Blue Catfish Density and Biomass in a Tidal Tributary in Coastal Virginia

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Abstract - *Ictalurus furcatus* (Blue Catfish) provide trophy recreational fishing opportunities in Virginia's tidal rivers; however, potential ecological impacts are of concern. We used mark–recapture techniques and electrofishing in 2007 and 2014 to estimate Blue Catfish density and biomass in Powell Creek. A 66% decline in fish density occurred between 2007 (708 fish/ha) and 2014 (239 fish/ha) and biomass declined by 31% over the same timeframe (266 kg/ha to 185 kg/ha). These findings are supported by long-term monitoring trends in the tidal James River. Here, we provide: (1) data relative to temporal shifts in abundance and biomass, (2) data for use in subsequent population-dynamics analyses, and, (3) points of caution when assuming temporally static populations for introduced species. We demonstrated the feasibility of low-frequency electrofishing and mark–recapture methods to estimate Blue Catfish abundance, and recommend use of the approach where catfish abundance estimates are important.

Introduction

Ictalurus furcatus (Valenciennes) (Blue Catfish) is native to the Mississippi River drainage and range geographically into Central America (Graham 1999). The species is a common, though not native, component of the fish assemblages of fresh to mesohaline sections within Virginia's tidal rivers (Hewitt et al. 2009, Tuckey and Fabrizio 2016). Blue Catfish constitutes a valuable recreational fishery in Virginia's tidal rivers; trophy sizes of up to 46 kg have been recorded (Virginia Department of Game and Inland Fisheries [VDGIF], Angler Awards Program, unpubl. data); however, managers and researchers are uncertain about overall impacts to the Chesapeake Bay ecosystem. Schmitt et al. (2017) found that Blue Catfish in tidal rivers are opportunistic omnivores, but evaluation of overall impacts to prey species are dependent on size estimates of populations of Blue Catfish.

Ecosystem-based management has broad applicability to the future health of the Chesapeake Bay and its tributaries, and modeling ecosystem processes and functions must be informed through various data inputs (Boesch 2006, Christianson et al. 2009). For example, the modeling software Ecopath with Ecosim requires biomass for its mass-balance–modeling structure, and direct estimates of Blue Catfish biomass would be useful for modeling ecosystems within the Chesapeake Bay watershed (Christianson et al. 2009). Although population estimates are available for some catfish species (Daugherty and Sutton 2005, Fabrizio et al. 2018, Newcomb 1989), monitoring programs rely heavily on relative-abundance indices to provide status and trends over time (Bodine et al. 2013). For example, standardized

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monitoring in the tidal rivers of Virginia, such as low-frequency (i.e., catfish surveys primarily focused on pelagic deep-water sections; Greenlee and Lim 2011) and high-frequency (i.e., fish community surveys focused on littoral shallow habitat) electrofishing surveys collect relative-abundance data to track through time. Managers generally prefer absolute abundance due to potential issues with variable catchability in relative-abundance estimates (Bonar et al. 2009, Hubert and Fabrizio 2007). Our objective was to describe the temporal shift from 2007 to 2014 in population characteristics (i.e., abundance, density, biomass, and length distribution) of Blue Catfish in a tidal tributary of the Chesapeake Bay.

Field-site Description

Our sampling focused on Powell Creek (37°17'35"N, 77°09'42"W), which is a tidal tributary of the James River ~110 km upstream from the Chesapeake Bay (Fig. 1). We chose Powell Creek because of its stream length and width, and feasibility of sampling all available habitats in a time-efficient manner. We processed

