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Division of Wildlife Resources - Native Aquatic Species

LEAST CHUB
(*Iotichthys phlegethontis*)

MONITORING SUMMARY

Snake Valley, 2003

Publication Number 03-25
Utah Division of Wildlife Resources
1594 W. North Temple
Salt Lake City, Utah
Kevin Conway, Director

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Final Report

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INTRODUCTION

Least chub (*Iotichthys phlegethontis*) historically occupied a variety of habitats including rivers, clear streams, springs, ponds, and marshes (Sigler and Miller 1963). However, all known populations are currently restricted to isolated springs and associated marshes. Least chub habitat typically consists of small springs or ponds with cool stable temperatures, relatively low, stable dissolved oxygen values, and low conductivities (Perkins et al. 1998). Least chub are typically found in habitats consisting of moderate to dense emergent, floating, and submergent vegetation. Wetland vegetation most commonly associated with least chub habitat include: olney threesquare (*Scirpus americanus*), common threesquare (*S. pungens*), softstem bulrush (*S. validus*), wiregrass (*Juncus balticus*), 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, which are endemic to the Bonneville Basin of Utah, have been declining since the 1940s (Holden et al. 1974), and studies over the last 20 years indicate a continued decline in their distribution and abundance (Perkins et al. 1998). Collections within the Bonneville Basin indicate that the approximate range of least chub once included Big Cottonwood Creek, the Provo River, Utah Lake, Beaver River, Parowan Creek, and Snake Valley (Sigler and Miller 1963, Crist 1990). However, Workman et al. (1979) surveyed historically occupied areas in Millard, Juab, Weber, Salt Lake, and Tooele counties, and concluded that least chub had been extirpated from a majority of their original range. Specifically, Workman and his colleagues showed that least chub distribution is limited to areas within Snake Valley, including the Gandy Salt Marsh complex, Leland Harris Spring complex, Callao Spring complex, Twin Springs (Bishop Springs), and Redden Springs. Surveys conducted by Utah Division of Wildlife Resources in the mid 1990s found two previously unknown populations of least chub in Juab County: one in the Sevier River drainage within Mills Valley, and another near the town of Mona in Juab Valley (Perkins et al. 1998). Further surveys in 2003 led to the discovery of another previously unknown population of least chub at Clear Lake Waterfowl Management Area in Millard County.

The first recorded collection of least chub in Snake Valley was by C. L. Hubbs in 1942 at the Gandy Salt Marsh complex in Millard County (Sigler and Miller 1963). In 1970, R. R. Miller collected least chub from the Leland Harris spring complex in Juab County (Sigler and Sigler 1996). These findings prompted the West Desert survey conducted by Workman et al. (1979), which revealed the distribution of least chub was limited to Snake Valley. Osmundson (1985) found that least chub were most abundant in the Gandy Salt Marsh spring complex and Leland Harris spring complex within Snake Valley. He noted that least chub were least abundant in Miller Springs (near Leland) and Bishop Springs (Twin and Central Springs). Further research has indicated that least chub have been extirpated from the Callao and Redden Spring complexes (Crist 1990). Thus, within Snake Valley, least chub are limited to the Gandy Salt Marsh complex, Leland Harris spring complex, and Bishop Springs complex (Perkins et al. 1998).

Due to their declining distribution and abundance, least chub are currently classified as a conservation species by the State of Utah (Perkins et al. 1998). In 1998, the Conservation Agreement and Strategy for Least Chub (*Iotichthys phlegethontis*) in the State of Utah (Perkins et al. 1998) was developed in an effort to expand least chub populations and enhance their habitat. Conservation actions identified in the Conservation Agreement include: wetland re-vegetation, water quality improvements, grazing enclosure construction, surveys of suitable least chub habitat, control of nonnative species, genetic analysis, and monitoring of least chub populations. Long-term population monitoring is necessary to determine least chub trends and their response to implementation of conservation actions.

In August 2003, the Utah Division of Wildlife Resources conducted the eleventh consecutive year of least chub monitoring in Snake Valley, Utah. The objective of this ongoing effort is to monitor least chub populations and their habitat trends in Snake Valley within the West Desert Geographic Management Unit (Perkins et al. 1998). The areas sampled and methodology used are consistent with monitoring conducted in previous years (Fridell et al. 1999, Fridell and Marr 2000, Fridell and Malecki 2001, Fridell et al. 2002).

METHODS

In Snake Valley, least chub were sampled at three spring complexes: Leland Harris, Gandy Salt Marsh, and Bishop Springs (Figures 1-3). A total of 77 sites were visited within these complexes (Leland Harris = 12, Gandy = 52, Bishop Springs = 13). Each of the 77 sites has been designated as an annual monitoring site and has been individually marked with permanent stakes. To determine the presence/absence of least chub, a minimum of one wire minnow trap (44.5 cm long, 22.9 cm diameter, 0.66 cm mesh) was placed at each site where water depth was sufficient to submerge the trap openings. All traps were set at a minimum depth of 13 cm (5") and were left for two to four hours before being removed. Trap locations, trap depths, and total trapping times were recorded at each site. All captured fish were positively identified and respective lengths were measured and recorded. Least chub size distribution was examined for each spring complex by plotting length frequency histograms in one millimeter increments. In addition, mean length for least chub was calculated for each spring complex.

Habitat inventories were conducted at all springs to assess physical parameters of the site and to determine species occurrence and abundance of aquatic flora. Pool size, maximum water depth, substrate depth, bank condition, livestock damage, and similar habitat indices were recorded on standardized data sheets. Limited water quality parameters, including pH, dissolved oxygen, and temperatures were also recorded at each station.

RESULTS

From August 18, 2003 to August 21, 2003, a field crew totaling 13 individuals surveyed 77 pre-established sites within the Leland Harris, Gandy Salt Marsh, and Bishop Springs complexes. Least chub comprised 23.7% (least chub = 254; Utah chub = 795; speckled dace = 24) of all fish captured in Snake Valley (Tables 4, 6, and 8). Of the 77 springs sampled, least chub occurred in 21 (27.3%), Utah chub (*Gila atraria*) occurred in 19 (24.7%), and speckled dace (*Rhinichthys osculus*) occurred in eight (10.4%) (Tables

1-3). A brief synopsis of the spring complexes follows.

