Fish community composition and movement patterns in a hydrologically impacted urban stream

Dr. Michael T. Booth, Adam J. Sanders, and Megan A. Urbanic

Department of Biological Sciences, University of Cincinnati, Cincinnati, Ohio

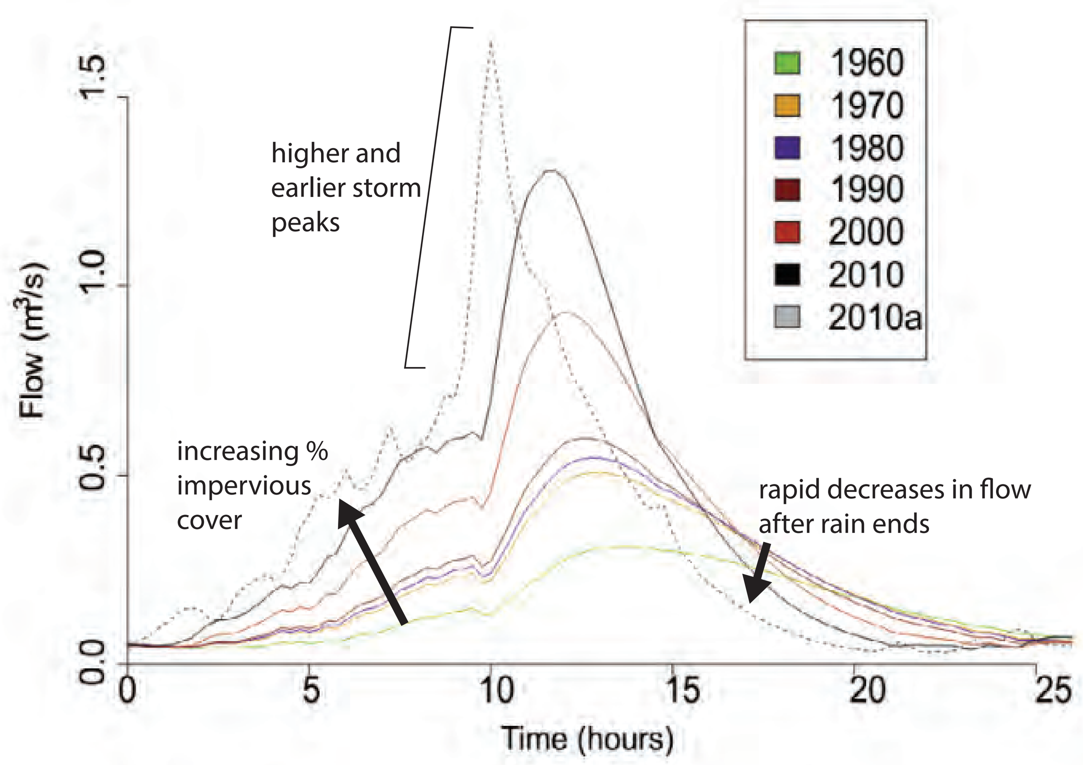
www.mikeboothlab.org @mikeboothlab

University of CINCINNATI

Context

"Urban stream syndrome" (Walsh et al 2005)

Feature	Consistent response	Inconsistent response
Hydrology	↑ Frequency of overland flow ↑ Frequency of erosive flow ↑ Magnitude of high flow ↓ Lag time to peak flow ↑ Rise/fall of storm hydrographs	Baseflow magnitude
Channel morphology	↑ Channel width ↑ Pool depth ↑ Scour ↓ Channel complexity	Sedimentation
Fishes	↓ Sensitive fishes	Tolerant fishes Fish abundance /biomass



▲Figure 1. Increasing impervious surface cover leads to increased runoff, resulting in rapid increases in stream flow, earlier and steeper storm peaks, and more rapid recession, often to lower baseflow than prior to the change in landcover. Higher velocity flows can scour sediment and displace organisms

Figure adapted from: Miller, J. D., H. Kim, T. R. Kjeldsen, J. Packman, S. Grebby, and R. Dearden. 2014. Assessing the impact of urbanization on storm runoff in a peri-urban catchment using historical change in impervious cover. Journal of Hydrology 515:59–70.

