Science Advances
AAAS

Supplementary Materials for

First source-to-sink monitoring shows dense head controls sediment flux and runout in turbidity currents

Ed L. Pope*, Matthieu J. B. Cartigny, Michael A. Clare, Peter J. Talling, D. Gwyn Lintern, Age Vellinga, Sophie Hage, Sanem Açikalin, Lewis Bailey, Natasha Chapplow, Ye Chen, Joris T. Eggenhuisen, Alison Hendry, Catharina J. Heerema, Maarten S. Heijnen, Stephen M. Hubbard, James E. Hunt, Claire McGhee, Daniel R. Parsons, Stephen M. Simmons, Cooper D. Stacey, Daniela Vendettuoli

*Corresponding author. Email: edward.pope@durham.ac.uk

Published 18 May 2022, *Sci. Adv.* **8**, eabj3220 (2022)
DOI: 10.1126/sciadv.abj3220

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Supplementary Text

Freshwater and sediment is delivered to the head of Bute Inlet by two rivers, the Homathko and Southgate Rivers. Of these, the Homathko supplies >80% of freshwater to Bute Inlet *(39, 40)*. The deltas of these two rivers are incised by subaqueous channels which later merge, downstream of M6, to form a single channel which terminates about 43 km down-channel of the Homathko Delta (Fig. 1). As the confluence of the Homathko and Southgate branches of the channel occurs down-channel of M6, turbidity currents triggered on the Southgate Delta will not be identified in the ADCP records from M6. However, they may be identified at M4 if they runout sufficiently far. It is therefore important to identify a clear methodology for identifying where turbidity currents were most likely sourced.

Turbidity currents on the Homathko and Southgate Deltas are likely to be triggered under the same conditions due to their similar environmental setting *(43)*. Both rivers drain mountainous glaciated catchments with peaks in river discharge associated with the Freshet which is a consequence of enhanced spring and summer glacier and snow melt *(43)*. Previous studies of Bute Inlet turbidity currents, and flows in nearby Howe Sound, British Columbia, showed that flows were most likely triggered during periods when fluvial discharge was above a certain threshold and during periods when there was the greatest tidal range *(39, 43, 53, 54)*. Nonetheless, turbidity currents sourced from the Homathko River are more likely given the greater sediment and freshwater supplied by this river *(40)*.

Turbidity currents at M4 were therefore more likely to have been sourced from M6, when the arrival time at M4 was closely associated with arrival times of flows at M6. During the 206 day deployment a total of 24 turbidity currents were observed at M4. Of these, the arrival times of 19 were associated with observed turbidity currents at M6. Using their arrival times, these flows had transit velocity of 0.3 to 4.8 m s^{-1} over 8.5 km (Table s3).

Of the remaining five events, one (7/10/2018) is not associated with any turbidity current at M6 and is therefore thought to have originated from the Southgate Delta. The four other turbidity currents were judged to have originated from the Southgate Delta rather than the Homathko Delta. This is due to the extremely slow transit speeds (<0.05 m s^{-1}) at which they would need to travel, if they were remnants of the temporally closest event at M6. Moreover, the turbidity currentss with which they may have been associated with at M6 had slow ADCP-measured velocities at M6. This suggests that the flows were already weak at M6, making their passage as far as M4 unlikely.

In addition to these additional five distinct turbidity currents inferred to come from the Southgate Delta, an additional turbidity current appears to have arrived (07/08/2018 17:04:50) at M4 during the passage of another flow (arrived at 07/08/2018 11:30:14). The initial flow was observed at M6, and is therefore believed to have originated from the Homathko Delta; this initial flow took ∼73 minutes to traverse the ∼10 km between M6 and M4. A second flow was observed to have arrived at M6 soon after the passage of the first flow. If this second flow is the same as the second flow pulse observed in M4, then it traversed the ∼10 km between moorings in ∼62 minutes. However, this is unlikely as the peak measured velocities of the flow at M6 (<1 m s^{-1}) and its other flow characteristics (see Tables 1 and s3) suggest that the flow was too slow moving and dilute to have reached M4 this quickly. We therefore believe that this secondary flow pulse was also sourced from the Southgate Delta.

