Habitat Use and Movement of

Bluehead Sucker, Flannelmouth Sucker, and Roundtail Chub in the Colorado River

Final Report to:

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11 January 2001

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Acknowledgments

We gratefully acknowledge the contributions of other individuals who provided assistance in this investigation. Rick Anderson (CDOW) provided administrative and technical advice. Frank Pfeifer and Mike Baker (USFWS) provided additional equipment. Cameron Walford (Larval Fish Laboratory) provided assistance in the field. This study was funded by the Colorado Division of Wildlife.

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Executive Summary

This investigation was conducted as a pilot study to describe habitat use of roundtail chub *Gila robusta*, flannelmouth sucker *Catostomus latipinnis*, and bluehead sucker *Catostomus discobolus* during fall low-flow conditions in the Colorado River near Grand Junction, Colorado. Radio telemetry was used to make observations of fish locations during day and night. Fish locations were estimated using triangulation, and water depth and mean water-column velocity were measured at each fish location.

Results show that during the fall low-flow period, bluehead sucker, flannelmouth sucker, and roundtail chub in the Colorado River make localized movements and can be intensively studied using radio telemetry. Our preliminary assessment of the data suggests that habitat use during the day may be an acceptable surrogate for habitat use at night for bluehead sucker and flannelmouth sucker, but not for roundtail chub. Roundtail chub tended to occupy shallower habitats during the night. The implication of this result is that future investigations may be able to rely on daytime observations for describing habitat for suckers, but investigations of roundtail chub habitat use will probably require day and night observations to obtain an accurate description of environmental requirements of this species.

It should be noted that this report does not provide a detailed analysis of the data collected during the investigation. Additional analyses of this data set should be conducted in order to understand species and temporal differences in habitat use.

Introduction

This investigation was conducted as a pilot study to describe habitat use of roundtail chub *Gila robusta*, flannelmouth sucker *Catostomus latipinnis*, and bluehead sucker *Catostomus discobolus* during fall low-flow conditions in the Colorado River near Grand Junction, Colorado. Radio telemetry was used to make observations of fish locations during day and night. Fish locations were estimated using triangulation, and water depth and mean water-column velocity were measured at each fish location. Results of this investigation can be used to aid design and conduct of future studies of fish habitat use and movement in the Colorado River. Habitat use and movement data may support development of flow recommendations for the target species in the Colorado River.

Study Area

The study area was approximately a 3.2-km reach (RM 176-178 from confluence with Green River) of the Colorado River near Grand Junction, Colorado. This river reach included several pool, run, and riffle habitats.

Materials and Methods

Radio telemetry system

Radio transmitters and receiver were purchased from Advanced Telemetry Systems (Isanti, Minnesota). Two antennae were used: a hand-held square-loop directional antenna and a omni-directional whip antenna. Internal and external radio transmitters were used. Internal transmitters were 17 mm long, 13 mm in diameter, and weighed 11.0 g. Internal transmitters

used ten frequencies between 40.170 and 40.352 MHz (55 pulses per minute). External transmitters were 8×9×25 mm long with a 203 mm-long antenna, and weighed 2.7 g. External transmitters used five frequencies between 40.600 and 40.681 MHz (40 pulses per minute). Internal transmitters were used on all flannelmouth suckers. Both types of transmitters were used on bluehead suckers and roundtail chubs. Transmitters had a maximum range of approximately 200 m.

Precision of the directional bearings estimated with the telemetry system was measured using methods of White and Garrott (1990). Studies showed that errors of the receiving system had a mean of -8°from true and standard deviation of 4°.

Surgical procedures

Four roundtail chub, five flannelmouth sucker, and five bluehead sucker ranging from 306 to 562 mm total length and 261 to 1629 g were collected from the study reach (Table 1). Internal radio transmitters were surgically implanted into the abdominal cavity of fish using a modification of methods described by Beyers and Carlson (1993). Fish were anesthetized with 200 mg/L tricaine methanesulfonate and positioned, ventral side up, on an operating table. An incision through the abdominal wall just posterior to the pelvic girdle was extended posteriorly for approximately 30 mm. A radio transmitter was inserted into the abdominal cavity and positioned anterior to the pelvic girdle. Incisions were closed with 4-0 nonabsorbable multi-filament polyamide suture material attached to 3/8-circle reverse-cutting needles. Three or four simple interrupted sutures, 5-8 mm apart, were used to realign and secure the abdominal wall. Following closure, fish were weighed, measured, and placed in a recovery tank. External

radio transmitters were attached near the dorsal fin of study fish using the method described by Winter (1983).

Table 1. Summary of fish characteristics on date of radio implantation.

Species	Radio[a] Frequency (MHz)	Total Length (mm)	Fish Mass (g)	Date Implanted
Bluehead sucker	40.202	400	773	9/18/00
Bluehead sucker	40.222	402	563	9/18/00
Bluehead sucker	40.681	394	ND	9/25/00
Bluehead sucker	40.600	419	ND	9/25/00
Bluehead sucker	40.352	394	601	9/18/00
Flannelmouth sucker	40.332	496	1348	9/18/00
Flannelmouth sucker	40.170	494	ND	9/25/00
Flannelmouth sucker	40.241	480	1075	9/18/00
Flannelmouth sucker	40.262	490	1148	9/18/00
Flannelmouth sucker	40.282	562	1629	9/18/00
Flannelmouth sucker	40.302	496	ND	9/25/00
Roundtail chub	40.661	306	261	9/18/00
Roundtail chub	40.621	410	591	9/18/00
Roundtail chub	40.641	374	484	9/18/00

[a]40.600 MHz series were external transmitters; 40.200 to 40.400 MHz series were internal transmitters.

ND = no data.

Fish locations and habitat measurements

Fish were telemetered during day and night so that diel patterns of habitat use and movement could be described. Diel data were collected by telemetering fish frequently for 24 hours or more. In addition to diel data, fish were also located occasionally throughout the investigation in order to observe longer-term movement patterns.

Most fish locations were estimated by triangulation using two or three bearings as described by White and Garrott (1990). In a few instances fish locations were estimated by direct observation using radio telemetry because the habitat occupied by the fish was obvious and close to the shore. Positions estimated by direct observation were less than 5 m from shore and were easily identified because the fish could be telemetered from close range and from several directions. The UTMs for these direct observations were obtained by placing a GPS receiver at the location. Once all fish location estimates were obtained, a GPS was used to navigate to the location and habitat was measured. Water depth was measured to the nearest 0.01 m using a stadia rod. Mean water-column velocity was measured to the nearest cm/sec using a Marsh-McBirney model 201 current meter mounted on a top-set rod at 0.6 total depth. Mean water-column velocity was measured only at locations where it was possible to wade. At deeper locations, inability to control movement of the boat prevented accurate estimation of water velocities.

Data analysis

A useful measure of accuracy of triangulation estimates is the size of the 95% confidence ellipse around the estimate. A confidence ellipse for each estimate was calculated using

procedures described by White and Garrott (1990). Summary statistics for ellipse size were calculated for all data. Because fish behavior often changes during day and night, summary statistics were also calculated for ellipse data stratified by day and night observations. Day and night periods were defined based on civil twilight for 15 September 2000 (http://mach.usno.navy.mil/cgi-bin/aa_rstablew).

Habitat use of fish was described by constructing frequency distributions for water depth stratified by day and night observations. Frequency distributions for mean water-column velocity were not constructed because the data set was incomplete and because the measure has little relevance to the velocity at the point where fish actually resided in the water column.

Diel fish movement patterns were described by plotting fish positions in UTM coordinate space. Example plots for bluehead sucker (40.600 MHz; 10 to 12 October; 57-hour duration), flannelmouth sucker (40.332 MHz; 11 to 12 October; 38-hour duration), and roundtail chub (40.641 MHz; 26 to 27 September; 40-hour duration) were constructed.

Results

One bluehead sucker (40.202 MHz) died or expelled its radio transmitter soon after implantation, thus habitat observations were made on 4 bluehead sucker, six flannelmouth sucker, and three roundtail chub. A total of 220 observations were made during the investigation (Appendix 1). Thirty-four triangulated locations were on land and are identified in Appendix 1 with a “y” in the column labeled “Uncertain estimate”. These data do not represent fish locations in the river, but do show that the fish were within 200 m of the UTM given in the table. Of the remaining 186 observations, 19 were obtained by direct observation. All of the

remaining observations (167) were obtained by triangulation. The 95% confidence ellipses for these estimates for bluehead sucker, flannelmouth sucker, and roundtail chub were 316, 336, and 415 m^2, respectively (Table 2). Estimates for all species ranged from 2 to 8646 m^2. Stratifying data by day and night did not reveal consistent patterns in accuracy of triangulated positions (Table 2). Average ellipse size for bluehead sucker was smaller during the day compared to night (167 versus 501 m^2). The opposite pattern was observed for flannelmouth sucker. Average ellipse size for flannelmouth sucker was 365 m^2 during day and 264 m^2 during night. Confidence ellipse size was similar during day and night for roundtail chub. Several sources of error that may have influenced triangulation estimates are discussed below.

Frequency distributions suggest that habitat use of bluehead sucker and flannelmouth sucker did not change with time of day (Figures 1 and 2). Depth distributions for both suckers are similar for day and night. In contrast, there is some evidence that roundtail chub tended to occupy shallower habitats during the night (Figure 3). Approximately 3% of night observations for roundtail chub were in habitats >3-m deep, whereas 21% of day observations were in habitats >3-m deep.

