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Effects of Fire on Soil Seed Banks on the Hanford Site

Sarah Baker
Office of science, DOE ERULF
University of Washington
Pacific Northwest National Laboratory
Richland, WA 99352

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Participant: ____
Signature

Research advisor: ____
Signature

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Abstract

The Hanford wildfire in the summer of 2000 destroyed much of the vegetation on the Hanford site, often resulting in soil erosion and dust storms. The 200 W area has been affected by dust storms, and a re-vegetation project has been planned for the area to the west, the source of much of the dust. To determine if the seed bank in this area had been damaged by the fire, inhibiting natural re-growth, soil samples were collected from three burned areas and watered to see how much seedling emergence would occur. The soil was then sifted for grass seeds and the seeds examined for signs of fire damage. From this data it was concluded that significant damage to the seed bank probably occurred in the 200 W expansion area, and slight damage may have occurred primarily to monocot seeds in the seed banks farther west.

Research category (circle one):

Physics Chemistry Biology Engineering Computer Science Other_____

School author attends: University of Washington
DOE National Laboratory Attended: Pacific Northwest National Laboratory
Mentor's Name: Dr. Michael Sackschewsky
Phone: (509) 376-2554
E-mail: michael.sackschewsky@pnl.gov

Author's name: Sarah Baker
Mailing address: 172 Kranichwood St.
City/State Zip: Richland, WA 99352
Phone: (509) 627-4002
E-mail address: saraheb99@hotmail.com

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Introduction

On June 27, 2000 a fatal car accident on the Hanford Site sparked a fire, the intensity of which the area had not witnessed in years. This fire raged for many days and eventually consumed 163,884 acres, many of those on central Hanford and the neighboring Arid Lands Ecology Reserve (ALE).

This fire had a massive impact on the vegetation of the Hanford site. Most of the effected *Artemisia tridentata* (big sagebrush) and bunchgrass communities, which comprise roughly half of the Hanford site vegetation, experienced greater than 75% vegetative loss (BAER 2000). Complete destruction of all vegetation occurred on approximately 85% of the burned areas. These areas experienced severe fire intensity, resulting in complete consumption of vegetation and organic litter on the soil surface (BAER 2000).

One such devastated area is located in the 200 W expansion area. As can be seen on other areas of Hanford, the loss of vegetation has resulted in soil erosion and wind blown soil. Much of this dust blows west into the 200 W Area, creating unsafe and unhealthy working conditions for the people there. This has become a concern, and the possibility of planting native grasses as erosion control has been considered. This procedure would have to take place in the fall when adequate precipitation is present. It would be unnecessary to do so, however, if the natural vegetation was going to return on its own in a reasonable amount of time.

In order for the natural vegetation to return a viable seed bank would have to exist within the upper soil horizon. Seed banks are vital to arid ecosystems, where seeds can survive in the soil for many years and germinate when the conditions are suitable (Guo, Rundel, and Goodall 1998). The Burn Area Emergency Rehabilitation (BAER) report predicted that the seed bank was not affected by the Hanford fire since it moved quickly. To confirm this, the BAER team collected soil samples from within the burn area and watered them for a five-day period, a process that did result in germination of unidentified seedlings. This demonstrated that the seed bank was intact and would germinate with adequate precipitation.

The BAER seed bank study did not indicate where the soil samples were collected, or indicate what species of seedlings emerged. To determine if the BAER findings would apply to the 200 W Area, I conducted a similar trial under the guidance of Dr. Michael Sackschewsky. In addition, grass seeds were separated from the soil and examined to determine how much fire scarring occurred. Due to time and equipment constraints, dicot seeds were not examined. This process provided insight into whether growth in the watered samples was affected by fire damage, or simply representative of the amount of seed in the seed bank.

Methods

Study Sites

The seed bank study consisted of four sites near 200 W, sites A, B, C, and D. The first site, site A, was within the 200 W expansion area on Quincy sand substrate. Prior to the fire this area contained a diverse and well-established population of native vegetation, including such species as sagebrush, *Grayia spinosa* (spiny hopsage), and many types of bunchgrasses and native forbs (Sackschewsky et al. 1992). *Bromus tectorum* (cheatgrass) was also present, but not to the extent of many other areas on the Hanford site. Sites B and C were located roughly 1.5 miles to the west, on Esquatzel silt loam. The vegetation of sites B and C was classified as post-fire shrub steppe, due to a fire several years before. The vegetation consisted of such species as *Chrysothamnus nauseosus* (gray rabbitbrush), *Chrysothamnus viscidiflorus* (green rabbitbrush), cheatgrass, native grasses, and native forbs. Established sagebrush was also present, having been planted four years earlier.

