MAJOR EROSIVE LANDS IN THE UPPER YELLOWSTONE RIVER DRAINAGE BASIN FROM LIVINGSTON, MONTANA TO YELLOWSTONE LAKE OUTLET, YELLOWSTONE NATIONAL PARK

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SUMMARY

Rapid soil erosion (termed accelerated erosion) in northern Yellowstone Park has been qualitatively investigated for some time. Results of these efforts include geologic studies, comparisons of historical photographs, range management evaluations, and systematic though qualitative observations. The most recent debate dealing with erosion involves the periodic, high turbidity of the Yellowstone River during the summer. Groups involved in Yellowstone River recreational activities expressed concern that the River was becoming increasingly muddy during the summer months. Therefore, the National Park Service, in conjunction with several federal and state agencies, initiated two studies of suspended sediment, turbidity, and erosion. These were set in the upper Yellowstone River Basin. They were directed by Yellowstone Park's Fisheries Assistance Office (Fish and Wildlife Service).

The first study was undertaken in 1985. Results quantified the suspended sediment and turbidity in the Yellowstone River and identified significant sediment contributing tributaries between Lake Outlet and Livingston, Mt. A second study (this report) was initiated in 1987 to determine major source areas for the measured sediment loads, both inside Yellowstone National Park (YNP) and in parts of the Gallatin National Forest (GNF). Objectives were 1) to inventory and locate major erosional features, 2) to provide information to researchers and land managers about important erosion processes within the study area, and 3) to compare erosive areas with the sedimentation data to discover the relation between the extent and character of erosive area and sediment yield in drainage basins.

METHODS

The study area includes the Yellowstone River drainage from Yellowstone Lake outlet, Yellowstone National Park downstream to Livingston, Montana. This includes the northern part of Yellowstone Park and parts of the Gallatin National Forest, outside the wilderness areas. Private land was not evaluated.

For this study, erosion is defined as the detachment and transfer of soil or regolith material to perennial stream courses, but not transport within them. Eroded material is also limited to the fraction of available material less than 2 mm in diameter, the sizes of particles carried as suspended sediment in streams.

Mapping methods are modified from those used in Forest Service wildland soil inventories and other large scale erosion inventories. These methods were adapted to the delineation of highly erosive lands in the study area. Mapping was completed at a scale of 1:62,500. Publication map scale is 1:125,000.

RESULTS

Landscapes for the Yellowstone National Park portion and the Cooke City area were classified into fourteen major landscape groups (MLG's). These reflect combinations of landform, geology, and vegetation that influence erosion potential. These were used to determine major erosional processes and to stratify further sampling in highly erosive areas.

Seven major types of highly erosive lands (map units) were identified. The most common occur on steep slopes of andesitic volcanic terrain, especially in the northeast part of the park. Three kinds of erosive areas occur on soft, Cretaceous-aged shales: on steep shale scarp slopes, eroding parts of shale-rich landslides, and exposed shales in high elevation, glaciated valleys. Lake sediment terraces are important sources of fine sediment when near perennial streams, although they are not aerially extensive. Hydrothermally-altered areas, though composed of erodible material, may contribute less to suspended sediment than other map units because of larger particle sizes. Large-scale channel erosion occurs in varying geologies in different landscapes.

Eroding glacial till in high drainages, eroding shale scarp slopes, and eroding glacial headwalls in poorly-indurated volcanic rocks constitute 80% of the highly eroding lands in Yellowstone Park and the Cooke City area, underlining their importance to stream sediment contributions in the overall area. Channel side cutting into alluvium or lake sediments is much lower in total area. However, these map units are located directly on major streams in these areas, raising their importance beyond areal extent.

Of these erosive lands, most is contained in the Upper Lamar River, Gardner River, and Soda Butte drainages, and the Yellowstone River drainage from Lake Outlet to Tower Junction. The top five watersheds with the highest proportion of erosive land to total drainage area are Soda Butte Creek, the Boundary Line Area, Upper Lamar River, Reese Creek, and the Gardner River. These are the most erodible areas in a geomorphic sense, though because of other factors each area may not contribute equally to stream sedimentation. The important erosional processes in these areas are related to eroding glacial till in high drainages (Soda Butte Creek), eroding shale scarp slopes (Boundary Line Area and Gardner River), and eroding glacial headwalls in poorly-indurated volcanic rocks (Upper Lamar River and Reese Creek).

Other than the headwaters of Soda Butte Creek, Gallatin Forest lands have very few acres of highly erosive lands. The sediment study also reports low sediment contributions from these drainages. However, private lands within and below Forest boundaries can be significant sources of sediment.

A semi-quantitative ranking can be made between sediment discharge from selected drainages and the total erosive acres present. The top four drainages in sediment production are also the top four in total erosive acreage, namely the Lamar-Tower, Yellowstone from Lake to Tower, Soda Butte, and the Gardner River drainages. They rank above the remainder by a factor of eight or more in both extent and sediment discharge. The remainder have little or no highly erosive land, and had low average turbidity or suspended sediment discharge values (for example, Slough, Lava, and Big creeks). This indicates consistency between estimates of sediment contribution and erosive acreage.

CONCLUSIONS

Results from both the sediment study and the erosion study point to the upper Lamar River, Soda Butte Creek, and the Gardner River (primarily Mt. Everts) drainage basins as by far the most important sediment producers in the Yellowstone River above Corwin Springs, and also the major sources for sediment and turbidity measured at Livingston. Sediment contributions are substantially higher in the Yellowstone Park portion of the study area than in the Gallatin Forest part.

These differences are not easily explained in a reconnaissance study such as this, but some hypotheses can be offered. The Gallatin National Forest and Yellowstone National Park both have broadly similar characteristics, there are some important differences. During the Pleistocene, Yellowstone National Park was largely covered by a thick ice cap. This is in contrast to the Gallatin Forest, which was glaciated primarily from local, mountaintop sources. The volcanic rocks of the Gallatin apparently differ widely from those in the eastern part of the Park. Also, landforms on the Gallatin Forest are evidently more representative of post-glacial hillslope processes such as fluvial (water) erosion than are those in the Park. Many areas in the latter still bear scars of the violence of meltwater and glacial damming in the last parts of the Pleistocene. Finally, Yellowstone Park is much more active tectonically than are other parts of the Rocky Mountains.

This document has been abbreviated. Please see Henry Shovic for a complete copy.