

Kilarc Project Alternative, Research Center White Paper

By WaterWise Consulting, Colfax, CA, August 24, 2009

Introduction

This report examines potential opportunities for using facilities of the Kilarc Project to conduct research on Central Valley steelhead production. Establishing a research center at the Kilarc Project site is one of four major goals of the proposed Kilarc Trust Old Cow/Kilarc Alternative. The four goals are:

- Continuation of green power generation,
- Enhancement of recreational fishing, fire protection, and community services in the Cow Creek watershed,
- Increased production of Central Valley steelhead in the Cow Creek watershed, and
- Improved understanding of the factors that affect natural and artificial production and protection of steelhead.

Previous reports address the first three goals (Davis Hydro 2009a, 2009b). This report provides a general description of related research opportunities presented by the proposed Alternative, evaluates the feasibility of using the Kilarc Project facilities for conducting the research, and provides three preliminary examples of research projects that could take advantage of existing and modified Kilarc facilities.

Research Opportunities of the Proposed Alternative

Research included in the proposed Alternative would be designed to improve understanding of the factors that affect the health and production of Central Valley steelhead, particularly in the Cow Creek watershed. It is expected that most of the research would be conducted within the 3.6-mile Kilarc Project headrace, but research could also be carried out in Old Cow Creek and other nearby streams.

The headrace currently includes a variety of canal types, including steel flumes, concrete lined canals and sections trenched into the existing substrate (partially reinforced with gunnite). Three significant sections lined with the existing substrate and totaling about a mile in length most closely approximate natural stream conditions, but all sections have much less instream structure and much more uniform flow and depth than found in most natural streams.

The headrace would serve three functions for the proposed Alternative. First, the headrace would continue its hydropower function of conveying water to the power station penstock. Second, parts of the headrace would be modified to support artificial spawning beds for enhancing steelhead production in the Cow Creek drainage. (Preliminary plans for the artificial spawning beds and

associated canal modifications are described in a previous document (Davis Hydro 2009a.) And finally, the headrace would serve as a facility for conducting field experiments to test factors that potentially affect steelhead spawning and production of juveniles. The production and research functions of the headrace would overlap because a major objective of the field experiments would be to understand how to maximize numbers of juveniles produced in the spawning beds.

The headrace would be re-engineered to increase detailed control of flow and allow monitoring of various parameters. This re-engineering could include installing full controls to operate different engineering gates and very small dams along the canal. The control system would have inputs from regular data ports along the canal for measuring flow and water depth. In addition this data system would be usable for instrumentation of individual experiments along its full length. The data gathered along the canal (and possibly in other research areas) would be telemetered to an onsite laboratory that could be located in the old transformer building.

The relatively uniform conditions within the different sections of the headrace could be used to advantage for testing effects of different habitat factors. For example, flow velocity, depth, substrate and cover could be varied and controlled to determine effects on steelhead habitat selection, feeding success, growth, and other response variables. Adding structure incrementally to vary hydraulic complexity could be used to study fry rearing habitat needs. Spawning habitat requirements could be tested by varying substrate particle size, flow velocities, and overhead cover. Cameras and other remote sensing devices could be installed to research spawning steelhead habitat selection, redd construction, mating behaviors, redd superimposition, in-gravel flow and water quality conditions, survival and development of eggs and alevins, behavior of emerging fry and other habitat conditions and fish responses.

In other studies, barriers and culverts could be installed in sections of the canal to study passage performance of adult steelhead. The headrace could also provide opportunities for investigating the performance of different types of small fish screens. The knowledge gained from such research efforts would be applied to enhance production of steelhead in Cow Creek and other streams.

Many previous attempts to artificially construct spawning habitat for anadromous salmonids, particularly salmon, have failed. However, most such attempts were made in natural streams where opportunities for controlling flow and other conditions were limited, whereas conditions in the headrace would be subject to substantial control. Results of such experiments would allow for changes and improvements to the headrace spawning beds. It is hoped that the research would ultimately lead to a

better understanding of optimal conditions for steelhead spawning beds in general.

