



Lindis River low flow investigations

Part B: Water temperature

June 2017



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Prepared for the Lindis Catchment Group

by

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1. Background

The effect of surface flow and groundwater inputs on water temperature in the Lindis River has been an issue previously assessed (Dale & Olsen 2016¹). Temperature is a fundamental factor affecting all aspects of stream systems. It can affect fish populations directly by influencing survival, growth, spawning, egg development and migration, and indirectly through effects on physicochemical conditions and food supplies (Olsen *et al.*, 2012²).

Dale & Olsen (2016) concluded that Lindis River temperature monitoring, undertaken over the 2014/15 irrigation season, suggested that the suitability of the reach from the Lindis Crossing to the Clutha River confluence for trout is likely to be limited during warmer months (December-March) due to higher water temperatures. They further concluded that maintenance of flow connectivity, sufficient for juvenile trout to move upstream and downstream to refuge habitats such as the perennially flowing reach in the vicinity of the Ardgour Road hydrological site, and the Clutha River, is a key consideration when setting an appropriate minimum flow.

Temperature loggers at flow monitoring sites have been deployed in the Lindis River by the Otago Regional Council for a number of years now. The sites include:

- Clutha confluence.
- Lindis Crossing (SH8 bridge).
- Ardgour Road bridge.
- Rutherfords.

As a part of the recent low flow investigations and the critical riffle analysis for fish passage (refer to the Part A report), I deployed additional temperature loggers at the following sites:

- LT1: Lower Lindis critical riffle T1 (approximately 60-70 metres from the Clutha River confluence). Deployed 24 February 2017.
- LT Main: Lower Lindis pool between critical riffle T2 and T3. Deployed 14 December 2016.
- LT3: Lower Lindis critical riffle T3 (or more correctly 150 metres upstream of the start of the T3 transect). Deployed 24 February 2017.
- LGL: Lindis Gaining Reach – Lower (or bottom) site (45 metres downstream of the start of the transect). Deployed 24 February 2017.

¹ Dale, M. & Olsen, D. 2016. Update of scientific work in the Lindis catchment: 2008-2015. Otago Regional Council.

² Olsen, D., Tremblay L., Clapcott J., & Holmes R. 2012. Water temperature criteria for native aquatic biota. Auckland Council Technical Report 2012/036.

- AT1: Ardgour Road Bridge Reach critical riffle T1 (50 metres upstream of the start of the transect). Deployed 24 February 2017.

In addition to these loggers, two temperatures loggers were deployed (15 December 2016 and 9 January 2017) to measure ambient air temperature in the Lower Lindis reach amongst poplars and willows (approximately 1.7 metres above ground level).

The locations of all temperature loggers are shown in Figure 1. Photos of some site are presented in Figures 2 to 8.

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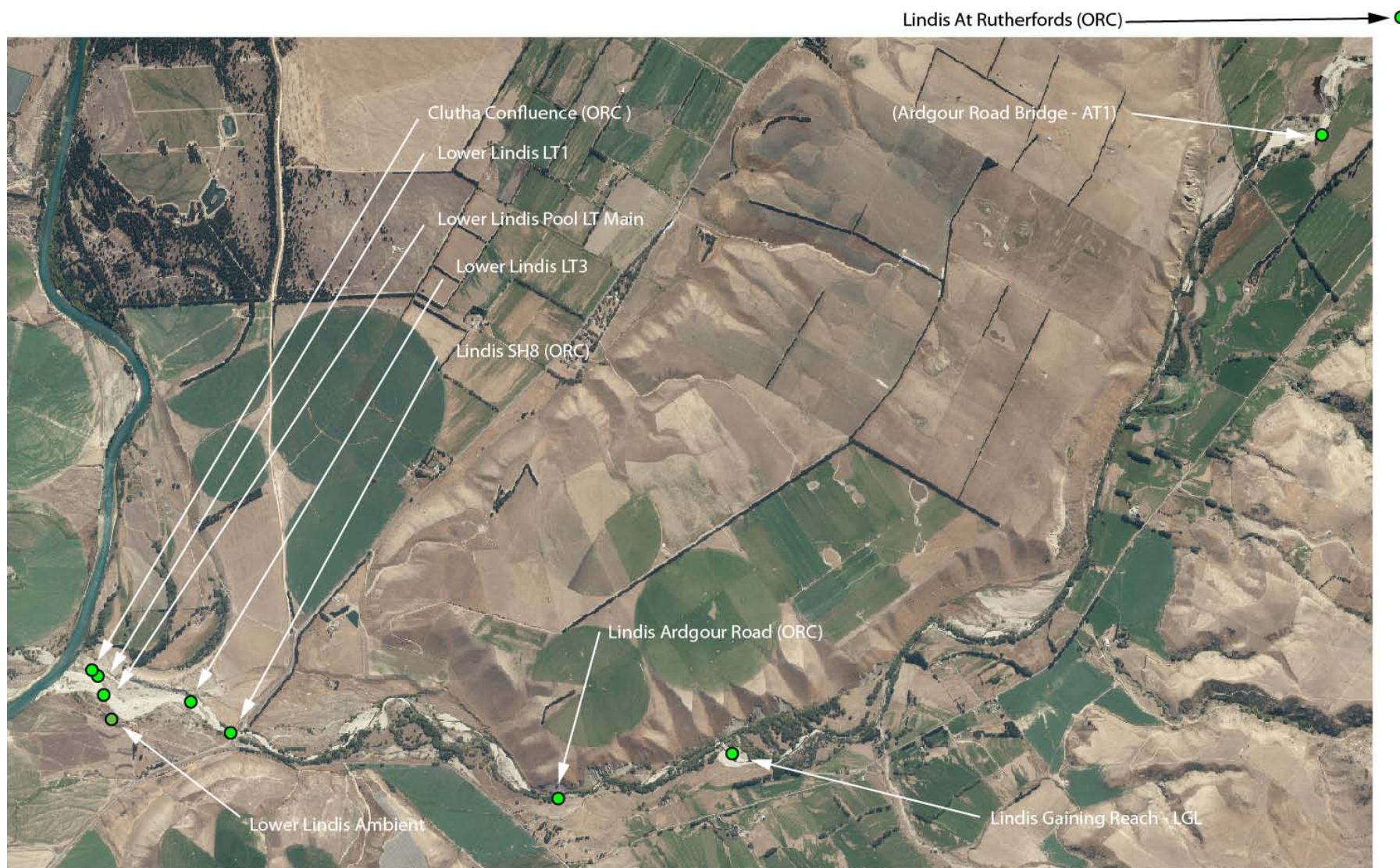


