Wriggle

coastalmanagement

Whanganui Inlet

Fine Scale Monitoring Data 2016/17

Prepared for

Tasman District Council

May 2017

Cover Photo: Whanganui Inlet northern arm Site A 2017, with dense seagrass beds within firm muddy sands.

Whanganui Inlet, bare soft muddy sediments within the large main southern basin at Site C, January 2017.

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by

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1. INTRODUCTION

Developing an understanding of the condition and risks to coastal and estuarine habitats is critical to the management of biological resources. These objectives, along with understanding change in condition/trends, are key objectives of Tasman District Council's State of the Environment Estuary monitoring programme. Recently, Tasman District Council (TDC) undertook a vulnerability assessment of the region's coastlines to establish priorities for a long-term monitoring programme (Robertson and Stevens 2012). The assessment identified the Waimea, Moutere, Motueka Delta, Motupipi, Ruataniwha and Whanganui estuaries as priorities for monitoring.

For Whanganui Inlet, the monitoring and management process consists of three components developed from the National Estuary Monitoring Protocol (NEMP) (Robertson et al. 2002) as follows:

1. **Ecological Vulnerability Assessment** (EVA) of the estuary to major issues and appropriate monitoring design. A region-wide EVA has been undertaken (Robertson and Stevens 2012) providing specific recommendations for Whanganui Inlet.
2. **Broad Scale Habitat Mapping** (NEMP approach). This component documents the key habitats within the estuary, and changes to these habitats over time. Broad scale mapping of Whanganui Inlet was undertaken in 2016 (Stevens and Robertson 2016), and historically in the late 1980s (Davidson 1990).
3. **Fine Scale Monitoring** (NEMP approach). Monitoring of physical, chemical and biological indicators. This component, which provides detailed information on the condition of Whanganui Inlet, was first undertaken in December 2015 (Robertson and Stevens 2016) and repeated in January 2017, the latter being the subject of this report.

In 2016, TDC commissioned Wriggle Coastal Management to undertake the second year of a proposed 3 year consecutive annual baseline of fine scale monitoring at established sites in Whanganui Inlet. In addition, TDC requested that a new fine scale site be established and sampled in unvegetated soft mud flats, the dominant habitat in the southwestern arm of the estuary (Figure 1).

The current report describes the location of the newly established site and presents the results of the January 2017 fine scale sampling. To minimise costs, it was agreed that data only reports would be prepared for the 2015/16 and 2016/17 monitoring, with a full report undertaken at the next scheduled 5 yearly monitoring interval in 2022. At this time the combined data set, including sampling undertaken at Sites A and B in 2014/15 as part of Ben Robertson's PhD studies, will be fully analysed and compared with estuary condition ratings in order to assess the overall estuary condition, identify any issues and recommend ongoing monitoring and management.

WHANGANUI INLET

Whanganui Inlet is a large (2,741ha), relatively unmodified, shallow, well-flushed, seawater-dominated, tidal lagoon type estuary that is open to the sea via a narrow entrance mouth. The inlet is the third largest estuary of its type in the South Island and is located 19km southwest of Farewell Spit at the top of the west coast of NZ's South Island (Figure 1). It is fed by 4 main streams on the south and east sides, [Mangarakau Drain (mean flow 0.66$m^3.s^{-1}$), Mangarakau Stream (0.48$m^3.s^{-1}$), Wairoa River (0.16$m^3.s^{-1}$), and Muddy Creek (0.59$m^3.s^{-1}$) - flow data from NIWA Coastal Explorer] and a large number of smaller streams. A number of other water bodies (e.g. the Kaihoka Lakes and Lake Otuhie) in the immediate vicinity increase the value of the estuary/freshwater complex for wildlife. Much of the estuary catchment is forest (primarily native 91%), with intensive pastoral use at 6%. The road along the southern and eastern estuary margins has resulted in numerous causeways restricting tidal flushing to many of the upper estuary arms.

Previous broad scale mapping (Davidson 1990) identified the dominant intertidal estuary habitat as seagrass (859ha) growing predominantly in soft muds, sandflats (826ha), mudflats (146ha), saltmarsh (96ha), and cobble, gravel and rock fields (27ha). The subtidal zone comprised 769ha (28%) of the estuary area. There has been some historical loss of high value saltmarsh habitat due to reclamation and drainage around margin areas (~60ha), with resulting shoreline modification (e.g. seawalls, bunds, roads) now restricting the capacity of saltmarsh to migrate inland in response to predicted sea level rise.

