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Investigation of a Recreation Monitoring Programme for Lake Ellesmere / Te Waihora

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Front page photo: Bird watcher at the Harts Creek/Waitatari Bird hide on Lake Ellesmere/Te. Photo: Frances Schmechel, Environment Canterbury.

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Executive Summary

- The impetus for this study was the long- identified need for data about recreational use of Lake Ellesmere/Te Waihora – New Zealand's largest coastal lake, and an area increasingly recognised for its cultural, environmental, scientific and recreation values.
- While the recreational use of Lake Ellesmere/Te Waihora is already well-recognised, there is only limited published data about this use and, as yet, no documented effort to coordinate data into a coherent form that might allow use trends and their implications to be assessed.
- An intentional and important parameter for this study was its focus on 'monitoring' rather than on 'research' – hence the report's emphasis on approaches associated with measuring indicators to establish baselines and determine changes in patterns of use over time.
- The study employed a literature scan, discussions with key informants and a workshop to elucidate key principles applied in the collection of recreation use data, and find examples of monitoring approaches used in large, natural open space recreation contexts.
- The literature review revealed a range of methods for monitoring use of recreation settings, including direct observations, on-site counters, visitor registrations and inferred counts. Each of these approaches is described and evaluated in this report, and ultimately considered in relation to its applicability to Lake Ellesmere/Te Waihora.
- The report gives specific emphasis to monitoring the recreational use of large, natural open spaces – where visitation is typically widely dispersed, and often varied in character, leading to challenges in determining levels of use across space and time. The literature confirmed a dearth of published examples documenting recreation monitoring in such settings and, in particular, their application in coastal, marine or freshwater recreation contexts.
- Lake Ellesmere/Te Waihora has many of the characteristics and complexities associated with large, natural open settings, including: multiple identifiable recreation sites and activities and large distances between sites; multiple access points; infrequent visitation; considerable non-recreation human use; complex governance; and highly variable environmental conditions. These factors were carefully considered as part of determining an appropriate recreation monitoring programme.
- Information from the literature review and key informant discussions was used to distil a set of attributes for effective recreation monitoring within the Lake Ellesmere/Te Waihora context. Attributes were determined at both the programme and data-specific scales:
  - At the programme level, recreation monitoring design ought to be: i) suited to the specific context; ii) simple to implement (cost-effective, practical and feasible long-term); iii) representative and flexible (accommodating of diverse activity types and the possibility of new or unanticipated uses); and iv) supported by those agencies and organisations who have invested resources in the collection of data gathered under the programme
  - At the data-specific scale, five key attributes were determined. Data ought to be: i) quantifiable; ii) reliable; iii) valid; iv) accessible; and v) enduring.
- Known Lake Ellesmere/Te Waihora recreation data sources were then assessed against the identified criteria in order to recommend a possible recreation monitoring programme. The study identifies seven recreation activities (and their data sources, likely

data granularity and recommended data collection timeframe) most suitable for on-going measurement and collation.

- The report concludes with the identification of the next steps towards implementation of the proposed recreation monitoring programme, future considerations that might influence the composition of the monitoring programme, and further research that could add depth to understanding the recreation dimension of Lake Ellesmere/ Te Waihora. Exploring the association of the cultural dimension of Te Waihora and the lake's recreation values is an area that could be a useful focus of future research.

Chapter 1 Introduction

1.1 Lake Ellesmere/Te Waihora Background

Lake Ellesmere/Te Waihora1 is New Zealand's largest coastal lake, and the country's fifth largest overall. Situated around 30km from Christchurch city, the lake covers an area of approximately 20,000 ha (Hughey, Johnston, Lomax & Taylor, 2013). The lake is of international significance for its birdlife (Hughey et al., 2013) and is a rich biological environment that hosts indigenous plant and fish species (Hughey et al., 2013). Lake Ellesmere/Te Waihora is of high cultural significance for Ngāi Tahu, with the lake long being valued as a mahinga kai site and an important source of mana (Hughey et al., 2013). The importance of the lake's wildlife habitat, wetland vegetation and fish, as well as its significance for Ngāi Tahu history, mahinga kai and customary fisheries, have been recognised by a National Water Conservation Order that seeks to legislatively protect these values (National Water Conservation (Te Waihora/ Lake Ellesmere) Order 19902).

Lake Ellesmere/Te Waihora has a complex management structure. Seven agencies hold statutory or other regulatory responsibilities for the lake; Ministry for Environment, Ministry for Primary Industries, Department of Conservation, Environment Canterbury, Selwyn District Council, Christchurch City Council and the Canterbury District Health Board. These agencies work in consultation with other non-statutory organisations, interest groups and industry partners including Fonterra, the Waihora Ellesmere Trust, Te Ara Kakariki, universities and other organisations and stakeholders invested in the Lake (Espiner, Stewart & Lizamore, 2017).

Approximately 70 per cent of the lake margin is owned or administered by the Department of Conservation, Te Rūnanga o Ngāi Tahu, Selwyn District Council, Environment Canterbury, or Christchurch City Council (Ford et al., 2017). Other margin areas and parts of the lake bed are under private ownership. Under the Ngāi Tahu Claims Settlement Act 1998, ownership of much of the lake bed that was in Crown reserves was returned to Te Rūnanga o Ngāi Tahu.

Management of the lake and its margin areas is also informed by the Te Waihora Joint Management Plan/Mahere Tukutahi o Te Waihora, a statutory document prepared by Ngāi Tahu and the Department of Conservation containing objectives, policies and methods for effective integrated management of the Ngāi Tahu lake bed and surrounding margins managed by the Department of Conservation (Te Rūnanga o Ngāi Tahu and Department of Conservation, 2005). In most respects management is controlled by provisions of the

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[1] Although in recent times often referred to as Te Waihora/Lake Ellesmere, the official gazetted place name is "Lake Ellesmere (Te Waihora)". We have opted for the naming approach used by the local community in its Lake Strategy (Lake Ellesmere Issues Group, 2004) and adopted by the Waihora Ellesmere Trust (a community trust monitoring and advocating the implementation of the community strategy for the Lake.

[2] Originally named the National Water Conservation (Lake Ellesmere) Order 1990, the Order was amended, with additional values to be protected, and renamed, in 2011. (Parliamentary Counsel Office, 2020)

relevant regional and district policies and plans (e.g., the Regional Policy Statement, Regional Coastal Environment Plan, the Land and Water Regional Plan, the Selwyn District Plan and the Christchurch City Plan) or wildlife and fisheries regulations.

1.2 Recreation at Lake Ellesmere/Te Waihora

Figure 1 Sailing Boats at Lakeside Domain. Photo: Ellesmere Aquatic Club

Since the 1880s Lake Ellesmere/Te Waihora has provided a wide range of outdoor recreation opportunities, and is identified as a potentially nationally significant water body for recreation (Ministry for the Environment, 2004). Recreational activities that are known to occur on the lake and its margins are: fishing (for trout, flounder/pātiki, eel/tuna, whitebait/inanga), gamebird hunting, water sports (swimming, kayaking, sailing, power-boating, windsurfing), walking, cycling, bird watching, photography, camping, picnicking (Hughey, 2013), geocaching, 4-wheel driving, educational activities (Espiner et al., 2017), and volunteerism (Booth, 2009).

Recreational use of Lake Ellesmere/Te Waihora is highly dispersed, with many different individual recreation sites and points of access existing around the lake (Espiner et al., 2017). Figure 3 (page 3) shows the 13 key sites around Lake Ellesmere/Te Waihora where recreational activities are known to occur. Table 1 (page 4) provides a summary of the nature of recreational use of the key recreation sites.

Figure 2 Map of Lake Ellesmere/Te Waihora with 13 key recreation sites indicated[3]

[3] # 12 refers to two sites that are regularly used by photographers.

Table 1 Recreational Activities at key locations on Lake Ellesmere/Te Waihora

Activity	Preferred locations for activities
Gamebird hunting	• Kaituna Lagoon to Lakeside Domain, particularly at Greenpark Sands stretching up to Harts Creek/Waitatari
Trout angling	• Main river mouths: Selwyn River, Harts Creek/Waitatari, Irwell, LII, Halswell • To a lesser extent Kaituna and Boggy Creek
Eeling	• Not reported
Whitebaiting	• River mouth of LII and Selwyn River
Floundering	• Greenpark Sands, Some placing of nets at Timberyard Point
Boating (including windsurfing and kite surfing)	• Kitesurfing and windsurfing: Lakeside Domain • Some windsurfers use the northern side of the Lake at Greenpark Sands to do their “speed runs” • Rowing and Kayaking: Selwyn River, Lakeside Domain • Water-skiing and jet-skiing: Lakeside Domain • Sailing: Lakeside Domain
Cycling	• Rail Trail
Birdwatching	• Harts Creek/Waitatari Bird Hide, Kaituna Sunset Point, Greenpark Sands, Many locations around the lake
Photography	• Pull over areas on SH75, Harts Creek/Waitatari, Many areas around lake for scenic landscape capturing
Picnicking	• Lakeside Domain, Harts Creek/Waitatari, Selwyn Delta, Kaituna Sunset Point, Fishermans Point, Kaitorete Spit, Greenpark Sands
Walking	• Harts Creek/Waitatari, Yarrs Flat, Kaituna Sunset Point, Lower Selwyn Huts
Camping	• Lakeside Domain (camping also occurs at nearby at popular Coes Ford Recreation Reserve, as well as Chamberlains Ford Recreation Reserve, 3km and 7km away from the lake respectively)
Geocaching	• Determined by location of geocaches which evolve over time
4WD	• Greenpark Sands, Yarrs Flat, Taumutu, up the stopbanks and on the mud during low lake levels
Educational	• Various sites around lake
Volunteering	• Tree planting, site maintenance and predator trapping at various locations around lake
Lake opening	• Viewing of lake opening from Fisherman’s Point and end of Kaitorete Spit

See Appendix A of this report for further information on these activities, including recent estimates of recreational use, existing potential data sources, and possible future data sources.

Lake Ellesmere/Te Waihora is traditionally an important source of mahinga kai to Ngāi Tahu. Mahinga kai encompasses the social and educational elements of food gathering (Te Rūnanga o Ngāi Tahu and Department of Conservation, 2005) and participation in mahinga kai activities, such as the collection of swan eggs, remain important today. While this report does not specifically cover mahinga kai, it is noted that exploring the association of the cultural dimension of Te Waihora and the lake’s recreation values is an area that could be a useful focus of future research.

