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Migrations by Fluvial Largescale Suckers (*Catostomus macrocheilus*) after Transport Upstream of Milltown Dam, Montana

Abstract

Despite the abundance of largescale suckers (*Catostomus macrocheilus*) in western North America, little is known about their biology and ecology. Tens of thousands of largescale suckers annually congregate in the spring in the tailrace of Milltown Dam, Montana, apparently impeded on upstream migrations. To determine the destination of migrants and attributes of their migrations we implanted 14 fluvial largescale suckers with radio transmitters and tracked movements after transport upstream of Milltown Dam. Fish were apparently homing to natal areas and selected one of two drainages in which to spawn. Movements to upriver-most locations varied widely, fish used diverse areas in the watershed, and moved very far to spawn (mean 55 km, range 5.1-159.2 km). After the spawning period, fish moved either up or downstream, others stayed in the same location into the fall. Only two fish moved downstream of Milltown Dam after the spawning period and potentially back to a pre-spawning location. These movements demonstrate the effects of the dam on largescale sucker populations over a large spatial scale, and suggest that providing fish passage at Milltown Dam would result in a tremendous amount of biomass transferred to upriver areas. Fish passage considerations at Milltown Dam focus only on bull trout (*Salvelinus confluentus*) and westslope cutthroat trout (*Oncorhynchus clarki lewisi*). Providing upstream passage of largescale suckers at this dam may help promote full ecosystem recovery.

Introduction

Suckers (*Catostomus* spp.) are the most abundant fish family in rivers of the Columbia River drainage of western North America (Scott and Crossman 1973, Dauble 1986). Because of their abundance, largescale sucker (*C. macrocheilus*) populations are often viewed as healthy, though, in most of their range, populations have not been evaluated nor quantified (Dauble 1986). Indeed, in these same areas, fisheries managers acknowledge declines of native game fishes, particularly salmonids, and mitigate for losses due to hydropower development. Although native salmonids and sympatric suckers have adapted to the same local environments and include migration as a fundamental part of their life histories (Dauble 1986, McEvoy 1998, Baxter 2002), little attention is paid to the effects of fragmenting populations of suckers (Dauble 1986).

Studies of Milltown Dam on the Clark Fork River, in western Montana have focused on the movements of westslope cutthroat trout (*Oncorhynchus clarkii lewisi*) and bull trout (*Salvelinus confluentus*) after transport upstream of the dam. These studies show that fish passage is a necessary component to ensure life history expression, and is warranted for local conservation of these imperiled species (Swanberg 1997, Schmetterling 2003). Recently, the Environmental Protection Agency has ordered the removal of Milltown Dam, in part to reverse the declining trend in native salmonid populations. However, little is known about the tens of thousands of largescale suckers, aside from annual captures at Milltown Dam, where their upriver migrations are impeded (McEvoy 1998, Schmetterling and McEvoy 2000). Although highly abundant in rivers throughout their native range (Scott and Crossman 1973, Dauble 1986), abundance of fish does not guarantee a population's health (Minckley et al. 1991).

Although often targeted for extirpation or viewed as unwanted (Carl 1936, Wiley and Wydoski 1999, Baxter et al. 2003), suckers are a critical component of river ecosystems. They perform a major role in nutrient cycling, by converting plant matter into animal matter, and are an important food source for terrestrial and aquatic animals (*reviewed in* McEvoy 1998). Sub-adult and adult suckers are important prey for osprey (*Pandion haliaetus*), bald eagles (*Haliaeetus leucocephalus*), and great blue heron (*Ardea herodias*) (Dauble 1986, Stegner et al. 1992). Sympatric salmonines seasonally rely on the abundant eggs and larvae of suckers as food (MacPhee 1960, Dauble 1986, Beauchamp 1995).

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Largescale suckers use a wide range of substrates, water depths, and water velocities for spawning (McCart and Aspinwall 1970, Dauble 1986). In general, they are not considered spawning-habitat limited. Fluvial largescale suckers spawn in the spring as water temperature increases to 6-12º C and discharge increases from snowmelt run-off (Quinn and Tallman 1987, McEvoy 1998). In other systems, adfluvial suckers will home to their natal streams or natal areas for spawning using primarily olfaction (Olsen and Scidmore 1963, Werner 1979), similar to homing in salmonids (Quinn and Tallman 1987, Northcote 1997).

