

State of the Water: Te Waihora/Lake Ellesmere and Catchment

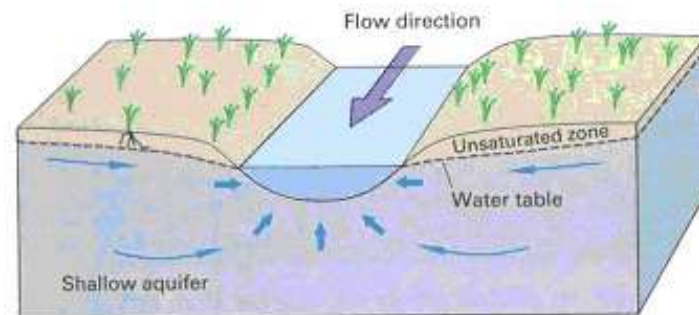
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Topics

- Define “State of the Water”
- Background
- State of the lake – Water
- Pressures
- Response

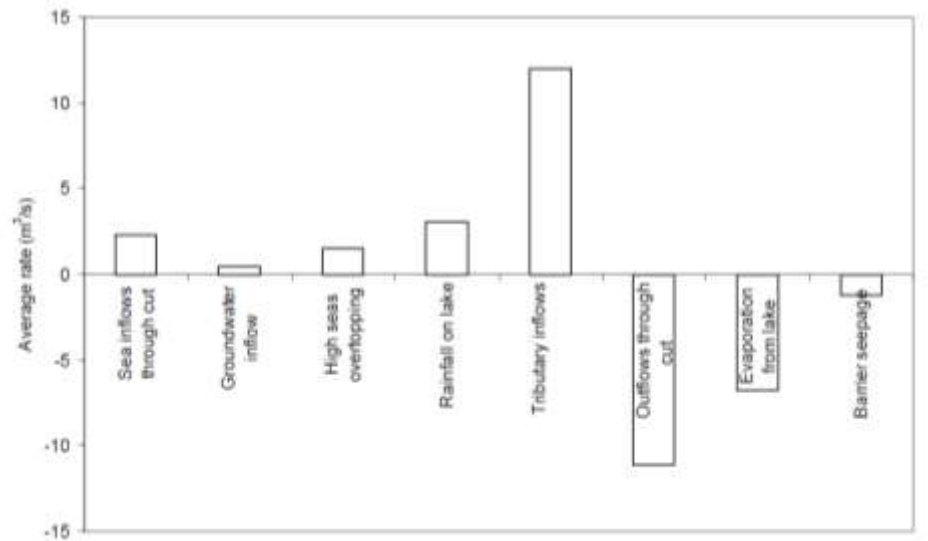
What do we mean by “State of the Water?”

- Water Quantity
 - Rainfall and lake levels
 - Tributary streams
- Water Quality
 - Lake
 - Tributary streams
 - Groundwater



Background

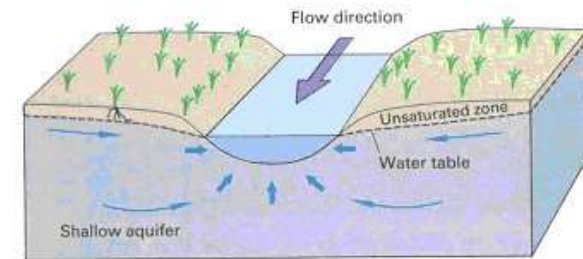
- Water balance
 - Inflows = rainfall, tributary inflows, seawater intrusion
 - Outflows = Intermittent lake openings, evapotranspiration



From Renwick *et al.* (2010)

Background

- Interconnected environment
 - Surface water & Groundwater
 - Freshwater & marine

