6. Historical Conditions of Macro Invertebrate

6.1 Introduction

As mentioned in Chapter 1, the LSCR supports and provides habitat for a variety of wildlife, aquatic animals and plant species with a perennial supply of effluent. According to the U.S. Environmental Protection Agency (EPA), aquatic invertebrates can be good indicators of wetland health. Factor affecting aquatic invertebrate community composition (a key indicator of water quality and aquatic conditions) include oxygen, toxic chemicals and nutrients. There have been several efforts to evaluate macro invertebrates in the effluent-dependent Santa Cruz River north of Tucson. This chapter briefly summarizes the purpose, methods, and findings of the previous studies.

6.2 Past Studies

The Roger Rd. WFR began discharging effluent to the LSCR in 1977. The LSCR became perennial for the first time in more than at least two decades due to a permanent source of water from the WRF. Harding Lawson Associates (HLA) sampled macro invertebrates at seven stations downstream of the Roger Rd. WRF in 1986 and 1997. The HLA's study (1986) is the first study of aquatic environment in the LSCR since effluent discharge began. HLA (1997) sampled aquatic organisms in 1997 to compare the results in 1986. They reported that overall diversity was slightly greater in 1997 compared to 1986. HLA (1986) also summarized the flow history for the LSCR. The Rillito River and Canada del Oro Wash were perennial at that time and were important water sources to the LACR. The reach of the LSCR from the confluence with the Rillito River to the confluence with the Gila River was ephemeral, and sufficient storm flows to allow the LSCR to floe the Gila River occurred only once every 10 to 20 years.

Arizona Department of Environmental Quality (ADEQ) conducted two informal macroinvertebrate surveys at Cortaro Rd in October, 1990 . The purpose of the sampling was to document the types of invertebrates that should be protected by water quality criteria being developed specifically for effluent-dominated waters. They found a small number of *Daphnia* [zooplankton] and four taxa including *Belostoma* (giant water bug), *Tropisternus lateralis* (hydrophild beetle), *Ischnura* (damselfly) and *Chironomus* (chironomid or non-biting midge). Overall, they found low species richness and consistent with a stream with poor water quality.

United States of Geological Survey (USGS) studied aquatic environment in central and southern Arizona in 1998 . They compared chlorophyll a levels and aquatic invertebrate community characteristics of effluent-dependent and non-effluent dependent streams.

The Arid West Water Quality Research Project Habitat Characterization Study (Arid West Study) was conducted by URS and CDM. The study was directed by the Pima County Regional Wastewater Reclamation Department (RWRD) with financial assistance of U.S. EPA. The field survey was conducted in 2002 and the final report was published in 2002. The objective of the study was to improve the scientific base for regulation of water quality, protection of species, habitats, and uses of watercourses, and designation of appropriate treated wastewater effluent controls in ephemeral and effluent-dependent watercourses of the arid and semi-arid western states including the LSCR. The Arid study discussed the findings of the study conducted by the Water Environment Research Foundation (WERF, 2000). The WERF study documented two important findings; 1) physical limitations on in-stream habitat appear to be greater than previously understood, and 2) the emphasis on wastewater treatment upgrades produced only limited improvements in the aquatic communities of effluent-dependent waters. The Arid Study discussed the factor(s) limiting aquatic community (e.g. abundance and diversity). The study pointed out that the limiting factor in the LSCR is not effluent quality, but physical habitat. The Arid Study suggests that regardless of efforts to create a "clean" effluent, there are limitations to what can be expected as a response in the aquatic community. Effluent-dependent waters tend to be associated with urban environments, where the impacts of stream ecosystems can come from many sources independent of wastewater treatment plant operations. For example, many urban river channels have been channelized for the purpose of flood control. The Arid Study emphasized the importance of physical habitat as a limiting factor of aquatic community.

Environmental Planning Group (EPG; 2002, 2004, 2006) conducted monitoring of the biological characteristics of a constructed aquifer recharge project site. The project site is approximately 18-acre on the Santa Cruz River, near Marana, Pima County, AZ. Monitoring at the site was conducted in June 2002 and 2004 and November 2004. The greatest change at the project site between 2002 and 2004 is the introduction of water into the recharge site. This has resulted in an overall increase in vegetation, birds and diversity of butterfly species. Diversity of bloodworms and aquatic earthworms was increased in 2004. The increase in bloodworms and aquatic earthworms could be related to the low dissolved oxygen level in 2004 (2.4 mg/L) (c.f. 3.6 mg/L in 2002. According to EPA, a recommended minimum dissolved-oxygen content to adequately support aquatic life is 5 mg/L), because both of them are tolerant of lower water oxygen contents. However, the study mentioned that it was difficult to make evaluation of changes in macroinvertebrate because of the limited number of samples.
Due to the loss of the control stricture for the diversion channel, sampling for macroinvertebrates was conducted in November, 2006. No aquatic earthworms nor any other taxa observed in 2004, except the Chironomids, were found in 2006. The study pointed out that the decrease in the diversity could be resulted from the loss of diversion structure and subsequent draining and drying of the diversion channel.

