Empire Spring Monitoring Report 2004 – 20013

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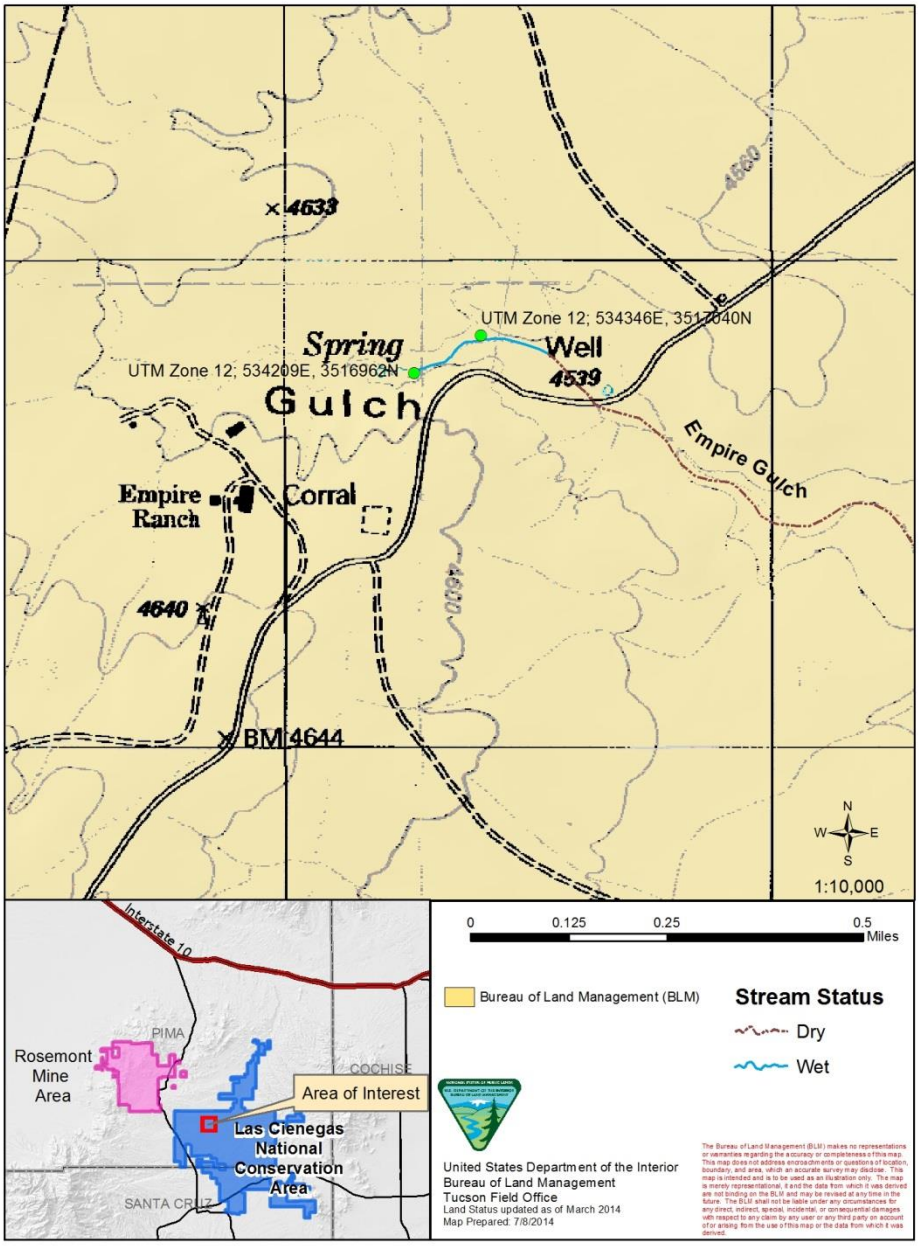
Introduction

