A Synthesis of Water Quality Problems in the Clark Fork River Basin

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Abstract

The Clark Fork River ecosystem is not just that water that maps call the Clark Fork River. This ribbon of surface water interacts with ground water, with the local climate, with the landscape through which it passes, and with the tributaries that feed it. These interactions acting over time deter- mine the river's nature or overall condition. As users of the river we tend to be most concerned about certain aspects of the river's condition, including its water quality, the quantity and pattern of flow, and the nature and abundance of its biota. The Clark Fork is a complex river system of the Northern Rockies with a history of abusive uses, a present of multiple stressful uses, and a future that could be characterized by a number of scenarios. The river appears to be recovering from some of the past abuses, and suffering various types of impacts from the current uses. The future condition of this river system is dependent (1) on its own ability to recover from the past and to assimilate the present, and (2) on the wisdom and concern of those who shape its future management.

Summary of Water Quality Issues in the Clark Fork Ecosystem

Let us concentrate on the current water quality issues in the Clark Fork, with occasional looks at the past and future when the need arises to understand the river's present behavior or our future options. Because of the size and complexity of this system, I will divide it into three rivers for the purpose of discussion.

Upper River

The upper river begins as little more than a creek (160 ft3/s mean daily flow) born of the union of several smaller creeks. It grows to a medium sized river (3,000 ft3/s), swollen by three major tributaries (Little Blackfoot River, Rock Creek, and the Blackfoot River) by the time it reaches the Milltown Reservoir near Missoula. The principal problem of the upper river is the toxicity associated with heavy metals leaching and eroding from sites contaminated by historic mining and smelting operations in the headwaters. The present situation is greatly improved over the past as a result of treatment systems and settling ponds installed in the upper river over the past 30 years. Prior to these control efforts, the upper river was a biological desert. With reduction in metals loads. the dilution provided by tributaries allowed Clark Fork water quality to improve to the point that organisms fro~ the tributaries could recolonize the mainstem. Populations of aquatic insects (see Canton and Chadwick paper) and fish (see Phillips paper) have shown Considerable recovery. Still, there continue to be frequent exceedances of the water quality criteria for the protection of aquatic life and occasional catastrophic events (treatment system failures or floods that wash toxic sediments from the flood plain into the river).

Two Superfund sites have been designated in the headwaters and it is hoped that remedial actions at these sites will improve water quality and the fishery. However, a number of issues raised at this symposium cause us to look carefully at these efforts. Paradoxically, fish populations in the Clark Fork actually decrease as one moves farther downstream from the Superfund sites (see Phillips paper). A number of explanations for this have been offered. Water chemistry changes in the downstream direction may increase toxicity or bioavailability of metals (see Babb and Pagenkopf paper). Tailings washed down the river years ago and deposited in the flood plain may con- tribute significantly to the river's metal load (see Rice and Ray paper). Eutrophication of the uppermost reaches of the river with associated increases in fish food organisms may make it possible to support greater fish populations. None of these explanations are mutually exclusive. Although contributing to fishery problems, siltation, dewatering by irrigation, and loss of habitat caused by channelization during highway and railroad construction do not seem sufficient to explain the downstream decline in fish populations according to the regional fishery biologist (D. Workman, personal communication).

Upper River Tributaries

The upper river tributaries, so important to the upper river's condition and ability to recover, also have problems. The Little Blackfoot with its respectable brown trout population suffers from dewatering and streambed manipulation by irrigators. A tributary of Flint Creek which enters the Clark Fork at Drummond has metal contamination from historic mining and continues to have trout contaminated with mercury to a level of some health concern. Rock Creek, a blue-ribbon trout stream of national significance, may be threatened by sediment loading and siltation of its bed from logging operations. The Blackfoot River with its high water quality and excellent rainbow trout population (1,000 to 1,500/mile), has numerous tributaries that may be stressed by logging, placer mining, development, and herbicide spraying occurring in this basin. Sediment and nutrient loadings to the lakes of the Clearwater River, a tributary of the Blackfoot, are a particular concern. Continued impacts to these tributaries could reduce their ability to function as nurseries and sources of recolonizers for the mainstem. The Blackfoot River's ability to interact beneficially with the mainstem may already be reduced by the small dam near its confluence with the mainstem and by the Milltown Reservoir where it joins the mainstem (tagged Blackfoot River fish have not been found in the Clark Fork--D. Workman, personal communication). Any future reconstruction of these two structures should address how a new structure might reduce this impact.

