Life history of Southern red bellied dace, Phoxinus erythrogaster, an Imperiled New Mexico Cyprinid

2006 Report of Activities

A New Mexico Game and Fish
Share with Wildlife Funded Project

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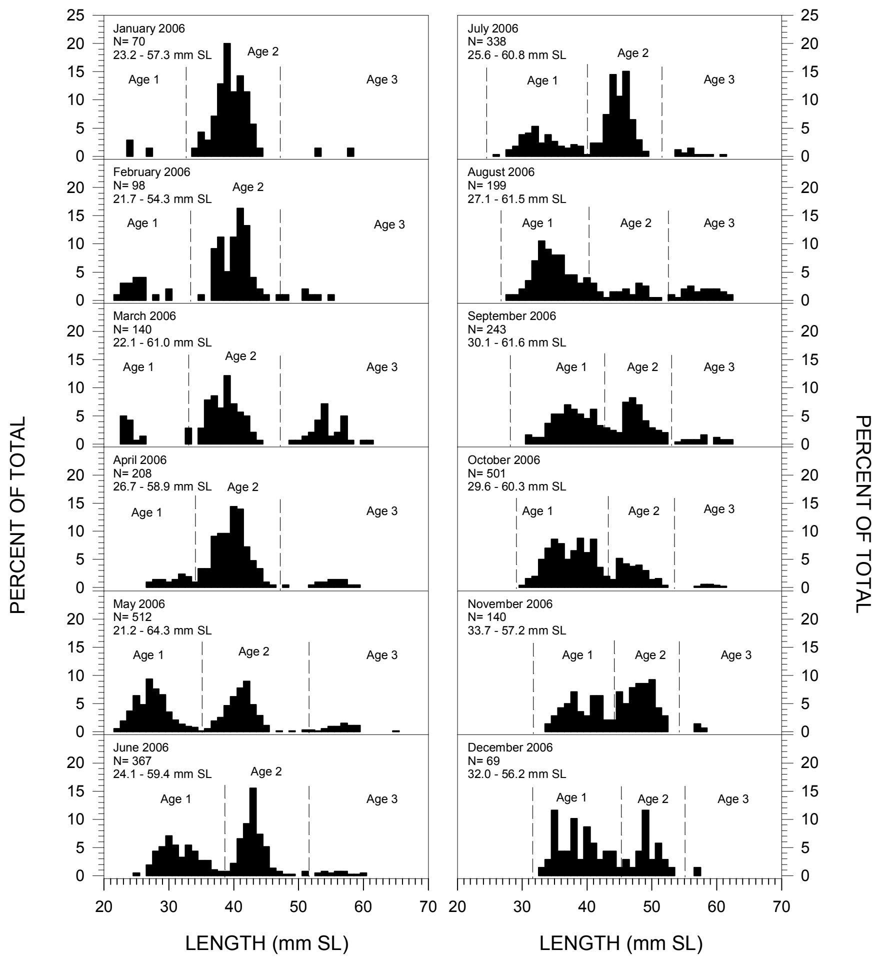

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Project Title:

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INTRODUCTION

Southern redbelly dace, *Phoxinus erythrogaster*, is unique among native fish in New Mexico because of its extremely limited relictual distribution. Although this species has been protected in New Mexico as an endangered species (19 NMAC 33.1) since 1975, it is common and widespread throughout much of the rest of its range in the Mississippi River basin. The New Mexico population of southern redbelly dace is confined within the headwaters and tributaries of the Mora River, especially Coyote Creek. Records at the Museum of Southwestern Biology-Division of Fishes (University of New Mexico) also indicate that a small population may persist in Jarosa Creek (a tributary of Coyote Creek). The New Mexico population of southern redbelly dace is thought to be a relict from the Pleistocene (Sublette et al., 1990) when cooler ambient temperatures allowed a more widespread distribution of dace throughout lower elevation streams in New Mexico. Elevated ambient and water temperatures, in the Post-Pleistocene, likely restricted southern redbelly dace to limited areas with suitable habitat conditions and resulted in the loss of dace from lower elevations. Other relictual populations are known from Colorado (Sublette et al., 1990) and portions of Mississippi and Tennessee (Starnes and Starnes, 1980). In general, populations of southern redbelly dace are disjunct and often widely separated (Propst, 1999) likely as a result of Post-Pleistocene warming.

The most commonly occupied habitats of southern redbelly dace appear to be spring and small stream areas with cold clear water and abundant aquatic vegetation (Becker, 1983). These habitats also provide the necessary cover (e.g., undercut banks, fallen terrestrial vegetation, larger substrata) and spawning habitat (moderate water velocity with clean gravel) utilized by southern redbelly dace (Ross, 2001). In New Mexico, southern redbelly dace are known to be relatively common in deep pools associated with undercut banks.

The spawning season of southern redbelly dace ranges from May to July in higher latitude states, such as Wisconsin (Becker, 1983), but begins in April and ends in July in Tennessee (Etnier and Starnes, 1993). The timing and duration of the spawning season in New Mexico is likely intermediate between Wisconsin and Tennessee because of the high elevation (ca. 2,500 m) of populations in New Mexico. Males become intensely colorful during spawning season with golden-yellow fins and banded sides rivaled only by brilliant red of the lower pectoral and dorsal fins, chin, lower head, and abdomen (Becker, 1983). Spawning occurs as numerous males (Greenfield, 1973) compete to fertilize the eggs expelled by the ripe female (Smith, 1908; Etnier and Starnes, 1993). Total number of mature eggs at any time during spawning season is estimated to be about 300 (Settles and Hoyt, 1978). Fertilized eggs are demersal and quickly settle into the gravel where they develop (Smith, 1908).

