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Measuring Participation in Outdoor Activities:

An exploration of methods

Developed for QORF with funding from the Queensland Government, Department of National Parks, Recreation and Racing.

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waytobe (WTB) is a consulting agency that uses a collaborative approach to assist organisations identify and deliver on potential. Donna is the Consulting Manager of WTB, with experience as a researcher, academic, NFP CEO, team leader, manager & teacher. wyatobe deliver on a diverse range of practical and applied research and developmental projects especially relating to the development and enhancement of sport and recreation based planning and experiences

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Table of Contents

1.0 Introduction

The genesis of this report stems from the Queensland Outdoor Recreation Federation's (QORF) determination to identify and assess available tools for measuring visitation and monitoring participation in outdoor recreation activities at Queensland parks. While this is not the only use of parks (consider also tourism, education, conservation activities), it is readily acknowledged that unlike other more formal forms of physical activity, outdoor recreation often takes place independent of structured organisation, can be done alone or in small groups, and is comprised of a diverse range of pursuits. These defining factors mean that without intentional effort, outdoor recreation participation is difficult to measure. With physical activity research continuing to demonstrate the actual and aspirational appeal of outdoor recreation pursuits as dominant forms of activity (e.g. Australian Sports Commission, 2016), QORF have identified value in identifying valid forms of measurement that can be considered by land and water managers to assess the demand and use of their sites for these purposes.

1.1 Report Methods

The following report is based on a series of data gathering activities including:

- a **desktop review** to identify measurement opportunities that capture people's participation in outdoor recreation in different land and water managed sites. This was sourced through data searches for visitor management and visitor counts and included both peer reviewed literature and applied practices of national and international land and water managers (e.g. US Forest Service, NZ Department of Conservation; QPWS);
- **engagement with key land and water managers** to explore any additional methods for capturing park visitation. A list of QORF's partner and stakeholder land and water managers was developed and outreach made to engage in communication around the measurement techniques already being used, and to assess the strengths and weaknesses of different measurement approaches. This outreach included workshops, individual meetings and electronic communications;
- **analysis of limitations and strengths** of different measurement methods considering best context. This was based on reviews of methods, feedback from park managers, and interrogation of technical information relating to the use of different methods and tools.

2.0 Parks Management & Measurement

Park management plans are considered fundamental documents which can support good governance, transparency and accountability. Since the 1990's the quality of park plans have come under investigation, with research demonstrating that plans that lead to successful implementation and service delivery include common elements such as:

a) A **factual base**,
b) An outline of **goals**,
c) Implementation guidelines,
d) Policies,
e) Internal consistency,
f) Inter-organisational coordination, and
g) **Monitoring** practices (e.g. Berke & Godschalk, 2009, Brody, 2003; Eagles et al., 2014).

While each of these components is valuable, it is also recognised that monitoring and analysing ongoing visitor involvement and participation are vitally important (Eagles et al., 2014; Orellana et al., 2012; Probstl & Prutsch, 2009), with such information providing a foundation for policy development and implementation. More specifically, visitor monitoring (use type, intensity and location, impact measurements) is also identified as a research priority within park recreation and tourism (Eagles, 2014). This is, in part, a result of concerns for park management relating to their use, ecological impacts and habitat fragmentation; as well as spatial and social conflicts and the benefits of green and nature spaces for human health and well-being (e.g. Aikoh et al., 2012; Probstl-Haider, 2015).

Specifically, it is recognised that park management, whether in protected areas or not, benefits from understanding the size, scope, nature and distribution of visitors and visitor use (e.g. Loomis, 2000; Pettebone et al., 2010). Capturing this information however is not straightforward and often proves resource intensive. Focusing just on visitors, the challenges of securing visitor use data are real, with many parks (e.g. national parks, conservation estates and reserves) having a mandate to provide and protect ecological, historical and cultural values and also at least, allow recreation. This leads to the need for a balance between some mix of conservation, education, commercial and recreational objectives which may prove in competition with each other.

For example, park managers will have responsibilities for pest and fire management, protecting biodiversity, conserving natural and cultural heritage, and/or maintaining water quality[1]. In Queensland and other jurisdictions, park managers may also have responsibilities for providing access and rights for traditional owners and indigenous communities and enabling opportunities and experiences for people to protect, use, enjoy and value these spaces (e.g. State of Queensland, 2014) through recreation, education and/or tourism. It leads on from this that the achievement of planning and a management balance to address land/ water manager's objectives is required.

This report focuses on how land and water managers might monitor visitor use, especially for recreation purposes. As opposed to use for educational or tourism reasons, recreational participation may require no or limited permits (under current access arrangements in many jurisdictions) and the duration and frequency of visitation is undefined. Importantly, recreational use is commonly identified as being an area of usage growth, with land and water managers acknowledging increasing pressure to provide recreational access and infrastructure to meet growing community demand and expectations, while continuing to protect natural resources (e.g. City of Ipswich, 2014; Seqwater, 2013).

2.1 Visitor Counts, Visitor Use

At the most protected end of park visitation there is a desire to provide people with the opportunity to enjoy the protected area estate, but to also ensure that enjoyment does not damage the things people come to see or experience. Achieving the balance to meet both conservation needs and quality user experience requires understanding and monitoring not just of ecological, historical and cultural features of a park but also monitoring visitors' patterns of use and characteristics. This may include tracking overall visitor use levels (e.g. parkwide visitation), plus determining more spatially

[1] For the Great Barrier Reef Marine Park (GMRMP) it also includes managing for shipping, research and commercial and recreational fishing and collecting (Great Barrier Reef Marine Park Authority, 2008).

precise information such as impacts and demand for particular trails or park features (e.g. trail specific or site specific visitation).

How this measurement is undertaken needs to be informed by different park management strategic and operational objectives, but reliable and accurate visitor numbers can help inform management decisions on (for example):

- Schedule of maintenance tasks;
- Optimisation of visitor flow;
- Staff and resource allocation;
- Ways to increase or manage carrying capacity;
- Justification for visitor services, facilities and staffing;
- Planning for the reduction of conflict between user groups;
- Compliance with regulations (e.g. dog walking, recreation activity use);
- Trail, signage and amenity upgrades;
- Trends and predictions of future use and areas of concentration; and
- Capital works expenditure.

To successfully inform these park management decisions, different visitor count information would be needed. For example, total use of park data would be valuable for justification of visitor services, facilities and staff provision; while knowledge on visitation, usage patterns and behaviours of different user types can assist with planning to reduce visitor or user conflict (D'Antonio et al., 2010; Duke et al., 2008). To understand these details requires:

- a **mix of methods that suit the objectives** of the monitoring program,
- the availability of **resources**, and
- an understanding of the **accuracy level** required.

In modern park management, historical practices of determining visitor use on the basis of a) 'best guess', b) unsystematic monitoring or c) stand-alone field observations are not adequate to sufficiently or accurately inform park management nor to help understand the changing visitor use of parks. Rather what are needed is systematic (and preferably long term) monitoring programs that inform understanding of, for example:

- current use,
- visitor load,
- visitor density,
- variation of visitation patterns that occur throughout the year (temporal use),
- points of actual or potential user conflict,
- areas of high/ low use,
- calculating the social, economic and political importance of recreational use,
- the activities or pursuits that are in demand, and preferably
- information about the visitors themselves including their demographic profile etc (e.g. Arnberger, 2006; Duke et al., 2008; Watson et al., 2000; Wolf et al., 2012).

Through accurate visitor counts park managers are better placed to demonstrate accountability and good stewardship for sustainable development. Importantly such information can also assist with achieving the equilibrium sought across conservation, preservation and regulation, as well as inform support of visitor activities that benefit individuals and community. Further, the capture of accurate visitor use data is essential to determine how to reduce the negative impacts of visitors both on others visitors and the ecological environment (Kaczynski et al., 2003; Zelenka & Kacetl, 2013); and to be able to anticipate and respond to visitors demands for their preferred activity/s in specific park/ area locations (Santos et al, 2016).

2.1.1 A Snapshot of Benefits from Visitor Monitoring

A range of arguments have been presented that indicate the value of collecting visitor data in recreational parks and natural areas. Drawing on government, land manager, academic and international sources these include:

- To understand how to balance conservation and visitor use;
- Improve recreation opportunities;
- Reduce risk of conflict between different user groups;
- To understand incident frequency;
- Analyse the environmental, social and economic impacts;
- To inform the development of infrastructure;
- To shape marketing and promotions to appropriate audiences;
- To understand where and when to provide and upgrade visitor services and facilities;
- To identify existing and future demand for recreational spaces;
- To evaluate the effectiveness of park planning;
- To gauge economic value of outdoor recreation/ park visitation;
- Identify visitor needs and experiences etc (e.g. Ankre et al., 2016; Harmon-Price, 2005; Wood et al., 2013; Yuan & Fredman, 2008).

2.2 Example Measurement Approaches

A range of techniques are used to capture information on outdoor recreation participation. These vary from local or regional assessments of use through to national and annual assessments to track participation and trends. Examples of some of these methods and the scale of application can be found in the table below. The selection included is in no way comprehensive. Rather the examples offer some insight into different measurement objectives and vary in scale from high level studies with little area-specific feedback through to targeted and locally relevant assessments.

Table 1: Examples of Scaled Park Visitor Data Capture

Jurisdiction & Sponsor	Report & Scale	What information is captured	Methods
United States **The Outdoor Foundation is a not for profit agency established by the Outdoor Industry**	Outdoor Participation Reports 2007-2017 National Participation Study	Tracks American participation trends in outdoor recreation	**Online survey** capturing responses from over 40,000 Americans aged 6 and over. Covers 114 different activities & captures information

Association to inspire and grow outdoor enthusiasts. It is comprised of broad based coalitions and partnerships of public, private and not for profit organisations			on socio-demographics, self-reported participation (outdoor outings), frequency, activity choice, spending on outdoor gear & activities, motivations & constraints
United States **United States Forest Service**	National Visitor Use Monitoring Program National Study	Produces estimates of the volume of recreational visitation to National Forests & Grasslands; and produces descriptive information about visitation. The Monitoring Program is designed, over time, to cover the volume of 154 national forests & grasslands on 193 million acres of public lands.	**Onsite surveys** and **traffic counts** of visitors leaving a national forest or grassland – to capture information on visitation and the characteristics of recreation related visits to national forests and benefits of recreation to Americans. Sampling is random and both counts and surveys are undertaken from random locations and days in any forest over a period of one year. Each forest is sampled once in 5 years.
United States **US Fish & Wildlife Service**	National Survey of Fishing, Hunting and Wildlife-Associated Recreation National Study	Details information on the number of US residents 16 years and older who fish, hunt or wildlife watch. It also provides information on expenditure for trips, equipment and other items. The Fish and Wildlife Service have sponsor the national service every 5 years and have done so since 1955.	Data collected by US Census Bureau based on random selection of households for screening interviews. In 2016/ 2017 samples included 5782 potential anglers & hunters & 6231 potential wildlife watchers. 3 waves of **detailed interviews** undertaken re participation & expenditure (April, September 2016, January 2017). Survey methodology was similar to that used in 2011, 2006, 2001,