Milltown Dam offers a unique opportunity to research movements and homing of largescale suckers after transport upstream of a barrier, because the dam is located at the confluence two rivers, the Blackfoot and Clark Fork (Figure 1). Milltown Dam, constructed in 1907, has no fish passage facilities for upstream migrants to the dam even though it annually impedes the upriver migrations of 11 species and up to hundreds of thousands of individual fish, mostly largescale suckers (Schmetterling and McEvoy 2000, Schmetterling 2003). Migrants at the dam presumably hatched and reared in areas upstream of the dam and moved downstream over the dam at some point in their lives, matured in the Clark Fork River and migrated upstream to the dam in an attempt to spawn in upriver areas (Schmetterling and McEvoy 2000, Schmetterling 2003). Although data suggest suckers cannot complete their spawning migrations because they are blocked by the dam (Schmetterling and McEvoy 2000), it is unknown whether the tailrace is the destination of their spawning migration (McEvoy 1998). The objectives of this study were to (1) determine if suckers would continue to migrate upriver after release, (2) determine their destination and (3) describe their post-spawning period movement.

Methods

Study Area

Milltown Dam, a 3.2 mega-watt hydroelectric facility, is approximately 10 km upstream of Missoula, Montana on the Clark Fork River immediately downstream of the confluence of the Blackfoot River (Figure 1). This five turbine, run-of-the-river dam offers no upstream fish passage over its 12m drop, and only allows downstream fish passage (aside from turbine passage of fish <200 mm) when spilling, typically during spring snowmelt runoff. The Clark Fork and Blackfoot rivers have a mean annual flow of 30 and 46 m^3 sec^{-1} and, combined, drain 15,541 km^2 east of Milltown Dam (Schmetterling and McEvoy 2000). The reservoir impounds an area that extends approximately 2 km upstream on each river.

We used an upstream fish trap (radial gate raceway) located adjacent to the apron of Milltown Dam to capture upriver migrants (Schmetterling and McEvoy 2000, Schmetterling 2003). The radial gate was manipulated to create an attractant flow of 1.4m^3 sec^{-1}, with mean velocities ranging from 60 to 90 cm sec^{-1} (Schmetterling and McEvoy 2000). Largescale suckers, the most abundant fish in the river, typically comprise 90% of the annual captures in the radial gate raceway (Schmetterling and McEvoy 2000). Once trapped, we netted fish and sorted them by species.

As discharge increases in the spring during runoff, the flows from the rivers do not mix until downstream of Milltown Dam (Schmetterling 2002, 2003). As a result, during certain periods, water from only one river source may be present in the fish trap and the percent can be quantified based on the concentration of barium in each water source in a discharge-based model (Schmetterling 2002). In past studies with salmonids (Schmetterling 2002, 2003), captures in the radial gate raceway and movements after transport upstream of Milltown Dam corresponded to the dominant water source in the radial gate raceway.

In order to capture fish that would likely ascend both rivers, we selected suckers that were captured from various mixtures of Clark Fork and Blackfoot river water to implant with radio transmitters. We chose non-ripe fish (see below) greater than 0.5 kg and in good condition, i.e., no abrasions or ulcerations, which frequently result from prolonged attempts to ascend the concrete apron (Schmetterling and McEvoy 2000). Prior to implanting suckers with radio transmitters, they were anesthetized with approximately 125 mg L^{-1} tricaine methanesulfonate (Finquel™), measured (mm, fork length), weighed (g), identified for sex, and checked for degree of ripeness. We identified male suckers by the presence of nuptial tubercles on the anal and caudal fins and caudal peduncle (McCart and Aspinwall 1970, Dauble 1986, McEvoy 1998). We defined ripeness as the release of eggs or milt with light pressure to

