plateau

### Geography:

Cougar Creek: Westcentral YNP

PATCH SIZE	CENER POINT COORDINATES
large	505001, 4951353
moderate	503835, 4946212

small	504593, 4947472
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Fern Cascades: Southwestern YNP near Old Faithful

PATCH SIZE	CENER POINT COORDINATES
large	512726, 4921138
moderate	509858, 4923901
small	514727, 4920299

Yellowstone Lake: Southeastern YNP

PATCH SIZE	CENER POINT COORDINATES
large	555432,4896617
moderate	554447,4902793
small	555839,4905336

**Habitat:** Coniferous forests dominated by lodgepole pine, although subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.), Engelmann spruce (*Picea engelmannii* Parry), and whitebark pine (*Pinus albicaulis* Engelm.) may be locally abundant.

**Geology:**

Cougar Creek: Ryolite and tuff (moderately infertile Quaternary volcanics)

Fern Cascades: Ryolite (moderately infertile Quaternary volcanics)

Yellowstone Lake: Lake sediments and andesite (moderately fertile Eocene volcanics)

**Watersheds/hydrology:** N/A

**Site history:**

Cougar Creek: ~130-year-old even-aged stands that originated after fires in 1860s.

Fern Cascades: ~290-year-old even-aged stands that originated after fires in early 1700s.

Yellowstone Lake: ~250-year-old even-aged stands that originated mid 1700's (small and moderate patches); >400 year-old uneven aged stand (large patch).

**Climate:** The climate is generally cool and dry; on the plateau, mean January temperature is -11.4° C and mean July temperature is 10.8° C (Dirks and Martner 1982).

Mean annual precipitation is 56.25 cm with relatively moist springs and dry summers (Dirks and Martner 1982).

**Sampling methods:** In July 1990, four permanent transects were established in each of the nine patches, extending from the center to the edge of the patch along subcardinal directions (NE, NW, SW, and SE). Transects varied in length, depending on patch size and shape. The edge of the patch was defined by unburned forest, a light-surface burn, a topographic barrier or an unforested area. Sampling on each transect began 20 m from the center point of the patch and continued at fixed intervals (20 m in the small patches, 100-m in moderate patches and the large patches at Fern Cascades and Cougar Creek and 200 m in the large patch at Yellowstone Lake) as long as the transect continued through areas affected by crown fire. At transitions between burn severity classes (e.g., between crown fire and a severe-surface burn), sampling points were located on the edge and at three 20-m intervals on either side of the edge. Subsequent sampling points were again located at the fixed intervals until the next edge was encountered. Sampling points were marked in the field with wooden stakes, flagging and rock cairns and were sampled during July and August of 1990-1993 and again in 1996.

A 50-m<sup>2</sup> circular plot was centered on each sampling point, and slope, aspect, and burn severity were recorded in 1990. The proportion of prefire serotinous lodgepole pine trees was recorded within a 50-m radius of the sampling point was recorded in 1992 following methods in Tinker et al. (1994). For vegetation measurements, an 8-m line was centered on the sampling point and extended perpendicular to the main axis of the transect. Percent cover data were recorded within eight 0.25-m<sup>2</sup> plots spaced at 1-m intervals along this line. At each point in a 25-point 0.5-m x 0.5-m point-intercept frame (cf. Floyd and Anderson [1982, 1987]), the underlying plant species or cover type (exposed mineral soil, unburned litter, charred litter, pebble, cobble, or boulder) was recorded. Percent cover was determined by aggregating the data from the eight 0.25-m<sup>2</sup> plots. Species richness was measured by recording all species within an area extending 1 m along the 8-m line. Nomenclature follows Dorn (1992).

Individuals of *Epilobium angustifolium*, *Lupinus argenteus*, *Arnica cordifolia*, *Carex geyer* *Carex rossii*, *Pinus contorta* and *Vaccinium scoparium* were censused within each of the eight 0.25-m<sup>2</sup> plots with perennials classified as seedlings of the year or sprouts based on morphological characters (Turner et al. unpublished data). *Pinus contorta* seedlings were counted annually and the counts recorded by seedling age (yrs) to estimate recruitment through time.

