CITY of PERTH

Point Fraser Monitoring and Evaluation Program

2011 Report

By, Mark Lund, Michelle Newport, Eddie van Etten, Pascal Scherrer, and Rob Davis

Prepared for,

City of Perth

Mine Water and Environment Research Centre

Centre for Ecosystem Management

Report No. 2012-2

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 Associate Professor 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 Jessica Turner 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.

Associate Professor Mark Lund can be contacted at:

School of Natural Sciences
Edith Cowan University
270 Joondalup Drive
Joondalup WA 6027

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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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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.

This report covers monthly monitoring of water quality in the wetland from January to December 2011. 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 influx of saline Swan River water during high tides, and incoming slightly salty water from stormwater and Lake Vasto. The main loss of water from the wetland is evaporation which concentrates the salt up to undesirable levels. Salt levels are becoming problematic and might need active management to control (deliberate draining of the wetland).

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. This year reliable data on inflows and outflows was obtained for most of the year. This data will continue to improve in 2012 as most problems have been sorted.

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 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.

Approximately 8 kg of N and 1.3 kg of P were estimated to enter Point Fraser with approximately 3.8 kg of N and 0.2 kg of P exported to Zone 3. This represents a removal efficiency of 53% for N and 84% for P. Despite this high efficiency, Total N on a number of occasions exceeded the target concentrations for discharge. Removal of P appeared successful in preventing exceedances of the target values for discharge. Uptake of nutrients by the Supersorb Zeolite clays added to W1 and W2 appears to be a major pathway for nutrient removal.

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. Baumea articulata although increasing in area at the start of the year has suffered a large dieback later in the year, possibly due to increasing salinity. A total of 17.51 kg of P were stored in the plant biomass (living) in October up from 11.05 kg in 2010. Nitrogen increased in October in living biomass from 23.18 kg in 2010 to 27.9 kg in 2011. These increases appear to be linked to increases in biomass and high growth rates.

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).

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)

a)

b)

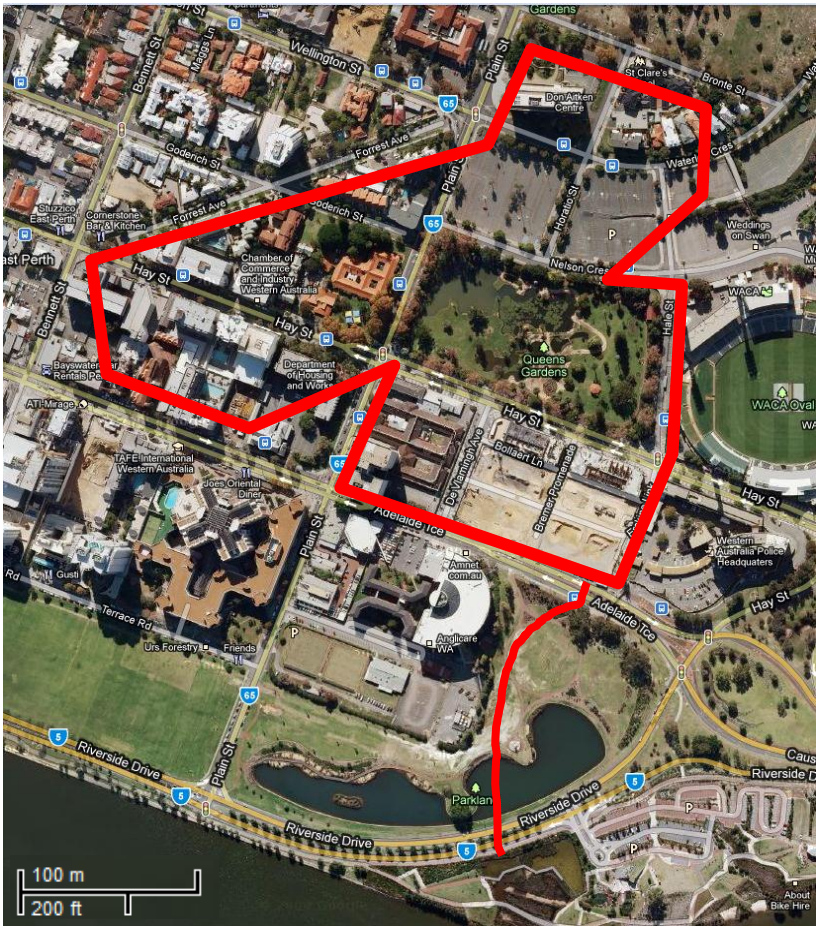


Figure 1. Aerial photographs of Point Fraser in a) 2000 and b) 2010 (showing catchment area for the wetland in red). Photographs taken from Google Earth, 2011.

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 second annual report of the PFMEP and covers the period January to December 2011.

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).

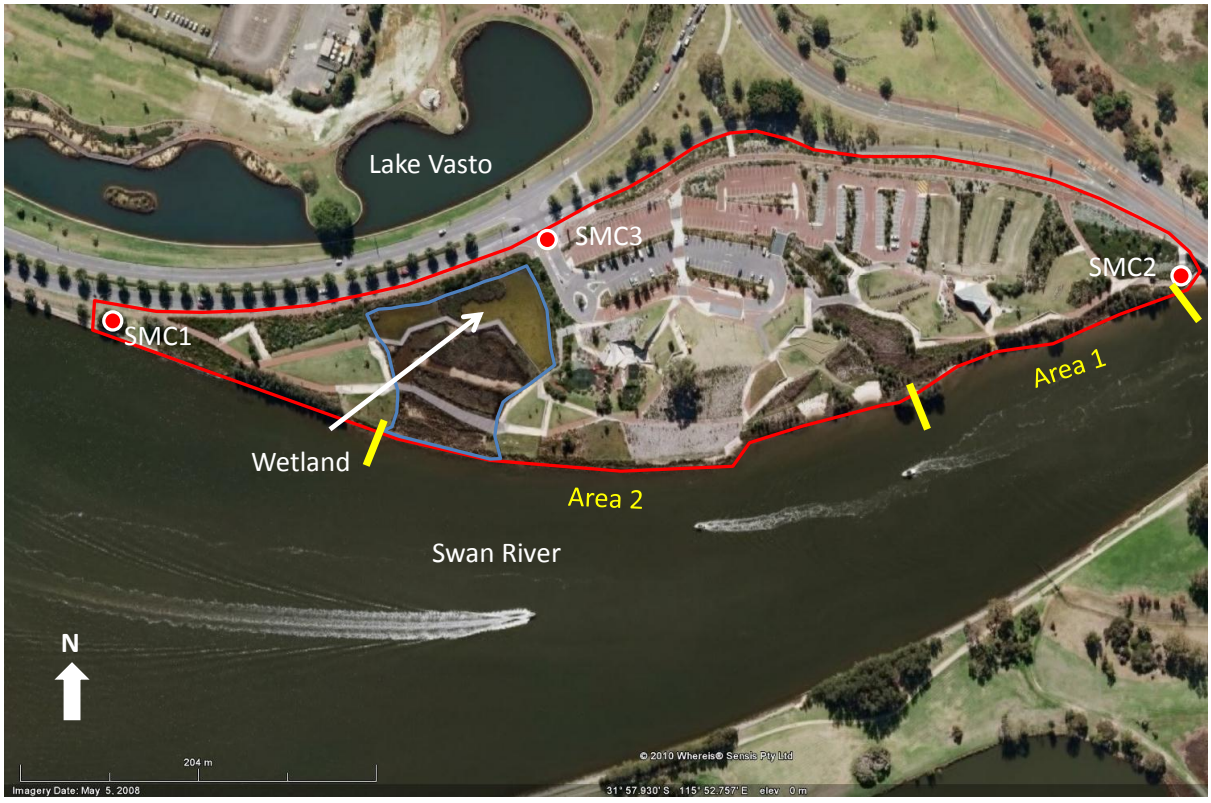


Figure 2. Aerial photograph of Point Fraser (bounded by the red line), showing the constructed wetland (bounded by the blue line), Lake Vasto, the social monitoring sites (red and white circles, SMC1-3) and the foreshore monitoring areas (yellow). Photograph adapted from Google Earth, 2010.

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).

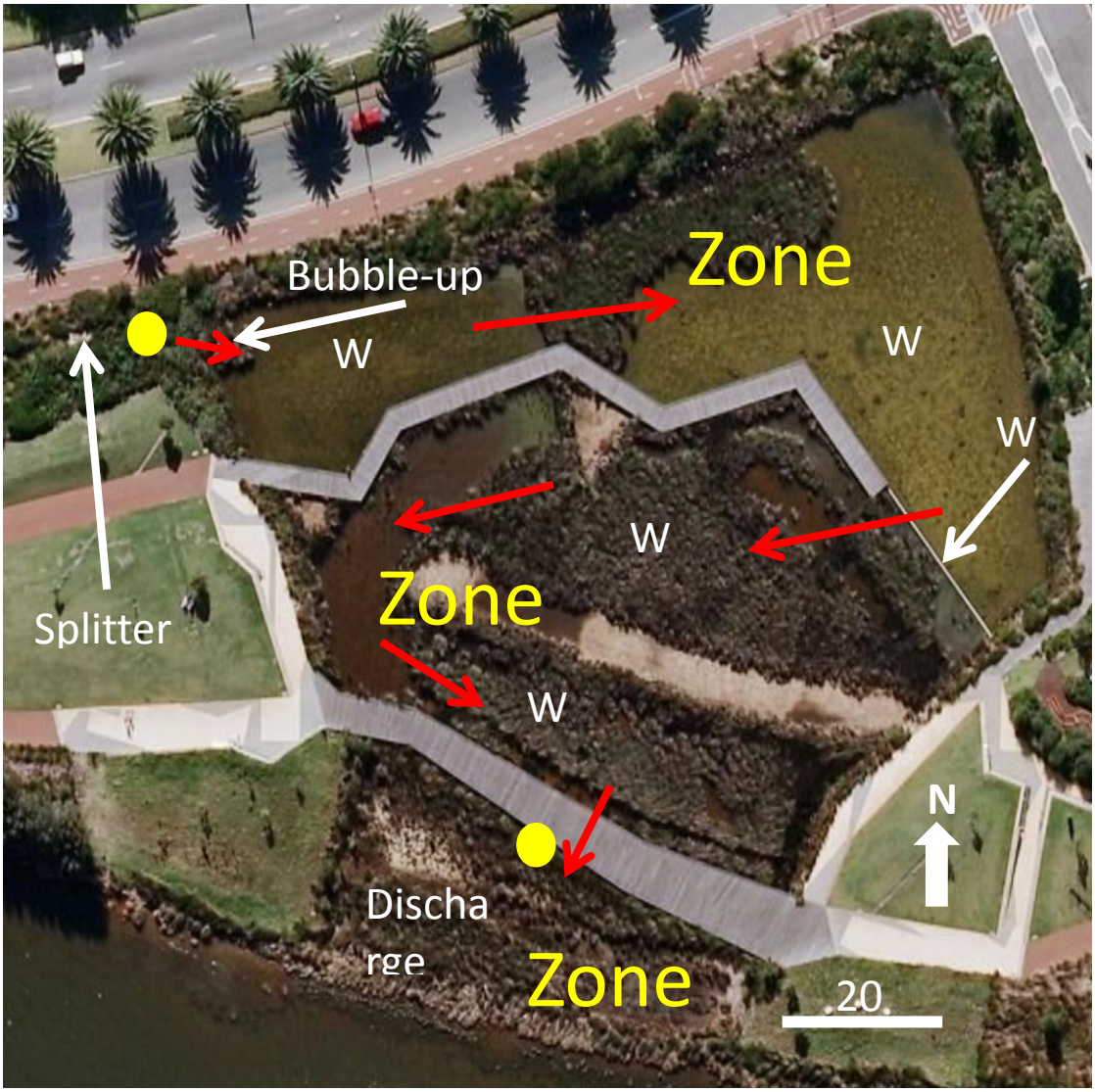


Figure 3. Aerial photograph showing the movement of water (red arrows) through the Point Fraser constructed wetland. Yellow circles mark the fixed inlet and outlet monitoring structures. Sampling sites are indicated as W1 to W4. Imagery adapted from Google Earth, 2010.

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, however this report covers the period January to December 2011.

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 were sent to SGS Australia Ltd for analysis. SGS Australia offers NATA accredited analyses and detailed QA/QC processes (except where noted). All samples were collected, stored and preserved as recommended by the company.

6.2.2 SEDIMENT QUALITY (WSQ)

In May 2011, 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 P, total organic carbon (TOC), total metals (Al, Fe, Mn, As, Cd, Cr, Cu, Hg, Pb, Ni, Zn), wet and

[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

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 ISCO Bubble Flow Module when water depth in the BUG reached a set limit. In addition an Acoustic Doppler Velocity meter (Unidata) was used to measure flows in the pipes linking the splitter box and BUG. In 2010, this was located at the splitter box end of the pipe but was relocated to the BUG end on 2/7/11; this was to improve flow measurements which had been problematic in 2010. 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 taken every hour whilst flows are occurring.

At the outlet to W4 (pipe), an ISCO 6712 Autosampler was installed, this was triggered by a ISCO Bubble Flow Module. The bubble flow tube was attached to 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.

Samples from the autosamplers were 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 2011, the wetland vegetation was mapped. Photographs are taken at fixed points (Table 1; Figure 5) to record vegetation health.

Table 1. The Site codes, Site names and Site Coordinated of WV Monitoring Photopoints (GPS co-ordinates use UTM Zone 50 with datum GDA94)

Site Code	Site Name	Easting	Northing	Notes
WV1	Wetland #1 - Weir b/n Zone 1 and 2	393898	6462962	4 photos: NE, SE, E and S directions
WV2	Wetland #2 – Zone 2 middle	393869	6462969	3 photos: E, S and N directions
WV3	Wetland #3 – Zone 2 west side	393832	6462961	2 photos: E and S directions
WV4	Wetland #4 – Mound in Zone 2	393900	6462937	3 photos: NW, W and SW directions
WV5	Wetland #5 – Zone 1	393917	6462988	2 photos: SW and W directions

Figure 5. Location of vegetation monitoring photopoints (WV1-WV5)

Three quadrats (200 mm x 200 mm) were randomly taken from each major plant species (*Baumea articulata*, *Eleocharis acuta, Juncus kraussii*) 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 composite biomass from each sample area (above and below ground) at 500 ^{o}C and then 1000 ^{o}C.

6.2.5 MACROINVERTEBRATES (MINVERT)

In May and October 2011 macroinvertebrate samples were collected from Zone 1 and Zone 2 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 2011, the third round of visitor surveys, visitor counts and visitor observations was undertaken. A fourth survey round in October 2011 included visitor counts and observations but no surveys as per agreement with COP, as issues of survey saturation were identified in round three. Social monitoring for each round was carried out 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 the datasheets were appended to the 2010 report.

Some minor adjustments to the visitor survey were made in round three as suggested in the 2010 report to improve data integrity and gain some additional data. A copy of the updated form is attached as an Appendix. Changes included:

- Rewording of Question 1 (Place of residence) to make it easier to respond and improve data quality;
- Minor wording changes, such as including ‘spouse’ in the option of ‘partner’ to read ‘spouse/partner’;
- Removing the option ‘passing through’ from question 9 to improve data quality and avoid duplication of collection;

- Separating ‘tables and chairs’ in Questions 10 and 11 into individual items of ‘tables’ and ‘chairs’ to be rated;
- Adding an *importance* rating to the existing *quality* rating of items in Question 10.

6.2.7 AVIFAUNA

In early June and early November 2011, a survey of all birds seen within the park or flying above it were recorded. Surveys were conducted in the early morning and were timed to avoid adverse weather conditions. During surveys, the entire area of parks and garden were surveyed by walking at a steady pace and recording all birds encountered by both call and sightings. Particular attention was paid to the wetland areas to ensure that cryptic species and water birds were recorded.

6.2.8 FORESHORE MONITORING

In May 2011, the foreshore of Point Fraser was monitored at 3 sites in each of the two areas shown in Figure 2. Photographs were taken at each site and condition assessed. The locations of the foreshore monitoring sites are shown in Figure 6.

Figure 6. Locations of the foreshore monitoring sites (F1A-C and F2A-C) (taken from Google Earth 2010)

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 slightly above average rainfall in 2011 reaching 860.8 mm rather than the 850 mm long-term average (Bureau of Meteorology, Mt Lawley station). In Figure 7, daily rainfall measured at Point Fraser and by the Bureau of Meteorology (Mt Lawley) is 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.

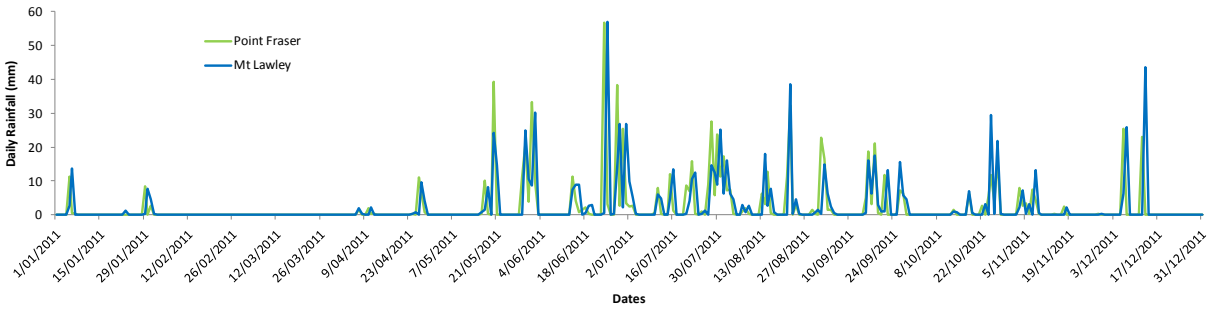


Figure 7. Daily rainfall measured at Point Fraser and Mt Lawley in 2011. Mt Lawley data from the Bureau of Meteorology and recorded 9 pm to 9 am, Point Fraser data recorded 12 am to 12 pm.

There were a number of intense rainfall events, with the largest of 56.8 mm (24/6/11), four >30 mm (20/5/11, 1/6/11, 28/6/11 and 22/8/11) with an additional 8 that were between 20

and 30 mm (30/5/11, 30/6/11, 28/7/11, 30/7/11, 1/9/11, 18/9/11, 6/12/11 and 12/12/11). During the July event water depth in Zone 1 exceeded the boardwalk wall allowing short cutting of flow into Zone 2 (Figure 8). Flow was observed (by ML) entering W1 on the 14/6/11 (flow <0.01 m s^{-1}), 28/6/11 (velocity 0.13 m s^{-1}) and 28/7/11 (velocity 0.25 m s^{-1}). However, backflows (as detailed in the 2010 report) were observed on 18/5/11, 21/5/11, 30/5/011, 16/6/11, 2/7/11 and 22/8.

The bypass in the splitter box was observed in action on the 28/7/11, at the time of the highest daily inflow of 1100 m^3. A similar flow was also recorded on 18/9/11, and was likely on 24/6/11 during the largest rainfall event (flows were not measured). This suggests that the bypass is working to protect the wetland from very large flows.

High tides in the Swan River resulted in flooding of Zone 3 to within 40 mm of the weir between it and Zone 3. Contrary to that reported in 2010, this tide was observed pushing river water through the outlet structure into Zone 2. Interestingly, water height in W4 was high and would have resulted in outflow. This may be the source of the high salt levels observed in Zone 2. 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 needs protection from flooding).

Recommendation 1.

Installation of a flap valve over the end of the outlet pipe is recommended to prevent saltwater intrusion into the wetland.

Recommendation 2.

Backflow from W1 into the drainage network remains the most important issue reducing the effectiveness of the wetland in treating stormwater. Anecdotal evidence from the COP also suggests that the entire design catchment is not connected to the wetland drain. As such this will increase the likely demand for top-up from Lake Vasto and means that wetland can not be tested as its design parameters.

a) W1 – note overtopping of weir

b) splitter box (showing bypass weir)

c) High tides in Zone 3

d) Wave action during a high tide on the foreshore

e) Outflow from W4

f) High tides resulting in inflows from the Swan River through the outlet into W4

Figure 8. Photographs of the Point Fraser wetland taken during 2011.

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

In the first half of the year the Starflow instrument was left in its 2010 position to test whether the apparently poor results from 2010 were simply due to the low rainfall. This was not the case and on the 2/7/11, the Starflow was relocated to the downstream end of the input pipe. This substantially improved performance of the instrument, however the nature of the instrument ensures that it will occasionally produce spurious results due to eddy currents or noise (Unidata *pers. comm*.). Where velocity measurements appeared out of context with surrounding data (recordings were taken every minute) or the water depth recorded by the Staflow, then the velocity was adjusted to be the average of the preceding and following reliable data. Although flows were detected on a number of occasions, the physical set up of the inlet pipes (see 2010 report), only flows where the depth in the BUG pit (as measured by the ISCO Bubble Flow meter) exceeded the lip of the BUG were considered to have entered W1. As the pipe was always full when the BUG was full (depth 0.56 m), flows were determined by simply multiplying the cross-sectional area of the full pipe with the velocity. Flows were then doubled to reflect that there were two parallel drains entering W1. Inflows were calculated across the year as shown in Table 2.

Table 2. Summary of inflow data collected and calculations made to estimate daily flows into Point Fraser in 2011.

Dates	Instrumentation	Comments
1/1/11 to 9/4/11	No ISCO or Starflow data	Between 24 and 28 April 2011 18.8 mm of rainfall (including 11 mm on one day) failed to produce depths in BUG that reached the lip. On this basis, it is reasonable to assume that the other significant rains of 11.2 mm (5/1/11) and 8.4 mm (29/1/11) would have been unlikely to generate flows into the wetland. It is believed that these rain events did not generate wetland inflows as the drainage network was dry and most of the runoff was used to effectively fill the network.
10/4/11 To 8/6/11	ISCO Data BUT no Starflow Data	An average velocity of 106.5 m s^{-1} was calculated for all the times where flow occurred between 23/7/11 and 30/12/11. This was used in conjunction with the ISCO data to estimate flows during this time.
9/6/11 to 2/7/11	No ISCO or Starflow Data	A technical fault in the ISCO Bubble Flow meter ensured that between 9/6/11 and 2/7/11 no data was collected. Flows cannot be calculated for this period. A total of 152.4 mm of rain fell during this time, with four significant events, a moderate fall in 14/6/11, the largest daily rainfall on 24/6/11 and two large events on the 28/6/11 and 30/6/11. These are all likely to have produced inflows into the wetland. An estimate of likely flows based on other similar events would suggest flows of 400, 1200, 800 and 800 m^3 respectively.
3/7/11 to 23/7/11	No ISCO but Starflow Data	The technical fault prevented collected of ISCO data, however the Starflow meter also measures depth. A close examination of the data suggested that depths of over 0.5 m (located at a different height to the ISCO) were associated with flows into the wetland. This information combined with the pattern of recorded velocities was used to determine when flows were likely.
24/7/11 TO 30/12/11	Both ISCO and Starflow Collecting data	A complete set of Starflow velocities (every 1 min) and ISCO BUG depths (every 15 min) were recorded for this time period.

Recommendation 3.

The unique design of the inlet structure means that a depth sensor in the BUG as well as the Starflow are required to accurately estimate inflows. It is recommended that a Unidata depth sensor be purchased by COP and coupled to the Neon Telemetry System.

The catchment (assuming it was 18.3 ha) received a total of 148,852.2 m^3 of rainwater. Typically for hard surfaces, a runoff coefficient of 0.6 would be conservative suggesting that at least 89,311.3 m^3 of rainfall from the catchment should have reached the splitter box.

A total of 8111 m^3 (measured) and an additional 3200 m^3 (estimated for 9/6/11 to 2/7/11) entered W1 through the BUG in 2011. This is substantially lower than the catchment runoff estimates would suggest is likely. This supports anecdotal comments from COP that the following re-development of the old bus depot that the drainage network was not reconnected to the full catchment. This is also further compounded by a leak identified in the drainage network that is allowing water to backflow out of the Point Fraser wetland.

The wetland is topped up by water pumped automatically from Lake Vasto (Ozone Reserve) when water levels drop to heights that might impact on the vegetation. The City of Perth records the inflows from the pumps and between May and October 2011 no water was pumped, with 1567 m^3 added throughout the rest of the year. This is substantially less than 6923 m^3 used in 2010 and reflects the improved rainfall in 2011.

In addition, the wetland received direct rainfall of 813.4 mm in 2011, which equates to 5764.6 m^3 (area is 7087 m^2). Total rainfall recorded at Point Fraser was 47.4 mm less than the Bureau of Meteorology official figures for Mt Lawley. This may reflect inaccuracies in the measurements at Point Fraser (tipping buckets, as used at Point Fraser can underestimate low rainfall events) or patchiness in rainfall over Perth.

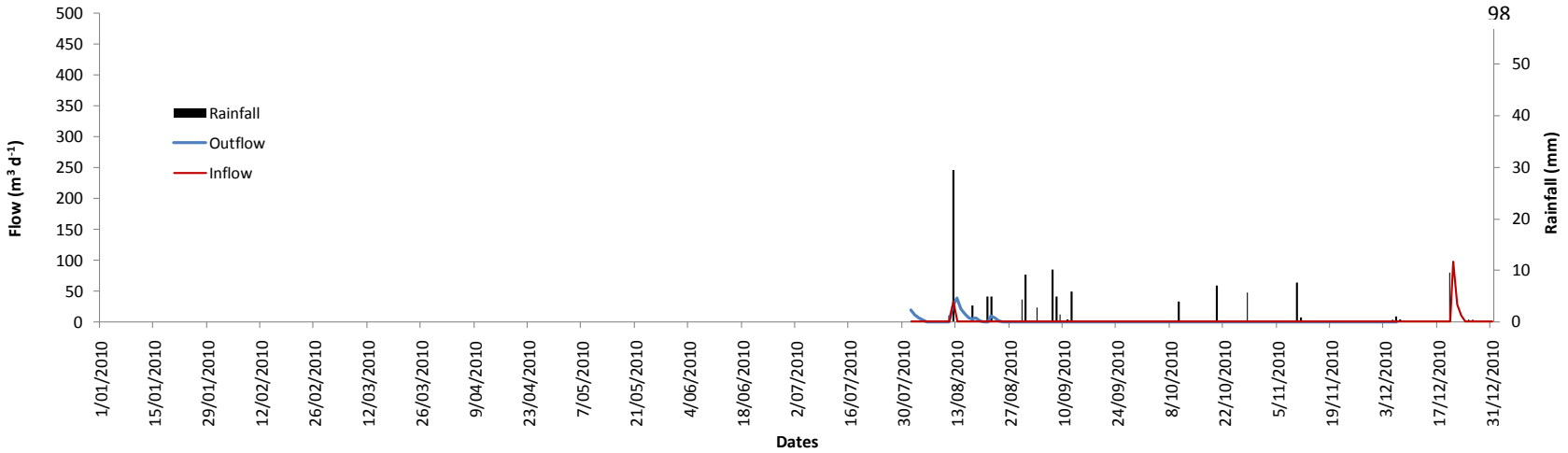
7.2.2 OUTFLOWS

ISCO Bubble Flow module data was available from 25/3/11 to 30/12/11. Close examination of the Unidata depth sensor suggests that in mid December 2010 the instrument developed a fault which saw it report slowly increasing depths. This finding suggests that the December 2010 outflows from the wetland were incorrect. It is probably reasonable based on the data collected in 2010 to assume that over the summer there were no outflows from the wetland, therefore the period between 1/1/11 and 24/3/11 is assumed to have no outflows.

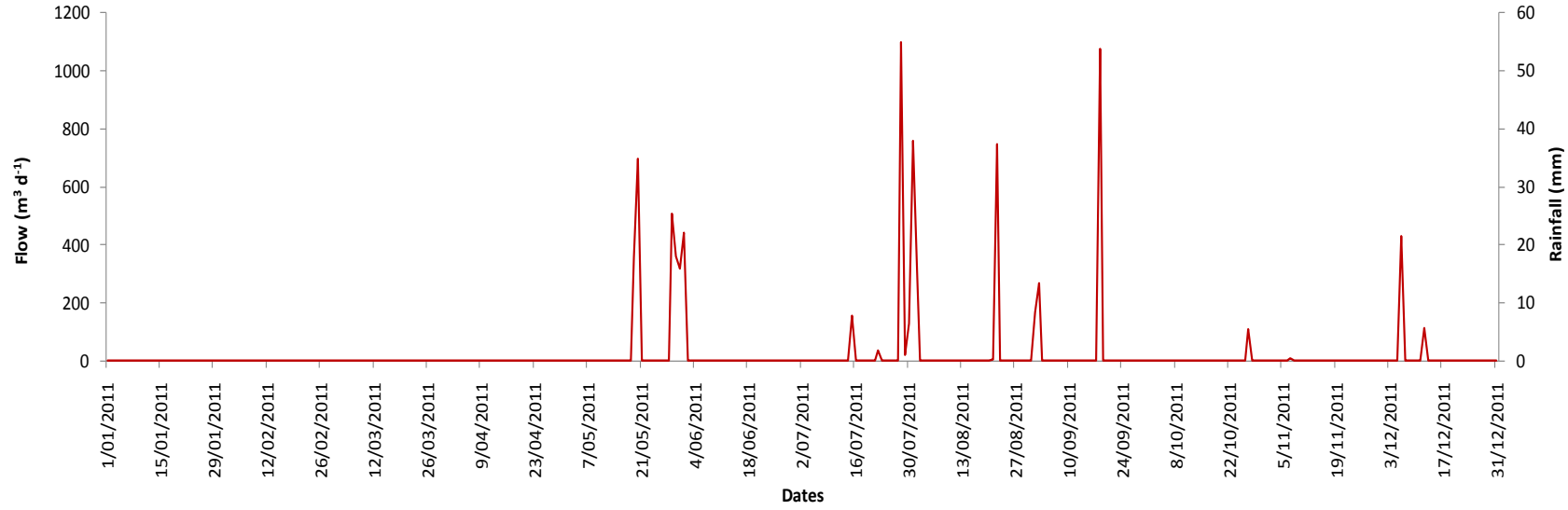
A rating curve was developed using a Marsh McBirney Flow meter, by measuring velocity at a range of depths. The velocity data were used with cross sectional areas to create flow rates at particular depths, these data were plotted and a polynomial function fitted. As more data are collected this curve will be further refined. The constants from this equation were used to calculate flows for all water heights greater than the outlet (115 mm). Depths greater than 195 mm were considered to have reached the maximum discharge rate (i.e. the pipe was full).

