

STATUS OF BIGSCALE LOGPERCH (*PERCINA MACROLEPIDA*)
AND GREENTHROAT DARTER (*ETHEOSTOMA LEPIDUM*)
IN NEW MEXICO

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New Mexico Department of Game and Fish
Share with Wildlife Program

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INTRODUCTION

Many freshwater fishes in the American Southwest are protected under state and federal laws because of declines in distribution and abundance, primarily due to human alteration of habitat and introduction of non-native species (Miller 1961; Minckley and Deacon 1968). Threat of extinction due to habitat modification is high (Ricciardi and Rasmussen 1998), and monitoring changes in abundance and distribution provide information for policy making decisions.

The native range of *Percina macrolepida* (bigscale logperch) includes the Sabine River in Louisiana, the Red River of Oklahoma and Arkansas, numerous Gulf of Mexico drainages in Texas, the lower Rio Grande of Texas, the Rio San Carlos in Mexico, and the Pecos River of New Mexico (Hubbs, 1990; Page and Burr, 1991; Buchanan and Stevenson, 2003). In the Pecos River drainage of New Mexico, bigscale logperch is locally common in Santa Rosa, Sumner and Brantley reservoirs (Koster, 1957; Sublette et al., 1990), and in the Black River (Propst, 1999) (Figure 1). Bigscale logperch is rare in mainstem Pecos River collections between Sumner Dam and Roswell (Propst, 1999; USFWS, unpublished data). Bigscale logperch was introduced into the Arkansas River in Oklahoma and Arkansas (Buchanon and Stevenson, 2003), the Canadian River in New Mexico (Sublette et al., 1990), the Platte River in northern Colorado (Platania, 1990), and the Sacramento-San Joaquin River system of California (Moyle, 2002). Bigscale

logperch were collected in Elephant Butte Reservoir in 2003 (Hansen, 2004, unpublished report, New Mexico Department of Game and Fish, Santa Fe, NM), and more specimens have been collected from Elephant Butte Reservoir and the Rio Grande upstream to the San Acacia Diversion Dam since that time (Davenport and Remshardt in press). The Rio Grande population of bigscale logperch is considered non-native.

Bigscale logperch are found in swift, non-turbulent and moderately deep waters with cobble substrate in lotic conditions (Stevenson and Thompson 1978), and along wave-swept shorelines with gravel and cobble substrate in lentic conditions (Propst, 1999). In Lake Texoma, Oklahoma, juvenile bigscale logperch were collected over littoral areas with deep sand, and adults were collected over windswept areas having little sand (Jackson, 1984). Early life history larval characteristics were described from the Trinity River, Texas (Simon and Kaskey, 1992). Spawning time in Texas (Stevenson, 1971; Hubbs, 1985) and Oklahoma (Hubbs, 1985) is between February and May.

Greenthroat darter is native to the Colorado, Guadalupe and Nueces River drainages in the Edwards Plateau of Texas, and the Pecos River basin in New Mexico (Page and Burr, 1991). Greenthroat darter is found in spring systems (spring headwaters and spring runs), creeks and small rivers, over vegetated gravel and rubble riffles. In New Mexico, greenthroat darter is found in several habitats at Bitter Lake National Wildlife Refuge including Bitter Creek, the west side spring ditch adjacent to Units 6 and 7, have been found in man made waterfowl impoundments. Additional areas with greenthroat darter are the modified spring pond at Rattlesnake Spring, Carlsbad Caverns

National Park, Blue Spring and a single specimen from the Rio Penasco collected in the 1970's (Sublette et al. 1990). Greenthroat darter is found in stenothermal and eurythermal habitats. The reproductive biology of greenthroat darter is well studied (at least in Edwards Plateau, Texas population), but little is known about other life history aspects such as feeding habits, predation etc.

The objectives of this study were: 1) summarize bigscale logperch and greenthroat darter survey data from Pecos River basin in New Mexico; 2) resurvey both species at core sites and; 3) provide recommendations for long term standardized monitoring for both species such as determining long-term site occupancy of bigscale logperch (Appendix I).

METHODS

We used a 3-m seine to capture fishes at 10 (of 14) core sites in 2007 (Table 1). We recorded the length of the seine-haul, water depth, and meso-habitat type, and measured total and standard length of each bigscale logperch. Big scale logperch are uncommon during Pecos River fish community monitoring in De Baca, Chaves and Eddy counties. Long-term Pecos River sites are monitored multiple times yearly, and focus on mainstem Pecos River fishes. Collections from these long-term sites are included in order to quantify how uncommon bigscale logperch are in main-stem Pecos River collections. We calculated the proportion of sites where logperch were detected in 14 core sites (Table 1) for each year (Figure 4). We calculated the mean number of bigscale logperch collected per year at core sites, but yearly changes should be interpreted with

caution because of non-standardized collection methods. Bigscale logperch collections were summarized from 15 long-term mainstem Pecos River monitoring sites. Annual raw numbers of bigscale logperch collected are provided in Table 3.

Greenthroat darter were sampled with 1/4 and 1/8 inch wire mesh minnow traps at Rattlesnake Spring and Bitter Lake National Wildlife Refuge and with a Smith-Root backpack electro-fisher on the Rio Penasco. Wire mesh minnow traps were set overnight. In the past greenthroat darter were collected with dip nets in the natural channel at Rattlesnake Spring (David Propst, NMDGF, personal communication).

