LARVAL FISH CATCHES IN THE LOWER MILK RIVER, MONTANA IN RELATION TO TIMING AND MAGNITUDE OF SPRING DISCHARGE

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ABSTRACT

Larval fishes were sampled in the Milk River, Missouri River drainage, Montana from May to August 2002, 2003 and 2004 to describe temporal spawning distribution in relation to spring discharge. Total larval catch-per-unit-effort (CPUE) in 2002 (28.9 fish/100 m^3) was an estimated 29 times greater than in 2003 (0.99 fish/100 m^3) and 16 times greater than in 2004 (1.78 fish/100 m^3). In 2003 and 2004 more than one third of the total catch occurred before 12 June whereas in 2002, only 5% of the total catch occurred before 12 June. Marked differences in larval species composition were also observed between years, suggesting that a later peak in discharge may benefit some species and an earlier peak others. In 2002, when flows peaked later (at 77 $m^3 s^{-1}$), common carp Cyprinus carpio represented 37% of the total larval catch. Common carp were proportionally less abundant in 2003 (7.2%) and 2004 (1.4%) than in 2002. In 2004, when flows peaked (at 163 $m^3 s^{-1}$) 32 days earlier than in 2002 but only 15 days earlier than in 2003 (at 73 $m^3 s^{-1}$), shorthead redhorse Moxostoma macrolepidotum and suckers Catostomus sp. were the numerically dominant taxa. These results indicate that the timing, not necessarily the magnitude, of peak spring

(10 nephelometric turbidity units (NTU), July) as a result of hypolimnetic discharge and sediment trapping by the reservoir. However, there has been a 60% decrease in the magnitude of the 2-year flood in the Milk River and similar decreases in low frequency, high intensity flood events because of seven irrigation impoundments (Shields et al., 2000).

A water development project has been proposed that would divert water from the Milk River during high spring flows into an off-stream storage reservoir with up to a 74 millions m^3 capacity. The proposed project would further decrease the magnitude of the 2-year flood and the frequency of other chance flooding. The potential impacts of this proposed water development project are not adequately understood. The objective of this study was to investigate temporal and spatial distribution of larval fish in relation to different annual spring discharges to assess the effects of further flow regulation on the reproductive success of fishes in the lower Milk River.

STUDY AREA

The Milk River is one of the largest tributaries to the upper Missouri River at 1126 km in length and 57 839 km^2 in drainage area. The river irrigates approximately 558 km^2 of land, primarily in crops of alfalfa, native hay, oats, wheat and barley (United States Bureau of Reclamation, 1983; Simonds, 1998). Twelve municipalities rely on the river for drinking water and sewage treatment. Most of the water comes from the Milk River Project, a U.S. Bureau of Reclamation irrigation project developed in 1902. This project diverts and stores water with three storage dams, four diversion dams and a pumping plant (Simonds, 1998).

The portion of the Milk River included in this study extends approximately 225 km upriver from the confluence of the Milk River with the Missouri River, to 37 km above Vandalia Dam. The study area also included the first 4.8 km of the Missouri River downstream of the Milk River. The Missouri River immediately below its confluence with the Milk River was characterized by turbulent, cold (May–July, mean 13.0°C), clear, deepwater habitat. The Milk River from its mouth to 25 km below Vandalia Dam had slow, warm (May–July, mean 17.0°C), turbid, shallow-water habitat with incised channels and riffles. The Milk River from Vandalia Dam 37 km upstream had slow, warm (May–July, mean 16.0°C), deepwater habitat.

METHODS

Larval fish samples were taken weekly during daylight hours from mid-May to mid-August 2002, 2003 and 2004. Larval fish were sampled with $0.5 \times 1.8\ m^2$ conical nets (750 μm Nitex mesh) with attached buckets and weighted with two 4.5 kg lead weights. A General Oceanics 230 OR flow metre was suspended in the mouth of the net to

This active sampling approach was used to compensate for a possible lack of larval drift during low flow periods. After each tow, the cod-end cups were removed and the water drained out. The contents were preserved in 10% formalin and Phloxene-B, a chemical dye, was added to stain larval fishes.