The total daily discharge in and out of the wetland and rainfall for 2010 (revised) and 2011 are shown in Figure 9. Total outflow in 2011 was 3551.2 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 1568.6 mm of evaporation which equates to a loss of 11,116.7 m^3 over 2011. Therefore the total outflow of 14,667.9 m^3 was substantially lower than the inflows (difference of 5405.4 m^3). It is assumed that allowing for errors in the estimates that the difference can be accounted for by the backflow into the drainage network.

a) 2010 Rainfall, inflows and outflows



b) 2011 Inflows



c) 2011 Rainfall and outflows

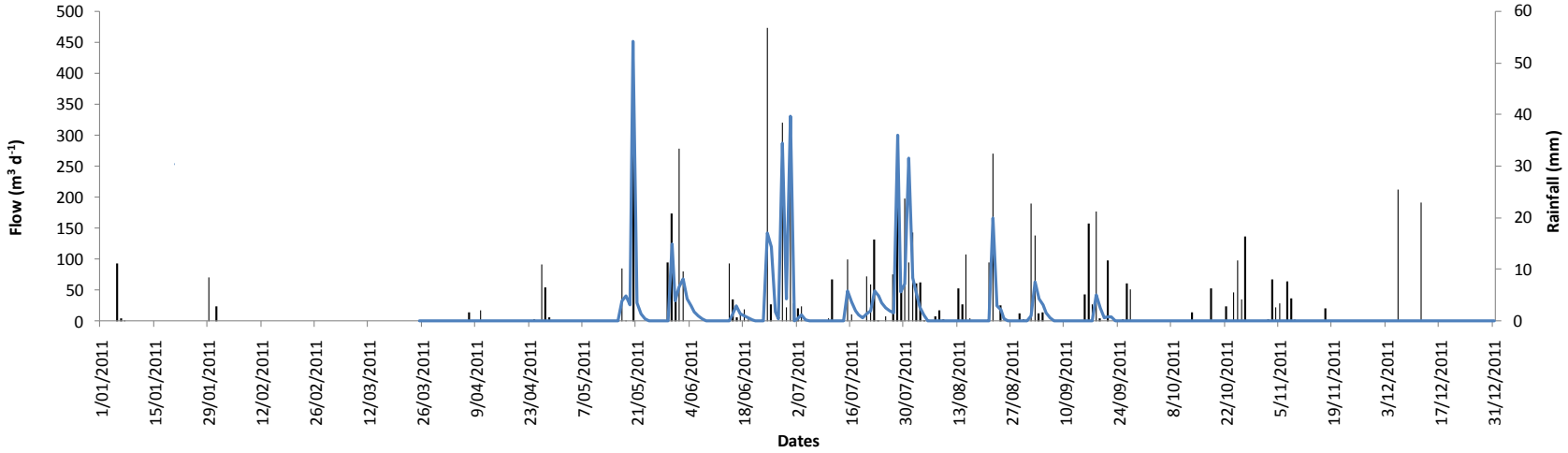
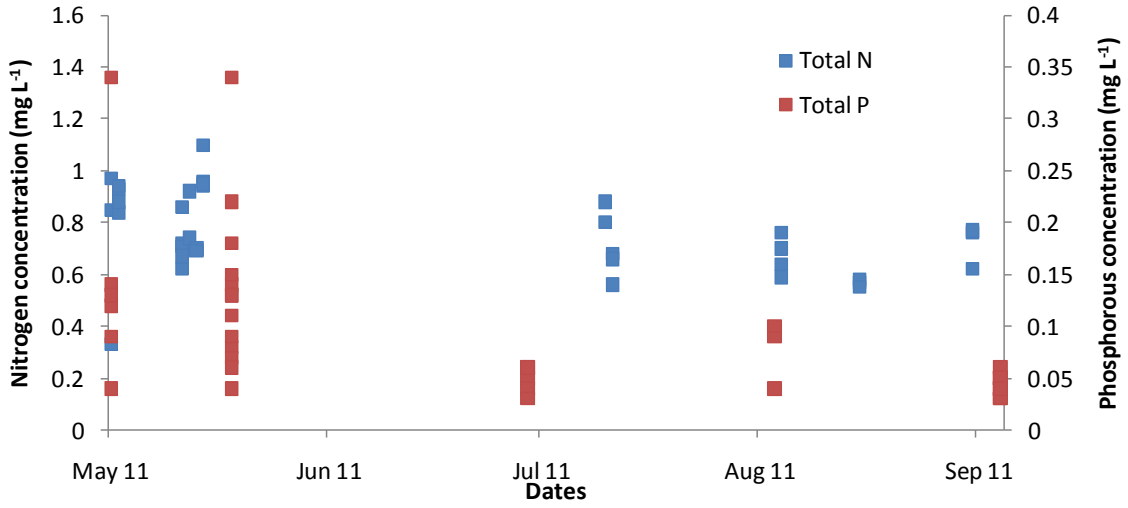


Figure 9. Daily totals for a) 2010 rainfall, inflows and outflows (revised figures), b) 2011 inflows and c) 2011 rainfall and outflow, for the Point Fraser wetland.

7.2.3 QUANTIFICATION OF NUTRIENT LOADS

Samples were collected during storm events for both the inlet and outlet. Inlet samples were taken at hourly intervals and the outlet at daily intervals reflecting the time that flow was present and the likely changes. Concentrations of total N were generally higher in the outlet than inlet (mean of 1.07±0.05 mg L^{-1} compared to 0.75±0.03 mg L^{-1}), but total P showed the opposite trend (outlet: 0.05±0.01 mg L^{-1}; inlet: 0.10±0.01 mg L^{-1}). The first flush is a theory which suggests that the first heavy rain following a period of dry weather will effectively wash the catchment and so the stormwater will initially contain high concentrations of mainly particulate material, which decreases as the storm event progresses. Although this makes intuitive sense, there is little evidence to support it (see Hall, 2006; Khwanboonbumpen, 2006). Analysing the storm events entering Point Fraser particularly for total P, it can be seen in Figure 10 that on the two main May events, there is a considerable range of reported total P values ranging from 0.04 – 0.34 mg L^{-1} (19 – 20/5/11 over 12 h) and 0.08 – 0.34 mg L^{-1} (29 – 30/5/11 over 9 h). There was no consistent pattern as to when during the storm event that high or low concentrations occurred. All later events did showed lower total P concentrations (peaking at only 0.13 mg L^{-1}). Total N concentrations during storm events were much more consistent across the event than seen for total P; a slight decline in total N was seen across events over the year.

a) Inlet



b) Outlet

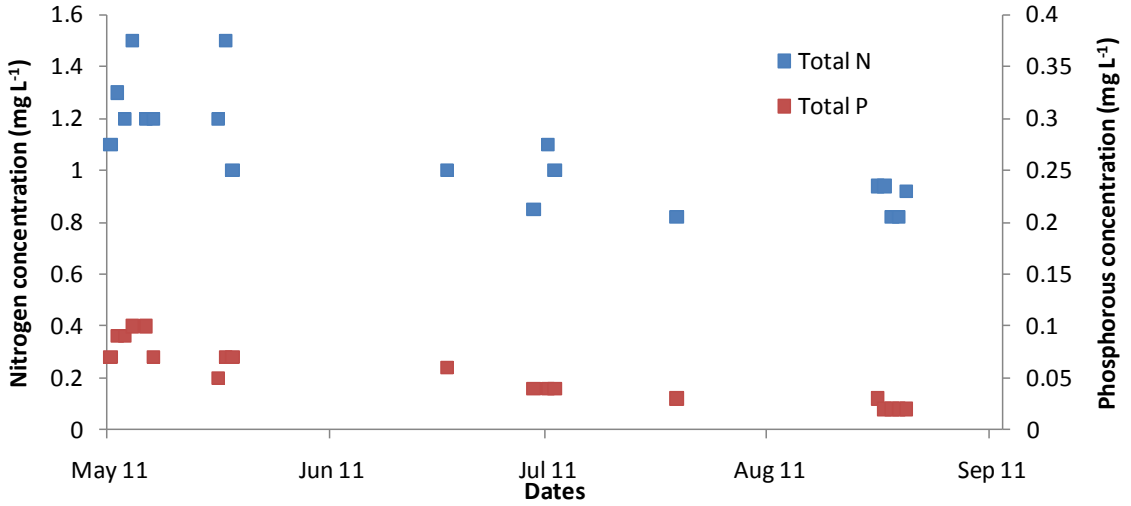


Figure 10. Concentrations of Total P and Total N recorded in the a) inlet and b) outlet autosamplers over 2011.

Loads of N and P entering and leaving Point Fraser were estimated by multiplying flows by the concentrations from the storm event sampling. It was assumed that concentrations remained unchanged between sampling events. Backflow was estimated as the difference between inflow and outflow. Lake Vasto loads were estimated from monthly samples taken from Lake Vasto (where available) multiplied by the monthly quantity of water pumped. Rainfall loads were estimated using nutrient concentrations in rainfall taken from Khwanboonbumpen (2006) for Bannister Creek. Approximately 8 kg of N and 1.3 kg of P were estimated to enter Point Fraser (with >90% of the load coming in via the drain). A small quantity of the load was lost via backflow out of the wetland. Approximately 3.8 kg of N and 0.2 kg of P were estimated to be exported to Zone 3, with potentially some further removal prior to reaching the Swan River. This represents a removal efficiency of 53% for N and 84% for P. Removal efficiency is very high for P and this is probably due to uptake by the Supersorb activated zeolite clay in W1 and W2. The wetland is not designed to specifically target N removal (no provision for subsurface flows or ponds with low ORP) other than through the use of Supersorb activated zeolite clay and plant uptake. While the Supersorb appears successful in reducing ammonia and NOx, total N in the form of particulate/organic N appears to increase through the system. This does not translate to large export loads as the volume of water leaving the wetland is small. Presumably this N is produced by plant biomass, the die-off of *Baumea articulata* may account for some of this material.

Table 3. Water and nutrient budget for the Point Fraser wetland, including removal efficiency for nutrients. Numbers in brackets are total inputs without losses due to backflow. + indicates estimated flows (9/6/11 – 2/7/11). Removal efficiency determined from total input (excluding backflow) and total output.

	Water (m^3)	N (g)	P (g)
Inflow	8,111 +3,200	5,989.0 +3,040.0	763.5 +416.0
Rainfall	5,764.6	1540.1	126.4
Top-up from Vasto	1,567.0	593.6	171.1
Backflow	-3,974.7	-3,060.5	-170.9
TOTAL INPUTS	14,667.9	8,102.2	1,306.1
	(18,642.6)	(11,162.7)	(1477.0)
Outflow	3,551.2	3773.1	307.6
Evaporation	11,116.7	NA	NA
TOTAL OUTPUTS	14,667.9	3773.1	207.6
Removal Efficiency		53%	84%

Total N concentrations should aim to be <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 in the outflow samples (12 out of 19 times) reaching a maximum value of 1500 µg L^{-1} on the 20/5/11. However, only 1 out of 37 values in the inlet exceeded the threshold for Total N reaching only 1100 µg L^{-1} on 1/6/11. Phosphorus concentrations in the wetland were generally below a target of <100 µg L^{-1} (Figure 12) 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). However on 20 and 22/5/11 total P in the outlet reached the upper limit of 100 µg L^{-1}. In comparison, there were 15 out of 37 exceedances of the target in the inflow for Total P, with the peak value reaching 340 µg L^{-1}.

7.2.4 CONCLUSIONS

1. Create a water budget for the wetland.

A water budget was created for 2011. Backflow out of wetland into the drainage network was estimated as 21% of the total inflows (including direct rainfall). A leak in the drainage network is believed responsible for the backflow (which accounts for 35% of stormwater inflows). Reductions in the catchment size (due to possible lack of reconnection of the network following the old bus depot redevelopment may reduce total flows to the wetland by over 80%.

2. Quantify nutrient loads in and out of the wetland

Approximately 8 kg of N and 1.3 kg of P were estimated to enter Point Fraser with approximately 3.8 kg of N and 0.2 kg of P exported to Zone 3. This represents a removal efficiency of 53% for N and 84% for P. Despite this efficiency, Total N on a number of occasions exceeded the target concentrations for discharge. Removal of P appeared successful in preventing exceedances of the target values for discharge.

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

Monthly data for common physico-chemical parameters are shown in Figure 11. Water temperatures were highest January to March and November and December at >25 oC. December and February were lower than the other peak times, which probably reflects air temperatures. As W3 was often the shallowest part of the wetland, it was also often slightly warmer than the other parts.

Lake Vasto is much less saline (2.13 ± 0.06 mS cm^{-1}) than the Point Fraser wetland during the months where it is used as top-up water. It therefore is useful in diluting the high salinities encountered in the wetland during the non-winter months (June to September). Water in

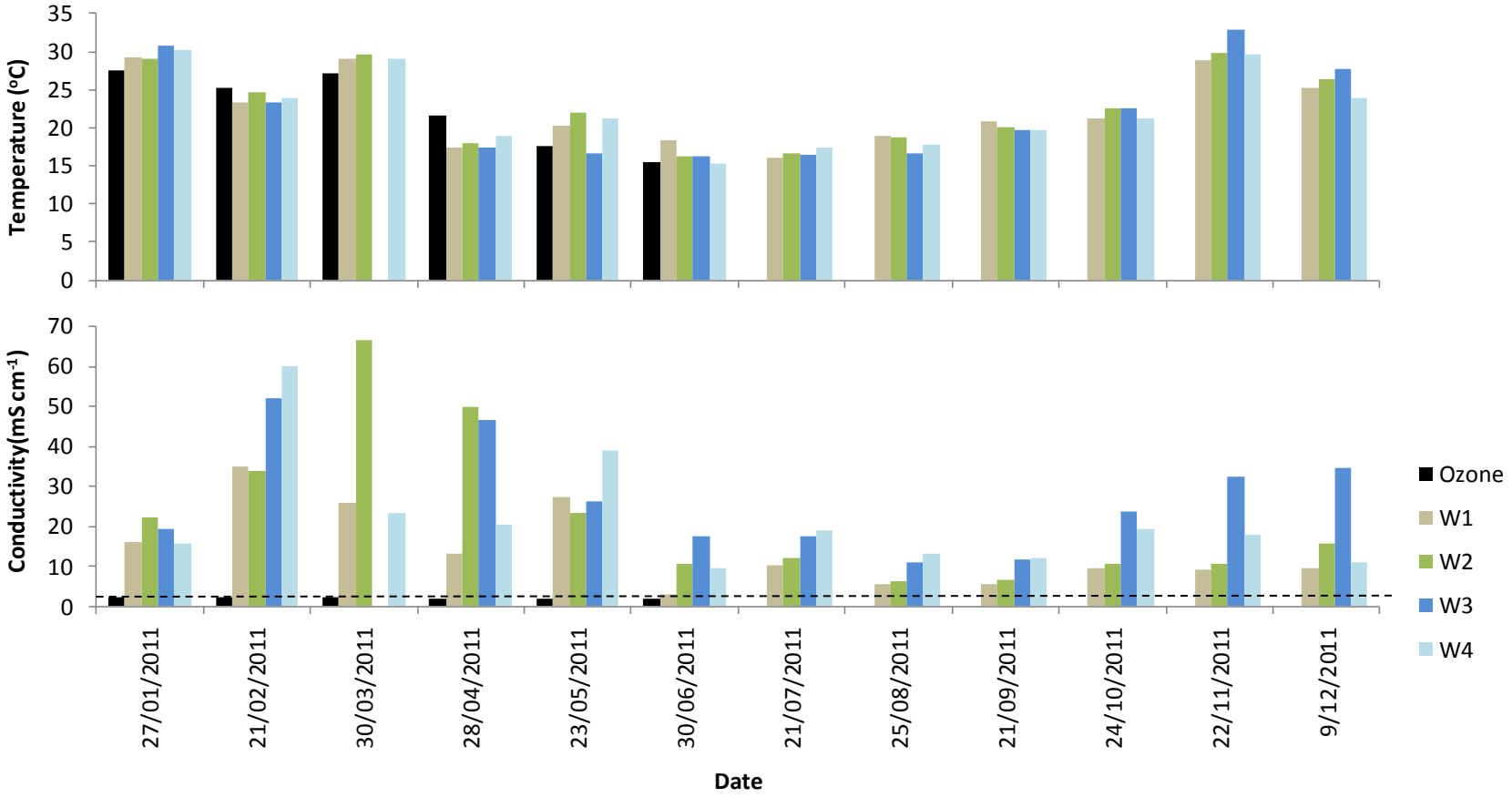
the inflow ranged in conductivity from 0.75 mS cm^{-1} (30/6/11) to 2.63 mS cm^{-1} (26/9/11) on the three occasions it was measured. The four ponds of the wetland all behave differently with respect to conductivity; this shows that despite obvious connections between W1 and W2, there is actually little movement from W2 back to W1. W1 had the lowest conductivities, although this was assisted by the inputs of water from Lake Vasto. Despite this, only from June to December were conductivities <12.5 mS cm^{-1}. W2 shows a similar pattern although in December conductivity exceeded 12.5 mS cm^{-1}. W2 conductivities peaked at 66.4 mS cm^{-1} in March 2011, which is saltier than seawater (54 mS cm^{-1}). The changes seen in conductivity appear consistent with evapo-concentration and low water depths. As in 2010, W3 had very high conductivities in summer when it dries to small pools. 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. Conductivities in Point Fraser were high enough throughout most of the year to stress plants particularly in Zone 2 and during the summer months in Zone 1 (see section7.5). Substantially higher conductivities were recorded in 2011 compared to 2010. This suggests that the wetland is not exporting enough salt to maintain concentrations. A possible explanation is that the outlet structure is responsible. The outlet is designed to take surface waters only and what may be happening is that the low salinity inflows are simply moving over the denser more saline water in the wetland exiting via the drain.

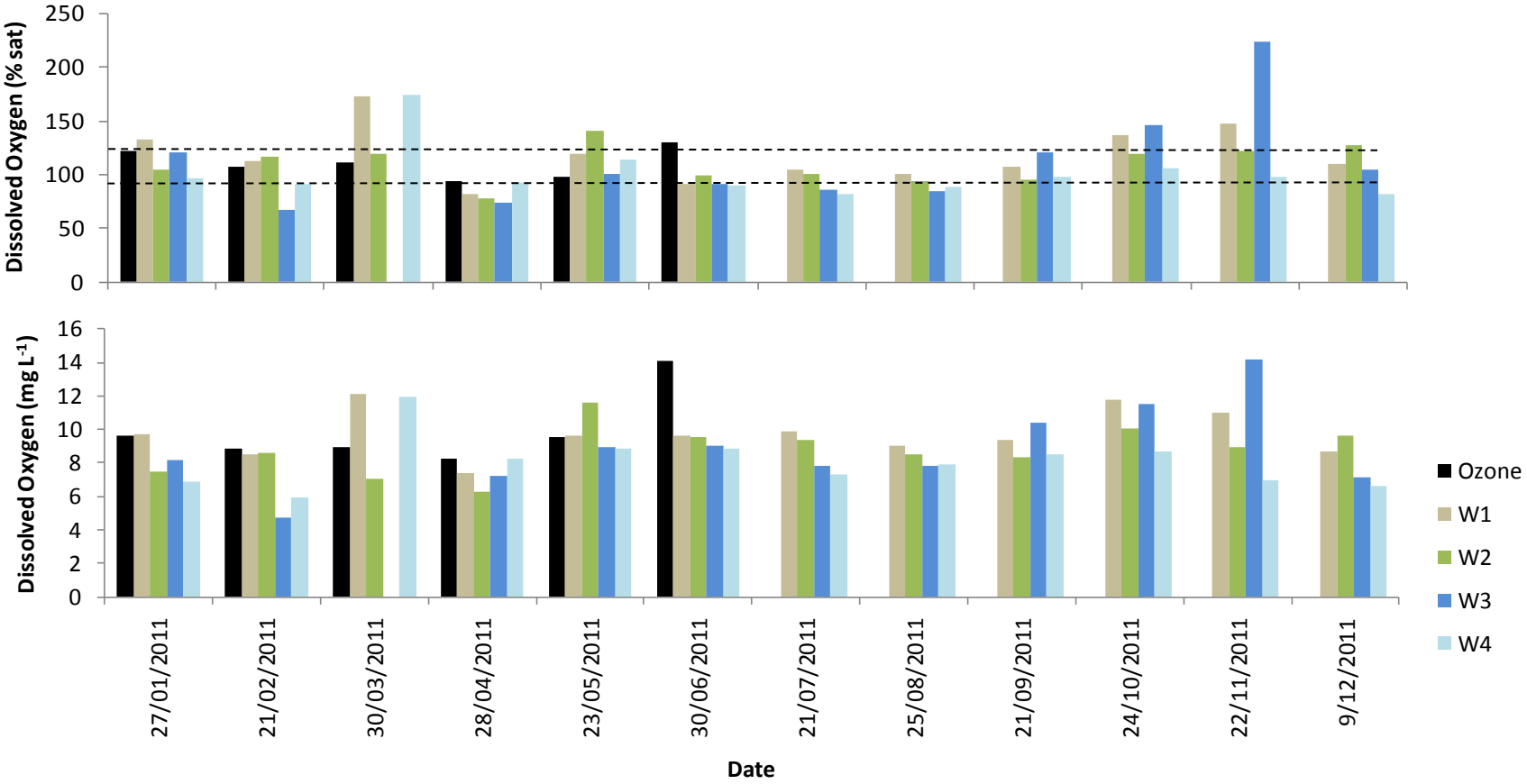
Recommendation 4.

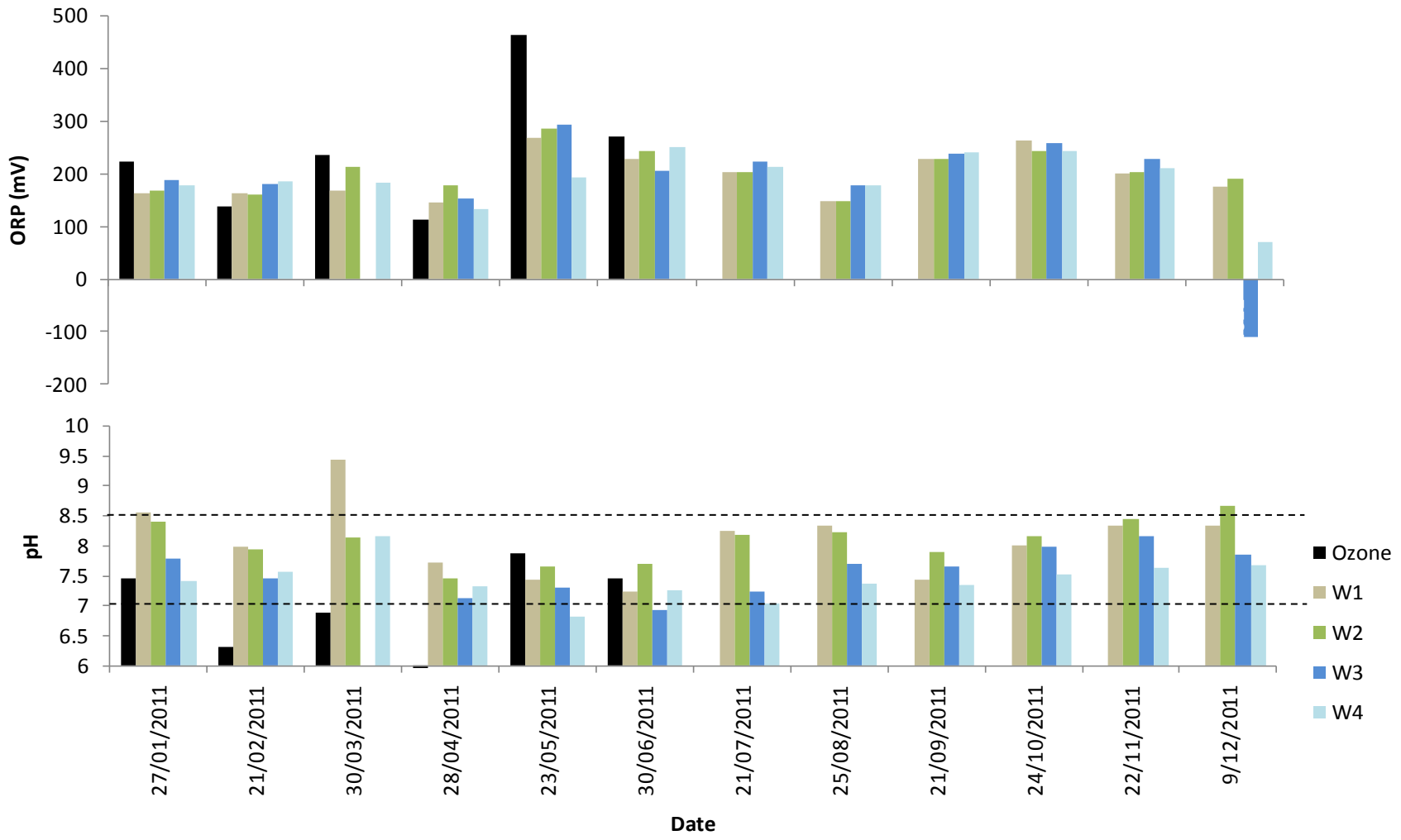
High salinities (>12.5 mS cm^{-1}) are becoming more frequent in the wetland and are most likely stressing the vegetation. It is recommended that the cause of the high salinities be investigated. This includes measuring chloride in inflows, outflows and at depth in the wetland. This can be achieved by adding chloride as a parameter in the monitoring program.

Dissolved oxygen concentrations were recorded in excess of 100% saturation, indicating high algal growth in the water (high rates of photosynthesis can temporarily raise % saturation above 100%). Dissolved oxygen concentrations also on a number of occasions dropped below ANZECC & ARMCANZ (2000) recommended guidelines for protection of aquatic systems but not significantly. This may indicate increasing biological oxygen demand from the sediments due to build up of organic material. At present, this is not a significant concern but if levels were to decline much more then it would need further investigation (Figure 11).

pH was always circum-neutral to slightly alkaline, with only a couple of times when values occurred outside recommended guideline levels. pH was marginally higher in Zone 1 compared to Zone 2, suggesting that algae in the open water of Zone 1 may account for the higher values. 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. Only in Zone 2 in December were ORP values <100 mV recorded. Turbidity was below ANZECC & ARMCANZ guideline levels, but was highest across the wetland in March. It appears that high turbidity is associated with low water levels as it was most common in W3. It is likely that the very shallow water depths allowed for sediment to be stirred up and measured as turbidity.


Temperature (°C)
35
30
25
20
15
10
5
0
Conductivity(mS cm-1)
70
60
50
40
30
20
10
0
Ozone
W1
W2
W3
W4
27/01/2011
21/02/2011
30/03/2011
28/04/2011
23/05/2011
30/06/2011
21/07/2011
25/08/2011
21/09/2011
24/10/2011
22/11/2011
9/12/2011
Date


Dissolved Oxygen (% sat)
250
200
150
100
50
0
Dissolved Oxygen (mg L-1)
16
14
12
10
8
6
4
2
0
27/01/2011
21/02/2011
30/03/2011
28/04/2011
23/05/2011
30/06/2011
21/07/2011
25/08/2011
21/09/2011
24/10/2011
22/11/2011
9/12/2011
Date
Ozone
W1
W2
W3
W4


ORP (mV)
500
400
300
200
100
0
-100
-200
pH
10
9.5
9
8.5
8
7.5
7
6.5
6
27/01/2011
21/02/2011
30/03/2011
28/04/2011
23/05/2011
30/06/2011
21/07/2011
25/08/2011
21/09/2011
24/10/2011
22/11/2011
9/12/2011
Date
Ozone
W1
W2
W3
W4

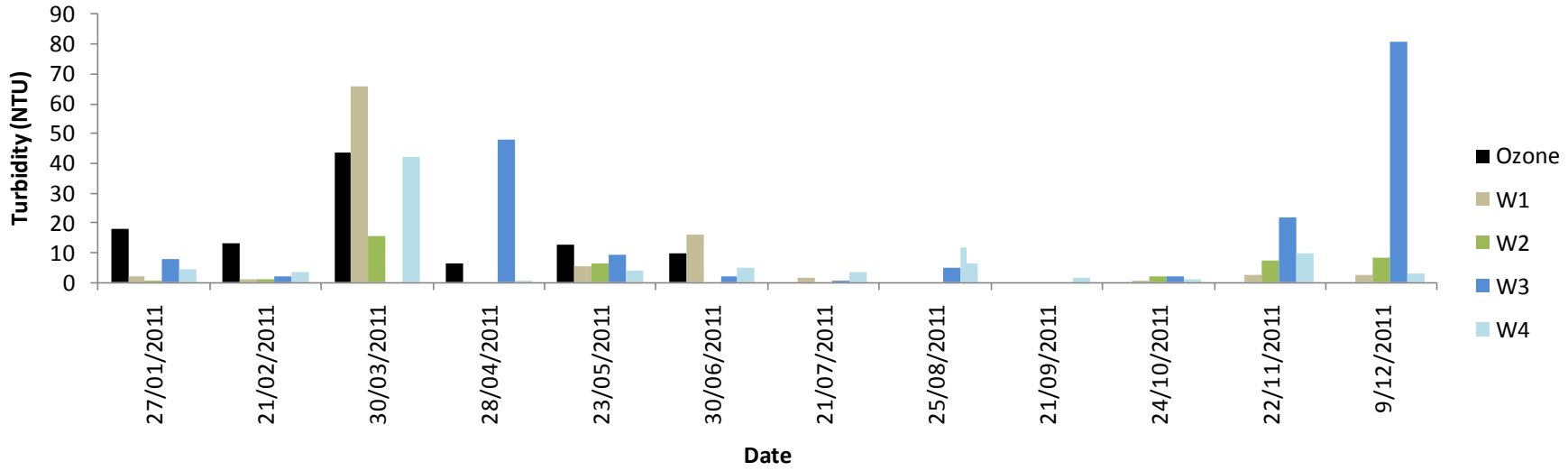
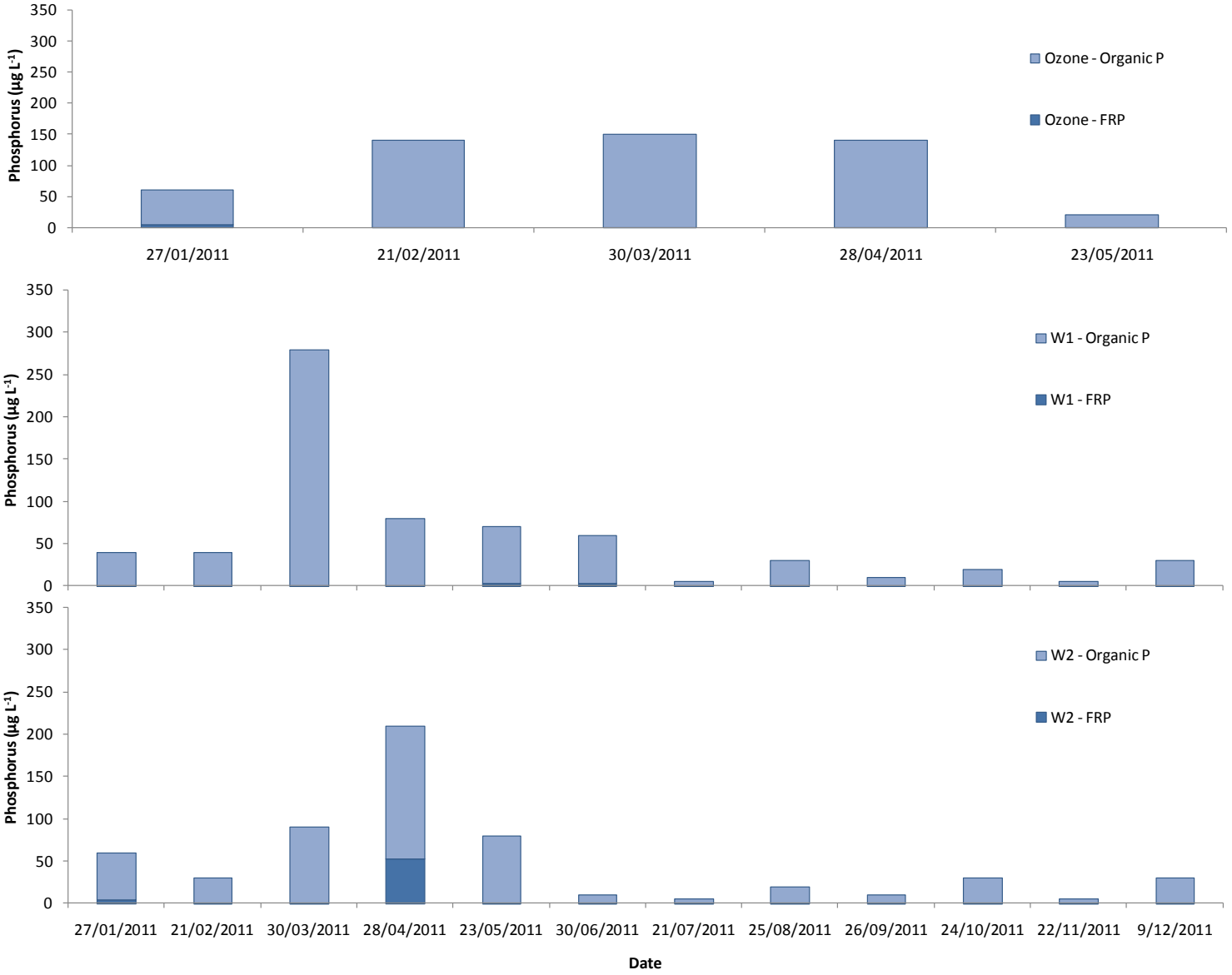


Figure 11. Physico-chemical parameters measured monthly at Point Fraser sites (W1-W4 and Lake Vasto (Ozone). Dotted lines show relevant ANZECC & ARMCANZ (2000) guideline levels (see Table 3 for details).

Phosphorus concentrations generally increased across the wetland as total P and were highest in summer and spring. Evapoconcentration during this period probably accounts for the high P concentrations. Concentrations at these times often exceeded the targets of <100 µg L^{-1} (Figure 12) 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). This appears to contradict the findings of the nutrient budget which showed that P was greatly reduced from inlet to outlet. However, at times of outflow, concentrations in W4 were all below the target level. FRP concentrations were all below detection at <10 µg L^{-1} except for a recording of 53 µg L^{-1} in W2 in April. The organic P (could also be particulate bound) accounted for the majority of the P measured. Settling of the P bound particulates appears to have occurred between W1 and W2. Lake Vasto had high total P concentrations of 60-150 µg L^{-1}, but very low FRP at <3 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. Iron binds P, hence this explains the low available P (FRP) and the high particulate P. Topping up the wetland with Lake Vasto water, 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.