In 2007, greenthroat darter were sampled on the Rio Penasco, at Rattlesnake Spring and at Bitter Lake National Wildlife Refuge. In 2006, Rattlesnake Spring was sampled for greenthroat darter; fish were sampled with wire mesh minnow traps, and backpack electro-fishers in three locations: 1) spring pond, 2) irrigation channel and 3) natural channel. Greenthroat darter collections at Bitter Lake National Wildlife Refuge date to 1995.

Data were compiled from USFWS, New Mexico Fish and Wildlife Conservation Office and U.S. Park Service, Carlsbad Caverns National Park file data. For our analysis we lumped collections from Bitter Creek and Lost River confluence, and all traps set in the west side spring ditch. Two private property sites, Cottonwood Creek and Blue Spring (Eddy Co), have not been surveyed to date. If access to these sites is allowed we will survey and provide that information to NMDGF in a report addendum.

RESULTS

We summarized total bigscale logperch caught by year from 1986 through 2007 (Figure 2). Total logperch collected each year was variable, and ranged from 0 in 1998 to 102 in 1992. In 2007 we collected 21. Mean logperch collected at each site by year is summarized in Figure 3, and was also variable. Annual percentage of core sites where bigscale logperch were collected is summarized in Figure 4; site occupancy ranged from about 0.20 to 0.80, but not every core site was sampled every year and year-to-year comparisons of occupancy may not reflect actual changes in distribution. Mean number of bigscale logperch collected at each core site (Figure 5) varied annually. In 2007, five of 10 core sites had bigscale logperch present (Table 1).

Number of bigscale logperch at the 15 sites varied from 0 to 19 in the years 1992-2007. Brantley Inflow, the only site closely associated with a reservoir, had the most years with collections (6) and the most fish collected, however bigscale logperch have not been collected at this site since 2001. All other mainstem Pecos River sites had between 0 and 4 fish collected in the 15 years of collections.

File data from Carlsbad Caverns National Park provided data from 2000 through 2002; and USFWS file data for 2006 and 2007. No greenthroat darter were collected or observed in 2002 and 2006 at Rattlesnake Spring (Figure 6). Western mosquitofish were collected in the natural channel in 2006; this was the first collection of this species at the spring. Largemouth bass, *Micropterus salmoides*; green sunfish, *Lepomis cyanellus* were collected. These fish are considered undesirable by the Park, and a removal effort was designed and implemented in June 2007. Fish sampling of Rattlesnake Springs in 2007

collected more greenthroat darter than were detected during previous surveys (Figure 7), because the spring was drained for renovation. A total of 216 greenthroat darter was removed during renovation of the spring in June. This number likely equals the total population of darter in the spring. Greenthroat darter were collected monthly after renovation (Figure 8 and 9) with highest catch rate in August (4.0 fish/trap day).

At Bitter Lake National Wildlife Refuge, greenthroat darter were historically collected from Bitter Creek, Lost River confluence, and the west side spring ditch adjacent to Units 6 and 7 (Table 3). Greenthroat darter were collected from Bitter Creek annually between 1995 and 1998, however no greenthroat darter have been collected from Bitter Creek/Lost River since 1999. Greenthroat darter were collected from the west side spring ditch in the majority of years sampled, including 2007. Refuge staff also collected greenthroat darter in Bitter Creek, Lost River confluence and in the west side spring ditch. Sampling at Cottonwood Creek in 2002 and 2003 found no greenthroat darter, and the channel was filled with vegetation and tumbleweeds. No greenthroat darter were collected from the Rio Penasco in 2007, however we could not access previously sampled sites on private property.

DISCUSSION

Bigscale logperch were collected in large numbers in reservoirs. We easily captured bigscale logperch at Santa Rosa, which accounts for 66% of the 2007 total catch. However, in main-stem Pecos River sites, bigscale logperch were infrequently captured, and occur in small numbers. Years 2002 through 2004 are noteworthy, because

no bigscale logperch were collected from any mainstem site, and river drying occurred during these years. Unequal effort, differing sites, and imperfect detection probability in mainstem sites confuses the status of bigscale logperch in New Mexico, and any changes in distribution that appear to occur may be real changes in distribution, or artifacts of unequal effort. Even within core sites, number of sites visited and number of sampling locations varied from year to year, and comparisons should be cautious.

Greenthroat darter were found at all previously sampled sites, with the exception of Bitter Creek on Bitter Lake National Wildlife Refuge. Habitat changes in Bitter Creek, mainly encroachment of common reed into the riparian area, likely explain the absence of greenthroat darter. Greenthroat darter is more restricted in range in New Mexico than bigscale logperch, found only in relatively unmodified springs and spring runs such as Rattlesnake Spring, Blue Spring, and Bitter Lake National Wildlife Refuge. We recommend implementing a standardized, repeatable site-occupancy monitoring protocol outlined in the appendix to monitor changes in distribution and abundance of both species.

Preferred habitat for bigscale logperch is deep water over a variety of substrates (Stevenson 1971). Loss of deep water habitat in the main-stem Pecos River is a possible explanation for rarity of bigscale logperch in mainstem collections. In the Black River, bigscale logperch were collected from deep pools with little velocity, but higher velocity was always in close proximity upstream and downstream (personal observation). Mainstem Pecos River collections are often associated with deep shoreline habitats (personal observation), but collections are too infrequent to draw any conclusions. Pecos River flows are stored in Santa Rosa and Sumner reservoir, and Pecos River flows are

maintained by a combination of irrigation return flows, groundwater seepage and sewage effluent (Mourant and Shomaker, 1970; Mower et al., 1964). Because of this, surface flow intermittence, and extreme low flows occur in sections of the Pecos River. Surface flow intermittence in 2002, 2003 and 2004 caused decreases in abundance in riverine fishes (Hoagstrom et al. 2007), and bigscale logperch were not collected in mainstem collections during this period. Even during years when surface flow is continuous, irrigation season flows are limited, and deep water can be uncommon when river flows decrease (personal observation). Seasonal dewatering of the mainstem Pecos River may have resulted in confining bigscale logperch to lentic environments in reservoirs, and spring fed tributaries such as the Black River. Another explanation for the current distribution of bigscale logperch is that it is a tributary species, and was always uncommon in the mainstem Pecos River. The collections of bigscale logperch in the Black River support bigscale logperch affinity for spring fed river systems.