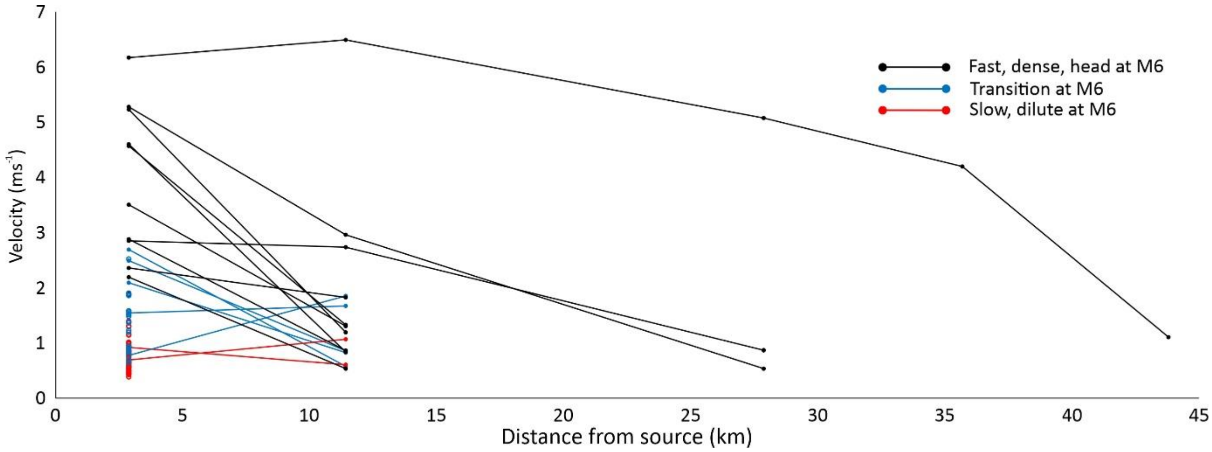

Fig. S1. Maximum measured velocities of turbidity currents in Bute Inlet relative to their structure type at M6.

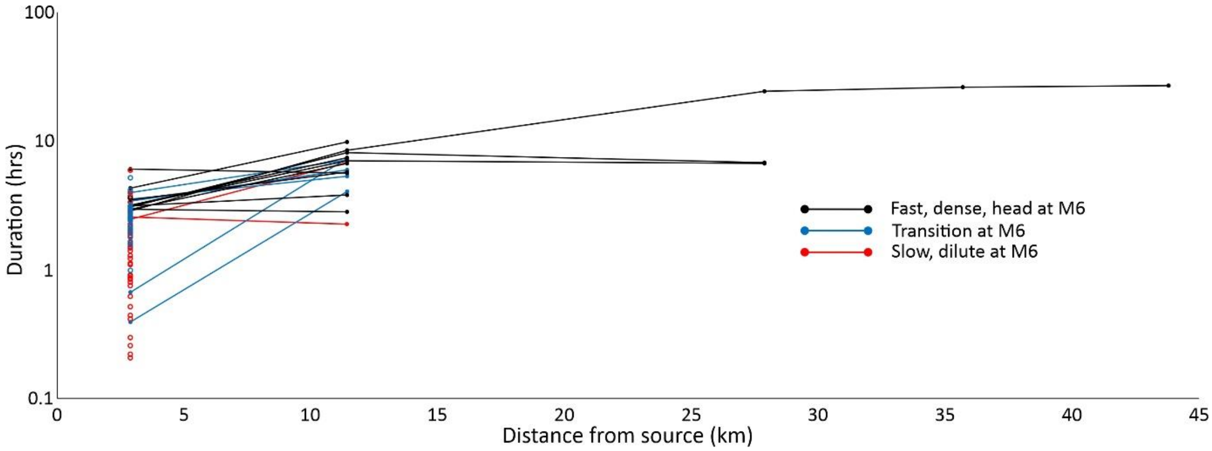

Fig. S2. Measured durations of turbidity currents in Bute Inlet relative to their structure type at M6.

