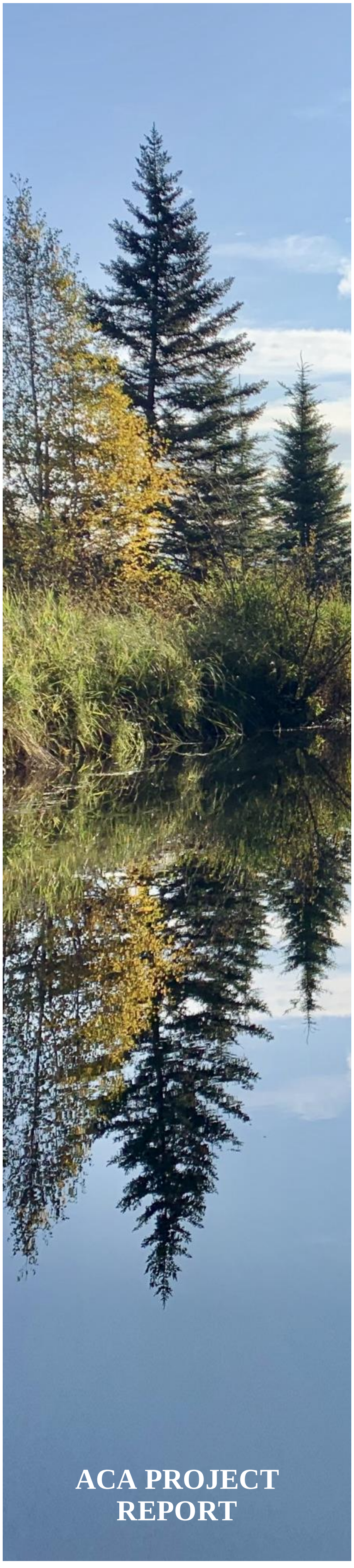

Temperature and Dissolved Oxygen Conditions of Callum Creek, Alberta, 2021–2022

Alberta Conservation Association

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Temperature and Dissolved Oxygen Conditions of Callum Creek, Alberta, 2021–2022

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EXECUTIVE SUMMARY

With genetically pure populations currently occupying only 5% of their historical range in Alberta and the species listed as *Threatened* under the *Species at Risk Act*, restoring and expanding pure westslope cutthroat trout *(Oncorhynchus clarkii lewisi)* (WSCT) populations is critical to safeguard against extirpation. Based on the current and historical presence of WSCT, the Callum Creek watershed in southwestern Alberta was identified as suitable for potential WSCT restoration and expansion. From spring 2021 until spring 2022, we monitored temperature and dissolved oxygen (DO) levels at ten locations in the Callum Creek watershed to determine if DO and stream temperature levels were limiting factors for WSCT distribution and survival.

Summer temperatures in the Callum Creek mainstem in 2021 were unsuitably high for WSCT for periods ranging from one to three consecutive weeks. Mean daily stream temperatures at all sampling locations in the Callum Creek mainstem exceeded WSCT thermal tolerance levels. However, tributaries to Callum Creek may provide summer thermal refuge for WSCT, as temperatures within tributary sampling sites remained largely within their tolerance range. In contrast, winter DO measurements in the mainstem and one tributary remained above the minimum threshold level for WSCT, suggesting that overwintering oxygen conditions may not be a limiting factor for WSCT survival and distribution within the Callum Creek watershed.

Key words: westslope cutthroat trout, Callum Creek, stream temperature, dissolved oxygen.

ACKNOWLEDGEMENTS

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1.0 INTRODUCTION

Genetically pure populations of westslope cutthroat trout *(Oncorhynchus clarkii lewisi)* (WSCT) currently occupy only 5% of their historical range in Alberta (Alberta Westslope Cutthroat Trout Recovery Team 2013), and the species is currently listed as *Threatened* under the federal *Species at Risk Act* (Fisheries and Oceans Canada 2019). Restoring and expanding pure WSCT populations is critical to safeguard against extirpation. Through discussions with various stakeholders involved with the Native Trout Recovery Program, Callum Creek was identified as a candidate for WSCT range expansion (C. Johnson, pers. comm.). Historical angling photos suggest WSCT were once abundant in the Callum Creek watershed, but they are now restricted to isolated pockets in the upper headwater reaches, with pure strain populations being restricted to small high elevation pockets of spring-fed streams originating in the Porcupine Hills (Fisheries and Oceans Canada 2019).

Two key factors likely to influence WSCT range expansion potential in Callum Creek include the availability of suitable stream temperature and overwintering potential. Winter dissolved oxygen (DO) has been documented as a limiting factor for winter salmonid survival (Norris 2012). Westslope cutthroat trout require DO concentrations of 3.5 mg/L and above to survive (AEP 1997, CCME 1999). Summer stream temperature suitability for westslope cutthroat trout is limited by an upper incipient lethal temperature of 19.7 °C (95% CI: 19.1–20.3ºC; Bear et al. 2005).

From spring 2021 until spring 2022, we conducted stream temperature and DO surveys throughout the Callum Creek watershed to determine if either were a limiting factor for WSCT survival and distribution.

2.0 STUDY AREA

The Callum Creek watershed is a major contributing tributary to the Oldman River in southwestern Alberta, situated immediately adjacent to Alberta's largest remaining WSCT core area. Pure strain WSCT populations are thought to be restricted to Playle Creek and upper Sharples Creek, small spring-fed tributaries originating on the western slopes of the Porcupine Hills (Figure 1). Callum Creek is a Hydrologic Unit Code 10 watershed with a catchment area of 21,560 ha, and a mainstem that is approximately 44 km in length. Originating along the eastern slopes of the Rocky Mountains and the spring-fed Porcupine Hills, the creek flows through the forests of the Montane Natural Subregion and the Foothills Fescue Subregion (Natural Regions Committee 2006) before entering the Oldman River mainstem approximately 24 km upstream of the Oldman Dam, and 92 km west of the City of Lethbridge (49°7'N, 114°1'W). Much of the watershed is located on the Waldron Grazing Cooperative, the largest block (65,000 acres) of deeded land along the eastern slopes of the Rocky Mountains of Alberta.