Protection of spring systems that support greenthroat darter is vital to conserving this species. Spring fed tributaries were common in Santa Rosa (El Rito Creek); Roswell Artesian Basin (Berrenda Creek, Spring River, Rio Hondo and Rio Felix), and Carlsbad (Major Johnson Springs, Carlsbad Spring, Black River). These tributaries were a major contribution to Pecos River flow in the past (Havenor 1968), and most likely maintained diverse spring system fish assemblages. Many spring fed tributaries have decreased or ceased to flow since increase in appropriation from the artesian and shallow aquifers (Havenor 1968). Loss of these habitats led to restriction of greenthroat darter to the few remaining springs with flow.

Saline encroachment into fresh water aquifers in the Roswell Artesian Basin is another problem associated with decreased spring flows (Havenor 1968). Historic over-appropriation of the freshwater aquifer allowed movement of saline waters into the Roswell artesian basin increasing salinity of tributaries, ground water and water applied to agricultural fields (Havenor 1968). Irrigation returns result in higher salinity Pecos River flows, and reservoirs downstream of the Roswell Basin impound water and further increase salinity through evaporation. Salinity tolerances of bigscale logperch have not been studied (to our knowledge), but bigscale logperch may be excluded from the lower Pecos River if their salinity tolerances are low.

Other water quality issues may also prevent the presence of bigscale logperch from mainstem Pecos River. Golden algae (*Prymnesium parvum*) blooms have been recorded since 2002 in the Pecos River from Brantley Reservoir downstream into Texas. Golden algae produce toxic blooms in cold, high conductivity water. These blooms originate in Pecos River reservoirs in winter and are spread downstream by current and have resulted in fish kills in many sections of the Pecos River. Core sites downstream of reservoirs are sampled yearly and no bigscale logperch have been collected from this reach since 2002. In fact, during October 2007 monitoring at these sites (County road 30 crossing, Rocky Arroyo, Malaga Bend and Delaware River confluence) no fish were collected from the mainstem. The exception was in the Black River where bigscale logperch were collected and algae blooms have not happened. Physical water chemistry (stenothermal, spring water with lower conductivity) in the Black River may prevent the golden algae blooms. Therefore this tributary is an important refuge for bigscale log perch.

CONCLUSIONS

Bigscale logperch are present in the Pecos River in New Mexico in a variety of habitats, including: reservoirs, reservoir tailwaters, mainstem Pecos River, and in one tributary, but are most numerically abundant in reservoirs. Bigscale logperch were not found in the Pecos River below Brantley Reservoir, likely because of golden algae blooms, and were not collected from mainstem Pecos River sites during years when surface flow intermittence occurred. Depopulated river sections could repopulate if river conditions improve. The data set does not allow for annual or site comparisons because of unequal effort, differing sites, and imperfect detection probability. Because of this, we recommend occupancy rate estimation for bigscale logperch in order to quantify occupancy at core sites. Decreased Pecos River flows, golden algae blooms, and increased salinity all are threats to New Mexico populations of bigscale logperch. Populations associated with reservoirs are more resilient to vagaries of flow, but are not impervious to golden algae blooms. The Black River population is an important refuge population from increased salinity and golden algae blooms. Greenthroat darter distribution is more restricted than bigscale logperch, and its habitat has greater potential for change. Loss of greenthroat darter from Bitter Creek and possibly Cottonwood Creek illustrates this threat. More surveys of Cottonwood Creek are needed to ascertain status of greenthroat darter. Greenthroat darter were successfully transplanted into Rattlesnake Spring in 1999. More transplants into native range should be considered to expand range of this fish.

