RESEARCH ABSTRACT

Principal Investigator(s): Paul E. Hammond and Philip J. Gallaway
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Study Title: Surface modification of Muddy River lahar deposit, Mount St. Helens National Volcanic Monument, Skamania County, Washington

Key Words: geology upland lahar mudflow

geomorphology erosion lahar archives

Abstract: Purpose of the project is to note and describe the extent of modification, since 1980, of the surface of the upper Muddy River lahar deposit. Several traverses will involve measurements concerning the density, width, and depth of drainage channels, and changes to interfluve areas. These will be compared with features recorded on aerial photographs and related to longitudinal gradients of channels and surface. The information is to be summarized in a written report.

A small part of this project was completed in summer 1991. In three traverses laid across the lahar plain in the area just north of road FS 83, six surfaces are recognized. They are:

(1) the surface marginal to the 1980 lahar deposit, consisting of bedrock or older lahar deposits, mantled by tephra, soil, and/or vegetation;

(2) a high standing "primary" surface atop the May 18, 1980 lahar, probably that of the morning flow, marked by a hardened surface of fine grains and cobbles, isolated boulders, and wood fragments protruding above the surface, and the beginnings of fresh vegetation;

(3) a "boulder pavement" surface, standing about 2 meters in elevation below the "primary" surface, of unburied boulders from which post-lahar sheet flow and wash has removed fine sediments, lacks abundant new vegetation;

(4) a "pumice" surface, marked by a carpet of packed, rounded pumice, almost on level with the "boulder pavement" surface but distinctive to be easily mapped, produced by sheet flow in 1980 carrying abundant pumice, and marked locally by clusters of new trees;

(5) areas of "reworked boulders" forming channels of high-water overflow during spring and heavy rain runoff, without vegetation, lying marginally to

(6) "young channels" of active stream flow, erosion and deposition, at depths 2-10 meters below the

"primary" surface, and lacking vegetation.

The surfaces recognized have not been compared with post-1980 aerial photography.

Type of Measurement(s): Tape, pace and compass with aid of a Brunton compass. Elevation control will be by altimeter.

Frequency of Measurement(s): Traverses will be run at about every 1000 meters. Mapping will start about July 20th 1991 and continue over the summer. Estimated completion day, allowing field checking, is October 1, 1991.

Data Storage: Information (hard copy) will be filed with headquarters, Mount St. Helens National Volcanic Monument. Another hard copy will be on file in the Department of Geology, Portland State University.

Long-term plans: Data available for collaborative efforts: Philip Gallaway will conduct the study as part of an independent study at Portland State University. Paul E. Hammond will instruct and supervise the work.

No long-term plan is presently being considered in a study of the ongoing surface modification of the Muddy River laharic deposit.

Baseline data will be available for future collaborative efforts.

RESEARCH ABSTRACT

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Study Title: Recovery of stream ecosystems following catastrophic disturbances

Key Words: aquatic, animal, stream, vertebrate, invertebrate, organic, wood, ecosystem, blowdown zone, algae, fish, amphibian, sedimentation, watershed, archives

Abstract: This study was conducted in the Clearwater basin of Mount St. Helens. Three projects within the study investigate recovery of trout and sculpin populations, tailed frog populations, and invertebrate populations. Trout were studied in the main channel of Clearwater Creek, and the effects of large woody debris in the stream on fish populations were examined. Trout populations were still low as of 1990, being one-tenth to 20% of that in undisturbed stream systems; this appears largely due to interruption of spawning in years following the blast and to continuing lack of spawning habitat. Trout densities were found to be higher in areas with lots of woody debris. The condition of trout was high throughout the stream in years since 1984 presumably due to rapid recovery of high abundance of invertebrate prey. By 1985 sculpin densities were as high as or higher than in undisturbed streams.

Tailed frogs were studied in the tributaries of Clearwater Creek. Frog population densities in basins that were completely deforested were low or zero apparently due to increase in air and water temperatures above tolerance of frogs. Moderately high densities were recorded in streams in intact forests. In streams for which headwaters are in intact forests but the downstream area was deforested, frog population densities were the

highest recorded. These high densities appear due to a combination of conditions optimum for adults and tadpoles. Heavily shaded headwaters are ideal for adults, whereas open downstream reaches provide abundant algae on which the tadpoles feed.

Recovery of invertebrate populations in tributaries of Clearwater Creek was rapid due to scouring of sediments that revealed pre-eruption stream substrate within the first two years after the 1980 eruption. Invertebrate populations in these tributaries were similar to undisturbed streams two years after the

eruption. However, densities in the main stem of Clearwater Creek are still significantly lower than in undisturbed streams of similar size.

Type of Measurement(s): Numbers of individuals; mean size of tadpoles of tailed frogs; size of trout; particle size, discharge, and cover; frequency of pools and riffles, volumes of pools, stream temperatures.

