State of Utah
DEPARTMENT OF NATURAL RESOURCES
Division of Wildlife Resources - Native Aquatic Species

COLUMBIA SPOTTED FROG

(*Rana luteiventris*)

POPULATION MONITORING SUMMARY

Gandy, Bishop Springs, Tule Valley
2004

Publication Number 04-32
Utah Division of Wildlife Resources
1594 West North Temple
Salt Lake City, Utah
Miles Moretti, Director

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INTRODUCTION

The Columbia spotted frog (*Rana luteiventris*) is a medium sized, light to dark brown frog distinguished by its rough skin, dark dorsal spots, and yellow or salmon coloring on its underparts (Wright and Wright 1995). Spotted frogs are highly aquatic, inhabiting marshy edges of lakes, ponds, springs, and slow moving, cool streams with organic substrate. In the West Desert, the spotted frog inhabits wetland areas associated with springs and seeps characterized by bulrush *(Scirpus americanus*), salt grass (*Distichlis spicata*) and cattail (*Typha* sp.). Breeding in the West Desert typically occurs during a six to seven week period in March and April (James et al. 1998, Fridell et al. 2001).

The Columbia spotted frog is contiguously distributed from southeastern Alaska to Oregon and western Wyoming with isolated populations existing in Utah and Nevada. It is hypothesized that the spotted frog was common in Utah throughout the Lake Bonneville region more than 15,000 years ago (Hovingh 1993). A putative distribution decline following the recession of Lake Bonneville caused the isolation of several remaining populations (Hovingh 1993). Today, many of these populations are vulnerable, and some may now be extirpated (Ross et al. 1993).

The northern leopard frog (*Rana pipiens*) is sympatric with the spotted frog in Bishop Springs and Gandy Marsh within the West Desert. Although reproduction is usually temporally separated (Ross et al. 1994, Fridell et al. 2003), overlap in egg deposition has been observed in the West Desert. Spotted frog egg masses have a loose circular shape, measure 7-10 cm in diameter, and consist of 500-600 eggs having 1-2 membranous envelopes. In contrast, leopard frog egg masses are deposited as a dense globular ball of as many as 6,500 eggs, each having 2-3 envelopes (Stebbins 1985). Additional morphological differences include direct attachment to vegetation and

greater rigidity in gelatinous matrices in leopard frog egg masses (Stebbins 1985), compared to unattached egg masses and a loose gelatinous matrix in spotted frog egg masses. Dumas (1966) reported that leopard frogs displace spotted frogs. Ross et al. (1994) suggested that leopard frogs are not native to the West Desert. However, we have observed both species in Bishop Springs and Gandy Marsh for more than 10 years, and have documented successful reproduction annually since 1994. Long-term monitoring should determine if these species could continue to be sympatric in the West Desert.

The Columbia spotted frog was proposed for listing in 1989 under the Endangered Species Act. In 1993, the U.S. Fish and Wildlife Service (USFWS) determined that federal listing of Utah spotted frog populations was warranted, although listing was precluded at that time (USFWS 1993). Reasons for the proposed listing included loss of habitat, introduction of non-native species, and the vulnerability of Utah's small, isolated populations (Perkins and Lentsch 1998). In response to regional declines and threats to spotted frog populations, the Utah Division of Wildlife Resources (UDWR) conducted spotted frog inventories in 1993 and began developing and implementing spotted frog conservation actions. These activities lead to the development of the Spotted Frog Conservation Agreement and Strategy (SFCAS; Perkins and Lentsch 1998), endorsed by the USFWS in February of 1998 (USFWS 1998). Based on protective actions and accomplishments in years following the implementation of the SFCAS, the USFWS removed the Utah populations as candidates for listing in 1999, and determined that listing was not warranted for the Wasatch Front populations in 2002 (USFWS 2002).

The goal of the SFCAS is to ensure the long-term viability of the spotted frog within its historical range through the collaboration of private landowners and natural resource agencies

(Perkins and Lentsch 1998). This goal includes two primary objectives: 1) the reduction or elimination of threats to the spotted frog and its habitat to the extent that extinction of Utah populations is unlikely; and 2) the long-term maintenance of spotted frog populations throughout its historical range in Utah (Perkins and Lentsch 1998). Recent declines of amphibians worldwide warrant the implementation of long-term monitoring and inventories (Stebbins and Cohen 1995). A vital component of the SFCAS is population monitoring in conjunction with habitat and population enhancement activities.

The SFCAS describes spotted frog Geographic Management Units (Sevier River, Wasatch Front, and West Desert; Perkins and Lentsch 1998) based on hydrologic subregions (United States Geological Survey 1974). Spotted frog monitoring locations in the West Desert include: Snake Valley, Tule Valley, and Ibapah Valley. This report summarizes monitoring efforts within Tule Valley and portions of Snake Valley (Bishop Springs and Gandy Marsh). The populations in Ibapah Valley, and Miller Spring and Leland Harris Springs in Snake Valley, are currently monitored by the Central Region of the UDWR, and are not discussed here. Bishop Springs, the largest of the areas, contains four springs which feed into confined, fast-flowing streams that spread into numerous channels and large, shallow, open water marshes (Figure 1). Gandy Marsh consists of numerous spring heads and associated marshes along the western edge of Gandy Salt Lake (Figure 2). Tule Valley contains 13 individual springs that comprise four geographically isolated marsh complexes (Figure 3). The northern-most marsh complex in Tule Valley is Coyote Springs (Tule 7), whereas South Tule Spring (Tule 6) is the southern-most complex. The Willow Springs complex consists of Tule 1, Tule 2, and Tule 8, and the North Tule Spring complex contains Tule 3, Tule 4a, Tule 4b, Tule 4c, and Tule 5. Spotted frog reproduction in Tule Valley is monitored within each of these

individual springs.

METHODS

Spotted frog surveys in spring 2004 were conducted at Bishop Springs, Gandy Marsh, and Tule Valley. Monitoring sites were selected based on historical records and previous annual population monitoring (James et al. 1998, Fridell et al. 2001, Fridell et al. 2003, Wheeler et al. 2003a, Wheeler et al. 2003b). In addition, United States Geological Survey 7.5 minute topographic maps and Geographical Positioning System (GPS) units were used to locate habitat areas and plot UTM coordinates.

Visual encounter surveys were conducted at each site by walking transects along the banks and in shallow water searching for egg clusters, defined as egg masses located in close proximity to one another. The following assessments were made at each egg cluster: egg mass age class, number of masses, egg mass depth, egg mass distance to shore, water temperature, pH, conductivity, and dissolved oxygen. Water temperature, dissolved oxygen, and conductivity measurements were taken using model 55 YSI and 85 YSI units and pH was measured with a pHTestr2. Snout vent length (SVL) was recorded for all amphibians captured. Dead spotted frogs were salvaged and stored in 95% ethanol for histological analysis. Physical habitat parameters taken at each site included elevation, percent of open water, substrate, bank type and condition, livestock damage, algal abundance, and aquatic flora present.

Sites were visited weekly to locate new egg masses, track survival of previously encountered masses, and ensure that monitoring was conducted during the peak period of egg deposition. Masses were classified into five developmental age class categories: age class-1) mass below water surface and resting on substrate or vegetation, envelopes clear and ova small, dark, and circular; age class-

2) mass starting to float to surface, envelopes opaque and ova kidney-shaped or elongated; age class-3) mass at water surface with top layer of eggs crusty due to desiccation, embryos have tails and are close to hatching; age class-3+) mass starting to disarticulate and often yellow in color, half or more of the embryos have hatched and are feeding on the mass or swimming freely as tadpoles; and dead) embryos white, with disarticulation of both the embryos and the egg mass.

Egg mass counts were used to determine relative abundance and to estimate the number of breeding adults in the population. If individual breeding adults oviposit or fertilize exactly one egg mass per year (Wells 1977) and each egg mass is the product of a single breeding pair, then doubling the number of egg masses deposited during a single breeding season can provide an approximation of breeding population size ($\widehat{N}$). Breeding population size was calculated to facilitate comparison with geographic management subunit population goals in the SFCAS (Perkins and Lentsch 1998).

RESULTS

Spotted frog annual monitoring sites in the West Desert were surveyed between March 23 and April 1, 2004. The total number of egg masses detected within each area (Bishop Springs, n = 213; Gandy Marsh, n =131; and Tule Valley, n =1,326) is presented in Table 1. Table 2 contains the number of egg masses observed at each site annually since 1997. Adult spotted frogs were observed within all monitoring areas. Adult and juvenile leopard frogs were encountered in Snake Valley at Bishop Springs and Gandy Marsh. Bullfrogs were observed at Bishop Springs, and, although bullfrog tadpoles were observed at Gandy Marsh on August 21, 2002, no adult bullfrogs or bullfrog tadpoles have been observed since. Age class breakdown of egg masses, water quality parameters, habitat conditions, and observations for Bishop Springs, Gandy Marsh, and Tule Valley follow.

Bishop Springs

Bishop Springs was visited on March 25th and April 1st, 2004. A total of 213 egg masses were observed (Table 1). Egg masses were first observed on March 25th, with 202 masses, composed of age classes 1-3. Peak egg deposition had already occurred by then. Egg mass numbers observed at Bishop Springs are lower than 2003, but similar to previous years (Table 2, Figure 4).

Mean depth of egg masses observed in Bishop Springs was 4.8 cm (SE = 0.13) with a mean distance to shore of 5.02 meters (SE = 0.19). Mean water temperature was 14.0 ^{o}C (SE = 0.24), and mean pH was 7.6 (SE = 0.01). Mean conductivity was 913 FS (SE = 33.6) and mean dissolved oxygen measured 7.06 mg/L (SE = 0.14). Table 4 and Figures 5-10 contain spotted frog egg mass characteristics and water parameters recorded at Bishop Springs.

The majority of egg masses were located in still, shallow marsh areas. No egg masses were found in areas with fast moving water. One adult spotted frog was observed at Bishop Springs. Leopard frogs were observed throughout Bishop Springs. Leopard frog and spotted frog egg mass deposition temporally overlapped in an area of Bishop Springs near Foote Reservoir. Heavy cattle damage was observed throughout Bishop Springs, and was characterized by cropped and trampled vegetation, trampled banks, and manure. There was also a decrease in water flow observed during the monitoring period which left many of the more shallow areas recently dry.

Gandy Marsh

Gandy Marsh was visited on March 24th and March 30th, 2004. A total of 131 egg masses were observed during the survey period (Table 1). The total numbers of egg masses observed

annually since 1997 are presented in Table 2 and Figure 11.

Mean water depth of egg masses at Gandy was 4.5 cm (SE = 0.28) and mean distance to shore was 11.2 meters (SE = 0.75). Mean water temperature near egg masses was 15.6 ^{o}C (SE = 0.31) and mean pH was 7.6 (SE = 0.02). Mean conductivity measured 597 FS (SE = 15.5) and mean dissolved oxygen was 6.10 mg/L (SE = 0.22). Spotted frog egg mass characteristics and water quality parameters recorded at Gandy Marsh are presented in Table 4 and Figures 11-17.