Walker et al. (2005) sampled macro invertebrate at two locations in the LSCR between Roger and Ina Rds. WRFs. The study reported that 1) the stream channel substrate was underlain by relatively fine material, such as sand and gravel; 2) dissolved oxygen levels were relatively low, especially in summer, and they decreased with distance from the effluent outfall; 3) the levels of reduced and organic nitrogen (as measured by ammonia-N and total kjeldahl nitrogen respectively) as well as organic carbon were high; and as a result, 4) diversity of macroinvertebrates was very low. The authors pointed out that the low diversity of aquatic macroinvertebrates may be resulted from combination of poor water quality with a lack of suitable substrate. This conclusion is consistent with the finding of the Arid West Study.

Each study used a different method to collect invertebrates. According to the Arid West Study, key differences include a) samplers varied between a Surber sampler and kick nets of varying sizes, b) carrying mesh sizes in the sampler from 205 microns to 1,000 microns, and c) the number and/or area of habitat sampled at each site. This indicates that the data of the previous studies may not be directly comparable due to the method differences.

The Arid West Study summarized the sampling methods and results of the previous macro invertebrate studies. Table 6.1 is a summary table of the comparison of the methods used in the previous studies and Table 6.2 is a summary table of the results of the previous studies. Those tables were created using the information found in the Arid West Study and other past studies. As mentioned above, it should be noted that the results of the previous studies may not be directly comparable due to the method differences.

Table 6.1 Comparison of Invertebrate Collection and Identification Methods

Invertebrate Study	Sample Period	Sample Site	Sample Method	Sample Processing	Reported Taxonomic Identifi cation
Harding Lawson Associates (1986)	May 20 and 24, 1985	Downstream of Roger WRF	Benthic Invertebrates: Samples collected from runs and riffles (mostly runs) with a 1-m kick net held in place in the current. A 1-m^2 area was agitated upstream of the net to a depth of 10-20 cm. In addition, grab samples were collected and screened through a 250-micron mesh sieve. Zooplankton: Clarke-Bumpus plankton tow net. Two samples/site. 400 L collected from deepest part of channel	Invertebrates: Kick net and grab samples - sugar water method used to separate animals from debris. Zooplankton: No processing necessary.	Appears to be the lowest level practical for all groups.
ADEQ (1990)	October 1 and 23, 1990	Cortato Road Crossing	No information available	No information available	No information available
Harding Lawson Associates (1997)	April 2 and 3, 1997	Downstream of Roger WRF, Cortaro Road Crossing, Avra Valley Bridge Crossing, Sandario Road, Trico-Marana Bridge Crossing, Hardin Road, Sasco Road (Redrock Road) Crossing	Benthic Invertebrates: Two Surber samples (1 ft2) collected from runs and riffles (mostly runs) at each site. Sampler fitted with a 1,000-micron mesh net. Zooplankton: Two samples per site with a 15-in a Motte plankton tow net. Samples collected for 1-2 minute period at each site.	No information available	Lowest taxonomic level practical, mostly family level.

Table 6.1 Comparison of Invertebrate Collection and Identification Methods (continue)

Invertebrate Study	Sample Period	Sample Site	Sample Method	Sample Processing	Reported Taxonomic Identification
USGS (1998)	January 1996	Cortaro Road Crossing?	NAWQA method: Five semiquantitative riffle samples using modified Surber sampler with 425-micron mesh net. Samples composited (1.25 m^2). Qualitative sample from all habitat types using 210-micron mesh D-frame kick net.	No information available	Insects - family level; non-insects - lowest level practical - usually order and class
Arid West Study (2002)	June 2000	Upstream and Downstream of Roger WRF, Downstream of Cortaro Road Bridge, Downstream of the Ina Road Bridge, Downstream of the Trico-Marana Bridge	D-frame kick net with 500-micron mesh; Three 1-minute kick nets from variety of habitat types.	Field counted; subsampled as necessary	Field identification to lest practical level - typically, family for insects; order or class for non-insects
EPG (2002, 2004, 2006)	6/19/2002, 6/16/2004, 11/8/2006	Aquifer Recharge Project Site, near Marana, Pima County.	Bottom kick net (900-um mesh) collection (2x30-second duration).	Samples were preserved with alcohol-formalin solution.	Identified to Species if possible
Walker et al. (2005)	June 2003 and February 2004	Downstream of Roger WRF and upstream of Ina WRF	ADEQ method: Samples are collected and composited from 3- 1 m^2 areas of riffle habitats at each site, using a D-frame kick net.	Minimally processed to remove large debris and sand in a field. Samples are preserved with 99% isopropyl alcohol on-site.	Identified to genus or species level for the insects and levels specified in the Macroinvertebrate procedures manual for all other taxa groups.

