



Te Waihora/Lake Ellesmere State of the Lake 2015

Edited by: Adrienne J. Lomax, Kirsty A. Johnston, Kenneth F. D. Hughey, Kenneth J. W. Taylor



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Preface

The 2015 Living Lake Symposium is the fifth to be held by WET, so it is only fitting that the theme for this year is “Realising the vision – mountains to the sea, ki uta ki tai”. Not only does this reflect the progression of information, education and awareness of Te Waihora/Lake Ellesmere, but it embodies the environmental ethos of Ngāi Tahu - ki uta ki tai. Translated literally as “from the mountains to the sea” it represents the Ngāi Tahu way of understanding the natural environment, including how it functions, how people relate to it and how it can be looked after appropriately.

It cannot be doubted that the goal of this Symposium – and of those who are dedicated to the health of Te Waihora/Lake Ellesmere – is to develop a more complete understanding of how the Lake functions (both as an ecosystem and as part of a wider ecosystem), how people identify with and value it and its surrounds, and most importantly, how it can be cared for, celebrated and appreciated by all. This “picture” can only be illustrated through the gathering of diverse but valid data and information.

Therefore, the content of this report covers a wide range and depth of information, building on the set of indicators that were reported against in 2013. Whilst this represents a maturation in State of the Lake reporting, it is by no means a job completed. Future reporting will be guided by the recommendations in this document, to build a fuller picture of the Lake, what influences its health, and how we can better achieve our goal of continued improvement.

I encourage you to review, reflect and discuss the findings in this year’s report, and to consider what further information might be required for your own vision of Te Waihora/Lake Ellesmere to be realised.

Ruth Markham-Short
Chair, Waihora Ellesmere Trust

Feedback on the report

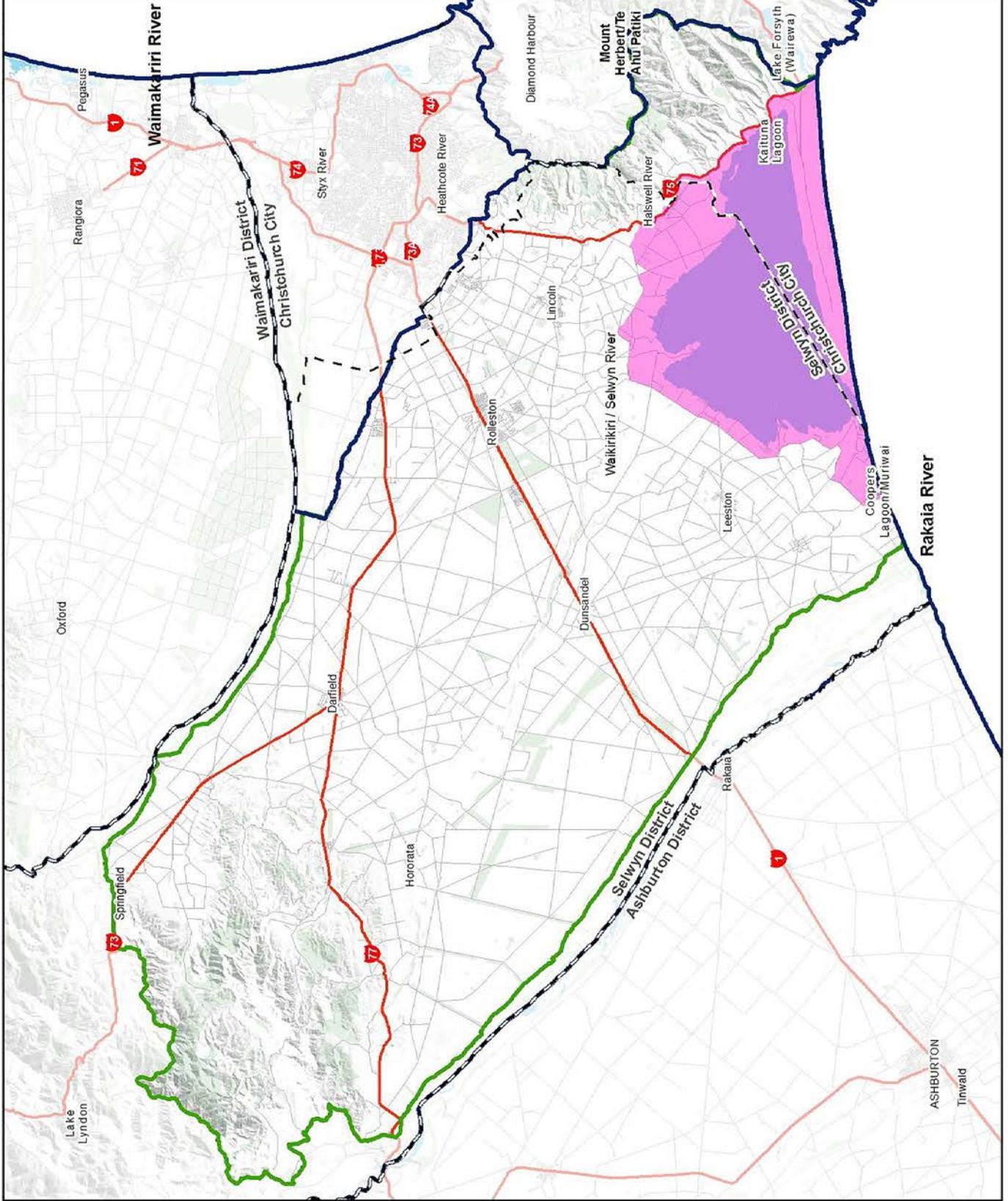
Waihora Ellesmere Trust would like to hear your feedback on this report. What is missing, what do you want to know more about? What data exist that we have overlooked? If you have any comments please send them to manager@wet.org.nz.

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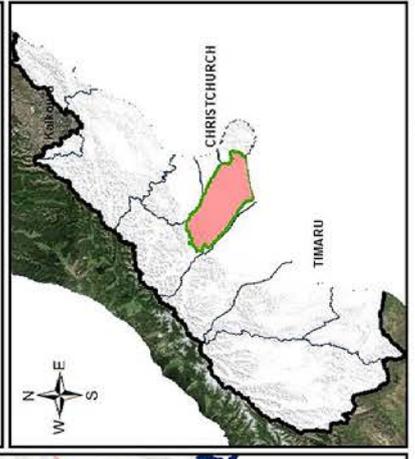
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0 10 20 30 40 50 Kilometres



-  CWMS Zone Boundary
-  Selwyn - Waihora Catchment
-  Territorial Authority Boundaries
-  Te Waihora Cultural Landscape/Values Management Area - Lake Area





Te Waihora/Lake Ellesmere is one of New Zealand’s most important wetland systems. It is of cultural, natural, historic, recreational and commercial importance to many people. The outstanding values of the lake are recognised in a National Water Conservation Order as: habitat for wildlife, indigenous wetland vegetation, and fish; and as being of significance in accordance with tikanga Māori in respect to Ngāi Tahu history, mahinga kai and customary fisheries. Internationally, Te Waihora/Lake Ellesmere is significant for its birdlife abundance and diversity.

More information about the lake and its values can be found in *Te Waihora/Lake Ellesmere State of the Lake 2013* and *Te Waihora/Lake Ellesmere: State of the Lake and Future Management* (2008).

Why are we reporting on the state of the lake?

It has long been recognised that the health of the lake and its tributaries has declined since the arrival of European settlers. In response, a variety of lake and land management interventions are underway or planned. We need to monitor and report on the state of the lake in order to know if our interventions are working – to measure progress towards the restoration of Te Waihora.

This report aims to show how the lake is changing, raising awareness of lake and land management issues. Importantly, through this report, we aim to strengthen links between science, monitoring and lake management.

This 2015 report is an update to *Te Waihora/Lake Ellesmere State of the Lake 2013*, covering the same topics and using the same approach. Our focus, two years on, is the period from July 1, 2013 to June 30, 2015. The geographic area covered includes the lake itself and its margins and, for some values such as land use and economy, the wider Selwyn-Waihora catchment. The test on whether data are reported or not is: “Does it tell us something important about how the lake is changing or what might influence this?”

Who is this report for?

This report is for anyone with an interest in the lake – people who work and play in the area, tangata whenua, decision makers and managers, industry and interest groups, and the wider community.

How has this report been compiled?

Nine topics have been included as separate sections. The choice of topics is based on those identified and reported in *Te Waihora/Lake Ellesmere State of the Lake and Future Management*, 2008. For the 2015 report we have divided the governance and management section into two parts, with one part covering lake level management in more detail. We have done this to more fully explain:

- the history of lake opening
- the new resource consent, granted in 2014, for managing lake openings (held jointly by Ngāi Tahu and Environment Canterbury),
- changing lake levels, in particular the openings over the last two years.

Outcomes, indicators and measures of success

For each state of the lake topic an outcome statement has been agreed¹ and where possible, measures of success identified (see Table 1.1). For each section a small set of indicators was also selected. The indicators report on the **state** of the lake and environs, the **pressures** which are causing changes to the state, and the **actions/programmes** (responses) underway. The indicators are based on those reported in 2013. Some indicators have been reviewed and amended, e.g., where more meaningful data can be used or have become available.

The state of the environment framework we are using is the expanded version of the OECD’s Pressure-State-Response framework. We refer to the driving forces which influence the pressures on the lake. We also report on the impacts from these forces and pressures on the natural environment – what do these mean for the people who use the lake and the species that inhabit the lake and its margins.

Figure 1:1 below explains the framework.

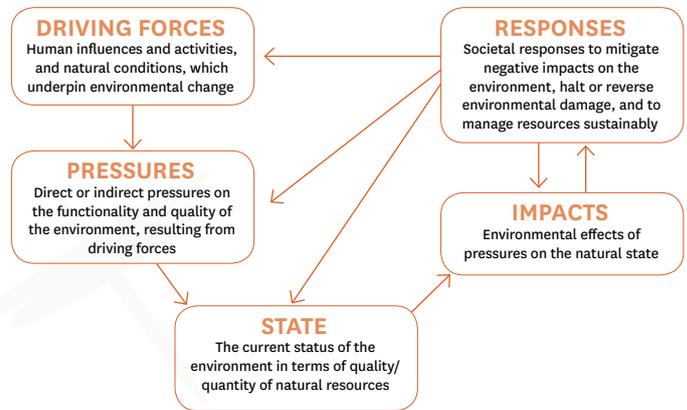


Figure 1.1: OECD’s Pressure-State-Response framework.

Measures of success are identified for all topics (see Table 1.1). Work will continue to refine these measures as needed, e.g., if lake management policies change or different values come to light.

Lake level management

As noted above we have included information (section 2a) about lake level management and data on the lake opening regime over the last 2½ years.

We have asked the authors of each section to report on the influence of lake level management over the last two years on their topic/indicators. Managing lake levels requires balancing the needs and wishes of multiple parties for multiple values. We intend that the information presented will contribute to informed decision making for Te Waihora and lake openings/levels in the future.

Summarising the data

For each section (with the exception of Governance and management) we have summarised the current state using traffic light bars. This is subjective, particularly where there are gaps in available data. Like a signal, the traffic light bars provide a simple, visual way to represent the current state of the lake or progress towards our topic measures of success. This signal system will be used again in two years’ time to compare progress. The bar is a continuum from very poor current state/ progress (red) through to good current state/progress, consistent with desired outcomes – our measures of success (green).



We also summarise trends for some topic indicators where a trend can be reported, i.e., is the state improving or declining in relation to the desired state, is there no apparent change, or don’t we know.

Recommendations

This is a report on monitoring and the recommendations authors make relate to monitoring, not to management. Are we looking at the right ‘state of the lake’ indicators, what are the data gaps, what are suggestions for future monitoring? Are the measures of success ‘measurable’, do we need to identify some interim measures in the short term?

Authors and data

Individuals and organisations, with expertise in the nine topics, have contributed content for the sections. Sections are collated here into one report and authors give an overview of the current state of the lake and its environs relative to their topic/ indicators.

¹For an explanation of the source of the outcome statements see <http://www.wet.org.nz/wp-content/uploads/2013/10/2013-November-summary-of-outcomes-for-Te-Waihora.pdf>

A new integrated monitoring strategy

Over the past year or so, led by Ken Hughey from Lincoln University, work has been underway to develop an integrated state of the environment monitoring strategy for the lake and its environs, supported by the Whakaora Te Waihora programme. The intention is to make integrated monitoring operational and enable regular, timely, reporting on the state of the lake – based on methods that are scientifically robust, fit-for-purpose, supported by the community and cost-effective.

Integration is on multiple levels: people and agencies working together, the combining of relevant environmental, social, cultural and economic data for reporting purposes and provision of data and information that can relate interventions and outcomes to each other on some level.

Through this strategy, the framework and indicators used in *Te Waihora/Lake Ellesmere State of the Lake 2013* will be further developed and applied. Specific objectives for the strategy are that:

- the framework used can work irrespective of the lake management actions being undertaken by different parties
- it provides for a monitoring and reporting implementation pathway
- it outlines how the staff and students of Lincoln University and the University of Canterbury will regularly contribute to the monitoring and assist with reporting on the state of the lake and its environs.

The strategy will remain, by design, a work in progress. For more information see www.wet.org.nz.

Table 1.1: Proposed Success Measures (Source of measures of success acknowledged where derived from a planning document or similar; otherwise developed by author of the monitoring strategy based on discussion with a reference group)

Topic	How will we know if we have achieved success?	Draft Measures of success
– 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 is included in decision making	<ul style="list-style-type: none"> ● 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
– 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	<ul style="list-style-type: none"> ● Diverse agricultural landscapes are supported with no one predominant 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
– 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	<ul style="list-style-type: none"> ● 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
– Vegetation	Significant indigenous vegetation of the lake margin, wetlands and tributary streams is protected and restored	<ul style="list-style-type: none"> ● An annual net gain of key habitat (e.g., raupō) and maintenance of important habitat types (e.g., saltmarsh) ● Maintain or increase populations of 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
– Wildlife	Indigenous wildlife (birds, lizards, terrestrial invertebrates) and associated habitats are protected	<p>BIRDS:</p> <ul style="list-style-type: none"> ● 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 ● w <p>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</p>
– Fish	Native fish populations (including koura (freshwater crayfish) and kakahi (freshwater mussels)) and associated habitats are protected and restored	<ul style="list-style-type: none"> ● 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
– Recreation	Compatible recreation needs are provided for, including good access, water quality, and habitat for wildlife, including for sports fisheries	<ul style="list-style-type: none"> ● Recreational user survey results show increased level of use ● Recreational user survey results show increasing quality of experience (quality includes measures of visitor facility provision, ease of access, signage/information availability, fish and game catch limits, water quality and lake level)
– Economy	Sustainable water use supports economic development	<ul style="list-style-type: none"> ● 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
– Cultural health	Customary rights and use are recognised and mahinga kai species abundance and diversity is restored to a level to enable customary use	<ul style="list-style-type: none"> ● The 11 objectives, taken from the <i>Mahaanui Iwi Management Plan 2013</i> are achieved

More information

Additional information and links are available from the WET website.

For background, context and information about values associated with Te Waihora/Lake Ellesmere please see other sections of the 2015 State of the Lake Report www.wet.org.nz/projects/2015-state-of-the-lake/



How will we know when we have achieved success?

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, with all activities operating at good practice or better, and the wider community is included in decision making

Context

The importance of Te Waihora/Lake Ellesmere is recognised in a National Water Conservation Order, which lists the lake’s outstanding features as wildlife habitat, habitat for indigenous wetland vegetation and fish, and significance in relation to tikanga Māori in respect of Ngāi Tahu history, mahinga kai and customary fisheries. All regional policy statements, regional plans and district plans must be consistent with the provisions of the Water Conservation Order. The majority of the Te Waihora lake bed and all surrounding Conservation lands are managed in accordance with the *Te Waihora Joint Management Plan 2005 (JMP)* (prepared by the Department of Conservation and Ngāi Tahu in accordance with the Ngāi Tahu Claims Settlement Act 1998) which has the status of an Iwi Management Plan under the Resource Management Act and that of a Conservation Management Plan under the Conservation Act 1987.

A significant amount of lake margin, approximately 70% or 53 km, is owned or administered by the Department of Conservation (DOC), Te Rūnanga o Ngāi Tahu (TRoNT), Selwyn District Council (SDC), Environment Canterbury (ECan), and Christchurch City Council (CCC). Additional to lake margin land, Te Rūnanga o Ngāi Tahu holds the fee simple ownership of the Te Waihora lake bed on behalf of the iwi.

The catchment for the lake is large and activities throughout the catchment have varying impacts on the lake and its tributaries. Many organisations play important roles in the governance and management of Te Waihora and its catchment. These include organisations with a statutory role (namely, Environment Canterbury, Selwyn District Council, Christchurch City Council, Department of Conservation, Ministry for Primary Industries, Fish & Game NZ, and Te Rūnanga o Ngāi Tahu), non-statutory organisations, and a range of interest groups whose views are taken into consideration. A diagrammatic explanation of the key parties involved in the governance and management of the lake and catchment is available on the WET website.

Committed Partners

There continues to be a number of key organisations and partnerships that play important roles in managing Te Waihora and its catchment. The partnerships between Te Rūnanga o Ngāi Tahu, Papatipu Rūnanga, Department of Conservation, Environment Canterbury, Selwyn District Council, and Christchurch City Council have strengthened over the past two years and continue to play a pivotal role in the governance and management of the physical resources of the lake and catchment. Industry, community organisations and other stakeholders including Fonterra, Waihora Ellesmere Trust (WET), Te Ara Kākāriki and the universities continue to play an increasingly valuable role in delivering tangible and meaningful action on the ground.

Of particular note since 2013 is the progress made by the Selwyn-Waihora Zone Committee to develop a solutions package, in consultation with their community, to improve cultural and environmental outcomes in the Selwyn-Waihora catchment while maintaining farm viability and economic growth. The actions to achieve this objective were described in the Zone Implementation Programme (ZIP) Addendum and given effect to in the proposed Selwyn-Waihora sub-regional plan (Plan Change 1¹ to the Land and Water Regional Plan). This plan contains specific policies, rules and limits. A special feature of the Selwyn-Waihora sub-region – and a key feature of proposed Plan Change 1 of the Canterbury Land & Water Regional Plan – is the Cultural Landscape/Values Management Area (CLVMA), an area encompassing the lake, its margins, wetlands, springs and tributaries (see map on page 4).

The CLVMA recognises the significance of Te Waihora/Lake Ellesmere to Ngāi Tahu. The Area will be managed as a single integrated freshwater mahinga kai system with outstanding values in order to:

- Protect mahinga kai, wāhi tapu and wāhi taonga
- Restore the health of the lake
- Recognise the cultural and ecological sensitivity of the Area to discharges of contaminants and the taking and use of fresh water.

Some aspects of the proposed plan change have been challenged and it is anticipated that Plan Change 1 will be finalised some time in 2016.

Working Collaboratively

Individual agencies have their specific statutory roles but working in collaboration has brought many benefits to the catchment. The table overleaf outlines some of the key achievements by the various governance and management collaborative groups over the past two years.



Lake margin working group (Te Waihora Agencies Group) August 2015

Recommendations

For good governance and management, engagement of the wider community is desirable. Currently, no information is available about levels of wider community engagement with the lake. It is recommended that avenues be explored to undertake a survey of awareness of and attitudes towards the lake among local community members. Increasing awareness is a step to achieving the overall outcome of good governance and management. In more general terms, if the ‘state of the lake’ is improving then governance and management are successful.

What do farmers think?

Although we have no recent research on attitudes to the lake, Environment Canterbury has recently asked farmers across four zones, including Selwyn-Waihora, about their understanding of the Canterbury Water Management Strategy (CWMS) and attitudes to water management in general. The survey was undertaken in July 2015 and involved telephone interviews with nearly 500 farmers including 137 in Selwyn-Waihora.

The research is being used to make sure communication about actions – such as preparing Farm Environment Plans and other requirements of new planning rules – is effective.

In Selwyn-Waihora

- only 34% of respondents agreed that water quality is declining while 41% disagreed
- 52% disagreed that recreational use of waterways is becoming restricted, and 22% neither agreed nor disagreed
- 95% see that affordable and efficient water management is essential for the future of farming in Canterbury
- all respondents had heard of the CWMS and over 70% reported being somewhat familiar or very familiar with the CWMS
- over 60% felt they had had the opportunity to contribute their views to development of water management plans
- over 65% believed the CWMS will be somewhat effective or very effective in protecting water quality and keeping decisions about water use out of the courts.
- over 90% are aware of the new planning rules governing nutrient loss
- 45% had attended meetings about planning changes.



The full report can be found on the ECan website.

¹ Referred to as Variation 1 until September 2015 when the Land and Water Regional Plan became operative.

