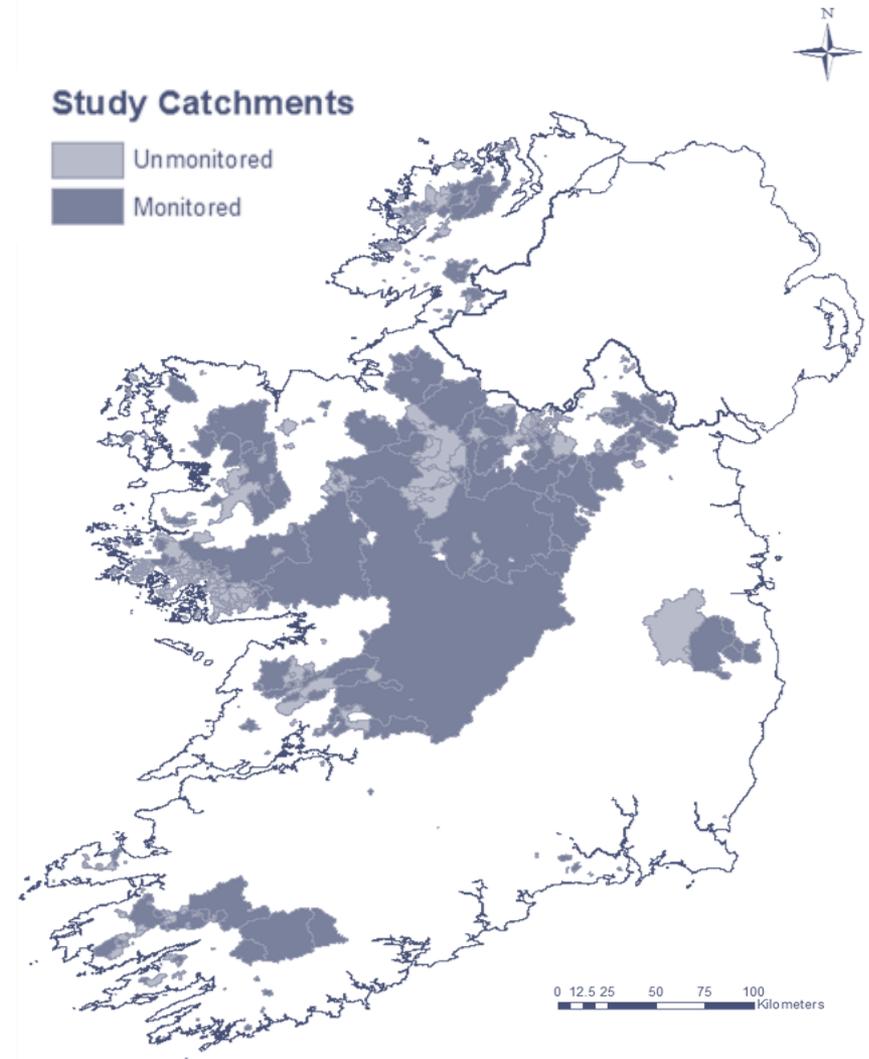# Predicting ecological status of unmonitored lakes based on