Four adult spotted frogs were observed during the monitoring period at Gandy. One spotted frog was observed in amplexus with an adult leopard frog on March 24th. Numerous leopard frogs were observed and heard calling throughout the monitoring period. Leopard frog egg masses were observed near spotted frog egg masses on several occasions, with temporally overlapping development.

Tule Valley

Tule Valley was visited on March 22nd and March 23rd, 2004. A total of 1,326 egg masses were recorded (Table 1). The first egg masses were detected on March 22 in Tule 7 (Coyote Springs), and represented all age classes. The total number of egg masses observed in Tule Valley are shown in Table 2 and Figure 18.

Tule Valley egg masses were located at a mean depth of 3.65 cm (SE = 0.05) and a mean distance to shore of 4.07 meters (SE = 0.09). Mean water temperature at egg masses was 16.2 ^{o}C (SE = 0.13). Water pH averaged 7.9 (SE = 0.01). Mean conductivity near egg masses was 1,678 FS (SE = 18.3), and dissolved oxygen averaged 8.86 mg/L (SE = 0.11). Spotted frog egg mass characteristics and water quality parameters measured in Tule Valley are presented in Tables 4 and 5 and Figures 19-24.

Many spotted frogs were observed or heard calling during the monitoring period at Tule Valley. The majority of egg masses were observed at Tule 7 (Coyote Springs: 78 %, n = 1,036; Table 3). No egg masses were found at Tule 8, likely due to the spring being filled with dense vegetation. Livestock damage was moderate in Tule 3, 4a, 4b, and 5 and was characterized by cropped and trampled vegetation, damaged banks and substrate, and manure.

SUMMARY AND CONCLUSIONS

Bishop Springs

- A total of 213 spotted frog egg masses were observed during spring 2004 monitoring (Table 1).
- The estimated spotted frog breeding population size ($\widehat{N}$ = 426) at Bishop Springs is below the SFCAS target level of 1000.
- The number of spotted frog egg masses observed in 2004 is the second lowest recorded since standard monitoring began (Table 2, Figure 4).
- The long-term viability of the Bishop Springs spotted frog population is threatened by habitat degradation from livestock grazing and de-watering due to diversion of the Foote Reservoir outflow.

Gandy Marsh

- The total number of spotted frog egg masses counted during spring 2004 monitoring was 131 (Table 2).
- The estimated spotted frog breeding population size ($\widehat{N}$ = 262) at Gandy Marsh is below the SFCAS target level of 1000.
- Numbers of egg masses observed at Gandy are comparable to numbers observed in 2002 and 2003 (Table 2, Figure 11).
- There was extensive overlap in spotted and leopard frog egg deposition timing. In addition high numbers of juvenile and adult leopard frogs were observed at Gandy Marsh. Ranid species interactions should be monitored at the Gandy Marsh to evaluate potential adverse

impacts to spotted frogs.

Tule Valley

- A total of 1,326 spotted frog egg masses were documented during spring 2004 monitoring (Table 1).

- The estimated spotted frog breeding population size ($\widehat{N}$ = 2,652) in Tule Valley currently exceeds the SFCAS target of 1000.

- The spring 2004 egg mass total is the lowest observed in Tule Valley since 1999 (Table 2, Figure 18).

- Egg masses at Tule 7 (Coyote Springs) comprised 78% of all egg masses observed in Tule Valley (n = 1,036); no egg masses were observed in Tule 8 (Table 3).

- The Tule Valley spotted frog population is currently stable, however spotted frog breeding habitat could be vulnerable to succession of spring complexes and livestock grazing impacts.

LITERATURE CITED

Dumas, P.C. 1966. Studies of the *Rana* species complex in the Pacific Northwest. Copeia 1966: 60-74.

Fridell, R.A., M.A. Webb, K.L. Smith, E.P. Bixler. 2001. Columbia spotted frog (*Rana luteiventris*) population monitoring summary: Gandy, Bishop Springs, Tule Valley 2000. Utah Division of Wildlife Resources Publication Number 01-19. 23 pp.

Fridell, R.A., K.K. Wheeler, M.G. Harker, D.M. Manske. 2003. Columbia spotted frog (*Rana luteiventris*) population monitoring summary: Gandy, Bishop Springs, Tule Valley 2001. Utah Division of Wildlife Resources Publication Number 03-07. 23 pp.

Hovingh, P. 1993. Aquatic habitats, life history observations, and zoogeographic considerations of the spotted frog (*Rana pretiosa*) in Tule Valley, Utah. Great Basin Naturalist 53(2): 168-179.

James, S.M., T.E. Anderson, K.M. Comella, and R.A. Fridell. 1998. Spotted frog monitoring, West Desert, Utah, 1998. Utah Division of Wildlife Resources.

Perkins, M.J. and L.D. Lentsch. 1998. Conservation Agreement and Strategy for spotted frog (*Rana luteiventris*) in the State of Utah. Utah Division of Wildlife Resources Publication Number 98-24. 71 pp.

Ross, D.A., D.L. Shirley, P.A. White, and L.D. Lentsch. 1993. Distribution of the spotted frog along the Wasatch Front in Utah, 1991-1992. Utah Division of Wildlife Resources Publication Number 93-4. 24 pp.

Ross, D.A., M.C. Stanger, K.P. McDonald, D.L. Shirley, P.A. White and L.D. Lentsch. 1994. Distribution, habitat use, and relative abundance indices of spotted frogs in the West Desert, Utah, 1993. Utah Division of Wildlife Resources Publication Number 93-15. 29 pp.

Stebbins, R.C. 1985. A field guide to western reptiles and amphibians. Houghton Mifflin Company, NY. 336 pp.

Stebbins, R.C. and N.W. Cohen. 1995. A natural history of amphibians. Princeton University Press. Princeton, N.J. 316 pp.

United States Fish and Wildlife Service. 1998. Endangered and threatened wildlife and plants. New

12 month finding for a petition to list the Utah Wasatch Front and West Desert populations of spotted frog. Federal Register 63 (63):16218-16220.

United States Fish and Wildlife Service. 1993. Endangered and threatened wildlife and plants; finding on petition to list the spotted frog. Federal Register 58 (87):27260-27263.

United States Fish and Wildlife Service. 2002. Endangered and threatened wildlife and plants; 12-month finding for a petition to list the Wasatch Front Columbia Spotted Frog as threatened throughout its range. Federal Register 67 (169): 55758-55767.

United States Geological Survey. 1974. Hydrologic Unit Map - 1974 State of Utah.

Wells, K.D. 1977. The social behavior of anuran amphibians. Animal Behavior 25:666-693.

Wheeler, K.K., M.S. Gowans, K.E. Dutcher, and R.A. Fridell. 2003a. Columbia spotted frog (*Rana luteiventris*) population monitoring summary: Gandy, Bishop Springs, Tule Valley 2002. Utah Division of Wildlife Resources Publication Number 03-12. 28 pp.

Wheeler, K.K., R.A. Fridell, K.E. Dutcher, and S.E. Jones. 2003b. Columbia spotted frog (*Rana luteiventris*) population monitoring summary: Gandy, Bishop Springs, Tule Valley 2003. Utah Division of Wildlife Resources Publication Number 03-24. 28 pp.

Wright, A.A. and A.H. Wright. 1995. Handbook of frogs and toads of the United States and Canada. Comstock Publishing Associates, Ithaca, N.Y. 640 pp.

Table 1. Total number of spotted frog egg masses observed by age class in Bishop Springs, Gandy Marsh, and Tule Valley, spring 2004.

Site	AC 1	AC 2	AC 3 & 3+	Dead	Total
Bishop	**75**	**21**	**117**	**0**	**213**
Gandy	**0**	**0**	**130**	**1**	**131**
Tule Valley	**243**	**308**	**561**	**214**	**1,326**

Table 2. Total number of spotted frog egg masses found in Bishop Springs, Gandy Marsh, and Tule Valley for the years 1997 - 2004.

Site	Bishop	Gandy	Tule Valley
1997	**not surveyed**	**406+**	**1,451**
1998	**275**	**1,545**	**441**
1999	**274**	**672**	**1,220**
2000	**241**	**784**	**1,631**
2001	**201**	**585**	**2,072**
2002	**357**	**90**	**2,203**
2003	**615**	**115**	**3,870**
2004	**213**	**131**	**1,326**

Table 3. Total number of spotted frog egg masses observed by age class (AC) at individual springs

in Tule Valley, spring 2004.

Site	AC 1	AC 2	AC 3 & 3+	Dead	Total
Tule 1	1	0	62	0	63
Tule 2	0	0	45	0	45
Tule 3	0	0	38	0	38
Tule 4A	0	0	49	1	50
Tule 4B	0	0	18	0	18
Tule 5	1	8	45	19	73
Tule 6	1	0	1	1	3
Tule 7	240	300	303	193	1,036
Tule 8	*	*	*	*	*
Tule Valley	243	308	561	214	1,326

*** No egg masses were found at this site during spring 2004 monitoring.**

Table 4. Mean and standard error of spotted frog egg mass depth and distance to shore, water temperature, pH, conductivity, and dissolved oxygen (D.O.) measurements recorded during spotted frog monitoring at Bishop Springs, Gandy Marsh, and Tule Valley, spring 2004.

		Egg Mass Depth (cm)	Egg Mass Distance to Shore (m)	Temperature (EC)	pH	Conductivity (FS)	D.O. (mg/L)
Bishop	0	4.8	5.02	14.0	7.6	913	7.06
	se=	0.13	0.19	0.24	0.01	33.6	0.14
	n=	213	213	213	213	107	213
Gandy	0	4.5	11.2	15.6	7.6	597	6.10
	se=	0.28	0.75	0.31	0.02	15.5	0.22
	n=	131	131	131	108	78	131
Tule Valley	0	3.65	4.07	16.2	7.9	1678	8.86
	se=	0.05	0.09	0.13	0.01	18.3	0.11
	n=	1,326	1,326	1324	1,119	407	1,326

Table 5. Mean and standard error of spotted frog egg mass depth and distance to shore, water temperature, pH, conductivity and dissolved oxygen (D.O.) measurements recorded during spotted frog monitoring at individual springs in Tule Valley, spring 2004.

