‘MANGEMANGEROA MEDICAL’

An Estuarine Health Check

A study of the water quality of the

Mangemangeroa Estuary

By Ethan McCormick

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Introduction

The Mangemangeroa Reserve is a rare estuarine environment with bush and forest bordering entanglements of mangroves leading into the estuary waterway. It's diverse ecosystem of shellfish, crabs, worms, birds and plants makes it unique for suburban Auckland.

Estuaries are a meeting place of fresh and salt water and being at the end of our waterway systems they are a very precious resource. Factors that can pollute our estuaries are nutrients, pathogens and sediment. Nutrients and pathogens get into the water from fertilisers, sewerage, storm water and detergents. Sediment can get into an estuary from runoff and erosion and can be accelerated by land development and floods. It can damage the gills of fish, smother marine life and plants, and destroy the ecosystem. Eventually an estuary will die when it fills with sediment and becomes dry land.

The Mangemangeroa has a long history. The native Maori Tangata Whenua of the area were the Ngai Tai Iwi and they thrived on the rich marine life which included scallops, pipis and mussels. In summer months mako sharks would come into the waterway. The French explorer Dumont D'urville in 1827 named the Whitford embayment area 'Bay Cruise'. This included the Mangemangeroa, Turanga and Waikopua estuaries. From a picture taken circa 1864 there was little sediment and mangroves present and ferries made regular trips down the estuaries. The land of the Mangemangeroa was farmed from 1870 until 1992 by the Somervilles.

There has been a large increase in sedimentation in the estuary since the 1950's. This was most probably due to land development in the area. Dredging of the Pine Harbour Marina began in 1986 with the sediment being dumped in the Whitford Embayment until 2007, which may also have had an effect. The Friends of the Mangemangeroa have been busy since 2002 replanting the valley which helps reduce pollution and sedimentation in the estuary. However the Whitford side of the estuary is bordered by open lifestyle blocks and farmland.

NIWA undertake studies on the deposition of sediment in the estuary while the nearest estuaries that Auckland Council do water quality testing on are the Turanga and Tamaki estuaries. However it appears that sedimentation is still increasing in the Mangemangeroa and there has been no water quality testing done there. I wanted to find out what the water quality was like and if sedimentation is affecting this.

Question

What is the water quality of the Mangemangeroa Estuary like and how is sedimentation affecting it?

Aim

To test the water quality of the Mangemangeroa Estuary and to see if sedimentation affects it.

Hypothesis

The water quality of the Mangemangeroa Estuary will be satisfactory however increased sedimentation will be affecting estuary health in some areas.

Variables

<u>Independent variable:</u>

The area of the estuary that is being tested.

<u>Dependent variables:</u>

Water temperature, conductivity, salinity, DO % saturation, DO ppm, pH, Secchi depth.

<u>Controlled variables:</u>

Tide level, the sampler, weather conditions.

Equipment

- **Inflatable boat**
- **Clip board or folder**
- **Vivid**
- **Data sheets**
- **Eutech ecoscan con 6**
- **PH-037 Waterproof pH meter**
- **TPS WP-82 meter**
- **Secchi disk**
- **Clothes pegs**
- **Tape measure or ruler**
- **Piece of refill paper**
- **Pen and pencil**
- **Phone or device**
- **Life jackets**
- **Other method instructions**
- **Freshwater (to rinse probes in)**
- **Backpacks or bags (to store the equipment in)**

Measuring Turbidity using a secchi disk

Method

1. **Select four testing sites evenly spread across estuary**
2. **Anchor inflatable boat at testing site at high tide**
3. **Record all necessary information on the data sheet (Area number, GPS Coordinates, Date, Time, Tides, Weather, Flow rate, Previous weather/Rainfall and any other observations)**
4. **Use the Eutech ecoscan con 6 meter to measure conductivity and record on data sheet (see other method sheets in log book)**
5. **Measure the water temperature using the Eutech meter, and record on the data sheet. (see other method sheets in log book)**
6. **Calculate the salinity (using the 'friends of five creeks salinity conversion' website) by entering the conductivity and temperature and then calculating, and record this salinity on the data sheet (see how to convert conductivity to salinity in log book)**
7. **Measure the D.O Percent saturation using the TPS WP-82 dissolved oxygen meter, and then record on the data sheet (see other method sheets in log book)**
8. **Measure the D.O ppm using the dissolved oxygen meter, and then record on the data sheet (see other method sheets in log book)**
9. **Measure the pH using the PH-037 Waterproof pH meter, and record the result on the data sheet (see other method sheets in log book)**