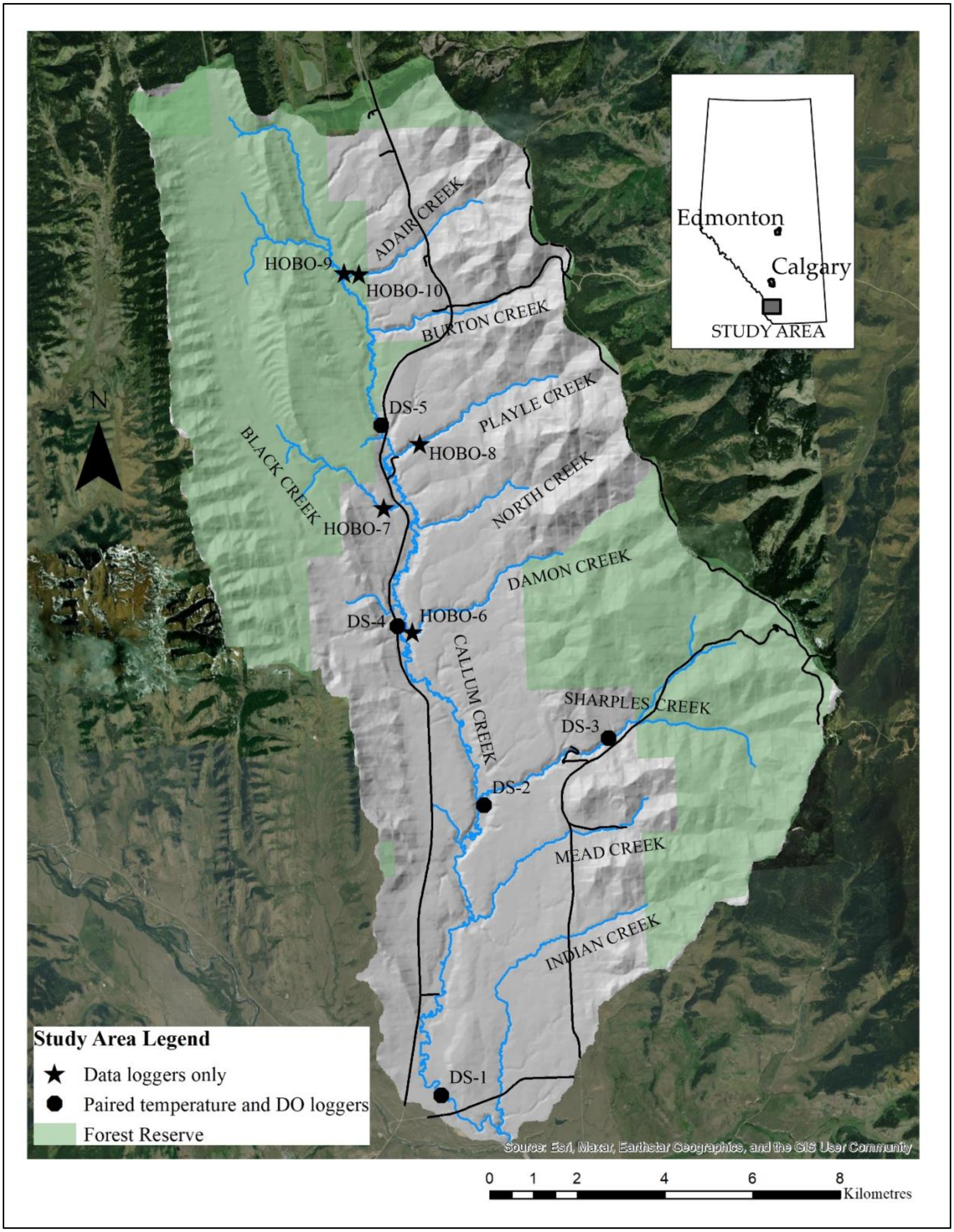

Figure 1. Stream temperature and dissolved oxygen (DO) monitoring locations in the Callum Creek watershed, May 2021 to March 2022. Inset map shows the study area within the province of Alberta.

3.0 MATERIALS AND METHODS

From May 2021 to March 2022, we monitored stream temperature and DO throughout the Callum Creek watershed. Using a combination of geographical information system (GIS), satellite imagery from Google Earth, and local knowledge, we established ten monitoring stations in the Callum Creek watershed, based on summer and winter access and the presence of potential overwintering pools with riffle sections. In spring 2021, we installed PME minidot datasondes (DS) paired with HOBO temperature loggers at four locations on the Callum Creek mainstem and one location on Sharples Creek (Figure 1, Appendix 1); the datasondes measured both DO and temperature, while the HOBO temperature loggers measured temperature only. We installed an additional five HOBO temperature loggers on Damon Creek, Black Creek, Playle Creek, Adair Creek and upper Callum Creek (Figure 1, Appendix 1), all of which monitored temperature at one-hour intervals. In November 2021, we removed the five lone HOBO temperature loggers before freeze-up but left the remaining five that were paired with datasondes over winter (Figure 1). The remaining loggers were cleaned before winter sampling.

In addition, from November 2021 until spring thaw 2022, we conducted biweekly DO and temperature measurements using a hand-held YSI (PRO Plus) at the five paired datasonde/HOBO temperature logger locations, as a contingency measure against datasonde fouling, freezing, or malfunction. At each location, we drilled a hole through the ice and took readings for both DO and temperature. Most locations had an under-ice water depth of less than 0.5 m and were suitable for only one reading (Appendix 1). For analyses, we excluded periods where datasondes were fouled or frozen.