Empire Gulch is a tributary to Cienega Creek on the Las Cienegas NCA north of Sonoita, Arizona. The upper spring (Empire Spring) is located adjacent to the Empire Ranch building complex. This perennial spring issues from a relatively stable head-cut erosion feature and can be described as a depression type spring (Sada et al. 2001). Water flows between 6 and 40 gpm and thermally stable at its source with a temperature range from 13.0 to 20.5°C. Dissolved oxygen at the source varies seasonally from 2.7 to 6.3 (BLM files: monthly survey 2008-2013) . However, temperature and other water quality parameters vary downstream. The length of flow varied from 790ft to over 1,400ft during the period 2006 to 2010 (BLM files: annual June wet/dry stream monitoring). The riparian area is comprised of Fremont's cottonwood (*Populus fremontii*), Goodding willow (*Salix gooddingii*), yew willow (*Salix taxifolia*), and Arizona Walnut (*Juglans major*). Understory plants include *Eleocharis spp., Juncus articus var. balticus*, yerba mansa (*Amnopsis californica*), and water cress (*Rorippa nasturtium- aquaticum*) and duck weed (*Lemna* sp.). Stream substrate is composed of soft mud and decaying organic material. The channel is comprised of habitat features including trench pools, glides and short runs. Often the glides and runs will be choked with emergent vegetation (marsh) and pools are often covered with a nearly complete layer of duckweed provided there has not been any recent flooding.

Gila topminnow (*Poeciliopsis occidentalis occidentalis*) and longfin dace (*Agosia chrysogaster*) from Cienega Creek were first transplanted to this spring run below the head pool in 2001. The Gila topminnow population has been augmented several times.

Management of the area for aquatic and riparian values began in 1989; the area was fenced with barb-wire to exclude livestock from 3,300 feet of riparian habitat. Later, a cement low water crossing was added. The livestock exclosure was expanded by 2,400 feet and a 200 foot crossing lane for livestock was created to facilitate cattle seasonal movements through the eastern end of the exclosure.

Figure 1. Map of the study reach at Empire Spring, LCNCA.



Methods

The entire length of open water habitat from the first tributary wash to, but not including the head spring are seined annually in the fall (October/November). The habitats are drag seined in an upstream progression with a 1/8" mesh 15 by 6 foot seine with a double weighted lead line. All fish, leopard frogs, tadpoles, and Belostomatids (*Lethocerus medius* and *Abetis herberti*) insects greater than 1.5 cm were counted and returned downstream of subsequent seining efforts. Because of its great depth, the head-spring pool is not sampled.

Prior to surveys water quality is measured. Dissolved oxygen and water temperature were monitored using a meter (YSI 550, calibrated on site) with a permeable membrane probe and thermocouple. ColorpHast® 6.5-10.0 indicator strips (0.2 unit increments) were used to measure pH. A conductivity meter calibrated with 1413 µS solution was used to measure conductivity.

Results

Gila topminnow was first released in 2001, but monitoring data strongly indicates the lack of persistence even with augmentation (table 1 and figure 2). Longfin dace were released in 2001, but not augmented as were topminnow. Gila topminnow were not collected after 2010. This species was largely collected in pools and runs close to the headspring. In contrast, the leopard frog tadpole populations has been increasing over time with an inverse relationship to *Abetis* and *Lethocerus* (figure 2). There have been no observations of leopard frog mortality from chytrid fungus even though the population has been infected for years (Rosen, et al 2013). Leopard frog captures have generally increased in recent years with a peak of 49 in 2012 (table 1). *Abetis* numbers vary widely (range 86 to 635). Likewise *Lethocerus* numbers were highly variable ranging from 7 to 142 . Water quality and quantity measurements are summarized in table 1.

Table 1. Water Quality Data for 2008 through 2013

Parameter	Min	Max
Range DO mg/L	2.2	6.3
Range Temp °C	13.0	20.5
Range Flow gpm	6	40

Table 1. Empire Gulch Survey Data 2004 to 2013.