hydrogeomorphology and land use
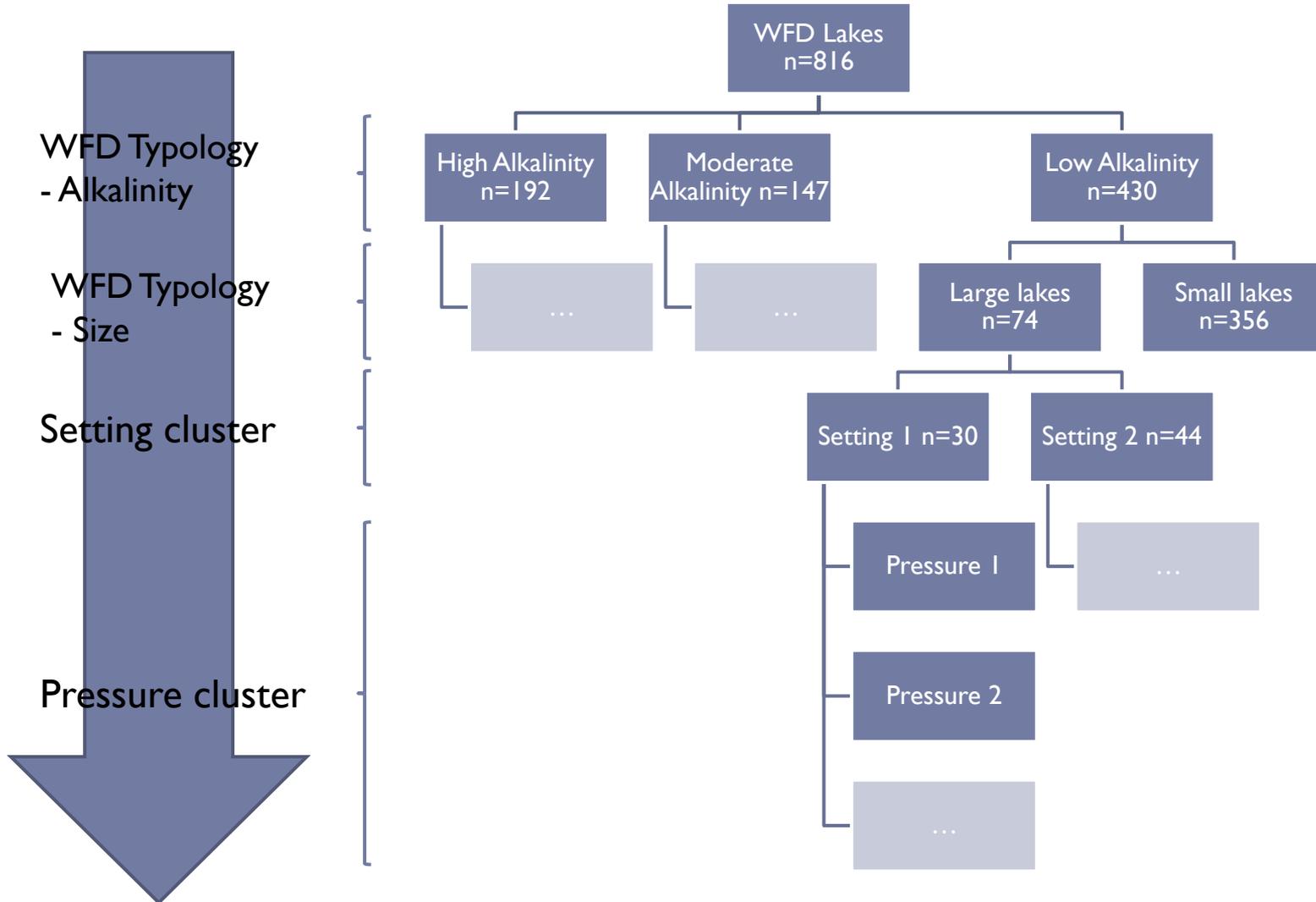
Wynne C., Tierney, D. and I. Donohue