We affixed datasondes and HOBO temperature loggers to T-bar posts, which were pounded into the streambed. Where anchor points did not exist, we post-pounded 90-cm sections of T-bar into the streambank for anchoring. For safety reasons, we covered the exposed portion of T-bars with a rubber protector. Datasondes were encased in 10-cm diameter flow-through ABS containers and affixed to the T-bar with quick links and secured in place with heavy duty, 160-pound break-strength, 35-cm cold-weather zip ties. We anchored datasondes and cases to anchor points (i.e., tree-trunk, bridge-piling, or T-bar posts) using 0.8-mm diameter airplane cable and u-clamps. We installed datasondes mid-way up the water column to avoid exposure to streambed sediments, sinking debris, surface ice, or floating debris.

We calculated the daily mean, maximum, and minimum stream temperature for each HOBO temperature logger, and the daily mean DO for each datasonde. We compared our DO results to the threshold required for WSCT survival. We compared our temperature results to the upper incipient lethal temperature (UILT) for WSCT, and determined how long DO and temperature stayed above or below these thresholds (Appendix 2). We compared datasonde and YSI measurements as a quality control measure, and to assess reliability of both methods (Appendix 3 and 4).

4.0 RESULTS

4.1 Summer temperature conditions

Of the ten monitoring locations, all five on the Callum Creek mainstem exceeded UILT for WSCT for 12–45 days in total, and 8–26 days consecutively (Table 1, Figure 2, Appendix 2). In contrast, four of the five tributary locations remained below UILT for trout, with only Black Creek exceeding trout tolerances for six consecutive days (Table 1, Figure 2, Appendix 2). Two locations (HOBO-1, HOBO-10) recorded maximum stream temperatures over 30ºC (Appendix 2).

During summer months, datasondes recorded slightly higher temperatures than the HOBO temperature loggers at the same locations (Table 1). This is likely due to their position in the middle of the water column compared to the HOBO temperature loggers that were affixed closer to the streambed. Stream temperature readings remained generally consistent between the three methods (datasondes, dataloggers, and YSI unit), but some variation did occur, especially during the December 2 sampling event (Appendix 5).

Table 1. Number of days mean daily temperature exceeded upper incipient temperature thresholds for WSCT in the Callum Creek watershed, summer 2021.

Waterbody	Instrument ID	# Days average temperature exceeded 19.7°C	
		Total	Consecutive
Callum Creek	DS - 1	45	26
	HOBO - 1	40	26
Callum Creek	DS - 2	32	14
	HOBO - 2	30	14
Callum Creek	DS - 4	31	14
	HOBO - 4	30	14
Callum Creek	DS - 5	25	8
	HOBO - 5	19	8
Callum Creek	HOBO -10	12	8
Black Creek	HOBO - 7	6	6
Sharples Creek	DS - 3	0	0
	HOBO - 3	0	0
Damon Creek	HOBO - 6	0	0
Playle Creek	HOBO - 8	0	0
Adair Creek	HOBO - 9	0	0