The existing data set is too small to compare movement patterns of different species. Example plots suggest that flannelmouth sucker and roundtail chub tend to move farther distances than bluehead sucker (Figure 4), but examination of data for other fish shows that tendency for movement varies with individuals (Table A2).

Table 2. Summary statistics for 95% confidence ellipses (m^2) around fish locations estimated using triangulation. Summary statistics are provided for all data, and for the same data stratified by day and night observations.

All Triangulation Data

Species	Mean	Standard Error	Minimum	Maximum	*n*
Bluehead sucker	316	83	28	2937	38
Flannelmouth sucker	336	73	27	4145	68
Roundtail chub	415	146	2	8646	61

Day Triangulation Data

Species	Mean	Standard Error	Minimum	Maximum	*n*
Bluehead sucker	167	24	28	375	21
Flannelmouth sucker	365	99	27	4145	49
Roundtail chub	428	295	2	8646	29

Night Triangulation Data

Species	Mean	Standard Error	Minimum	Maximum	*n*
Bluehead sucker	501	177	34	2937	17
Flannelmouth sucker	264	63	37	929	19
Roundtail chub	403	87	13	1620	32

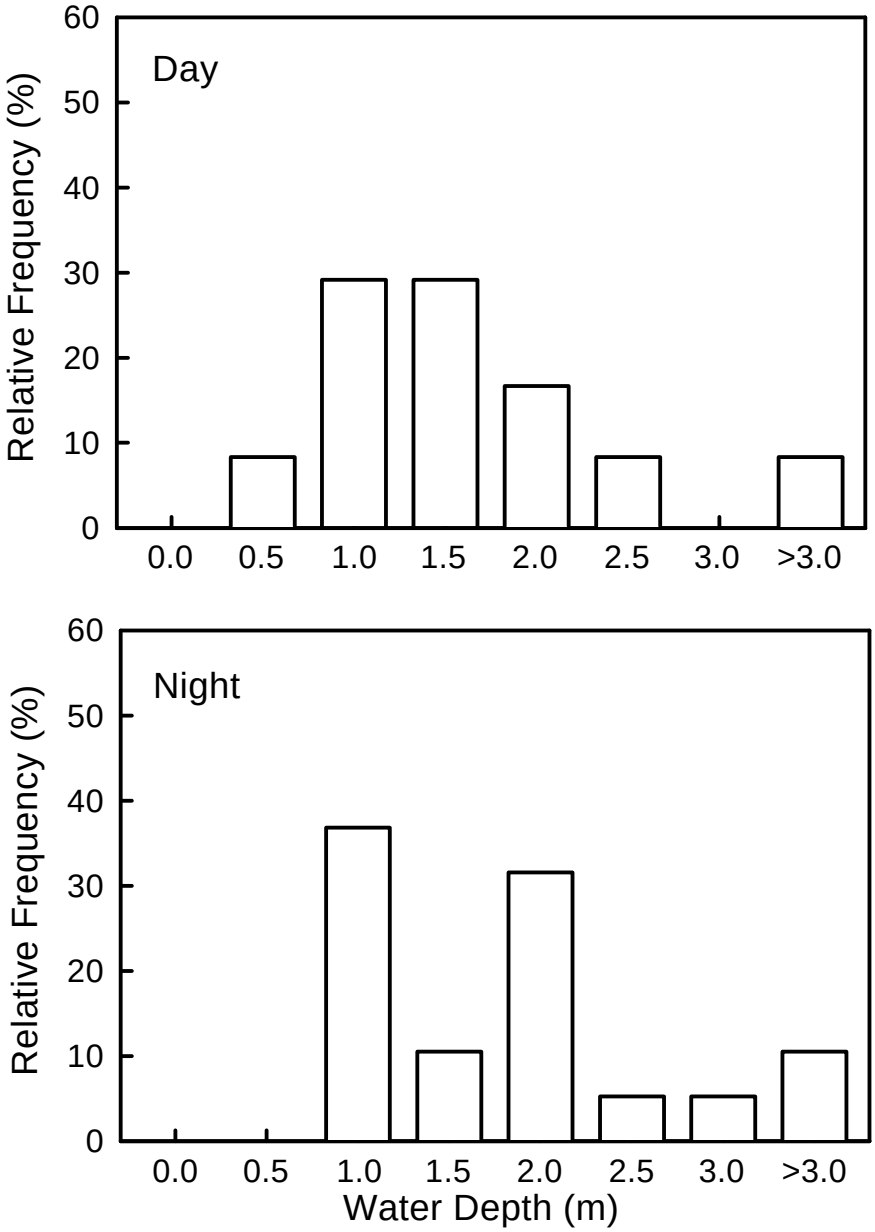

Figure 1. Frequency distributions describing water depth at locations occupied by bluehead sucker in the Colorado River near Grand Junction, Colorado. The number of day and night observations were 24 and 19, respectively.

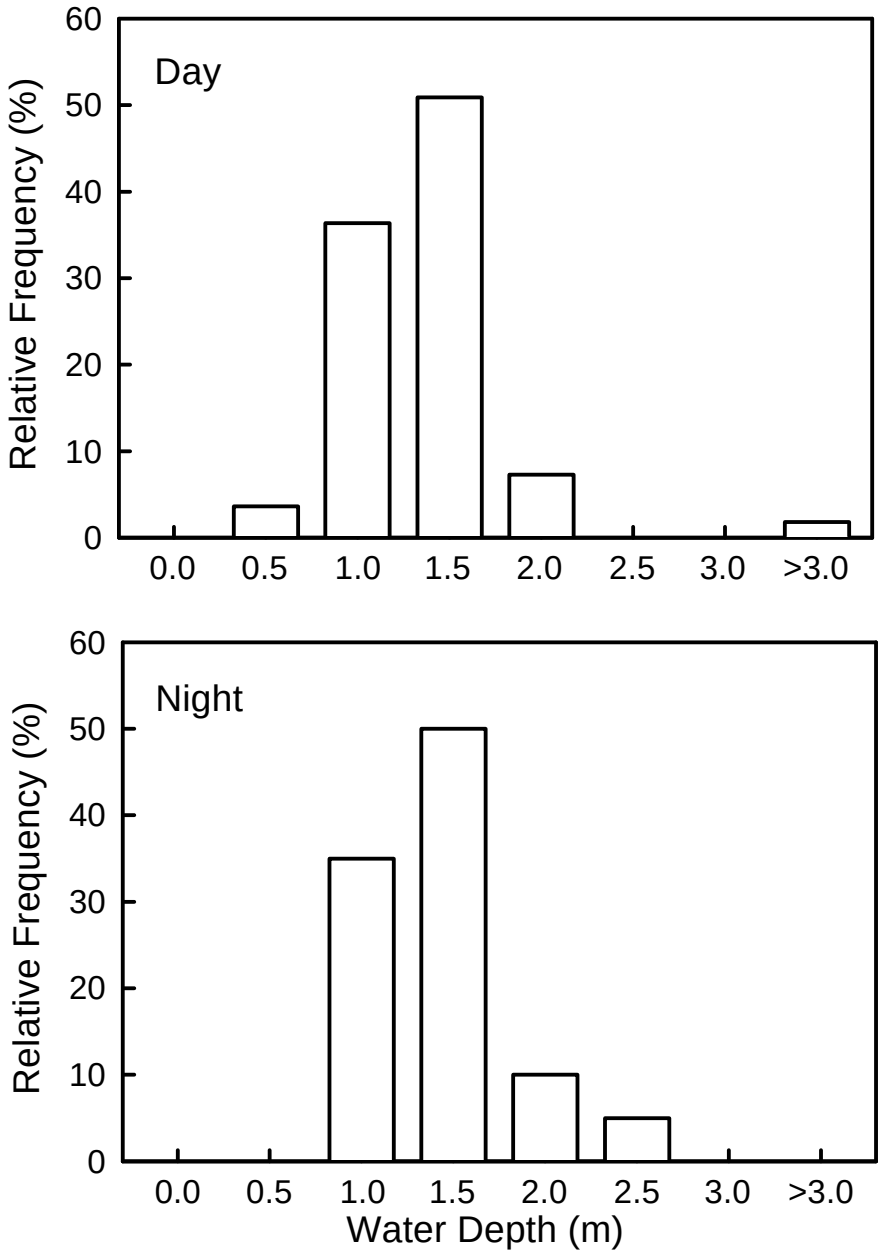

Figure 2. Frequency distributions describing water depth at locations occupied by flannelmouth sucker in the Colorado River near Grand Junction, Colorado. The number of day and night observations were 55 and 20, respectively.