Species	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
CLF tadpole	13	82	30	273	188	72	47	262	145	250
CLF frog	1	2	5	5	9	4	10	22	49	8
LF Dace	52	57	68	20	54	3	1	0	0	0
Abetis sp.	635	530	105	121	463	130	194	97	399	86
Lethocerus	7	15	32	66	142	7	17	29	52	15
G Topminnow	3	1	11	0	2	0	0	0	0	0

Figure 2. Leopard frog tadpole and predacious insect abundance 2004 – 2013
at Empire Gulch, Pima Co., AZ

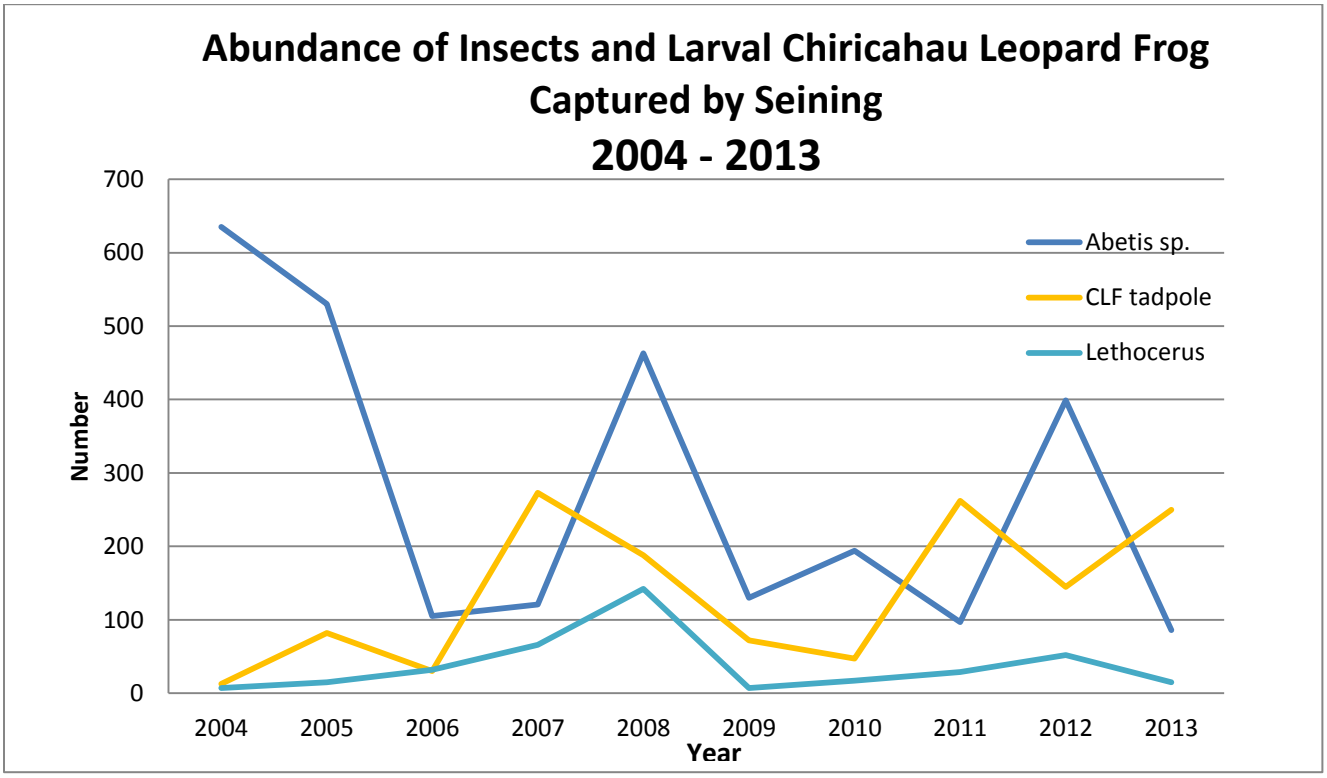
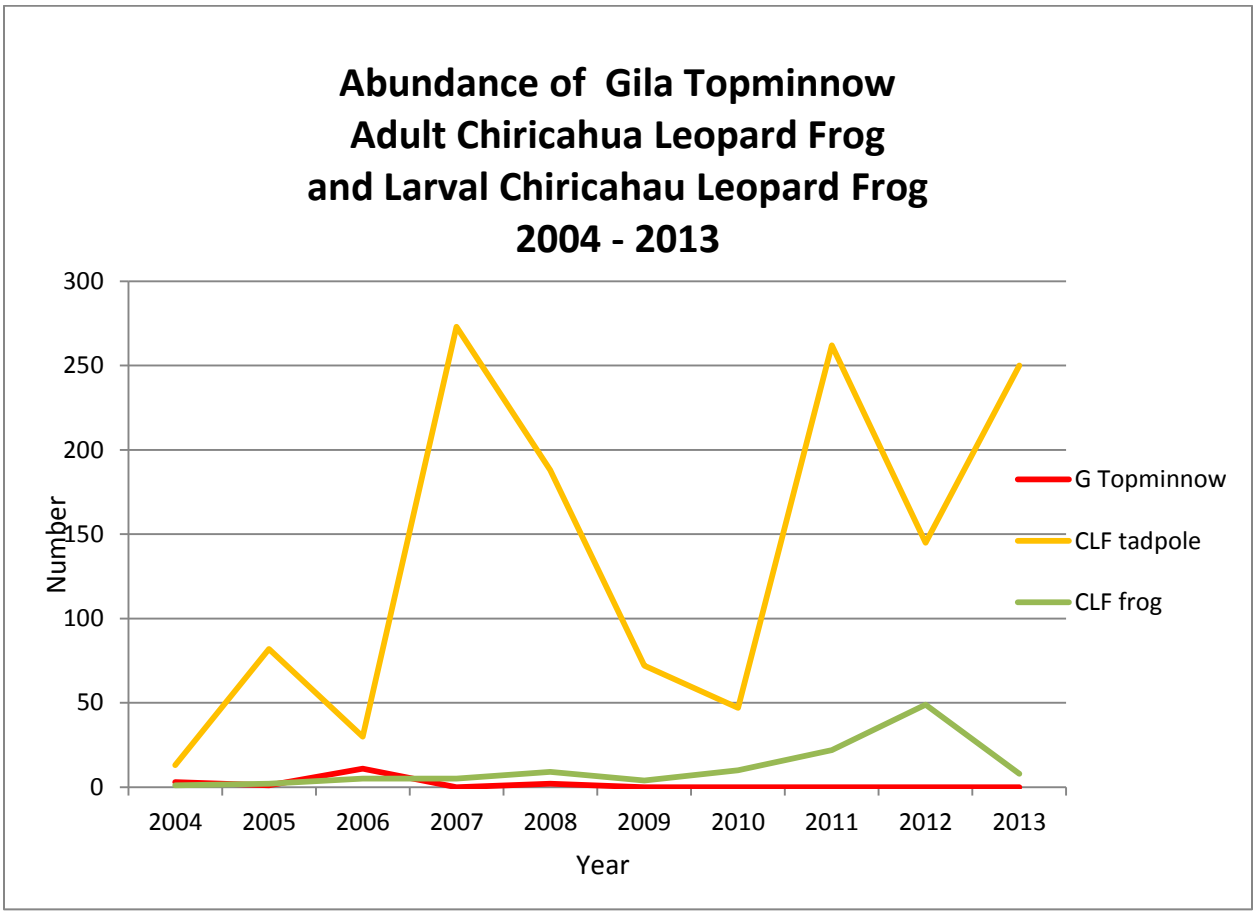


