Testing Landscape Metrics as Indicators of Lake Ecological Condition

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Introduction

Landscape metrics generated by GIS may be useable as indicators of nearshore stress to lakes since they can integrate conditions over the broader watershed contributing area. Our goal was to identify and test landscape metrics as indicators of lake watershed condition. We used data collected from 101 lakes in the PNW states (ID, OR, WA) as part of the USEPA National Lakes Assessment (NLA) to develop landscape indicators and demonstrate their potential usefulness for future surveys.

Why use landscape indicators in assessments?

--Fairly easy to generate and can be generated evenly regardless of lake size.

--Useful for capturing the signal of stressors that are not measured by 'on the ground data collection' (e.g. sediment delivery).

--Some landscape metrics are complementary to other indicators of lake stress such as physical habitat metrics, but at a different scale of resolution.

--Useful supplement to information collected from shoreline or as a substitute for shoreline habitat data where lakes are prohibitively large for field data collection.

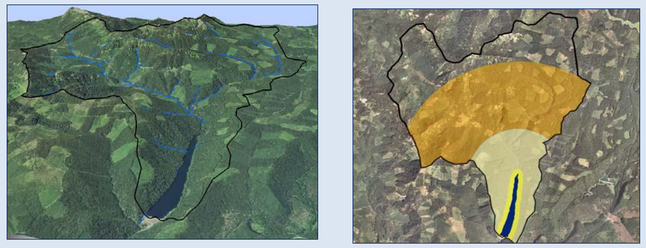
Assumptions

1. Nearshore physical habitat conditions determined from field collected metrics are related to landscape metrics. The strength of the relationship varies with proximity.
2. Lakes in watersheds with extensive watershed scale disturbance are likely to have higher lakeshore disturbance.

Types of (GIS) landscape metrics available--60 total

--NLCD cover metrics (% forest, % scrub-shrub)

--Erosion metrics (RUSLE cover factor, Potential Unit Grazing).



Metrics generated at watershed scale and 200m, 2km, 5km buffer widths.

Methods 1: Identify best landscape metrics

--Calculate GIS landscape metrics from 101 NLA Region 10 sample lakes.

--ID landscape metrics with strongest correlation to field collected physical habitat metrics.

--Check if these best landscape metrics are intuitive, logical, and explainable.

--Determine best buffer width for the top landscape metrics.

--Check for reasonable correlations with other stressor indicators (water quality metrics).

Field physical habitat metrics from NLA :

Riparian Metric	*Field collection*
Lakeshore habitat	Estimates vegetation structure and complexity in riparian zone
Littoral habitat	Estimates extent of fish cover features within the littoral zone
Habitat complexity	Combination of littoral and lakeshore habitat metrics
Lakeshore Disturbance	Estimates of direct human alteration in proximity to the lakeshore

Best (GIS) landscape metrics identified:

Metric	*Description*	*Units*	*Best buffer*
Forest cover	Areas where woody vegetation, generally > 6 meters tall, accounts for 25-100 % of the cover.	% total cover	200m
Scrub-shrub cover	Areas of woody vegetation with aerial stems, generally less than 6 meters tall. Shrubs account for 25-100% of the cover.	% total cover	2Km
RUSLE cover factor	An input factor to Revised Universal Soil Loss Equation (RUSLE) model. RUSLE –C is used to reflects the effect of land management practices on erosion rates. **(High RUSLE-C value = higher erosion)**	unitless	Basin-wide
Potential Unit Grazing	Intensity of potential cattle/calf grazing based on estimations of cattle usage and 'cow habitat'.	unitless	Basin-wide

Correlations of landscape to physical habitat & W. Q. metrics:

Condition metrics	Forest Cover	Scrub-shrub Cover	RUSLE Cover Factor	Potent. Unit Grazing
		Physical Habitat Metrics		
Lakeshore habitat	***0.65***	***-0.66***	**-0.46**	-0.01
Littoral habitat	***0.50***	***-0.57***	**-0.30**	0
Habitat complexity	***0.64***	***-0.68***	**-0.44**	0
Lakeshore Disturbance	**-0.28**	0.12	-0.01	**0.34**
		Water Quality Metrics		
Conductivity	***-0.59***	***0.52***	**0.38**	**0.41**
Turbidity	***-0.75***	***0.54***	***0.51***	**0.36**
Total Nitrogen	***-0.53***	**0.43**	**0.33**	**0.39**
Total phosphorous	***-0.62***	***0.54***	**0.42**	**0.34**
Chlorophyll-a	***-0.54***	**0.28**	**0.23**	**0.50**
DO in epilimnion	**0.41**	**-0.44**	**-0.24**	-0.04
Secchi depth	***0.70***	**-0.47**	**-0.38**	**-0.42**

Red=large correlation Blue=moderate correlation

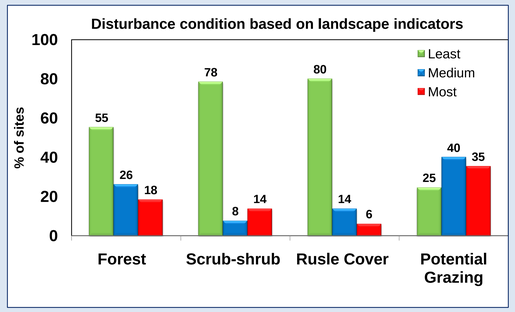
Methods 2: Test Landscape *Indicators*

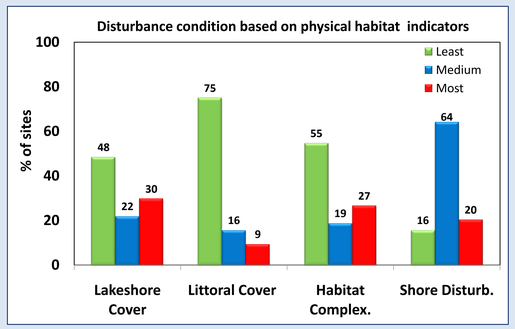
--Calculated disturbance condition thresholds for 4 top landscape metrics using data from Western Mtn ecoregion reference condition sites (N=17).

--Applying these thresholds back to the greater Western Mtn. Ecoregion NLA Region 10 data set (N=65) to calculate percent of sites in "least, intermediate, and most' disturbed condition based on these landscape indicators.

--Using the same Western mtn. sites (N=65) calculate percent of sites in "least, intermediate, and most' disturbed condition for the habitat indicators using the thresholds developed from NLA.

--Compare results between the two types of indicators.





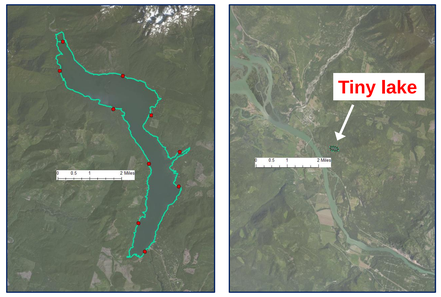
Results

- Forest cover is the best performing landscape metric as it has the most consistent large correlations to many water quality and riparian metrics. Also, it yielded similar results to the habitat complexity and Lakeshore cover indicators in the indicator test.
- Scrub-shrub and RUSLE C factor were considered good metrics as they had consistent correlations to the condition metrics and show similar patterns to riparian indicators in the disturbance condition test, with majority of sites in the least disturbed category.
- Potential Unit Grazing results were most similar to the lakeshore disturbance indicator. Both of these estimate a much lower portion of the sites in the least disturbed category.

Conclusions /Next Steps

Landscape metrics could be used to add another dimension to condition assessments for lakes. Potential usefulness is greatest for large lakes where only a very small portion of the shoreline can be assessed using only the ten transect points from the National lakes Assessments field protocols.

All physical habitat metrics are collected at 10 points regardless of lake size in the National Lakes Assessment.



This preliminary analysis shows possible usefulness of these landscape indicators. Further testing is need, which will require a larger dataset of both reference sites and sites from different ecoregions.

Besides evaluating landscape metrics using calculation of extent of disturbance condition (stressor extent), relative risk should also be evaluated. This will require a larger dataset than was available. Extent of stressors is only part of the condition assessment. Even if widespread and common, a particular stressor may have little effect biologically where is does occur.

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