Identification of larval fishes was performed using a key based on information from Auer (1982), Holland-Bartels et al. (1990) Wallus et al. (1990) and Kay et al. (1994). Each fish was enumerated and assigned a taxonomic classification (typically genus or species). Eggs were enumerated but not identified. A U.S. Geological Survey gauging station on the Milk River near Nashua, Montana provided daily discharge measurements ($m^3 s^{-1}$). A portable turbidimeter and thermometer provided site-specific measurements of water temperatures ($^\circ$C) and turbidity (NTU).

Larval fishes were placed into groups based on relative abundance and taxonomic categories. Groups included common carp Cyprinus carpio, other Cyprinidae, buffalos Ictiobus sp., river carpsucker Carpoides carpio, shorthead redhorse Moxostoma macrolepidotum, goldeye Hiodon alosoides and freshwater drum Aplodinotus grunniens. Less common fishes were placed into a mixed category (Table I). We standardized group catches to the number of larvae per 100 m^3 of filtered water (CPUE). Extrapolation of CPUE to fish per 100 m^3 was used because average individual net-tow volume of all 3 years was approximately 70 m^3. Reproductive patterns of each group were assessed in relation to the timing and magnitude of peak discharge in each year.

RESULTS

Estimated total larval fish density was 29 times greater in 2002 (28.9 fish/100 m^3) than in 2003 (0.99 fish/100 m^3) and 16 times greater than in 2004 (1.78 fish/100 m^3). The differences in densities among years were associated with distinct differences in the spring discharge patterns of the Milk River (Figure 2). In 2002, spring discharge peaked latest, at 78 $m^3 s^{-1}$ on 28 June and returned to $<$