WFD Monitoring Programme Design

- 12000+ lakes in Ireland
- 816 lakes on WFD programme
- 227 monitored for WFD

Study Catchments

Unmonitored

Monitored

0 12.5 25 50 75 100
Kilometers

Cluster Approach to Grouping Lakes

WFD Typology
- Alkalinity

WFD Typology
- Size

Setting cluster

Pressure cluster

WFD Lakes
n=816

High Alkalinity
n=192

Moderate
Alkalinity n=147

Low Alkalinity
n=430

…

…

Large lakes
n=74

Small lakes
n=356

Setting 1 n=30

Setting 2 n=44

Pressure 1

…

Pressure 2

…

Donor Lake Approach to Status Assignment

- Lakes in similar settings and subject to similar pressures, will be of similar ecological status

- Create groups of lakes with similar setting and land use
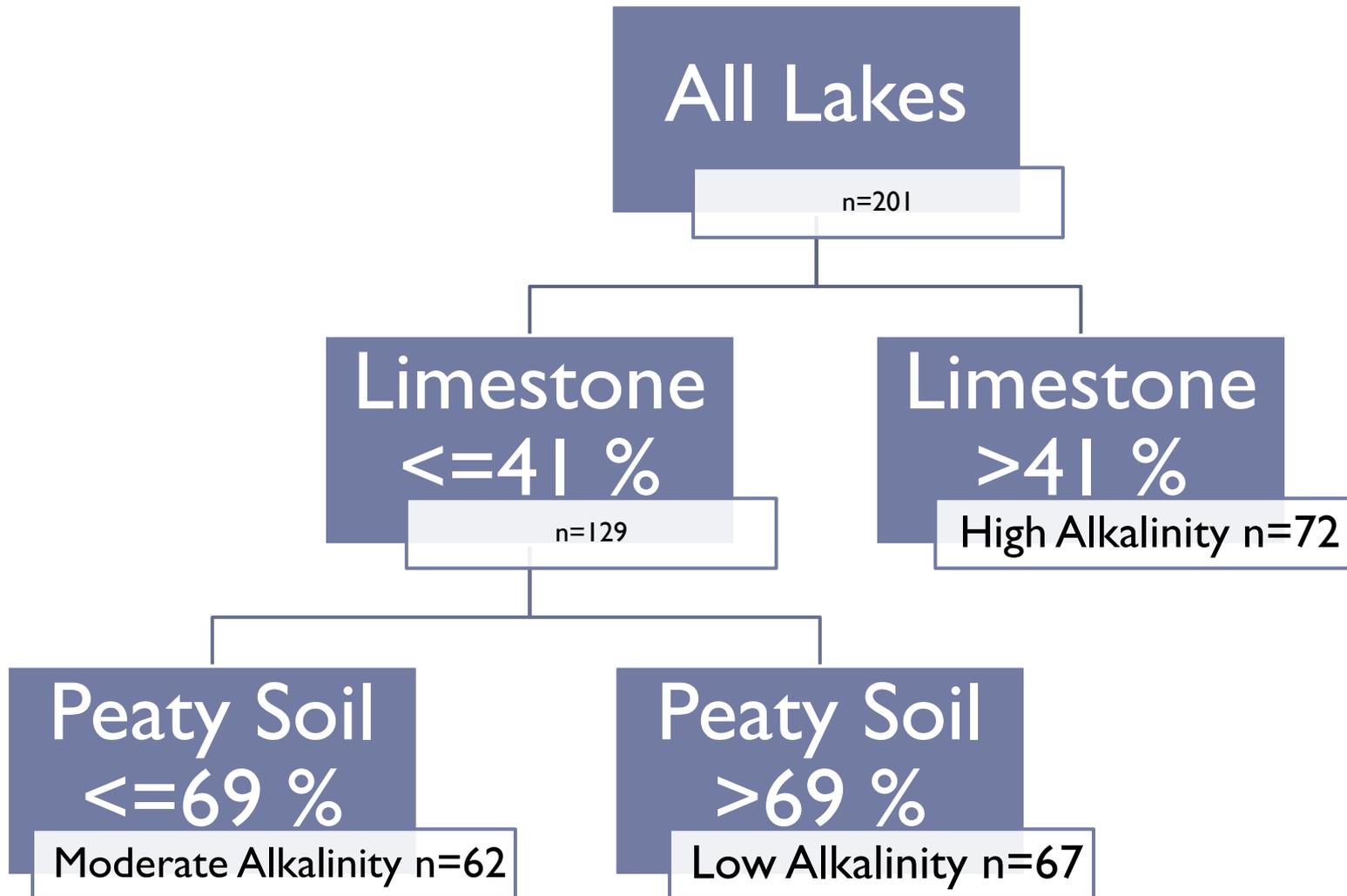
- Identify a monitored lake within the group