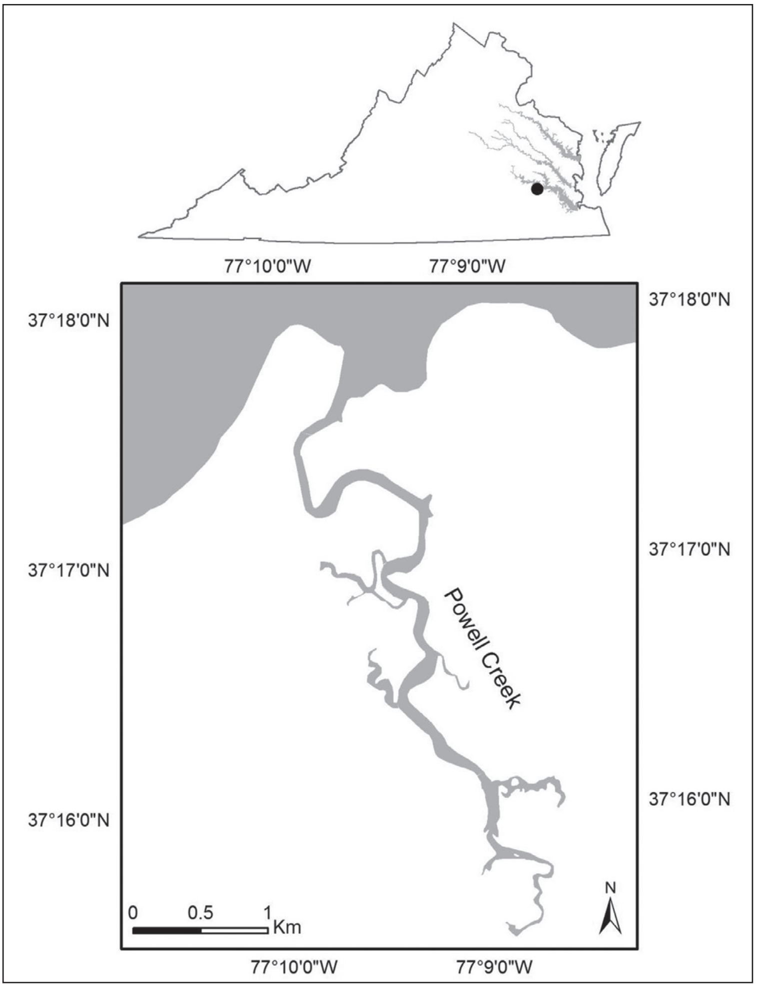

Figure 1. Study-area map of Powell Creek, which is located on the southern shoreline of the James River within the Coastal Plain region of Virginia.

overhead imagery in ArcGIS software and determined that the study area comprised ~42 ha over 4.8 km of available habitat for Blue Catfish and had a maximum stream width of 130 m. Habitat within the creek included sections up to 10 m deep along bends, large amounts of woody debris, human-made structures such as dock pilings and old wooden barges, and aquatic vegetation dominated by *Hydrilla verticillata* (L.f. Royle) (Hydrilla). The sample area was an extended embayment of the James River, with tidal influence resulting in fresh and brackish water mixing within the sample area.

Methods

Mark–recapture

We conducted a mark–recapture survey in mid-July in 2007 and 2014. Each mark–recapture survey consisted of 3 sampling days, with a 24-h period between sampling events. Sampling in all years occurred when water temperatures were 28–30 °C with minimal salinity influence (0.1–0.3 ppt), and water conductivity was between 180–400 µS. We collected Blue Catfish via low-frequency pulsed (15 pulses/s) DC boat electrofishing as described by Greenlee and Lim (2011). During each event, we thoroughly sampled all available habitat within the creek. We timed our sampling around strong flowing tides because our protocol depends on continuous tidal flow (Greenlee and Lim 2011). During ebb tide, sampling began ~4.8 km from the creek mouth and continued downstream moving slowly with the outgoing tide; conversely, the opposite occurred during a flooding tide.

Two netters in each chase boat collected fish and placed them in large on-board oxygenated livewells. In 2007, we employed 13–14 chase boats to collect fish during electrofishing; 6 boats were used for each event in 2014. We used fewer chase boats in 2014 because standardized catfish surveys in the tidal James River revealed lower catch rates as compared to 2007 (VDGIF, unpubl. data); thus, we sought to be efficient with personnel and equipment. In both years, we satisfied the random-mixing assumption by redistributing fish at 6–10 locations evenly spaced throughout the creek. In 2007, biologists collected and processed fish from aboard each boat. In 2014, netters placed fish in onboard live wells, and midway through sampling, boats that were at capacity offloaded the catch into 2 large, oxygenated live wells (1893 L) located on shore. At the completion of sampling, those fish were processed and released near the onshore location; however, the majority of fish were held in onboard livewells, and redistributed throughout the study after processing to satisfy the random-mixing assumption. Regardless of year, we measured for total length (TL; mm), weighed, and marked (fin clip to differentiate day of capture) all captured fish. Fish received an adipose clip on the first event, and an upper caudal clip on the second event in each year. On the second and third events, we inspected fish for marks and noted if they were recaptures.

Analysis

We used the Schnabel estimator to evaluate Blue Catfish population size and calculate 95% confident intervals (Schnabel 1938). Blue Catfish showed high sitefidelity within the study area during a telemetry project in 2007 (VDGIF, unpubl. data), so we assumed a closed population. We employed a 24-h time-period between sampling events to support the assumption of a closed population, such that egress or ingress would be minimal or non-existent over a short timeframe. The model estimated total population size based on all fish marked and recaptured during the 3 days of each mark–recapture process.

