

Memo

Date	8 August 2018
To	Hurunui-Waiau Zone Committee
CC	Ian Whitehouse, Ned Norton
From	Jarred Arthur

Hurunui River at State Highway 7: faecal source tracking 2017/18

Summary

Water sampling was undertaken weekly in the Hurunui River in the reach above State Highway 7 over the 2017/18 summer. This was specifically to determine the extent and source of faecal microorganism contamination using the indicator bacterium *E. coli* and faecal source tracking (FST). FST is a laboratory technique that helps differentiate between animal sources of *E. coli* contamination including ruminants (cattle and sheep), birds and humans. The 2017/18 summer study built on the findings from an earlier inconclusive study carried out over the 2016/17 summer. The present study has produced clearer conclusions, key of which is that the high faecal contamination events, that occur at times suitable for swimming in the Hurunui River near State Highway 7, are likely the result of the large populations of black-backed gulls nesting and residing along the gravel beds of the Hurunui River upstream of State Highway 7.

Background

Faecal source tracking (FST) was undertaken in the Hurunui River at the State Highway 7 contact recreation site in the summer of 2016/17. This was in response to the degrading microbial water quality at the site that has rendered it unsuitable for swimming (graded as 'poor') as per the MfE & MoH (2003) primary contact recreational health guidelines¹ (Arthur, 2018; Dynes and Arthur, 2017). That earlier FST study found that both ruminant and avian faecal contamination were contributing to the elevated *E. coli* levels recorded at the site (Dynes and Arthur, 2017). However, those earlier results were inconclusive due to the analysis being limited to only two samples, and the failure of one result to detect any faecal source DNA signatures, despite there being elevated *E. coli* concentrations at the time. Additional *E. coli* sampling in the river indicated that *E. coli* levels were consistently high near Lower River Road, low upstream of Morrisons Road, and fluctuated considerably at other sites between Morrisons Road and State Highway 7. FST samples for the earlier 2016/17 summer study were only collected from one location near the State Highway 7 Bridge, so FST analyses did not give any spatial indication of what type of animal contamination was occurring upstream of the State Highway 7 site. Further information on the 2016/17 study can be found in a memo prepared for the Hurunui-Waiau Zone Committee dated 18 September 2017 (Dynes and Arthur, 2017).

¹ The MfE & MoH (2003) '[Microbiological water quality guidelines for marine and freshwater recreational areas](#)' provides a detailed background to the sampling protocols, grading criteria, and response protocols used for assessing primary contact recreation health in New Zealand.

Following a Zone Committee meeting discussing the 2016/17 results, the Committee requested that further *E. coli* sampling and FST investigations be undertaken upstream of the State Highway 7 swimming site. The following memo details the findings of these additional investigations undertaken over the 2017/18 summer by Environment Canterbury staff. It reports the results of:

- weekly sampling for *E. coli* at multiple sites in the Hurunui River between Camp Road and State Highway 7; and
- an investigation of possible animal sources for *E. coli* at multiple sites in the Hurunui River between Camp Road and State Highway 7 using FST techniques.

What we did

Monitoring site selection

Data from the 2016/17 *E. coli* investigation indicated that the primary contributions of faecal contamination in the Hurunui River at State Highway 7 occurs within a 10.5 km reach between Camp Road and the State Highway 7 Bridge. Based on this information, Environment Canterbury decided to focus the 2017/18 FST investigation on several sites between these two locations, targeting sampling upstream and downstream of any obvious inflows (e.g. side tributaries) or suspected major contributors of contamination to the river.

In mid-late November, a vehicle and foot survey was conducted to explore the study reach for the existence of bankside tributaries and potential contaminant sources. Due to difficulties accessing parts of the river, and safety crossing it, a second exploratory survey was conducted by jet boat. The exploratory surveys found that few side tributaries with substantial flows exist within the reach with one exception located at Dalzells Road (Figure 1). An earlier kayaking survey by Ned Norton (Technical Lead of Hurunui-Waiau Zone sub-regional planning process) on 22 October 2017 made general observations of braided river bird nesting locations in the area (Figure 1). That survey found black-backed gulls nesting below Camp Road with the number of birds increasing progressively until approximately 2 km below the Lower River Road site. Further black-backed gull colonies were situated further downstream, but bird numbers declined more and more towards State Highway 7. A few hundred metres upstream of Camp Road was a black-billed gull colony, a species with a “nationally critical” conservation status, with hundreds of birds present (i.e., a much smaller colony than the largest black-backed gull colony which numbered thousands of birds; Figure 1). Further small colonies of black-fronted terns (“nationally endangered” conservation status) and black-backed gulls nested sporadically over a 10 km reach upstream of Camp Road (Figure 1). The foot and jetboat surveys in late-November supported these findings and found no other obvious sources of direct (i.e. instream or surface water tributary) faecal contamination to the river.

