THE GUADALUPE-SAN ANTONIO-NUECES RIVER BASIN PROJECT

PHASE I:
Review of Existing Biological Data

By

Willard C. Young
Bobby G. Whiteside
Glenn Longley
Neil E. Carter

Aquatic Station
Southwest Texas State University

Final Report

to

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Collection Records of Fishes

From the Guadalupe River System there were recorded 9 orders, 18 families, 43 genera, and 85 species. Of these, 9 orders, 17 families, 41 genera, and 75 species appear to be valid (Table 1). Six orders, 15 families, 38 genera, and 72 species were recorded for the San Antonio River System. Of these, 6 orders, 17 families, 37 genera, and 64 species appear to be valid (Table 1). For the Nueces River System, 9 orders, 26 families, 52 genera, and 89 species were recorded. Of these, 9 orders, 25 families, 51 genera, and 76 species appear to be valid (Table 1).

A composite checklist of fish species recorded in the entire study area, including the Nueces, Guadalupe, and San Antonio river systems is presented in Table 1. The sources of information on which the checklist is based are given for each river system at the end of the table.

Tables 2, 3, and 4 give a checklist of fishes in each of the major streams and lakes of each of the three river systems. A list of sources of data for each stream or lake is given at the end of each table.

Species distributions in each of the three river systems are given for each species for which sufficient information was available (Figs. 5-93). Only data which contained sufficient information to pinpoint the collection localities were plotted. Figures 2, 3, and 4 in the introduction will allow more accurate determination of collection localities of the species on the distribution maps.

Table 1. Composite checklist of fish species from the Nueces (NRS), Guadalupe (GRS), and San Antonio river systems (SARS). Family names are given in all capitals and the scientific name of each species is followed by the common name in parenthesis. X indicates that the species was recorded from that river system. X* indicates that it is questionable if the species identification was correct or if the correct collection location was given. # indicates that the species was not recorded from that river system but the river system is within the recorded range of the species.

Fish	Stream System		
	GRS	SARS	NRS
LEPISOSTEIDAE			
Lepisosteus spatula (alligator gar)	X	X	X
Lepisosteus platostomus (shortnose gar)			X*
Lepisosteus oculatus (spotted gar)	X	X	X
Lepisosteus osseus (longnose gar)	X	X	X
ELOPIDAE			
Elops saurus (ladyfish)	#	#	X
CLUPEIDAE			
Alosa chrysochloris (skipjack herring)	#	#	#
Brevoortia gunteri (finescale menhaden)			X
Brevoortia patronus (Gulf menhaden)			X
Dorosoma petenense (threadfin shad)	X	#	X
Dorosoma cepedianum (gizzard shad)	X	X	X
ENGRAULIDAE			
Anchoa mitchilli (bay anchovy)			X
Anchoa hepsetus (striped anchovy)			X*
SALMONIDAE			
Salmo gairdneri (rainbow trout)	X		
CHARACIDAE			
Astyanax mexicanus (Mexican tetra)	X	X	X
CYPRINIDAE			
Cyprinus carpio (carp)	X	X	X
Carassius auratus (goldfish)	X	X	#
Notemigonus crysoleucas (golden shiner)	X	X	X
Opsopoeodus emiliae (pugnose minnow)	X	X	X
Hybopsis aestivalis (speckled chub)	X	X	#
Notropis atherinoides (emerald shiner)	X*		

Table 1. (Continued)

Fish	Stream System		
	GRS	SARS	NRS
Notropis oxyrhynchus (sharpnose shiner)	X*		
Notropis amabilis (Texas shiner)	X	X	X
Notropis shumardi (silverband shiner)	X		
Notropis chalybaeus (ironcolor shiner)		X*	
Notropis texanus (weed shiner)	X	X	X
Notropis simus (bluntnose shiner)			X*
Notropis blennius (river shiner)		X*	
Notropis amnis (pallid shiner)	X	X	
Notropis venustus (blacktail shiner)	X	X	X
Notropis lutrensis (red shiner)	X	X	X
Notropis proserpinus (proserpine shiner)		X*	
Notropis stramineus (sand shiner)	X	X	X
Notropis atrocaudalis (blackspot shiner)			X*
Notropis volucellus (mimic shiner)	X	X	X*
Notropis buchanani (ghost shiner)	X	X	X
Notropis boops (bigeye shiner)	X*		
Dionda episcopa (roundnose minnow)	X	X	X
Hybognathus nuchalis (silvery minnow)	#		
Hybognathus placitus (plains minnow)	#	#	#
Pimephales vigilax (bullhead minnow)	X	X	X
Pimpehales promelas (fathead minnow)	X	X	X
Campostoma anomalum (stoneroller)	X	X	X
CATOSTOMIDAE			
Cycleptus elongatus (blue sucker)	#	#	#
Ictiobus bubalus (smallmouth buffalo)	X	X	X
Carpiodes carpio (river carpsucker)	X	X	X
Moxostoma congestum (grey redhorse)	X	X	X
Moxostoma erythrurum (golden redhorse)	X*		
Moxostoma duguesnii (black redhorse)	X*		
Minytrema melanops (spotted sucker)	X		
Erimyzon sucetta (lake chubsucker)	X	X	
Erimyzon oblongus (creek chubsucker)	X*		
AMEIURIDAE (=ICTALURIDAE)			
Ictalurus punctatus (channel catfish)	X	X	X
Ictalurus furcatus (blue catfish)	X	X	X
Ictalurus melas (black bullhead)	X	X	X
Ictalurus natalis (yellow bullhead)	X	X	X
Ictalurus nebulosus (brown bullhead)	X*	X*	X*
Trogloglanis pattersoni (toothless blindcat)		X	
Pylodictis olivaris (flathead catfish)	X	X	X
Satan eurystomus (widemouth blindcat)		X	
Noturus gyrinus (tadpole madtom)	X	X	X
Noturus nocturnus (freckled madtom)		X*	

Table 1. (Continued)

Fish	Stream System		
	GRS	SARS	NRS
ANGUILLIDAE			
Anguilla rostrata (American eel)	X	#	X
BELONIDAE			
Strongylura marina (Atlantic needlefish)			X
CYPRINODONTIDAE			
Lucania parva (rainwater killifish)		X	
Fundulus grandis (gulf killifish)			X
Zygonectes notatus (blackstripe topminnow)	X	X	
Zygonectes olivaceus (blackspotted topminnow)	X*		
Cyprinodon variegatus (sheepshead minnow)	X	#	X
POECILIDAE			
Gambusia geiseri (largespring gambusia)	X		
Gambusia gaigei (Big Ben gambusia)			X*
Gambusia affinis (mosquitofish)	X	X	X
Gambusia georgei (San Marcos gambusia)	X		
Poecilia latipinna (sailfin molly)	X	X	X
Poecilia formosa (amazon molly)	X	X	X
ATHERINIDAE			
Menidia audens (Mississippi silverside)		X*	
Menidia beryllina (tidewater silverside)	X	X	X
Labidesthes sicculus (brook silverside)	X*		
PERCICHTHYIDAE			
Morone chrysops (white bass)	X	X	X
CENTRARCHIDAE			
Micropterus dolomieui (smallmouth bass)	X		
Micropterus punctulatus (spotted bass)	X	X	
Micropterus treculi (Guadalupe bass)	X	X	X
Micropterus salmoides (largemouth bass)	X	X	X
Chaenobryttus gulosus (warmouth)	X	X	X
Chaenobryttus cyanellus (green sunfish)	X	X	X
Lepomis symmetricus (bantam sunfish)		X*	
Lepomis punctatus (spotted sunfish)	X	X	X
Lepomis microlophus (redear sunfish)	X	X	X
Lepomis macrochirus (bluegill)	X	X	X
Lepomis humilis (orangespotted sunfish)	X		
Lepomis auritus (redbreast sunfish)	X	X	X
Lepomis megalotis (longear sunfish)	X	X	X
Lepomis marginatus (dollar sunfish)	X*		

Table 1. (Continued)

Fish	Stream System		
	GRS	SARS	NRS
Enneacanthus obesus (banded sunfish)		X*	
Ambloplites rupestris (rock bass)	X		X
Pomoxis annularis (white crappie)	X	X	X
Pomoxis nigromaculatus (black crappie)	X	X	X
PERCIDAE			
Hadropterus scierus (dusky darter)	X	#	
Hadropterus shumardi (river darter)	X	X	
Percina caprodes (logperch)	X	X	
Percina macrolepida (big scale logperch)	X		
Etheostoma chlorosomum (bluntnose darter)	X	X	
Etheostoma gracile (slough darter)	X	X	X
Etheostoma fusiforme (swamp darter)			X*
Etheostoma spectabile (orangethroat darter)	X	X	X*
Etheostoma lepidum (greenthroat darter)	X	X	X
Etheostoma grahami (Rio Grande darter)			X*
Etheostoma fonticola (fountain darter)	X		X*
Etheostoma microperca (least darter)			X*
CARANGIDAE			
Oligoplites saurus (leatherjacket)			X
GERRIDAE			
Eucinostomus argenteus (spotfin mojarra)			X
Eucinostomus lefroyi (mottled mojarra)			X
Gerres cinereus (yellowfin mojarra)			X
POMADASYIDAE			
Pomadasys crocro (burro grunt)			X*
SCIAENIDAE			
Aplodinotus grunniens (freshwater drum)	#	X	X
Bairdiella chrysura (silver perch)			X
Scianenops ocellata (red drum)			X
Leiostomus xanthurus (spot)			X
Micropogon undulatus (Atlantic croaker)			X
Pogonias cromis (black drum)			X
Cynoscion nebulosus (spotted seatrout)			X
SPARIDAE			
Lagodon rhomboides (pinfish)			X
Archosargus probatocephalus (sheepshead)			X

Table 1. (Continued)

Fish	Stream System		
	GRS	SARS	NRS
CICHILIDAE			
Cichlasoma cyanoguttatum (Rio Grande perch)	X	X	X
Tilapia mossambica (Mozambique tilapia)	X	X	
MUGILIDAE			
Mugil cephalus (striped mullet)	X	X	X
Mugil curema (white mullet)	X	X	X
GOBIIDAE			
Gobiomorus dormitator (bigmouth sleeper)	#	#	X
Gobiosoma bosci (naked goby)	X*		X
BOTHIDAE			
Paralichthys lethostigma (southern flounder)			X
SOLEIDAE			
Trinectes maculatus (hogchoker)	X		X
Achirus lineatus (lined sole)			X

Sources of data:

Guadalupe River System - 1, 2, 11, 20, 21, 26, 28, 43, 47, 51, 81, 83, 86, 87, 88, 89, 90, 92, 93, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 119, 156, 158, 159, 182, 192, 193, 195, 199, 202, 203, 210, 213, 220, 223, 224, 227, 236, 243, 253, 257, 260, 261, 262, 265, 266, 267, 269, 285, 295, 298, 299, 301, 302, 304, 305, 306, 307, 308, 309, 312, 314, 315, 316, 317.

San Antonio River System - 11, 51, 83, 88, 119, 168, 169, 170, 171, 177, 178, 187, 190, 194, 201, 208, 219, 221, 223, 227, 228, 232, 233, 236, 237, 240, 246, 247, 248, 263, 265, 268, 278, 295, 296, 299.

Table 3. Checklist of the fishes found in the major streams and lakes of the San Antonio River System. X indicates that the species was recorded from that locality. X* indicates that it is questionable if the species identification was correct or if the correct collection location was given.

Species	Stream or Lake			
	San Antonio River	Medina River	Cibolo Creek	Medina Lake
Lepisosteus spatula	X	X		
Lepisosteus oculatus	X	X	X	
Lepisosteus osseus	X	X	X	X
Dorosoma cepedianum	X	X	X	X
Astyanax mexicanus	X	X	X	X
Cyprinus carpio	X	X	X	X
Notemigonus crysoleucas	X	X	X	X
Opsopoeodus emiliae	X	X	X	
Hybopsis aestivalis	X	X	X	
Notropis amabilis		X		
Notropis chalybaeus		X*		
Notropis texanus	X	X		
Notropis amnis	X			
Notropis venustus	X	X		X
Notropis lutrensis	X	X	X	X
Notropis proserpinus	X*		X*	
Notropis stramineus	X	X		
Notropis volucellus	X	X		
Notropis buchanani	X	X		X
Dionda episcopa		X	X	
Pimephales vigilax	X	X	X	X
Pimephales promelas	X			X
Gampostoma anomalum	X	X		X
Ictiobus bubalus	X	X	X	X
Carpiodes carpio	X	X	X	X
Moxostoma congestum	X	X	X	X
Erimyzon sucetta			X	
Ictalurus punctatus	X	X	X	X
Ictalurus furcatus	X			X
Ictalurus melas	X	X	X	X
Ictalurus natalis	X	X	X	X
Ictalurus nebulosus	X*			
Pylodictis olivaris	X	X	X	X
Noturus gyrinus	X			X
Noturus nocturnus	X*			
Lucania parva	X			
Zygonectes notatus	X	X	X	

Table 3. (Continued)

Species	Stream or Lake			
	San Antonio River	Medina River	Cibolo Creek	Medina Lake
Gambusia affinis	X	X	X	X
Poecilia latipinna	X	X	X	X
Poecilia formosa	X		X	
Menidia audens		X*		
Menidia beryllina	X			
Morone chrysops		X		X
Micropterus punctulatus		X		X
Micropterus treculi		X		
Micropterus salmoides	X	X	X	X
Chaenobryttus gulosus	X	X	X	X
Chaenobryttus cyanellus	X	X	X	X
Lepomis symmetricus				X*
Lepomis punctatus	X	X		X
Lepomis microlophus	X	X	X	X
Lepomis macrochirus	X	X	X	X
Lepomis auritus	X	X	X	X
Lepomis megalotis	X	X	X	X
Enneacanthus obesus			X*	
Pomoxis annularis	X	X	X	X
Pomoxis nigromaculatus		X		
Hadropterus shumardi	X		X	
Percina caprodes	X	X	X	X
Etheostoma chlorosomum	X			
Etheostoma gracile	X			
Etheostoma spectabile		X		
Etheostoma lepidum		X		
Aplodinotus grunniens	X			
Cichlasoma cyanoguttatum	X	X	X	X
Tilapia mossambica	X			
Mugil cephalus	X			
Mugil curema	X			

Sources of data:

San Antonio River - 51, 88, 119, 219, 228, 237, 246, 263, 296, 299.

Table 3. (Continued)

Medina River - 51, 83, 170, 227, 236, 240, 265, 295, 296.

Cibolo Creek - 51, 247, 278, 296, 299.

Medina Lake - 168, 169, 177, 178, 187, 190, 194, 201, 223, 232, 233, 240, 248, 265, 296.

Sources of information on which the distribution maps for each river system are based are as follows:

Guadalupe River System (Figs. 5 - 41) - 1, 2, 11, 26, 28, 43, 47, 81, 83, 97, 98, 99, 101, 103, 104, 106, 107, 108, 109, 119, 156, 158, 159, 182, 192, 193, 195, 199, 202, 203, 210, 213, 220, 223, 224, 227, 243, 253, 257, 260, 261, 262, 266, 267, 269, 270, 295, 298, 299, 301, 302, 304, 305, 306, 307, 308, 309, 312, 313, 314, 315, 316, 317;

San Antonio River System (Figs. 41 - 66) - 51, 83, 168, 169, 170, 171, 177, 178, 187, 190, 194, 201, 208, 221, 223, 227, 228, 232, 233, 236, 240, 247, 248, 265, 268, 278, 295, 296, 299;

Nueces River System (Figs. 66 - 93) - 51, 83, 84, 106, 159, 166, 174, 181, 183, 184, 185, 186, 191, 197, 202, 207, 217, 222, 223, 229, 232, 237, 240, 245, 246, 247, 254, 256, 263, 264, 268, 296, 297, 299, 303.

In several instances there are species names which occur on species checklists but not on species distribution maps. These are due to questionable identification or location records, or to the inclusion in checklists of species names taken from publications which give only general species distributional ranges that include all or some part of the drainage systems in the study area, but no precise locations. In addition, several fishes indicated in generalized distributional studies as having ranges that may extend into the study area are omitted

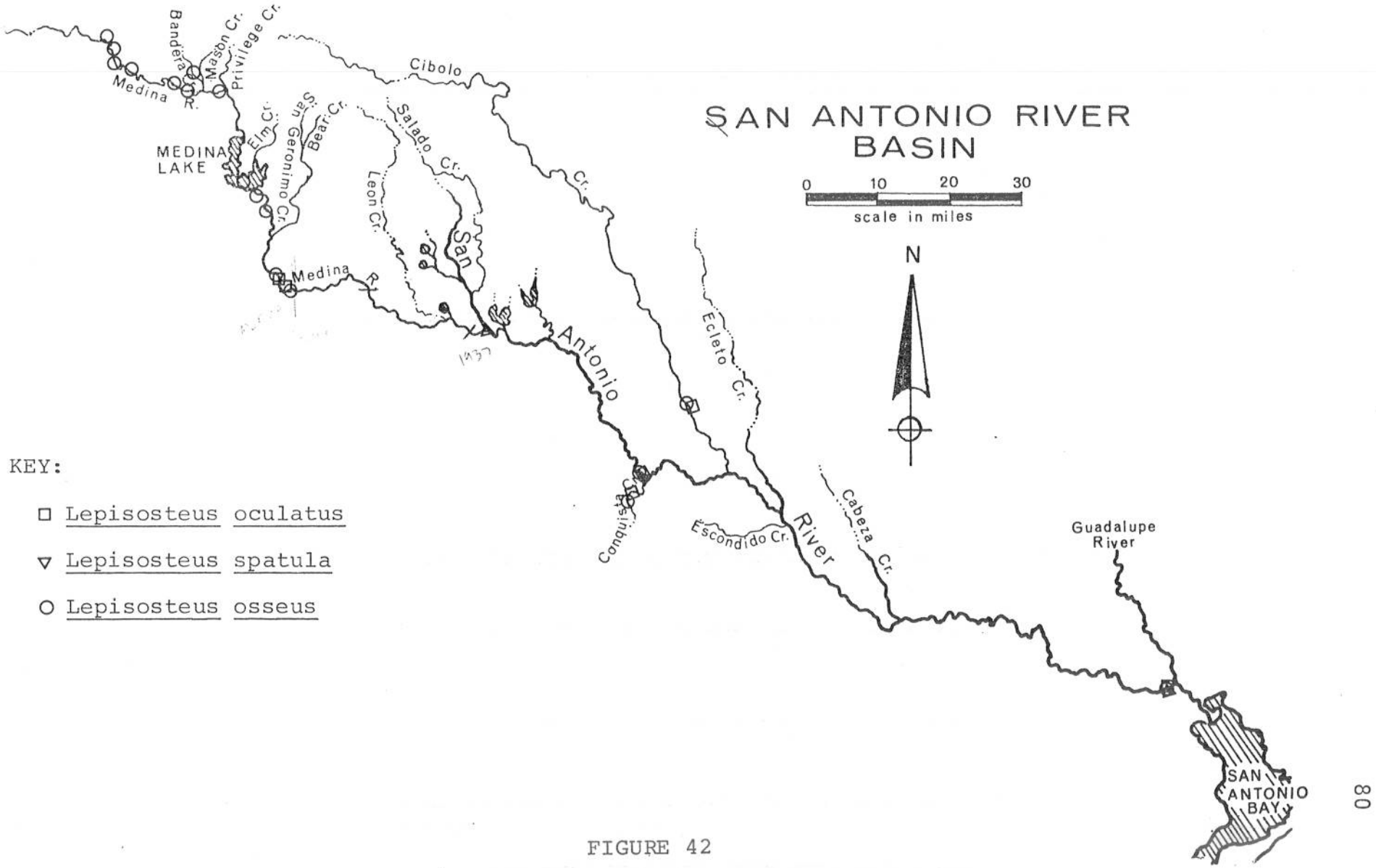
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
□ Lepisosteus oculatus
▽ Lepisosteus spatula
○ Lepisosteus osseus
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo Cr.
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
Medina R.
San Antonio River
Ecleto Cr.
Conquista Cr.
Escondido Cr.
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 42

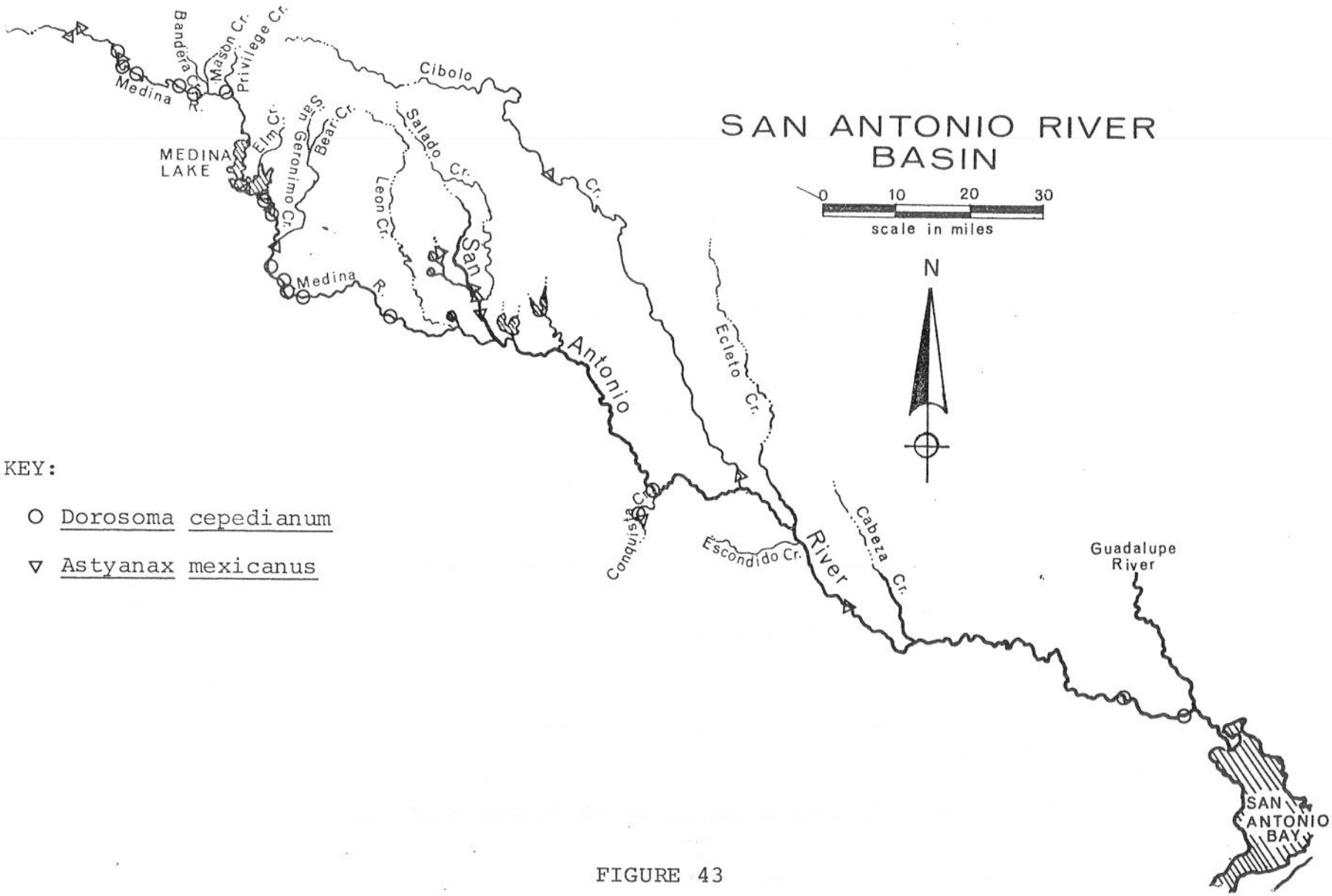
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
O Dorosoma cepedianum
▽ Astyanax mexicanus
Medina
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
Medina R.
San Antonio
Ecleto Cr.
Conquista Cr.
Escondido Cr.
River
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 43

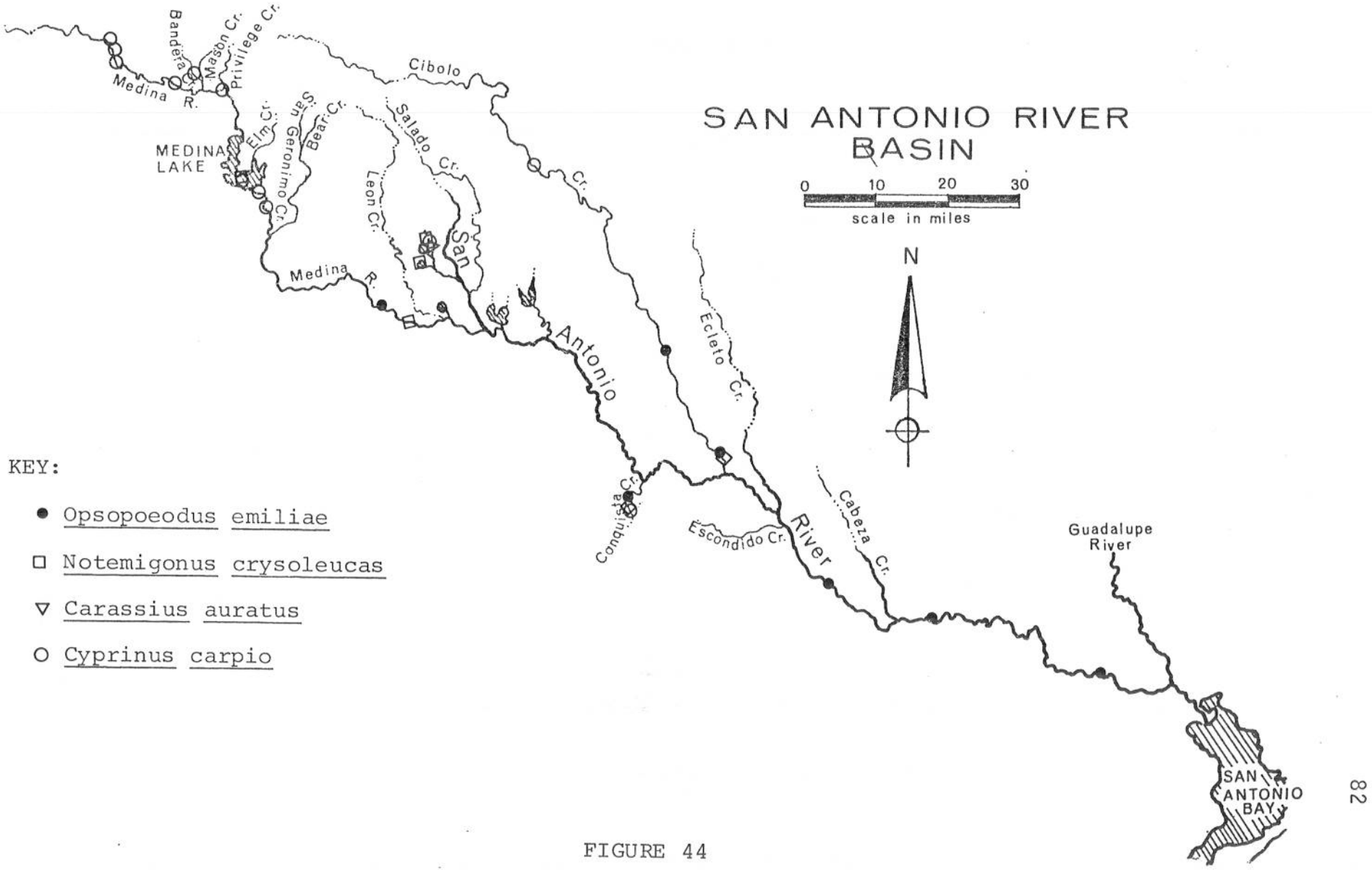
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
Medina R.
Bandera
Mason Cr.
Privilege Cr.
Cibolo
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
Medina R.
San Antonio
Cr.
Ecleto Cr.
Conquista Cr.
Escondido Cr.
River
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY
KEY:
● Opsopoeodus emiliae
□ Notemigonus crysoleucas
▽ Carassius auratus
○ Cyprinus carpio