The need for recreational user data to aid recreation management and connection with the Lake was among actions identified through a two–year extensive community consultation process ending in 2004 with an agreed Community Strategy for the Lake (Lake Ellesmere Issues Group, 2004). Collecting such data was included in the first ten-years of action in the Strategy. However the complexities of data collection proved to be problematic, due to the

numerous agencies with overlapping monitoring responsibilities and no mechanism to bring the data together in a way that informs community and decision makers (Waihora Ellesmere Trust, 2014). An integrated monitoring strategy for Lake Ellesmere/Te Waihora was developed, initially by the Waihora Ellesmere Trust, following feedback from the 2013 Living Lakes Symposium and its implementation is led by Trustee Prof. Ken Hughey from Lincoln University and the Waterways Centre for Freshwater Management. The strategy seeks to monitor a range of values present at Lake Ellesmere/Te Waihora that would enable regular measurement and reporting to help evaluate the effectiveness of management and to report on the state of the lake (Hughey, 2016). Recreation at Lake Ellesmere/Te Waihora is one of the values encompassed by the integrated monitoring strategy.

While the significance of Lake Ellesmere/Te Waihora for recreation is widely recognised, Hughey (2013) has highlighted that there is very little quantitative information about trends in recreational use and as such recommended that a system for measuring user days per annum for the different activities occurring on and around Lake Ellesmere/Te Waihora be established.

The need to understand recreational use of lake and wetland environments is also recognised by the Canterbury Water Management Strategy (CWMS), a collaborative framework launched in 2009 and used by Environment Canterbury to guide sustainable management of Canterbury's water bodies (Canterbury Mayoral Forum, 2010). A positive trend in the availability and quality of recreational opportunities is a key target in the CWMS, including a target for 2020 of better mapping and understanding of recreational opportunities currently available.

A further need for information on recreational use of Lake Ellesmere/Te Waihora was identified in a recent Environment Canterbury review of freshwater-based recreation and amenity values in the Canterbury region (Cessford & Jones, 2018). The review identified a gap in the understanding of the level of recreational use of, and information about, recreationists in lake and estuary environments in the Canterbury Region, within which Lake Ellesmere/Te Waihora is situated.

1.3 Purpose of Study

The purpose of this study was to explore and document a set of attributes with the potential to inform the development of a robust, fit-for-purpose recreation monitoring programme for Lake Ellesmere/Te Waihora. Such a programme will allow for longitudinal data capture to increase understanding of the recreational use of the lake and its margins.

The data obtained will enable the establishment of a baseline understanding and create the opportunity for regular measurement and reporting of long-term patterns and changes in recreation use. This will help lake managers evaluate the impact of lake management decisions on recreational use and support lake stakeholders to make well-informed decisions plus maintain and develop quality visitor experiences.

Development of such a recreation monitoring programme marks a step towards contributing recreation monitoring data to the Lake Ellesmere/Te Waihora integrated monitoring strategy (Hughey, 2016).

1.4 Approach

The approach used for this study involved three stages:

1. A detailed review of the recreation monitoring literature, with a focus on recreation monitoring methods and monitoring in large natural open spaces.
2. A series of 'key informant' discussions with selected individuals and groups knowledgeable about recreation at Lake Ellesmere/Te Waihora.
3. A synthesis of the literature review and informant discussions, to allow the development of a suitable recreation monitoring programme that allows for longitudinal data capture to inform understanding of the recreational use of Lake Ellesmere/Te Waihora.

1.5 Review of Literature

To gain an understanding of the current monitoring practices used locally and internationally, it was necessary to undertake a wide-ranging review of the recreation monitoring literature.

In the past, some studies have used systematic literature reviews to summarise and assess the state of knowledge on a given topic (Ford, Berrang-Ford & Paterson, 2011; Spector, Cradock-Henry, Beaven & Orchiston, 2019; Thomsen, Powell & Monz, 2018). These reviews used systematic and explicit methods and criteria to select relevant results, such as: searching particular databases, limiting the search to peer-reviewed articles, limiting the search to a certain date range, using defined key words for searches.

Given the purpose of the current review was to gain a holistic understanding of recreation monitoring practices being used in a variety of contexts, in this case a less prescribed approach was taken, consistent with the study's exploratory aims. Notwithstanding this, some parameters for the literature search are possible to define.

Five main electronic databases were used to gather references:

- CAB Abstracts
- Web of Science
- ScienceDirect
- SpringerLink
- Google Scholar

Database searches involved terms relating to 'recreation monitoring' in general and 'monitoring' in 'dispersed/open/coastal/wetland/marine environments'.

An internet search was also used to source non-academic reports and documents. Hughey & Coleman (2006) acknowledge the usefulness of internet-based scans for the detection of government or NGO reports that would not otherwise be picked up in academic database searches. Recreation monitoring information may be recorded as part of studies targeting other issues, for example studies looking primarily at ecological management of a recreation area (e.g., Dennis, Davies, Thomson & Barnes, 2005). There is potential for such studies to be overlooked in typical scholarly online searches.

1.6 Key Informant Discussions

Discussions (in the form of a workshop and one-on-one interviews) with key informants were held to complement the review of the literature and to gain some local knowledge about the Lake Ellesmere/Te Waihora environment. [4]

Selection of organisations and individuals for participation as key informants was based on three criteria: i) the organisation's or individual's involvement in management of recreation opportunities at Lake Ellesmere/Te Waihora; ii) the organisation's or individual's representation for a particular activity or interest; iii) the organisation's or individual's willingness and availability to participate in the study.

Key informants from the following organisations and groups participated in a workshop:

- Department of Conservation
- Environment Canterbury
- Selwyn District Council
- Waihora Ellesmere Trust
- Fish & Game New Zealand

Some key informants could not attend the workshop, but contributed through one-on-one interviews. These included representatives from:

- Christchurch City Council
- Ellesmere Lions Club
- Ellesmere Aquatic Club
- Fish & Game New Zealand
- Lincoln University (post graduate students and recreation or tourism experts)

Their contributions are attributed as "Personal Communication" in this report.

Key informants were asked to contribute their knowledge in relation to the following areas:

1. Types of recreation activities occurring at Lake Ellesmere/Te Waihora and particular locations where activities take place
2. Possible recreation use data sources (both existing datasets and possible future ones) that could be used as indicators for the monitoring programme
3. Perceptions of what would be appropriate monitoring methods for Lake Ellesmere/Te Waihora and attributes of effective monitoring in that environment
4. Development of a Monitoring Programme for Recreational Use of Lake Ellesmere/Te Waihora

The data generated through the literature review and from key informant discussions was synthesised and used to inform the development of a suitable recreation monitoring programme and a suite of recommendations with the potential to provide a longitudinal recreational use dataset for the lake and its margins.

[4] All key informants consented to attribution of their names to comments in this report.

Chapter 2
Literature Review

The review begins by providing an outline of outdoor recreation research in general, before focussing more specifically on visitor monitoring methods – both traditional and more recent. Previous approaches to monitoring recreational use of large natural open spaces are then considered, before the specific case of Lake Ellesmere/Te Waihora is introduced. The section concludes by outlining a set of attributes intended to aid in assessing the merits of monitoring programmes and data sources potentially applicable to Lake Ellesmere/Te Waihora.

2.1 Outdoor Recreation Research

Outdoor recreation research is described as experimental, theoretical or investigational work that is undertaken to acquire new knowledge in regard to recreation occurring in natural environments (Devlin, 1995).

Outdoor recreation research provides valuable information to recreation managers, with data collected and collated as part of outdoor recreation research supporting many management outcomes such as:

- Measuring the success of management actions
- Identifying demand trends
- Relating use levels to social and physical impacts
- Allocating infrastructure and services
- Identifying the social, economic and political importance of the recreational use
- Development of natural resource and recreation management policies (Cessford & Burns, 2008; Schägner et al., 2017; Wardell & Moore, 2004).

Booth (2006), in a review of outdoor recreation research in New Zealand, presents a 'Visitor Research Framework' which identifies seven different types of information that currently exists in the New Zealand outdoor recreation research literature and is collected to inform management of recreation areas. The 'Visitor Research Framework' was developed to provide a common language for managers and researchers and represents a spectrum of complexity in visitor research. The seven types of data described under the framework are summarised in Table 2.

Table 2 Seven types of visitor information (adapted from Booth 2006)

Type	Name of Type	Summary of Type
1	Visit Numbers	Type 1 data comprises of the number of recreational visits to a place and represents the most basic type of visitor information. This type of data can provide information on how many people visit a place and where and when the visit occurred
2	Visit and Visitor Characteristics	Type 2 data builds on Type 1 data to describe the nature of the recreational use and users, providing information on who the visitor is, what they are doing, when they visit and what facilities they use
3	The Visitor Experience	Type 3 data explains the recreational behaviour by exploring concepts such as visitor perceptions, expectations, motivations and satisfactions

4	Visitor Impacts	Type 4 information concerns the negative outcomes of recreation use, with adverse effects being social, economic or environmental
5	Recreational Benefits	Type 5 information concerns the positive outcomes from recreation use. These benefits may occur on-and-off site and at different scales such as benefits to the environment, the individual, the community and the nation
6	Recreation Resource Demand and Supply	Type 6 information involves the recreational demand and for recreational resources from visitors, this demand may be real or yet unrealised. Information about the supply of recreational opportunities can be explored as part this
7	Recreation Management Processes and Techniques	Type 7 information explores the role of management actions in the recreation experience

Booth's (2006) framework makes it clear that managers require information about recreational use at very different levels. Each type of data serves distinct purposes, and sophistication and complexity increases markedly between types 1 and 7.

2.2 Monitoring and Understanding Recreational Use

While outdoor recreation research involves investigations and acquiring new knowledge, outdoor recreation *monitoring* is the actual process of observing and measuring indicators to understand baselines and detect change and patterns over time (Hadwen, Hill & Pickering, 2008). This gathering of information on recreation use patterns is often collectively referred to as 'visitor monitoring' (Cessford & Burns, 2008).

While many different types of information can be ascertained through visitor monitoring, it is monitoring visitor numbers to a place (Type 1 data as referred to by Booth, 2006) that is arguably the most important and fundamental aspect of recreational use to monitor (Cessford & Burns, 2008; Hornback & Eagles, 1999; Schägner et al., 2017; Wardell & Moore, 2004).

