

Table 1. Proposed sampling reaches and fixed station locations for canal and stream fish monitoring.

Stream or canal reach	Reach boundaries	Fixed station locations
<b>San Pedro River</b> Hereford to Fairbank	SE¼ Sec. 9, T23S, R22E SW¼ Sec.15, T20S, R21E	Upper--1 mile NW Hereford-SE¼ Sec.4, T23S, R22E Middle*--1.5 mile S Lewis Springs-SE¼ Sec.31, T21S, R22E Lower*--Charleston-SE¼ Sec.2, T21S, R21E
Cascabel to Redington	SW¼ Sec.10, T13S, R19E NW¼ Sec.19, T12S, R19E	Upper*--Hughes Ranch-NE¼ Sec.5, T13S, R19E Middle--Near Soza Ranch-NW¼ Sec.32, T12S, R19E Lower--Above gaging station-NE¼ Sec.19, T12S, R19E
Aravaipa Creek to Gila River	SW¼ Sec.23, T7S, R16E NE¼ Sec.23, T5S, R15E	Upper*--Confluence with Aravaipa Creek-SE¼ Sec.9, T7S, R16E Middle--Dudleyville-SE¼ Sec.6, T6S, R16E Lower--1 mile SE confluence with Gila River-NW¼ Sec.25, T5S, R15E
<b>Gila River</b> Coolidge Dam to Needles Eye	T3S, R18E (unsurveyed) NE¼ Sec.34, T3S, R17E	Upper+--0.5 mile downstream from Coolidge Dam-T3S, R18E (unsurveyed) Middle--2.6 mile downstream from Coolidge Dam-T3S, R18E (unsurveyed) Lower--Hook and Line Ranch-SE¼ Sec.24, T3S, R17E
Little Ash Creek to Hayden	SW¼ Sec.11, T4S, R16E NE¼ Sec.13, T5S, R15E	Upper--2 mile downstream from Dripping Spring Wash-NW¼ Sec.28, T4S, R16E Middle*--0.2 mile downstream from Deer Creek-NE¼ Sec.33, T4S, R16E Lower--0.2 mile upstream from O'Carroll Canyon--SW¼ Sec.5, T5S, R16E
Hayden to Mineral Creek	NE¼ Sec.13, T5S, R15E NW¼ Sec.12, T4S, R13E	Upper*--Confluence with San Pedro River-NE¼ Sec.23, T5S, R15E Middle--1 mile SE Kearney-SW¼ Sec.35, T4S, R14E Lower*--Riverside-NW¼ Sec.7, T4S, R14E
Mineral Creek to Ashurst-Hayden Dam	NW¼ Sec.12, T4S, R13E NW¼ Sec.8, T4S, R11E	Upper*--0.5 mile W Diamond A Ranch-NE¼ Sec.9, T4S, R13E Middle*--Cochran-SW¼ Sec.5, T4S, R12E Lower*--0.5 mile E confluence with Box O Wash-NE¼ Sec. 15, T4S, R11E
<b>Salt River</b> Stewart Mtn. Dam to Granite Reef Dam	Unsurveyed SE¼ Sec.13, T2N, R6E	Upper--0.75 mile SSW Stewart Mtn. Dam-unsurveyed Middle--1 mile W Blue Point Ranger Station-SW¼ Sec. 34, T3N, R7E Lower--1 mile E Granite Reef Dam-SW¼ Sec.18, T2N, R7E
<b>CAP canal</b> Hayden-Rhodes Aqueduct	NE¼ Sec.30, T10N, R18W SE¼ Sec.11, T2N, R6E	Bouse Hills Pumping Plant--Sec.10, T7N, R16W Little Harquahala Pumping Plant--Sec.18, T3N, R13W Hassayampa Pumping Plant--Sec.29, T4N, R4W
Fannin-McFarland Aqueduct	NW¼ Sec.19, T2N, R7E NE¼ Sec.29, T6S, R9E	Salt-Gila Pumping Plant--Sec.19, T2N, R7E

Table 1. Continued.

Stream or canal reach	Reach boundaries	Fixed station locations
Tucson Aqueduct	SE¼ Sec.32, T14S, R12E SE¼ Sec.32, T14S, R12E	Brady Pumping Plant--Sec.15, T7S, R9E Red Rock Pumping Plant--Sec.34, T9S, R10E San Xavier Pumping Plant--Sec.33, T14S, R12E
Florence-Casa Grande canal Ashurst-Hayden Dam to Pima lateral feeder canal	NW¼ Sec.8, T4S, R11E SW¼ Sec.28, T5S, R9E	Upper--Above China Wash fish barrier-NW¼ Sec.13, T4S, R10E Middle--Below China Wash fish barrier-NE¼ Sec. 14, T4S, R10E Lower--Pima lateral turnout-SW¼ Sec.28, T5S, R9E
SRP Arizona Canal Granite Reef Dam to electrical fish barrier	NE¼ Sec.13, T2N, R6E SW¼ Sec.13, T2N, R6E	None (census)
Electrical fish barrier to Indian Bend Wash	SW¼ Sec.13, T2N, R6E NW¼ Sec.11, T2N, R4E	None (opportunistic)
SRP South Canal Granite Reef Dam to electrical fish barrier	SE¼ Sec.13, T2N, R6E SW¼ Sec.13, T2N, R6E	None (census)
Electrical fish barrier to terminus	SW¼ Sec.13, T2N, R6E SW¼ Sec.11, T1N, R5E	None (opportunistic)

\*Existing Fall Fish Count sampling station

Table 2. Proposed 10 year sampling schedule of random stations for monitoring of target reaches in the San Pedro River.

Reach	Year	Location	Month
Hereford to Fairbank	1997	SE ¼ Sec.33, T22S, R22E	June
	1998	SW ¼ Sec.35, T20S, R21E	August
	1999	NE ¼ Sec.20, T22S, R22E	August
	2000	SE ¼ Sec.27, T20S, R21E	March
	2001	SE ¼ Sec.30, T21S, R22E	March
	2002	NW ¼ Sec.26, T20S, R21E	January
	2003	SE ¼ Sec. 9, T23S, R22E	September
	2004	NW ¼ Sec.26, T20S, R21E	November
	2005	SW ¼ Sec.18, T21S, R22E	October
	2006	NW ¼ Sec.13, T21S, R21E	February
Cascabel to Redington	1997	SE ¼ Sec.30, T12S, R19E	May
	1998	NE ¼ Sec. 9, T13S, R19E	October
	1999	NE ¼ Sec. 9, T13S, R19E	September
	2000	NW ¼ Sec.10, T13S, R19E	June
	2001	NE ¼ Sec. 9, T13S, R19E	March
	2002	NE ¼ Sec.30, T12S, R19E	December
	2003	SE ¼ Sec.30, T12S, R19E	April
	2004	NW ¼ Sec. 4, T13S, R19E	December
	2005	NE ¼ Sec. 9, T13S, R19E	August
	2006	SE ¼ Sec.30, T12S, R19E	April
Aravaipa Cr. to Gila R.	1997	NW ¼ Sec. 6, T6S, R16E	February
	1998	SW ¼ Sec.25, T5S, R15E	December
	1999	NW ¼ Sec. 8, T6S, R16E	March
	2000	NW ¼ Sec. 9, T7S, R16E	November
	2001	SE ¼ Sec. 6, T6S, R16E	April
	2002	NW ¼ Sec.17, T6S, R16E	September
	2003	NE ¼ Sec.32, T6S, R16E	January
	2004	SE ¼ Sec. 9, T7S, R16E	April
	2005	SE ¼ Sec.20, T6S, R16E	August
	2006	SW ¼ Sec.24, T5S, R15E	October

Table 3. Database structure and codes for Gila River Basin fish monitoring. Asterisk denotes a relational variable common to both databases.

Variable	Type	Format	Comment	Codes
STREAM*	Numeric	1.0	Stream or canal name code	1=San Pedro River 2=Gila River 3=Salt River 4=CAP Canal 5=SRP South Canal 6=SRP Arizona Canal 7=PCG Canal
REACH*	Numeric	2.0	Reach name code	1, 2, or 3 for upstream, middle, and downstream reaches, respectively
STATION*	Numeric	2.0	Station name code	1, 2, or 3 for upstream, middle, and downstream, respectively (fixed stations); 0 for random stations
MONTH*	Numeric	2.0	Month sample taken or begun	
DAY*	Numeric	2.0	Day sample taken or begun	
YEAR*	Numeric	2.0	Year sample taken or begun	
HOUR <sup>1</sup>	Numeric	2.0	Hour (military time) sample taken or begun	
MIN <sup>2</sup>	Numeric	2.0	Minute sample taken or begun, will be converted to hundredths of hours for analysis	
HABTYPE*	Numeric	1.0	Macrohabitat type unit code	1=pool (area of water column with low current velocity and near-zero surface gradient and little or no surface turbulence, often with small substrates; includes eddies and pocket water) 2=riffle (area of water column with fast current velocity and steep surface gradient, considerable surface turbulence, often with large substrates; includes cascades and rapids) 3=run (area of water column with rapid, non-turbulent flow, usually too deep to be a riffle and too fast to be a pool; includes glides) 4=various; to be used for qualitative or canal sampling
HABNUM*	Numeric	2.0	Macrohabitat number, counted sequentially from the downstream station boundary	
QUANQUAL <sup>3</sup>	String	1.0	Quantitative (effort recorded) or qualitative (effort not recorded) sample	Y=Yes (quantitative) N=No (qualitative)

Table 3. Continued.

Variable	Type	Format	Comment	Codes
GEARTYPR <sup>1</sup>	Numeric	2.0	Gear type code	Entrapment/Entanglement: 1=gill net 2=trammel net 3=hoop net 4=fyke net 5=trap net 6=minnow trap 7=shock/gill net 8=shock/trammel net 9=experimental gill net Seining: 10=straight seine 11=bag seine 12=kick seine 13=dip net Angling: 14=spincast 15=fly rod 16=dropline 17=trotline Electrofishing: 18=backpack shocker 19=boat shocker 20=bank shocker Miscellaneous 25=trammel net/drifted 26=gill net/drifted 27=other (describe)
PULSE <sup>1</sup>	Numeric	4.0	Electroshocker pulse rate setting (pulses per second)	
VOLTS <sup>1</sup>	Numeric	3.0	Electroshocker voltage setting	
WATTS <sup>1</sup>	Numeric	4.0	Electroshocker electrical output; calculated from formula of Burkhardt and Gutreuter (1995)	
AMPS <sup>1</sup>	Numeric	3.1	Electroshocker amperage setting	
COND <sup>1</sup>	Numeric	4.0	Conductivity ( $\mu\text{S}/\text{cm}$ ) of water; required for determination of electroshocker output and water quality	
TEMP <sup>1</sup>	Numeric	3.1'	Temperature ( $^{\circ}\text{C}$ ) of water; required for determination of electroshocker output and water quality	
SECONDS <sup>1</sup>	Numeric	4.0	Electroshocker effort in seconds fished	
HABSHOCK <sup>1</sup>	Numeric	3.0	Areal percent of habitat type sampled by electrofishing	
SEINMESH <sup>1</sup>	Numeric	4.2	Mesh size (in) (bar measure) of seine or dip net	
SEINLEN <sup>1</sup>	Numeric	3.0	Length (ft) of seine or dip net	
SEINHGHT <sup>1</sup>	Numeric	2.0	Width (height or depth) (ft) of seine or dip net	
HAULNUM <sup>1</sup>	Numeric	2.0	Number of seine hauls or dip net sweeps taken within the area defined by HABSEINE	

Table 3. Continued.

Variable	Type	Format	Comment	Codes
HABSEINE <sup>1</sup>	Numeric	3.0	Areal percent of habitat type sampled by seine or dip net	
NETMESH <sup>1</sup>	Numeric	4.3	Mesh size (in) (bar measure) of entanglement/entrapment gears	
NETLEN <sup>2</sup>	Numeric	3.0	Length (ft) of entanglement/entrapment gears	
NETWIDHT <sup>1</sup>	Numeric	2.0	Width (height or depth) (ft) of entanglement/entrapment gears	
SOAKEFF <sup>1</sup>	Numeric	3.1	Effort (hr) fished (soaked) by entanglement/entrapment gears	
BAITTYPE <sup>1</sup>	Numeric	1.0	Bait type code for angling gears	1-artificial lure 2-live bait 3-garbage (corn, cut bait, etc.) 4-stink bait
HOOKNUM <sup>1</sup>	Numeric	2.0	Number of hooks per line for angling gears	
SOAKEFF <sup>1</sup>	Numeric	3.1	Effort (hr) fished (soaked) by angling gears	
SPECIES <sup>2</sup>	String	4.0	Species name code, where first two letters of genus is followed by first two letters of species	Examples: CYLU denotes <i>Cyprinella lutrensis</i> ; AGCH denotes <i>Agosia chrysogaster</i> ; "???" indicates species unknown, and specimen should be preserved for voucher; HYER denotes a hybrid (identify in comments if possible and preserve); "0000" indicates no fish were caught
AGE <sup>1</sup>	Numeric	1.0	Categorization to young-of-year or older age classes	0=young-of-year (including larvae) 1=age-1 or older
FISHNUM <sup>2</sup>	Numeric	3.0	Number of fish represented in record; if length and other data taken, should always equal 1; if more than one of a species was captured but individual data not taken, record the number; if sampling effort did not capture fish, should equal 0	
VOUCHER <sup>2</sup>	Numeric	2.0	Number of fish preserved for voucher	
COMMENT*	String	25.0	Narrative information not recordable in other areas of the field form, such as length, weight, presence of external parasites, spinal or cranial deformity, ulceration, etc.	
HABLEN <sup>2</sup>	Numeric	4.1	Longitudinal length (m) of macrohabitat unit	
HABWID1 <sup>2</sup>	Numeric	3.1	Lateral width (m) of macrohabitat unit, measured at point 1/4 the distance of the unit length from the downstream origin	

Table 3. Continued.

Variable	Type	Format	Comment	Codes
HABWID2 <sup>2</sup>	Numeric	3.1	Lateral width (m) of macrohabitat unit, measured at point 1/2 the distance of the unit length from the downstream origin	
HABWID3 <sup>2</sup>	Numeric	3.1	Lateral width (m) of macrohabitat unit, measured at point 3/4 the distance of the unit length from the downstream origin	
ZMAX <sup>2</sup>	Numeric	3.0	Maximum depth (cm) of macrohabitat	
SUBSTRAT <sup>2</sup>	Numeric	1.0	Category of dominant substrate in macrohabitat, modified from Lane (1947)	1=clay (0.24-4.0 $\mu$ m) 2=silt (4-62 $\mu$ m) 3=sand (62-2000 $\mu$ m) 4=gravel (2-64 mm) 5=cobbie (64-255 mm) 6=boulder (256-4096 mm) 7=bedrock (>4,096 m) 8=detritus 9=concrete (for lined canals)

<sup>1</sup> Fish collection form<sup>2</sup> Habitat sampling form

Table 4. Recent (since 1970) occurrence of fishes in target canals and streams in the Gila River Basin. SPR=San Pedro River north of Mexican border, GR=Gila River between Coolidge Dam and Ashurst-Hayden Dam, SR=Salt River between Stewart Mountain Dam and Granite Reef Dam, CAP=Central Arizona Project aqueduct, FCG=Florence-Casa Grande canal, SRP=Salt River Project canals.