Figure 1. Lindis River and ambient temperature monitoring sites, December 2016 – April 2017.



Figure 2. LT1: Lower Lindis critical riffle T1. Top (24 February 2017). Logger deployed in water shaded by lupin bushes (red arrow). Bottom, site on 23 March 2017.



Figure 3. LT Main: Lower Lindis pool between critical riffle T2 and T3. 14 December 2016.



Figure 4. LT3 (150 metres upstream of the start of the T3 transect). Top, 24 February 2017. Bottom, 23 March 2017 during prolonged low flow event.



Figure 5. Gaining Reach LGL, 24 February 2017. Arrow indicates approximate position of logger.



Figure 6. Gaining Reach LGL, 23 March 2017 during prolonged low flow event. Arrow indicates approximate position of logger.



Figure 7. AT1: Ardgour Road Bridge Reach, dry, 23 March 2017 during prolonged low flow event. Arrow indicates approximate position of exposed logger.



Figure 8. Lower Lindis ambient temperature loggers (indicated by red arrows), 9 January 2017.

2. Methods

All temperature loggers were deployed within perforated PVC pipes for protection and to reduce the risk of direct exposure to sunlight, and placed in shaded or partially shaded locations (Figures 2 to 8). Data were downloaded at regular intervals, with final data being downloaded on 24 April 2017. The logger at LGL was lost following a fresh on 12 April 2017 (7.5 cumecs at Ardgour Road recorder). Data from it were downloaded on 23 March 2017.

Ambient air temperature, daily global radiation and daily sunshine hours data for the same period were also accessed from the Cromwell climate station.

We followed the approach outlined in Dale & Olsen (2016) for assessing temperature effects on fish and applied this the Otago Regional Council temperature monitoring data for the period October 2016 – March 2017 inclusive. Dale & Olsen (2016) noted that brown trout and rainbow trout are likely to be the fish that are most sensitive to high water temperatures in the Lindis River, and their thermal requirements are relatively well understood. Todd *et al.* (2008) calculated acute and chronic thermal criteria for both of these species, with acute criteria applied as the highest two-hour average water temperature measured within any 24-

hour period, while chronic criteria are expressed as the maximum weekly average temperature (Todd *et al.*, 2008).

Most native fish species are more tolerant of high temperatures than trout. Olsen *et al.* (2012) developed interim thermal criteria for native species for which there was sufficient information. No acute criteria are available for the native fish species present in the Lindis River, but chronic thermal criteria were available for longfin eels (34°C for adults, 28°C for elvers (juveniles)) and common bully (24°C in upland sites) (Olsen *et al.*, 2012).

3. Data presentation & analysis (to date)

Water and ambient temperature data, along with flow and climate data, are presented in Figures 9 to 16.

It is clear that some water temperature loggers became exposed on some occasions (Ardgour Road Bridge reach T1, Lower Lindis LT1 and the Otago Regional Council's Clutha Confluence logger).

Analysis of the regional council water temperature data found that temperatures at Rutherfords and Ardgour Road sites were suitable for rainbow trout, brown trout, longfin eels and common bullies throughout the period 1 October 2016 to 31 March 2017 (Table 1). Water temperatures at SH8 exceeded the chronic thermal criterion for rainbow trout on one day (18.4°C on 20 February 2017), but were suitable for all other species listed throughout the period (Table 1). The flow at the SH8 site on 20 February ranged from 0.434 to 0.642 m³/s (mean 0.588 m³/s).

At the Clutha confluence site water temperature data was only available for the period from 1 October 2016 to 26 January 2017, as this site went dry from 28 January. Thermal criteria were not exceeded for any species during this period (Table 1).

At the Ryder Lower Lindis Main site, water temperature data was available for the period from 14 December 2016 to 24 April 2017. Water temperatures at this site exceeded the chronic thermal criterion for rainbow trout on 8 days in late February and early March (19, 20, 21, 22, 24 and 28 February and 1 and 2 March), with the average daily temperature on these days exceeding 18.2°C. Chronic thermal criteria were met for all other species listed throughout the period (Table 1). Acute thermal criteria for rainbow trout were not met on six days, mostly again in the late February and early March period (20 and 28 February and 1, 2 and 10 March, and 2 April). Acute thermal criteria for brown trout were not met on three days (1 March, 2 March and 10 March). This period of data is presented in Figure 16 along with local ambient air temperature and river flows. Water temperatures at the Ryder Lower Lindis Main site appear to closely track ambient temperature (rather than flow) and visual observations of the logger between 22 – 27 February and again on 23 March indicated that it was submerged over this period.

Table 1. Summary of the number of days exceeding acute and chronic thermal criteria for the protection of rainbow and brown trout, eel and common bully at four sites in the Lindis River. Based on Otago Regional Council temperature monitoring data.

