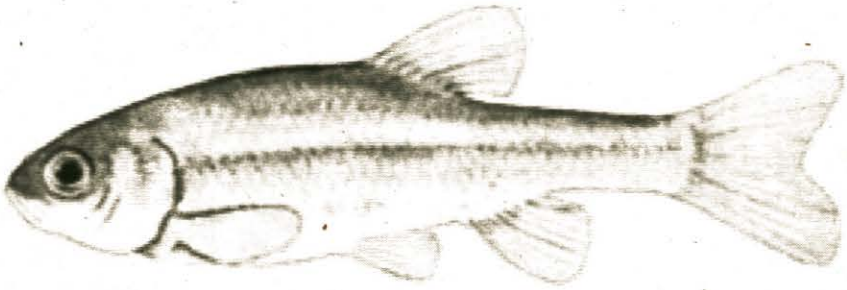
State of Utah
DEPARTMENT OF NATURAL RESOURCES
Division of Wildlife Resources – Native Aquatic Species

LEAST CHUB

(Iotichthys phlegethontis)

MONITORING SUMMARY

Central Region
2000-2001



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Utah Division of Wildlife Resources
1594 W. North Temple
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MONITORING SUMMARY

Central Region, 2000 and 2001

Prepared by:

Kristine W. Wilson
and
Joshua C. Whiting

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Central Region, 2000

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1. INTRODUCTION

Least chub *(Iotichthys phlegethontis)* is a small cyprinid endemic to the Bonneville Basin. Least chub historically occupied a variety of habitats including rivers, clear streams, springs, ponds, and marshes (Sigler and Miller 1963). Current populations are restricted to isolated springs and associated marshes with cool stable temperatures, relatively low, stable dissolved oxygen values, low conductivities, with moderate to dense, emergent, floating, and submergent vegetation (Perkins et al. 1998). Wetland vegetation most commonly associated with least chub habitat include: olney threesquare *(Scirpus americanus),* clustered field sedge *(Carex praegracilis),* common cattail *(Typha domingensis),* common spikerush *(Eleocharis palustris),* duckweed *(Lemna sp.),* cutleaf water parsnip *(Berula erecta),* and waterfern *(Azolla mexicana).*

Least chub have been declining in distribution and abundance since the 1940s (Holden et al. 1974) and studies over the last 20 years indicate this trend is continuing (Perkins et al. 1998). Although information on historic distribution and habitat is scarce, least chub have been documented in Little Salt Lake, Iron County in 1936 (Hubbs and Miller 1948) and in Big Cottonwood Creek southeast of Salt Lake City in 1954 (Pendleton and Smart 1954). Recent collections within the Bonneville Basin indicate that the approximate range of least chub once included Big Cottonwood Creek, Provo River, Utah Lake, Beaver River, Parowan Creek, and within the Snake Valley (Sigler and Miller 1963, Crist 1990).

Monitoring conducted by the Utah Division of Wildlife Resources since 1993 indicates that least chub are currently limited to areas in Juab County including Snake Valley, Mills Valley (in the Sevier drainage below Yuba reservoir), and the Mona Springs complex (in the Utah Lake drainage) (Perkins et al. 1998, Wilson et al. 1999).

Due to their declining distribution and abundance, least chub are currently classified as a conservation species by the State of Utah (UDWR 1998). The Conservation Agreement and Strategy (Perkins et al. 1998) identifies the following actions as necessary to enhance and protect extant populations: wetland vegetation and water quality improvements, grazing exclosure construction, surveys of suitable least chub habitat, control of nonnatives, genetic analysis, and monitoring of least chub populations. Extensive monitoring efforts are outlined in the Conservation Agreement in order to assess least chub populations, habitat, and trends in response

to actions implemented by governing agencies. This report summarizes the results of the 2000 field monitoring activities in the Central Region.

2. METHODS

Least chub populations were monitored at Mona Springs (Figure 1), Mills Valley (Figure 2), and Fish Springs National Wildlife Refuge (FSNWR). Snake Valley was surveyed in conjunction with the Southern Region and results are reported in the Southern Region's annual report. A total of 21 sites were sampled within these spring complexes (Mona Springs = 13, FSNWR = 2, Mills Valley = 6; Table 1). Fish were captured using mesh minnow traps with a variable number of traps placed at each sampling site. Within each predetermined site, traps were set for 2-4 hours at a minimum depth of 12 cm. Trap location, trap depth, and total trapping time were recorded. All trapped fish were measured to the nearest millimeter and classified by species.

Habitat inventories were conducted at all sites to assess physical parameters and to determine abundance of aquatic flora. Water depth, substrate depth, pool size, bank condition, water temperature, pH, dissolved oxygen, and ungulate damage were all recorded on standardized data sheets.

3. RESULTS

During the months of August and October 2000, field crews surveyed 21 sites within the Mills Valley, Mona Springs, and FSNWR. Of the 21 sites sampled, least chub were found in only 5 (29%) (Table 1). Least chub comprised 4.7% (28/595) of all fish caught in these spring complexes (Table 2).

3.1 Mona Springs Complex

Within the Mona Springs complex, a total of 12 least chub, 196 western mosquitofish *(Gambusia affinis)*, 36 plains killifish *(Fundulus zebrinus)*, 33 speckled dace *(Rhinichthys osculus)*, 29 Utah chub *(Gila atraria)*, 22 fathead minnow *(Pimephales promelas)*, and 16 rainwater killifish *(Lucania parva)* were captured (Table 3). Least chub were trapped in three of the 13 sampling sites (Tables 1 & 3). Ungulate damage ranged from none to minimal in all

springs. Among sites containing least chub, water temperature ranged from 14.3EC to 16.1EC (mean = 15.3EC), dissolved oxygen ranged from 4.13 to 4.53 mg/L (mean = 4.31 mg/L), and pH ranged from 7.5 to 7.8 (mean = 7.6). Substrate throughout all sites consisted of organic silt.

3.2 Mills Valley Spring Complex

Only one of the six monitoring sites at Mills Valley contained least chub (Table 1). Two least chub were captured at site # 3 and one Utah chub was captured at site # 2 (Table 4). No fish were captured at sites: 1, 4, 5, or 6 (Table 4). At the site containing least chub, substrate depth ranged from 0.51 m to 1 m, water temperature was 15.8EC, dissolved oxygen was constant at 8.9 mg/L, and pH was 7.8. Also, average water depth was 0.3 m, substrate consisted of rich organic material, and ungulate damage was moderate to severe.

3.3 Fish Springs National Wildlife Refuge

Within the FSNWR, two separate springs were monitored: Walter Spring and Deadman Spring. In 2000, least chub were captured only in Walter Spring.

3.3.1 Walter Spring

At Walter Spring, least chub accounted for 88% (least chub = 14) of all fish captured during monitoring in 2000 (Tables 2 & 5). Ungulate damage was not significant since sampling sites are located within the FSNWR where cattle grazing does not occur. Water depth averaged 0.91 m, substrate depth averaged 0.3 m, water temperature averaged 18.5EC, substrate consisted of organic silt, dissolved oxygen averaged 5.72 mg/L, and pH was constant at 7.7.

3.3.2 Deadman Spring

During monitoring in 2000, no least chub were captured at Deadman Spring (Table 1). Western mosquitofish (n = 185) comprised 84% of fish captured and Utah chub (n = 34) comprised the remaining 16% of fish captured (Table 6). Ungulate damage was not significant since sampling sites are located within FSNWR where cattle grazing does not occur. Water depth averaged 0.12 m, substrate depth averaged 1.5 m, water temperature averaged 22.2EC, dissolved oxygen averaged 3.08 mg/L, and pH was constant at 7.5. Substrate is comprised entirely of organic silt.

4. DISCUSSION

4.1 Mona Springs Complex

Within Mona Springs, least chub were captured at three of the13 sites during monitoring in 2000 (Tables 3 and 7). The results suggest a declining least chub population (Figure 3). Due to a decrease in least chub and an increase in nonnative species abundance, primarily western mosquitofish (Figure 4), an emergency plan was developed and implemented to prevent further decline of the least chub population at the Mona Springs complex. During November 2000, a mechanical non-native removal project was undertaken at Mona Springs. It is expected that removing competition for space, food, and limited spawning habitat will improve survival chances for least chub (Wilson and Thompson 1999).

4.2 Mills Valley Spring Complex

Least chub were captured at fewer sites in 2000 than in 1999 (Table 1) but the percentage of least chub captured increased (Table 2). Species composition at Mills Valley has also changed over time, and fortunately, no nonnatives were sampled in 2000 (Figure 5). Future monitoring should incorporate more sites to more accurately estimate trends in species composition and abundance.

4.3 Fish Springs National Wildlife Refuge

4.3.1 Walter Spring

Walter Spring was chemically treated in 1996 and 230 least chub were introduced on 17 May 1996 from the nearest spring complex, Leland Harris. Within two weeks of the introduction fry were observed throughout shallow vegetated areas within the spring, and by 1997, thousands of least chub were observed. A crude catch/unit effort ratio estimated the population to be 6200 adults (UDWR, data on file). Monitoring in 1999 and 2000 indicated western mosquitofish have re-invaded, therefore, least chub are no longer the only fish present in Walter Spring (Table 8 and Figure 6).

4.3.2 Deadman Spring

Deadman Spring was chemically treated in November 1995. After which, Utah chub were reintroduced to the spring in December 1995. However, western mosquitofish were observed in an April 1996 survey of Deadman Spring, so in June and July 1996, the spring was chemically treated again. In May 1997, the UDWR again introduced Utah chub, along with least chub, into Deadman Spring (Wilson 1999). Unfortunately, western mosquitofish were again observed in 1998 (Table 8). Least chub have decreased in abundance each year since the re-invasion of western mosquitofish while western mosquitofish have increased in abundance (Figure 7).

