Effects of renovation on the Sacajawea Park Lagoon system in Livingston, Montana
by Thomas Patrick Clancey

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Fish and Wildlife Management
Montana State University

Abstract:
The water chemistry, morphology, and trout populations in sections of Fleshman Creek and the water quality and quantity in the Sacajawea Park lagoon were studied from July 1980 to July 1982 to determine the effects of renovation on the lagoon system. Prior to renovation (June 1, 1981), water from Fleshman Creek flowed through all three study sections and the sediment filled Sacajawea Park Lagoon basin. After renovation, the two downstream study sections and the lagoon contained water from the Yellowstone River. Average dissolved oxygen concentrations , temperatures and pH levels increased and turbidities, conductivities, alkalinities and hardnesses in the affected areas decreased following renovation. Physical alteration of one stream section resulted in (1) a decrease in channel width, average depth and total cover, (2) increases in average velocity and sinuosity and (3) elimination of the estimated 67 (± 13) trout present. Following renovation, the beginning of recolonization by trout was documented. Before renovation, the lagoon area contained only a stream of water averaging 21 cm in depth with a peak discharge of 0.28 m^3/s and was unsuitable for recreation. After the removal of nearly 23,000 m^3 of sediments, the lagoon averaged 1.5 m in depth, contained over 23,000 m^3 of water and was attractive to boaters, fishermen, and other recreationists.

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APPROVAL

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Thomas Patrick Clancey

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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Signature Pat Clancy

Date May 23, 1983

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ABSTRACT

The water chemistry, morphology, and trout populations in sections of Fleshman Creek and the water quality and quantity in the Sacajawea Park Lagoon were studied from July 1980 to July 1982 to determine the effects of renovation on the lagoon system. Prior to renovation (June 1, 1981), water from Fleshman Creek flowed through all three study sections and the sediment filled Sacajawea Park Lagoon basin. After renovation, the two downstream study sections and the lagoon contained water from the Yellowstone River. Average dissolved oxygen concentrations, temperatures and pH levels increased and turbidities, conductivities, alkalinities and hardnesses in the affected areas decreased following renovation. Physical alteration of one stream section resulted in (1) a decrease in channel width, average depth and total cover, (2) increases in average velocity and sinuosity and (3) elimination of the estimated 67 ($\pm$ 13) trout present. Following renovation, the beginning of recolonization by trout was documented. Before renovation, the lagoon area contained only a stream of water averaging 21 cm in depth with a peak discharge of 0.28 m^3/s and was unsuitable for recreation. After the removal of nearly 23,000 m^3 of sediments, the lagoon averaged 1.5 m in depth, contained over 23,000 m^3 of water and was attractive to boaters, fishermen, and other recreationists.

INTRODUCTION

The Sacajawea Park Lagoon System at Livingston, Montana has been severely impacted by sediments from Fleshman Creek since its formation. It was created in 1939 and by 1959 it had become too shallow to hold fish or provide a site for general recreation and required dredging to make it fully usable again. Concern for the adverse impacts of continuing deposition on the general use of the lagoon and on its suitability for the annual Children's Trout Derby caused interested state and local officials and private citizens to form the Save Our Lagoon Committee in April 1976 to determine ways to rehabilitate the lagoon.

The efforts of this committee resulted in the State of Montana entering into an agreement with the U. S. Environmental Protection Agency (E.P.A.) in July 1980 to renovate the Sacajawea Park Lagoon System under the Clean Lakes Act of 1977. This Act, in part, provided a means whereby states could enter into an agreement with the E.P.A. to receive funds for the development and implementation of restoration programs for lakes which would provide significant public benefits over a long period of time.

The plan for renovation of the Sacajawea Park Lagoon System included recommendations that the lagoon be excavated to bedrock and a source of water other than Fleshman Creek be used to reduce the rate of future sedimentation in the system. The objectives of this study were to

measure changes in selected water quality parameters, channel morphology, and trout populations which resulted from the renovation of the lagoon system. Field work was conducted from July 1980 through July 1982.

