Data associated with the publication: "Sensor-Equipped Unmanned Surface Vehicle for High-Resolution Mapping of Water Quality in Low- to Mid-Order Streams"

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Dataset description:

Study sites:
The AquaBOT was tested in four streams and rivers in the United States. The first test was along an 8.8-km reach of the Clinch River (6th-order river) in Tennessee on November 8, 2019. The AquaBOT was then run in three low- to mid-order streams in Iowa, including a 1.0-km reach of Walnut Creek (3rd order) on November 13, 2019, a 0.42-km reach of South Beaver Creek (2nd order) on November 14, 2019, and a 2.3-km reach of Alleman Creek (2nd order) on June 3, 2020. Alleman Creek is the focal stream for a larger project evaluating conservation practice effects on water quality (pre-treatment data are presented here) and additional data were collected at this site (i.e., see 'manual water quality measurements' section). Twenty-six tile drains are present along the 2.3-km reach of Alleman Creek, and the location (latitude/longitude) of each tile drain was recorded. Additional information about the study sites, including drainage area, land cover/land use, and channel width can be found in Griffiths et al. (2022).

AquaBOT water quality measurements:
Longitudinal measurements of water quality at each of the four study sites were collected using the AquaBOT, an unmanned surface vehicle equipped with water quality sensors. The AquaBOT was designed and assembled using commercial off-the-shelf technologies. The water quality sensors included a nitrate sensor (ecoN, OTT HydroMet, Germany) and a multiparameter sonde (EXO1, YSI Inc., Yellow Springs, OH). The multiparameter sonde had four sensors: dissolved oxygen, turbidity, temperature/conductivity, and total algae/chlorophyll a. A pH sensor was sometimes substituted for the total algae sensor. Geospatial data were collected using a GPS unit (AtlasLink GNSS Smart Antenna, Hemisphere GNSS, Inc., Scottsdale, AZ). All sensor data were logged every minute by a datalogger (CR6, Campbell Scientific, Inc., Logan, UT). The AquaBOT was operated using a remote control unit. Details on the AquaBOT design and water

quality sensor specifications (i.e., measurement range, accuracy, resolution, response time) can be found in Griffiths et al. (2022).

Prior to each AquaBOT deployment, the sensors on the multiparameter sonde were calibrated and the zero point on the nitrate sensor was checked, following the manufacturers' instructions. In the Clinch River, the AquaBOT was operated from a motorboat while both vehicles travelled in the downstream direction. In contrast, the AquaBOT was maneuvered along each Iowa stream (Walnut Creek, South Beaver Creek, and Alleman Creek) by an operator walking along the stream bank in the downstream direction, except in South Beaver Creek, where the AquaBOT was operated in the upstream direction. There were periods when the AquaBOT had to be operated from the stream channel (i.e., due to physical and visual obstructions) and all attempts were made to minimize sediment suspension. Turbidity data were not analyzed in these instances. In all four streams and rivers, the AquaBOT generally traveled in the thalweg, but was maneuvered to any flowing tile drains in the Iowa streams to capture the effects of these inputs.

Manual water quality measurements:
Manual water quality measurements were also conducted along the 2.3-km reach of Alleman Creek on July 22, 2020. Water quality was measured using the multiparameter sonde every ~100 m. Grab samples were also collected every ~100 m and transported to the laboratory on ice for same-day analysis using the nitrate sensor.

Data files and data dictionary:
All data are in 6 tabs in one Excel file (.xlsx) file.

Tab 1: Clinch River
Tab 2: Walnut Creek
Tab 3: South Beaver Creek
Tab 4: Alleman Creek
Tab 5: Alleman Creek manual sampling
Tab 6: Alleman tile drain locations

Tab 1: Clinch River

Column	Heading	Units/ Format	Description	Measurement Method
1	DATE_TIME	YYYYMMDD HH:MM	Measurement date and time.	
2	LAT_DD	Decimal degrees	Latitude of water quality measurement in decimal degrees (WGS84).	GPS unit on AquaBOT (AtlasLink GNSS Smart Antenna, Hemisphere GNSS, Inc.)
3	LONG_DD	Decimal degrees	Longitude of water quality measurement in decimal degrees (WGS84).	GPS unit on AquaBOT (AtlasLink GNSS Smart Antenna, Hemisphere GNSS, Inc.)
4	DISTANCE_M	m	Distance of water quality measurement relative to the most upstream measurement site.	Estimated in GIS.
5	TEMP_DEG_C	°C	Water temperature.	Temperature sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
6	COND_US/CM	µS/cm	Conductivity.	Conductivity sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
7	SP_COND_U	µS/cm	Specific conductivity.	Conductivity sensor on multiparameter sonde

