Gravel and large wood augmentation for salmon habitat restoration; the first five years of The Green River Fish Habitat Restoration Pilot Project.

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Abstract The Green River Gravel and Wood Nourishment Project was initiated in 2002 by the Seattle District of the U.S. Army Corps of Engineers (USACE) in response to a Biological Opinion to recover listed salmonid species in the Green River basin in Washington State. The project is located four miles downstream from the Howard Hanson dam, and 1 mile downstream from the City of Tacoma water supply diversion dam. Both dams block upstream fish passage, as well as inhibit the downstream movement of spawning sized gravels and large woody material, resulting in bed armoring and a reduced frequency of fish habitat formed by large wood. Since the 1960s, USACE dam operations have significantly reduced peak outflows but augmented late summer flows for fisheries enhancement. The first year of the project involved construction of two engineered logjams and two gravel bars consisting of a total of 4,000 tons of screened spawning gravel. In subsequent years USACE has adapted the project in response to observed geomorphic changes by increasing the placed gravel quantity, modifying the gravel bar configurations and size distribution, and initiated a large woody material "haul and place" program. Currently Seattle District annually places 14,000 tons of imported spawning gravel and collects, sorts, transports, and places several tons of large woody material (stumps, logs with rootballs, and small trees) directly in the river below the dams prior to the onset of high streamflows.

As part of an adaptive management strategy, USACE and its contractors have conducted annual physical and biological monitoring of a two mile treatment reach (Zone 1) and control reach to track annual adjustments of the channel and floodplain morphology, and fish usage. The monitoring includes streambed composition, channel bathymetry, channel morphology, distribution of habitat, and spawning redd locations. The monitoring effort has resulted in several significant findings, which include: Full gravel bar erosion and entrainment occurs in a matter of days during moderate flows, gravel and cobble transport rates are significantly higher than predictions, gravel has been deposited several miles below the loading site, restoring or enhancing several acres of spawning beds by reducing streambed armoring and increasing access to side channels. Current below-dam wood nourishment rates are less than the annual reservoir wood delivery rate, however significant increases in wood abundance over baseline have been observed, which is strongly correlated to nourishment of large woody material. Fish use of deposited nourishment gravel for spawning redds has been immediate and widespread. Post-project biological monitoring indicates increased use of the log jams and gravel deposition areas for spawning, by both Chinook salmon and steelhead, compared with the baseline data.