The RECCAP* Project: Using mosses and lichens to monitor environmental contaminants

*Retrospective Analyses of Contaminants in Cryptogams in the AOSR Partnership

Mosses and lichens absorb moisture, nutrients, and environmental contaminants directly from the air and precipitation. As a result, these species can be used to measure the type, distribution, and intensity of environmental contamination.

The Alberta Biodiversity Monitoring Institute (ABMI) has a collection of thousands of moss and lichen samples, collected from more than 1,000 locations between 2003 and the present day, that are stored at the Royal Alberta Museum in Edmonton, Alberta (Figure 1). This world-class museum collection was originally acquired for biodiversity monitoring. In the RECCAP project, we examined the opportunities to expand the use of our collection to specifically look at the intensity and distribution of environmental contaminants. We wanted to know if we could use archived samples of moss and lichen to credibly assess the pattern of and trends in environmental contamination.

To address this question, we partnered with experts at the Wood Buffalo Environmental Association (WBEA). WBEA has intensively studied contaminant deposition in the Athabasca Oil Sands Region (AOSR) using lichens since 2004. They are widely regarded as having a "gold standard" environmental contaminant deposition monitoring program. If our results were similar to the results from WBEA, we would feel confident that archived samples of moss and lichen can be used to provide credible results throughout the rest of Alberta.

Do data from our archived moss and lichen collections correspond strongly with WBEA data in the Athabasca Oil Sands Region?

Oil sands surface mining activities in the AOSR can contribute to environmental contamination in the region through the dust and emissions originating from mines, roads, quarries, and facilities. WBEA and others have shown that contaminants such as vanadium, sulfur, and nickel are elevated within 20 km of oil sands mines in this region; element concentrations typically decrease and then plateau with distance from the mines (Figure 2).

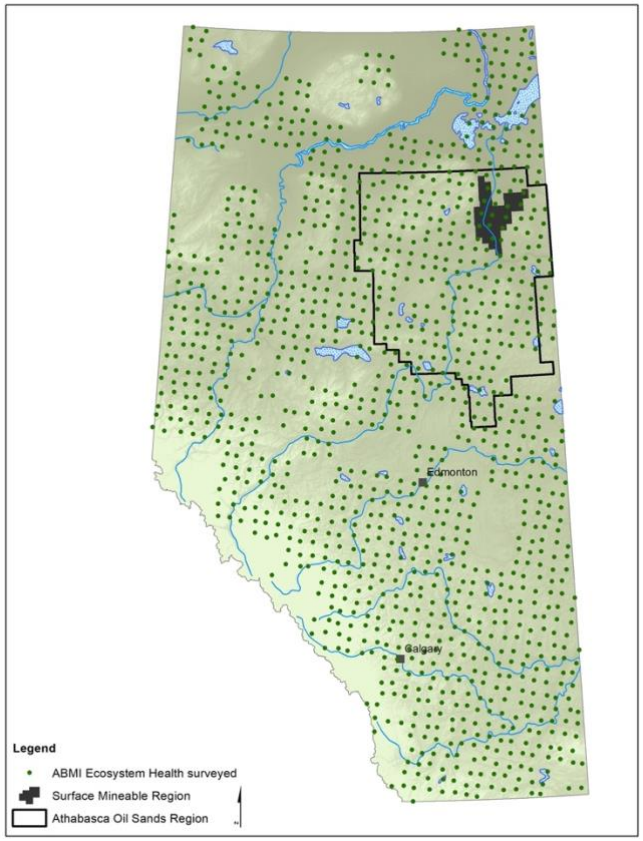

Figure 1. Monitoring locations in Alberta where moss and lichen have been collected and archived at the provincial museum.

With these patterns in mind, we evaluated environmental contaminant loading in two species: the tree-dwelling Hooded Tube Lichen and the soil-dwelling Big Red Stem Moss. We used three different laboratory methods to further explore the most cost-effective way to evaluate environmental contaminant loading in moss and lichen species.

Big Red Stem Moss

Hooded Tube Lichen

Key Findings

- Our historical collection of moss and lichen species can be used to support environmental contaminant monitoring.
- Measurements for multiple elements were strongly correlated with the levels detected by WBEA across species and analytical methods (Figure 2).
- Inexpensive laboratory methods worked well when compared to more expensive laboratory methods. This result suggests that inexpensive laboratory methods can be used as a first pass to complete a baseline assessment that identifies environmental contaminant “hot spots” in Alberta.
- Some of our results suggest that small-scale activities, such as gravel pits or roads, may have a strong local impact on environmental contaminant loading. We believe that the distribution of environmental contaminants may be patchier and more localized that current scientific findings suggest.

