Research Questions

1. Are nitrogen-fixing and ammonia-oxidizing bacteria present in burned soils after fires of different intensities?
2. Are there differences in the presence/absence of nitrogen-fixing and ammonia-oxidizing bacteria between burned and control sites?
3. Are there differences in the species of ammonia-oxidizing bacteria present in burned and control soils?

Conclusions

1. Intensively burned soils yielded less DNA from surface samples (0-10 cm) than the corresponding lower (0-20 cm) samples. Three out of four time-points yielded greater DNA from non-burned than from burned soils except at one site.
2. A lower amplification efficiency was observed for amoA (54%) than for nirS (76%) in samples collected one and three months after the fire. The number of samples from which amoA could be amplified increased to 91% and 92% at five and 14 months after the fire, respectively, while the number of samples from which nirS could be amplified remained relatively constant at 5 and 14 months.
3. Close to three-quarters of amoA sequences isolated from non-burned soils showed no discernible pattern of species distribution.
4. T-RFLP profiles of the nirS PCR pool obtained from non-burned samples tended to group separately from the nirS profiles of moderately and badly burned samples as determined by statistical analysis.
5. Taken together, our results suggest that the fire severely decreased the number of ammonia-oxidizing bacteria in the surface soils, yet did not have a lasting effect on the composition of these bacteria. On the other hand, it appears that fire does alter the composition of the diazotrophic community.

Abstract

The Cerro Grande Fire burned 50,000 acres of forest surrounding Los Alamos, NM in early May 2000, and created regions of badly burned, moderately burned, and unburned soils. To investigate the community structure of nitrogen cycling bacteria in soil following burns of different heat intensities, samples were taken to a depth of 10 cm, from four plots within each burn treatment type at one month, three months, five months, and 14 months after the fire. DNA was extracted from samples using a bead-mill homogenization technique, and was quantified. The total amount of DNA increased during the three-month time point in all samples, possibly due to seasonal precipitation. Unburned soils usually contained more extractable DNA, while moderately and badly burned soils had comparable amounts of extractable DNA. Using primers specific for the amoA (ammonia-oxidizing bacterial) and the mnf (nitrogen-fixing bacterial) genes, nested PCR results showed a general trend of fewer samples with detectable amoA (44% of samples) from the one and three month time points. Nitrogen fixers showed a stronger presence (88% of samples based on amplifiable nirS) during this same time period. The number of samples from which amoA could be amplified increased to 91% and 92% at five and 14 months, respectively. The number of samples from which nirS could be amplified remained relatively constant at five and 14 months.

Introduction

Fire plays an important role in many ecosystem processes and is particularly crucial for the release of nutrients that are tied up in soils and litter (Wright and Bailey 1978). Depending on the degree of heating, fire can produce a range of short-term effects on the ecosystems including: an increase in soil temperature that can kill many microorganisms, lower relative humidity close to the ground due to loss of insulating vegetation and litter, destruction of much of the N and C in the litter, and increase in soil ammonium levels. Many studies have examined the impact of fire on plants and animals, but few studies have examined the impact of fire on soil microorganisms, and few of these used culture-independent methods (an example is Burgos et al. 2000). From these limited studies it appears that the intensity of the burn is a key factor in determining which microbial species survive. In general, it has been observed that spore formers and acidophilic bacteria survive better, and cyanobacterial, fungal, and algal populations are depressed by fire (Vazquez et al. 1993). The release of nutrients and comminuting elimination of vegetation (removing a major N sink) can allow microbial species, especially nitrifiers, to flourish. Indeed, previous studies found strong effects of fire on soils, and nitrifiers (Aber and Gonsalez 1999), including decreases (Klopetak et al. 1990) and increases in nitrogen-fixing species. However, specific information on the fate of nitrogen-fixers and nitrogen-oxidizers following fires of differing intensities; their recovery over time, and the nature of the species composition remaining among the surviving bacterial and fungal populations is currently lacking. The goal of the current study is to investigate whether ammonia oxidizers and nitrifiers survive following fires of differing intensities, their recovery over time, and the nature of the species composition remaining among the surviving bacterial and fungal populations is currently lacking. The goal of the current study is to investigate whether ammonia oxidizers and nitrifiers survive following fires of differing intensities, their recovery over time, and the nature of the species composition remaining among the surviving bacterial and fungal populations is currently lacking. The goal of the current study is to investigate whether ammonia oxidizers and nitrifiers survive following fires of differing intensities, their recovery over time, and the nature of the species composition remaining among the surviving bacterial and fungal populations is currently lacking.