

A calibrated ecological health assessment for Southland's lakes

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Introduction

- Monitoring methods to date have focused on the state and trend of Southland's lakes, with little regard to anthropogenic drivers or holistic ecosystem function.
- This makes it difficult to explain to a community why a lake is in poor condition and determine how it can be improved.
- The calibrated ecological health assessment project collates existing physical and biological data into a holistic framework that includes values important to the community.
- This work is based on the Ecological Integrity (EI) Framework by Schallenberg et al. (2011), who focused on four key components: 'nativeness', pristineness, diversity, and resilience.

Methods

Analysis was split into two steps:

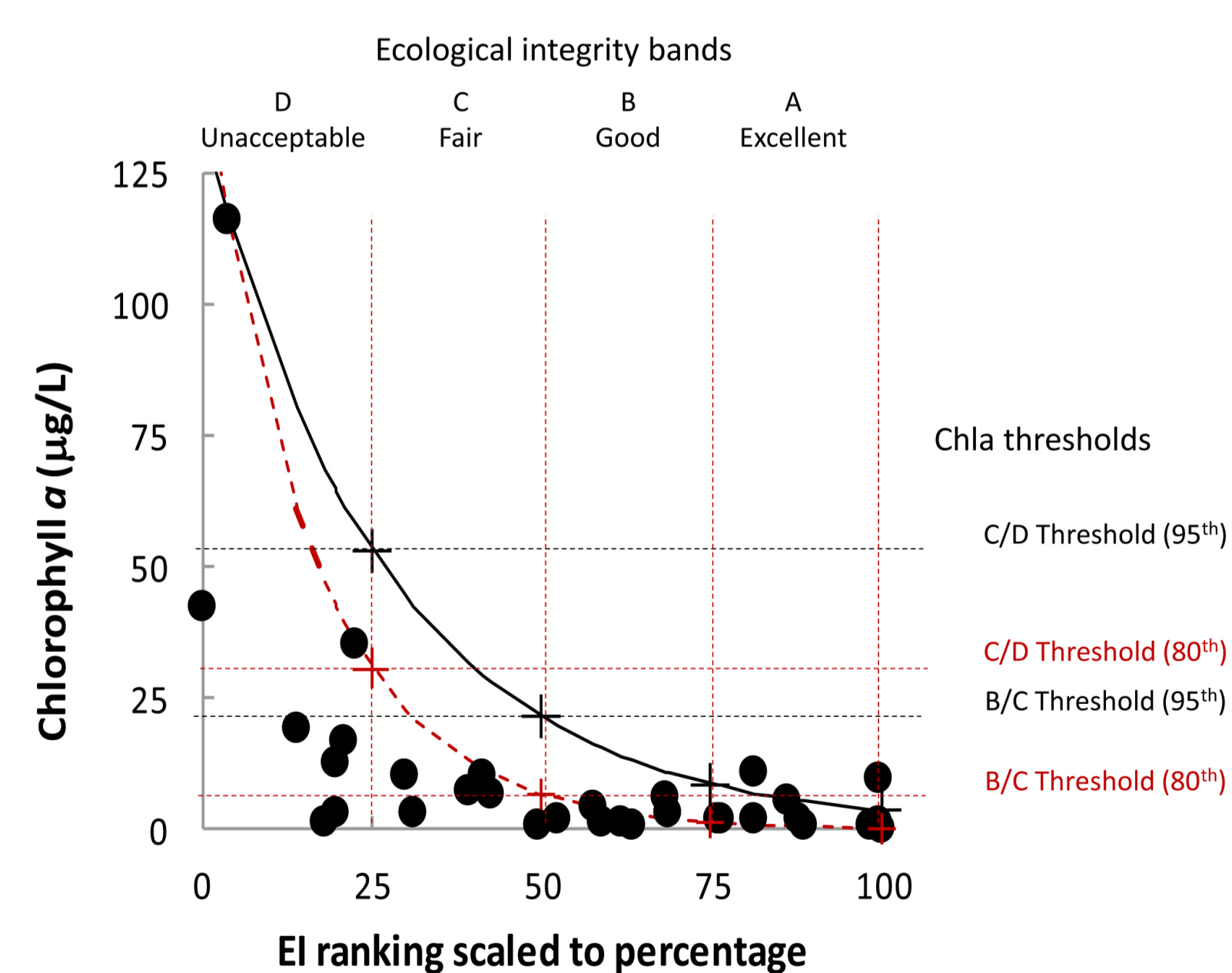
1. Establish a calibrated holistic lake assessment protocol based on EI.
2. Use existing data to assess the current ecological integrity of Southland's lakes within a national context.