Based on these results, we recommend that moss and lichen be further incorporated into the OSM Terrestrial Biological Monitoring (TBM) program as “biomonitors” with a particular emphasis on detecting local-scale environmental contamination. This will help us understand local variation in contaminant deposition, the source of these contaminants, and facilitate stronger incorporation of contaminant drivers into the TBM program.

We also identify the strong opportunity that exists at the provincial scale to create a contaminants baseline for all of Alberta. This could be done using ABMI archival collections or other complementary collections. These recommendations could be particularly valuable in areas lacking permanent monitoring infrastructure.

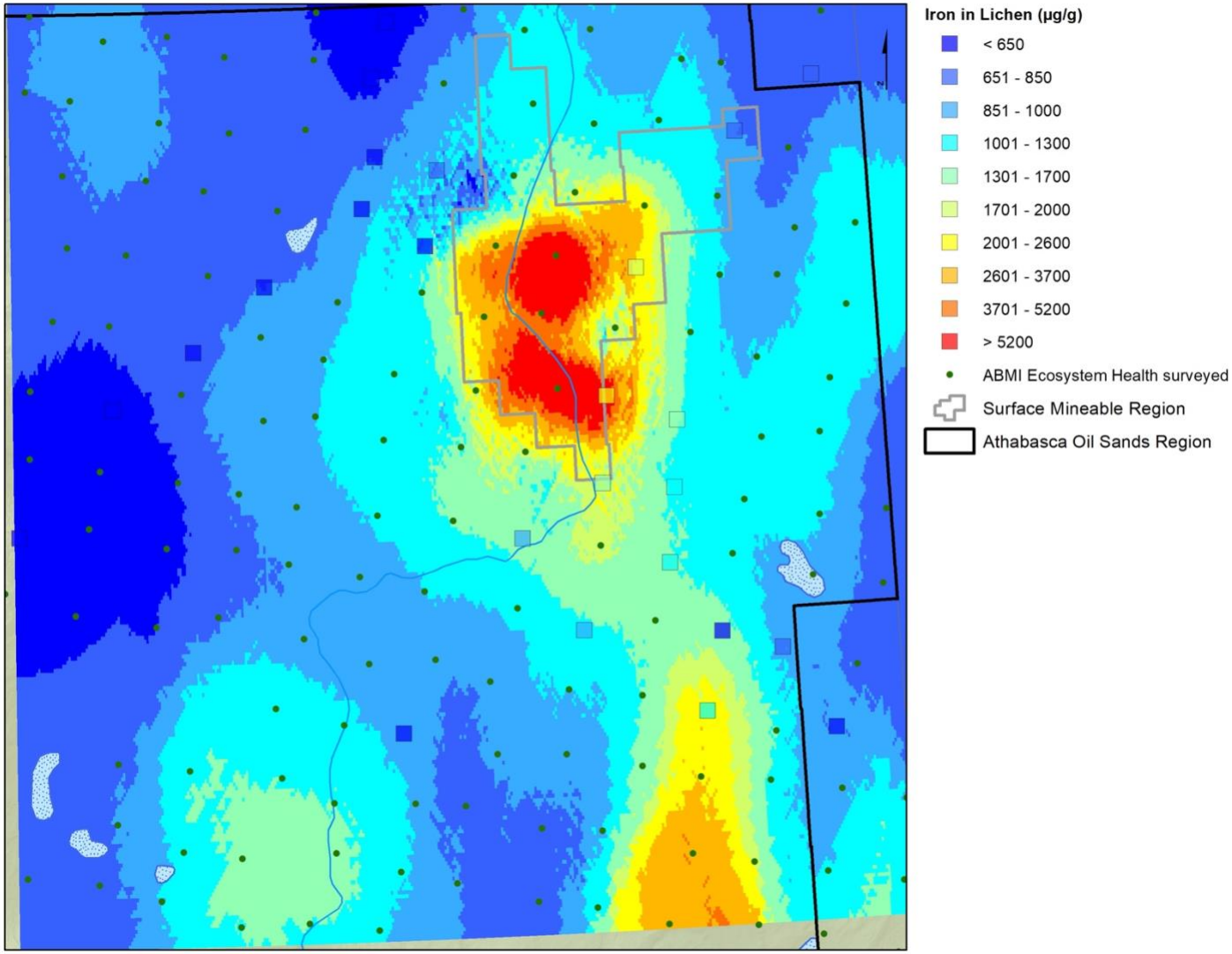

Figure 2. Map depicting (a) predicted environmental iron concentrations from WBEA models [background colouration] and (b) iron concentrations in lichens collected at ABMI sites [coloured squares].