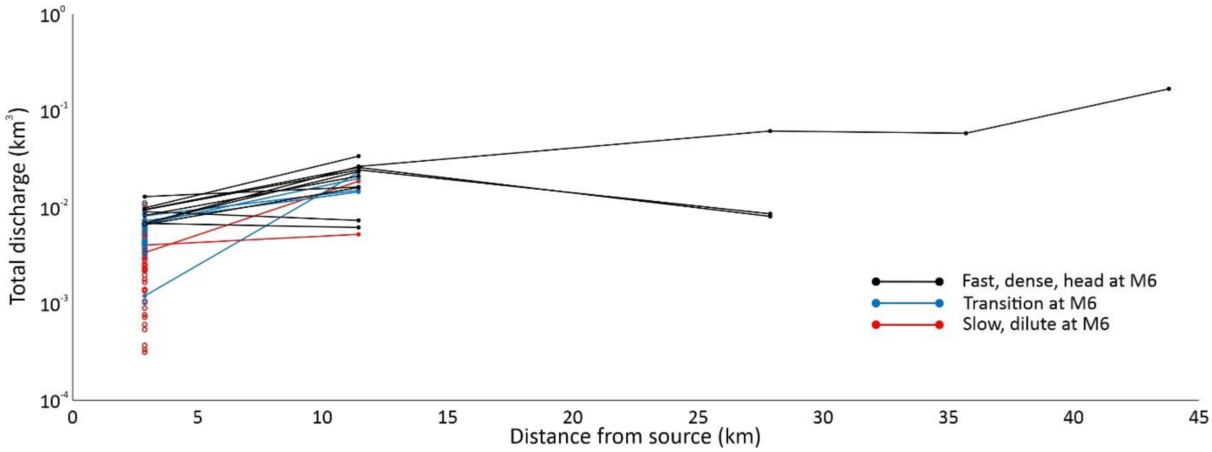

Fig. S3. Total discharge (sediment and water) of turbidity currents in Bute Inlet relative to their structure type at M6.

