Age and growth of June sucker (Chasmistes liorus) from otoliths

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June sucker, Chasmistes liorus, is endemic to Utah Lake, Utah County, Utah (Miller and Smith 1981). This species is federally listed as endangered, and the wild population may number <500 individuals (based on mark-recapture estimates, C. Keleher, Utah Division of Wildlife Resources, personal communication). The remaining C. liorus population appears to suffer from lack of recruitment to the adult population, apparently in part due to predation on juveniles by an abundant population of introduced white bass (Morone chrysops; U.S. Fish and Wildlife Service 1995). Present recovery efforts include artificial propagation. Adult C. liorus are captured as they proceed up the Provo River to spawn, gametes are stripped and combined, and offspring are raised in captivity until they reach a size large enough to avoid predation by white bass. These juveniles then are returned to Utah Lake, except for those retained as brood stock. To effectively evaluate survival of captive-reared individuals and to estimate age at recruitment to the breeding population, one must understand natural patterns of C. liorus growth in Utah Lake. Although adult size is well documented, no data are available on C. liorus growth patterns. In this paper I report growth pattern, size at age, and age at death of individuals estimated from presumptive annuli on otoliths (lapilli) from 10 C. liorus from the wild population. This study provides previously unavailable data on age and growth to serve as a baseline for comparing C. liorus growth patterns.

Ten C. liorus (7 in June 1992 and 3 in June 1994) died from unknown causes, possibly as a result of stress associated with spawning activities, and were recovered by the Utah Division of Wildlife Resources. Standard length, total length, mass, and sex were recorded for each individual. Lapilli were removed, cleaned, and embedded in epoxy resin (Serifix, Struers Corporation, Westlake, OH) for sectioning. Otoliths were sectioned in the frontal plane using a lapidary grinder (Struers Model DAP-7, Struers Corporation, Westlake, OH) and mounted on a glass slide. Thin sections were observed with a Wild dissecting microscope at 24X to determine number of annuli (age), and images were captured via a video camera mounted on the microscope and a TARGA board in the computer to measure annual increments on otoliths. Annual increments for the first 10 presumptive annuli were measured with the use of MOCHA image analysis software (Jandel Scientific Inc.). Estimated length at age was calculated using the following formula (modified Fraser-Lee method, Campana 1990):

\[ L_x = L_o + (L_c - L_o)(R_x - R_o)/(R_c - R_o) \]

where \( L_x \) is estimated total length at age \( x \), \( L_o \) is length at capture, \( R_x \) is otolith radius at age \( x \), and \( R_c \) is otolith radius at capture. \( L_c \) is estimated length at swim-up (11 mm; Snyder and Muth 1988), and \( R_o \) is estimated otolith radius at swim-up (0.09 mm, measured from otoliths). An age-growth curve for ages 1–10 was generated by averaging back-calculated sizes at age for each sex (Fig. 1).

Estimated ages of individuals ranged from 10 to 41 yr. Two individuals had 10 presumptive annuli at death in 1992. All others had more than 25 annuli at death (Table 1). Chasmistes liorus exhibited a 3-stage growth pattern. Back-calculated lengths at age indicated
Although 10 is a relatively small sample size, this sample may represent 2% of the remaining population, well above the proportion sampled in most studies on age and growth of fish. Because *C. liorus* is endangered and individuals cannot be obtained easily, validation of ages derived from otoliths has not been done. Validation of age estimates using otolith annuli has been done for other cyprinids (leatherside chub [*Gila copei*], Johnson et al. 1995; Utah chub [*Gila atraria*], unpublished data), and *C. liorus* appears to exhibit similar patterns of annulus formation. Ages derived from sectioned otoliths of *Xyrauchen texanus* have been validated for younger age classes, and ages appeared reliable for older age classes (McCarthy and Minckley 1987). However, until a validation study of ages derived from sectioned otoliths of *C. liorus* is possible, ages in this study should be considered preliminary (Beamish and McFarlane 1983).

In most fishes growth rate decreases after sexual maturity (Alm 1959). *Chasmistes liorus* examined in this study show a decreased rate of growth after about 5 annuli, and all individuals in this study were reproductively mature. Assuming that decreased growth rate indicates probable maturation, *C. liorus* may mature as early as age 5, but at least by age 10. In 1980 the smallest reproductive individuals were 440 and 490 mm total length for males and females, respectively (Shirley 1983). If growth patterns of these fish are similar to that documented in this study, then the smallest individuals likely would have been 6–10 yr old.

U.S. Fish and Wildlife Service (1995) reported total length of reproducing females

### Table 1. Presumptive age, sex, total length, year of death, and estimated total length at presumptive ages 1–10 for 10 *Chasmistes liorus*. Total lengths at ages >10 yr were not calculated.

| Presumptive age | Sex | TL   | Death 1 | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  |
|-----------------|-----|------|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 10              | F   | 526  | 1992    | 101 | 277 | 388 | 437 | 468 | 487 | 503 | 520 | 522 | 526 |
| 26              | M   | 518  | 1992    | 91  | 259 | 343 | 390 | 383 | 414 | 430 | 449 | 469 | 470 |
| 31              | F   | 580  | 1992    | 197 | 294 | 353 | 397 | 425 | 457 | 476 | 497 | 517 | 538 |
| 34              | F   | 539  | 1992    | 149 | 273 | 362 | 332 | 351 | 366 | 390 | 421 | 434 | 457 |
| 35              | F   | 568  | 1992    | 70  | 176 | 232 | 262 | 299 | 330 | 348 | 368 | 382 | 403 |
| 41              | F   | 555  | 1992    | 141 | 204 | 264 | 320 | 365 | 395 | 420 | 438 | 451 | 455 |
| 30              | F   | 558  | 1994    | 76  | 203 | 256 | 325 | 366 | 383 | 383 | 411 | 421 | 430 |
| 36              | F   | 592  | 1994    | 97  | 205 | 251 | 291 | 327 | 348 | 373 | 394 | 405 | 424 |
| 37              | M   | 502  | 1994    | 96  | 172 | 214 | 255 | 286 | 322 | 350 | 369 | 380 | 400 |

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Fig. 1. Mean (±1 SE) total length at age 1–10 for male (n = 3) and female (n = 7) *C. liorus* in Utah Lake, Utah Co., Utah, USA. Length at age calculated from presumed annual increments on otoliths. Length at ages >10 was not calculated.
was larger than males in both 1980 and 1991. Until age 10 growth patterns do not differ
between sexes in this study. However, all females were larger than males, suggesting
that differences in total length between sexes result from increased growth of females relative
to males after sexual maturation.

*C. liorus* age and growth patterns appear similar to those of other large-bodied western
suckers (e.g., *Chasmistes cujus*, Scoppettone 1988, Scoppettone and Vinyard 1991; *Xyrauchen texanus*, McCarthy and Minckley 1987). Delayed maturity and long adult life may be adaptations to uncertain recruitment caused by environmental fluctuations (Scoppettone and Vinyard 1991). These characteristics have allowed populations of *C. liorus* and other similar species to persist, even though recruitment has been extremely limited because of recent human disturbance. It is my hope that recovery efforts can improve recruitment before the aging adult population becomes extinct.

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