USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

TITLE: Sediment Flushing Capabilities of Unsteady River Flows and Effects on Spawning Gravel

DURATION: September 1996 to August 1998

FEDERAL FUNDS REQUESTED: $67,840

NON-FEDERAL (MATCHING) FUNDS PLEDGED: $135,681

PRINCIPAL INVESTIGATORS: Panos Diplas, Department of Civil Engineering, Virginia Polytechnic Institute and State University Donald J. Orth, Department of Fisheries and Wildlife, Virginia Polytechnic Institute and State University

CONGRESSIONAL DISTRICT: Ninth

STATEMENT OF CRITICAL WATER PROBLEM:

In a report released by Nature Conservancy on April 29, 1996, freshwater aquatic species are identified as the most imperiled groups of species in the United States. The impairment of streams due to excessive sedimentation is one of the most pervasive problems affecting streams in the United States. National surveys have repeatedly singled out sedimentation as the single most important pollutant based on quantity as well as economic and ecological effects (Judy et ai. 1984, USEPA 1990). Excessive sedimentation in streams is due to combined influences of land use practices and ineffective streambank and riparian protection. Effects of sediment on degraded warmwater stream fisheries and communities has received the least scientific inquiry (Waters 1995), despite the fact that rates of endangerment are increasing for stream fauna (Master 1990, Warren and Burr 1994, Bogan 1995). For example, over two-thirds of all madtom species (Ictaluridae, *Noturus* spp.) are threatened or endangered and habitat degradation is the most commonly cited factor (Etnier and Starnes 1991, Simonson and Neves 1992, Fuselier and Edds 1995). Sources of sediment pollution in Virginia and the Chesapeake Bay watershed are due primarily to urban land uses, followed by agriculture and forestry (Jones and Holmes 1985, Wolman and Schick 1967). Roadbuilding and stream crossings also contribute to excessive sedimentation and reductions in fish and invertebrates (Reed 1977). In the midwest U.S., streambank erosion was a major cause of sediment production (Lyons and Counney 1990) .Any land disturbance activities in the floodplain has the potential to disrupt the equilibrium sediment budget in streams because floodplains contain previously stored sediments. Reservoirs create sediment sinks and altered flows that change the sediment characteristics and channel form. Restoration programs require creation of appropriate channel and floodplain morphology to encourage the deposition and storage of sediments in developing floodplain habitats. The restoration and rehabilitation of damaged or degraded ecosystems has been identified as a

research area of first priority (National Research Council 1992, Naiman et al. 1995). Rehabilitation of damaged riparian-riverine ecosystems can be prohibitatively expensive and are hampered by a lack of data on the reference condition (i.e., the unimpaired, self-maintaining channel). Therefore, it is fundamental that restoration protocols seek to utilize the natural restoration capabilities of flowing water and consider the dynamic equilibrium in the physical system. The science of restoring sediment-altered stream channels has proceeded slowly for several reasons. Detailed post-project evaluations of morphological changes are done infrequently (Kondolf and Micheli 1995). Also, the theory of bed mobilization is based on uniform flow and substrate, although natural channels are extremely heterogeneous with respect to streambed and gradient profile. Furthermore, almost. all of the available literature deals with the removal of fine sediment from the stream substrate under uniform and steady flow conditions, while there is a paucity of knowledge about the role of non-uniform and unsteady flows, which are prevalent during events that are capable of mobilizing the bed material and flushing the fine sediment. Many well-intentioned, non-governmental organizations (e.g., Adopt a Stream Foundation, Coalition to Restore Urban Waters, Izaak Walton League of America, River Watch Network, Trout Unlimited) have initiated habitat improvement projects. These groups, if properly guided, can be a valuable source of volunteer labor to accomplish restoration.

STATEMENT OF RESULTS OR BENEFITS

Theory of bed mobilization is presently based on uniform flow and substrate conditions, assumptions that may be inadequately simplistic when designing restoration plans for streams. Because channel restoration plans are often designed without adequate knowledge of the flow-sediment dynamic, the structures often fail and may change the channel morphology and increase sedimentation (Apman and Otis 1969, Frissell and Nawa 1992). This study will help to develop guidance on how to make the river do the work of channel restoration and create stable benthic environments for fish reproduction and early development. This research will identify how pathways of water flow at small spatial scales are affected by fine sediments under unsteady flow conditions and how the physical changes affect reproduction of certain warmwater fishes.

We expect that reproductive success of certain guilds of warmwater stream fishes in local habitat patches will be controlled by the local shear stresses, sediment instability during high flows, or deposition patterns of fine sediment. We also expect that we can develop ecological criteria that can be applied to the quantitative model predictions. The research will provide a measure of the uncertainty of hydrodynamic predictions under controlled (lab flume) and natural stream conditions.