The Milltown Reservoir, which divides the upper river from the middle river, is another focus of concern. Another Superfund site, the reservoir is characterized by metal-contaminated sediments that washed downriver and collected here, contaminating the drinking water of Milltown with arsenic. The reservoir's dam is slated for reconstruction beginning after high flow in 1986. In the past, annual maintenance drawdowns of the reservoir released quantities of sediments to the middle river occasionally causing fish kills and severely exceeding water quality criteria to protect aquatic life. However, at the request of the Department of Fish, Wildlife and Parks, Montana Power Company, owner of the dam, adopted a new method of lowering the reservoir that greatly decreased loss of sediments. Subsequent fish population inventories suggest that this has had a positive effect on the fishery. Although the pro- posed reconstruction will release heavy metals to the middle river, studies of recent drawdowns suggest that sediment release can be kept to a level that should not cause acute toxicity to fish. Engineering studies of the dam indicate that reconstruction is necessary to prevent dam failure. Since the new structure is expected to survive only 50 years, reconstruction does not represent a permanent solution to the problem of the contaminated sediments in the reservoir. Montana Power has stated that reconstruction will eliminate the need for annual drawdowns, which, if true, should be beneficial to water quality.

Middle River

Water from the Blackfoot, Bitterroot, and St. Regis Rivers swell the Clark Fork's discharge to nearly 10,000 ft3/s just above its confluence with the Flathead River. Past water quality concerns in this section focused on organic wastes originating from the Missoula Sewage Treatment Plant and a large pulp and paper mill. Historically, loadings of organic matter and nutrients exceeded the river's assimilative capacity and produced excessive foaming and growths of Sphaerotilus. The pulp mill's untreated effluent was sufficiently toxic to cause fish kills. The mill added primary treatment (settling ponds) soon after it opened, and the addition of secondary treatment at the mill (1974) and at the sewage plant (1978) greatly reduced most of these problems. Monitoring of aquatic insect populations in the middle river over the past 30 years by The Institute of Paper Chemistry (see Rades paper) suggests that the river has recovered from the earlier severe pollution problems but is growing steadily more eutrophic, perhaps as a result of continued urban growth in the Missoula Valley. Given this, the pulp mill owners' request in 1983 for permission to increase its discharge and to discharge year round is a cause for some concern.

The public's perception of water quality degradation throughout the river system, the view that the middle river fishery was below that which would be supported, and the lack of historic data on this river reach resulted in wide-spread public support for more information on the possible impacts of the new pulp mill discharge before a permit was granted. Of particular concern were the possible effects of year-round discharge during summer low flow conditions, the cumulative effect of the additional nutrient loading on downstream reservoirs and lakes, synergistic effects with upper river metal loadings, and the legal precedent set for the Nondegradation Policy. The Water Quality Bureau responded with a temporary permit, a promise to prepare an EIS before issuing a longer permit, and a monitoring program designed to fill in some of the information gaps. Some of the results obtained during the first year of monitoring included: no violations of the dissolved oxygen standard were observed in the middle river (except briefly at the bottom of a reservoir further downriver); some toxic organics were identified in mill effluent (at concentrations approaching those lethal to aquatic life); during high flow, copper exceeded water quality criteria for the protection of aquatic life in the entire middle river, otherwise metals were at acceptable levels (note the detection level for cadmium was not low enough to determine if it violated standards); also during high flow, algal nutrients exceeded EPA criteria for prevention of nuisance algae.

Perhaps the three issues of greatest concern here are esthetics, nutrients, and the fishery. Year-round discharge means that the highly colored mill effluent is entering the river when it is having its greatest recreational use. Since it takes several miles for the effluent to mix and become unnoticeable, the esthetic impact may be greater than that associated with seepage alone. Nutrients are a concern because of their potential contribution to enrichment of reservoirs and lakes downstream and because the point sources in this stretch of river (sewage plant and mill) may be among the most controllable sources of nutrients to the river. Finally, the fishery is 1ess than that expected for a river with the characteristics of the middle Clark Fork according to fishery biologists with the Montana Department of Fish Wildlife and Parks. Several explanations may be offered: the occasional water quality criteria violations for metals are sufficient to reduce fish populations; water quality parameters not presently monitored (such as toxic organics) are limiting the fishery; water quality problems during extreme 1.Ow flow years are limiting (the year of monitoring was an average flow year); spawning and rearing habitat is inadequate. This last possibility brings us to a discussion of the tributaries of the middle river.