		Egg Mass Depth (cm)	Egg Mass Distance to Shore (m)	Temperature (EC)	pH	Conductivity (FS)	D.O. (mg/L)
Tule 1	0	**2.11**	**5.93**	**21.2**	**7.6**	*	**10.4**
	se=	**0.11**	**0.20**	**0.26**	**0.01**	*	**0.38**
	n=	**63**	**63**	**63**	**63**	*	**63**
Tule 2	0	**1.23**	**7.29**	**23.8**	**7.8**	*	**9.41**
	se=	**0.08**	**0.23**	**0.03**	**0.03**	*	**0.52**
	n=	**45**	**45**	**45**	**45**	*	**45**
Tule 3	0	**8.12**	**6.23**	**10.3**	**8.08**	**1142**	**9.06**
	se=	**0.66**	**0.33**	**0.12**	**0.01**	**.06**	**0.04**
	n=	**38**	**38**	**38**	**38**	**38**	**38**
Tule 4A	0	**3.56**	**4.6**	**22.9**	**8.4**	**1529**	**10.8**
	se=	**0.37**	**0.25**	**0.14**	**0.03**	**5.23**	**0.38**
	n=	**50**	**50**	**50**	**50**	**50**	**50**
Tule 4B	0	**2.15**	**6.13**	**21.2**	**7.9**	**1504**	**5.68**
	se=	**0.06**	**0.00**	**0.00**	**0.00**	**0.00**	**0.08**
	n=	**18**	**18**	**18**	**18**	**18**	**18**
Tule 5	0	**3.38**	**5.17**	**20.8**	**7.99**	**1513**	**11.2**
	se=	**0.06**	**0.13**	**0.23**	**0.03**	**11.98**	**0.59**
	n=	**73**	**73**	**73**	**73**	**73**	**73**
Tule 6	0	**2.33**	**4.7**	**22.7**	**7.4**	*	**6.54**
	se=	**0.67**	**1.4**	**0.9**	**0.03**	*	**3.8**
	n=	**3**	**3**	**3**	**3**	*	**3**

Table 5. (Continued)

		Egg Mass Depth (cm)	Egg Mass Distance to Shore (m)	Temperature (EC)	pH	Conductivity (FS)	D.O. (mg/L
Tule 7	**0**	**3.97**	**3.47**	**14.5**	**7.9**	**1782**	**8.4**
	se=	**0.06**	**0.10**	**0.11**	**0.01**	**29.8**	**0.12**
	n=	**1,036**	**1,036**	**1.034**	**829**	**236**	**1,036**
Tule 8	**0**	‡	‡	‡	‡	‡	‡
	se=	‡	‡	‡	‡	‡	‡
	n=	**0**	**0**	**0**	**0**	**0**	**0**
Tule Valley	**0**	**3.66**	**4.07**	**16.2**	**7. 9**	**1677**	**8.86**
	se=	**0.05**	**0.09**	**0.13**	**0.01**	**18.3**	**0.11**
	n=	**1,326**	**1,326**	**1,324**	**1,119**	**407**	**1,326**

*** Conductivity not recorded at these sites during 2004**

‡ No egg masses were found at this site; habitat parameters were not taken.

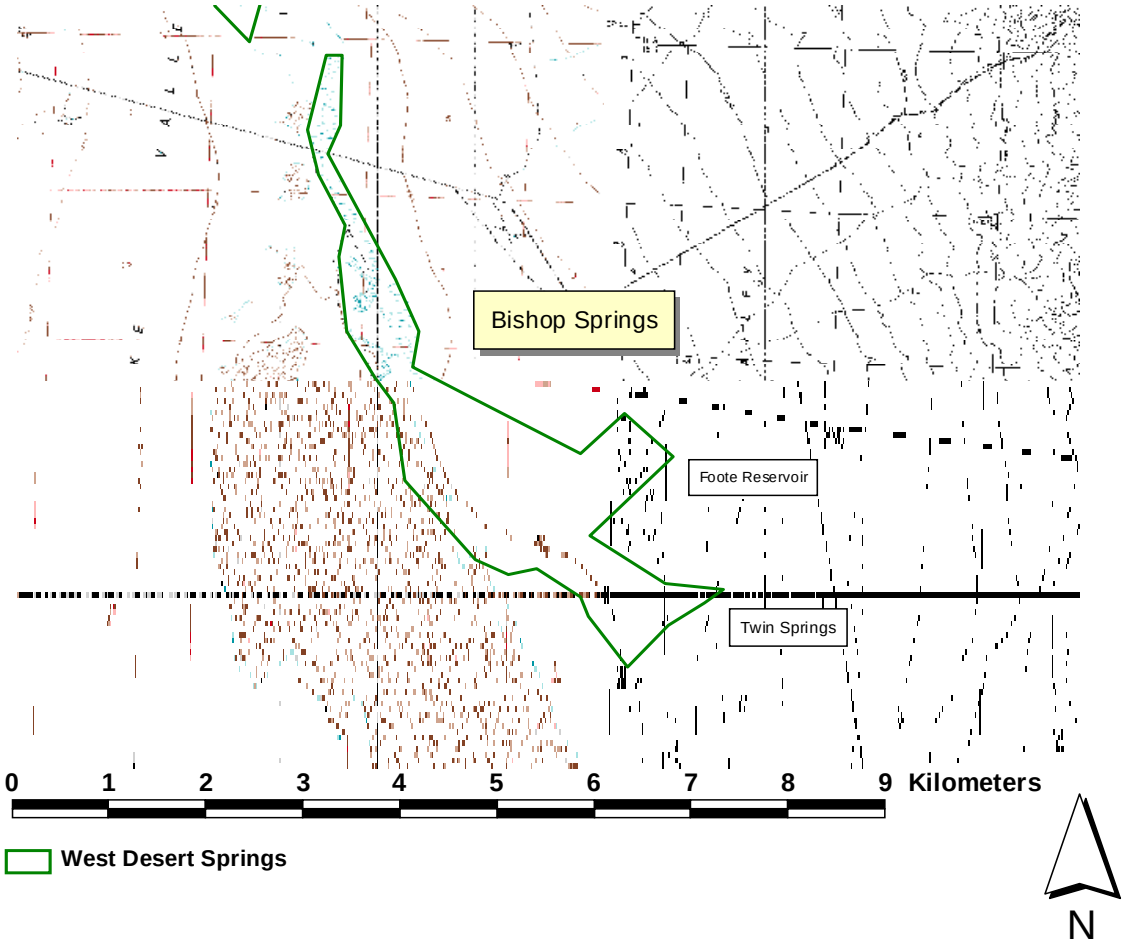

Figure 1. Location of Bishop Springs, Snake Valley, Utah. Gandy Quadrangle, 7.5 minute series, 1:25,000 Scale.

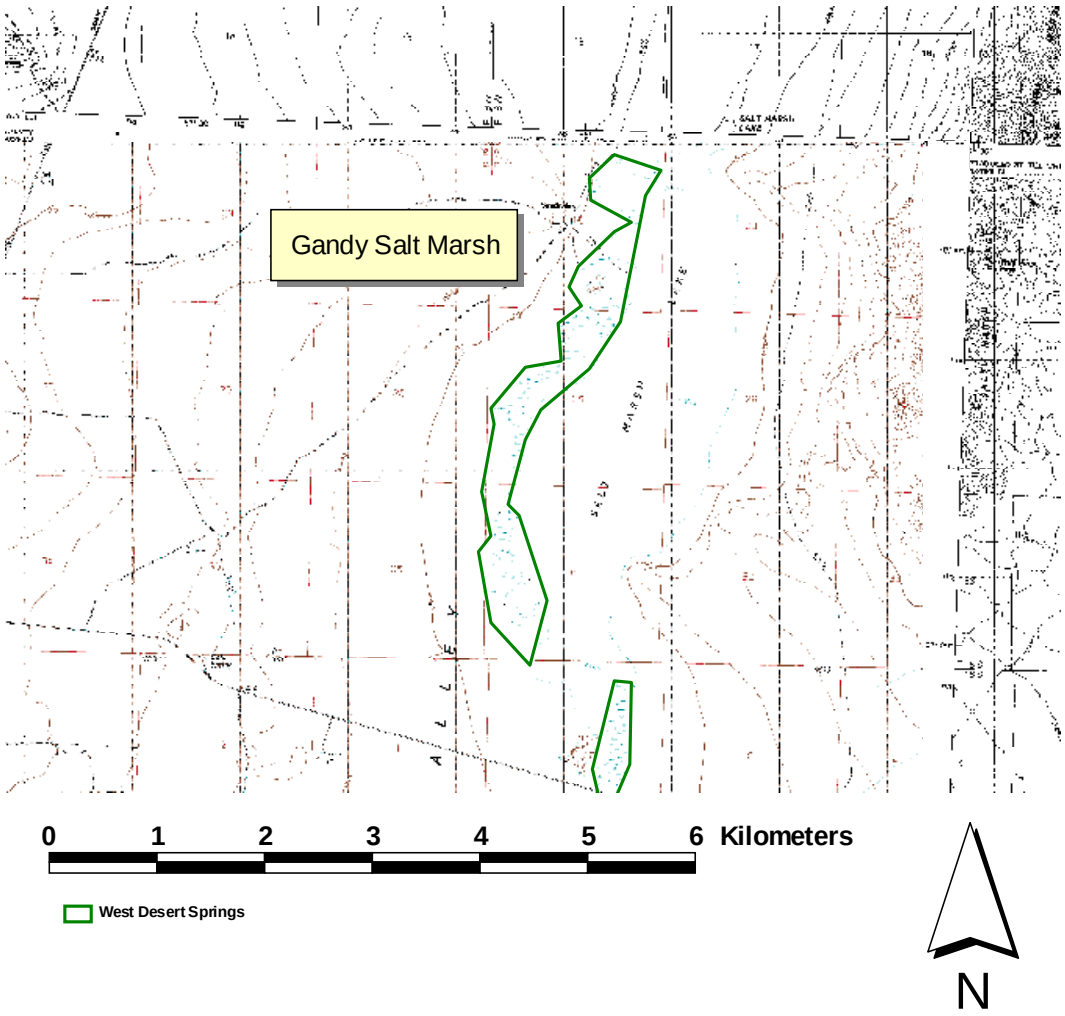

Figure 2. Location of Gandy Marsh, Snake Valley, Utah. Gandy Quadrangle, 7.5 minute series, 1:25,000 Scale.

