Point Fraser Monitoring and Evaluation Program

2010 Report

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Mine Water and Environment Research Centre

Centre for Ecosystem Management

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1 MINE WATER AND ENVIRONMENT RESEARCH CENTRE

Founded at Edith Cowan University in 2008, the Mine Water and Environment Research (MiWER) Centre was formed by Dr Clint McCullough and Assoc. Prof. Mark Lund. The research group has a focus on pit lakes formed from mining, although research also covers all inland water bodies. Our research covers most aspects of rehabilitation, remediation and the ecology of inland waters.

MiWER is also a member of Edith Cowan University's research centre, the Centre for Ecosystem Management.

More information on MiWER and our projects can be found at www.miwer.org.

2 ACKNOWLEDGEMENTS

The support of Jackie Nichol and Vicki-Lee Tarca at the City of Perth has been greatly appreciated. Thanks to the City of Perth for funding this work. Thanks to Edith Cowan University for the provision of in-kind and infrastructure support for the project. Thanks also to the range of volunteers and research assistants that have helped with various aspects of the project.

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2.1.1.1 FRONTISPIECE

Plate 1. Mark Lund collecting water samples at Site W2 (Point Fraser).

This report should be referenced as follows.

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3 CONTENTS

4 EXECUTIVE SUMMARY

Point Fraser was developed in 2004 to convert former lawn area to a recreation space, with environmental values. In addition, a wetland was constructed to intercept and treat a stormwater drain from East Perth (catchment 18.3 Ha) that had previously discharged untreated into the Swan River. In 2010, the City of Perth contracted the Mine Water and Environment Research Centre at Edith Cowan University to undertake a comprehensive monitoring program at the site. The aim was to determine how well the wetland and to a lesser extent other components of the development achieved the goals originally set for the site.

Monthly monitoring of water quality in the wetland commenced in April 2010. Results suggest that water quality is generally within the normal ranges that might be expected in stormwater wetland on the Swan Coastal Plain. Salinity was higher than might be expected in a freshwater lake, especially in the last ponds (W3 and W4) of the wetland. This is partially due to an influx of saline Swan River water during construction, much of the salt accumulated in the bund between W3 and W4, however this was been scraped to remove a large proportion of the salt. The lack of good flow through the wetland has limited flushing of the remaining salt out of the wetland. Unless good flushing is achieved salt concentrations will continue to increase through evaporation and may reach levels (~4 ppt) that require management action to prevent plant depths. Actions could include artificial flushing of the wetland with Lake Vasto water.

Solar powered monitoring stations were established at both inlet and outlets to the wetland. These were designed to allow for quantification of nutrient loads in and out of the system so that the overall removal efficiency could be determined. Good data on rainfall, depth in the inlet (not flow) has been collected. However, it has not been possible to quantify inflows, issues with triggering of the autosamplers has also prevented storm flows from being captured in any detail. Compounding and hindering these issues has been one of the driest years on record. Work is currently underway to ensure that the monitoring stations will work properly for winter 2011.

The team has identified issues associated with the inlet structure that means that much of the water that enters the wetland (Zone 1) later drains back into the drainage network, and as such it is effectively lost from the wetland. The reasons are two-fold, firstly the shallow slope of all the drains relative to the wetland mean that it is particularly susceptible to the relative heights of water in the incoming drains compared to the wetland (i.e. if the wetland is higher water drains out and vice versa), and secondarily as there is probably a leak in the drainage network which is continuously reducing the height of the drain water allowing

backflow to occur. This issue is significantly impacting on wetland function, as it means that the wetland treats only a small proportion of the actual drain flow. Further the lack of water remaining in the wetland costs the COP in the additional expenses associated with using Lake Vasto waters to keep wetland wet. Resolution of this problem is beyond the scope of the monitoring project and needs to be undertaken urgently to ensure the wetland can perform its function.

Wetland performance during a significant storm event was observed and it was clear that the design prevented serious damage to the wetland. All stormwater appeared to be contained in the wetland and despite a higher than usual tide, this did not overflow into the wetland.

Wetland vegetation is growing well, there is evidence that the three major species (*Juncus kraussii, Baumea articulata* and *Eleocharis acuta*) are currently competing with each other for space and the extents of each will change over time. A large quantity (16.4 kg of P and 228.5 kg of N) of nutrients were stored in the plant biomass (living and dead) in May and this increased by 12% for P and 50% for N in October. Some of the dead material will be a sink for nutrients as it becomes incorporated into the sediment, although a proportion will be available to be liberated back into the water by decompositional processes.

Biodiversity measured through bird and macroinvertebrate communities showed communities rich in cosmopolitan common taxa. Community richness was greater in October compared to May. It appears that the wetland is attracting appropriate diversity for its stage of maturity.

Social monitoring was undertaken to see how people use the site. Point Fraser does not appear to be a destination of choice but is used extensively as people pass through it primarily for exercise or park in the car parks to access the city.

Overall the wetland appears to performing its various functions successfully, despite problems associated with the inflow which mean that the wetland treats comparatively little incoming stormwater.

5 INTRODUCTION

Point Fraser is named after the colonial botanist Sir Charles Fraser who explored the Swan River in 1827 when he accompanied Captain Stirling's expedition. The site was originally named 'Boodjargabbeelup' by Noongar peoples, when it was still a peninsula and prior to river reclamation in the 1930s. Point Fraser is located between Riverside Drive and the Swan River, next to the Causeway. The land was reclaimed using spoil from the dredging of the river used to deepen the water around Heirisson Island and causeway (see Figure 1a). Prior to 2004, the site was a lawn area containing a carpark, a helipad and a shipping container used for bike hire. A stormwater drain (Point Fraser Main Drain) discharged into the river at this point. The catchment of the drain was 18.3 Ha of East Perth located mainly west of the WACA Cricket Ground (Figure 1b).

a)

b)

Figure 1. Aerial photographs of Point Fraser in a) 2000 and b) 2010 (showing catchment area for the wetland in red). Photographs taken from Google Earth, 2011.

After 2000, the City of Perth sort to improve the quality of stormwater discharge to the Swan River and improve aesthetic, recreational and environmental values of the area. This culminated in the Point Fraser redevelopment; the first stage was the creation of a constructed wetland which was completed in 2004. The second stage saw the redevelopment of the remaining area and was completed in 2007. The redevelopment included construction of new car parks, a bicycle hire facility, grassed areas, BBQ facilities, a children's playground, a mixture of native bush areas and parkland and the constructed wetland.

The objectives of the Pt Fraser redevelopment project were to:

1. "Improve the quality of urban stormwater discharging to the Swan River through the Point Fraser wetland, including stormwater management run-off from the surrounding area;
2. Establish a wetland habitat and breeding place for native fauna which will be attractive to avifauna, in particular Black Swans;
3. Promote passive recreation and community education, including use of the wetland to demonstrate stormwater management techniques;
4. Enhance the landscape and visual aesthetic; and
5. Provide a recreational and educational environment and experience for the public." (quoted from Syrinx Environmental Pl, 2005)

The effectiveness of the wetland in removing nutrients from stormwater is an important consideration in the entire re-development and will provide value information for similar projects in the City. The City of Perth commissioned the authors to undertake a 5 year monitoring program to evaluate how the redevelopment was meeting its original objectives. Specifically to monitor, evaluate and report on the following, as taken from the Point Fraser Monitoring and Evaluation Plan (PFMEP; COP, 2010):

1. The quality of urban stormwater discharging to the Swan River long term, as a result of the redevelopment of Point Fraser by determining the amount of pollutant removal via the constructed wetland;
2. The quality of wetland habitat and the quantity and quality of breeding places for native avifauna presence, behaviours and habitat use;
3. The ongoing ecological health of the constructed wetland via its conformance with relevant water quality guidelines and legislation requirements.
4. The quality, quantity and type of recreational and educational use of Point Fraser by determining the diversity of visitor presence, behaviour, use, expectations and

satisfaction and awareness of reports/information specific to Point Fraser performance; and

5. The long term integrity and quality of the restoration of the foreshore edge, as a result of the redevelopment of Point Fraser by determining vegetation health and structural reliability.

This is the first annual report of the PFMEP and covers the period April to December 2010.

6 METHODS

6.1 STUDY SITE

The majority of the study was conducted in the constructed wetland in the Point Fraser reserve, however foreshore monitoring occurred in two areas (1 & 2) while avifauna and social monitoring were conducted across the entire reserve (Figure 2).

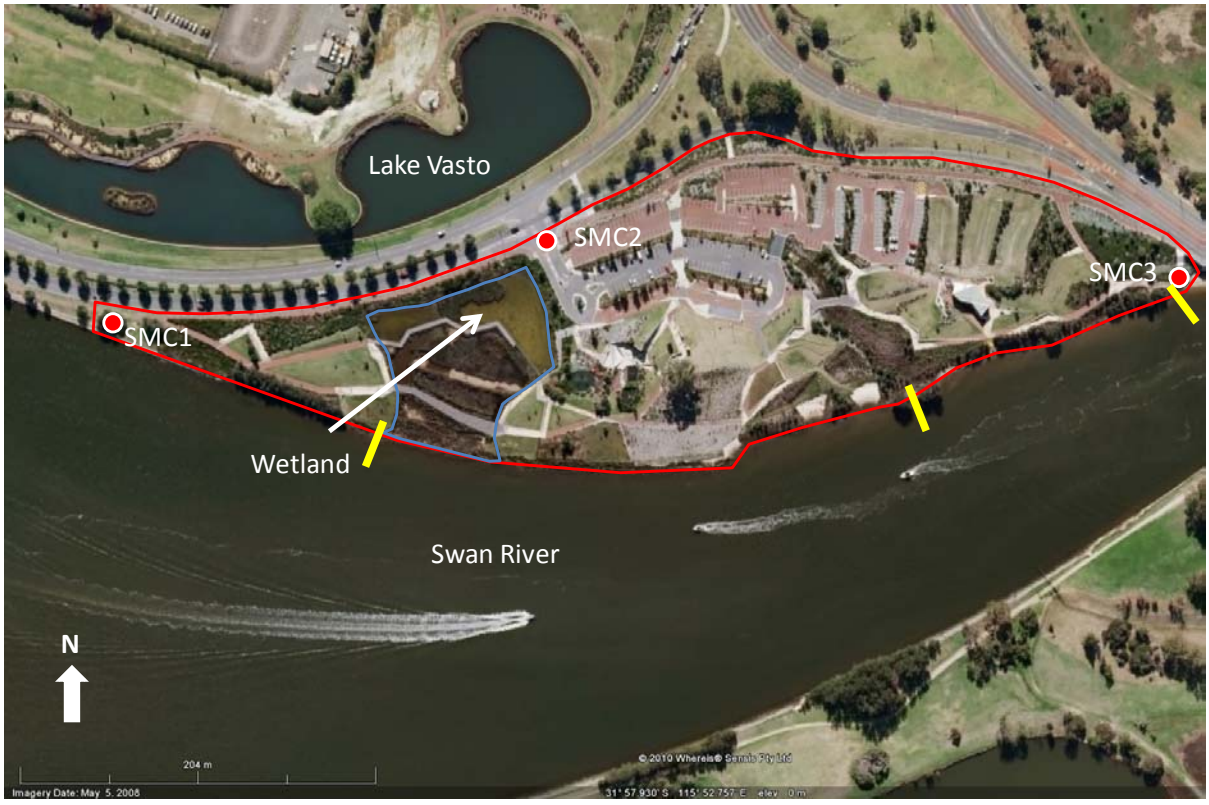

Figure 2. Aerial photograph of Point Fraser (bounded by the red line), showing the constructed wetland (bounded by the blue line), Lake Vasto, the social monitoring sites (red and white circles, SMC1-3) and the foreshore monitoring areas (yellow). Photograph adapted from Google Earth, 2010.

Water enters the wetland from the catchment via the East Perth drain; this arrives at the splitter box where low flows are directed via two pipes into a bubble-up grate (BUG) in W1 (Figure 3). High flows exceed the weir in the splitter box and part of the flow is directed via a pipe and another BUG into the Swan River. Bubble-up grates slow the flow rate reducing erosion and providing opportunities for particulates to settle. Water flows from W1 to W2 (Zone 1), and then when levels exceed those of the weir, water flows into W3 and then W4

(Zone 2) before exiting via a small pipe into the foreshore vegetation (Zone 3) and then into the Swan River. The boardwalk separating W1 and W2 from W3 contains a weir that is set higher than the control weir. The boardwalk weir is designed to overflow only in exceptionally high flow conditions. A similar weir lies under the boardwalk separating the discharge area from W4. This contains a valve to prevent ingress of water from the Swan River at times of exceptionally high tides, while also permitting exceptional high water levels in W4 to discharge. W1 to W4 are lined to prevent interaction with underlying acid sulphate soils (Syrinx Environmental Pl, 2009). W1 and W2 are covered with a thin layer (approx. 20 mm) of Supersorb activated zeolite clay, while W3 and W4 have layer of soil (100-200 mm deep) to grow plants in. The cleared strip between W3 and W4 is actually a small mound that effectively prevents water moving directly from the weir to the discharge point. Excessive build up of salt in the mound, resulted in removal of the surface layer (Syrinx Environmental Pl, 2008), which is why it is currently devoid of plants. As stormwater flows infrequently into the wetland, the ponds W1 and W2 (which must remain under 250-300 mm of water and W3 and W4 which must be under 50-100 mm of water must be topped up with water taken from Lake Vasto (Syrinx Environmental Pl, 2009).

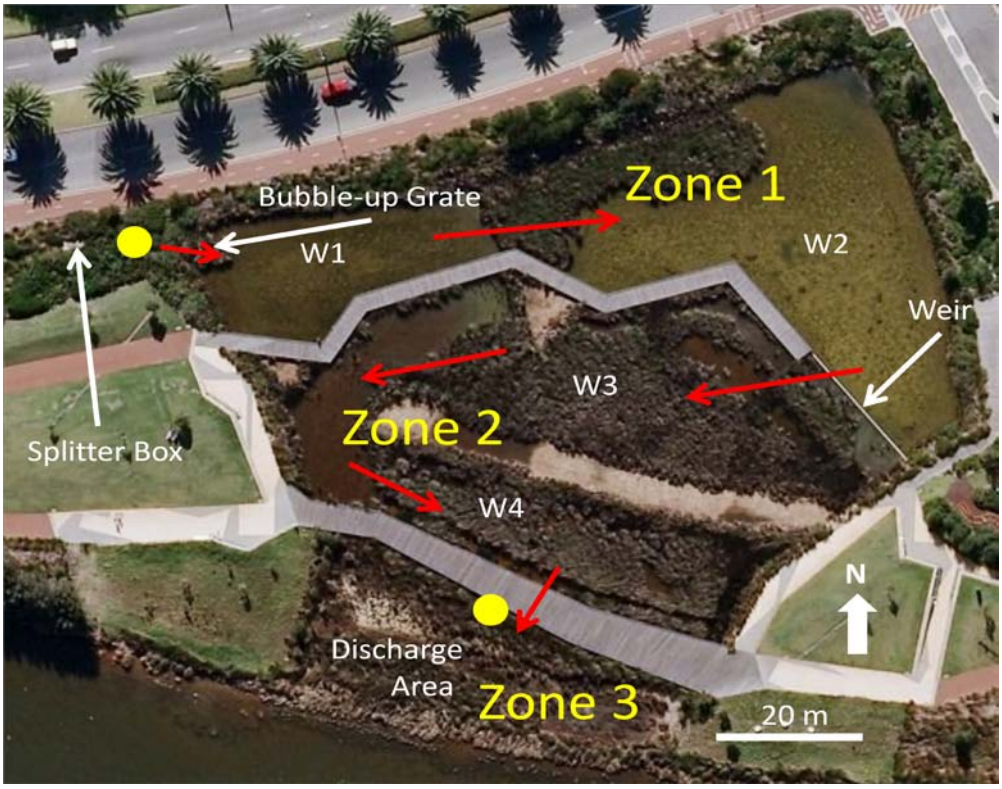

Figure 3. Aerial photograph showing the movement of water (red arrows) through the Point Fraser constructed wetland. Yellow circles mark the fixed inlet and outlet monitoring structures. Sampling sites are indicated as W1 to W4. Imagery adapted from Google Earth, 2010.

Photographs of all the sampling sites are shown in Figure 4.

a) W1

b) W2

c) W3

d) W4

e) Discharge area (Zone 3)

Figure 4. Photographs of the sampling sites in Point Fraser constructed wetland

6.2 SAMPLING

The sampling procedures used in this study are provided in condensed form below but are available in more detail in PFMEP (COP, 2010). The monitoring program commenced in April 2010. This report therefore covers the period April to December 2010.

6.2.1 WATER QUALITY (WSWQ)

Sampling for this study was conducted on the third week of every month. On each occasion, pH, oxidation reduction potential (ORP), conductivity, temperature and dissolved oxygen (% saturation and mg L^{-1}), turbidity and chlorophyll *a* were measured *in situ* in the water using a Hydrolab Datasonde (4a) multimeter at each site (and Ozone in April). At each site, a water sample was collected, an unfiltered aliquots (subsample) of this sample were bottled for determination of total nitrogen (total N[1]) and total phosphorus (total P). Another aliquot was filtered in the field (through 0.5 µm Pal Metrigard filter paper) before bottling prior to determination of nitrate/nitrite (NO_x), filterable reactive phosphorus (FRP) and ammonia (NH_3). At quarterly intervals (May, Aug, Nov), water was also collected for determination of Chlorophyll *a* and Phaeophytin, total hardness, metals (Al, Fe, Mn, As, Cd, Cr, Cu, Hg, Pb, Ni, Zn) and total suspended solids). Another aliquot was filtered in the field (through 0.5 µm Pal Metrigard filter paper) before bottling prior to determination of dissolved organic carbon (DOC).

Samples for April and May were split between ALS Laboratory Group Ltd and SGS Australia Ltd, however all later samples were directed to SGS Australia Ltd alone. Both companies offer NATA accredited analyses and detailed QA/QC processes (except where noted). All samples were collected, stored and preserved as recommended by the laboratories.

6.2.2 SEDIMENT QUALITY (WSQ)

In May 2010, eight sediment cores were randomly taken each from W2 and W3. The cores were clear acrylic tubes (50 mm dia.). Cores were pressed into the sediment to a maximum depth of 100 mm or touching the liner (which ever came first), the top was sealed, core extracted and bottom sealed. Water was carefully decanted from each core and the sediment transferred to a glass jar. Four jars were analysed for total Kjeldahl N (TKN), Total

[1] All nutrients are reported as per their respective elements i.e. Total N-N, Total P-P, FRP-P, NOx-N and NH_3-N

P, total organic carbon (TOC), total metals (Al, Fe, Mn, As, Cd, Cr, Cu, Hg, Pb, Ni, Zn), wet and dry weight and loss on ignition (LOI) at 500 ^{o}C and 1000 ^{o}C. All analysis was undertaken at SGS Australia Ltd, except for the LOI which was not NATA accredited and therefore was undertaken at Edith Cowan University.

Sediment depth in W2 was measured at 8 random sites using a ruler as the distance from the surface to the liner. It was not possible to distinguish between the zeolite layer and accumulated sediment.

6.2.3 QUANTIFICATION OF LOADS IN AND OUT OF THE WETLAND (WSFM & AWWQ)

At the inlet to W1, an ISCO 6712 Autosampler was installed, this was triggered by an Acoustic Doppler Velocity meter (Unidata) when flows occurred. A solar panel is connected to the system to recharge the battery for the system. In addition, a tipping bucket rain gauge (Unidata) was installed. The rain gauge and acoustic Doppler are both connected to a data logger with telemetry (Unidata Neon). The autosampler pulls samples from the bubble-up pit, samples are collected every hour.

At the outlet to W4 (pipe), an ISCO 6712 Autosampler was installed, this was triggered by a hydrostatic depth sensor (Unidata) mounted in W4. When water depth exceeds the height of the discharge pipe, water starts to discharge from the wetland triggering sample collection. Samples are collected every 24 hours. This system is connected to a data logger with telemetry (Unidata Neon) and is supported by a solar panel recharging the battery.

The monitoring equipment was fully installed by June 2010 but technical problems prevented it collected data until the beginning of August 2010. No samples were collected by the autosamplers, the reasons are detailed later. Samples from the autosamplers would have been collected within 2-3 days of collection and sent to SGS for determination of Total N and Total P, turbidity and Total suspended solids.

6.2.4 WETLAND VEGETATION (WV)

In October and May 2010, the wetland vegetation was mapped. Three quadrats (200 mm x 200 mm) were randomly taken from each major plant species (*Baumea articulata*, *Eleocharis acuta, Juncus kraussii, Halosarchia* sp) where present in W1 and W2 (combined), W3 and W4. All the plant material (above and below ground) in the quadrat was removed. For each quadrat, the above ground material had each stem length measured, the

percentage of leaves that mature, new or senescent determined and the number of flowers recorded. Dry weight of above and below ground material for each quadrat was measured, samples of dried material were sent to SGS Australia Ltd for analysis of TKN and Total P. Loss on ignition was then performed on biomass from each quadrat (above and below ground) at 500 ^{o}C and then 1000 ^{o}C.

6.2.5 MACROINVERTEBRATES (MINVERT)

In May and October 2010 macroinvertebrate samples were collected from W2 and W4 using a 250 µm dip net over two 5 m transects per site. Samples were preserved in 70% ethanol and returned to the laboratory for sorting, identification (to Family) and counting.

6.2.6 SOCIAL MONITORING (SM)

In May and October 2010 a survey of visitors was undertaken between 7 am and 6:30 pm on a weekday and weekend day. Surveyors were based at each end of Point Fraser (see Figure 2) capturing walkers and cyclists moving through the park, a third person was based near the road entrance to capture people using the Point Fraser car-park for visiting the city. Between the hourly visitor counts, park users were approached and invited to self-complete a three-page visitor survey. On the hour, for the first 15 minutes, the numbers of people and vehicles entering or leaving the park were recorded at the three sites on Observation Count data sheets. Between the hourly visitor counts, a surveyor walked from the east to west entrance ensuring all areas of the reserve were covered and recorded the behaviour of park users using the Observation Behaviour datasheet. An aerial photograph was used to mark the location of stationary park users. Copies of all the data sheets and survey are presented in the Appendices.

A number of adjustments to the survey methodology and survey tools were made from the original project brief specified by the City of Perth to improve the quality of the data collected and adjust for factors as outlined in Table 1.

Following the second round of surveying, additional improvements to the visitor survey have been identified during data analysis. The proposed changes include modifying selected survey questions to improve clarity and quality of data collected.

Table 1. Changes to originally specified survey program

Element	Change	Justification
Visitor survey - tool	Significant reformatting and improvements to visual presentation. Refinement of scales Simplification of text	A simple, easy to read and visually pleasing survey is imperative for successful completion of self-complete surveys. Pilot testing and round one data analysis resulted in some minor improvements in wording to avoid apparent weak points.
Visitor survey – application	Hourly surveying throughout entire day Self-complete surveys	Extension of the survey frequency and use of self-complete technique provides improved capture rate and overall survey completions.
Visitor count - tool	Significantly revamped survey tool to account for on-ground realities Added directional breakdown and capture of external path traffic at SMC1.	Local on-ground realities required significant adjustments to the survey tools to collect data that has any relevance and can be interpreted.
Visitor observation - tool	Included aerial photograph to capture geographic usage.	Simple to use with little extra effort, but highly relevant to assess space usage.
Survey period	Final visitor count was conducted at 6pm, not 7pm.	Assessment was restricted to daylight hours (31 May 2010 – sunset: 5.20pm, twilight ends: 5.47pm) as park is not lit up at night.

6.2.7 AVIFAUNA

In May and October 2010, a survey of all birds seen within the park or flying above it were recorded. Surveys were conducted in the early morning.

6.2.8 FORESHORE MONITORING

In May 2010, the foreshore of Point Fraser was monitored at 3 sites in each of the two areas shown in Figure 2. Using a foreshore condition assessment form (see Appendix) each site was profiled and sketched. In addition, the overall condition of the foreshore was examined and noted.

7 RESULTS AND DISCUSSION

7.1 HOW WELL DOES THE WETLAND WORK?

The Point Fraser Constructed Wetland is a highly engineered wetland designed to perform a range of tasks, primarily stormwater treatment but aesthetics and biodiversity values are also important constraints on the design. As the wetland is isolated from groundwater (by a liner) to prevent oxidation of underlying acid sulphate soils, this simplifies the hydrology of the ponds but has constrained the design in terms of wetland depth. Constructed wetlands attempt to maximize the retention time for water entering the systems as the longer the water is retained generally the more treatment is possible. Peak stormwater flows can scour the wetland, reduce treatment times and the overall wetland efficiency. To reduce the potential for this, the wetland has a splitter box that allows high flows to be split with a part of the flow directed into the Swan River.

Perth had below average rainfall in 2010 only reaching 503.8 mm rather than the 850 mm long-term average (Bureau of Meteorology, Mt Lawley station). In Figure 5, daily rainfall measured at Point Fraser and by the Bureau of Meteorology (Mt Lawley and Perth Airport) are shown for comparison. These sites are all within a 10 km radius of each other, showing local variability in rainfall. Further, rainfall at Point Fraser was recorded each day from 12 am to 12 pm, while Bureau of Meteorology data are recorded at 9 am for each day and reflects the previous 24 h. This explains the Point Fraser data appearing out of sync by a day on some occasions.

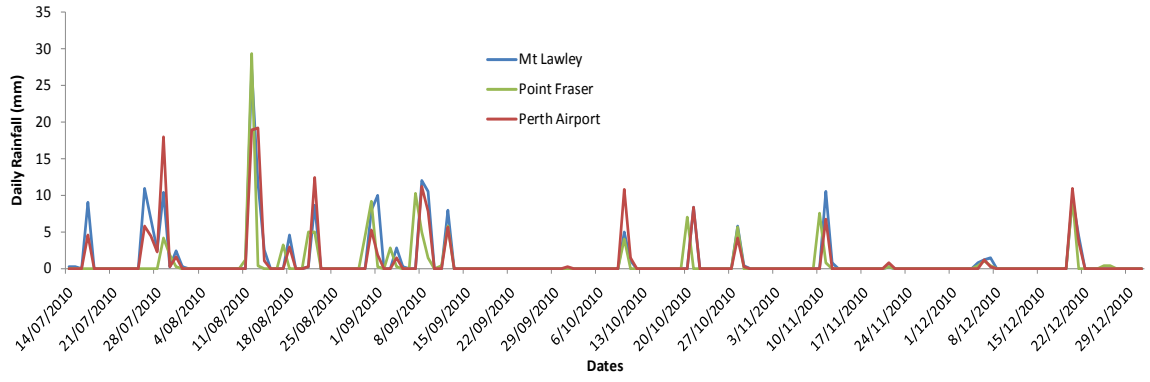

Figure 5. Daily rainfall measured at Point Fraser, Mt Lawley and Perth Airport between 14/7/10 and 31/12/10. Mt Lawley and Perth Airport data from the Bureau of Meteorology and recorded 9 pm to 9 am, Point Fraser data recorded 12 am to 12 pm.

There were two intense rainfall events, one of 40.2 on the 23/3/10 and then on the 9/7/10 when 40.6 mm were recorded. The automated monitoring equipment was not operational until 14/7/10, missing both these events. During the July event water depth in Zone 1 exceeded the boardwalk wall allowing short cutting of flow into Zone 2 (Figure 6). No overtopping of the wall between Zone 2 and 3 was observed. No flows out of Zone 2 were observed; therefore it appears that all the inflows were captured by Zone 2, which would allow a measure of treatment prior to any subsequent release. High tides in the Swan River resulted in flooding of Zone 3 to a depth of approximately 200 mm at the boardwalk. These tides can be potentially destructive to armouring and poorly covered vegetated areas (see section on the Foreshore), and pose challenges to automated sampling equipment, which need protection from flooding). No evidence was seen of river water intrusion into Zone 2.

a) W1 – note overtopping of weir

b) between W2 and W3 (normal)

c) Flooding of discharge area

d) Flooding around outlet sampler housing

Figure 6. Photographs of the Point Fraser wetland at a time of the highest daily rainfall for 2010.

The top of the inlet pipe in the splitter box is approximately the same height as the top of the BUG. This means that the connecting pipe has a slope of approximately 80 mm over 17 m. The lip of the BUG in W1 is located approximately 40 mm lower than the weir. Therefore in many situations the height of water in W1 will be higher than the top of the BUG. Unless the water height in the splitter box is the same or higher than that of the wetland then water will flow back out of the wetland into the splitter box (Figure 7). Ordinarily this should not be a serious issue as the water within the drainage network should not be going anywhere and therefore the amount of backflow should be minimal (Figure 8). This does not

appear to be case currently, as the water level in the drain is continuously falling permitting backflow until the wetland is drained down to the level of the BUG. This water has not been observed draining into the Swan River via the highflow bypass pipe in the splitter box. When the water in Zone 1 is 30 mm (above the BUG and 10 mm below the weir) this equates to approximately 60 m^3 of water draining back into the drain (Figure 8).

Figure 7. Water flowing from the wetland (W1) back into the drainage network via the bubble-up drain (taken 12/7/10).

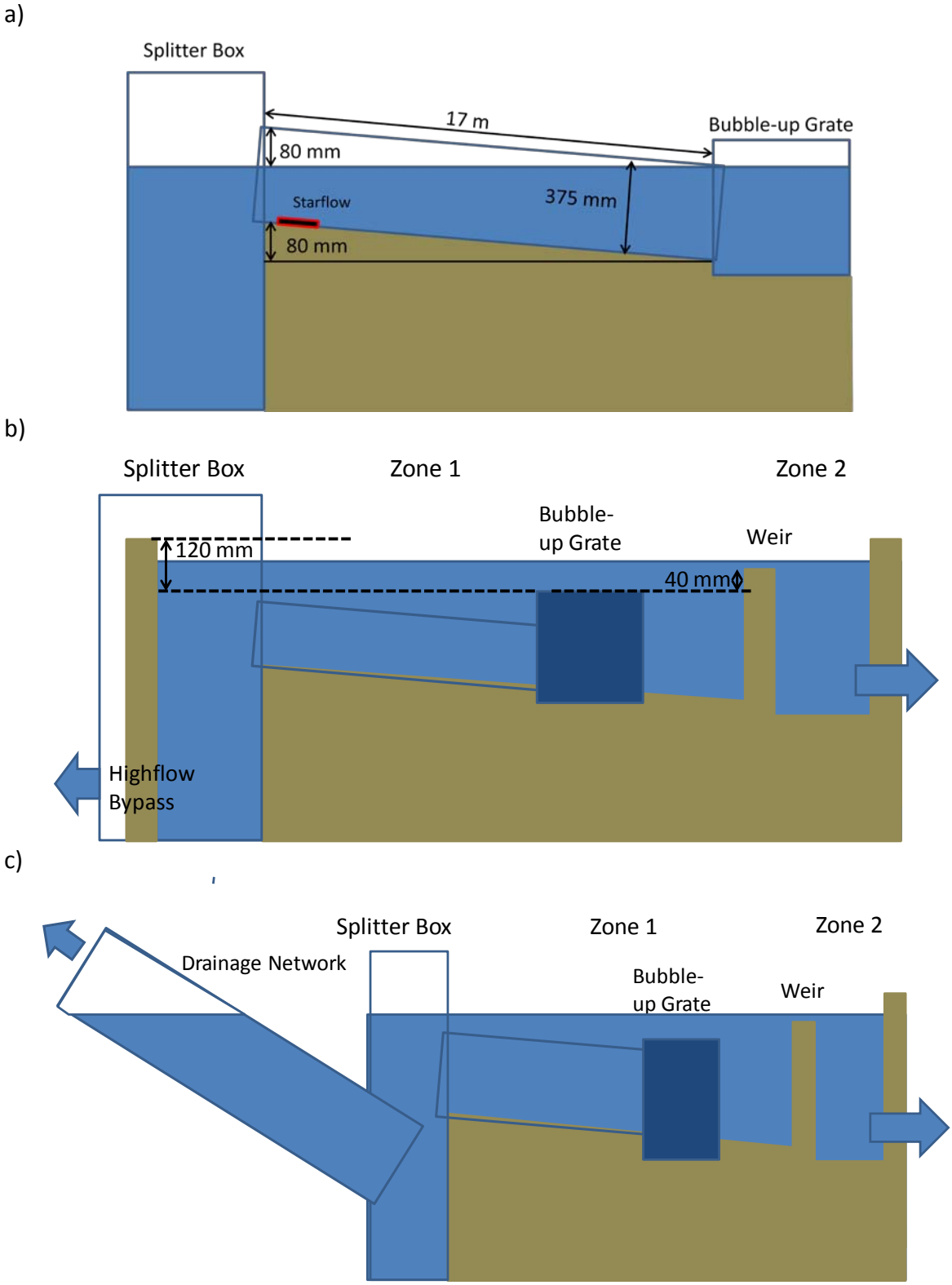

Figure 8. Diagrammatic representation (not to scale) showing the relationship between a) the splitter box and bubble-up grate (W1), b) between the weirs and splitter box, and c) showing how without an alternate exit the wetland should only backflow into the drainage network until it reaches the same height as the wetland.

7.2 INFLOW AND OUTFLOW

The specific aims of measuring the inflow and outflow of the wetland were to:

1. Create a water budget for the wetland.

This will show how the water moves through the wetland (hydraulic residence times) as well as allowing quantification of nutrient loads.

2. Quantify nutrient loads in and out of the wetland

This will show how nutrient loads change during storm flows (the 'first flush' effect) and allows determination of wetland nutrient removal efficiency.

7.2.1 INFLOWS

The Starflow instrument is an Acoustic Doppler device that measures flow and can also measure water depth. From August to December 2010, it successfully logged water depth in the inlet pipe at minute intervals but does not appear to have measured flow velocity effectively. It is not unusual for the Acoustic Doppler to produce occasional false peaks in no flow conditions (Unidata *pers. comm.*). However, the velocity data was highly variable from one time interval to the next which suggests that it is struggling to get a reading. There is no evidence that the instrument is faulty and it is more likely that its current location is too turbulent. Relocation to the other end of the pipe, near the BUG should address this issue. Backflow and generally low flows will make it difficult for the Starflow to work effectively.

Recommendation 1.

Accurate measurements of inflows from the stormwater system are still required to determine incoming nutrient loads.

Flow from August to December were determined using the Starflow velocity data and from the depth. To achieve this Manning's formula for an open-channel, a slope of 0.47% (80 mm drop over 17 m calculated from City of Perth plans), concrete pipe (for Mannings roughness coefficient) and cross-sectional area (estimated from depth for a circular pipe 375 mm dia). Flows were determined for every 10 mm depth up to an including 375 mm using an online calculator (http://www.hawsedc.com/engcalcs/Manning-Pipe-Flow.php). In Excel flows

were plotted against depth and a third order polynomial equation developed to accurately map the curve produced (Figure 9). Only one independent velocity measurement has been taken when outflow into the wetland has been observed and this occurred when there was head of 110 mm (above the top of the pipe in the splitter box) and it was 0.13 ms^{-1}. This matches the 0.12 ms^{-1} estimate from the above calculations well. However, once the situation shown in Figure 8 is considered, then a depth of 295 mm at the Starflow would not be associated with any actual flow. To overcome this, any depths <295 mm were considered to generate no flows and the flow was estimated as the difference between the flow calculated for the actual depth and the flow at 295 mm estimated from the equation below. As previously described, the height of water in the splitter box only triggers flows when it is higher than water in the wetland, therefore the calculated flows are probably an over-estimate of actual flows. The quantity of backflow cannot be estimated.

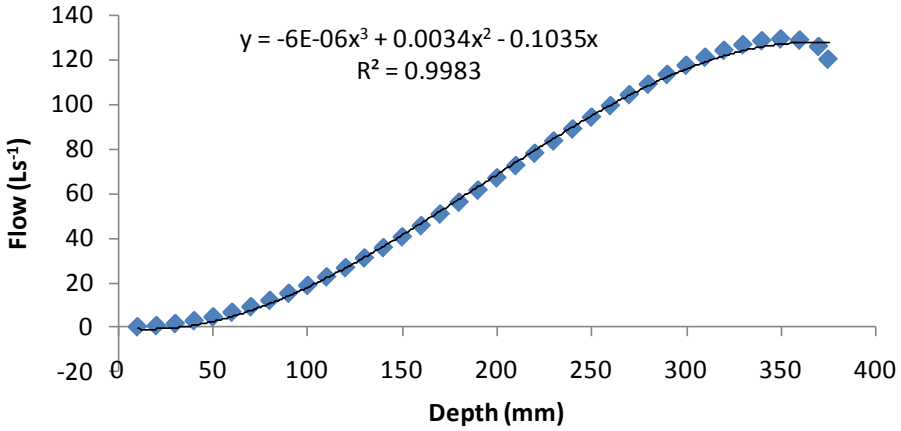

Figure 9. Plot of depth vs estimated flow for the inlet pipe (trendline equation shown with r^2 value).

Velocity data was combined with estimates of cross-sectional area based on depth to calculate flows. To remove spurious velocity measurements, all velocities >0 recorded that were 0 in the previous minute and following minute were taken as 0. Cross sectional area of the pipe was determined from the depth using Manning formula (taken from www.lmnoeng.com/CircularCulvert.htm) and then multiplied by the velocity.