The conservation status of southern redbelly dace in currently occupied habitats in New Mexico is largely unknown. However, the highly restricted range of this species should be cause for some concern. The limited distribution and abundance of southern redbelly dace increases the likelihood of extirpation in a relatively short time period if local environmental conditions degrade. The relict population of southern redbelly dace in New Mexico is thought to be diminishing (Sublette et al., 1990), but it appears to be faring better in spring and spring-run habitats compared with riverine habitats (J.S. Pittenger, pers. comm.). Southern redbelly dace has been reported to hybridize with central stoneroller, *Campostoma anomalum,* (Cross and Minckley, 1960) and creek chub, *Semotilus atromaculatus*, (Trautman, 1957) and could be an issue in portions of their New Mexico range where these species frequently co-occur. Nonnative species likely to pose a predatory threat to southern redbelly dace include brown trout, *Salmo trutta,* and rainbow trout, *Oncorhynchus mykiss*, as they occupy similar elevations and habitats. These two trout species have been present in the same vicinity as southern redbelly dace in previous sampling efforts (unpubl. data) and could pose the most immediate threat to the continued persistence of dace. Other potential threats include groundwater pumping, which is thought to have led to declines of southern redbelly dace in Alabama (Boschung and Mayden, 2004), and sedimentation of spring and creek habitats.

Thorough research on the life history of southern redbelly dace is necessary for management of existing populations and recovery of the species in New Mexico. Little information on southern redbelly dace life history traits are available and to date no such comprehensive study has been undertaken in New Mexico. Some data are available on the food habits of southern redbelly dace from other regions where they have been found to feed on diatoms and other microscopic aquatic plant material (Forbes, 1883; Philips, 1969), and may also feed on small insects (i.e., chironomids; McNeely, 1987). However, the relative composition of the diet of southern redbelly dace could be quite different from streams in Minnesota (Philips, 1969) where the most complete data is available. The growth, age-class structure, and life span of southern redbelly dace are also largely unknown for the unique New Mexico population.

Funding for the first year of this project was received in November 2005 with sampling efforts initiating in January 2006. This draft report contains information on collections made from January through December 2006.

Project Objectives and Needs

This study proposes to describe life history traits of southern redbelly dace in New Mexico. Life history information on the relictual population of southern redbelly dace in New Mexico will provide insight to factors that are necessary to sustain this population in perpetuity. A better understanding of the autecology of this imperiled species will also aid in the development and implementation of effective conservation strategies to protect this species from biotic and abiotic threats to its continued persistence. This information will help achieve the greater mission and goals of wildlife conservation which is the legislative mandate of the New Mexico Department of Game and Fish.

Materials and Methods

Personnel.—Field and Laboratory work will be completed solely by American Southwest Ichthyological Research, including Steven P. Platania, Robert K. Dudley, and Michael A. Farrington (see Section IV [E]: Specifications [Offeror Experience] for details).

Field.— A total of at least 24 monthly fish collections will be made in Coyote Creek, a tributary of the Mora River, at NM State Hwy 434, just downstream of Black Lakes, Black Lake, New Mexico (UTM Zone 13: 4014360N, 477713E) in 2006 and 2007 (Figure 1). This site was chosen because it supports an abundant population of southern redbelly dace (based on 2000 - 2001 sampling efforts). Adult and juvenile fishes will be collected with a 3.0 m x 1.8 m 4.8-mm mesh seine while larval fish will be taken with a 1.0 m x 1.0 m 0.8-mm mesh seine. Sampling for larval fish will begin annually in March and continue through August to ensure that any early or late spawning efforts are detected.

Sampling efforts will be directed towards collection of a representative sample of the ichthyofaunal community (as opposed to being focused exclusively on the capture of southern redbelly dace), in addition to ensuring that a sufficient number of southern redbelly dace will be taken to complete a life-history study. All available aquatic mesohabitats will be sampled independent of their relative abundance or any habitat preference exhibited by southern redbelly dace. Retained adult and juvenile fish will be fixed in the field in a solution of 10% formalin and subsequently returned to the laboratory where they will be processed prior to being transferred to 70% ethanol. Conversely, larval fish will be preserved and maintained in 5% buffered formalin. Field notes will be recorded for every collection and will include sampling effort, water depth and temperature, and information on changes in habitat availability. All retained specimens will be deposited in the Division of Fishes of the Museum of Southwestern Biology at University of New Mexico.

A total of 12 collections was made during 2006 resulting in 2,885 southern redbelly dace. Monthly samples ranged from 69 to 512 individuals (mean= 240) with the smallest collections occurring while surface ice covered the creek (Jan, Feb, Dec 2006).

Laboratory.—Adult and juvenile southern redbelly dace will be measured to the nearest 0.1 mm standard length (SL) with electronic calipers while larval fish lengths will be measured (0.1 mm SL) under a stereomicroscope equipped with an ocular micrometer. Length-frequency histograms will be prepared for each sample date and will include all southern redbelly dace collected at that site on that date. Age of fish will be derived from histogram plots of SL and separation of age-classes verified, as necessary and if possible through scale analysis. These data will also be analyzed to determine growth-rates and survivorship of southern redbelly dace. Mean monthly size (mm SL) will be calculated by age class (independent of gender) and used to generate growth curves. Annual age class survivorship will be determined for each age class and adjusted for sampling effort.

