An integrated monitoring strategy for Te Waihora-Lake Ellesmere:

A continuing work in progress[1]

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1. Introduction

Te Waihora/Lake Ellesmere is NZ's fifth largest lake by area, is highly diverse, contains values across the four well-beings (Cultural, Environmental, Economic, Social) and is a taonga for Ngāi Tahu. Unfortunately there are many factors contributing to a decline in the state of some, or parts of, these values, and a range of interventions are planned or are in place to reverse these declines - or, to otherwise maintain other already 'high performing' values. While there is monitoring across the range of values (see Hughey et al. 2013) there are many gaps and there is a lack of integration with no formally agreed to strategy[2] (except for birds, water quality and water quantity) that would enable regular measurement and reporting to help evaluate the effectiveness of management, or to report holistically on the state of the lake (and on the catchment more broadly). Such an approach would be consistent with the general principles that underpin Monitoring, Evaluation, Reporting and Improvement (see http://www.nrm.gov.au/my-project/monitoring-and-reporting-plan/meri).

This strategy addresses the above expressed needs, and does so in a way that links with existing and proposed monitoring by the established management agencies, and with the applied teaching and research focus of Lincoln University[3] (complemented by the University of Canterbury, e.g., water science, freshwater fish). In a nutshell the aim is to integrate the disparate aims for the lake and the range of management interventions to produce an integrated monitoring strategy that will lead to ongoing integrated reporting on the state of the lake and its environs, that is scientifically robust, fit-for-purpose, supported by the community and is cost-effective

The report is built around the following structure for the full range of values (or topic areas) associated with the Lake and environs:

Topic/ value cluster	What we want to know from measures of success	Targets	Indicators	Monitoring details		
				Existing monitoring	University monitoring contribution	Ongoing gaps in monitoring
e.g., vegetation	Key themes identified in existing planning/ policy documents	Measurable targets where applicable	Specific indicators related directly to desired outcomes	Details of what it is, who is doing it, how often, and reporting	Complementary monitoring contribution – what, who, when and reporting	Specific monitoring gaps that remain

[1] This strategy aims to develop and have implemented an ongoing set of indicators that can consistently report on targets set for the lake and environs. It recognises there will be occasional change to some indicators but that a core is necessary to provide ongoing trend monitoring. This document is an update of that 'completed' on 12 August 2015.

[2] The Monitoring Strategy reference group (representing Ngāi Tahu, ECan, Fish and Game and DOC) has been involved in helping build and in reviewing this document and is fully supportive of its contents, and recognises that the targets and indicators in some parts of the document will be developed further as more work is undertaken.

[3] A strength of Lincoln University is its ability to integrate the required expertise from faculties that together represent the 4 well-beings, and that there are already courses that cut across the entire campus where applied monitoring associated with Te Waihora/Lake Ellesmere can potentially be included. Additionally the Waterways Centre and specific University of Canterbury courses are well placed to contribute in other areas.

The above framework allows to us to then build a reporting metric along the lines of:

$\sum$ WTW + LWP + ZIP + XYZ_n = Environmental and other outcomes

Informed by: ➡ Integrated Monitoring Strategy ➡ Integrated reporting

Where:

WTW=	Whakaora Te Waihora programme of work
LWP=	Living Water Project, largely the Fonterra/DOC Ararira/LII River programme (but also more general Fonterra work)
ZIP=	Selwyn Waihora Zone Implementation Programme
XYZ=	Programmes of work undertaken separately by DOC, ECan, SDC, CCC, F&G, WET etc

Given the above framework the remainder of this document:

- outlines the monitoring strategy objectives
- introduces the key principles underpinning the proposed monitoring strategy,
- introduces a proposed monitoring framework,
- provides an assessment of existing monitoring (including the identification of gaps), and
- suggests a proposed implementation and reporting pathway that where possible will incorporate Lincoln University and University of Canterbury teaching and research initiatives.

2. Strategy aim and objectives

The key aim of this document is to present an integrated monitoring strategy for Te Waihora/Lake Ellesmere and environs that builds on and complements, in an integrated way, desired outcomes for the lake and environs and management interventions and approaches (e.g., CWMS, WTW and the Living Water Project) and monitoring strategies, e.g., re birds and water quality and quantity. Specific objectives are that it:

- Develops a monitoring framework that can work irrespective of the management actions being undertaken by the different parties
- Details a monitoring and reporting implementation pathway
- Shows how students can contribute to the above monitoring in timely and quality assured ways to assist with reporting on the state of the lake and its environs.

3. Key principles underpinning the proposed monitoring strategy

The monitoring strategy needs to be consistent with the following principles:

- Ensuring all monitoring is related to desired (measurable) outcomes which reflect the 4 well-beings, Ngāi Tahu aspirations, and the principles and targets of the CWMS and the Selwyn-Waihora ZIP
- It builds on existing monitoring, where the indicators meet SMARTA[4] criteria

[4] SMARTA indicators are specific, measurable, achievable, relevant, timely, and may be already in use.

