

FISHERIES SURVEY of the lower Muddy River below the Wells-siding Diversion Dam

DRAFT REPORT

Prepared for:

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Dry plunge pool below the Wells-siding Diversion in July 2004.

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Virgin River chub (Gila seminuda).

EXECUTIVE SUMMARY

Historical collections below the Wells-siding Diversion indicate that native fishes are, at best, rare in the lower Muddy River (Deacon and Bradley 1972, Cross 1976). The August 2003 Nevada Department of Wildlife collection of Virgin River chub (*Gila seminuda*) immediately below the Wells-siding Diversion created some speculation as to the status of native fishes below the diversion. Presently, the Southern Nevada Water Authority is investigating options to develop water rights on the lower Muddy River. We surveyed the lower Muddy River from the Wells-siding Diversion to the Overton Wildlife Management Area to determine the distribution and abundance of native fishes in this area.

We found both Virgin River chub and speckled dace (*Rhinichthys osculus*) below the Wells-siding Diversion in May 2004. All but one of the Virgin River chub were young-of-the-year. We collected a 1-year-old Virgin River chub 6.75 miles (10.9 km) below the Wells-siding Diversion. We did not collect any native fishes during surveys conducted in July and September 2004. Water levels were generally lower in July and September 2004 than in May 2004.

Habitat, flow, and temperature appeared suitable for Virgin River chub at many of our sampling stations below the Wells-siding Diversion during all of the sampling trips. Additionally, the areas where we could sample were limited by time and accessibility constraints, so there may be more suitable habitat that we were not able to sample. We recommend a more intensive survey of the fish fauna of the lower Muddy River to determine whether native fishes persist year-round below Wells-siding Diversion. Additionally, we recommend installing thermographs at selected locations below Wells-siding Diversion and investigating the magnitude of native fish entrainment into the canal that leads to Bowman Reservoir.

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INTRODUCTION AND BACKGROUND

Sampling by Deacon and Bradley (1972) and Cross (1976) showed that fish populations below the Wells-siding Diversion Dam were predominantly comprised of nonnative fishes. In the 1960s only one native fish, a Virgin River chub (*Gila seminuda*), was collected downstream from the Wells-siding diversion by Deacon and Bradley (1972). Subsequent surveys in the mid-1970s found no native fishes below the Wells-siding Diversion. Fisheries surveys of the Muddy River during the 1990s focused on the Moapa dace (*Moapa coriacea*) and the Moapa White River springfish (*Crenichthys baileyi moapae*) in the Warm Springs area of the Upper Muddy River and the core of the Virgin River chub population from Reid Gardner Power Station Dam to the I-15 Bridge (Scoppetone 1993; Scoppetone et al. 1998; Jim Heinrich, NDOW, personal communication). However, in August 2003 the Nevada Department of Wildlife (NDOW) found 18 Virgin River chub immediately downstream from the Wells-siding Diversion (Jim Heinrich, NDOW, personal communication).

Recent electrofishing surveys further downstream from the diversion have not found any native fishes (Jim Heinrich, NDOW, personal communication), prompting questions about the size, distribution, and permanence of any native fish populations below the Wells-siding Diversion. Flows to this section of the river are sporadic and based on the amount of water routed to Bowman Reservoir by the Wells-siding Diversion. It is unclear whether the current flow regime, and its associated impacts on fish habitat and water quality, allows for a permanent native fish population in areas below the Wells-siding Diversion. Native fishes found in this area of the river may have drifted from larger populations upstream and are unable to persist below the diversion over time.

The Southern Nevada Water Authority (SNWA) is planning on utilizing Muddy River water for municipal water supply, which may change flows below Bowman Reservoir. In order to determine the potential impacts of reduced flows below the Wells-siding Diversion on the fish community, SNWA contracted BIO-WEST, Inc. (BIO-WEST) to perform a fisheries survey of the Muddy River from the Wells-siding Diversion Dam to Lake Mead. The following report presents the results of that survey and compares those results with historical information on the fish community of the Muddy River below the Wells-siding Diversion.

STUDY AREA

The study area for this project was the lower Muddy River from the Wells-siding Diversion to the confluence of the Muddy River with Lake Mead. During spring and summer 2004, this extended from River Mile (RM) 14.75 to RM 2.0 (map inset). We conducted reconnaissance trips on April 30, 2004, and May 1, 2004, to delineate sampling stations along the lower Muddy River. The river was overgrown with vegetation and impassable in many spots from the Wells-siding Diversion to the Overton Wildlife Management Area (WMA). Access was also limited by the amount of private

property along the bank from Wells-siding Diversion to the Overton WMA. We accessed the river at a variety of paved road crossings and dirt roads. With the restricted access and difficulty of maneuvering for any distance once we entered the river channel, we determined that the best course of action would be to sample multiple small areas along the length of the channel versus a few larger areas. We sampled everywhere that was accessible from a property ownership and a vegetation standpoint (Table 1, map inset).

Table 1. Sites accessible in April 2004 and subsequently surveyed for native fishes in May, July, and September 2004.

Site Name	River Mile	Upper Site Boundary			Lower Site Boundary			Single-Point Representation		
		Northing	Easting	Zone	Northing	Easting	Zone	Northing	Easting	Zone
Wells-siding Diversion	14.75	-	-	-	-	-	-	4055626	723798	11
Above Route 169	13.5	-	-	-	-	-	-	4054168	724675	11
Route 169	13.25	4053665	725063	11	4053574	725099	11	-	-	-
Below Route 169	13.0	4053284	725292	11	4053253	725309	11	-	-	-
Gubler Road	12.5	4052541	725860	11	4052541	725885	11	-	-	-
Yamashita Road	11	4050553	727508	11	4050454	727594	11	-	-	-
Cottonwood Road	10	4049391	728418	11	4049375	728424	11	-	-	-
Cooper Road	9.5	4048687	728797	11	4048390	728922	11	-	-	-
Lewis Road	8	4046264	730196	11	4046203	730245	11	-	-	-
Below Lewis Road	7.75	4045997	730321	11	4045904	730326	11	-	-	-
Overton WMA Diversion Dam	7.5	-	-	-	-	-	-	4054420	730593	11
End of channel	6.25	-	-	-	-	-	-	4043879	732012	11

While the study area extended to RM 2.0, the reconnaissance trip in April 2004 showed that the last area where the active channel could be sampled was at RM 6.25 on the Overton WMA. Between the Overton WMA and Lake Mead, the river became a marsh and eventually dried out. We were unable to access the river immediately below the Overton WMA to determine exactly where the river ended. However, we did access a marsh area near RM 4.25, within the Lake Mead National Recreation Area, and walked across a 400 m-wide field of inundated sedges and cattails. We did not find, or see, an active river channel in this area. From Saint Thomas Point we observed what

should have been the confluence of the Muddy River with Lake Mead, but we did not see a connection between the river and the lake at that time.

METHODS

Within our sampling stations we used 1.2 m x 4.5 m x 3 mm seines, 1.2 m x 3 m x 3 mm seines, 1.8 m x 9.1 m x 6.4 mm seines, hoop nets, and Gee minnow traps. Hoop nets had 0.61-m diameter mouths and were 2.1 m long with 6.4 mm mesh. Hoop nets and minnow traps were fished over night. We also experimented with a Coffelt backpack electrofisher during the May 2004 sampling trip. The effort expended at each site depended on the habitat and amount of accessible area. At most sites we tried to use all methods on at least the first trip. We used dog food to bait the hoop nets and minnow traps during the July and September 2004 sampling trips.

We recorded the following information for each sample: sample number, river mile (in 0.25-mile [0.4 km] increments), reach, date and time of collection, habitat type, gear type, approximate length and width of the habitat sampled, average and maximum depths, the two dominant substrate types (silt, sand, fine gravel [< 25 mm diameter], coarse gravel [25-75 mm diameter], small cobble [75-150 mm diameter], large cobble [150-255 mm diameter], and boulder [> 255 mm diameter]), and cover availability. The total number of each fish species captured in each seine haul was recorded. When more than 50 red shiner (*Cyprinella lutrensis*) were captured in a single seine haul, their numbers were estimated. We measured all native fish species for total length (mm) until 100 lengths for each species were obtained in each reach. During each trip we also measured the total length of a representative sample of nonnative fishes that we collected, other than red shiner and western mosquitofish (*Gambusia affinis*). Red shiner and western mosquitofish were not measured.

We used discharge measured by the U.S. Geological Survey (USGS) at the Glendale, Nevada, gage (09419000). We measured temperature periodically throughout each sampling trip using a hand-held thermometer. The GPS coordinates were acquired with a Garmin eTrex Summit hand-held GPS unit with a NAD 27 GIS projection.

RESULTS

Discharge

The USGS gaging station on the Muddy River closest to the study area was near Glendale, Nevada. Unfortunately, this gaging station is above the Wells-siding Diversion, which diverts water to Bowman Reservoir. Therefore, the impact of that diversion on flows in the study area cannot be determined, except by the visual observations we made in the field. During the reconnaissance trip

on April 30 and May 1, 2004 average daily discharge was 33 cfs (Figure 1). Flow remained constant around 30 cfs at the Glendale, Nevada, gage throughout May 2004. However, we found that flows dropped substantially below the Wells-siding Diversion between May 17-18, 2004. While the flows at the Glendale, Nevada, gage remained between 25 and 35 cfs for most of July, August, and September 2004, flows appeared to be substantially lower than this below the Wells-siding Diversion during our sampling trips.