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Table 1. **Percentage of monitoring sites containing least chub at Mona Springs, Mills Valley, Deadman Spring (FSNWR), and Walter Spring (FSNWR), 1995-2000.**

Year	Mona Springs	Mills Valley	Deadman (Fish Springs)*	Walter (Fish Springs)*
1995	7/12 (58%)	-	-	-
1996	6/12 (50%)	-	-	-
1997	7/12 (58%)	-	-	-
1998	1/12 (8%)	5/8 (63%)	4/4 (100%)	4/4 (100%)
1999	1/12 (8%)	2/6 (33%)	2/4 (50%)	2/3 (67%)
2000	3/13 (23%)	1/6 (16%)	0/1 (0%)	1/1 (50%)

***The Fish Springs complex sites were chemically treated and least chub introduced in 1996 and 1997.**

Table 2. **Proportion of least chub trapped at Mona Springs, Mills Valley, Deadman Spring (FSNWR), and Walter Spring (FSNWR), 1995-2000.**

Year	Mona Springs	Mills Valley	Deadman (Fish Springs)	Walter (Fish Springs)
1995	256/648 (40%)	-	-	-
1996	57/339 (17%)	-	-	-
1997	46/358 (13%)	-	-	-
1998	38/172 (22%)	23/98 (23%)	11/125 (9%)	393/393 (100%)
1999	8/113 (7%)	13/45 (29%)	3/180 (0.02%)	64/64 (100%)
2000	12/357 (3%)	2/3 (66%)	0/219 (0%)	14/16 (88%)

Table 3. Species present and number of fish captured in each site at the Mona Springs complex, October 2000.

	Species Present							
Site	LC	UC	SD	PK	MF	FM	CP	RK
1	-	-	-	-	1	-	-	-
2	1	3	-	6	72	-	-	1
3	-	-	-	-	33	-	-	-
4	-	-	-	-	3	-	-	-
5a	4	8	-	4	27	19	17	-
5b	-	3	-	-	24	-	-	5
6	-	1	-	-	14	2	-	3
7	-	-	6	-	-	-	-	-
8	-	2	4	-	-	1	-	-
9	-	-	-	-	2	-	-	-
10	7	1	-	-	-	-	-	1
11	-	-	1	-	1	-	-	1
12	-	11	22	26	19	-	1	5

LC=Least Chub, UC=Utah Chub, SD=Speckled Dace, PK=Plains Killifish
MF=Western Mosquitofish, FM=Fathead Minnow, CP=Carp, RK=Rainwater Killifish.

Table 4. Species present and number of fish captured in each site at Mills Valley, October 2000.

Site	Species Present	# Captured
1	-	-
2	UC	1
3	LC, UC,	2, 1
4	-	-
5	-	-
6	-	-

LC=Least Chub, UC=Utah Chub

Table 5. Species present and number of fish captured in each site at Walter Spring (FSNWR), August, 2000.

	Species Present	
Site	LC	MF
1	1	-
2	-	2
3	-	-
4	13	-

LC=Least Chub, MF=Western Mosquitofish

Table 6. Species present and number of fish captured in each site at Deadman Spring (FSNWR), August, 2000.

	Species Present		
Site	MF	UC	LC
1	121	34	-
2	65	-	-
3	1	-	-
4	7	-	-

UC=Utah Chub, MF=Western Mosquitofish

Table 7. Fish species present from 1995 to 2000 in the Mona Springs complex.

Site	1995	1996	1997	1998	1999	2000
1	-	-	PK	PK	-	MF
2	MS	-	SD, MF	MF	PK, MF	MF, LC
3	LC, UC, SD, PK, MF, CP, FM	-	LC	-	PK	MF
4	-	UC	UC	SD, PK	-	MF
5	LC, UC, SD, PK, MF, FM	LC, UC, SD, PK, MF, FM, YP	LC, UC, PK, MF, FM	LC, UC, SD, PK, MF, FM,	LC, UC, SD, PK, MF, FM, RK	* LC, MF, UC, PK, CP, FM
6	LC, UC, SD, MF	LC, UC, MF	PK, MF	-	PK	UC, MF RK, FM
7	LC, UC, SD	LC, UC	LC, UC, SD, FM	SD	-	SD
8	LC, UC, MF, PK	LC, UC, MF	LC	SD	SD	UC, FM SD
9	LC, UC, PK	-	LC, UC, PK, MF	-	-	MF
10	LC, UC, PK	LC, UC, PK, MF, FM	LC, UC, PK, MF	-	-	LC, UC, RK
11	UC	-	-	-	-	MF, RK, SD
12	-	LC, PK, MF	LC, UC, MF	-	-	UC, MF, RK, PK, CP, SD

LC=Least Chub, UC=Utah Chub, SD=Speckled Dace, PK=Plains Killifish
MF=Western Mosquitofish, FM=Fathead Minnow, RK=Rainwater Killifish, YP=Yellow Perch
* indicates site 5 is a combination of sites 5a and 5b

Table 8. Fish species present from 1995 to 1999 in Deadman and Walter Spring (FSNWR).

	Deadman	Walter
1995	UC, MF	UC, MF
1996	MF	LC
1997	LC, UC	LC
1998	LC, UC, MF	LC
1999	LC, MF, UC	LC
2000	UC, MF	LC, MF

LC=Least Chub, UC=Utah Chub, MF=Western Mosquitofish
* Indicates when spring was chemically treated and least chub were introduced.

Figure 1. Aerial map of the least chub monitoring sites at the Mona Springs complex, Juab Co.

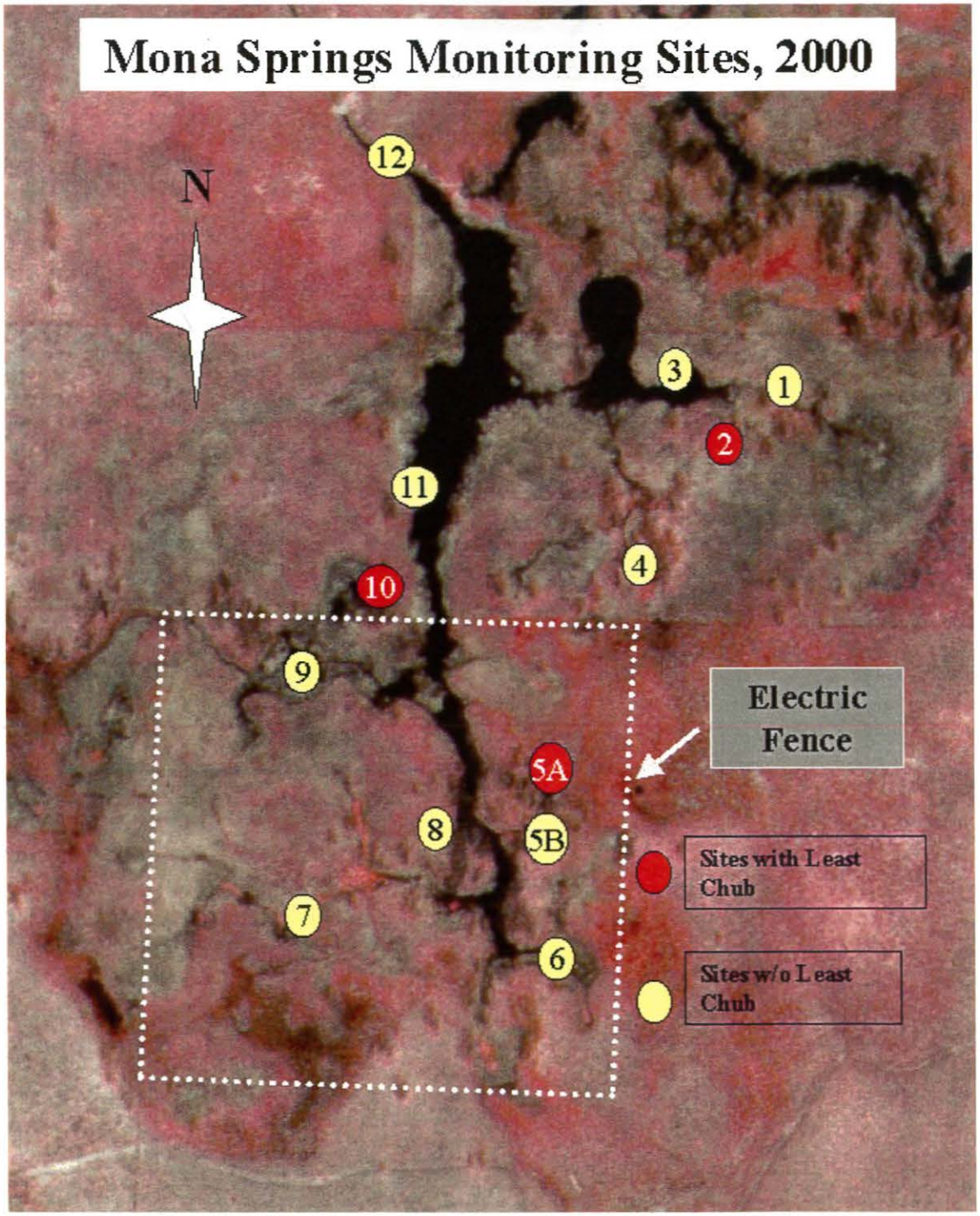


Figure 2. Aerial map of least chub monitoring sites at Mills Valley, Juab County.