Type 1 data provides a baseline understanding of how many people visit an area. Once baseline visitor data is established, changes in visitor numbers can be detected and the impact of management interventions can subsequently be measured (Cessford & Burns, 2008). More granular spatial observational monitoring of visitors may record (within an open place) data on types of recreational activities relevant to environmental management and planning (e.g., Bouma, Robertson, Rennie & Oulton, 2007; Robertson & Rennie 2006; Thomson 2003).

It is primarily Type 1 data (Visit Numbers) that this report will consider, given the importance of this data in establishing a baseline understanding of how many people are using Lake Ellesmere/Te Waihora and its margins for recreation activities and which activities are being undertaking where. While not the focus here, it is important to emphasise that higher level data (such as why people visit, where they are from, their perceptions and impacts) are also critical in helping to develop a comprehensive picture of outdoor recreation. The foundational step in visitor monitoring, however, is the number of people who visit and where those visits occur.

2.3 Traditional Recreational Use Monitoring Methods

Various methods of monitoring visitor numbers have been used to understand recreational use patterns (Cessford & Burns, 2008; Cope, Doxford & Millar, 1999; Hornback & Eagles, 1999; Robertson & Rennie, 2006). Cessford & Burns (2008) describe these methods as falling into four distinctive types of monitoring.

These monitoring types and associated methods are described in Table 3 and further discussed below.

Table 3 Monitoring types and associated methods for monitoring visitor numbers

Monitoring Type	Methods	Method Description
Direct observation	Field observers	People on-site who manually record visitor dat
	Camera recordings	Video recordings or photos of visitors on-site, manually reviewed to collect visitor data
	Remote sensing	Aerial photography or imagery from satellites or aircraft that show visitor presence and distribution at specific times
On-site counters	Mechanical or electronic counters	Devices placed on-site to record the passage of visitors who activate a trigger and record a 'count' when passing the device
Visit registration	Visitor book/register	Voluntary or compulsory self-registration of visit in book/register
	Permits	Use of existing administrative system such as permits to enter an area or undertake an activity to gain visitor information
Inferred counts	Survey or interview counts	Undertaking of visitor surveys or interviews to gain visitor information
	Use of 'indicators' such as vehicle counts	Use of existing information as 'indicators' to infer visitor information

2.3.1 Direct Observations

Field Observations

Field observations are accurate and can include descriptive data in addition to basic visitor number counts (Cessford & Burns, 2008). It is a well-used traditional method of monitoring both in New Zealand (Thomson, 2003) and overseas (Hornback & Eagles, 1999). Given the accuracy of this method, having observers on-site is the preferred method for calibrating other counts (Schwartz, Stewart & Backlund, 2010).

Camera Recordings

Use of photographs or video recordings can be an accurate and flexible method and an alternative to on-site field observers (Manning, 2014). Fairfax, Dowling & Nelder (2014) used digital cameras triggered by movement sensors to capture photographs of different track users. They describe the monitoring method to be relatively low cost over time and helpful in its ability to differentiate different types of activities occurring in one location.

Remote Sensing

Remote sensing can be used to monitor over large areas, providing a snapshot in time of the spatial extent of visitors in an area. Smallwood, Beckley, Moore & Kobryn (2011) used overflights by a small aircraft over a 12 month period to conduct aerial surveys of Ningoloo Marine Park off the north-western coast of Australia. The aerial survey provided information

on numbers of recreationists, the type of activity they were engaged in and the spatial distribution of users.

2.3.2 On-Site Counters

On-site counters are one of the most common methods used to collect visitor numbers data (Booth, 2006), being used widely around the world to record visit numbers (Cessford & Muhar, 2003). There are a variety of counter types in existence. Physically activated counters include mechanical counters on a gate or door (activated by the physical opening) and pressure counters on a path (activated by being stepped on). Active and passive optical counters are triggered by the interruption of infra-red signals by a passing visitor. Magnetic sensing counters and microwave sensing counters are activated by changes in magnetic fields and radio waves respectively, and are primarily used to count vehicles.

The various counter types all have advantages and disadvantages, so a range of considerations should be taken into account when choosing a counter type, including: susceptibility to false counts by wildlife or tree branches etc., ability to conceal counter to limit interference by visitors, cost, level of information recorded (time and date etc.), ability to differentiate between different uses (e.g. vehicles, bikes, people), power consumption and sensitivity to environmental conditions (e.g. temperature) (Cessford & Burns, 2008).

2.3.3 Visitor Registration

Self-Registration

Self-registration is a simple method that can be used to collect visitor number data, along with additional data including visitor profile and trip information (Watson, Cole, Turner & Reynolds, 2000). For example visitors to the Harts Creek/Waitatari bird hide are currently invited to register their presence at the hide in a visitor's book. The method can be used to produce long-term data, as some types of registrations (such as hut books) have a long history (Cessford & Burns, 2008).

Figure 3 Harts Creek/Waitatari Bird Hide. Photo: Katie Nimmo

The reliability of this method can vary when used on a voluntary basis, as not all visitors will register if they do not have to. While an effective self-registration system will have a

sufficient rate of visitor registration, if the proportion of visitors who choose to register is relatively consistent over time, the method may still be able to produce useful trend data with lower rates of registration (Cessford & Burns, 2008).

The rate of registration can vary across sites, being most effective in areas used by a few visitors who are very interested in nature conservation subjects (Vuorio, Emmelin & Sandell, 2003). Furthermore, visitor registration is more effective when the registration site is placed part way along a trail where users are likely to stop at points of interest, a scenic view, a stream crossing, the top of a hill (Watson et al., 2000).

Due to the variation in registration rates with this method, ongoing calibration is required to provide estimations of registration rates (Cessford & Burns, 2008).

Permits

Data on the use of permits and other administrative records is relatively accurate and can be simple to acquire, but can only be used for situations and activities where permits are required or other records kept. It is often possible to acquire additional information about the user and activity, such as visitor age or origin, which is collected as part of the existing permit registration process (Cessford & Burns, 2008).

2.3.4 Inferred Counts

Survey or Interview Counts

Visitor surveys or interviews can be used to obtain a range of visitor information, as visitors can be asked any questions desired. Visitor number estimates can be gathered (Type 1 data as referred to by Booth, 2006) as well as more in depth information about visitor characteristics/experience and recreation impacts, benefits, demand and the impact of management actions (information types 2-7 as referred to by Booth, 2006). Surveying requires careful sampling and survey design to ensure a representative sample is taken and effective questions are asked (Cessford & Burns, 2008).

Surveys and interviews can be undertaken on-site (field surveys) or off-site (online/postal/phone surveys).

Indicator Counts

Recreation use can be estimated by measuring proxy ‘indicators’ rather than counting visitors directly. This method can help take advantage of existing information and measures linked to visitor use that may be more easily accessible than direct visitor counts. Indicators that have been used as proxy variables for visitor counts include: vehicle counts (Ziesler & Pettebone, 2018), ticket sales (English et al., 2003), accommodation use (Kelly, Williams, Schieven & Dunn, 2006), weather conditions, the economy, media attention (Millhäusle, Anderwald, Haeni & Haller, 2016), amount of damaged vegetation (Cole, 2004), campsite size, amount of rubbish, number of campfires (Wolf, Hagenloh & Croft, 2012), number of information brochures taken and transport service use (Watson et al. 2000).

The use of indicator variables requires extensive calibration effort and precision is low in the absence of this (Cessford & Burns, 2008). Calibration can be undertaken by taking a sample measure of both recreation use and the level of some variable that can serve as a proxy for visitation. Analysis then establishes the relationship between the visitation proxy variable and actual visitation. Applying the relationship that has been estimated from the sample to the annual or seasonal total count of whatever proxy variable is used gives the total visitation estimate (English, Kocis, Arnold, Zarnoch & Warren, 2003).

The practicality of using indicator counts varies across sites. While some sites may not have any suitable indicator variables, others can utilise indicator variables for successful estimation of recreation visitation (Wagar, 1969, as cited in English et al., 2003, p. 333).

Many recent studies that have successfully used proxy variables for visitation have been at sites that are either developed that have facilities such as visitors centres (Ziesler & Pettebone, 2018) or ski fields (English et al., 2003) or have high levels of visitation (Kelly et al., 2006; Millhäusle et al., 2016). Having such developments onsite mean that there are more opportunities to select proxy variables that are closely related to actual visitation and as such have more effective proxy variables (Wagar, 1969, as cited in English et al., 2003, p. 333). High levels of visitation mean more 'traces' left by visitors that can be monitored (such as amount of rubbish left behind or number of brochures taken) and levels of visit data that meet data requirements for some types of methods (Kelly et al., 2006).

2.4 New Methods for Monitoring Recreational Use

While a review of the literature indicates that the traditional methods outlined above are the predominant ways of collecting monitoring data, a number of new approaches to recreation monitoring are being trialled and applied. Three new key methods of data collection are apparent in the literature and are discussed below: use of drones, mobile phone app-based information and mobile phone positioning data.

Cessford & Jones (2018), in a review of freshwater-based recreation values in the Canterbury region, recommend developing broader and more consistent use estimation techniques and systems to address the identified information gap for lake-based recreation and user information. They highlight that innovative technologies and new monitoring approaches such as mobile phone tracking, app-based information and use of drones, appear to have potential and should be considered as part of the development of a systematic baseline monitoring approach.

2.4.1 Drones

The use of drones to collect aerial imagery represents a newer form of remote sensing, a 'direct observation' monitoring type as described in Table 2 above. Drones can be much more versatile, cost effective and offer higher resolution imagery than traditional methods of gaining aerially imagery via aircraft and satellite (Ancin-Murguzur, Munoz, Monz & Hausner, 2019; Utomo, 2019).

Ancin-Murguzur et al. (2019) used drones to monitor visitor numbers is a large urban park. They concluded that drones can be a reliable and valid tool for counting visitors, classifying visitors (age group, gender, activity engaged in) and recording spatial patterns of park use. In comparison to traditional on-the-ground monitoring, drones can cover a larger observational area and collect data in ways that a human observer cannot because of accessibility or practicality for activities such as lake/stream use, rock climbing or walking on long/convoluted trails.