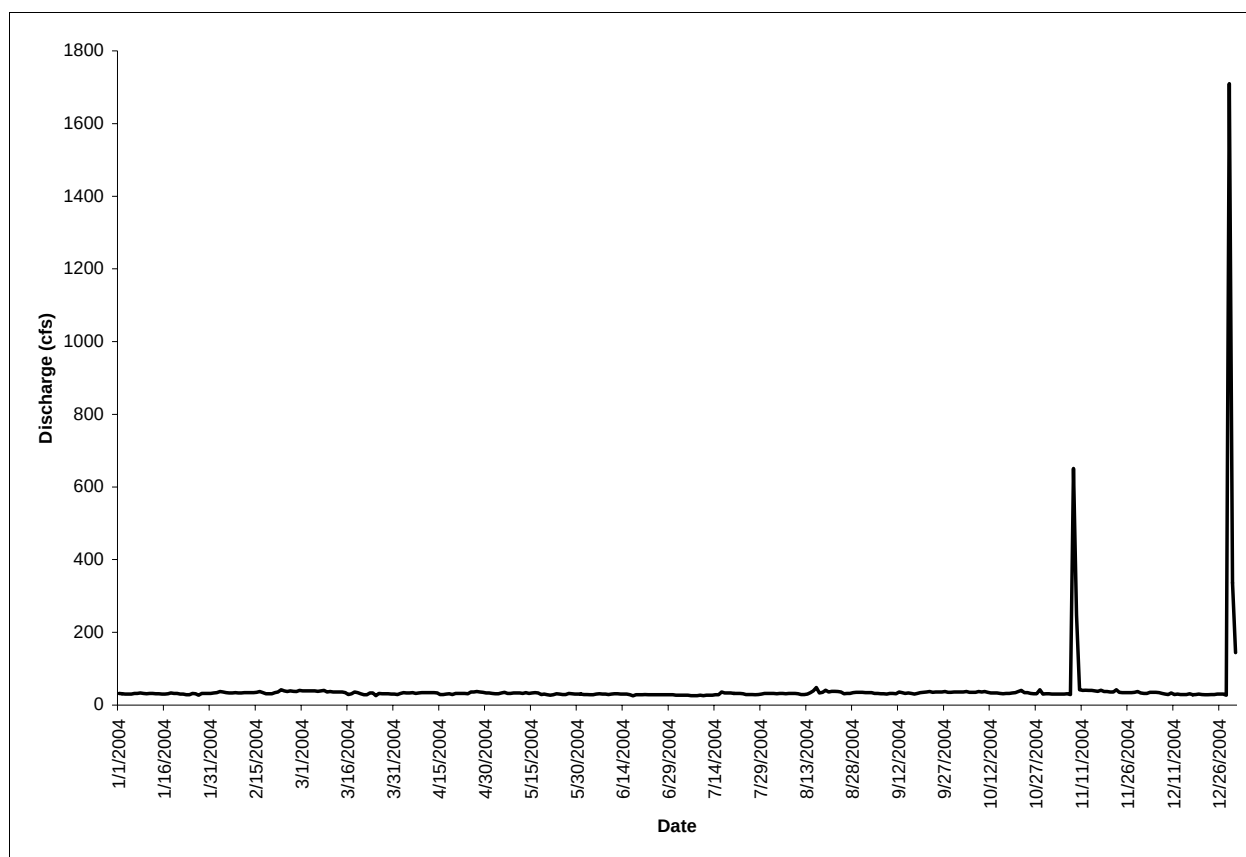


Figure 1. Average daily discharge^a recorded at the USGS gage near Glendale, Nevada, on the Muddy River for calendar year 2004 (January 1, 2004, to December 31, 2004). ^a Data are provisional.

Temperature

The difference between the minimum and maximum temperatures recorded during each trip was near 6°C (Figure 2). The highest temperature was recorded during the July trip (26°C). In general we did not take temperatures during the hottest part of the day, because we had usually finished sampling by then.

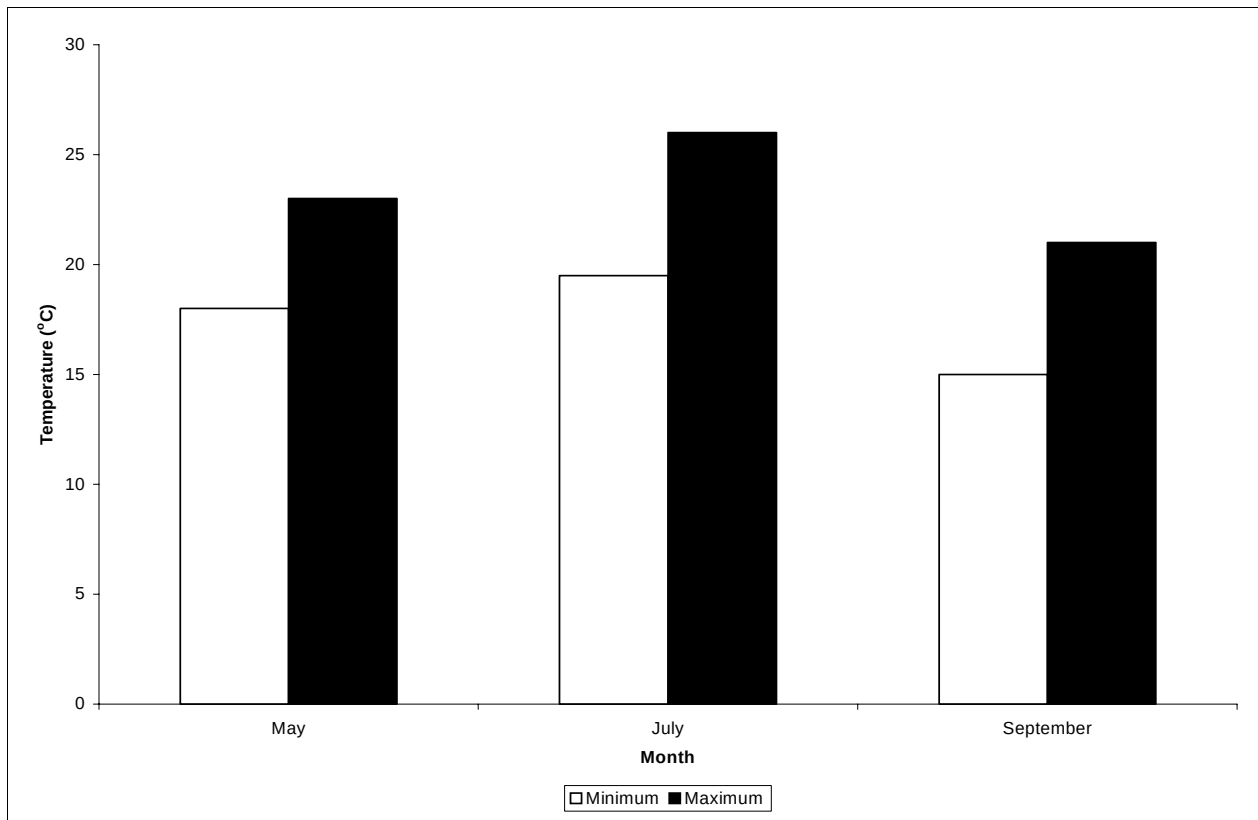


Figure 2. Minimum and maximum temperature recorded during each sampling trip on the Muddy River in 2004.

May 2004

Habitat

We sampled the study area from May 17-20, 2004. We found that flows below the Well-siding Diversion had dropped substantially between May 17 and May 18, 2004. The drop in water levels was related to the operation of Well-siding Diversion and caused a substantial change in habitat immediately below the diversion. During the reconnaissance trip and when we set hoop nets the evening of May 17, 2004, we found a large plunge pool area immediately below the diversion. However, increased water diversion overnight on May 17-18, 2004 caused the entire river to be diverted into the canal and no water to pass over the diversion itself. On the morning of May 18, 2004, depth had decreased by nearly 50% in the large plunge pool. The average and maximum depths we recorded on May 18, 2004 were probably half of those we would have recorded on May 17, 2004 (Figure 3). Silt and sand were the dominant substrates. Less than 30 m below the diversion the channel became too overgrown to effectively sample, so the majority of our sampling took place in the plunge pool immediately below the diversion. By May 20, 2004, the Wells-siding Diversion station was completely dry.

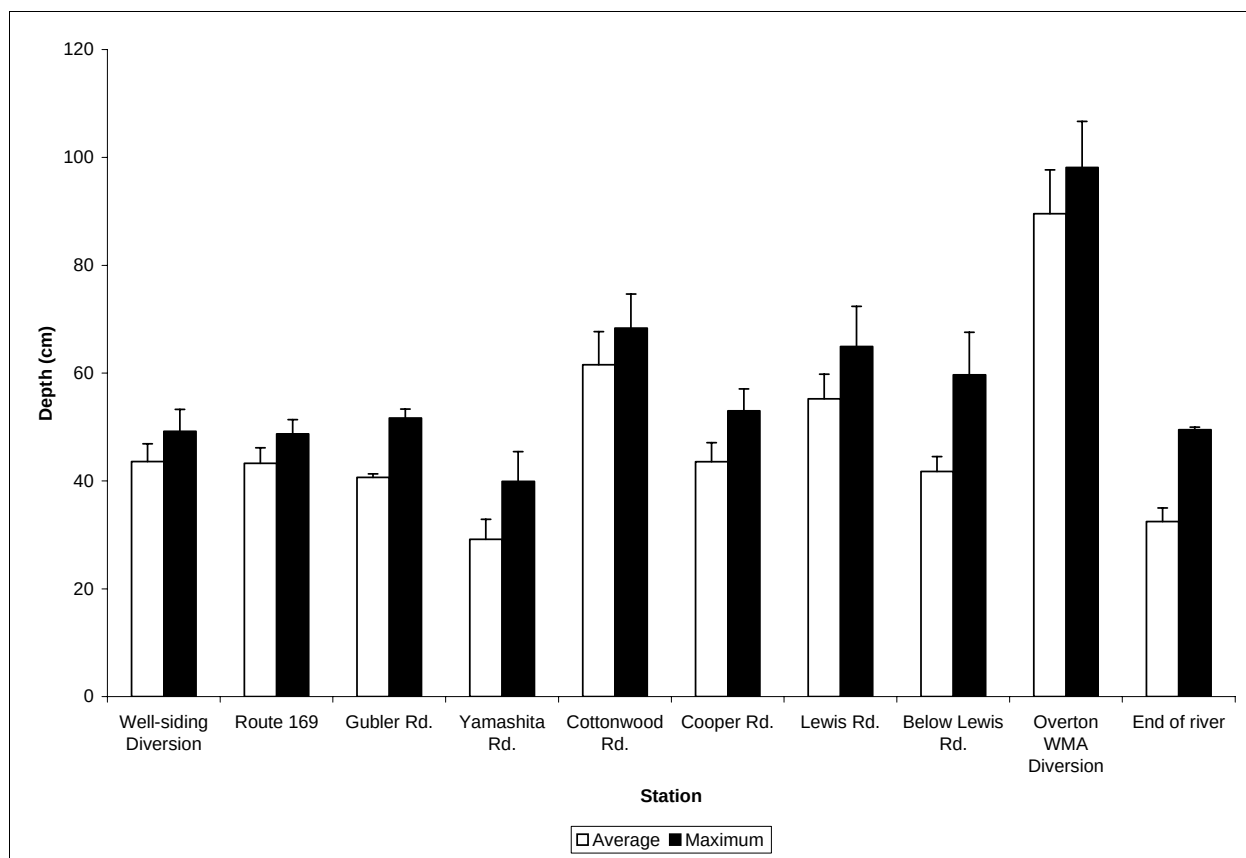


Figure 3. Mean average and mean maximum depths at all stations sampled during May 2004.

The Route 169 station was comprised mostly of deep run and pool habitats. Mean average and mean maximum depths recorded at this sampling station were similar to those found at the Wells-siding Diversion station. We also saw a substantial decrease in water levels at this station between May 17-18, 2004. We would estimate that depths were 30% greater on May 17, 2004, when nets were set than on May 18, 2004, when nets were retrieved. Silt and sand were the dominant substrate, and the channel had a dense or overhanging riparian vegetation. While the water level went down at this station, it did not dry. The river quickly became impassable because of overhanging vegetation upstream and downstream of this station.

The Gubler Road and Yamashita Road stations had considerably different habitat than most of the other stations we sampled. Both of these stations had some cobble and gravel substrates, which led to riffle, run, and pool sequences, whereas many of the other stations had a simple u-shaped channel with relatively homogenous runs and pools. The mean average and mean maximum depths at the Gubler Road and Yamashita Road stations were lower than those at most of the other stations because of habitat differences. The river quickly became impassable because of overhanging vegetation upstream and downstream of these stations.

