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Abundance of Gulf Coast Waterdogs (*Necturus beyeri*) along Bayou Lacombe, Saint Tammany Parish, Louisiana

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Abstract.—Few ecological studies have been conducted on Gulf Coast Waterdogs (*Necturus beyeri*), and published studies have focused on relatively small stream sections of 125 m to 1.75 km. In 2015, we sampled 25 sites along a 13.4-km stretch of Bayou Lacombe (Saint Tammany Parish, Louisiana, USA) to better understand factors that may influence the distribution of Gulf Coast Waterdogs within streams. We checked 250 unbaited traps once per week for 3 weeks, capturing 170 Gulf Coast Waterdogs at 18 of 25 sites. We used hierarchical models of abundance to estimate abundance at each site, as a function of site covariates including pH, turbidity, and distance from headwaters. The abundance of Gulf Coast Waterdogs within Bayou Lacombe was highest toward the center of the sampled stream segment, but we found no evidence that pH or turbidity affected abundance within our study area. Site-level abundance estimates of Gulf Coast Waterdogs ranged from 0 to 82, and we estimated there were 767 (95% Bayesian credible interval [CRI]: 266–983) Gulf Coast Waterdogs summed across all 25 sampling sites. We derived an estimate of 6,321 (95% CRI: 2,139–15,922) Gulf Coast Waterdogs for the entire 13.4-km stream section, which includes our 25 sites and the adjoining stream reaches between sites. Our results suggest that Gulf Coast Waterdogs may be uncommon or absent in the headwaters, possibly because of shallow water and swift currents with limited preferred habitats. Gulf Coast Waterdogs favor the middle stream reaches with adequate depth and abundant preferred microhabitats.

Gulf Coast Waterdogs (*Necturus beyeri*) are permanently aquatic, nocturnal salamanders with both lungs and external gills and inhabit lotic streams and rivers of the mid-Gulf Coast (Petranka, 1998). They are active in the cooler months from late fall through early spring, rarely being captured or trapped in the hottest months (Viosca, 1937; Brenes and Ford, 2006). Shoop and Gunning (1967) electroshocked Gulf Coast Waterdogs in summer, but studies have posited that they may have reduced activity in summer because of an increased presence of predatory fishes and reduced invertebrate prey (Neill, 1963; Bart and Holzenthal, 1985). Shoop and Gunning (1967) found prey items in a large proportion of Gulf Coast Waterdogs during warmer months, indicating that they were actively foraging at that time. Bart and Holzenthal (1985) posited that Gulf Coast Waterdogs may even aestivate in the substrate below leaf litter mats during warm weather. Adults tend to prefer habitats with underwater structures, such as sunken logs, undercut banks, or networks of tree roots, whereas juveniles primarily reside in leaf litter beds (Bart and Holzenthal 1985). *Necturus* members exhibit limited movements and high site fidelity, possibly because of specific microhabitat preferences for feeding and reproduction (Shoop and Gunning, 1967; Ashton and Braswell, 1979; Ashton, 1985; Brenes and Ford, 2006).

Gulf Coast Waterdogs occur in two disjunct areas separated by the Mississippi River, namely, east–central Texas into west–central Louisiana and the Florida Parishes of Louisiana east through Mississippi to the Mobile drainage in Alabama (Guyer et al., 2020). Guyer et al. (2020) restricts each lineage to the following drainages: Mobile lineage, Mobile (AL) to Biloxi (MS); Pearl lineage, Wolf (MS) to Pearl (LA); Pontchartrain lineage, Bayou Bonfouca to Blind (LA); and Western lineage, Calcasieu (LA) to West Fork of the San Jacinto, TX. All ecological studies of Gulf Coast Waterdogs in Louisiana have occurred in Talisheek Creek, which is part of the Pearl lineage (Shoop, 1965; Shoop and Gunning, 1967; Bart and Holzenthal, 1985). Gulf Coast Waterdogs are a species of management concern tracked by the Louisiana Department of Wildlife and Fisheries, where it is ranked as S3 in the state (rare and local with 21–100 known populations).