Frequency of Measurement(s): Once per year beginning in 1980, ongoing.

Data Storage: Field notebooks; digital data on floppy disks in Systat format in personal possession.

Long-term plans: Data available for collaborative efforts: Projects are ongoing. Date of completion is indefinite. Several manuscripts are in progress (1991).

Data are available as background information for selective collaborations.

RESEARCH ABSTRACT

Principal Investigator(s): Paul Heilman and Shiou Kuo
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Study Title: Survival and growth of native plant species planted in the Mount St. Helens blast area.

Key Words:	terrestrial	plant	riparian	trees	herbs
grasses	legumes	conifers	Douglas fir	cottonwood	revegetation
hardwoods	fertilizer	erosion control	ashfall zone	archives	

Abstract: The principal objective of this research was to determine the potential of establishing vegetative cover in areas with deep deposits of volcanic materials from the eruptions of Mount St. Helens in 1980 in order to provide for erosion control. Three sites northeast and northwest of the mountain that received approximately 25 cm or more of volcanic materials were studied: two with largely pumice materials and one with predominately fine ash.

Greenhouse experiments were conducted to determine the influence of N forms, and N and P rates on seedling establishment and growth of grasses and forbs. Many of these species and varieties emerged rather well in the pumice material, but their emergence was severely restricted in the ash.

The field seeding trial contained 28 species and/or varieties of grasses and legumes seeded at three sites. Reasonably good establishment and growth was obtained with several species on the two pumice sites but not at the plots on fine ash. Nine types of seeded grasses performed satisfactorily. Legumes generally performed very poorly in the seeding trials. The survival of planted Douglas fir varied considerably among sites. Net annual growth and foliar N were significantly improved by fertilizers applied as a supplement to individual trees. The established grasses and legumes did not have any significant effect on growth performance of the trees. The performance of cottonwood on the mudflow of the North Fork of the Toutle River has been disappointingly poor, despite the significant improvement of foliar N levels and net growth of the trees by fertilizer treatments.

Type of Measurement(s): Laboratory studies: analyses of volcanic soils collected from research sites included particle size, porosity, bulk density, thickness of soil layers, pH, CEC, organic C, exchangeable Ca, Mg, Na, NH_4^+-N, available phosphate; and a fertilizer leaching study.

Greenhouse studies: seedling emergence, dry matter yield for herbs on 3 different soil types; dry matter yield, number and fresh weight of nodules on legume roots to determine effects of N source and N and P rates on herbs in 3 soil types.

Field studies: number of transplanted individuals survived; flowering and seed maturation, % germination and emergence for sowed seeds; kg/ha fertilizer, seeding rates (1,000 seeds/kg, kg/ha), density (plants/m^2), % cover, dry weight of seeded grasses (g/m^2); uptake of N and P (g/m^2) for seeded herbs; height (cm), annual growth (cm), % survival, color of Douglas fir seedlings; fertilizer applications to Douglas fir; height, growth rate, and nutrient concentration in foliage for cottonwoods.

Frequency of Measurement(s): Soil analyses were performed in 1981 and 1983.

Greenhouse experiments performed once in 1982.

Field experiments were performed 1981-1983. Herbs were planted in transplanting trials in 1982; survival evaluated each growing season. Herb and grass seed sown and fertilized in field trials in fall 1981 and spring 1982; emergence evaluated twice in fall 1981; other observations made two years after seeding. Additional herb and grass seeding trial conducted in 1983. Douglas fir seedlings planted and fertilized May 1982; annual growth measured yearly and other observations made two years after planting. Cottonwood stem cuttings planted April 1981; fertilized April 1982; height measured yearly and other observations made in 1982.

Data Storage: Data is on file in SAS software at Washington State University Computing Center.

Long-term plans: Data available for collaborative efforts: Data is available for collaborative efforts. Monitoring of plots will continue, though it will become less frequent.

RESEARCH ABSTRACT

Principal Investigator(s):
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Study Title: Effects of airfall tephra on forests northeast of Mount St. Helens

Key Words:	physical	terrestrial	plant	upland	trees
conifers	true firs	forest decline	ashfall zone	survival	foliage
volcanic ash	soil oxygen	physiological	Abies amabilis	Pacific silver fir	archives

Abstract: The May 18th, 1980 eruption of Mount St. Helens deposited tephra over a very large area of forest land in Southwest Washington. Tephra affected forest stands primarily by covering the foliage. Most tephra originally deposited is now on the forest floor; however, much of the finest deposits were retained by the foliage and still persist in the crowns of many trees.