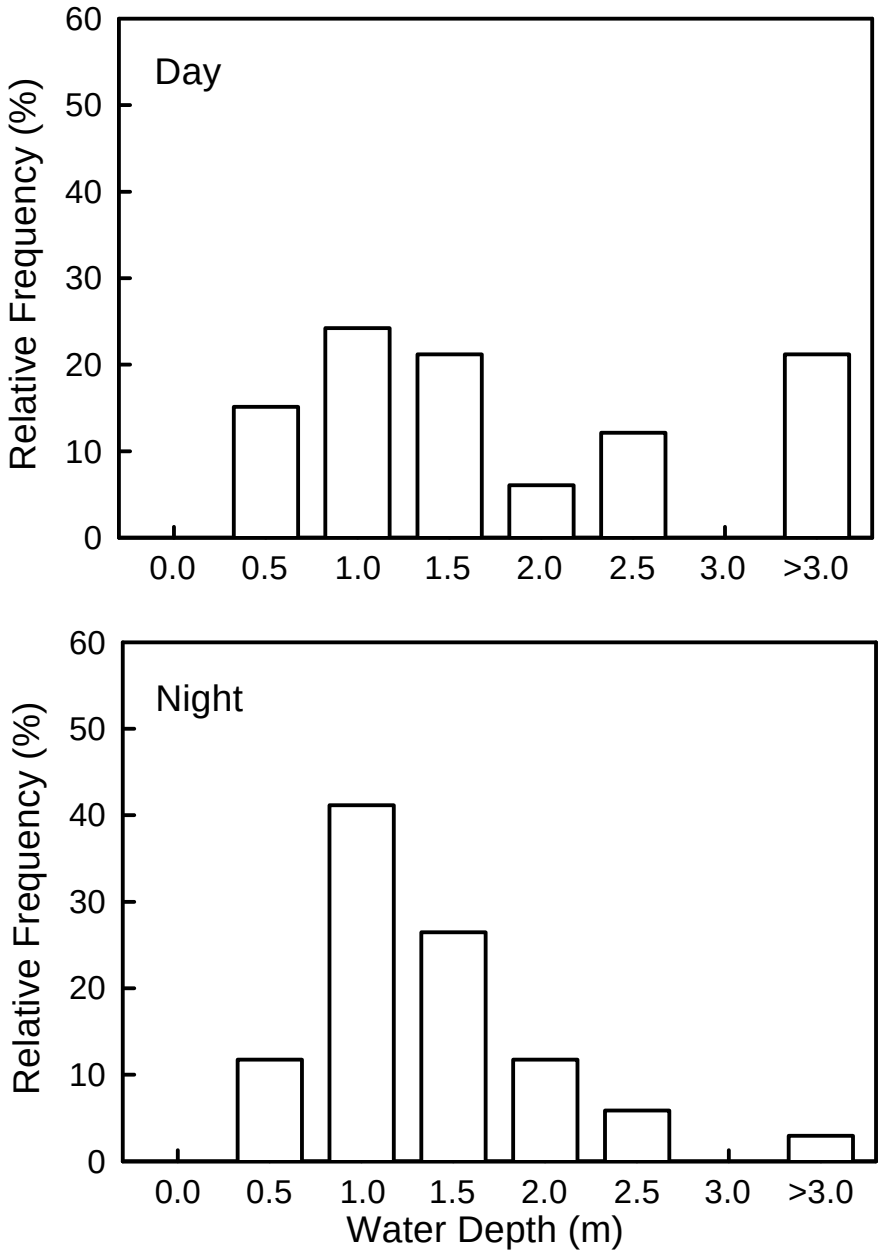

Figure 3. Frequency distributions describing water depth at locations occupied by roundtail chub in the Colorado River near Grand Junction, Colorado. The number of day and night observations were 33 and 34, respectively.

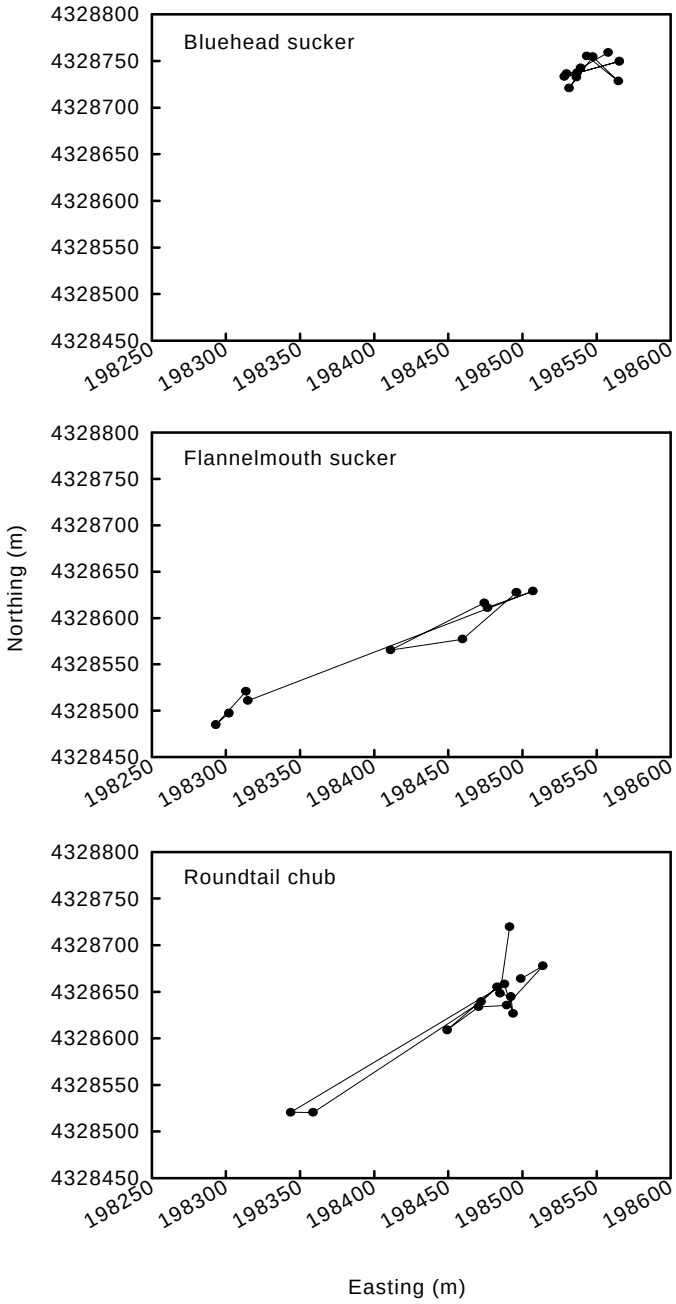

Figure 4. Dielmovement of bluehead sucker, flannelmouth sucker, and roundtail chub in the Colorado River near Grand Junction, Colorado.

Discussion

This investigation showed that during the fall low-flow period, bluehead sucker, flannelmouth sucker, and roundtail chub in the Colorado River make localized movements and can be intensively studied using radio telemetry. A critical assumption of using radio telemetry to describe habitat use of fish is that estimated fish locations are accurate. If this assumption is not met, then the resulting habitat descriptions may not be useful. There are three factors that may have influenced the accuracy of estimated radio telemetry locations in this investigation. The first factor is rate of movement of fish during triangulation. When fish move during the triangulation process, uncertainty in the estimated location (ellipse size) increases. We did observe fish moving on several occasions and movement is probably responsible for the large confidence intervals on some observations. This source of error can be minimized by using two observers with radio receivers so that triangulation azimuths can be collected simultaneously. The second factor that may have influenced accuracy of estimated locations is fish depth. Casual observations suggested that during the day, radio signals from flannelmouth sucker were more difficult to detect than during twilight and night. This outcome may have been caused by fish occupying deeper water during day in order to avoid bright conditions or predators. This source of error can be minimized by the use of radio transmitters with sufficient signal to be detected at any depth. The third factor that may have affected accuracy of estimated locations is observer error. We attempted to minimize observer error by using standardized procedures. However, conducting round-the-clock observations, and working in darkness are challenging conditions for human observers. Observer error was probably greater at night. There was no consistent pattern in uncertainty in triangulation estimates during day and night (Table 2). Lack of a pattern may mean that different sources of error dominated at different times. For example, inaccuracy in triangulation during

the day may have been due to a tendency for fish to occupy deeper water, whereas inaccuracy at night may have been due to fish movement and observer error.

Success of radio telemetry investigations can be influenced by the type of transmitters used. We evaluated use of external and internal transmitters. The external transmitters used in this investigation had greater transmission range than the internal transmitters but they also have the disadvantage of potentially modifying fish behavior if they become fouled with debris. No study fish were recaptured. Consequently, it cannot be determined if fouling affected fish behavior. Recapture of tagged fish could be used to assess potential influence of transmitter attachment in future investigations. Results of this investigation suggest that transmitters having equal or greater range than the external transmitters should be used in future studies. External transmitters can probably be used if observations are made soon after attachment. If longer-term observations are planned, then internal transmitters should be used.

Habitat use by fish during night and day are equally important, but nighttime habitat use is rarely investigated. We investigated habitat use during night and day to facilitate evaluation of the importance of potential diel patterns. Our preliminary assessment of the data suggests that habitat use during the day may be an acceptable surrogate for habitat use at night for bluehead sucker and flannelmouth sucker, but not for roundtail chub. The implication of this result is that future investigations may be able to rely on daytime observations for describing habitat for suckers. In contrast, investigations of roundtail chub habitat use will probably require day and night observations to obtain an accurate description of environmental requirements of this species.

It should be noted that this report does not provide a detailed analysis of the data collected during the investigation. Additional analyses of this data set should be conducted in order to understand species and temporal differences in habitat use.

Recommendations for Future Investigations

1. Consider the size of fish potentially available so that they can be equipped with the largest transmitters that can be obtained without exceeding 2% of body weight.
2. Use radio transmitters with equal or greater range than the external transmitters used in this investigation.
3. Use two observers to simultaneously collect triangulation azimuths to minimize uncertainty caused by fish movement.

References

Beyers, D. W., and C. A. Carlson. 1993. Movement and habitat use of triploid grass carp in a Colorado irrigation canal. North American Journal of Fisheries Management 13:141-150.

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Appendix

Table A1. Summary of bluehead sucker, flannelmouth sucker, and roundtail chub locations and habitat use in the Colorado River near Grand Junction, Colorado, estimated using radio telemetry.

