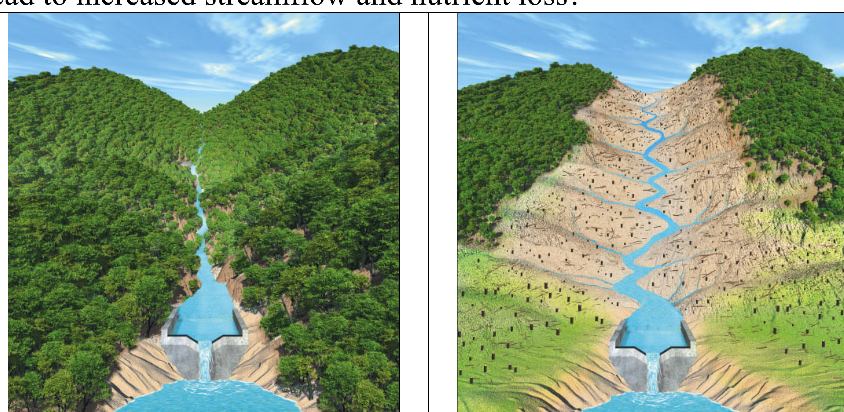
Hubbard Brooks Experimental Forest- Case Study

The USDA Forest Service established the Hubbard Brook Experimental Forest (HBEF) in 1955 as a hydrologic research center. The Hubbard Brook flows through New Hampshire's White Mountain National Forest and drains a range of small mountains. The tributaries of Hubbard Brook form a set of discrete watersheds, separated by mountain ridges. Six of the south-facing watersheds are similar in size (~10-40 hectares), have relatively uniform characteristics (e.g., soils, vegetation, geology, atmospheric deposition), are lined with watertight bedrock and glacial till, and are representative of the surrounding northern hardwood forest that comprises much of the northeastern United States and Canada. The uniformity allows for comparisons to be made between watersheds, the watertight bedrock makes quantitative hydrologic and elemental budgets possible, and the similarity to surrounding ecosystems allows for extrapolations of results to a broader area. For these reasons as well as many logistical ones (e.g., ownership and administrative control), these watersheds are ideal for conducting long-term ecosystem experiments.

Part 1

The Effects of Deforestation on the Loss of Water and Soil Nutrients

In 1963, botanist F. Herbert Bormann, forest ecologist Gene Likens, and their colleagues began carrying out such a controlled experiment. The goal was to compare the loss of water and soil nutrients from an area of uncut forest (the control site) with an area that had been clear-cut (the experimental site). They built V-shaped concrete dams across the creeks at the bottoms of several forested valleys in the HBEF in New Hampshire (Figure 1). The dams were designed so that all surface water leaving each forested valley had to flow across a dam, where scientists could measure its volume and dissolved nutrient content. This study compared the loss of water and nutrients from an uncut forest in watershed 3, the control site, to watershed 2, the experimental site that had been clear-cut (figure 1). The hypothesis of the study was: does deforestation lead to increased streamflow and nutrient loss?



Watershed 3- Control site (W3) | Watershed 2- Experimental site (W2)

Figure 1. Hubbard Brook Experimental Forest: Watersheds 1 and 2

All trees in Watershed 2 (the experimental site) were cut in December 1965 and left on top of the snow. In the summers of 1966, 1967, and 1968, two herbicides were applied to the entire watershed to prevent the regrowth of any vegetation. Scientists believe that the herbicide was added in such low concentrations that it did not negatively affect organisms in the watershed or downstream.