Name	Parties	What they do	Key achievements over the last 2 years
Te Waihora Co-Governance	<ul style="list-style-type: none"> Te Rūnanga o Ngāi Tahu Environment Canterbury Selwyn District Council Christchurch City Council (observer at present) 	<p>Collaboratively exercise the following statutory and non-statutory powers:</p> <ul style="list-style-type: none"> Preparation, review or change of RMA planning and policy instruments Resource consenting Compliance, monitoring and enforcement Annual and long term planning Operational works within the catchment including lake opening, drain management and other works Biodiversity and biosecurity Bylaw making Relationship management 	<ul style="list-style-type: none"> Selwyn District Council has become a full participant in the Co-Governance Agreement Lake opening actions that include <ul style="list-style-type: none"> A resource consent for the term of 15 years (expiring 2029) held jointly by Environment Canterbury and Te Rūnanga o Ngāi Tahu Spring openings that have resulted in good fish recruitment Lowering of beach crest to assist tuna/eel migrations.
Selwyn-Waihora Zone Committee	<ul style="list-style-type: none"> Environment Canterbury Selwyn District Council Christchurch City Council Members of Papatipu Rūnanga (6) Community members 	<ul style="list-style-type: none"> Facilitate community involvement in the development, implementation, review and updating of a Zone Implementation Programme (ZIP) that gives effect to the Canterbury Water Management Strategy in the Selwyn Waihora Zone Monitor progress of the implementation of the Zone Implementation Programme 	<ul style="list-style-type: none"> Confirmed the Selwyn-Waihora ZIP Addendum that recommended a package to improve cultural and environmental outcomes in the Selwyn-Waihora catchment while maintaining farm viability and economic growth. The addendum described how this will be achieved through the Selwyn-Waihora Sub-regional Section of the Land & Water Regional Plan and other actions Invitation from Zone Committee to Te Rūnanga o Ngāi Tahu, as lakebed owner, to lead the In-Lake Interventions discussions
Te Rūnanga o Ngāi Tahu Te Waihora Management Board	<ul style="list-style-type: none"> Te Rūnanga o Ngāi Tahu Te Taumutu Rūnanga Te Ngāi Tūāhuriri Rūnanga Te Hapū o Ngāti Wheke Te Rūnanga o Koukourārata Ōnuku Rūnanga Wairewa Rūnanga 	<ul style="list-style-type: none"> Owner of the lake bed Aboriginal/customary rights and interests Joint holder lake opening consent Manage commercial fishing activities on lakebed Represent Papatipu Rūnanga Joint Management Plan implementation Whakaora Te Waihora Joint Plan implementation Statutory Advisor to Fish & Game Councils Advocacy 	<ul style="list-style-type: none"> Joint Management Plan review with DOC Te Waihora Lakebed Agreement with fishers ANG 13 ACE (Annual Catch Entitlement) quota tender process undertaken Board chair representing Te Rūnanga o Ngāi Tahu on Co-Governance group Engagement over Osborne's Drain Acts as reference Board for Lake issues
Whakaora Te Waihora	<ul style="list-style-type: none"> Ministry for the Environment Environment Canterbury Te Rūnanga o Ngāi Tahu 	<p>A joint cultural and restoration programme that aims to:</p> <ul style="list-style-type: none"> Accelerate restoration of ecosystem health Begin restoration of cultural sites and mahinga kai Protect and restore lake margin wetland habitats, indigenous vegetation and wildlife and lowland tributaries Improve lake and catchment management practices Establish a robust monitoring and investigations programme 	<ul style="list-style-type: none"> Planted approximately 40 additional sites with native plants and continued maintenance programme Weed and willow control at priority sites Re-battered 15.2 km of waterways Erosion control works on the Kaituna River Two automated monitoring stations installed in the lake (real time data) Several science investigations completed and underway (see tewaihora.org) 5 Farm Environment Plan workshops, 2 Phosphorus and Sediment Management Field Days 53 Farm Environment Plans completed Supported Te Ara Kākāriki (TAK) - planting undertaken by 1,000 students from 12 local schools Supported the development of an integrated monitoring strategy (LU/UC)
Living Water	<ul style="list-style-type: none"> Department of Conservation Fonterra <p>Signed in 2013, Living Water is a 10 year partnership between DOC and Fonterra to foster, implement and promote healthy functioning ecosystems and environmental sustainability at 5 sites across New Zealand, including Te Waihora, where dairying is a significant industry.</p>	<p>Vision</p> <p>A sustainable dairy industry is part of healthy, functioning ecosystems that together enrich the lives of all New Zealanders.</p> <p>Guiding principles</p> <ul style="list-style-type: none"> Achieve a positive and measurable impact on water quality and biodiversity Create positive engagement and value with our communities <p>Key Focus area for Te Waihora</p> <ul style="list-style-type: none"> Ararira/LII catchment 	<ul style="list-style-type: none"> Project planning and implementation underway Baseline report of the Ararira/LII catchment and recommendations for restoration and monitoring Stakeholder engagement and updates Support for a number of projects/groups including University of Canterbury drain rehabilitation trials at Silverstream; on-farm projects; Canterbury Plantout (TAK); collaboration with Waihora Ellesmere Trust (WET) on rehabilitation and recreation opportunities; Kids Discovery Plantout (Lincoln Primary & TAK); Kidsfest (Lincoln Envirotown) Fish survey of Ararira/LII catchment
Te Waihora Agencies Group	<ul style="list-style-type: none"> Te Rūnanga o Ngāi Tahu Environment Canterbury Selwyn District Council Christchurch City Council Department of Conservation Ministry for Primary Industries Canterbury District Health Board Fish & Game NZ Waterways Centre for Freshwater Management Living Water Waihora Ellesmere Trust (facilitator). 	<ul style="list-style-type: none"> To facilitate regular exchange of information between agencies, and to provide information and updates to key governance and management forums such as the Te Waihora Co-Governance Group and the Selwyn-Waihora Zone Committee To promote the values and knowledge associated with the lake through educational outreach (including the biennial Living Lake symposium) To maintain oversight of activities within the catchment, and identify, discuss and, if necessary, escalate issues of concern 	<ul style="list-style-type: none"> Re-established regular group meetings (formerly Statutory Agencies Group) and expanded membership to include the Waterways Centre (Lincoln University/University of Canterbury), CDHB, and Living Water Two fora to identify lake related research topics Established a Lake Margin Working Group to discuss issues including leases and access Supporting the development of an Integrated Monitoring Strategy for the lake and environs Umbrella group for the planning and organising of the Living Lake Symposium (hosted by WET) and the 2015 State of the Lake report (published by WET)

More information

Additional information and links are available from the WET website.

For background, context and information about values associated with Te Waihora/Lake Ellesmere please see other sections of the 2015 State of the Lake Report www.wet.org.nz/projects/2015-state-of-the-lake/



Context

Te Waihora/Lake Ellesmere has no natural outlet to the sea and there is a long history of opening the lake to the sea by breaching Kaitorete Spit. Prior to European settlement of Te Wai Pounamu, tribal records/ mātauranga indicate tangata whenua made periodic breaches of Kaitorete Spit to facilitate fish migration and to reduce flooding at Taumutu. The first written record of the artificial opening of Te Waihora was in 1852 and from 1868 local farmers started opening the lake in an informal way until the Lake Ellesmere Drainage Board was formally set up in 1905. There were no set levels at this time for an opening.



1880s - opening the lake with horse drawn scoops

Permanent outlets, primarily constructed of wood, were built in 1904 (Dobson's Culvert) and 1908 (Pannett's Culvert). Pannett's Culvert lasted until 1925 when it was destroyed by the sea. In 1947 the North Canterbury Catchment Board succeeded the Drainage Board

and managed the lake openings until the creation of Environment Canterbury in 1989¹.

Opening levels were agreed in 1947 as 1.05 m.a.s.l. (summer) and 1.13 m.a.s.l. (winter). Today, these levels are specified in a National Water Conservation Order (WCO) as minimum levels above which the lake may be opened.

The levels are:

- 1.05 m.a.s.l. – 1 August to 31 March
- 1.13 m a.s.l. – 1 April to 31 July
- Any level between 15 September to 15 October
- Any level between 1 April to 15 June (since 2014)

The ability to decide to open at any level in spring and autumn is to allow decision makers to consider opening to facilitate fish passage. The lake level is determined each week by averaging readings taken at gauges at Nutts Cut and Taumutu.

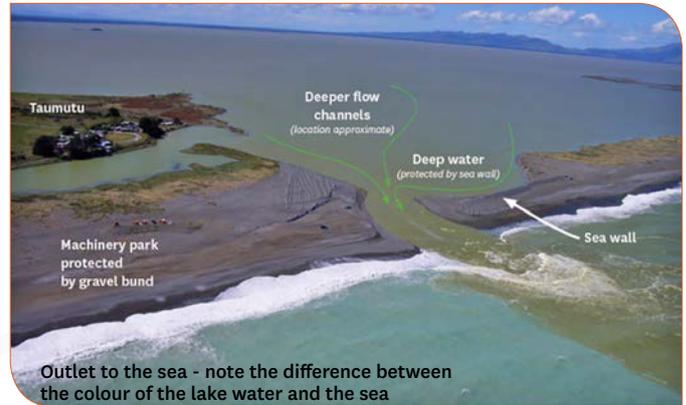
Environment Canterbury maintains a dataset that records every lake opening since 1901. The introduction of power scoops in the 1930s resulted in an average lake opening at around 1.54m reduced to around 1.19m by the 1950s. Parallel to this, on average the number of lake openings each year also increased. Today the number of openings each year generally varies between 2 and 6 and it is not automatic that the lake will be opened as soon as minimum permitted opening levels are exceeded.

The WCO also allows for consideration of closing of the lake once it drops below 0.60 m.a.s.l. between 1 October and 31 March. To date, mechanical closure of the lake has never been attempted and depending on the circumstances may not be practical. Many factors need to be considered before a closure could be attempted which include: volume of material on site to infill the cut, the length and width of the cut, forward weather forecast, sea conditions including tidal variations and how close natural closure may be.

The rating apportionment for funding lake openings is set out in Environment Canterbury's Long Term Plan. From July 2012 lake edge property owners that benefit from reduced land inundation and improved drainage contribute 50% of the funding, a works and services rate makes up 25% of the funding and general rate makes up 25%. Prior to 2012 the split was 70%/15%/15% respectively but was changed to recognise the benefits of managing the level of the lake for a broader range of values. In the future, a resource consent condition requires Central Plains Water Limited to also pay a proportion of the opening cost in recognition of the extra water the lake will receive. The cost of each lake opening ranges from between \$20,000 to \$120,000 depending on how much work is required on site.

¹ Further information on lake opening methods and proposals is at www.hydroeco.net/tewaihora/
² M.a.s.l. - metres above sea level

How is the lake opened to the sea?

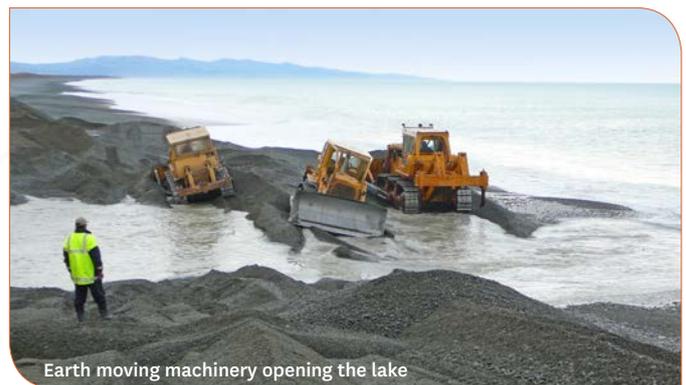


Outlet to the sea - note the difference between the colour of the lake water and the sea

Openings are achieved by using heavy earthmoving machinery to make a pilot cut through Kaitorete Spit near Taumutu. The cut can be over 300 metres long (depending on the amount of gravel over-wash into the lake) and connects to a widened deep water pool in the lake to maximise flow into the cut. The deep water is vital for opening the lake and work is done to protect it by maintaining and creating a seawall (gravel bund) on the Spit to attempt to minimise gravel over-washing into the lake during large seas. Difference in water level between the lake and the sea is vital for getting water running out to sea (lake water level must be higher than sea water level) with the final work to open occurring just after high tide.

The success of any lake opening depends on favourable weather conditions. Wind strength, wind direction, sea swell, wave direction, and tides are all factors that can affect openings.

In difficult weather and/or with adverse sea conditions multiple attempts may be necessary and a successful opening may take weeks, or even months to achieve. An opening is generally considered successful when it persists for at least four days. In bad weather with rough seas it is simply not possible or safe to access the site or to operate machinery.



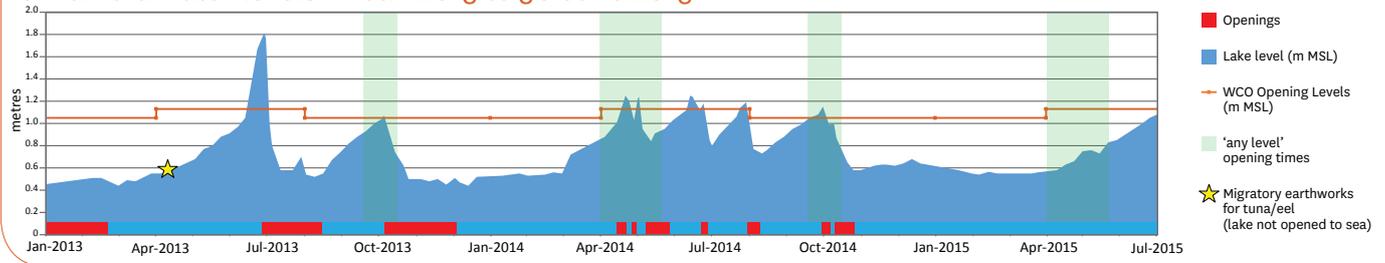
Earth moving machinery opening the lake

Decision Making Process

Prior to 2006 it was at the sole discretion of Environment Canterbury and its predecessors as to when the lake would be opened. Preventing flooding was the dominant driver and the main reason for the lake being opened. In 2006 new resource consents were required and a 'Protocol' was negotiated requiring prior consultation with the following groups: Te Rūnanga o Ngāi Tahu, Te Taumutu Rūnanga, Department of Conservation, the Rating District Liaison Committee, Fish and Game NZ, Commercial Fishermen's Association, Selwyn District Council, Christchurch City Council and the Waihora Ellesmere Trust. The lake opening Protocol is essentially a short guide for collaborative and transparent decision making and a forum in which every group has the opportunity to make their view known.

In 2014 resource consents were again renewed and are now held jointly between Te Rūnanga o Ngāi Tahu and Environment Canterbury.

Te Waihora water levels - 1 Jan 2013 to 30 June 2015



The Protocol has been updated but is still in operation allowing all Protocol Group members to have input before the final decision is made by the two joint consent holders. Experts are engaged as required to provide technical advice and forward weather and sea conditions are also considered. When, and at what level, the lake is opened to the sea requires the consideration of a number of matters including wildlife, wetland vegetation, fish habitat, mahinga kai, customary fisheries, water quality, summer levels, land inundation, waterway networks and infrastructure, and fish migration for a variety of species in autumn and spring.

Lake Openings between 1 January 2013 and 30 June 2015

The lake was opened successfully 10 times between 1 January 2013 and 30 June 2015.

Te Waihora openings: 1 Jan 2013 - 30 June 2015

Date opened	Date closed	No. days open	Level open	Level closed
15/12/2012	21/02/2013	68	1.08	0.51
29/06/2013	15/08/2013	47	1.81	0.52
5/10/2013	4/12/2013	60	1.07	0.51
21/04/2014	29/04/2014	8	1.25	1.03
2/05/2014	11/05/2014	9	1.24	0.84
15/06/2014	21/05/2014	6	1.24	1.12
24/06/2014	29/06/2014	6	1.18	0.85
29/07/2014	9/08/2014	15	1.19	0.73
30/09/2014	6/10/2014	6	1.15	0.99
9/10/2014	25/10/2014	16	1	0.58

No openings between 1 Jan and 30 June 2015

2013 was a notable year due to three long opening periods, earthworks to aid tuna/eel migration and a significant flood event. Opening periods in 2013 saw the lake open for 68 days, 47 days and 60 days respectively. Analysis of wave buoy data from 2013 indicates that overall it was a calmer year than usual meaning that there was less opportunity for gravel to be deposited and fill in the cut. The direction of the waves were also a feature in these longer opening periods with more waves coming from an east or south-east direction rather than a southerly direction which tends to close the cut.

In June 2013 the lake reached its highest level since 1941 (1.81m) after a storm prevented safe access to the opening site and large seas meant

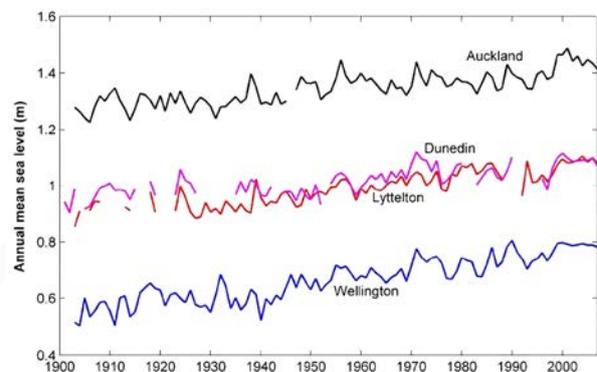
that multiple attempts to open the lake were unsuccessful.

2014 recorded seven openings in total. All openings in 2014 were relatively short compared to 2013 ranging between 6 to 16 days.

There were no lake openings between 1 January – 30 June 2015.

Future Openings

Environment Canterbury is committed to co-governance within the Selwyn-Waihora catchment and joint decision making will continue in the future (see section 2). Sea level around Canterbury is rising at 1.9 +/- 0.1 mm/yr (Hannah and Bell 2012) making it harder to open the lake and will likely mean that the lake will need to be opened at higher levels in the future.



Annual mean sea level time series to 2008 from the four primary tide gauges (Auckland, Wellington, Lyttelton, Dunedin) before detrending. Sea level is relative to a particular port datum, with an arbitrary 0.6 m offset subtracted from Auckland to reduce the plot size. (Hannah and Bell 2012).

References

- Environment Canterbury has a dataset of all lake openings since records began in 1901.
- Hannah, J. and Bell, R.G. (2012) Regional sea level trends in NZ. Journal of Geophysical Research 117: C01004

Acknowledgements:

Bruce Gabites (Coastal and Fluvial Resource Scientist – Environment Canterbury), Justin Cope (Team Leader Hazards and Coastal – Environment Canterbury)

Tuna/eel migration

In autumn adult tuna/eel migrate to the sea to breed and complete their life cycle. In April 2013 concern was raised when tuna/eel were dying on Kaitorete Spit trying to migrate to sea. The pathway for them to travel was too long and many were dying when the sun rose and they had not made it to the sea. The lake level was not high enough to allow an opening to help their migration so earthworks were carried out to "shorten the path" they had to travel to sea. A wedge was cut half way into the Spit and the Spit crest was lowered allowing the tuna/eel to swim in closer and then have less distance to climb/travel. This also allowed sea water to wash over the Spit to help keep the pathway wet.



Tuna/eel migration in 2014 as the lake is opened

More information

Additional information and links are available from the WET website.

For background, context and information about values associated with Te Waihora/Lake Ellesmere please see other sections of the 2015 State of the Lake Report www.wet.org.nz/projects/2015-state-of-the-lake/



Section 3

Land use and land cover

Te Waihora/Lake Ellesmere – State of the Lake 2015

Lead author: Kirsty Johnston, with Katherine Glasgow, Michael Fletcher, Ognjen Mojsilovic, Ian brown - Environment Canterbury

How will we know when we have achieved success?

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

Context

Measures of land cover and land use are descriptive indicators for state of the environment reporting. Land cover is the physical material at the earth's surface, such as forests, pasture, water, or asphalt. Land use is the activity or economic function to which people put the land, such as forestry, sheep and beef farming, recreation, or urban settlement. Land cover is a state indicator, describing quantity and quality. It reflects changes in land use. Land use is a pressure indicator and tells us about the driving forces that change environmental conditions. Monitoring and reporting changes in land cover and land use, over time, are fundamental to understanding and managing the driving forces and pressures that affect Te Waihora/Lake Ellesmere (refer to *Te Waihora/Lake Ellesmere State of the Lake 2013*). Catchment land use and land cover - past, present and future are inextricably linked with the state of the lake.

State: Land cover

As reported in 2013, changes in land cover in the Selwyn District, including the current state, reflect changes in land use influenced by population growth and shifts in business enterprise (refer Economy section). Again, the Land Cover Database (LCDB) derived from satellite photography of New Zealand is used to report on land cover change – this time between LCDB3 (2007/08) and LCDB 4 (2012/13) – the LCDB is compiled at 5-yearly intervals.