Leland Harris (Sample # 03-001 - 03-012)

Least chub were captured in eight of 12 (66.7%) sites sampled at Leland Harris (Table 1). Species present in this complex included least chub and Utah chub (Table 5). Least chub comprised 15.8% (least chub = 81, Utah chub = 433) of all fish captured (Table 4). Most springs were classified as having low ungulate damage consisting of minimal bank disturbance. Spring Four was classified as having moderate ungulate damage consisting of cropped vegetation around spring heads and unstable banks resulting from trampling. Among sites containing least chub, average water depth ranged from 0.03 to 1.8 m and surface water temperature ranged from 15E to 22E C (0 = 19.0E C). Dissolved oxygen ranged from 0.85 to 8.88 mg/L (0 = 2.75 mg/L), and pH ranged from 7.5 to 8.0 (0 = 7.78). Substrates at all sites in Leland Harris were primarily organic and silt.

Length frequency distributions of least chub at Leland Harris (Figure 4) show that the greatest number of fish caught were between the lengths of 37 and 50 mm. Mean length of least chub captured at Leland Harris was 43 ± 4.2 mm.

Gandy Salt Marsh (Sample # 03-013 - 03-064)

Least chub were captured in eight of 52 (15.4%) sites sampled at Gandy Salt Marsh complex (Table 1). Species present in this complex included least chub, Utah chub, and speckled dace (Table 7). Least chub comprised 68.2% (least chub = 137; Utah chub = 51; speckled dace = 13) of all fish captured (Table 6). Livestock damage was concentrated at sites outside of exclosures. Among sites containing least chub, average water depth ranged from 0.12 to 1.25 m and surface water temperatures ranged from 12.1E to 22E C (0 = 17.3E C). Dissolved oxygen ranged from 1.45 to 9.6 mg/L (0 = 4.6 mg/L), and pH ranged from 7.5 to 8.5 (0 = 7.8). Substrate of the majority of sites in the Gandy Salt Marsh complex was organic with an occurrence of silt to a lesser extent. The continuing drought has caused water levels at the Gandy Salt Marsh

complex to be lower than ever since annual monitoring began in 1993, with most water being confined to spring heads.

Length frequency distributions of least chub at Gandy Salt Marsh (Figure 5) show that the majority of fish collected were between 32 and 48 mm in length. Mean length of least chub captured at Gandy Salt Marsh was 41 ± 5.1 mm.

Bishop Springs (Sample # 03-065 - 03-077)

Least chub were captured in five of 13 (38.5%) sites sampled at Bishop Springs (Table 1). Species present in this complex included least chub, Utah chub, and speckled dace (Table 9). Least chub comprised 10.1% (least chub = 36; Utah chub = 311; speckled dace = 11) of all trapped fish (Table 8). Black spot cysts appeared on many least chub and Utah chub captured throughout Bishop Springs. Ungulate damage was low at all sites, however, at Twin Springs South, livestock has reduced the quality of the bank. Among sites containing least chub, average water depth ranged from .06 to >3.0 m, with surface water temperatures ranging from 19.6E to 29EC (0 = 23.0EC). Dissolved oxygen ranged from 1.92 to 13.07 mg/L (0 = 5.6 mg/L), and pH ranged from 7.25 to 7.8 (0 = 7.45). Organic material and clay constituted the major substrates at all Bishop Springs sites.

Least chub length frequency distributions for Bishop Springs show that most fish collected were between 39 and 46 mm in length (Figure 6). Mean length of least chub captured at Bishop Springs was 41 ± 3.6 mm.

Lower parts of Bishop Springs have dried annually in recent years due to dewatering at Foote Reservoir and drought. Sites 1 and 2 have been dry or had less than five cm of water since 1996. This year a much larger section of Bishop Springs was dry including sites 3, 4, and 5. To verify presence of fish, six traps were set for three hours between the Foote Reservoir outflow and site 5. Utah chub, speckled dace, and young of year common carp (*Cyprinus carpio*) were captured in these traps. This is the first time common carp have been captured during monitoring in Snake Valley.

SUMMARY

Leland Harris

- X Least chub were trapped in eight of 12 (66.7%) of the springs at Leland Harris (Table 1).
- X Since annual monitoring began in 1993, Leland Harris has yielded the highest percentage of springs containing least chub 9 of 11 years (Table 1).
- X All Leland Harris sites have yielded least chub at least once since monitoring began in 1993.

Gandy Salt Marsh

- X Least chub were trapped in eight of 52 (15.4%) of the springs at Gandy Salt Marsh (Table 1). This is the lowest percentage of sites containing least chub recorded since monitoring began in 1993.
- X For the third year in a row, water levels at Gandy Salt Marsh complex were the lowest since annual monitoring began. Eight traps could not be set because the site was dry or there was too little water.
- X Livestock damage has been controlled by the construction of exclosures, and has been confined to areas outside of these exclosures. The damage outside of the north exclosure is extensive, including one site that contained a decomposing cow carcass.
- X Least chub have been captured in a total of 29 different springs since 1993 (Table 7).

Bishop Springs

- X Least chub were trapped in five of 13 (38.5%) of the springs at Bishop Springs (Table 1). This is the same percentage as in 1997, which is the lowest number of sites containing least chub since monitoring began in 1993.
- X Largemouth bass (*Micropterus salmoides*) were observed at South Twin Spring, Foote Reservoir and Central Spring (Site 7).
- X Sites 1 through 5 were dry due to dewatering at Foote Reservoir and drought conditions (Table 9).

X Dewatering at Foote Reservoir is continuing to reduce habitat and threaten long-term viability of least chub at Bishop Springs.

Table 1. Number and percentage of springs where least chub were captured at Leland Harris, Gandy Salt Marsh, and Bishop Springs from 1993 to 2003.