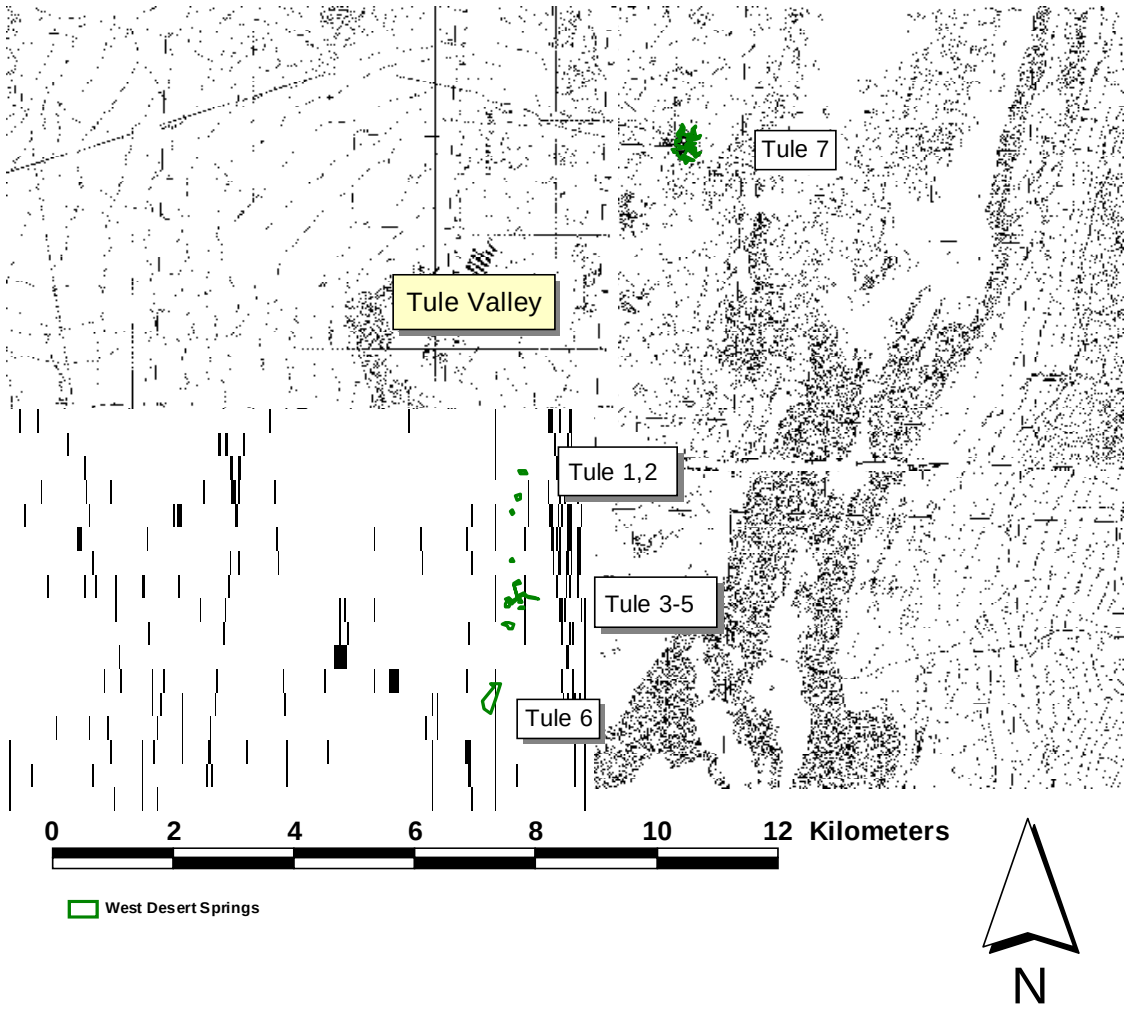

Figure 3. Location of Tule Valley, Utah. Chalk Knolls and Coyote Knolls Quadrangles, 7.5 minute series, 1:25,000 Scale.

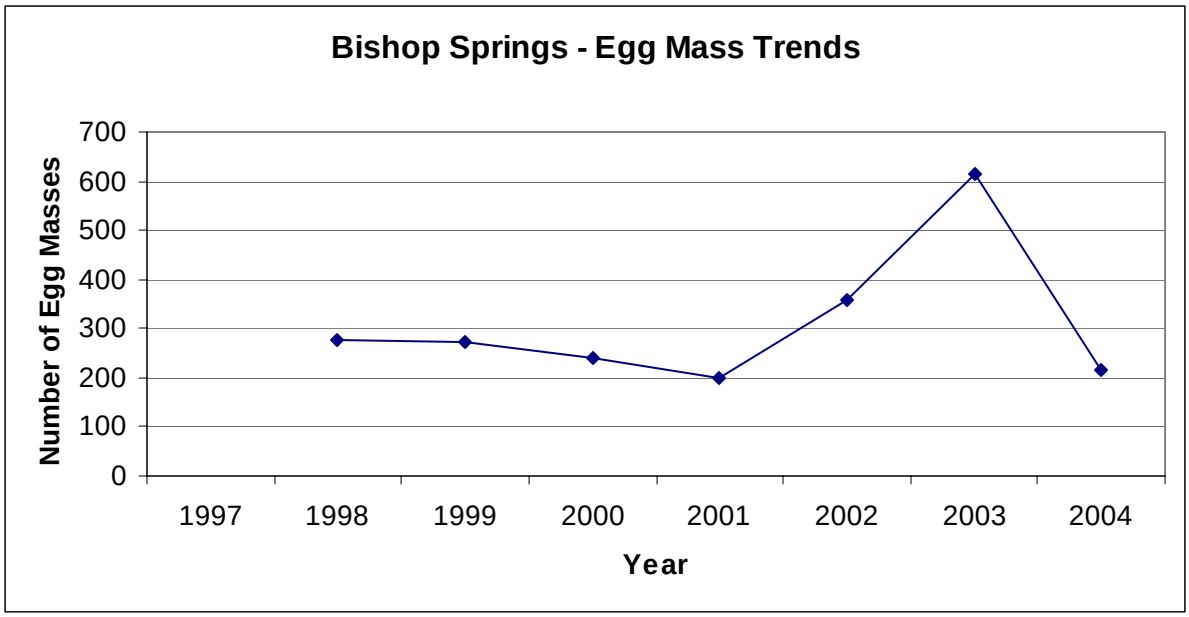

Figure 4. Number of spotted frog egg masses observed during annual monitoring from 1998 to 2004 at Bishop Springs, Utah.

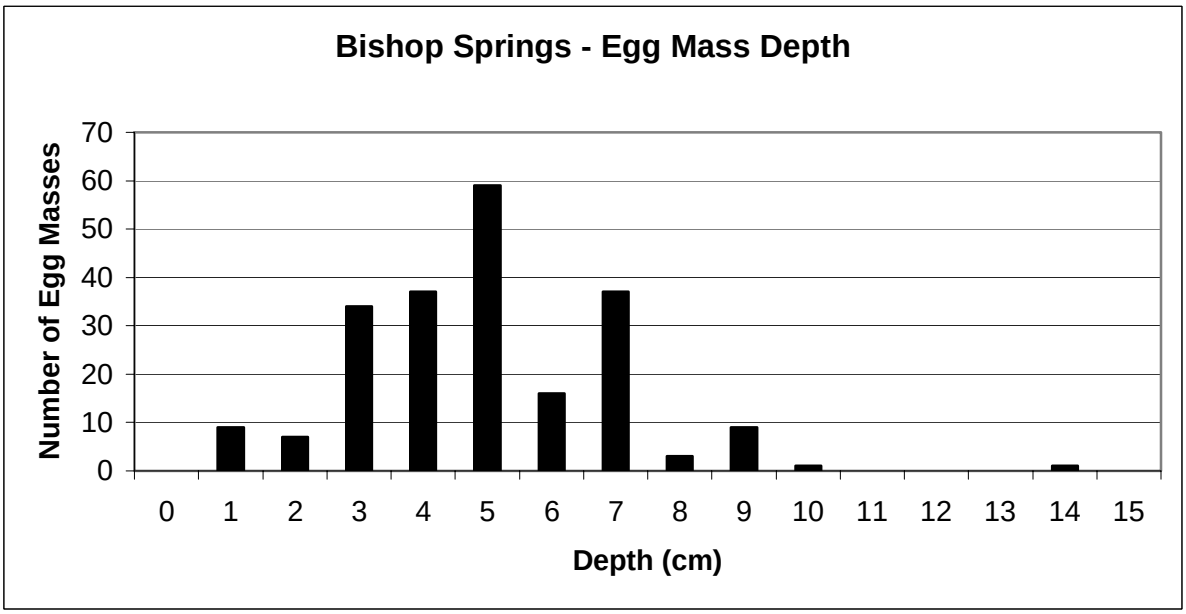

Figure 5. Depth (cm) of spotted frog egg masses measured during monitoring at Bishop Springs, Utah, spring 2004.

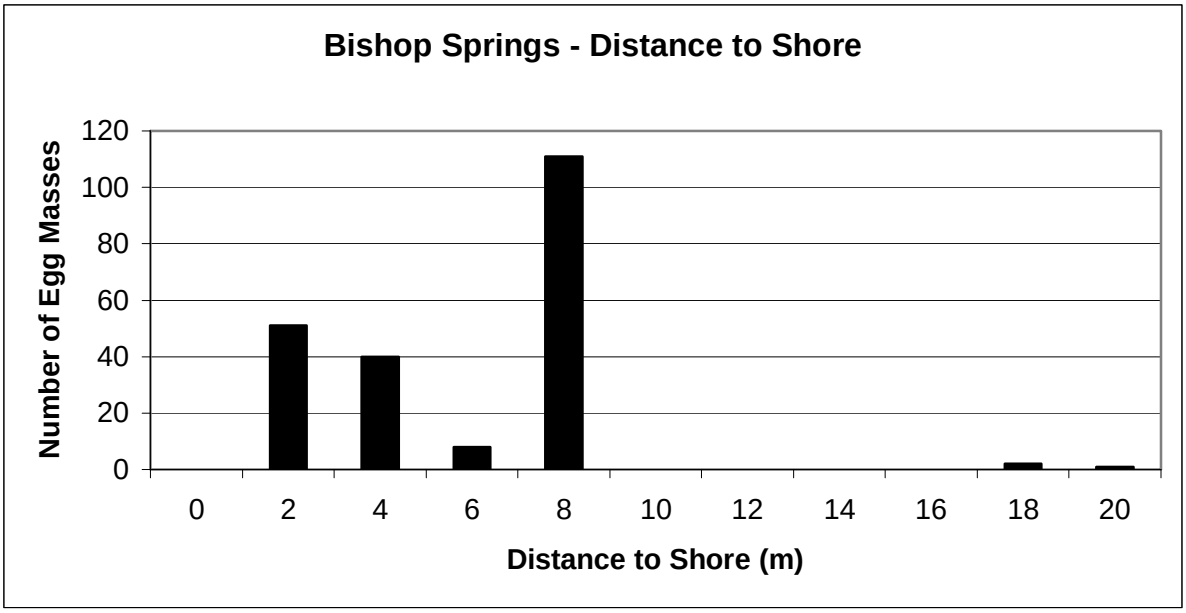

Figure 6. Distance to shore (m) of spotted frog egg masses observed during monitoring at Bishop Springs, Utah, spring 2004.

