Where Vikings Roamed: A landscape classification of the north coast of Newfoundland's northern peninsula

1. Introduction & Summary

The purpose of the analysis in this report was to investigate the ecosystems present on the tip of the northern peninsula of Newfoundland (NL). This region is historically significant, specifically L'Anse aux Meadows which is the site of the first European settlement in North America, dated ~1000 CE (Wallace 2003). I performed a minimum distance supervised classification of the region using Landsat-8 satellite imagery with six training classes. The overall accuracy of the classification was acceptable at 80.0% (kappa = 0.66). The minimum separabilities were 1.55 and 1.59, but all others were $\geq$1.89. The land is dominated by lichen barrens, coniferous forests, and tuckamore. These results may have useful applications in the tourism, conservation, and anthropology sectors.

2. Study Area and Data

Norse explorers arrived at L'Anse aux Meadows between 990-1050 CE as estimated by radiocarbon dating and the style of recovered artifacts such as remnants of buildings (Wallace 2003). Prior to Norse settlement, the area was occupied by at least five Indigenous groups spanning as long as 6000 years ago, but it is unlikely that any of these groups came into contact with the Vikings at L'Anse aux Meadows (Government of Canada 2022). The site was rediscovered by Norwegian archaeologists in 1960 and today is a National Historic Site of Canada and UNESCO World Heritage Site where tourists can explore the meadows, walk through recreated Norse buildings, and observe the artifacts (Wallace 2006).

Imagery used for analysis was captured by Landsat-8 on October 6, 2018 at 14:40 h (Figure 1; USGS 2020). The area is not mountainous, therefore topographic shadow in October was not a major concern. This specific image was chosen because cloud cover was exceptionally low (0.05%) which made for optimal display and analysis.

3. Methods

To classify cover types of the area, I used PCI Catalyst Professional (PCI Geomatics 2021) to perform a minimum distance supervised classification (Wacker & Landgrebe 1972) using bands 2-6 (blue, green, red, near-infrared, shortwave infrared) as input. I selected 5-10 training areas per class. Initially, I included nine training classes: water, lichen barrens, tuckamore (krummholz), coniferous forest, fires, wetlands, bare rock, and exposed soil. Fires and wetlands were not classifying well and were therefore removed. The same was true for exposed soil, which I then merged with bare rock as these are similar cover types. I ran the classification with the six remaining classes, performed random sampling (n = 30) to assess accuracy, and finally I sieved the result to improve the final display. To preserve small water bodies present throughout the landscape (i.e., ponds), water was excluded from the sieving process.

4. Results and Discussion

4.1 Separability

Average separability was high at 1.93 (range: 1.55 – 2.00). The minimum separability was 1.55 for tuckamore and tundra meadows, and 1.59 for coniferous and tuckamore. The difficulty separating coniferous and tuckamore forests was expected, as tuckamore is a type of coniferous forest. Reasons for the issues in separating tuckamore and tundra meadows are less clear, but one explanation may be that the signatures are similar due to tuckamore struggling to meaningfully grow and the tundra meadows being lightly vegetated (Table 1).

Table 1. Signature separabilities for minimum distance classification of the tip of Newfoundland's northern peninsula, Canada.

		Class					
		Water	Lichen Barrens	Tuckamore	Coniferous Forest	Bare Rock/ Exposed Soil	Tundra Meadow
Class	Lichen Barrens	2.00	-	-	-	-	-
	Tuckamore	2.00	1.99	-	-	-	-
	Coniferous Forest	2.00	2.00	1.59	-	-	-
	Bare Rock/Exposed Soil	2.00	1.90	2.00	2.00	-	-
	Tundra Meadows	2.00	1.99	1.55	2.00	2.00	-

4.2 Accuracy

The overall accuracy of the classification was minimally acceptable at 80.0% (kappa = 0.66), as determined after random sampling ($n = 30$). Tuckamore and coniferous forest had low accuracies (20.0%; 33.3%) and low kappa values (0.14; 0.29) as these classes are likely spectrally similar. Other reasons for low accuracies may be the random sampling process selected pixels that were not homogenous in their cover type (Table 2).