Species[a]	Frequency	Date	Time	Direct[b] observation	UTM northing	UTM easting	Ellipse area (m)	Depth (m)	Velocity (cm/sec)	Habitat type	Uncertain[c] estimate
FS	40.17	09-Oct-00	21:07:00	n	4328503.29	198321.36	720.722	1.3	.	run	n
FS	40.17	10-Oct-00	9:22:00	n	4328607.92	198475.18	94.634	1.2	48	run	n
FS	40.17	10-Oct-00	10:31:00	n	4328600.29	198483.3	83.799	1.4	.	run	n
FS	40.17	10-Oct-00	20:30:00	n	4328494.16	198314.28	217.68	1.25	64	run	n
FS	40.17	11-Oct-00	7:52:00	n	4328626.79	198474.75	162.293	1.45	.	run	n
FS	40.17	11-Oct-00	8:39:00	n	4328615.25	198483.64	90.824	1.05	61	run	n
FS	40.17	11-Oct-00	10:35:00	n	4328619.27	198480.87	221.286	0.8	38	run	n
FS	40.17	11-Oct-00	12:21:00	n	4328605.73	198457.49	161.705	0.75	27	run	n
FS	40.17	11-Oct-00	15:13:00	n	4328609.7	198461.41	156.232	0.75	24	run	n
FS	40.17	11-Oct-00	18:39:00	n	4328612.59	198475.75	106.736	1.1	49	run	n
FS	40.17	11-Oct-00	20:25:00	n	4328656.2	198548.9	.	.	.	.	y
FS	40.17	11-Oct-00	21:11:00	n	4328639.49	198487.11	189.709	0.6	48	run	n
FS	40.17	12-Oct-00	1:30:00	n	4328613.39	198463.46	473.574	0.8	28	run	n
FS	40.17	12-Oct-00	9:48:00	n	4328637	198507	44.679	0.975	98	run	n
FS	40.17	12-Oct-00	19:49:00	n	4328504.42	198295.32	191.904	1.05	74	run	n
BS	40.222	28-Sep-00	12:30:00	n	4328555.42	200138.43	374.934	0.8	56	run	n
FS	40.241	24-Oct-00	11:08:00	n	4328544.61	200474.97	226.449	1.35	.	run	n
FS	40.241	24-Oct-00	12:10:00	n	4328588.05	200627.48	141.826	1.3	.	run	n
FS	40.241	24-Oct-00	12:55:00	n	4328597.79	200607.02	26.452	1	72	run	n
FS	40.241	24-Oct-00	13:50:00	n	4328596.24	200610.82	34.439	1.15	68	run	n
FS	40.241	24-Oct-00	15:22:00	n	4328605.5	200596	.	.	.	.	y
FS	40.241	24-Oct-00	16:03:00	n	4328584.87	200614.58	105.504	1.15	64	run	n
FS	40.241	24-Oct-00	17:40:00	n	4328570.19	200589.77	472.787	1.4	.	run	n
FS	40.241	24-Oct-00	19:42:00	n	4328593.8	200168.7	.	.	.	.	y
FS	40.241	26-Oct-00	8:03:00	n	4328582.11	200168.5	44.525	1.1	46	run	n
FS	40.241	26-Oct-00	8:55:00	n	4328573.85	200177.81	40.493	1.2	54	run	n
FS	40.241	26-Oct-00	9:40:00	n	4328563.2	200180.45	328.905	1.35	.	run	n
FS	40.262	28-Sep-00	13:20:00	n	4328565.62	200455.22	129.135	1.3	52	run	n
FS	40.262	24-Oct-00	11:40:00	n	4328595.27	199970.8	29.496	1.4	.	eddy	n
FS	40.262	24-Oct-00	13:15:00	n	4328589.42	199958.68	59.954	1.4	.	run	n

FS	40.262	24-Oct-00	14:35:00	n	4328595.81	199967.27	31.662	1.45	.	eddy	n
FS	40.262	24-Oct-00	15:35:00	n	4328592.69	199969.45	38.125	1.25	.	eddy	n
FS	40.262	24-Oct-00	16:35:00	n	4328592.68	199968.59	39.459	1.3	.	eddy	n
FS	40.262	24-Oct-00	17:35:00	n	4328593.15	199968.71	37.705	1.3	.	eddy	n
FS	40.262	24-Oct-00	18:20:00	n	4328594.82	199973.33	92.237	1.375	.	eddy	n
FS	40.262	24-Oct-00	19:30:00	n	4328596.15	199965.2	57.762	1.45	.	interface	n
FS	40.262	25-Oct-00	9:55:00	n	4328591.72	199963.82	48.162	1.35	.	interface	n
FS	40.262	25-Oct-00	11:10:00	n	4328586.32	199971.49	56.941	1.25	.	run	n
FS	40.262	26-Oct-00	8:11:00	n	4328588.79	199955.17	66.918	1.65	.	eddy	n
FS	40.262	26-Oct-00	9:30:00	n	4328590.44	199982.26	33.819	1	40	run	n
FS	40.282	26-Sep-00	17:48:00	n	4328477.51	198214.57	166.868	0.41	81	riffle	n
FS	40.282	27-Sep-00	18:05:00	n	4328476.67	198288.79	141.658	0.6	68	run	n
FS	40.282	27-Sep-00	19:00:00	n	4328519.8	198369.3	.	.	.	.	y
FS	40.282	28-Sep-00	11:30:00	n	4328516.16	198297.74	206.096	0.8	39	run	n
FS	40.282	10-Oct-00	9:35:00	y	4328537.3	198421.9	.	1	15	eddy	n
FS	40.282	10-Oct-00	10:22:00	y	4328537.3	198421.9	.	1	15	eddy	n
FS	40.282	10-Oct-00	20:34:00	n	4328490.7	198340.2	.	.	.	.	y
FS	40.282	11-Oct-00	3:55:00	n	4328520.32	198339.68	80.277	2.15	.	run	n
FS	40.282	11-Oct-00	15:23:00	n	4328525.1	198388.74	31.882	1.6	.	eddy	n
FS	40.282	11-Oct-00	19:03:00	n	4328504.96	198296.31	845.17	1.2	.	run	n
FS	40.282	11-Oct-00	21:58:00	n	4328478.71	198272.18	128.34	0.75	110	run	n
FS	40.282	12-Oct-00	2:14:00	n	4328490.7	198340.2	.	.	.	.	y
FS	40.282	12-Oct-00	10:01:00	n	4328519.8	198369.3	.	.	.	.	y
FS	40.282	12-Oct-00	11:56:00	n	4328497.94	198323.13	115.94	1.35	.	run	n
FS	40.282	12-Oct-00	16:51:00	n	4328513.06	198281.95	1652.73	0.75	67	run	n
FS	40.302	09-Oct-00	21:20:00	n	4328516.7	198386.8	.	.	.	.	y
FS	40.302	09-Oct-00	21:20:00	y	4328537.3	198421.9	.	1	15	eddy	n
FS	40.302	10-Oct-00	9:36:00	n	4328537.3	198421.9	641.86	1.1	11	eddy	n
FS	40.302	10-Oct-00	9:36:00	y	4328537.3	198421.9	641.86	1	15	eddy	n
FS	40.302	10-Oct-00	10:22:00	n	4328537.3	198421.9	641.86	1.1	11	eddy	n
FS	40.302	10-Oct-00	10:22:00	y	4328537.3	198421.9	641.86	1	15	eddy	n
FS	40.302	10-Oct-00	20:20:00	n	4328536.7	198420.6	.	.	.	.	y
FS	40.302	11-Oct-00	3:20:00	n	4328617.85	198474.19	219.8	0.95	49	run	n
FS	40.302	11-Oct-00	11:12:00	n	4328518.68	198337.26	82.68	>3	.	run	n
FS	40.302	11-Oct-00	12:03:00	n	4328508.3	198319.49	713.24	1.7	.	run	n

