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Observations of Co-Nest Building and Spawning in Native and Non-Native Chub Species (*Nocomis* spp.) in the Swannanoa River, North Carolina

Abstract

Co-nest building and spawning among individuals of the native population of River Chub (*Nocomis micropogon*) and among those of an introduced population of Bluehead Chub (*N. leptocephalus*) observed in the Swannanoa River (French Broad River basin) during Spring 2024 represents the first time such behaviors have been documented between two species of *Nocomis*. Observations of these behaviors are described and discussed in the context of potential hybridization and the impact of introduced Bluehead Chubs in the French Broad River basin.

Keywords

Species Introduction, Spawning Ecology, River Chub, Bluehead Chub

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Cover Page Footnote

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INTRODUCTION

The leuciscid genus *Nocomis* contains seven species distributed throughout eastern North America (Fricke et al. 2024). Species of *Nocomis* are perhaps best well-known for the nests constructed during the spawning season in Spring and early Summer, in which males dig a pit in the stream substrate and subsequently pile pebbles into a mound (Jenkins and Burkhead 1994). These behaviors have been well-studied in the relatively widespread River Chub, *Nocomis micropogon*, and Bluehead Chub, *Nocomis leptocephalus* (i.e., Reighard 1943; Wallin 1989; Johnston 1991; Maurakis et al. 1991; Maurakis and Woolcott 1996; Maurakis et al. 1997; Sabaj et al. 2000; Maurakis and Green 2001). The two species are largely allopatric, with natural sympatry occurring in river basins in Virginia (Lachner and Jenkins 1971). Introductions of both species have also occurred throughout North America, notably with the introduction of the Bluehead Chub into several watersheds of the Tennessee River basin, including the French Broad River where the first vouchered specimens date to 1997 (Tracy et al. 2020). Behavioral interactions between these two species in areas where they are either sympatric or in streams where introductions have occurred have not been studied.

During Spring 2024 snorkel surveys in the Swannanoa River, a 5th order tributary of the French Broad River basin in western North Carolina, native River Chubs and non-native Bluehead Chubs were observed co-building nests (i.e., piling and manipulating pebbles on the same nests together), followed by spawning. Behavioral interactions between these two species are herein described for the first time.

METHODS

An approximately 1.3 km stretch of the Swannanoa River (upstream most coordinates: 35.60583, -82.43461; downstream most coordinates: 35.60884, -82.44777) flowing on the campus of Warren Wilson College was opportunistically surveyed between 8:30–14:30 on April 30, May 2, 6, 8, and 13, and June 18, 2024. Within the surveyed section, wetted widths ranged from 10.4–21.8 m and water temperatures ranged from 16.3–23.7°C. Landcover around the site is a combination of mixed forest, row crops, and pastures.

Two methods were used to identify within stream nest building locations in riffle, run, and pool habitats. Sections of the Swannanoa River were slowly walked in a zig-zag pattern while wearing polarized glasses to identify nests in shallower habitats. Snorkeling searches were conducted in deeper areas. Once a nest was identified, I snorkeled the adjacent area for 5–30 minutes depending on the level of activity. Dominant males were identified as those males with nuptial head coloration (pink in River Chubs and blue in Bluehead Chubs), well-developed tubercles, and engaging in the majority of nest construction and spawning. Accessory males (following Jenkins and Burkhead, 1994) were identified as those males with no or subdued head coloration, tubercles ranging from weakly-developed to well-developed, a black stripe margined dorsally by a brassy stripe down the flank, and engaging in little to no nest constructing or spawning. Videos and images were taken with a GoPro HERO 8 Black. The location of the nest was recorded with a handheld GPS for potential re-visits, along with the distance to the nearest bank and depth (0.1 m) with a measuring tape and meter stick, respectively. All fish species associated with the nest were identified and recorded.