Figure 3.1 shows LCDB4 mapped by combining like cover classes into major groups. Pasture appears as the predominant land cover.

Land cover change for cover classes highlighted in the State of the Lake 2013 report (and shown Figure 3.3 overleaf), can be summarised as follows:

- forest harvested – continued increase (79.3% or 217 ha harvested)
- exotic forest plantings, a decrease (-11.1% or -700 ha)
- built up area – small increase (1.6% or +30ha)
- transport infrastructure – no change
- mixed exotic shrubland – no change
- orchard, vineyard and other perennial crops – continued decrease (-12% or -53 ha)

Notable changes between LCDB3 and LCDB4 include:

- lake and pond – moderate increase (27% or +448 ha)
- surface mines and dumps – small increase (5.6% or +5 ha)
- urban park and open space – small decrease (-4.5% or -20 ha)
- matagouri or grey scrub – small decrease (-2.8% or -139 ha)
- manuka/kanuka – small decreases (-1.0% or -19 ha)
- gorse and broom – small decrease (-3.12% or -178 ha)
- deciduous hardwoods – small decrease (1.57% or -66 ha).

Because LCDB4 is from 2012/13 imagery, it doesn't show the recent expansion of urban residential settlement in Prebbleton, Lincoln and Rolleston, or the increase in water storage infrastructure such as that developed for the Central Plains Water Limited (CPW) scheme. Also, while the small changes in manuka/kanuka, matagouri or grey scrub may seem inconsequential, knowing what's left, and where, for native vegetation can help inform biodiversity restoration efforts, including in the lake's catchment.

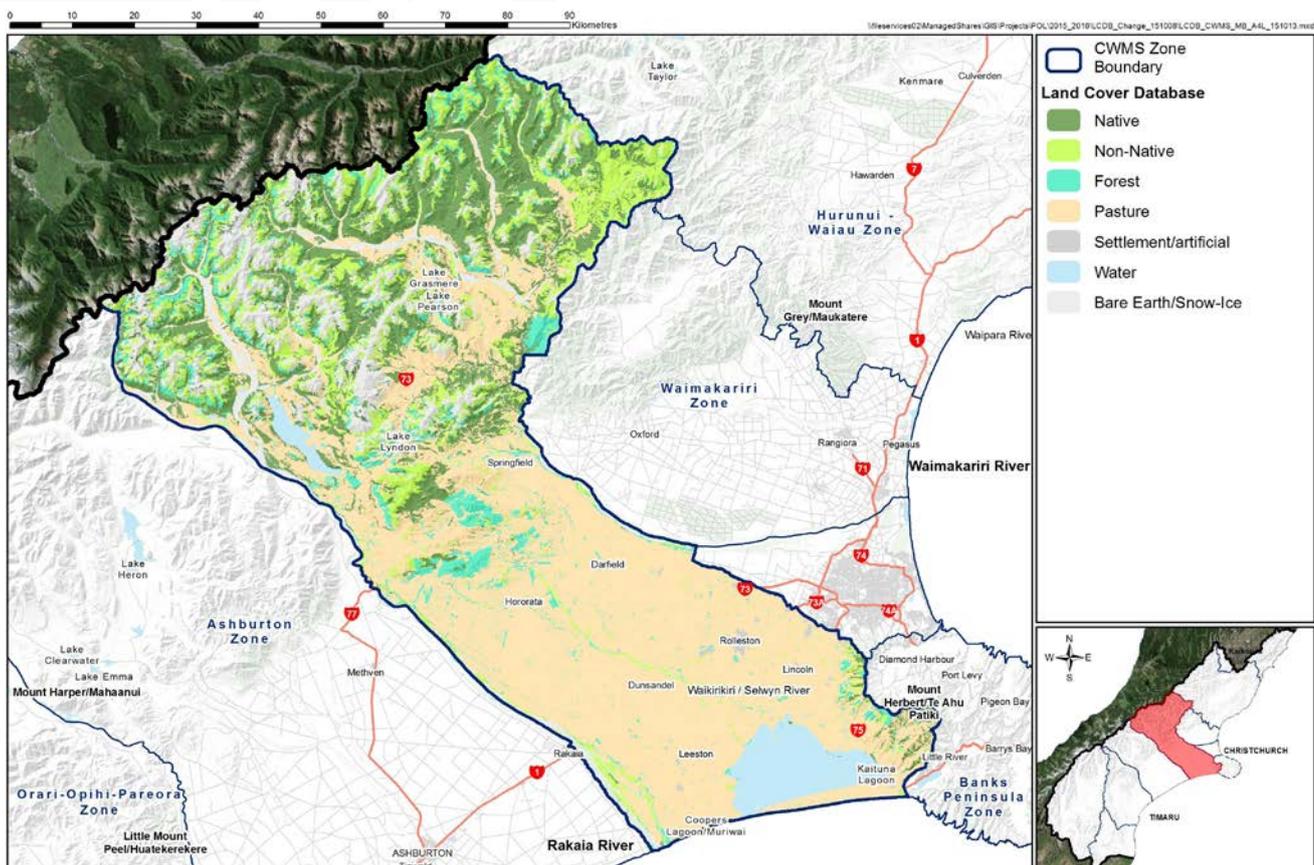
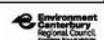


Figure 3.1: Land Cover Database4 (2012/13) mapped for the Selwyn District/Selwyn Waihora Canterbury Water Management Strategy (CWMS) zone. Source: LCDB4. Environment Canterbury 2015



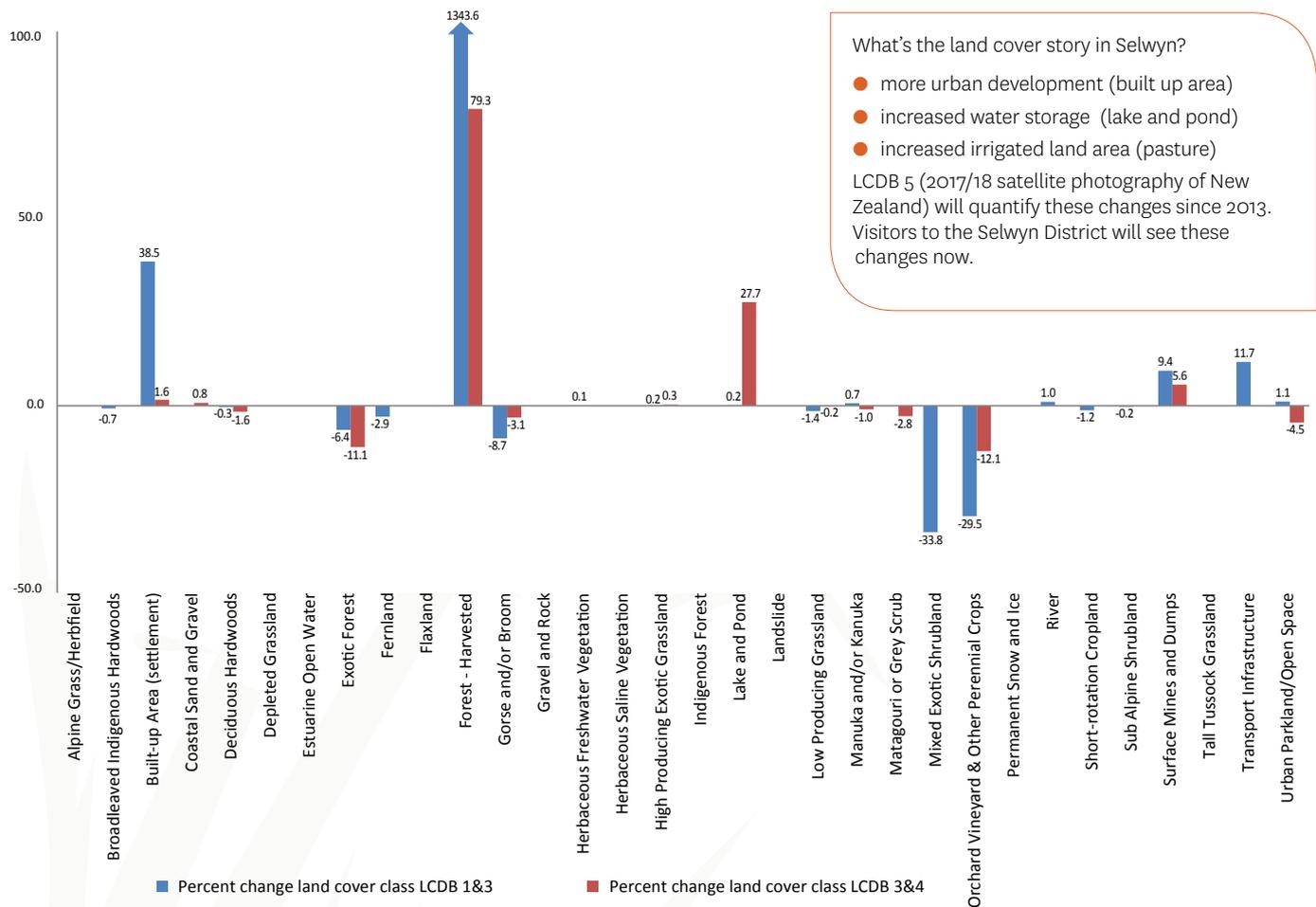


Figure 3.2: Percent change for each land cover class between LCDB1 (1996/97) and LCDB3 (2007/08) – blue bars; and, between LCDB3 and LCDB4 (2012/13) – red bars. No blue or red bar showing means 0.0% change

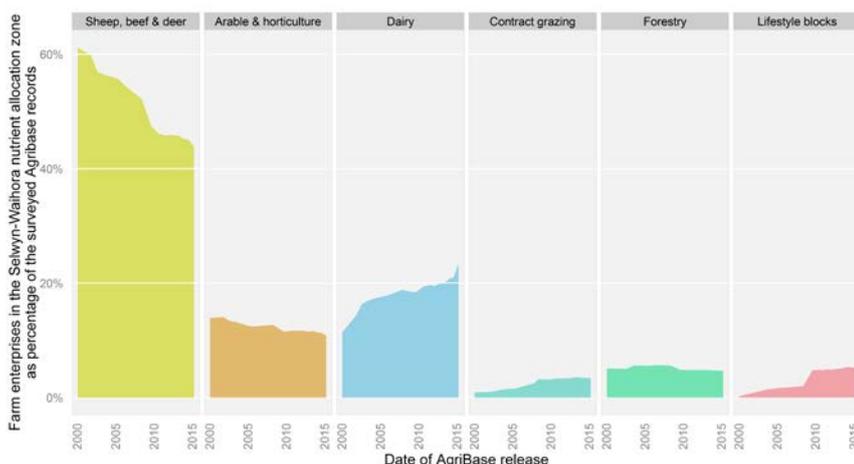
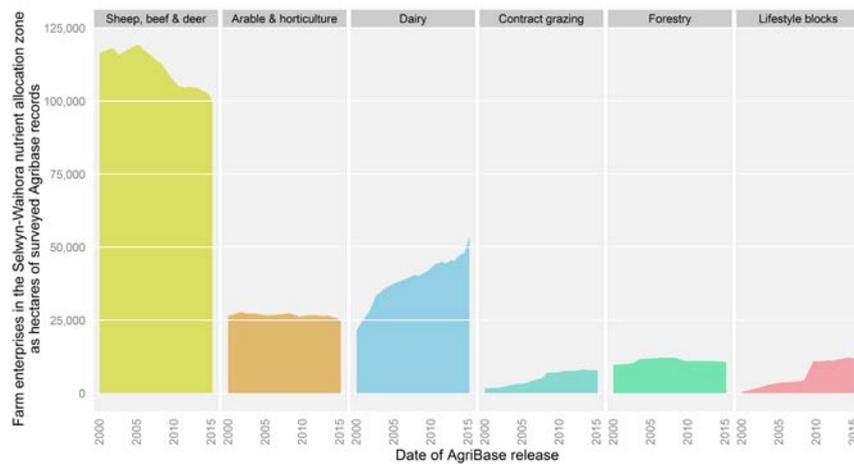


Figure 3.3: Land use change from 2000 to 2015 in the Selwyn-Waihora Nutrient Allocation Zone
Source: AgriBase,ASUREQuality, 2000-2015. Environment Canterbury 2015

Pressures: Land use

Figure 3.3 reports rural land use change for the Selwyn-Waihora Nutrient Allocation Zone from 2000 to 2015 for six major land use classes. The upper Figure 3.3 plot shows change in area (hectares) for the land use classes. The lower plot, shows change in percent. Data represent hectares or percent of AgriBase record for each land use class within the 180,200 ha Nutrient Allocation Zone. Figure 3.4 shows the Selwyn-Waihora Nutrient Allocation Zone (gold boundary) within the Selwyn-Waihora CWMS Zone. Refer to Figure 3.1 for CWMS Zone boundaries.

Over time, knowing the percent change in the total area for each major land use class in the Nutrient Allocation Zone provides us with information about the shifts in economic activity to which people put the land (refer Economy section). Knowing about these shifts helps us gauge if pressures on the lake from land use have increased or lessened.

For the Selwyn-Waihora Water Management Zone Table 3.1 shows a steady increase between 2003 and 2013 and between 2013 and 2015 in the percent change for dairy, contract grazing and lifestyle blocks. The proportion of total area used for dry stock, cropping (arable) and horticulture, and forestry, has decreased.

Figures 3.5a and 3.5b show changes in Irrigated area and irrigated consented volume respectively. This is calculated by summing estimated groundwater allocation on the face of issued resource consents. Actual water use will differ. Data should be treated as annual estimates to summarise change in irrigation area and allocated groundwater for the combined Selwyn-Waimakariri and Rakaia-Selwyn groundwater zones for the years reported.

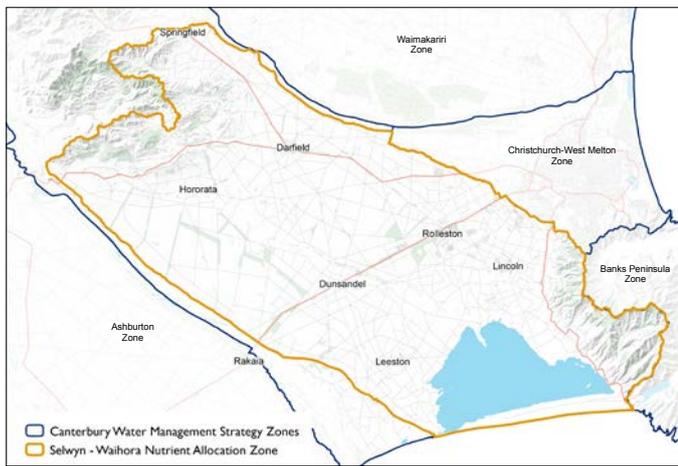


Figure 3.4: Selwyn-Waihora Nutrient Allocation Zone
Source: Environment Canterbury 2015

Table 3.1: Percent area of major land use classes in the Selwyn-Waihora Nutrient Allocation Zone, focusing on part of the zone that had AgriBase data available in 2003, 2013 and 2015

Source: AgriBase, AsureQuality, 2003-2015. Environment Canterbury 2015

Land use class	2003	2013	2015
Dry stock	58%	51%	49%
Dairy	18%	22%	25%
Cropping & horticulture	13%	13%	11%
Forestry	5%	4%	4%
Contract grazing	1%	4%	4%
Lifestyle blocks	1%	3%	3%

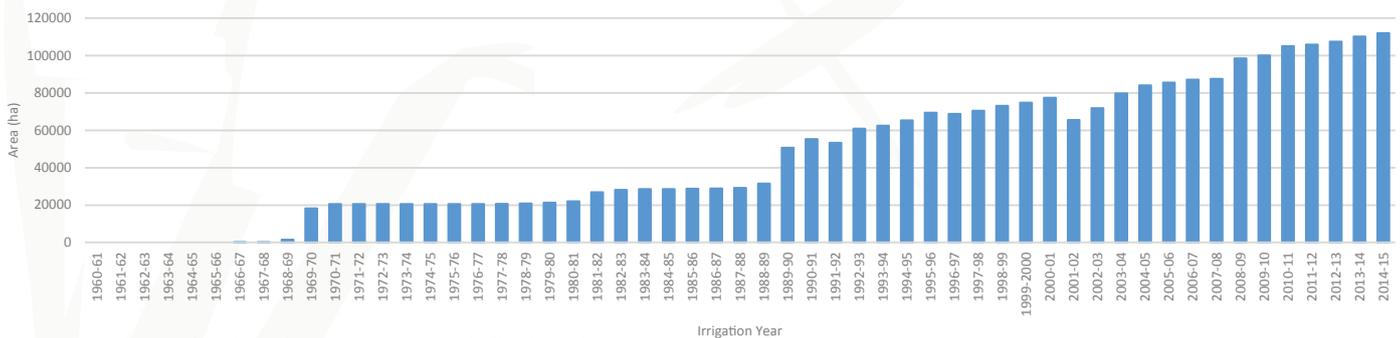


Figure 3.5a: Changes in irrigated area 1960 to 2015 – indicative only
Source: Environment Canterbury 2015

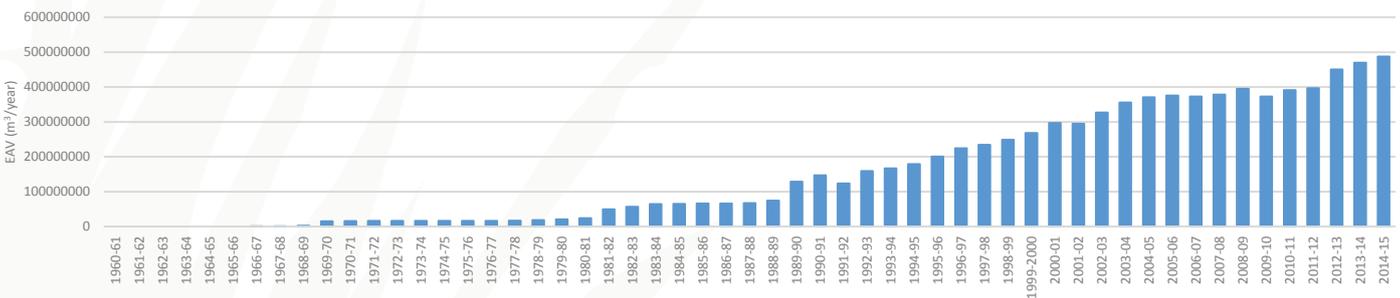


Figure 3.5b: Changes in irrigation consented volume 1960 to 2015 – indicative only
Source: Environment Canterbury 2015

Response

Farm Environment Plans (FEPs) are being used as a land and water management tool in the Selwyn-Waihora Water Management Zone to reduce land use pressures on the lake and to help improve water quality. FEPs include nutrient budgets for management of diffuse pollution. A FEP will address environmental pressures from farming and assure good management practice¹ is in place. Each FEP will be unique to each farm and reflect local climate, soils and land use, and the aspirations of each farmer. Industry groups such as Fonterra, DairyNZ, Beef and Lamb New Zealand, and the Foundation for Arable Research (FAR), have their

own FEP templates and are working with their clients, levy payers and shareholders to prepare plans. In 2014, under Whakaora Te Waihora, Environment Canterbury staff co-ordinated FEP workshops in the lower Selwyn-Waihora Water Management Zone to introduce farmers to the FEP and get them started on drafting their plans. Rural consultants visited each farmer after the workshops to assist. In total, 53 FEPs were prepared in the lower zone through this initiative. FEPs will be audited from 2017 on. The performance target is an A or B rating in the audit – this is a grade of good practice. In the next State of the Lake report

¹ Good management practice is defined in the publication Industry Agreed Good Management Practices Relating to Water Quality was launched in May 2015 by the primary sectors

Canterbury Region Dairy Report 2014-2015 Season shows less serious but more minor non-compliance

Environment Canterbury has reported less serious non-compliance with resource consent conditions in the 2014-15 dairy season than in the previous year, but higher rates of minor non-compliance.

In the Selwyn Waihora Zone, 68.25% of farms were compliant with all conditions of their resource consents. This is a significant increase in the level of compliance compared with 2013-14 (54%) and is above the regional average of 64%. All consents apart from one were monitored in the Selwyn-Waihora Zone. Results can be found in the Canterbury Region Dairy Report 2014-2015 Season.

Compliance monitoring site inspections identified several common issues

- exceedance of application depth and/or ponding of dairy effluent were among the most common reasons for non-compliance, although the levels of these non-compliances were lower than in previous seasons. Other main non-compliances related to storage ponds. There was only one instance of a direct discharge to water. Where there was significant non-compliance or enforcement action, follow-up site inspections were conducted.