Feasibility of using the Kilarc Project for Research on Steelhead Production

Conceptually, a typical small hydro project has many features that make it well suited for conducting research on fishes. Among the most important of these is that the projects are located where the fish naturally reside and divert the same water that the fish inhabit. As a result, the test subjects are relatively easy to obtain and well adapted to test conditions. The small buildings that house the power plant and other project facilities can often, as in this case, be adapted to the needs of research. Finally, as described in the previous section, the headrace of small hydro projects often provides a relatively uniform environment that can be modified, manipulated, and controlled as needed for conducting field experiments. The headrace is much more easily modified and controlled than a natural stream, but maintains much more of the natural conditions that the fish are adapted to than would be available in a laboratory setting.

The proposed Kilarc Project Alternative has a number of features that make it especially well suited for research on fish, including research on steelhead production. These features include the following:

- The Alternative has been specifically designed for fisheries research to proceed in concert with fish production and power generation. A great deal of fisheries research has already been conducted at hydropower projects, typically as part of relicensing efforts. However, such research is often limited because of conflicts with power generation. In contrast, the proposed Alternative would allow most research efforts to proceed with relatively minor impacts on generation.
- The Alternative would commit a portion of revenues from the continued power generation to support fisheries research. Such a long-term commitment of funds to Central Valley fisheries research constitutes a rare opportunity.
- Continued operation of the Kilarc Project facilities, while generating green power, would likely have little adverse effect on Central Valley steelhead or other fishes in the Cow Creek drainage. It is uncertain if steelhead ever ascend Whitmore Falls and enter the Project area, but if so, they do so only occasionally, when flows are unusually high (PG&E 2007). Furthermore, there is little suitable habitat for steelhead spawning in the Project reach (PG&E 2007). There is no evidence that operation of the Kilarc Project has adversely affected resident rainbow trout and other species currently present in the bypass reach.

- Water temperature and water quality conditions of Old Cow Creek support a healthy rainbow trout population and, therefore, would be suitable for steelhead production in the Kilarc Project headrace. Most of the Project headrace is well shaded by vegetation and the topography, minimizing solar heating. Trophic conditions of the creek could likely be duplicated in the headrace with appropriate habitat enhancements.
- Cow Creek currently has a steelhead run from which the spawning stock for the constructed spawning beds of the headrace could be obtained. Alternatively, if ESA restrictions precluded use of these fish, steelhead might be obtained from hatcheries. For experiments on rearing fish, the juveniles could be obtained from successful spawning beds in the headrace or from hatcheries. For most studies of juvenile steelhead, juvenile resident rainbow trout captured or diverted from Old Cow Creek would probably serve as adequate substitutes for steelhead juveniles.
- Although higher in elevation, the headrace is close enough to the bypassed channel to allow return of juvenile steelhead produced in the headrace to Old Cow Creek by way of constructed return channels (cf. Davis Hydro 2009a). Such return of the juveniles is essential for the enhanced steelhead production function of the proposed Alternative, but it also provides research opportunities. For instance, juveniles could be counted automatically as they entered the return channels, providing an efficient procedure for estimating production.
- The Kilarc Project is located immediately upstream of an established migratory corridor for Central Valley steelhead. Therefore, juvenile steelhead produced in Old Cow Creek would be able to naturally emigrate to the ocean and return to Cow Creek as adults.
- A significant part of the headrace including the largest spawning bed area is accessed by road 10 months of the year, facilitating research project construction, monitoring, and maintenance activities (Davis Hydro 2009a).
- Whitmore Falls and other natural barriers present in Old Cow Creek provide opportunities for research on fish passage (described in greater detail below).
- Funds generated from power generation could be used to support offsite research that contributed to steelhead production.