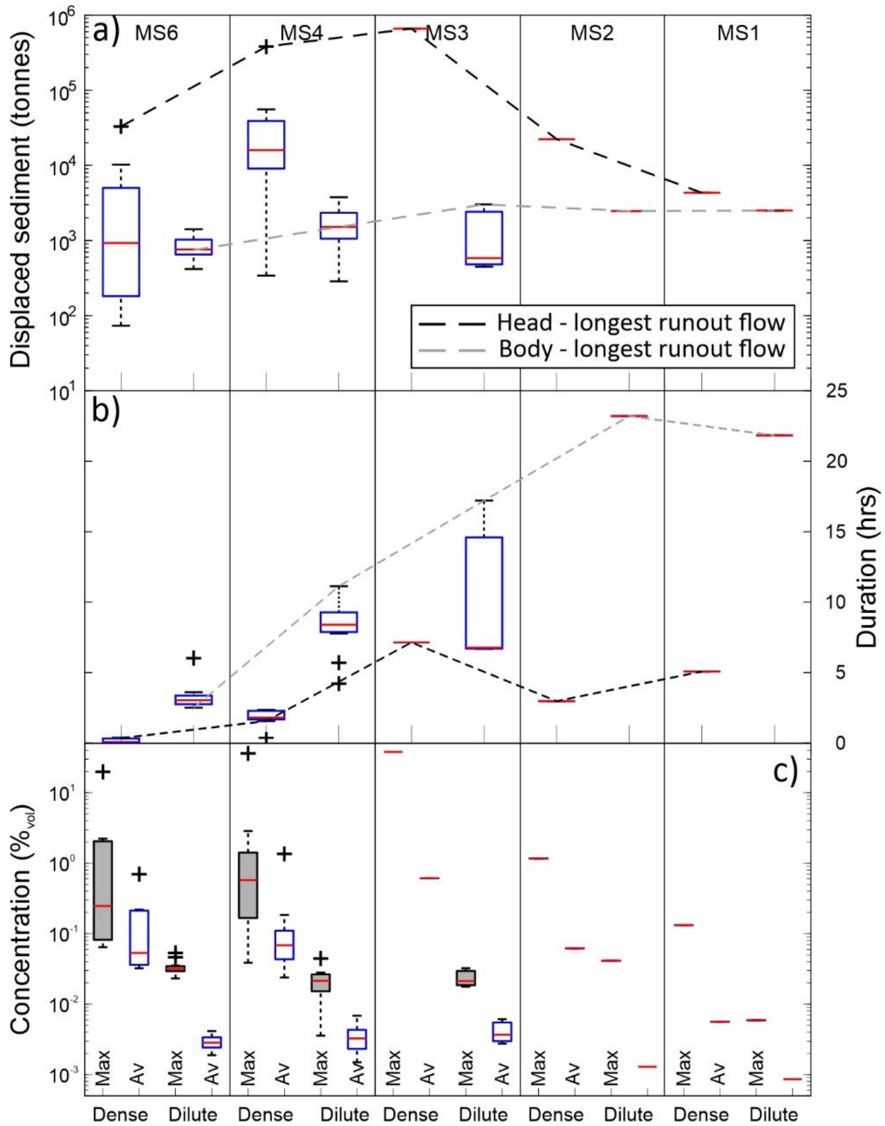

Fig. S4. Displaced sediment, durations and concentrations of the dense and dilute parts of turbidity currents in Bute Inlet characterised as having a fast, dense head at M6. The dense and dilute parts of the **turbidity current**s are defined by when $C_{fb} > C_{fi}$ and when $C_{fb} < C_{fi}$. All calculations are based on iteratively solved Chézy equations assuming a bed friction coefficient (C_{fb}) of 0.004.

Table S1. Specifications and location information for the moorings and instruments used in this study.

Mooring	Depth (m)	ADCP freqeuncy (kHz)	Height above bed (m)	Vertical bin size (m)	Temporal resolution (seconds)	Distance from delta front (m)	Slope angle (°)
MS6	176	300	30	1	6	2880	3.15
MS5	304	600	-	0.5	6	11420	4.36
MS4	314	600	25	0.5	6	12080	1.15
MS3	472	300	~8	0.5	6	27870	0.97
MS2	562	600	20	1	6	35690	1.59
MS1	607	600	20	1	4	43800	0.16

Table S2. Dates of turbidity currents originating from the Homathko Delta and measured background velocities before the arrival of the observed flows.