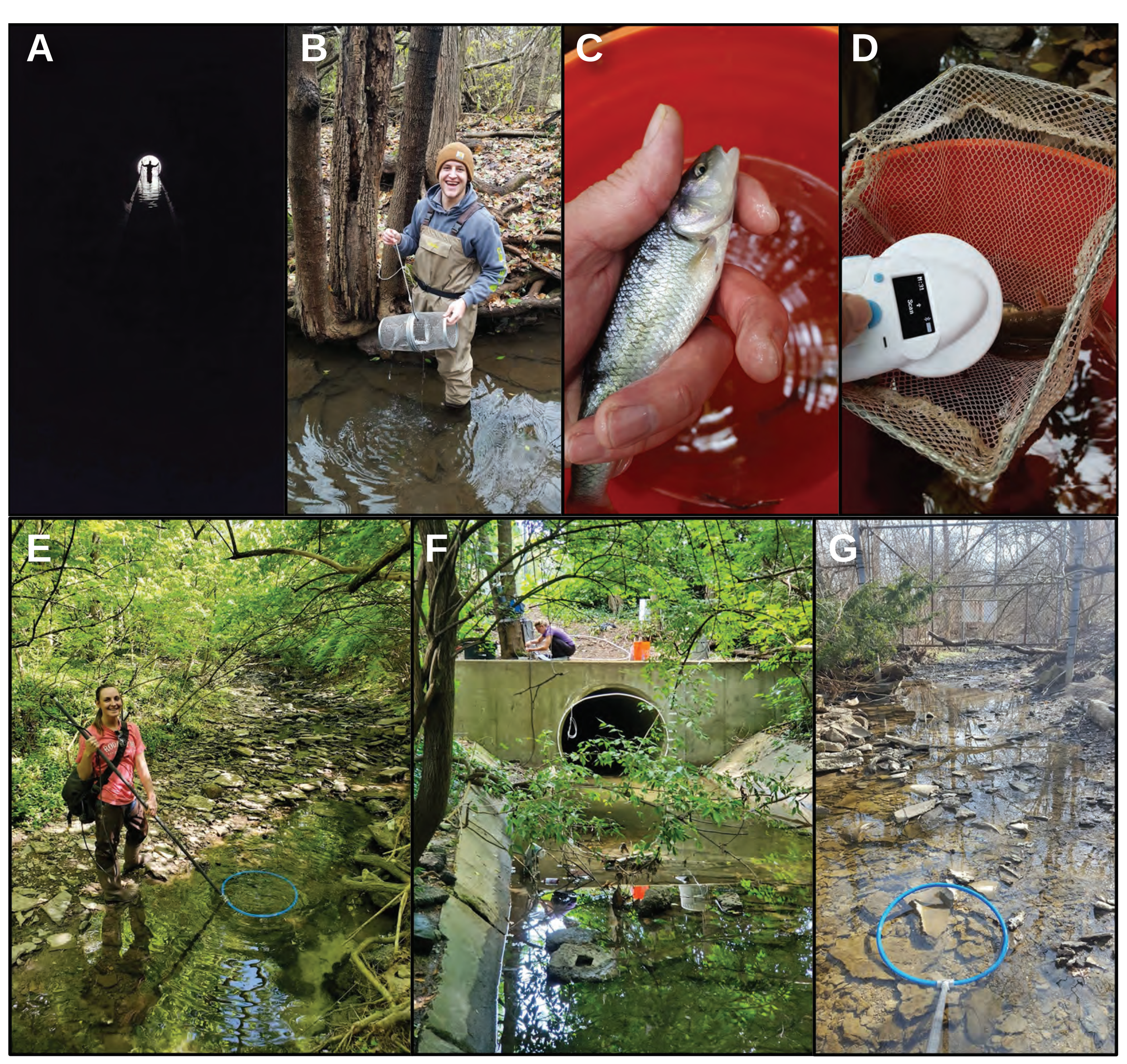
▲Figure 2. In urban settings, streams are often buried or culverted and in addition to hydrologic modification, are impacted by a variety of human impacts. A) Headwaters of Cooper Creek, a tributary to Mill Creek in Cincinnati, OH. A stormsewer drainage network is the primary source of flow. B) Flows increase rapidly following storms--flows shown are about 15 minutes after a moderate, localized thunderstorm, which increased flows dramatically. C) High flows and frequent erosion events lead to channel overwidening or incision. In addition, pipes buried under streams (e.g., sanitary sewers) can capture surface flows, dewatering the creek or leak contaminants into the channel. D) Although culverts are simple habitats, they may provide overhead cover and pool habitat that is otherwise scarce. E) Non-point sources of pollution, as well as illicit dumping (e.g., dumped paint from an autobody shop shown here) directly impact urban water quality