			1996 & 1991. Outlier analysis conducted to confirm or delete unsubstantiated expenditures.
Scotland, Great Britain **Scottish Natural Heritage, with support from Forestry Commission Scotland, National Parks and Greenspace Scotland**	Scotland's People and Nature Survey	Quantitative research survey beginning in 2013 (following the completion of the Scottish Recreation Survey, 2003-2012), and will run every third year for 10 years. Captures information on number of people participating, activities, places visited, benefits, recreational use of woods and forests, value of parks & landscapes	**Large scale face to face survey** in respondent's home with series of questions embedded in Scottish Opinion Survey. Based on interviews with representative samples of @ 1000 adults living in Scotland each month. Some questions are asked monthly, others less frequently. Each month interviews are conducted in 55 different sampling points to capture geographical spread. Quotas are based on age, sex, social grade & working status
New Zealand **Department of Conservation Visitor Monitoring**	DOC National Monitoring and Reporting System – Annual Survey of New Zealanders	New Zealand are delivering a systematic data capture system designed to capture information on the state and any change in components of ecological integrity and visitation across public conservation land. Key centralised data capture on Visitors – Annual Survey of New Zealanders	**National Survey** using a combination of computer-assisted telephone interviewing and online surveying. Electoral roll used to sample (not limited by those with a phone number). Sample drawn from the 16 Regional Council areas divided across the 4200 sample size. Quotas are imposed to reach 'hard to engage' populations. Individuals targeted were invited to participate via mail, with reminders provided 2, 3, 5 and 8 weeks later. Data

			captured includes engagement with conservation, views of DOC, and their use of public conservation lands and waters.
Queensland **Qld Government Department National Parks, Sport and Racing**	NPSR Annual Report 2016-2017 Departmental Performance Objective 1 – Queensland's outstanding parks and forests are protected, enjoyed and cherished now and into the future, enhancing Queenslander's wellbeing and prosperity	Service Standard: Number of overnight camper stays hosted on national parks and forests. This service standard measures how effectively the department achieves the National Parks service area's objective of facilitating access to ecotourism, recreation and heritage experiences in national parks and forests.	Assessment is calculated from the **number of overnight camper stays** hosted on QPWS managed parks and forests.

2.3 Factors that influence visitor behaviour

As indicated above there are variations in what park managers seek to understand relating to visitor movement and visitation; and how rigorously this is done. It is not the role of this report to critique any one approach, rather to determine how visitation might be monitored or measured by land and water managers – should the determination be made to do so.

In preface to that however, some baseline challenges about what is being monitored or measured are worth acknowledging:

- The movement of people is a complex process and can be informed (for example) by individual motivations, resources, proximity, relationships, awareness and opportunity;
- The physical movement of people can be understood on some level by examining the sequence of movement from point a – b – c and this can be accurately tracked using GPS (Xia et al., 2008);
- Individual's decision making will affect the choices, routes and facilities they might access on a site;
- The characteristics of a site or destination may influence decision making and recreational behaviour (Lew & McKercher, 2006);
- An understanding of time, not just movement is valuable. When time (e.g. duration, season, time of day) information is overlaid with information on trail/route networks and infrastructure availability there is enhanced understanding of the attractiveness of areas and ability to predict movement through a site (Smallwood et al., 2012; Xia et al., 2011).

Within academic, research, park management and tourism forums there is agreement on the importance of visitor information to inform strategic management and planning. The nature of this information will vary based on the need of park management but there is consistent recognition that traditional management approaches that just focus on the resource, without factoring in the significance of the human engagement, are deficient in informing park planning or management (e.g. Archer et al., 2001; Horneman et al., 2002; National Review, n.d.).

3.0 Visitor Monitoring Methods

The following section sets out different methods that are, have been, or can be, used by park managers to estimate or monitor visitors – their use, their numbers, their dispersion in parks. In preface to this section it is worth noting that no one method has been deemed to be **the** most suitable. Each method has some current or historical value and use, and each will need to be assessed for best fit with each park, its management, objectives, monitoring needs and resource capacity.

For example, some methods will be best to capture certain types of data, other methods may be deemed more useful because they are cost effective, easy to use or considered most effective. Each land or water manager would need to determine the mix that best suits their areas of management.

3.1 Challenges

There are ongoing challenges with any attempt to capture visitor usage and participation. Most outdoor recreation sites provide opportunity for a range of outdoor activities (e.g. walking, picnicking, wildlife viewing, fishing, mountain biking, swimming etc), and may:

- Have complete or incomplete networks of trails,
- Include multi- or single-use trails,
- Experience conflict in visitor use (e.g. horse and motorbike, legal and illegal activities),
- Provide day use facilities and/or the opportunity for overnight camping/ stays,
- Vary in the season or time of day when usage is highest, and
- Have substantial entrances and exit locations.

Each of these variables impacts on what can be counted, when, where, how and to what level of credibility or accuracy for planning and management purposes.

Even when data capture is focused just on visitation (not visitor characteristics), the measurement of overall visits, visitors and monitoring of visitor use of parks are considered to be difficult or expensive to obtain; or insufficiently accurate to inform park planning and management. In fact, all methods of visitor count will provide estimates rather than exact figures, but each also has potential advantages and disadvantages which may vary somewhat dependent on the relevance to a particular site, its context and nature of its visitors. That being said, there are examples of best practice in visitor-monitoring that demonstrate the crucial role of accurately assessing visitation and its impacts (e.g. US National Visitor Use Monitoring Program), and how important it is to determine the visitor variables being monitored, in order to achieve useful feedback (Wolf et al., 2012).

3.2 Methods for Collecting Data on Visitors

The choice of method for data collection should only be selected once it is determined what data is required (and variables). In the following, systematic methods of data collection are reported. This begins with an overview of self-counting, direct counting and indirect counting methods in Table 2, and then more detailed assessment of commonly used and emergent methods that deserve further consideration.

NB: While methods are presented independently, the best approaches for collecting data include the use of **more than one method** that when combined reinforce, verify or double-sample visitor use, time, activities, motivations etc. Guesswork options are not represented.

Table 2 Basic, established methods of estimating visitor use levels (Adapted from D'Anotonio et al., 2010; O'Brien & Morris, 2010; Watson et al., 2000)

Method	Examples	Limitations	Benefits/ Best Use
Self-Counting **Best used in areas where access is restricted and/or usage is low.**	Voluntary registration; Self-issued permits; Mandatory permits	Subject to inaccuracies; visitor non-compliance. Often lack descriptive information such as visitor use patterns, visitor characteristics, motivations, behaviour. Information will be restricted to what visitors say they do/ intend; not necessarily what they do. Self-selection bias. Accuracy: Require mechanisms to estimate registration rates to understand accuracy OR enforced compliance of permit requirements.	Visitor burden is low for voluntary registration; higher for permits (incl. sense of control & compliance requirements). Relatively inexpensive to administer, but this will vary with permits especially where there is a need for enforcement. Inexpensive.
Direct Counting **Best used in areas with limited number of access points**	Observational techniques – External (as visitors arrive or leave – e.g. trailheads, car parks). May observe through use of cameras, video or human observers. Internal (from specific locations based within the park – e.g. trail segment or destination). May be static observations or roaming (e.g.	Time consuming for staff; Subject to inaccuracies – need trained team & good levels of inter-observer reliability; Visual interpretations only, lack detailed information or confirmation of demographics or visitor motivations/ itineraries Management costs can be high – personnel time to monitor visitor traffic & to set, maintain & move. Accuracy is questionable e.g. roaming observations by park staff is often biased to data capture during heavy visitor use. Needs to be randomised.	Can provide use estimations & data on use patterns & behaviour, group size & method of travel Unobtrusive, make no demand on visitor time – but may raise issues of privacy especially when visitors are observed in the park Accuracy best with human observers who have a systematic model of data capture that reduce bias.

	during park staff patrols)		
	Surveys	Time consuming – for visitors, rely on recall, can be challenges in achieving complete answers. Management costs high – expertise for survey design, personnel costs, administration of survey, data entry, coding and analysis Accuracy is dependent on sampling technique (i.e. not convenience sampling)	Any type of information can be obtained. Can provide use estimations & data on use patterns & behaviour – including use patterns, demographics, itineraries, motivations. Better than observation if there is dispersed use. Can streamline administration through use of e-surveys on site
	Visitor diaries	Can be more accurate than surveys as there is less reliance on recall, but demand more the visitor in terms of time and therefore often are incomplete; or only completed by few people.	Can provide use estimations & data on use patterns & behaviour – including use patterns, demographics, itineraries, motivations. Better than observation if there is dispersed use. Inexpensive
Indirect Counting	Pressure plates, automatic trail counters, electronic vehicle counters	Do not capture visitor demographics or visitor itineraries; Subject to vandalism if not well placed/ hidden; Can be expensive to purchase; Sensitive to temperature changes/ dust/ fire etc.; Need to be calibrated, accuracy should be checked; Battery/ power life needs monitoring.	Basic versions are relatively inexpensive, easy to set up and maintain. Infrared technologies have increased scope and scale of data that can be captured – speed of travel, direction of travel
	Indirect Estimation – predicting visitor use from predictor variables e.g. weather, water course levels, trailhead or vehicle counts	The predictor variable needs to be carefully evaluated – for initial and ongoing suitability; Predictive power is limited and will be determined by strength of the relationship; initial management costs high – but should decline	Useful where there is an easy to measure predictor variable demonstrated to confidently predict visitor use characteristic (regression analysis). Once the relationship is quantified, monitoring of ongoing relevance may be all that is needed for a period of time. Visitor burden is very limited.

3.3 Current & Emerging Visitor Monitoring Techniques

The following outlines strengths and limitations of some of the main monitoring techniques currently in use, or being tested for use, in parks visitor management. The techniques presented are not confined to visitor counts, but include tools to capture more complex and complete data on visitation.

1. This review begins with details on emergent techniques which may require further refinement before having wide spread application. With technological developments providing ever new monitoring options it is worth considering the potential for standardising how information is captured.
2. Further, more established and well used techniques are examined.

It is worth repeating throughout the report that while all techniques have value, their relevance to any site will be dependent on the questions to be answered, the measurements to be captured, the resources available and the objectives to be fulfilled.

EMERGING – TECHNOLOGY DRIVEN

3.3.1 Public Participation Geographic Information System

Spatially explicit participatory planning or the use of public participation geographic information systems (PPGIS) mapping is a relatively new approach for managing and understanding visitors to parks.

While most often used to inform spatial planning or to understand visitor values, ecological knowledge or community engagement with a site (Brown et al., 2015), PPGIS mapping offers the potential for providing insight into:

- the spatial distribution of visitors
- including locations they report visiting and
- potentially the frequency of visitation.

While this application aligns most directly with the practice of volunteered geographic information (VGI) or user generated content, and is essentially a form of crowd sourced data, it may provide a mechanism for land and water managers to capture specific user information on their outdoor recreation participation practices.