Prior to determination of SL, a subsample of 20 southern redbelly dace (specimens ≥25 mm SL) was obtained from each sample and assigned a unique number. The subsample will be used to determine sample gender ratios, reproductive status, length-mass relationships, and dietary composition of southern redbelly dace. The 20 individuals per sample will be measured (SL mm), viscera removed (assigned the same unique number as the body), and mass of both the body and ovaries determined. Adjusted gonadosomatic mass, defined as the mass of the body after extraction of all major internal organs (heart, liver, gonads, and gut), will be recorded for each member of the subsample. Eviscerated specimens and excised ovaries were blotted on tissue paper and mass of each determined (wet weight) to the nearest 0.001 g on an analytical balance. Excised male gonads were examined under a stereomicroscope and length and maximum width along the left testis determined to the nearest 0.01 mm with an ocular micrometer.

Stomach and intestinal tracts (=gut) removed from the subsample of adult southern redbelly dace in each collection will be dissected and contents examined for dietary composition and endoparasites. Material in the gut will be rinsed into a petri-dish and examined under a dissecting microscope. Dietary material will be identified to the appropriate taxonomic level and enumerated. Correlations between SL and eviscerated body mass will be generated from the cumulative dataset and segregated by gender. Analysis of covariance (ANCOVA) will be used to test for slope and elevation differences in length-mass linear regression relationships between genders and sample stations while a t-test will be employed to detect any statistical differences in SL of the sexes.

Upon completion of this project, we intend to published information gathered from this project, in combination with historical collection data, in a peer-reviewed scientific journal. That paper will serve for the immediate future as the primary document on the distribution and conservation status of fishes of the New Mexico portion of the South Canadian River (for an example see: Bestgen, K. R. and Platania, S. P. 1991. Status and conservation of Rio Grande silvery minnow, *Hybognathus amarus*. Southwestern Naturalist 36 [2]: 225-232).

Summary of 2006 Results

Length frequency histograms indicate the presence of at least three age classes in the population (Figure 2). The 2004 year class (Age 2 fish) initially comprised the majority of the population through July 2006. Age 1 specimens (2005 year class) were the second most abundant cohort in the population and comprised the majority of post-July 2006 samples. Age 0 individuals (specimens < 20 mm SL) were not present in 2006 collections. If 2007 population dynamics follow those observed in 2006, the 2006 year class should be taken in January or February 2007. Concerted efforts will be made in 2007 to collect larval (Age 0) southern redbelly dace.

Both total length and standard length of southern redbelly dace were recorded and linear regression of the lengths plotted to provide predictive equation (Figure 3). Southern redbelly dace in the samples ranged from 21.2 to 64.3 mm SL. A subsample of 50 individuals was selected from each monthly collection (total = 600) and further analyzed to determine gender, length-mass ratios, and gonadosomatic index values. Female southern redbelly dace comprised 59% (n=354) of the subsample with monthly ratios ranging from 38% to 86% (Figure 4). Female southern redbelly dace were more than 50% of the monthly sample on eight occasions, were exactly 50% of the sample on one occasion, and were less than 50% of the sample on only three occasions.

Mass (both whole body and eviscerated body) of southern redbelly dace was correlated with standard length (Figure 5). In addition, mass-length relationships were determined by gender (Figure 6). The largest southern redbelly dace, in both length and body mass, were female. The maximum size southern redbelly dace during 2006 was a 63.3 mm SL (6.14 gms whole body mass) female with an eviscerated body mass of 3.79 gms. The maximum size male southern redbelly dace collected was 58.4 mm SL while maximum whole body mass was 3..67 gms.

Mean monthly gonadosomatic index values for females southern redbelly dace ranged from 3.66 in July to 21.70 in April. Spawning period appeared to be April and May but might have included March and June (Figure 7). Besides the containing the largest mean monthly GSI values, April and May generated the 24 largest individual values and the greatest standard deviation around the mean.

Attempts were made to record daily water temperature at the study site (Figure 8). Unfortunately, multiple failure of the recording device resulted in extended periods without water temperature information. In 2006, surface ice covered large portions of the sampling site from January through February and December.