10. **Measure the secchi depth using the secchi disk, and record this on the data sheet (see other method sheets in log book)**
11. **Pull up anchor and move to next testing site, and repeat this process.**

Map showing testing areas

RESULTS

TABLES SHOWING WATER TESTING RESULTS PER AREA

TABLE 1: AREA 1

	Day 1	Day 2	Day 3	Mean
Water Temp °C	13.9	14.8	13.3	14.0
Conductivity mS	42.4	45.9	26.4	38.2
Salinity	35.5	37.9	21.4	31.6
D.O % Saturation	92.6	77.3	95.2	88.4
D.O ppm	7.8	6.2	9.1	7.7
pH	8.2	8.0	8.2	8.1
Secchi Depth cm	60.0	75.0	65.0	66.7
Turbidity NTU	15.0	11.0	14.0	13.3

TABLE 2: AREA 2

	Day 1	Day 2	Day 3	Mean
Water Temp °C	14	14.8	13	13.9
Conductivity mS	50	48	42.3	46.8
Salinity	41.9	39.9	36.3	39.4
D.O % Saturation	92	83	102	92.3
D.O ppm	7.3	6.7	8.6	7.5
pH	8.2	8.1	8.2	8.2
Secchi Depth cm	60.0	100.0	75.0	78.3
Turbidity NTU	15.0	5.0	11.0	10.3

TABLE 3: AREA 3

	Day 1	Day 2	Day 3	Mean
Water Temp °C	14.4	14.7	13.2	14.1
Conductivity mS	52	52	53.8	52.6
Salinity	41.9+	41.9+	41.9+	41.9+
D.O % Saturation	92	83.2	96.2	90.5
D.O ppm	7.3	6.8	7.0	7.1
pH	8.2	8.2	8.3	8.2
Secchi Depth cm	100.0	85.0	75.0	86.7
Turbidity NTU	5.0	9.0	11.0	8.3