DESCRIPTION OF STUDY AREA

The Sacajawea Park Lagoon System is located in southcentral Montana in Park County at the City of Livingston (Figure 1). It is formed by two side channels of the Yellowstone River which the city severed from the river with rock dikes. The 2.3 hectare (ha) lagoon was formed where the two side channels converged. With the elimination of flows from the Yellowstone River in 1939, the sole source of water for the system became Fleshman Creek.

Fleshman Creek has its headwaters on Bangtail Ridge in the Bridger Mountains west of Livingston. It flows in an easterly direction for approximately 23 kilometers (km). The drainage area is 63 km^2 consisting largely of moderately alkaline loam and clay-loam soils (Don Freeman, personal communication) used for rangeland, irrigated cropland, and some housing. The creek has an average gradient of 34 meters per kilometer (m/km) and typically contains less than 0.28 cubic meters per second (m^3/s) of water from July to April. However, during the spring, flows may increase to 1.42 m^3/s, at which time significant amounts of soil and organic materials are transported.

The Yellowstone River, which is within a few hundred feet of the Sacajawea Park Lagoon, flows north at Livingston. Its drainage area above Livingston is 9197 km^2 (U.S.G.S.) in primarily igneous and sedimentary deposits (Perry, 1962). Maximum discharge during the 1981 water