While the opportunity for information gathering is broadened through using people's willingness to map and share their experiences electronically, volunteered information is limited in its value depending on the accuracy of the information needed, and that provided (Goodchild, 2008). To allay some of those fears, effective use of PPGIS mapping requires the most accurate initial source data with locationally accurate information which holds attribute, positional, temporal and semantic accuracy (Kinkenberg, 2017). The precision of the level of accuracy required would differ depending on whether data capture is local or regional/ national; and how the information is to be used. For the purposes of measuring participation, frequency and popular locations for outdoor recreation, the greater the precision of the source maps will result in higher degrees of confidence in the results – e.g. apparent hotspots or to monitor trends.

PPGIS Example 1 – Interactive Website, New Zealand

The Department of Conservation (DOC) in New Zealand, along with the University of Queensland and University of Waikato, jointly conducted a pilot-study to collect public values, experiences and development preferences for conservation land in the Southland and Otago regions in New Zealand during a 50 day period in early 2011. This was done through the **development of an interactive website** that allowed visitors to conservation areas to identify and map their park experiences and values.

Respondents were reached through a number of mechanisms in an effort to attain a random sample including:

- Postal invitations mailed to local households to participate in the study which provided instructions and access codes to an online survey;
- Visitors to conservation areas were approached on-site and provided with instructions and access codes if they wanted to complete the survey at their convenience; and
- Members of the general public who expressed interest in the survey could request access codes online, to complete the survey.

Strengths of approach

- The methodology provides capacity for self-reporting of recreation usage that can inform where people go and the experiences or attractions of different trails and areas.
- The technique also allows for 'hotspot' mapping and analysis of areas or experiences that respondents identify as key destinations. The online survey provided the chance for people to map areas of use (or interest or appeal) and then the density of markers can demonstrate high through to low density of responses in a spatial area.

Limitations of approach

- There was a lower response rate than anticipated especially from the postal outreach. In total only 178 full responses were mapped, with an additional 91 partial responses for a total of 268 participants. Recommendations were made to eliminate postal outreach and focus on public awareness of the survey, and include a prize to increase response rates.
- This type of measurement demonstrates results of self-selected respondents rather than random sample. A large sample size would be needed to achieve a result that might be statistically representative of the population/ visitor cohort.

In use, the GIS mapping tool offered useful information, but would have been strengthened from:

- Reducing the number of different markers respondents were asked to pin to around 10 (not 30);
- Allowing respondents to map to areas rather than individual points;
- Provide the capacity for respondents to save and revisit their response so they can complete later;

- Provide a navigation bar or mechanism to allow respondents to navigate into key visitor sites more easily (e.g. spatial bookmark/ more detail in maps provided);
- Understand that completion of this type of data capture requires internet access with good download speed. If seeking information from those in areas with poor internet reception it might be useful to set up a dedicated computer in a local visitor centre to enable completion. (NZ Dept of Conservation, October 2011)

Example 2 - PPGIS to Understand Visitor Movement & Experience, Northern Sydney

PPGIS has also been used in to have recreation users map their use and patterns. While PPGIS tends to provide the opportunity for communities to build a map, for land and water managers looking to measure participation the application can be refined to allow information to be added to create a cumulative picture of use. A study of Northern Sydney national parks with mountain bike riders revealed PPGIS to be cost effective and efficient, with strong correlations found between PPGIS and GPS tracking results. Additionally, the data captured clarified why riders chose specific tracks or routes (Wolf et al., 2015) thus indicating this approach can provide a template to capture self-reported land and water use for recreation purposes.

PPGIS Strengths

- Offers insights in spatial distribution attributes such as locations people report visiting and possible frequency;
- Enables data capture re reasons for park visitor activity and identification of location specific management that could improve existing experiences (Wolf et al., 2015);
- Potential to overlay distributions from different visitor groups (e.g. MTB riders, horseriders);
- Online PPGIS mapping has shown initial popularity with sample audience as it is seen as innovative and a one-off commitment;
- Valuable tool in multi-method approach and can be used to calibrate other methods.

PPGIS Limitations

- Data capture relies on self-reporting and recall (e.g. locations, specific sites found on a map to assign spatial attributes);
- Does not capture the exact time spent at specific sites or facilities;
- Effort is required to establish the PPGIS data capture resources (technology, people);
- Visitor time impost can be quite high when using online mapping tools;
- Data processing time is high;
- Does not provide a visitor count – but can be used to calibrate with other methods.

3.3.2 GPS Mapping

GPS tracking provides the opportunity to capture actual (vs reported) spatio-temporal distributions of visitors and captures entire travel routes (not just single locations) of visitors (Orellana et al., 2012; Wolf et al., 2012; Wolf et al., 2015). Compared with observational or survey techniques, GPS-based methodologies in general have been found to be more detailed, accurate and robust and

require minimal time demands on the visitor and less training for staff (Hallo et al., 2005; Ligtenburg et al., 2008).

Example- Tourism Tracer, Tasmania

In 2016 a joint exercise between the University of Tasmania and Ionata Digital led to the development of Tourism Tracer, a living dashboard that tracks the movement of volunteer visitor samples to Tasmania who stay from 4 to 14 days. On arrival participating tourists are provided with smart phones that record accurate, real time (temporal and spatial) data of their travel patterns through a purpose built app that relays GPS location information. (For further detail see Tourism Tracer website: www.tourismtracer.com/about/). In addition, a series of smartphone pop up surveys are undertaken to capture personal insights from those who are involved. The surveys also capture socio-demographic information, knowledge of Tasmania and cultural background and allow the opportunity to gauge greater understanding of the experience of the visitor, not just their movement.

GPS Strengths

- The data resulting from GPS strategies are detailed and more accurate spatially than data collected using traditional methodologies;
- GPS mapping can be used in concert with other data sources such as visitor surveys and recreation ecology assessments;
- Can provide insight into spatial extent and duration of any off-trail use;
- Provide opportunity to examine large and small scale visitor movement and visitor flow on and off trails;
- Capture entire travel routes of visitors (Orellana et al., 2012);
- GPS tracking systems (whether collected from smartphone tracking applications or supplied by researchers), are easy to use and can be implemented in unobtrusive ways to visitors OR engage them in active citizen contribution/ participation.

GPS Limitations[2]

- Reliance on visitor sharing tracking information (opt in is needed);
- Data capture may be sporadic;
- Basic GPS tracking data benefits from also querying visitors regarding their park recreation habits (e.g. favourite trails, accompanying group, whether and where they recreated in the near vicinity outside the park etc);
- Data capture requires some level of technical knowledge to import and share data;
- Outcomes dependent on depth of analysis, which can be complex.

3.3.2.1 Mobile Apps/ Volunteer Generated Information (VGI)

While Tourism Tracer has been specifically developed, there are also multiple apps that provide people with the opportunity to map their own routes as they participate in their outdoor recreation.

[2] Meta-data from telecommunications firms do capture a level of spatio-temporal data, and socio-demographics. In areas with digital access, there is scope to gauge broad scale information if agreement can be established with telcos, fine enough detail can be gauged and privacy considerations addressed. This topic is addressed in Recommendations.

In Australia Strava is popular, but the range of app options continue to grow and provide a mix of data recording of the distance people travel, the route they took, pace, elevations achieved and the chance to geotag photos to share with self and others. These apps can be used personally to track movement; or the information can become part of a community of participants to map new routes, promote events, update and share reports of current conditions and inspire others to get involved.

The mass connection to global navigation systems via smartphones and location based social networks offer both potential opportunities and challenges for understanding visitor behaviour and monitoring visitor use of parks.

Specific examples of relevant mobile apps/ location-based social networks include:

- Strava (free) – for running, walking and cycling[3]. Can compare your ride/walk with others who have used the same route and have heat maps to demonstrate which routes an individual has travelled the most and how often the route is ridden. NB Though designed for cycling, horse riders are using this app to monitor their routes.
- Ride with GPS – provides opportunity to drag and draw own routes and includes elevation profiles. Provides an Ambassador program to review rides and ride quality from other riders around the world.
- Map My Ride/ Walk/ Run/ Hike (free) – tracks and logs specific outdoor activities and elevation information; provides online journal of trails/ routes, records pace, distance, route navigation. Data can be synced to free online account to share information with others. Upgrade features include crowdsourced coaching advice from experience recreationists, audio coaching and live tracking.
- EveryTrail/AllTrails (free) – Global web 2.0 platform for geo-tagged user-generated content that provides scope for hiking, cycling, geocaching, kayaking, horse riding etc. Provides scope for people to plot a trip, load photos and video on a map; includes route tracking, audio guides, map downloads, stats.
- EndoMondo (free) – track movement, check stats, audio feedback on distance and pace, maintains a log, share with others through social networks, add pictures, tag friends etc.

VGI Strengths

- Strava's global heatmapping (now with 3+ trillion data points) can show where app users most commonly participate in a named activity, across 31 different pursuits[4] (see: https://labs.strava.com/heatmap/#2.00/121.76363/40.93140/hot/all);
- Where a participatory planning process is introduced that engages visitors in tourism and recreational planning decisions, willingness to share GPS data can be high;
- With existing social sharing apps it is possible to exploit volunteered geographic information (VGI) through different online sharing platforms (e.g. Strava, RunKeeper);
- Can access GPS data through individuals existing equipment (own tracking devices), rather than having to supply these and train visitors in their use.

[3] The term cycling will be used inclusively for all forms of self-propelled bicycle riding.
[4] Strava is used by skiers, hikers, swimmers, kiteboarders, mountaineers etc.

VGI Limitations

- Inconsistent use of app/s may result in incomplete data sets;
- Challenges in accessing data sources from people outside an identified and recruited sample;
- Where data capture comes from publicly available sources, site specific detail may be low and non-representative;
- Can be difficult to sustain visitor sample communication and engagement if data collection period occurs over a period of weeks;
- When using VGI methods, legal and ethical concerns need to be investigated;
- VGI data may be impacted by measurement error, loss in detail, inconsistency (e.g. do people use the geotagging guidelines, is there positional quality?), and would benefit from cross-validation of data sets.

3.3.3 Social Media Analysis

There is growing awareness that content-rich geographic and social visitor data is being produced by users of different social media platforms. Though yet to be proven as consistent and accessible forms of primary data, the use of geotagged data captured and shared through social media applications has the potential to provide information about people's behaviour, activities and interactions with the environment on both spatial and temporal scales (Heikinheimo et al., 2017; Wood et al., 2013).

Example – Instagram Posts, Finland

A study undertaken in Finland sought to identify how well social media data content matched findings derived from traditional national park visitor surveys. The study was undertaken using the most visited National Park in Finland at the same time the park had an on-site visitor survey being conducted over a 9 month period in 2016. Using a series of social media data captured from posts on Instagram API over a corresponding 5 month period in 2016, publicly available posts were accessed[5]. This included seeking information from geotags, timestamps, content and user profiles through which they identified who their social media users were, where they travelled in the park (their spatial patterns), when social media users were in and moved through the park (temporal patterns), and what activities were being done.