The medium and large spring-fed streams with sandy bottoms that Gulf Coast Waterdogs inhabit are particularly susceptible to degradation because of water pollution and siltation, which have been implicated in declines in congeneric species elsewhere (e.g., Gendron, 1999). It is possible that these same stressors impact distribution, abundance, and habitat use by Gulf Coast Waterdogs, but the importance of these factors is unknown (Petranka, 1998). Prey and predator abundances, which may also be impacted by water quality, likely impact distribution and abundance of Gulf Coast Waterdogs (Shoop and Gunning, 1967; Bart and Holzenthal, 1985).

Because of the limited stream lengths examined in the few ecological studies of Gulf Coast Waterdogs, it is difficult to say with certainty where the best habitat lies along a stream (Shoop and Gunning, 1967; Bart and Holzenthal, 1985; Brenes and Ford, 2006). Therefore, a larger scale study was needed to examine habitat preferences in the context of longer stream lengths. We hypothesized that the shallow headwaters, with limited leaf mats and coarse woody debris, both known to be important for various life stages of Gulf Coast Waterdogs, would be limited in their use by the species. Likewise, we hypothesized the more expansive, turbid, and sediment-filled lower reaches of streams, with an abundance of predators, would also be less desirable for Gulf Coast Waterdogs. Finally, we hypothesized that the most suitable habitat would occur in the relatively clear, sandy-bottomed middle sections of the stream, which are replete with deeper holes and an abundance of coarse woody debris and leaf mats.

This study took place along Bayou Lacombe, which is part of the Pontchartrain lineage of Gulf Coast Waterdogs described by Guyer et al. (2020). Here, we captured Gulf Coast Waterdogs by using unbaited minnow traps along a 13.4-km stretch of the

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bayou, beginning at its headwaters, to better understand factors that may influence their distribution and abundance. The quantitative data on this tracked species may be of use as a comparison with future studies along Bayou Lacombe, as well as other systems across lineages and along a stream health gradient.

Materials and Methods

Study Area and Site Selection.—We conducted this study on Bayou Lacombe, a designated natural and scenic river that flows from its headwaters into Lake Pontchartrain in Saint Tammany Parish in southeastern Louisiana, USA (Fig. 1). Using ArcGIS (ArcMap 10.1; ESRI, Redlands, California, USA), we randomly selected 30 50-m stream sections separated from each other by at least 100 m from either end of the stream section. After scouting the sites on 21 January 2015, we deemed site BL01 unable to be sampled, as it was too shallow to place the traps. We also discarded sites BL27–BL30 on our initial trip to set the traps, as the water was too deep to safely sample from a canoe. Therefore, we sampled 25 sites (sites BL02–BL26) covering an approximate stream reach of 13.4 km.

We chose a minimum distance of 100 m between sites based upon studies of this species and congeners that show strong site fidelity with limited movements (Cagle, 1954; Shoop and Gunning, 1967; Bart and Holzenthal 1985; Brenes and Ford, 2006). After random site selection, the midpoint of our traps at a given site was a mean of 554 m from the midpoint of an adjacent site (SE = 28.6, range = 370–830).

Data Collection.—At each site, we placed 10 unbaited 6.35-mm mesh Gee minnow traps for a total of 250 traps (Tackle Factory, Fillmore, New York, USA). We decided against baiting traps because doing so may have led to our results being confounded by bait availability or freshness, and we were confident that we could catch Gulf Coast Waterdogs without baiting. We wrapped burlap over half of the traps at each site and left the other half as they came originally (Duffy, 1961). We secured the burlap to the cylinder by weaving two large zip ties through each side of the trap and then secured the burlap to the funnel by use of several small zip ties. Within a site, we randomly set both trap types, typically setting half on each side of the stream, but this was not always possible because of stream morphology and depth. When possible, we tried to set traps in deeper locations within a site, both to improve trapping success and to avoid traps becoming exposed in receding waters over the course of trapping.