Phosphorus (µg L-1)
350
300
250
200
150
100
50
0
Ozone - Organic P
Ozone - FRP
27/01/2011
21/02/2011
30/03/2011
28/04/2011
23/05/2011
W1 - Organic P
W1 - FRP
W2 - Organic P
W2 - FRP
30/06/2011
21/07/2011
25/08/2011
26/09/2011
24/10/2011
22/11/2011
9/12/2011
Date

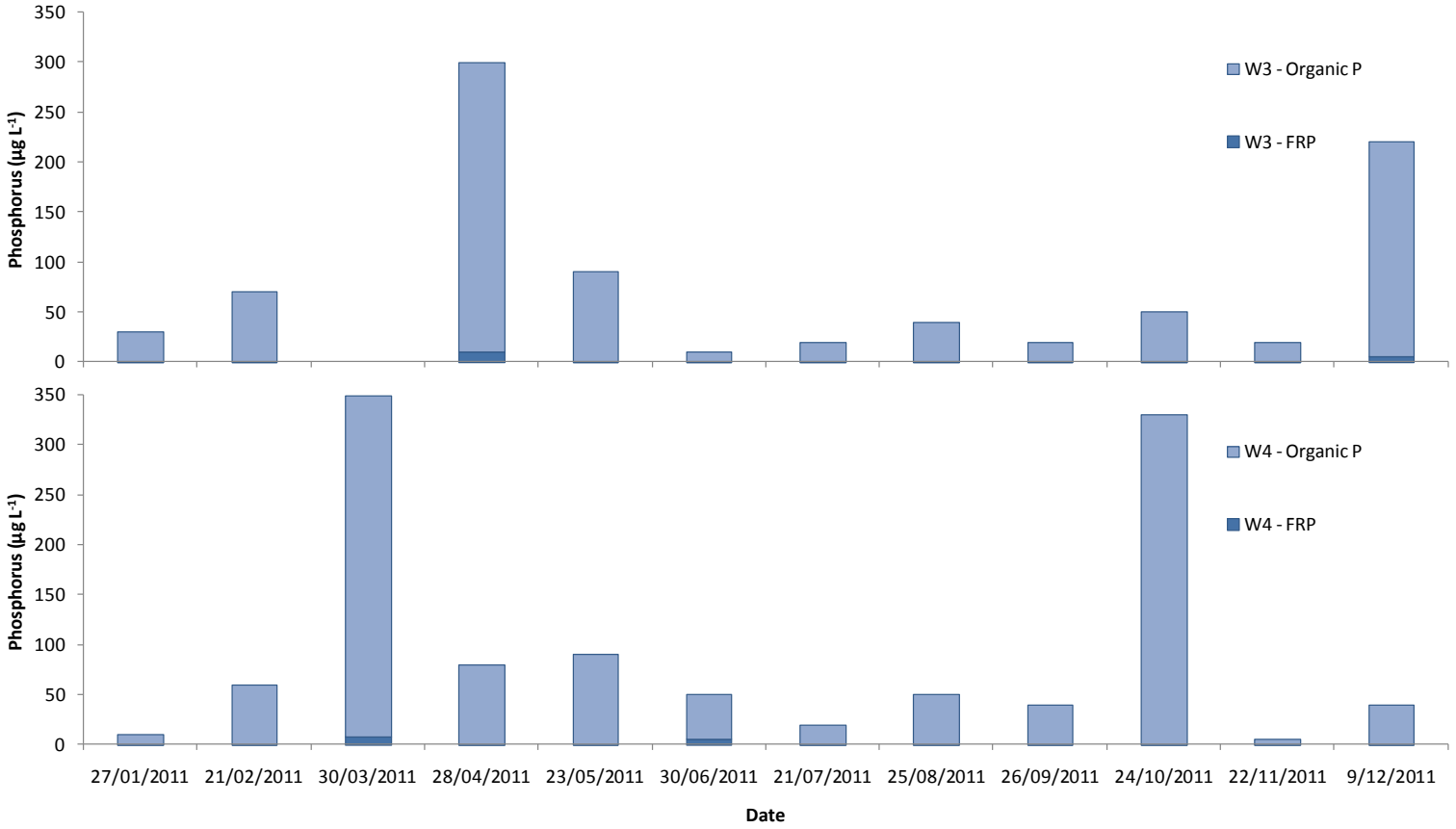
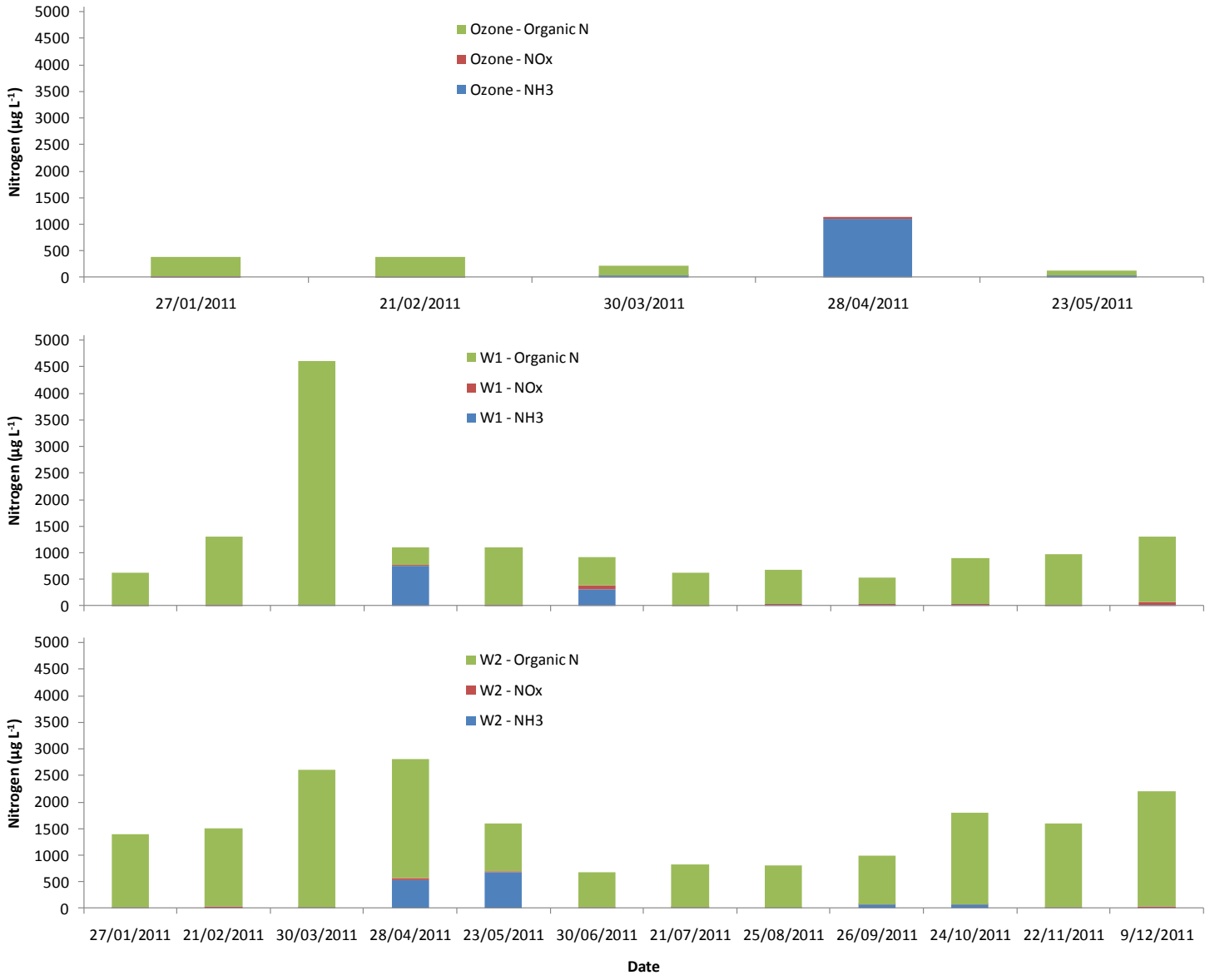


Figure 12. Phosphorus (Total P = Organic P + FRP) concentrations recorded at all sites in the wetland. Majority of FRP concentrations were below detection at 2 µg L^{-1}.

Lake Vasto contained relatively low total N (<400 µg L^{-1}) concentrations with NOx and NH_3 being low (<40 µg L^{-1}), except in April where the NH_3 concentration was 1,100 µg L^{-1}. These high concentrations are reflected in all the wetland ponds reaching 3,000 µg L^{-1} in W3. It is likely that top-up from Lake Vasto transferred the NH_3 to the wetland. The cause of the high concentration in Lake Vasto is not known. In all ponds, organic N (organic or particulate) accounted for the majority of the N present. In W4 concentrations of NH_3 and NOx were generally lower than in W1, however organic N was higher. This suggests that the Supersorb Activated Zeolite and other wetland processes were effective in reducing dissolved forms of N, but possible plant breakdown was responsible for the increase in organic N.

The ANZECC/ARMCANZ (2000) guidelines for aquatic ecosystems in the south west of Australia for wetlands or lakes/reservoirs are presented in

Table **4**. 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. Overall there is little difference in the number of exceedances across the wetland, indicating the wetland may not be having much influence on water quality. 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. Concentrations of dissolved oxygen do not presently represent a cause for concern.


Ozone - Organic N
Ozone - NOx
Ozone - NH3
Nitrogen (µg L-1)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
27/01/2011
21/02/2011
30/03/2011
28/04/2011
23/05/2011
W1 - Organic N
W1 - NOx
W1 - NH3
W2 - Organic N
W2 - NOx
W2 - NH3
30/06/2011
21/07/2011
25/08/2011
26/09/2011
24/10/2011
22/11/2011
9/12/2011
Date

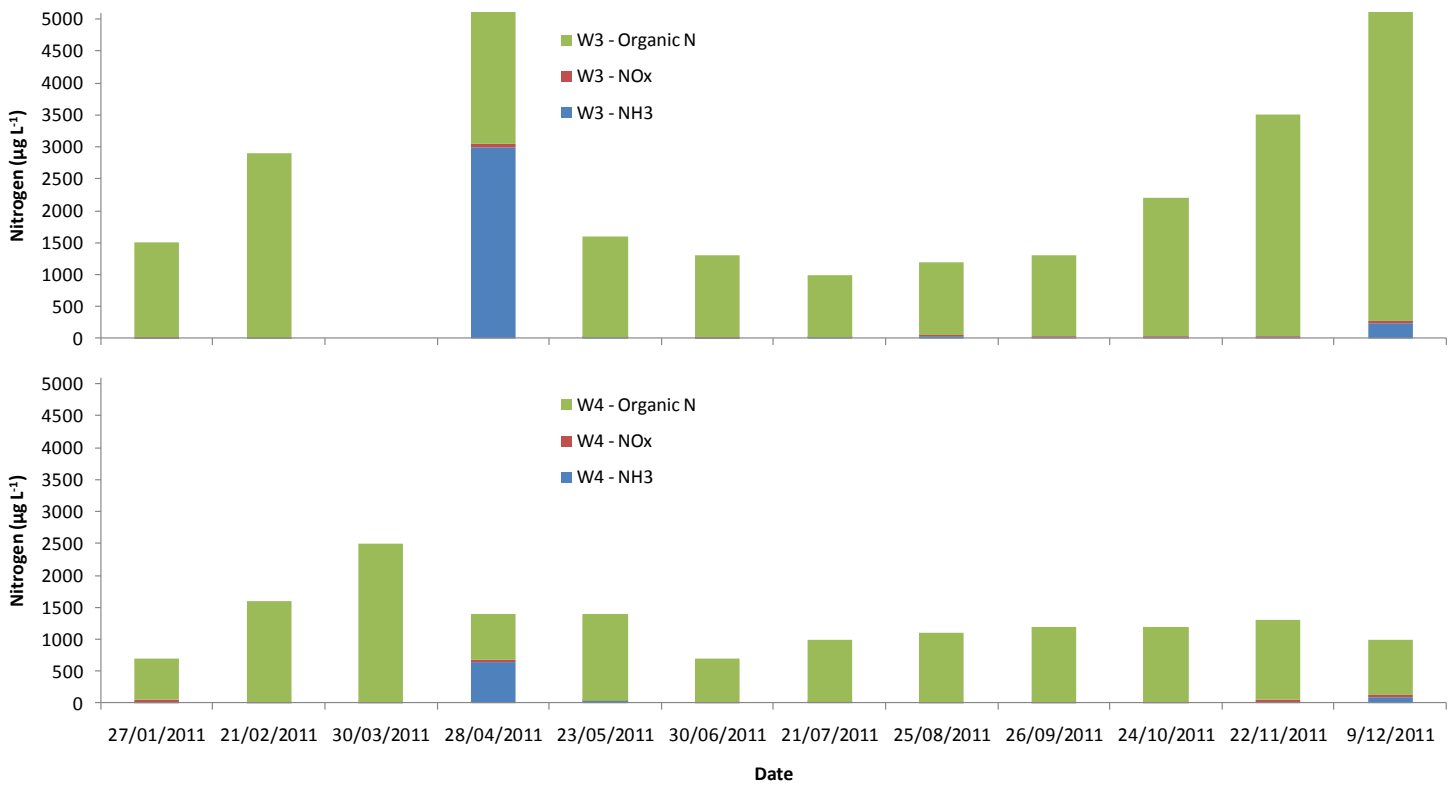


Figure 13. Nitrogen (Total N = Organic N + NH_3 + NOx) concentrations recorded at all sites in the wetland. Note on the 22/12/10 analytical error prevented Organic N being determined.

Table 4 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
Dissolved oxygen	90-120% saturation	5 (12)	4 (12)	8 (9)	4 (9)
pH	7.0-8.5	2 (12)	1 (12)	1 (11)	1 (12)
Conductivity	0.3-1.5 mS cm^{-1}	12 (12)	12 (12)	12 (11)	12 (12)
Turbidity	10-100 NTU	0 (12)	0 (12)	0 (11)	0 (12)
Total P	<60 µg L^{-1}	3 (12)	3 (12)	4 (11)	4 (12)
FRP	<30 µg L^{-1}	1 (12)	0 (12)	0 (11)	0 (12)
Total N	<1500 µg L^{-1}	1 (12)	6 (12)	6 (11)	2 (12)
NOx	<100 µg L^{-1}	0 (12)	0 (12)	0 (11)	0 (12)
Ammonia	<40 µg L^{-1}	4 (12)	4 (12)	4 (11)	2 (12)

7.3.2 QUARTERLY DATA

A broader range of parameters and metals were sampled from each pond at quarterly intervals Table 5). Water hardness was 'extremely high' throughout the year. 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, unlike in 2010 the correlation between turbidity and TSS was only r=0.41, suggesting that turbidity was a poor substitute for measuring 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. This may also help explain the increased organic N concentrations in this zone. Chlorophyll *a* concentrations were highest in February and tended to be higher in W3 than other ponds. Chlorophyll *a* concentrations were low compared to 2010. 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 August and November Cu and Zn (also in May) concentrations exceeded the guidelines across the entire wetland. The highest Zn concentration was 120 µg L^{-1} (guideline is 8 µg L^{-1}) recorded in W3 and W4 in May. The highest concentration of Cu was 17 µg L^{-1} (guideline is 1.4 µg L^{-1}) recorded in W3 in August, however due to the water

Table 5. 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 5, 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)	21/02/2011					23/05/2011					25/08/2011				22/11/2011			
Analysis (mg L^{-1})	**Trigger Values**	**W1**	**W2**	**W3**	**W4**	**Ozone**	**W1**	**W2**	**W3**	**W4**	**Ozone**	**W1**	**W2**	**W3**	**W4**	**W1**	**W2**	**W3**	**W4**
Total Suspended Solids		17	47	69	130	7	16	68	43	100	6	24	32	12	40	14	17	120	59
Total Hardness (CaCO3)		3600	3800	7500	7000	150	3400	4000	3600	4500	150	580	660	1200	1400	770	840	3000	1600
Ca		280	290	550	510	15	250	300	290	330	15	58	68	120	140				
Mg		710	730	1500	1400	28	690	800	700	890	28	100	120	210	270				
Al (µg L^{-1})	55	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
As (µg L^{-1})	13 As(V)	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Cd (µg L^{-1})	0.2[H]	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cr (µg L^{-1})	1 Cr[C] (VI)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cu (µg L^{-1})	1.4[H]	<5	<5	<5	<5	7	<5	<5	<5	<5	<5	7	7	10	6	7	7	17	8
Ni (µg L^{-1})	11[H]	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	5	5	5	7	6
Pb (µg L^{-1})	3.4[H]	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Zn (µg L^{-1})	8[CH]	<10	<10	<10	<10	10	110	<10	120	120	20	20	20	60	60	10	<10	40	30
Mn (µg L^{-1})	1900[C]	<5	74	95	85	130	150	51	190	420	160	45	25	28	27	14	39	97	37
Fe (µg L^{-1})		<20	<20	<20	<20	50	<20	<20	<20	260	<20	80	80	240	210	<20	20	120	30
Hg (µg L^{-1})	0.6 (Inorganic)[B]	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
DOC		12	13	32	16	1.2	10	15	17	11	1	5.9	6.7	11	11	12	19	53	18
Chlorophyll a (µg L^{-1})		16	10	22	44	6.8	12	11	18	5.2	14	1.7	1	1.5	<0.5	2	2.7	7.3	4.5
Phaeophytin (µg L^{-1})		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
TKN (µg L^{-1})		1.3	1.5	2.9	1.6	0.38	1.1	1.6	1.6	1.4	0.12	0.68	0.8	1.2	1.1	0.97	1.6	3.5	1.3
BOD		<5	<5	<5	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Turbidity (NTU)		3.7	3.9	20	9.1	11	3.7	3.7	3.1	6.3	6.7	2.4	1.9	2.5	2.6	2.6	2.8	10	5

Table 6 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

hardness this was below the trigger value. Only in Ozone in February did Cu exceed the trigger value due to the lower water hardness at this site. Detection limits from the Analytical Laboratories were higher than the trigger values for As, and Cr therefore it is possible that exceedances occurred that were not detected.

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 clear exceedances of ANZECC/ARMCANZ (2000) guidelines for metals concentration for both Cu and Zn. It is likely that the wetland would have discharged some of these concentrations into the Swan River. 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) for P but not for N. Close examination of physico-chemical parameters found a number of exceedances of ANZECC/ARMCANZ (2000) guidelines however with the exception of salinity, these exceedances were unlikely to be of significant consequence. Salinities within the wetland have increased since 2010 and exceeded that of seawater on two occasions. Overall the wetland appeared to have a positive effect on reducing nutrient concentrations of water entering it.

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.

Comparison to previous years will allow the development of sediment to be measured.

Sediments were sampled in May 2011 for a range of metals and nutrients as shown in Table 7. The average depth of sediment to the liner in W2 was 98.8 ± 11.3 mm. This shows an average increase in the depth of sediment of 12.5 mm since 2010. 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 6975 ± 448 mg kg^{-1}, compared to 1495 ± 588 mg kg^{-1} in W3, which represents in both ponds an increase over 2010. 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 775 ± 81 mg kg^{-1} in W2 compared to 60 ± 15 mg kg^{-1} in W3, also up compared to 2010. 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. The sediments appear to be taking up a large quantity of the incoming nutrients, with the zeolite substantially outperforming standard sediment (W3). No metal concentrations exceeded any ANZECC & ARMCANZ (2000) guidelines for sediment.

Table 7. Sediment concentrations of selected metals and nutrients in W2 and W3 in May 2011.

Variable (mg kg^{-1})	ANZECC & ARMCANZ (2000) Interim Guidelines (Low-High)	W2	W3
TKN		6975 ± 448	1495 ± 588
TP		775 ± 81	60 ± 15
TOC		1.0 ± 0.8	2.8 ± 2.0
Al		80000 ± 12356	1345 ± 190
As	20-70	14.3 ± 0.9	<2
Cd	1.5-10	<0.4	<0.4
Cr	80-370	11.0 ± 4.8	<5
Cu	65-270	12.0 ± 1.7	<5
Fe		13250 ± 2056	2700 ± 534
Ni	21-52	11.0 ± 3.6	<4
Pb	50-220	32.0 ± 7.1	9.0 ± 0.5
Zn	200-410	82.5 ± 16.1	25.0 ± 6.2
Mn		422.5 ± 67.5	10.3 ± 1.3
Hg	0.15-1	<0.05	<0.05

Figure 14. Photograph of a sediment cores taken at W2.

Table 8 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 (91.2±1.3%) compared to the sandier sediment in W3 (40.7±6.6%).W2 whose function is partially for sedimentation of incoming particulates has accumulated higher proportions of organic and inorganic carbon than W3.

Table 8. 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	91.2 ± 1.3	40.7 ± 6.6
% Organic C	12.3 ± 2.4	2.8 ± 0.6
% Inorganic C	6.6 ± 1.5	1.9 ± 0.3

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 were conducted in late May 2011 and late October 2011 as part of biannual monitoring as outlined in the PFMEP (Year 2).

7.5.1.1 CHANGES IN VEGETATION DISTRIBUTION FROM 2010 TO 2011

Five main plant communities were determined and mapped during the initial monitoring (Year 1; May 2010). These communities were remapped in May 2011 and October 2011 with particular focus on any change in condition and extent of these main types (Figure 15), as well as recruitment and colonisation of new plants. In general, the spatial distribution of plant communities has remained reasonably stable, although there have been some notable changes. Specifically, the following changes between May 2010 and May 2011 were found:

1) *Baumea articulata* – the one small patch of *Baumea articulata* in 2010 on the western end of Zone 2 has expanded to approximately triple its size. This patch has spread into open water to the north and west and into *Juncus* dominated vegetation to the east (Figure 15; Table 9 & Table 10). A second smaller patch of *B. articulata* has developed to the north-east of this patch (Figure 15) again in relatively deep water (at time of monitoring). It seems most of the expansion in this community occurred during winter and spring 2010 (confirmed during the October 2010 monitoring) with many of the plants subsequently succumbing to effects of wetland drying over summer. At present most of the stems are brown and presumably dead, but there are encouraging signs of regrowth following the recent inundation and rain. By October 2011, *Juncus kraussii* was beginning to dominate the dead patches of *Baumea*.

2) *Eleocharis acuta* – This community is dominated by *Eleocharis acuta* (Common Spikerush, Cyperaceae) but is mixed with small amounts of *Juncus kraussii*. During 2011, there has been some contraction of this community at its margins (Figure 15), mainly being taken over by *J. kraussii*

dominated vegetation (type 4 below). Furthermore the relative cover of *J. kraussii* has increased in some patches of this community. This suggests that *J. kraussii* may be slowly taking over this community. By October 2011, the ratio of *E. acuta* to *J. kraussii* was generally 70%:30%.

3) *Ficinia nodosa* – this community is dominated by Knotted Club Rush (previously *Isolepis nodosa*) and tends to occur on surrounding slopes on non-inundated areas. Its distribution has been more or less stable over the past year.

4) *Juncus kraussii* – this is the most widespread vegetation type of the wetland and dominants each wetland zone. It consists of dense stands of *Juncus kraussii* (Sea Rush, Juncaceae) of between 60 to 90% cover. It is expanding at its margins, particularly where it abuts *E. acuta* community (type 2 above; Figure 15). However contractions in its extent due to expansion of *B. articulata* and loss of Juncus patches to open water means that its total coverage (in m^2) is more-or-less the same as 2010 (see Table 9 & Table 10). The density of *J. kraussii* plants and its dominance over other species is increasing (now generally 80-90% cover).

5) Samphire and other halophytes – This community is dominated by *Tecticornia indica* and other *Tecticornia* spp. (commonly known as samphires and until recently 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* (which has been increasing in cover). There has been a slight expansion of this community along the edges of the raised mound in Wetland Zone 2, as well as a major expansion in Wetland Zone 3 (Figure 15; Table 9 & Table 10).

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

- Mixed shrubs on embankments – this community consists of a range of shrub species with medium to high cover. Dominant species include *Scaevola crassifolia, 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). Three new areas of open water have developed in Zone 2 over the last year (albeit small in size; Figure 15).

7.5.1.2 TREE & SHRUB SPECIES

Melaleuca cuticularis – two patches of young trees were observed on slightly raised mounds, both within Zone 2. These are most likely plants surviving from original planting in *ca.*2004. They are mostly found on the margin of *Juncus* community where it abuts samphire/halophytes. One mound had 7 trees in 2010; all but one of these had survived as of October 2011 and had grown slightly (Figure 18). The other mound had 10 trees in 2010, and all these were still living, healthy and growing at October 2011.

Melaleuca lateritia – this compact shrub was found interspersed throughout the *Juncus* community of Zone 2. Some 20 plants were observed in 2010. However, some 28 plants were counted in 2011. The difference is likely to be due to improved detectability due to shrubs emerging above generally dense cover of *Juncus* in this area rather than recruitment of additional plants.

7.5.1.3 CHANGE IN AREA CALCULATED USING GIS

B. articulata was only found in Zone 2 and *J. kraussii* was the only species recorded in Zone 1 (**Table 10**). 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. Possibly the high salinity in 2011 has also impacted on this species, which suffered a severe dieback in 2011. 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. High salinities and this species lower tolerance to them than *J. kraussii* may also explain the apparent movement of *J. kraussii* into the *E. acuta* beds. 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.

A photographic record of each vegetation community was taken at fixed locations (Figure 16 to Figure 22).

Table 9. Area (m^2) of each cover type and its percentage of total study area and of wetland area (as of May 2010 and May 2011).

Type	2010 Area (m^2)	2011 Area (m^2)	% total 2010	% total 2011	% wetland 2010	% wetland 2011
Baumea articulata	16.9	64.3	0.2	0.7	0.2	0.9
Eleocharis acuta	405.6	352.4	4.7	4.1	5.7	5.0
Ficinia nodosa	154.3	154.3	1.8	1.8	2.2	2.2
Juncus kraussii	3234.3	3229.3	37.7	37.6	45.6	45.6
Samphire / halophytes	355.1	383.0	4.1	4.5	5.0	5.4
Open Water	2305.0	2287.9	26.9	26.7	32.5	32.3
Boardwalk, Weir etc	615.9	615.9	7.2	7.2	8.7	8.7
Total Wetland	7087.2	7087.1	82.6	82.6	100	100
Mixed shrubs (slopes)	1285.6	1285.6	15.0	15.0		
Raised Ground (~bare)	209.9	209.9	2.4	2.4		
Grand Total	8582.7		100	100		

Table 10 Area (m^2) of each plant community by wetland zone as of May 2011 (area changes in m^2 from May 2010 are indicated in parenthesis).

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	64.3 (+47.4)	309.7 (-42.1)	65.1	1865.4 (+4.0)	924.8 (-17.1)	145.8 (+7.8)	3375.1
3	0	42.7 (-11.1)	89.3	738.7 (-9.0)	0.0	237.3 (+20.1)	1108.0
TOTAL	64.3	352.4	154.4	3229.2	2287.9	383.1	6471.3

Figure 15. Map of vegetation types and other cover as of October 2011. Changes from 2010 and general direction of expanding vegetation types are indicated by arrows.

May 2010

May 2011

October 2010

October 2011

Figure 16. Photographs taken at photopoint WV1 looking south-east

May 2010

May 2011

October 2011

Figure 17. Photograph taken at photopoint WV2 looking south. Vegetation here is dense *Juncus kraussii* and its extent and condition is generally stable

May 2010

October 2010

May 2011

October 2011

Figure 18. Photograph taken at photopoint WV2 looking west towards patch of *Melaleuc*a trees

May 2010

October 2010

May 2011

October 2011

Figure 19. Photograph taken at photopoint WV3 looking east (note expansion and subsequent death of *Baumea articulata*). Photos have been taken in slightly different directions (top is due east, whilst others are ESE to focus more on the declining *Baumea*).

May 2010

May 2011

October 2011

Figure 20. Photographs taken at photopoint WV4 looking west.

May 2010

October 2010

May 2011

October 2011

Figure 21. Photograph taken at photopoint WV4 looking north towards city. NB: Direction and elevation of photograph has varied slightly each year.

May 2010

May 2011

Figure 22. Photographs taken at photopoint WV5 looking south-west

7.5.2 VEGETATION BIOMASS AND GROWTH

Baumea articulata was in decline in 2011 and produced few living stems and no flowers[2] in May or October, while all the other species sampled had flowers all year, although *E. acuta* produced no flowers in May (Figure 23). There was little difference in mean leaf length in all species except *B. articulata* in both months. *Baumea articulata* had a greatly reduced leaf length in October. This year there was little variability between sites, except for *J. kraussii* in W4 in October which had a lower mean count of leaves than W2 and W3.

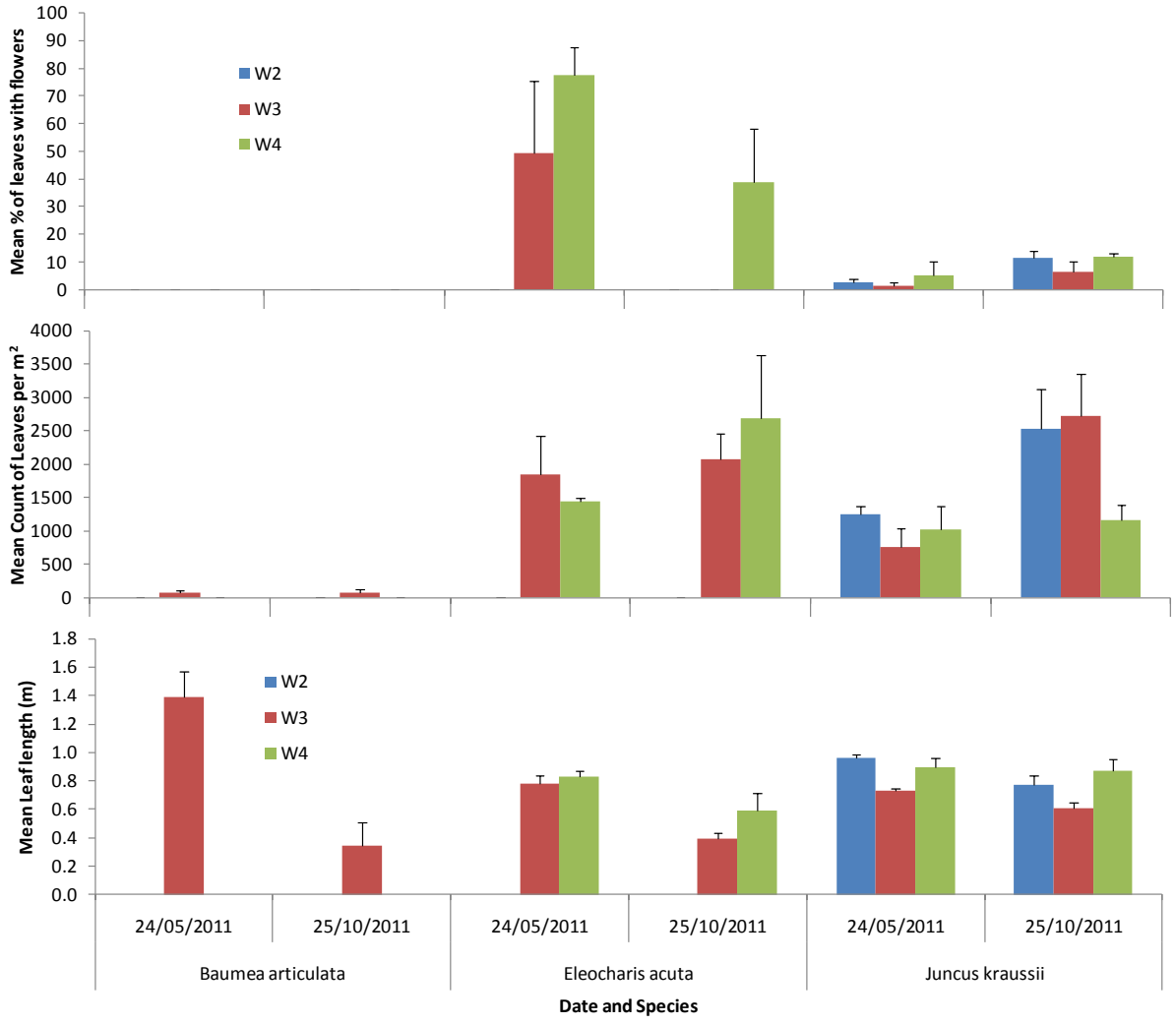


Figure 23. Mean (±SE) for percentage of leaves with flowers, count of leaves per m² and leaf length for each species on each sampling occasion for each wetland site.

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

Baumea articulata had low below ground biomass, virtually no live material above ground and a high proportion of dead material in both May and October (Figure 24). At the end of 2010 this stand was growing and expanding, however despite the higher rainfall in 2011, the stand appears to be dying. This may be due to high salinities or unfavourable water depths. It is uncertain whether the stand will recover. Below ground biomass in other species increased between May and October although there was little difference in live or dead above ground material. The biomass of the plants varies between species and ponds.