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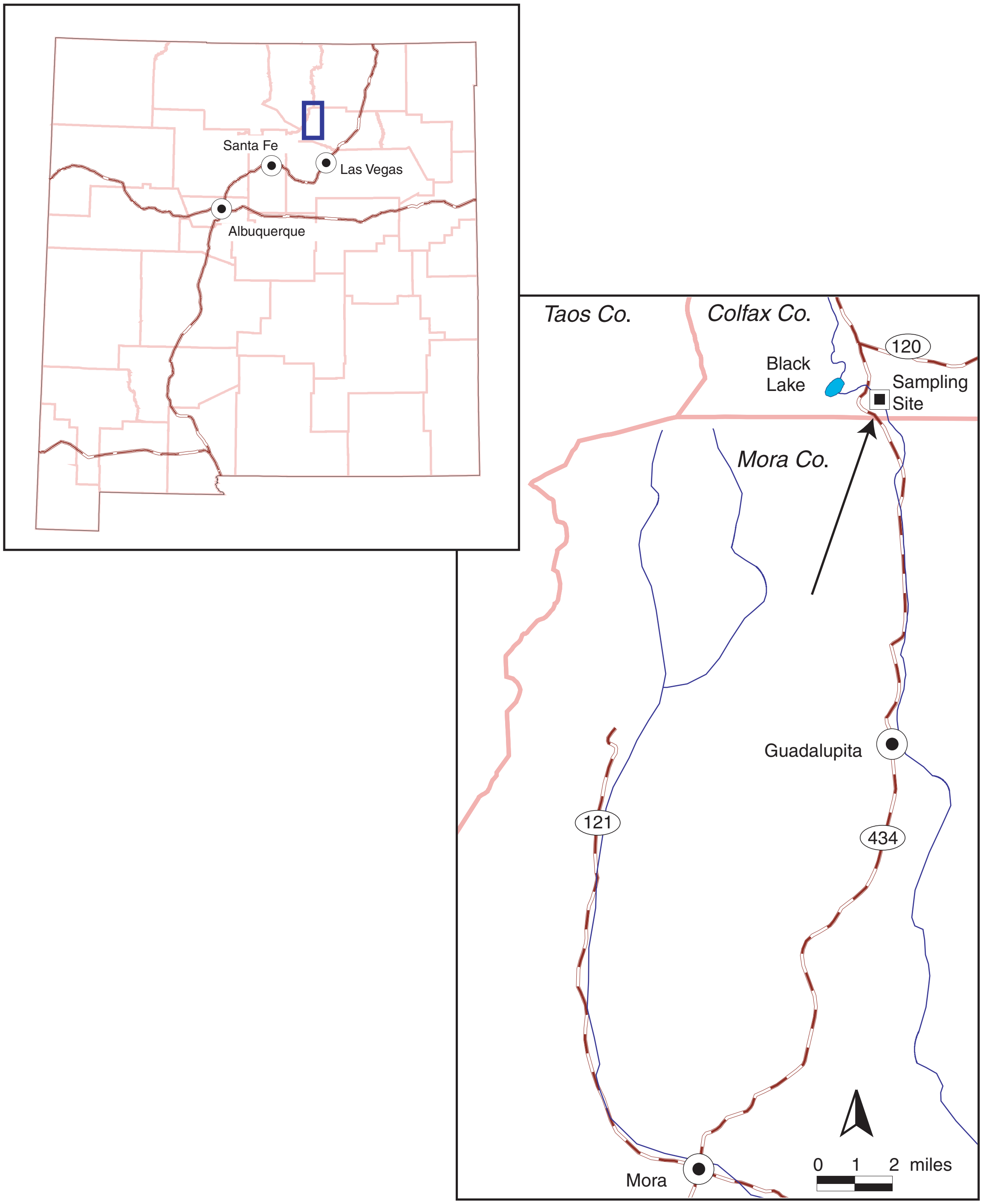

Figure 1. Coyote Creek (Mora River System, Canadian River Drainage) sampling locality for southern redbelly dace during 2006 (square).