We set all 250 traps from 17–19 March 2015. The traps were checked every week for the next 3 weeks (23–24 March 2015, 31 March–2 April 2015, and 7–9 April 2015). Each trip except for the first sampling occasion involved breaking the sites up into 3 days of sampling, as there were 3 bridge crossings (near sites 2, 13, and 21) where we could put in or take out a canoe (Fig. 1). After checking sites BL22–BL26, we canoed downstream and took out at either the U.S. Fish and Wildlife Service office or at the Main Street boat ramp in Lacombe, Louisiana (Fig. 1). We took measurements of water temperature, pH, and turbidity at all sites for the last two sampling occasions but only at a subset of sites for the initial deployment and first sampling occasion. We used a waterproof handheld combo meter to measure water temperature and pH (Hanna Instruments HI98129; Woonsocket, Rhode Island, USA). We measured turbidity in nephelometric turbidity units (NTUs) by using a Secchi disk placed at the bottom of a clear cylindrical tube according to Myre and Shaw (2006).

We placed two loggers that recorded water depth as well as temperature in our study area (HOBO U20-001-01; Onset Corporation, Bourne, Massachusetts, USA), namely, one at site BL18 and the other at site BL26 (Fig. 1). At each site, we placed the logger on the bayou substrate and tied the logger to a branch above the water with nylon string. To conduct barometric pressure compensation for deriving water depth, we placed an additional logger of the same type at site BL18 high on a tree along the stream bank.

For all Gulf Coast Waterdogs, we measured the distance from the snout to the anterior limit of the cloaca (hereafter snout–vent length [SVL]) and the distance from the anterior cloaca to the tail tip with a plastic ruler through a clear zip top bag. We weighed Gulf Coast Waterdogs in a disposable cup placed on a tared digital scale (PPS200; Pesola, Schindellegi, Switzerland). We swabbed all Gulf Coast Waterdogs captured on the second sample for a related disease project (Glorioso et al., 2017). Last, we took 50 triangular-shaped tissue samples from near the midpoint of the underside of the tail of a subset of captures (no more than four per site) for a related genetics project. In addition to Gulf Coast Waterdogs, we noted all bycatch.

Data Analysis.—We used a Poisson binomial mixture model to estimate the abundance of Gulf Coast Waterdogs as a function of site covariates while accounting for imperfect detection (Royle, 2004; Kery and Schaub, 2012). This is an explicit hierarchical model that simultaneously models the observation process (i.e., detection probability) and the ecological state process (i.e., population abundance; Royle and Dorazio, 2008). This type of model needs both spatial and temporal replication. The 25 sites (i) served as our spatial replication, and the 3 samples (j) of each provided the temporal replicates. Because of unexpected sampling issues with burlap-wrapped traps (see Results and Discussion), only counts across all nonburlap-wrapped traps within a site were analyzed. These counts were summed for each sampling period and formed the capture history (y_{ij}) for this analysis. We assumed demographic closure within our population of Gulf Coast Waterdogs across the sampling period.

We treated detection probability (p) as constant across sites and sampling occasions and modeled the abundance of Gulf Coast Waterdogs as a function of the following three covariates: pH, turbidity, and distance downstream from the headwaters. We predicted a priori that abundance would have a negative linear relationship with the environmental covariates such that abundance would decrease as pH and turbidity increase. For distance from the headwaters, we predicted a quadratic relationship in which sites in the middle of the sampling area would have a higher abundance than on the ends. Estimates of site abundance (N_i) are modeled from the Poisson distributed variable λ_i, and covariates that affect lambda are modeled with the following equation:

$$\log(\lambda_i) = \alpha 0 + \alpha 1 * \mathrm{pH} + \alpha 2 * \mathrm{Turbidity} + \alpha 3 * \mathrm{Distance} + \alpha 4 * \mathrm{Distance}^2$$

Model fitting was done in the R statistical environment (R Core Team, 2018) with Markov chain Monte Carlo Bayesian model fitting by using the package R2WinBUGS to call WinBUGS 1.4.3 software (Spiegelhalter et al., 2003). All covariates were scaled to have mean values of 0 and a standard deviation of 1, as is typical in this type of modeling (Kery and Schaub, 2012).We used uninformative priors spanning the range of possible values for estimated parameters to account for our lack of prior knowledge of parameter estimates (Royle and Dorazio, 2008). Fitting in WinBUGS was done using 3 separate