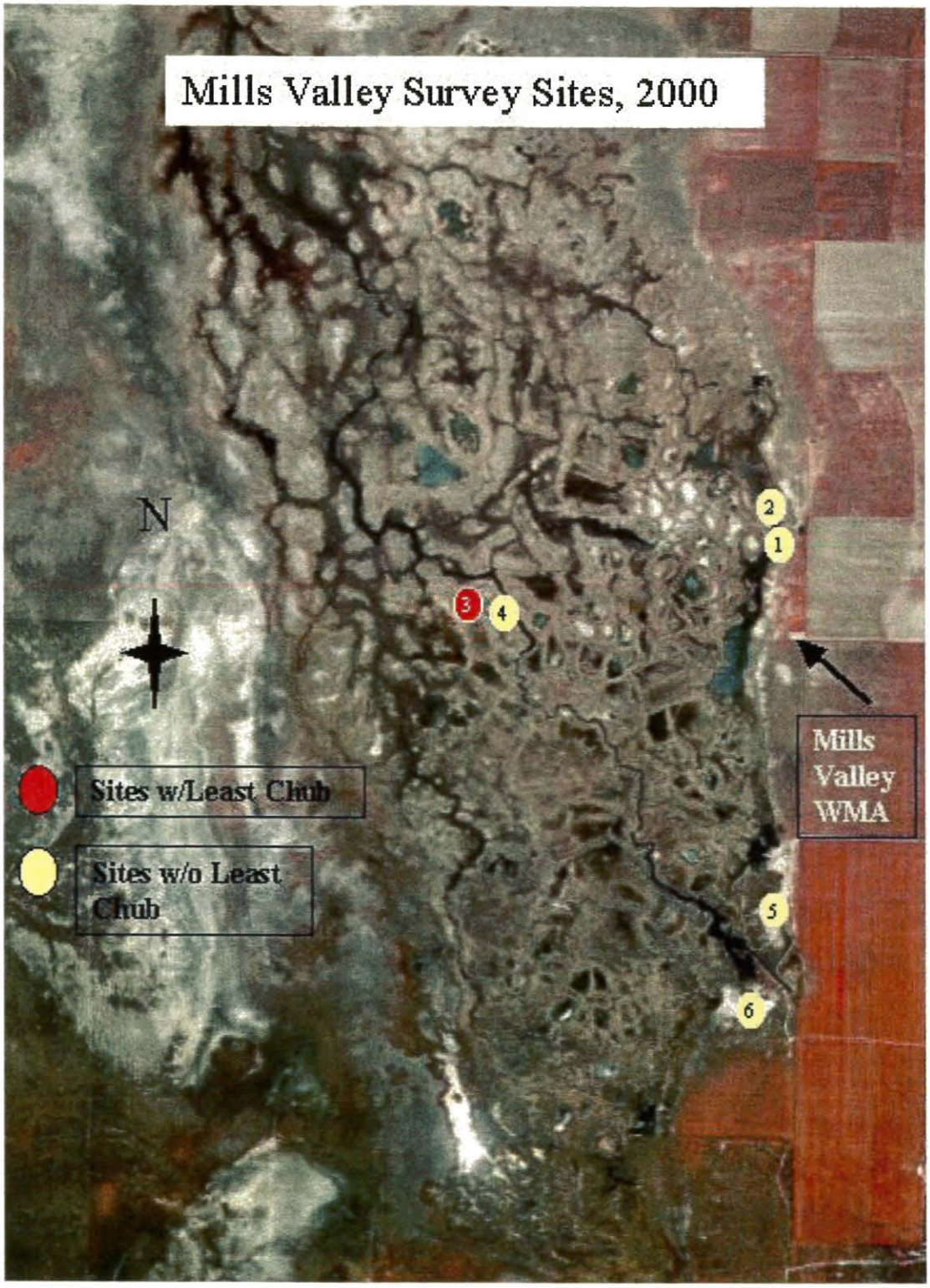


Figure 3. Least chub decline overtime at Mona Spring; 1995 (n =256), 1996 (n = 56), 1997 (n = 44), 1998 (n = 3), 1999 (n = 8), 2000 (n = 12).

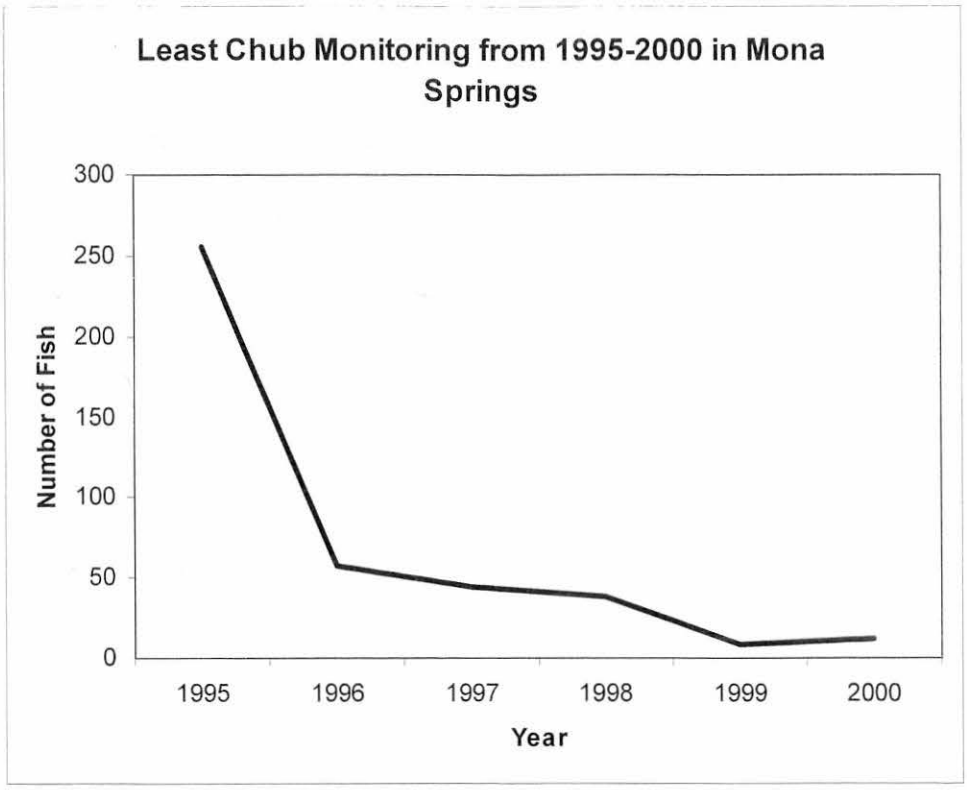


Figure 4. Change in species composition over time at Mona Springs, 1995-2000.

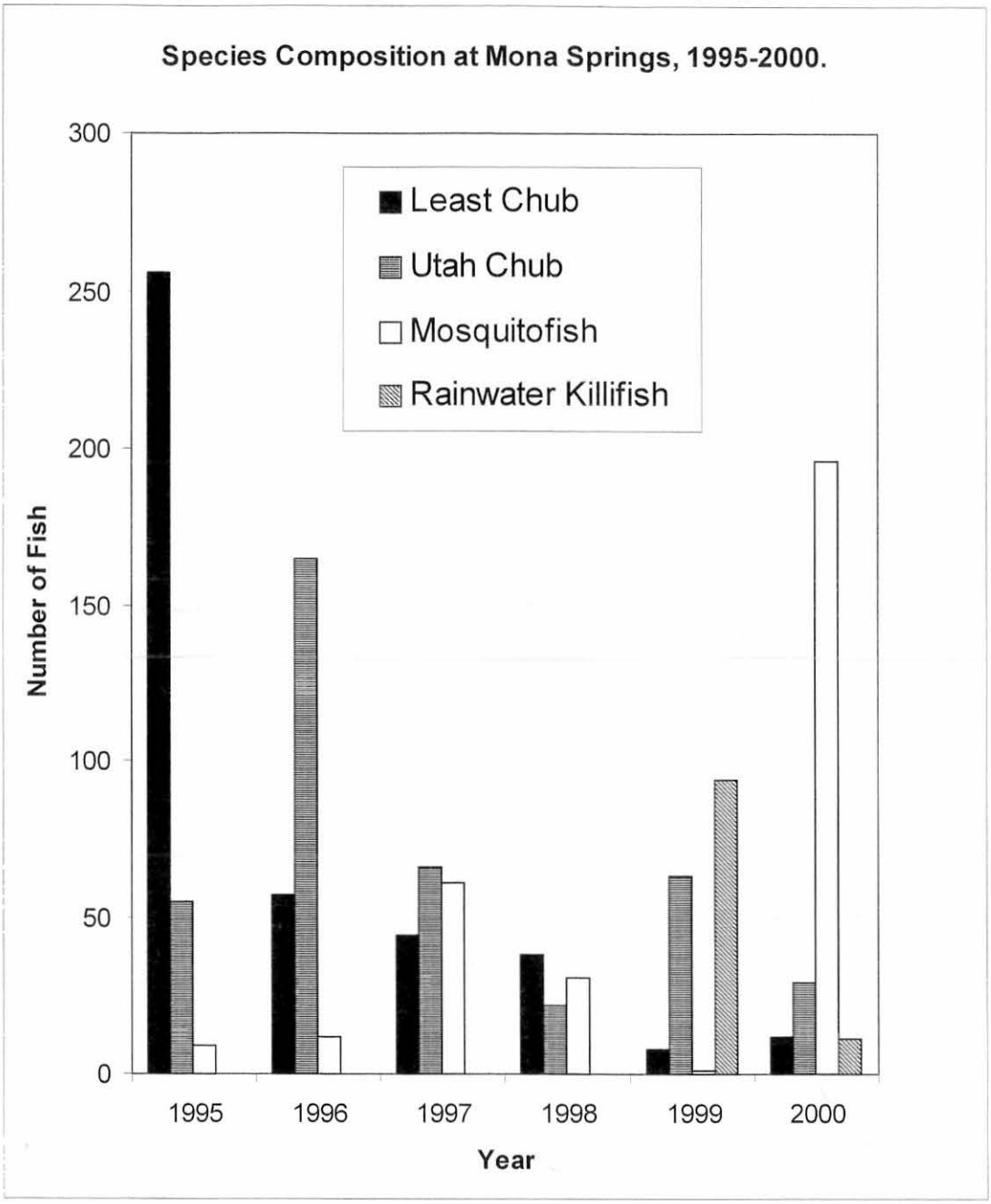


Figure 5. Change in species composition over time at Mills Valley, 1998-2000.