Framework development

- Ecological surveys from 36 shallow (Drake et al., 2009, 2010; Schallenberg & Kelly 2012; Schallenberg & Kelly 2013) and 17 deep lakes (Özkundakci et al., 2014) were obtained for analysis.
- Data were modelled, using non-linear least-absolute-value curve fitting, against two measures of EI:
 - an independent assessment by three lake experts (Drake et al. 2010); and
 - the percentage of the lake's catchment in native vegetation.
- Quartile bandings (A-D) were applied to each attribute to provide consistency with the National Objectives Framework.

Assessment

- Southland's lakes were assessed against the calibrated framework using all available data.
 - Attributes were scored and banded, and finally aggregated into an overall EI score by averaging the minimum attribute band scores for each component (i.e. a minimum aggregation method).
- Figure 1. Calibration results between shallow lake chlorophyll-a and ecological integrity (EI) expert assessment rankings. 95th percentile (black) and 80th percentile (red) curves were intersected with quartile lines to provide threshold values.



Results

Calibration

- Nine attributes were successfully modelled for shallow lakes, three belonging to nativeness, four to pristineness, and two to resilience (Table 1).
- Six attributes were successfully modelled for deep lakes, four belonging to pristineness, and two to diversity.

Table 1. Attributes that were successfully calibrated against independent assessments of EI.

LAKE TYPE	EI COMPONENT	ATTRIBUTE	UNIT
Shallow	Nativeness	Native fish	%
Shallow	Nativeness	Macrophyte species	%
Shallow	Nativeness	Macrophyte cover	%
Shallow	Pristineness	Chlorophyll-a	µg/L
Shallow	Pristineness	Total nitrogen	µg/L
Shallow	Pristineness	Total phosphorus	µg/L
Shallow	Pristineness	Trophic lake index	Index
Shallow	Resilience	Nutrient balance index	Index
Shallow	Resilience	Food chain length	µ15N units
Deep	Pristineness	Total nitrogen	µg/L
Deep	Pristineness	Total phosphorus	µg/L
Deep	Pristineness	Chlorophyll-a	µg/L
Deep	Pristineness	Maximum macrophyte depth	m
Deep	Diversity	Rotifer species richness	Count
Deep	Diversity	Phytoplankton species richness	Count

Assessment of Southland lakes

Shallow

- Lakes Calder and Sheila (Stewart Island) had 'excellent' EI (Table 2).
- Lakes George and Vincent (mainland Southland) had 'good' EI.
- The Reservoir and Lake Murihiku had 'fair' to 'unacceptable' EI.

Deep

- Lake Manapouri's EI was rated 'excellent'.
 - Te Anau was rated 'good' due to a higher diversity of rotifer species, resulting in a reduced diversity component (inverse relationship).
- Figure 2. A diagram of the EI components for The Reservoir. Attributes belonging to 'nativeness' are shown, of which The Reservoir scores the lowest in percentage native macrophyte cover.