As a control group, an unburned area to the south of 200 W near Army Loop road was chosen as study site D. This site had the same soil type and vegetation classification as site A.

Data collection

Using standard soil moisture tins, five soil samples were collected from each site by pressing the tin into the soil and removing the surface core. This was done every 5 meters along 20 meter transect lines at each location. Any roots or surface litter present was included in the samples.

Each sample was mixed and divided into two 175 ml sub-samples. One sub-sample from each sample was placed in dishes and watered daily. If daily watering was not possible, the samples were covered with plastic to prevent drying. On the second day an overhead halogen lamp was added on a 12 - hour per day cycle to provide additional light. With the light in place, the average temperature of the samples was approximately 20 degrees C. Samples were randomized daily, all seedling emergence recorded, and all seedlings classified as dicot or monocot. This process continued for 30 days, from July 7, 2000, until August 18, 2000. Emergence from the burn samples was negligible the last week of the study, so it did not seem necessary to continue (Figure 1). This was in keeping with previous seed bank studies that indicate most seedling emergence occurs within the first three weeks and subsequent emergence is usually insignificant (Thompson and Grime 1979). Selected samples were kept alive until September 1, 2000, to facilitate possible identification.

Each soil sample was then air dried and sifted using 0.5 and 1.0 mm sieves from a set of fine soil sieves to separate particles larger than 0.5 mm. These particles were then examined under a 0.67-4x magnification microscope and any intact grass seeds or seed fragments were separated. These were then counted and examined for evidence of fire scarring and damage.

Results

The soil sample watering resulted in sizeable emergence from sub-samples in areas B, C, and D (Figure 2) Of the three burn sites, site C showed the highest total emergence with a total of 49 seedlings; 46 dicots and 3 monocots. Several of these dicots were later identified as the introduced and widespread weed *Lactuca serriola* (prickly lettuce). Site B had the second highest emergence with a total of 40 seedlings; 27 dicots and 13 monocots. Only one seedling, later identified as the common weed *Descurainia pinnata* (western tansymustard), emerged from the site A samples. Site D, the control group, showed the highest emergence with a total of 67 seedlings; 44 monocots and 23 dicots. Site D showed a wide variety of seedlings, including 42 cheatgrass individuals, three individuals of another grass species, numerous unidentified dicots, and a possible E*pilobium* (willowherb) individual. Identification of the seedlings was difficult due to their small size and immaturity.

Table 1 shows the results of the soil sieving procedure. Site A samples contained 61 grass seeds and seed fragments, with 19 of those showing signs of fire damage. Sites B and C showed the highest amount of grass seed present, with 368 and 607 seeds and seed fragments respectively. Site B contained 43.2% burned seed, and site C contained 36.1% burned seed. The control site contained 117 seeds and seed fragments, with none showing signs of fire damage.

Discussion

It is possible that the fire affected the seed bank of site A. This option seems the most obvious since only one seedling emerged out of the site A samples, as compared to the 67 total seedlings from the control area. The two areas had the same soil types and pre-fire vegetation classifications, so site A emergence should have resembled emergence from the control site. It did not, so it is likely that the fire damaged the seed bank in site A. The soil sieving data also supports this since 31.2% of the 69 grass seeds found in site A were burned. It is possible that the samples taken from site A were not representative of the seed bank, but this seems unlikely. Wind erosion is another possible explanation for the low germination from site A. If the wind removed soil, it would also have removed seed with it. This could be the cause of the low germination and low seed count from site A. Whatever the cause, however, it is apparent that the seed bank of site A has been damaged and may not be completely viable.

It appears that the fire affected the moncot seeds in the seed banks of sites B and C as well. Site D, the control site, had 44 grasses emerge. Sites B and C had less, 13 and three grass seedlings respectively (Figure 2). This is supported by the fact that 43.2% of the ungerminated grass seed and seed fragments in site B were burned, and 36.1% were burned in site C. Thus, it is possible that the fire may have damaged the grass seed in these sites and contributed to low germination.

The dicots in these sites, however, do not show any negative effects. Sites B and C actually showed greater dicot emergence than the control site (Figure 2). The fact that most arid land dicot seeds are smaller than grass seed is a possible explanation for this lack of fire damage. While the larger grass seeds tend to stay near the surface, the smaller dicots become buried deeper in the soil and shielded from the fire. This finding is supported by previous research indicating that cheatgrass, and species of *Agropyron* and *Poa* are often the only taxa with significantly lower seed pools after a fire (Hassan and West 1986).