Table 2. Accuracy statistics following random sampling ($n = 30$) for minimum distance classification of the tip of Newfoundland's northern peninsula.

Class	Producer's accuracy (%)	User's accuracy (%)	Kappa
Water	94.7	100	1.00
Lichen Barrens	100	100	1.00
Tuckamore	50.0	20.0	0.14
Coniferous Forest	50.0	33.3	0.29
Bare Rock/Exposed Soil	33.3	100	1.00
Tundra Meadows	50.0	100	1.00

4.3 Percent Cover

The majority of the image was dominated by water (53.9%), which was mostly ocean. This was followed by lichen barrens (14.2%), tuckamore (12.4%), coniferous forest (11.4%), tundra meadows (4.3%), and bare rock/exposed soil (3.8%). Excluding all water, lichen barrens constituted 30.8% of the land cover, tuckamore covered 27.0%, coniferous forest comprised 24.7%, tundra meadows occupied 9.3%, and bare rock/exposed soil was 8.2% (Figures 2-3).

4.4 Conclusions and Recommendations for Future Analyses

Understanding and mapping the land cover types of an area are important for understanding the ecosystems on the landscape. The northern peninsula of NL is dominated by two ecoregions: the Strait of Belle Isle Barrens and the Northern Peninsula Forest (Government of Newfoundland and Labrador 2017). The former occupies most of the coastal region and is dominated by arctic-alpine plants (PAA Newfoundland and Labrador 2000), which is reflected by tuckamore, lichen barrens, and tundra meadows. The latter occupies much of the interior of the peninsula where coniferous forests predominate (Bell 2002). These vegetation types of these ecoregions are well-represented in the classification results.

The results presented here are not a perfect classification and could be improved by selecting more or better training areas and perhaps by utilizing different displays and input bands. However, this simple analysis adequately captures the majority of the prevailing land cover types present in the region.
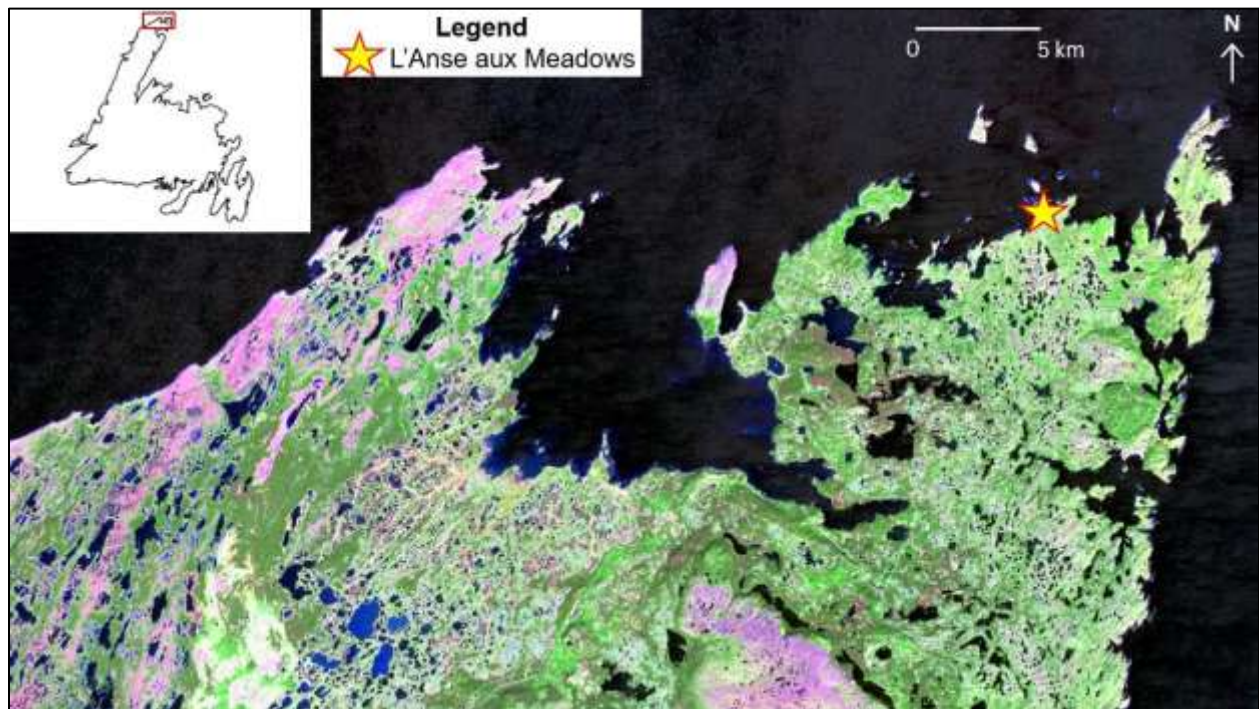
5. Image Displays