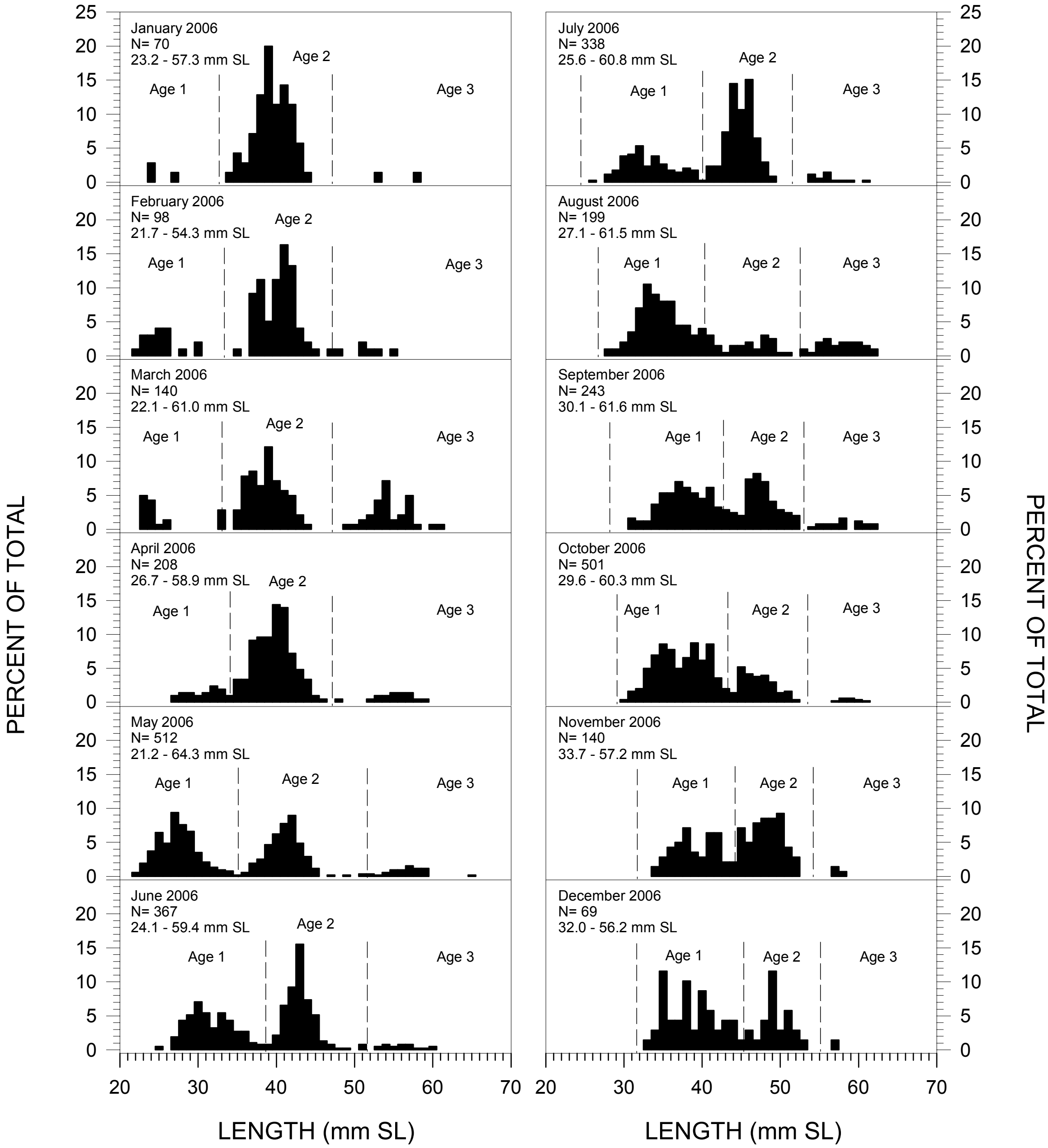

Figure 2. Length frequency historgrams of southern redbelly dace from January through December 2006. Dashed vertical lines separate putative age classes.

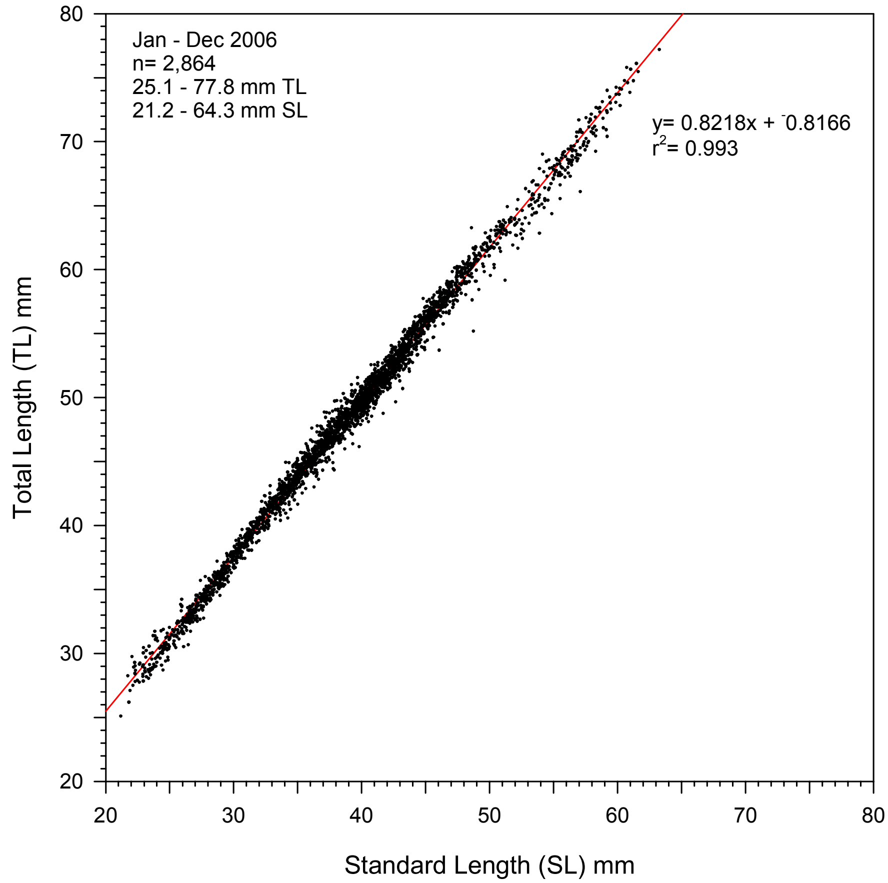

Figure 3. Correlation between total length and standard length in southern redbelly dace collected in Coyote Creek, New Mexico from January through December 2006.