Environment Canterbury resource management officers also recognised many good practices on dairy farms during their inspections.

Source: Environment Canterbury 2015

FEP audit results will provide one of our measures of success. FEPs are rapidly being put in place – a good response to date.

With Stage 1 of the CPW scheme in operation, all farms under this scheme have FEPs. CPW scheme farms have also shifted from using groundwater to stored surface water for irrigation. The influence this scheme has on the tributary streams feeding into Te Waihora and on the lake itself, together with FEP audit results, will provide useful response information for future state of the lake reporting.

Influence of lake level management in last 2 years

There are no quantitative data to report the influence of lake level management on land use and land cover. Anecdotally we know that stock fencing that extends into the lake bed is ineffective when lake levels are extremely low – stock can wander around the end of the fence and into the bed.

Lake margin farmers, particularly in the lower Huritini Halswell area, were affected by extensive flooding from extreme weather mid-2013. Data are not available to quantify any effects from this on-farm flooding on the lake.

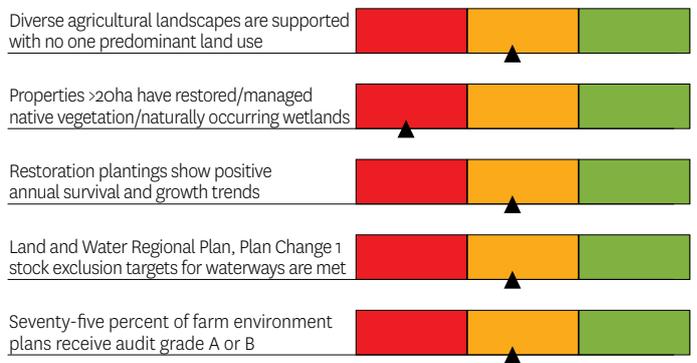
Summary

Land use and land cover data show further expansion of intensive land use in the Selwyn-Waihora Water Management Zone/Te Waihora catchment – rural and urban. Interpreting these data together with the driving forces behind this change (population, commodity prices, people's values for land), and the water quality results, provides context for summarising land use and land cover:

- Pressures on the lake from land use have increased
- Changes in land cover reflect the shifts in business enterprise from which these pressures arise.

Measures of success

In future, as FEP audit results become available together with quantitative data about riparian management and restoration projects, we can better report on response and what progress we are making towards the measures of success.



Recommendations

In 2013 the question was asked: Have we got the right information? This time the question is: Have we got enough of the right information? While more data is becoming available for reporting the suggested set of land indicators (refer *Te Waihora/Lake Ellesmere State of the Lake 2013*), the same challenge remains: the availability of timely, relevant, data critical to land and water management. It is recommended that, consistent with the draft integrated lake monitoring strategy, people and agencies involved in monitoring land indicator data continue to explore ways of sharing their data, including making better use of geographic information systems (GIS) and the web for state of the lake reporting.

References/ useful links

See www.wet.org.nz for more information about references and data used here.

Hughey, K.F.D., Johnston, K.A., Lomax, A.J., and Taylor, K. J. W. (eds). 2013. *Te Waihora/ Lake Ellesmere: State of the Lake 2013*. Technical Report No. 1, Waihora Ellesmere trust, Christchurch. New Zealand.

See http://www.stats.govt.nz/browse_for_stats/environment/environmental-reporting-series/environmental-indicators/Home/Land/land-cover.aspx for national environmental reporting of land cover including for the Canterbury region via an interactive map.

Great effort by Fonterra Suppliers in the Selwyn-Waihora catchment

Dairy farmers supplying Fonterra milk have achieved almost 100% compliance fencing their stock out of defined permanent waterways on their farms.

A defined waterway is one that permanently contains water and is greater than 1metre in width and deeper than 30cm at any point at any time of year. Fonterra's minimum standard for stock exclusion is a permanent fence, ie no standards or fences on reels. Data from Fonterra (Table 3.2) report the change in farmer effort and compliance from mid-2013.



Table 3.2: Fonterra suppliers and defined waterways stock exclusion in the Selwyn-Waihora

Source: Fonterra Ltd. 2015

Key: DWW: defined waterways; FDSE: Fonterra defined stock exclusion; NFDSE: Non Fonterra defined stock exclusion

	Jul 2013	Jan 2014	Jul 2014	Jan 2015	Sep 2015
DWW Stock Excluded (km)	225	278	307	325	323
DWW NOT Stock Excluded (km)	28	13	3	2	1
Total DWW (km)	253	292	310	327	323
% FDSE	89%	95.4%	99.0%	99.5%	99.8%
Non-DWW Stock Excluded (km)	242	238	233	234	225
Non-DWW NOT Stock Excluded (km)	53	60	52	56	54
Total Non-DWW (km)	296	299	286	290	279
% NFDSE	81.9%	79.8%	81.6%	80.6%	80.6%
Total DWW's (km)	549	591	596	617	602
Crossings Compliant (number)	129	199	267	307	291
Crossings Non-Compliant (number)	0	1	1	0	0
% Compliant Crossings	100%	99.5%	99.6%	100%	100.0%
Number of Verified Farms	64	118	144	152	152

More information

Additional information and links are available from the WET website.

For background, context and information about values associated with Te Waihora/Lake Ellesmere please see other sections of the 2015 State of the Lake Report www.wet.org.nz/projects/2015-state-of-the-lake/



Section 4 Water

Te Waihora/Lake Ellesmere – State of the Lake 2015

Lead authors: Kimberley Robinson, Tim Davie - Environment Canterbury

How will we know when we have achieved success?

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

Context

Te Waihora/Lake Ellesmere is a large lowland lake located near the Canterbury coast, and is of cultural, ecological, recreational and economic (commercial fishing) importance. The water quantity, quality and ecology of the lake and tributaries are enormously important for the maintenance of these values.

The lake is predominately fed by surface water inflows, rainfall on the lake, and seawater intrusion. Most water moving through the lake is lost via outflows to the coast and evapotranspiration (Renwick et al. 2010). A large proportion of tributary streams in the catchment are sourced from upwelling groundwater, which heavily influences the water quality and quantity of these spring-fed streams. Therefore, the water quality and quantity of Te Waihora/Lake Ellesmere is not only influenced by water bodies in the immediate vicinity of the lake, but also the wider catchment and includes both the surface and groundwater environments.

Te Waihora/Lake Ellesmere is intermittently open to the coastal environment at the southern end of Kaitorete Spit, near Taumutu.

State: Rainfall and lake levels

Rainfall during the past two years has been close to average (Figures 4.1 and 4.2). The most notable periods were a wet late summer and autumn in 2014 and a dry spring and summer in 2014-15.

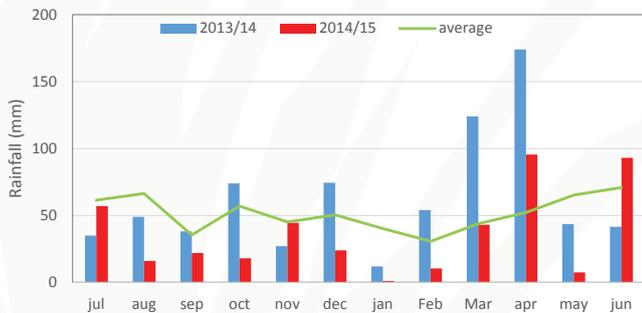


Figure 4.1: Monthly total and 10 year average rainfall at Tai Tapu (Environment Canterbury Ryans Bridge Recorder)

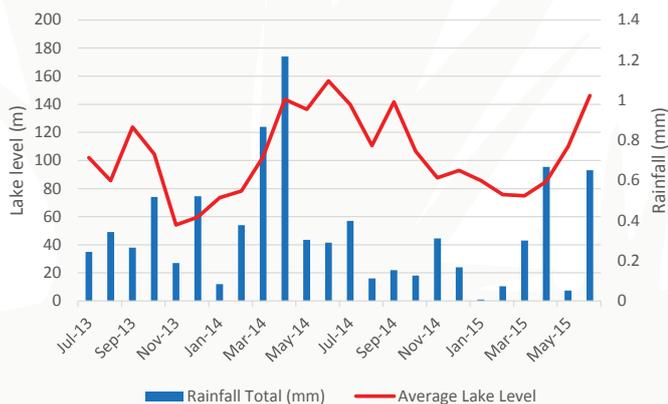


Figure 4.2: Average monthly lake level and monthly total rainfall (Tai Tapu) from July 2013-June 2015

State: Water quality and ecosystem health

The state of surface water quality and ecosystem health is monitored for Te Waihora/Lake Ellesmere and tributary streams, and the groundwater environment. Selected tributary streams are monitored for water quality, aquatic ecosystem health and recreational water quality, while the lake is routinely monitored monthly at 5 sites for water quality and potentially toxic cyanobacteria, and an additional site for recreational water quality during the summer (Figure 4.3). Groundwater monitoring is carried out annually for approximately 40 wells in the Te Waihora/Lake Ellesmere catchment. While groundwater inflow is not directly a major contributor to the water balance of the lake, the majority of tributary streams within the catchment are predominately sourced from upwelling groundwater and heavily influenced by the quality of this source.

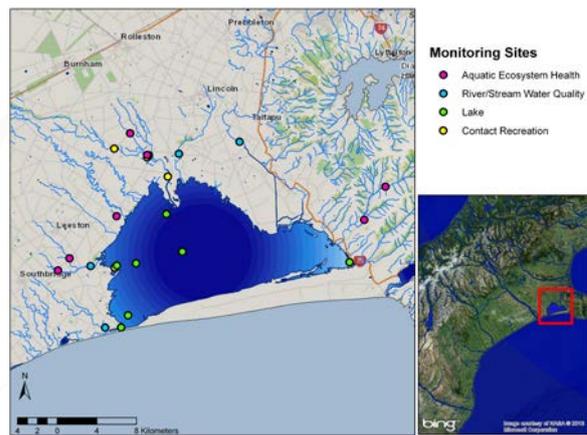


Figure 4.3: Regular surface water quality monitoring sites for Te Waihora/Lake Ellesmere and tributary streams

Lake trophic status

The state of water quality for Te Waihora/Lake Ellesmere is described by the trophic level index (TLI), an indicator of enrichment based on raw water quality measurements of nutrients, algae and water clarity. The overall TLI score is categorised into seven different trophic states designed to describe the condition of the lake. The TLI increases as the result of an increase in nutrient concentrations and algae, and a decrease in water clarity.

Te Waihora/Lake Ellesmere has generally been in a hypertrophic state for the duration of sampling (approximately 20 years). Since the dip in trophic status in 2013, the lake has steadily increased in hypertrophic state. Te Waihora/Lake Ellesmere has returned to a trophic state similar to pre-2010 when the lake was identified as having the highest TLI in New Zealand (Verburg et al. 2010) (Figure 4.4).

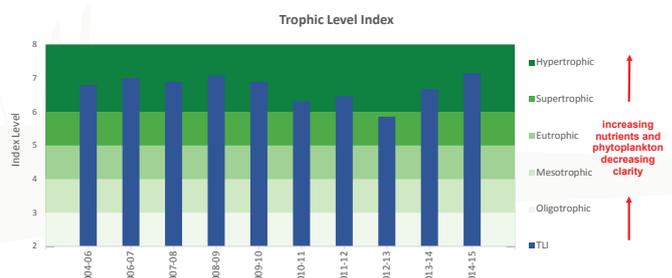


Figure 4.4: Trophic level index for Te Waihora/Lake Ellesmere

Water Quality of Tributary Streams

The water quality of tributary streams (Table 4.1) is measured monthly for the Te Waihora/Lake Ellesmere catchment. Water quality measurements such as nutrients, water clarity and faecal indicator bacteria (*Escherichia coli*) are summarised into an annual water quality index used to describe the overall condition of a site.

Streams within the Te Waihora/Lake Ellesmere catchment are generally of poor-fair water quality. Drivers of such water quality include nutrient enrichment and elevated faecal indicator bacteria. Streams are generally clear, however water clarity is often reduced following heavy rainfall. The number of streams considered to be of 'poor' water quality increased slightly in 2013-14. However a return from poor to fair for Waikewai Creek in 2014-15 saw the overall number of poorly graded streams return to the same as 2012-13 (Table 4.1; Figure 4.5).

Table 4.1: Water quality of tributary streams

Site	2010-11	2011-12	2012-13	2013-14	2014-15
	Grade	Grade	Grade	Grade	Grade
Halswell River McCartney's Bridge Site No:SQ32872	Poor	Poor	Poor	Poor	Poor
Harts Ck at Lower Lake Rd Site No:SQ30992	Poor	Poor	Poor	Poor	Poor
LII Stm at Pannetts Rd bge Site No:SQ30878	Fair	Fair	Poor	Poor	Poor
Selwyn R at Coes Ford Site No:SQ30916	Poor	Poor	Poor	Poor	Poor
Boggy Creek Lake Road	Poor	Poor	Poor	Poor	Poor
Doyleston Drain Lake Rd	Poor	Poor	Poor	Poor	Poor
Waikewai Creek Gullivers Rd - Beside Hall Site No:SQ34540	Fair	Fair	Fair	Poor	Fair
Kaituna Stm at recorder Site No:SQ30782	Poor	Fair	Fair	Fair	Fair

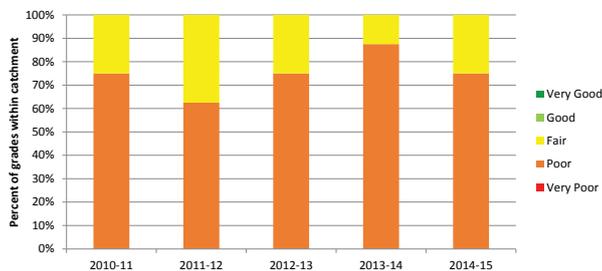


Figure 4.5: Percentage of water quality index grades for streams within Te Waihora/Lake Ellesmere catchment

Aquatic Ecosystem Health of Tributary Streams

Aquatic ecosystem health is monitored annually for selected tributary streams via the collection of invertebrate species and a habitat assessment. Invertebrate taxa are good indicators of water quality as they live in the stream year round and respond to changes in water quality and habitat such as increases in sedimentation or algae/plants.

Table 4.2: Invertebrate and habitat grades of tributary streams

	2008		2009		2010		2011		2012		2013		2014	
	Invertebrate	Habitat	Invertebrate	Habitat	Invertebrate	Habitat	Invertebrate	Habitat	Invertebrate	Habitat	Invertebrate	Habitat	Invertebrate	Habitat
Birdlings Brook	Poor	Good	Good	Good	Fair	Good	Poor	Good	Very Good	Fair	Very Poor	Very Poor	Fair	Poor
Hammer Road Drain	Very Poor	Fair	Very Poor	Poor	Very Poor	Good	Very Poor	Poor	Very Poor	Poor	Very Poor	Very Poor	Poor	Poor
Harts Creek			Fair	Fair	Poor	Good	Very Good	Good	Very Poor	Very Poor	Poor	Poor	Very Poor	Poor
Prices Stm-upper	Very Poor	Poor	Very Poor	Poor	Very Poor	Poor	Very Good	Good	Fair	Good	Good	Good	Poor	Poor
Prices Stm-lower	Very Poor	Poor	Very Poor	Fair	Very Poor	Poor	Very Poor	Poor	Very Poor	Poor	Very Poor	Very Poor	Very Poor	Poor
Boggy Creek	Very Poor	Poor	Very Poor	Poor	Very Poor	Good	Very Poor	Good	Poor	Fair	Poor	Poor	Fair	Fair
Kaituna Stream	Poor	Poor	Very Poor	Poor	Very Poor	Poor	Very Poor	Poor	Very Poor	Poor	Very Poor	Very Poor	Very Poor	Poor
Selwyn River	Very Poor	Good	Very Good	Very Good	Good	Good	Very Good	Good	Very Good	Good	Very Good	Very Good	Very Good	Good
Silverstream	Very Poor	Good	Very Good	Good	Poor	Good	Very Good	Good	Good	Poor	Very Good	Very Good	Very Good	Poor
Kaituna Stm-upper	Very Good	Very Good	Good	Good	Very Poor	Good	Very Good	Good	Good	Good	Good	Good	Very Good	Very Good

Invertebrate grades are variable throughout the Te Waihora/Lake Ellesmere catchment with 40-50% of sites graded fair or better for the past four years (Table 4.2: figure 4.6). Over time the number of sites with poor or very poor grades has declined. However, there has been an increase in sites with a poor or very poor habitat grade in recent years indicating that some stream habitats are becoming more degraded (Table 4.2; Figure 4.7). Habitat degradation has the potential to influence the structure of stream life and aquatic communities.

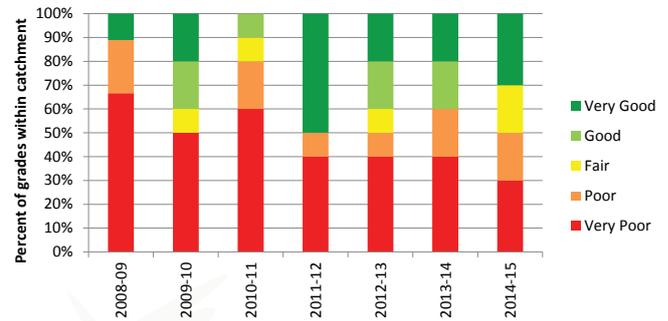


Figure 4.6: Percentage of invertebrate grades for streams within Te Waihora/Lake Ellesmere catchment

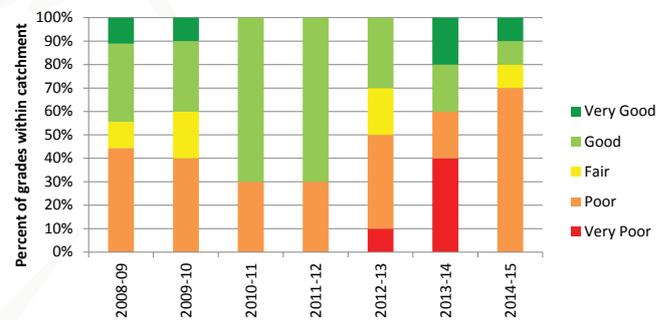


Figure 4.7: Percentage of habitat grades for streams within Te Waihora/Lake Ellesmere catchment

Recreational Water Quality

Recreational water quality monitoring is carried out weekly during the summer months for both Te Waihora/Lake Ellesmere and Waikirikiri/Selwyn River. A 'suitability for recreation' grade for each site is derived from faecal indicator bacteria (*E. coli*) measurements and a qualitative risk based assessment (Sanitary inspection category). This grade is used to describe the overall condition of the site in terms of suitability for recreation. Sites graded 'poor' and 'very poor' are generally considered unsuitable for recreation. In recent years, the recreational water quality site for Te Waihora/Lake Ellesmere at Lakeside Domain has been graded poor, with an increased risk of becoming ill from water based recreational activities that result in full immersion. Therefore this site is no longer considered suitable for recreational purposes. Recreational water quality has been consistently poor or very poor for the lower Waikirikiri/Selwyn River over the duration of monitoring (Table 4.3). Previous studies have identified a spring-fed tributary which flows into Waikirikiri/Selwyn River immediately upstream of Coes Ford site as a likely source of faecal contamination, resulting in the decline of grade from good at Chamberlains Ford, to poor downstream at Coes Ford (Robinson, 2013). Lateral drains that feed into the tributary stream early

Table 4.3: Suitability for recreation grades for Te Waihora/Lake Ellesmere and Waikiriki/Selwyn River

	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Te Waihora - Lakeside Domain	Poor	Fair	Fair	Fair	Fair	Good	Good	Good	Good	Fair	Poor	Poor
Waikiriki/Selwyn River - Chamberlains Ford	Good	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good	Good
Waikiriki/Selwyn River - Coes Ford	Poor*	Fair	Poor	Very poor	Very Poor	Very Poor	Very Poor	Poor	Poor	Poor	Poor	Poor
Waikiriki/Selwyn River - Upper Huts	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Very Poor	Very Poor	Very Poor	Very Poor	Very Poor

in the season are likely pathways for faecal contamination, and hence *E. coli* concentrations for Waikiriki/Selwyn River at Coes Ford are generally greatest early in the summer (November-December), and that location may be more suitable for recreational activities later in the summer (late December-February).

Potentially Toxic Cyanobacteria

The presence of potentially toxic cyanobacteria in the lake is a public health risk for both recreational activities and cultural practices such as mahinga kai gathering. Cyanobacteria may be toxic to dogs and livestock due to the production of cyanotoxins. Previously, scum forming species such as *Anabaena* and *Nodularia* have been the dominant potentially toxic cyanobacteria species for Te Waihora/Lake Ellesmere. These species tend to bloom over the warmer summer months, and die off over winter. Since early 2014, the lake has been dominated by the potentially toxic picocyanobacteria. This bloom has prevailed in the lake year round and the public health warning for this bloom remains current. The picocyanobacteria bloom followed a sustained period where concentrations of potentially toxic cyanobacteria were below the recommended threshold of 1.8 mm³/L, and therefore were not considered a public health risk (Figure 4.8). During 2013 the lake was open to the sea for two prolonged periods of time, and the increasingly saline environment may not have been favourable for elevated concentrations of potentially toxic cyanobacteria.