Monitoring site	Period	Maximum hourly temperature (°C)	Maximum daily average temperature (°C)	Number of days exceeding thermal criteria						
				Acute (maximum 2-hour average)		Chronic (weekly average)				
				Rainbow trout	Brown trout	Rainbow trout	Brown trout	Longfin eel (adult)	Longfin eel (elver)	Common bully
				23.8°C	24.6°C	18.2°C	19.6°C	30°C	28°C	24°C
Ryder Lindis Main	14/12/16 – 24/04/17	26.3 (28 Feb)	19.5 (1 Mar)	6	3	8	0	0	0	0
Rutherford's	1/10/16 – 31/03/17	21.5 (20 Feb)	17.5 (20 Feb)	0	0	0	0	0	0	0
Ardgour Road	1/10/16 – 31/03/17	19.5 (5 Dec)	16.3 (19, 20 Feb)	0	0	0	0	0	0	0
SH8	1/10/16 – 31/03/17	22.5 (20 Feb)	18.4 (20 Feb)	0	0	1	0	0	0	0
Clutha confluence	1/10/16 – 26/01/17	22.9 (30 Dec)	17.5 (30 Dec)	0	0	0	0	0	0	0

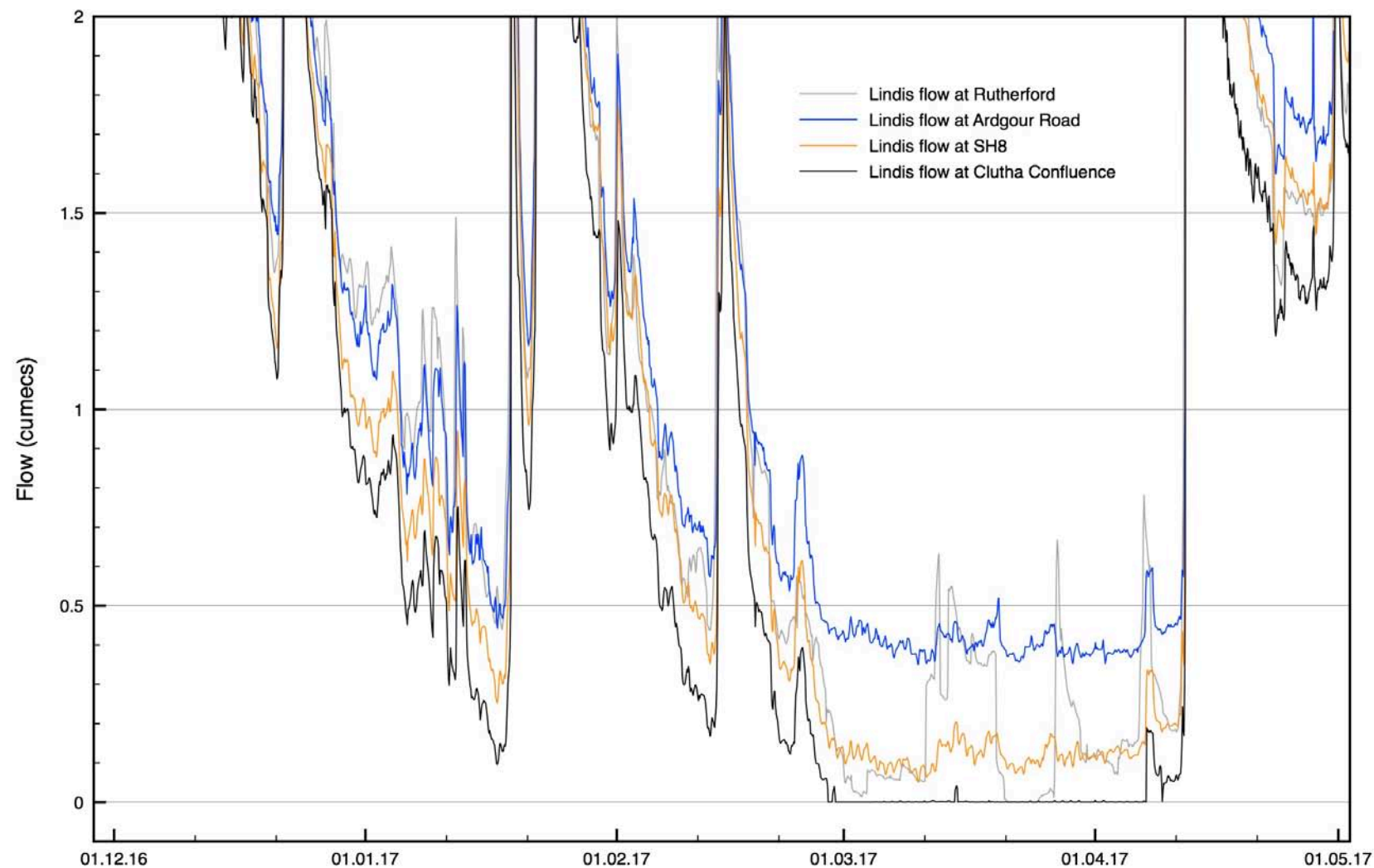


Figure 9. Lindis River Otago Regional Council flow data for December 2017 to May 2017.