Based on the findings of the exploratory surveys, six sites with good access were selected for weekly *E. coli* and FST sampling throughout summer 2017/18 (Figure 1). The furthest upstream, ‘Camp Road’, was selected due to the limited influence of bird colonies on contamination at the site. ‘Lower River Road’ was situated amongst moderate-to-large populations of black-backed gulls, while ‘Hurunui Domain Road’ was located downstream of the largest nesting bird colonies. The ‘1.5 km upstream’ and ‘State Highway 7’ sites were located further downstream amongst progressively diminishing populations of nesting birds. A sixth monitoring site was located in the lower reaches of the small side tributary at Dalzells Road. The purpose of this site, in conjunction with ‘Hurunui Domain Road’, was to measure the influence of any contamination in the tributary on the mainstem of the Hurunui River. The ‘Hurunui Domain Road’ site was located approximately 1 km downstream of the tributary confluence to assess any effects of the tributary after mixing.

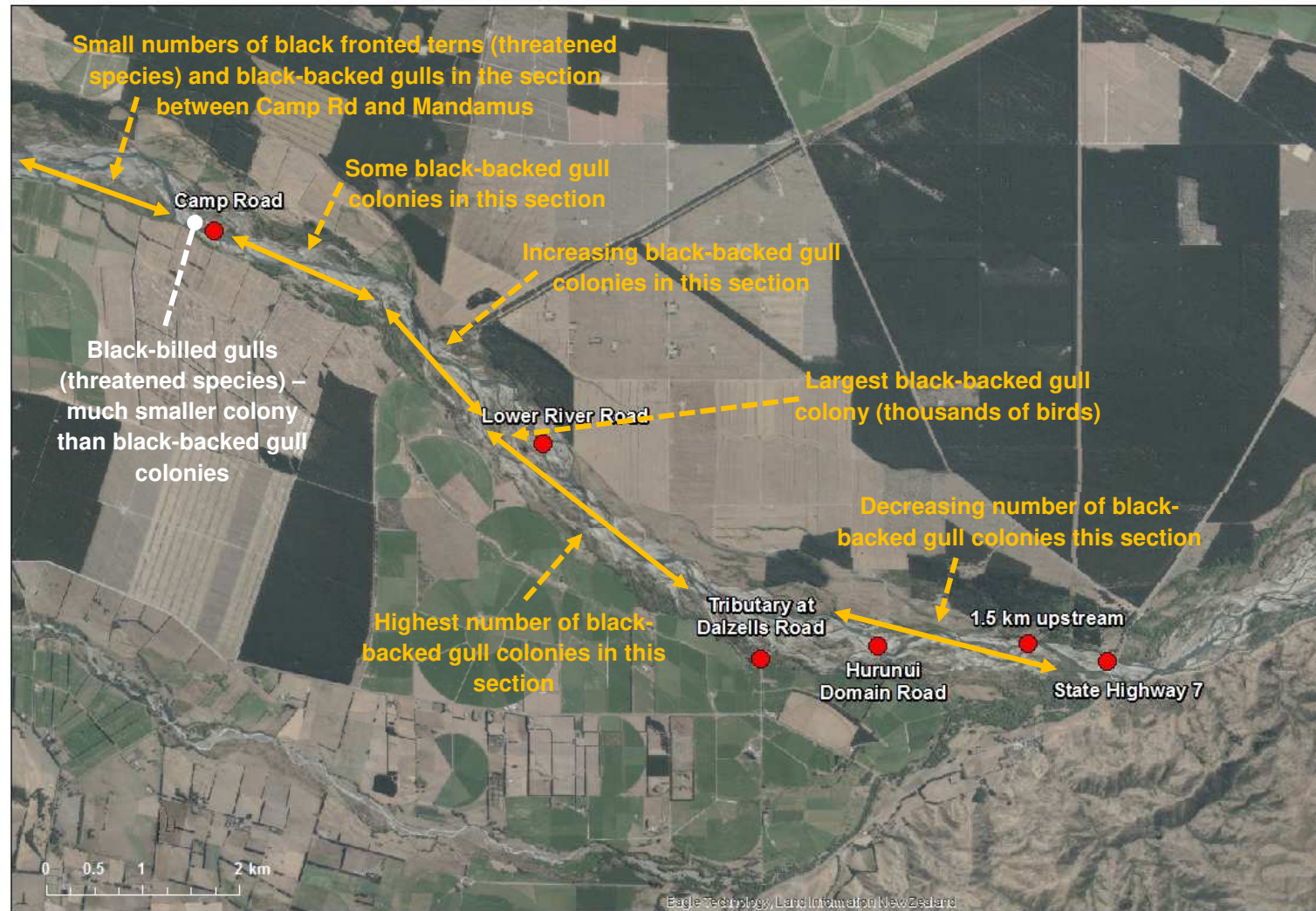


Figure 1: *E. coli* and faecal source tracking monitoring sites in the Hurunui River above State Highway 7, and Ned Norton's (22/10/2017) bird observations.

