OCCUPANCY ESTIMATION OF BIGSCALE LOGPERCH IN THE PECOS RIVER, NEW MEXICO

2009 REPORT OF ACTIVITIES

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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 1998), and monitoring changes in abundance and distribution provide information for policy making decisions.

The native range of bigscale logperch (*Percina macrolepida*) 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). 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 was collected in Elephant Butte Reservoir in 2003 (Hansen, 2004; in litt.), 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, 2008). 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 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). Spawning time in Texas and Oklahoma is between February and May (Stevenson, 1971; Hubbs, 1985).

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 main-stem Pecos River fishes, specifically Pecos bluntnose shiner (*Notropis simus pecosensis*). No standardized monitoring protocol exists for bigscale logperch. Detection probability is an important source of variation in presence-absence surveys (MacKenzie et al. 2002; Williams et al. 2002; MacKenzie and Nichols 2004), and apparent absences or changes in distribution might be due to imperfect detection. Bigscale logperch population trends and distribution changes are unclear because standardized monitoring has not been implemented specifically for bigscale logperch. Proportion of area occupied (PAO) estimation uses temporally and spatially replicated surveys to generate maximum likelihood estimates of detection probability for the species, and proportion of sites occupied in closed populations that account for imperfect detection (MacKenzie et al. 2002).

We conducted a pilot-study on nine sites in the Pecos River drainage in 2008 to determine distribution and detection probability of bigscale logperch in the Pecos River, New Mexico, and to determine if occupancy estimation is practical for monitoring species of concern in the Pecos River drainage, New Mexico. In 2009, we expanded sampling to include 16 sites on the Pecos, Black, and Delaware Rivers.

Methods

PAO methods and assumptions

A likelihood-based method for estimating proportion of area (or sites) occupied is described by MacKenzie et al. (2002; 2006). This approach is an extension of closed-population capture-recapture models, and has similar assumptions, specifically that each area or site is closed to changes in occupancy during the sampling period. That is, there is no colonization or extinction at a given site during the sampling period. Additional assumptions are correct identification of species, and the probability of detecting a species is independent of the probability of detecting the species at all other sites (MacKenzie et al., 2002; 2006).

Each site must be visited a minimum of two times per sampling season. Detection or non-detection and survey-specific covariates (e.g., salinity, turbidity, effort) are recorded for each site and sampling occasion. An encounter history is created for each species at each site (e.g., {10010}, where the species is detected on the first and fourth of five sampling occasions). Parameters that can be estimated are p, the probability of detecting a species, given it is present at a site, and ψ, the proportion of sites occupied. Both parameters can be related to site-specific and survey-specific covariates by the logit function (MacKenzie et al., 2002; 2006). Several computer software packages are available online for parameter estimation (e.g., PRESENCE, MARK).

Field Methods

We collected relative abundance data for fish communities at 26 sites in 2007 and 2008 in the Pecos River and tributaries (Figure 1). Nine of the 26 sites were included in as occupancy estimation sites (Figure 1). We chose occupancy estimation sites based on access and previous collections of bigscale logperch (sites were not randomly chosen). Occupancy estimation sites were visited 3 to 4 times each between 15 July and 30 July 2008. In 2009, occupancy monitoring was performed during June at the following sites: Delaware River at US-285, Black River at ranch site, Black River center, and Black River crossing crossing, Pecos at Malaga Bend, US-380, Scout Camp (Bitter Lake NWR), US-70, gasline crossing, Bosque Draw, Old Fort Park, US-60, Puerto de Luna gauging station, Puerto de Luna, El Rito Confluence, and River Ranch.

To collect relative abundance data, we performed 8-17 seine-hauls during each sampling occasion. We used a 2.5 m by 1.0 m seine, mesh size approximately 3.2 mm, at all sites. We recorded the length of the seine-haul, water depth, meso-habitat type, substrate, and standard length of each bigscale logperch. Other species of fishes that could be positively identified to species were counted and released immediately. Unidentified fishes were preserved in 10% formalin, and identified and counted in the laboratory. Voucher specimens were donated to the Southwestern Museum of Biology.

For each sampling occasion, we recorded water temperature, salinity, pH, dissolved oxygen, conductivity, and turbidity. After completing each sampling occasion, we calculated the total area seined (effort).