The results of the analysis revealed that the social media data could provide a useful source of additional and complementary information to traditional survey data. It offered a source of continuous monitoring of what was happening and revealed some changes in trends and emerging activities taking place in the park.

Social media sources can also provide information by examining the results generated from existing analytical tools (where relevant). For example:

[5] Data collection was conducted using a custom made tool written for Python programming language. All publicly available posts for the allocated time period were requested from the Instagram API (www.instagram.com/developer).

- *Google Analytics* of any park websites can help management understand what people are searching for that leads to them to a park. This may help with understanding visitors and latent demand;
- *Gnip* (owned by Twitter) can deliver information on what people are tweeting, delivered in real time and allow exploration of trends and influencers;
- *Facebook Pages Insights* can be useful if any park management has a facebook page to help understand their audience and what engages them on that page (including visits, posts, unique engagements etc).

Social Media Analysis Strengths

- Can be used to detect more popular sub-regions in a park/ region;
- Can present a broader and more dynamic picture of activities especially of younger people;
- May reveal emerging activities not considered in survey design and questions;
- Through monitoring of social media platforms it is possible to access an ongoing insight into the spatio-temporal changes of visitors (e.g. across seasons); understand visitor profiles; identify emerging activities; map traffic hotspots; and/or understand visitor sentiment (through content analysis)[6] ;
- Can provide a mechanism for estimating visitation rates without survey data when modelling is done to anticipate and scale visitation rates;
- There is emerging evidence that assessing the density of existing geo-located photographs posted on photo-sharing websites (e.g. flickr, instagram) correlates with empirical data from more traditional sources (Wood, 2013).

Social Media Analysis Limitations

- Of limited value in areas with low usage or where there are limited social media posts;
- People may tag locations based on the overall area (name of the park), not precise location names within the park;
- Poor mobile phone reception will influence the potential to post, or the number of posts;
- Posts tend to occur closer to infrastructure (e.g. accommodation) and by younger age cohorts;
- People travelling from further afield may be more likely to post than those who live in close proximity or regularly visit a park;
- Different locations and activities may be more or less suited to taking photographs or using social media (e.g. water based pursuits, remote areas, high risk);
- Not all social media users will use any one social media (or image sharing) site, therefore managers may have to monitor Instagram, flickr, pinterest, twitter etc to gain a broad or inclusive view of users;
- Can be a challenge to access usable data from the owner/ administrator of the application;
- Greater development of practical tools are needed before social media monitoring is operationally used to monitor visitors in recreational areas, but it does provide an additional dynamic to understanding (Heikinheimo et al., 2017);

[6] NB To gain value from this, there may need to be an increase in social media postings for individual parks. This may require promotion of specific hashtags related to place names, activities or nature sightings.

- To be effective there needs to be more work done comparing social media with field based studies to determine reliable statistical relationships (Wood, 2013).

3.3.4 Aerial Surveys/ Remote Sensing

Early aerial surveying has been used to count wilderness visitors since the 1960's but the success was limited by low resolution film, the need to avoid low altitude flights (air traffic control and incompatibility with landscape values), and costs. With increasing availability, affordability and ease of use, drone technology has the potential to reinvigorate aerial surveying as a means of counting park visitors and examining their spatial dispersion. Importantly aerial surveying can also be used to monitor recreation areas over time and may be of particular value for determining use on rivers and dams where the coverage is less dense and higher altitude flights are feasible.

Simply, drones or unmanned aerial vehicles (UAV's) are a common use word to define self-propelled airborne devices that operate with no on-board pilot. Different forms of drones are used for a range of purposes including military through to recreational and professional (e.g. agricultural use, land surveying) and they vary in size, range, endurance and what they can carry (Paneque-Galvez et al., 2014). In Australia, the safety laws for drones or what are known as remotely piloted aircraft (RPA), vary depending on whether the purpose of use is recreational or commercial. In brief if the RPA weighs less than 2kg, no operator's certificate is required (regardless of purpose), though the Civil Aviation Safety Authority should be notified. If the purposes are considered commercial (including if someone is paid to operate the drone) or the RPA is 2kg or greater, an RPA operator's certificate (ReOC) will be required[7].

Work undertaken by the Water Research Laboratory based at the University of New South Wales[8] has demonstrated the effective use of drones or unmanned aerial vehicles (UAV's) for asset inspection and mapping, monitoring of beaches, estuaries and wetlands, vegetation mapping, facility inspections and aerial photography and cinematography (Water Research Laboratory, n.d). While these purposes do not explicitly capture visitor use or counts, the technology is sufficient for this purpose. Example information on drone specifications and types of measurements, profiles and mapping achieved through drone surveying can be found in Appendix 2.

In other jurisdictions drones have been used for the counting and monitoring of wildlife (e.g. Hodgson et al., 2013), as well as for law enforcement and the monitoring of illegal activities (e.g. hunting) in parklands (Schiffman, 2014). Considered in conservation circles to be of particular value for monitoring large areas difficult to cover by ground, drone monitoring is generally viewed as an emerging and efficient tool for monitoring activity, behaviour and change (Sandbrook, 2015; Schiffman, 2014).

Aerial Surveying Strengths

- Can be used in remote areas;

[7] The Australian Civil Aviation Authority provides basic rules for flight of RPA's and fact sheets and updates as regulations regarding drone safety are revised. Anyone wishing to fly a drone would need to be aware of Part 101 of the Civil Aviation Safety Regulations. These can be found at: https://www.legislation.gov.au/Details/F2016C00889

[8] The Water Research Laboratory operate the beach cameras for a number of sites including CoastalWatch on the Gold Coast.

- Can provide high definition aerial video/ photographic data;
- Cost effective method to collect high quality elevation data;
- Spatial accuracy of drone surveys is considered to be high and data is captured in a relatively short timescale (e.g. Anderson & Gaston, 2013);
- Effective in open landscapes (possible to count tents, kayaks, rafts etc);
- Large areas can be surveyed in a short space of time;
- Spatial spread of visitors can be surveyed.

Aerial Surveying Limitations

- May be expensive, especially if multiple samplings are required;
- Impact on visitors can be high as drone flights may be intrusive and/or incompatible with park values;
- Most effective in open landscapes, not those enclosed or with dense canopy;
- Privacy considerations need to be factored in to determine if it is lawful and ethical to monitor people without their knowledge[9];
- Accuracy for the purposes of estimating visitor use/ flow is untested/ inconclusive and may vary based on flight conditions;
- Quality and weight of the drone will impact on flying time. Cheaper UAV's often have flight times of less than one hour;
- Depending on the area and use, UAV's may need to be deployed by approved pilots to ensure compliance with professional flight regulations;
- In addition to following civil aviation safety regulations there may be local council and/or national park laws impacting on drone flights in certain areas that may need to be negotiated (however there may also be relaxations for permitted drone use without an operator's license where you are flying over your own land).

DIRECT COUNTING/ OBSERVATIONS

3.3.5 Camera / Video Imaging

Cameras and video recordings are used in a number of jurisdictions to monitor visitation and site conditions. For example, Coastalwatch cameras are used on the Gold Coast to provide,

1. coastal management information including beach changes and effectiveness of coastal / beach protection interventions; and
2. visitor insights into the weather, conditions and size of the crowd.

Using ARGUS coastal imaging cameras supplied and maintained by the Water Research Laboratory based at the University of New South Wales, imagery of the beach and shoreline are continuously captured through one or more automated cameras that collect and transfer time-series images via an internet connection. Photos are taken at regular intervals every hour of the day for periods of

[9] Privacy concerns are not limited to drone use, but have equal relevance with other forms of image capture or photography. A study undertaken in Australia in 2011 indicated that farmers (for example) were happy to be monitored in principle, but that satellite monitoring was considered an invasion of their privacy (Purdy, 2011, p. 205).

years providing the opportunity to capture, monitor, document and quantify change, activity, conditions etc (Water Research Laboratory, 2017).

Where this is a specific instance and includes outsourced data analysis and management, camera and video monitoring have been used for decades within natural areas, especially in remote or difficult to access sites with long field of vision (e.g. off shore island beaches).

Camera Strengths

- Well tested method internationally, especially in urban recreation areas;
- Can be motion sensitive or time lapse;
- Cameras can be set to capture images at fixed intervals which can maximise coverage and operating time without maintenance;
- Range of information re visitor profile and temporal and spatial patterns captured from imagery can include number of trail/ park users, group size, directions of movement, type of user and potentially nature of group (adults & children; male or female) and user conflict;
- Valuable in high use areas where it might be difficult to separate users accurately. Has been found to be more reliable than visual count by human observers in heavily used intersections with multiple user types (Arnberger et al, 2005);
- Wireless reading of observations through mobile technology is available;
- Valuable form of calibrating other data collection techniques such as counters or field counts.

Camera Limitations

- Time consuming, manual exercise to interpret data;
- Can impact on visitor experience of isolation, remoteness, freedom;
- Expensive and vulnerable equipment to use and maintain;
- Maintenance required to ensure calibration and image quality is sustained;
- Power requirements may mean this is less feasible away from permanent sites. Power source can be unreliable and will need to be maintained – e.g. solar, buffer batteries, standard electricity (e.g. Kajala et al., 2007);
- Can raise ethical and privacy issues.

3.3.6 Ocular Data/ Field Observations

The reporting of visual in-the-field observations can be useful and offer supplementary insight into visitor numbers and characteristics. When done in a strategic and coordinated manner, visual observations can provide context for other findings and result in richer understandings than counts or quantitative reporting alone. Visual field observations are done by human observers who record visitor numbers at fixed sites, or by roaming and using recording forms or hand counters to capture data.

Ocular data can include:

- Field note taking – on topics relevant to data collection (e.g. amounts/ location of litter, expanded trail usage, observed conflicts, types of use, appropriateness of use as per the land/water managers use protocols etc);

- Photographs at locations of interest/investigation.

3.3.6.1 Visual Estimates

Another form of ocular data is used by sites with limited resources to establish a 'best guess'. These might include:

- Field counts – this often includes staff counting users on a particular trail in a one hour time period and then multiplying that number by the number of hours that trail is open;
- Taking visual estimates of people seen on the day;
- Count of cars parked in areas near hiking trails – and multiplying the car count by a factor informed by historic or current counts (e.g. 2, if normal practice is 2 people/ vehicle).

Field Obs Strengths

- Portable/ mobile;
- Useful for short term counts;
- Human observers can readily differentiate between users (e.g. walker, cyclist, kayaker);
- Provides opportunity to capture descriptive data (e.g. behaviour, equipment);
- Can be permanent in some staffed sites (e.g. staff entry, interpretation centre, gift shop);
- Can be used to confirm/ validate automated equipment/ other counts.

Field Obs Limitations

- Resource intensive of staff / people time;
- Can be inaccurate for longer duration counts;
- Often used in unsystematic ways;
- Subjective and requires staff training;
- Less feasible away from permanent or key access areas.