Common name	Scientific name	SPR <sup>4</sup>	GR <sup>4</sup>	SR <sup>4</sup>	CAP <sup>5</sup>	FCG <sup>6</sup>	SRP <sup>7</sup>
Roundtail chub <sup>1</sup>	<i>Gila robusta</i>	-	-	+	-	-	+
Fathead minnow	<i>Pimephales promelas</i>	+	-	-	-	+	+
Goldfish	<i>Carassius auratus</i>	-	-	-	+	-	+
Longfin dace <sup>1</sup>	<i>Agosia chrysogaster</i>	+	-	-	-	+	+
Grass carp	<i>Ctenopharyngodon idella</i>	-	-	-	-	-	+
Grass carp X bighead carp	<i>Ctenopharyngodon idella</i> X <i>Aristichthys nobilis</i>	-	-	-	-	-	+
Carp	<i>Cyprinus carpio</i>	+	+	+	+	+	+
Red shiner	<i>Cyprinella lutrensis</i>	+	+	-	+	+	+
Spikedace <sup>1</sup>	<i>Meda fulgida</i>	-	+	-	-	-	-
Razorback sucker <sup>1</sup>	<i>Xyrauchen texanus</i>	-	-	-	+	-	-
Sonora sucker <sup>1</sup>	<i>Catostomus insignis</i>	+	+	+	+	-	+
Desert sucker <sup>1</sup>	<i>Pantosteus clarki</i>	+	+	+	+	+	+
Bigmouth buffalo	<i>Ictiobus cyprinellus</i>	-	-	-	-	-	+
Largemouth bass	<i>Micropterus salmoides</i>	+	+	+	+	-	+
Bluegill	<i>Lepomis macrochirus</i>	-	+	+	+	-	+
Green sunfish	<i>Lepomis cyanellus</i>	+	+	+	+	-	+
Smallmouth bass	<i>Micropterus dolomieu</i>	-	-	-	-	-	+
Redear sunfish	<i>Lepomis microlophus</i>	-	-	-	+	-	+
Green sunfish X bluegill	<i>Lepomis cyanellus</i> X L. <i>macrochirus</i>	-	+	-	-	-	-
Black crappie	<i>Pomoxis nigromaculatus</i>	-	-	-	+	-	-
Black bullhead	<i>Ameiurus melas</i>	+	-	-	-	-	+
Flathead catfish	<i>Pylodictis olivaris</i>	?	-	+	+	-	+
Channel catfish	<i>Ictalurus punctatus</i>	-	+	+	+	+	+
Yellow bullhead	<i>Ameiurus natalis</i>	+	+	+	+	+	+
Mosquitofish	<i>Gambusia affinis</i>	+	+	-	+	+	+
Sailfin molly	<i>Poecilia latipinna</i>	-	-	+	-	-	-
Rainbow trout	<i>Oncorhynchus mykiss</i>	-	-	+	-	-	+
Walleye	<i>Stizostedion vitreum</i>	-	-	+	-	-	+
Threadfin shad	<i>Dorosoma petenense</i>	-	-	+	+	-	+
Mossambique tilapia	<i>Tilapia mossambica</i>	-	-	-	-	-	+
Redbelly tilapia	<i>Tilapia zilli</i>	-	-	-	-	-	+
Blue tilapia	<i>Tilapia aurea</i>	-	-	-	-	-	+
Yellow bass	<i>Morone mississippiensis</i>	-	-	+	-	-	+
Striped bass	<i>Morone saxatilis</i>	-	-	-	+	-	-
Oscar	<i>Astronotus ocellatus</i>	-	-	-	-	-	+

<sup>1</sup>Native species

Sources: Reclamation data (Fall Fish Count surveys)<sup>2,3</sup>; J. Simms, BLM, personal communication<sup>3</sup>; J. Warnecke, AGPD, personal communication<sup>4</sup>; FWS (1976)<sup>4</sup>; Mueller (1989)<sup>6</sup>; T. Burke, USBR, personal communication<sup>7</sup>; Reclamation data<sup>2,3</sup>; Marsh and Winckley (1982)<sup>1</sup>; Wright and Sorensen (1995)<sup>1</sup>

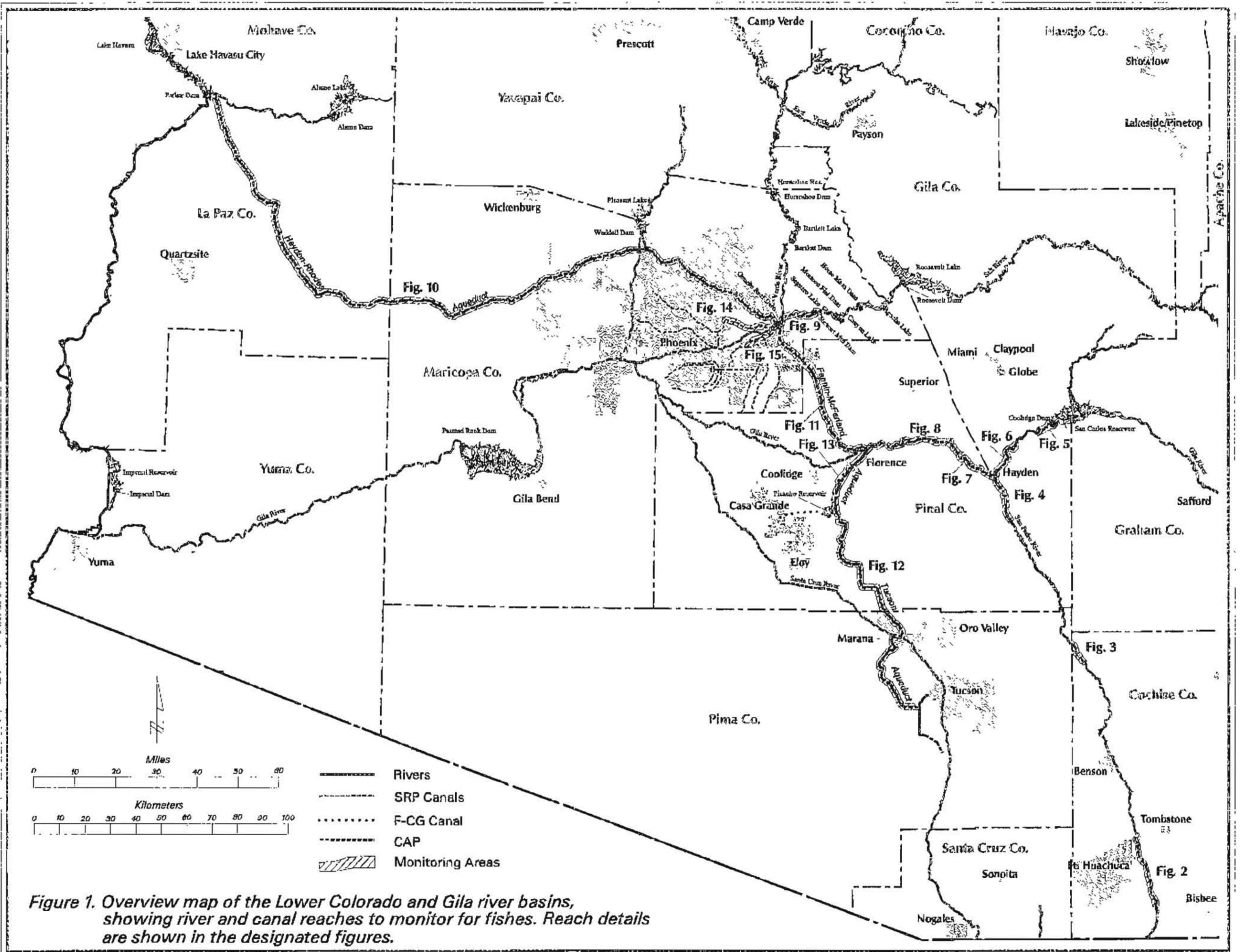
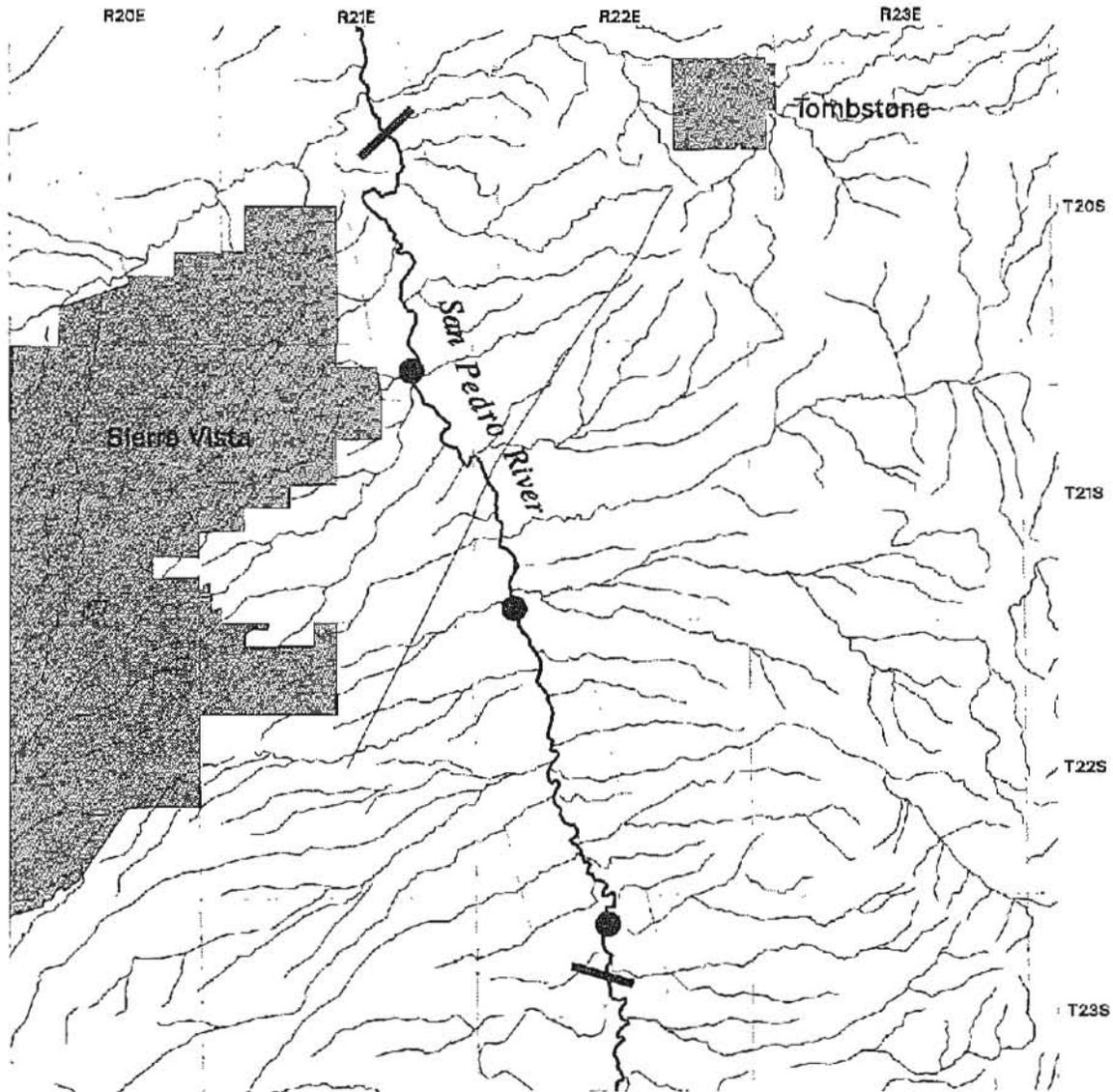


Figure 1. Overview map of the Lower Colorado and Gila river basins, showing river and canal reaches to monitor for fishes. Reach details are shown in the designated figures.

# Gila River Basin Fish Monitoring



- Station Location
- Reach Boundary
- Mainstem River
- Tributary Streams
- City Area

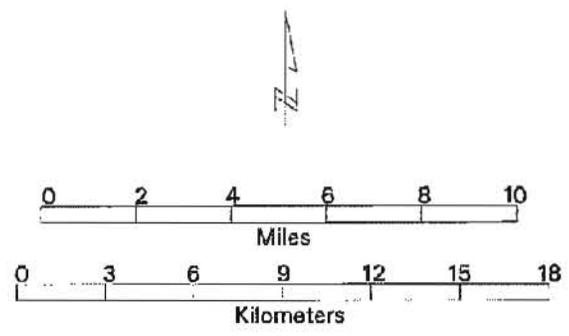
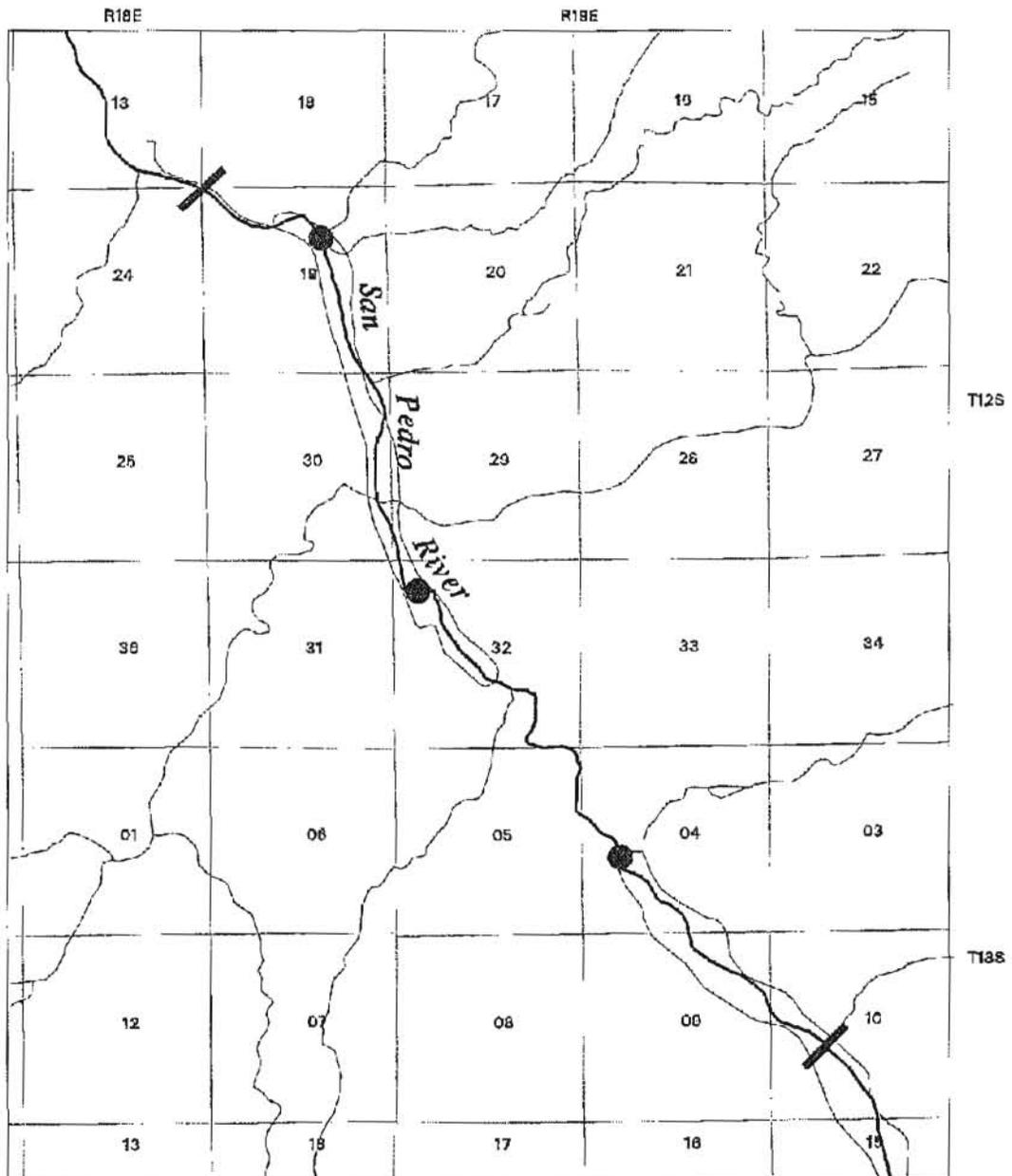