- That all indicators report against measurable targets or desired outcomes and related intervention points
- Ensuring all monitoring data collected are scientifically credible
- That all collected data are held in at least one central point but are accessible[5] to all
- It uses the Pressure-State-Response[6] framework for reporting
- It is based on the identification of system-relevant and manageable boundaries
- Ensuring there is high-level buy-in to the strategy from all key participants and partners
- Ensuring implementation is cost-effective

4. The monitoring framework

Consistent with the objectives and the above principles it is agreed that:

- the boundary will be the Te Waihora-Lake Ellesmere catchment (Figure 1), while noting that monitoring data can be scaled to report solely on the lake and its immediate environs where appropriate. We note the possible extension where relevant into the marine environment, e.g., the southern bays of Banks Peninsula including in relation to aquaculture activities.
- it will concern all water related activities and outcomes.
- monitoring will cover the 9 broad topic areas identified for the 2013 state of the lake report, cross-referenced to desired outcomes and to the Pressure-State-Response framework of environmental reporting.
- subject to the above more specific and targeted output and outcome monitoring will be undertaken.
- where appropriate Lincoln University and University of Canterbury students and the Waterwatch programme or other citizen science projects will undertake relevant core and targeted monitoring.
- a central data holding and management point will be established but that there will be free and open access to all interests.

[5] It is accepted that this may require a meta data sharing protocol and that results could also contribute to and by used by LAWA – see http://www.lawa.org.nz/.
[6] See OECD (1996) and Ministry for the Environment (1997) for an explanation of the pressure-state-response model.

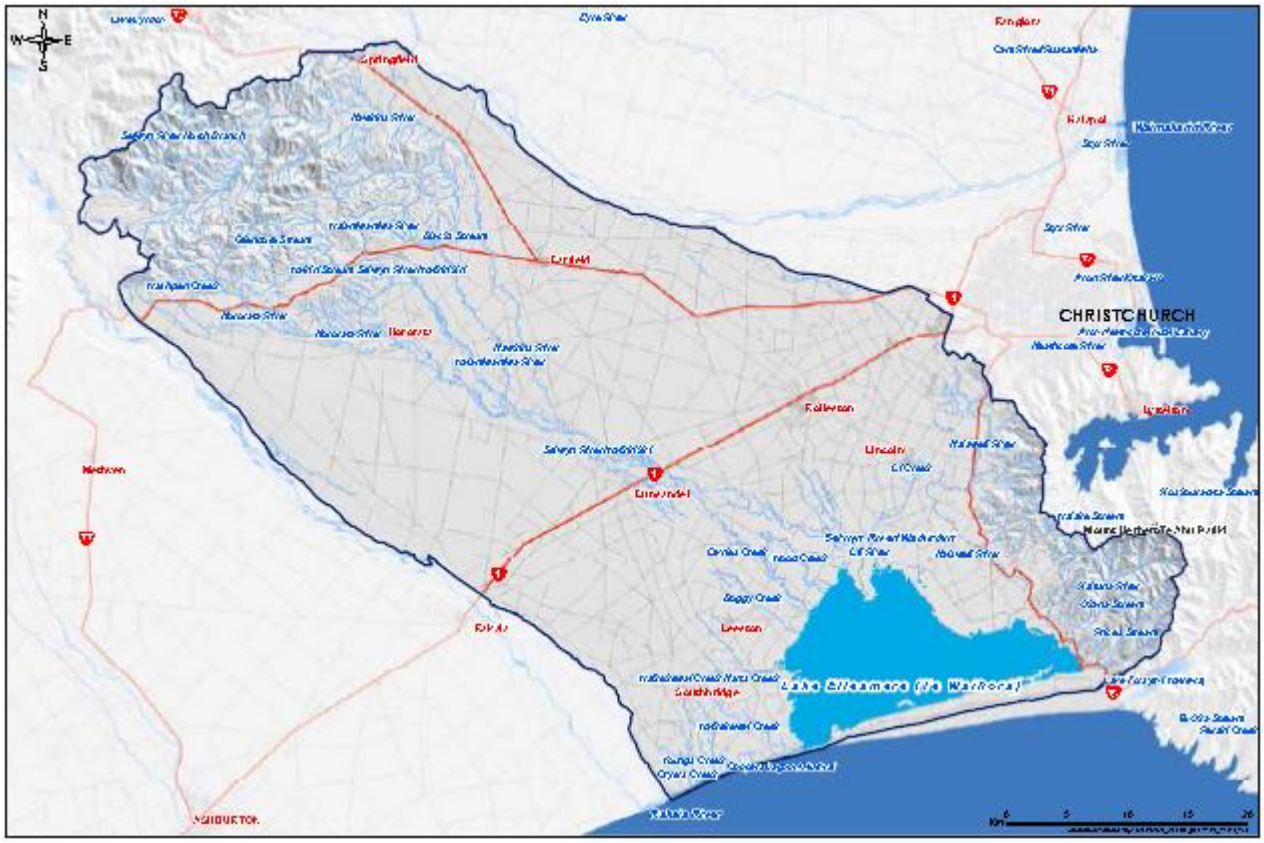

Figure 1. Te Waihora/Lake Ellesmere catchment: boundary of the monitoring strategy