FIGURE 44

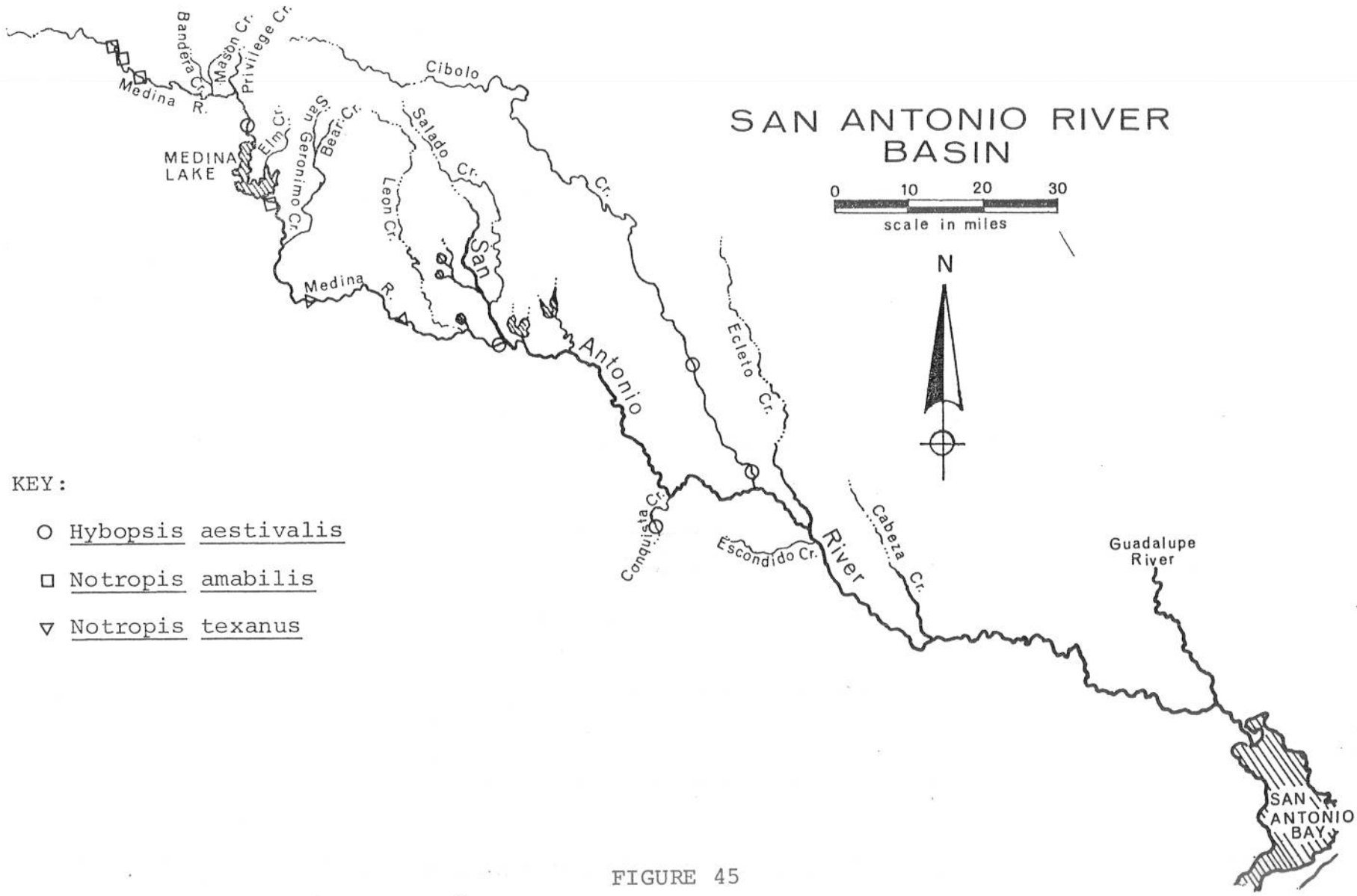
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
Hybopsis aestivalis
Notropis amabilis
Notropis texanus
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo Cr.
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
Medina R.
San Antonio River
Ecleto Cr.
Conquista Cr.
Escondido Cr.
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 45

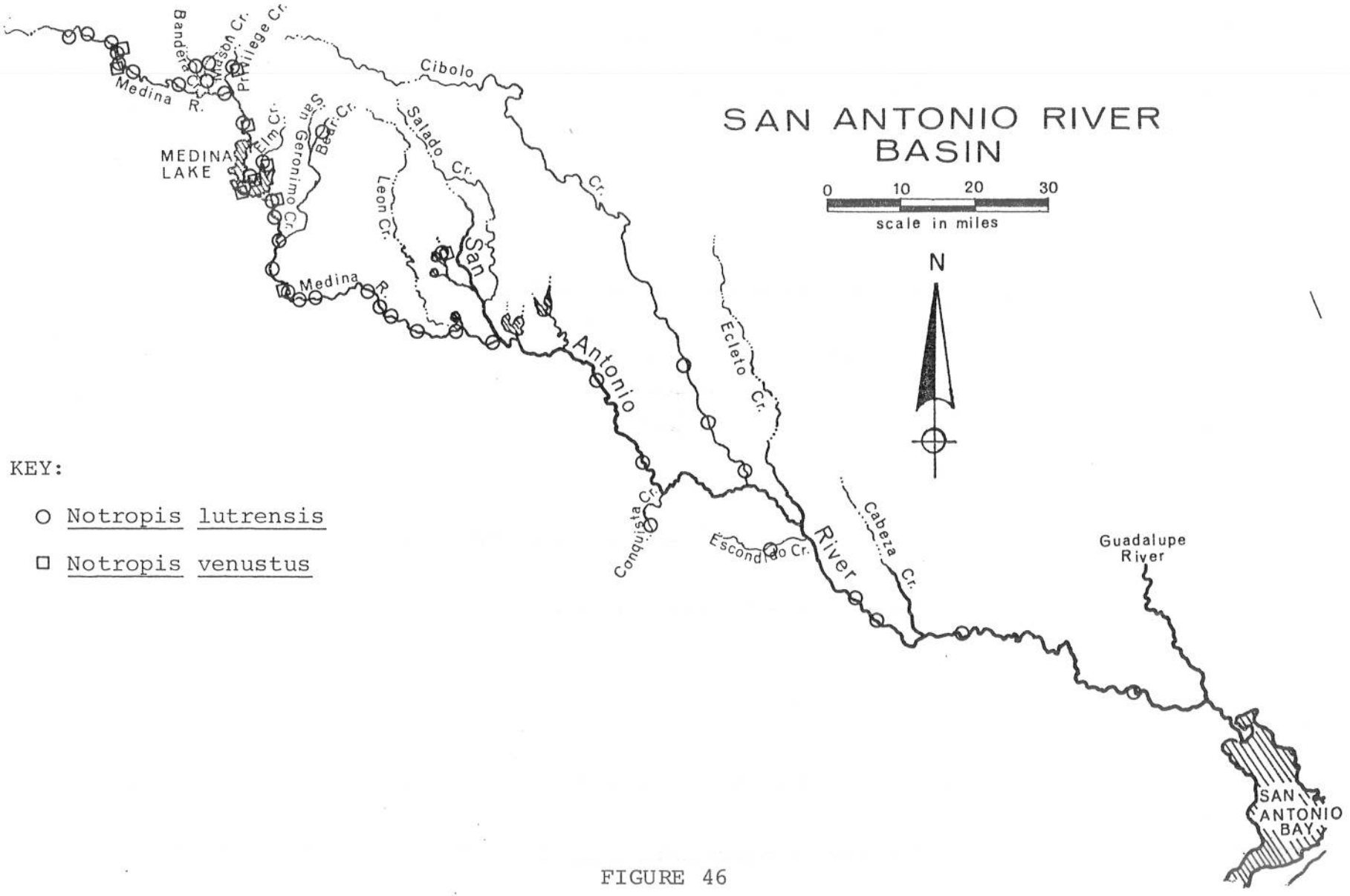
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
Notropis lutrensis
Notropis venustus
Medina R.
Bandera Cr.
Hanson Cr.
Privilege Cr.
Cibolo Cr.
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Leon Cr.
Salado Cr.
Medina R.
San Antonio River
Ecleto Cr.
Conquista Cr.
Escondido Cr.
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 46

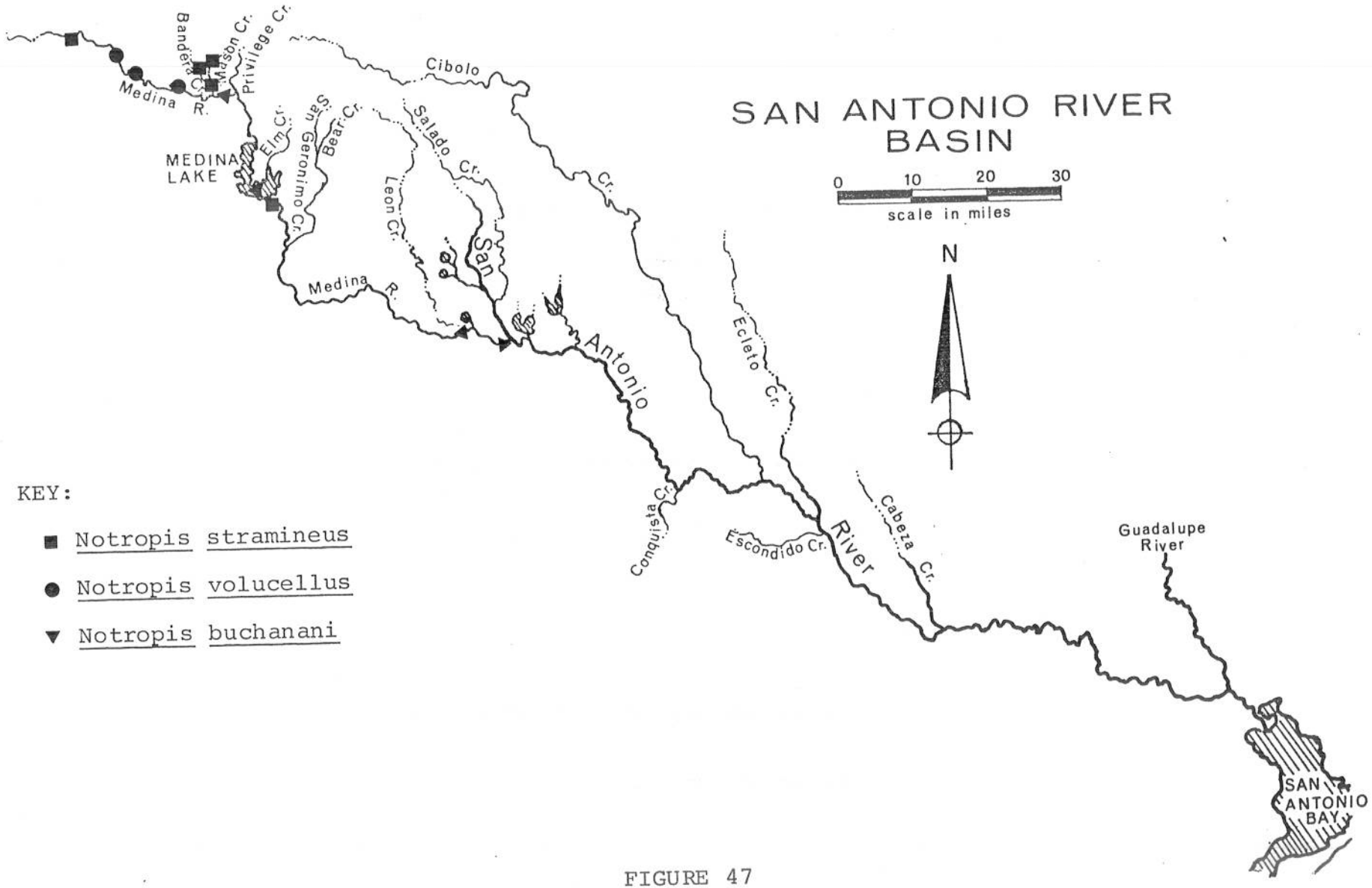
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
Notropis stramineus
Notropis volucellus
Notropis buchanani
Medina R.
Bandera Cr.
Hilson Cr.
Privilege Cr.
Cibolo
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
Medina R.
San Antonio
Ecleto Cr.
Conquista Cr.
Escondido Cr.
River
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 47

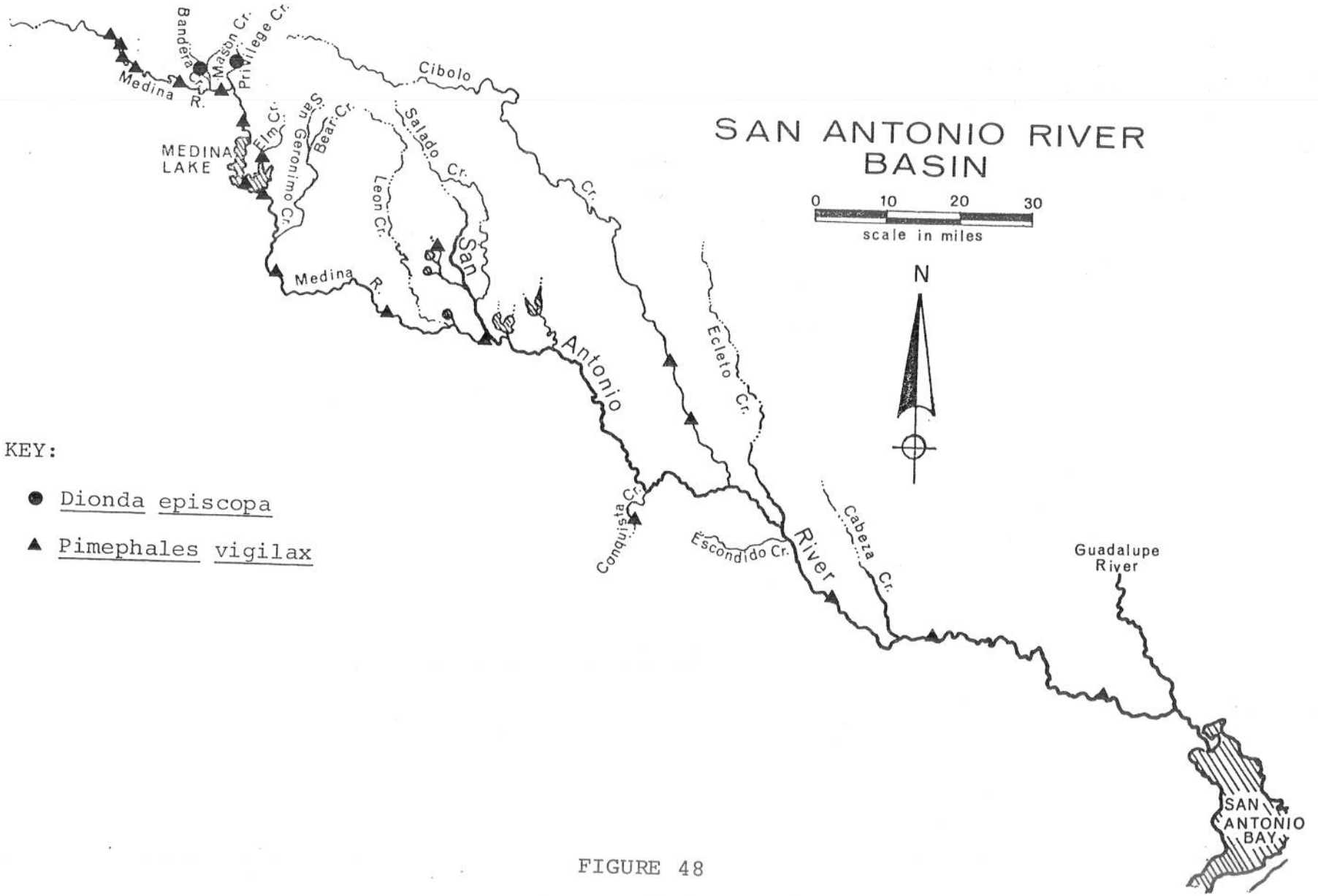
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
Dionda episcopa
Pimephales vigilax
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo Cr.
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
San Antonio River
Ecleto Cr.
Conquista Cr.
Escondido Cr.
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 48

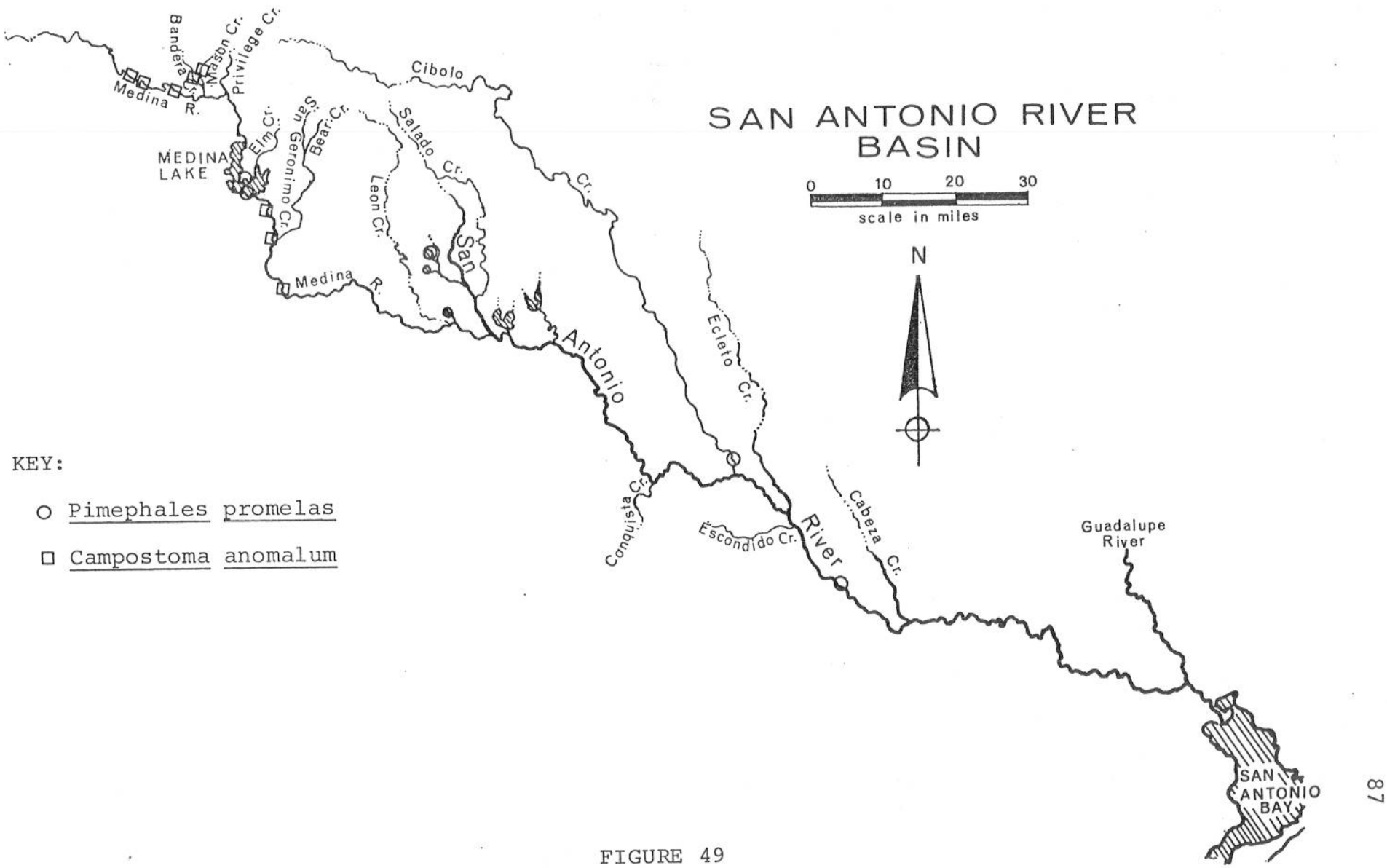
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
○ Pimephales promelas
□ Campostoma anomalum
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
Medina R.
San Antonio
Ecleto Cr.
Conquista Cr.
Escondido Cr.
River
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 49

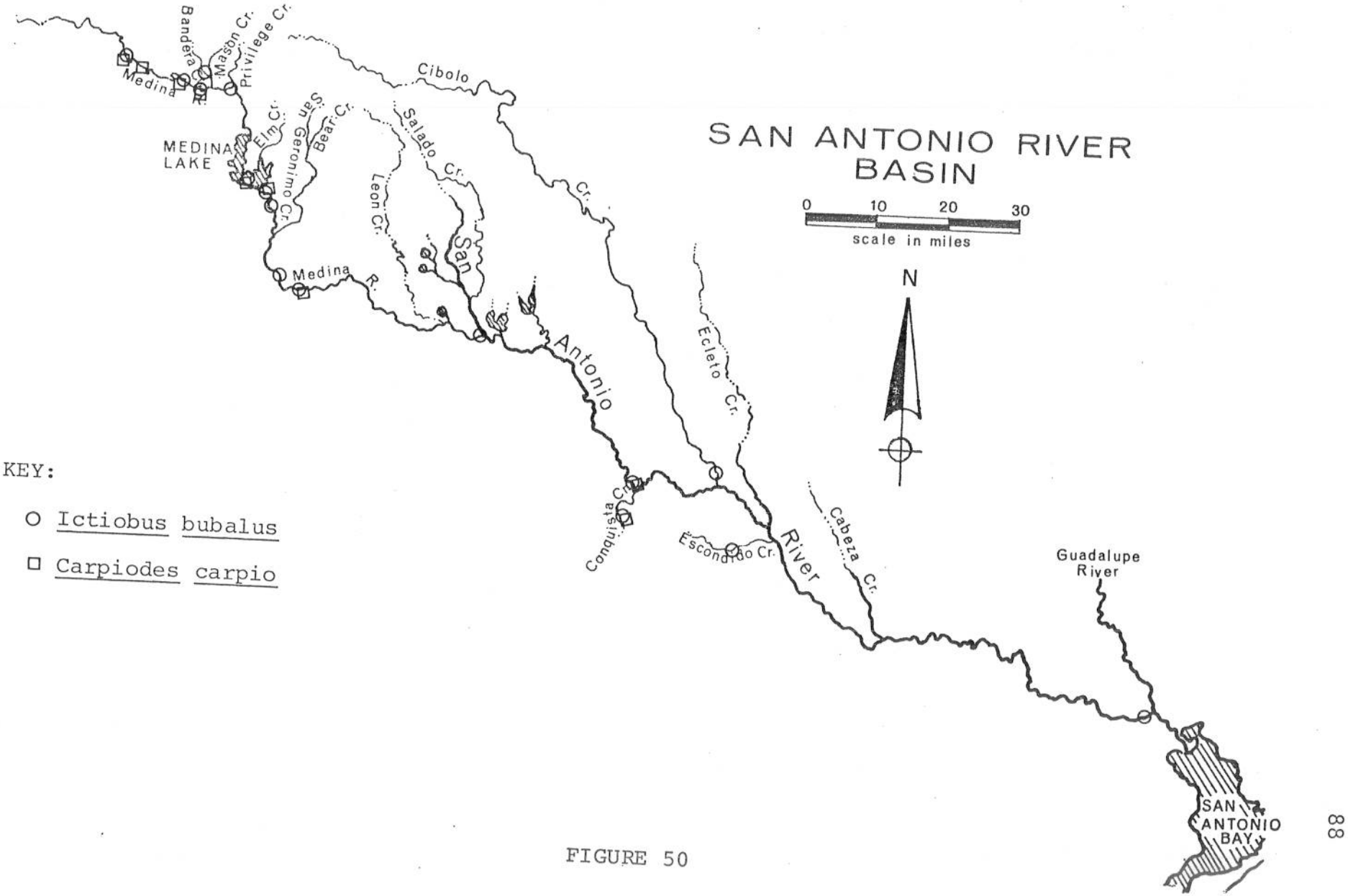
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
Ictiobus bubalus
Carpiodes carpio
Bandera
Medina
Mason Cr.
Privilege Cr.
Cibolo
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
Medina R.
San Antonio
Cr.
Ecleto Cr.
Escondido Cr.
River
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 50

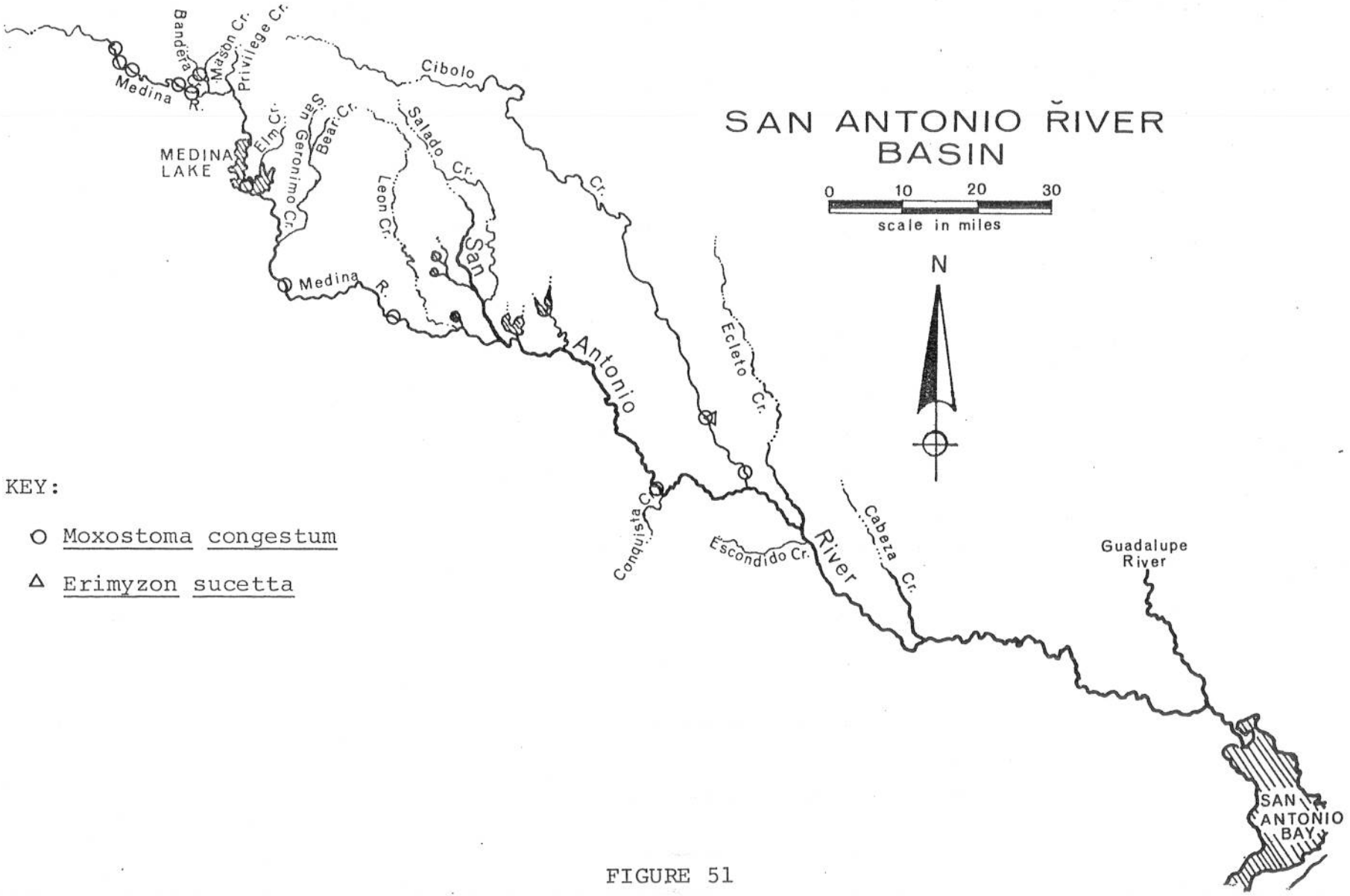
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
O Moxostoma congestum
Δ Erimyzon sucetta
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
San Antonio
Ecleto Cr.
Conquista Cr.
Escondido Cr.
River
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 51


SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
O Ictalurus furcatus
▼ Ictalurus punctatus
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo Cr.
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
San Antonio River
Medina R.
Conquista Cr.
Escondido Cr.
Ecleto Cr.
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 52

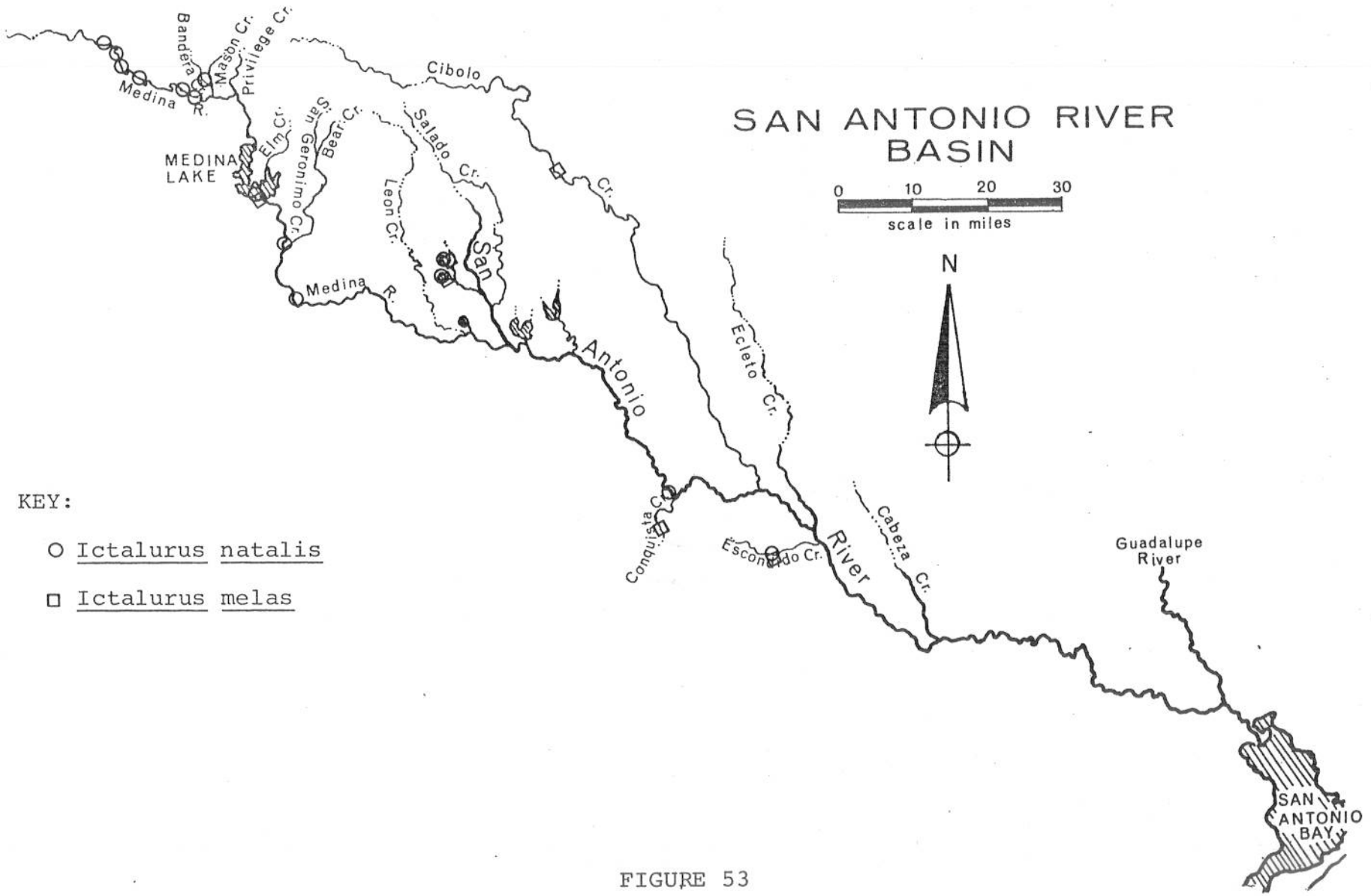
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
Ictalurus natalis
Ictalurus melas
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo
Cr.
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
Medina R.
San Antonio
Ecleto Cr.
Conquista Cr.
Escondido Cr.
River
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 53

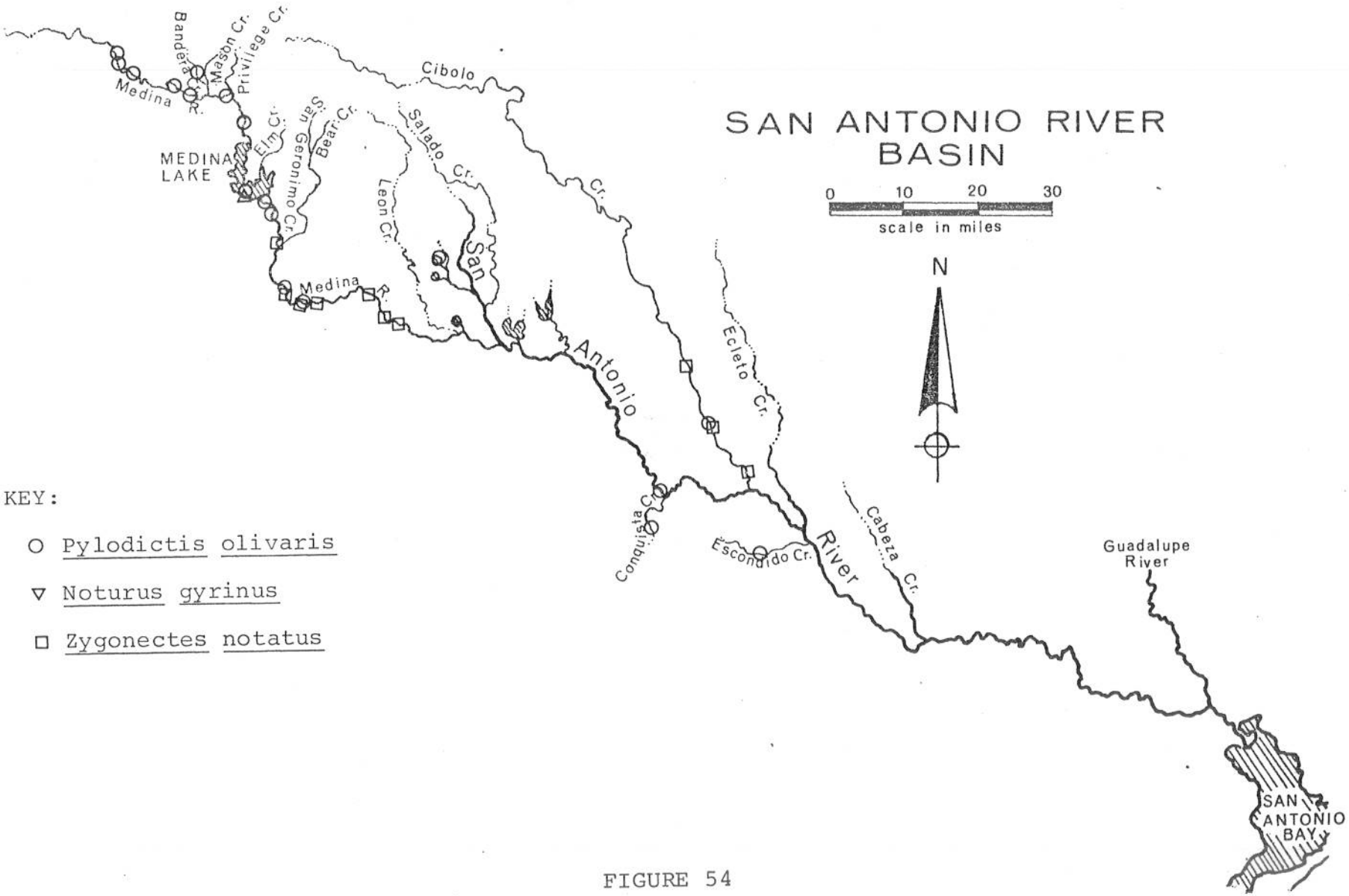
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
Pylodictis olivaris
Noturus gyrinus
Zygonectes notatus
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo Cr.
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
San Antonio River
Ecleto Cr.
Conquista Cr.
Escondido Cr.
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 54

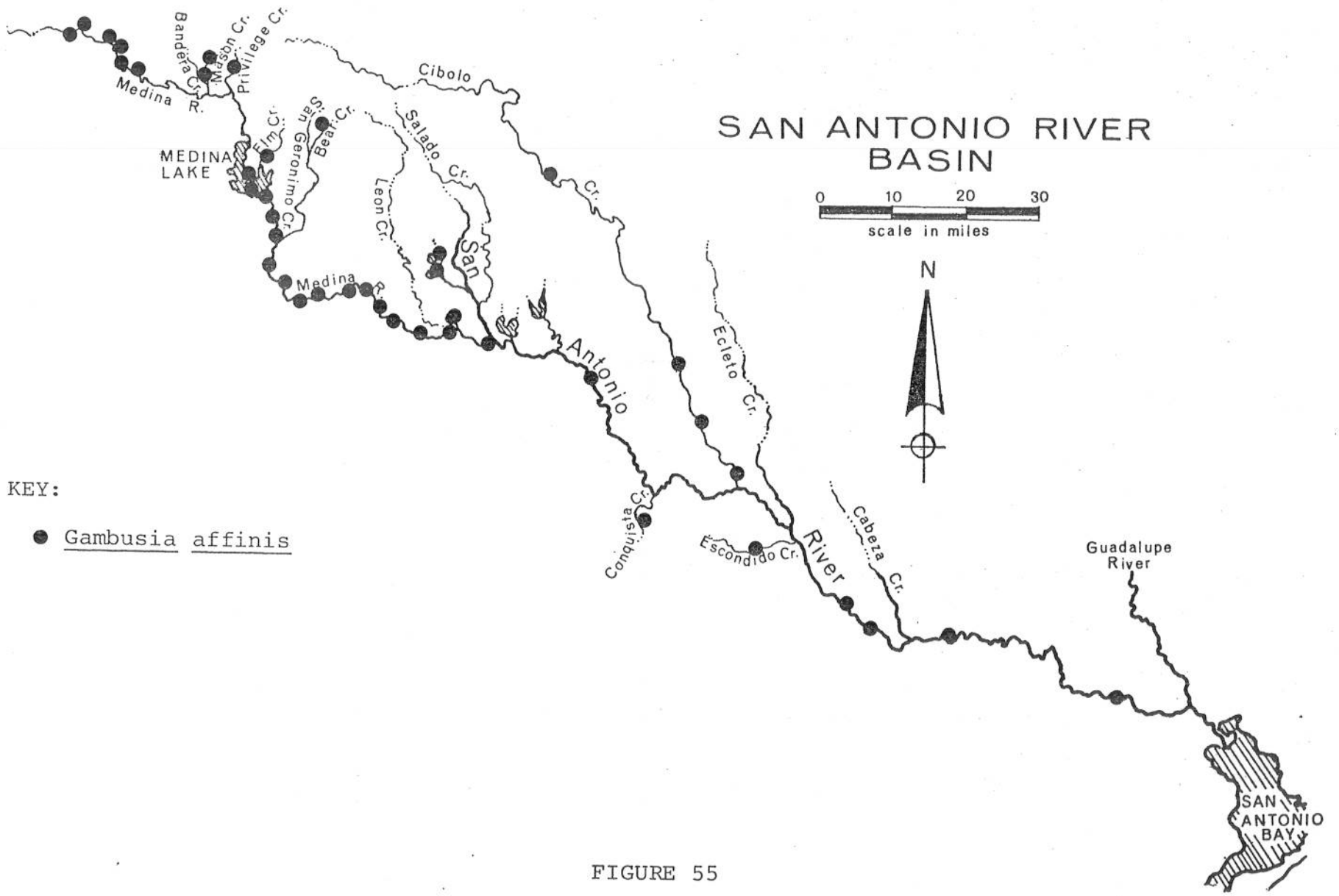
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
Gambusia affinis
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo
MEDINA LAKE
Elm Cr.
Geronimo Cr.
San
Bear Cr.
Salado Cr.
Leon Cr.
Medina
San Antonio
Cr.
Ecleto Cr.
Conquista Cr.
Escondido Cr.
River
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 55

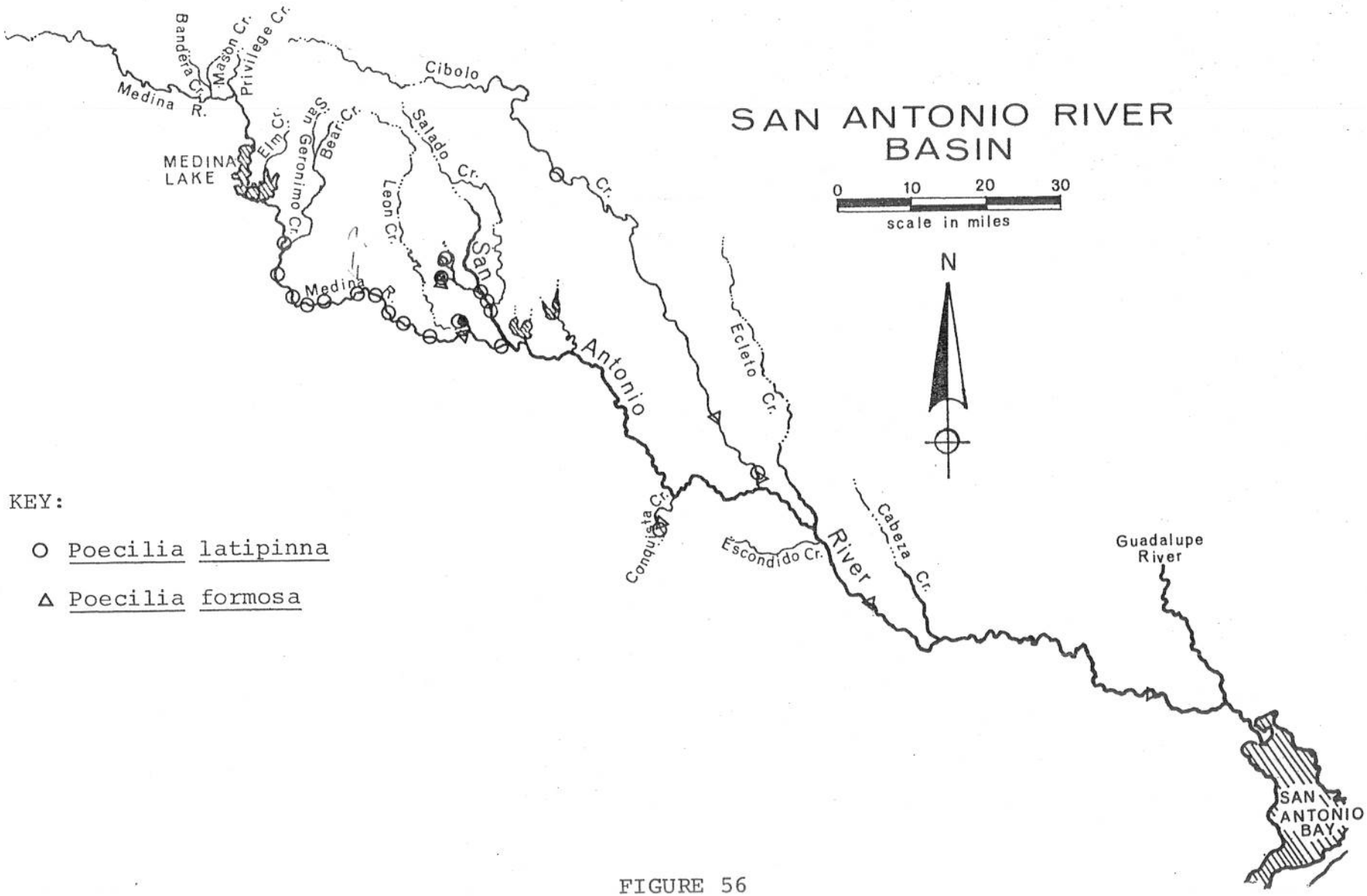
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
○ Poecilia latipinna
△ Poecilia formosa
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
Medina R.
San Antonio
Cr.
Ecleto Cr.
Conquista Cr.
Escondido Cr.
River
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 56

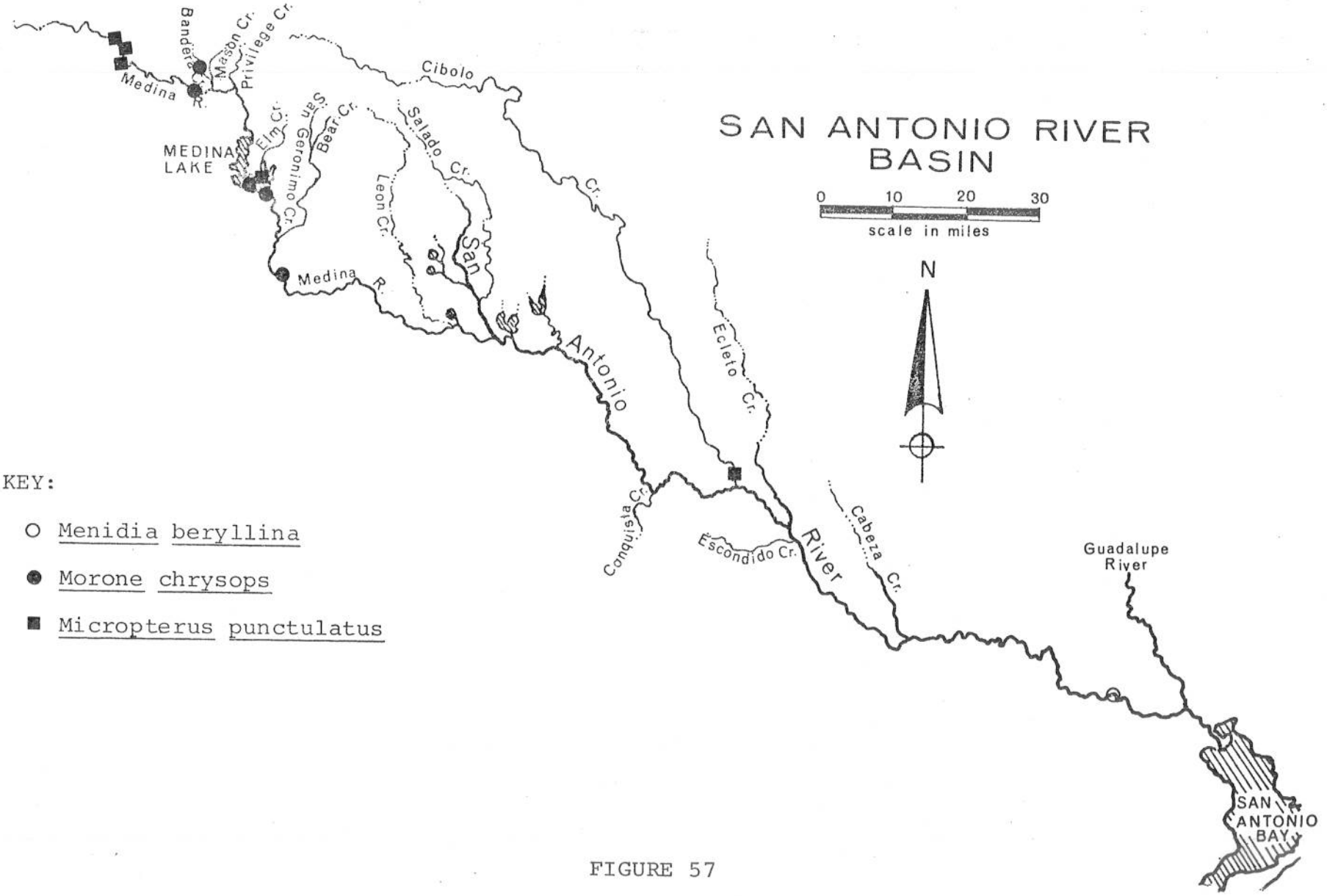
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
Menidia beryllina
Morone chrysops
Micropterus punctulatus
Medina R.
Bandera R.
Mason Cr.
Privilege Cr.
Cibolo Cr.
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
San Antonio River
Ecleto Cr.
Conquista Cr.
Escondido Cr.
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 57

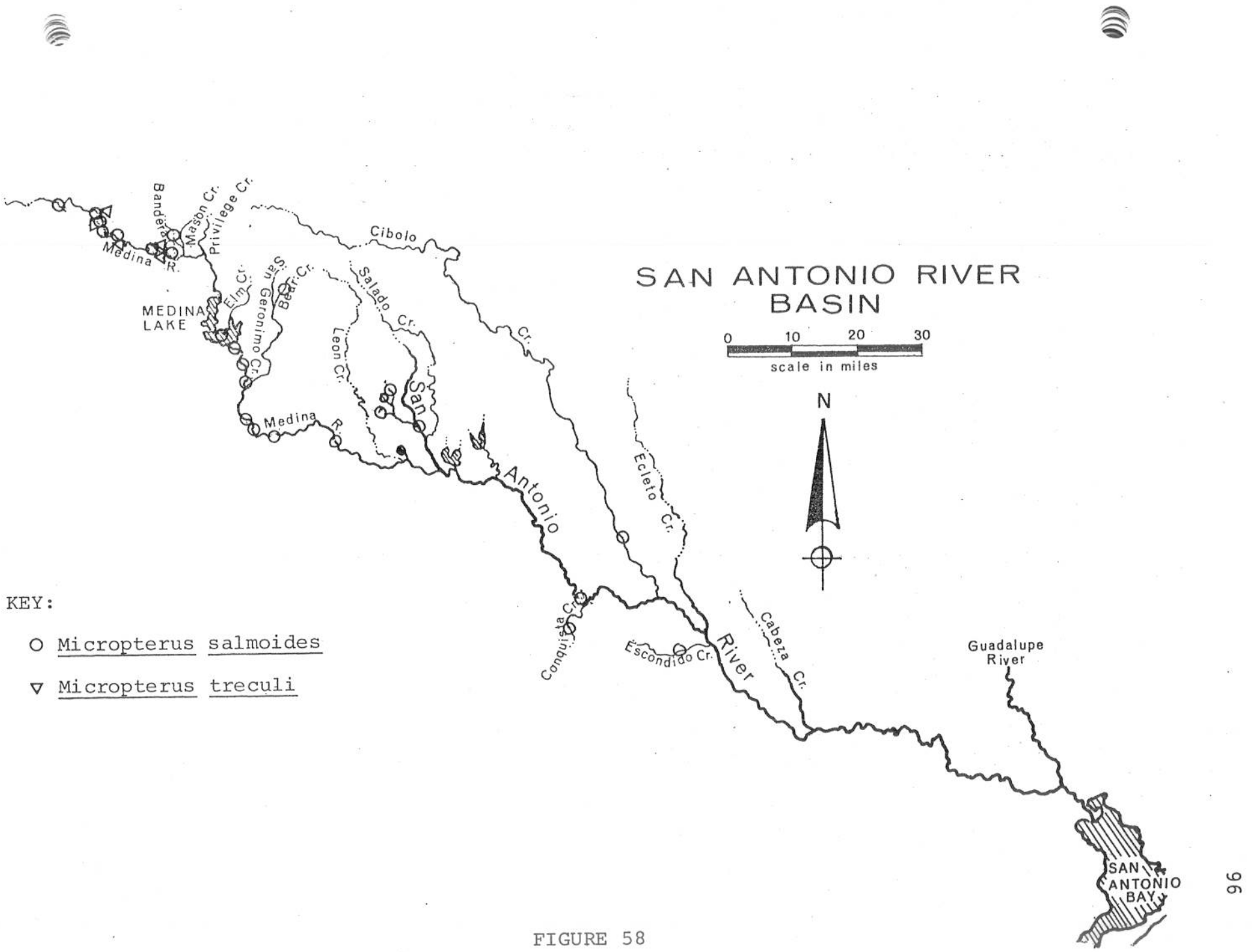
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
O Micropterus salmoides
▽ Micropterus treculi
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo Cr.
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
Medina R.
San Antonio River
Ecleto Cr.
Conquista Cr.
Escondido Cr.
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 58