The Cottonwood Road station had a narrow, entrenched channel with deep runs and pools. Silt and sand were the primary substrates, and much of the channel was covered by a dense canopy of overhanging riparian vegetation. There was also a beaver dam near the bottom of this station. The river quickly became impassable because of overhanging vegetation upstream and downstream of this station.

The Cooper Road station had a wider channel than the Cottonwood Road station, but it was still dominated by deep runs and pools upstream of the road. The area upstream of Cooper Road was dominated by silt and sand substrates, with a few areas of fine gravel. For a short distance downstream of the road crossing, there was some riffle and run habitat, but the river quickly became impassable because of overhanging vegetation in this area.

The portion of Lewis Road station on the upstream side of the road crossing was similar to the upstream portion of the Cooper Road station. However, on the downstream side of the bridge culvert, there was a large plunge pool that was over 150 cm deep. The plunge pool also had large cobbles and boulders as the primary substrates. The pool flowed into a riffle on the downstream end, but the river quickly became impassable with overhanging vegetation in this area.

The below Lewis Road station had a narrow, entrenched channel similar to the Cottonwood Road station. This site had mid-depth runs separated by pools, and sand and silt substrates. Dense overhanging vegetation made the river impassable on the upstream and downstream ends of this station.

We sampled the pond above the Overton WMA Diversion Dam and the outflow areas below the dam. The pond had areas greater than 200 cm deep and had silt substrate. The outflow area had several small concrete-lined pools and a riffle/run complex below the road crossing.

The last defined channel area accessible for sampling was the end of the river station. Overton WMA personnel felt that there was no defined channel below this site (Keith Brose, NDOW, personal communication). Only a small section of river was accessible for sampling in this area; the rest was heavily overgrown. The station consisted of shallow to mid-depth runs surrounding a pool created by a culvert outflow from ponds on the Overton WMA. Sand and fine gravel were the dominant substrates.

Fishes

We collected 31 Virgin River chub in May 2004 (Table 2). The majority of the Virgin River chub were collected immediately below the Wells-siding Diversion. However, we collected Virgin River chub at the Cooper Road and Lewis Road stations, too. All but one of the Virgin River chub we collected were young-of-the-year (YOY) (Figure 4). The Virgin River chub collected at the Lewis Road station was probably a 1-year-old fish (162 mm). We also collected two speckled dace in May 2004. One speckled dace was collected immediately below the Wells-siding Diversion, and the other was collected at the Gubler Road station. Both speckled dace were YOY (34 mm and 39 mm).

Table 2. Number of samples and number of fishes collected at each station during the May 2004 sampling trip.

Station	Seine Hauls	Hoop Nets	Minnow Traps	E-fish	VRC ^a	SD ^b	BB ^c	BG ^d	BLC ^e	CC ^f	CP ^g	FHM ^h	GS ⁱ	LMB ^j	MF ^k	RS ^l	TL ^m	TSS ⁿ	CF ^o
Wells-siding Diversion	3	10	13	1	26	1	0	0	0	0	0	1	0	0	3	0	0	1	4
Above Route 169	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Route 169	9	10	10	0	0	0	1	0	0	0	0	9	1	3	0	102	1	0	3
Below Route 169	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Gubler Road	3	0	0	0	0	1	0	0	0	0	0	15	0	0	65	149	0	0	5
Yamashita Road	13	3	4	0	0	0	0	2	0	1	1	17	0	3	0	361	0	0	1
Cottonwood Road	4	5	5	0	0	0	3	1	0	1	0	3	0	1	0	34	0	0	0
Cooper Road	14	11	10	0	4	0	1	7	0	0	1	7	0	1	9	694	0	0	3
Lewis Road	5	5	5	1	1	0	1	11	0	0	5	4	3	3	1	135	0	0	4
Below Lewis Road	6	4	5	1	0	0	0	5	0	0	2	32	3	0	0	451	0	0	7
Overton WMA Diversion	0	10	10	2	0	0	2	7	1	0	5	10	0	2	6	198	0	0	10
End of channel	2	0	0	0	0	0	0	0	1	0	0	73	0	9	354	242	0	0	68
Total	59	58	62	5	31	2	8	33	2	2	14	171	7	22	438	2,366	1	1	105

^a VRC = Virgin River chub
^b SD = Speckled dace
^c BB = Black bullhead
^d BG = Bluegill
^e BLC = Black crappie
^f CC = Channel catfish
^g CP = Common carp
^h FHM = Fathead minnow
ⁱ GS = Green sunfish
^j LMB = Largemouth bass
^k MF = Western mosquitofish
^l RS = Red shiner
^m TL = Blue tilapia
ⁿ TSS = Texas spiny softshell turtle
^o CF = Crayfish

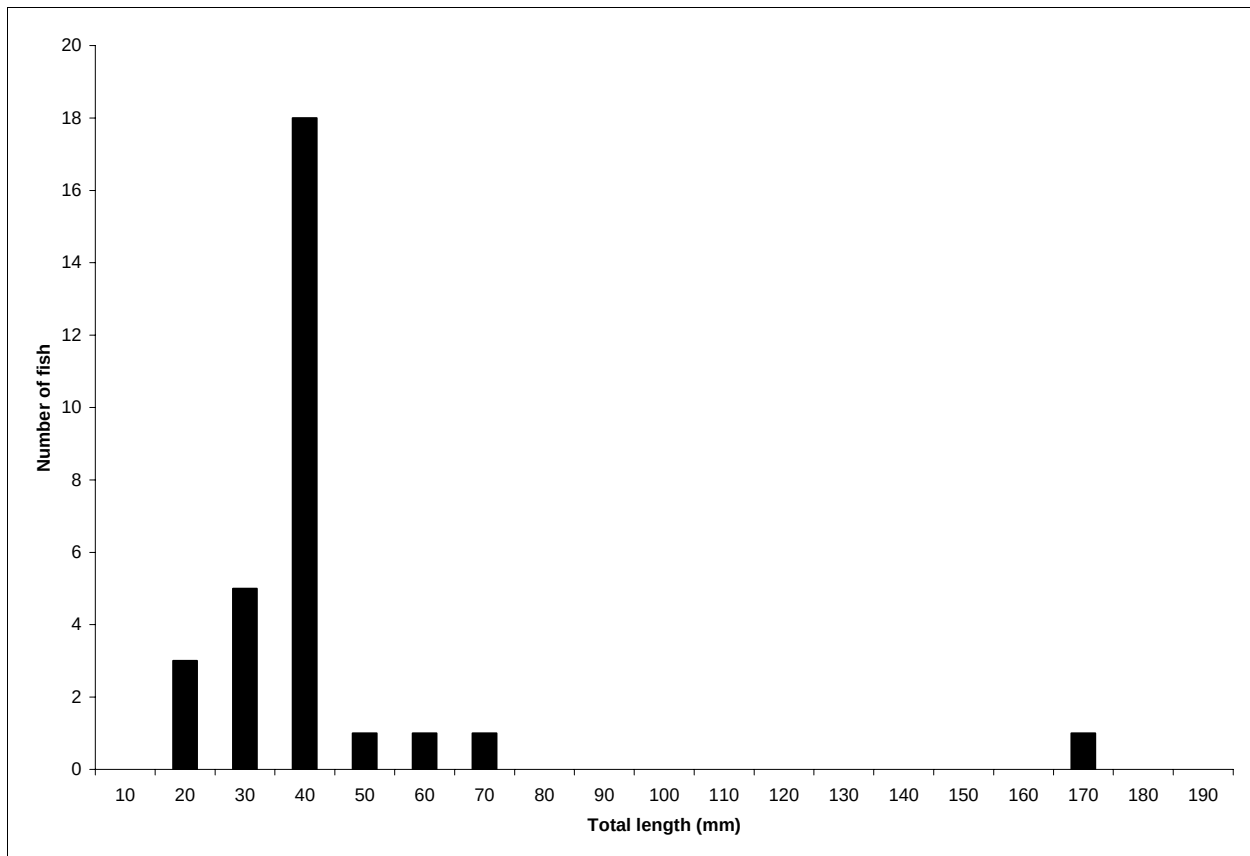


Figure 4. Length frequency histogram of Virgin River chub collected in May 2004.

Nonnative minnows dominated the seining catch (Figure 5). Red shiner, western mosquitofish, and fathead minnow (*Pimephales promelas*) had the highest CPE (catch per effort) in seining collections. Largemouth bass (*Micropterus salmoides*), Virgin River chub, and bluegill sunfish (*Lepomis cyanellus*) were the next three most abundant species in seining collections.

Red shiner was also the dominant species collected in hoop nets and minnow traps in May 2004 (Figure 6). Bluegill sunfish and fathead minnow were the next most abundant species collected using hoop nets. Few fishes were collected using minnow traps.

In addition to fishes, we also collected relatively large numbers of crayfish throughout the study area and one Texas spiny softshell turtle (*Apalone spinifera emoryi*). The red swamp crayfish (*Procambarus clarki*) was the dominant species found during our collections, but we saw a few specimens of the virile crayfish (*Orconectes virilis*), as well. We also observed bullfrogs (*Rana catesbeiana*) throughout the study area.