Figure 2. Map of the upper San Pedro River, Hereford to Fairbank Reach

# Gila River Basin Fish Monitoring



- Station Location
- ▬ Reach Boundary
- Mainstem River
- Tributary Streams

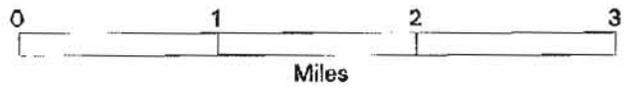
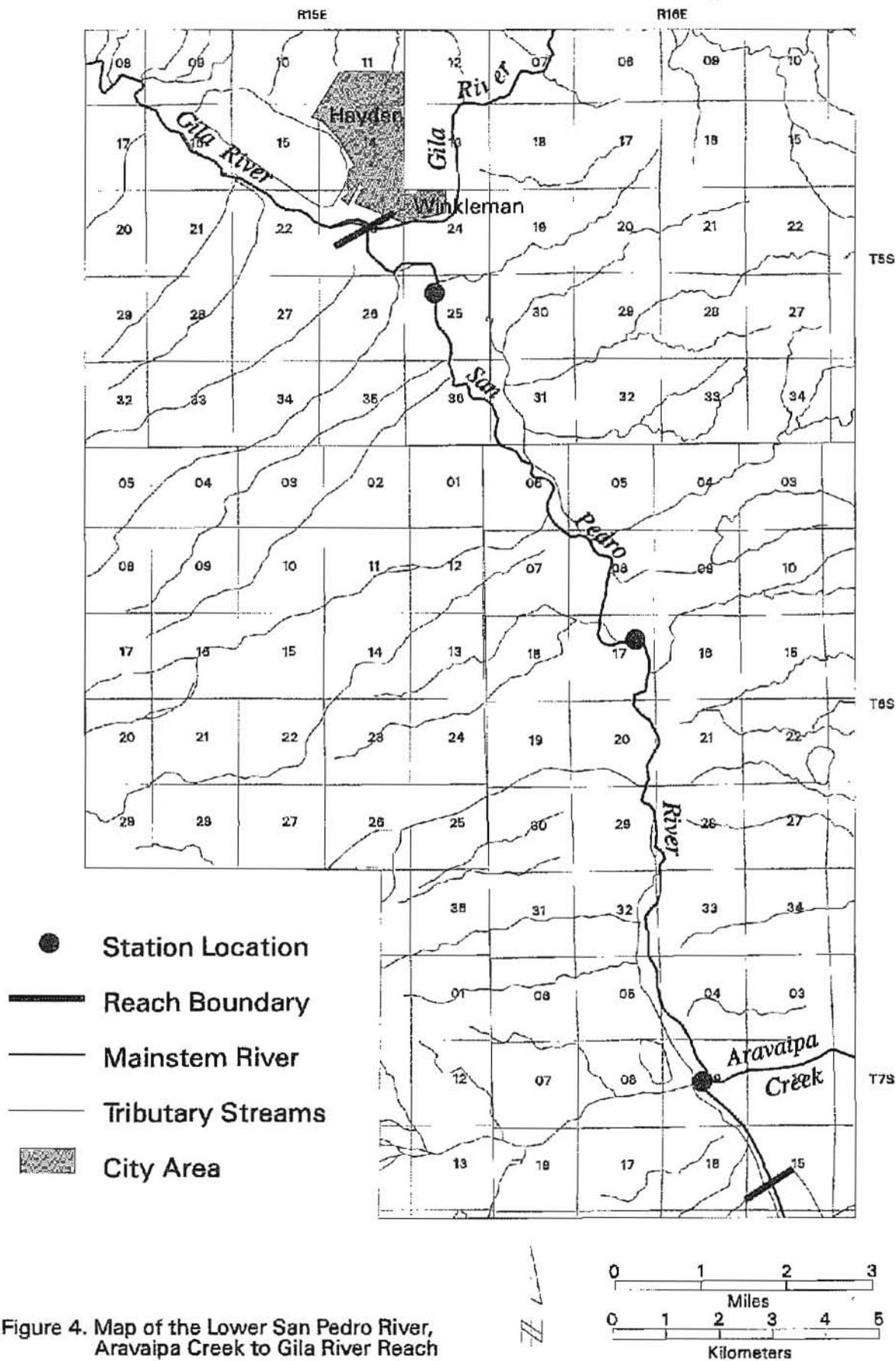
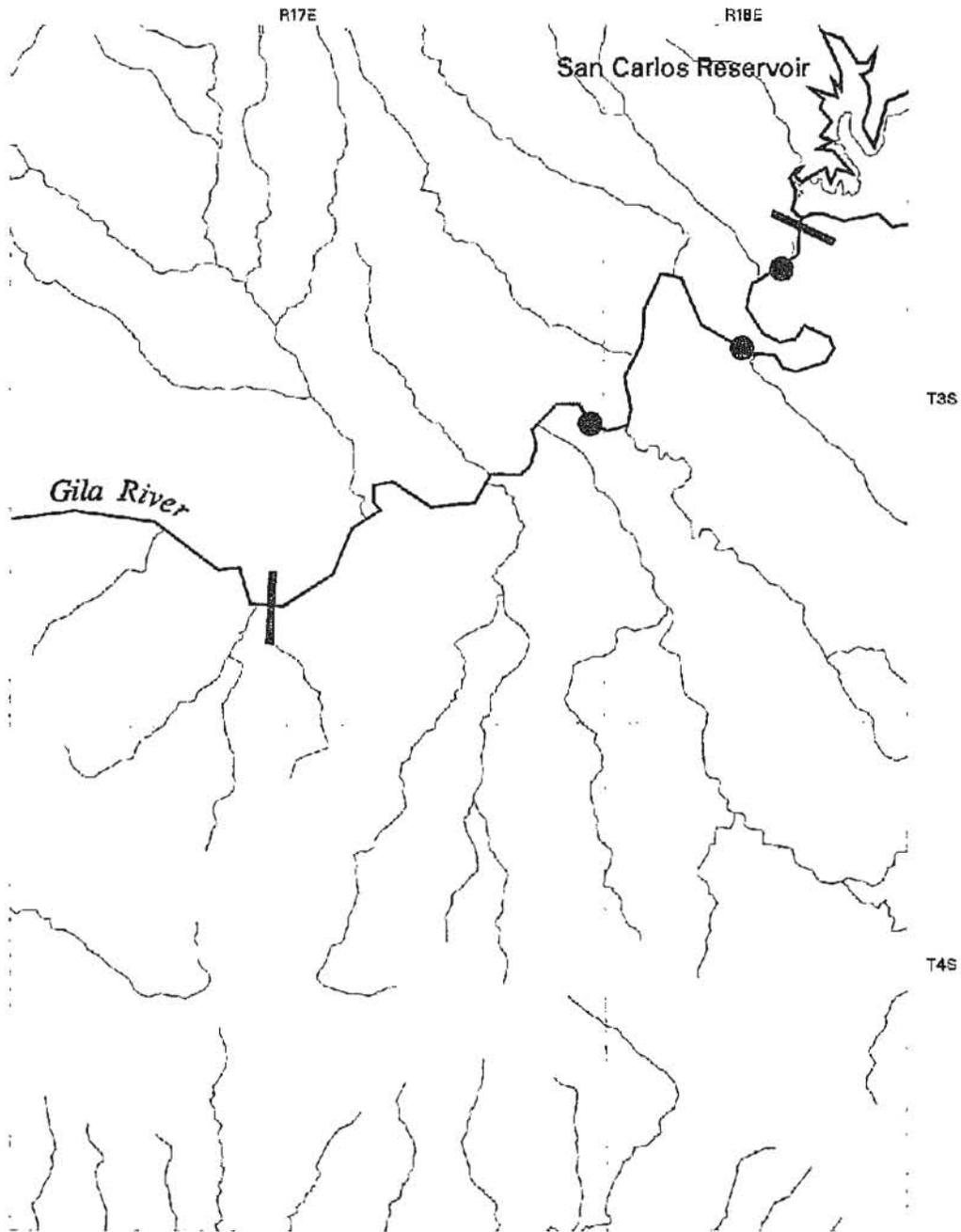


Figure 3. Map of the middle San Pedro River, Cascabel to Redington Reach

# Gila River Basin Fish Monitoring



# Gila River Basin Fish Monitoring



- Station Location
- Reach Boundary
- Mainstem River
- Tributary Streams

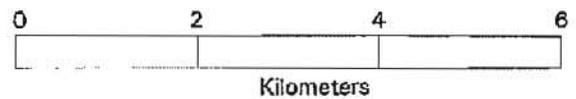
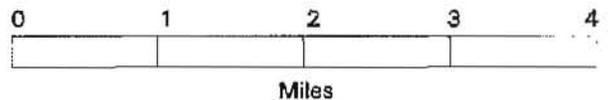
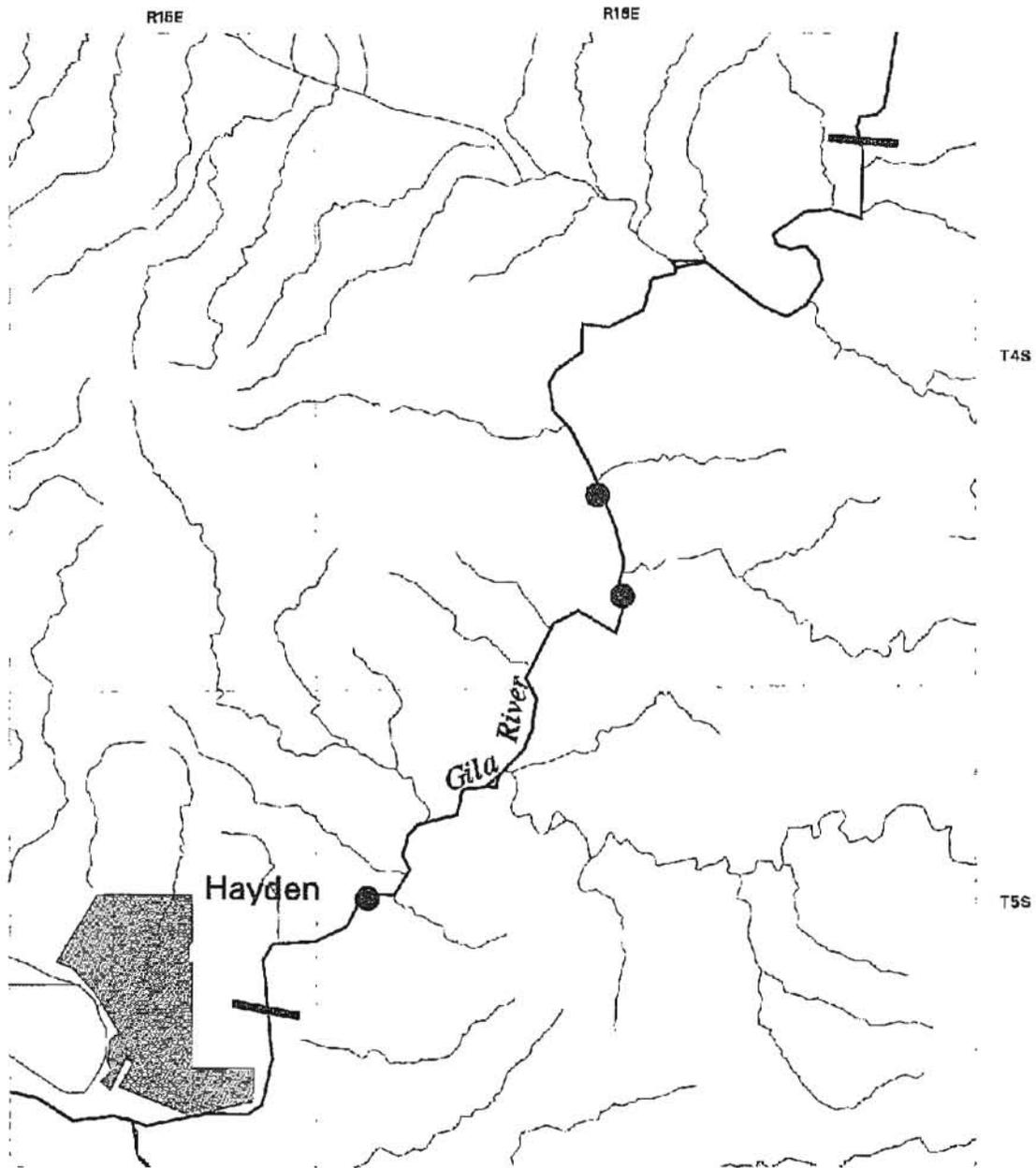


Figure 5. Map of the middle Gila River, Coolidge Dam to Needles Eye Reach

# Gila River Basin Fish Monitoring



- Station Location
- Reach Boundary
- Mainstem River
- Tributary Streams
- City Area