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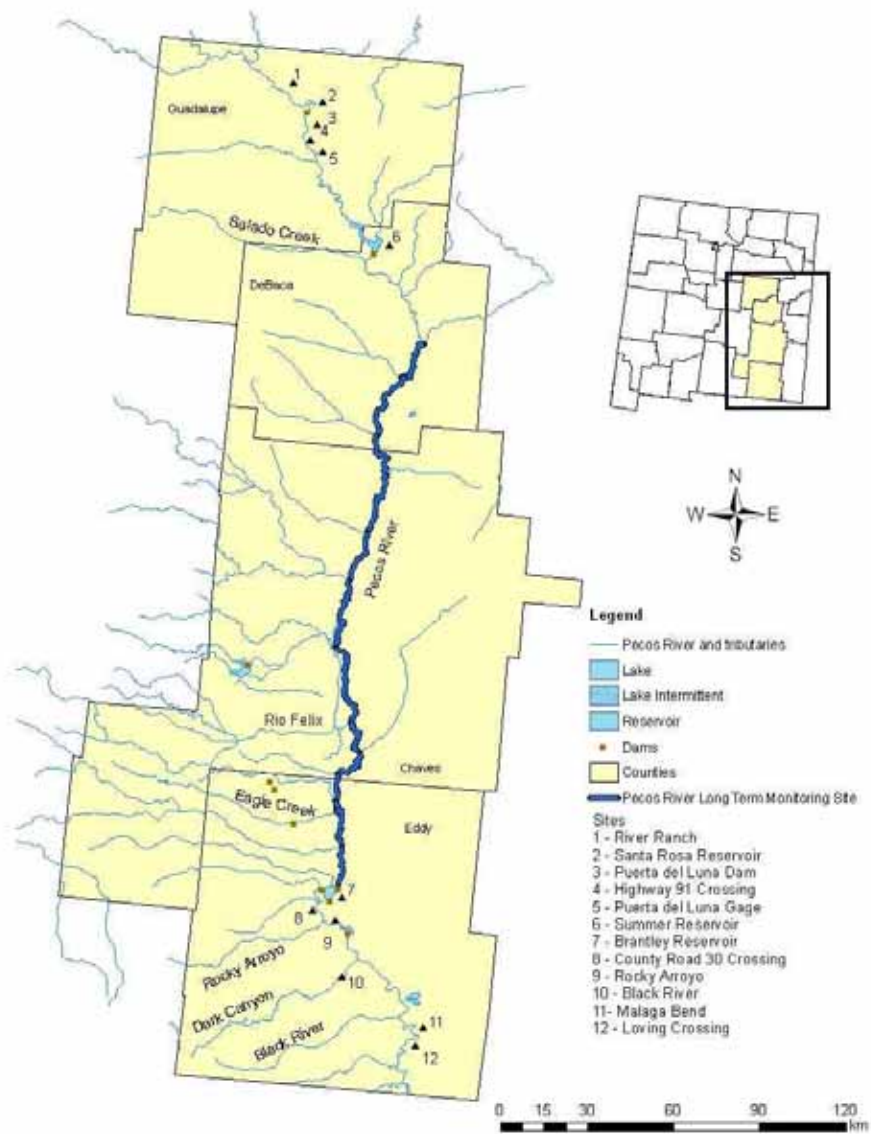


Figure 1. Map of Middle Pecos River New Mexico with bigscale logperch core sites listed from upstream to downstream.

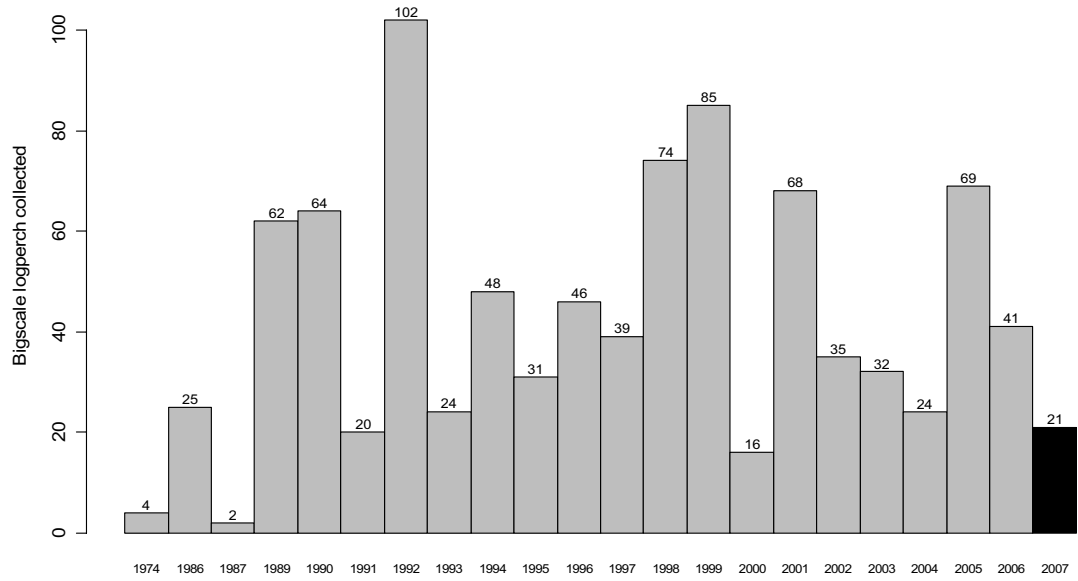


Figure 2-Total number of bigscale logperch collected, by year, in the Pecos River basin, New Mexico.

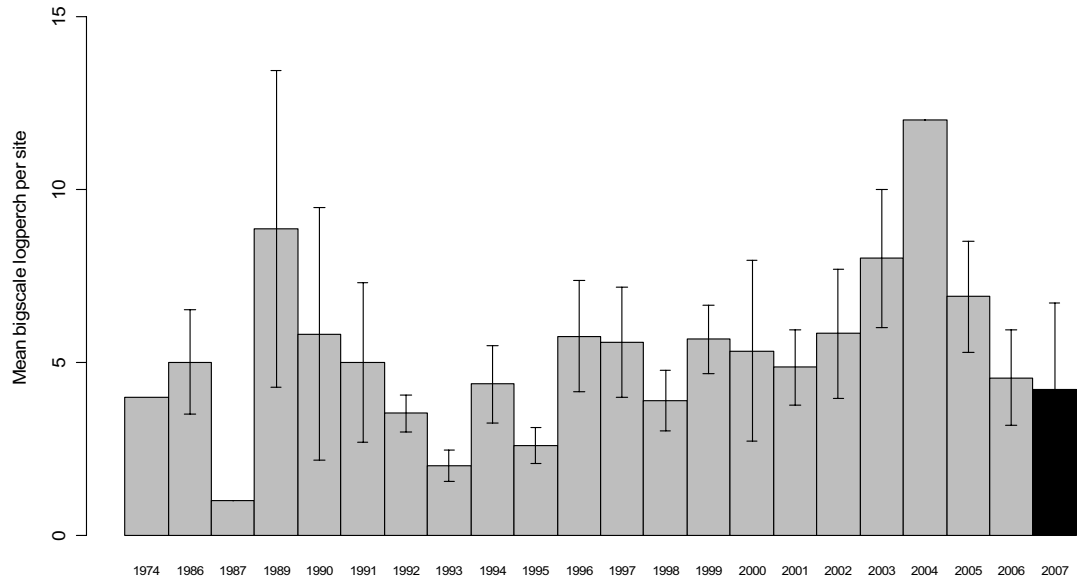


Figure 3-Mean number of bigscale logperch collected at each site, by year, in the Pecos River basin, New Mexico. Bars represent one standard error of the mean.