Project goals

1) Assess diversity and composition of the fish community prior to stormwater improvement projects

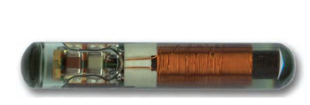
2) Understand movement patterns of common headwater fishes and assess whether movements occur in response to flow events

Methods

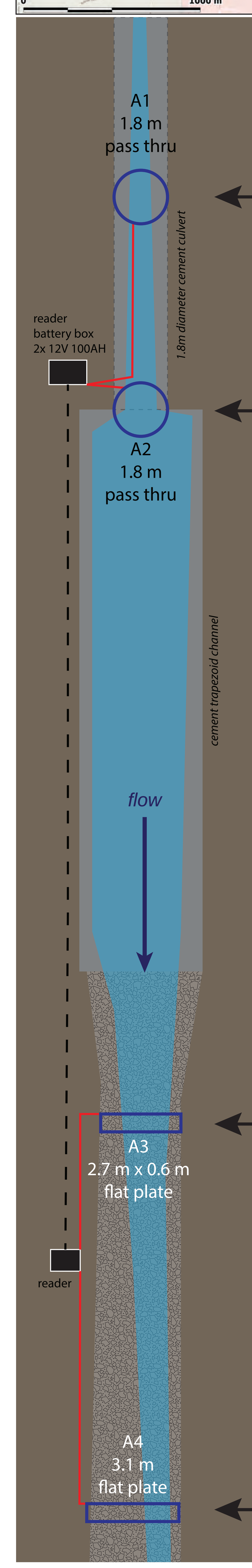


◄Figure 3. A) The majority of fish were collected from the headwaters of Cooper Creek, inside a 1.8 m cement culvert using a seine in November and December 2018. B) Fish were additionally sampled using minnow traps in habitats within the first 150m of the stream channel. C) Fish were tagged using passive integrated transponder tags (PIT), inserted into the body cavity through a small incision in the ventral musculature near the pectoral fin. D) Recaptured fish during subsequent tagging events were IDed using a handheld PIT tag reader, then weighed, measured, and released at the capture location. E) We used a custom fabricated submersible PIT tag antenna connected to a dual mode PIT tag reader (OregonRFID), read range approximately 25-40 cm. F) We installed 2 stationary antennas (see figure 4) within the culvert and 2 antennas downstream of the outlet pool. G) All potentially wetted habitat (regardless of whether it was currently wet) was scanned with the portable antenna once per week to detect tags no longer in fish (dropped or mortality).