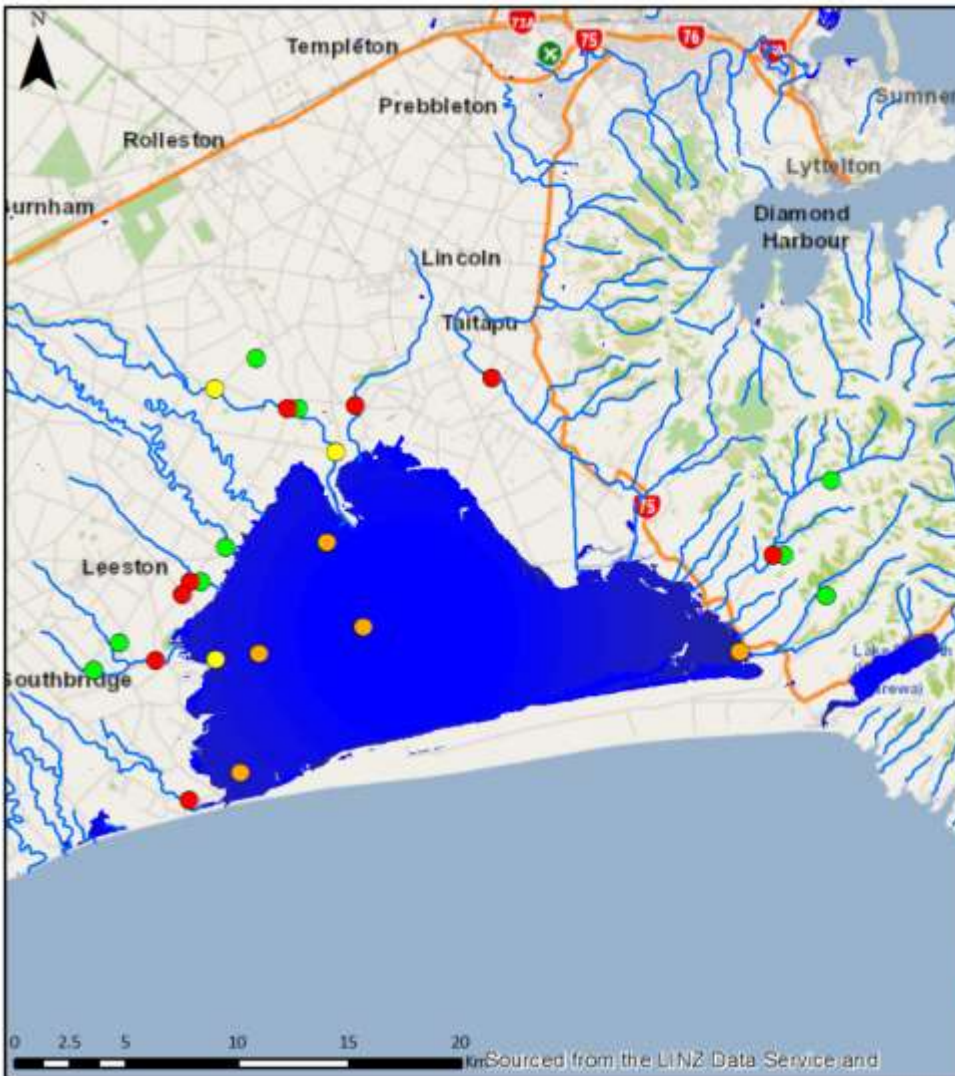


Background

- Phytoplankton dominated
 - 1968 shift from clear & macrophyte dominated, to phytoplankton dominated
 - Supported by nutrient enrichment
 - Cyanobacteria blooms
 - Potentially toxic species
 - Humans and animals
 - De-oxygenation = fish kills



State of the water quality



- Lake and tributary streams
- Water quality, ecology and recreational water quality
- Lake = water quality, phytoplankton/cyanobacteria, recreation
- Streams = water quality, aquatic ecosystem health, recreation

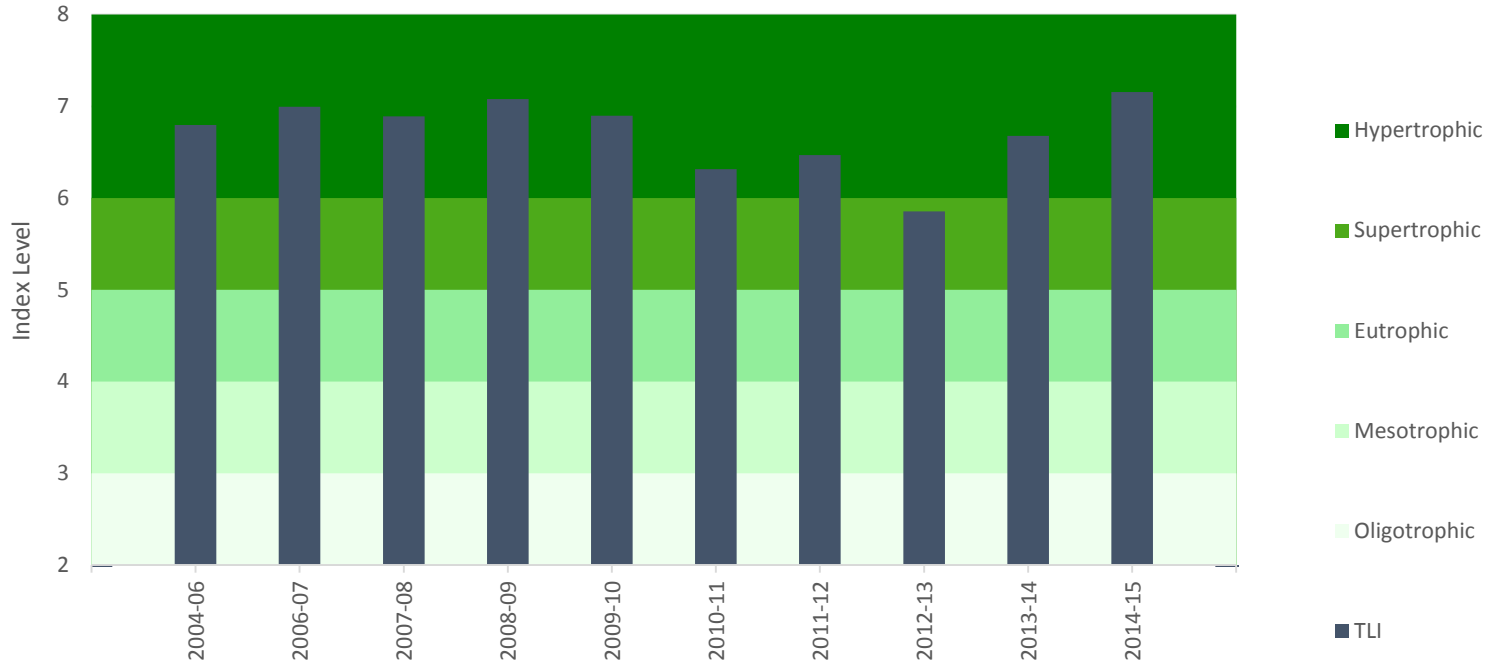
Determining Water Quality “State”