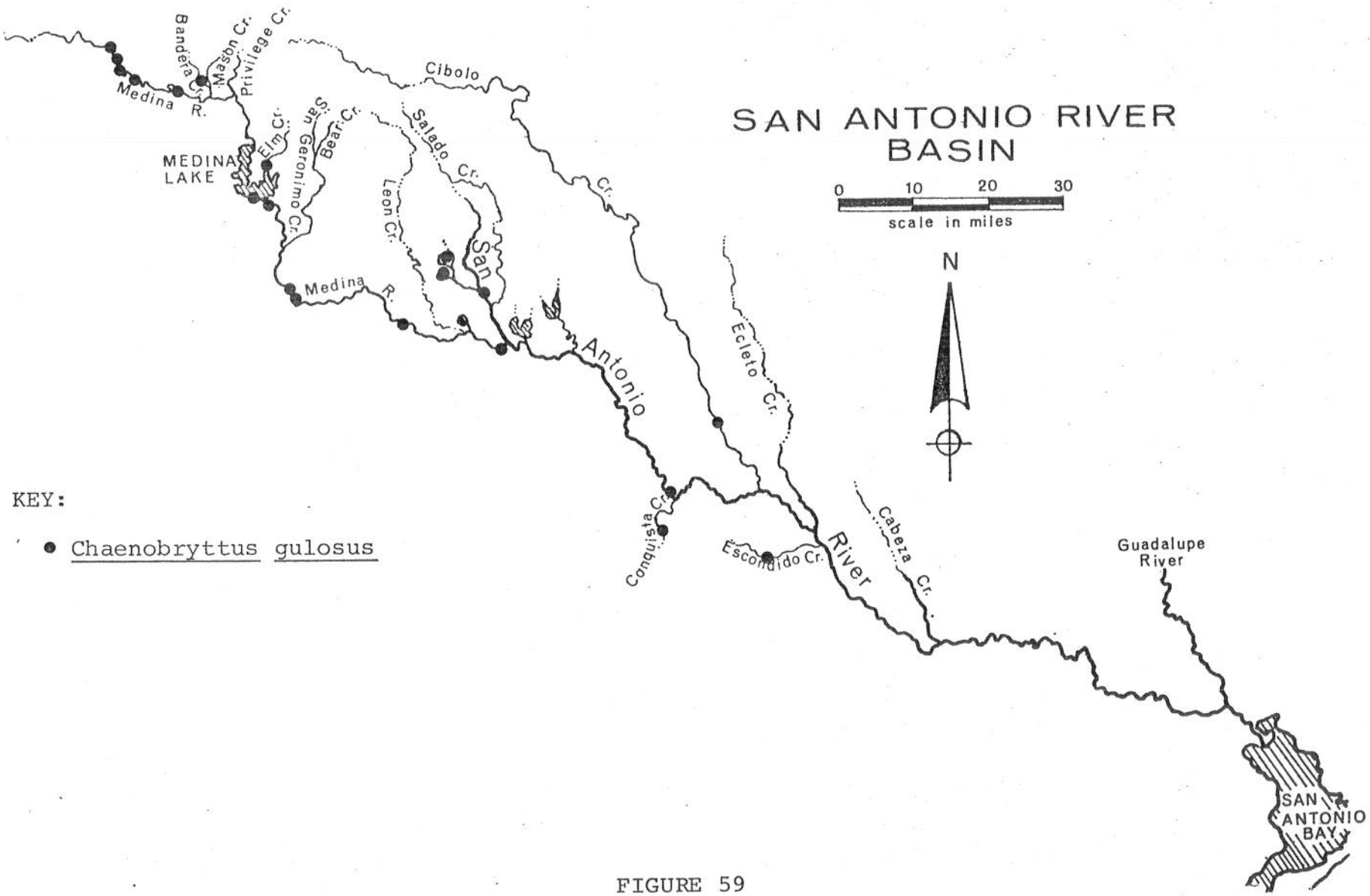
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
• Chaenobryttus gulosus
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Leon Cr.
Saledo Cr.
Medina R.
San Antonio
Cr.
Ecleto Cr.
Conquista Cr.
Escondido Cr.
River
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 59

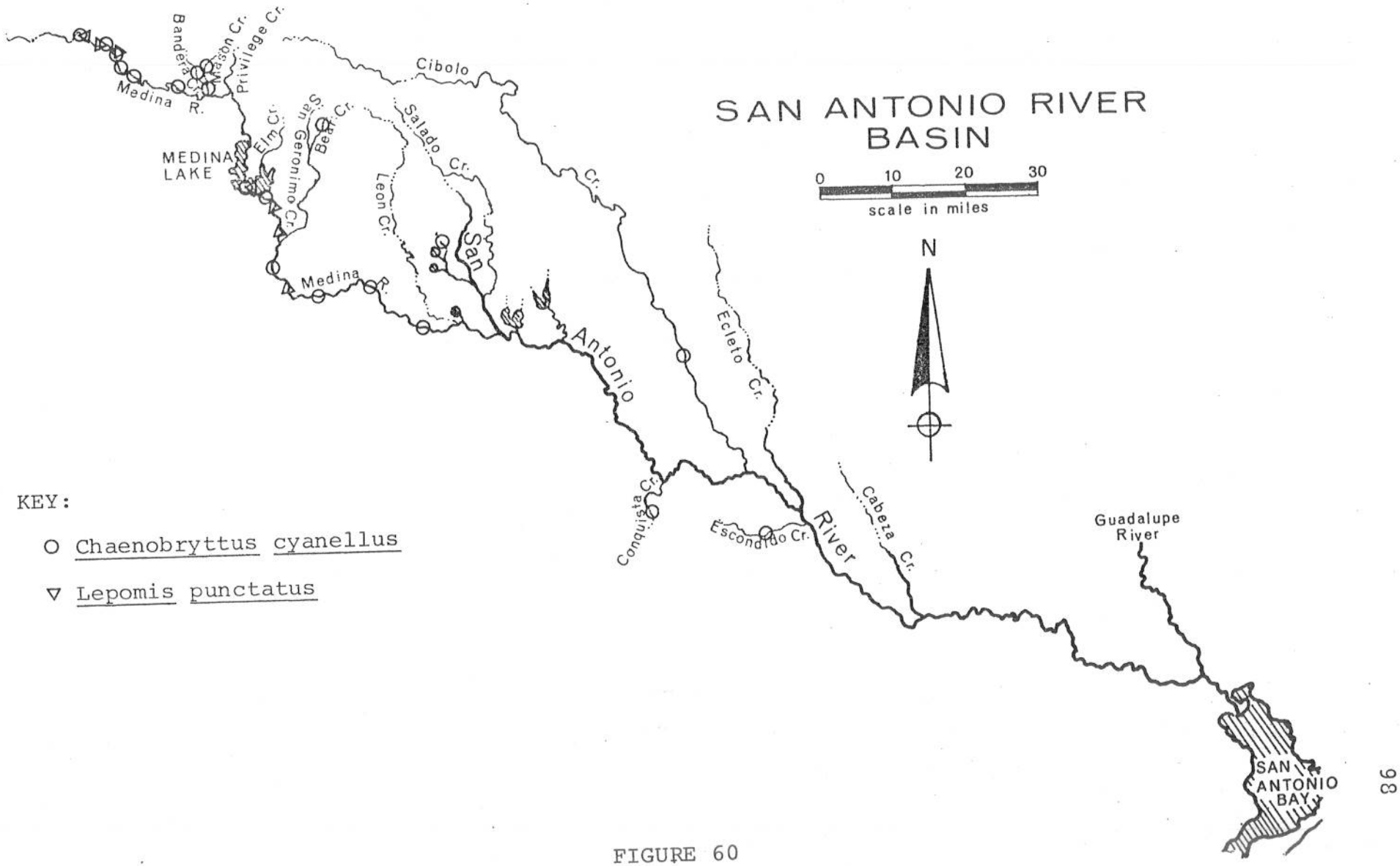
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
○ Chaenobryttus cyanellus
▽ Lepomis punctatus
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo
Cr.
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
San
Medina R.
Antonio
Ecleto Cr.
Conquista Cr.
Escondido Cr.
River
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 60

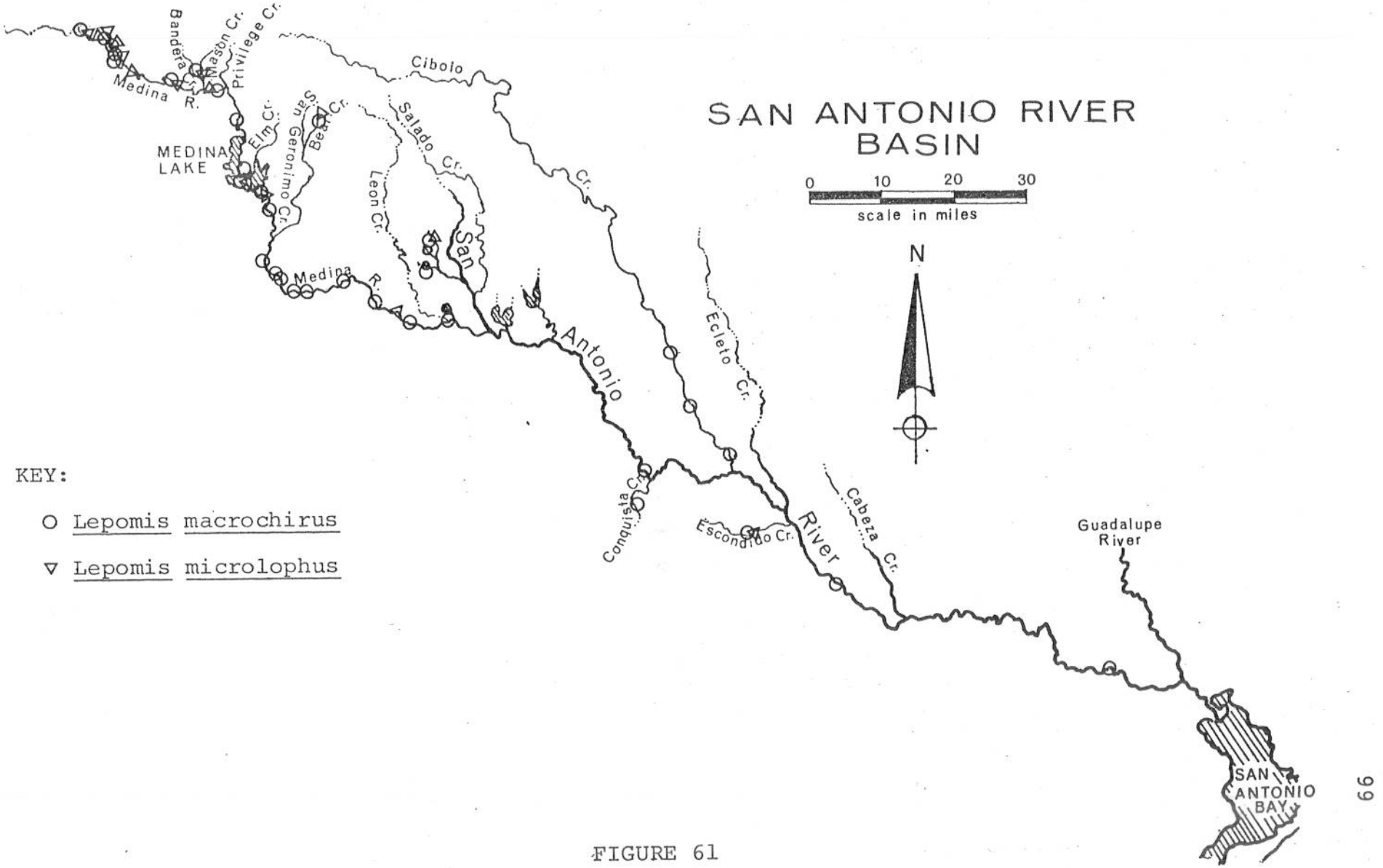
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
Lepomis macrochirus
Lepomis microlophus
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo Cr.
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
San Antonio River
Ecleto Cr.
Conquista Cr.
Escondido Cr.
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 61

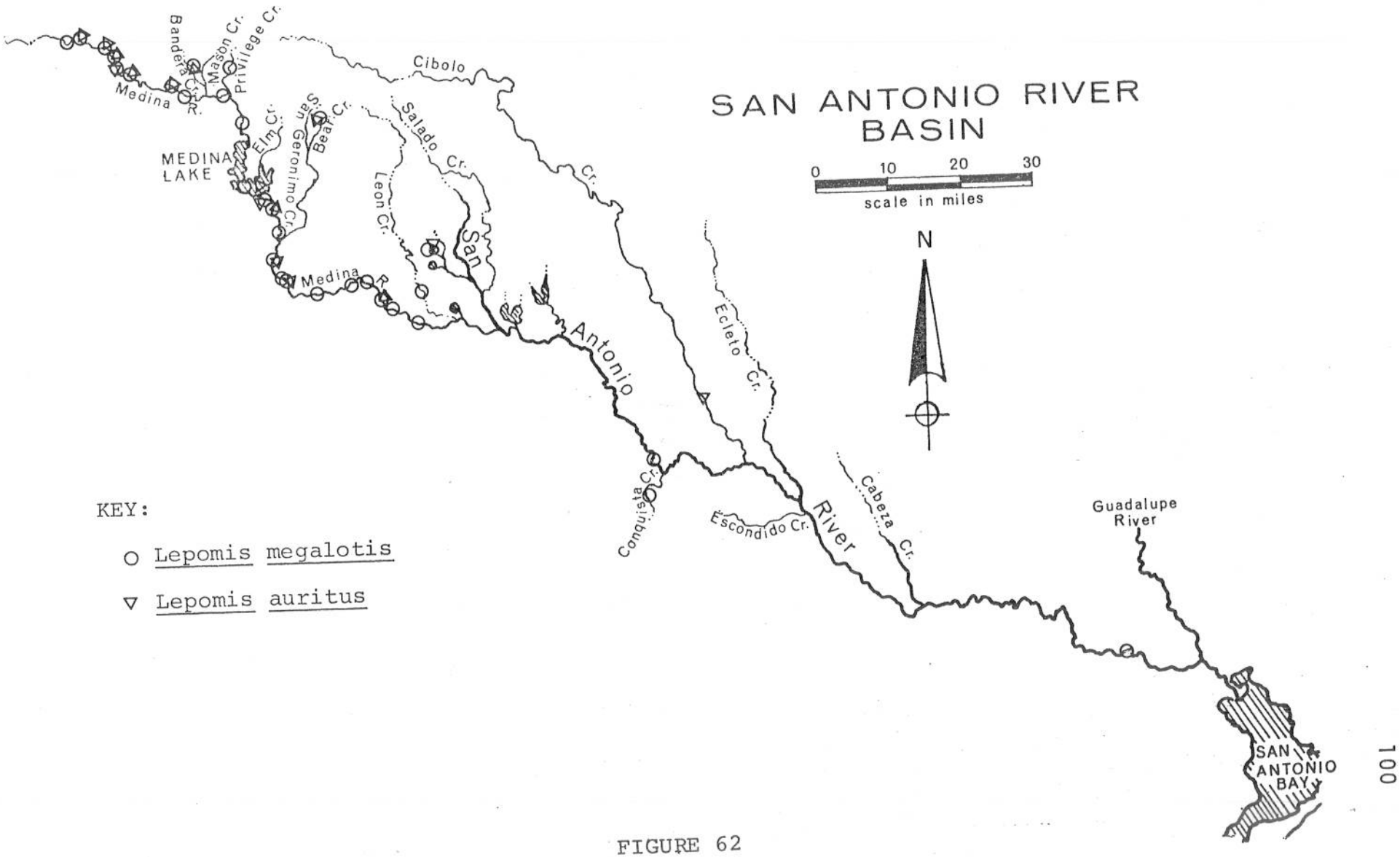
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
○ Lepomis megalotis
▽ Lepomis auritus
Medina
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo
Cr.
Salado Cr.
San Geronimo Cr.
Bear Cr.
Elm Cr.
MEDINA LAKE
Leon Cr.
Medina
San Antonio
River
Ecleto Cr.
Conquista Cr.
Escondido Cr.
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 62

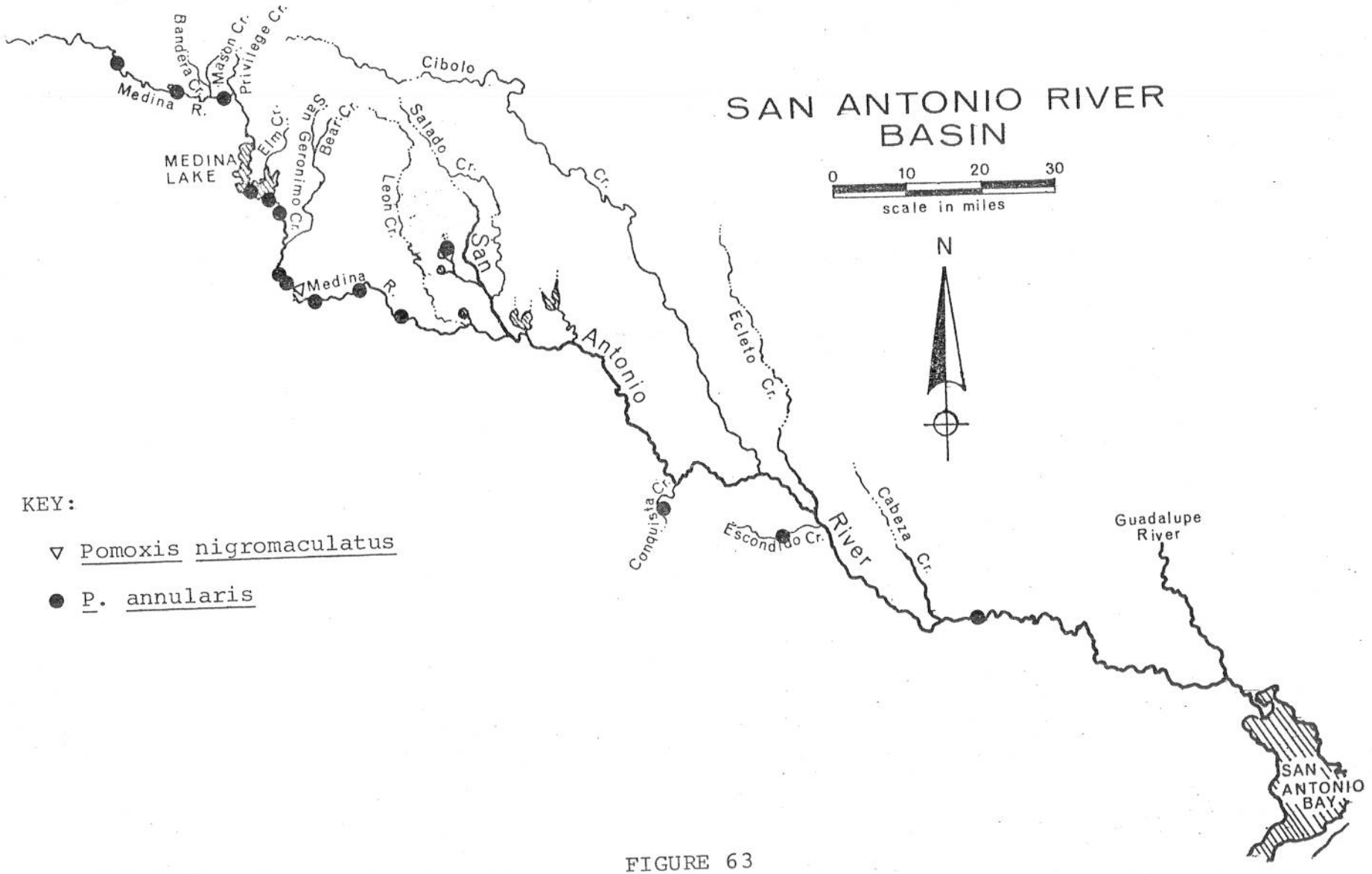
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
▽ Pomoxis nigromaculatus
● P. annularis
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo Cr.
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
San Antonio River
Ecleto Cr.
Conquista Cr.
Escondido Cr.
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 63

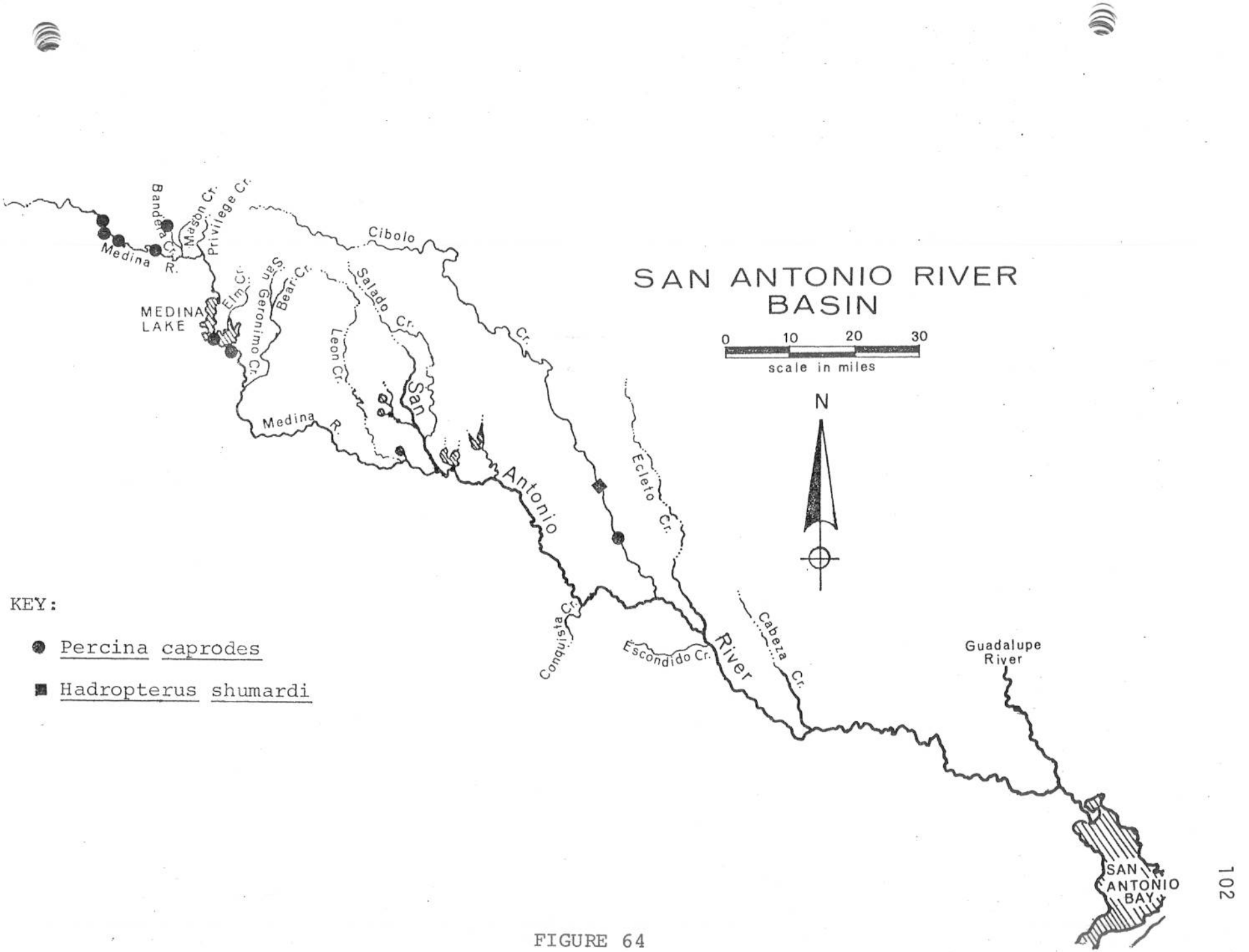
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
Percina caprodes
Hadropterus shumardi
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo Cr.
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
Medina R.
San Antonio River
Conquista Cr.
Escondido Cr.
Ecleto Cr.
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 64

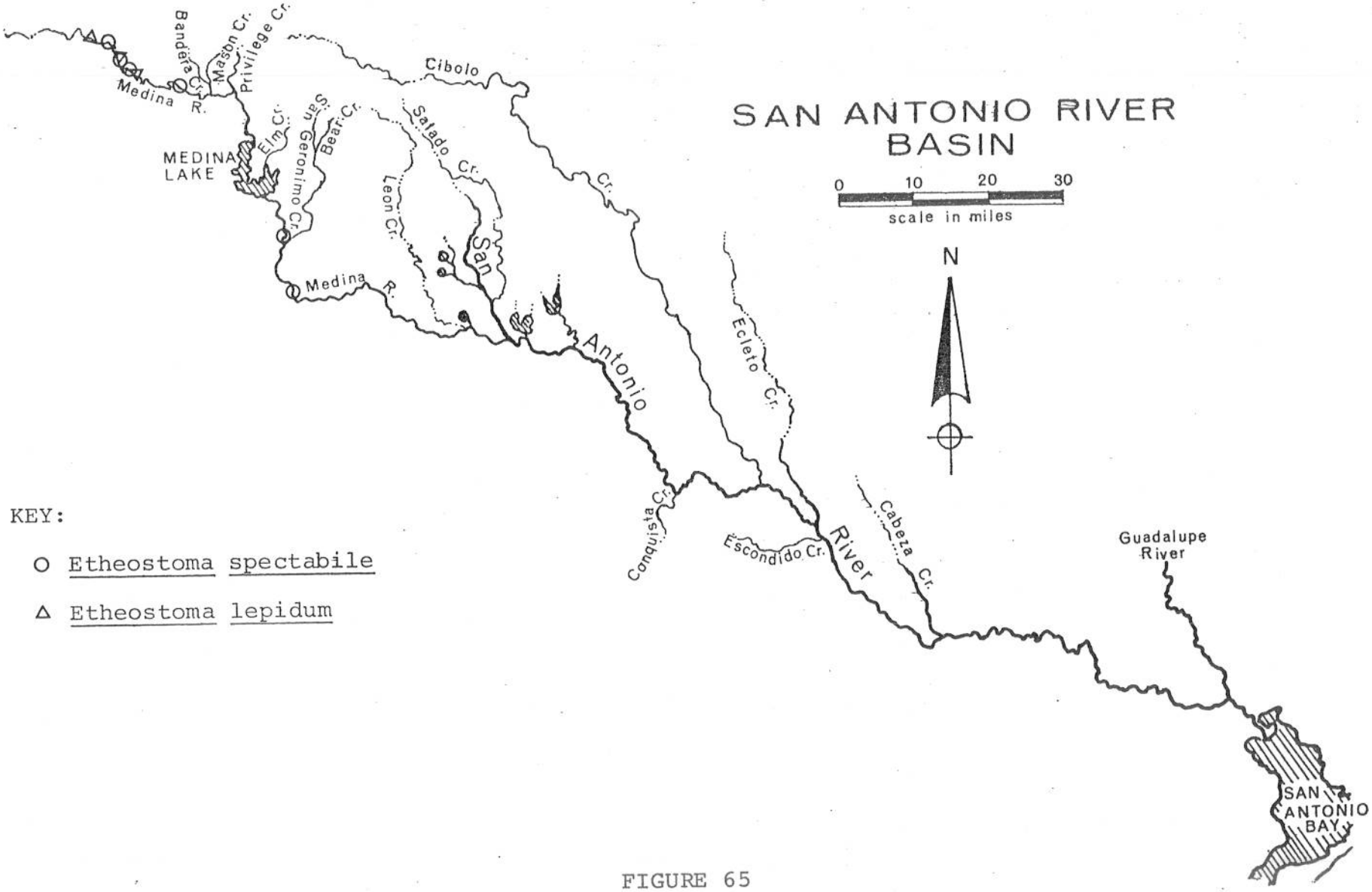
SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
O Etheostoma spectabile
Δ Etheostoma lepidum
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo Cr.
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
San Antonio River
Ecleto Cr.
Conquista Cr.
Escondido Cr.
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 65


SAN ANTONIO RIVER BASIN
0 10 20 30
scale in miles
N
KEY:
Chichlasoma cyanoguttatum
Mugil cephalus
Tilapia mossambica
Medina R.
Bandera Cr.
Mason Cr.
Privilege Cr.
Cibolo Cr.
MEDINA LAKE
Elm Cr.
San Geronimo Cr.
Bear Cr.
Salado Cr.
Leon Cr.
San Antonio River
Medina R.
Ecleto Cr.
Conquista Cr.
Escondido Cr.
Cabeza Cr.
Guadalupe River
SAN ANTONIO BAY

FIGURE 66

from our checklists and distribution maps, since there are no firm records that indicate they occur there. The following discussion includes only those species that require further consideration to clarify their status in the river systems.

Hubbs (95) indicated that Ichthyomyzon gagei (southern brook lamprey) may occur in the Guadalupe River System, but Hubbs (83, 85) showed it occurs only in east Texas. Thus, it is assumed that this species does not occur in the Guadalupe River System.