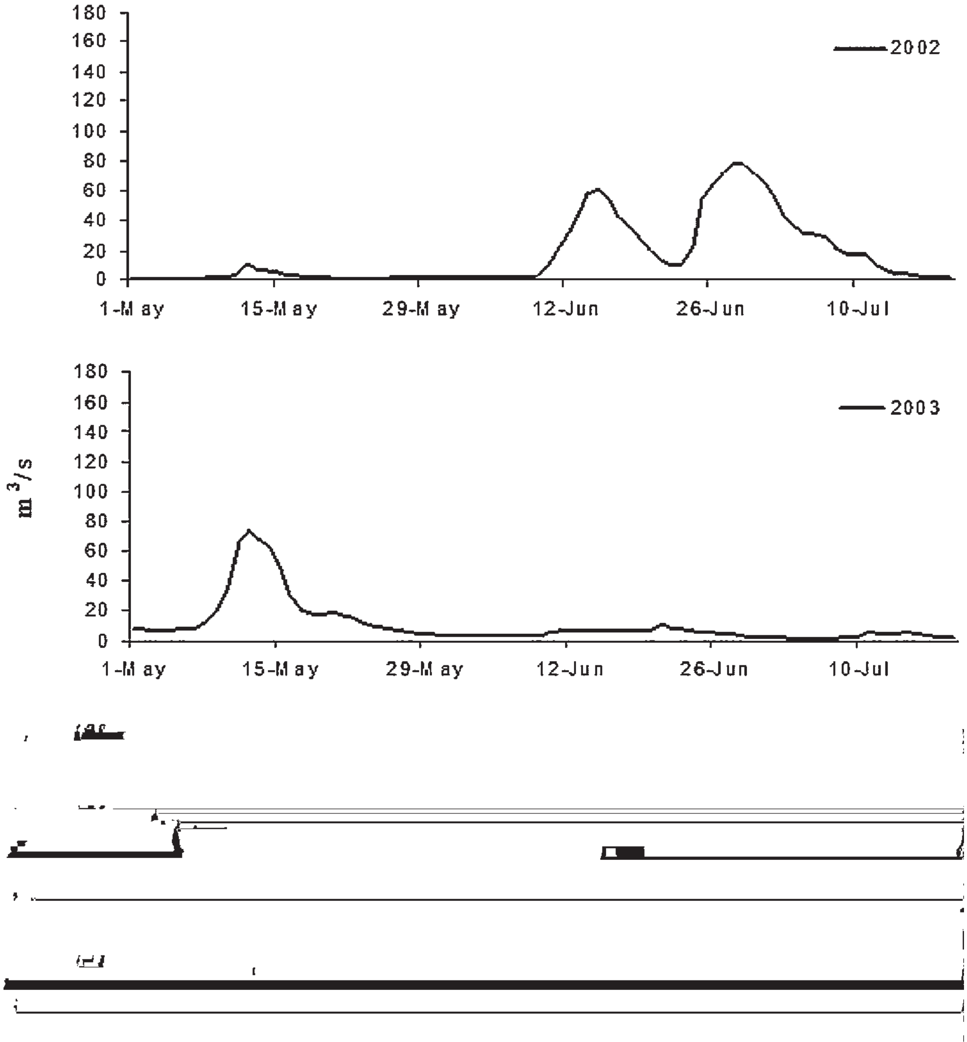

Figure 2. Spring discharge for the lower Milk River near Nashua, Montana during 2002–2004

More taxa were also found in 2002 (14) than in 2003 (9) or 2004 (12; Table I). Taxa identified at species level in 2002 included two species of concern, paddlefish Polyodon spathula and blue sucker Cycleptus elongatus. Neither of these species was collected in 2003 or 2004.

Differences in the contribution of dominant taxa were also evident among years. Of the 8044 total fish caught in 2002, common carp (N = 3000; 37.3%) and Ictiobus sp. (N = 1865; 23.2%) accounted for nearly two-thirds of the catch. Total catches in 2003 (250 fish) and 2004 (211 fish) were more than an order of magnitude lower. In 2003, shorthead redhorse (N = 124; 49.6%) was the dominant taxon. In 2004, shorthead redhorse (N = 47; 22.3%) and Catostomus sp. (N = 37; 17.5%) were the dominant taxa. Shorthead redhorse showed a lower relative abundance in 2002 (1.0% of total catch) than in 2003 or 2004.

Differences in the timing of peak abundance of taxa were observed among years. In 2002, carp, buffalo and river carpsucker densities peaked in mid-June. Densities of goldeye, freshwater drum, shorthead redhorse and other Cyprinidae (i.e. excluding carp) peaked in late July. In 2003, buffalo and river carpsucker densities peaked in late May, but at much lower numbers than in 2002. Carp densities peaked in mid-June and Cyprinidae (excluding carp) and freshwater drum densities peaked in early July. No larval goldeye were captured in 2003 but goldeye were