	Mooring M6		Mooring M4		Mooring M3		Mooring M2		Mooring M1	
Flow Number	Date	Background velocity (m/s)	Date	Background velocity (m/s)	Date	Background velocity (m/s)	Date	Background velocity (m/s)	Date	Background velocity (m/s)
1	14/05/2018	0.117								
2	16/05/2018	0.093								
3	22/05/2018	0.100								
4	22/05/2018	0.096								
5	26/05/2018	0.097								
6	27/05/2018	0.097								
7	28/05/2018	0.097	28/05/2018	0.047	29/05/2018	0.117				
8	12/06/2018	0.109								
9	20/06/2018	0.095								
10	20/06/2018	0.098								
11	21/06/2018	0.097								
12	21/06/2018	0.099	21/06/2018	0.055						
13	22/06/2018	0.096								
14	22/06/2018	0.099								
15	22/06/2018	0.096								
16	23/06/2018	0.094								
17	23/06/2018	0.092								
18	24/06/2018	0.093								
19	25/06/2018	0.097								
20	26/06/2018	0.102								
21	30/06/2018	0.091								
22	04/07/2018	0.095	05/07/2018	0.043						
23	05/07/2018	0.100								
24	07/07/2018	0.099								
25	08/07/2018	0.092								
26	08/07/2018	0.105								
27	08/07/2018	0.093								
28	08/07/2018	0.105								
29	09/07/2018	0.086								
30	10/07/2018	0.095								
31	10/07/2018	0.081	10/07/2018	0.047						
32	11/07/2018	0.093								
33	11/07/2018	0.083	11/07/2018	0.060						
34	11/07/2018	0.101								
35	12/07/2018	0.098	12/07/2018	0.062						
36	13/07/2018	0.095								
37	21/08/2018	0.089								
38	22/07/2018	0.090								
39	22/07/2018	0.090	22/07/2018	0.036						
40	23/07/2018	0.093								
41	24/07/2018	0.098								
42	24/07/2018	0.089	24/07/2018	0.040						
43	25/07/2018	0.104								
44	25/07/2018	0.082								
45	26/07/2018	0.088								
46	27/07/2018	0.105								
47	27/07/2018	0.085								
48	29/07/2018	0.091	29/07/2018	0.043						
49	31/07/2018	0.098								
50	31/07/2018	0.083								
51	01/08/2018	0.094								
52	01/08/2018	0.098								
53	01/08/2018	0.099								
54	01/08/2018	0.097								
55	01/08/2018	0.092	02/08/2018	0.048						
56	03/08/2018	0.101								
57	04/08/2018	0.099								
58	05/08/2018	0.098								
59	05/08/2018	0.089								
60	05/08/2018	0.096								
61	06/08/2018	0.102	06/08/2018	0.042	06/08/2018	0.106				
62	06/08/2018	0.120								
63	06/08/2018	0.087								
64	06/08/2018	0.100								
65	07/08/2018	0.097	07/08/2018	0.047						
66	07/08/2018	0.092	07/08/2018	N/A						
67	08/08/2018	0.102								
68	08/08/2018	0.093								
69	09/08/2018	0.096								
70	09/08/2018	0.085								
71	10/08/2018	0.102								
72	10/08/2018	0.083	10/08/2018	0.049						
73	11/08/2018	0.092								
74	11/08/2018	0.087								
75	15/08/2018	0.088								
76	16/08/2018	0.102								
77	16/08/2018	0.085								
78	19/08/2018	0.090	19/08/2018	0.035						
79	20/08/2018	0.091	20/08/2018	0.039	20/08/2018	0.099	20/08/2018	0.059	20/08/2018	0.049
80	21/08/2018	0.096								
81	21/08/2018	0.083								
82	21/08/2018	0.094								
83	23/08/2018	0.087								
84	24/08/2018	0.089								
85	27/08/2018	0.087								
86	30/08/2018	0.096								
87	01/09/2018	0.092								
88	01/09/2018	0.087	01/09/2018	0.047						
89	04/09/2018	0.088								
90	05/09/2018	0.087								
91	05/09/2018	0.087								
92	06/09/2018	0.082								
93	07/09/2018	0.087								
94	08/09/2018	0.081								
95	11/09/2018	0.091								

Table S3. Summary of turbidity current properties from the 2018 deployment in Bute Inlet.