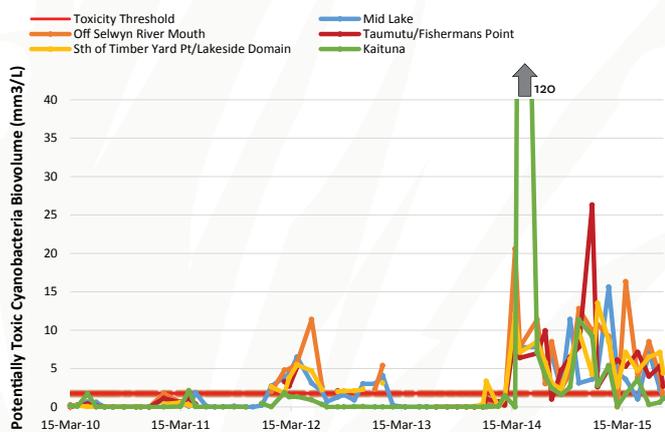


Figure 4.8: Potentially toxic cyanobacteria biovolumes for selected sites in Te Waihora/Lake Ellesmere

Groundwater quality

Groundwater quality has the potential to heavily influence the water quality and quantity of tributary streams that have a strong groundwater link, and subsequently influences the lake water quality. Groundwater is used extensively in the Te Waihora catchment for drinking and, from time to time, faecal indicator bacteria and nitrate concentrations exceed drinking water standards in groundwater. Results from the spring 2014 groundwater quality survey showed one well out of 40 where *E. coli* bacteria were detected, and therefore exceeded the national drinking water standard (MOH, 2008). In 2013 there were 2 wells which exceeded this standard but in 2012 there were none. The majority (80%) of the monitoring wells are less than 50 m deep.

Nitrate nitrogen concentrations near the lake are close to natural background levels (less than 2.8 mg/L). Further up towards State Highway One the concentrations are higher. These nitrate concentrations have the potential to influence the nitrate concentrations in nearby spring-fed streams that flow into Te Waihora/Lake Ellesmere. Samples from three monitoring wells exceeded the Maximum Allowable Value of 11.3 mg/L nitrate nitrogen for drinking water in the 2014 survey (Figure 4.9).

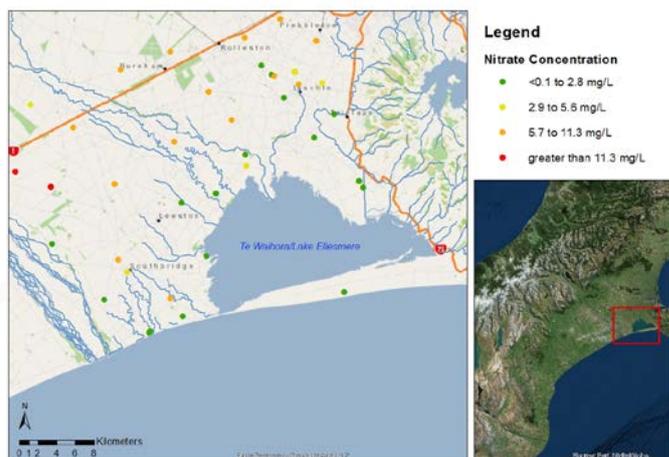


Figure 4.9: Nitrate-nitrogen concentrations recorded in groundwater during 2014

2014 was the first time in several years that groundwater was sampled for Dissolved Reactive Phosphorus (DRP) in the survey. Phosphorus concentrations showed an inverse pattern to nitrate nitrogen with higher DRP concentrations near the lake and lower DRP concentrations further up the plains. Rock and soil types near the lake are likely influencing the availability and mobility of phosphorus in the groundwater (Figure 4.10).

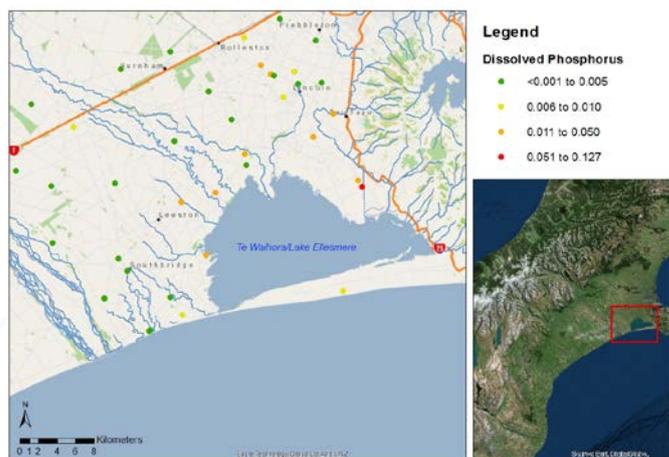


Figure 4.10: Dissolved reactive phosphorus concentrations recorded in groundwater during 2014

State: Water quantity

In the *Te Waihora/Lake Ellesmere State of the Lake 2013* the modelled mean annual low flows (7 day) and the current minimum flows (irrigation restrictions) were presented. Flows are monitored at a number of locations. There have been no significant changes in flows in the last two years.



Pressures

Te Waihora/Lake Ellesmere continues to be under considerable pressure from surrounding land use such as agricultural intensification and increasing water usage. Poor water quality, sediment inputs and a decline in stream habitat for a large proportion of tributary streams are potential pressures influencing aquatic communities, and contributing towards further pressure on the lake. Sediment and nutrient loads from tributary streams to the lake have the potential to contribute to the turbid nature of the lake via sediment suspension, and the support of algal production by nutrient enrichment.

Responses

- Proposed Plan Change 1 (Selwyn-Waihora sub regional plan) is the first step in long-term nutrient reductions and includes:
 - o A cultural zone around the lake with tight restrictions on agricultural activities
 - o Elsewhere in the catchment improvement in agriculture to beyond 'good management practice'¹ is expected.
 - o Tighter stock exclusion rules for the lake and waterways, including drains
 - o Specific minimum flow and restriction regimes for tributary rivers and streams
- Whakaora Te Waihora, Living Water and other habitat improvement initiatives aiming to contribute to better ecosystem health through active restoration work
- Trials on re-establishing macrophytes in the lake to reduce bank erosion (and sediment input) and improve general water clarity
- Work has been done to identify the amount of wetland that would be required in the catchment to significantly decrease nitrogen inputs into the lake.
- Targeted stream augmentation, to increase low flows in selected waterways without increasing adverse effects such as flooding. A successful experiment to augment Boggy Creek using deep groundwater has been undertaken and another is underway to augment the upper Irwell system with currently consented Rakaia stockwater. A report on the Boggy Creek experiment is available from the Selwyn-Waihora Zone Committee website.

Influence of Lake level management in last 2 years

Management of the lake level in the last 2 years is unlikely to have had a major influence on water quality, but would rather aid the migration of aquatic species which play a major role in the aquatic lake environment. Intermittent openings of the lake to the sea alter the water chemistry of the lake and lead to an increase in salinity as seen in 2013, when the lake was opened to the sea for prolonged periods of time. A reduction in nutrients and algal biomass for the outer lake sites resulted in an improvement in trophic status from hypertrophic to supertrophic, and the water was visibly clearer. However, prolonged periods of lake opening do not necessarily mean 'better' water quality as the lake shifts towards a more saline environment. This has the potential to change the ecosystem dynamics in the lake which some freshwater species may no longer tolerate due to the increasingly saline environment. For example, an increase in salinity may be detrimental to the re-establishment of some macrophyte/plant species in the lake bed.

Kaituna water quality and cultural monitoring

Since late 2014 Kaituna Valley landowners have partnered with rūnanga representatives to undertake a monthly water quality and cultural monitoring programme. Observations are recorded and samples of water are collected at a number of locations and tested for nitrogen,



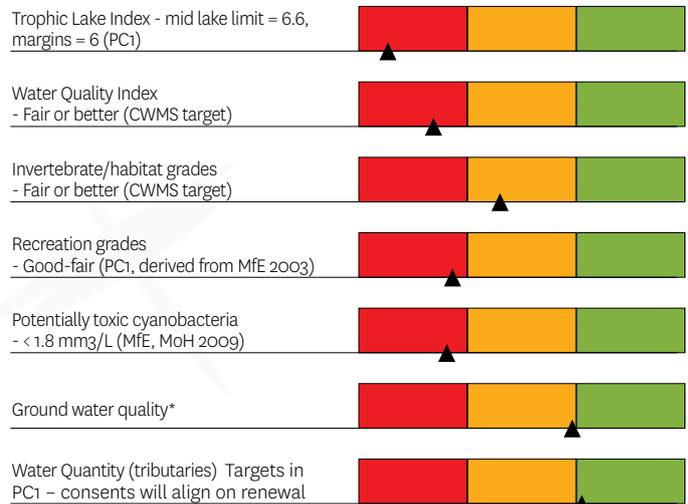
phosphorus, suspended sediment and faecal coliforms.

The catchment of the Kaituna River is just over 4000 ha in size and located on the fringe of Banks Peninsula. The Kaituna is one of the largest tributaries of Te Waihora/Lake Ellesmere.

Summary

The state of the lake remains in a hypertrophic state typical of nutrient saturation, elevated algal biomass and decreased water clarity. Water quality and aquatic ecosystem health indicators suggest room for improvement in tributary streams with a high proportion of stream sites graded poor for both water quality and invertebrate communities.

While the overall water quality of the lake (measured by TLI), and cyanobacteria concentrations improved following a prolonged period of lake opening in summer 2012/2013, the intrusion of saltwater for a lengthy duration is not necessarily a good outcome. Over the last 2 years there has been a slight decline overall in the water quality of the lake and environs. The traffic light bars below summarise monitoring results.



*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

Recommendations

The recent addition of permanent monitoring stations within the lake, providing real time information on water quality, offers exciting possibilities for more people to engage with lake management. It is recommended that ways are explored to maximise the impact of this information through visual interpretation that speaks directly to the many communities of interest in lake management. It is also recommended, consistent with the integrated lake monitoring strategy, that other parties (e.g., universities, local community) get involved in additional monitoring of the lake and this information is stored in a central repository/data base.

References/data sources

See www.wet.org.nz for information about the references and data sources used here.

¹ The publication Industry Agreed Good Management Practices Relating to Water Quality was launched in May 2015 by the primary sectors

More information

Additional information and links are available from the WET website.

For background, context and information about values associated with Te Waihora/Lake Ellesmere please see other sections of the 2015 State of the Lake Report www.wet.org.nz/projects/2015-state-of-the-lake/



Section 5 Vegetation

Te Waihora/Lake Ellesmere – State of the Lake 2015

Lead authors: Philip Grove, Jodi Rees - Environment Canterbury

How will we know when we have achieved success?

Significant indigenous vegetation of the lake margin, wetlands and tributary streams is protected and restored

Context

Monitoring of indigenous vegetation around the margin of Te Waihora/ Lake Ellesmere is completed through periodic survey. Reporting on trends in lake shore vegetation using survey data can only be done when there are consecutive surveys to yield ecologically meaningful results. Data from two surveys, 1983 and 2007, were analysed and trends reported in the State of the Lake 2013. It is planned to repeat the 2007 survey 10 years on for the same area surveyed in 2007. All survey data have been entered into a spatial database to enable ongoing analysis of trends in vegetation cover and wetland habitats around the lake shore. Data collected in summer 2017 will be entered into the database and enable reporting again on trends in lake shore vegetation. Results of the 2017 survey can then be used to report on progress towards the outcome of protecting and restoring significant indigenous vegetation of the lake margin. Table 5.1 summarises completed surveys of indigenous vegetation around the margin of Te Waihora/ Lake Ellesmere.

Table 5.1: Completed surveys of vegetation around the margin of Te Waihora/Lake Ellesmere

Date of survey	Area surveyed/ mapped	Data collected	Results published	Source
1983	4,400 ha lake margin	Extent, location and types of indigenous vegetation present	1984	Clark and Partridge
2007	4,400 ha lake margin +1,000 ha adjoining	Extent, location and types of indigenous vegetation present	2008 2013	State of the Lake 2008 State of the Lake 2013

There is no equivalent baseline information on the location and extent of indigenous vegetation and wetland habitats of tributary streams or catchments beyond the immediate lake shore. However, mapping of indigenous vegetation restoration projects for the lake catchment, including the lake margin and tributaries was initiated in 2013.

Weed surveys are conducted to inform weed control programmes. Control programmes for willows and other weeds in lake shore wetlands have continued. Further environmental weed surveys of tributary catchments (Waikirikiri/Selwyn, Ararira/LII, and Huritini/Halswell) have been carried out.

The Department of Conservation, with support from the Whakaora Te Waihora programme, commissioned an ecological assessment of its lake shore reserve lands around Greenpark in 2014. The resulting report summarises the impacts of grazing, weeds and vehicles on the lake shore between the Ararira/LII and Huritini/Halswell Rivers (see Pressures below).

State

State and trends of lake shore vegetation can be reported following the summer 2017 survey.

Pressures

Information regarding pressures, i.e., weeds, stock grazing and vehicles, on lake shore vegetation is summarised below.

Weeds

Exotic willows and other weeds pose a serious threat to the indigenous biodiversity of the lake margin. DOC, with support from the Te Waihora Regional Flagship programme and Environment Canterbury has continued to carry out willow control at selected sites around the lake margin. Environment Canterbury has carried out additional willow control work on private land.

Reed canary grass (*Phalaris arundinacea*), a North American species that is highly invasive of freshwater and slightly saline wetland habitats, is well established and widespread in northern and north-western tributaries of Te Waihora/Lake Ellesmere. It was highlighted as a concern in the State of the Lake 2013. In 2013 Environment Canterbury initiated an investigation into the feasibility of eradicating reed canary grass from Te Waihora/Lake Ellesmere catchment. As part of this investigation surveys were conducted to better understand its extent within catchment tributaries (Jensen 2014, von Tippelskirch 2015). Results of these surveys showed that reed canary grass was widespread and abundant in the lower Waikirikiri/Selwyn-Silverstream catchment and locally abundant along the lower Huritini/Halswell Canal. A number of small, scattered infestations were also detected along the lower reaches of the Arariri/LII River, in addition to those already recorded from the lake shore.

It was concluded that eradication of reed canary grass from the wider catchment would not be possible, at least for the present. Instead the current control strategy is focused on removing scattered/outlying infestation sites on the lake shore and lower Ararira/LII, and prevention of spread into vulnerable lake shore wetland habitats. Beyond these defined areas, the goal is containment rather than eradication (von Tippelskirch 2014).

Protecting mahinga kai areas should be seen as an important driver for the control of reed canary grass in the Te Waihora/Lake Ellesmere catchment. Reed canary grass infestations were reported as unsuitable for inanga spawning (Taylor 2002, Taylor and Marshall 2013). Further spread of reed canary grass could be minimised by universal adoption of cleaning-down procedures for heavy machinery moving between sites (von Tippelskirch 2014).

In controlling outlier populations of reed canary grass, other priority weed species could be controlled at the same time for efficiency (e.g., yellow flag *Iris pseudacorus*, purple loosestrife *Lythrum salicaria* and beggars' tick *Bidens frondosa*) (von Tippelskirch 2014).

The lower section of the Huritini/Halswell River was surveyed for key wetland environmental weed species in early 2014. The survey covered the main river, contributing drains and the old course of the river. Its purpose was to establish weed species presence and distribution, and determine if control should be undertaken. Priorities for control were determined by considering possible impact on Te Waihora lake margins, their ability to spread and feasibility to control or eliminate the weed.

The highest priority weeds for control include: reed canary grass, grey willow (*Salix cinerea*), yellow flag, green goddess (*Zantedeschia aethiopica* 'green goddess'), purple loosestrife and beggars' tick. These weeds are mostly confined to the main river, are of scattered occurrence and are relatively easily eliminated.



Purple loosestrife

Stock grazing and vehicles

Department of Conservation reserve land on the eastern lake shore between the Ararira/LII and Huritini/Halswell confluences was surveyed and a report produced to assess the impact of stock grazing and vehicles on ecological values (Jensen 2014). The Greenpark Sands Conservation Area is an extensive saltmarsh that is also internationally significant bird habitat. However, parts of the Greenpark Sands Conservation Area are still leased for grazing, while lake shore saltmarsh in this area has, in places, been heavily damaged by duck hunters' vehicles. The report recommended that grazing be removed from conservation land as it is detrimental to saltmarsh ecology. It also recommended that vehicle use be restricted.

Responses

Generally, good progress has been made with willow and reed canary grass control on some parts of the lake shore. Willows have continued to spread in other areas, such as Harts Creek. Responses to pressures on lake margin vegetation can be summarised as follows:

- scattered/outlying willow infestations at Selwyn Huts, Greenpark Sands, lower Ararira/LII and Kaitorete Spit lake shore have been controlled
- larger willow infestations at Boggy Creek, Yarrs Flat, Ward-Williams and Lakeside reserves have been removed to protect valuable native lake shore wetland vegetation in these areas
- scattered lake shore and lower Ararira/LII infestations of reed canary grass have been controlled over successive years
- an infestation of another wetland weed, *Carex pendula*, has been controlled at Boggy Creek

Influence of Lake level management in last 2 years

As noted in the State of the Lake 2013, and Section 2a of this report, there were several episodes of unusually prolonged lake opening periods in 2012-2013, as well as a period of unusually high lake levels and associated flooding in June 2013. When the lake remains open for long periods (more than a month), especially in summer, this has detrimental effects on lake shore plant communities:

- high salinity levels created by evaporation of ponded water on flat areas cause extreme stress to most plant species
- salt stress can also be detrimental to submerged/aquatic vegetation, especially during the seedling development phase. Low lake levels expose aquatic plants to desiccation
- lake margin wetland plant communities dry out and become vulnerable to invasion by exotic dryland species (Philippe Gerbeaux pers. comm. October 2015)

Observations suggest that prolonged openings and low lake levels over recent summers have had localised detrimental effects on lake shore vegetation. The planned 2017 survey will show whether lake shore vegetation has recovered. For lake margin vegetation, lake openings during summer months should be avoided as much as possible.

Summary

While recent weed control has protected/maintained some areas of freshwater wetland habitat e.g., Ward Williams Wildlife Management Reserve, other areas, e.g., raupō at Harts Creek are still being lost to willow spread. Similarly, for saltmarsh, there are improvements in some areas but loss/damage from vehicles and ongoing stock grazing at Greenpark Sands, plus some localised loss/damage following protracted low summer lake levels.

There are no comprehensive data available for threatened or at-risk plant species but recent willow control along Department of Conservation lake shore between Lake Road South and Ward Williams Reserve has been beneficial for swamp nettle *Urtica linearifolia*, which is classified as 'at-risk'.

There have been benefits from control of scattered lake shore reed canary grass infestations.

Willow control is showing progress in some areas where control is undertaken but willow is continuing to spread in other areas.

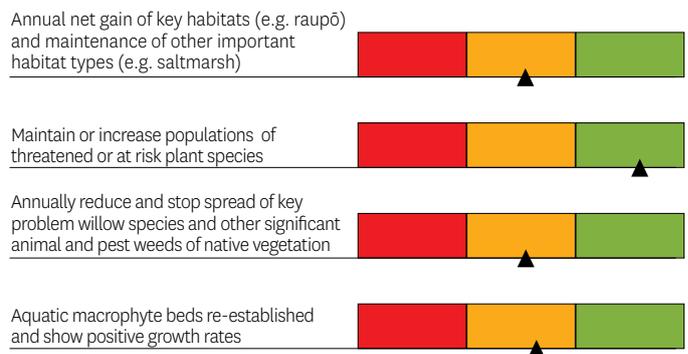
An aquatic plant restoration trial is currently underway as part of the Whakaora Te Waihora programme (see below).

More information

Additional information and links are available from the WET website.

For background, context and information about values associated with Te Waihora/Lake Ellesmere please see other sections of the 2015 State of the Lake Report www.wet.org.nz/projects/2015-state-of-the-lake/

Measures of success for lake margin vegetation can be summarised as:



Recommendations

Measures to address damage caused by vehicle access, and additional resourcing for weed control and lake margin land acquisition are recommended. Monitoring recommendations include:

- 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

References/useful links

See www.wet.org.nz for information about the references and data sources used here.