Hubbs (95) indicated that Polyodon spatula (paddlefish) may occur in the Guadalupe River System. However, the Guadalupe River System is in the extreme south end of game area 4 which Hubbs (95) indicated is within the range of the paddlefish. Since Hubbs (85) gave its range as east Texas, it is assumed that this species does not occur in the study area.

Chaney (300) recorded one specimen of Lepisosteus platostomus from the Nueces River between the Calallen Dam and the Wesley Seale Dam. Hubbs (85, 95) reported its range in Texas as limited to north Texas. Thus, this record was probably a misidentification.

According to Hubbs (95) Amia calva (bowfin) might occur in any of the drainage basins in the study area, however, he indicated the study area is in the extreme southern end of the range. Hubbs (85) stated that this species was limited on the southwest by a line between Brazos and Matagorda counties. Thus, it is assumed that this species does not occur in the study area.

Texas Parks and Wildlife Department (245) recorded two specimens of Elops saurus from the lower Nueces River. Hubbs (95) listed it as a coastal form. Knapp (116) said it enters the lower parts of rivers, and Parker, Gallaway, and Moore (138) indicated it is a marine and estuarine form. Thus, this species may occur in the lower parts of all three river systems in the study area.

Although no collections of Alosa chrysochloris have been reported from the study area, Hubbs (95) indicated that it may occur in any of the three river systems in the study area. Knapp (116) stated that it occurred in the Gulf of Mexico and in adjacent streams in Texas. Parker, Gallaway, and Moore (138) reported it is an estuarine and freshwater form. Thus, it is possible that this species occurs in the study area.

Chaney (300) recorded many specimens of Brevoortia patronus from the lower Nueces River. Hubbs (95) did not list this species from freshwaters in Texas, however, Knapp (116) stated that the young may ascend streams. Parker, Gallaway, and Moore (138) listed it as a marine and estuarine form. Thus, this species probably occurs in the lower Nueces River.

No records of Dorosoma petenense in the San Antonio River System were found. However, Hubbs (85,95) and Knapp (116) showed its range included this river system. Since this species has been recorded from river systems adjacent to the San Antonio River System, it very likely occurs in the San Antonio River System and has probably been confused with the more common species, D. cepedianum.

Texas Parks and Wildlife Department (245) collected 212 specimens of Anchoa hepsetus from the lower Nueces River. Parker, Gallaway, and Moore (138) listed this species as being marine and estuarine and Hubbs (95) listed it as a coastal form. Knapp (116) listed A. mitchilli as the only species of anchovy which enters the Texas rivers where he found it in abundance in the mouths of rivers. Since Texas Parks and Wildlife Department (245) did not list A. mitchilli in their collections, Anchoa hepsetus may have been a misidentification.

No records could be found of releases of Salmo gairdneri into Canyon Lake. However, one specimen was reported taken by gill nets in Canyon Lake by the Texas Parks and Wildlife Department in January 1966 (295). Since many releases of S. gairdneri have been made into the Guadalupe River below Canyon Dam (see p. 166), it is possible that some were released into Canyon Lake also. However, there is no evidence that this is a self-reproducing population.

Hubbs (95) indicated that Esox americanus (redfin pickerel) may occur in the Guadalupe River System. However, this would be the extreme southern end of the range given by Hubbs (95). Knapp (116) gave its range as east Texas and Hubbs (85) stated that it is limited on the southwest by a line between Brazos and Matagorda counties. Thus, it is assumed that this species does not occur in the study area.

Carassius auratus was collected from Woodlawn and Davis lakes in the San Antonio River System by the Texas Parks and

Wildlife Department (240, 247, 296). Within the Guadalupe River System, Whiteside (316) collected this species from the Blanco River, the Texas Parks and Wildlife Department (266, 295) collected it from Flat Rock Lake and Lake McQueeney, and Kuehne (119) collected it from the Comal River. No specimens of this species have been recorded from the Nueces River System. Since this species is an important bait and aquarium fish and is often released into streams and lakes as indicated by the above disjunct distribution, it likely also occurs in the Nueces River System.

We found no record of Hybopsis aestivalis from the Nueces River System, but it was collected from the San Antonio and the Guadalupe river systems. Hubbs (95) and Knapp (116) gave the entire state as within the range for H. aestivalis. Thus, this species probably occurs in the Nueces River System.

Rhinichthys cataractea (longnose dace) was not reported from the study area, although Hubbs (95) indicated that this species may occur in any of the river systems in the study area. Knapp (116) stated that this species occurs in tributaries of the Rio Grande and in the Pecos region of west Texas. Hubbs (83, 85) reported that the species is known only from the Rio Grande. Thus, it is assumed that this species does not occur in the study area.

No records were found of collections of Phenacobius mirabilis (suckermouth minnow) from the study area. While Hubbs (95) indicated that this species may occur in any of the river

basins in the study area, Hubbs (85) gave the Texas range as limited chiefly to northeast Texas and the lower Colorado River System and Knapp (116) listed it as uncommon in Texas. Thus, it is assumed that this species does not occur in the study area.

Smith (309) reported one specimen of Notropis atherinoides from the Blanco River seven miles east of Wimberley and Mecham (304) reported this species from the San Marcos River at San Marcos. Hubbs (95) indicated that this species occurs in game areas 1, 2, and 4, all of which extend into the northeastern edge of the study area. However, Hubbs (85) indicated that this species occurs only in east Texas and although he stated (83), "Notropis atherinoides is not known southeast of the Trinity drainage", he apparently intended to say southwest instead of southeast. Thus, the occurrence of this species in the Blanco and San Marcos rivers is questionable.

The Texas Parks and Wildlife Department (269) recorded Notropis oxyrhynchus from Lake Dunlap. Hubbs (95) indicated that this species might occur in the study area. Hubbs (85) stated that this species is limited to the Texan Biotic Province (Fig. 94) which includes only the Guadalupe River System portion of the study area. However, Knapp (116) stated that this species is confined to the Brazos River System. Thus, the occurrence of this species in the study area is questionable.

No records of collections of Notropis fumeus (ribbon shiner) in the study area were found. Hubbs (85, 95) indicated that the extreme southwest part of its range may extend into the study

area. However, Knapp (116) stated that this species occurs in the Red River and extends southward into Texas only as far as the Brazos River System. Thus, it is questionable if this species occurs as far southwest as the study area.

Reno (308) reported two specimens of Notropis shumardi from the Blanco River one mile east of Wimberley. Hubbs (85, 95) indicated that its range may extend into the study area. Knapp (116) listed the range of this species as "known only from the Brazos River system but possibly occurs in the lower parts of adjacent rivers in Texas." Hubbs (83) listed additional collection localities but none were in the study area. Thus, this species possibly occurs in at least the Guadalupe River System of the study area.

The Texas Parks and Wildlife Department (296) collected one specimen of Notropis chalybaeus from Cibolo Creek. Hubbs (85, 95) and Knapp (116) gave the range for this species as the eastern part of the state. Thus, it is likely that this specimen was misidentified and therefore this species does not occur in the study area.

The Texas Parks and Wildlife Department (297) collected six specimens of Notropis simus from the upper part of the Nueces River, two miles south of Montell. Knapp (116) and Hubbs (85, 95) gave its Texas range as the Rio Grande and its tributaries east to near Laredo. Since the collection site of this species is adjacent to the Rio Grande System, this may be a correct identification and an extension of its known range.

Caldwell (299) reported four specimens of Notropis blennius from Woodlawn Lake, Bexar County. Hubbs (83, 85, 95) and Knapp (116) showed that it does not occur in Texas south of the Red River drainage. Thus, we assume this species does not occur in the study area.

No records were found of Notropis potteri (chub shiner) being in the study area. Knapp (116) gave its range as the Brazos and Red River systems. However, Hubbs (95) indicated its range may include part of the study area. Since no records of this species in the study area were found, and since the exact range given by Hubbs (95) for this species cannot be pinpointed, it is likely that this species does not occur in the study area.

Records of collections of Notropis amnis were found for both the Guadalupe and the San Antonio river systems. Hubbs (95) indicated that both of these river systems are within its range. However, Knapp (116) showed its range to include only the Guadalupe River System in the study area. Since Hubbs (95) is the more recent paper of the two, it is assumed that these were correct identifications of N. amnis, and that this species is found in both river systems.

The Texas Parks and Wildlife Department (296) collected one specimen of Notropis proserpinus from the San Antonio River and one specimen from Cibolo Creek, Knapp (116) and Hubbs (85, 95) showed its Texas range to be the Rio Grande and its tributaries, including the Pecos River. It is assumed the two specimens were misidentified since this species is easily

confused with the more common, closely related species N. lutrensis.

The Texas Parks and Wildlife Department (297) reported 38 specimens of Notropis atrocaudalis from Lake Corpus Christi. Knapp (116) stated the Texas range of this species is "East Texas west to Guadalupe system (rare) ...." Hubbs (83) stated, "There are no specimens in the Texas A. and M. collection from west of the Brazos River." Hubbs (85, 95) gave its range in Texas as the eastern part of the state. Thus, it is probable that these specimens were misidentified.

Collection records of Notropis volucellus were found for all three river systems in the study area. The only record from the Nueces River System was a collection of five specimens reported by the Texas Parks and Wildlife Department (231) from Hondo Creek, a tributary of the Frio River. Knapp (116) reported it as occurring throughout Texas and Hubbs (95) showed its range included all of Texas except the extreme western part of the state. However, Hubbs (85) stated that its range is discontinuous and that it is absent from the Nueces River System. N. volucellus may have been confused with a similar species, N. buchanani, which occurs in the Nueces River System. Thus, its occurrence in the Nueces River System is questionable.

Caldwell (299) recorded Notropis boops from the Guadalupe River five miles below Canyon Lake Dam. Hubbs (95) did not list this species in his checklist of Texas fishes. Knapp (116) and Moore (126) listed it from the Red River System between Texas

and Oklahoma. Thus, it is assumed that this species does not occur in the study area.

No records were found to indicate Hybognathus nuchalis occurs in the study area. However, Hubbs (95) indicated its range may reach the Guadalupe River System and Knapp (116) stated its Texas range as being "in large silty rivers, oxbows and backwater areas in the central and eastern parts of Texas. Rather widespread in the state but nowhere common." According to these distribution descriptions, this species may occur in at least the Guadalupe River System in the study area.

No records were found of Hybognathus placitus being in the study area. However, Hubbs (95) and Knapp (116) indicated that its range may include any of the river systems in the study area. Thus, it is possible that this species occurs in the study area.

No records were found to indicate that Cycleptus elongatus occurs in the study area. The Academy of Sciences of Philadelphia (1) listed Carpiodes elongatus as being collected from the Guadalupe River near Victoria, however, it could not be determined if they were referring to Cycleptus elongatus or a subspecies of the river carpsucker, Carpiodes carpio elongatus. Hubbs (85, 95) and Knapp (116) indicated that Cycleptus elongatus may occur in small numbers throughout the study area. Thus, it is assumed that Cycleptus elongatus occurs in the study area.

The Texas Parks and Wildlife Department (269) recorded specimens of Moxostoma erythrurum from lakes Dunlap, Placid,

Meadow, and H-4 on the Guadalupe River. However, Hubbs (83, 85, 95) and Knapp (116) showed that the nearest extension of the range of this species to the study area is the Red River System. Thus, it is assumed that these specimens were the closely related, commonly occurring M. congestum, and that M. erythrurum does not occur in the study area.

Fowler (56) listed Moxostoma duquesnii from the Colorado and Guadalupe rivers. Hubbs (83) stated, "Because this fish has not otherwise been recorded in Texas, it is presumed that the record is based on specimens of M. congestum, with which M. duquesnii has much in common."

Everman and Kendall (51) reported Minytrema melanops from the Guadalupe River near New Braunfels in 1894. Hubbs (95) reported it as introduced into game area 6 which includes the study area. Hubbs (85) stated that they are found north and east of a line from Fort Worth to Houston but not south and west of it. Knapp (116) gave the range for this species as "Widespread but not common; from Minnesota to Iowa to Pennsylvania on the north to northern Florida; southwest to the Rio Grande...." Hubbs (83) stated that "No recent collections are available west of the San Jacinto drainage." Since this species is not easily confused with other species of suckers, it is assumed that this 1894 record of M. melanops for the Guadalupe River was correct, but it is questionable if this species still occurs there.

Hubbs, Kuehne, and Ball (100) recorded Erimyzon oblongus from the headwaters of the Guadalupe River. However, Hubbs (85) stated that the above record was based on E. sucetta. Thus, this species is not known to occur in the study area.

Fowler (56) recorded Ictalurus nebulosus from the Nueces River, probably on the basis of his (1904) record from Hondo Creek. Hubbs (83) stated that Fowler's fish, on re-examination, proved to be I. natalis. Evermann and Kendall (51) listed I. nebulosus from San Marcos, Comal, and San Antonio springs and stated that this species was quite numerous at San Marcos and Comal springs. Hubbs (83) stated that I. natalis was the only species of the genus in these springs in 1954. Recently, Whiteside (313, 316, 317) collected both I. natalis and I. melas from the San Marcos River but only a few specimens were I. melas. Thus, it is assumed that the records of I. nebulosus were based on misidentified specimens of I. natalis.

Hubbs (94), Hubbs and Bailey (82), and Suttkus (162) reported that Trogloglanis pattersoni and Satan eurystomus have been taken only from deep artesian wells in the vicinity of San Antonio.

Noturus gyrinus was recorded from all three river systems in the study area. Hubbs (85) stated that this species is not found in the upper portions of these river systems which lie within the Balconian Biotic Province (Fig. 94) nor in those parts of the San Antonio or Nueces river systems which lie within the Tamaulipan Biotic Province (Fig. 94). However, there were

records of this species from Medina Lake (187, 190, 201) which is in the Balconian Biotic Province and from several localities in the Nueces River System (174, 181, 237, 245, 297) which are in the Tamaulipan Biotic Province. The only species in the study area with which N. gyrinus is sometimes confused is young-of-the-year bullheads. Thus, the above records of N. gyrinus were probably correct.

Evermann and Kendall (51) stated that they obtained eight specimens of Noturus nocturnus from San Antonio Springs at San Antonio. Hubbs (85) stated that this species is found north and east of a line from Fort Worth to Houston but not south and west of it. Though Hubbs (95) later included the study area within the range of N. nocturnus, Knapp (116) stated that this species is not common in Texas. Thus, it is assumed that this record of N. nocturnus was a misidentification.

Anguilla rostrata was recorded from the Nueces and Guadalupe river systems, but no records of the species were found for the San Antonio River System. Hubbs (85, 95) and Knapp (116) stated that the range of this species includes the entire study area. Since this species is most frequently taken on hook and line or with traps, data which is usually not recorded or published, it is assumed that this species also occurs in the San Antonio River System, but has never been reported.

Evermann and Kendall (51) recorded Lucania parva from San Antonio Springs at San Antonio. Hubbs (95) indicated that the range of this species may include the San Antonio River System. Hubbs (85) stated that members of this species "occur

abundantly in the saline waters of the Pecos but not in the nearby less saline habitats in Texas." Hubbs (85) also reported that they are often found in the Rio Grande above Falcon Dam and that perhaps they occupy most of the Tamaulipan Biotic Province (Fig. 94) which includes the San Antonio River System. Thus, the Evermann and Kendall (51) record may be correct.

The Texas Parks and Wildlife Department (245) recorded Fundulus grandis from the lower Nueces River. Hubbs (95) listed this species as coastal and Knapp (116) gave its range as "Gulf Coast from Florida to Mexico. A brackish water species ranging from salinities of 2 to 25 parts per thousand salt." Parker, Gallaway, and Moore (138) listed it as an estuarine and freshwater form. Thus, it is assumed that this species occurs in the lower Nueces River System.

Records of Zygonectes notatus were found for the Guadalupe and San Antonio river systems but not for the Nueces River System. Hubbs (85) indicated this species in Texas occurs in the Texan and Austroriparian biotic provinces. The Texan Biotic Province includes parts of the Guadalupe and San Antonio river systems but not the Nueces River System (Fig. 94). Knapp (116) said Z. notatus is typical of headwaters and fast streams in Texas. Hubbs (95) indicated that its range might extend south into the Nueces River System. It is assumed that Z. notatus occurs only in the Guadalupe and San Antonio river systems of the study area.

The only record of Zygonectes olivaceus from the study area was by Kuehne (119) from Lake Belmont (H-4 Lake) on the

Guadalupe River. Hubbs (95) indicated that the range of this species in Texas might include this area. However, Hubbs (85) stated that the western limit of this species corresponds with the western limit of the Mixed Pine-Oak Region in east Texas (Fig. 94). Kuehne (119) also collected Z. notatus from Lake Belmont and several other localities on the Guadalupe River, and stated that the specimens identified as Z. olivaceus may have been very aberrant Z. notatus. It is assumed that this was probably a misidentification and that Z. olivaceus does not occur in the study area.

Records of Cyprinodon variegatus were found for the Nueces and Guadalupe river systems but not for the San Antonio River System. Hubbs (95) indicated that this species may occur in the lower sections of any of the three river systems in the study area. Hubbs (85) stated that this species may occupy most of the Tamaulipan Biotic Province which includes parts of the San Antonio and Nueces river systems (Fig. 94). Knapp (116) gave its Texas range as "Very abundant on the Texas coast in salinities from 10 to 25 parts per thousand salt. Not uncommon in purely fresh waters of the coastal streams...." Thus, it is possible that C. variegatus may also occur in the San Antonio River System.

The only record of Gambusia gaigei from the study area was that of the Texas Parks and Wildlife Department (297) from the Dry Frio River. Hubbs (85, 95), Knapp (116), and Hubbs and Springer (104) stated that this species occurs only in the Big

Bend area of west Texas. Thus, this record of G. gaigei is assumed to be a misidentification.

Hubbs (85) stated that Poecilia formosa is restricted to the extreme southern tip of the state. Hubbs (95) also stated that it has been introduced into game area E6 which includes the upper portions of all three river systems in the study area. Drewry, Delco, and Hubbs (47) and Hubbs (91) stated that this species was introduced into the San Marcos River at San Marcos, and Whiteside (313, 315, 317) and Smith (307) have recorded this species from the San Marcos River. The Texas Parks and Wildlife Department recorded P. formosa from several localities in the San Antonio River System (237, 246, 247, 296) and from Lake Corpus Christi and the lower Nueces River (245, 246, 297). This species has either extended its range in recent years or there are several cases of misidentification.

Knapp (116) gave the range for Menidia audens as "now known to be widely scattered over most of the state." Hubbs (83) stated, "The records attributed to me are based on specimens of Menidia beryllina (Cope) misidentified by me. In Texas, M. audens is known only from the Red River and its tributaries (chiefly Caddo Lake)." No other records of this species in the study area were found except for Knapp (116), who stated that he collected it from the Medina River. It is assumed that M. audens does not occur in the study area.

The only record of Labidesthes sicculus in the study area was that of Mecham (304) from the San Marcos River at San Marcos.

Hubbs (85) stated that the Texas range for this species is north and east of a line from Fort Worth to Houston but not south and west of it. In recent years, we have collected extensively in the San Marcos River at San Marcos and have not taken this species. Thus, it is assumed that this record is incorrect.

Records of Micropterus punctulatus were found for the Guadalupe and San Antonio river systems and records of M. treculi were found for all three river systems in the study area. Knapp (116) considered these as two subspecies and Hubbs (83) considered them as distinct species. At best, they are difficult to separate, and many of the specimens reported may not be correctly identified. Our collections from the Guadalupe River System, made over the last six years, have yielded two specimens that might be identified as M. treculi. However, it remains questionable if M. punctulatus and M. treculi are distinct species.

Only one record of Lepomis symmetricus was recorded from the study area; a single specimen collected by the Texas Parks and Wildlife Department (296) from Medina Lake. Hubbs (92, 95) gave the Texas range of this species as the eastern part of Texas. Thus, it is assumed that the single specimen was misidentified.

Hubbs (95) indicated that the range of Lepomis humulis may extend into any of the three river systems in the study area, and Hubbs (85) indicated that its range may extend into the Guadalupe and San Antonio river systems. The only records for this species in the study area were from the Guadalupe River System and apparently this is the only river system in the study

area in which L. humulis occurs.

The only reports that Lepomis marginatus occurs in the study area were made by the Texas Parks and Wildlife Department (269) on the basis of collections from lakes Dunlap, McQueeney, H-4, and H-5. Hubbs (85, 95) and Knapp (116) listed the Texas range of this species as east Texas. Thus, it is probable that these records are based on a misidentification of the common, closely related L. megalotis.

Callahan (278) reported three specimens of Enneacanthus obesus from Cibolo Creek. Hubbs (95) did not list this species in his checklist of Texas fishes. Moore (126) gave the range of this species as southeastern New Hampshire to Florida, in coastwise waters. Thus, we consider this record of E. obesus as a misidentification.

Several records of Ambloplites rupestris were found for both the Guadalupe and Nueces river systems but not for the San Antonio River System. Brown (27) stated that this species has been introduced extensively in the Edwards Plateau area. Thus, it is possible that this species also occurs in the San Antonio River System.

Records of Hadropterus scierus were found for only the Guadalupe River System in the study area. Knapp (116) stated that this species is generally widespread throughout Texas in suitable habitats and Hubbs (95) indicated that its range may extend into the other two river systems in the study area. However, Hubbs (85) stated that H. scierus is abundant in the

Guadalupe River System and northern streams, but absent from the Nueces. He considered the Guadalupe River System to include the San Antonio River System. Thus, it is possible that this species occurs in both the Guadalupe and San Antonio river systems.

The only records of Etheostoma fusiforme from the study area were reported by Evermann and Kendall (51) who gave the collection localities as, "Rio Seco and Rio Leona at Uvalde (as Boleosoma gracile types, Gilbert, 1859b), and (as Poecilichthyes gracilis, Synopsis)...." Hubbs (85) stated that E. fusiforme occurs in the Red River System east of Lake Texoma and is absent from the Sabine River and elsewhere in Texas. Thus, it is assumed that the above records were likely misidentifications of E. gracile, which occurs in the study area.

Records of Etheostoma spectabile were found for all three river systems in the study area. Hubbs (83, 85) and Strawn (158, 159) stated that this species is found in the Guadalupe and San Antonio river systems but is absent from the Nueces River System. The Texas Parks and Wildlife Department reported two specimens of E. spectabile from the upper Nueces River (240) and two specimens from the upper West Nueces River(244). It is questionable if the Nueces River System specimens indicated as E. spectabile were correctly identified. They may have been confused with E. lepidum which commonly occurs in that area.

The only record of Etheostoma grahami from the study area was that of Knapp (116) who gave its range as, "Nueces River in Texas south into the Rio Grande and streams of Chihuahua, west to

the Pecos." However, Hubbs (83) stated, "This fish is not known in the Nueces River System, where it is replaced by E. lepidum." Also, Hubbs (95) and Strawn (158, 159) indicated its range does not include the study area. Thus, it is assumed that E. grahami does not occur in the study area.

Fowler (56) recorded Etheostoma microperca as Microperca punctulata, from Sabine, Trinity, Colorado, and Nueces rivers. However, Hubbs (83) stated that E. microperca does not occur in Texas and that he suspected that Fowler (56) based his statement of the range on misidentified specimens of E. gracile. Thus, it is assumed that E. microperca does not occur in the study area.

Hubbs (83, 85), Strawn (158, 159), and Hubbs, Kuehne, and Ball (100) stated that Etheostoma fonticola is endemic to the Comal and San Marcos springs and adjacent waters downstream, where it is found in dense vegetation in flowing water. In addition to these locality records, the Texas Parks and Wildlife Department (245) reported four specimens of this species from the lower Nueces River. It is assumed that the Nueces River specimens were misidentified since the Nueces River offers such a contrast in habitat when compared to those from which E. fonticola has been previously collected.

We found several records of collections of Aplodinotus grunniens from the Nueces River System and one report of a single specimen taken from the San Antonio River by the Texas Parks and Wildlife Department (296). No records of this species were

found for the Guadalupe River System. Hubbs (95) and Knapp (116) indicated that the range of this species includes the entire study area. Thus, it is possible that this species also occurs in the Guadalupe River System.

Whiteside (317) collected several specimens of Tilapia mossambica from Canyon Lake on June 16, 1972 and August 29, 1972, which were the first records of this species collected in Canyon Lake. Hubbs (88) stated that established populations of this species now occur in the San Antonio and San Marcos springs. No other records were found for this species in the study area.

Records of Gobiomorus dormitator were found only for the Nueces River in the study area. However, Hubbs (95) indicated the range of this species may extend into any of the three river systems in the study area, so it is possible that this species occurs in the lower part of all three river systems in the study area.

Collections of Gobiosoma bosci were reported from the lower Nueces River by Chaney (300) and by the Texas Parks and Wildlife Department (245) as well as from Lake McQueeney (269). Hubbs (95) gave the range of this species as coastal. Parker, Gallaway, and Moore (138) gave its habitat as marine, estuarine, and freshwater. Thus, the Lake McQueeney record is questionable.

The species Gerres cinereus, Eucinostomus lefroyi, and Pomadasys crocro listed by Chaney (300) and Oligoplites saurus reported by the Texas Parks and Wildlife Department (245) were

all recorded as collected from the lower Nueces River. However, Hubbs (95) did not include these species in his checklist of Texas freshwater fishes and Bailey, et al. (7) stated that all of these species occur in the Atlantic. Parker, Gallaway, and Moore (138) gave the habitat of G. cinereus, E. lefroyi, and O. saurus as marine and estuarine, and the habitat of P. crocro as only marine. While it is possible that these species enter into the lower parts of the Nueces River, the occurrence of P. crocro there is questionable.

The Academy of Natural Sciences of Philadelphia (1) listed Achirus achirus as collected from the Guadalupe River near Victoria. Hubbs (95), Parker, Gallaway, and Moore (138), and Bailey, et al. (7) do not list this species. Thus, it is assumed that the specimens recorded were misidentified or that the species name is a synonym for some other species.

Distribution Patterns of Fishes

The only major contribution to our knowledge of the distribution of fishes throughout the entire study area is that of Hubbs in 1957 (85). He discussed the distribution patterns of fishes in Texas in relation to terrestrial biotic areas (Fig. 94) and to stream systems.

The following discussion is based principally upon Hubbs' (85) conclusions concerning fish distributions related to the study area. These are supplemented by additional information that has come to light in this current survey.

Quantitative Analysis of Fishery Resources

Of primary concern to water development organizations is the ability to appraise the effects of changes of any kind resulting from man's activities on water resources. Observing the response of fish populations to changes in their environment is one way to make this appraisal. However, quantitative determinations of fish populations are necessary, and these are difficult to obtain. For any one fishing method the catch is not a reliable criterion of actual abundance of all species. Sampling methods are selective with respect to species, size, and sex of individuals; therefore, representativeness of these sampling methods depend on the care and thoroughness used in sampling.