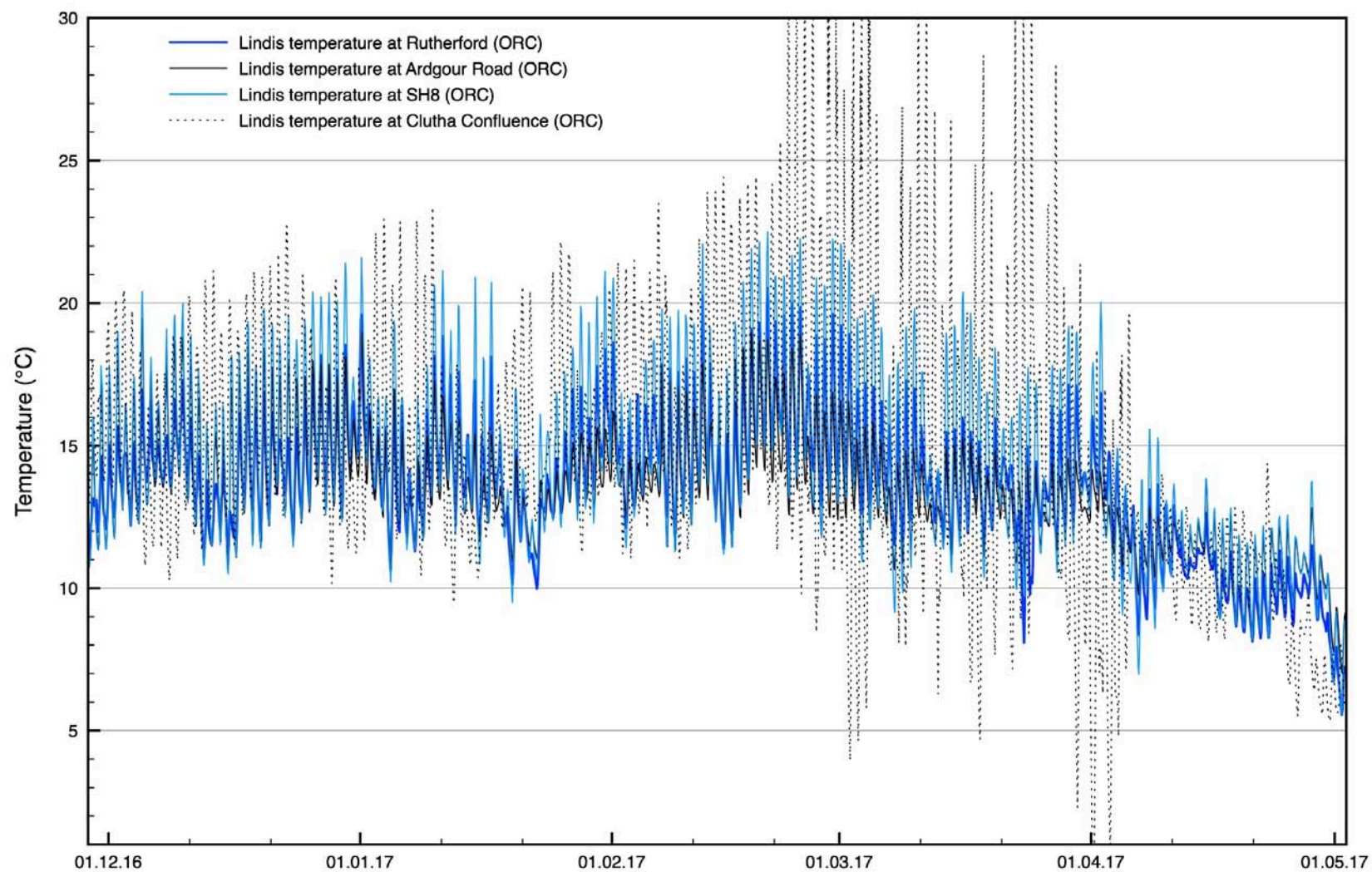


Figure 10. Lindis River temperatures. December 2016 – May 2017. Data from Otago Regional Council loggers. Clutha confluence logger often exposed from late February to late March.