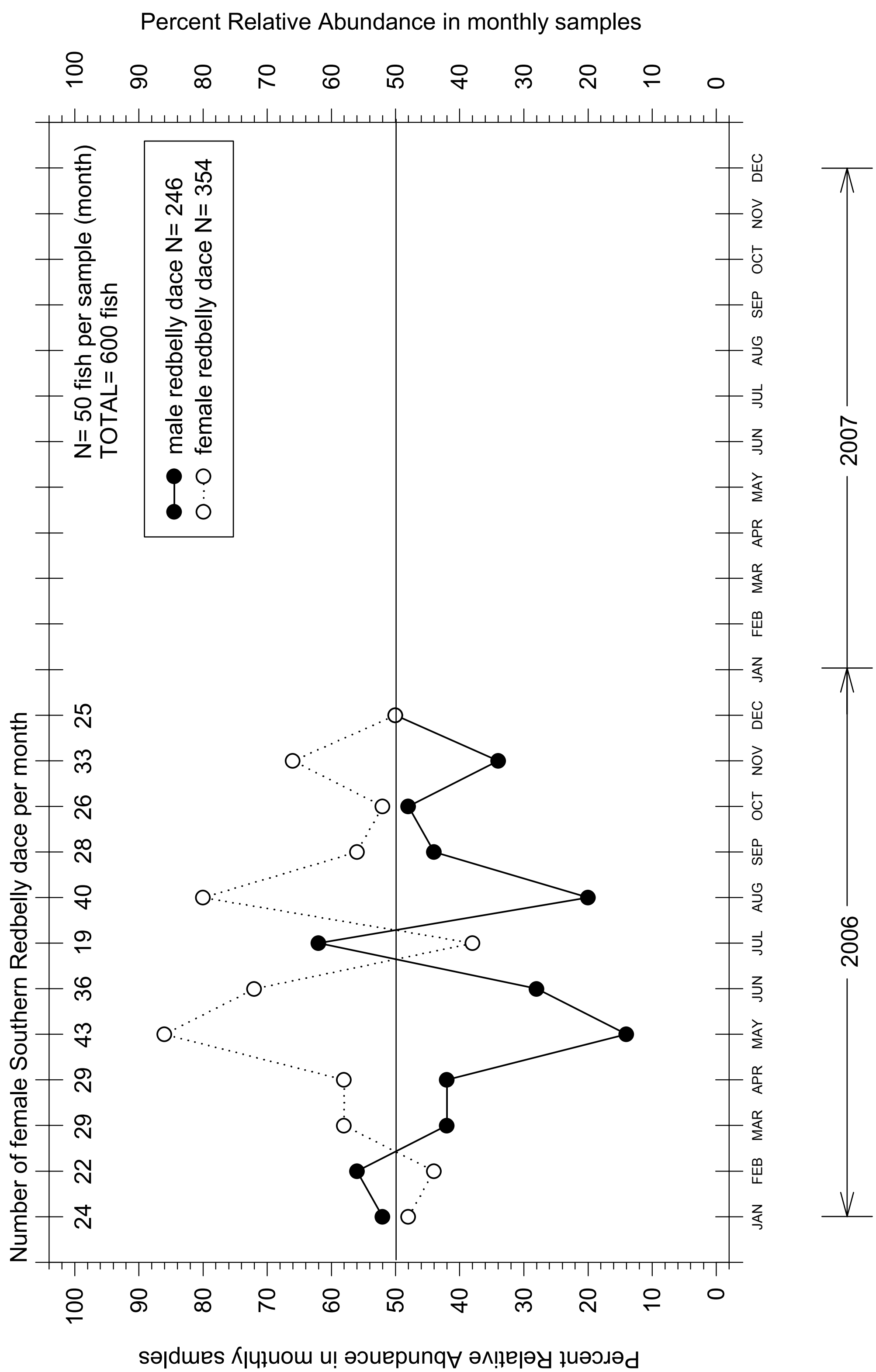

Figure 4. Southern redbelly dacemonth gender ratiosfrom January through December 2006.

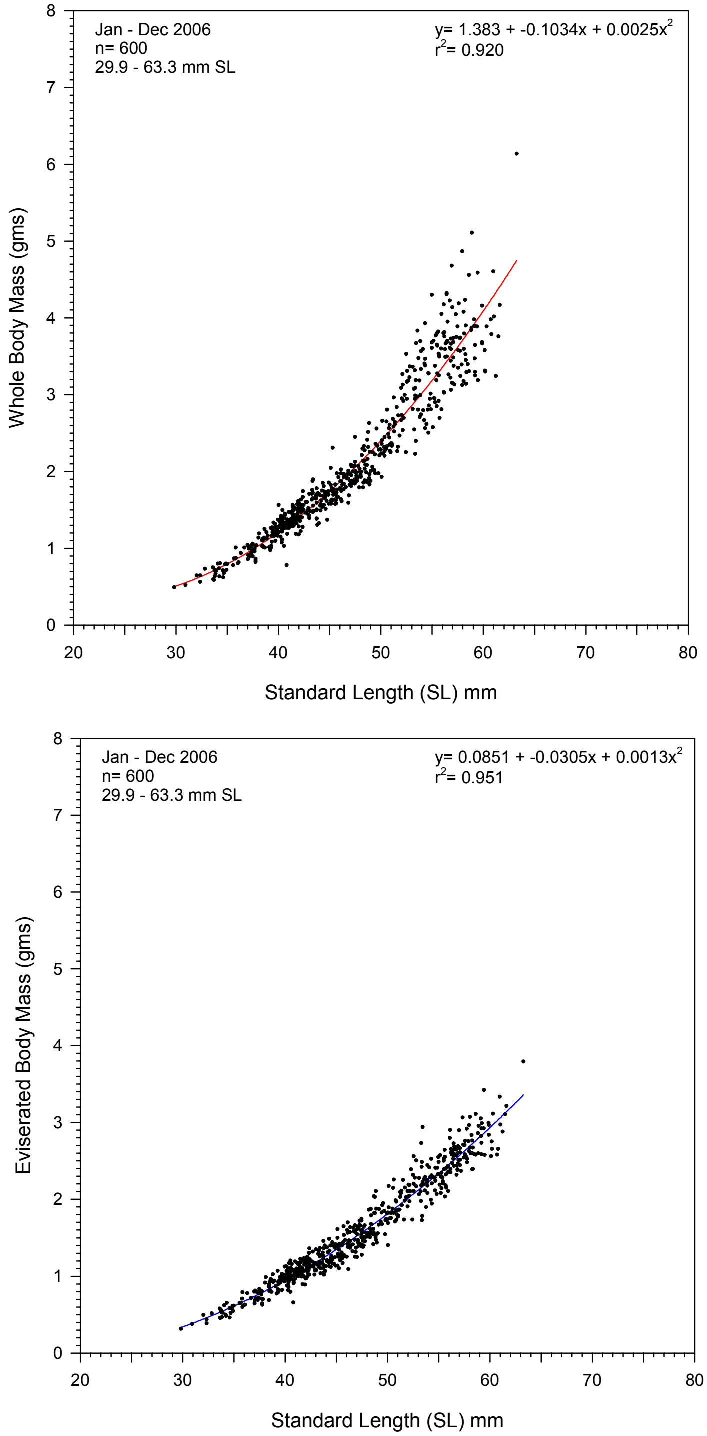

Figure 5. Body mass (whole and eviserated) length (standard) ratios of southern redbelly dace during 2006.