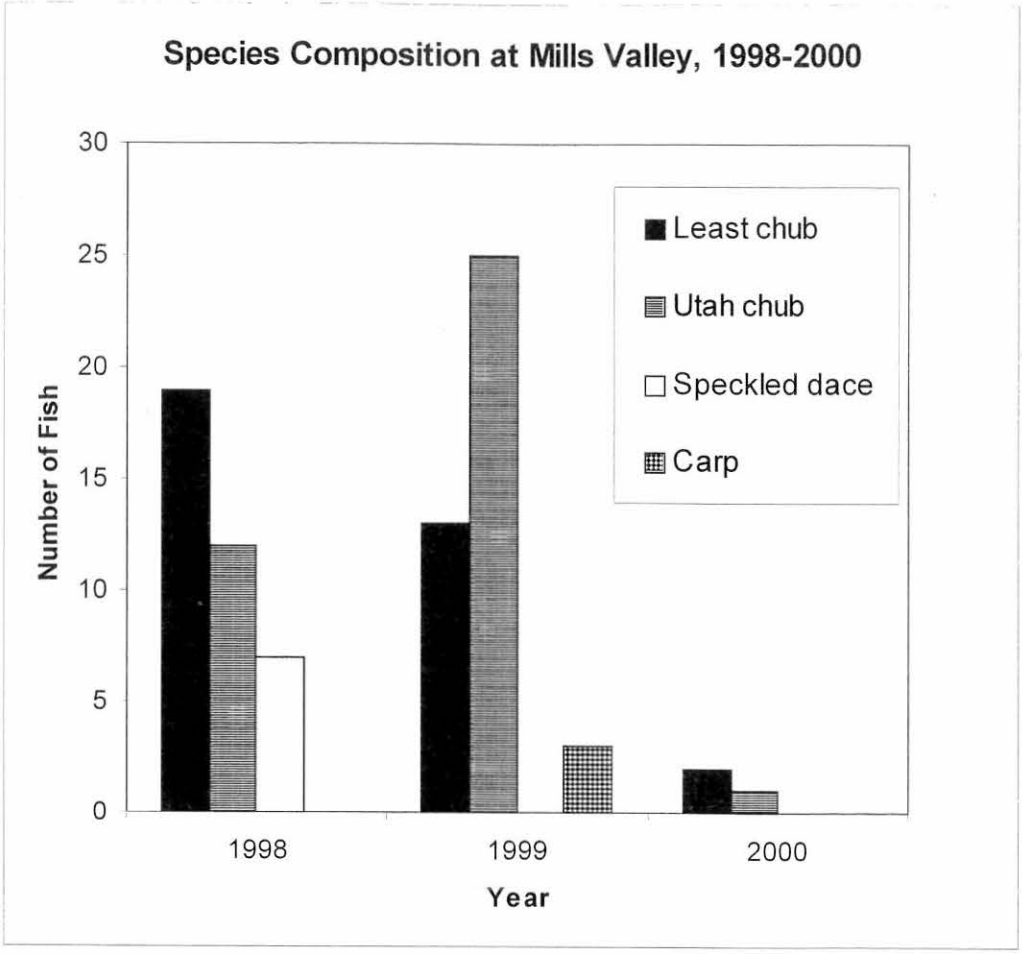


Figure 6. Change in species composition over time at Walter Springs (FSNWR), 1997-2000.

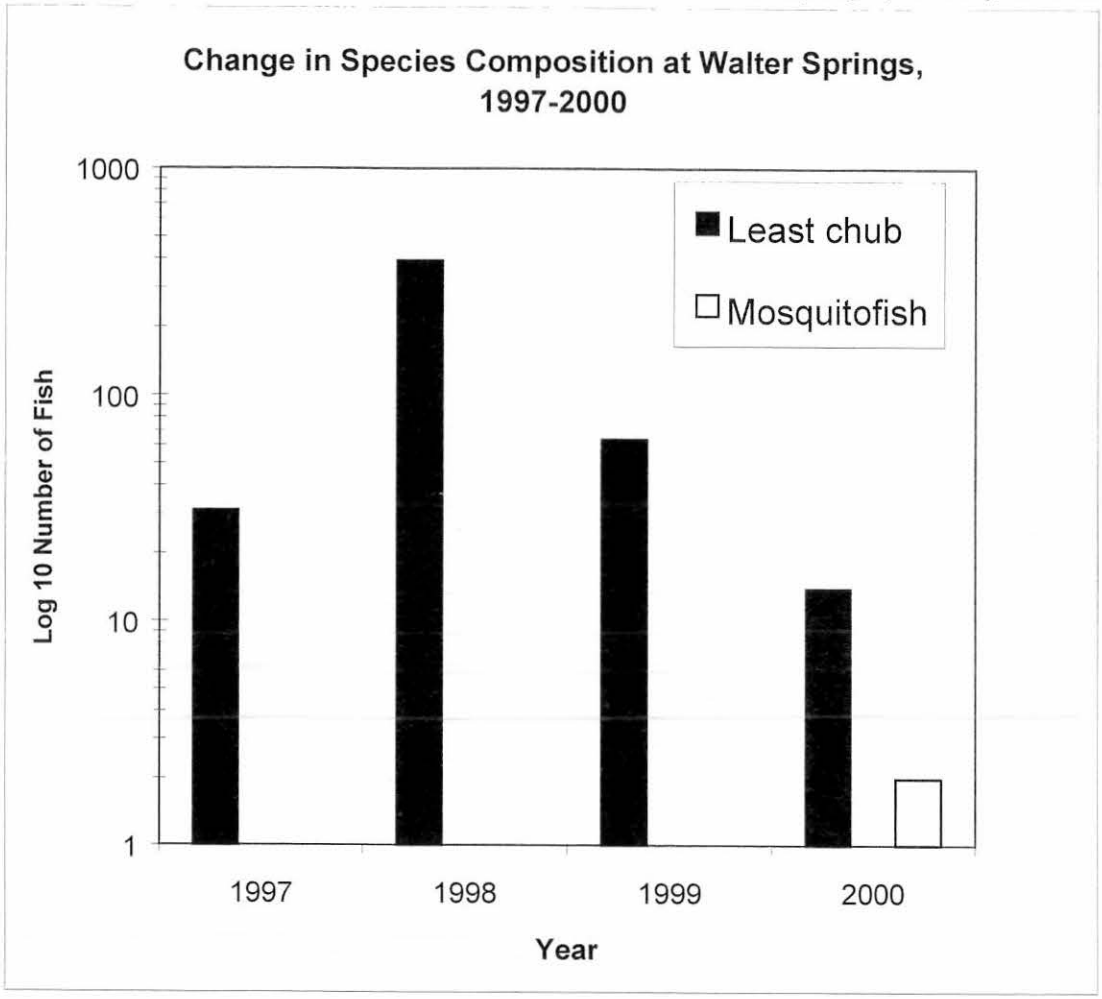
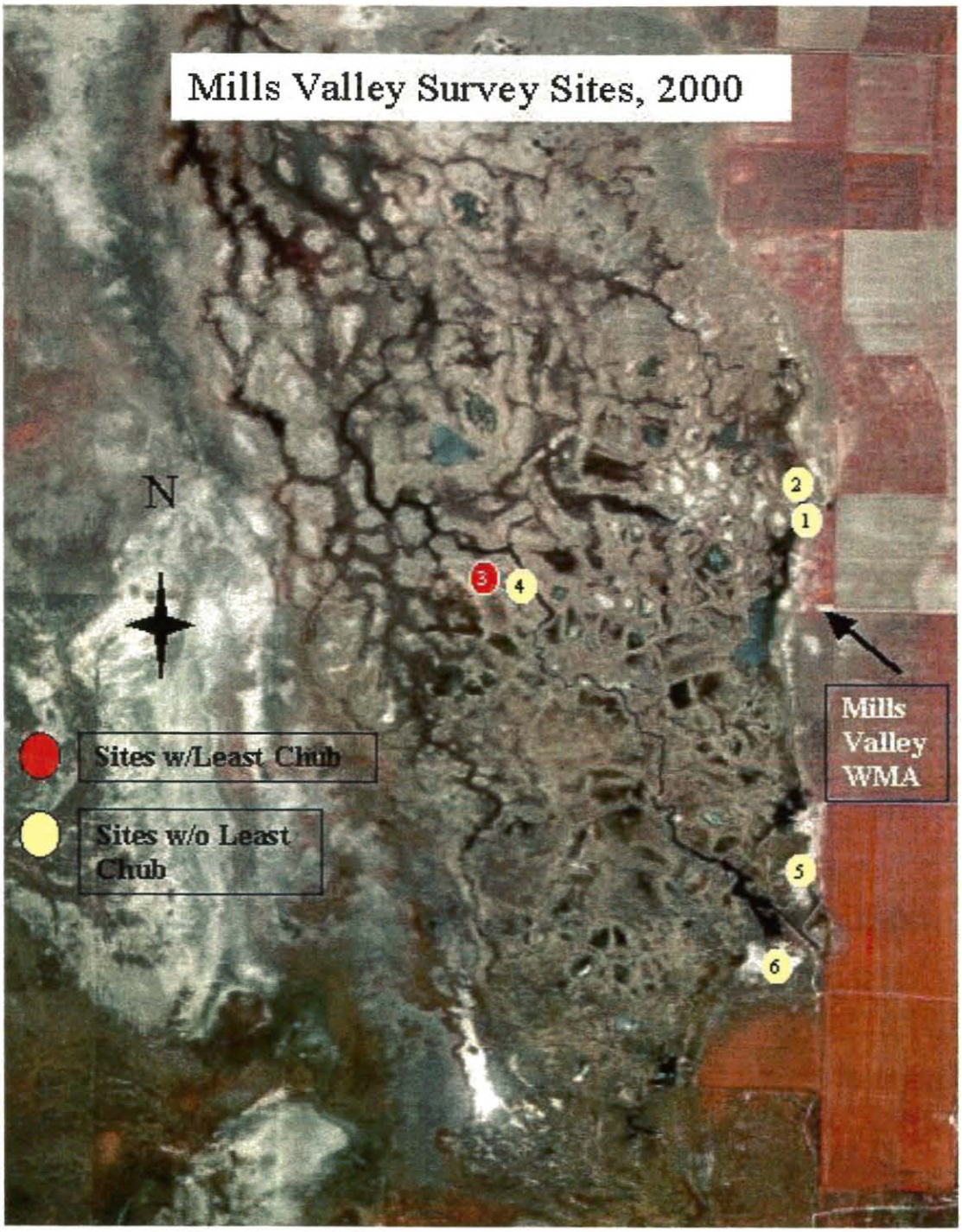


Figure 7. Change in species composition over time at Walter Springs (FSNWR), 1997-2000.