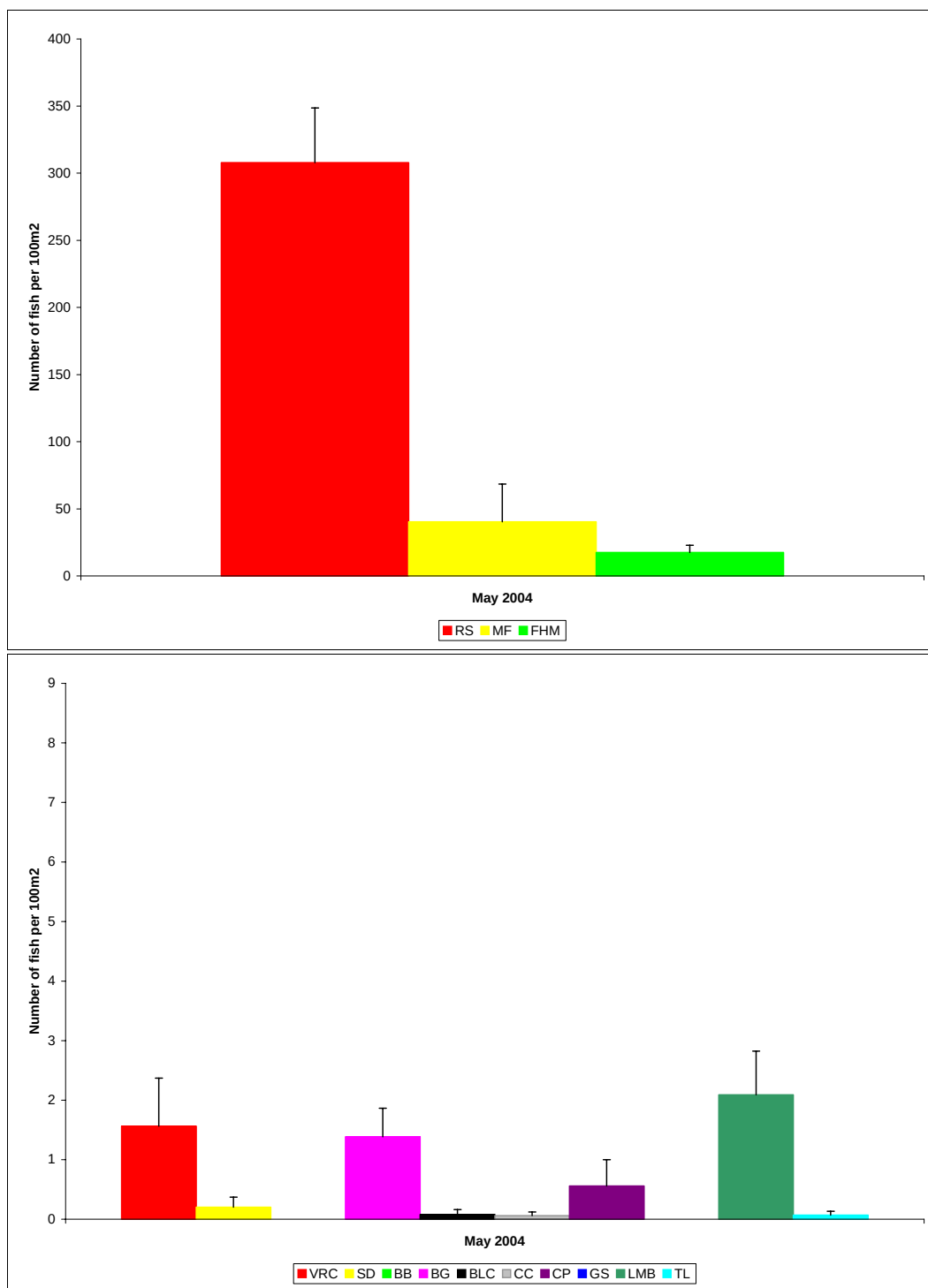


Figure 5. Number of (a) red shiner, western mosquitofish, and fathead minnow; and (b) all other species collected per 100 m² seining in May 2004.

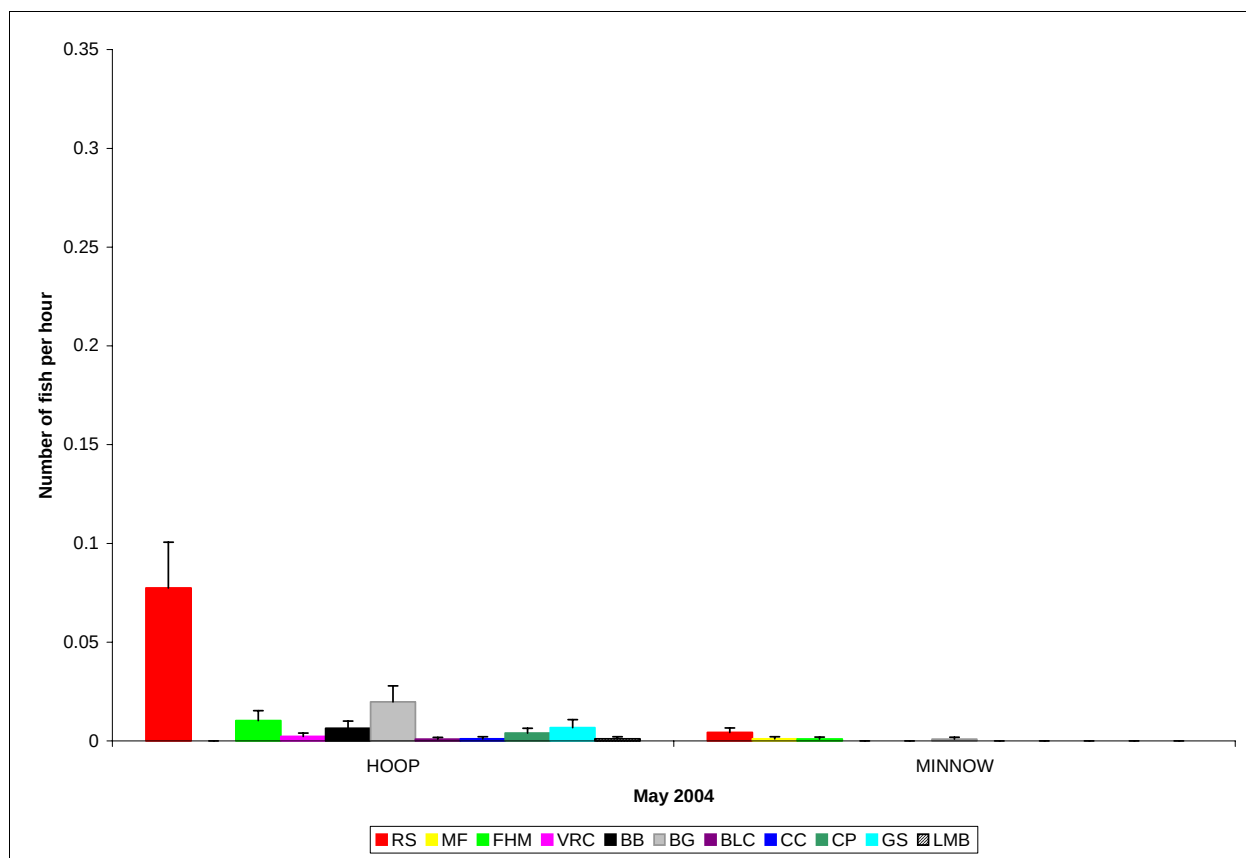


Figure 6. Number of fish collected per hour of hoop netting and minnow trapping in May 2004.

July 2004

Habitat

Habitat remained similar at most of our stations between May 2004 and July 2004, except that most stations appeared to have lower water levels. The lower water levels were reflected in the differences between the mean average depths of the two sampling trips (Figure 7). Mean maximum depths showed a similar trend. We did not sample at the Wells-siding Diversion station in July 2004 because this station remained dry. Additionally, we could not relocate the end of river station during this trip. We sampled two new stations, above Route 169 and below Route 169, in July 2004. The above Route 169 station was dominated by mid-depth runs with some mid-depth pools. Substrate was dominated by silt, sand, and gravel. Overhanging riparian vegetation shaded much of the channel. The below Route 169 station was dominated by shallow runs and pools. Silt was the dominant substrate and detritus and woody debris were common in the channel. Both these stations were relatively small in size, because the river quickly became impassable with overhanging vegetation both upstream and downstream of the stations.

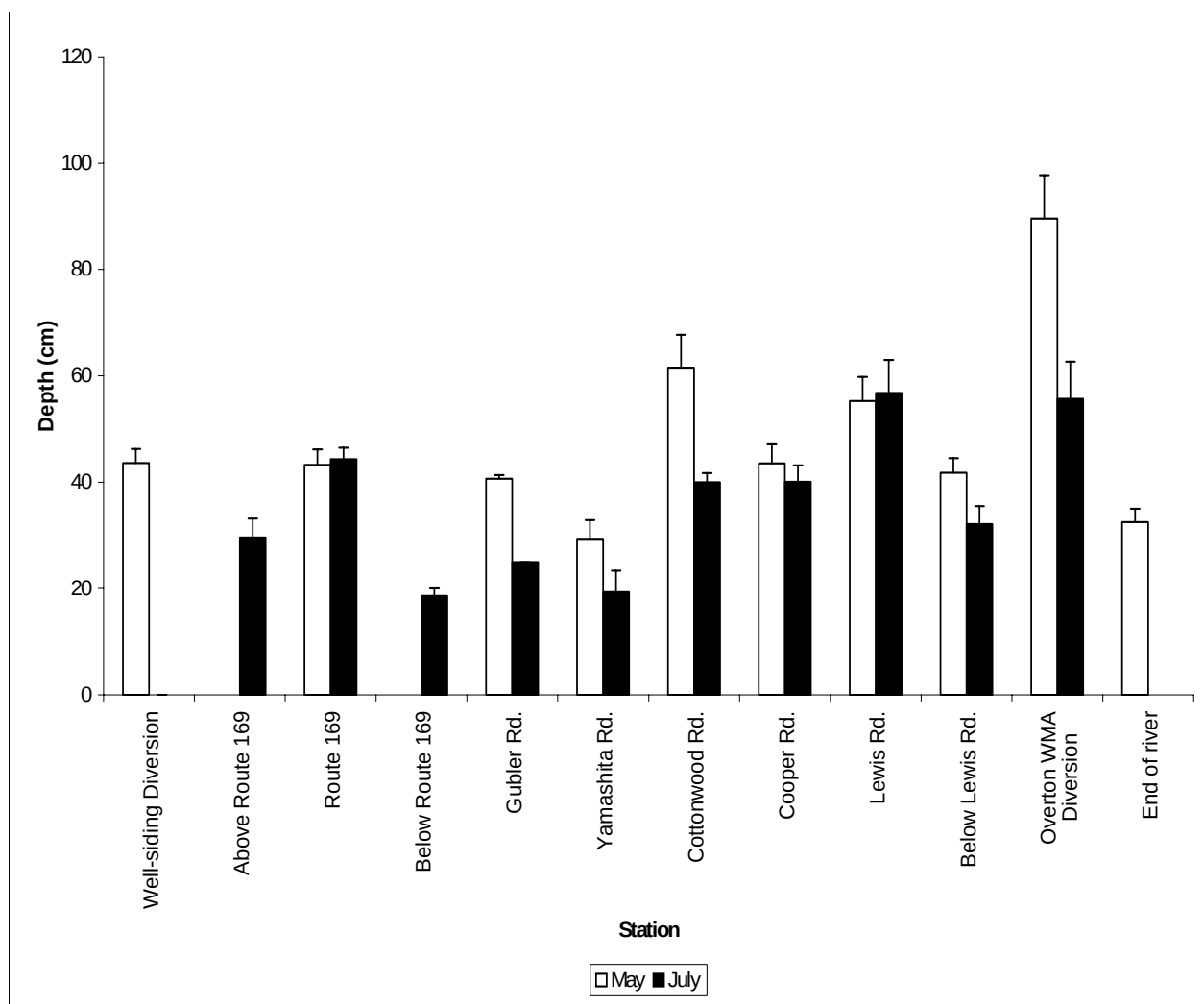


Figure 7. Mean average depths of samples collected throughout the study area in May 2004 and July 2004.

Fish

We did not collect any native fish during the July 2004 sampling trip (July 9-11, 2004), despite a expending a similar amount of effort as during the May 2004 trip (Table 3). Seining collections were again dominated by red shiner, fathead minnow, and western mosquitofish (Figure 8), and hoop net and minnow trap collections were dominated by black bullhead (*Ameiurus melas*) and red shiner, respectively (Figure 9). We saw an increase in the abundance of black bullhead, common carp (*Cyprinus carpio*), and largemouth bass in seining collections in July 2004 over May 2004. We also saw an increase in the abundance of black bullhead in the hoop net collections in July 2004. As in May 2004 we collected spiny softshell turtles, red swamp crayfish, virile crayfish, and observed bullfrogs throughout the study area.