Irish WFD Lake Typology

| Parameters	Boundaries											
Alkalinity (mg/L $CaCO_3$)	<20				20-100				>100			
Depth (m)	<4		>4		<4		>4		<4		>4	
Area (ha)	<50	>50	<50	>50	<50	>50	<50	>50	<50	>50	<50	>50
Type	1	2	3	4	5	6	7	8	9	10	11	12

Predicted WFD alkalinity groups

Hydrogeomorphological clustering: Low Alkalinity Lakes

▸ Hydrogeomorphological characterisation was carried out separately for each of the 2 low alkalinity size groups.

▸ Within each group, K means analysis was used to cluster lakes based on hydrogeomorphological characteristics

| Hydrogeomorphological Setting	
Range in Near-Lake Slope (°)	Mean Catchment Slope (°)
Altitude (m)	Aquifer Category (%)
Shoreline Development Index (SDI)	Poorly productive, Productive, Karst
Catchment Area:Lake Area	Likelihood of Inadequate Percolation (%)
Density Upstream Lakes (m/km^2)	Very High-Low, Made
Catchment Area (km^2)	Subsoil type (%)
Stream Density (m/km^2)	Dry, Peat, Wet Inorganic

Hydrogeomorphological clustering: Low Alkalinity Lakes
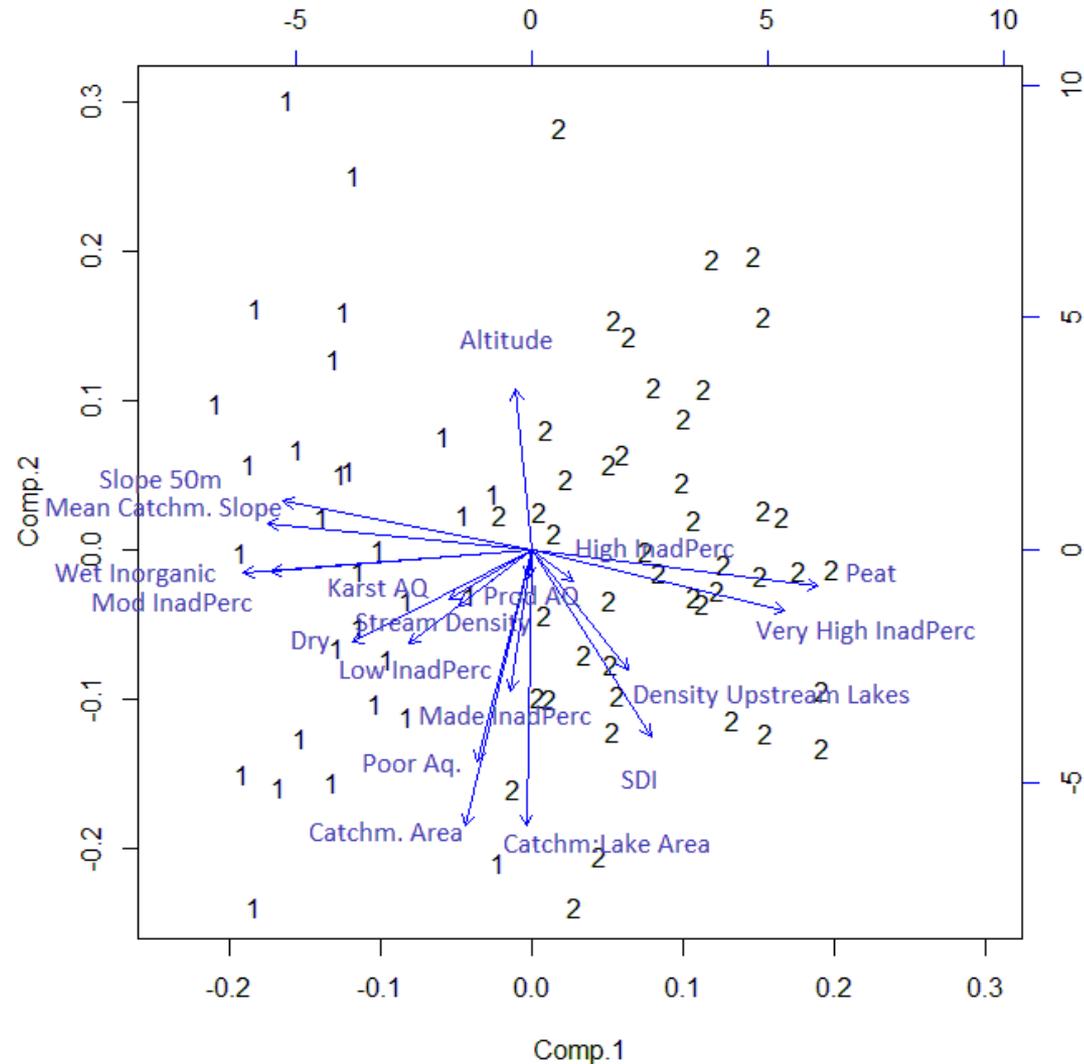
Land use clustering: Low Alkalinity Lakes