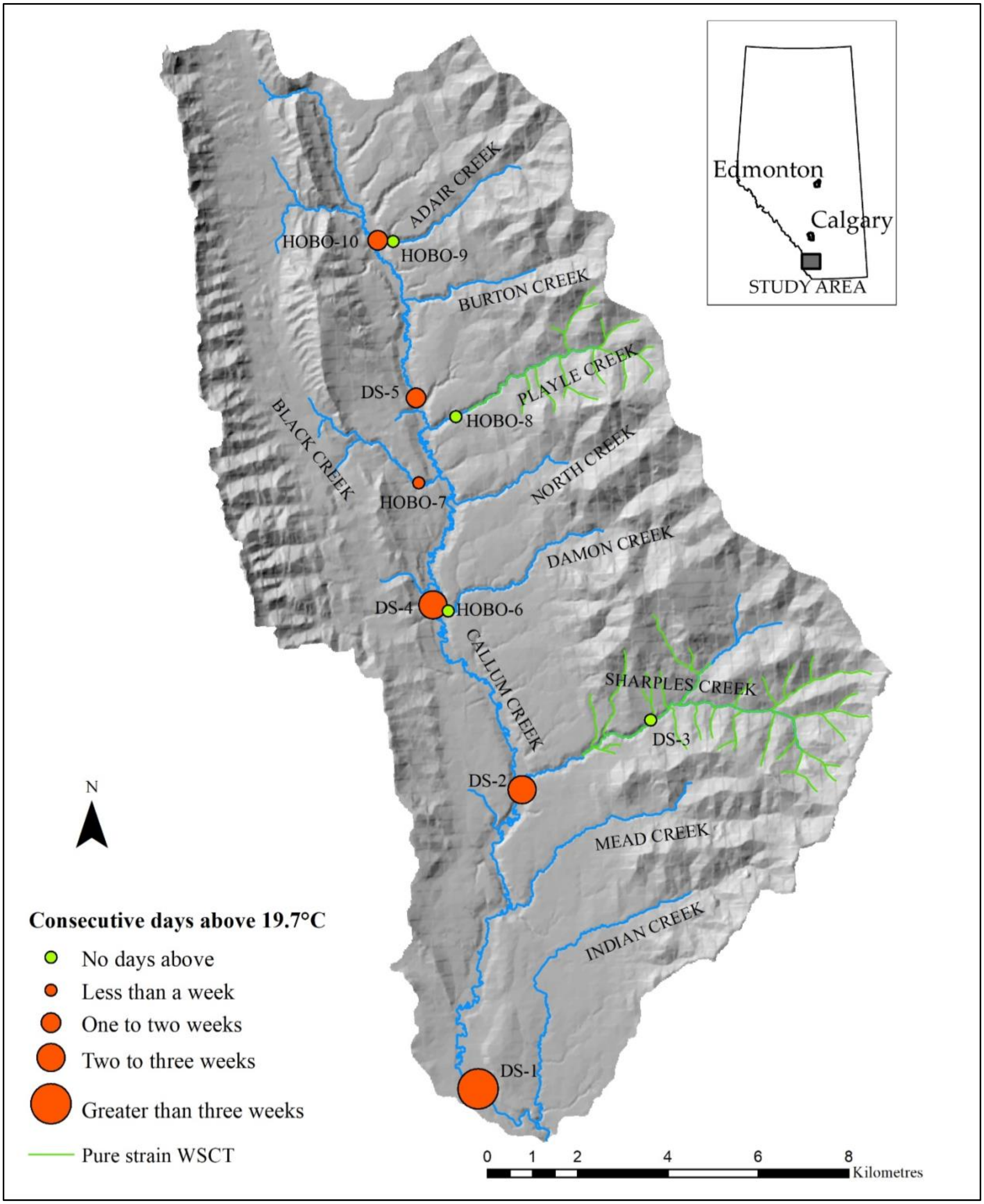

Figure 2. Number of consecutive days datasondes recorded temperatures above the daily mean upper incipient threshold for westslope cutthroat trout on Callum Creek, May 2021 to March 2022.

4.2 Dissolved oxygen conditions

As a result of datasonde fouling in summer or complete site freeze up during winter, reliable data were obtained from only two datasondes (DS-3 winter only and DS-4 summer and winter). Therefore, data from these two sites are discussed in greater detail than others.

Only DS-4 recorded consistent data during summer sampling (Appendix 3). The DS-4 station was near the confluence of Damon Creek, below a mid-stream woody obstruction that provided slight riffle turbulence and reliable DO data for the entire sampling duration. This location remained above 3.5 mg/L threshold from May 2021 until ice-off in spring 2022 (Appendix 3). The DS-3 station recorded stable and consistent DO readings from November until it was removed in April 2022, but also experienced occasional fouling during the summer months. The stable winter readings at DS-3 are likely due to the logger location, as it was installed downstream of a large beaver dam on Sharples Creek that provided consistent, ice-free flow. Datasondes at stations DS-1, DS-2, and DS-5 either fouled immediately after install, intermittently throughout summer deployment, or froze sporadically during the winter; therefore, these data were deemed not reliable enough to draw any solid conclusions.

All bi-weekly YSI readings at all stations recorded during the winter sampling period remained above the 3.5 mg/L threshold (Appendix 4). Except for one station (DS-1) that had no flow during December, all stations had suitable sampling conditions and readings were recorded (Appendix 4). No sampling occurred in January due to extreme weather events and poor driving conditions. There was a good match between datasonde and YSI DO measurements, with an R^2 value of 0.89 (Appendix 6); we omitted several outliers from the analysis that were likely recorded during times of no flow or when datasondes were frozen.

5.0 SUMMARY

Summer temperatures in the Callum Creek mainstem in 2021 were unsuitable for WSCT for periods ranging from one to three consecutive weeks due to high stream temperatures. Mean daily stream temperatures at all sampling locations in the Callum Creek mainstem exceeded WSCT thermal tolerance levels. However, some tributaries to Callum Creek may provide summer thermal refuge for WSCT. For example, Playle and Sharples creeks, which are known to support WSCT populations, remained largely within temperature tolerance ranges. Damon and Adair creeks also remained suitable; however, WSCT presence in those tributaries is unknown. Winter DO remained above minimum threshold levels in the mainstem and one tributary suggesting that overwintering oxygen condition may not be a limiting factor for WSCT survival and distribution within the Callum Creek watershed.

Identifying datasonde install locations for winter monitoring was a challenge in Callum Creek. We observed site-specific freezing at all winter locations and periods of no flow at DS-1. Avoiding wide gravel bars where multiple channels are present, and where hyporheic flow may be more common may result in more consistent winter data collection. Monthly visits to datasonde locations during summer months to inspect and clean sensors may provide more accurate data.