Table 3. Number of samples and number of fishes collected at each station during the July 2004 sampling trip.

Station	Seine Hauls	Hoop Nets	Minnow Traps	VRC ^a	SD ^b	BB ^c	BG ^d	BLC ^e	CC ^f	CP ^g	FHM ^h	GS ⁱ	LMB ^j	MF ^k	RS ^l	TL ^m	TSS ⁿ	CF ^o
Wells-siding Diversion	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Above Route 169	0	3	5	0	0	0	0	0	0	2	1	0	2	0	18	0	0	31
Route 169	9	12	10	0	0	1	0	0	0	0	34	4	1	0	54	0	12	0
Below Route 169	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gubler Road	3	0	0	0	0	0	0	0	0	0	15	0	0	25	117	0	0	15
Yamashita Road	12	0	0	0	0	0	0	0	2	1	13	0	6	5	134	0	0	0
Cottonwood Road	7	10	10	0	0	0	5	0	0	1	0	1	3	3	25	0	1	0
Cooper Road	12	10	10	0	0	0	8	0	0	2	25	0	5	7	307	0	4	5
Lewis Road	10	11	8	0	0	219	24	0	3	15	4	11	2	2	24	0	1	8
Below Lewis Road	7	4	7	0	0	3	1	0	0	3	46	1	11	0	498	0	1	5
Overton WMA	3	10	5	0	0	15	5	1	0	16	76	1	7	10	381	0	2	16
Diversion																		
End of channel	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total	63	60	60	1	0	238	42	1	5	40	214	18	37	52	1,558	0	21	80

^a VRC = Virgin River chub
^b SD = Speckled dace
^c BB = Black bullhead
^d BG = Bluegill
^e BLC = Black crappie
^f CC = Channel catfish
^g CP = Common carp
^h FHM = Fathead minnow
ⁱ GS = Green sunfish
^j LMB = Largemouth bass
^k MF = Western mosquitofish
^l RS = Red shiner
^m TL = Blue tilapia
ⁿ TSS = Texas spiny softshell turtle
^o CF = Crayfish

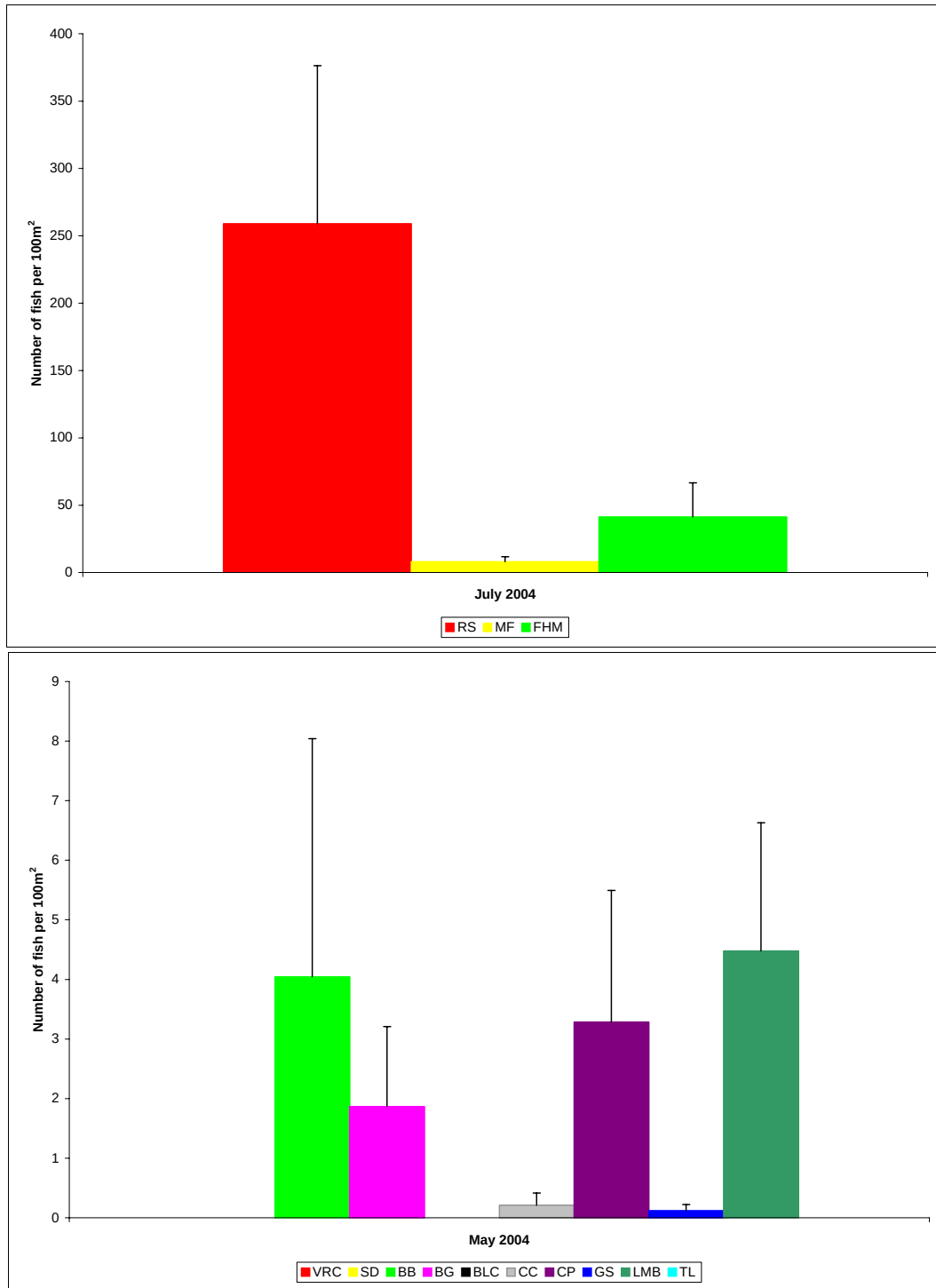


Figure 8. Number of a) red shiner, western mosquitofish, and fathead minnow and b) other species collected per 100m² seining in July 2004.

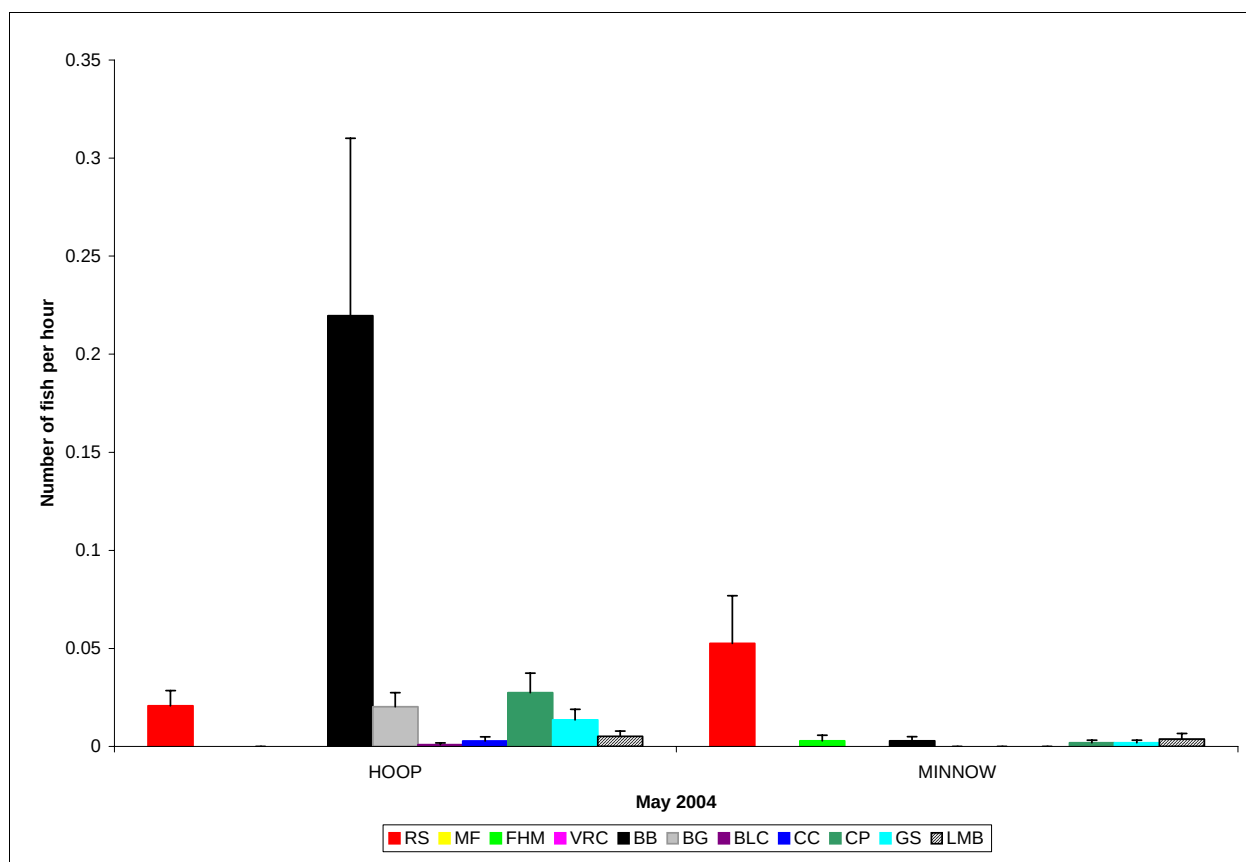


Figure 9. Number of fish collected per hour of hoop netting and minnow trapping in July 2004.

September 2004

Habitat

The Wells-siding Diversion station remained dry in September 2004. The remaining stations appeared to have similar habitat to the July 2004 sampling trip. However, a comparison of the mean average depth of samples collected at each sampling station showed that water levels may have been higher from the Cooper Road station downstream to the Overton WMA Diversion (Figure 10). We did not sample the below Route 169 station in September 2004 because the habitat available there in July 2004 was poor.

Fishes

As in July 2004 we did not collect any native fishes during the September 2004 sampling trip (September 7-9, 2004), despite expending effort similar to the May 2004 sampling trip (Table 4).

Table 4. Number of samples and number of fishes collected at each station during the September 2004 sampling trip.