The resultant estimated flows (for a single pipe, effectively half total flow) are shown in Figure 10 alongside measured daily rainfall. The Starflow does appear to respond to most of the rainfall events, however the data collected is generally poor (patchy and inconsistent). There was a small inflow of 65 m^3 (depth) or 3.3 m^3 (velocity) that occurred on the 12/8/10 when the highest rainfall recorded (between August and December) occurred (29.4 mm).

According to Syrinx Environmental Pl. (2003a), this daily rainfall is close to the 32 mm of a 1 ARI storm event that should generate from the full 18.3 ha catchment runoff of about 3514 m^3. This suggests that either the catchment is actually much smaller than designed for, runoff coefficients are lower than the 0.6 used here, a significant portion of the water is bypassing the wetland or that the estimated flow is too low. That a significant portion of runoff drainage is bypassing the wetland fits with the suggestion that water is draining out of the drainage network upstream of the splitter box and it the most probable explanation. The wetland is topped up by water pumped automatically from Lake Vasto when water levels drop to heights that might impact on the vegetation. The City of Perth records the inflows from the pumps, between August and October no water was pumped, with 2836 m^3 added in November and 917 m^3 in December. In addition, the wetland received direct rainfall of 121.2 mm (31/7/10 to 31/12/10), which equates to 860 m^3 (area is 7087 m^2). Total inflows August to December equal 4951 m^3 (based on the depth flow calculation).

Flows measured by the Starflow are used to trigger the autosampler and the lack of accurate flow measurements failed to result in any samples being collected.

Recommendation 2.

It is recommended that until the Starflow is working reliably that an alternative method be employed to trigger the autosamplers. The addition of ISCO bubble flow meters would serve the purpose and are available from ECU.

Recommendation 3.

It is recommended that the alternate exit/leak within the drainage network be identified and fixed. This is severely impacting on the function of the wetland, preventing it performing any useful function. Furthermore, loss of incoming water is resulting in increased need for pumping from Lake Vasto to maintain water levels.

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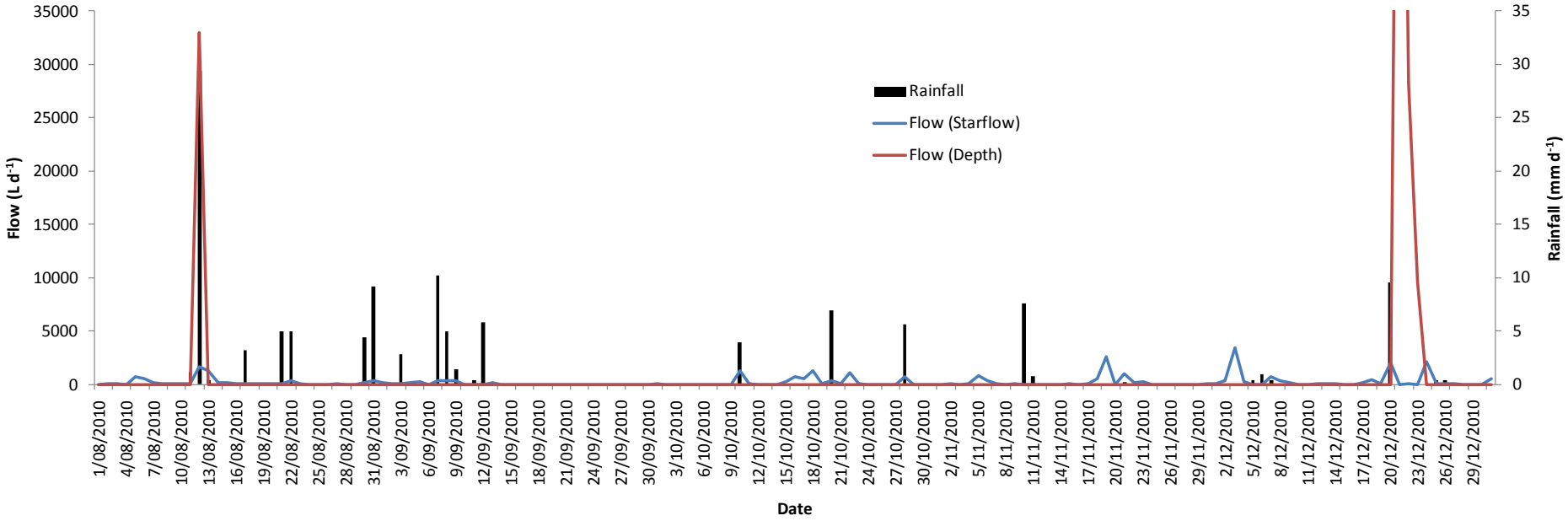


Figure 10. Estimated flows (from depth and velocity) for the wetland inlet per day (only from a single pipe, effectively half the actual flow) and total daily rainfall.

7.2.2 OUTFLOWS

Reliable data were obtained from the 1/8/10 to 31/12/10. A rating curve was developed using a Marsh McBirney Flow meter, by measuring velocity at a range of depths. The velocity data were used with cross sectional areas to create flow rates at particular depths, these data were plotted and a polynomial function fitted. The constants from this equation were used to calculate flows for all water heights greater than the outlet. Depths greater than 195 mm were considered to have reached maximum discharge rate (i.e. the pipe was full). The total daily discharge in and out of the wetland and rainfall are shown in Figure 11. Total outflow was 1075 m^3. Calculating likely evaporation (ignoring transpiration, which can increase loss considerably depending on the species (Sanchez-Carrillo *et al.*, 2001)) using Bureau of Meteorology pan evaporations corrected with Black and Rosher (1980) values for the Peel Inlet (as cited in Congdon, 1985), then there was 720.3 mm of evaporation which equates to a loss of 5105 m^3 over August to December. Therefore the total outflow of 6180 m^3 exceeded total inflows by 1229 m^3. This discrepancy equates to a drop of approximately 0.17 m in the water level across the entire wetland. This suggests that while there are inaccuracies in the water budget, particularly associated with the inflows and loss due to evaporation that these may be relatively minor. The pumping from Lake Vasto accounted for approximately 76% of the total inputs into the wetland between August and December. There are also indications that W3 and W4 was being overfilled with Lake Vasto water at the end of December, as there were substantial outflows that could not be explained by inflows or rainfall.

Recommendation 4

There appears to be evidence that the wetland on occasion has been overfilled, with Lake Vasto waters as part of the ongoing topping up of the system. Topping up Zone 1 to a height above the bubble up grate will result in loss of additional waters to the drainage network. ECU will provide the City of Perth with new recommended heights for the topping up of both Zone 1 and Zone 2 which should reduce the chances of this re-occurring.

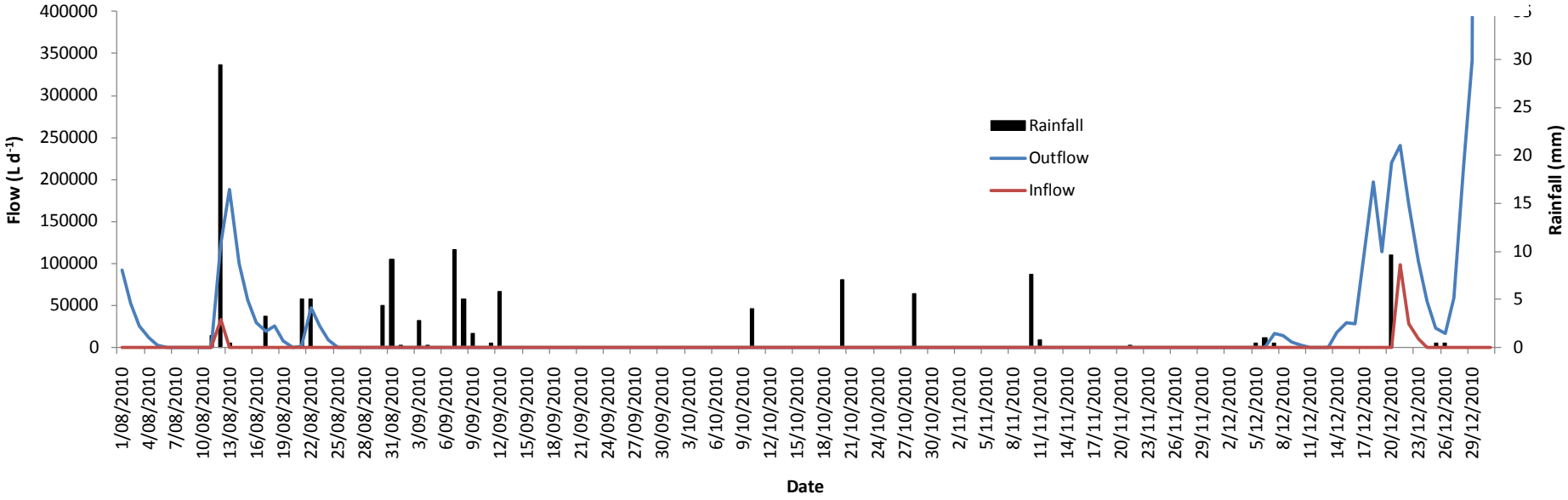


Figure 11. Daily totals for inflow, outflow and rainfall for the Point Fraser wetland.

7.2.3 CONCLUSIONS

1. Create a water budget for the wetland.

A water budget was created for the months August to December. Its accuracy was limited by limitations in the inflow measurements. Issues associated with the inflow measurements included backflow out of the wetland, which appear to be due to there being leakage or an alternative exit in the drainage network upstream of the Point Fraser splitter box.

2. Quantify nutrient loads in and out of the wetland

Not achieved, as issues associated with appropriate triggering of autosamplers and a lack of rain ensured that no inflow or outflow nutrient data was obtained.

7.3 WATER QUALITY IN THE WETLAND

The specific aims of measuring the water quality in the wetland were to:

1. Determine how physico-chemical variables and nutrient concentrations changed on a monthly timescale

This will show whether there are any management issues associated with water quality over the year. The data will allow the effectiveness of various processes responsible for nutrient uptake or release to be inferred.

2. Examine how key metals and other selected parameters change quarterly between all the ponds.

This will provide information on metal removal by the wetland but also highlight any metals of concern, which might require management actions.

7.3.1 MONTHLY DATA

Lake Vasto (Ozone) was warmer (1-2 ^{o}C) that the Point Fraser wetland, probably as it was very turbid at the time (Figure 13) which would enhance heat absorption. Generally W1 and W2 were warmer than W3 and W4, although it became reversed in October and November. The open water of W1 and W2 will generally be more strongly heated than the more shaded

vegetated W3 and W4. However in the summer months the shallower water in W3 and W4 would heat more rapidly than the deeper water of W1 and W2 despite the vegetation.

Lake Vasto is much less saline (2.06-2.15 mS cm^{-1}) than W1 and W2 (3.62-10.25 mS cm^{-1}) (Figure 13). In the drier months (April, May, October, November) W3 is the most saline of the ponds at a maximum of 21.2 mS cm^{-1} (almost half that of seawater). W4 conductivities were much lower suggesting that W3 and W4 waters were not connected and W3 was undergoing strong evapo-concentration. The regular topping up of the lake with Lake Vasto waters will tend to counteract some of these high salinities via dilution. Salt crusting is evident in W3 and in the cleared mound between W3 and W4. Salinities of >7 ppt (James & Hart, 1993) for the plants *Eleocharis acuta*, and >10 ppt for *Juncus kraussii* (Zedler *et al.*, 1990) and *Baumea articulata* (Chambers *et al.*, 1995) are known to impact on growth, this equates to an approximate conductivity of 12.5 and 18 mS cm^{-1} respectively.

Recommendation 5.

High salinities (>12.5 mS cm^{-1}) are likely to start negatively impacting on emergent plants in the wetland. Although salinities within the wetland substantially exceeded these levels on only one occasion, ongoing poor flows into and out of the wetland are likely to see salinities increase and management action might be required. It is recommended that ongoing monitoring of conductivity continue and management action be undertaken where 12.5 mS cm^{-1} is exceeded for two months, or >20 mS cm^{-1} is detected on any occasion.

Dissolved oxygen concentrations were recorded in excess of 100% saturation, indicating excessive algal growth in the water (high rates of photosynthesis can temporarily raise % saturation above 100%), and coincided with high chlorophyll *a* (algal biomass) concentrations (Figure 13). Chlorophyll *a* concentrations were not high enough to cause aesthetic problems as the algae were mainly planktonic. However, W2 did suffer from a bloom of filamentous algae in September that did look unsightly (Figure 12). Filamentous algae can be easily controlled by harvesting by grounds staff.

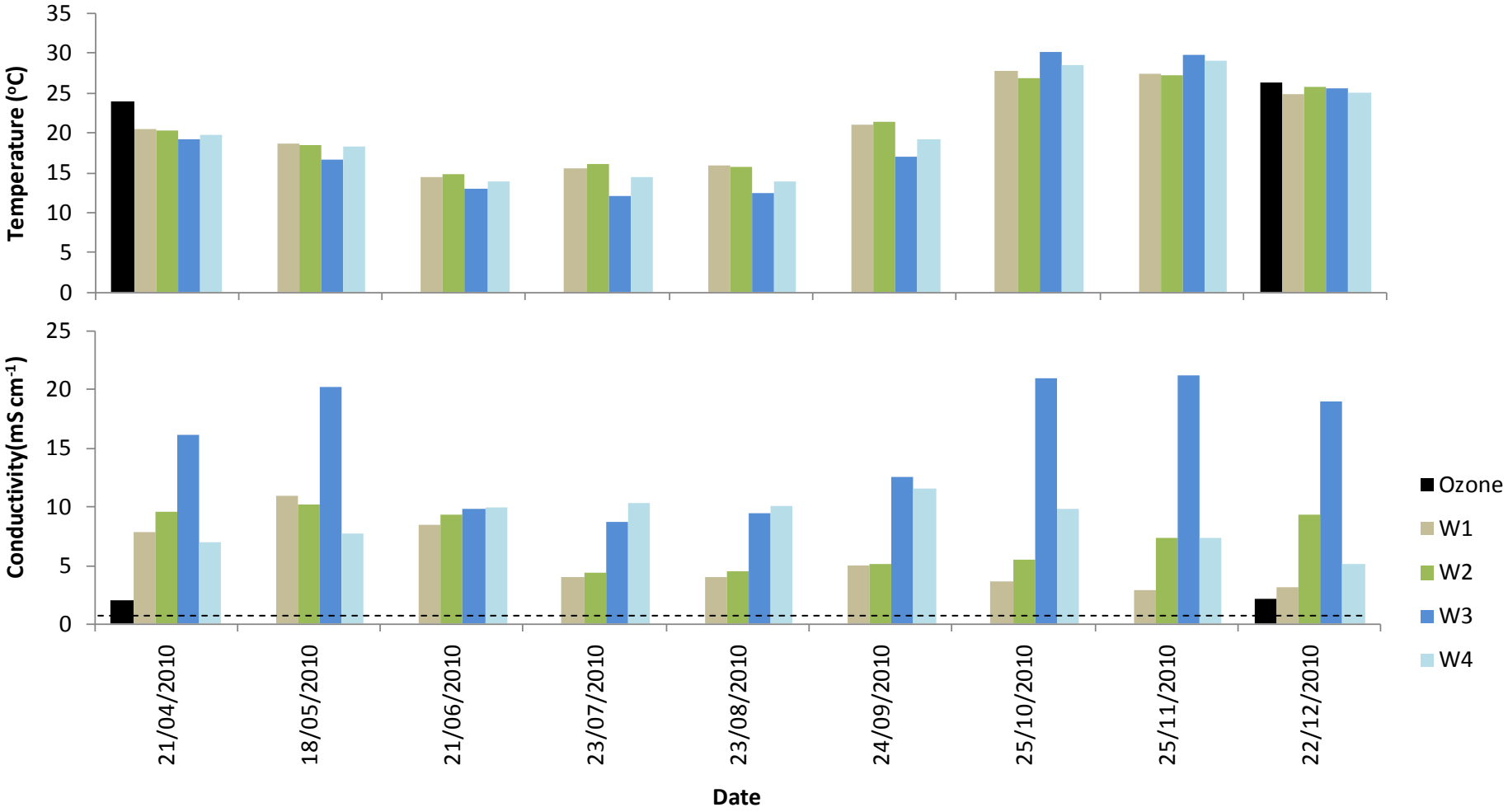
Dissolved oxygen concentrations were not low enough to pose a problem to biota except in April in W3 where they dropped to 40% saturation which would have resulted in loss of sensitive taxa. Better maintenance of water levels should reduce the chances of the problem re-occurring. pH was always circum-neutral to slightly alkaline. Growth of algae can cause the pH to become more alkaline and the highest pH occurred at the time of greatest algal growth. Oxidation reduction potential values greater than 100 mV pose no issue for

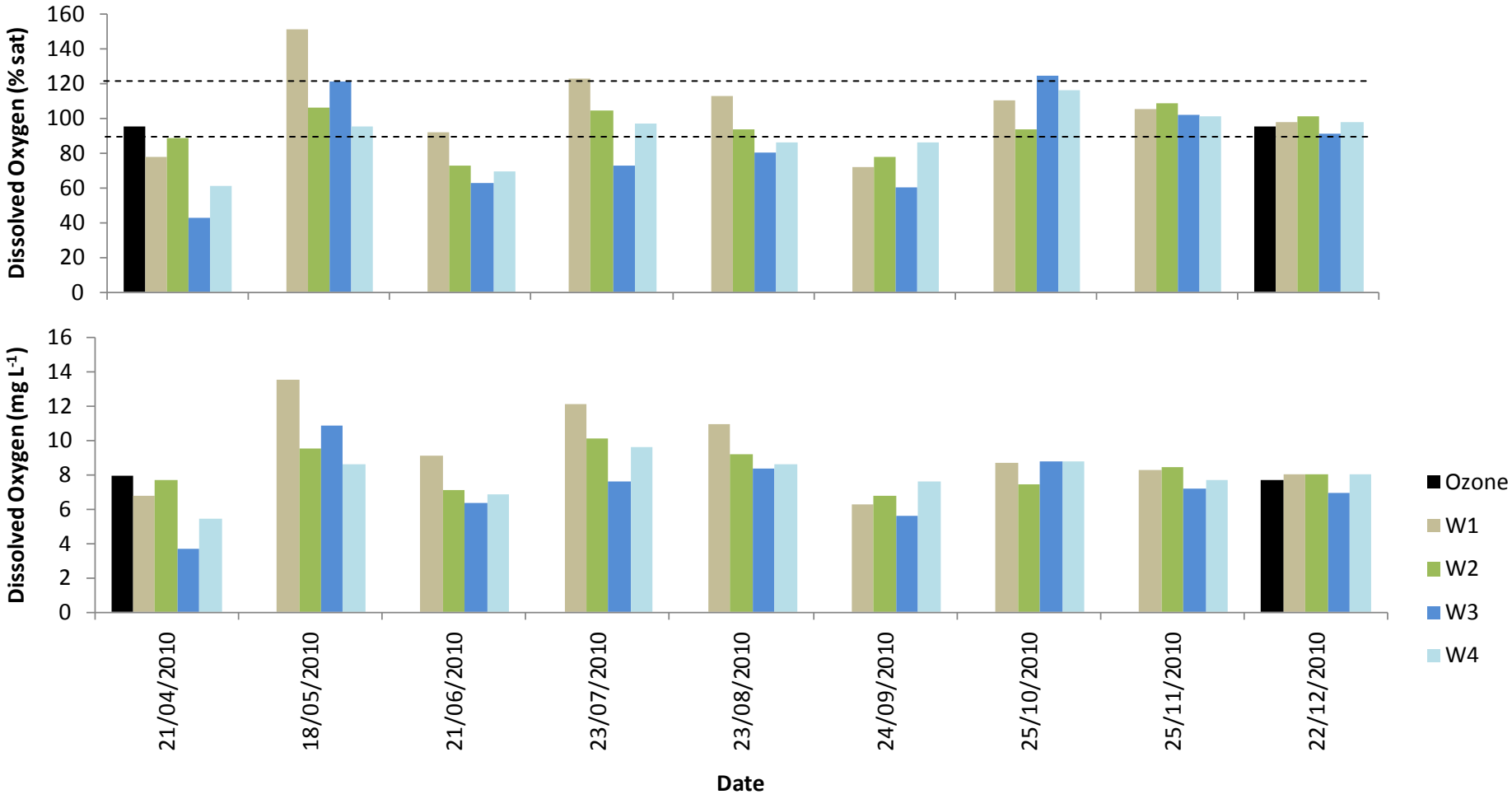
wetland processes. However, under 100 mV, the process of denitrification can occur which is the conversion of nitrates to nitrogen gas by bacteria. This is a desirable process for constructed wetlands as it results in the permanent loss of nitrogen from the system. Turbidity was high in W3 and W4 in October and November, this could possibly be due to algae in the water and however the other parameters do not support this. It is more likely that the very shallow water depths allowed for sediment to be stirred up and measured as turbidity.

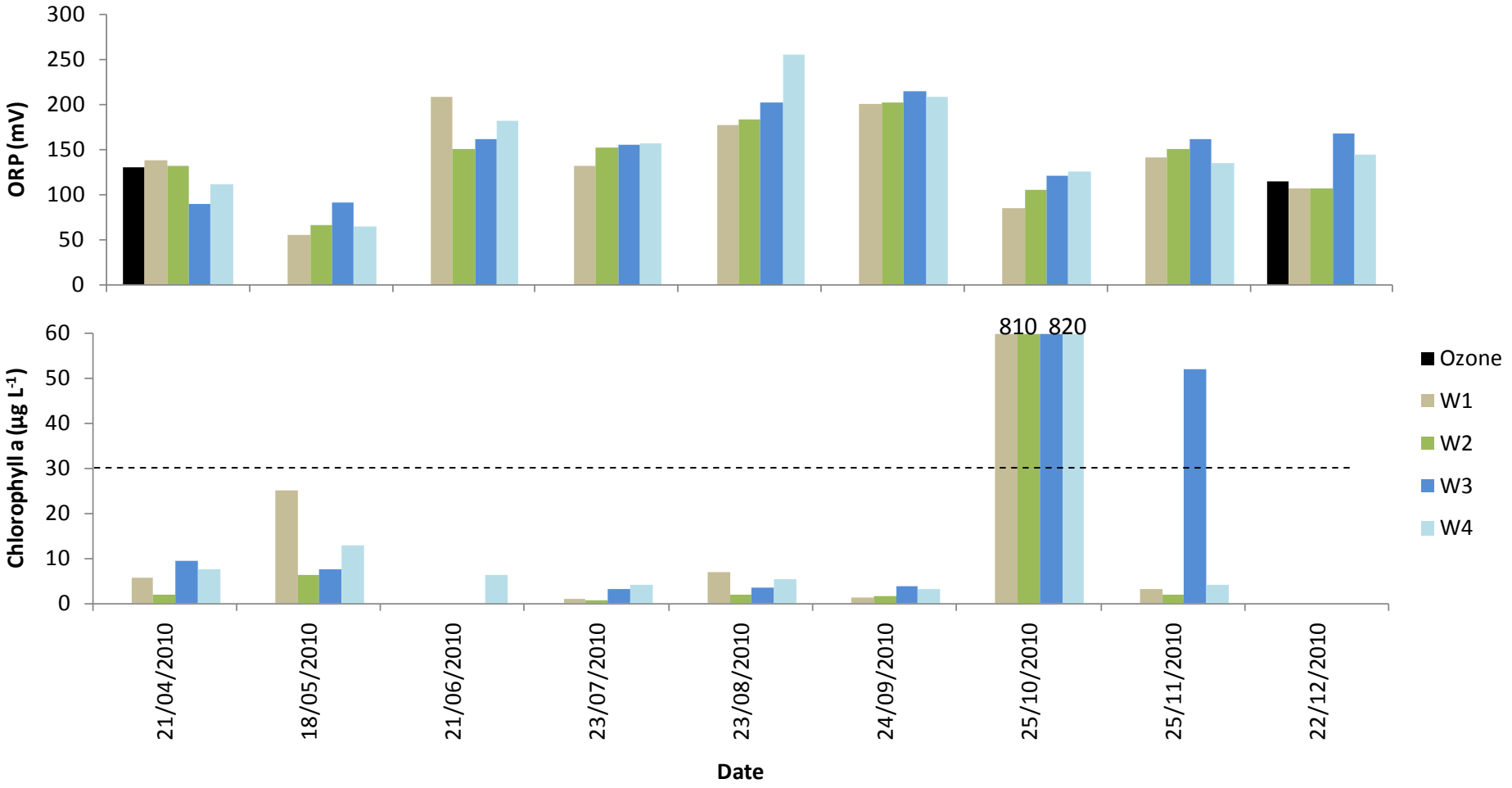
Recommendation 6.

W1 is not an official part of the current monitoring program and was monitored as per the other ponds by ECU at no cost to the City to determine whether it should be included. Although there is some similarity in water quality parameters between W1 and W2, there are sufficient differences to recommend that W1 monitoring be fully incorporated into the regular monitoring program.

Figure 12. Floating filamentous algae in W2 in September 2010.


Temperature (°C)
35
30
25
20
15
10
5
0
Conductivity(mS cm-1)
25
20
15
10
5
0
21/04/2010
18/05/2010
21/06/2010
23/07/2010
23/08/2010
24/09/2010
25/10/2010
25/11/2010
22/12/2010
Date
Ozone
W1
W2
W3
W4


Dissolved Oxygen (% sat)
160
140
120
100
80
60
40
20
0
Dissolved Oxygen (mg L-1)
16
14
12
10
8
6
4
2
0
21/04/2010
18/05/2010
21/06/2010
23/07/2010
23/08/2010
24/09/2010
25/10/2010
25/11/2010
22/12/2010
Date
Ozone
W1
W2
W3
W4


ORP (mV)
300
250
200
150
100
50
0
Chlorophyll a (µg L-1)
60
50
40
30
20
10
0
810
820
Ozone
W1
W2
W3
W4
21/04/2010
18/05/2010
21/06/2010
23/07/2010
23/08/2010
24/09/2010
25/10/2010
25/11/2010
22/12/2010
Date

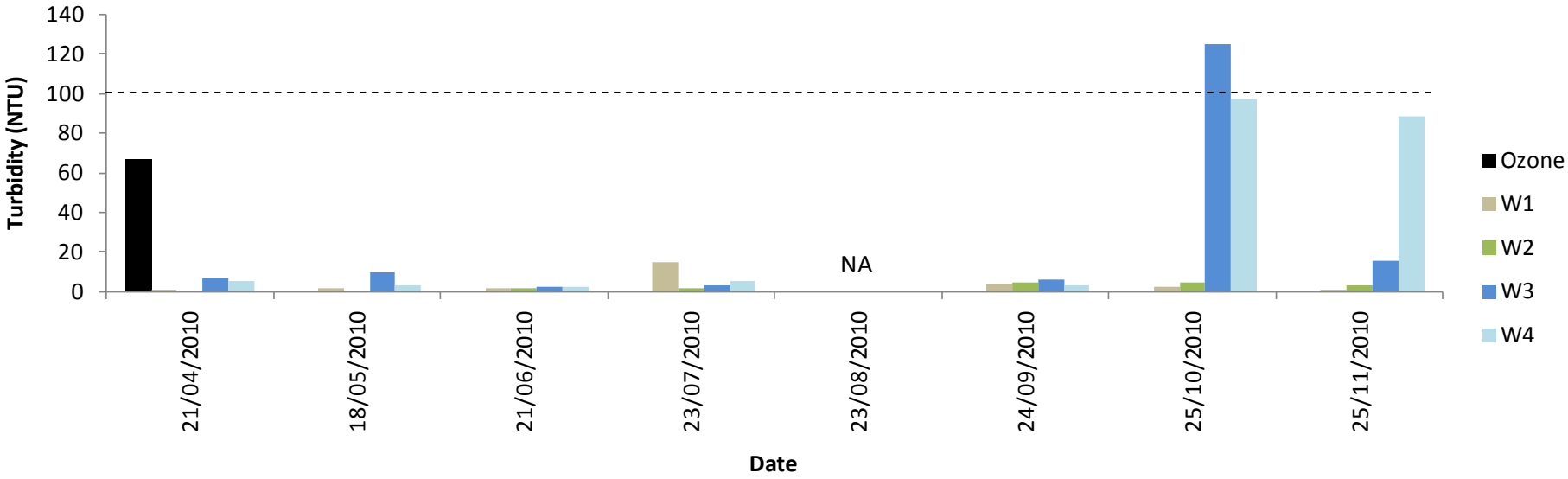
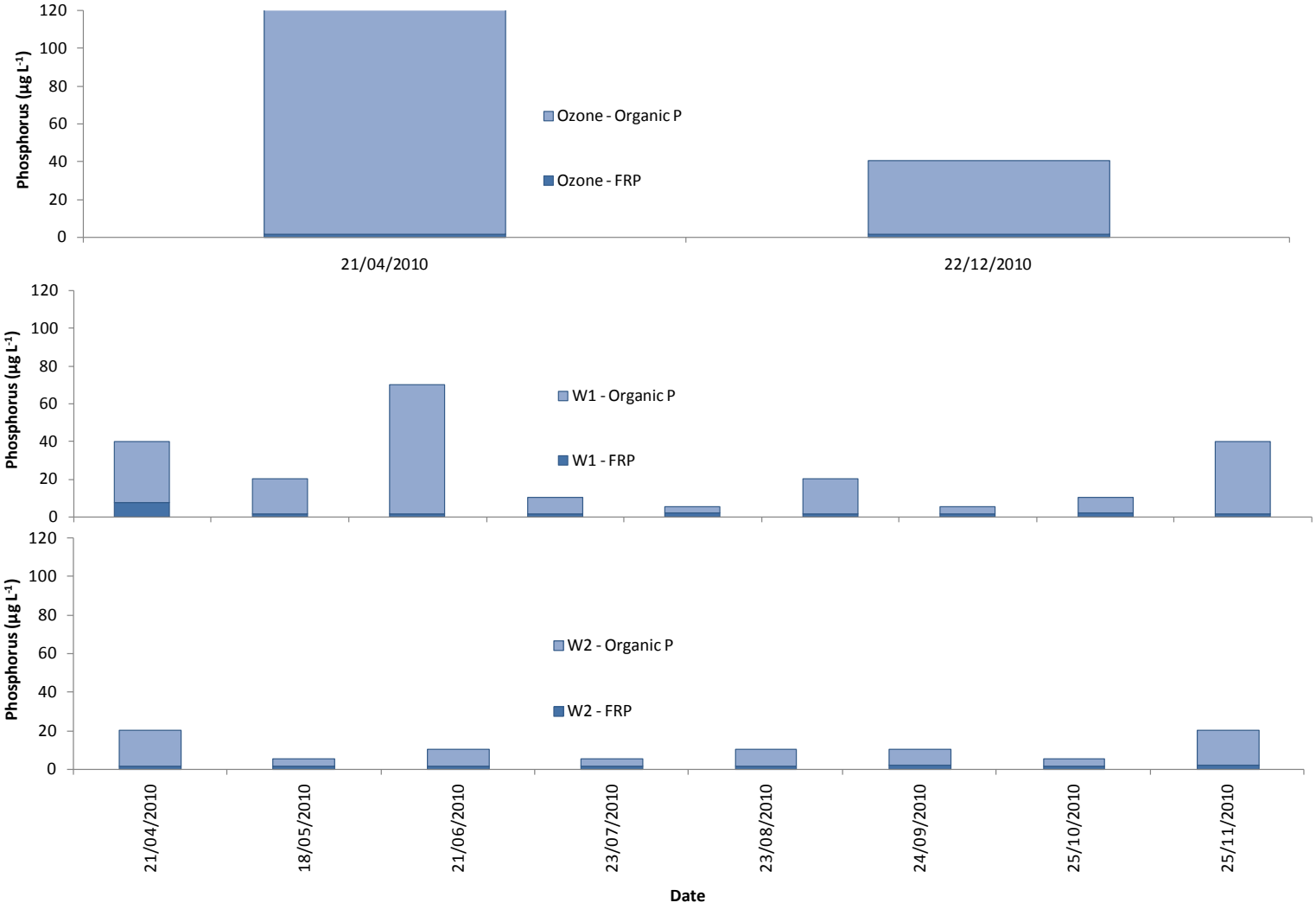


Figure 13. Physico-chemical parameters measured monthly at Point Fraser sites (W1-W4 and Lake Vasto (Ozone). Dotted lines show relevant ANZECC/ARMCANZ (2000) guideline levels (see Table 2 for details)

Phosphorus concentrations in the wetland were generally below targets of <100 µg L^{-1} (Figure 15) recommended for the Mounts Bay Drain catchment by the Swan River Trust (Swan River Trust, 2009a), as part of the Swan-Canning Water Quality Improvement Plan (Swan River Trust, 2009b). FRP concentrations were all below detection at <10 µg L^{-1}. The Organic P (could also be particulate bound) accounted for the majority of the P measured. The highest P concentrations occurred in W1, presumably reflecting incoming load. In April, both W3 and W4 had high total P concentrations presumably due to evapo-concentration of the limited water in these ponds. Settling of the P bound particulates appears to have occurred between W1 and W2. Lake Vasto had high Total P concentrations of 160 µg L^{-1}, but very low FRP at 1 µg L^{-1}. It is presumed that the principle function of Lake Vasto is to precipitate iron prior to the water being used for irrigation. At the time of sampling this had resulted in highly turbid waters which are assumed to be due to wind re-suspended iron floc (Figure 14). Iron binds P, hence this explains the low available P (FRP) and the high particulate P. Topping up the wetland with Lake Vasto water, if this turbidity is normal will not add significant amounts of FRP, but will add iron particulates which may improve the wetland sediment P binding capacity. Although P binds strongly to iron, it is easily released under anoxic or low ORP conditions; therefore maintenance of oxic and high ORP conditions will become increasing important to retain P.