5. Evaluation of existing monitoring (including the identification of gaps)

The existing monitoring and reporting information as presented at the 2013 and 2015 Te Waihora-Lake Ellesmere Living Lake Symposia was linked to nine topic areas, namely:

1. governance and management
2. land use and land cover
3. water quantity and water quality
4. vegetation
5. wildlife
6. fish
7. recreation
8. economy
9. cultural health

This framework can be further considered, re-organised and evaluated in a range of ways, for example, Ecosystem Service (ES) category: provisioning, regulating, supporting, cultural (Table 2 demonstrates how such a framework might be populated, and reported).

Table 2. An Ecosystem Services application to the nine topic/value areas (incorporating a traffic light approach to show the state of the Service as at 2013)

		Ecosystem Service Category			
		Supporting	Provisioning	Regulating	Cultural
	Definition of ES	Necessary for the production of all other ecosystem services	Products obtained from ecosystems	Benefits obtained from the regulation of ecosystem processes	Nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences
Value/topic cluster	Examples	Recycling, primary production and soil formation	Food (including seafood and game), crops, wild foods, and spices; raw materials (including lumber, skins, fuel wood, organic matter, fodder, and fertilizer); genetic resources (including crop improvement genes, and health care); water	Waste decomposition and detoxification; purification of water and air; pest and disease control; carbon sequestration and climate change	Cultural (including use of nature as motif in books, film, painting, folklore, national symbols, architect, advertising, etc.); spiritual and historical (including use of nature for religious or heritage value or natural); recreational experiences (including ecotourism, outdoor sports, and recreation); science and education
Governance			Effective governance will lead to better lake management regime and improve provisioning		Governance effectiveness perceived as very important by Maori and by the wider community
Land use & land cover		Enhanced biodiversity should help other ES	Increased emphasis on biodiversity will help the lake	Diversity of land uses likely to be better for lake management	Landscape aspects important to the community
Water	Level		Lake opening regime affects flounder and whitebait recruitment		
	Quality			Water quality problems related to pest control re bacteria etc	Very negative view of water quality of the lake held by Maori and other groups
Vegetation	Terrestrial Natives			Natives purify water	Aesthetic and Maori benefits
	Terrestrial Weeds			Willows - some carbon sequestration	Willows valued by some people
	Lake Macrophytes	Provide habitat, prevent wave action on shore, purify water: Terrible state		Purify water, help prevent shoreline erosion: Terrible state	Help provide cleaner water near lake shore valued by people - terrible state

Wildlife	Native birds				Internationally important and valued
	Game birds		Game birds		Huge resource and level of use
	Mahinga kai birds		Black swan eggs		More necessary
	Lizards				Valued by science and for conservation
	Terrestrial inverts	Very productive system			Valued by science and for conservation
Fish	Eels		Largest eel fishery in NZ		Largest eel fishery in NZ
	Whitebait		Food		Highly valued but degraded
	Bullies & smelt	Very productive system			
	Aquatic inverts	Very productive system			
	Rudd & goldfish	Threaten other services		Eat aquatic plants which affects shoreline etc	
Recreation					Lake supports a diverse range of recreation values but some in a degraded state (e.g., trout angling)
Economy			Eel and flounder fisheries very important; some economic costs of flooding farmland		Some ecotourism related to birdlife mainly
Cultural health			Very important to Ngāi Tahu - mixed currently		Very important to Ngāi Tahu

The nine topic areas will be retained with sub-categorising where necessary. Note also that topic (9) cultural health will be subject to its own reporting while acknowledging a need to include tangata whenua input and recognition of tangata whenua values into the design of monitoring of all other topic areas.

The chosen framework has the following strengths and weaknesses:

1. Strengths:
    a. The topics and (many of the) indicators were tested and accepted for the 2015 symposium
    b. The generic outcome statements appeared appropriate although very generic
    c. There is a manageable range and number of indicators for the nine topic areas
2. Weaknesses:
    a. Most topic areas (probably with the exception of freshwater which is now well defined in the Canterbury Land and Water Regional Plan and Plan Change 1) need more defined, measurable desired outcomes, and intervention triggers relevant to the indicators
    b. Some topic areas, especially governance and management, have a limited range or application of indicators, but we could produce them, e.g., re engagement or awareness

c. Key food chain/trophic level components are missing from ongoing monitoring, e.g., lake flies
d. Fisheries monitoring, especially non-commercial, is very poorly developed (although we note that Ngāi Tahu/WTW/NIWA are doing work here which we need to tap into; and we note the eel habitat index being developed and implemented by Cawthron Institute for Waituna)
e. Revegetation programmes and linked consideration of wildlife needs development

All of the above have been addressed in developed the improved framework.

