FISHES OF THE RIO YAQUI

RECOVERY PLAN

1995

YAQUI FISHES

RECOVERY PLAN

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for

Region 2
U.S Fish and Wildlife Service
Albuquerque, New Mexico

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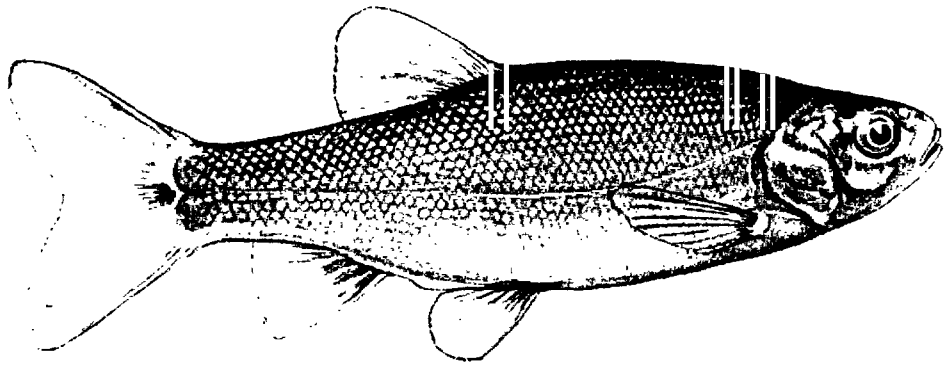
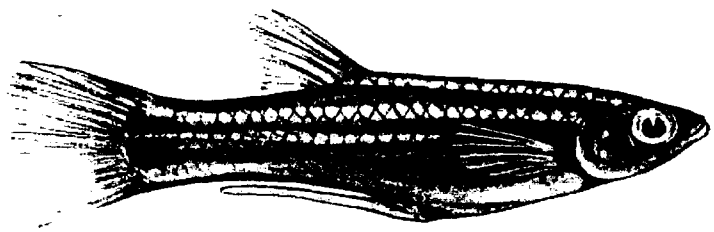
Regional Director, U.S. Fish and Wildlife Service

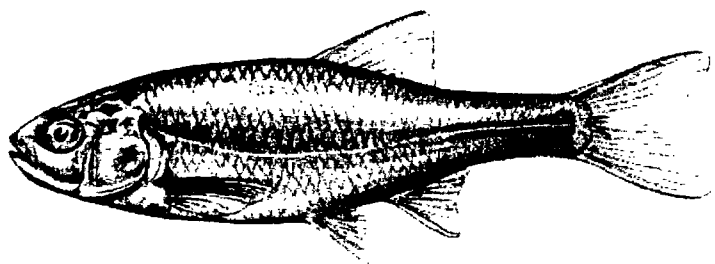
Date: 3/29/95



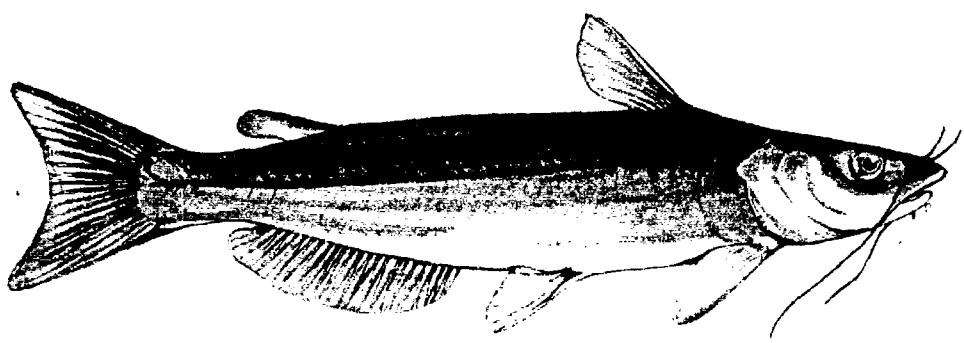
YAQUI CHUB



YAQUI TOPMINNOW



BEAUTIFUL SHINER



YAQUI CATFISH

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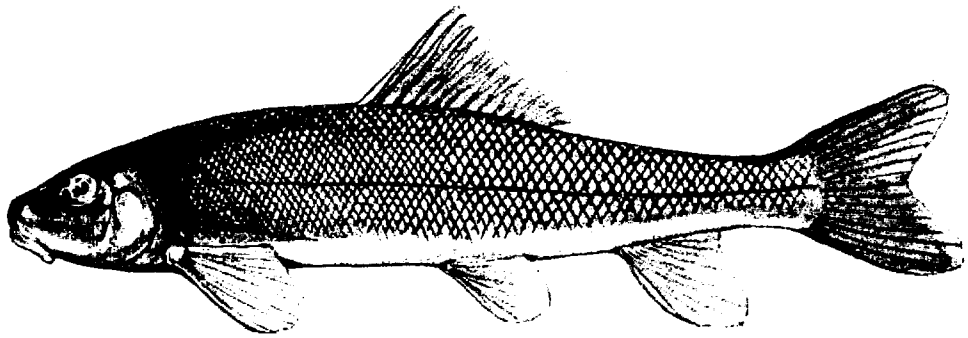
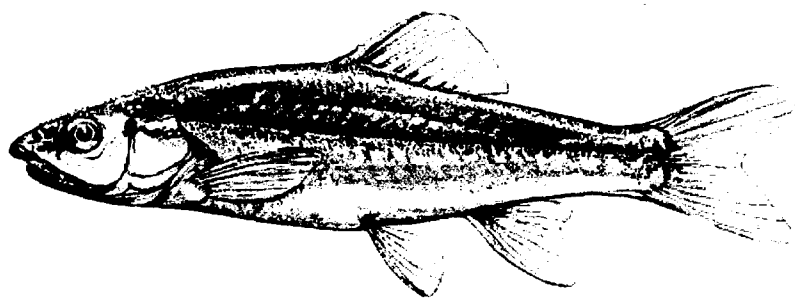
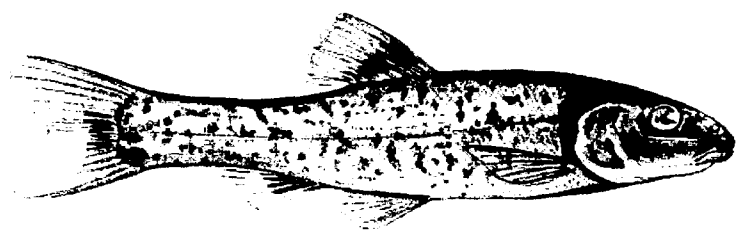


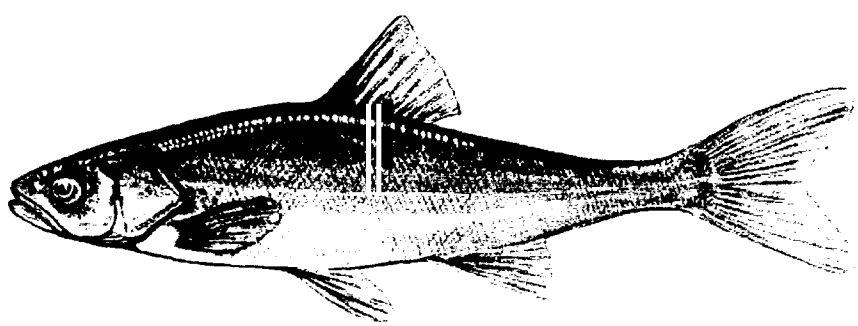
YAQUI SUCKER



LONGFIN DACE



MEXICAN STONEROLLER



ROUNDTAIL CHUB

Prints taken from Arizona Game and Fish poster, NATIVE FISH OF ARIZONA

DISCLAIMER

Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views, official positions, or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service **only** after they have been signed by the Regional Director or Director as **approved**. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

This revised recovery plan was essentially completed when the Secretary of Interior's policy initiatives regarding public participation in recovery plan preparation and implementation was announced on July 1, 1994. The Notice of Opportunity for Public Review and Comment for this revised recovery plan was published in the Federal Register on June 7, 1994. Although there has been considerable communications with the public, experts on the species and affected agencies, the implementation schedule has not been expanded to include a participation plan as envisioned by the new policy initiatives. As implementation continues, the U.S. Fish and Wildlife Service will work with affected stakeholders to ensure recovery proceeds in a manner that minimizes the social and economic costs to the affected publics while recovery is achieved. Future revisions will incorporate a participation plan.

Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1994. Yaqui Fishes Recovery Plan. USDI Fish and Wildlife Service, Albuquerque, New Mexico. 48 pp.

Additional copies may be purchased from:

Fish and Wildlife Reference Service:
5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814

301/492-6403 or 1-800-582-3421

The fee for the Plan varies depending on the number of pages of the Plan.

ACKNOWLEDGEMENTS

Preparation of the Yaqui fishes recovery plan benefited from review and comment by the following members of the U.S. Fish and Wildlife Service, Region 2 Desert Fishes Recovery Team:

W. L. Minckley, Arizona State University, Desert Fishes Recovery Team Leader
Tom Burke, U.S. Bureau of Reclamation
David Propst, New Mexico Department of Game and Fish
Kirk Young, Arizona Game and Fish Department
Jerome A. Stefferud, U.S. Forest Service
Jeff Simms, U.S. Bureau of Land Management
Alejandro Varela-Romero, Centro Ecologico de Sonora, Mexico

This recovery plan has gone through several revisions and has had a long road to completion. Many people have contributed their time and expertise towards improving this plan, expecially Dr. W.L. Minckley. Dr. Minckley's first-hand knowledge and historical perspective on the fishes of the Rio Yaqui has been invaluable to their conservation and to the completion of this recovery plan. His assistance on this plan is greatly appreciated.

EXECUTIVE SUMMARY

Current Status: Four Yaqui fish species are included in this plan,two listed as endangered, the Yaqui chub (*Gila purpurea*) (USFWS 1984) and Yaqui topminnow (*Poeciliopsis occidentalis sonorensis*) (USFWS 1967), and two threatened species, the Yaqui catfish (*Ictalurus pricei*)(USFWS 1984), and the beautiful shiner (*Cyprinella formosa*) (USFWS 1984). All formerly occurred throughout the Rio Yaqui Basin in USA and Mexico. Current distribution in Mexico is imperfectly known. USA populations are limited primarily to the San Bernardino/Leslie Canyon NWR and West Turkey Creek, Cochise County, Arizona. Beautiful shiner and Yaqui catfish also occurred in the Mimbres River in New Mexico.

Habitat Requirements and Limiting Factors: In the United States, Yaqui fishes are heavily dependent on artesian wells and spring flows on San Bernardino NWR (SBNWR). Three stream sections, Leslie Creek, West Turkey Creek and Black Draw, contain Yaqui fishes. Water development and pumping of underground aquifers constitute the greatest threat to survival of Yaqui fishes, followed closely by introduction of non-native organisms.

Recovery Objectives: Stabilize existing populations and downlist Yaqui chub and Yaqui topminnow. Reintroduce Yaqui catfish and beautiful shiner into historic habitats in the USA and establish self-sustaining populations.

Recovery Criteria: Although present in the US, these populations will not continue to persist unless they are managed intensively. Also, populations and habitats need to be stabilized in Mexico before delisting can be considered.

Action Needed:

1. Develop co-operative effort with Mexico for the recovery of Yaqui fishes.
2. Secure habitat and water sources for the Yaqui fishes in the USA and Mexico.
3. Conduct research on the biology and habitat requirements of Yaqui fishes.
4. Manage the fish and their essential habitats.
5. Introduce and maintain self-sustaining populations within their historic range.
6. Monitor existing and established populations and habitats.

