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Bootstrapping in ecosystems.

Perry, DA; Amaranthus, MP; Borchers, JG; Borchers, SL; Brainerd, RE
Bioscience. Vol. 39, no. 4, pp. 230-237. 1989.

Within the constraints of resource supply or other environmental factors, the biological system characterized by strong positive feedback among its components is in many respects self-generating--its productivity and stability determined largely through its internal interactions. In this article the authors review recent work on one particular relationship--reciprocal interactions between plants and soils. They argue that some ecosystems are continually pulling themselves up by their own bootstraps. Through close mutual interactions between plants and soil organisms, these ecosystems create the conditions that allow the systems to persist. Severing the close links between plants and soils has contributed to degradation of many ecosystems, and restoring these links is an important step toward rehabilitation.

Descriptors: ecosystem dynamics; ecosystem stability; soil; plants; reviews

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Mycorrhizae, mycorrhizospheres, and reforestation: Current knowledge and research needs.

Perry, DA; Molina, R; Amaranthus, MP
CAN. J. FOR. RES./J. CAN. RECH. FOR. Vol. 17, no. 8, pp. 929-940. 1987.

Management of mycorrhizae and associated organisms is an important reforestation aid. Its three major components are protection of the indigenous soil community and evaluation of inoculation needs, integration of inoculation programs into existing reforestation technology, and research. Clear-cutting frequently results in reduced mycorrhizae formation, particularly when reforestation is delayed and no other host plants are present to maintain fungal populations. Implications of such reductions for reforestation vary with environmental factors and tree species. Adequate mycorrhiza formation is especially critical for ectomycorrhizal trees growing on poor soils or in environments where seedlings must establish quickly to survive. It may also be important where early successional, noncrop plants do not support the same mycobiont as the crop. In such circumstances, a self-reinforcing trend may develop, with poor mycorrhiza formation reducing seedling survival and poor tree stocking leading to further loss of mycorrhizal inocula.

Descriptors: reforestation; reviews; forests; forest management; rhizosphere

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Effect of soil transfer on ectomycorrhiza formation and the survival and growth of conifer seedlings on old, nonreforested clear-cuts.

Amaranthus, MP; Perry, DA
CAN. J. FOR. RES./J. CAN. RECH. FOR. Vol. 17, no. 8, pp. 944-950. 1987.

Small amounts (150 mL) of soil from established conifer plantations and mature forest were transferred to planting holes on three clear-cuts in southwest Oregon and northern California to enhance mycorrihiza formation. The clear-cuts, 8-27 years old and unsuccessfully reforested, included a range of environmental conditions. At Cedar Camp, a high-elevation (1720 m) southerly slope with sandy soil, transfer of plantation soils increased 1st-year Douglas-fir (Pseudotsuga manziesii (Mirb.) Franco) seedling survival by 50%. Soil from a plantation on a previously burned clear-cut doubled mycorrhiza formation and tripled seedling basal area growth. Soil from mature forest did not improve survival and growth. Less dramatic effects owing to soil transfer were evident on other sites, which were lower in elevation and had clayey soils with greater water-holding capacity, and where woody shrubs had apparently preserved mycorrhizal fungi. Soil from a plantation on a previously unburned clear-cut increased mycorrhizal branching on sugar pine (Pinus lambertiana Dougl.) seedlings.

Descriptors: soil; seedlings; clear cutting; growth; survival; Pseudotsuga menziesii; Pinus lambertiana

http://www.csa.com/partners/viewrecord.php?requester=gs&collection=ENV&recid=3567354

The functioning of ectomycorrhizal fungi in the field: Linkages in space and time

Amaranthus, MP; Perry, DA
Plant and Soil [PLANT SOIL]. Vol. 159, no. 1, pp. 133-140. 1994.