Column	Heading	Units/Format	Description	Measurement Method
		S/CM		on AquaBOT (EXO1, YSI Inc.)
8	TURB_FNU	FNU	Turbidity.	Turbidity sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
9	CHL_MG/L	mg/L	Chlorophyll concentration.	Total algae sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
10	DO_%SAT	% saturation	Dissolved oxygen in percentage saturation.	Dissolved oxygen sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
11	DO_MG/L	mg/L	Dissolved oxygen concentration.	Dissolved oxygen sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
12	NO3_MG_N/L	mg N/L	Nitrate-N concentration.	5 mm nitrate sensor on AquaBOT (ecoN, OTT HydroMet.)

Tab 2: Walnut Creek

Column	Heading	Units/Format	Description	Measurement Method
1	DATE_TIME	YYYYMMDD HH:MM	Measurement date and time.	
2	LAT_DD	Decimal degrees	Latitude of water quality measurement in decimal degrees (WGS84).	GPS unit on AquaBOT (AtlasLink GNSS Smart Antenna, Hemisphere GNSS, Inc.)
3	LONG_DD	Decimal degrees	Longitude of water quality measurement in decimal degrees (WGS84).	GPS unit on AquaBOT (AtlasLink GNSS Smart Antenna, Hemisphere GNSS, Inc.)
4	DISTANCE_M	m	Distance of water quality measurement relative to the most upstream measurement site.	Estimated in GIS.
5	TEMP_DEG_C	°C	Water temperature.	Temperature sensor on on multiparameter sonde AquaBOT (EXO1, YSI Inc.)
6	COND_US/CM	µS/cm	Conductivity.	Conductivity sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
7	SP_COND_US/CM	µS/cm	Specific conductivity.	Conductivity sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
8	DO_%SAT	% saturation	Dissolved oxygen in percentage saturation.	Dissolved oxygen sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
9	DO_MG/L	mg/L	Dissolved oxygen concentration.	Dissolved oxygen sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
10	PH	N/A	pH.	pH sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
11	NO3_MG_N/L	mg N/L	Nitrate-N concentration.	5 mm nitrate sensor on AquaBOT (ecoN, OTT HydroMet.)

Tab 3: South Beaver Creek

Column	Heading	Units/Format	Description	Measurement Method
1	DATE_TIME	YYYYMMDD HH:MM	Measurement date and time.	
2	LAT_DD	Decimal degrees	Latitude of water quality measurement in decimal degrees (WGS84).	GPS unit on AquaBOT (AtlasLink GNSS Smart Antenna, Hemisphere GNSS, Inc.)
3	LONG_DD	Decimal degrees	Longitude of water quality measurement in decimal degrees (WGS84).	GPS unit on AquaBOT (AtlasLink GNSS Smart Antenna, Hemisphere GNSS, Inc.)
4	DISTANCE_M	m	Distance of water quality measurement relative to the most upstream measurement site.	Estimated in GIS.
5	TEMP_DEG_C	°C	Water temperature.	Temperature sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
6	COND_US/CM	µS/cm	Conductivity.	Conductivity sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
7	SP_COND_US/CM	µS/cm	Specific conductivity.	Conductivity sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
8	TURB_FNU	FNU	Turbidity.	Turbidity sensor on multiparameter sonde on

Column	Heading	Units/Format	Description	Measurement Method
				AquaBOT (EXO1, YSI Inc.)
9	DO_%SAT	% saturation	Dissolved oxygen in percentage saturation.	Dissolved oxygen sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
10	DO_MG/L	mg/L	Dissolved oxygen concentration.	Dissolved oxygen sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
11	PH	N/A	pH.	pH sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
12	NO3_MG_N/L	mg N/L	Nitrate-N concentration.	5 mm nitrate sensor on AquaBOT (ecoN, OTT HydroMet.)