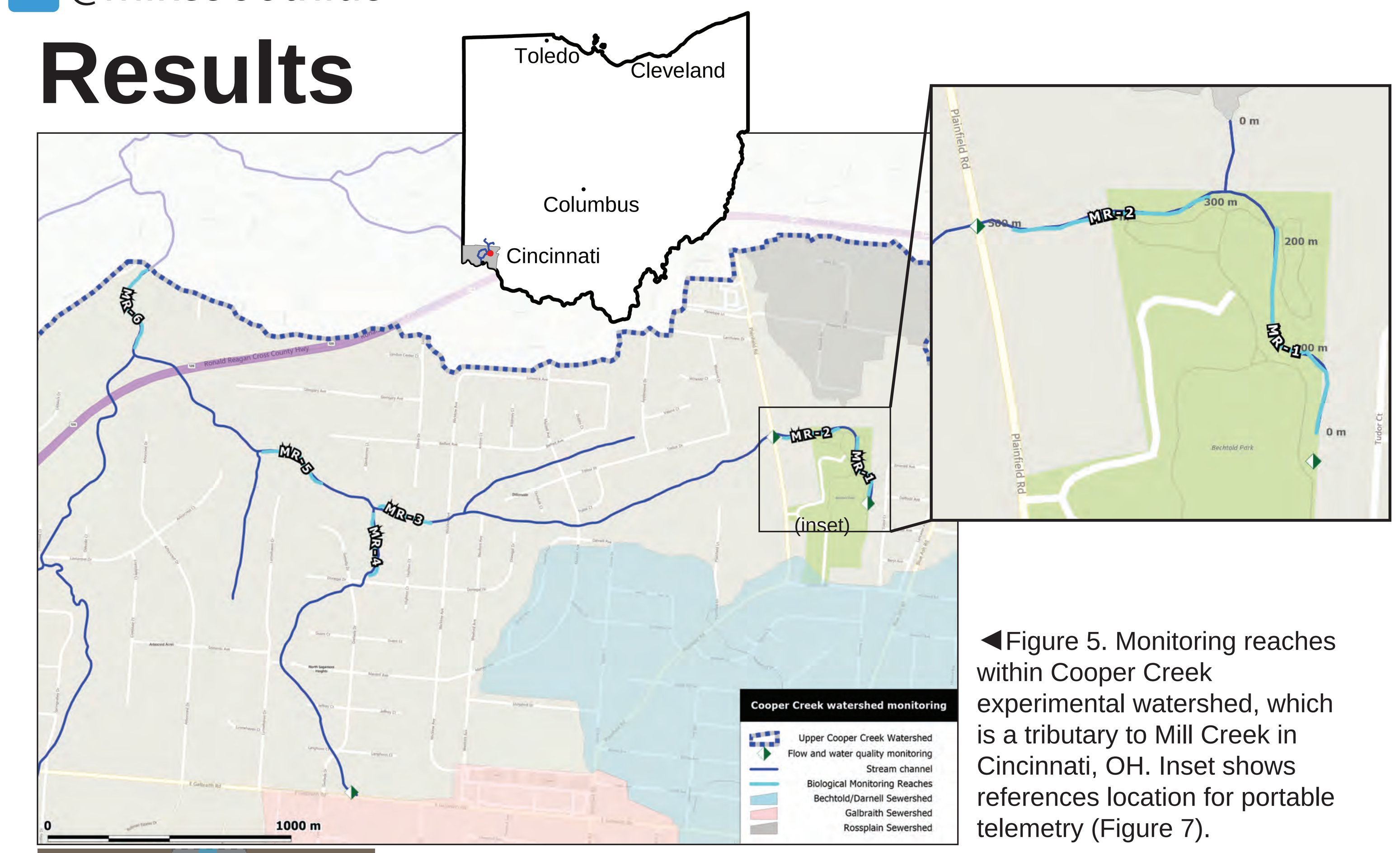
►Figure 4. Schematic of stationary antenna installation at the headwaters of Cooper Creek. Two multiplexed PIT tag readers (OregonRFID) with two antennas each were installed in the stream channel. A1 and A2 are continuously wetted, while A3 and A4 have minimal surface flow except during storm events. Red lines indicate twinax wire connections, dashed line is power connection, sourced from deep cycle batteries