Sample collection, processing and analysis

Water samples were collected under near-to baseflow conditions from 6 December 2017 until the cessation of the recreational water quality monitoring season on 19 March 2018. A single 250 mL sample was collected each week for laboratory analysis of *E. coli* concentrations in the water. FST sampling involved the weekly collection of two 1 L samples for PCR (polymerase chain reaction)-marker analysis, and two 2 L samples for sterol analysis. PCR-marker analysis examines the DNA profiles of faecal signatures and matches them to specific animal types. For this study, the PCR-markers used were a general marker, two human-specific markers, and specific markers for ruminant (e.g. cattle and sheep) and avian (e.g. braided river bird) species. "Faecal" sterols are lipids found mainly in animal faeces, and sterol analysis examines sterol "fingerprints" that can be quite distinctive between species. Upon collection, all samples were kept cool with ice packs and transported to their respective laboratories for processing (Hills Laboratories for *E. coli* samples and ESR for FST samples). FST samples were filtered, frozen and stored until the end of the sampling season, while *E. coli* samples were analysed with results returned within 24 hours.

Due to the expensive analysis costs, Environment Canterbury staff decided to only analyse a subset of stored FST samples for PCR-markers and sterols. The prioritisation of samples to analyse for FST was based on numerous criteria including samples that:

- were collected under flows best representative of swimming conditions (e.g., low flows);
- were well spread out across the sampling reach; and
- contained high *E. coli* counts to give the best chance of returning conclusive FST results.

At the end of the sampling season, Environment Canterbury staff examined *E. coli* results across the range of sampling sites and compared them to the best possible river flow recording site (Hurunui River at Mandamus). They then notified ESR which samples should be analysed for FST on what dates.

What we found

E. coli concentrations

E. coli concentrations were often high in the Hurunui River upstream of State Highway 7 in the summer of 2017/18 (Figure 2). Except for the 'Camp Road' site, all mainstem Hurunui River sites regularly exceeded the MfE & MoH (2003) Action guideline concentration of 550 *E. coli*/100 mL. In particular, 'Lower River Road' and 'Hurunui Domain Road' exceeded the Action guideline on over half of the sampling occasions. 'Camp Road' contained low-to-moderate levels of *E. coli* over the summer, remaining below the MfE & MoH (2003) Alert guideline value of 260 *E. coli*/100 mL 69% of the time. The side tributary at Dalzells Road exceeded the Alert guideline value on five occasions, and the Action guideline value on one occasion.

Samples collected from 'Lower River Road', 'Hurunui Domain Road', and 'State Highway 7' were selected for FST analyses. This was because they provided numerous high *E. coli* counts and therefore a higher probability of returning conclusive FST results. They were also well distributed spatially across the study reach. The sample dates that were selected for FST analyses coincided with high *E. coli* results at the three selected sites, and with base flows or receding flows for at least three days after a peak flow event (Figure 3). The remaining samples that were excluded from FST analyses will remain in storage for a brief period of time in case more analyses are required.

Table 1 details ESR's combined interpretation of PCR-marker and sterol analysis results. Similar PCR-marker signatures were exhibited across all analysed sites indicating that avian and ruminant faecal contamination was present on all occasions (Table 1A). The proportion of ruminant markers was generally low ranging between 1-10% on most occasions, but sometimes at less than 1% or between 10-50%. Human faecal markers were present on one or two sampling occasions across all sites, but at very low levels, and were not supported by the presence of any sterols indicative of human faecal contamination (Tables A2 & A3). 'Key' sterol levels (including those indicative of ruminant and human faecal contamination) were very low or absent on almost all sampling occasions across all three sites. The exception was the detection of ruminant sterols (R2) at 'Lower River Road' on 13 February 2018. Avian sterols were present across all samples sites on all sampling occasions analysed. Appendix 1 presents summary tables for PCR-marker and sterol analysis results separately.

A single sample collected from 'Lower River Road' on the 6 December 2017 showed very high *E. coli* concentrations of greater than 2420 MPN/100 mL (Table 1). This coincided with a low-level flow between 18 and 19 m³/s as recorded at Mandamus. *E. coli* concentrations were far lower at other sites on the same sampling date with the next highest concentration recorded at 'Hurunui Domain Road' (770 MPN/100 mL). Given the abnormally high concentration at a single site compared to others at the same time, Environment Canterbury requested ESR to analyse the single sample to determine the animal source(s) of contamination. Similar to other analysed samples, the 6 December 2018 exceedance at 'Lower River Road' coincided with the presence of avian PCR-markers and sterols, a low number of ruminant PCR-markers (1-10% contribution), and no indicative presence of 'key' (ruminant or human) sterols.