Year	Leland Harris	Gandy	Bishop Springs	Total
1993	07 of 11 (63.6%)	22 of 50 (44.0%)	11 of 13 (84.6%)	40 of 74 (54.1%)
1994	08 of 12 (66.7%)	18 of 50 (36.0%)	07 of 13 (53.8%)	33 of 75 (44.0%)
1995	10 of 12 (83.3%)	15 of 50 (30.0%)	05 of 11 (45.5%)	30 of 73 (41.1%)
1996	08 of 12 (66.7%)	15 of 50 (30.0%)	08 of 13 (61.5%)	31 of 75 (41.3%)
1997	10 of 12 (83.3%)	13 of 50 (26.0%)	05 of 13 (38.5%)	28 of 75 (37.3%)
1998	09 of 12 (75.0%)	15 of 51 (29.4%)	09 of 13 (69.2%)	33 of 76 (43.4%)
1999	10 of 12 (83.3%)	15 of 51 (29.4%)	07 of 13 (53.9%)	32 of 76 (42.1%)
2000	09 of 12 (75.0%)	15 of 52 (28.9%)	08 of 13 (61.5%)	32 of 77 (41.6%)
2001	07 of 12 (58.3%)	11 of 52 (21.2%)	08 of 13 (61.5%)	26 of 77 (33.8%)
2002	09 of 12 (75.0%)	11 of 52 (21.2%)	09 of 13 (69.2%)	29 of 77 (37.7%)
2003	08 of 12 (66.7%)	08 of 52 (15.4%)	05 of 13 (38.5%)	21 of 77 (27.3%)

Table 2. Number and percentage of springs where Utah chub were captured at Leland Harris, Gandy Salt Marsh, and Bishop Springs from 1993 to 2003.

Year	Leland Harris	Gandy	Bishop Springs	Total
1993	09 of 11 (81.8%)	07 of 50 (14.0%)	10 of 13 (76.9%)	26 of 74 (35.1%)
1994	07 of 12 (58.3%)	08 of 50 (16.0%)	08 of 13 (61.5%)	23 of 75 (30.7%)
1995	08 of 12 (66.7%)	14 of 50 (28.0%)	09 of 11 (81.8%)	31 of 73 (42.5%)
1996	08 of 12 (66.7%)	10 of 50 (20.0%)	09 of 13 (69.2%)	27 of 75 (36.0%)
1997	10 of 12 (83.3%)	05 of 50 (10.0%)	06 of 13 (46.2%)	21 of 75 (28.0%)
1998	08 of 12 (66.7%)	09 of 51 (17.7%)	09 of 13 (69.2%)	26 of 76 (34.2%)
1999	09 of 12 (75.0%)	04 of 51 (07.8%)	07 of 13 (53.9%)	20 of 76 (26.3%)
2000	08 of 12 (66.7%)	04 of 52 (07.7%)	09 of 13 (69.2%)	21 of 77 (27.3%)
2001	10 of 12 (83.3%)	04 of 52 (07.7%)	10 of 13 (76.9%)	24 of 77 (31.2%)
2002	07 of 12 (58.3%)	04 of 52 (07.7%)	12 of 13 (92.3%)	23 of 77 (29.9%)
2003	08 of 12 (66.7%)	03 of 52 (5.8%)	08 of 13 (61.5%)	19 of 77 (24.7%)

Table 3. Number and percentage of springs where speckled dace were captured at Leland Harris, Gandy Salt Marsh, and Bishop Springs from 1993 to 2003.

Year	Leland Harris	Gandy	Bishop Springs	Total
1993	0 of 11 (00.0%)	27 of 50 (54.0%)	05 of 13 (38.5%)	32 of 74 (43.2%)
1994	0 of 12 (00.0%)	13 of 50 (26.0%)	02 of 13 (15.4%)	15 of 75 (20.0%)
1995	0 of 12 (00.0%)	15 of 50 (30.0%)	03 of 11 (27.3%)	18 of 73 (24.7%)
1996	0 of 12 (00.0%)	21 of 50 (42.0%)	00 of 13 (00.0%)	21 of 75 (28.0%)
1997	0 of 12 (00.0%)	14 of 50 (28.0%)	00 of 13 (00.0%)	14 of 75 (18.7%)
1998	0 of 12 (00.0%)	07 of 51 (13.7%)	02 of 13 (15.4%)	09 of 76 (11.8%)
1999	0 of 12 (00.0%)	03 of 51 (05.9%)	02 of 13 (15.4%)	05 of 76 (06.6%)
2000	0 of 12 (00.0%)	10 of 52 (19.2%)	02 of 13 (15.4%)	12 of 77 (15.6%)
2001	0 of 12 (00.0%)	07 of 52 (13.5%)	04 of 13 (30.8%)	11 of 77 (14.3%)
2002	0 of 12 (00.0%)	10 of 52 (19.2%)	02 of 13 (15.4%)	12 of 77 (15.6%)
2003	0 of 12 (00.0%)	5 of 52 (09.6%)	03 of 13 (23.1%)	08 of 77 (10.4%)

Table 4. Species and number of fish captured at Leland Harris springs (n = 12), Snake Valley, Utah from 1999 to 2003.

Spring No.	1999	2000	2001	2002	2003
1	LC=19,UC=31	UC=5	UC=4	-	LC=2,UC=25
2a	LC=81,UC=28	LC=32,UC=15	LC=34,UC=123	LC=3,UC=121	UC=43
2b	LC=84,UC=36	LC=16,UC=16	LC=4,UC=84	LC=53,UC=121	LC=38,UC=244
3	LC=120,UC=2	LC=32	LC=19,UC=52	LC=8,UC=3	LC=6,UC=1
4	LC=15	LC=12	LC=21	LC=16	LC=11
5	LC=210	LC=14	LC=7,UC=3	LC=6	-
6	LC=2	LC=4	UC=12	LC=9,UC=5	LC=2
7	LC=42,UC=165	LC=8,UC=99	LC=32,UC=185	LC=138,UC=43	LC=11,UC=101
8	LC=6,UC=17	UC=4	-	-	UC=1
9	UC=182	UC=5	UC=138	LC=1,UC=45	UC=12
10	UC=34	LC=1,UC=1	UC=46	-	LC=2,UC=6
11	LC=16,UC=123	LC=213,UC=30	LC=93,UC=2	LC=9,UC=9	LC=9
Total	LC=595,UC=618	LC=332,UC=175	LC=210,UC=649	LC=243,UC=347	LC=81,UC=433

LC = least chub, UC = Utah chub

Table 5. Fish species captured at Leland Harris, Snake Valley, Utah from 1993 to 2003.

