An Approach to verify the assumptions in the red, green, and gray matrix for CMPs

Information need

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A considerable amount of attention has been given to fish passage problems and methods to provide adequate passage for fish through culverts and numerous publications and technical report provide varying degrees of detail with respect to installation and fish passage. (Anderson and Bryant 1980; Baker and Votapka 1990) Barriers to fish passage listed by Furniss et al. (1991) include water velocity and depth in the culvert, the distance between the culvert outfall and stream surface, and lack of a pool below the culvert. They also provide a guidelines and examples for installation and maintenance of road crossings. Most of their design criteria are based on engineering considerations. Although, a large number of guidelines and examples are generally available (see Evans and Johnston 1980), an estimated 5,500 culverts were identified as barriers in Washington and Oregon (GAO 2001). The report also states that the extent to which culverts block fish passage is largely unknown. Furthermore, most projects that are used to remedy passage are not systematically monitored (GAO 2001). Few examples are available for monitoring or evaluation of criteria.

A rigorous set of criteria is used to evaluate culverts for fish passage throughout the Tongass National Forest. The criteria are assumed to measure of the ability of a juvenile fish to move through a culvert at specified high flow events. An underlying assumption of the criteria used in the "red", "gray", and "green" classification system is that the abundance of fish above a culvert is affected by the perceived ability of the fish to move through the culvert at specified flows. The information is used to identify and prioritize culverts that need to be replaced to bring road crossings into compliance with existing laws and regulations for state and federal standards. The system of classifying culverts into "red", "green" of "gray" with respect to fish passage is a useful tool to identify potential problems with fish passage at road crossings with culverts. The classification system has great implications with respect to allocation of financial resources when culverts are identified as blocks and prioritized for replacement.

The criteria were selected on commonly accepted features that limit upstream access through culverts (Furniss and others 1991). However, the values that were assigned to criteria were based on professional judgment (M. Furniss, personal communication). In some instances, swimming speeds (burst or sustained) of some species have been measured (Furniss and others 1991; Mackinnon and Hoar 1953); however, they vary among species and size of the fish. Adult fish are able to negotiate higher velocities (Bell 1973). Although useful as starting points, they are not sufficient to test the assumptions of the criteria that are presently being applied.

A study is in progress to assess seasonal movement of juvenile Dolly Varden and cutthroat trout and to identify the range of discharges in a small high gradient stream that may affect their movement. Information from this study will contribute to our knowledge of when and at what flows these salmonids move and if there are upper limits to flows when fish move. However, it will not determine if the criteria presently used to classify culverts are able to

differentiate among culverts to provide fish passage. Presently, no evidence is available that illustrates differences in the abundance of fish among the three classifications or if there is a relationship between abundance and one or more of the criteria used to classify culverts. This is an important question. The primary reason to replace "red" culverts (other that to meet regulatory statutes) is to restore or increase fish populations above the culvert.

Two approaches may be used to examine the assumptions used to classify culverts. One is to use an artificial steam environment and challenge individual fish to pass culverts set at defined gradients or with a perch of varying heights. An advantage is that velocities could be controlled and each measure could be individually assessed. However, such tests do not integrate the complexities of natural conditions and often do not adequately measure all of the assumptions. A systematic and statistically sound evaluation of the field application of the methodology can provide an assessment of the assumptions and determine if there are differences in fish abundance among the three groups. A field evaluation with an appropriate statistical design can provide an effective evaluation of the assumptions used to classify and prioritize culverts with fish passage problems.

A substantial number of road crossings of both anadromous and non-anadromous fish streams have been identified and classified throughout southeast Alaska. They represent a sample pool of almost 3,000 road crossings. Furthermore, most of the criteria have been measured on each culvert and have habitat data associated with them. However, none have population abundance information and few measurements were made on crossings that were classified as "green". Samples for the study will be drawn from all three categories from this set of culverts. Within this sample set, streams will be stratified into anadromous and non-anadromous. Fish population abundance in stream reaches above and below culverts on each

stream will be estimated. In the ANOVA design, above and below are designated as classes and culvert classifications are treatments. The design will test for differences in salmonid abundance between classes, among treatments, and interactions between treatments and classes.

Relationships between fish abundance and culvert criteria can be examined from the pooled sample of all culvert groups with fish abundance as a function of culvert criteria using a multiple regression analysis. Significant relationships between fish abundance and habitat measurements can be explored with a stepwise regression analysis.

The study would require a two year period to collect data with the emphasis on estimating fish abundance, verifying culvert measurements, and conducting habitat surveys in the study reaches above and below the culverts. An additional year would be required to complete data analysis, and a final report and manuscript; however, results would be presented periodically through annual progress reports and informal presentations as they become available.

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