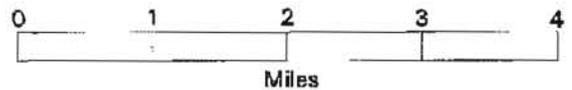
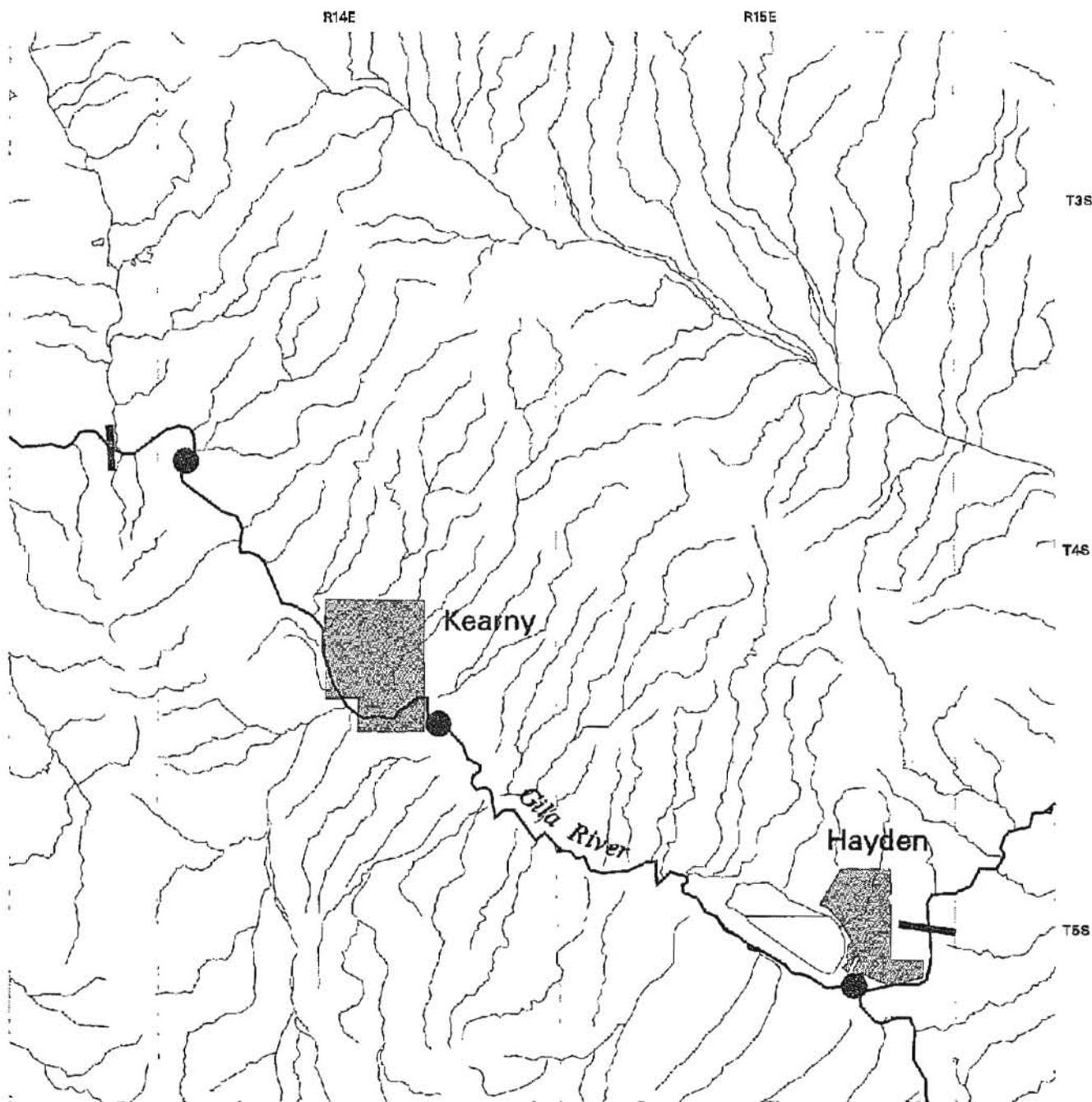
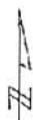


Figure 6. Map of the middle Gila River, Little Ash Creek to Hayden

# Gila River Basin Fish Monitoring



- Station Location
- Reach Boundary
- Mainstem River
- - Tributary Streams
- City Area

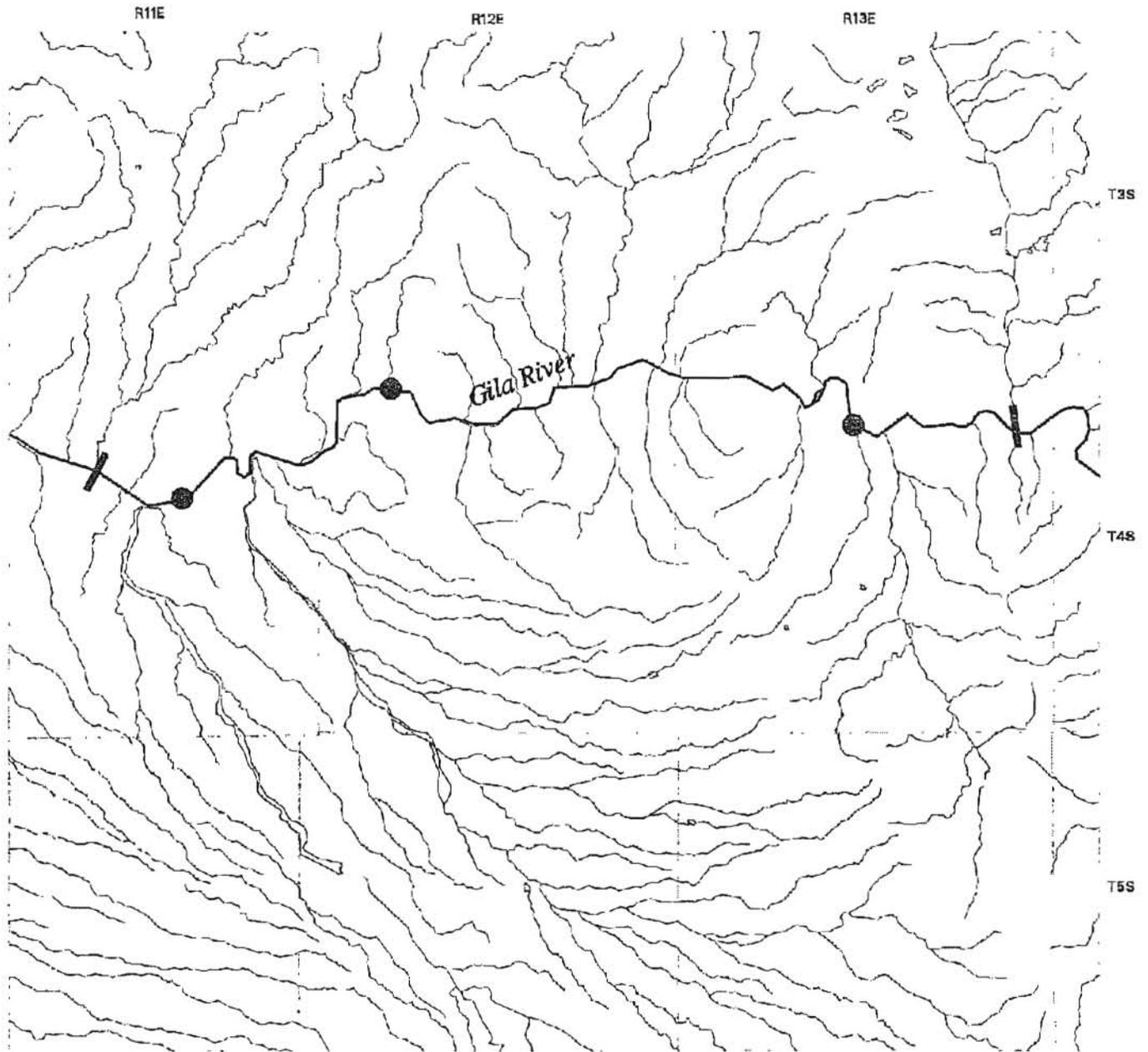


0 1 2 3 4 5  
Miles

0 2 4 6 8  
Kilometers

Figure 7. Map of the middle Gila River, Hayden to Mineral Creek Reach

# Gila River Basin Fish Monitoring



- Station Location
- Reach Boundary
- Mainstem River
- Tributary Streams

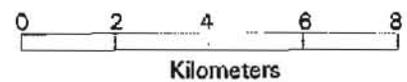
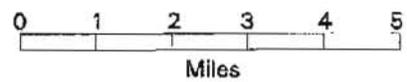


Figure 8. Map of the middle Gila River,  
Mineral Creek to Ashurst-Hayden Dam Reach

# Gila River Basin Fish Monitoring

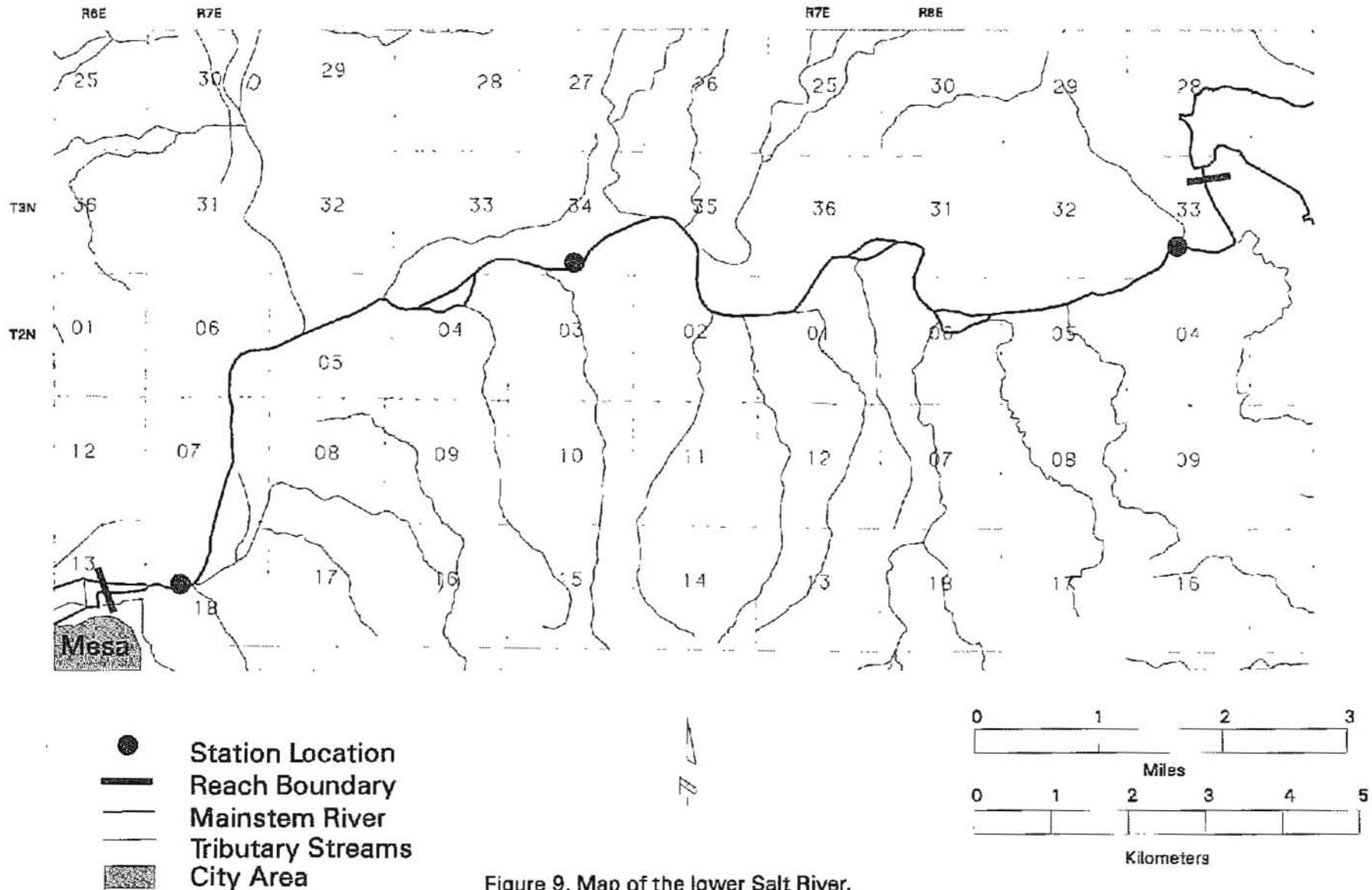
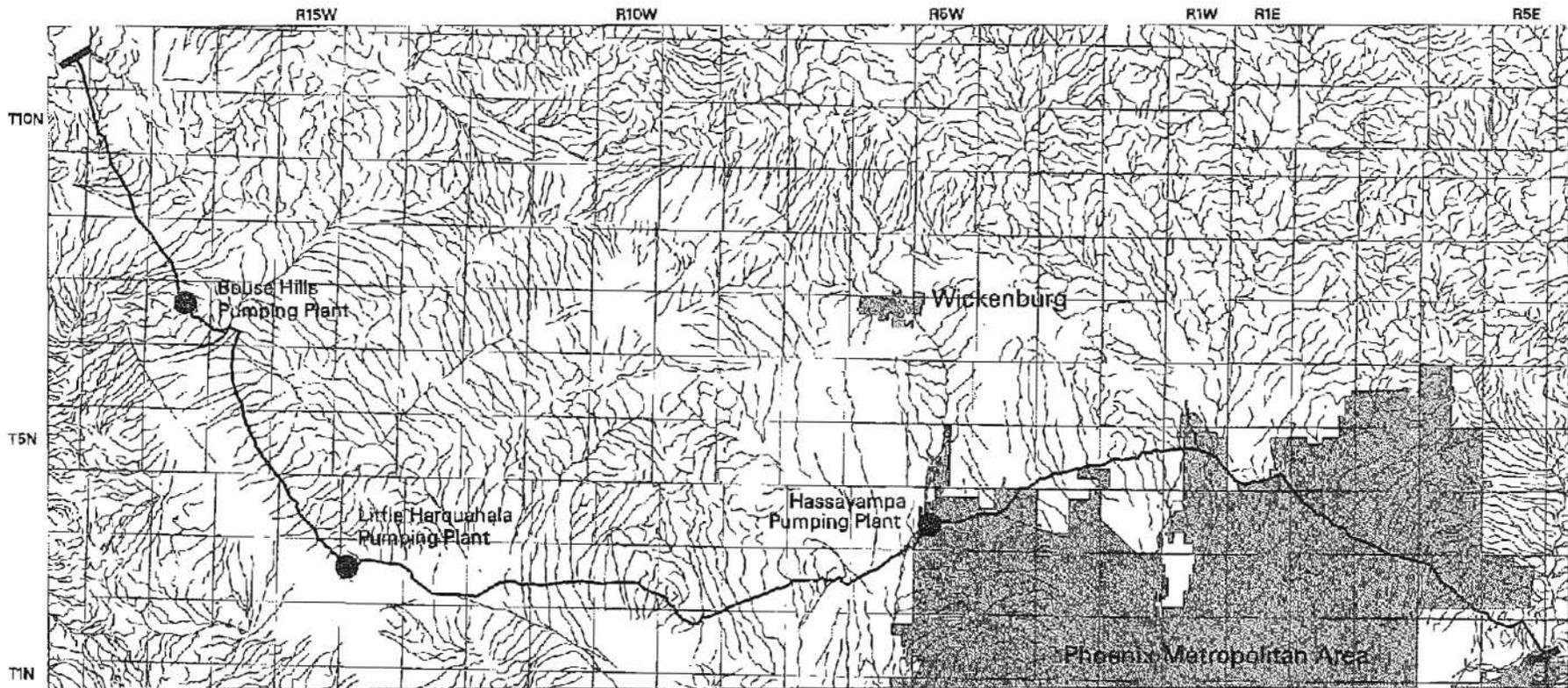


Figure 9. Map of the lower Salt River,  
Stewart Mtn. Dam to Granite Reef Dam Reach

# Gila River Basin Fish Monitoring



- Station Location
- Reach Boundary
- Hayden-Rhodes Aqueduct
- Rivers and Streams
- ▨ City Area