Spring	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	LC, UC	LC, UC	LC, UC	LC, UC	UC	LC, UC	LC, UC	UC	UC	-	LC, UC
2a	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	UC
2b	-	LC, UC	LC, UC	LC, UC	LC, UC	LC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC
3	LC	LC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC	LC, UC	LC, UC	LC, UC
4	LC	LC	LC	LC	LC	LC	LC	LC	LC	LC	LC
5	UC	-	LC	-	LC	LC	LC	LC	LC, UC	LC	-
6	LC, UC	LC, UC	LC, UC	LC	LC, UC	UC	LC	LC	UC	LC, UC	LC
7	UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC
8	LC, UC	-	LC	-	LC, UC	LC	LC, UC	UC	-	-	UC
9	UC	-	UC	UC	UC	UC	UC	UC	UC	LC, UC	UC
10	UC	-	-	UC	LC, UC	UC	UC	LC, UC	UC	-	LC, UC
11	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC

LC = least chub, UC = Utah chub

Table 6. Species and number of fish captured by spring (n = 52) in the Gandy Salt Marsh complex, Snake Valley, Utah from 1999 to 2003.

Spring No.	1999	2000	2001	2002	2003
1	-	-	-	-	Water Depth < 5cm
2	-	-	-	-	-
3	-	-	-	-	Water Depth < 5cm
4	SD = 1	-	-	-	-
5	LC = 19	LC = 9, SD = 1	LC = 22, SD = 4	LC = 3, SD = 8	-
6	LC = 1	LC = 7, SD = 2	-	LC = 5, SD = 2	-
7	Water Depth < 5cm	Water Depth < 5cm	Water Depth < 5cm	Water Depth < 5cm	-
8	LC = 11	LC = 33	LC = 115, SD = 13	LC = 240, SD = 29	LC = 1, SD = 1
9	-	-	-	-	-
10	-	-	-	-	-
11	-	-	-	Water Depth < 5cm	-
12	-	LC = 1	-	Water Depth < 5cm	Water Depth < 5cm
13	-	-	-	-	-
14	LC = 164, UC = 1	LC = 25, UC = 4	LC = 51, UC = 2	LC = 41, SD = 13	-
15	LC = 3	-	Water Depth < 5cm	Water Depth < 5cm	-
16	LC = 1, UC = 1	LC = 1	LC = 4, UC = 7	-	LC = 13, UC = 15
17	LC = 13	LC = 21	LC = 72, UC = 2, SD = 1	LC = 12, UC = 19, SD = 1	LC = 8, UC = 35, SD = 2
18	-	Water Depth < 5cm	-	Water Depth < 5cm	-
19	-	-	-	Water Depth < 5cm	-
20	LC = 5	LC = 4, UC = 2	LC = 14	LC = 7, UC = 13	LC = 11, UC = 1
21	-	-	-	-	-
22	-	-	-	Water Depth < 5cm	-
23	-	-	-	-	-
24	-	-	-	Water Depth < 5cm	-
25	Water Depth < 5cm	-	Water Depth < 5cm	Water Depth < 5cm	-
26	LC = 2, UC = 4, SD = 1	SD = 1	UC = 1	UC = 2	-
27	-	-	-	-	-

Table 6. (continued)

Spring No.	1999	2000	2001	2002	2003
28	LC = 335	LC = 56, SD = 8	LC = 16, SD = 8	LC = 50, SD = 23	LC = 2, UC = 6
29-37	LC = 18	LC = 40, SD = 5	-	SD = 1	-
38	LC = 134	LC = 219	LC = 378, SD = 273	LC = 112, SD = 18	LC = 100, SD = 2
39	SD = 1	LC = 9, SD = 3	LC = 54, SD = 273	LC = 7, SD = 7	-
40	-	SD = 1	SD = 4	-	SD = 2
41	-	-	-	-	-
42	-	-	-	-	LC = 1
43	-	-	-	-	-
44	LC = 5, UC = 2	LC = 117	LC = 5	LC = 29, UC = 4	-
45	-	SD = 1	-	-	-
46	LC = 21	LC = 29	LC = 24	-	-
47	-	-	-	-	-
48	-	-	-	-	-
49	-	-	-	-	-
50	-	Water Depth < 5cm	Water Depth < 5cm	Water Depth < 5cm	Water Depth < 5cm
51	-	-	-	-	-
52	-	Water Depth < 5cm	-	-	-
53	-	LC = 12, SD = 16	Water Depth < 5cm	LC = 13, SD = 5	LC = 1
54	-	UC = 16, SD = 1	-	-	-
55	-	UC = 2	-	-	-
56	-	-	-	-	-
57	LC = 1	Water Depth < 5cm	Water Depth < 5cm	Water Depth < 5cm	-
58	-	-	-	-	-
59	Not Sampled	-	-	-	-
60	-	-	-	-	-
Total	LC = 732, UC = 8, SD = 3	LC = 583, UC = 24, SD = 39	LC = 755, UC = 12, SD = 30	LC = 519, UC = 38, SD = 107	LC = 137, UC = 51, SD = 13

LC = least chub, UC = Utah chub, SD = speckled dace

Table 7. Fish species captured at Gandy Salt Marsh complex, Snake Valley, Utah from 1993 to 2003.

Spring	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-	-	-	-	-	-	-	-	-	-	*
2	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	*
4	SD	-	-	-	-	SD	SD	-	-	-	-
5	SD	LC	-	LC, SD	-	-	LC	LC, SD	LC, SD	LC, SD	-
6	LC	LC	LC	LC, SD	SD	LC	LC	LC, SD	-	LC, SD	-
7	-	*	*	*	*	*	*	*	*	*	-
8	LC, SD	LC	LC, SD	LC	LC	LC	LC	LC	LC, SD	LC, SD	LC, SD
9	-	SD	-	LC, UC, SD	LC	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-
11	LC, SD	UC	-	-	-	-	-	-	-	*	-
12	LC, SD	LC	LC	LC	-	LC, UC	-	LC	-	*	*
13	-	-	-	-	SD	-	-	-	-	-	-
14	LC, SD	LC, SD	LC, UC, SD	LC, UC, SD	LC, SD	LC	LC, UC	LC, UC	LC, UC	LC, SD	-
15	LC, SD	-	-	-	*	*	LC	-	*	*	-
16	LC, UC	LC, UC	UC	UC, SD	UC, SD	UC	LC, UC	LC	LC, UC	-	LC, UC
17	LC, UC	LC, UC, SD	LC, UC, SD	LC, UC, SD	LC, UC, SD	LC	LC	LC	LC, UC, SD	LC, UC, SD	LC, UC, SD
18	-	-	-	-	-	-	-	*	-	*	-
19	-	-	-	-	-	-	-	-	-	*	-
20	SD	SD	UC	UC	-	LC, UC	LC	LC, UC	LC	LC, UC	LC, UC
21	-	-	-	-	-	-	-	-	-	-	-
22	SD	-	UC	-	-	-	-	-	-	*	-
23	-	-	-	-	-	-	-	-	-	-	-
24	LC	-	UC	SD	-	-	-	-	-	*	-
25	-	-	*	*	*	-	*	-	*	*	-
26	LC, SD	UC	LC, UC	-	UC	UC	LC, UC, SD	Sd	UC	UC	-
27	SD	-	-	SD	-	-	-	-	-	-	-