Station	Seine Hauls			Hoop Nets			Minnow Traps			VRC ^a	SD ^b	BB ^c	BG ^d	BLC ^e	CC ^f	CP ^g	FHM ^h	GS ⁱ	LMB ^j	MF ^k	RS ^l	TL ^m	TSS ⁿ	CF ^o
	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Wells-siding Diversion										DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Above Route 169	0	2	3							0	0	0	0	0	0	0	1	0	0	0	0	0	0	24
Route 169	9	10	10							0	0	1	0	0	0	0	1	1	1	110	233	2	0	1
Below Route 169	n/a	n/a	n/a							n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Gubler Road	6	0	0							0	0	2	0	0	0	0	6	0	0	261	300	0	0	66
Yamashita Road	11	0	0							0	0	0	0	0	0	1	93	0	2	89	157	0	0	0
Cottonwood Road	6	8	8							0	0	1	1	0	0	0	0	1	2	0	0	0	0	1
Cooper Road	12	12	11							0	0	1	2	0	0	0	10	0	2	15	139	0	1	4
Lewis Road	7	8	10							0	0	16	2	0	0	3	0	4	0	0	110	0	0	9
Below Lewis Road	9	5	11							0	0	6	0	0	0	1	21	1	0	0	525	0	0	0
Overton WMA Diversion	3	15	10							0	0	0	9	2	1	2	20	1	1	108	271	0	0	2
End of channel	2	0	0							0	0	0	0	0	0	0	0	0	0	107	0	0	0	175
Total	65	60	63							0	0	27	14	2	1	7	152	8	8	690	1,735	2	1	282

^a VRC = Virgin River chub
^b SD = Speckled dace
^c BB = Black bullhead
^d BG = Bluegill
^e BLC = Black crappie
^f CC = Channel catfish
^g CP = Common carp
^h FHM = Fathead minnow
ⁱ GS = Green sunfish
^j LMB = Largemouth bass
^k MF = Western mosquitofish
^l RS = Red shiner
^m TL = Blue tilapia
ⁿ TSS = Texas spiny softshell turtle
^o CF = Crayfish

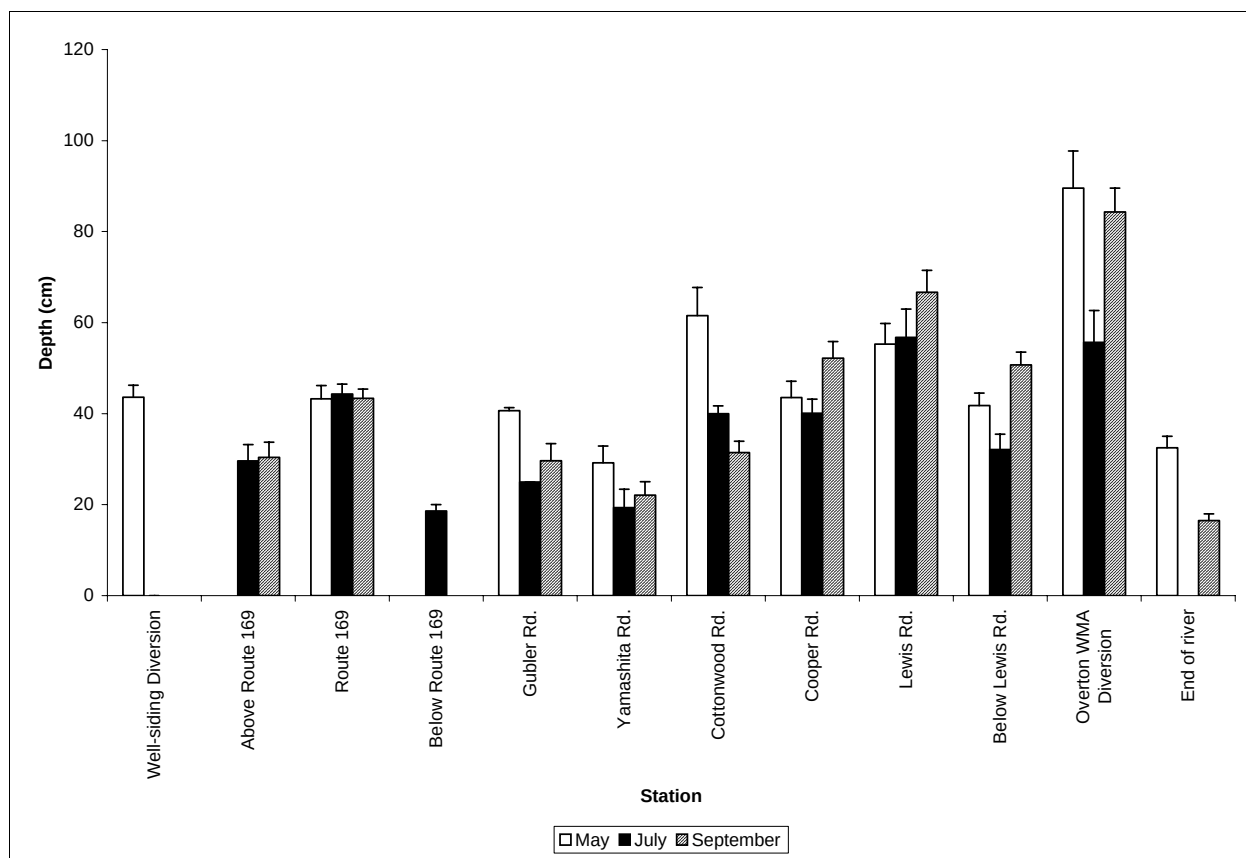


Figure 10. Mean average depths of samples collected throughout the study area in May, July, and September 2004.

In general, the seining, hoop netting, and minnow trapping CPE was lower during the September 2004 sampling trip than during the May or July 2004 trips (Figures 11 and 12). Red shiner, western mosquitofish, and fathead minnow remained the most abundant species found in seining collections. Black bullhead was the most abundant species in both hoop net and minnow trap collections in September 2004. As in May and July 2004, we collected spiny softshell turtles, red swamp crayfish, virile crayfish, and observed bullfrogs throughout the study area.

COMPARISONS WITH HISTORICAL DATA

NDOW collected Virgin River chub immediately below the Wells-siding Diversion using hoop nets in August 2003 (NDOW, unpublished data). Their hoop net catch rate for Virgin River chub was considerably higher than our May 2004 catch rate in the same area (Figure 13). During our July and September 2004 sampling trips, the area below the Wells-siding Diversion was dry, so we were unable to repeat sampling in that area. NDOW also collected black bullhead and common carp with

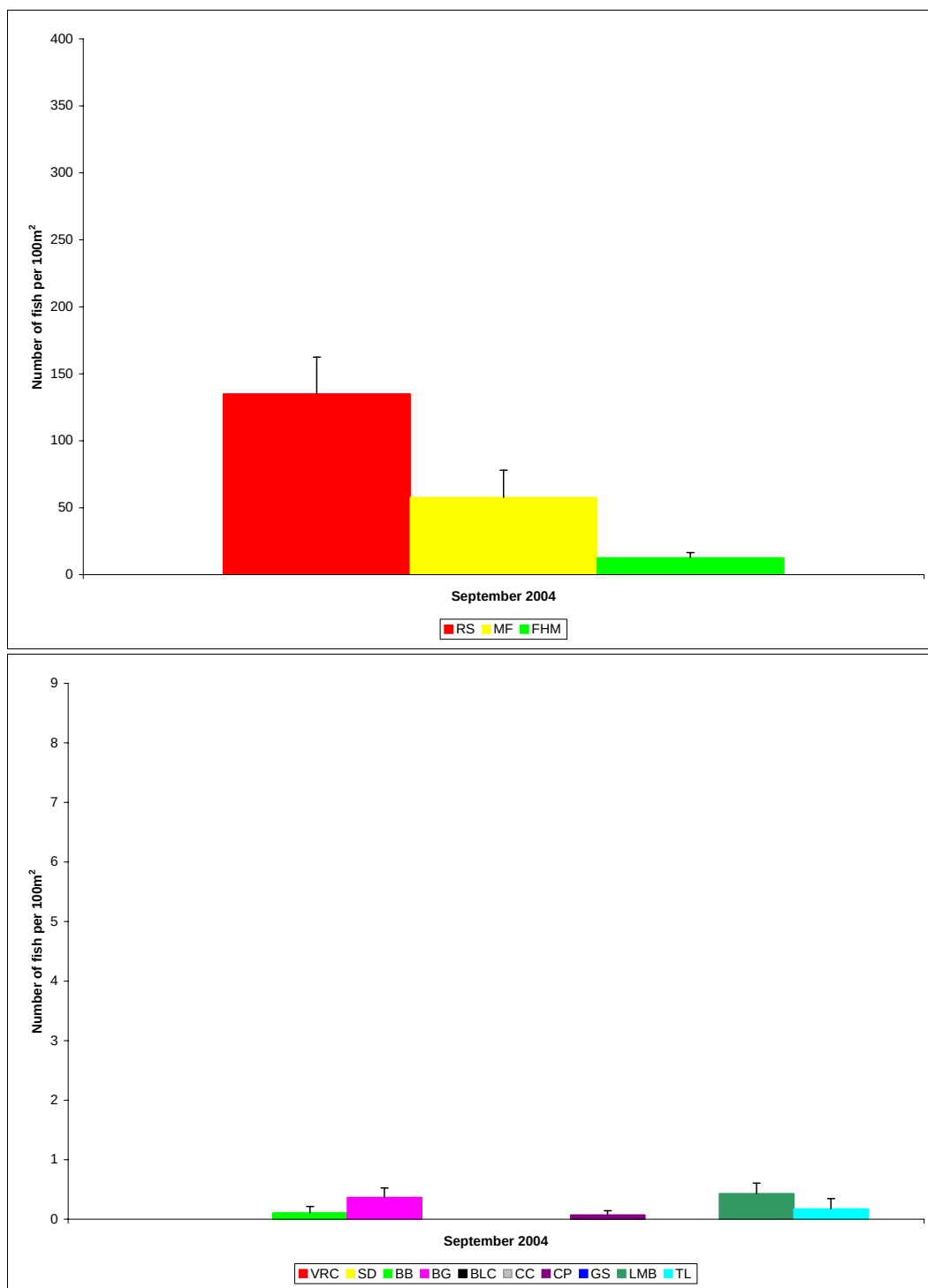


Figure 11. Number of (a) red shiner, western mosquitofish, and fathead minnow; and (b) other species collected per 100 m2 seining in September 2004.