Total Estimated Costs of Recovery:

Costs: (000's)

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Need 6	Total
1995	5.0	50.0	15.0	140.0	1.0	5.0	216.0
1996	5.0	50.0	15.0	140.0	2.0	5.0	217.0
1997	5.0	1500.0	10.0	150.0	2.0	6.0	1673.0
1998	5.0	50.0	10.0	150.0	2.0	6.0	223.0
1999	5.0	5.0	15.0	160.0	3.0	8.0	196.0
2000	5.0	5.0	10.0	160.0	3.0	8.0	191.0
2001	5.0	5.0	10.0	175.0	3.0	10.0	207.0
2002	5.0	5.0	13.0	175.0	2.0	10.0	210.0
2003	5.0	5.0	10.0	185.0	2.0	10.0	217.0
2004	5.0	5.0	13.0	185.0	2.0	10.0	220.0
Recovery Cost	50.0	1680.0	121.0	1620.0	22.0	78.0	3570.0

Date of Recovery: Downlisting should be initiated 10 years following the approval of this plan if recovery criteria are met.

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I. Introduction

This Recovery Plan deals with four threatened or endangered taxa, beautiful shiner (*Cyprinella formosa*), Yaqui chub (*Gila purpurea*), Yaqui catfish (*Ictalurus pricei)* and Yaqui topminnow[1] (*Poeciliopsis occidentalis sonoriensis*), which inhabit the Rio Yaqui drainage basin of southeastern Arizona (AZ) (Fig. 1) and northwestern Sonora (SON), Mexico (US Bureau of Sport Fisheries and Wildlife [USBSFW] 1966, US Fish & Wildlife Service [USFWS] 1984a, 1986, 1994a). Headwaters of this river system also provided historic habitat in the USA for four additional indigenous fishes, longfin dace (*Agosia cf., chrysogaster*), Mexican stoneroller (*Campostoma ornatum*), roundtail chub (*Gila robusta*) and Yaqui sucker (*Catostomus bernardini*) (Minckley 1973, 1985; McNatt 1974), all currently candidates for listing in both the USA and Mexico (USFWS 1994a; Secretaria de Desarrollo Social [SEDESOL] 1994; Table 1). Seven of the eight species are also considered imperiled by the State of Arizona (Arizona Game & Fish Department [AZGFD] 1992). Livestock overgrazing, erosion, water diversion, aquifer pumping, non-indigenous species, destruction or alteration of most natural fish habitats and drought have caused the extirpation of four of the eight taxa in the Río Yaqui basin, USA.

This Plan has been integrated with the San Bernardino National Wildlife Refuge Management Plan (USFWS 1987) and San Bernardino National Wildlife Refuge Comprehensive Management Plan (USFWS 1994b [in preparation]). Most of the listed and candidate species physically occur, are reintroduced or are to be reestablished on that refuge, which also encompasses designated critical habitats for beautiful shiner, Yaqui chub and Yaqui catfish (USFWS 1984a). This Plan was therefore prepared in context and as part of the conceptual, ecosystem-level management program for an "Area of Ecological Concern" defined in the Comprehensive Management Plan to include "associated natural resource components and their respective jurisdictions." "Interjurisdictional efforts could...[thus] lead to cooperative management agreements between the Service [USFWS] and other land owners including the government of México when possible." Only in this manner can the intent of this Plan be attained to foster sustainable ecosystem function in the USA portion of the basin and hopefully the entire Río

[1]Various common names are applied to topminnows. "Gila" topminnow is commonly used for all populations of Poeciliopsis occidentalis, as Robins et al. (1991) chose not to recommend common names for subspecies and that epithet was historically applied (Bailey et al. 1948). Meffe et al. (1983) suggested, alternatively, that the name "Sonoran" topminnow be used for the two forms combined, with "Yaqui" and "Gila" for the respective subspecies. Minckley & Deacon (1991) followed the last suggestion and provided common names for subspecies of western freshwater fishes; this approach is applied here.

TABLE 1. Federal and State Listing status of Rio Yaqui fishes.
Taxa extripated from the USA portion of the Rio Yaqui basin are marked with an asterisk (*); beautiful shiner has been successfully reintroduced on San Bernardino/Leslie Canyon NWR

Taxa	Listing Status[1]			
	USA	AZ	MEXICO	Designated Critical Habitat
Agosia chrysogaster, longfin dace	Candidate 2	not listed	Threatened	not appl.
Campostoma ornatum, Mexican stoneroller	Candidate 2	Endangered	Endangered	not appl.
**Cyprinella formosa*, beautiful shiner	Threatened	Endangered	Threatened	yes
Gila purpurea, Yaqui chub	Endangered	Endangered	Endangered	yes
**Gila robusta*, roundtail chub[2]	Candidate 2	Threatened	Rare	not appl.
**Catostomus bernardini*, Yaqui sucker	Candidate 2	Endangered	Rare	not appl.
**Ictalurus pricei*, Yaqui catfish	Threatened	Endangered	Rare	yes
Poeciliopsis occidentalis sonoriensis, Yaqui top-minnow	Endangered	Endangered	Threatened	no

1. References include AZGFD 1992; SEDESOL 1994; and USBSFW 1966, USFWS 1984a, 1994a.

2. Roundtail chub also is listed by the NM State Legislature (1974) as equivalent to federally threatened.

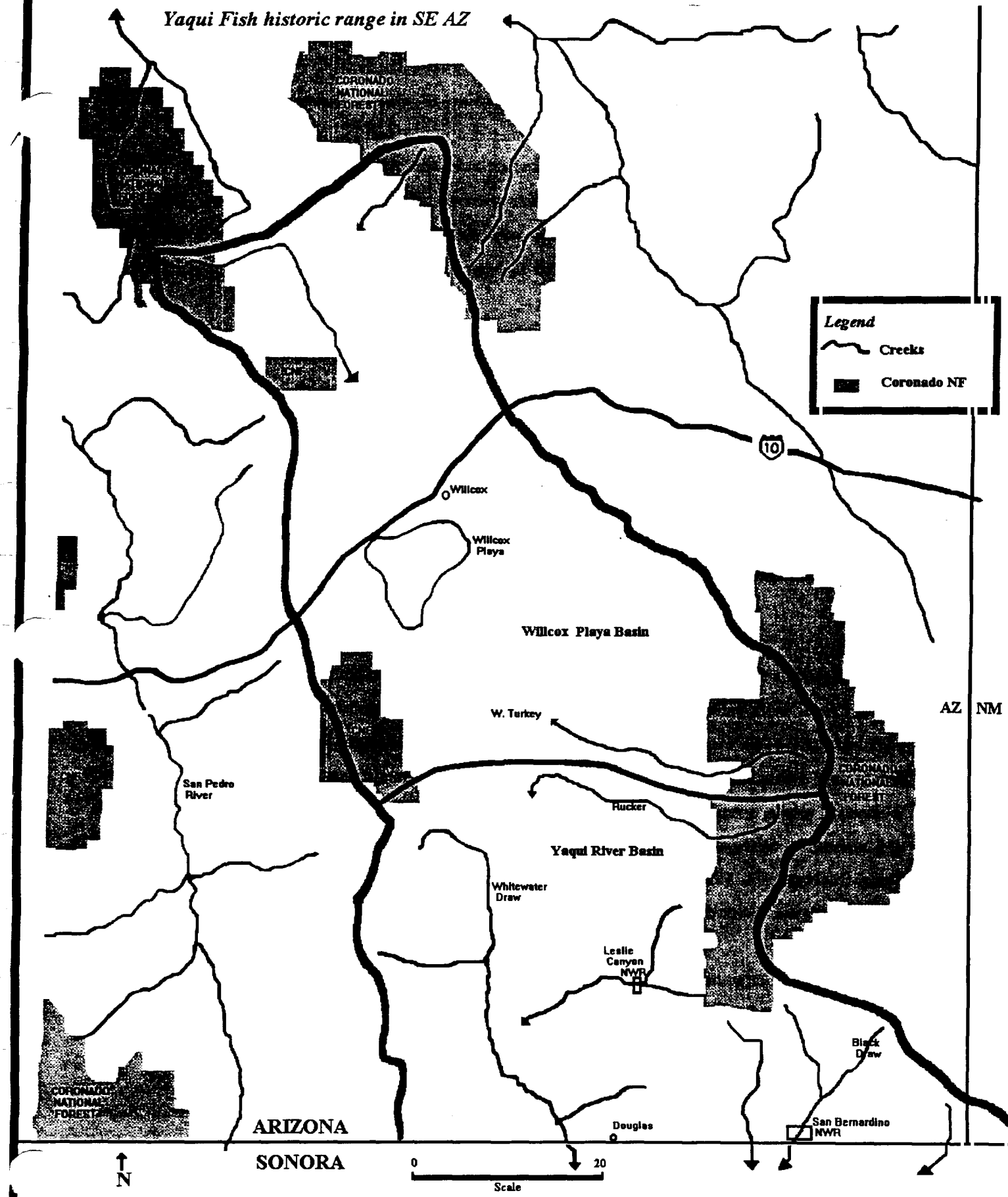
Yaqui Fish historic range in SE AZ
CORONADO NATIONAL FOREST
Legend
Creeks
Coronado NF
10
Willcox
Willcox Playa
Willcox Playa Basin
W. Turkey
AZ
NM
San Pedro River
Rucker
Yaqui River Basin
Whitewater Draw
Leslie Canyon NWR
Black Draw
CORONADO NATIONAL FOREST
ARIZONA
SONORA
Douglas
San Bernardino NWR
N
0
20
Scale

Figure 1

Yaqui watershed. Means to accomplish this end include **a)** habitat stabilization, restoration and enhancement, **b)** reestablishment and population stabilization for threatened and endangered species, **c)** enhancement of other indigenous aquatic biota in ways that prevent continued deterioration to preclude future listings and thereby **d)** optimize regional biological diversity both on and off National Wildlife Refuge lands.

A. Location and Description of the Río Yaqui Basin

The Río Yaqui basin lies between Longitude 27° and 32° N and Latitude 107° and 110°, 40' W. It comprises ~73,000 km² of which only ~1500 km² (<2.0%) is in the USA. Beginning as the Río Papigochic in western Chihuahua (CHI), the stream enters SON to receive Río de Bavispe, then flows south into Golfo de California near Ciudad Obregón (Hendrickson *et al.* 1981). Total annual discharge near the mouth averages 2800 ha³, making it one of the larger streams in the region.

The drainage in the USA includes parts of Cochise Co., AZ, and Hidalgo Co., NM. Aquatic habitats with indigenous fishes are in the San Bernardino and southern Sulphur Springs valleys, AZ. Four species (Yaqui chub, sucker, catfish and topminnow) are (or were) found nowhere else in the USA. The USA part of the Río Yaqui system receives runoff from the Swisshelm, Chiricahua, Mule, Pedregosa, Perilla and Peloncillo mountains. Waters supporting indigenous fishes include Rucker, Leslie and Whitewater creeks, a reach in Black Draw (= San Bernardino Creek = Río de San Bernardino in Mexico) and associated ciénegas, pools/marshes and springs fed by flowing artesian wells in San Bernardino Valley (McNatt 1974, Minckley 1985). Other than cattle-watering tanks, no permanent surface waters now exist in the NM portion (USFWS 1986).

Geologic and biotic evidence join to support the presumed intimate drainage connections in the recent past between the Sulphur Springs (Willcox Playa) Valley and Río Yaqui watershed. First, both Douglas and San Bernardino valleys are related to the Sulphur Springs Valley and San Simon Trough, respectively, concordant with regional trends in geologic structure (Meinzer & Kelton 1913, Cooper 1959, Menges & McFadden 1981). Second, an early report (Rutter 1896) exists for Yaqui chub from Morse

Canyon (West Turkey Creek), which enters Sulphur Springs Valley from the Chiricahua Mountains. The specimens' identity cannot be confirmed since they were lost in the San Francisco Earthquake of 1904 (Miller & Lowe 1964, 1967; Hendrickson *et al.* 1981). However, West Turkey Creek also supports a population of longfin dace (*Agosia cf., chrysogaster*) morphologically distinct from those in the Gila River basin and most similar to those from the Yaqui (Hendrickson 1987). The same genetic relationship has been confirmed by C. A. Tibbits and T. E. Dowling (Arizona State University [AZSU], unpubl. data) using allozyme and mtDNA technology. The Sulphur Springs Valley is therefore included here as part of the potential recovery area for Río Yaqui fishes.