M6 Flows	Flow Type	Maximum ADCP velocity (m/s)	Duration (hours)	Water volume Displaced (km3)	Maximum sediment discharge (kg/s)	Sediment volume displaced (metric tons)
1	Type 2	1.58	2.06	0.0058	75	141
2	Type 3	0.94	1.92	0.0036	29	20
3	Type 2	1.87	2.60	0.0064	119	305
4	Type 2	0.94	2.07	0.0044	6	29
5	Type 3	0.56	2.62	0.0044	35	21
6	Type 3	0.56	0.22	0.0003	8	1
7	Type 1	2.85	3.15	0.0094	561	1,538
8	Type 2	0.87	1.65	0.0040	8	27
9	Type 3	0.48	1.57	0.0022	2	2
10	Type 2	1.23	2.18	0.0055	30	87
11	Type 3	0.49	0.30	0.0005	5	1
12	Type 1	2.88	2.95	0.0090	433	1,830
13	Type 3	0.44	0.84	0.0014	6	2
14	Type 3	0.65	1.56	0.0025	3	3
15	Type 3	0.81	2.82	0.0060	6	37
16	Type 3	0.65	2.26	0.0040	3	12
17	Type 2	1.86	4.16	0.0086	50	77
18	Type 1	2.36	2.94	0.0068	452	486
19	Type 3	0.66	2.82	0.0055	9	21
20	Type 3	0.84	3.72	0.0067	8	23
21	Type 2	2.49	3.53	0.0081	201	555
22	Type 2	2.69	0.39	0.0010	13,576	607
23	Type 3	0.63	1.61	0.0028	8	5
24	Type 2	1.19	2.74	0.0057	16	47
25	Type 2	1.38	0.99	0.0032	73	156
26	Type 3	1.31	3.35	0.0073	19	71
27	Type 3	1.15	2.49	0.0053	13	52
28	Type 3	0.62	1.22	0.0022	6	6
29	Type 3	0.85	2.86	0.0054	11	35
30	Type 3	0.65	2.15	0.0038	5	10
31	Type 3	0.92	2.57	0.0040	6	12
32	Type 3	0.86	2.50	0.0042	4	6
33	Type 2	0.77	0.67	0.0012	14	10
34	Type 1	1.88	3.61	0.0067	209	643
35	Type 1	4.57	3.16	0.0082	8,595	2,055
36	Type 3	0.68	1.96	0.0035	12	15
37	Type 3	0.87	1.96	0.0036	6	14
38	Type 2	1.56	2.01	0.0047	81	195
39	Type 1	4.65	3.34	0.0094	17,479	10,902
40	Type 2	1.36	5.18	0.0111	63	263
41	Type 3	0.74	1.29	0.0020	4	4
42	Type 2	2.09	3.41	0.0072	51	131
43	Type 3	0.94	1.10	0.0023	5	15
44	Type 2	1.53	3.13	0.0063	181	344
45	Type 3	0.70	2.90	0.0049	6	32
46	Type 3	0.58	0.91	0.0017	19	6
47	Type 2	0.64	2.85	0.0042	7	12
48	Type 1	4.60	6.05	0.0128	6,401	1,485
49	Type 3	0.57	2.50	0.0047	8	20
50	Type 2	0.69	2.56	0.0041	2	16
51	Type 3	0.47	0.41	0.0007	2	1
52	Type 3	0.44	0.86	0.0014	2	3
53	Type 3	1.01	2.81	0.0052	19	25
54	Type 3	0.61	1.50	0.0023	4	8
55	Type 1	3.50	3.48	0.0066	923	533
56	Type 3	1.40	3.98	0.0067	21	18
57	Type 3	0.44	0.52	0.0008	6	2
58	Type 3	0.43	2.01	0.0030	5	3
59	Type 3	0.54	1.40	0.0025	4	4
60	Type 2	1.90	3.00	0.0073	616	662
61	Type 1	5.28	3.07	0.0094	2,178	4,032
62	Type 3	0.82	0.80	0.0018	18	15
63	Type 2	1.48	2.42	0.0044	88	174
64	Type 2	0.84	1.82	0.0038	13	31
65	Type 2	5.23	4.30	0.0098	3,446	1,183
66	Type 2	0.92	2.54	0.0045	21	27
67	Type 3	1.14	2.51	0.0051	35	48
68	Type 2	1.58	2.47	0.0063	155	491
69	Type 2	1.51	3.01	0.0066	111	195
70	Type 2	0.89	2.40	0.0041	19	31
71	Type 3	0.70	2.16	0.0040	10	28
72	Type 2	1.54	3.97	0.0067	84	91
73	Type 3	0.77	0.21	0.0003	1	0
74	Type 3	1.30	3.12	0.0068	19	82
75	Type 3	0.70	2.57	0.0042	15	13
76	Type 3	1.00	2.03	0.0041	13	37
77	Type 3	0.92	2.70	0.0041	2	15
78	Type 2	0.69	2.46	0.0034	12	11
79	Type 1	6.17	2.86	0.0068	138,568	33,684
80	Type 3	0.52	1.12	0.0018	2	4
81	Type 2	2.52	3.09	0.0061	245	453
82	Type 3	0.57	0.26	0.0004	2	0
83	Type 3	0.59	0.44	0.0006	1	0
84	Type 2	0.72	2.49	0.0047	23	32
85	Type 3	0.56	0.89	0.0014	9	3
86	Type 3	0.66	0.62	0.0009	2	1
87	Type 2	0.77	1.55	0.0034	6	23
88	Type 1	2.19	3.13	0.0068	356	1,035
89	Type 3	0.38	0.75	0.0011	12	2
90	Type 3	0.80	1.48	0.0030	22	33
91	Type 3	0.95	5.92	0.0106	6	27
92	Type 3	0.66	2.06	0.0033	3	12
93	Type 3	0.69	1.84	0.0030	37	20
94	Type 3	0.50	1.85	0.0026	14	23
95	Type 3	0.98	1.79	0.0033	4	12
Mean	All Flows	1.33	2.27	0.0046	2,064	690
Mean	Type 1	3.72	3.43	0.008	16,014	5,293
Mean	Type 2	1.51	2.59	0.005	646	214
Mean	Type 3	0.79	1.89	0.003	26	26