Middle River Tributaries

The middle river has several tributaries known to have significant impacts as well as a number that are relatively pristine. Rattlesnake Creek is a high quality stream flowing from a protected watershed; however, there is a potential for impact as it flows through Missoula to reach the Clark Fork. Joining the river just below Missoula, the Bitterroot River and its tributaries receive significant inputs of sediment and nutrients from logging, agriculture, and urban development and contribute a substantial load of these pollutants to the Clark Fork. Probably of greater significance, however, is the dewatering of the Bitterroot and its tributaries for irrigation, especially during low flow years, with obvious fishery impacts. At Darby, the Bitterroot supports about 300 to 350 fish/mi; this drops to 200 to 250 in dewatered sections where young age classes of fish are especially reduced (D. Workman, personal communication).

A series of tributaries between the Bitterroot and the Flathead Rivers have sufficient flow and appropriate habitat to function as important nursery areas for the Clark Fork (Six Mile. Nine Mile. Petty. Fish. Trout and Cedar Creeks, and the St. Regis River). Most of these suffer some combination of the following impacts: overgrazing, logging, urban development, dewatering, highway construction. Other small creeks in this reach of the river pass through culverts that are not passable by fish. Every effort should be made to mitigate these impacts or to hold the line at the present level of impact. A better understanding of the changing condition of these tributaries and their role in the Clark Fork system is essential.

Problems surfacing in the middle Clark Fork basin include growing problems of contamination on the Missoula Valley aquifer involving septic systems, leaking gas tanks and pipelines and pesticide spills. The interaction of this aquifer and the river is poorly understood. and the aquifer's impact on river water quality needs to be evaluated, especially downgradient of Missoula. Additional concern has been expressed for the potential for acid rain impacts on the poorly buffered waters of lakes and streams in the Bitterroot Mountains.

Lower River

The lower river is a very large river (20,000 ft3/s) formed by the union of the Clark Fork with the Flathead River. The river flows through a series of reservoirs and into Lake Pend Oreille in Idaho. Many of the water quality problems of the lower river are a result of the flow regime of the reservoirs and the lake. Unlike some reservoirs, these fast-flushing reservoirs offer a poor environment both for river and lake fisheries. Slowing river flow causes particles to settle, forming the muddy bottom of a lake--poor habitat for river bottom insects that support a river fishery. Yet flow is fast enough to inhibit the development of lake biota (algae and small crustaceans) that sup- port a lake fishery. And both river and lake fisheries suffer from sudden drastic drawdowns that leave spawning and rearing areas high and dry. Earlier attempts to establish a river fishery in the largest reservoir, Noxon, had been unsuccessful. Maintenance of more stable water levels in recent years has permitted the development of a bass and perch fishery (see Rumsey and Huston paper); however, this fishery was surely set back by the recent (April 1985) drastic drawdown ordered by the Bonneville Power Administration for power generation purposes.

Other concerns associated with the reservoirs include the settling of metals from the upper river, eutrophic conditions associated with nutrient loading, and possible synergistic interactions between these. Sediments in the lower river reservoirs appear to have higher metal concentrations than do the sediments of tributaries of the Clark Fork (see Johns and Moore paper). However, concentrations are much lower than those observed at Milltown, probably as a result of sediment dilution from tributaries and eroded bank material. It is not clear whether these sediments represent a hazard to ground water (as at Milltown) or to aquatic life. Limited sampling in the reservoirs by the Water Quality Bureau in 1984 revealed reduced oxygen conditions and pH levels for a short time in the deepest part of Noxon Reservoir, but not to the point that substantial releases of metals would be expected. However, metal concentrations were slightly higher in the lower river reservoirs during summer when compared to spring and fall samples (and bottom samples were slightly higher than surface samples); hence, more monitoring at this time of year is warranted. Unless the reservoirs become more eutrophic or show lower dissolved oxygen and pH values in some years, release of metals to the water column from sediments does not appear to present a problem.