In 2009, we collected habitat data for each site. We used 10 transects, each 10 m apart, and collected 10 evenly-spaced measurements of depth, substrate, and visually classified flow and meso-habitat. At each bank, we recorded presence or absence of undercut bank, overhanging vegetation, and other fish cover. Habitat measurements were converted to site-level characterizations and used as covariates in occupancy models.

Data Analysis

We used program PRESENCE to estimate occupancy rates and detection probabilities for all species collected at nine occupancy estimation sites in 2008. Our reference model was $\psi(.)p(.)$, where species presence and detection are held constant. While this model might not be the best representation of nature, it allows quick comparison of species occupancy and detection for all species encountered. We ran seven additional single-season models for bigscale logperch and red shiner (*Cyprinella lutrensis*), the most commonly occurring species, to examine the importance of covariates (time, turbidity, salinity, and effort) on species presence and detection. First, we held species presence constant, $\psi(.)$, and varied p by time, effort, and turbidity separately, $p(t)$ and $p(Cov)$. Next, we held species detection constant, $p(.)$, and varied ψ by effort, turbidity, and salinity, $\psi(Cov)$. We ranked the models by AIC (Aikake, 1973; Burnham and Anderson, 1998). We combined the lowest-ranked $\psi(.)p(Cov)$ model with the lowest-ranked $\psi(Cov)p(.)$ model into a $\psi(Cov)p(Cov)$ model to determine if including covariates in both parameters improved model fit (Bailey et al., 2004). We chose a priori models with covariates we felt most likely to influence species presence and detection.

Additionally, we explored differences in detection probability by habitat guild. We assigned each fish a primary habitat in the water column, pelagic, benthic, or littoral (littoral might include cut-bank, vegetation, debris, etc. along the shoreline). We used point estimates of detection probability from $\psi_{(.)}p_{(.)}$ for each species as the response for a 3-way Kruskal-Wallis test (Zar, 1998; Dalgaard, 2002).

RESULTS

Fish collections. Between 15 July and 30 July 2008, we captured 4,835 fishes representing thirty-one species, in 38 sampling occasions (Table 1). Bigscale logperch was collected at only six of 26 locations (Figure 1, sites 1, 2, 6, and 21). In summer 2008, the site below Sumner Reservoir dried and no bigscale logperch were collected, but were present in both October 2007 and October 2008. We collected a single bigscale logperch in the same location, likely the same fish, at River Ranch on the first two visits to the site. We collected 10, 19, 10, and 12 bigscale logperch from the Puerto de Luna gauging station, and 3, 6, 3, and 3 from the Black River site during repeat visits. Bigscale logperch were easily captured in near-shore habitat in Santa Rosa and Sumner reservoirs, and had higher relative abundance compared to river sites (Table 2).

Bigscale logperch PAO and detection. From eight candidate models, we chose $\psi_{(.)}p_{(.)}$ to estimate ψ and p for bigscale logperch (Table 3). Including covariates did not improve AIC scores, however, sample sizes were small and bigscale logperch was found at only three sites. Bigscale logperch $\hat{\psi}$ was 0.33 (95% confidence interval 0.11-0.67) and 0.83 for $\hat{p}$ (95% confidence interval 0.52-0.96).

Red shiner PAO and detection. We chose $\psi_{(.)}p_{(Turbidity)}$ from the eight candidate models for red shiner (Table 4). Red shiner $\hat{\psi}$ was 0.92 (95% confidence interval 0.41-0.99) and $\hat{p}$ was greater than 0.80 23 of 33 total sampling occasions.

Comparison of detection probabilities. Fishes in the pelagic habitat guild had slightly higher detection probabilities than either benthic or littoral species (Figure 2), however, these differences were not statistically significant ([illegible] =0.87, *P*=0.65). Several species of pelagic guild fishes had detection probabilities of 1.0 (Table 1).

The following table is presence-absence data for fish species collected during June 2009.