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1. INTRODUCTION

Least chub (*Iotichthys phlegethontis*) is a small cyprinid endemic to the Bonneville Basin. Least chub historically occupied a variety of habitats including rivers, clear streams, springs, ponds, and marshes (Sigler and Miller 1963). Current populations are restricted to isolated springs and associated marshes with cool stable temperatures, relatively low, stable dissolved oxygen values, low conductivities, with moderate to dense, emergent, floating, and submergent vegetation (Perkins et al. 1998). Wetland vegetation most commonly associated with least chub habitat include: olney threesquare (*Scirpus americanus*), clustered field sedge (*Carex praegracilis*), common cattail (*Typha domingensis*), common spikerush (*Eleocharis palustris*), duckweed (*Lemna sp.*), cutleaf water parsnip (*Berula erecta*), and waterfern (*Azolla mexicana*).

Least chub have been declining in distribution and abundance since the 1940s (Holden et al. 1974) and studies over the last 20 years indicate this trend is continuing (Perkins et al. 1998). Although information on historic distribution and habitat is scarce, least chub have been documented in Little Salt Lake, Iron County in 1936 (Hubbs and Miller 1948) and in Big Cottonwood Creek southeast of Salt Lake City in 1954 (Pendleton and Smart 1954). Recent collections within the Bonneville Basin indicate that the approximate range of least chub once included Big Cottonwood Creek, Provo River, Utah Lake, Beaver River, Parowan Creek, and within the Snake Valley (Sigler and Miller 1963, Crist 1990).

Monitoring conducted by the Utah Division of Wildlife Resources since 1993 indicates that least chub are currently limited to areas in Juab County including Snake Valley, Mills Valley (in the Sevier drainage below Yuba Reservoir), and the Mona Springs complex (in the Utah Lake drainage) (Perkins et al. 1998, Wilson et al. 1999, Wilson and Whiting 2002).

Due to their declining distribution and abundance, least chub are currently classified as a conservation species by the State of Utah (UDWR 1998). The Conservation Agreement and Strategy (Perkins et al. 1998) identifies the following actions as necessary to enhance and protect extant populations: wetland revegetation and water quality improvements, grazing exclosure construction, surveys of suitable least chub habitat, control of nonnatives, genetic analysis, and monitoring of least chub populations. Extensive monitoring efforts are outlined in the

Conservation Agreement in order to assess least chub populations, habitat, and trends in response to actions implemented by governing agencies. This report summarizes the results of the 2001 field monitoring activities within the Central Region.

2. METHODS

Least chub populations were surveyed at Mona Springs (Figure 1), Mills Valley (Figure 2), and Fish Springs National Wildlife Refuge (FSNWR). Snake Valley was surveyed in conjunction with the Southern Region and results are reported in the Southern Region's annual report. A total of 15 sites were sampled at Mona Springs (n = 13) and Fish Springs (n = 2) (Table 1). Fish were captured using mesh minnow traps with a variable number of traps placed at each sampling site. Within each predetermined site, traps were set for 2-4 hours at a minimum depth of 12 cm.

Trap location, trap depth, and total trapping time were recorded. All trapped fish were measured to the nearest millimeter and classified by species. Habitat inventories were conducted at all sites to assess physical parameters and to determine abundance of aquatic flora. Water depth, substrate depth, pool size, bank condition, water temperature, pH, dissolved oxygen and ungulate damage were all recorded on standardized data sheets.

Results of monitoring conducted in 2000 suggest that locations previously selected as monitoring sites within Mills Valley may not reflect the true composition of species present in this system. Therefore, a complete survey of the Mills Valley was conducted in 2001(Figure 2). Aerial photos of the wetland/spring complex were reviewed to determine the number and location of springs that should be surveyed to accurately represent fish species present throughout the entire system. Twenty five sites were selected and a variable number of traps were set in each. All traps were set overnight at a minimum depth of 12 cm.

All trapped fish were measured to the nearest millimeter and classified by species. Trap location, trap depth, and total trapping time were recorded. A GPS reading was taken at each site to identify the location of each sample site on a 7.5 minute quad map. At the sites where fish were captured or observed, habitat inventories were conducted to assess physical parameters and to determine abundance of aquatic flora. Water depth, substrate depth, pool size, bank condition,

water temperature, pH, dissolved oxygen, and ungulate damage were all recorded on standardized data sheets.

3. RESULTS

During the months of August and September 2001, field crews surveyed 15 sites within the Mona Springs and Fish Springs complexes. Of the 15 sites sampled, least chub were found in 4 (27%) (Table 1). Least chub comprised 0.01% (7/633) of all fish caught in these spring complexes (Table 2).

3.1 Mona Springs Complex

Within the Mona Springs complex, a total of five least chub, 197 western mosquitofish (*Gambusia affinis*), 68 Utah chub (*Gila atraria)*, 43 rainwater killifish (*Lucania parva*), one fathead minnow (*Pimephales promelas*), and one common carp (*Cyprinus carpio*) were captured (Table 3). Least chub were trapped in three of the 13 sampling sites at the Mona Springs complex (Tables 1 & 3). Ungulate damage ranged from none to moderate in all springs. Among sites containing least chub, water temperature ranged from 16.3 to 17.0°C (mean = 16.7°C), dissolved oxygen ranged from 4.52 to 5.04 mg/L (mean = 4.86 mg/L), and pH was constant at all sites with a value of 7.4. Substrate throughout all sites consisted of organic silt.

In order to eliminate cattle grazing, an electric fence was constructed around monitoring sites 5 through 9 at Mona Springs in March 2000 (Figure 1). Ungulate damage decreased from high to none following fencing and Site 9 experienced a decrease in pool size from 28.3m x 22.9m (1998) to 18.22m x 13.71m (2001). Bank condition was good at all sites. Changes in plant species included an increase in upland grasses and thistle and a decrease in riparian rush (*Juncus sp*). At site 6, algal abundance decreased from common to none and floating vegetation changed from 80 % to none. Also, the percentage of floating vegetation decreased from 100 to 80 percent at site 7.

3.2 Fish Springs National Wildlife Refuge

Within the FSNWR, two separate springs were monitored: Walter Spring and Deadman Spring. In 2001, least chub were captured only in Walter Spring.

3.2.1 Walter Spring

At Walter Spring, least chub accounted for only 1% (N = 2) of all fish captured (Tables 2 & 4), while western mosquitofish comprised the remaining 99% (N=192) (Table 4). Ungulate damage was not significant since sampling sites are located within the FSNWR where cattle grazing does not occur. Water depth averaged 0.91m, substrate depth averaged 0.3 m, water temperature averaged 21.4°C, dissolved oxygen averaged 11.67 mg/L, and pH was 9.5. Substrate throughout the site consisted of organic silt.

3.2.2 Deadman Spring

No least chub were captured at Deadman Spring during monitoring in 2001 (Tables 1 & 2). Utah chub (N = 14) comprised 11% of all fish captured, while western mosquitofish (N=110) comprised the remaining 89% (Table 5). Deadman Spring is located within the FSNWR, therefore ungulate damage was negligable. Maximum water depth was 1.8 m, substrate depth averaged 0.30 m, water temperature averaged 15.6°C, dissolved oxygen averaged 1.9 mg/L, and pH was 7.5. Substrate throughout the site consisted of organic silt.

3.3 Mills Valley Spring Complex

Fourteen of the 25 sites sampled (56%) contained least chub (Table 1). Least chub comprised 84% (N = 1641) of all fish captured (Tables 2 & 6). Utah chub (N = 300) comprised 15 % and speckled dace (*Rhinichthys osculus*) (N =17) comprised the remaining 1% of all fish captured (Table 6). Least chub mean total length was 33 mm (Figure 3). Within sites containing least chub, substrate depth ranged from 0.30 m to 0.91 m (mean = 0.60 m), water temperature ranged from 14.8 to 24.0°C (mean = 17.5°C). Dissolved oxygen averaged 8 mg/L, while pH ranged from 7.6 to 8.8. Throughout all sites, substrate consisted of organic material. Ungulate damage was moderate to severe.

4. DISCUSSION

4.1 Mona Springs Complex

In October 2000, a mechanical nonnative removal project was undertaken at the Mona Springs complex. Approximately 35,000 nonnative fish were removed during the 17-day project

(Wilson and Olsen 2002). Least chub captured during the nonnative removal project were held in a live well until project completion, then released into sites 5 and 10. This may explain why least chub were captured only in sites 5 and 10 during monitoring in 2001. Between 2000 and 2001, fewer least chub were captured, rainwater killifish and Utah chub slightly increased, and the number of western mosquitofish remained the same despite nonnative removal, (Figures 4 and 5). However, western mosquitofish were captured at fewer sites in 2001 (7) than in 2000 (9) (Table 7). Due to low least chub abundance in 2001, the nonnative removal project was repeated in late October 2001 to prevent further decline of the least chub population at Mona Springs. It is expected that decreasing competition for space, food, and limited spawning habitat will improve least chub survivability (Wilson and Thompson 1999).

Habitat comparisons between pre-fencing (1998) and post-fencing (2001) revealed little change in pool size at sites 5 through 8. Pool size decreased at site 9 and 10, but this decrease may be associated with reduced water output at the spring head due to recent drought conditions. Algal abundance also decreased at site 6 following fencing, perhaps resulting from a decrease in nutrients associated with cattle waste. Sites 1 through 4 and 10 through 12 were not fenced, and even though grazing continued at these sites, habitat conditions changed little. At site 10, bank condition improved and pool size decreased from 22.4m x 13.5m in1998 to 9.1m x 7.6m in 2001.

4.2 Fish Springs National Wildlife Refuge

4.2.1 Walter Spring

Walter Spring was chemically treated in 1996 and 230 least chub were introduced on 17 May 1996 from the nearest spring complex, Leland Harris. Within two weeks of the introduction, fry were observed throughout shallow vegetated areas within the spring, and by 1997, thousands of least chub were observed. A crude catch/unit effort ratio estimated the population to be 6200 adults (data on file, UDWR). However, sampling in 1999, 2000, and 2001 has revealed a significantly reduced least chub population and a dramatic increase in western mosquitofish abundance (Figure 6).