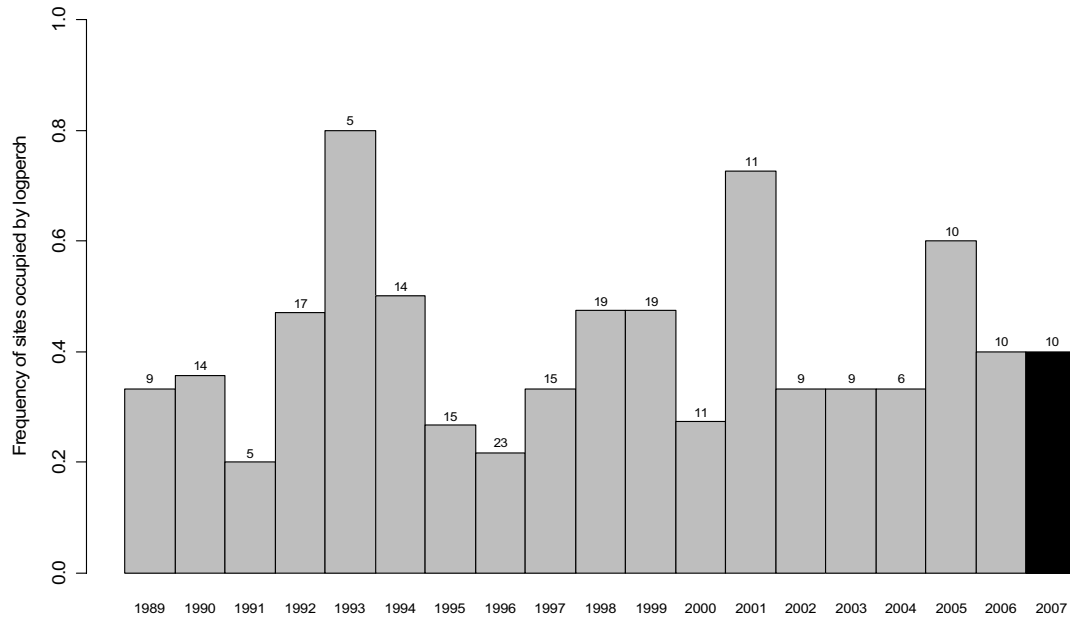


Figure 4-Proportion of core sites where bigscale logperch were collected, by year, in the Pecos River basin, New Mexico. Numbers plotted above bars represent the number of core sites sampled in that year.

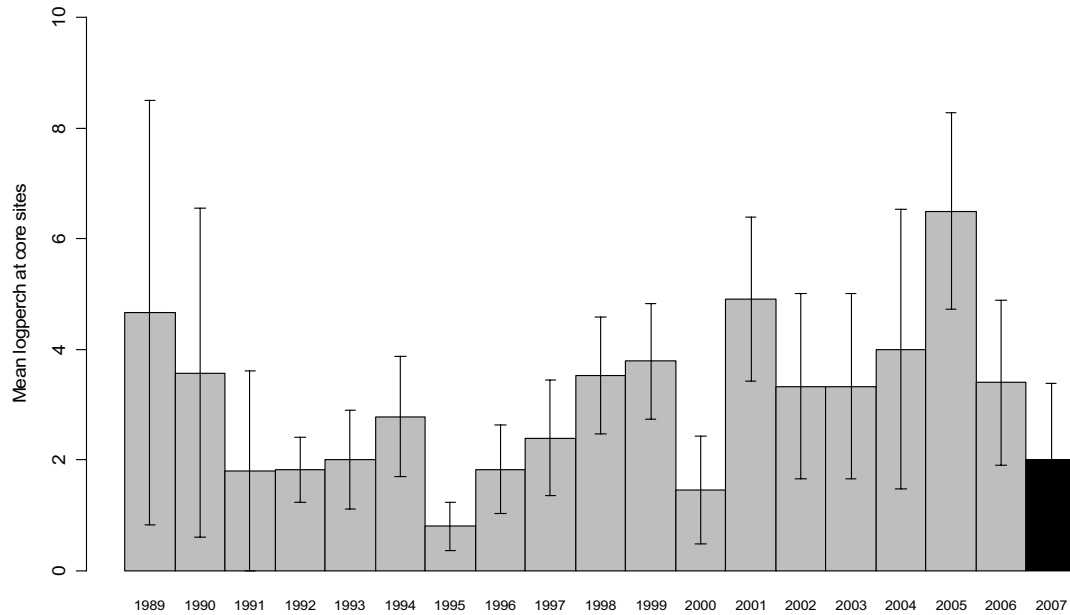


Figure 5-Mean number of bigscale logperch collected at each core site, by year, in the Pecos River basin, New Mexico. Bars represent one standard error of the mean.