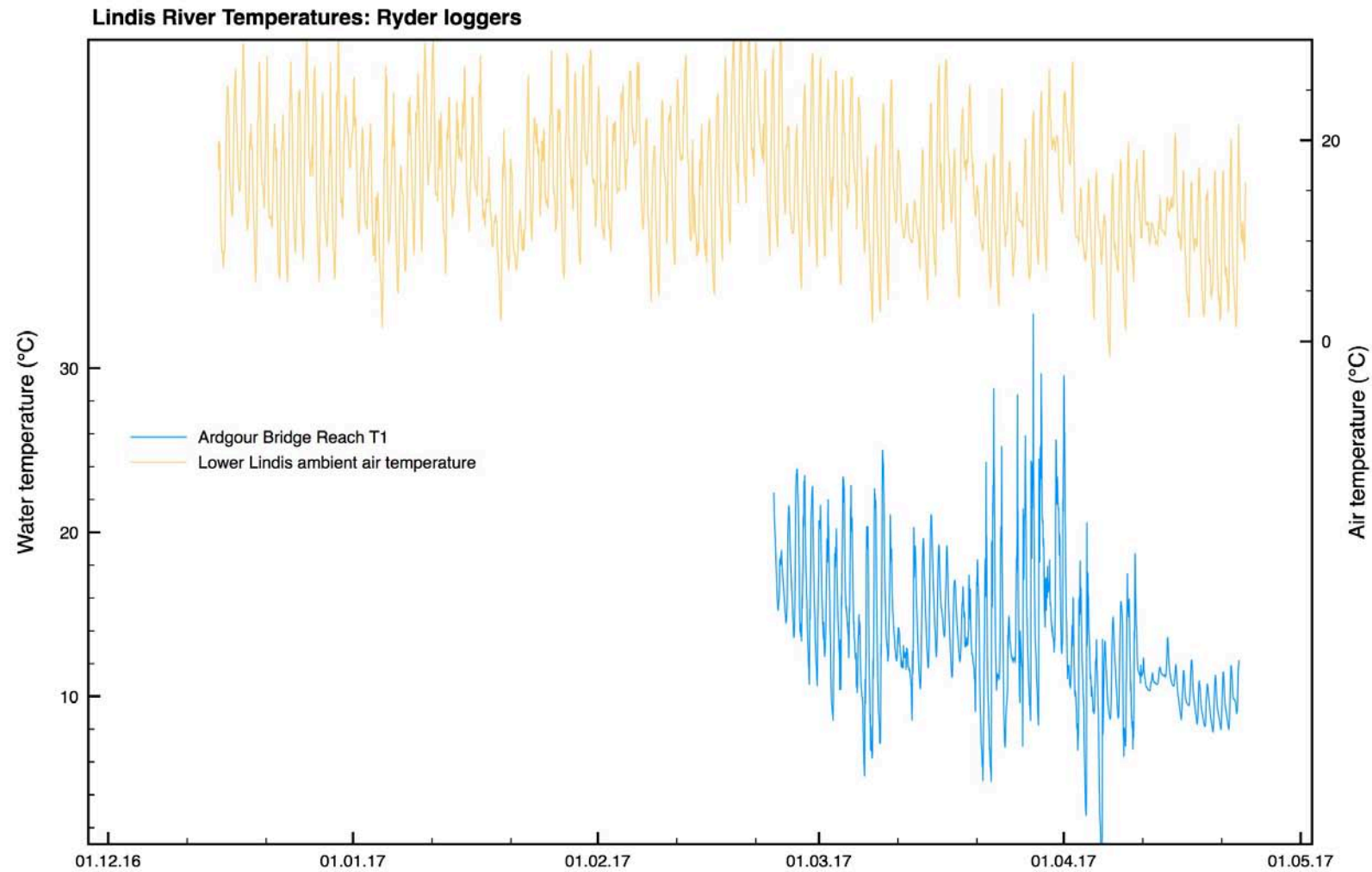


Figure 11. Lindis River temperatures at Ardgour Road Bridge Reach site T1 (Ryder logger). Lindis ambient air temperature measured at the lower reach below SH8. December 2016 – May 2017. Logger exposed for periods between late February to early April.

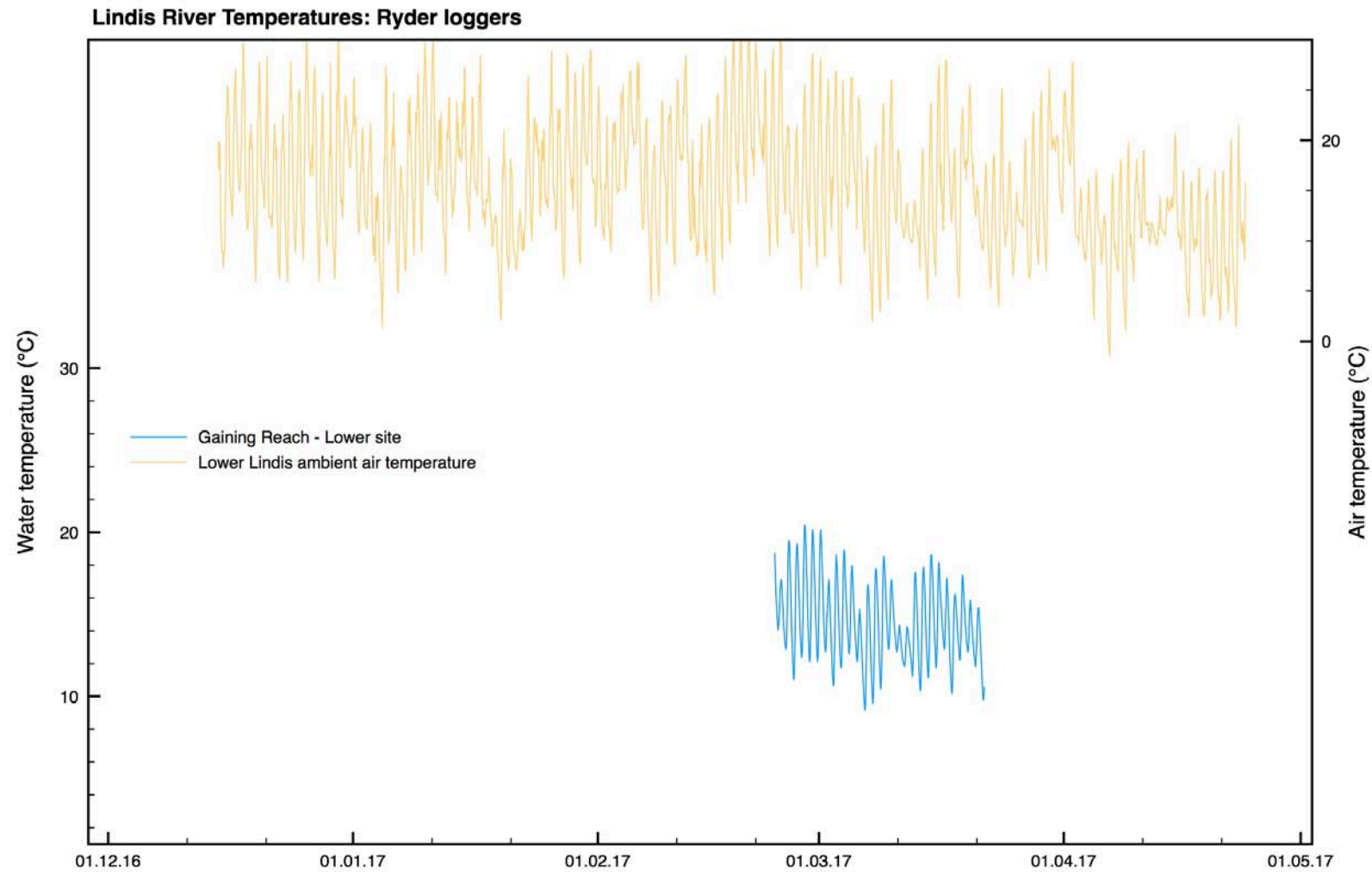


Figure 12. Lindis River temperatures at Gaining Reach lower site (Ryder logger). Lindis ambient air temperature measured at the lower reach below SH8. Note logger was lost after late March 2017.