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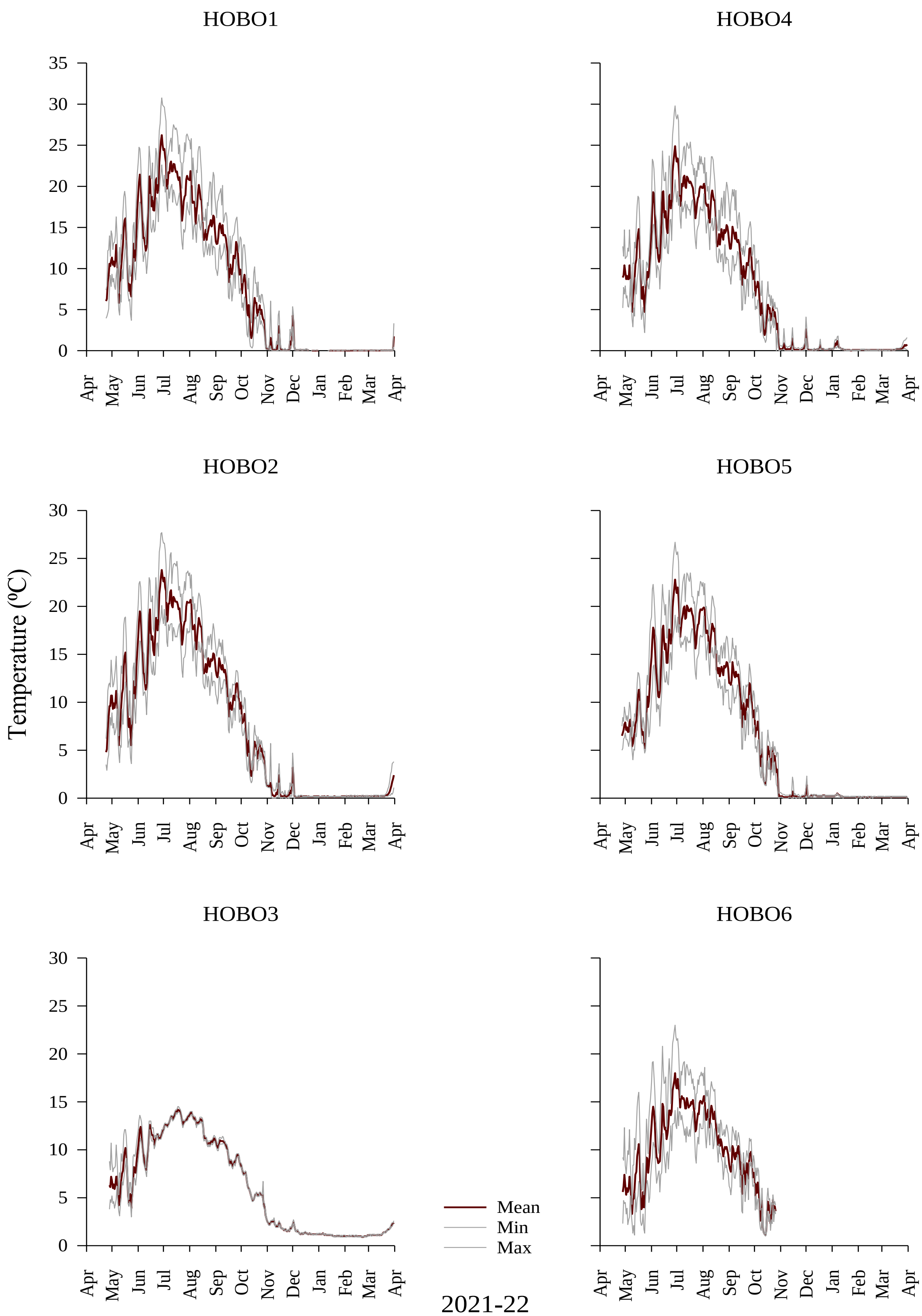
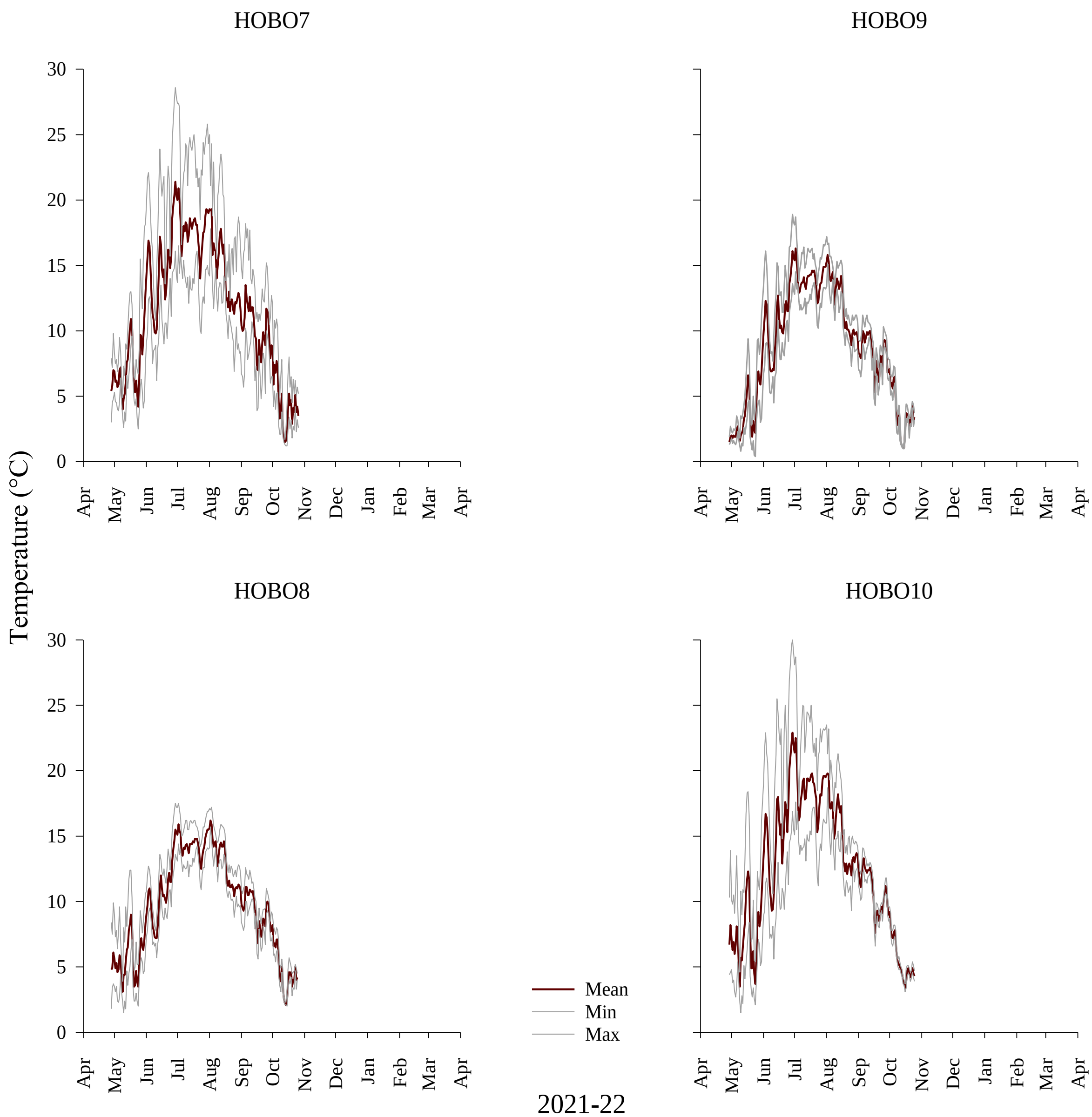
7.0 APPENDICES

Appendix 1. Callum Creek datasonde, temperature logger, and YSI sampling locations, 2021–2022.

