Southeast Sustainable Salmon Fund
Statement of Work

Project Title: Biological Impacts of Hydraulic Disturbances Associated with Jet Boating

Project Number: 45259; NOAA Objective: RM&E

Project Manager
Ben Kirkpatrick, Regional Habitat Biologist, Habitat and Restoration Division, Alaska Department of Fish and Game, P.O. Box 240020, Douglas, Alaska 99824
Phone (907) 465-4288, FAX 465-4272 Email: ben_kirkpatrick@adfg.state.ak.us

Principle Investigator
Dr. David Hill, Assistant Prof. of Civil Engineering, Department of Civil and Environmental Engineering, Penn State University, 212 Sackett Building, University Park, PA 16802
Phone (814) 863-7305, fax (814) 863-7304, dfhill@engr.psu.edu

Project Period: 4/1/03 – 6/30/04

Project Description
Commercial recreation activity has emerged as a major activity during the last ten years within the Alaska Chilkat Bald Eagle Preserve (CBEP). This type of activity was not significant either at the time of Preserve creation in 1982 or during the time of CBEP Management Plan development during the mid-eighties. For these reasons, the 1985 CBEP Plan did not address the management of this use in a significant manner. The management of this activity is now necessary given the levels and locations of this use, and given the likelihood that this type of use will continue to grow over the planning period in the next 20 years.

The use of large jet-drive boats for conducting tours of the CBEP was not considered or envisioned 15 years ago. The Alaska Department of Fish and Game (ADF&G) and others have identified the use of these boats in sensitive habitats as an issue of potential concern. There is a significant body of literature documenting the effects of powerboats on various waterbodies. This previous research indicates there are likely to be impacts if the use levels are high enough. It has been decided that quantifying the impacts in the upper Chilkat River is warranted to the extent possible.

The PI conducted a field study; sponsored by ADF&G, during the summer of 2002, with the primary goal of documenting near-bank wake heights and turbidity values. Measurements of ADF&G boats and commercial tour boats were made under a wide variety of conditions (i.e. speeds, loadings, etc.). The data from this study was compiled in a report submitted to ADF&G in October 2002 and should be of use in terms of justifying management decisions.

One of the major conclusions of this initial study was that jet-boat induced hydraulic disturbances at the river banks that were, in many cases, comparable to those of the ambient stream flow. As a result, it was impossible to rule out the possibility that this activity was having an impact on the river banks and on rearing salmonids. In light of this, it is proposed to conduct additional study that will specifically address the question of whether or not these disturbances are of biological significance.
I. Objectives/Justification

The specific objectives of the planned study include:

- Detailed quantification of the flow and turbidity distributions near the banks, in the absence of boating activity. The previous study only made limited measurements of these quantities, as the emphasis was on wake heights. What is being sought here is a thorough understanding of the ‘baseline’ conditions that rearing salmonids experience. This will be achieved with acoustic Doppler velocimeters and optical backscatter sensors. By traversing these instruments in the vertical and in the cross-channel directions, a detailed two-dimensional map of turbidity, mean velocity, turbulence intensity, and shear stress can be developed.

- Detailed quantification of the flow and turbidity distributions near the banks, in the presence of boating activity. The previous study made only rough comparative estimates of boat-related and flow-related bank impacts. The near-bank disturbances will be functions of the height of the wakes striking the banks.

To improve the statistical significance of the results, ADF&G boats will be used extensively for this portion of the research. This will allow for the execution of a greater number of trials, as well as greater control over the trials. As the 2002 study provided good information about the wake heights of the commercial boats, the ADF&G boats will be operated under conditions designed (e.g. heavily loaded, close to the banks, etc.) to reproduce the commercial boat wake heights.

- Laboratory study of the response of hatchling fish to various fluid mechanical parameters and turbidity. A preliminary review of the pertinent literature reveals that several past studies along these lines have been conducted. Unfortunately, many have been poorly done, from a fluid mechanics point of view. As one example, Killgore et al. (1987) studied the effects of turbulence on fish eggs and larvae. However, the authors speak of turbulence in units of pressure, which is physically meaningless. There have been other studies which have been very well done, but which are not terribly applicable to the present situation. As one example, Nietzel et al. (2000) conducted an experiment in which young fish were introduced into the shear layer created by a fluid jet. The rates of mortality and severe injury were related to the strain rate of the flow. While useful, the study considered only one-time exposure to high levels of shear. In the current context, multiple exposures to lower levels of shear are more relevant.

Therefore, it is proposed to conduct a systematic laboratory study of how hatchling fish respond to hydraulic parameters such as shear stress, turbulence intensity, and turbidity. Of paramount interest is how the levels of these parameters that are required to produce significant mortality compare to those that are measured in the field.

II. Methodology

Numerous methods will be used in order to achieve these objectives:

- The near-bank velocity and turbidity profiles will be measured with an array of acoustic Doppler velocimeters and optical backscatter sensors.
• The laboratory studies will be conducted with a variety of facilities. In order to assess the effects of shear stress, a rotating Couette flow will be used. Comprised of two concentric cylinders (one fixed, one rotating), this arrangement generates a flow field characterized by constant stress. By adjusting the rotational rate of the free cylinder, the level of shear stress can be carefully controlled.

In order to assess the effects of turbulence intensity, a ‘stirred tank’ will be used. A common apparatus in turbulence experiments, this facility consists of a rectangular tank with an oscillating grid at one end. The amplitude and frequency of the grid set the levels of the turbulent fluctuations in the tank, again provided for a highly controlled experiment.

Finally, in order to assess the effects of turbidity, solutions of varying turbidity will be prepared with sediment samples collected from the banks of the Chilkat River. A centrifugal pump and a diffuser plate will be used to gently recirculate the water in order to keep the sediment in suspension. By exposing hatchling fish to different levels of turbidity for different lengths of time, an understanding of what impact, if any, the intense sediment pulses associated with boating activity are having.

Benefits to salmon/salmon fisheries/salmon fishers

The Department of Natural Resources (DNR) and ADF&G will use this report to assist with management of commercial motorized tours in the CBEP. The management of objects of the CBEP include protecting and sustaining the natural salmon spawning and rearing areas of the Chilkat River and Chilkoot River systems within the preserve in perpetuity. Identifying the wake characteristics and water depth

Stakeholder support

The Upper Lynn Canal Fish and Game Advisory Council, Lynn Canal Gillnetters Association, Alaska Chilkat Bald Eagle Preserve Advisory Council have supported this project.

Partners

Penn State University will collect and analyze the field data for this project. The ADF&G Divisions of Sport Fish and Commercial Fisheries will assist with logistics and field camp gear. The Division of Park and Outdoor Recreation will also assist with logistics.

Results/Deliverable products

Penn State University (PSU) with assistance from ADF&G will finalize an Operational Plan prior to beginning fieldwork in summer 2003.

PSU will deliver a final report that will summarize and analyze the data collected before the end of the 2003-4 academic year.

Milestones/Project Timelines

The project will begin in May 2003. A final operational plan will be completed by April 2003. Fieldwork will be conducted during the summer of 2003 and laboratory work will be conducted during the 2003-4 academic year. A final report will be completed by May 2004. If further funding is available this project will be extended for another year.
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