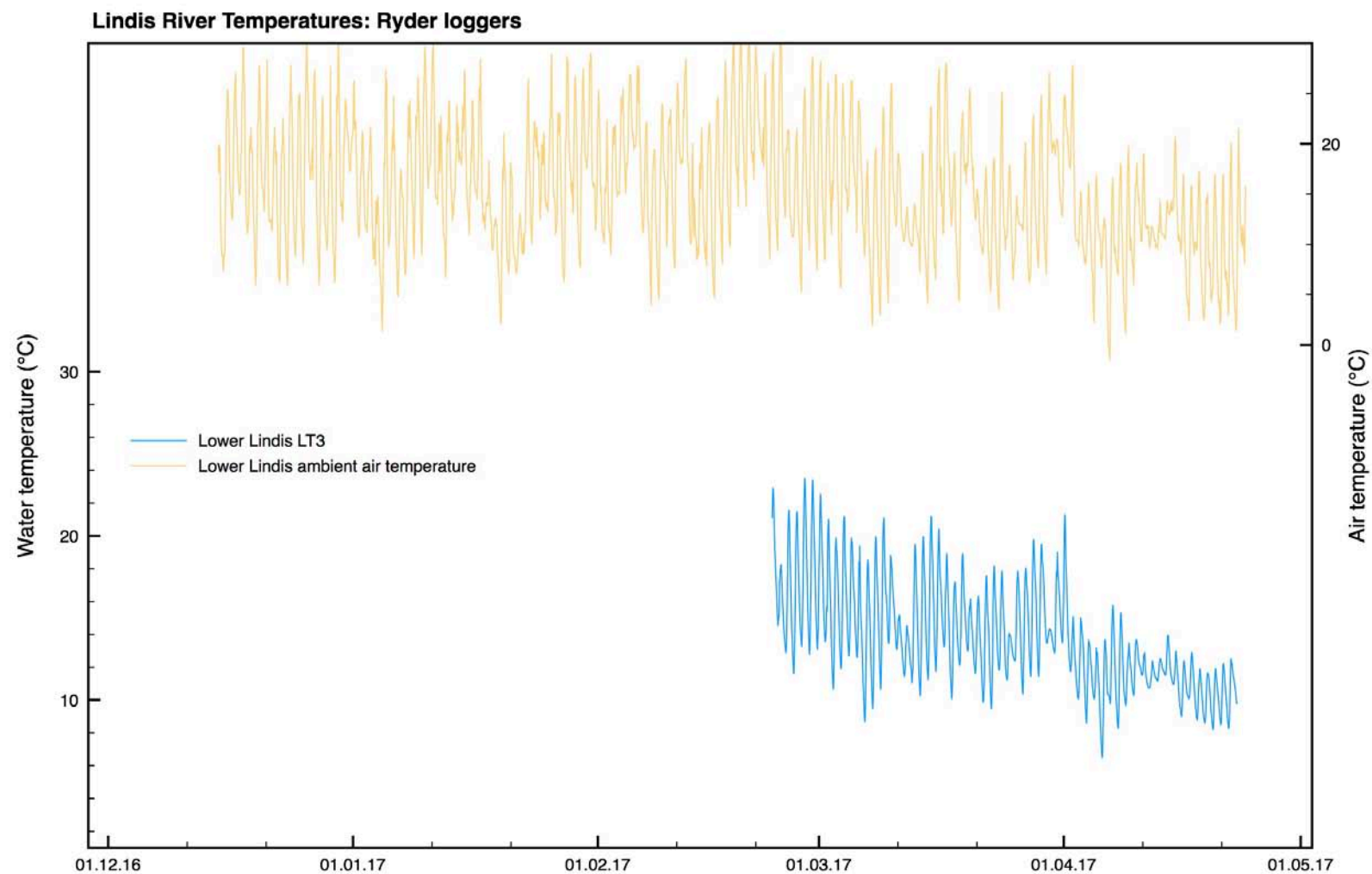


Figure 13. Lindis River temperatures at Lower Lindis site LT3 (Ryder logger). Lindis ambient air temperature measured at the lower reach below SH8. December 2016 – May 2017.