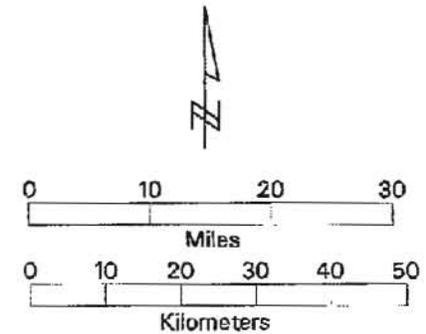


Figure 10. Map of the Hayden-Rhodes Aqueduct

# Gila River Basin Fish Monitoring

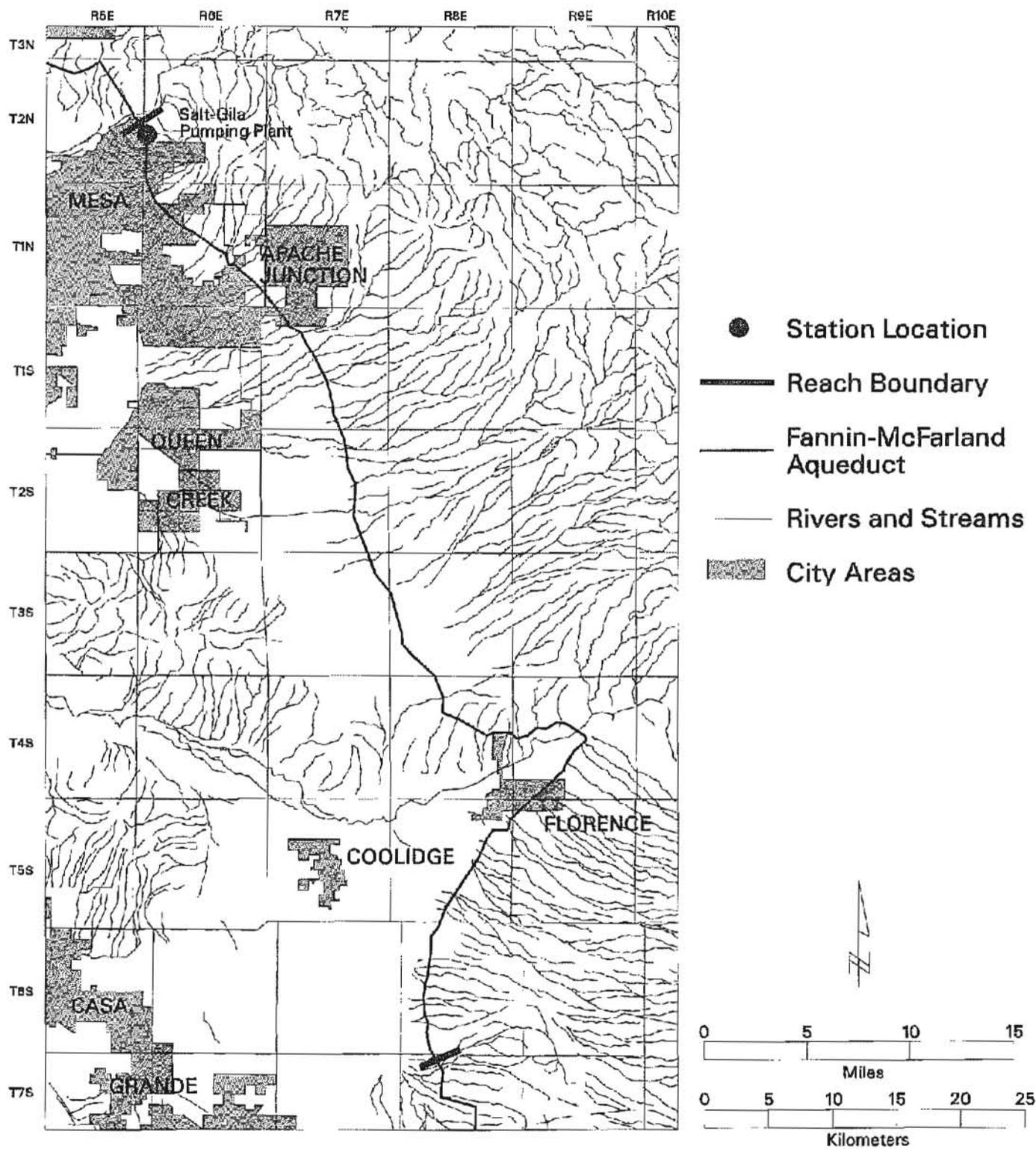


Figure 11. Map of the Fannin-McFarland Aqueduct

# Gila River Basin Fish Monitoring

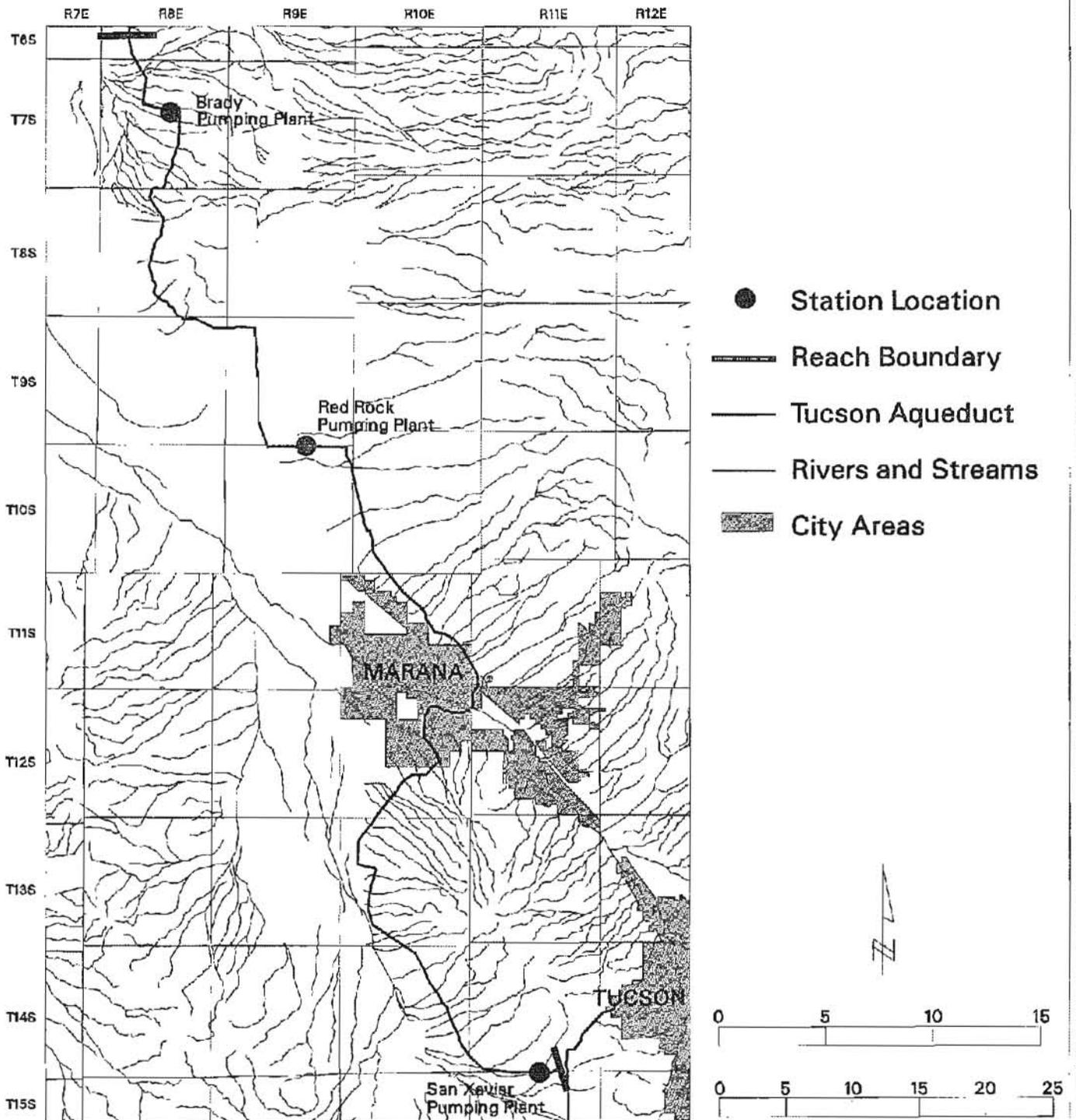
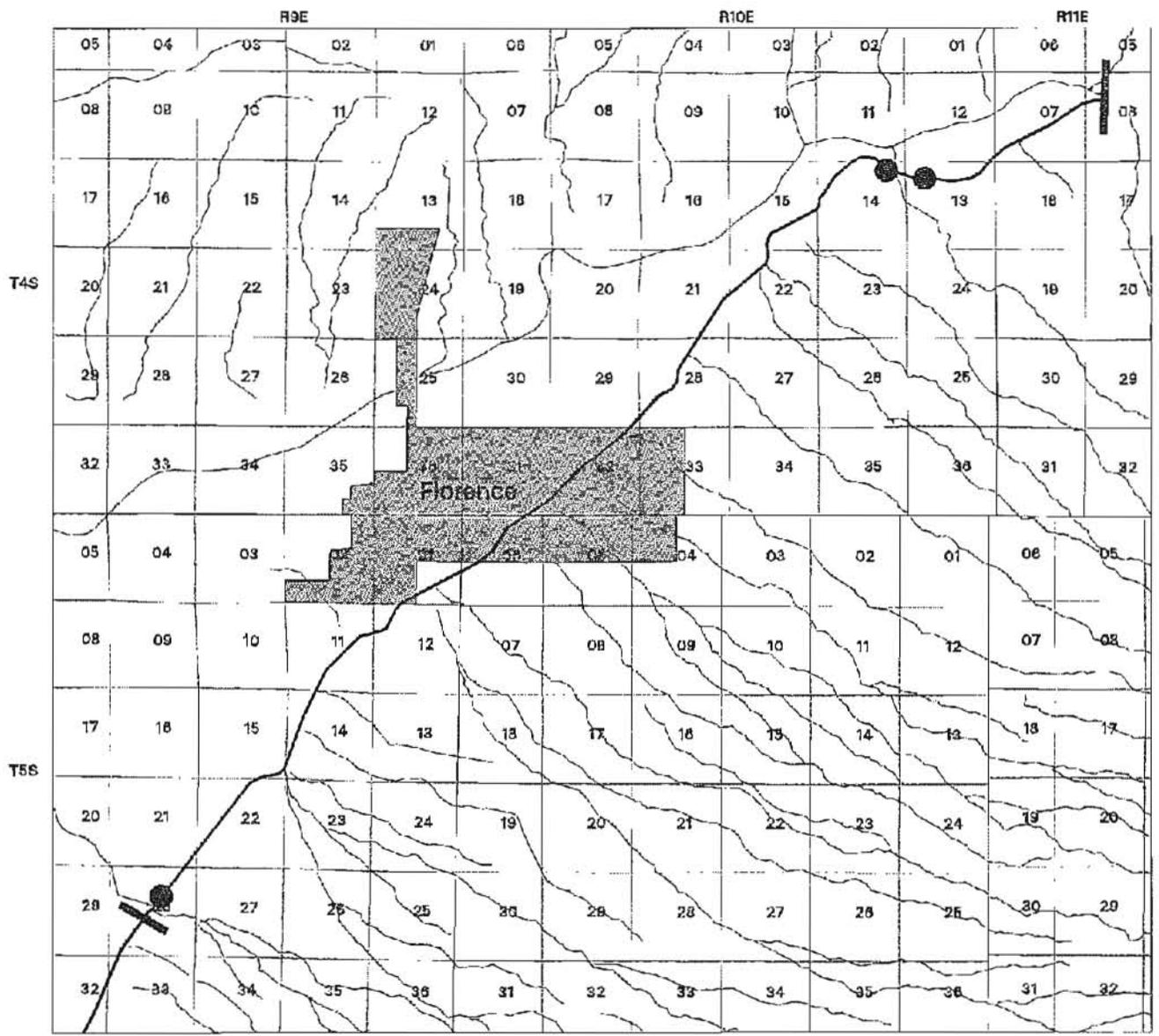


Figure 12. Map of the Tucson Aqueduct

# Gila River Basin Fish Monitoring



- Station Location
- Reach Boundary
- Upper Florence-Casa Grande Canal
- Rivers and Streams
- ▨ City Areas

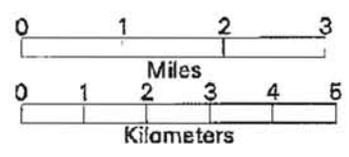
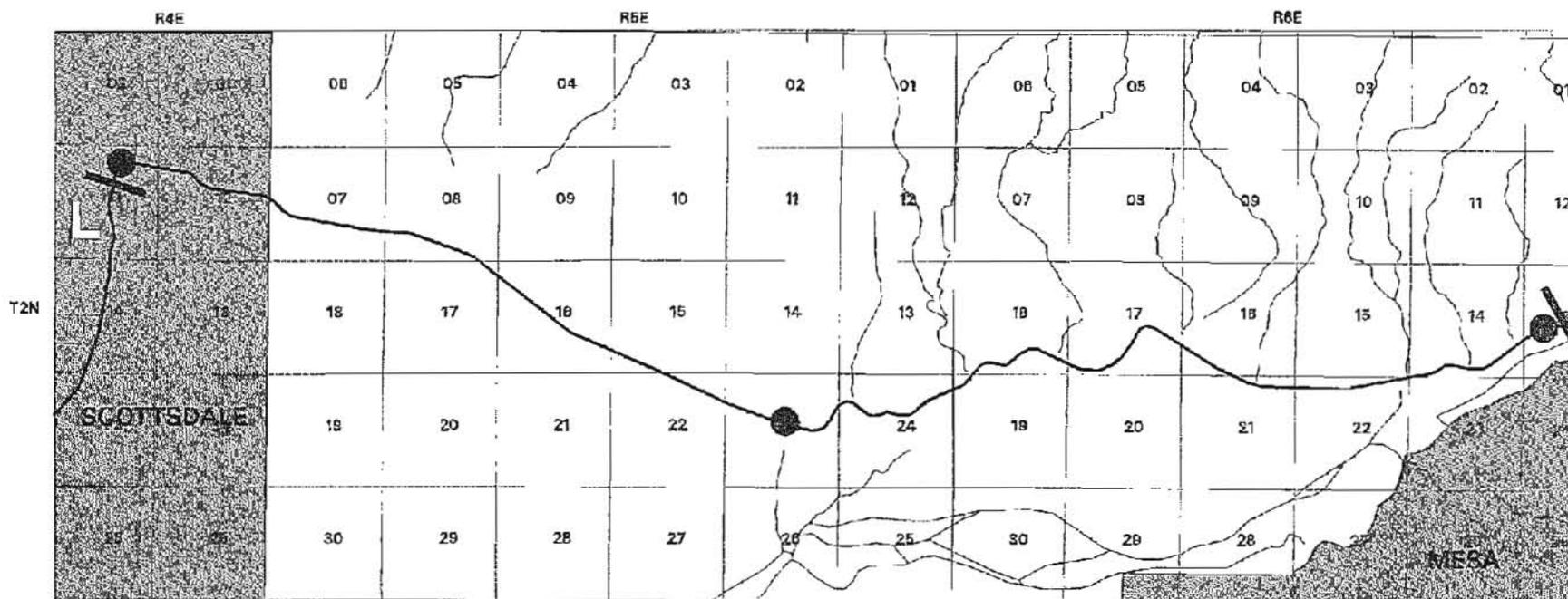


Figure 13. Map of the upper Florence-Casa Grande Canal, Ashurst-Hayden Dam to Pima lateral feeder canal

# Gila River Basin Fish Monitoring



- Station Location
- Reach Boundary
- Upper Arizona Canal
- Rivers and Streams
- City Areas