▸ Land use characterisation was carried out separately within each setting (K means group).

▸ Lakes were clustered based on land use/cover characteristics.
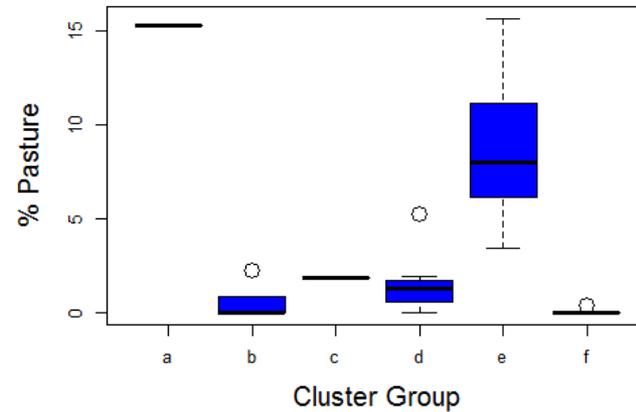
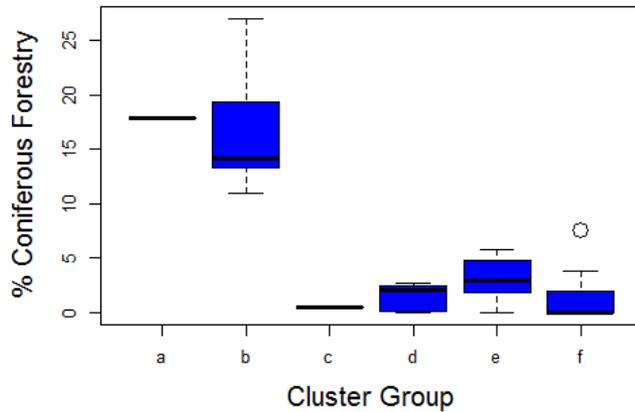| Land Use/Cover	
No. Certified Sewer Outflows per catchment	Sheep Density (LSU/ha)
No. UWWT Discharges per catchment	% Urban Land Cover
Population Density (people per km^2)	% Coniferous Forestry
Septic Tank Density (septic tanks per km^2)	% Arable
Cattle Density (LSU/ha)	% Pasture