- Indicators
 - Are not direct measurements
 - Calculated based on raw data
 - Describe the general condition

Lake Trophic Status

- Indicator = Trophic Level Index (TLI)
 - Indicator of enrichment
 - Based on measurements of nutrients (TN & TP), algae/phytoplankton and water clarity

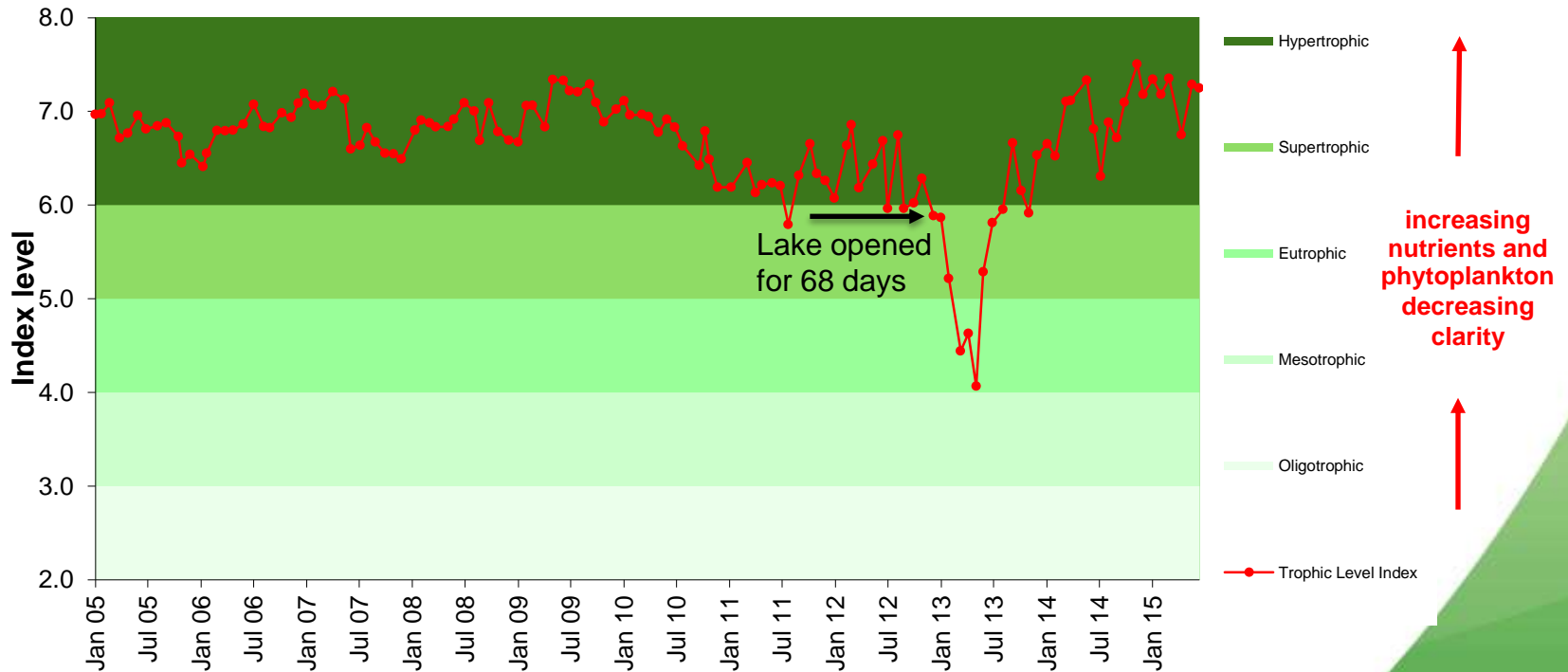
Te Waihora/Lake Ellesmere: TLI



↑
 increasing
 nutrients and
 phytoplankton
 decreasing
 clarity
 ↑

| TLI | Trophic state | General Description |
|-----|--------------------|--|
| <1 | Ultra-microtrophic | practically pure, very clean, often have glacial sources |
| 1-2 | Microtrophic | very clean, often have glacial sources, very low nutrient enrichment |
| 2-3 | Oligotrophic | clear and blue, with low levels of nutrients and algae |
| 3-4 | Mesotrophic | moderate levels of nutrients and algae |
| 4-5 | Eutrophic | green and murky, with higher amounts of nutrients and algae |
| 5-6 | Supertrophic | very high nutrient enrichment and high algae growth |
| >6 | Hypertrophic | saturated in nutrients, highly fertile, excessive algae growth |

Monthly TLI



Pressure driving Lake TLI

- Nutrient enrichment from inflowing streams – supports increased algal growth
- Mixing and resuspension of benthic sediments and in-lake cycling of associated nutrients