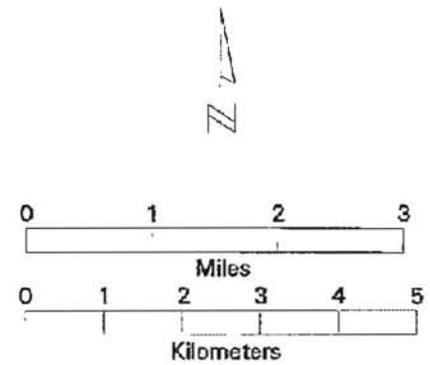
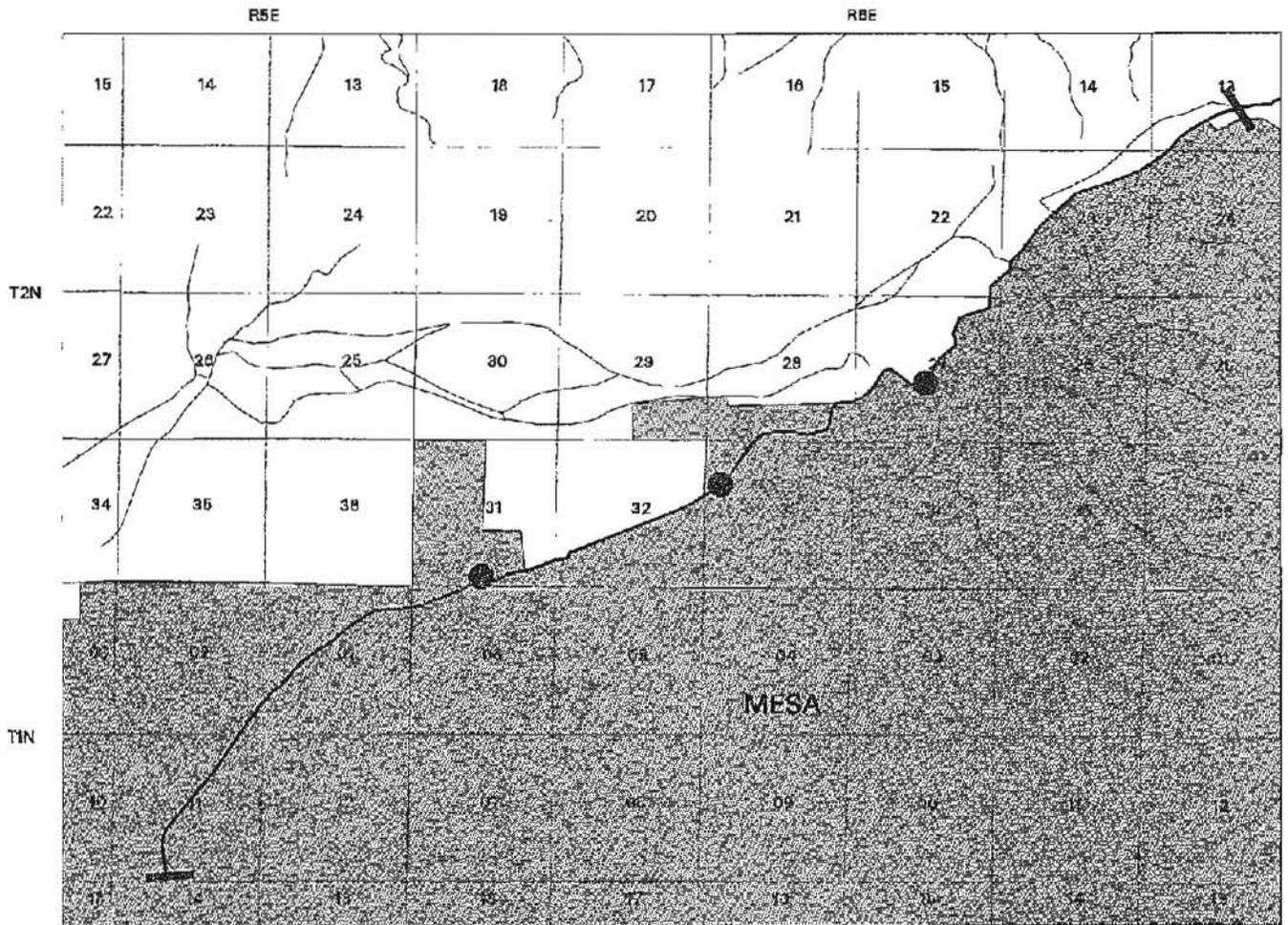


Figure 14. Map of the upper Arizona Canal, Granite Reef Dam to Indian Bend Wash

# Gila River Basin Fish Monitoring



- Station Location
- Reach Boundary
- South Canal
- Rivers and Streams
- City Areas

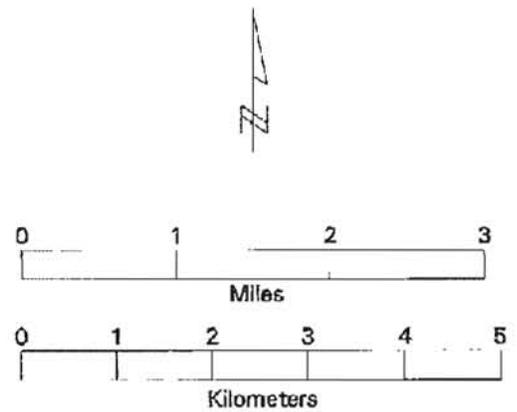


Figure 15. Map of the South Canal

APPENDIX I



### HABITAT SAMPLING FORM

STREAM NAME \_\_\_\_\_ Code    
 REACH NAME \_\_\_\_\_ Code    
 STATION NAME \_\_\_\_\_ Code

PAGE \_\_\_\_\_ OF \_\_\_\_\_  
 QC: \_\_\_\_\_  
 DATE MO  / DA  / YR

UTM: ZONE 12       E       N PHOTOS: ROLL #  FRAMES  -

HABITAT NO.   HABITAT TYPE \_\_\_\_\_ Code    
 HABITAT WIDTH (m) #1   #2   #3    
 DOMINANT SUBSTRATE \_\_\_\_\_ Code   COMMENTS \_\_\_\_\_

HABITAT LENGTH (m)     
 MAX. DEPTH (cm)

HABITAT NO.   HABITAT TYPE \_\_\_\_\_ Code    
 HABITAT WIDTH (m) #1   #2   #3    
 DOMINANT SUBSTRATE \_\_\_\_\_ Code   COMMENTS \_\_\_\_\_

HABITAT LENGTH (m)     
 MAX. DEPTH (cm)

HABITAT NO.   HABITAT TYPE \_\_\_\_\_ Code    
 HABITAT WIDTH (m) #1   #2   #3    
 DOMINANT SUBSTRATE \_\_\_\_\_ Code   COMMENTS \_\_\_\_\_

HABITAT LENGTH (m)     
 MAX. DEPTH (cm)

HABITAT NO.   HABITAT TYPE \_\_\_\_\_ Code    
 HABITAT WIDTH (m) #1   #2   #3    
 DOMINANT SUBSTRATE \_\_\_\_\_ Code   COMMENTS \_\_\_\_\_

HABITAT LENGTH (m)     
 MAX. DEPTH (cm)

HABITAT NO.   HABITAT TYPE \_\_\_\_\_ Code    
 HABITAT WIDTH (m) #1   #2   #3    
 DOMINANT SUBSTRATE \_\_\_\_\_ Code   COMMENTS \_\_\_\_\_

HABITAT LENGTH (m)     
 MAX. DEPTH (cm)

Figure 17. Field form to be used for recording of macrohabitat information in streams (reduced size).

APPENDIX 2

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FOR FISH POPULATIONS IN SELECTED WATERS  
OF THE GILA RIVER BASIN, ARIZONA

U.S. BUREAU OF RECLAMATION  
PHOENIX AREA OFFICE  
P.O. BOX 9980  
PHOENIX, ARIZONA 85068

OCTOBER 1996

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## STANDARD OPERATING PROCEDURES

### FIELD MANUAL RIVERS AND STREAMS

#### LONG-TERM MONITORING PLAN FOR FISH POPULATIONS IN SELECTED WATERS OF THE GILA RIVER BASIN, ARIZONA

**INTRODUCTION**--This standard operating procedures manual, part of an overall quality control/quality assurance program in development for the *Long-Term Monitoring Plan for Fish Populations in Selected Waters of the Gila River Basin, Arizona* (Monitoring Plan), was produced to ensure that all field data are gathered according to standardized, repeatable methods. It describes specific steps to be taken during all field monitoring activities, and provides background information on objectives, justification, and sampling design. See the Monitoring Plan for further information. Reclamation intends this manual to be used in association with annual mandatory field training, and should be carried in the field at all times by data collectors for reference. It is likely that the manual will be updated periodically for clarity and to reflect changes to the Monitoring Plan that may become necessary over time. Reclamation will provide waterproof copies of the manual to all field investigators during annual training sessions, or upon request. In the methods descriptions below, arrows (→) denote field procedures that must be undertaken explicitly.

**OBJECTIVES**--Collect information on the status of fish populations and instream habitats at selected sampling stations to determine: 1) presence of species (species richness); 2) species absolute and relative abundance (assemblage structure); 3) species distributions; 4) annual reproductive success; and 5) instream macrohabitat dimensions and dominant substrates.

**SAMPLING CREWS**--A sampling crew of at least three, and preferably four, individuals is required for efficient collection of field monitoring data. These individuals should be experienced in fish collection techniques and identification of the local fish fauna. It is vital that sampling crews be headed by an individual with such proven field experience. The field crew leader must be present during all monitoring excursions, and he/she must attend the annual training sessions that will be conducted by Reclamation.

**SAMPLING DESIGN**--Because native and nonnative fishes respond in different ways to environmental disturbances (e.g., flooding) in different geomorphic reach types (e.g., highly confined canyons vs. poorly confined valleys), sampling

reaches are stratified according to geomorphology. This should facilitate an understanding of the variance of fish species richness, distribution, and assemblage structure.

Three fixed, systematic sampling stations are permanently established within each geomorphic stream reach to estimate within-reach variance of monitored parameters. A systematic sampling design can substantially reduce data variability, and thus the sample size required to obtain a given level of precision. Systematic sampling should also provide a reasonable expectation that stations are representative of the reach, and will ensure a wide spatial distribution of sampling sites.

Fixed station sampling consists of a combination of intensive quantitative sampling over a 200 m reach of stream, and extensive qualitative sampling of uncommon habitats in contiguous reaches. Data from each 200 m quantitative sample will determine assemblage structure of common species, and extensive qualitative samples will enhance the ability to determine species richness and presence of rare species.

Species occurrence and abundance are influenced by availability of habitats. Thus, to minimize bias of assemblage structure estimates and ensure a representative sample, sampling effort should be proportional to the amount of different habitats available. Quantitative fixed-station sampling therefore is stratified to the primary macrohabitat level (pool, riffle, or run) to partition the variance among species collections. Quantification of macrohabitat dimensions provides an estimate of habitat availability, and tracks habitat changes over time. By quantifying sampling effort according to macrohabitat, comparisons of species richness and assemblage structure among macrohabitat types across stations and years will be facilitated.

**PERMITS**--Valid State and Federal collecting permits must be in possession of sampling crews when performing monitoring. The incidental take statement in the 1994 biological opinion "Transportation and Delivery of Central Arizona Project Water to the Gila River Basin in Arizona and New Mexico" serves as Reclamation's permit for take of federally-protected species, and Reclamation will request that subcontractors who do not possess their own Federal permits be designated as subpermittees under Federal permit provisions. Subcontractors will be responsible for obtaining their own State collecting permits.

**FIELD FORMS**--All mandatory data collections must be recorded in pencil on the fish collection and habitat sampling forms provided. This will ensure that all required information is recorded and compatible with the database structure. Master copies of field forms (provided) should be photocopied on site-in-the-rain paper or a similar waterproof bond for use in the field. The habitat sampling form is intended to

inventory macrohabitats that will be sampled in quantitative stations, which will guide fish collections. The fish collection form quantifies gear types, sampling effort, and species abundance data.

- Certain header information (see Table 1 for complete descriptions, and Figures 1-2) is common to both field forms to ensure that the data sets are relational in the database. These variables include stream, reach, and station names (numerically coded for data entry), sampling date, habitat type name (pool, riffle, or run; coded for data entry; Table 1), and unique number for each macrohabitat encountered within a station. All of these variables must be filled in on each form (codes can be recorded at a later time if the text fields are completed properly while in the field). If continuation forms are needed to complete recording of data for a particular macrohabitat or station, they must be tracked in the upper right-hand corner of the data sheets. The field crew leader should record his/her initials in the QC field of each form following review and assurance that the data were filled in properly.
- The fish collection form also includes a variable describing whether the sample is quantitative (where sampling effort is recorded) or qualitative (sampling effort not required), and what gear type is deployed. These fields must be filled in. Other sampling gear data and sampling effort requirements, and fish capture variables, are described below. It is intended that a separate fish collection form be used for each separate gear type and macrohabitat.
- The habitat sampling form, in addition to the common header variables identified above (stream, reach, and station names; date), should also have the UTM coordinates recorded for the lower station boundary, and the photo roll and frame numbers for slides taken of the sampling reach from the upper and lower station boundaries. For each macrohabitat sampled quantitatively for fishes, this form should also be filled in with a unique habitat number, numbered sequentially upstream beginning with 1, that must correspond to the habitat number for that macrohabitat on the fish collection form. The habitat type (pool, riffle, run) should also be recorded for each macrohabitat, which also must match the fish collection form. In addition, for each macrohabitat, the habitat sampling form should have a single macrohabitat length measurement, three equidistant width measurements, a maximum depth measurement, and a dominant substrate category filled

in. Any sampling irregularities or features of note for a macrohabitat should be described in the comments field. Further specifics for filling in these forms appear below.

**STATION LOCATION AND IDENTIFICATION**--Travel routes to and UTM locations for fixed sampling station are shown in Table 2 [to be completed following this field season]. Reclamation will mark downstream station boundaries with labeled aluminum tags tied to flagged rebar stakes, where possible. Downstream station boundaries should be further defined using the Global Positioning System (GPS).

- Record the stream name, reach name, and station name on each habitat sampling form and fish collection form used at a given monitored sampling station. Also record the date and time (fish collection form only) the station macrohabitat sampling was begun on each form.
- Upstream station boundaries will be 200 stream meters above the downstream boundary. Measure along the thalweg (the deepest part of the channel) with either a tape measure or hip chain. Upstream boundary locations may vary depending on changes in channel sinuosity over time, and therefore they should not be permanently marked. Temporarily mark the upstream boundary with a flagged stake.
- Photo-documentation of upper and lower station boundaries is required. Fill in the appropriate **station identifier form** (provided) with station boundary (upper or lower), boundary view (up or down), and the sampling date with a black dry marker. Include this form in the lower left corner of each photo (and in focus) to ensure the slide is permanently identified. Take one 35 mm color slide of the stream reach facing upstream while standing at the lower station boundary, and take one slide facing downstream. Repeat for the upper station boundary. Record the photo roll and frame numbers on the habitat sampling form.

**MACROHABITAT IDENTIFICATION**--Sampling stations must be partitioned to the primary macrohabitat level (pool, riffle, or run as defined in Table 1).

- Prior to fish sampling (below), macrohabitat unit boundaries should be temporarily identified with flagged stakes. The type name of the habitat unit (Table 2) must be recorded on the habitat sampling form along with a unique consecutive number (starting at 1) designating the longitudinal position of the

unit in the sampling reach, beginning from the downstream boundary.

- The following macrohabitat dimensions should be measured and recorded after fishes have been collected (below) to ensure that fish-habitat relationships are disturbed as little as possible. Length (to the nearest m) of the habitat type (or portion thereof, if the lower and upper station boundaries do not include an entire macrohabitat) shall be measured with a meter tape or hip chain and recorded on the habitat sampling form. Measure stream (wetted) width within each macrohabitat with a meter tape (to the nearest 0.01 m) at three equidistant points along the length of the macrohabitat, and record. Maximum depth of each habitat type (to the nearest cm) and the dominant substrate category (e.g. boulder, gravel; Table 1) should also be recorded as additional estimators of habitat change over time. Once all macrohabitat information has been collected (including fish collections), remove all boundary flags.