Individual trees, either of the same or different species, can be linked spatially and temporally by the hyphae of ectomycorrhizal (ECM) fungi that allow carbon and nutrients to pass among them and promote forest establishment following disturbance. Spatial and temporal linkages between plants influence the function of ECM fungi in the field. Studies indicate that ECM linkages can reduce plant competition for resources, promote forest recovery, and influence the pattern of plant succession. The degree of influence depends on many factors, including the composition and arrangement of the vegetative community and soil and climatic conditions. Management practices that create intense disturbance and loss of organic matter or promote the introduction of non-ectomycorrhizal host species can decrease the ability of plants to form linkages with ECM fungi. Management practices that retain living trees and shrubs and input of organic matter provide the energy source and substrate necessary for ECM linkages.

More research is needed to determine the degree to which ECM fungal linkages occur in the field and their role in ecosystem function and long-term health.

Descriptors: trees; ectomycorrhizas; nutrient transport

http://md1.csa.com/partners/viewrecord.php?requester=gs&collection=ENV&recid=4702879

Diversity and host specificity of ectomycorrhizal fungi retrieved from three adjacent forest sites by five host species

Massicotte, HB; Molina, R; Tackaberry, LE; Smith, JE; Amaranthus, MP
Canadian Journal of Botany/Revue Canadien de Botanique [Can. J. Bot./Rev. Can. Bot.]. Vol. 77, no. 8, pp. 1053-1076. Aug 1999.

Seedlings of Abies grandis (Dougl.) Lindl. (grand fir), Lithocarpus densiflora (Hook. & Arn.) Rehd. (tanoak), Pinus ponderosa Dougl. ex Laws. (ponderosa pine), Pseudotsuga menziesii (Mirb.) Franco (Douglas-fir), and Arbutus menziesii Pursh (madrone) were planted in mixture and monoculture in soil collected from three adjacent forest sites in southwestern Oregon (a clearcut area, a 25-year-old Douglas-fir plantation, and a mature 90- to 160-year-old Douglas-fir - pine forest) to determine the effect of host tree diversity on retrieval of ectomycorrhizal morphotypes. In this greenhouse bioassay, 18 morphotypes of mycorrhizae were recognized overall from all soils with a total of 55 host-fungus combinations: 14 types with ponderosa pine, 14 with Douglas-fir, 10 with tanoak, 10 with grand fir, and 7 for madrone. Four genus-specific morphotypes were retrieved (three on ponderosa pine and one on Douglas-fir), even in mixture situations, demonstrating selectivity of some fungal propagules by their respective host. Five types were detected on all hosts, but not necessarily in soils from all sites. The remaining nine types were associated with two, three, or four hosts, which indicates a wide potential for interspecific hyphal linkages between trees. More morphotypes were retrieved from the monoculture treatments compared with the mixture treatments, although the differences were not significant. Several examples of acropetal replacement of one fungus by another (interpreted as succession) were recorded on all hosts during the course of the experiment. These results illustrate the importance of different host species in maintaining ectomycorrhizal fungus diversity, especially fungi with restricted host range, and the strong potential for fungal linkages between trees in forest ecosystems.

Descriptors: Ectomycorrhizas; Species composition; Host specificity; Species diversity; Trees; USA, Oregon

http://www.csa.com/partners/viewrecord.php?requester=gs&collection=ENV&recid=4517150

Evaluating the Effects of Varying Levels and Patterns of Green-tree Retention: Experimental Design of the DEMO Study

Aubry, KB; Amaranthus, MP; Halpern, CB; White, JD; Woodard, BL; Peterson, CE; Lagoudakis, CA; Horton, AJ
Northwest Science [Northwest Sci.]. Vol. 73, suppl., pp. 12-26. 1999.