6. The monitoring and reporting strategy

The framework:

The monitoring and reporting strategy builds on the existing data summarised from the 2013 and 2015 symposia and reported in Table 1 by:

- Adding and refining, where possible, measurable targets, against which indicator changes can be reported and used for management purposes
- Additional indicators related to more specific monitoring categories, where necessary
- Identifying who is undertaking the existing monitoring, where there are gaps, and specific where universities can contribute.

The value/cluster monitoring details:

Governance and Management

Topic/ value cluster	What we want to know from measures of success	Targets	Indicators	Monitoring details		
				Existing monitoring	University monitoring contribution	Gaps in monitoring
Governance and management	The role of Ngāi Tahu and kaitiakitanga is recognised in governance of the lake and catchment, there is integrated management of land and water use, and the wider community included in decision making	• Ngāi Tahu express satisfaction with governance and management arrangements • All other agencies and key stakeholders are satisfied • Community are happy with levels of consultation and understand the decision making processes with respect to the lake and environs	• Whether it is occurring or not • Levels of satisfaction with arrangements • As above	• Reviews of co-governance arrangements	•	• A survey of awareness of and attitudes towards the lake among local community members

Discussion points:

In terms of the first target, details of how the relationship(s) between governance agencies is working is probably out-of-scope; what is important is that it is being actively monitored – the results of reviews do not need to be reported.
Overall then awareness is different to governance but governance is irrelevant if there is no awareness/engagement. ECan/SDC/CCC have surveyed residents in the past, but have not included questions relevant to the lake.
Along the pathway to good governance, an interim specific target is increasing awareness, with a benchmark defined by an initial, benchmarking, survey. If the 'state of the lake' is improving then governance and management are delivering the desired outcome.
Lake Opening Management - this is specific aspect of management that directly affects most other values.
Lake level – it has been agreed that current methodology for measuring lake level is appropriate as the data set goes back to 1901. There may not be a perfect regime for lake opening that will please everyone.

Land use and Land Cover

Topic/ value cluster	What we want to know from measures of success	Targets	Indicators	Monitoring details		
				Existing monitoring	University monitoring contribution	Gaps in monitoring
Land use and land cover	Land use and development is integrated with water management; natural and cultural values are respected; all land use activities operate at good practice or better	• Diverse agricultural landscapes are supported with no one land use • Properties >20ha have restored/managed native vegetation/naturally occurring wetlands • Restoration plantings show positive annual survival and growth trends • Land and Water Regional Plan, Plan Change 1 (PC1) stock exclusion targets for waterways being met • Farm Environment Plans receive audit grade A or B	• % change in land uses; % change in irrigable area; number of restoration projects • number of restoration projects; proportion of properties >20ha actively restoring/ managing a native vegetation/ wetland area • % survival rates • % growth rates by species • % effectively fenced • % audits undertaken • % meeting grade target	• ECan land use database changes; irrigation area changes; restoration project maps • ECan and related data (NB may be limited to those properties requiring FEPs in conjunction with a resource consent application) • Fonterra; ECan FEP audit process • ECan FEP audit process??	• Lincoln Uni: LINC 101 – 600 students 2015 doing veg monitoring Shannon Page (possible link to birds and invertebrates): Jon Sullivan)	• FEP audit results • quantitative data about riparian management and restoration projects, • explore ways of sharing data, including making better use of geographic information systems (GIS) and the web for state of the lake reporting.

Discussion points:

Information on changes in land use, measured against the 2003 data, will give a measure of diversity. Land use is also linked to nutrient management and water quality. Monitoring changes in land use/cover alongside changes in water quality may help to evaluate whether or not nutrient management is a suitable way to be managing lake water quality.

FEPs will be audited from 2017 and the performance target is an A or B rating in the audit – this should relate to 'good practice'. It is noted that FEPs will not necessarily include a biodiversity component, i.e., it is not a requirement. It is also not known if FEPs will include reports of restoration projects, or if this data will be collated and/or made available. Revegetation targets cross link to vegetation/wildlife/cultural values. It is hard to get meaningful data on number/location of restoration projects (output). Monitoring of representative sites over time should show how biodiversity changes.