Re-establishing the macrophyte beds

NIWA scientists, with partners from the Waterways Centre for Freshwater Management, are undertaking trials to re-establish aquatic macrophytes (submerged leafy plants) in the lake. Historically, the macrophyte beds were found around much of the lake shore and provided food and shelter for lake life and buffered wave action, creating areas of clearer water around the lake edge. The beds were destroyed in the 'Wahine storm' in 1968.

Seeds and plants have been sourced from around the lake and a culture facility with 30 tanks has been established at Taumutu, with the local community looking after the plants. Around 2700 pots of plants are now growing in the tanks, although there have been some losses.

To give the plants the best chance, wave barriers will be installed at a trial lake site to reduce wave disturbance. Low lake levels at critical times have delayed the installation, which is now planned to start from late November 2015.

This research is being carried out as part of the Whakaora Te Waihora Joint Cultural and Ecological Restoration programme of work, which takes a long term approach to restoration of the health of the lake over at least two generations.





Section 6 Wildlife

Te Waihora/Lake Ellesmere – State of the Lake 2015

Lead authors: Kirsty Percasky, Anita Spencer - Department of Conservation,
Ken Hughey* - Lincoln University, Waihora Ellesmere Trust

How will we know when we have achieved success?

Indigenous wildlife and associated habitats are protected and biodiversity increased

Context

The wildlife of Te Waihora/Lake Ellesmere includes wetland birds, lizards, and terrestrial and aquatic invertebrates. While there is extensive knowledge about the birdlife of Te Waihora, the growing body of knowledge about lizards and invertebrates is more recent. What we know is reported in this section.

The wildlife of Kaitorete Spit (monitored lizards and terrestrial invertebrates) is reported also. Kaitorete Spit is part of the lake's environs.

Little new work on lake aquatic invertebrates has occurred in the last two years - no new material is reported (refer to the 2013 and 2008 state of the lake reports). While there is no active monitoring of lake

flies (*Chironomus zealandicus*), anecdotal observations are reported. Aquatic invertebrates monitored in lake tributary rivers and streams are reported in the Water section.

Birdlife

State

An annual February bird monitoring census is undertaken (and has been since 2013) to help determine the state of birdlife. Numbers recorded in the three surveys appear roughly similar (i.e., 55164 in 2014 and 47858 in 2015, compared to 55728 in 2013) but more surveys are required before detailed trend analysis can be undertaken. Trend data for nine indicator bird species, representing the main guilds present, are reported in Table 6.1. Of note is the apparent decline in grebe observations.

Table 6.1: Abundance of indicator bird species during February bird counts from 1985 – 2015

Key to agencies: NZWS: New Zealand Wildlife Service; OS: Ornithological Society of New Zealand; CCC: Christchurch City Council; WET et al.: Waihora Ellesmere Trust, Department of Conservation, OS, CCC and others

Year	1985	1986	1987	1988	1989	2006	2007	2008	2013	2014	2015
Agency	NZWS/ OS	NZWS/ OS	NZWS	NZWS/ OS	NZWS/ OS	OS/ CCC	OS/ CCC	OS/ CCC	WET et al.	WET et al.	WET et al.
Australasian Crested Grebe	0	0	0	0	0	5	11	6	9	3	1
Black Cormorant	129	121	191	150	233	223	254	89	396	615	339
Australasian Bittern	0	11	2	1	0	0	0	0	1	12 ¹	NA
Black Swan	2928	5694	12682	10385	5717	10006	10651	9011	8598	7473	5528
Australasian Shoveler	272	79	6075	541	263	3405	1946	1161	5173	5893	2070
Pied Stilt	1300	7362	2212	2067	2776	2937	2566	5776	3726	4959	4777
Wrybill	19	81	38	5	37	230	459	146	429	243	167
Red-necked Stint	200	137	71	0	99	26	63	18	34	44	31
Caspian Tern	15	29	18	18	15	63	38	96	405	386	113

¹ Note that bittern require specialised, targeted monitoring with 2014 being the first of a 5-year male bittern monitoring programme. Numbers prior to 2014 represent numbers seen overall on wetland bird census days. Data have yet to be collected for 2015.

Bittern - a nationally endangered species

In 2014 the Department of Conservation (DOC) applied for and received funding over 5 years from Environment Canterbury to monitor Australasian bittern at four sites around Te Waihora (and to set up and maintain predator control at a site at Harts Creek). Bittern monitoring is now undertaken using the DOC monitoring protocol for this species. The four sites being monitored are Harts Creek, and the river mouth areas of the Huritini/Halswell, Irwell and Ararira/LII rivers. Results are presented in Table 6.2.

Table 6.2: Estimated numbers of male bittern at key sites around Te Waihora/Lake Ellesmere in 2014

Location	Range in number of booming male birds	Maximum number
Harts Creek Wildlife Management Reserve	6-8	8
Irwell River Mouth	1-2	2
Ararira/LII Rivermouth	0	0
Huritini/Halswell Rivermouth	1-2	2
Total		12

Pressures (and known driving forces) on birdlife are diverse, namely:

- predation by introduced mammals (and some native birds, e.g., harrier hawk and black-backed gull)
- wetland habitat loss as a result of:
 - o land use intensification
 - o invasion by exotic species, e.g., willows – see Vegetation section
- the lake opening and closing regime, especially for some species, including Australasian crested grebe
- physical disturbance, mainly via recreational users, both around the lake and on Kaitorete Spit.

Most notable amongst the above pressures over the past few years has been spring opening of the lake to allow migratory fish to enter. This has rapidly lowered lake and river levels mid nesting season. As a result grebe nests, which are built on the water attached to submerged vegetation, fail.

Responses

- traplines (CCC) to protect royal spoonbill nesting areas and other bird species, including key areas of Kaitorete Spit. DOC also have a trapline along the seaward side of Kaitorete Spit
- traplines (DOC) along the Kaituna River to protect nesting Australasian crested grebe with traps maintained each spring/summer through the nesting period
- installation of trial nesting platforms for grebes (see overleaf)
- DOC trapping in the Harts Creek area to enhance bittern conservation (which will complement ongoing local voluntary effort in Tramway Reserve)

* Ken Hughey is Chief Science Advisor for the Department of Conservation but is contributing here in his Lincoln University and Waihora Ellesmere Trust roles.

Lizards

Four species of lizard are found around the lake environs, three of which are of conservation concern and have New Zealand threatened species rankings (Hitchmough et al., 2013):

- Central Canterbury spotted skink (*Oligosoma* aff. *lineocellatum* 'central Canterbury', nationally vulnerable)
- McCanns skink (*Oligosoma Maccannii*)
- Canterbury gecko (*Woodworthia* cf. *brunnea*, declining)
- common skink clade 5 (*Oligosoma* aff. *polychrome* clade 5, declining).



Spotted skink

DOC undertakes annual lizard monitoring at four sites along Kaitorete Spit to measure the response of lizards to predator control carried out by DOC and CCC across the Spit. When the predator control was set up at the end of 2012 spotted skink numbers were so low that they were not able to be detected despite setting 150 pitfall traps over six sites for four nights. In 2015, for the second consecutive year, spotted skinks have been captured during monitoring. 2015 results indicate that spotted skinks are starting to recover with a total of 14 captured over two different sites.

For the past 2 years a lizard inventory in some of the lake edge DOC reserves has been undertaken. The inventory has detected common skink at some sites. A report on this work should be available for the next state of the lake report.

Terrestrial Invertebrates

Two flightless moths endemic to Kaitorete Spit have been monitored for the past two years. It is still too early to report any trend data.



Kupe's grassmoth

Kupe's grassmoth *Kupea electilis* is found in open dry areas associated with the host plant *Zoysia minima* and is monitored by walking transects and counting the males as they are disturbed. The other flightless moth is called the Kaitorete jumper *Kiwaia jeanae*; when disturbed it bounces around like a flea and is monitored using a timed

walk through of *Raoulia* cushions. Protecting the habitat of both species is a priority, with the main known threats being invasion of host habitat by the introduced species marram and yellow-tree lupin, and trampling by stock.



Female katipo spider

DOC has been monitoring katipo spider (*Latrodectus katipo*) along fixed transects spaced down the coastal side of Kaitorete Spit since 2004. While the data need further analysis, there is an indication of improving population numbers. Weed encroachment of katipo habitat, mainly yellow tree lupin overgrowing pingao, is the main threat at Kaitorete to katipo survival.

An extensive programme of weed control is gradually reducing tree lupin cover, allowing pingao to expand naturally. Katipo spiders are now being observed on transects which formerly had lupin cover and no katipo.

Aquatic invertebrates

There is no active monitoring of 'lake flies' but anecdotal reports suggest reduced numbers in the spring/summers of 2013/14 and 2014/15 when lake levels were reduced and remained low. An early indication from spring 2015 is of higher lake fly numbers.

Influence of Lake level management in last 2 years

There is some suggestion that the ongoing low lake levels in the summers of 2013/14 and 2014/15 were detrimental to some native birdlife (Walker 2015), including migratory wading bird species, and beneficial to others. There is too little monitoring data to properly evaluate this observation. There is however one demonstrable exception – the Australasian crested grebe. Grebe nests were exposed by the rapid drop in lake level when the lake was opened for spring fish migration purposes - this likely reduced

nesting success. DOC and others are responding by providing floating nesting platforms (see story below).

There is no research demonstrating a link between lake level management and lizards or terrestrial invertebrates. There is anecdotal observation of a relationship between extended spring-early summer openings and lower lake fly numbers which needs research.

Summary

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 (specific measures not yet identified)



The overall state of native birdlife is good, except for the key species noted. It is too soon to detect trends for the existing three years of bird monitoring data. It does appear that some Arctic migratory wading bird species that visit the lake have declined in numbers over many years. This is likely the result of conditions in the Arctic, and on the flyways, rather than lake conditions.

For at-risk lizard, bird, and terrestrial invertebrate species, interventions are in place. Species recovery will be monitored and reported. Monitoring data from Kaitorete Spit over a range of habitats and species is demonstrating some improvement, e.g., with lizards and katipo.

Recommendations

- 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.

References

See www.wet.org.nz for information about the references and data sources used here, including indicator species.

Grebe nesting platforms

This year, DOC is working in partnership with Davis Ogilvie and partners (who have donated their time and expertise) to build floating nesting platforms for the grebes. Platform design is based on the success of similar structures installed on Lake Wanaka. Trail cameras are installed to monitor grebe behaviour around the platforms, and to understand any modifications needed. Platforms have been on the water since August, will remain until February 2016, and then be removed. It is planned to replace the platforms for the 2016 nesting season.



Australasian crested grebe



View of one of the platforms

More information

Additional information and links are available from the WET website.

For background, context and information about the values associated with Te Waihora/Lake Ellesmere please see other sections of the 2015 State of the Lake Report www.wet.org.nz/projects/2015-state-of-the-lake/



Section 7 Fish

Te Waihora/Lake Ellesmere – State of the Lake 2015

Lead authors: Phil Jellyman, Shannan Crow and Don Jellyman - NIWA

How will we know when we have achieved success?

Native fish populations (including koura (freshwater crayfish) and kakhi (freshwater mussels)) and associated habitats are protected and restored



Dr. Phil Jellyman (left) and Dr. Shannan Crow (right) examining the abundance of shortfin eels during sampling in Te Waihora/Lake Ellesmere.

Context

With almost 50 fish species recorded from Te Waihora/Lake Ellesmere, it is likely to have amongst the highest recorded fish diversity of any lake in New Zealand. It is not however, the number of freshwater fish species that has resulted in such high diversity, but rather the occasional influx of a diverse range of marine species. The influx of fish species, both freshwater and marine, occurs when Te Waihora is open to the sea and fishes migrate into and out of the lake. When the lake is open for extended periods, the lake level decreases until it reaches sea level and then tidal exchanges occur between the lake and sea that increase lake salinity levels. These salinity levels can vary widely across the lake creating conditions that are suitable for both freshwater and marine fish species.

Artificial lake openings are a critical tool used to manage fishery values in Te Waihora. But with only limited numbers of lake opening events occurring each year it is important to know how the timing and duration of lake openings influence fish recruitment. Timing of fish recruitment has been a focus of fisheries research since the previous State of the Lake report in 2013. Research has tended to focus on eels (tuna) and flounder (pātiki) because they are of greatest interest to both customary and commercial fishers. There are two eel and three main flounder species caught in the lake - shortfin eel, black flounder, yellowbelly flounder and sand flounder being the most common. Longfin eel are rarely caught. Whilst defining key recruitment periods for these fish has been a recent focus, the growth and condition of eels and flounders are also key factors that underpin the fisheries.

State

Assessing the state of native fishes in the lake is more complex than for other lake values because in the murky lake waters it is not easy to observe whether fisheries values are markedly changing. The high resource requirements for sampling means that there are often limited data available. Regular commercial catch data exist for eels and flounder (see Figure 7.1). For most other native species, data are either limited or practically non-existent. The commercial eel fishery in Te Waihora commenced in the early 1970s and peaked in the late 1970s when it accounted for almost half of the total New Zealand eel catch. However, concerns over the sustainability of these catches led the lake to be declared a controlled fishery in 1978. From 2000, the annual Total Allowable Commercial Catch (TACC) has been set at 121.93 tonnes; this has been reached most years primarily composed of shortfin males (approx. 75% of the TACC) (Figure 7.1a). Ministry for Primary Industries (MPI) also hold data on the customary permits issued by Lake kaitiaki (guardians) on behalf of Ngāi Tahu for customary harvest in Te Waihora because

a certain percentage of the quota is also set aside for customary and recreational fishers.

The commercial flounder fishery in Te Waihora varies dramatically, as do the proportions of the three main species in the catch, but catches of black flounder are typically double those of either sand or yellowbelly flounder. Annual variation in catches of flounder can be seen from the commercial catches of flounder over the past 60 years, which shows that flounder catches in adjacent years can vary by more than 10-fold (Figure 7.1b). There has been an active commercial flounder fishery in the lake since the late 1890s, and the variability of catch reflects flounder abundance rather than fishing effort. Most commercial flounder fishers in the lake also fish for eels, and observing the number and size of the bycatch of juvenile flounder enables them to predict the strength of upcoming cohorts of flounder because these species only occupy the lake for 2 to 3 years before leaving to spawn in the ocean.

The other commercial fishery is yelloweye mullet, although it is significantly smaller than either the eel or flounder fishery averaging only 5.8 tonnes per annum. This fishery shows marked seasonal variability and primarily occurs between June and August. The quantity of mullet caught, or the variability in the total catch between years, is likely to reflect variation in market demand more than annual variability in fish numbers. The final fishery in Te Waihora is for whitebait, but there are no reliable catch data available. Recent recruitment work undertaken by NIWA as part of the Whakaora Te Waihora programme indicates the whitebait catch from around the mouth of the lake is almost entirely composed of inanga, which is the most abundant species along much of the east coast of the South Island.

There are two major prey fish species in the lake and these are common bully and common smelt. These fish were by far the most numerous during recent recruitment monitoring by NIWA at locations close to the lake opening site. However, their numbers can vary substantially at different sites around the lake and common smelt in particular are usually most abundant along the western shoreline. The determinants of spatial variability in common bully abundance is a focus of current research.

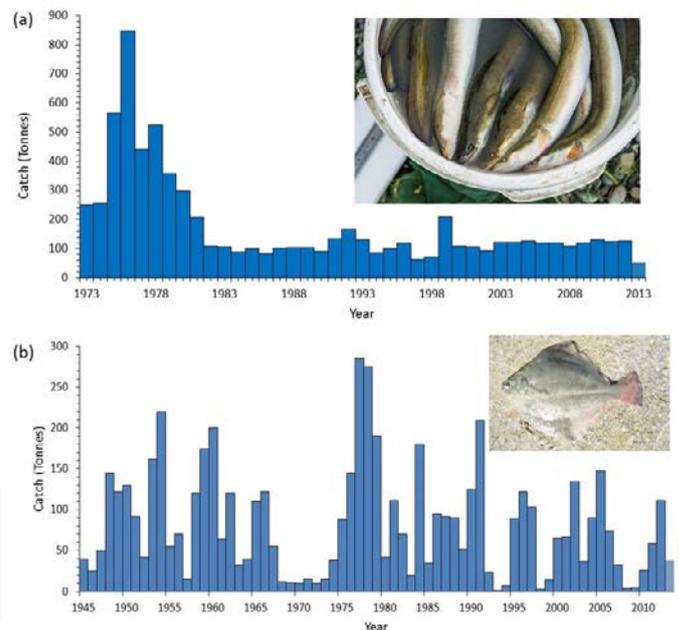


Figure 7.1: Annual commercial catch of eels (a) and flatfish (b) from Te Waihora. Note that the commercial fisheries differ in total duration and that the 2013 fishing year was still in progress when these figures were produced. Data from MPI.

Pressures

The timing and duration of lake openings is perhaps the largest pressure on fish communities because this process affects the abundance of subsequent cohorts, particularly for short-lived, fast growing fish such as flounder. Whilst opening the lake at the right times of year is critical for fishes, if the outlet does not close before the hottest summer months there is the potential for a range of negative effects to occur as a result of low summer lake levels, although this is yet to be quantified. The effects of extended low summer lake levels would likely include: (1) the loss of lake margin habitat and feeding areas for fish, (2) high water temperatures in the shallower parts of the lake which can result in decreased water quality and increased likelihood of algal blooms, which can potentially be toxic, (3) access to potential spawning habitat around lake margins is reduced for prey species, (4) the lake is shallower which reduces the water depth for pelagic feeding fishes, and (5) access issues for commercial, cultural and recreational fishers. The extent of habitat change through time and whether or not there has been significant habitat degradation because of historical land use change has never been quantified. Te Waihora will always be a shallow lake with the potential for extreme wind-fetch effects to rapidly alter habitat conditions for fish.

In the face of all these pressures, most native species appear to be well adapted to cope compared to introduced fishes. Introduced and pest fish species may be less tolerant of some of the extreme conditions that can occur in Te Waihora. For example, goldfish have been observed in large numbers in selected tributaries seeking salinity refuge after extended periods when the lake has remained open. Fish species whose abundance in the lake is closely aligned with appropriately timed lake openings are more vulnerable to inter-annual variability in recruitment (e.g., flounder), but for longer-lived species such as eels, populations appear to be relatively stable based on commercial and customary data from recent years. Recent analyses on data collected by NIWA (and its predecessor organisation) at various times since the 1970s has found that there has been no significant change over time in the length of shortfin eels and whilst shortfin eel condition showed some variation between years, there was no increasing or decreasing trend over decadal time scales.

Responses

Changes to native fish values are difficult to report on at present because of a lack of data. However, data limitations have not stopped a number of management initiatives targeted at improving conditions for native fish (and other wildlife). For example, the use of set nets has long been prohibited around the mouths of major lake tributaries affording some protection to fish moving between the lake and tributaries and, more recently, a large section at the eastern end of the lake has been gazetted as a customary fishing area (Horomaka kōhanga) from which commercial fishers are excluded. As expanded on below, the National Water Conservation (Te Waihora/Lake Ellesmere) Order (WCO) now allows for the lake to be opened at certain times of the year specifically for fish movement into and out of the lake.

Influence of lake level management in last 2 years

Lake levels are intensively managed, but only recently has there been specific provisions made through amendments to the WCO, allowing for the lake to be opened for fish migrations. The lake can be opened manually during April 1 to June 15 at any level. Openings during this time improve eel escapement from the lake, allowing mature eels access to the sea for spawning. In April 2013 it was not possible to open the lake to enable eel emigration so earthworks were carried out to shorten the distance eels had to travel over Kaitorete Spit to assist their seaward migration attempt.

Changes in lake level management are likely to be most apparent when examining fish recruitment. Insufficient data are currently available to determine whether there has been improved recruitment in the last two years, primarily because of a lack of recruitment data prior to 2013. Because of the extended periods when the lake was open in 2013, it is likely that above average flounder recruitment occurred in that year, which should result in good catches during the upcoming summer of 2015 if survival rates are comparable to previous years. The WCO allows for the lake to be opened (at any level) between 15 September and 15 October to accommodate fish recruitment. There is the possibility that lake openings during this time could have a negative effect if they reduce the lake to a low level (e.g., 0.6 m) and the lake remains at this

level throughout spring and summer, as was the case over 2014–2015. However, the effect of low summer lake levels on fish populations in Te Waihora has not been investigated to assess its potential impact.

Summary

An upward trend in diversity of native fish populations	No change
An upward trend in the abundance of native fish populations	Data deficient
Commercial fisheries quotas being sustained in the lake	No change
Viable populations of key mahinga kai species maintained	
Habitat for key 'threatened and at risk' species increased/maintained	Data deficient
Pest species significantly impact native fish or lake habitat	Data deficient
Fish barriers removed or negative effects mitigated	No change*

*although assessments of fish barriers have been undertaken in some lake tributaries.