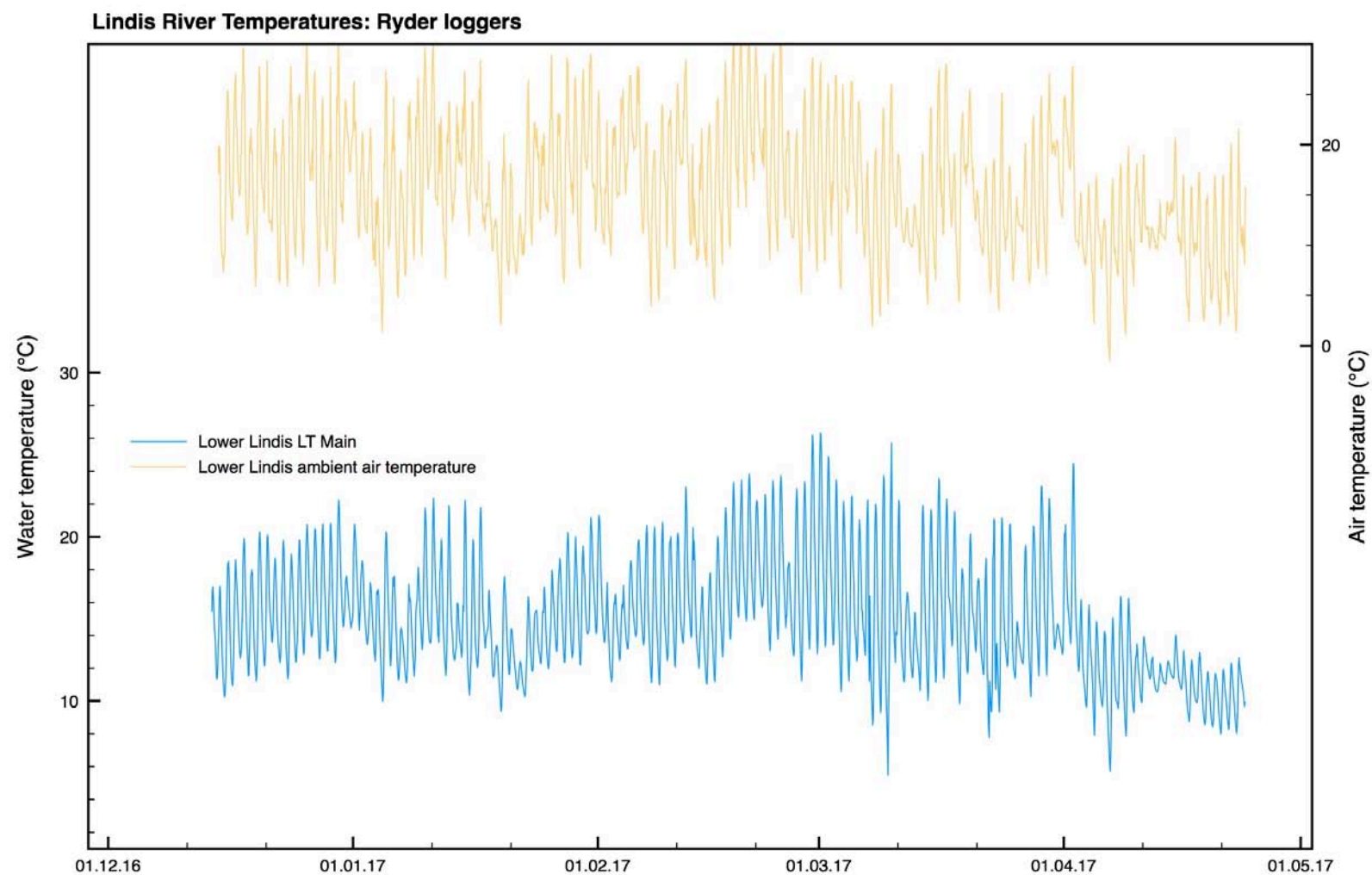


Figure 14. Lindis River temperatures at Lower Lindis LT Main site (Ryder logger). Lindis ambient air temperature measured at the lower reach below SH8. December 2016 – May 2017.