Figure 1. Colour composite (654) of the tip of the northern peninsula in Newfoundland, Canada on October 6, 2018, 14:40 h. Landsat-8 image courtesy of the U.S. Geological Survey. Display generated with PCI Catalyst Professional. Newfoundland provincial boundary provided by the Government of Newfoundland and Labrador.
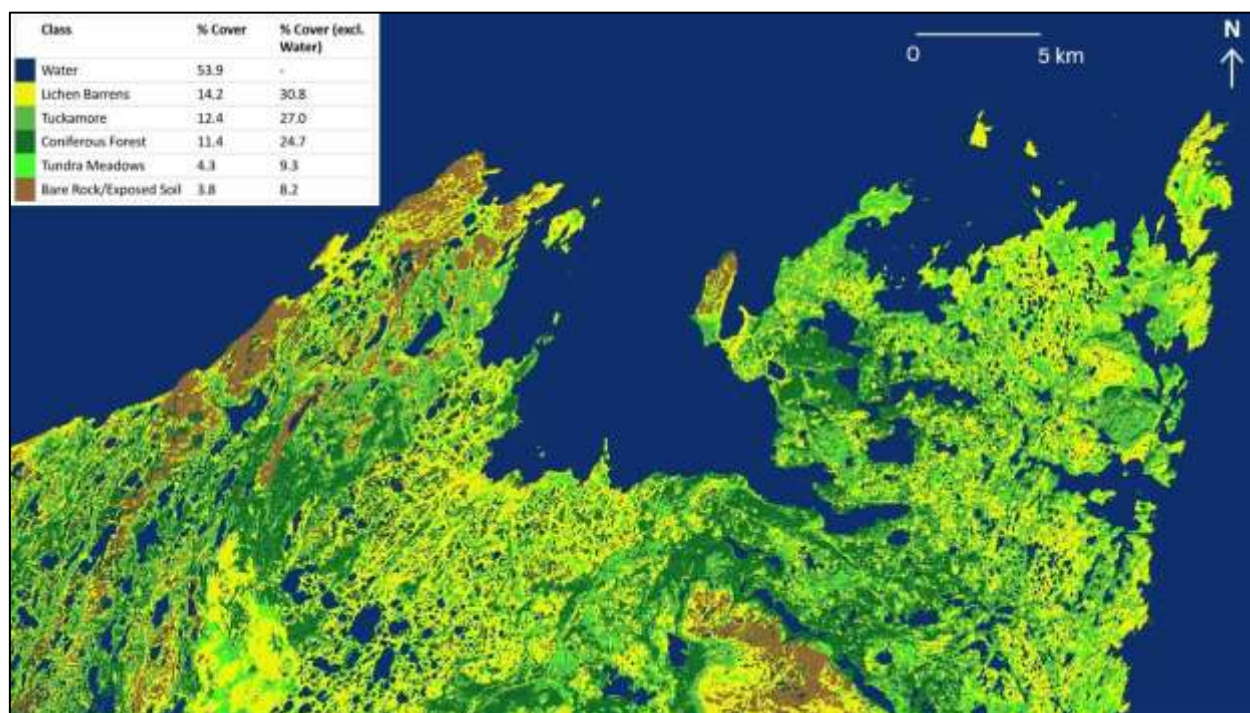