The bulk of fishery data on the Guadalupe, San Antonio, and Nueces river basins are a result of Texas Parks and Wildlife field surveys. Some of the data came from research supported by private organizations and educational institutions. In all of these studies, personnel made only limited use of poisons. The difficulties encountered in sampling with poisons in streams and the serious public repercussions that could have occurred with their use prevented wide utilization of this sampling method. Some of the data were obtained by hoop nets, fyke nets, barrel traps, and rod-and-reel fishing. However, the largest part of the data was collected by gill nets and seines. Gill nets were usually experimental; that is, nets

had webbing of different mesh size. The mesh sizes most often employed were: 1-, 1 1/2-, 2-, 2 1/2-, and 3-inch square measure. Occasionally gill nets of one mesh size were used in sampling. The mesh sizes employed for these nets were either 2- or 3-inch square measure. Bag seines and common sense minnow seines were the main types of seines utilized. Bag seines were usually about 30 ft long by 6 ft deep with a mesh size of 1/4-inch square measure. Common sense minnow seines ranged from 4 to 10 ft long by 4 ft deep and had a mesh size of 1/8-inch square measure.

According to Bennett (14) gill nets are selective for pelagic fishes, and therefore, do not yield completely representative samples. However, the potential for a representative sample taken from a fish population does exist with use of experimental gill nets because of the different mesh sizes utilized. But such factors as non-random distribution of fish, movement of fish, presence or absence of spines on fish, mesh size of nets, time of day, season, and others will add to the selectivity of gill nets. Seines are somewhat less selective than most other types of gear (14). However, seines can be used efficiently only in waters no deeper than the depth of the seine and where the bottom is devoid of snags. Certain fishes can be expected to escape from seines by jumping over the cork line at the top and by going under the lead line at the bottom. All of the above factors, as well as others not defined, add to the selectivity of the respective gears and

cause enough experimental error in sampling to require that the results be cautiously interpreted.

A large number of personnel (fishery technicians and biologists) were utilized in the fish sampling programs conducted on the three river basins. A problem causing concern is that these people varied in competence in the fisheries profession and they followed no standardized sampling procedure. The sampling programs differed according to gear used and fishing effort. Attempting to derive concrete conclusions based on data collected in such a manner is impossible. This is a difficulty faced when inappropriate experimental designs are used; that is, statistical confounding is unavoidable under these circumstances. At best, then, only rough approximations to quantitative accuracy of fish populations are possible. In other words, further study is needed with an experimental design that will provide unambiguous results.

Number of species was one statistic used to evaluate fisheries resources and water quality of the three river basins. If Gause's Principle (134) of no more than one species per ecological niche holds, then the number of species is an indication of the number of filled niches. Probably the more niches filled, the greater the production for that type of habitat. However, one should be cautious in this approach since many fishes may have a wide tolerance of habitat type and feeding habits and, therefore, niches may be poorly separated.

One species, then, might have the ability to produce as much as several species together. Number of species may also be an index to environmental disturbance. According to Patrick (139, 140) "healthy" streams contain a great many species representing various taxonomic groups. However, interpretation of results on this basis must be handled carefully. There are polluted streams that have many fish species (110). On the other hand, there are unpolluted streams that have few fish species; for example, trout streams have few species because of their cold waters. But in specific instances number of species is a useful index to the environmental conditions of a stream. For example, the presence of some fish above a point of entry of a waste and their paucity or absence below the point of entry suggests that the waste is detrimental to the fish. Of course, number of species as an index to environmental quality will take on more meaning as other kinds of information are used in conjunction with it. For example, data on kinds of fishes and their standing crops are needed to help in the appraisal of the effects of changes resulting from pollutants or from measures taken for stream improvement. All aquatic organisms are more or less sensitive to environmental changes, and the fate of any of them can be instructive concerning the nature and magnitude of these changes. Data on abundance of the different age classes for non-migratory fish species as well as average growth rates is significant. Numerous representatives of different age classes whose growth rates are

average suggest no environmental anomalies which are restrictive to these fishes have occurred in recent times.

According to Ramsey (142) many fishes in the minnow family (Cyprinidae) are good indicators of "clean" water. In this study Notropis spp. (shiners), which belong to the minnow family, were used as a biological indicator of undisturbed environmental conditions because they were widespread in the river systems. There appeared to be no distributional or ecologic limitation problem for these minnows. However, it should be pointed out that no real knowledge of the specific factors which limit the distribution and abundance of the Notropis spp. is known. That is, before these minnows will be of much value as indicator organisms it must be determined if their absence at a locality is due to pollutional damage or to natural habitat limitation.

The percentage of sport fish, rough fish, and minnows taken per sample were used with corresponding information on total number of species and number of Notropis spp. to formulate some idea of the environmental status of the river basins' water resources. Sport fish were arbitrarily defined as small insectivorous fish (bluegills, crappies, other sunfishes, etc.), and secondary predators (largemouth bass, trout, blue catfish, etc.). Rough fish were considered as species with relatively short food chains (gizzard shad, buffalo, carp, suckers, etc.). Minnows were mainly fishes belonging to the family Cyprinidae

(carp excluded). See Table 5 for specific separation of fishes to sport, rough, and minnow groups. The status of a fish population may indicate suitable or unsuitable environmental conditions. But it should be pointed out that the water quality requirements of most fish have never been adequately investigated, so there is no real information of environmental factors which limit fish distribution and abundance; that is, the value of fish as indicators of water conditions for uses other than fishing has not been shown.

The data on number of species, rough fish, sport fish, and minnows are summarized according to river basin and habitat (Tables 6-9). The data represent 23 years of field investigations; therefore, any changes that may have occurred in a habitat during this period is obscured. So, caution should be exercised in evaluating significance of any results. Two of the habitat classifications are mainstream and deep storage impoundments. The mainstream impoundments are arbitrarily defined as bodies of water less than 3,000 acres, and the deep storage impoundments are defined as bodies of water greater than 3,000 acres. Other habitat designations are minor, major, and principal streams. Minor streams are defined as intermittent streams (148); i.e., streams which receive their waters mostly from runoff, and because the runoff is seasonal, stream flow occurs only during wet periods. Major streams are permanent streams (148), i.e., streams which receive their waters mostly through seepage and springs from subsurface water and are tributaries

Table 5. An arbitrary separation of fishes for the Guadalupe, San Antonio, and Nueces river basins into sport, rough, and minnow classifications (Common names obtained from Bailey, et al. (7))

Sport Fishes	Rough Fishes	Minnows
Rainbow trout	Alligator gar	Mexican tetra
Channel catfish	Spotted gar	Golden shiner
Blue catfish	Longnose gar	Pugnose minnow
Flathead catfish	Threadfin shad	Speckled chub
American eel	Gizzard shad	Texas shiner
White bass	Carp	Silverband shiner
Spotted bass	Goldfish	Weed shiner
Guadalupe bass	Blue sucker	Pallid shiner
Largemouth bass	Smallmouth buffalo	Blacktail shiner
Warmouth	River carpsucker	Red shiner
Green sunfish	Grey redhorse	Sand shiner
Spotted sunfish	Spotted sucker	Mimic shiner
Redear sunfish	Lake chubsucker	Ghost shiner
Bluegill	Black bullhead	Roundnose minnow
Orangespotted sunfish	Yellow bullhead	Bullhead minnow
Redbreast sunfish	Freshwater drum	Fathead minnow
Longear sunfish	Mozambique tilapia	Stoneroller
Rock bass		Tadpole madtom
White crappie		Rainwater killifish
Black crappie		Gulf killifish
Rio Grande perch		Blackstripe topminnow
Smallmouth bass		Sheepshead minnow
		Largespring gambusia
		Mosquito fish
		San Marcos gambusia
		Sailfin molly
		Amazon molly
		Tidewater silverside
		Dusky darter
		River darter
		Logperch
		Big scale logperch
		Bluntnose darter
		Slough darter
		Orangethroat darter
		Greenthroat darter
		Fountain darter

Table 6. A comparison of the average number of fish species taken by seines from the Guadalupe, Nueces, and San Antonio river basins (1950-1972).

River Basins	Sources of Data	Average Number of Fish Species				
		Impoundments		Streams		
		Mainstream[1]	Deep Storage[2]	Minor[3]	Major[4]	Principal[5]
Guadalupe:	109, 182, 192, 193, 199, 210, 213, 223, 236, 243, 266, 269, 285, 295.	10	13	4	12	14
Nueces:	174, 181, 183, 184, 186, 191, 197, 207, 217, 222, 229, 237, 240, 245, 246, 251, 263, 268, 296, 297.	7	12	7	7	11
San Antonio:	168, 170, 171, 177, 190, 194, 201, 223, 232, 233, 236, 240, 247, 268, 278, 296.	9	14	6	8	4
Weighted Mean		10	13	5	9	7

1 Impoundments arbitrarily defined as bodies of water less than 3,000 acres.
2 Impoundments arbitrarily defined as bodies of water greater than 3,000 acres.
3 Intermittent streams (148).
4 Permanent streams that are tributaries to principal streams (148).
5 The permanent stream from which the river basin gets its name.

Table 7. A comparison of the average number of fish species taken by gill nets from the Guadalupe, Nueces, and San Antonio river basins (1950-1972).

River Basins	Sources of Data	Average Number of Fish Species				
		Impoundments		Streams		
		Mainstream[1]	Deep Storage[2]	Minor[3]	Major[4]	Principal[5]
Guadalupe:	109, 182, 192, 193, 199, 210, 213, 223, 236, 243, 266, 269, 285, 295.	11	27	--	8	9
Nueces:	174, 181, 183, 184, 186, 191, 197, 207, 217, 222, 229, 237, 240, 245, 246, 251, 263, 268, 296, 297.	9	14	10	8	9
San Antonio:	168, 170, 171, 177, 190, 194, 201, 223, 232, 233, 236, 240, 247, 268, 278, 296.	9	15	6	6	8
Weighted mean		10	21	9	7	8

1 Impoundments arbitrarily defined as bodies of water less than 3,000 acres.
2 Impoundments arbitrarily defined as bodies of water greater than 3,000 acres.
3 Intermittent streams (148).
4 Permanent streams that are tributaries to principal streams (148).
5 The permanent stream from which the river basin gets its name.

Table 8. A comparison of the percentage of rough fish, sport fish, and minnows taken by seine from the Guadalupe, Nueces, and San Antonio river basins (1950-1972).

River Basins	Sources of Data	Rough Fish (%)			Sport Fish (%)			Minnows (%)		
		Main-stream[1]	Deep Stor-age[2]	Streams[3]	Main stream[1]	Deep Stor-age[2]	Streams[3]	Main stream[1]	Deep Stor-age[2]	Streams[3]
Guadalupe:	109, 182, 192 193, 199, 210, 213, 223, 236, 243, 266, 269, 285, 295.	15	45	1	41	17	17	44	38	82
Nueces:	174, 181, 183, 184, 186, 191, 197, 207, 217, 222, 229, 237, 240, 245, 246, 251, 263, 268, 296, 297.	0	31	3	19	4	15	81	65	82
San Antonio:	168, 170, 171, 177, 190, 194, 201, 223, 232, 233, 236, 240, 247, 268, 278, 296.	5	6	1	34	35	14	61	59	85
Weighted Percentages		8	29	2	36	11	15	56	60	83

1 Impoundments arbitrarily defined as bodies of water less than 3,000 acres.
2 Impoundments arbitrarily defined as bodies of water greater than 3,000 acres.
3 Intermittent and permanent streams combined.

Table 9. A comparison of the percentage of rough fish, sport fish, and minnows taken by gill nets from the Guadalupe, Nueces, and San Antonio river basins (1950-1972).

River Basins	Sources of Data	Rough Fish (%)			Sport Fish (%)			Minnows (%)		
		Main-stream[1]	Deep Stor-age[2]	Streams[3]	Main stream[1]	Deep Stor-age[2]	Streams[3]	Main stream[1]	Deep Stor-age[2]	Streams[3]
Guadalupe:	109, 182, 192 193, 199, 210, 213, 223, 236, 243, 266, 269, 285, 295.	59	63	78	39	37	22	2	0	0
Nueces:	174, 181, 183, 184, 186, 191, 197, 207, 217, 222, 229, 237, 240, 245, 246, 251, 263, 268, 296, 297.	71	58	78	29	42	22	0	0	0
San Antonio:	168, 170, 171, 177, 190, 194, 201, 223, 232, 233, 236, 240, 247, 268, 278, 296.	54	64	78	44	36	22	2	0	0
Weighted Percentages		61	61	78	37	39	22	2	0	0

1 Impoundments arbitrarily defined as bodies of water less than 3,000 acres.
2 Impoundments arbitrarily defined as bodies of water greater than 3,000 acres.
3 Intermittent and permanent streams combined.

to principal streams. A principal stream is a permanent stream from which the river basin gets its name. Admittedly, this classification of habitats is broad.

A comparison of the average number of fish species for the Guadalupe, Nueces, and San Antonio river basins are given in Table 6 (seine data) and Table 7 (gillnet data). The weighted means given for each habitat type represent the average number of species for all three river basins combined. The largest weighted mean was associated with deep storage impoundments. This value may indicate a more diverse habitat for deep storage impoundments than for mainstream impoundments and streams. Mainstream impoundments had a larger weighted mean than did streams, but the difference probably is not significant since these impoundments are river-like in nature. Comparisons between stream habitats gave varied results. In Table 6, minor streams had a smaller weighted mean than did the major or principal streams, but the reverse situation was seen in Table 7. In Tables 6 and 7 no appreciable difference between the average number of fish species for each river basin within any of the habitat groups was noted. However, the Guadalupe River Basin did have a greater, or at least an equivalent, average for each habitat classification than did the other two river basins except in the case of minor streams. This river basin probably has a greater diversity of habitat as compared to the other basins because it extends farther onto the Edwards Plateau.

Comparison of the percentage of rough fish, sport fish, and minnows are given by Table 8 (seine data) and Table 9

(gillnet data). Percentages are given for mainstream and deep storage impoundments, and streams. The various kinds of streams (defined in this report as minor, major, and principal) were combined to facilitate presentation of the data. Obviously, the results may change with the subdivision of the stream category to minor, major, and principal streams. But hopefully, a representative picture of the population structure for impoundments and stream habitats is obtained from the habitat classification used in Tables 8 and 9. The weighted percentages listed for each habitat represent the percentage of rough fish, sport fish, and minnows respectively for the three river basins combined.

In Table 8 the weighted percentages indicated that rough fish populations were larger in impoundments than in streams, sport fish populations were greater in stream-like habitats (mainstream impoundments and streams) than in deep storage impoundments, and streams had more minnows in their fish populations than did impoundments. Most of the rough fish taken by seines were young-of-the-year gizzard shad that happened to be in shallow water at the time of sampling. The sport fish were mainly small sunfish.

In Table 9 the weighted percentages indicated a larger rough fish population for streams than for impoundments, and more sport fish for impoundments than for streams. The results for the rough fish data were opposite to those shown by seining data in Table 8. No definite reasons that would explain these

conflicting results are readily apparent. But the rough fish as well as the sport fish gillnet data represented a wider size and species range than did seining data. Therefore, the gillnet data may be more representative of the true population structure than was the seining data. Gill nets rarely caught minnows, but occasionally large golden shiners were taken. When these minnows were caught they came from impoundment habitats in either the Guadalupe or San Antonio river basins.

Comparisons between the three river basins showed variable results for the percentages of rough fish, sport fish, and minnows in mainstream and deep storage impoundments (Tables 8 and 9). However, in streams the percentages were similar; that is, streams of the three river basins appeared to have similar population structures.

The fisheries data on number of species, percent rough fish, sport fish, and minnows have been summarized by figures for the Guadalupe (Figs. 95 to 111), San Antonio (Figs. 112 to 123), and Nueces (Figs. 124 to 149) river basins. It is intended that the figures be used only as a source of information to gain some insight to the status of the fisheries of the three river basins. However, interpretation of the figures will be left to the discretion of the user. The point is that the use of the information presented by the figures to evaluate environmental conditions is too risky at this stage. Fish are potentially useful indicators of the environmental status of an aquatic habitat. But before they can be used to reliably reflect

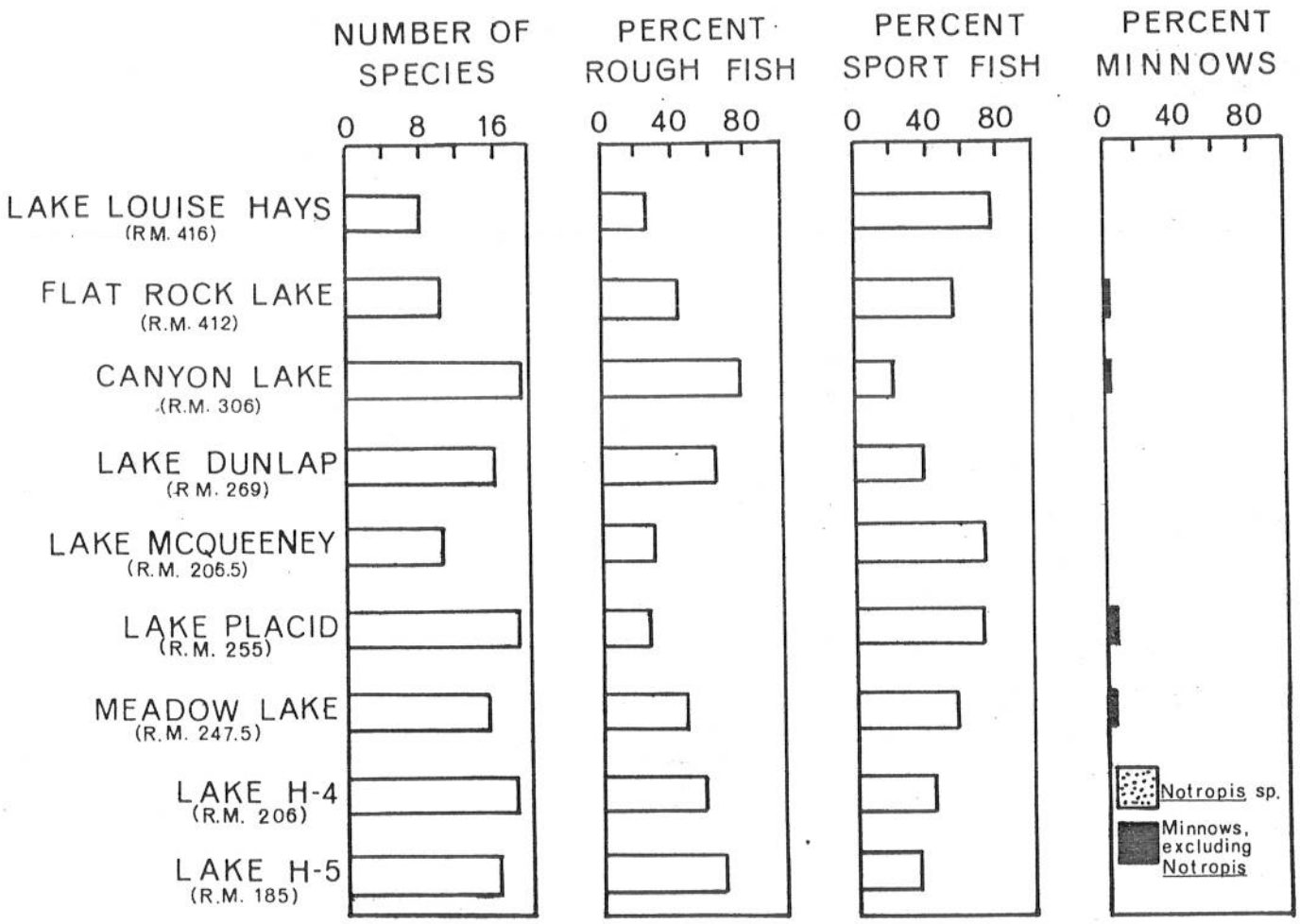

Figure 95. Number of fish species and percent number of sport fish, rough fish, and minnows, Texas Parks and Wildlife gillnet data for 1969-70, Guadalupe River Basin lakes (266, 269, 295).

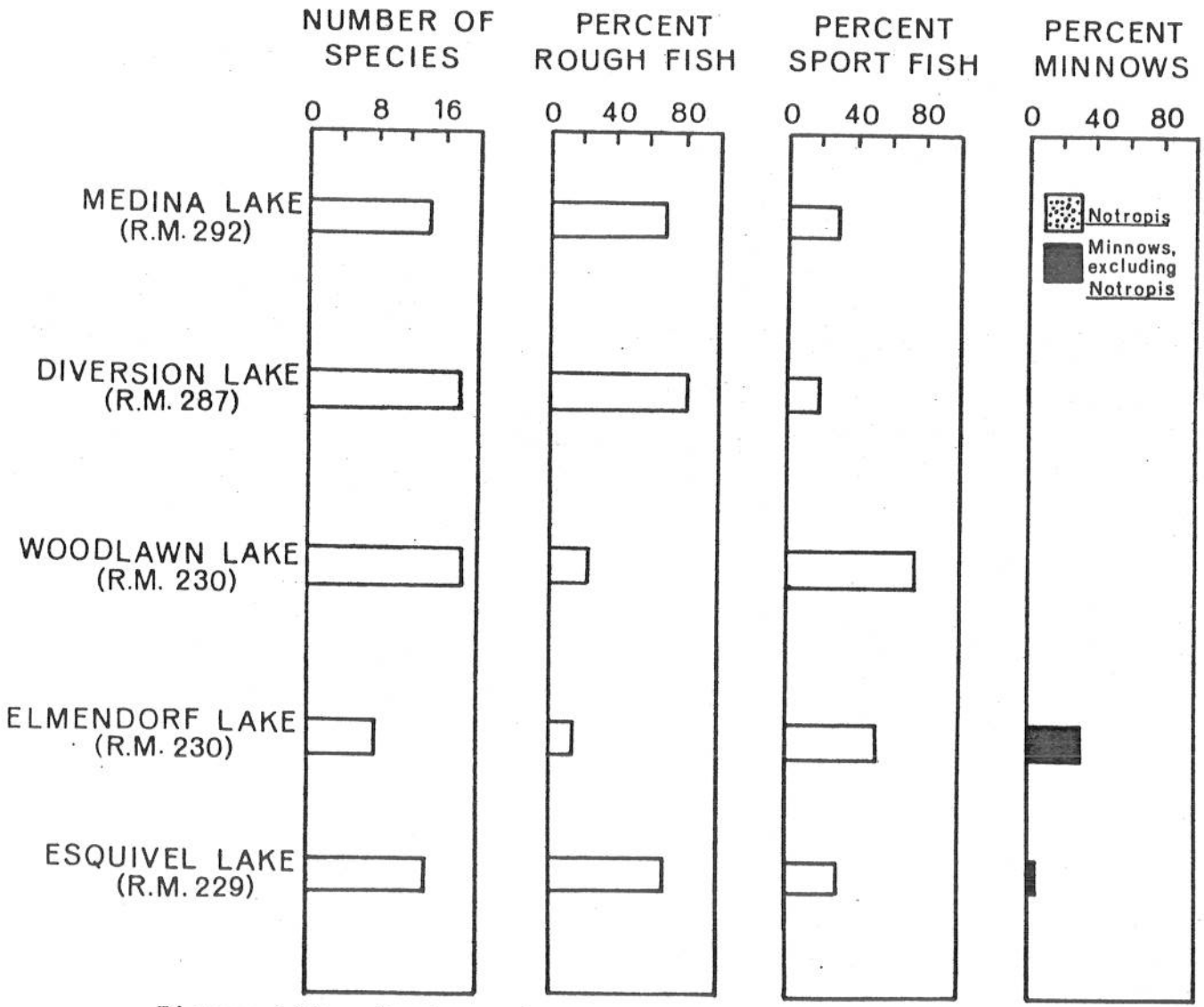

Figure 112. Number of species and percent number of sport fish, rough fish, and minnows, Texas Parks and Wildlife gillnet data for 1963-64, San Antonio River Basin lakes (232, 233, 240, 247, 248).

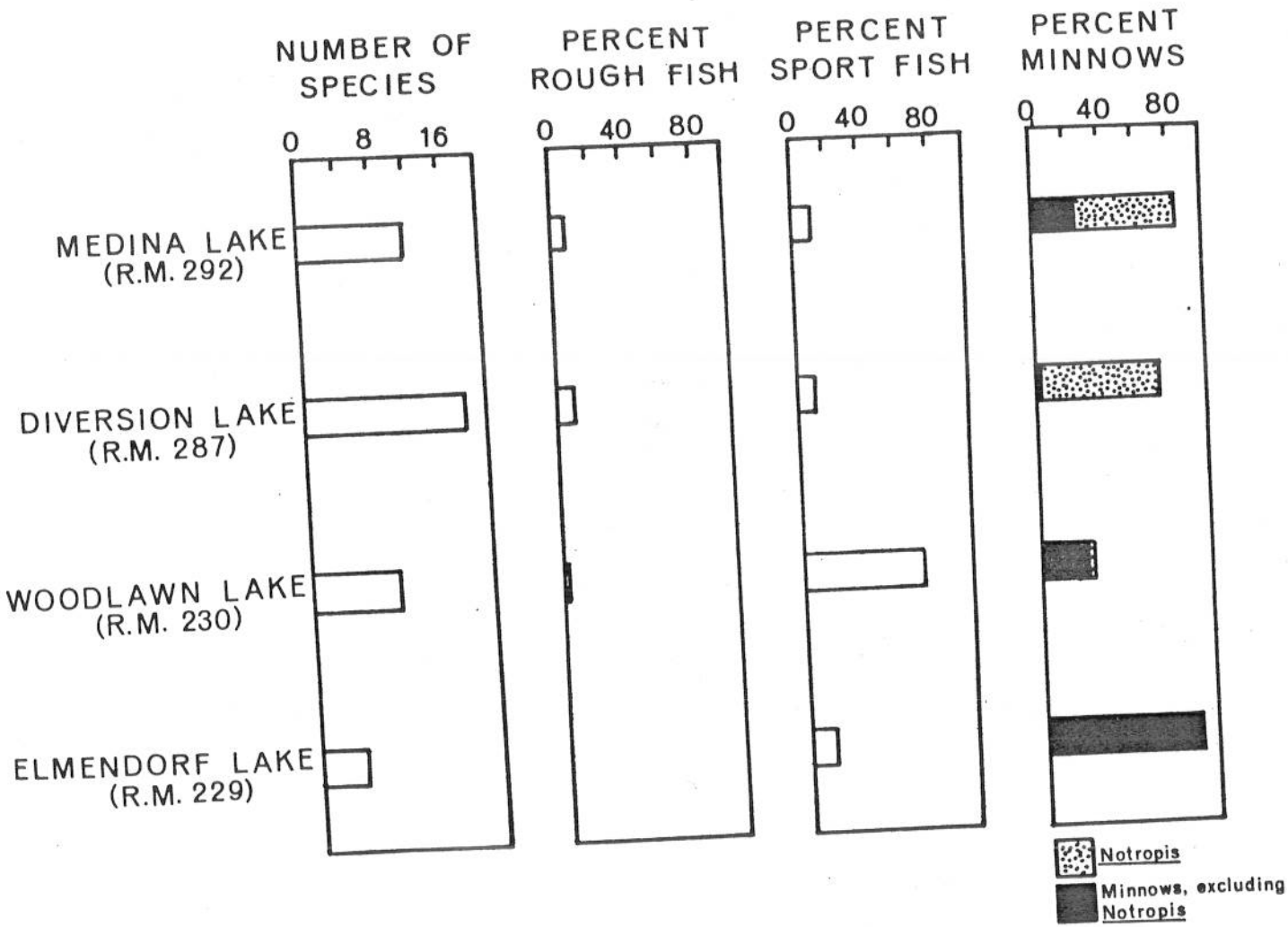

Figure 113. Number of fish species and percent number of sport fish, rough fish, and minnows, Texas Parks and Wildlife seining data for 1962-63, San Antonio River Basin lakes (232, 233, 240, 247, 248).