TABLE 4: AREA 4

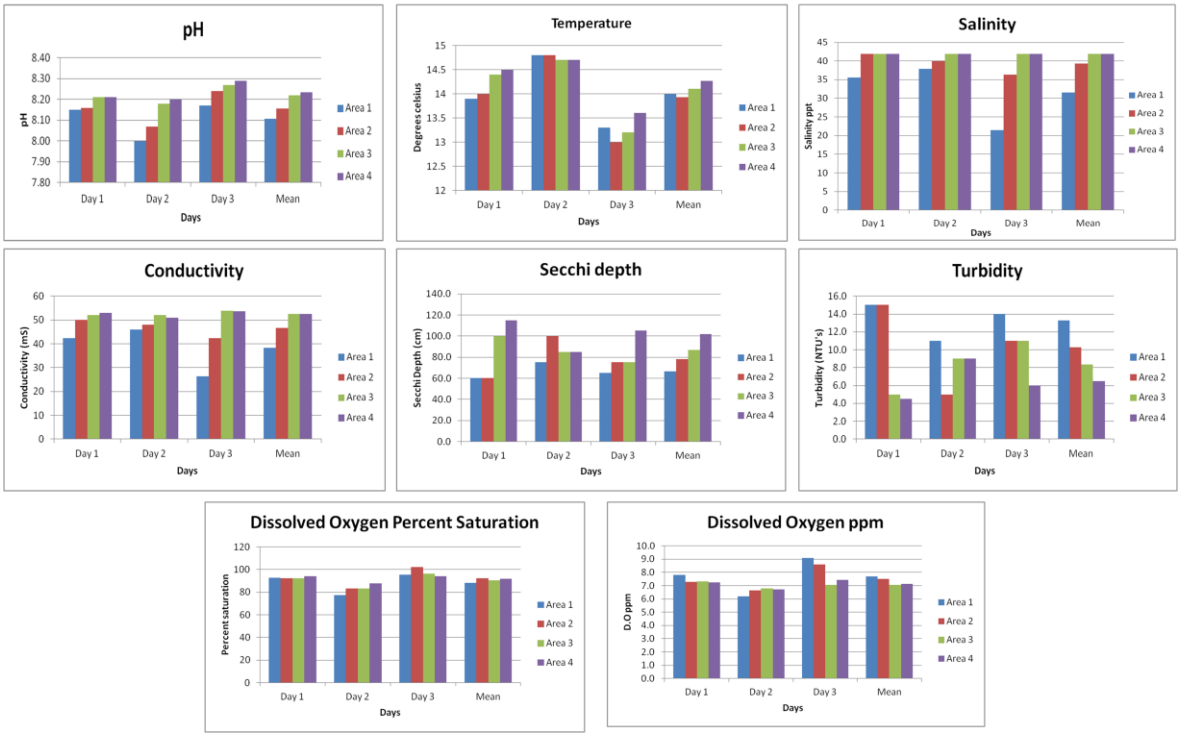
	Day 1	Day 2	Day 3	Mean
Water Temp °C	14.5	14.7	13.6	14.3
Conductivity mS	53	51	53.6	52.5
Salinity	41.9+	41.9+	41.9+	41.9+
D.O % Saturation	94	87.7	94.2	92.0
D.O ppm	7.23	6.73	7.43	7.1
pH	8.21	8.2	8.29	8.2
Secchi Depth cm	115	85	105	101.7
Turbidity NTU	4.5	9	6	6.5

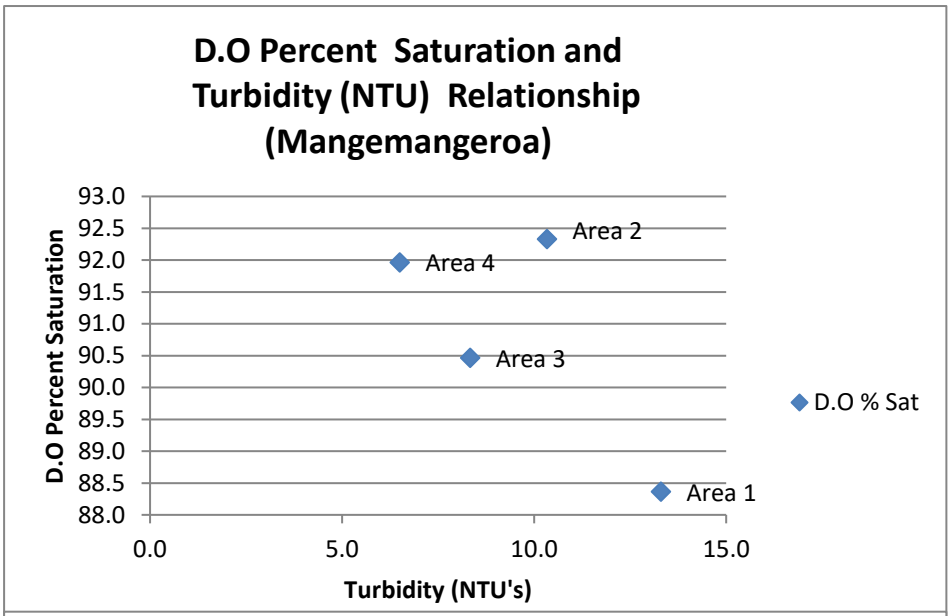
Table 5: Comparison of Mangemangeroa results to ANZECC guidelines and Auckland Council tests