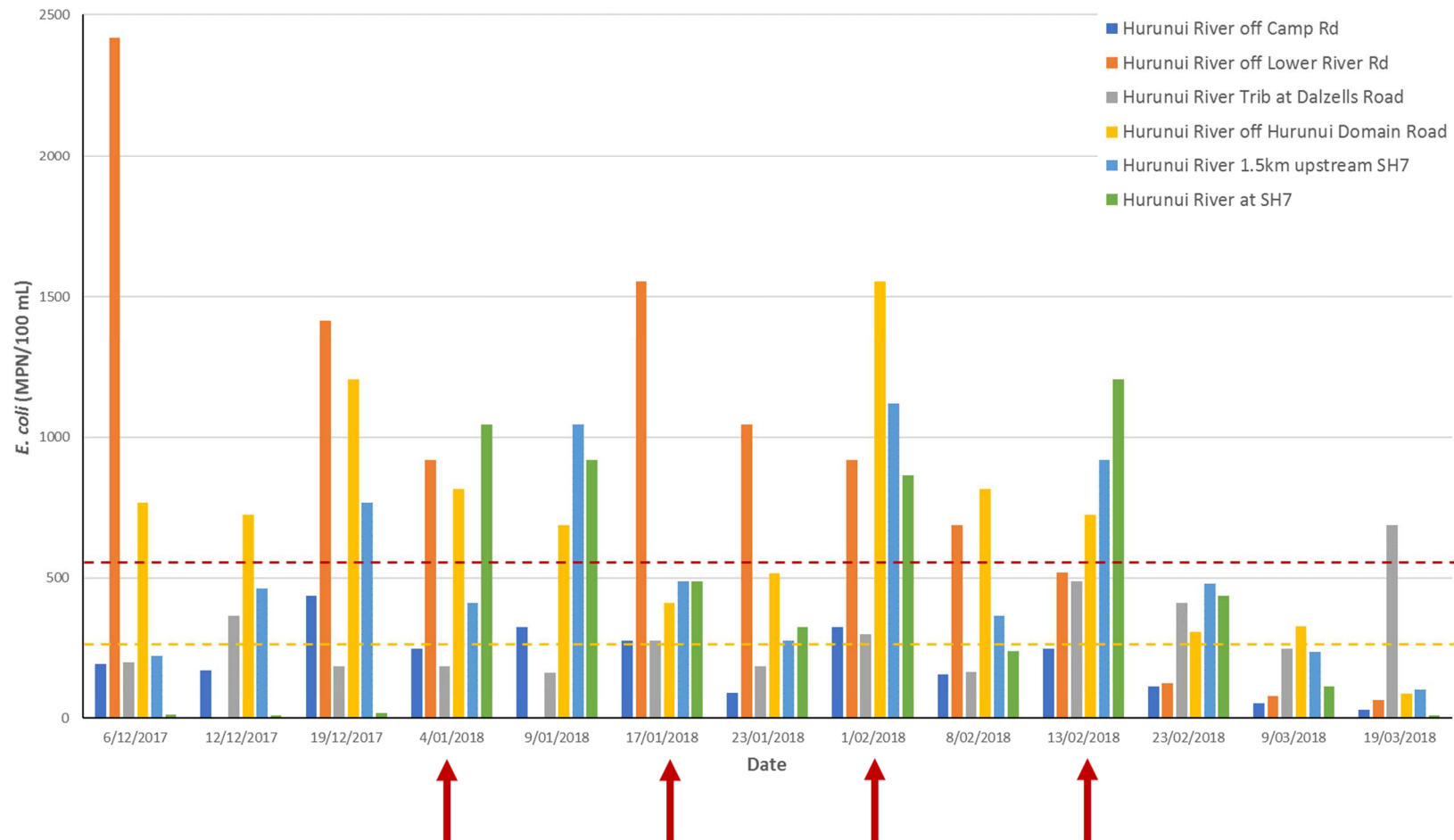


Figure 2. 2017/18 summer *E. coli* results from six sites monitored in the Hurunui River above State Highway 7. Dashed lines represent the MfE & MoH (2003) 'Action' (red) and 'Alert' response modes of 550 *E. coli*/100 mL and 260 *E. coli*/100 mL respectively. Red arrows indicate occasions from which samples were analysed for faecal source tracking using PCR markers and sterols. Only Hurunui River sites located at Lower River Road (orange), Hurunui Domain Road (yellow) and State Highway 7 (green) were analysed for faecal source tracking.