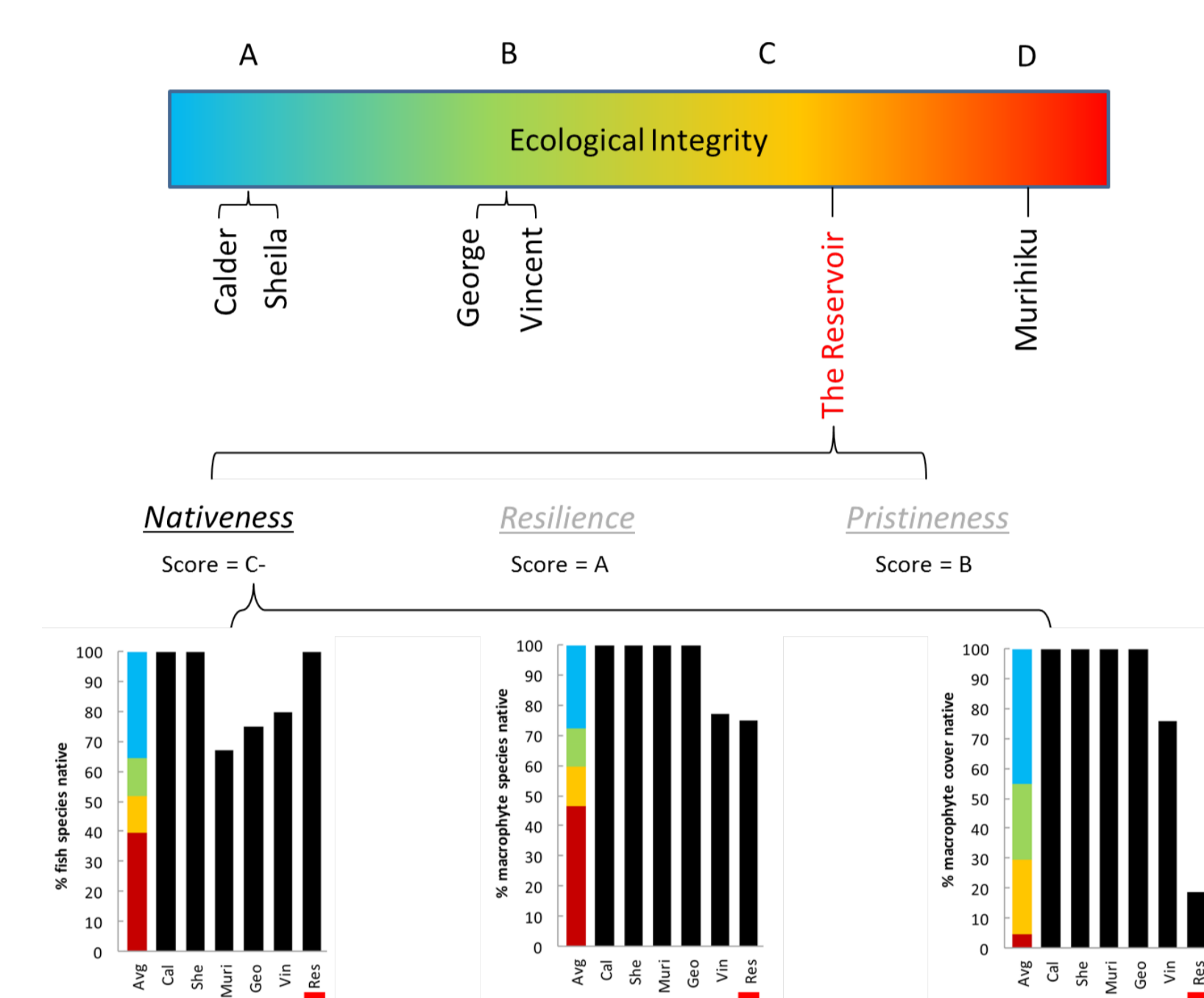


Table 2. EI rankings for shallow lakes. The EI sub-components for The Reservoir are displayed to demonstrate how rankings were calculated.

LAKE	LAKE TYPE	PRISTINENESS	RESILIENCE	NATIVENESS	DIVERSITY	EI
Calder	Shallow	A	A	A	-	A
Sheila	Shallow	A	A	A	-	A
Murihiku	Shallow	D	-	B	-	D
George	Shallow	B	A	B	-	B
Vincent	Shallow	B	A	A-	-	B
The Reservoir	Shallow	C	A	C-	-	C-
Te Anau	Deep	A	-	-	B	B
Manapouri	Deep	A	-	-	A	A

References

- Drake D, Kelly D, Schallenberg M, Ponder-Sutton A. & Enright M. 2009. Shallow coastal lakes in New Zealand: assessing indicators of ecological integrity and their relationships to broad-scale human pressures. NIWA Client Report: CHC2009-005. NIWA, Christchurch. 55 p.
- Drake DC, Kelly D, Schallenberg M 2010. Shallow coastal lakes in New Zealand: current conditions, catchment-scale human disturbance, and determination of ecological integrity. Hydrobiologia 658: 87-101.
- Kelly D, Schallenberg M, Waters S, Shearer K, Peacock L. 2016. A calibrated ecological health assessment for Southland lakes. Prepared for Environment Southland. Cawthron Report No. 2832. 56p. plus appendices.
- Kelly D, Shearer K, Schallenberg M. 2013. Nutrient loading to shallow coastal lakes in Southland for sustaining ecological integrity values. Prepared for Environment Southland. Cawthron Report No. 2375. 41 p. plus appendix.
- Özkundakci D, Hamilton DP, Kelly D, Schallenberg M, De Winton M, Verburg P, Trolle D 2014. Ecological integrity of deep lakes in New Zealand across anthropogenic pressure gradients. Ecological Indicators 37: 45-57.
- Schallenberg M, Kelly D 2012. Ecological condition of six shallow Southland lakes. Report prepared by Cawthron Institute for Environment Southland. Environment Southland, Invercargill. 53 p.
- Schallenberg M, Kelly D 2013. Estimates of reference conditions for Southlands shallow, lowland lakes. Report prepared by Hydrosphere Research Ltd. for Environment Southland. Environment Southland, Invercargill. 68 p.

Conclusions

- The method of assessing lake EI has been largely successful at identifying overall lake health and is broadly in line with previous assessments of Southland's lakes.
- It is recommended that this system be adopted as a way of holistically measuring lake health.
- The use of EI should supplement, rather than replace, existing methods of assessing lake health (e.g. NOF, Lake SPI).