Branch and foliage morphology of Pacific silver fir (Abies amabilis) results in its ability to intercept and retain tephra for the longest periods. Significant damage to the pre-1980 eruption foliage occurred after the eruption and continued through the summer. The amount of damage seen on the needles was significantly related to the amount of ash on the foliage. Foliar damage appeared to be related to elevated needle temperatures. The increase in needle temperature was not related to the temperature of the ash when it fell but was related to the ability of the needles to dissipate energy absorbed from the sun.

Seven sites ranging from 15 to 135 km from Mount St Helens were selected to study the impact of airfall tephra on the growth of Abies amabilis, A. procera, Pseudotsuga menziesii, Tsuga heterophylla, and T. mertensiana. As tephra depth increased, there was a corresponding increase in visible foliar damage and associated decreases in diameter and height growth. Reduction in diameter growth was greater than reduction in height growth. The reduction in diameter growth approached 50% in both trees and saplings of A. amabilis. Growth reduction in true firs was greater than in associated species. This difference was related to their greater capacity for interception and retention of airfall tephra. Damage to trees, and resulting growth reductions, were due to tephra coverage of both the foliage and the soil. Coverage of the foliage resulted in foliar damage, foliage abscission and reduction of total tree foliar area, and increased fine root mortality. Tephra coverage of the soil had the potential to restrict oxygen diffusion into the soil. However, soil oxygen concentrations less than 10% were measured only once over a 2-year period.

Although Pacific silver fir seedlings and small trees recovered within two years after the eruption, mature and old-growth trees throughout the deposition zone began to show symptoms of advanced decline and mortality in 1986. In late 1988, nine growing seasons after the tephra deposition many mature and old-growth mid-elevation conifer stands within the tephra deposition area are still showing substantial growth losses,

decline, and mortality. Preliminary studies of the effects of the tephra deposition have revealed that in some areas virtually all Pacific silver fir trees are succumbing, probably as a result of the effects of tephra deposition, lack of subsequent recovery, or related insect or disease attacks. In other areas, Pacific silver fir recovered to some extent, ranging from slight to complete recovery. Within stands, the recovery of this species also varied widely. Presently, we are assessing the extent of growth loss within the tephra deposition zone. Preliminary results indicate growth losses are limited to Pacific silver fir, but are quite variable within the tephra deposition zone. The ongoing study is investigating the recovery of this species by relating its vigor to stand age, species composition, stand canopy structure, and other site variables.

Type of Measurement(s): We have set up 36 clusters of 3 circular plots each (0.05 hectares) in the areas impacted by ash deposition on the districts of Randle, Packwood and St. Helens. Measurements taken in each plot consist of: diameters of all trees, radial increments of selected trees, depth of 5 different textural layers of tephra in the soil, selected tree heights, and visual assessment of the severity of damage to Pacific silver fir trees.

Frequency of Measurement(s): Measurements began in July 1980 and continue through the present. Research plots were set up on a semi-permanent basis and their location has been precisely recorded. For the objectives of our project, repeated yearly measurements will only be taken on some representative sites.

Data Storage: Most of our data is still in the process of being analyzed. Data has been stored into conventional computer ASCII files and is available for analysis with any statistical package. Data concerning the effects of airfall tephra on physiological processes in true firs and on growth of sapling and full-size trees and on soil oxygen levels has been published. Data concerning effects of airfall tephra on forest decline, especially Abies amabilis is in data files in LOTUS 1,2,3 and will be published in Gerardo Segura's PhD dissertation.

Long-term plans: Data available for collaborative efforts: Seeking funding to further investigate effects of airfall tephra on mature trees in forests northeast of the volcano. We are very interested in maintaining our plot system for future reevaluations of general declining conditions. Our data and plot location information is available for any future collaborative research.

RESEARCH ABSTRACT

Principal Investigator(s): Greg Johnson
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Study Title: Toutle River off channel habitat enhancement evaluation

Key Words:	aquatic	animal	fish	stream	vertebrate
coho salmon	trapping	off channel	riverine	pond	archival
habitat enhancement		mudflow	lahar	over-wintering	

Abstract: Juvenile coho salmon require one year of fresh water bearing before migrating to the ocean. As flows increase and temperatures drop in the fall under-yearling coho tend to migrate from native streams to small tributaries, ponds, swamps and marshes. Because the Mount St. Helens mudflow inundated or made inaccessible this kind of winter habitat, it is considered a limiting factor to salmon production on the Toutle. This study, which consists of evaluation of enhancement of these winter bearing areas, consists of upstream/downstream trapping of juvenile coho salmon at various sites on the Toutle.

Type of Measurement(s):
Flows - cubic feet/second and gallons/minute
Temps - degrees Fahrenheit
Salmon counts
Trout counts
Fish measurements - length, weight
Habitat measurements - bearing area in square meters

Frequency of Measurement(s): 2-4 times per week, October through July, 1987-1991.

Data Storage: Harvard Graphics; inter-office memoranda.