We converted total population estimates to densities by dividing the population estimate by the number of hectares within Powell Creek (i.e., 42 ha). We estimated total biomass for each year separately according to Hayes et al. (2007). This method incorporated density, length–weight regression coefficients, and relative length–frequency data directly collected during this study.

Results

We collected a total of 16,494 Blue Catfish over the 2-y study period. We found a substantial (66%) decrease in abundance and density from 2007 to 2014 (Fig. 2a; Table 1). Within the same timeframe, there was a 31% decrease in biomass (Fig. 2b; Table 1). Length–frequency plots indicated consistent length collected over the

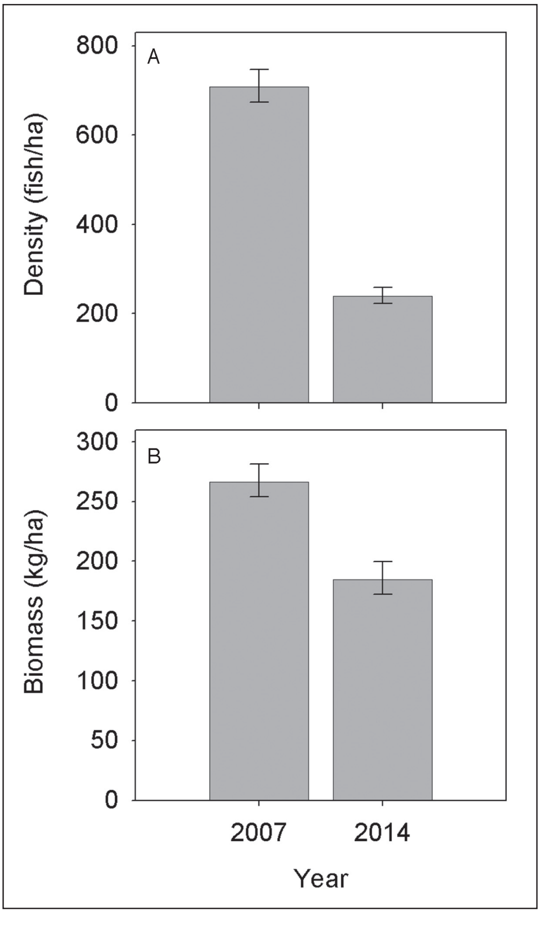

Figure 2. (a) Estimated density (fish/ha) and (b) biomass (kg/ha) for Blue Catfish in Powell Creek in 2007 and 2014. Bars represent 95% confidence intervals.

course of the 3 events within each year, with the exception of smaller fish in 2014 (Fig. 3). In general, we collected larger fish in 2014 as compared to 2007 (Fig. 3).

Discussion

We found densities of Blue Catfish in Powell Creek in 2014 declined to 66% of the level estimated in 2007. A decline in biomass was also evident, but it was not as dramatic as density owing to a strong shift in size distribution to larger fish. According to Greenlee and Lim (2011), the tidal James River population experienced a prolonged period of population expansion since initial stockings in

Table 1. Survey data for Blue Catfish summarized for each year including the number of marks applied (marks), recaptures (recaps), total catch, abundance, density (fish/ha), and biomass (kg/ha). Numbers within parentheses represent 95% confidence intervals.

Year	Marks	Recaptures	Total catch	Abundance	Density	Biomass
2007	8233	1456	11,696	29,745 (28,292–31,356)	708 (674–747)	266 (254–281)
2014	3717	699	4800	10,041 (9348–10,845)	239 (223–258)	185 (172–200)