Depending on their flow regimes, reservoirs, like lakes, can experience eutrophication as a result of excess nutrient loading. Whether water quality in the Clark Fork reservoirs will degrade as a result of increased nutrient loading depends on whether the algal populations are limited by nutrients or by flushing time. In the case of the Thompson Falls and Cabinet Gorge Reservoirs, flushing time is almost certainly limiting. In Noxon Reservoir, nutrients may sometimes be limiting during low flow summer conditions. Water Quality Bureau data from August 1984 did not find severe algal blooms in the main channel (visibility was about 13 feet). However, most aquatic systems display considerable variation from year to year, and without data from sever- al earlier years it is not possible to determine whether the Champion discharge increased algal populations significantly. However, it is relevant to ask if current water quality in Noxon Reservoir is acceptable. Several years of monitoring on the reservoir should make it possible to determine its aver- age condition. If water quality is unacceptable, or if it appears to be degrading, or if the nutrients in the reservoir's sediments appear to be increasing, it would be appropriate to determine what sources of nutrients could be reduced.

Reservoirs can also support nuisance growths of aquatic macrophytes or pondweeds in shallow areas. Cabinet Gorge Reservoir has extensive weed beds that have elicited complaints from boaters. Such beds often receive most of their nutrients from the sediments and are limited mainly by the area of sediments shallow enough for sufficient light to reach the bottom to support their growth. It is likely that the construction of Noxon Reservoir greatly de- creased the rate at which the Cabinet Gorge Reservoir is filling in, slowing the development of these shallow areas. Noxon Reservoir has some weed beds in shallow areas in the Finian Flats region and where tributaries enter and form shallow deposits. The rate at which Noxon fills in and the amount of nutrients in the sediments filling it will have the greatest effect on the formation of such beds. Except where they interfere with boating or swimming, weed beds are usually not a problem; indeed, they are beneficial to lake fisheries. However, sudden die offs of large areas as a result of a drawdown can result in oxygen depletion as the plants decompose.

Lower River Tributaries
The Flathead River, the largest tributary of the Clark Fork, has a number of important water quality concerns. The best known is the enrichment of Flathead Lake, which appears to have reached a threshold with respect to its ability to assimilate phosphorus. Like many large lakes, Flathead appears to be phosphorus limited and its phosphorus load has increased significantly from natural background levels to a point where this once oligotrophic lake has experienced blue-green algal blooms for the past few summers (J. Stanford, personal communication). Control of point sources has begun and the significance of nonpoint sources is being evaluated.

The Flathead River fisheries downstream of Kerr and Hungry Horse Dams suffer from water level fluctuations and occasional dewatering of the river. The recent introduction of the opossum shrimp Mysis relicta to the Flathead region lakes may have serious impacts on lake fisheries, as it appears to compete with salmon fry for food. Another concern is the planned development of a surface coalmine in Canada on Cabin Creek, a headwater tributary of the North Fork of the Flathead. The release of sediment and heavy metals could cause significant impacts to the biota of this pristine part of the Flathead ecosystem.

Prospect Creek (which enters the Clark Fork at the Thompson Falls Reservoir) flows past the U.S. Antimony mine/mill. While ground water near the tailing ponds exhibits elevated levels of dissolved sulfates, sodium, and antimony, surface water is less affected (only the antimony water quality criteria is approached--see Shapley and Woessner paper). This loading is probably not significant for the Clark Fork, and, given the intermittent nature of the creek near the ponds, there is little damage to fish habitat. However, the mill is operating at a very low level relative to historic operations. In the event that the mill resumed larger scale operations, or in the event of a spill from the ponds, more significant impacts could occur.

One of the greatest concerns for the future of this part of the Clark Fork is the possible impact of the proposed mining in the Cabinet Mountains Wilderness. Several mining companies (principally ASARCO and U.S. Borax) have filed claims for as many as nine mines. If the mining is permitted, the first mine is likely to be ASARCO's proposed silver mine near Rock Creek which joins the Clark Fork downstream of Noxon Dam. The biota of pristine Rock Creek should be very susceptible to sediment and metal loading (metals are most toxic in extremely soft water such as that of Rock Creek).