The estuary is valued for its aesthetic appeal, rich biodiversity, duck shooting, whitebaiting, fishing, boating, walking, and scientific appeal. It is a dual protected area with a marine reserve in the southern third and a wildlife reserve over the remaining two-thirds, and a RAMSAR application is pending on Westhaven Inlet, Mangarakau Swamp and Lake Otuhie. Ecologically, habitat diversity and condition is high. It has almost all of its intertidal vegetation intact, including saltmarsh (113ha) and large areas of seagrass (778ha in 2013), as well as dunes, cliffs, islands, rock platforms, underwater reefs, and a well-vegetated terrestrial margin dominated by coastal forest (including kahikatea, pukatea, rata, beech, rimu and nikau palm). Approximately 30 species of marine fish use the inlet at some stage of their life history. It is an important breeding and nursery area for snapper, flatfish, kahawai and whitebait. It is also important for bird life (particularly waders), and is connected to large areas of relatively unmodified wetland, freshwater streams and terrestrial vegetation.

1. Introduction (continued)

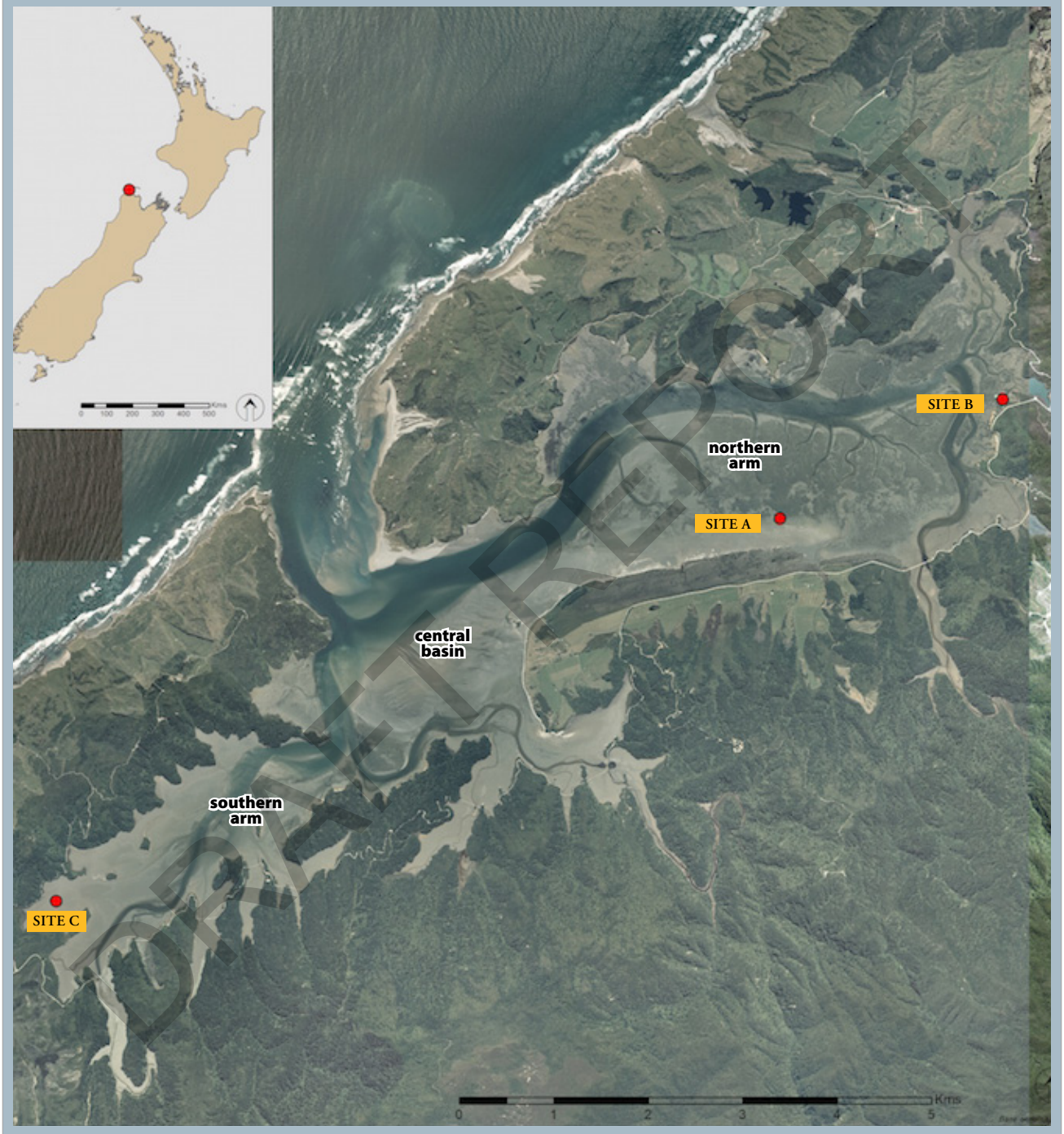


Figure 1. Whanganui Inlet - location of fine scale monitoring and sediment plate sites.

2. METHODS

FINE SCALE MONITORING

Fine scale monitoring is based on the methods described in the National Estuary Monitoring Protocol (NEMP; Robertson et al. 2002), and subsequent extensions (e.g. Robertson et al. 2016b) and provides detailed information on indicators of chemical and biological condition of the dominant habitat type in the estuary. This is most commonly unvegetated intertidal mudflats at low-mid water (avoiding areas of significant vegetation and channels) with 1-2 sites per estuary (although this varies depending on estuary size or complexity). The recently developed NZ ETI (Robertson et al. 2016a,b) also requires assessment of sediment condition in the primary mud deposition zone of estuaries where eutrophic conditions are most likely to be first expressed.