Land use clustering: Low alkalinity large lakes
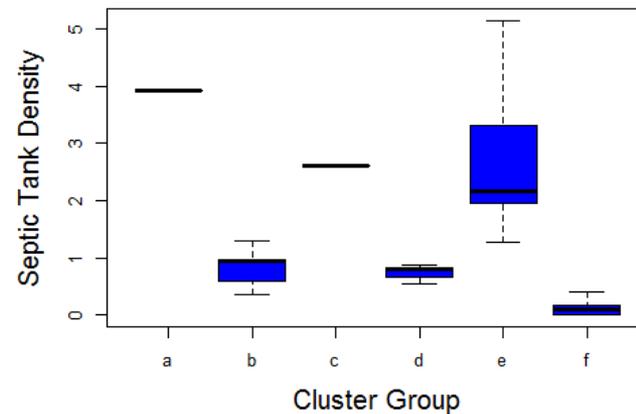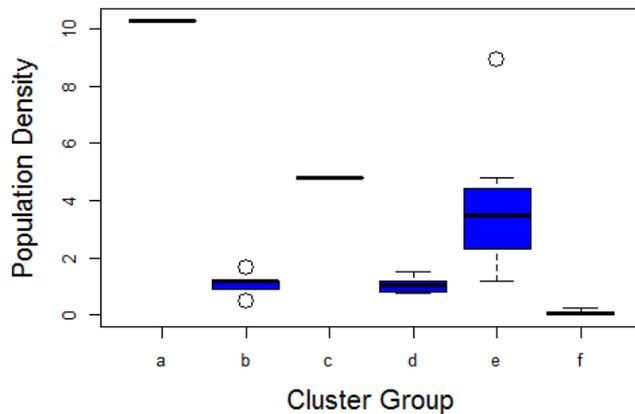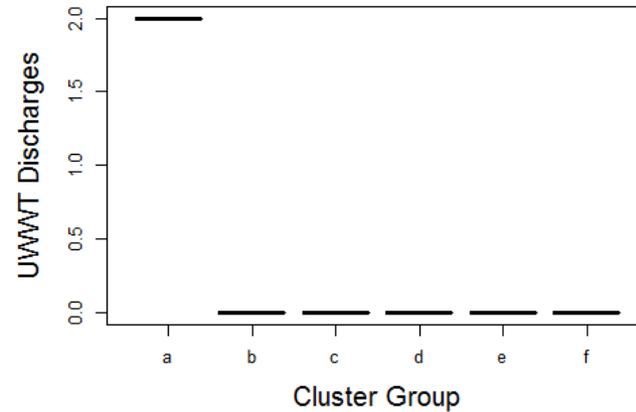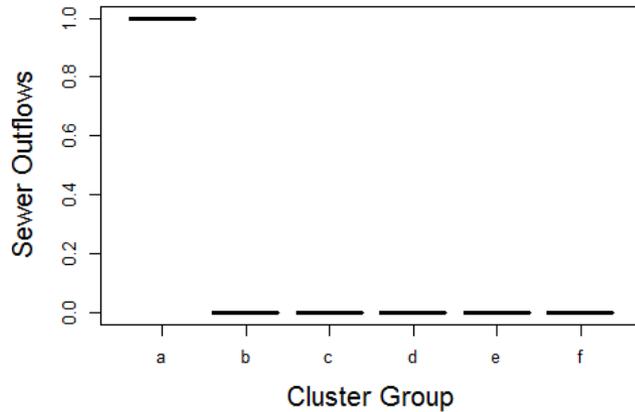
Land use clustering: Low alkalinity large lakes
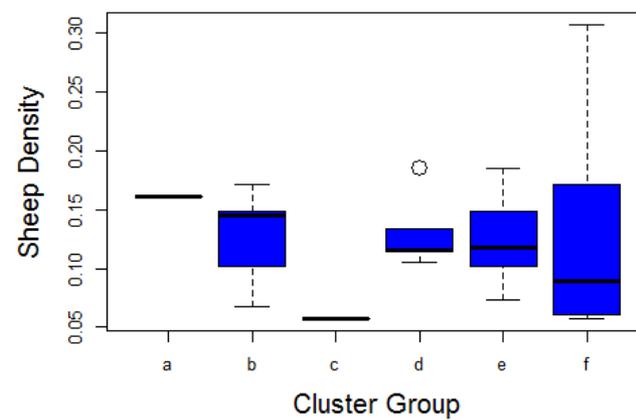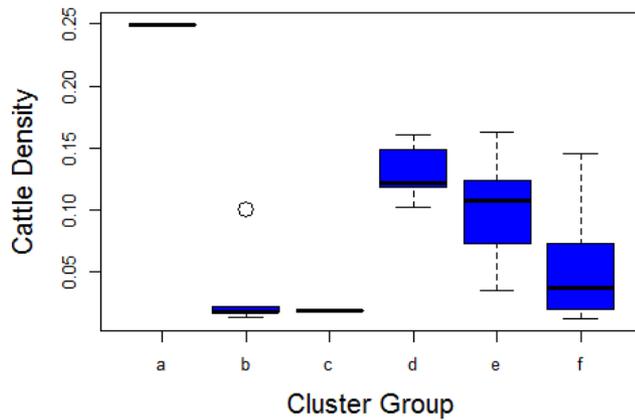
Land use clustering: Low alkalinity large lakes