FS	40.302	11-Oct-00	21:34:00	n	4328599.23	198462.13	90.19	1.65	.	run	n
FS	40.302	12-Oct-00	1:30:00	n	4328622.64	198487.93	271.99	1.1	.	run	n
FS	40.302	12-Oct-00	9:53:00	n	4328607.4	198505.2	.	.	.	.	y
FS	40.302	12-Oct-00	12:37:00	n	4328651.65	198501.5	561.76	0.75	64	run	n
FS	40.302	12-Oct-00	17:01:00	n	4328707.16	198510.49	69836.56	0.4	61	riffle	n
FS	40.302	12-Oct-00	17:35:00	n	4328619.91	198462.48	1340.56	1.1	37	run	n
FS	40.332	27-Sep-00	11:20:00	n	4328581.46	198444.52	143.77	1	42	run	n
FS	40.332	27-Sep-00	13:00:00	n	4328539.59	198426.77	509.2	0.8	22	run	n
FS	40.332	27-Sep-00	15:30:00	n	4328535.16	198419.39	.	0.95	14	eddy	n
FS	40.332	27-Sep-00	18:00:00	n	4328536.7	198420.6	.	.	.	.	y
FS	40.332	28-Sep-00	11:30:00	n	4328534.52	198418.48	.	0.95	4	eddy	n
FS	40.332	10-Oct-00	9:44:00	y	4328537.3	198421.9	.	1	15	eddy	n
FS	40.332	10-Oct-00	10:22:00	y	4328537.3	198421.9	.	1	15	eddy	n
FS	40.332	11-Oct-00	3:24:00	n	4328627.48	198495.99	46.1	1.25	.	run	n
FS	40.332	11-Oct-00	8:35:00	n	4328577.12	198459.76	35.81	0.475	2	eddy	n
FS	40.332	11-Oct-00	10:50:00	n	4328565.47	198411.03	2071	1.9	.	run	n
FS	40.332	11-Oct-00	12:14:00	n	4328616.32	198474.31	4145.38	1.3	.	run	n
FS	40.332	11-Oct-00	15:10:00	n	4328611.06	198476.34	227.5	1.35	.	run	n
FS	40.332	11-Oct-00	18:33:00	n	4328628.91	198507.02	36.6	0.6	62	interface	n
FS	40.332	11-Oct-00	22:09:00	n	4328510.95	198314.76	166.68	1.6	.	run	n
FS	40.332	12-Oct-00	2:08:00	n	4328520.77	198313.5	929.09	1.5	.	run	n
FS	40.332	12-Oct-00	11:58:00	n	4328484.93	198293.24	134.91	0.7	56	run	n
FS	40.332	12-Oct-00	16:53:00	n	4328497.25	198302	144.02	1.2	.	run	n
FS	40.332	12-Oct-00	20:44:00	n	4328536.7	198420.6	.	.	.	.	y
BS	40.352	26-Sep-00	15:40:00	n	4328537.19	198342.89	118.38	1.5	14	interface	n
BS	40.352	27-Sep-00	9:50:00	n	4328542.69	198342.02	215.01	0.9	9	interface	n
BS	40.352	27-Sep-00	12:40:00	n	4328555.87	198344.97	31.31	0.9	9	interface	n
BS	40.352	27-Sep-00	14:15:00	n	4328535.47	198353.63	123.22	2.5	.	run	n
BS	40.352	27-Sep-00	18:30:00	n	4328530.78	198352.45	236.92	3	.	run	n
BS	40.352	09-Oct-00	21:25:00	n	4328528.02	198356.46	33.52	>3	.	eddy	n
BS	40.352	10-Oct-00	10:12:00	n	4328529.06	198357.45	47.89	>3	.	eddy	n
BS	40.352	11-Oct-00	3:55:00	n	4328536.8	198341	160.7	1.65	.	run	n
BS	40.352	11-Oct-00	8:15:00	n	4328541.79	198357.17	123.06	1.9	.	run	n
BS	40.352	11-Oct-00	11:40:00	n	4328550.95	198340.06	273.31	1.05	19	run	n
BS	40.352	11-Oct-00	15:41:00	n	4328526.79	198355.52	34.84	>3	.	eddy	n

BS	40.352	11-Oct-00	19:04:00	n	4328535.42	198354.73	117.58	2.4	.	run	n
BS	40.352	11-Oct-00	22:14:00	n	4328535.11	198356.91	105.76	>3	.	run	n
BS	40.352	12-Oct-00	2:23:00	n	4328543.18	198330.38	617.27	1	24	interface	n
BS	40.352	12-Oct-00	10:03:00	n	4328543.37	198346.24	159.94	1.75	.	run	n
BS	40.352	12-Oct-00	12:06:00	n	4328506.1	198361.5	.	.	.	.	y
BS	40.352	12-Oct-00	17:06:00	n	4328519.8	198369.3	.	.	.	.	y
BS	40.352	12-Oct-00	20:19:00	n	4328538.99	198344.74	248.83	1.85	.	run	n
BS	40.6	09-Oct-00	20:30:00	n	4328719.17	198537.5	439.21	0.95	82	run	n
BS	40.6	09-Oct-00	22:10:00	n	4328753.79	198541.28	1552.82	0.8	7	eddy	n
BS	40.6	10-Oct-00	8:54:00	n	4328758.91	198557.77	248.88	1.4	.	run	n
BS	40.6	10-Oct-00	10:56:00	n	4328705.6	198561.5	.	.	.	.	y
BS	40.6	10-Oct-00	12:45:00	n	4328742.44	198539.36	255.44	1.3	.	run	n
BS	40.6	10-Oct-00	19:51:00	n	4328676.2	198571.8	.	.	.	.	y
BS	40.6	10-Oct-00	21:00:00	n	4328635.5	198530	.	.	.	.	y
BS	40.6	11-Oct-00	3:15:00	n	4328733.09	198528.3	2936.77	0.7	93	run	n
BS	40.6	11-Oct-00	7:43:00	n	4328749.42	198565.33	123.06	1.35	.	run	n
BS	40.6	11-Oct-00	10:10:00	n	4328737.27	198536.9	211.12	0.85	82	run	n
BS	40.6	11-Oct-00	15:03:00	n	4328736.2	198529.81	350.14	0.6	56	run	n
BS	40.6	11-Oct-00	18:20:00	n	4328732.44	198536.47	232.59	0.9	90	run	n
BS	40.6	11-Oct-00	20:20:00	n	4328676.2	198571.8	.	.	.	.	y
BS	40.6	11-Oct-00	21:07:00	n	4328720.88	198531.57	810.88	0.8	116	interface	n
BS	40.6	12-Oct-00	1:23:00	n	4328676.2	198571.8	.	.	.	.	y
BS	40.6	12-Oct-00	9:35:00	n	4328754.31	198547.53	276.36	1.45	.	run	n
BS	40.6	12-Oct-00	13:03:00	n	4328728.39	198564.65	44.85	0.225	38	riffle	n
BS	40.6	12-Oct-00	17:45:00	n	4328755.31	198543.38	249.87	1.3	.	run	n
BS	40.6	12-Oct-00	21:20:00	n	4328736.2	198590.2	.	.	.	.	y
RC	40.621	26-Sep-00	18:30:00	n	4328516.74	198355.84	39.03	>3	.	eddy	n
RC	40.621	27-Sep-00	13:00:00	n	4328532.19	198377.65	77.01	>3	.	run	n
RC	40.621	27-Sep-00	19:05:00	n	4328514.24	198355.94	29.08	2.5	.	eddy	n
RC	40.621	10-Oct-00	19:55:00	n	4328621.32	198484.89	256.01	1.3	.	run	n
RC	40.621	10-Oct-00	20:50:00	n	4328607.4	198505.2	.	.	.	.	y
RC	40.621	11-Oct-00	3:19:00	n	4328613.48	198487.45	78.07	1.3	.	run	n
RC	40.621	11-Oct-00	8:08:00	n	4328536.7	198420.6	.	.	.	.	y
RC	40.621	11-Oct-00	18:42:00	n	4328577.35	198453.27	49.72	1.1	.	run	n
RC	40.621	11-Oct-00	21:12:00	n	4328641.5	198498.03	102.38	0.95	75	run	n

RC	40.621	12-Oct-00	1:28:00	n	4328609.81	198440.77	1407.36	0.65	23	run	n
RC	40.621	12-Oct-00	10:19:00	n	4328542.99	198369.75	77.62	>3	.	run	n
RC	40.621	12-Oct-00	12:36:00	n	4328586.99	198460.59	51.42	1.4	.	run	n
RC	40.621	12-Oct-00	17:24:00	n	4328611.98	198504.31	23.37	0.85	60	interface	n
RC	40.621	12-Oct-00	20:24:00	n	4328561.08	198372.47	174.28	0.675	11	run	n
RC	40.641	26-Sep-00	0:00:00	n	4328617.2	198464.8	765.66	0.7	23	interface	n
RC	40.641	26-Sep-00	15:05:00	n	4328663.97	198499	211.49	0.4	48	riffle	n
RC	40.641	26-Sep-00	17:05:00	n	4328677.74	198513.88	189.35	0.375	76	riffle	n
RC	40.641	26-Sep-00	19:20:00	n	4328635.56	198489.47	159.98	0.575	30	run	n
RC	40.641	26-Sep-00	20:30:00	n	4328656.2	198548.9	.	.	.	.	y
RC	40.641	26-Sep-00	21:30:00	n	4328633.88	198470.45	472.17	0.4	12	run	n
RC	40.641	26-Sep-00	23:00:00	n	4328608.94	198449.17	1620.44	0.54	16	run	n
RC	40.641	27-Sep-00	6:30:00	n	4328654.93	198483.05	300.65	0.12	4	shoreline	n
RC	40.641	27-Sep-00	8:00:00	n	4328639.12	198472.11	445.77	0.3	8	run	n
RC	40.641	27-Sep-00	9:10:00	n	4328520.35	198358.82	189.66	>3	.	eddy	n
RC	40.641	27-Sep-00	11:59:00	n	4328656.2	198548.9	.	.	.	.	y
RC	40.641	27-Sep-00	12:20:00	n	4328609.6	198422.2	.	.	.	.	y
RC	40.641	27-Sep-00	14:05:00	n	4328520.56	198343.77	84.19	>3	.	interface	n
RC	40.641	27-Sep-00	14:52:00	n	4328658.11	198487.95	8646.41	0.2	14	eddy	n
RC	40.641	27-Sep-00	17:45:00	n	4328626.69	198493.66	63.62	1	76	run	n
RC	40.641	27-Sep-00	19:20:00	n	4328644.58	198492.18	156.21	0.5	42	run	n
RC	40.641	27-Sep-00	21:00:00	n	4328656.2	198548.9	.	.	.	.	y
RC	40.641	27-Sep-00	22:00:00	n	4328648.09	198484.82	242.14	0.4	18	interface	n
RC	40.641	28-Sep-00	6:30:00	n	4328719.79	198491.5	1004.8	0.6	48	run	n
RC	40.641	09-Oct-00	20:35:00	n	4328615.19	198463.57	1410.15	0.7	29	run	n
RC	40.641	09-Oct-00	22:00:00	n	4328629.63	198498.08	66.58	1.075	96	run	n
RC	40.641	10-Oct-00	9:27:00	n	4328573.9	194471	.	.	.	.	y
RC	40.641	10-Oct-00	19:58:00	n	4328635.5	198530	.	.	.	.	y
RC	40.641	10-Oct-00	21:00:00	n	4328595.88	198467.51	1608.15	1.6	.	run	n
RC	40.641	11-Oct-00	3:28:00	n	4328597.7	198453.04	124.12	1	36	run	n
RC	40.641	11-Oct-00	8:12:00	n	4328511.06	198329.82	60.12	2	.	run	n
RC	40.641	11-Oct-00	11:06:00	n	4328518.14	198321.69	169.98	1.9	.	run	n
RC	40.641	11-Oct-00	15:20:00	n	4328538.55	198383.87	44.81	2.4	.	run	n
RC	40.641	11-Oct-00	18:31:00	n	4328642.29	198510.69	93.86	0.9	90	run	n
RC	40.641	11-Oct-00	21:21:00	n	4328590.01	198452.38	112.16	1.375	.	interface	n