Results

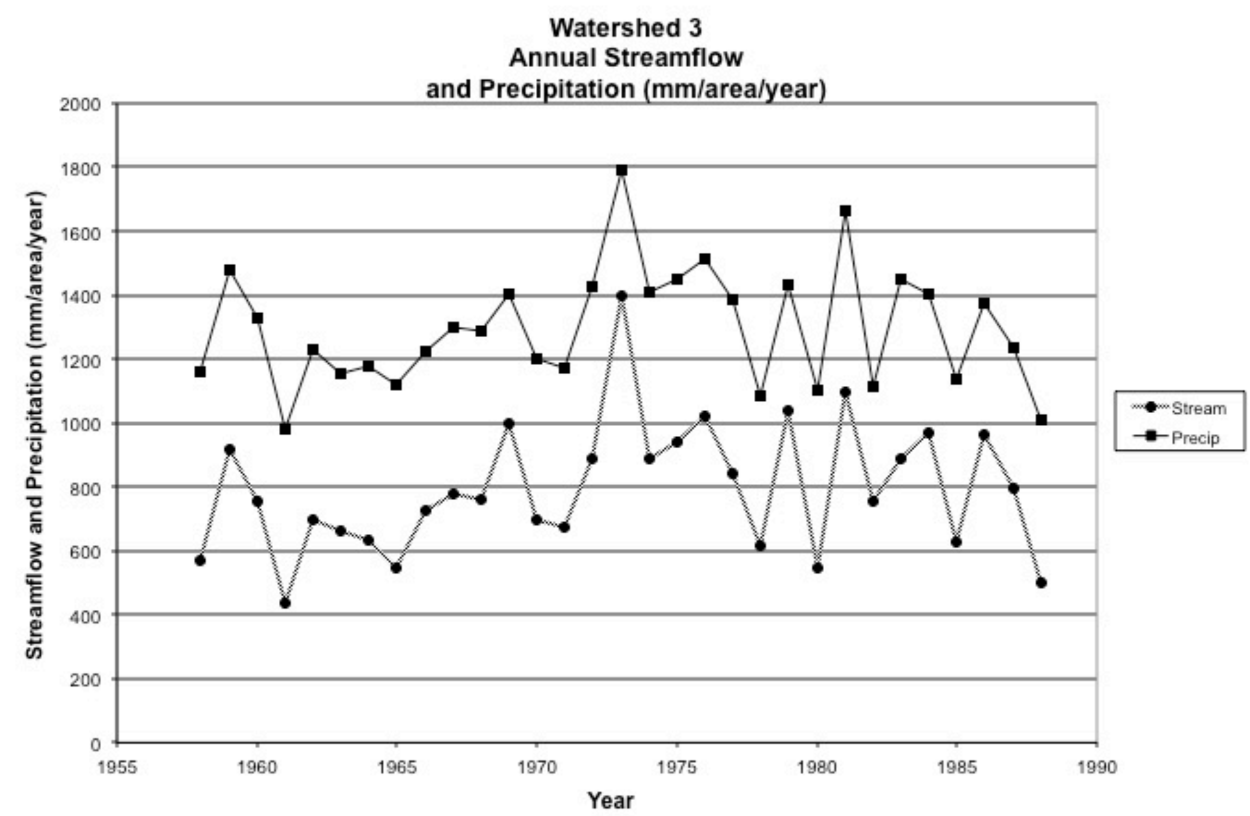


Figure 2. Watershed 3 Annual Streamflow and Precipitation (mm/area/year)