Within the selected intertidal sites, samples are collected and analysed for the following variables.

- Salinity, Oxygenation (Redox Potential Discontinuity depth - aRPD or RPmV),
- Grain size (% mud, sand, gravel).
- Organic Matter and Nutrients: Total Organic Carbon (TOC), Total Nitrogen (TN), Total Phosphorus (TP).
- Heavy metals and metalloids: Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), Zinc (Zn) plus Arsenic (As). Analyses are based on non-normalised whole sample fractions to allow direct comparison with ANZECC (2000) Guidelines.
- Macroinvertebrate abundance and diversity (infauna and epifauna).
- Other potentially toxic contaminants: measured in certain estuaries where a risk has been identified.

Synoptic water samples from estuary surface and bottom waters and subtidal sediment samples also provide very useful information to support intertidal assessments where estuaries include subtidal habitat that is at risk from eutrophication and sedimentation (e.g. deep stratified areas or main channel sections in estuaries where the mouth is restricted).

For Whanganui Inlet, two fine scale sampling sites (A and B) have previously been established in dense seagrass beds in the mid-low water zone, the most sensitive high value intertidal habitat type within the estuary. To increase spatial coverage in the estuary, a new site (C) was established in 2017 in muddy (soft to very soft mud) unvegetated intertidal flats in the southwest arm of estuary near the established sediment monitoring plates (Figure 1). Site coordinates are presented in Appendix 2.

When sampled the site is marked out and divided into 12 equal sized plots and within each area, ten plots are selected, a random position defined within each, and sampling undertaken as described in the following sections:

Physical and chemical analyses

- At each site, average apparent Redox Potential Discontinuity (aRPD) depth was recorded within each plot, and in one representative plot, redox potential (RPmV) was directly measured with an oxidation-reduction potential (ORP) meter at 0, 1, 3, 6 and 10cm depths below the surface.
- At each site, three samples (two a composite from four plots and one a composite from two plots) of the top 20mm of sediment (each approx. 250gms) were collected adjacent to each core for chemical analysis. All samples were kept in a chilly bin in the field before dispatch to R.J. Hill Laboratories for chemical analysis (details of lab methods and detection limits in Appendix 1):
- Samples were tracked using standard Chain of Custody forms and results checked and transferred electronically to avoid transcription errors.
- Photographs were taken to record the general site appearance.
- Salinity of the overlying water was measured at low tide.

Infauna (animals within sediments) and epiflora/fauna (surface dwelling plants and animals)

From each of 10 plots, 1 sediment core [130mm diameter (area = 0.0133m^2) tube] was collected.

- The core tube was manually driven 150mm into the sediments, removed with the core intact and inverted into a labelled 0.5mm nylon mesh bag. Once all replicates had been collected at a site, the bags were transported to a nearby source of seawater and fine sediments were washed from the core. The infauna remaining were carefully emptied into a plastic container with a waterproof label and preserved in 70% isopropyl alcohol - seawater solution.

2. Methods (continued)

- The samples were sorted by experienced Wriggle staff before being sent to a commercial laboratory for counting and identification (Gary Stephenson, Coastal Marine Ecology Consultants, Appendix 1).
- Where present, macroalgae and seagrass vegetation (including roots), was collected within each of three representative 0.0625m^2 quadrats, squeezed (to remove free water), and weighed in the field. In addition, the % cover of each plant type was measured.