Opportunistic species (*Cirsium arvense*, *Collinsia parviflora*, *Gayophytum diffusum*, and *Lactuca serriola*), which frequently were sparse at individual sampling points, were sampled along 1-m wide belt transects between sampling points (belt transect lengths varied). Belt transects were established using hip chains to record the total number of individuals observed within 0.5 m on either side of the transect.

**Taxonomy and systematics:** Dorn, R. D. 1992. Vascular plants of Wyoming. 2nd Edition. Mountain West Publishing, Cheyenne, Wyoming.

### **CLASS III. DATA SET STATUS AND ACCESSIBILITY**

**For internal use only.**

### **CLASS IV. DATA STRUCTURAL DESCRIPTORS**

#### **A. Data set file**

**Identity:** YNPpatches.txt

**Size:** 690 kb

**Format and storage mode:** ASCII text, tab delimited. No compression scheme was used.

**Missing value code:** “.”

**Header information:** See variable names in Section B.

**Alphanumeric attributes:** Uppercase

**Authentication procedures:** Column sums (see tables below)

#### **B. Variable Information**

<b>Variable Name</b>	<b>Variable definition</b>	<b>Units</b>	<b>Range for Numeric Values</b>	<b>Column sum</b>
<i><b>General information about sampling point</b></i>				
<b>YEAR</b>	Year sampled	N/A		
<b>SITE</b>	Name of site (Cougar, Lake or Fern)	N/A		
<b>PATCH</b>	Small, medium or large patch size	N/A		
<b>TRANS</b>	Orientation of transect (NE, NW, SW or SE)	N/A		
<b>DCTR</b>	Distance along transect from	meters		

Variable Name	Variable definition	Units	Range for Numeric Values	Column sum
	center of patch			
<b>ELEV</b>	Elevation of sampling point	meters	2112-2666	4116855
<b>SLOPE</b>	Slope	degrees	0-40	22603
<b>ASP</b>	Aspect	N/A	1-7	6150
<b>BURN</b>	<p>0=unburned, no sign of fire effects;</p> <p>1=light surface burn. Low-intensity surface fire in which canopy trees retain green needles and generally did not die, although some stems scorched. Soil organic layer still largely intact, though burned in small patches.</p> <p>2=severe surface burn. High-intensity surface fire with extensive canopy tree mortality, but needles on canopy trees are not consumed by fire; pre-fire soil organic layer largely consumed, but soil covered by dead leaves fallen from the canopy after the fire.</p> <p>3=crown fire. Needles of canopy trees completely consumed by fire; soil organic layer almost entirely consumed, and soil is bare with no litter.</p>			
<b>BURNCL</b>	<p>CR=crown fire (3);</p> <p>SB=severe-surface fire, brown needles (2);</p> <p>SG=light-surface fire, green needles (1);</p> <p>UB=unburned (0).</p> <p>This is a character value for burn severity (BURN)</p>			

Variable Name	Variable definition	Units	Range for Numeric Values	Column sum
<b>SCSSN</b>	<p>Successional stage classification:</p> <p>LP0 (0-40 yrs) = Recently burned lodgepole pine stands in the grass to seedling/sapling stage before canopy closure; trees usually &lt; 2 m in height.</p> <p>LP1 (40-150 yrs) = Closed canopy of even-aged, often dense lodgepole pine; young pole stage.</p> <p>LP2 (150-300 yrs) = Closed canopy dominated by lodgepole pine; overstory still largely intact; understory may contain small conifers, but is generally open and park like.</p> <p>LP3 (&gt;300 yrs)=Canopy quite irregular, predominantly of old lodgepole pine but containing some Engelmann spruce, subalpine fir and whitebark pine in the pole-sized class; understory usually dense.</p>			
<b>SRCEI</b>	Distance to nearest unburned forest	meters	0-655	290215
<b>SRCEII</b>	Distance to nearest severe-surface burn	meters	0-425	122845
<b>NSEROT</b>	Number of pre-fire serotinous trees of 12 trees scored for serotiny	No. (0 to 12) of 12 trees scored for serotiny in a 50-m radius plot	0-12	5314
<b>PSEROT</b>	Percent of pre-fire serotinous trees surrounding each sampling point (computed as $\text{NUMSEROT}/12 * 100$ )	Percent		
<b><i>Plant species richness</i></b>				
<b>RICH</b>	Number of plant species within 8m x 1m transect	Number	0-33	24064
<b><i>Belt transect data from focal point to next point</i></b>				
<b>BCIAR</b>	Number of	Number / ha	0-68462	1583552.5