Selected Examples of Research Projects

1. Design and Performance of Constructed Spawning Habitat

As previously noted, the primary purpose of the research proposed for the Kilarc Alternative is to support protection and enhancement of steelhead production. The research and production goals are complementary, in that the thrust of the research will be to determine how to produce the most fish. Spawning beds constructed in the headrace would be the principal means for effecting enhanced steelhead production, so research to maximize spawning bed performance would directly contribute to the production goal.

Much of the headrace that would be most suitable for spawning beds is easy to access, which would greatly facilitate construction and modification of the beds. Experimentation would include using different types of spawning gravel additions for the spawning beds. Water quality, depth, flow, cover, and substrate in major sections are relatively uniform. All of these variables, except water quality, could be varied from year to year to determine the combination that resulted in the greatest production of juvenile steelhead.

Considerable effort will be devoted to developing a technique for counting steelhead fry as they leave individual spawning beds. If such a technique were successfully developed, the production of several spawning bed designs, with replicates, could be tested simultaneously.

2. Downstream Fish Passage and Diversion Screening

The Cow Creek area has a large number of irrigation diversions that likely entrain many juvenile steelhead during their outmigrations. The need to protect these fish leads to confrontation between farmers and the agencies charged with protecting steelhead. Current practice by State and Federal Authorities is to find moneys and agents to put screens on the diversions at considerable cost. Installation of screens could be greatly accelerated by developing lower cost and more easily maintained devices to keep small fish out of diversions. This research project would address the design and maintenance of fish screens or bypasses as a necessary and important part of fish protection. Screens and fish returns in the diversion could be explored. Diversion screens do not work very well unless they are well maintained. Failures often result not from the performance of the screens per se, but rather from a lack of screen maintenance. While in some cases, large concrete and steel screening structures might be required, this research project would study and implement other approaches that could be more effective because they would be less expensive and thereby encourage cooperation between the diverter and the agency.

A variety of screen designs and other avoidance devices, including those already developed and newly conceived designs, would be tested. Testing

would include ease and effectiveness of screen maintenance. The testing could be conducted under a variety of flow conditions, both at the intakes for the fish return channels in the headrace and at existing diversions in the Cow Creek drainage. Performance of the screens in the headrace could be investigated closely by using cameras to study behavior of steelhead fry near the screens and effects of debris on the screens.

3. Upstream Fish Passage Barriers

There is currently considerable interest in upstream passage of steelhead at natural and artificial barriers. There are several natural fish barriers in the general vicinity of the Kilarc Project that provide opportunities to study this issue. Specifically, behavior of adult steelhead could be studied at both the Whitmore Falls and the higher “impassable” falls in the bypass reach of Old Cow Creek under a variety of flow conditions. The objectives of this research would be to evaluate the accessibility of habitat upstream of the barriers for steelhead spawning, and to determine environmental and biological factors that influence steelhead passage for use in developing a general steelhead passage model.

Unless prevented by ESA restrictions, the research would likely use steelhead that had been trapped downstream and moved under suitable flow conditions to just below the study falls. These fish would be studied to determine their behavior and passage success at different flows. Some of the study fish could be radio tagged to track their upstream and downstream movement using radio receivers mounted near the falls. Data could be transmitted from field sensors to the new Kilarc Lab for real-time analysis of fish movement as related to factors potentially affecting passage, such as fish size, flow, time of day, date, and weather conditions

References

- Davis Hydro. 2009a. The Kilarc Steelhead Project. An Alternative to the Demolition of the Kilar Hydropower Project. Davis, CA. June 2009.
- Davis Hydro. 2009b. Project Scope and Studies. Davis Hydro Working Paper, K-4. Davis, CA. July 2009.
- Pacific Gas and Electric Company (PG&E). 2007. Kilarc-Cow Creek Project, FERC No. 606, Aquatic Habitat and Fisheries Resource Report. Prepared by Entrix, Inc., Concord, CA. November 2007.