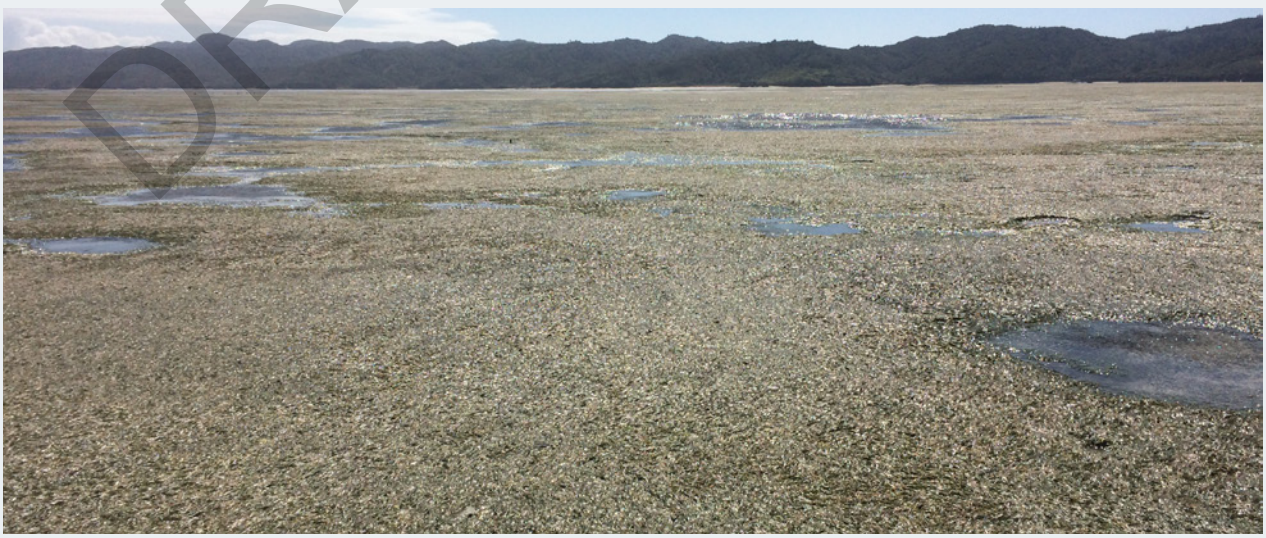
Conspicuous epifauna visible on the sediment surface within the 60m x 30m sampling area were semi-quantitatively assessed based on the UK MarClim approach (MNCR 1990, Hiscock 1996, 1998). Epifauna species were identified and allocated a SACFOR abundance category based on percentage cover (Table A, Appendix 1), or by counting individual organisms >5mm in size within quadrats placed in representative areas (Table B, Appendix 1). Species size determines both the quadrat size and SACFOR density rating applied, while photographs are taken and archived for future reference. This method is ideally suited to characterise often patchy intertidal epifauna, and macroalgal and microalgal cover.

Sediment Accumulation

To determine the future sedimentation rate, a simple method of measuring how much sediment builds up over a buried plate over time is used. Once a plate has been buried and levelled, probes are pushed into the sediment until they hit the plate and the penetration depth is measured. A number of measurements on each plate are averaged to account for irregular sediment surfaces, and a number of plates are buried to account for small scale variance. These are then measured over time (commonly annually) to assess sediment accrual.

Three sites, each with four plates (20cm square concrete paving stones) were established in December 2015 in Whanganui Inlet in upper tidal deposition areas where fine muds accumulate. Two sites were at the fine scale Sites A and B located in dense seagrass beds, and one at a soft mud site in the southern arm adjacent to Site C (Figure 1). Plates were buried deeply in the sediments where stable substrate was located and positioned 2m apart in a linear configuration along the baseline of each fine scale site or at a marked transect. Wooden pegs were used to mark the start, middle and end of each transect (0m, 5m and 10m respectively). To ensure plate stability, steel waratahs (0.8 or 1.6m long) were driven into the sediments until firm substrate was encountered beneath the plates, and the plates placed on these. Steel reinforcing rod was also placed horizontally next to buried plates to enable relocation with a metal detector.

The GPS positions of each plate were logged, and the depth from the undisturbed mud surface to the top of the sediment plate recorded (Appendix 2). In the future, these depths will be measured annually and, over the long term, will provide a measure of the rate of sedimentation in the estuary.



Whanganui Inlet northern arm Site B 2017, with dense seagrass beds in deep soft muds.

3. RESULTS

A summary of the results of the 6 January 2017 fine scale intertidal monitoring of Whanganui Inlet is presented in Table 1, with detailed results in Appendix 2. With the inclusion of Ben Robertson's PhD sampling, a 3 year consecutive annual baseline monitoring block has now been completed at Sites A and B, with a single year of data from Site C. While a 3 year baseline would ideally be completed at all sites, it is recognised that TDC need to allocate and balance available resources across a wider coastal monitoring programme where higher priorities may exist.

Table 1. Summary of fine scale physical, chemical, plant growth and macrofauna results (means), Whanganui Inlet, December 2015 and January 2017.

Year Site	aRPD	Salinity	TOC	Mud	Sand	Gravel	Cd	Cr	Cu	Ni	Pb	Zn	As	Hg	TN	TP
	cm	ppt	%				mg/kg									
15/16 A	1	33	0.53	32.0	67.0	1.0	0.017	10.1	4.7	4.7	8.6	30.0	2.7	<0.01	667	413
15/16 B	1	33	1.19	68.3	31.1	0.6	<0.01	18.7	8.2	8.8	14.4	52.0	5.0	<0.01	933	733
16/17 A	1	32	0.49	33.5	65.2	1.1	0.0212	9.3	4.8	8.22	4.22	30.0	2.5	<0.01	600	378
16/17 B	1	32	1.03	69.1	29.1	1.8	0.0498	17.7	8.8	14.9	7.8	53.4	4.9	0.0136	720	772
16/17 C	1	29	0.70	82.9	16.6	0.5	0.0236	15.4	7.0	13.0	7.58	45.0	5.2	0.01	600	896

Year Site	Seagrass Biomass and Cover	Macroalgal Biomass and Cover	Macrofauna Abundance	Macrofauna Richness
	g.m^{-2} wet weight (%)	g.m^{-2} wet weight (%)	Individuals/m^2	Species/core
15/16 A	2213 (90-100%)	0	2162	8.2
15/16 B	3920 (90-100%)	0	1912	8.0
16/17 A	2090 (90-100%)	0	1695	7.3
16/17 B	2500 (90-100%)	0	1304	7.7
16/17 C	0 (0)	0	2102	6.6

Sampling years represent consecutive annual summer sampling undertaken in December 2015 and January 2017.
Ben Robertson's PhD sampling was undertaken at a similar time in 2014/15.