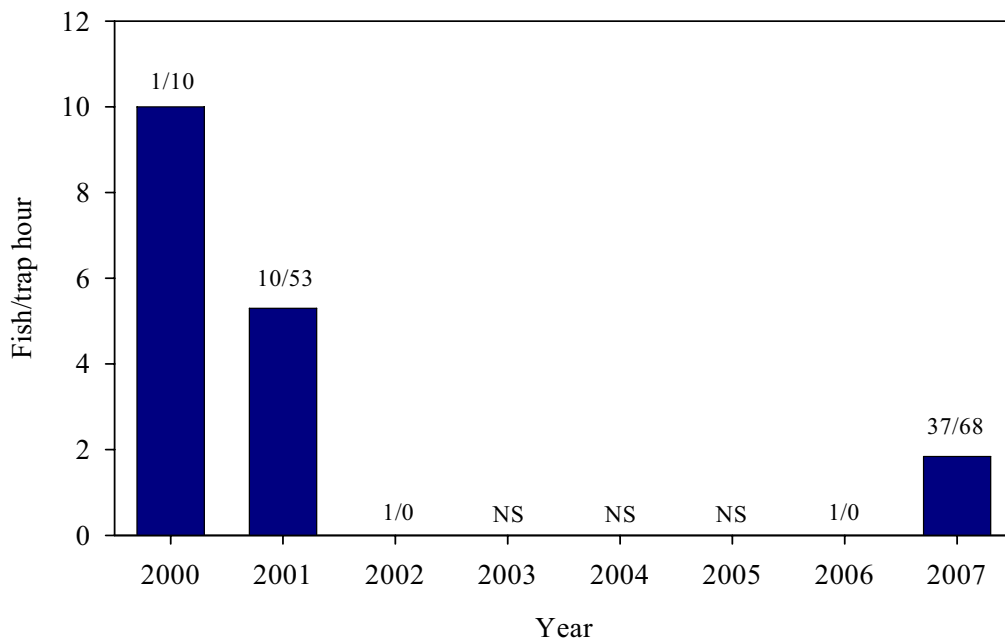


Figure 6. Number of greenthroat darter per trap hour (total number of fish collected divided by hours trapped) at Rattlesnake Spring 2000 through 2007. Number above bar is number of hours trapped/ number of fish collected. NS = not sampled.

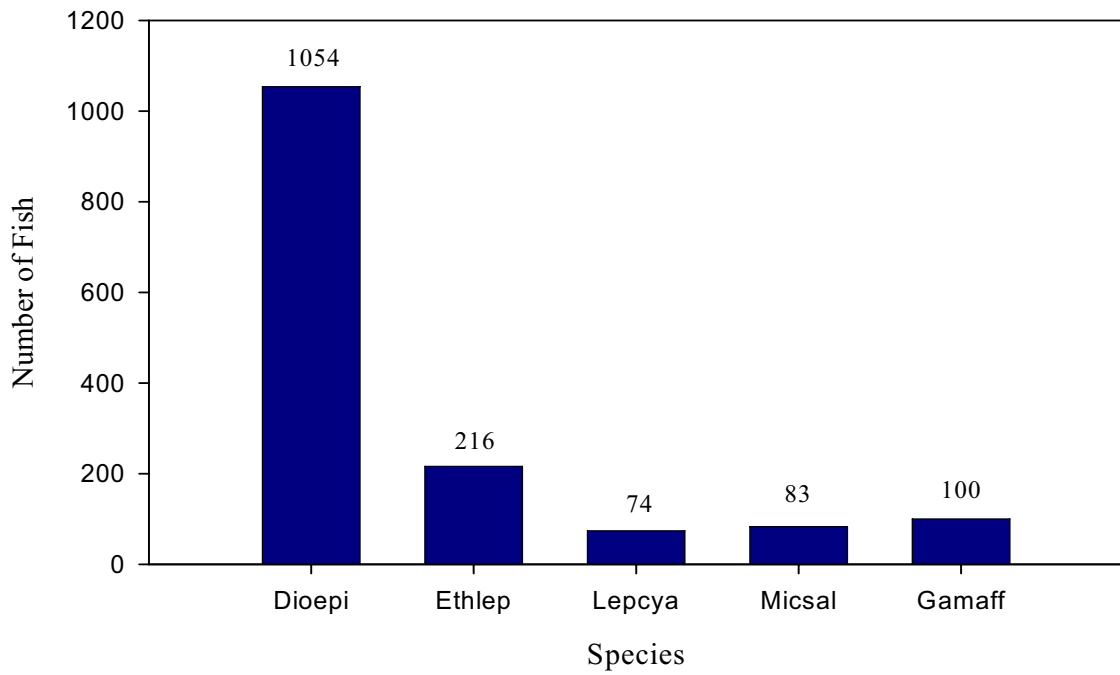


Figure 7. Number of fish collected in June 2007 during restoration of Rattlesnake Spring. Number above bar is total number of each species. (Dioepi = *Dionda episcopa*, Ethlep = *Etheostoma lepidum*, Lepcya = *Lepomis cyanellus*, Micsal = *Micropterus salmoides*, Gamaff = *Gambusia affinis*)