Recommendations for future work

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. It is likely that tributaries provide key functions for different species and life stages of fish although the role that tributaries play may vary markedly depending on environmental conditions. 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.

With an improved understanding of how to manage lake openings for key cultural and commercial species, and the option to open the lake specifically to enhance fish recruitment during certain times of the year (15 September to 15 October), there is the potential for increased numbers of small fish to be in the lake – regardless of whether they are sourced from tributaries or the sea. However, for additional recruits to result in the enhancement of eel and flounder fisheries in the lake there needs to be sufficient resources to support more of these fish (e.g., habitat and food). It is not currently known whether recruitment is limiting these fish populations or whether there are sufficient prey resources available to increase the abundance of eel and flounder species. Future work could also 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.

References/useful links

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Fish Recruitment when the lake is closed

Fish recruitment monitoring work by NIWA from 2013-2015 has shown that fish recruitment can occur during periods of lake-outlet closure confirming the observations of Ngāi Tahu fishers about mahinga kai species entering the lake by moving over the gravel bar during southerly/south-westerly storms. Overtopping events require limited energy to be expended by fish to get into the lake since they are transported passively by wave energy and results suggest that this method is highly likely to be facilitating the recruitment of longfin eel, shortfin eel, torrentfish, yellowbelly flounder and sand flounder into the lake.

Common smelt and common bullies may also enter the lake during overtopping events although this could not be confirmed by the NIWA study because these species are likely to contain both lake-reared recruits and ocean recruits and they cannot be told apart from simple observations.

It should be noted that the contribution of overtopping events to recruitment will largely be dependent on barrier height. For example, south-westerly storms that occur within a couple of weeks of lake closure while the outlet is low should result in much larger seawater inflows (and thus fish recruitment) into the lake, compared to when the beach barrier has built to a sufficient height to keep most south-west storm waves out. Given the multiple overtopping events that occurred during the NIWA study, it was estimated that these events may have contributed between 5-12% of the fish recruitment during their study.



Significant amounts of sea water overtop the gravel bar at the closed outlet of Te Waihora (16 September 2013)

Koura and Kakahi Population Status Investigation

Duncan Gray, Environment Canterbury

The koura/freshwater crayfish and kakahi/freshwater mussel are enigmatic members of Canterbury's aquatic biodiversity. However, both species are considered as threatened by the Department of Conservation and there is very limited information available for the region (Figure 7.2). Both koura and kakahi are an important mahinga kai species and play a role in maintaining the water quality of our lakes and rivers.



Figure 7.2: The current known populations of koura and kakahi. Presumably there are many others known to members of the community.

This Environment Canterbury investigation aims to collate information available on the two species in the region. Specifically, where have they been found historically, where can they be found today, and what we can learn from this information to help protect them.

Stage 1 is to create a database of known historical and current populations across Canterbury. Stage 2 is proposed to involve field work to assess if historical populations still remain and the health of current populations. The process will also provide a lot of useful information about habitat preferences and resilience to stressors. Stage 3 will involve either the development of planning rules to protect populations or the instigation of population restoration and protection initiatives.

If you have seen these creatures recently or many years ago Environment Canterbury would like to know. Details of the online survey can be found on the WET website.



Kakahi living in the bed of a stream



Kakahi arranged on a fish measuring board



Adult koura

Photos of koura and kakahi courtesy of EOS Ecology

Inanga Spawning Habitat

Michael Greer, Environment Canterbury

The inanga (whitebait) fishery is hugely important in New Zealand, both commercially and culturally. The complex life cycle of inanga has put them under pressure from multiple sources, and the species is now classified as 'declining'. Overall, the biggest threat to the species is considered to be the destruction and restriction of spawning habitats.

Between January and June adult inanga spawn in tidally influenced waterways on exceptionally large (spring) tides just after new or full moon. Spawning occurs at the upper margin of tidal intrusion amongst submerged vegetation that is above the influence of normal tides. As a result, the eggs develop out of the water and hatch when the riparian vegetation is inundated again on the next set of spring tides. Hatchlings are quickly washed out to sea where they remain until spring at which time they return to freshwater and migrate upstream as whitebait.

Through the Land and Water Regional Plan (LWRP), Environment Canterbury aims to provide protection for inanga spawning via a schedule of known inanga spawning areas. The effectiveness of the current schedule system is, however, extremely limited. Inanga spawning surveys have not been conducted in most Canterbury waterways and the majority of confirmed spawning areas are not listed in the current schedule. To improve the protection of inanga spawning habitat in the Canterbury Region, Environment Canterbury has developed a model that predicts and maps the areas within the region's waterways where inanga spawning could potentially occur based on the upstream extent of tidal intrusion during spring-tides. In the Te Waihora catchment the model accurately predicts spawning habitat when the lake is open and tidal (see map). However, the area available for spawning may be underestimated when the lake is closed and inanga are forced to spawn when water level is high during flooding or high winds.

Where field work has been undertaken, the model has proved extremely successful at predicting where inanga spawning could occur. As a result, the maps of potential inanga spawning habitat produced by the model

have been included in the notified version of the recent omnibus plan change (Plan Change 4) of the LWRP. The provisions of the notified version of Plan Change 4 will mean, if accepted, that activities that may disrupt inanga spawning cannot occur without resource consent in areas identified as potential inanga spawning areas, during and immediately before the spawning season.

In its current state Plan Change 4 of the LWRP still includes a schedule of confirmed spawning sites alongside the potential areas of spawning. It is proposed that these sites have a higher level of protection than the modelled potential spawning areas, and resource consent would be required to conduct certain activities in confirmed sites all year round. In previous versions of the LWRP the schedule of known inanga spawning sites has failed to include the vast majority of confirmed spawning sites. Plan Change 4 remedies this and all known sites in the Canterbury Region are included in the schedule. There are three confirmed sites in the Te Waihora catchment, two in the Waikewai Stream and one in the Kaituna River (see map).

It is hoped that the proposed changes to rules around inanga spawning in Plan Change 4 of the LWRP will markedly improve the protection provided to this commercially and culturally valuable species, and will result in an increase in the regional abundance and distribution of the species.



More information

Additional information and links are available from the WET website.

For background, context and information about the values associated with Te Waihora/Lake Ellesmere please see other sections of the 2015 State of the Lake Report www.wet.org.nz/projects/2015-state-of-the-lake/



Section 8 Economy

Te Waihora/Lake Ellesmere – State of the Lake 2015

Lead author: Hafsa Ahmed, with Kirsty Johnston - Environment Canterbury

How will we know when we have achieved success?

Sustainable water use supports economic development and lake/water related tourism opportunities increase

POPULATION STATISTICS FOR SELWYN



Selwyn's population is projected to reach 75,000 by 2031

UNEMPLOYMENT

NEW ZEALAND	5.70%
CANTERBURY REGION	3.10%
SELWYN DISTRICT	2.10%



7.0% decrease in Jobseeker Support recipients in 2015 compared to 2014

ARRIVALS



GDP



In 2015 GDP in Selwyn was up 7% from 2013, and 4.0% for the year to March 2015 while New Zealand had 3.2% growth

CONSENTS

Residential consents



Non-residential consents



EMPLOYMENT BY INDUSTRY (ESTIMATES) 2015

Manufacturing	3662	
Construction	3536	
Agriculture, forestry & fishing	2932	
Healthcare & social assistance	2437	
Education & tertiary	2316	

GUEST NIGHTS



TOTAL COWS



HOUSE PRICES



Context

A large proportion of the Selwyn District, including all of the more intensively farmed and urban residential areas, lies within the catchment of Te Waihora/Lake Ellesmere. Economic activity in the District has remained buoyant - with a growing economy come benefits but also pressures on the environment, including on the state of the lake.

A number of economic indicators were reported in the State of the Lake 2013 to gauge changes to the Selwyn District economy that may effect, in some way, changes in the state of the lake. Some of these indicators are proxy measures of pressures on the lake from economic activity (e.g., population, total cows, irrigated area). Others are a measure of economic benefits derived from the lake (e.g., recreation, fishing). For this report, the proxy measures for economic pressures and measures of benefits are reported. Other indicator data reported in 2013 are used as supporting information to provide a fuller picture of Selwyn District's economic state.

Over time, tracking and reporting on water use will allow calculation of indicators such as GDP compared to water use and water quality. Ratios like these can show if there is any evidence of decoupling, i.e., whether pressures on the lake from economic activity in the catchment have lessened (and not at the expense of economic development). In future, GDP for the Selwyn District compared to the amounts of environmental expenditure on the lake, both public and private, could be used to report on restoration effort as a proportion of economic development.

State

The economic indicators (Table 8.1 overleaf) suggest increased economic activity in Selwyn District since 2013. Different factors contributing to this include population increase, increased building activity (some of which is in response to the Canterbury earthquakes of 2011), dairy farming, and investments in irrigation. Building construction reached a peak in 2013 and 2014 with an increase in residential and non-residential consent figures. The median house price value in Selwyn has increased by approximately

9% since 2013. Retail spending in Selwyn has also increased from \$58m to \$65m over the year to March 2015 suggesting more household spending. The provisional GDP estimate shows that Selwyn's economy grew by 4% in the March 2015 year while New Zealand's economy grew by 3.2% over the same period. Projections by Statistics New Zealand suggest that there will be approximately 30,000 more people in Selwyn by 2031 which is likely to create 10,860 households in the district.

With more business activity happening in the region, the region's annual unemployment rate was at 2.1% in March 2015. In response, Jobseeker Support recipients decreased by around 7% in March 2015 compared with the previous year. The manufacturing industry is currently a top employer followed by construction and agriculture, forestry and fishing industries.

Stage 1 of the Central Plains Water Limited (CPW) scheme has recently been completed and is expected to irrigate approximately 23,000 ha (60% of the area is already irrigated from groundwater). Once fully developed, the scheme will irrigate around 60,000 ha of land. It is expected to increase the region's agricultural output by \$592m per annum and estimated to generate around 1130 jobs. While the number of cows in Selwyn increased by 9% from 2011/12 to 2013/14, the dairy pay-out for Selwyn for 2015 has declined to approximately \$279m compared to \$533m in 2014. If dairy prices remain weak, this will likely impact export prices and farmers may lose significant amounts of money. This could lead to lower cow numbers in Selwyn from 2015. Dairy prices are predicted to pick up again in the March 2016 quarter.¹

Tourism has a significant role within Selwyn District and total guest night figures increased by approximately 5% over the past year (9% in total since 2013). The Regional Tourism Index for both international and domestic travellers for Selwyn has continued to improve since 2013.²

¹ Monthly Economic Indicators, August 2015, The Treasury

² Regional Tourism Indicators, Ministry of Business, Innovation and Employment

Table 8.1: Economic indicators for Selwyn District

Economic indicators	Reported in 2013 (or for year noted)	Reported for 2015 (or for year noted)	% change between years noted	source
Population (inc net international migration of 208)	42,300	44,595	+5.4%	Statistics NZ
GDP	\$1562 M	\$1672 M	+7%	Infometrics
Employment by industry (top 5)	(2014)			
Manufacturing	3700	3662	-1%	MBIE
Construction	3000	3536	+17.9%	
Agriculture, forestry and fishing	2800	2932	+4.7%	
Healthcare and social assistance	2300	2437	+6%	
Education and tertiary	2200	2316	+5.3%	
Total cows	(2011/12) 145,202	(2013/14) 159,795	+10%	Dairy NZ
Consents (\$ value)	(2013)	(2014)		Statistics NZ
Residential/Non-residential	\$408 M/82 M	\$417M/81M	+2.2%/-1.2%	
Median house price	\$469,825	\$519,950	+ 10.7%	Infometrics
SDC operating expenditure	\$75.6M	\$80M	+5.8%	SDC LTP
Waihora-Ellesmere associated quota value	\$1,830M (2009)	Not available		MPI, Butcher 2009
Irrigated area Ellesmere Waihora (estimated)	(2012/13) 107,438 ha ³	111,973 ha	+1%	Environment Canterbury 2015
Recreation visits	26,950 days (estimate)	No change ⁴	N/A	See Recreation section this report
Guest nights	79948	87282	+0.9%	Infometrics

³ Irrigated area calculated by summing estimated groundwater allocation on the face of issued resource consents.

⁴ See the recreation section – note that there are three key recreational activities for which data were available in 2013: only for mountain biking on the Rail has this data been updated and it shows no change. Unfortunately Fish and Game has not been able to provide up to date data re waterfowl hunter and angler numbers.

Pressures

Selwyn has recorded the fastest population increase of any New Zealand territorial authority over the past seven years. The District's economy has been performing well and has been the strongest economy in New Zealand over the past two years. It is unlikely that pressures on the lake and its environs from economic activity have lessened since 2013. The population, total cows and irrigation indicators show continuing increase, indicating further land use intensification (urban and rural), which will mean greater demand for water, and increased discharges to water.

Responses

The Canterbury Land and Water Regional Plan, now partially operative, sets region wide environmental limits and Environment Canterbury has notified proposed Plan Change 1 which includes rules specific to the Selwyn-Waihora Water Management Zone. With the development of the CPW scheme, there will be monitoring undertaken to assess impacts on water quality and nutrient levels in Te Waihora/ Lake Ellesmere and its tributaries. Farm environment plans (FEPs) are already in place for Stage 1 CPW – a condition of making this operational. As a tool for good practice, FEPs will help reduce pressures on the lake from primary production (see Land section).

Selwyn District Council (SDC) through its 2031 strategy aims to promote tourism and recreation. A 'Newcomers and Migrants' strategy under development will also provide some information to promote recreation opportunities around the lake.

Increased urban development requires provision to be made for stormwater and sewerage. In 2012, on around 17 ha of land, SDC began development of the Ellesmere Stormwater Wetland, funded by developer contributions, to service some areas of new development. The wetland includes native plantings, walkways, and an innovative floating wetland treatment system. Elsewhere, such as at the Te Whāriki development in Lincoln, developers have made their own stormwater arrangements using swales, wetlands and native vegetation. The Eastern Selwyn Sewerage Scheme, which became operational in 2013, services major growth areas including Rolleston, West Melton, Lincoln and Prebbleton and will ensure effluent is well managed.

Influence of Lake level management in last 2 years

It is likely that, with two exceptions, there has been little influence from the new lake level management regime on economic activities which may

affect the state of the lake. Effects of lake levels on land use as a result of flooding are separate, and the result of extreme weather events rather than lake level management itself. The two exceptions are commercial fisheries and aquatic recreation. For commercial fisheries, the spring lake openings are considered positive as they facilitate fish passage and contribute to healthy fish stocks for future years. The impact on tourism/visitor numbers of prolonged low lake levels over the summer is likely to be negative, deterring some of those involved in water sports from visiting the lake. There are no data to quantify aquatic recreation impacts.

Summary

While the economic indicators point to increased pressures on the lake, it is too early to tell what, if any difference, changes in intensive land use, including the implementation of the new Land and Water Regional Plan, have made to the state of the lake, or what difference the recent downturn in dairy prices is making to the overall mix of pressures in the District. Similarly, there are no direct measures of what effect continued urban-residential expansion is having - on the tributaries to the lake, the lake itself, or to the state of the environment in the wider catchment.

Economic development is decoupled from water quality – the health of the lake and its tributaries have improved and economic activity in Selwyn is buoyant.



Recommendations

In future, reporting on farm environment plans, and tracking and reporting on water use over time will allow 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. Consistent with the draft integrated monitoring strategy, economic indicators focused on the pressures from and benefits of economic activity (around and on the lake) should be measured at a finer scale than at District level.

References/useful links

See www.wet.org.nz for more information about references and data used here.

More information

Additional information and links are available from the WET website.

For background, context and information about values associated with Te Waihora/Lake Ellesmere please see other sections of the 2015 State of the Lake Report www.wet.org.nz/projects/2015-state-of-the-lake/



How will we know when we have achieved success?

Compatible recreation needs are provided for, including good access, water quality, and habitat for wildlife, including for sports fisheries

Context

Both historically (from at least the 1880s), and in contemporary times, Te Waihora/Lake Ellesmere has provided for a wide range of water-based recreation activities, e.g., trout angling, waterfowl hunting, whitebaiting, powerboating, windsurfing, rowing, kayaking and swimming. Land based activities within the lake's environs include cycling, picnicking, bird watching and walking. Apart from waterfowl hunting and trout angling, and more recently biking on the Little River Rail Trail, there are few data on numbers of recreational users on or around the lake or on the quality of their experiences. Other than for the Rail Trail, there were no recent data available to report on the state of recreation at the lake since 2013. Data from Fish and Game about waterfowl hunter numbers and angling numbers were unavailable. The lack of data in general makes reporting on the types and levels of recreation and quality of experience difficult. Consequently, much of what is presented here is based on the limited published material and anecdotal information used for reporting in 2013.

State of recreation activities

There are two major indicators of the state of recreation – level of use and quality of experience. Quantitative data are lacking for both indicators. The information reported in 2013 is repeated in Table 9.1.

Table 9.1: Estimated levels of use for recreational activities at Te Waihora/Lake Ellesmere

Activity	Highest historic levels of use – recreation user days per annum	Estimated level of use 2015 ¹ – recreation use days (range)
Trout angling	100,000 – probably in the 1960s	3300–5100
Cycling on Rail Trail	6000 – 7000 – contemporary activity	6000–7000
Waterfowl hunting	5000 – 10000 – probably much more activity before habitat loss	4000–6000
Boating, including windsurfing	10000 – 20000 – huge regattas held in 1920s through to 1940s	1500–3000
Bird watching	1000 – 1980s onward	500–1500
Other – whitebaiting, walking, picnicking	10000 – 20000 – likely to have been very large numbers in 1920s through to early 1980s, esp picnickers	0–2000 1000–5000 1000–5000 1000–2000
other (e.g., eeling, floundering, photography, 4WD driving, camping at Lakeside and geocaching)		
Total		
Lower range	132000	18300
Mid range	145000	26950
Upper range	158000	36600

Source: Recreation: A Background Paper Contributing to the Te Waihora/Lake Ellesmere: State of the Lake 2013 Technical Report No. 1. Kenneth F. D. Hughey, (Lincoln University/Waihora Ellesmere Trust)

¹Apart from cycling, the data are the same as for 2013 – there is no reason to change any of these estimates

Pressures (and driving forces) on recreation activities and management responses

There are a range of pressures which affect the quality of recreational activities in and around the lake which, in turn, impact on the numbers of people using the lake. Most pressures on recreation therefore relate to quality parameters for an activity – management responses relate to the quality of experience. Table 9.2 outlines this relationship between pressure and response for recreational activities at the lake.

Table 9.2: Pressures and responses for recreational activities at Te Waihora/Lake Ellesmere

Activity	Pressures (and Driving Forces, where identifiable)	Responses
Trout angling	<ul style="list-style-type: none"> Decline in fish numbers (bycatch, reduction in spawning trout numbers, lack of good spawning habitat) Poor water quality (agricultural intensification) 	<ul style="list-style-type: none"> <i>Managed access points</i> – available for angling around the lake <i>Advocacy programmes</i> – Fish and Game advocate for improved quality and quantity of water in the tributaries of the lake to support improved angling experience. This has included making submissions on the Land and Water Regional Plan (LWRP) and the Selwyn-Waihora sub regional Plan (PC1). LWRP and Canterbury Water Management Strategy (CWMS) efforts to improve water quantity and quality (see Land and Water sections)
Cycling on Rail Trail	<ul style="list-style-type: none"> <i>Access/facilities:</i> Currently there is no off-road cycling connect between the trail and Christchurch (on-going planning issues). Wind and lake flies can be annoying to cyclists (natural events, poor water quality) 	<ul style="list-style-type: none"> The trail is progressively being linked to others so that there is a continuous largely off-road connection to Christchurch
Waterfowl hunting	<ul style="list-style-type: none"> <i>Conflicting values:</i> Bird watching (Government change to status of Canada goose meaning year round hunting allowed); restrictions on 4-wheel drive use (vehicle impacts on native vegetation). <i>Water quality</i> - Toxic algae warnings: Perceived very seriously by duck hunters especially those using dogs. <i>Access points/visitor facilities:</i> Duck hunters now have restricted access, for driving, to some parts of the lake (impact on native vegetation); Signage in poor condition - causes confusion (resources) 	<ul style="list-style-type: none"> None, from a hunters' perspective From other perspectives: plan rules restricting off road driving; DOC signage, management of maimai and the funding from the maimai fees is used for work around the lake margin; lake opening protocol group that may consider timing in relation to duck shooting season (if there is a F&G comment) LWRP and CWMS efforts to improve water quality

Table continues overleaf

Activity	Pressures (and Driving Forces, where identifiable)	Responses
Boating, including windsurfing	<ul style="list-style-type: none"> Water levels: Bad boating conditions occur when the lake is open to the sea for an extended period of time and the lake 'bottoms out' (management regime) Water quality: Algal blooms (especially since 2014 potentially toxic cyanobacteria), occasional bad smell, poor water clarity (agricultural intensification) Access/facilities: Lack of launching sites for kayakers and rowers on rivers like the Ararira/ LII (lack of planning) 	<ul style="list-style-type: none"> LWRP and CWMS efforts to improve water quality Public health warning for the lake ongoing since February 2014
Bird watching	<ul style="list-style-type: none"> Conflicting values: Hunting scares birds and bird watchers (Government change of status for Canada goose means hunting year-round); Off road driving Lake level: not being managed in a way that is always appropriate for migratory wading birds (management regime) 	<ul style="list-style-type: none"> Lake level management: WCO seeks to manage lake levels in a way that meets native bird habitat needs, but also has to manage for fish and native vegetation
White-baiting	<ul style="list-style-type: none"> Timing of lake opening: When lake openings do not occur at the right time there is effectively no whitebait run - it appears October-November is the best time (management regime) 	<ul style="list-style-type: none"> Management action: A spring lake opening provided for (WCO) and so lake likely to be open more often during the whitebait season
Informal recreation including walking, dog walking, picnicking	<ul style="list-style-type: none"> Access: Limited lake access points with car parking Information: Limited information available for visitors, particularly on site 	<ul style="list-style-type: none"> Interpretation panels: Information panels were installed in late 2014 at key access points around the lake (Ngāi Tahu/DOC) Lake Access Brochure: produced by WET and reprinted in 2014, provides information about access points and permitted activities

Influence of Lake level management in last 2 years

The spring openings may have benefited the whitebait fishery – see the Fish section. In terms of boating, the prolonged summer openings will have been detrimental but there is no 'hard' data to support this. From a waterfowl hunting perspective Fish and Game North Canterbury report that it is the weather that determines hunting activity on the lake more so than lake levels - hunters prefer rough weather that causes wave action and keeps the birds off the water and airborne (Steve Terry, pers. comm. 2016).