4. MONITORING RECOMMENDATIONS

Whanganui Inlet has been identified by TDC as a priority for monitoring, and is a key part of TDC's coastal monitoring programme being undertaken in a staged manner throughout the Tasman region. Based on the December 2015 and January 2017 fine scale monitoring results, in conjunction with sedimentation rate and broad scale assessments and risk indicator ratings, it is recommended that monitoring continue in Whanganui Inlet as follows:

Fine Scale Monitoring

A three year baseline of fine scale intertidal sampling is now available for Sites A, B with inaugural sampling completed at Site C. Undertake repeat monitoring ate all three sites on a 5 yearly cycle (next scheduled for 2022) at which time it is proposed that a full analysis and discussion of the results be undertaken.

Broad Scale Habitat Mapping

It is recommended that broad scale habitat mapping be undertaken at 10 yearly intervals (next scheduled for 2026).

Intensive Investigations

The 2016 broad scale report also recommended investigations be undertaken in order to better understand issues related to excessive muddiness and seagrass loss in the estuary.

The combined results will provide valuable information on current estuary condition and ongoing trends, particularly regarding the primary issues in the estuary of elevated muddiness and loss of seagrass.

5. ACKNOWLEDGEMENTS

This monitoring has been undertaken with the support and assistance of Trevor James (Coastal Scientist, TDC).

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Whanganui Inlet, upper southern arm, Site C, 2017.

APPENDIX 1. DETAILS ON ANALYTICAL METHODS

Indicator	Laboratory	Method	Detection Limit
Infauna Sorting and ID	CMES	Coastal Marine Ecology Consultants (Gary Stephenson) *	N/A
Grain Size	R.J Hill	Wet sieving, gravimetric (calculation by difference).	0.1 g/100g dry wgt
Total Organic Carbon	R.J Hill	Catalytic combustion, separation, thermal conductivity detector (Elementary Analyser).	0.05g/100g dry wgt
Total recoverable cadmium	R.J Hill	Nitric/hydrochloric acid digestion, ICP-MS (low level) USEPA 200.2.	0.01 mg/kg dry wgt
Total recoverable chromium	R.J Hill	Nitric/hydrochloric acid digestion, ICP-MS (low level) USEPA 200.2.	0.2 mg/kg dry wgt
Total recoverable copper	R.J Hill	Nitric/hydrochloric acid digestion, ICP-MS (low level) USEPA 200.2.	0.2 mg/kg dry wgt
Total recoverable nickel	R.J Hill	Nitric/hydrochloric acid digestion, ICP-MS (low level) USEPA 200.2.	0.2 mg/kg dry wgt
Total recoverable lead	R.J Hill	Nitric/hydrochloric acid digestion, ICP-MS (low level) USEPA 200.2.	0.04 mg/kg dry wgt
Total recoverable zinc	R.J Hill	Nitric/hydrochloric acid digestion, ICP-MS (low level) USEPA 200.2.	0.4 mg/kg dry wgt
Total recoverable mercury	R.J Hill	Nitric/hydrochloric acid digestion, ICP-MS (low level) USEPA 200.2.	<0.27 mg/kg dry wgt
Total recoverable arsenic	R.J Hill	Nitric/hydrochloric acid digestion, ICP-MS (low level) USEPA 200.2.	<10 mg/kg dry wgt
Total recoverable phosphorus	R.J Hill	Nitric/hydrochloric acid digestion, ICP-MS (low level) USEPA 200.2.	40 mg/kg dry wgt
Total nitrogen	R.J Hill	Catalytic combustion, separation, thermal conductivity detector (Elementary Analyser).	500 mg/kg dry wgt
Dry Matter (Env)	R.J. Hill	Dried at 103°C (removes 3-5% more water than air dry).	

* Coastal Marine Ecology Consultants (established in 1990) specialises in coastal soft-shore and inner continental shelf soft-bottom benthic ecology. Principal, Gary Stephenson (BSc Zoology) has worked as a marine biologist for more than 25 years, including 13 years with the former New Zealand Oceanographic Institute, DSIR. Coastal Marine Ecology Consultants holds an extensive reference collection of macroinvertebrates from estuaries and soft-shores throughout New Zealand. New material is compared with these to maintain consistency in identifications, and where necessary specimens are referred to taxonomists in organisations such as NIWA and Te Papa Tongarewa Museum of New Zealand for identification or cross-checking.