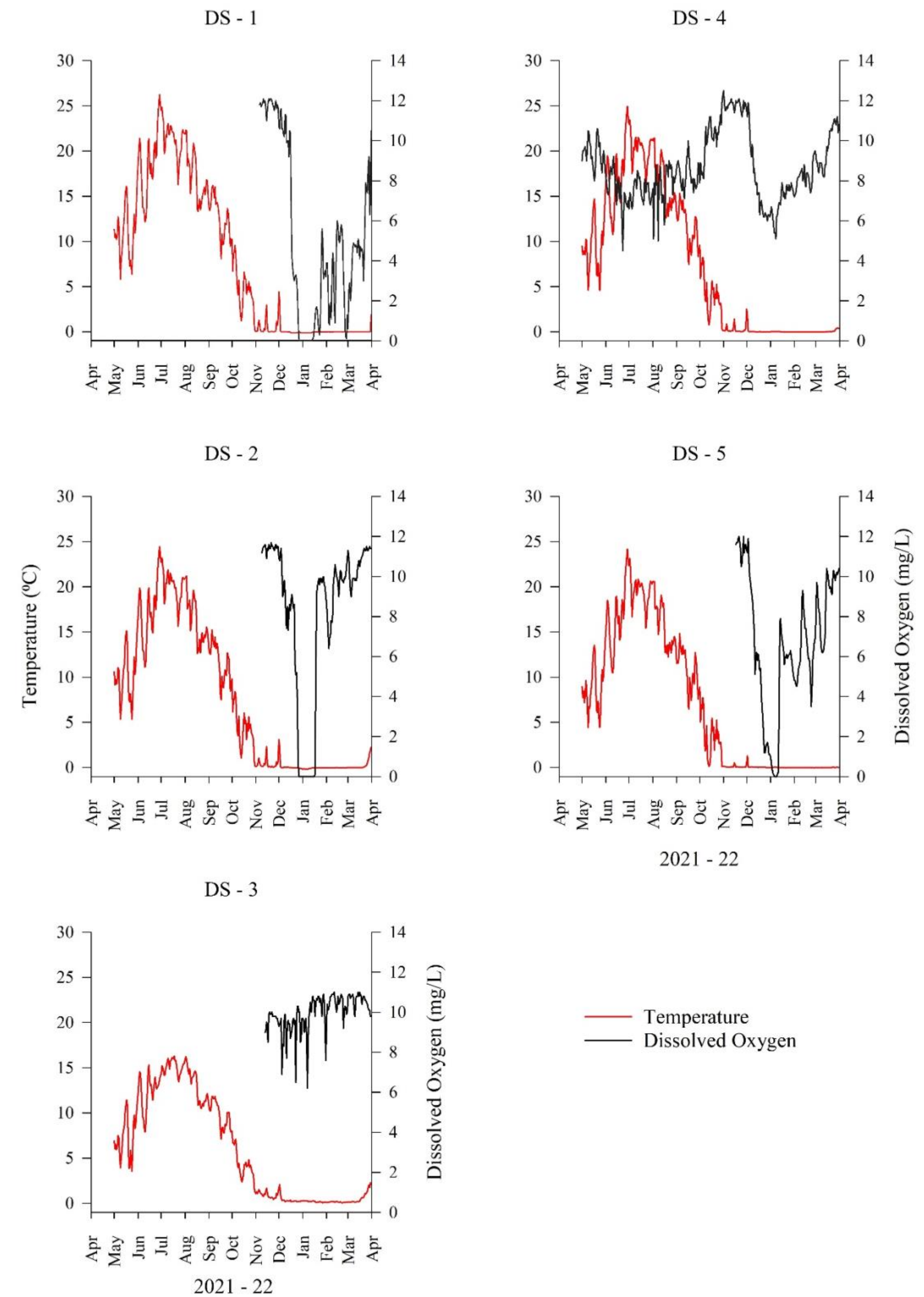
Waterbody	Station ID	Equipment			NAD 83 Zone	Easting	Northing
Callum Creek	DS-1 & HOBO-1	Datasonde	HOBO temperature Logger	YSI	11 U	706091	5521034
Callum Creek	DS-2 & HOBO-2	Datasonde	HOBO temperature Logger	YSI	11 U	707066	5527658
Sharples Creek	DS-3 & HOBO-3	Datasonde	HOBO temperature Logger	YSI	11 U	709914	5529198
Callum Creek	DS-4 & HOBO-4	Datasonde	HOBO temperature Logger	YSI	11 U	705096	5531749
Callum Creek	DS-5 & HOBO-5	Datasonde	HOBO temperature Logger	YSI	11 U	704717	5536337
Damon Creek	HOBO-6	HOBO temperature Logger			11 U	705432	5531620
Black Creek	HOBO-7	HOBO temperature Logger			11 U	704779	5534453
Playle Creek	HOBO-8	HOBO temperature Logger			11 U	705599	5535917
Adair Creek	HOBO-9	HOBO temperature Logger			11 U	704210	5539797
Callum Creek	HOBO-10	HOBO temperature Logger			11 U	703870	5539824

Appendix 2. Daily mean, minimum, and maximum stream temperature collected by ten HOBO data loggers in Callum Creek drainage, May 2021 to March 2022.