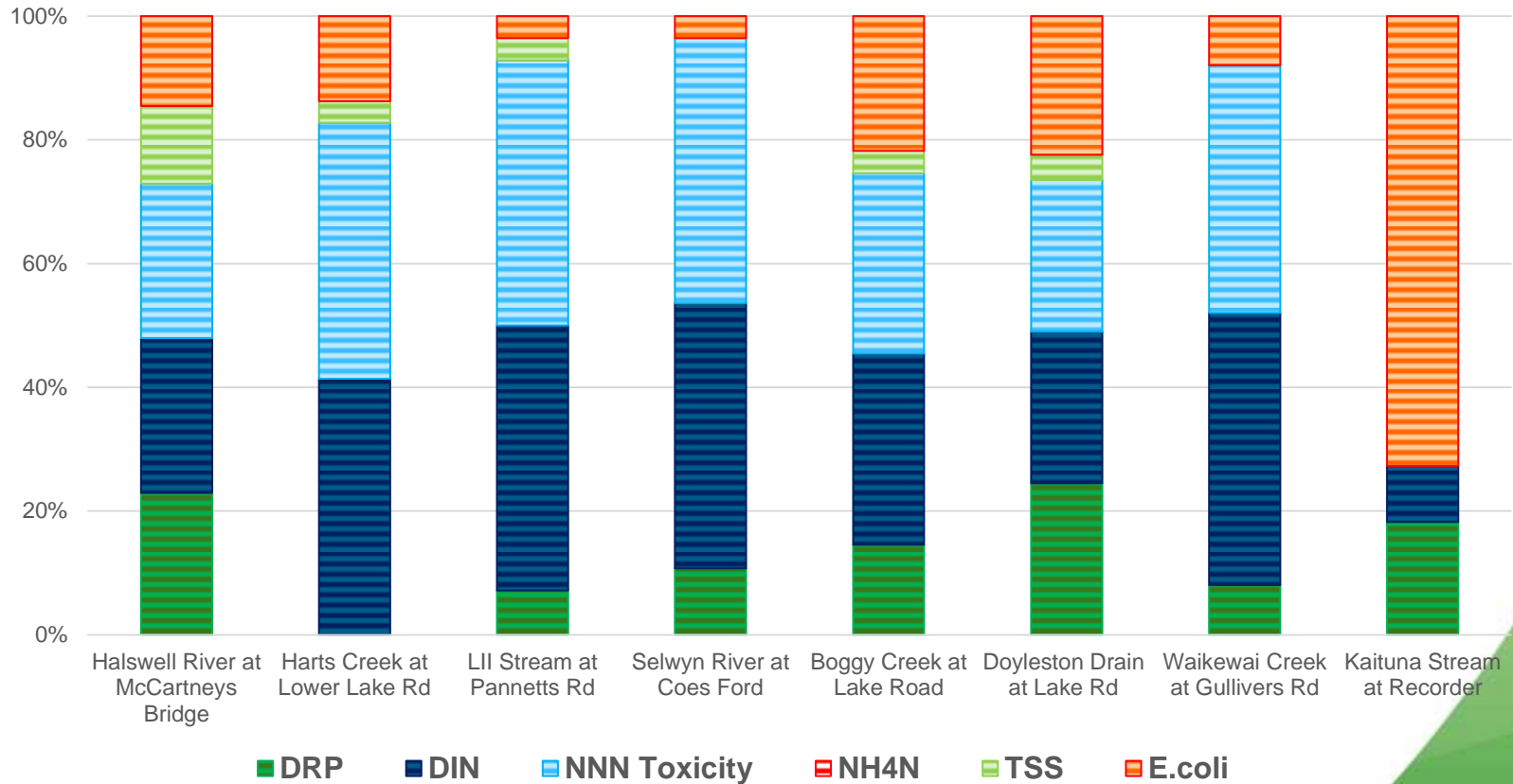
Water quality of tributary streams

- Indicator = Water Quality Index (WQI)
 - Combined water quality measurements
 - nutrients (N & P)
 - water clarity
 - faecal bacteria

Te Waihora/Lake Ellesmere: WQI

| | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 |
|--------------------------------------|---------|---------|---------|---------|---------|
| Halswell River at McCartney's Bridge | Poor | Poor | Poor | Poor | Poor |
| Harts Creek at Lower Lake Rd | Poor | Poor | Poor | Poor | Poor |
| LII Stream at Pannetts Rd bridge | Fair | Fair | Poor | Poor | Poor |
| Selwyn River at Coes Ford | Poor | Poor | Poor | Poor | Poor |
| Boggy Creek at Lake Road | Poor | Poor | Poor | Poor | Poor |
| Doyleston Drain at Lake Rd | Poor | Poor | Poor | Poor | Poor |
| Waikewai Creek at Gullivers Rd | Fair | Fair | Fair | Poor | Fair |
| Kaituna Stream at Recorder | Poor | Fair | Fair | Fair | Fair |