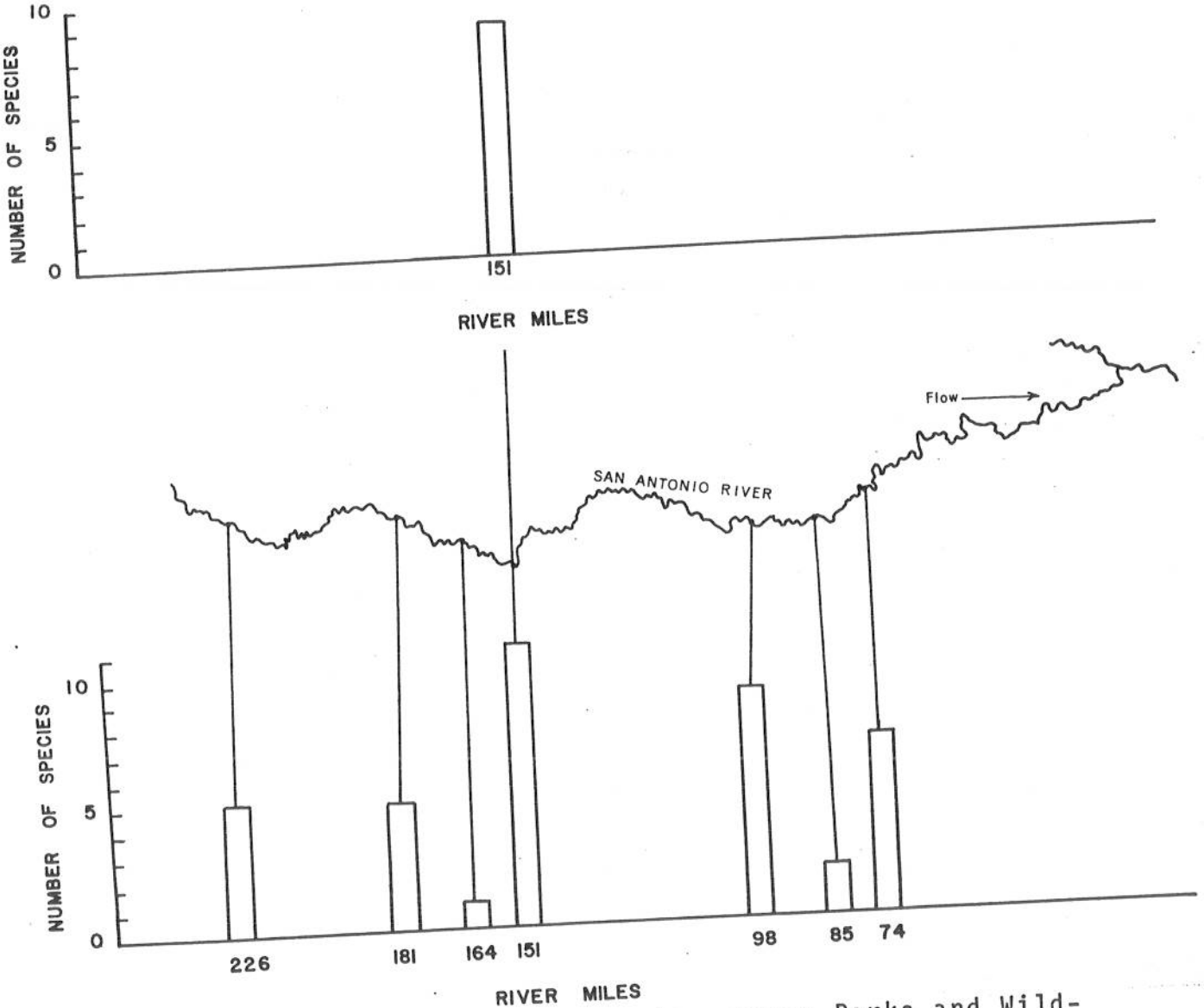

Figure 114. Number of fish species, Texas Parks and Wildlife seining data for 1958-64 (bottom) and 1968-70 (top), San Antonio River, San Antonio River Basin (240, 247, 263, 268, 296).

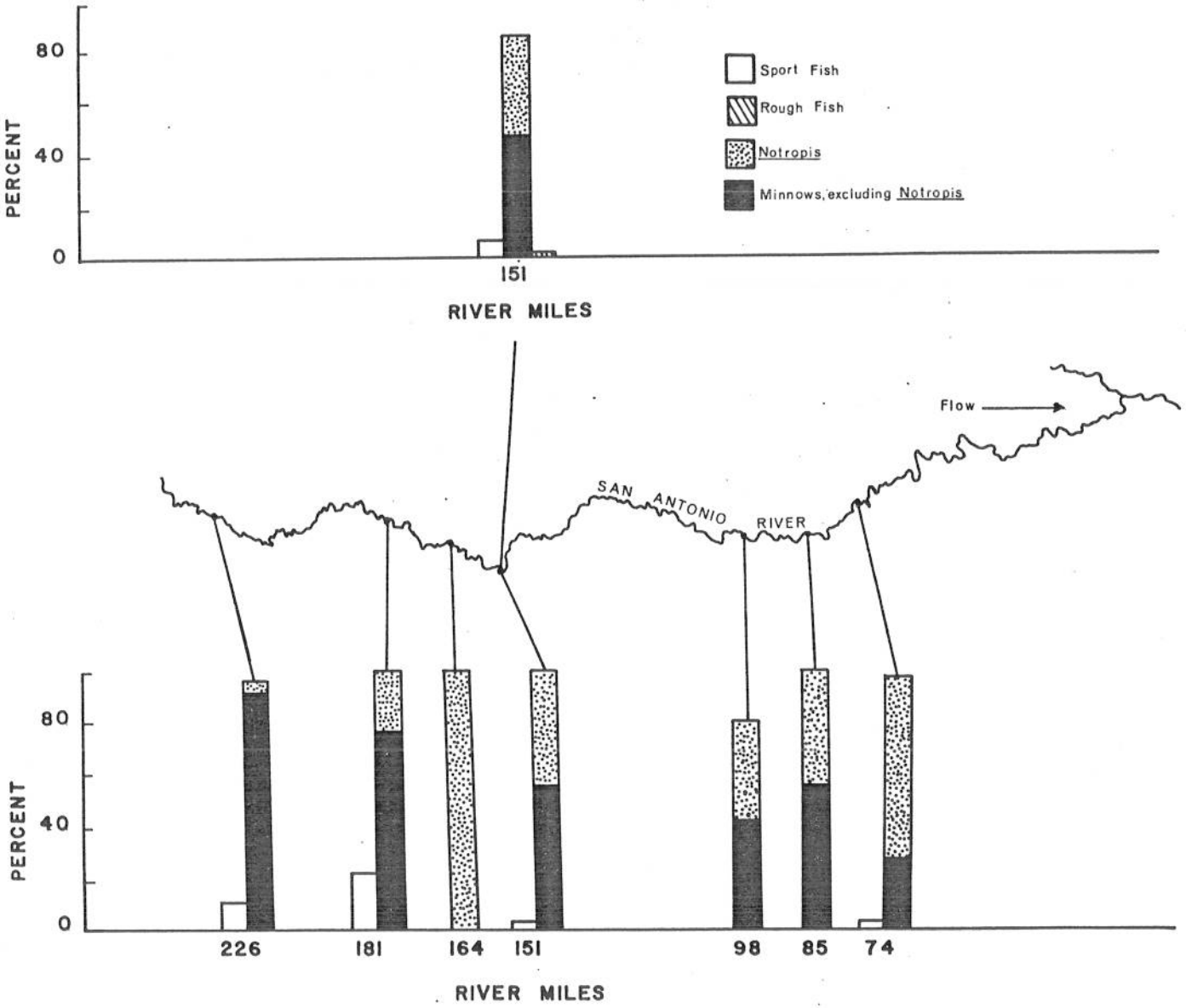

Figure 115. Percent number of sport fish, rough fish, and minnows, Texas Parks and Wildlife seining data for 1958-64 (bottom) and 1968-70 (top), San Antonio River, San Antonio River Basin (240, 247, 263, 268, 296).

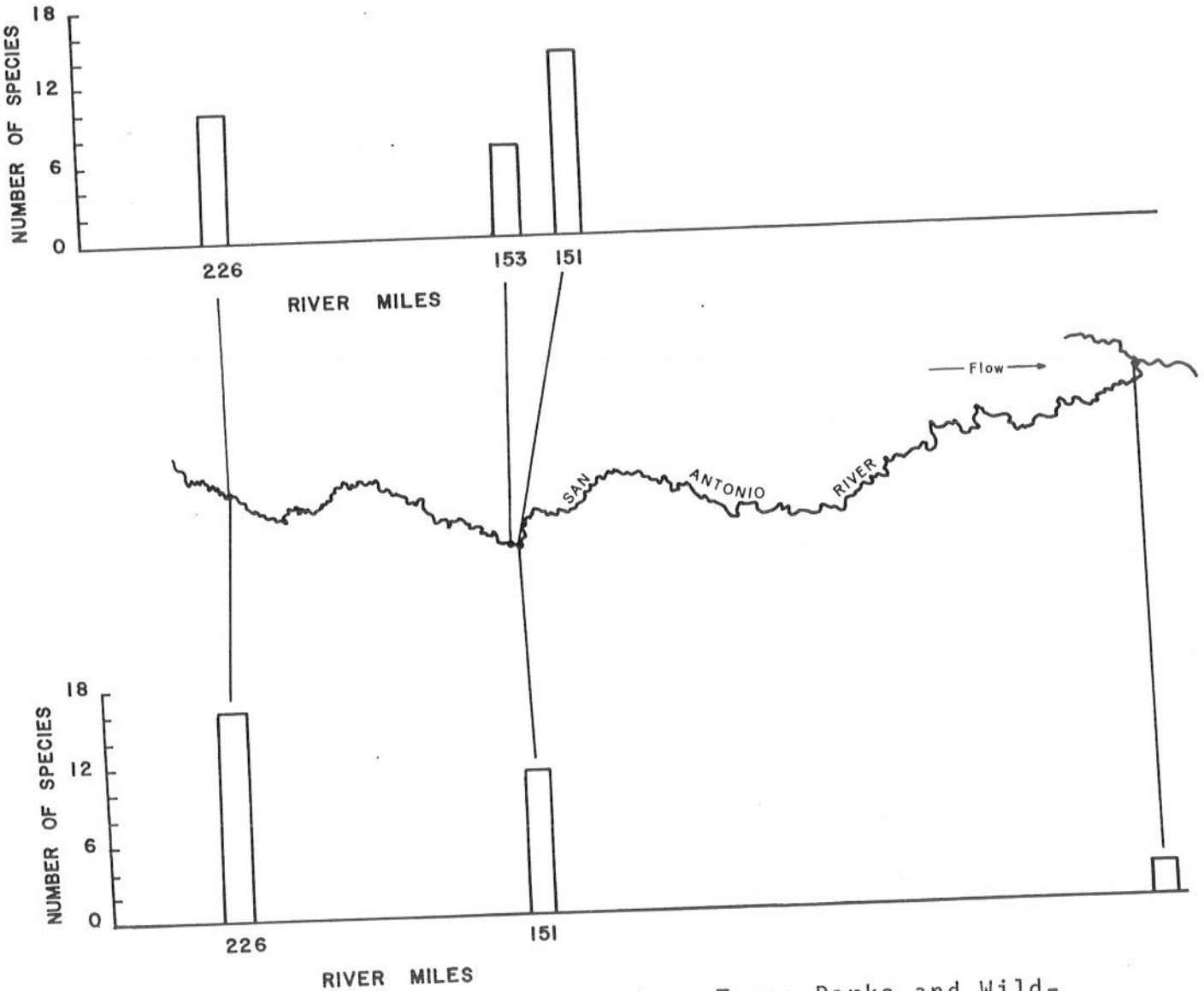

Figure 116. Number of fish species, Texas Parks and Wildlife gillnet data for 1958-64 (bottom) and 1968-70 (top), San Antonio River, San Antonio River Basin (240, 247, 263, 268, 296).

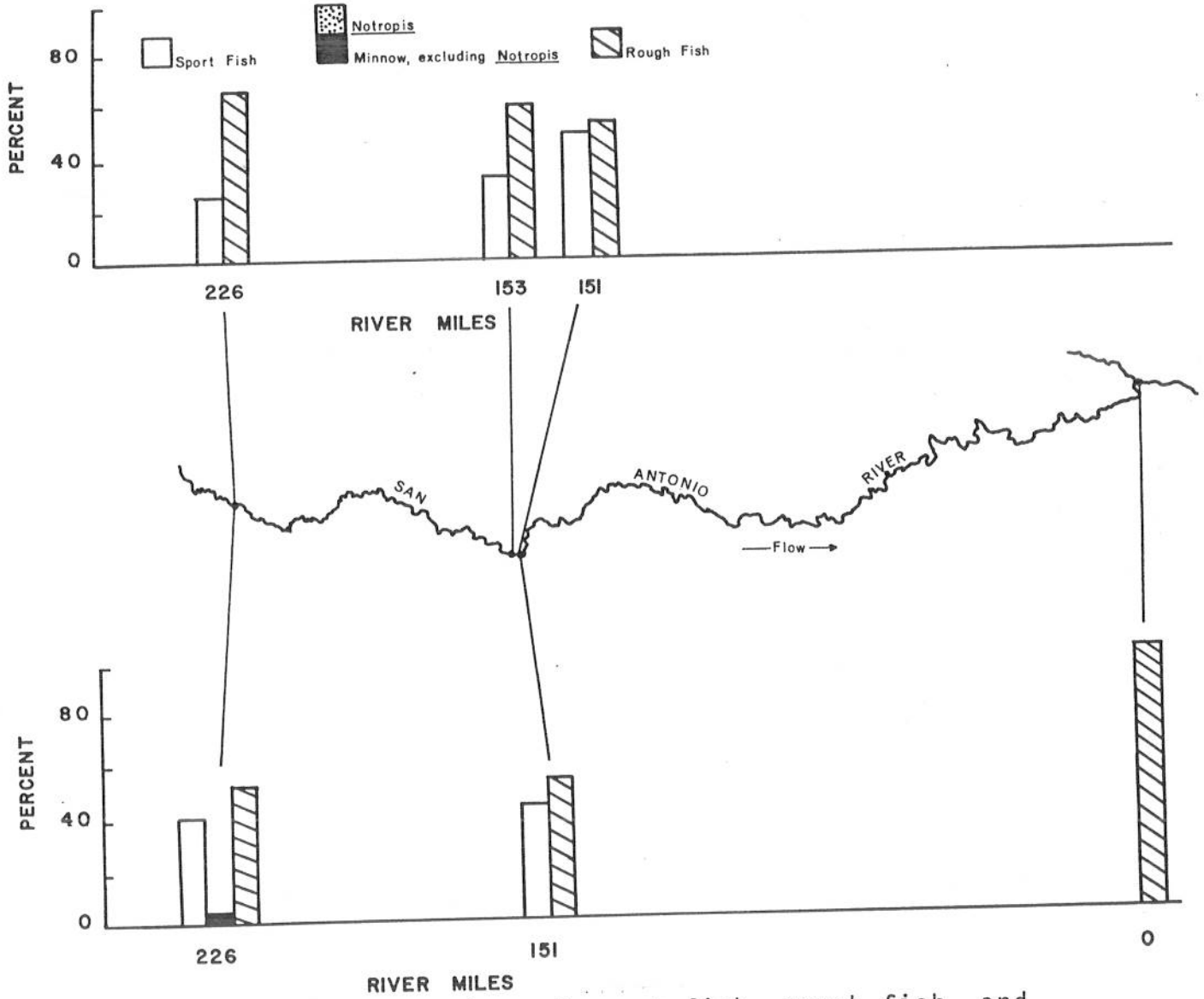

Figure 117. Percent number of sport fish, rough fish, and minnows, Texas Parks and Wildlife gillnet data for 1958-64 (bottom) and 1968-70 (top), San Antonio River, San Antonio River Basin (240, 247, 263, 268, 296).

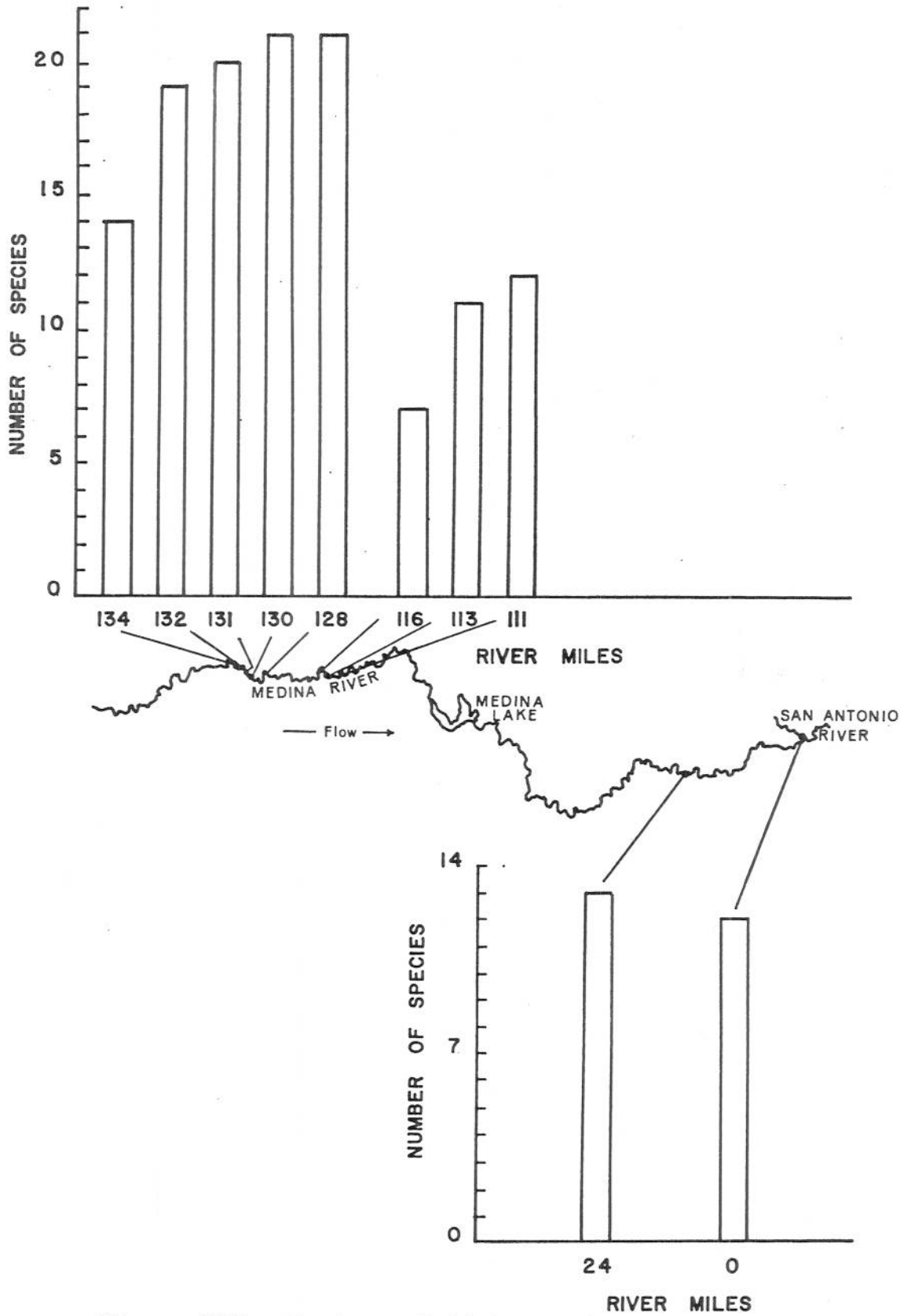

Figure 118. Number of fish species, Texas Parks and Wildlife rotenone data (top) and combined seining and gillnet data (bottom) for 1953-54, Medina River, San Antonio River Basin (170).

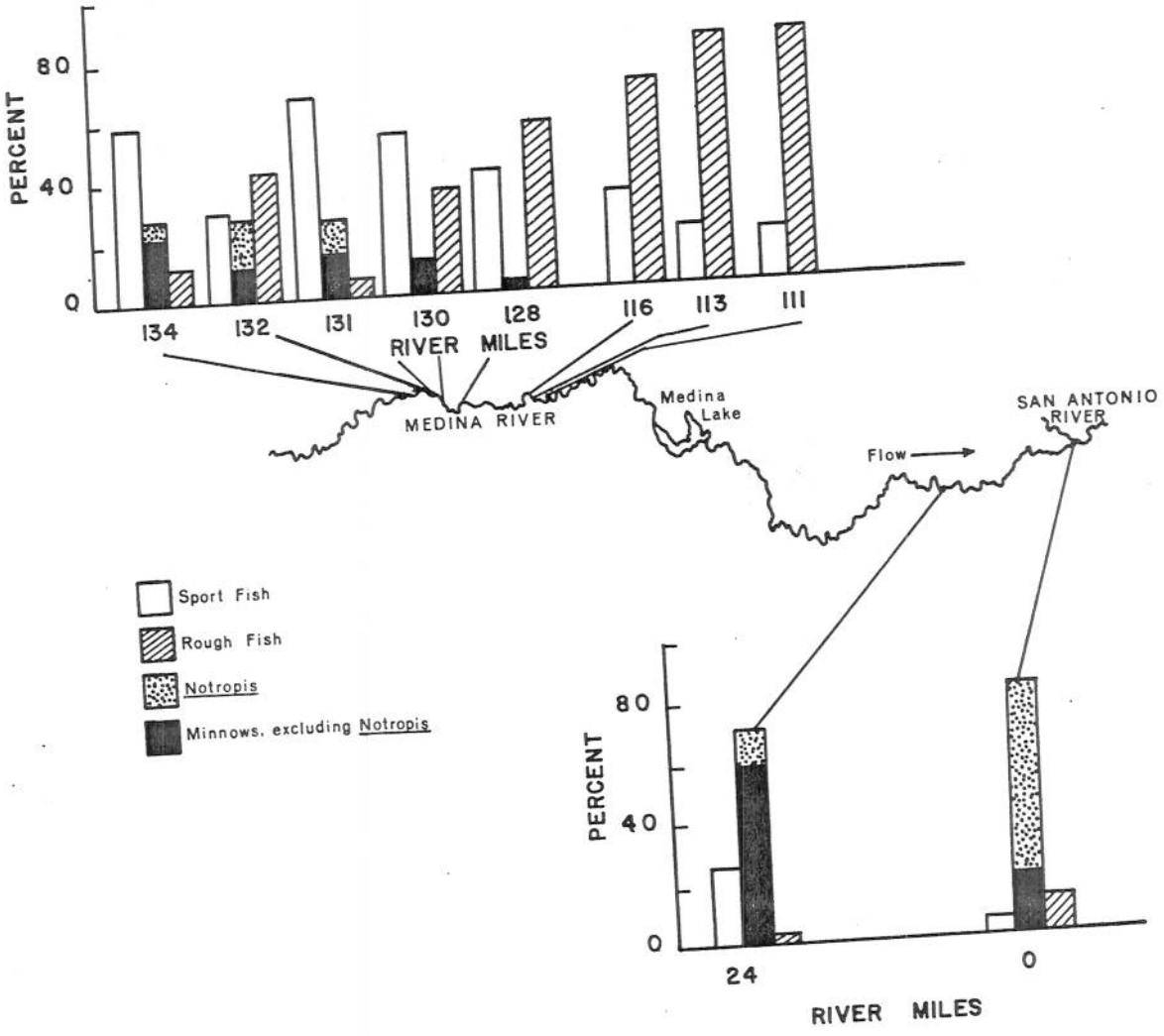

Figure 119. Percent number of sport fish, rough fish, and minnows, Texas Parks and Wildlife rotenone data (top) and combined seining and gillnet data (bottom) for 1953-54, Medina River, San Antonio River Basin (170).

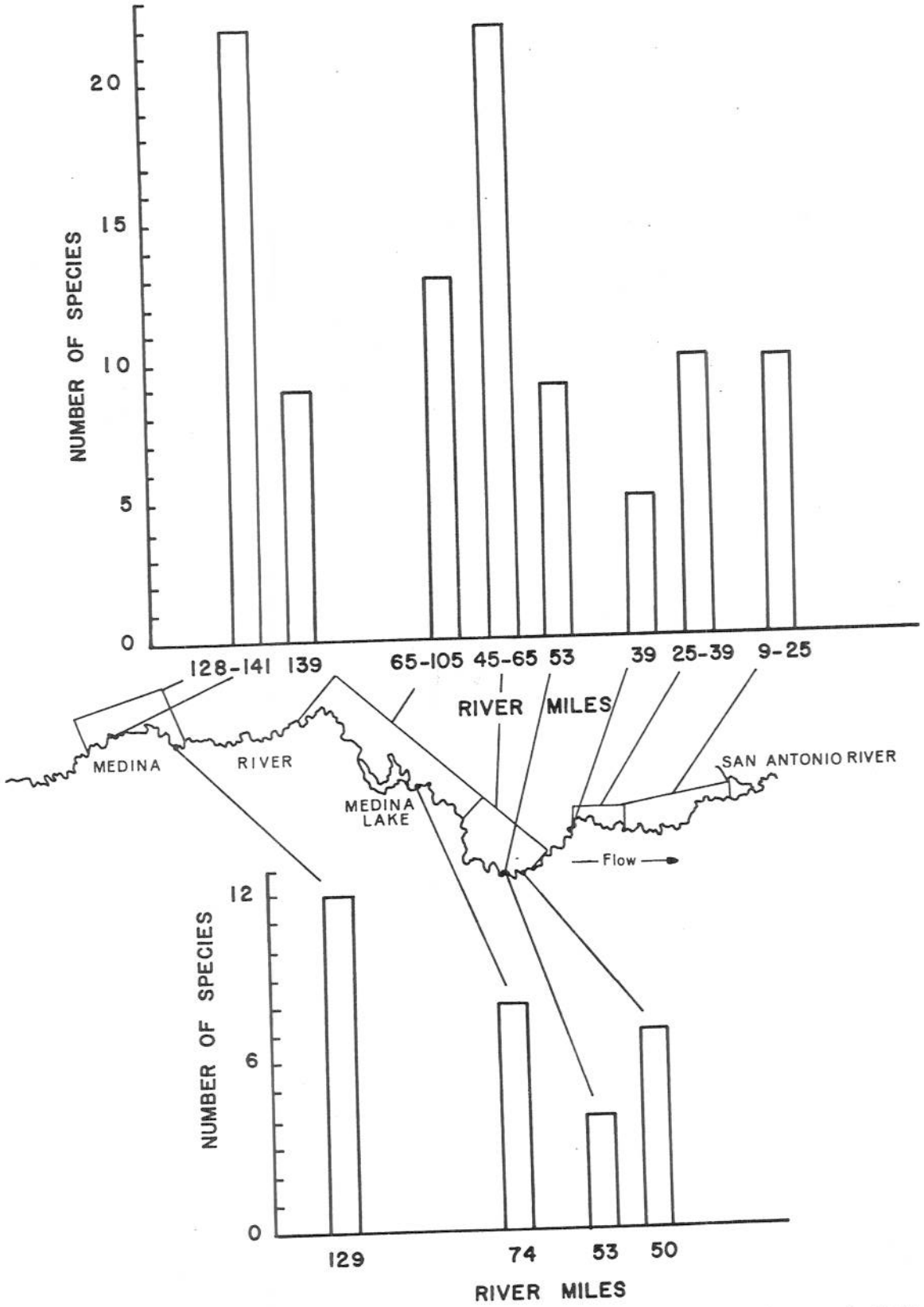

Figure 120. Number of fish species, Texas Parks and Wildlife seining data (top) and gillnet data (bottom) for 1953-54, Medina River, San Antonio River Basin (170).