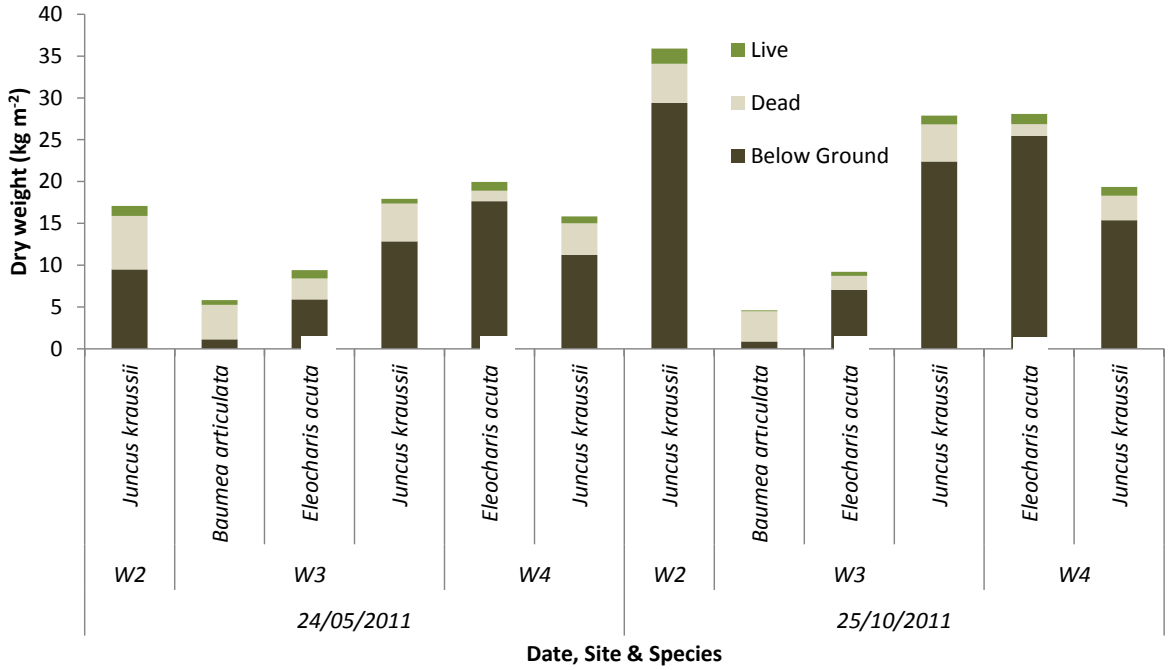


Figure 24 Mean dry weight (g) of live, dead and below material from collected species, from sites on two occasions.

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) are shown in Table 11. The proportion of plant material that is LOI_{1000} is low in *B. articulata* and *E. acuta* with no trends over time. However in *J. kraussii* there appears to be a general increase in the proportions from 2010 to 2011 and from May to October only in the live and to a lesser extent dead material. This is often associated with rapid growth where plants mass transport materials to their leaves during transpiration. The decline in LOI_{500} in below ground tissues of *J. kraussii* and *E. acuta* suggests a diluting of the carbon stored as the amount of material has increased since 2010. This is associated with rapid growth of the plant. These results suggest that both *E. acuta* and *J. kraussii* have made the most of the wetter conditions of 2011 and grown substantially.

Table 11. Loss on ignition (LOI) of each plant sampled, per area sampled in May and October 2010 and 2011. LOI shown for 500 °C and 1000 °C.

Wet-land	Species	Type of Material	18/05/2010		26/10/2010		24/05/2011		25/10/2011	
			LOI_{500} (%)	LOI_{1000} (%)	LOI_{500} (%)	LOI_{1000} (%)	LOI_{500} (%)	LOI_{1000} (%)	LOI_{500} (%)	LOI_{1000} (%)
W2	*Juncus kraussii*	Below Ground	60.7	1.0	48.9	0.7	32.9	1.6	17.0	0.8
		Dead	95.2	0.9	94.2	0.6	92.5	10.8	87.5	6.7
		Live	95.3	2.5	95.9	2.8	90.7	9.1	95.4	26.9
W3	*Baumea articulata*	Below Ground	72.8	1.3	65.5	1.6	72.4	6.3	75.8	7.1
		Dead	93.6	0.7	86.5	3.9	89.4	10.9	81.9	7.0
		Live	93.8	3.3	91.4	3.5	89.7	11.5	-	-
	Eleocharis acuta	Below Ground	88.1	1.3	34.5	0.9	27.0	1.0	42.7	1.5
		Dead	89.1	1.2	70.8	8.9	85.0	5.7	66.7	4.2
		Live	94.8	1.7	93.8	2.2	90.9	5.8	91.6	9.2
	Juncus kraussii	Below Ground	70.3	1.3	21.8	0.7	25.1	1.1	12.2	0.9
		Dead	93.8	1.3	70.0	7.2	89.4	7.3	91.4	1.0
		Live	96.3	2.7	91.5	4.7	94.2	18.4	94.6	28.7
W4	*Eleocharis acuta*	Below Ground	56.6	1.0	78.4	1.2	16.6	1.0	21.5	0.9
		Dead	88.7	1.3	88.4	2.6	86.1	10.0	89.8	6.7
		Live	92.8	0.7	91.6	1.9	93.0	11.3	92.1	5.8
	Juncus kraussii	Below Ground	72.4	1.8	39.1	1.2	19.6	0.9	15.9	0.9
		Dead	92.1	2.4	91.1	4.7	91.1	9.2	91.6	0.0
		Live	95.2	3.2	94.7	3.1	93.2	15.4	94.8	14.8

7.5.3 VEGETATION NUTRIENT LOADS

Baumea articulata, E. acuta and *J. kraussii* have similar concentrations of P and approximately twice the concentration of N in live above ground material compared to 2010 (Figure 25). P concentrations tend to be similar in plants from year to year as few species accumulate P. N concentrations are more variable but higher concentrations tend to be associated with active growth as N is not stored but is reflected in proteins and enzymes. The wetter conditions of 2011 appear to reduced differences in nutrient concentrations between parts of the plants and species compared to 2010.

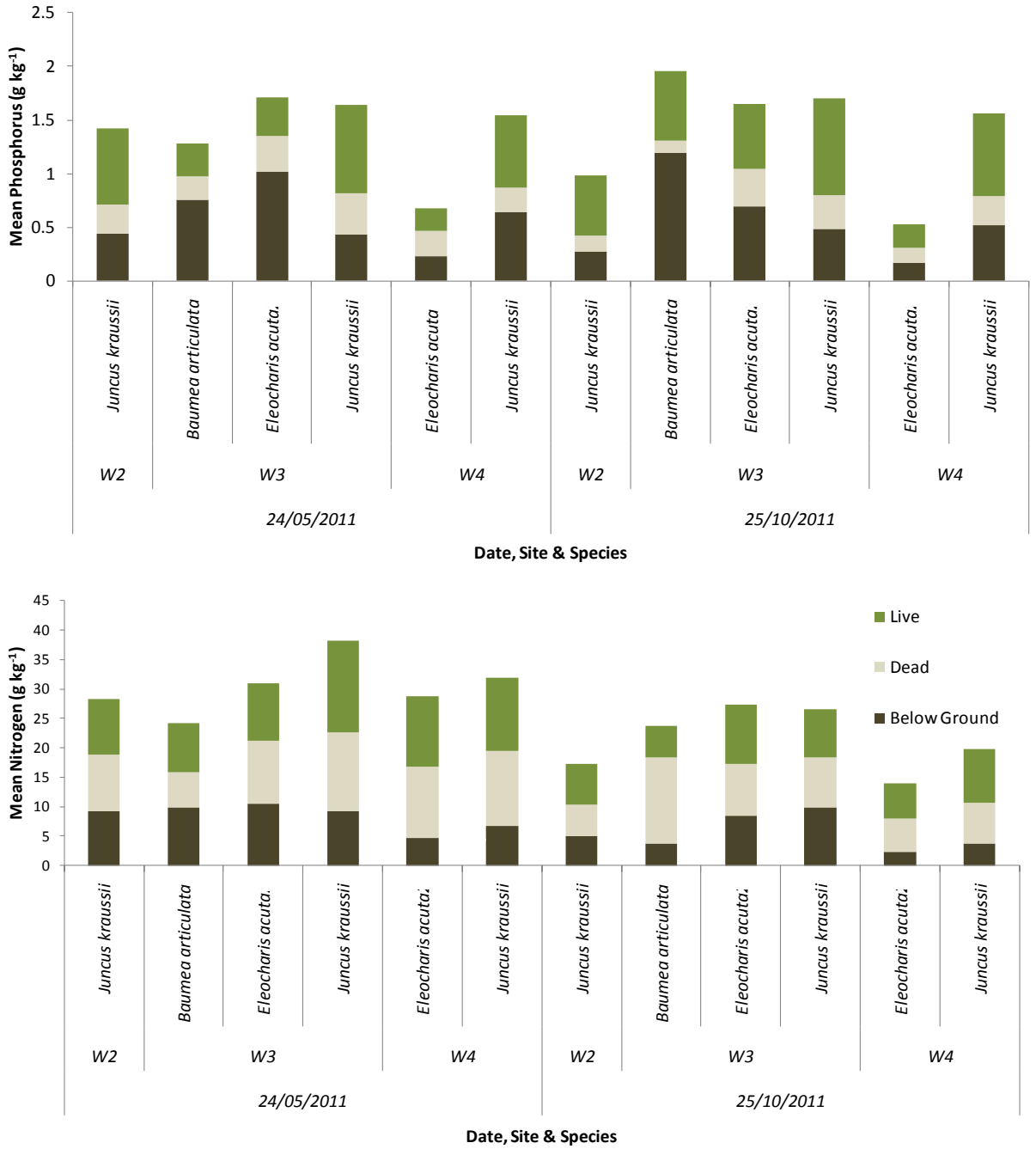


Figure 25. Mean quantities of phosphorus and nitrogen stored per kg of dry weight of live, dead and below ground parts of sampled species, over the seasons and between sites.

The loads of nutrients bound in live *J. kraussii* in Zone 1increased from May 2010 to October 2011, increasing by over 1 kg for P and 46 kg for N (Table 12). Dead material for this species changed little between 2010 and 2011 for P and N. In Zone 2, P increased by over 4 kg and 80 kg of N in live material over the same period. Dead material showed a similar pattern to

zone 1. *Baumea articulata* despite an increase in areal extent in 2011, contained low nutrient loads. This was probably due to the poor health of this species in 2011. Eleocharis acuta showed little change in P in live material from 2010 to 2011, but N doubled.

Table 12. Total loads of N and P in living (above and below ground) and dead biomass per area of stands at each site. Note that the 2010 figures have been recalculated for *Eleocharis acuta* and *Juncus kraussii* for Zone 2.

			Area (m^2)		P Live (kg)		N Live (kg)		P Dead (kg)		N Dead (kg)	
Date	**Zone**	**Species**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**
May	1	*Juncus kraussii*	625.1	625.1	3.02	2.54	36.42	54.97	1.12	1.08	17.62	38.89
	2	*Baumea articulata*	16.9	64.3	0.04	0.07	0.37	1.03		0.06		1.63
		Eleocharis acuta	351.8	309.7	1.35	1.21	10.01	22.14	0.20	0.27	6.51	6.60
		Juncus kraussii	1861.4	1865.4	5.74	12.45	58.56	180.03	1.06	1.91	43.61	101.19
October	1	*Juncus kraussii*	625.1	625.1	1.66	4.67	34.33	83.22	0.49	0.50	27.00	15.65
	2	*Baumea articulata*	16.9	64.3	0.08	0.02	1.05	0.07	0.01	0.01	0.28	0.98
		Eleocharis acuta	351.8	309.7	1.18	1.69	17.33	23.29	0.13	0.14	4.87	3.90
		Juncus kraussii	1861.4	1865.4	8.13	11.13	122.25	140.49	1.95	2.03	54.73	54.56

When the effects of area are removed and simply efficiency of storage is assessed as in Table 13, it shows that *B. articulata* stores the least N and P, with the other species being very similar for P and N in live material. In dead material there was little change between 2010 and 2011 in P but there was a decline in *J. kraussii* N loads.

Table 13. 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.

			P Live (kg)		N Live (kg)		P Dead (kg)		N Dead (kg)	
Date	**Zone**	**Species**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**
May	1	*Juncus kraussii*	0.48	0.41	5.83	8.79	0.18	0.17	17.62	2.82
	2	*Baumea articulata*	0.26	0.11	2.18	1.59	0.00	0.10	0.00	0.00
		Eleocharis acuta	0.38	0.39	2.85	7.15	0.06	0.09	6.51	1.85
		Juncus kraussii	0.31	0.67	3.15	9.65	0.06	0.10	43.61	2.34
October	1	*Juncus kraussii*	0.27	0.75	5.49	13.31	0.08	0.08	27.00	4.32
	2	*Baumea articulata*	0.45	0.12	6.19	0.42	0.04	0.04	0.28	1.67
		Eleocharis acuta	0.33	0.48	4.93	6.62	0.04	0.04	4.87	1.38
		Juncus kraussii	0.44	0.60	6.57	7.55	0.10	0.11	54.73	2.94

7.5.4 FORESHORE MONITORING

Monitoring Area 1 has experienced a clear deterioration in foreshore condition during 2011 with greater proportion of foreshore being classified as having significant to severe erosion (Table 14). Planted and naturally colonised areas of *Juncus* and other fringing wetland plants have dramatically declined along this section of foreshore and this appears to have made the sediment in this area more prone to erosion by wind- and boat-driven waves (see Section 7.6). Subsequently sediment has been lost around the *Casuarina* grove up slope, exposing root systems and jeopardising the health of this previously healthy stand of trees (see photos at Appendix 1).

The headland area between Monitoring Areas 1 & 2 has been particularly affected by increased erosion. Previously roots of the large *Casuarina* trees at this point had been exposed through erosion of sediment with various attempts to protect this stand of trees by rock re-enforcement and shells/pebbles. More roots have been exposed through erosion over the past year, so much so that one large tree has fallen into the river, and another is showing signs of crown decline (Section 7.6).

It is recommended that Area 1 (including the headland between Areas 1 & 2) receive immediate remedial treatment in the form of sandbagging and planting of fringing sedges/rushes to reduce erosion and help prevent further loss of trees.

Monitoring Area 2 is relatively stable with dense *Juncus* and sedge cover protecting the foreshore from erosion (Table 14; Section 7.6)

Table 14. Condition Summary Table at each Study Site as of May 2011. Data for 2010 is included in parentheses (**in red**) where different from 2011.

Site	Erosion	Slumping	Sedimentation	Vege-tation	Regen-eration	Weeds	Log/Brush	Rock Work	Beach Areas	Fauna Use	Comments / Notes
F1A	25% Minimal (**30%**); 55% Localised (**60%**); 15%Significant (**10%**); 5% Severe (**0%**)	40% Minimal; 50% Localised; 10% Significant	80% Minimal; 20% Localised	2	4 (**3**)	3	N/A	Mostly consists of shell; Increased erosion of shells and underlying mud	Stable; but some erosion at high water mark	Nil	Needs infill planting to stop erosion; erosion is mostly confined to areas with little plant (rush) cover. Rush cover is reduced from 2010 (cause for concern)
F1B	0 Minimal (**20%**); 40% Localised (**30%**); 30%Significant (**50%**); 30% Severe (**10%**)	30% Minimal (**40%**); 40% Localised (**50%**); 20% Significant (**10%**); 10% Severe (**0%**)	80% Minimal (**70%**); 20% Localised (**30%**)	3	3	3	N/A	Rock armoury around headland no longer effective. Wave action and high tides have eroded soil around trees exposing roots	Mostly stable; some erosion around edges near headlands	Nil	Erosion of headland either side of beach is significant exposing roots of trees; one tree has fallen into river; these areas need rock (or sandbag) armoury and infill planting.
F1C	40% Minimal (**85%**); 20% Localised (**10%**); 20% Significant (**5%**); 20% Severe (**0%**)	50% Minimal (**90%**); 20% Localised (**10%**); 30% Significant (**0%**)	90% Minimal; 10% Localised	3 (**1**)	4 (**3**)	4	Limited effective-ness	N/A	Loss of rushes and sedges at edge. Major increase in erosion in this area	Nil	Stability from dense rush/sedge cover has been lost since 2010. Increased erosion including roots of Casuarina trees
F2A	100% Minimal	100% Minimal	70% Minimal (**60%**); 30% Localised (**40%**)	2	3	2 (**3**)	Stable	Small amount of sedimentation	N/A	Trampling of veg'n by waterbirds	Increase in amount of rubbish washed up from river (high tide). More couch grass invasion.
F2B	60% Minimal; 10% Localised (**20%**); 20% Significant; 10% Severe (**0%**)	70% Minimal; 10% Localised; 20% Significant	90% Minimal (**70%**); 10% Localised (**30%**)	2 (**1**)	4	3	Stable	Intact with minimal sedimentation	N/A	Trampling of veg,n by waterbirds	Some human trampling (to access river)
F2C	85% Minimal (**95%**); 5% Localised; 5% Significant (**0%**); 5% Severe (**0%**)	90% Minimal; 10% Localised	80% Minimal (**70%**); 20% Localised (**30%**)	2	3	2 (**3**)	Stable	Minor sedimentation; rock work not effective against high tides and storm surges – erosion of mud around tree roots	Erosion mostly on margins; Reasonably stable	Nil	Stable embayment, but increased erosion of headland and flanks; increase in weed cover

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.

7.6 FORESHORE PHOTOGRAPHS

Photographs taken at Foreshore Monitoring Site 1A in an easterly direction. Note: loss of sedge/rush vegetation at river edge.

May 2010

May 2011

October 2010

October 2011

Photographs taken at Foreshore Monitoring Site 1A in Westerly direction

May 2010

May 2011

Photographs taken at Foreshore Monitoring Site 1A in Southerly direction

May 2010

May 2011

October 2011

Photographs taken at Foreshore Monitoring Site 1B in westerly direction. Note: *Casuarina* tree on headland has fallen into the river.

May 2010

May 2011

October 2011

Photographs taken at Foreshore Monitoring Site 1B in an Easterly direction

May 2010

May 2011

Photographs taken at Foreshore Monitoring Site 1C in a Westerly direction

May 2010

May 2011

Photographs taken at Foreshore Monitoring Site 2A in a Southerly direction

May 2010

May 2011

Photographs taken at Foreshore Monitoring Site 2B in Southerly direction

May 2010

May 2011

October 2011

Photographs taken at Foreshore Monitoring Site 2A in an Easterly direction

May 2010

May 2011

Photographs taken at Foreshore Monitoring Site 2C in Southerly direction

May 2010

May 2011

October 2010

October 2011

Photographs taken at Foreshore Monitoring Site 2C in a Westerly direction

May 2010

May 2011

October 2011

Photographs taken at Foreshore Monitoring Site 2C in Easterly direction

May 2010

May 2011

October 2011

Photographs taken of Casuarina Trees at Headland between Foreshore Monitoring Sites 2C and 1A

May 2010

May 2011

October 2011

7.6.1 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*). Baumea articulata while it expanded in area in May, by October the plants were largely dead.

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 compared to 2011, although this was probably helped by the wetter year.

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 2010 and 2011 indicating that the wetland was removing nutrients from incoming water.

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 in some areas was significant.

7.7 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.

During 2010 and 2011, a total of 27 species of bird have been recorded at Point Fraser, with 11 species in June 2011 and 17 in November 2011 (Table 15). Perth experienced an extremely dry summer in 2010/2011 and this resulted in a poor number of birds in the autumn 2011 survey. Rainfall had still not occurred by this time and consequently numbers of both bush birds and water birds were very low, as seen in Table 15. Although it was expected that the permanent water at the site would act as a drought refuge, it is likely that water birds sought more permanent and larger wetlands elsewhere on the Swan Coastal Plain.

Based on the four surveys so far, the Point Fraser wetlands support a moderate diversity of water birds and a low diversity of other bird groups. Few new water birds are being added to the list; however a first record of the Hardhead duck was obtained in the spring 2011 surveys. Land birds are highly influenced by flowering and the spring survey resulted in a new honeyeater species, the Western Wattlebird, being recorded due to the prolifically flowering native plants present at the time of the survey. Most honeyeaters present were utilising the flowering shrubs. As the eucalypts are growing, Striated Pardalotes appear to be regularly utilising the site. This species is an obligate eucalyptus feeder and is a good sign of the success of revegetation of this species on site. Most other land birds recorded are those that benefit from the lawn areas and include the Australian Magpie, Magpie-lark and Willie Wagtail.

Possibly as a result of ongoing control efforts by the DEC, or due to the climactic conditions recently experienced, numbers of Rainbow Lorikeets were significantly lower than any survey to date, with only two individuals recorded in spring 2011. This is to be seen as a positive outcome given the competitive interactions between this and local native species of nectarivore.

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. An interesting ongoing record during the November survey was the Little Grassbird. This species was recorded in spring 2010 as well and is considered likely to be breeding at the site. It requires dense reed-beds around wetlands and is a good indicator of the relative lack of disturbance and quality of the reed-bed.

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

		June 2011		November 2011	
Common Name	**Species**	**No.**	**Notes**	**No.**	**Notes**
Anatidae (ducks and swans)					
Pacific Black Duck	*Anas superciliosa*	2	Loafing in pond	15	10 in flight, 5 loafing in pond
Hardhead	*Aythya australis*			2	In pond area
Columbidae (pigeons and doves)					
Laughing Dove	*Streptopeila senegalensis*			1	In flight
Anhingidae (darters)					
Phalacrocoracidae (cormorants)					
Great Cormorant	*Phalacrocorax carbo*			2	In flight over site
Threskiornithidae(Ibis and Spoonbills)					
Australian White Ibis	*Threskiornis molucca*	3	In flight over site		
Laridae (terns and gulls)					
Silver Gull	*Chroicocephalus novaehollandiae*	2	In flight over site	4	One perched on boardwalk
Psittacidae (lorikeets and parrots)					
Rainbow Lorikeet	*Trichoglossus haeatodus*	54	Introduced	2	Both perched in the Flooded Gum
Pardalotidae (pardalotes)					
Striated Pardalote	*Pardalotus striatus*			4	In native eucalypts
Meliphagidae (honeyeaters)					
Singing Honeyeater	*Lichenostomus virescens*	4	Ground pouncing on lawns	3	Near flowering plants
Western Wattlebird	*Anthochaera lunulata*			1	Heard calling

		June 2011		November 2011	
Common Name	**Species**	**No.**	**Notes**	**No.**	**Notes**
Red Wattlebird	*Anthochaera carunculata*	2	In flight over site	6	Feeding in flowering *Melaleuca lateritia*
Brown Honeyeater	*Lichmera indistincta*			11	Throughout site
White-cheeked Honeyeater	*Phylidonyris niger*	4	In flowering shrubs	5	In flowering shrubs
Artamidae (Woodswallows, Magpies, Butcherbirds)					
Australian Magpie	*Gymnorhina tibicen*	1	In flight over site		
Rhipiduridae (flycatchers)					
Willie Wagtail	*Rhipidura leucophrys*	3	Using lawns	4	A juvenile was being fed. Possible breeding nearby?
Corvidae					
Australian Raven	*Corvus coronoides*			3	Foraging on the ground
Monarchidae					
Magpie-lark	*Grallina cyanoleuca*			4	Feeding on lawns
Megaluridae					
Little Grassbird	*Megalurus gramineus*			1	Seen in wetland reeds near boardwalk
Timaliidae (White-eyes)					
Silvereye	*Zosterops lateralis*	1	heard		
Hirundinidae (swallows)					
Welcome Swallow	*Hirundo neoxena*	14	Aerial feeding over ponds	4	Aerial feeding over site
Number of species		11		17	

7.7.1 CONCLUSIONS

1. Determine the range of birds utilizing the park

Achieved, with 20 species recorded.

7.8 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 35 taxa were collected in the wetland in 2011 from May and October (

Table 16) an increase from 26 in 2010 (Figure 26a). Taxa were generally salt tolerant and Foraminifera and Polychaeta are primarily marine groups. 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). These taxa continue to occur in the Point Fraser wetlands having been found in 2010, which 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 7-10 taxa, but also for abundance. Zone 1 has a higher taxa richness than zone 2, suggesting the open water provides slightly more habitat options for species.

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 26b, it can be seen that the community in 2011 is different to that in 2010. Differences between seasons appear to be stronger than differences between zones.

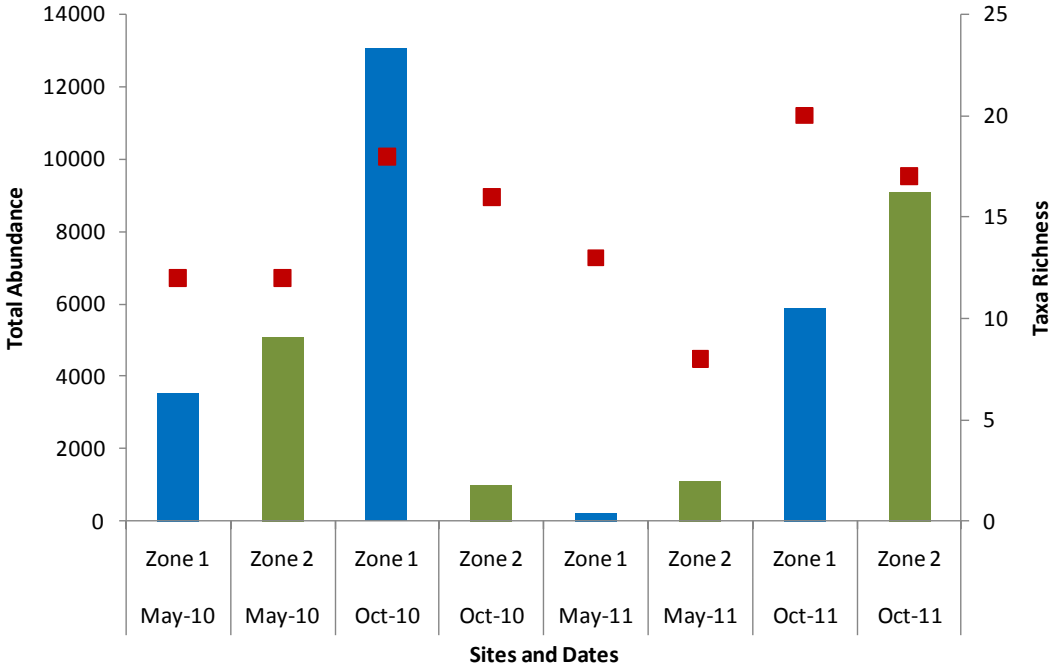
The introduced fish *Gambusia holbrooki* was observed in W1 and W2 in the summer months. They are known predators of a many surface dwelling macroinvertebrates and amphibians (Pyke, 2008). On occasion, *G. holbrooki* were also seen in W3 and W4. Removal and control of *G. holbrooki* populations is difficult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

Table 16. Total abundance (from two 5 m transects) at Zone 1 and 2 of macroinvertebrates (>250 µm) in May and October 2010 and 2011. Spp in **bold** indicate new taxa for 2011 while in *italics* were only found in 2010; J=Juveniles (too small to identify), L= larvae, P = Pupa, both J and P were excluded from taxa richness.

								2010				2011			
								May		October		May		October	
Phylum	**Class**	**Order**	**subOrder**	**Family**	**subFamily**	**Life-stage**		**Zone 1**	**Zone 2**	**Zone 1**	**Zone 2**	**Zone 1**	**Zone 2**	**Zone 1**	**Zone 2**
Aracnida		Acariformes		Orabatidae			spp			48		9		8	30
Arthropoda	Insecta	Diptera		Ceratopogonidae	Dasyheleinae	L	*spp*		46	20	15				
						L	**spp**							2	
				Chironomidae		J	*spp*		120		15				
					Chironominae	L	spp	200	1336	103	465	2	3	139	91
					Tanypodinae	L	spp			22	71		1	21	9
						P	**spp**								1
					Orthocladiinae	L	spp	15	24					9	
				Tipulidae		L	**spp**					2			
		Coleoptera		Dytiscidae		L	spp	15	23	4	3	2		1	
				Hydrophilidae		L	spp	5	1	4	2	1		2	2
				Hydraenidae		L	**spp**					1			
		Hemiptera		Corixidae			spp	5	35	29	10			1	
				Veliidae			**spp**					1		1	1
		Odonata	Epiprocta			J	*spp*	5			1				
				Telephlebiidae			*spp*			3	1				
			Zygoptera	Libellulidae			*spp*		1						
						J	*spp*	5	42	1	1				
				Chorismagrionidae			*spp*		2						
				Coenagrionidae			*spp*			3	10				
				Lestidae			**spp**							2	

								2010				2011			
								May		October		May		October	
Phylum	**Class**	**Order**	**subOrder**	**Family**	**subFamily**	**Life-stage**		**Zone 1**	**Zone 2**	**Zone 1**	**Zone 2**	**Zone 1**	**Zone 2**	**Zone 1**	**Zone 2**
		Trichoptera		Hydroptilidae		L	*spp*			4					
				Leptoceridae		L	spp	26			2			1	1
						P	*spp*			1					
	Crustacea	Amphipoda		Paramelitidae			**spp**							85	
			Cladocera	Chydoridae			*spp*			52					
	Copepoda	Calanoida					*spp*	20		1016	6				
		Cyclopoida					spp	25	40	100	15	1		11	19
		Harpacticoida					**spp**							2	
	Isopoda			Sphaeromatidae			spp	5		88	56	19	132	12	49
	Ostracoda						spp	2960	3400	11568	294	189	926	5505	8374
	Decapoda			Palaemonidae			**spp**						12		2
Foramnifera							spp				9	4	5	8	304
Mollusca	Gastropoda			Physidae			**spp**							2	
				Pomatiopsidae			spp	25				1	20	52	7
				Ancylidae			**spp**								1
Annelida	Polychaeta						spp			4	7				7
	Oligochaeta						**spp**								53
	Hirundinea						spp	230	20	4		5	10	9	149
Nematoda							**spp**								1
					Taxa Richness			12	12	18	16	13	8	20	17
					Abundance			3541	5090	13074	983	237	1109	5873	9101

a)



b)

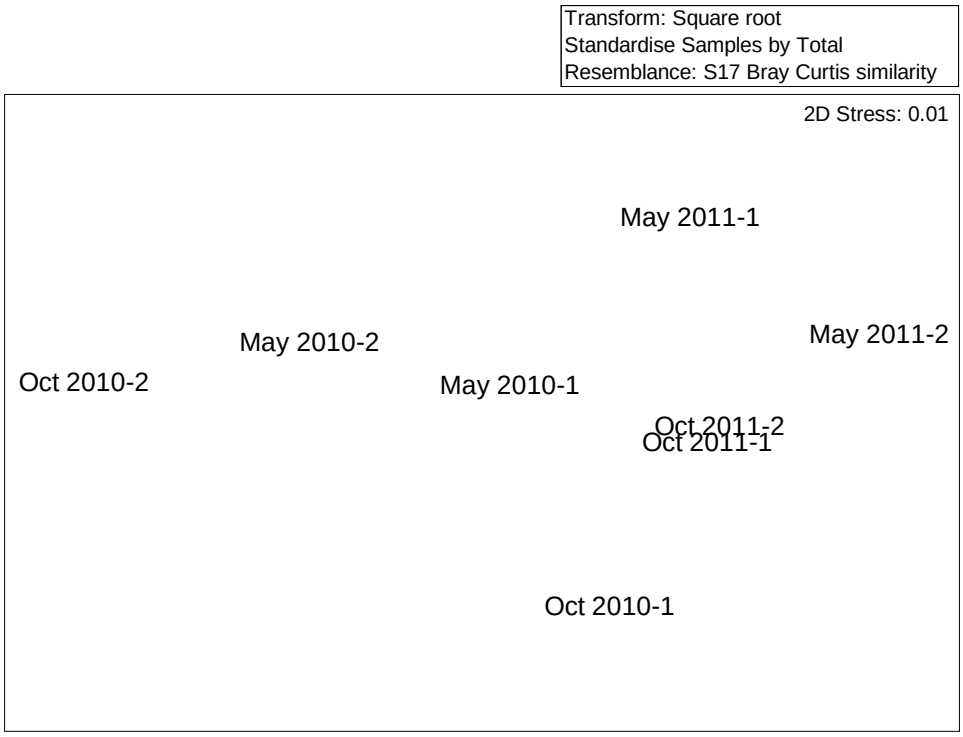


Figure 26. Macroinvertebrate a) Abundance and taxa richness, and b) Multi-dimensional scaling plot showing similarity of sites to each other in terms of community structure, data collected from zones (- indicates zone) at Point Fraser in May and October 2010 and 2011.

7.8.1 CONCLUSIONS

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

Achieved, with 35 taxa collected which is higher than recorded in 2010.

7.9 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 (May and October) sampling program: (1) visitor counts; (2) visitor surveys; and (3) visitor behaviour observations. Survey collection, visitor counts and observation of behaviour occurred for two days each monitoring event as outlined in Table 17. No visitor surveys were conducted in Round 4 as per agreement with COP due to issues of survey saturation identified during Round 3.