Te Waihora/Lake Ellesmere: WQI 2015

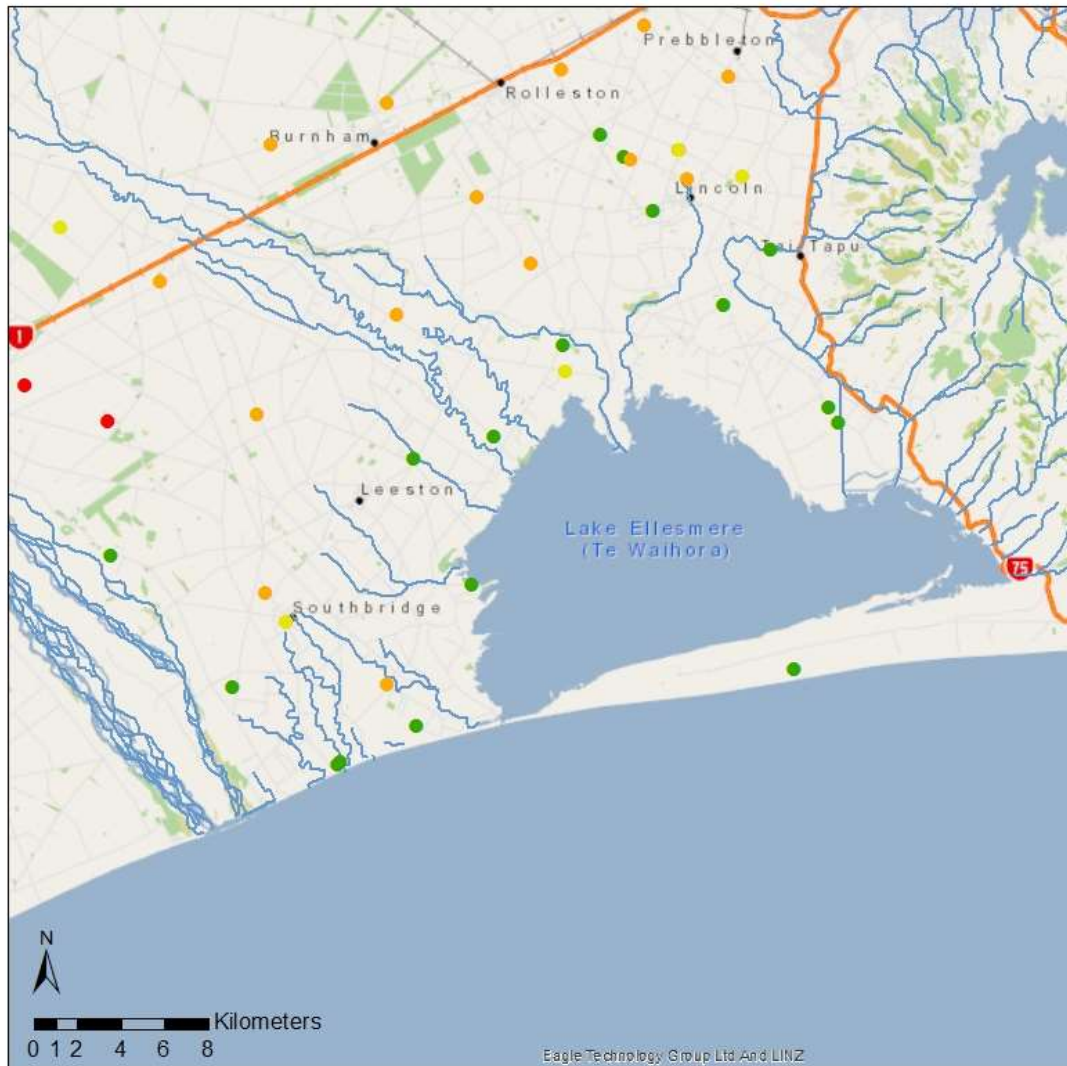


- Relative proportion of water quality measures that exceed thresholds
- Dissolved inorganic nitrogen and nitrate toxicity for stream life
- Faecal indicator bacteria for Kaitūna Stream
- Phosphorus inputs

Pressure driving water quality in tributary streams

- Faecal inputs
 - stock access or wipe-off losses in land drainage
 - Birds
 - Leaking septic tanks
- Phosphorus
 - Losses via drainage or soil erosion
- Elevated nitrogen concentrations
 - Nitrate leaching and upwelling groundwater

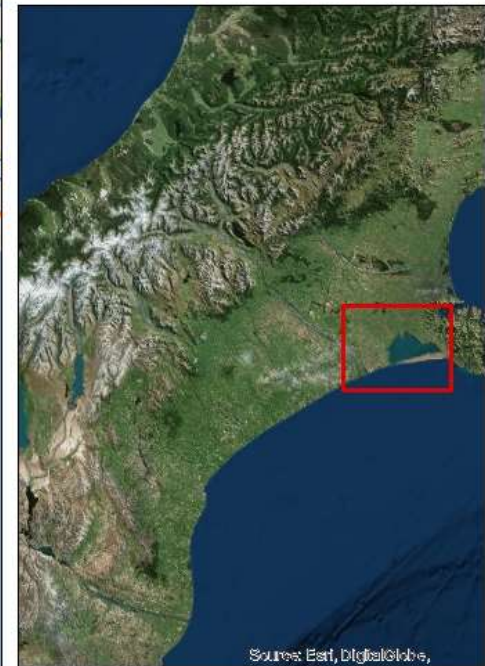
Groundwater influence



Legend

Nitrate Concentration

- <math><0.1\text{ to }2.8\text{ mg/L}</math>
- $2.9\text{ to }5.6\text{ mg/L}$
- $5.7\text{ to }11.3\text{ mg/L}$
- $\text{greater than }11.3\text{ mg/L}$

