ASSESSMENT OF A FLOW ENHANCEMENT PROJECT AS A RIPARIAN AND FISHERY HABITAT MITIGATION EFFORT

Robert J. Henszey, Steven W. Wolff,
Thomas A. Wesche and Quentin D. Skinner
Wyoming Water Research Center, University of Wyoming

and

W.A. Hubert
Wyoming Cooperative Fish and Wildlife Research Unit

Abstract

As part of mitigation procedures for impacts caused by the Cheyenne Stage II water development project in the Little Snake River Drainage, Wyoming, the flow in a previously ephemeral watercourse on the east slope of the Laramie Range is being enhanced to create a perennial stream. Water used to enhance this flow is obtained by transbasin diversion. The mitigation is being done in hopes of enhancing the riparian and fishery habitat. Currently, a comprehensive study is being conducted at the University of Wyoming to assess the results of this action and the feasibility of applying this strategy to other watershed. The project focuses upon defining conveyance efficiency, channel development, groundwater storage, alteration of riparian vegetation, and formation of trout habitat. In this paper we describe the overall mitigation project, our study design, and preliminary results.

Introduction

With the ever-increasing demand for water in the western United States, more efficient utilization of existing supplies is needed. A goal of any water development project should be to maximize benefits to the greatest number of water users. These water users generally fall into four main categories: 1) industry, 2) municipalities, 3) agriculture, and 4) recreation. A common method for a municipality to obtain water for its use is by transbasin diversion. Such projects can have dramatic effects on the streamside zone below the point of diversion by reducing or eliminating streamflow, resulting in serious impacts to the riparian and aquatic resources.

Diverted water supplies are usually conveyed by means of either pipelines or open channels. An alternative method for conveyance is by using natural watercourses. If ephemeral streams can be used, and flow releases are controlled and maintained year-round, new riparian and aquatic habitat can be created. To date, such a strategy has received little attention. Currently, the City of Cheyenne, Wyoming, is pursuing such a strategy as one mitigation measure for its water development program.

The goal of our study is to assess the results of this mitigation strategy, and the feasibility of applying this strategy to other

watersheds. Specific objectives include defining channel development, conveyance efficiency, groundwater storage, alteration of riparian vegetation, and formation of trout habitat. This paper will describe each of these objectives and present some results to date.

Description of Study Area

The stream selected for flow enhancement was the South Fork of Middle Crow Creek (SFMCC) and one of its tributaries. The SFMCC is located within the North Platte River basin of southeast Wyoming, 20 miles east of Laramie within the boundaries of the Medicine Bow National Forest. The headwaters of this once ephemeral stream rise on the east slope of the Sherman Mountains at an elevation of 8,200 feet above mean sea level. The drainage runs in an easterly direction for ten miles to its confluence with the Middle Fork of Crow Creek between Granite Springs and Crystal Lake Reservoirs. The upper 5.5 miles of stream is on national forest lands while the lower 4.5 miles is primarily private land. For this project, the primary study area has been limited to the portion of the SFMCC watershed that is located on national forest lands (Figure 1).

Historically, the SFMCC was an ephemeral foothills stream which flowed primarily in response to spring snowmelt and intense precipitation events. Scattered springs and seeps throughout the drainage provided limited areas of surface flow during non-runoff periods. Only a portion of the drainage had a defined stream channel present. Land use of the area is primarily for agriculture (cattle grazing) and recreation (camping, fishing, hiking, rock climbing).

Municipal water was first released into the SFMCC during late summer of 1985. Presently, 1 cubic foot per second (cfs) is being discharged into both the main channel and its tributary, with maximum potential releases of 5 and 3 cfs, respectively. In conjunction with the flow augmentation, six livestock exclosures were established in the lower reaches of the study area to provide protection for developing aquatic and riparian resources.

Results to Date

Channel Development

During the fall of 1984, 47 valley bottom cross-sections were selected, permanently marked, and surveyed across the valley floor on the SFMCC and its tributary within our study area. In 1986, an additional ten cross-sections were added. These cross-sections were located based on channel gradient, vegetation type, and the type of channel control exhibited (geologic, vegetative or biologic). All cross-sections are resurveyed annually and are used to assist the amount and rate of channel development.

Since flow augmentation began in 1985, 50 percent more stream channel (3,221 feet) has developed, though only 35 percent (9,656 feet) of the total valley length within the study area is now channelized. Of the 3,221 feet of new channel on the SFMCC, almost all has developed by downcutting. Surveys conducted in 1988 indicated that in several of the unchannelized meadow areas the water has become more confined (decreased top width, increased depth, increased velocity), which may be a precursor to channel development.