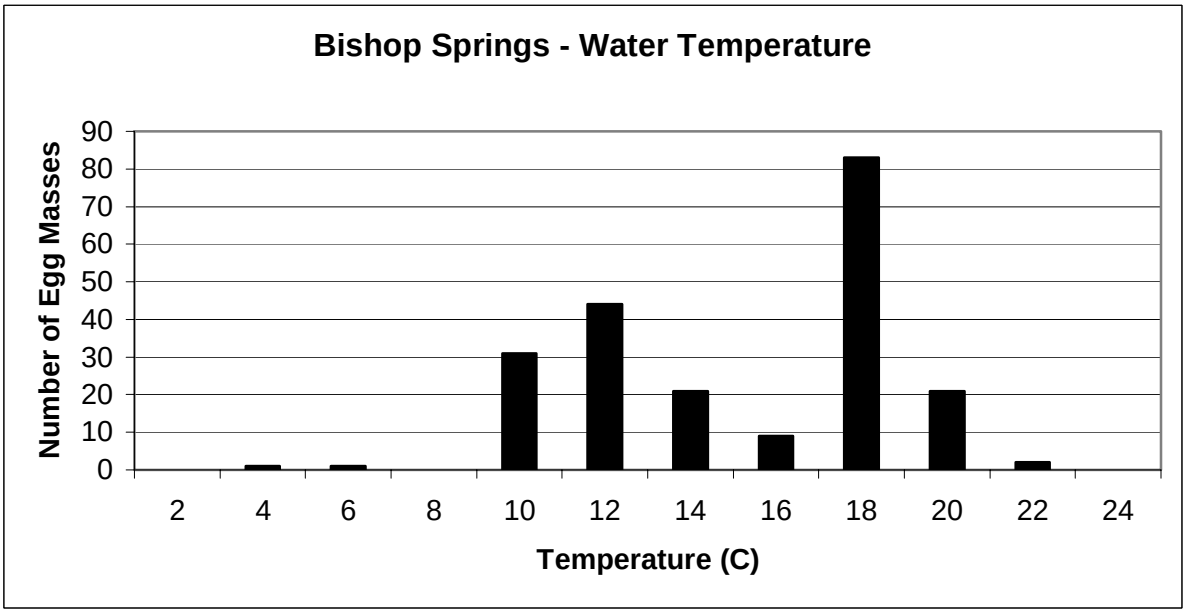

Figure 7. Temperature (^{o}C) measured at spotted frog egg masses during monitoring at Bishop Springs, Utah, spring 2004.

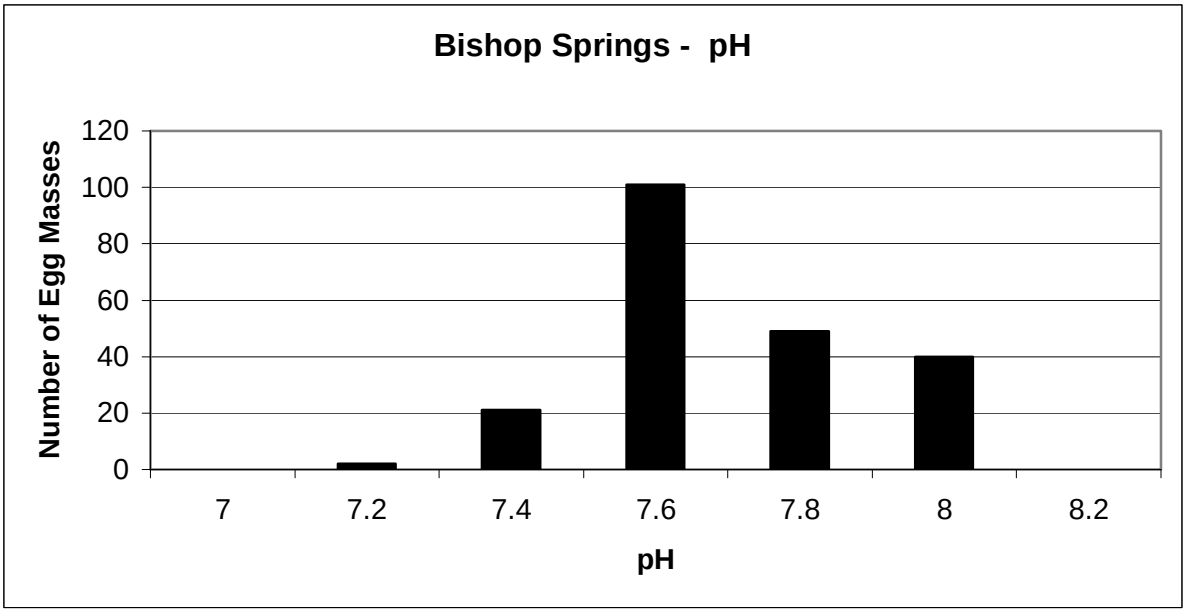

Figure 8. pH recorded at spotted frog egg mass clusters during monitoring at Bishop Springs, Utah, spring 2004.

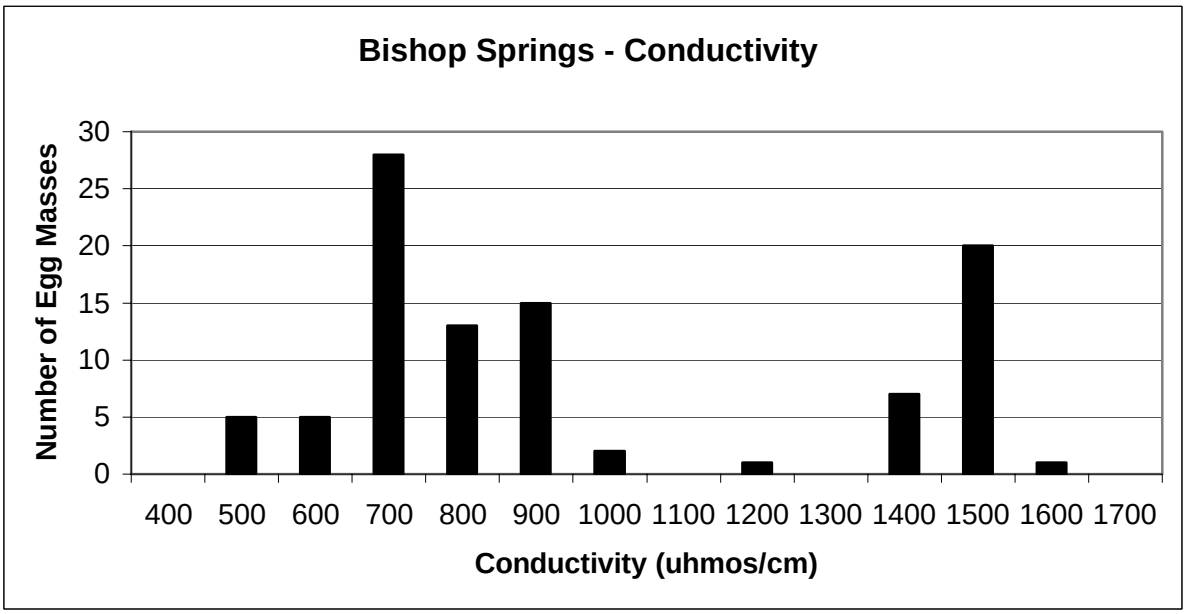

Figure 9. Conductivity (umhos/cm) measured at spotted frog egg masses during monitoring at Bishop Springs, Utah, spring 2004.

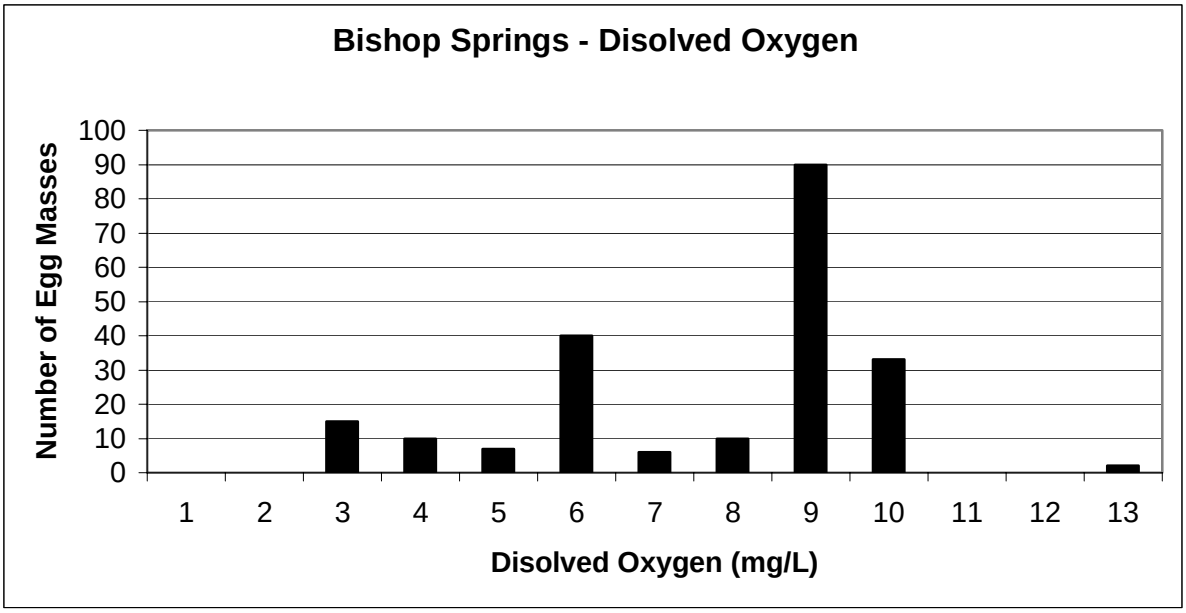

Figure 10. Dissolved oxygen (mg/L) measured at spotted frog egg masses during monitoring at Bishop Springs, Utah, spring 2004.

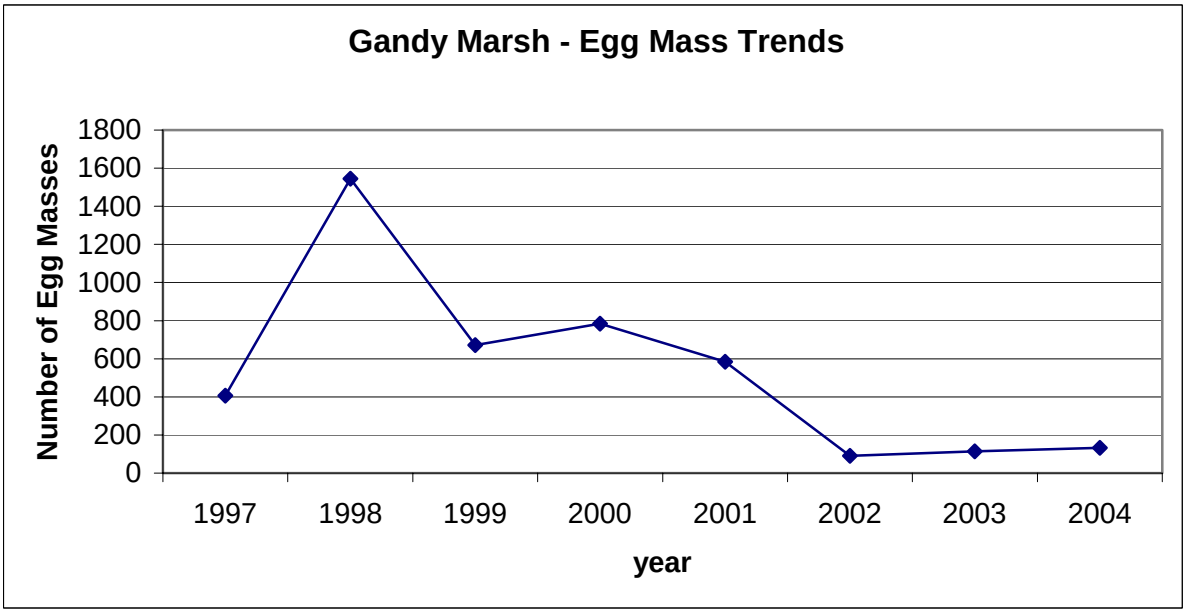

Figure 11. Number of spotted frog egg masses observed during annual monitoring from 1997 to 2004 at Gandy Marsh, Utah.