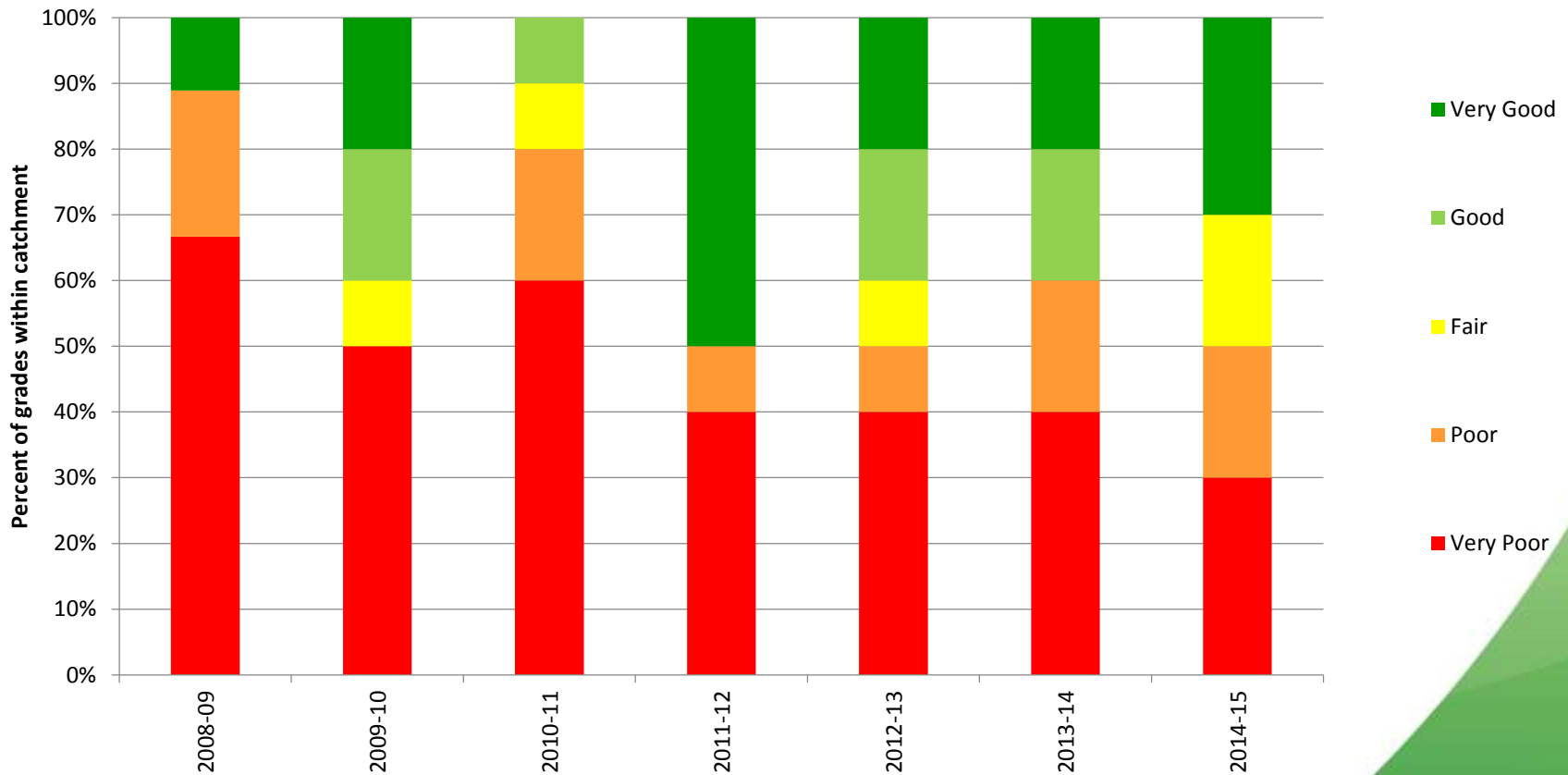


- Nitrates $> 5.7\text{ mg/L}$ near spring sources
 - Above stream life toxicity thresholds