RESULTS AND DISCUSSION

During the observation period, I observed five nests being tended to solely by River Chubs, four nests just by Bluehead Chubs, and six nests with both male River Chubs and Bluehead Chubs. These latter six nests were located within 3 m of the nearest bank, either near a rootwad, downed tree (Fig. 1), or boulder (Fig. 2) at depths of 0.5–0.8 m. In three of these nests a dominant River Chub was observed building and spawning, with dominant Bluehead Chubs and accessory males of both species present in the vicinity (within ~1 m), but not engaging in active building or spawning. In the other three nests, both a dominant River Chub and dominant Bluehead Chub engaged in active nest building (Fig. 2) and spawning in the same mound. Behaviors of both species followed those as described by Sabaj et al. (2000). Males of both species carried pebbles to the nest and dropped them during nest construction, moved pebbles within the nest, dug troughs (River Chub) or pits (Bluehead Chub), and engaged in anal-fin fanning. Each species engaged in these behaviors in different parts of the same nest (i.e., the periphery, middle, and upstream facing slope) and were not confined to particular areas. Spawning was characterized by an alignment and run by a female, followed by a semi-circular clasp by the male before dissociation (Sabaj et al. 2000). The spawning troughs and pits of dominant males were located either on the upstream slope of the nest (n=1) or near the middle apex of the nest (n=2) when located upstream of a downed tree.

Agonistic behaviors were observed between the dominant males of the two species in only one of these nests. These included non-contact head displacement, head butting displacement, chases, and circular swims as described by Maurakis et al. (1997) conducted by a River Chub towards dominant and accessory Bluehead Chubs, as well as accessory River Chubs. The dominant River Chub would engage in these agonistic behaviors in between nest construction and spawning. Species observed schooling over nests included Central Stonerollers (*Camptostoma anomalum*), Saffron Shiners (*Hydrophlox rubricroceus*), Warpaint Shiners (*Coccotis coccogenis*), and Whitetail Shiners (*Cyprinella galactura*). One to two Green Sunfish (*Lepomis cyanellus*) were occasionally observed in these schools. Fantail Darters (*Etheostoma flabellare*) were also observed inhabiting one abandoned and two active nests, with presumed foraging (digging into the gravel with the snout) occurring in one active nest.

While Wallin (1989), Johnston (1991), and Sabaj et al. (2000) reported co-nest use between individual Bluehead Chub males, this is the first recorded observation of co-nest building and spawning by two different species of *Nocomis*. Kim et al. (2020) similarly reported nest sharing by male Bluehead Chubs and hypothesized that this behavior may reduce individual energy use. In two of the co-inhabited nests, dominant males of both species were observed picking up pebbles from nearby (less than 0.5 m) abandoned nests, another potential energy-reducing behavior (Kim et al. 2020). Unlike what was reported by Sabaj et al. (2000), both the Bluehead and River Chubs appeared to engage in similar numbers of spawning events. However, it is unclear if females of each species are exclusively spawning with conspecific males, or if heterospecific spawning between the two species is occurring. Lachner and Jenkins (1971) reported the frequent occurrence of hybrid River Chubs and Bluehead Chubs in the James River where they naturally co-occur, with at least one, but usually more, hybrid specimens present in 60% of 25 collections examined. Despite this reported hybridization, it is unknown if co-nest building by males also occurs in these streams where both species are native. Given these observed hybrids in the James River and the

rates of hybridization among leuciscid species associated with mound nests in general (Corush et al. 2021), hybridization between both chub species in the Swannanoa River is predicted to occur.



Figure 1. Dominant male River Chub (left, foreground) and dominant male Bluehead Chub (right, foreground) over a nest in the Swannanoa River. Two accessory male Bluehead Chubs are present in the background.



Figure 2. Dominant male Bluehead Chub (left, with pebble in mouth) and dominant male River Chub (right) over a nest in the Swannanoa River.

The impacts of the introduction of Bluehead Chubs on River Chub populations in the French Broad River basin are unclear. Co-nest building may allow both species to effectively reproduce through lowered energetic demands as described above and/or by reduced vigilance by males facilitated by an increase in the number of individual fishes on the nest (Betts et al. 2024). Alternatively, resource competition and hybridization may be detrimental to native River Chub populations. Tracy (2008) reported the decline and possible extirpation of populations of River Chubs in several other tributaries of the French Broad River that coincided with increases in numbers of introduced Bluehead Chubs. Individuals of *Nocomis* are the most commonly encountered fish species in the Swannanoa River watershed and observations described here indicate River Chubs are present and actively spawning despite the presence of Bluehead Chubs. However, the relative numbers of both species and their potential hybrids in the Swannanoa River are unknown. As the mound building behavior of species of *Nocomis* makes them important ecosystem engineers (Moore et al. 2023), understanding the nature of the interactions between these two species may play a pivotal role in the conservation of habitat structure necessary to the foraging and reproduction of native fishes of the French Broad River basin, particularly given the levels of sedimentation that can occur throughout the watershed and negatively impact native fish assemblages.

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