4.2.2 Deadman Spring

Deadman Spring was chemically treated in November 1995 and Utah chub were reintroduced into the spring in December 1995. However, western mosquitofish were observed in an April 1996 survey of Deadman Spring, therefore, in June and July 1996, the spring was chemically treated again. In May 1997, UDWR again introduced Utah chub as well as least chub into Deadman Spring (Wilson 1999). Unfortunately, western mosquitofish were again observed during 1998 (Table 8). Since the re-invasion of western mosquitofish, least chub have decreased in abundance overtime, while western mosquitofish have increased in abundance (Table 2 and Figure 7).

4.3 Mills Valley Spring Complex

A complete survey of Mills Valley in 2001 revealed a thriving and abundant least chub population. Exotic fish have not invaded Mills Valley, (a few adult carp and one largemouth bass were observed during sampling), therefore, little or no competition and/or predation exists between native and nonnative fishes (Table 6).

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Table 1. Percentage of sites containing least chub at Mona Springs, Mills Valley, Deadman Spring (FSNWR), and Walter Spring (FSNWR) from 1995-2001.

Year	Mona Springs	Mills Valley	Deadman (Fish Springs)*	Walter (Fish Springs)*
1995	7/12 (58%)	-	-	-
1996	6/12 (50%)	-	-	-
1997	7/12 (58%)	-	-	-
1998	1/12 (8%)	5/8 (63%)	4/4 (100%)	4/4 (100%)
1999	1/12 (8%)	2/6 (33%)	2/4 (50%)	2/3 (67%)
2000	3/13 (23%)	1/6 (16%)	0/4 (0%)	2/4 (50%)
2001	3/13 (23%)	14/25 (56%)	0/1 (0%)	1/1 (100%)

*The Fish Springs complex sites were chemically treated and least chub introduced in 1996 and 1997.

Table 2. Proportion of least chub trapped at Mona Springs, Mills Valley, Deadman Spring (FSNWR), and Walter Spring (FSNWR) from 1995-2001.

Year	Mona Springs	Mills Valley	Deadman (Fish Springs)*	Walter (Fish Springs)*
1995	256/648 (40%)	-	-	-
1996	57/339 (17%)	-	-	-
1997	44/358 (12%)	-	-	-
1998	38/172 (22%)	23/98 (23%)	11/125 (9%)	393/393 (100%)
1999	8/113 (7%)	13/45 (29%)	3/180 (0.02%)	64/64 (100%)
2000	12/357 (3%)	2/3 (66%)	0/219 (0%)	14/16 (88%)
2001	5/315 (2%)	1641/1950 (84%)	0/124 (0%)	2/194 (1%)

* The Fish Springs complex sites were chemically treated and least chub introduced in 1996 and 1997.

Table 3. Species present and number of fish captured in each site at the Mona Springs complex, October 2001.

	Species Present							
Site	LC	UC	SD	PK	MF	FM	CP	RK
1	-	-	-	-	8	-	-	-
2	-	-	-	-	16	-	-	-
3	-	-	-	-	13	-	-	-
4	-	-	-	-	8	-	-	-
5A	1	9	-	-	23	-	-	32
5B	2	52	-	-	-	1	1	1
6	-	-	-	-	14	-	-	6
7	-	7	-	-	-	-	-	-
8	-	-	-	-	115	-	-	-
9	-	-	-	-	-	-	-	2
10	2	-	-	-	-	-	-	2
11	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-

LC=Least Chub, UC=Utah Chub, SD=Speckled Dace, PK=Plains Killifish
MF=Western Mosquitofish, FM=Fathead Minnow, CP=Carp, RK=Rainwater Killifish.

Table 4. Species present and number of fish captured in each site at Walter Spring (FSNWR), September 2001.

	Species Present	
Trap	LC	MF
1	-	37
2	-	137
3	1	9
4	1	9

LC=Least Chub, MF=Western Mosquitofish

Table 5. Species present and number of fish captured in each site at Deadman Spring (FSNWR) September 2001.

	Species Present		
Trap	LC	UC	MF
1	-	-	44
2	-	-	11
3	-	-	55
4	-	14	-

LC= Least Chub, UC=Utah Chub , MF=Western Mosquitofish

Table 6. Species present and number of fish captured in each site at Mills Valley, October 2001.

Site	Species Present	# Captured
1	-	-
2	LC	2
3	UC	3
4	-	-
5	LC	26
6	-	-
7	LC,UC,SD	1190,4,2
7N	LC	4
8	-	-
9	LC,SD	24,4
10	-	-
11	LC,UC,SD	230,98,1
A	LC,UC	4,194
B	LC,UC,*CP	88,1,-
B2	LC,SD	2,4
BS	LC,SD	37,4
C	LC	20
D	*LMB	-
E	SD	1
F	LC	1
G	-	-
H	-	-
I	LC	5
J	-	-
K	LC	10

LC=Least Chub, UC=Utah Chub, SD=Speckled Dace, *LMB=Largemouth bass
*CP=Carp
* Indicates fish observed, not caught

Table 7. Fish species present from 1995 to 2001 in the Mona Springs complex.

Site	1995	1996	1997	1998	1999	2000	2001
1	-	-	PK	PK	-	MF	MF
2	MS	-	SD, MF	MF	PK, MF	LC, UC, MF, RK, PK	MF
3	LC, UC, SD, PK, MF, CP, FM	-	LC	-	PK	MF	MF
4	-	UC	UC	SD, PK	-	MF	MF
5	LC, UC, SD, PK, MF, FM	LC, UC, SD, PK, MF, FM, YP	LC, UC, PK, MF, FM	LC, UC, SD, PK, MF, FM,	LC, UC, SD, PK, MF, FM, RK	* LC, MF, UC, PK, CP, FM	* LC, MF, UC, RK, CP, FM
6	LC, UC, SD, MF	LC, UC, MS, MF	PK, MF	-	PK	UC, MF, RK, FM	MF, RK
7	LC, UC, SD	LC, UC	LC, UC, SD, FM	SD	-	SD	UC
8	LC, UC, MF, PK	LC, UC, MS, MF	LC	SD	SD	UC, FM, SD	MF
9	LC, UC, PK	-	LC, UC, PK, MF	-	-	MF	RK
10	LC, UC, PK	LC, UC, PK, MF, FM	LC, UC, PK, MF	-	-	LC, UC, RK	LC, RK
11	UC	-	-	-	-	MF, RK, SD	-
12	-	LC, PK, MF	LC, UC, MF	-	-	UC, MF, RK, PK, CP, SD	-

LC=Least Chub, UC=Utah Chub, SD=Speckled Dace, PK=Plains Killifish
MF=Western Mosquitofish, FM=Fathead Minnow, RK=Rainwater Killifish, YP=Yellow Perch, CP=Carp
* indicates site 5 is a combination of sites 5A and 5B

Table 8. Fish species present from 1995 to 2001 in Deadman and Walter Springs (FSNWR).

	Deadman	Walter
1995	UC, MF	UC, MF
1996	MF	LC*
1997	LC*, UC	LC
1998	LC, UC, MF	LC
1999	LC, UC, MF	LC
2000	UC, MF	LC, MF
2001	UC, MF	LC ,MF

LC=Least Chub, UC=Utah Chub, MF=Western Mosquitofish.
* Indicates when spring was chemically treated and least chub were introduced.

Figure 1. Aerial map of the least chub monitoring sites at the Mona Spring complex, Juab County.

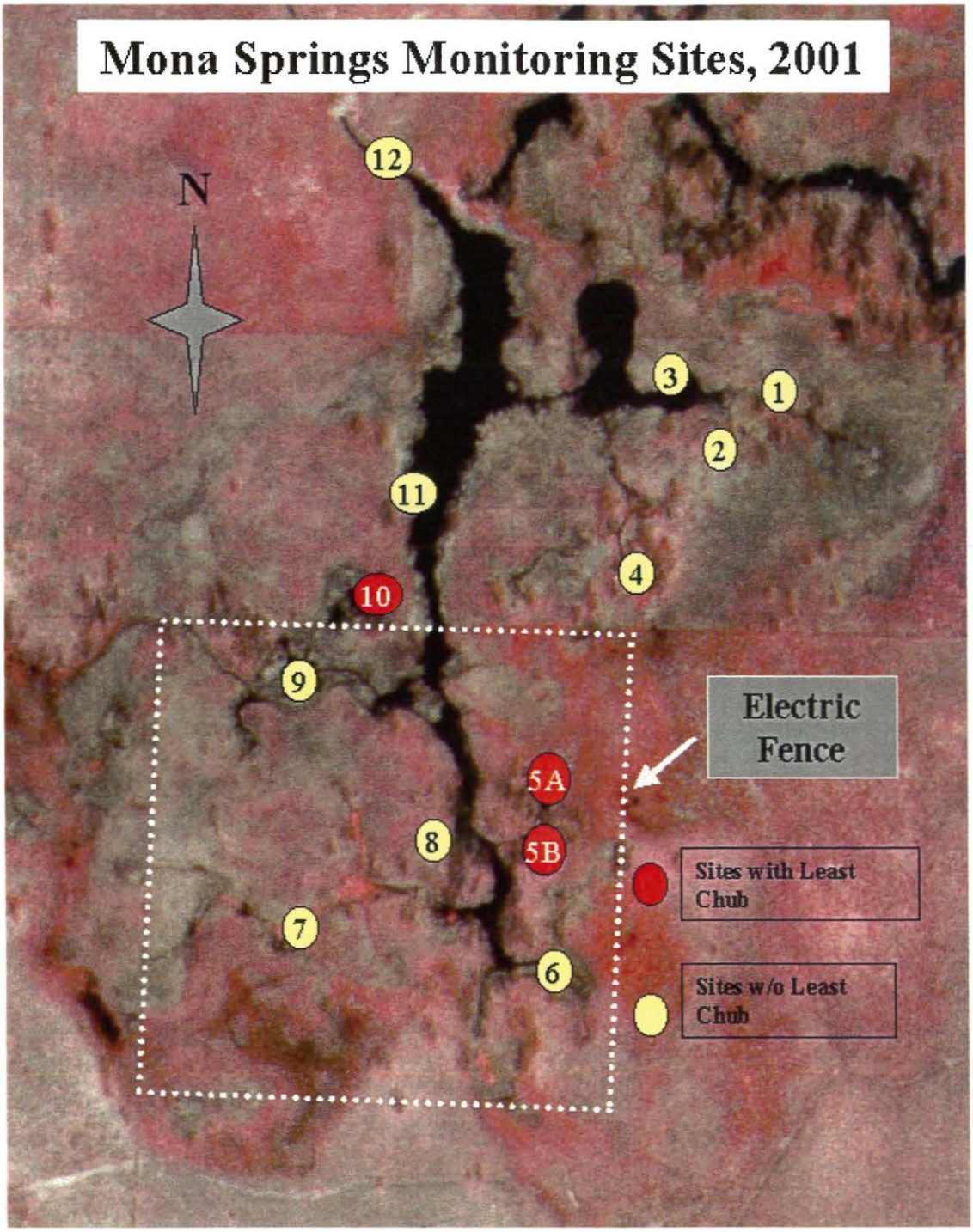

Figure 2. Aerial map of the least chub monitoring sites at Mills Valley, Juab County.