Water

Topic/ value cluster	What we want to know from measures of success	Targets	Indicators	Monitoring details		
				Existing monitoring	University monitoring contribution	Gaps in monitoring
Water quantity and water quality	Water quantity: ecosystem and cultural health is restored and safeguarded; water users have reliable supplies, including for customary use, and recreational activities Water quality: water quality is improved to sustain cultural values; indigenous and wildlife species are supported; drinking water is safe and water quality suitable for recreation	• Trophic Lake Index (TLI) - mid lake limit = 6.6, margins = 6 (PC1) • Water Quality Index - Fair or better (Canterbury Water Management Strategy (CWMS target) • Invertebrate/habitat grades - Fair or better (CWMS target) • Recreation grades - 'Suitability for Recreation Grade' of Good-fair (PC1, derived from MfE 2003) • Potentially toxic cyanobacteria - < 1.8 mm3/L (Public health guideline -Ministry for the Environment and Ministry of Health in 2009) • Ground water quality (N&P) - 8.5 mg/L for nitrate nitrogen (PC1), NB for drinking water Maximum Allowable Value of 11.3 mg/L nitrate nitrogen for drinking water (MoH, 2013), E. coli < 1 organism/100 ml (PC1), no target set for P • Water Quantity (tributaries) minimum flow and restriction regimes set out in PC1	• Change in TLI • Change in WQI • Change in Invertebrate/habitat grade • Change in recreation grades • Presence/absence of potentially toxic cyanobacteria • N&P levels in ground water; E coli in groundwater; • Measure of flow; amount of time restrictions in place	• Existing and ongoing ECan monitoring regime for both quantity and quality • Kaituna Valley community monitoring (ECan led)	• Targeted complementary monitoring by Waterways Centre: Jenny Webster-Brown and Jon Harding students – begun 2015	• There is no integrated WQ monitoring strategy – Waterways will work with others to establish one in 2015/16

Discussion points:

The targets for water quality in the lake and tributaries, and in ground water, are defined in regional plans and informed, in some cases, by national guidelines. There clear links to CWMS ZIP targets and Environment Canterbury is preparing interactive maps for state of the environment reporting which will include information on habitat grades and invertebrate grades at selected locations.

The Living Water programme will be undertaking monitoring for the Ararira/LII catchment.

It is worth noting that fine sediment monitoring is poorly done, and that while agrichemicals have been measured in the last 10 years, they are not regularly monitored.

It is noteworthy that a health warning has been in place at Te Waihora for potentially toxic algal blooms since February 2014.

There are targets (NPS) for primary and secondary recreational water contact and, for the lake, achieving the secondary target is critical – this should be reflected in report targets.

Flows relate to other values, e.g., fish passage.

Vegetation

Topic/ value cluster	What we want to know from measures of success	Targets	Indicators	Monitoring details		
				Existing monitoring	University monitoring contribution	Gaps in monitoring
Vegetation	Significant indigenous vegetation of the lake margin, wetlands and tributary streams is protected and restored	• An annual net gain of key habitat (e.g., raupo) and maintenance of important other habitat types (e.g., saltmarsh); • Maintain or increase threatened or at risk plant species • Annually reduce and stop spread of key problem willow species and other significant animal and pest weeds of native vegetation • Aquatic macrophyte beds re-established and show positive growth rates	• Habitat change as recorded in the 10-yr survey • Annual or biennial report on threatened or at risk species • Change in area of willow species and number of infested areas • Annual report on other pest species status – presence/ absence; location • Annual report on area of native aquatic restoration activity and success	• ECan 10yr monitoring regime • ECan/DOC? • Annual monitoring of weeds esp willow • ECan	• See land use and land cover	• Establishing permanent 10x10 m monitoring plots on public conservation land and ensuring comprehensive monitoring is undertaken at regular intervals, e.g., 3 yearly • Continue to monitor lake margins and key tributaries for weed spread • Where willows have been removed, and where vehicle/stock access has been removed from lake shore, establish photo points to monitor change • An offer has been made to compile a list of threatened species known to be present around the lake, and current threat ranking

Discussion points:

The 1984 Clark & Partridge vegetation survey of the lake margin will be used as the primary benchmark, with the target being no net loss of any key habitat types.

For threatened species, the target is to increase populations present at the lake. It is noted that in specific locations it may not be desirable to have an increase in certain species or habitat types, e.g., raupo. The target relates to net area around lake, as long as increase is not at the expense of other habitats of value.

The lack of an integrated annual monitoring programme for 'threatened and at risk' species, and generally for weed incursion and overall state change is a significant gap. The design of a stratified 10x10m quadrat network would help resolve these issues. A work programme is necessary to develop this network.