Drones have already been successfully used in environmental monitoring on the margins of Lake Ellesmere/Te Waihora. Fake (2019) used drone imagery to monitor plant communities at Kaitorete Spit Scientific Reserve and drone imagery is also currently being used to monitor damage caused by vehicles on the Greenpark Sands area of Lake Ellesmere/Te Waihora (J. Blakely, pers. comm., September 18, 2019).

While drone based monitoring technology is constantly developing and is currently used in some recreation contexts, there are limitations with the technology. There is a lack of ethical and practical experience on work with drones in recreational management and potentially significant issues around effects on wildlife (Wallace, Martin & White, 2018). The presence of drones can be considered a threat to people's privacy and in some environments may affect the quality of peoples' recreational experiences or disturb wildlife (Dolesh, 2015). Other limitations such as the cost of obtaining and running the drones (Ancin-Murguzur et al., 2019) may mean the technology is more suited for occasional/periodic monitoring.

2.4.2 Mobile Phone Based Techniques

Mobile phone based technologies are becoming increasingly present in the outdoor recreation monitoring literature (Pickering, Rossi, Hernando & Barros, 2018). Mobile phone based technologies represent a form of an 'inferred count' monitoring type as defined in Table 2. Data gathered from use and presence of phones creates a new kind of indicator from which visitor information can be inferred.

App-Based Information

Geotagged photos on phone applications such as flickr[5] have been explored as a proxy for visitation numbers to natural areas. While use of mobile apps for data collection is still at the experimental stage (Muñoz et al., 2019; Pickering et al., 2018), some studies have found geotagged photos to be a useful proxy for visitation (Keeler et al., 2015; Levin, Lechner & Brown, 2017; Muñoz, Hausner & Monz, 2019; Orsi & Geneletti, 2013; Walden-Schreiner, Rossi, Barros, Pickering, & Leung, 2018; Wood, Guerry, Silver & Lacayo, 2013). Of particular note, Wood et al. (2013) compared observational visitation data collected from 836 recreational sites in 31 countries with data generated from geotagged photographs uploaded to flickr. The study found a reliable statistical relationship between the number of people counted and the flickr-generated estimate of user-days and the authors therefore conclude that the crowd-sourced information can indeed serve as a reliable proxy for more traditional and time intensive empirical counts.

A number of limitations of this method have been identified. Visitation rates to an area may be too low to result in a suitable density of geotagged photos (Orsi & Geneletti, 2013) and different recreational activities may be more or less suited to taking photographs (Wood et al., 2013). Also, the perceived value of a trip may influence whether people take or share photographs, resulting in a bias against images from visitors who travel shorter distances from home (Wood et al., 2013). Much technical analysis and calibration is also required for this method (Orsi & Geneletti, 2013; Walden-Schreiner et al., 2018).

Metadata from mobile phone applications can also be used to gain visitor use estimates. Some applications track user's locations and collect other visitor data such as user demographic information. Campermate is a widely used application in New Zealand, which collection a variety of data from users. Data from the Campermate application has recently been used to inform visitor research (pers. comm., D. Simmons, October 30, 2019).

[5] https://www.flickr.com/

Figure 4 Motorhomes at Lakeside Domain. Photo: RV Camper

Other types of mobile applications are used to collect 'citizen science' data, whereby members of the public upload observations to the database. eBird[6] is one example of a citizen science based application, where members contribute by collecting data on the distribution and abundance of birds through uploading sightings to the database (Sullivan et al., 2014). Given that location is logged as part of the bird sighting, such data could be used as a monitoring indicator for birdwatching in the area.

Mobile Phone Positioning

Visitor location data can also be obtained through monitoring the positioning of mobile phones, such as data collected from phone companies which store the location of mobile phones based on data captured by proximate cell phone towers. This method has been used to study the geographical distribution of international visitors (Ahas, Aasa, Roose, Mark & Slim, 2008) and suggested as a possibility for use in monitoring visitor numbers to outdoor recreation areas (Hansen, 2017).

The method would require extensive calibration in order for researchers to differentiate between recreational and all other uses. Use of mobile phone positioning also presents issues around privacy and transfer of information from network companies to third parties (Ahas et al., 2008). Finally, to work well, the method would require sufficient network coverage and reception in order to acquire precise results in remote areas (Hansen, 2017).

Mobile phone data is already being used in New Zealand to provide information on the number of people in an area within a given timeframe. Data Ventures, a New Zealand "data trust" that operates as a commercial arm of Stats NZ, sources datasets from the major mobile phone companies in New Zealand and analyses this data to capture the number of people who are located in a given area at a given time . Data Ventures currently offers a 'Population Density' product, where users can purchase information on the sum total of mobile devices in an area down to the suburb resolution at any given hour. This information is then used for purposes such as comparing days before and during an event, analysing seasonal trends and emergency planning. Data Ventures has worked to address privacy issues by receiving anonymised data from the mobile phone companies and only being able to detect the total number of phones in a given area rather than track movement of an individual phone (Data Ventures, 2019).

[6] https://ebird.org/home

2.4.3 Other 'Big Data' Tools

The New Zealand Ministry of Business, Innovation & Employment (2020) hosts the Regional Tourism Indicators data set, which measures the change in level of expenditure of international and domestic travellers in New Zealand. Whilst this data is aggregated to the boundaries of the Selwyn District Territorial Authority and cannot identify the numbers of travellers visiting Te Waihora, it does provide a general insight into the value of spending by tourists in that district or region. If future recreation monitoring activities include ways to identify the origin of visitors to key recreation sites around the lake, RTI data could be used to roughly extrapolate how Lake Ellesmere/Te Waihora contributes to the local and national economy via domestic and international tourism.

Finally, the University of Tasmania has developed a package of digital tools called "Tourism Tracer" (https://tourismtracer.com/about/) which tracks tourists' complete trips through a destination at a large spatial scale (e.g. Tasmania, Sweden or Hokkaido). Data can be collected according to age, home country, length of stay, and reason for travel. It also collects data which records how long somebody stays at a particular location within the country of destination (e.g. Lake Ellesmere/Te Waihora). However the tool is licensed and will likely require funding from a range of stakeholders in New Zealand at a regional or national level, plus considerable uptake by both domestic and international tourists in order to provide relevant data about visitors to Te Waihora/Lake Ellesmere.

2.5 Monitoring Recreational Use of Large Natural Open Spaces

The monitoring approaches outlined above have been applied in a range of recreation settings. Some settings require special consideration because of their character, type or level of use, with one such setting being large natural open spaces. Large natural open spaces are vast natural outdoor settings in which dispersed recreation occurs, with examples such as lakes, coastal and marine environments, wetlands and some terrestrial areas such as wilderness areas or national parks.

Where urban, and often regional, park settings are frequently characterised by defined entry and egress, clearly defined boundaries and sometimes supporting infrastructure, large natural open spaces have multiple points of visitor access and limited or no containment infrastructure leading to highly dispersed visitor patterns, making monitoring of visitors difficult (Fisher et al., 2018; Hornback & Eagles, 1999; Vuorio, Emmelin & Sandell 2003; Walden-Schreiner et al., 2012). Furthermore, the sheer size of large natural open spaces, along with numerous types of recreational pursuits that the area can support, pose further challenges for monitoring (Vrana, 1999).

While it is evident that some studies have explored visitor monitoring in large natural open spaces, our review of the recreation monitoring literature determined that there is a dearth of published examples specifically documenting the implementation of recreation monitoring in such settings. Indeed, according to Hansen (2017), "studies that critically discuss challenges and experiences regarding applied visitor monitoring methods in open coastal and marine landscape settings hardly exist" (p. 282).

Pickering, Rossi, Hernando & Barros (2018) specifically highlight an information gap for visitor monitoring and management in freshwater and marine protected areas and Blahna (2005) describes an overall lack of examples of recreation monitoring in settings characterised by dispersed visitor use.

A review of the available literature suggests that most recreation monitoring is focused on visitors within formalised park settings. Therefore the identified methods of monitoring visitors have predominantly been applied and tested within these administrative settings. Other settings appear largely absent from the literature. Pickering et al. (2018), for instance, outline that despite the increasing size of marine protected areas globally and the high levels of visitation to some of these areas, most research tends to focus on terrestrial natural areas. In their analysis of 758 abstracts from the first seven International Monitoring and Management of Visitors in Recreational and Protected Areas conferences, nearly all were from terrestrial natural areas, with only 15 abstracts documenting visitor monitoring and management in the context of freshwater and marine protected areas.

The dearth of information about monitoring recreation in large natural open spaces such as marine and coastal areas, lakes and open forest/mountain areas is likely linked to the additional monitoring challenges present in such settings - compared to monitoring within many typical park settings (Hansen, 2017; Vrana, 1999; Walden-Schreiner, Leung, Newburger & Woiderski, 2012).

Hansen (2017) explored what challenges can be identified from visitor monitoring in open coastal and marine settings through designing and implementing a monitoring strategy for a large coastal marine protected area in Sweden. Hansen (2017) used a mixed-method approach, as one recreation monitoring method alone was not able to reach the dispersed visitors in the open space: (1) an on-site questionnaire survey, (2) an on-site interview survey and (3) a combination of on-site and roaming observations. The need for using a mixed method approach in such open space was one of the key learnings identified by Hansen. The primary challenges faced were unsuitable weather conditions and challenges in acquiring a representative sample of recreationalists. Hansen noted that these challenges were likely due to the nature of the open space context, being more exposed than other environments to changing weather conditions and the greater dispersion of visitors across the site making getting a representative sample challenging.

Walden-Schreiner et al. (2012) implemented visitor use monitoring in a large open meadow setting of Yosemite National Park, where they developed and tested a method that they present as accessible, replicable and acceptably accurate. The authors define ‘accessible’ as the method involving low-cost materials and being able to be implemented by volunteers with varying levels of technical expertise, with an ‘accessible’ method allowing for greater integration into other plans for open landscape monitoring that may be operating with limited budgets or personnel resources, and providing the opportunity to engage community partners in collection of managerially relevant data. ‘Replicable’ was identified as the method being able to be replicated by volunteers and ‘acceptably accurate’ involved determining if the proposed data uses were appropriate given the measured error. The method undertaken consisted of unobtrusive direct observation by trained human observers, whereby volunteers were trained to undertake visual scans of selected areas. This method is suggested as applicable to other large natural open spaces, however it is specified that the method was tested in a high-use area, therefore it is not known whether the method would be useful in lower use areas.