Figure 14. Photograph of Lake Vasto, highlighting the turbid waters


Phosphorus (µg L-1)
120
100
80
60
40
20
0
Ozone - Organic P
Ozone - FRP
21/04/2010
22/12/2010
Phosphorus (µg L-1)
W1 - Organic P
W1 - FRP
Phosphorus (µg L-1)
W2 - Organic P
W2 - FRP
21/04/2010
18/05/2010
21/06/2010
23/07/2010
23/08/2010
24/09/2010
25/10/2010
25/11/2010
Date

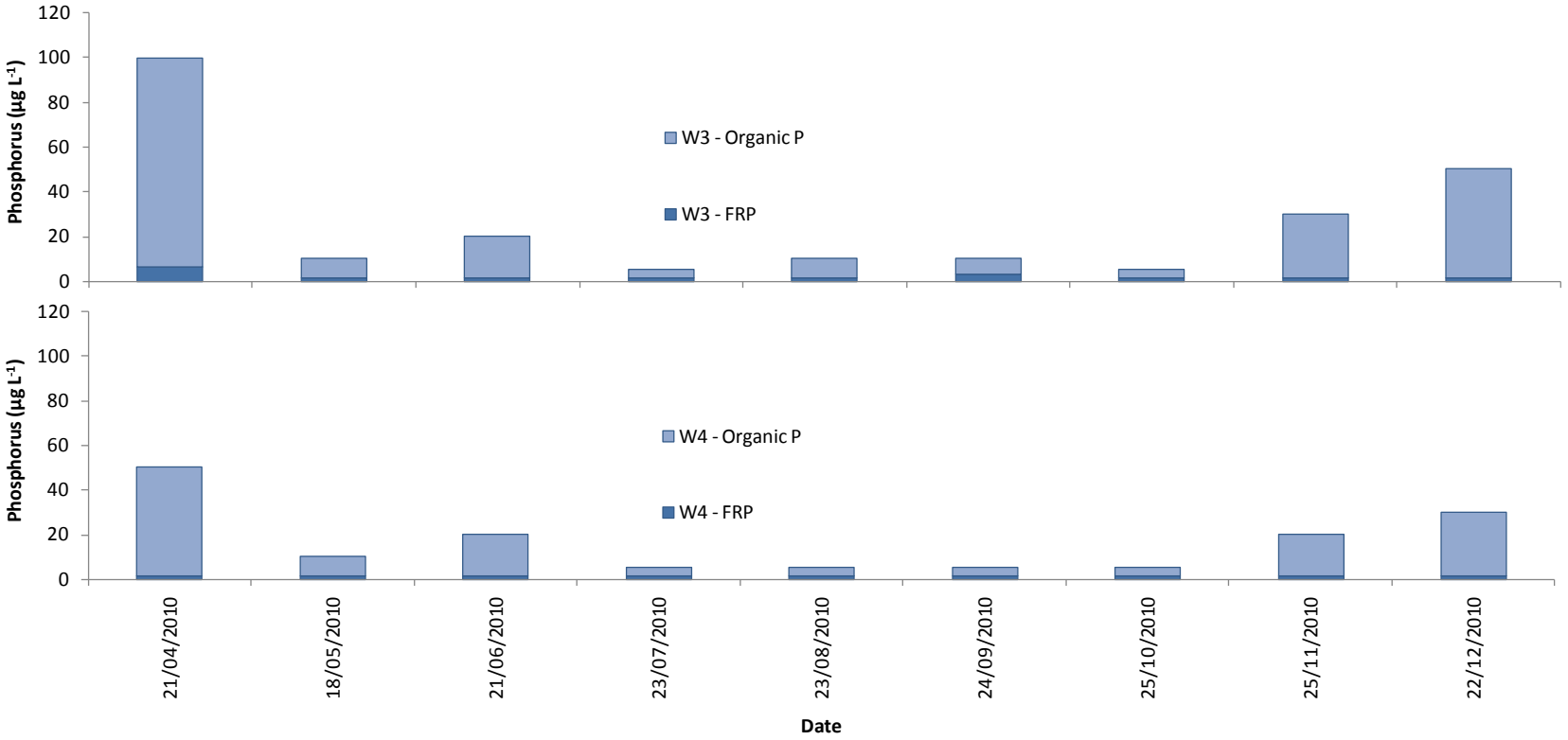
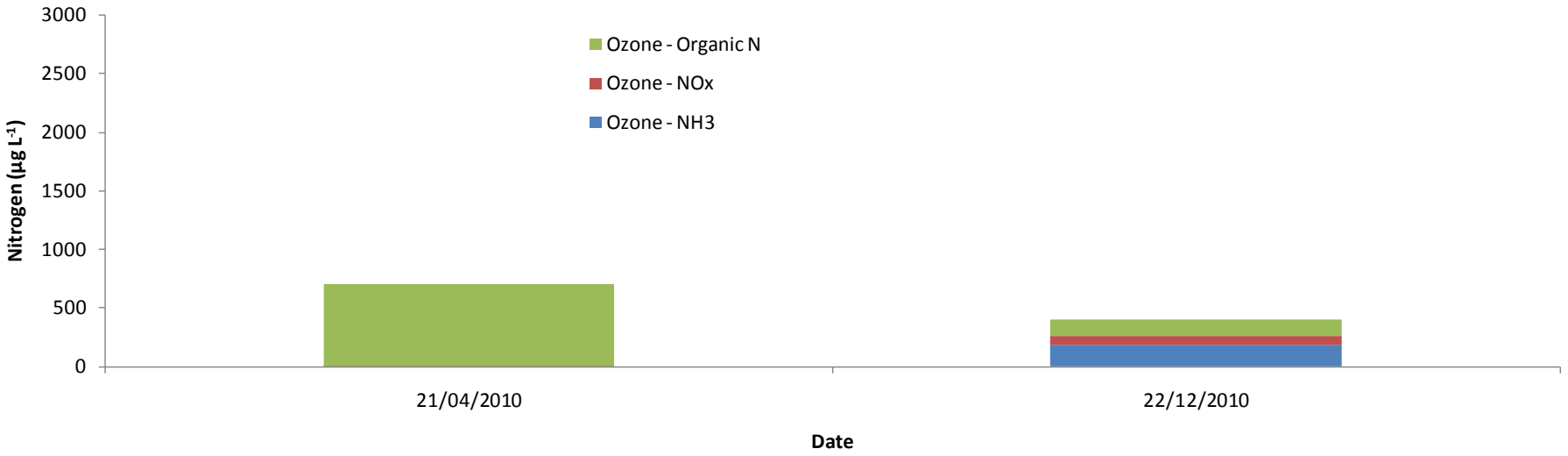
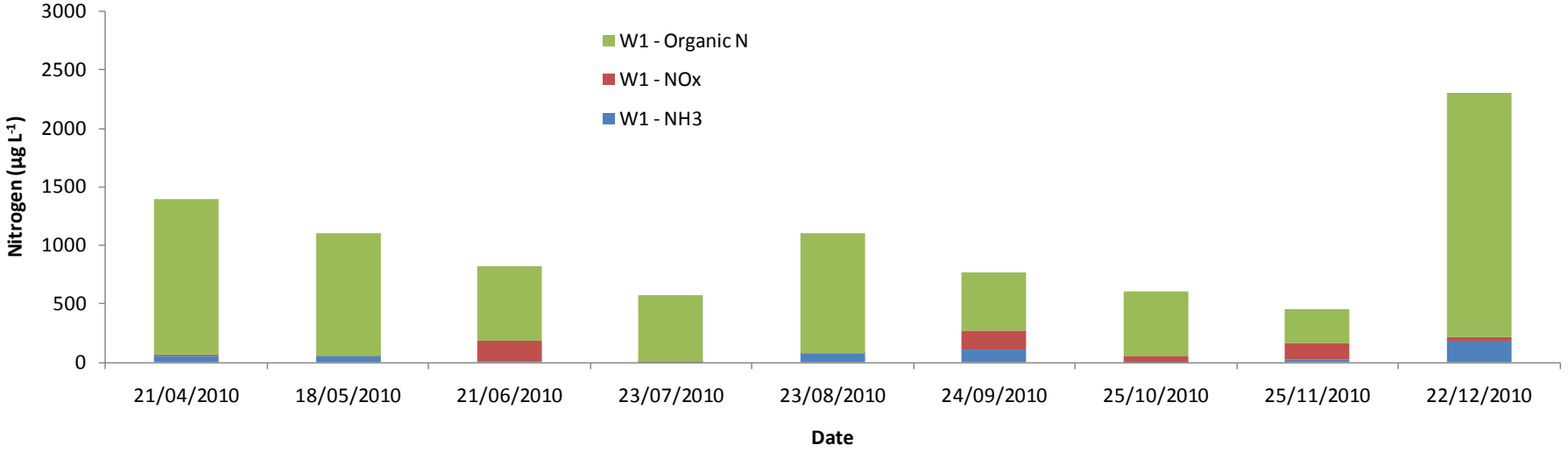


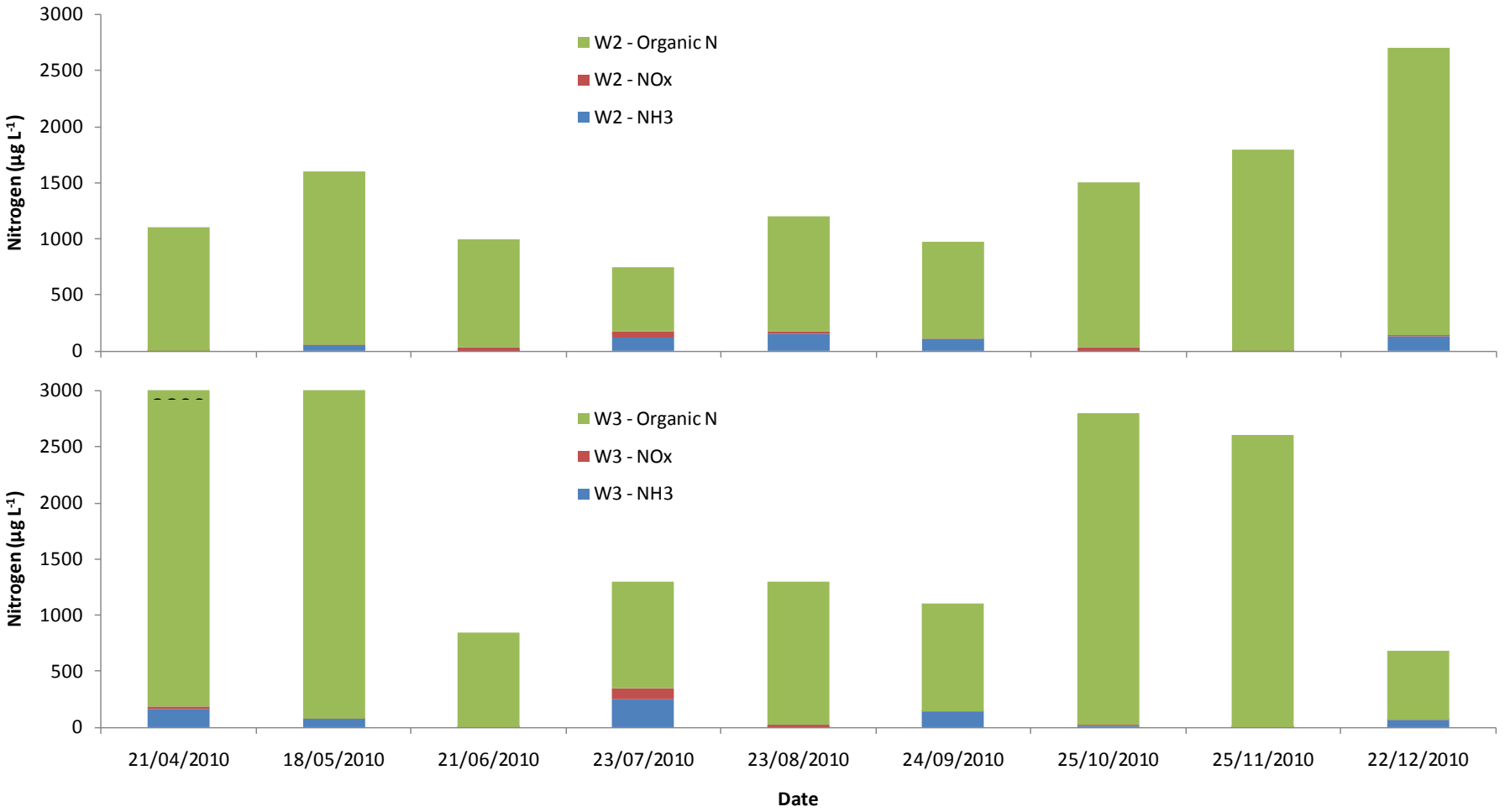
Figure 15. Phosphorus (Total P = Organic P + FRP) concentrations recorded at all sites in the wetland. Majority of FRP concentrations were below detection at 2 µg L^{-1}.

Lake Vasto contained relatively low Total N (700 µg L^{-1}) concentrations with NOx and NH_3 being below detection (<5 µg L^{-1}). In all ponds, organic N (organic or particulate) accounted for the majority of the N present. In W1, which reflects any inflows, showed only high concentrations of NH_3 in August and September at 77 and 110 respectively, while <60 µg L^{-1} (often below detection <5 µg L^{-1}) for the remainder of the months sampled. The Supersorb Activated Zeolite added to the sediment in Zone 1 is especially useful for removal of NH_3 from water (its main use is in the aquaculture industry). In W2, NH_3 concentrations generally remain unchanged or decrease from those reported for W1, however in July and August concentrations increase up to 150 µg L^{-1} (August). This suggests that the zeolite may be reducing NH_3 concentrations at low flows but in the most substantial inflows that occurred in July and August that it may have been less effective. NH_3 is also converted by nitrification to NOx; this appears to occur in July and August where NOx concentrations increase in W2 and NH_3 concentrations are also high. In June, September to November NOx concentrations ranged between 53 and 170 µg L^{-1} in W1. This contrasts with the lower concentrations in W2 which peaked in July at 52 µg L^{-1}. NOx is the preferred form of N for plant growth (although most other forms can also be used) and the drop in NOx in W2 might be due to uptake (see Section 7.5.3 – high storage of N in plant biomass) or denitrification. Discharge from the wetland (if it occurred) comes from W4 and this pond showed low <66 µg L^{-1} NH_3 and <23 µg L^{-1} NOx concentrations. W3 showed the highest NH_3 and NOx concentrations at 250 and 100 µg L^{-1} respectively in July. Total N concentrations should aim to <1000 µg L^{-1} to meet the Mounts Bay Water Quality improvement targets (Swan River Trust, 2009a), however in the Point Fraser higher concentrations were seen at all sites except W4. At W4, Total N concentrations exceeded the target on only one occasion (reaching 1100 µg L^{-1}) suggesting that the wetland was successfully reducing Total N concentrations to the target level

The ANZECC/ARMCANZ (2000) guidelines for aquatic ecosystems in the south west of Australia for wetlands or lakes/reservoirs are presented in Table 2. These trigger values are designed for natural wetlands and are only indicative of possible issues. Constructed wetlands would be expected to exceed many of these trigger values as their role is treat water of poor quality, however it would be expected that as water passes through the wetland, the frequency of exceedance would decrease as the water is treated. For all the nutrients there are the fewest exceedances in W4 compared to other ponds, suggesting that the wetland is treating nutrients in the incoming water. Salinities were higher than the guidelines, as the incoming water (at least from Lake Vasto) is already saltier than the guidelines. Dissolved oxygen was both higher and lower than the recommended value at different times. Low dissolved oxygen is the most problematic as low levels can impact on biota in the water and anoxia can result in the release of iron or manganese sediment bound P.


3000
2500
2000
1500
1000
500
0
Nitrogen (µg L-1)
Ozone - Organic N
Ozone - NOx
Ozone - NH3
21/04/2010
22/12/2010
Date


3000
2500
2000
1500
1000
500
0
Nitrogen (µg L-1)
W1 - Organic N
W1 - NOx
W1 - NH3
21/04/2010
18/05/2010
21/06/2010
23/07/2010
23/08/2010
24/09/2010
25/10/2010
25/11/2010
22/12/2010
Date


3000
2500
2000
1500
1000
500
0
Nitrogen (µg L-1)
W2 - Organic N
W2 - NOx
W2 - NH3
W3 - Organic N
W3 - NOx
W3 - NH3
21/04/2010
18/05/2010
21/06/2010
23/07/2010
23/08/2010
24/09/2010
25/10/2010
25/11/2010
22/12/2010
Date

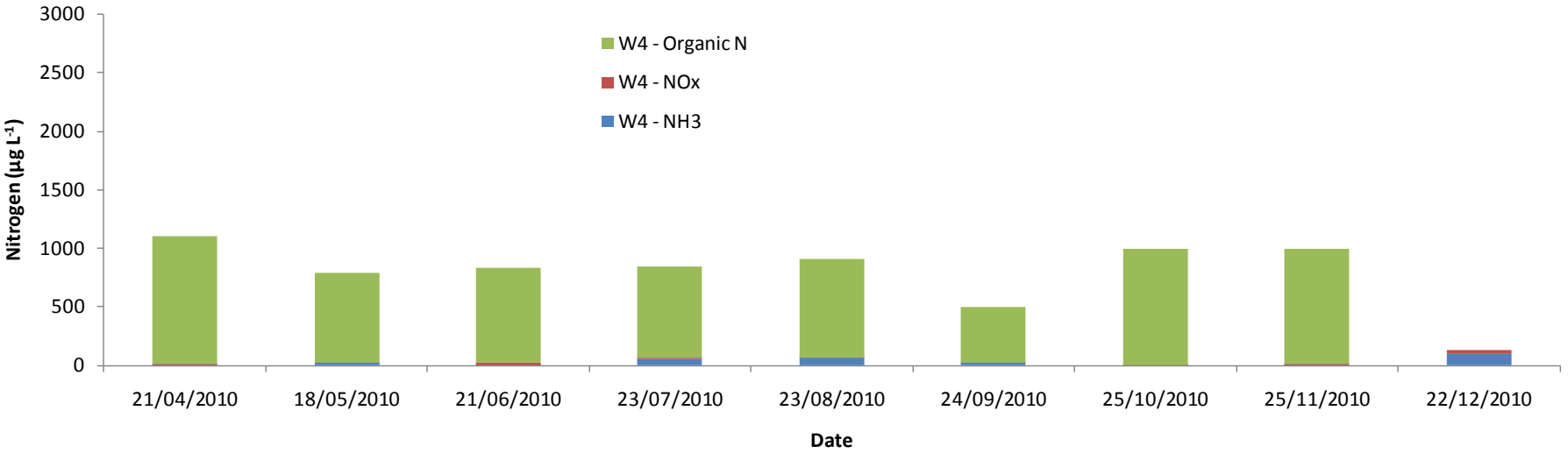


Figure 16. Nitrogen (Total N = Organic N + NH_3 + NOx) concentrations recorded at all sites in the wetland. Note on the 22/12/10 analytical error prevented Organic N being determined.

Table 2 ANZECC/ARMCANZ (2000) guideline for aquatic ecosystems in the south west of Australia for wetlands or lakes/reservoirs

Parameter	Acceptable range	Number of Exceedances (# samples)			
		W1	W2	W3	W4
Chlorophyll *a*	<30 µg L^{-1}	1 (4)	1 (4)	1 (4)	1 (4)
Dissolved oxygen	90-120% saturation	4 (9)	3 (9)	7 (9)	4 (9)
pH	7.0-8.5	2 (9)	3 (9)	2 (9)	0 (9)
Conductivity	0.3-1.5 mS cm^{-1}	9 (9)	9 (9)	9 (9)	9 (9)
Turbidity	10-100 NTU	0 (8)	0 (8)	0 (8)	0 (8)
Total P	<60 µg L^{-1}	1 (9)	0 (9)	1 (9)	0 (9)
FRP	<30 µg L^{-1}	0 (9)	0 (9)	0 (9)	0 (9)
Total N	<1500 µg L^{-1}	0 (9)	3 (9)	4 (9)	0 (9)
NOx	<100 µg L^{-1}	3 (9)	0 (9)	1 (9)	0 (9)
Ammonia	<40 µg L^{-1}	4 (9)	4 (9)	4 (9)	2 (9)

7.3.2 QUARTERLY DATA

A broader range of parameters and metals were sampled from each pond at quarterly intervals (with an additional sample taken in October by mistake; Table 3). Water hardness was 'extremely high' in May but has since declined to 'very high' levels (see Table 4) presumably due to dilution with rainfall, topping up water from Lake Vasto and inflows. Total suspended solids (TSS) measures all the particulates retained on a filter, it can often be approximated (for a specific site) by turbidity. Turbidity is relatively easy to measure compared to TSS. Given the limited range of the data, a relatively strong linear correlation of ($r = 0.81$) exists between turbidity and TSS. TSS tends to be higher in W3 and W4, presumably as Zone 1 is designed to settle particulates while Zone 2 is shallow and potentially more mixed by winds re-suspending sediment. Chlorophyll *a* concentrations show no real difference between Zones suggesting that the additional suspended material is inorganic. In October, chlorophyll *a* concentrations were extremely high at >810 µg L^{-1} compared to the normal concentrations of >52 µg L^{-1}. It is likely the high concentrations were the result of the algal bloom seen in September (see Figure 12). Despite high algal biomass in the water, biological oxygen demand remained below detection on all occasions (<5 mg L^{-1}).

All the metals measured had concentrations (due to water hardness in some cases) that were below the ANZECC/ARMCANZ (2000) trigger values for the 95% protection of aquatic systems with the exception in October where W1 had Cu of 7 µg L^{-1} and W4 had Zn of 70 µg L^{-1}. Zinc was highest in concentration at W4 on all occasions, which suggests that some of materials used in the wetland construction might be releasing Zn into this pond alone. In a similar way, Fe concentrations also were highest in W3, possibly due to the more stagnant water allowing for some release of iron from the sediments (localized anoxia). Detection limits from the Analytical Laboratories were higher than requested on several occasions (this issue has been rectified) and there may have been exceedances of the trigger values for As, Cd and Cr due to detection limits being above the trigger value. However this is unlikely as at other times, concentrations were very low.

Table 3. Quarterly concentrations of metals and selected other parameters recorded in May, August, October 2010. ANZECC/ARMCANZ (2000) trigger values for protection of 95% of species in aquatic ecosystems provided. (H= must be adjusted for hardness as in Table 4, C = does not necessarily protect against chronic effects, B= possible biomagnification needs to be considered). Values in blue have detection limits above the trigger value, while red values exceed the trigger value.

	ANZECC (2000)	18/05/2010				23/08/2010				25/10/2010				25/11/2010			
Analysis (mg L^{-1})	**Trigger Values**	**W1**	**W2**	**W3**	**W4**	**W1**	**W2**	**W3**	**W4**	**W1**	**W2**	**W3**	**W4**	**W1**	**W2**	**W3**	**W4**
Total Suspended Solids		16	15	26	26	11	15	14	18	<5	27	74	38	<5	16	39	8
Total Hardness (CaCO3)		1130	916	1810	820	320	360	870	870	140	230	370	220	70	210	360	210
Ca		107	79	160	112	34	41	130	130	53	62	290	140				
Mg		210	174	343	131	57	63	140	140	62	96	390	150				
Al (µg L^{-1})	55	<10	<10	<10	<10	<20	<20	<20	<20	<20	20	20	<20	7	7	5	5
As (µg L-1)	13 As(V)	2	2	3	2	<20	<20	<20	<20	<20	<20	<20	<20	<1	3	<5	2
Cd (µg L^{-1})	0.2^{H}	<0.1	<0.1	<0.1	<0.1	<1	<1	<1	<1	<5	<5	<5	<5	<0.1	<0.1	<5	<0.1
Cr (µg L^{-1})	1 Cr^{C} (VI)	<1	<1	<1	<1	<5	<5	<5	<5	<5	<5	<5	<5	<1	<1	<5	<1
Cu (µg L^{-1})	1.4^{H}	5	3	5	3	<5	<5	<5	<5	7	<5	5	<5	3	3	<5	3
Ni (µg L^{-1})	11^{H}	<1	<1	1	<1	<5	<5	<5	<5	5	5	9	8	<1	2	<5	3
Pb (µg L^{-1})	3.4^{H}	<1	<1	<1	<1	<5	<5	<5	<5	<5	<5	<5	<5	<1	<1	<5	<1
Zn (µg L^{-1})	8^{CH}	7	9	7	26	<10	<10	50	40	20	20	20	70	15	17	29	21
Mn (µg L^{-1})	1900^{C}	13	14	21	19	<5	16	14	9	180	33	14	31	38	24	23	45
Fe (µg L^{-1})		<50	<50	70	<50	40	60	250	80	30	70	110	40	49	23	100	48
Hg (µg L^{-1})	$0.6(Inorganic)^{B}$	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
DOC		0.001	19	39	13	9.5	13	21	16	6.3	21	55	21	3.4	20	37	12
Chlorophyll *a* (µg L^{-1})		25	6.4	7.5	13	6.9	2.1	3.7	5.3	810	810	820	820	3.2	2.1	52	4.3
Chlorophyll *a* Trichromatic (µg L^{-1})		<0.5	<0.5	<0.5	<0.5	0	0	0	0	360	350	360	360	2.6	0.7	24	6.7

	ANZECC (2000)	18/05/2010				23/08/2010				25/10/2010				25/11/2010			
Analysis (mg L^{-1})	**Trigger Values**	**W1**	**W2**	**W3**	**W4**	**W1**	**W2**	**W3**	**W4**	**W1**	**W2**	**W3**	**W4**	**W1**	**W2**	**W3**	**W4**
Phaeophytin (µg L^{-1})		240	250	250	250	21	22	21	22	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	3.6
TKN						1.1	1.1	1.2	0.91	0.56	1.5	2.8	1	0.33	1.8	2.6	1
BOD						<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Turbidity (NTU)						0.7	2.8	1.2	2	3.2	2.1	15	2.9	2.1	2.9	3.6	4

Table 4 Approximate factors to apply to soft water trigger values for selected metals in freshwaters of varying water hardness (taken from (ANZECC/ARMCANZ, 2000) (TV = Trigger value).

Hardness category (mg/L as CaCO3)	Cd	Cu	Pb	Ni	Zn
Soft (0–59)	TV	TV	TV	TV	TV
Moderate (60–119)	X 2.7	X 2.5	X 4.0	X 2.5	X 2.5
Hard (120–179)	X 4.2	X 3.9	X 7.6	X 3.9	X 3.9
Very hard (180–240)	X 5.7	X 5.2	X 11.8	X 5.2	X 5.2
Extremely hard (400)	X 10.0	X 9.0	X 26.7	X 9.0	X 9.0

7.3.3 CONCLUSIONS

1. Determine how physico-chemical variables and nutrient concentrations changed on a monthly timescale
2. Examine how key metals and other selected parameters change quarterly between all the ponds

There were two exceedances of ANZECC/ARMCANZ (2000) guidelines for metals concentration, however only one was of concern (with potential to be discharged), which was for Zn and occurred in W4 in October. No outflow from the wetland was recorded in October. The wetland appeared to achieve its principal objective of discharging water meeting the requirements of the Swan-Canning Water Quality Improvement Plan (Swan River Trust, 2009a, b). There was some evidence of nutrient uptake by the sediments of W1 and W2. Close examination of the monthly nutrient and physico-chemical parameters found a number of exceedances of ANZECC/ARMCANZ (2000) guidelines particularly in the first three ponds, there were few in W4. It should be noted that as the wetlands purpose is to treat water to a high quality, it is expected that initial water qualities will be poor. Overall the wetland appeared to have a positive effect on reducing metal and nutrient concentrations of water entering it. However it should be noted that most of the water entering was rainwater or water from Lake Vasto.

7.4 SEDIMENT

The specific aims of measuring the sediment quality in the wetland were to:

1. Determine how key metal and nutrients were accumulating in the sediment.

This will show whether there are any management issues associated with sediment quality. The data will allow the effectiveness of various processes responsible for nutrient uptake or release to be inferred.

2. To evaluate how the sediment is developing over time.

This will in 2010 simply provide a baseline against which subsequent years can be compared.

Sediments were sampled in May 2010 for a range of metals and nutrients (Table 5). The average depth of sediment to the liner in W2 was 86.3 ± 10.5 mm. This included the zeolite layer which was impractical to separate from the newly formed sediment on top. As a result, the W2 sediment had very high Al concentrations (zeolite is an Al mineral) compared to W3. The zeolite also appeared to have bound a large concentration of nitrogen (probably NH_3) giving a total concentration of 5,245 ± 2,307 mg kg^{-1}, compared to 453 ± 73 mg kg^{-1} in W3. Compared to the sediment nutrient concentrations recorded by Davis et al. (1993) across 40 natural wetlands of the Swan Coastal Plain this is about half the average concentration of 10,770 ± 930 mg kg^{-1}. The zeolite might also be binding P as concentrations were 263 ± 82 mg kg^{-1} in W2 compared to 40 ± 4 mg kg^{-1} in W3. These concentrations were significantly lower than those of Davis et al. (1993) at 1,100 ± 580 mg kg^{-1}. This suggests that there is still plenty of uptake capacity for nutrients in the sediment.

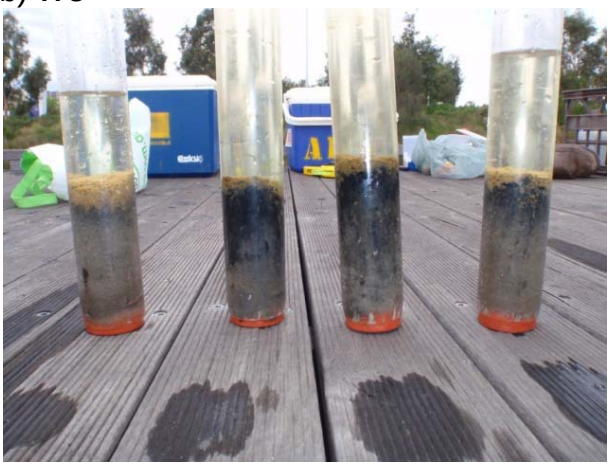
Table 5. Sediment concentrations of selected metals and nutrients in W2 and W3 in May 2010.

Variable (mg kg^{-1})	ANZECC & ARMCANZ (2000) Interim Guidelines (Low-High)	W2	W3
Moisture Content (%)		87.1 ± 5.9	30.3 ± 5.3
TKN		5,245 ± 2,307	453 ± 73
TP		263 ± 82	40 ± 4
TOC		4.1 ± 2.0	0.7 ± 0.4
Al		171,250 ± 72,926	2,010 ± 1,067
As	20-70	20.3 ± 8.1	1.0 ± 0.0
Cd	1.5-10	0.2 ± 0.0	0.2 ± 0.0
Cr	80-370	9.5 ± 0.9	3.4 ± 0.9
Cu	65-270	24 ± 3	4 ± 1
Fe		24,250 ± 6,316	2,775 ± 855
Ni	21-52	16 ± 3	2 ± 0
Pb	50-220	68 ± 24	9 ± 2
Zn	200-410	154 ± 29	22 ± 6
Mn		878 ± 273	13 ± 4
Hg	0.15-1	0.15 ± 0.03	0.03 ± 0.00

Chara sp. was found growing in W3 during the sediment sampling in May 2010 (Figure 17).

a) W2

b) W3



c) *Chara* sp in W3

Figure 17. Photographs of the sediment cores taken at a) W2, b) W3, and c) a close up of a W3 core.

Table 6 shows the sediment composition in W2 and W3. W2 has sediment primarily consisting of sedimented particulates and zeolite. This is reflected in the high proportion of water (87.1±5.9%) compared to the sandier sediment in W3 (30.3±5.3%).W2 whose function is partially for sedimentation of incoming particulates has accumulated higher proportions of organic and inorganic carbon than W3.

Table 6. Mean (±SE) for sediment %moisture (Dry weight at 105 °C), % organic carbon (Loss on Ignition at 500 °C) and %inorganic carbon (Loss on Ignition at 1000 °C) at sites W2 and W3.

	W2	W3
% Moisture	87.1 ± 5.9	30.3 ± 5.3
% Organic C	15.3 ± 1.9	2.3 ± 0.2
% Inorganic C	17.1 ± 4.2	13.0 ± 1.4

7.5 VEGETATION

The specific aims of sampling the vegetation were to:

1. Map the coverage of the aquatic plant species in the wetland.

This will show how the plant communities in the wetland are developing. It will also allow the area of each species to be determined and this information will be used in the nutrient load calculations.

2. Measure development of biomass of major plant species within the wetland (Zones 1 and 2).

This will show whether the plants are becoming larger and/or denser. It also provides a basis to determine nutrient loads in the vegetation.

3. Measure the concentration of nutrients (N & P) in live, dead and below ground parts of each species in each site.

This will allow the total load of nutrients stored in plant material to be determined. It will also indicate which species are best for nutrient uptake.

The specific aims of the foreshore monitoring were to:

4. Establish some regular sites where the condition of the foreshore can be monitored. Key items of interest are erosion, weed invasion and the effectiveness of armouring that may have been put in place.

This will allow issues on the foreshore that require management action to be identified and acted upon before substantial damage is done to the site.

7.5.1 VEGETATION COMMUNITIES

Wetland vegetation mapping and photo-point monitoring was conducted in late May and October 2010. The vegetation of the wetland is shown in Figure 18. Based on observations, the following major cover types were determined across the wetland:

Baumea articulata – one small patch (~17m^2) of *Baumea articulata* (Jointed Rush, Cyperaceae) occurs on the western end of Zone 1 in relatively deep water (at time of monitoring). It is likely that the patch has been contracting in area and there was no sign of recent colonisation via rhizomes or new seedlings. The patch is however relatively dense with 60-70% cover.

Eleocharis acuta – This community is dominated by *Eleocharis acuta* (Common Spikerush, Cyperaceae) with 50-70% cover, but also has some *Juncus kraussii* (10-30% cover). This community mainly occurs on the eastern side of Zone 2 seemingly on slightly deeper water than the other wetland communities.

Ficinia nodosa – this community is dominated by Knotted Club Rush (previously *Isolepis nodosa*) and tends to occur on surrounding slopes on non-inundated areas.

Juncus kraussii – this is the most widespread vegetation type of the wetland and dominants each Zone. It consists of dense stands of *Juncus kraussii* (Sea Rush, Juncaceae) of between 60 to 90% cover. There was active recruitment of young plants into the shallow open water.

Samphire and other halophytes – This community is dominated by *Tecticornia indica* and other *Tecticornia* spp. (commonly known as samphires and previously in the genus *Halosarcia*). They don't appear to be on the original planting list and so are likely to have colonised raised mounds of the wetland and other areas which dry in summer. These raised areas appear to accumulate salts during the drying phase and also support other halophytes such as *Frankenia pauciflora*.

In addition to these plant communities, other communities were found:

Mixed shrubs on embankments – this community consists of a range of shrub species with medium to high cover. Dominant species include *Scavola crassifolia,*

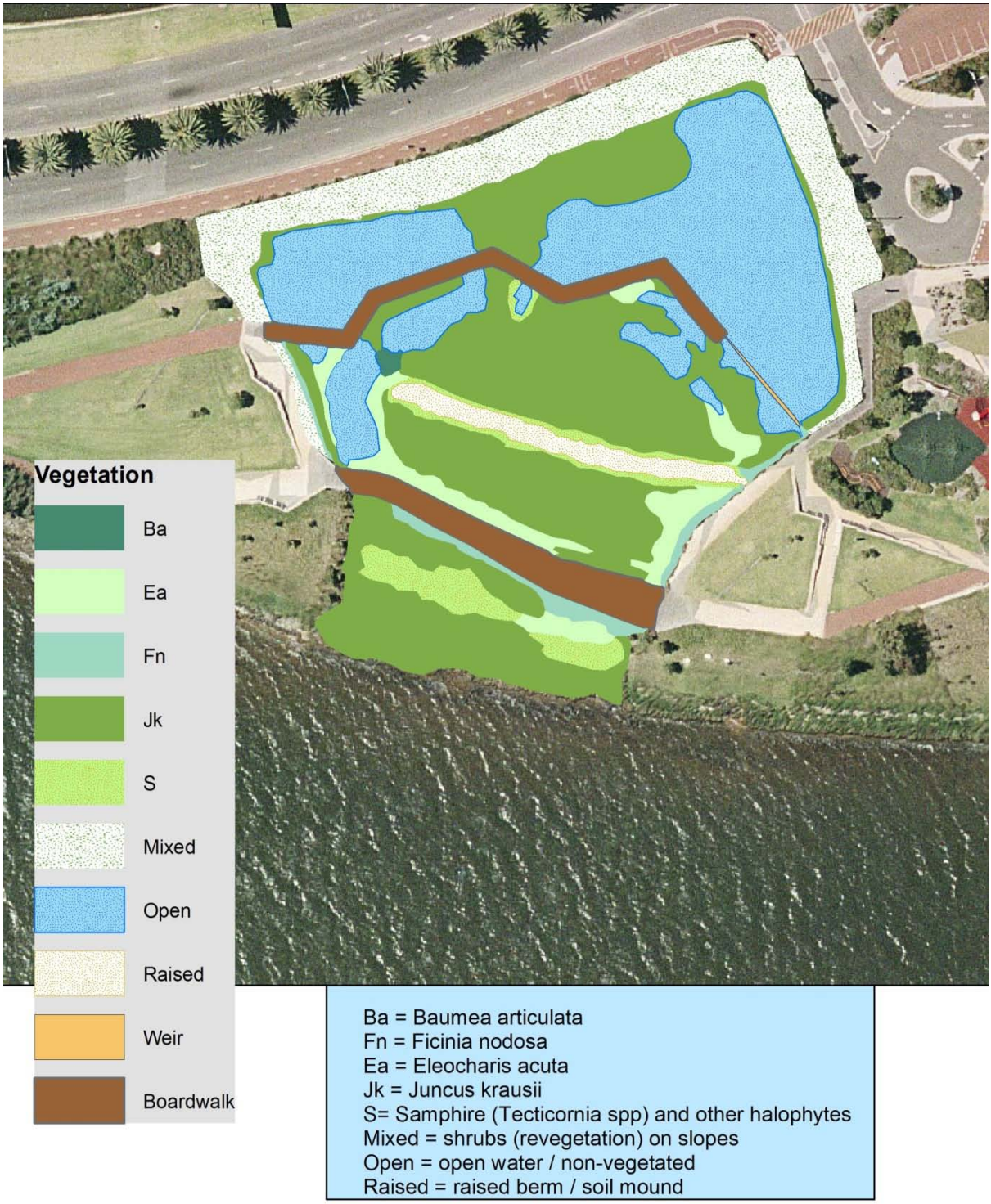


Figure 18. Map of vegetation types and other cover as of May 2010.

Kunzea ericifolia, Myoporum caprarioides, Ficinia nodosa and *Atriplex cinerea*. Most of these species were planted around the edge of the wetland.

Open Water – no plant species were found in these areas (although filamentous algae was common).

Within the wetland, sporadic occurrences of two tree/shrub species were noted:

Melaleuca cuticularis – two patches of young trees were observed on slightly raised mounds, both within Zone 2.They are mostly found on the margin of *Juncus* community where it abuts samphire/halophytes. One mound has 7 trees; the other has about nine trees between 1.5 to 3 m high. Also 20 trees occur in Zone 3, again on raised ground relative to the wetland basin. No seedlings or recent recruitment were noted, so it can be assumed that these are individuals surviving from the time of original planting in 2004-5.

Melaleuca lateritia – this compact shrub was found interspersed throughout the *Juncus* community of Zone 2. Some 20 plants were observed (see map for location). These plants were mature (flowering; ~1.5 m high) and no seedlings or recent recruitment was noted, which suggests that these are individuals planted in 2004-5.

The major community was *J. kraussii* which occupied 45.6% of the entire wetland, followed by *E. acuta* at 5.7% with all other communities occupying <5% each (Table 7).

Table 7. Area (m^2) of each cover type and its percentage of total study area and of wetland area (as of May 2010).