3.3.7 Recreation/ Usage Surveys and Questions

A range of survey instruments or the inclusion of relevant questions into existing survey data capture have been used for decades to determine who is making use of land and water for recreational purposes. With practice and knowledge, surveys are relatively straightforward to develop and there are batteries of questions that can be transferred to different jurisdictions that address different variables (e.g. service quality, trip experience, conflict). There are also issues of resourcing that impede the feasibility of survey distribution especially for larger land/ water managers regardless of the type of survey model selected.

Survey Types

- Adding Questions to International / Domestic Tourism Visitor Surveys
- Trailhead / Access Point Surveys
- Household surveys/ Population surveys
- Catchment survey – snapshot of population within a given distance of a site[10]

[10] O'Brien and Morris (2010) assessed advantages and disadvantages of survey data capture for the Forestry Commission in the UK. A table of their findings can be found in Appendix 1.

Survey Strengths

- Enable **capture of a breadth of information** including socio-demographics, visitor / group characteristics, trip characteristics (e.g. planning, entry and exit points, length of stay, where vehicles were parked), activity participation as well as understanding of satisfaction, motivation and or issues of concern (e.g. crowding or conflict);
- Can be **distributed in multiple ways** – online (survey link), offline but electronically (e.g. use of tablet/ smartphone with mobile offline survey app – droidsurvey, isurvey), face to face (paper and clipboard), in remote areas and trailheads, at any time of day to suit known or anticipated usage patterns;
- Enable 'in the moment' feedback and response if they are distributed (for example) as visitors exit the trail or waterway;
- Can be **repeated** to explore changes over time;
- **Simple to complete** for the respondent ;
- **Choice in analysis tools** and processes from those as simple as descriptive statistics (frequencies, means, medians) to more complex analysis through statistical package tools (e.g. SPSS),or forms of analysis (e.g. regression analysis).

Survey Limitations

- **Resource intensive** to distribute surveys face to face either in paper or e-form;
- Determinations need to be made of the 'best' locations and times for distribution of surveys and these may not be conducive to **staffing** – e.g. remote locations, multiple locations, early/ late in the day for times needed to capture users;
- The **amount of time needed** to ensure multiple days of data capture, not just a single snapshot;
- **Size of sample** impacts on the generalisability of the findings therefore more time needed to capture the diversity of users of different sites;
- Respondents may have a **low desire** to complete the survey at the end of their recreation experience therefore incentives might be required;
- If the study is longitudinal, specific **questions may become less relevant over time** leading to questions being added/ removed reducing comparative information between years;
- Visitation information may be impacted by **assumptions made to interpret the data** (e.g. does several times doing something = 2 or 4?)

3.3.8 Multi-Method

As outlined previously, there are multiple levels of information that can best inform visitor management. Part of this may involve understanding how many people visit a park, where they go and/or how long they may remain in the park boundary. Additionally, there is strength in understanding the activities undertaken, the motivations for visitation, social groupings of visitation, frequency, benefits, concerns and experience. No one monitoring or measurement tool will capture all this information, and the most thorough monitoring programs utilise a mix of techniques that allow for data checking, correlation of information and the development of a depth of understanding of visitors.

Multi Method Example – Survey + Manual Count + Mechanical Count

The US Forest Service undertakes a National Visitor Use Monitoring Program (NVUM) to produce estimates on the volume of recreation visitation to National Forests and Grasslands and to produce descriptive information relating to that visitation – e.g. activity participation, demographics, visit duration, measures of satisfaction and trip spend relating to the visit. Though data capture techniques and quality has varied over the years, the US Forest Service has information on visitor use since 1924. In 1996 a field survey was developed to estimate recreation use on the national forests throughout the United States and it is this which has evolved into the NVUM program (Zarnoch et al., 2005).

This survey involves a stratified multistage sampling design spread over a 5 year sampling cycle. This means that all national forests are sampled once every 5 years. The sampling design divides each national forest into areas or site types that contain a range of individual sites with similar recreational attributes. These include:

- Day use developed sites;
- Overnight use developed sites;
- Wilderness sites; and
- General forest areas.

In addition to selecting random vehicles to be interviewed to complete the survey, other methods are used in the NVUM sampling design. These include mechanisms to estimate the number of recreational visitors to determining numbers and their park 'status' (e.g. are they arriving, exiting [for the last time], exiting a site or area but still in the park etc). Where around-the-clock monitoring might provide the most exact values this is not a feasible or efficient use of time and resources. Rather the Forest Service uses a 24 hour *mechanical count* of all traffic in addition to a 6 hour window of vehicle occupant interviewing, as well as manual hand tally count of exiting vehicles at designated interview points traversed by visitors. This process is designed to provide:

- A ratio of observed exiting vehicles to the 6 hour mechanical vehicle count which is used to calibrate the 24 hour vehicle count for an estimate of total exiting vehicles in a 24 hour period;
- An estimate of the proportion of exiting vehicles that carry last-existing recreationists; and
- The average number of people in a last-exiting recreation vehicle.

Combined the three methods and values are used to estimate recreation use at the site over a 24 hour period (Zarnoch et al., 2005) and it is generally considered that the format is more statistically sound and more accurately measures visitor use and characteristics (USDA Forest Service, 2007).

Multi Method Strengths

- Opportunity for continuous or rolling data capture that provides trend and use information that can assist with site management;

- Surveys provide the opportunity to capture a breadth of data and to gain deep understanding of visitor activities and experience;
- Questions can be adjusted to suit site and objectives and to link with other monitoring data (e.g. visitor profiles, intentions, impacts);
- Surveys can be distributed through multiple channels to suit resources/ demographics;
- Multi methods are valuable to enhance calibration;
- Since traffic counters count traffic in both directions (most often), the hand tally count of exiting traffic helps determine a clearer picture of in/ out rations for the traffic counter;
- Opportunity to cross check & confirm through multiple data sources.

Multi-Method Limitations

- Require additional resources to implement each method and coordinate across methods;
- Reliance on the skill of field interviewers to capture visitor willingness to complete survey questions and to maintain quality control;
- Multiple methods may be expensive and time consuming;
- Need to set up effective and well located survey/ count locations that ensure random sampling approaches;
- Multi method approaches require rigorous sampling and research design;
- Need to ensure completeness and accuracy of interviewers survey questioning;
- Reducing interviewer selection bias;
- Ensuring methods used are complementary and not assuming all data is automatically comprehensive or aligned.

INDIRECT – ON SITE COUNTING

3.3.9 Vehicle Counts

Vehicle counts can be useful to understand the people at one time (PAOT) in an area, and assists with informing visitor capacity decisions (Lawson et al., 2002). Vehicle counts can be done manually or through the use of car park cameras or motion sensors in high use areas (single access roads, campsites). Typically, the car count is then multiplied by a number (e.g. 2, 2.5, 3) that indicates typical vehicle occupancy and/ or that accommodates for people who might enter the park via non-vehicular means or through other entrances.

Example – Parks Victoria

For the last 15 years, Parks Victoria has been monitoring traffic at key visitor sites. In the past they used Portable Tube Classifiers for short-term surveys at different locations using a rotation system. They have recently upgraded these to *Remote Tube Classifiers* (MetroCount) to facilitate remote site monitoring and data download. The change in resource was a result of the availability of upgraded technology, but also the need to relieve increasing pressures on staff time and capacity as vehicle counters have required time and skill to check and download data, and to distribute and disseminate. Though commercially specific, the Remote Tube Classifiers demonstrate the availability of vehicular site monitoring that can:

- provide data directly to base and require minimal human and time resources once in place;
- be provided with a corrosion resistant enclosure that can be permanently powered by a solar panel attached to the cabinet;
- function in relatively low volume monitoring sites (e.g. National Park entrances) and on sealed and unsealed roads;
- provide remote connection to a monitoring site to download data and conduct equipment checks (MetroCount, https://metrocount.com/products/mc5606-remote-tube-classifier/).

Vehicle Count Strengths

- Automatically record and store data on vehicle arrivals independent of staff observation;
- Provides a useful support tool for confirming the accuracy of car counting or any other single method;
- Ease of use providing potential for park staff to collect and analyse empirical data on a regular basis, rather than use external consultants.

Vehicle Count Limitations

- The need to find appropriate sites for traffic axle counters – are they only capturing park visitation?;
- The risk of double-counting where there are multiple access points and multiple counters;
- The need to periodically check the accuracy of the counting mechanisms;
- The need for clarity on the estimation equation from vehicle count to number of visitors (e.g. how to account for number of axles, adjustment for counting traffic entering and leaving park, currency and correctness of estimation of average number of visitors per vehicle).

3.3.10 'Other' Traffic Counters

A range of alternative on-site counters have been developed to record the passage of visitors. Different types include mechanical counters, acoustic slabs, pressure counters, active optical counters, magnetic sensing counters, microwave sensing counters etc. Each utilise a different technology to sense movement or detect changes; and have varying capacity to transmit data 'back to base' or store within their own closed system, and to capture time and date information.

Counters at trailheads can be set up to capture usage of a trail and could be set up along the trail. There are different instructions for optimal use that need to be applied to different products and the 'vehicles' or usage they are set to capture –e.g. mountain bikes, horses, walkers, trail bikes. Generally counters are set up around 100 meters from the trailhead so they do not count people going back and forth to cars (e.g. for forgotten items), and preferably at a point where people, horses, bikes are travelling in single file.

Mechanical counters can also be used that rely on physical displacement or *movement of structures* to trigger a count. For example, movement from a hinged boardwalk, turnstile, gate or stile could trigger the count mechanism. Appendix Three provides some additional information on traffic counters (including identification of commercially available counters in use in Queensland) but

please note, there is rapid evolution in the development and capacity of counters and research should be conducted to determine the best use and relevance of different counters in different conditions.

Traffic Counter Strengths

- Can function well in remote areas for extended and continuous periods of time;
- Many detect direction of movement;
- Are or can be hidden from view of visitors;
- Can be waterproof;
- Cause no disturbance to visitors;
- Have been used to quantify visitor use at trailheads, inform statistical modelling of visitor use, inform planning and capital project applications;
- Portable.

Traffic Counter Limitations

- Each product or means for recording visitor passes vary, and independent consideration of value to site would need to be determined based on context;
- Rigour is required in installation and operation to minimise count error (e.g. People walking or travelling side by side in groups can reduce the chance of accurate visitor detection, counters in areas where people pause may count individuals multiple times as they pause in the counter's range of detection);
- Weather conditions and climactic change can impact on the counters 'receiving eye';
- Raw data from automated counters benefit from calibration to estimate data error and convert to reliable estimates of visitation (Pettebone et al., 2010);
- Power source may not suit environment;
- Software requirements for downloading, storing and processing count data will also need to be established;
- While comprehensive counting technology is available it is expensive to purchase counting systems that differentiate between users and transmit the data to an online data management platform.

OTHER

3.3.11 Entry fees, Bookings & Permits

Monitoring and assessment of car entry fees and/ or camping/ usage permits provides a mechanism to understand the direct usage of parks. The National Park Service in the USA recommend that each car entry fee be multiplied by a formula reflective of each sites 'typical' vehicle load of passengers. For example, in more popular parks this might be by 2.5, in less used parks, by 1.5.