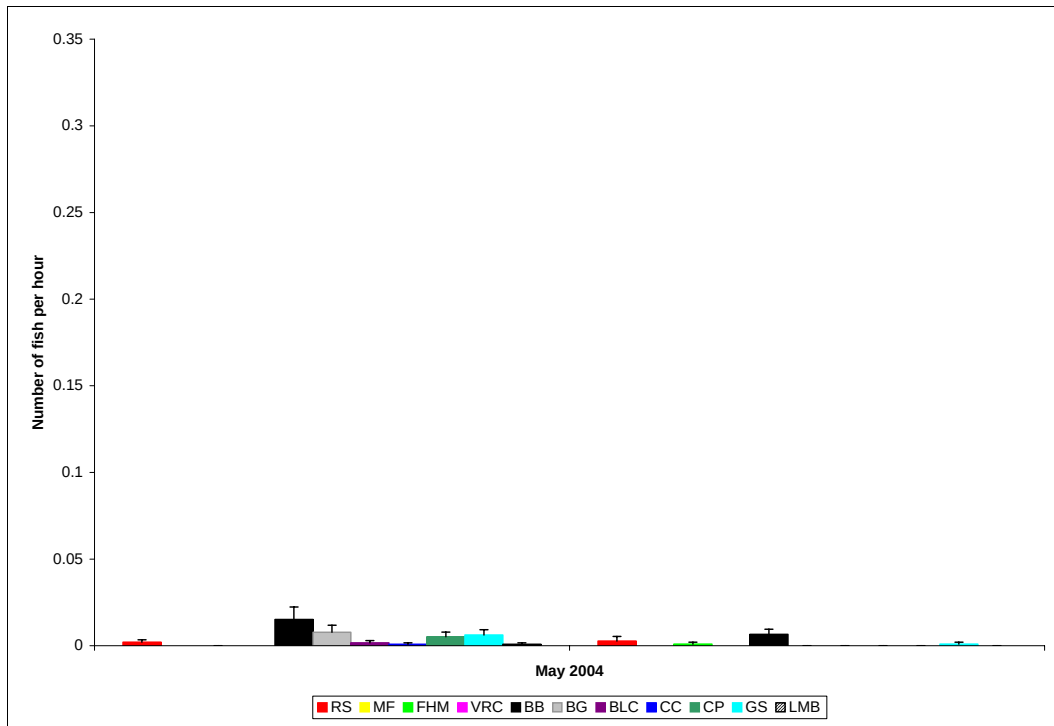


Figure 12. Number of fishes collected per hour of hoop netting and minnow trapping in September 2004.

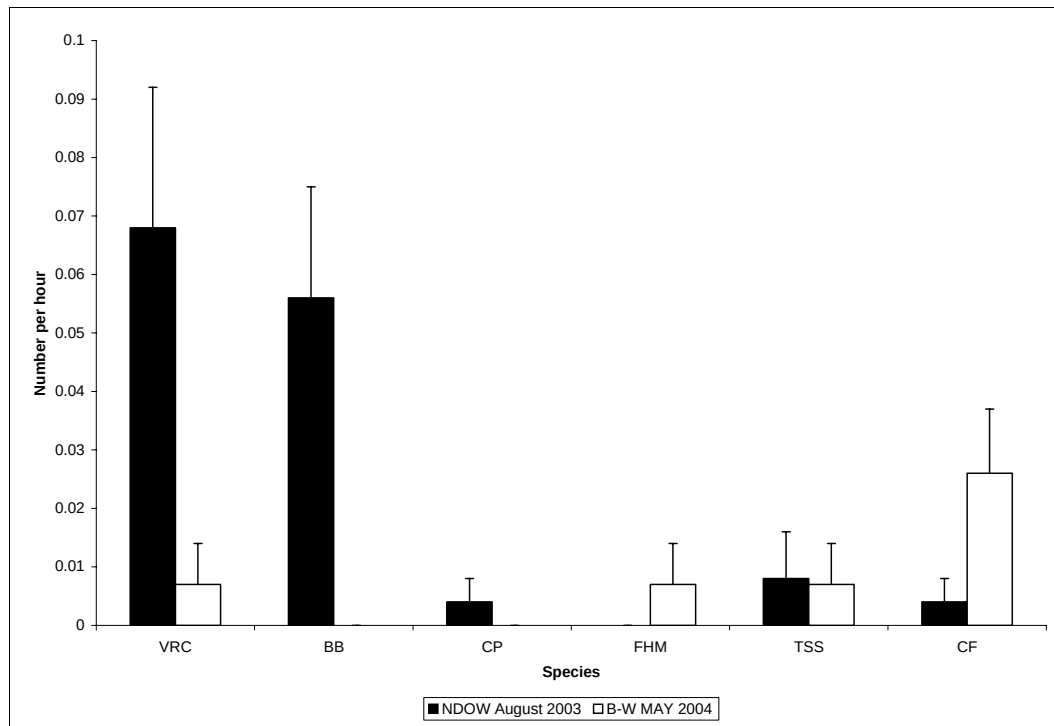


Figure 13. Number of fish collected per hour of hoop netting conducted by the Nevada Department of Wildlife (NDOW) in August 2003 versus BIO-WEST in May 2004.

hoop nets in August 2003. We did not collect either of these species using hoop nets, minnow traps, seines, or electrofishing during May 2004 sampling below the Wells-siding Diversion. However, we did collect speckled dace and fathead minnow.

In addition to having a higher catch rate for Virgin River chub, NDOW also found larger Virgin River chub in this area (Figure 14). Some of the difference in the length frequency histograms was caused by summer growth, but NDOW also found Virgin River chub larger than 220 mm. These fish are probably 2- to 3-year-old fish, whereas all the Virgin River chub we collected below the Wells-siding Diversion in May 2004 were YOY fish. Only one of the Virgin River chub we collected below the Wells-siding Diversion in May 2004 was collected with a hoop net. The remainder were collected using seines and a backpack electrofishing unit.

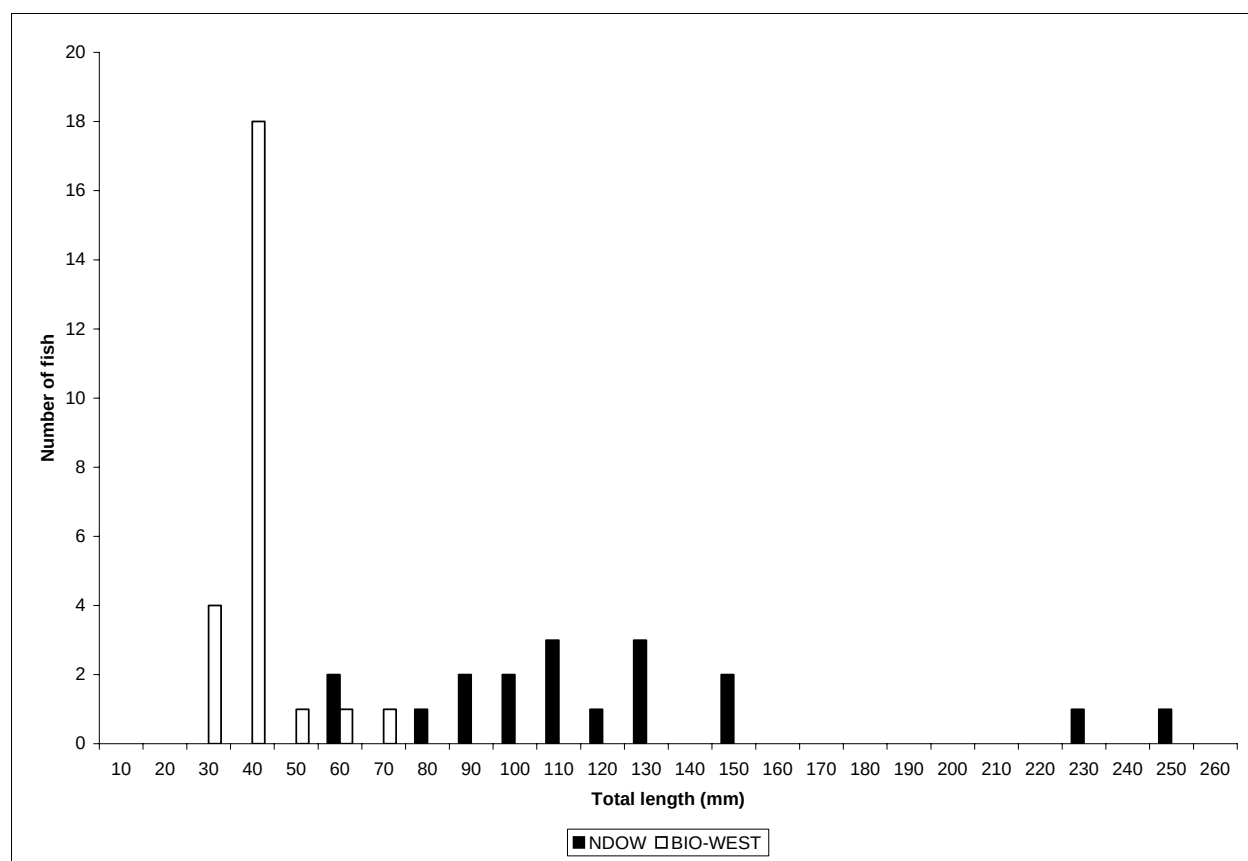


Figure 14. Length frequency histogram of Virgin River chub collected below the Wells-siding Diversion by NDOW in August 2003 and BIO-WEST in May 2004.

One potential reason that Virgin River chub are found immediately below the Wells-siding Diversion is that these fish are transported from upstream areas of higher abundance. Discharge information from the USGS gage near Glendale, Nevada, shows that a few small spike events preceded NDOW sampling on August 20, 2003 (Figure 15). These small spike events could have transported fish downstream below the Wells-siding Diversion. However, increases of similar magnitude were seen in August 2004, and the overall hydrograph was similar between summer and early autumn 2003 and 2004.

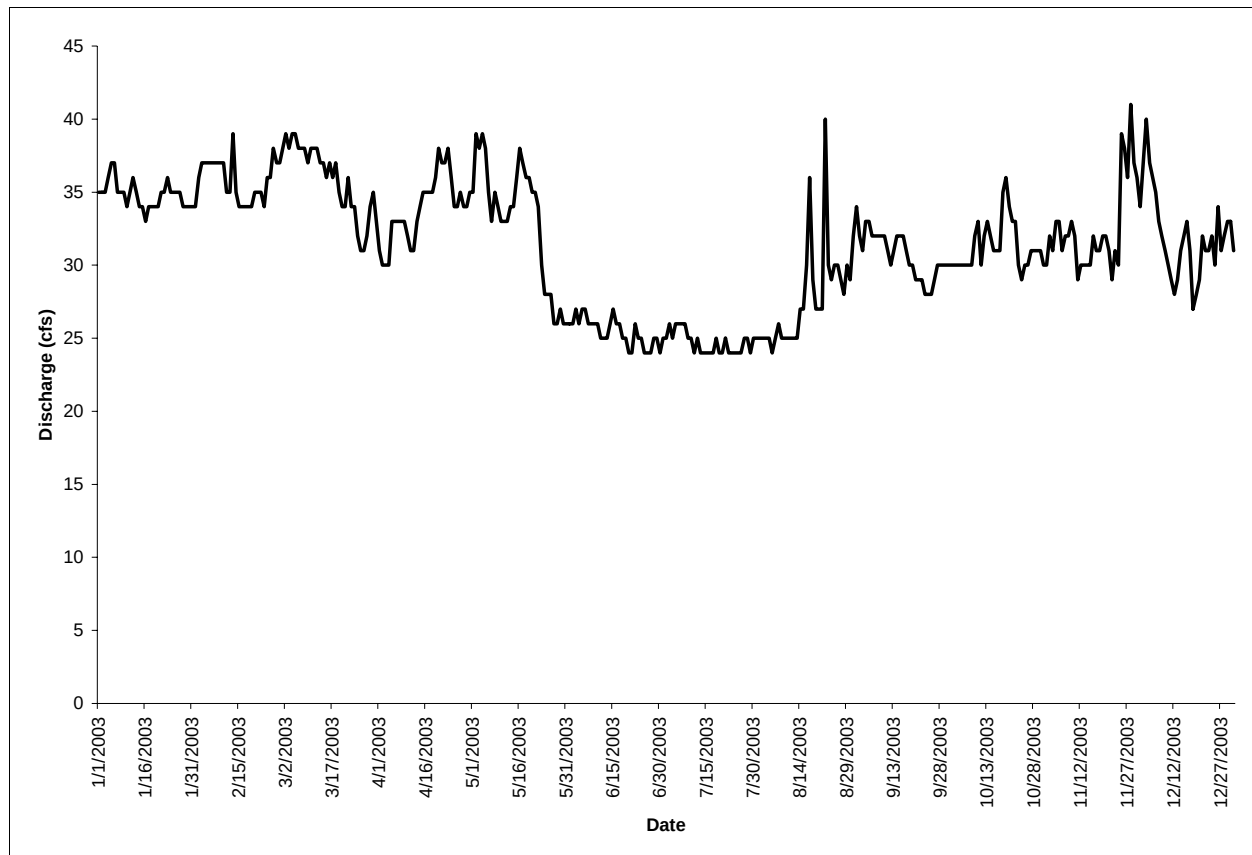


Figure 15. Average daily discharge recorded at the USGS gage near Glendale, Nevada, on the Muddy River for calendar year 2003 (January 1, 2003, to December 31, 2003).