In New Zealand, similar research found multiple longitudinal beach transects, comprising observational counts of beach users with activity and location recorded by trained observers and sometimes coupled with interview data, provided useable data in beach use studies in the Waikato region (Thomson, 2003).

Figure 5 Kayaking at Lakeside Domain. Photo: Shane Epiha
Lake Ellesmere Aquatic Club

Vrana (1999), as part of a manual that provides guidelines and a review of protected area monitoring (see Hornback & Eagles, 1999), describes that methods such as visitor entry permits, on-site surveys and aerial surveys of visitor activity have been used with varying degrees of success in monitoring visitor use of marine and coastal protected areas. While all have been used successfully for visitor monitoring in some marine and coastal protected areas, the author identifies some limitations of these methods for monitoring in “open” areas. Visitor entry permits are reliant on the need for a permitting system to be in place, which many marine and coastal areas do not have. On-site surveys require trained personnel to administer the surveys and put a burden on the visitors, while it can be challenging to collect a representative sample of visitors given the dispersed nature of the environment. Aerial surveys were used to observe the number of vessels in marine areas, however such surveys are dependent upon the ability of survey personnel to distinguish the different types of activity.

Smallwood, Beckley, Moore & Kobryn (2011) have also discussed the use of aerial photos to study recreational activities in coastal and marine areas. They undertook aerial monitoring of a protected marine and coastal area using a small plane to record numbers of visitors and types of activities being undertaken. They report that their aerial surveys proved to be an effective method for rapidly obtaining recreational data with high spatial accuracy and state that while such a method only provides a snapshot of the activity at any one time, it has broad applicability to marine and coastal areas as it provides comprehensive data to benchmark existing recreational use, as well as monitor future changes in activity patterns.

Some studies that have explored the use of geotagged photos (from mobile phone app data such as Flickr) to provide recreational use measures, have specifically identified that this kind of monitoring method could be well suited for use in large, dispersed and openly accessible areas (Fisher et al., 2018; Orsi & Geneletti, 2013).

Given the sparse literature covering recreation monitoring in large natural open spaces and the specific and unique considerations required for undergoing monitoring in such settings,

special consideration should be given to establishing a monitoring programme for these areas.

2.6 Lake Ellesmere/Te Waihora as a Large Natural Open Space for Recreation

With multiple points of access and limited containment infrastructure, recreation on Lake Ellesmere/ Te Waihora and its margins is highly dispersed. The range of setting characteristics shown and described in Table 3, further identify Lake Ellesmere/Te Waihora as a large natural open space recreation setting.

Table 4 Characteristics of Lake Ellesmere/Te Waihora as a large natural open space setting

Characteristic	Description
Multiple activities	A wide range of recreational activities are undertaken on the lake and its margins
Multiple sites	Recreational activities occur at 13 key sites around the lake area, with recreation also occurring outside of these key sites
Vast distances between sites	Some recreational sites are separated from each other by many kilometres, with some key recreation sites being over 50km by road from one another
Multiple/unclear access points	Sites often have multiple access points, meaning recreationists may approach sites from different directions. Some access points are from private land
Infrequent visit rates	Some sites and recreational activities have very low visit/participation rates (with some sites likely to be visited fewer than 10 times per day and some activities only being undertaken sporadically i.e. windsurfing)
Non recreational use	A number of sites around the lake have small resident populations. Others visit the area for activities such as food gathering. Some of this use would not be considered recreational in nature
Complex governance and management	Many different organisations and groups are involved in the management of the lake and its margins
Variable environmental conditions	Weather conditions at the lake can be highly variable, which influences recreational use of the lake

Figure 6 Boating at Lakeside Domain. Photo: Shane Epiha, Ellesmere Aquatic Club

2.7 Attributes of Effective Recreational Use Monitoring within the Lake Ellesmere/Te Waihora Context

Given the characteristics of the large natural open space setting of Lake Ellesmere/Te Waihora, the design of a monitoring programme for this place must be given special consideration. Taking into account the information gained through a review of the literature and key informant discussions, it is evident that to be effective in such settings, both the monitoring programme itself and the data underpinning the monitoring programme must adhere to a number of key attributes.

Attributes for effective recreation monitoring at Lake Ellesmere/Te Waihora have been identified and are discussed below. Effective monitoring of the recreational use of Lake Ellesmere/Te Waihora depends on the robustness at both the programme and data source levels. Hence the analysis of the key attributes is discussed at each of these two scales.

2.7.1 Programme-level Attributes

Four key attributes are identified for the wider programme level of recreation monitoring. For a Lake Ellesmere/Te Waihora recreation monitoring programme to be effective, it is suggested that these four attributes be considered and addressed in designing a monitoring programme.

Suited to specific context

The monitoring programme needs to be specific to the context in which the monitoring is to take place. This includes taking into consideration:

- The purpose of the monitoring – must be clear about what monitoring is intended to achieve, what management goals are being addressed (Hornback & Eagles, 1999).
- The character of the setting – physical conditions at place may affect what monitoring options are available (Cessford & Burns, 2008).

Simple to implement

The monitoring programme should be relatively simple to implement, including being:

- Cost effective to run - the cost of operating and supporting visitor monitoring programmes is described as the main limitation in implementing such programmes (Cessford & Burns, 2008).
- Practical to implement - the practicality of a monitoring programme has been described as a direct influencer of the accuracy of the programme (Cessford & Burns, 2008, Hornback & Eagles, 1999).
- Feasible long term – the longevity of a monitoring programme depends on its simplicity to run (Cessford & Burns, 2008).

Representative and Flexible

The monitoring programme should be able to represent and capture known recreational uses as much as possible and have sufficient flexibility so that:

- Unanticipated needs for new information can be fulfilled, with yet unknown recreation activities and data sources able to be later incorporated.

- The programme is effective irrespective of management actions being undertaken by different management parties.
- Monitoring can be used at different scales, including both spatial (e.g. individual site verses whole lake) and temporal scales (e.g. trends over one season verses longitudinal trends) (Cessford & Burns, 2008).

Supported

The monitoring programme needs to have the support of groups and organisations who provide and use the data gathered under the programme.

Gaining 'buy in' to the monitoring programme from those who are involved in collection of the data is important, whether they be management organisations or recreation clubs. The success and longevity of the monitoring programme is dependent on a shared responsibility for capture of and access to the data.

'Support and Buy-In' is one of eight principles of effective environmental monitoring in marine environments as described by Kirby, Gioia & Law (2014). The authors developed principles of effective monitoring marine oil and chemical spills. They outline that environmental monitoring post-spill involves many organisations and groups, and for the monitoring to be effective these organisations and groups must support and 'buy-in' to the monitoring programme.

2.7.2 Data-level Attributes

Attributes should also be considered at the data level, as it is the data collected that forms the basis of the monitoring programme. Five key attributes have been identified and recommended for consideration in selection of data sources for a Lake Ellesmere/Te Waihora recreation monitoring programme. These five attributes are identified on the basis of the monitoring programme focusing primarily on visit numbers - Type 1 data (as described by Booth, 2006).

Quantifiable

Quantifiable in the context of this report means that the data can be reduced to a number, for example the number of visitor people or number of visitor days in a given period of time.

Having quantifiable data enables clear observation of trends and changes over time, meaning the effect of management interventions can be measured (Hornback & Eagles, 1999).

Reliable

Reliable in the context of this report means that the data collected is consistent and representative.

The more reliable the data, the better the outcomes of the processes for which the data are used (Cessford & Burns, 2008). Any proxy variables selected should be able to be measured reliably, either being closely related to actual visitation (Wagar, 1969, as cited in English et al., 2003, p. 333) or the relationship with visitation is stable and therefore can be calibrated to provide accurate estimates (Cessford & Burns, 2008).

Undertaking monitoring sampling that was representative of the actual recreational use has been highlighted as one of the key challenges to overcome in monitoring visitors in large natural open spaces (Hansen, 2017).

Valid

Valid in the context of this report means that the data is accurate and measures what it is intended to measure.

Hornback & Eagles (1999) describe determining target levels of validity as one of the key steps in the process of measuring public use in marine protected areas.

Whiting et al. (2012) describe validity (along with reliability) as being an essential element of monitoring efforts and that both validity and reliability should always be considered when attempting to evaluate data collection strategies.

Accessible

Accessible in the context of this report means that monitoring data is practical to obtain.

Visitor data should not be overly complicated to obtain if the monitoring programme is to be sustained over time (Hornback & Eagles, 1999).

The cost of operating and supporting visitor monitoring programmes is described as the main limitation in implementing such programmes (Cessford & Burns, 2008). The cost of acquiring, operating and maintaining monitoring tools, as well as the time required by people to collect and analyse data can therefore pose a significant restraint on what kinds of monitoring data is practical to obtain.

'Accessible' was one of the components of the method for monitoring visitor use in large natural open spaces presented by Walden et al. (2012). 'Accessibility' in their study meant the method involved low-cost materials and could be implemented by volunteers with varying levels of technical expertise.

Having volunteers involved in the collection of visitor monitoring data could be one way to keep costs down, with this approach being used successfully by Walden et al. (2012). It is important to emphasise, however, that this must not compromise the 'enduring' nature of the data.

Partnering with local outdoor recreation, conservation or other community groups in the collection of visitor data is also an opportunity to engage community partners (Loomis, 2000) and foster community support of monitoring initiatives (Walden et al., 2012).

The use of existing and secondary data is another way to source accessible data that provides user information. Wardell & Moore (2004) recommend that opportunities for using such data should be explored before developing a visitor monitoring system or collecting new data for a specific application.

Enduring

Enduring in the context of this report means that the data is able to be collected long term, that the collection process is replicable and therefore allows changes to be measured over time.

Both Schägner et al. (2017) and Loomis (2000) describe the long-term nature of recreation data being 'crucial' to effective management of the recreational area.

'Replicable' was one of the attributes of the method used for monitoring visitor use in large natural open spaces presented by Walden et al. (2012).

Cessford & Burns (2008) state that visitor count data should be collected as part of a wider long-term monitoring programme and describe the establishment of a baseline data resource

with allowance for ongoing accumulation over time as invaluable. Not all useful applications for monitoring data will necessarily be identified when a monitoring programme commences, but by having enduring data, there is the potential for additional applications to later become apparent once long-term datasets have been collected.

2.8 Assessment of Data Attributes for Lake Ellesmere/Te Waihora

The possible data sources for monitoring recreational use at Lake Ellesmere/Te Waihora, as identified through the literature review and key informant interviews, are assessed against the five attributes described above to determine the level of applicability of each data source to each attribute.