Site	Fathead Minnow	Red Shiner	Common Carp	River Carpsucker	Gray Redhorse	Mexican Tetra	Western Mosquitofish	Gulf Killifish	Sheepshead Minnow	Inland Silverside	Yellow Bullhead
Delaware River	X	X	X			X	X				X
Black R., ranch site	X	X	X		X		X				
Black R., center	X	X			X		X				
Black R., crossing	X	X	X	X	X	X					
Pecos @ Malaga		X	X	X		X		X	X	X	

Site	Largemouth Bass	Spotted Bass	Green Sunfish	Bluegill	Longear Sunfish	Bigscale Logperch					
Delaware River			X								
Black R., ranch site	X	X		X	X	X					
Black R., center	X		X	X	X	X					
Black R., crossing	X			X	X	X					
Pecos @ Malaga											

Discussion

Bigscale logperch regularly occurred only in reservoirs and nearby areas, and the Black River. In 2007-2008, no bigscale logperch were collected in the Pecos River during routine monitoring between Fort Sumner and Brantley Reservoir. Ease of capture in reservoirs suggests large populations might exist inside reservoirs, and the proximity of mainstem collections to reservoirs suggests bigscale logperch occurrences in the mainstem are the result of being washed out of reservoirs during releases. Historical distribution of bigscale logperch in New Mexico was likely more widespread than it is currently (Sublette 1999). Bigscale logperch are usually associated with 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. 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.

Increased salinity and 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 and effect 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 (Shawn Denny, NMDGF personal communication). Physical water chemistry (stenothermal, spring water with lower conductivity) in the Black River might prevent the golden algae blooms, serving as an important refuge for Pecos River fishes.

Detections of a species are a combination of species abundance and detection probability. Overall detection probability was high for most species in the Pecos River, indicating single-pass seining is sufficient for detecting presence or absence of most species of fishes, especially pelagic fishes. Improved estimates of *p* for all species will likely result in clear differences in detection probabilities between pelagic fish and other guilds. However, several species had low detection probabilities that are likely the result of small sample size. Species with very low occupancy are more heavily influenced by sites with single detections than species that are widespread (e.g. suckermouth minnow [*Phenacobius mirabilis*] vs. red shiner). Including more sites within a target species distribution will improve accuracy and precision of estimates of detection probability, and support the reliability of single-pass seining for presence-absence fish data.

An assumption required for occupancy estimation is no changes in occupancy occur during the sampling period. Some migratory species found in the Pecos River, such as gizzard shad (*Dorosoma cepedianum*), likely violate this assumption. Point estimates should be interpreted with knowledge of the species' biology. Changes in occupancy are more likely at the extreme edges of a species' distribution, where abundance is often decreased. One site, River Ranch, we detected a single bigscale logperch on two consecutive days. Both bigscale logperch were the same size and collected in the same location, making it very likely the same fish. No bigscale logperch were encountered on two subsequent visits. Given the relative ease bigscale logperch were collected at other sites, it seems more likely emigration or death of a single individual might have caused a change in occupancy that violates model assumptions, rather than a false absence. Similarly, suckermouth was detected only once overall.

Suckermouth minnow might have extremely low detection probability, or occupancy might have changed at this site and no other sites were occupied at any point during surveys. Increased samples and locations will improve estimates of p and ψ, and help determine distributions with greater accuracy.

Recommendations

We recommend continued occupancy estimation sampling in 2009. Including more sites and more sampling occasions will improve estimates for all species. Determining which species are a priority to monitor and targeting locations of interest for those species will improve sampling efficiency and also improve estimates. After obtaining reliable estimates of p, alternative sampling designs could be implemented, such as randomly selecting a subset of sites to make repeat visits, double sampling every site (as opposed to 4-5 samples for fewer sites), or a removal design in which sites are dropped after the initial detection of the species in interest. Continued monitoring will also allow for comparison of yearly changes in p and ψ. Increasing sample sizes will also allow a more thorough exploration of which covariates, including site-level habitat characteristics, influence p and ψ. A habitat preference study and examination of tolerances to environmental characteristics are necessary to determine why bigscale logperch are rare outside of reservoirs and the Black River. However, bigscale logperch appear secure in the Black River and in reservoirs on the Pecos River, in New Mexico. Surveys in near-shore habitat should be completed on all impoundments on the Pecos River to determine the importance of reservoirs for bigscale logperch.

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Table 1-Observed occupancy, estimated occupancy, estimated detection probability, and precision of detection probability for fish species encountered on the Pecos River, NM, during site-occupancy estimation of bigscale logperch. *Denotes species with too few encounters to estimate detection or occupancy.