Table 17. Dates of year 1 and 2 assessment events

		Dates of data collection		Type of data collection	
		Weekday	**Weekend**	**Visitor Observations & Behaviour Counts**	**Visitor Surveys**
YEAR ONE 2010	May (Round 1)	Wed 19 May 2010	Sat 29 May 2010	Yes	Yes
	October (Round 2)	Wed 27 Oct 2010	Sat 30 Oct 2010	Yes	Yes
YEAR TWO 2011	May (Round 3)	Wed 25 May 2011	Sat 28 May 2011	Yes	Yes
	October (Round 4)	Wed 26 Oct 2011	Sat 5 Nov 2011	Yes	No

7.9.1 VISITOR COUNTS

Observation counts results for 2011 are presented as the weekday monitoring event and the weekend monitoring event for each survey round (i.e. October and May) Table 18, Table 19 and Table 20 below. The majority of park users were pedestrians (66% to 81%) compared to cyclists (19% to 34%). Extrapolated visitor counts indicate that in and outbound daily pedestrian traffic at the West (SMC 1) and East (SMC 2) entrances were around 130 visitors, while bicycle traffic was roughly between 20 and 30 users, though there was considerable variation as evident from the data. 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. On the weekend, car park use was significantly lower as few people seemed to access Point Fraser by car for recreational purposes.

Table 20 displays the monitoring results from the path along the outside of Point Fraser parkland. Extrapolated weekday bike use to/from the city was 544/472 in May and 396/380 in October. Weekend bike use was within the same range (380/448 in May, 524/368 in October). This is significantly higher than traffic through the parkland. There was also significant pedestrian traffic along the outside of the park with up to 340 users per day.

Table 18. Extrapolated visitor counts data – Round 3, May 2011 survey round (All sites)

WEEKDAY - MAY 2011																				
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	24	16	4	0	8	24	20	24	0	0	0	0	52	4	0	44	32	84	24	24
8	8	0	0	0	8	16	20	24	0	20	0	0	19	0	0	76	16	112	20	24
9	8	8	0	0	4	12	64	0	0	4	0	0	76	4	0	52	12	76	64	0
10	0	4	0	4	12	4	28	32	0	8	0	0	20	12	0	8	12	24	28	36
11	4	4	12	0	16	4	8	12	0	0	0	0	16	8	4	0	24	8	20	12
12	4	8	12	0	16	8	0	12	4	0	0	0	20	36	20	4	44	20	12	12
13	4	24	0	0	68	12	4	4	0	4	0	12	16	8	4	20	76	60	4	16
14	16	8	0	0	12	0	4	4	0	0	0	0	0	12	12	0	40	8	4	4
15	12	0	4	8	0	0	4	4	0	0	4	0	4	20	8	0	20	0	12	12
16	8	12	12	4	12	16	16	16	4	0	0	0	20	84	60	4	84	32	28	20
17	40	44	0	8	64	8	4	0	8	0	0	0	8	144	128	4	240	56	4	8
18	8	48	4	0	64	0	0	0	0	0	0	0	4	52	48	0	120	48	4	0
Total	136	176	48	24	284	104	172	132	16	36	4	12	255	384	284	212	720	528	224	168
Total %	81%		19%		56%		44%		4%		1%		53%		41%		76%		24%	

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

† main road entrance

‡ pedestrian entrance

Table 18 (cont.)

WEEKEND - MAY 2011																				
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	8	0	0	4	8	4	4	4	0	0	0	0	0	0	0	20	16	4	4
8	28	48	0	4	80	32	4	20	4	0	0	4	0	8	8	0	120	80	4	28
9	20	20	12	4	24	12	28	48	0	24	4	8	0	12	0	0	44	56	44	60
10	84	32	0	28	28	48	16	12	0	0	0	0	0	12	4	0	116	80	16	40
11	24	8	4	0	16	32	20	20	0	0	0	8	0	12	12	0	52	40	24	28
12	12	44	20	40	28	8	52	4	0	0	8	4	0	36	20	0	60	52	80	48
13	8	20	12	24	4	16	28	4	8	0	0	0	0	20	8	0	28	36	40	28
14	4	12	12	20	8	8	16	20	0	0	0	12	0	16	20	0	32	20	28	52
15	20	28	32	12	20	20	36	28	0	8	0	20	0	24	24	0	64	56	68	60
16	24	16	36	12	48	24	20	24	0	4	0	28	0	20	28	4	100	48	56	64
17	20	32	0	0	28	16	0	28	0	0	4	0	0	16	28	0	76	48	4	28
18	0	8	0	0	12	0	0	24	0	8	0	0	0	12	4	0	16	16	0	24
Total	256	276	128	144	300	224	224	236	16	44	16	84	0	188	156	4	728	548	368	464
Total	66%		34%		53%		47%		12%		20%		37%		31%		61%		39%	

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

† main road entrance

‡ pedestrian entrance

Table 19. Extrapolated visitor counts data – Round 3, October 2011 survey round (All sites)

WEEKDAY - OCTOBER 2011																				
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	32	0	0	12	20	8	8	4	20	0	4	96	0	0	80	28	152	8	12
8	8	12	0	12	12	8	4	0	0	0	0	0	92	4	28	124	48	144	4	12
9	0	0	4	0	0	0	0	0	0	4	0	0	72	4	4	16	4	20	4	0
10	0	4	4	0	4	12	4	0	0	0	0	4	32	8	4	8	8	24	8	4
11	20	4	0	0	12	8	4	4	0	8	0	0	12	4	4	0	36	20	4	4
12	0	8	0	0	8	0	0	0	0	0	0	0	12	20	12	0	20	8	0	0
13	24	12	0	8	8	12	8	0	0	0	0	0	12	16	4	4	36	28	8	8
14	0	0	0	4	0	0	4	4	0	0	0	0	16	12	4	8	4	8	4	8
15	0	0	4	0	0	0	8	12	4	40	0	0	12	48	24	4	28	44	12	12
16	8	4	12	0	8	16	0	0	12	0	0	0	12	104	72	0	100	20	12	0
17	8	8	0	8	12	8	12	0	4	0	0	0	12	128	128	4	152	20	12	8
18	24	52	4	4	12	28	4	0	4	8	0	0	4	48	36	12	76	100	8	4
Total	104	136	28	36	88	112	56	28	28	80	0	8	384	396	320	260	540	588	84	72
Total	79%		21%		70%		30%		7%		1%		53%		39%		88%		12%	

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

† main road entrance

‡ pedestrian entrance

Table 19(cont)

WEEKEND - OCTOBER 2011

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	12	4	4	16	8	108	12	0	0	0	112	4	0	4	0	36	20	112	128
8	8	20	0	12	32	8	12	0	0	0	0	0	20	8	0	8	40	36	12	12
9	24	8	4	0	20	44	0	16	0	12	4	0	8	4	0	0	44	64	8	16
10	8	16	12	0	12	4	24	4	0	0	0	20	4	8	0	4	20	24	36	24
11	12	24	8	4	16	4	16	0	0	12	4	4	12	8	8	0	36	40	28	8
12	20	4	8	8	4	0	4	8	8	8	4	0	12	12	0	0	32	12	16	16
13	16	0	0	36	36	12	8	0	4	12	0	0	28	16	4	4	60	28	8	36
14	8	0	16	8	0	24	8	8	0	0	0	8	16	16	0	0	8	24	24	24
15	12	0	0	0	0	8	4	0	0	0	0	0	12	20	4	8	16	16	4	0
16	0	8	8	0	12	8	0	8	0	0	0	0	12	12	0	0	12	16	8	8
17	0	24	0	0	24	0	8	8	0	0	0	0	12	12	0	0	24	24	8	8
18	8	8	0	0	4	4	0	0	8	4	0	0	4	8	4	0	24	16	0	0
Total	132	124	60	72	176	124	192	64	20	48	12	144	144	124	24	24	352	320	264	280
Total	66%		34%		54%		46%		13%		29%		50%		9%		55%		45%	

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

† main road entrance

‡ pedestrian entrance

Table 20. Extrapolated visitor counts data – Round 3, May and October 2011 survey round (SMC3 – Path along the outside of parkland)

MAY 2011								
	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	60	12	192	24	16	16	80	16
8	24	4	160	32	44	36	72	52
9	20	4	32	8	68	56	36	52
10	24	16	20	20	36	16	44	40
11	12	20	8	4	28	20	28	48
12	20	24	8	8	4	8	16	40
13	12	8	28	12	24	0	12	12
14	4	8	8	28	12	4	16	40
15	8	4	36	28	36	16	40	44
16	20	16	4	76	12	16	28	32
17	24	28	28	124	4	0	4	44
18	112	56	20	108	8	0	4	28
Total	340	200	544	472	292	188	380	448
OCTOBER 2011								
7	24	12	116	20	20	12	52	24
8	28	8	124	20	52	12	216	92
9	4	16	28	12	48	44	76	120
10	20	12	16	8	24	40	48	40
11	20	12	8	8	44	12	32	4
12	0	0	0	12	8	12	20	28
13	24	0	4	0	20	0	20	20
14	12	0	4	12	8	4	24	4
15	28	4	24	28	0	4	8	0
16	20	0	24	44	4	0	4	8
17	28	28	24	128	4	8	8	16
18	60	64	24	88	28	4	16	12
Total	268	156	396	380	260	152	524	368

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

7.10 VISITOR SURVEYS

The 364 surveys completed during Survey Rounds 1 and 2 were supplemented with an additional 204 surveys from Round 3 in May 2011 (Table 21).

Table 21. Number of surveys collected

	Survey rounds			
	Round 1 May-10	**Round 2 Oct-10**	**Round 3 May-11**	**Total**
Weekday	69	73	89	231
Weekend	123	99	115	337
TOTAL	192	172	204	568

7.10.1 DEMOGRAPHICS

In Round 3, the survey respondents were made up equally of men (50%) and women (50%), in line with the total over the three survey rounds (Table 22 & Figure 27).

Table 22. Respondent gender (%)

	Round 1			Round 2			Round 3			Overall
Gender	**Week-day**	**Week-end**	**Overall**	**Week-day**	**Week-end**	**Overall**	**Week-day**	**Week-end**	**Overall**	**Rounds 1 - 3**
Male	59	49	53	47	45	46	57	45	50	50
Female	41	51	47	53	55	54	43	55	50	50

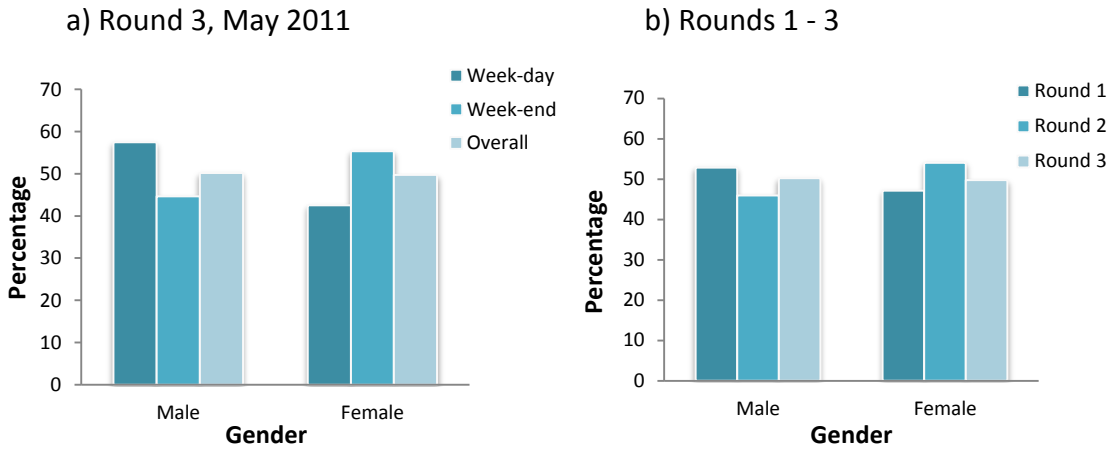


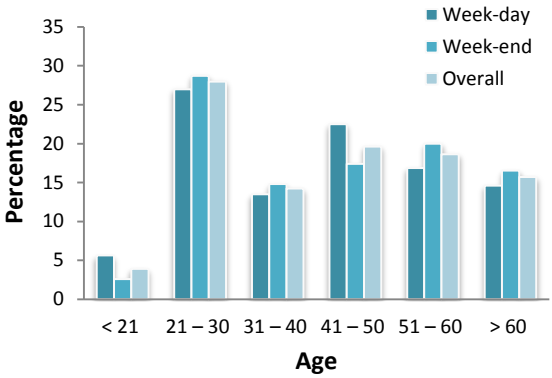
Figure 27. Respondent gender (%) by a) Round 3 – May 2011, b) Rounds 1 - 3

In Round 3, the 21-30 years age group were the most frequent users (28%), followed by the 41-50 years age group (20%). The 51 – 60 years age group and >60 years age groups were made up of 19% and 16% of respondents each respectively. Fourteen percent (14%) of respondents were aged between 31 – 40 years old. There were minimal respondents under the age of 21 years (4%) (Table 23 & Figure 28).

Table 23. Respondent age (%)

Age groups	Round 1			Round 2			Round 3			Overall Rounds 1-3
	Week-day	Week-end	Overall	Week-day	Week-end	Overall	Week-day	Week-end	Overall	
< 21	4	4	4	1	8	5	6	3	4	4
21 – 30	23	28	26	25	20	22	27	29	28	26
31 – 40	12	20	17	18	19	19	13	15	14	16
41 – 50	22	14	17	17	16	16	22	17	20	18
51 – 60	20	21	21	18	16	17	17	20	19	19
> 60	19	14	16	21	20	21	15	17	16	17

a) Round 3, May 2011



b) Rounds 1 - 3

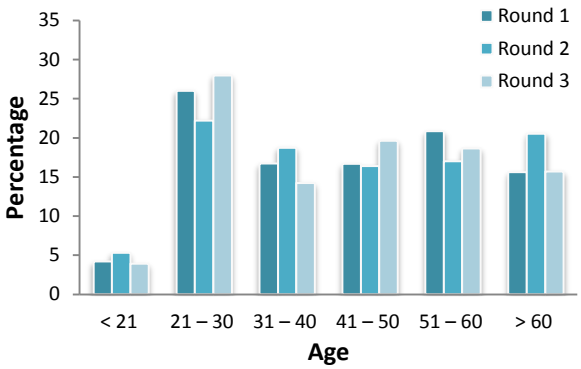
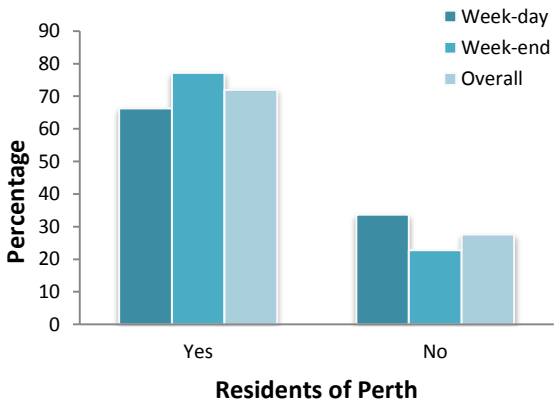


Figure 28. Respondent age (%) by a) Round 3 – May 2011, b) Rounds 1 - 3

Of the 204 respondents in Round 3, 72% were residents of Perth. This is consistent with the overall results to date (71%) (Table 24 & Figure 29).

a) Round 3, May 2011



b) Rounds 1 - 3

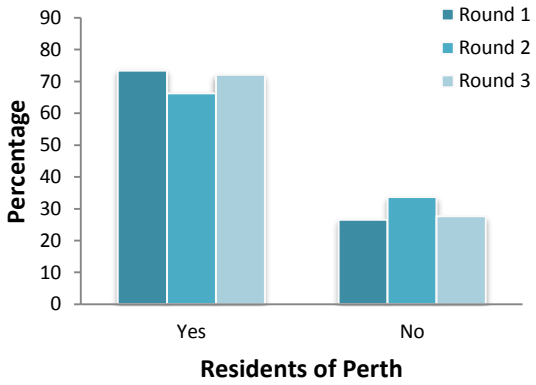


Figure 29. Resident of Perth (%) a) Round 3 – May 2011, b) Rounds 1 - 3

In survey round 3, the largest percentage of respondents from Perth residents came from the postcode 6004 (East Perth) (13%), followed by postcodes 6000 (Perth) (6%) and 6151 (Kensington, South Perth) and 6100 (Burswood, Lathlain, Victoria Park) with five percent respectively. These 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 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 30).

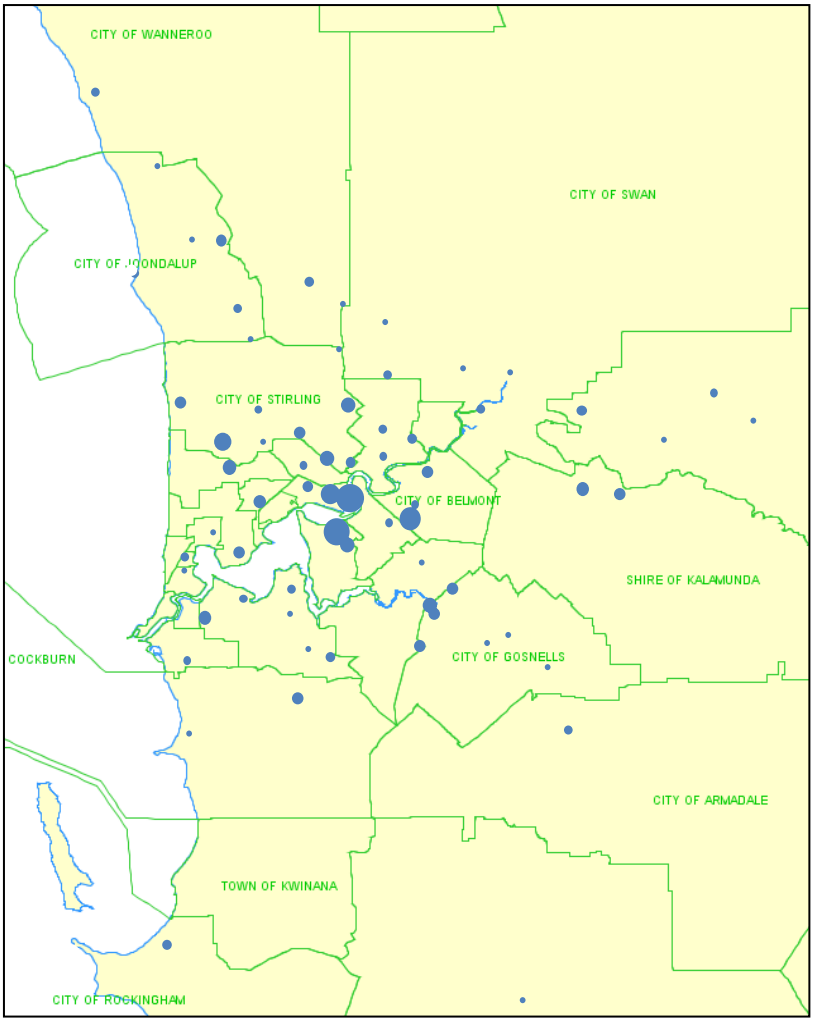


Figure 30. Map of Perth City, blue dots represent nearest postcode that respondents reported in the survey as being their residence (size of dot represents % of the total postcodes reported). Map of Perth taken from the http://www.water.wa.gov.au Geographic Data Atlas.

Of all 204 respondents in Round 3, 18% came from overseas. The majority of respondents who lived in Australia were from Western Australia (72%), with 4% coming from New South Wales, 3% each from Victoria and Queensland (Table 24. Resident of Perth (%)

Resident of Perth	Round 1			Round 2			Round 3			Overall Rounds 1-3
	Week-day	Week-end	Overall	Week-day	Week-end	Overall	Week-day	Week-end	Overall	
Yes	74	73	73	60	71	66	66	77	72	71
No	26	27	27	40	29	34	34	23	28	29

Table 25).

Table 24. Resident of Perth (%)

Resident of Perth	Round 1			Round 2			Round 3			Overall
	Week-day	Week-end	Overall	Week-day	Week-end	Overall	Week-day	Week-end	Overall	Rounds 1-3
Yes	74	73	73	60	71	66	66	77	72	71
No	26	27	27	40	29	34	34	23	28	29

Table 25. Break down of survey respondents' state of origin (%)

Respondents origin	Round 1			Round 2			Round 3			Overall
	Week-day	Week-end	Over-all	Week-day	Week-end	Over-all	Week-day	Week-end	Overall	Rounds 1-3
ACT	0	1	1	0	0	0	0	1	1	0
NSW	2	4	3	7	2	4	2	5	4	4
NT	0	0	0	0	0	0	0	0	0	0
QLD	0	0	0	4	0	2	5	1	3	2
SA	0	0	0	2	1	1	0	0	0	0
TAS	3	0	1	0	0	0	0	0	0	0
VIC	5	3	3	2	3	3	6	1	3	3
WA	73	75	74	59	69	65	66	77	72	71
Overseas	17	18	18	27	25	25	21	15	18	20

Sixteen countries were represented by international survey respondents in Round 3. The largest group of overseas respondents were from the USA (17%). This was followed by Germany (11%), Ireland (11%), Singapore (11%) and UK (11%). The complete list of overseas survey respondents is shown in Appendix C.

7.10.2 PARK USE

In the recent survey round, the majority of respondents' mode of transport to Point Fraser was 'on foot' (69%) (Table 26& Figure 31). The second most popular mode of transport was by car (16%), followed by bicycle (6%). Five percent (5%) of respondents used a mixture of transport modes to get to Point Fraser and 2% used public transport. No respondents used a boat to get to Point Fraser.

a) Round 3, May 2011 b) Rounds 1 - 3

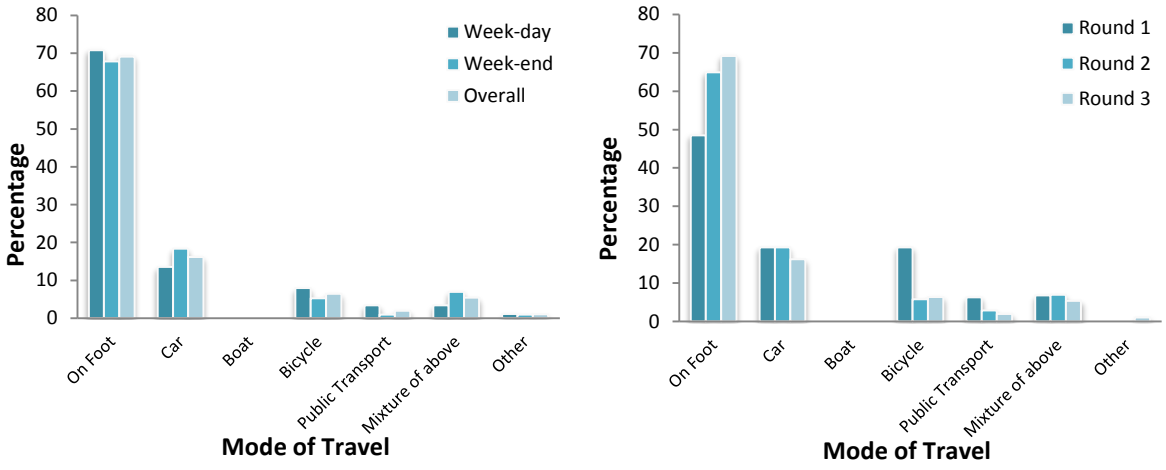


Figure 31. Mode of travel (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

Of Round three's 204 survey respondents, 5% utilised more than one mode of transport to get to Point Fraser. The most common mode of transport combination was 'bicycle / walk' (46%) (Table 26. Mode of transport (%)

Transport mode	Round 1			Round 2			Round 3			Overall Rounds 1-3
	Week day	Week end	Overall	Week day	Week end	Overall	Week day	Week end	Overall	
On Foot	49	48	48	59	69	65	71	68	69	61

Car	15	22	19	29	12	19	14	18	16	18
Boat	0	0	0	0	0	0	0	0	0	0
Bicycle	23	17	19	3	8	6	8	5	6	11
Public Transport	1	9	6	4	2	3	3	1	2	4
Mixture of above	12	4	7	6	8	7	3	7	5	6
Other	0	0	0	0	0	0	1.1	0.9	1	0

Table 27). The second most common mode of transport combination was followed by both 'car / walk' and 'public transport / walk' at 18% each. Other mode of transport combinations included, 'car / bicycle' and 'car / walk / bicycle' with 9% each. Unlike in previous survey rounds, 'public transport / bicycle' was not a mode of travel combination used by Round 3 respondents.

Table 26. Mode of transport (%)

Transport mode	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
On Foot	49	48	48	59	69	65	71	68	69	61
Car	15	22	19	29	12	19	14	18	16	18
Boat	0	0	0	0	0	0	0	0	0	0
Bicycle	23	17	19	3	8	6	8	5	6	11
Public Transport	1	9	6	4	2	3	3	1	2	4
Mixture of above	12	4	7	6	8	7	3	7	5	6
Other	0	0	0	0	0	0	1.1	0.9	1	0

Table 27. Mode of travel combinations

Mode of travel combinations	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
Bicycle / walk	13	20	15	0	13	9	0	63	46	23
Car / bicycle	13	0	8	0	13	9	33	0	9	9
Car / walk	38	80	54	33	63	55	33	13	18	43
Car / walk / bicycle	0	0	0	33	0	9	0	13	9	6
Public transport / bicycle	13	0	8	33	0	9	0	0	0	6
Public transport / walk	25	0	15	0	13	9	33	13	18	14

Overall in Round 3, 78% of respondents had visited Point Fraser before. Thirty-five percent (35%) visited weekly (Table 28 & Figure 32). Fourteen percent visited daily, followed by 12% of respondents who visited once or twice a year, 10% visited monthly and 7% visited less than once per year. It was the first time to visit Point Fraser for 22% of respondents.

a) Round 3, May 2011 b) Rounds 1 - 3

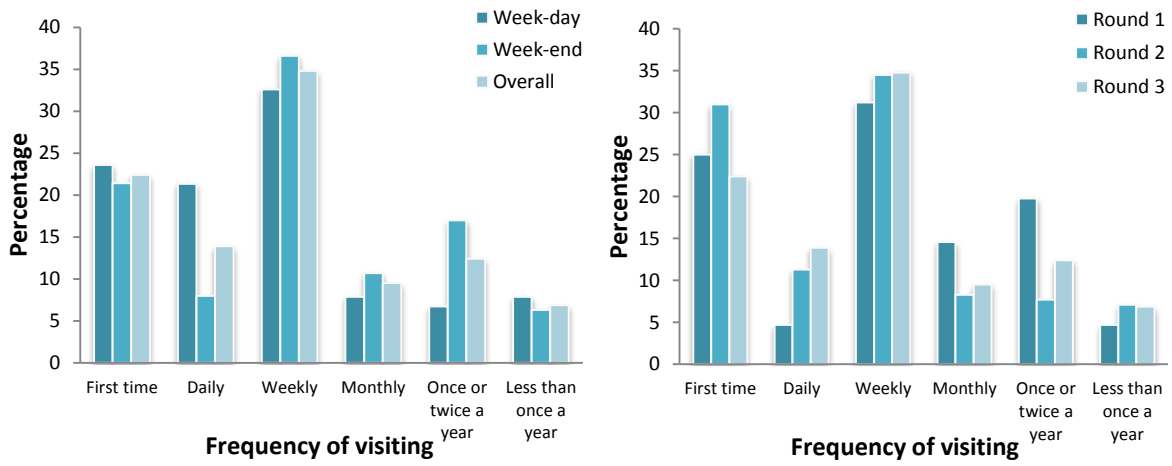


Figure 32. Frequency of visiting point Fraser (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

The majority of respondents (40%), in Round 3, were visiting Point Fraser on their own, while 23% were visiting with their partner and 22% with friends (Table 29 & Figure 33). Visiting Point Fraser with your family made up 10% of respondents and 2% visited with work associates. Two percent (2%) selected 'other'. This included a person visiting with an overseas visitor and several respondents indicating that they were with both family and friends or partner and friends.

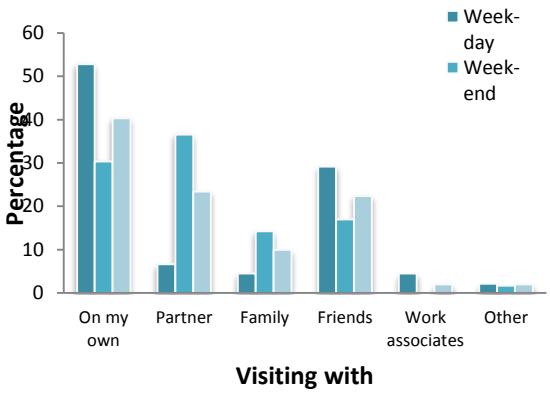
Table 28. Frequency of visiting Point Fraser

Frequency of visit	Round 1			Round 2			Round 3			Overall
	Week-day	Week-end	Overall	Week-day	Week-end	Overall	Week-day	Week-end	Overall	Rounds 1-3
First time	25	25	25	30	32	31	24	21	22	26
Daily	6	4	5	14	10	11	21	8	14	10
Weekly	33	30	31	26	41	35	33	37	35	34
Monthly	13	15	15	11	6	8	8	11	10	11
Once or twice a year	16	22	20	14	3	8	7	17	12	14
Less than once a year	7	3	5	6	8	7	8	6	7	6

Table 29. Respondent visiting Point Fraser with (%)

Visiting with	Round 1			Round 2			Round 3			Overall
	Week-day	Week-end	Overall	Week-day	Week-end	Overall	Week-day	Week-end	Overall	Rounds 1-3
On my own	40	27	31	43	38	40	53	30	40	37
Partner	2	3	3	11	16	14	7	37	23	13
Family	28	28	28	11	13	12	5	14	10	17
Friends	22	37	32	24	31	28	29	17	22	27
Work associates	2	1	1	7	1	4	5	0	2	2
Other	7	4	5	4	2	3	2	2	2	3

a) Round 3, May 2011



b) Rounds 1 - 3

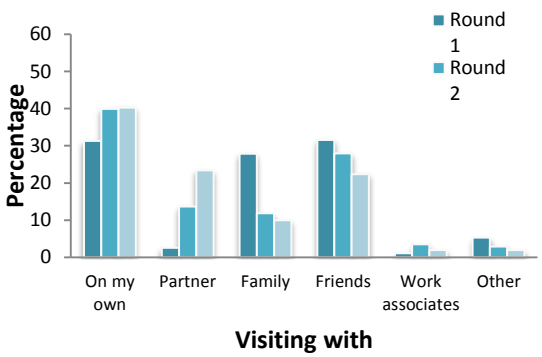


Figure 33. Respondent visiting with (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

In the recent survey period, the majority of respondents arrived at Point Fraser over three peak periods during the day. These included between 7am to 9am (7 – 8am 14% and 8 – 9am 10%); 11am – 1pm (11 – 12pm 11% and 12 – pm 12%); and 2 – 4pm (2 – 3pm 10% and 3 – 4pm 10%). In general Point Fraser was busiest in the morning, at lunchtime and towards early afternoon (Table 30 & Figure 34).

Table 30. Visitor arrivals over time (%)

	Round 1			Round 2			Round 3			Overall
Time arrived	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
Between 6 - 7 am	4	0	2	1	3	2	1	2	2	2
Between 7 - 8 am	0	11	7	14	10	12	13	15	14	11
Between 8 - 9 am	4	6	5	7	16	12	7	12	10	9
Between 9 - 10 am	22	11	15	11	9	10	6	8	7	11
Between 10 - 11 am	16	20	18	14	9	11	8	9	9	13
Between 11 - 12 noon	12	12	12	14	5	9	8	13	11	10
Between 12 - 1 pm	9	5	6	7	4	5	14	10	12	8
Between 1 - 2 pm	9	7	8	12	9	11	8	5	6	8
Between 2 - 3 pm	9	15	13	7	10	9	12	8	10	10
Between 3 - 4 pm	6	10	8	7	8	8	9	10	10	9
Between 4 - 5 pm	7	3	5	4	5	5	10	8	9	6
Between 5 - 6 pm	3	2	2	3	10	7	5	1	2	4

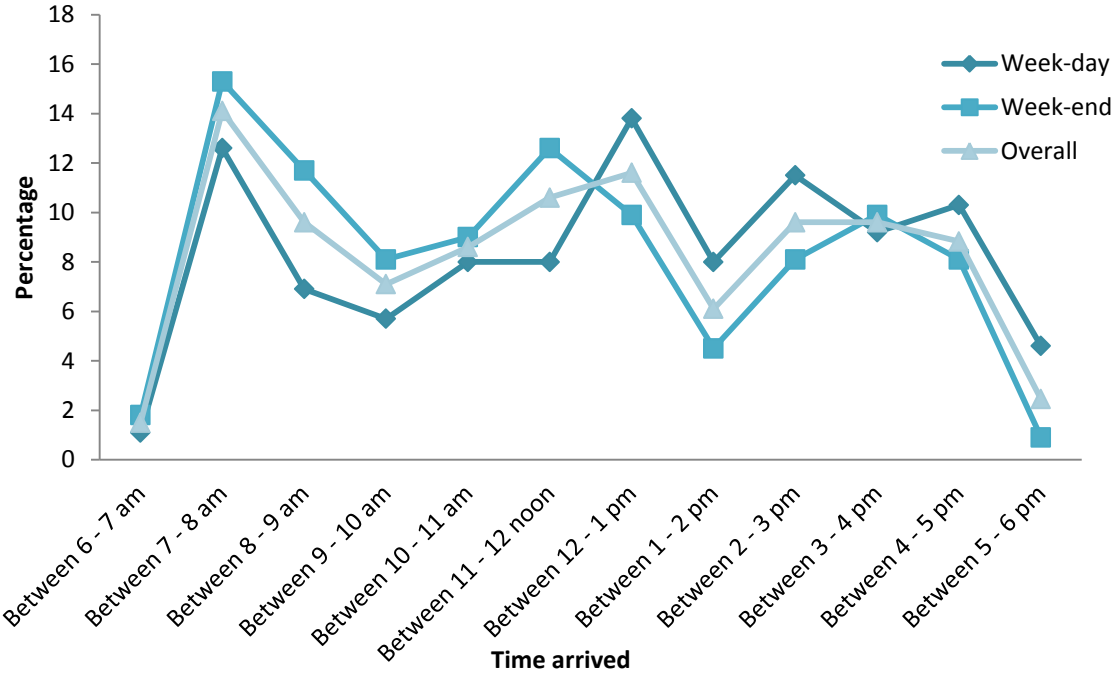


Figure 34. Visitor arrivals over time, Round 3, May 2011

Over half (56%) of survey respondents were passing through Point Fraser (Table 31). Of those respondents who were not passing through, 21% stayed for less than 1 hour and 18% stayed for 1 – 2 hours. A small proportion of respondents, (3%) stayed for 2 – 4 hours and just 1% for more than 4 hours.