Permits and entry fees can also apply where there are visitor use limits or areas are controlled (e.g. some National Park classifications, in-demand camp sites, protected islands, commercial activities etc). An examination of visual data from QPWS Permits – Camping April – June 2017, reveals data capture includes base information on visitor postcode, campsite, booking duration, facility use and

the number of adults, children and infants in a group. Additional data could be captured through this engagement.

Equally, event permits contain and capture information on special activities or organised events (QPWS and Local Councils; Commercial and non-commercial) and evaluation of these permit requests and allocations can provide at least crude data on the size of the group, the activities undertaken, and the possible impacts of activities on the environment and other park visitors.

Other indirect methods of visitor count include collation and assessment of fishing and hunting licenses (recreational, commercial, off shore, stocked impoundments). These offer insight into the demographic and recreational intentions of the license or permit holder, but may not capture actual engagement, or all individuals who undertake these activities in an area. Also, it is possible to capture data from commercial permit holders of their client data for visitors brought into an area.

Fees/Permits Strengths

- Provides a supporting means to count visitors where data capture is systematic and consistent;
- Permits/ entry/ camping booking and fees are considered to be part of 'business as usual';
- Flexible source with the ability to tweak permit and license data capture systems.

Fees/Permits Limitations

- Inconsistent internal application of booking systems;
- Requires consistent and correct data entry systems and processes;
- Lack of compliance on behalf of the recreation user;
- Where accessing information from commercial providers, requires their cooperation.

3.3.12 Secondary Data Mining

Where direct visitor monitoring or interpretation is not conducted, it is possible to glean some indicative data through other data sources. Of specific use in Australia is the capacity to seek insight through the National and International Visitor Surveys, conducted by Tourism Research Australia (TRA). These surveys are undertaken annually and information can be broken down not only by state, but by region, type of accommodation used, reason for visit, leisure activities undertaken, travel party, by visitor night and by visitor spend.

The National Visitor Survey (NVS) is undertaken via a large-scale telephone survey (landline and mobile phones) which has been running since 1998. Interviews are conducted on most days of the year and there is an annual quota of 120,000 interviews (TRA, 2017).

The International Visitor Survey (IVS) samples 40,000 departing, short-term international travellers over the aged of 15 years, at the departure lounges of the eight major international airports. Of the 100 questions asked, information includes nature of the travel party, purpose and places of visit, activities undertaken, demographics and expenditure. Both surveys use sampling methods to achieve some level of representative diversity.

Through the TRA it is possible to secure access to research information across international and domestic visitation. Of relevance to this discussion, a 'tourist' or a 'visitor' is defined as someone

who is travelling to a place other than their usual environment to do things for which they are not renumerated (ABS, 2006). This very broad definition allows the capture of data on visitors who may not consider themselves 'tourists', but subsequently can offer regional and destination level insights for parks management. Given TRA data capture includes information on visitation relating to nature based tourism or leisure travel[11] including visitation to national or state parks and activities undertaken, it is possible to extract some complementary information to inform the annual number of visitors to regional or LGA 'national parks/ state parks' from these two surveys; and the activities of the respondents in that region/ park (Driml, 2010; Walters & Driml, 2013).

Secondary Data Strengths (IVS/NVS)

- Data capture is undertaken nationally and systematically;
- Survey capture is regular and long term (e.g. domestic surveys are undertaken quarterly and have been since 1998), therefore five or ten or 20 years of trend averages can be secured;
- Domestic visitor survey collects data on day as well as overnight trips;
- Information collected includes (for day and overnight trips) demographics, main destination, purpose of trip, leisure activities and travel party among others;
- Domestic visitor survey has used a dual frame sample method since 2014 to capture Australians without residential landline phones. This expands the sample and reduces some coverage bias, however it also created a break in the survey series because the mode of data capture changed;
- Regional and sub-regional data can be accessed through direct request with TRA.

Secondary Data Limitations (IVS/NVS)

- The data capture is not specifically targeted on park visitations or use;
- Some data will be incomplete due to the small sample sizes at regional and sub-regional levels;
- International Visitor Survey does not align region visited and activities undertaken (though the domestic survey does);
- With small sample sizes, a 5 year average may be as precise as the data can be;
- Domestic survey relies on participant recall and will only capture recall periods of 7 days for day trips and 28 days for domestic overnight trips;
- Data are not published by TRA at a sub-regional or regional level, but are available on request. To secure deeper and specific level information from TRA, the park manager/ LGA will need to be specific in the questions they want data mined;
- As with any sampling framework, data are subject to sampling error.

3.4 Summary

While there are multiple possible visitor management tools and models to suit the resources and approach of park managers, in practice the effectiveness of implementation of these depends on the needs and intentions of management, the extent and nature of visitor management activities, and

[11] Nature based tourism is defined as "leisure travel undertaken largely or solely for the purpose of enjoying natural attractions and engaging in a variety of nature based activities – from scuba diving and bushwalking to simply going to the beach" (Tourism Australia Website: http://www.tourism.australia.com/en/markets-and-research/industry-sectors/nature-and-wildlife.html).

the social, environmental, regulatory, political and/or economic local conditions. Choices can and will need to be made based on whether park management is focused on retaining the visitor experience, protecting the resource and visitor experience, monitoring and managing visitor impact, and/ or setting objectives for achieving visitor optimisation. They can also be made based on the value attributed to making explicable decisions, the need to plan for necessary investments, or simply be made based on an acceptance of importance of understanding visitor experience and expectations.

The most fundamental visitor information needed for park management is the number of visitors for an area; and even this most basic of visitor data is needed to inform strategic and operational planning to support management outcomes for conservation and visitor management. Of essential importance for understanding the number of visitors and/or their use of the park is the reliability of the data. The more reliable, the better the outcomes and the more effective the application of this information for visitor flow modelling, capital works applications, or management of visitor impacts. This means that a rigorous process is required to not only choose data capture methods, but that sources of error need to be recognised, the methods selected are sustained over time, and high standards are applied to the establishment, collection, processing, storage and reporting of data.

4.0 Current Practices in Visitor Monitoring

There has been some exploratory research undertaken in Sweden to explore park manager experiences of visitor management in outdoor recreation areas. A qualitative study of visitor monitoring management in 12 recreational areas demonstrated that even when there are national directives relating to growing participation in outdoor recreation (2012 Swedish National goals in Outdoor Recreation), the use and application of visitor monitoring in parks:

- is often mired in traditional forms of measurement,
- is tied to individual park managers skills and competencies, and
- could be enhanced through additional staff training in new ways of visitor management and building foundations for decision making (Andre et al., 2016).

To gain some insight into how visitor monitoring is being undertaken by Queensland land/ water managers, a short questionnaire was emailed to 20 resource management staff throughout the state (e.g. Local/ Regional Councils, QPWS, Water storage authorities, Scouts Qld etc). Fourteen managers responded in the time frame, with the initial data capture followed by some targeted conversations to seek additional information or confirm meaning. As with findings in other jurisdictions, it is evident a variety of monitoring approaches are taken, and methods vary between areas. Some land managers apply consistent methods, but are not systematic in their data capture. Others take regional approaches but have limited sustained, standardised and regular monitoring. Most acknowledge there is additional information that would be useful, but they may currently lack the knowledge, skill, resources or policy to activate additional monitoring mechanisms.

In overall terms the findings revealed that park managers:

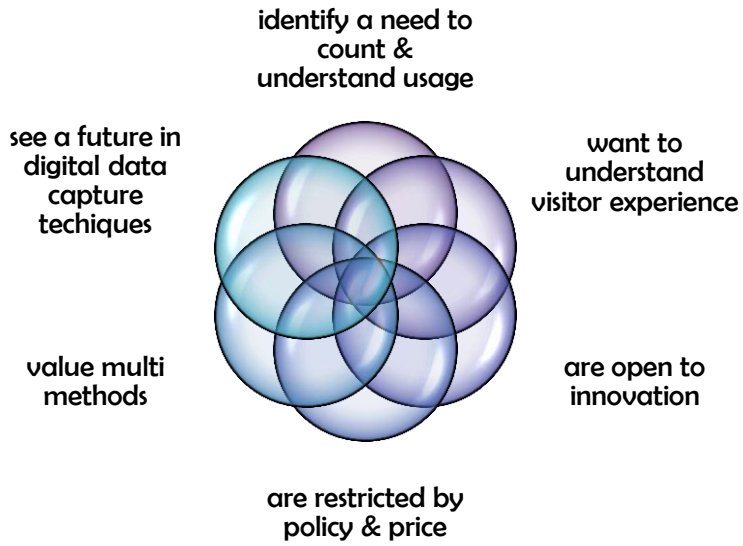

Figure 1: Park Managers Perceptions of Visitor Monitoring

Further the feedback on the surveys revealed that across the jurisdictions:

2 are not currently undertaking any form of visitor monitoring

2 use surveillance cameras

3 use unsystematic observations to monitor visitation

9 use at least one form of automated counter

Counter data is recorded **monthly**

3 have suffered vandalism of counters

5 monitor through analysis of permits/ bookings

6 have used surveys (intercept, visitor, participation) at some time

Time and **confusion** about best methods are constraining factors in data capture

The survey revealed a diversity of approaches and sophistication in visitor monitoring, from non-existent through to multi-layered (e.g. mix of counters, event analysis, social media review, surveys, site and trail specific monitoring etc).

> Managers closer to SEQ tended to have the greatest number of resources allocated and those more regional had the least.

Monitoring and measurement appeared to also be impacted by change in staff with monitoring being driven in some instances by personal passion more than organisational policy and priority.

When asked about ideal monitoring approaches, the managers indicated they were open to suggestions, while others were more specific and stated there was value in:

- Implementing fully digitised and automated counting systems that cover all major trails/ areas with back to base data recording;
- Creating a tenure blind centralised data warehouse to store and analyse the comprehensive counter network across the state/ region;
- Taking a state wide approach to data capture for all QPWS including visitor surveying of the experience, as well as capture of spatial movement and visitor numbers;
- Moving beyond counters to other forms of automatic, geo-locational data capture (e.g. Strava type digital recording/ development of a parks app to capture visitor movement and profiles/ analysis of Telco meta-data sources).

5.0 Conclusions and Recommendations

Recommendation 1: That visitor monitoring and participation measurement be considered as **long term and essential** features of park management; and resources be allocated to the development of comprehensive systems.