Aquatic Ecosystem Health of Tributary Streams

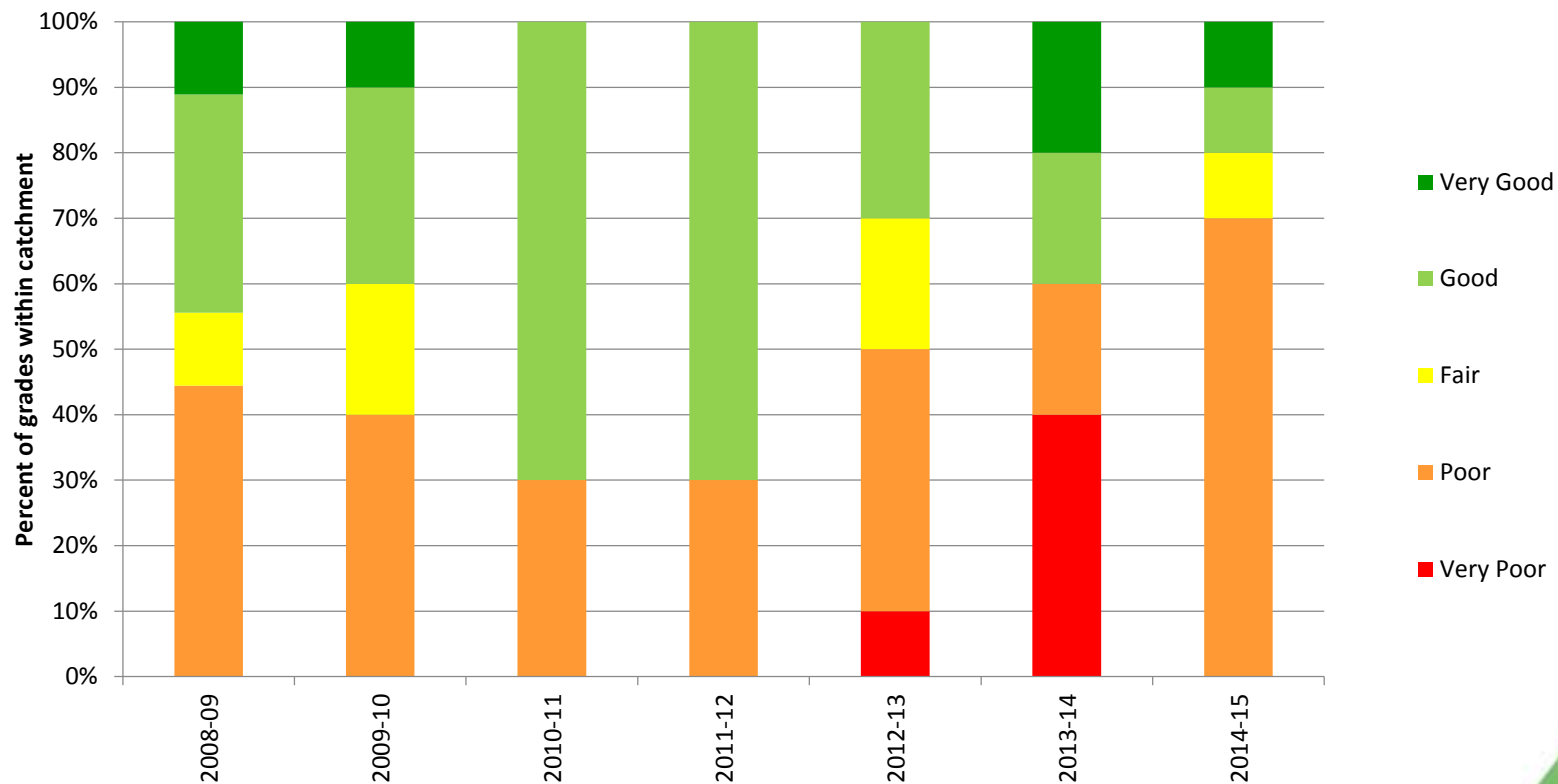
- Invertebrate taxa used as indicators of stream health
 - Respond to changes in water quality and habitat health over time
- Habitat data used to determine stream health
 - Sedimentation, algae or macrophyte overgrowth
 - Riparian fencing and planting
 - Land use

Invertebrate grades for tributary streams



- Improvement in invertebrate grades since 2010
- 50-60% of sites remain graded poor or very poor

Habitat Grades for Tributary Streams



- Increase in poor or very poor habitat grades

Pressure on Aquatic Ecosystems

- Lack of intact riparian vegetation,
- High sediment inputs
- Excessive in stream plant growth supported by high nutrient inputs
- Reduced or intermittent flows
- Nitrate toxicity – species loss?

Suitability for recreation

| | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 |
|--|-----------|-----------|-----------|-----------|-----------|-----------|
| Te Waihora/Lake Ellesmere - Domain | Good | Good | Good | Fair | Poor | Poor |
| Waikirikiri/Selwyn River - Chamberlains Ford | Good | Good | Good | Good | Good | Good |
| Waikirikiri/Selwyn River - Coes Ford | Very Poor | Poor | Poor | Poor | Poor | Poor |
| Waikirikiri/Selwyn River - Upper Huts | Poor | Very Poor | Very Poor | Very Poor | Very Poor | Very Poor |