Survey respondents were asked what activities they were doing at Point Fraser and were able to select multiple responses. In Round 3, by far the majority of respondents (75%) were 'walking' in (and mostly through) the reserve rather than specifically visiting the reserve (Table 31. Time period respondents stay at Point Fraser (%)

Time period	Round 1			Round 2			Round 3			Overall Rounds 1-3
	Week day	Weekend	Overall	Week day	Week-end	Overall	Week day	Weekend	Overall	
Passing through	55	40	45	46	62	55	62	52	56	52
< 1	13	22	19	18	14	16	21	21	21	19

hour										
1 - 2 hours	17	26	23	21	16	18	11	23	18	20
2 - 4 hours	10	9	9	6	5	5	3	4	3	6
> 4 hours	4	2	3	10	3	6	2	1	1	3

Table 32 & Figure 35). Of Round 3 survey respondents, 19% were cycling and 17% running / jogging. General enjoyment of Point Fraser was considered by 11% of respondents and 9% were there for photography. Four (4%) percent were using the services of About a Bike Hire. Smaller proportions of respondents were utilising interpretative trails (3%), playground (3%) and other (3%). The 'other' activities specified by respondents included, car park, canoeing, enjoying time with grandchildren, Frisbee, looking and walking dog (Section 11.5).

There have been a number of changes to this survey question over the three survey rounds which reflect the fluctuations in the data, evident in the table below. In the second survey round, cycling, running / jogging and walking were added as activity choices to the survey. This affected the results of Round 2, leading to a dramatic reduction in the percentage choosing 'passing through' (35%). In the third survey round, 'passing through' was removed completely to gain a clearer insight of the specific activities respondents were undertaking. For example rather than a survey respondent just indicating that they were 'passing through', they were now required to specify if they were 'walking' or 'cycling' or 'running'. This gives more clarity to the data.

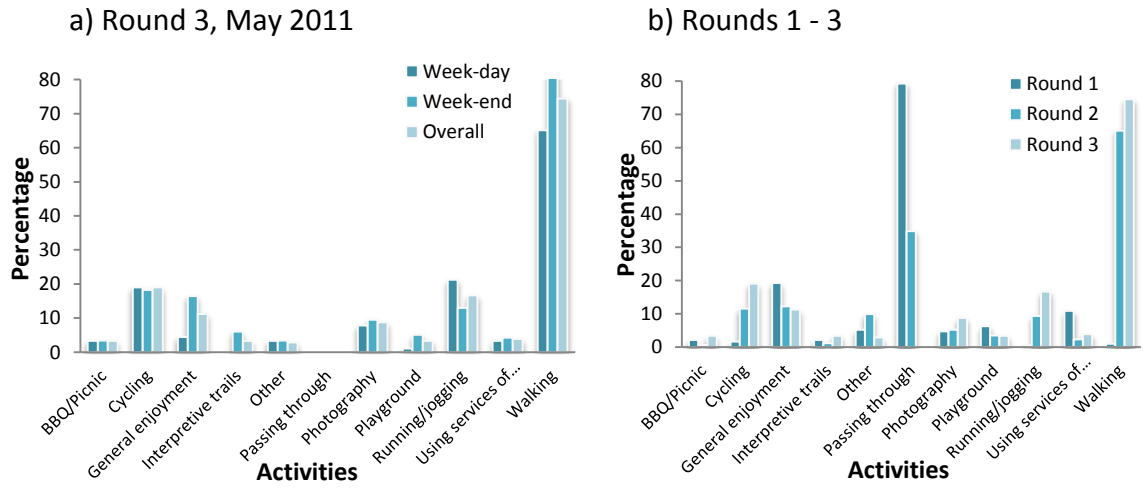


Figure 35. Activities undertaken at Point Fraser (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

Respondents were asked for the main reasons why they visited Point Fraser (Table 31.

Time period respondents stay at Point Fraser (%)

Time period	Round 1			Round 2			Round 3			Overall Rounds 1-3
	Weekday	Weekend	Overall	Weekday	Week-end	Overall	Weekday	Weekend	Overall	
Passing through	55	40	45	46	62	55	62	52	56	52
< 1 hour	13	22	19	18	14	16	21	21	21	19
1 - 2 hours	17	26	23	21	16	18	11	23	18	20
2 - 4 hours	10	9	9	6	5	5	3	4	3	6
> 4 hours	4	2	3	10	3	6	2	1	1	3

Table 32. Activities undertaken at Point Fraser (%)

Activities	Round 1			Round 2			
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Week
BBQ/Picnic	0	3	2	0	1	1	3
Cycling	0	0	2	11	12	12	19
General enjoyment	17	20	19	14	11	12	5
Interpretive trails	0	3	2	1	1	1	0
Other	13	6	5	18	4	10	3
Passing through	80	79	79	30	38	35	
Photography	0	7	5	7	4	5	8
Playground	3	8	6	7	1	4	1
Running/jogging	0	0	1	11	8	9	21
Using services of About Bike Hire	10	11	11	4	1	2	3
Walking	0	0	1	62	68	65	65

Table 33 & Figure 36). More than sixty percent (64%) indicated that they were visiting Point Fraser for exercise. Another popular response was 21% who were spending time with family / friends. Less popular reasons for visiting Point Fraser included 'scenery' (4%), 'other' (4%),

'rest and relax' (2%), 'experiencing nature' (2%), 'something new and different' (1%), 'proximity to the city' (1%)and 'proximity to the river' (1%). No respondents indicated that the reason they had visited Point Fraser was to 'learn about storm water' or 'learn about the environment'. The respondents who chose 'other' specified a number of reasons for visiting Point Fraser rather than just selecting a single reason in the question.

a) Round 3, May 2011

b) Rounds 1 – 3

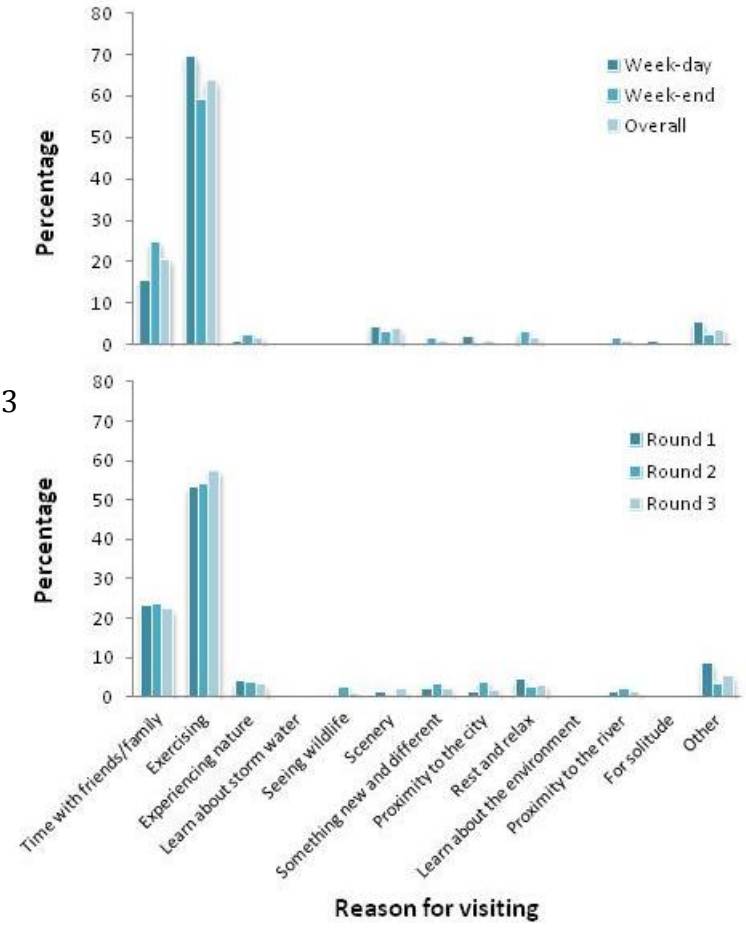


Figure 36. Reason for visiting Point Fraser (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

7.10.3 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). In Rounds 1 – 3 respondents were asked about the quality of park features. Overall satisfaction was very high, with very few negative ratings with the exception of the rating of the toilet facilities. Ninety-six (96%) percent of respondents were satisfied with the cleanliness of the park with one percent rating it very poor and 3% neither poor nor good (Table 30 & Figure 37).

Table 31. Time period respondents stay at Point Fraser (%)

Time period	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Week-end	Overall	Weekday	Weekend	Overall	Rounds 1-3
Passing through	55	40	45	46	62	55	62	52	56	52
< 1 hour	13	22	19	18	14	16	21	21	21	19
1 - 2 hours	17	26	23	21	16	18	11	23	18	20
2 - 4 hours	10	9	9	6	5	5	3	4	3	6
> 4 hours	4	2	3	10	3	6	2	1	1	3

Table 32. Activities undertaken at Point Fraser (%)

Activities	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
BBQ/Picnic	0	3	2	0	1	1	3	4	3	2
Cycling	0	0	2	11	12	12	19	18	19	11
General enjoyment	17	20	19	14	11	12	5	17	11	14
Interpretive trails	0	3	2	1	1	1	0	6	3	2
Other	13	6	5	18	4	10	3	4	3	6
Passing through	80	79	79	30	38	35				
Photography	0	7	5	7	4	5	8	10	9	6
Playground	3	8	6	7	1	4	1	5	3	4
Running/jogging	0	0	1	11	8	9	21	13	17	9
Using services of About Bike Hire	10	11	11	4	1	2	3	4	4	6
Walking	0	0	1	62	68	65	65	82	75	47

Table 33. Reason for visiting Point Fraser (%)

Reasons for visiting	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
Time with friends/family	7	32	23	17	29	24	16	25	21	22
Exercising	62	48	53	45	61	54	70	59	64	58
Experiencing nature	7	3	4	5	3	4	1	3	2	3
Learn about storm water	0	0	0	0	0	0	0	0	0	0
Seeing wildlife	2	0	1	5	1	3	0	0	0	1
Scenery	0	2	1	2	0	1	5	4	4	2
Something new and different	3	2	2	5	2	3	0	2	1	2
Proximity to the city	3	0	1	8	1	4	2	0	1	2
Rest and relax	7	4	5	5	1	3	0	4	2	3
Learn about the environment	0	0	0	0	0	0	0	0	0	0
Proximity to the river	2	1	1	5	0	2	0	2	1	1
For solitude	0	0	0	0	0	0	1	0	0	0
Other	8	9	9	6	1	3	6	3	4	5

Table 34. Quality of features – cleanliness (%)

Cleanliness	Round 1			Round 2			Round 3			Overall
	Week-day	Week-end	Overall	Week-day	Week-end	Overall	Week-day	Week-end	Overall	Rounds 1-3
1 = very poor	2	0	1	0	1	1	0	0	0	0
2	0	0	0	1	0	1	1	1	1	1
3	5	3	4	12	3	7	0	5	3	5
4	30	39	36	26	42	35	39	49	45	39
5 = excellent	64	58	60	59	52	55	58	45	51	55
N/A	0	0	0	1	1	1	1	0	1	1

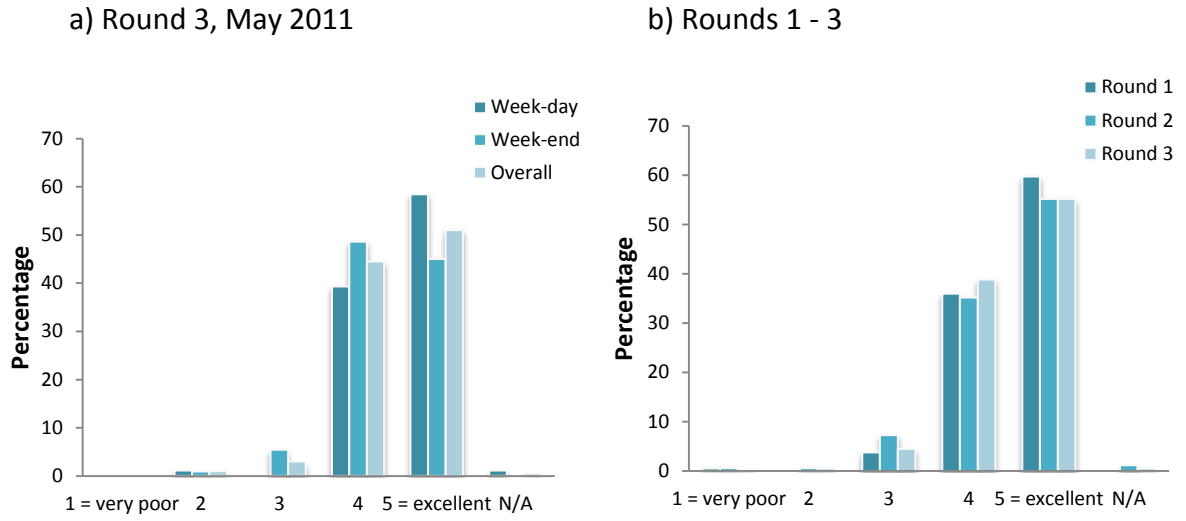


Figure 37. Quality of features – cleanliness (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

Access was rated as good or excellent by 93%, with 2% rating it as poor and 5% neither poor nor good (Table 35 & Figure 38). The comments in Appendix B highlight areas for improvement with regards to access, including negative comments regarding paid parking and lack of public transport.

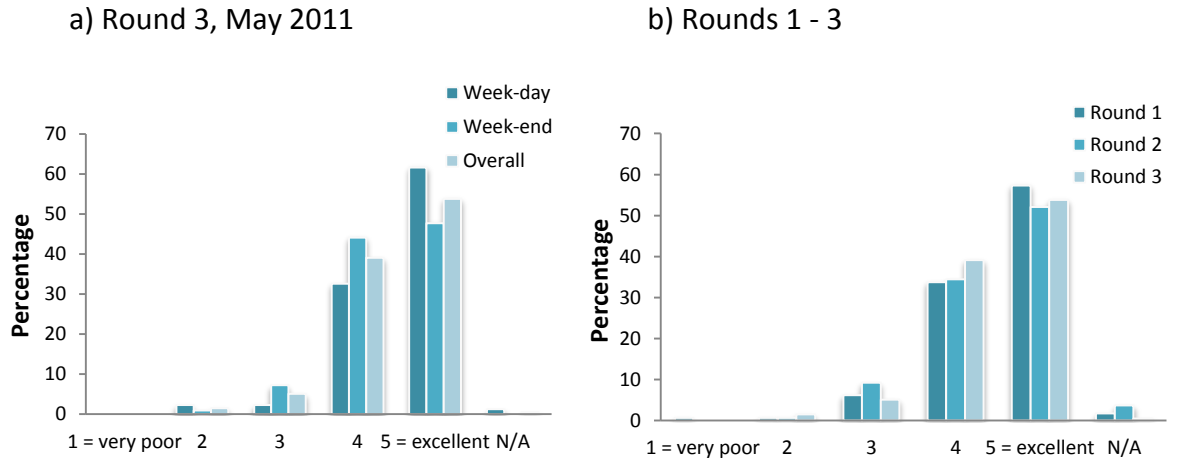


Figure 38. Quality of features – access (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

Playground facilities were also rated positively. Although almost a third (29%) of respondents ticked ‘not applicable’, indicating that they did not use or were not familiar with the playground facilities (Table 36 & Figure 39).

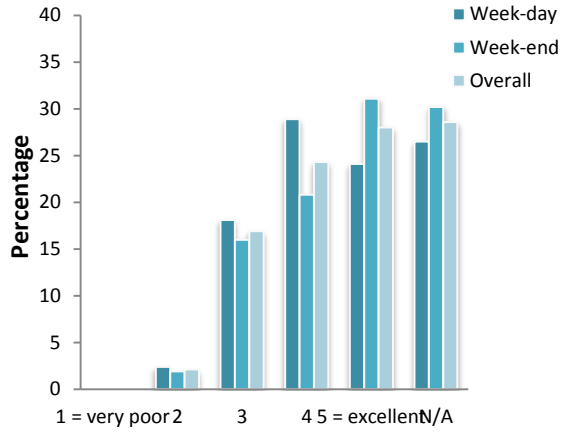
Table 35. Quality of features – access (%)

Access	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
1 = very poor	2	0	1	0	0	0	0	0	0	0
2	0	1	1	1	0	1	2	1	2	1
3	5	7	6	12	7	9	2	7	5	7
4	28	37	34	26	41	34	33	44	39	36
5 = excellent	65	53	57	55	50	52	62	48	54	55
N/A	2	2	2	6	2	4	1	0	1	2

Table 36. Quality of features – playground facilities (%)

Playground facilities	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
1 = very poor	0	0	0	0	1	1	0	0	0	0
2	5	0	2	1	3	3	2	2	2	2
3	11	13	12	14	13	13	18	16	17	14
4	25	20	22	17	28	23	29	21	24	23
5 = excellent	22	30	27	26	24	25	24	31	28	27
N/A	38	36	37	41	31	35	27	30	29	33

a) Round 3, May 2011



b) Rounds 1 - 3

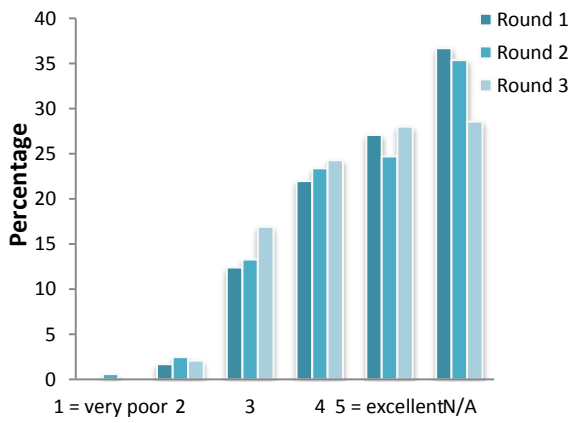
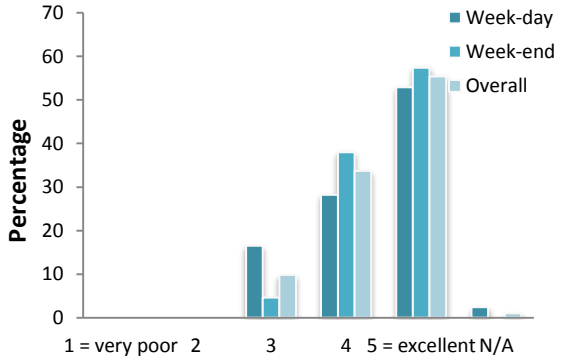


Figure 39. Quality of features – playground facilities (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

Point Fraser parkland was rated very highly for its scenic beauty with 89% rating the parkland as good or excellent and with minimal negative responses and 10% neutral about the scenery (Table 37 & Figure 40).

a) Round 3, May 2011



b) Rounds 1 - 3

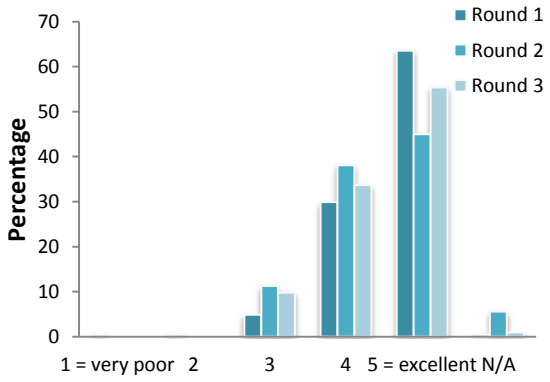


Figure 40. Quality of features – scenic beauty (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

The high rate (34%) of 'not applicable' with regards to the quality of barbeque facilities highlights a lack of awareness, familiarity with or use of the facilities (Table 38 & Figure 41). As per comments for improvements (Appendix B) and as illustrated in site photographs (see 2010 report), 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.

Table 37. Quality of features – scenic beauty (%)

Scenic beauty	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
1 = very poor	2	0	1	0	0	0	0	0	0	0
2	0	1	1	0	0	0	0	0	0	0
3	5	5	5	15	9	11	17	5	10	9
4	27	31	30	35	41	38	28	38	34	34
5 = excellent	67	62	64	45	45	45	53	57	55	55
N/A	0	1	1	6	6	6	2	0	1	2

Table 38. Quality of features – BBQ facilities (%)

BBQ facilities	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
1 = very poor	0	0	0	0	1	1	1	0	1	0
2	6	1	3	9	0	4	6	7	7	5
3	6	19	14	9	16	13	25	18	21	16
4	16	16	16	16	25	21	23	25	24	21
5 = excellent	13	17	15	19	11	15	14	14	14	15
N/A	59	48	52	46	47	47	30	37	34	44

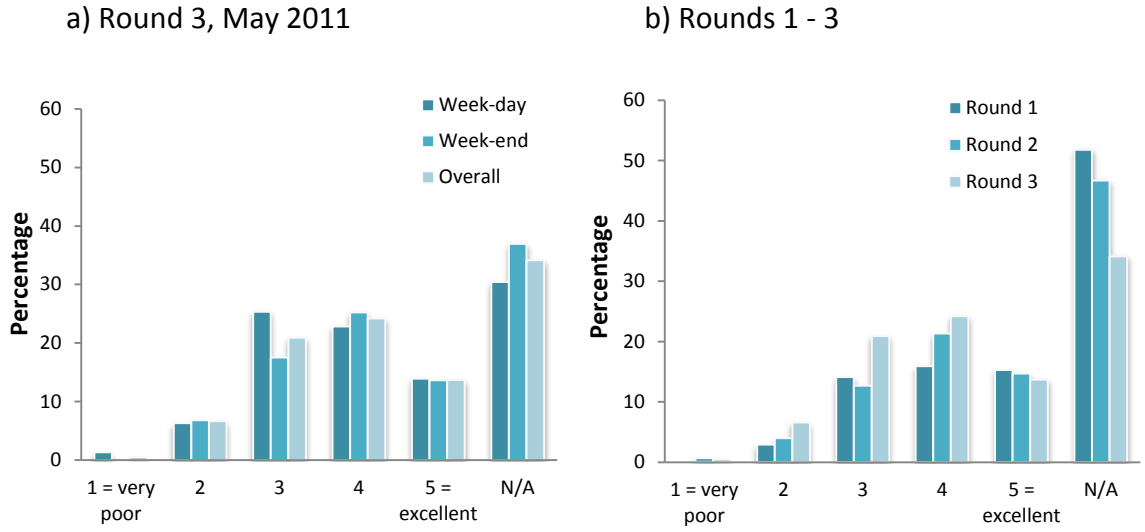


Figure 41. Quality of features – BBQ facilities (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

Out of the surveyed features of Point Fraser parkland, the toilet facilities attracted the most criticism. Considering 19% of 'non-applicable' responses, a total of 26% rated the toilet facilities as very poor or poor, compared to a 34% of positive responses and 21% rating them neither good nor bad (Table 39 & Figure 42). Issues of availability, placement, cleanliness and accessibility (i.e. disabled access) as also highlighted by a substantial number of comments (see Appendix B) require immediate attention.

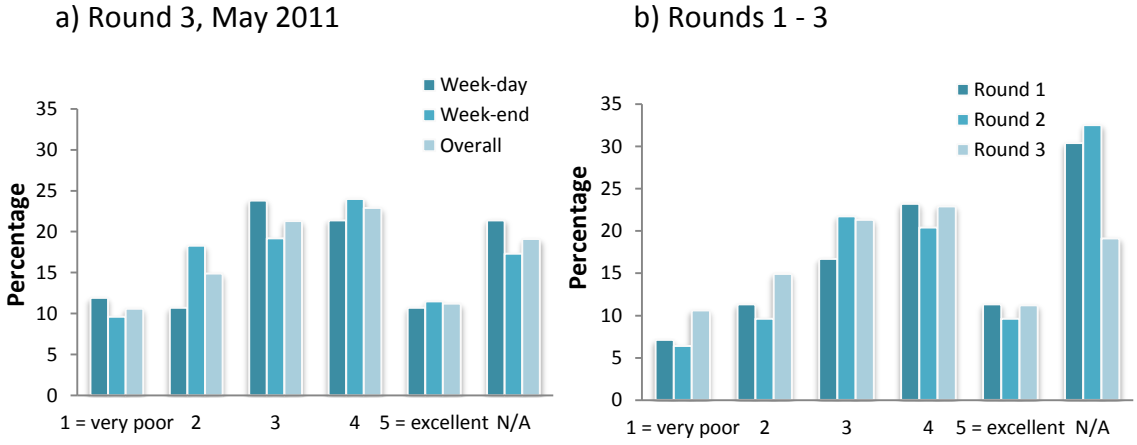


Figure 42. Quality of features – Toilet facilities (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

Overall, 12% of respondents rated the signage as poor or very poor, 29% were neutral and 56% were positive (Table 40 & Figure 43). Round 3 comments regarding signage (Appendix B) highlight a need in particular for directional signage. The survey does not make a distinction between directional, informational or interpretive signage. Use, perception, needs and effectiveness of different types of signage in the reserve are aspects that warrant further research.

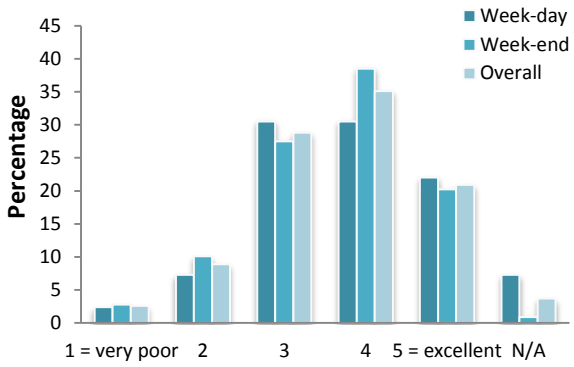
Table 39. Quality of features – Toilet facilities (%)

Toilet facilities	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
1 = very poor	10	6	7	7	6	6	12	10	11	8
2	8	13	11	12	8	10	11	18	15	12
3	16	17	17	21	23	22	24	19	21	20
4	25	22	23	13	26	20	21	24	23	22
5 = excellent	12	11	11	13	7	10	11	12	11	11
N/A	30	31	30	34	32	33	21	17	19	27

Table 40. Quality of features – Signage (%)

Signage	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
1 = very poor	0	3	2	0	0	0	2	3	3	2
2	3	6	5	4	0	2	7	10	9	6
3	24	21	22	23	19	21	31	28	29	24
4	37	33	34	30	45	38	31	39	35	36
5 = excellent	30	24	26	33	21	26	22	20	21	24
N/A	6	13	10	10	15	13	7	1	4	9

a) Round 3, May 2011



b) Rounds 1 - 3

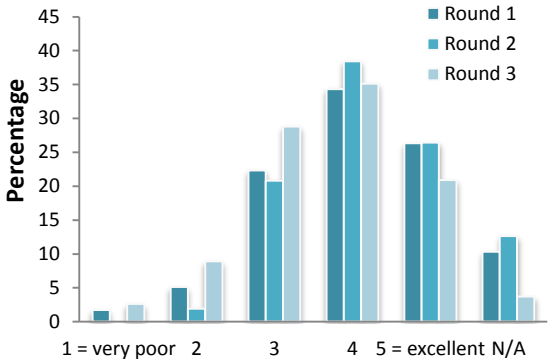
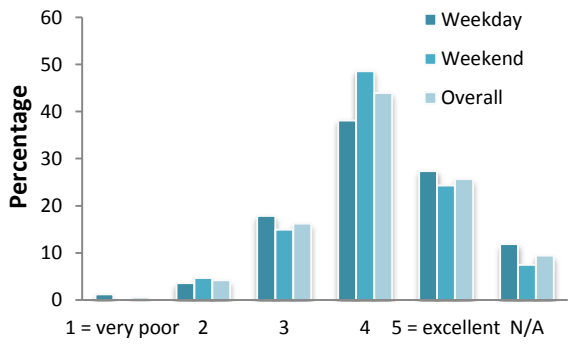


Figure 43. Quality of features – Signage (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

In Rounds 1 and 2, seating and tables had been combined. However, since there are no tables in the park, it was considered that seating and tables should in fact be separated to present a more accurate picture. Almost three quarters of respondents (74%) in Round 3 were positive about the quality of the seating (Table 41 & Figure 44). While 15% considered the seating to be neither good or bad and 5% were dissatisfied. However, 18% of respondents considered the quality of tables negatively, 26% neutral and 35% were positive.

a) Seating - Round 3, May 2011



b) Tables - Round 3, May 2011

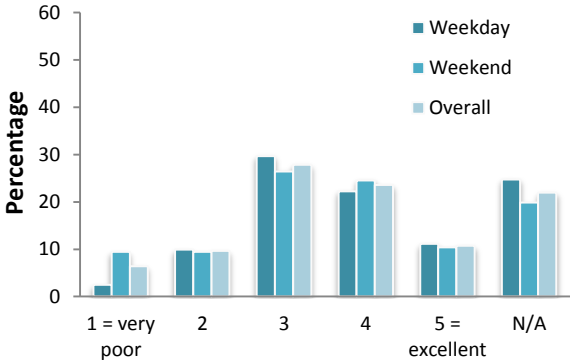


Figure 44. Quality of features – Seating and tables (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

Twenty-three (23%) percent of respondents rated education as not applicable, with 44% rating it as good or excellent, 25% neither good nor bad, and 8% as poor or very poor (Table 42 & Figure 45). 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 41. Quality of features – Seating and tables (%)

Seating	Round 3		
	Weekday	Weekend	Overall
1 = very poor	1	0	1
2	4	5	4
3	18	15	16
4	38	49	44
5 = excellent	27	24	26
N/A	12	7	9

Tables	Round 3		
	Weekday	Weekend	Overall
1 = very poor	2	9	6
2	10	9	10
3	30	26	28
4	22	25	24
5 = excellent	11	10	11
N/A	25	20	22

Table 42. Quality of features – Education (%)

Education	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
1 = very poor	2	2	2	3	2	3	1	0	1	2
2	3	6	5	3	5	4	8	7	7	5
3	20	19	19	20	17	18	25	25	25	21
4	16	29	24	24	15	19	26	30	28	24
5 = excellent	15	15	15	19	14	16	15	17	16	16
N/A	44	30	35	31	47	40	25	21	23	32

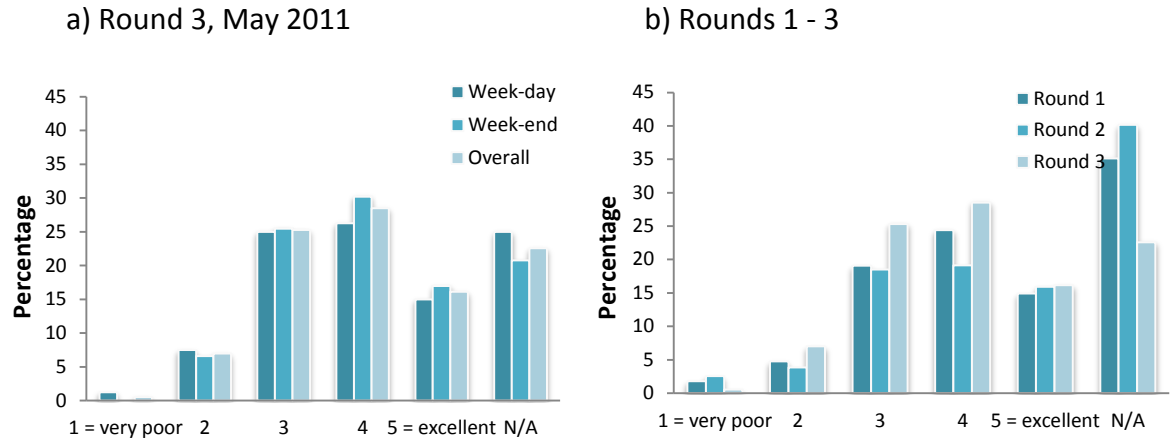


Figure 45. Quality of features – education (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

Forty-two (42%) percent of respondents ranked About Bike Hire as excellent or good, 13% as neither bad nor good and 7% as either poor or very poor (Table 43). Thirty-eight (38%) 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. These data require cautious interpretation as it appears that there is limited awareness of the name and presence of 'About a Bike hire' amongst respondents.