In general there are a range of general and specific recommendations that can assist in capturing *visitor use* information. Based on studies of why visitor information is not captured and what drives the effective collation of this information these include:

- Organisational acknowledgement and prioritisation of the need and value of having current and accurate visitor use data;
- A long term view of data capture so trend information can be determined to manage for change;
- A balance of strategic, tactical and operational approaches;
- Allocation of resources to enable visitor use data capture and analysis e.g. budgeted and expended *funding*, personnel *time*, staff *training* on available methods to collect and analyse visitation data;
- Effective and *systematic sampling frameworks* and practices to ensure data capture is representative and reasonable;
- The development of standardised and systematic methodologies and toolkits to enable monitoring and measurement practices and enhance efficiency and effectiveness;
- Plan for comprehensive counting that includes capturing data from a range of complementary sources;
- Respect and flexibility to accommodate to local conditions;
- The use of reliable and accurate techniques (not best guess or unsystematic monitoring

(e.g. Sources: D'Anotonio et al., 2010; National Review, n.d.; Pettebone et al., 2010; Watson et al., 2000; Zelenka & Kacetl, 2013).

Recommendation 2: That **training and education** opportunities be developed / coordinated for park visitor managers to build confidence and competence in designing and implementing successful monitoring practices.

While any one method of visitor monitoring can be valuable, a **comprehensive understanding** of park visitation requires awareness of what is occurring, who is in the park and the behaviours and experiences of visitors. This means there is a need for the use of multiple and systematic methods of data capture; and though data capture does not need to be continuous there is a requisite to confirm visitor numbers, activities and behaviours through cross-checking to determine the veracity of the findings from any one data gathering instrument. The capacity to understand and action wise monitoring and measurement tools in different jurisdictions, and effectively process the data captured, is enhanced through trained and capable staff confident and aware of their role, the methods used and analysis possibilities.

Recommendation 3: Investigations be undertaken to explore the viability of centralised repository/s of park visitation data to streamline information and inform management decisions including regional responses. This could be developed based on a range of possible approaches from the broad scale to organisationally specific, for example:

1. a ***central data storehouse*** **(all jurisdictions)** where land and water managers record like data (from whatever counting or data capture methods they use), that could be collated and analysed for wider park management use;
2. organisationally specific ***central data warehouse*** for existing state wide park managers (**QPWS** who have the authority to implement a one system approach); and/ or
3. through trialling and refining ***regional or area specific databases*** (e.g. SEQ, FNQ, CQ) that require the collaboration of smaller numbers of land/ water managers. This could result in more complete pictures of outdoor recreation activity and spatial distribution across multiple jurisdictions, and each park estate could increase the potential for informed and coordinated management decisions.

Based on research and the feedback from current Queensland land and water managers, there may be value in having a coordinated central capacity to analyse and interrogate data of visitation. The resources required to instigate, capture, record and analyse visitor monitoring is time consuming and the information, even where captured over time, is held in isolation. This is a function of the layers of management and responsibility in Queensland being spread across multiple jurisdictions, yet we know these arbitrary perimeters do not singularly define the spatial movement of outdoor recreationists, nor of fauna or flora. Subsequently a more complete picture would assist state wide, regional and local planning and management.

Recommendation 4: The establishment of a **network of parks and visitor managers** to provide a supportive and expert forum for the sharing of ideas, processes, rationales and experiences of visitor monitoring. This could be state-wide and/or developed at a regional level to enable more systemic cooperation across jurisdictions involved in data sharing (see Recommendation 3). This could lead to

development of organisational or state wide visitor monitoring resources that meet Queensland conditions and enable coordinated data capture and warehousing for analysis.

At a pragmatic level park managers can be isolated in the work they do. Depending on internal lines of reporting and organisational priorities and expectations, park managers may not only have siloed responsibilities within their organisations, but also require specific skill sets to effectively advocate for as well as assess, establish, manage, resource, evolve and sustain visitor monitoring and measurement.

Recommendation 5: Coordinate the development of a meaningful/ opt in ***app for park users*** that captures socio-demographic information (e.g. age, gender, postcode) as well as spatio-temporal data and provides the opportunity to map and interrogate individual visits, direction, mode of travel, duration of visit/ activity, stops on route, photo attachments, visit comments etc[12].

NB. Any new development needs to at least meet the known desirable features of existing apps; and would need widespread promotion to become a worthwhile source of data capture for VGI.

There are emerging technologies and existing systems that hold data of potential value for understanding visitation at parks. As indicated in responses from some of the current survey group, telecommunications companies in Australia already capture Big Data that could provide complementary sources of information on visitation to parks. When considered as a data source, it has been demonstrated the digital universe is large and it is anticipated that by 2020, the amount of data created and copied annually will reach 44 trillion gigabytes (e.g. as many digital bits as there are stars in the universe) (EMC Digital Universe, 2014).

Recommendation 6: Activate **discussions and engagement with telco's and/ or big data analysts** to determine how fine a scale of park visitor data resolution can be captured, the scope of data that can be accessed, and the spatial relevance for parks managers (in areas with wifi reception).

Telecommunication providers access and already run a range of analytics on people's phones and this data can be very locationally specific. Data capture can include postcode, age, sex and can be spatially mapped, for example, time of arrival (at a park), time of departure, and potentially direction and speed of movement to help differentiate walkers from cyclists (for example). Of note, any outcomes of this type of data capture will be contained by the *parameters of privacy laws* and other considerations relating to the sharing of personal information; and will have some cost imperative to consider. If considered feasible this information could prove a powerful source of raw data on at least the number and broad activity of visitors within a park; and may in the

[12] As an alternative, it may be worthwhile exploring the feasibility of developing a coordinated ***state / nation-wide approach to a key Mobile App owner*** (e.g. Strava) to access existing and emerging data on users socio-demographics, spatial and temporal movement and more qualitative reflections (e.g. peak parts of the route, photo attachments to maps etc)

future also provide insight into who visitors are not just when they are on park and where they travel on that site[13].

NB. If feasible, this process may best be begun with a small proof-of-concept project to experiment and refine the possibilities of data access and assessment.

[13] Sunshine Coast Council are in early stage discussions with Telstra Research and Product Development to explore the potential of smartphone meta-data-mining. Specifically conversations are focused on the type of data that might be captured and shared within the georeferenced box of Sugar Bag Reserve. QORF and parks managers may be advantaged from sharing costs and resources if early indications are positive for visitor monitoring purposes.

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Appendix One – Advantages and disadvantages of survey methods

Source: O'Brien & Morris, 2010, pp. 9-10

Survey Method	Advantages	Disadvantages
Telephone	Personal vocal contact with respondents. Interviewer can clarify questions or misunderstandings.	Cannot use maps or photos for illustration. Response rates may be lower than for household or site surveys. Show cards cannot be provided so questions need to have options that are easy to remember.
Household	Face to face contact with the interviewer allowing personal contact which can increase response rates. Computer assisted approaches are often use which ensures greater survey accuracy. These surveys can usually be more details and a bit longer than other survey approaches.	Resource intensive and expensive.
Postal	People can fill in forms when they want. Cheaper approach as no interviewer needed.	Often low response rates as people forget to complete or throw away survey. Introduces self-selection bias that can be minimised by weighting the sample.
Internet	Easy to set up with on-line survey approaches available e.g. survey monkey, social media platforms. Can be easy for respondents to complete. Cheaper as no interviewer needed. Can use panels set up by Market Research companies to get a more representative (quota) sample.	There can be limitations with the formatting of questionnaires. Will not reach those without access to a computer/ mobile technology. If a link to the survey is made from an organisations's website then only those who visit the website will have the chance of getting involved. Introduces self-selection bias that can be minimised by weighting the sample.
Email	Can gain responses reasonably quickly. Little cost involved. You can attach pictures if needed.	Need a list of email addresses. People may dislike receiving unsolicited emails. Will only reach those with an email address.
Site – Interviewer administered	Face to face contact with the interviewer allowing personal contact which can increase response rates. Can provide staff with an opportunity to make contact with visitors.	Site crowding can bias the sample as on busy days a smaller proportion of the visitors are sampled, however this can be corrected by weighting the sample. No information provided on non site users.
Site – Self administered	The survey can be taken away and completed. Respondents may feel more able to comment when not watched or asked	Response rate may be lower than for an interviewer administered questionnaire. If the respondent has any confusion about the questions they have no one to ask for

	by an interviewer. Good way to get information on visitors to a specific site. Cheaper as no interviewer needed.	clarification. Introduces self-selection bias that can be minimised by weighting the sample. No information provided on non-site users.

Appendix Two – Water Research Laboratory, UAV/ Drone Surveying Fact Sheet Extract

Source: http://www.wrl.unsw.edu.au/sites/wrl/files/uploads/PDF/UAV-drone-surveying.pdf

SenseFly eBee RTK UAV

Type:	Fixed wing UAV
Wingspan & weight:	96 cm, 700 g
Propulsion:	160 W brushless DC motor
Max flight time:	40 mins
Cruise speed:	40-90 km/h
Wind resistance:	Up to 25 knots (45 km/hr)
Coverage per flight:	Up to 1 km^2

Capabilities:

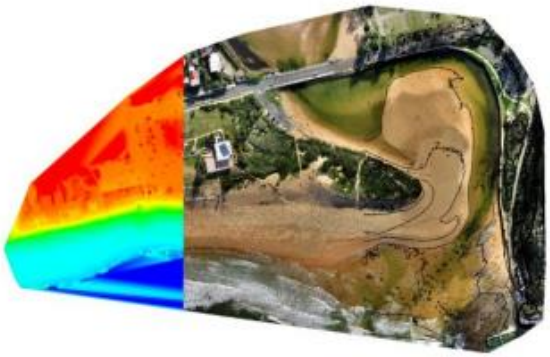
- RGB camera & Near Infrared (NIR) camera
- RTK GPS receiver
- Inertial measurement unit
- Pitot probe
- Optical ground sensor
- Autonomous flight through built in auto pilot
- Ortho-rectified aerial images with a resolution of 3 cm/pixel
- NDVI maps to assess vegetation health
- Dense point cloud comprising millions of points
- Google Earth overlays of the data
- Data visualisation via fly-through videos

DJI Phantom 3 Advanced UAV

Type:	Quadcopter UAV
Diagonal dimension:	59 cm
Weight:	1,280 g
Max flight time:	23 mins
Cruise speed:	58 km/h
Wind resistance:	Up to 35 km/hr
Hover accuracy:	+/-0.1 m vertical, +/-1.5 m horizontal
Coverage per flight:	Up to 0.5 km^2

Capabilities:

- 12.4 M camera
- 2.7 K video camera
- 3 axis gimbal for image stabilisation
- Live video streaming
- GPS/GLONASS receiver
- Ultrasonic ground sensor
- Manual & auto flight modes



Data Products

- High resolution ortho-rectified aerial photo mosaics
- High density 3D elevation point cloud (x, y, z, r, g, b)
- Near infra-red point data for vegetation mapping
- Cross sectional 2D elevation profiles
- 3D animated "Fly-Through" videos from 3D data
- High Definition aerial video footage

Appendix Three – Automatic Counter Equipment

Deciding on the frequency of counting that is required can help determine the value of manual counts vs the use of automated equipment. Automatic counters are generally identified as more expensive as they require upfront purchase. However, these costs can balance out over time as the ongoing operating costs may not be extensive (where equipment can be secured and maintained), and they can reduce staff time in terms of manual surveying and counting.