Basin-wide diversity of aquatic habitats is high (Hendrickson *et al.* 1981). Mountain creeks are cold, clear and support both indigenous and non-indigenous trouts. However, most fishes in the basin, including those treated here, occupy intermediate- to low-elevation, warmwater creeks, ciénegas, and moderate- to large-sized rivers. Creeks typically have alternating riffles and pools in which heterogeneity is enhanced by undercut banks, boulders and woody debris. Gravel bottoms in swift areas are vegetated with algae. Ciénegas, stream-associated marshlands with low, emergent aquatic plants and hydric-adapted trees (*e.g.,Salix* spp.), were historically common but have suffered severe degradation since the arrival of Europeans (Hendrickson & Minckley 1985). Rivers vary from pool-riffle types with boulder and gravel bottoms to long, strongly flowing reaches over gravel and sand (Campoy-Favela *et al.* 1989). Near the sea, riverine fish faunas include a number of marine forms (Hendrickson *et al.* 1981, Minckley *et al.* 1986).

B. Historical Perspectives

The upper Río Yaqui watershed has attracted humans since prehistoric times, with evidence of active use dating to the Clovis culture >10,000 years ago (Ardizone 1980, Neily & Beckwith 1985). Spanish presence dates to 1694 when Padre Eusebio Francisco Kino passed through the San Bernardino area (Lanning 1981, Hendrickson & Minckley 1985). Feral livestock were abundant by 1822, when the San Bernardino Land Grant was acquired by Ignacio Perez. The Land Grant was purchased in 1884 by "Texas" John Slaughter, for cattle and farming operations which lasted until 1937, when the property was sold (Ervin 1965) and passed among a number of owners until The Nature Conservancy (TNC)

bought it in 1979 (Lanning 1981). Leslie Creek was acquired by TNC in 1988. The two parcels were respectively transferred to USFWS in 1982 and 1988, for the purpose of establishing San Bernardino National Wildlife Refuge (NWR).

C. Accounts of Listed Taxa

The four listed fishes of the upper Yaqui basin, along with four co-occurring Candidate-2 taxa, comprise a unique sub-set of the aquatic-dependent biota of the USA. Seven of 12 organisms (including one each of frog, snake, snail and plant in addition to the fishes) occur only in the immediate vicinity of San Bernardino/Leslie Canyon NWR. An ecosystem-based Recovery Plan similar to that recently completed for the Ash Meadows NWR in NV for a number of fishes, molluscs and plants (USFWS 1990) is thus timely and appropriate for the upper Río Yaqui biota. Detailed accounts for listed species follow; references from which comparable information may be obtained on Candidate-2 taxa are provided later.

1. Beautiful shiner

a. Description–Body compressed, depth about same as length of head. Snout pointed, mouth oblique. Lateral line slightly decurved, with 36-40 scales. Anal fin-rays 8-9; dorsal and pelvic fin-rays 8. Pharyngeal teeth 0,4-4,0. Non-breeding body coloration tan to olivaceous dorsally, metallic silver laterally, belly usually lighter. Dorsolateral scales outlined with melanophores. Breeding males yellow-orange to orange on caudal and lower fins; dorsal fin dark. Body bluish, often masked with wash of orange, pink or yellow. Dorsum of head red to orange, sides of head brassy to brassy-orange (Minckley 1973).

b. Nomenclature–The taxon presently known as *Cyprinella formosa* was originally described as *Moniana formosa* by Girard (1857) from Río Mimbres, CHI. The type locality was corrected to Mimbres River, Luna Co., NM by Gilbert (1978). Chernoff & Miller (1982) discussed its taxonomy and distribution and synonymized *Moniana formosa, Notropis santamariae* (Laguna Santa Maria, CHI; Evermann & Goldsborough 1902) and *N. mearnsi* (San Bernardino Creek, SON; Snyder 1915 [likely both AZ and SON, Taylor 1967]) as *Notropis formosus*, later assigned to the genus *Cyprinella* by

Mayden (1985, 1989). Treatment of *N. formosus* as a subspecies of red shiner (*Notropis lutrensis)* by Contreras-Balderas (1975) and Gilbert (1978) has not been accepted (Matthews 1980, 1987, Chernoff & Miller 1982, Smith & Miller 1986).

*c. **Historic Distribution***—Beautiful shiner historically occurred in the USA only in San Bernardino Valley and Mimbres River, NM (Minckley 1973, Sublette *et al.* 1990). Its range in México included the Río Yaqui system (hereafter "Yaqui beautiful shiner"), Guzman basin (ríos del Carmen, Santa Maria and Casas Grandes, CHI, and Río Yaqui, CHI-SON; "Guzman beautiful shiner"), (Fig. 2) and the much smaller Bavicora and Sauz basins to the south and east in CHI, respectively (Smith & Miller 1986). The species was first recorded from what is now San Bernardino/Leslie Canyon NWR (and the USA) by Miller & Winn (1943); it was extirpated there by 1970 (Minckley 1973, 1985; DeMarais & Minckley 1993). The Guzman beautiful shiner (or a derived form; R.R. Miller in Propst & Stefferud 1994) disappeared from Mimbres River, NM after 1951 (Koster 1957, Rogers 1975, Sublette, *et al.* 1990, New Mexico Game Commission 1974), but persists in México (Propst & Stefferud 1994). This Plan also includes recommendations for recovery for the Guzman beautiful shiner.

*d. **Current Status***—Beautiful shiner is suffering reductions in natural range in México as a result of changes in land and water use and impacts of non-indigenous species (*e.g.*, Miller 1978; Chernoff & Miller 1982; Hendrickson *et al.* 1981; Hendrickson 1984). Hendrickson *et al.* (1981) mapped distribution of the Yaqui beautiful shiner in 1978 and expressed concern that it might soon be negatively influenced by introductions of non-indigenous fishes, especially of the closely related red shiner. Campoy-Favela *et al.* (1989) recommended endangered status for the species in the lower Río Yaqui system based on negative changes in abundance and distribution between 1978 and 1987-88. Recent records for Guzman beautiful shiner in ríos Casas Grandes, del Carmen and Santa Maria basins were provided by Propst & Stefferud (1994). The species persists in permanently watered stream courses of the Bavicora Basin, but these habitats have been diminished by agriculture (D. E. Propst, pers. comm.). We have no information on current status of the species in the Sauz Basin.

Present occurrence of the Yaqui beautiful shiner in the USA originates from stock collected under permit from the Mexican Government in 1989 from Río Moctezuma, CHI and held at Dexter National Fish

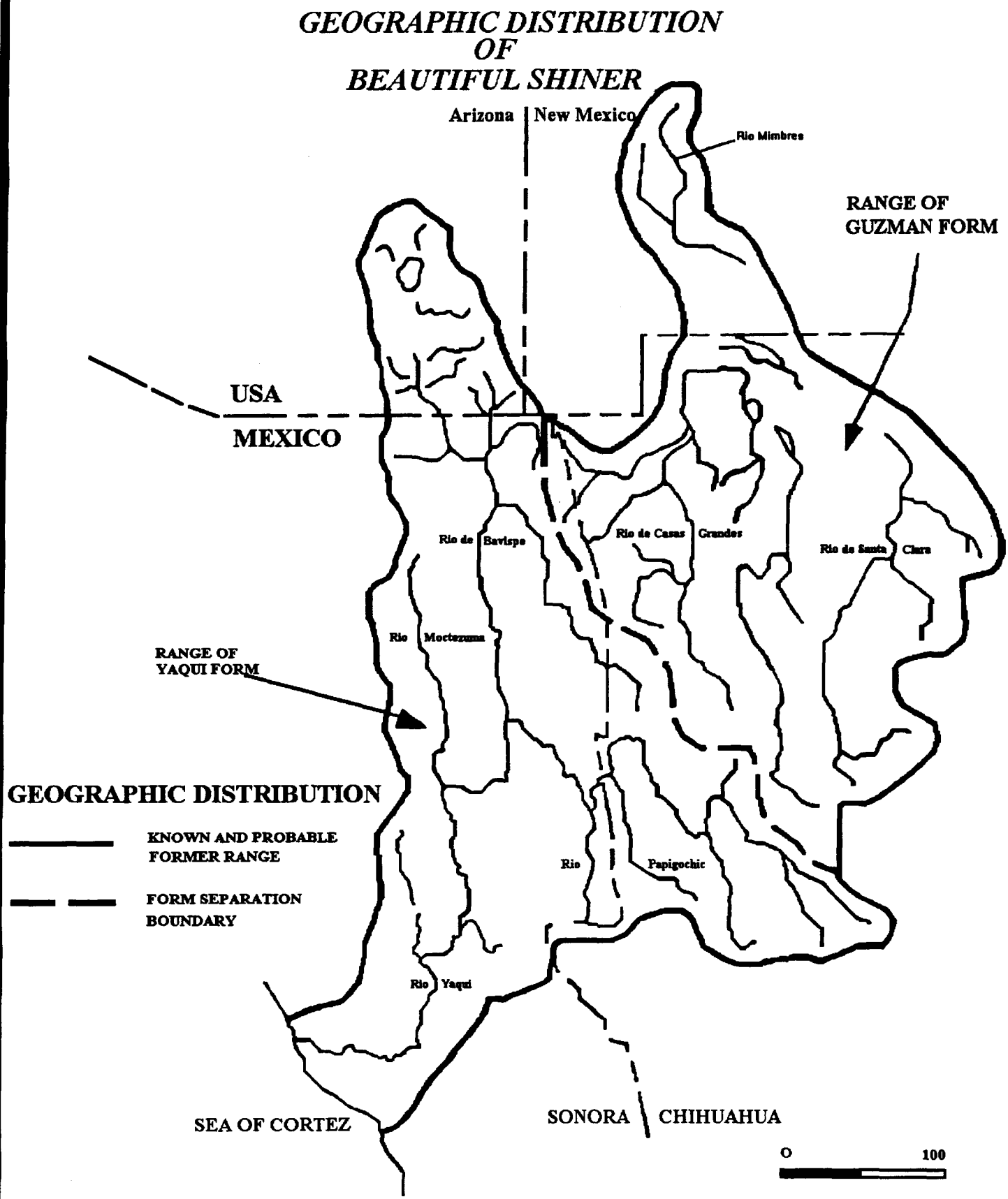
GEOGRAPHIC DISTRIBUTION
OF
BEAUTIFUL SHINER
Arizona
New Mexico
Rio Mimbres
RANGE OF
GUZMAN FORM
USA
MEXICO
Rio de Bavispe
Rio de Casas Grandes
Rio de Santa Clara
Rio Moctezuma
RANGE OF
YAQUI FORM
GEOGRAPHIC DISTRIBUTION
KNOWN AND PROBABLE
FORMER RANGE
FORM SEPARATION
BOUNDARY
Rio Papigochic
Rio Yaqui
SEA OF CORTEZ
SONORA
CHIHUAHUA
0
100

Figure 2

Hatchery & Technology Center (NFHTC), Dexter, NM. That stock from was released on San Bernardino NWR in 1990 and now lives as reproducing populations in three ponds. Dexter NFHTC also has in culture a stock of the Guzman beautiful shiner previously captured from Río Casas Grandes, CHI (Jensen 1993), in anticipation of future reintroduction.