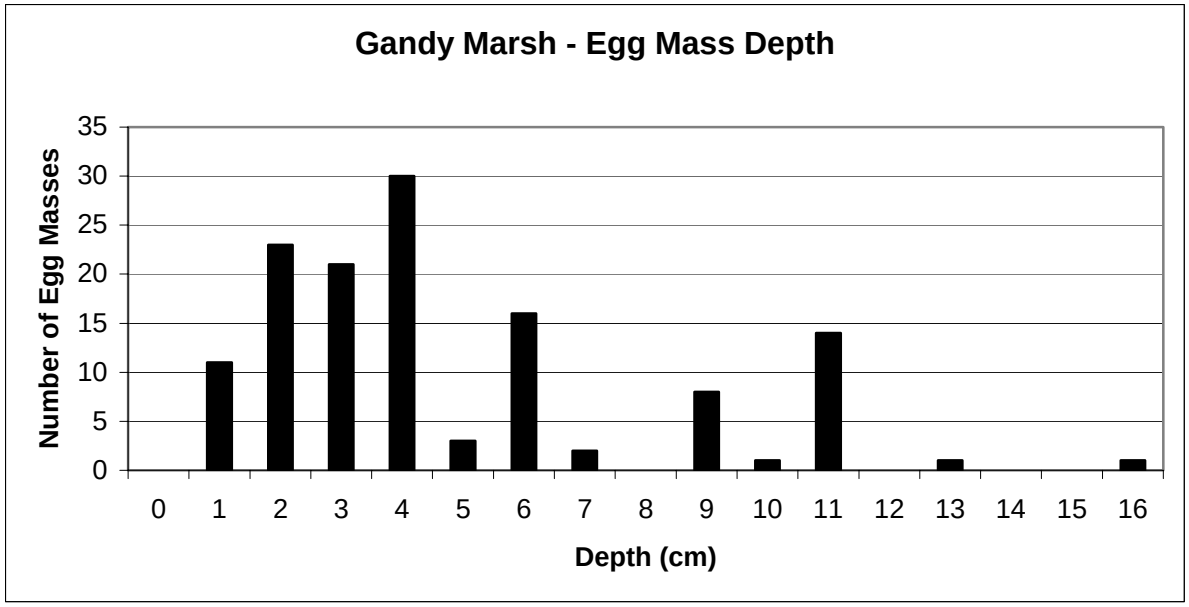

Figure 12. Depth (cm) of spotted frog egg masses observed during monitoring at Gandy Marsh, Utah, spring 2004.

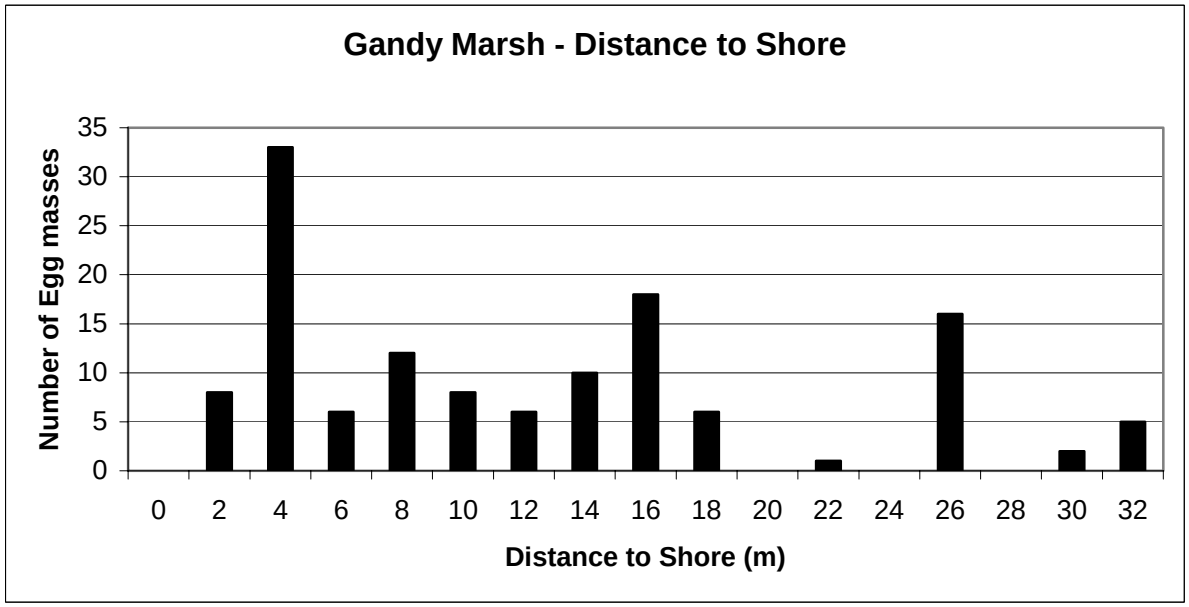

Figure 13. Distance to shore (m) of spotted frog egg masses observed during monitoring at Gandy Marsh, Utah, spring 2004.

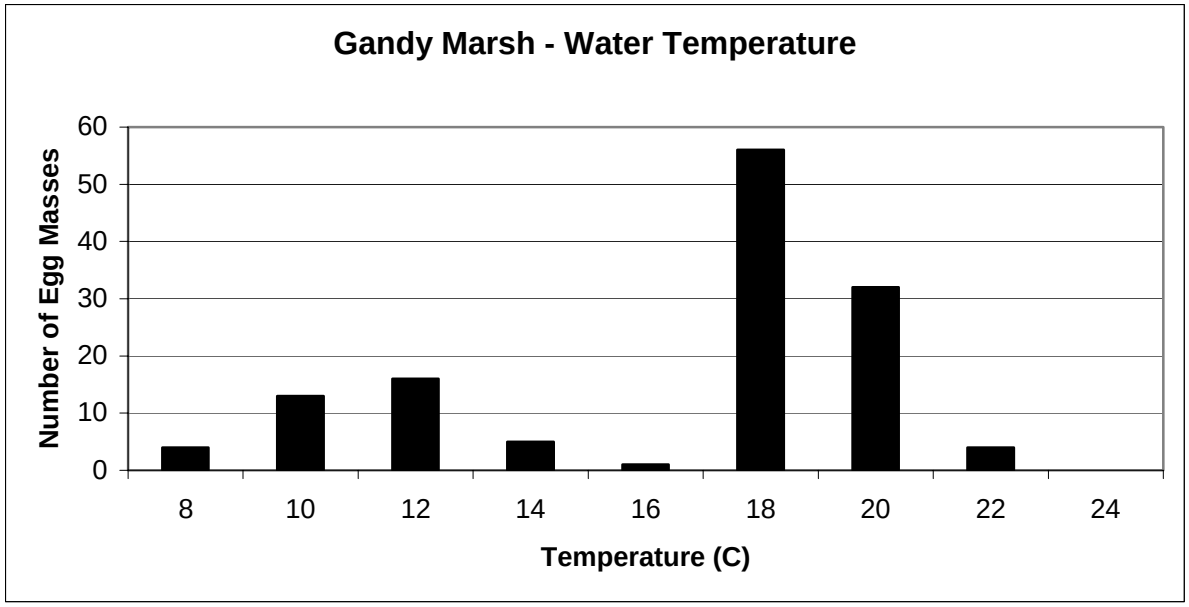

Figure 14. Temperature (^{o}C) measured at spotted frog egg masses during monitoring at Gandy Marsh, Utah, spring 2004.

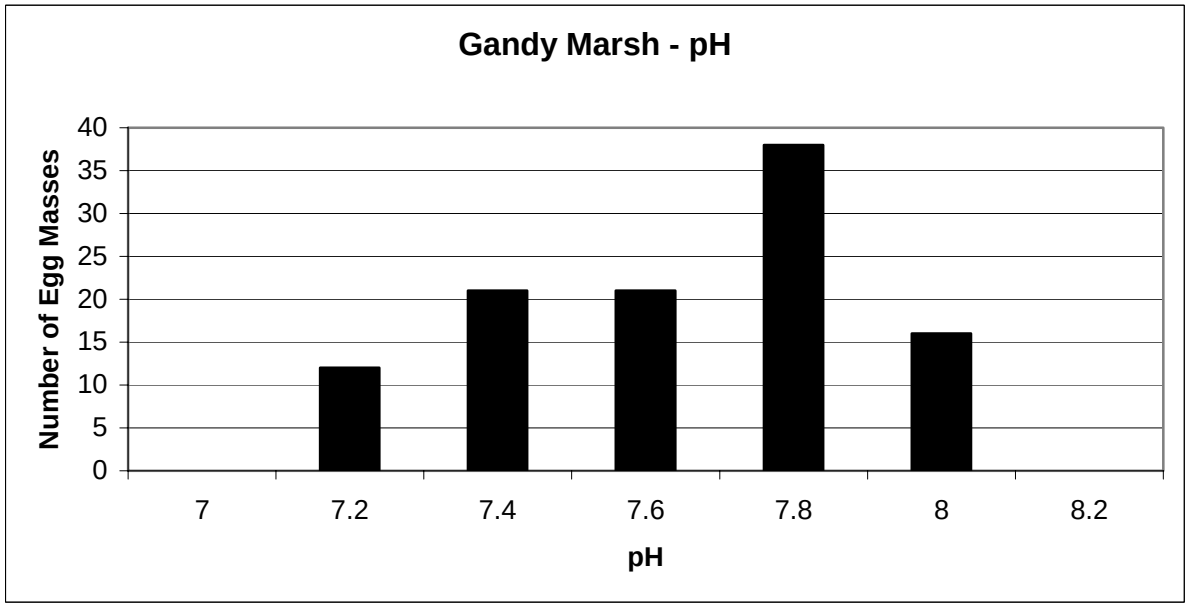

Figure 15. pH recorded at spotted frog egg masses during monitoring at Gandy Marsh, Utah, spring 2004.