Lake Pend Oreille

One of the greatest water quality concerns on the lower river is the long-term quality of Lake Pend Oreille--a deep oligotrophic lake in Idaho that receives most of its inflow from the Clark Fork. Lake area residents perceive that the lake's water quality is degrading, citing as evidence increased growth of periphyton (attached algae) on boats and increased growth of algae and aquatic plants in shallow areas. Lake residents feel that nutrient loading from the Clark Fork is responsible, although such phenomena might be explained by natural variation or by increases in shoreline loading associated with increased local development. However, measurements of midlake water clarity over a number of years show a disturbing downward trend though the data are insufficient to give a high level of confidence in this trend (Mike Beckwith. personal communication).

The algal productivity of such a lake is almost certainly limited by phosphorus loading to the lake. The magnitude and timing of the response of a lake to a given change in phosphorus loading depends largely on its flushing time. In the case of Fend Oreille, flushing time is more difficult to estimate meaningfully than was true of the reservoirs. The lake's overall flushing time is 3 years. However, the northern part of the lake, which receives the inflow of the Clark Fork, also contains the lake outlet. While it receives most of the loading. this northern arm also flushes more quickly than the southern part of the lake. Thus. the lake's behavior may not be predict- able simply from models that relate loading to trophic state. Despite this. our first objective should be to determine the phosphorus load to the lake and to predict the likely extent and rate of change in water quality from existing models. If these models suggest that the lake is in no imminent danger, drastic nutrient control actions could await several years of frequent assessments of water clarity (and chlorophyll content) over the summer; this information should help to determine whether a trend in water quality degradation is discernible. Additionally, loadings should continue to be assessed to determine the response of this lake to various loading levels. If models suggest that the lake may be receiving excess loading, control efforts could begin while the studies are conducted. By the time any substantial reduction in loading is achieved, several years of monitoring of the lake's conditions under present loading should be available to compare to its condition after load reduction.

Given experience with other lake improvement programs, it is likely that near shore water quality problems will respond most to control of shoreline sources of nutrients while midlake problems will respond to the largest overall source, which may well be the Clark Fork. It is important to realize that nutrients may not be the only threat to the Pend Oreille ecosystem. Development around the lake is very likely affecting wetlands, littoral areas, incoming streams, and other areas critical to fisheries and bird populations. Local concern must address these impacts as well as the Clark Fork loadings.

In Conclusion - Not Just an Industrial Sewer

Like most rivers with high quality tributaries, the Clark Fork is a resilient system that responded quickly and strongly with improved water quality and fisheries to the treatment of point sources of metals and organic matter and to stabilization of water levels in reservoirs. However, the system and its improved state are fragile because: (1) diffuse sources of metals in the flood plain of the upper river wash into the river during floods and storms, (2) treatment system failures allow occasional toxic shocks to the system, (3) occasional extreme drawdowns in the lower river reservoirs can wipe out fisheries that have been building over several years. In addition to such catastrophic events, the river suffers from the creeping degradation brought on by greater and greater impacts on its tributaries--especially the effects of dewatering and siltation. The lakes of the Clark Fork system appear to be suffering from enrichment. The greatest long-term concerns for the system are the long-term control of metal loading in the upper river, the loss of fish habitat associated with reservoirs and with tributary impacts, the enrichment of lakes, and the proposed mine district in the lower river.

Clearly, the Clark Fork River is a complex natural system with many problematic interactions with the artificial systems of man. However, the Clark Fork is not "just an industrial sewer" for a number of reasons. Many of the water quality problems discussed above do not stem from traditional industrial point sources. Many come from municipal sources or from land uses such as logging and agriculture or from flow manipulation for power generation. Reducing industrial effluents and controlling the metal problem in the headwaters will not solve all the Clark Fork's problems (although these are important for certain problems in some reaches).

Additionally, unlike an industrial sewer, the Clark Fork is a living system, with potential for recovery or further degradation. Although it is a hard-working river, it is still a river of startling beauty with tremendous opportunities for fishing and floating, scenery and serenity, peace and excitement. If we write it off as a sewer, or decide that its problems are too complex, too expensive, too political, we have much to lose. If we allocate resources to identify the causes of the most serious problems and deal with those causes, we have much to gain.

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