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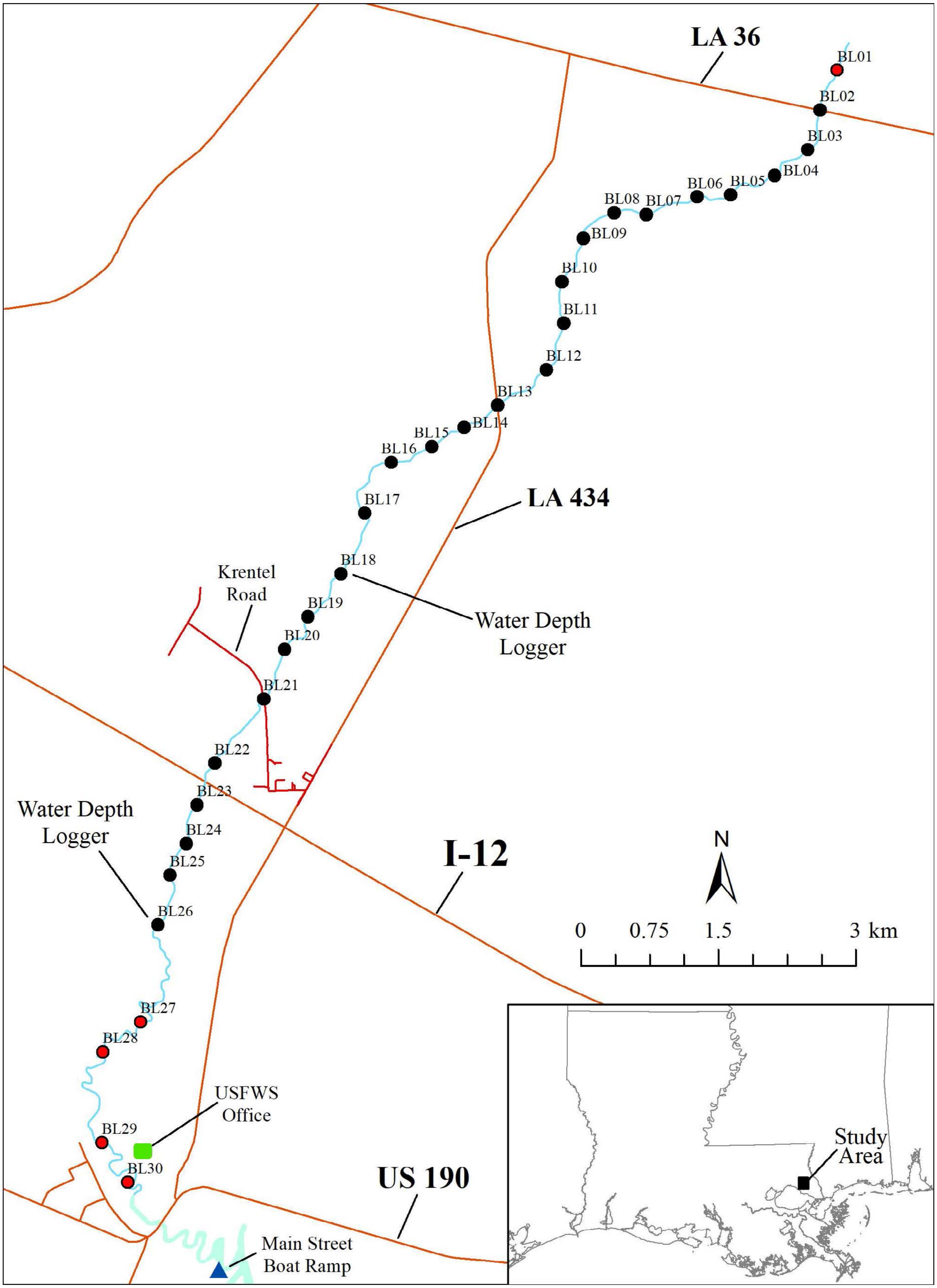

FIG. 1. The location of 30 randomly selected trapping sites for Gulf Coast Waterdogs in 2015 along Bayou Lacombe, Saint Tammany Parish, Louisiana. Trapping sites with colocated water depth loggers are also shown. Red circles indicate sites not trapped because of too shallow (BL01) or too deep (BL27–BL30) water to do so effectively and/or safely.