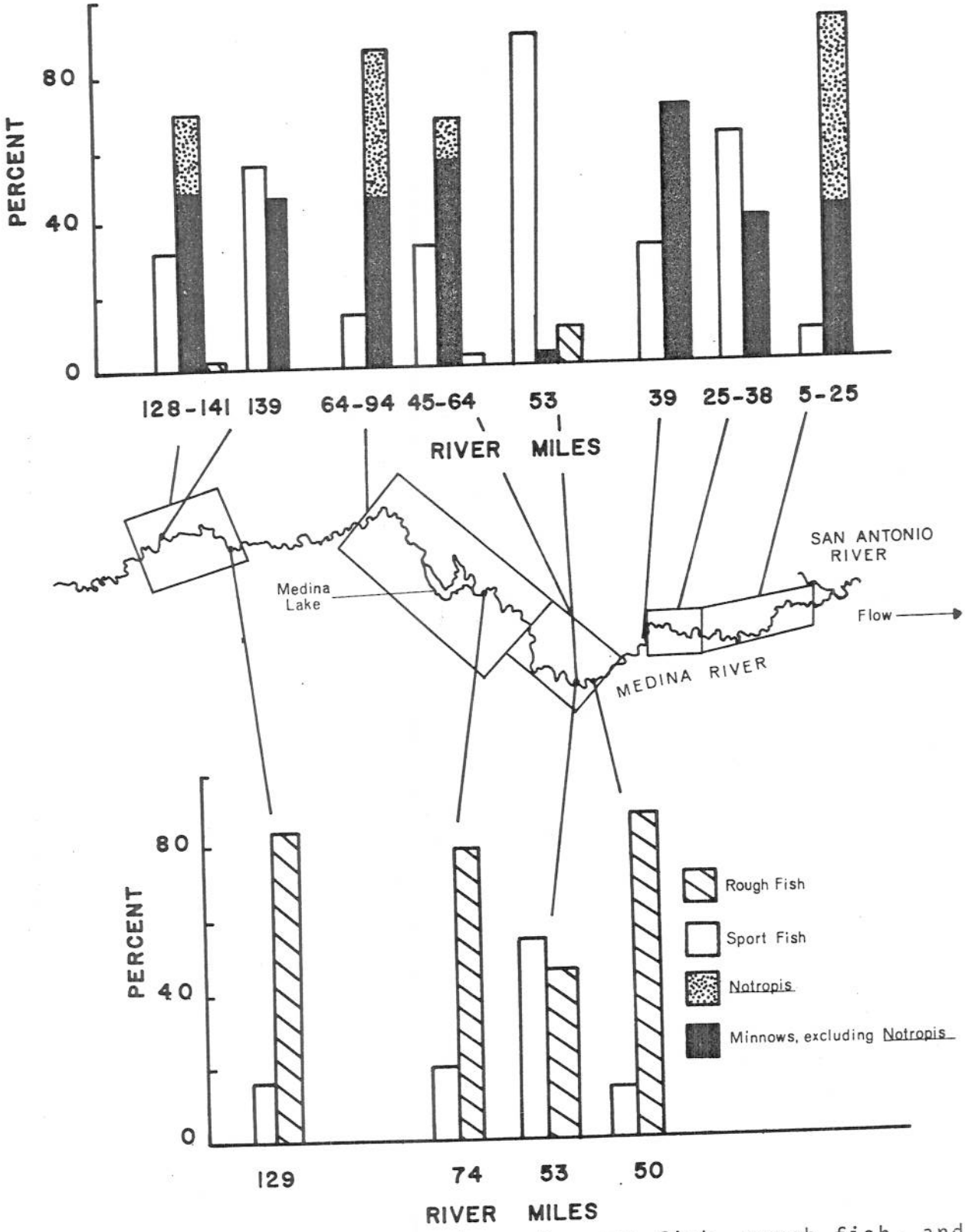

Figure 121. Percent number of sport fish, rough fish, and minnows, Texas Parks and Wildlife seining data (top) and gillnet data (bottom) for 1953-54, Medina River, San Antonio River Basin (170).

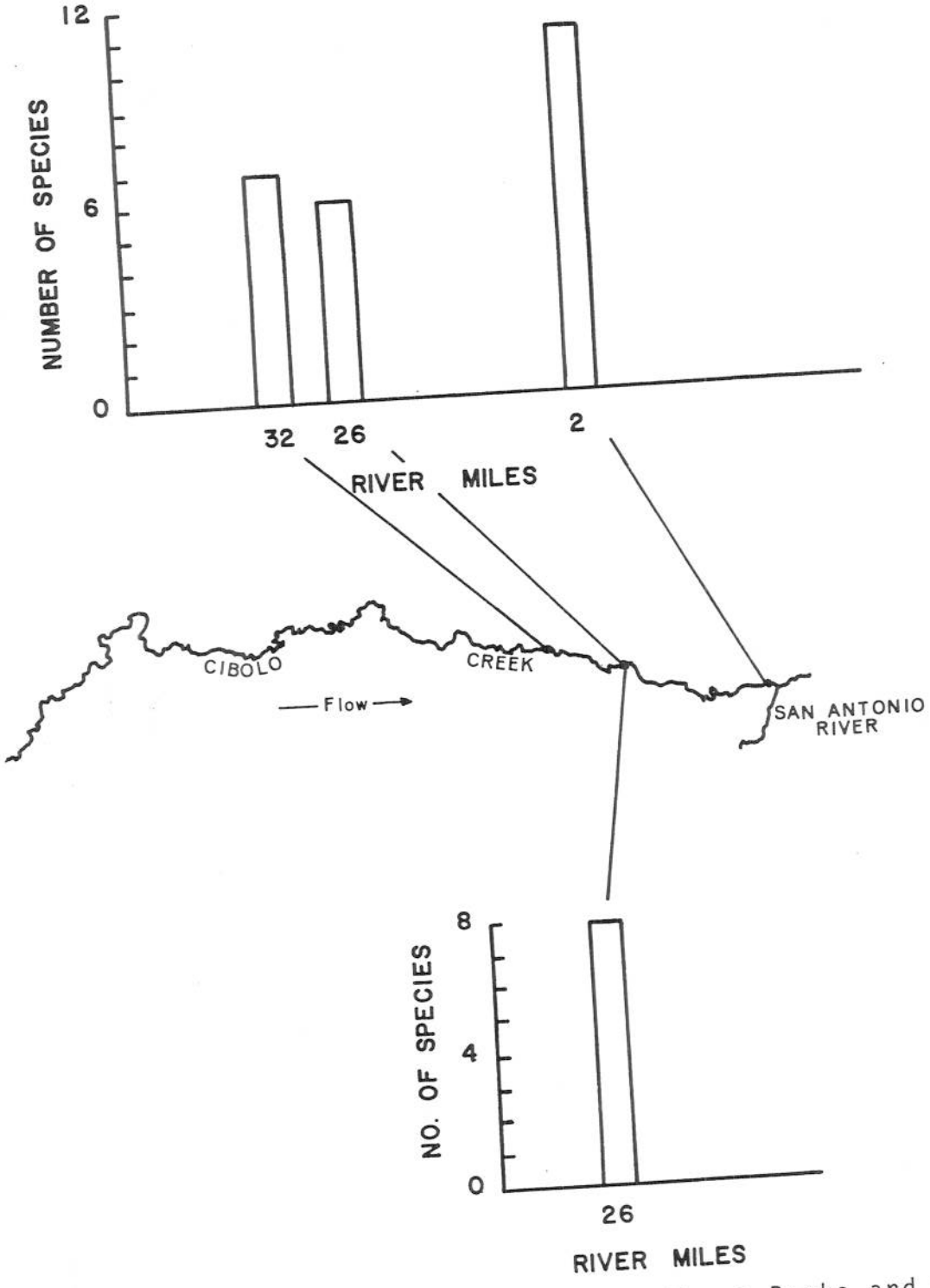

Figure 122. Number of fish species, Texas Parks and Wildlife seining data (top) and gillnet data (bottom) for 1962-64, Cibolo Creek, San Antonio River Basin (296).

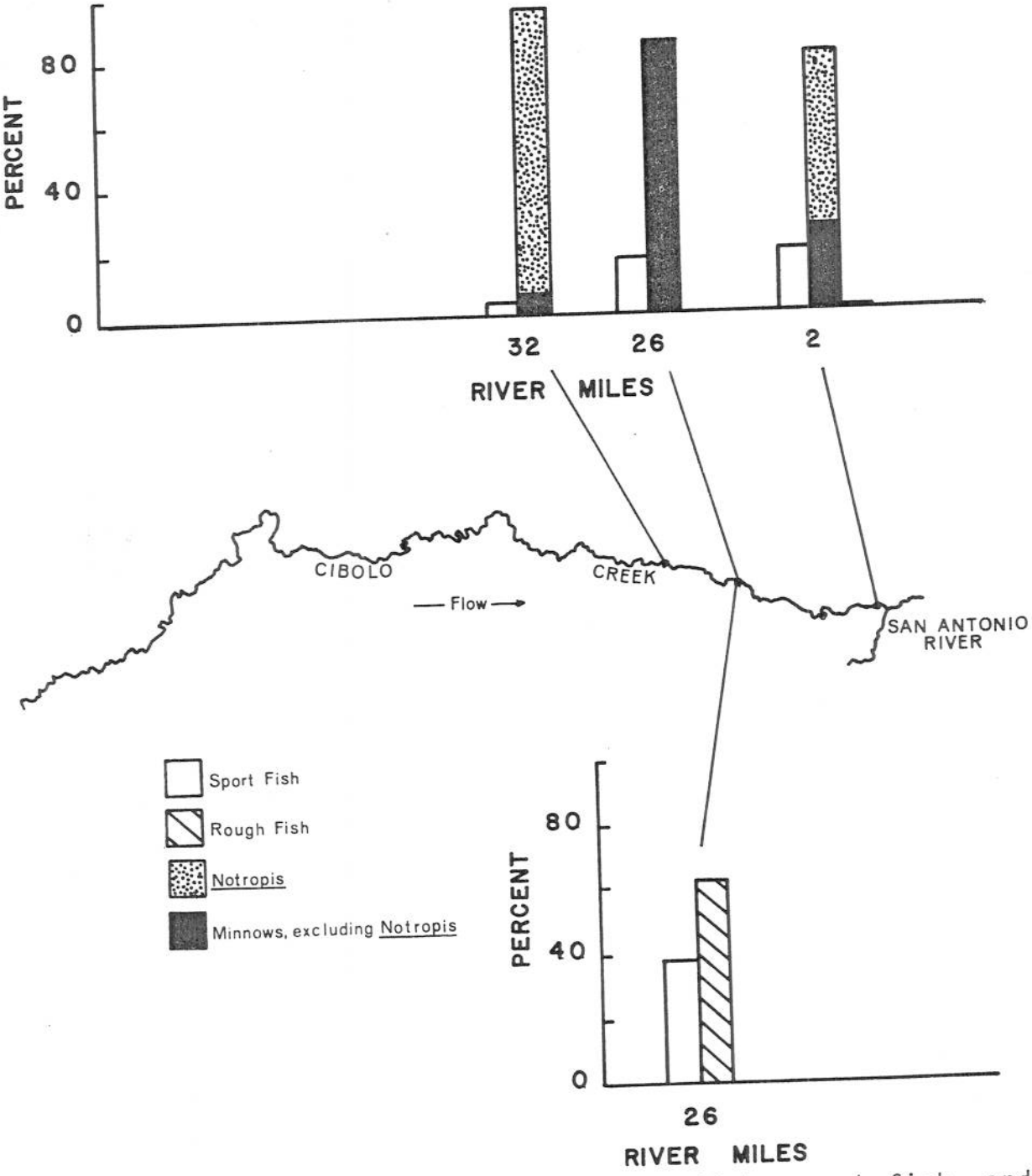

Figure 123. Percent number of sport fish, rough fish, and minnows, Texas Parks and Wildlife seining data (top), and gillnet data (bottom) for 1962-64, Cibolo Creek, San Antonio River Basin (296).

the suitability or unsuitability of the environment the fish species present, their relative abundance, condition, number of year classes, growth of the different year classes, and reproductive success must be shown to be an index of something tangible. In other words, the habitat preferences, natural food, water quality requirements, etc. for the various species of fish must be known. To begin to answer these questions a good sampling procedure must be used to get a representative picture of the fish population. A sampling design is needed that will adjust for gear selectivity and allow for maximal gear efficiency relative to the habits of the fishes. Such a design, then, will necessitate the use of chemicals or a combination of sampling methods based on the probable distribution of fishes by habitat. Unfortunately, fishery data taken by such a carefully planned sampling method are not available for analysis at present.

AQUATIC INVERTEBRATES

The aquatic invertebrates have received little attention in Texas. The limited information about aquatic invertebrates in published papers, theses, and state reports bears this out. The available information has been found after a diligent search of records. It is apparent that in the limited duration of this study a complete list of all records pertaining to aquatic invertebrates could not be compiled, since many scattered

communities but not by routine chemical analysis include: periodic releases of organic matter, the occurrence of toxic wastes such as heavy metals or pesticides, or occasional releases of salt from brine holding tanks in oil fields.

The cave invertebrates were not discussed or listed in the previous discussion though many of them are aquatic. Reddel (145, 146) listed several endemic forms that occur in caves throughout this river basin. The most notable forms occur in Ezell's Cave located in the underground Purgatory Creek system in San Marcos (121, 145).

Aquatic Invertebrates of the San Antonio River Basin

Very little work has been done on the aquatic invertebrates, other than cave forms, in the San Antonio River Basin. Locations of invertebrate collection sites in this basin are given in Figure 151.

Mollusca:

Several publications (32, 51, 160, 161) listed mollusks that occur in this river basin. In addition, Murray and Roy (130) gave a checklist that included 88 clams and 96 freshwater snails from Texas, but they did not give distribution information and the report contained some apparent inaccuracies as to which snails are aquatic and which are terrestrial. The most valuable contribution of the paper was a good bibliography of the Mollusca

Figure 151. San Antonio River Basin aquatic invertebrate collecting locations.

Location	River Mile	Stream
1	0.7	San Antonio River
2	195.1	San Antonio River
3	198.0	San Antonio River
4	19.0	Salado Creek
5	55.0	Leon Creek

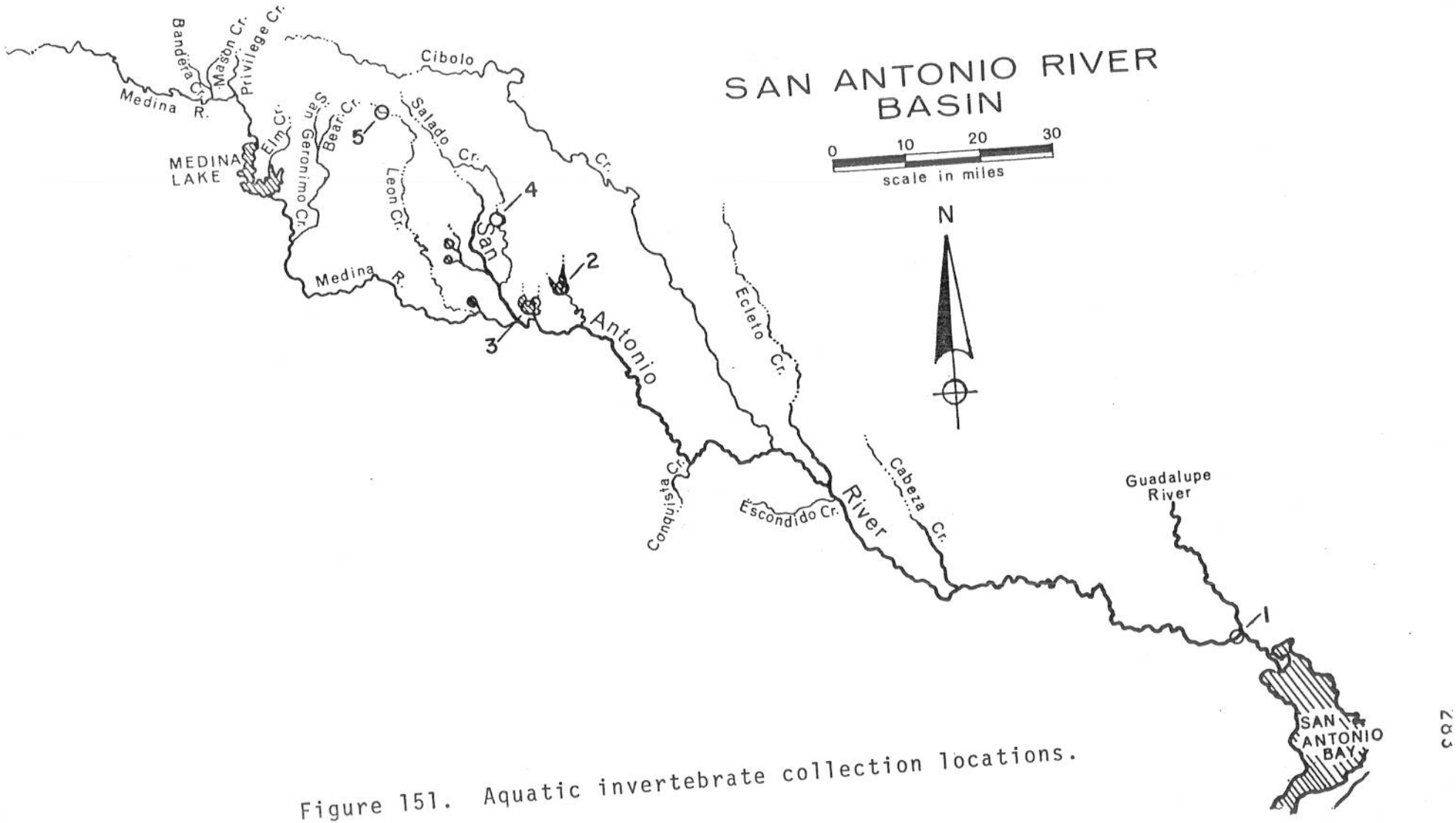

Figure 151. Aquatic invertebrate collection locations.

literature of Texas. A list of Mollusca recorded from this basin is given in Table 17.

Annelida:

Giesler (67) reported oligochaete worms in bottom samples from Braunig and Calaveras lakes, but he did not identify them further.

Crustacea:

Publications on the Crustacea gave only fragmentary reports of the forms found in the San Antonio River Basin (38, 58, 79, 141) and these are summarized in Table 18. Of interest are reports (58, 79) that Macrobrachium spp. were once found in San Pedro Springs in San Antonio. Since they have not been reported in recent years, they have apparently been eliminated from the headwaters of the San Antonio River by some environmental condition.

Insecta:

Very little is known of the aquatic insects of this basin. The San Antonio River Authority (SARA) plans to begin taking stream bottom macroinvertebrate samples at their collecting stations in the fall of 1972 (Ken Cave, SARA, personal communication). The lack of records of insects in this basin

Table 17. Aquatic mollusca reported from the San Antonio River Basin, Texas

Taxonomic unit	Reference	Location
Gastropoda		
Basommatophora		
Physidae		
Physa virgata	33	Statewide
P. humerosa	32	Bexar Co.
P. halei	51,154,161	Bexar Co.
P. amygdalus	161	Type Locality-"Texas"
Lymnaeidae		
Lymnaea (=Fossaria) humilis	33,130	Statewide
L. bulimoides techella	33	Statewide
L. desidosa	51,154	Leon Cr., Bexar Co.
Pseudosuccinea columella	33,154	Statewide
Galba bulimoides techella	161	San Antonio R., Bexar Co.
G. drussa	161	Leon Cr.,Bexar Co.
Planorbidae		
Gyraulus parvus	33	Statewide
Helisoma trivolvis lentum	33	Statewide
H. tenue	32	Bexar Co.
Promenetus exacuous	33	Statewide
Tropicorbis obstructus	33	Statewide
T. liebmanni	32	Bexar Co.
Planorbis bicarinatus (=*Helisoma anceps*)	130,154	San Antonio R., Bexar Co.
P. antrosus	161	San Antonio R., Bexar Co.
P. lentus	161	"Common in all streams"
P. liebmanni	51,154	Leon Cr.,Bexar Co.
P. trivolvis	125,161	(Creek), San Antonio Bexar Co.
Segmetina ammigira	154	Leon Cr.,Bexar Co.
S. havanensis	154	(Collected by Roemer)
S. obstructa	154	"Abundant north to Austin"
Ancylidae		
Ferrissa sp.	33	Central and south Texas

Table 17. Continued

Taxonomic unit	Reference	Location
Mesogastropoda		
Vivaparidae		
Viviparus sp.	33	Central and south Texas
Campeloma sp.	33	Central and south Texas
Valvatidae = Bulimidae		
Valvata tricarinata	33	Central and south Texas
Amnicolidae		
Amnicola sp.	33,51	Central and south Texas
Cochliopa texana	33	Central and south Texas
Pleurocercidae		
Goniobasis comalensis	51,154	Helotes Cr., Bexar Co.
Ampullaridae (Not native)		
Ampullaria sp.	33	Central and south Texas
Thiaridae (imported)		
Thiara sp.	33	Central and south Texas
Pelecypoda		
Eulamellibranchia		
Unionidae		
Unio laticostatus	154	San Antonio R., Goliad Co.,Medina R Bexar Co.
U. aureau	125,154	San Antonio R.
U. hurmanii	154	Medina R.
U. luteolus	154	San Antonio R.
U. undulatus	154	Guadalupe R., Comal Co.
U. pauciplicatus	154	Guadalupe R., Gonzales Co.
U. multiplicatus	154	Guadalupe R.

Table 18. Aquatic Crustacea reported from the San Antonio River Basin, Texas

Taxonomic unit	Reference	Location
Malacostraca		
Decapoda		
Astacidae		
Procambarus clarkii	141	Bexar Co.
Paeneidae		
Macrobrachium carcinus	58,79	San Antonio

will certainly hamper this effort, but this type of sampling must be done before a complete evaluation of the ecosystem in the river is possible.

The aquatic insects that have been reported from the San Antonio River Basin are presented in Table 19 along with collectors and collection sites. Locations of collecting sites are given in Figure 151.

Ephemeroptera:

The only specific reference to collections of Ephemoroptera in this river basin was by Moore (127) who listed seven species collected in Bexar County.

Odonata:

Ferguson (54) listed four species of Odonata from Bexar County. A report by the Texas Parks and Wildlife Department (168) indicated that odonates are a common food item of large-mouth bass and channel catfish in Medina Lake. Since odonates are usually larger than most aquatic insects, they would be expected to be a significant part of the food of insectivorous fish.

Neuroptera:

The spongilla-fly, Sisyra vicaria was noted by Parfin and Gurney (137) as occurring in San Antonio.

Table 19. Aquatic Insecta reported from the San Antonio River Basin, Texas

Taxonomic unit	Reference	Location
Ephemeroptera		
Ephemeridae		
Caenis sp.	127	Bexar Co.
Heptageniidae		
Stenonema majus	127	Bexar Co.
S. frontale	127	Bexar Co.
Baetidae		
Baetis vigans	127	Bexar Co.
B. sp.	127	Bexar Co.
Leptophlebiidae		
Thraulodes sp.	127	Bexar Co.
Tricorythidae		
Tricorythodes sp.	127	Bexar Co.
Odonata		
Calopterygidae		
Hetaerina americana	54	Bexar Co.
Agrionidae		
Argia sedula	54	Bexar Co.
Libellulidae		
Libellula luctosa	54	Bexar Co.
Erythemis (=*Mesothemis*) *simplicicollis*	54	Bexar Co.
Neuroptera		
Planipennia		
Sisyridae		
Sisyra vicaria	137	San Antonio
Climacia chapini	137	Boerne
Coleoptera		
Polyphaga		
Elmidae		
Heterelmis (*vulnerata* ?)	31	Balconian, Texan Biotic province
H. obscura	31	San Antonio
Microcylloepus (*pusillus* ?)	31	Balconian Biotic Province
Hexacylloepus ferrugineus	31	Balconian Biotic Province
Dubiraphia sp.	31	Medina R., Bandera Co.

Table 19. Continued

Taxonomic unit	Reference	Location
Trichoptera		
Psychomyiidae		
Polypectropus charlesi or *santiago*	55	(Stream) near Bandera (Possibly Medina R.)
Glossosomatidae		
Protoptila alexanderi	149	San Antonio R., San Antonio
Diptera		
Nematocera		
Culicidae		
Psorophora signipennis	42	San Antonio
Aedes trivittatus	42	5
A. aegypti	42	San Antonio
A. inhabitor	42	San Antonio
Simuliidae		
Simulium virgatum	288	Helotes Cr.

Coleoptera:

The only known records of Coleoptera taken in this basin are five species of riffle beetles reported by Burke (31).

Trichoptera:

Two species of Trichoptera have been described from localities in the San Antonio River Basin: Protoptila alexanderi by Ross (149) from the San Antonio River, and a new form, "Genus C", by Flint (55) from a stream near Bandera. Flint (personal communication) now considers this new form to be either Polyplectropus charlesi or P. santiago.

Diptera:

Cushing (42) reported four species of mosquitos from this basin. Wiseman and Eads (288) made extensive collections of blackflies (Simuliidae) in central and south Texas, however the only record in the San Antonio River Basin was of Simulium virgatum in Helotes Creek in Bexar County. Blackflies can cause considerable annoyance to humans by swarming and their bites are painful, causing pronounced welts in a short time.

Callahan and Fishburn (278) have the only in-depth report on benthic invertebrates in this basin. Their report was a study to determine the effect of waste effluent from Randolph Air Force Base on Cibolo Creek. They had two upstream and four

downstream stations where they sampled numerous physicochemical parameters, along with biological data. They collected macroinvertebrates at six stations with Ponar dredges and identified major taxa. Chironomids were the most numerous taxon above the outfall but their numbers decreased downstream. Other groups noted above the outfall were oligochaetes, roundworms, crustaceans, gastropods, coleopterans, and dipterans. The first station below the outfall showed only four groups; chironomids, oligochaetes, one roundworm, and one snail. Zooplankton, also sampled at the six stations, occurred in higher numbers above the outfall. This report presented only raw data with no discussion of materials and methods, so the information is of limited value.

Aquatic Invertebrates of the Nueces River Basin

Members of only a few phyla of aquatic invertebrates have been recorded from the Nueces River Basin and the few collected are very poorly known. Locations of invertebrate collection sites in the Nueces River Basin are given in Figure 152.

Mollusca:

More records (32, 33, 51, 161) occur for the mollusks than any other invertebrate group in the Nueces River Basin. A list of Mollusca occurring in this basin is given in Table 20. A