Table 7. (continued)

Spring	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
28	LC	LC	UC	LC, SD	LC	LC, SD	LC	LC, SD	LC, SD	LC, SD	LC, UC
29-37	LC, SD	-	LC, SD	LC, SD	LC, SD	LC, SD	LC	LC, SD	-	SD	-
38	LC, SD	LC, SD	LC, SD	LC	LC	LC	LC	LC	LC, SD	LC, SD	LC, SD
39	LC, SD	LC, SD	UC, SD	SD	LC, SD	LC, SD	SD	LC, SD	LC, SD	LC, SD	-
40	SD	-	SD	SD	LC, SD	-	-	SD	SD	-	SD
41	-	-	-	-	-	-	-	-	-	-	-
42	LC, UC, SD	LC	LC, UC, SD	SD	-	-	-	-	-	-	LC
43	LC, SD	LC, UC, SD	LC, SD	LC, SD	-	-	-	-	-	-	-
44	LC, UC, SD	LC, UC	LC, UC, SD	LC, UC, SD	LC	LC, UC	LC, UC	LC	LC	LC, UC	-
45	LC, UC, SD	LC, UC, SD	SD	LC, UC, SD	-	LC, UC	-	SD	-	-	-
46	LC, SD	LC, SD	LC, UC, SD	LC, UC, SD	LC, UC	LC	LC	LC	LC	-	-
47	SD	SD	SD	-	-	-	-	-	-	-	-
48	SD	-	SD	-	SD	-	-	-	-	-	-
49	-	-	-	-	-	-	-	-	-	-	-
50	-	-	-	-	*	*	-	*	*	*	*
51	-	-	-	-	-	LC, UC	-	-	-	-	-
52	-	-	-	SD	SD	-	-	*	-	-	-
53	LC, SD	-	-	SD	LC, SD	LC, SD	-	LC, SD	*	LC, SD	LC
54	-	LC, SD	-	UC	-	UC, SD	-	UC, SD	-	-	-
55	UC, SD	LC, UC, SD	LC, UC	LC, UC	UC, SD	UC	-	UC	-	-	-
56	LC, SD	LC, SD	LC, SD	SD	LC, SD	SD	-	-	-	-	-
57	LC, UC, SD	-	LC	SD	LC	-	LC	*	*	*	-
58	SD	-	-	-	SD	-	-	-	-	-	-
59	#	#	#	#	#	#	#	-	-	-	-
60	#	#	#	#	#	-	-	-	-	-	-

LC = least chub, UC = Utah chub, SD = speckled dace

* = Contained < 5cm of Water

= Site Not Sampled

Table 8. Species and number of fish captured by spring (n = 13) in Bishop Springs , Snake Valley, Utah from 1999 to 2003.

Spring No.	1999	2000	2001	2002	2003
South Twin	-	‡	UC = 1	UC = 1, †	LC = 2, UC = 18, †
North Twin	-	UC = 7	UC = 30	UC = 8	UC = 45
1	*	*	-	LC = 5, UC = 3, SD = 1	*
2	*	*	LC = 4	LC = 2, UC = 2	*
3	LC = 4	LC = 8, UC = 5	LC = 1, UC = 3	LC = 3, UC = 11	*
4	-	LC = 12, UC = 12	LC = 8, UC = 62	LC = 15, UC = 46	*
5	LC = 11, UC = 21, SD = 1	LC = 7, UC = 14, SD = 1	UC = 19	LC = 4, UC = 19	*
6	LC = 4	LC = 6, UC = 1	LC = 7, UC = 5, SD = 3	LC = 4, UC = 2, SD = 3	LC = 7, UC = 7, SD = 4
7	LC = 5, UC = 91	LC = 6, UC = 22	LC = 9, UC = 60, SD = 1	LC = 4, UC = 38, †	LC = 12, UC = 167
8	LC = 2, UC = 16	LC = 6, UC = 38, SD = 1	LC = 1, UC = 4, SD = 1	LC = 13, UC = 17	UC = 12, SD = 3
9	LC = 7, UC = 13	LC = 1, UC = 39	UC = 15, SD = 1	-	LC = 1, UC = 30
10	UC = 17, SD = 3	UC = 52	LC = 6, UC = 41	UC = 16	UC = 22, SD = 4
11	LC = 6, UC = 1	LC = 2	LC = 17, UC = 8	LC = 4, UC = 2	LC = 14, UC = 10
Total	LC = 39, UC = 159, SD = 4	LC = 48, UC = 190, SD = 2	LC = 53, UC = 248, SD = 6	LC = 54, UC = 165, SD = 4	LC = 36, UC = 311, SD = 11

LC = least chub, UC = Utah chub, SD = speckled dace

† Largemouth bass observed

‡ Largemouth bass and goldfish observed

* = Area de-watered due to diversion of Foote Reservoir

Table 9. Fish species captured at Bishop Springs, Snake Valley, Utah from 1993 to 2003.