In western Oregon and Washington, recent changes in federal forest management policy contained in the Northwest Forest Plan have led to new harvest prescriptions on millions of acres of public lands. For example, on upland sites, standards and guidelines now require that live (green) trees are retained in at least 15% of the area within each harvest unit and recommend that at least 70% of this retention is in patches of moderate to larger size (0.2-1.0 ha or more). These prescriptions for green-tree retention were based on the professional judgement and collective knowledge of many of the biologists who have studied the organisms and ecological processes that characterize these forests, but they have not been rigorously tested nor implemented on a broad geographic scale. Several prescriptions for green-tree retention are being evaluated experimentally by the Demonstration of Ecosystem Management Options (DEMO) study. In this paper, we briefly review recent changes in forest management policy and existing information gaps that led to the establishment of the DEMO study. We then provide an overview of the criteria for site selection, the experimental design and harvest prescriptions, the scope of scientific inquiry, and the collaboration that has occurred between scientists and land managers. These discussions provide the context and experimental framework for the individual research papers that comprise the remainder of this volume.

Descriptors: Forest practices; Harvesting; Patches; Research programs; Government policy; USA, Pacific Northwest

Logging and forest roads related to increased debris slides in southwestern Oregon.

Amaranthus, MP; Rice, RM; Barr, NR; Ziemer, RR
Journal of Forestry [J. FOR.]. Vol. 83, no. 4, pp. 229-233. 1985.

Debris slides over a 20-year period were inventoried on 137,500 acres of forested land in the Klamath Mountains of southwest Oregon. Frequency during the study period was about one slide every 4.3 years on each 1,000 acres--an erosion rate of about 1/2 yd super(3) per acre per year. Erosion rates on roads and landings were 100 times those on undisturbed areas, while erosion on harvested areas was seven times that of undisturbed areas. Three-quarters of the slides were found on slopes steeper than 70 percent and half were on the lower third of slopes. The results serve as a guide to appraising slide risk associated with planned timber harvests or road construction on forested slopes.

Descriptors: soil erosion; roadsides; forestry; environmental impact

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Volume 4 Page 266 - September 1990
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Volume 4 Issue 3

Species Migrations and Ecosystem Stability During Climate Change: The Belowground Connection

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Abstract: Compatibility between the belowground mutualists of resident species and the needs of immigrant species will strongly influence the successful transition from one perennial plant community to another during climate change. A hiatus in the overlap between plant species that maintain a positive link with the soil ecosystem could result in site capture by weeds and rapid degradation of the productive capacity of soils. We discuss instances in which such rapid degradation has occurred and argue for the crucial importance of protecting plant-soil links in the coming decades through maintaining biodiversity and utilizing management practices that help plants keep a firm grip on the soil. Examples of the latter include partial and dispersed cutting in forestry, use of green cover crops in agriculture and grazing intensities that permit degraded range to rebuild.

http://md1.csa.com/partners/viewrecord.php?requester=gs&collection=ENV&recid=4517153

Interaction of Fungal Sporocarp Production with Small Mammal Abundance and Diet in Douglas-fir Stands of the Southern Cascade Range

Cazares, E; Luoma, DL; Amaranthus, MP; Chambers, CL; Lehmkuhl, JF
Northwest Science [Northwest Sci.]. Vol. 73, suppl., pp. 64-76. 1999.

Small mammal population densities are highly variable across forest stands and landscapes. The species composition and abundance of ectomycorrhizal fungi (EMF) may influence the ability of forests to provide suitable habitat for small mammals. Identification and interpretation of changes in the abundance of these organisms, or in their inter-relationships due to experimental harvest, require that we first identify the patterns and potential causes of natural variability in the pre-harvest communities. Pretreatment data were gathered from the Watson Falls block of a green-tree retention experiment to establish baseline conditions. The six experimental treatments that comprise this block lie in two spatially distinct areas that differ in environment and forest composition. The initial variability in EMF, small mammals, and their relationships was documented. Three primary questions are addressed in this paper: (1) Are the abundance and species composition of EMF sporocarps similar between the two areas of the Watson Falls block? (2) How does sporocarp consumption vary among small mammal species and by area? (3) For common truffle genera, is sporocarp biomass

correlated with the spore frequency of those genera in small mammal diets? The Watson Falls block was found to have spatial and temporal variation in EMF production, small mammal mycophagy, and small mammal abundance. However, truffles were consistently the primary food item in the diet of all three small mammal species in this study. Small mammals are potentially important agents of truffle dispersal into disturbed areas where EMF are locally extirpated. This study furthers knowledge of the role of small mammal mycophagy in the functioning of forest ecosystems.