Epifauna (surface-dwelling animals)

SACFOR Percentage Cover and Density Scales (after Marine Nature Conservation Review - MNCR)

A. PERCENTAGE COVER	Growth Form	
	i. Crust/Meadow	ii. Massive/Turf
>80	S	-
40-79	A	S
20-39	C	A
10-19	F	C
5-9	O	F
1-4	R	O
<1	-	R

SACFOR Category
S = Super Abundant
A = Abundant
C = Common
F = Frequent
O = Occasional
R = Rare

- Whenever percentage cover can be estimated for an attached species, it should be used in preference to the density scale.
- The massive/turf percentage cover scale should be used for all species except those classified under crust/meadow.
- Where two or more layers exist, for instance foliose algae overgrowing crustose algae, total percentage cover can be over 100%.

B. DENSITY SCALES

SACFOR size class				Density				
i	ii	iii	iv	0.25m²	1.0m²	10m²	100m²	1,000m²
<1cm	1-3cm	3-15cm	>15cm	(50x50cm)	(100x100cm)	(3.16x3.16m)	(10x10m)	(31.6x31.6m)
S	-	-	-	>2500	>10,000			
A	S	-	-	250-2500	1000-9999	>10,000		
C	A	S	-	25-249	100-999	1000-9999	>10,000	
F	C	A	S	3-24	10-99	100-999	1000-9999	>10,000
O	F	C	A	1-2	1-9	10-99	100-999	1000-9999
R	O	F	C			1-9	10-99	100-999
-	R	O	F				1-9	10-99
-	-	R	O					1-9
-	-	-	R					<1

APPENDIX 2. 2016/17 DETAILED RESULTS

Fine Scale Site Boundaries

Whanganui Site A	1	2	3	4
NZTM EAST	1566187	1566161	1566136	1566161
NZTM NORTH	5507268	5507326	5507310	5507254
Whanganui Site C	1	2	3	4
NZTM EAST	1558497	1558541	1558561	1558518
NZTM NORTH	5503232	5503191	5503212	5503254

Whanganui Site B	1	2	3	4
NZTM EAST	1568490	1568431	1568433	1568493
NZTM NORTH	5508582	5508575	5508546	5508552

Fine Scale Station Locations, Whanganui Inlet, January 2017

Whanganui Site A	1	2	3	4	5	6	7	8	9	10
NZTM EAST	1566181	1566174	1566165	1566161	1566154	1566158	1566163	1566169	1566159	1566157
NZTM NORTH	5507277	5507286	5507299	5507315	5507311	5507298	5507284	5507275	5507267	5507280
Whanganui Site B	1	2	3	4	5	6	7	8	9	10
NZTM EAST	1568487	1568476	1568466	1568452	1568453	1568468	1568476	1568487	1568485	1568472
NZTM NORTH	5508579	5508579	5508579	5508576	5508568	5508567	5508567	5508568	5508561	5508558
Whanganui Site C	1	2	3	4	5	6	7	8	9	10
NZTM EAST	1558505	1558516	1558528	1558539	1558548	1558535	1558524	1558511	1558520	1558530
NZTM NORTH	5503231	5503220	5503209	5503197	5503206	5503214	5503229	5503240	5503247	5503233

Whanganui Inlet sediment plate and peg locations and depth of plate (mm) below surface

Site A Sed Plates	NZTM EAST	NZTM NORTH	Dec 2015 (mm)	Jan 2017 (mm)	
Peg 1	1566187	5507266	+100	-	FMS - Firm Muddy Sand
Plate 1	1566186	5507266	96	107	
Plate 2	1566184	5507264	96	113	
Peg 2	1566183	5507263	+100	-	
Plate 3	1566182	5507264	112	131	
Plate 4	1566181	5507263	104	120	
Peg 3	1566179	5507262	+100	-	
Site B Sed Plates	NZTM EAST	NZTM NORTH			
Peg 1	1568491	5508583	+100	-	VSM - Very Soft Mud
Plate 1	1568493	5508581	116	151	
Plate 2	1568493	5508580	95	123	
Peg 2	1568493	5508579	+100	-	
Plate 3	1568493	5508578	88	114	
Plate 4	1568493	5508576	86	120	
Peg 3	1568493	5508573	+100	-	
Site C Sed Plates	NZTM EAST	NZTM NORTH			
Peg 1	1558497	5503232	+100	-	SM - Soft Mud
Plate 1	1558498	5503233	75	75	
Plate 2	1558500	5503234	103	103	
Peg 2	1558501	5503236	+100	-	
Plate 3	1558502	5503237	77	75	
Plate 4	1558502	5503238	77	77	
Peg 3	1558504	5503240	+100	-	

Epifauna abundance and macroalgal cover for Whanganui Inlet fine scale sites A, B and C, January 2017