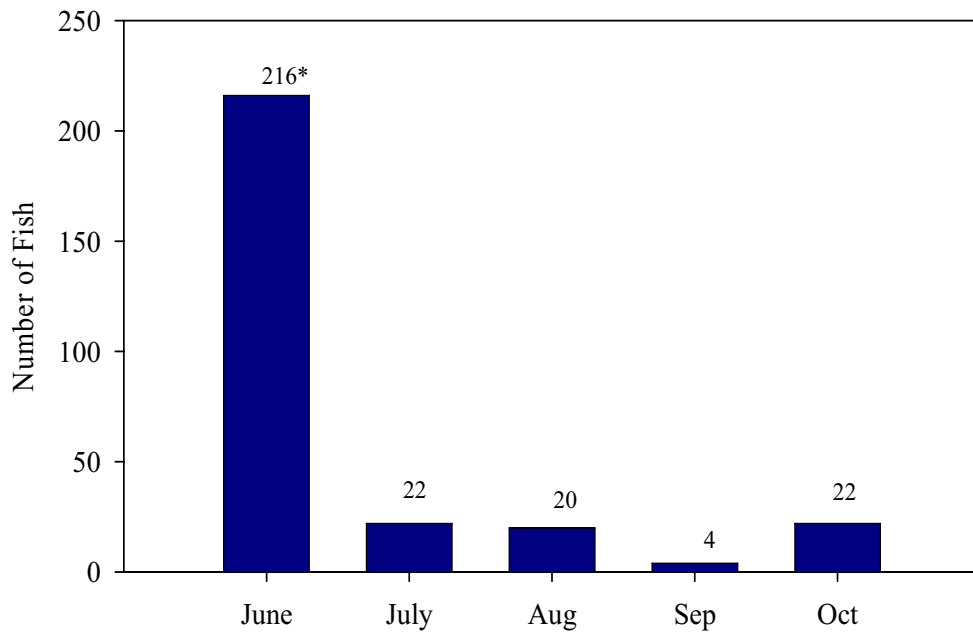


Figure 8. Number of greenthroat darter collected from Rattlesnake Spring during renovation (June), and collected during monthly (July through October) minnow trapping in 2007. Number above bar is number of fish collected monthly.

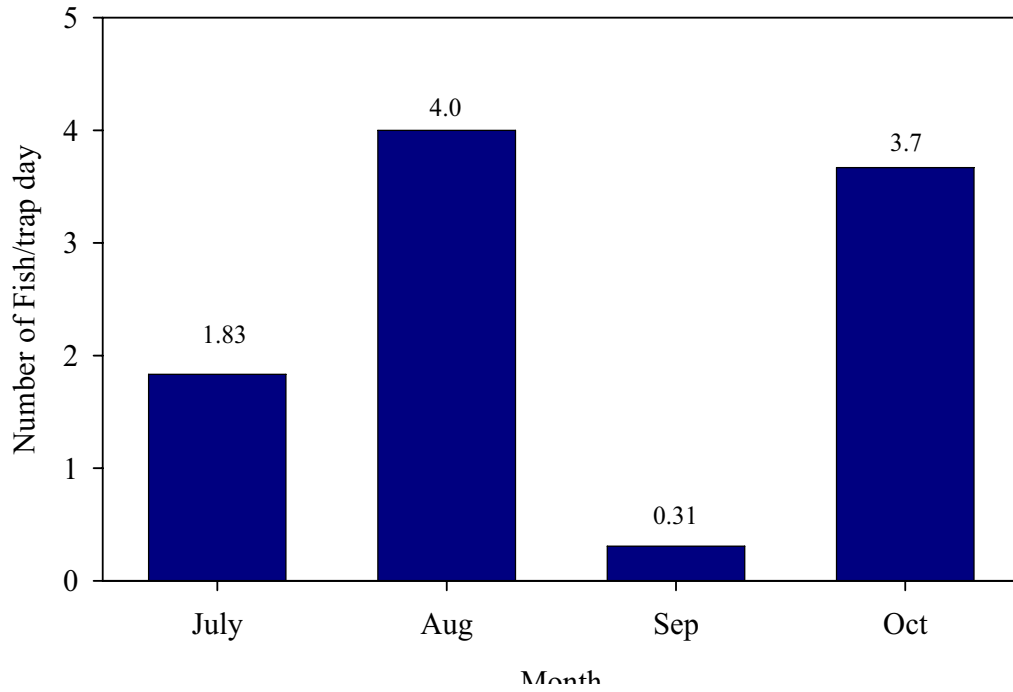


Figure 9. Number of greenthroat darter collected per trap day during 2007 monthly trapping at Rattlesnake Spring. Number above bar number of fish divided by days of trapping during that month.

Table 1. List of core sites, site type, coordinates and number of fish collected in 2007 for bigscale logperch collections in the Pecos River basin, New Mexico, listed from upstream to downstream. ns = not sampled.

Location	Site Type	Sampled in 2007?	Coordinates: Lat.long.	Coordinates: UTM Zone 13S (NAD 83)	No. collected in sampling history and in 2007
River Ranch	mainstem	Yes	N35.05330 W104.74076	523640 E, 3878984 N	9, 1
Santa Rosa Reservoir	reservoir	Yes	N35.0284 W104.6888	528388 E, 3876237 N	13, 14
Pecos River below Santa Rosa Dam	tailwater	Yes	N35.0284 W104.6888	528388 E, 3876237 N	ns, 0
Puerto de Luna Dam	mainstem	No	N 34.8263, W 104.6270	534107 E, 3853844 N	ns
Puerto de Luna Bridge (NM Hwy 91)	mainstem	Yes	--	534268 E, 3853898 N	2, 1
Puerto de Luna Gage	mainstem	Yes	N34.7301 W104.5247	543514 E, 3843213 N	6, 4
Sumner Dam	reservoir	No	--	ns	13, ns
Pecos River below Sumner Dam	tailwater	Yes	N34.60328 W104.38733	556176E, 3829220N	1
Brantley	reservoir	No	--	ns	ns
Brantley Inflow	mainstem	Yes	N32.59700 W104.35157	560848 E, 3606797 N	42, 0
Highway 30 Crossing	tailwater	Yes	N32.54370 W104.36628	559503 E, 3600880 N	2, 0
Rocky Arroyo	tailwater	Yes	N32.52147 W104.34512	561505 E, 3598428 N	11, 0
Black River	mainstem	Yes	N32.23608 W104.07401	587242 E, 3566980 N	3, 0
Malaga Bend	mainstem	Yes	N32.21881 W104.00200	594044 E, 3565126 N	4, 0
Loving Crossing	mainstem	No	N 32.3134 W 104.0590	558581 E, 3575564 N	5, ns

Table 2. Bigscale logperch collections from Pecos River fish community monitoring 1992-2007.