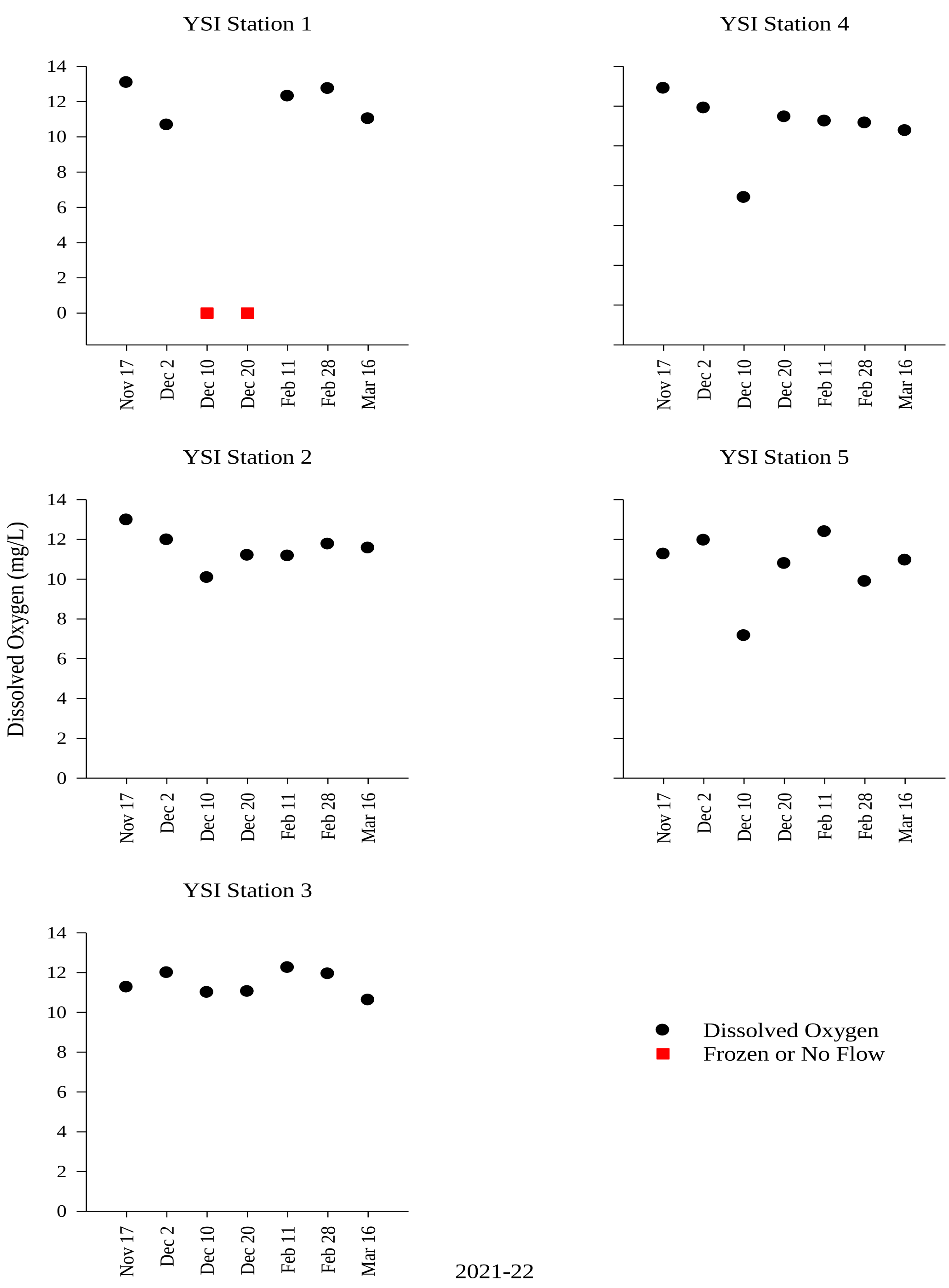



HOBO7
HOBO9
HOBO8
HOBO10
Temperature (°C)
30
25
20
15
10
5
0
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
Mean
Min
Max
2021-22