Figure 3. Chiricahua leopard frog, tadpole and Gila topminnow abundance 2004 – 2013 at Empire Gulch, Pima Co., AZ



Conclusions and Management Implications

Gila topminnow were established in 2001 with 689 fish. The population was augmented in 2002, 2003 and 2006 with 70 and 473, and 52 fish, respectively, but has not persisted. Water quality parameters do not seem to be a limiting factor. However, duck weed often makes a nearly complete cover of the water's surface. The lack of sunlight penetration into the water has largely shift the trophic structure of the aquatic ecosystem from algal driven to one driven by detritus. The ability to feed by sight may also be hampered by low light levels below the duckweed. The scud, *Hyalella Azteca,* is abundant in the spring run and is a known component of the diet in other places. The predator load in this sluggish marsh like habitat is relatively heavy and comprised of leopard frogs, giant fishing spiders, backswimmers, water scorpions, giant water bugs, beetle larvae, dragonfly larvae, and damselfly larvae. All of these are capable of ingesting topminnow (size range for the species is approximately 6 to 55mm). Longfin dace were not collected after 2010 and only near the headspring and Gila topminnow were last collected in 2009.

The lack of success in establishing a population in Empire Spring is likely a result of high predation rates and unsuitable habitat conditions related to extensive habitat coverage by duck weed and watercress. The plants covering the habitat serve as a substrate for insect predators at the water's surface where topminnow spend much of their time. Normally, predacious insects remain on the bottom and plants anchored to substrate, where by limiting predation opportunities. Water quality has been relatively stable and suitable for fish, but the data was collected near the source. Regular collection of water quality in downstream pools was not collected. These locations have more vegetation and litter which likely reduces dissolved oxygen level overnight below those at the spring source.

In contrast, Chiricahua leopard tadpole numbers appear to be large as indicated by catch rates. Even though the invertebrate predator load is high, catch rates have generally increased over time. However, catch rates of tadpoles had an inverse relationship to abundances of *Abetis* and to a lesser degree, *Lethocerus.* It is likely that flooding reduces insect predator numbers which periodically relieves predation rates on fish and tadpoles.

The Empire Gulch leopard frog population is a likely candidate as a source of resistant genes and a reservoir of genetic variability for such efforts, as it has survived many years with *Bd* and recently has increased in population size (Dr. P.C. Rosen, Univ. of AZ Herpetologist).

During fish surveys on Cienega Creek the author has found it is common to observe predation on Gila topminnow and small longfin dace when held with *Abetis*. This is not the case when *Abetis* is held with tadpoles at Empire Spring. However, *Abetis* have been observed to take dragonfly larvae even when tadpoles are far more abundant when being held together prior to enumeration and release.

Literature Cited

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Sada, D.W., J.E. Williams, J.C. Silvey, A. Halford, J. Ramakka, P. Summers, and L. Lewis. 2001. Riparian area management; a guide to managing restoring, and conserving springs in the Western United States. Technical Reference 1737-17. Bur. Land of land Management, Denver, Colorado. BLM/ST/ST-01/001+1737. 70pp.

Appendix A: List of predacious invertebrates of Empire Spring, LCNCA

List Prepared by Margarethe Brummermann PhD (Univ Arizona) and Robert Beatson

Libellula saturate (flame skimmer)
Archilestes grandis (spreadwing damselfly)
Hesperagrion heterodoxum (painted damselfly)
Sympetrum signiferum (spot-winged meadowhawk)
Notonectus shooteri (backswimmer)
Ranatra qudridentata (water scorpion)
Dolomedes triton (fishing spider)
Ranatra qudridentata (water scorpion)
Lethocerus medius (toebiter)
Abedus herberti (giant water bug)

List prepared by Doug Danforth

ZYGOPTERA (DAMSELFLIES)

Lestidae (Spreadwings)
Lestes alacer (Plateau Spreadwing)
Coenagrionidae (Pond Damsels)
Apanisagrion lais (Black-and-White Damsel)
Argia hinei (Lavender Dancer)
Argia nahuana (Aztec Dancer)
Argia plana (Springwater Dancer)
Argia fumipennis (Variable Dancer)
Enallagma civile (Familiar Bluet)
Ischnura demorsa (Mexican Forktail)
Ischnura denticollis (Black-fronted Forktail)
Hesperagrion heterodoxum (Painted Damsel)
Telebasis salva (Desert Firetail)

ANISOPTERA (DRAGONFLIES)

Aeshnidae (Darners)
Anax walsinghami (Giant Darner)
Rhionaeschna multicolor (Blue-eyed Darner)

Gomphidae (Clubtails)
Erpetogoomphus lampropeltis natrix (Serpent Ringtail)

Libellulidae (Skimmers)
Libellula saturata (Flame Skimmer)
Orthemis ferruginea (Roseate Skimmer)
Perithemis intensa (Mexican Amberwing)
Pachydiplax longipennis (Blue Dasher)
Sympetrum corruptum (Vareagated Meadowhawk)
Pantela flavescens (Wandering Glider)
Pantela hymenea (Spot-winged Glider)