RC	40.641	12-Oct-00	1:29:00	n	4328621.1	198505.95	13.4	1.4	.	run	n
RC	40.641	12-Oct-00	10:16:00	y	4328519	198370.9	.	0.9	9	eddy	n
RC	40.641	12-Oct-00	12:12:00	y	4328519	198370.9	.	0.9	9	eddy	n
RC	40.641	12-Oct-00	17:12:00	n	4328526.13	198410.49	39.91	1	15	eddy	n
RC	40.641	12-Oct-00	17:12:00	y	4328526.13	198410.49	.	1	15	eddy	n
RC	40.641	12-Oct-00	20:55:00	n	4328537.69	198394.49	296.46	2.1	.	run	n
RC	40.661	26-Sep-00	16:05:00	n	4328532.16	198412.42	170.61	0.9	2	eddy	n
RC	40.661	26-Sep-00	17:35:00	n	4328587.9	198387.8	.	.	.	.	y
RC	40.661	27-Sep-00	9:35:00	n	4328519.8	198369.3	.	.	.	.	y
RC	40.661	27-Sep-00	11:59:00	n	4328618	198517.2	.	.	.	.	y
RC	40.661	27-Sep-00	12:48:00	n	4328532.41	198411.35	834.09	1.1	1	eddy	n
RC	40.661	27-Sep-00	14:30:00	n	4328528.09	198408.3	140.06	1.35	7	eddy	n
RC	40.661	27-Sep-00	15:10:00	n	4328528.09	198408.3	140.06	1.35	7	eddy	n
RC	40.661	27-Sep-00	15:15:00	n	4328531.69	198372.94	59.19	>3	.	run	n
RC	40.661	27-Sep-00	17:55:00	n	4328538.08	198381.17	91.72	>3	.	run	n
RC	40.661	27-Sep-00	21:00:00	n	4328619.84	198464.51	792.48	0.6	18	interface	n
RC	40.661	27-Sep-00	22:00:00	n	4328618	198517.2	.	.	.	.	y
RC	40.661	28-Sep-00	6:30:00	n	4328624.5	198496.14	630.31	1.1	80	run	n
RC	40.661	28-Sep-00	9:40:00	n	4328635.5	198530	.	.	.	.	y
RC	40.661	28-Sep-00	11:50:00	n	4328619.95	198499.35	38.14	1.1	90	run	n
RC	40.661	09-Oct-00	20:50:00	n	4328549.26	198388.63	88.31	1.95	.	run	n
RC	40.661	09-Oct-00	21:50:00	n	4328555.7	198419.6	44.48	1.85	.	run	n
RC	40.661	10-Oct-00	9:10:00	n	4328607.97	198467.4	431.19	1.1	42	run	n
RC	40.661	10-Oct-00	10:15:00	n	4328549.56	198443.23	2.44	0.45	3	eddy	n
RC	40.661	11-Oct-00	4:03:00	n	4328517.36	198367.81	92.7	0.6	6	eddy	n
RC	40.661	11-Oct-00	8:22:00	n	4328508.52	198341.76	32.56	>3	.	interface	n
RC	40.661	11-Oct-00	11:50:00	n	4328501.77	198339.23	23.18	2.4	.	eddy	n
RC	40.661	11-Oct-00	15:34:00	n	4328505.49	198339.3	25.404	2.5	.	eddy	n
RC	40.661	11-Oct-00	18:52:00	y	4328537.3	198421.9	.	1	15	eddy	n
RC	40.661	11-Oct-00	21:47:00	y	4328534.9	198419.8	.	1.1	1	eddy	n
RC	40.661	12-Oct-00	1:50:00	n	4328537.3	198421.9	327.376	1	15	run	n
RC	40.661	12-Oct-00	1:50:00	y	4328537.3	198421.9	.	1	15	eddy	n
RC	40.661	12-Oct-00	9:59:00	y	4328537.3	198421.9	.	1	15	eddy	n
RC	40.661	12-Oct-00	12:29:00	n	4328527.19	198402.85	9.525	2.05	.	eddy	n
RC	40.661	12-Oct-00	17:13:00	n	4328516.7	198386.8	.	.	.	.	y

RC	40.661	12-Oct-00	17:13:00	y	4328528.7	198411.5	.	1.15	8	eddy	n
RC	40.661	12-Oct-00	20:27:00	n	4328529.11	198405.64	16.432	1.5	.	eddy	n
BS	40.681	09-Oct-00	21:05:00	n	4328511.4	198309.51	305.356	1.5	.	run	n
BS	40.681	10-Oct-00	20:04:00	n	4328541.82	198421.51	.	1.55	.	interface	n
BS	40.681	11-Oct-00	3:38:00	n	4328509.63	198328.41	83.028	2	.	run	n
BS	40.681	11-Oct-00	8:25:00	n	4328509.82	198318.96	185.387	2	.	run	n
BS	40.681	11-Oct-00	11:56:00	n	4328492.15	198332.76	27.876	0.4	8	eddy	n
BS	40.681	11-Oct-00	15:22:00	n	4328519.51	198365.55	39.349	1.7	.	eddy	n
BS	40.681	11-Oct-00	18:49:00	n	4328508.09	198313.61	208.896	1.6	.	run	n
BS	40.681	11-Oct-00	21:51:00	n	4328514.4	198304.24	320.079	1.3	.	run	n
BS	40.681	12-Oct-00	2:07:00	y	4328519	198370.9	.	0.9	9	eddy	n
BS	40.681	12-Oct-00	10:05:00	y	4328511.4	198364.7	.	2.1	.	eddy	n
BS	40.681	12-Oct-00	12:14:00	y	4328519	198370.9	.	0.9	9	eddy	n
BS	40.681	12-Oct-00	17:00:00	y	4328519	198370.9	.	0.9	9	eddy	n
BS	40.681	12-Oct-00	20:13:00	n	4328510.93	198327.56	99.039	1.9	.	run	n

[a]BS = bluehead sucker, FS = flannelmouth sucker, RC = roundtail chub.
[b]Fish location estimated by direct observation not triangulation because the locality was obvious and close to the shore.
[c]Triangulated fish location was on land. Data do not represent fish location in the river, but do show that the fish was within 200 m of the locality.
. = missing data.

Table A2. Summary of data useful for estimating habitat use of bluehead sucker, flannelmouth sucker, and roundtail chub in the Colorado River near Grand Junction, Colorado. Data are identical to those in Appendix 1 except that uncertain observations have been omitted.

Species[a]	Frequency	Date	Time	Direct[b] observation	UTM northing	UTM easting	Ellipse area (m)	Depth (m)	Velocity (cm/sec)	Habitat type
FS	40.17	09-Oct-00	21:07:00	n	4328503.29	198321.36	720.722	1.3	.	run
FS	40.17	10-Oct-00	9:22:00	n	4328607.92	198475.18	94.634	1.2	48	run
FS	40.17	10-Oct-00	10:31:00	n	4328600.29	198483.3	83.799	1.4	.	run
FS	40.17	10-Oct-00	20:30:00	n	4328494.16	198314.28	217.68	1.25	64	run
FS	40.17	11-Oct-00	7:52:00	n	4328626.79	198474.75	162.293	1.45	.	run
FS	40.17	11-Oct-00	8:39:00	n	4328615.25	198483.64	90.824	1.05	61	run
FS	40.17	11-Oct-00	10:35:00	n	4328619.27	198480.87	221.286	0.8	38	run
FS	40.17	11-Oct-00	12:21:00	n	4328605.73	198457.49	161.705	0.75	27	run
FS	40.17	11-Oct-00	15:13:00	n	4328609.7	198461.41	156.232	0.75	24	run
FS	40.17	11-Oct-00	18:39:00	n	4328612.59	198475.75	106.736	1.1	49	run
FS	40.17	11-Oct-00	21:11:00	n	4328639.49	198487.11	189.709	0.6	48	run
FS	40.17	12-Oct-00	1:30:00	n	4328613.39	198463.46	473.574	0.8	28	run
FS	40.17	12-Oct-00	9:48:00	n	4328637	198507	44.679	0.975	98	run
FS	40.17	12-Oct-00	19:49:00	n	4328504.42	198295.32	191.904	1.05	74	run
BS	40.222	28-Sep-00	12:30:00	n	4328555.42	200138.43	374.934	0.8	56	run
FS	40.241	24-Oct-00	11:08:00	n	4328544.61	200474.97	226.449	1.35	.	run
FS	40.241	24-Oct-00	12:10:00	n	4328588.05	200627.48	141.826	1.3	.	run
FS	40.241	24-Oct-00	12:55:00	n	4328597.79	200607.02	26.452	1	72	run
FS	40.241	24-Oct-00	13:50:00	n	4328596.24	200610.82	34.439	1.15	68	run
FS	40.241	24-Oct-00	16:03:00	n	4328584.87	200614.58	105.504	1.15	64	run
FS	40.241	24-Oct-00	17:40:00	n	4328570.19	200589.77	472.787	1.4	.	run
FS	40.241	26-Oct-00	8:03:00	n	4328582.11	200168.5	44.525	1.1	46	run
FS	40.241	26-Oct-00	8:55:00	n	4328573.85	200177.81	40.493	1.2	54	run
FS	40.241	26-Oct-00	9:40:00	n	4328563.2	200180.45	328.905	1.35	.	run
FS	40.262	28-Sep-00	13:20:00	n	4328565.62	200455.22	129.135	1.3	52	run
FS	40.262	24-Oct-00	11:40:00	n	4328595.27	199970.8	29.496	1.4	.	eddy
FS	40.262	24-Oct-00	13:15:00	n	4328589.42	199958.68	59.954	1.4	.	run
FS	40.262	24-Oct-00	14:35:00	n	4328595.81	199967.27	31.662	1.45	.	eddy
FS	40.262	24-Oct-00	15:35:00	n	4328592.69	199969.45	38.125	1.25	.	eddy