*e. **Ecology**--*Life history and ecology of the beautiful shiner are poorly known. It is a mid-water-column species, remaining near but rarely within beds of plants or other cover along pond margins. In México, Hendrickson *et al.* (1981) reported it on riffles of small streams and in intermittent pools of creeks with high percentages of riffle habitat when flowing in wet periods. The fish has adapted well to ponds and is thriving at San Bernardino NWR (USFWS 1994b).

2. Yaqui chub

*a. **Description**--*Head and anterior body thickened, thinning posteriorly. Scales large, broadly imbricate, radii on all fields. Scales in lateral line <59. Dorsal, anal and pelvic fin-rays typically 8 (rarely 7). Dorsal-fin origin behind pelvic-fin insertion; pharyngeal teeth 2,5-4,2. Body dark over-all, usually lighter below. Some breeding males with distinctive, bluish sheen over body; reproductive females straw-yellow to light brown. Lateral bands scarcely developed or absent. Vertically elongate, diffuse, trangle-shaped caudal spot usually present (Minckley 1973).

*b. **Nomenclature**--*The Yaqui chub was originally described as *Tigoma purpurea* Girard (1857) from Río San Bernardino, SON along with a number of other animals likely based on specimens collected on both sides of the border (Taylor 1967); as noted before, the chub was also recorded from Sulphur Springs Valley (Rutter 1896). Its nomenclatorial history following assignment to the genus *Gila* by Miller (1945) is straightforward (reviewed by Minckley 1973). Hendrickson *et al.* (1981) noted, however, that western populations classified as Yaqui chub appeared differentiated, and DeMarais (1991) subsequently segregated and named all but the San Bernardino creek population as a new species, *Gila eremica.*

*c. **Historic Distribution**--*Historic range of Yaqui chub was originally thought to include the uppermost

Río Yaqui basin west in SON to ríos Sonora and Matape (Minckley 1980, Minckley & Brown 1994). With identification of *Gila eremica* as distinct, the known distribution for Yaqui chub became restricted to the now-occupied area in the USA of San Bernardino/Leslie Canyon NWR (Black Draw, various ponds and Leslie Creek), House Pond on the Slaughter Ranch Historic Site (under easement for USFWS management) and West Turkey Creek in the Chiricahua Mountains (private and US Forest Service lands) (DeMarais & Minckley 1991, 1993). It was historically and is currently known in México only from the short perennial reach of Río San Bernardino (= Black Draw), just south of the USA-Mexican Boundary (Varela-Romero *et al.* 1992).

d. Current Status--The current distribution of Yaqui chub is equivalent to its known historic range (DeMarais & Minckley 1993). A large percentage of existing populations resulted from reintroductions, and the species has responded positively to management by developing large and viable stocks in diverse habitats (USFWS 1994b). DeMarais & Minckley (1991, 1993) reviewed its distribution, morphology and genetics and were unable to discern evidence for any detrimental effects of past or present habitat changes, population variations or manipulations related to management efforts.

e. Ecology--Yaqui chub live in deep pools in creeks, scoured areas of ciénegas and other stream-associated, quiet waters. They seek cover in daylight, especially undercut banks and in areas of accumulated debris. In artificial ponds adults similarly tend to occupy the lower part of the water column and seek shade. They feed mostly on algae, insects and detrital material (Galat & Gerhardt 1987). Young occupy near-shore zones, often near the lower ends of riffles. Growth to maturity is rapid, often within the first summer of life. Spawning is protracted throughout the warmer months, with greater activity in spring. Reproductive potential is high and large populations develop quickly from a few adults (DeMarais & Minckley 1993).

3. Yaqui catfish

a. Description--Body slender, streamlined; old (large) fish thicker bodied. Caudal fin shallowly forked; anal fin with broadly rounded distal margin, 23-25 rays. Body profusely speckled in young, adults more

unicolored, dark gray to black dorsally, white to grayish beneath. Barbels jet-black except on immediate chin where gray to whitish. Channel and blue catfishes (*Ictalurus punctatus, I. furcatus*) with more deeply forked caudal fin in both, distal margin of anal fin less broadly rounded (24-29 rays) or essentially straight (>30 rays), respectively, and anal fin-base much longer in both (Minckley 1973). Another, undescribed catfish resembling *I. pricei* has been introduced and is established in the Gila River drainage (D. Propst, New Mexico Department of Game & Fish [NMDGF], pers. comm.), but its morphology, status and overall distribution are yet to be determined.

b. Nomenclature–Yaqui catfish was originally described as *Villarius pricei* by Rutter (1896) from Río San Bernardino, SON. The name *pricei* was transferred among a number of genera before being settled in *Ictalurus* (see Hendrickson *et al.* 1981). *Ictalurus meeki* (Regan 1907), described from the upper Río Papigochic, was tenatively referred to synonymy of *I. pricei* by Hendrickson *et al.* (1981). Taxonomic status of Mexican catfishes in other than the ríos Yaqui-Casas Grandes basins remains unclear, although Hendrickson (1984) also referred catfish from Río San Lorenzo, Sinaloa to this species and anticipated other localities from more southern Mexican rivers as collections become available.

c. Historic Distribution–The original range of forms referred to Yaqui catfish in México included the ríos Yaqui and Casas Grandes basins, from the latter of which it is apparently extirpated (Smith & Miller 1986, Propst & Stefferud 1994), south through the Río Fuerte system (Miller 1976, 1978). Distribution in the Río Yaqui basin in 1978 was mapped by Hendrickson *et al.* (1981). A population of Yaqui catfish stocked into the upper Santa Cruz River, AZ in 1899 (Chamberlain 1904) persisted until the late 1950's (Miller & Lowe 1964, 1967). It reportedly originated from Río Sonora in SON, from which basin the species is otherwise known from a single collection (Miller 1940). Other than from the Santa Cruz stocking, no records supported by specimens are known from the USA (Minckley 1973, 1985).

d. Current Status–Yaqui catfish was captured under permit from the Mexican Government from ríos Aros, SON and Sirupa, CHI in 1987 and 1990, respectively, and is currently under culture at Dexter NFHTC (Jensen 1993) in anticipation of future reintroduction. The fish is considered imperiled in México, at least in the Río Yaqui basin, due to habitat modification and loss and actual and potential hybridization with channel and blue catfishes, both of which are non-indigenous (Hendrickson *et al.*

1981; Miller 1989, Kelsch & Baca 1991). Post-1978 distributional records were provided by Campoy-Favela *et al.* (1989), who also commented on its reduced relative abundance and downward population trends in México.

*e. **Ecology***—Little is known of the ecology of Yaqui catfish. Minckley (1973, 1985) thought it to resemble channel catfish. It was most commonly caught in larger rivers in areas of medium to slow current over gravel/sand substrates (Hendrickson *et al.* 1981). The species grows rapidly and achieves large sizes in ponds at Dexter NFHTC (Jensen 1992, 1993).

4. Yaqui topminnow[2]

*a. **Description***—Dorsal profile slightly curved, body elongate. Caudal fin rounded to almost square. Males small, rarely >25 mm standard length; females larger, sometimes >50 mm, usually 30-45 mm. Anal fin of male elongated into a copulatory organ (gonopodium), extending forward past tip of snout when in copulatory position. Ova fertilized internally, young developing within female's body and born alive. Gravid females with abdomens distended and urogenital areas darkened. Body tan to olivaceous, darker above, often white on belly. Scales on dorsum darkly outlined by melanophores, extending as specks to upper belly and pre-pectoral area. Lateral band dark, continuous along sides posterior to dorsal-fin origin. Fin-rays outlined with melanophores; fins lacking dark spots. Breeding males black, with some gold on predorsal midline and orange at base of gonopodium and sometime on bases of dorsal and pelvic fins (Minckley 1973).

*b. **Nomenclature***—Yaqui topminnow was originally described as *Girardinus occidentalis* by Girard (1859) from Río San Bernardino, SON. It was transferred among a number of genera until Hubbs & Miller (1941) reviewed and stabilized it as *Poeciliopsis*. It was subsequently recognized as a full species, *Poeciliopsis sonoriensis* (Miller & Lowe 1964, 1967) until relegated to subspecific rank under

[2]Earlier recovery efforts and planning for topminnows were directed by a Recovery Plan (USFWS 1984b, under revision) which included both the Gila and Yaqui subspecies (Brooks 1985, Bagley *et al.* 1991, Brown & Abarca 1992) and also, at least tacitly, Mexican stocks. Only the Yaqui topminnow populations in the USA are specifically covered by the present Plan.

P. occidentalis by Minckley (1969, 1973).

c. Historic Distribution--Distributions of subspecies of Sonoran topminnow are imperfectly known. *Poeciliopsis o. sonoriensis* (Yaqui topminnow) in the northern Río Yaqui basin must have come into contact with *P. o. occidentalis* (Gila topminnow) somewhere in the middle Yaqui basin, since the latter's geographic range extends from the Gila basin southwest through the ríos Sonora and Matape to include the lower Río Yaqui basin (Vrijenhoek *et al.* 1985). It is unknown if *sonoriensis* and *occidentalis* grade into one another, hybridize in a narrow band or co-occur. Statements of known historic distribution therefore include a composite of both, which collectively inhabit most of the Río Yaqui basin <1300 m elevation (Hendrickson *et al.* 1981, Campoy-Favela *et al.* 1989). The northern limit in the Río de Bavispe subbasin is the Río San Bernardino. None is recorded in the Río Papigochic subbasin (Hendrickson *et al.* 1981, Campoy-Favela *et al.* 1989).

d. Current Status--Topminnow distribution and abundance have undoubtedly declined due to habitat deterioration and loss through stream incision, drainage of ciénegas and habitat desiccation. A large population expired in 1969, for example, with drying of Astin Spring, Cochise Co., AZ (Minckley 1973; DeMarais & Minckley 1993). In 1978, however, topminnows were abundant in lower-elevation habitats of the Yaqui basin along stream margins, and equally so in thermal waters fed by artesian sources at higher elevations (Hendrickson *et al.* 1981). Campoy-Favela *et al.* (1989) also found them abundant in lower-elevation habitats in 1987-88. Management efforts on the San Bernardino/Leslie Canyon NWR, including removal of western mosquitofish, (*Gambusia affinis*), rehabilitation of ciénegas and springs and reintroductions (Minckley & Brooks 1985, USFWS 1986), have succeeded in maintaining 15 separate and viable populations (USFWS 1994b).

Western mosquitofish, a diminutive but voracious non-indigenous predator widely introduced throughout the western USA for mosquito control, is the factor to which much of the general decline and disappearance of topminnows from the Gila basin has been attributed (Schoenherr 1973, 1977; Meffe 1983, 1985, Minckley *et al.* 1991), was first recorded in AZ in the 1920's and quickly spread to populate essentially all aquatic habitats (Minckley *et al.* 1977). For some reason, however, it did not appear in collections

in the Rio Yaqui basin, USA until 1979. As soon as it established, negative impacts on topminnows were evident, including reductions in numbers, changes in population structure (loss of smaller size classes) and physical damage to adults as a result of direct attacks (Galat & Robertson 1988, 1992). Western mosquitofish were rarely present in collections from northwestern México in 1978 (Hendrickson *et al.* 1981, Hendrickson 1984), but have continued to spread (Campoy-Favela *et al.* 1989, Juárez-Romero *et al.* 1991, Varela-Romero *et al.* 1992) at the presumed expense of topminnows.