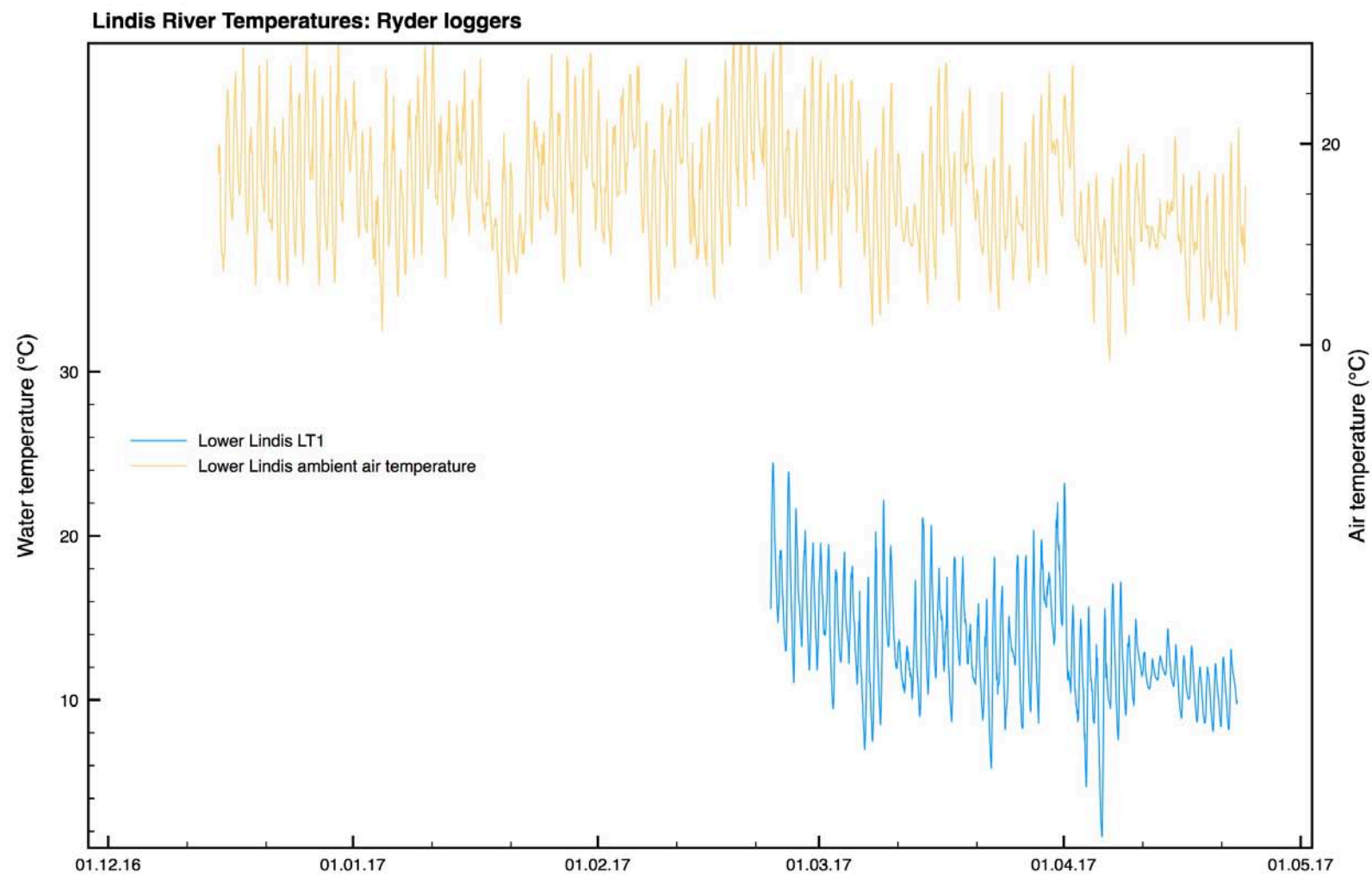


Figure 15. Lindis River temperatures at Lower Lindis site LT1 (Ryder logger). Lindis ambient air temperature measured at the lower reach below SH8. December 2016 – May 2017. Lower observed to be exposed in late March.

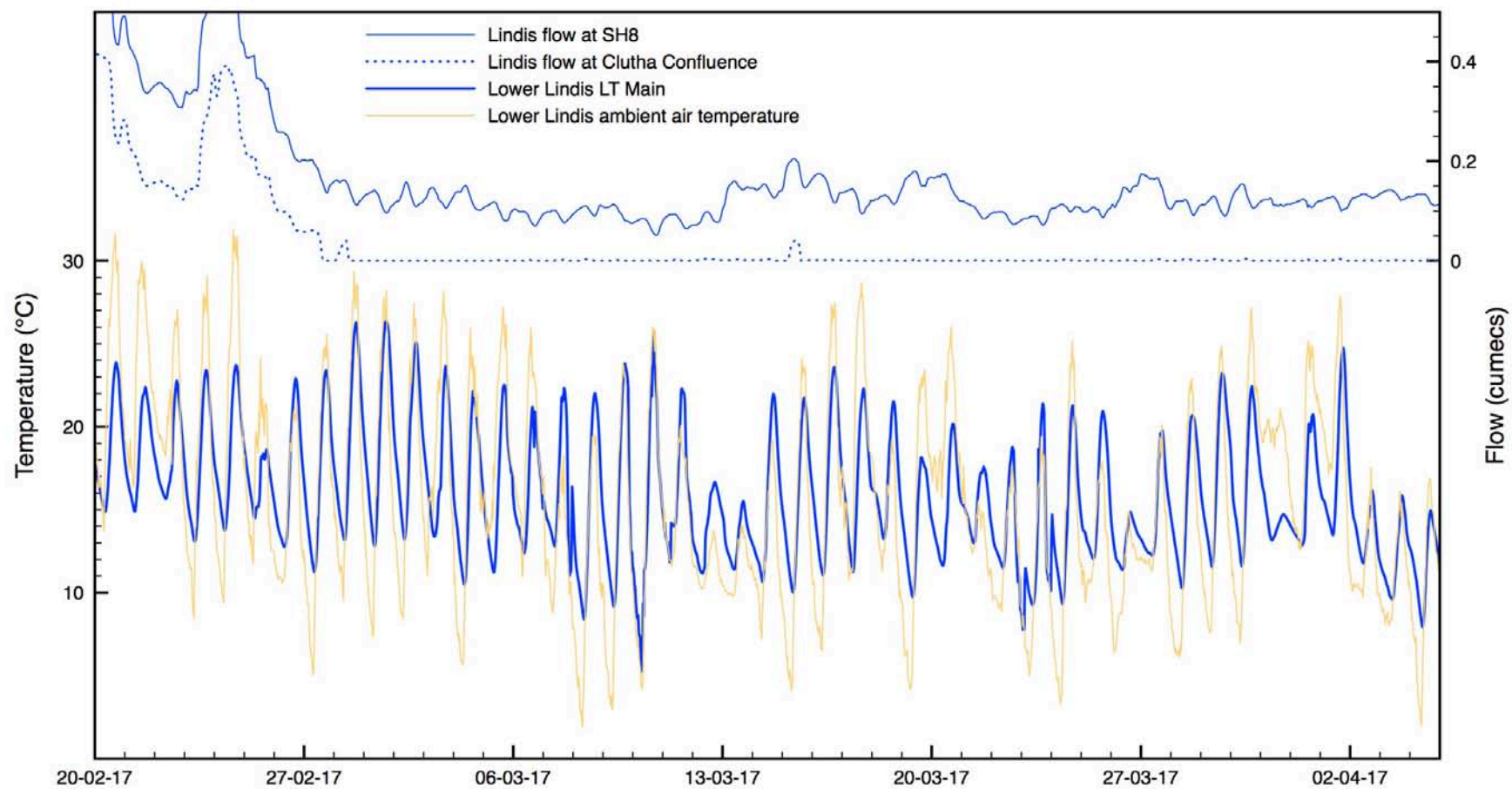


Figure 16. Lindis River lower reach flow and temperatures for the period 20 February 2017 5 April 2017.