Nearly all of the identified data sources produce ‘quantifiable’ data, meaning trends and changes can easily be measured over time.

There is variation amongst the different data sources in terms of the data produced being ‘reliable’ and ‘valid’. Some sources had the potential to produce data that is representative and accurate in terms of measuring the level of recreation use of Lake Ellesmere/Te Waihora, while other sources have little correlation to the number of people actually undertaking recreation at Lake Ellesmere/Te Waihora.

Most of the data sources had ‘accessible’ data. Given that many of the sources represent data that are already being collected, the data can be practical and relatively cost effective to obtain.

Most data sources can produce ‘enduring’ data, however for many of the sources, the data is collected by an organisation or group. As such, the enduring nature of the data is reliant on the organisation or group to continue data collection on a long term basis. In some instances the data is very likely to be collected on a long term basis due to legislative or statutory requirements (e.g. hunting and fishing licences). Some of the data sources based on mobile phone/website technology have unknown applicability to the five attributes, given the lack of information about the data that these technologies could produce.

Figure 7 Hunting on Lake Ellesmere/Te Waihora. Photo: Richard Cosgrove, Fish and Game NZ

Table 5 Applicability of the five attributes of different monitoring data sources for effective recreational use monitoring at Lake Ellesmere/Te Waihora

The applicability of an attribute to a data source is indicated by a 'low' (*very little applicability*), 'medium' (*some applicability*) or 'high' (*significant applicability*) rating. A question mark ('?') indicates the applicability is unknown.

Monitoring Type (see Table 1)	Monitoring Data Source	Quantifiable	Reliable	Valid	Accessible	Enduring	Comments
Direct observation	On-site observers	High	Medium	High	Medium	High	Applicable to all attributes, but may not always be practical and cost effective to obtain data
	On-site camera recordings	High	High	High	Medium	Medium	Applicable to all attributes, but the cost and resources required to run monitoring equipment may mean that data is not practical to obtain on a long term basis
	Selwyn District Council car counts	High	Medium	Medium	High	Medium	Applicable to all attributes, but reliance on Selwyn District Council to continue monitoring means there is some uncertainty around the enduring nature of the data on a long terms basis
	Drone imagery	High	High	High	Medium	Medium	Applicable to all attributes, but the cost and expertise required to run monitoring may mean that data is not practical to obtain on a long term basis
On-site counters	Rail trail track counter data	High	High	High	High	Medium	Applicable to all attributes, but reliance on Christchurch to Little River Rail Trail Trust to continue monitoring means there is some uncertainty around the enduring nature of the data on a long terms basis
	DOC vehicle counter data	High	High	Medium	High	?	Applicable to quantifiable, reliable, accessible and valid attributes (although calibration is required to ensure data is valid). DOC have not indicated how long they intend to have the counters installed, so the enduring nature of the data is unknown

Monitoring Type (see Table 1)	Monitoring Data Source	Quantifiable	Reliable	Valid	Accessible	Enduring	Comments
Visit registration	Harts Creek/Waitatari Visitors Book	High	High	Medium	High	Medium	Applicable to all attributes, but reliance on Christchurch to Little River Rail Trail Trust to continue monitoring means there is some uncertainty around the enduring nature of the data on a long terms basis
	Game bird hunting licences	High	Medium	Low	Medium	High	Little applicability to 'valid', as the number of hunting licences held is not specific to how many people actually undertook gamebird hunting at Lake Ellesmere/Te Waihora
	Fishing licences	High	Medium	Low	Medium	High	Little applicability to 'valid', as the number of fishing licences held is not specific to how many people actually undertook fishing at Lake Ellesmere/Te Waihora
Inferred counts	On-site visitor surveys and interviews	High	Medium	High	Medium	Medium	Applicable to all attributes, but cost and resource requirements may limit data collection. Effective sampling required to ensure data is representative
	Fish & Game angler survey	High	Medium	Medium	High	High	Applicable to all attributes, special attention required to ensure representativeness of sampling and accuracy in the relative number of respondents who actually fished at Lake Ellesmere/Te Waihora
	Fish & Game game bird hunting survey	High	Medium	Medium	High	High	Applicable to all attributes, special attention required to ensure representativeness of sampling and accuracy in the relative number of respondents who actually hunted at Lake Ellesmere/Te Waihora
	Mai mai counts	High	High	Low	High	High	Applicable to all attributes other than valid, as the number of mai mais may have little correlation to the number of people actually undertaking gamebird hunting at Lake Ellesmere/Te Waihora

Monitoring Type (see Table 1)	Monitoring Data Source	Quantifiable	Reliable	Valid	Accessible	Enduring	Comments
	Ellesmere Aquatic Club membership	High	Medium	Medium	High	High	Applicable to all attributes, but membership may not always have a close or consistent relationship with actual use of the lake for water sports
	Geotagged photos in mobile phone applications (e.g. Flickr)	High	?	?	?	Medium	Applicable to 'reliable', 'valid' and 'accessible' are unknown
	Data from mobile phone apps Campermate and Rankers	?	?	?	?	Medium	Applicable to 'quantifiable', 'reliable', 'valid' and 'accessible' are unknown. Further information on what data is collected and how it is collected is required
	Data from eBird app/website (logged bird sightings)	High	?	Medium	Medium	Medium	Data can be requested from Cornell University. It is unknown to what extent the data is representative of actual birdwatching activity at Lake Ellesmere/Te Waihora
	Mobile phone positioning data	High	Medium	Low	Low	Medium	Data is not readily accessible, nor is it valid given that recreationists and non-recreationists cannot yet be differentiated
	Tourism Tracer	High	TBC	TBC	Low	TBC	Untested tool in Aotearoa/New Zealand, requiring licencing and high levels of participation by tourists
	Regional Tourism Indicators	High	High	Low	High	High	Data is aggregated to the boundaries of the Selwyn District Territorial Authority and cannot identify the numbers of travellers visiting Te Waihora,

Chapter 3 Recommendations

A number of recommendations for recreational use monitoring at Lake Ellesmere/Te Waihora are now outlined, based on an analysis of the literature review. The proof of concept stage for a possible recreation monitoring programme is presented, including recommended next steps for the recreation monitoring programme and some future considerations to be taken into account. Finally recommendations are presented for possible broader future research concerning recreation at Lake Ellesmere/Te Waihora.

3.1 Recreation Monitoring Programme for Lake Ellesmere/Te Waihora

The purpose of this study was to explore and document a set of attributes with the potential to inform the development of a robust, fit for purpose monitoring programme for Lake Ellesmere/Te Waihora that allows for longitudinal data capture to increase understanding of the recreational use of the lake and its margins.

This report has suggested a range of attributes, both at the programme and data levels, which should be considered in development of a recreation monitoring programme for Lake Ellesmere/Te Waihora. Possible sources of monitoring data have been assessed against the data level attributes.

Using this information, a possible recreation monitoring programme for Lake Ellesmere/Te Waihora is now suggested.

3.1.1 Recreational Use Monitoring Programme – Proof of Concept

To demonstrate how the attributes of an effective recreation monitoring programme for a large, open access physical feature can be applied, an example is presented in Table 5 as a ‘proof of concept’. This is a programme comprising seven distinct data sources, covering a range of the key locations and activities at Lake Ellesmere/Te Waihora.

A number of authors suggest having a mixed method approach in a recreation monitoring programme, particularly if the monitoring is occurring in a large dispersed setting (Arnberger & Hinterberger, 2003; Cessford & Burns, 2008; Hansen, 2017). Cessford & Burns (2008) state that monitoring over larger areas may require a network of key indicative visitor count sites that provide counts that are representative of the larger area. The recreation monitoring programme suggested below covers a range of key activities at key locations around the lake.

In selecting which activities and data sources should be represented, consideration was given to the applicability of the five attributes of effective monitoring data sources identified for monitoring recreation at Lake Ellesmere/Te Waihora. These are reflected in the proof of concept.

Consideration was also given to the activities represented by the selected data sources. The key recreation activities undertaken at Lake Ellesmere/Te Waihora include cycling, fishing, gamebird hunting, walking, camping and birdwatching. These activities are captured, to at

least some degree, by the proof of concept. There are some activities that are known to occur at the lake, but are not captured by the proof of concept. This is primarily due to these not yet having feasible sources of data for monitoring levels of participation.

The consistency of the proof of concept as a whole was tested against the four identified attributes of an effective recreation monitoring programme for Lake Ellesmere/Te Waihora:

1. Suited to specific context

    - The proof of concept is deemed to be suited to the specific Lake Ellesmere/Te Waihora environment. There is a high degree of specificity to the lake, with considerations taken into account around the character of the setting and a range of key activities and sites represented.

2. Simple to implement

    - The proof of concept is primarily made up of existing data sources, which means the programme would be simpler to implement than if this data collection had to be established from scratch.

    - There is still some work to be done in establishing how data will be collated, stored and reported overall, as well as who will be responsible for doing this and overseeing the programme generally. There is potential for the proof of concept to run smoothly if roles within the programme are clear, relevant organisations and groups are able to embed the monitoring programme into their work plan and effective communication is maintained amongst the organisations involved in the programme.

3. Representative and adaptable

    - The proof of concept includes many of the key recreation activities and sites at Lake Ellesmere/Te Waihora. These form an appropriate beginning in representing recreational use of the lake and its margins. There is a future opportunity to include further known activities and recreation sites within the monitoring programme, however it may be challenging to feasibly collect data for some activities and sites.

    - There is some flexibility to fulfil unanticipated needs for new information, with yet unknown activities able to be incorporated into the programme at a later stage.

    - The proof of concept has the potential to deliver information at different scales. Data collected could show different temporal trends, be that different seasons or on a longitudinal scale.

4. Supported

    - All of the groups and organisations involved with the data collection stage of the monitoring programme have indicated their support for a recreation monitoring programme at Lake Ellesmere/Te Waihora (except for eBird, which is run by Cornell University, but who make logged data available to the public).

    - As indicated above, there is still a need to determine roles and responsibilities within the monitoring programme. Being clear about who does what will help to support continued ‘buy-in’ to the monitoring programme, as things are more likely to run smoothly without confusion over roles and responsibilities.