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TABLE 1. Unbaited minnow trap captures of Gulf Coast Waterdogs by site in 2015 in Bayou Lacombe, Saint Tammany Parish, Louisiana.[a]

	No. of captures in:		
Site	1st sample	2nd sample	3rd sample
BL02	0	0	0
BL03	0	0	0
BL04	0	0	0
BL05	0	0	0
BL06	0	0	0
BL07	0	1	0
BL08	0	1	0
BL09	1	0 (1)	0
BL10	0	0	0
BL11	3	3	1
BL12	2	6	0
BL13	0	0 (1)	1
BL14	0	0	0
BL15	9	3	0 (1)
BL16	1	1	2
BL17	3	10	1
BL18	5 (1)	4	2
BL19	2	5	2
BL20	9 (1)	9 (3)	5 (6)
BL21	10	5	3 (1)
BL22	5	11 (1)	4
BL23	0	9	4
BL24	0	3	1
BL25	4	0	0
BL26	0	0	2 (1)
Total	54 (2)	71 (6)	28 (9)

[a] The numbers in parentheses indicate the number of captures in burlap-wrapped minnow traps.

chains of 22,000 iterations with the first 2,000 discarded and thinned to retain every 20th value in the posteriors. Model convergence was assessed by visually inspecting parameter trace plots and based on the R-hat potential scale reduction values of each parameter (Gelman and Hill, 2007). Derived values including the total abundance of Gulf Coast Waterdogs at all study sites and for the entire stretch of Bayou Lacombe were modeled within WinBUGS, and we report the mean and 95% Bayesian credible intervals (CRIs) for parameter estimates.

RESULTS

We captured a total of 170 Gulf Coast Waterdogs over 3 sampling occasions (Glorioso and Waddle, 2020; Table 1). We captured Gulf Coast Waterdogs at 18 of the 25 sites, but none at the 5 northernmost sites (sites BL02–BL06; Fig. 2), although it should be noted that all 5 traps not wrapped in burlap were stolen from site BL02 after the first trap check and not replaced. The northernmost sites had generally shallower and faster water, and with water depth decreasing over the course of the study, the traps were sometimes exposed partially or completely. No other salamanders were captured in traps, but *Lithobates sphenocephalus* (Southern Leopard Frog), *Lithobates clamitans* (Green Frog), *Nerodia rhombifer* (Diamond-Backed Watersnake), and *Liodytes rigida* (Glossy Swampsnake) were each captured once. Crustaceans (crawfish and glass shrimp), fish (sunfish, pirate perch, madtom, and grass pickerel), and odonate larvae constituted nearly all other bycatch.

Despite results being from half the initial effort, we had only 17 total captures (10%) from burlap traps, of which 10 were captured from site BL20 (Table 1). We did not anticipate the degree that the burlap would swell in the water, causing funnel entrances to frequently become blocked. In addition, sand often

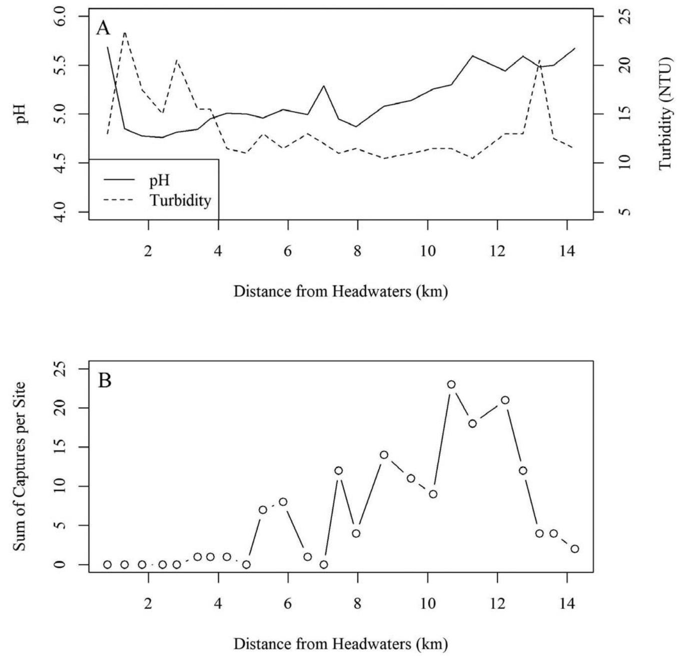

FIG. 2. (A) Mean of pH and turbidity measurements taken at each site on the second and third trap check plotted with the distance from the headwaters of each site on the x-axis. (B) The number of total captures (summed across 3 sampling occasions) in nonburlap-wrapped minnow traps by distance from headwaters at 25 randomly selected trapping sites for Gulf Coast Waterdogs in 2015 along Bayou Lacombe, Saint Tammany Parish, Louisiana.

