

silvery minnow's range has been so greatly restricted that the species is extremely vulnerable to catastrophic events, such as a prolonged period of low or no flow (*i.e.*, the loss of all surface water) (59 FR 36988; Dudley and Platania 2001).

In the middle Rio Grande, the spring runoff coincides with and may trigger the silvery minnow's spawn (Platania and Hoagstrom 1996; Service 1999; Dudley and Platania 2001). For example, 1,850 cubic feet per second (cfs) of water was released from Cochiti Reservoir on May 13, 2002, to provide for silvery minnow spawning. Following the release, a significant spawning event occurred in the middle Rio Grande. During a spawn, semibuoyant (floating) eggs drift downstream in the water column (Smith 1999; Dudley and Platania 2001) (see "Primary Constituent Elements" section of this final rule for further information on spawning). However, diversion dams are believed to act as instream barriers and prevent silvery minnows from moving upstream after hatching (Service 2001b; Dudley and Platania 2001; 2002a). In fact, the continued downstream displacement and decline of the silvery minnow in the middle Rio Grande is well documented (Dudley and Platania 2001).

During the irrigation season (approximately March 1 to October 31 of each year) in the middle Rio Grande, silvery minnow often become stranded in the diversion channels (or irrigation ditches), where they are unlikely to survive (Smith 1999; Lang and Altenbach 1994). For example, when the irrigation water in the diversion channels is used on agricultural fields, the possibility for survival of silvery minnows in the irrigation return flows (excess irrigation water that flows from agricultural fields and is eventually returned to the river) is low, because silvery minnows perish in canals because of unsuitable habitat, dewatering, or predation (Lang and Altenbach 1994). Unscreened diversion dams also entrain (trap) silvery minnow fry (fish that have recently emerged from eggs) and semibuoyant eggs (Smith 1998; 1999). However, some irrigation water is returned to the river via irrigation waterways in the reach of the middle Rio Grande from the Isleta reach, which helps sustain flow in certain segments of this reach. Nevertheless, we do not have evidence that these riverside drains offer suitable refugia for the silvery minnow.

Perhaps even more problematic for the silvery minnow in the middle Rio Grande are drought years during the irrigation season when there may be

little supplemental water (water that is used to augment river flows) available. Compounding this problem is stream bed aggradation (*i.e.*, the river bottom is rising due to sedimentation) below San Acacia, NM, where the bed of the river is now perched above the bed of the low flow conveyance channel (LFCC). The LFCC is immediately adjacent to and parallels the Rio Grande for approximately 75 mi (121 km) and was designed to expedite delivery of water to Elephant Butte Reservoir, pursuant to the Rio Grande Compact of 1939. The LFCC diverted water from the Rio Grande from 1959 to 1985. Because the river bed is now above the LFCC, waters in the mainstem of the river are drained from the river bed into the LFCC. The LFCC has the capacity to take approximately 2,000 cfs of the river's flow, via gravity. If natural river flow is 2,000 cfs or less, the LFCC can dewater the Rio Grande from its heading at the San Acacia Diversion Dam south to Elephant Butte Reservoir.

However, the LFCC has not been fully operational since 1985 because of siltation of the lower end (*i.e.*, stream bed aggradation) at Elephant Butte Reservoir. Even without water diversion into the LFCC, seepage from the river to the LFCC is occurring and causing some loss of surface flows in the river channel (BOR 2001a). In effect, water is drained from the Rio Grande into the LFCC thereby resulting in water losses in the reach from the San Acacia reach. During some years this can result in prolonged recurring periods of low or no flow.

It is believed that, historically, the silvery minnow was able to withstand periods of drought primarily by retreating to pools and backwater refugia, and swimming upstream to repopulate upstream habitats (Deacon and Minckley 1974; J. Smith, U.S. Fish and Wildlife Service, pers. comm. 2001). Platania (1995) posits that after prolonged recurring periods of low or no flow the silvery minnow may have been able to repopulate downstream habitat the following year because eggs drifted from upstream populations (Platania 1995). Although able to survive droughts historically through such movements, the present-day middle Rio Grande dries and dams prevent upstream movement. As a result silvery minnows can become trapped in dewatered reaches and may die in isolated pools before the river becomes wetted again. The inability of the population to find adequate refugia during prolonged recurring periods of low or no flow and to repopulate extirpated reaches creates a very unstable population (Service 2001b).

In some isolated pools, Smith and Hoagstrom (1997) and Smith (1999) documented complete mortality of silvery minnows in the middle Rio Grande in both 1996 and 1997 during prolonged periods of low or no flow. These studies documented both the relative size of the isolated pool (*i.e.*, estimated surface area and maximum depth) in relation to pool longevity (*i.e.*, number of days the isolated pool existed) and the fish community within isolated pools. Isolated pools found during these conditions typically only lasted for about 48 hours before drying up completely (Smith 1999). Those isolated pools that persisted longer than 48 hours lost greater than 81 percent of their estimated surface area and greater than 26 percent of their maximum depth within 48 hours. Moreover, isolated pools receive no surface inflow, water temperatures increase, and dissolved oxygen decreases; depending on location, size, and duration of the prolonged recurring periods of low or no flow, these factors may result in the death of all fish (Tramer 1977; Mundahl 1990; Platania 1993b; Ostrand and Marks 2000; Ostrand and Wilde 2001). Therefore, when periods of low or no flow are longlasting (over 48 hours), complete mortality of silvery minnows in isolated pools can occur.

Formation of isolated pools also increases the risk of predation of silvery minnows in drying habitats. Predators, primarily fish and birds, have been observed in high numbers in the middle Rio Grande, consuming fish in drying, isolated pools where those fish become concentrated and are more vulnerable to predation (J. Smith, pers. comm. 2001).

The potential for prolonged recurring periods of low or no flow in the middle Rio Grande becomes particularly significant for the silvery minnow below the San Acacia Diversion Dam, where most silvery minnows have been recently captured. In the river reach above (north of) the San Acacia Diversion Dam, return flows from current irrigation operations and other activities are routed back into the mainstem of the middle Rio Grande. At times, this can provide a fairly consistent flow in particular stretches of the Isleta reach. However, at the San Acacia Diversion Dam, once diversions are made (*i.e.*, to irrigation canals, as well as seepage losses to the LFCC) the return flows continue in off-river channels (with a few exceptions at Brown's Arroyo and the 10-mile outfall of the LFCC) until they enter Elephant Butte Reservoir. Thus, unlike in the Isleta reach, the silvery minnow does not receive the benefit of irrigation return flows in the San Acacia reach.