Wildlife

Topic/ value cluster	What we want to know from measures of success	Targets	Indicators	Monitoring details		
				Existing monitoring	University monitoring contribution	Gaps in monitoring
Wildlife	Indigenous wildlife (birds, lizards, terrestrial invertebrates) and associated habitats are protected	BIRDS: • Bird species diversity is maximised with a target average level of 39 species from 7 guilds recorded per annum • Bird species with a defined conservation risk and which rely on the lake for critical life stage requirements have populations enhanced • The optimised range of habitat conditions for the diversity of bird species present is provided LIZARDS - Specific measures not yet identified TERRESTRIAL INVERTEBRATES - Specific measures not yet identified AQUATIC INVERTEBRATES (LAKE): Measures needed • NB aquatic invertebrates are monitored for rivers and streams and reported in the Water section	• Presence/absence of indicator bird species • Numbers of bitterns • Area of habitat(s) on an annual seasonal need basis • Presence/ absence by species and habitat type • Presence/ absence by species and habitat type	• Bird monitoring strategy – annual February survey • DOC monitoring of bitterns	• LU – Mike Bowie/Jon Sullivan (LU), monitoring insects/ lizards	• Need to define a target for bittern numbers and habitat needs For birds and lizards: • maintain current monitoring and species recovery interventions, and report on responses Terrestrial invertebrates: • maintain current monitoring and species recovery interventions, and report on responses • encourage student researchers to target key shoreline areas of the lake to document species presence Aquatic invertebrates: • develop and implement a monitoring programme for lake flies (*Chironomus zealandicus*) that links to changing lake levels.

Discussion points:

The birdlife strategy focuses on the Annual Wetland Bird Count (February) – a collaborative undertaking between a number of groups and individual volunteers. Other bird monitoring at the lake includes:

- F&G do annual count of paradise shelduck and black swans, no monitoring of mallard at the lake but they are working on rectifying that.
- CCC – two wader censuses Nov/Dec and June/July – part of nationwide wader census started in 1984, now expanded to include some other species. Occasional or regular surveys on CCC sections for which data sets are saved – Lake Ellesmere eastern Shoreline, Kaitorete Spit, Prices Valley, Kaituna River, Kaitorete Base Ephemeral Wetland, Kaituna Rivermouth Saltmarsh.

- CCC targeted species specific monitoring – spoonbill breeding; crested grebe numbers; white fronted and Caspian tern colonies; mapping breeding territories of banded dotterels at core areas on Kaitorete Spit. Suggests lake wide surveys might be needed of nesting banded dotterels, tern and spoonbill colonies and Caspian tern colony at Greenpark (and any others) to record birds not in CCC area.

It has been further agreed by the reference group that the reporting area for wildlife includes Kaitorete Spit:

- Lizards only monitored at Kaitorete Spit. There is lack of data elsewhere around the lake.
- There is a need for inventory work and benchmarks to be established, and a need to identify representative areas for monitoring. Ararira Wetland/Yarrs Flat WMR may be a possibility for lizards (common skink) and terrestrial invertebrates.

Possible targets for lizards and terrestrial invertebrates include:

- No net loss of habitats over time – annual/seasonal users
- Consistency of presence/absence over 5 year rolling period

Pests:
CCC record trapping results from traplines along the Rail Trail (seasonal) and the DOC trapline at Kaituna River; DOC and CCC also have traplines on Kaitorete Spit.

Fish

Topic/ value cluster	What we want to know from measures of success	Targets	Indicators	Monitoring details		
				Existing monitoring	University monitoring contribution	Gaps in monitoring
Fish	Native fish (including koura and mussels) populations and associated habitats are protected and restored	• An upward trend in diversity and abundance of native fish populations • Economically and culturally viable populations of harvest/mahinga kai species maintained • Habitat for key 'threatened and at risk' species increased and maintained • Pest species having a significant impact on native fish or on lake habitat generally are controlled to effective levels • Fish barriers removed or negative effects mitigated	• ???? • Eel (tuna) and flounder (patiki) annual catches • Whitebait habitat monitoring • ???? • ???? • Fish barrier database	• NIWA 20-yr data record from Taumutu; work with Living Water Project re LII • MPI commercial data • ECan habitat modelling validated and monitored • ECan data	• Uni of Canterbury – ecology field programme 2015 onwards: Jon Harding • Could be a summer student	As yet there is no agreement between the parties on what an integrated fish monitoring programme should 'look like' but a strategy is being produced by NIWA for WTW (see below) • Citizen science could monitor and report on barrier status

<u>Discussion points:</u>

Monitoring of native fish (commercial, cultural) and introduced fish (e.g., trout which is a resource, and rudd which is a pest) and their habitats is perhaps the most challenging of the all the value clusters. NIWA is carrying out work for WTW which will provide data for reporting and target setting.