Descriptors: Fungi; Abundance; Mycophagy; Dispersal; Forests; USA, Oregon; Mammalia

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Research Article
Effects of erosion on ecto- and VA-mycorrhizal inoculum potential of soil following forest fire in southwest Oregon

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Received: 7 August 1992 Accepted: 11 December 1992
Abstract The Longwood Complex wildfire in the Siskiyou Mountains of southern Oregon in August 1987 created an opportunity to study erosion and its effects on mycorrhizal fungus inoculum potential of a forest soil on steep slopes. As measured by the erosion-bridge method, most erosion occurred in a single, intense storm in December after the fire and amounted to an estimated 2 to 4 cm of surface soil. Captured eroded soil had a higher pH and P and Mg levels than residual soil. Seedlings ofLibocedrus decurrens andPseudotsuga menziesii were planted on eroded plots with additions of captured eroded soil (ET) or pasteurized eroded soil (PET) transferred to the planting holes. After one growing season,Libocedrus seedlings formed nearly 4 times the vesicular-arbuscular mycorrhizae in ET treatments and more than twice as much in PET treatments than in controls. Survival and basal area growth were significantly better in ET than in the other treatments, and both ET and PET produced more seedling shoot growth than did controls.Pseudotsuga seedlings did not differ in measured

characteristics between treatments; ectomycorrhiza formation was slight, evidently the result of reduced inoculum potential resulting from the fire.

Key words Libocedrus - ectomycorrhizae - erosion - inoculum potential - Pseudotsuga - vesicular-arbuscular mycorrhizae – wildfire

http://md1.csa.com/partners/viewrecord.php?requester=gs&collection=ENV&recid=2522577

The plant-soil bootstrap: Microorganisms and reclamation of degraded ecosystems.

Perry, DA; Amaranthus, MP

Plants divert large amounts of energy belowground, where it creates favorable soil structure and supports soil organisms--such as mycorrhizal fungi--that benefit plant growth. Disrupting the positive links between plants and soils may have contributed to the degradation of numerous ecosystems, including high elevation forests, both moist and dry tropical forests, and grasslands. Reestablishing beneficial soil organisms has facilitated reclamation of some sites, and is likely to aid reclamation of others as well.

Descriptors: mycorrhizas; plants; rhizosphere

http://md1.csa.com/partners/viewrecord.php?requester=gs&collection=ENV&recid=3589510

Soil moisture, native revegetation, and Pinus lambertiana seedling survival, growth, and mycorrhiza formation following wildfire and grass seeding

Amaranthus, MP; Trappe, JM; Perry, DA
Restoration Ecology [RESTOR. ECOL.]. Vol. 1, no. 3, pp. 188-195. 1993.

Grass seeding is widely used for erosion control, but its consequences for soil and regeneration following fire have been measured only infrequently. This study investigates the effect of grass seeding on the type and extent of plant cover; soil moisture percentage; and moisture stress, survival, growth, and root-tip and mycorrhiza formation of Pinus lambertiana (sugar pine) seedlings in a clearcut intensely burned by wildfire. One-year-old containerized sugar pine seedlings were planted in seeded and nonseeded areas in Spring 1988 and 1989 in the Longwood Fire area of southwest Oregon. In 1988, tree seedlings in grass-seeded plots experienced intense competition from the grass, reduced root-tip and mycorrhiza formation, low levels of soil moisture to meet evapotranspirational demand, high levels of mortality, and reduced growth. In 1989, however, the opposite was true: tree seedlings in nonseeded plots experienced competition from invading native annuals and perennials, low levels of soil moisture in summer, and higher levels of mortality. The studies we report here further indicate that, in an area characterized by extended summer drought, annual ryegrass impeded regeneration of sugar pine during the first season following the fire. Native species

cover and richness have been significantly reduced in the seeded area and may affect long-term soil stability, productivity, and conifer restoration. Seeding of annual ryegrass at high rates under these conditions would seem ill advised.