Tab 4: Alleman Creek

Column	Heading	Units/Format	Description	Measurement Method
1	DATE_TIME	YYYYMMDD HH:MM	Measurement date and time.	
2	LAT_DD	Decimal degrees	Latitude of water quality measurement in decimal degrees (WGS84).	GPS unit on AquaBOT (AtlasLink GNSS Smart Antenna, Hemisphere GNSS, Inc.)
3	LONG_DD	Decimal degrees	Longitude of water quality measurement in decimal degrees (WGS84).	GPS unit on AquaBOT (AtlasLink GNSS Smart Antenna, Hemisphere GNSS, Inc.)
4	DISTANCE_M	m	Distance of water quality measurement relative to the most upstream measurement site.	Estimated in GIS.
5	TEMP_DEG_C	°C	Water temperature.	Temperature sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
6	COND_US/CM	µS/cm	Conductivity.	Conductivity sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
7	SP_COND_US/CM	µS/cm	Specific conductivity.	Conductivity sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
8	CHL_MG/L	mg/L	Chlorophyll concentration.	Total algae sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
9	DO_%SAT	% saturation	Dissolved oxygen in percentage saturation.	Dissolved oxygen sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
10	DO_MG/L	mg/L	Dissolved oxygen concentration.	Dissolved oxygen sensor on multiparameter sonde on AquaBOT (EXO1, YSI Inc.)
11	NO3_MG_N/L	mg N/L	Nitrate-N concentration.	5 mm nitrate sensor on AquaBOT (ecoN, OTT HydroMet.)

Tab 5: Alleman Creek Manual Sampling

Column	Heading	Units/Format	Description	Measurement Method
1	DATE_TIME	YYYYMMDD HH:MM	Measurement date and time.	
2	LAT_DD	Decimal degrees	Latitude of water quality measurement in decimal degrees (WGS84).	Hand-held GPS unit.
3	LONG_DD	Decimal degrees	Longitude of water quality measurement in decimal degrees (WGS84).	Hand-held GPS unit.
4	DISTANCE_M	m	Distance of water quality measurement relative to the most upstream measurement site (from the Alleman Creek AquaBOT run on 6/3/20).	Estimated in GIS.
5	TEMP_DEG_C	°C	Water temperature.	Temperature sensor on multiparameter sonde (EXO1, YSI Inc.); measured in-situ.
6	SP_COND_US/CM	µS/cm	Specific conductivity.	Conductivity sensor on multiparameter sonde (EXO1, YSI Inc.); measured in-situ.
7	TURB_FNU	FNU	Turbidity.	Turbidity sensor on multiparameter sonde (EXO1, YSI Inc.); measured in-situ.
8	CHL_MG/L	mg/L	Chlorophyll concentration.	Total algae sensor on multiparameter sonde

Column	Heading	Units/ Format	Description	Measurement Method
				(EXO1, YSI Inc.); measured in-situ.
9	DO_%SAT	% saturation	Dissolved oxygen in percentage saturation.	Dissolved oxygen sensor on multiparameter sonde (EXO1, YSI Inc.); measured in-situ.
10	DO_MG/L	mg/L	Dissolved oxygen concentration.	Dissolved oxygen sensor on multiparameter sonde (EXO1, YSI Inc.); measured in-situ.
11	NO3_MG_N/L	mg N/L	Nitrate-N concentration.	5 mm nitrate sensor (ecoN, OTT HydroMet.); measured in laboratory on grab samples.

Tab 6: Alleman Tile Drain Locations

Column	Heading	Units/ Format	Description	Measurement Method
1	TILE_ID		Tile drain ID (#1-26).	
2	LAT_DD	Decimal degrees	Latitude of tile drain outlet in decimal degrees (WGS84).	Hand-held GPS unit.
3	LONG_DD	Decimal degrees	Longitude of tile drain outlet in decimal degrees (WGS84).	Hand-held GPS unit.
4	DISTANCE_M	m	Distance of tile drain measurement relative to the most upstream measurement site (from the Alleman Creek AquaBOT run on 6/3/20).	Estimated in GIS.

Associated manuscript:

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