Table 6 Possible recreation monitoring programme for Lake Ellesmere/Te Waihora

Recreation Activity	Data Source	Information Provided by Data	Organisation Who Manages Data	Data Granularity (smallest scale data can be analysed at)	Recommended Data Collection Timeframe	Rationale For Inclusion in Monitoring Programme
Cycling	Rail Trail Track Counter Data	Number of bikers on rail trail	Christchurch to Little River Rail Trail Trust	Day	Once per year	• Applicable to all effective monitoring attributes. • Represents a key activity • Utilises existing data collected by the Rail Trail Trust, who have not indicated that they anticipate cessing data collection
Walking and Bird Watching	Harts Creek/Waitatari Visitors Book	Estimate of number of people visiting Harts Creek/Waitatari Bird Hide - further information on activity type (walking, birdwatching, photography), visitor origin, date of visit, party size, general comments	Ellesmere Lions Club and Alan Reese	Day	Every 6 months	• Applicable to all effective monitoring attributes • Captures a range of activities (walking, birdwatching, photography) at a key location • Additional information such as group size, visitor origin and day of visit can be collected • Utilises an existing data source, the Ellesmere Lions Club have indicated support for continuing collecting visitor book data to support the monitoring programme (G. Pile, pers. comm., October 22, 2019. A Reese, pers. comm., Nov 22, 2019)

Recreation Activity	Data Source	Information Provided by Data	Organisation Who Manages Data	Data Granularity (smallest scale data can be analysed at)	Recommended Data Collection Timeframe	Rationale For Inclusion in Monitoring Programme
Trout Fishing	Fish & Game national angler survey	Estimated number of angler days over a year	Fish & Game NZ	Two month period	Every 7 years (survey is only undertaken every 7 years)	• Applicable to all effective monitoring attributes • Captures a key activity • Utilises an existing data source
Gamebird Hunting	Fish & Game game bird hunting survey	Proportion of North Canterbury game bird hunting licence holders who hunt at Lake Ellesmere/Te Waihora, duration of visit, number and species of catch per visit	Fish & Game NZ	Season	Once per year	• Applicable to all effective monitoring attributes • Captures a key activity • Utilises an existing data source
Visiting Key Recreation Points	Vehicle Counter Data	Number of vehicles using Kaituna Sunset Point, Yarrs Flat, Lakeside Domain, Lower Selwyn Huts	Department of Conservation	Minute	Once per year	• Applicable to most monitoring attributes • Utilises an existing data source. • Covers four key recreation sites • Calibration of counters is proposed as part of the “next steps” for the programme
Bird Watching	Logged sightings/visits on eBird app/website	The number, timing, location and species of logged bird sightings (including ‘hot spots’)	eBird – Based out of Cornell University	Quarterly (3 months based on season)	Once per year	• Applicable to most effective monitoring attributes • Captures a key activity • Utilises an existing data source

Recreation Activity	Data Source	Information Provided by Data	Organisation Who Manages Data	Data Granularity (smallest scale data can be analysed at)	Recommended Data Collection Timeframe	Rationale For Inclusion in Monitoring Programme
Camping	Selwyn District Council on-site counts of cars	The number of cars at Lakeside Domain when staff make visits to the site throughout summer season	Selwyn District Council	Day	As often as staff resourcing allows – collation once a year	• Applicable to all effective monitoring attributes • Utilises an existing data source, SDC indicate they anticipate counts continuing long term
Volunteerism	Te Ara Kakariki Waihora Ellesmere Trust	Numbers of volunteers on planting days or trapping groups	Te Ara Kakariki Waihora Ellesmere Trust	Number of volunteers per planting day Number of volunteers in trapping group, hours volunteered per month	Once a year	• Tracks community involvement as a form of recreation

Calibration of the vehicle counters is required as part of implementing the monitoring programme proof of concept. Calibrating what was recorded with what actually happened is a critical component of data reliability and validity (Cessford & Burns, 2008).

The vehicle counters count all vehicles passing, therefore collecting general counts that include non-recreational users, so calibration would need to take place so that the proportion of recreational users to non-recreational users can be established. Given that more than one person can be in a vehicle (and the counter only counts the number of vehicles) and that a vehicle could re-enter an area multiple times, calibration also needs to occur to establish the average number of people per vehicle and whether vehicles are being counted more than once.

An example of calibration for the vehicle counters is onsite surveying of vehicles to determine the number of people in the vehicle, whether the purpose of the visit is for recreation and the incidence rate of the same vehicle re-entering the area multiple times within a given period. This surveying could occur at each vehicle counter site for a number of days staggered throughout a season/year, being sure to avoid known events etc. that may impact on the representativeness of that particular day. A student could be hired to undertake three days of calibration surveying at each of the four vehicle counter sites, for which a budget of approximately $2500 would need to be allocated to cover wages and basic operational costs.

Figure 8 Cycling the Little River Rail Trail. Photo: Robin Smith

While a number of organisations are responsible for collecting and managing the seven sources of data proposed for the monitoring programme, there would need to be one central place where the collected data is collated, stored, analysed and reported annually. Possible options for the monitoring programme central data management include Lincoln University's Centre for Excellence (Sustainable Tourism for Regions, Landscapes and Communities), the Waterways Centre for Freshwater Management and the Te Waihora Co-Governance group.

3.1.2 Next Steps for Lake Ellesmere/Te Waihora Recreation Monitoring Programme

This report has outlined an initial recreation monitoring programme for Lake Ellesmere/Te Waihora that would allow collection of baseline recreation data. To support the continuation of momentum in development and implementation of the recreation monitoring programme, a number of next steps are recommended.

1. Estimate costs: While general cost/affordability of data collection was considered as part of the attributes of effective monitoring, exact costings and budgeting of undertaking the proposed monitoring programme still needs to occur
2. Seek funding: Once costs are determined, funding to support the cost of operating the monitoring programme should be sought
3. Calibrate vehicle counters: Vehicle counters were installed by the Department of Conservation in October 2019, however calibration of the counters needs to occur before the data collected can provide useful information for the monitoring programme
4. Establish roles: Given the various organisations involved in collection and collation of the data in the proposed monitoring programme, clear roles need to be established. This includes deciding on where the overall collation/reporting responsibility will sit and ensuring effective communication amongst organisations
5. Run pilot test: The recreation monitoring programme should be pilot tested to determine whether the proposed programme is feasible in practice and whether any changes need to be made
6. Socialise data: The data gained from the monitoring programme may have many applications and uses for different groups, so should be made available to all who would benefit from access to the data. The data should be made available for university and school students, in addition to the various organisations involved in management of Lake Ellesmere/Te Waihora. There may also be opportunities for such students to be involved in collecting and collating the data as part of courses and projects

3.1.3 Future Considerations for Lake Ellesmere/Te Waihora Recreation Monitoring Programme

Once initial testing of the pilot monitoring has occurred and initial baseline monitoring of recreation use is underway, further consideration should be given to increase the efficiency and effectiveness of the recreation monitoring programme. This will include regularly reviewing the initial programme to determine what actions could be taken to improve the programme.

If and when adequate funding, resources and information become available, consideration should be given to widening the scope of the monitoring programme to include additional data sources, representation of more recreation activities and more sophisticated types of visitor information (Table 1).

As highlighted in Section 2.5.2, mobile phone based monitoring technologies are becoming increasingly present, with much development occurring. Such technology could prove useful in providing information on recreational use of Lake Ellesmere/Te Waihora and therefore inclusion of use data from mobile phone based technologies, such as data from Campermate, should be further investigated and considered as these technologies become more assessable.

In the future, it may be possible to capture a wider range of the recreation activities that occur at Lake Ellesmere/Te Waihora as part of the proposed monitoring programme. A range of key recreation activities are represented in the initial monitoring programme, with selection based on currently accessible monitoring data and the identified attributes of effective monitoring. However, a wide variety of recreation activities are undertaken on the lake and its margins, so the more activities that are included within the recreation monitoring programme, the more representative of recreation at Lake Ellesmere/Te Waihora the programme will be. Photography is one particular recreational activity that would be beneficial to have represented in the monitoring programme in the future, as anecdotal evidence suggests that this could be a popular activity at Lake Ellesmere/Te Waihora given the environment's unique landscape and birdlife (Kelvin McMillan, Christchurch City Council, pers. comm., October 7, 2019).

While the initial recreation monitoring programme focuses on visitor use data (Type 1 data as described by Booth, 2006), future collection of visitor experience data through onsite surveying would enable understanding of visitor characteristics, perceptions, expectations, motivations and satisfactions (Types 2 & 3 as described by Booth, 2006).

A further future consideration concerns the possibility of using environmental data as a proxy indicator for recreation use. Once some baseline recreation data has been recorded, there could be some investigation as to whether this data could be reliably correlated with readily available influencing environmental variables such as wind speeds, lake level or lake water quality. Should some significant correlation be present, there could be an opportunity to use these data sets to create a model that estimates recreation use based on environmental conditions.

3.2 Recommended Future Research

While this study has focused on developing a means to monitor the recreational use of Lake Ellesmere/Te Waihora and its margins, many opportunities exist to explore other aspects of recreation in this setting. The following examples highlight some recommended opportunities for future research that could advance understanding of the recreation dimension of Lake Ellesmere/Te Waihora:

1. An in-depth qualitative study of the past and present recreation networks at Lake Ellesmere/Te Waihora could be undertaken. Using an available recreation network, additional information could be gathered about recreation at the lake, including elements of experience and future demand.

2. The application of identified attributes of effective recreation monitoring to other large natural open spaces could be explored. Can these attributes help inform development of recreation monitoring programmes for other areas that have similar setting characteristics to Lake Ellesmere/Te Waihora?

3. Calibration of data resulting from the proposed monitoring programme against other monitoring programmes (e.g. Canterbury Water Management Strategy or Department of Conservation visitor), in order to determine if recreation monitoring data can be reliably compared with these other monitoring programmes.

4. Does recreation at Lake Ellesmere/Te Waihora contribute to health and wellbeing at individual and community levels and how can opportunities to promote this be fostered?

5. Investigation of the tourism potential of Lake Ellesmere/Te Waihora – is there opportunity and demand for eco-tourism activities and guiding?
6. Exploration of the association between the cultural dimension of Te Waihora, including mahinga kai and the Lake's recreation values, particularly with respect to mātauranga Māori. This might include discussing Rūnanga information needs, how these would best be met, and how this information would be incorporated. There could be potential to develop further funding applications (co-designed with Taumutu Rūnaga) for more substantial research which properly reflects mātauranga Māori, Rūnanga priorities, and appropriate methodologies.
7. Further analysis of demand for recreation at Lake Ellesmere/Te Waihora through off-site surveying, including exploring why people do not visit the Lake.