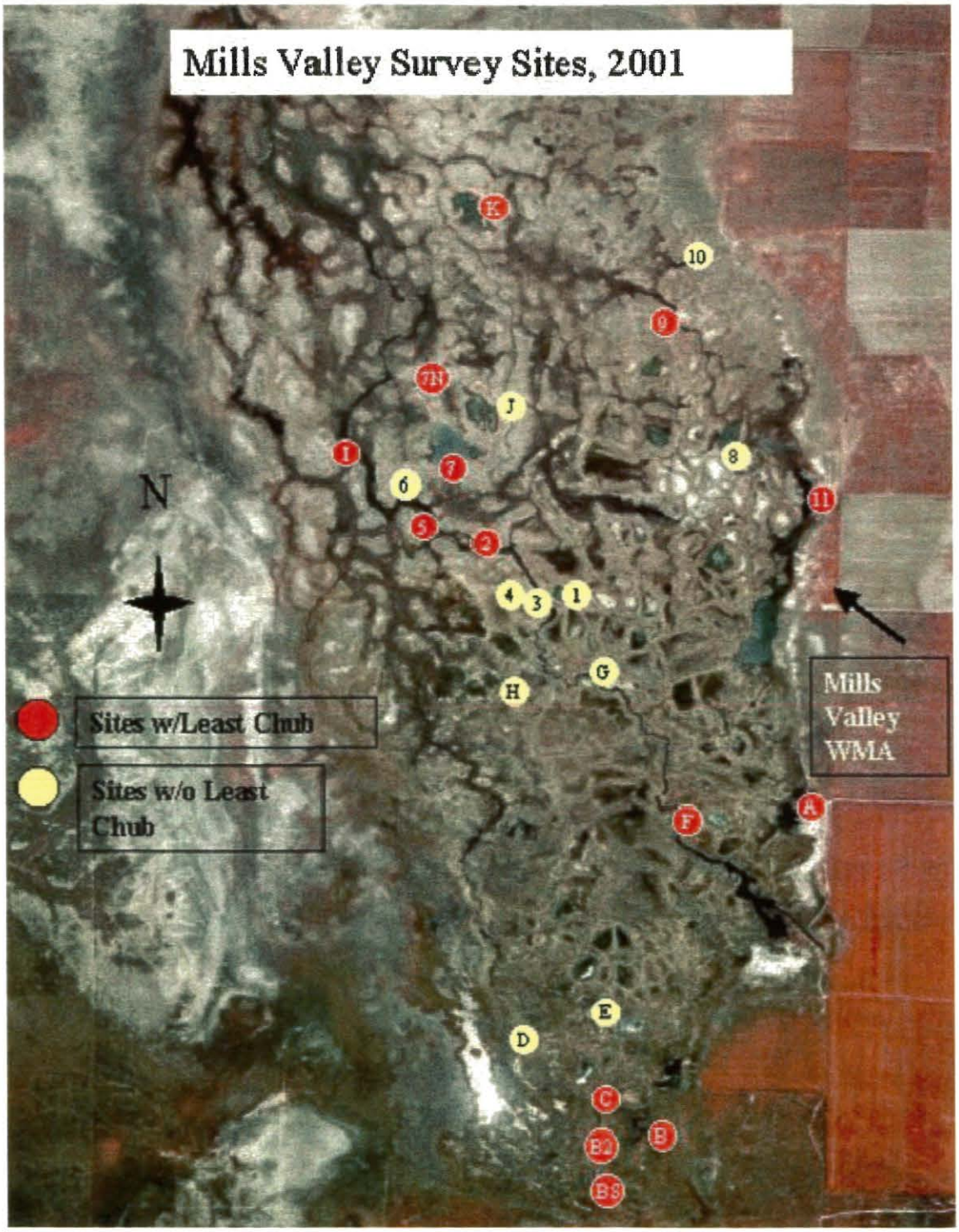

Figure 3. Least Chub length frequency distribution at Mills Valley in 2001 (n = 418).

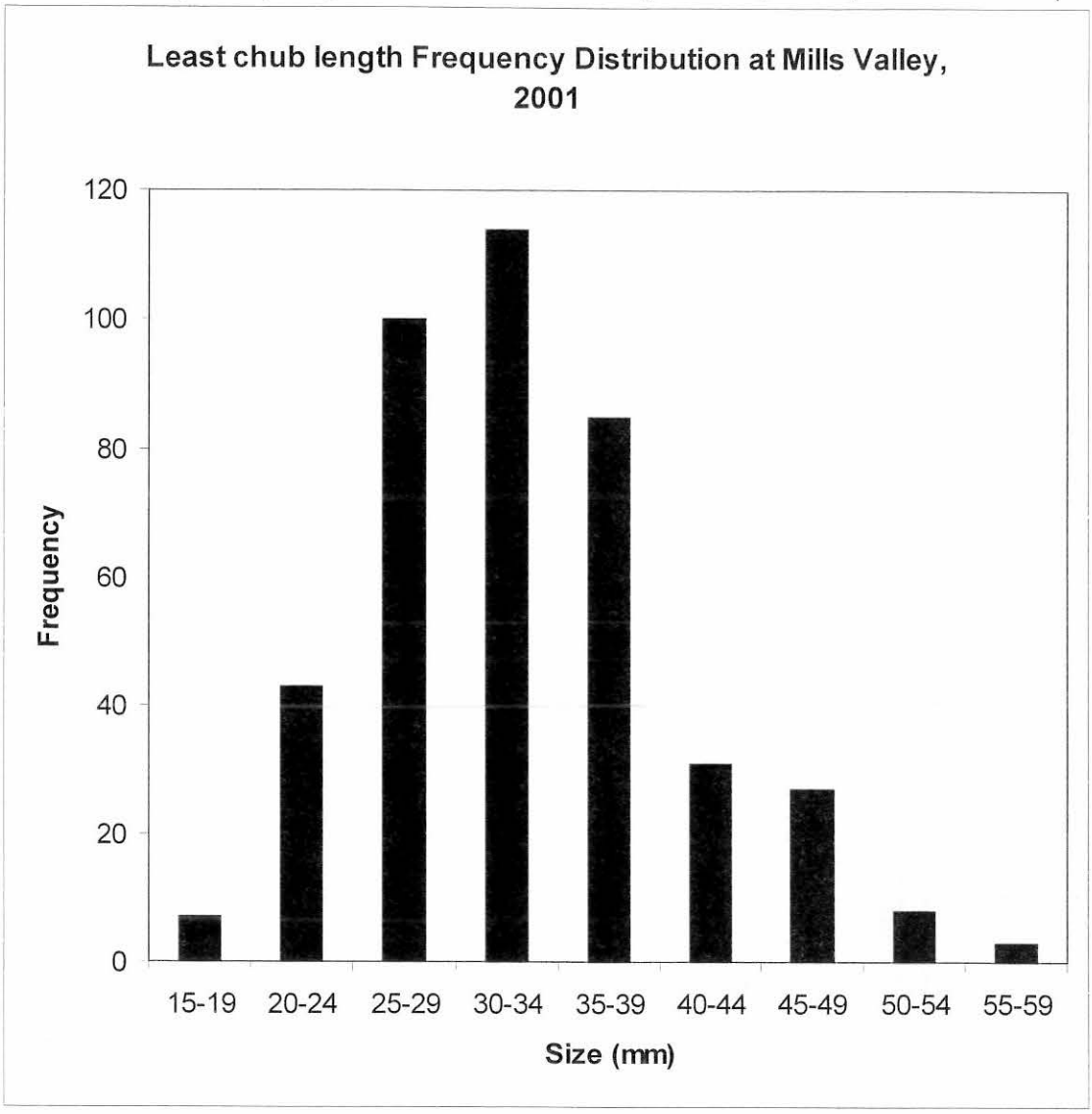

Figure 4. Least chub decline over time at Mona Spring; 1995 (n=256), 1996 (n=56), 1997 (n = 44), 1998 (n = 3), 1999 (n = 8), 2000 (n = 12), 2001 (n = 5).