Spring	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
S Twin	LC, UC	UC, ‡	UC, ‡	UC, ‡	UC, ‡	‡	-	‡	UC	UC, †	LC, UC, †
N Twin	UC, ‡	UC	UC	UC, ‡	UC, ‡	UC	-	UC	UC	UC	UC
1	LC	*	Not Sampled	LC, UC	*	*	*	*	-	LC, UC, SD	*
2	LC, SD	-	Not Sampled	LC	*	*	*	*	LC, UC	LC, UC	*
3	LC, UC	LC	*	LC, UC	*	LC, UC, SD	LC	LC, UC	LC, UC	LC, UC	*
4	LC, UC	LC, UC, SD	*	LC, UC	*	LC, UC, LB	-	LC, UC	LC, UC	LC, UC	*
5	LC, UC, SD	LC, UC	LC, UC, SD	LC, UC	*	LC, UC, SD	LC, UC, SD	LC, UC, SD, LB	UC	LC, UC	*
6	LC, UC	LC	LC, UC, SD	-	LC	LC	LC	LC, UC	LC, UC, SD	LC, UC, SD	LC, UC, SD
7	LC, UC, SD	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC, SD	LC, UC, SD, †	LC, UC
8	UC, SD	LC	LC, UC, SD	LC, UC	LC, UC	LC, UC	LC, UC	LC, UC, SD	LC, UC, SD	LC, UC	UC, SD
9	LC, UC	UC	UC	UC	LC, UC	LC, UC	LC, UC	LC, UC	UC, SD	-	LC, UC
10	LC, UC, SD	LC, UC	UC	-	UC	LC, UC	UC, SD	UC	LC, UC	UC	UC, SD
11	LC	UC, SD	LC, UC	LC	LC	LC, UC	LC, UC	LC	LC, UC	LC, UC	LC, UC

LC = least chub, UC = Utah chub, SD = speckled dace, LB = largemouth bass, GF = goldfish

■ Largemouth bass observed

‡ Largemouth bass and goldfish observed

* Area de-watered due to diversion of Foote Reservoir.

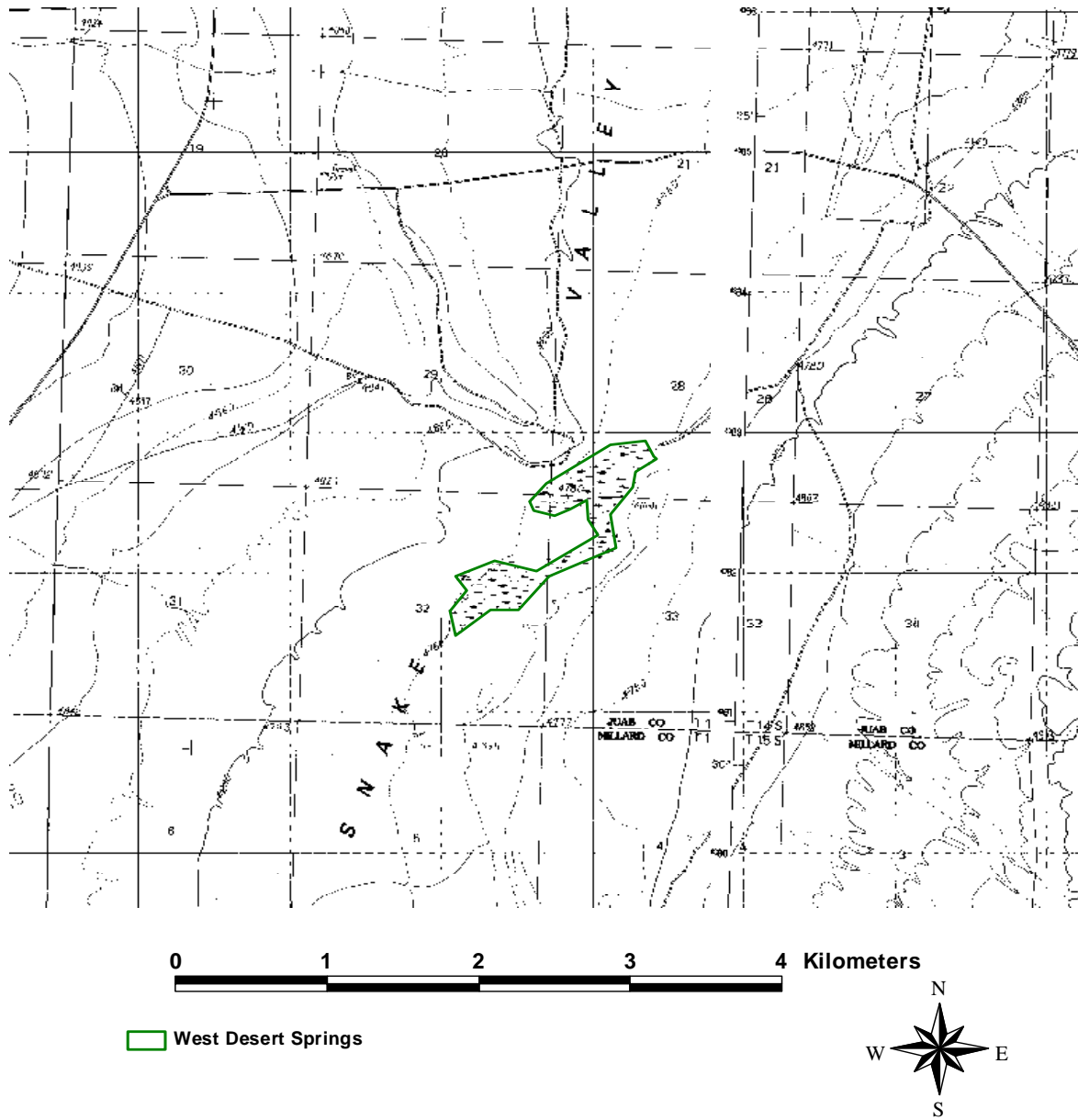


Figure 1. Location of Leland Harris least chub monitoring site. Gandy quadrangle, 7.5 minute series, 1:25,000 Scale, Juab Co.,

UT.