*e. **Ecology***—Far more is known of the ecology of the Gila River subspecies of Sonoran topminnow than for the Yaqui form (Schoenherr 1973, 1977, Constantz 1976, Meffe 1985, Minckley *et al.* 1991 & references cited). Galat & Robertson (1988, 1992) specifically studied the Yaqui form in spring- and artesian-fed habitats and Black Draw on the San Bernardino NWR. Both topminnows live in shallow, warm, quiet waters and only occasionally in moderate to relatively swift currents. Preferred habitats usually include dense mats of algae and debris along stream margins or in eddies below riffles, typically over sandy substrates covered with organic muds and debris. They become most abundant in marshes, especially those fed by thermal springs or artesian outflows (in part Simms & Simms 1992). Topminnows eat detritus, living vegetative material, amphipod crustaceans and aquatic insect larvae including mosquitos (Minckley 1973, Gerking & Plantz 1980). Female Yaqui topminnows may have >20 young per brood at intervals of ~20 days. Reproduction occurs year-around where winter temperatures are ameliorated by inflow of springs, but under conditions of fluctuating temperature begins in early April and ends in October (Minckley 1973, Galat & Robertson 1988, 1992). Few individuals in nature live more than a year.

5. Other Biotic Components

*a. **Fishes and Other Vertebrates***—Longfin dace, Mexican stoneroller (*Campostoma ornatum*), roundtail chub (*Gila robusta*) and Yaqui sucker (*Catostomus bernardini*), comprise the remainder of the eight-species fish fauna originally inhabiting the upper Río Yaqui, USA. The first two still occur, the dace on both the San Bernardino and Leslie Creek properties, in Rucker Canyon and in West Turkey Creek (Sulphur Springs Valley). As noted earlier, the Yaqui longfin dace is morphologically and genetically

distinct from that of the Gila River basin (Hendrickson 1987, Tibbits & Dowling AZSU, pers. comm.) Mexican stoneroller has only recently been found in San Bernardino Creek (DeMarais & Minckley 1993), but occurred naturally in Rucker Canyon, from which it was originally described as *Campostoma pricei* (Jordan & Evermann 1886). This nominal species was synonymized with *C. ornatum* by Burr (1976). It's population fluctuates dramatically, prompting Minckley (1973) to erroneously report its extirpation (Burr 1976, Minckley 1985) after sampling at a time of low population.

Minckley (1973) likely also erred by questioning locality data and dismissing the record of specimens of roundtail chub labled as caught in 1954 from San Bernardino Creek he saw at the University of Arizona (UAZ) in ~1967. At the time he (pers. comm.) was unaware that the chub lived just downstream from the USA-Mexican boundary in Arroyo Cajón Bonito, SON (Hendrickson *et al.* 1981). Unfortunately, the UAZ specimens have not been relocated. This chub almost certainly entered the USA portion of the drainage in wet periods, a pattern also likely the case for Yaqui catfish and Yaqui sucker in the San Bernardino area and for the Yaqui catfish in the Mimbres system. It is thus included as a species to be desired in the upper Río Yaqui "Area of Ecological Concern." The only older name applied to roundtail chubs from the Yaqui basin is *Gila minacae* Meek (1904), synonymized with *G. robusta* by Miller (1976). Based on preliminary genetic data, roundtail chubs from the Yaqui system may, however, be as distinctive as longfin dace from those in the Gila River system (T.E. Dowling, AZSU, pers. comm.).

Yaqui sucker was abundant in Astin Spring in Black Draw in 1967 (Minckley 1973), but disappeared upon system-wide drying in or about 1969 (Minckley 1973, DeMarais & Minckley 1993). It was common in México in 1978 (Hendrickson *et al.* 1981) and remained so in 1987-88 (Campoy-Favela *et al.* 1989). This species was also described from the Río San Bernardino by Girard (1857), It's only synonym is *Catostomus sonoriensis* (Snyder 1915). Morphological similarity of Yaqui and Sonora (*Catostomus insignis*) suckers, the latter of which occurs in the adjacent Gila River basin, has led a number of workers to consider the first at most a subspecies of the second (or conspecific; Minckley 1973, Hendrickson *et al.* 1981). In light of demonstrated differences between Gila and Yaqui forms of longfin dace and roundtail chub (see above), this perception might best be re-examined.

Two other regionally indigenous aquatic dependent vertebrates, Chiricahua leopard frog (*Rana chiricahuaensis*) and Mexican garter snake (*Thamnophis eques*) have also become rare or disappeared locally. The first was common into the 1970's on San Bernardino NWR before suffering severe population declines due to non-indigenous bullfrogs (*Rana catesbeiana).* The native frog is eaten by adult bullfrogs and now persists only in Leslie Creek where bullfrogs have not yet appeared (Rosen & Schwalbe in press). Bullfrog-free areas have been established elsewhere, in which leopard frogs reappear or persist when reintroduced. In addition, tadpoles from Leslie Creek are reared at the Arizona-Sonora Desert Museum, Tucson, AZ. Capture efforts for Mexican garter snakes yield large (old) animals, indicating bullfrogs also have negative impacts on young snake survival. Four small ponds fenced against bullfrogs have been created on San Bernardino NWR in attempts to re-establish viable indigenous frog populations and enhance the snake as well. Cooperators include AZGFD, National Biological Survey, UAZ and USFWS Phoenix Ecological Services Office (USFWS 1994b).

b. Invertebrates--The San Bernardino springsnail (*Pyrgulopsis bernardina*) (Hershler 1994) is a Candidate-2 species clearly in jeopardy due to habitat loss and degradation, western mosquitofish predation and efforts to eliminate non-indigenous fishes (USFWS 1994b). Limited habitat poses the snail's most severe problem. Only a single spring provides the shaded, hillside seepage habitat presumably necessary for their survival. Research is needed to determine habitat and other factors needed to insure survival.

c. Plants--The Huachuca water umbel, *Lilaeopsis schaffneriana* subsp. *recurva,* was recorded along the margins of House Pond on the Slaughter Historical Site in 1981, along Black Draw ~0.8 km upstream from the USA-Mexican Boundary in 1989-90, and along Río San Bernardino, SON near Highway 2 in 1988. The first and last were destroyed by dredging and flood, respectively, soon after being recorded (Warren *et al.* 1991). USFWS (1994b) cited other locales for this plant on San Bernardino NWR. Suckling (1993) petitioned the US Department of Interior for listing as endangered; no action has yet been taken. Arizona TNC personnel have transplanted Huachuca umbel with limited success; alternative means for protection and restoration need exploring.

D. Decline of the Aquatic Biota

1. Watershed-level Effects of Human Uses

Most of the USA-Mexican borderlands (Gehlbach 1981, Humphrey 1986), including all of southeastern AZ and southwestern NM, have been heavily used for cattle grazing and local farming. Mining and other activities also effected some detrimental habitat or landscape changes. Diversity of natural landscapes quickly diminished under grazing pressure, especially when ranges were overstocked (Wagoner 1960). Chihuahuan Desert scrub expanded, grasslands deteriorated or locally disappeared and riparian and aquatic habitats were destroyed or reduced to disturbed, disjunct remnants (USFWS 1994b). Today's regional vegetation nonetheless remains a desert grassland, closely intermingled with Chihuahuan desert scrub on drier sites (Lanning 1981). Mesquite (*Prosopis glandulosa*) bosques are the predominant lowland communities, along with pockets of riparian broadleafed woodlands and ciénega habitats where water persists at or near the surface (Marrs-Smith 1983)

2. Influences on Aquatic Habitat and Biota

Physical and other impacts associated with watershed use and misuse led, in turn, to dramatic reductions in aquatic habitats and biota. In the past as today, water was a scarce and sought-after commodity. Relatively abundant supplies in the upper Río Yaqui basin, especially after artesian wells were built in the later 1800's, led to large-scale cattle grazing and concentrated farming.

Severe grazing pressure (including trampling) also led to incision of stream channels that drained and desiccated ciénegas, diversion and modification of stream channels themselves and excessive exploitation of underground aquifers; all reduced the quantity and quality of natural surface waters. Streams from springs and wells were channeled to fields and tanks. Black Draw changed from a marshy swale (ciénega) in the 1850's to a creek lined with cottonwoods (*Populus fremontii*) in the 1890's to an arroyo by the 1960's that was three to five meters deep, to 25 m wide and usually dry (Brandt 1951, Lanning 1981, DeMarais & Minckley 1993). Similar patterns typified the region (Hastings 1959, Hastings & Turner 1965, Cooke & Reeves 1976, Hendrickson & Minckley 1985, Williams *et al.* 1985). Introduction of non-indigenous species into stock-watering ponds and elsewhere came later, and their spread to remnant natural habitats contributed further to a general decline in aquatic communities

(Minckley 1973, 1985, 1991). Included were highly predatory taxa such as largemouth bass (*Micropterus salmoides*), bullfrog, and western mosquitofish, and competitors/predators such as bullhead catfish (*Ameiurus* spp.), bluegill (*Lepomis macrochirus*) and black crappie (*Pomoxis nigromaculatus*).

Paraphrased below are DeMarais & Minckley's (1993) summaries of specific habitat and fish-faunal changes in the San Bernardino/Leslie Canyon NWR area. Comments generalizing their coverage, originally prepared with specific reference to Yaqui chub, are in brackets [ ].

> Decline of [the aquatic biota] must have begun with regional arroyo cutting in the late 1800s (Hastings 1959; Hastings & Turner, 1965; Cooke & Reeves, 1976; Hendrickson & Minckley, 1985). [Yet] Edgar A. Mearns collected chubs and three other fishes, Yaqui sucker, beautiful shiner, and Sonoran topminnow, from Black Draw near the border in 1893 (Snyder, 1915).
>
> The next known collections were in 1943 (Miller & Simon, 1943). Five native species [including Yaqui chub] were in Astin Spring, the most upstream permanent water in Black Draw about 3.2 km north of the Boundary. Others included sucker, longfin dace, shiner, and topminnow. Only the last was between Astin Spring and 3.2 km south of the border. The same five remained in 1950 when Black Draw [was sampled] from the Boundary to 3.2 km downstream (Hendrickson *et al.*, 1981). Astin Spring was not visited, but all but the sucker were recorded from other artesian-fed waters.
>
> Chubs, suckers, and topminnows remained in Astin Spring in 1965. Black Draw was intermittent, supporting only longfin dace and topminnow in isolated pools along its upper 4.3 km. The shiner persisted in one artesian-fed pond. Black Draw was dry below Astin Spring to the border in 1966, and intermittent with only topminnow in a [single] pool in 1968. Astin Spring at that time supported one of two known populations of chubs along with the last Yaqui sucker[s] and one of no more than eight small stocks of topminnow in the United States (Minckley, 1973; Hendrickson *et al.*, 1981). The second stock of chub, estimated at 20 or fewer (McNatt, 1974), persisted in marshes fed by an artesian well (USFWS, 1986); the last was seen in 1976.
>
> Astin Spring failed in 1969. Just before desiccation about 200 adults each of Yaqui chub and then-federally-listed Sonoran topminnow (US Bureau of Sport Fisheries and Wildlife, 1966) were transferred to Leslie Creek (Minckley, 1973; Minckley & Brooks 1985), where both species established (Minckley, 1973, 1985; McNatt 1974; Silvey, 1975). Yaqui sucker was extirpated from the United States when Astin Spring dried, and beautiful shiner disappeared soon after the artesian well feeding its pond was capped in *c.* 1970 (Minckley, 1973). Topminnow populations were reduced to survivors in Leslie Creek and five isolated springs/artesian flows.
>
> In 1970-72, Leslie Creek was proposed for a sportfishing lake (AZGFD 1972; Wigel & Olding, 1976). Although presence of listed topminnow and rare Yaqui chub deterred the project (Silvey, 1975), it was not until the watershed was judged inadequate in size to support such an impoundment and questions of water-rights arose that the project was shelved. Leslie Creek then almost disappeared during a drought in 1975-76. As insurance against extinction, about 225 chubs were transferred in 1976 to Dexter [NFH] (Johnson & Jensen 1991). They survived to reproduce prolifically in a 0.04-ha pond.