- Group A - human point sources
- Group B - higher % coniferous forestry cover
- Group C - higher population and septic tank densities and low agricultural activity
- Group D - low pressures overall, but had higher cattle densities than Groups B, C, E and F
- Group E - higher % pasture cover and higher septic tank densities
- Group F - overall low pressures

Status Assignment: Donor Lake Approach
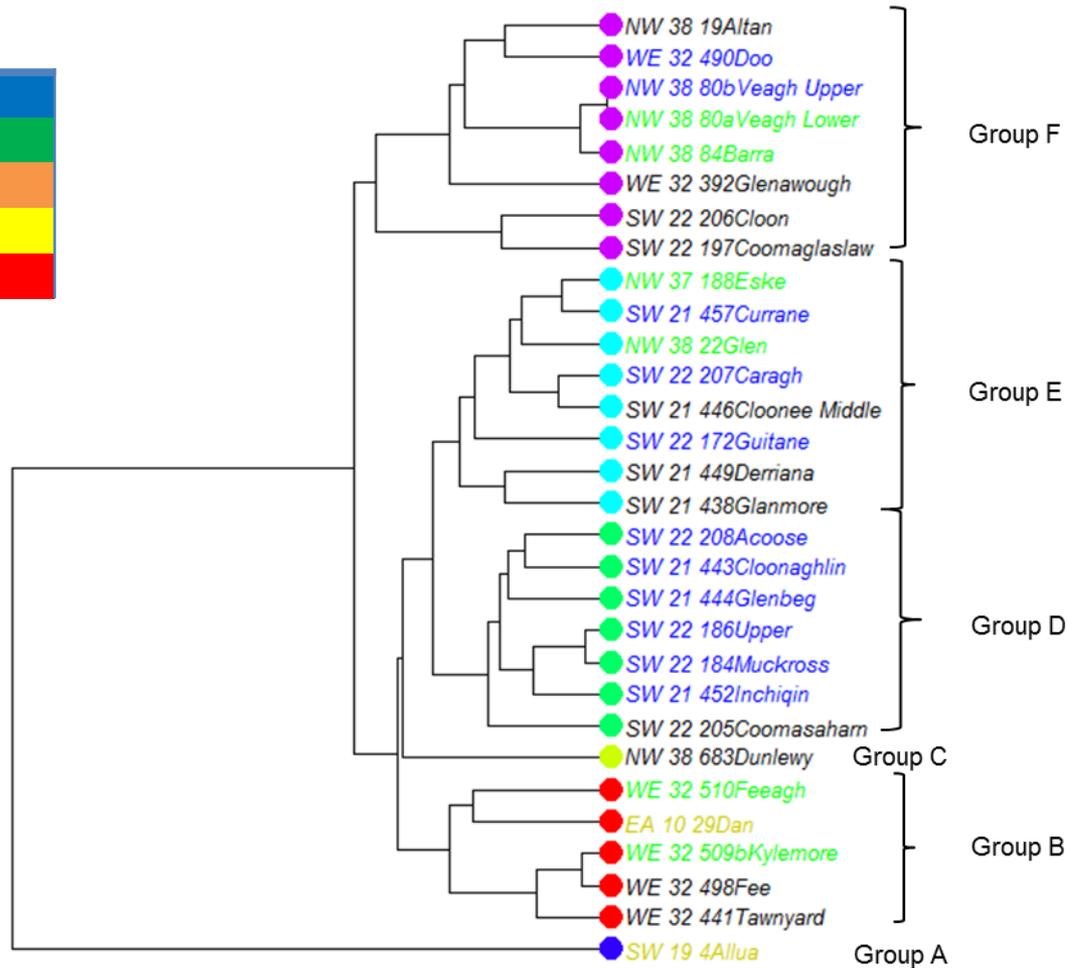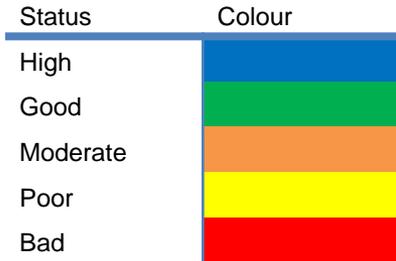
Status Assignment: Donor Lake Approach