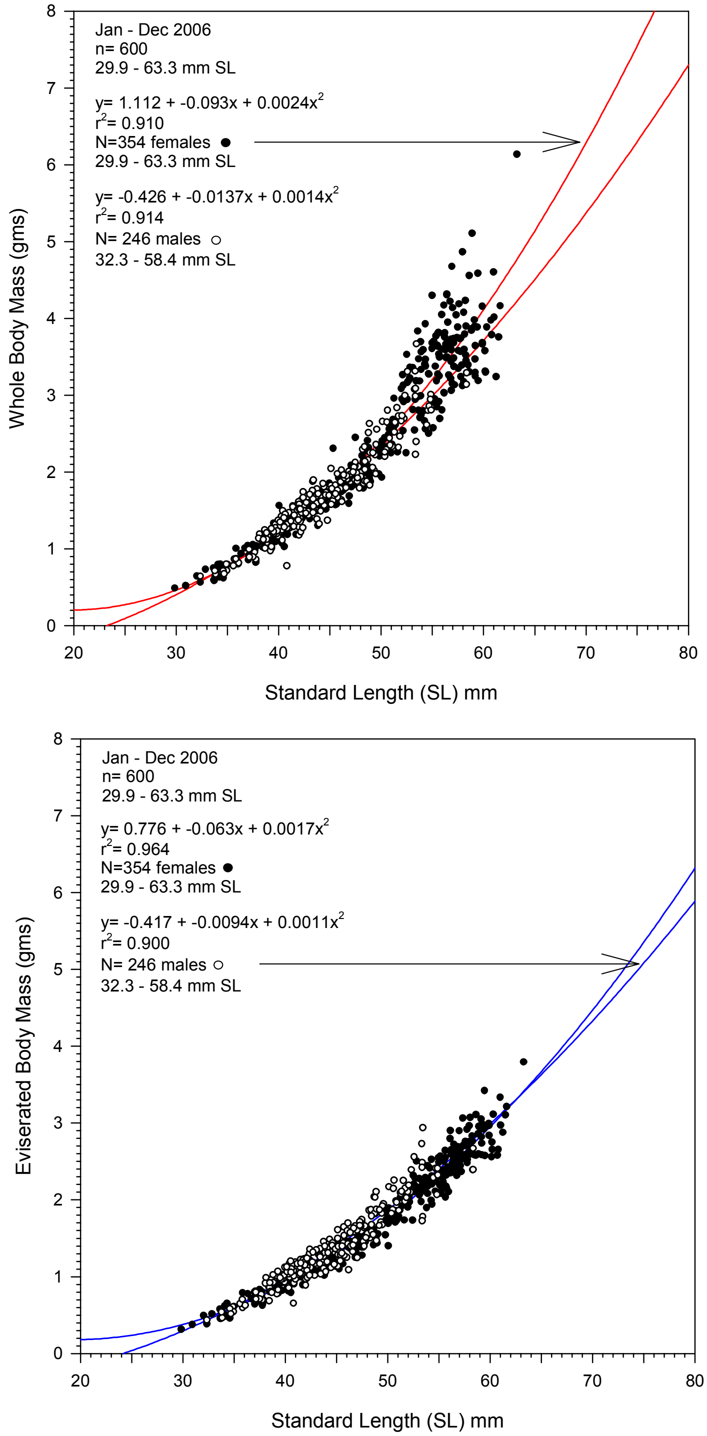

Figure 6. Body mass (whole and eviserated) length (standard) ratios of southern redbelly dace by gender during 2006.