Descriptors: forests; clearings; wildfire; seeding; revegetation; mycorrhizas; vegetation; erosion control; soil erosion; water stress; soil water; incineration; drought; Pinus lambertiana; Secale; USA, Oregon

http://www.springerlink.com/(101sqp45nfloqc55olaj1t55)/app/home/contribution.asp?referrer=parent&backto=issue,5,6;journal,31,41;linkingpublicationresults,1:402971,1

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Research Note
Rapid root tip and mycorrhiza formation and increased survival of Douglas-fir seedlings after soil transfer

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Received: 10 August 1988 Accepted: 23 February 1989
Abstract In order to re-inoculate soil with mycorrhizal fungi, small amounts (about 150 ml) of soil from an established Douglas-fir plantation were added to planting holes when Douglas-fir seedlings were planted on an old, unrevegetated clearcut in the Klamath Mountains of Oregon. Seedlings were lifted throughout the growing season to determine the influence of soil transfer on the rate of root tip initiation and mycorrhiza formation. Six weeks after planting, seedlings receiving plantation soil had formed 62% more root tips than controls; however, no statistically significant differences were apparent 15 weeks after planting. By that time, a small percentage of root tips were visibly mycorrhizal; seedlings receiving transferred soil had the most colonization (13.6 vs 3.5 per seedling, p le0.05). Of seedlings receiving transfer soil, 36.6% survived the first growing season, compared to 11.3% of control seedlings. At this high elevation, soils often remain frozen well into spring, leaving only a brief period betwen the time when soils become warm enough for root growth and the onset of summer drought. Under these conditions, the rapid root growth and mycorrhiza formation stimulated by plantation soil increases the ability of seedlings to survive the first growing season.

Key words reforestation - root-tip production - soil biology - soil transfer - survival
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Diversity and host specificity of ectomycorrhizal fungi retrieved from three adjacent forest sites by five host species

H. B. Massicotte, R. Molina, L. E. Tackaberry, J. E. Smith, and M. P. Amaranthus

Abstract: Seedlings of Abies grandis (Dougl.) Lindl. (grand fir), Lithocarpus densiflora (Hook. & Arn.) Rehd. (tanoak), Pinus ponderosa Dougl. ex Laws. (ponderosa pine), Pseudotsuga menziesii (Mirb.) Franco (Douglas-fir), and Arbutus menziesii Pursh (madrone) were planted in mixture and monoculture in soil collected from three adjacent forest sites in southwestern Oregon (a clearcut area, a 25-year-old Douglas-fir plantation, and a mature 90- to 160-year-old Douglas-fir - pine forest) to determine the effect of host tree diversity on retrieval of ectomycorrhizal morphotypes. In this greenhouse bioassay, 18 morphotypes of mycorrhizae were recognized overall from all soils with a total of 55 host-fungus combinations: 14 types with ponderosa pine, 14 with Douglas-fir, 10 with tanoak, 10 with grand fir, and 7 for madrone. Four genus-specific morphotypes were retrieved (three on ponderosa pine and one on Douglas-fir), even in mixture situations, demonstrating selectivity of some fungal propagules by their respective host. Five types were detected on all hosts, but not necessarily in soils from all sites. The remaining nine types were associated with two, three, or four hosts, which indicates a wide potential for interspecific hyphal linkages between trees. More morphotypes were retrieved from the monoculture treatments compared with the mixture treatments, although the differences were not significant. Several examples of acropetal replacement of one fungus by another (interpreted as succession) were recorded on all hosts during the course of the experiment. These results illustrate the importance of different host species in maintaining ectomycorrhizal fungus diversity, especially fungi with restricted host range, and the strong potential for fungal linkages between trees in forest ecosystems.

Key words: fungal succession, fungal communities, compatibility, Arbutus menziesii, Pseudotsuga menziesii, Pinus ponderosa, Abies grandis, Lithocarpus densiflora.