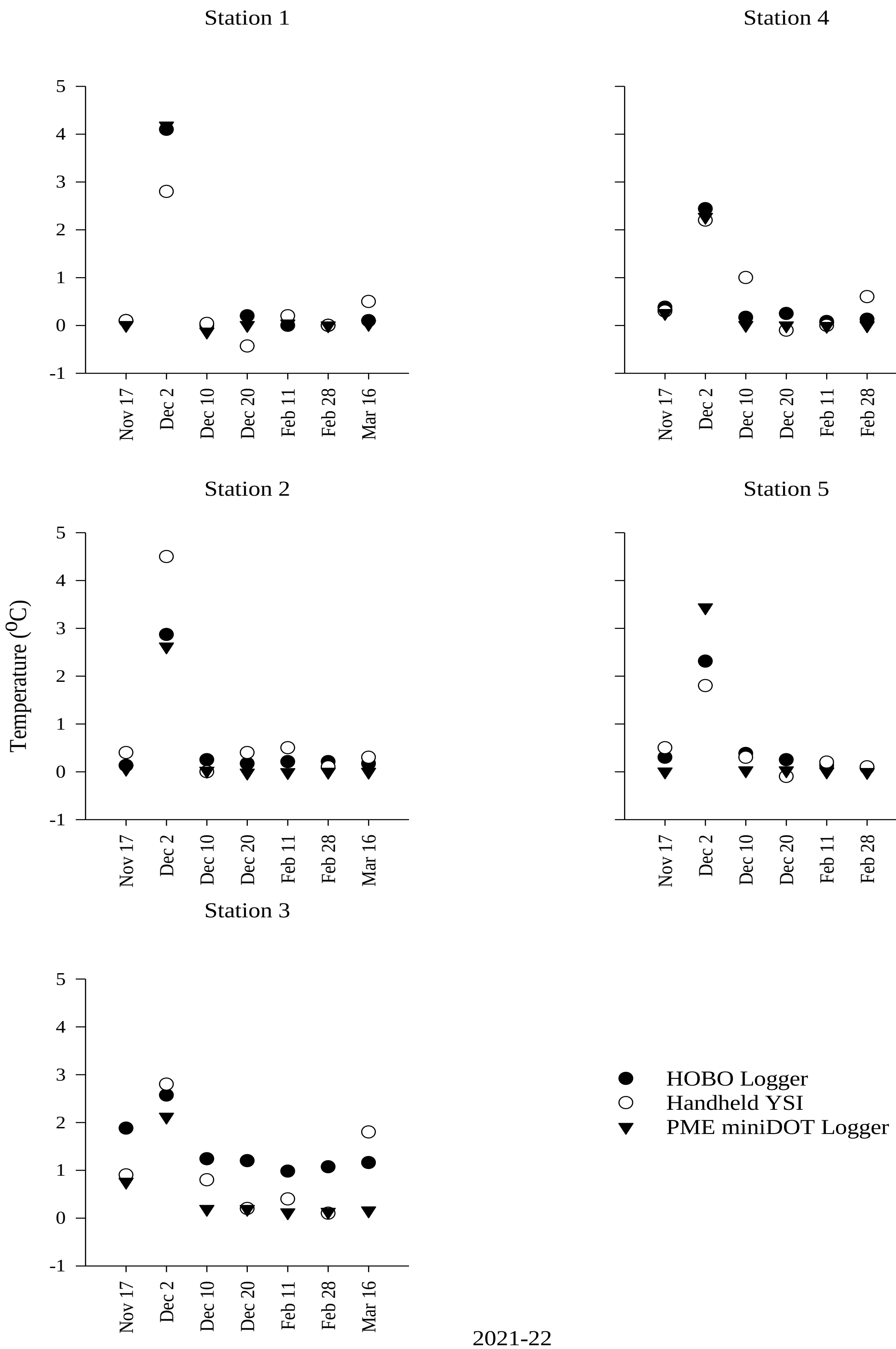
Appendix 3. Daily mean stream temperature and dissolved oxygen concentrations collected by datasondes in Callum Creek drainage, May 2021 to March 2022.



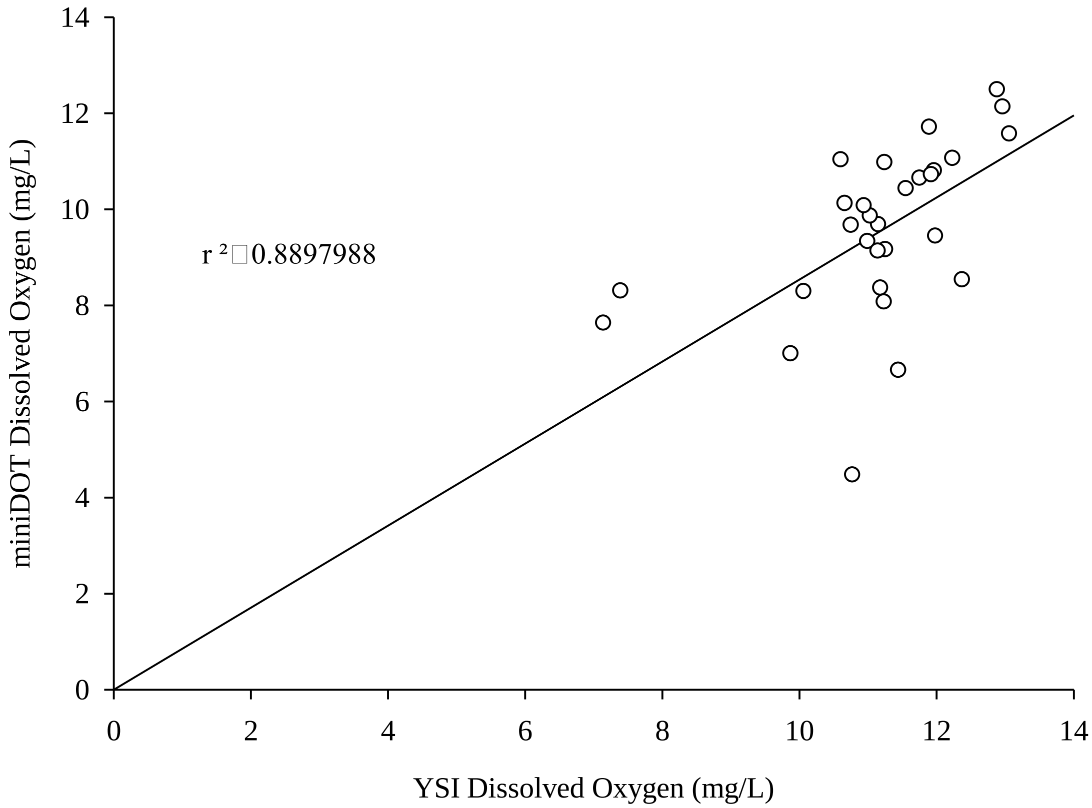
Appendix 4. YSI winter dissolved oxygen concentrations in Callum Creek drainage from November 2021 to April 2022.



Appendix 5. Comparison of datasonde (PME miniDOT logger), HOBO datalogger, and YSI stream temperature readings in Callum Creek drainage from November 2021 to April 2022.



Appendix 6. Relationship between datasondes (PME miniDOT) and hand-held YSI measurements of dissolved oxygen on Callum Creek, November 2021 to March 2022.



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