**FISH COLLECTIONS**--Unless habitats absolutely are not conducive to electrofish sampling, it is required that data obtained by electrofishing be used as the primary descriptor of assemblage structure at each fixed, quantitative 200 m station. Standardization of sampling by this technique therefore requires that electrofishing be employed first through each macrohabitat. Electrofishing gears should be standardized to electrical configuration and power output, if possible.

- Macrohabitats should be sampled in an upstream progression with single-pass electrofishing. Pools should be sampled in an upstream direction, while swift-flowing macrohabitats should be sampled in a downstream direction into blocking nets. Two persons should closely attend the electrofisher with fine-meshed dip nets to capture stunned fishes when sampling pools. Every attempt should be made to sample all of the available habitat and capture all fishes possible. Pulse rate, voltage, and amperage must be recorded, and conductivity and temperature readings are also required to determine electrical power output (wattage). Record both the number of seconds shocked in the macrohabitat, as well as the estimated percentage of the available macrohabitat that was sampled.

Other methods should also be employed if the investigator considers sampling of a particular habitat inadequate by electrofishing. Whenever possible, gear-type combinations should be consistently applied to a site over time, unless habitat changes dictate sampling modifications.

- If seines or dip nets are deployed, recording of mesh size and length and width (depth) of the gear is required. Effort shall be quantified by recording the number of seine hauls or dip net sweeps taken within the macrohabitat (standardize dip net sweeps to 1 m long sweeps), and the estimated percentage of the available macrohabitat sampled.
- Data unique to entrapment and entanglement gears that must be recorded include mesh size and net length and width (depth), with effort quantified in hours soaked or deployed (to the nearest 1/10th hour).
- Should sampling by angling or trot line be undertaken, bait type (Table 1) should be recorded, and effort should be identified as the number of hooks and hours (to nearest 1/10th) fished.
- Captured fishes from a single-gear sample from a macrohabitat should be kept alive in buckets of water or holding nets until ready for processing. Fishes should be sorted to species, then sorted to age class, and enumerated. Counts for each species and age class should be recorded on the fish collection form for that macrohabitat and gear. Data that must be recorded from captured fishes at quantitative stations include a four-letter code for species, consisting of the first two letters of the generic name and the first two letters of the specific name, an age category designation (age-0 or young-of-year, and older, age-1+ fish), and the number of fish enumerated for each species and age collected by a particular sampling gear within each macrohabitat (Table 1). It is mandatory that the number of each species/age class preserved for voucher be identified in the voucher field. Optional variables such as fish length, weight, sex, reproductive condition, number and kind of external parasites, external anomalies, and other notes should be recorded in the comments field.
- Vouchers (see below) must be taken from a sample of each species collected at each station.
- Following completion of quantitative sampling at each fixed station, extensive qualitative sampling with various gear types must be conducted to search for species that were not collected in the 200 m quantitative reach. This search should concentrate on unusual habitats upstream and/or downstream from the quantitative reach, where detection of novel species might be expected. All individuals of new species should be enumerated (as for quantitative samples) on a separate form (Quantitative Sample = N

on the fish collection form). Recording of sampling effort is not required for qualitative samples. Vouchers (below) must also be taken for any species not found in quantitative samples.

**VOUCHER COLLECTIONS**--Several (3+) specimens of each permitted species encountered at each sampling station should be preserved for museum vouchers, when possible. Quality photo-documentation of species not permitted for take should be made. Vouchers will provide scientific credibility to the monitoring project, ensure the accuracy of species identifications in the field, and scientifically document species occurrence and distribution.

→ Voucher specimens should be preserved in 10% formalin immediately following recording of pertinent field data. If specimen body depths are greater than approximately 3 cm (1 1/4 in), specimens should be cut along the right, lower body wall or injected with 10% formalin into the peritoneal cavity and major muscle masses to ensure adequate tissue fixation. Specimens should be retained in labeled, leakproof plastic jars or buckets and submitted to Reclamation, who will deposit them at the ASU Collection of Fishes. Reclamation will provide rite-in-the-rain collection labels to investigators to ensure that taxonomic identification (if possible), date, time, and method of collection, locality, number of specimens, and collector name(s) are recorded for each sample. The number of each species preserved at each site must be recorded on the fish collection form in the voucher field.

**QUALITY CONTROL**--Prior to leaving a sampling station, the field crew leader should review all data sheets used at the station to ensure that all appropriate fields, including data codes, have been filled in properly, and that there are no missing data. The crew leader should then enter his/her initials in the QC field.

**FIELD NOTES**--An important aspect of data sampling is recording of field notes. Field forms do not allow the type of narrative description of sampling site conditions, sampling problems, or other observational data that may be important to document sampling procedures or physical conditions at a particular site. To aid in compiling an overview of each sampling station, a sketch map should also be made to depict station morphology, including the distribution of macrohabitat types and their numbers.

**STEPWISE MONITORING PROCEDURES**--The following itemization describes the recommended ordered procedures, in abbreviated form, for conducting monitoring at a station:

1) Locate lower station boundary, mark with flagged stake

- 2) Record header information on fish collection and habitat sampling forms
- 3) Begin measuring upstream along thalweg with tape or hipchain
- 4) Record macrohabitat type names, sequential numbers, and lengths on habitat sampling form, marking macrohabitat boundaries with flagged stakes
- 5) End measurement and mark upper boundary with flagged stake at 200 m
- 6) Number and name macrohabitats on fish collection forms to match those on habitat sampling form(s)
- 7) Measure and record stream temperature and conductivity on fish collection forms
- 8) In an area below the lower station boundary, adjust electroshocker settings so that fishes are captured effectively
- 9) Record electroshocker settings (volts, amps, etc.) on fish collection form for habitat #1
- 10) Begin single-pass electrofish sampling of lowermost macrohabitat, collecting all fish possible
- 11) Store fishes alive in a bucket filled with stream water
- 12) Sort and enumerate fishes according to species and age class, and record on the appropriate fish collection form
- 13) Select specimens of each species to be preserved for voucher, store in container with 10% formalin and a completed collection tag, and record the number preserved on the appropriate fish collection form
- 14) Return remaining fishes alive to stream below the macrohabitat just sampled
- 15) Record sampling effort (seconds electroshocked and percent macrohabitat sampled) on the appropriate fish collection form
- 16) If electrofish sample is considered inadequate for the macrohabitat, resample with different gear type(s), repeating steps 10-15 as appropriate
- 17) Proceed upstream to the next macrohabitat, and repeat steps 10-16 for each until the 200 m sample is completed
- 18) Measure three widths, maximum depth, and the dominant substrate category for each macrohabitat just sampled for fishes, and record on appropriate habitat sampling forms
- 19) Fill out the appropriate station identifier form and photograph the upper and lower station boundaries, record the roll and frame numbers on the habitat sampling form
- 20) Fill out header information on a new fish collecting form, to be used for qualitative sampling
- 21) Sample fishes with appropriate gear types in areas upstream and downstream from the 200 m station, looking for species that were not found previously

- 22) Record numbers and preserve vouchers for any new species found during qualitative sampling on the appropriate fish collection form
- 23) Review and correct all data sheets for omissions, legibility, and obvious mistakes, and record initials in the QC field for each form
- 24) Record field notes for the sampling station
- 25) Remove all flagged stakes and hip chain string from the site, and proceed to the next station

Table 1. Descriptions of variables and their codes to be entered on the Fish Collection Form. Location numbers refer to fields of the Fish Collection and Habitat Sampling forms shown in Figures 1-2.

Location	Description	Codes
1	Name of stream	1=San Pedro River 2=Gila River 3=Salt River 4=C&P Canal 5=SRP South Canal 6=SRP Arizona Canal 7=FCG Canal
2	Name of reach (see Table 2 for site names)	1=upstream-most reach 2=second downstream reach 3=third downstream reach 4=fourth downstream reach
3	Name of station (see Table 2 for site names)	0=Random 1=Upper (fixed) 2=Middle (fixed) 3=Lower (fixed)
4	Month sample taken or begun	01-12
5	Day sample taken or begun	01-31
6	Year sample taken or begun	00-99
7	Hour (military time) sample taken or begun	00-23
8	Minute sample taken or begun	00-59
9	Name of macrohabitat type	1=pool (area of water column with low current velocity and near-zero surface gradient and little or no surface turbulence, often with small substrates; includes eddies and pocket water) 2=riffle (area of water column with fast current velocity and steep surface gradient, considerable surface turbulence, often with large substrates; includes cascades and rapids) 3=run (area of water column with rapid, non-turbulent flow, usually too deep to be a riffle and too fast to be a pool; includes glides) 4=various; to be used for qualitative sampling

Table 1. Continued.

Location	Description	Codes
10	Number of macrohabitat number, counted sequentially from the downstream station boundary	
11	Quantitative (effort recorded) or qualitative (effort not recorded) sample	Y=Yes (quantitative) N=No (qualitative)
12	Name of gear type	Entrapment/Entanglement: 1=gill net 2=trammel net 3=hoop net 4=fyke net 5=trap net 6=minnow trap 7=shock/gill net 8=shock/trammel net 9=experimental gill net Seining: 10=straight seine 11=bag seine 12=kick seine 13=dip net Angling: 14=spincast 15=fly rod 16=dropline 17=trotline Electrofishing: 18=backpack shocker 19=boat shocker 20=bank shocker Miscellaneous 25=trammel net/drifted 26=gill net/drifted
13	Electroshocker pulse rate setting (pulses per second)	
14	Electroshocker voltage setting	
15	Electroshocker electrical output; calculated from formula of Burkhardt and Gutreuter (1995)	
16	Electroshocker amperage setting	

Table 1. Continued.

Location	Description	Codes
17	Conductivity ( $\mu\text{S}/\text{cm}$ ) of water; required for determination of electroshocker output and water quality	
18	Temperature ( $^{\circ}\text{C}$ ) of water; required for determination of electroshocker output and water quality	
19	Electroshocker effort in seconds fished	
20	Areal percent of habitat type sampled by electrofishing	
21	Mesh size (in) (bar measure) of seine or dip net	
22	Length (ft) of seine or dip net	
23	Width (height or depth) (ft) of seine or dip net	
24	Number of seine hauls or dip net sweeps taken within the macrohabitat	
25	Areal percent of habitat type sampled by seine or dip net	
26	Mesh size (in) (bar measure) of entanglement/entrapment gears	
27	Length (ft) of entanglement/entrapment gears	
28	Width (height or depth) (ft) of entanglement/entrapment gears	

Table 1. Continued.

Location	Description	Codes
29	Effort (hr) fished (soaked) by entanglement/ entrapment gears	
30	Bait type code for angling gears	1=artificial lure 2=live bait 3=gabrage (corn, cut bait, etc.) 4=stink bait
31	Number of hooks per line for angling gears	
32	Effort (hr) fished (soaked) by angling gears	
33	Species name code, where first two letters of genus is followed by first two letters of species	Examples: CYLU denotes <i>Cyprinella lutrensis</i> ; AGCH denotes <i>Agosia chrysogaster</i> ; "????" indicates species unknown, and specimen should be preserved for voucher; HYBR denotes a hybrid (identify in comments if possible and preserve); "0000" indicates no fish were caught
34	Categorization to young-of-year or older age classes	0=young-of-year (including larvae) 1=age-1 or older
35	Number of fish represented in record; if length and other data taken, should always equal 1; if more than one of a species was captured but individual data not taken, record the number; if sampling effort did not capture fish, should equal 0	
36	Number of specimens preserved for voucher	

Table 2. Continued.

Location	Description	Codes
37	Narrative information not recordable in other areas of the field form, such as length, weight, presence of external parasites, spinal or cranial deformity, ulceration, etc.	
38	Longitudinal length (m) of macrohabitat unit	
39	Lateral width (m) of macrohabitat unit, measured at point 1/4 the distance of the unit length from the downstream origin	
40	Lateral width (m) of macrohabitat unit, measured at point 1/2 the distance of the unit length from the downstream origin	
41	Lateral width (m) of macrohabitat unit, measured at point 3/4 the distance of the unit length from the downstream origin	
42	Maximum depth (cm) of macrohabitat	
43	Category of dominant substrate in macrohabitat, modified from Lane (1947)	1=clay (0.24-4.0 $\mu$ m) 2=silt (4-62 $\mu$ m) 3=sand (62-2000 $\mu$ m) 4=gravel (2-64 mm) 5=cobble (64-256 mm) 6=boulder (256-4096 mm) 7=bedrock (>4.096 m) 8=detritus 9=concrete (for lined canals)

Table 1. Continued.

Location	Description	Codes
44	Narrative information not recordable in other areas of the field form, such as unusual cover attributes, bank features, etc.	
45	Current page number of total if continuation sheets are required to complete data recording for a macrohabitat (fish collection) or a station (habitat sampling)	
46	Initials of field crew leader certifying that the data sheet was completed properly	
47	Universal Transverse Mercator (UTM) location for lower station boundary	
48	Roll and frame numbers for photos (slides) taken of the lower and upper station boundaries	

Table 2. Travel routes to fixed sampling stations, approximate UTM coordinates for lower station boundaries, and topographic quadrangle names. All directions are from Phoenix, Arizona. All UTM coordinates are in Zone 12. Numbers in parentheses refer to stream, reach, and station codes, respectively.

Station	Travel route	UTM-Quad
San Pedro River Hereford (1-1-1)	I-10 south to State Hwy 90, south through Sierra Vista to	Hereford 7.5'
Lewis Springs (1-1-2)		Lewis Springs 7.5'
Charleston (1-1-3)		Fairbank 7.5'
Hughes Ranch (1-2-1)		Soza Canyon 7.5'
Soza Wash (1-2-2)		Soza Canyon 7.5'
Gage Station (1-2-3)		Redington 7.5'
Aravaipa Creek (1-3-1)		Lookout Mtn. 7.5'
Dudleyville (1-3-2)		Dudleyville 7.5'
Mouth (1-3-3)		Winkleman 7.5'
Gila River Coolidge Dam (2-1-1)		Coolidge Dam 7.5'
Hawk Spring Cyn (2-1-2)		Coolidge Dam 7.5'
Hook&Line Ranch (2-1-3)		Coolidge Dam 7.5'
Copper Canyon (2-2-1)		Christmas 7.5'
Dear Creek (2-2-2)		Christmas 7.5'
O'Carroll Canyon (2-2-3)		Christmas 7.5'
San Pedro River (2-3-1)		Winkleman 7.5'

Table 2. Continued.