Surface Hydrology

Six Parshall flumes were installed on the SFMCC between 1985 and 1986 to monitor the hydrologic response of the watershed to enhanced flow. Flumes are located: 1) at the mainstream outlet; 2) at the tributary

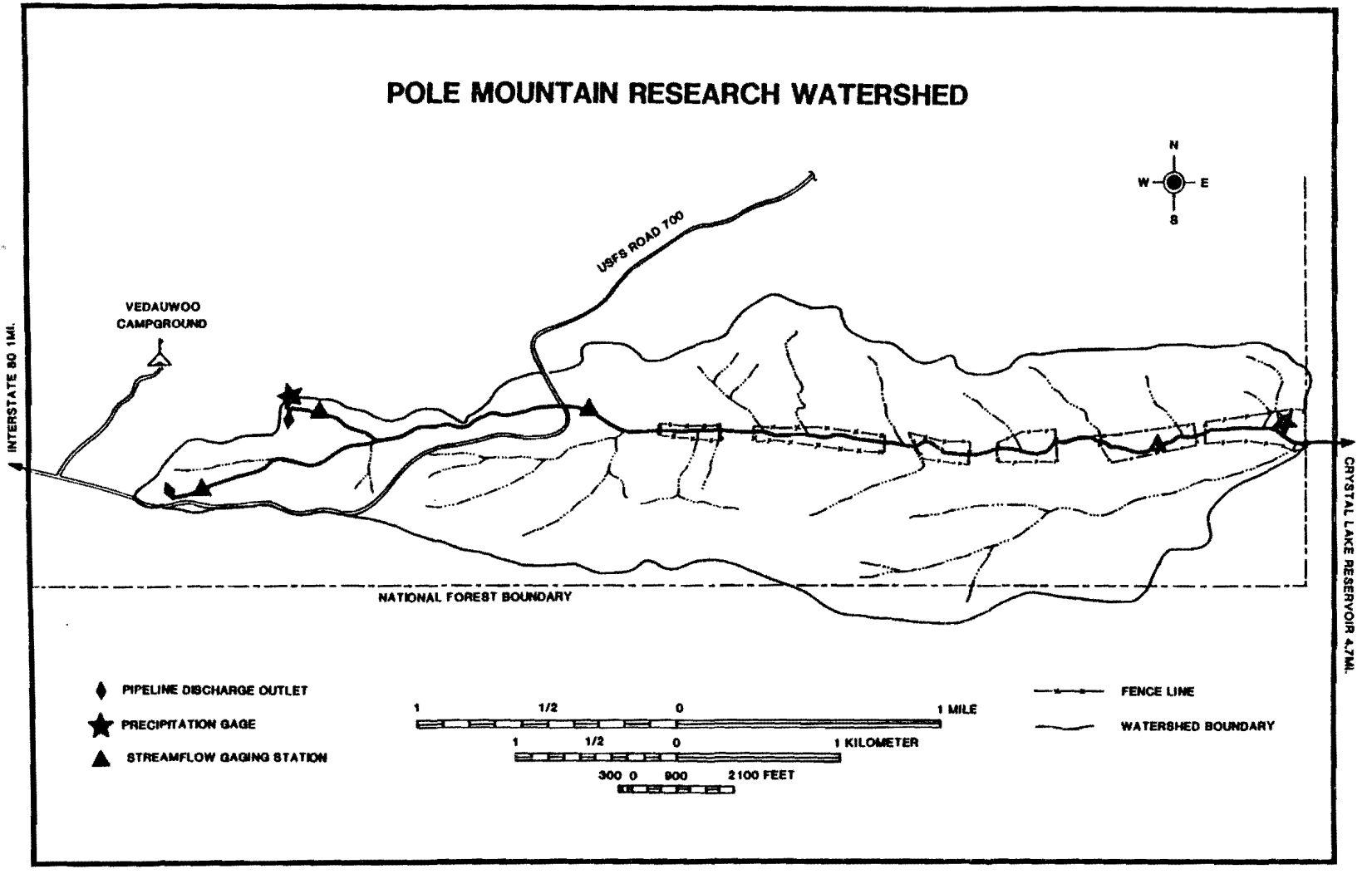

Figure 1. The Pole Mountain Research Watershed for the South Fork of Middle Crow Creek.

outlet; 3) midway through the study area; 4) just above the forest boundary; 5) 0.5 miles below the forest boundary; and 6) 0.5 miles upstream from the mouth of the SFMCC. Flumes are equipped with precipitation gauges with Alter shields were also installed on the watershed.

Mean monthly flows (not including periods when discharges were zero) for the SFMCC ranged from 1.7 to 0.4 cfs. The duration of periods when discharges into the SFMCC were turned off between 1985 and 1988 ranged from 2 to 54 days and totaled 206 days or 17 percent of the first 40 months of required flow augmentation. Very little data on conveyance loss for the SFMCC watershed has been evaluated, but rough estimates indicate that losses may be as high as 50 percent during July and August, and near zero during winter months. However, summertime losses should be greatly reduced as the system develops. Total annual precipitation recorded within the watershed ranged from 15.9 to 19.2 inches form 1985 to 1988.