Access for recreation

There are a number of locations around the lake where the lake edge can be accessed for a variety of recreational activities. Of particular note are Kaituna Quarry, Lakeside Domain, and Lower Selwyn Huts.

A map showing the different access points is available on the Waihora Ellesmere Trust website.

In addition, there are many legal roads, both formed and unformed which lead to the lake edge. In places it can be hard to identify the legal roads and some are impossible to navigate, being underwater at times.

There are also some routes across conservation land, identified in the *Te Waihora Joint Management Plan (2005)*, which allow access for food gathering and hunting. Vehicle use off these routes is not permitted.

Conclusions and Recommendations

Te Waihora/Lake Ellesmere remains an important recreational resource for Canterbury and, for bird watching, the lake is of international significance. However, most recreational activities declined in use through to the 1970s/80s and have remained roughly static since – the main exception being the increase in cycling on the Rail Trail.

Because there is so little information about trends in numbers of recreational users and the quality of their experience, the following data should be measured:

- 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.

With lake management interventions underway (e.g., to improve water quality, increase environmental flows in some rivers, enhance riparian management, and restore macrophyte beds) it will be important to understand what influence these interventions have on the quality of recreation activity experience and the levels of use, i.e., how the state of the lake affects recreation at the lake.

Two other issues remain unresolved since 2013:

1. There are conflicts between some recreation groups, e.g., Canada goose hunters and the needs of bird watchers and of the birds themselves – a facilitated discussion forum is required to clarify and attempt to resolve these issues.
2. Along with the lack of indicator data, there is a general lack of information about recreational opportunities and how best to manage these. An ongoing strategy to improve and share information could be developed together with a business case for constructing and developing a visitor/research centre for Te Waihora/Lake Ellesmere.

Summary

The state of recreation is much reduced across almost all categories compared to the levels of use in the 1970s and earlier. The reasons for this reduction are varied and include water quality issues, which may have contributed to declining trout fishing opportunities and to a reduction in numbers participating in any activities involving contact with water. Ongoing pressures on recreational activities at Te Waihora/lake Ellesmere persist and responses to date have not fully addressed these.



*Quality includes measures of visitor facility provision, ease of access, signage/information availability, fish and game catch limits, water quality and lake level.

These routes should only be used when ground conditions are firm and dry. When ground conditions are wet, vehicles can cause adverse effects on mahinga kai or conservation values. Once a track becomes rutted and boggy new vehicle tracks often appear alongside the designated route which compounds the damage.

Information about access routes across conservation land is available from the Department of Conservation and Fish & Game NZ.



More information

Additional information and links are available from the WET website.

For background, context and information about values associated with Te Waihora/Lake Ellesmere please see other sections of the 2015 State of the Lake Report www.wet.org.nz/projects/2015-state-of-the-lake/



How will we know when we have achieved success?

When the 11 objectives, taken from the Mahaanui Iwi Management Plan 2013 and listed in the table overleaf, are achieved.

Context

A critical feature of this Report Card is the selection of indicators, which relate directly to the tangata whenua objectives for Te Waihora as articulated in Mahaanui Iwi Management Plan 2013. Indicator selection was driven primarily by the knowledge of existing indicators that are already in use by tangata whenua and feasible to monitor, the availability of existing data, the degree to which the indicators are representative of the eco-cultural system of Te Waihora that is valued and used by Ngai Tahu, and the likelihood that the indicators would continue to be monitored in the future.

Colour coding is used to highlight the aggregate scores awarded for each of the components.

- This outcome has been achieved.

- Processes are being implemented, work is in progress and there is a likelihood that this outcome will be achieved.

- This outcome has not been achieved. There are processes in place that could realise this objective.

- This outcome has not been achieved. Processes are still being developed that could realise this objective.

- This outcome has not been achieved. There are no processes in place that are likely to realise this objective.

Table 10.1 overleaf provides the assessment of indicators for 2013 and 2015.

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Overall assessment of the Cultural Health of the State of the Lake

The overall score for the cultural health of the lake in 2015 is compared to the overall score awarded in 2013. The change in overall score reflects the many initiatives that are underway in the catchment and, consistent with the scale above, confirms that while outcomes may not have been achieved, there “are processes in place that could realise this objective”.

2013 Overall Grade



2015 Overall Grade



Black swan eggs

Rūnanga, Te Hapū o Ngāti Wheke (Rāpaki), Te Rūnanga o Koukourārata, Ōnuku Rūnanga, Wairewa Rūnanga, Te Taumutu Rūnanga ISBN: 978-0-473-23667-0 accessed at <http://mkt.co.nz/mahaanui-iwi-management-plan/>

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Whakaora Te Waihora (9 December 2011) Joint Cultural and Ecological Restoration Plan Approved by the Te Waihora Co-Governance Group

Table 10.1: Assessment of indicators

Objective	Indicator	2013 Grade	2015 Grade	
Ngāi Tahu are active co-governors of Te Waihora and its catchment.	1. Yes / No to formal co-governance arrangement in place for the catchment as a whole.	Green	Green	
	2. Yes / No to formal long term commitment to Whakaora Te Waihora	Orange	Yellow	
Land and water management in the catchment effectively provides for the Treaty partner status of Ngāi Tahu, and the taonga status of Te Waihora.	3. Yes / No to Te Rūnanga o Ngāi Tahu, Te Waihora Management Board or Ngai Tahu entity being joint holders of the consent for the lake opening.	Green	Green	
	4. Yes / No to Te Rūnanga o Ngāi Tahu, Te Waihora Management Board or Ngai Tahu entity being the joint consent authority for the catchment	Red	Red	
	5. Yes / No to Ngāi Tahu approval being sought for activities involving the lakebed	Orange	Yellow	
The cultural health of Te Waihora is restored, including the restoration of mahinga kai species abundance and diversity to a level to enable customary use.	6. Good health of, and physical access to, mahinga kai sites and places within the Te Waihora catchment is restored, including but not limited to: a. Muriwai; b. Greenpark Sands; c. Pākoau; d. Kaitōrete; e. Kaituna kōhanga f. Waikirikiri; g. Waiwhio; h. Halswell River; i. Ahuriri Reserves; and j. Yarrs Lagoon.	Orange	Orange	
	7. Mahinga kai species traditionally gathered still found across historic range	Red	Red	
	8. Satisfaction of whanau that Te Waihora and its tributaries are managed as a customary fishery including but not limited to: a. A lake opening regime the reflects the needs of the customary fishery; b. Tributary water quality and quantity that enhances cultural health and mahinga kai, and enables customary use; c. The use of exclusion zones for commercial fishing /non-commercial fishing areas.	8. Satisfaction of whanau that Te Waihora and its tributaries are managed as a customary fishery including but not limited to: a. A lake opening regime the reflects the needs of the customary fishery; b. Tributary water quality and quantity that enhances cultural health and mahinga kai, and enables customary use; c. The use of exclusion zones for commercial fishing /non-commercial fishing areas.	Yellow	Yellow
		9. Whanau can access sites to gather where they wish, and how they wish.	Orange	Orange
		10. Iwi specific flow preferences identified and provided for in catchment flow regimes.	Orange	Yellow
	Land and water use in the catchment respects the boundaries, availability and limits of our freshwater resources and the need to protect soil and water resources for future generations.	11. Level of extraction (groundwater, surface water)	Orange	Yellow
		12. Number of inter-catchment transfers	Red	Orange
13. Satisfaction of whanau with lake level management – including openings that allow for: a. Increased fish recruitment; b. Higher and fluctuating lake levels; c. Salinity maintained at a higher level than current regime allows; d. Longer duration of openings when required for fish values; and e. Allowing the lake to be tidal for longer periods of time.		13. Satisfaction of whanau with lake level management – including openings that allow for: a. Increased fish recruitment; b. Higher and fluctuating lake levels; c. Salinity maintained at a higher level than current regime allows; d. Longer duration of openings when required for fish values; and e. Allowing the lake to be tidal for longer periods of time.	Yellow	Yellow
	14. The investigation of opening the lake at the southern end of Te Koru, in addition to, or instead of, the current site.	Green	Green	
	15. Water quality (TLI)	Red	Orange	
	The relationship between land use, groundwater, surface water and Te Waihora is recognised and provided for according to the principle of Ki Uta Ki Tai.	16. Groundwater quality	Orange	Orange
		17. Quality of drinking water at the marae	Green	Green
18. % of land use change		Orange	Orange	
The cultural health of lowland waterways is restored, through the restoration of water quality and quantity and riparian margins.	19. Water quality parameters	Red	Orange	
	20. Water quantity parameters	Red	Orange	
Wetlands and waipuna are recognised and protected as wāhi taonga, and there is an overall net gain of wetlands in the catchment.	21. Area of wetlands (ha) restored as habitat	Orange	Orange	
	22. Yes / No and number of restoration initiatives spread across the catchment.	Green	Green	
	23. Satisfaction of whanau with the level of protection afforded waipuna (springs)	Orange	Orange	
All waterways have healthy, planted riparian margins, and are protected from stock access.	24. Index of Riparian Condition	Orange	Yellow	
	25. Kilometres (%) of river/waterway length without stock access	Orange	Yellow	
	26. Kilometres (%) and/or hectares of river/waterway length with riparian protection	Orange	Yellow	
The discharge of contaminants to the lake and waterways in the catchment is eliminated.	27. Water quality parameters	Red	Red	

More information

This brief summary draws on a more detailed report, which is available from the WET website.

For background, context and information about values associated with Te Waihora/Lake Ellesmere please see other sections of the 2015 State of the Lake Report www.wet.org.nz/projects/2015-state-of-the-lake/

Te Waihora/Lake Ellesmere State of the Lake 2013 concluded with a qualitative assessment of overall trends in each of the topic areas, and the adequacy of then available information for characterising the state or condition of the resource. A similar approach has been adopted here, and has again been presented in tabular form. The focus has shifted slightly, now that measures of success have been identified and progress towards their achievement evaluated. Generally, there is more than one measure for each topic area. In Table 11.1 I have attempted to provide an overall assessment across the suite of measures for each topic area. While this is a somewhat arbitrary exercise, and the position of the marker has limited meaning in an absolute sense, it does provide a basis over time for identifying progress in a relative way.

In 2013 we noted that:

“At face value...there are no obvious indications of on-going

deterioration in values or well-beings supported by the lake and its environs. However, lack of progress in addressing cultural health outcomes is a reminder that the current state of the lake disenfranchises Tangata Whenua. Moreover..., in a complex system with inherent time lags, it may take a number of years for the consequences of processes of decline to become apparent.”

At the end of 2015, that statement still holds true, although it is pleasing to note at least a small positive shift in the overall assessment for cultural health. And just as evidence of decline may take some time to manifest itself, so too will it take years, in some cases, for the consequences of interventions intended to improve lake outcomes to become apparent. What is also clear from the “traffic light” summary is that for all of our topic areas we have some distance to travel in our progression to success.

Table 11.1: Assessment of overall trends

Topic area	Key finding	Adequacy of data for measuring success	OVERALL current state/progress towards measures of success	TREND 0 = no change since 2013 + = enhanced/improved - = deteriorated
Governance and management	<i>“The partnerships between Te Rūnanga o Ngāi Tahu, Papatipu Rūnanga, Department of Conservation, Environment Canterbury, Selwyn District Council and Christchurch City Council have strengthened over the past two years and continue to play a pivotal role in the governance and management of the physical resources of the lake and catchment”</i>	Good	Not assessed	+
Lake level management	<i>“When, and at what level, the lake is opened to the sea requires the consideration of a number of matters, including wildlife, wetland vegetation, fish habitat, mahinga kai, customary fisheries, water quality, summer levels, land inundation, waterway networks and infrastructure, and fish migration for a variety of species”</i>	Poor-good depending on value being considered	Not assessed	+
Land use and land cover	<i>“Land use and land cover data show further expansion of intensive land use in the Selwyn-Waihora Water Management Zone/Te Waihora catchment – rural and urban”</i>	Good		0
Water	<i>“Since the dip in trophic status in 2013, the lake has steadily increased in hypertrophic state”</i> <i>“Streams within the Te Waihora/Lake Ellesmere catchment are generally of poor-fair water quality”</i> <i>“There have been no significant changes in flows in the last two years”</i>	Good		- for lake quality 0 for other measures
Vegetation	<i>“While recent weed control has protected/maintained some areas of freshwater wetlands habitat...other areas are still being lost to willow spread”</i> <i>“When the lake remains open for long periods (more than a month), especially in summer, this has detrimental effects on lake shore plant communities”</i>	Good - but insufficient frequency for two-yearly reporting		0
Wildlife	<i>“The overall state of native birdlife is good, except for the key species noted. It is too soon to detect trends...”</i> <i>“For at risk lizard, bird and terrestrial invertebrate species interventions are in place”</i>	Good for birds, patchy for lizards and terrestrial invertebrates, non-existent for aquatic invertebrates		0
Fish	<i>“The extent of habitat change through time and whether or not there has been significant habitat degradation because of historical land-user change has never been quantified. Te Waihora will always be a shallow lake with the potential for extreme wind-fetch effects to rapidly alter habitat conditions for fish”</i>	Good catch data for commercial species. Limited or non-existent for other native species		0
Economy	<i>“Selwyn has recorded the fastest population increase of any New Zealand territorial authority over the past seven years. The District’s economy has been performing well and has been the strongest economy in New Zealand over the past two years. It is unlikely that pressures on the lake and its environs from economic activity have lessened since 2013”</i>	Good for indicators of economic growth. Composite indicators linking GDP with water resource outcomes require development		+
Recreation	<i>“The state of recreation is much reduced across almost all categories compared to the levels of use in the 1970’s and earlier. The reasons for this reduction are varied and include water quality issues...”</i>	Good for biking on the rail trail, adequate for angling and waterfowl hunting, poor for all other activities		?
Cultural health	<i>“The change in overall score reflects the many initiatives that are underway in the catchment and... confirms that while outcomes may not have been achieved, there are processes in place that could realise this objective”</i>	Good for most indicators		+

It is apparent that since the 2013 report, the overall information base for the state of lake values has grown substantially. However, much of that growth has been in areas that were already relatively data rich. For example, long established monitoring programmes for water quality, hydrology and lake level continue to furnish sufficient information to fully characterise current condition and changes, both spatially and over time. In other topic areas, the establishment of a comprehensive and consistent approach to monitoring (for example for birdlife on and around the lake) will provide us with good information in coming years with which to assess both state and trend. However, natural fluctuations in the distribution and abundance of species, or other measures of environmental quality, mean that it will take some time before the impact of pressures on some lake values are fully understood. Similarly, the infrequency of measurement or observation in relation to some topic areas such as vegetation, even where good historical data exist, means that there may be little new to report at a two-yearly time scale.

Of continuing concern, is the lack of information on which to base meaningful assessments of key lake values such as recreation, non-commercial fisheries, and components of the wildlife. Addressing these shortcomings remains a high priority. Individual sections in this report also identify specific information gaps and make recommendations as to the means by which they should be filled.

On the other hand, there are new initiatives and obligations which will generate significant data on both state and on the efficacy of regulatory interventions. In the former category are the outcomes from the new comprehensive lake monitoring strategy (see section 1), which provides a coherent framework for the collection of information on the resources of the lake and catchment and a fertile opportunity for the universities and other institutions to involve themselves in long-term research programmes with major educational benefits. The rapid development of cheap and effective environmental sensor technology also means that there is considerable potential for a much greater role for communities to become involved in data gathering programmes. At the same time, implementation of new regional plans in the catchment will impose requirements on resource users to collect and provide information on aspects of their activities relevant to our understanding of environmental pressures.

In this report we have asked authors to provide their assessments of the influence of the lake level regime on their topic areas over the last two years. These findings are briefly summarised in Table 11.2. Over the reporting period there were two periods of unusually prolonged openings and associated low lake levels. While there is generally little or no specific or empirical information on such effects, anecdotal evidence and expert judgement reinforce the long-held views that (i) there is no one level or opening regime that is optimal for all values, and (ii) long-



duration openings are good for fish recruitment. However, protracted low levels, particularly over summer, are detrimental for many of the lake's natural values, through loss of habitat, desiccation, and increased salinity gradients.

Table 11.2: Influence of lake level management

Topic area	Data available for quantitative assessment	Influence of lake level management 2013-2015
Land use and land cover	No	Stock can access the lake bed when lake levels are extremely low. Flooding from extreme weather events has a major impact on farming operations around the lake margins ¹
Water	Yes	Unlikely to have had a major impact on water quality, apart from substantial increases in salinity and reductions in nutrient concentrations in 2013 when the lake remained open for long periods. Changes in salinity influence ecosystem dynamics
Vegetation	No	Long summer openings (2013) impact negatively on plant communities through salt stress and desiccation. Drying out of wetland plant communities increases the risk of invasion by dryland exotic plants
Wildlife	No	Low summer lake levels are likely to be detrimental to migratory waders but may benefit other species. Rapid drops in lake level in the spring reduces nesting success for Australasian crested grebe.
Fish	Some	Autumn openings (at any level) now provided for in the Water Conservation Order allow mature eels access to the sea for spawning. Spring openings enable fish recruitment. However, a low summer lake level could have a negative effect through reduced habitat.
Economy	No	Impacts on the economy of lake level management are expressed through its consequences for the commercial fisheries and recreation on and around the lake. The effects of flooding on lake edge farm land can be considerable (see footnote)
Recreation	No	Spring openings in the last two years may have benefited the whitebait fishery. Prolonged low summer lake levels have resulted in complaints from boaters. It is likely that low levels also reduce the quality of the experience for rail trail cyclists
Cultural health	Some	Satisfaction of whanau with lake level management is a cultural health indicator. An opening regime that benefits fish values generally and fish recruitment specifically, is particularly valued

The 2013 report identified the development of the Selwyn-Waihora sub-regional chapter of the Land and Water Regional Plan, under the aegis of the Canterbury Water Management Strategy, as an expression of the community's objectives for the resources of the catchment, and an important future influence on environmental state. That chapter has now been completed and is likely to become operative soon. Recently, Environment Canterbury signalled its intention to also put in place a set of region-wide rules specifically addressing the management of nutrients from farming and other activities. As indicated above, the implementation of these plans will generate important information on environmental impacts. More importantly though, they articulate the shared vision and outcomes of all who have a stake in the future of the lake and its catchment, and provide part of the package of solutions that will allow those outcomes to be achieved. Reports such as this are the means by which progress to that realisation is tracked and shared.

¹Although flood events are not directly related to lake level management, their mitigation can be affected by the ability to open the lake subsequently. Antecedent levels will also have some influence on the extent of flooding.

More information

Additional information and links are available from the WET website.

For background, context and information about values associated with Te Waihora/Lake Ellesmere please see other sections of the 2015 State of the Lake Report www.wet.org.nz/projects/2015-state-of-the-lake/