became entrapped in burlap-wrapped traps to the point of blocking funnel entrances. We excluded all captures from burlap traps for our abundance analysis because of the problems with the burlap causing inconsistent catchability among traps and sites. We should note, however, that all sites with burlap trap captures also had at least one nonburlap trap capture.

Our hierarchical Poisson binomial mixture model of abundance performed well and provided estimates of the abundance of Gulf Coast Waterdogs with adequate precision. Our model results indicated that despite our predictions, there was no support for the hypothesis that pH or turbidity influenced abundance in Bayou Lacombe (i.e., 95% CRI of the effect parameters overlap 0; Table 2). This result is likely because of the relatively low range of variation in these variables across sites (Fig. 2). However, there was strong support for a quadratic relationship between abundance and distance from headwaters (Table 2). Our model predicted higher abundances in the middle portion of Bayou Lacombe as we expected. Detection probability for Gulf Coast Waterdogs was estimated to be 0.087 (95%

TABLE 2. Mean, standard deviation, and 95% Bayesian credible interval (CRI) of parameter effects on abundance of Gulf Coast Waterdogs in 2015 in Bayou Lacombe, Saint Tammany Parish, Louisiana.

				95% CRI	
Parameter	Effect	Mean	SD	Lower	Upper
$\alpha0$	Intercept	1.90	0.56	0.93	3.09
$\alpha1$	pH	−2.02	4.65	−9.36	7.62
$\alpha2$	Turbidity	2.16	4.65	−7.49	9.47
$\alpha3$	Distance	6.76	0.93	5.00	8.74
$\alpha4$	Distance^2	−5.19	0.76	−6.80	−3.71

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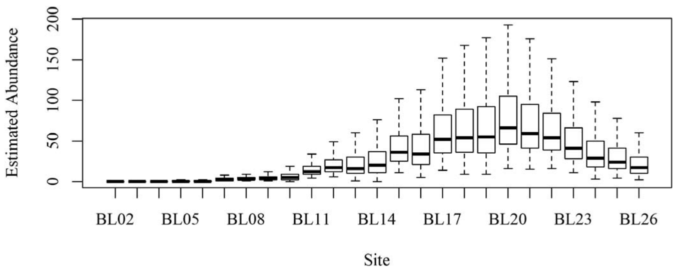

FIG. 3. Boxplots of posterior estimates of abundance by site for Gulf Coast Waterdogs in 2015 along Bayou Lacombe, Saint Tammany Parish, Louisiana. The black bar indicates the mean value of the abundance estimates, with the boxplot whiskers representing the 95% Bayesian credible interval.

CRI: 0.028–0.193). Mean estimates of site-level abundance ranged from 0 to 82 (Fig. 3). We estimated that there were 767 (95% CRI: 266–983) Gulf Coast Waterdogs across all our sampling sites. Using the distance from the headwaters of each possible 50-m plot, we can extrapolate that there were 6,321 (95% CRI: 2,139–15,922) Gulf Coast Waterdogs in the entire length of Bayou Lacombe from our most upstream to our most downstream site.

We cannot know how many individuals the 170 total captures of Gulf Coast Waterdogs comprise, as they were not marked. However, because of the triangular-shaped pieces of tissue taken from 50 of the individuals over the first 2 samples, we are confident that a minimum of 15 of the total captures were recaptures. Of the 15 known recaptures, all were adults, including 14 males and 1 female. Because of nearly identical measurements, it is likely that at least one male captured with tissue taken in the first sample was recaptured on both the second and third sample at site BL18.