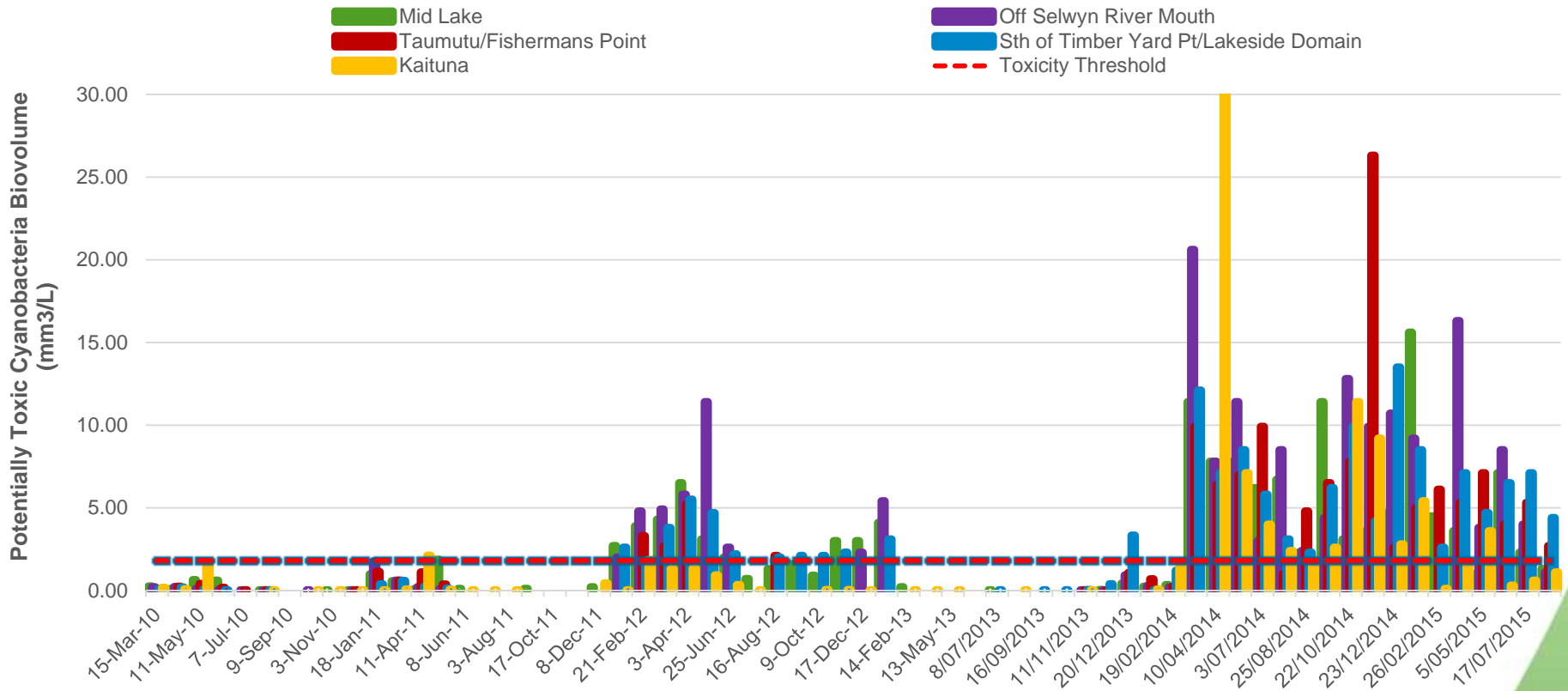
Potentially toxic cyanobacteria

- Characteristics of bacteria and algae
- Often referred to as “Blue-green Algae”
- Planktonic in Te Waihora/Lake Ellesmere
- Some Potentially Toxic/Harmful species
 - Ability to produce cyanotoxins

Major Potentially Toxic Species in Te Waihora

- Anabaena
- Nodularia
- Picocyanobacteria





- Nodularia bloom early 2012, followed by picocyanobacteria bloom
- Pico-cyanobacteria bloom since early 2014 – present (nearly 2 years)
 - Pico-cyanobacteria are cyanobacteria too small to identify
 - Often don't produce bright green visible scum like appearances like Nodularia or Anabaena

Pressure on recreational uses

- Considered unsuitable for recreational activities involving full immersion
 - Sources of faecal contamination include livestock and birds
 - Contamination may arise in lake, or from tributary inflows
- Potential cyanotoxins production from cyanobacteria blooms
 - Cyanotoxins are harmful to humans and animals
 - Supported by elevated nutrients
 - N-fixers, more reliant on phosphorus
 - Iron

Catchment Pressures Summary

- Elevated nitrogen in groundwater – tributary streams – Te Waihora/Lake Ellesmere
 - nitrate toxicity, cyanobacteria blooms, macrophyte/aquatic plant growth
- Phosphorus
 - cyanobacteria blooms
- Faecal contamination - recreation
- Sedimentation – smothers benthic habitat

Response

- Proposed Plan Change 1 (Selwyn-Waihora sub regional plan)
 - Cultural zone around the lake
 - Improvement in agricultural practice
 - Beyond Good Management Practices
 - Stock exclusion rules for lake, waterways and drains
 - Minimum flow and restriction regimes in tributary streams

Response

- Whakaora Te Waihora, Living Water etc.
 - Restoration work
- Macrophyte re-establishment trials
- Wetland research for intercepting nitrogen inputs to the lake
- Stream augmentation
 - E.g Boggy Creek and deep groundwater

Summary

- Elevated nutrients, faecal contamination, sedimentation, reduced flow impact the lake catchment ecosystem
- Regulatory plans and restoration work
 - Macrophyte trials, wetland research, stream augmentation