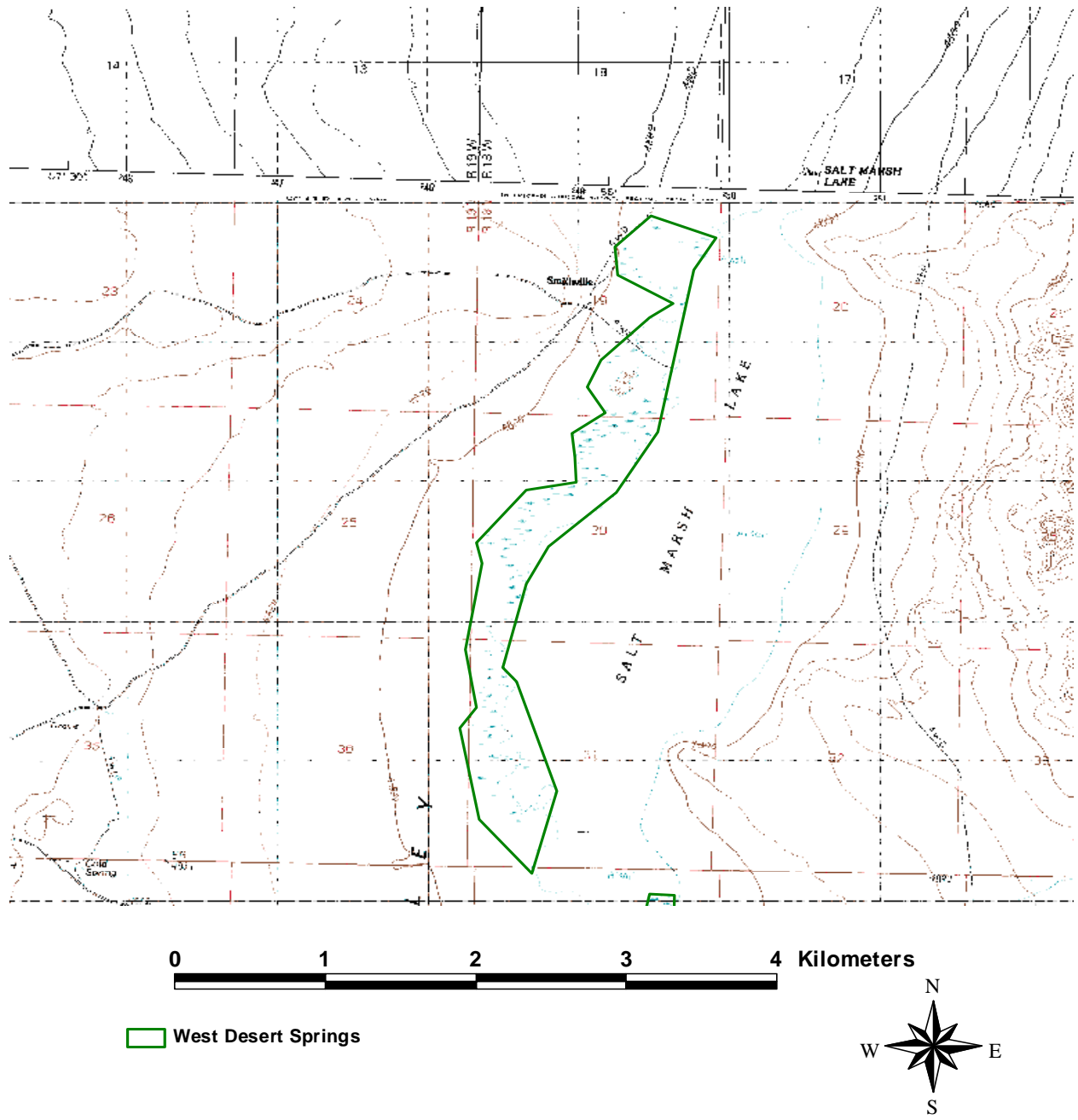


Figure 2. Location of Gandy Salt Marsh least chub monitoring site. Gandy quadrangle, 7.5 minute series, 1:25,000 Scale, Juab

Co., UT.

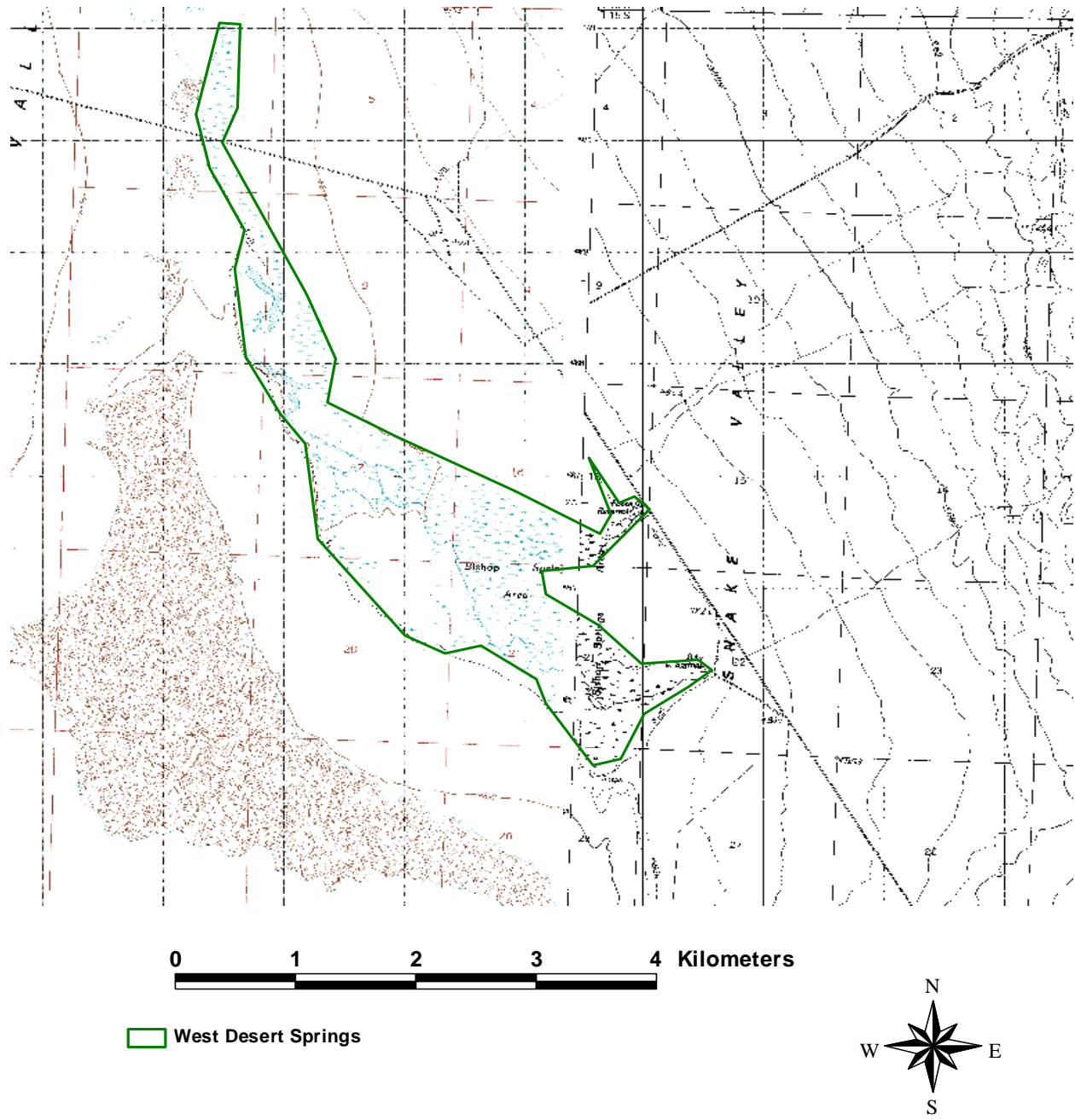


Figure 3. Location of Bishop Springs least chub monitoring site. Gandy quadrangle, 7.5 minute series, 1:25,000 Scale, Juab Co.,

UT.

