AUSABLE BAYFIELD CONSERVATION AUTHORITY
SOIL HEALTH MONITORING PROJECT

SUMMARY REPORT

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AUSABLE BAYFIELD CONSERVATION
CREATING AWARENESS | TAKING ACTION

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INTRODUCTION

The role of soil health in delivering ecosystem services is becoming an increasingly popular concept partly due to the United Nation's declaration of 2015 as the International Year of the Soils and also perhaps a result of resultant regional activities that have recently highlighted the relationship. There are many definitions of soil health with most referring to a sustained capacity to function for a given purpose such as agricultural production or environmental protection. The general status of soil health across the landscape is poorly understood, mainly due to a lack of relevant data. The minor volume of data that does exist has been re-purposed from existing soil fertility assessments and is too narrow in perspective to adequately address the multiple and integrated aspects of soil health.

There are a number of different metrics of soil health with organic matter being recognized as an important metric because it influences the three components of soil: the biological, the chemical and the physical. Organic matter is also measured in the typical suite of soil samples. There is some evidence that soil organic matter levels have been decreasing over the last several decades (see link below).
(http://image.s6.exacttarget.com/lib/fe9912737766057a74/m/1/April+Guelph+Bulletin.pdf)
The effect of this reduction in organic matter levels on the other important soil health metrics such as water holding capacity is unknown. An assessment of the current state of soil health is needed. An examination of field soil health indices, relative to indices from benchmark sites such as forested areas, fence lines and/or permanent pasture, will help to contextualize findings.

A project was initiated within the Ausable Bayfield Conservation Authority (ABCA) watershed in the fall of 2016, with the goal of completing a minimal assessment of the status of soil health under current wide-spread agricultural production. The assessment was performed across several soil textures, with comparisons to relevant benchmarks. Several benchmarks were identified including current "natural" sites, which are assumed to be unchanged from past decade. Soil organic matter concentrations from historic soil surveys reported in 1992 (Middlesex County) and 1952 (Huron County) also provided temporal benchmark values.

METHODS

Watershed soils were divided by texture into four classes: sand, loam, clay loam, clay. Several farms, representative of current widespread farming practices, were selected from each soil class for an assessment involving a suite of soil health metrics. Where possible, farms were selected for testing if they had been previously been sampled for the 1952 or 1992 soil surveys, so a more direct comparison could be made for the specific farm. Otherwise, a comparable benchmark on a forested site or a fencerow was selected. Fields were further selected based on the recently harvested corn crop and lack of recent tillage (i.e., tillage in the previous six months). Corn fields provided good sampling locations, free of sampling impediments. The longer the period since tillage was preferred as the physical characteristics would be more typical of a long-term steady state condition.

The soil health metrics used in the ABCA study (Table 1) were chosen to reflect those characteristics that were slow and resistant to rapid change, reflecting the longer term definition of soil health. Soil health metrics that could be changed very rapidly with simple soil amendments, such as pH or fertility values, were not included. Metrics that were integrative, in contrast to the highly specific metrics, were also preferred reflecting a more holistic approach. For example, Infiltration rates reflect both pore size distribution and connectivity of these pores through the surface horizons.

TABLE 1 – SOIL HEALTH METRICS EVALUATED IN AGRICULTURAL FIELDS IN THE AUSABLE BAYFIELD CONSERVATION AUTHORITY JURISDICTION (NOVEMBER/DECEMBER 2016)

Metric	Unit	Description
Soil Organic Matter (SOM)	%	Composite sample, following OMAFRA guidelines for fertility sampling
Total SOM	T/ha	SOM values improved by accounting for topsoil depth and bulk density
Topsoil Depth	cm	Depth of A horizon
Wet Aggregate Stability (WAS)	%	Yoder type wet sieving method on undisturbed sample
Bulk Density (BD) 0-15cm	g/cm^3	Dry bulk density method, on undisturbed soil collected in 3 inch rings.
Bulk Density (BD) 15-30cm	g/cm^3	Dry bulk density method, on undisturbed soil collected in 3 inch rings.
Porosity 0-15cm	%	Calculated using bulk and particle densities
Porosity 15-30cm	%	Calculated using bulk and particle densities
Resistance to Penetration (RTP) 0-15cm	psi	Standardized force method with 1/2 inch cone penetrometer
Resistance to Penetration (RTP) 15-30cm	psi	Standardized force method with 1/2 inch cone penetrometer
Infiltration Rate (INFL)	mm/hr	Single ring infiltrometer, saturated hydraulic conductivity with constant head method

The values of these metrics for the agricultural soils were compared to the relevant benchmarks soils. The above metrics were assessed at 18 sites:

- four (4) clay sites, plus one benchmark
- four (4) clay loam sites, plus one benchmark
- two (2) loam sites, plus one benchmark
- four (4) sand sites plus one benchmark

Sampling of the sites took place in November and early December of 2016. Physical condition of the soils for sampling was excellent due to sufficient regular rainfall, but not saturated conditions. These conditions made sampling much easier and the resulting values much more meaningful.