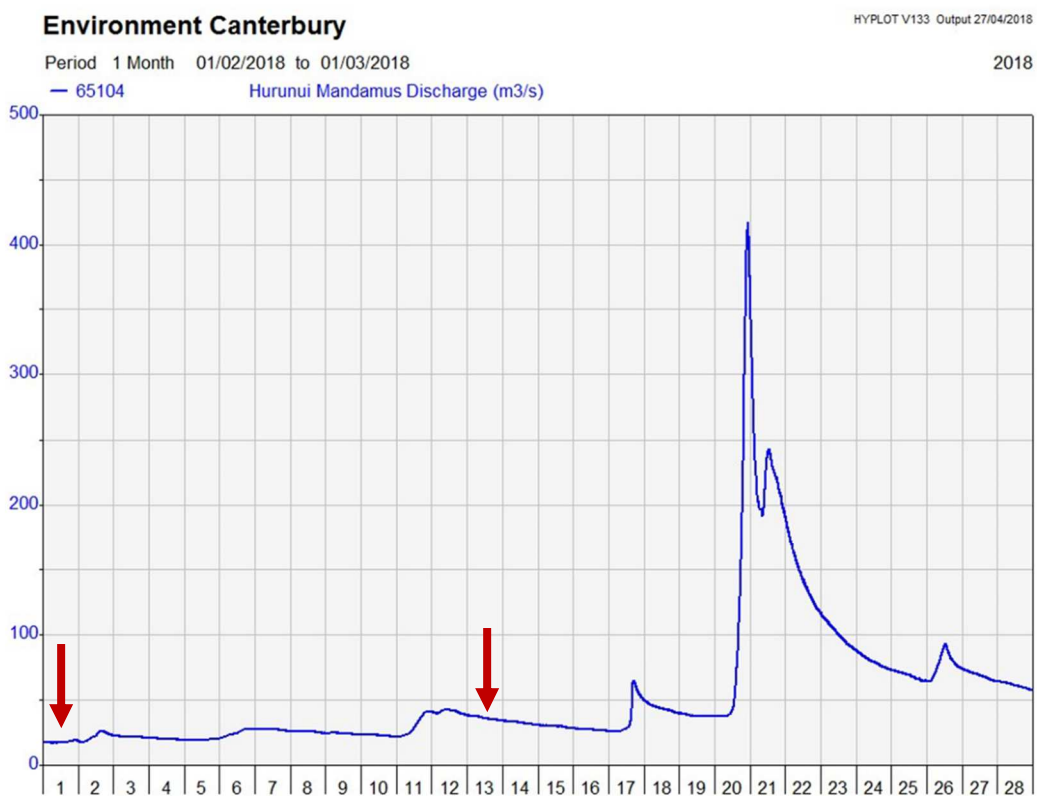
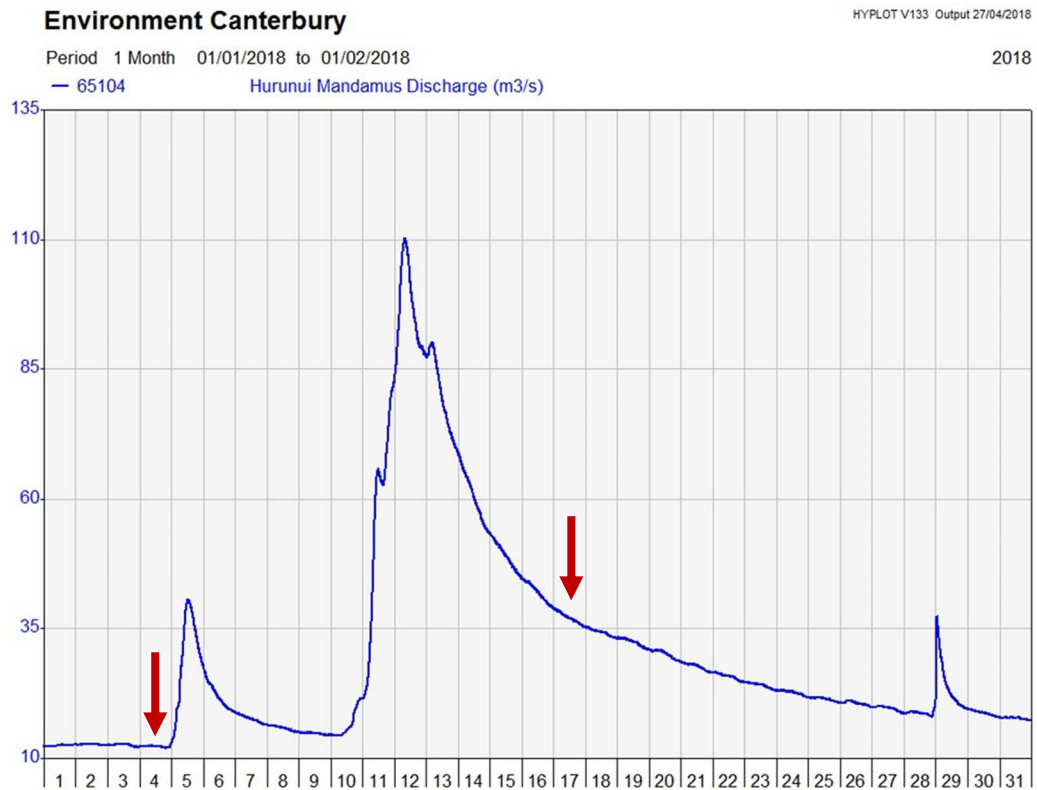


Figure 3. Flow in the Hurunui River at Mandamus in January (top) and February (bottom) 2018. Red arrows indicate the times at which analysed faecal source tracking samples were collected.