Few collections were made in Whitewater Draw just east of Douglas before it was essentially dried in the 1970's, presumably due to upstream water development and livestock overgrazing, and severely polluted near the USA-Mexican border by smelting operations (W.L. Minckley, AZSU, pers. comm.). Based on specimens deposited at the University of Michigan, R.R. Miller caught three indigenous species in 1939 (longfin dace, Mexican stoneroller, Yaqui topminnow), along with introduced common carp (*Cyprinus carpio*), goldfish (*Carassius auratus*) and black bullhead (*Ameiurus melas*). James R. Simon caught all the same species except stoneroller in two collections in 1943. In the 1960's and 1970's, Minckley (AZSU, pers. comm.) seined only goldfish and black bullhead until 1979, when western mosquitofish appeared. The last has now spread throughout the lower Whitewater Creek drainage in AZ, and presumably in Mexico.

E. Conservation Efforts

DeMarais & Minckley (1993) also reviewed subsequent conservation efforts (again specifically for Yaqui chub), some of which may be generalized to the whole biota as follows.

> Acquisition of habitat started in 1979 with purchase of the San Bernardino Ranch by The Nature Conservancy (TNC). The property was transferred to USFWS ownership in 1982 to establish the San Bernardino NWR (USFWS, 1987). The historic "Texas John" Slaughter home, outbuildings, and one major spring/pond complex were deeded to the Johnson Historical Foundation, with biological management remaining USFWS responsibility. Leslie Creek, which survived a proposed impoundment revisited and again rejected in 1984 (Earth Technology Corporation, 1984), was added to the NWR in 1989, again through TNC purchase transferred to USFWS.

Habitat improvements commenced immediately upon acquisition of San Bernardino Ranch in 1979 (1982 by USFWS) and Leslie Canyon in 1988. Biological processes damaged by poor grazing practices, intense farming and occasional droughts were restored. Desirable woody plants were reestablished along stream courses, which along with installation of gabion structures, reduced erosion and stabilized banks. Undesirable woody species were thinned, weeds in abandoned fields were mowed to benefit indigenous grasses and some reseeding was implemented.

Efforts to remove non-indigenous fishes (*e.g.*, black bullhead, black crappie, bluegill, largemouth bass) and to combat spread of western mosquitofish, which appeared in 1979, commenced with renovation of House Pond, exclusion of undesirable species through barriers, and removal of native species and drying by diversion or capping of artesian flows followed by reestablishment of habitat and native biota. Finally, ciénegas were restored by piping water, allowing flow into suitable areas such as abandoned farm fields and constructed ponds with associated stream runs where indigenous Yaqui fishes could expand populations after natural dispersal or stocking.

> Yaqui chubs from Dexter NFHTC were stocked on San Bernardino Ranch in 1980, immediately following TNC purchase. [Two of three] stockings succeeded. [The Dexter NFH] stock failed [in 1984] for unknown reasons and was immediately reinstated with 100 fish [from North Pond stock established in 1980]. House Pond was [renovated in 1984-85 to remove] mosquitofish, a species incompatible with topminnows also managed there. [It was] restocked with chubs [and topminnow] in 1986. Also in 1986, because secure populations were established on the NWR, Yaqui chub was removed from Dexter NFH [and stocked in West Turkey Creek, where they established] (Minckley & DeMarais 1993).

Yaqui chub reappeared in Black Draw in 1987, either from the 1980 stocking or through upstream dispersal from México. Considerable USFWS effort had by then been expended in erosion control and revegetation, and positive results of this, coupled with consecutive wet years and appearance of Mexican stoneroller (not before recorded from the stream [Hendrickson *et al.* 1981]), make the latter most tenable (DeMarais & Minckley 1993). While these activities proceeded, further plans were implemented to acquire extirpated species from México for culture and ultimate reintroduction back into historic habitats.

After arranging for appropriate Mexican permits, personnel from USFWS, AZGFD, AZSU and El Centro de Ecologico, Hermosillo, SON collaborated in two trips for Yaqui catfish (Río Aros, SON 1987; Río Sirupa, CHI 1990) and one for beautiful shiner (Arroyo Moctezuma, CHI, 1989). Yaqui catfish are at Dexter NFHTC (Jensen 1993), where it has been studied morphologically and genetically for positive identification (Miller 1989, Kelsch & Baca 1991) and to ascertain basic information required for successful culture. The shiners were held at Dexter NFHTC, then 400 individuals of Yaqui beautiful shiner were reintroduced in May 1990 on San Bernardino NWR. It established and expanded into today's sub-populations.

II. RECOVERY

A. Objectives

The primary objective of this Recovery Plan is to restore the Río Yaqui fishes as secure and self-sustaining members of the indigenous fish fauna of the aquatic ecosystems in which they once occurred. The San Bernardino/Leslie Canyon NWR will serve as a refugium and source of stocks for recovery of these fishes. The limited amount of habitat available in the USA and the fact that this habitat is at the northern limits of range for essentially all species means that recovery cannot be accomplished entirely in the USA. Other jurisdictions (including private landowners) in the USA and México must be full partners in the Río Yaqui fishes recovery effort in order for them to be delisted. The most intensive

management efforts may occur on refuge lands in AZ, but the Plan also calls for reintroduction of Guzman beautiful shiner and Yaqui catfish into their suspected former range in the Mimbres River watershed, NM. This, plus inclusion of the Sulphur Springs (Willcox Playa) Valley, AZ, as part of an "Area of Ecological Concern," expands the need for partnerships with other Federal, State, local and private agencies and individuals. It also is clear that expansion of secure populations of the subject species into México will be required in order for recovery to occur. Every effort must be made to work cooperatively with the Mexican Federal, State and local governments and private individuals to ensure survival of these species.

1. Conditions for downlisting or delisting[3]

All the following conditions must be met within currently occupied habitat for a period of 10 years before consideration of delisting for beautiful shiner and Yaqui catfish or downlisting for Yaqui chub and topminnow:

a--Secure and protect San Bernardino Valley aquifers so that all artesian-well and other flows from subsurface sources are perennial. Secure and protect Leslie Creek, Black Draw and Mimbres River, NM watersheds to ensure adequate, perennial flow. And,

b--Eradicate all non-indigenous fish species and other undesirable organisms such as bullfrogs from critical habitat. And,

c--protect critical habitat and other habitats where species of concern occur or are reestablished from human disturbances including excessive grazing, irrigated agriculture, mining, introductions of non-indigenous species and water diversion or removal.

In addition to criteria **a-c** just listed, the following objectives must be met for each of the four listed

[3]Invariably, subjective words become controversial when used relative to downlisting/delisting of imperiled species. The following definitions apply for purposes of this Plan: **Secure** is used in the inclusive sense of legal protection and protection from natural (physical, chemical or biological) catastrophes as well as technologically and economically possible; **Reestablished** means maintaining a self-sustaining population, with no or minimal human intervention; and **Self-sustaining** populations are reproducing naturally and maintaining sizes and structures indicative of persistence for a reasonable period of time. **Reasonable**, in this context, is defined as through tens to hundreds of generations.

species.

a. Beautiful shiner--Delist when:

1) Arizona populations of Yaqui beautiful shiner are reestablished, self-sustaining and secure for at least 10 years in all suitable, existing and reclaimed San Bernardino/Leslie Canyon NWR habitats;

2) Guzman beautiful shiner is reestablished, self-sustaining and secure for at least 10 years in the Mimbres River and other available habitats within its historic range in NM; and

3) self-sustaining populations of both forms are secure within their historic ranges in México.

b. Yaqui chub--Due to the limited historic distribution of Yaqui Chub, delisting is not currently considered an option. Downlist to threatened status when:

1) self-sustaining populations are established and secure on San Bernardino and Leslie Canyon NWR lands, and

2) self-sustaining populations are established and secure in West Turkey Creek, AZ under a formal Conservation Management Plan or other binding agreement, accepted and implemented by the jurisdictions involved.

c. Yaqui topminnow--Downlist to threatened when self-sustaining populations have survived at least 10 years in all suitable, existing and reclaimed San Bernardino/Leslie Canyon NWR habitats.

d. Yaqui catfish-- San Bernardino/Leslie Canyon NWR and associated waters, because of their physical size, can only act as a genetic and population refugium. Delisting can occur when recovery in the form of protection of wild populations from threats of hybridization, negative interactions with non-indigenous species or other nagative impacts is assured in México and Mexican populations are

therefore secure and self-sustaining.

2. Stepdown Outline

Items in the stepdown (and narrative, which follows) may appear to emphasize Rio Yaqui habitats and imperiled taxa. Using the same recovery actions where applicable for Rio Mimbres habitats and the Guzman beautiful shiner is, however, the intent.

1.0 Cooperate on recovery with México.

1.1 Pursue agreements and development of management plans for long-term survival of fishes of concern in México.

1.2 Develop and implement cooperative management plans.

2.0 Manage existing habitats and populations.

2.1 Determine aquifer recharge zone, capacities and configuration and characteristics of sub-surface flow.

2.2 Protect watershed and aquifer.

2.3 Determine amounts of water required to maintain listed species.

2.4 Revise and continue implemention of San Bernardino/Leslie Canyon NWR Master Plan.

2.4.1 Develop water-use plan for San Bernardino/Leslie Canyon NWR.

2.4.2 Develop and implement genetic monitoring plans and schedules for each species.

2.4.3 Develop and implement management plan for each species of concern.

2.5 Develop or enhance new and existing habitats; monitor success of habitat management.

2.6 Eradicate and secure against reinvasion or new introductions of non-indigenous species.

3.0 Determine biological requirements of listed species.

3.1 Examine and document life histories.

3.2 Determine impacts of intra- and interspecific interactions in habitats occupied by combinations of species.

3.3 Determine habitat requirements and habitat utilization.

3.4 Determine and delineate genetic composition of existing populations.

3.5 Monitor health of fish populations and occupied habitats.

4.0 Protect historic habitats of fishes of concern in the USA.

4.1 Maintain levels and quality of subsurface waters sufficient to sustain springs and flow of artesian wells, thereby protecting surface waters.

4.1.1 Apply proper or enhanced land-use practices.

4.1.2 Exclude development such as mining or irrigated agriculture.

4.1.3 Forge agreements to assure aquifer water quality.

4.2 Work with water users and appropriate agencies and individuals to prevent overuse of water from essential aquifers.

4.3 Obtain instream flow water-rights for sufficient water to maintain surface flows in watercourses important to recovery.

4.4 Acquire and protect or protect through conservation agreements, habitat management plans or other binding agreements the essential waters and habitats needed for long-term survival of fishes of concern.

5.0 Assess habitats for reintroduction and reestablish the species of concern within appropriate habitats in historic ranges.

5.1 Identify areas for possible reintroductions.

5.2 Develop culture techniques for and effect reintroductions of Yaqui catfish.

5.2.1 Develop breeding protocol.

5.2.2 Determine fish size, time of year and stocking densities required to insure survival.

5.2.3 Stock and monitor success of reintroductions.

5.3 Reintroduce, reestablish and monitor populations of other species of concern.

5.4 Work with public agencies and private landowners to manage existing and reintroduced populations of fishes of concern.

6.0 Develop information and education programs for all species, their habitats and the ecosystem(s) upon which they depend.

6.1 Develop comprehensive programs of information and education.

6.2 Insure broad dissemination of information in both English and Spanish.

6.3 Establish and maintain archives of published and unpublished materials relevant to aquatic organisms and aquatic habitats of concern in permanent depositories.

2. Narrative

1.0 Cooperate on recovery with México. Due to limited habitat in the USA, close cooperation with México must occur prior to consideration of downlisting or delisting any of the Yaqui fishes or the Guzman beautiful shiner. Although the small parts of historic Rio Yaqui and Rio Mimbres watersheds occurring in the USA may be adequate to provide refugia to prevent extinction, full recovery to delisting cannot occur without protection of the species and their habitats in México.