Site	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Old Fort Park															2	
La Espiaita							1									
Willow Creek																
Six Mile Draw				1										1	2	
Crockett Draw															3	1
Cortez Gasline																
Bosque Draw							1									
Gasline							2							1		
NM Hwy 70		1			1			1						2		
Acme								1								
Scout										2						
NM Hwy 380																
Lake Arthur							1									
NM Hwy 82																
Brantley Inflow		5	1		2		2	8		1						

Table 3. Greenthroat darter monitoring sites 1995 through 2007 at Bitter Creek National Wildlife Refuge: sites trapped, number of greenthroat darter per trap hour, and total number of fish collected annually. ns = not sampled.													
Site	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Unit 6 (west side drain)	ns	ns	ns	ns	0.10	ns	0.01	0	ns	1.0	ns	0	0.12
Unit 7 (west side drain)	ns	ns	ns	ns	0	ns	0.06	0.9	ns	0	ns	ns	0
Bitter Creek /Lost River	0.12	0.15	0.15	0.05	ns	ns	0	0	ns	0	0	ns	0
Unit 16 (west side drain)	ns	ns	ns	ns	0.05	ns	0	ns	ns	ns	ns	ns	ns
Total Fish	37	36	21	4	3	0	8	16	0	2	0	0	5

APPENDIX

Occupancy is the fraction of sampling units in a landscape where a target species is present (MacKenzie and Royle 2005). However, species that are present at a site may go undetected. Detection probability is an important source of variation in abundance and in presence-absence surveys (MacKenzie et al. 2002; Williams et al. 2002; MacKenzie and Nichols 2004). Few animals have detection probabilities of 1, that is they are always detected when present. Detection of a species implies presence at a site, but lack of detection does not mean the species is absent unless detection is perfect. Site-occupancy estimation uses temporally and spatially replicated surveys to generate maximum likelihood estimates of detection probability for the species and site occupancy in closed populations that account for imperfect detection (MacKenzie et al. 2002).

Occupancy rate estimation is much more practical for large-scale monitoring programs than capture-recapture or removal methods and requires fewer assumptions, and is much easier to implement than capture-recapture. Occupancy and population size should be positively correlated at the appropriate scale (MacKenzie and Nichols 2004), but while changes in occupancy may reflect changes in abundance or distribution, occupancy does not reflect changes in animal density. Occupancy may be the variable of interest when monitoring changes in a species' range, as is the case with bigscale logperch. Occupancy rate estimation allows statistically valid comparisons of populations from year to year, while accounting for imperfect detection, and requires considerably fewer resources and effort than capture-recapture or removal methods. Occupancy rate estimation was suggested as a surrogate for abundance estimation and

was successfully used to monitor frogs, salamanders, and birds (MacKenzie et al. 2002; MacKenzie et al. 2003; Bailey et al. 2004; MacKenzie et al. 2004). We propose long-term occupancy monitoring for bigscale logperch in the Pecos River as a surrogate for abundance estimation, and to track changes in occupancy and distribution.

METHODS

Initially, we propose a pilot-study implementing the “standard design” (MacKenzie and Royle, 2005), in five fluvial sites between Santa Rosa and Brantley. Each site will be sampled on three consecutive days, once in spring and once in fall. Three consecutive samples is the recommended minimum number of repeat samples (MacKenzie and Royle, 2005). After the initial pilot-study, we will include more sites, including sites outside of known bigscale logperch range. We will also determine if the “removal design,” in which sites are dropped after the first detection of the target species, is more efficient and appropriate than the “standard design” (MacKenzie and Royle, 2005).

Each sample will consist of 10 seine-hauls, concentrating (but not limited to) shoreline cut-bank runs. We will record the length of each seine haul, and the total and standard length of all bigscale logperch collected. We will also record other species collected and basic water quality parameters.

We will create an encounter history for bigscale logperch at each site (either detected or not detected at each visit). Data will be analyzed in MARK (“occupancy” data-type) or program PRESENCE. We will include relevant covariates and create models that have constant detection probability across time and space, and varying

detection probability across time, varying detection probability across space, and fully varying detection probability across time and space. We will use AICc to rank models and select the most appropriate (Akaike, 1973). We will use program R for other statistical analyses and to create graphics. After selecting an appropriate model, we will generate estimates of occupancy and detection probability for bigscale logperch in spring and fall.

SUMMARY

Occupancy-estimation of bigscale logperch will produce reliable, statistically valid comparison of percent-area occupied by logperch, as well as probability of detection. Additional information produced by this research includes detection probabilities of all species encountered, and differences in occupancy and detection probability at different season. Future research could multi-species, multi-season, and multi-gear models. The overall objective is to create a standardized, long-term monitoring protocol for bigscale logperch that is reliable, efficient, and statistically valid for tracking changes in distribution and occupancy.

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