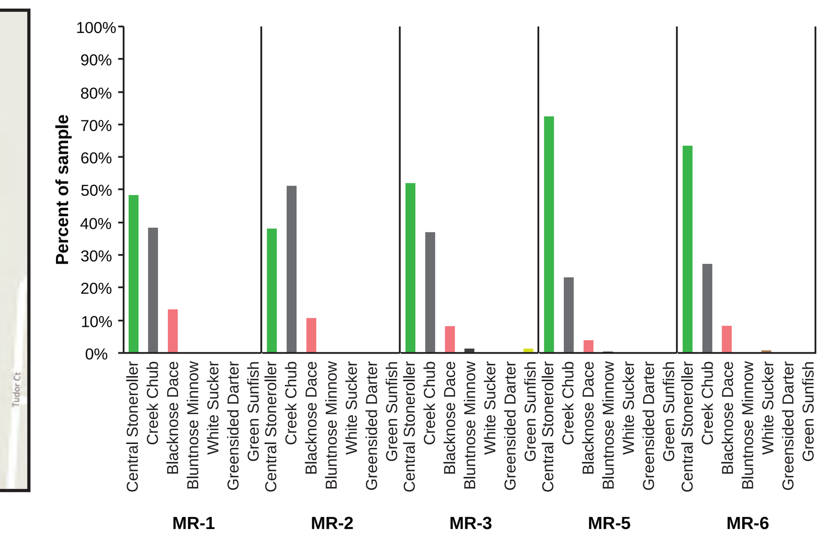
134.2khz half duplex
passive integrated transponder (PIT)
12 mm x 2.12 mm