<b>Variable Name</b>	<b>Variable definition</b>	<b>Units</b>	<b>Range for Numeric Values</b>	<b>Column sum</b>
	<i>Cirsium arvense</i> stems per hectare			
<b>BCOPA</b>	Number of <i>Collinsia parviflora</i> stems per hectare	Number / ha	0-650000	10433127.97
<b>BGADI</b>	Number of <i>Gayophytum diffusum</i> stems per hectare	Number / ha	0-1666667	37867462.16
<b>BLETT</b>	Number of <i>Lactuca serriola</i> stems per hectare	Number / ha	0-10000	98880.03
<b>BPICO1</b>	Number of 1 <sup>st</sup> yr <i>Pinus contorta</i> stems per hectare	Number / ha	0-70000	263805
<b>BPICO2</b>	Number of 2 <sup>nd</sup> yr <i>Pinus contorta</i> stems per hectare	Number / ha	0-180000	1328240
<b>BPICO3</b>	Number of 3 <sup>rd</sup> yr <i>Pinus contorta</i> stems per hectare	Number / ha	0-820000	5738788
<b>BPICO4</b>	Number of 4 <sup>th</sup> yr <i>Pinus contorta</i> stems per hectare	Number / ha	0-616000	8191351
<b>BPICO5</b>	Number of 5 <sup>th</sup> yr <i>Pinus contorta</i> stems per hectare	Number / ha	0-41520	520808
<b>BPICOX</b>	Number of all other <i>Pinus contorta</i> seedlings stems per hectare	Number / ha	0-625000	11167287
<b>BPOTR1</b>	Number of 1 <sup>st</sup> yr <i>Populus tremuloides</i>	Number / ha	0-10000	62708.43



Variable Name	Variable definition	Units	Range for Numeric Values	Column sum
	stems per hectare			
<b>BPOTR2</b>	Number of 2 <sup>nd</sup> yr <i>Populus tremuloides</i> stems per hectare	Number / ha	0-20000	251489.73
<b>BPOTR3</b>	Number of 3 <sup>rd</sup> yr <i>Populus tremuloides</i> stems per hectare	Number / ha	0-14500	184437
<b>BPOTR4</b>	Number of 4 <sup>th</sup> yr <i>Populus tremuloides</i> stems per hectare	Number / ha	0-11500	180811
<b>BPOTR5</b>	Number of 5 <sup>th</sup> yr <i>Populus tremuloides</i> stems per hectare	Number / ha	0-11000	103192
<b>BPOTRX</b>	Number of all other <i>post-fire Populus tremuloides</i> stems per hectare	Number / ha	0-45000	388754.94
<b>Percent cover data</b>				
<b>PARCO</b>	Percent cover of <i>Arnica cordifolia</i>	Percent	0-40	3181.5
<b>PEPAN</b>	Percent cover of <i>Epilobium angustifolium</i>	Percent	0-72.5	34591.3
<b>PLUAR</b>	Percent cover of <i>Lupinus argenteus</i>	Percent	0-31.5	1700.83
<b>POFRBS</b>	Percent cover of all other forbs	Percent	0-72.5	16184.37
<b>PCACA</b>	Percent cover of <i>Calamagrostis</i>	Percent	0-86.5	1494