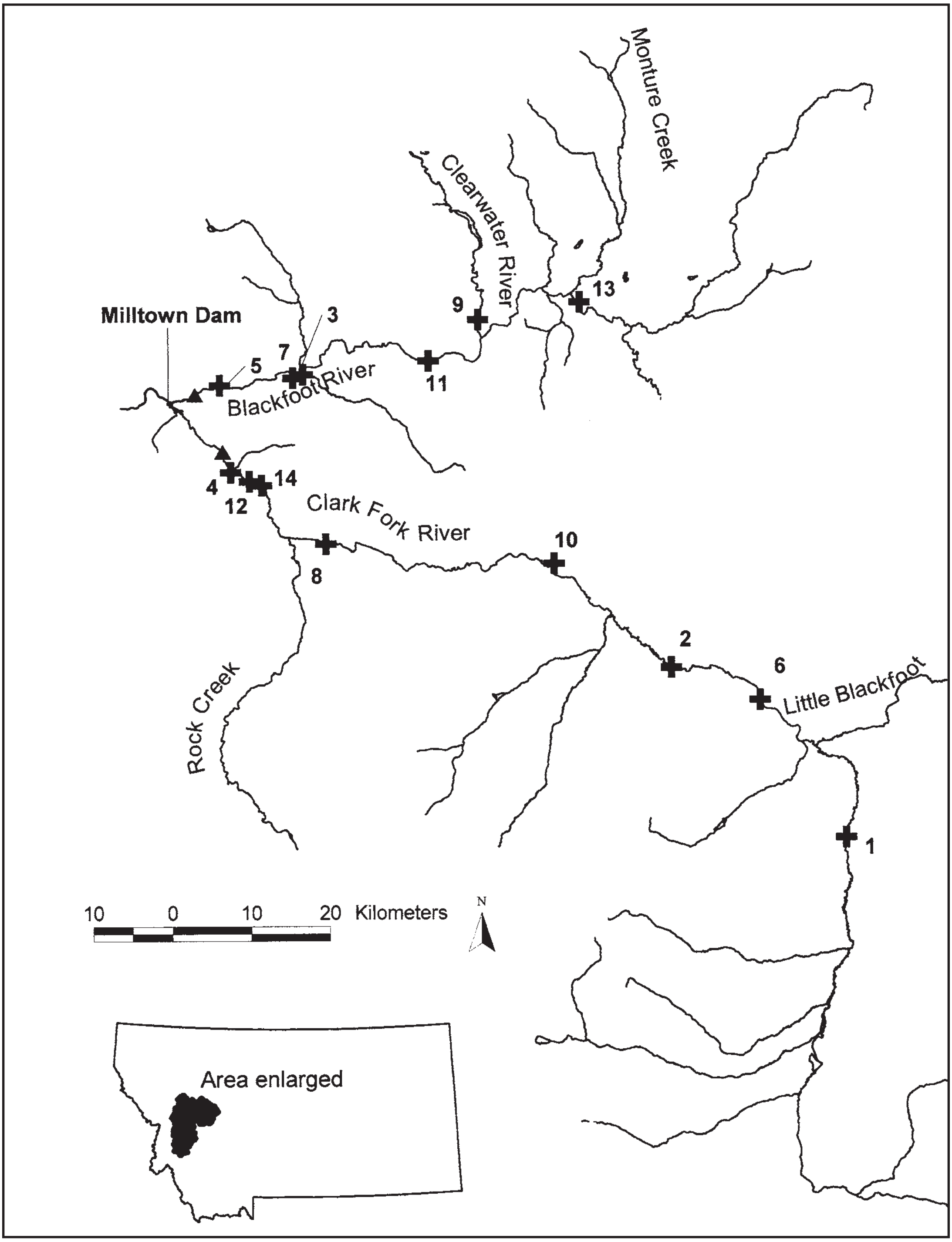

Figure 1. Spawning locations of radio-tagged largescale suckers (crosses) after transport upstream of Milltown Dam, Montana and release into the Blackfoot or Clark Fork river in 2002. Fish 1 and 2 were released into the Clark Fork River the rest were released in to the Blackfoot River. Release locations are represented by triangles. The Blackfoot and Clark Fork rivers flow east to west; numbers and letters correspond to individual fish in Tables 1 and 2.

the ventral surface. All females captured at the radial gate raceway during the spring are gravid (Schmetterling and McEvoy 2000).

We surgically implanted radio transmitters (Lotek Wireless, 150 MHz) into largescale suckers following the same procedure used for westslope cutthroat trout (Schmetterling 2001), with small (2. 5 cm) incisions along the ventral midline anterior to the pelvic girdle. We used an external antenna that we passed through the body wall posterior to the pelvic fins also along the ventral-midline, using a catheter needle and grooved director. We closed incisions with three or four stainless steel surgical staples.

After surgery, we placed suckers in a holding pen in the radial gate raceway to regain consciousness and then immediately transported them upstream where they were released. Fish were transported in a 120L cooler with compressed air and released into either the Blackfoot River (4 km upstream of Milltown Dam) or Clark Fork River (10 km upstream of Milltown Dam; Figure 1). We released fish in the river that had the dominant flow in the fish trap when fish were captured according to the discharge-based model in Schmetterling (2002).