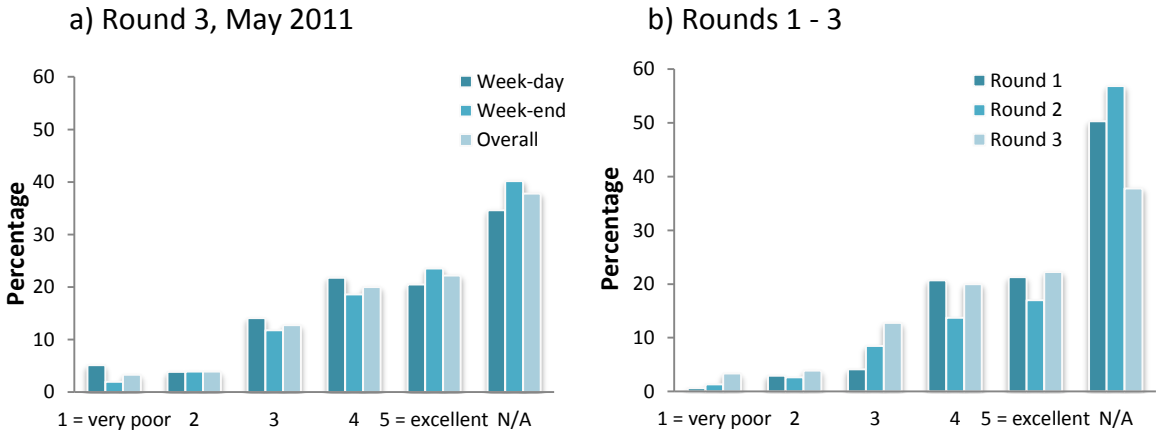


Figure 46. Quality of features – About Bike Hire (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

Thirty-nine (39%) percent of respondents ranked staff interaction as excellent or good, 12% as neither bad nor good and 15% as either poor or very poor (Table 44 & Figure 47). Thirty-five 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. Thus as per comments regarding the previous item, caution is required in the interpretation of these results.

Table 43. Quality of features – About Bike Hire (%)

About bike hire	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
1 = very poor	2	0	1	1	1	1	5	2	3	2
2	2	4	3	5	5	3	4	4	4	3
3	2	6	4	10	10	8	14	12	13	9
4	19	21	21	14	14	14	22	19	20	18
5 = excellent	21	21	21	10	10	17	21	24	22	20
N/A	55	48	50	59	59	57	35	40	38	48

Table 44. Quality of features – Staff interaction (%)

Staff interaction	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
1 = very poor	0	3	2	0	0	2	8	4	6	3
2	5	5	5	5	5	3	11	7	9	6
3	10	14	12	8	11	10	9	14	12	11
4	15	11	12	16	12	14	16	15	16	14
5 = excellent	16	18	18	27	17	21	26	20	23	20
N/A	55	50	51	44	55	51	30	39	35	46

a) Round 3, May 2011 b) Rounds 1 - 3

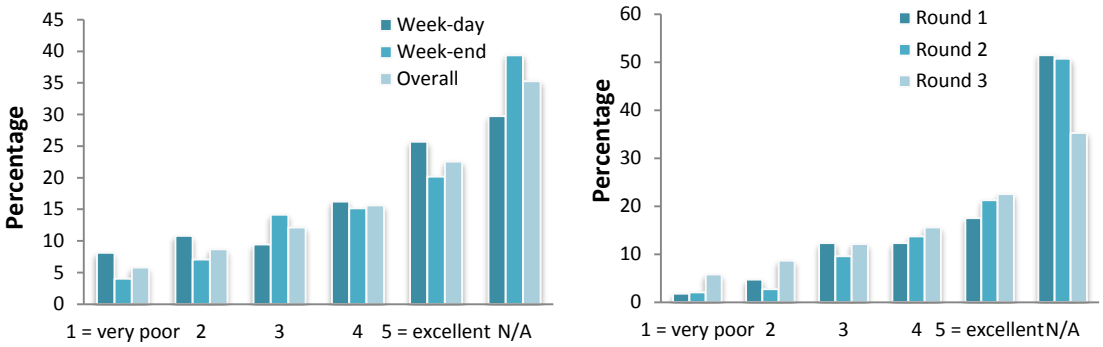


Figure 47. Quality of features – Staff interaction (%) by a) Round 3 – May 2011, b) Rounds 1-3.

In addition to the listed features, there was also the option for 'other' features not listed. The list below outlines what Round 3 respondents specified as 'other':

- Access from one type of cycling track to another plus appropriate signage;
- very poor;
- Heirisson Island

In Round 3, the importance of park features was added to give depth to the analysis of park satisfaction, also using a 5-point Likert scale (1=very poor; 5=excellent). Overall respondents considered cleanliness of the park to be importance, with 79% selecting high importance and 18% selecting important (Table 45 & Figure 48).

Table 45. Importance of features – cleanliness (%)

Cleanliness	Round 3		
	Weekday	Weekend	Overall
1 = low importance	0	0	0
2	1	0	1
3	1	3	2
4	21	15	18
5 = high importance	76	82	79
N/A	0	0	0

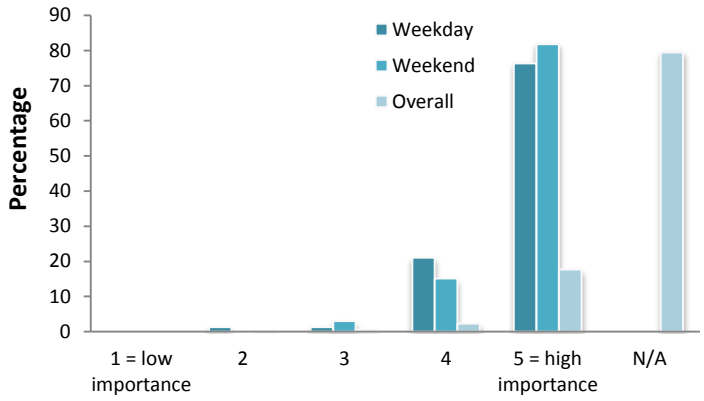


Figure 48. Importance of features – cleanliness (%) by Round 3 – May 2011.

Access was considered to be an important feature with 93% either selecting important or high importance, 5% were neutral and 2% considered it be of low importance (Table 35 & Figure 49).

Table 46. Importance of features – access (%)

Access	Round 3		
	Weekday	Weekend	Overall
1 = low importance	0	1	1
2	1	1	1
3	4	6	5
4	36	24	30
5 = high importance	57	67	63
N/A	1	0	1

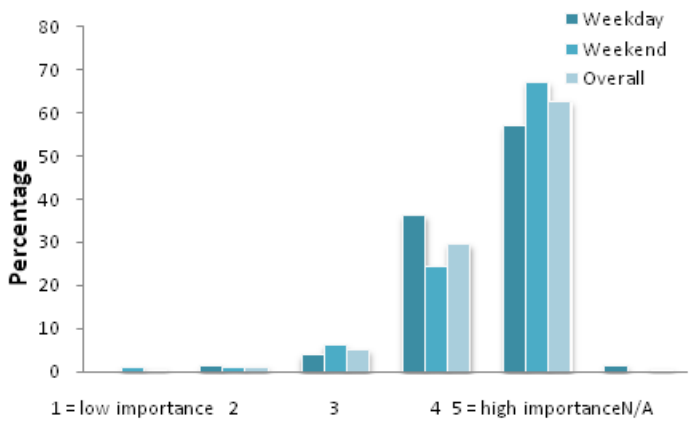


Figure 49. Importance of features – access (%) by Round 3 – May 2011.

The importance of playground facilities was quite varied with 19% considering it to be of low importance and 18% were considered it to be neither important or not important. Twenty-seven (27%) indicated playground facilities to be of high importance and 24% important. While 13% selected playground facilities as not applicable to them (Table 47 & Figure 50).

Table 47. Importance of features – playground (%)

Playground	Round 3		
	Weekday	Weekend	Overall
1 = low importance	5	13	10
2	11	8	9
3	19	16	18
4	30	18	24
5 = high importance	22	32	27
N/A	12	13	13

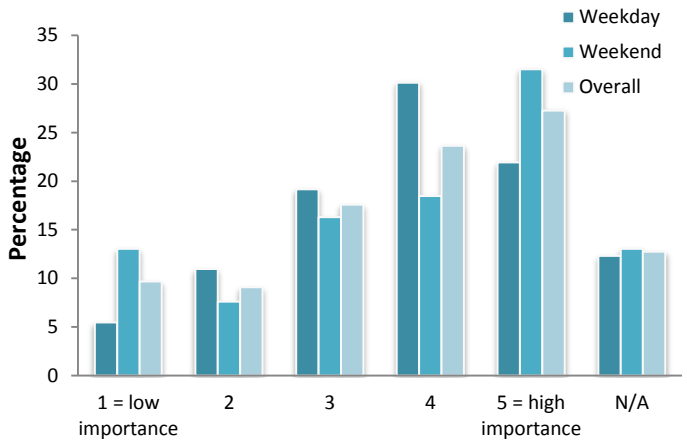


Figure 50. Importance of features – playground (%) by Round 3 – May 2011.

Sixty-five (65%) percent of respondents considered the importance of scenic beauty to not applicable to them, while 34% considered it to be of importance or high importance. One percent (1%) were neutral and 1% selected scenic beauty to be of low importance (Table 48 &

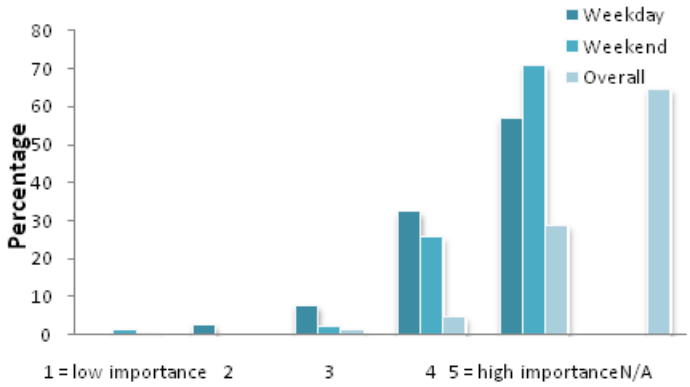


Figure 51).

Table 48. Importance of features – scenic beauty (%)

Scenic beauty	Round 3		
	Weekday	Weekend	Overall
1 = low importance	0	1	1
2	3	0	0
3	8	2	1
4	32	26	5

5 = high importance	57	71	29
N/A	0	0	65

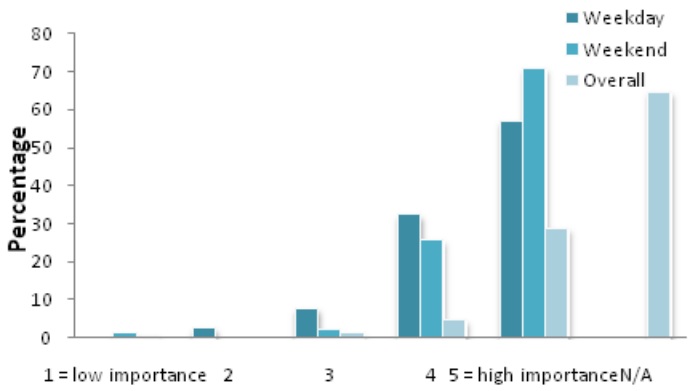


Figure 51. Importance of features – scenic beauty (%) by Round 3 – May 2011.

The importance of BBQ facilities was varied. The majority of respondents (52%) indicated BBQ facilities to be of importance or high importance. Twenty-two (22%) percent of respondents were neutral, while 14% considered BBQ facilities to be of low importance and 12% not applicable (Table 49& Figure 52).

Table 49. Importance of features – BBQ facilities (%)

BBQ facilities	Round 3		
	Weekday	Weekend	Overall
1 = low importance	4	5	5
2	8	9	9
3	24	21	22
4	28	29	29
5 = high importance	27	21	23
N/A	8	15	12

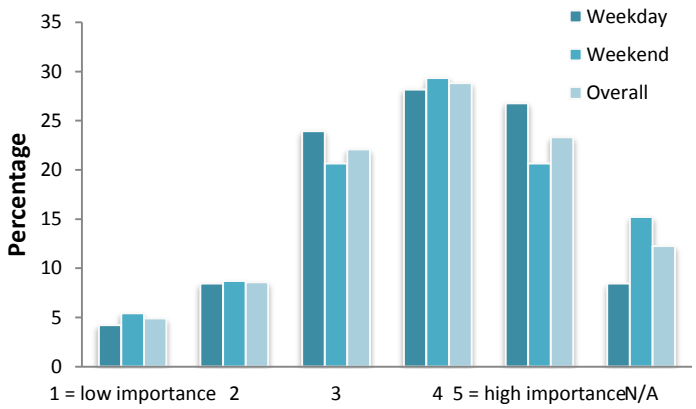


Figure 52. Importance of features – BBQ facilities (%) by Round 3 – May 2011.

Toilet facilities were considered to be of high importance to 56% of respondents and of importance to 30%. A smaller proportion of respondents ticked either neutral (7%), less important (2%) or low importance (2%) and 4% considered toilet facilities to be not applicable (Table 50 & Figure 53).

Table 50. Importance of features – Toilet facilities (%)

Toilet facilities	Round 3		
	Weekday	Weekend	Overall
1 = low importance	2	1	2
2	1	4	2
3	4	9	7
4	32	27	30
5 = high importance	58	53	56
N/A	3	5	4

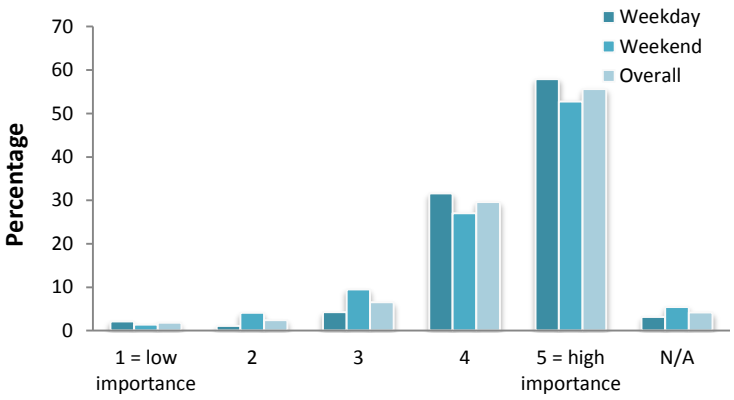


Figure 53. Importance of features – Toilet facilities (%) by Round 3 – May 2011.

Signage was considered to be a feature in the park of importance, with 40% indicating high importance and 39% importance. Of the respondents, 14% were neutral, 4% considered signage to be less importance, 2% low importance and 1% not applicable (Table 51 & Figure 54).

Table 51. Importance of features - Signage (%)

Signage	Round 3		
	Weekday	Weekend	Overall
1 = low importance	1	3	2
2	7	2	4
3	14	14	14
4	43	36	39
5 = high importance	32	45	40
N/A	3	0	1

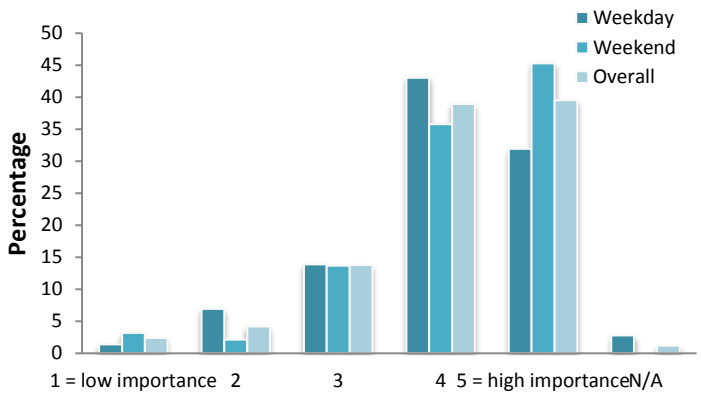


Figure 54. Importance of features – Signage (%) by Round 3 – May 2011.

The importance of seating was rated highly among respondents, with 37% high importance and 43% importance. Ten (10%) percent of respondents considered seating

to be neither important nor not important and 6% less or low importance. While 4% indicated that the importance of seating was not applicable (**Table 52** & **Figure 55**).

Table 52. Importance of features - Seating (%)

Seating	Round 3		
	Weekday	Weekend	Overall
1 = low importance	0	4	2
2	5	2	4
3	11	10	10
4	47	40	43
5 = high importance	32	40	37
N/A	4	3	4

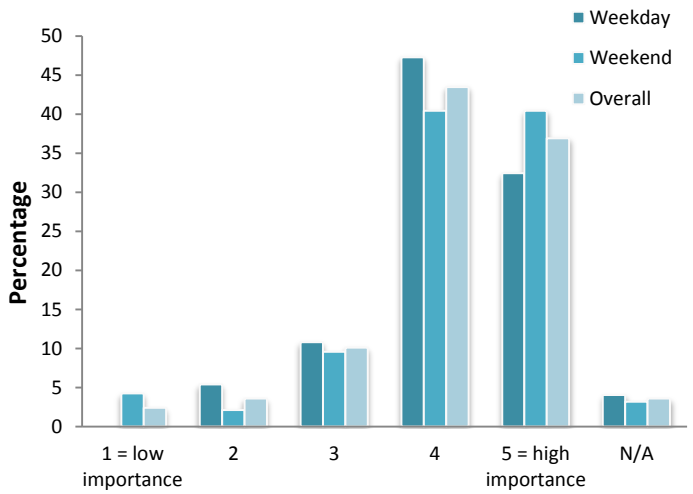


Figure 55. Importance of features – Seating (%) by Round 3 – May 2011.

The importance of tables as a feature was more varied with 26% considering them to be of high importance, while 41% important. Sixteen (16%) percent were neutral about the importance of tables and 10% considered tables to be of less or low importance. Tables were not applicable for 7% of respondents (Table 53 & Figure 56).

Table 53. Importance of features - Tables (%)

Tables	Round 3 - May 2011		
	Weekday	Weekend	Overall
1 = low importance	1	5	4
2	10	3	6
3	16	16	16
4	50	34	41

5 = high importance	18	32	26
N/A	4	9	7

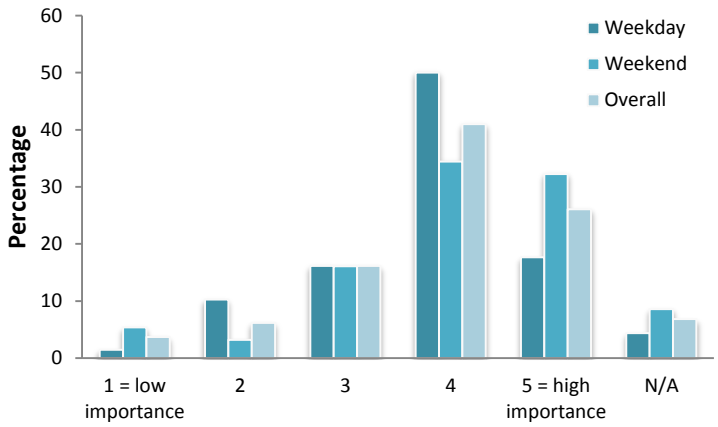


Figure 56. Importance of features – Tables (%) by Round 3 – May 2011.

Education was considered to be of importance or high importance by 57% of respondents, 21% were neutral and 9% less or low importance. Twelve (12%) considered education to be not applicable (Table 54 & Figure 57).

Table 54. Importance of features - Education (%)

Education	Round 3		
	Weekday	Weekend	Overall
1 = low importance	3	4	4
2	9	3	5
3	27	17	21
4	30	35	33
5 = high importance	20	28	24
N/A	11	13	12

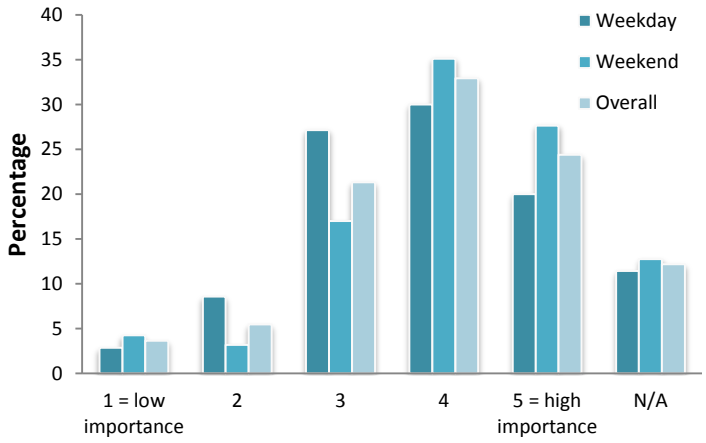


Figure 57. Importance of features – Education (%) by Round 3 – May 2011.

Of the survey respondents, 17% considered the importance of About a Bike Hire to be not applicable to them. More than fifty percent (51%) viewed About a Bike Hire as an important feature, 19% were neutral and 13% considered it to be of low importance (Table 55 & Figure 58).

Table 55. Importance of features – About a Bike Hire (%)

About a Bike Hire	Round 3		
	Weekday	Weekend	Overall
1 = low importance	5	11	8
2	8	3	5
3	18	19	19
4	36	26	30
5 = high importance	18	22	21
N/A	15	19	17

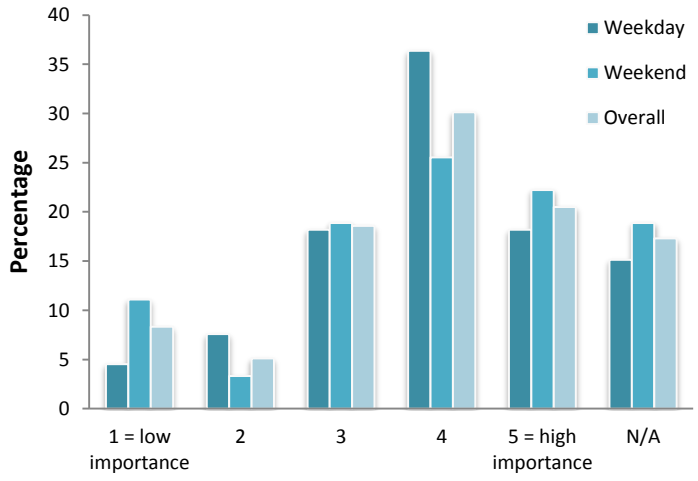


Figure 58. Importance of features – About a bike hire (%) by Round 3 – May 2011.

Staff interaction was considered to be of low importance to 16% of respondents, while 20% were neutral about the feature. Forty-six (46%) percent indicated that interaction with staff was of high importance to them and 18% felt this was not applicable (Table 56 & Figure 59).

Table 56. Importance of features – Staff interaction (%)

Staff interaction	Round 3		
	Weekday	Weekend	Overall
1 = low importance	14	11	12
2	6	2	4
3	22	19	20
4	27	22	24
5 = high importance	19	24	22
N/A	13	21	18

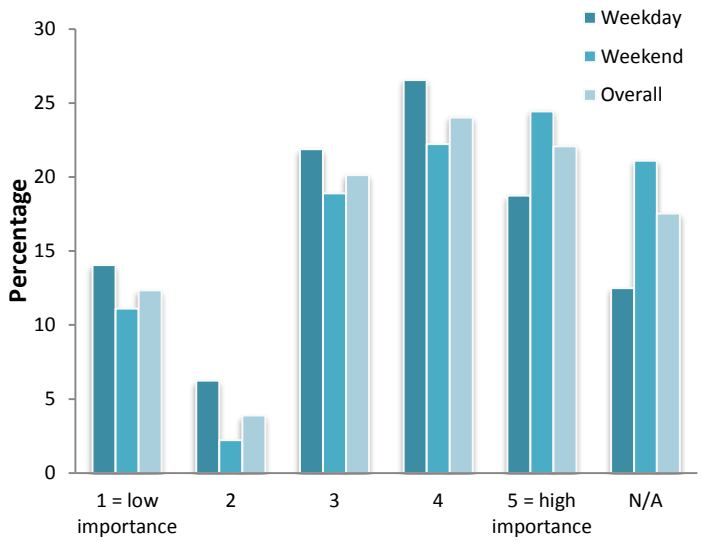


Figure 59. Importance of features – Staff interaction (%) by Round 3 – May 2011.

The importance of 'other' features was considered high by 71% of respondents, 5% neutral, 5% low importance and 19% not applicable. However, no respondents actually specified what 'other' meant to them (Table 57).

Table 57. Importance of features – Other (%)

Other	Round 3		
	Weekday	Weekend	Overall
1 = low importance	0	11	5
2	0	0	0
3	0	11	5
4	33	33	33
5 = high importance	42	33	38
N/A	25	11	19

7.10.4AVAILABILITY 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 significant proportion of respondents (38%) indicated 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. While 45% considered the availability of toilets 'about right', 1% 'too many' and 15% '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. 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.

a) Round 3, May 2011

b) Rounds 1 - 3

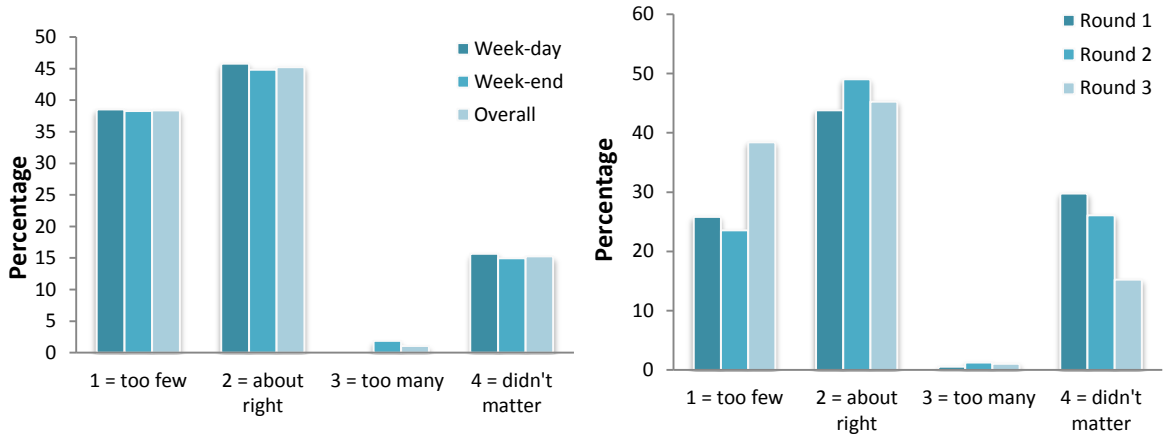


Figure 60. Availability of feature – Toilets (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

Sixteen percent (12%) considered that there were 'too few' barbeque facilities (Table 58.

Availability of features – Toilets (%)

Toilets	Round 1			Round 2			Round 3			Overall
	Week-day	Week-end	Overall	Week-day	Week-end	Overall	Week-day	Week-end	Overall	Rounds 1-3
1 = too few	18	30	26	25	23	24	39	38	38	30
2 = about right	42	45	44	46	51	49	46	45	45	46
3 = too many	2	0	1	3	0	1	0	2	1	1
4 = didn't matter	39	25	30	26	26	26	16	15	15	23

Table 59 & Figure 61). While 49% indicated that the number of barbeque facilities was 'about right', 2% said there were 'too many' and 34% 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 (34%) indicating that the availability of barbeques 'didn't matter'.

Table 58. Availability of features – Toilets (%)

Toilets	Round 1			Round 2			Round 3			Overall
	Week-day	Week-end	Overall	Week-day	Week-end	Overall	Week-day	Week-end	Overall	Rounds 1-3
1 = too few	18	30	26	25	23	24	39	38	38	30
2 = about right	42	45	44	46	51	49	46	45	45	46
3 = too many	2	0	1	3	0	1	0	2	1	1
4 = didn't matter	39	25	30	26	26	26	16	15	15	23

Table 59. Availability of features – BBQs (%)

BBQs	Round 1			Round 2			Round 3			Overall
	Week-day	Week-end	Overall	Week-day	Week-end	Overall	Week-day	Week-end	Overall	Rounds 1-3
1 = too few	5	15	12	12	11	11	15	16	16	13
2 = about right	37	45	42	47	47	47	52	47	49	46
3 = too many	0	0	0	1	1	1	1	2	2	1
4 = didn't matter	58	40	47	40	41	40	32	35	34	40

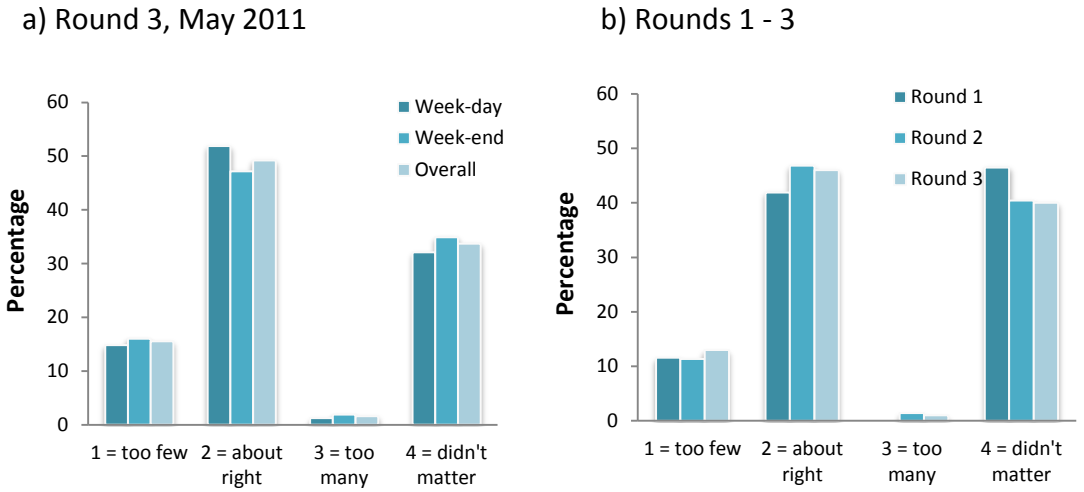
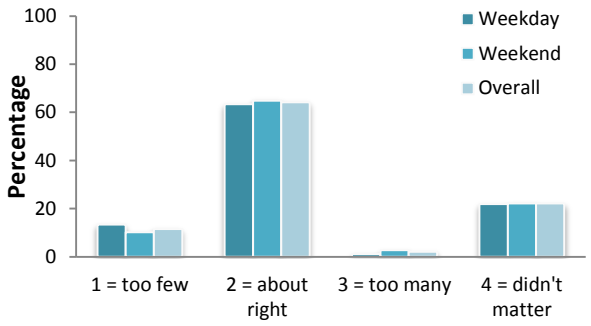


Figure 61. Availability of feature – BBQ facilities (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

In Round 3 survey, the question regarding the availability of seating and tables was separated. Previously seating and tables had been combined as one feature, however, given that there are no tables in the park, the data could be presented more clearly with the differentiation. Twelve (12%) percent of respondents indicated that the availability of seating was 'too few'. A large proportion of respondents, 64%, indicated that the availability of seating was 'about right' and 22% 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. Twenty-three (23%) of respondents considered that there were 'too few' tables which is consistent with the known lack of tables. While, interestingly, 51% indicated that the availability of tables was 'about right'. One (1%) percent considered that there were 'too many' and 26% said that it 'didn't matter'. 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.

a) Seating - Round 3, May 2011



b) Tables - Round 3, May 2011

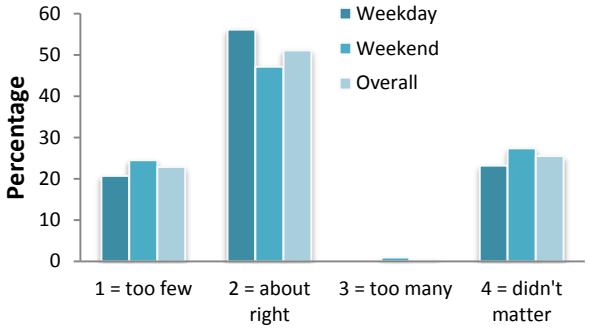


Figure 62. Availability of feature (%) by a) Seating - Round 3, May 2011, b) Tables - Round 3, May 2011.