1.1 Agreements and management plans to insure long-term survival of Rio Yaqui fishes and Guzman beautiful shiner in México must be pursued through all conceivable sources, including but not limited to the International Boundary & Water Commission, U.S. State Department relative to North American Free Trade Agreement stipulations and side agreements, SEDESOL of México, and other appropriate governmental agencies, and with conservation-oriented non-governmental agencies such as TNC in the USA and private entities in Mexico.

1.2 Final agreements between and among USA and Mexican agencies should include provisions for management of existing and reestablished populations. Such agreements should be negotiated to have positive or minimal negative impacts on agencies and their operations. As appropriate, all projects considered which potentially impact fishes of concern or their habitats should comply with existing laws and regulations of the country in which they occur, with maximum cooperation

between countries to benefit the species of concern. Agreements should provide basic protection for the fishes, access to sites, management rights to improve and enhance sites, and provisions for eradication and exclusion of non-indigenous species.

2.0 Manage existing habitats and populations.

2.1 Delineate catchment area, recharge and flow rates, storage volumes and other attributes of the underground aquifers for San Bernardino/Leslie Canyon NWR through contract or other agreement with US Geological Survey or other appropriate agency or organization, and expand or contract agreements obtained in **2.2** (below) to include those specific areas.

2.2 Seek binding agreements among and between political units, agencies and private landowners (**4.1-4.4**, below) to protect the watershed and presumed catchments for underground aquifers from detrimental changes in water quality and quantity.

2.3 Determine quantities of water required to sustain populations of listed species at levels now being maintained at San Bernardino/Leslie Canyon NWR and develop storage or water-acquisition systems to assure perpetuation of those quantities through drought or other water-short periods.

2.4 Revise and continue implementation of the San Bernardino/Leslie Canyon NWR Master Plan, as appropriate. The Master Plan should be reviewed and revised to provide guidance for maintaining the health and genetic integrity of all species of fishes and other imperiled biotic elements.

2.4.1 Develop water-use plan based on information and agreements under **2.1-2.3**, above and **4.1-4.4**, below to guide water use on the NWR that maximizes maintenance of populations of taxa of concern.

2.4.2 Develop and implement genetics monitoring plan. Assess genetic changes over time and prevent management activities which might result in loss of variability. Develop genetics maintenance programs for imperiled biotic elements.

2.4.3 Develop management plans which assure self-sustaining and genetically variable populations of each species of concern, communities of aquatic organisms operating in as natural a state as possible so that functioning ecosystems of aquatic, semi-aquatic, riparian and terrestrial components may be efficiently maintained.

2.5 Develop, enhance and monitor existing habitats. Efforts should be made to improve and perpetuate existing habitats as high-quality environments.

2.6 Prevent introductions of non-indigenous species. Success of recovery efforts will require restoration and repopulation of historic habitats. Because non-indigenous fishes and other organisms compete with, prey upon and sometimes hybridize with indigenous species, invasions by non-indigenous species must be prevented, and the latter must be removed where possible. Barriers and other means of excluding non-indigenous species must be utilized, as needed. Renovation of habitats containing non-indigenous species must occur prior to reestablishment of indigenous taxa.

3.0 Determine biological requirements of species of concern.

3.1 Examine and document life histories. Broad gaps exist in knowledge of the biology of imperiled organisms of concern. Information should be gathered, published and synthesized on the ecological requirements for reproduction, survival, growth, parasites, behavior and other biological attributes of each.

3.2 Determine intra- and interspecific interactions between and among species in occupied habitats. Data on interactions along with life-history information (**3.1**, above) will provide insights on the dynamics needed to manage multi-species communities.

3.3 Determine habitat requirements and define habitat utilization. Information on quality and quantity of habitat needed to maintain or expand populations are largely intuitive. Recovery may require reconstruction or modification of habitats, and habitat research should be conducted to develop information upon which to base future decisions, especially as efforts expand to establish and maintain multi-species communities.

3.4 Ascertain genetic profiles for existing populations. Baseline genetic information is required to document existing differences and similarities between isolated populations and establish genetic criteria for future management. Plans for genetic monitoring (**2.4.2,** above) should commence and be integrated with any genetics research.

3.5 Monitor fish populations and habitats. A program of monitoring should be developed which incorporates standard sampling protocols designed to assess population sizes and species and habitat health and well-being, while at the same time forming the basis for sampling relative to other research tasks. Managers and researchers should closely integrate their sampling protocols to minimize needs for species take and habitat disruption.

4.0 Protect historic habitat of fishes of concern in the USA. The fishes of concern were historically in the San Bernardino and Sulphur Springs valleys in AZ and Mimbres River watershed in NM. At present, they are only on the San Bernardino/Leslie Canyon NWR and in West Turkey Creek in AZ. Their distributions in México vary from restricted for Yaqui chub to uncertainly broad for Yaqui and Guzman beautiful shiners, Yaqui catfish and Yaqui topminnow. A recovery program for these fishes requires ecosystem-level protection due to the number of listed species and regional scarcity of water. Protection of habitats as ecosystem components is thus the most important requirement for recovery. Protection can be accomplished by preventing activities that disturb watersheds and/or directly or indirectly influence springs, artesian wells and their associated marsh-lands and outflows.

4.1 Maintain quality and quantity of subsurface waters. Refugia are needed to protect listed fishes until recovery can begin in México. This was accomplished in part by establishing the San

Bernardino/Leslie Canyon NWR. For refugia to succeed, however, both sub-surface and surface waters must be protected from contamination and depletion. Sub-surface flow presumably derives from a now-undefined recharge area north of refuge lands. The recharge/aquifer area and size should be investigated as soon as possible, and a master plan incorporating conservation principles to ensure water quality and quantity should be developed and implemented as soon as the recharge/ aquifer area is delineated. In the meantime:

4.1.1 Proper or enhanced land-use practices should be applied throughout the presumed recharge areas, as well as throughout the watershed;

4.1.2 development such as mining or irrigated agriculture that might influence depletion or quality of water should be avoided; and

4.1.3 agreements among Federal, State and private landowners should be forged to ensure maintenance of quality of infiltrated water during and following the recharge/aquifer identification period.

4.2 Work with water-users and appropriate agencies to prevent overuse of water. The San Bernardino NWR and Mexican agriculturists are currently using the same aquifer, which feeds the NWR system of artesian wells. Effects of high-volume pumping in México have already been detected (San Bernardino/Leslie Canyon NWR files). Negotiations should be started immediately to prevent or ameliorate competitive water-uses that influence water flows on the San Bernardino NWR (see **1.1** and **4.1**, above).

4.3 Acquisition of instream-flow water-rights should be pursued where possible to protect existing stream flows from development or other competing activities that influence water flows on the San Bernardino/Leslie Canyon NWR (see **1.1** and **4.1**, above). Acquisition of instream-flow water-rights would help to maintain historic discharges and provide perennial fish habitats.

4.4 Protection and acquisition of habitats and waters are essential for long-term survival.

Ecosystems supporting the listed species in the USA are small and vulnerable to disruption, especially through water withdrawal or introductions of non-indigeneous species. Protection and expansion of their habitats are thus imperative. Conservation agreements, habitat management plans and management easements should be pursued and implemented, thereby creating partnerships with private landowners and other agencies. Areas for possible acquisition should be identified and purchased as they become available from willing sellers.

5.0 Assess habitats for reintroduction and reestablish the species of concern within appropriate habitats in historic ranges.

5.1 Identify areas for possible reestablishment of species of concern. Potential reintroduction sites within the historic ranges should be identified, and agreements negotiated (see **4.3**, above) to implement reestablishment of fishes of concern (Williams et al. 1988). For example, for Guzman beautiful shiner and Yaqui catfish, parts of the Mimbres River watershed should be considered, a reach of which is already owned by NMDGF. Other public or private lands with willing landowners should be looked at along the Mimbres. Permanent cattle-watering tanks and other such habitats in the Mimbres River and Sulphur Springs watersheds should also be considered.

5.2 Develop culture techniques and effect reintroductions for Yaqui catfish.

5.2.1 Develop breeding protocol to ensure all available captive adults contribute to production of progeny to be used for restoration efforts. Produce fish of sufficient size, number, and genetic quality required for recovery.

5.2.2 Determine fish size, time or year, stocking densities, and other factors required to enhance survival and improve chances for contribution of stocked fish to re-covery of the species.

5.2.3 Stock into suitable habitats as needed and monitor reintroduction efforts.

5.3 Stocking of other species of concern should proceed as habitats, appropriate numbers of individuals and sufficient biological information become available, to maximize population sizes and dispersion into a number of separated stocks. Replicate stocks are necessary to buffer against unforseen disasters; the limited habitat available for Yaqui fishes in the USA makes such an event far more probable than with species managed over broader geographic areas. Routine monitoring protocols should be developed and implemented in concert with **5.2.3**, above.

5.4 Work with public agencies and private landowners to manage existing and reintroduced populations of species of concern. Management agreements (see **4.3**, above) should be pursued to allow reestablishment of listed species into historic habitats on private lands. Agreements should provide basic protection for the fishes, access to sites and management rights to improve or enhance sites, and eradicate and exclude non-native fishes. Such agreements should be negotiated to have positive impacts on landowners and their operations. All projects considered by federal agencies which potentially impact fishes of concern or their habitats should comply with existing laws and regulations.

6.0 Develop information and education programs for all species, their habitats and the ecosystem(s) upon which they depend.

6.1 Develop comprehensive programs of information and education. Information and education programs should highlight the plight of listed fishes, their value as part of the heritage of natural biodiversity of the USA and Mexico, and their role as indicators of environmental quality and indices of ecosystem health.

6.2 Insure broad dissemination of information. Program information should be designed to give the public a better understanding of the fishes of concern and widely disseminated at local, state, national and international levels. Special provisions should be made for production and dissemination in Mexico of Spanish-language versions of all appropriate program materials.

6.3 Archives of published and unpublished materials relevant to aquatic organisms and aquatic

habitats of concern should be established and maintained at permanent depositories including San Bernardino/Leslie Canyon NWR.

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III - IMPLEMENTATION SCHEDULE

The following implementation schedule outlines actions and costs for the Yaqui fishes recovery program. It is a guide for meeting the objectives discussed in Part II of the Plan. The schedule indicates task priorities, task numbers, task descriptions, duration of tasks, responsible agencies, and estimated costs. These actions, when accomplished, should bring about the recovery of Yaqui fishes and protect their habitat. It should be noted that estimated monetary needs for all parties involved in recovery are identified for the first three years only, and therefore are not reflective of total recovery costs. Costs are estimated to assist in planning. This recovery plan does not obligate any involved agency to expend the estimated funds. Though work with private landowners is called for in the plan, landowners are not obligated to expend any funds.

Definition of Priorities

Priority 1 - Those actions that are absolutely essential to prevent the extinction of the species in the foreseeable future.

Priority 2- Those actions necessary to maintain the species' current population status.

Priority 3- All other actions necessary to provide for full recovery of the species.