Data collection—We located the suckers 5-7 times/week until July and less frequently (1-5 times/month) until 10 December 2002. We determined general locations (<400 m) from a truck using an omni directional antenna and occasionally from a small fixed-wing aircraft using a three element Yagi antenna, attached to the wing strut. For greater accuracy (<40 m) we located fish on the ground with a three-element Yagi directional antenna. We assumed that fish spawned at their upstream-most location if they held for several days, or remained in known spawning locations (e.g., mouths of tributaries, and in tributaries), when date and temperatures corresponded to known spawning conditions (Dauble 1986, McEvoy 1998).

Results

Between 15 March and 20 May 2002, we captured 5,187 largescale suckers in the radial gate raceway at Milltown Dam. We implanted 14 largescale suckers (10 male and 4 female) with radio transmitters. Two largescale suckers were released into the Clark Fork River (Fish 1 and 2), the rest were released in the Blackfoot River (Table 1). Surgeries were generally rapid and averaged 98 s (range 60-130 s). We located each fish an average of 39 times (SD 8 times). High flow and turbidity during the spawning period made visual observations impossible.

Although only two largescale suckers were released in the Clark Fork River, eight ascended the Clark Fork River and remained in it during the spawning period. Six of these eight suckers that ascended the Clark Fork River were released into the Blackfoot River, and moved up to 24 km up the Blackfoot River before switching to the Clark Fork River. All suckers that ascended the

TABLE 1. Descriptions of sex, fork length (mm), weight (kg), date captured, capture water source (Clark Fork River [CFR] or Blackfoot River [BFR]) and percent, for largescale suckers transported upstream of Milltown Dam in 2002. Fish 1 and 2 were released in the Clark Fork River 10 km upstream from Milltown Dam, the rest in the Blackfoot River at km 4.0. Fish numbers correspond to numbers in Figure 1.

Fish Number	Sex	Length	Weight	Date Captured	Capture Water Source
1	F	436	0.96	1-Apr	CFR (66%)
2	M	447	0.92	1-Apr	CFR (66%)
3	F	467	1.18	8-Apr	BFR (59%)
4	M	423	0.87	8-Apr	BFR (59%)
5	F	508	1.56	11-Apr	BFR (58%)
6	M	420	0.92	11-Apr	BFR (58%)
7	F	469		12-Apr	BFR (>80%)
8	F	489	1.52	15-Apr	BFR (100%)
9	F	470	1.73	15-Apr	BFR (100%)
10	M	455	0.93	29-Apr	BFR (93%)
11	F	537	1.52	1-May	BFR (95%)
12	F	505	1.53	1-May	BFR (95%)
13	F	531		3-May	BFR (97%)
14	F	483		17-May	BFR (100%)

TABLE 2. Descriptions of drainage ascended, distance (km) migrated from Milltown Dam (MTD), dates arrived, departed and duration in spawning location, for radio-tagged largescale suckers transported upstream of Milltown Dam. Fish 1 and 2 were released in the Clark Fork River 10 km upstream from Milltown Dam and were the only fish captured in predominantly Clark Fork River water, the rest were released in the Blackfoot River at km 4.0. Fish numbers correspond to numbers in Figure 1.

Fish #	Drainage Ascended	Distance migrated from MTD (km)	Date arrived at presumed spawning location	Date departed from presumed spawning location	Duration (days)	Post spawning distance (km)	Post spawning direction
1	CFR	159.2	14-Jun	21-Jun	7	2.0	Up
2	CFR	106.0	31-May	7-Jun	7	7.5	Down
3	BFR	21.0	29-Apr	26-Jun	58	11.5	Up/ Down
4	CFR	17.5	22-May		125a	21.7	
5	BFR	5.1	5-May	13-May	8	36.4	Down
6	CFR	120.1	7-Jun	21-Jun	14	47.2	Down
7	BFR	20.1	15-May	26-May	11	6.4	Up/ Down
8	CFR	36.4	22-May	27-May	5	4.5	Down
9	BFR	58.0	10-Jun	15-Jun	5	130.6	Down
10	CFR	78.6	7-Jun	19-Jun	12	0	
11	BFR	40.1	20-May	15-Jun	26	97.6	Down
12	CFR	16.5	28-May	7-Jun	10	0	
13	BFR	75.6	29-Jun	20-Jul	21	10.7	Up/ Down
14	CFR	15.5	21-Jun	lost		56.8	Down