Variable Name	Variable definition	Units	Range for Numeric Values	Column sum
	<i>canadensis</i>			
<b>PCAGE</b>	Percent cover of <i>Carex geyeri</i>	Percent	0-47	3706.33
<b>PCALA</b>	Percent cover of <i>Calamagrostis</i> spp. (recorded in 1996 only)	Percent	0-86.5	7503.6
<b>PCARO</b>	Percent cover of <i>Carex rossii</i>	Percent	0-46.5	6650.9
<b>PCARU</b>	Percent cover of <i>Calamagrostis rubescens</i>	Percent	0-52	3088.6
<b>POGRMS</b>	Percent cover of all other graminoids	Percent	0-95	17258.77
<b>PCEVE</b>	Percent cover of <i>Ceanothus velutinus</i>	Percent	0-33	319
<b>PVASC</b>	Percent cover of <i>Vaccinium scoparium</i>	Percent	0-75	3969.17
<b>POSHRB</b>	Percent cover of all other shrubs	Percent	0-35	2083
<b>PABLA</b>	Percent cover of <i>Abies lasiocarpa</i>	Percent	0-17.5	78.5
<b>PPIAL</b>	Percent cover of <i>Pinus albicaulis</i>	Percent	0-55.5	103
<b>PPICO</b>	Percent cover of <i>Pinus contorta</i>	Percent	0-60.5	8840.6
<b>PPIEN</b>	Percent cover of <i>Picea engelmannii</i>	Percent	0-8	19.5
<b>PPOTR</b>	Percent cover of <i>Populus tremuloides</i>	Percent	0-8	156.5
<b>PBOUL</b>	Percent cover of boulders	Percent	0-30	2173.2
<b>PCOBB</b>	Percent cover	Percent	0-19	2850.8

Variable Name	Variable definition	Units	Range for Numeric Values	Column sum
	of cobbles			
<b>PPEBB</b>	Percent cover of pebbles	Percent	0-80	13659
<b>PSOIL</b>	Percent cover of bare mineral soil	Percent	0-94.5	58621.13
<b>PMOSS</b>	Percent cover of moss	Percent	0-58.5	10135.1
<b>PLITR</b>	Percent cover of unburned litter	Percent	0-93	59899.03
<b>PCHAR</b>	Percent cover of charred litter	Percent	0-44.5	6434.63
<b>PROOT</b>	Percent cover of tree roots	Percent	0-28	3320.9
<b>PLOG</b>	Percent cover of logs	Percent	0-57	24166.93
<b>PH2O</b>	Percent cover of open water	Percent	0-12.5	47.9
<b>PCIAR</b>	Percent cover of <i>Cirsium arvense</i>	Percent	0-24.5	335.5
<b>PCOPA</b>	Percent cover of <i>Collinsia parviflora</i>	Percent	0-11.5	169
<b>PGADI</b>	Percent cover of <i>Gayophytum diffusum</i>	Percent	0-49.5	1227
<b>PHIAL</b>	Percent cover of <i>Hieracium albiflorum</i>	Percent	0-7	193.5
<b>PLETT</b>	Percent cover of <i>Lactuca serriola</i>	Percent	0-2	3.5
<b><i>Censuses for selected species (includes tree seedlings)</i></b>				
<b>ACSDL</b>	Number of <i>Arnica cordifolia</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-30	526
<b>ACSPR</b>	Number of <i>Arnica cordifolia</i> sprouts per m <sup>2</sup>	Number / m <sup>2</sup>	0-106.5	10697.5