Table 6.2 Comparison of Invertebrates Reported from the Previous Studies

Phylum/Division	Class	Order	Family	Genus/Species	Harding Lawson (1986)	ADEQ (10/1/1990)	ADEQ (10/23/1990)	Harding Lawson (1997)	USGS (1998)	Arid West Study (2002)	EPG (2002)	EPG (2004)	EPG (2006)	Walker et al. (2005): Sampling 6/25/2003	Walker et al. (2005): Sampling 2/28/2004
Invertebrates															
Cnidaria	Hydrozoa	Hydroida	Hydridae	*Hydra americana*	X										
Platyhelminthes	Nemertea							X							
Annelida	Oligochaeta						X			X					
		Haplotaxida	Tubificidae											X	X
	Clitellata	Haplotaxida	Naididae	*Amphichaeta sp.*							X	X			
Arthropoda	Crustacea	Ostracoda			X										
		Cladocera								X					
			Bosminidae	*Bosmina sp.*	X										
			Daphnidae	*Daphnia sp.*		X					X				
			Moinidae	*Moina sp.*	X										
		Copepoda	Cyclopidae	*Eucyclop sp.s*	X										
	Insecta	Collembola						X							
		Ephemeroptera										X			
		Ephemeroptera	Baetidae							X					
		Plecoptera	Chloroperlidae	*Sweltsa sp.*	X										
		Odonata	Coenagrionidae	*Coenagrion/Enallagma*											
			Coenagrionidae	*Ischnura sp.*			X								
			Coenagrionidae								X				
			Libellulidae												
		Hemiptera						X		X					
		Hemiptera	Corixidae									X			
			Naucoridae								X				
			Belostomatidae	*Belostoma sp.*			X		X						
			Corixidae	*Pseudocorixa beameri*	X										X
				Corisella sp.											
			Gerridae	*Gerris sp.*	X										
		Megaloptera						X		X					
		Coleoptera						X		X					
			Elmidae	*Heterelmis glaber*	X										
			Hydrophilidae	*Tropisternus sp.*	X										
			Hydroscaphidae					X							
				Berosus sp.											

Phylum/Division	Class	Order	Family	Genus/Species	Harding Lawson (1986)	ADEQ (10/1/1990)	ADEQ (10/23/1990)	Harding Lawson (1997)	USGS (1998)	Arid West Study (2002)	EPG (2002)	EPG (2004)	EPG (2006)	Walker et al. (2005): Sampling 6/25/2003	Walker et al. (2005): Sampling 2/28/2004
Invertebrates															
				Enochrus sp.											
			Hydroporinae	*Hydrochus sp.*											
			Dytiscidae	*Eretes occidentalis*											
				Laccophilus maculosus											
				Liodessus obscurellus											
			Dryopidae	*Postelichus sp.*											
			Noteridae	*Pronoterus sp.*	X										
		Lepidoptera							X						
		Trichoptera						X							
		Diptera	Chironomidae				X	X		X					
				Chironomus sp.	X		X							X	X
				Eukiefferiella											X
				Goeldichironomus sp.											
				Unid. Orthocladiinae											
				Bryophaenocladius sp.							X	X			
				Glyptotendipes sp.							X	X	X		
			Chaoboridae	*Chaoborus sp.*											
			Culicidae						X						
			Dolichopodidae					X							
			Muscidae						X						
			Psychodidae											X	
			Psychodidae	*Psychoda sp.*	X				X						
			Psychodidae	*Pericoma*										X	X
			Simuliidae					X							
			Syrphidae					X							
			Tabanidae	*Tabanus sp.*	X										
			Tipulidae	*Ormosia*											X
	Hydracarina			*Hydryphantes sp.*											
	Crustacea	Amphipoda	Dogielinoridae	*Hyalella azteca cx.*							X				
	Annelida	Hirudinea		*Erpobdella punctata punctata*											

6.3 References

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