Figure 2. Output of minimum distance supervised classification of the northern peninsula in Newfoundland, Canada. Generated with PCI Catalyst Professional.
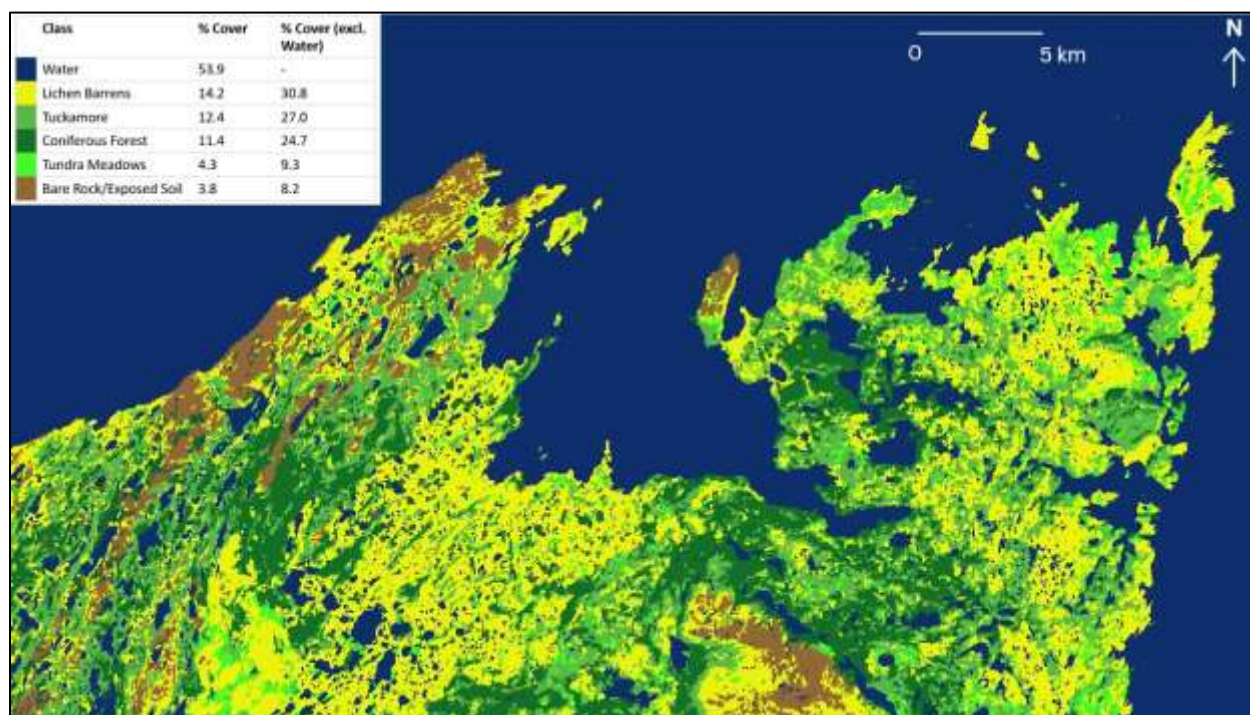

Figure 3. Sieved result of minimum distance supervised classification of the northern peninsula in Newfoundland, Canada. Generated with PCI Catalyst Professional.

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