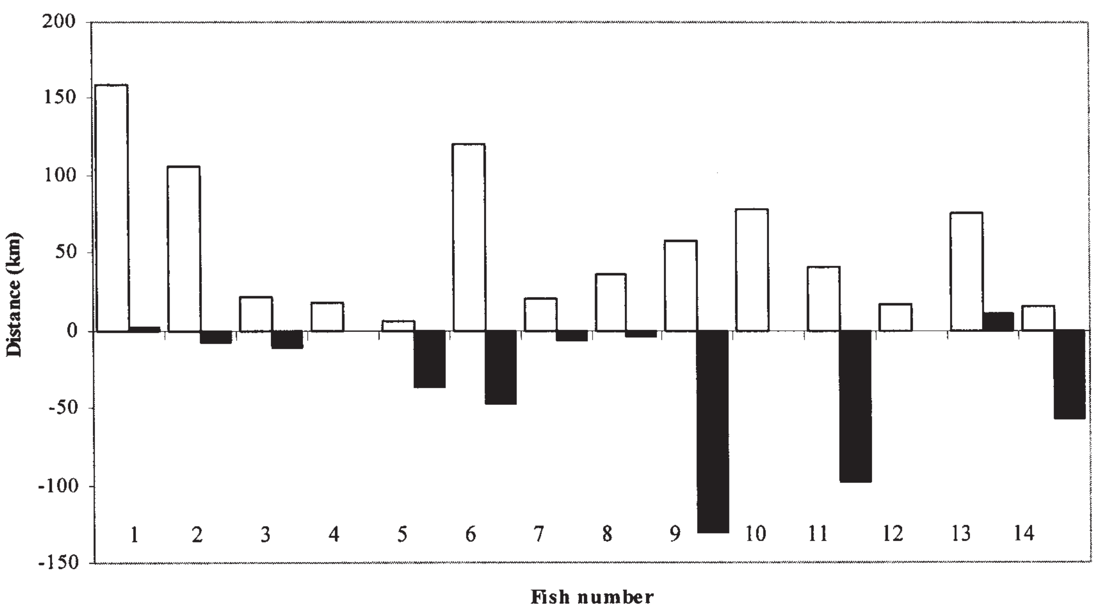

Figure 2. Pre-spawning (white bars) and post-spawning (black bars) movements by individual largescale suckers after transport upstream of Milltown Dam, Montana. Fish numbers correspond to numbers in Figure 1 and Tables 1 and 2.

Blackfoot River were released into the Blackfoot River (Table 2).

Largescale sucker migrations averaged 55 km (SD 46.8, range 5.1-159.2km) from Milltown Dam after transport and they spent an average of 25 d (SD 15, range 5-125 d) in these locations (Table 2). Most fish remained in the in the mainstem rivers (Figure 1), two used the mouths of tributaries and one ascended a tributary, presumabley for spawning (Figure 1; Table 2).

After remaining at what we considered spawning locations, four largescale suckers moved upstream between 1.5 and 10.7 km (Table 2; Figure 2), but only two of these remained at these locations into the fall (the other two eventually moved downstream). The remaining nine largescale suckers, and two that moved upstream after spawning, migrated downstream to fall and winter locations. One male largescale sucker died at at its upstream-most location (Table 2), possibly after spawning. Although it had been observed several times at this location, we recovered its radio transmitter after 125 days at this location. Seven of eleven suckers only moved downstream from their spawning locations; though only two moved downstream of Milltown Dam shortly after spawning, during high flows.

Discussion

Many suckers captured at Milltown Dam migrated long distances after upstream transport past Milltown Dam, similar to migrations made by salmonids (Swanberg 1997; Schmetterling 2003). Despite capturing these during their upstream migrations and possibly under-representing the true distances fish may have migrated, some distances we observed were much more than previously documented for fluvial largescale suckers (60 km, Dauble 1986), though longer migrations may occur (e.g., Baxter 2002). Because of the movements after transport upstream of the dam, it does not appear that the tailrace is the spawning destination, though suckers congregate there for spawning (D. A. S. personal observation, McEvoy 1998). Although the results from this study are based on a small sample, they demonstrate long-distance movements and suggest that future research into this understudied, abundant species is warranted.