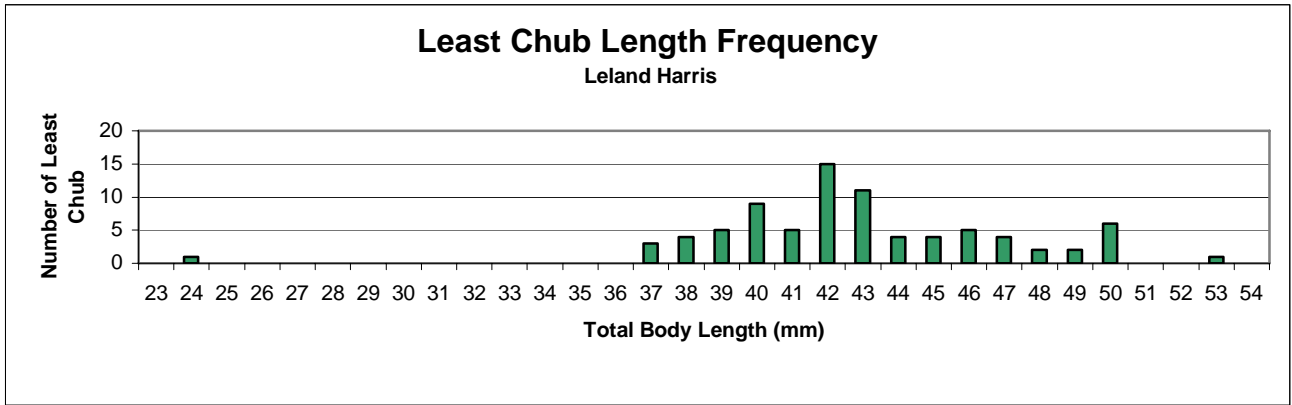


Figure 4. Length frequency distribution of least chub (n = 81) captured at Leland Harris monitoring sites, Snake Valley, Utah, August 2003.

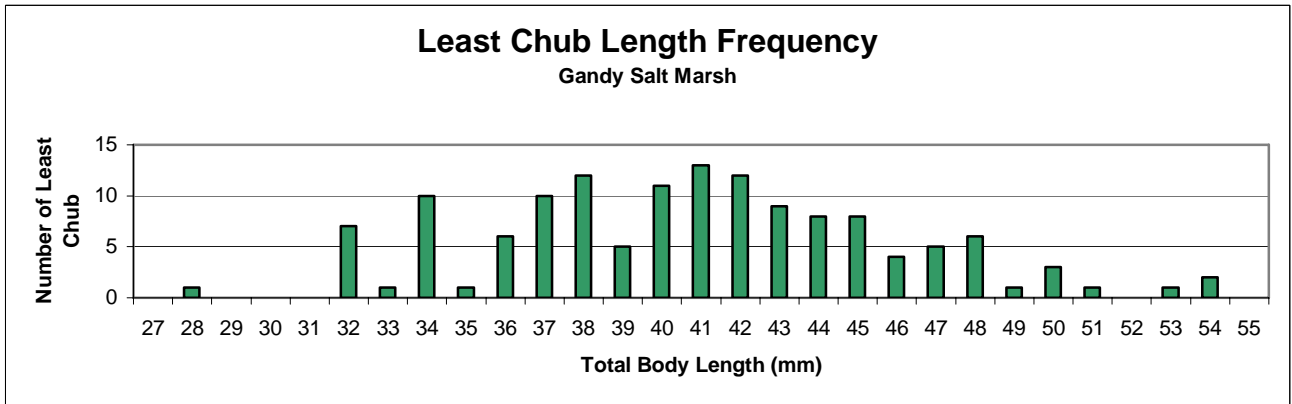


Figure 5. Length frequency distribution of least chub (n = 137) captured at Gandy Salt Marsh complex monitoring sites, Snake Valley, Utah, August 2003.

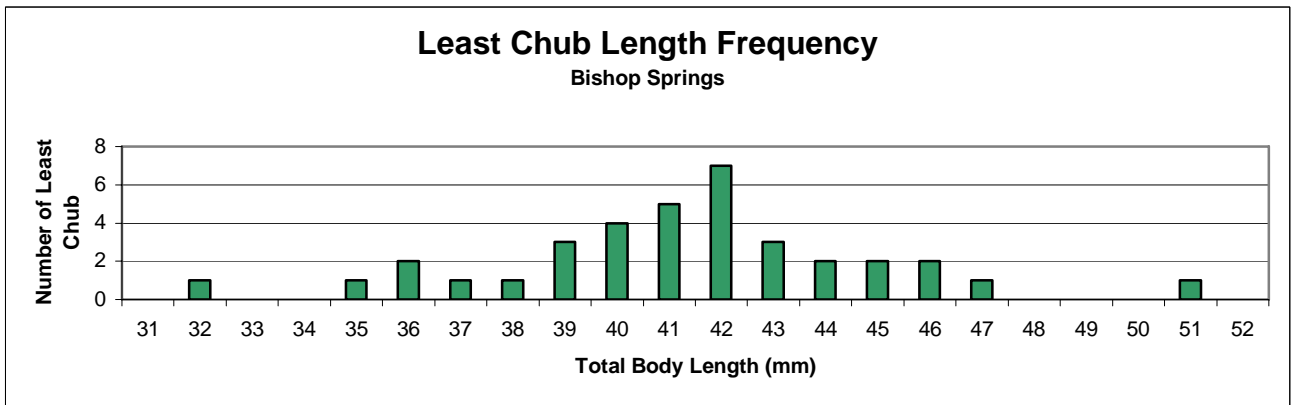


Figure 6. Length frequency distribution of least chub (n = 36) captured at Bishop Springs monitoring sites, Snake Valley, Utah, August 2003.

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