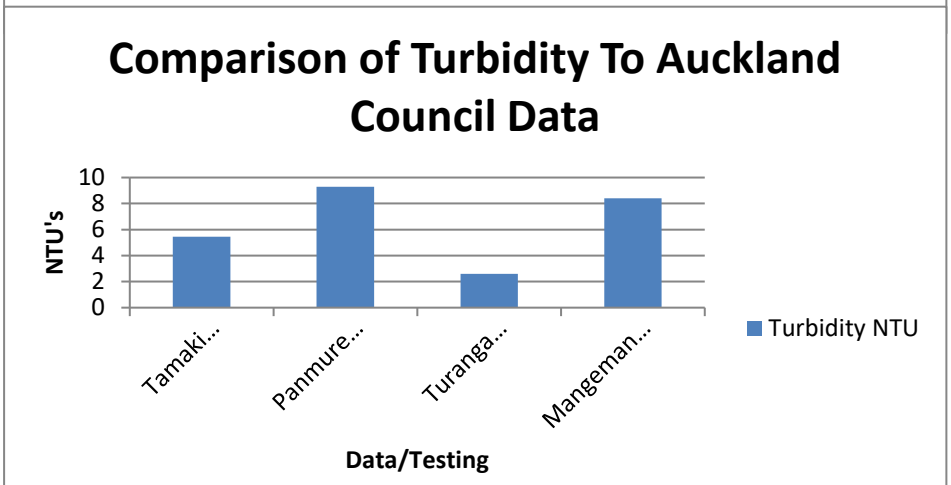
Parameter	Mangemangeroa My results	ANZECC Excellent	ANZECC Satisfactory	Tamaki A.C	Turanga A.C	Panmure A.C
Temperature °c	14.1	N/A	N/A	15.34	17.25	17.31
Conductivity	47.5	N/A	N/A	N/A	N/A	N/A
Salinity ppt	38.7	N/A	N/A	34.26	34.29	34.87
D.O % Saturation	90.8	>90	80-90	97.8	92.3	96.3
D.O ppm	7.35	N/A	N/A	7.7	7.8	6.8
pH	8.18	7.5-8	7-7.5 or 8-8.5	N/A	N/A	N/A
Turbidity (NTU)	8.4	>2	2 to 10	5.45	2.6	9.3

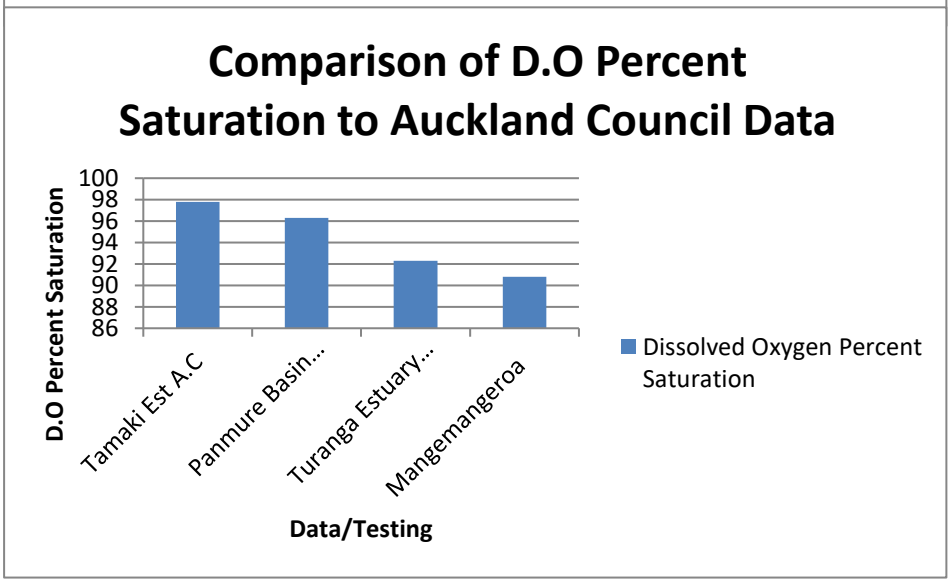
Graphs

GRAPHS SHOWING RESULTS FROM TABLES 1,2,3,4




D.O Percent Saturation and Turbidity (NTU) Relationship (Mangemangeroa)
D.O Percent Saturation
93.0
92.5
92.0
91.5
91.0
90.5
90.0
89.5
89.0
88.5
88.0
Area 2
Area 4
Area 3
Area 1
0.0
5.0
10.0
15.0
Turbidity (NTU's)
D.O % Sat