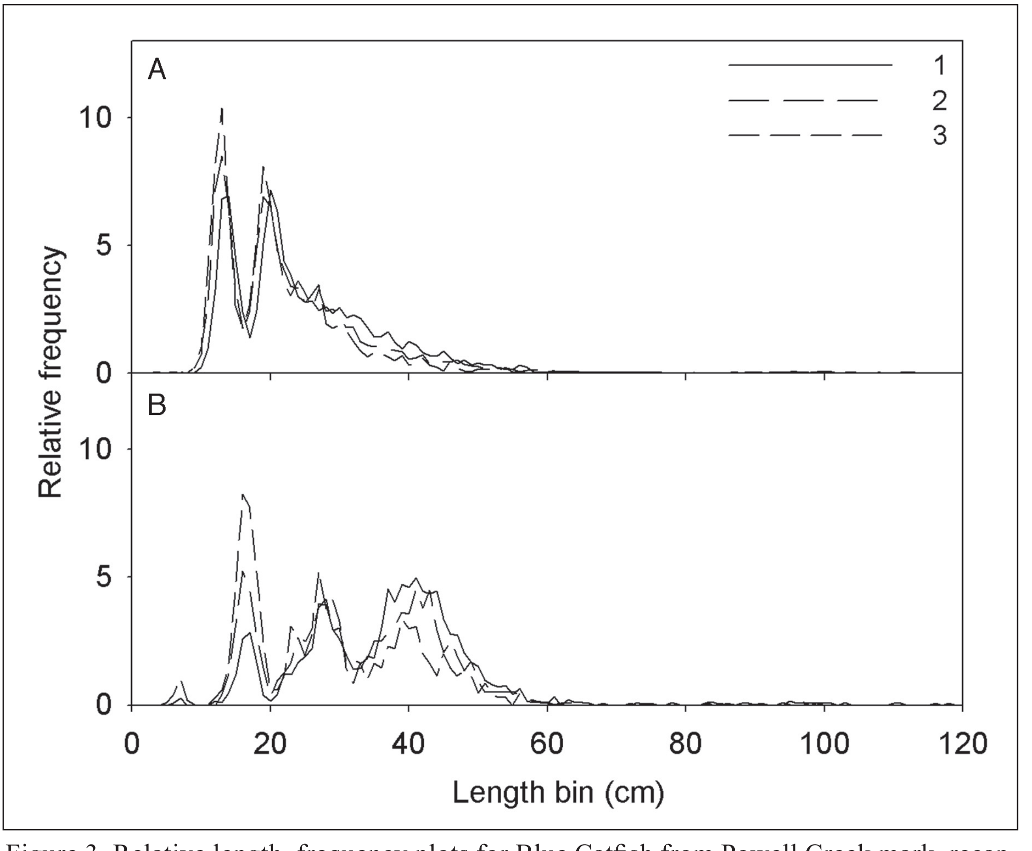

Figure 3. Relative length–frequency plots for Blue Catfish from Powell Creek mark–recapture events from (a) 2007 and (b) 2014. The mark–recapture events are shown in the legend as 1–3, and each corresponding line represents a different event.

the mid-1970s with an increasing linear trend in catch per unit effort from 2001 to 2008. Trends in density aligned with data from other independent sampling programs; declines in density and shifts in size structure in Powell Creek were consistent with changes in the tidal James River demonstrated by standardized monitoring data (i.e., low- and high-frequency electrofishing surveys; VDGIF, unpubl. data).

Another mark–recapture study of Blue Catfish was conducted from 2012 to 2014, but it focused on different sampling approaches including coordinated efforts with commercial trap-net fishers in order to assess the mainstem James River population (Fabrizio et al. 2018). Fabrizio et al. (2018) estimated densities of Blue Catfish (214–466 mm fork length) to be 544 fish/ha in a 12-km stretch of the mainstem James River. Those researchers used coded wire-tag recaptures to inform a robust design model to estimate abundance and density. The carrying capacity of the mainstem river is likely higher for Blue Catfish given the higher habitat availability (e.g., deeper channel) compared to a smaller side-tributary.

Electrofishing occurred during summer months when water-temperature conditions were adequate to maximize capture efficiency (Bodine et al. 2013). Also, depleted river-bottom dissolved oxygen may have forced fish to occupy shallower depths, which increased their vulnerability to capture (Buckmeier and Schlechte 2009). Morphology (e.g., size and depth) of Powell Creek provided a feasible sampling situation given our desired mark–recapture closed-population modeling structure and available resources.

Telemetry results within Powell Creek in 2007 supported the assumption of closure, and we intentionally kept time periods between sampling events short (24 h) to minimize ingress or egress. Pine et al. (2012) indicated that stream segments can be considered closed if movements are monitored and time between sampling events is short. To satisfy the assumption of random mixing between sampling events, we redistributed fish at 6–10 locations spread throughout the creek after each event. We supplemented holding tanks with dissolved oxygen to reduce stress and minimize mortality, and we observed no fish floating on the surface following processing.

Our study provides baseline population-data for statistical modeling (e.g., ecosystem-based, and hierarchical Bayesian models). Model developers should consider that density patterns of Blue Catfish are both temporally and spatially variable within Virginia's tidal rivers and tributaries (Schloesser et al. 2011). For example, the James River is highly productive and has among the highest abundance of Blue Catfish relative to other coastal rivers in Virginia (Greenlee and Lim 2011). We intend to expand mark–recapture efforts to other tidal rivers in Virginia to provide estimates of population size, density, and biomass to inform additional modeling efforts. Here, our calculations provided snapshots of population size of Blue Catfish in Powell Creek and offer solid estimates of abundance for use in population-dynamics analyses. We have demonstrated the feasibility of using low-frequency pulsed-DC boat electrofishing and mark–recapture methods to estimate Blue Catfish population size, and we recommend using this approach in areas where obtaining catfish-population size is critically important.

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