

the gill opening. The fins are lemon-amber, and sometimes the paired fins are bright golden-amber. Females and young are pale olive above, silvery on the sides, and have watery-white fins; their eyes are silvery, with only a little gold coloration, rather than golden as in the males (Sigler and Miller 1963; Page and Burr 1991).

Sigler and Sigler (1987) considered the least chub to be a short-lived and slow-growing species: least chub mature within 1 year and rarely live beyond 3 years of age. Of 218 fish aged by various investigators, less than 1 percent of the fish reached 4 years of age, and only 2 fish reached a total length of 7.6 cm (3 in.). A least chub of average size would be about 3.3 cm (1.3 in.) and weigh 0.57 g (0.02 oz) (Sigler and Workman 1975; Workman et al. 1976; Crawford 1979).

Least chub begin spawning in the spring when water temperatures reach about 16 °C (60 °F; Sigler and Sigler 1987). The least chub is a partial and intermittent spawner. Crawford (1979) found that least chub females produced only a few eggs at any time but release eggs over an extended period. The number of eggs produced at any one time is variable and may range from about 300 to 2,700 (Sigler and Sigler 1987). Although the peak spawning activity occurs in May, the reproductive season lasts from April to August, and perhaps longer depending on environmental conditions. The least chub has evolved this reproductive strategy (i.e., repetitive spawning during one season and of spreading the spawn over many weeks) perhaps as an adaptation to unpredictable environmental changes that are present in desert habitats. The least chub presumably initiates spawning in response to increases in water temperature and photoperiod, which may act in concert with other environmental and physiological factors, including exposure to direct sunlight (Crawford 1979; Sigler and Sigler 1987).

The least chub releases its sex products over vegetation (Crawford 1979). The adhesive eggs then sink and usually attach to the underwater vegetation. Fertilized eggs hatch in about 2 days at water temperatures of 22 °C (72 °F; Crawford 1979). The presence of submerged vegetation provides an important habitat for eggs and young larvae by furnishing needed oxygen and food (Crist and Holden 1980).

Common foods of the least chub include algae (Chlorophyta and Chrysophyta) midges (Chironomidae), and microcrustaceans; but they also eat other items (Sigler and Sigler 1987). Of 185 least chub taken from 27 springs,

121 stomachs contained 14 food types including algae, crustaceans, and insects (Workman et al. 1979). It also is believed that mosquito larvae make up a significant portion of their diet (Sigler and Miller 1963; Sigler and Workman 1975). Workman et al. (1979) noted that least chub diet changed throughout the year, and vegetation was more important during winter months.

The least chub was once widely distributed within the Bonneville Basin of northwestern Utah. The fish occupied a variety of habitats including streams, springs, and ponds, and it was classified as "excessively common" in its preferred habitats (Jordan and Everman 1896). Yarrow and Henshaw found least chub in the Beaver River (Cope and Yarrow 1875). Jordan (1891, cited by Jordan and Evermann 1896) collected least chub from ponds near the mouth of the Provo River. Jordan and Evermann (1896) stated that least chub occurred in "tributaries of Great Salt Lake and Sevier Lake." Least chub also have been observed in Utah Lake, Beaver River, Parowan Creek, Clear Creek, and the Provo River (reviewed by Sigler and Miller 1963; Hickman 1989). More recently, C.D. Barbour, University of Utah, (*in litt.* 1970) collected least chub from the Gandy Salt Marsh Complex in the Snake Valley. In 1970, R.R. Miller, University of Michigan, (*in litt.* 1971), found large numbers of least chub in the Leland Harris Springs complex, also in Snake Valley.

A decline in distribution and abundance of the least chub was first noted in the 1940's and 1950's (Baugh 1980). Hubbs and Miller collected least chub on trips into Utah during the 1940's and 1950's, and also noted a decrease in abundance (Holden et al. 1974). The fish is now restricted to the Snake Valley of the Bonneville Basin.

Least chub occur on a mixture of Federal, State, and private lands at five locations in the Snake Valley. Small numbers of least chub exist in two isolated springs: Central Spring (Bishop Spring Complex, Millard County) and Miller Spring (Juab County), but the fish is most abundant in Leland Harris Spring Complex (Juab County) and Gandy Salt Marsh Complex (Millard County). Recent surveys by the Utah Division of Wildlife Resources (UDWR), Salt Lake City, (*in litt.* 1993) indicated that some least chub in Snake Creek, south of Grandy Salt Marsh. However, no studies have been conducted to determine the distribution, abundance, or status of this Snake Creek population (L. Lentsch, UDWR, pers. comm. 1993).

Historically, the least chub inhabited a variety of habitat types in different environments (Lamarra 1981; Sigler and

Sigler 1987). Least chub now occupy springs, marshes and pools, and stream habitats. Osmundson (1988) reported collections of least chub from 38 sites, and these fish were captured in pools from 0.3 to 260 m³ (3 to 2,800 ft²) in size and with water depths of 0.1 to 3.6 m (0.4 to 12ft). In some of these habitats, certain environmental parameters fluctuate. The springs exhibit cool stable temperature, relatively low conductivity, and little variation in dissolved oxygen content. The marsh and pool environments exhibit extreme diurnal fluctuations in dissolved oxygen, and water temperatures that may vary between 15 and 32 °C (59–90 °F) (Crist and Holden 1980; Lamarra 1981). Seasonal water quality changes in the marshes and stream segments result in fish movement back and forth between different habitat types, especially between the springs and marshes (Crist and Holden 1980).

Vegetation is an important habitat component for the least chub (Crist and Holden 1980), and Sigler and Workman (1975) reported that least chub habitat included aquatic plants that were "plentiful and provided excellent cover." Water parsnip (*Berula erecta*), wire rush (*Juncus balticus*), and algae are common in and around the springs and marshes that are inhabited by the fish (Sigler and Workman, 1975). However, many other plants occur in areas occupied by the fish including *Chara* sp., duckweed (*Laemna* sp.), watercress (*Nasturtium* sp.), bulrushes (*Scirpus* sp.), cattails (*Typha* sp.), and sedges (*Cyperus* sp.) (Sigler and Sigler 1987).

Least chub has not been collected outside of Snake Valley since 1965 (Hickman 1989). They continue to decline in Snake Valley, and studies conducted in the past 15 years indicate a steady decline in their distribution and abundance. Workman et al. (1979) collected least chub from 36 sites in 5 major spring complexes in Snake Valley, but Osmundson (1985) found it in only 2 of 5 complexes where it previously existed. Crist (1990) reported that least chub were extirpated from springs on the Bagley Ranch and the Redden Springs Complex. Least chub numbers are now declining within the Gandy Salt Marsh and Leland Harris Spring Complex. Recent collections by UDWR personnel indicate that least chub occurs in only 3 of 5 springs sampled in the Leland-Harris Complex and 6 of 12 springs in the Grandy Salt Marsh. A continuing decline of the least chub has prompted the American Fisheries Society to recognize it as a threatened species (Deacon et al. 1979).