Species	Guild	$\psi_{(obs)}$	$\hat{\psi}_{(.)}$ (SE)	$\hat{p}_{(.)}$ (SE)	SE{$\hat{p}_{(.)}$}/ $\hat{p}_{(.)}$
Dorosoma cepedianum	Pelagic	0.56	0.60 (0.18)	0.52 (0.13)	0.25
Astyanax mexicanus	Pelagic	0.33	0.33 (0.16)	0.80 (0.13)	0.16
Campostoma anomalum	Benthic	0.44	0.58 (0.25)	0.34 (0.15)	0.44
Cyprinella lutrensis	Pelagic	0.89	0.89 (0.10)	0.93 (0.05)	0.05
Macrhybopsis aestivalis	Benthic	0.11	0.11 (0.10)	1.0 (NA)	NA
Hybognathus placitus	Pelagic	0.11	0.11 (0.10)	0.65 (0.30)	0.46
Notropis girardi	Pelagic	0.11	0.11 (0.10)	1.0 (NA)	NA
Notropis jemezanus	Pelagic	0.22	0.24 (0.15)	0.54 (0.21)	0.39
Notropis simus	Pelagic	0.11	0.11 (0.10)	1.0 (NA)	NA
Notropis stramineus	Pelagic	0.44	0.44 (NA)	1.0 (NA)	NA
Phenocobius mirabilis	Benthic	0.11	*	*	NA
Pimephales promelas	Littoral	0.44	0.46 (0.17)	0.65 (0.13)	0.20
Platygobio gracilis	Pelagic	0.11	0.11 (0.10)	1.0 (NA)	NA
Rhinichthys cataractae	Benthic	0.11	0.11 (0.10)	1.0 (NA)	NA
Semotilus atromaculatus	Pelagic	0.11	0.12 (0.13)	0.44 (0.29)	0.66
Carpiodes carpio	Benthic	0.67	0.72 (0.18)	0.50 (0.12)	0.24
Catostomus commersoni	Benthic	0.33	0.38 (0.19)	0.44 (0.17)	0.39
Moxostoma congestum	Benthic	0.22	0.23 (0.14)	0.71 (0.18)	0.25
Ictalurus punctatus	Littoral	0.33	0.34 (0.16)	0.72 (0.14)	0.19
Amierus melas	Littoral	0.22	0.26 (0.17)	0.44 (0.21)	0.48
Menidia beryllina	Pelagic	0.22	0.23 (0.14)	0.65 (0.21)	0.32
Cyprinodon variegatus	Littoral	0.22	0.22 (0.14)	0.83 (0.15)	0.18
Fundulus zebrinus	Littoral	0.55	0.67 (0.22)	0.40 (0.14)	0.35
Fundulus grandis	Littoral	0.22	0.22 (0.14)	1.0 (NA)	NA
Gambusia affinis	Littoral	0.67	0.67 (0.16)	0.77 (0.09)	0.12
Lepomis cyanellus	Littoral	0.22	*	*	NA
Lepomis megalotis	Littoral	0.11	0.11 (0.10)	1.0 (NA)	NA
Micropterus salmoides	Littoral	0.55	0.58 (0.17)	0.63 (0.12)	0.19
Micropterus dolomeiu	Littoral	0.44	0.45 (0.17)	0.81 (0.10)	0.12
Micropterus punctatus	Littoral	0.33	0.38 (0.19)	0.44 (0.19)	0.43
Percina macrolepida	Benthic	0.33	0.33 (0.15)	0.83 (0.11)	0.13

Table 2-Comparison of bigscale logperch collections from reservoirs and river locations 2007-2008 in the Pecos River basin, New Mexico.

Site	No. Collected	No. per 100m^2	Relative Abundance
Santa Rosa Reservoir	14		
Sumner Reservoir	34	6.4	52%
PDL gage	18	5.4	24%
Black River	6	3.9	5.2%

Table 3-AIC values for candidate models estimating occupancy and detection probability of bigscale logperch in the Pecos River basin, New Mexico.