Table 1. Summary results of faecal source tracking undertaken in the Hurunui River above State Highway 7. Table includes ESR's overall interpretation of faecal sterol and PCR marker signatures for each site on each date.

ESR Number	Client Reference	Site Description	Date Sampled	<i>E. coli</i> (MPN/100mL)	Faecal Sterols	PCR Markers	Overall Conclusion
CMB180001	SQ30065	Hurunui at SH7	4/01/2018	1046	Low key sterols, possible avian, plant sterols	ruminant (1-10%) + avian + possible human (BiADO detected & BacH also detected but < LOQ)	Avian dominated source of faecal pollution. Some ruminant PCR markers present but at low levels and not supported by sterols. Possible human in one sample is very low level and not supported by sterols.
CMB180039	SQ30065	Hurunui at SH7	17/01/2018	488	Low sterols level	ruminant (10-50%) + avian	
CMB180339	SQ30065	Hurunui at SH7	1/02/2018	866	Low key sterols, possible avian, plant sterols	ruminant (1-10%) + avian	
CMB180390	SQ30065	Hurunui at SH7	13/02/2018	1203	Low key sterols, possible avian, plant sterols	ruminant (10-50%) + avian	
CMB180005	SQ36298	Hurunui off Hurunui Domain Rd	4/01/2018	816	Low key sterols, possible avian, plant sterols	ruminant (1-10%) + avian	Avian dominated source of faecal pollution. Some ruminant PCR markers present but at low levels and not supported by sterols. Possible human in one sample is very low level and not supported by sterols.
CMB180037	SQ36298	Hurunui off Hurunui Domain Rd	17/01/2018	411	Low sterols level	ruminant (10-50%) + avian possible human (BiADO & BacH detected but < LOQ)	
CMB180337	SQ36298	Hurunui off Hurunui Domain Rd	1/02/2018	1553	Low key sterols, possible avian, plant sterols	ruminant (1-10%) + avian	
CMB180388	SQ36298	Hurunui off Hurunui Domain Rd	13/02/2018	727	Low key sterols, possible avian, plant sterols	ruminant (10-50%) + avian	
CMB172426	SQ36243	Hurunui off Lower River Rd	6/12/2017	2420	Low key sterols, possible avian, plant sterols	ruminant (1-10%) + avian	Avian dominated source of faecal pollution. Some ruminant PCR markers present but at low levels and not supported by sterols. Possible human in two samples is very low level and not supported by sterols.
CMB180004	SQ36243	Hurunui off Lower River Rd	4/01/2018	921	Low key sterols, possible avian, plant sterols	ruminant ($\leq 1\%$) + avian	
CMB180042	SQ36243	Hurunui off Lower River Rd	17/01/2018	1553	Low key sterols, possible avian, plant sterols	ruminant (1-10%) + avian possible human (BiADO & BacH detected but < LOQ)	
CMB180342	SQ36243	Hurunui off Lower River Rd	1/02/2018	921	Low key sterols, possible avian, plant sterols	ruminant (1-10%) + avian + possible human (BiADO detected & BacH also detected but < LOQ)	
CMB180393	SQ36243	Hurunui off Lower River Rd	13/02/2018	517	Avian, possible ruminant	ruminant (1-10%) + avian	

Discussion and conclusions

The 2017/18 *E. coli* monitoring in the Hurunui River upstream of State Highway 7 showed that faecal bacteria levels were highest at sites downstream of large braided river bird nesting colonies. This was particularly evident near Lower River Road and Hurunui Domain Road, downstream of which numbers of black-backed gulls were at their highest. The results of FST analyses support this with avian signatures appearing to be the dominant source of faecal PCR-markers and sterols, followed by low proportions of ruminant (cattle and sheep) signatures. Observations in October 2017 found that braided river bird numbers decreased downstream of Hurunui Domain Road, and it is assumed that this remained the case for the entirety of the summer recreational bathing season. However, elevated *E. coli* concentrations have persisted at State Highway 7 over the past five years and have resulted in a 'poor' swimming grade at the site. 2017/18 FST investigations at State Highway 7 and 1.5 km upstream have revealed that nesting bird populations were also likely to be the major contributor of faecal contamination here. In comparison, the Hurunui River near Camp Road contained far lower concentrations of *E. coli* as it is situated upstream of the high-density bird nesting sites.