Type	Area (m^2)	% total	% wetland
Baumea articulata	16.9	0.2	0.2
Eleocharis acuta	405.6	4.7	5.7
Ficinia nodosa	154.3	1.8	2.2
Juncus kraussii	3234.3	37.7	45.6
Samphire and other halophytes	355.1	4.1	5.0
Open Water	2305.0	26.9	32.5
Boardwalk, Weir etc	615.9	7.2	8.7
Total Wetland	7087.2	82.6	100.0
Mixed shrubs (surrounding slopes)	1285.6	15.0	
Raised Ground (~bare)	209.9	2.4	
Grand Total	8582.7	100.0	

B. articulata was only found in Zone 2 and *J. kraussii* was the only species recorded in Zone 1 (Table 8). Zone 1 was predominantly open water as the design intended. *Juncus kraussii* was planted in Zone 1 in an area of deeper sediments and does not appear to have spread out

from this area. *Baumea articulata* is a species that prefers deeper and reliable inundation, the highly variable nature of the water levels in Zone 2 do not appear to have helped this species. Improved maintenance of water levels in Zone 2 might see this species recover and expand in area. The deep water conditions of Zone 1 might suit this species and it can potentially recruit into this area. *Ficinia nodosa* is only found along the eastern edge of Zone 2 and northern edge of Zone 3. *Eleocharis acuta* occurred in patches and strips around the edge of *J. kraussii*. At this stage it is difficult to determine whether this is the species finding their specific niches or competition between the two species. Samphires appear to have colonized Zone 2 and 3 from areas outside the wetland, being common species along the Swan River. The high salt levels in the sediments resulting from the drying of the zones appear to favour these species; the samphires do not survive prolonged inundation.

Table 8. Area (m^2) of each vegetation type by wetland zone as of May 2010.

Zone	*Baumea articulata*	*Eleocharis acuta*	*Ficinia nodosa*	*Juncus kraussii*	Open Water	Samphire/ Halophytes	TOTAL
1	0	0	0	625.1	1363.1	0	1988.2
2	16.9	351.8	65.1	1861.4	941.9	138.0	3375.1
3	0	53.8	89.3	747.7	0.0	217.2	1108.0
TOTAL	16.9	405.6	154.3	3234.3	2305.0	355.1	6471.3

A photographic record of each vegetation community was taken at fixed locations (Figure 19). Photographs from May 2010 taken at each site are shown in Figure 20 to Figure 24, October photographs can be found in the Appendix.

As part of an ECU third year student project Shireen McGuiness undertook a vegetation survey at Point Fraser. Part of her study that was relevant to the monitoring program was a comparison of the species planted (as per Syrinx Environmental Pl, 2003b) and the current species found in the wetland, the results are shown in Table 9. A total of 25 species were planted, of those only 8 remain and only 2 would be considered common. In addition, 4 new species have become established in the wetland, of these one was a weed (*Cynodon dactylon* – Couch grass). The other species are commonly found in the Swan River and are believed to have dispersed naturally into the wetland. *Juncus kraussii* was not according to Syrinx Environmental Pl (2003b) planted in the wetland but it was planted on the foreshore. *Juncus kraussii* does appear to have been planted in the wetland and is now the dominant species, although it is possible that it colonised from the foreshore.

Table 9. A comparison of species originally planted as per Syrinx Environmental Pl (2003b) and those that are currently inhabiting the wetland (Zones 1 and 2). (C)= common species; (U) = uncommon species

Species	Originally Planted (2003)	Current Species (2010)
Melaleuca cuticularis	X	X (U)
Atriplex cinerea	X	
Beaufortia squarrosa	X	
Eremaea pauciflora	X	
Frankenia pauciflora	X	X (U)
Hypocalymma angustifolium	X	
Kunzea ericifolia	X	
Melaleuca lateritia	X	X (U)
Myoporum caprarioides	X	
Pultenaea reticulata	X	
Regelia inops	X	
Lobelia alata	X	
Samolus repens	X	X (U)
Triglochin huegelii	X	
Ornduffia parnassifolia	X	
Xyris laxifloria	X	
Baumea articulata	X	X (U)
Baumea juncea	X	
Baumea vaginalis	X	
Carex inversa	X	
Eleocharis acuta	X	X (C)
Ficinia nodosa	X	X(U)
Meeboldina scariosa	X	
Triglochin huegelii	X	
Juncus kraussii		X (C)
Cynodon dactylon		X (U)
Tecticornia lepidosperma		X (U)
Maireana sp.		X (U)

Sites were revisited in October 2010 with vegetation re-mapped and photos again taken. The extent and cover of each vegetation type had not changed over the 5 months period between monitoring, with the exception of the *Baumea articulata* patch in Zone 2 which had spread into open waters to the east and west of its current distribution. The area of this vegetation type had increased from ~ 17 m^2 to ~ 28 m^2 (see photos). Small shoots emerging from the edge of the patch suggest this species is actively colonising into deeper waters. The water level in Zone 1 was approximately 20 cm below the weir between Zone 1 and 2

whereas at May 2010 it was at the level of the Weir. Therefore water levels were slightly lower at the time of the October monitoring compared to the May monitoring (which reflects the relatively dry period from September to October). The only other change between monitoring periods was the higher number of *Melaleuca lateritia* shrubs and seedlings in the Juncus community in Zone 2 (increase from 20 plants to some 33). This may reflect improved ability to detect this species with lower water levels (eg due to easier access) rather than recent recruitment of new individuals. There was no change in the number of *Melaleuca cuticularis* trees detected, although most trees were flowering prolifically during the October monitoring period (not flowering in May). Similarly, other species such as *Samolus repens*, a small herb, were detected in the *Juncus* and *Eleocharis* communities in spring because they were in flower.

Figure 19. Location of vegetation monitoring photopoints (WV1-WV5)

a) west

b) south-east

c) south

Figure 20. Photographs taken at photopoint WV1 on 21-5-2010 and the direction taken

a) east

b) south

c) west

Figure 21. Photographs taken at photopoint WV2 on 21-5-2010 and the direction taken

a) west

b) south

Figure 22. Photographs taken at photopoint WV3 on 21-5-2010 and the direction taken

a) north-west

b) west

c) south-west

Figure 23. Photographs taken at photopoint WV4 on 21-5-2010 and the direction taken

a) south-west

b) west

Figure 24. Photographs taken at photopoint WV5 on 21-5-2010 and the direction taken

7.5.2 VEGETATION BIOMASS AND GROWTH

Baumea articulata first starting producing a few flowers[2] in October on <5% of leaves/stem, while all the other species sampled had flowers all year, although *E. acuta* produced slightly more flowers in October compared to May (Figure 25). *Eleocharis acuta* appeared to produce substantially more leaves in October compared to May in W4 but less in W3, *J. kraussii* showed similar variability in seasonal response between sites. This suggests either that species are behaving differently between sites or more likely that errors in the estimation of plant standing crops are responsible. Leaf length has on average increased for all species except *B. articulata*, particularly for *E. acuta*.

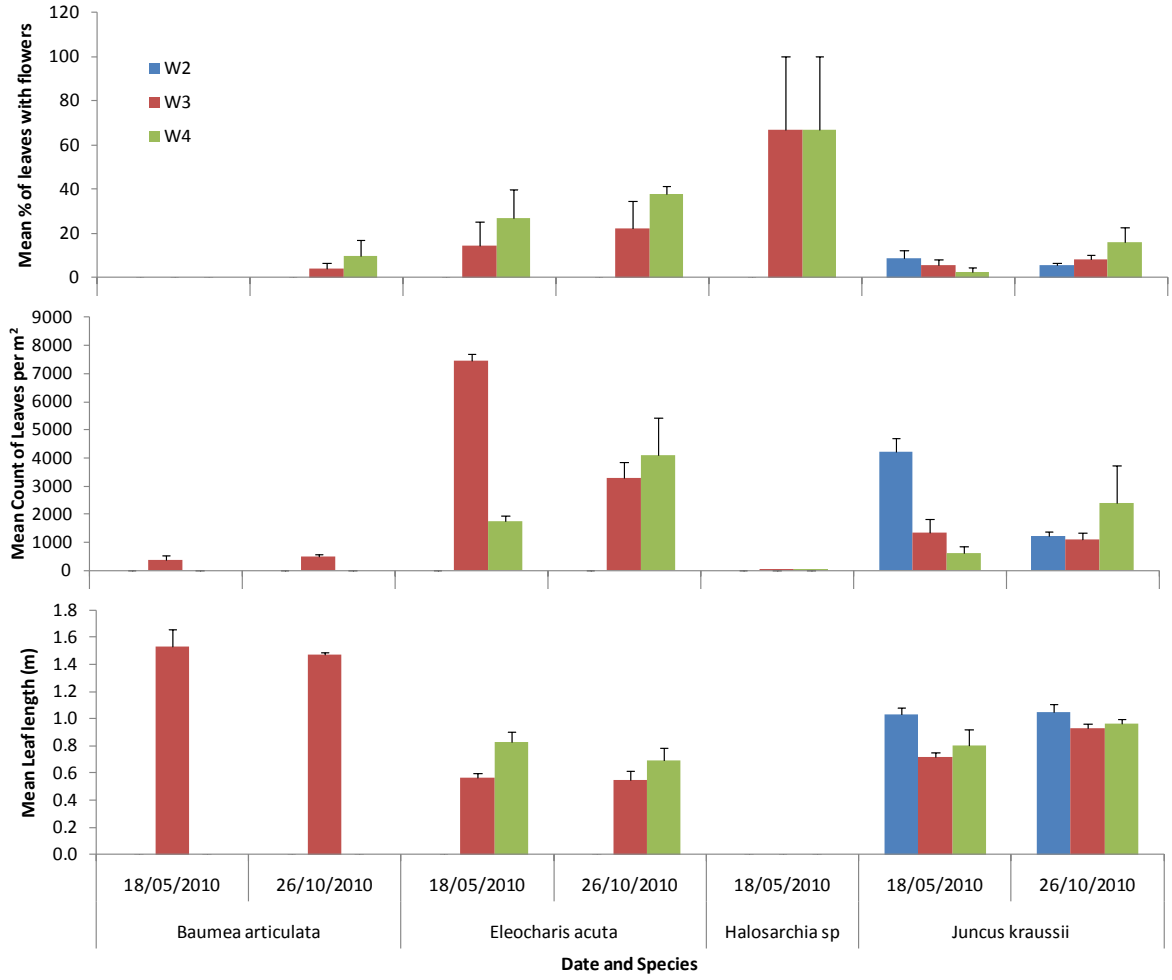


Figure 25. Mean (±SE) for percentage of leaves with flowers, count of leaves per m² and leaf length for each species on each sampling occasion for each wetland site.

[2] For these species, the flower is actually an inflorescence – a cluster of multiple flowers.

The stand of *J. kraussii* in W2 had a large quantity of dead material in May, however this had halved by October (Figure 26). None of the other *J. kraussii* stands showed a similar response, with similar quantities in both seasons. The reason for the large amounts of dead material in *J. kraussii* are unclear as it is unlikely that W2 would have low water levels or water quality issues that could account for it. With the exception of W2, where it appeared to decline for *J. kraussii* all other species generally increased slightly in live biomass between the seasons, reflecting the likely spring growth. The poor winter conditions (low rainfall) may have contributed to the small increase. Below ground biomass appeared to increase substantially in all species at all sites, except for little change for *J. kraussii* in W2. This growth in below ground biomass in a poor rainfall year (lowest on record; Bureau of Meteorology), shows that the plants are becoming established should respond well to a good growth season.

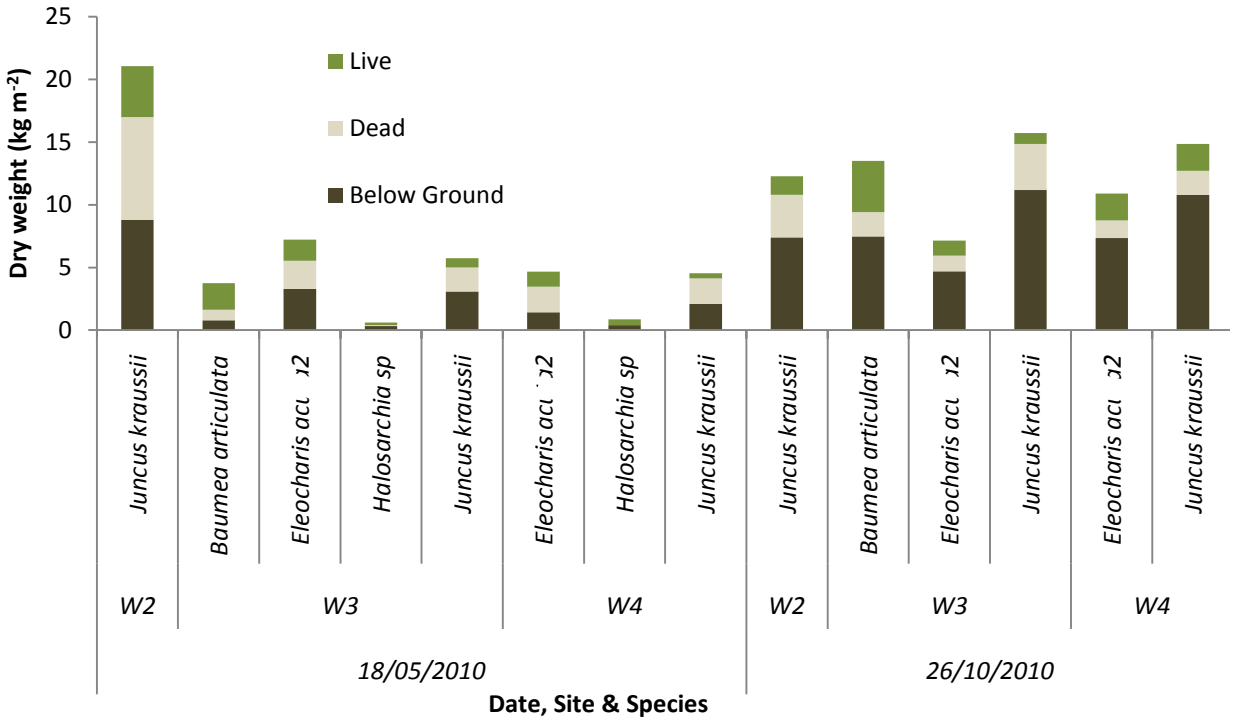


Figure 26 Mean dry weight (g) of live, dead and below material from collected species, from sites on two occasions.

In addition, to dry weight, the relative proportions of C (loss on ignition to 500 ^{o}C) and carbonates (loss on ignition to 1000 ^{o}C) is shown in Table 10. The highest proportions of C were found in the living above ground biomass, while this declined in the dead material (probably as breakdown had liberated C relative to inorganic components). The below ground biomass was lowest in C, indicating that a range of inorganic materials were

attached to the roots. This is a typical occurrence as oxygen leakage through the roots causes some metals to oxidize (iron in particular) and they accumulate as precipitate around the roots.

Table 10. Loss on ignition (LOI) of each plant sampled, per area sampled in May and October 2010. LOI shown for 500 °C and 1000 °C.

Species	Wetland	Type of Material	May		October	
			LOI_{500} (%)	LOI_{1000} (%)	LOI_{500} (%)	LOI_{1000} (%)
Juncus kraussii	2	Live	95.3	2.5	95.9	2.8
		Dead	95.2	0.9	94.2	0.6
		Below Ground	60.7	1.0	48.9	0.7
Juncus kraussii	3	Live	96.3	2.7	91.5	4.7
		Dead	93.8	1.3	70.0	7.2
		Below Ground	70.3	1.3	21.8	0.7
Eleocharis sp.	3	Live	94.8	1.7	93.8	2.2
		Dead	89.1	1.2	70.8	8.9
		Below Ground	88.1	1.3	34.5	0.9
Baumea articulata	3	Live	93.8	3.3	91.4	3.5
		Dead	93.6	0.7	86.5	3.9
		Below Ground	72.8	1.3	65.5	1.6
Juncus kraussii	4	Live	95.2	3.2	94.7	3.1
		Dead	92.1	2.4	91.1	4.7
		Below Ground	72.4	1.8	39.1	1.2
Eleocharis sp.	4	Live	92.8	0.7	91.6	1.9
		Dead	88.7	1.3	88.4	2.6
		Below Ground	56.6	1.0	78.4	1.2

7.5.3 VEGETATION NUTRIENT LOADS

Baumea articulata and *E. acuta* stored significant quantities of P in below ground material, nearly double that *of J. kraussii* in May (Figure 27). *Juncus kraussii* had the lowest loads of P in W2, despite similar water P concentrations to other sites, possibly reflecting water flow patterns between W1 and W2 that effectively bypass the stand. The live material of all species contained very similar concentrations of P. The patterns are very similar for N, with *J. kraussii* in W2 having the lowest loads, although overall *J. kraussii* appeared to have higher loads of N in leaves compared to the other species.

The October below ground data shows much lower concentrations of P than May, however this might be due to the much larger quantities of below ground biomass recorded at this time effectively diluting the concentration. Concentrations of P in live and dead material in October are very similar to May. Nitrogen concentrations were more even in October

between species but the concentrations were relatively similar to May. In Table 11 the estimated amount of P and N stored in plant material (living and dead) is shown for each area of the wetland. Not surprisingly given its area, the most nutrients are stored in *J. kraussii*. In May, the total amount of P stored in living material

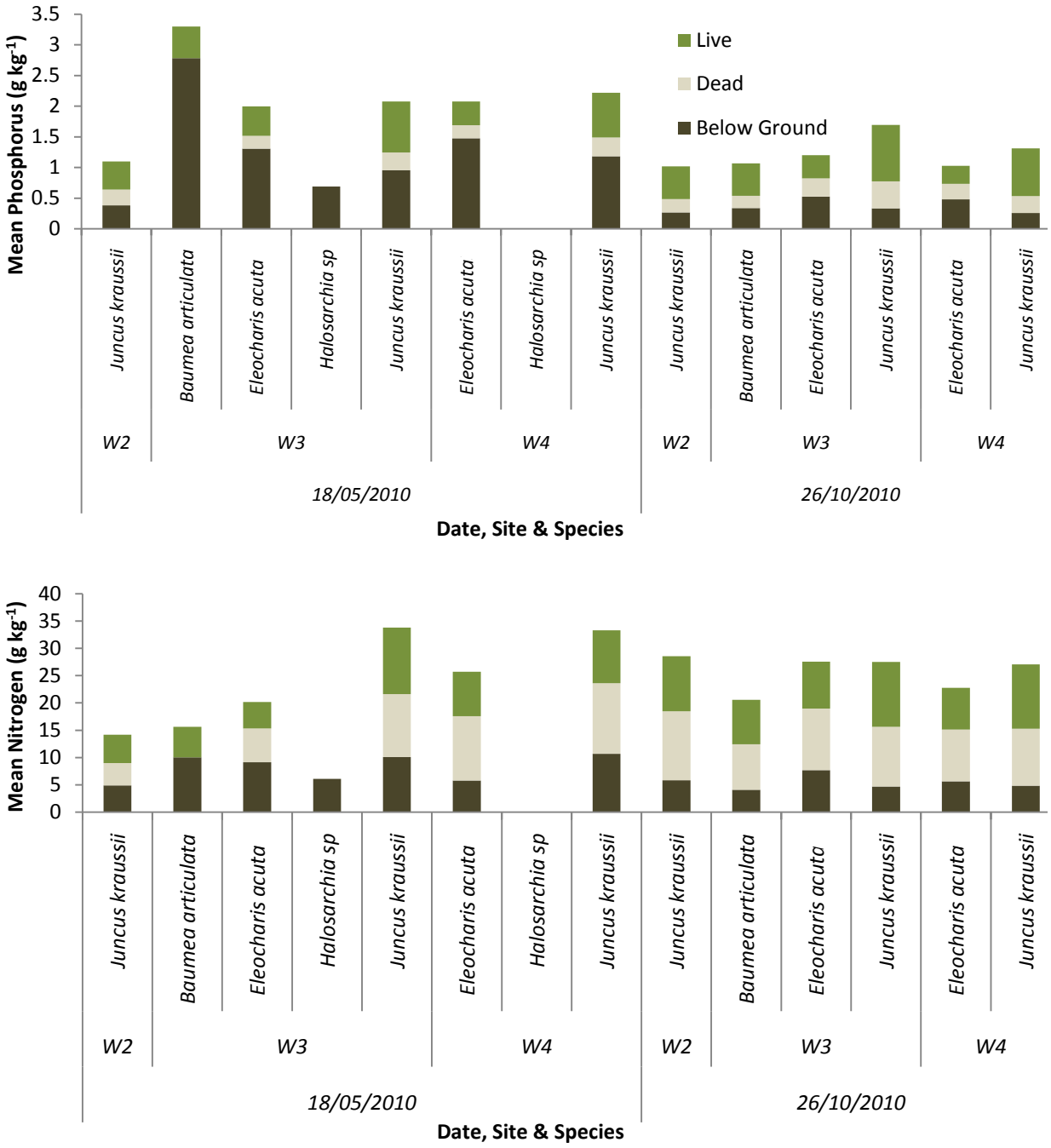


Figure 27. Mean quantities of phosphorus and nitrogen stored per kg of dry weight of live, dead and below ground parts of sampled species, over the seasons and between sites. Note, insufficient material collected for analysis for *Halosarchia* sp in W4 18/5/10.

was 13.5 kg and in dead material 2.9 kg, compared to 142.8 kg and 85.7 kg for N living and dead respectively. In October, this had increased to 14.5 kg and 4.0 kg for P in living and dead respectively and 222.5 kg and 122.4 for N, living and dead respectively. The quantity in dead material is interesting as it can be released back to the water as the material decays or can be a permanent sink as the organic matter becomes incorporated into the sediment.

Table 11. Total loads of N and P in living (above and below ground) and dead biomass per area of stands at each site.

Date	Site	Species	Area m^2	P Live kg	N Live kg	P Dead kg	N Dead kg
18/05/2010	W2	*Juncus kraussii*	625.1	3.02	36.42	1.12	17.62
	W3	*Baumea articulata*	16.9	0.04	0.37		
		Eleocharis acuta	351.8	1.82	13.79	0.20	4.56
		Juncus kraussii	1861.4	7.21	67.16	1.05	42.96
	W4	*Eleocharis acuta*	53.8	0.17	0.81	0.02	1.17
		Juncus kraussii	747.7	1.21	24.29	0.50	19.38
26/10/2010	W2	*Juncus kraussii*	625.1	1.66	34.33	0.49	27.00
	W3	*Baumea articulata*	16.9	0.08	1.05	0.01	0.28
		Eleocharis acuta	351.8	1.02	14.95	0.15	5.33
		Juncus kraussii	1861.4	8.30	118.65	2.95	75.52
	W4	*Eleocharis acuta*	53.8	0.20	3.01	0.02	0.67
		Juncus kraussii	747.7	3.20	50.56	0.38	13.64

When the effects of area are removed and simply efficiency of storage is assessed as in Table 12, it shows that *B. articulata* stores the least N and P, with *E. acuta* out performing *J. kraussii* at P removal at all sites but performing more poorly for N removal. In October, the situation changes with *B. articulata* performing much better and similar to *J. kraussii*, with a slight drop in *E. acuta*'s performance with P. As different species appear to take up nutrients at different rates at different times of the year, having a mixed stand ensures strong uptake throughout the year.

Table 12. Total loads of N and P in living (above and below ground) and dead biomass per area of stands at each site standardized for a fixed stand size of 100 m^2.

Date	Site	Species	Area m^2	P Live kg	N Live kg	P Dead kg	N Dead kg
18/05/2010	W2	*Juncus kraussii*	100	0.48	5.83	0.18	2.82
	W3	*Baumea articulata*	100	0.26	2.18	0.00	0.00
		Eleocharis acuta	100	0.52	3.92	0.06	1.30
		Juncus kraussii	100	0.39	3.61	0.06	2.31
	W4	*Eleocharis acuta*	100	0.31	1.51	0.04	2.18
		Juncus kraussii	100	0.16	3.25	0.07	2.59
26/10/2010	W2	*Juncus kraussii*	100	0.27	5.49	0.08	4.32
	W3	*Baumea articulata*	100	0.45	6.19	0.04	1.67
		Eleocharis acuta	100	0.29	4.25	0.04	1.51
		Juncus kraussii	100	0.45	6.37	0.16	4.06
	W4	*Eleocharis acuta*	100	0.38	5.60	0.03	1.25
		Juncus kraussii	100	0.43	6.76	0.05	1.82

7.5.4 FORESHORE MONITORING

The locations of the foreshore monitoring sites are shown in Figure 28.

Figure 28. Locations of the foreshore monitoring sites (F1A-C and F2A-C) (taken from Google Earth 2010)

The condition of each foreshore monitoring site is shown in Table 13. Sites F1A and F1B had areas with sparse vegetation and this had resulted in some undesirable erosion and in F1B the rock armouring had ceased to be effective and needs management action to remedy.

Site F2B shows some human trampling. Armouring of areas around F1A and F1B needs to repaired and replanted to prevent further damage to the foreshore.

Recommendation 7

The foreshore is monitored annually in May and the results are usually compiled within a month. It is recommended that the draft report on the foreshore monitoring be provided to the City of Perth by end of June, to allow the City to respond to any issues that have been identified.

Table 13. Condition Summary Table for each Foreshore Monitoring Site

Site	Erosion	Slumping	Sedimentation	Vege-tation	Regen-eration	Weeds	Log/Brush	Rock Work	Beach Areas	Fauna Use	Comments / Notes
F1A	30% Minimal; 60% Localised; 10% Significant	40% Minimal; 50% Localised; 10% Significant	80% Minimal; 20% Localised	2	3	3	N/A	Mostly consists of shell; Stable & effective	Stable	Nil	Needs infill planting to stop erosion; erosion is mostly confined to areas with little plant (sedge) cover.
F1B	20% Minimal; 30% Localised; 50% Significant; 10% Severe	40% Minimal; 50% Localised; 10% Significant	70% Minimal; 30% Localised	3	3	3	N/A	Rocks around headland appear to have shifted; rock armoury no longer effective	Stable; very good condition; little erosion	Nil	Erosion of headland either side of beach is significant; these areas need rock armoury and infill planting
F1C	85% Minimal; 10% Localised; 5% Significant	90% Minimal; 10% Localised	90% Minimal; 10% Localised	1	3	4	Buried by debris but appears effective	N/A	Sandy slopes stable and being colonised by rush	Nil	Mostly very stable due to plants (effective erosion control)
F2A	100% Minimal	100% Minimal	60% Minimal; 40% Localised	2	3	3	Stable	Small amount of sedimentation	N/A	Trampling of veg'n by waterbirds	Large amount of rubbish washed up from river (high tide)

Site	Erosion	Slumping	Sedimentation	Vege-tation	Regen-eration	Weeds	Log/Brush	Rock Work	Beach Areas	Fauna Use	Comments / Notes
F2B	60% Minimal; 20% Localised; 20% Significant	70% Minimal; 10% Localised; 20% Significant	70% Minimal; 30% Localised	1	4	3	Stable	Intact with minimal sedimentation	N/A	Trampling of veg,n by waterbirds	Some human trampling (to access river)
F2C	95% Minimal; 5% Localised	90% Minimal; 10% Localised	70% Minimal; 30% Localised	2	3	3	Stable	Minor sedimentation; rock work mostly stable and effective	Little to no erosion; Very stable	Nil	Stable embayment; good visual amenity

Note 1: Erosion/Slumping/Sedimentation Classes: 0-5 % Minimal - Little evidence of erosion/slumping/sedimentation; 5-20 % Localized - Localized areas of erosion/slumping/ sedimentation; 20-50 % Significant - Active erosion/slumping/sedimentation is obvious along many parts of this section; >50% Severe - Significant erosion/slumping/sedimentation is more or less continuous along this section.

Note 2: Vegetation Condition: 1 = Healthy- There is no observable damage or injury to the vegetation; 2 = Some Sick - Some species show signs of insect/human damage above normal levels or a general decline in health such as defoliation or presence of dying branches; 3 = Many sick or dying- Many plants show sign of severe decline in health with a number of dead and dying plants present; 4 = Majority dead- Few of the native plants present are healthy

Note 3: Vegetation Regeneration: 1 = Abundant- Seedlings occur in high numbers and are observable from any section of the area; 2 = Frequent- Seedlings are common. Regeneration may occur in small stands of sporadically over large areas of the section; 3 = Occasional: Seedlings are infrequent, occurring no more than once or twice with the area; 4 = Rare: Seedlings occur very infrequently and may be observed only once or twice within the surveyed section.

Note 4: Weeds: 1 = Abundant- Weeds are predominating. They can be seen from any section of the surveyed area; 2 = Frequent- Weeds are common. They are patchy or occur in low numbers over a large percentage of the site; 3 = Occasional- Weeds occur sporadically, more than once or twice within the area; 4 = Rare- Weeds occur infrequently within the area. They may be observed only once or twice.

7.5.5 CONCLUSIONS

1. Map the coverage of the aquatic plant species in the wetland.

Aquatic plant coverage was successfully mapped with *Juncus kraussii* the dominant plant, followed by *Eleocharis acuta* and then a small plot of *Baumea articulata*. There is little evidence of weed invasion, although the wetland appears to have been colonised by species from the foreshore (possibly including *J. kraussii*).

2. Measure development of biomass of major plant species within the wetland (Zones 1 and 2).

Biomass of all major plant species in the wetland were measured in both May and October (dead, above ground and below ground). Biomass appears to be increasing although with only a single year's data, some of the changes seen may be just seasonal.

3. Measure the concentration of nutrients (N & P) in live, dead and below ground parts of each species in each site.

Loads of nutrients in aquatic plants increased between May and October indicating that the wetland was removing nutrients from incoming water. The nutrient loads within the parts of plant species and between sites were variable between sampling times. This suggests that use of a mixed set of species for nutrient removal will enhance overall removal rates as different species are more effective at nutrient uptake at different times of the year.

4. Establish some regular sites where the condition of the foreshore can be monitored. Key items of interest are erosion, weed invasion and the effectiveness of armouring that may have been put in place.

Sites have been established and erosion appears minimal.

7.6 AVIFAUNA

The specific aims of sampling the avifauna were to:

1. Determine the range of birds utilizing the park

Biodiversity is an important goal of the redevelopment of the Point Fraser reserve and avifauna are a good indicator of changes in biodiversity.

A total of 25 species of bird have been recorded at Point Fraser with 19 species in May compared to 17 in October. Of these 10 were water birds (Wood Ducks are not water dependant). A number of exotic species were also recorded. Exotic species, particularly Rainbow Lorikeets were the most abundant species. The majority of bush birds were common taxa.

Based on the two surveys so far, the Point Fraser wetlands support a moderate diversity of water birds and a low diversity of other bird groups. The habitat available for land birds is very small and primarily consists of dense plantings of prolifically flowering natives such as *Calothamnus*, surrounding the wetlands as well as *Melaleuca's* and *Tuarts* in the carpark areas. Unsurprisingly, most non-waterbirds were honeyeaters that were utilising the nectar producing plants. The most common land birds recorded were the Brown Honeyeater, Singing Honeyeater and Red Wattlebird and the White-cheeked Honeyeater. All apart from the White-cheeked Honeyeater as regarded as generalist species that have benefited form urbanization and thus cope well with urban landscapes as long as nectar is present. The White-cheeked Honeyeater's presence is a positive record as this species is generally associated with natural bush land areas. It is however frequently recorded in areas close to the river (R. Davis, *pers. obs.*). Very large numbers of the introduced and declared pest, the Rainbow Lorikeet were recorded during each survey. Most of these were using the exotic palm trees for roosting or were flying overhead.

In terms of water birds, the wetlands support low numbers and a low diversity of species. The Pacific Black Duck was the most commonly recorded but this is a highly abundant bird associated with degraded urban wetlands. The Grey Teal and Australian Wood Duck were also recorded but both are often associated with urban wetlands. A small number of wading birds utilized the wetland fringes and exposed mud and these included the Black-fronted Dotterel and Yellow-billed Spoonbill. The Australian Darter and several species of cormorant were also recorded. However, these fish-eating birds were generally associated with the Swan River edge rather than the actual wetlands. An interesting record during the November survey was the Little Grassbird. The distinctive call of this species was heard from the reed-bed in the wetlands. This probably indicates that a good quality reed habitat is present and it is suspected that this species may also be breeding here.

Ongoing surveys are planned to further characterize the utilization of the wetlands by birds. It is too early to draw any firm conclusions on habitat preferences or habitat quality for birds.

Table 14. Avifauna recorded in the Point Fraser Reserve in May and October 2010

		May 2010		October 2010	
Common Name	**Species**	**No.**	**Notes**	**No.**	**Notes**
Anatidae (ducks and swans)					
Australian Wood Duck	*Chenonetta jubata*	4			
Grey Teal	*Anas gracilis*	2	Loafing in pond		
Pacific Black Duck	*Anas superciliosa*	10	Loafing in pond	5	Loafing in pond
Anhingidae (darters)					
Australasian Darter	*Anhinga novaehollandiae*	1	Roosting on riverbank		
Charadriidae (plovers)					
Black-fronted Dotterel	*Elseyornis melanops*			1	Salty depression of main wetland
Laridae (terns and gulls)					
Silver Gull	*Chroicocephalus novaehollandiae*	8	In flight over site	1	In flight over site
Crested Tern	*Thalasseus bergii*			1	In flight over site
Phalacrocoracidae (cormorants)					
Little Pied Cormorant	*Microcarbo melanoleucos*	1	In flight over site	1	Feeding in river
Great Cormorant	*Phalacrocorax carbo*	1	In flight over site		
Little Black Cormorant	*Phalacrocorax sulcirostris*	4	In flight over site		
Threskiornithidae(Ibis and Spoonbills)					
Yellow-billed Spoonbill	*Plataela flavipes*	3	Roosting on boardwalk		
Accipitridae (hawks and eagles)					
Black-shouldered Kite	*Elanus axillaries*			1	River shore
Cacatuidae (cockatoos)					
Corella sp.	*Cacatua sp.*	3	Mix of Eastern Long-		

		May 2010		October 2010	
Common Name	**Species**	**No.**	**Notes**	**No.**	**Notes**
			billed and Little Corellas from aviary escapes		
Columbidae (pigeons and doves)					
Laughing Dove	*Streptopeila senegalensis*			1	
Spotted Dove	*Streptopeila chinensis*	1			
Hirundinidae (swallows)					
Welcome Swallow	*Hirundo neoxena*	4	Aerial feeding	2	Aerial Feeding
Megaluridae					
Little Grassbird	*Megalurus gramineus*			2	In reeds
Meliphagidae (honeyeaters)					
Singing Honeyeater	*Lichenostomus virescens*	5		4	
Red Wattlebird	*Anthochaera carunculata*	7	In flowering *Eucalyptus rudis*	1	
Brown Honeyeater	*Lichmera indistincta*	2		10	
White-cheeked Honeyeater	*Phylidonyris niger*	4	In flowering shrubs	2	In *Calothamnus*
Monarchidae					
Magpie-lark	*Grallina cyanoleuca*			1	In flight
Pardalotidae (pardalotes)					
Striated Pardalote	*Pardalotus striatus*	3	In *E. rudis*	1	Heard
Psittacidae (lorikeets and parrots)					
Rainbow Lorikeet	*Trichoglossus haeatodus*	36	Introduced	26	
Rhipiduridae (flycatchers)					
Willie Wagtail	*Rhipidura leucophrys*	4		2	
Number of species		19		17	

7.6.1 CONCLUSIONS

1. Determine the range of birds utilizing the park

Achieved, with 25 species recorded.

7.7 MACROINVERTEBRATES

The specific aims of the macroinvertebrate monitoring program were to:

1. Determine what species were using different zones of the wetland

This will show the ability of the wetland to support biodiversity and provides a baseline for any development of biodiversity.

A total of 26 taxa were collected in the wetland in 2010 from May and October (Table 15). Taxa were generally salt tolerant and Foraminifera are primarily a marine group. Although the taxa are generally cosmopolitan and tolerant, the dragonflies belonging to the Telephlebiidae have a high SIGNAL score of 9 indicating they are highly sensitive (Chessman, 2003). If these taxa continue to occur in the Point Fraser wetlands then it is a very positive biodiversity indicator. The most abundant taxa were the Ostracoda; the high numbers were partially due to the use of 250 µm net which ensures these taxa are collected. October or spring is generally considered the time of highest species richness and abundance on the Swan Coastal Plain (Davis *et al.*, 1993). This was reflected in the Point Fraser wetlands particularly in species richness which increased by 3-4 taxa, but not for abundance in W4. The high salinity seen especially in October in W3 and to a lesser extent W4 appears to have reduced taxa abundance at this time. However, it has created opportunities for salt tolerant taxa which is why overall taxa richness increased compared to May. On both sampling occasions taxa richness was slightly higher in W2 than W4, suggesting that the higher salinities in W4 restricts taxa diversity (Figure 29a).

Community composition as shown by functional feeding groups is dominated by the abundances of Ostracoda (Figure 29b). In October, the relative abundance of plankton increases compared to May where predators and herbivores appear more important. The Primer 6 (Primer Inc) software package was used to produce ordinations of the data (MDS), a technique for translating the similarities in communities in terms of richness and abundance into a physical distance and then plotting that distance to visually demonstrate those relationships. In Figure 29c, it can be seen that the community in W4 in October is

different to the other times and sites. This further supports Recommendation 5. that salinity needs to be controlled in W3 and W4.