Results

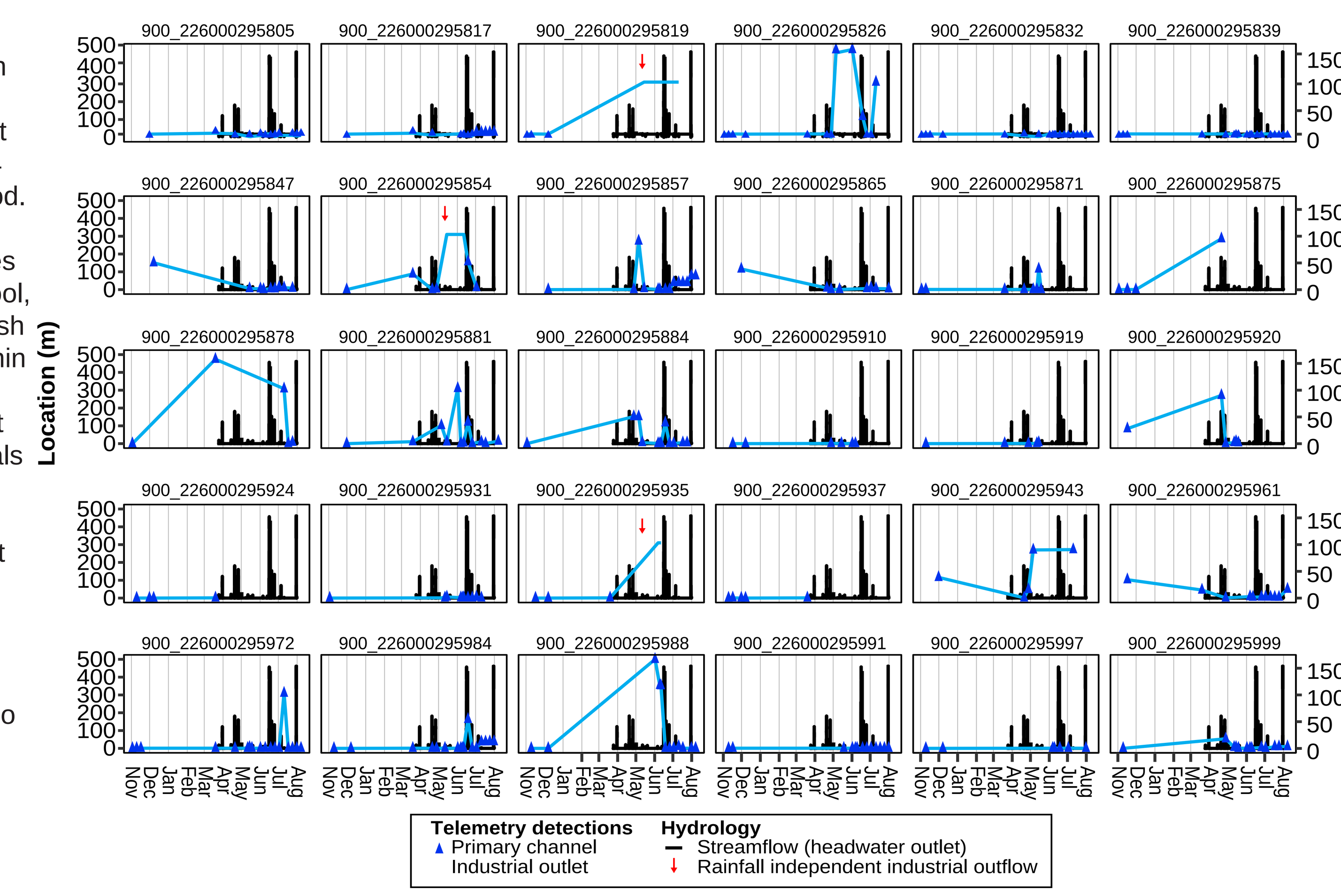


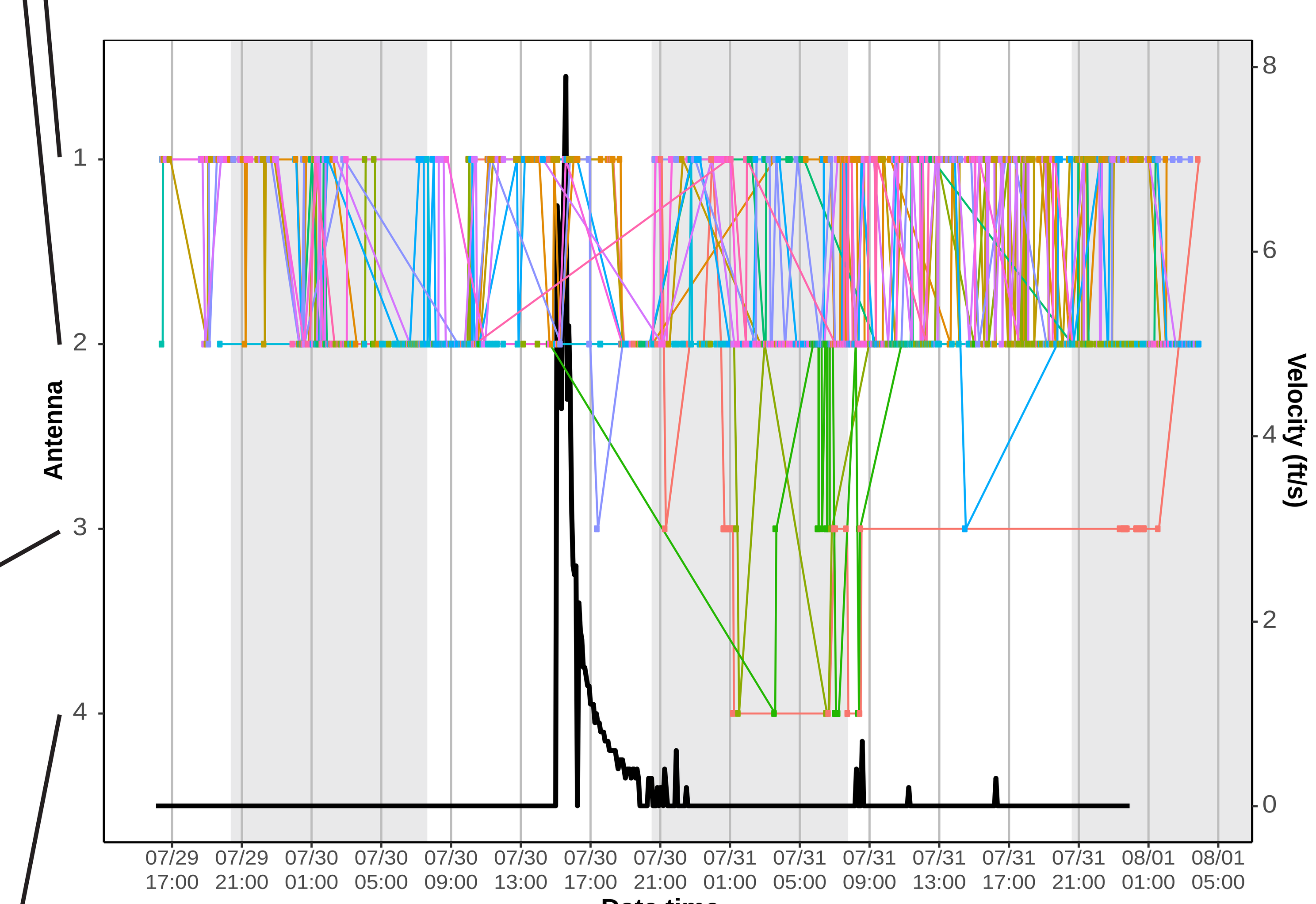
◄Figure 5. Monitoring reaches within Cooper Creek experimental watershed, which is a tributary to Mill Creek in Cincinnati, OH. Inset shows references location for portable telemetry (Figure 7).