It is hoped that as part of this work NIWA will develop an integrated fish monitoring strategy with associated targets and indicators. A workshop[7] was held at NIWA on 31st July 2015 which was well attended by representatives from a range of organisations (WET, NIWA, ECan, DOC, University of Canterbury, Lincoln University, and Ngāi Tahu). At the end of the workshop the following were agreed as areas to attempt to report on in 2015, and as a basis from which to develop a more integrated strategy moving forward

<u>Native fish monitoring strategy</u>

- NIWA to produce at end of their work commitment for WTW

[7] It was agreed at the workshop that the participants provided an appropriate forum for working with NIWA to provide feedback and input into the monitoring strategy being produced for WTW.

Commercial fisheries

- Continue to monitor short-fin eels

Diversity and abundance

- Use a small number of representative sites to report on, but being clear that they may not represent the whole lake.
- Look at mahinga kai spp, e.g., tuna/pātiki and bullies
- Sites: Taumutu (initially) and then possibly the Ararira/LII, and elsewhere

Target (from CWMS): An upward trend in diversity and abundance of native fish populations.

Fish passage

- Report on the presence/absence of barriers – assuming that removal will be positive for the fish. This work will be done in association with ECan and could involve community participation in monitoring barriers and changes.

Target – seek to have all barriers removed or their effects mitigated by 2020

Inanga spawning sites

- Look at habitat and assume potential spawning sites will be good for the fish population.

Target (from CWMS): correct the decline in habitat quality or ecosystems

Pest species – no data available

Apart from presence/absence there is no current data. Ongoing reporting can include recommendations on future monitoring.

Overall then while fishes occupying the lake have been the focus of recent research:

- There are many tributaries that flow into the lake and the importance of these areas as habitat and for fish migrations are poorly understood. For example, tributaries may be the key spawning grounds for species that cannot find adequate spawning habitat in the lake (although many of the species will spawn at sea), may provide temperature refuge at times when the lake temperature is particularly high, and are critical habitat for longfin eels.

- At present we do not know the extent of spawning in tributaries for key prey fish species such as common bully or whether fish species that spawn in the lake are limited by the availability of spawning habitat.

- It is not currently known whether recruitment of small fish is limiting these eel and flounder populations or whether there are sufficient prey resources available to increase the abundance of eel and flounder species.

- There is a need to examine the effects of extended low summer lake levels on fish communities. Specifically, work could focus on the loss of lake margin habitat and high water temperatures.

Economy

Topic/ value cluster	What we want to know from measures of success	Targets	Indicators	Monitoring details		
				Existing monitoring	University monitoring contribution	Gaps in monitoring
Economy	Sustainable water use supports economic development	• Economic development in the Selwyn District is decoupled from water quality – the health of the lake and its tributaries have improved and economic activity in Selwyn is buoyant	• Population (incl net international migration of 208) • GDP Employment by industry (top 5) – Manufacturing – Construction – Agriculture, forestry and fishing – Healthcare and social assistance – Education and tertiary • Total cows • Consents ($ value) – Residential – Non-residential • Median house price • SDC operating expenditure • Waihora-Ellesmere associated quota value • Irrigated area Ellesmere Waihora (estimated) • Recreation visits • Guest nights	• Data already recorded for most indicators and a matter of updating • ECan in association with LU	• Lincoln University Commerce student – to be negotiated: contact Hugh Bigsby, Agribusiness & Commerce Faculty	• See recreation – very little up to date data are available • Calculation of composite economic indicators such as expenditure on environmental protection associated with the lake, GDP compared to water use and water quality. Changes in these types of indicators will show whether human induced pressures on the lake and its tributaries (from production and consumption in the Selwyn District) have lessened.

<u>Discussion points:</u>

It is noted that measuring recreation in $$ is not necessarily the best measure, but it is an indicator widely used.

A more significant question concerns how economic growth generally is related back to lake health? Is all the profit going to shareholders or are there positive environmental gains as prosperity increases in Selwyn? Do regional economic indicators link to investment in the lake? In this context an additional indicator, Environmental expenditure vs GDP growth has been added, but had yet to be developed.

Recreation

Topic/ value cluster	What we want to know from measures of success	Targets	Indicators	Monitoring details		
				Existing monitoring	University monitoring contribution	Gaps in monitoring
Recreation	Compatible recreation needs are provided for, including good access, water quality, and habitat for wildlife, including for sports fisheries	• Levels of use and value increase annually to sustainable levels • There is adequate provision for recreational access • Interpretation provision meets user needs	• User days per key activity; perceptions of satisfaction for key activities • Availability of access to key recreational areas • Levels of user satisfaction • Availability of interpretation material • Levels of user satisfaction	• Rail trail track counter • National angling survey - F&G • F&G gamebird harvest survey	• Lincoln Uni – duck hunter phone surveys (2015?) to be undertaken by a PG social science methods course	• Whitebaiting, picnicking, camping, walking • User surveys generally

Discussion points:

Overall there is a huge lack of quantitative and qualitative data about some recreational users. This needs to be addressed but is not a simple task.