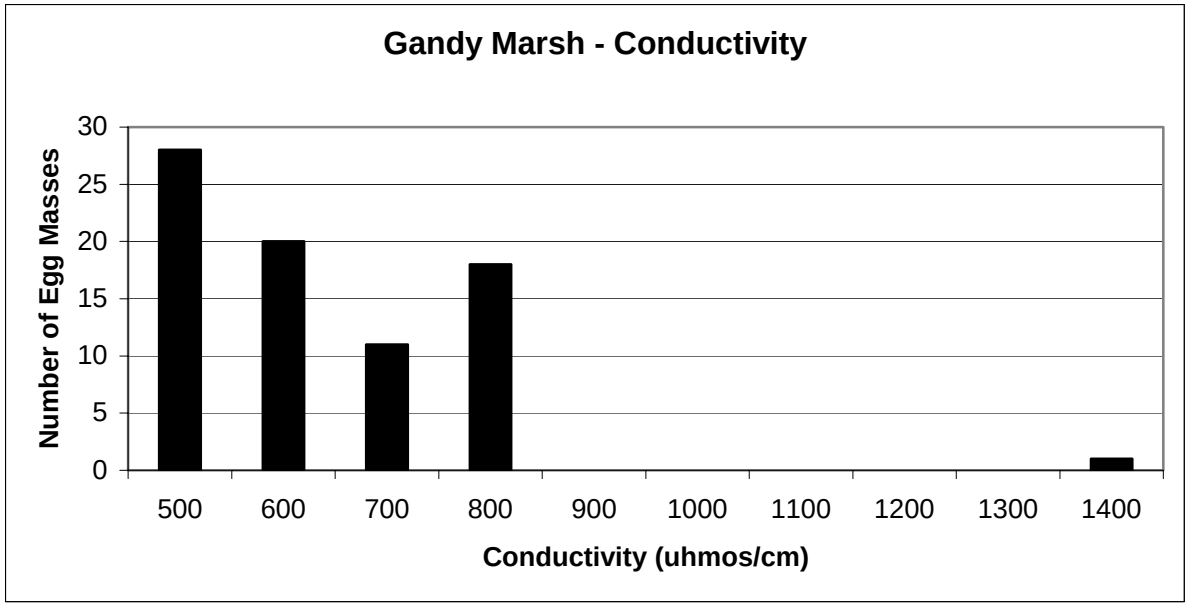

Figure 16. Conductivity (umhos/cm) measured at spotted frog egg masses during monitoring at Gandy Marsh, Utah, spring 2004.

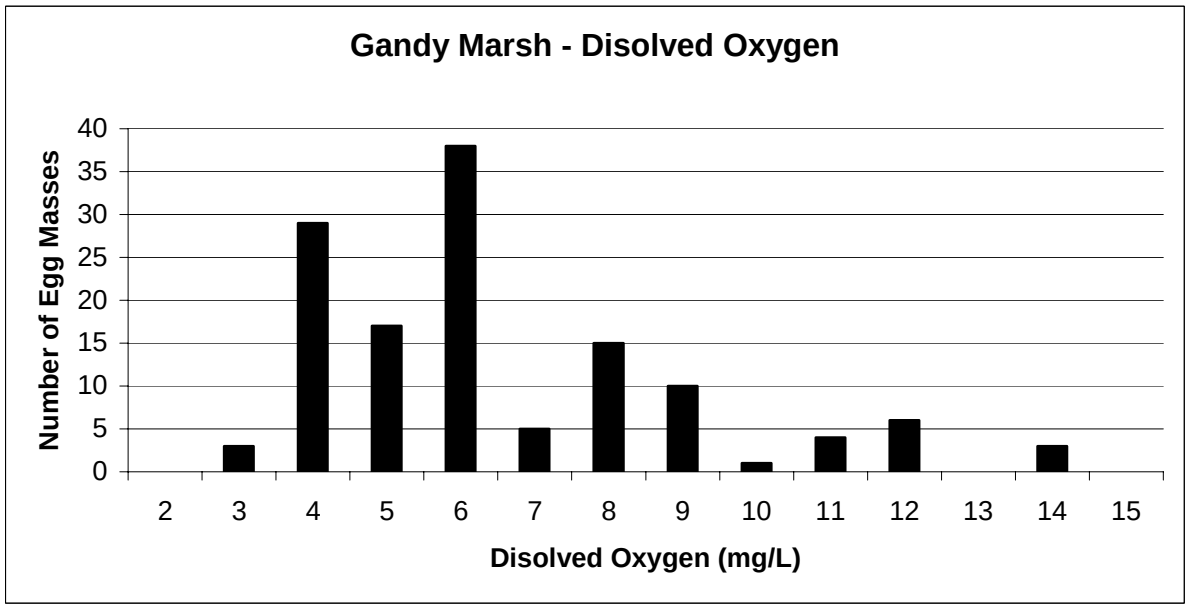

Figure 17. Dissolved oxygen (mg/L) measured at spotted frog egg masses during monitoring at Gandy Marsh, Utah, spring 2004.

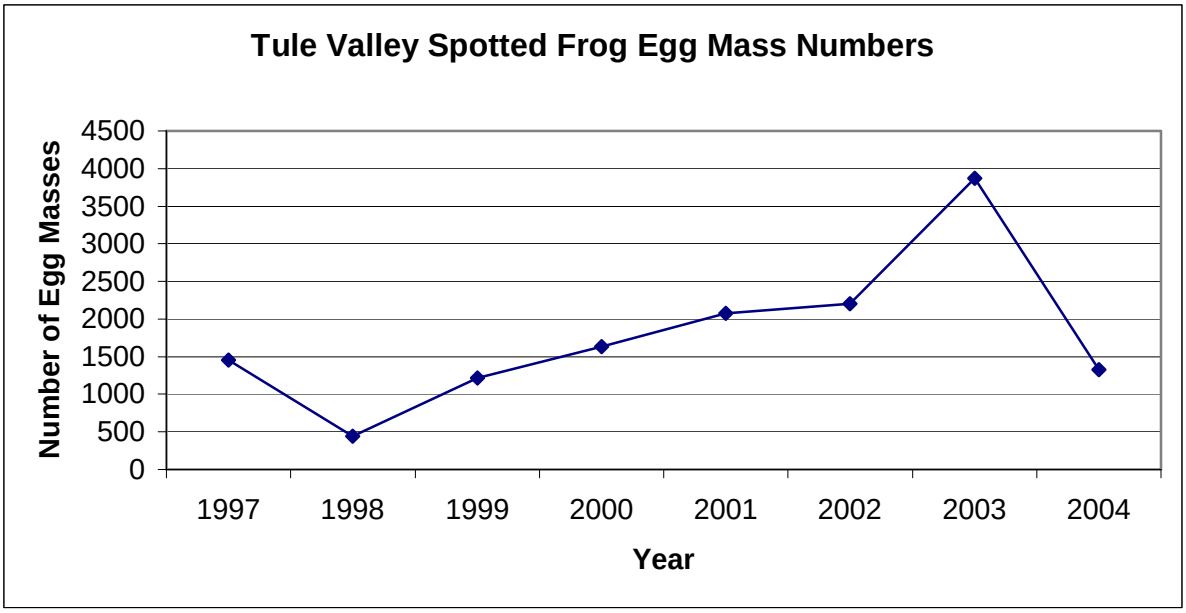

Figure 18. Number of spotted frog egg masses observed during annual monitoring from 1997 to 2004 at Tule Valley, Utah.

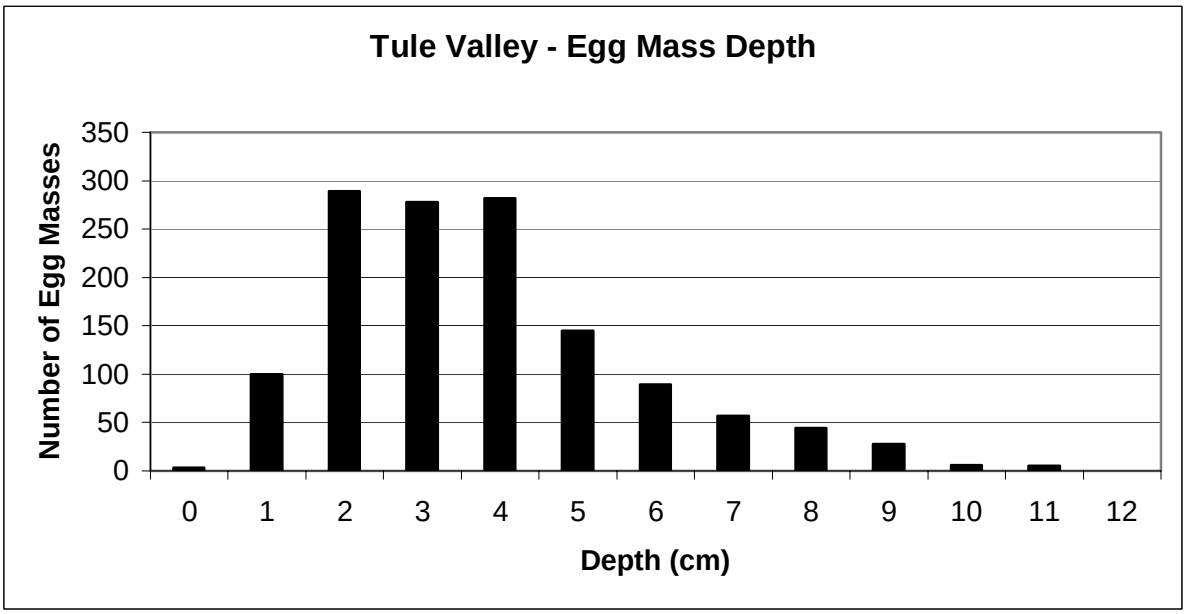

Figure 19. Depth (cm) of spotted frog egg masses observed during monitoring in Tule Valley, Utah, spring 2004.

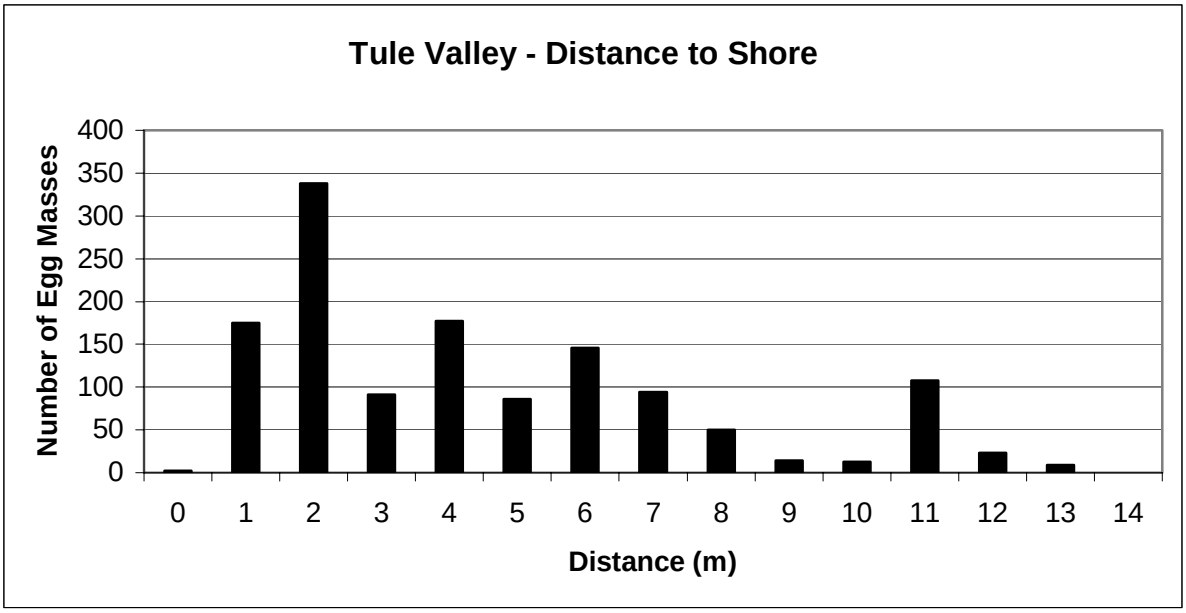

Figure 20. Distance to shore (m) of spotted frog egg masses observed during monitoring in Tule Valley, Utah, spring 2004.