Station	Travel route	UTM-Quad
Indian Camp Wash (2-3-2)		Kearney 7.5'
Riverside (2-3-3)		Kearney 7.5'
Diamond A Ranch (2-4-1)		Grayback 7.5'
Cochran (2-4-2)		North Butte 7.5'
Box O Wash (2-4-3)		North Butte 7.5'
<b>Salt River</b> Stewart Mtn. Dam (3-1-1)		Stewart Mtn. 7.5'
Blue Point RS (3-1-2)		Stewart Mtn. 7.5'
Granite Reef Dam (3-1-3)		Granite Reef Dam 7.5'

**HABITAT SAMPLING FORM**

STREAM NAME 1  Code   PAGE 45 OF 48

RACE NAME 2    QC: 48

STATION NAME 3    DATE NO 7 / 5 / 68

UTM: ZONE 12  41            EASTING: SCAL # 41 FRAMES

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HABITAT NO. 10   HABITAT TYPE 9    Code  HABITAT LENGTH (m)

HABITAT WIDTH (m)             MAX. DEPTH (cm)

DOMINANT SUBSTRATE 48             COMMENTS 41

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HABITAT NO.   HABITAT TYPE     Code  HABITAT LENGTH (m)

HABITAT WIDTH (m)             MAX. DEPTH (cm)

DOMINANT SUBSTRATE             COMMENTS

---

HABITAT NO.   HABITAT TYPE     Code  HABITAT LENGTH (m)

HABITAT WIDTH (m)             MAX. DEPTH (cm)

DOMINANT SUBSTRATE             COMMENTS

---

HABITAT NO.   HABITAT TYPE     Code  HABITAT LENGTH (m)

HABITAT WIDTH (m)             MAX. DEPTH (cm)

DOMINANT SUBSTRATE             COMMENTS

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HABITAT NO.   HABITAT TYPE     Code  HABITAT LENGTH (m)

HABITAT WIDTH (m)             MAX. DEPTH (cm)

DOMINANT SUBSTRATE             COMMENTS

PART OF COLLECTION

Figure 1. Habitat sampling form showing numbered locations of variables described in Table 1 and discussed in the text.



APPENDIX 3

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FOR FISH POPULATIONS IN SELECTED WATERS  
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U.S. BUREAU OF RECLAMATION  
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PHOENIX, ARIZONA 85068

OCTOBER 1996

STANDARD OPERATING PROCEDURES

**FIELD MANUAL**  
**CANALS**

LONG-TERM MONITORING PLAN FOR FISH POPULATIONS  
IN SELECTED WATERS OF THE GILA RIVER BASIN, ARIZONA

**INTRODUCTION**--This standard operating procedures manual, part of an overall quality control/quality assurance program in development for the *Long-Term Monitoring Plan for Fish Populations in Selected Waters of the Gila River Basin, Arizona* (Monitoring Plan), was produced to ensure that all field data are gathered according to standardized, repeatable methods. Due to the unique habitats and sampling challenges presented by canal monitoring, however, Reclamation recognizes that canal monitoring must be opportunistic, varying according to sampling accessibility to structural features that may concentrate fishes. Therefore, many compromises regarding standardization and repeatability may be necessary.

This manual describes specific steps to be taken during all field monitoring activities, and provides background information on objectives, justification, and sampling design. See the Monitoring Plan for further information. Reclamation intends this manual to be used in association with annual mandatory field training, and should be carried in the field at all times by data collectors for reference. It is likely that the manual will be updated periodically for clarity and to reflect changes to the Monitoring Plan that may become necessary over time. Reclamation will provide waterproof copies of the manual to all field investigators during annual training sessions, or upon request. In the methods descriptions below, arrows (→) denote field procedures that must be undertaken explicitly.

**OBJECTIVES**--Collect information on the status of fish populations and instream habitats at selected sampling sites to determine: 1) presence of species (species richness); 2) species relative abundance (assemblage structure); 3) species distributions; and 4) species annual reproductive success.

**SAMPLING CREWS**--A sampling crew of at least two, and preferably three or more, individuals is required for efficient collection of field monitoring data from canals (logistical difficulties in sampling the Central Arizona Project (CAP) canal in particular may require additional personnel). These individuals should be experienced in fish collection techniques and identification of the local fish fauna. It is vital that sampling crews be headed by an

individual with such proven field experience. The field crew leader must be present during all monitoring exercises.

**SAMPLING DESIGN**--CAP canal sampling reaches were delineated according to the established geopolitical divisions representing the Hayden-Rhodes, Fannin-McFarland, and Tucson aqueducts. Sampling of SRP canals primarily will be limited to the South Canal between Granite Reef Dam and the junction of the Tempe and Consolidated canals, and the Arizona Canal between Granite Reef Dam and Indian Bend Wash. Other areas of the SRP canal system should be opportunistically sampled where possible. The reach of concern in the FCG canal extends from Ashurst-Hayden Dam to the Pima Lateral feeder canal. See Table 2 for travel routes to canals (to be completed following this field season).

Due to logistical difficulties of sampling the deep, high current-velocity habitats characteristic of the CAP aqueduct, CAP canal stations are located at structural features that facilitate sampling (pumping plant forebays). Because annual dry-up procedures vary from year to year on the SRP canals, no fixed sampling stations are established there except between the electrical fish barriers and Granite Reef Dam on the Arizona and South canals. For this reason, sampling below the electrical fish barriers in the SRP canals will be opportunistic, varying according to sampling accessibility to structural features that may concentrate fishes. FCG canal sampling will also follow this pattern (no fixed sampling stations). Precise descriptions of sampling sites must be recorded by canal investigators.

**PERMITS**--Valid State and Federal collecting permits must be in possession of sampling crews when performing monitoring. The incidental take statement in the Gila River Basin BO serves as Reclamation's permit for take of federally-protected species, and Reclamation will request that subcontractors who do not possess their own Federal permits be designated as subpermittees under Federal permit provisions. Subcontractors will be responsible for obtaining their own State collecting permits.

**FISH COLLECTION FORM**--All mandatory data collections must be recorded in pencil on the fish collection forms provided. This will ensure that all required information is recorded and compatible with the database structure. Master copies of field forms (provided) should be photocopied on rite-in-the-rain paper or a similar waterproof bond for use in the field. The fish collection form quantifies gear types, sampling effort, and species abundance data.

Canal sampling will not require use of the habitat sampling form. Most canals are concrete-lined, and thus habitats are not expected to change except as required by structural

modification. Also, since canal habitats have not been formally classified, and sampling in canals is necessarily opportunistic, there seems little utility in attempting to monitor changes in canal habitat or in quantifying fish populations associated with particular canal habitats.

- The fish collection form includes stream, reach, and station names (numerically coded for data entry; see Table 1 for complete descriptions, and Figure 1), sampling date and time, a yes/no quantitative sample field, and gear type as header variables. All of these variables must be filled in on each form (codes can be recorded at a later time if the text fields are completed properly while in the field). For the SRP and FCG canals that have no formal sampling stations, the station name code field should be recorded with a vehicle or map mileage from the upper boundary of the canal reach (e.g., miles below Ashurst-Hayden Dam, or miles below South Canal electrical fish barrier); local landmark names should be entered in the text portion of the station name field. There is no requirement to type canal habitats, and thus the habitat type and habitat number fields need not be filled in. Although recording of gear type effort is mandatory (see below), the quantitative sample field should always be entered with an "N" (denoting a qualitative sample) to differentiate the qualitative nature of canal sampling compared with the more structured, quantitative sampling conducted in streams. If continuation forms are needed to complete recording of data at a particular site, they must be tracked in the upper right-hand corner of the data sheets. The field crew leader should record his/her initials in the QC field of each form following review and assurance that the data were filled in properly. It is intended that a separate fish collection form be used for each separate gear type and sampling site.
- If electrofishing, pulse rate, voltage, and amperage must be recorded, and conductivity and temperature readings are also required to determine electrical power output (wattage). Record the number of seconds shocked at each sampling site to quantify effort, but the percentage habitat sampled field need not be filled in.
- If seines or dip nets are deployed, recording of mesh size and length and width (depth) of the gear is required. Effort shall be quantified by recording the number of seine hauls or dip net sweeps taken within the macrohabitat (standardize dip net sweeps to 1 m long sweeps). The percentage habitat sampled field need not be filled in.

- Data unique to entrapment and entanglement gears that must be recorded include mesh size and net length and width (depth), with effort quantified in hours soaked or deployed (to the nearest 1/10th hour).
- Should sampling by angling or trot line be undertaken, bait type (Table 1) should be recorded, and effort should be identified as the number of hooks and hours (to nearest 1/10th) fished.
- Captured fishes from a single-gear sample from a site should be kept alive in buckets of water or holding nets until ready for processing. Fishes should be sorted to species, then sorted to age class, and enumerated. Counts for each species and age class should be recorded on the fish collection form for that macrohabitat and gear. Data that must be recorded from captured fishes include a four-letter code for species, consisting of the first two letters of the generic name and the first two letters of the specific name, an age category designation (age-0 or young-of-year, and older, age-1+ fish), and the number of fish enumerated for each species and age collected by a particular sampling gear within each macrohabitat (Table 1). It is mandatory that the number of each species/age class preserved for voucher be identified in the voucher field (see below). Optional variables such as fish length, weight, sex, reproductive condition, number and kind of external parasites, external anomalies, and other notes should be recorded in the comments field.

**VOUCHER COLLECTIONS**--Several (3+) specimens of each permitted species encountered at each sampling station or reach should be preserved for museum vouchers, when possible. Quality photo-documentation of species not permitted for take should be made. Vouchers will provide scientific credibility to the monitoring project, ensure the accuracy of species identifications in the field, and scientifically document species occurrence and distribution.

- Voucher specimens should be preserved in 10% formalin immediately following recording of pertinent field data. If specimen body depths are greater than approximately 3 cm (1 1/4 in), specimens should be cut along the right, lower body wall or injected with 10% formalin into the peritoneal cavity and major muscle masses to ensure adequate tissue fixation. Specimens should be retained in labeled, leakproof plastic jars or buckets and submitted to Reclamation, who will deposit them at the ASU Collection of Fishes. Reclamation will provide rite-in-the-rain collection labels to investigators to ensure that taxonomic identification (if possible), date, time, and method of collection, locality, number of specimens, and

collector name(s) are recorded for each sample. The number of each species preserved at each site must be recorded on the fish collection form in the voucher field.

**QUALITY CONTROL**--Prior to leaving a sampling station or site, the field crew leader should review all data sheets used at the site to ensure that all appropriate fields, including data codes, have been filled in properly, and that there are no missing data. The crew leader should then enter his/her initials in the QC field.

**FIELD NOTES**--An important aspect of data sampling is recording of field notes. Field forms do not allow the type of narrative description of sampling site conditions, sampling problems, or other observational data that may be important to document sampling procedures or physical conditions at a particular site. Submission of field notes to Reclamation is mandatory.

**STEPWISE MONITORING PROCEDURES**--The following itemization describes the recommended ordered procedures, in abbreviated form, for conducting monitoring at a canal site:

- 1) Record header information on the fish collection form
- 2) Begin sampling, collecting all fish possible
- 3) Store fishes alive in a bucket filled with canal water or in holding nets
- 4) Sort and enumerate fishes according to species and age class, and record on the appropriate fish collection form
- 5) Select specimens of each species to be preserved for voucher, store in container with 10% formalin and a completed collection tag, and record the number preserved on the appropriate fish collection form
- 6) Return remaining fishes alive to canal to an area that will not be resampled
- 7) Record gear information and sampling effort on the appropriate fish collection form
- 8) If the sample is considered inadequate for the canal area just sampled, resample with different gear type(s), repeating steps 1-7 as appropriate
- 9) Review and correct all data sheets for omissions, legibility, and obvious mistakes, and record initials in the QC field for each form
- 10) Record field notes for the sampling station or reach site, and proceed to the next station
- 11) Proceed to the next sampling area, and repeat steps 1-10 for each until the reach or station is adequately sampled

**Table 1.** Descriptions of variables and their codes to be entered on the Fish Collection Form. Location numbers refer to fields of the Fish Collection Forms shown in Figure 1.

Location	Description	Codes
1	Name of stream	1=San Pedro River 2=Gila River 3=Salt River 4=CAP Canal 5=SRP South Canal 6=SRP Arizona Canal 7=FCG Canal
2	Name of reach (see Table 2 for site names)	1=upstream-most reach 2=second downstream reach 3=third downstream reach 4=fourth downstream reach
3	Name of station (see Table 2 for site names)	1=Upper (fixed) 2=Middle (fixed) 3=Lower (fixed) various to denote mileage below SRP or FCG canal reach origin
4	Month sample taken or begun	01-12
5	Day sample taken or begun	01-31
6	Year sample taken or begun	00-99
7	Hour (military time) sample taken or begun	00-23
8	Minute sample taken or begun	00-59
9	Name of macrohabitat type	No entry required for canal sampling
10	Number of macrohabitat number	No entry required for canal sampling
11	Quantitative (effort recorded) or qualitative (effort not recorded) sample	N=No for canal sampling

Table 1. Continued.

Location	Description	Codes
12	Name of gear type	Entrapment/Entanglement: 1=gill net 2=trammel net 3=hoop net 4=fyke net 5=trap net 6=minnow trap 7=shock/gill net 8=shock/trammel net 9=experimental gill net Seining: 10=straight seine 11=bag seine 12=kick seine 13=dip net Angling: 14=spincast 15=fly rod 16=dropline 17=trotline Electrofishing: 18=backpack shocker 19=boat shocker 20=bank shocker Miscellaneous 25=trammel net/drifted 26=gill net/drifted
13	Electroshocker pulse rate setting (pulses per second)	
14	Electroshocker voltage setting	
15	Electroshocker electrical output; calculated from formula of Burkhardt and Gutreuter (1995)	
16	Electroshocker amperage setting	
17	Conductivity ( $\mu\text{S}/\text{cm}$ ) of water; required for determination of electroshocker output and water quality	
18	Temperature ( $^{\circ}\text{C}$ ) of water; required for determination of electroshocker output and water quality	

Table 1. Continued.

Location	Description	Codes
19	Electroshocker effort in seconds fished	
20	Areal percent of habitat type sampled by electrofishing	No entry required for canal sampling
21	Mesh size (in) (bar measure) of seine or dip net	
22	Length (ft) of seine or dip net	
23	Width (height or depth) (ft) of seine or dip net	
24	Number of seine hauls or dip net sweeps taken within the area	
25	Areal percent of habitat type sampled by seine or dip net	No entry required for canal sampling
26	Mesh size (in) (bar measure) of entanglement/entrapment gears	
27	Length (ft) of entanglement/entrapment gears	
28	Width (height or depth) (ft) of entanglement/entrapment gears	
29	Effort (hr) fished (soaked) by entanglement/entrapment gears	
30	Bait type code for angling gears	1=artificial lure 2=live bait 3=gabrage (corn, cut bait, etc.) 4=stink bait
31	Number of hooks per line for angling gears	

Table 1. Continued.

Location	Description	Codes
32	Effort (hr) fished (soaked) by angling gears	
33	Species name code, where first two letters of genus is followed by first two letters of species	Examples: CYLU denotes <i>Cyprinella lutrensis</i> ; AGCH denotes <i>Agosia chrysogaster</i> ; "????" indicates species unknown, and specimen should be preserved for voucher; HYBR denotes a hybrid (identify in comments if possible and preserve); "0000" indicates no fish were caught
34	Categorization to young-of-year or older age classes	0=young-of-year (including larvae) 1=age-1 or older
35	Number of fish represented in record; if length and other data taken, should always equal 1; if more than one of a species was captured but individual data not taken, record the number; if sampling effort did not capture fish, should equal 0	
36	Number of specimens preserved for voucher	
37	Narrative information not recordable in other areas of the field form, such as length, weight, presence of external parasites, spinal or cranial deformity, ulceration, etc.	
44	Narrative information not recordable in other areas of the field form, such as unusual cover attributes, bank features, etc.	

Table 1. Continued.

Location	Description	Codes
45	Current page number of total if continuation sheets are required to complete data recording for a site	
46	Initials of field crew leader certifying that the data sheet was completed properly	