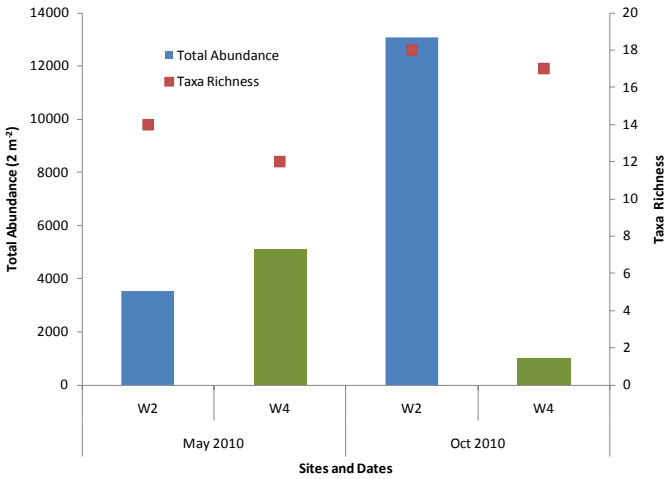
The introduced fish *Gambusia holbrooki* was observed in W1 and W2 in the summer months. They are known predators of a many surface dwelling macroinvertebrates and amphibians (Pyke, 2008). On occasion, *G. holbrooki* were also seen in W3 and W4. Removal and control of *G. holbrooki* populations is difficult and ultimately unlikely to be effective. Amphibians were not sampled during this study.

Table 15. Total abundance (from two 5 m transects) at W2 and W4 of macroinvertebrates (>250 µm) in May and October 2010. To convert to per m^2, divide by 2.

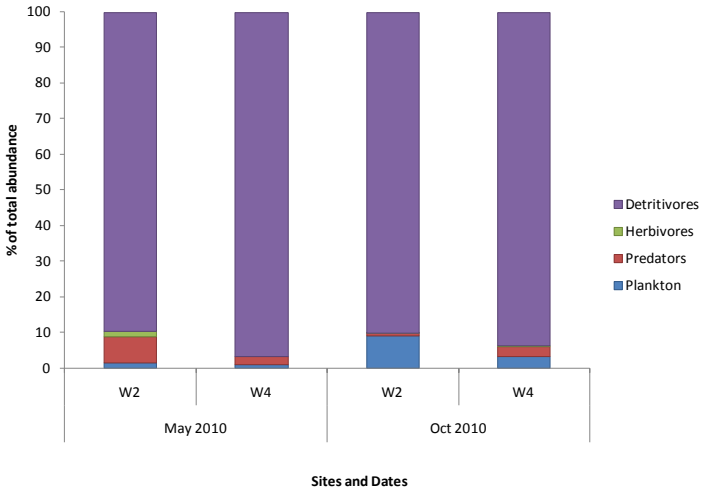
Phylum (sp = subphylum, c = class)	Order	Suborder	Family	Tribe	Type	Common Name	May 2010 W2	May 2010 W4	Oct 2010 W2	Oct 2010 W4
Formanifera						Protista	0	0	0	9
Arachnida	Acarina		Limnesiidae			Mites	0	0	48	0
Mollusca	Gastropoda					Snails	25	0	0	0
Annelida	Hirudinae					Leeches	230	20	4	0
	Polycheata					Marine worms	0	0	4	7
Arthropoda (sp Crustacea)	Cladocera		Chydoridae			Zooplankton	0	0	52	0
	Copepoda	Calanoida				Zooplankton	20	0	1016	6
		Cyclopoida				Zooplankton	25	40	100	15
	Isopoda		Sphaeromatidae				5	0	88	56
	Ostracoda						2960	3400	11568	294
	Odonata	Epiproctophora			Early instars	Dragonflies	5	0	0	1
c Insecta			Telephlebiidae				0	0	3	1
			Libellulidae				0	1	0	0
		Zygoptera			Early instars	Damselflies	5	42	1	1
			Chorismagrionidae				0	2	0	0
			Coenagrionidae				0	0	3	10
	Hemiptera		Coroxidae			Bugs	5	35	29	10
	Trichoptera				Pupae	Caddisflies	0	0	1	0

Phylum (sp = subphylum, c = class)	Order	Suborder	Family	Tribe	Type	Common Name	May 2010 W2	May 2010 W4	Oct 2010 W2	Oct 2010 W4
			Hydroptilidae				0	0	4	0
			Leptoceridae				26	0	0	2
	Coleoptera		Dytiscidae		Adults	Beetles	15	23	4	3
			Hydrophilidae		Adults		5	1	4	2
	Diptera		Chironomidae		Early instars	Midges	0	120	0	15
				Chironominae			200	1336	103	465
				Tanypodinae			0	0	22	71
				Orthocladiinae			15	24	0	0
			Ceratopogonidae	Dasyheleinae		Biting Midges	0	46	20	15
Total Abundance							3541	5090	13074	983
Taxa Richness							14	12	18	17

a)



b)



c)

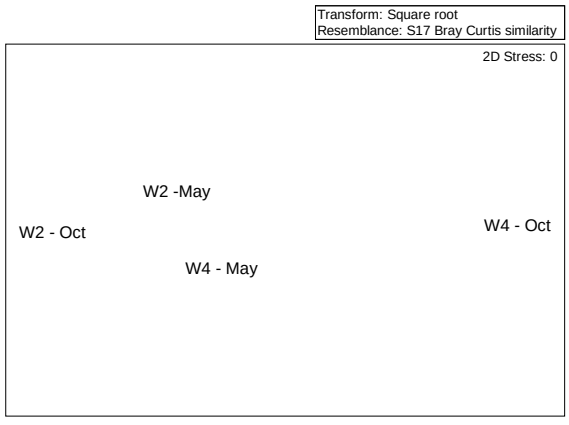


Figure 29. Macroinvertebrate a) Abundance and taxa richness, b) % composition of functional feeding groups and c) Multi-dimensional scaling plot showing similarity of sites to each other in terms of community structure, data collected from sites at Point Fraser in May and October 2010.

7.7.1 CONCLUSIONS

1. Determine what species were using different zones of the wetland

Achieved, with 25 taxa collected. The higher salinities of W3 and W4 saw the presence of more marine species than in W1 and W2.

7.8 SOCIAL MONITORING

The specific aims of the social monitoring program were to:

1. Determine visitor usage of Point Fraser

This will show how people are utilising the reserve, including the mode of transport in and out

2. Observe usage of Point Fraser by the public

This will show what people are doing once at the reserve

3. Interview park users for why they used the park

This will provide a better understanding of why the park is being used by the public.

In order to achieve the aims, three assessment tools were applied in a biannual (October and May) sampling program: (1) visitor counts; (2) visitor surveys; and (3) visitor behaviour observations. As no guided tours were conducted in 2010, the fourth component outlined in the original proposal - an assessment of guided tour feedback - did not occur. Survey collection, visitor counts and observation of behaviour occurred for two days each monitoring event as outlined in Table 16.

Table 16. Dates of first year assessment events

YEAR ONE - 2010	Weekday	Weekend
May	Wed 19 May 2010	Sat 29 May 2010
October	Wed 27 Oct 2010	Sat 30 Oct 2010

7.8.1 VISITOR COUNTS

Observation counts results are presented as the week day monitoring event and the weekend monitoring event for each survey round (i.e. October and May) in Tables 2 & 3 below. The majority of park users were pedestrians (60 to 80%) compared to cyclists. Extrapolated visitor counts indicate that in- and outbound daily pedestrian traffic at the West and East Entrances are around 200 visitors each, while bicycle traffic was roughly between 50 and 100 users in May and up to 368 users in October. The main entry points for both pedestrians and cyclists were the West (SMC1) and East (SMC2) Entrances (roughly equal use) while the Car park Entrance (SMC3) was predominately used as access point for a commuter car park by city workers during the week. City workers frequently exited the car park along informal tracks through the garden beds between the car park and the road (see also Appendix H), possibly along the shortest route or as indicated by one commuter "to avoid getting run down by cyclists" along the outside path which were difficult to see from the pedestrian entrance at SMC3. On the weekend, car park use was significantly lower as few people seemed to access Point Fraser by car for recreational purposes. Indeed, the application of ticket parking even on weekend days appears to be a deterrent for recreational park users (cf. comments on how to improve Point Fraser from Visitor Survey in Appendix E).

Given the vantage point of SMC1 overlooking both the inside and the outside bike/footpaths, and indications by survey participants and carpark users regarding potential conflict with cycling commuters using the bike path along the outside of Point Fraser parkland and crossing the carpark entrance at SMC3, the research team monitored pedestrian and bike traffic also along the outside path. As shown in Table 4, weekday bike use to and from the city ranged between 360 (to city) and 476 (from city) per day during the week, and 996 (to city) and 412 (from city) on the weekend. This is significantly higher than traffic through the parkland. We recommend that these figures be triangulated with bike-counter data placed along this track in the past. There was also significant pedestrian traffic along the outside of the park with up to 272 users per day. Given the use of the parkland carpark for commuter parking, combined with the high level of bicycle and pedestrian traffic crossing the carpark entrance (SMC3), this entrance should be seen as a considerable safety risk. The survey team reported a number of incidences and near misses between turning cars and bicycles at the intersection.

Table 17. Extrapolated visitor counts data – May survey round (All sites)

WEEKDAY - MAY 2010																				
Site	SMC1				SMC2				SMC3								Total			
Type	Walking		Cycling		Walking		Cycling		Walking†		Cycling†		Vehicle†		Walking‡		Walking		Cycling	
Time*	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
7	12	12	0	0	12	12	16	16	0	4	0	0	32	0	0	24	24	52	16	16
8	0	8	0	0	12	12	4	4	0	16	0	0	68	4	0	52	12	88	4	4
9	16	12	4	0	16	16	4	4	0	4	8	0	40	4	0	16	32	48	16	4
10	20	4	4	0	8	8	8	8	0	4	0	0	4	0	0	4	28	20	12	8
11	4	8	0	0	8	8	8	8	0	0	0	0	16	8	8	4	20	20	8	8
12	12	12	4	4	28	28	12	12	12	4	0	0	4	4	4	4	56	48	16	16
13	20	28	16	12	12	12	8	0	0	12	0	0	16	4	16	16	48	68	24	12
14	20	16	4	8	4	4	4	8	8	4	0	4	24	8	12	4	44	28	8	20
15	12	20	8	0	12	4	8	0	8	0	0	0	8	28	8	0	40	24	16	0
16	12	16	12	8	16	12	12	0	0	0	0	4	16	72	32	0	60	28	24	12
17	48	40	0	8	44	28	12	0	4	16	0	0	4	68	44	0	140	84	12	8
18	36	60	0	4	56	16	0	0	4	0	0	0	4	40	12	4	108	80	0	4
Total	212	236	52	44	228	160	96	60	36	64	8	8	236	240	136	128	612	588	156	112
Total %	80		20		70		30		9		2		57		33		80		20	

* hourly data was extrapolated from hourly 15 minute counts commencing on the hour

† main road entrance

‡ pedestrian entrance

Table 17. (cont.)

WEEKEND - MAY 2010																				
Site	SMC1				SMC2				SMC3								Total			
Type	Walking		Cycling		Walking		Cycling		Walking†		Cycling†		Vehicle†		Walking‡		Walking		Cycling	
Time*	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
7	8	20	0	0	8	0	0	0	16	16	0	0	4	4	0	0	32	36	0	0
8	8	16	0	0	0	16	4	0	12	12	12	8	0	0	0	0	20	44	16	8
9	20	24	12	4	20	4	0	0	16	16	0	0	8	4	0	0	56	44	12	4
10	20	12	8	16	4	20	0	8	20	20	12	12	0	0	0	0	44	52	20	36
11	44	12	0	20	20	12	12	8	36	32	0	0	4	0	0	0	100	56	12	28
12	20	24	28	0	8	24	4	4	12	12	12	12	12	0	0	0	40	60	44	16
13	12	12	0	12	24	32	12	12	16	0	0	4	4	12	0	0	52	44	12	28
14	8	12	0	24	24	20	8	8	0	0	0	0	12	0	0	0	32	32	8	32
15	28	20	0	24	52	20	16	16	0	8	0	0	0	8	0	0	80	48	16	40
16	0	16	12	0	24	4	8	8	0	8	0	8	12	16	0	0	24	28	20	16
17	32	28	12	0	0	24	16	16	0	0	0	0	4	0	0	0	32	52	28	16
18	0	0	0	0	24	4	0	0	8	0	0	0	0	8	0	0	32	4	0	0
Total	200	196	72	100	208	180	80	80	136	124	36	44	60	52	0	0	544	500	188	224
Total %	74		26		72		28		59		16		26		0		74		26	

* hourly data was extrapolated from hourly 15 minute counts commencing on the hour

† main road entrance

‡ pedestrian entrance

Table 18. Extrapolated visitor counts data – October survey round (All sites)

WEEKDAY - OCTOBER 2010																				
Site	SMC1				SMC2				SMC3								Total			
Type	Walking		Cycling		Walking		Cycling		Walking†		Cycling†		Vehicle†		Walking‡		Walking		Cycling	
Time*	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
7	28	28	4	0	20	24	40	28	8	0	0	0	40	4	0	8	56	60	44	28
8	0	12	4	0	12	4	20	40	0	16	0	4	104	8	0	60	12	92	24	44
9	8	12	8	8	16	12	112	16	0	8	0	0	68	0	0	48	24	80	120	24
10	12	24	0	16	28	16	4	8	0	0	0	0	24	0	0	8	40	48	4	24
11	12	4	0	48	8	16	20	12	4	0	0	0	4	8	0	4	24	24	20	60
12	24	8	0	8	24	28	16	40	4	16	4	0	20	12	0	4	52	56	20	48
13	40	12	0	0	20	20	16	4	4	8	0	0	12	12	4	0	68	40	16	4
14	4	0	0	4	0	0	20	4	0	0	0	0	4	16	8	0	12	0	20	8
15	8	4	0	0	16	12	24	12	4	0	0	0	4	12	8	0	36	16	24	12
16	12	28	4	4	8	8	28	8	0	0	4	4	8	64	56	0	76	36	36	16
17	8	8	12	0	24	24	32	40	4	0	0	0	8	88	108	0	144	32	44	40
18	4	56	4	0	84	20	36	16	8	12	0	0	4	40	40	0	136	88	40	16
Total	160	196	36	88	260	184	368	228	36	60	8	8	300	264	224	132	680	572	412	324
Total %	82		18		41		59		6		1		53		39		62		38	

* hourly data was extrapolated from hourly 15 minute counts commencing on the hour

† main road entrance

‡ pedestrian entrance

Table18.(cont)

WEEKEND - OCTOBER 2010																				
Site	SMC1				SMC2				SMC3								Total			
Type	Walking		Cycling		Walking		Cycling		Walking†		Cycling†		Vehicle†		Walking‡		Walking		Cycling	
Time*	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
7	16	16	16	8	28	12	20	12	0	0	8	4	4	0	8	0	52	28	44	24
8	16	24	4	16	20	12	32	12	0	0	4	0	0	4	0	0	36	36	40	28
9	64	8	8	20	12	28	8	44	4	0	8	4	24	12	0	0	80	36	24	68
10	16	16	20	8	8	20	36	24	0	0	0	0	20	12	4	4	28	40	56	32
11	8	12	8	28	0	4	16	4	0	8	16	0	16	16	0	16	8	40	40	32
12	16	0	36	0	8	12	0	20	0	8	0	0	0	0	8	16	32	36	36	20
13	32	8	12	4	0	12	8	0	0	0	0	0	12	16	0	0	32	20	20	4
14	8	20	12	8	16	4	12	0	0	0	0	12	8	8	0	0	24	24	24	20
15	36	20	4	0	4	28	0	0	0	0	0	0	28	8	0	0	40	48	4	0
16	12	0	12	8	12	32	24	4	0	4	0	0	16	20	20	0	44	36	36	12
17	8	20	0	4	16	0	16	8	0	0	0	0	4	32	0	0	24	20	16	12
18	28	16	4	12	4	28	12	0	0	0	0	0	8	4	0	0	32	44	16	12
Total	260	160	136	116	128	192	184	128	4	20	36	20	140	132	40	36	432	408	356	264
Total %	66		34		41		59		2		16		64		18		55		45	

* hourly data was extrapolated from hourly 15 minute counts commencing on the hour

† main road entrance

‡ pedestrian entrance

Table 19. Extrapolated visitor counts data – October survey round (SMC3 – Path along the outside of parkland)

MAY 2010								
	WEEKDAY				WEEKEND			
Type	Walking/ Running		Cycling		Walking/Running		Cycling	
Time*	To city	From city	To city	From city	To city	From city	To city	From city
7	8	0	72	32	20	36	480	48
8	16	4	124	28	28	16	168	36
9	0	4	28	20	36	20	64	32
10	12	16	12	20	24	0	32	60
11	0	4	16	48	8	0	44	36
12	28	4	20	28	4	0	24	56
13	4	4	12	8	24	16	24	12
14	8	0	8	8	16	8	36	40
15	8	16	8	32	8	24	32	16
16	20	52	0	48	36	16	52	24
17	56	48	44	148	28	20	28	40
18	112	44	16	56	16	0	12	12
Total	272	196	360	476	248	156	996	412
	OCTOBER 2010							
7	20	8	144	8	20	20	72	20
8	20	4	92	32	12	12	276	76
9	16	4	36	28	36	20	60	68
10	8	8	36	4	20	36	60	20
11	8	4	4	28	16	20	32	8
12	8	24	0	12	20	0	36	20
13	24	0	16	0	0	12	40	36
14	4	0	28	4	28	12	44	20
15	4	4	4	36	16	0	28	40
16	24	4	20	72	28	0	32	48
17	8	12	12	112	4	28	28	20
18	56	32	20	96	28	16	8	44
Total	200	104	412	432	228	176	716	420

* hourly data was extrapolated from hourly 15 minute counts commencing on the hour

The placement of a commuter carpark in the recreational parkland which facilitates the

peak hour use and contributes to the traffic incidence risk was questioned verbally by several surveyees and highlighted in some survey responses. Similarly, questions were raised about parking availability to access the proposed Café/Restaurant given the current usage by city workers rather than park users.

7.9 VISITOR SURVEYS

A total of 364 surveys were completed during two survey rounds (May & October) in 2010 (Table 20). In May, a total of 192 surveys (69 weekday / 123 weekend) and in October a total of 172 (73 weekday /99 weekend) surveys were conducted.

Table 20. Number of surveys collected

	Survey rounds 2010		
	May	**October**	**TOTAL**
Weekday	69	73	142
Weekend	123	99	222
TOTAL	192	172	364

7.9.1 DEMOGRAPHICS

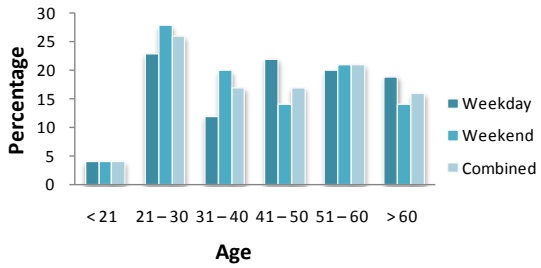
Overall the survey respondents were made up equally of men (50%) and women (50%) (Table 21).

Table 21. Respondent gender (%)

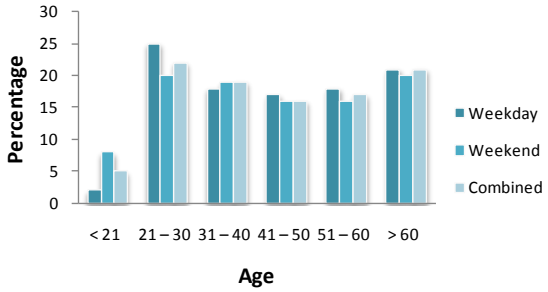
		May			October			Total
		Week-day	**Week-end**	**Combined**	**Week-day**	**Week-end**	**Combined**	**2010**
Respondent gender (%)	Male	59	49	53	47	46	46	50
	Female	41	51	47	53	54	54	50

The 21-30 years age group were the most frequents users (24%), followed by the 51-60 years age group (19%; Figure 30). The 31-40 years and >60 years age groups were made up of 18% of respondents each, followed up 17% for the 41-50 age group. There were minimal respondents under the age of 21 years (5%).

a) May



b) October



c) Combined 2010

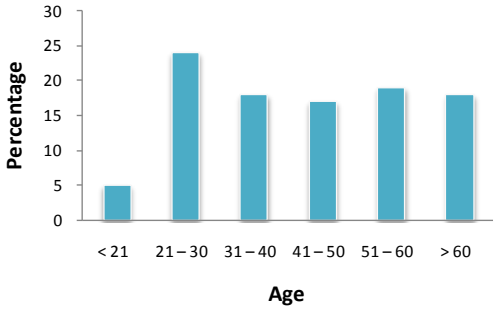
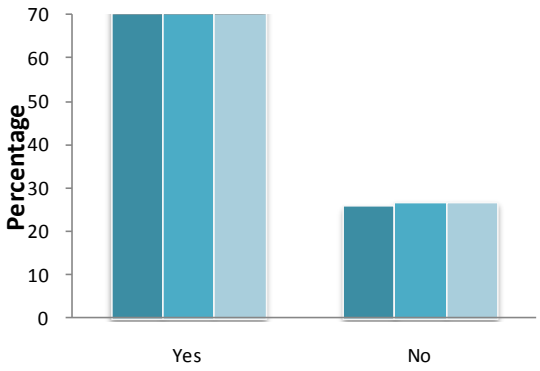


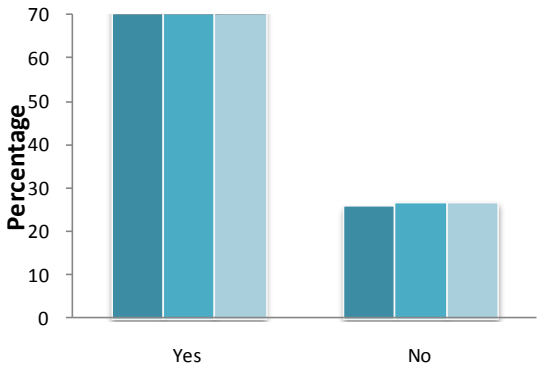
Figure 30. Respondent age (%) by a) May, b) October, and c) combined

Of the 364 respondents, 70% were residents of Perth city and this was consistent over both survey rounds (Figure 31).

a) May



b) October



c) Combined 2010

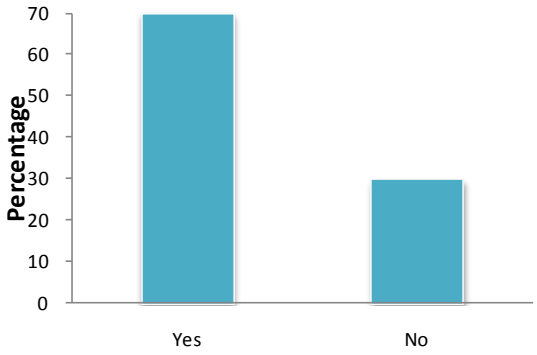


Figure 31. Resident of Perth (%) by a) May, b) October, and c) combined

In total the largest percentage of respondents from Perth city residents came from the postcode 6004 (East Perth) (9.3%), followed by postcode 6151 (Kensington, South Perth) (8.1%) and postcode 6100 (Burswood, Lathlain, Victoria Park) (5.9%). These three postcode areas are all within very close proximity to Point Fraser. However, there were respondents represented from all over Perth, both north and south of the river. This data reflects that Perth city residents who use Point Fraser are not limited to a particular geographical region of the city however; the largest user groups live within very close proximity to the park (see Figure 32).

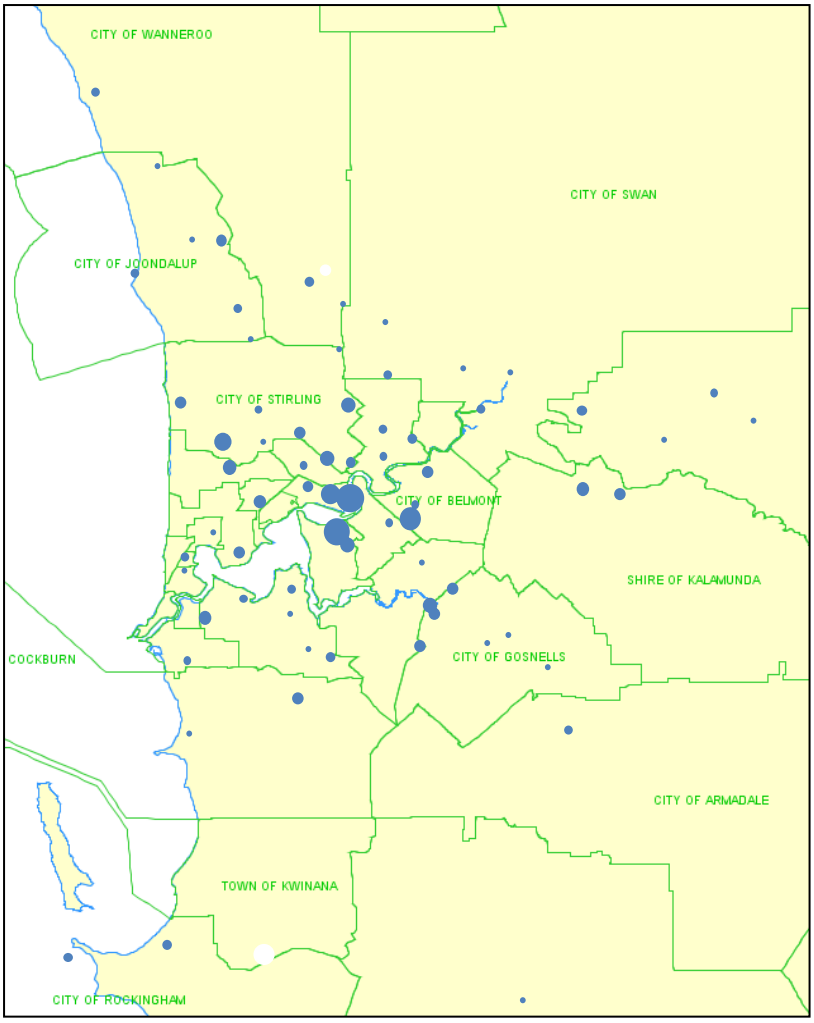


Figure 32. Map of Perth City, blue dots represent nearest postcode that respondents reported in the survey as being their residence (size of dot represents % of the total postcodes reported). Map of Perth taken from the http://www.water.wa.gov.au Geographic Data Atlas.

Of all 364 respondents, 20% came from overseas. The majority of respondents who lived in Australia were residents of Perth city (70%), with 9% coming from interstate and 1% from other parts of Western Australia (Table 22).

Table 22. Break down of survey respondents' town of origin (%)

	Town of origin	Total 2010
Where survey respondents from (overall) (%)	Australia (Perth)	70
	Australia (WA excluding Perth)	1
	Australia (Interstate)	9
	Overseas	20
	Not valid	0

Of the Australian residents, excluding Western Australians, the largest percentage of respondents came from New South Wales (34%), closely followed by Victoria (31%) (Table 23).

Table 23. Australian respondents' state of origin (%)

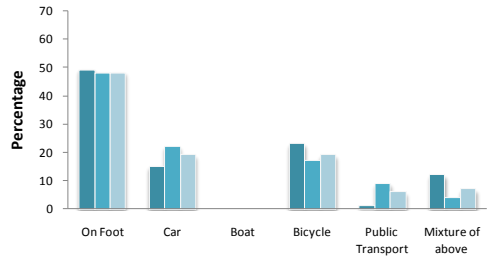
	State	Total 2010
What state Australian respondents from (%)	ACT	3
	NSW	39
	NT	0
	QLD	10
	SA	6
	TAS	6
	VIC	35

Twenty-three countries were represented by international survey respondents. One quarter of respondents from overseas were from the UK (25%). The second largest group of non-Australia respondents was from Germany (10%). Following this, respondents from Canada (7%), China (7%), New Zealand (7%). The complete list of overseas survey respondents is shown in the Appendices.

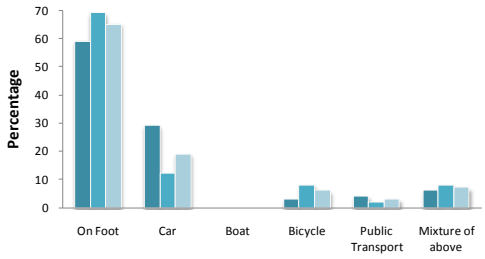
7.9.2 PARK USE

Over both survey rounds, the majority of respondents' mode of transport to Point Fraser was 'on foot' (56%; Figure 33). The second most popular mode of transport was by car (19%), followed by bicycle (13%). Seven percent (7%) of respondents used a mixture of transport modes to get to Point Fraser and 5% used public transport. No respondents used a boat to get to Point Fraser.

a) May



b) October



c) Combined 2010

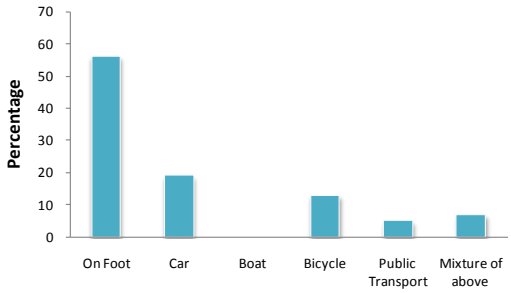


Figure 33. Mode of travel (%) by a) May, b) October, and c) combined.

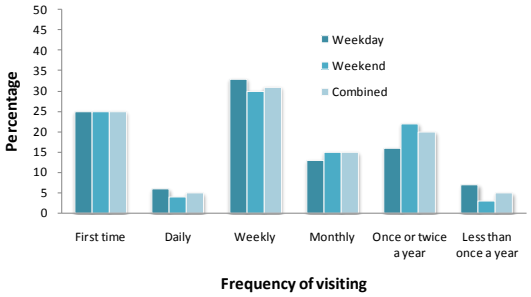
Of the 364 survey respondents, 24 utilised more than one mode of transport to get to Point Fraser. The most common mode of transport combination was 'car, on foot / walked' (54%) (Table 24). The second most common mode of transport combination was followed by 'public transport, on foot / walked' (17%), followed by 'bicycle, on foot / walked' (13%). Other mode of transport combinations included, 'car, bicycle'; 'car, on foot / walked, bicycle'; and, 'public transport, on foot / walked'.

Table 24. Mode of travel combinations

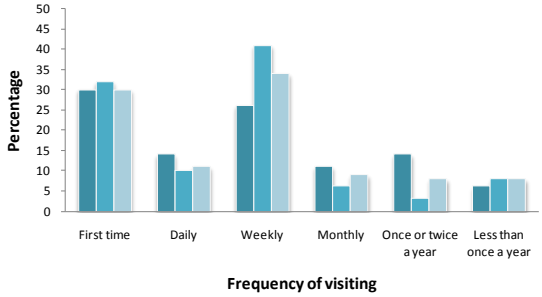
	Mode of travel	Total 2010
Mode of travel combinations (%)	Bicycle, on foot / walked	13
	Car, bicycle	8
	Car, on foot / walked	54
	Car, on foot / walked, bicycle	4
	Public transport, bicycle	4
	Public transport, on foot / walked	17

Overall, 73% of respondents had visited Point Fraser before. More than thirty percent visited weekly (33%), followed by 14% of respondents who visited once or twice a year (Figure 34). It was the first time to visit Point Fraser for 28% of respondents.

a) May



b) October



c) Combined 2010

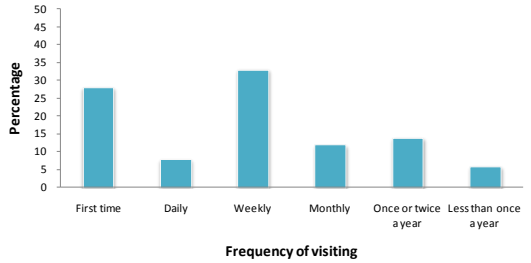
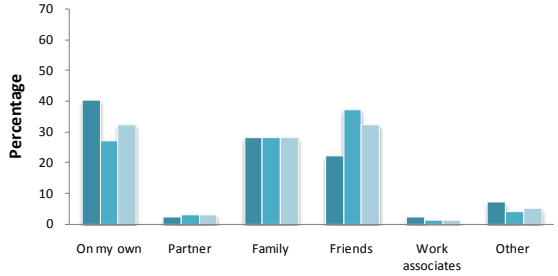


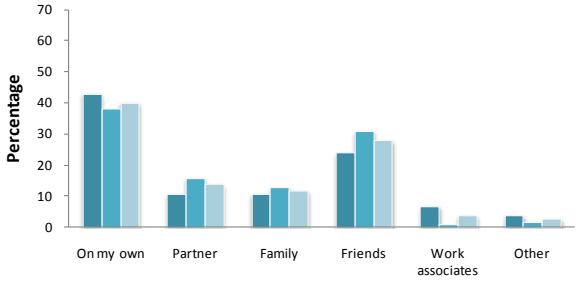
Figure 34. Frequency of visiting point Fraser (%) by a) May, b) October, and c) combined.

The majority of respondents (35%) were visiting Point Fraser on their own, while 30% were visiting with friends and 20% with family (Figure 35). Visiting Point Fraser with your partner made up 8% of respondents and 2% visited with work associates. Four percent (4%) selected 'other'. This included a disability support worker visiting with a client, a person visiting with work associates, several respondents visiting with their dog and a number indicating that they were with family and friends.

a) May



b) October



c) Combined

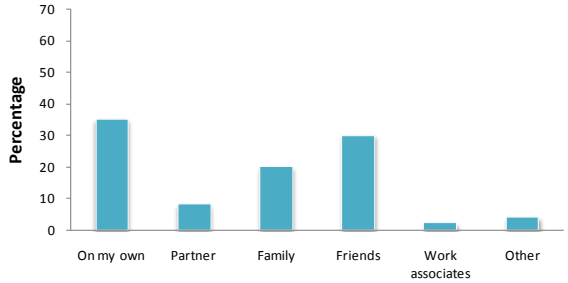


Figure 35. Respondent visiting with (%) by a) May, b) October, and c) combined.

Over both survey periods, the majority of respondents arrived at Point Fraser between 9am to 11am (10 – 11am 15% and 9 – 10am 13%). In the afternoon, 2 – 3pm, 11% of respondents arrived. In general Point Fraser was busiest in the morning and towards early afternoon (Figure 36).

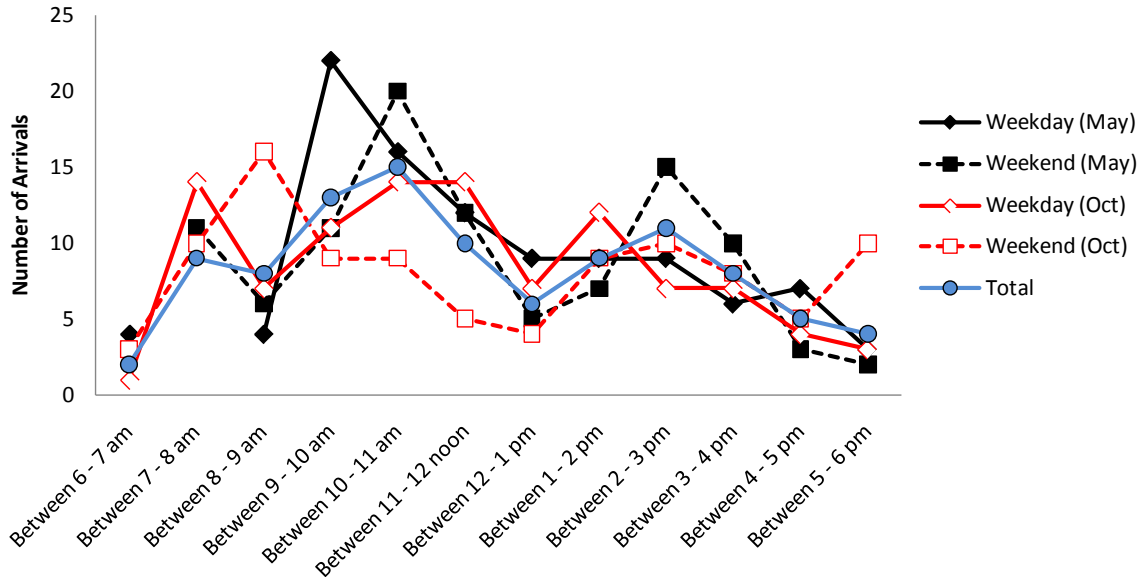


Figure 36. Visitor arrivals over time

Half (50%) of survey respondents were passing through Point Fraser (Table 25). Of those respondents who were not passing through, 21% stayed for 1 – 2 hours or less than 1 hour (14%).