Long-term plans: Data available for collaborative efforts: Johnson plans two to three more years of juvenile coho trapping. Johnson and his data are available for future collaborative efforts. Data will be in a final report at Washington Department of Fisheries.

RESEARCH ABSTRACT

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Study Title: 1. Ecological factors determining population size of Aphis varians.

2. Factors causing pattern of Altica tombacina population on fireweed.

Key Words: terrestrial plant animal invertebrate insect herbivory predation competition population dynamics archives

Abstract: 1. Research is intended to assess the ecological factor(s) of greatest importance in determining the population size of an aphid (Aphis varians) feeding on fireweed (Epilobium angustifolium). We manipulated the host plant (by shading, watering, and fertilizing), the size of fireweed patches, the density of a leaf-feeding beetle (Altica tombacina) which also utilizes fireweed, and the presence of predators of the aphid (primarily ladybird beetles and syrphid flies) by means of cages.

Preliminary results:
Predation is overwhelmingly important in limiting aphid population growth. We found that in the presence of large natural enemy populations, aphids attained their highest densities on small isolated clusters of fireweed. Only in the absence of predators (i.e. in cages) do host plant quality and competing herbivores play a role in aphid population dynamics; aphids were either not affected by fireweed patch size, or were less abundant on small patches of their host plant in the absence of natural enemies. This result points out that the relationship between a herbivore and the geography of host plant islands depends on a larger embedding web of interactions.

2. The leaf-feeding beetle (Altica tombacina) tends to be found in large numbers on selected plants of fireweed and absent from nearby fireweed plants. This is largely the result of the habit of several females to lay eggs on one plant and of the general adult population to congregate on one or a few plants. The consequence of this community structure is that as density increases, survivorship decreases due to competition for food. The effect of beetle populations on fireweed is the stripping of foliage from densely inhabited plants.

Type of Measurement(s): Density of all insects associated with fireweed measured on a per stem basis for 200 marked plants, some within experimental cages and others undisturbed; direct observation of movement rates for aphids and ladybugs; rate of growth of aphid colonies.

Frequency of Measurement(s): Populations censused every 2 weeks during growing seasons of 1985-1989.

Data Storage: ASCII and SYSTAT computer files (5 1/4 in. floppy disks formatted for use by an IBM-compatible P.C. using D.O.S.).

Long-term plans: Data available for collaborative efforts: Part of this project was completed in 1989. Manuscripts concerning completed studies will be published in 1991. Our long-term plans are to return to our original study sites and repeat our experiments in 1992-1995. The point of this will be to evaluate the effects of fireweed patch size as the succession further enriches the community. We hypothesize that pairwise biotic interactions will be weaker because the enriched biota will dilute particular interactions.

We will be glad to cooperate with anyone, especially individuals who could broaden our taxonomic base. Part of our long-term goals include developing mathematical models of invasions and reconstruction of communities. We would be particularly interested in cooperating with other researchers who have spatially structured data.

RESEARCH ABSTRACT

Principal Investigator(s): Ernest L. Karlstrom
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Study Title: Observation of recolonization of amphibians and reptiles in North Fork Toutle River debris avalanche.

Key Words: terrestrial, aquatic, animal, ponds, vertebrate, amphibian, reptile, survival, recolonization, migration, debris avalanche, archives

Abstract: Various reports indicate in situ survival of or early migration of some amphibians into regions of the blast zone following the major eruptions on May 1980. Investigators observed salamanders, frogs and toads as early as 1980 and 1981 in areas of heavy ashfall northeast of the crater. Survival at higher elevations likely was favored by snow and ice cover and the fact that many animals were in hibernacula.

This study has concentrated on a series of ponds located on the hummocky valley floor of the North Fork between Elk Rock and Spud Mountain, 14 km northwest of the crater. Here the major avalanche debris and lahar flows covered the valley to depths exceeding 75 meters and certainly wiped out existing and presumably active populations.

Continuing monitoring of study sites through 1990 has documented seven species of sixteen predicted for the area (one reptile species) present and breeding. Reproduction rates are low for most with some reproducing sporadically and others in greater numbers. Some interspecific competition is developing and will be further investigated. A lowland frog species has moved in that may not have previously coexisted with the other species present here.

Type of Measurement(s): Observations of species present and breeding; approximate numbers of adults; observations of eggs and juveniles.

Frequency of Measurement(s): Annually beginning in 1984 (excepting 1988), once per month March-September, more often in April and May.

Data Storage: Field notebooks in personal possession.

Long-term plans: Data available for collaborative efforts: Karlstrom plans an ongoing study for at least the next ten years. Long range goals of this study include monitoring of successional stages for amphibians and reptiles in this highly impacted habitat, as well as other aspects of their reproduction, physiology, and behavior.

Karlstrom and his data are available for future collaborative efforts.