Groundwater Hydrology

Between 1985 and 1986, four shallow alluvial groundwater wells cased with 2-inch PVC pipe were installed along each of the valley bottom cross-sections to evaluate the groundwater response to flow augmentation. Presently, there are a total of 234 wells on the SFMCC watershed.

As would be expected, groundwater levels have been elevated significantly since streamflow augmentation began, and in many areas is at or near the soil surface. Much of the unchannelized meadow is also flooded to a depth of 2 to 5 inches, because the augmented streamflow has spread across the alley floor. Where water has become more confined by a developing channel, the standing water has subsided and the groundwater level has dropped. Groundwater levels are, however, still significantly higher than they were prior to streamflow augmentation.

Riparian Vegetation

Evaluation of the riparian vegetation response to streamflow augmentation has been subdivided into the forest (aspen, Populus tremuloides), shrub (shrubby cinquefoil, Pentaphylloides floribunda), and herbaceous plant community responses. Data have been collected from all three community types, but analysis has so far focused on the herbaceous plant community. Within the herbaceous plant community, the dominant riparian plant species evaluated include sedge (Carex spp.), tufted hairgrass (Deschampsia cespitosa), and reedgrass (Calamagrostis neglecta). Some limited data prior to streamflow augmentation (1985) are available, but the primary herbaceous vegetation study design is based upon 22 sites on the SFMCC and 11 comparison sites on similar nearby watersheds. Sites are stratified into dry, moist, moist-wet, and wet meadow types. Each site is sampled at the peak of the growing season (first two weeks of August) for total above-ground biomass, density, and basal cover.

After two years of augmented streamflow on the SFMCC, the dominant riparian plant species composition is shifting towards more water tolerant species. The amount of sedge (mostly water loving species) in the dry and moist-wet meadows appears to be increasing, and the amount of sedge in the moist and wet meadows has definitely increased. Tufted hairgrass (a moist meadow species) appears to be declining in the flooded moist, moist-wet, and wet meadows, but may be increasing in the dry meadows since the water table has been elevated. Reedgrass (a moist meadow species) has also increased in the dry meadows, while remaining relatively unchanged in the other three meadow types. The proportion of bare ground in the flooded meadows has increased, most notably in the moist-

wet meadows where it has increased from 1 percent in 1986 to 32 percent in 1987. As the protective plant cover decreases and the proportion of bare ground increases, the potential for accelerated channel development in these unchannelized meadows should increase.

Fish Habitat

Evaluation of the development of fish (brook trout, Salvelinus fontinalis) habitat on the SFMCC has been divided into two sections, stream habitat and beaver pond habitat. To assess the stream habitat, both the Habitat Quality Index (HQI) (Wyoming Game and Fish Department) and the Physical Habitat Simulation (PHABSIM) System (U.S. Fish and Wildlife Service) were used. The HQI predicts the potential standing crop of trout based on measured physical parameters of the stream. PHABSIM estimates the total amount of habitat usable to trout in a stream at varying discharges. Beaver pond habitat was evaluated by conducting annual surveys of the size and number of ponds within the study area.

Results of the HQI indicate that the SFMCC should be able to sustain trout populations as well as, and probably better than, similar streams in the Pole Mountain area. The analysis of the SFMCC using PHABSIM estimates the total amount of habitat usable to trout in a stream at varying discharges. Beaver pond habitat was evaluated by conducting annual surveys of the size and number of ponds within the study area.

Beaver pond habitat increased significantly from 1985 to 1987. Total surface area of ponds increased from 1.5 acres to over 3.0 acres, while the overall number of ponds in the study increased from 8 in 1985 to 24 in 1987. These ponds have been stocked by the Wyoming Game and Fish Department and now support catchable sized brook trout.

Summary

Given the ever-increasing demand for water in Wyoming, multiple uses of existing supplies need to be investigated thoroughly on every water development project being discussed. If natural resource management agencies have several options available to them when evaluating these projects, the chances for improving or limiting impacts to the resource are increased.

The long-term success of the SFMCC mitigation project has yet to be determined. Thus, the overall goal of this study is to determine the hydrologic and biologic feasibility of conveying municipal water via ephemeral stream channels. Below are several preliminary conclusions from the evaluation of the SFMCC watershed after three years of enhanced flows.

1. Stream channel length has increased 50 percent, but still occupies only 35 percent of the total valley length within the study area;

2. In areas where a developed channel does not exist, water has spread across the valley floor, flooding the riparian zone to a depth of 2 to 5 inches;

3. The herbaceous plant species composition in the meadows is shifting from less water tolerant species, such as tufted hairgrass, to more water tolerant species, such as the sedges;

4. The proportion of bare ground has increased as much as 31 percent between 1986 and 1987. This may increase the potential for accelerated channel development;

5. Suitable trout habitat in both stream and ponded areas has formed due to the enhanced flow. The ponds have been stocked with brook trout and now support a brook trout fishery; and

6. The single most important factor that will determine the success or failure of the SFMCC flow enhancement project is the attainability of a permanent (uninterrupted) release of water into the SFMCC system.

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