▲Figure 6. Fish community composition in monitoring reaches of Cooper Creek from upstream (MR-1) to downstream (MR-6). MR-4 was dry during the sampling period. All reaches were dominated by Stonerollers, Creek Chub, and Blacknose Dace, downstream reaches also included several other species.

►Figure 7. Movement patterns of Creek Chub with stream flow between November 2018 and August 2019 observed more than 4 times during the study period. Although some individuals were never observed in sites outside the culvert outlet pool, more than 50% of tagged fish are no longer observed within the study reach and >29 individuals have died or lost their tags. Several individuals made long distance movements, potentially beyond the study reach, but returned to the culvert. Tagged fish were never observed in the industrial outfall channel until an asynchronous flow event (no rainfall, no flow in main channel, >1cfs in industrial channel). Flow monitoring began in April 2019.





◄Figure 8. Observations of tagged Creek Chub in the antenna array (colored lines) and culvert flow velocity (black line) at the outlet of the Bechtold sewershed immediately prior to and during a large rainfall (50mm in 1 hrs) and flow event. Grey areas are night, white areas are day. Each colored line is an individual fish (12 individuals presented). We did not observe any tagged fish from downstream locations enter the pool or current residents permanently leave, although several individuals moved downstream and returned prior to flows receeding.

Acknowledgements

We thank Hamilton County Soil and Water Conservation District (A. Lehmann) for advice and flow data, Sycamore Twp for access to Bechtold Park, and the many landowners in the Cooper Creek watershed who provided access to the stream. We thank N. Wilse, P. Young, D. Berning, A. Manning, G. Israel. D. Argo, and C. Hintz for help electrofishing and B. Cox and G. Israel for assisting with portable telemetry surveys. M. Urbanic was supported by a Biology Undergraduate STEM fellowship and A. Sanders received undergraduate research funding from UC Environmental Studies for the purchase of tagging and telemetry supplies.