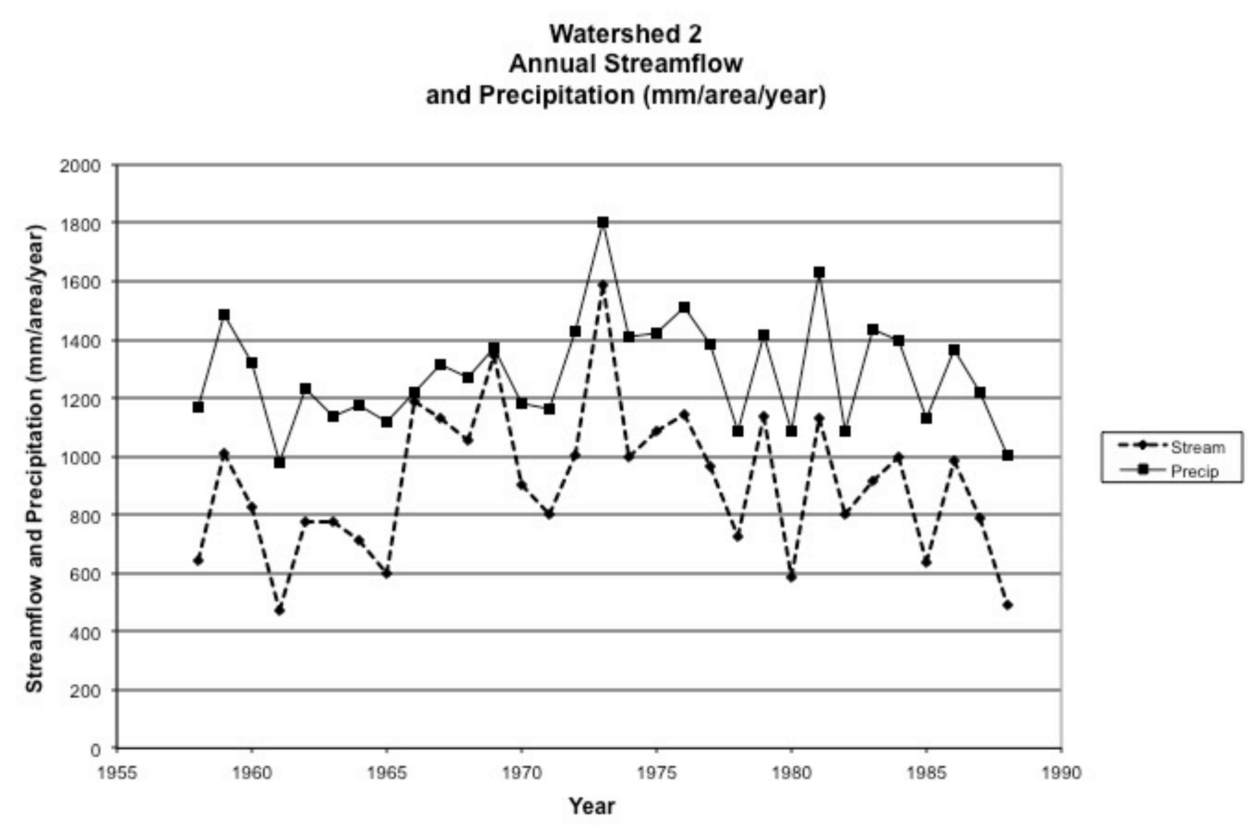


Figure 3. Watershed 2 Annual Streamflow and Precipitation (mm/area/year)

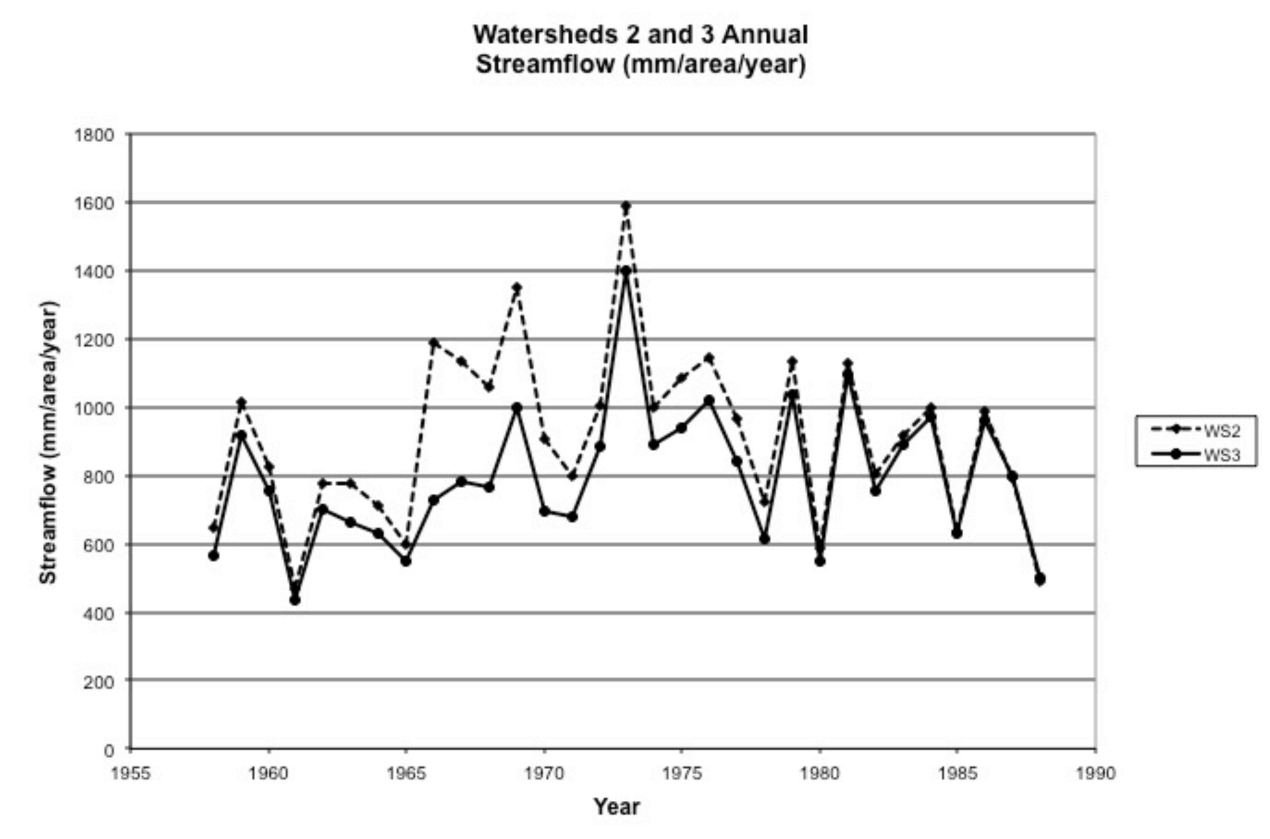


Figure 4. Watersheds 2 and 3 Annual Streamflow (mm/area/year)