We sexed only a subset of adult individuals with confidence during the first sample; however, captures were sexed with confidence during the second and third samples. The smallest male as evidenced by the presence of external cloacal papillae was 91-mm SVL. The smallest female as evidenced by the lack of external cloacal papillae and the presence of visible eggs was 102 mm. The majority (64%) of females $\geq$102 mm had visible eggs across all 3 samples; the true percent is likely greater, as we may have overlooked eggs, or we may have failed to properly note when we observed them. We measured 169 Gulf Coast Waterdogs, as 1 escaped capture before processing (Table 3). Only 13 of 169 (7.7%) measured Gulf Coast Waterdogs were juveniles of $\leq$90 mm SVL.

Water depths at site BL18 decreased significantly between setting the traps and the first sample, declining more gradually for the next week and a half before a minimal rain event slightly increased water levels near the study end (Fig. 4). However, at our southernmost site (site BL26), there appeared to be tidal influences to water depth, as we saw numerous fluctuations over short periods of time. The mean water temperature at site BL18 was 19.5°C (range = 14.6°C–22.7°C) and at site BL26 was 19.9°C (range = 15.3°C–23.4°C; Fig. 4).

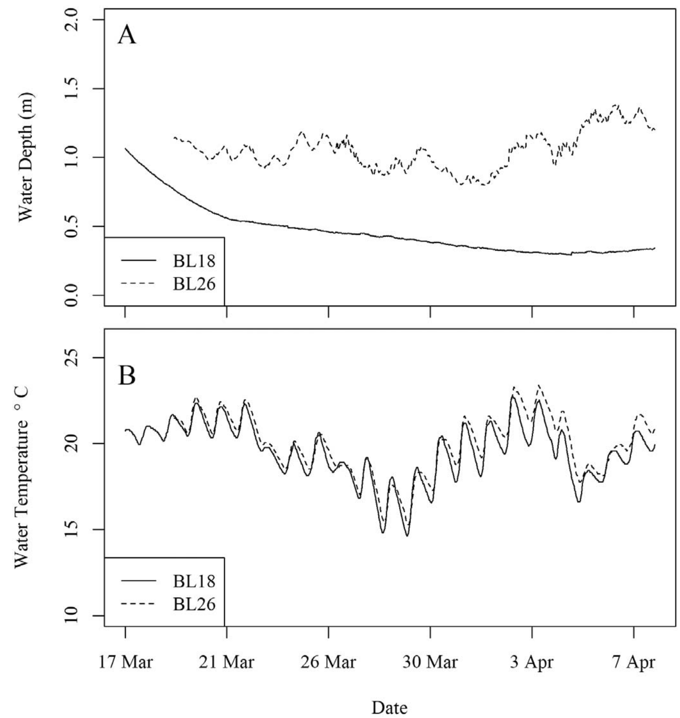

FIG. 4. Water depth (A) and temperature (B) at two trapping locations for Gulf Coast Waterdogs in 2015 along Bayou Lacombe, Saint Tammany Parish, Louisiana.

DISCUSSION

We had no captures at our five northernmost sites and only two or less at the next four sites. This result suggests that Gulf Coast Waterdogs may not reside at all, or in low abundances, in the headwaters of streams within its range. This is likely because shallower waters result in faster flows and contain less cover objects for adults and less leaf litter mats preferred by juveniles (Shoop and Gunning, 1967; Bart and Holzenthal, 1985). Our captures were also low at our southernmost sites, and our abundance model estimates of Gulf Coast Waterdogs were highest from BL17–BL22, about 8.8 km to 12.2 km from the headwaters, giving us confidence that we sampled the most suitable habitats in the bayou reach. We acknowledge that catchability may have varied across the stream length gradient because of microhabitat covariates that we did not measure or include in our model. However, we trapped the best perceived microhabitats based on previous studies to maximize catchability at each site, which provides confidence that abundance was truly lower at the headwaters and downstream reaches.

We had more than twice as many male captures as females, but without unique marks, there is no way to know how many

TABLE 3. Length and weight data for measured Gulf Coast Waterdogs in 2015 in Bayou Lacombe, Saint Tammany Parish, Louisiana.[a]

		SVL (mm)			Tail length (mm)			Total length (mm)			Mass (g)		
	n	Mean	SE	Range	Mean	SE	Range	Mean	SE	Range	Mean	SE	Range
All measured	169	108.8	1.04	55–136	54.3	0.43	33–65	163.1	1.40	89–198	22.1	0.46	3.0–36.8
Males	84	112.7	1.04	91–136	55.3	0.43	46–64	168.0	1.38	140–198	22.9	0.55	13.4–36.8
Females	36	112.8	1.21	102–126	57.2	0.70	49–65	170.0	1.73	151–187	24.9	0.68	18.4–35.1

[a] Note that some adults in the first sample were not assigned a sex because of a lack of confidence in sexing technique.