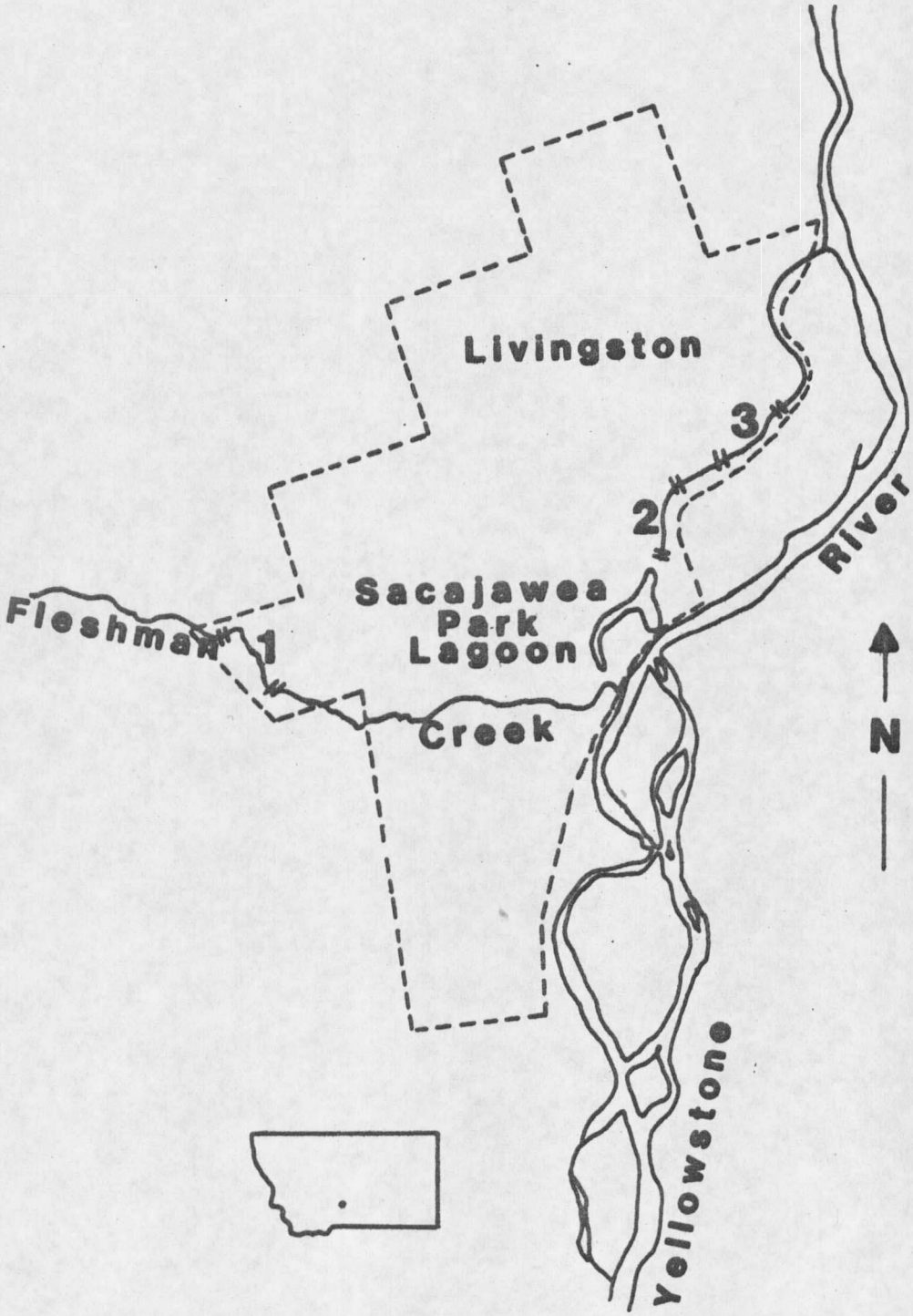

Figure 1. Map of the study area showing the location of study sections (1-3) on Fleshman Creek and the Sacajawea Park Lagoon.

year (Oct. 1980 - Sept. 1981) was 674 m^3/s on June 9, and minimum discharge was 21 m^3/s on February 11. The average discharge for the past 56 years has been 106.4 m^3/s (U.S.G.S., 1981).

Study Sections and Sites

Three study sections were established on Fleshman Creek near the Sacajawea Park Lagoon (Figure 1). Section 1 was established upstream from the lagoon and extended from Sun Avenue to a point 307 m upstream. This section served as a control and had no rehabilitative work performed on it. Section 2 was located immediately below Sacajawea Park Lagoon from South Second Street to South C Street. The channel in this section was originally 368 m in length. During renovation it was narrowed and given meanders by the strategic placement of sediments dredged from the lagoon, thereby lengthening it. Willow shoots and grasses were planted in the newly created banks to prevent erosion and to provide future cover over the stream. This section received water from Fleshman Creek prior to renovation and water from the Yellowstone River after Fleshman Creek was diverted from the lagoon. Section 3 was situated below the lagoon from South F Street to a point 400 m downstream. No physical alterations were performed on this section; however, as in Section 2, its source of water was from Fleshman Creek before renovation and from the Yellowstone River afterwards.

A site for sampling water in the Yellowstone River was also established. This site was located at the water intake structure for the lagoon and the city of Livingston.

From the start of this study on July 10, 1980, until Yellowstone River water was introduced on June 1, 1981, the lagoon contained only a shallow stream from Fleshman Creek which averaged about 21 cm in depth, 3.7 m in width and contained less han 0.28 m^3/s of water. The lagoon was not a lagoon as such because its basin was filled with sediments. The water in the creek at Station 1 (Figure 2) was sampled as the best indicator of what water in the lagoon might have been like.

Renovation was begun on July 31, 1980, when an earthfill dam was constructed at the head of the lagoon to divert Fleshman Creek away from the lagoon and into the Yellowstone River. Following this, the lagoon was excavated to bedrock. Over 22,935 m^3 of sediments were removed and stockpiled. A box type weir was constructed at the point of outflow from the lagoon to control the water level in the lagoon and the flow in Fleshman Creek below the newly formed lagoon. A pipeline then was constructed from the city's water intake on the Yellowstone River to the head of the lagoon to provide water believed to contain a lower suspended sediment load. After all construction and renovation was completed, water from the Yellowstone River filled the Sacajawea Park Lagoon within 24 hours (hrs) of introduction. Following filling, water was initially sampled at Stations 2-4 (Figure 2).