Group	Family	Species	Common name	Scale	Class	A	B	C
Bivalves	Veneridae	*Austrovenus stutchburyi*	Cockle	#	iii	F	R	-
Topshells	Amphibolidae	*Amphibola crenata*	Estuary mud snail	#	ii	O	-	R
	Buccinidae	*Cominella glandiformis*	Mudflat whelk	#	ii	O	F	-
	Trochidae	*Diloma subrostrata*	Grooved topshell	#	ii	O	C	-
	Buccinidae	*Zeacumantus lutulentus*	Spire shell	#	ii	A	F	-
Red algae	Gracilariaceae	*Gracilaria chilensis*	Gracilaria weed	%	ii	R	R	-
Green algae	Ulvaceae	*Ulva lactuca*	Sea lettuce	%	ii	R	R	-

Physical and chemical results for Whanganui Inlet fine scale sites A, B and C, January 2017

Year/Site/Rep	RPD	Salinity	TOC	Mud	Sand	Gravel	Cd	Cr	Cu	Ni	Pb	Zn	As	Hg	TN	TP
	cm	ppt	%				mg/kg									
2017 A 1-4 [b]	1	32	0.58	31.2	67.2	1.5	0.025	10	5.1	8.8	4.6	32	2.6	< 0.010	600	410
2017 A-4-8 [b]	1	32	0.48	40.5	58.3	1.0	0.02	9.4	4.9	8.2	4.2	30	2.5	< 0.010	<500	370
2017 A-9-10 [b]	1	32	0.33	24.2	75.2	0.7	0.016	7.8	3.9	7.1	3.5	26	2.2	< 0.010	<500	330
2017 B-1-4 [b]	1	32	1.18	67.9	28.9	3.2	0.055	18.9	9.5	15.9	8.6	56	5	0.013	800	750
2017 B-4-8 [b]	1	32	0.80	69.0	30.3	0.7	0.039	16	7.8	13.5	6.7	49	4.6	0.012	600	770
2017 B-9-10 [b]	1	32	1.20	71.6	27.0	1.4	0.061	18.7	9.3	15.6	8.4	57	5.3	0.018	800	820
2017 C-1-4 [b]	1	29	0.68	79.9	19.5	0.6	0.023	14.8	6.7	12.4	7.5	43	5.5	0.01	600	850
2017 C-4-8 [b]	1	29	0.70	84.7	14.9	0.5	0.022	15.6	7.1	13.3	7.6	46	5	< 0.010	600	910
2017 C-9-10 [b]	1	29	0.73	85.5	14.0	0.3	0.028	16.2	7.3	13.8	7.7	47	5	< 0.010	600	960
ISQG-Low [a]	-	-	-	-	-	-	1.5	80	65	21	50	200	20	0.15	-	-
ISQG-High [a]	-	-	-	-	-	-	10	370	270	52	220	410	70	1	-	-

[a] ANZECC 2000. [b] composite samples.

Redox Potential (mV) for Whanganui Inlet fine scale sites A, B and C, January 2017

Year/Site	Redox Potential (mV)				
	0cm	1 cm	3cm	6cm	10cm
2017 A	19	-320	-363	-406	-419
2017 B	29	-180	-300	-368	-396
2017 C	11	-226	-235	-321	-329

Seagrass (*Zostera muelleri*) cover and biomass for Whanganui Inlet fine scale sites A, B and C, Jan. 2017

Year/Site/Rep	Seagrass Cover	Seagrass Biomass
	%	g/m^2
2017 A 1-4 [b]	90-100%	2030
2017 A-4-8 [b]	90-100%	2150
2017 A-9-10 [b]	90-100%	2100
2017 B-1-4 [b]	90-100%	2680
2017 B-4-8 [b]	90-100%	2425
2017 B-9-10 [b]	90-100%	2400
2017 C-1-4 [b]	0%	0
2017 C-4-8 [b]	0%	0
2017 C-9-10 [b]	0%	0

Appendix 2. 2016/17 Detailed results (continued)