Fish frequently switched rivers after release and continued upstream considerable distances to what we considered their spawning areas, similar to the movements by westslope cutthroat trout and bull trout after transport upstream of Milltown Dam (Schmetterling 2003). Largescale suckers spawn in a variety of habitats (Geen et al. 1966, Dauble1986), and there is abundant spawning habitat for largescale suckers near Milltown Dam (with 10 km). These suckers migrated considerable distances beyond the dam, presumably spawned over a large geographic area, and the moved from one river to the other after release, suggesting that suckers may be homing to natal areas (Olsen and Scidmore 1963, Werner 1979). Suckers in this study apparently sought out specific areas to congregate presumably to spawn even though suitable spawning habitat is common in the immediate vicinity of Milltown Dam (McEvoy 1998).

Whereas past captures of westslope cutthroat, bull, and rainbow trout (*O. mykiss*) in the radial gate raceway showed fidelity to upstream spawning locations (Schmetterling 2002, 2003), several suckers in this study lacked fidelity by ascending and spawning in rivers that did not reflect their capture water. This lack of fidelity to the capture water source may be a result of delays after migrants reach the dam. However, since we did not determine if suckers had actually spawned, the fish in this study may have been searching for their natal area, but could not find it. In this year, we only trapped with predominantly Clark Fork water for a brief period and only two fish in this study were implanted with transmitters during predominantly Clark Fork flows. Later-arriving fish attempting to migrate up the Clark Fork River did not have the possibility of entering the fish trap when we were trapping with Clark Fork water. Capturing Clark Fork River-bound fish when we were trapping with Blackfoot River water may have been a reflection of a delay by fish finding the trap in a foreign water source. In an earlier study at Milltown Dam, rainbow trout would enter a foreign water source only after several days to weeks (Schmetterling 2002).

After reaching their upriver most locations and remaining there for periods, suckers moved both upstream and downstream in no discernable pattern. These movements are unlike post spawning movements made by adfluvial suckers (only downstream movements; Olsen and Scidmore 1963, Werner 1979) and fluvial largescale suckers that moved downstream to within 200 m of their pre-spawning, mainstem locations in the

Clark Fork River (McEvoy 1998). Interestingly, an upstream movement of suckers after spawning may explain the phenomena of a summer migration of largescale suckers to Milltown Dam (Schmetterling and McEvoy 2000). Annually, thousands of mature (based on body length), but non-ripe or in spawning condition, suckers congregate at the dam apparently impeded on an upriver migration. The migration of largescale suckers to Milltown Dam (Schmetterling and McEvoy 2000) may be postspawning, upstream movement, the reason of which is still unknown, but is similar to fluvial westslope cutthroat trout behavior in the area (Schmetterling 2001).

Interestingly, most fish stayed upstream of the dam after the spawning period concluded (or after spawning) and did not pass downstream over Milltown Dam to return to prespawning or premigration locations. When viewed within the context of tens of thousands of largescale suckers annually impeded by the dam, this represents a tremendous loss of biomass to upriver systems. Whereas we documented that only one radio tagged largescale sucker died after spawning, other studies suggest that post-spawning mortality of male largescale suckers is common (Dauble 1986, Schmetterling and McEvoy 2000). Since many male largescale suckers die after spawning, returning these individuals upstream (through fish passage or once the dam is removed) could replenish a significant amount of nutrients to the system. This may help to reverse the declines of stocks of native imperiled fish like westslope cutthroat and bull trout, similar to nutrients derived from salmon (*Oncorhynchus* spp.) carcasses (Bilby et al. 1998, Schmidt et al. 1998, Gresh et al. 2000). However, the effects of the loss of these nutrients to upriver areas are unknown.

As with salmonids, effects of the dam on populations of largescale suckers are unknown beyond the theoretical (Rieman and Dunham 2000, Schmetterling 2003). Although largescale suckers are abundant in the Clark Fork and Blackfoot rivers (Schmetterling and McEvoy 2000), the extent the dam has affected densities of suckers by fragmenting historically connected areas is unclear. These data on largescale sucker movement after transport upstream of Milltown Dam suggest an effect on a large geographic scale. Furthermore, because of the fragmentation of the upper Clark Fork watershed, providing passage for all species, including largescale suckers, may be necessary to mitigate for the long-term effects of the dam and may be the only way to fully achieve ecosystem restoration.

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