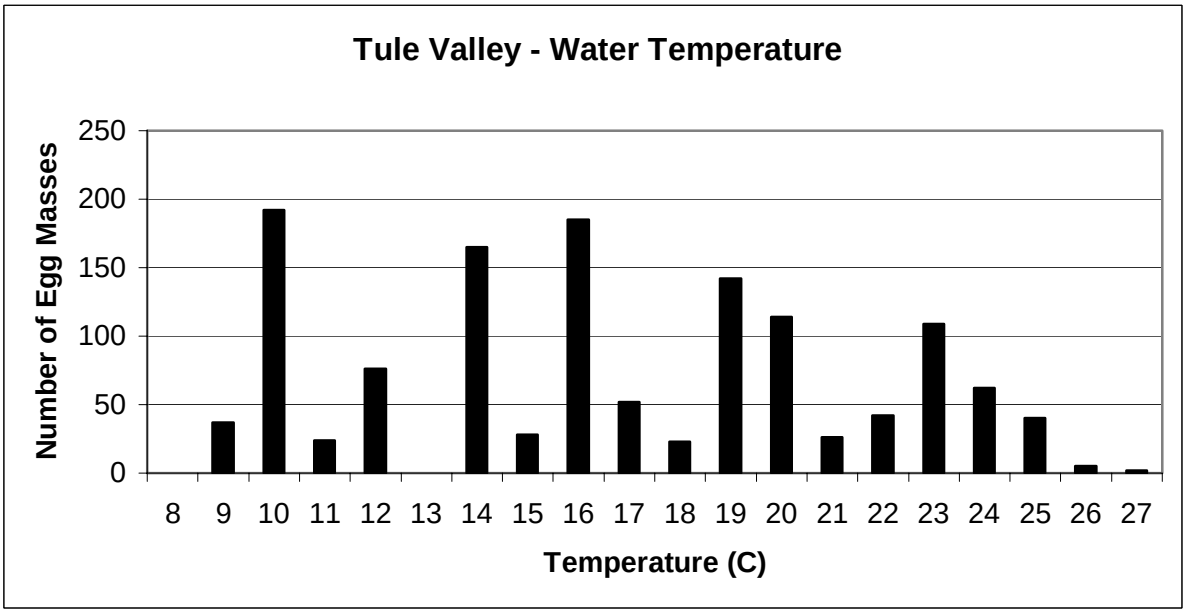

Figure 21. Temperature (^{o}C) measured at spotted frog egg mass clusters during monitoring in Tule Valley, Utah, spring 2004.

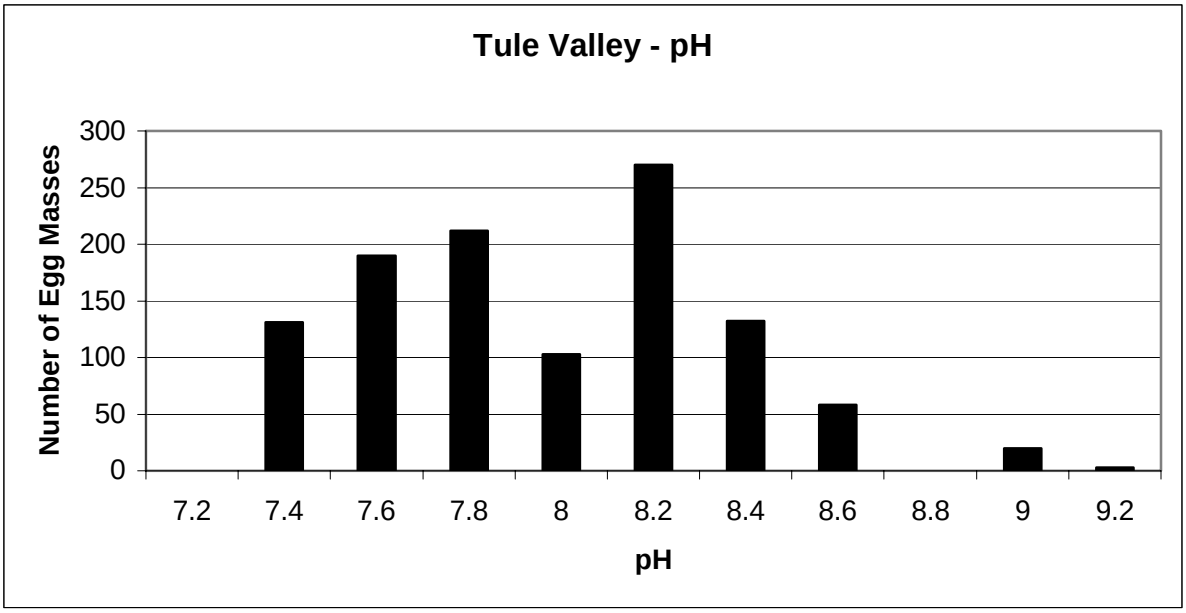

Figure 22. pH recorded at spotted frog egg masses during monitoring in Tule Valley, Utah, spring 2004.

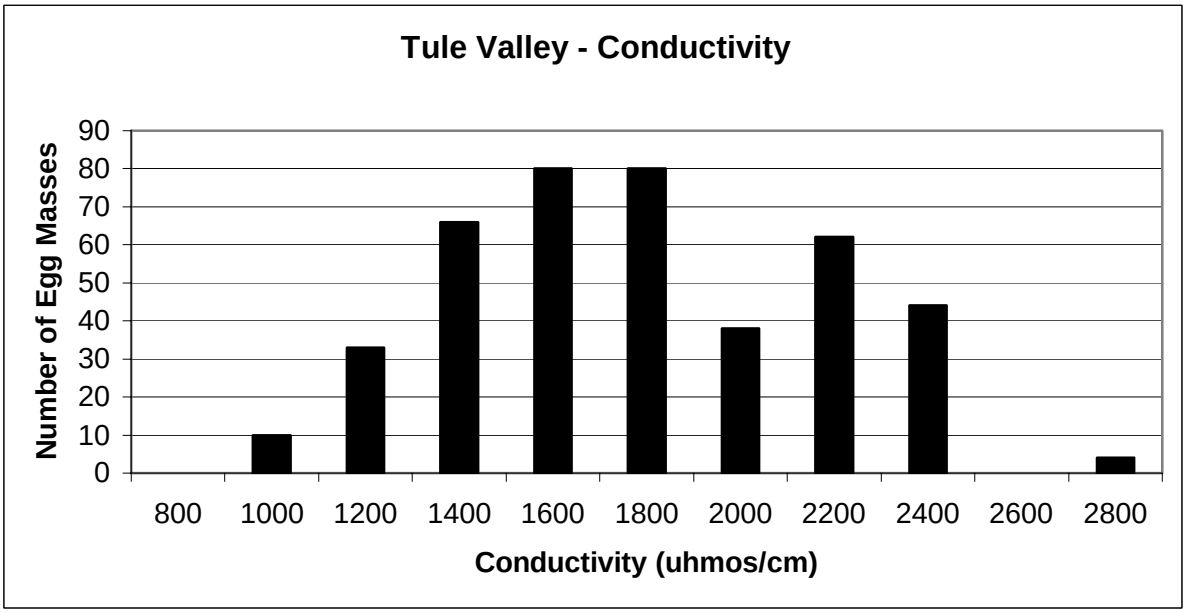

Figure 23. Conductivity (umhos/cm) measured at spotted frog egg masses during monitoring in Tule Valley, Utah, spring 2004.

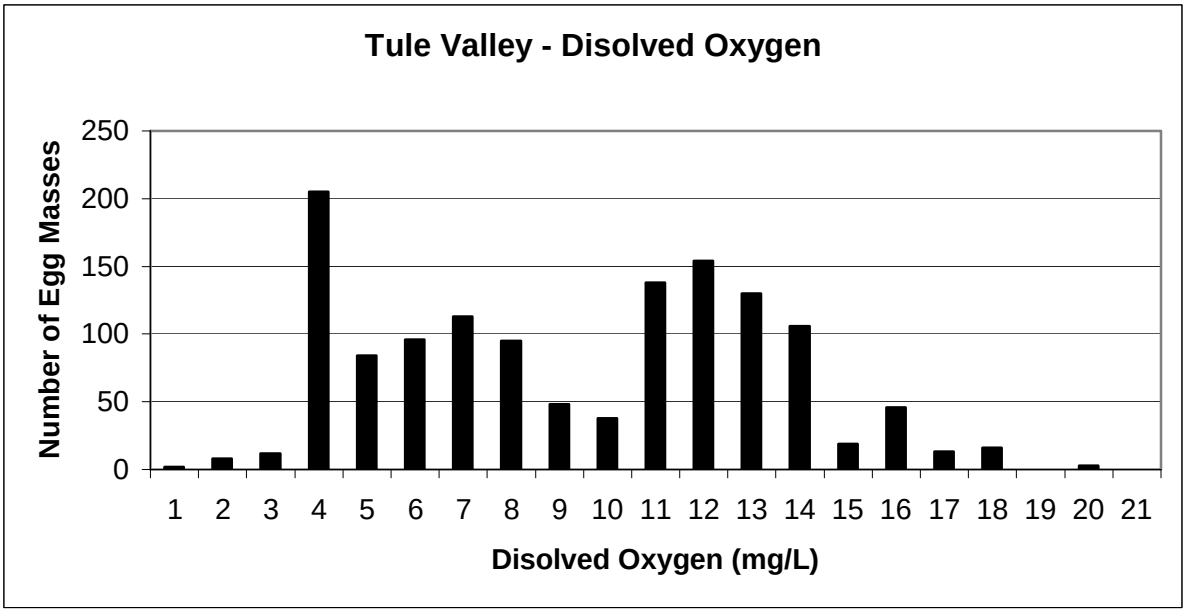

Figure 24. Dissolved oxygen (mg/L) measured at spotted frog egg masses during monitoring in Tule Valley, Utah, spring 2004.