The F&G National Angler Survey (every 7 years) took place in the 2014/15 season but data were not available for the 2015 state of the lake report. Data include angling use on the lake and tributaries and more qualitative data than in previous surveys, such as angler perceptions.

F&G undertake a Gamebird harvest survey. This is a phone survey to determine harvest trend which might now incorporate location.

Generally the following is required:

- User days per annum statistics for the main activities – trout angling, waterfowl hunting, whitebaiting, cycling, bird watching, walking and picnicking, perhaps undertaken on a bi- or triennial basis.
- Quality of experience measures – size and number of trout, number of waterfowl, access and other visitor-related facilities and provisions (including improved signage, walkways, boat ramps), water level and quality. Perceived quality can be gauged during the user days surveys.
- The formation of an 'expert panel' of lake recreationists to help monitor, report and advise on both the quality of experience and on user levels should also be considered as a way of helping progress these ideas.
- a facilitated discussion forum is required to clarify and attempt to resolve conflict issues, eg between hunters and bird watchers.

- An ongoing strategy to improve and share information about recreational opportunities.
- Develop a business case for constructing and developing a visitor/research centre for Te Waihora/Lake Ellesmere.

Cultural Health

Topic/ value cluster	What we want to know from measures of success	Targets	Indicators	Monitoring details		
				Existing monitoring	University monitoring contribution	Gaps in monitoring
Cultural health	Customary rights and use are recognised and mahinga kai species abundance and diversity is restored to a level to enable customary use	• The 11 objectives, taken from the Mahaanui Iwi Management Plan 2013 are achieved	• 11 objectives measured against a 5 point green to red scale	• Ngāi Tahu – Gail Tipa • Mahinga kai biohealth monitoring	•	•

Discussion points:

Can targets in other values/clusters be cross referenced to the 11 Ngāi Tahu objectives? It is noted that different groups value the same things (e.g., clean water) for different reasons.

7. Responsibilities for monitoring

Each topic area will have primary and complementary monitoring providers – the former will be responsible for overall coordination of reporting for each area as shown in Table 3.

Table 3. Proposed monitoring providers

Topic	Primary monitoring provider	Complementary monitoring provider
Governance and management	ECan and SDC, Living Water Project	Lincoln University
Land use and cover	ECan	Lincoln University
Water quality and quantity	ECan	University of Canterbury
Native vegetation	ECan, SDC, CCC	Lincoln University
Wildlife	DOC, OSNZ, WET and other community groups	Lincoln University
Fish	Ngāi Tahu, MPI and NIWA	University of Canterbury
Economy	ECan	Lincoln University
Recreation	Data from DOC and F&G	Lincoln University
Cultural health	Ngāi Tahu	

8. A proposed implementation and reporting pathway (incorporating where possible Lincoln University and University of Canterbury teaching initiatives)

General:

The biennial living lake symposium, and associated WET published 'State of the lake' reports, will remain the priority forum for integrated reporting.

Coordination of monitoring (and reporting) and quality control

- It is proposed that a part time position of monitoring and reporting coordinator be established within the Waterways Centre for Freshwater Management, or in another agreed organisation – this person would nurture and drive the monitoring and ensure appropriate coordination and reporting is undertaken. It is suggested the Te Waihora Agencies Group be responsible for funding this position and any operating expenses.
- All university and other monitoring will be peer reviewed etc against an agreed set of Standard Operating Procedures for all Topic Areas (Yet to be developed)
- All data will be stored centrally but will be freely accessible to all partner organisations.

Action points and timelines

A compendium of the additional agreed actions, overall and by topic area, is shown in Table 4.

Table 4. Additional agreed actions, timelines, estimated (additional) resource requirements, and responsibilities

Topic/ value cluster	Additional agreed actions	Estimated (additional) resource requirements	Responsibilities	timing
Monitoring programme manager	Appoint a part-time coordinator and agree on location	$60000 pa ???	Agencies Group/ Waterways	2015+
Governance & management	Community perceptions	Current	WET to explore options	Planned 2015+
Land use and cover	Develop improved SOP for LU student monitoring	$5000	LU – Shannon Page et al	2015
Water quality and quantity	Develop integrated water quality monitoring programme		Waterways Centre	2015+
Native vegetation	Establish monitoring plot SOP and applied framework	Current	ECan, DOC, Ngāi Tahu in association with LU	2015+
Wildlife	Develop monitoring programmes for terrestrial inverts and lizards	???	Lincoln University – Mike Bowie, recognising CCC and DOC work on Kaitorete Spit	2015+
Fish	Workshop to agree targets, indicators, monitoring programme Monitoring strategy	Current	NIWA for WTW	July 2015+
Recreation	Duck hunter phone survey	Current	Lincoln University	Possibly 2015, more likely 2016
Economy	Develop composite env expenditure vs GDP indicator	Current	ECan	2015+
Cultural health				