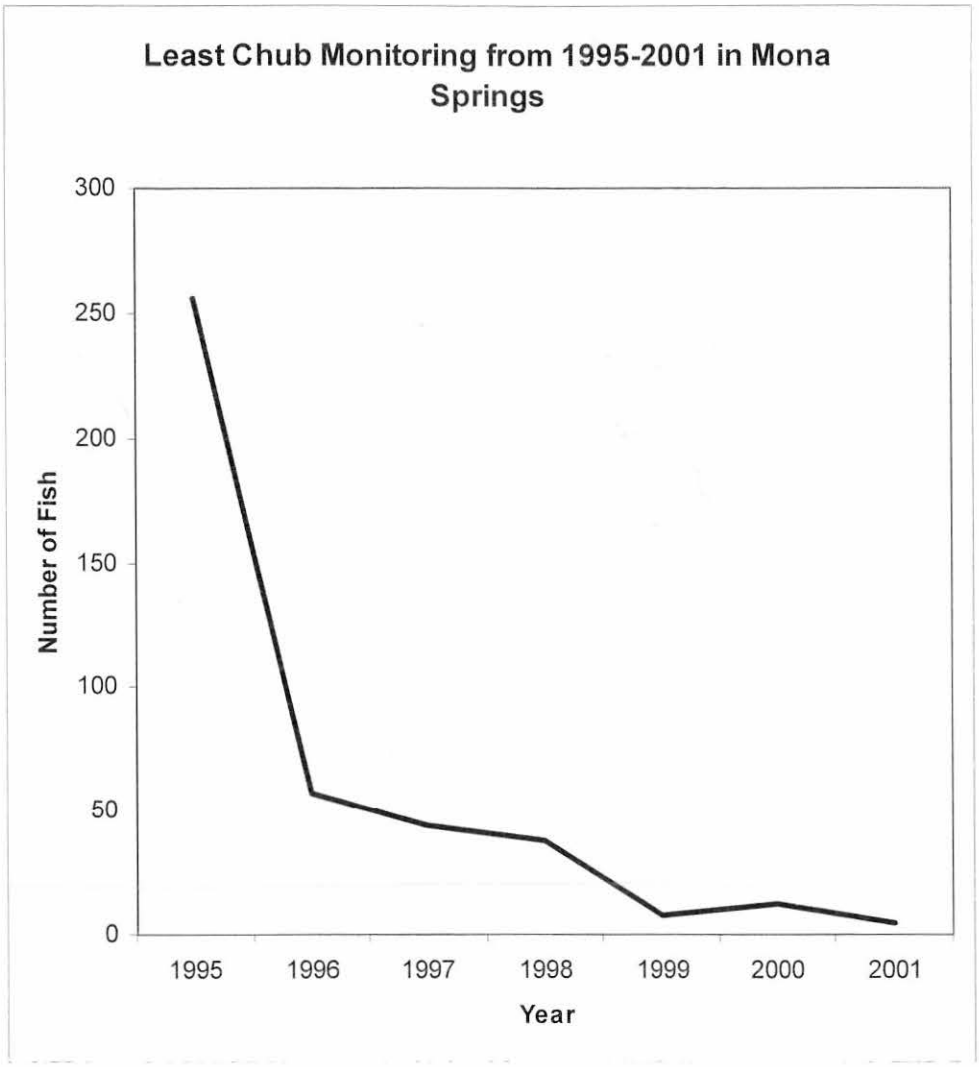

Figure 5. Change in species composition at Mona Springs, 1995-2001.

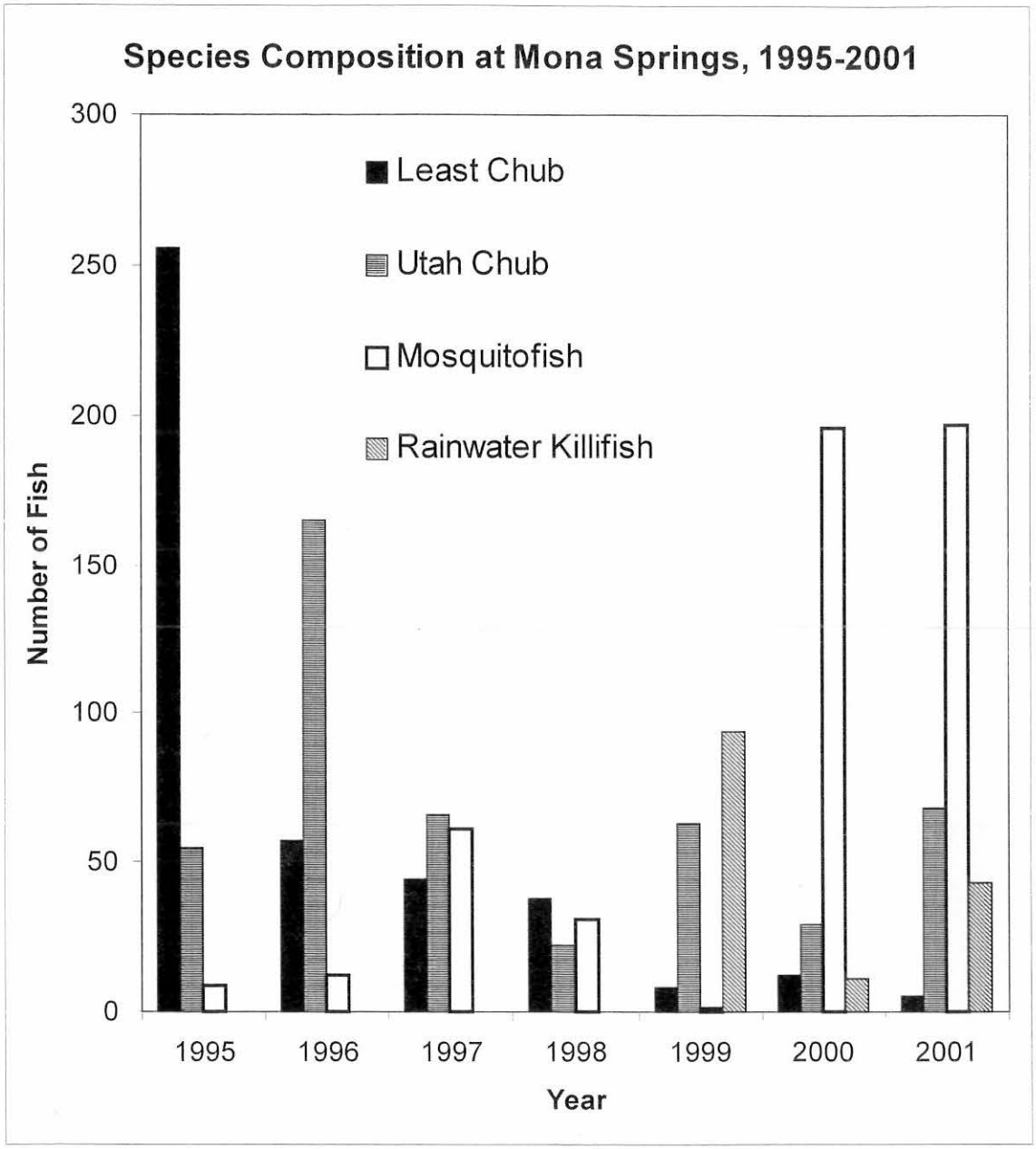

Figure 6. Change in species composition over time at Walter Spring (FSNWR), 1997-2001.

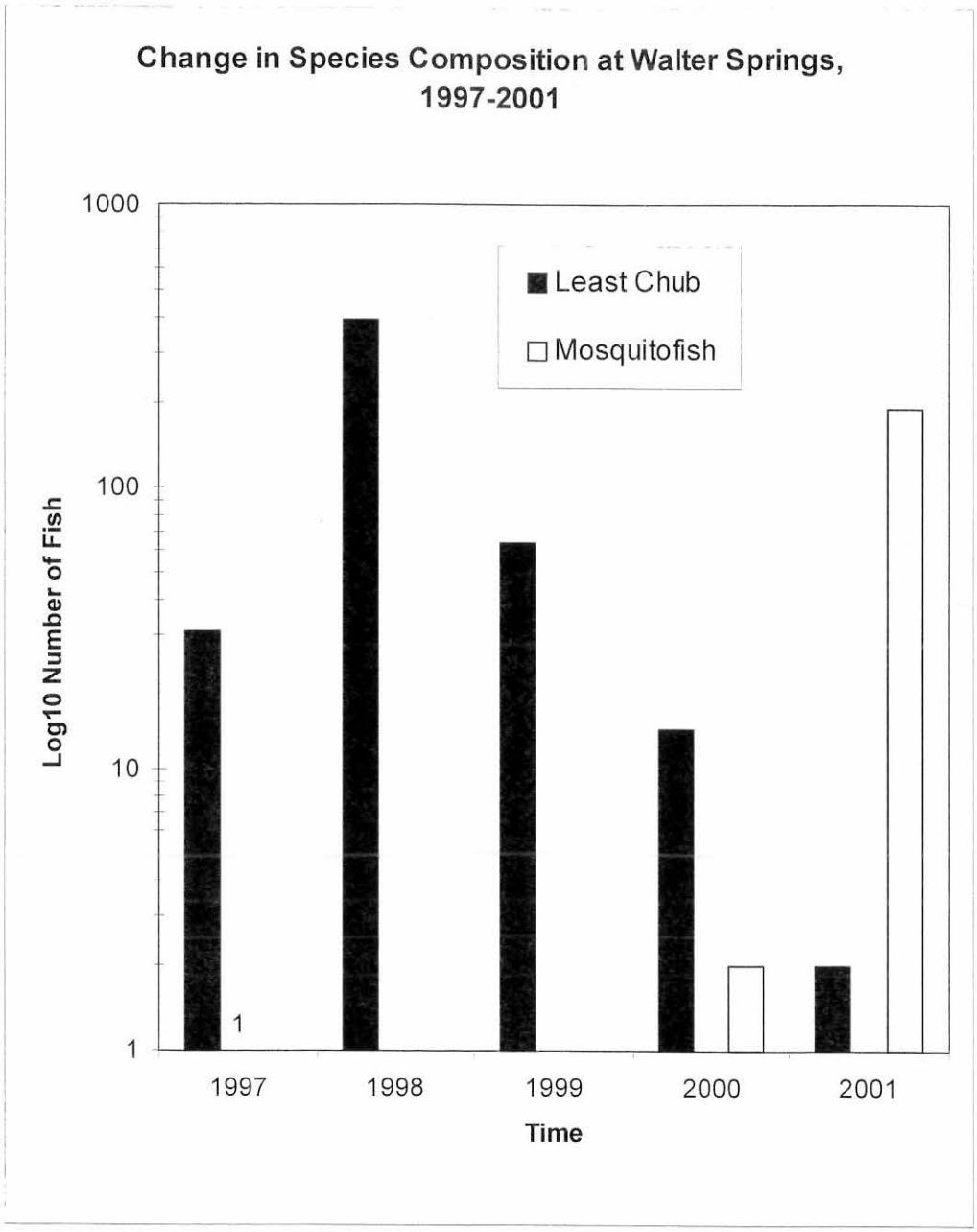

Figure 7. Change in species composition over time at Deadman Spring (FSNWR), 1997- 2001.