<b>Variable Name</b>	<b>Variable definition</b>	<b>Units</b>	<b>Range for Numeric Values</b>	<b>Column sum</b>
<b>EASDL</b>	Number of <i>Epilobium angustifolium</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-300	6903.5
<b>EASPR</b>	Number of <i>Epilobium angustifolium</i> sprouts per m <sup>2</sup>	Number / m <sup>2</sup>	0-123.5	43003.3
<b>LASDL</b>	Number of <i>Lupinus argenteus</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-11	304.5
<b>LASPR</b>	Number of <i>Lupinus argenteus</i> sprouts per m <sup>2</sup>	Number / m <sup>2</sup>	0-29	2035.5
<b>CRXSDL</b>	Number of <i>Carex</i> spp. seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-53	319.5
<b>CGSPR</b>	Number of <i>Carex geyeri</i> sprouts per m <sup>2</sup>	Number / m <sup>2</sup>	0-110.5	4773.5
<b>CROSPR</b>	Number of <i>Carex rossii</i> sprouts per m <sup>2</sup>	Number / m <sup>2</sup>	0-63	5417
<b>VSSDL</b>	Number of <i>Vaccinium scoparium</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-5	13
<b>VSSPR</b>	Number of <i>Vaccinium scoparium</i> sprouts per m <sup>2</sup>	Number / m <sup>2</sup>	0-102	12105
<b>COPA</b>	Number of <i>Collinsia parviflora</i> per m <sup>2</sup>	Number / m <sup>2</sup>	0-370	5152
<b>GADI</b>	Number of <i>Gayophytum diffusum</i> per m <sup>2</sup>	Number / m <sup>2</sup>	0-690	13407.5

<b>Variable Name</b>	<b>Variable definition</b>	<b>Units</b>	<b>Range for Numeric Values</b>	<b>Column sum</b>
<b>LETT</b>	Number of <i>Lactuca serriola</i> per m <sup>2</sup>	Number / m <sup>2</sup>	0-2.5	27
<b>CASDL</b>	Number of <i>Cirsium arvense</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-5.5	25
<b>CASPR</b>	Number of <i>Cirsium arvense</i> sprouts per m <sup>2</sup>	Number / m <sup>2</sup>	0-35	475
<b>HASDL</b>	Number of <i>Hieracium albiflorum</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-109	538
<b>HASPR</b>	Number of <i>Hieracium albiflorum</i> sprouts per m <sup>2</sup>	Number / m <sup>2</sup>	0-40	621
<b>PICO1</b>	Number of 1 <sup>st</sup> year <i>Pinus contorta</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-51.5	1030.5
<b>PICO2</b>	Number of 2 <sup>nd</sup> year <i>Pinus contorta</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-127.5	4625.5
<b>PICO3</b>	Number of 3 <sup>rd</sup> year <i>Pinus contorta</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-218	4227
<b>PICO4</b>	Number of 4 <sup>th</sup> year <i>Pinus contorta</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-101.5	2376
<b>PICO5</b>	Number of 5 <sup>th</sup> year <i>Pinus contorta</i>	Number / m <sup>2</sup>	0-50	411.5

Variable Name	Variable definition	Units	Range for Numeric Values	Column sum
	seedlings per m <sup>2</sup>			
<b>PICOX</b>	Number of all other <i>Pinus contorta</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-315.5	5667.7
<b>ABLA</b>	Number of <i>Abies lasiocarpa</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-2	6
<b>PIAL</b>	Number of <i>Pinus albicaulis</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-8.5	14
<b>PIEN</b>	Number of <i>Picea engelmannii</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-1.5	3.5
<b>PSME1</b>	Number of 1 <sup>st</sup> year <i>Pseudotsuga menziesii</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-2	5
<b>PSME2</b>	Number of 2 <sup>nd</sup> year <i>Pseudotsuga menziesii</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-9	56
<b>PSMEX</b>	Number of all other <i>Pseudotsuga menziesii</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-10	107
<b>POTR1</b>	Number of 1 <sup>st</sup> year <i>Populus tremuloides</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-13	59

<b>Variable Name</b>	<b>Variable definition</b>	<b>Units</b>	<b>Range for Numeric Values</b>	<b>Column sum</b>
<b>POTR2</b>	Number of 2 <sup>nd</sup> year <i>Populus tremuloides</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-8.5	79
<b>POTR3</b>	Number of 3 <sup>rd</sup> year <i>Populus tremuloides</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-73.5	137
<b>POTR4</b>	Number of 4 <sup>th</sup> year <i>Populus tremuloides</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-2.5	43.5
<b>POTR5</b>	Number of 5 <sup>th</sup> year <i>Populus tremuloides</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-3.5	15
<b>POTRX</b>	Number of all other <i>Populus tremuloides</i> seedlings per m <sup>2</sup>	Number / m <sup>2</sup>	0-7	61