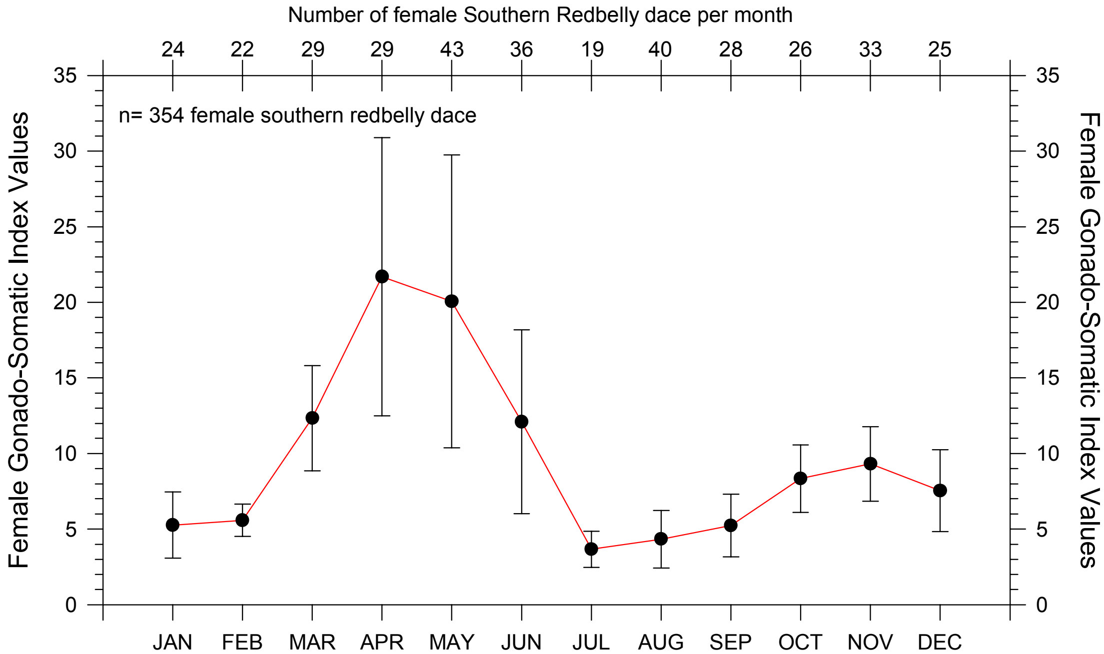

Figure 7. Mean monthly gonadosomatic index values of female southern reddbelly dace. Capped bars indicate one standard error around the mean.

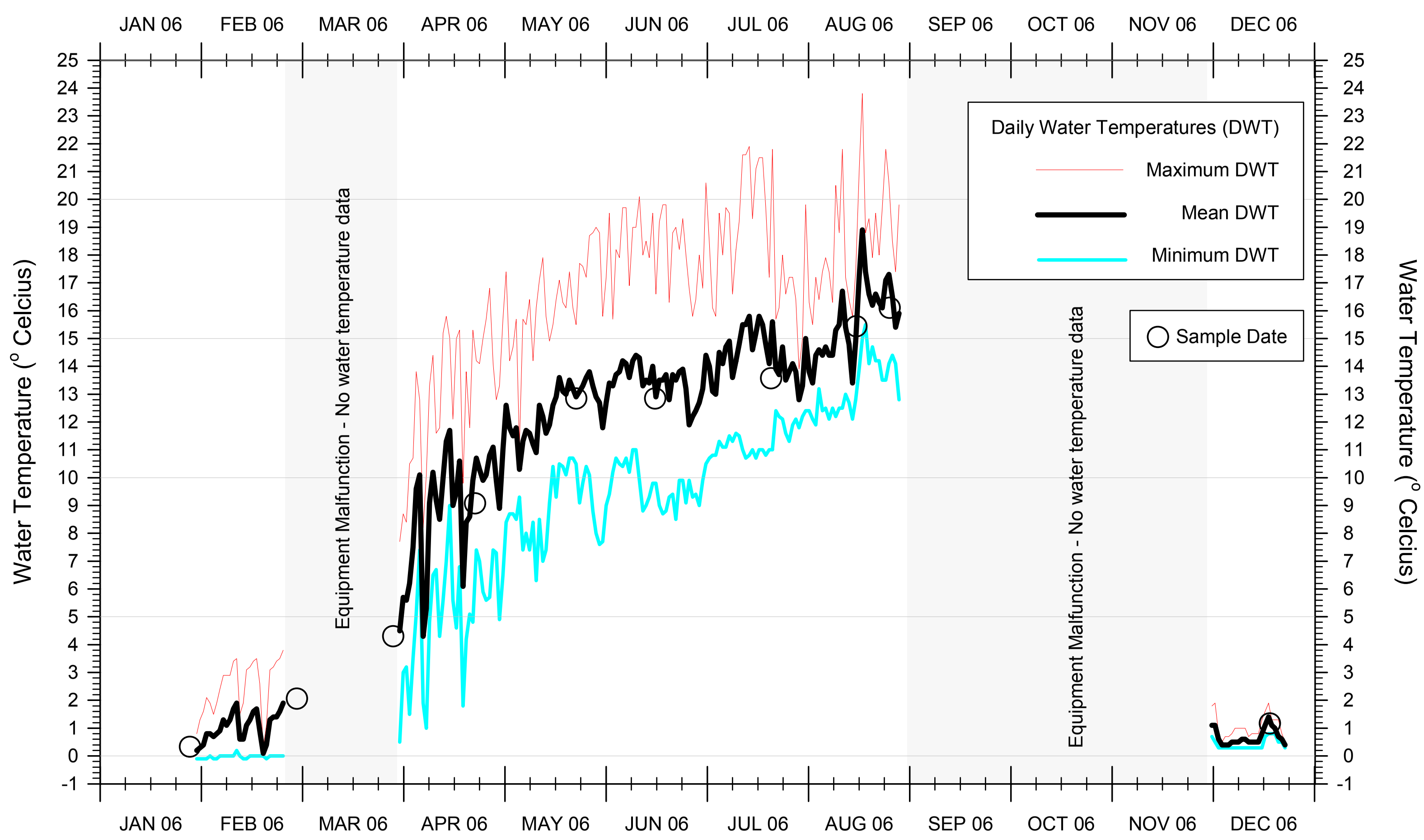

Figure 8. Minimum, maximum, and meand daily water temperatures during 2006 at the southern redbelly dace sampling site, Coyote Creek, Mora County, New Mexico. Water temperature data presented above are based on hourly temperatures. Hollow circles indicate sampling dates.