The seed banks in sites B and C may have been damaged slightly by the fire, but it appears that site A received considerable fire damage. Although native perennial grasses and some shrubs may re-sprout and help re-vegetate the 200 W expansion area, soil erosion may remain a problem without growth from the seed bank. Before the completion of this study it was decided that a re-vegetation project would take place in the 200 W expansion area to control soil erosion. *Poa sandbergii* (Sandberg's bluegrass) and *Agropyron cristatum* (crested wheatgrass) were chosen for the project. The results of this study support this decision, and it appears that human intervention into the re-vegetation of this area is warranted.

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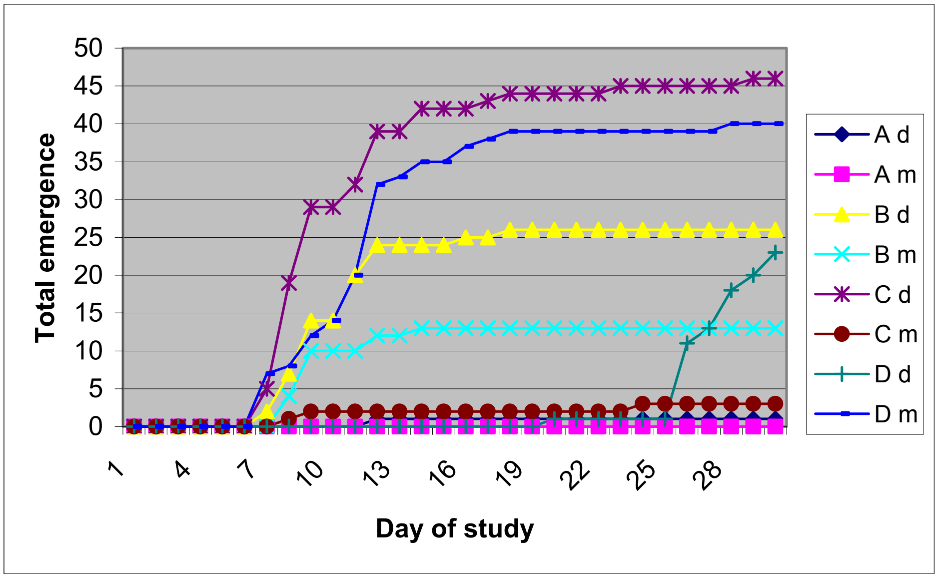
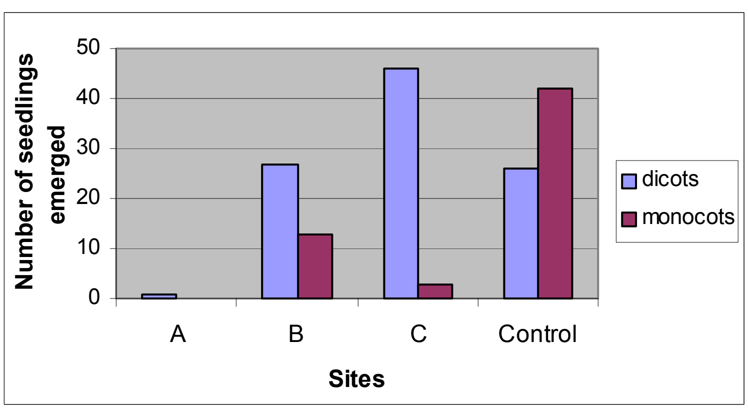
Figure 1:

Tables and Figures



Total seedling emergence over the study period (7/30-8/18). Each study site is shown and seedling types are indicated (‘d’ indicates dicot seedlings, ‘m’ indicates monocot seedlings).

Figure 2



Total seedling emergence from each site.

Table 1:

Site A			Site B			Site C			Site D		
Sample	Total seed	Burned	Sample	Total seed	Burned	Sample	Total seed	Burned	Sample	Total seed	Burned
1	8	3	1	18	12	1	149	54	1	38	0
2	8	3	2	99	35	2	154	54	2	19	0
3	9	6	3	22	8	3	46	21	3	32	0
4	32	7	4	194	84	4	222	74	4	25	0
5	4	0	5	35	19	5	36	16	5	8	0
Total:	61	19	Total:	368	159	Total:	607	219	Total:	117	0

Total grass seed and seed fragments, and total burned seed and seed fragments per soil sample.

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