Infauna (numbers per 0.01327m² core) **(Note NA = Not Assigned)**

Whanganui Inlet Sites A and B, January 2017

	Species	NZ Hybrid AMBI	A-01	A-02	A-03	A-04	A-05	A-06	A-07	A-08	A-09	A-10	B-01	B-02	B-03	B-04	B-05	B-06	B-07	B-08	B-09	B-10
Anthozoa	*Anthopleura aureoradiata*	3					1															
Anthozoa	Edwardsia sp. 1	2			1										1	2						4
Nemertea	Nemertea sp. 3	NA						1														
Polychaeta	*Abarenicola affinis*	1									1	1										
Polychaeta	*Boccardia acus*	2	6		2	1						3	1			2				1	1	
Polychaeta	*Boccardia syrtis*	2																				
Polychaeta	*Hyboscolex longiseta*	3											1		1		2	3	2	4	3	
Polychaeta	Maldanidae	1	1						1													
Polychaeta	Nereididae	3	3	1	1		2	2		8	2	1		1	1	1			4	2	1	
Polychaeta	*Nicon aestuariensis*	3											5	3	2	1	4	1	2	3	2	2
Polychaeta	*Perinereis vallata*	2	5	1		1	5	3		2	2	3		1			1	3	1	4	1	2
Polychaeta	*Scolecolepides benhami*	4						1		4	5											
Polychaeta	*Scoloplos cylindrifer*	1	2	4	1	1	4			3	2	5										
Polychaeta	Spionidae sp. 1	NA																				
Polyplacophora	*Chiton glaucus*	2					1															
Gastropoda	*Cominella glandiformis*	3	1												2							
Gastropoda	Gastropoda Unidentified	NA																1	2			
Gastropoda	*Micrelenchus tenebrosus*	1															1					
Gastropoda	*Notoacmea* spp.	2		2				1							1	1			3			1
Gastropoda	*Zeacumantus lutulentus*	2	2	8		1	10	16	10	15	11	8				1		3	1	2	1	
Bivalvia	*Arthritica* sp. 1	4						1		1				1	10	2		1	7		2	3
Bivalvia	*Austrovenus stutchburyi*	2	4	4	4	2	5	2	4	3	1	3	2		1	3		2	3	3	2	1
Bivalvia	*Linucula hartvigiana*	2		3				1					2	2	3	1	5	6	7	4		1
Bivalvia	*Paphies australis*	2						1														
Bivalvia	*Tellina liliana*	2		1																		
Crustacea	Amphipoda sp. 1	5	1																			
Crustacea	Amphipoda sp. 2	4																				
Crustacea	*Austrohelice crassa*	5		1								1										
Crustacea	*Halicarcinus whitei*	3		1					1								1					
Crustacea	Phoxocephalidae sp. 1	2																				
Insecta	Diptera sp. 1	2							1													
Asteroidea	*Patiriella regularis*	NA																1	1			
Total species in sample			**9**	**10**	**5**	**5**	**7**	**10**	**5**	**7**	**7**	**8**	**5**	**5**	**9**	**9**	**6**	**9**	**11**	**8**	**8**	**7**
Total individuals in sample			**25**	**26**	**9**	**6**	**28**	**29**	**17**	**36**	**24**	**25**	**11**	**8**	**22**	**14**	**14**	**21**	**33**	**23**	**13**	**14**

Appendix 2. 2016/17 Detailed results (continued)

Infauna (numbers per 0.01327m² core) **(Note NA = Not Assigned)**

Whanganui Inlet Site C, January 2017

	Species	NZ Hybrid AMBI	C-01	C-02	C-03	C-04	C-05	C-06	C-07	C-08	C-09	C-10
Anthozoa	*Anthopleura aureoradiata*	3										
Anthozoa	Edwardsia sp. 1	2	3							2	2	1
Nemertea	Nemertea sp. 3	NA										
Polychaeta	*Abarenicola affinis*	1										
Polychaeta	*Boccardia acus*	2				2					1	
Polychaeta	*Boccardia syrtis*	2				1	2					
Polychaeta	*Hyboscolex longiseta*	3										
Polychaeta	Maldanidae	1										
Polychaeta	Nereididae	3	1		2	2	1	1	1	1	1	2
Polychaeta	*Nicon aestuariensis*	3	1	3	5	4	6	3	1	2	1	3
Polychaeta	*Perinereis vallata*	2										
Polychaeta	*Scolecolepides benhami*	4	4	4	5		3	4	2		5	6
Polychaeta	*Scoloplos cylindrifer*	1										
Polychaeta	Spionidae sp. 1	NA					1					
Polyplacophora	*Chiton glaucus*	2										
Gastropoda	*Cominella glandiformis*	3		2			1				1	
Gastropoda	Gastropoda Unidentified	NA										
Gastropoda	*Micrelenchus tenebrosus*	1										
Gastropoda	*Notoacmea spp.*	2										
Gastropoda	*Zeacumantus lutulentus*	2										
Bivalvia	*Arthritica* sp. 1	4	11	5	25	26	24	19	4	5	8	23
Bivalvia	*Austrovenus stutchburyi*	2				1		1			2	1
Bivalvia	*Linucula hartvigiana*	2										
Bivalvia	*Paphies australis*	2										
Bivalvia	*Tellina liliana*	2										
Crustacea	Amphipoda sp. 1	5							1			
Crustacea	Amphipoda sp. 2	4	2									
Crustacea	*Austrohelice crassa*	5					1		2			
Crustacea	*Halicarcinus whitei*	3										
Crustacea	*Phoxocephalidae* sp. 1	2	7	1	2	1	2		3	1	4	4
Insecta	Diptera sp. 1	2										
Asteroidea	*Patiriella regularis*	NA										
Total species in sample			**7**	**5**	**5**	**7**	**9**	**5**	**7**	**5**	**9**	**7**
Total individuals in sample			**29**	**15**	**39**	**37**	**41**	**28**	**14**	**11**	**25**	**40**