Previous FST results obtained from 2016/17 investigations showed an influence of ruminant (e.g. cattle and sheep) contamination occurring at State Highway 7. 2017/18 investigations showed that ruminant contamination continues to occur at the site, but most likely at low levels compared to that of bird contamination. *E. coli* monitoring of a side tributary at Dalzells Road found that low-to-moderate faecal contamination generally exists within the waterway. Lower water quantities in the tributary compared to those in the Hurunui River mainstem means that the tributary is unlikely to have a profound influence on mainstem Hurunui River *E. coli* concentrations after mixing. This was supported by *E. coli* concentrations in the tributary being generally lower than that of the Hurunui River receiving environment at Hurunui Domain Road (a notable exception occurring on 19 March 2018). With no other major surface water tributaries flowing into nearby reaches of the Hurunui River, it is unlikely that faecal contamination is being sourced from nearby land uses under baseflow conditions (i.e. without overland flow resulting from rainfall). It is therefore likely that the high faecal contamination events that occur at times suitable for swimming in the Hurunui River near State Highway 7 are the resultant of the large populations of black-backed gulls nesting and residing along the gravel beds of the Hurunui River upstream of State Highway 7.

References

- Arthur, J.B. (2018). Canterbury water quality monitoring for recreation: annual summary report 2017/18 (in draft). Environment Canterbury draft technical report.
- Dynes and Arthur (2017) Hurunui River recreational water quality summary 2016/17. Environment Canterbury memorandum prepared for the Hurunui-Waiiau Zone Committee, 18 September 2017.
- Ministry for the Environment (MfE) and Ministry of Health (MoH) (2003). Microbiological water quality guidelines for marine and freshwater recreational areas. Ministry for the Environment, Wellington.

Appendix 1

Table A 1: Summary of 2017/18 faecal source tracking PCR results for the Hurunui River above State Highway 7. See <http://www.esr.cri.nz/water-science/our-work/faecal-source-tracking/> for more information about FST analysis and interpretation.

ESR Number	Client Reference	Description / Site ID	Date Sampled	<i>E. coli</i> MPN / 100mL	General GenBac / 100 ml	Human BacH / 100 ml	Human BiADO / 100 ml	Ruminant BacR / 100 ml	Proportion Ruminant	Avian GFD / 100 ml	Conclusion
CMB180001	SQ30065	Hurunui at SH7	4/01/2018	1046	32,000	D, <LOQ	48	230	1-10%	45	faecal source - ruminant (1-10%) + avian + possible human (BiADO detected & BacH also detected but < LOQ)
CMB180039	SQ30065	Hurunui at SH7	17/01/2018	488	26,000	<17	<21	470	10-50%	80	faecal source - ruminant (10-50%) + avian
CMB180339	SQ30065	Hurunui at SH7	1/02/2018	866	150,000	<17	240	610	1-10%	420	faecal source - ruminant (1-10%) + avian
CMB180390	SQ30065	Hurunui at SH7	13/02/2018	1203	26,000	<17	<21	430	10-50%	84	faecal source - ruminant (10-50%) + avian
CMB180005	SQ36298	Hurunui off Hurunui Domain Rd	4/01/2018	816	39,000	<17	<21	260	1-10%	100	faecal source - ruminant (1-10%) + avian
CMB180037	SQ36298	Hurunui off Hurunui Domain Rd	17/01/2018	411	22,000	D, <LOQ	D, <LOQ	420	10-50%	82	faecal source - ruminant (10-50%) + avian possible human (BiADO & BacH detected but < LOQ)
CMB180337	SQ36298	Hurunui off Hurunui Domain Rd	1/02/2018	1553	140,000	<17	110	510	1-10%	360	faecal source - ruminant (1-10%) + avian
CMB180388	SQ36298	Hurunui off Hurunui Domain Rd	13/02/2018	727	26,000	<17	<21	420	10-50%	69	faecal source - ruminant (10-50%) + avian
CMB172426	SQ36243	Hurunui off Lower River Rd	6/12/2017	2420	110,000	<17	<21	300	1-10%	2,000	faecal source - ruminant (1-10%) + avian
CMB180004	SQ36243	Hurunui off Lower River Rd	4/01/2018	921	65,000	94	<21	100	1% or less	100	faecal source - ruminant (≤1%) + avian
CMB180042	SQ36243	Hurunui off Lower River Rd	17/01/2018	1553	61,000	D, <LOQ	D, <LOQ	410	1-10%	200	faecal source - ruminant (1-10%) + avian possible human (BiADO & BacH detected but < LOQ)
CMB180342	SQ36243	Hurunui off Lower River Rd	1/02/2018	921	45,000	D, <LOQ	82	390	1-10%	180	faecal source - ruminant (1-10%) + avian + possible human (BiADO detected & BacH also detected but < LOQ)
CMB180393	SQ36243	Hurunui off Lower River Rd	13/02/2018	517	27,000	19	<21	330	1-10%	86	faecal source - ruminant (1-10%) + avian

Abbreviations: NA = sample was not analysed for this marker.
 NC = not calculated
 D, < LOQ = detected but at a level less than the limit of quantitation

Table A 2. Sterol results for 2017/18 faecal source tracking monitoring in the Hurunui River above State Highway 7. See <http://www.esr.cri.nz/water-science/our-work/faecal-source-tracking/> for more information about FST analysis and interpretation.