Scenarios:

▶ All monitored lakes agree in status

Simple! Select suitable donor and assign group status

▶ No lakes are monitored

Implications for monitoring programme

Amalgamation of groups, if pressures allow

▶ Lakes do not agree in status

Weight of evidence approach

Status Assignment: Weight of evidence approach

Group	Name	Mean TP mg L^{-1}	Max TP mg L^{-1}	EQR Mac	Status Mac	Mean Chl a µg L^{-1}	Max Chl a µg L^{-1}	EQR Phy	Status Phy
B	Dan	0.014	0.072	0.650	Mod	2.0	5.1	1.066	High
	Kylemore	0.010	0.027	0.875	Good	2.0	6.8	1.066	High
	Feeagh	0.009	0.020	0.725	Good	2.2	4.8		

Status Assignment: Weight of evidence approach

▸ Group B contained 3 monitoring lakes, ranging in macrophyte status from Moderate to Good; Dan, Feeagh and Kylemore.

▸ While Dan was of Moderate macrophyte status, it was of High phytoplankton status.

▸ The rest of the lakes in the group were Good status.

▸ This suggests that Good would be an appropriate status assignment.

▸ As a surveillance monitoring lake, Kylemore is proposed as donor.

Status assignment for low alkalinity large lakes

▸ While pressures were low within this setting overall, a range of nationally important pressure types were present.

▸ Land use groups were characterised by sewer and wastewater discharges, septic tank and population densities, forestry, pasture and livestock densities.

▸ Group status assignments ranged from Moderate to High, with groups characterised by low agricultural and human population pressures remaining at High status, while lakes with a mixture of pressures, which included sewer and wastewater discharges (Group A) and higher coniferous forestry cover showing impact.

▸

Status assignment for low alkalinity lakes

▸ The majority of lakes assigned to the High status class had low overall pressures. However, a number of these lakes had high percentage of coniferous forestry within their catchments. These lakes may be at risk in the future if the forestry within the catchment is to be felled.

▸ Within this setting, not all status classes were represented within all of the settings. This may be due to the relationship between setting and anthropogenic activity.

▸

Acknowledgements

TCD:
Ian Donohue
Katherine Webster

EPA:
Deirdre Tierney
Gary Free
Wayne Trodd
Ruth Little
Bryan Kennedy
Caroline Plant
Martin McGarrigle
Jim Bowman
Anthony Mannix
Donal Daly
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