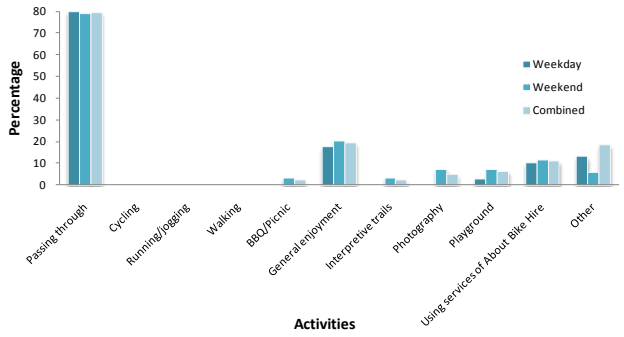
Survey respondents were asked what activities they were doing at Point Fraser and were able to select multiple responses. By far the majority of respondents in Round 1 (79%) were passing through

Table 25. Time period respondents stay at Point Fraser (%)

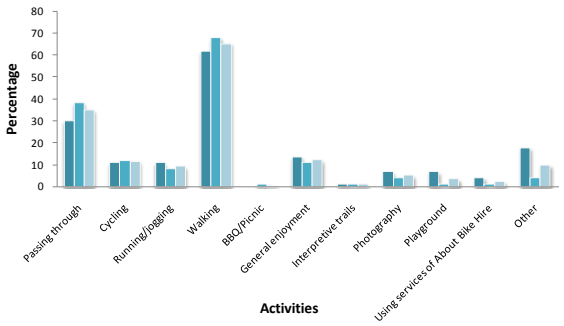
		May			October			Total
	Time period	**Week-day**	**Week-end**	**Combined**	**Week-day**	**Week-end**	**Combined**	**2010**
How long are you planning to stay at Point Fraser (%)	Passing through	55	40	45	46	62	55	50
	< 1 hour	13	22	19	18	14	16	14
	1 - 2 hours	17	26	23	21	16	18	21
	2 - 4 hours	10	9	9	6	5	5	8
	> 4 hours	4	3	3	10	3	6	5

the reserve rather than specifically visiting the reserve (Figure 37). In the second survey round, cycling, running / jogging and walking were added as activity choices to the survey. This dramatically affected the results of Round 2, leading to a dramatic reduction in the percentage choosing 'passing by' (35%) and a significant proportion of respondents choosing 'walking' (65%) as their activity. General enjoyment was considered by 16% of respondents. Nine percent (9%) of respondents indicated 'other' activity, which includes, bird watching, fishing, visiting Heirisson Island and looking for kangaroos, kayaking, parking, passing time, rollerblading and scouts (see also Appendices).

a) May



b) October



c) Combined 2010

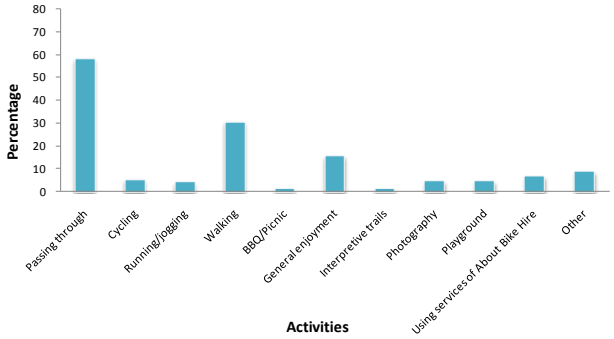
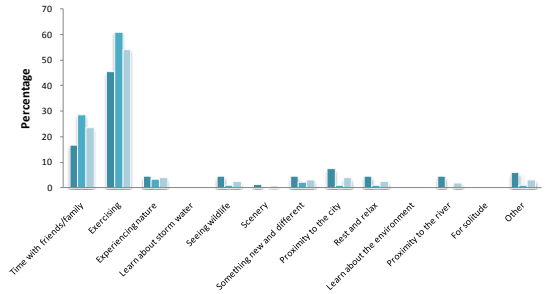


Figure 37. Activities undertaken at Point Fraser (%) by a) May, b) October, and c) combined. Please note: the inclusion of 'cycling', 'running/jogging' and 'walking' as activity options in the October surveys contributed to a strong shift in responses away from 'passing through' towards the mentioned categories, compared to the May surveys.

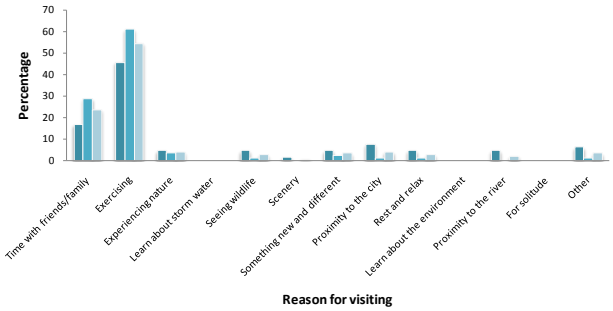
Respondents were asked for the main reasons why they visited Point Fraser (Figure 38). More than half (54%) indicated that they were visiting Point Fraser for exercise. Another popular response was 23% who were spending time with family / friends. Less popular reasons for visiting Point Fraser included 'experiencing nature' (4%), 'rest and relax' (4%), 'something new and different' (3%), 'seeing wildlife' (2%), 'proximity to the city' (2%) and

'scenery' (1%). No respondents indicated that the reason they had visited Point Fraser was to 'learn about storm water' or 'learn about the environment'.

a) May



b) October



c) Combined 2010

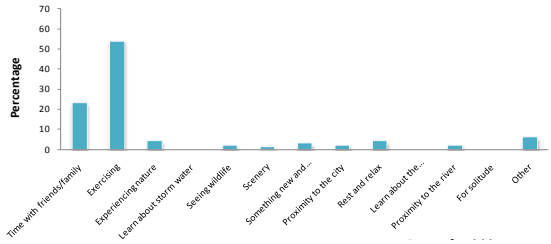


Figure 38. Reasons for visiting Point Fraser (%) by a) May, b) October, and c) combined.

7.9.3 PARK SATISFACTION

Respondents were asked about the quality of the features at Point Fraser using a 5-point Likert scale (1=very poor; 5=excellent). Overall satisfaction was very high, with very few negative ratings with the exception of the rating of the toilet facilities. Ninety-four percent of respondents were satisfied with the cleanliness of the park with one percent rating it very poor and 5 percent neither poor nor good (Table 26 and Figure 39).

Table 26. Quality of features – cleanliness (%)

		May			October		
	Cleanliness	**Week-day**	**Week-end**	**Combined**	**Week-day**	**Week-end**	**Combined**
How would you rate the quality of the following features (%)	1 = very poor	2	0	1	0	1	1
	2	0	0	0	1	0	1
	3	5	3	4	12	3	7
	4	30	39	36	26	42	35
	5 = excellent	64	58	60	59	52	55
	N/A	0	0	0	1	1	1

Access was rated as good or excellent by 89%, with one percent rating it as poor and eight percent (8%) neither poor nor good (Table 27 and Figure 39). The comments in Appendices highlight areas for improvement with regards to access, including negative comments regarding paid parking and lack of public transport.

Table 27. Quality of features – access (%)

		May			October		
	Access	**Week-day**	**Week-end**	**Combined**	**Week-day**	**Week-end**	**Combined**
How would you rate the quality of the following features (%)	1 = very poor	2	0	1	0	0	0
	2	0	1	1	1	0	1
	3	5	7	6	12	7	9
	4	28	37	34	26	41	34
	5 = excellent	65	53	57	55	50	52
	N/A	1.5	1.8	1.7	5.5	2.2	3.7

Playground facilities were also rated positively. Although more than a third of respondents ticked 'not applicable', indicating that they did not use or were not familiar with the playground facilities (Table 28 and Figure 39).

Table 28. Quality of features – playground facilities (%)

		May			October		
	Playground facilities	**Week-day**	**Week-end**	**Combined**	**Week-day**	**Week-end**	**Combined**
How would you rate the quality of the following features (%)	1 = very poor	0	0	0	0	1	1
	2	5	0	2	1	3	3
	3	11	13	12	14	13	13
	4	25	20	22	17	28	23
	5 = excellent	22	30	27	26	24	25
	N/A	37	37	37	42	31	35

Point Fraser parkland was rated very highly for its scenic beauty with 88% rating the parkland as good or excellent and with minimal negative responses (Table 29 and Figure 39).

Table 29. Quality of features – scenic beauty (%)

		May			October		
	Scenic beauty	**Week-day**	**Week-end**	**Combined**	**Week-day**	**Week-end**	**Combined**
How would you rate the quality of the following features (%)	1 = very poor	2	0	1	0	0	0
	2	0	1	1	0	0	0
	3	5	5	5	14	9	11
	4	27	31	30	35	41	38
	5 = excellent	67	62	64	45	45	45
	N/A	0	1	1	6	5	6

The high rate of 'not applicable' with regards to the quality of barbeque facilities highlights a lack of awareness, familiarity with or use of the facilities (Table 30 and Figure 39). As per comments for improvements (Appendices) and as illustrated in site photographs (Appendices), there is scope for adding barbeque facilities in more frequented areas as well as providing support structures such as tables and shade facilities to make these areas more user-friendly and attractive. Staff from About Bike Hire which is near a barbeque in the park further support these observations, highlighting that there are is no shade, no table and no group-style seating near the current barbeque or anywhere in the park.

Table 30. Quality of features – BBQ facilities (%)

		May			October		
	BBQ facilities	**Week-day**	**Week-end**	**Combined**	**Week-day**	**Week-end**	**Combined**
How would you rate the quality of the following features (%)	1 = very poor	0	0	0	0	1	1
	2	6	1	3	9	0	4
	3	6	19	14	9	16	13
	4	16	16	16	16	25	21
	5 = excellent	13	17	15	19	11	15
	N/A	59	48	52	46	47	47

Out of the surveyed features of Point Fraser parkland, the toilet facilities (a set of two adjacent portable toilets – see photographs in Appendix H) attracted the most criticism. Considering 31 percent of 'non-applicable' responses, a total of 17 percent rated the toilet facilities as very poor or poor, compared to a 35 percent of positive responses and 19 percent rating them neither good nor bad (Table 31 and Figure 39). Issues of availability, placement, cleanliness and accessibility (i.e. disabled access) as also highlighted by a substantial number of comments (see Appendix E) require immediate attention.

Table 31. Quality of features – Toilet facilities (%)

		May			October		
	Toilet facilities	**Week-day**	**Week-end**	**Combined**	**Week-day**	**Week-end**	**Combined**
How would you rate the quality of the following features (%)	1 = very poor	10	6	0	7	6	1
	2	8	13	3	12	8	4
	3	16	17	14	21	22	13
	4	25	22	16	13	26	21
	5 = excellent	11	11	15	13	7	15
	N/A	30	31	52	34	31	47

Overall, five percent of respondents rated the signage as poor or very poor (Table 32 and Figure 39). Issues of signage vary from expectations of further interpretation of natural features and park history, to a perceived lack of directional, information and/or instructional signs as highlighted by respondents' comments in Appendix E. In line with improving awareness of the parkland, there is significant scope for improving the entry statements and 'branding' of the park. The survey team found that many people were not aware of the name Point Fraser or that they were in fact inside the Point Fraser parkland. As illustrated by

photographs in Appendix H, some signage is obstructed and much of the signage (including the entry statements) are small, inconspicuous or with lots of small writing that a passer-by on a bike, in a car or even on foot would be unable to read without coming to a full stop (cf. Appendix H).

Table 32. Quality of features – Signage (%)

		May			October		
	Signage	**Week-day**	**Week-end**	**Combined**	**Week-day**	**Week-end**	**Combined**
How would you rate the quality of the following feature (%)	1 = very poor	0	0	2	0	0	0
	2	3	3.2	5	4	0	2
	3	24	23.8	22	23	19	21
	4	37	36.5	34	30	45	38
	5 = excellent	30	30.2	26	33	21	26
	N/A	6	6.3	10	10	15	13

Similar to the signage, five percent rated the quality of the seating and tables (actually, there are no tables) as poor or very poor (Table 33 and Figure 39). As illustrated by the photographs (Appendix H) and comments (Appendix E), apart from the artistic bench seats which are somewhat obstructed in parts from practical use by their railings (part of the design), there is no group seating and no tables available. Along with the lack of shade, we consider this as a serious deterrent in particular for potential users of the barbeque areas.

Table 33. Quality of features – Seating and tables (%)

		May			October		
	Seating and tables	**Week-day**	**Week-end**	**Combined**	**Week-day**	**Week-end**	**Combined**
How would you rate the quality of the following feature (%)	1 = very poor	0	1	1	1	0	1
	2	0	3	2	9	5	6
	3	17	18	18	14	16	15
	4	40	39	39	25	39	32
	5 = excellent	33	22	26	19	20	20
	N/A	10	17	14	32	20	25

Thirty-eight percent of respondents rated education as not applicable, with 37 percent rating it as good or excellent, 19 percent neither good nor bad, and 6 percent as poor or very poor (Table 34 and Figure 39). There was no definition of 'education' presented in the

survey and as such it was up to the respondents to identify what they considered to be education. As no guided tours were offered during the survey period, we consider this response as relating predominately to the signage.

Table 34. Quality of features – Education (%)

		May			October		
	Education	**Week-day**	**Week-end**	**Combined**	**Week-day**	**Week-end**	**Combined**
How would you rate the quality of the following feature (%)	1 = very poor	2	2	2	3	2	3
	2	3	6	5	3	5	4
	3	20	19	19	20	17	18
	4	16	29	24	24	15	19
	5 = excellent	15	15	15	19	14	16
	N/A	44	30	35	31	47	40

Thirty-six percent of respondents ranked About Bike Hire as excellent or good, six percent as neither bad nor good and four percent as either poor or very poor (Table 35 and Figure 39). Fifty-three percent rated it as not applicable, indicating that they had never used the services of About Bike Hire or were unaware of it. These figures were reflected in the question on staff interaction (Table 36 and Figure 39).

Table 35. Quality of features – About Bike Hire (%)

		May			October		
	About bike hire	**Week-day**	**Week-end**	**Combined**	**Week-day**	**Week-end**	**Combined**
How would you rate the quality of the following feature (%)	1 = very poor	2	0	1	1	1	1
	2	2	4	3	0	5	3
	3	2	6	4	6	10	8
	4	19	21	21	13	14	14
	5 = excellent	21	21	21	25	10	17
	N/A	55	48	50	54	59	57

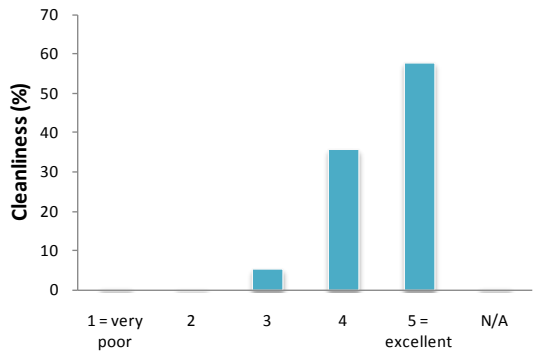
Thirty-two percent of respondents ranked staff interaction as excellent or good, eleven percent as neither bad nor good and six percent as either poor or very poor (Table 36 and Figure 39). Fifty-one percent rated it as not applicable, indicating that they didn't have any interaction with staff while visiting Point Fraser. Most respondents thought staff referred to City of Perth staff, while others reported on interactions with ECU survey teams or About

Bike Hire. Clarification of this question in the survey instrument for 2011 should make the focus interactions with City of Perth staff.

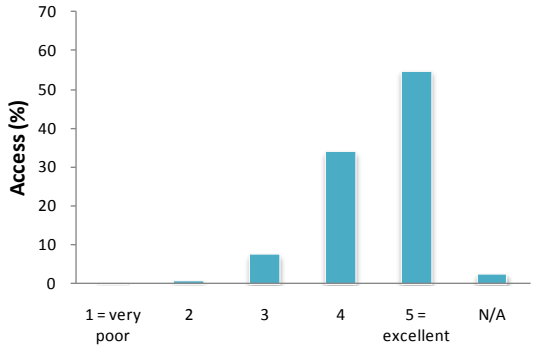
Table 36. Quality of features – Staff interaction (%)

		May			October		
	Staff interaction	Weekday	Weekend	Combined	Weekday	Weekend	Combined
How would	1 = very poor	0	3	2	5	0	2
you rate	2	5	5	5	0	5	3
the quality	3	10	14	12	8	11	10
of the	4	15	11	12	16	12	14
following	5 = excellent	16	18	18	27	17	21
feature (%)	N/A	55	50	51	44	55	51

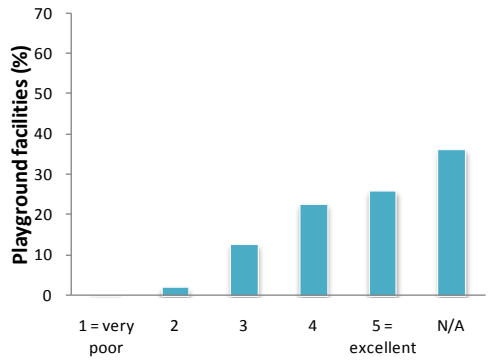
a) Cleanliness



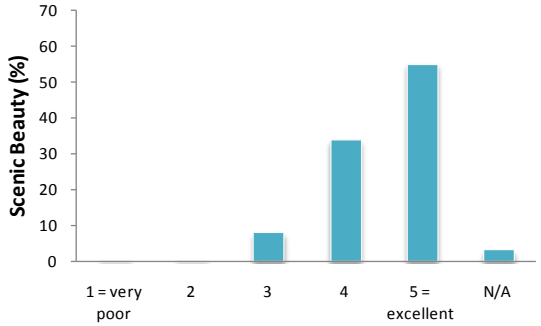
b) Access



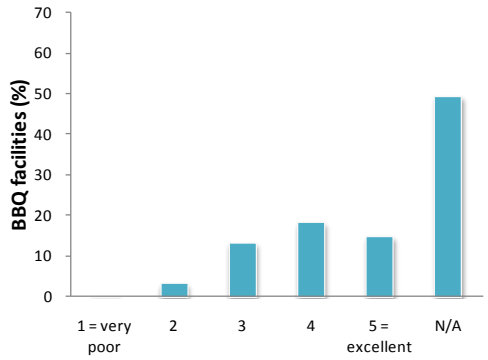
c) Playground facilities



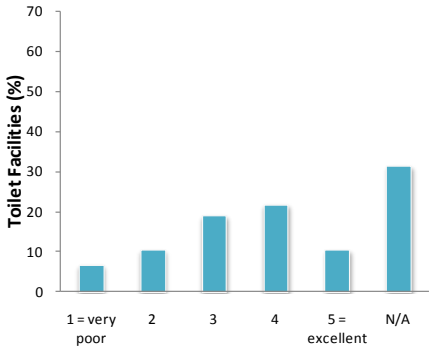
d) Scenic Beauty



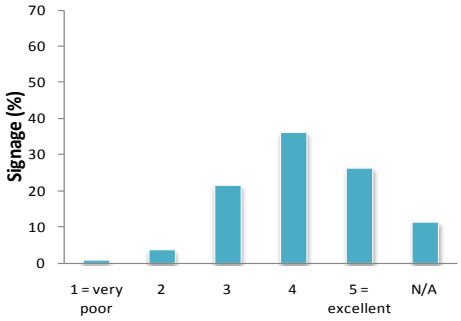
e) BBQ facilities



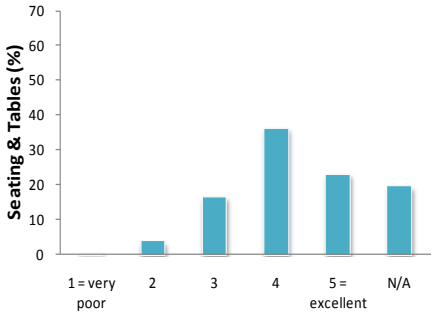
f) Toilet facilities



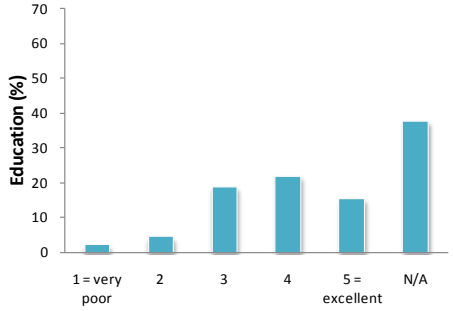
g) Signage



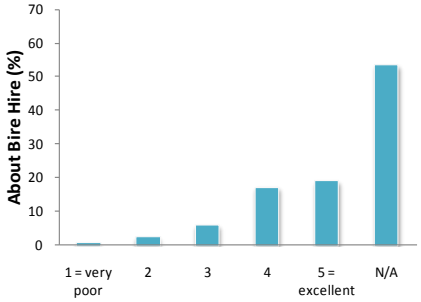
h) Seating and tables



i) Education



j) About Bike Hire



k) Staff Interaction

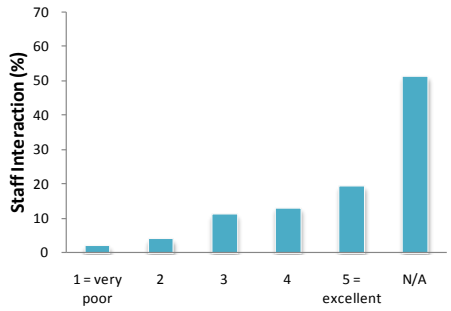


Figure 39. Quality of features (%), a) cleanliness, b) access, c) playground facilities, d) scenic beauty, e) BBQ, f) toilet facilities, g) signage; h) seating and tables, i) education, j) About Bike Hire, and k) staff interaction.

In addition to the listed features, there was also the option for 'other' features not listed. The list below outlines what respondents specified as 'other':

- Bike hire should be more prominent so people could find it. Wetlands full of slime (mosquitoes)?
- Bike Hire was closed.
- Cleanliness - at points it's great but near the causeway underpass it is quite dirty.
- Cyclists are too fast, no respect for walkers (no respect for walkers, dangerous). Separate path for cyclists.
- Don't know.
- Don't like the grasses.
- I wish for more barbeques, including Langley Park.
- More cafe facilities.

7.9.4 AVAILABILITY OF FEATURES

Respondents were asked about the availability of the features at Point Fraser using a 4-point scale (1=too few; 2=about right; 3=too many; 4=didn't matter). Generally, respondents indicated that the availability of the facilities was 'about right', with the exception of the availability rating for toilet facilities. A high proportion of respondents noted that the availability of park features 'didn't matter' which reflects either that they were passing through the park and didn't have a need for such facilities or a lack of awareness of facilities.

One quarter (25%) of respondents considered that there were 'too few' toilets, which adds to the issues with toilet facilities outlined in quality of features - toilets above and comments provided by respondents (Table 37 and Figure 40). While 46% considered the availability of toilets 'about right', 1% 'too many' and 28% 'didn't matter'. The high proportion of respondents who said that they availability of toilets didn't matter is a reflection of the significant number of people passing through the parkland.

Table 37. Availability of features – Toilets (%)

		May			October		
	Toilets	**Week-day**	**Week-end**	**Combined**	**Week-day**	**Week-end**	**Combined**
How would you rate the availability of facilities for your Point Fraser Experience? (%)	1 = too few	18	30	26	25	23	24
	2 = about right	42	45	44	46	51	49
	3 = too many	2	25	1	3	26	1
	4 = didn't matter	39		30	26		26

Twelve percent (12%) considered that there were 'too few' barbeque facilities (Table 38 and Figure 40). While 44% indicated that the number of barbeque facilities was 'about right', 1% said there were 'too many' and 44% said that it 'didn't matter'. The number and availability of barbeque facilities is limited and impacts the opportunities for recreational use of the park, also exacerbated by the lack of tables and seating. The significant number of people passing through the park reflects the high proportion of respondents (44%) indicating that the availability of barbeques 'didn't matter'.

Table 38. Availability of features – BBQs (%)

	BBQs	May			October		
		Week-day	Week-end	Combined	Week-day	Week-end	Combined
How would you rate the availability of facilities for your Point Fraser Experience? (%)	1 = too few	5	15	12	12	11	11
	2 = about right	37	45	42	47	47	47
	3 = too many	0	0	0	1	1	1
	4 = didn't matter	58	40	47	40	41	40

Eight percent (8%) of respondents indicated that the availability of seating and tables was 'too few' and two percent considered that there were 'too many' (Table 39 and Figure 40). A large proportion of respondents, 62%, indicated that the availability of seating and tables was 'about right' and 28% said it 'didn't matter' suggesting either not needing to use these facilities or a lack of awareness that these facilities exist within the park. It is important to consider the type of use (e.g. walking, passing through etc.) when considering these responses, as the majority of current use would not include the use of seating in their activities.

Table 39. Availability of features – Seating & tables (%)

	Seating & tables	May			October		
		Week-day	Week-end	Combined	Week-day	Week-end	Combined
How would you rate the availability of facilities for your Point Fraser Experience? (%)	1 = too few	2	7	5	14	8	11
	2 = about right	62	67	65	52	65	59
	3 = too many	3	0	1	1	2	2
	4 = didn't matter	33	26	29	32	24	27

Overall, ten percent of respondents rated the signage as 'too few' (Table 40 and Figure 40). As outlined above in quality of features – signage, issues of signage vary from expectations of further interpretation of natural features and park history, to a perceived lack of directional, information and/or instructional signs as highlighted by respondents'

comments. While 67% of respondents said the availability of signage was 'about right', three percent said there were 'too many' and 19% said it 'didn't matter'.

Table 40. Availability of features – Signage (%)

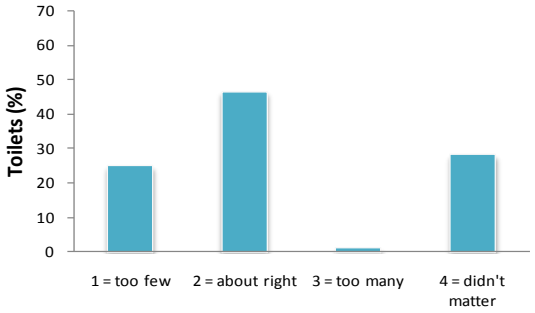
		May			October		
	Signage	**Week-day**	**Week-end**	**Combined**	**Week-day**	**Week-end**	**Combined**
How would you rate the availability of facilities for your Point Fraser Experience? (%)	1 = too few	6	12	10	12	9	10
	2 = about right	68	72	70	61	66	64
	3 = too many	2	1	1	7	5	6
	4 = didn't matter	24	15	18	20	20	20

In regard to the number of other people at Point Fraser, 14% considered that there were 'too few' (Table 41 and Figure 40). Fifty-eight percent (58%) indicated that the number of people was 'about right', while only four percent said that it didn't matter. For 24% the number of people in the park 'didn't matter'.

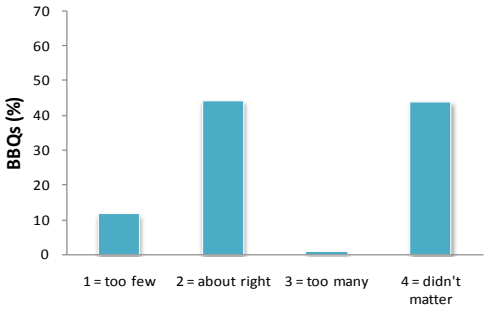
Table 41. Availability of features – Number of other people (%)

		May			October		
	Number of other people	**Week-day**	**Week-end**	**Combined**	**Week-day**	**Week-end**	**Combined**
How would you rate the availability of facilities for your Point Fraser Experience? (%)	1 = too few	13	19	17	8	14	11
	2 = about right	63	60	61	53	58	56
	3 = too many	3	3	3	5	5	5
	4 = didn't matter	22	18	20	35	23	29

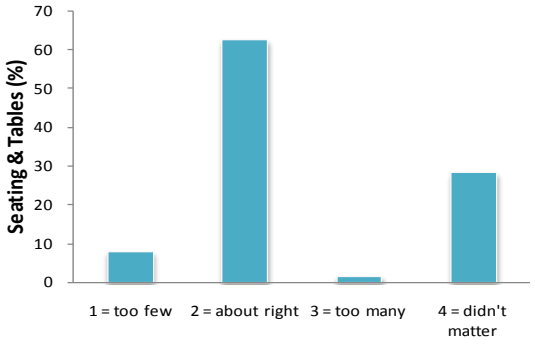
a) Toilets



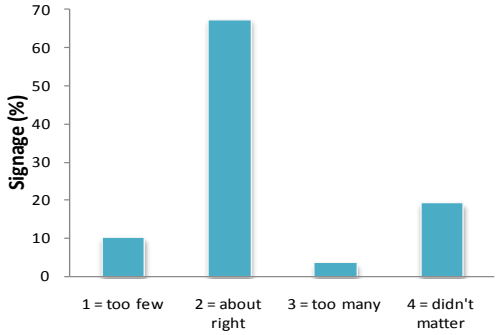
b) BBQs



c) Seating and Tables



d) Signage



) Number of other people

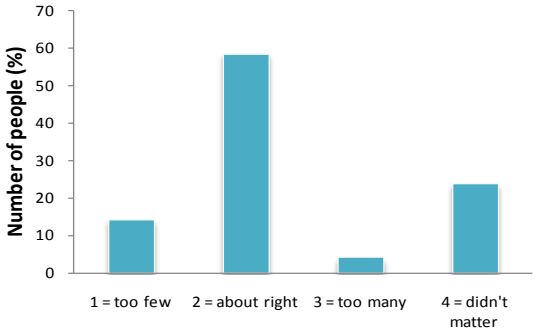


Figure 40. Availability of features (%) –a) toilet, b) BBQ, c) seating and tables, d) signage, and e) number of people.

In addition to the features which respondents rated availability, there was also the option for 'other' features not listed. The list below outlines what respondents specified as 'other':

- Barbecues, including Langley Park
- Bikes - fast bikes should not be here
- Car park
- Very good

Respondents were asked about their overall satisfaction with their Point Fraser experience (Table 42). Of the 364 respondents, 41% were very satisfied with their experience and 47% were satisfied. Ten percent (10%) indicated that they were neither satisfied or dissatisfied. Two percent of respondents were very dissatisfied or dissatisfied with their visit to Point Fraser.

Table 42. Overall satisfaction with Point Fraser experience

		May			October			Total
		Week-day	Week-end	Combined	Week-day	Week-end	Combined	
Overall, how satisfied were you with your visit to Point Fraser (%)	1 = very dissatisfied	0	1	1		2	1	1
	2	0	1	1	3	2	2	1
	3	5	8	7	21	7	13	10
	4	42	48	46	36	59	49	47
	5 = very satisfied	54	42	46	40	30	34	41

Respondents provided suggestions on how to improve Point Fraser. The full list of responses is provided in Appendix E. The following highlights the main themes:

- Improving quality of and increasing the number of toilets
- Establishing a Café to buy food and drinks
- Improving and increasing the amount of signage
- Providing shading/weather protection
- Improving access
- Improving lighting
- Improving quality and width of paths
- Increasing awareness/promotion of Point Fraser
- Location of bike hire place
- Improving pedestrian-bicycle interaction

- Increase the amount of barbeque facilities
- Other miscellaneous suggestions

Respondents were asked if they would visit Point Fraser again (Table 43). Eighty-nine percent (89%) said that they would visit again. While one percent (1%) said no and ten percent (10%) said maybe they would visit Point Fraser again.

Table 43. Repeat visitation

		May			October			Total
		Week-day	Week-end	Combined	Week-day	Week-end	Combined	2010
Do you think you will visit Point Fraser again?	Yes	91	96	94	81	86	84	89
	No	0	0	0	4	1	2	1
	Maybe	9	4	6	15	13	14	10

Following on from the question about repeat visitation, respondents were asked why or why not they would visit Point Fraser again. Appendix I lists the responses. The reasons why people would visit Point Fraser again were generally around the beauty of the location, opportunities for exercise, close proximity to home, relaxing, for parking and the facilities. The reasons why people would not return to Point Fraser were generally because they lived outside Perth.

Ninety-one percent (91%) of respondents said that they would recommend Point Fraser to others and eight percent (8%) maybe would (Table 44). Only one percent said that they wouldn't recommend Point Fraser to other people.

Table 44. Recommend visitation

		May			October			Total
		Week-day	Week-end	Combined	Week-day	Week-end	Combined	2010
Would you recommend visiting Point Fraser to others?	Yes	93	95	94	89	86	87	91
	No		2	1		2	1	1
	Maybe	7	3	5	11	12	12	8

Respondents were offered to leave their contact details if they would like to be contacted about their response to the survey. Out of the 364 completed surveys, 100 respondents

(27%) provided their contact details. A list of the contact details has been provided to the city of Perth as a separate file to ensure confidentiality.

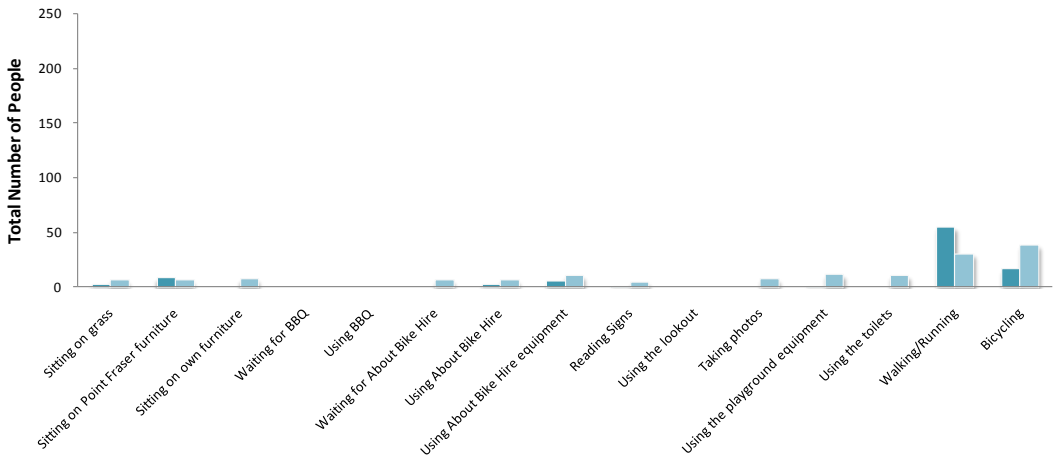
7.9.5 VISITOR OBSERVATIONS – BEHAVIOUR

Between the hourly visitor counts, a surveyor walked from the east to west entrance ensuring all areas of the reserve were covered and recorded the behaviour of park users using the Observation Behaviour datasheet (Appendix C). They also had an aerial photograph (Appendix D) to record the spatial arrangement of stationary visitors. Nevertheless, very few people were stationary and as such this tool rendered insufficient data for useful analysis. The visitor behaviour observations support the visitor survey data which highlighted that the vast majority of users use the parkland as an area to pass through during their regular exercise activity such as walking, running or cycling (Figure 41). Additional comments are listed in Appendix J.

Some final observations regarding park use:

- The park is not lit up at night (with the exception of the playground) and people avoid entering the park in the dark, choosing the lit shared path along the road instead.
- The main use of the park is for its commuter carpark (on weekday) and as part of an exercise route (both weekday and weekend).
- Few people seem to come to Point Fraser specifically to use the park, with the exception of people hiring equipment from About Bike Hire.
- Many people don't recognise the 'landmark Point Fraser'; it's just a nice area they pass through but not specifically come to.

a) May



b) October

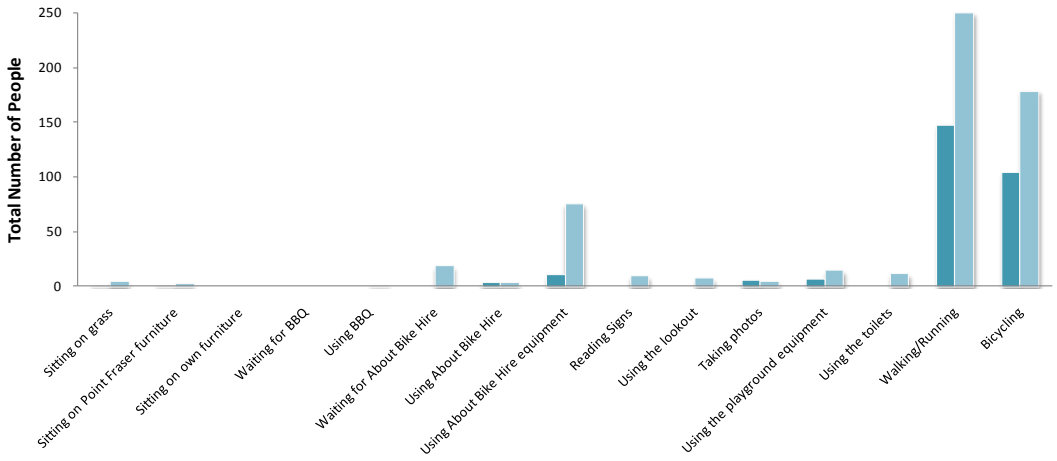


Figure 41. Number of people observed to engage in specific activities during hourly single-pass behaviour observations.

Some areas for potential improvements:

Recognition: At each entrance, a pleasant entry sign/entry statement indicating to people that they are entering (or passing) Point Fraser.

Lighting: use is limited to daylight hours, as paths and BBQ area is not lit up (even though lights are installed). Lighting up the playground might reduce vandalism but is unlikely to attract kids/families given that it would be their bedtime.

Seating/shade: tables and improved shading, particularly near the BBQ facilities, would make the area more user friendly.

Toilets: current park users highlight that improvement to the toilet facilities are of importance to them

Parking: Pay parking applies to weekends also. Why? Free parking on weekends may facilitate specific park usage.

Commercial facilities: There is some outdated signage in the park, indicating development of commercial areas to be completed by 2009.

7.9.6 CONCLUSIONS

1. Determine visitor usage of Point Fraser
2. Observe usage of Point Fraser by the public
3. Interview park users for why they used the park

Point Fraser is well visited by the public, however most are passing through as part of an exercise regime (walking, jogging or cycling). Few people surveyed indicated that they had come to Point Fraser specifically. The carpark is heavily used by city workers during the week. Improvements to signage and the construction of a café are likely to see the park become more of a destination in its own right.