ESR Number	Client Reference	Site Description	coprostanol	24-ethylcoprostanol	epicoprostanol	cholesterol	cholestanol	24-methylcholesterol	24-ethylepicoprostanol	stigmasterol	24-ethylcholesterol	24-ethylcholestanol	total sterols
CMB180001	SQ30065	Hurunui at SH7	16	9	3	945	88	160	2	165	521	38	1947
CMB180039	SQ30065	Hurunui at SH7	7	9	2	612	34	165	4	242	421	16	1512
CMB180339	SQ30065	Hurunui at SH7	14	15	4	865	96	181	6	135	525	34	1875
CMB180390	SQ30065	Hurunui at SH7	17	21	5	1128	119	366	12	478	1196	58	3400
CMB180005	SQ36298	Hurunui off Hurunui Domain Rd	15	13	3	842	94	229	8	216	679	38	2137
CMB180037	SQ36298	Hurunui off Hurunui Domain Rd	7	9	2	603	36	164	5	253	385	12	1476
CMB180337	SQ36298	Hurunui off Hurunui Domain Rd	20	20	6	962	104	230	10	173	667	47	2239
CMB180388	SQ36298	Hurunui off Hurunui Domain Rd	15	25	4	1138	109	376	11	518	1314	66	3576
CMB172426	SQ36243	Hurunui off Lower River Rd	14	12	3	828	67	233	7	181	380	41	1766
CMB180004	SQ36243	Hurunui off Lower River Rd	16	13	4	975	106	280	6	221	1233	43	2897
CMB180042	SQ36243	Hurunui off Lower River Rd	9	10	3	1077	52	323	5	266	1403	34	3182
CMB180342	SQ36243	Hurunui off Lower River Rd	18	22	3	876	115	265	10	218	732	51	2310
CMB180393	SQ36243	Hurunui off Lower River Rd	23	55	7	1393	115	480	21	555	1360	79	4088

NOTES: All values are reported in parts per trillion (ppt).

Coloured values indicate that the measured level is close to or below the lowest measurement standard and caution should be used in calculation of some ratios.

Values in italics are below the lowest measurement standard.

Table A 3. Interpretation of sterol results for 2017/18 faecal source tracking monitoring in the Hurunui River above State Highway 7. See <http://www.esr.cri.nz/water-science/our-work/faecal-source-tracking/> for more information about FST analysis and interpretation

ESR Number	Client Reference	Site Description	Date Sampled	<i>E. coli</i> (MPN/100mL)	Total Sterols ppt	Faecal F1, F2	Human H1, H2, H3	Ruminant R1, R2, R3	Wildfowl	Conclusion
CMB180001	SQ30065	Hurunui at SH7	4/01/2018	1046	1947	No	No	No	Yes	Low key sterols, possible avian, plant sterols
CMB180039	SQ30065	Hurunui at SH7	17/01/2018	488	1512	-	-	-	-	Low sterols level
CMB180339	SQ30065	Hurunui at SH7	1/02/2018	866	1875	No	No	No	Yes	Low key sterols, possible avian, plant sterols
CMB180390	SQ30065	Hurunui at SH7	13/02/2018	1203	3400	No	No	No	Yes	Low key sterols, possible avian, plant sterols
CMB180005	SQ36298	Hurunui off Hurunui Domain Rd	4/01/2018	816	2137	No	No	No	Yes	Low key sterols, possible avian, plant sterols
CMB180037	SQ36298	Hurunui off Hurunui Domain Rd	17/01/2018	411	1476	-	-	-	-	Low sterols level
CMB180337	SQ36298	Hurunui off Hurunui Domain Rd	1/02/2018	1553	2239	No	No	No	Yes	Low key sterols, possible avian, plant sterols
CMB180388	SQ36298	Hurunui off Hurunui Domain Rd	13/02/2018	727	3576	No	No	No	Yes	Low key sterols, possible avian, plant sterols
CMB172426	SQ36243	Hurunui off Lower River Rd	6/12/2017	2420	1766	No	No	No	Yes	Low key sterols, possible avian, plant sterols
CMB180004	SQ36243	Hurunui off Lower River Rd	4/01/2018	921	2897	No	No	No	Yes	Low key sterols, possible avian, plant sterols
CMB180042	SQ36243	Hurunui off Lower River Rd	17/01/2018	1553	3182	No	No	No	Yes	Low key sterols, possible avian, plant sterols
CMB180342	SQ36243	Hurunui off Lower River Rd	1/02/2018	921	2310	No	No	No	Yes	Low key sterols, possible avian, plant sterols
CMB180393	SQ36243	Hurunui off Lower River Rd	13/02/2018	517	4088	F2	No	(R2)	Yes	Avian, possible ruminant

NOTES: Sterol levels below 2000 ppt may be too low for some sterol interpretations.
For Human and Ruminant sterols, the ratio's meeting thresholds are noted in brackets.
Where Yes is also in brackets this indicates a lower degree of certainty.