Model	AIC	ΔAIC
$\psi_{(.)}p_{(.)}$	26.25	0.00
$\psi_{(.)}p_{(Effort)}$	31.01	4.76
$\psi_{(.)}p_{(Turbidity)}$	31.39	5.14
$\psi_{(.)}p_{(t)}$	39.00	12.75
$\psi_{(Turbidity)}p_{(.)}$	73.48	47.23
$\psi_{(Effort)}p_{(.)}$	74.20	47.95
$\psi_{(Turbidity)}p_{(Effort)}$	74.50	48.25
$\psi_{(Salinity)}p_{(.)}$	75.01	48.76

Table 4-AIC values for candidate models estimating occupancy and detection probability of red shiner in the Pecos River basin, New Mexico.

Model	AIC	ΔAIC
$\psi_{(.)}p_{(Turbidity)}$	22.33	0.00
$\psi_{(.)}p_{(.)}$	24.83	2.50
$\psi_{(.)}p_{(Effort)}$	28.19	5.86
$\psi_{(.)}p_{(t)}$	33.82	11.49
$\psi_{(salnity)}p_{(Turbidity)}$	260.79	238.46
$\psi_{(Salinity)}p_{(.)}$	261.78	239.45
$\psi_{(Effort)}p_{(.)}$	268.43	246.10
$\psi_{(Turbidity)}p_{(.)}$	268.43	246.10