8 CONCLUSIONS

1. The quality of urban stormwater discharging to the Swan River long term, as a result of the redevelopment of Point Fraser by determining the amount of pollutant removal via the constructed wetland;

The wetland due to the inflow issues mainly treated Lake Vasto top-up water and rainwater rather than the target stormwater. There is some evidence that water quality did improve across the wetland. It is also likely that all discharges from the wetland were below ANZECC/ARMCANZ (2000) guidelines for the protection of aquatic systems and relevant targets set for the Swan River (see Swan River Trust, 2009a, b).

2. The quality of wetland habitat and the quantity and quality of breeding places for native avifauna presence, behaviours and habitat use;

Wetland vegetation is developing strongly with three main species *Juncus kraussii*, *Eleocharis acuta* and *Baumea articulata* competing with each other for space especially in Zone 2. Weed penetration into the wetlands is very low. The vegetation has survived well with minor issues associated with low water levels on occasion and peaks in water salinity. The wetland has attracted a broad range of avifauna, including a number of exotics. It does not appear that the wetland is currently being used heavily for breeding.

3. The ongoing ecological health of the constructed wetland via its conformance with relevant water quality guidelines and legislation requirements.

The wetland is developing a typical macroinvertebrate community, although the salinity levels in Zone 2 are encouraging more marine species than typical wetland species. The community is mainly composed of cosmopolitan and tolerant fauna. A more sensitive taxa was recorded which suggests that the wetland biodiversity will continue to improve. The introduction of *Gambusia holbrooki* (Mosquitofish) probably from the drainage network is unfortunate as they have a negative impact on surface dwelling macroinvertebrates. They are virtually impossible to eliminate without use of rotenone or by drying the wetland.

4. The quality, quantity and type of recreational and educational use of Point Fraser by determining the diversity of visitor presence, behaviour, use, expectations and satisfaction and awareness of reports/information specific to Point Fraser performance; and

Point Fraser is heavily used by the public, however the main reasons for visiting are for parking (during the week) and passing through (mainly for exercise as part of the pathway around this part of the Swan River). Despite this, the park attracted a number of international and international visitors. It appears that most visitors are largely unaware of Point Fraser per se and do not choose to deliberately visit the site. Overall users were pleased with the majority of facilities, excluding the public toilets and lack of a café. Lack of lighting within the park, prevents its use at this time.

5. The long term integrity and quality of the restoration of the foreshore edge, as a result of the redevelopment of Point Fraser by determining vegetation health and structural reliability.

The foreshore appeared to be developing well, with only a couple of minor areas where erosion was potentially causing a problem.

9 SUMMARY OF RECOMMENDATIONS

Recommendation 1.

Accurate measurements of inflows from the stormwater system are still required to determine incoming nutrient loads.

Priority: HIGH
Responsibility: ECU/COP
Comments: Measuring the inlet is challenging given the problems with incoming flow and backflow. ECU will attempt to resolve issues associated with the monitoring equipment, however COP may need to fund additional components for the monitoring system (such as more depth sensors) to enable accurate measurement.

Recommendation 2.

It is recommended that until the Starflow is working reliably that an alternative method be employed to trigger the autosamplers. The addition of ISCO bubble flow meters would serve the purpose and are available from ECU.

Priority: HIGH
Responsibility: ECU
Comments: Completed, although this has not resolved all the problems associated with monitoring the inlet.

Recommendation 3.

It is recommended that the alternate exit/leak within the drainage network be identified and fixed. This is severely impacting on the function of the wetland, preventing it performing any useful function. Furthermore, loss of incoming water is resulting in increased need for pumping from Lake Vasto to maintain water levels.

Priority: HIGH
Responsibility: COP
Comments: Until this problem is addressed by the COP then the wetland will fail to meet its primary objective of stormwater treatment.

Recommendation 4.

There appears to be evidence that the wetland on occasion has been overfilled, with Lake Vasto waters as part of the ongoing topping up of the system. Topping up Zone 1 to a height above the bubble up grate will result in loss of additional waters to the drainage network.

ECU will provide the City of Perth with new recommended heights for the topping up of both Zone 1 and Zone 2 which should reduce the chances of this reoccurring.

Priority: MEDIUM
Responsibility: ECU
Comments: ECU is currently determining suitable water levels for both Zone 1 and 2 and these will be supplied to COP for implementation.

Recommendation 5.

High salinities (>12.5 mS cm^{-1}) are likely to start negatively impacting on emergent plants in the wetland. Although salinities within the wetland substantially exceeded these levels on only one occasion, ongoing poor flows into and out of the wetland are likely to see salinities increase and management action might be required. It is recommended that ongoing monitoring of conductivity continue and management action be undertaken where 12.5 mS cm^{-1} is exceeded for two months, or >20 mS cm^{-1} is detected on any occasion.

Priority: LOW
Responsibility: ECU/COP
Comments: ECU will continue to measure salinity as part of the regular monitoring program and will advise COP if any management actions are required.

Recommendation 6.

W1 is not an official part of the current monitoring program and was monitored as per the other ponds by ECU at no cost to the City to determine whether it should be included. Although there is some similarity in water quality parameters between W1 and W2, there are sufficient differences to recommend that W1 monitoring be fully incorporated into the regular monitoring program.

Priority: HIGH
Responsibility: COP/ECU
Comments: A revised monitoring program and budget has been submitted to the COP to allow for inclusion of W1 into the monitoring program. ECU has continued to include W1 in its monitoring program.

Recommendation 7.

The foreshore is monitored annually in May and the results are usually compiled within a month. It is recommended that the draft report on the foreshore monitoring be provided to the City of Perth by end of June, to allow the City to respond to any issues that have been identified.

Priority: HIGH
Responsibility: ECU
Comments: For 2011, this has already been done.

10 REFERENCES

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11 APPENDIX

11.1 VEGETATION PHOTOGRAPHS FOR FIXED PHOTOPOINTS TAKEN IN OCTOBER 2010

a) west

b) south-east
(not taken)

c) south

Figure 42. Photographs taken at photopoint WV1 on 25-10-2010 and the direction taken

a) east

b) south

c) west

Figure 43. Photographs taken at photopoint WV2 on 25-10-2010 and the direction taken

a) south-east

b) south

Figure 44. Photographs taken at photopoint WV3 on 25-10-2010 and the direction taken

a) north-west

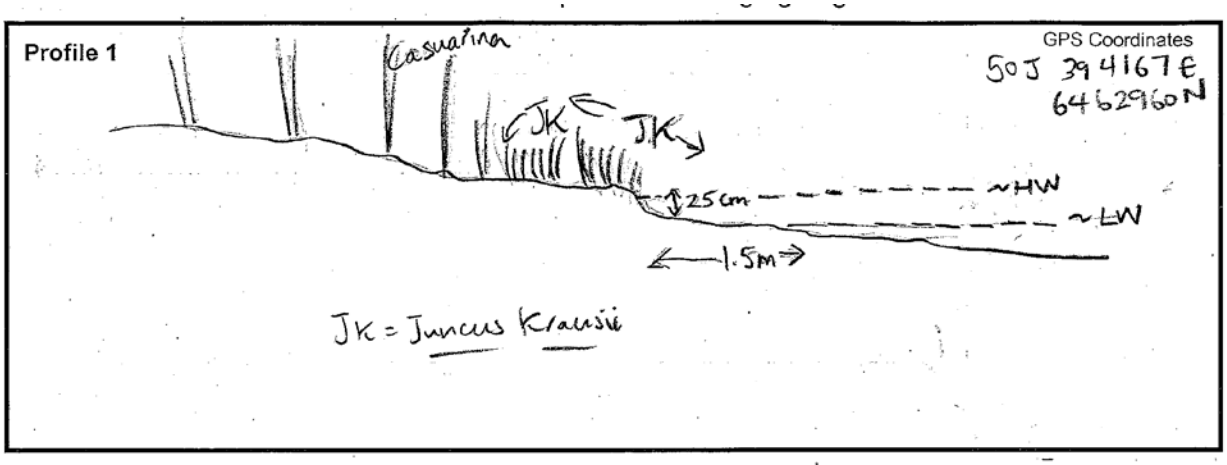
b) west

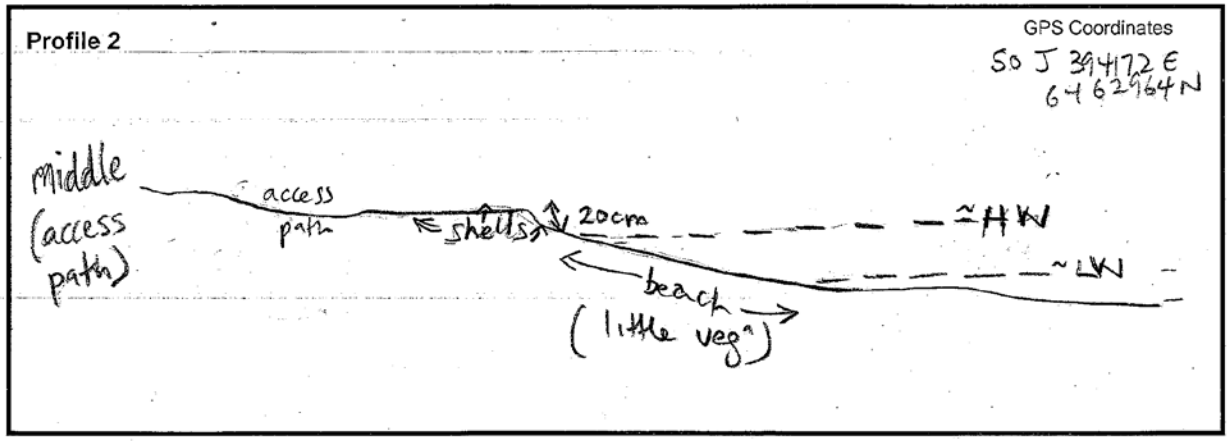
c) south-west

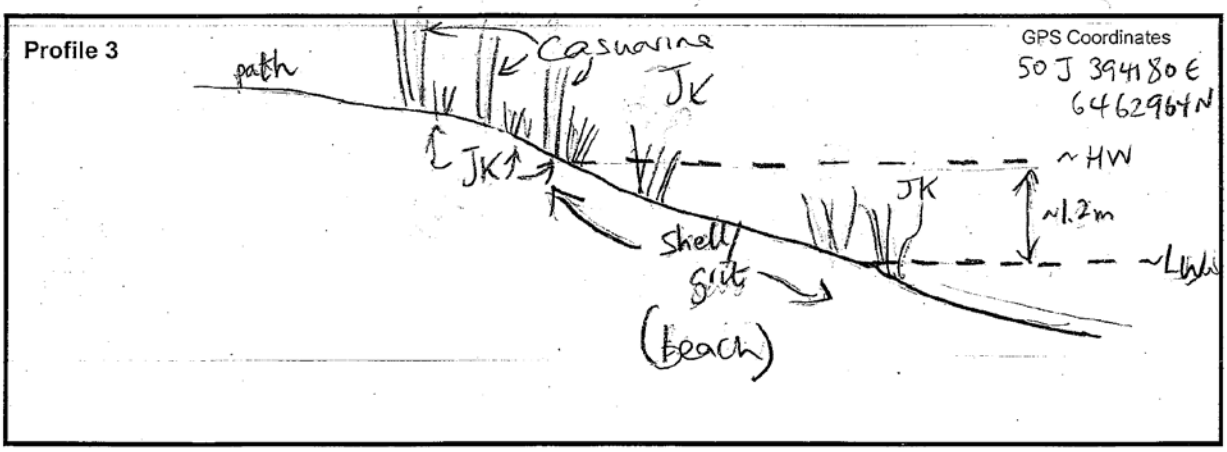
Figure 45. Photographs taken at photopoint WV4 on 25-10-2010 and the direction taken

11.2 PHOTOGRAPHS AND FORESHORE PROFILE SKETCHES AT SITE F1A (CAPTURED AT APPROXIMATELY 2PM ON 24-5-2010)

Foreshore Profiles Site F1A

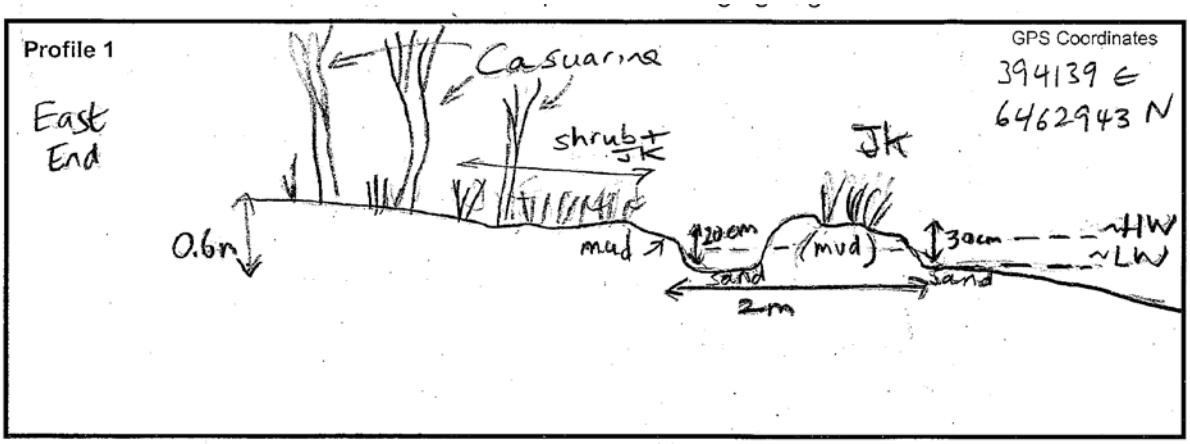


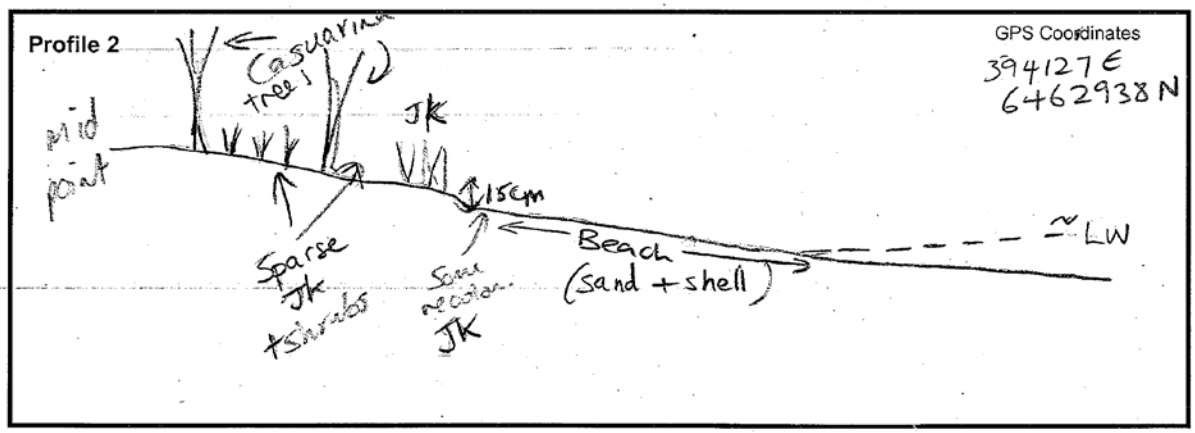


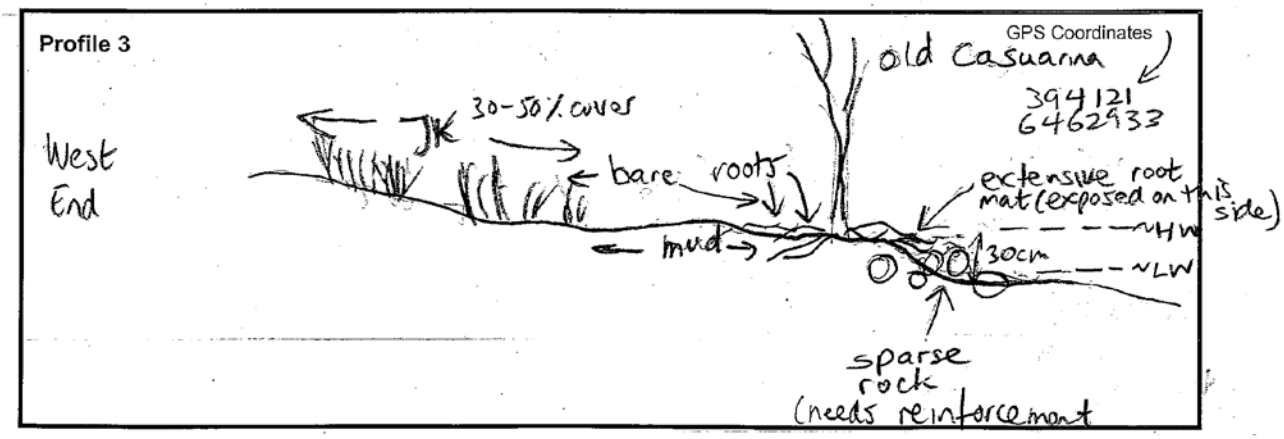


11.3 PHOTOGRAPHS AND FORESHORE PROFILE SKETCHES AT SITE F1B (CAPTURED AT APPROXIMATELY 2.30PM ON 24-5-2010)

Foreshore Profiles of Site F1B

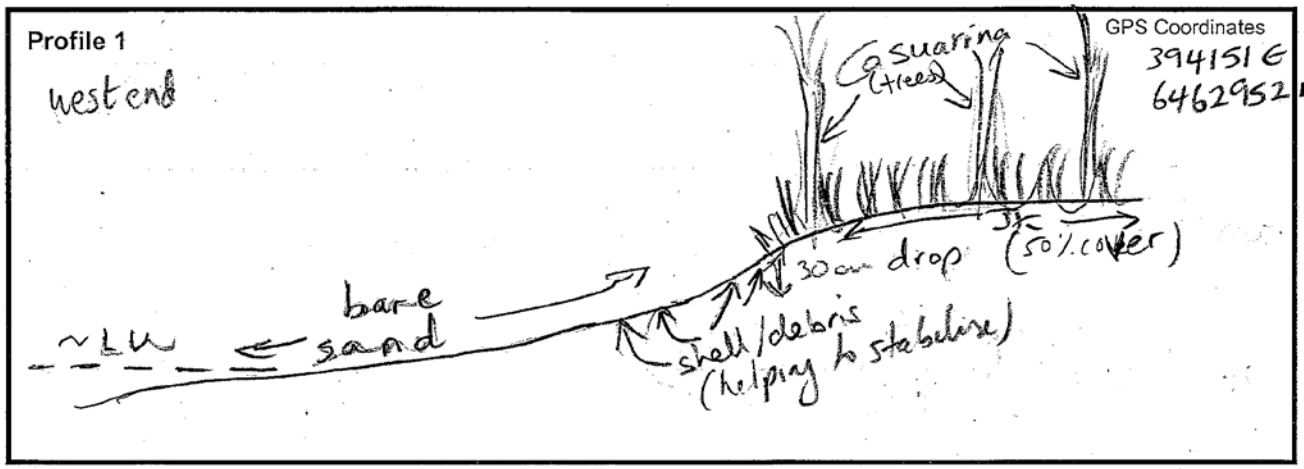


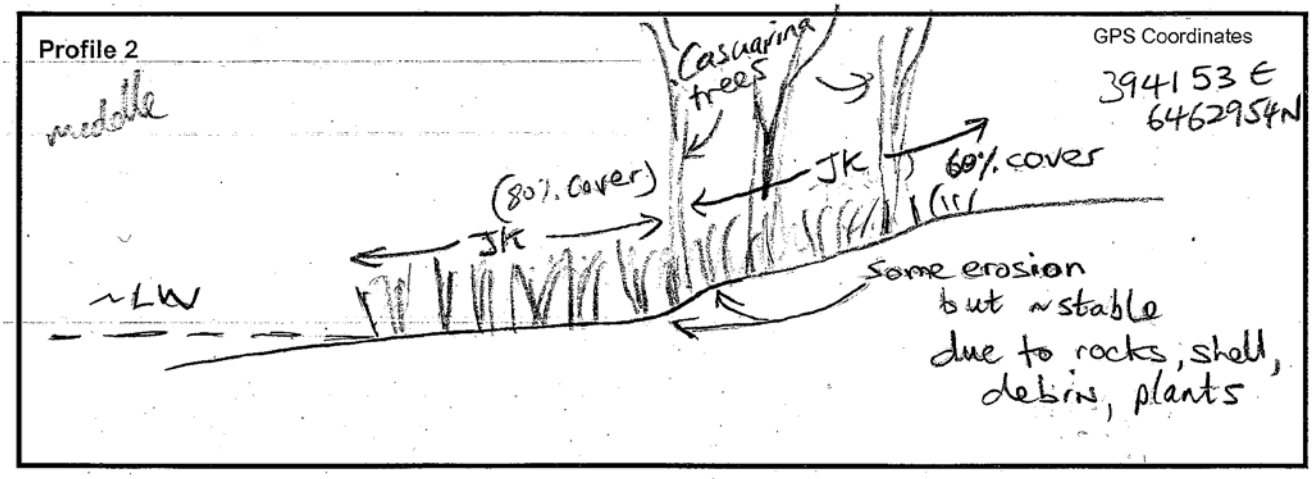




11.4 PHOTOGRAPHS AND FORESHORE PROFILE SKETCHES AT SITE F1C (CAPTURED AT APPROXIMATELY 3PM ON 24-5-2010)

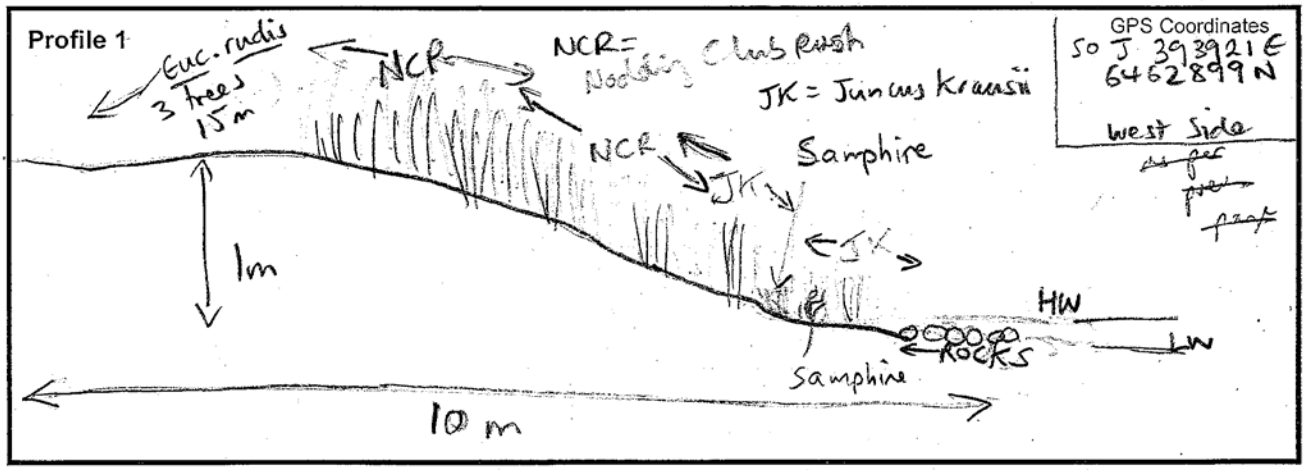
Foreshore Profiles of Site F1C

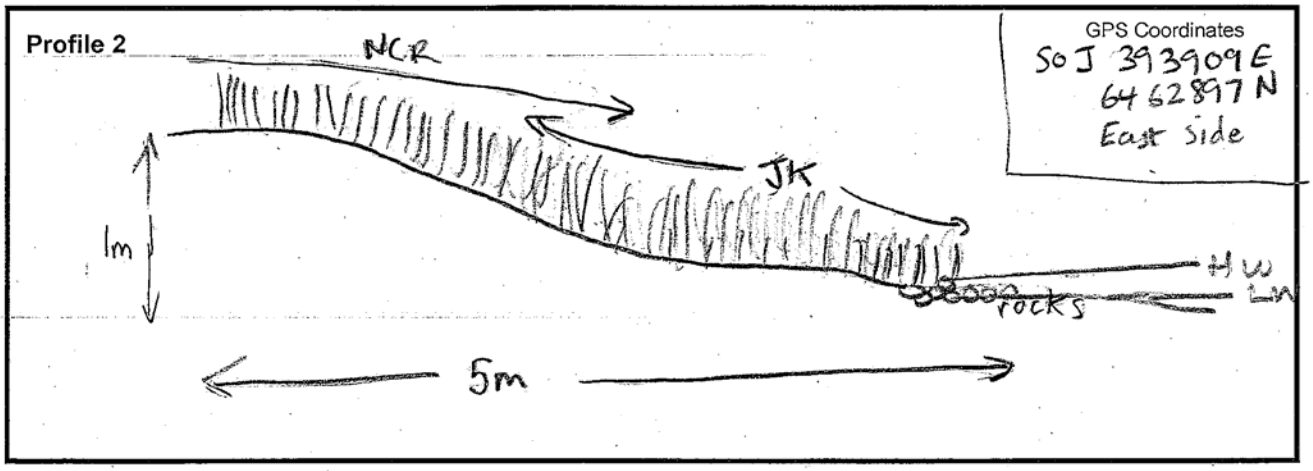




11.5 PHOTOGRAPHS AND FORESHORE PROFILE SKETCHES AT SITE 2A (CAPTURED AT APPROXIMATELY 3.45PM ON 21-5-2010)

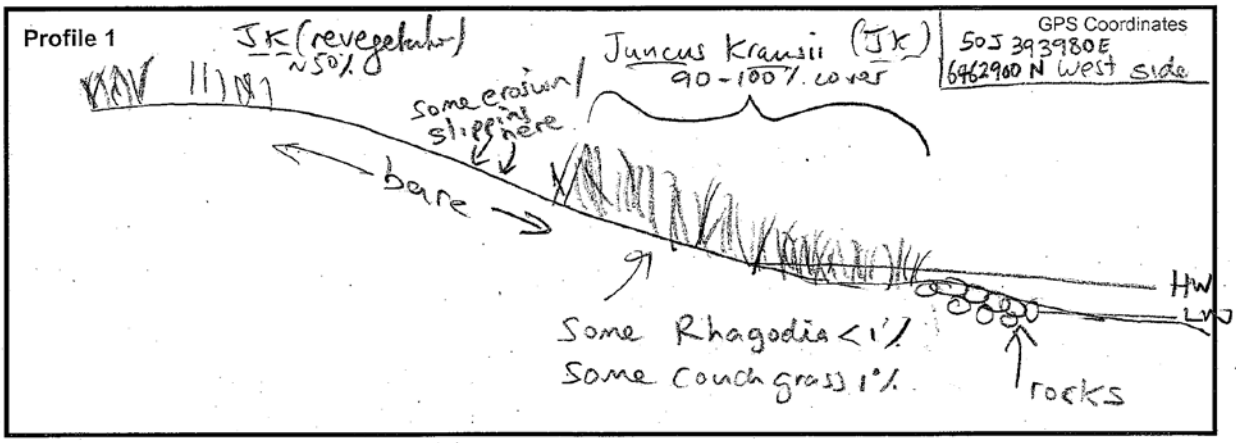
Foreshore Profiles of Site F2A

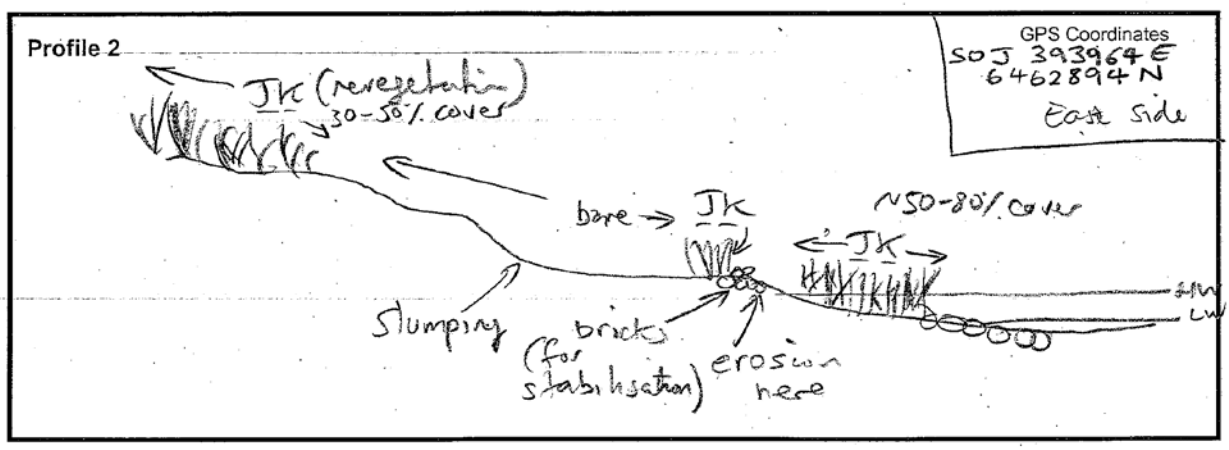




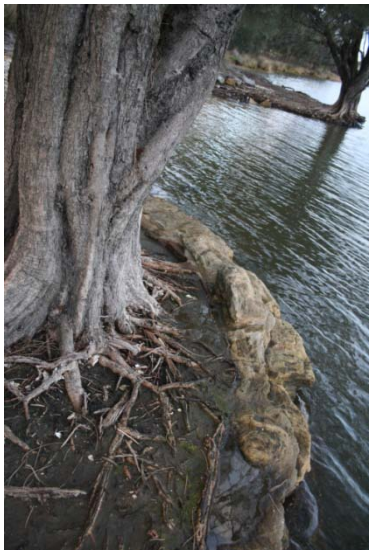
11.6 PHOTOGRAPHS AND FORESHORE PROFILE SKETCHES AT SITE 2B (CAPTURED AT APPROXIMATELY 4.15PM ON 21-5-2010)

Foreshore Profiles for Site F2B

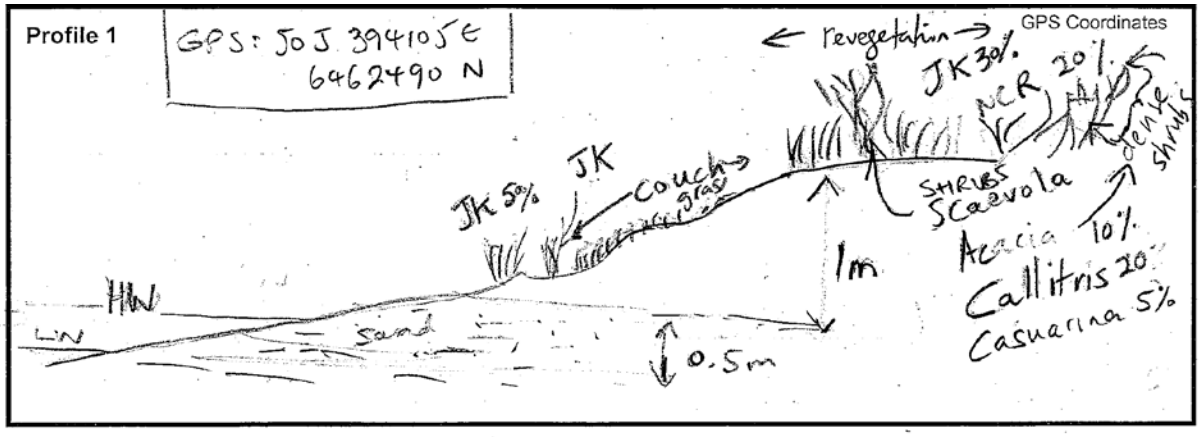


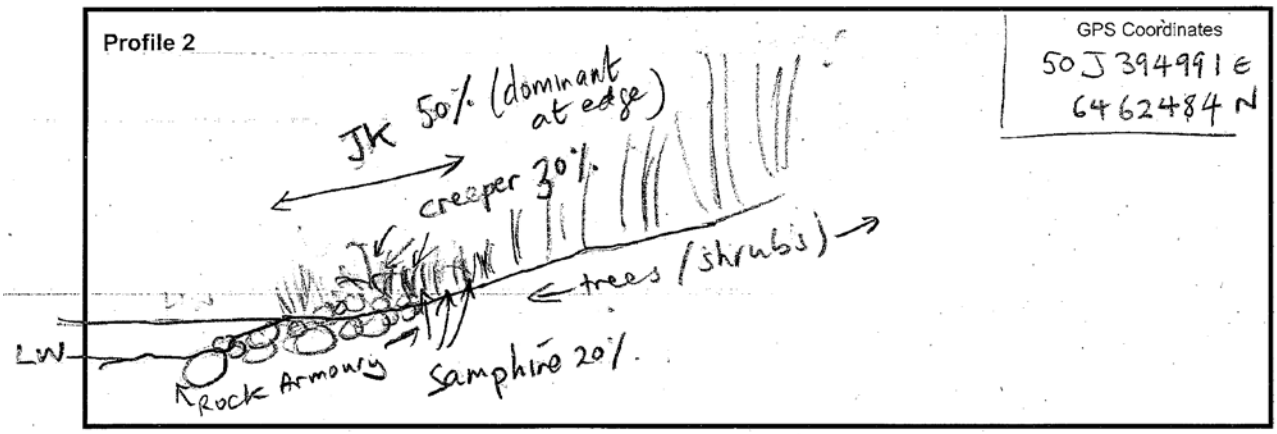


11.7 PHOTOGRAPHS AND FORESHORE PROFILE SKETCHES AT SITE 2C (CAPTURED AT APPROXIMATELY 5PM ON 21-5-2010)



Foreshore Profiles of Site F2C





Version 2.20052010

Point Fraser

Observation – Count (SMC1 - Park)

CITY of PERTH

Recorder Name:……

Date: …… Time:……

Weather Conditions:……

Any safety/health hazards:……

Site Code: ***SMC1*** *(*see diagram on back page)* Site Name: ***West entrance***

Time	Walking/Running IN*	Walking/Running OUT*	Bicycling IN*	Bicycling OUT*	Other (Please note)
7-7.15am					
8-8.15am					
9-9.15am 10-10.15am					
11-11.15am					
12-12.15pm					
1-1.15pm					
2-2.15pm					
3-3.15pm					
4-4.15pm					
5-5.15pm					
6-6.15pm					

Comments (also use back of page):

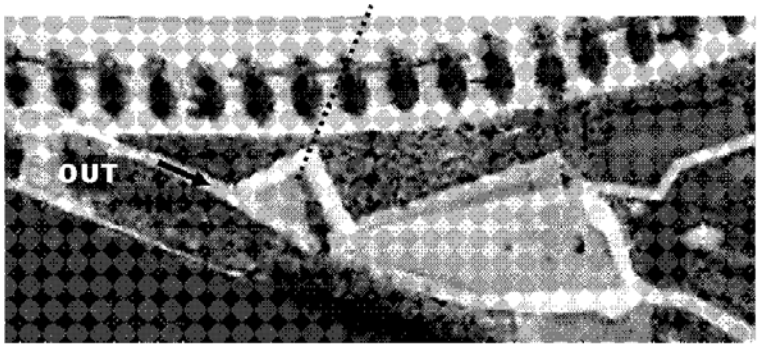
POINT FRASER MONITORING & EVALUATION PROGRAM (2010-2011) Page 1 of 4

Point Fraser

Observation – Count (SMC1 - Park)

Comments (contd.):

Position of surveyor SMC1 (Park & Road counts)



Version 2.20052010

Point Fraser

Observation – Count (SMC1 - Road)

Recorder Name:……

Date: …… Time:……

Weather Conditions:……

Any safety/health hazards:……

Site Code: ***SMC1*** *(*see diagram on back page)* Site Name: ***West entrance***

Time	Walking/Running		Bicycling		Comments
	TO City*	FROM City*	TO City*	FROM City*	
7-7.15am					
8-8.15am					
9-9.15am					
10-10.15am					
11-11.15am					
12-12.15pm					
1-1.15pm					
2-2.15pm					
3-3.15pm					
4-4.15pm					
5-5.15pm					
6-6.15pm					

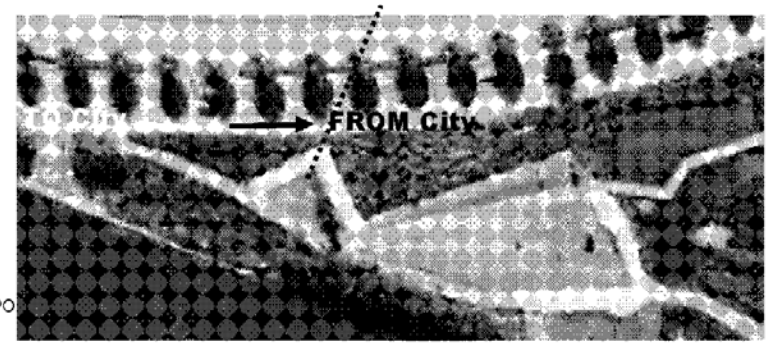
Comments (also use back of page):

Point Fraser

Observation – Count (SMC1 - Road)

Comments (contd.):

Position of surveyor SMC1 (Park & Road counts)



PO

Version 2.20052010

Point Fraser

Observation – Count (SMC2)

Recorder Name:……

Date: …… Time:……

Weather Conditions:……

Any safety/health hazards:……

Site Code: ***SMC2*** *(*see diagram on back page)* Site Name: ***East entrance***

Time	Walking/Running IN*	Walking/Running OUT*	Bicycling IN*	Bicycling OUT*	Other (Please note)
7-7.15am					
8-8.15am					
9-9.15am					
10-10.15am					
11-11.15am					
12-12.15pm					
1-1.15pm					
2-2.15pm					
3-3.15pm					
4-4.15pm					
5-5.15pm					
6-6.15pm					

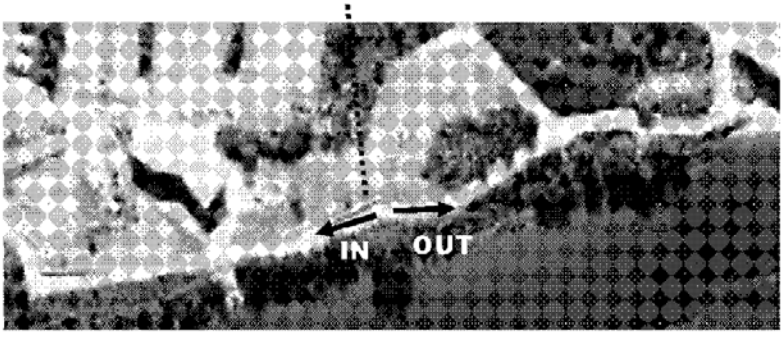
Comments (also use back of page):

Point Fraser

Observation – Count (SMC2)

Comments (contd.):

Position of surveyor SMC2 (counts)



Version 2.20052010

Point Fraser

Observation – Count (SMC3)

Recorder Name:……

Date: …… Time:……

Weather Conditions:……

Any safety/health hazards:……

Site Code: ***SMC3*** *(*see diagram on back page)* Site Name: ***Carpark entrance***

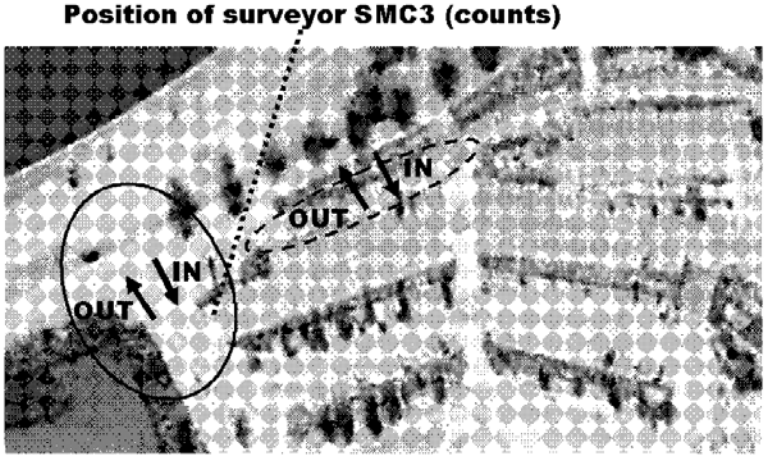
	Road Entrance*						***Pedestrian Entrance / Garden beds****	
Time	**Walking/Running**		**Bicycling**		**Vehicle**		**Walking**	
	IN	**OUT**	**IN**	**OUT**	**IN**	**OUT**	**IN**	**OUT**
7-7.15am								
8-8.15am								
9-9.15am								
10-10.15am								
11-11.15am								
12-12.15pm								
1-1.15pm								
2-2.15pm								
3-3.15pm								
4-4.15pm								
5-5.15pm								
6-6.15pm								

Point Fraser

Observation – Count (SMC3)

Comments:

Position of surveyor SMC3 (counts)



Pedestrian Entrance / Garden Bed

Road Entrance

POINT FRASER MONITORING & EVALUATION PROGRAM (2010-2011)

Page 2 of 2

Point Fraser

Visitor Surveys

CITY of PERTH

Participant Information

Dear Visitor,

The City of Perth has contracted Associate Professor Mark Lund and his research team from the School of Natural Sciences at Edith Cowan University (ECU) to conduct a monitoring and evaluation program for Point Fraser. Point Fraser is a wetland that has been built by the City to treat stormwater runoff from the roads before it enters the Swan River. Associated with the wetland, the City has created an area of public amenity, including some commercial activities, playground and areas for enjoyment of nature. The City has also rehabilitated the foreshore of the Swan River.