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individuals that our results represent. We did collect a tissue sample from 50 individuals, and of the 15 known-sex recaptures among them, all but 1 was male. This finding implies that overall catchability may vary between the sexes. Alternatively, it may be that the true sex ratio in this population is skewed toward males and initial catchability is similar between the sexes. Males, however, may be less trap shy than females and more likely to re-enter traps after their initial capture. More research on this population using uniquely marked individuals would help to clarify which of these hypotheses has support.

Brenes and Ford (2006) had no captures of Gulf Coast Waterdogs in Smith County, Texas, when water temperatures rose much above 18°C, despite trapping year-round at one of their two creeks. However, our mean water temperature during sampling was greater than 19°C and reached close to or higher than 23°C at our two loggers. Therefore, water temperature alone may not determine lower capture rates in warmer periods. Capture rates may also be impacted by decreasing prey availability in warmer periods as Bart and Holzenthal (1985) suggested, which likely varies across drainages and latitudes within the range of Gulf Coast Waterdogs.

Shoop (1965) indicated for a population just east of this study in Talisheek Creek that the minimum SVLs for adult males and females were 112 mm and 115 mm, respectively. However, Sever and Bart (1996) examined 17 gravid or nest-tending females from the same system and had a gravid individual of 103-mm SVL. We observed females with visible eggs as small as 102-mm SVL, and males, evidenced by the presence of external cloacal papillae, as small as 91-mm SVL in Bayou Lacombe. We measured SVL to the anterior of the cloaca, whereas Shoop (1965) measured to the posterior of the cloaca, making our estimates more similar than they appear. However, this method difference cannot explain the difference in male SVL measured in the two studies. It is possible that young males in our study may not be of reproductive size despite their external secondary sexual characteristics (Shoop, 1965). Talisheek Creek and Bayou Lacombe represent different mitochondrial lineages (Guyer et al., 2020); perhaps there exists some drainage variation in size at maturity between the Pearl (Talisheek) and Pontchartrain (Bayou Lacombe) lineages.

Despite our overall success at capturing Gulf Coast Waterdogs, it was disappointing for the use of burlap-wrapped traps, representing half of our effort, to essentially fail. The idea to wrap the traps in burlap came from Duffy (1961) who stated that Percy Viosca learned of the technique from a local who trapped *Necturus* quite successfully in the general area of this study. Viosca, a pre-eminent herpetologist and naturalist with the Louisiana Department of Wildlife and Fisheries, used burlap-wrapped traps to capture and describe four new species of *Necturus* (Viosca, 1937). He surmised that the nocturnal *Necturus* liked the darkness of these traps. The mesh that was used on Viosca's traps was much wider, and the burlap was also necessary to prevent escape through the mesh. We had hoped to compare capture rates between burlap-wrapped and unwrapped minnow traps, but the blocked funnel entrances preclude that comparison. If we were to try again, we would not use burlap on the funnels at all and just wrap the outside of the trap.

Shoop and Gunning (1967) posited Gulf Coast Waterdogs lived in restricted stream segments associated with preferred microhabitats such as leaf litter beds. Our study supports this earlier work, as Gulf Coast Waterdogs were found unevenly distributed throughout the system, with few to no individuals in the northernmost reaches, and most individuals were captured between 6 km and 11 km from the headwaters. Although we did not quantify microhabitats, most captures occurred in the vicinity of leaf litter mats and other submerged structures, further supporting the conclusions of Shoop and Gunning (1967). The population of Gulf Coast Waterdogs in Bayou Lacombe seems robust, likely owing to its relatively unaltered state with clear water and abundant microhabitats. However, actions within the watershed that increase siltation may also impact Gulf Coast Waterdogs and the other flora and fauna of this designated natural and scenic river.

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