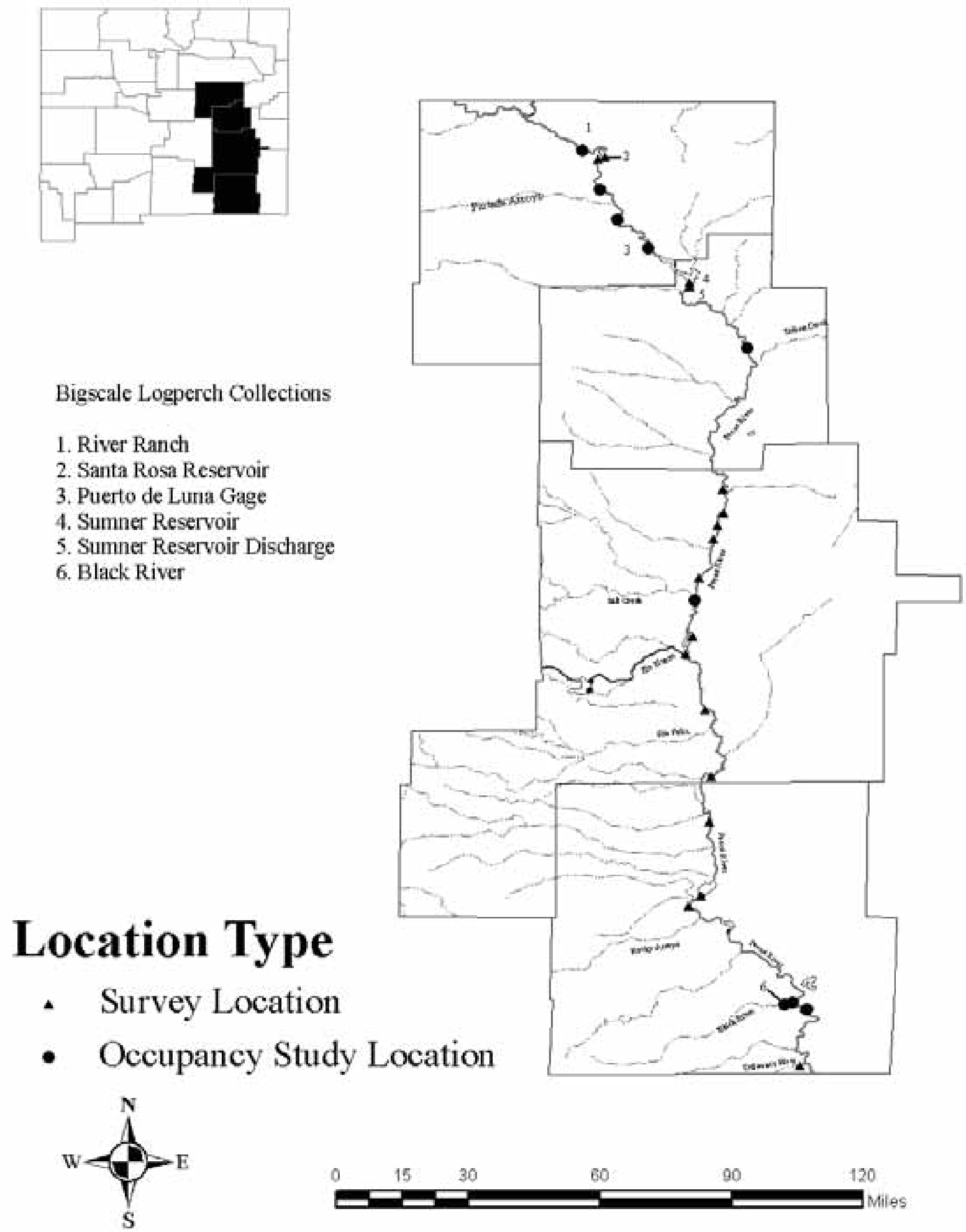

Figure 1-Study area and sample locations for bigscale logperch site-occupancy estimation in the Pecos River drainage, New Mexico, 2007 and 2008.

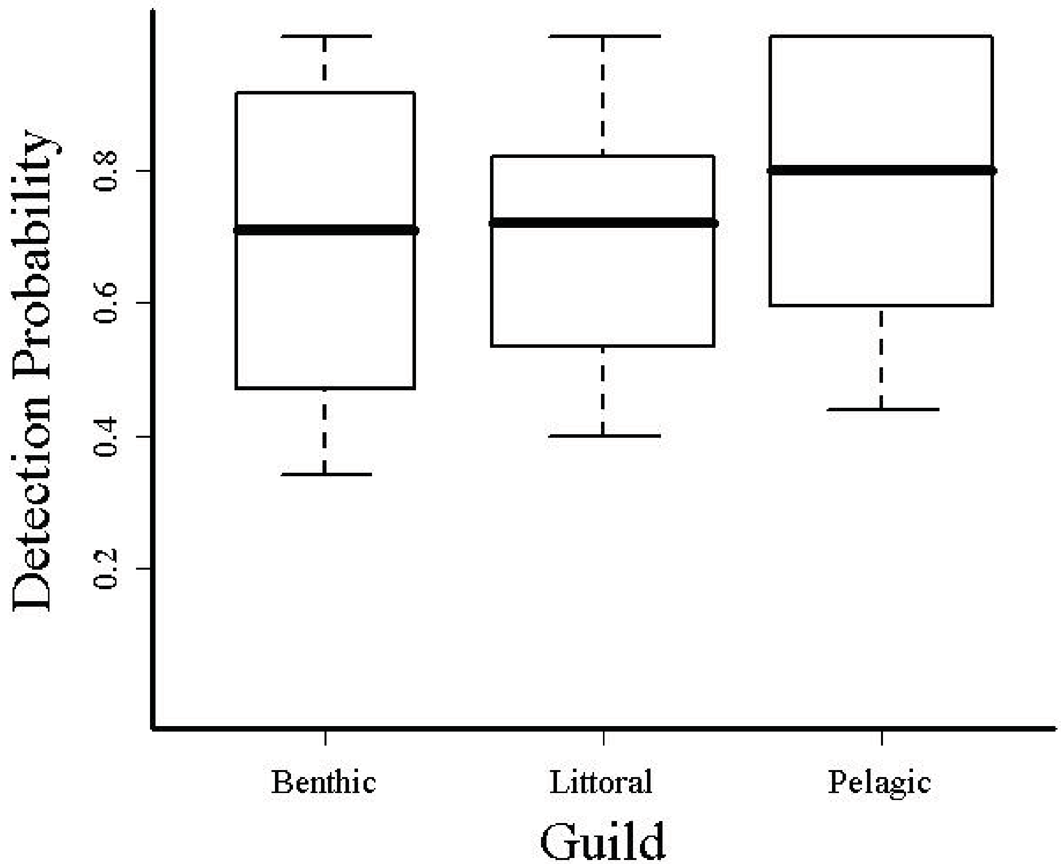

Figure 2-Distribution of detection probabilities of three guilds of fishes found in the Pecos River, New Mexico. Detection probabilities were point-estimates taken from occupancy estimation models.