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Appendix A: Activity Types, Locations, Use Estimates and Sources of Use Data

Adapted from Espiner et al., 2017

Activity	Preferred locations for activities	Recent recreation level estimate	Existing potential data sources	Possible future data sources
Gamebird hunting	• Kaituna Lagoon to Lakeside Domain, particularly at Greenpark Sands stretching up to Harts Creek/Waitatari	• A 2012 helicopter count of all mai mais on DOC and Ngai Tahu land (i.e. not on private land of which there are many around the lake), indicated there were 167 • Anecdotal evidence suggests mai mai use is declining (S. Terry, Fish and Game NZ, pers. comm., October 3, 2019)	• Mai mai counts • Hunting licences • Fish & Game annual Game Bird Harvest Survey	• Introduction of additional survey questions to Fish & Game annual survey for those who report game bird hunting at Lake Ellesmere/Te Waihora
Trout angling	• Main river mouths: Selwyn River, Harts Creek/Waitatari, Irwell, Lll, Halswell • To a lesser extent Kaituna and Boggy Creek	• 7000 Angler days on Te Waihora / Lake Ellesmere and its larger tributaries for (2014/2015)	• Fish & Game National angling survey undertaken every 7 years • Fishing licences	• Introduction of additional survey questions to Fish & Game angler survey for those who report angling at Lake Ellesmere/Te Waihora river mouths
Eeling	• Not reported	• Not known	• None known	• None known
Whitebaiting	• River mouth of LII and Selwyn River	• Not known	• None known	• None known
Floundering	• Greenpark Sands • Some placing of nets at Timberyard Point	• Not known	• None known	• None known

Activity	Preferred locations for activities	Recent recreation level estimate	Existing potential data sources	Possible future data sources
Boating (including windsurfing and kite surfing)	• Kitesurfing and windsurfing: Lakeside Domain • Some windsurfers use the northern side of the Lake at Greenpark Sands to do their "speed runs" • Rowing and Kayaking: Selwyn River, Lakeside Domain • Water-skiing and jet-skiing: Lakeside Domain • Sailing: Lakeside Domain	• Anecdotal data indicates low use by windsurfers or kite surfers with some evidence to suggest more jet-ski users are now using the lake • One school group using the Selwyn River for rowing training. This group is keen to recruit other groups to the area • Ellesmere Aquatic Club has a current membership of 14 families (G. Duncan, pers. comm., 22 November, 2019)	• Ellesmere Aquatic Club membership	• School usage of Selwyn River mouth for rowing
Cycling	• Rail Trail	• Approximately 10000 cyclists use the Rail Trail each year	• Rail trail track counters	• None known
Birdwatching	• Harts Creek/Waitatari Bird Hide • Kaituna Sunset Point • Greenpark Sands • Many locations around the lake	• Not known	• Harts Creek/Waitatari visitors book	• Use of citizen logged bird sightings/visits on apps/websites such as eBird or iNaturalist

Activity	Preferred locations for activities	Recent recreation level estimate	Existing potential data sources	Possible future data sources
Photography	• Pull over areas on SH75 • Harts Creek/Waitatari • Many areas around lake for scenic landscape capturing	• Anecdotal evidence suggests the lake could be a key site for photography (Kelvin McMillan, Christchurch City Council, pers. comm., October 7, 2019)	• Harts Creek/Waitatari visitors book	• None known
Picnicking	• Lakeside Domain, Harts Creek/Waitatari, Selwyn Delta, Kaituna Sunset Point, Fishermans Point, Kaitorete Spit, Greenpark Sands	• Not known	• Vehicle counters	• None known
Walking	• Harts Creek/Waitatari • Yarrs Flat • Kaituna Sunset Point • Lower Selwyn Huts	• Not known	• Harts Creek/Waitatari visitors book • Vehicle counters	• Track counters on defined walking tracks • Use counter in toilet at Kaituna
Camping	• Lakeside Domain (camping also occurs at nearby at popular Coes Ford Recreation Reserve, as well as Chamberlains Ford Recreation Reserve, 3km and 7km away from the lake respectively)	• Not known	• Selwyn District Council car/campsite counts periodically throughout summer season	• Applications such as Campermate/Rankers • Use counter in toilet at Lakeside campsite

Activity	Preferred locations for activities	Recent recreation level estimate	Existing potential data sources	Possible future data sources
Geocaching	• Determined by location of geocaches which evolve over time	• Multiple geocaches in the vicinity of the Lake (46 active caches listed in 2016) with over 2000 finds recorded on the geocaching website from 2006-2016	• Number of caches and recorded number of finds for each cache	• None known
4WD	• Greenpark Sands, Yarrs Flat, Taumutu, up the stopbanks and on the mud during low lake levels	• Not known	• None known	• None known
Educational	• Various sites around lake	• Organisations such as Waihora Ellesmere Trust and Lincoln University sometimes take field trips • Te Ara Kākāriki has annual planting days at the lake, which typically attract 150 – 200 people	• None known	• None known
Volunteering	• Tree planting, site maintenance and predator trapping at various locations around lake	• Not known	• None known	• None known
Lake opening	• Viewing of lake opening from Fisherman's Point and end of Kaitorete Spit	• Not known	• None known	• None known

Appendix B: Lake Ellesmere/Te Waihora Lake Access Points, Infrastructure and Monitoring Possibilities

Adapted from Espiner et al., 2017

Location	Site description	Recreation infrastructure/monitoring possibilities
1. Fisherman's Point	○ Public access point to lake set amongst a small fishing village ○ Apex of Kaitorete Spit visible in the distance, with access through a ford	○ Slipway into the lake ○ A small number of picnic tables ○ Fishing boats along lake margin ○ Recreational facilities seem geared for the local community rather than visitors
2. Johnstons Road / Lakeside Wildlife Management Area	○ Wide open space with areas of native plantings ○ Accessed down a long gravel road through several farm gates	○ Limited evidence of recreation infrastructure
3. Timber Yard Point / Lakeside Domain	○ Flat grassy area with wetland areas and pebble beach at lake edge ○ Good access	○ Good evidence of recreation infrastructure, albeit in a run-down conditions ○ Facilities include: a large campsite area (where some semi-permanent campervans exist), picnic tables, slipway and upright posts in the water ○ Ellesmere Aquatic Club building dominates the foreshore

Location	Site description	Recreation infrastructure/monitoring possibilities
4. Harts Creek/Waitatari Wildlife Reserve	○ Centred around a walk that runs through farmland, forest and wetland settings ○ Good access	○ Clear evidence of recreation infrastructure ○ Short (3-minute) walk leading to a picnic table and a natural amphitheatre (Patterns Place) ○ Longer walk (20 minutes) along gravel and boardwalk trail ending at a bird hide ○ Visitors book present at the bird hide ○ Boardwalk and bird hide regularly maintained by the Ellesmere Lions Club
5. Boggy Creek	○ Expansive view of Banks Peninsula ○ Evidence of native plantings ○ Lots of birdlife ○ Narrow access track best suited to vehicles with high ground clearance	○ Location is geared towards gamebird hunting and fishing (mai mai present)
6. Irwell Conservation Area	○ Remote site ○ Unclear dirt access road ○ New plantings and willows being removed	○ Boat access into the water ○ Evidence of duck shooting ○
7. William Wildlife Management Reserve	○ Expansive view of Banks Peninsula ○ Basic site	○ Boat access into the water ○ Some evidence of horse riding
8. Lower Selwyn Huts	○ Nearby to small-scale river-side community of baches ○ Established site ○ Good views of Banks Peninsula	○ Tidy and spacious parking area ○ Boat access into the Selwyn River via a concrete ramp ○ Walkway leads to the lake through maturing native plants ○ Mai mai visible in the water

Location	Site description	Recreation infrastructure/monitoring possibilities
9. Yarrs Flat	○ Wide open space with good views out to lake and Banks Peninsula ○ Many recent native plantings	○ Recently upgraded carpark and tidy mown grassy area ○ Recently installed wooden poles to try prevent 4WD vehicles from going beyond the carpark ○ Walking opportunity to wetland area at lake edge ○ Angler access and good water access nearby from Wolfes Road at the Lll River
10. Greenpark Sands	○ An expansive lakeshore area between Embankment Rd and Hudsons Rd ends ○ Open flats covered with native grasses and tussock ○ Abundant birdlife and clear views to the Southern Alps and Banks Peninsula ○ Key access point at Green Park Huts ○ Other access from the ends of Jarvis Road, Clarks Road and Embankment Road	○ Informal walking track towards the lake ○ Evidence of extensive damage to the area from 4WD vehicle use ○ DOC toilet on site
11. Kaituna Sunset Point	○ Well established and maintained site ○ Accessed immediately off the main highway ○ Rotary sponsored signage in carpark ○ New plantings in the area	○ Sealed carpark area ○ Picnic tables in grassy area adjacent to carpark ○ Well maintained walking track (approximately 500m) from carpark to lake edge with interpretation at the end ○ Public toilet and additional picnic table sited along the track towards the lake edge ○ Rail trail cycle-way passes through at the end of the walkway ○ Historic quarry brick huts at end of track ○ Geocache in carpark/picnic area
12. Highway 75 pull over areas 1 & 2	○ Gravel/dirt pull over area immediately off SH75 ○ Both sites are on the outside of sharp corners of the road ○ Dangerous pulling in and out of the areas	○ Rail trail cycle-way passes between the pull over areas and the lake

Location	Site description	Recreation infrastructure/monitoring possibilities
13. Kaitorete Spit	○ Bayleys Road (accessible from Jones Road or directly from SH75) provides access along he spine of Kaitorete for much of the length of the Spit. It is sealed for the first 5 km from SH 75 (ChCh/Akaroa road). The next 15 km is shingle but in relatively good condition. At the 20km point there is a gate and from there to the outlet there is a legal unformed and unmarked road. Many wheel tracks wander all over and there are shingle pits to avoid. This last bit is 4WD but from the SH75 to the gate is fine for a car.. ○ Mountain bike passage possible in dry summer periods. ○ Most of the route is through private farmland.	○ No infrastructure on lake side, there are legal but unmarked public accessways linking Bayleys Road to the lake.