Comparison of Turbidity To Auckland Council Data
NTU's
10
8
6
4
2
0
Tamaki...
Panmure...
Turanga...
Mangeman...
Data/Testing
Turbidity NTU


Comparison of D.O Percent Saturation to Auckland Council Data
D.O Percent Saturation
100
98
96
94
92
90
88
86
Tamaki Est A.C
Panmure Basin...
Turanga Estuary...
Mangemangeroa
Data/Testing
Dissolved Oxygen Percent Saturation

Discussion

To measure the health of the Mangemangeroa Estuary I needed to find out what factors to measure. I researched previous studies and found that while no water quality testing had been done there have been studies on sedimentation by NIWA. They have found that between 1955 and 2002 over 1 metre of sediment has been deposited at the upper end of the estuary. Also during this time the mangrove forest has increased by 50%. Andrew Swales found that from 2000-2004 most of the sediment was deposited during floods and was becoming trapped in the estuary. He also found that the mangroves do not increase sedimentation rates. NIWA also started an Estuarine Ecological Monitoring Programme in 2000 which looks at sedimentation and also it's effect on invertebrates in the estuaries of the Whitford Embayment and around Auckland. This shows that the sediment mud content of the Mangemangeroa is slightly higher than surrounding estuaries. Some of the closest estuaries that Auckland Council currently do water quality testing on are the Panmure Basin, Tamaki and Turanga Estuaries. Some of the parameters they test for are Dissolved Oxygen (DO), temperature, turbidity, salinity, bacteria, nitrogen and phosphorus.

A Waikato Regional Council report outlined the parameters that they test for (which are similar to Auckland Council) as well as sampling suggestions and water quality guidelines. These guidelines are based on those recommended by the Australian and NZ Environment Conservation Council (ANZECC) and I used these as the focus of my testing.

Overall I tested for 7 water quality parameters which included water temperature, pH, conductivity, salinity, dissolved oxygen (ppm and %saturation) and turbidity. I decided not to test for nitrogen, phosphorus and bacteria as these tests are best carried out in a laboratory to be accurate and are beyond my scope. This meant I could focus my project on sedimentation as a pollutant which appears to be the main problem in the Mangemangeroa Estuary.

Dissolved Oxygen (DO) is the amount of oxygen that is in the water and can be measured in %saturation or parts per million (ppm) which is the same as mg/L. Like humans, fish and other marine life need oxygen to breathe and the best levels should be greater than 90% saturation. The higher the DO, the more different species of plant and animal life the water can support. Low DO levels can indicate pollution from sediment as well as nutrients and pathogens.

The pH or acidity is measured on a scale of 0-14. A pH of 7-8.5 is ideal for marine life in waterways to thrive. Water temperature is also important as marine life cannot survive if water is too hot or cold. Dissolved oxygen levels also decrease in warmer water.

Conductivity shows how easily electricity can flow through water and is measured in micro or milli Siemens. Salt water has a higher conductivity due to the increased ions present and this can be converted to a salinity reading (measured in parts per thousand ppt). I needed to measure this as increasing salinity can decrease DO levels.

Turbidity or water clarity is how much suspended sediment there is in the water. When the sediment settles it creates sedimentation. Turbidity can be measured in secchi depth or

Nephelometric Turbidity Units (NTUs). Increased turbidity can block sunlight for aquatic plants and warm the water which both act to decrease DO levels.

I went through a long process to find a suitable and accurate way to test for DO. Some methods include chemical tests (Hach Pacific or La Motte Winkler Tests), DO soluble tablets and meters. While all methods were costly, the chemical tests were hazardous and the DO tablets would only give a range rather than a set figure. I managed to arrange a loan of a Dissolved Oxygen Meter from NIWA which had the advantage of being very accurate, convenient and easy to use. However I was only able to measure the DO at the surface of the water.