	M4 Flows	Flow Type	Maximum ADCP velocity (m/s)	Duration (hours)	Water volume Displaced (km3)	Maximum sediment discharge (kg/s)	Sediment volume displaced (t)
7		Type 1	2.74	10.52	0.0243	12,664	57,027
12		Type 3	0.86	4.22	0.0073	15	302
18		Type 1	1.82	10.03	0.0233	2,192	24,384
21		Type 2	0.86	7.97	0.0149	119	1,734
22		Type 3	0.57	6.07	0.0104	16	423
31		Type 3	0.61	3.39	0.0052	22	175
33		Type 1	1.85	10.98	0.0229	1,633	14,137
35		Type 2	1.33	11.11	0.0209	688	10,479
39		Type 2	1.46	10.05	0.0200	1,065	11,479
42		Type 2	0.82	8.94	0.0144	163	1,580
48		Type 2	0.83	8.45	0.0162	180	3,764
55		Type 2	1.30	8.59	0.0160	195	2,744
61		Type 1	2.96	12.17	0.0257	3,108	22,773
65		Type 2	1.19	14.73	0.0337	294	158
72		Type 2	1.67	10.67	0.0198	1,187	10,843
78		Type 2	1.07	10.20	0.0185	115	91
79		Type 1	6.49	12.70	0.0263	369,318	381,851
84		Type 3	0.71	1.64	0.0017	23	94
88		Type 3	0.53	5.70	0.0062	97	286
	Mean	All Flows	1.56	8.85	0.0172	20,689	28,649
	Mean	Type 1	3.17	11.28	0.025	77,783	100,034
	Mean	Type 2	1.17	10.08	0.019	445	4,763
	Mean	Type 3	0.66	4.20	0.006	35	256

	M3 Flows	Flow Type	Maximum ADCP velocity (m/s)	Duration (hours)	Water volume Displaced (km3)	Maximum sediment discharge (kg/s)	Sediment volume displaced (metric tons)
7		Type 3	0.87	6.69	0.0085	387	448
61		Type 3	0.53	6.78	0.0080	613	583
79		Type 1	5.08	24.35	0.0614	276,015	663,095
	Mean	All Flows	2.16	12.60	0.0260	92,338	221,375
	Mean	Type 1	5.08	24.35	0.061	276,015	663,095
	Mean	Type 2					
	Mean	Type 3	0.70	6.73	0.008	500	516

	M2 Flows	Flow Type	Maximum ADCP velocity (m/s)	Duration (hours)	Water volume Displaced (km3)	Maximum sediment discharge (kg/s)	Sediment volume displaced (metric tons)
79		Type 1	4.20	26.18	0.0582	12,734	24,792
	Mean	All Flows	4.20	26.18	0.0582	12,734	24,792

	M1 Flows	Flow Type	Maximum ADCP velocity (m/s)	Duration (hours)	Water volume Displaced (km3)	Maximum sediment discharge (kg/s)	Sediment volume displaced (metric tons)
79		Type 2	1.11	26.91	0.1679	804	6,819
	Mean	All Flows	1.11	26.91	0.1679	804	6,819

Table S4. Turbidity current characteristics of flows observed at M4 believed to have originated from the Southgate Delta.

Flow	Date	Time	Maximum ADCP Velocity (m/s)	Duration (hours)	Water volume displaced (km3)	Maximum sediment discharge (kg/s)	Sediment volume displaced (tonnes)
1	05/07/2018	17:47:02	0.639	8.09	0.00450	63	301.45
2	15/07/2018	19:09:24	0.38	4.91	0.00000	134	0.56
3	17/07/2018	20:29:02	0.391	7.78	0.00005	40	316.10
4	07/08/2018	17:04:50	1.117	9.15	0.00500	498	4584.48
5	26/08/2018	22:24:38	0.4223	2.43	0.00010	59	67.17
6	07/10/2018	01:10:56	0.422	6.97	0.00212	47	221.49