In Round 3, 19% of respondents rated the signage as 'too few' (Table 60. Availability of features – Seating & tables (%)

Seating	Round 3 Weekday	Weekend	Overall
1 = too few	13	10	12
2 = about right	63	65	64
3 = too many	1	3	2
4 = didn't matter	22	22	22

Tables	Round 3 Weekday	Weekend	Overall
1 = too few	21	25	23
2 = about right	56	47	51
3 = too many	0	1	1
4 = didn't matter	23	27	26

Table 61 & Figure 63). 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 65% of respondents said the availability of signage was 'about right', 2% said there were 'too many' and 14% said it 'didn't matter'.

a) Round 3, May 2011

b) Rounds 1 - 3

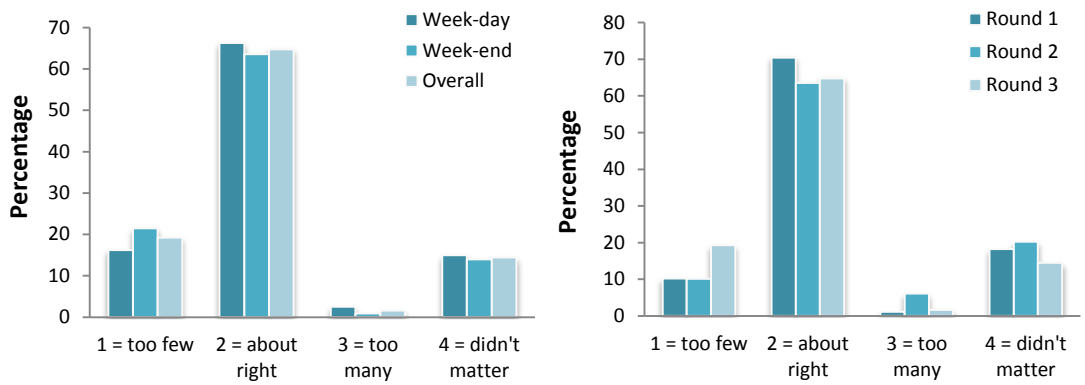


Figure 63. Availability of feature – Signage (%) by a) Round 3, May 2011, b) Rounds 1-3.

In regard to the number of other people at Point Fraser, 11% considered that there were 'too few' (Table 62 & Figure 64). Sixty-five percent (65%) indicated that the number of people was 'about right', while only 3% said that 'too many'. For 21% the number of people in the park 'didn't matter'.

Table 60. Availability of features – Seating & tables (%)

Seating	Round 3		
	Weekday	Weekend	Overall
1 = too few	13	10	12
2 = about right	63	65	64
3 = too many	1	3	2
4 = didn't matter	22	22	22

Tables	Round 3		
	Weekday	Weekend	Overall
1 = too few	21	25	23
2 = about right	56	47	51
3 = too many	0	1	1
4 = didn't matter	23	27	26

Table 61. Availability of features – Signage (%)

Signage	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
1 = too few	6	12	10	12	9	10	16	21	19	14
2 = about right	68	72	70	61	66	64	66	64	65	66
3 = too many	2	1	1	7	5	6	3	1	2	3
4 = didn't matter	24	15	18	20	20	20	15	14	14	17

Table 62. Availability of features – Number of other people (%)

Number of other people	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
1 = too few	13	19	17	8	14	11	11	11	11	13
2 = about right	63	60	61	53	58	56	66	65	65	61
3 = too many	3	3	3	5	5	5	1	4	3	4
4 = didn't matter	22	18	20	35	23	29	21	20	21	23

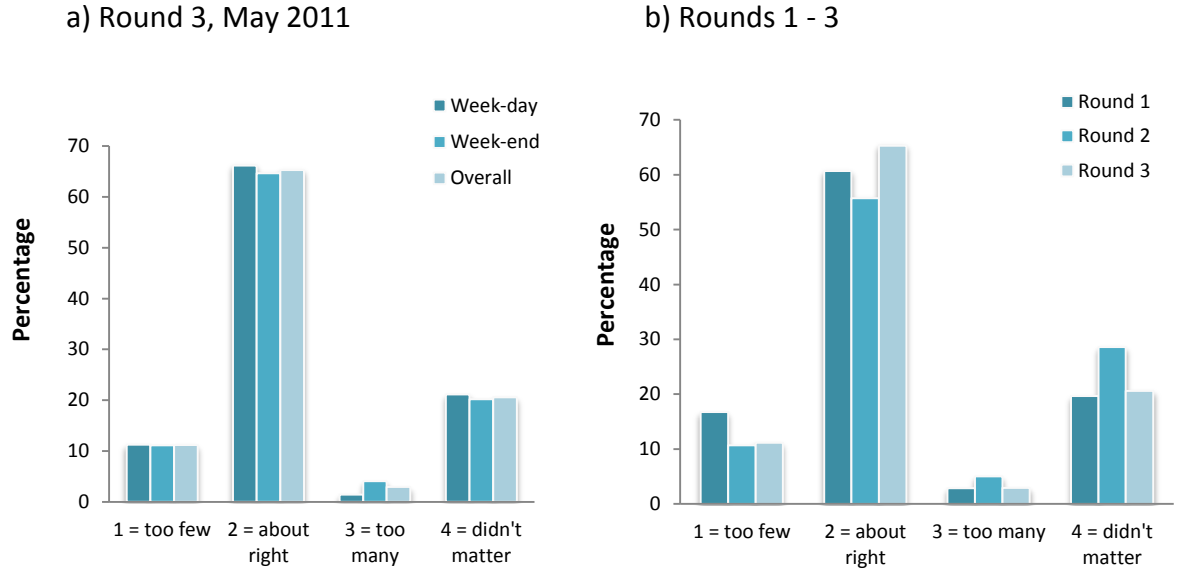


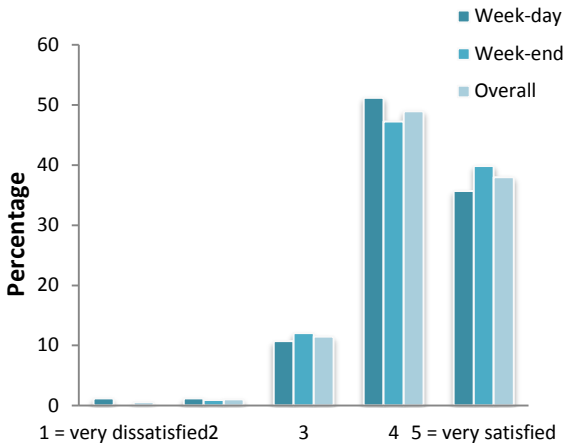
Figure 64. Availability of feature – Number of other people (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

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' in Round 3:

- BBQ please by Langley Park, toilet block and playground
- Car park
- Require lighting for summer evenings
- Signage - mark distance for joggers

Respondents were asked about their overall satisfaction with their Point Fraser experience (Table 63& Figure 65). Of the Round 3 survey respondents, 49% were very satisfied with their experience and 38% were satisfied. Eleven percent (11%) indicated that they were neither satisfied or dissatisfied. One percent (1%) of respondents were very dissatisfied or dissatisfied with their visit to Point Fraser.

a) Round 3, May 2011



b) Rounds 1 - 3

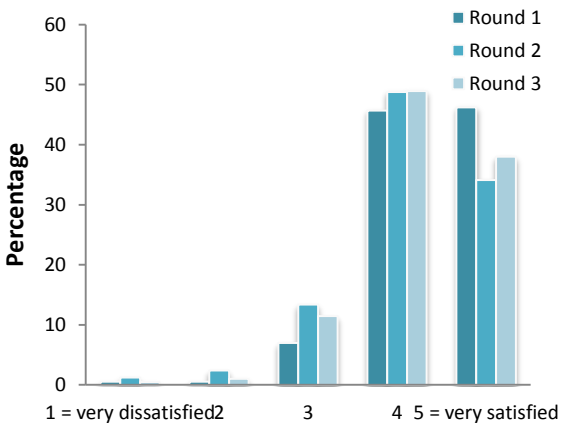


Figure 65. Overall satisfaction (%) by a) Round 3 – May 2011, b) Rounds 1 - 3.

Respondents from Round 3 provided suggestions on how to improve Point Fraser. The full list of responses is provided in Appendix B.

Respondents were asked if they would visit Point Fraser again (Table 63. Overall satisfaction with Point Fraser experience

Overall satisfaction	Round 1			Round 2			Round 3			Overall Rounds 1-3
	Week day	Week end	Overall	Week day	Week end	Overall	Week day	Week end	Overall	
1 = very dissatisfied	0	1	1	0	2	1	1	0	1	1
2	0	1	1	3	2	2	1	1	1	1
3	5	8	7	21	7	13	11	12	11	11
4	42	48	46	36	59	49	51	47	49	48
5 = very satisfied	54	42	46	40	30	34	36	40	38	40

Table 64). Ninety-four (89%) percent said that they would visit again. While one percent (1%) said no and 6% said maybe they would visit Point Fraser again.

Following on from the question about repeat visitation, respondents were asked why or why not they would visit Point Fraser again. Appendix F lists the responses.

Ninety-one percent (91%) of respondents said that they would recommend Point Fraser to others and eight percent (8%) maybe would (Table 65). Only one percent said that they wouldn't recommend Point Fraser to other people.

Table 63. Overall satisfaction with Point Fraser experience

Overall satisfaction	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
1 = very dissatisfied	0	1	1	0	2	1	1	0	1	1
2	0	1	1	3	2	2	1	1	1	1
3	5	8	7	21	7	13	11	12	11	11
4	42	48	46	36	59	49	51	47	49	48
5 = very satisfied	54	42	46	40	30	34	36	40	38	40

Table 64. Repeat visitation

Repeat visitation	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
Yes	91	96	94	81	86	84	90	97	94	91
No	0	0	0	4	1	2	1	3	1	1
Maybe	9	4	6	15	13	14	9	0	6	8

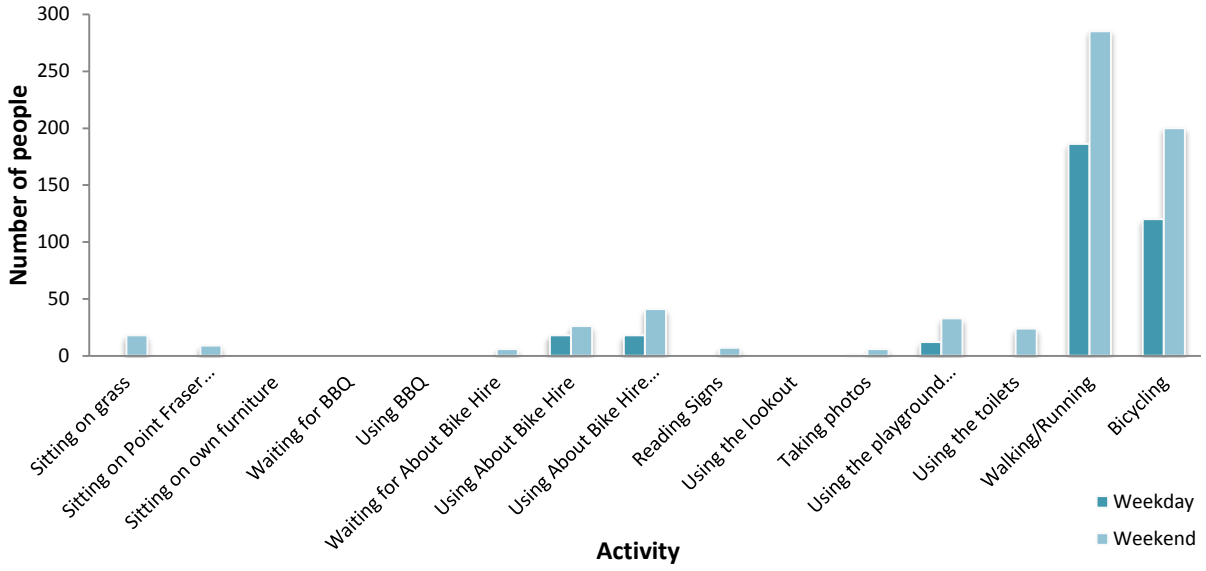
Table 65. Recommend visitation

Recommend visitation	Round 1			Round 2			Round 3			Overall
	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Weekday	Weekend	Overall	Rounds 1-3
Yes	93	95	94	89	86	87	94	95	95	92
No	0	2	1	0	2	1		1	1	1
Maybe	8	3	5	11	12	12	6	4	5	7

7.10.5VISITOR 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. They also had an aerial photograph 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 66).

a) Round 3 – May 2011



b) Round 4 – October 2011

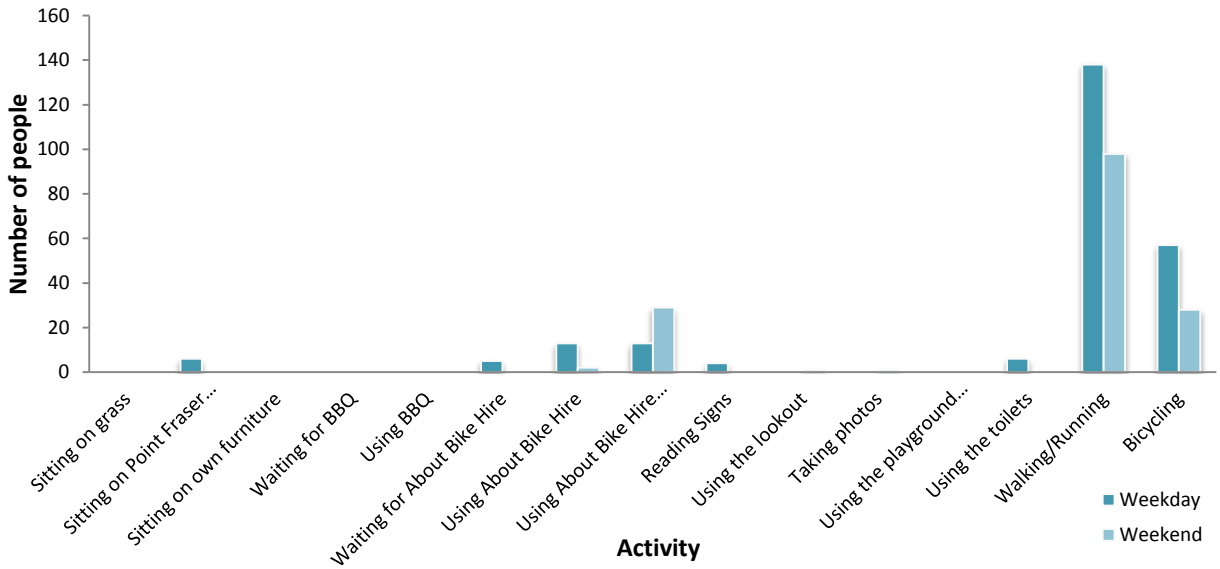


Figure 66. Number of people observed to engage in specific activities during hourly single-pass behaviour observations.

7.10.6CONCLUSIONS

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). Awareness of 'Destination Point Fraser' and its features, particularly relating to its ecological function, seems very low amongst respondents. Accordingly, few people surveyed indicated that they had come to Point Fraser specifically, but most are simply using it as a thoroughfare. The car park 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;

In 2011, quantitative estimates of removal efficiency for nutrients were achieved with excellent removal of P and good removal of N. Backflow out of the wetland has still not been resolved, it reduces the accuracy of water budget estimation and removal efficiencies. No evidence of a first flush was recorded although higher concentrations of nutrients were recorded earlier in the year in the stormwater. The wetland catchment is believed to be substantially smaller than designed for which may account for the high removal efficiencies. Although wetland retention of metals and P kept concentrations below guideline levels for the most part, N concentrations did exceed guidelines and appear to increase across the wetland (ANZECC/ARMCANZ, 2000; 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. *Baumea articulata* although initially expanding in area, suffered a major dieback, possibly due to the high salinities. 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. Increasing water salinity remains a major concern and concentrations are now often likely to limiting plant growth and recruitment. 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 was damaged in a number of areas by high tides and strong winds resulting in the loss of some *Melaleuca's*, ongoing management of this area is required to prevent erosion becoming more difficult to control.

9 SUMMARY OF RECOMMENDATIONS

Recommendation 1.

Installation of a flap valve over the end of the outlet pipe is recommended to prevent saltwater intrusion into the wetland.

Priority: HIGH
Responsibility: COP

Comments: In 2011, entry of Swan River Water at a high tide was observed entering W4 through the outlet structure. High salinities are problematic in the wetland and this is a significant source that could be easily controlled using a one way valve on the end of the pipe.

Recommendation 2.

Backflow from W1 into the drainage network remains the most important issue reducing the effectiveness of the wetland in treating stormwater. Anecdotal evidence from the COP also suggests that the entire design catchment is not connected to the wetland drain. As such this will increase the likely demand for top-up from Lake Vasto and means that the wetland cannot be tested as its design parameters.

Priority: HIGH
Responsibility: COP

Comments: Leaks in the drain line upstream of the wetland appear responsible for the W1 backflowing into the drainage network. Flows into the wetland are well below estimates for the design catchment which indicate that the wetland is operating well below its design capacity which may also be responsible for the high removal efficiencies seen.

Recommendation 3.

The unique design of the inlet structure means that a depth sensor in the BUG as well as the Starflow are required to accurately estimate inflows. It is recommended that a Unidata depth sensor be purchased by COP and coupled to the Neon Telemetry System.

Priority: HIGH
Responsibility: ECU/COP

Comments: Measuring the inlet is challenging given the problems with incoming flow and backflow. ECU have resolved the issues associated with the monitoring equipment in 2010, however it has been determined that purchase by COP of an additional depth sensor for the BUG is necessary to produce quality data.

Recommendation 4.

High salinities (>12.5 mS cm^{-1}) are becoming more frequent in the wetland and are most likely stressing the vegetation. It is recommended that the cause of the high salinities be investigated. This includes measuring chloride in inflows, outflows and at depth in the wetland. This can be achieved by adding chloride as a parameter in the monitoring program.

Priority: HIGH
Responsibility: ECU/COP

Comments: Adding measurement of chloride to the inflows, outflows and monthly monitoring data will allow the salt budget to be estimated. It is important to understand the salt balance between inflows and outflows to ensure that salinity does not continue to rise in the wetland leading to the death of vegetation.

10 REFERENCES

ANZECC/ARMCANZ (2000). Australian and New Zealand guidelines for fresh and marine water quality, Volume 2. Aquatic ecosystems - rationale and background Information. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

Chambers, J. M.; Fletcher, N. L. & McComb, A. J. (1995). *A guide to emergent wetland plants of south-western Australia.* Marine and Freshwater Research Laboratory, Murdoch University, Perth. 115pp.

Chessman, B. (2003). New sensitivity grades for Australian river macroinvertebrates. *Marine and Freshwater Research* 54: 93-103.

Congdon, R. A. (1985). *The water balance of Lake Joondalup*. Bulletin 183. Western Australian Department of Conservation and Environment, Lib Bk.

COP (2010). *Point Fraser Monitoring & Evaluation Program (PFMEP) 2010-2011 (Year 1)*. City of Perth, Perth, Western Australia.

Davis, J. A.; Rosich, R. S.; Bradley, J. S.; Growns, J. E.; Schmidt, L. G. & Cheal, F. (1993). *Wetland classification on the basis of water quality and invertebrate community data.* Water Authority of Western Australia and the Western Australian Department of Environmental Protection, Perth. 242pp.

Hall, S. (2006). *The contribution of heavy industry and commercial activity at Canning Vale to the loads of nitrogen and phosphorus released in the Bannister Creek Catchment area,* Master of Science thesis, Edith Cowan University, Perth.

James, K. & Hart, B. (1993). Effect of salinity on four freshwater macrophytes. *Marine and Freshwater Research* 44: 769-777.

Khwanboonbumpen, S. (2006). *Sources of nitrogen and phosphorus in stormwater drainage from established residential areas and options for improved management,* Ph.D. thesis, Edith Cowan University, Perth.

Pyke, G. H. (2008). Plague Minnow or Mosquito Fish? A Review of the Biology and Impacts of Introduced *Gambusia* Species. *Annual Review of Ecology, Evolution, and Systematics* 39: 171-191.

Sanchez-Carrillo, S.; Alvarez-Cobelas, M.; Benitez, M. & Angeler, D. G. (2001). A simple method for estimating water loss by transpiration in wetlands. *Hydrological Sciences* 46: 537-552.

Swan River Trust (2009a). Local Water Quality Improvement Plan: Mounts Bay Catchment. In: Swan River Trust, (Swan River Trust.Swan River Trusts Swan River Trust). Perth: WA Government.

Swan River Trust (2009b). Swan Canning Water Quality Improvement Plan. In: Swan River Trust, (Swan River Trust.Swan River Trusts Swan River Trust). Perth: WA Government.

Syrinx Environmental Pl (2005). *Point Fraser Demonstration Wetland Stage 1 Monitoring Report*. MON-0310-AnRpt. Perth.

Syrinx Environmental Pl (2008). *Update on restoration works undertaken at soil mounds, Point Fraser Stage 1 Wetland*. Minor Technical Report Syrinx Environmental Pl., Perth, Western Australia. 33pp.

Syrinx Environmental Pl (2009). *Point Fraser Maintenance Handbook*. 0505-HBK. Syrinx Environmental Pl., Perth, Western Australia. 170pp.

Zedler, J. B.; Paling, E. & McComb, A. (1990). Differential responses to salinity help explain the replacement of native Juncus kraussii by Typha orientalis in Western Australian salt marshes. *Australian Journal of Ecology* 15: 57-72.

11.1 APPENDIX A – UPDATED VISITOR SURVEY

Time:..... Date: ...../...../201... Surveyor Name: Version 4 02052011

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. Where are you from? (your usual place of residence)

Australia : Postcode _____ & State _____

Overseas: 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 ☐ By Car ☐ By Boat

☐ By Bicycle ☐ By 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/Spouse ☐ Other 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?

☐ Just 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)

☐ BBQ/Picnic	☐ Visit for general enjoyment	☐ Exploring interpretive trails
☐ Photography	☐ Visiting playground	☐ Using services of About Bike Hire
☐ Walking	☐ Cycling	☐ Running/Jogging
☐ Other (please specify):		

Please turn page

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

	Quality						Importance					
	Very poor				Very good		Low				High	
Overall cleanliness	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Access	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Playground facilities	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Scenic beauty	1	2	3	4	5	N/A	1	2	3	4	5	N/A
BBQ facilities	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Toilet facilities	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Signage	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Seating	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Tables	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Education	1	2	3	4	5	N/A	1	2	3	4	5	N/A
About Bike Hire	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Staff interaction	1	2	3	4	5	N/A	1	2	3	4	5	N/A
Other (please specify)_____	1	2	3	4	5	N/A	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	1	2	3	4
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): _____

_____

11.2 APPENDIX B – SUGGESTIONS ON HOW TO IMPROVE POINT FRASER

Round 3, May 2011

TOILETS

Toilets - please fix!
Better toilet facilities, otherwise it's very beautiful
Toilet
Toilets need upgrading immediately
Just about the toilets, try to lock them or make people keep them clean.
More toilets closer to the city end of the park
Better signs for where toilets are.
Toilets - only realised yesterday that there were demountable toilets. Really need better toilets, especially when walking the bridges, few and far between. Pathway - when travelling towards causeway the path doesn't follow course of the river and just comes to a dead end.
Better toilet facilities
Better toilet facilities (not Portables). Lighting.
Urgent upgrade of toilets
Toilets
Improve toilet facilities..
More toilets
The toilets are so disgusting and need to have them cleaned more regularly and would suggest to have more toilets!!

CAFE

Shop (coffee)
More cafe's and bars, particularly at the bottom of Coode St (South side) and bottom of Plain St (North side)
A cafe would be good - low key, not a chain cafe. Ambient, music etc.

PATHS

Connect link along foreshore for cyclists/ walkers
The path between the Riverside Drive entrance (west) and the steps to the causeway bridge is discontinuous and requires running through some unpaved bush. This area is well trodden and popular and would be best paved.
Wider walking/bike tracks
Separate bicycles from pedestrians
Yes - footpaths
A dedicated bike path
Either complete the path or have some signage would be great.
Maybe a different path/track to walk/run around for something different

SEATING / TABLES
Metal seating; to cold in A.M and winter - prefer wooden.
More tables
Covered seating.
Tables and chairs

LIGHTING
Lighting in the evening could be improved - very important.
More lighting and tables at the BBQ areas
Lights for BBQ
More lighting at night
Increase lighting areas.
More lighting at night time
Lights,
Improve lighting
Lighting.
More lights
Better lit pathway.

SIGNAGE
Confusion with bridges/ improve signs visitors some difficulty
Markings on tracks or signs for distance for joggers
Better signage RE. dead ends of paths
Better signs for where toilets are.
More posted maps.
Tracks down to the water should have rubbish bins and signage encouraging people to visit them at appropriate places near the water.
More signage.
Signage - where are the toilets? Where are the BBQ? Is there a swimming/splashing area?
Walk signals to cross road
Better entrance, clearer signs
Signage

SHADING / WEATHER PROTECTION
More trees for shade
Covered seating.
Weather indicators would be ideal.

PEDISTRIAN – BICYCLE INTERACTION
Bike riders are a bit aggressive - expect that they don't have to slow/ make way for anyone. How about some bike riders give way to pedestrians?
More signage for cyclists resulting in an easier experience
Separate bicycles from pedestrians
Bikes are really dangerous, uncontrolled. More drinking fountains. Toilet facilities.
Cycle path for cyclists separated from main walking pathway. Walking paths widened.

Bike coming through small area, bikes to fast. Monitor bike speed!

BBQ FACILITIES
BBQ tables and lights for BBQ
Table for BBQ near bike area
BBQ in wrong place, no table? or install around play area.
Put more BBQ
More BBQ's and picnic tables with night lighting for summer and shelters for ? weather
More BBQ/social facilities

MAINTENANCE
Cleanliness could be improved.
Generally its tidy but some spots rubbish strewn. Maybe a few more bins if there not too obtrusive.
Needs a good clean!
Clean up where bridge

WATER FACILITIES
More water fountains
Water fountain on path
More water facilities
More water facilities
Water fountains

MISC
Less car parking space!
Where are the dog bags?
Free beer would be nice.
Construct a jetty/pier into the water to walk out - would be beautiful.
Not really
Not at moment
No, keep it just as it is please.
My first visit so far.
Attract more people - check that the track is not going through secluded spots (for safety).
We arrived late in the afternoon - so need more time to look.
Yes - no shore side/ riverside development for Perth foreshore
Apart from that the natural environment is fantastic. Love the bird and wild life.
Free family events?

11.3 APPENDIX C – COUNTRY INTERNATIONAL RESPONDENTS FROM (%)

Country of origin	Round 1			Round 2			Round 3			Overall Rounds 1-3
	Week-day	Week-end	Overall	Week-day	Week-end	Overall	Week-day	Week-end	Overall	
Belgium	0	5	3	0	4	2	0	0	0	2
Brazil	0	10	7	0	0	0	0	0	0	2
Canada	20	14	16	0	0	0	0	6	3	6
China	0	0	0	11	9	10	0	6	3	5
Colombia	0	5	3	0	0	0	0	0	0	1
Czech Republic	0	10	7	0	0	0	0	0	0	2
Denmark	0	5	3	0	4	2	0	0	0	2
Egypt	10	0	3	0	0	0	0	0	0	1
Finland	0	0	0	0	0	0	0	6	3	1
France	0	5	3	0	0	0	5	0	3	2
Germany	0	0	0	28	9	17	0	24	11	10
Holland	0	0	0	0	0	0	0	6	3	1
Indonesia	0	0	0	0	0	0	0	12	6	2
Ireland	0	0	0	0	0	0	21	0	11	4
Italy	0	0	0	0	0	0	0	6	3	1
Japan	0	14	10	0	4	2	0	0	0	4
Korea	0	5	3	0	0	0	0	0	0	1
Malaysia	0	0	0	0	9	5	0	0	0	2
New Zealand	0	14	10	11	0	5	0	0	0	5
Norway	0	0	0	0	4	2	0	0	0	1
Philippines	0	0	0	0	0	0	5	0	3	1
Russia	0	5	3	0	0	0	0	0	0	1
Singapore	0	5	3	0	0	0	21	0	11	5
South Africa	10	0	3	0	0	0	0	0	0	1
Sweden	0	0	0	0	9	5	11	0	6	4
Switzerland	0	0	0	6	9	7	5	0	3	4
Taiwan	0	5	3	0	4	2	5	0	3	3
United Arab Eremites	0	0	0	0	0	0	0	6	3	1
United Kingdom	50	0	16	39	26	32	16	6	11	20
USA	10	0	3	6	9	7	11	24	17	9

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

Postcode	Suburb	May			October			Total
		Week-day	Week-end	Comb-ined	Week-day	Week-end	Comb-ined	
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

Postcode	Suburb	May			October			Total
		Week-day	Week-end	Comb-ined	Week-day	Week-end	Comb-ined	
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, Iluka, Kinross	0	1.2	0	2.5	0	1	.4
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

Postcode	Suburb	May			October			Total
		Week-day	Week-end	Comb-ined	Week-day	Week-end	Comb-ined	
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, Pinjar, Sinagra, Tapping, Wangara, Wanneroo	0	1.2	1.5	2.5	0	1	1.3
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	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

Postcode	Suburb	May			October			Total
		Week-day	Week-end	Comb-ined	Week-day	Week-end	Comb-ined	
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, Winthrop	0	0	.8	0	0	0	.4
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,	2.2	0	.8	0	1.5	1	.8

Postcode	Suburb	May			October			Total
		Week-day	Week-end	Comb-ined	Week-day	Week-end	Comb-ined	
	Brentwood, Mount Pleasant							
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

11.5 APPENDIX E – OTHER ACTIVITIES RESPONDENTS DID AT POINT FRASER

Other activities respondents did at Point Fraser		
Round 1, 2010	**Round 2, 2010**	**Round 3, 2011**
Fishing	Bird watching	Car park
Kayaking	For exercise	Canoeing
Lunch, relax, meditate	Kayaking	Enjoying time with grandchildren
Parking	Parking	Frisbee
Passing time	Scouts	Looking
Quiet	To Heirisson Island visiting the kangaroos	Walking dog
Rollerblading	Wheelchair	
Walking	Work	
Working		

11.6 APPENDIX F – WHY OR WHY NOT REPEAT VISITATION

I walk through every day on my way to work
Exercise
Part of exercise route
Access good
Go elsewhere, or holiday
For reasons detailed above, should we return to Perth
Weekly run
Daily walk routine
Very beautiful
Not here long enough
It is a beautiful area that is let down by inadequate toilet facilities for the large number of family and disabled groups that use the area
Passing through on way to work
Walk regularly around the river
I walk to the city often and pass through the park
Beautiful scenery
Passing through on walk
Exercise in the morning
Natural beauty, good walking trail
Great experience to visit such a beautiful environment
Exercising
Exercise every day
It's a beautiful place
Local area for lunchtime walk
Convenient route for exercise
It's very pretty and scenic and a nice place for walks
Nice to walk through
I won't be in Perth, I'm just visiting
Only here for a week
Perth has lovely parks and friendly people
It's a nice, well kept park and I'm often in Perth with little else to do
It's lovely for a picnic
It's close to Kensington and the city, ample parking, will probably visit again if we can.
It's beautiful and easy to access
Pleasant, close to the river and my home
Exercise
It's a nice walk
Daily route
Beautiful trip, beautiful area. Relaxation, walk, nature
I regularly hire bicycles from 'About Bike Hire'
Car park
Time will tell
Because it is where I walk
More exercise

More exercise
Good venue for walking
It's on the walk around the bridges
Walking around river
Weekly exercise
Great access and pleasant scenery
Live locally and walk most days
Beautiful, scenic, great for a run
It's a beautiful place and allows me to fully relax
Great access from city. Scenic.
Relaxing, quiet place in the city
Great to have this kind of natural space, beautifully kept, in the ? of the city, close to public transport
Very picturesque, natural, access to the river
To bring the grandchildren
Close to my apartment, nice walkthrough to east Perth or city
Part of weekly route
If we return to Perth
To bike ride and walk
It's a good place, nice for walks
Nice area to walk around and bring family
Nice waterfront walk. Rubbish could be cleared from the reedy waterfront section
Need to explore the entire area
Enjoy riding through restored foreshore area
Circular walk of the river Narrows - causeway
I walk through with a friend every Saturday morning at 7am for 16 years
Weekly walk
But not by myself - safety at my age (71 years)
Just for walking
Beautiful and enjoyment place
It's a nice place
Beautiful healthy place to spend time with friends and family
Passing through
Unique place for exercising, unique scenery, near city centre.
Nice scenic view for walking
Nice view and breeze after sunset
Beautiful place
Love natural environment
Good spot
Would like to bring overseas visitors here
Nice walk
Bike riding along the river
Because we walk here every week
Weekly run
Need more lights along river - too dark.
It's a beautiful place to come and experience the river