There are a range of motorised and non-motorised (e.g. bike, pedestrian) counters of traffic volume that are available. The choice of these will be localised and the following factors can play a role:

- Price/ Value for Money
- Commercial availability of the product
- Skill / time needed to download/ analyse data (physical collection or 'back to base' automation)
- Longevity of battery/ power storage
- Capacity to 'hide' counters in the environment to protect from theft, vandalism, weather conditions
- Level of accuracy required
- What is being counted (e.g. walkers only, walkers and bike riders, bike riders only, horse riders, trail bike riders etc)
- How long the count is occurring (e.g. permanently, temporarily)
- Environmental conditions

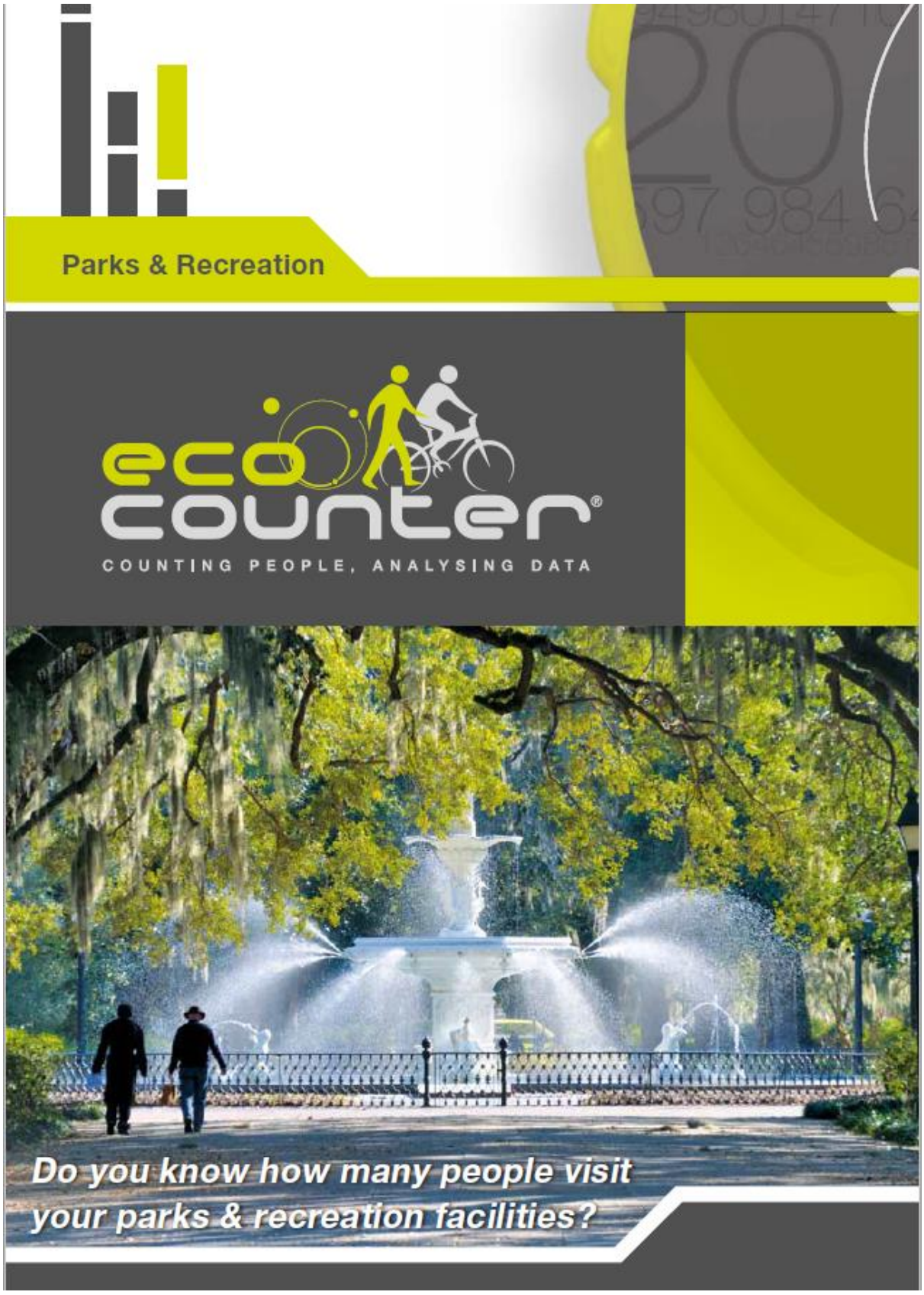
Of note, there are options to purchase commercially available trail counters in Australia, or to purpose build counters to suit conditions and budget. For example, the Department of Conservation in New Zealand have moved to a closed system of visitor monitoring, including building their own counters and analysing the information centrally. On a much smaller scale, South Burnett Regional Council have engaged a local supplier to build digital remote counters (TTC-10MT with no reflector, remote solar kit with battery back-up) to install on two trails.

Table 3: Example of commercially available trail counters in use in Qld

Company & Product	Technology	Features	Contact Information
Canadian TRAFx Infrared trail counter Counts walkers, hikers, joggers, skaters, horse riders, cyclists etc	Passive infrared	Compact, camouflaged design, battery life up to 4 years, large storage capacity, -40 - 55°, max range 6 m, built in clock.	https://www.trafx.net/
TRAFx Vehicle / Mountain bike / OHV counter	Low field Geomagnetic	Designed to be buried, pre-programmed for MTB/ OHV/ Vehicle use, battery life 8-9 months, -40 - 55°, built in	

		clock.	
Australian **Traker-Count**	Passive infrared	Estimated 20 year battery life, robust - sealed in solid milled aluminium case, unit is one solid device, easily hidden, placement 1-4 m from path of walkers.	http://www.islandresearch.com.au/
French **Eco-Counter** **Pyro-box** **Zelt** **Tube** **Slabs** **Multi-nature**	Passive infrared Inductive loop Pneumatic tube Pressure plate Combination – 2 or more sensors	Some products can differentiate between pedestrians & cyclists/ horseriders/ ATV's, Zelt is buried therefore invisible, work in all weather conditions, accuracy, directional counting, built in clock.	http://www.eco-compteur.com/en/component/k2/item/253-australia Local contact: Jamie Seeleither jamie.seeleither@eco-counter.com

Counter Example – Eco Counter Brochure



eco counter

Counting Solutions for pedestrians


Playgrounds


Splashpads / Waterparks / Swimming pools


Recreation facility entrances (indoor)


Recreation facility entrances (outdoor)

Why count visitors in parks and recreation facilities?

- Data to obtain funding for the development, renewal and rehabilitation of recreation facilities and outdoor spaces
- Metrics to monitor the performance of marketing and communication initiatives
- Determine the usage of parks and recreation facilities
- Figures to promote physical activity, health, and community involvement
- Help justify future investments, maintenance budgets and recreation infrastructure needs
- Determine peak visitation periods (hours, days, weeks, etc.) on facilities and trails


Bike paths


Hiking & Mountain biking trails


Equestrian trails


City & Dog Parks

Golden Gate National Parks Conservancy, San Francisco, CA

The Golden Gate National Parks Conservancy manages the recreation area and trails adjacent to the iconic Golden Gate Bridge, in partnership with the National Park Service. In order to better organize their planning efforts, they have installed 11 **MULTI**s and 1 **PYRO** sensor to understand the number of users enjoying the park on foot, bicycle, or horseback.

Shelby Farms Park Conservancy, Memphis, TN

The Shelby Farms Park Conservancy is gathering key figures on the number of cars entering their parking lots (4 **ZELT**s for Cars) as well as the number of visitors entering the park (2 **PYRO sensors**), resulting in a more accurate vehicle occupancy statistic. In addition to this, they have installed 2 **MULTI**s to quantify whether park users are walking or bicycling on their trail system. All of this data is transmitted automatically to the **Eco-Visio** software, allowing Shelby Farms Park staff to compile up-to-date reports without visiting each individual site.

Easy installation and clear trends

The **PYRO sensor** uses a combination of passive infrared pyroelectric technology and a high precision lens to detect and count people passing in the range of the sensor.

Features & Benefits

- **Self-calibrating**
- **Bidirectional detection**
- **Non-intrusive technology**
- **Low maintenance**

PYRO-Box: mobile & versatile

Key Points

- **Battery-powered full system**
- **Compact and robust**
- **Easy and fast installation**
- **Barely visible**
- **Range up to 65' (20m)**

Mobile Counting

Can easily be moved between multiple counting locations in parks, waterparks, swimming pools, etc.

Permanent Counting

The **PYRO-Box** is discreet and can easily be installed at the entrance of a park or a playground.

PYRO Posts: robust & discreet

Key Points

- **All-in-one System**
- **Extremly robust**
- **Resistant to vandalism**
- **Permanent or semi-permanent**
- **Range up to 100' (30m)**

Urban Post

- Specifically designed to blend into the urban environment.

Recycled Post

- Specifically designed to blend into the natural environment.

Want to count indoors?

We can help !

Counting Solutions for different user types

ZELT Loop: accurate bike counting

Key Points

- Invisible
- Bidirectional detection
- Battery-powered
- Invisible

Mountain Bikers

ZELT loops installed on MTB trails provide an accurate number of trail users allowing trail managers to anticipate erosion and enhance cyclist safety.

Bike Tourism & Active Living

ZELT loops are used to accurately and meaningfully assess the touristic, economic & social benefits of ecotourism.

MULTI: differentiating user types

How it works

The **MULTI** is an innovative and versatile counter that uses the **PYRO** sensor and **ZELT** loops to count and differentiate cyclists, pedestrians and horseback riders. The **PYRO** sensor is installed in a wooden recycled post to blend into environment.

Features & Benefits

- Counts & classifies users
- Bidirectional detection
- Battery-powered
- Versatile

Pedestrians / Cyclists

Useful to distinguish between both types of users as pedestrians and cyclists often share greenways and paths.

Pedestrians / Cyclists / Horseback Riders

2 **PYRO**s and a **ZELT** record each type of user and the direction they are moving in.

Counting & Analyzing different user types

Eco-TOTEM MULTI: displaying pedestrian & cyclist count data in real time

Key Points

- Display user type counts separately
- Fully customizable design
- Optional backlight for visibility at night
- Live data update on Public Web Page

The **Eco-TOTEM MULTI** is an eye-catching communication tool, displaying in real-time the number of cyclists and pedestrians on a daily and yearly basis.

It is a powerful way to communicate, **increase awareness,** and encourage the public to walk and cycle **while showing the value of multi-use facilities.**

Eco-Visio: a dedicated data analysis platform

User-friendly online software specifically designed for compiling, analyzing, and sharing pedestrian and cyclist data.

Analyze the counting data and create instant or customized report

Sort your counters by name, set up date, last data, etc.

Display comprehensive information about counting sites: description, pictures, and maps

Local weather data can be integrated into your analysis thanks to the Weather Module. This provides a better understanding of usage patterns.

- Temperature
- Wind
- Precipitation
- Weather Icons

Optimize the organization of your counting sites