Electrofishing surveys by NDOW in the vicinity of our Gubler Road and Yamashita Road stations have not found any native fish (Jim Heinrich, Nevada Department of Wildlife, personal communication).

From 1963-1968 Deacon and Bradley (1972) used seining and electrofishing to sample a variety of locations on the Muddy River, two of which were within our study area. They found a single Virgin River chub using electrofishing in the vicinity of our Route 169 station. However, they found no other native fish at that station or at a station near our Lewis Road/Below Lewis Road stations. Cross (1976) found a similar compliment of nonnative species as Deacon and Bradley (1972) in these same areas in 1974-1975, but he found no native fishes.

We found the same species as Deacon and Bradley (1972) and Cross (1976) collected, except for golden shiner (*Notemigonus crysoleucas*) and rainbow trout (*Oncorhynchus mykiss*), which Cross (1976) noted were probably incidentals from outside the system (Table 5). Additionally, we found six species not collected by either Deacon and Bradley (1972) or Cross (1976). Among these species was the native speckled dace.

Table 5. Species collected by Deacon and Bradley (1972), Cross (1976), and BIO-WEST (years) in the lower Muddy River.

COMMON NAME	SCIENTIFIC NAME	DEACON AND BRADLEY	CROSS	BIO-WEST
Virgin River chub	<i>Gila seminuda</i>	P ^a	A ^b	P
Speckled dace	<i>Rhinichthys osculus</i>	A	A	P
Rainbow trout	<i>Oncorhynchus mykiss</i>	A	P	A
Red shiner	<i>Cyprinella lutrensis</i>	P	P	P
Golden shiner	<i>Notemigonus crysoleucas</i>	P	P	A
Fathead minnow	<i>Pimephales promelas</i>	A	A	P
Western mosquitofish	<i>Gambusia affinis</i>	P	P	P
Common carp	<i>Cyprinus carpio</i>	P	P	P
Black bullhead	<i>Ameiurus melas</i>	P	P	P
Channel catfish	<i>Ictalurus punctatus</i>	A	A	P
Largemouth bass	<i>Micropterus salmoides</i>	P	P	P
Bluegill	<i>Lepomis macrochirus</i>	A	A	P
Green sunfish	<i>Lepomis cyanellus</i>	P	P	P
Black crappie	<i>Pomoxis nigromaculatus</i>	A	A	P
Blue tilapia	<i>Oreochromis aurea</i>	A	A	P

^a P = present.

^b A = absent.

DISCUSSION

The Muddy River has four native species. Two of these, the Moapa dace and the Moapa White River springfish, are restricted to the Upper Muddy River and the influence of thermal springs in that area. While the Virgin River chub has been found throughout the Muddy River, it is thought to be rare below the Wells-siding Diversion (Deacon and Bradley 1972, Cross 1976). The speckled dace is relatively uncommon throughout the system and has not been collected below the Wells-siding Diversion to our knowledge. We found both Virgin River chub and speckled dace below the Wells-siding Diversion during 2004 sampling.

Prior collections of Virgin River chub below the Wells-siding Diversion have occurred within 1-1.5 miles (1.6-2.4 km) downstream of the Wells-siding Diversion. Transport of Virgin River chub from larger, upstream populations seems to be a viable explanation for the fish found near the diversion, especially when those fish were YOY. We collected Virgin River chub 5.25 miles (8.5 km) and 6.75 miles (10.9 km) downstream of the Wells-siding Diversion. While the Virgin River chub we collected at the Cooper Road station were YOY, the Virgin River chub collected furthest downstream, at the Lewis Road station, was a 1-year-old fish. This collection may be evidence that Virgin River chub persist below the Wells-siding Diversion in limited numbers.

Since suitable Virgin River chub habitat existed on all three sampling occasions, we feel that Virgin River chub may persist below the Wells-siding Diversion in limited numbers. Most of the lower Muddy River, with the exception of the first mile (1.6 km) below the Wells-siding Diversion, appeared to have a continuous water supply throughout the critical summer low-flow period. While much of the river below the Wells-siding Diversion was entrenched and dominated by soft substrates, we did find several areas with suitable Virgin River chub habitat. Many stations had relatively deep pools and runs with overhanging vegetation and woody debris for cover.

Additionally, the overhanging vegetation seemed to keep temperatures fairly cool. Golden and Holden (2004) suggested that high temperatures associated with low flows may be one of the factors limiting Virgin River chub and other native fishes from reestablishing populations below Bunkerville Diversion on the lower Virgin River. Critical thermal maxima for Virgin River chub was found to be between 28°C and 36°C, depending on acclimation temperature, and preferred temperature was found to be 24°C (Deacon et al. 1987). On July 8, 2004, around 14:00 PST, we measured temperatures as high as 34°C in the lower Virgin River, supporting the assertion that high temperatures probably limit Virgin River chub and other native fishes in the lower Virgin River. Conversely, on July 10, 2004, at 13:20 PST, we measured a temperature of 26°C on the lower Muddy River, fairly close to the temperature preferendum for Virgin River chub and not within the critical range.

Nonnative fishes have also been implicated in declines of Virgin River chub populations in the Virgin River and the Muddy River (Deacon and Bradley 1972, Cross 1975, Cross 1976, Scopetone 1993, USFWS 1995, Scopetone et al. 1998, Golden and Holden 2004). Nonnative minnows

dominated the catch during our surveys of the Muddy River in 2004. Red shiner are thought to compete with and depredate native fishes, including Virgin River chub, in the Virgin River (Cross 1975, Deacon 1988, USFWS 1995). Additionally, western mosquitofish, green sunfish (*Lepomis cyanellus*), largemouth bass, channel catfish (*Ictalurus punctatus*), black bullhead, and blue tilapia (*Oreochromis aurea*) are all known to depredate native fishes in the southwest (Meffe 1985, Marsh and Langhorst 1988, Scopetone 1993, Marsh and Douglas 1997, Scopetone et al. 1998, Brandenburg and Gido 1999, Golden and Holden 2002). We collected all these species in the lower Muddy River. Therefore, even if flow, temperature, and habitat conditions are suitable, Virgin River chub may be unable to persist in the lower Muddy River because of competition with and predation by nonnative fishes.

A large portion of the lower Muddy River was relatively inaccessible because of dense vegetation growth or private property boundaries. We chose sampling stations based on both accessibility and the habitat suitability for native fishes but were only able to sample 11 stations, all of which were all less than 200 m long. It is possible that if low numbers of native fishes persisted over summer 2004, they may have been in areas where we were unable to sample. Recent high-flow events on the Muddy River may have removed some vegetation and made the river more accessible to sampling. Additional, more intensive sampling efforts in 2005 may definitively determine the distribution and abundance of native fishes in the lower Muddy River.

RECOMMENDATIONS

Current water-development scenarios involve diverting more water to Bowman Reservoir at the Wells-siding Diversion. Increased water diversion could lead to an increased frequency and duration of reduced flows, and potentially drying events, below the Wells-siding Diversion. It is difficult to ascertain the impacts of such reduced flow scenarios since it is unclear whether native fishes have established small, permanent communities in the lower Muddy River or are simply transient members of the fish community transported from larger populations upstream. Our surveys showed that native fishes are at least seasonally present below the Wells-siding Diversion. Virgin River chub and speckled dace may be present in low numbers year round below the Wells-siding Diversion, but our sampling effort may not have been intensive enough to detect native fishes present in low numbers. We recommend the following efforts to clarify the potential impacts of various water-development alternatives on Virgin River chub in the lower Muddy River.

1. Conduct additional surveys to further clarify native fish distribution and abundance in the lower Muddy River.

We found Virgin River chub further downstream on the Muddy River than NDOW, Deacon and Bradley (1972), and Cross (1976). The Virgin River chub found furthest downstream was also a 1-year-old fish. We found deep pools and runs with overhanging vegetation and woody debris for cover in several of our stations. Additionally, we were only able to sample a portion of the 8.5 miles

(13.7 km) of available habitat. Therefore, while we did not find any native fishes during our July 2004 and September 2004 sampling trips, we can not exclude the possibility that Virgin River chub and speckled dace may persist in low numbers year round in the lower Muddy River below Wells-siding Diversion. We recommend additional sampling using hoop nets, backpack electrofishing, and seining in 2005 to more definitively determine the persistence of Virgin River chub and speckled dace below the Wells-siding Diversion.

2. Place thermographs in selected areas throughout the lower Muddy River to determine if summer water temperatures are suitable for native fishes.

The results from our 2004 sampling trips suggest that flow, habitat, and temperature may be suitable for Virgin river chub and speckled dace throughout the majority of the lower Muddy River during the summer low-flow period. However, we were only present during three short periods from May through September 2004. Placing thermographs at selected locations throughout the lower Muddy River would provide constant information on whether the temperature remains suitable for Virgin River chub and speckled dace under the current flow regime.

3. Investigate the level of native fish entrainment in the canal leading from Wells-siding Diversion to Bowman Reservoir and the feasibility of installing a fish screen.

If Virgin River chub and speckled dace are continuously being transported downstream over the Well-siding Diversion to repopulate areas downstream of the diversion, then they are also probably being entrained in the canal leading to Bowman Reservoir. Water-development alternatives that will result in larger, more frequent diversions of water to Bowman Reservoir may increase the number of native fishes that are entrained into the canal. We recommend investigating the magnitude of native fish entrainment into the canal. If a substantial number of native fishes are entrained, then we would recommend investigating the feasibility of placing a fish screen on the entrance of the canal to prevent entrainment.

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