FS	40.262	24-Oct-00	16:35:00	n	4328592.68	199968.59	39.459	1.3	.	eddy
FS	40.262	24-Oct-00	17:35:00	n	4328593.15	199968.71	37.705	1.3	.	eddy
FS	40.262	24-Oct-00	18:20:00	n	4328594.82	199973.33	92.237	1.375	.	eddy
FS	40.262	24-Oct-00	19:30:00	n	4328596.15	199965.2	57.762	1.45	.	interface
FS	40.262	25-Oct-00	9:55:00	n	4328591.72	199963.82	48.162	1.35	.	interface
FS	40.262	25-Oct-00	11:10:00	n	4328586.32	199971.49	56.941	1.25	.	run
FS	40.262	26-Oct-00	8:11:00	n	4328588.79	199955.17	66.918	1.65	.	eddy
FS	40.262	26-Oct-00	9:30:00	n	4328590.44	199982.26	33.819	1	40	run
FS	40.282	26-Sep-00	17:48:00	n	4328477.51	198214.57	166.868	0.41	81	riffle
FS	40.282	27-Sep-00	18:05:00	n	4328476.67	198288.79	141.658	0.6	68	run
FS	40.282	28-Sep-00	11:30:00	n	4328516.16	198297.74	206.096	0.8	39	run
FS	40.282	10-Oct-00	9:35:00	y	4328537.3	198421.9	.	1	15	eddy
FS	40.282	10-Oct-00	10:22:00	y	4328537.3	198421.9	.	1	15	eddy
FS	40.282	11-Oct-00	3:55:00	n	4328520.32	198339.68	80.277	2.15	.	run
FS	40.282	11-Oct-00	15:23:00	n	4328525.1	198388.74	31.882	1.6	.	eddy
FS	40.282	11-Oct-00	19:03:00	n	4328504.96	198296.31	845.17	1.2	.	run
FS	40.282	11-Oct-00	21:58:00	n	4328478.71	198272.18	128.34	0.75	110	run
FS	40.282	12-Oct-00	11:56:00	n	4328497.94	198323.13	115.94	1.35	.	run
FS	40.282	12-Oct-00	16:51:00	n	4328513.06	198281.95	1652.73	0.75	67	run
FS	40.302	09-Oct-00	21:20:00	y	4328537.3	198421.9	.	1	15	eddy
FS	40.302	10-Oct-00	9:36:00	n	4328537.3	198421.9	641.86	1.1	11	eddy
FS	40.302	10-Oct-00	9:36:00	y	4328537.3	198421.9	641.86	1	15	eddy
FS	40.302	10-Oct-00	10:22:00	n	4328537.3	198421.9	641.86	1.1	11	eddy
FS	40.302	10-Oct-00	10:22:00	y	4328537.3	198421.9	641.86	1	15	eddy
FS	40.302	11-Oct-00	3:20:00	n	4328617.85	198474.19	219.8	0.95	49	run
FS	40.302	11-Oct-00	11:12:00	n	4328518.68	198337.26	82.68	>3	.	run
FS	40.302	11-Oct-00	12:03:00	n	4328508.3	198319.49	713.24	1.7	.	run
FS	40.302	11-Oct-00	21:34:00	n	4328599.23	198462.13	90.19	1.65	.	run
FS	40.302	12-Oct-00	1:30:00	n	4328622.64	198487.93	271.99	1.1	.	run
FS	40.302	12-Oct-00	12:37:00	n	4328651.65	198501.5	561.76	0.75	64	run
FS	40.302	12-Oct-00	17:01:00	n	4328707.16	198510.49	69836.56	0.4	61	riffle
FS	40.302	12-Oct-00	17:35:00	n	4328619.91	198462.48	1340.56	1.1	37	run
FS	40.332	27-Sep-00	11:20:00	n	4328581.46	198444.52	143.77	1	42	run
FS	40.332	27-Sep-00	13:00:00	n	4328539.59	198426.77	509.2	0.8	22	run
FS	40.332	27-Sep-00	15:30:00	n	4328535.16	198419.39	.	0.95	14	eddy

FS	40.332	28-Sep-00	11:30:00	n	4328534.52	198418.48	.	0.95	4	eddy
FS	40.332	10-Oct-00	9:44:00	y	4328537.3	198421.9	.	1	15	eddy
FS	40.332	10-Oct-00	10:22:00	y	4328537.3	198421.9	.	1	15	eddy
FS	40.332	11-Oct-00	3:24:00	n	4328627.48	198495.99	46.1	1.25	.	run
FS	40.332	11-Oct-00	8:35:00	n	4328577.12	198459.76	35.81	0.475	2	eddy
FS	40.332	11-Oct-00	10:50:00	n	4328565.47	198411.03	2071	1.9	.	run
FS	40.332	11-Oct-00	12:14:00	n	4328616.32	198474.31	4145.38	1.3	.	run
FS	40.332	11-Oct-00	15:10:00	n	4328611.06	198476.34	227.5	1.35	.	run
FS	40.332	11-Oct-00	18:33:00	n	4328628.91	198507.02	36.6	0.6	62	interface
FS	40.332	11-Oct-00	22:09:00	n	4328510.95	198314.76	166.68	1.6	.	run
FS	40.332	12-Oct-00	2:08:00	n	4328520.77	198313.5	929.09	1.5	.	run
FS	40.332	12-Oct-00	11:58:00	n	4328484.93	198293.24	134.91	0.7	56	run
FS	40.332	12-Oct-00	16:53:00	n	4328497.25	198302	144.02	1.2	.	run
BS	40.352	26-Sep-00	15:40:00	n	4328537.19	198342.89	118.38	1.5	14	interface
BS	40.352	27-Sep-00	9:50:00	n	4328542.69	198342.02	215.01	0.9	9	interface
BS	40.352	27-Sep-00	12:40:00	n	4328555.87	198344.97	31.31	0.9	9	interface
BS	40.352	27-Sep-00	14:15:00	n	4328535.47	198353.63	123.22	2.5	.	run
BS	40.352	27-Sep-00	18:30:00	n	4328530.78	198352.45	236.92	3	.	run
BS	40.352	09-Oct-00	21:25:00	n	4328528.02	198356.46	33.52	>3	.	eddy
BS	40.352	10-Oct-00	10:12:00	n	4328529.06	198357.45	47.89	>3	.	eddy
BS	40.352	11-Oct-00	3:55:00	n	4328536.8	198341	160.7	1.65	.	run
BS	40.352	11-Oct-00	8:15:00	n	4328541.79	198357.17	123.06	1.9	.	run
BS	40.352	11-Oct-00	11:40:00	n	4328550.95	198340.06	273.31	1.05	19	run
BS	40.352	11-Oct-00	15:41:00	n	4328526.79	198355.52	34.84	>3	.	eddy
BS	40.352	11-Oct-00	19:04:00	n	4328535.42	198354.73	117.58	2.4	.	run
BS	40.352	11-Oct-00	22:14:00	n	4328535.11	198356.91	105.76	>3	.	run
BS	40.352	12-Oct-00	2:23:00	n	4328543.18	198330.38	617.27	1	24	interface
BS	40.352	12-Oct-00	10:03:00	n	4328543.37	198346.24	159.94	1.75	.	run
BS	40.352	12-Oct-00	20:19:00	n	4328538.99	198344.74	248.83	1.85	.	run
BS	40.6	09-Oct-00	20:30:00	n	4328719.17	198537.5	439.21	0.95	82	run
BS	40.6	09-Oct-00	22:10:00	n	4328753.79	198541.28	1552.82	0.8	7	eddy
BS	40.6	10-Oct-00	8:54:00	n	4328758.91	198557.77	248.88	1.4	.	run
BS	40.6	10-Oct-00	12:45:00	n	4328742.44	198539.36	255.44	1.3	.	run
BS	40.6	11-Oct-00	3:15:00	n	4328733.09	198528.3	2936.77	0.7	93	run
BS	40.6	11-Oct-00	7:43:00	n	4328749.42	198565.33	123.06	1.35	.	run