For pH I used a probe which is quick, accurate and reliable compared to using test strips. A conductivity meter was used to measure conductivity because it is highly accurate. These readings were converted to salinity readings which were entered in to the DO meter to allow for the effect of salinity on DO. The meter was costly but I will be able to sell this after use. The main methods for measuring turbidity are clarity tubes, secchi disks or meters. Clarity tubes and meters tend to measure turbidity on the surface whereas a secchi disk can measure through the depth of the water. I made the secchi disk with simple DIY materials but secchi depth had to be converted to NTUs using a chart.

To conduct the tests, 4 areas of the estuary were selected ranging from Area1 (upstream near Whitford Bridge) to Area 4 (downstream at the estuary mouth). To reduce variables, tests were carried out by inflatable boat from high tide on 3 days over 3 weeks of similar weather. Mid tide testing had been recommended by Waikato Council but this was not possible due to very low water flow and poor access in the upper estuary areas. My results were compared to ANZECC guidelines and Auckland Council (AC) testing on the Panmure Basin and Turanga and Tamaki Estuaries (see Table 5).

- **pH: The pH of did not vary much over the areas (8-8.3) and this was of satisfactory standard.**
- **Water temperature: The temperatures varied over the days which may have been due to previous rainfall and weather. Temperature increased from downstream to upstream due to the effect of the freshwater. There are no ANZECC guidelines for temperature but my results were lower than AC tests which indicate that my results are most probably satisfactory.**
- **Salinity/Conductivity: Salinity consistently rose from Area 1 to 4 obviously because of the fresh to saltwater difference. My average of 38.7ppt compared well to AC tests which averaged 35ppt. Time of tide can affect this.**
- **Secchi Depth/Turbidity: This varied slightly over the days but generally rose from Areas 1 to 4. This showed that there was more sedimentation upstream. These results were converted to NTUs (using a conversion graph as per log book) to compare with ANZECC guidelines. This showed that overall the turbidity in the estuary is satisfactory but in Area1 upstream it is unsatisfactory. Compared to Turanga turbidity was much higher and slightly higher than the Tamaki Estuary and Panmure Basin.**
- **Dissolved Oxygen: This varied slightly but generally rose from Area 1 to 4. DO normally increases with salinity but this was accounted for by the DO meter. This shows that increased turbidity probably caused the decreased DO levels. The mean DO was 90.8%**

which is just above satisfactory. Compared to AC data the Mangemangeroa had the lowest mean DO level and was probably due to the effect of turbidity in Area1. DO ppm (or mg/L) ranged from 7.1 to 7.7 and was above the minimum requirements for marine life of 5ppm. This also compared well with AC results which ranged from 6.8 to 7.8ppm.

A view of Area 4

Most variables were controlled well. Weather conditions on the day of testing were similar but some factors such as turbidity may have been affected by weather on previous days (eg: rainfall). Time of day can affect DO levels (more photosynthesis and warmer water in the afternoon can increase DO) but it was not possible to control this and the time of the tide. Controlling the tide was easier due to better access and more constant salinity readings. There are also some difficulties with comparing to Auckland Council data as we don't know what their methods and variables were, however we can get an indication. To improve results carrying out more tests would help to improve accuracy and averages. With more time tests could be carried out at the same time of day and tide. With the right equipment nutrients and pathogens could also be tested for to give a better indication of water quality.

Conclusion

These results show that the Mangemangeroa Estuary's health is satisfactory however the upstream areas show much more turbidity and sediment pollution. These areas also had lower dissolved oxygen levels showing that increased sedimentation caused possible poorer water quality for marine life. The hypothesis of this project was proven correct but it was also shown that areas with higher sedimentation could be pinpointed to the upper reaches of the estuary.

Applications

The results concluded in this study are somewhat unique, due to no previous water quality testing being done on the Mangemangeroa Estuary. By doing these tests a link between dissolved oxygen and sedimentation in the upper areas of the estuary was found. I have forwarded this information to Alan La Roche and to The Friends of the Mangemangeroa Reserve. They can use it to help gain a better understanding of the estuary's health and how to continue to reduce sedimentation with further planting or other methods. One interesting thing to note is that the general water quality of another New Zealand estuary is now known, alongside the Turanga Estuary, Tamaki Estuary and the Panmure Basin.

Acknowledgements

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