As part of the evaluation program the City would like to know how Point Fraser is being used by the public, for what and how the facilities provided meet community needs. To help answer this question, the research team invites you to complete a short 15 min survey now with us, or in your own time (where you can mail in the completed survey) or online at the City of Perth website (under Point Fraser). The survey is completely anonymous with no identifying information collected. There is however opportunity to include a contact name and address, if you would like to City to provide a response based on your feedback. The information collected by the survey will be analysed by the ECU team and presented to the City annually in publically available reports – no information that would lead to the identification of participants appears in the report or is retained by ECU.

The information you provide will be used by the City to improve the facilities and amenity values of Point Fraser. As Point Fraser is a leading example of constructed wetland design in Western Australia, the results from this survey will help inform new wetlands being built.

Completion of the survey is voluntary, and participants must be over 18 years old. This survey has the approval of the ECU human ethics committee. Further information on the project can be obtained from the City of Perth or by contacting Associate Professor Mark Lund at ECU on Tel. 6304 5644 or email m.lund@ecu.edu.au

POINT FRASER MONITORING & EVALUATION PROGRAM (2010-2011)

Time: ... ... Date: .../.../201... Surveyor Name: Version 3.08102010

Point Fraser Visitor Survey

Thank you for visiting Point Fraser in the City of Perth. We would greatly appreciate if you could take a moment of your time and tell us about your experience.

1. Are you a resident of Perth?

☐ Yes, my postcode is: _____

☐ No, I am visiting from: (City): _____ (Country): _____

2. Your gender:

☐ Male ☐ Female

3. Your age:

☐ Under 21 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ Over 60

4. How did you travel to Point Fraser?

☐ On Foot ☐ Car ☐ Boat

☐ Bicycle ☐ Public Transport ☐ Other (please specify): _____

☐ Mixture of above (please specify): _____

5. How often do you visit Point Fraser?

☐ First time ☐ Daily ☐ Weekly ☐ Monthly ☐ Once or twice a year ☐ Less than once a year

6. Who are you visiting Point Fraser with?

☐ On my own ☐ Partner ☐ Family

☐ Friends ☐ Work associates ☐ Community group

☐ Other (please specify): _____

7. What time did you arrive at Point Fraser? (please tick)

Morning (am)							Afternoon (pm)				
6-7	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6

8. How long are you planning to stay at Point Fraser?

☐ passing through ☐ < 1 hour ☐ 1-2 hours ☐ 2-4 hours ☐ Over 4 hours

9. What activities are you doing at Point Fraser? (Tick all that apply)

☐ Passing through ☐ Cycling ☐ Running/jogging

☐ Walking ☐ BBQ/Picnic ☐ General enjoyment

☐ Interpretive Trails ☐ Photography ☐ Playground

☐ Using services of About Bike Hire ☐ Other (please specify): .....

Please turn page

10. How would you rate the **quality** of the following features of Point Fraser? (please circle)

	Very poor	←			→ Excellent	Not applicable
Cleanliness	1	2	3	4	5	N/A
Access	1	2	3	4	5	N/A
Playground facilities	1	2	3	4	5	N/A
Scenic beauty	1	2	3	4	5	N/A
BBQ facilities	1	2	3	4	5	N/A
Toilet facilities	1	2	3	4	5	N/A
Signage	1	2	3	4	5	N/A
Seating & Tables	1	2	3	4	5	N/A
Education	1	2	3	4	5	N/A
About Bike Hire	1	2	3	4	5	N/A
Staff interaction	1	2	3	4	5	N/A
Other (please specify)_____	1	2	3	4	5	N/A

11. How would you rate the **availability** of facilities for your Point Fraser experience? (please circle)

	Too few	About right	Too many	Didn't matter
Toilets	1	2	3	4
BBQs	1	2	3	4
Seating & Tables	1	2	3	4
Signage	1	2	3	4
No. of other people	1	2	3	4
Other (please specify)_____	1	2	3	4

12. What are your **main** reasons for visiting Point Fraser today? (Tick the most appropriate)

☐ Spending time with friends & family ☐ Exercising ☐ Experiencing nature

☐ Learn about storm water ☐ Seeing wildlife ☐ Scenery

☐ Something new and different ☐ Proximity to the City ☐ Rest and relax

☐ Learn about the environment ☐ Proximity to the river ☐ For solitude

☐ Other (please specify): .....

13. Do you think you will visit Point Fraser again?

☐ Yes ☐ No ☐ Maybe

b) Why or why not? Please explain. (Please provide as much detail as possible.)

_____

_____

_____

Please turn page

14. Would you recommend visiting Point Fraser to others?

☐ Yes ☐ No ☐ Maybe

15. Overall, how satisfied were you with your visit to Point Fraser? (please circle)

	Very dissatisfied				Very satisfied
Overall Experience	1	2	3	4	5

16. Do you have any suggestions how we could improve your experience at Point Fraser?

.....

.....

.....

.....

.....

Thank you for your time.

If you wish to be contacted in regards to your comments in this survey, please provide your details below:

Name: _____

Preferred contact method: _____

Details (email/phone/address): _____

_____

11.10 APPENDIX C – OBSERVATION BEHAVIOUR DATASHEET

Version 2.20052010

Point Fraser

Observation - Behaviour

Recorder Name:……

Date: …… Time: ……

Weather Conditions:……

Any safety/health hazards……

……

Behaviour	No. of People	Behaviour	No. of People
Sitting on grass		Taking Photos	
Sitting on Point Fraser furniture		Using the Playground equipment	
Sitting on own furniture		Using the toilets	
Waiting for BBQ		Using commercial facility 1	N/A
Using BBQ		Using commercial facility 2	N/A
Waiting for About Bike Hire		Using commercial facility 3	N/A
Using About Bike Hire		Walking / Running	
Using About Bike Hire Equipment		Bicycling	
Reading Signs			
Using the look out			
Comments:			

POINT FRASER MONITORING & EVALUATION PROGRAM (2010-2011) Page 1 of 2

11.11 APPENDIX D – AERIAL PHOTO MARKING LOCATION OF STATIONARY PARK USERS

Date: …. /05/2010 Time: …….. Surveyor: ……..

11.12 APPENDIX E – SUGGESTIONS ON HOW TO IMPROVE POINT FRASER

TOILETS
Availability of wheelchair accessible toilets. Picnic areas.
Better and more toilets
Build toilet areas, more seating
Clean wheelchair accessible toilets
More, cleaner toilets
It will be great when the coffee cafe and the toilets are built.
More toilet stops
More toilets
More toilets 'permanent'
More toilets (clean)
More toilets and jelly fish education..?
More toilets BBQ's and benches please.
More toilets that are accessible for people with disabilities
More toilets, somewhere for refreshments
More toilets, too many flies
More washing points, cleaner toilets
Maintaining the toilet facilities nice and clean.
Providing a sign board for the toilets.
Toilet and cafe
Toilet and cafe - I think they are planned?
Toilets
Toilets - I didn't see any
Toilets - proper toilet block. Free parking - free on weekends.
Proper toilet block

ACCESS
Access from Adelaide Terrace is poor.
Access. To far. Fix carpark pay m/c.
Build more carpark without paying fee
Need more disabled parking closer to bike hire
No charge parking on weekends
improved public transport access

CAFÉ
A very small unobtrusive coffee shop and cafe
Build a café
Café
Cafe for coffee!
Cafe to have snacks at, gym equipment.
Cafe! A good toilet.
Cafe?
Cafe's
Coffee cart, café
Coffee shop
Coffee shop/ ice cream
Explain the cafe sign - where's the closest
Free hot chocolate
It will be great when the coffee cafe and the toilets are built.
Maybe have a kiosk handy for coffee!
More places for refreshments
More restaurants, gallery, exercise outlet for people who are into fitness, childrens water park.

SHADING / WEATHER PROTECTION
Covered seating (against sun and wind), wooden seating
More shade facilities. A disabled toilet (toilets sometimes flooded)
More shade trees! Use deciduous to allow winter sun.
More shelter stops for rain in the winter
Plant many trees on both sides of the aisle ie. wouldn't be so hot!
improved shade
Shade for playground
Shelter for rain and perhaps more toilets

SIGNAGE
A little more signage would be nice for those visiting WA for the first time.
Allow access to other side using quad cycle.

	Move signs on paths in bushes. Better signage re. walking and riding protocols Explanation on the directions and about the animals and plants are not quite sufficient. Maybe bicycle signs ? for older people. Maybe some more info about past, present and future of this place. Maybe they could plant more trees and flowers here, and more educational things, such as signage for Point Fraser's history. More signage points improved signage and visibility for About Bike Hire
LIGHTING Better lighting when its dark! Make the walkway pass available and secure at night time as well as lights Night light. Place is not available and secure at nights	
PATHS Better trails and bike tracks, seating and toilets. Big paths to accommodate cyclists Bring new walkway to Point Fraser Extend walkway near playground so you don't have to go through parking lot Install walkway at west end of parking lot so we don't have to walk down path with bikes Make the trails friendlier to rollerbladers eg, get rid of dividing rocks, bumps, rough patches etc. There's more than just bikers who want to use this Safe walk tracks across to other side Would be great once paths are completed Wider bike paths	Walking trails - not enough signs to keep people left. Warnings about cars
	AWARENESS / PROMOTION Advertisement of the area, why build such a beautiful area and not advertise it. Bring people to it. More advertising in papers, school tours etc - so the public knows about the park. Interactive booth for visitors to get info on facilities and maps. More promotion about the area More publicity on the established drainage/ecosystem - via local newspapers / community radio
MISCELLANEOUS More education in the city Awesome!! Concerned about concerts on Herrisson Island and the impact it has on the environment and wildlife. Enjoy as is Cutting down the bushes which are unwanted Keep it as natural as possible - no additional development. It is so refreshing to have a place in the middle of the city to spend quiet time. Flies What you have done is very good. Keep planning to make things better.	LOCATION OF BIKE HIRE Bike hire is in the wrong spot to attract visitors - too out of the way Bike parks PEDESTRIAN-BICYCLE INTERACTION Make sure bikes and pedestrians apart Lycra (professional) bike riders - a lot of their bikes are illegal and have no bells. They show huge disregard for other riders and pedestrians. Does not help that the pathways are too narrow. Separate cycle path

Leave it as it is Love it! Fine for me to exercise More flies? My first time here and I don't use the amenities but it looked like there were plenty. Nice None - I wish we had it in our country Not really - I really enjoy running down here. Perfect Put more fish in river : -) Seems perfect to me. Play equipment usually wet from reticulation. Could aim it away from playground or use drip retic. The spraying of weeds should be cordoned off and ? playground area should be ? Some other facilities Water is dirty Yes, I think that metal seating is crazy - too cold to sit on in cool weather and too hot to sit on in warm sunny weather. Otherwise, its lovely here. Make it a bit more attractive, special events, stalls, things that attract people - a bit isolated When Pt Fraser was redeveloped 8 or so years ago the car park was expanded at the expense of the park and trees. Get rid of the car park! What's here is fine, enjoyable. Keep it simple. No - other than to suggest that there should be more areas like this along the river, particularly those which provide by wildlife and.....? I would rather see this as a flora and fauna sanctuary with only slight encouragement for people beyond present faculties	BBQ FACILITIES More barbeques, free sunscreen and fly repellent More BBQ facilities, toilets More BBQ's please! - on Langley Park close to playground. Picnic tables Provide more BBQ facilities. Too far on the way now. EXERCISE EQUIPMENT Gym equipment (outdoor)

11.13 APPENDIX F – COUNTRY INTERNATIONAL RESPONDENTS FROM (%)

		Total
	Country of origin	2010
What country international respondents from (%)	Belgium	3
	Brazil	3
	Canada	7
	China	7
	Colombia	1
	Czech Republic	3
	Denmark	3
	Egypt	1
	France	1
	Germany	10
	Japan	5
	Korea	1
	Malaysia	3
	New Zealand	7
	Norway	1
	Russia	1
	Singapore	1
	South Africa	1
	Sweden	3
	Switzerland	4
	Taiwan	3
	UK	25
	USA	5

11.14 APPENDIX G - PERTH RESIDENT'S POSTCODE (%) – HIGHLIGHTS INDICATE PERCENTAGES HIGHER THAN 5

		May			October			Total
Postcode	**Suburb**	**Week-day**	**Week-end**	**Combined**	**Week-day**	**Week-end**	**Combined**	
6000	Perth	4.3	2.4	3.1	2.5	9.2	7	4.7
6004	East Perth	8.7	4.7	6.1	5.0	18.5	14	9.3
6005	Kings Park, West Perth	0	1.2	.8	2.5	1.5	2	1.3
6006	North Perth	0	1.2	.8	0	7.7	5	2.5
6007	Leederville, West Leederville	0	2.4	0	2.5	1.5	2	.8
6008	Daglish, Shenton Park, Subiaco	4.3	4.7	3.1	2.5	0	1	2.1
6009	Crawley, Dalkeith, Nedlands	0	3.5	3.1	0	0	0	1.7
6010	Claremont, Karrakatta, Mount Claremont, Swanbourne	0	1.2	0	2.5	0	1	.4
6011	Cottesloe, Peppermint Grove	0	1.2	0	5.0	0	2	.8
6012	Mosman Park	0	5.9	0	0	1.5	1	.4
6014	Floreat, Jolimont, Wembley	2.2	1.2	3.1	5.0	0	2	2.5
6016	Glendalough, Mount Hawthorn	0	1.2	.8	0	0	0	.4
6017	Herdsman, Osborne Park	0	1.2	.8	0	1.5	1	.8
6018	Churchlands, Doubleview, Gwelup, Innaloo, Karrinyup, Woodlands	2.2	2.4	4.6	2.5	3.1	3	3.8
6019	Scarborough, Wembley Downs	2.2	2.4	1.5	0	3.1	2	1.7
6022	Hamersley	0	2.4	.8	0	0	0	.4
6023	Duncraig	0	1.2	.8	0	0	0	.4
6024	Greenwood, Warwick	0	1.2	1.5	0	0	0	.8
6025	Craigie, Hillarys, Kallaroo, Padbury	0	4.7	0	2.5	0	1	.4
6026	Kingsley, Woodvale	4.3	2.4	3.1	0	0	0	1.7
6028	Burns Beach, Currambine,	0	1.2	0	2.5	0	1	.4

Postcode	Suburb	May			October			Total
		Week-day	Week-end	Combined	Week-day	Week-end	Combined	
	Iluka, Kinross							
6030	Clarkson, Merriwa, Mindarie, Quinns Rocks, Ridgewood, Tamala Park	0	1.2	1.5	0	0	0	.8
6050	Coolbinia, Menora, Mount Lawley	0	1.2	.8	2.5	1.5	2	1.3
6051	Maylands	0	2.4	0	2.5	1.5	2	.8
6052	Bedford, Inglewood	0	1.2	.8	0	1.5	1	.8
6053	Bayswater	2.2	3.5	.8	2.5	1.5	2	1.3
6055	Caversham, Guildford, Hazelmere, Henley Brook, South Guildford, West Swan	0	7.1	0	2.5	0	1	.4
6056	Baskerville, Bellevue, Boya, Greenmount, Helena Valley, Herne Hill, Jane Brook, Koongamia, Middle Swan, Midland, Midvale, Millendon, Red Hill, Stratton, Swan View, Viveash, Woodbridge	0	1.2	0	2.5	3.1	3	1.3
6057	High Wycombe, Maida Vale	0	4.7	3.1	0	1.5	1	2.1
6059	Dianella	2.2	3.5	2.3	5.0	1.5	3	2.5
6060	Joondanna, Tuart Hill, Yokine	2.2	1.2	1.5	2.5	1.5	2	1.7
6061	Balga, Mirrabooka, Nollamara, Westminster	0	1.2	.8	0	0	0	.4
6062	Embleton, Morley, Noranda	0	1.2	0	0	3.1	2	.8
6063	Beechboro	0	1.2	.8	0	0	0	.4
6064	Alexander Heights, Girrawheen, Koondoola, Marangaroo	2.2	10.6	.8	0	0	0	.4
6065	Ashby, Darch, Gnangara, Hocking, Jandabup, Landsdale, Lexia, Madeley, Mariginiup, Melaleuca, Pearsall,	0	1.2	1.5	2.5	0	1	1.3

Postcode	Suburb	May			October			Total
		Week-day	Week-end	Combined	Week-day	Week-end	Combined	
	Pinjar, Sinagra, Tapping, Wangara, Wanneroo							
6066	Ballajura	0	4.7	0	0	1.5	1	.4
6070	Darlington	0	3.5	0	0	1.5	1	.4
6071	Glen Forrest, Hovea	0	0	.8	0	1.5	1	.8
6072	Mahogany Creek	0	0	0	0	1.5	1	.4
6076	Bickley, Carmel, Gooseberry Hill, Hacketts Gully, Kalamunda, Lesmurdie, Paulls Valley, Pickering Brook, Piesse Brook, Reservoir, Walliston		0	2.3	2.5	0	1	1.7
6100	Burswood, Lathlain, Victoria Park	4.3	0	6.1	7.5	4.6	6	5.9
6101	Carlisle, East Victoria Park	0	0	.8	0	1.5	1	.8
6102	Bentley, St James	0	0	0	0	1.5	1	.4
6103	Rivervale	2.2	0	.8	2.5	0	1	.8
6104	Ascot, Belmont, Redcliffe	0	0	3.1	0	0	0	1.7
6107	Beckenham, Cannington, Kenwick, Queens Park, Wattle Grove, Wilson	2.2	0	3.1	0	0	0	1.7
6108	Thornlie	2.2	0	.8	0	0	0	.4
6109	Maddington, Orange Grove	0	0	0	2.5	0	1	.4
6110	Gosnells, Huntingdale, Martin, South River	0	0	.8	0	0	0	.4
6111	Ashendon, Canning Mills, Champion Lakes, Karragullen, Kelmscott, Lesley, Roleystone, Westfield	2.2	0	.8	2.5	0	1	.8
6123	Mundijong, Whitby	0	0	0	2.5	0	1	.4
6147	Langford, Lynwood, Parkwood	4.3	0	1.5	2.5	1.5	2	1.7
6148	Ferndale, Riverton, Rossmoyne, Shelley	6.5	0	3.1	0	3.1	2	2.5
6149	Bull Creek, Leeming	4.3	0	2.3	0	0	0	1.3
6150	Bateman, Murdoch,	0	0	.8	0	0	0	.4

Postcode	Suburb	May			October			Total
		Week-day	Week-end	Combined	Week-day	Week-end	Combined	
	Winthrop							
6151	Kensington, South Perth	6.5	0	9.2	5	9.2	8	8.5
6152	Como, Karawara, Manning, Salter Point, Waterford	10.9	0	3.9	2.5	1.5	2	2.9
6153	Applecross, Ardross, Brentwood, Mount Pleasant	2.2	0	.8	0	1.5	1	.8
6154	Alfred Cove, Booragoon, Myaree	0	0	.8	0	0	0	.4
6155	Canning Vale, Willetton	2.2	0	.8	2.5	3.1	3	1.7
6156	Attadale, Melville, Willagee	4.3	0	1.5	0	0	0	.8
6157	Bicton, Palmyra	0	0	3.1	0	1.5	1	2.1
6162	Beaconsfield, South Fremantle, White Gum Valley	2.2	0	.8	2.5	0	1	.8
6163	Bibra Lake, Coolbellup, Hamilton Hill, Hilton, Kardinya, North Coogee, North Lake, O Connor, Samson, Spearwood	6.5	0	2.3	2.5	0	1	1.7
6166	Coogee, Henderson, Munster, Wattleup	0	0	0	2.5	0	1	.4
6168	Cooloongup, East Rockingham, Garden Island, Hillman, Peron, Rockingham	0	0	2.3	0	0	0	1.3

11.15 APPENDIX H – OTHER ACTIVITIES RESPONDENTS DID AT POINT FRASER

Riding own bike around the river
Bird watching
Fishing
Exercising and jogging
Visiting Heirisson Island
Heirisson Island visiting the kangaroos
Looking for kangaroos
Kayaking
Lunch, relax, meditate
Parking
Passing time
Quiet
Rollerblading
Scouts
Walking
Wheelchair
Working

11.16 APPENDIX I – POINT FRASER PHOTO GALLERY – SOCIAL MONITORING

PARK ENTRANCES

SMC1 – West Entrance

SMC1 – West Entrance: Surveyor conducting counts

SMC2 – East Entrance: Bridge underpass entry

SMC2 – East Entrance: Overpass entry

SMC2 – Conducting visitor surveys

SMC2 – Conducting visitor counts

SMC3 – Carpark entrance: Outside cycle path

SMC3 – Carpark signage

SMC3 – Commuters shortcutting to CBD

SMC3 – Commuters crossing road to CBD

SMC3 – Informal tracks / Shortcuts

SMC3 – Hidden roadside sign for carpark entry

USER ACTIVITIES

Running / Exercising

Cycling

Quad-bike riding (using hire equipment)

Enjoying scenery

FACILITIES

Toilets

Lookout

BBQ – note lack of table, seating or shade

BBQ – note bin and drink fountain

Sculpture

Sculpture also usable as seating

SEATING

Example of seating – not amenable for a family picnic or barbeque

Example of seating – artistic but impractical and uncomfortable

PLAYGROUND

View towards playground and Kiosk (not operational)

Playground equipment

Playground equipment

Playground equipment – Wheelchair accessible swing

ABOUT BIKE HIRE

Hire store - closed

Hire store with equipment

SURVEY POINTS

Surveyor conducting counts at SMC1

Surveyor conducting counts at SMC2

SIGNAGE

Out of date sign highlighting the development of a café / restaurant commencing in 2008 or 2009

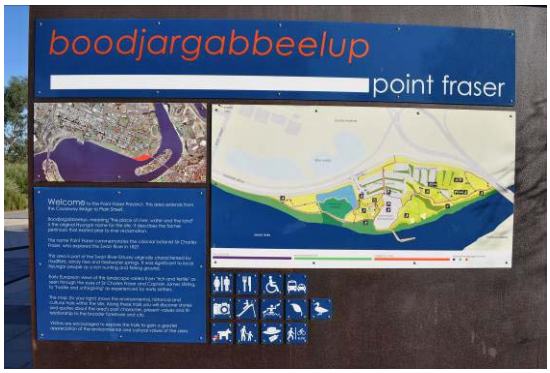
Pay display carpark sign

Directional sign

Directional sign along outside bikepath – very small print and lots of writing

Educational sign

Educational sign



Information sign

Instructional sign

Entrance statement – welcome sign near SMC3

Information and instructional sign near SMC2

Carpark entrance sign along road – obstructed by shrubs

Lack of signage? – Driver got confused in the carpark area how to get to About Bike Hire and attempted access via the boardwalk from the carkpark

VANDALISM

Damaged lawn from vandals conducting donuts with cars

Tire marks in carpark from vandals conducting donuts and burnouts with cars

11.17 APPENDIX J – WHY OR WHY NOT REPEAT VISITATION

A good walking circuit from South Perth
A little haven near the city
A place with good scenery
Accessible, clean, facilities
Accessible. Beautiful. Water and greenery. Access to inner city. Work out stations are great!
Always walk home
Beautiful
Beautiful park and gardens. Good bike track
Beautiful place
Because I'm from Russia
Because it is a lovely, clean and beautiful place
Because we walk around the bridges - walk every Saturday
Bike ride and for BBQ and playground
Bike ride, work BBQ, relax
Bike riding with friends
Calming
Clean fresh healthy way to enjoy a quality walk
Close to home, enjoy the walk
Close to home, nice park - good to exercise kids
Close to home, wheelchair accessible long path
Close to hotel, great view
Close to public transport. Safe. Nice view (except those annoying fences). Staff at about Bike Hire need to be more friendly.
Cycle (?)
Cycle path
Cycling through
Daily parking
Didn't really know it was here. But will come back and spend more time here rather than just a ride past
Do bridge to bridge 10 km loop Saturdays and Sundays
Easy access - part of a circuit. Off the road.
Easy access away from traffic
Easy access through the city, nice and quiet
Easy access, attractive, exercise
Enjoy
Enjoy the walk through - pleasant to view
Exercise
Exercise. Good to see new sites even though I have lived in Perth 40 years - not been this way.
First visit in 10 years. Very pleasant.
Fishing
For exercise
For exercising
For work to take clients for exercise
From USA, would love to visit again
Fun
Good area to walk through

Good atmosphere/ convenient location
Good exercise and relaxation
Good place to hang out, beautiful place
Good walking course
Good walking distance from East Perth and pleasant environment
Great outdoor area in Perth
Great walks
I am full of praise for overall management of these parklands. I do my bit to keep them that way especially picking up any broken bottles.
I am visiting Perth from South Africa
I can feel relaxed
I enjoy the ride to Burswood bridge/ Narrows
I like beautiful nature. Here is beautiful!
I like this beautiful and calmness
I like to go for a walk in such nice scenery
I live 12000 miles away in England. I have so many other places to visit in Australia and the world
I love it and commend whoever is responsible for environmental (?)
I love Pt Fraser - it is not well known
I love the 'bushland' experience
I really like the beauty of the place. The scenery is amazing
I will keep bringing clients here but we really need proper toilet facilities for the disabled - shaded seating would also be great
if more facilities would stay longer
It is a lovely setting for exercise
It is on my weekly walks
It is very pleasant and well loved
It makes a good walk around
It's quite close by
Its ? place and close to my place
Its a lovely place
Its a nice environment with great cycle paths
Its a place for people to relax and exercise, and I can spend time with friends and walk
Its a very nice place and clean
Its convenient to visit and have a good time
Its fun
Its nice and enjoyable
Jog or bike around river 1 or 2 times per week
Leaving country shortly
Like to go around the river
Like to run along the river
Like to walk from South Perth around the bridges
Live close by
Love walking through and seeing the beauty of nature. You think you are on another world
Lovely
Lovely scenery, easy access, close to city, peaceful, fresh air!
Lovely scenic spot for walking
May be going to migrate somewhere else

Morning walk..(can't read)
Moving to Darwin
My daily run goes through Point Fraser
Near to the river giving fresh air. No traffic or signals to watch for. Able to walk peacefully
Near to where I'm staying - it's a nice area for running, just - ?
Need to spend more time
Nice and quiet
Nice and quiet away from traffic
Nice and quiet, lots of room for the children
Nice bike track and water proximity
Nice place
Nice place to exercise
Nice place to relax and enjoy a walk
Nice place, clean and hopefully safe for anybody
Nice run along river
Nice spot
Nice to relax after a busy day in the city. Easily accessible and beautiful scenery
Nice walk
Nice walk around bridges
Nice, quiet, peaceful place to exercise away from the city
On exercise paths
Parking
Parking only. Ive rented kayaks here but they are way too expensive.
Part of my walk
Part of the route I take
Pass through
Passing through
Passing through on walk around river, good toilet stop, scenic, clean
Passing time on walks
Plan to go kayaking
Plan to jog around here
Pleasant place to exercise.....? (cant read)
Pleasant, good cycle tracks, good coffee.
Regular walk
Regularly walk through this area
Relaxing
Rent a bike
Reside in Melbourne
Ride around the river
Run through and toilet
Scenery
Scenic and enjoyable walkway
Scenic to pass through, as opposed to traffic
Scenic, beautiful
Scenic, cleanliness, bike hire
Scouting, Air Race, proximity to it.
So relaxing
Something to do
Such a beautiful area (Perth in general)

This is my 'backyard'
Too far from dropping off from the bus stop have a distance
Very enjoyable
Very peaceful, quiet
Very scenic park - lovely walks
Visit at least twice a week, walk from work for lunch, exercise, relax. Its a great spot.
Walk around the river
Walking around river
Walking weekly with friends for exercise
Walking, bringing visitors, Australia Day
We are leaving Perth tomorrow but if we would have stayed longer we would come back
We come on average 3 times per week
We cycle past here most weekends and will use About Bike Hire for kayaking
We enjoy our walk along here every week
We very much enjoyed the adventure
Weekly exercise
Would definitely visit this area if I come back to visit Perth in the future. It's beautiful, very well kept and established.

11.18 APPENDIX K – VISITOR BEHAVIOUR OBSERVATIONS – LIST OF COMMENTS

Comments - Wed 19 May 2010:

7:30 am: people passing through are mainly commuters

8:30 am: running group came through

8:30 am: solely commuters and runners/ cyclists exercising

9:30 am: group of cyclists rode onto wetland boardwalk only to find that they had to return (doesn't go through)

9:30 am: very quiet

9:30 am: people don't seem to have known about what this area offers - positively surprised

11:30 am: people in car park taking photos of their flash sportscar

11:30 am: Information from About Bike Hire staff:

carpark - since fee increased from $5 to $9.20 usage has decreased substantially;
design and planting of carpark: contribute to almost daily break-ins;
striated crake animals are coming back that weren't seen before which is positive, but also huge rats;
no seating and benches near BBQ area and no shade, no elderly people, families don't use;
7 day a week parking fee - why?;
microbrewery supposed to be built by now, not there yet. Where are customers going to park;
parking: visibility obscured by trees, almost daily break in's;
level of use dropped substantially since carpark fee increased. Before people used to park and catch a bus into the city or have their bikes and ride ointo work. Even short term bays were always full. Set up bollards for bike shop but often don't put down;

11:30 am: (coca-cola) truck tried to access about bike hire via boardwalk

12:30 pm: mother with small child walking through reeds

1:30 pm: 3 people standing in conversation **(not in stats above)**

1:30 pm: 7 people watching tow truck (**not in stats above)**

1:30 pm: tow truck to remove coca cola truck arrived at 1:25pm

2:30 pm: coca cola truck (still) broken down near bike hire

2:30 pm: rangers, security etc are blocking main entrance to bike hire (dealing with truck). Very large tow truck is also blocking entry

3:30 pm: coca cola truck gone, had fallen through boardwalk

3:30 pm: no one around at all.

4:30 pm: no one around except for one lady walking home from work (didn't want to do a survey)

5:30 pm: bike hire closed

6:30 pm: powerwalkers

6:30 pm: no lights at both ends, lights on in centre (playground and toilets)

Comments - Sat 29 May 2010:
8:30 am: most people are passing through early on a Saturday morning. Many cyclists on the paths.
10:30 am: seats are metal and get hot in summer and cold in winter, tiles are glarey.
12:30 pm: it doesn't seem that people are using the facilities.
12:30 pm: no one seems to have come to point fraser to 'hang out'
12:30 pm: mostly people are exercising and passing through
12:30 pm: bike hire is slow as it is the slow season
12:30 pm: people use point fraser as a point to exercise, it is part of the circuit for most people.
2:30 pm: mostly professional cyclist cycling through
3:30 pm: lots of people walking their dogs.
3:30 pm: large groups of friends cycling through
3:30 pm: 6 young adults sitting on/using playground equipment (all filled out a survey)
3:30 pm: 2 people asleep on the grass(with pilllows and blankets)
5:30 pm: bike hire closed
5:30 pm: one skate border near bike hire
5:30 pm: two rollerbladers
5:30 pm : young couple still sleeping on the grass
6:30 pm: west is NOT lit
6:30 pm: east is NOT lit
6:30 pm: playground and toilet is lit
6:30 pm: nobody using the footpath on the main road either

Comments - Wed 27 October 2010:
7:30 am: one runner making her own trail through bush between walkway and river
7:30 am: kevin has noted boat users using makeshift gap in UBG to drag boat past bike hire building and up to carpark
10:30 am: One person waiting for friend **(not in stats above)**
10:30 am: people are not wanting to be stopped even if they are walking
11:30 am: one person roller blading **(not in stats above)**
1:30 pm: last survey said that he cuts through the garden near the entrance to avoid being run over by the cyclists.
3:30 pm: 3 people kyacking **(not in stats above)**
4:30 pm: cyclist rode straight across car park entrance, vehicle didn't stop and the two collided**.. COMMENTS NOT ABLE TO READ**… Lots of brake action
5:30 pm: ducks crossing path for the delight of greener grass (east end)

Comments - Sat 20 October 2010 (One comment per row):

7:30 am: people doing morning exercise either on their own or in pairs
7:30 am: a couple of rowers on the river
7:30 am: clear skies but wind fresh
8:30 am: rowers on river
8:30 am people exercising
8:30 am: one dog walking couple
9:30 am: more leisure activities: people just walking or enjoying the scenery (relaxing)
9:30 am: more leisure boats on river
10:30 am: leisure boats more actively on river
11:30 am: more families around
11:30 am: general leisure
12:30 pm: 2 people playing cricket in car park (**NOT in stats above)**
4:30 pm: 8 people loitering in carpark **(NOT in stats above)**
4:30 pm afternoon hoons in carpark (6 cars) at 5:10 pm
4:30 pm I person fishing (**NOT in stats above)**
5:30 pm: hoons in the carpark still doing burnouts