BS	40.6	11-Oct-00	10:10:00	n	4328737.27	198536.9	211.12	0.85	82	run
BS	40.6	11-Oct-00	15:03:00	n	4328736.2	198529.81	350.14	0.6	56	run
BS	40.6	11-Oct-00	18:20:00	n	4328732.44	198536.47	232.59	0.9	90	run
BS	40.6	11-Oct-00	21:07:00	n	4328720.88	198531.57	810.88	0.8	116	interface
BS	40.6	12-Oct-00	9:35:00	n	4328754.31	198547.53	276.36	1.45	.	run
BS	40.6	12-Oct-00	13:03:00	n	4328728.39	198564.65	44.85	0.225	38	riffle
BS	40.6	12-Oct-00	17:45:00	n	4328755.31	198543.38	249.87	1.3	.	run
RC	40.621	26-Sep-00	18:30:00	n	4328516.74	198355.84	39.03	>3	.	eddy
RC	40.621	27-Sep-00	13:00:00	n	4328532.19	198377.65	77.01	>3	.	run
RC	40.621	27-Sep-00	19:05:00	n	4328514.24	198355.94	29.08	2.5	.	eddy
RC	40.621	10-Oct-00	19:55:00	n	4328621.32	198484.89	256.01	1.3	.	run
RC	40.621	11-Oct-00	3:19:00	n	4328613.48	198487.45	78.07	1.3	.	run
RC	40.621	11-Oct-00	18:42:00	n	4328577.35	198453.27	49.72	1.1	.	run
RC	40.621	11-Oct-00	21:12:00	n	4328641.5	198498.03	102.38	0.95	75	run
RC	40.621	12-Oct-00	1:28:00	n	4328609.81	198440.77	1407.36	0.65	23	run
RC	40.621	12-Oct-00	10:19:00	n	4328542.99	198369.75	77.62	>3	.	run
RC	40.621	12-Oct-00	12:36:00	n	4328586.99	198460.59	51.42	1.4	.	run
RC	40.621	12-Oct-00	17:24:00	n	4328611.98	198504.31	23.37	0.85	60	interface
RC	40.621	12-Oct-00	20:24:00	n	4328561.08	198372.47	174.28	0.675	11	run
RC	40.641	26-Sep-00	0:00:00	n	4328617.2	198464.8	765.66	0.7	23	interface
RC	40.641	26-Sep-00	15:05:00	n	4328663.97	198499	211.49	0.4	48	riffle
RC	40.641	26-Sep-00	17:05:00	n	4328677.74	198513.88	189.35	0.375	76	riffle
RC	40.641	26-Sep-00	19:20:00	n	4328635.56	198489.47	159.98	0.575	30	run
RC	40.641	26-Sep-00	21:30:00	n	4328633.88	198470.45	472.17	0.4	12	run
RC	40.641	26-Sep-00	23:00:00	n	4328608.94	198449.17	1620.44	0.54	16	run
RC	40.641	27-Sep-00	6:30:00	n	4328654.93	198483.05	300.65	0.12	4	shoreline
RC	40.641	27-Sep-00	8:00:00	n	4328639.12	198472.11	445.77	0.3	8	run
RC	40.641	27-Sep-00	9:10:00	n	4328520.35	198358.82	189.66	>3	.	eddy
RC	40.641	27-Sep-00	14:05:00	n	4328520.56	198343.77	84.19	>3	.	interface
RC	40.641	27-Sep-00	14:52:00	n	4328658.11	198487.95	8646.41	0.2	14	eddy
RC	40.641	27-Sep-00	17:45:00	n	4328626.69	198493.66	63.62	1	76	run
RC	40.641	27-Sep-00	19:20:00	n	4328644.58	198492.18	156.21	0.5	42	run
RC	40.641	27-Sep-00	22:00:00	n	4328648.09	198484.82	242.14	0.4	18	interface
RC	40.641	28-Sep-00	6:30:00	n	4328719.79	198491.5	1004.8	0.6	48	run
RC	40.641	09-Oct-00	20:35:00	n	4328615.19	198463.57	1410.15	0.7	29	run

RC	40.641	09-Oct-00	22:00:00	n	4328629.63	198498.08	66.58	1.075	96	run
RC	40.641	10-Oct-00	21:00:00	n	4328595.88	198467.51	1608.15	1.6	.	run
RC	40.641	11-Oct-00	3:28:00	n	4328597.7	198453.04	124.12	1	36	run
RC	40.641	11-Oct-00	8:12:00	n	4328511.06	198329.82	60.12	2	.	run
RC	40.641	11-Oct-00	11:06:00	n	4328518.14	198321.69	169.98	1.9	.	run
RC	40.641	11-Oct-00	15:20:00	n	4328538.55	198383.87	44.81	2.4	.	run
RC	40.641	11-Oct-00	18:31:00	n	4328642.29	198510.69	93.86	0.9	90	run
RC	40.641	11-Oct-00	21:21:00	n	4328590.01	198452.38	112.16	1.375	.	interface
RC	40.641	12-Oct-00	1:29:00	n	4328621.1	198505.95	13.4	1.4	.	run
RC	40.641	12-Oct-00	10:16:00	y	4328519	198370.9	.	0.9	9	eddy
RC	40.641	12-Oct-00	12:12:00	y	4328519	198370.9	.	0.9	9	eddy
RC	40.641	12-Oct-00	17:12:00	n	4328526.13	198410.49	39.91	1	15	eddy
RC	40.641	12-Oct-00	17:12:00	y	4328526.13	198410.49	.	1	15	eddy
RC	40.641	12-Oct-00	20:55:00	n	4328537.69	198394.49	296.46	2.1	.	run
RC	40.661	26-Sep-00	16:05:00	n	4328532.16	198412.42	170.61	0.9	2	eddy
RC	40.661	27-Sep-00	12:48:00	n	4328532.41	198411.35	834.09	1.1	1	eddy
RC	40.661	27-Sep-00	14:30:00	n	4328528.09	198408.3	140.06	1.35	7	eddy
RC	40.661	27-Sep-00	15:10:00	n	4328528.09	198408.3	140.06	1.35	7	eddy
RC	40.661	27-Sep-00	15:15:00	n	4328531.69	198372.94	59.19	>3	.	run
RC	40.661	27-Sep-00	17:55:00	n	4328538.08	198381.17	91.72	>3	.	run
RC	40.661	27-Sep-00	21:00:00	n	4328619.84	198464.51	792.48	0.6	18	interface
RC	40.661	28-Sep-00	6:30:00	n	4328624.5	198496.14	630.31	1.1	80	run
RC	40.661	28-Sep-00	11:50:00	n	4328619.95	198499.35	38.14	1.1	90	run
RC	40.661	09-Oct-00	20:50:00	n	4328549.26	198388.63	88.31	1.95	.	run
RC	40.661	09-Oct-00	21:50:00	n	4328555.7	198419.6	44.48	1.85	.	run
RC	40.661	10-Oct-00	9:10:00	n	4328607.97	198467.4	431.19	1.1	42	run
RC	40.661	10-Oct-00	10:15:00	n	4328549.56	198443.23	2.44	0.45	3	eddy
RC	40.661	11-Oct-00	4:03:00	n	4328517.36	198367.81	92.7	0.6	6	eddy
RC	40.661	11-Oct-00	8:22:00	n	4328508.52	198341.76	32.56	>3	.	interface
RC	40.661	11-Oct-00	11:50:00	n	4328501.77	198339.23	23.18	2.4	.	eddy
RC	40.661	11-Oct-00	15:34:00	n	4328505.49	198339.3	25.404	2.5	.	eddy
RC	40.661	11-Oct-00	18:52:00	y	4328537.3	198421.9	.	1	15	eddy
RC	40.661	11-Oct-00	21:47:00	y	4328534.9	198419.8	.	1.1	1	eddy
RC	40.661	12-Oct-00	1:50:00	n	4328537.3	198421.9	327.376	1	15	run
RC	40.661	12-Oct-00	1:50:00	y	4328537.3	198421.9	.	1	15	eddy

RC	40.661	12-Oct-00	9:59:00	y	4328537.3	198421.9	.	1	15	eddy
RC	40.661	12-Oct-00	12:29:00	n	4328527.19	198402.85	9.525	2.05	.	eddy
RC	40.661	12-Oct-00	17:13:00	y	4328528.7	198411.5	.	1.15	8	eddy
RC	40.661	12-Oct-00	20:27:00	n	4328529.11	198405.64	16.432	1.5	.	eddy
BS	40.681	09-Oct-00	21:05:00	n	4328511.4	198309.51	305.356	1.5	.	run
BS	40.681	10-Oct-00	20:04:00	n	4328541.82	198421.51	.	1.55	.	interface
BS	40.681	11-Oct-00	3:38:00	n	4328509.63	198328.41	83.028	2	.	run
BS	40.681	11-Oct-00	8:25:00	n	4328509.82	198318.96	185.387	2	.	run
BS	40.681	11-Oct-00	11:56:00	n	4328492.15	198332.76	27.876	0.4	8	eddy
BS	40.681	11-Oct-00	15:22:00	n	4328519.51	198365.55	39.349	1.7	.	eddy
BS	40.681	11-Oct-00	18:49:00	n	4328508.09	198313.61	208.896	1.6	.	run
BS	40.681	11-Oct-00	21:51:00	n	4328514.4	198304.24	320.079	1.3	.	run
BS	40.681	12-Oct-00	2:07:00	y	4328519	198370.9	.	0.9	9	eddy
BS	40.681	12-Oct-00	10:05:00	y	4328511.4	198364.7	.	2.1	.	eddy
BS	40.681	12-Oct-00	12:14:00	y	4328519	198370.9	.	0.9	9	eddy
BS	40.681	12-Oct-00	17:00:00	y	4328519	198370.9	.	0.9	9	eddy
BS	40.681	12-Oct-00	20:13:00	n	4328510.93	198327.56	99.039	1.9	.	run

[a]BS = bluehead sucker, FS = flannelmouth sucker, RC = roundtail chub.
[b]Fish location estimated by direct observation not triangulation because the locality was obvious and close to the shore.
. = missing data.