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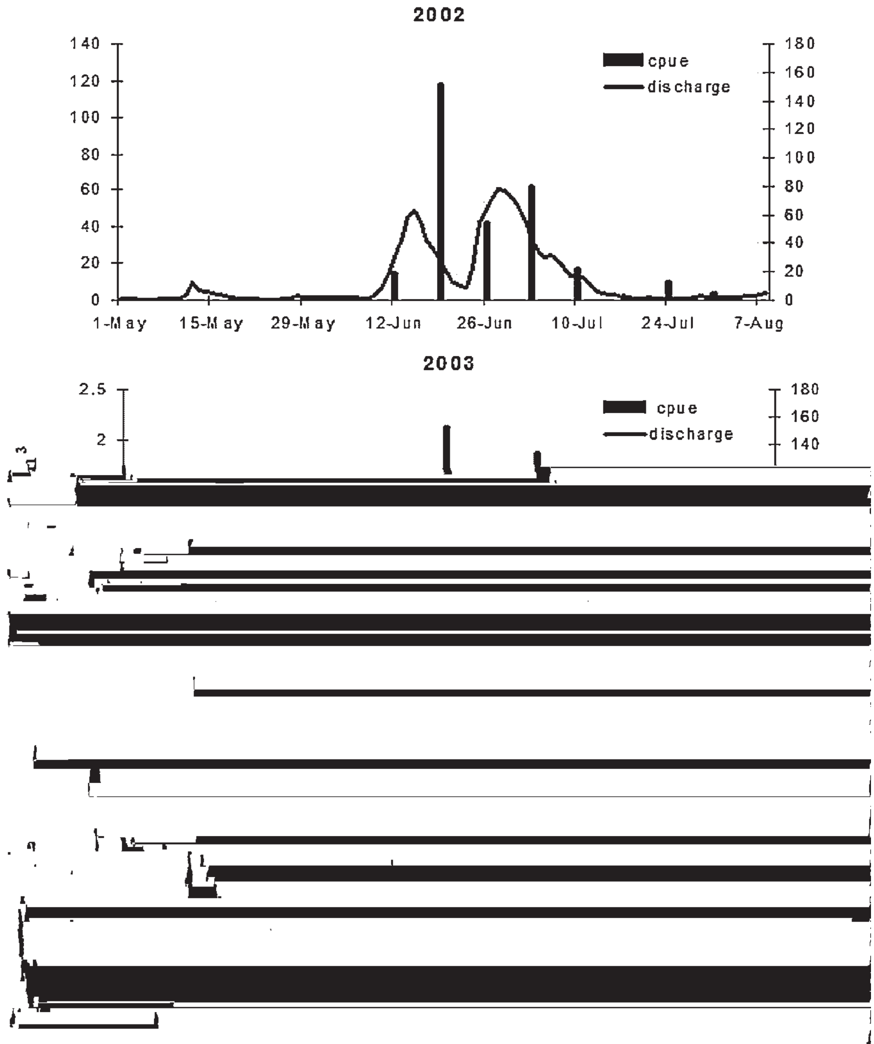

Figure 3. Total weekly larval fish catch-per-unit-effort in the lower Milk River, Montana in relation to spring discharge during 2002–2004

captured in 2002 (N = 204) and 2004 (N = 11). In 2004, shorthead redhorse densities peaked in mid-May. River carpsucker and buffalo densities peaked in early and mid-June, respectively. Cyprinidae (including carp) and goldeye densities peaked in late June. Freshwater drum densities peaked in early July.

DISCUSSION

Total larval fish abundance was 29 times greater in 2002 (28.9 fish/100 m^3) than in 2003 (0.99 fish/100 m^3) and 16 times greater than in 2004 (1.78 fish/100 m^3). Such inter-annual variability in reproductive success of riverine fishes has been observed elsewhere. Humphries et al. (2002) reported that total larval fish abundance in the Campaspe River, Australia differed by as much as two orders of magnitude among breeding seasons. Johnston et al. (1995) estimated that total annual larval drift in the Valley River, Canada ranged from 14 000 to >93 million among 7 study years. Smith et al. (2005) found that recruitment of smallmouth bass Micropterus dolomieu in rivers of Virginia, USA differed by as much as an order of magnitude among years.

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The reach of the lower Milk River below Vandalia Dam to its confluence with the Missouri River appears to provide better spawning conditions than do the more regulated river reaches sampled in this study. Moreover, the timing of spring discharge influences spawning success, as indicated by total larval fish densities. Further flow regulation, especially water withdrawals in mid-June through mid-July, may have a deleterious effect on fish reproduction in the Milk River. Further research is needed on the timing, magnitude and duration of spring discharge necessary to maintain spawning populations of native and game fish species. In addition, quantitative description of spawning habitat in the lower Milk River below Vandalia Dam would provide useful information for future research.

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ERRATUM

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The author has since identified that the current wording in certain sections in the article contradicts scientific