RESULTS AND DISCUSSION

The results are presented in the following tables. The values for the farmed fields on each soil texture are provided, followed by the benchmark value. A simple ratio of the farmed/benchmark value, is presented to show a relative degradation or improvement in that metric.

TABLE 2 – SAMPLING RESULTS FOR SOIL INDICATORS OVER FOUR SOIL TYPES, AS COMPARED TO BENCHMARK RESULTS FROM 1952 (HURON COUNTY) AND 1992 (MIDDLESEX COUNTY)

Soil Texture Class		Topsoil Depth (cm)	Wet Aggregate Stability (%)	Infiltration Rate (mm/hr)	Soil Organic Matter 15-30 cm (%)	Total Soil Organic Matter (T/ha)	Resistance to Penetration 0-15 (psi)	Resistance to Penetration 15-30 (psi)	Bulk Density 0-15 (T/m^3)	Bulk Density 15-30 (T/m^3)	Porosity 0-15 (%)	Porosity 15-30 (%)
CLAY	Average	25.5	65	536	5.9	194	98	155	1.28	1.32	52	50
	Benchmark	15.1	74	2297	10.6	131	49	129	0.82	1.14	69	57
	% of Benchmark	1.69	0.88	0.23	0.56	1.48	0.50	0.83	0.64	0.87	0.75	0.88
CLAY LOAM	Average	21.3	76	205	3.6	119	121	194	1.53	1.66	42	37
	Benchmark	18.8	72	1412	9.2	173	32	100	0.96	1.15	64	57
	% of Benchmark	1.13	1.05	0.15	0.39	0.69	0.27	0.51	0.63	0.69	0.66	0.66
LOAM	Average	21.5	73	52	4.4	133	90	145	1.38	1.49	48	44
	Benchmark	22.9	85	275	6.1	166	114	176	1.21	1.15	54	56
	% of Benchmark	0.94	0.87	0.19	0.72	0.80	1.27	1.21	0.87	0.78	0.88	0.78
SAND	Average	22.2	33	538	3.9	125	109	189	1.41	1.52	47	43
	Benchmark	23.2	22	2058	6.4	161	49	138	1.03	1.17	61	56
	% of Benchmark	0.96	1.46	0.26	0.61	0.78	0.45	0.73	0.73	0.77	0.76	0.76

TABLE 3 - AVERAGE PERCENT OF THE BENCHMARK FOR EACH TEXTURE CLASS

	Average % of Benchmark
CLAY	.85
CLAY LOAM	.62
LOAM	.85
SAND	.75

SUMMARY

Although there were a limited number of farms assessed, the initial general findings are valuable.

1. Most of the soil health metrics from the farmed soils were lower than the benchmark soils.
2. The extent to which the farmed/benchmark ratios were lower varied from 0.2 to 0.8 among the different metrics. Topsoil depth was the exception in that it was usually higher in farmed soils due to deep moldboard plowing.
3. Some metrics were better at identifying differences between the farmed and the benchmark soils. Infiltration rate was the most capable of detecting differences, likely because it is an integrative metric.
4. Clay loam soils showed the most degradation, with sands and clays the least.

FUTURE WORK

1. **Increase Sampling** Due to the limited nature of the sampling, a larger number of both farmed sites and especially benchmark sites should be evaluated. Relying on one benchmark per texture class can potentially bias the whole process.
2. **Refine Metrics** Some of the metrics showed similar results. For example, those metrics which involved two depths from 0-15cm and 15-30cm, (Resistance to Penetration (RTP), Bulk Density, Porosity) showed a common trend with poorer values at the deeper depth. As a result, not all of the metrics would have to be measured at all depths in future studies while other metrics may be needed to be added. The addition of an easy and integrative biological metric such as earthworm populations (middens per square meter) would provide a biological component of this assessment. Anecdotal evidence

observed by farmers during the drought of summer 2016 suggests that plant available water capacity would be a valuable addition to this suite of metrics.

3. Some metrics require in-situ field measurements and may not be successfully replicated in laboratory conditions. Further work is required to identify which metrics are capable of being completed in a laboratory situation on disturbed samples and are consistent with in-situ measurements under undisturbed field conditions.
4. **Refine Methods** The methods for some metrics may need to be refined to better elicit differences. For example, the Wet Aggregate Stability metric would likely have shown greater differences if a smaller soil sample or a larger sieve was used to minimize interference and improve efficiency during the wet sieving process.
5. Standard sample protocols, in addition to standard analytical methods need to be written to ensure consistent implementation of methods and effective interpretation of the results.