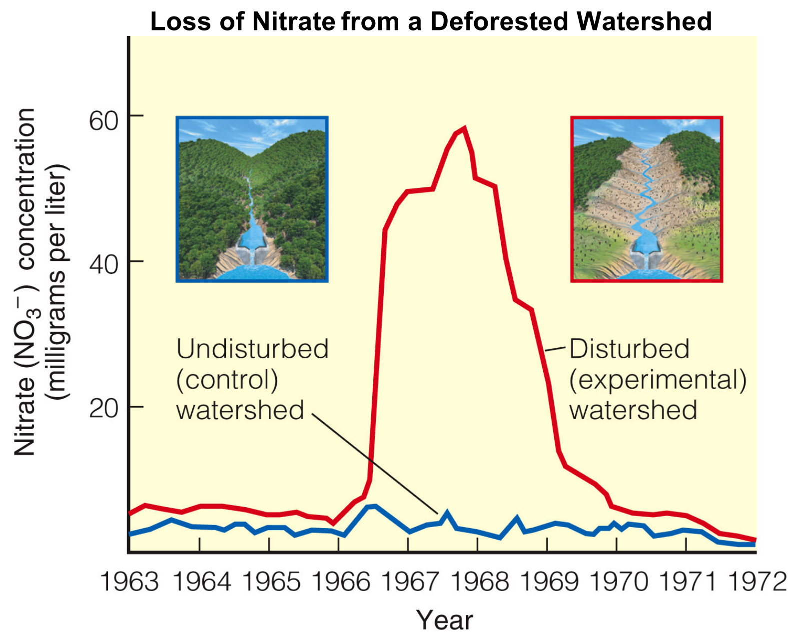


Figure 5. Loss of Nitrate from a Deforested Watershed

Secondary Succession- Regrowth of Vegetation After Environmental Disturbance

The original forest in watershed 2 had been composed of mature hardwood species such as sugar maple, American beech, and yellow birch (commercially valuable hardwood species). But when the scientists stopped applying herbicides, the regenerating forest had a different composition. Most of the trees were pin cherry and paper birch. This is due to the fact that their seeds had remained viable in the soil throughout the herbicide treatment. Studies at Hubbard Brook have demonstrated that these two species transpire more, and thus take up more water from the soil, than the original mature forest species.

<u>Part 2</u>

The Effects of Strip-Cutting on the Loss of Water and Soil Nutrients

In 1970 another watershed experiment was conducted in watershed 4. This watershed manipulation was conducted to examine the effects of strip-cutting on forest water yield (a.k.a. streamflow; i.e. how much water leaves the forest) and nutrient loss. The researchers hypothesized that strip-cutting would cause less damage and disturbance and therefore less water and nutrient loss than the clear-cutting experiment between watersheds 2 & 3 in 1965. Watershed 4 was divided into 49 east-west strips (almost following topographic contours) 25 m wide. In the autumn of 1970, every third strip was cut. The second series of strips was cut in 1972, leaving one series of strips uncut. Finally in 1974, the last set of strips was cut. Except for a buffer of trees that was left along the main stream channel, the entire watershed was clear-cut in these three phases.

Results- Synopsis

Strip-cutting did not result in significant increases in erosion, which causes soil to wash into streams and leave the forest. This can harm both the forest and streams; plants need nutrients in the soil to grow and most aquatic organisms in need clear, sediment free water, to survive. Streamwater nutrient concentrations and water yield increased during and immediately after strip-cutting, but in very small amounts when compared to the results of Watershed 2 in 1965. Ten years after strip-cutting watershed 4, dense natural regrowth was observed. The strip cut had a more desirable mix of species than the vegetation that had regenerated in Watershed 2 (from the 1965 clear-cut) with higher densities of yellow birch and sugar maple (commercially valuable hardwood species) and lower densities of pin cherry.