Agency Abbreviations

FWS	=	USDI Fish and Wildlife Service
		ES - Ecological Services
		FR- Fishery Resources Program
		RW- Refuges and Wildlife Program
AZGFD	=	Arizona Game and Fish Department
CES	=	Centro Ecologico de Sonora
ADWR	=	Arizona Department of Water Resources
AZSLD	=	Arizona State Land Department
BLM	=	Bureau of Land Management
USGS	=	United States Geological Survey
NMDGF	=	New Mexico Department of Game and Fish

PART III - IMPLEMENTATION SCHEDULE

GENERAL CATEGORY (1)	PLAIN TASK (2)	TASK # (3)	PRIORITY # (4)	TASK DURATION (5)	RESPONSIBLE AGENCY FWS REGION PROGRAM (6)	(6a)	OTHER (7)	FISCAL YEAR COSTS (ESTIMATE) FY95 (8)	FY96	FY97	COMMENTS (9)
	Pursue agreements and development of management plans for long-term survival of fishes of concern in Mexico.	1.1	1	Ongoing	2	RW	AEGFD CES	5,000	5,000	5,000	
	Develop and implement cooperative management plans.	1.2	2	Ongoing	2	RW	AEGFD CES	5,000	5,000	5,000	
	Determine aquifer recharge zone, capacities and configuration, and characteristics of sub-surface flow.	2.1	3	3 yrs	2	RW	AEGFD IBWC	50,000			
	Protect watershed and aquifer	2.2	1	Ongoing	2	RW/ES	AEGFD NMDGF	unknown	unknown	unknown	
	Determine amounts of water required to maintain listed species at San Bernardino/Leslie Canyon NWR.	2.3	2	3 yrs	2	RW		5,000	5,000	5,000	
	Revise and continue implementation of Refuge Master Plan.	2.4	3	1 yr	2	RW		1,000			
	Develop water-use plan for San Bernardino/Leslie Canyon NWR	2.4.1	2		2						
	Develop management plan for each species of concern.	2.4.2.	3	Ongoing	2	RW/FR	AEGFD NMDGF	5,000	5,000	5,000	
	Develop and implement genetic monitoring plans and schedules for each species.	2.4.3	2	Ongoing	2	RW/FR	AEGFD NMDGF	10,000	10,000	10,000	Genetic monitoring schedule set up every 5 years after baseline
	Develop or enhance new and existing habitats; monitor success of habitat management.	2.5	2	Ongoing	2	RW	AEGFD NMDGF	10,000	10,000	10,000	
	Eradicate and secure against reinvasion of new introductions of non-indigenous species.	2.6	1	Ongoing	2	RW/ES/FR	AEGFD NMDGF	10,000	10,000	10,000	
	Examine and document life histories.	3.1	2	5 yrs	2	RW/FR	AGFD NMDGF CES	15,000	15,000	15,000	
	Determine impacts of intra- and interspecific interactions in habitats occupied by combinations of species.	3.2	3	5 yrs	2	RW/FR	AEGFD NMDGF CES	8,000	8,000	8,000	
	Determine habitat requirements and habitat utilization.	3.3	3	3 yrs	2	RW/FR	AEGFD NMDGF CES	10,000	10,000	10,000	
	Determine . and delineate genetic composition of existing populations.	3.4	1	3 yrs	2	RW/FR	AEGFD NMDGF CES	8,000	8,000	8,000	
	Monitor health of fish populations and occupied habitats.	3.5	2	Ongoing	2	RW/FR	AEGFD NMDGF CES	2,000	2,000	2,000	
	Maintain levels and quality of subsurface waters.	4.1	1	Ongoing	2	RW/FR	AEGFD IBWC NMDGF	5,000	5,000	5,000	
	Apply proper or enhanced land-use practices.	4.1.1	2		2						
	Exclude development such as mining or irrigated agriculture.	4.1.2	2	Ongoing	2	RW/ES					
	Forge agreements to assure aquifer water quality.	4.1.3	1	Ongoing	2	RW/ES		1,000	1,000	1,000	
	·ith water users and appropriate es and individuals to prevent e of water from essential rs.	4.2	1	Ongoing	2	RW/ES	IBWC	1,500	1,500	1,500	

PART III - IM TION SCHEDULE

GENERAL CATEGORY (1)	PLAIN TASK (2)	TASK # (3)	PRIORITY # (4)	TASK DURATION (5)	RES. IBLE AGENCY FWS REGION (6)	PROGRAM (6a)	OTHER (7)	FISCAL YEAR COSTS (ESTIMATE) FY94 (8)	FY95	FY96	COMMENTS (9)
	Obtain Instream flow water-rights for sufficient water to maintain surface flows in watercourses important to recovery.	4.3	2		2	RW	AZGFD NMDGF				
	Acquire and protect or protect through conservation agreements and habitat management plans the essential waters and habitats needed for long-term survival of fishes of concern.	4.4	2	Ongoing	2	RW	AZGFD NMDGF	unknown	unknown	unknown	
	Identify areas for possible reintroductions.	5.1	3	2 yrs	2	RW/FR	AZGFD USFS BLM NMDGF	5,000	5,000	5,000	
	Develop culture techniques for Yaqui catfish.	5.2	3	Ongoing	2	FR/RW	AZGFD NMDGF	5,000	5,000	5,000	
	Develop breeding protocol.	5.2.1	3	1 yr	2	FR/RW		3,500	3,500	3,500	
	Determine fish size, time of year and stocking densities required to ensure survival.	5.2.2	3	3 yrs	2	FR/RW		4,500	4,500	4,500	
	Stock and monitor success of reintroductions.	5.2.3	3	Ongoing	2	RW/FR	AZGFD NMDGF	5,000	5,000	5,000	
	Reintroduce, reestablish and monitor populations of other species of concern.	5.3	3	Ongoing	2	RW/FR	AZGFD NMDGF	5,000	5,000	5,000	
	Work with public agencies and private landowners to manage existing and reintroduced populations of fishes of concern.	5.4	2	Ongoing	2	RW/FR/ES	AZGFD NMDGF	8,000	8,000	8,000	
	Develop comprehensive programs of information and education.	6.1	3	Ongoing	2	RW	AZGFD NMDGF	3,500	3,500	3,500	
	Insure broad dissemination of information in both English and Spanish.	6.2	3	Ongoing	2	RW	AZGFD NMDGF	1,000	1,000	1,000	
	Establish and maintain archives of published and unpublished materials relevant to aquatic organisms and aquatic habitats of concern in permanent depositories.	6.3	3	1 yr	2	RW	AZGFD NMDGF	1,000			

Appendix

Summary of Comments Received on the
Yaqui Fishes Recovery Plan

On June 7, 1994, a Federal Register notice announced that the draft Recovery Plan for the Endangered and Threatened Fishes of the Rio Yaqui was available for public review. The U.S. Fish and Wildlife Service(Service) accepted comments on the draft plan between June 7, 1994, and August 8, 1994. The comment period was then extended for an additional sixty days and ended October 7, 1994. A notice was also entered in the Douglas Dispatch, a daily paper in Douglas, Arizona. The draft recovery plan was distributed to 38 agencies and individuals. Comments were received from private landowners, Cochise County, AZ and from several state and federal agencies.

All comments were considered when revising the draft plan. The Service appreciates the time each of the commentors took to review the draft and to submit their comments.

The comments discussed below represent a composite of those received prior to the close of the public comment period. Comments of a similar nature are grouped together. Substantive comments that question approach, methodology, or finacial needs called for in the draft plan, or suggest changes to the plan are discussed here. Comments regarding simple editorial suggestions, such as better wording, measuring unit equivalency, or spelling and punctuation changes, were incorporated as appropriate without discussion here.

All comments received are retained as part of the Administrative Record of recovery plan development in the San Bernardino/Leslie Canyon National Wildlife Refuge Office, Douglas, Arizona.

Comment 1: Concerned the Service working through private organizations, individuals, and government agencies to address water problems in Mexico which effect the aquifer.

Service Response 1: The Service is ready to work with any individual or group, such as the Malpai Borderlands Group, The Nature Conservancy, or others to try to find solutions to water problems

on both sides of the border. In addition to working with federal, state and Mexican agencies and groups, the Service is willing to work with interested parties in finding a solution to this and other problems which effect the resources of the refuges.

Comment 2: Obtaining an instream flow right for Black Draw is not practical or needed.

Service Response 2: The Service feels that protection of water supplies is critical to maintaining these fishes on the refuge. However, due to the nature of Black Draw and the fact that there is surface flow in the creek for only 5-6 months of the year, instream flow rights are probably not practical or obtainable. Instream flow rights would not affect existing water rights and would make leaving the water in the stream bed a legal use.

Comment 3: Establishing hatchery structures on the refuge for all listed fish.

Service Response 3: The Service feels that there is no need to establish hatchery structures for the fish. Dexter National Fish Hatchery and Technology center is currently involved with trying to propagate the Yaqui catfish. The expertise and facilities are already in place in Dexter to do the research needed on these fish. Naturally reproducing populations under wild conditions are preferable to hatchery produced fish. All the species currently on the refuge have reproducing populations in numbers that should prevent genetic problems. The aim of the recovery plan is to have naturally reproducing populations and hatchery rearing of any of these fish would be a last ditch effort to prevent extinction.

Comment 4: Making agreements, and working with, private groups and individuals to reintroduce Yaqui fishes as opposed to acquiring land to accomplish this.

Service Response 4: The Service agrees that working with private groups and individuals will be important to the recovery and survival of these fishes. The Service has worked with, and will continue to work closely with individuals and groups for the benefit of these fishes. Groups such as the Malpai Borderlands Group and their commitment to preserving open space and

improving the habitat in the San Bernardino Valley will benefit the refuge and the Yaqui fishes. Land acquisition from willing sellers is another tool that can be used to benefit these species. Acquisition of the San Bernardino/Leslie Canyon NWR's has allowed the endangered fish populations to increase from near extinction and made possible the reintroduction of the beautiful shiner into the fish fauna of Arizona.

Comment 5: How recovery actions impact on public access to refuges and private lands which contain critical habitat for these species.

Service Response 5: The only critical habitat designation is made on aquatic habitats on the San Bernardino National Wildlife Refuge. No designated critical habitat is located on private land. Public access to private lands is determined by the private land owner. Even if their property contains Yaqui fishes the private landowner will still determine access to their own land. There is currently limited public access to San Bernardino NWR and recovery actions will not restrict it. Under Step 6 of the recovery plan, the refuge will play a major role in educating the public about the imperiled Yaqui fishes and this will mostly be carried out on the San Bernardino NWR.

Comment 6: Will Service maintain dialogue with local landowners and user groups who may be impacted by Recovery actions?

Service Reponse 6: Yes. The Service currently works with landowners that have Yaqui fishes on their property and will continue to work with landowners on Recovery items. One of the keys to recovery of these fishes is working with local landowners and agencies in a cooperative manner.

Comment 7: What is the critical habitat for Yaqui chub, Yaqui catfish, beautiful shiner, and Yaqui topminnow?

Service Response 7: For chub, shiner, and catfish, the listed critical habitat is all aquatic habitats on the San Bernardino National Wildlife Refuge. No listed critical habitat for the Yaqui topminnow.

Comment 8: Has mining played a role in the disappearance of these fish? Is mining a problem?

Service Response 8: Impacts from mining have had detrimental effects on the Yaqui fishes. Groundwater pumping for smelting operations have resulted in reduced habitat for these fishes. In the USA portion of the range, mining currently has minimal impacts. However, the area in which these fishes occur has a rich mineral history and mining is a potential threat to these small habitats.

Comment 9: There is speculation that the Mimbres River cannot support Guzman beautiful shiner due to habitat alterations over the last 100 years and the establishment of longfin dace in the river.

Service Response 9: Populations re-established on the San Bernardino NWR are in modified habitats and have adapted well. The shiner should be able to establish depending on whether or not exotic fishes and what kind of exotic fishes are present. It is not known what the interactions of the longfin dace and the shiner would be. In surveys done in the fall of 1994 on the Rio Bavispe in Sonora, Arizona Game & Fish and Fish & Wildlife Service personnel frequently found longfin dace and beautiful shiner in the same river reaches.

Comment 10: Are there any studies that can be used to direct habitat improvements?

Service Response 10: The Service is currently funding a study on habitat utilization by Yaqui fishes. This will help direct habitat improvement projects although more research is needed on all aspects of these fishes life histories and habitat preferences.

Comment 11: Is there any information on the relationship between precipitation and replenishment of the aquifer?

Service Response 11: No. The Service is funding a study of the aquifer to gather basic information as to the extent and capacities of the aquifer.